POST EVALUATION OF FLYOVERS WITH ADJOINING ROAD-NETWORK IN DHAKA CITY

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A Thesis Submitted to the Department Of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, in partial fulfillment of the degree of

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by

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The thesis titled "**POST EVALUATION OF FLYOVERS WITH ADJOINING ROAD-NETWORK IN DHAKA CITY**", submitted by **Nafis Anwari**, Student number- 1015042447 P and session October, 2015 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of **Master of Science in Civil Engineering (Transportation)** on 6^{th} of October, 2018.

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DECLARATION

It is hereby declared that, except where specific references are made to other investigators, the research work reported in this thesis has been solely performed by the author under the supervision of Dr. Md. Shamsul Hoque, Professor, Department of Civil Engineering, BUET. Neither this work nor any part of it has been submitted elsewhere for the award of any degree or diploma. To the best of the knowledge and belief of author, the thesis contains no material previously published or written by any other person except when due reference is made in the context of the thesis.

October, 2018

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DEDICATION

This work is dedicated to my father Md. Anwar Hossain Patwary, my mother Mst. Nasima Begum, my brother Nahyan Anwari and my wife Nishat Anjum Noshin.

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ABSTRACT

This study has been undertaken with the aim of evaluating the current performance of at-grade road networks in Dhaka city present in the study network of partially grade-separated flyovers. Level of Service (LOS) was chosen as the primary measure of performance of the road network. In addition mobility and congestion levels were assessed to evaluate whether or not flyovers have helped its area of influence significantly. The identified road segments were treated as urban street segments or multilane highways, depending on their characteristics. Road segment performance was extensively evaluated across four periods of measurement, namely weekend day, weekend night, weekday day and weekday night. Traffic flow and related parametric data were taken at peak hour periods. Specifically, analysis was done to assess grade-wise space usage in study areas, assess traffic flow, assess roadway conditions, determine saturation flow rates, assess mobility conditions, determine level of service, assess pedestrian risk at level crossings and assess congestion level in study areas.

LOS was shockingly found to be F at all considered urban street segments during all periods of measurement, indicating the worst possible traffic conditions. Flow-capacity ratio was found to vary between 0.28 and 11.84 at segment direction, indicating that present capacity of at-grade roads is insufficient to accommodate existing demand, which is expected to increase in future. Ratio of travel speed to free flow speed was found to vary between 0.02 and 0.29, while average travel speeds across entire facility of the study areas were generally found to hover around average walking speeds. It indicates that roads have very poor mobility. On the other hand, multilane highways were found to perform better, with LOS varying between A (best condition, free flow condition) to C (stable flow). In addition congestion analysis revealed that, congestion has generally increased over the years when compared with previous studies.

Reconnaissance survey and detailed observations at both above-grade and at-grade road facilities have revealed several critical factors that significantly reduced road performance. Among these factors are uncontrolled street parking and random bus stoppage, which have decreased road capacity and contributed to high flow-capacity ratios and poor LOS rating. In addition, traffic demand has increased considerably in recent years, fueled by rising private vehicle ownership (cars, jeeps, microbuses, etc.). What is more alarming is that construction of flyovers without proper traffic regulations have acted as inconsiderate supply side policies, that have encouraged growth of private vehicles at the expense of public transit.

If present traffic policies are allowed to continue and are not corrected, the temporary increase in capacity because of added grade facilities will worsen traffic congestion in the long-run, as shown using comparison with previous studies regarding traffic congestion. Congestion have even started forming above grade, which was not an occurrence two years ago. The root cause of the problem has been identified to uncontrolled and rampant growth of private vehicles. The study recommends that people’s choice of mode needs to be urgently shifted from private to public transit, which has been viewed as a perpetual solution in many countries around the world.

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List of Abbreviations of Technical Symbols and Terms

AASHTO	American Association of State Highway and Transportation Officials
BRT	Bus Rapid Transit
DMP	Dhaka Metropolitan Police
FFS	Free Flow Speed
FHA	Federal Highway Association
HCM	Highway Capacity Manual
LOS	Level of Service
MMF	Moghbazar-Mouchak Flyover
MMHF	Mayor Mohammad Hanif Flyover
MV	Motorized Vehicle
NMV	Non-motorized Vehicle
OECD	Organisation for Economic Co-operation and Development
PCE	Passenger Car Equivalent
PHF	Peak Hour Factor
SAMF	Shaheed Ahsanullah Master Flyover
TRB	Transportation Research Board
TS	Travel Speed

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Dhaka City, the capital of Bangladesh, is the chief economic, political and cultural center of the country. As a result, it attracts people from all over the country. Some 90 out of every 1,000 persons moved to urban areas in 2015, up 17 percent year-on-year, according to Bangladesh Sample Vital Statistics (BSVS) 2015, published by BBS. By the 21st century, the city has emerged as a megacity. However, along with this, came a myriad of problems, mainly related to overpopulation. In developing countries in particular, cities have experienced a rapid growth in transport-related challenges, including pollution, congestion, accidents, public transport decline, environmental degradation, climate change, energy depletion, visual intrusion, and lack of accessibility for the urban poor [1]. A large amount of economic losses to the local city is caused due to prodigious traffic congestion and will directly affect the city's image and development of the city. One of the main problems in Dhaka city is the acute transportation crisis, involving severe congestion and delays. A study about Dhaka city estimated travel time costs of USD 300 million per year due to traffic congestion. Considering additional vehicle costa and environmental damages and external costs, the total losses amount to USD 3868 million per year [2]. In an effort to mitigate Dhaka's traffic problems, the Government of Bangladesh has built flyovers across Dhaka city in line with Strategic Transport Plan (STP) [3]. However, the post-construction effectiveness of these flyovers have not been systematically studied yet. Despite construction of several flyovers, congestion degree increased while the mobility decreased [4]. It has now become imperative to assess the condition of flyovers in Dhaka city.

1.2 Rationale of the Study

Safe transportation of passengers and goods is the key business objective of any transportation system. A reliable and efficient transportation system primarily depends on its basic elements such as speed, comfort and safety. Between 2010 and 2016, the population of Dhaka city, escalated by around 20%, while for the same period the vehicle fleet grew by about 60% to approximately 950,000 vehicles, reflecting on the enormity of this bustling city [5], [6]. There is little scope for at-grade expansion of existing roadway [7], because majority of Dhaka city is built-up area [8]. Consequently, limited knowledge regarding interaction of flyovers with local conditions has led concerned authorities to prematurely rely on flyovers to mitigate traffic congestion. As a result, several flyovers have been built in Dhaka City to improve safety and mobility of at-grade traffic city [9]–[15]. However, existing flyovers were constructed in Dhaka considering localized impact of flyovers on only its aligned roads, rather than conducting additional impact studies on adjacent areas to assess overall impact. As a result, overall traffic scenario in Dhaka city has not improved. Rather, traffic has deteriorated in some places. In addition, with growing number of private cars in Dhaka city, situation will potentially worsen in future. To the best of author's knowledge, negligible study has been done in Bangladesh, to assess mobility and congestion degree of flyovers in their adjacent areas, even though numerous studies abroad emphasize its importance [16]–[20]. It is of paramount importance that future flyovers be built considering a holistic Traffic Impact Assessment (TIA) of both the flyover corridor and adjacent areas, whose necessity is stressed in this thesis.

1.3 Objectives of the Study

The study has been focused on the following broad objectives:

1. To assess the existing conditions of flyovers in Dhaka city and identify their deficiencies.
2. To conduct traffic impact assessment of the selected flyovers along the project influenced corridor.
3. To evaluate the justification of the flyovers as a remedial measure in reducing traffic congestions.
4. To provide recommendations on implementation of future flyovers.

1.4 Scope of the Study

The study covers six flyovers spread across Dhaka City. It is expected that this research will help transport planners and decision makers implement flyovers properly. The findings can be utilized to understand the current state of traffic in and around existing flyovers and help evaluate the post-construction effectiveness of the studied flyovers. The findings could also be used to establish the necessity in undertaking TIA before implementation of flyover in built-up areas.

1.5 Organisation of the Thesis

The research work performed has been presented in seven Chapters, which are described in the following:

Chapter One

Chapter One is an introduction to the thesis and describes about background, rationale, objectives and scope of the study. The methodology is also outlined briefly.

Chapter Two

Chapter Two outlines the theoretical literature reviews relevant to this research. The chapter begins with the conceptual development of flyovers and then describes extensively the historical background of construction of flyovers. It also describes the world's recent views regarding flyovers, shifting to the necessity of evaluating performance of at-grade road network around flyover. Various performance measures are explored in the process, emphasis on evaluation of Level of Service (LOS), which is the main basis for impact assessment in this thesis. Towards the end of the chapter, emergence flyovers in Dhaka city is explored. The chapter is concluded with an insight on research conducted to deal with the issue of flyovers in Dhaka

Chapter Three

Chapter Three describes the all the six studied flyovers and presents their schematic layout. It discusses the selection of the study area along with a brief discussion about those areas. Besides methodology adopted to conduct this research is discussed at length.

Chapter Four

Chapter Four elaborately presents the collected data on deficiencies of above-grade and at-grade road network in each study area. All data are then analysed in a systematic way. Appropriate graphical representation of the analyses aids in the proper inference of obtained results.

Chapter Five

Chapter Five presents critical findings of the analysed data. In addition, recommendations are made to address the problems of at-grade road network. Besides, limitations of the study and recommendations for future study are presented.

1.6 Overview

The next chapter systematically elaborates on the literature review related to flyovers and their evaluation.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter, with the intention of presenting the theoretical reviews of this research, starts by highlighting the historical development of flyovers and their initial regard by the world as a solution to urban traffic woes. Focus is then shifted to recent views of the developed world on flyovers, and in the process justification for evaluation of performance of road networks around flyovers is given. Towards the end of the chapter, possible methods of road performance evaluation are reviewed, highlighting LOS evaluation. Moreover, previous studies on flyovers in Dhaka city are enlisted in this chapter.

2.2 Initial Reasons Leading to Development of Flyovers

Flyovers were first considered in the USA in 1970s, when financial and environmental limitations suddenly stopped the freeway building programs of the 1950's and 1960's [21]. At that time, major cities throughout the nation were experiencing significant population growth and consequently, the traffic demands on each city's transportation infrastructure were increased dramatically. Increased traffic demands raised the overwhelming problem of decreased mobility. Sources of public transportation helped to alleviate congestion to some extent, but the majority of mobility was still handled by highway systems [22]. Transport planners realized that arterial highways will have to carry an ever increasing share of these rapidly expanding travel demand. The growth of residential population made them major trip generators and attractors along principal transportation corridors in many urban communities. This produced traffic volumes which saturated not only the freeway system, but the major arterials as well. Arterial intersections, unable to provide the capacity necessary to maintain safe and efficient traffic movement, produce bottlenecks, long traffic queues and generally retard flow along travel corridors [21]. Therefore, it had become extremely important to improve these systems [22].

2.3 Definition of Flyovers

Extensive studies have revealed flyovers to be defined in some varying degrees. With each new study, an additional element to its definition is revealed as outlined below.

Flyovers are light-weight, low-cost, prefabricated steel structures that elevate only one or two lanes over a traffic-choked city intersection but dramatically reduce congestion [23]. They are used at congested arterial intersections as a means of "unlocking" signal optimization strategies to produce a network of "continuous flow boulevards" or "super streets" [24]. It is a grade-separated structure that allows arterial through traffic to go over a crossing arterial or collector without slowing down or stopping for an at-grade signal capacity [11]. Flyovers are an important component of transport infrastructure, and are constructed at busy intersections or along the highways in order to facilitate the uninterrupted movement of traffic. The intended purpose of flyover construction is to reduce congestion in urban areas [17]

The term 'Flyover' is commonly used in the United Kingdom and in most Commonwealth countries to describe a grade separated or elevated bridge, road, railway or similar structure that crosses over another road or railway. It has the similar meaning of overpasses-known in the United States, yet with some differences. They have variable names in different countries and thus the term flyover is not fixed or agreed upon [25]. At an intersection, separating the grade and allowing the heavy traffic-movement to flow uninterrupted can mitigate congestion. Flyover is one such grade separation, where the through traffic-movement is bridged over an intersection [26].

Thus, flyover can be defined as grade-separated structure allowing uninterrupted traffic movement between two movements originally in conflict with each other at-grade. It is different from overpasses in the sense that the ramps of an overpass are connected to the road facility accommodating the original at-grade movement. Overpass only temporarily separates the grades of two movements at the conflict point before descending to the original grade. However, flyover is ideally designed as a continuously grade separated structure with separate ascending and descending ramps connected to side roads. Thus an arterial road is a type of flyover.

2.4 Historical Development of Flyovers and its Related Studies

Flyovers are not a new concept. The world's first railroad flyover was constructed in 1843 by the London and Croydon Railway at Norwood Junction railway station to carry its atmospheric railway vehicles over the Brighton Main Line [27]. Holborn Viaduct is the world's first flyover, connecting Holborn with Newgate Street, avoiding a deep dip in the road. It was built across the Fleet Valley to get rid of the steep Holborn and Snow Hills. It was built between 1863 and 1869 at a cost of over two million pound sterling, and was opened by Queen Victoria in 1869. It is also Europe’s first flyover. In the late 1950s and early 1960s, Chicago built three arterial flyovers to overcome capacity problems. The then-called "through-lane-overpass" successfully re-moved congestion at bottleneck intersections without impacting nearby ones. The capacity of each of the three arterials where an overpass was built increased from 114 to 300 percent, whereas the peak-hour demand at nine intersection approaches increased by an average of 33 percent. The peak-hour delay decreased from 82 to 17 sec per vehicle, for savings of 80,000 vehicle-hours per year and accidents decreased from 186 to 92 per year, after the flyover became operational, or about a 50 percent reduction [11].

The first flyover in India was opened on 14 April 1965 at Kemps Corner in Mumbai [28]. The 48-foot-long (15 m) bridge was constructed in about seven months by Shirish Patel at a cost of 17.5 lakh Indian Rupees (equivalent to 8.3 crore Indian Rupees or US$1.3 million in 2017) [29].

Londoners were becoming accustomed to flyovers after 1960 with the construction of the Westway flyover. It passed through north Kensington as well as very close to Acklam Road, overlooking many houses and the Hammersmith flyover. Partially completed Hammersmith flyover was designed to reduce traffic congestion from central London to the West [30]. Around this time, a group of new urban highways were built in Brazil during the dictatorship in the 1960s and 1970s, such as Rio de Janeiro’s Rebouças Tunnel and the Freyssinet Viaduct that directly linked the downtown to the fashionable South Zone of Copacabana, Ipanema, and Leblon [25].

Koger (1971) evaluated the design and construction of a flyover at a congested Hannover traffic circle. After extensive engineering analysis, he reported that all municipality expectations were met [21][21], [31].

In 1973, although the Red Book provided some general guidelines for building grade separations within the existing right-of-way of arterials [32], it did not consider any performance based analysis of flyovers.

Bagon briefly described many design aspects of flyover bridge built in Brussels, Belgium (Le. the AB-1 bridge completed in February of 1 975.) Although this article is concerned specifically with bridge design, it does indicate that flyovers can be constructed quickly, thereby reducing the potential conflicts with traffic operations [22], [33].

Pleasants (1980) considered the flyover a traffic improvement alternative separate from conventional grade separation techniques. He opined that removing 2000 cars per hour from the intersection help flyovers reduce fuel consumption of vehicles significantly by eliminating stop-and-go driving behaviour [21], [23].

Byington (1981) indicated that intersection accidents can be reduced by flyovers if proper attention is given in the structure's end treatment and good advance signing and roadway markings are used. Besides, he assessed demand volume and capacity, reviewing a range of flyover design formats, and highlighted the need to consider not only the traffic utilizing the flyover, but also the remaining ground level flows [34]. Issues of construction time span, flyover costs and intersection layout were studied by [33], Byington [34], Kroger [31] and Nobels-Kline [21].

A feasibility study of using flyovers by the Texas Transportation Institute (TTI) to reduce congestion at some critical intersections in Texas in 1983 revealed mixed results regarding the cost-effectiveness of a flyover. Although these analyses provided useful results, they were time-consuming and costly because there was no simple method to evaluate flyovers at that time [11].

Haefner (1985) described and justified the traffic engineering efficiency of a flyover by comparing the capacity of an at-grade signalized intersection to that of the same intersection with a flyover installed [22], [35].

Recker, Root and McNally (1985) described flyovers as prefabricated low-cost grade separation bridges. Besides, they examined the feasibility of the development of high flow urban arterials by means of an integration of flyover technology with signal optimization. The results of the study showed that the use of prefabricated flyovers, in conjunction with signal optimization, can significantly reduce travel delays and stops along heavily congested major arterials. The resulting high flow arterials can function effectively as "continuous flow boulevards," even when embedded in relatively dense urban traffic networks [21].

Bonilla and Urbanik (1986) showed that the capacity of congested arterials can be augmented in a cost effective manner by using grade separation. Flyover benefits were compared with average approach volumes of the current year plus 20 year forecast. The study revealed that such benefits relied on the amount of traffic diverted to the flyover and the ability of the improved intersection to process the remaining at-grade traffic. The report also identified operational considerations, proposed warranting conditions, and suggested implementation guidelines for the flyover development [22], [36].

Bonilla (1987) examined the numerous design considerations for flyovers including traffic capacity, minimum cross section for a given right-of-way, at-grade treatments and intersection geometrics. Giving a holistic view, he indicated that the implementation of flyovers becomes cost effective when less expensive at-grade solutions have been exhausted [11], [22]. However, it excluded relevant analysis of accessibility and mobility.

Witkowski (1988) compared between an urban-grade separated interchange and an at-grade intersection in terms of the delay, vehicle operating cost, accidents, and vehicle emissions for several traffic demand levels. The study revealed that the urban grade-separated interchange may be economically viable at an average daily demand as low as 40,000 total entering vehicles [37].

Auttakorn (2013) described the results of a pilot study of the benefits of a flyover bridge which was constructed over an existing at-grade intersection to increase capacity of traffic flow in two directions on one of the main highway. The study found that one-third of the total traffic volume diverted to the flyover, and despite an increase in traffic volume at the intersection, the vehicle delays were reduced by one-third over the same period; the saving in travel time and vehicle operating costs amounted to 421.65 million Baht [17].

The results of previous studies encouraged people to develop and construct flyovers to tackle traffic congestion and improve mobility.

2.5 Justification for Evaluation of Flyovers

Although flyovers are constructed with the intention of increasing welfare for the road users, the added benefits may come at the expense of other members of the society. The process of planning and implementation of an integrated highway system around USA took place in a short period of time resulting in unexpected negative consequences in entire urban areas [38]. Some of the negative effects of the swift implementation of highways in urban areas included divisions of well-established communities, relocations of entire families, excessive noise, and unwanted views that changed drastically the urban landscape.

With the construction of highways in urban areas, empty spaces would result. The spaces along and under elevated highways affect the city experience. They disconnect neighborhoods, produce undesirable views, and act as physical and psychological barriers making the pedestrian experience unpleasant [39]. Furthermore, the unclear territoriality of these spaces sometimes leads to land misuses such as dumping debris, abandoning of cars, or illegal activities. The inappropriate use of the vacant spaces under elevated highways can lead to social and economic problems in addition to being unsightly and lowering the value of adjacent properties [40].

Halprin (1966) opined that elevated freeways have done even worse damage to the areas through which they pass, by blocking out light and air, and generating noise pollution. He expressed grave concern over the fact that at-grade facilities under flyovers have been devoted to parking lots, automobile junkyards, cyclone fences, and rubbish. He summed up his observations stating that these externalities have done more damage to cities than freeways themselves have [40].

Flyovers were heavily promoted through the social and physical fabric of many cities without regard to the fact, that they ripped neighborhoods, created physical barriers and blight, exposed residents to negative environmental conditions [25], [41]. The process of planning and implementation of flyovers around USA took place in a short period of time, resulting in unexpected negative consequences in entire urban areas [25], [42]. Such negative externalities turned locals against similar development. At some point in the 1960s, public opinion came to focus on the negative consequences of freeway building, as opposed to the demonstrable advantages of modern, high-speed, express freeways serving a nation addicted to automobiles and to mobility [25], [43].

Civil rights activists and environmental activists joined together in the anti-freeway movement from 1960, asking for changes in transportation policy. They criticized the transportation planning process for inadequate treatment of the social and environmental impacts of transportation facilities; for focusing only on long-term plans and ignoring more immediate problems; and for using rigid technical procedures to justify bad projects [25], [44]. Such opposition to freeways resulted in a "freeway revolt" movement which gained its momentum in the late 1960s and early 1970s. Influential urbanists such as Jane Jacobs, Lewis Mumford, Herbert Gans and others voiced criticism of urban highways, freeways, expressways and other similar developments, calling for the end of highway construction in inner cities [25].

By the mid-1970s the combination of the anti-freeway movement, environmental movement, increasing flexibility in federal transportation funding and more local and state control over this funding was apparently effective in halting the progression of many freeway projects by mid 1970s and effectively ending it by 1990s. Many cities are re-evaluating past highway policy that pushed elevated interstate highways through central cities, with consequent severe damage to housing, business, and neighborhoods. Moved by the teardown movement of Congress for New Urbanism (CNU), at least 24 American cities have discusses or planned removals or teardowns of inner city elevated expressways or at least segments of them, and replace them with at grade boulevards to reclaim the resulting land for housing, recreational space and commercial development as well as to re-knit the urban fabric that was destroyed [45].

During 1970s, Portland, Oregon razed Harbor Drive freeway and thus provided the first U.S. example of freeway removal. Since then, San Francisco, California; Milwaukee, Wisconsin; New York City; and Toronto, Canada, have followed suit, and a number of other cities are currently contemplating the future of the aging freeway infrastructure [41].

There is growing consensus against flyovers across the world. Flyovers are not only aesthetically displeasing, but have also failed to control traffic congestion. Transport planners are now inclined to think that demand management is better solution than increased supply. Building flyover is supply solution and it would create its own demand, increasing congestion in the long run. For instance the Thai government implemented an ambitious plan of series of flyovers with metro (consisting of underground and elevated rail) in and around Bangkok in the early 1990s to control traffic congestion. However it did not eradicate problem, rather it promoted purchase and usage of private cars. Congestion in Bangkok is returning to the levels witnessed in 1980s [46].

Today, elevated roadways have become targets of removal for their suppression of development in an increasingly dense metropolis and the dangers they pose to urban air quality. Boston, New York, Portland initiated such teardowns [25], [45]. The Seoul Metropolitan Government (SMG) recently considered eliminating some useless overpasses that had once played a significant role in maintaining continuous traffic flow but soon lost their original, positive function and became an environmental burden. Seoul has already removed the city's first overpass-Ahyeon Overpass after tearing out 15 freeways in the past 12 years [47].

Recent studies in Asian region have heavily discouraged the construction of flyovers. Bansal and Singh (2014) devised an approach to cover sustainable designing and construction of series of flyovers, underpasses, river bridges and other infrastructure projects taken up in the new millennium in New Delhi, the capital city of India. The number of flyovers in Delhi had increased from 5 in 1982 to 74 in 2014. The findings of the study revealed that half of the increased roadway capacity is consumed by added traffic in about five years, 80 % of increased capacity is eventually consumed by induced traffic. They warned that it will be impossible to keep increasing infrastructure beyond its physical limits [48].

Maji et al. (2015) expressed concern regarding the overall benefit of flyover in non-lane based heterogeneous traffic state condition in developing countries like Bangladesh. The study opined that traffic operations underneath a flyover remain unmanaged and often pose a major concern in developing countries with non-lane-based heterogeneous traffic. The overall benefits of a flyover may be reduced in such traffic scenario [26].

From previous studies, it is evident that flyovers are not always the magic solution to all traffic problems of an area that they were once thought of previously. Faulty, incomprehensive planning and design of flyovers can lead to more harm than good in the long run, nullifying the investment of such expensive structures and eventual dismantling of flyovers in extreme cases. Thus, it is important to assess the post-construction effectiveness of flyovers by evaluating performance of both the flyover corridor and the surrounding area.

2.6 Measures to Evaluate Performance of Roads

The ultimate purpose of measuring performance is to improve transportation services for customers [49]. When developing performance measures, the literature emphasizes that the process should begin by defining an agency's vision, its mission and strategic objectives. While these may be long-range in focus, performance measures used by an agency must be related to those broad goals. Long-term strategic goals can be translated into specific annual goals, against which performance is measured. Policy-makers and agency staff must be educated to understand the performance measures and to accept the link between them and the agency's goals [50].

Performance measures should cover the full range of an agency's strategic objectives, but should nonetheless be few in number. In Japan, for example, the national ministry has established a core set of 17 performance measures [51]. Limiting the selection of measures to those that reflect the issues that are important to an agency will simplify data collection and reporting. It will also increase the likelihood the measures will be understood by the public and used effectively by agencies. In selecting a set of performance measures, it is important to recognize the distinction between input, output and outcome measures. Input measures reflect the resources that are dedicated to a program, output measures reflect the products of a program, and outcome measures look at the impact of the products on the goals of the agency [52]. Input-based and output-based performance measurement was more common in the past, but current trends are to increased use of outcome-based performance measures, in conjunction with output-based measures.

Outcomes can be more difficult to measure but are considered important to measure because they directly relate the activities an agency undertakes to its strategic goals. However, transportation agencies must consider the availability of data, the cost and time to collect the necessary data and the quality of the data in selecting performance measures. It must be possible to generate the measure with the technology and resources available to an agency if the performance measure is to be adopted.

Other issues that should be considered when selecting performance measures to evaluate a road network include the following (TRB, 2000):

1. Forecast-ability: is it possible to compare future alternative projects or strategies using this measure?
2. Clarity: is it likely to be understood by transportation professionals, policy makers and the public?
3. Usefulness: Does the measure reflect the issue or goal of concern? Is it an indicator of condition, which could be used as a trigger for action? Does it capture cause-and-effect between the agency's actions and condition?
4. Ability to diagnose problems: Is there a connection between the measure and the actions that affect it? Is the measure too aggregated to be helpful to agencies trying to improve performance?
5. Temporal Effects: Is the measure comparable across time?
6. Relevance: Is the measure relevant to planning and budgeting processes? Will changes in activities and budget levels affect a change in the measure that is apparent and meaningful? Can the measure be reported with a frequency that will be helpful to decision makers?

In summary, the list of performance measures that could be adopted by a transportation agency to evaluate its road network is essentially limitless. There is no one measure, or one set of measures, that could be identified as the "best" for all cases. Furthermore, although there are many common issues to be considered, there is not just one good way to develop a set of performance measures or establish a performance measurement system. In each case, the performance measures used must depend on the specific conditions of an agency, its goals, its resources, and its audience. Keeping the above mentioned criteria in mind, numerous methods of road performance have been developed over the years. However, they can be grouped under a finite number of categories, as outlined in the following paragraphs.

Performance measures used in the United States as prescribed by American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB) and Federal Highway Association (FHA) are indicated in the following table [53].

Table 2.1: Performance Measures Used in the United States

Accessibility	Average travel time from facility to destination (by mode)
	Average travel time from facility to major highway network
	Average trip length
	Overall mode split
	Mode split by facility or route
	Number of structures with vertical (or horizontal) clearance less than X ft.
	Bridge weight limits
Mobility	Origin-destination travel times
	Total travel time
	Average travel time from facility to destination
	VMT by congestion level
	Lost time due to congestion
	Delay per VMT
	Level of service
	Intersection level or service
	Volume/ Capacity ratio
Economic Development	Direct jobs supported or created
	Economic costs of accidents
	Economic costs of lost time
	Indirect jobs supported or created
Quality of Life	Lost time due to congestion
	Accidents (or injuries or fatalities) per VMT
	Customer perception of safety in system
	Tons of pollution (or vehicle emissions) generated
Environmental and Resource Conservation	Overall mode split
	Tons of pollution (or vehicle emissions) generated
	Fuel usage
	Number of accidents involving hazardous waste
Safety	Number of accidents per VMT
	Number of accidents per year
	Number of accidents per trip
	Number of accidents per capita
	Number of accidents per ton-mile traveled
	Response time to incidents
	Customer perception of safety while in system
	Accidents (or injuries or fatalities) per VMT
	Percentage of highway mainline pavement (or bridges) rated good or better
	Average response time for emergency services
	Railroad/highway-at-grade crossings
	Number of accidents involving hazardous waste
Operational Efficiency	Origin-destination travel times
	Total travel times
	Average travel time from facility to destination
	Average travel time from facility to major highway network
	Volume/capacity ratio
	Overall mode split
	Cost per ton-mile
	Average vehicle occupancy

(Table 2.1 continued)

System Preservation	Percent of roadway/bridge system below standard condition
	Age distribution
	Percentage of highway mainline pavement (or bridges) rated good or better

Performance measurement of road networks is gaining prominence not only in North America but also in many other developed nations around the world. The international perspective is interesting and the literature reflects a common desire to learn from others in this growing field. The US Federal Highway Administration conducted an "international scan" with a delegation of professionals visiting Australia, New Zealand, Japan and Canada to study how agencies in those countries use performance measurement in transportation planning and decision-making. The study team found that transportation agencies they visited used performance measures for setting priorities and making investment and management decisions to a greater extent than is typical in the United States. Amongst the lessons learned, the study team recommended that agencies consider implementing performance measurement for safety as this was considered the most impressive application and, used strategically, had resulted in a significant decline in fatalities. It was also observed that the use of indicators to measure performance on environmental matters proved the most challenging for transportation agencies in the countries visited [51].

Under the auspices of the Organisation for Economic Co-operation and Development (OECD), a scientific expert group conducted a study of performance indicators for the road sector [54], which was followed by a field test to refine and better define selected indicators [55]. The OECD work revealed that most countries are working with performance measures in many of the same broad categories as in Canada and the United States. Dimensions, or goals, against which performance is measured include:

1. Accessibility/mobility
2. Safety
3. Environment
4. Equity
5. Community
6. Program development
7. Program delivery
8. Program performance

In many cases, a user satisfaction index is reported which may be estimated from customer surveys or built from component measures such as those listed above. Interestingly, the environment – its protection and sustainability – is cited as an important goal for most transportation agencies and there is a common desire to be able to measure. In its field work, the OECD study tested 15 performance measures, listed below with notes from the study report [55]:

1. Average road user cost: Average cost of running a medium car, a light diesel truck, and an articulated six-axle truck for both rural and urban operation.
2. Level of satisfaction regarding travel time, reliability and quality of road user information: Expressed on a scale from one to ten on a market survey. Elements that contribute to this indicator are still being developed in most countries.
3. Protected road user risk: Drivers' and vehicle passengers' fatalities. From a road traffic perspective, the fatalities are compared to the number of registered vehicles. From a health perspective, the fatalities are compared to the total population. The OECD report suggested that fatality risk is not a suitable measure of safety performance of a road administration. More specific indicators (such as average speed, seat belt use, drunk drivers) should be developed.
4. Unprotected road user risk: Vulnerable road users (pedestrians, motorcyclists and cyclists) fatalities. From a road traffic perspective, the fatalities are compared to the number of registered vehicles. From a health perspective, the fatalities are compared to the total population.
5. Environmental policy/programs: A yes/no indicator not commonly used. More measurable indicators should be developed.
6. Processes in place for market research and customer feedback: A yes/no indicator that requires further development. Agencies using surveys were cautioned to phrase questions to ensure customers prioritize their needs, considering cost as a factor. Long term programs: A yes/no indicator.
7. Long term programs are considered useful management tools to help organizations achieve their goals.
8. Allocation of resources to road infrastructure: A yes/no indicator to evaluate the existence of a system covering broad issues related to resource allocation such as asset management systems.

9. Quality management/audit programs: A yes/no indicator to evaluate if agencies have a quality management system or plans to establish one.
10. Forecast values of road costs versus actual costs: An indicator that can serve as a measure of road administrations' managing ability.
11. Overhead percentage: The fixed costs of a road administration compared to the total costs it incurs. It provides a measure of the cost effectiveness of an administration in delivering and maintaining the road sector.
12. Value of assets: Calculated in many different ways, this indicator provides a measure of the net economic value of road infrastructure.
13. Roughness: A key determinant of pavement quality, travel cost and user satisfaction, it also reflects the structural quality of the road. The international roughness index is widely used.
14. State of road bridges: Engineering soundness of bridges; an indicator recommended for all road administrations.

Outside Europe and North America, arguably the most ambitious application of performance measurement exists in Australia and New Zealand. In 1993, Austroads (the Australasian Association of Road Transport and Traffic Authorities) established a program to develop and implement a set of national performance indicators for the road system and road authorities. A total of 72 performance indicators in ten categories were originally selected as the best representation of the economic, social, safety and environmental performance of the road system and road authorities. The indicators by category are listed in [56]. It is interesting to note that Austroads has recently embarked on a major review of the indicators it uses. Evaluated against the criteria of being relevant, feasible to collect data and comparable, it was found that 46 of the 72 measures are generally satisfactory and should therefore continue to form part of the national performance reporting process. However, the review suggested that 16 of the 72 measures should be abandoned. The remaining 10 measures do cover important outcome areas but do not meet the criteria and therefore should be replaced. Work to develop different indicators, and to refine some of those that will be retained, is expected to be conducted over the next two to three years.

From above literature review, it is clear that there is not one measure, or one set of measures, that can be considered the best for all transportation agencies. In each case, the performance measures used must depend on the specific conditions of an agency, its goals, its resources, and its audience. In road authorities around the world, common foci for performance measurement have been observed to include:

1. System condition and preservation,
2. Safety,
3. Accessibility, and
4. Mobility.

Thus in this study while evaluating impact on roads, emphasis has been given to evaluate mobility. Hence LOS was chosen as one of the measured of effectiveness of this study.

2.7 Level of Service (LOS)

Level of service (LOS) is a qualitative measure used to relate the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measure like speed, density, etc. LOS has been categorized in different manners in different countries. The most widely followed LOS categories are presents in the following sub-sections.

2.7.1 LOS in North America

The following section pertains to only North American highway LOS standards as in the HCM and AASHTO Geometric Design of Highways and Streets ("Green Book"), using letters A through F, with A being the best and F being the worst, similar to academic grading [57]. The categories of LOS along with their explanation are given below:

A: Free Flow. Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. The average spacing between vehicles is about 550 ft (167 m) or 27 car lengths. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed. LOS A generally occurs late at night in urban areas and frequently in rural areas.

B: Reasonably Free Flow. LOS A speeds are maintained, maneuverability within the traffic stream is slightly restricted. The lowest average vehicle spacing is about 330 ft (100 m) or 16 car lengths. Motorists still have a high level of physical and psychological comfort.

C: Stable Flow, at or Near Free Flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Minimum vehicle spacing is about 220 ft (67 m) or 11 car lengths. Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect but localized service will have noticeable effects and traffic delays will form behind the incident. This is the target LOS for some urban and most rural highways.

D: Approaching Unstable Flow. Speeds slightly decrease as traffic volume slightly increase. Freedom to maneuver within the traffic stream is much more limited and driver comfort levels decrease. Vehicles are spaced about 160 ft (50m) or 8 car lengths. Minor incidents are expected to create delays. Examples are a busy shopping corridor in the middle of a weekday, or a functional urban highway during commuting hours. It is a common goal for urban streets during peak hours, as attaining LOS C would require prohibitive cost and societal impact in bypass roads and lane additions.

E: Unstable Flow, Operating At Capacity. Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the posted limit. Vehicle spacing is about 6 car lengths, but speeds are still at or above 50 mi/h (80 km/h). Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Drivers' level of comfort become poor. This is a common standard in larger urban areas, where some roadway congestion is inevitable.

F: Forced or Breakdown Flow. Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS, because LOS is an average or typical service rather than a constant state. For example, a highway might be at LOS D for the AM peak hour, but have traffic consistent with LOS C some days, LOS E or F others, and come to a halt once every few weeks [58].

Figure 2.1 portrays a graphical representation of the categories of LOS with respect to operating speed and flow/capacity ratio.

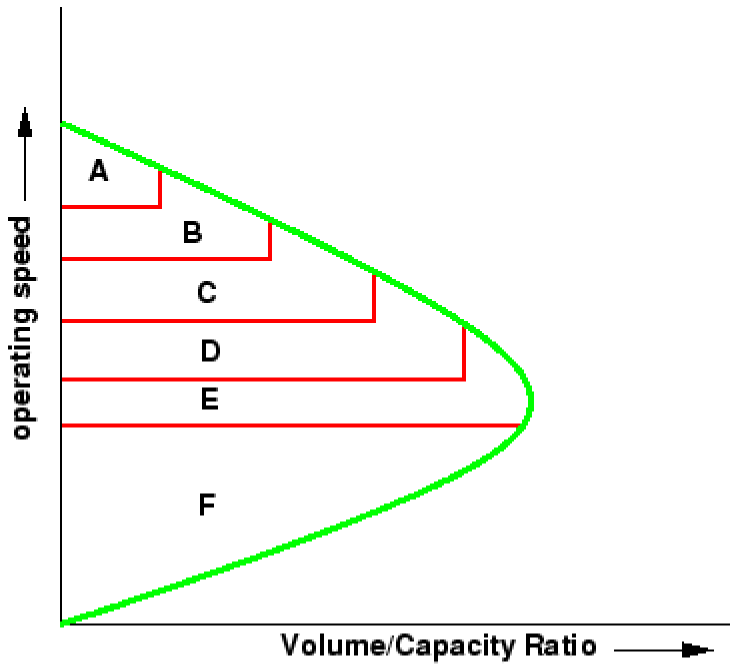


Figure 2.1: Operating Speed vs Volume/Capacity Ratio at Various LOS

Multimodal LOS

The 2010 HCM incorporates tools for multimodal analysis of urban streets to encourage users to consider the needs of all travelers. Stand-alone chapters for the bicycle, pedestrian, and transit have been eliminated, and methods applicable to them have been incorporated into the analyses of the various roadway facilities [57].

The primary basis for the new multimodal procedures is NCHRP Report 616: Multimodal Level of Service Analysis for Urban Streets. This research developed and calibrated a method for evaluating the multimodal LOS (MMLOS) provided by different urban street designs and operations. This method is designed for evaluating "complete streets," context-sensitive design alternatives, and smart growth from the perspective of all users of the street. It is used to evaluate the tradeoffs of various street designs in terms of their effects on the perception of auto drivers, transit passengers, bicyclists, and pedestrians of the quality of service provided by the street [59].

LOS for At-Grade Intersections

The HCM defines LOS for signalized and unsignalized intersections as a function of the average vehicle control delay. LOS may be calculated per movement or per approach for any intersection configuration, but LOS for the intersection as a whole is only defined for signalized and all-way stop configurations.

LOS in other Transportation Network Elements

Performance of other transportation network elements can also be communicated by LOS. Among them are:

1. At-Grade Intersections
2. Modern Roundabouts
3. Two-lane roadways (uninterrupted flow)
4. Multilane roadways (4 or more lanes) (uninterrupted flow)
5. Open freeway segments
6. Freeway entrances (merges), exits (diverges), and weaving lanes
7. Bicycle facilities (measure of effectiveness: events per hour; events include meeting an oncoming bicyclist or overtaking a bicyclist traveling in the same direction)
8. Pedestrian facilities (HCM measure of effectiveness: pedestrians per unit area)

Theoretical Considerations of LOS

An LOS standard has been developed by John J. Fruin for pedestrian facilities [60]. The standard uses American units and applies to pedestrian queues, walkways, and stairwells. This standard is not considered a good measure[citation needed] of pedestrian facilities by the planning or engineering professions, because it rates undesirable (and hence unused) sidewalks with an LOS A, while pedestrians tend to prefer active, interesting sidewalks, where people prefer to walk (but rate a worse LOS on this scale). To rectify this and other issues, The National Cooperative Highway Research Program (NCHRP) is conducting a project to enhance methods to determine LOS for automobiles, transit, bicycles, and pedestrians on urban streets, with particular consideration to intermodal interactions.

The A to F scale deals only with delays and service reliability. These delays are typically caused by congestion, breakdowns or infrequent service. It assumes there is a service in place that people can use. It also implies that poor LOS can be solved by increased capacity such as additional lanes or overcoming bottlenecks, and in the case of transit, more buses or trains. It does not deal for instance with cases where there is no bridge across a river, no bus or train service, no sidewalks, or no bike-lanes.

An expanded LOS might look like: 0 - No service exists. Latent demand may exist. 1 - Service is poor, unsafe or discouraging. Demand is suppressed below socially desirable levels. A-F - As per existing LOS scale. G - Further expansion of capacity is limited. H - No expansion is possible. Radical or innovative solutions are required.

2.7.2 LOS in the United Kingdom

The LOS measure is much more suited to American roads than roads in Europe and the UK, but the HCM is used. The technique is in UK textbooks, but is sparingly used. The individual countries of the UK have different bodies for each areas roads, and detailed techniques and applications vary in Scotland, England and Wales, but in general the practice is the same. Rural and urban roads are in general much busier than in the U.S, and service levels tend to be to the higher end of the scale, especially in peak commuting periods. It is acceptable for roads to operate at 85% capacity, which equates to LOS D and E. In general the principle is to take the volume of traffic in one hour and divide by the appropriate capacity of the road type to get a v/c rating, which can be cross-referenced to the textbooks with tables of v/c ratings and their equivalent LOS ratings. The lack of definitive categories towards LOS D, E and F limits the use, as a D or E category on an urban road would be acceptable. In certain circumstances the UK shortens the LOS categories to just A-D. A and B indicate free-movement of traffic (i.e. under 85% capacity), C reaching capacity 85%-100%, D over capacity. Little reference to this can be found in textbooks and it may just be an 'unwritten engineering practice', agreed with certain authorities.

2.7.3 LOS in Australia

In Australia LOS are an integral component of Asset Management Plans, defined as the service quality for a given activity. LOS are often documented as a commitment to carry out a given action or actions within a specified time frame in response to an event or asset condition data. LOS criteria were found to be similar to the ones used in HCM (2010), as covered by Austroads Guide to Traffic Engineering Practice Part 2.

2.7.4 Development of LOS concept in previous studies

The attempt by O’Brien (1993) through Traffic Calming at the local area, traffic route and metropolitan levels introduced the concept of Local Area Traffic Management (LATM) in Australia. Local Area Traffic Management (LATM) mainly focused on improvement of living and environmental conditions in residential streets. The LATM techniques included introduction of roundabouts, speed humps with sine wave profile and narrowing the street widths. In the second level of traffic calming on traffic routes, has been introduced via two generalized strategies ; the adoption of a road hierarchy sub-classification of “secondary arterial-capacity restrained”, or similar classification and altering the management of arterials along the route to reflect the adjacent land use and level of conflict. The paper suggests that in this second level a route may be managed to provide a good LOS along most of its length, but through shopping precinct it may have its traffic function lowered to allow some priority to parking and pedestrian movements. Thus intersection capacity is maintained but midblock capacity and Level of Service is reduced for traffic. The suggested third measure for metropolitan level is reduction in total traffic which the paper itself says that is far more difficult to achieve and can only be done using the corporate approach of setting targets, then devising strategies and actions to achieve those targets. Thus it aims to reduce the congestion by management of supply (traffic) segments, demand management (reduction), pricing policies (to reduce demand) and then travel restrictions by encouraging public transport system. The study indicates that Traffic Calming measure if adopted in a planned way can reduce the congestion and thereby improving traffic flow and operational conditions for better LOS [61].

Newman et.al [1989] early has presented extensive data on travel from 32 cities around the world. Their analysis of the data was aimed at “proving” that automobile dependence was related to city density [62]. Alternative evaluation of the data [61] demonstrate that the city area is the major determinant of average trip length and therefore total travel. Modal split often related to density and availability of public transport. Containment of city size (area) could be a major traffic calming objective into the future. Analysis of trip generation data for offices in freestanding urban / suburban locations compared to those in mixed use/multi-functional district centres indicates for lower daily trip generation in district centres – most likely due to the location of food, shopping, and business services within walking distance of the offices. Thus it indicated that these factors can affect LOS in such urban roads.

Dan Burden et.al (1999) suggested through analysis that by leaner widths, roads can gain efficiency, mode share and safety. The term “Road Diets” is used to indicate the loosening of lanes and widths in roads. Initially few roads were taken into consideration. The research have tossed a new term “Road Dieting” applied to “skinning up” streets/roads into leaner, more productive members of society. Here the roads considered ideal for dieting is a four lane road carrying 12-18,000 auto trips per day. The paper justifies the selection by calling such roads under the category of 'ideal patients' for dieting wherein such roads generate excessive speeds also erode the ability for transit, walking and bicycling. Thus the research says that with increase in lanes it has been found that people who have formerly mode choice, gives up trying to cross streets converted in four lanes, instead they join the daily traffic stream and add to the roadways level of service drain. The LOS is reduced and thereby the paper projects that by reducing the lanes and modifying the road with added turn lanes and bike lanes traffic moves at more uniform speed. These modifications have reduced the crashes and conflicts with people having more flexibility to enter and exit driveways more easily. The bike lanes gives motorists more border width, moving them six feet further from fixed objects such as utility poles, hydrants and other fixed objects. Similarly pedestrians gets six feet more separation from motorists. Comfort levels of all people using the corridor have markedly improved. This research has also indicated that for the selected streets the Average Daily traffic (ADT) has improved after introducing these "diets" and thus the LOS also improved for users opting for the modes [63].

A similar project report on Performance Measures for Road Networks prepared by the Transportation Association of Canada (2006) with the aim to improve transportation services for customers emphasized to identify the components which improve customer satisfaction by improving services. The report has selected the set of performance measures recognizing the distinction between input, output and outcome measures. Input measures reflect the resources that are dedicated to a program, output measures reflect the products of a program and outcome measures look at the impact of the products on the goals of the agency controlling the facility. The six outcomes suggested by the report for specific performance measures include; Safety, Transportation system preservation, Sustainability and environmental quality, Cost effectiveness, Reliability and Mobility/Accessibility. For each outcome the survey provided a list of possible performance measures and respondents were asked to indicate amongst them. The selected benchmarks and thresholds were verified by the respondents for their area of jurisdiction [64]. Each outcome indicated above is further divided into indices and the data collected on provincial highway network were compared against criteria that define good, fair and poor condition for the ranges which has been tabulated in the report. The performance measurement of other countries like United State of America and Australia has also been included in the report for comparison of outcomes and indices. Thus the report has devised indices for various outcomes to measure customer focus and the quality of facility. So that the same can be related with LOS for further planning and management.

Whiteley-Lagace et al. (2011) in their work have reviewed the implications and funding needs to move the road network from its current low LOS of D-grade to a B+ grade which will allow for more sustainable road network which leads to appropriate LOS and affordability. As per the paper Roads and traffic in the City of Hamilton , Canada, is the largest asset representing nearly one-third of the city's total assets [65]. The paper has evaluated the State of the Infrastructure (SOTI) report card to identify the prevailing functional class of the road and identifies deficiencies in the road network and the fund requirement to achieve a specific class of LOS. This paper has considered the rating of LOS as a function of three independent variables i.e. Condition and performance, Capacity vs need and Funding vs Need. Thus these 3-criteria model outlines the importance of defining a level of service for each of the assets and which is used as the baselines for defining the budgetary requirements and to assess transparency and accountability to the community for the upkeep of the asset within the City's portfolio. The study has devised a simple LOS measure for the road network as Overall Condition Index (OCI) which will give the condition of each road which can be aggregated to provide an overall condition for the network as a whole or alternatively for each of the discrete functional classes.

The performance of urban road networks depends on the practical capacity and actual volume of traffic on each of the links that constitute the network. Arasan et.al (2004) carried out a study on unrestricted movement of different types of vehicles which affects road space, lane concept and expression of flow values, based on standard lane width. Also, when different types of vehicles share the same road space without any physical segregation, the extent of vehicular interactions varies widely with variation in traffic mix [66]. To arrive at an estimate of practical capacity of road links, the research necessitated study of influence of roadway, traffic and other relevant features on vehicular movement using appropriate techniques. Modelling of traffic flow was used for studying the flow characteristics over a wide range of the involved variables. The study indicated that the design service volumes recommended for urban roads are for a LOS of C (about 0.7 times the maximum capacity). Capacity and service volume being expressed in Passenger Car Units (PCU), the study emphasised on PCU values for the different types of vehicles for quantifying traffic flow corresponding to LOS C. The research developed a Model to simulate heterogenic traffic flow in mid-block sections of Urban Road (in the city of Chennai).

There have been several attempts to derive PCU values applicable for homogeneous and heterogeneous traffic environments by Huber et al. (1982), Krammes et.al (1986), Cunagin et.al (1983), Sumner, *et al.* (1984), Elefteriadou, et al. (1997), Chandra et al (2000), and Tiwari, *et al.* (2000) [67]. There is general agreement among researchers that the PCU of a vehicle type will decrease with increase in its own proportion in the traffic stream, and that for a given road width, an increase in flow level will result in smaller PCU value for a vehicle type thus will have an impact of volume and thereby on LOS. In recent years Chandra and Kumar (2003) proposed capacity values for various road widths under mixed traffic conditions. They used a new concept for estimating PCU of various types of vehicles based on their projected areas on the road surface. The PCU factors, for urban roads, recommended by Indian Road Congress (IRC) are available in the IRC Code, IRC: 106-1990 [68]. The PCU values have been given in the Code for two levels of traffic mix, namely the percentage composition of a vehicle type being 5 per cent and 10 per cent and above. Again these conditions are indicative for urban roads with plain terrain conditions.

In another research by Arasan et al. (2008) explains that when the length and speed of the vehicles in a traffic stream vary significantly, the concept of occupancy, rather than density, is more appropriate to describe the traffic concentration. Thus a new concept of "area-occupancy" is proposed in the study claiming that it gives more consistent values irrespective of change in traffic composition. Area occupancy considers the horizontal projected area of the vehicle, without any restriction on the length of detection zone and width of road (treating the whole of the width of road as single unit without consideration of traffic lanes). The traffic data collected in this study, by video capturing the traffic flow, was fitted into negative exponential distribution and goodness of fit was tested using chi-squared test. Thereafter the model was validated with simulation methods [69]. The study also validated the models by feeding with observed data for a selected stretch and analysed the simulated data. It was found that the model revealed almost the same data as of field. Thus the research claims that the logical correctness of the concept of area-occupancy is validated by comparing the area

– occupancy with other with other two traffic flow parameters such as flow and speed under homogenous traffic conditions. Therefore the study says that area occupancy rather than occupancy is valid to measure accurately the extent of usage of road space by vehicles. Hence the capacity can be analysed through area occupancy to assign LOS.

The study carried out by Marwah et.al (2000) considered a model for simulating heterogenic condition of traffic with non-motorised vehicles inclusive in the stream. For level of service experiments a two-lane (7 m) wide-level tangent road section was selected for simulation runs. As based on the observed traffic composition in Kanpur, India, a benchmark traffic composition (Level I) is selected for simulation runs [70]. This benchmark composition has 35 percent of motorized vehicles and 65 percent of non motorized vehicles. Road stretch of 500 meter length with additional warming up zone of 300 meter length is adopted in this study for simulation experiments. Simulation runs are planned at increasing flow levels (8–10 flow levels) until flow approaches unstable state. It was planned to simulate 1600 vehicles for each run. To eliminate the effect of transient state, the statistics of the first one hundred vehicles were ignored. In the present study, level of service (LOS) is defined as composite of several operating characteristics that are supposed to measure the quality of service as perceived by the user at different flow levels. During analysis operating characteristics considered to define LOS are journey speed of cars, journey speed of motorized two wheelers, concentration, and road occupancy. Based on the simulation results of benchmark road and traffic composition (Level I) level of service is classified into LOS I, LOS II, LOS III, and LOS IV. Level of service criteria developed in this study may also help to identify the deficiencies of an urban road system and to plan for alternative improvements to attain a desired level of service. It was also proposed to use varying concept of occupancy, rather than density, to evaluate LOS of city roads.

2.7.5 Evolution of LOS concept across HCMs

HCM (1950) introduced transit and pedestrian impacts on motor vehicle capacity. Highway Capacity Manual (HCM) (1965) first introduced the concept of LOS and some corresponding performance measures which significantly represent the operating characteristics of a roadway. Six LOS were suggested based on some performance measures like average travel speed, peak hour factor, v/c ratio, load-factor at intersection and flow condition (stable, unstable or forced). In HCM (1985), density was selected as the primary measure for performance assessment and correspondingly five LOS were proposed. The bus transit chapter was expanded while a new pedestrian chapter was introduced. Besides a new bicycle chapter was introduced to highlight vehicle hindrance. HCM (2000) suggested average travel speed (ATS) as the exclusive parameter for assessment of LOS of urban street. Six LOS criteria were proposed on the basis of ATS value for four urban street classes individually whereas urban street class was determined based on the free flow speed. Besides, the edition expanded chapters involving LOS of bicycles and pedestrians. However, these created some problems. Pedestrian and bicyclist LOS measures reflected a motorist perspective of density. Moreover, Transit measures reflected a traveler's perspective, but the multiple LOS measures created issues with results interpretation. In most recent edition HCM (2010), six LOS were suggested along with threshold values of percent free-flow speed which was introduced as the main performance measure for LOS assessment of urban street for the automobile mode [71]. This version integrates multimodal analysis methods into appropriate chapters. Methodologies for all modes are presented together and intertwined, meaning no separate bicyclist, pedestrian, or transit passenger chapters were present. In addition, this version encourages software developers to add multimodal analysis features.

The 2000 edition of the Highway Capacity Manual (HCM) (1) uses two measures of effectiveness (MOEs) to assess level of service (LOS) of two-lane highways. The need for two MOEs arose from the perception, both by the researchers and the HCM user community, that previous attempts using average travel speed (ATS) in the 1965 edition of the HCM or percent time spent following (PTSF) in the 1985 edition did not grasp the complexity of these facilities. Other basic or additional MOEs have been proposed by researchers, and some have been adopted (for example, in South Africa, Finland, and Germany) [72].

2.7.6 Necessity of providing new framework for LOS

According to many research outcomes, LOS criteria suggested in HCM may not perfectly fit for urban roads under prevailing mixed traffic condition. For example, Bhuyan and Rao (2011) and Das et al. (2013) defined LOS criteria for Indian mixed traffic condition based on ATS [73], [74] the performance measure suggested in HCM (2000) and found threshold values of ATS significantly different from those proposed in HCM. Apart from conventional performance measures, few researchers recognized some alternative parameters that would be more appropriate in characterizing serviceability of a mixed traffic stream. Maitra et al. (1999) considered 'congestion' as a sole parameter to define LOS and consequently postulated a model to quantify the level of congestion [75]. Ten LOS classes were therefore proposed based on different congestion levels. In reviewing literature based on congestion measurement, Rao and Rao (2012) also put forward a few congestion based approaches for LOS evaluation [76]. On the other hand, Marwah and Singh (2000) realized LOS of urban streets related to multiple parameters instead of a single factor. Journey speed, concentration and road occupancy were hence, considered as explicit operating characteristics and on the basis of that, four distinct classes of level of service were suggested. However, disadvantage of both these approaches [75], [77] lies in its difficulties to estimate performance measures, specifically congestion or concentration. Also in evaluating LOS thresholds, no state-of-the art classification technique was adopted in either of these studies. It is thus seen that existing LOS prescribed by HCM is not always suitable for use with local conditions and data. Locally developed LOS determination method is becoming essential nowadays.

2.8 Flyovers in the Context of Dhaka City

In recent times, flyovers have been constructed as a priority measure on roadway intersections to reduce traffic congestion in Dhaka city. Economic growth has put a significant burden on existing transport networks in recent years. Transport issues have become a major political issue of most countries, especially in areas where population density is the highest [78]. Dhaka is suffering tremendously from perpetual traffic congestion on the backdrop of huge population density. Different transport policies regarding regulatory measures and construction related measures have been carried to reduce the traffic congestion problem. The Government of Bangladesh has prepared different transportation policies, not only to reduce traffic congestion, but also to build a reliable transportation system for Dhaka. Such policies include:

- Greater Dhaka Metropolitan Area Integrated Transport Study (DITS), 1994
- Dhaka Urban Transport Project (DUTP), 1998
- National Land Transport Policy, 2004
- Strategic Transport Plan (STP), 2004

- Dhaka Urban Transport Network Development Study (DHUTS), 2010
- Urban Transport Policy, 2015
- Dhaka Structure Plan, 2015

Dhaka's first comprehensive urban transport study, the Dhaka lntegrated Transport Study (DITS), emphasized on flyover construction. This was the start of development of flyovers in Bangladesh. The study was commissioned by the Government of Bangladesh in 1992-93, conducted under the Planning Commission and UNDP and reported in 1994. The study put forth recommendations considering mainly traditional elements of urban transport planning: developing road infrastructure, constructing flyovers, developing bus terminals and bus routes, and improving traffic flow management at intersections and across the road network [79]. The Dhaka Integrated Transport Study (1994) discouraged construction of flyovers over intersections if the congested roadway junction can be solved by a low cost traffic management scheme. Some transportation policies identified the locations for the construction of flyovers to improve roadway intersections, while other transport policies provided recommendations for overall road transport network development. Besides there were no specific guidelines for construction of flyovers in Dhaka [80].

In 2005, Strategic Transport Plan (STP) for the Dhaka city, prepared for next 20 years, tried to introduce a transport plan to cope up with the demand of the megacity, Dhaka. The document incorporated sets of objectives to introduce a safe and reliable public transport system which would be affordable to individuals [79]. STP only recommended construction of the Khilgaon Flyover, and the re-study of the proposal for construction of the Moghbazar-Mouchak Flyover, Kuril Flyover and Jatrabari-Gulistan Flyover (also known as Mayor Mohammad Hanif Flyover), as a mass rapid transit system, and multimodal interchange stations were proposed at these locations. STP identified that the Cantonment Staff Quarters flyover (Mirpur Flyover) proposed by the Roads and Highways Department would resolve the conflicts between road and railway traffic, as a Metro line was proposed in the same area [80]. Under three strategies STP considered ten options to solve the traffic problems of Dhaka. All the options (except the base) assumed that circular water way around Dhaka city would be completed and there would be major improvement in the railway system which would cost an estimated US$ 40 million and US$ one billion respectively over 20 years. The options were compared using eight objective functions including cost and eight subjective functions including affordability and social and economic development. The best two alternatives among these ten options proposed were neither subway nor flyover. However, the elected representatives of people of Government of Bangladesh (GOB) decided the strategy for the Strategic Transportation Plan (STP) on their own, ignoring the expert and consultant opinion, ultimately indicating that the worst proposal was chosen. The cost in either of these is more than double of the best two alternatives [46].

Dhaka Urban Transport Study (DHUTS) aims at formulating the Urban Transport Network Development Plan integrated with urban development plan of Dhaka Metropolitan Area (DMA) for the period up to 2025. Based on this plan, a general outline of the urban transport projects would be drawn which will be implemented on a priority basis The target year of the plan is set as the year of 2025, which consists short term (2010 -2015), medium term (2016-2020) and long term (2021-2025) [79]. The Dhaka Urban Transport Network Development Study (2010) identified flyover projects as very urgent, because they believed that these projects would be helpful in easing chronic traffic congestion and remove roadway intersection bottlenecks, and have no special problems for implementation [80].

The Dhaka Structure Plan (2015) proposed the construction of the Moghbazar-Mouchak flyover, while the Dhaka Structure Plan (2015) and the Urban Transport Policy (2015) gave more emphasis to construction of the BRT and MRT line rather than the construction of flyovers. On contrary, Dhaka Structure Plan (2015) also identified the construction of flyovers and other road infrastructures as a threat to the development of the future transportation road network in Dhaka, as they are not integrated with the overall road network development plan. The plan also identified that during the last few decades, a number of flyovers (Mohakhali, Jatrabari, Kuril, Banani, and Khilgaon) have been constructed in Dhaka without an integrated approach. The Moghbazar-Mouchak flyover currently under construction has not been integrated with the Hatirjheel project and the proposed Shantinagar-Jhilmil project at Keraniganj. Therefore, Dhaka Structure Plan (2015) recommended following an integrated approach with consideration of multimodal transport facilities (BRT line, MRT line, ring road, and elevated expressway) before undertaking the construction of flyovers in Dhaka [80].

Another factor that induced emergence of flyover as a traffic congestion mitigation tool is interruption between road and rail operation in Dhaka city. Rail contributes significantly in mass transportation system of Dhaka city by providing access to transportation for industrial or personal purposes. From the beginning, it is playing an important role in unifying the country. Several roads including major arterial roads within the Dhaka City Corporation area intersect with these railroads at level crossings to create conflicts and increase congestion and accident potential [81]. Haque (2011) found that 53% of all rail related accidents in Dhaka city occur at level crossings [82]. Thus policy-makers turned to flyovers to resolve this rail-road problem. Interestingly, almost all existing flyovers are built over the railway track to avoid congestion from waiting for the inter-district train that passes through the major intersections in the city [25].

However, the aforementioned policies and provisions are more based on pen & paper formalities and their findings and recommendations are merely implemented and followed. Decision is still dominated by the assumptions, political biases, and instilled human behaviors of the first highway-building era. The political leaders and city officials in Dhaka city developed their own visions of flyover that would speed autos to their destination, bypassing the monstrous traffic jams that clogged the major intersections. [25].

With an aim to reduce congestion in Dhaka, Government of Bangladesh (GOB) has focused on construction of flyovers and elevated, often aiming for quick implementation without using any feasibility study. Ad hoc flyover projects were proposed and implemented by different government ministries in unsynchronized manner. Myopic views of the agencies are deteriorating city condition. Even though all construction projects require Environmental Impact Assessment (EIA), Social Impact Assessment (SIA) and Traffic Impact Assessment (TIA) beforehand, such documents are only available for most of the flyover projects in Dhaka city. Often these documents are neither cross-checked by any of the authorized organizations nor undergo through post evaluation [25].

In 1987, the Roads and Highway Department (RHD) of Bangladesh first recommended construction of grade separated flyovers at four congested rail-crossings intersections [25], [83]. Mohakhali Flyover, the first flyover of Dhaka, opened in 2004 and stretched out to Ziaur Rahman road as a part of World Bank’s Dhaka Urban Transport Project

(DUTP-II). The flyover has now become an inherent part of the development of Dhaka city and several more flyovers have been built since then. However the present situation is alarming now. Dhaka's flyover now dates back to the Long Island case: turbid mass of traffic in the elevated flyovers, pushed, packed and raised between two sides. Thus it is now a matter of great concern how much flyovers are benefiting us at the moment [25]? In this light, the performance evaluation of these flyovers is imperative.

2.9 Previous Studies on Flyovers in Dhaka City

Although flyovers are familiar sights across Dhaka, only few studies have approached this subject systematically. Islam and Saha (2005) studied the impact of Mohakhali flyover as an urban element, but that was at a time when Mohakhali flyover was the sole flyover in Dhaka city. Several other flyovers constructed since then have influenced traffic operations on Mohakhali flyover, which has not been covered in this study [84].

Taleb and Majumder (2011) conducted a research on flyover projects at Khilgaon and Mohakhali and Khilgaon intersections in Dhaka. They evaluated how people in adjacent land of newly constructed flyovers are affected. The study revealed that flyover construction deteriorated the visual impact while some local businessmen experienced reduced incomes [25], [85]. However, the questionnaire surveys were conducted on an inadequate sample number, which maybe non-representative.

After looking at the city's Strategic Transport Plan (STP) and other policy documents related to transport, Akhter (2009) suggested that there is no potential for flyover in Dhaka from social, financial and economic point of view [25], [46].

Uddin (2006) performed static and dynamic linear analyses on seismic loading on Khilgaon flyover. He suggested design of such type of structure considering a probable earthquake and investigated the behavior of the Khilgaon flyover under seismic forces. However, the study neither evaluated the performance of Khilgaon flyover nor other flyovers from mobility and accessibility point of view [10].

Bureau of Research Testing and Consultation (BRTC) identified problems linked to Jatrabari and Saidabad intersection in 2008 before construction of Jatrabari-Gulistan Flyover and tried to offer rational solutions to those problems. [86]. The study identified several forms of side frictions along the corridor as well as problems affecting Jatrabari, Gulapbag and Saidabad intersections that were contributing traffic problems along this corridor. The study proposed various traditional low cost but effective traffic control and roadway capacity augmentation measures to restore level of service (LOS) as well as functionality of this corridor before advocating any expensive measure including construction of flyover. In addition, the report warned that an apparent solution might turn into a future obstacle if flyover is constructed without understanding the root causes of the problem. The report concluded against constructing capital intensive flyovers without implementing these cost effective precursor measures [86]. However, the government and policy-makers did not pay heed to the suggestions of the report and went ahead with construction of the flyover.

Kader and Hoque (2009) investigated the piers of Khilgaon Flyover in Dhaka from a structural point of view, focusing on bending strength-deformation characteristics. However, the study did not consider mobility, accessibility and performance evaluation of flyover [87].

Kader and Hoque (2010) extended their previous work on Khilgaon Flyover to analyses of lateral strength and ductility of the piers of this flyover. They evaluated lateral strengths of the piers of Khilgaon flyover analytically under bending and shear mode of failure independently and presented the results in normalized form [88].

In his analysis of railway accidents at level crossings in Dhaka city, Haque (2011) calculated the value of Traffic Moments of the accident-prone level crossings and suggested grade separation for highly accident prone level crossings [82].

While working on Jatrabari-Gulistan flyover project, Hassan and Alam (2013) recorded and analyzed noise levels in major intersections located at surrounding the flyover as well as key places, such as hospitals, educational institutions; religious institutions etc. at various periods of measurement. They also performed noise modelling for generator and wheel loader used in the construction site of flyover. In addition, noise level data of Jatrabari-Gulistan flyover, Khilgaon flyover and Kuril flyover were compared with each other [89].

After investigating on spaces beneath flyovers in Dhaka, Roushan (2013) proposed some design interventions. She forewarned that most spaces under flyovers will be inaccessible, forgotten and become a haven for illicit activities [25], [79].

Kabir (2014) assessed the socio-environmental implications of flyover in neighborhoods, focusing on changes the flyovers made in the adjacent areas and how they affected marginal occupants in the neighborhood areas. Besides, she explored makeshift communal usages and how these uses differ from people's perception of flyovers as an object of mobility. She also outlined how the flyover blighted spaces are perceived, produced and inhabited by the marginal community in a densely populated mega city like Dhaka. However, the study didn't cover the performance evaluation of these flyovers projects [25].

Islam and Kabir (2014) presented innovative use of space under Tejgaon flyover in Dhaka city for the economically marginalized and the poor. The study delved into basic standards and necessities of built environment in South Asian context along with the human perception & design possibilities for simple but quality space [90].

Hasnat, Hoque and Islam (2016) evaluated the economic, environmental and safety impact of selected at-grade railway crossings on Dhaka city. The portrayed economic losses, environmental impact and safety hazard of the busiest 7.15 kilometer railway corridor which has six level crossings. The study estimated 32.95 million USD annual losses from delays and emission in the studied level crossings [91].

Kadir, Hasan, Sen and Mitra (2016) studied nine major intersections with rail-road traffic conflict, and estimated vehicle operating cost and environmental cost for delay at major railroad intersections of Dhaka city corporation area. The study showed that total daily loss of time, annual cost of required additional fuel and cost of air pollution are 751.3 minutes, 103.59 million BDT and 8813.50 million BDT respectively for the studied nine intersections [81]. Although, the study dealt with rail-road traffic conflict in terms of vehicle operating cost and environmental cost, it did not incorporate any analysis regarding the flyover or traffic flow and mobility.

Performance evaluation with the help of VISSIM simulation software on Mohakhali flyover by Mamun, Mohammad, Haque and Riyad (2016) helped them suggest to extend the flyover by constructing additional links to and from the Gulshan Mohakhali connecting road and augment flyover capacity. They found remarkable improvement in the extended version of the flyover by simulating it in VISSIM. However, data were only collected for weekday, day period, because it considered data for only 9:30 to

10:30 am on Sunday and for 5:00 to 6:00 pm on Thursday. Flyovers besides Mohakhali flyover in Dhaka city was not considered [92].

Anwari, Hoque and Islam (2016a) emphasized on operational effectiveness of the partially grade-separated flyovers built on level crossings in Dhaka city till February 2016. They focused on assessment of vehicular as well as pedestrian safety at level crossings under those flyovers, degree of congestion and speed characteristics. However, the study did not utilise the variation of flow during different times of the day. Besides, such analysis did not incorporate flyovers built later, but still playing an important part in the transportation sector of Dhaka city [93].

Anwari, Hoque and Islam (2016b) delved deeper into the reasons for poor traffic operation and rail-road conflict at Shaheed Ahsanullah Master Flyover, identifying and evaluating the at-grade traffic movement at Tongi Level Crossing under the flyover. This paper vividly portrayed the traffic problems prevailing at Tongi Railway Crossing. However, this flyover covers only a small part of the whole city and did not extend to other flyovers in Dhaka city. So, holistic impact on mobility and accessibility in Dhaka city could not be assessed [94].

Rahman (2017) developed disaggregate induced travel demand models of transport infrastructure for Dhaka, Bangladesh. He was mainly interested in measuring trips, mode and route switch behavior, and residential mobility behaviour induced by construction of flyovers [80].

Miyauchi (2017) explored how the opening of Jatrabari-Gulistan Flyover in 2013 had influenced urban trip patterns. With the help of cellular phone data, the research claimed that about routes intersecting with flyovers generate 23.8% more trips compared to alternative routes do. Besides, the study identified a diurnal variation in trip generation between central business district and sub-urban areas [95].

In a recent study of traffic characteristics of Moghbazar-Mouchak Flyover, Rasel, Huda and Barua (2018) assessed total traffic volume, traffic composition and spot speed in weekdays and weekends. They study also evaluated the perceptions of the commuter towards the flyover [96].

Islam (2018) evaluated the performance of six partially grade-separated flyovers in Dhaka City by assessing road usage levels, congestion levels and mobility conditions across four periods of measurement, namely weekend day, weekend night, weekday day and weekday night. He was interested on public transport and non-motorized vehicles. However, he only analyzed the impact along flyover corridor and did not consider impact on adjacent roads [97].

Currently, only a handful of studies have systematically evaluated the performance and effectiveness of these flyovers in Dhaka city. Although significant research has been carried out on flyovers in abroad, these studies rarely include the performance evaluation of these flyovers in Dhaka city. The aforementioned literatures neither dealt comprehensively with the performance evaluation of these of flyovers nor did they quantify the identified problems. Besides, there is huge scope yet of incorporating temporal variation of traffic flow and volume along with pedestrian consideration in the performance evaluation of these. In this backdrop, this research is an attempt to investigate how the partially grade separated flyovers of Dhaka City have facilitated city-dwellers in terms of mobility and accessibility. The main objectives of this study are to assess the existing conditions of flyovers in Dhaka city and identify their deficiencies, conduct traffic impact assessment of the selected flyovers along the project influenced corridor, evaluate the justification of the flyovers as a remedial measure in reducing traffic congestions, and provide recommendations on implementation of future flyovers.

2.10 Overview

This chapter has methodologically arranged to elaborate on the concept of flyovers. The chapter has emphasized that improper planning and feasibility studies before construction of flyover can lead to waste of huge investments, because the surrounding at grade roads may not get the benefits as planned. Rather, more harm than good may have been done to roads. Using this argument, rationale has been provided to study performance of road network around flyovers. Different methods of performance evaluation are then explored, after which the methods are narrowed to LOS evaluation. LOS is given special emphasis in this chapter, highlighting its development over the years as well as its incorporation into the HCM. The chapter concludes by outlining the status of existing flyovers in Dhaka city as well as summarizing research previously done on flyovers in Dhaka city.

CHAPTER 3
METHODOLOGY

3.1 Introduction

Methodology provides description of the thesis work. This study includes reconnaissance survey, final field survey, observations and empirical analysis of primary and secondary data. All surveys were conducted in fair weather conditions to mitigate the effect of weather on traffic. The general study area is introduced at first. Then the procedures used and specific areas studied for each part of the study are outlined.

3.2 General Study Area

The study considered 6 partially grade separated flyovers constructed in Dhaka city till 2017. Full grade separated flyovers were ignored in this study because of their low connectivity with adjacent roads. In addition, the partially grade separated Banani-Mirpur flyover (Zillur Rahman Fyover) was not studied because of military restriction on site prevented the author from collecting sufficient data. A brief glimpse of all the flyovers in Dhaka city is provided in Table 3.1.

Table 3.1: Descriptive Characteristics of Flyovers in Dhaka City

<table>
<tr><th colspan="2">Name</th><th>Grade separation type</th><th>No. of Lanes</th><th>Length (km)</th><th>No of Ramps</th><th>Construction Cost (crore Taka)</th><th>Date of Commencement of Traffic Operations</th><th>Implementing Authority</th></tr>
<tr><td colspan="2">Mohakhali Flyover</td><td>Partial</td><td>4</td><td>1.12</td><td>2</td><td>116.00</td><td>04 November 2004</td><td>RHD</td></tr>
<tr><td colspan="2">Khilgaon Flyover</td><td>Partial</td><td>2</td><td>1.90</td><td>3</td><td>81.75</td><td>22 March 2005</td><td>LGED</td></tr>
<tr><td colspan="2">Shaheed Ahsanullah Master Flyover</td><td>Partial</td><td>2</td><td>0.35</td><td>2</td><td>23.75</td><td>23 May 2010</td><td>RHD</td></tr>
<tr><td colspan="2">Zillur Rahman Flyover</td><td>Full</td><td>4</td><td>1.79</td><td>8</td><td>199.88</td><td>27 March 2013</td><td>Bangladesh Army</td></tr>
<tr><td colspan="2">Banani Overpass</td><td>Partial</td><td>6</td><td>0.81</td><td>2</td><td>103.00</td><td>27 December 2012</td><td>Bangladesh Army</td></tr>
<tr><td colspan="2">Bijoy Sarani-Tejgaon Link Road Flyover</td><td>Full</td><td>4</td><td>1.14</td><td>2</td><td>168.00</td><td>20 April 2010</td><td>RAJUK</td></tr>
<tr><td colspan="2">Kuril Flyover</td><td>Full</td><td>2</td><td>3.10</td><td>10</td><td>254.00</td><td>04 August 2013</td><td>RAJUK</td></tr>
<tr><td colspan="2">Jatrabari-Gulistan Flyover</td><td>Partial</td><td>4</td><td>11.8</td><td>13</td><td>2,300.00</td><td>11 October 2013</td><td>Orion Group</td></tr>
<tr><td rowspan="4">Moghbazar -Mouchak Flyover</td><td>Phase 1</td><td>Partial</td><td>4</td><td>2.00</td><td rowspan="4">15</td><td rowspan="4">1218.89</td><td>30 March 2016</td><td rowspan="4">LGED</td></tr>
<tr><td rowspan="2">Phase 2</td><td>Partial</td><td>1</td><td>2.25</td><td>15 September 2016</td></tr>
<tr><td>Partial</td><td>1</td><td>0.45</td><td>17 May 2017</td></tr>
<tr><td>Phase 3</td><td>Partial</td><td>2</td><td>4.00</td><td>26 October 2017</td></tr>
</table>

The location of each flyover is shown in the following google map image. In addition, the area adjacent to each considered flyover has been extensively studied to assess the impact of flyover on both the corridor and the adjacent area. The studied road segments beside each flyover are represented in the following google maps as shown in Figures 3.1 to 3.6

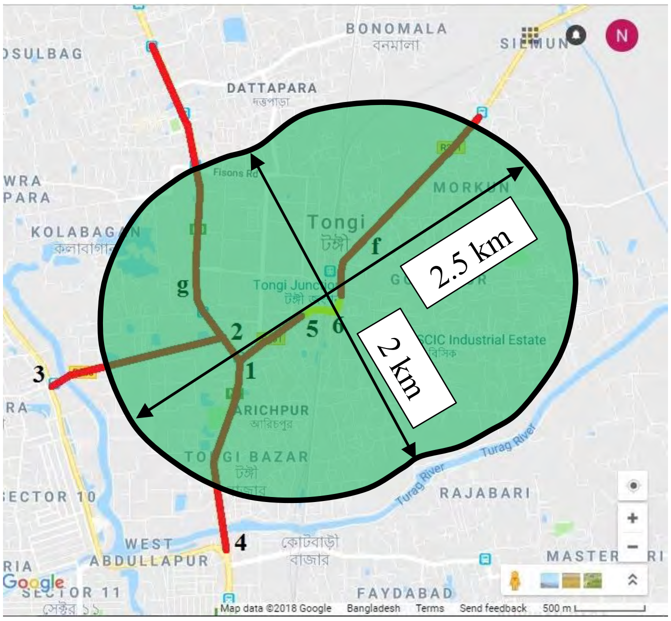


Figure 3.1: Study Area of Shaheed Ahsanullah Master Flyover

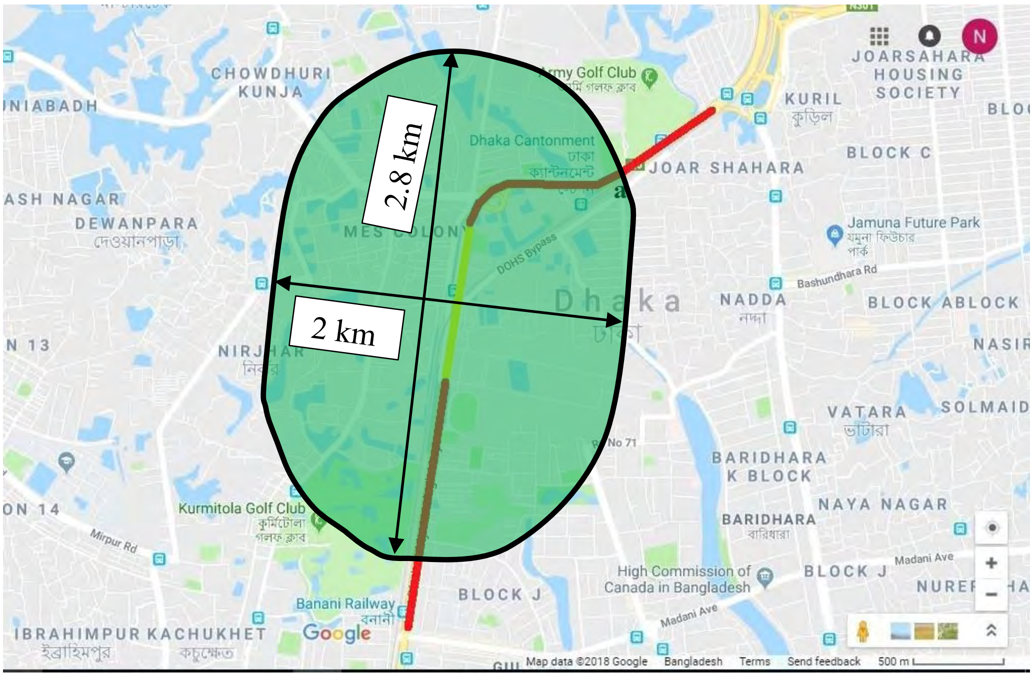


Figure 3.2: Study Area of Banani Overpass

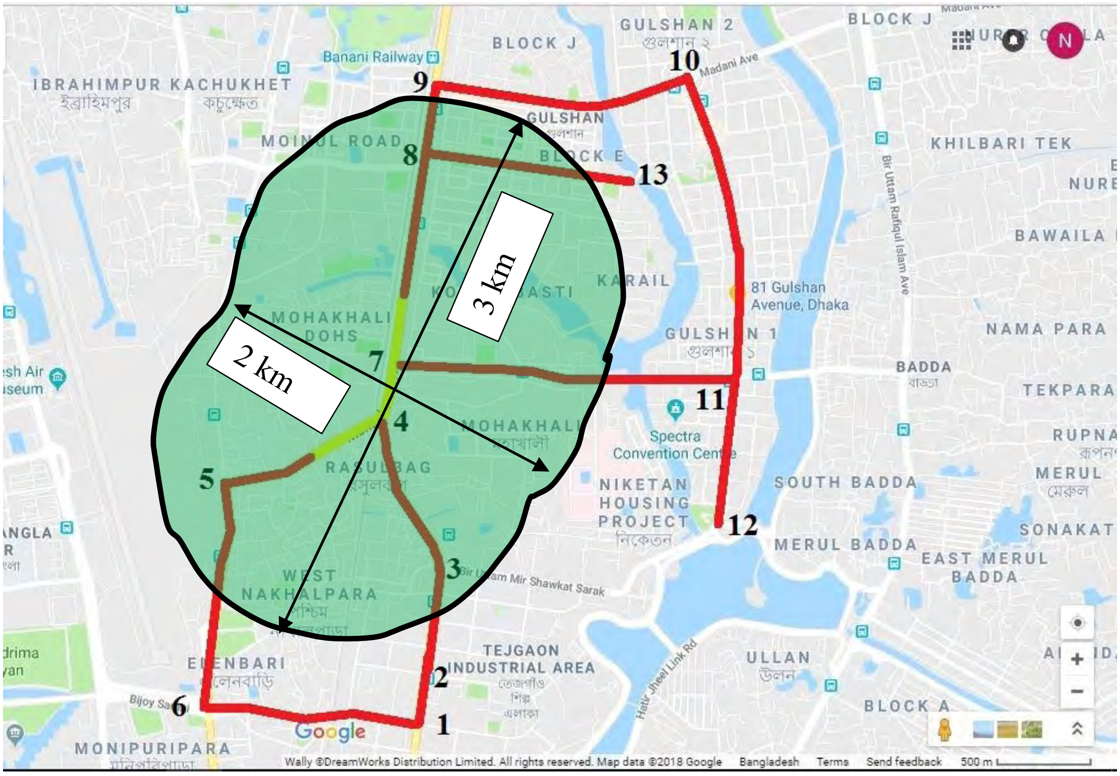


Figure 3.3: Study Area of Mohakhali Flyover

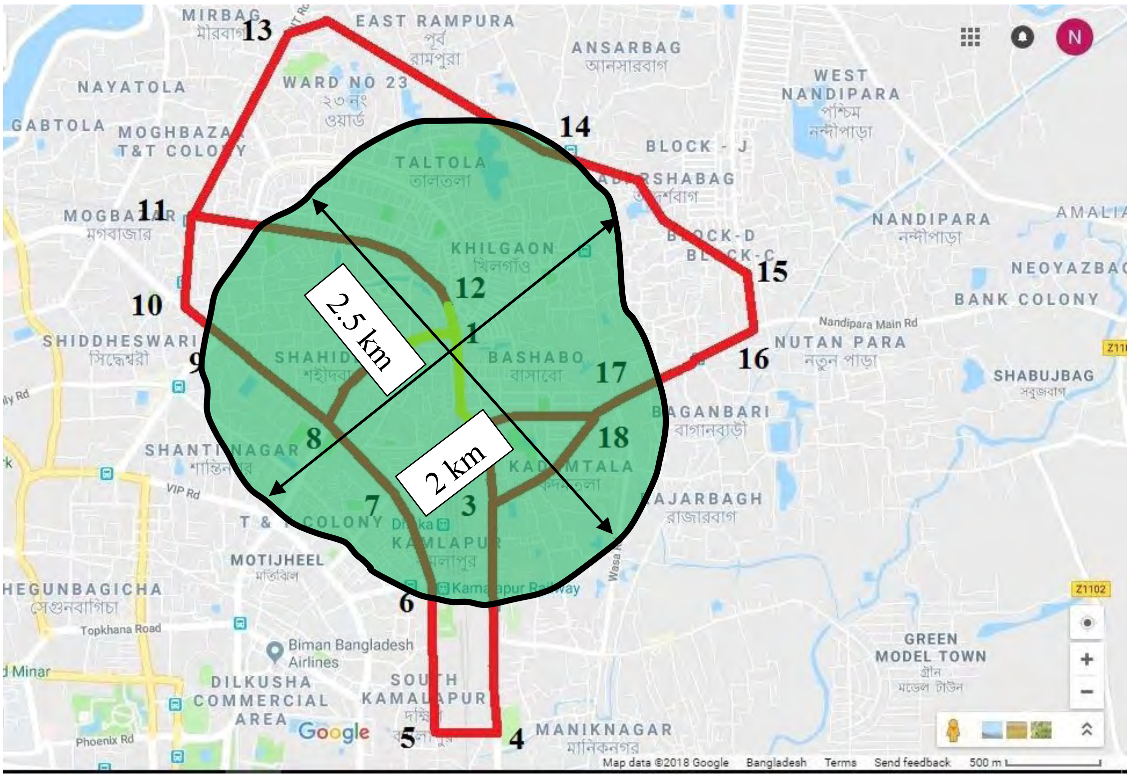


Figure 3.4: Study Area of Khilgaon Flyover

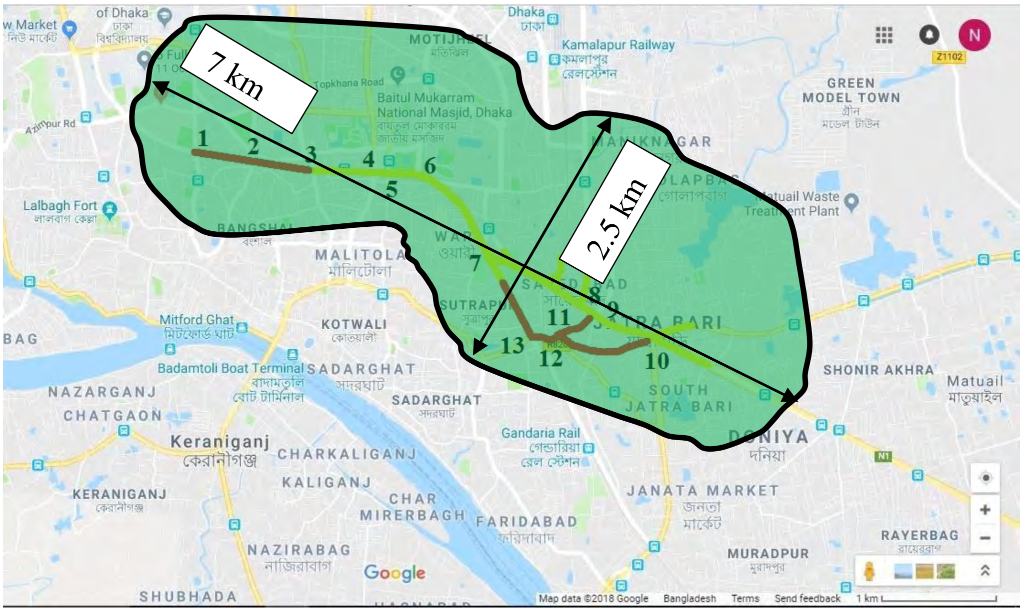


Figure 3.5: Study Area of Jatrabari-Gulistan Flyover

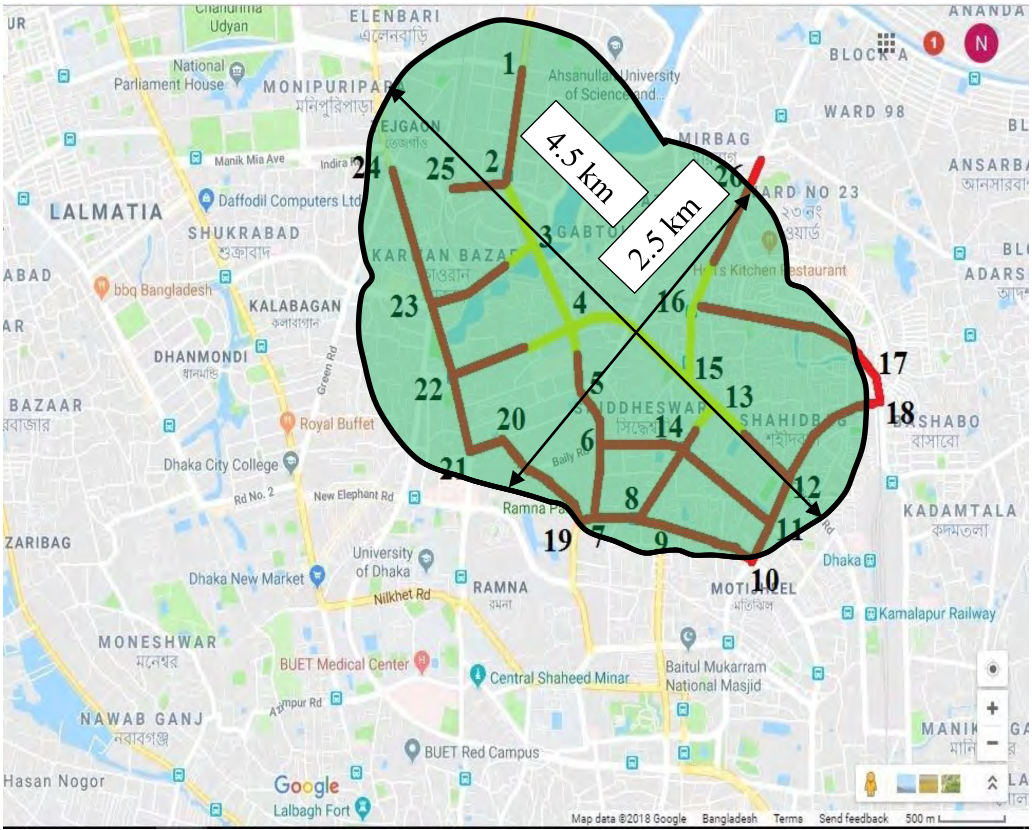


Figure 3.6: Study Area of Moghbazar-Mouchak Flyover

In Figures 3.1 to 3.6, the studied roadway segments are bound by the labelled intersections. The yellow lines indicate the route along the flyover corridor while the red lines indicate the route adjacent to the flyover. The shaded green area shows the influence area around each flyover. The study area of Ahsanulah Master Flyover is exceptional because it has both urban street segments and multi-lane highways. 5 urban street segments and 2 multi-lane highways (labeled f and g) were studied around Ahsanullah Master Flyover. All street segments of the remaining flyovers are treated as urban street segments. The street segments of each flyover along with their lengths are shown in the following table.

Table 3.2: Segment Labels of Each Flyover

Ahsanullah Master Flyover		**Banani Overpass**		**Mohakhali Flyover**	
Segment Label	Length (km)	Segment Label	Length (km)	Segment Label	Length (km)
1-2	0.22	a	-	1-2	0.27
2-3	1.29			2-3	0.59
1-4	1.38			3-4	0.85
1-5	0.68			4-5	0.91
5-6	0.14			5-6	1.22
f	-			6-1	1.13
g	-			4-7	0.30
				7-8	1.15
				7-11	1.83
				8-9	0.35
				8-13	1.22
				9-10	1.38
				10-11	1.66
				11-12	0.85
Khilgaon Flyover		**Jatrabari-Gulistan Flyover**		**Moghbazar-Mouchak Flyover**	
Segment Label	Length (km)	Segment Label	Length (km)	Segment Label	Length (km)
1-2	0.52	1-2	0.50	1-2	0.75
2-3	0.41	2-3	0.54	2-3	0.43
3-4	1.25	3-4	0.54	2-25	0.54
4-5	0.32	4-5	0.12	3-4	0.61
5-6	0.81	5-6	0.26	3-23	0.87
6-7	0.49	6-7	1.00	4-5	0.4
7-8	0.52	7-8	0.86	4-15	1.01
8-9	0.74	8-9	0.17	4-22	0.97
9-10	0.28	9-10	0.53	5-6	0.43
10-11	0.47	10-11	0.85	6-7	0.47
11-12	1.52	9-11	0.37	6-14	0.63
12-1	0.14	11-12	0.10	7-8	0.37
1-8	0.89	12-13	0.17	7-19	0.1
11-13	1.09	7-13	0.73	8-9	0.15
13-14	1.69	8-14	0.52	8-14	0.55
14-15	1.17			9-10	0.73
15-16	0.30			10-11	0.27
16-17	0.84			11-12	0.34
17-18	0.13			11-14	0.82
18-2	0.64			12-13	0.74
18-3	0.74			12-18	0.89

(Table 3.2 continued)

Khilgaon Flyover		Jatrabari-Gulistan Flyover		Moghbazar-Mouchak Flyover	
Segment Label	Length (km)	Segment Label	Length (km)	Segment Label	Length (km)
				13-14	0.37
				13-15	0.28
				15-16	0.47
				16-17	1.52
				17-18	0.14
				19-20	0.8
				20-21	0.27
				21-22	0.51
				22-23	0.47
				23-24	1.09

The position of all these six flyovers in Dhaka city have been depicted in Figure 3.7 to visualize and understand better its geographical position and probable demographic and traffic characteristics. For calculation purposes, the lengths of only urban street segments were required. So, lengths of multilane highway segments were not determined. Wherever suitable, the following abbreviated versions of the studied flyovers will be used in this thesis: Shaheed Ahsanullah Master Flyover (SAMF); Jatrabari-Gulistan Flyover, also known as Mayor Mohammad Hanif Flyover (MMHF); and Moghbazar-Mouchak Flyover (MMF).

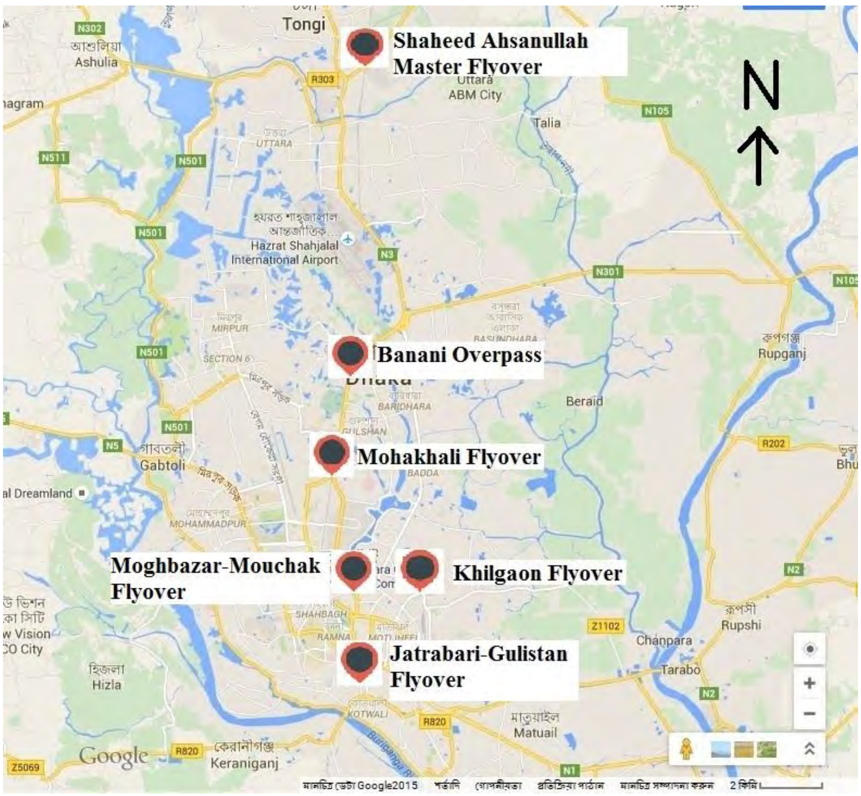


Figure 3.7: Locations of Studied Flyovers

3.3 Reconnaissance Survey

A reconnaissance survey was conducted to realize the alignment of the study corridor and the surrounding land use. All studied flyovers were initially visited to visualize the field condition, and assess method to conduct the surveys and analyses. Reconnaissance survey was conducted by walking along each flyover corridor (both above grade and at grade) and on the adjacent areas of each flyovers. The long lengths of the study corridor and temporal variation of data taken behooved several months of empirical studies. Hence, the survey started on 17 March 2017 and ended on 11 October 2017.

3.4 Assessment of Roadway Conditions

During Reconnaissance survey roadway conditions of all studied segments were observed, and the following data for each direction of road segment were recorded: approach grades at intersections, parking maneuver rate, bus stoppage rate, lane width and presence of exclusive turning lanes. In addition, from land use patterns it was determined whether the road segment was beside a commercial area or not. Commercial areas attract lot of public activities and slow down vehicle flow. Parking maneuver rate represents the number of vehicles attempting to park or leave parking area per hour. Bus stoppage rate represents the number of buses stopping to pick up or drop off passengers per hour. Lane width was measured by measuring total roadway width using odometer then dividing the width by the number of lanes.

3.5 Classified Traffic Count

15-minute classified traffic counts were performed by Cordon count method during four periods of measurement, namely, weekend day, weekend night, weekday day and weekday night. As per HCM (2010) [57] a 15-minute analysis period should be used for operational analyses. This duration will accurately capture the adverse effects of demand peaks. a complete evaluation should always include an analysis of conditions during the 15-minute period that experiences the highest traffic demand during a 24-hour period. HCM (2010) allows use of longer analysis periods (upto 1 hour) but discourages 1 hour or longer analysis periods, because the adverse impact of short peaks in traffic demand may not be detected.

If traffic demand exceeds capacity for a given 15-minute analysis period, then a multiple-period analysis should be conducted. This type of analysis consists of an evaluation of several consecutive 15-minute time periods. The periods analyzed would include an initial analysis period that has no initial queue, one or more periods in which demand exceeds capacity, and a final analysis period that has no residual queue. Field observations revealed that demand exceeded capacity at peak 15-minute analysis period. However, because of budget constraints it was not possible to conduct multiple period surveys. Hence, only peak 15-minute period traffic count was considered in this study.

The peak time representing the highest traffic flow was found after manual analysis of 24 hour traffic flow count obtained by preliminary investigations on site. Vehicles were videoed by enumerators at each studied segment of the respective flyover. For each flyover, its segments were simultaneously videoed to properly measure and compare traffic flow at each segment. Vehicles were then counted after analyzing video. Classified traffic count is later used to calculate flow-capacity ratio and assess the level of service of each roadway segment in each direction. This study classifies vehicles into the following mode:

1. Rickshaw
2. Motorcycle
3. Bicycle
4. Car/ Jeep/ Microbus
5. CNG
6. Human Hauler
7. Bus
8. Utility
9. Truck

Traffic count is converted to one hour traffic flow using peak hour factor (PHF).

3.6 Assessment of Free Flow Speed

HCM (2010) defines Free Flow Speed (FFS) as the average speed of the traffic stream when traffic volumes are sufficiently low that drivers are not influenced by the presence of other vehicles and when intersection traffic control is not present or is sufficiently distant as to have no effect on speed choice [57]. Spot speeds were taken at free flow conditions by timing vehicles over a 100 feet segment at free flow conditions. Longer lengths could have induced unwanted speed variations. On the other hand, shorted lengths may make human errors in recording time significant.

The following basic guidelines were followed in selecting a suitable stretch to obtain accurate results:

1. Any location may be used for solution of a specific traffic engineering problem.
2. The geometry of road should be plain, without any adulation or slope.
3. For accurate results, selection a section where is road condition is good and where drivers drive comfortably.
4. Intersections joining or diverting traffic should not interrupt the traffic flow or speed of the vehicles passing the stretch.
5. The stretch should be free from speed breakers, precaution signs etc., and the drivers should be able to travel with their natural style.
6. Experimentation should be done in the time of free traffic flow.
7. The drivers should not be aware of the experiment going on, else he may be distracted.

Intra-frame scene capture based on superimposed image at free-flow conditions was used to determine travel time at free flow conditions and subsequently space mean FFS. FFS was measured for each class of vehicle. Flow conditions are considered "free" when less than 12 vehicles per mile are on a road, translating to a space headway of minimum 137 m between consecutive vehicles [98]. Hence, a video camera aimed at a 150m selected segment of the road at mid-block was used to capture vehicle images and calculate speeds. The speed was considered FFS if there was no vehicle preceding the target vehicle in the 150 m segment. Preliminary video footage during initial reconnaissance survey to determine general time for free flow conditions revealed that free flow occurred during 6am-8am (day) and 1am-5am (night). Thus FFS was measured during those times.

3.7 Assessment of Travel Speed

Floating car method was used to assess travel speed at each direction of each segment by recording the travel time (including motion time, segment delay and through vehicle delay) and dividing the segment length by the travel time. So this speed considers any stop-time delay. Motion time includes time spent by vehicle in motion. Segment delay is additional time spent by vehicle on road if it had to slow down or stop because of a traffic obstruction in the segment, such as lane changing behaviors of other vehicles, or if pedestrians crossing mid-block obstructed vehicles. Through vehicle delay is the time spent by through vehicles in traffic congestion at the intersections. A permitted error of ± 1.0 miles/hour and 95% confidence interval was chosen to get speed difference (R) of 4 miles/hour between maximum and minimum value of travel times. As a result, a minimum of 10 test runs were required as per Manual of Transportation Engineering Studies [99]. Hence, 10 test runs over each segment was done during peak hour to determine the travel speed. Segment length was found using Google map.

3.8 Determination of Signal Timings

Signal timings are necessary to calculate approach capacity at an intersection. For each considered intersection, cycle time and green time at each direction were measured using stopwatch. All signal timings were assumed as fixed time signals.

3.9 Assessment of Level of Service

Level of Service (LOS) is determined separately for multilane highways and urban street segments, as described below.

3.9.1 Urban street segments

HCM (2010) defines an urban street segment as a length of urban street from one boundary intersection to the next, including the upstream boundary intersection but not the downstream boundary intersection. For the purpose of analysis, the urban street is separated into individual elements that are physically adjacent and operate as a single entity for the purpose of serving travelers. Two elements are commonly found on an urban street system: points and links. A point represents the boundary between links and is usually represented by an intersection or ramp terminal. A link represents a length of roadway between two points. A link and its boundary intersections are referred to as a segment. An urban street facility is a length of roadway that is composed of contiguous urban street segments and is typically functionally classified as an urban arterial or collector street [57].

The methodology used to calculate LOS for urban street segments is provided below.

Step One: Determine Free Flow Speed

Free flow speed was measured according to procedure outlined previously.

Step Two: Determine Travel Speed

Free flow speed was measured according to procedure outlined previously.

Step Three: Determine Saturation Flow Rate

HCM (2010) defines saturation flow rate the number of vehicles per hour per lane that could pass through a signalized intersection if a green signal was displayed for the full hour, the flow of vehicles never stopped, and there were no large headways [57]. Saturation flow rate is calculated for each direction of each segment of study area. Adjusted saturation flow rate is determined using the following equation.

$$s = s_o f_w f_{HV} f_g f_p f_{bb} f_a f_{LU} f_{LT} f_{RT} f_{Lpb} f_{Rpb}$$

where:

s = adjusted saturation flow rate (pcu/h/ln)

s_o = base saturation flow rate (pcu/h/ln)

f_w = adjustment factor for lane width

f_{HV} = adjustment factor for heavy vehicles in traffic stream

f_g = adjustment factor for approach grade

f_p = adjustment factor for existence of a parking lane and parking activity adjacent to lane group

f_{bb} = adjustment factor for blocking effect of local buses that stop within intersection area

f_a = adjustment factor for area type

f_{LU} = adjustment factor for lane utilization

f_{LT} = adjustment factor for left-turn vehicle presence in a lane group

f_{RT} = adjustment factor for right-turn vehicle presence in a lane group

f_{Lpb} = pedestrian adjustment factor for left-turn groups

f_{Rpb} = pedestrian-bicycle adjustment factor for right-turn groups.

Parameters used to determine saturation flow rate have been determined using the methods explained in the following sub-sections.

Adjustment Factor for Lane Width

f_W is calculated according to the following table provided in HCM (2010). Procedure followed to measure lane width was mentioned earlier.

Table 3.3: Lane Width Adjustment Factor

Average Lane Width (ft)	Adjustment Factor (fw)
<10.0"	0.96
>10.0-12.9	1.00
>12.9	1.04

Adjustment Factor for Heavy Vehicles in Traffic Stream

f_{HV} is calculated using the following equation.

$$f_{HV} = 100/(100 + P_{HV} (E_T - 1))$$

where:

P_{HV} = percent heavy vehicles in the corresponding movement group (%), and

E_T = equivalent number of through cars for each heavy vehicle = 2.0.

This factor does not address local buses that stop in the intersection area. So local buses were not included in the calculation of the above equation.

Adjustment Factor for Approach Grade

f_g is calculated using the following equation:

$$f_g = 1 - P_g /200$$

where:

P_g = the approach grade for the corresponding movement group (%).

This factor applies to grades ranging from -6.0% to +10.0%. An uphill grade has a positive value and a downhill grade has a negative value.

Adjustment Factor for Existence of a Parking Lane and Parking Activity Adjacent to Lane Group

f_P is calculated using the following equation

$$f_P = \frac{N - 0.1 - \frac{18N_m}{3600}}{N} \geq 0.05$$

where:

N_m = parking maneuver rate adjacent to lane group (maneuvers/h), and

N = number of lanes in lane group (ln)

If no parking is present, then f_P a value of 1.00. The parking maneuver rate corresponds to parking areas directly adjacent to the lane group and within 250 ft upstream of the stop line. A practical upper limit of 180 maneuvers/h should be maintained with Equation 18-8.A minimum value off,, from this equation is 0.050. Each maneuver (either in or out) is assumed to block traffic in the lane next to the parking maneuver for an average. The factor applies only to the lane group that is adjacent to the parking.

Adjustment Factor for Blocking Effect of Local Buses that Stop Within Intersection Area

f_{bb} is calculated according to the following equation

$$f_{bb} = \frac{N - \frac{14.4N_b}{3600}}{N} \geq 0.05$$

where:

N = the number of lanes in lane group (ln)

N_b = the bus stopping rate on the subject approach (buses/h).

HCM (2010) recommends that this factor should be used only when stopping buses block traffic flow in the subject lane group. A practical upper limit of 250 buses/h should be maintained [57]. The factor used here assumes an average blockage time of 14.4 s during a green indication.

Adjustment Factor for Area Type

The area type adjustment factor f_A accounts for the inefficiency of intersections in CBDs relative to those in other locations. When used, it has a value of 0.90. It should be used in areas where the geometric design and the traffic or pedestrian flows, or both, are such that the vehicle headways are significantly increased.

Adjustment Factor for Lane Utilization

The input lane utilization adjustment factor, f_{LU} is used to estimate saturation flow rate for a lane group with more than one exclusive lane. If the lane group has one shared lane or one exclusive lane, then this factor is 1.0.

Adjustment Factor for Left-turn Vehicle Presence in a Lane Group

f_{RT} is calculated according to the following equation

$f_{RT} = 1/E_R$

where:

E_R = equivalent number of through cars for a protected right-turning vehicle

Adjustment Factor for Right-turn Vehicle Presence in a Lane Group

f_{LT} is calculated according to the following equation

$f_{LT} = 1/E_L$

where:

E_L = equivalent number of through cars for a protected left-turning vehicle

=1.05 for protected movement

Step 4: Determine Segment Capacity

HCM (2010) defines the capacity of a movement group as the maximum number of vehicles that can discharge from a queue during the analysis period, divided by the analysis period duration. It is the maximum sustainable flow rate at which vehicles can be reasonably expected to traverse a point or a uniform segment of a lane or roadway during a specified time period under given conditions. This value is needed for the movements entering the segment at the upstream boundary intersection and for the movements exiting the segment at the downstream boundary intersection. [57]. Capacity of each direction of each segment is calculated using the following equation.

c =Nsg/C

where:

c = capacity (veh/h)

N = number of lanes (ln)

s = saturation flow rate (veh/h)

g = effective green time (s)

C = cycle time (s)

The above equation applies to the capacity of a given lane group serving one traffic movement, and for which there are no permitted left-turn movements. Capacity applies to a segment while saturation flow applies to an intersection.

Step 5: Determine Level of Service (LOS)

TS/FFS ratio and Flow/Capacity ratio are calculated for each direction of each segment of the study area. This is then used to calculate LOS of that segment direction for the study period using the following table.

Table 3.4: LOS Criteria for Automobiles for Urban Street Segments

Travel Speed as a Percentage of Base Free-Flow Speed (%)	LOS by Volume-to-Capacity Ratio	
	≤ 1	≥ 1
>85	A	F
>67-85	B	F
>50-67	C	F
>40-50	D	F
>30-40	E	F
≤ 30	F	F

LOS is calculated here using Volume-to-Capacity ratio (also called Flow/Capacity ratio) of through movement at downstream boundary intersection. It is to be mentioned here that NMVs were omitted in LOS calculations. Only automobiles were considered.

The reasons for such are explained in Chapter 4, Data Collection and Analysis when the topic arises. A summary of the procedure to determine LOS is outlined in the flowchart in Figure 3.8.

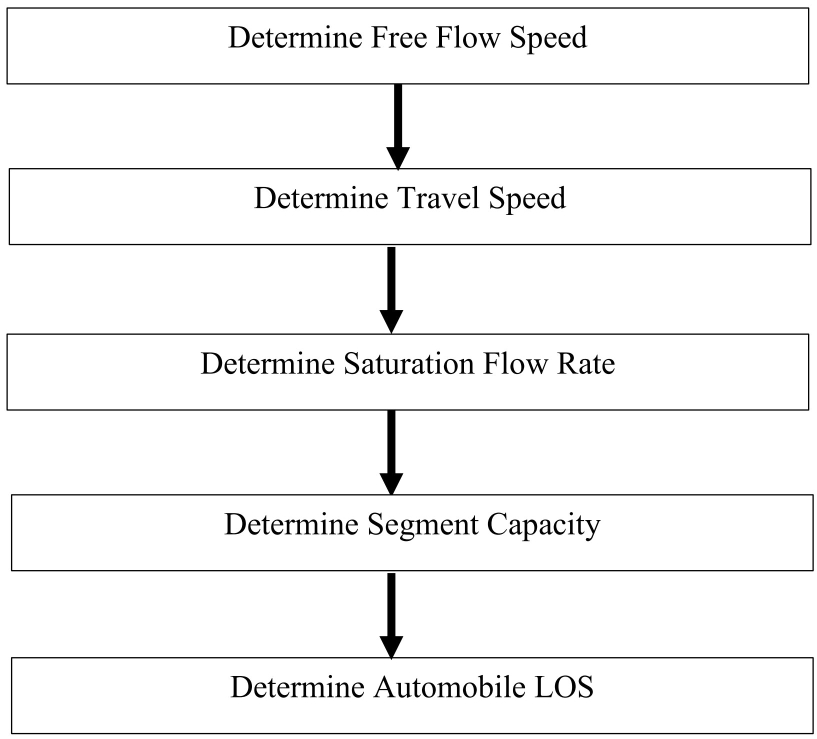


Figure 3.8: Determination of Automobile LOS for Urban Street Segments

3.9.2 Multilane highways

HCM (2010) defines multilane highway as a highway with at least two lanes for the exclusive use of traffic in each direction, with no control or partial control of access, but that may have periodic interruptions to flow at signalized intersections no closer than 2 miles [57]. The methodology used to calculate LOS for urban street segments is provided below.

Step One: Input Data

The following parameter values (with either site specific or default values) are specified at first: demand volume; number and width of lanes; right side and median lateral clearance; type of median; roadside access points per mile; percent of heavy vehicles, such as trucks, buses, and RVs; PFFF; terrain; and driver population factor.

Step Two: Compute FFS

FFS is the mean speed of passenger cars measured during periods of low to moderate flow (up to 1,400 pcu/h/ln). For a specific multilane highway segment, speeds are virtually constant in this range of flow rates. FFS can be determined directly from field measurements or can be estimated as described in HCM (2010) using posted speed limits and accompanying factors to adjust calculated speed. However, HCM (2010) recommends using field measurements if possible. Hence FFS of each study area was measured on field using procedure mentioned previously (Assessment of FFS). Additional benefits to using field values is that further adjustment factors to speed are not necessary.

Step 3: Select FFS Curve

Once the multilane highway segment's FFS is determined, one of the four base speed-flow curves shown in the following figure is selected for use in the analysis. The following figure is a reproduction of Exhibit 14-2 of HCM (2010) [57].

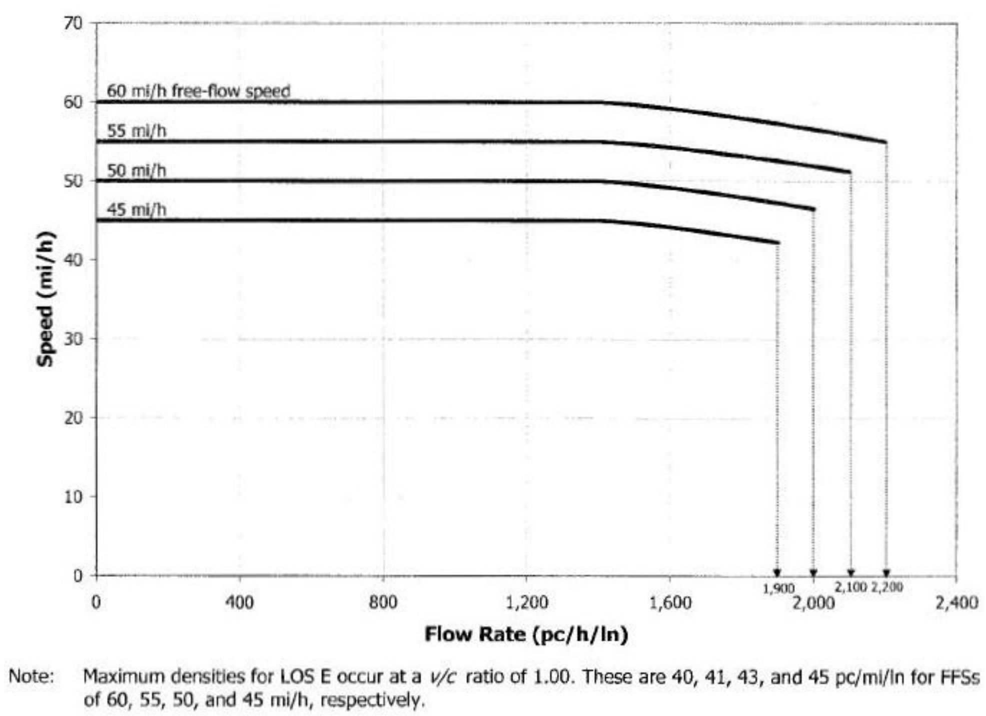


Figure 3.9: Speed-Flow Curves for Multilane Highways at Base Conditions

Equations describing the above curves are provided in the following table.

Table 3.5: Equations Describing Speed-Flow Curves for Multilane Highways

FFS (mi/h)	For $v_P \leq 1400$ pcu/h/ln, Speed (mi/h)	For $v_P > 1400$ pcu/h/ln, Speed (mi/h)
60	60	$60-[5.00 \times \{(v_P - 1400)/800\}^{1.31}]$
55	55	$55-[3.78 \times \{(v_P - 1400)/700\}^{1.31}]$
50	50	$50-[3.49 \times \{(v_P - 1400)/600\}^{1.31}]$
45	45	$45-[2.78 \times \{(v_P - 1400)/500\}^{1.31}]$

HCM (2010) does not recommend interpolating between curves, rather advises to use the following criteria for selecting an appropriate curve:

42.5 mi/h< FFS < 47.5 mi/h: use FFS= 45 mi/h,

47.5 mi/h< FFS< 52.5 mi/h: use FFS= 50 mi/h,

52.5 mi/h< FFS < 57.5 mi/h: use FFS = 55 mi/h,

57.5 mi/h< FFS < 62.5 mi/h: use FFS = 60 mi/h.

It means that observe FFS are rounded to the nearest 5 mi/h for selecting appropriate FFS curve. This method is followed in this study.

Step 4: Adjust Demand Volume

The basic speed-flow curves of Figure 3.9 are based on flow rates in equivalent passenger cars per hour, with the driver population dominated by regular users of the multilane highway segment. Demand volumes expressed as vehicles per hour under prevailing conditions must be converted to this basis the following equation is used for this adjustment:

$$v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p}$$

where:

v_p = demand flow rate under equivalent base conditions (pcu/h/ln)

V = demand volume under prevailing conditions (pcu/h)

PHF = peak hour factor

N = number of lanes (one direction)

f_{HV} = adjustment factor for presence of heavy vehicles in traffic stream

f_p = adjustment factor for atypical driver populations,

The above parameters are explained in detail below.

Peak Hour Factor

HCM (2010) defines peak hour factor (PHF) as the hourly ratio of hourly volume during analysis hour to the peak 15-minute flow rate within the analysis hour. The PHF represents the variation in traffic flow within an hour. Observations of traffic flow consistently indicate that the flow rates found in the peak 15 minutes within an hour are not sustained throughout the entire hour. The application of the PHF in above equation accounts for this phenomenon. On multilane highways, typical PHFs range from 0.75 to 0.95. Lower values are typical of lower-volume conditions. Higher values are typical of urban and suburban peak-hour conditions. Field data should be used if possible to develop PHFs that represent local conditions. HCM (2010) recommends using PHF value of 0.88 for rural multilane highways and 0.95 for suburban facilities [57]. Since local data was not available in this study, and all multilane highways in the study were observed to be part of suburban facilities, PHF value of 0.95 is used in this study.

Adjustment Factor for Presence of Heavy Vehicles in Traffic Stream

f_{HV} is calculated using the following equation

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$

where:

f_{HV} = heavy-vehicle adjustment factor,

P_T = proportion of trucks and buses in traffic stream,

P_R = proportion of RVs in traffic stream,

E_T = passenger car equivalent (PCE) of one truck or bus in traffic stream,

E_R = PCE of one RV in traffic stream.

A heavy vehicle is defined as any vehicle with more than four wheels on the ground during normal operation. Such vehicles are generally categorized as trucks, buses, or RVs. Trucks cover a wide variety of vehicles, from single-unit trucks with double rear tires to triple-unit tractor-trailer combinations. Small panel or pickup trucks with only four wheels are, however, classified as passenger cars. Buses include intercity buses, public transit buses, and school buses. Because buses are in many ways similar to single-unit trucks, both types of vehicles are considered in one category. RVs include a wide variety of vehicles from self-contained motor homes to cars and small trucks with trailers (for boats, all-terrain vehicles, or other items). In many cases, trucks will be the only heavy vehicle present in the traffic stream. In others, the percentage of RVs will be small compared with trucks and buses. If the ratio of trucks and buses to RVs is 5:1 or greater, all heavy vehicles may be (but do not have to be) considered to be trucks. In this study none of the road segments were observed to have RVs. So the above equation is limited to trucks and buses only in this study.

PCE of One Truck or Bus in Traffic Stream

PCE of one truck or bus in traffic stream, E_T, is determined according to terrain types. In this regard, HCM (2010) considers three types of terrains, namely General Terrain, Upgrades and Downgrades.

General terrain refers to extended lengths of multilane highway containing a number of upgrades and downgrades where no single grade is long enough or steep enough to have a significant impact on the operation of the overall segment. As a guideline for this determination, extended-segment analysis can be applied where no one grade of 3% or more is longer than 0.25 miles, or where no single grade between 2% and 3% is longer than 0.50 miles.

Any grade between 2% and 3% and longer than 0.5 mi, or 3% or greater and longer than 0.25 mi, should be considered to be a separate segment. The analysis of such segments must consider the upgrade conditions and the downgrade conditions separately, as well as whether the grade is a single, isolated grade of constant percentage or part of a series forming a composite grade. Knowledge of specific impacts of heavy vehicles on operating conditions on downgrades is limited. In general, if the downgrade is not severe enough to cause trucks to shift into a lower gear (to engage engine braking), heavy vehicles may be treated as if they were on level terrain segments. Where a downgrade is severe, trucks must often use low gears to avoid gaining too much speed and running out of control. In such cases, their effect on operating conditions is more significant than on level terrain.

In this study, because of budget constraints, it was not possible to accurately measure grades of multilane highways. However, field observations showed the studied segments to be more or less level. Hence, all multilane highway segments were assumed to fall under general terrain category. As per HCM (2010), There are three categories of general terrain, namely:

1. **Level terrain:** Any combination of grades and horizontal or vertical alignment that permits heavy vehicles to maintain the same speed as passenger cars. This type of terrain typically contains short grades of no more than 2%. Here, E_T = 1.5 and E_R = 1.2.
2. **Rolling terrain:** Any combination of grades and horizontal or vertical alignment that causes heavy vehicles to reduce their speed substantially below that of passenger cars but that does not cause heavy vehicles to operate at crawl speeds for any significant length of time or at frequent intervals. Crawl speed is the maximum sustained speed that trucks can maintain on an extended upgrade of a given percent. If the grade is long enough, trucks will be forced to decelerate to the crawl speed, which they can maintain for extended distances. Appendix A of Chapter 11, Basic Freeway Segments, HCM (2010) contains truck performance curves that provide truck speeds for various lengths and severities of grade. The same curves may be used for uninterrupted-flow segments on multilane highways. Here, E_T = 2.5 and E_R = 2.0.
3. **Mountainous terrain:** Any combination of grades and horizontal and vertical alignment that causes heavy vehicles to operate at crawl speed for significant distances or at frequent intervals. Mountainous terrain is relatively rare. Generally, in segments severe enough to cause the type of operation described for mountainous terrain, there will be individual grades that are longer and steeper than the criteria for general terrain analysis. Here, E_T = 4.5 and E_R = 4.0

In this study, the segments were assumed to fall under level terrain category. Hence, in this study, values of E_T and E_R are 1.5 and 1.2 respectively.

Adjustment Factor for Atypical Driver Populations

The base traffic stream characteristics for multilane highway segments are representative of regular drivers in a traffic stream composed substantially of commuters, or drivers who are familiar with the facility. It is generally accepted that traffic streams composed of driver populations with different characteristics (e.g., recreational drivers) use freeways less efficiently. The adjustment factor f_p is used to reflect the effect of driver population. The values off usually range from 0.85 to 1.00, although lower values have been observed in some cases. HCM (2010) recommends using a value of 1.00 in general, which is followed in this study. It means that drivers are assumed to be familiar with their respective roadway facilities.

Step 5: Estimate Speed and Density

At this point in the methodology, the following have been determined: (a) the FFS and appropriate FFS curve for use in the analysis, and (b) the demand flow rate expressed in passenger cars per hour per lane under equivalent base conditions. With this information, the estimated speed and density of the traffic stream can be determined. With the equations specified in Table 3.5, the expected mean speed of the traffic stream can be computed. A graphical solution using Figure 3.9 can also be performed. This study followed the graphical approach. With the estimated speed determined, the following equation is used to estimate the density of the traffic stream:

$$D = v_P / S$$

where:

D = density (pc/mi/ln),
v_P = demand flow rate (pc/h/ln), and
S = mean speed of traffic stream (mi/h).

Step 6: Determine LOS

Expected prevailing LOS is determined using the following table after entering the density obtained from previous equation, and considering the flow/capacity ratio.

Table 3.6: LOS Criteria for Automobiles for Multilane Highway

LOS	FFS (mi/h)	Density (pc/mi/ln)
A	All	>0-11
B	All	>11-18
C	All	>18-26
D	All	>26-35
E	60	>35-40
	55	>35-41
	50	>35-43
	45	>35-45
F	Demand Exceeds Capacity	
	60	>40
	55	>41
	50	>43
	45	>45

As per HCM (2010), the capacity of a multilane highway segment under base conditions varies with the FFS. For 60-mi/h FFS, the capacity is 2,200 pcu/h/ln. For lesser FFSs, capacity diminishes. For 55-mi/h FFS, the capacity is 2,100 pcu/h/ln; for 50-mi/h FFS, 2,000 pcu/h/ln; and for 45-mi/h FFS, 1,900 pcu/h/ln. Since local data of study area was not available, the above-mentioned values were used to determine capacity of multilane highways in this study. A summary of the procedure to determine LOS is outlined in the following flow chart in Figure 3.10.

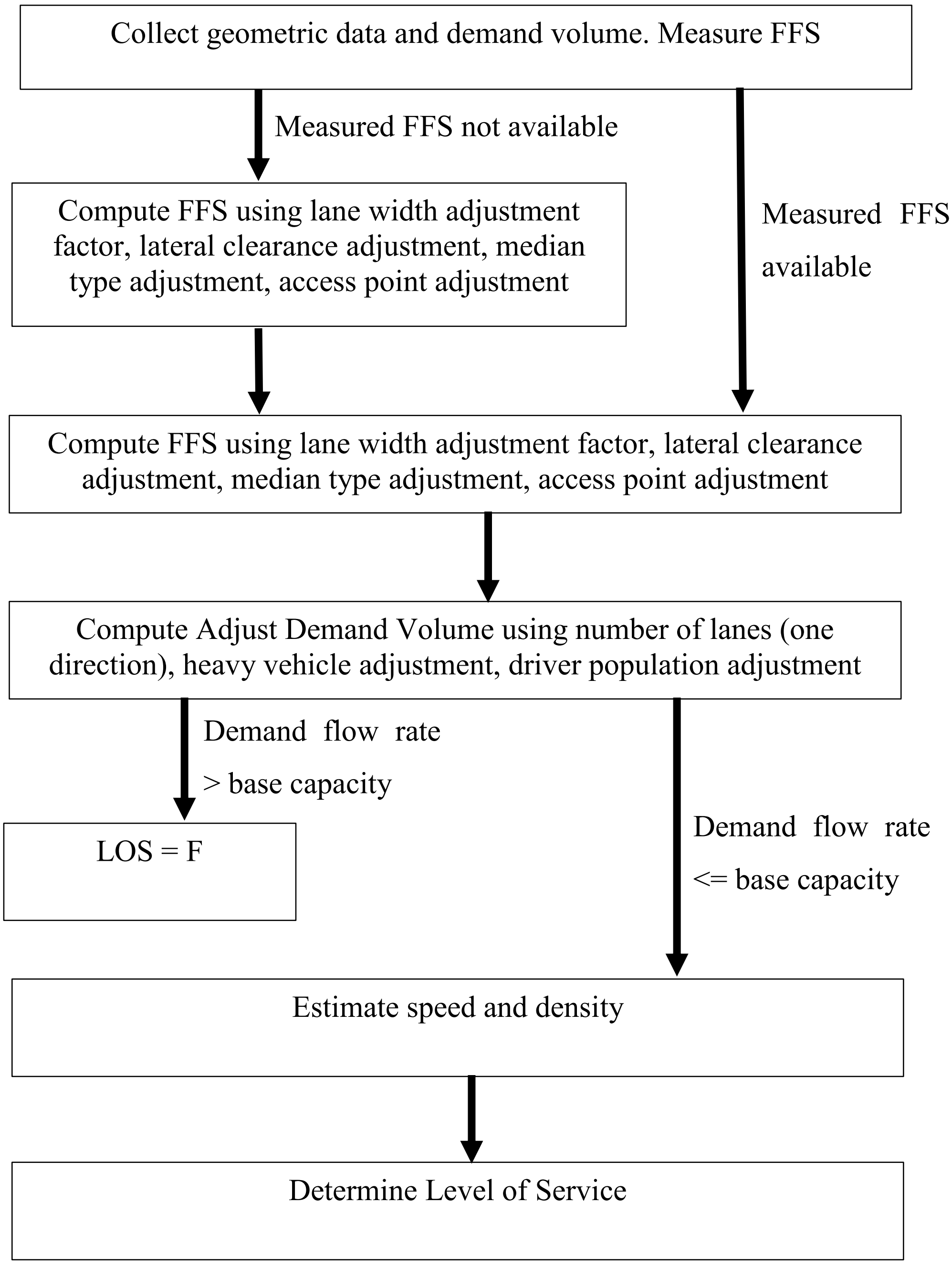


Figure 3.10: Determination of Automobile LOS for Multilane Highways

3.10 Assessment of Congestion Level

One of the main objectives of constructing flyovers was to eliminate conflicts and congestion at grade level. This study has been done to ascertain how much flyovers have fulfilled this objective. In addition this analysis will evaluate the justification of the flyovers as a remedial measure in reducing traffic congestion, which is one of the main objectives of this thesis. Because of budget and time constraints, it was not possible to assess congestion level of entire study area. Congestion level was measured along the flyover corridor both above-grade and at-grade. In this study, congestion level is represented by queue length. Reconnaissance survey revealed that the most critical spot where congestion occurred along flyover corridor was at the level crossing of each study area. Level crossings were observed to be the location where vehicles were stopped the most frequently. Passenger and freight trains cross these routes and were observed to delay motor vehicles by 5-10 minutes per instance of stoppage. The studied level crossing and the corresponding flyover are mentioned in the following table:

Table 3.7: Studied Level Crossings

Name of Flyover	Name of Level Crossing
Shaheed Ahsanullah Master Flyover	Ahsanullah Master Level Crossing
Banani Overpass	Banani Level Crossing
Mohakhali Flyover	Mohakhali Level Crossing
Khilgaon Flyover	Khilgaon Level Crossing
Jatrabari-Gulistan Flyover	Saidabad Level Crossing
Moghbazar-Mouchak Flyover	Moghbazar Level Crossing

In respect to the present study, author has considered queues formed due to complete stop-situation at level crossing. The traffic flow is disrupted completely and delayed at level crossing because the traffic capacity is lower and road vehicles are forced to stop at level crossing to ensure uninterrupted free train movement than at other portions of the roadway. Traffic delays at level crossings include delays caused by deceleration of vehicles while approaching the level crossing, reduced vehicle speed surrounding area of the level crossing, time needed for vehicles to resume freeway speed after exiting from level crossing, and vehicle queues formed at the level crossing. In this study, queue length is defined as the length of the line of motor vehicles that have been stopped at a level crossing in order for the trains to pass. It was measured at eight level crossings that experience significant road traffic operation using video based image processing technique. The total queue was first videoed at a particular level crossing. The first and last car in a particular lane and direction were identified. The corresponding positions of the cars were then superimposed on the surrounding pedestrian footpath and marked physically using flower pots. Then, the length between the markers along the footpath was measured using measuring tape to measure queue length. The length was taken as that measured from the front bumper of the car stopping nearest to the level crossing to the front bumper of the car stopping at the end that lane. Because the approach roads have multiple lanes, queue length was taken as the average measured length after considering all the lanes in a particular direction. Then, the queue lengths from all directions were added to get total queue length at an intersection.

3.11 Assessment of Pedestrian Exposure to Risk at Level Crossings

To assess the risk of pedestrians to traffic, a one hour count of pedestrians to determine pedestrian flow at peak hour traffic was conducted in the stud area. Because of economical and temporal constraints, it was not possible to assess pedestrian flow at all segments of the study areas. Hence, the most critical spot for accident potential was observed via reconnaissance survey. Based on pedestrian flows, level crossings in the study area were observed to be the most location for pedestrian accidents. Field observation has revealed that in the absence of any grade separated crossing facilities, the pedestrians are compelled to cross the level crossings, thereby exposing and putting them in danger from both road and rail traffic. Based on Focused Group Discussion (FGD) and consultation with safety experts of Bangladesh Road Transport Authority (BRTA), five (5) major factors were identified those have potential to aggravate risk of pedestrians, namely: carrying head load; talking on mobile phone or using head phones; carrying children; running; and being old and/ or disabled. These were considered as critical risk factors. No distinction was made for pedestrians crossing the road transversely or in parallel; they were counted together.

3.12 Overview

This chapter elaborated on the procedures followed and areas surveyed in the various parts of the study. The next chapter focuses on the collection and analysis of data in assessing present performance of at grade facilities along flyover corridor and adjacent to it.

CHAPTER 4
DATA COLLECTION AND ANALYSIS

4.1 Introduction

In this chapter data are described and evaluated to assess the performance of roadway facilities along flyover corridor and also in the adjacent area. Data have been collected from primary investigation as outlined in Chapter Three. The data were processed by making customized data entry and analyzed using Microsoft Excel. Although general characteristics of the study areas have been provided in Chapter Three, this chapter explores the study area in greater detail, where relevant. Unless otherwise stated, the sources of compiled data in the tables that appear in this chapter are from observation surveys conducted by the researcher within the period of 2017-2018.

4.2 Assessment of Grade-Wise Space Usage in Studied Areas

The aim of this section is to provide a justification for the subsequent impact evaluation of at-grade roads in the study areas. The relative usage of road space over and under flyover corridor is deemed to be a suitable indicator for this justification. Classified traffic count data have been collected both manually and using video. The results of the count are provided in Table A.1 of Appendix A according to each flyover and period of measurement. In Table A.1, “Over” refers to above-grade flow while “Under” refers to at-grade flow. Since vehicles of various sizes and weights pass through the study area, it was felt that their impact needed to be judged using a common standard. Hence, the vehicle counts were converted to passenger car units, using the PCEs provided below [100]. Count of each class of vehicle was multiplied with the respective PCE to get PCU count.

Table 4.1: PCE of Various Vehicles

Vehicle	PCE	Vehicle	PCE
Rickshaw/Van	2.00	Tempo	0.75
Motorcycle	0.75	Bus	3.00
Bicycle	0.50	Utility	1.00
Car	1.00	Truck	3.00
CNG	0.75	Bullock Carts	4.00

(source: Ministry of Communications, Government of Bangladesh)

The vehicle flow was calculated by converting the 15 minute traffic flow into one hour flow using PHF of 0.92 for urban street segments recommended by Highway Capacity Manual [57], which is depicted in Figures 4.1 to 4.12. Traffic flow data have also been compared with previous studies taken by the author in 2015. A modal percentage analysis for each flyover is also done, emphasizing on public transit (buses) and NMVs.

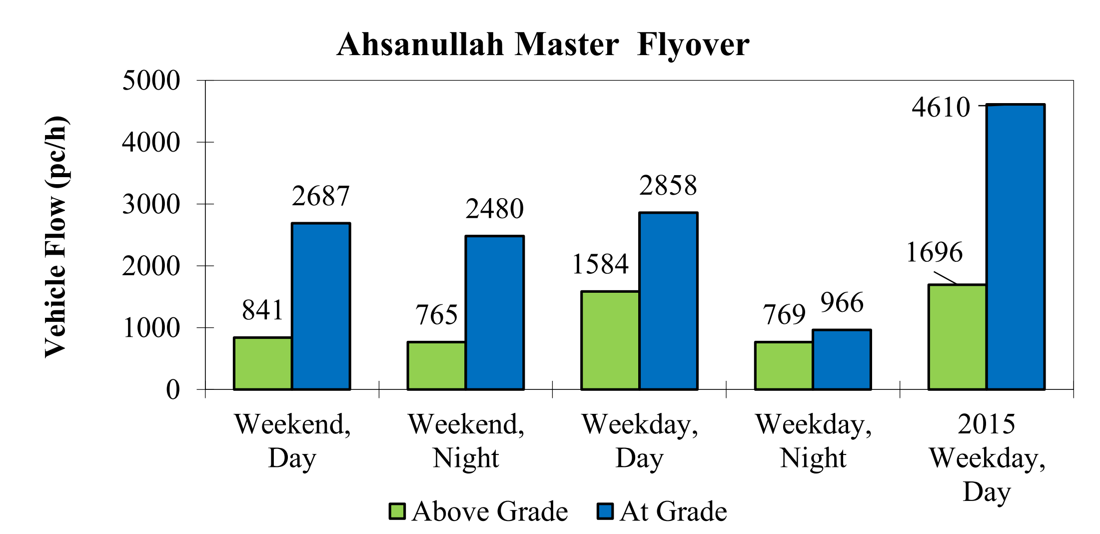
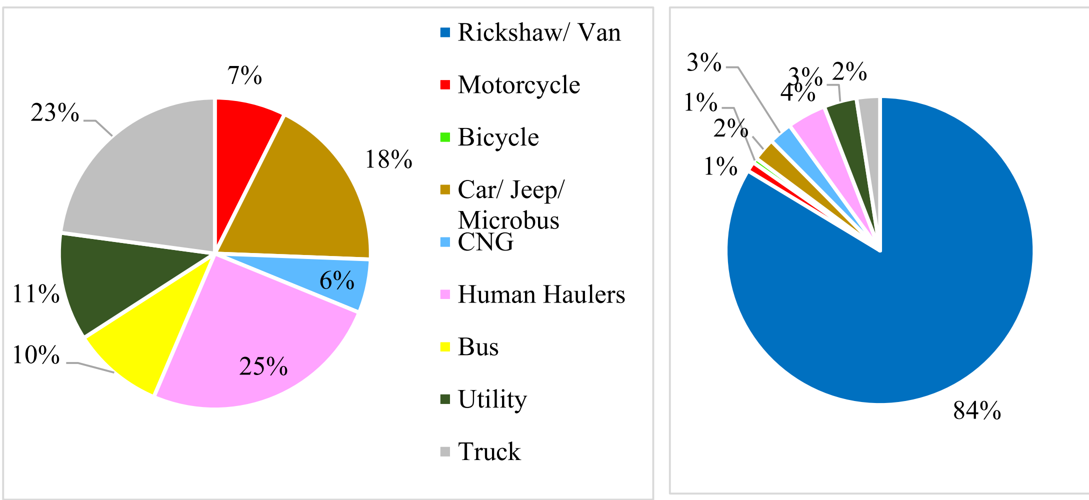


Figure 4.1: Flow Variation with Grade at SAMF

Figure 4.1 reveals that the largest flow above grade occurred in weekday, day (1584 pc/h) while the smallest flow occurred in weekend night (765 pc/h). The largest flow at grade occurred in weekday, day (2858 pc/h) while the smallest flow occurred in weekday, night (966 pc/h). The above grade to at grade flow ratio varied from 0.31:1 (weekend, day and weekend, night) to 0.8:1 (weekday, night), indicating that majority of vehicles preferred at grade facilities. Comparison with previous studies [101] reveal that vehicle flow has surprisingly decreased above grade by 6.62% and at grade by 38% (from 2015 to 2017). The flow decreased both at-grade and above-grade level, implying that fewer vehicles are using this corridor. The above-grade to at-grade flow ratio at Shaheed Ahsanullah Master Flyover varied from 0.31:1 (weekend, day and weekend, night) to 0.8:1 (weekday, night), indicating that majority of vehicles preferred at grade facilities. The overall ratio of above-grade to at-grade flow is only 0.44:1, indicating that only 30.57 % of total flow at Ahsanullah Master Flyover corridor uses this grade-separated facility while remaining 69.43% face conflicts at grade along flyover corridor. This has been observed to be the worst case among the six selected flyovers. Field observations have revealed that the roads connecting Tongi and Ghorasal through this flyover has broken down. Besides, repair work has begun recently. This introduces a new dimension of long queue of vehicles throughout his road. Hence, to avoid, rider discomfort, long queue of vehicles in this route, longer travel time and overall, complete uncertainty, road users avoid this flyover corridor route. As a result, flow in this flyover corridor has been decreased substantially.

On the other hand, the above grade to at grade flow ratio has increased from 0.37:1 to 0.55:1 in between 2015 to 2017, indicating an increasing trend for vehicles to move from at grade to above grade, which is a positive sign for constructing this flyover. As a result, it is expected that this flyover will divert more traffic above grade in future, although a larger proportion of vehicles in this flyover corridor will always use at-grade road because of the demographic and commercial importance of this region. Modal percentage analysis, i.e. analysis of percentage of each class of identified vehicle in traffic stream, is also provided for each flyover. The modal analysis is provided considering average flow across the four periods of measurement, namely, weekend day, weekend night, weekday day and weekday night.



Above Grade	At Grade

Figure 4.2: Grade-wise Modal Comparison at SAMF

Figure 4.2 shows that above grade, human haulers (25%) and trucks (23%) are the most common modes. At grade, rickshaw/ van (84%) is the overwhelming majority. Buses occupy only a negligible portion of at-grade traffic (2%), because passengers embark and alight at touchdown points of flyover ramps, which essentially means at the middle of the road. Sudden stoppage of buses slows down following cars, reduces capacity and acts as a potential accident black-spot for passengers because they face conflicts with the other vehicles while crossing road to reach desired bus or leave bus. Above grade, it is seen that cars (18%) occupy larger share of traffic compared to buses (10%). Critical analysis has also revealed that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

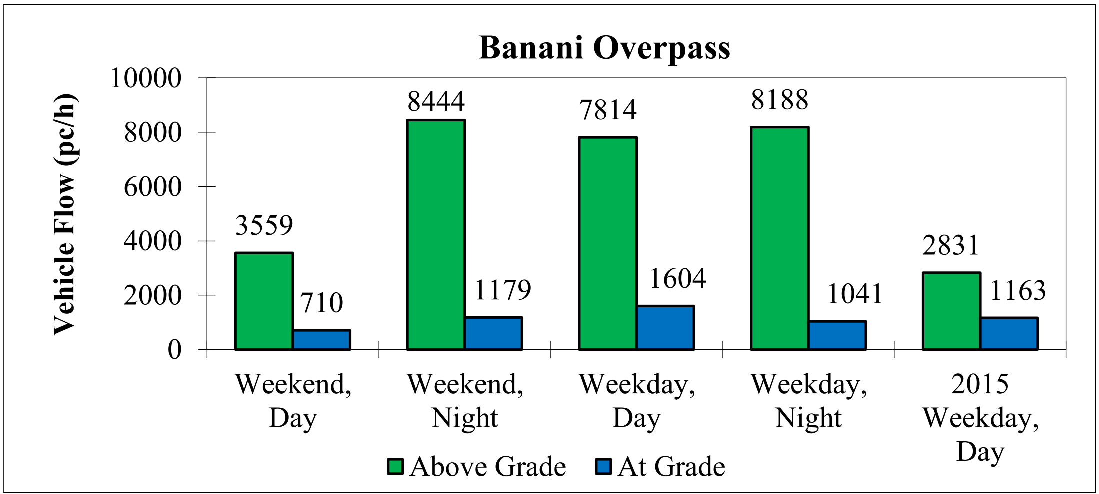


Figure 4.3: Flow Variation with Grade at Banani Overpass

Figure 4.3 reveals that the largest flow above grade occurred in weekend, night (8444 pc/h) while the smallest flow occurred in weekend, day (3559 pc/h). The largest flow at grade occurred in weekday, day (1604 pc/h) while the smallest flow occurred in weekend, day (710 pc/h). The above-grade to at-grade flow ratio varied from 4.87:1 (weekday, day) to 7.86:1 (weekday, night), indicating that overwhelming majority of vehicles preferred above grade facilities. The low at-grade flow ratio can be attributed to access restriction to surrounding areas. Banani Overpass has been the most successful in segregating at-grade flow to above-grade.

Banani Overpass goes over Mirpur Cantonment Area, where access is restricted to the general public. As a result, vehicles using at grade facilities travel in only two directions, either towards Hazrat Shahjalal Airport, or towards Banani. Comparison with previous studies [101] reveal that vehicle flow has increased above grade by 176.05% and at grade by 37.97% (from 2015 to 2017), indicating that traffic flow has increased on absolute terms. On the other hand, the above grade to at grade flow ratio has increased from 2.43:1 to 4.87: 1, indicating a phenomenal increasing trend for vehicles to move from at grade to above grade.

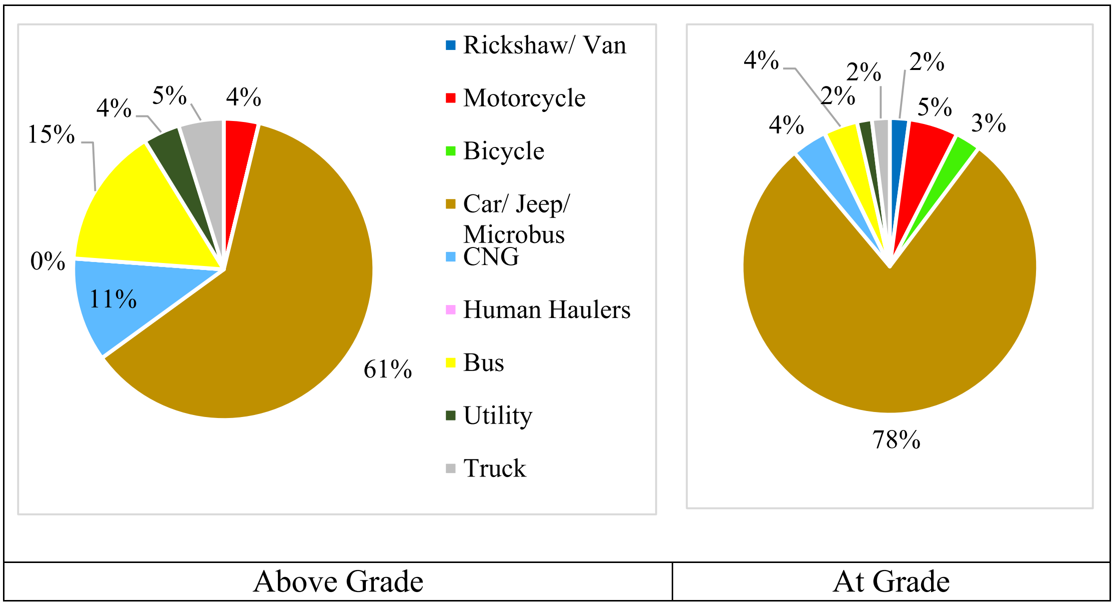


Figure 4.4: Grade-wise Modal Comparison at Banani Overpass

Figure 4.4 shows that above grade, cars (61%) is the most common mode, followed by buses (15%). At grade, cars (78%) is the overwhelming majority. Buses occupy only a negligible portion of at-grade traffic (4%), because the surrounding at-grade area is restricted to military residential area only. Above grade, it is seen that cars occupy larger share of traffic compared to buses. Critical analysis has also revealed that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

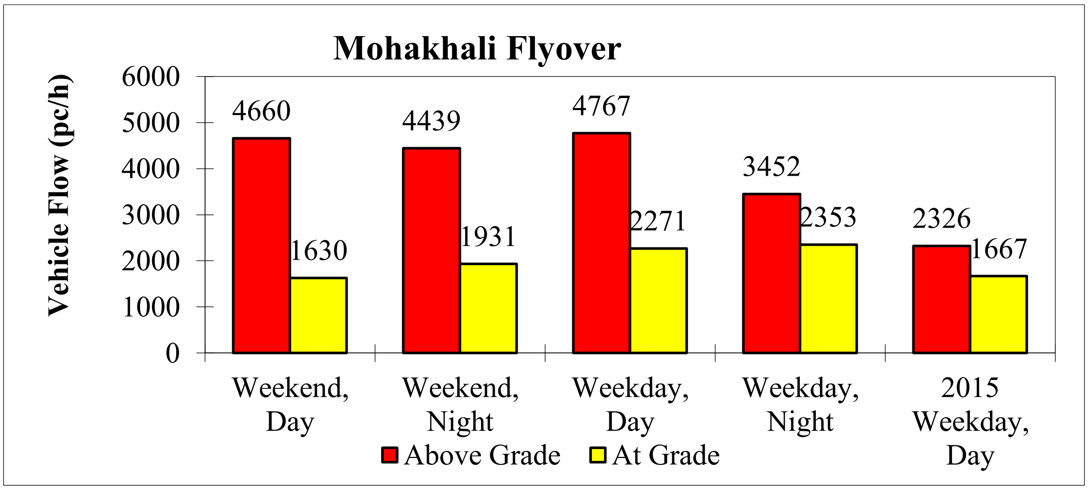


Figure 4.5: Flow Variation with Grade at Mohakhali Flyover

Figure 4.5 reveals that the largest flow above grade occurred in weekday, day (4767 pc/h) while the smallest flow occurred in weekend, night (3452 PCU/h). The largest flow at grade occurred in weekday, night (2353 pc/h) while the smallest flow occurred in weekend, day (1630 pc/h). The above-grade to at-grade flow ratio varied from 1.47:1 (weekday, night) to 2.86:1 (weekend, day), indicating that although majority of the vehicles preferred above- grade facilities, a sizeable portion continued to travel at grade. Comparison with previous studies [101] reveal that vehicle flow has increased above grade by 104.98% and at grade by 36.20% (from 2015 to 2017), indicating that traffic flow has increased on absolute terms. On the other hand, the above grade to at grade flow ratio has risen from 1.40:1 to 2.12: 1

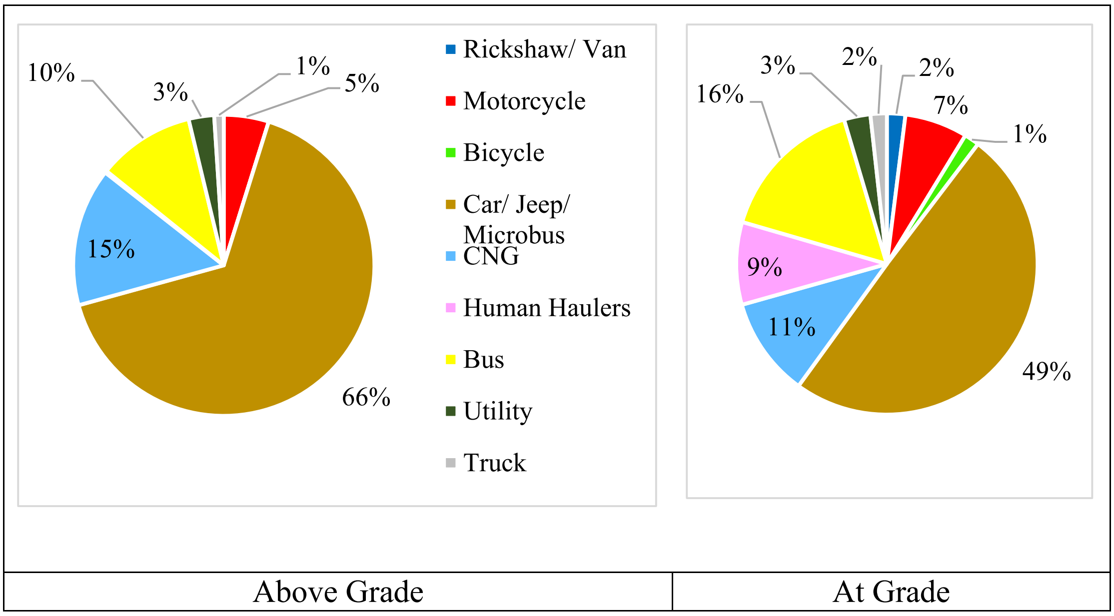


Figure 4.6: Grade-wise Modal Comparison at Mohakhali Flyover

Figure 4.6 shows that above grade, cars (66%) is the most common mode, followed by CNG (15%). At grade, cars (49%) is the overwhelming majority. Buses occupy more traffic share at grade (16%) than above grade (10%). Buses are forced to use at-grade facilities because of important transit stops at grade. Besides, the flyover is near to the important Mohakhali Bus Terminal, which attracts and generates huge number of trips for buses. Thus, buses by-passing Mohakhali travel above grade. Hence it is seen that buses using local bus stops are not benefited by flyovers. A portion of above-grade buses pick up and drop off passengers at the touchdown points of flyover ramps, which acts as bottlenecks and accident black-spots, as discussed previously. Both above-grade and at-grade charts show that cars occupy larger share of traffic compared to buses. Critical analysis has also revealed that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

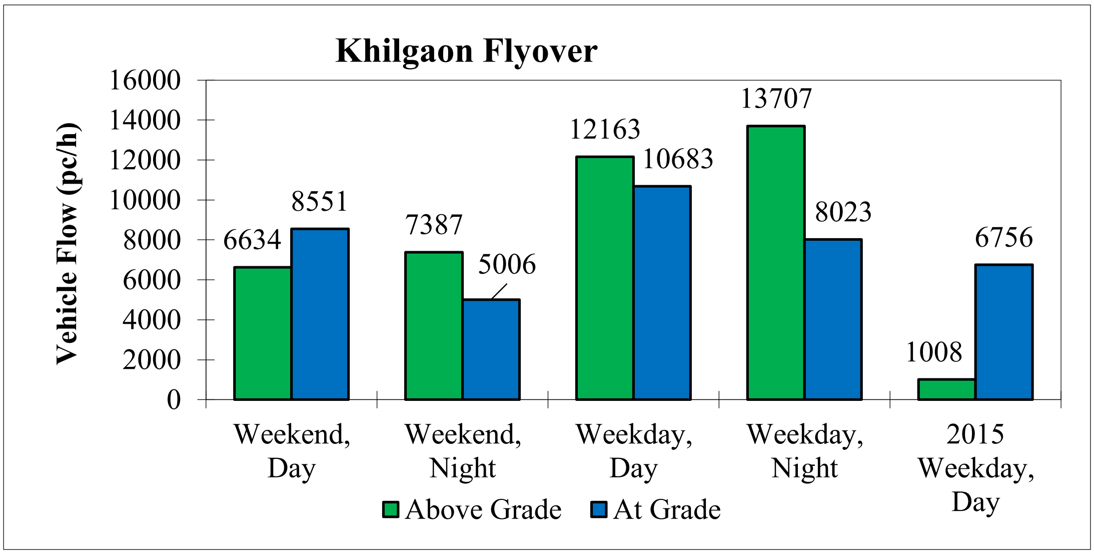


Figure 4.7: Flow Variation with Grade at Khilgaon Flyover

Figure 4.7 reveals that the largest flow above grade occurred in weekday, night (13707 pc/h) while the smallest flow occurred in weekend, day (6634 pc/h). The largest flow at grade occurred in weekday, day (10683 pc/h) while the smallest flow occurred in weekend, night (5006 pc/h). The above-grade to at-grade flow ratio varied from 0.78:1 (weekend, day) to 1.71:1 (weekday, night), indicating that although majority of the vehicles preferred above- grade facilities, a sizeable portion continued to travel at grade. Comparison with previous studies [101] reveal that vehicle flow has increased dramatically above grade by 1106.30% and at grade by 58.14% (from 2015 to 2017), indicating that traffic flow has increased on absolute terms. On the other hand, the above grade to at grade flow ratio has increased from 0.15:1 to 1.14: 1, indicating a phenomenal increasing trend for vehicles to move from at grade to above grade.

Figure 4.8 shows that above grade, cars (50%) is the most common mode, followed by buses (30%). At grade, rickshaw/ van (94%) is the overwhelming majority. Buses occupy more traffic share at grade (30%) than at grade (negligible). It has been observed that almost all buses use above-grade facilities while negligible portion of buses use at-grade facilities. Although Khilgaon is an important commercial and residential area in Dhaka city, and is in close proximity to Kamalapur Railway station, little integration has been observed between rail and public transit. Passengers at Khilgaon embark and alight at touchdown points of flyover ramps, which essentially means at the middle of the road. Thus, flyover ramps act as bottlenecks and accident black-spots, as discussed previously.

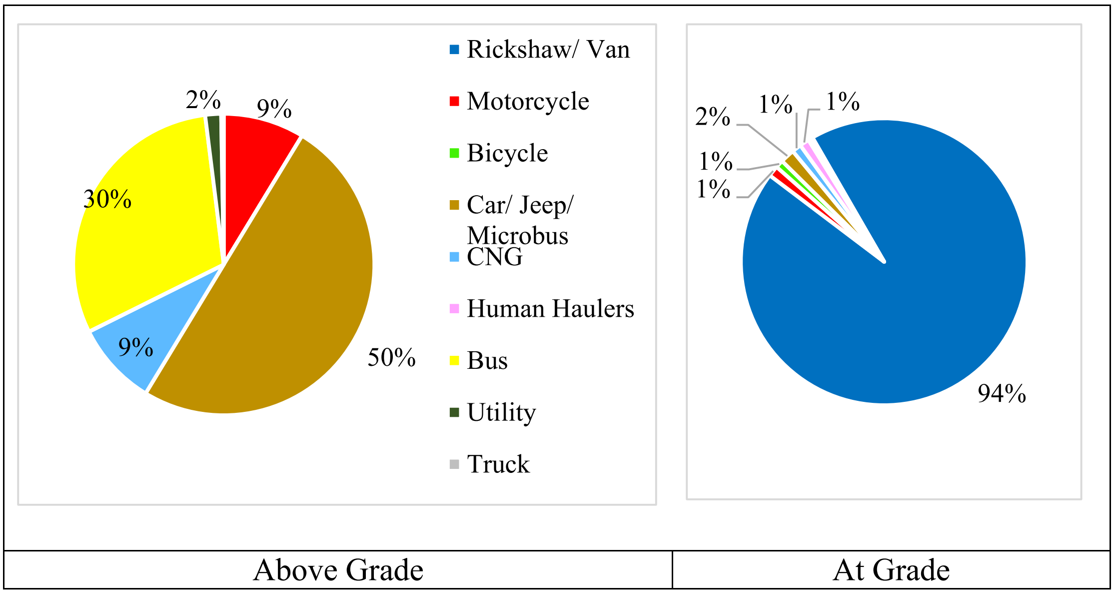


Figure 4.8: Grade-wise Modal Comparison at Khilgaon Flyover

The huge NMV flow makes it impossible to operate buses at grade, thus buses choose to pick up and drop off passengers at the ramps. From above charts, it is evident that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

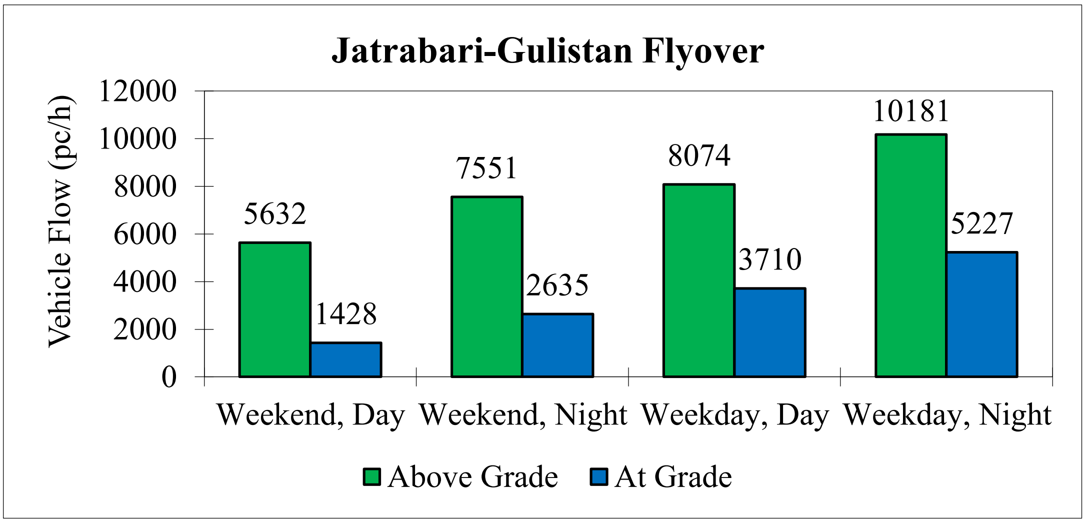


Figure 4.9: Flow Variation with Grade at MMHF

Figure 4.9 shows that the largest flow above grade occurred in weekday, night (10181 pc/h) while the smallest flow occurred in weekend, day (5632 pc/h). The largest flow at grade occurred in weekday, night (5227 pc/h) while the smallest flow occurred in weekend, day (1428 pc/h). The above-grade to at-grade flow ratio varied from 1.94:1 (weekday, night) to 3.95:1 (weekend, day), indicating that although majority of the vehicles preferred above- grade facilities, a sizeable portion continued to travel at grade. Comparison with previous studies [101] reveal that vehicle flow has increased dramatically above grade by 2324.31% and at grade by 54.58% (from 2015 to 2017), indicating that traffic flow has increased on absolute terms. On the other hand, the above grade to at grade flow ratio has increased from 0.14:1 to 2.18: 1.

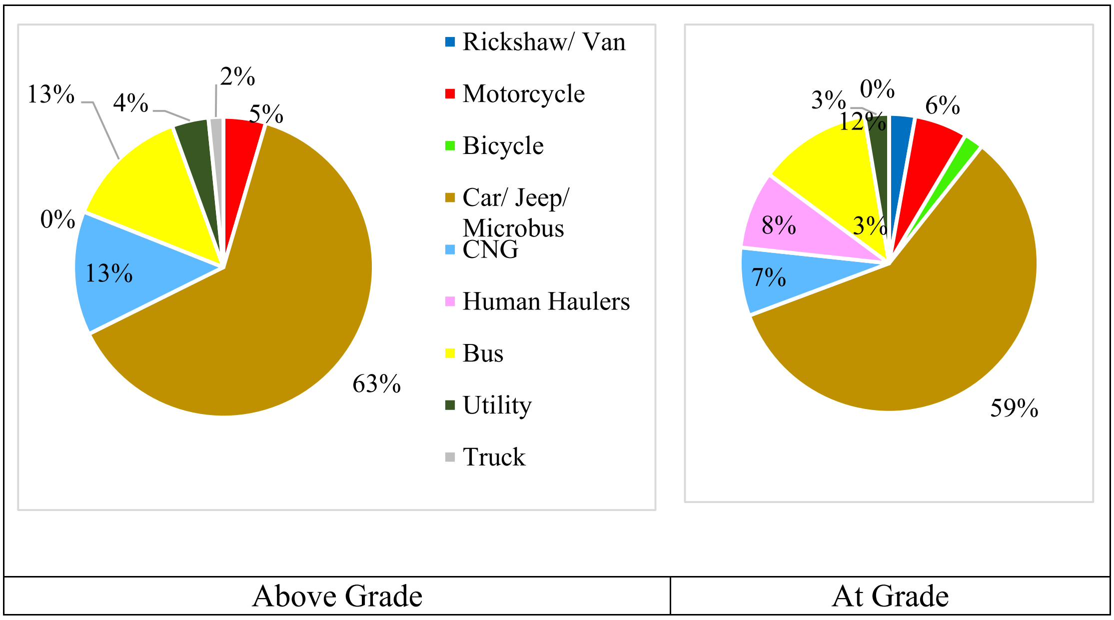


Figure 4.10: Grade-wise Modal Comparison at MMHF

Figure 4.10 shows that above grade, buses (48%) is the most common mode, followed by cars (20%). At grade, rickshaw/ van (51%) is the most common mode, followed by buses (34%). Buses occupy more traffic share above grade (48%) than at grade (34%). Above grade buses travel to cities and districts south of Dhaka. In addition, the flyover is beside Saidabad Bus Terminal. Buses from the at-grade terminal are connected to the flyover using exclusive ramps. This is a good policy, because buses are directly connected to above-grade facilities. However, some buses continue to use at-grade roads to pick up and drop off passengers. Such actions should only have been limited to the terminal area. However, the terminal area is often packed with parked buses, limiting the space for the actual purpose of the terminals. As a result, buses often stop and park at grade along the flyover corridor for boarding and alighting purposes. This limits capacity along grade and acts as a potential accident black-spot for passengers. From above charts, it is evident that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

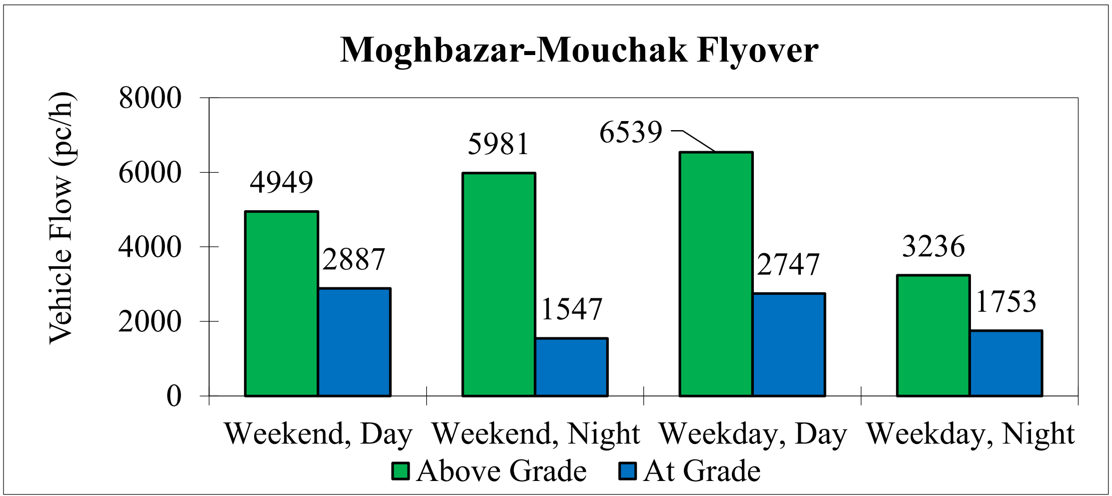


Figure 4.11: Flow Variation with Grade at MMF

Figure 4.11 portrays that the largest flow above grade occurred in weekday, day (6539 pc/h) while the smallest flow occurred in weekday, night (3236 pc/h). The largest flow at grade occurred in weekend, day (2887 pc/h) while the smallest flow occurred in weekend, night (1547 pc/h). The above-grade to at-grade flow ratio varied from 1.71:1 (weekend, day) to 3.87:1 (weekend, night), indicating that although majority of the vehicles preferred above- grade facilities, a sizeable portion continued to travel at grade.

Figure 4.12 shows that above grade, cars (48%) is the most common mode, followed by buses (20%). At grade, cars (40%) is the most common mode, followed by rickshaw/ van (35%). Buses occupy more traffic share above grade (20%) than at grade (9%). Above-grade buses use the flyover to bypass the busy Moghbazar and Mouchak areas. However, some buses continue to use at-grade roads to pick up and drop off passengers because the concerned study area is a commercially and residentially important place. Some buses travelling above grade have been observed to drop off and pick up passengers at the touchdown point of flyover ramps. Thus, flyover ramps act as bottlenecks and accident black-spots, as discussed previously.

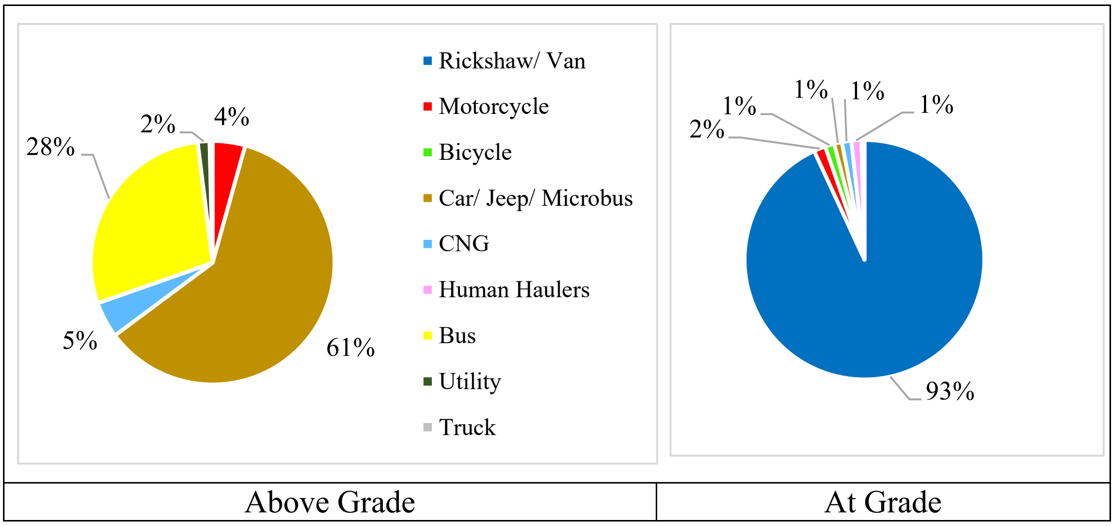


Figure 4.12: Grade-wise Modal Comparison at MMF

From above charts, it is evident that NMVs (rickshaw/van and bicycle) cannot use above-grade facilities of the flyover and are entirely restricted to at-grade roads. Flyover ramp grades physically limit operation of NMVs above grade. It means that a section of traffic will always travel at grade. Hence, because of NMVs, at-grade traffic conflict and congestion is perennial.

From Figures 4.1 to 4.12, it is revealed that even though majority of vehicles use above grade facilities, a significant fraction of vehicles use at grade roads. This is because of land use pattern. Observation of author revealed that the surrounding land beside flyover has commercial and residential importance, meaning the land will always attract people and generate trips. Comparison with previous studies [101] have revealed that flyovers have been successful in diverting an increasing proportion of vehicles above grade. However, it is also observed that vehicle flow has increased in absolute terms both above grade and at grade. It has also been observed that NMVs will always continue to use at-grade facilities and cannot use above-grade facilities. Thus it may not be possible to completely eliminate at grade flow. Moreover, it has been alarmingly observed that existing flyover facilities are benefitting private automobiles (cars, jeeps and microbuses) than public transit (buses). This will act as a supply-side policies and invite more private cars into the study area, worsening delay and congestion in future. Hence, it is imperative to evaluate the performance of road facilities around the flyover which is explored in the following sections, and then adopt necessary corrective measures.

4.3 Assessment of Traffic Flow in Studied Areas

Classified traffic count was performed to assess the flow capacity ratio in the study area. Directional classified traffic count of each road segment (segments labelled as per Figures 3.1 to 3.6) was taken during weekend day, weekend night, weekday day and weekday night. The collected data and their analyses with respect to each flyover are summarized in the following sub-sections. The analyses includes modal percentage analysis, i.e. analysis of percentage of each class of identified vehicle in traffic stream, for each segment direction of the study area of each flyover. The modal analysis is provided considering average flow across the four periods of measurement, namely, weekend day, weekend night, weekday day and weekday night. Collected data have been presented and analysed using tables and figures provided in Appendices B and C.

4.3.1 Shaheed Ahsanullah Master Flyover

In Shaheed Ahsanullah Master Flyover, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 24.03.2017 (Friday); Weekend, Night data was collected at 8.30 pm - 8.45 pm on 19.05.2017 (Friday); Weekday, Day data was collected at 5.15 pm - 5.30 pm on 20.04.2017 (Tuesday); Weekday, Night data was collected at 8.00 pm - 8.15 pm on 20.04.2017 (Tuesday). The time period for collecting data in each measurement period have been identified from analysis of hourly traffic count over a period of 24 hours in this corridor.

Classified count data have been represented in Table B.1 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.1. At Ahsanullah Master Flyover, Figure B.1 shows that flow is highest at segment 1-5/5-1 (average segment flow of 2771 pc/h) and lowest at segment g1/g2 (average segment flow of 1801 pc/h). Segment flow is the summation of the two directional flows in each segment. Average segment flow is the segment flow averaged over the four periods of measurement. The flow variation occurs because although many buses use 1-5/5-1 segment, only few buses use f1/f2 and g1/g2 segment. Inter city buses predominantly use segments f1/f2 and g1/g2 while inter city buses use segments g1/g2. The average, minimum and maximum segment directional flow during weekend, day were observed to be 1153 pc/h, 633 pc/h (segment 3-2) and 1466 PCU/h (segment 1-2) respectively. The average, minimum and maximum segment directional flow during weekend, night were observed to be 961 pc/h, 723 pc/h (segment g2) and

1472 pc/h (segment 5-1) respectively. The average, minimum and maximum segment directional flow during weekday, day were observed to be 1299 pc/h, 1035 pc/h (segment g1) and 1867 pc/h (segment 5-1) respectively. The average, minimum and maximum segment directional flow during weekday, night were observed to be 998 pc/h, 431 pc/h (segment 6-5) and 1948 pc/h (segment 1-2) respectively. The highest directional flow occurred during weekday, night along direction 1-2 (1948 pc/h) while the lowest directional flow occurred during weekday, night along segment 6-5 (431 pc/h).

It is seen that flow is greater at weekdays than at weekends. Since these segments are on the outskirts of Dhaka city, people use it during the weekdays to commute to work in Dhaka. Since most offices are closed in weekends, commuters rarely use these roads during weekends. The charts show that flow is greater during weekday, day than at weekday night, possibly because commuters return to their homes after work during evening.

A modal percentage analysis for each segment of the study area is provided in Figure C.1 of Appendix C. From Figure C.1 the most common transport mode at grade at urban street segments was observed to be rickshaw/ van (36% combined), followed by bus (29%) and car/ jeep/ microbus (17%). The most common transport mode at grade at multilane highways was observed to be bus (32% combined), followed by rickshaw/ van (26%) and car/ jeep/ microbus (19%). Private automobiles, thus were observed to have the third-highest traffic volume occupancy. The low road occupancy of cars may be attributed to the fact that the suburbs around Shaheed Ahsanullah Master Flyover houses low-income people. So, car ownership is a rarity in these places.

4.3.2 Banani Overpass

In Banani Overpass, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 17.03.2017 (Friday); Weekend, Night data was collected at 9.30 pm - 9.45 pm on 18.03.2017 (Saturday); Weekday, Day data was collected at 5.15 pm - 5.30 pm on 09.05.2017 (Tuesday); Weekday, Night data was collected at 9.30 pm - 9.45 pm on 20.04.2017 (Tuesday).

Classified count data have been represented Table B.2 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.2. As noted in Chapter 3 (Methodology), at-grade vehicles travel mainly along the flyover corridor since the surrounding access roads are access controlled and have military restrictions. So, only one roadway segment (labelled a) was studied. The roadway segment was labelled as multilane highway as per HCM (2010) because the signalized intersections at this segment are more than 2 miles apart. Vehicles using at grade facilities travelling towards Hazrat Shahjalal Airport are moving in a1 direction, while vehicles moving towards Banani are moving in a2 direction. The highest directional flow occurred during weekday, day along direction a1 (966 pc/h) while the lowest directional flow occurred during weekend, day along segment a1 (349 pc/h).

Except weekday, day, there is little variation in traffic flow between each direction. However, in weekday, traffic moving towards Hazrat Shahjalal Airport is 50% times more than that in the opposite direction. This may be because data was taken during evening peak, when people return to their homes (outside Dhaka city) from their offices (inside Dhaka city). A modal percentage analysis for each segment of the study area is provided in Figure C.2 of Appendix C. From Figure C.2 the most common transport mode at grade at urban street segments was observed to be car/ jeep/ microbus (79% combined). Public transport occupied only 4% of total traffic. This is because land surrounding the at-grade road is restricted to military residential area. So, general public do not use at-grade facilities usually.

4.3.3 Mohakhali Flyover

In Mohakhali Flyover, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 17.03.2017 (Friday); Weekend, Night data was collected at 8.30 pm - 8.45 pm on 18.03.2017 (Saturday). Weekday, Day data was collected at 5.15 pm - 5.30 pm on 16.05.2017 (Tuesday). Weekday, Night data was collected at 8.00 pm - 8.15 pm on 30.05.2017 (Tuesday).

Classified count data have been represented in the Table B.3 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.3. At Mohakhali Flyover, Figure B.3 shows that flow is highest at segment 8-9/9-8 (average segment flow of 3461 pc/h) and lowest at segment 7-11/11-7 (average segment flow of 1742 pc/h). The general trend shows that flow is largest during weekday, day and smallest during weekend, night. The average, minimum and maximum segment directional flow during weekend, day were observed to be 821 pc/h, 483 pc/h (segment 13-8) and 1305 pc/h (segment 8-9) respectively. The average, minimum and maximum segment directional flow during weekend, night were observed to be 953 pc/h, 480 pc/h (segment 8-13) and 1944 pc/h (segment 8-9) respectively. The average, minimum and maximum segment directional flow during weekday, day were observed to be 1949 pc/h, 1340 PCU/h (segment 11-7) and 2628 pc/h (segment 8-9) respectively. The average, minimum and maximum segment directional flow during weekday, night were observed to be 1142 pc/h, 740 pc/h (segment 11-7) and 1627 pc/h (segment 5-6) respectively. The highest directional flow occurred during weekday, day along direction 5-6 (2628 pc/h) while the lowest directional flow occurred during weekend, night along segment 8-13 (480 pc/h).

It is observed that flow is higher in weekday than in weekend. The rationale for higher flow in weekday compared to weekend day time period may be explained by the fact that people from newly developed residential area such as Uttara, Basundhara Residential Area, Nikhunja and sub-urban area like, Abdullahpur, Tongi, Gazipur come to capital for work purpose. As house rent and living expense is extremely high in Dhaka, people who work in capital with low salary prefer to live outside the main city to save their cost and they usually do not come to the capital during weekend days. Hence, weekday flow in this flyover corridor is generally higher than weekend flow. A modal percentage analysis for each segment of the study area is provided in Figure C.3 of Appendix C. From Figure C.3 the most common transport mode at grade at urban street segments was observed to be car/ jeep/ microbus (58% combined), followed by public transport (20%). The study area is besides Mohakhali Bus Terminal, hence buses occupy relatively higher percentage compared to other modes.

4.3.4 Khilgaon Flyover

In Khilgaon Flyover, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 06.10.2017 (Friday); Weekend, Night data was collected at 8.30 pm -8.45 pm on 06.10.2017 (Saturday). Weekday, Day data was collected at 5.15 pm -5.30 pm on 11.10.2017 (Wednesday). Weekday, Night data was collected at 8.30 pm- 8.45 pm on 11.10.2017 (Wednesday).

Classified count data have been represented in Table B.4 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.4. At Khilgaon Flyover, Figure B.4 shows that flow is highest at segment 1-8/8-1 (average segment flow of 4074 pc/h) and lowest at segment 17-18/18-17 (average segment flow of 1592 pc/h). The general trend shows that flow is largest during weekday, day and smallest during weekend, night. The average, minimum and maximum segment directional flow during weekend, day were observed to be 2522 pc/h, 766 pc/h (segment 13-14) and 4340 pc/h (segment 1-8) respectively. The average, minimum and maximum segment directional flow during weekend, night were observed to be 1573 pc/h, 566 pc/h (segment 17-18) and 2653 pc/h (segment 7-6) respectively. The average, minimum and maximum segment directional flow during weekday, day were observed to be 3135 pc/h, 979 pc/h (segment 17-18) and 5380 pc/h (segment 1-8) respectively. The average, minimum and maximum segment directional flow during weekday, night were observed to be 2299 pc/h, 767 pc/h (segment 17-18) and 4108 pc/h (segment 1-8) respectively. The highest directional flow occurred during weekday, day along direction 1-8 (5380 pc/h) while the lowest directional flow occurred during weekend, night along segment 17-18 (566 pc/h). Segment 1-8/8-1 has been observed to generally have the highest flow. This segment connects Khilgaon to other busy areas of Dhaka, namely Moghbazar and Mouchak. Hence this transport corridor has high demand. Segment 17-18/18-17 has been observed to generally have the lowest flow. This road segment runs through Basabo Residential Area and is a two-lane road. The narrow road width constricts traffic flow.

It is observed that flow is higher in weekday than in weekend. The rationale for higher flow in weekday compared to weekend day time period may be explained by the fact that people from surrounding districts and areas come to Motijheel for work purpose. As house rent and living expenses are extremely high in Dhaka, people who work in Motijheel area with low salary prefer to live outside the main city to save their cost and they usually do not come to main capital during weekend days. Hence, Weekday flow in this flyover corridor is generally higher than weekend flow. A modal percentage analysis for each segment of the study area is provided in Figure C.4 of Appendix C. From Figure C.4 the most common transport mode at grade at urban street segments was observed to be rickshaw/ van (84% combined), followed by car/ jeep microbus (5%). Public transport only occupies 1% of total traffic volume.

4.3.5 Jatrabari-Gulistan Flyover

In Jatrabari-Gulistan Flyover, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 06.10.2017 (Friday); Weekend, Night data was collected at 9.30 pm - 9.45 pm on 17.03.2017 (Friday). Weekday, Day data was collected at 5.15 pm - 5.30 pm on 21.08.2017 (Monday). Weekday, Night data was collected at 8.00 pm - 8.15 pm on 21.08.2017 (Monday).

Classified count data have been represented in Table B.5 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.5. At Jatrabari-Gulistan Flyover, Figure B.5 shows that flow is highest at segment 4-5/5-4 (average segment flow of 3421 pc/h), followed closely by segment 9-10/10-9 (average segment flow of 3418 pc/h) and lowest at segment 8-9/9-8 (average segment flow of 1575 pc/h). The general trend shows that flow is largest during weekday, night and smallest during weekend, day. The average, minimum and maximum segment directional flow during weekend, day were observed to be 789 pc/h, 479 pc/h (segment 8-9) and 1089 pc/h (segment 6-5) respectively. The average, minimum and maximum segment directional flow during weekend, night were observed to be 1275 pc/h, 627 pc/h (segment 9-8) and 1634 pc/h (segment 5-4) respectively. The average, minimum and maximum segment directional flow during weekday, day were observed to be 1572 pc/h, 700 pc/h (segment 9-8) and 2116 pc/h (segment 11-12) respectively. The average, minimum and maximum segment directional flow during weekday, night were observed to be 2386 pc/h, 1174 pc/h (segment 9-8) and 3029 pc/h (segment 2-3) respectively. The highest directional flow occurred during weekday, night along direction 2-3 (3029 pc/h) while the lowest directional flow occurred during weekend, day along segment 8-9 (479 pc/h).

Segment 4-5/5-4 has been observed to generally have the highest flow. This segment acts as an entry point to Old Dhaka, which is a major mixed residential and commercial area of Dhaka city. Passengers who travel to and fro between Old Dhaka tend to embark and disembark transit and para-transit vehicles along this corridor. Since most of the roads of Old Dhaka are narrow (2 lane roads) and winding, large transit vehicles (buses) cannot usually penetrate further into Old Dhaka. So most buses use segment 4-5/5-4. Segment 9-10/10-9 is near Saidabad Bus Terminal, where buses from all over the country come to Dhaka or leave Dhaka. This terminal is one of the three bus terminals in Dhaka city where transit connects Dhaka to the rest of the country. As a result people use this segment to travel from their houses to the terminal and vice-versa. The road segment is also used by buses to pick up or drop off passengers. Even though segment 8-9/9-8 is adjacent to bus terminal, flow is low there because the ad-grade roads have been narrowed by the flyover pillars, which have divided the road segment there into 4 parts. Two of the parts are used to park buses, especially those that do not get room to park inside the terminal. The lanes where buses are parked cannot be used by other vehicles since 2 of the 4 parts of the road are single lanes. Hence, flow is practically zero in those lanes, meaning flow is diverted to the other lanes, which cannot handle much traffic.

It is observed that flow is higher in weekday than in weekend. The rationale for this may be explained by the fact that people from sub-urban area like, Narayanganj, Bhulta, Munshipur, Fatullah, Munshiganj come to the capital for work purpose and leave Dhaka after their office. As house rent and living expenses are extremely high in Dhaka, people who work in Motijheel area with low salary prefer to live outside the main city to save their cost and they usually do not come to main capital during weekend days. Hence, Weekday flow in this flyover corridor is generally higher than weekend flow. Hence, Weekday flow in this flyover corridor is generally higher than weekend flow.

It has also been noticed that since the communication between port city, Chittagong and the capital, Dhaka is established through this route, freight flow (truck) dramatically rises in night time as this type of vehicular flow is limited in day time in capital. So, weekday, night flow is higher than weekday, day flow. Dhaka Metropolitan Police (DMP) has banned covered goods trucks on June 30 2009 with a capacity of more than one-and-a-half tonnes from operating in the capital during the day, between Sunday and Thursday in an attempt to reduce large vehicles clogging roads during peak hours. A modal percentage analysis for each segment of the study area is provided in Figure C.5 of Appendix C. From Figure C.5 the most common transport mode at grade at urban street segments was observed to be rickshaw/ van (55% combined), followed by public transport (21%). Car/ jeep/ microbus occupies 9% of total traffic volume.

4.3.6 Moghbazar-Mouchak Flyover

In Moghbazar-Mouchak Flyover, Weekend, Day data was collected at 5.15 pm - 5.30 pm on 13.10.2017 (Friday); Weekend, Night data was collected at 8.30 pm - 8.45 pm on 13.10.2017 (Friday); Weekday, Day data was collected at 5.15 pm -5.30 pm on 16.10.2017 (Monday). Weekday, Night data was collected at 8.30 pm- 8.45 pm on 16.10.2017 (Monday).

Classified count data have been represented in Table B.6 of Appendix B, while a comparison among total flow across different roadway segments and their directions have been presented in Figure B.6. At Moghbazar-Mouchak Flyover, Figure B.6 shows that flow is highest at segment 12-18/18-12 (average segment flow of 4274 pc/h) and lowest at segment 11-14/14-11 (average segment flow of 1456 pc/h). The general trend shows that flow is largest during weekday, day and smallest during weekend, night. The average, minimum and maximum segment directional flow during weekend, day were observed to be 1892 pc/h, 758 pc/h (segment 11-14) and 4340 pc/h (segment 18-12) respectively. The average, minimum and maximum segment directional flow during weekend, night were observed to be 1044 pc/h, 319 pc/h (segment 4-22) and 2592 pc/h (segment 12-18) respectively. The average, minimum and maximum segment directional flow during weekday, day were observed to be 2664 pc/h, 1030 pc/h (segment 11-14) and 5807 pc/h (segment 18-12) respectively. The average, minimum and maximum segment directional flow during weekday, night were observed to be 1458 pc/h, 575 pc/h (segment 4-22) and 4108 pc/h (segment 18-12) respectively. The highest directional flow occurred during weekday, day along direction 18-12 (5807 pc/h) while the lowest directional flow occurred during weekend, night along segment 4-22 (319 pc/h).

Segment 12-18/18-12 has been observed to generally have the highest flow. As explained earlier during analysis of Khilgaon Flyover flow, this segment connects Khilgaon to other busy areas of Dhaka, namely Moghbazar and Mouchak. Hence this transport corridor has high demand. Segment 11-14/14-11 has been observed to generally have the lowest demand. This segment, also known as Baily Road, is at a relaxed part of the city. It is adjacent to residential areas of prominent judiciary figures as well as some ministers. Hence land use in this area is dominated by low-rise buildings. As relatively fewer people live in this area compared to other parts of the city, this segment has lower demand than other road segments.

It has been observed that flow is higher in weekdays than in weekends. Moghbazar-Mouchak Flyover is the one of the largest flyovers in Dhaka City, whose influence area includes congested, but commercially and administratively important areas such as

Malibagh, Mouchak, Moghbazar, Tejgaon, Kawran Bazar, Satrasta area and Bangla Motor area. Consequently, vehicular flow increases above the flyover at weekday period. On the contrary, as the number of people, who come to Dhaka for official, administrative and commercial purpose, drastically decreases in this region during weekend day, flow is lower at this time compared to weekday, day. It is interesting to note that weekend, day flow is higher than weekday, night. This maybe because of people's preference to shop in Kawran Bazar during the weekends. Kawran Bazar is one of the largest wholesale marketplaces in Dhaka city as well as in South Asia. People in Dhaka city prefer to go to market for their daily needs once a week and weekend time is the best suit for this purpose. A modal percentage analysis for each segment of the study area is provided in Figure C.6 of Appendix C. From Figure C.6 the most common transport mode at grade at urban street segments was observed to be rickshaw/ van (38% combined), followed by car/ jeep/ microbus (31%). Public transport occupies only 9% of total traffic volume.

4.3.7 Overview

The previous section (Section 4.3) analyzed traffic flow at all study areas with respect to different periods of measurement. Flow trends were identified and explanations offered for such trends. Traffic flow data will be used to calculate flow-capacity ratio and assess LOS for the study areas. The following section (Section 4.4) entails the first step to calculating segment capacity.

4.4 Assessment of Roadway Conditions and Parameters

As part of the pre-requisites to assess the level of service, it is important to quantify the following parameters for each roadway segment:

a. Number of lanes
b. lane width
c. approach grade at intersection
d. parking maneuver rate
e. bus stopping rate
f. presence of central business district
g. presence of exclusive turning lanes
h. presence of protected/ permitted turning movements

These primary parameters along with their derived secondary parameters (as explained in Chapter 3 Methodology) are presented in the following sub-sections for each flyover. The collected data are presented and analyzed in tables of Appendix D.

4.4.1 Shaheed Ahsanullah Master Flyover

Data collected from reconnaissance survey are presented in Table D.1 of Appendix D. In Table D.1, lane width for each direction is found by dividing the directional width by the number of lanes in that direction. This is then used to calculate adjustment factor for lane width, f_w outlined as per Chapter 3, Methodology.

Table D.2 outlines calculation of adjustment factors considering parking and bus stoppage rate. In Table D.2, N_m represents parking maneuver rate (maneuvers/h) , which is used to determine adjustment factor for existence of a parking lane and parking activity adjacent to lane group, f_P. N_b represents bus stopping rate (buses/h), which is used to determine adjustment factor for blocking effect of local buses that stop within intersection area, f_{bb}. The conversion from N_m to f_P and from N_b to f_{bb} have already been explained in Chapter 3, Methodology. Segments f and g were ignored in this calculation because they are categorized as multi-lane highways. The calculations in Table 4.9 only pertain to urban street segments. It is to be mentioned here that parking effect of para-transit vehicles, such as rickshaws, CNG and human haulers have not been covered by HCM (2010). As a result the author used his own judgment to classify the parking type of these modes under existing criteria. Since rickshaws and CNG wait on average longer than human haulers, and unlike human haulers, do not have fixed travel routes, rickshaw and CNG were counted under private vehicle parking. On the other hand, human haulers were observed to have many characteristics similar to buses. Both modes park temporarily to pick up and drop off passengers and cannot stay for indefinite time at one spot. Hence parking of human haulers was classified under bus stoppage rate.

Approach grade at all segments were observed to be zero, hence the roads were assumed to be horizontal at all intersections. So, $f_g = 1.0$ for all segments. The roads are far away from any central business district. So, $f_A = 1.0$. No exclusive turning lanes were observed in any roads. Even though roadway geometry and markings designated certain lanes of the segment as exclusive lanes, field observations showed that traffic from any lane could move to any direction, representing haphazard traffic movement. Hence, all lanes of segments were considered as shared lanes. The input lane utilization adjustment factor, f_{LU} is used to estimate saturation flow rate for a lane group with more than one exclusive lane. If the lane group has one shared lane or one exclusive lane, then this factor is 1.0. Based on above discussion, f_{LU} value was taken as 1.0 for all segments. Field observations revealed that turning movements were sometimes protected and sometimes permitted, but there was no definite pattern. Besides, non-lane heterogeneous traffic movement made it difficult to calculate adjustment factors for turning vehicles. Since no clear guidelines were found in HCM to determine adjustment factors for turning vehicles in heterogeneous conditions, all turning movements were considered protected. Pedestrian–bicycle adjustment factor for right-turn groups, f_{Rpb}, and pedestrian-bicycle adjustment factor for right-turn groups, f_{Lpb}, are taken as 1.0, since the turning movements are considered protected.

As per HCM (2010),

Adjustment factor for left-turn vehicle presence in a lane group, $f_{RT} = 1/E_R$

where, E_R = equivalent number of through cars for a protected right-turning vehicle

= 1.18 for protected movement

Adjustment factor for right-turn vehicle presence in a lane group, $f_{LT} = 1/E_L$

where, E_L = equivalent number of through cars for a protected left-turning vehicle

= 1.05 for protected movement

Now, these factors were developed considering right-hand traffic of USA. Since the study area in Bangladesh has left-hand traffic, the values of E_R and E_L have been switched in this study. Hence,

$f_{RT} = 1/1.05 = 0.8475$ (to 4 decimal places)

$f_{LT} = 1/1.18 = 0.9524$ (to 4 decimal places)

Unless otherwise stated, the values of factors explained previously pertain to the road segments of remaining studied flyovers.

From Table D.2, it is seen that on average, parking maneuvers were most prevalent on weekday, night (N_m = 11.30 maneuvers/h) and least prevalent on weekend, night (5 maneuvers/h). The average, minimum and maximum parking maneuver rates on weekend, day were measured at 6.80 maneuvers/h, 1 maneuvers/h (segment directions 5-6 and 6-5) and 15 maneuvers/h respectively (segment direction 1-5). The average, minimum and maximum parking maneuver rates on weekend, night were measured at 5 maneuvers/h, 1 maneuvers/h (segment direction 3-2) and 10 maneuvers/h respectively (segment direction 1-4). The average, minimum and maximum parking maneuver rates on weekday, day were measured at 8.30 maneuvers/h, 2 maneuvers/h (segment directions 5-6 and 6-5) and 14 maneuvers/h respectively (segment direction 1-4). The average, minimum and maximum parking maneuver rates on weekday, night were measured at 11.30 maneuvers/h, 1 maneuvers/h (segment direction 6-5) and 23 maneuvers/h respectively (segment direction 4-1). Segment 1-4/4-1 was observed to be the busiest parking site (12.88 maneuvers/h on average) while segment 5-6/6-5 was found to be the least busy (2 maneuvers/h on average).

Buses stopped most frequently on weekend, day (N_b = 30.40 buses/h) and least frequently on weekday, night (18.50 buses/h). The average, minimum and maximum bus stoppage rates on weekend, day were measured at 30.40 buses/h, 0 buses/h (segment directions 5-6 and 6-5) and 72 buses/h respectively (segment direction 4-1). The average, minimum and maximum bus stoppage rates on weekend, night were measured at 24 buses/h, 0 buses/h (segment directions 5-6 and 6-5) and 49 buses/h respectively (segment direction 2-1). The average, minimum and maximum bus stoppage rates on weekday, day were measured at 19.90 buses/h, 0 buses/h (segment directions 5-6 and 6-5) and 53 buses/h respectively (segment direction 4-1). The average, minimum and maximum bus stoppage rates on weekday, night were measured at 18.50 buses/h, 0 buses/h (segment directions 5-6 and 6-5) and 38 buses/h respectively (segment direction 4-1). Segment 1-4/4-1 was observed to be the busiest bus stop area (47.00 buses/h on average) while segment 5-6/6-5 was found to be the least busy (0 buses/h on average).

4.4.2 Banani Overpass

Data collected from reconnaissance survey are presented in Table D.3 of Appendix D. The width of at-grade road along Banani Overpass corridor varies from place to place. The number of lanes also increase at the rail level crossing. However, since the narrowest part of a road controls the capacity, roadway width was measured at the narrowest part. Hence each segment direction was observed to have 2 lanes at its narrowest portion. Since the studied at-grade road at Banani Overpass is a multilane highway, parking and bus stoppage adjustment factors do not need to be determined. Besides, field observations revealed that parking and bus stoppage were negligible because of restricted land use of the study area (limited to residential area of military personnel). General vehicle users' fear and respect for military personnel prevents them from parking unnecessarily along the study corridor.

4.4.3 Mohakhali Flyover

Data collected from reconnaissance survey are presented in Table D.4 of Appendix D. Table D.4 outlines calculation of adjustment factors considering parking and bus stoppage rate. The roads at-grade to Mohakhali Flyover have such geometry and traffic and pedestrian flows as to significantly increase the vehicle headways. As mentioned previously the columns of the flyover take up a significant portion of road space along flyover corridor, and hence restrict flow. Besides, unchecked pedestrian movements at all segments contribute to increasing the vehicle headways. Moreover, during peak times, flow often exceeds road capacity. Hence, f_A is taken as 0.9.

From Table D.5, it is seen that on average, parking maneuvers were most prevalent on weekday, day (N_m = 6.82 maneuvers/h) and least prevalent on weekday, night (4.82 maneuvers/h). The average, minimum and maximum parking maneuver rates on weekend, day were measured at 5.71 maneuvers/h, 1 maneuvers/h (segment directions 4-3 and 9-10) and 12 maneuvers/h respectively (segment direction 1-2). The average, minimum and maximum parking maneuver rates on weekend, night were measured at 5.71 maneuvers/h, 0 maneuvers/h (segment directions 5-4, 6-1 and 1-6) and 12 maneuvers/h respectively (segment direction 7-8). The average, minimum and maximum parking maneuver rates on weekday, day were measured at 6.82 maneuvers/h, 2 maneuvers/h (segment directions 1-6, 6-1 and 8-9) and 12 maneuvers/h respectively (segment direction 3-2). The average, minimum and maximum parking maneuver rates on weekday, night were measured at 4.82 maneuvers/h, 1 maneuvers/h (segment directions 1-6 and 6-1) and 10 maneuvers/h respectively (segment directions 8-13 and 10-9). Segment 8-13/13-8 was observed to be the busiest parking site (7.25 maneuvers/h on average) while segment 8-9/9-8 was found to be the least busy (4.38 maneuvers/h on average).

Buses stopped most frequently on weekday, day (N_b = 19.93 buses/h) and least frequently on weekday, night (10.89 buses/h). The average, minimum and maximum bus stoppage rates on weekend, day were measured at 12.86 buses/h, 0 buses/h (segment directions 1-6, 6-1, 8-13 and 13-8) and 33 buses/h respectively (segment direction 8-7). The average, minimum and maximum bus stoppage rates on weekend, night were measured at 19.93 buses/h, 0 buses/h (segment directions 1-6, 6-1, 8-13 and 13-8) and 49 buses/h respectively (segment direction 9-8). The average, minimum and maximum bus stoppage rates on weekday, day were measured at 15.93 buses/h, 0 buses/h (segment directions 1-6, 6-1, 8-13 and 13-8) and 47 buses/h respectively (segment direction 9-8). The average, minimum and maximum bus stoppage rates on weekday, night were measured at 10.89 buses/h, 0 buses/h (segment directions 1-6, 6-1, 8-13 and 13-8) and 34 buses/h respectively (segment direction 8-9). Segment 8-9/9-8 was observed to be the busiest bus stop area (37.00 buses/h on average) while segment 1-6/6-1 was found to be the least busy (0 buses/h on average).

4.4.4 Khilgaon Flyover

Data collected from reconnaissance survey are presented in Table D.6 of Appendix D. Table D.6 outlines calculation of adjustment factors considering parking and bus stoppage rate. The roads at-grade to Khilgaon Flyover have such geometry and traffic and pedestrian flows as to significantly increase the vehicle headways. As mentioned previously the columns of the flyover take up a significant portion of road space along flyover corridor, and hence restrict flow. Besides, unchecked pedestrian movements at all segments contribute to increasing the vehicle headways. Moreover, during peak times, flow often exceeds road capacity. In addition, the study area of Khilgaon Flyover is close to CBD, Motijheel. Hence, f_A is taken as 0.9.

From Table D.7, it is seen that on average, parking maneuvers were most prevalent on weekday, day (N_m = 11.52 maneuvers/h) and least prevalent on weekend, day (3.43 maneuvers/h). The average, minimum and maximum parking maneuver rates on weekend, day were measured at 3.43 maneuvers/h, 1 maneuvers/h (segment directions 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-18, 18-17, 2-18, 18-2 and 18-3) and 8 maneuvers/h respectively (segment direction 7-8). The average, minimum and maximum parking maneuver rates on weekend, night were measured at 4.00 maneuvers/h, 0 maneuvers/h (segment directions 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-16, 17-18, 18-17, 2-18, 18-2, 3-18 and 18-3) and 12 maneuvers/h respectively (segment direction 11-12). The average, minimum and maximum parking maneuver rates on weekday, day were measured at 11.52 maneuvers/h, 4 maneuvers/h (segment directions 13-14 and 14-13) and 25 maneuvers/h respectively (segment direction 11-12 and 12-11). The average, minimum and maximum parking maneuver rates on weekday, night were measured at 10.62 maneuvers/h, 4 maneuvers/h (segment directions 13-14 and 14-13) and 25 maneuvers/h respectively (segment directions 11-12 and 12-11). Segment 11-12/12-11 was observed to be the busiest parking site (16.25 maneuvers/h on average) while segment 2-18/18-2 was found to be the least busy (2.25 maneuvers/h on average).

Buses stopped most frequently on weekday, day (N_b = 6.98 buses/h) and least frequently on weekday, night (4.26 buses/h). The average, minimum and maximum bus stoppage rates on weekend, day were measured at 2.60 buses/h, 0 buses/h (segment directions 3-4, 4-3, 4-5, 5-4, 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-16, 17-18, 18-17, 2-18, 18-2, 3-18 and 18-3) and 15 buses/h respectively (segment directions 9-10 and 11-10). The average, minimum and maximum bus stoppage rates on weekend, night were measured at 2.62 buses/h, 0 buses/h (segment directions 1-2, 2-1, 2-3, 3-2, 3-4, 4-3, 4-5, 5-4, 1-12, 12-1, 1-8, 8-1, 11-13, 13-11, 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-16, 17-18, 18-17, 2-18, 18-2, 3-18 and 18-3) and 15 buses/h respectively (segment direction 9-8). The average, minimum and maximum bus stoppage rates on weekday, day were measured at 6.98 buses/h, 0 buses/h (segment directions 3-4, 4-3, 4-5, 5-4, 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-16, 17-18, 18-17, 2-18, 18-2, 3-18 and 18-3) and 21 buses/h respectively (segment directions 11-13 and 13-11). The average, minimum and maximum bus stoppage rates on weekday, night were measured at 4.26 buses/h, 0 buses/h (segment directions 2-1, 2-3, 3-2, 3-4, 4-5, 5-4, 5-6, 6-5, 12-1, 1-8, 8-1, 11-13, 13-11, 13-14, 14-13, 14-15, 15-14, 15-16, 16-15, 16-17, 17-16, 17-18, 18-17, 2-18, 18-2, 3-18 and 18-3) and 21 buses/h respectively (segment direction 8-9). Segment 9-10/10-9 was observed to be the busiest bus stop area (12.88 buses/h on average) while segments 4-5/5-4, 13-14/14-13, 14-15/15-14, 15-16/16-15, 16-17/17-16, 17-18/18-17, 2-18/18-2 and 3-18/18-3 were jointly found to be the least busy (0 buses/h on average).

4.4.5 Jatrabari-Gulistan Flyover

Data collected from reconnaissance survey are presented in Table D.8 of Appendix D. Table D.8 outlines calculation of adjustment factors considering parking and bus stoppage rate. The roads at-grade to Jatrabari-Gulistan Flyover have such geometry and traffic and pedestrian flows as to significantly increase the vehicle headways. As mentioned previously the columns of the flyover take up a significant portion of road space along flyover corridor, and hence restrict flow. Besides, unchecked pedestrian movements at all segments contribute to increasing the vehicle headways. Moreover, during peak times, flow often exceeds road capacity. Hence, f_A is taken as 0.9.

From Table D.9, it is seen that on average, parking maneuvers were most prevalent on weekday, day (N_m = 13.27 maneuvers/h) and least prevalent on weekday, night (3.70 maneuvers/h). The average, minimum and maximum parking maneuver rates on weekend, day were measured at 3.83 maneuvers/h, 0 maneuvers/h (segment directions 8-9 and 9-8) and 10 maneuvers/h respectively (segment direction 6-7). The average, minimum and maximum parking maneuver rates on weekend, night were measured at 7.13 maneuvers/h, 0 maneuvers/h (segment directions 4-5, 5-4 and 8-9) and 12 maneuvers/h respectively (segment directions 7-8 and 8-14). The average, minimum and maximum parking maneuver rates on weekday, day were measured at 13.27 maneuvers/h, 1 maneuvers/h (segment direction 5-4) and 21 maneuvers/h respectively (segment direction 9-11). The average, minimum and maximum parking maneuver rates on weekday, night were measured at 3.70 maneuvers/h, 0 maneuvers/h (segment directions 8-9 and 9-8) and 7 maneuvers/h respectively (segment directions 3-4 and 8-14). Segment 6-7/7-6 was observed to be the busiest parking site (10.13 maneuvers/h on average) while segment 4-5/5-4 was found to be the least busy (1.13 maneuvers/h on average).

Buses stopped most frequently on weekday, night (N_b = 15.63 buses/h) and least frequently on weekend, night (9.63 buses/h). The average, minimum and maximum bus stoppage rates on weekend, day were measured at 15.37 buses/h, 0 buses/h (segment directions 9-11 and 11-9) and 41 buses/h respectively (segment direction 7-8). The average, minimum and maximum bus stoppage rates on weekend, night were measured at 9.63 buses/h, 0 buses/h (segment directions 4-5, 5-4, 8-9, 9-8, 9-11 and 11-9) and 28 buses/h respectively (segment direction 2-3). The average, minimum and maximum bus stoppage rates on weekday, day were measured at 11.87 buses/h, 0 buses/h (segment directions 8-9 and 9-8) and 25 buses/h respectively (segment direction 2-1). The average, minimum and maximum bus stoppage rates on weekday, night were measured at 15.63 buses/h, 0 buses/h (segment directions 9-11 and 11-9) and 39 buses/h respectively (segment direction 11-10). Segment 10-11/11-10 was observed to be the busiest bus stop area (20.13 buses/h on average) while segment 4-5/5-4 was found to be the least busy (1 buses/h on average).

4.4.6 Moghbazar-Mouchak Flyover

Data collected from reconnaissance survey are presented in Table D.10 of Appendix D. Table D.10 outlines calculation of adjustment factors considering parking and bus stoppage rate. Moghbazar-Mouchak Flyover study area connects many commercially important areas, including Moghbazar, Mouchak, Khilgaon, Tejgaon, Shahbag and Kakrail, where traffic and pedestrian flows significantly increase the vehicle headways. Hence, f_A is taken as 0.9.

From Table D.11, it is seen that on average, parking maneuvers were most prevalent on weekday, night (N_m = 6.45 maneuvers/h) and least prevalent on weekend, day (2.58 maneuvers/h). The average, minimum and maximum parking maneuver rates on weekend, day were measured at 2.58 maneuvers/h, 0 maneuvers/h (segment directions 7-8, 8-7, 7-19, 19-7, 8-9, 9-8, 11-12, 19-20, 21-20, 21-22, 23-24, 24-23) and 7 maneuvers/h respectively (segment direction 17-18). The average, minimum and maximum parking maneuver rates on weekend, night were measured at 4.70 maneuvers/h, 0 maneuvers/h (segment directions 7-8, 8-7, 8-9, 9-8, 20-21 and 21-20) and 12 maneuvers/h respectively (segment direction 16-17). The average, minimum and maximum parking maneuver rates on weekday, day were measured at 5.41 maneuvers/h, 0 maneuvers/h (segment directions 7-8, 8-7, 7-19, 19-7, 8-9, 9-8, 20-21, 21-20, 21-22, 22-21, 22-23 and 23-22) and 25 maneuvers/h respectively (segment direction 16-17 and 17-16). The average, minimum and maximum parking maneuver rates on weekday, night were measured at 6.45 maneuvers/h, 0 maneuvers/h (segment directions 7-8, 8-7, 7-19, 19-7, 8-9 and 9-8) and 25 maneuvers/h respectively (segment directions 16-17 and 17-16). Segment 16-17/17-16 was observed to be the busiest parking site (16.25 maneuvers/h on average) while segments 7-8/8-7, 8-9/9-8 was found to be the least busy (0 maneuvers/h on average).

Buses stopped most frequently on weekend, night (N_b = 11.95 buses/h) and least frequently on weekday, night (9.17 buses/h). The average, minimum and maximum bus stoppage rates on weekend, day were measured at 10.98 buses/h, 0 buses/h (segment directions 2-25, 25-2, 4-22, 22-4, 6-14, 14-6, 7-8, 8-7, 7-19, 19-7, 8-9, 9-8, 10-11, 11-10, 11-12, 12-11, 11-14, 14-11, 12-18, 18-12, 19-20, 20-19, 20-21 and 21-20) and 56 buses/h respectively (segment direction 2-3). The average, minimum and maximum bus stoppage rates on weekend, night were measured at 11.95 buses/h, 0 buses/h (segment directions 2-25, 25-2, 4-22, 22-4, 6-14, 14-6, 7-8, 8-7, 7-19, 19-7, 8-9, 9-8, 10-11, 11-10, 11-12, 12-11, 11-14, 14-11, 12-18, 18-12, 16-26, 26-16, 17-18, 18-17, 19-20, 20-19, 20-21 and 21-20) and 53 buses/h respectively (segment direction 3-2). The average, minimum and maximum bus stoppage rates on weekday, day were measured at 11.56 buses/h, 0 buses/h (segment directions 2-25, 25-2, 4-22, 22-4, 6-14, 14-6, 7-19, 19-7, 8-9, 9-8, 10-11, 11-10, 11-12, 12-11, 11-14, 14-11, 20-21 and 21-20) and 39 buses/h respectively (segment direction 2-3). The average, minimum and maximum bus stoppage rates on weekday, night were measured at 9.17 buses/h, 0 buses/h (2-25, 25-2, 4-22, 22-4, 6-14, 14-6, 7-19, 19-7, 8-9, 9-8, 10-11, 11-10, 11-12, 12-11, 11-14, 14-11, 12-18, 18-12, 16-26, 26-16, 17-18, 18-17, 20-21 and 21-20) and 33 buses/h respectively (segment direction 10-9). Segment 2-3/3-2 was observed to be the busiest bus stop area (42.00 buses/h on average) while segments 2-25/25-2, 4-22/22-4, 6-14/14-6, 7-19/19-7, 8-9/9-8, 10-11/11-10, 11-12/12-11, 11-14/14-11 and 20-21/21-20 were jointly found to be the least busy (0 buses/h on average).

4.4.7 Discussions

Parking and bus stoppage are significant factors that have been observed to reduce roadway capacity in all study areas except Banani Overpass, as will be revealed in later sections. All study areas except Banani Overpass have mixed commercial and residential land uses, with limited off-street parking. Traffic flow assessment revealed that among all the modes, private cars take up the most space on road. People traveling to their homes or offices are forced to park on street because of limited parking facilities or to avoid high parking fees in off-street parking facilities of markets. Parking on street reduces effective road width for passing vehicles. Besides, parking and un-parking maneuvers slow down through traffic and reduce road capacity. Situation is worsened by additional parked para-transit vehicles such as rickshaw, CNG and human haulers looking for passengers and waiting on street. Human haulers tend to wait until their passenger capacity (usually 12 seats) is full, increasing the time spent parked. Besides, many rickshaws were observed to wait near intersections, instead of mid-block, where impact of traffic would be lower. To increase the probability of getting passengers, rickshaws tend to wait at the confluence of different directions. Such confluence points are intersections. Thus rickshaws at intersections pose as hazardous obstructions, especially for turning vehicles, and consequently reduce the capacity at intersections. It essentially indicates lack of enforcement of law officers. According to the law, it is illegal to park at intersections and also in many public places, but this is not properly enforced. Resolving this problem is difficult. It may not be possible to provide additional off-street parking facilities in the study areas because most areas are built-up and there is limited scope for future development of infrastructure in those areas. Law officers need to strictly enforce parking regulations. The core reason behind excessive parking is the rampant use of private automobiles on roads. Use of private vehicles needs to be restricted, which can be done through use of road taxes, license restrictions, car purchase taxes, etc. However, the most effective method would be to encourage more people to use public buses and mass rapid transit.

Buses operate on a franchise system that has many owners. It cannot be said to operate like a true public bus system that is prevalent in many parts of the world. In a true public bus system, such as Bus Rapid Transit (BRT), all buses are owned by one entity only (usually the government). Buses are available to people round the clock for travel, even at off peak times. Each bus continuously runs throughout the day and rests at depot only to refuel or for maintenance purposes. Since the owner is usually the government, it is not worried about making losses at off-peak times from low revenue. This is because the main aim of the government is to serve the general public and work for their welfare, not to make profits. However, in Bangladesh, it is seen that intra-city buses operate on a franchise system consisting of many owners, each wishing to maximize profits at minimum trip numbers. Hence, most buses run at peak times, creating an artificial over-capacity situation in buses. Buses compete unhealthily among themselves to pick up and drop off passengers according to the wish of the passengers. So, buses often stop mid-block and in the middle lane to pick up and drop off passengers, leading to flow breakdowns and congestion. Passengers are also prone to accidents when they embark or disembark in the middle of the road. The flow breakdowns and sudden stoppage of buses force the following vehicles to slow down and change lanes, which reduces road capacity. As it is not profitable to run buses at off-peak times, most bus owners do not usually allow buses to run at off-peak time, creating artificial shortages. Hence, passengers at off-peak times do not find many buses to travel on. At that time, most buses are parked either on road (reducing capacity) or in terminals, making it difficult for passengers to embark buses on duty. This is not the true function of terminals. Buses are supposed to dwell in terminals for only a short time, just enough for passengers to embark and disembark. Besides, terminals should have only enough space for buses to make U turns and restart trips. However, it is seen that in Dhaka city, the three terminals in Gabtoli, Saidabad and Mohakhali are used mainly as parking spaces for buses. It is often seen that buses dwell at one stop longer than necessary to pick up extra passengers and hence block the following traffic for a longer time period. Dwelling on one stop longer than expected makes bus travel schedule to subsequent stops unpredictable. Hence, people often have to wait longer than expected on bus stops to embark on their desired bus. All these make bus service in Dhaka undesirable, discouraging people to use the existing public bus services and encouraging them to buy more cars, which in turn induces more parking problems for private automobiles. To address this problem, the government needs to make public bus services popular by introducing BRT system in Dhaka city.

4.5 Determination of Saturation Flow Rate

Determination of saturation flow rate is one of the primary steps in determination of LOS of the study areas. Saturation flow rate is calculated as per HCM (2010) [57] using the following equation:

Adjusted saturation flow rate:

$s = s_o f_w f_{HV} f_g f_p f_{bb} f_a f_{LU} f_{LT} f_{RT} f_{Lpb} f_{Rpb}$

where

s = adjusted saturation flow rate (pc/h/ln),

s_o = base saturation flow rate (pc/h/ln),

f_w = adjustment factor for lane width,

f_{HV} = adjustment factor for heavy vehicles in traffic stream,

f_g = adjustment factor for approach grade,

f_p = adjustment factor for existence of a parking lane and parking activity adjacent to lane group,

f_{bb} = adjustment factor for blocking effect of local buses that stop within intersection area,

f_a = adjustment factor for area type,

f_{LU} = adjustment factor for lane utilization,

f_{LT} = adjustment factor for left-turn vehicle presence in a lane group,

f_{RT} = adjustment factor for right-turn vehicle presence in a lane group,

f_{Lpb} = pedestrian adjustment factor for left-turn groups, and

f_{Rpb} = pedestrian-bicycle adjustment factor for right-turn groups.

Base saturation flow rate (s_o) default value is 1900 pcu/h/ln, which is also considered in this study. Values of f_W, f_g, f_P, f_{bb}, fa, f_{LU}, f_{LT}, f_{RT}, f_{Lpb} and f_{Rpb} have already been discussed in previous sections.

Values of f_{HV} along with adjusted saturation flow rate calculations for each segment direction of the study area of each flyover is provided in tables of Appendix E. The temporal variation at each segment direction is also highlighted using tables at Appendix E.

4.5.1 Shaheed Ahsanullah Master Flyover

Calculation of adjusted saturation flow rate for each segment direction of the study area of Shaheed Ahsanullah Master Flyover is provided in Table E.1 of Appendix E. The calculations shown in Table E.1 pertain to only urban street segments. Multilane highways (segments f1/f2 and g1/g2) are addressed in later sections.

From Table E.1, it is seen that saturation flow rate is generally highest along segment direction 6-5 (average flow rate of 1421 pc/h) and lowest along segment 3-2 (average flow rate of 1235 pc/h). Considering the period of measurement, flow rate was calculated to be the highest during weekend, night (average flow rate of 1344 pc/h) and lowest during weekend, day (average flow rate of 1284 pc/h). The average, minimum and maximum segment directional saturation flow rate during weekend, day was calculated to be 1284 pc/h, 1122 pc/h and 1428 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekend, night was calculated to be 1344 pc/h, 1303 pc/h and 1433 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, day was calculated to be 1324 pc/h, 1263 pc/h and 1414 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, night was calculated to be 1316 pc/h, 1223 pc/h and 1417 pc/h respectively. It is seen that saturation flow rate is higher in weekday compared to weekend, and higher at night compared at day.

4.5.2 Banani Overpass

Since the studied at-grade road at Banani Overpass is a multilane highway, saturation flow rate do not need to be determined.

4.5.3 Mohakhali Flyover

Calculation of adjusted saturation flow rate for each segment direction of the study area of Mohakhali Flyover is provided in Table E.2 of Appendix E. From Table E.2, it is seen that saturation flow rate is generally highest along segment direction 6-5 (average flow rate of 1324 pc/h) and lowest along segment 2-1 (average flow rate of 1174 pc/h). Considering the period of measurement, flow rate was calculated to be the highest during weekday, night (average flow rate of 1289 pc/h) and lowest during weekend, night (average flow rate of 1228 pc/h). The average, minimum and maximum segment directional saturation flow rate during weekend, day was calculated to be 1233 pc/h, 1062 pc/h and 1323 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekend, night was calculated to be 1228 pc/h, 1138 pc/h and 1323 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, day was calculated to be 1257 pc/h, 1195 pc/h and 1330 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, night was calculated to be 1289 pc/h, 1239 pc/h and 1328 pc/h respectively. It is seen that saturation flow rate is higher in weekday compared to weekend, and higher at night compared at day.

4.5.4 Khilgaon Flyover

Calculation of adjusted saturation flow rate for each segment direction of the study area of Khilgaon Flyover is provided in Table E.3 of Appendix E. From Table E.3, it is seen that saturation flow rate is generally highest along segment direction 12-1 (average flow rate of 1318 pc/h) and lowest along segment 3-18 (average flow rate of 1211 pc/h). Considering the period of measurement, flow rate was calculated to be the highest during weekend, day (average flow rate of 1278 pc/h) and lowest during weekday, day (average flow rate of 1236 pc/h). The average, minimum and maximum segment directional saturation flow rate during weekend, day was calculated to be 1278 pc/h, 1228 pc/h and 1327 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekend, night was calculated to be 1277 pc/h, 1242 pc/h and 1327 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, day was calculated to be 1236 pc/h, 1187 pc/h and 1307 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, night was calculated to be 1245 pc/h, 1187 pc/h and 1323 pc/h respectively. It is seen that saturation flow rate is higher in weekend compared to weekday, and higher at night compared at day.

4.5.5 Jatrabari-Gulistan Flyover

Calculation of adjusted saturation flow rate for each segment direction of the study area of Jatrabari-Gulistan Flyover is provided in Table E.4 of Appendix E. From Table E.4, it is seen that saturation flow rate is generally highest along segment direction 5-4 (average flow rate of 1305 pc/h) and lowest along segment 8-9 (average flow rate of 1191 pc/h). Considering the period of measurement, flow rate was calculated to be the highest during weekend, night (average flow rate of 1257 pc/h) and lowest during weekday, day (average flow rate of 1218 pc/h). The average, minimum and maximum segment directional saturation flow rate during weekend, day was calculated to be 1245 pc/h, 1178 pc/h and 1299 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekend, night was calculated to be 1257 pc/h, 1212 pc/h and 1311 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, day was calculated to be 1218 pc/h, 1118 pc/h and 1305 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, night was calculated to be

1247 pc/h, 1183 pc/h and 1305 pc/h respectively. It is seen that saturation flow rate is higher in weekend compared to weekday, and higher at night compared at day.

4.5.6 Moghbazar-Mouchak Flyover

Calculation of adjusted saturation flow rate for each segment direction of the study area of Jatrabari-Gulistan Flyover is provided in Table E.5 of Appendix E. From Table E.5, it is seen that saturation flow rate is generally highest along segment directions 8-9 and 9-8 jointly (average flow rate of 1346 pc/h) and lowest along segment 3-2 (average flow rate of 1191 pc/h). Considering the period of measurement, flow rate was calculated to be the highest during weekend, day (average flow rate of 1287 pc/h) and lowest during weekday, day (average flow rate of 1282 pc/h). The average, minimum and maximum segment directional saturation flow rate during weekend, day was calculated to be 1287 pc/h, 1181 pc/h and 1346 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekend, night was calculated to be 1283 pc/h, 1174 pc/h and 1346 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, day was calculated to be 1282 pc/h, 1207 pc/h and 1346 pc/h respectively. The average, minimum and maximum segment directional saturation flow rate during weekday, night was calculated to be 1286 pc/h, 1190 pc/h and 1346 pc/h respectively. It is seen that saturation flow rate is higher in weekend compared to weekday, and higher at night compared at day.

4.6 Determination of Segment Capacity

Segment capacity helps in determining LOS of each direction of each segment of the study area. This section only entails determination of segment capacity. LOS calculation is outlined in later sections. Segment capacity is determined from saturation flow rate using the following formula:

$c = Nsg/C$

where c = capacity (pc/h)
N = number of lanes (ln)
s = saturation flow rate (pc/h)
g = effective green time (s)
C = cycle time (s)

From the above equation, it is evident that green signal times of each approach and cycle time of each intersection need to be measured before determining segment capacity. The intersection signal times as well as the segment capacity calculations are presented in the following subsections. The segment capacity is measured only for urban street segments and not for multilane highways. Observed green signal times are provided in figures of Appendix F while subsequent calculations of segment capacity are provided in tables of Appendix G.

4.6.1 Shaheed Ahsanullah Master Flyover

The intersection signal times for each period of measurement is provided in Figure F.1. In Figure F.1, the intersections are labelled as per Google Image maps of the study area depicted in Figure 3.1. The green times shown in Figure F.1 of the respective approaches are in seconds. This green time is measured for through vehicle movement. Field observations revealed that there was no fixed pattern of phase switch. Phase movements were controlled by traffic police on field. To simplify calculations, all movements from one approach were assumed to face the green time at the same phase, before moving to the next approach. Thus the turning movements were assumed to be protected and to finish before start of next phase. Ten complete cycles were observed at each intersection and the average green time at each approach (rounded to nearest second) was determined, as shown in Figure F.1. Summation of green times for all approaches at an intersection gives cycle time. The phase duration green times (D_P) were used to calculate effective green time as per the following equation.

Effective green time, $g = D_P - l_1 - l_2$

Where D_P = phase duration (green time)

l_1 = start-up lost time = 2s by default

l_2 = clearance lost time = yellow change interval + red clearance (also called all-red) – extension of effective green (if actuated, then default value is taken as 2s, if non-actuated, then zero).

Observations revealed that phase durations were actuated by hand of on-field traffic police without following any prescribed guidelines. Hence for calculation purposes in this study, all phases were assumed to follow fixed signal rules. So effective green extension was taken as zero. Red clearance time was assumed to be zero. Yellow change interval was observed to be 3s generally. Start-up lost time was taken at the default value of 2s.

Hence, g = D_P – 5s.

These general guidelines were also followed at the intersections of the study areas of remaining flyovers, unless otherwise stated. The signal times of the intersections of the study area at Shaheed Ahsanullah Master Flyover were used to calculate segment directional capacity as per the following table.

From Table G.1, it is seen that capacity is generally highest along segment 1-2/2-1 (average segment capacity of 2678 pc/h) and lowest along segment 2-3/3-2 (average segment capacity of 601 pc/h). Considering the period of measurement, capacity was calculated to be the highest during weekday, day (average segment directional capacity of 946 pc/h) and lowest during weekend, day (average segment directional capacity of 901 pc/h). The average, minimum and maximum segment directional capacity during weekend, day was calculated to be 901 pc/h, 220 pc/h and 1360 pc/h respectively. The average, minimum and maximum segment directional capacity during weekend, night was calculated to be 939 pc/h, 271 pc/h and 1619 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, day was calculated to be 946 pc/h, 281 pc/h and 1275 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, night was calculated to be 976 pc/h, 308 pc/h and 1371 pc/h respectively.

It is seen that weekend capacity is lower than weekday capacity. A possible reason for this is the increase in bus stoppage rate during weekends, as noted in Table 4.9. As the studied routes link Dhaka to northern divisions of the country including Sylhet and Rajshahi, it is possible that buses stop along these routes to pick up and drop off passengers. Most people living in the study area in Tongi have their home district in other places. During weekend, they get time to visit their home districts for personal reasons, which would not be possible during weekdays. Segment 1-2/2-1 has the highest capacity mainly because it has the highest number of lanes in the study area (3 lanes per direction). Besides, it has the highest average effective green time to cycle time ratio. Segment 2-3/3-2 has the lowest capacity because it has the lowest number of lanes in the study area (1 lane per direction), making it essentially a 2-lane 2-way road. Thus vehicles have to get into the wrong side of the road to overtake slower vehicles, making overtaking maneuvers less frequent and more risky. So capacity naturally decreases here. It has been observed that on-street parking is a significant factor in reducing capacity of entire study area, and this is prevalent in all studied flyovers except Banani Overpass. Effect of parking and bus stoppage on capacity has already been discussed in earlier sections (Assessment of Roadway Conditions).

4.6.2 Banani Overpass

Since the studied at-grade road at Banani Overpass is a multilane highway, segment capacity do not need to be calculated. Default values of segment capacity provided by HCM (2010) for various free flow speeds are used in this study, as outlined in Chapter 3, Methodology.

4.6.3 Mohakhali Flyover

The intersection signal times for each period of measurement is provided in Figure F.2. In Figure F.2, the intersections are labelled as per Google Image maps of the study area depicted in Figure 3.3. The signal times of the intersections of the study area at Mohakhali Flyover were used to calculate segment directional capacity as per Table G.2. From Table G.2, it is seen that capacity is generally highest along segment 5-6/6-5 (average segment capacity of 3649 pc/h) and lowest along segment 1-6/6-1 (average segment capacity of 893 pc/h). Considering the period of measurement, capacity was calculated to be the highest during weekday, night (average segment directional capacity of 1173 pc/h) and lowest during weekend, night (average segment directional capacity of 1044 pc/h). The average, minimum and maximum segment directional capacity during weekend, day was calculated to be 1088 pc/h, 308 pc/h and 1812 pc/h respectively. The average, minimum and maximum segment directional capacity during weekend, night was calculated to be 1044 pc/h, 443 pc/h and 1836 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, day was calculated to be 1120 pc/h, 328 pc/h and 2181 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, night was calculated to be 1173 pc/h, 408 pc/h and 2365 pc/h respectively. Segment 5-6/6-5 has the highest capacity mainly because it has the most lanes (4 lanes per direction) in the study area. Segment 1-6/6-1 has the lowest capacity mainly because it has the least lanes (2 lanes per direction) in the study area. Also, it has the lowest effective green time to cycle time ratio in general. It is seen that capacities are similar across all periods of measurement, indicating similar traffic conditions at all periods of measurement.

4.6.4 Khilgaon Flyover

The intersection signal times for each period of measurement is provided in Figure F.3. In Figure F.3, the intersections are labelled as per Google Image maps of the study area depicted in Figure 3.4. The signal times of the intersections of the study area at Khilgaon Flyover were used to calculate segment directional capacity as per Table G.3. From Table G.3, it is seen that capacity is generally highest along segment 2-3/3-2 (average segment capacity of 2540 pc/h), followed closely by segment 11-12 (average segment capacity of 2471 pc/h) and segment 13-11 (average segment capacity of 2469 pc/h). Capacity was found to be lowest along segment 13-14/14-13 (average segment capacity of 589 pc/h), followed closely by segment 16-17 (average segment capacity of 604 pc/h). Considering the period of measurement, capacity was calculated to be the highest during weekend, day (average segment directional capacity of 738 pc/h) and lowest during weekday, night (average segment directional capacity of 706 pc/h). The average, minimum and maximum segment directional capacity during weekend, day was calculated to be 738 pc/h, 172 pc/h and 1388 pc/h respectively. The average, minimum and maximum segment directional capacity during weekend, night was calculated to be 734 pc/h, 248 pc/h and 1391 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, day was calculated to be 717 pc/h, 202 pc/h and 1412 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, night was calculated to be 706 pc/h, 248 pc/h and 1332 pc/h respectively. Segment 2-3/3-2 has the highest capacity because of a combination of having many lanes (3 lanes per direction) and a high effective green time to cycle time ratio. Segment 13-14/14-13 has the lowest capacity mainly because of a combination of having few lanes (1 lane per direction) and a low effective green time to cycle time ratio. It is seen that capacities are similar across all periods of measurement for a particular road segment, indicating similar traffic conditions at all periods of measurement.

4.6.5 Jatrabari-Gulistan Flyover

The intersection signal times for each period of measurement is provided in Figure F.4. In Figure F.4, the intersections are labelled as per Google Image maps of the study area depicted in Figure 3.5. The signal times of the intersections of the study area at Jatrabari-Gulistan Flyover were used to calculate segment directional capacity as per Table G.4. From Table G.4, it is seen that capacity is generally highest along segment 6-7/7-6 (average segment capacity of 1666 pc/h) and lowest along segment 8-9/9-8 (average segment capacity of 712 pc/h. Considering the period of measurement, capacity was calculated to be the highest during weekend, night (average segment directional capacity of 679 pc/h) and lowest during weekday, day (average segment directional capacity of 643 pc/h). The average, minimum and maximum segment directional capacity during weekend, day was calculated to be 662 pc/h, 339 pc/h and 894 pc/h respectively. The average, minimum and maximum segment directional capacity during weekend, night was calculated to be 679 pc/h, 311 pc/h and 923 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, day was calculated to be 643 pc/h, 305 pc/h and 880 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, night was calculated to be 662 pc/h, 320 pc/h and 894 pc/h respectively. It is observed that majority of the segments have similar capacities, because most segments have the same number of lanes (2 per direction). Segment 6-7/7-6 has the highest capacity mainly because of a relatively high effective green time to cycle time ratio. Segment 8-9/9-8 has the lowest capacity mainly because of having few lanes (1 lane per direction). It is seen that capacities are similar across all periods of measurement for a particular road segment, indicating similar traffic conditions at all periods of measurement. Capacity has been found to be generally higher at weekend than at weekday, albeit slightly. The low capacity at weekend can be attributed to increased on-street parking at that time in the study area. Land use in Jatrabari study area is mixed residential and commercial, and most institutions along the study corridor have no or limited parking. Hence, during weekdays, when people go to their office, many of them park their private vehicles on street, reducing effective road width and capacity.

4.6.6 Moghbazar-Mouchak Flyover

The intersection signal times for each period of measurement is provided in Figure F.5. In Figure F.5, the intersections are labelled as per Google Image maps of the study area depicted in Figure 3.6. The signal times of the intersections of the study area at Jatrabari-Gulistan Flyover were used to calculate segment directional capacity as per Table G.5. From Table G.5, it is seen that capacity is generally highest along segment 21-22/22-21 (average segment capacity of 3534 pc/h), followed closely by segment 7-8 (average segment capacity of 3522 pc/h). Capacity was found to be lowest along segment 11-14/14-11 (average segment capacity of 656 pc/h). Considering the period of measurement, capacity was calculated to be the highest during weekday, night (average segment directional capacity of 1094 pc/h) and lowest during weekend, day (average segment directional capacity of 1070 pc/h). The average, minimum and maximum segment directional capacity during weekend, day was calculated to be 1070 pc/h, 209 pc/h and 2126 pc/h respectively. The average, minimum and maximum segment directional capacity during weekend, night was calculated to be 1093 pc/h, 294 pc/h and 2315 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, day was calculated to be 1085 pc/h, 272 pc/h and 2180 pc/h respectively. The average, minimum and maximum segment directional capacity during weekday, night was calculated to be 1094 pc/h, 257 pc/h and 2346 pc/h respectively. Segment 21-22/22-21 has the highest capacity because of a combination of having low bus stoppage rate, low parking rate and relatively high effective green time to cycle time ratio. Besides, it has the largest number of lanes in the study area (4 lanes per direction). Segment 7-8/8-7 has high capacity for similar reasons. Segment 11-14/14-11 has the lowest capacity mainly because of a low effective green time to cycle time ratio. It is seen that capacities are similar across all periods of measurement for a particular road segment, indicating similar traffic conditions at all periods of measurement.

4.7 Assessment of Mobility Conditions

Free Flow Speed (FFS) and Travel Speed (TS) were measured to assess mobility conditions of study areas. Travel speed helps evaluate how much the surrounding areas have benefited from flyovers. The ratio of TS/FFS is an indication of the mobility of roadway segments. FFS was originally measured for all classes of vehicles. To simplify calculations, the weighted average FFS of all vehicle classes was determined for each study area. However, this reduced FFS drastically to such an extent that further calculations where FFS values were applied were not feasible. This is because of the huge difference in speeds between motorized vehicles (MVs) and non-motorized vehicles (NMVs). MVs were observed to have FFS in the range of 50-100 km/h, whereas NMVs were observed to have FFS in the range of 10-15 km/h. Besides, HCM (2010) [57] treats LOS of NMVs differently from MVs.

In the following subsections, FFS considering all vehicle modes is determined first. FFS is determined for study area of each flyover, as well as for each period of measurement, namely, weekend day, weekend night, weekday day and weekday night. However, because of time and budget constraints, it was not possible to determine FFS separately for each road segment and each direction of the study area. Nevertheless, because free flow conditions were observed to be similar in each segment, hence FFS was measured at a convenient location, chosen following the guidelines outlined in Chapter 3, Methodology to choose a suitable location. FFS measured at one segment was used to represent FFS of all segments in the study area of that particular flyover.

The classified FFS presented includes non-motorized vehicles (NMVs) such as rickshaws and bicycles. Rickshaw is a para-transit vehicle, the determination of whose LOS has not been fully covered in HCM (2010) [57]. In addition, bicycle only makes up a negligible portion of total traffic. Hence these two modes of traffic have been omitted during Level of Service (LOS) evaluation.

After this, FFS is then evaluated omitting NMVs, because this value of FFS is used in determining LOS. TS is then calculated at each road segment. Because of time and budget constraints, TS could not be calculated for each class of MV, which would have been the ideal case. Hence LOS was measured considering only private motor vehicles, namely cars, because, private motor vehicles were observed to occupy the largest volume on road. The mobility assessment at each flyover concludes with a comparison of TS/FFS at each direction of each segment to justify the impact assessment of each flyover. TS is only determined for at-grade conditions. Collected data have been presented and analysed in the following subsections as well as in Appendix H. In the tables at Appendix H, “Over” refers to above-grade conditions while “Under” refers to at-grade conditions.

4.7.1 Shaheed Ahsanullah Master Flyover

The observed travel times at Shaheed Ahsanullah Master Flyover at free flow and peak-hour conditions are presented in the following subsections.

Determination of Free Flow Speed

Observed travel times at free flow conditions and their subsequent calculations of FFS are provided in Table H.1. Observed travel times are used to calculate weighted average FFS, first considering NMVs, and next omitting NMVs, which are depicted in Figure 4.13.

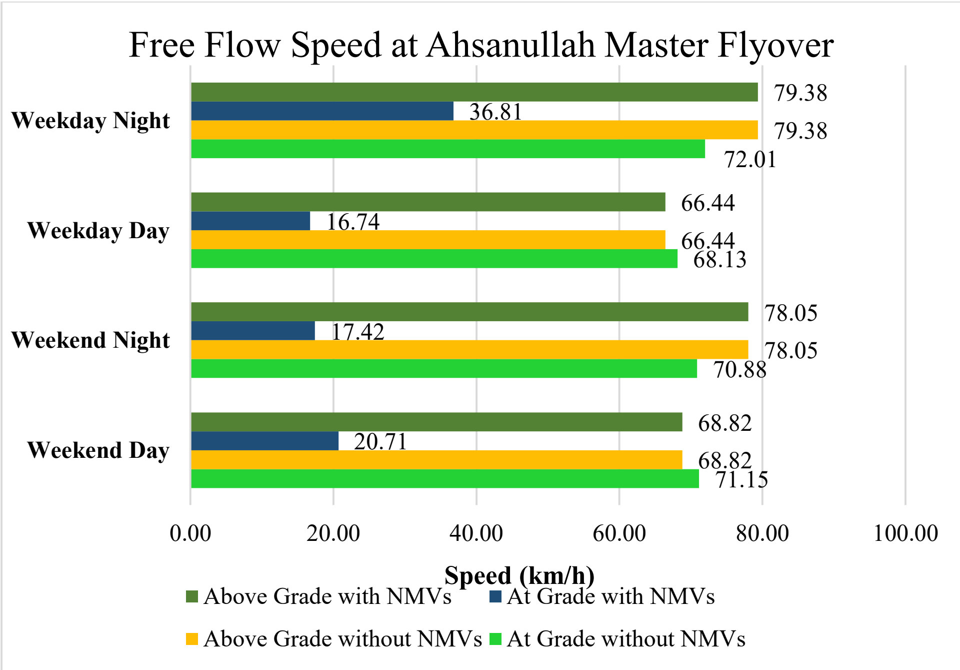


Figure 4.13: Observed FFS at SAMF

Figure 4.13 shows that the free flow speed varies between 65-80 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is drastically reduced (decreased by 49-75%) if NMVs are considered, to the extent that LOS calculations no longer become feasible with such low FFS. This is one of the reasons for ignoring NMV speeds in LOS calculations. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period. This may indicate that time of day does not affect free flow conditions. It also reveals that above-mentioned factors are similar irrespective of grade.

Determination of Travel Speed and Ratio of TS/FFS

Observed travel times at peak flow conditions are used to calculate values of TS, which are provided in Table H.2 and Figure H.1. TS, FFS without considering NMVs and the ratio of TS/FFS for Shaheed Ahsanullah Master Flyover is provided in Table 4.2. This ratio of TS/FFS will be used in the determining LOS.

Table 4.2: TS/ FFS Ratio Calculation for SAMF

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	5.68	71.15	0.08	4.32	70.88	0.06
	2-1	5.73	71.15	0.08	4.06	70.88	0.06
2-3	2-3	15.09	71.15	0.21	13.35	70.88	0.19
	3-2	14.59	71.15	0.20	12.68	70.88	0.18
1-4	1-4	8.70	71.15	0.12	8.71	70.88	0.12
	4-1	8.78	71.15	0.12	8.78	70.88	0.12
1-5	1-5	6.98	71.15	0.10	6.72	70.88	0.09
	5-1	7.87	71.15	0.11	6.76	70.88	0.10
5-6	5-6	3.57	71.15	0.05	4.26	70.88	0.06
	6-5	3.41	71.15	0.05	3.75	70.88	0.05
		Weekday, Day			Weekday, Night		
1-2	1-2	6.18	68.13	0.09	5.41	72.01	0.08
	2-1	5.02	68.13	0.07	5.51	72.01	0.08
2-3	2-3	15.72	68.13	0.23	15.02	72.01	0.21
	3-2	15.83	68.13	0.23	14.62	72.01	0.20
1-4	1-4	9.01	68.13	0.13	8.33	72.01	0.12
	4-1	9.15	68.13	0.13	8.26	72.01	0.11
1-5	1-5	7.25	68.13	0.11	6.43	72.01	0.09
	5-1	7.16	68.13	0.11	7.10	72.01	0.10
5-6	5-6	3.39	68.13	0.05	4.06	72.01	0.06
	6-5	3.26	68.13	0.05	3.89	72.01	0.05

From the above-mentioned figure and tables, it is seen that travel speed varies between 3 to 16 km/h. On average, vehicles moved fastest on weekend, day and slowest on weekend, night. The minimum and maximum directional speeds on weekend, day were measured at 3.41 km/h (segment direction 6-5) and 15.09 km/h respectively (segment direction 2-3). The minimum and maximum directional speeds on weekend, night were measured at 3.75 km/h (segment direction 6-5) and 13.35 km/h respectively (segment direction 2-3). The minimum and maximum directional speeds on weekday, day were measured at 3.26 km/h (segment direction 6-5) and 15.83 km/h respectively (segment direction 3-2). The minimum and maximum directional speeds on weekday, night were measured at 3.89 km/h (segment direction 6-5) and 15.02 km/h respectively (segment direction 2-3). Segment 2-3/3-2 was found to have the highest travel speed (14.61 km/h on average) while segment 5-6/6-5 was found to have the slowest travel speed (3.70 km/h on average).As segment 5-6/6-5 accommodates a railway crossing, segment delay in that segment is increased by crossing trains. It is also close to Tongi Railway Station, trains travel more slowly through here than usual. Average travel speeds along the study area are only slightly above the average walking speed of 5 km/h [102]. TS/FFS ratio varies between 0.05 and 0.23, revealing very poor mobility conditions.

4.7.2 Banani Overpass

Since the studied at-grade road at Banani Overpass is a multilane highway, as per HCM (2010), travel speed was omitted in determination of LOS. Only FFS was determined for this study area. The observed travel times at free flow conditions and their subsequent calculations of FFS are provided in Table H.3. Observed travel times are used to calculate weighted average FFS, first considering NMVs, and next omitting NMVs, which are depicted in the following graph.

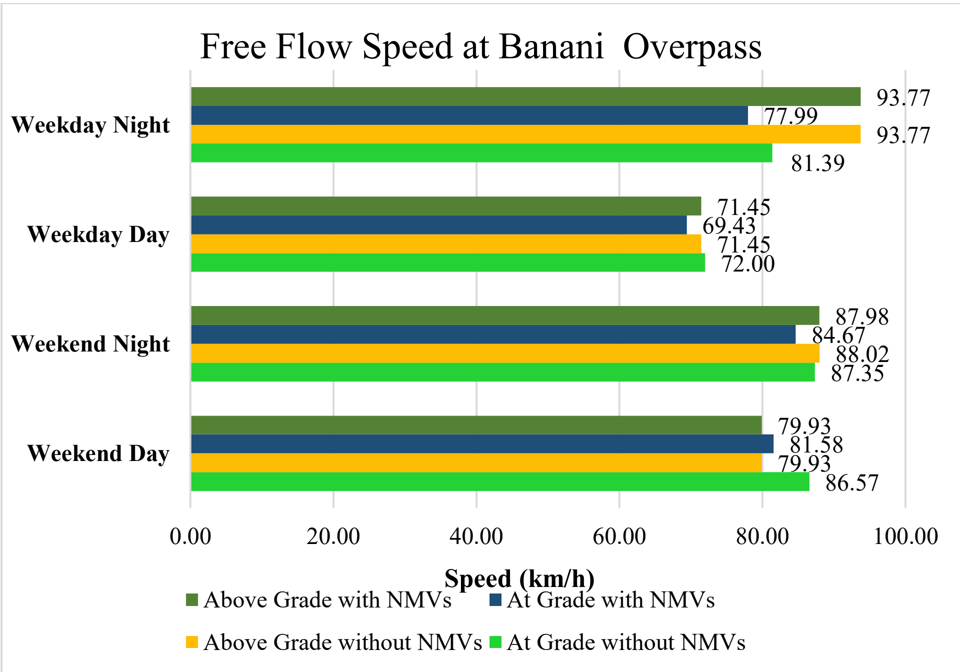


Figure 4.14: Observed FFS at Banani Overpass

From Figure 4.14, it is seen that the FFS varies between 71-94 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is slightly reduced (decreased by 3-6%) if NMVs are considered. Nevertheless, since NMVs are omitted in some study areas, FFS is calculated finally while omitting NMVs to keep calculation and analysis uniform across all flyovers studied. The reason for the slight decrease in FFS without considering NMVs, as opposed to a drastic decrease experienced in some flyovers, is that NMVs only make up a small portion of traffic at Banani Overpass. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period.

4.7.3 Mohakhali Flyover

The observed travel times at free flow and peak-hour conditions are presented in the following subsections.

Determination of Free Flow Speed

Observed travel times at free flow conditions at Mohakhali Flyover and their subsequent calculations of FFS are provided in Table H.4. Observed travel times are used to calculate weighted average FFS, first considering NMVs, and next omitting NMVs, which are depicted in Figure 4.15.

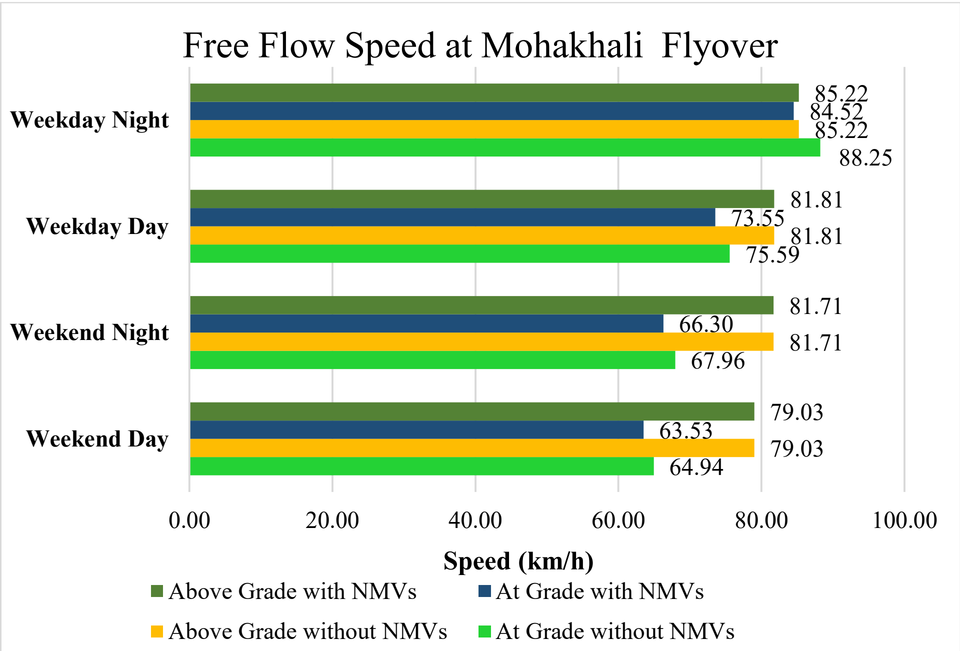


Figure 4.15: Observed FFS at Mohakhali Flyover

From Figure 4.15, it is seen that the FFS varies between 65-88 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is slightly reduced (decreased by 2-4%) if NMVs are considered. Nevertheless, since NMVs are omitted in some study areas, FFS is calculated finally while omitting NMVs to keep calculation and analysis uniform across all flyovers studied. The reason for the slight decrease in FFS without considering NMVs, as opposed to a drastic decrease experienced in some flyovers, is that NMVs only make up a small portion of traffic at Mohakhali Flyover. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period.

Determination of Travel Speed and Ratio of TS/FFS

Observed travel times at peak flow conditions are used to calculate values of TS, which are provided in Table H.5 and Figure H.2. TS, FFS without considering NMVs and the ratio of TS/FFS for Shaheed Ahsanullah Master Flyover is provided in Table 4.3. This ratio of TS/FFS will be used in the determining LOS.

Table 4.3: TS/ FFS Ratio Calculation for Mohakhali Flyover

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	5.90	64.94	0.09	3.91	67.96	0.06
	2-1	5.94	64.94	0.09	4.17	67.96	0.06
2-3	2-3	6.44	64.94	0.10	5.81	67.96	0.09
	3-2	7.02	64.94	0.11	6.22	67.96	0.09
3-4	3-4	7.63	64.94	0.12	8.09	67.96	0.12
	4-3	8.25	64.94	0.13	7.85	67.96	0.12
4-5	4-5	8.36	64.94	0.13	9.81	67.96	0.14
	5-4	7.92	64.94	0.12	8.93	67.96	0.13
5-6	5-6	8.73	64.94	0.13	8.94	67.96	0.13
	6-5	9.04	64.94	0.14	8.35	67.96	0.12
6-1	6-1	7.92	64.94	0.12	6.83	67.96	0.10
	1-6	7.49	64.94	0.12	6.37	67.96	0.09
4-7	4-7	6.00	64.94	0.09	4.64	67.96	0.07
	7-4	5.80	64.94	0.09	4.27	67.96	0.06
7-8	7-8	10.16	64.94	0.16	10.29	67.96	0.15
	8-7	9.90	64.94	0.15	9.73	67.96	0.14
7-11	7-11	11.47	64.94	0.18	13.04	67.96	0.19
	11-7	10.87	64.94	0.17	12.27	67.96	0.18
8-9	8-9	5.59	64.94	0.09	5.22	67.96	0.08
	9-8	4.69	64.94	0.07	4.26	67.96	0.06
8-13	8-13	10.93	64.94	0.17	11.99	67.96	0.18
	13-8	10.07	64.94	0.16	10.93	67.96	0.16
9-10	9-10	9.54	64.94	0.15	11.87	67.96	0.17
	10-9	10.42	64.94	0.16	11.80	67.96	0.17
10-11	10-11	10.64	64.94	0.16	10.00	67.96	0.15
	11-10	10.02	64.94	0.15	9.13	67.96	0.13
11-12	11-12	8.65	64.94	0.13	9.32	67.96	0.14
	12-11	7.52	64.94	0.12	8.45	67.96	0.12
Total Facility		**8.81**	**64.94**	**0.14**	**8.69**	**67.96**	**0.13**

(Table 4.3 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	6.19	75.59	0.08	6.57	88.25	0.07
	2-1	6.51	75.59	0.09	6.84	88.25	0.08
2-3	2-3	6.79	75.59	0.09	6.52	88.25	0.07
	3-2	6.86	75.59	0.09	5.93	88.25	0.07
3-4	3-4	7.21	75.59	0.10	7.67	88.25	0.09
	4-3	7.57	75.59	0.10	8.90	88.25	0.10
4-5	4-5	8.19	75.59	0.11	7.91	88.25	0.09
	5-4	7.82	75.59	0.10	7.66	88.25	0.09
5-6	5-6	7.73	75.59	0.10	9.12	88.25	0.10
	6-5	7.88	75.59	0.10	10.13	88.25	0.11
6-1	6-1	8.03	75.59	0.11	7.10	88.25	0.08
	1-6	6.78	75.59	0.09	7.18	88.25	0.08
4-7	4-7	7.53	75.59	0.10	5.65	88.25	0.06
	7-4	7.36	75.59	0.10	4.97	88.25	0.06
7-8	7-8	9.56	75.59	0.13	8.57	88.25	0.10
	8-7	9.22	75.59	0.12	8.02	88.25	0.09
7-11	7-11	9.22	75.59	0.12	11.32	88.25	0.13
	11-7	9.20	75.59	0.12	11.01	88.25	0.12
8-9	8-9	7.74	75.59	0.10	6.03	88.25	0.07
	9-8	7.54	75.59	0.10	5.84	88.25	0.07
8-13	8-13	8.83	75.59	0.12	10.00	88.25	0.11
	13-8	8.65	75.59	0.11	9.38	88.25	0.11
9-10	9-10	7.95	75.59	0.11	10.03	88.25	0.11
	10-9	8.34	75.59	0.11	9.53	88.25	0.11
10-11	10-11	9.72	75.59	0.13	11.30	88.25	0.13
	11-10	9.57	75.59	0.13	11.60	88.25	0.13
11-12	11-12	7.46	75.59	0.10	9.16	88.25	0.10
	12-11	6.86	75.59	0.09	8.31	88.25	0.09
Total Facility		**8.18**	**75.59**	**0.11**	**8.74**	**88.25**	**0.10**

From the above-mentioned figure and tables, it is seen that travel speed varies between 3 to 12 km/h. On average, vehicles moved fastest on weekend, day (total facility speed of 8.81 km/h) and slowest on weekday, day (total facility speed of 8.18 km/h). The total facility, minimum and maximum directional speeds on weekend, day were measured at 8.81 km/h, 4.69 km/h (segment direction 9-8) and 11.47 km/h respectively (segment direction 7-11). The total facility, minimum and maximum directional speeds on weekend, night were measured at 8.69 km/h, 3.91 (segment direction 1-2) and 13.04 km/h respectively (segment direction 7-11). The total facility, minimum and maximum directional speeds on weekday, day were measured at 8.18 km/h, 6.19 km/h (segment direction 1-2) and 9.72 km/h respectively (segment direction 10-11). The total facility, minimum and maximum directional speeds on weekday, night were measured at 8.74 km/h, 4.97 km/h (segment direction 7-4) and 11.60 km/h respectively (segment direction 11-10). Segment 7-11/11-7 was found to have the highest travel speed (11.05 km/h on average) while segment 1-2/2-1 was found to have the slowest travel speed (5.75 km/h on average). TS/FFS ratio varies between 0.06 and 0.19, revealing very poor mobility conditions.

4.7.4 Khilgaon Flyover

The observed travel times at Khilgaon Flyover at free flow and peak-hour conditions are presented in the following subsections.

Determination of Free Flow Speed

Observed travel times at free flow conditions at Khilgaon Flyover and their subsequent calculations of FFS are provided in Table H.6. Observed travel times are used to calculate weighted average FFS, first considering NMVs, and next omitting NMVs, which are depicted in Figure 4.16.

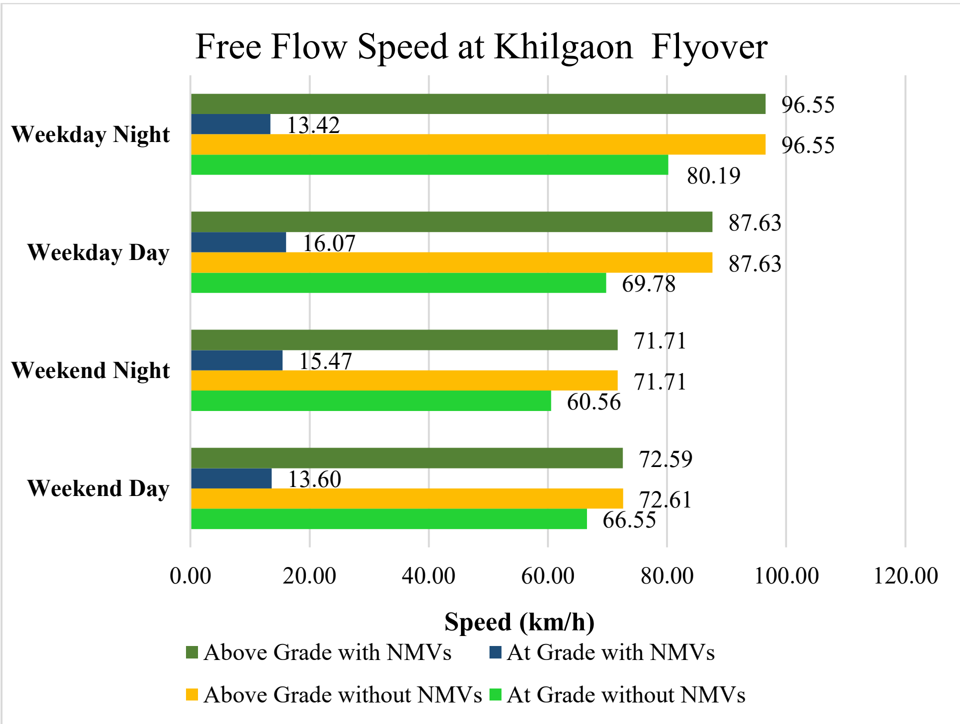


Figure 4.16: Observed FFS at Khilgaon Flyover

From Figure 4.16, it is seen that the FFS varies between 60-97 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because

NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is drastically reduced (decreased by 74-83%) if NMVs are considered, to the extent that LOS calculations no longer become feasible with such low FFS. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period.

Determination of Travel Speed and Ratio of TS/FFS

Observed travel times at peak flow conditions are used to calculate values of TS, which are provided in Table H.7 and Figure H.3. TS, FFS without considering NMVs and the ratio of TS/FFS for Shaheed Ahsanullah Master Flyover is provided in Table 4.3. This ratio of TS/FFS will be used in the determining LOS.

Table 4.4: TS/ FFS Ratio Calculation for Khilgaon Flyover

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	10.58	66.55	0.16	7.06	60.56	0.12
	2-1	11.37	66.55	0.17	7.29	60.56	0.12
2-3	2-3	9.73	66.55	0.15	6.53	60.56	0.11
	3-2	9.90	66.55	0.15	6.39	60.56	0.11
3-4	3-4	19.31	66.55	0.29	13.11	60.56	0.22
	4-3	19.56	66.55	0.29	13.26	60.56	0.22
4-5	4-5	10.97	66.55	0.16	7.65	60.56	0.13
	5-4	11.23	66.55	0.17	7.39	60.56	0.12
5-6	5-6	18.29	66.55	0.27	12.36	60.56	0.20
	6-5	18.04	66.55	0.27	12.69	60.56	0.21
6-7	6-7	10.05	66.55	0.15	6.64	60.56	0.11
	7-6	10.20	66.55	0.15	6.61	60.56	0.11
7-8	7-8	10.34	66.55	0.16	6.55	60.56	0.11
	8-7	10.35	66.55	0.16	6.57	60.56	0.11
8-9	8-9	10.48	66.55	0.16	6.99	60.56	0.12
	9-8	10.39	66.55	0.16	7.26	60.56	0.12
9-10	9-10	6.12	66.55	0.09	3.94	60.56	0.07
	10-9	6.19	66.55	0.09	4.11	60.56	0.07
10-11	10-11	9.68	66.55	0.15	6.54	60.56	0.11
	11-10	9.85	66.55	0.15	6.65	60.56	0.11
11-12	11-12	18.17	66.55	0.27	13.20	60.56	0.22
	12-11	18.20	66.55	0.27	13.16	60.56	0.22
12-1	12-1	10.91	66.55	0.16	7.61	60.56	0.13
	1-12	10.77	66.55	0.16	8.32	60.56	0.14
1-8	1-8	11.72	66.55	0.18	7.61	60.56	0.13
	8-1	12.11	66.55	0.18	7.88	60.56	0.13
11-13	11-13	16.61	66.55	0.25	12.14	60.56	0.20
	13-11	16.97	66.55	0.26	11.83	60.56	0.20
13-14	13-14	12.44	66.55	0.19	10.25	60.56	0.17
	14-13	11.99	66.55	0.18	10.57	60.56	0.17

(Table 4.4 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			**Weekend, Night**		
14-15	14-15	10.35	66.55	0.16	8.57	60.56	0.14
	15-14	10.66	66.55	0.16	8.91	60.56	0.15
15-16	15-16	7.43	66.55	0.11	4.93	60.56	0.08
	16-15	7.53	66.55	0.11	5.03	60.56	0.08
16-17	16-17	15.21	66.55	0.23	10.07	60.56	0.17
	17-16	14.93	66.55	0.22	10.29	60.56	0.17
17-18	17-18	5.53	66.55	0.08	3.89	60.56	0.06
	18-17	5.68	66.55	0.09	3.64	60.56	0.06
18-2	18-2	12.90	66.55	0.19	8.35	60.56	0.14
	2-18	12.90	66.55	0.19	8.55	60.56	0.14
18-3	18-3	12.86	66.55	0.19	9.19	60.56	0.15
	3-18	13.69	66.55	0.21	8.99	60.56	0.15
Total Facility		**12.46**	**66.55**	**0.19**	**8.77**	**60.56**	**0.14**
		Weekday, Day			**Weekday, Night**		
1-2	1-2	9.65	69.78	0.14	7.39	80.19	0.09
	2-1	10.30	69.78	0.15	8.05	80.19	0.10
2-3	2-3	8.37	69.78	0.12	5.92	80.19	0.07
	3-2	7.93	69.78	0.11	6.24	80.19	0.08
3-4	3-4	17.06	69.78	0.24	13.12	80.19	0.16
	4-3	17.44	69.78	0.25	13.04	80.19	0.16
4-5	4-5	9.50	69.78	0.14	6.95	80.19	0.09
	5-4	9.50	69.78	0.14	7.19	80.19	0.09
5-6	5-6	15.49	69.78	0.22	12.10	80.19	0.15
	6-5	15.69	69.78	0.23	11.93	80.19	0.15
6-7	6-7	8.46	69.78	0.12	6.10	80.19	0.08
	7-6	8.32	69.78	0.12	6.40	80.19	0.08
7-8	7-8	8.41	69.78	0.12	6.00	80.19	0.07
	8-7	8.20	69.78	0.12	6.19	80.19	0.08
8-9	8-9	8.79	69.78	0.13	6.99	80.19	0.09
	9-8	9.14	69.78	0.13	6.63	80.19	0.08
9-10	9-10	4.78	69.78	0.07	3.82	80.19	0.05
	10-9	5.21	69.78	0.08	3.80	80.19	0.05
10-11	10-11	8.29	69.78	0.12	6.18	80.19	0.08
	11-10	7.97	69.78	0.11	6.10	80.19	0.08
11-12	11-12	16.09	69.78	0.23	12.46	80.19	0.16
	12-11	15.35	69.78	0.22	12.80	80.19	0.16
12-1	12-1	9.55	69.78	0.14	7.43	80.19	0.09
	1-12	9.30	69.78	0.13	7.35	80.19	0.09
1-8	1-8	10.11	69.78	0.15	7.61	80.19	0.09
	8-1	10.04	69.78	0.14	7.22	80.19	0.09
11-13	11-13	15.45	69.78	0.22	12.06	80.19	0.15
	13-11	15.27	69.78	0.22	11.64	80.19	0.15
13-14	13-14	11.50	69.78	0.17	9.84	80.19	0.12
	14-13	11.05	69.78	0.16	10.17	80.19	0.13
14-15	14-15	9.83	69.78	0.14	8.63	80.19	0.11
	15-14	9.58	69.78	0.14	8.11	80.19	0.10

(Table 4.4 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekday, Day			Weekday, Night		
15-16	15-16	6.13	69.78	0.09	4.61	80.19	0.06
	16-15	6.19	69.78	0.09	4.76	80.19	0.06
16-17	16-17	12.64	69.78	0.18	9.62	80.19	0.12
	17-16	12.53	69.78	0.18	9.47	80.19	0.12
17-18	17-18	4.03	69.78	0.06	3.26	80.19	0.04
	18-17	4.72	69.78	0.07	3.60	80.19	0.04
18-2	18-2	11.16	69.78	0.16	8.23	80.19	0.10
	2-18	10.54	69.78	0.15	7.87	80.19	0.10
18-3	18-3	11.46	69.78	0.16	9.06	80.19	0.11
	3-18	11.68	69.78	0.17	8.59	80.19	0.11
Total Facility		**10.78**	**69.78**	**0.15**	**8.41**	**80.19**	**0.10**

From the above figure and table, it is seen that travel speed varies between 3 to 20 km/h. On average, vehicles moved fastest on weekend, day (total facility speed of 12.46 km/h) and slowest on weekday, day (total facility speed of 8.41 km/h). The total facility, minimum and maximum directional speeds on weekend, day were measured at 12.46 km/h, 5.53 km/h (segment direction 17-18) and 19.46 km/h respectively (segment direction 4-3). The total facility, minimum and maximum directional speeds on weekend, night were measured at 8.77 km/h, 3.64 (segment direction 18-17) and 13.26 km/h respectively (segment direction 4-3). The total facility, minimum and maximum directional speeds on weekday, day were measured at 10.78 km/h, 4.03 km/h (segment direction 17-18) and 17.44 km/h respectively (segment direction 4-3). The total facility, minimum and maximum directional speeds on weekday, night were measured at 8.41 km/h, 3.26 km/h (segment direction 17-18) and 13.12 km/h respectively (segment direction 3-4). Segment 3-4/4-3 was found to have the highest travel speed (15.74 km/h on average) while segment 17-18/18-17 was found to have the slowest travel speed (4.29 km/h on average). TS/FFS ratio varies between 0.04 and 0.29, revealing very poor mobility conditions.

4.7.5 Jatrabari-Gulistan Flyover

The observed travel times at Jatrabari-Gulistan at free flow and peak-hour conditions are presented in the following subsections.

Determination of Free Flow Speed

Observed travel times at free flow conditions at Jatrabari-Gulistan Flyover and their subsequent calculations of FFS are provided in Table H.8. Weighted average FFS is depicted in Figure 4.17.

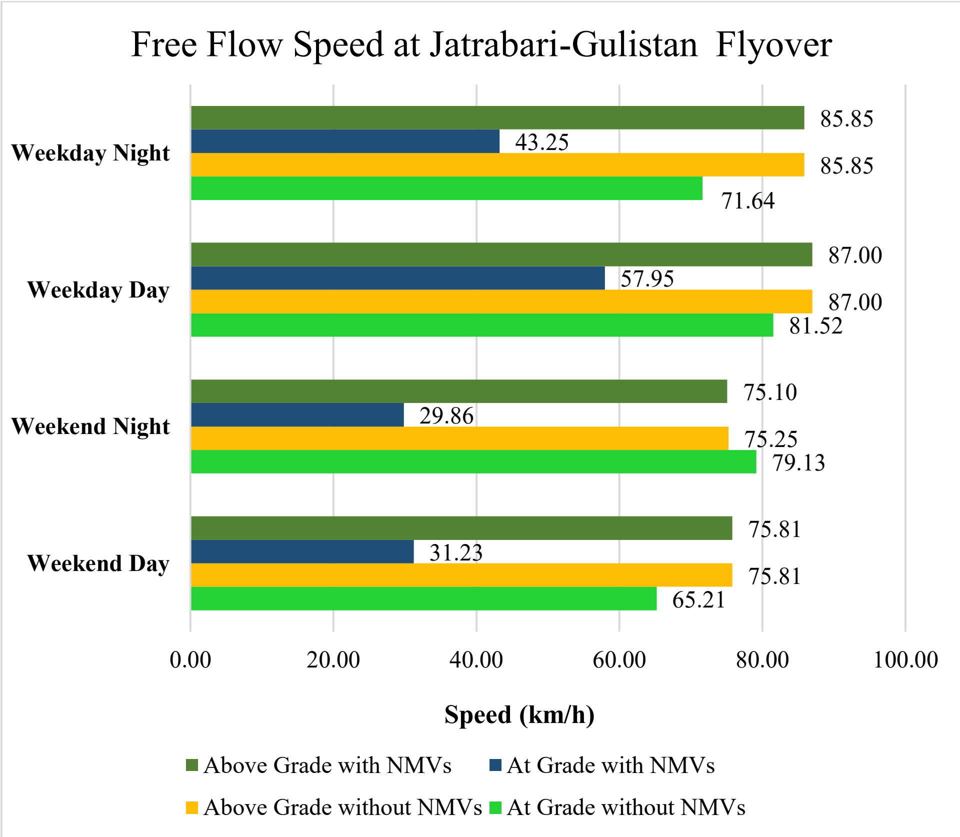


Figure 4.17: Observed FFS at MMHF

From Figure 4.17, it is seen that the FFS varies between 65-87 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is drastically reduced (decreased by 29-62%) if NMVs are considered, to the extent that LOS calculations no longer become feasible with such low FFS. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period.

Determination of Travel Speed and Ratio of TS/FFS

Observed travel times at peak flow conditions are used to calculate values of TS, which are provided in Table H.9 and Figure H.4. TS, FFS without considering NMVs and the ratio of TS/FFS for Jatrabari-Gulistan Flyover is provided in Table 4.5. This ratio of TS/FFS will be used in the determining LOS.

Table 4.5: TS/FFS Ratio Calculation for MMHF

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	7.47	65.21	0.11	7.18	79.13	0.09
	2-1	7.55	65.21	0.12	7.35	79.13	0.09
2-3	2-3	8.76	65.21	0.13	8.29	79.13	0.10
	3-2	8.74	65.21	0.13	8.18	79.13	0.10
3-4	3-4	9.69	65.21	0.15	9.23	79.13	0.12
	4-3	9.53	65.21	0.15	8.99	79.13	0.11
4-5	4-5	2.48	65.21	0.04	2.46	79.13	0.03
	5-4	2.67	65.21	0.04	2.38	79.13	0.03
5-6	5-6	5.50	65.21	0.08	5.31	79.13	0.07
	6-5	4.87	65.21	0.07	4.72	79.13	0.06
6-7	6-7	15.86	65.21	0.24	12.87	79.13	0.16
	7-6	15.46	65.21	0.24	12.56	79.13	0.16
7-8	7-8	13.38	65.21	0.21	11.41	79.13	0.14
	8-7	13.45	65.21	0.21	11.44	79.13	0.14
8-9	8-9	3.33	65.21	0.05	3.40	79.13	0.04
	9-8	3.53	65.21	0.05	3.33	79.13	0.04
9-10	9-10	7.28	65.21	0.11	6.92	79.13	0.09
	10-9	7.47	65.21	0.11	7.18	79.13	0.09
10-11	10-11	11.04	65.21	0.17	10.25	79.13	0.13
	11-10	10.94	65.21	0.17	10.08	79.13	0.13
9-11	9-11	6.70	65.21	0.10	6.73	79.13	0.09
	11-9	6.42	65.21	0.10	6.65	79.13	0.08
11-12	11-12	2.15	65.21	0.03	2.42	79.13	0.03
	12-11	2.47	65.21	0.04	2.49	79.13	0.03
12-13	12-13	3.14	65.21	0.05	2.69	79.13	0.03
	13-12	3.24	65.21	0.05	2.91	79.13	0.04
7-13	7-13	10.37	65.21	0.16	9.29	79.13	0.12
	13-7	10.97	65.21	0.17	8.85	79.13	0.11
8-14	8-14	8.71	65.21	0.13	7.95	79.13	0.10
	14-8	8.76	65.21	0.13	7.74	79.13	0.10
Total Facility		**8.16**	**65.21**	**0.13**	**7.54**	**79.13**	**0.10**
		Weekday, Day			Weekday, Night		
1-2	1-2	7.44	81.52	0.09	7.73	71.64	0.11
	2-1	7.59	81.52	0.09	7.77	71.64	0.11
2-3	2-3	8.74	81.52	0.11	9.20	71.64	0.13
	3-2	8.09	81.52	0.10	8.58	71.64	0.12
3-4	3-4	9.74	81.52	0.12	8.86	71.64	0.12
	4-3	9.36	81.52	0.11	9.39	71.64	0.13
4-5	4-5	2.41	81.52	0.03	2.54	71.64	0.04
	5-4	2.57	81.52	0.03	2.61	71.64	0.04
5-6	5-6	5.07	81.52	0.06	5.59	71.64	0.08
	6-5	4.83	81.52	0.06	4.98	71.64	0.07
6-7	6-7	12.02	81.52	0.15	16.23	71.64	0.23
	7-6	12.11	81.52	0.15	16.50	71.64	0.23

(Table 4.5 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekday, Day			Weekday, Night		
7-8	7-8	10.27	81.52	0.13	13.25	71.64	0.19
	8-7	9.87	81.52	0.12	13.20	71.64	0.18
8-9	8-9	3.11	81.52	0.04	3.26	71.64	0.05
	9-8	3.21	81.52	0.04	3.54	71.64	0.05
9-10	9-10	6.95	81.52	0.09	6.69	71.64	0.09
	10-9	7.12	81.52	0.09	7.75	71.64	0.11
10-11	10-11	10.90	81.52	0.13	10.10	71.64	0.14
	11-10	10.49	81.52	0.13	8.96	71.64	0.13
9-11	9-11	6.81	81.52	0.08	7.29	71.64	0.10
	11-9	6.47	81.52	0.08	6.93	71.64	0.10
11-12	11-12	2.59	81.52	0.03	2.47	71.64	0.03
	12-11	2.47	81.52	0.03	2.56	71.64	0.04
12-13	12-13	3.25	81.52	0.04	2.68	71.64	0.04
	13-12	3.22	81.52	0.04	3.27	71.64	0.05
7-13	7-13	9.73	81.52	0.12	9.91	71.64	0.14
	13-7	10.23	81.52	0.13	10.40	71.64	0.15
8-14	8-14	7.16	81.52	0.09	7.89	71.64	0.11
	14-8	7.15	81.52	0.09	8.17	71.64	0.11
Total Facility		**7.57**	**81.52**	**0.09**	**8.01**	**71.64**	**0.11**

From the above-mentioned figure and tables, it is seen that travel speed varies between 2 to 17 km/h. On average, vehicles moved fastest on weekend, day (total facility speed of 8.16 km/h) and slowest on weekend, night (total facility speed of 7.54 km/h). The total facility, minimum and maximum directional speeds on weekend, day were measured at 8.16 km/h, 2.15 km/h (segment direction 11-12) and 15.86 km/h respectively (segment direction 6-7). The total facility, minimum and maximum directional speeds on weekend, night were measured at 7.54 km/h, 2.38 (segment direction 5-4) and 12.87 km/h respectively (segment direction 6-7). The total facility, minimum and maximum directional speeds on weekday, day were measured at 7.57 km/h, 2.41 km/h (segment direction 4-5) and 12.11 km/h respectively (segment direction 7-6). The total facility, minimum and maximum directional speeds on weekday, night were measured at 8.01 km/h, 2.47 km/h (segment direction 11-12) and 16.50 km/h respectively (segment direction 7-6). Segment 6-7/7-6 was found to have the highest travel speed (14.20 km/h on average) while segment 11-12/12-11 was found to have the slowest travel speed (2.45 km/h on average). TS/FFS ratio varies between 0.03 and 0.24, revealing very poor mobility conditions.

4.7.6 Moghbazar-Mouchak Flyover

The observed travel times at Moghbazar-Mouchak Flyover at free flow and peak-hour conditions are presented in the following subsections.

Determination of Free Flow Speed

Observed travel times at free flow conditions at Moghbazar-Mouchak Flyover and their subsequent calculations of FFS are provided in Table H.10. Observed travel times are used to calculate weighted average FFS, first considering NMVs, and next omitting NMVs, which are depicted in Figure 4.18.

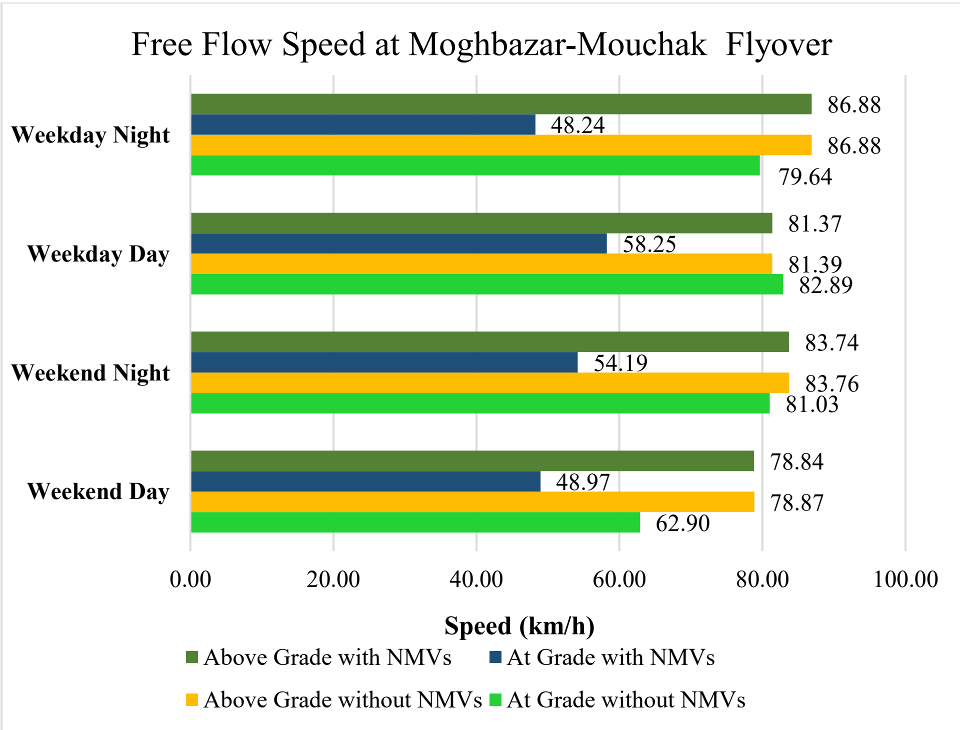


Figure 4.18: Observed FFS at MMF

From Figure 4.18, it is seen that the FFS varies between 63-87 km/h while NMVs are omitted. Above Grade FFS is similar whether or not NMVs are considered because NMVs make up only a negligible portion of above grade traffic. However, at grade FFS is drastically reduced (decreased by 22-39%) if NMVs are considered. Although it is still technically possible to calculate LOS with the calculated FFS (considering NMVs), FFS values are used omitting NMVs to keep calculation and analysis uniform across all flyovers studied. Besides, HCM (2010) does not provide clear guidelines to calculate FFS of rickshaws. A comparison of FFS without considering NMVs reveal similar at-grade and above-grade speeds at each measurement period.

Determination of Travel Speed and Ratio of TS/FFS

Observed travel times at peak flow conditions are used to calculate values of TS, which are provided in Table H.11 and Figure H.5. TS, FFS without considering NMVs and the ratio of TS/FFS for Jatrabari-Gulistan Flyover is provided in Table 4.6. This ratio of TS/FFS will be used in the determining LOS.

Table 4.6: TS/FFS Ratio Calculation for MMF

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
1-2	1-2	7.60	62.90	0.12	6.35	81.03	0.08
	2-1	7.30	62.90	0.12	7.05	81.03	0.09
2-3	2-3	5.04	62.90	0.08	4.46	81.03	0.06
	3-2	5.22	62.90	0.08	4.82	81.03	0.06
2-25	2-25	10.17	62.90	0.16	9.66	81.03	0.12
	25-2	8.62	62.90	0.14	8.77	81.03	0.11
3-4	3-4	6.26	62.90	0.10	5.98	81.03	0.07
	4-3	6.18	62.90	0.10	6.86	81.03	0.08
3-23	3-23	5.27	62.90	0.08	5.63	81.03	0.07
	23-3	7.03	62.90	0.11	6.95	81.03	0.09
4-5	4-5	5.20	62.90	0.08	4.58	81.03	0.06
	5-4	4.58	62.90	0.07	5.06	81.03	0.06
4-15	4-15	10.12	62.90	0.16	8.83	81.03	0.11
	15-4	8.72	62.90	0.14	8.06	81.03	0.10
4-22	4-22	6.33	62.90	0.10	6.64	81.03	0.08
	22-4	7.32	62.90	0.12	6.82	81.03	0.08
5-6	5-6	5.61	62.90	0.09	5.56	81.03	0.07
	6-5	6.11	62.90	0.10	6.06	81.03	0.07
6-7	6-7	5.21	62.90	0.08	5.33	81.03	0.07
	7-6	5.76	62.90	0.09	6.76	81.03	0.08
6-14	6-14	5.71	62.90	0.09	5.66	81.03	0.07
	14-6	7.11	62.90	0.11	6.72	81.03	0.08
7-8	7-8	3.95	62.90	0.06	3.94	81.03	0.05
	8-7	4.61	62.90	0.07	5.08	81.03	0.06
7-19	7-19	4.04	62.90	0.06	2.63	81.03	0.03
	19-7	4.07	62.90	0.06	3.56	81.03	0.04
8-9	8-9	3.96	62.90	0.06	2.79	81.03	0.03
	9-8	3.67	62.90	0.06	4.46	81.03	0.05
8-14	8-14	5.90	62.90	0.09	5.85	81.03	0.07
	14-8	6.63	62.90	0.11	6.18	81.03	0.08
9-10	9-10	4.69	62.90	0.07	6.06	81.03	0.07
	10-9	6.72	62.90	0.11	7.80	81.03	0.10
10-11	10-11	3.18	62.90	0.05	3.90	81.03	0.05
	11-10	4.75	62.90	0.08	5.62	81.03	0.07
11-12	11-12	4.41	62.90	0.07	4.28	81.03	0.05
	12-11	4.93	62.90	0.08	5.50	81.03	0.07
11-14	11-14	6.87	62.90	0.11	6.76	81.03	0.08
	14-11	7.42	62.90	0.12	7.63	81.03	0.09

(Table 4.6 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekend, Day			Weekend, Night		
12-13	12-13	10.48	62.90	0.17	6.28	81.03	0.08
	13-12	10.39	62.90	0.17	7.26	81.03	0.09
12-18	12-18	12.11	62.90	0.19	7.88	81.03	0.10
	18-12	11.72	62.90	0.19	7.61	81.03	0.09
13-14	13-14	4.22	62.90	0.07	4.68	81.03	0.06
	14-13	5.38	62.90	0.09	6.94	81.03	0.09
13-15	13-15	6.12	62.90	0.10	3.42	81.03	0.04
	15-13	6.19	62.90	0.10	4.11	81.03	0.05
15-16	15-16	9.68	62.90	0.15	5.74	81.03	0.07
	16-15	9.85	62.90	0.16	6.65	81.03	0.08
16-17	16-17	18.17	62.90	0.29	13.20	81.03	0.16
	17-16	18.20	62.90	0.29	13.16	81.03	0.16
16-26	16-26	16.61	62.90	0.26	12.14	81.03	0.15
	26-16	16.97	62.90	0.27	11.83	81.03	0.15
17-18	17-18	10.91	62.90	0.17	7.61	81.03	0.09
	18-17	10.77	62.90	0.17	8.32	81.03	0.10
19-20	19-20	9.65	62.90	0.15	9.72	81.03	0.12
	20-19	10.36	62.90	0.16	9.40	81.03	0.12
20-21	20-21	3.74	62.90	0.06	3.85	81.03	0.05
	21-20	4.75	62.90	0.08	5.28	81.03	0.07
21-22	21-22	5.57	62.90	0.09	5.40	81.03	0.07
	22-21	6.27	62.90	0.10	6.35	81.03	0.08
22-23	22-23	3.16	62.90	0.05	3.83	81.03	0.05
	23-22	4.37	62.90	0.07	5.17	81.03	0.06
23-24	23-24	8.80	62.90	0.14	8.66	81.03	0.11
	24-23	8.61	62.90	0.14	10.24	81.03	0.13
Total Facility		**7.14**	**62.90**	**0.11**	**6.75**	**81.03**	**0.08**
		Weekday, Day			Weekday, Night		
1-2	1-2	6.55	82.89	0.08	8.41	79.64	0.11
	2-1	6.32	82.89	0.08	8.93	79.64	0.11
2-3	2-3	4.85	82.89	0.06	5.98	79.64	0.08
	3-2	4.68	82.89	0.06	6.67	79.64	0.08
2-25	2-25	9.17	82.89	0.11	10.25	79.64	0.13
	25-2	8.56	82.89	0.10	10.59	79.64	0.13
3-4	3-4	6.85	82.89	0.08	8.12	79.64	0.10
	4-3	6.98	82.89	0.08	9.01	79.64	0.11
3-23	3-23	6.53	82.89	0.08	8.64	79.64	0.11
	23-3	6.29	82.89	0.08	8.52	79.64	0.11
4-5	4-5	4.49	82.89	0.05	5.15	79.64	0.06
	5-4	4.09	82.89	0.05	5.01	79.64	0.06
4-15	4-15	8.92	82.89	0.11	12.33	79.64	0.15
	15-4	8.48	82.89	0.10	11.71	79.64	0.15
4-22	4-22	6.99	82.89	0.08	9.19	79.64	0.12
	22-4	6.55	82.89	0.08	9.69	79.64	0.12

(Table 4.6 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekday, Day			Weekday, Night		
5-6	5-6	6.05	82.89	0.07	7.17	79.64	0.09
	6-5	5.72	82.89	0.07	8.01	79.64	0.10
6-7	6-7	5.10	82.89	0.06	7.47	79.64	0.09
	7-6	5.53	82.89	0.07	7.81	79.64	0.10
6-14	6-14	5.93	82.89	0.07	7.78	79.64	0.10
	14-6	6.12	82.89	0.07	8.44	79.64	0.11
7-8	7-8	4.40	82.89	0.05	5.55	79.64	0.07
	8-7	4.72	82.89	0.06	6.08	79.64	0.08
7-19	7-19	2.27	82.89	0.03	3.30	79.64	0.04
	19-7	1.64	82.89	0.02	3.70	79.64	0.05
8-9	8-9	3.03	82.89	0.04	3.46	79.64	0.04
	9-8	3.44	82.89	0.04	4.01	79.64	0.05
8-14	8-14	6.26	82.89	0.08	8.73	79.64	0.11
	14-8	6.10	82.89	0.07	8.43	79.64	0.11
9-10	9-10	7.13	82.89	0.09	8.58	79.64	0.11
	10-9	7.24	82.89	0.09	8.24	79.64	0.10
10-11	10-11	4.18	82.89	0.05	5.61	79.64	0.07
	11-10	4.58	82.89	0.06	5.52	79.64	0.07
11-12	11-12	4.98	82.89	0.06	5.93	79.64	0.07
	12-11	4.85	82.89	0.06	5.05	79.64	0.06
11-14	11-14	7.35	82.89	0.09	9.38	79.64	0.12
	14-11	7.48	82.89	0.09	9.45	79.64	0.12
12-13	12-13	8.79	82.89	0.11	6.99	79.64	0.09
	13-12	9.14	82.89	0.11	6.63	79.64	0.08
12-18	12-18	10.04	82.89	0.12	7.22	79.64	0.09
	18-12	10.11	82.89	0.12	7.61	79.64	0.10
13-14	13-14	5.46	82.89	0.07	5.35	79.64	0.07
	14-13	6.48	82.89	0.08	6.16	79.64	0.08
13-15	13-15	4.78	82.89	0.06	3.82	79.64	0.05
	15-13	5.21	82.89	0.06	3.80	79.64	0.05
15-16	15-16	8.29	82.89	0.10	6.18	79.64	0.08
	16-15	7.97	82.89	0.10	6.10	79.64	0.08
16-17	16-17	16.09	82.89	0.19	12.46	79.64	0.16
	17-16	15.35	82.89	0.19	12.80	79.64	0.16
16-26	16-26	15.45	82.89	0.19	12.06	79.64	0.15
	26-16	15.27	82.89	0.18	11.64	79.64	0.15
17-18	17-18	9.55	82.89	0.12	7.43	79.64	0.09
	18-17	9.30	82.89	0.11	7.35	79.64	0.09
19-20	19-20	10.02	82.89	0.12	10.75	79.64	0.14
	20-19	9.59	82.89	0.12	10.08	79.64	0.13
20-21	20-21	4.15	82.89	0.05	5.37	79.64	0.07
	21-20	4.68	82.89	0.06	5.72	79.64	0.07
21-22	21-22	6.81	82.89	0.08	9.05	79.64	0.11
	22-21	7.00	82.89	0.08	8.41	79.64	0.11
22-23	22-23	5.22	82.89	0.06	5.92	79.64	0.07
	23-22	5.01	82.89	0.06	5.21	79.64	0.07

(Table 4.6 continued)

Segment	Segment Label	TS (km/h)	FFS (km/h)	TS/FFS	TS (km/h)	FFS (km/h)	TS/FFS
		Weekday, Day			Weekday, Night		
23-24	23-24	9.81	82.89	0.12	9.59	79.64	0.12
	24-23	10.43	82.89	0.13	9.06	79.64	0.11
Total Facility		**7.14**	**82.89**	**0.09**	**8.00**	**79.64**	**0.10**

From the above-mentioned figure and tables, it is seen that travel speed varies between 2 and 19 km/h. On average, vehicles moved fastest on weekday, night (total facility speed of 8.00 km/h) and slowest on weekend, night (total facility speed of 6.75 km/h). The total facility, minimum and maximum directional speeds on weekend, day were measured at 7.14 km/h, 3.16 km/h (segment direction 22-23) and 18.20 km/h respectively (segment direction 17-16). The total facility, minimum and maximum directional speeds on weekend, night were measured at 6.75 km/h, 2.63 (segment direction 7-19) and 13.20 km/h respectively (segment direction 16-17). The total facility, minimum and maximum directional speeds on weekday, day were measured at 7.14 km/h, 1.64 km/h (segment direction 19-7) and 16.09 km/h respectively (segment direction 16-17). The total facility, minimum and maximum directional speeds on weekday, night were measured at 8.00 km/h, 3.30 km/h (segment direction 7-19) and 12.80 km/h respectively (segment direction 17-16). Segment 16-17/17-16 was found to have the highest travel speed (14.93 km/h on average) while segment 7-19/19-7 was found to have the slowest travel speed (3.15 km/h on average). TS/FFS ratio varies between 0.02 and 0.29, revealing very poor mobility conditions.

4.7.7 Discussions

The above analysis and field observations have revealed that at grade vehicles move very slowly compared to FFS. TS/FFS ratio were found to be less than 0.30 and rarely rose above 0.20 at all segments of all study areas, indicating very poor mobility conditions. Low travel speeds can be attributed to high through-vehicle delay at intersections (because of signal timings) and long running time. Vehicles could not move at free flow speeds because of forced flows. Moreover, side friction factors (obstructions that limit speed at the side lanes) such as on-street parking, bus stoppages, street vendors and pedestrians reduced travel speeds significantly. Parking and bus stoppage were discussed in earlier sections. Field observations revealed that in several instances, people waiting for buses queued at the roadside in an effort to enter the desired bus before other people could.

Footpaths were observed to be in dilapidated conditions or to have inadequate width in many segments. So, people are forced to walk on road to reach destinations. Besides, guard rails/ picket rails were missing along many footpaths, for which people were freely able to cross roads transversely mid-block, causing segment delays for vehicles. Pedestrian foot-overbridges were rarely seen, and even in the few places that had foot over-bridges, most people did not use them, opting instead to traverse at grade. Other sources of side friction include cutting up roads to lay utility lines, which reduces effective roadway width and creates bottlenecks. Such influence often reaches the footpath and pedestrians are forced to walk on road segment at that time. Thus pedestrians pose a major challenge to improving road mobility.

To address this problem, footpath conditions need to be improved first. In cities of other countries, pedestrians are given the most importance among all transport modes. The general model in other countries is to create adequate footpath and related facilities to enable people to technically traverse from one end of the city to another. Buses are used to travel long distances while bicycles and footpaths are used to cover the remaining trip from bus stop to final destination, or from initial destination to bus stop. People need to be educated from school level regarding use of footpaths, overpasses and underpasses. Grade separated facilities such as overpasses and underpasses should be provided at mid-block, while at-grade zebra crossings will facilitate pedestrians when pedestrian signals sync with intersection traffic signals.

In Dhaka city, however, the general model has gone against the norm. Instead of prioritizing pedestrians, the authorities have preferred to develop road facilities; especially for private automobiles, while ignoring public buses. Since it is not feasible to travel to many places by walking, people prefer to use para-transit vehicles such as rickshaw, CNG and human haulers. Rich people prefer to use their own private cars. Hence, public buses remain unpopular due to not having the door-to-door convenience provided by private automobiles. Foot overpasses cannot be provided on the roads along the flyover corridor, because flyovers have been built at too low height to accommodate further structures. Instead, there is a recorded incident of an existing foot over-bridge being dismantled to make way for Moghbazar-Mouchak Flyover.

4.8 Determination of Level of Service

Level of Service (LOS) is determined separately for multilane highways and urban street segments for each direction of each segment. As per HCM (2010) [57], LOS is supposed to be measured individually for different classes of vehicles. However, because of time and budget constraints, it was not possible to collect such vast amount of data to calculate LOS for all classes of vehicles. Hence LOS was measured considering only private motor vehicles, namely cars, because, private motor vehicles were observed to occupy the largest volume on road. As discussed in the previous subsection, TS was determined for only private cars, and this was assumed to represent TS of all classes of MVs. Thus LOS calculations presented in subsequent sections represent an overall LOS for all classes of MVs, but considering TS of private cars.

4.8.1 Shaheed Ahsanullah Master Flyover

Five segments of Shaheed Ahsanullah Master Flyover are Urban Street segments while the remaining two segments are multilane highways. So LOS calculation is different for the two types of segments. This is presented below.

Urban Street Segment

The LOS calculations for urban street segments are presented in the following table.

Table 4.7: LOS Calculation for SAMF (Urban Street Segment)

(a) Weekend, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.08	1466	1067	1.37	F
	2-1	0.08	1288	1360	0.95	F
2-3	2-3	0.21	721	220	3.28	F
	3-2	0.20	633	344	1.84	F
1-4	1-4	0.12	1156	1238	0.93	F
	4-1	0.12	1152	899	1.28	F
1-5	1-5	0.10	1453	975	1.49	F
	5-1	0.11	1271	903	1.41	F
5-6	5-6	0.05	1417	1028	1.38	F
	6-5	0.05	1281	975	1.31	F

(Table 4.7 continued)

(b) Weekend, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.06	892	1351	0.66	F
	2-1	0.06	779	1619	0.48	F
2-3	2-3	0.19	844	291	2.90	F
	3-2	0.18	1006	271	3.72	F
1-4	1-4	0.12	794	1079	0.74	F
	4-1	0.12	881	1069	0.82	F
1-5	1-5	0.09	1217	858	1.42	F
	5-1	0.10	1472	737	2.00	F
5-6	5-6	0.06	1240	1074	1.15	F
	6-5	0.05	1240	1039	1.19	F

(c) Weekday, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.09	1360	1335	1.02	F
	2-1	0.07	1253	1674	0.75	F
2-3	2-3	0.23	1072	281	3.81	F
	3-2	0.23	1210	317	3.82	F
1-4	1-4	0.13	1149	1137	1.01	F
	4-1	0.13	1138	1013	1.12	F
1-5	1-5	0.11	1818	987	1.84	F
	5-1	0.11	1867	708	2.64	F
5-6	5-6	0.05	1347	1019	1.32	F
	6-5	0.05	1512	992	1.52	F

(d) Weekday, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.08	1948	1317	1.48	F
	2-1	0.08	953	1165	0.82	F
2-3	2-3	0.21	1148	308	3.73	F
	3-2	0.20	753	371	2.03	F
1-4	1-4	0.12	1470	1371	1.07	F
	4-1	0.11	821	1361	0.60	F
1-5	1-5	0.09	996	871	1.14	F
	5-1	0.10	993	861	1.15	F
5-6	5-6	0.06	535	1193	0.45	F
	6-5	0.05	431	940	0.46	F

From Table 4.7, LOS has been found to be F at all segments of the study area during all periods of measurement, indicating worst traffic conditions possible. Considering the flow-capacity ratio (v/c), segment 2-3/3-2 is in the most critical state, with a combined v/c of 3.07 and an average v/c of 3.14. Segment 1-2/2-1 is in the least critical state, with a combined v/c of 0.91 and an average v/c of 0.94. Weekday, day faced relatively worst traffic conditions while weekday, night faced relatively best traffic conditions. Combined, average, minimum and maximum segment directional v/c during weekend, day were calculated to be 1.31, 1.52, 0.93 (segment direction 1-4) and 3.28 (segment direction 2-3) respectively. Combined, average, minimum and maximum segment directional v/c during weekend, night were calculated to be 1.10, 1.51, 0.48 (segment direction 2-1) and 3.72 (segment direction 3-2) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, day were calculated to be 1.45, 1.89, 0.75 (segment direction 2-1) and 3.82 (segment direction 3-2) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, night were calculated to be 1.03, 1.29, 0.45 (segment direction 5-6) and 3.73 (segment direction 2-3) respectively.

Multilane Highway

The LOS calculations for multilane highway are presented in the following table.

Table 4.8: LOS Calculation for SAMF (Multilane Highway)

(a) Weekend, Day

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
f	f1	1020	44.22	45	0.95	2	0.82	1	674.50
	f2	1270	44.22	45	0.95	2	0.80	1	858.00
g	g1	973	44.22	45	0.95	2	0.89	1	595.00
	g2	1044	44.22	45	0.95	2	0.87	1	654.50
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**	**v/c**			**LOS (km/h)**
f	f1	45		14.52	3800	0.27			B
	f2	45		18.46	3800	0.33			C
g	g1	45		12.80	3800	0.26			B
	g2	45		14.09	3800	0.27			B

(Table 4.8 continued)

(b) Weekend, Night

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
f	f1	723	44.04	45	0.95	2	0.84	1	453.22
	f2	801	44.04	45	0.95	2	0.82	1	514.72
g	g1	844	44.04	45	0.95	2	0.89	1	496.32
	g2	723	44.04	45	0.95	2	0.90	1	421.26
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
f	f1	45		10.07	3800		0.19		A
	f2	45		11.44	3800		0.21		B
g	g1	45		11.03	3800		0.22		B
	g2	45		9.36	3800		0.19		A

(c) Weekday, Day

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
f	f1	1131	42.58	45	0.95	2	0.77	1	769.41
	f2	1242	42.58	45	0.95	2	0.78	1	839.62
g	g1	1035	42.58	45	0.95	2	0.87	1	628.99
	g2	1051	42.58	45	0.95	2	0.84	1	654.65
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
f	f1	45		15.43	3800		0.30		B
	f2	45		19.07	3800		0.33		C
g	g1	45		13.15	3800		0.27		B
	g2	45		14.46	3800		0.28		B

(d) Weekday, Night

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
f	f1	1353	44.74	45	0.95	2	0.86	1	831.39
	f2	1044	44.74	45	0.95	2	0.82	1	668.69
g	g1	895	44.74	45	0.95	2	0.91	1	517.62
	g2	638	44.74	45	0.95	2	0.86	1	390.76
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
f	f1	45		18.48	3800		0.36		C
	f2	45		14.86	3800		0.27		B
g	g1	45		11.50	3800		0.24		B
	g2	45		8.68	3800		0.17		A

From Table 4.8, LOS A has been found at selected segments at weekend night and weekday night. On the other hand road segments generally faced LOS B and C, indicating reasonably free flow to stable flow at the studied multilane highways. Average traffic densities across the segments were found to be 14.97 pc/mi, 10.48 pc/mi, 15.53 pc/mi and 13.38 pc/mi during weekend day, weekend night, weekday day and weekday night respectively. On the other hand, flow-capacity ratio was found to be generally highest at weekday day and weekday night (v/c of 0.26). Multilane highways have been observed to perform better than urban street segments in terms of LOS.

4.8.2 Banani Overpass

Only one segment was considered in the study area of Banani Overpass, and it is a multilane highway. The LOS calculation is presented in the following table.

Table 4.9: LOS Calculation for Banani Overpass

(a) Weekend, Day

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
a	a1	349	53.77	55	0.95	2	0.95	1	192.23
	a2	362	53.77	55	0.95	2	0.98	1	193.20
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
a	a1	55		3.50	4200		0.08		A
	a2	55		3.51	4200		0.09		A

(b) Weekend, Night

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
a	a1	575	54.25	55	0.95	2	0.99	1	305.54
	a2	604	54.25	55	0.95	2	0.98	1	323.94
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
a	a1	55		5.56	4200		0.14		A
	a2	55		5.89	4200		0.14		A

(c) Weekday, Day

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
a	a1	966	44.72	45	0.95	2	0.97	1	522.95
	a2	638	44.72	45	0.95	2	0.97	1	344.76

(Table 4.9 continued)

Segment	Segment Label	Mean Speed (mi/h)	Density (pc/mi)	Capacity (pc/h)	v/c	LOS (km/h)
a	a1	45	11.62	3800	0.25	B
	a2	45	7.66	3800	0.17	A

(d) Weekday, Night

Segment	Segment Label	Flow (pc/h)	FFS (mi/h)	Selected FFS Curve (mi/h)	PHF	N	f_{HV}	f_P	v_P (pc/h/ln)
a	a1	533	50.55	50	0.95	2	0.96	1	291.98
	a2	509	50.55	50	0.95	2	0.96	1	279.39
Segment	**Segment Label**	**Mean Speed (mi/h)**		**Density (pc/mi)**	**Capacity (pc/h)**		**v/c**		**LOS (km/h)**
a	a1	50		5.84	4000		0.13		A
	a2	50		5.59	4000		0.13		A

From Table 4.9, LOS A has been found at all segments during weekend day, weekend night and weekday night. Both LOS A and B have been observed at weekday day. This indicates that the best traffic conditions prevail at grade conditions around Banani Overpass. Flow-capacity ratio varied between 0.08 and 0.13.

4.8.3 Mohakhali Flyover

All segments of the study area of Mohakhali Flyover are urban street segments. The LOS calculation is presented in the following table.

Table 4.10: LOS Calculation for Mohakhali Flyover

(a) Weekend, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.09	1182	1243	0.95	F
	2-1	0.09	1102	886	1.24	F
2-3	2-3	0.10	1109	1273	0.87	F
	3-2	0.11	1030	1198	0.86	F
3-4	3-4	0.12	770	1445	0.53	F
	4-3	0.13	728	1621	0.45	F
4-5	4-5	0.13	793	1625	0.49	F
	5-4	0.12	822	953	0.86	F
5-6	5-6	0.13	966	1646	0.59	F
	6-5	0.14	1110	1812	0.61	F
6-1	6-1	0.12	691	610	1.13	F
	1-6	0.12	652	308	2.12	F

(Table 4.10 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
4-7	4-7	0.09	612	1105	0.55	F
	7-4	0.09	776	1149	0.67	F
7-8	7-8	0.16	1034	1129	0.92	F
	8-7	0.15	1165	1118	1.04	F
7-11	7-11	0.18	591	640	0.92	F
	11-7	0.17	533	834	0.64	F
8-9	8-9	0.09	1305	1122	1.16	F
	9-8	0.07	1274	1141	1.12	F
8-13	8-13	0.17	507	733	0.69	F
	13-8	0.16	483	874	0.55	F
9-10	9-10	0.15	559	949	0.59	F
	10-9	0.16	509	1031	0.49	F
10-11	10-11	0.16	724	944	0.77	F
	11-10	0.15	661	945	0.70	F
11-12	11-12	0.13	673	1194	0.56	F
	12-11	0.12	640	938	0.68	F
Total facility		**0.14**	**821**	**1088**	**0.75**	**F**

(b) Weekend, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.06	1681	1035	1.62	F
	2-1	0.06	1115	1009	1.11	F
2-3	2-3	0.09	1516	1472	1.03	F
	3-2	0.09	1009	910	1.11	F
3-4	3-4	0.12	958	1014	0.94	F
	4-3	0.12	799	1392	0.57	F
4-5	4-5	0.14	972	1317	0.74	F
	5-4	0.13	959	1222	0.78	F
5-6	5-6	0.13	1061	1388	0.76	F
	6-5	0.12	1168	1836	0.64	F
6-1	6-1	0.10	693	499	1.39	F
	1-6	0.09	681	443	1.54	F
4-7	4-7	0.07	746	1195	0.62	F
	7-4	0.06	849	1258	0.68	F
7-8	7-8	0.15	1351	1163	1.16	F
	8-7	0.14	1202	1197	1.00	F
7-11	7-11	0.19	715	589	1.21	F
	11-7	0.18	583	728	0.80	F
8-9	8-9	0.08	1944	972	2.00	F
	9-8	0.06	1404	1179	1.19	F
8-13	8-13	0.18	480	686	0.70	F
	13-8	0.16	537	794	0.68	F

(Table 4.10 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
9-10	9-10	0.17	615	865	0.71	F
	10-9	0.17	565	941	0.60	F
10-11	10-11	0.15	828	841	0.98	F
	11-10	0.13	709	899	0.79	F
11-12	11-12	0.14	849	1410	0.60	F
	12-11	0.12	696	969	0.72	F
Total facility		**0.13**	**953**	**1044**	**0.91**	**F**

(c) Weekday, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.08	2009	1112	1.81	F
	2-1	0.09	1781	1025	1.74	F
2-3	2-3	0.09	2024	1541	1.31	F
	3-2	0.09	2039	1221	1.67	F
3-4	3-4	0.10	1796	1261	1.42	F
	4-3	0.10	1847	1574	1.17	F
4-5	4-5	0.11	2252	1643	1.37	F
	5-4	0.10	2245	990	2.27	F
5-6	5-6	0.10	2628	1642	1.60	F
	6-5	0.10	2495	2181	1.14	F
6-1	6-1	0.11	2009	547	3.67	F
	1-6	0.09	1884	328	5.74	F
4-7	4-7	0.10	1627	1124	1.45	F
	7-4	0.10	2031	1448	1.40	F
7-8	7-8	0.13	2112	1219	1.73	F
	8-7	0.12	2186	1319	1.66	F
7-11	7-11	0.12	1509	557	2.71	F
	11-7	0.12	1340	790	1.70	F
8-9	8-9	0.10	2282	1078	2.12	F
	9-8	0.10	2436	1206	2.02	F
8-13	8-13	0.12	1671	826	2.02	F
	13-8	0.11	1752	798	2.19	F
9-10	9-10	0.11	1553	865	1.80	F
	10-9	0.11	1479	902	1.64	F
10-11	10-11	0.13	2068	983	2.10	F
	11-10	0.13	1855	924	2.01	F
11-12	11-12	0.10	1781	1254	1.42	F
	12-11	0.09	1884	1005	1.88	F
Total facility		**0.11**	**1949**	**1120**	**1.74**	**F**

(Table 4.10 continued)

(d) Weekday, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.07	1329	1270	1.05	F
	2-1	0.08	1166	1255	0.93	F
2-3	2-3	0.07	1397	1513	0.92	F
	3-2	0.07	1175	1354	0.87	F
3-4	3-4	0.09	1121	1182	0.95	F
	4-3	0.10	982	1776	0.55	F
4-5	4-5	0.09	1235	1384	0.89	F
	5-4	0.09	1119	1154	0.97	F
5-6	5-6	0.10	1627	1725	0.94	F
	6-5	0.11	1481	2365	0.63	F
6-1	6-1	0.08	1091	408	2.68	F
	1-6	0.08	865	427	2.03	F
4-7	4-7	0.06	948	1292	0.73	F
	7-4	0.06	1055	1498	0.70	F
7-8	7-8	0.10	1358	1478	0.92	F
	8-7	0.09	1367	1308	1.05	F
7-11	7-11	0.13	959	542	1.77	F
	11-7	0.12	740	797	0.93	F
8-9	8-9	0.07	1619	1197	1.35	F
	9-8	0.07	1580	1378	1.15	F
8-13	8-13	0.11	998	862	1.16	F
	13-8	0.11	867	597	1.45	F
9-10	9-10	0.11	959	943	1.02	F
	10-9	0.11	747	827	0.90	F
10-11	10-11	0.13	1229	1060	1.16	F
	11-10	0.13	943	999	0.94	F
11-12	11-12	0.10	1088	1166	0.93	F
	12-11	0.09	937	1073	0.87	F
Total facility		**0.10**	**1142**	**1173**	**0.97**	**F**

From Table 4.10, LOS has been found to be F at all segments of the study area during all periods of measurement, indicating worst traffic conditions possible. Considering the flow-capacity ratio (v/c), segment 1-6/6-1 is in the most critical state, with a combined v/c of 2.40 and average v/c of 2.54. Segment 3-4/4-3 is in the least critical state, with a combined v/c of 0.80 and an average v/c of 0.82. Weekday, day faced relatively worst traffic conditions (total facility v/c of 1.74) while weekend, day faced relatively best traffic conditions (total facility v/c of 0.75). Combined, average, minimum and maximum segment directional v/c during weekend, day were calculated to be 0.75, 0.81, 0.45 (segment direction 4-3) and 2.12 (segment direction 4-7) respectively. Combined, average, minimum and maximum segment directional v/c during weekend, night were calculated to be 0.91, 0.95, 0.57 (segment direction 4-3) and 2.00 (segment direction 8-9) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, day were calculated to be 1.74, 1.96, 1.14 (segment direction 6-5) and 5.74 (segment direction 1-6) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, night were calculated to be 0.97, 1.09, 0.55 (segment direction 4-3) and 2.68 (segment direction 6-1) respectively.

4.8.4 Khilgaon Flyover

All segments of the study area of Khilgaon Flyover are urban street segments. The LOS calculation is presented in the following table.

Table 4.11: LOS Calculation for Khilgaon Flyover

(a) Weekend, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.16	4014	1255	3.20	F
	2-1	0.17	3782	779	4.86	F
2-3	2-3	0.15	2732	1148	2.38	F
	3-2	0.15	3247	1253	2.59	F
3-4	3-4	0.29	3449	1264	2.73	F
	4-3	0.29	3163	1151	2.75	F
4-5	4-5	0.16	2674	847	3.16	F
	5-4	0.17	2868	775	3.70	F
5-6	5-6	0.27	2396	889	2.70	F
	6-5	0.27	3258	651	5.01	F
6-7	6-7	0.15	3686	809	4.56	F
	7-6	0.15	3831	881	4.35	F
7-8	7-8	0.16	3736	676	5.52	F
	8-7	0.16	3116	692	4.51	F
8-9	8-9	0.16	3096	670	4.62	F
	9-8	0.16	3924	678	5.79	F
9-10	9-10	0.09	3750	684	5.48	F
	10-9	0.09	2817	666	4.23	F
10-11	10-11	0.15	2559	909	2.81	F
	11-10	0.15	2254	1173	1.92	F
11-12	11-12	0.27	2544	1288	1.98	F
	12-11	0.27	2554	1379	1.85	F
12-1	12-1	0.16	2762	772	3.58	F
	1-12	0.16	3396	1083	3.13	F

(Table 4.11 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-8	1-8	0.18	4340	524	8.29	F
	8-1	0.18	4212	736	5.72	F
11-13	11-13	0.25	2380	1205	1.98	F
	13-11	0.26	2986	1388	2.15	F
13-14	13-14	0.19	766	390	1.96	F
	14-13	0.18	896	172	5.22	F
14-15	14-15	0.16	1516	358	4.24	F
	15-14	0.16	1780	390	4.56	F
15-16	15-16	0.11	1607	395	4.07	F
	16-15	0.11	1354	293	4.63	F
16-17	16-17	0.23	1366	247	5.53	F
	17-16	0.22	1344	319	4.21	F
17-18	17-18	0.08	776	354	2.19	F
	18-17	0.09	864	296	2.91	F
18-2	18-2	0.19	899	365	2.46	F
	2-18	0.19	1075	313	3.44	F
18-3	18-3	0.19	1083	423	2.56	F
	3-18	0.21	1068	442	2.42	F
Total facility		**0.19**	**2522**	**959**	**2.63**	**F**

(b) Weekend, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.12	2282	1184	1.93	F
	2-1	0.12	2425	735	3.30	F
2-3	2-3	0.11	2011	1226	1.64	F
	3-2	0.11	2582	1391	1.86	F
3-4	3-4	0.22	1892	1210	1.56	F
	4-3	0.22	2129	1230	1.73	F
4-5	4-5	0.13	1760	838	2.10	F
	5-4	0.12	1687	719	2.35	F
5-6	5-6	0.20	1459	905	1.61	F
	6-5	0.21	2083	652	3.19	F
6-7	6-7	0.11	2133	798	2.67	F
	7-6	0.11	2653	839	3.16	F
7-8	7-8	0.11	2117	678	3.12	F
	8-7	0.11	2393	697	3.44	F
8-9	8-9	0.12	1874	657	2.85	F
	9-8	0.12	2119	661	3.20	F
9-10	9-10	0.07	2023	686	2.95	F
	10-9	0.07	1703	667	2.55	F
10-11	10-11	0.11	1270	926	1.37	F
	11-10	0.11	1700	1184	1.44	F
11-12	11-12	0.22	1559	1182	1.32	F
	12-11	0.22	1558	1390	1.12	F

(Table 4.11 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
12-1	12-1	0.13	1751	707	2.48	F
	1-12	0.14	1884	1179	1.60	F
1-8	1-8	0.13	2414	521	4.63	F
	8-1	0.13	2592	696	3.72	F
11-13	11-13	0.20	872	1102	0.79	F
	13-11	0.20	1591	1313	1.21	F
13-14	13-14	0.17	1177	367	3.21	F
	14-13	0.17	986	260	3.79	F
14-15	14-15	0.14	882	376	2.35	F
	15-14	0.15	1054	390	2.70	F
15-16	15-16	0.08	985	422	2.34	F
	16-15	0.08	855	318	2.69	F
16-17	16-17	0.17	832	248	3.35	F
	17-16	0.17	891	331	2.69	F
17-18	17-18	0.06	566	380	1.49	F
	18-17	0.06	583	298	1.96	F
18-2	18-2	0.14	584	342	1.71	F
	2-18	0.14	785	358	2.19	F
18-3	18-3	0.15	737	384	1.92	F
	3-18	0.15	627	395	1.59	F
Total facility		**0.14**	**1573**	**734**	**2.14**	**F**

(c) Weekday, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.14	4887	1216	4.02	F
	2-1	0.15	4784	669	7.15	F
2-3	2-3	0.12	4231	1412	3.00	F
	3-2	0.11	4962	1214	4.09	F
3-4	3-4	0.24	4263	1188	3.59	F
	4-3	0.25	3755	1020	3.68	F
4-5	4-5	0.14	3437	1146	3.00	F
	5-4	0.14	3595	631	5.69	F
5-6	5-6	0.22	2945	804	3.67	F
	6-5	0.23	3681	475	7.75	F
6-7	6-7	0.12	4497	715	6.29	F
	7-6	0.12	4253	929	4.58	F
7-8	7-8	0.12	4498	683	6.58	F
	8-7	0.12	3682	623	5.91	F
8-9	8-9	0.13	3725	692	5.38	F
	9-8	0.13	4686	471	9.95	F
9-10	9-10	0.07	4165	538	7.74	F
	10-9	0.08	3122	639	4.89	F
10-11	10-11	0.12	3167	951	3.33	F
	11-10	0.11	2497	827	3.02	F

(Table 4.11 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
11-12	11-12	0.23	3201	1155	2.77	F
	12-11	0.22	3140	1133	2.77	F
12-1	12-1	0.14	3573	1078	3.31	F
	1-12	0.13	3866	1360	2.84	F
1-8	1-8	0.15	5380	599	8.98	F
	8-1	0.14	5325	682	7.81	F
11-13	11-13	0.22	2806	1126	2.49	F
	13-11	0.22	3357	1388	2.42	F
13-14	13-14	0.17	1754	371	4.73	F
	14-13	0.16	1985	202	9.81	F
14-15	14-15	0.14	1870	334	5.6	F
	15-14	0.14	2171	363	5.99	F
15-16	15-16	0.09	2057	387	5.32	F
	16-15	0.09	1656	340	4.88	F
16-17	16-17	0.18	1660	288	5.76	F
	17-16	0.18	1710	325	5.26	F
17-18	17-18	0.06	979	368	2.66	F
	18-17	0.07	1063	315	3.38	F
18-2	18-2	0.16	1177	363	3.24	F
	2-18	0.15	1459	335	4.35	F
18-3	18-3	0.16	1527	354	4.31	F
	3-18	0.17	1100	391	2.81	F
Total facility		**0.15**	**3135**	**717**	**4.37**	**F**

(d) Weekday, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.09	3008	1058	2.84	F
	2-1	0.10	2665	808	3.3	F
2-3	2-3	0.07	3189	1281	2.49	F
	3-2	0.08	3492	1236	2.83	F
3-4	3-4	0.16	3276	1205	2.72	F
	4-3	0.16	2924	1072	2.73	F
4-5	4-5	0.09	1949	858	2.27	F
	5-4	0.09	2046	610	3.35	F
5-6	5-6	0.15	2092	807	2.59	F
	6-5	0.15	2680	580	4.62	F
6-7	6-7	0.08	3427	702	4.89	F
	7-6	0.08	3278	851	3.85	F
7-8	7-8	0.07	3580	620	5.77	F
	8-7	0.08	2924	576	5.08	F
8-9	8-9	0.09	3036	621	4.89	F
	9-8	0.08	3654	604	6.05	F
9-10	9-10	0.05	2467	681	3.62	F
	10-9	0.05	2554	800	3.19	F

(Table 4.11 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
10-11	10-11	0.08	3219	1016	3.17	F
	11-10	0.08	1988	1141	1.74	F
11-12	11-12	0.16	2466	1158	2.13	F
	12-11	0.16	2374	1200	1.98	F
12-1	12-1	0.09	2726	762	3.58	F
	1-12	0.09	2818	1069	2.64	F
1-8	1-8	0.09	4108	515	7.97	F
	8-1	0.09	3927	593	6.62	F
11-13	11-13	0.15	2053	1023	2.01	F
	13-11	0.15	2462	1332	1.85	F
13-14	13-14	0.12	1339	346	3.87	F
	14-13	0.13	1425	248	5.74	F
14-15	14-15	0.11	1358	326	4.16	F
	15-14	0.10	1570	356	4.41	F
15-16	15-16	0.06	1525	356	4.28	F
	16-15	0.06	1132	332	3.41	F
16-17	16-17	0.12	1251	281	4.45	F
	17-16	0.12	1205	376	3.2	F
17-18	17-18	0.04	767	423	1.81	F
	18-17	0.04	771	358	2.16	F
18-2	18-2	0.10	872	419	2.08	F
	2-18	0.10	989	375	2.64	F
18-3	18-3	0.11	1140	386	2.95	F
	3-18	0.11	827	306	2.7	F
Total facility		**0.10**	**2299**	**706**	**3.25**	**F**

From Table 4.11, LOS has been found to be F at all segments of the study area during all periods of measurement, indicating worst traffic conditions possible. Considering the flow-capacity ratio (v/c), segment 1-8/8-1 is in the most critical state, with a combined v/c of 6.64 and average v/c of 6.72. Segment 11-13/13-11 is in the least critical state, with a combined v/c of 1.87 and an average v/c of 1.86. Weekday, day faced relatively worst traffic conditions (total facility v/c of 4.37) while weekend, night faced relatively best traffic conditions (total facility v/c of 2.14). Combined, average, minimum and maximum segment directional v/c during weekend, day were calculated to be 3.42, 3.71, 1.85 (segment direction 12-11) and 8.29 (segment direction 1-8) respectively. Combined, average, minimum and maximum segment directional v/c during weekend, night were calculated to be 2.14, 2.35, 0.79 (segment direction 11-13) and 4.63 (segment direction 1-8) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, day were calculated to be 4.37, 4.88, 2.42 (segment direction 13-11) and 9.95 (segment direction 9-8) respectively.

Combined, average, minimum and maximum segment directional v/c during weekday, night were calculated to be 3.25, 3.54, 1.74 (segment direction 11-10) and 7.97 (segment direction 1-8) respectively.

4.8.5 Jatrabari-Gulistan Flyover

All segments of the study area of Jatrabari-Gulistan are urban street segments. The LOS calculation is presented in the following table.

Table 4.12: LOS Calculation for MMHF

(a) Weekend, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.11	886	633	1.40	F
	2-1	0.12	740	641	1.15	F
2-3	2-3	0.13	902	647	1.39	F
	3-2	0.13	791	707	1.12	F
3-4	3-4	0.15	742	666	1.12	F
	4-3	0.15	599	666	0.90	F
4-5	4-5	0.04	742	670	1.11	F
	5-4	0.04	905	714	1.27	F
5-6	5-6	0.08	814	894	0.91	F
	6-5	0.07	1089	661	1.65	F
6-7	6-7	0.24	842	793	1.06	F
	7-6	0.24	756	791	0.96	F
7-8	7-8	0.21	739	707	1.04	F
	8-7	0.21	689	666	1.03	F
8-9	8-9	0.05	479	339	1.41	F
	9-8	0.05	530	435	1.22	F
9-10	9-10	0.11	910	625	1.46	F
	10-9	0.11	800	602	1.33	F
10-11	10-11	0.17	898	836	1.07	F
	11-10	0.17	739	414	1.79	F
9-11	9-11	0.10	723	642	1.13	F
	11-9	0.10	581	551	1.05	F
11-12	11-12	0.03	947	621	1.53	F
	12-11	0.04	871	800	1.09	F
12-13	12-13	0.05	935	480	1.95	F
	13-12	0.05	740	809	0.91	F
7-13	7-13	0.16	997	544	1.83	F
	13-7	0.17	774	821	0.94	F
8-14	8-14	0.13	809	803	1.01	F
	14-8	0.13	694	673	1.03	F
Total facility		**0.13**	**789**	**662**	**1.19**	**F**

(Table 4.12 continued)

(b) Weekend, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.09	1169	627	1.86	F
	2-1	0.09	995	649	1.53	F
2-3	2-3	0.10	1397	659	2.12	F
	3-2	0.10	1556	791	1.97	F
3-4	3-4	0.12	1155	596	1.94	F
	4-3	0.11	1443	763	1.89	F
4-5	4-5	0.03	1420	688	2.07	F
	5-4	0.03	1634	731	2.24	F
5-6	5-6	0.07	1441	892	1.62	F
	6-5	0.06	1192	643	1.85	F
6-7	6-7	0.16	1261	864	1.46	F
	7-6	0.16	1182	867	1.36	F
7-8	7-8	0.14	1506	923	1.63	F
	8-7	0.14	1167	682	1.71	F
8-9	8-9	0.04	756	311	2.44	F
	9-8	0.04	627	360	1.74	F
9-10	9-10	0.09	1487	606	2.45	F
	10-9	0.09	1316	573	2.30	F
10-11	10-11	0.13	1297	685	1.89	F
	11-10	0.13	1341	443	3.03	F
9-11	9-11	0.09	1015	757	1.34	F
	11-9	0.08	1229	645	1.90	F
11-12	11-12	0.03	1426	625	2.28	F
	12-11	0.03	1267	885	1.43	F
12-13	12-13	0.03	1344	437	3.08	F
	13-12	0.04	1591	807	1.97	F
7-13	7-13	0.12	1530	518	2.95	F
	13-7	0.11	1064	770	1.38	F
8-14	8-14	0.10	1278	901	1.42	F
	14-8	0.10	1153	685	1.68	F
Total facility		**0.10**	**1275**	**679**	**1.88**	**F**

(c) Weekday, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.09	1205	687	1.75	F
	2-1	0.09	1390	613	2.27	F
2-3	2-3	0.11	1785	704	2.53	F
	3-2	0.10	1575	755	2.09	F
3-4	3-4	0.12	1490	623	2.39	F
	4-3	0.11	1719	730	2.36	F

(Table 4.12 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
4-5	4-5	0.03	1706	654	2.61	F
	5-4	0.03	1744	537	3.25	F
5-6	5-6	0.06	1648	737	2.23	F
	6-5	0.06	1499	577	2.60	F
6-7	6-7	0.15	1585	855	1.85	F
	7-6	0.15	1846	777	2.37	F
7-8	7-8	0.13	1898	864	2.20	F
	8-7	0.12	1812	625	2.90	F
8-9	8-9	0.04	751	305	2.46	F
	9-8	0.04	700	366	1.91	F
9-10	9-10	0.09	1968	569	3.46	F
	10-9	0.09	1767	610	2.90	F
10-11	10-11	0.13	1584	732	2.16	F
	11-10	0.13	1633	430	3.80	F
9-11	9-11	0.08	982	636	1.54	F
	11-9	0.08	1253	529	2.37	F
11-12	11-12	0.03	2116	647	3.27	F
	12-11	0.03	1417	838	1.69	F
12-13	12-13	0.04	1599	452	3.54	F
	13-12	0.04	1803	651	2.77	F
7-13	7-13	0.12	1768	542	3.26	F
	13-7	0.13	1481	775	1.91	F
8-14	8-14	0.09	1790	880	2.03	F
	14-8	0.09	1638	602	2.72	F
Total facility		**0.09**	**1572**	**643**	**2.44**	**F**

(d) Weekday, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.11	2162	698	3.10	F
	2-1	0.11	1908	617	3.09	F
2-3	2-3	0.13	3029	732	4.14	F
	3-2	0.12	2318	763	3.04	F
3-4	3-4	0.12	2621	527	4.98	F
	4-3	0.13	2375	743	3.19	F
4-5	4-5	0.04	2786	790	3.53	F
	5-4	0.04	2749	634	4.34	F
5-6	5-6	0.08	2455	726	3.38	F
	6-5	0.07	2370	619	3.83	F
6-7	6-7	0.23	2400	894	2.69	F
	7-6	0.23	2447	823	2.97	F
7-8	7-8	0.19	2809	802	3.50	F
	8-7	0.18	2418	738	3.27	F

(Table 4.12 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
8-9	8-9	0.05	1282	320	4.01	F
	9-8	0.05	1174	412	2.85	F
9-10	9-10	0.09	2798	595	4.70	F
	10-9	0.11	2625	632	4.15	F
10-11	10-11	0.14	2551	788	3.24	F
	11-10	0.13	2494	385	6.47	F
9-11	9-11	0.10	1994	755	2.64	F
	11-9	0.10	1816	590	3.08	F
11-12	11-12	0.03	2903	670	4.33	F
	12-11	0.04	2208	737	3.00	F
12-13	12-13	0.04	2442	455	5.36	F
	13-12	0.05	2476	787	3.14	F
7-13	7-13	0.14	2924	590	4.96	F
	13-7	0.15	2165	704	3.07	F
8-14	8-14	0.11	2605	642	4.06	F
	14-8	0.11	2276	686	3.32	F
Total facility		**0.11**	**2386**	**662**	**3.61**	**F**

From Table 4.12, LOS has been found to be F at all segments of the study area during all periods of measurement, indicating worst traffic conditions possible. Considering the flow-capacity ratio (v/c), segment 9-10/10-9 (combined v/c of 2.84 and average v/c of 2.84) and segment 10-11/11-10 (combined v/c of 2.66 and average v/c of 2.93) are in the most critical state. Segment 6-7/7-6 is in the least critical state, with a combined v/c of 1.85 and an average v/c of 1.84. Weekday, night faced relatively worst traffic conditions (total facility v/c of 3.61) while weekend, day faced relatively best traffic conditions (total facility v/c of 1.19). Combined, average, minimum and maximum segment directional v/c during weekend, day were calculated to be 1.19, 1.23, 0.90 (segment direction 4-3) and 1.95 (segment direction 12-13) respectively. Combined, average, minimum and maximum segment directional v/c during weekend, night were calculated to be 1.88, 1.95, 1.34 (segment direction 9-11) and 3.08 (segment direction 12-13) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, day were calculated to be 2.44, 2.51, 1.54 (segment direction 9-11) and 3.80 (segment direction 11-10) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, night were calculated to be 3.61, 3.71, 2.64 (segment direction 9-11) and 6.47 (segment direction 11-10) respectively.

4.8.6 Moghbazar-Mouchak Flyover

All segments of the study area of Moghbazar-Mouchak Flyover are urban street segments. The LOS calculation is presented in the following table.

Table 4.13: LOS Calculation for MMF

(a) Weekend, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.12	1907	1655	1.15	F
	2-1	0.12	1580	1254	1.26	F
2-3	2-3	0.08	2017	850	2.37	F
	3-2	0.08	1411	1161	1.22	F
2-25	2-25	0.16	1676	2126	0.79	F
	25-2	0.14	1737	363	4.78	F
3-4	3-4	0.10	1492	950	1.57	F
	4-3	0.10	1395	1023	1.36	F
3-23	3-23	0.08	1627	1093	1.49	F
	23-3	0.11	1446	1068	1.35	F
4-5	4-5	0.08	1988	1303	1.53	F
	5-4	0.07	1683	902	1.87	F
4-15	4-15	0.16	1284	869	1.48	F
	15-4	0.14	1205	649	1.86	F
4-22	4-22	0.10	894	209	4.27	F
	22-4	0.12	1093	532	2.05	F
5-6	5-6	0.09	2224	777	2.86	F
	6-5	0.10	1885	717	2.63	F
6-7	6-7	0.08	1599	908	1.76	F
	7-6	0.09	1239	827	1.50	F
6-14	6-14	0.09	1038	436	2.38	F
	14-6	0.11	1008	392	2.57	F
7-8	7-8	0.06	1544	1905	0.81	F
	8-7	0.07	1202	1660	0.72	F
7-19	7-19	0.06	1150	962	1.20	F
	19-7	0.06	1097	1190	0.92	F
8-9	8-9	0.06	1485	1575	0.94	F
	9-8	0.06	1220	1765	0.69	F
8-14	8-14	0.09	1599	1180	1.36	F
	14-8	0.11	1646	1098	1.50	F
9-10	9-10	0.07	2232	1185	1.88	F
	10-9	0.11	1907	1634	1.17	F
10-11	10-11	0.05	1361	1006	1.35	F
	11-10	0.08	1379	728	1.90	F
11-12	11-12	0.07	1349	533	2.53	F
	12-11	0.08	1519	781	1.95	F
11-14	11-14	0.11	758	362	2.09	F
	14-11	0.12	813	363	2.24	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
12-13	12-13	0.17	3096	670	4.62	F
	13-12	0.17	3924	678	5.79	F
12-18	12-18	0.19	4212	670	6.28	F
	18-12	0.19	4340	526	8.25	F
13-14	13-14	0.07	1630	1369	1.19	F
	14-13	0.09	1403	1589	0.88	F
13-15	13-15	0.10	3750	684	5.48	F
	15-13	0.10	2817	666	4.23	F
15-16	15-16	0.15	2559	909	2.81	F
	16-15	0.16	2254	1173	1.92	F
16-17	16-17	0.29	2544	1288	1.98	F
	17-16	0.29	2554	1379	1.85	F
16-26	16-26	0.26	2380	1205	1.98	F
	26-16	0.27	2986	1388	2.15	F
17-18	17-18	0.17	2762	772	3.58	F
	18-17	0.17	3396	1083	3.13	F
19-20	19-20	0.15	1276	1098	1.16	F
	20-19	0.16	1297	998	1.30	F
20-21	20-21	0.06	1328	1186	1.12	F
	21-20	0.08	1432	2008	0.71	F
21-22	21-22	0.09	1880	1989	0.94	F
	22-21	0.10	1384	1440	0.96	F
22-23	22-23	0.05	2794	1199	2.33	F
	23-22	0.07	2414	1883	1.28	F
23-24	23-24	0.14	2672	1522	1.76	F
	24-23	0.14	2325	1148	2.02	F
Total facility		**0.11**	**1892**	**1070**	**1.77**	**F**

(b) Weekend, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.08	1018	1843	0.55	F
	2-1	0.09	1005	1514	0.66	F
2-3	2-3	0.06	1112	1083	1.03	F
	3-2	0.06	893	1192	0.75	F
2-25	2-25	0.12	841	2132	0.39	F
	25-2	0.11	862	300	2.87	F
3-4	3-4	0.07	738	890	0.83	F
	4-3	0.08	809	1095	0.74	F
3-23	3-23	0.07	729	1059	0.69	F
	23-3	0.09	1019	910	1.12	F
4-5	4-5	0.06	1062	1200	0.88	F
	5-4	0.06	1171	869	1.35	F
4-15	4-15	0.11	574	877	0.65	F
	15-4	0.10	691	615	1.12	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
4-22	4-22	0.08	319	294	1.09	F
	22-4	0.08	445	642	0.69	F
5-6	5-6	0.07	1215	821	1.48	F
	6-5	0.07	1294	756	1.71	F
6-7	6-7	0.07	853	831	1.03	F
	7-6	0.08	809	915	0.88	F
6-14	6-14	0.07	417	410	1.02	F
	14-6	0.08	448	325	1.38	F
7-8	7-8	0.05	675	1907	0.35	F
	8-7	0.06	710	1624	0.44	F
7-19	7-19	0.03	454	1133	0.40	F
	19-7	0.04	578	1388	0.42	F
8-9	8-9	0.03	676	1940	0.35	F
	9-8	0.05	834	1738	0.48	F
8-14	8-14	0.07	1050	1381	0.76	F
	14-8	0.08	1144	1134	1.01	F
9-10	9-10	0.07	1215	1412	0.86	F
	10-9	0.10	958	1629	0.59	F
10-11	10-11	0.05	817	943	0.87	F
	11-10	0.07	791	643	1.23	F
11-12	11-12	0.05	814	531	1.53	F
	12-11	0.07	916	796	1.15	F
11-14	11-14	0.08	397	334	1.19	F
	14-11	0.09	387	358	1.08	F
12-13	12-13	0.08	1874	657	2.85	F
	13-12	0.09	2119	661	3.20	F
12-18	12-18	0.10	2592	696	3.72	F
	18-12	0.09	2414	521	4.63	F
13-14	13-14	0.06	967	1209	0.80	F
	14-13	0.09	813	1558	0.52	F
13-15	13-15	0.04	2023	686	2.95	F
	15-13	0.05	1703	667	2.55	F
15-16	15-16	0.07	1270	926	1.37	F
	16-15	0.08	1700	1184	1.44	F
16-17	16-17	0.16	1559	1182	1.32	F
	17-16	0.16	1558	1390	1.12	F
16-26	16-26	0.15	872	1098	0.79	F
	26-16	0.15	1591	1313	1.21	F
17-18	17-18	0.09	1751	707	2.48	F
	18-17	0.10	1884	1179	1.60	F
19-20	19-20	0.12	412	943	0.44	F
	20-19	0.12	559	910	0.61	F
20-21	20-21	0.05	498	1285	0.39	F
	21-20	0.07	649	2315	0.28	F
21-22	21-22	0.07	867	1955	0.44	F
	22-21	0.08	816	1622	0.50	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
22-23	22-23	0.05	1379	1189	1.16	F
	23-22	0.06	1343	1576	0.85	F
23-24	23-24	0.11	1304	1855	0.70	F
	24-23	0.13	1540	1216	1.27	F
Total facility		**0.08**	**1044**	**1093**	**0.95**	**F**

(c) Weekday, Day

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.08	2650	1728	1.53	F
	2-1	0.08	2399	1714	1.40	F
2-3	2-3	0.06	2532	998	2.54	F
	3-2	0.06	2171	1249	1.74	F
2-25	2-25	0.11	1825	2128	0.86	F
	25-2	0.10	1722	392	4.39	F
3-4	3-4	0.08	2333	967	2.41	F
	4-3	0.08	2348	1171	2.01	F
3-23	3-23	0.08	2296	1029	2.23	F
	23-3	0.08	2215	1007	2.20	F
4-5	4-5	0.05	2318	1348	1.72	F
	5-4	0.05	2524	968	2.61	F
4-15	4-15	0.11	1825	981	1.86	F
	15-4	0.10	1869	583	3.21	F
4-22	4-22	0.08	1472	272	5.42	F
	22-4	0.08	1715	603	2.84	F
5-6	5-6	0.07	2429	968	2.51	F
	6-5	0.07	2819	952	2.96	F
6-7	6-7	0.06	1840	1052	1.75	F
	7-6	0.07	1516	926	1.64	F
6-14	6-14	0.07	1649	355	4.64	F
	14-6	0.07	1737	281	6.19	F
7-8	7-8	0.05	2421	1823	1.33	F
	8-7	0.06	2282	1649	1.38	F
7-19	7-19	0.03	2053	1271	1.62	F
	19-7	0.02	2127	1056	2.01	F
8-9	8-9	0.04	1759	1239	1.42	F
	9-8	0.04	1818	2044	0.89	F
8-14	8-14	0.08	1869	1365	1.37	F
	14-8	0.07	1869	986	1.90	F
9-10	9-10	0.09	2834	1249	2.27	F
	10-9	0.09	2981	991	3.01	F
10-11	10-11	0.05	1840	879	2.09	F
	11-10	0.06	1766	754	2.34	F
11-12	11-12	0.06	1825	528	3.45	F
	12-11	0.06	2068	985	2.10	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
11-14	11-14	0.09	1030	299	3.44	F
	14-11	0.09	1111	305	3.65	F
12-13	12-13	0.11	4298	642	6.70	F
	13-12	0.11	5417	651	8.33	F
12-18	12-18	0.12	5697	671	8.49	F
	18-12	0.12	5807	491	11.84	F
13-14	13-14	0.07	2326	1422	1.64	F
	14-13	0.08	1899	1576	1.20	F
13-15	13-15	0.06	4924	538	9.15	F
	15-13	0.06	3827	649	5.90	F
15-16	15-16	0.10	3864	905	4.27	F
	16-15	0.10	3260	1194	2.73	F
16-17	16-17	0.19	4019	1129	3.56	F
	17-16	0.19	4041	1354	2.98	F
16-26	16-26	0.19	2806	1126	2.49	F
	26-16	0.18	3357	1388	2.42	F
17-18	17-18	0.12	3996	697	5.73	F
	18-17	0.11	4416	1160	3.81	F
19-20	19-20	0.12	2046	1019	2.01	F
	20-19	0.12	2237	888	2.52	F
20-21	20-21	0.05	1980	1252	1.58	F
	21-20	0.06	2252	2180	1.03	F
21-22	21-22	0.08	2767	1822	1.52	F
	22-21	0.08	2694	1744	1.54	F
22-23	22-23	0.06	3599	1258	2.86	F
	23-22	0.06	3798	1755	2.16	F
23-24	23-24	0.12	3673	1740	2.11	F
	24-23	0.13	3651	1090	3.35	F
Total facility		**0.09**	**2664**	**1085**	**2.46**	**F**

(d) Weekday, Night

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
1-2	1-2	0.11	1131	1867	0.61	F
	2-1	0.11	1193	1771	0.67	F
2-3	2-3	0.08	1135	1211	0.94	F
	3-2	0.08	1082	1221	0.89	F
2-25	2-25	0.13	1121	1966	0.57	F
	25-2	0.13	1472	381	3.87	F
3-4	3-4	0.10	838	952	0.88	F
	4-3	0.11	914	1059	0.86	F
3-23	3-23	0.11	934	942	0.99	F
	23-3	0.11	1105	940	1.18	F
4-5	4-5	0.06	1073	1359	0.79	F
	5-4	0.06	1193	986	1.21	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
4-15	4-15	0.15	796	855	0.93	F
	15-4	0.15	923	637	1.45	F
4-22	4-22	0.12	575	257	2.24	F
	22-4	0.12	798	548	1.46	F
5-6	5-6	0.09	1153	805	1.43	F
	6-5	0.10	1318	915	1.44	F
6-7	6-7	0.09	834	878	0.95	F
	7-6	0.10	801	886	0.90	F
6-14	6-14	0.10	733	373	1.97	F
	14-6	0.11	764	370	2.07	F
7-8	7-8	0.07	909	1614	0.56	F
	8-7	0.08	853	1904	0.45	F
7-19	7-19	0.04	725	640	1.13	F
	19-7	0.05	765	1112	0.69	F
8-9	8-9	0.04	760	1780	0.43	F
	9-8	0.05	821	1798	0.46	F
8-14	8-14	0.11	1403	1420	0.99	F
	14-8	0.11	1578	1285	1.23	F
9-10	9-10	0.11	1310	1353	0.97	F
	10-9	0.10	1287	1499	0.86	F
10-11	10-11	0.07	1211	904	1.34	F
	11-10	0.07	1351	645	2.09	F
11-12	11-12	0.07	1232	555	2.22	F
	12-11	0.06	1581	1018	1.55	F
11-14	11-14	0.12	638	324	1.97	F
	14-11	0.12	689	278	2.48	F
12-13	12-13	0.09	3036	621	4.89	F
	13-12	0.08	3654	604	6.05	F
12-18	12-18	0.09	3927	593	6.62	F
	18-12	0.10	4108	515	7.97	F
13-14	13-14	0.07	1394	1316	1.06	F
	14-13	0.08	1284	1367	0.94	F
13-15	13-15	0.05	2467	681	3.62	F
	15-13	0.05	2554	800	3.19	F
15-16	15-16	0.08	3219	1016	3.17	F
	16-15	0.08	1988	1141	1.74	F
16-17	16-17	0.16	2466	1158	2.13	F
	17-16	0.16	2374	1200	1.98	F
16-26	16-26	0.15	2053	1023	2.01	F
	26-16	0.15	2462	1338	1.84	F
17-18	17-18	0.09	2726	762	3.58	F
	18-17	0.09	2818	1069	2.64	F
19-20	19-20	0.14	718	887	0.81	F
	20-19	0.13	841	918	0.92	F
20-21	20-21	0.07	729	1237	0.59	F
	21-20	0.07	914	2346	0.39	F

(Table 4.13 continued)

Segment	Segment Label	TS/FFS (km/h)	Flow (pc/h)	Capacity (pc/h)	v/c	LOS (km/h)
21-22	21-22	0.11	1071	1893	0.57	F
	22-21	0.11	1072	1672	0.64	F
22-23	22-23	0.07	1501	1398	1.07	F
	23-22	0.07	1720	1968	0.87	F
23-24	23-24	0.12	1507	1890	0.80	F
	24-23	0.11	1698	1276	1.33	F
Total facility		**0.10**	**1458**	**1094**	**1.33**	**F**

From Table 4.13, LOS has been found to be F at all segments of the study area during all periods of measurement, indicating worst traffic conditions possible. Considering the flow-capacity ratio (v/c), segment 12-18/18-12 (combined v/c of 7.07 and average v/c of 7.23) is in the most critical state, while segment 20-21/21-20 (combined v/c of 0.71 and average v/c of 0.76) is in the least critical state. Weekday, day faced relatively worst traffic conditions (total facility v/c of 3.04) while weekend, night faced relatively best traffic conditions (total facility v/c of 1.11). Combined, average, minimum and maximum segment directional v/c during weekend, day were calculated to be 1.77, 2.14, 0.69 (segment direction 9-8) and 8.25 (segment direction 18-12) respectively. Combined, average, minimum and maximum segment directional v/c during weekend, night were calculated to be 0.95, 1.17, 0.28 (segment direction 21-20) and 4.63 (segment direction 18-12) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, day were calculated to be 2.46, 3.04, 0.86 (segment direction 2-25) and 11.84 (segment direction 18-12) respectively. Combined, average, minimum and maximum segment directional v/c during weekday, night were calculated to be 1.33, 1.71, 0.39 (segment direction 21-20) and 7.97 (segment direction 18-12) respectively.

4.8.7 Discussions

LOS F has been observed at the urban street segments of the study areas all flyovers for all periods of measurement. Multilane highways have fared better, ranging from LOS A to LOS C across different periods of measurement. However, since majority of the studied road segments are urban street segments, it is a great cause for concern that most of the roads have worst traffic conditions. It essentially means that flyovers have failed to improve mobility both along their corridor and in the adjacent at-grade roads. Several reasons can be attributed to this abysmal road performance. Road capacity is lower than intended because of side friction factors and pedestrians, as noted in previous sections. On the other hand, traffic demand is huge and it is increasing with time, as noted with while comparing traffic flows in previous studies. Traffic demand on the studied segments is increasing mainly because of dramatic rise in usage of private automobiles. As noted in earlier sections (Assessment of Traffic Flow), private vehicles occupy the most space on road. Previous studies have established that considering the same number of passengers, cars would occupy more volume than buses. The usage of cars is rising because of unpopularity of walking and using public transport system, as discussed in previous sections.

It is commendable that government is trying to improve traffic mobility and reduce congestion by providing more road space via flyovers. However, the alarming thing is that construction of flyovers providing unrestricted access to all modes of traffic, including private automobiles, acts as a supply-side policy. It provides short term benefits, but in the long run encourages more cars to ply the roads and increases congestion. Newspaper reports showed revealed that immediately after construction of Moghbazar-Mouchak Flyover, people got some respite from congestion and mobility increased considerably. However, after one week, the traffic in the affected area returned to its previous state of congestion [103]. This happened because of unchecked growth of private automobiles. The situation is similar across the remaining flyovers. Only Banani Overpass is an exception, because of restricted military access to the land around the flyover. As a result, traffic flow is low at grade at all periods of measurement. Through traffic usually use above grade facilities to bypass this area. This rule is not applicable however, to the other influence areas of flyovers, because those areas have mixed uses and are open to the general public.

To address this problem, the symptom needs to be considered first. Flow-Capacity ratio is extremely high at all segments, during all periods of measurement. Flow is high during different periods of measurement for different reasons. Most of the studied areas are of mixed residential and commercial areas housing all sorts of institutions, including residences, educational institutions, shops, markets and offices. These arose from unplanned development of the Dhaka city. During weekday, day LOS was found during evening peak, when people return to their homes from office. During weekday, night some people are still on road trying to return home from office. These people include those that travel large distances between home and office. It also includes commuters living outside Dhaka. During weekends, home-office trips are negligible. Instead people either do their weekly shopping or visit other people (friends, relatives, etc.) or travel to other places for leisure. Hence, the trip purpose changes from weekday to weekend, but traffic flow continues to exceed capacity.

To resolve this problem, flow-capacity ratio needs to be reduced to below 1. Either flow has to be reduced, or capacity has to be increased, or a combination of both has to be done. As Dhaka City is a built up area, there is little scope to increase capacity at grade. Besides, increasing capacity above grade and providing unrestricted access to private vehicles will tend to increase flow in the long run. So, traffic flow needs to be controlled by adopting demand-side policies, as adopted by many cities around the world. BRT needs to be introduced in Dhaka city to facilitate travel of city dwellers. To make BRT popular among citizens, it needs to be provide safe, reliable and fast travel for passengers. Instead of having isolated flyovers, city should be encompassed by a network of connected flyovers acting as a single entity, such as a fully grade separated arterial road. Only BRT buses will be allowed to use the flyover. Meaning only buses will be benefited and will enjoy fast travel. Since buses will not be in conflict with other modes, such trips will be safe. Observation of current bus service system reveals an unhealthy competition to get passengers at the expense of other buses. Buses often travel recklessly on roads and pull into bus stoppage rashly to get more passengers than others. Sometimes these buses do not see people attempting to cross roads or do not notice potential passengers waiting on road (instead of bus station or footpath) for buses. Thus buses might hit passengers, resulting in fatal accidents. Such incidents appear in newspapers on a regular basis.

Observation of current bus service system reveals that many buses continue to use at grade facilities even when it is possible to use above-grade facilities to continue journeying along their designated route. This is because bus stops are situated at grade, and no facilities are provided for passengers to embark/ disembark above grade. Besides, no connecting facilities have been provided from flyovers to at-grade roads for passengers. While this is understandable from the point of view of ensuring mobility for vehicles above grade (by limiting pedestrian movement above grade), it has seriously limited potential of public transit system to use above grade facilities. Hence, existing flyovers have not benefited the public bus system. Instead of benefiting public transport system as should be the norm, existing flyovers has mainly benefited private vehicles.

BRT system should be owned, operated and controlled by a single entity, such as the government. The government will not think to make profits, instead provide reliable services to the mass people at all times. Buses will run round the clock, stopping at terminals only to refuel, pick up and drop off passengers, and make U turns (if necessary) to restart trips. When a single entity is chosen to be the owner of all buses, it will never let buses rest, because it knows that keeping the bus at rest will incur losses for the entity. Control of BRT by a single entity will mean that buses will not compete with each other for passengers, and will not unnecessarily dwell on a particular stop until it is full of passengers. So, bus service will become more reliable. If the control is given to a private entity, there is danger of overpricing bus fares and acting as a monopoly. Therefore it is best to give BRT ownership to a public entity who can be held accountable to the general people. Hence, BRT system needs to be owned by the government of the country.

When general people compare the safe, reliable and fast travel experience offered by BRT system with slow and unreliable travel experience offered by private vehicles stuck at grade in traffic gridlock, people will automatically start switching to public transport. This will act as the greatest force to shift people from private to public transport. When demand for public transport increases and existing buses become inadequate, the government can introduce more buses into the system to reduce bus headway and accommodate the growing demand. Once this option is exhausted, the government can acquire larger buses (articulated or double decker) to accommodate demand. Hence this is a perpetual solution, where supply can be adjusted to meet demand. Bus stations will be situated on the flyover, at the median. People will reach above grade via lifts. People will travel from initial destination to bus station or from bus station to initial destination by para transit, bicycle or walking. To address this, pedestrian facilities and footpaths need to be included. People will travel from footpath to the median of at-grade road by underpasses. Then travel up to the bus station by lifts. When people start shifting to public transport, traffic flow will automatically decrease, promoting mobility, decreasing congestion, increasing the LOS and help achieve the flyovers their original objectives.

4.9 Assessment of Congestion Level in Study Areas

One of the main objectives of constructing flyovers was to eliminate conflicts and congestion at grade level. This study has been done to ascertain how much flyovers have fulfilled this objective. In addition this analysis will evaluate the justification of the flyovers as a remedial measure in reducing traffic congestion, which is one of the main objectives of this thesis. Because of budget and time constraints, it was not possible to assess congestion level of entire study area. Congestion level was measured along the flyover corridor both above-grade and at-grade. In this study, congestion level is represented by queue length. Reconnaissance survey revealed that the most critical spot where congestion occurred along flyover corridor was at the level crossing of each study area, as mentioned in Chapter 3, Methodology. Collected queue length data are summarized in the following graphs.

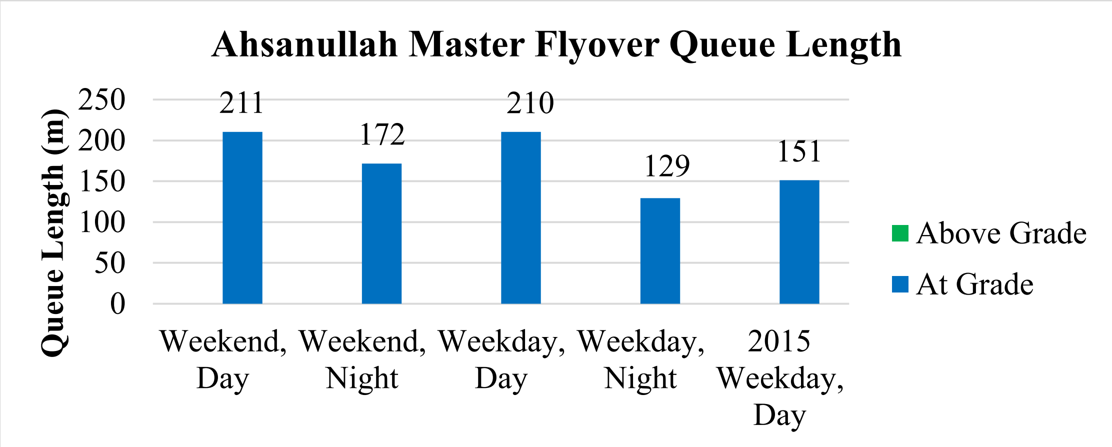


Figure 4.19: Temporal Comparison of Queue Length at SAMF

From above graph, longest queue length at grade was recorded at weekend, day (211 m), followed closely by weekday, day (210 m) while the shortest was recorded at weekday, night (129 m). Compared to a study in 2015 by Anwari et al. [101], queue length in weekday, day has increased by 39.21% in 2017. The fact that queue length has developed at grade along the corridor of Shaheed Ahsanullah Master Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. No queue length was observed to have formed above grade.

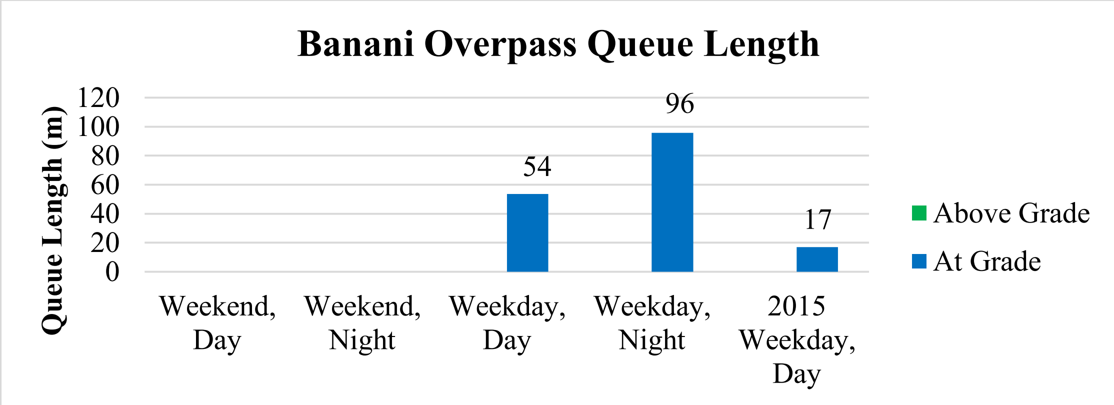


Figure 4.20: Temporal Comparison of Queue Length at Banani Overpass

From above graph, longest queue length at grade was recorded at weekday, night (96 m), while the shortest was recorded at weekday, day (54 m). Compared to a study in 2015 by Anwari et al. [101], queue length in weekday, day has increased sharply by 214.71% in 2017. The fact that queue length has developed at grade along the corridor of Mohakhali Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade conditions. No queue length was observed to have formed above grade. Besides, no congestion was observed at weekends. This is probably because the surrounding land is a restricted area controlled by the military. During weekdays, some commuters use the at grade roads while majority travel above grade. Sine commuters do not come to Dhaka for work during weekends, the at grade roads have low traffic demand during weekends. Consequently, congestion is negligible during weekend along the study corridor.

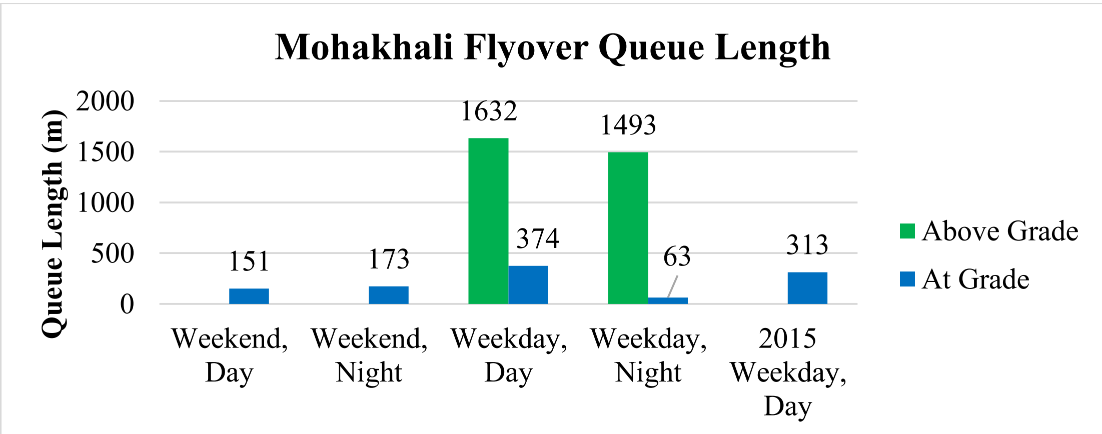


Figure 4.21: Temporal Comparison of Queue Length at Mohakhali Flyover

From above graph, longest queue length at grade was recorded at weekday, day (374 m), while the shortest was recorded at weekday, night (63 m). Compared to a study in 2015 by Anwari et al. [101], queue length in weekday, day has increased by 19.40% in 2017. The fact that queue length has developed at grade along the corridor of Mohakhali Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade conditions. In addition, measurement of above grade queue length shows that queues have developed at weekday, whereas there was no queue length in 2015. Highest above grade queue length was observed at weekday, day (1632 m).

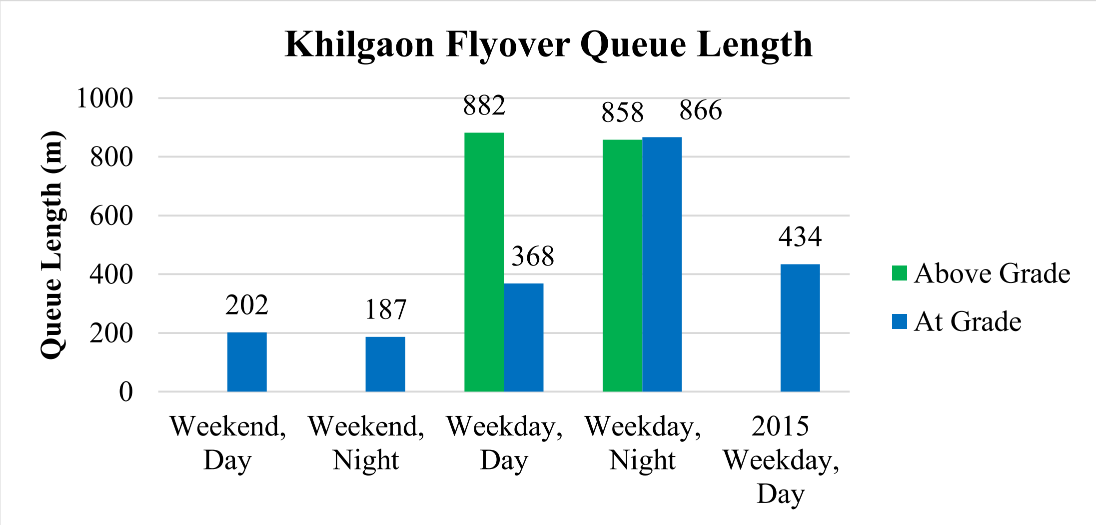


Figure 4.22: Temporal Comparison of Queue Length at Khilgaon Flyover

From above graph, longest queue length at grade was recorded at weekday, day (866 m), while the shortest was recorded at weekend, night (187 m). Compared to a study in 2015 by Anwari et al. [101], queue length in weekday, day has surprisingly decreased by 15.21% in 2017. The fact that queue length has developed at grade along the corridor of Mohakhali Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade conditions. In addition, measurement of above grade queue length shows that queues have developed at weekday, whereas there was no queue length in 2015. Highest above grade queue length was observed at weekday, day (882 m).

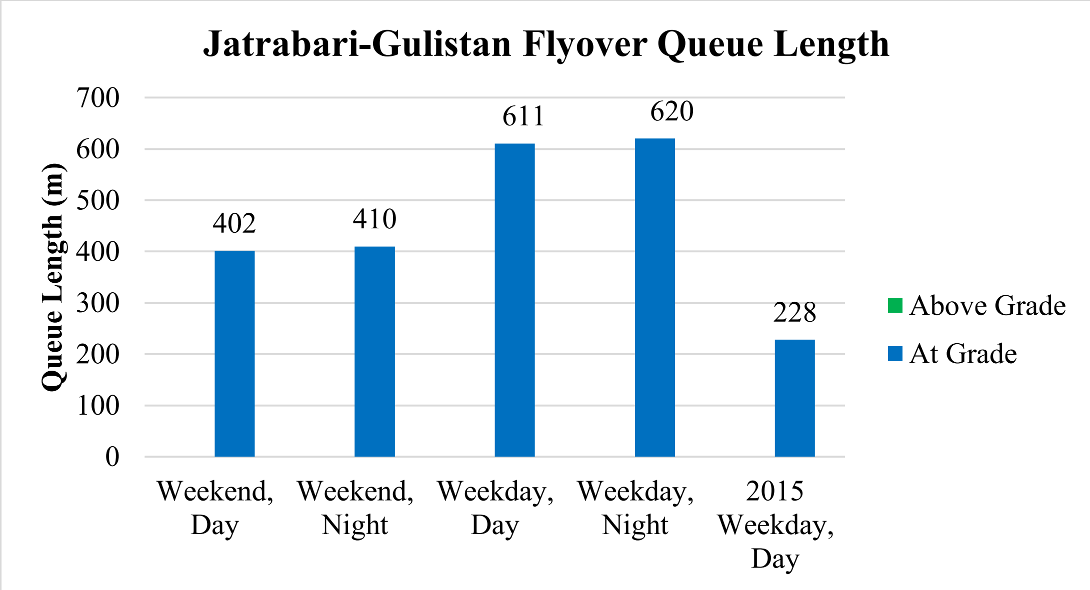


Figure 4.23: Temporal Comparison of Queue Length at MMHF

From above graph, longest queue length at grade was recorded at weekday, night (620 m), while the shortest was recorded at weekend, day (402 m). Compared to a study in 2015 by Anwari et al. [101], queue length in weekday, day has dramatically increased by 17.85% in 2017. The fact that queue length has developed at grade along the corridor of Jatrabari-Gulistan Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade conditions. No queue lengths were observed to have formed above grade.

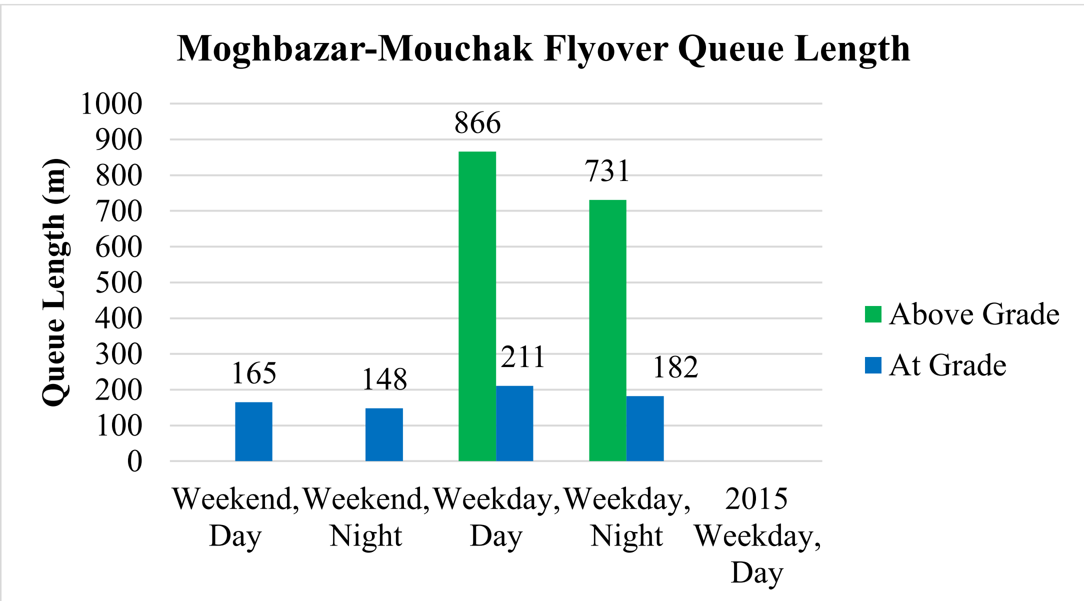


Figure 4.24: Temporal Comparison of Queue Length at MMF

From above graph, longest queue length at grade was recorded at weekday, day (211 m), while the shortest was recorded at weekend, night (148 m). Comparison with previous studies was not possible because the construction of concerned flyover was not completed when previous studies were conducted [101]. The fact that queue length has developed at grade along the corridor of Moghbazar-Mouchak Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade conditions. Highest above grade queue length was observed at weekday, day (866 m).

Assessment of congestion level have revealed that queue length has developed at grade at all flyover corridors during all periods of measurement, indicating that congestion is a significant problem at the studied areas. This congestion has grown alarmingly with time, after comparing with previous studies. It indicates that congestion level has worsened with time and will probably continue to do so in future. This can be coupled with traffic flow analysis done at Section 4.2, which indicated that vehicle flow has increased in absolute terms over time. Similarly, congestion level has been observed to increase over time. Careful analyses at Section 4.2 show that above-grade to at-grade traffic flow has increased in many flyovers. While this may be a positive sign in the sense that flyover has been successful in diverting more traffic above grade, this may induce traffic congestion above grade. Figures 4.31, 4.32 and 4.34 confirm this notion, showing that queue length has developed above grade in 2017, from zero congestion in 2015. It may indicate that existing capacity of flyovers is not enough to handle the flow. As a result, it is evident that existing flyovers have completely failed to ease long-term congestion levels in Dhaka city. It strengthens the views already outlined in section 4.8: the construction of flyovers providing unrestricted access to all modes of traffic, including private automobiles, acts as a supply-side policy. It provides short term benefits, but in the long run encourages more cars to ply the roads and increases congestion.

Field observations to understand the reason behind failure of flyovers to mitigate traffic congestion have revealed serious design flaws in all the flyovers. Flyovers, in their truest sense are not supposed to touch down directly to main at-grade roads. They are supposed to form a continuous grade-separated road network around the city to facilitate movement like road arterials do. Flyovers should be connected to minor at-grade roads via separate ascending and descending ramps to minimize bottleneck effects and congestion at touchdown point. Instead of following this norm like many cities around the world has, Dhaka city has opted to connect flyovers directly to the primary at-grade roads via ramps. It has a two-fold effect. Vehicles after descending flyover are stopped at the immediate next intersection. For example, vehicles moving northbound through Moghbazar-Mouchak Flyover can avoid congestion by passing over Moghbazar (intersection 4 at Figure 3.6) and Hatirzheel intersections (intersection 3 at Figure 3.6). However, they fall into deep congestion at Pubali Bank-Rangs Flyover intersection (intersection 1 at Figure 3.6). So this has actually shifted traffic congestion from Moghbazar and Hatirzheel intersections and instead worsened congestion level at Pubali Bank-Rangs Flyover intersection. So, benefits obtained by vehicles in bypassing Moghbazar and Hatirzheel intersections is completely nullified at the next intersection. Rather, the increased congestion has worsened sufferings for the local people living around Pubali Bank-Rangs Flyover intersection. Thus the existing flyovers in Dhaka city do not function as flyovers, rather they function as overpasses.

Another bad effect of placing ramps on at-grade roads is that ramps have to be widened at touchdown point, reducing effective road width at grade level. Thus at-grade road capacity decreases. Field observations reveal that the columns of flyovers occupy a huge footprint at grade level, reducing the road width there. It is often seen that additional capacity provided above grade is nullified by the capacity loss at grade due to the huge columns of flyovers. Thus even though flyovers have managed to shift a larger portion of vehicles above grade, the relatively lower flow at grade cannot pass smoothly because of reduced capacity at grade. Thus it is seen in Section 4.9 that flow-capacity ratio is larger than 1, which has induced LOS F in all studied areas. Consequently, it can be said that the existing flyovers cannot be justified as a remedial measure in reducing traffic congestions.

4.10 Assessment of Pedestrian Exposure to Risk at Level Crossings

It was mentioned in previous sections that pedestrians are the most vulnerable road-users, yet they are one of the most neglected while considering traffic facilities in Dhaka city. This section is used to assess how much accident potentials pedestrians face in the absence of grade-separated facilities along the study area. Because of economic and time constraints, it was not possible to conduct pedestrian assessment in all segments, which would have been the ideal case. Hence, the most critical spot for accident potential was observed via reconnaissance survey. Based on pedestrian flows, level crossings in the study area were observed to be the most location for pedestrian accidents. Field observation has revealed that in the absence of any grade separated crossing facilities, the pedestrians are compelled to cross the level crossings, thereby exposing and putting them in danger from both road and rail traffic. Based on Focused Group Discussion (FGD) and consultation with safety experts of Bangladesh Road Transport Authority (BRTA), five (5) major factors were identified those have potential to aggravate risk of pedestrians, namely: carrying head load; talking on mobile phone or using head phones; carrying children; running; and being old and/ or disabled. These were considered as critical risk factors. The results of extensive field observation for four periods of measurement, namely, weekend day, weekend night, weekday day and weekday night are depicted in the following tables and figures. The average, minimum and maximum pedestrian counts for each type of identified factor is also provided at the end of Table 4.14 for each period of measurement.

Table 4.14: One (1) Hour Count of Pedestrians

(a) Weekend, Day

Name of Level Crossing	Classification of People						
	Carrying Head load	Using mobile/ headphone	Carrying Child	Running	Old and disabled	No Extra Activity	Total
Malibagh Rail Gate	84	43	87	77	133	2113	**2537**
Moghbazar Level Crossing	75	96	110	105	124	1550	**2060**
Saidabad Level Crossing	62	58	105	46	119	1710	**2100**
Khilgaon Level Crossing	119	40	52	21	265	2112	**2609**
Mohakhali Level Crossing	110	62	89	105	140	2330	**2836**
Banani Level Crossing	25	20	0	1	23	315	**384**

(Table 4.14 continued)

Name of Level Crossing	Classification of People						
	Carrying Head load	Using mobile/ headphone	Carrying Child	Running	Old and disabled	No Extra Activity	Total
Ahsanullah Master Level Crossing	75	42	153	77	174	1701	**2222**
Total	**550**	**361**	**596**	**432**	**978**	**11831**	**14748**
Average	79	52	85	62	140	1690	-
Minimum	25	20	0	1	23	315	-
Maximum	119	96	153	105	265	2330	-

(b) Weekend, Night

Name of Level Crossing	Classification of People						
	Carrying Head load	Using mobile/ headphone	Carrying Child	Running	Old and disabled	No Extra Activity	Total
Malibagh Rail Gate	58	36	53	46	87	1539	**1819**
Moghbazar Level Crossing	38	37	50	42	53	837	**1057**
Saidabad Level Crossing	62	51	89	45	113	944	**1304**
Khilgaon Level Crossing	98	45	52	20	230	1771	**2216**
Mohakhali Level Crossing	68	58	77	90	125	1308	**1726**
Banani Level Crossing	22	22	0	0	20	253	**317**
Ahsanullah Master Level Crossing	69	42	128	67	144	1352	**1802**
Total	**415**	**291**	**449**	**310**	**772**	**8004**	**10241**
Average	59	42	64	44	110	1143	-
Minimum	22	22	0	0	20	253	-
Maximum	98	58	128	90	230	1771	-

(Table 4.14 continued)

(c) Weekday, Day

Name of Level Crossing	Classification of People						
	Carrying Head load	Using mobile/ headphone	Carrying Child	Running	Old and disabled	No Extra Activity	Total
Malibagh Rail Gate	111	55	110	60	233	2675	**3244**
Moghbazar Level Crossing	116	122	68	36	189	2916	**3447**
Saidabad Level Crossing	102	59	133	40	182	1843	**2359**
Khilgaon Level Crossing	133	36	60	5	410	3367	**4011**
Mohakhali Level Crossing	128	67	110	133	205	3863	**4506**
Banani Level Crossing	19	9	0	0	8	462	**498**
Ahsanullah Master Level Crossing	84	42	211	90	241	2620	**3288**
Total	**693**	**390**	**692**	**364**	**1468**	**17746**	**21353**
Average	99	56	99	52	210	2535	**-**
Minimum	19	9	0	0	8	462	**-**
Maximum	133	122	211	133	410	3863	**-**

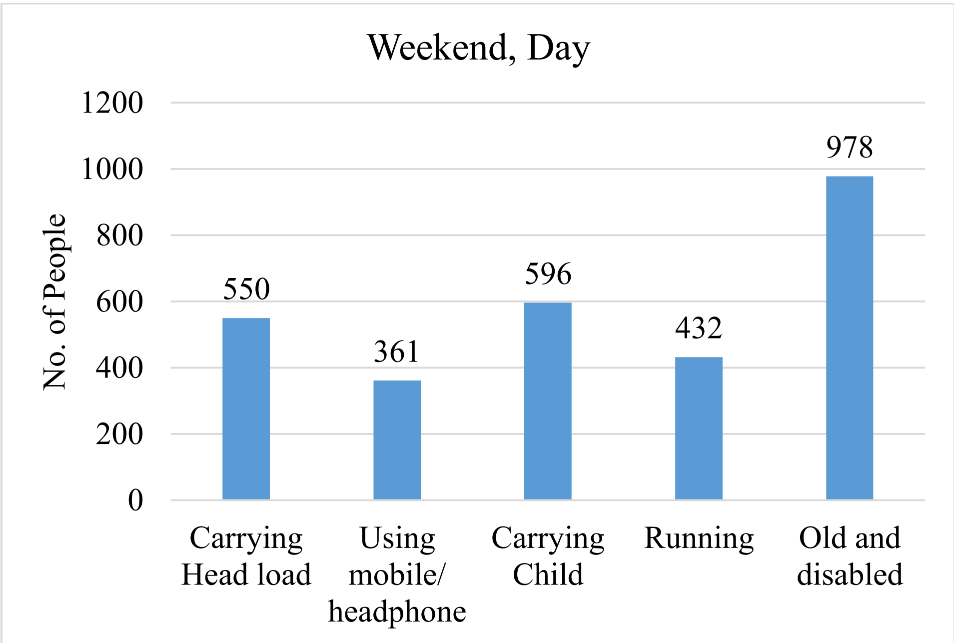
(d) Weekday, Night

Name of Level Crossing	Classification of People						
	Carrying Head load	Using mobile/ headphone	Carrying Child	Running	Old and disabled	No Extra Activity	Total
Malibagh Rail Gate	61	30	60	33	137	1602	**1923**
Moghbazar Level Crossing	85	95	52	22	136	2111	**2501**
Saidabad Level Crossing	97	62	125	41	69	1332	**1726**

(Table 4.14 continued)

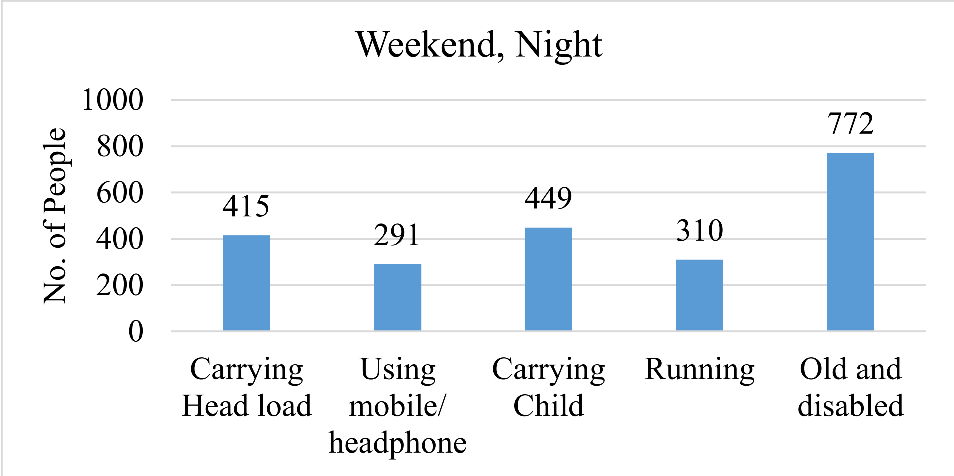
Name of Level Crossing	Classification of People						
	Carrying Head load	**Using mobile/ headphone**	**Carrying Child**	**Running**	**Old and disabled**	**No Extra Activity**	**Total**
Khilgaon Level Crossing	125	30	59	10	250	2762	**3236**
Mohakhali Level Crossing	120	61	100	125	115	3482	**4003**
Banani Level Crossing	22	12	0	0	12	421	**467**
Ahsanullah Master Level Crossing	81	44	190	86	222	2363	**2986**
Total	**591**	**334**	**586**	**317**	**941**	**14073**	**16842**
Average	84	48	84	45	134	2010	-
Minimum	22	12	0	0	12	421	-
Maximum	125	95	190	125	250	3482	-

The pedestrian count considering critical risk factors only is shown in the following graphs.

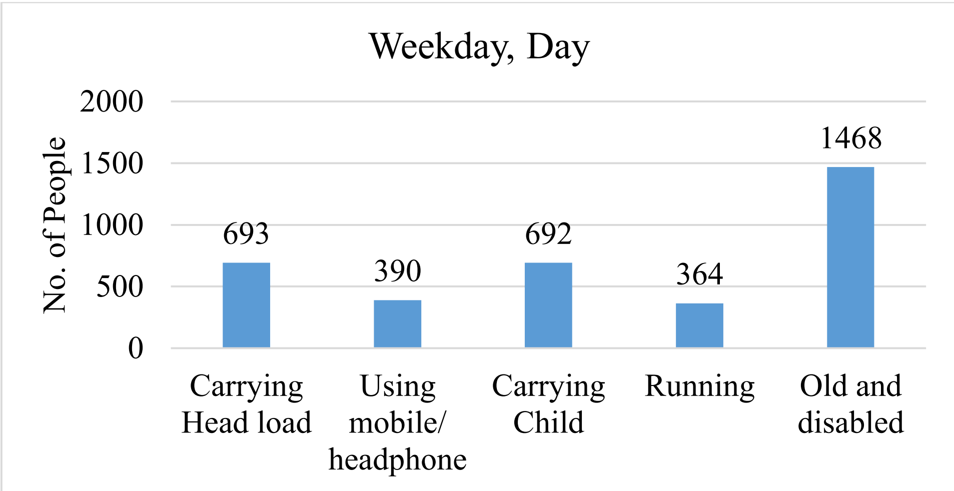


(a) Weekend, Day

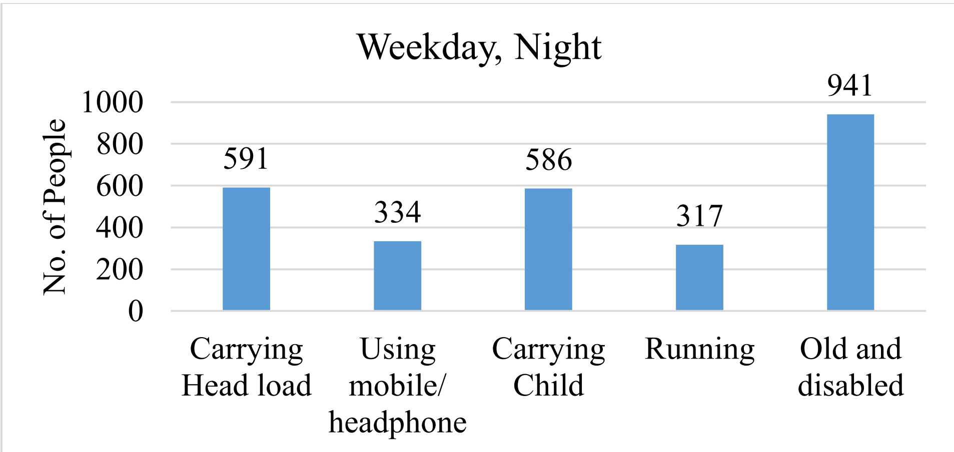
(Figure 4.25 continued)



(b) Weekend, Night



(c) Weekday, Day

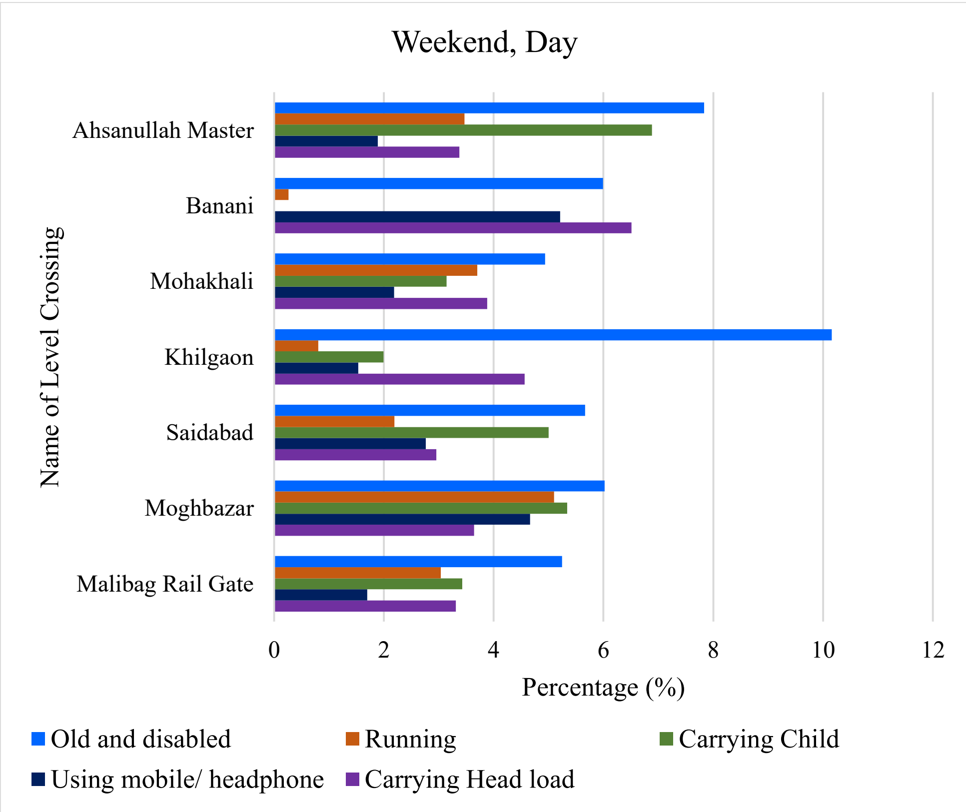


(d) Weekday, Night

Figure 4.25: Number of Pedestrians Observed under Each Risk Criterion

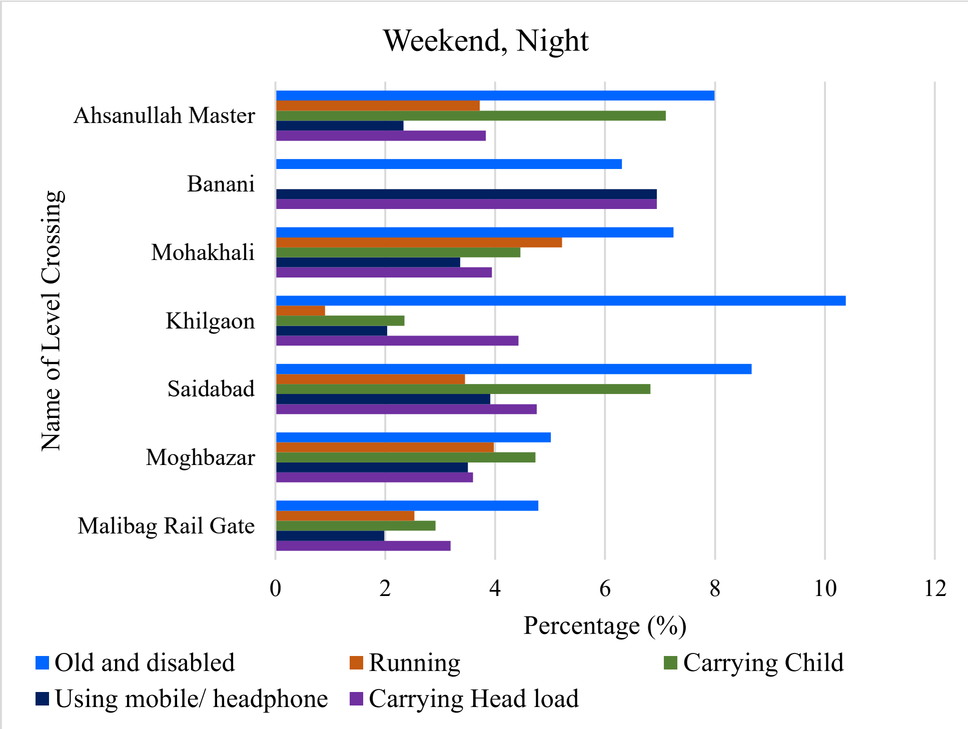
From Figure 4.25, with respect to critical risk factors, “Old and Disabled” was the most common risk criteria (average 1040 pedestrians across the four periods of measurement), while “Using Mobile/Headphone” was the least common risk criteria (average 344 pedestrians across the four periods of measurement). The relative percentage of people for each critical factor at each level crossing is shown in Figure 4.26.

Figure 4.26 reveals that on average, relative percentage of people under excessive risk during weekend day, weekend night, weekday day and weekday night are 19.78%, 21.84%, 16.89% and 16.44% respectively. It indicates that accident severity might be highest at weekend night and lowest at weekday night. On the other hand from Table 4.14, with respect to total count, accident potential is highest at weekday day (21353 pedestrians) at lowest at weekend night (10241 pedestrians). Mohakhali Level Crossing has been observed to have highest accident potential (3268 pedestrians on average across the four periods of measurement) while Banani Level Crossing has been observed to have the lowest accident potential (417 pedestrians on average across the four periods of measurement).

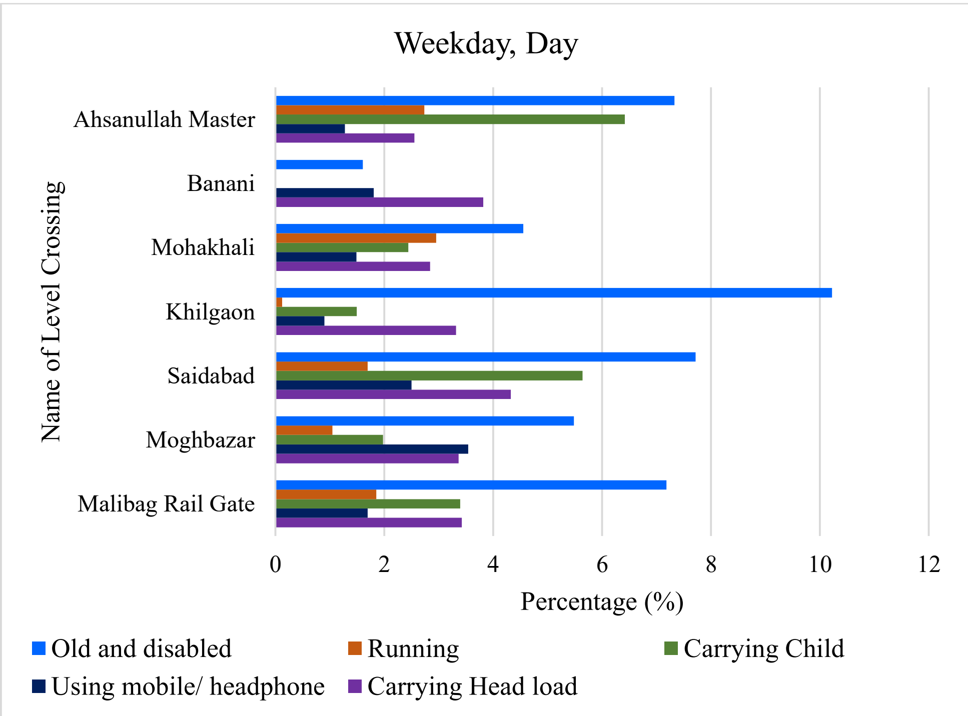


(a) Weekend, Day

(Figure 4.26 continued)

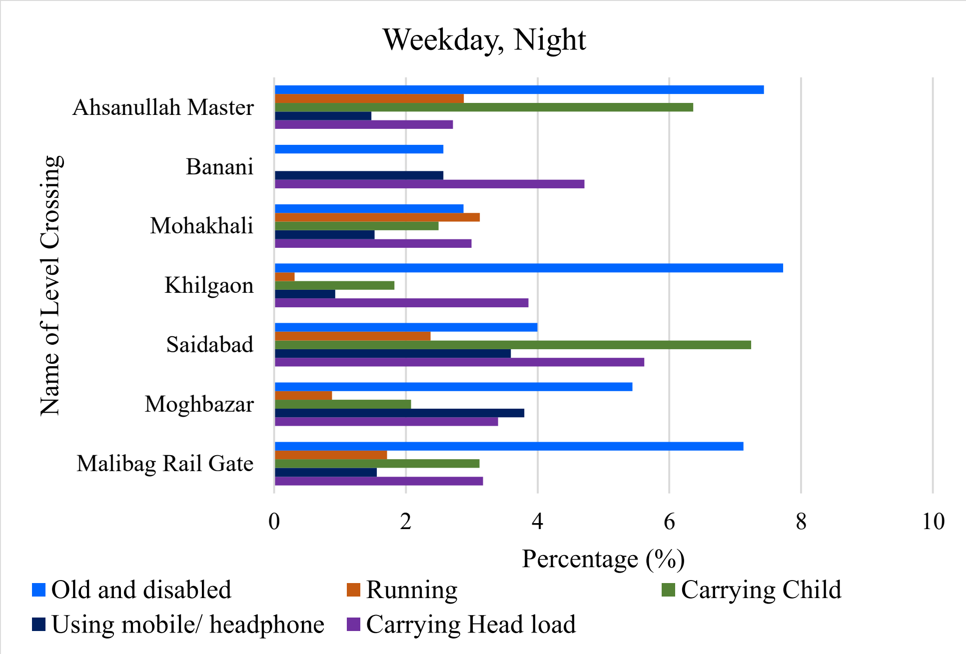


(b) Weekend, Night



(c) Weekday, Day

(Figure 4.26 continued)



(d) Weekday, Night

Figure 4.26: Relative Percentage of People under Excessive Risk

As discussed previously in Section 4.7, pedestrians remain one of the most neglected road users in Dhaka city. Pedestrian foot-overbridges were rarely seen, and even in the few places that had foot over-bridges, most people did not use them, opting instead to traverse at grade. Unrestrained pedestrian movement at level crossing exposes pedestrians to risk from both road and rail traffic. Thus flyovers have not been able to separate rail traffic from pedestrians. To address this problem, grade-separated overpasses can be built over level crossings along the alignment of footpath. This needs to be complemented with guard rails to prevent pedestrians from crossing at-grade. In many countries, if overpasses or underpasses are not feasible, an alternative option of using an active protection level crossing (sound, light and barriers) with funnel gates for pedestrians is used. This also requires finding the way to appropriately close the area around the level crossing so that pedestrians could not go around the protection systems. With respect to cost, this study recommends using overpasses. It is not feasible to use underpasses because roads have often been observed to be dug up to adjust utility lines.

4.11 Identification of Deficiencies of Existing Flyovers

Throughout this chapter, observations and analysis have been presented to highlight deficiencies of at-grade roads and the reasons behind such deficiencies. Many of these reasons can also be attributed to deficiencies of flyovers. Deficiencies of flyovers is presented as the last section, because throughout this chapter several deficiencies were discussed. Supporting data and evidence were provided throughout this chapter and as the situation arose. As a result, the discussed deficiencies are summarized in the following paragraphs. In addition, additional deficiencies are discussed.

It has been observed that private automobiles makes up a significant percentage of vehicles in many study areas. Construction of flyovers without restraining car movement has acted as a supply side policy to increase traffic, thus reducing mobility and increasing conflict and congestion in the long run. Increased dependence on private automobiles has also increased parking maneuver rate and decreased roadway capacity. Thus flow has increased while capacity has decreased, worsening the traffic conditions. In addition, unplanned construction without co-ordination with other projects has reduced potential for implementation of other projects. Figure 4.27 shows where existing flyovers come in conflict with future projects in Dhaka City.

In Figure 4.27, red lines indicate the 3 proposed BRT routes in STP (BRT 1, BRT 2 and BRT 3) while yellow lines indicate the 3 proposed MRT routes in STP (MRT 4, MRT 5, MRT 6). The blue lines indicate alignments of constructed flyovers, namely, Banani Overpass, Mohakhali Flyover, Khilgaon Flyover and Moghbazar-Mouchak Flyover. The conflict points are marked by orange circles and labelled as per the following:

A: Conflict of Banani Overpass with BRT 3 and MRT 4

B: Conflict of Mohakhali Flyover with BRT 3 and MRT 4

C: Conflict of Moghbazar-Mouchak Flyover with BRT 1 and BRT 4

D: Conflict of Khilgaon Flyover with MRT 4 route

E: Conflict of Moghbazar-Mouchak Flyover with BRT 1

F: Conflict of Moghbazar-Mouchak Flyover with BRT 3

G: Conflict of Moghbazar-Mouchak Flyover with MRT 4

H: Conflict of Moghbazar-Mouchak Flyover with MRT 5 and BRT 3

A total of 8 conflict points have thus been identified, which, unless adjusted and accommodated for, will nullify future transit development in Dhaka City. Moreover, BRT 3 line has been observed to be in conflict with a segment of Moghbazar-Mouchak Flyover and with the entire segment of Banani Overpass.

In addition, flyover ramps have been observed to meet at-grade roads. It indicates that, high-capacity flyover is being directly linked to low-capacity at-grade road, and nullifying benefits from the high capacity of flyovers.

Throughout the chapter, it has been emphasized that public transport has not benefited much from above-grade facilities of flyovers. This occurred because of lack of bus stops and connection for passengers between footpath and bus stops. In addition, NMVs cannot use above-grade facilities because it is difficult for them to physically climb grades. Since flyovers cannot solve the at-grade conflict with NMVs, it will not be able to solve the congestion problem too in Dhaka city.

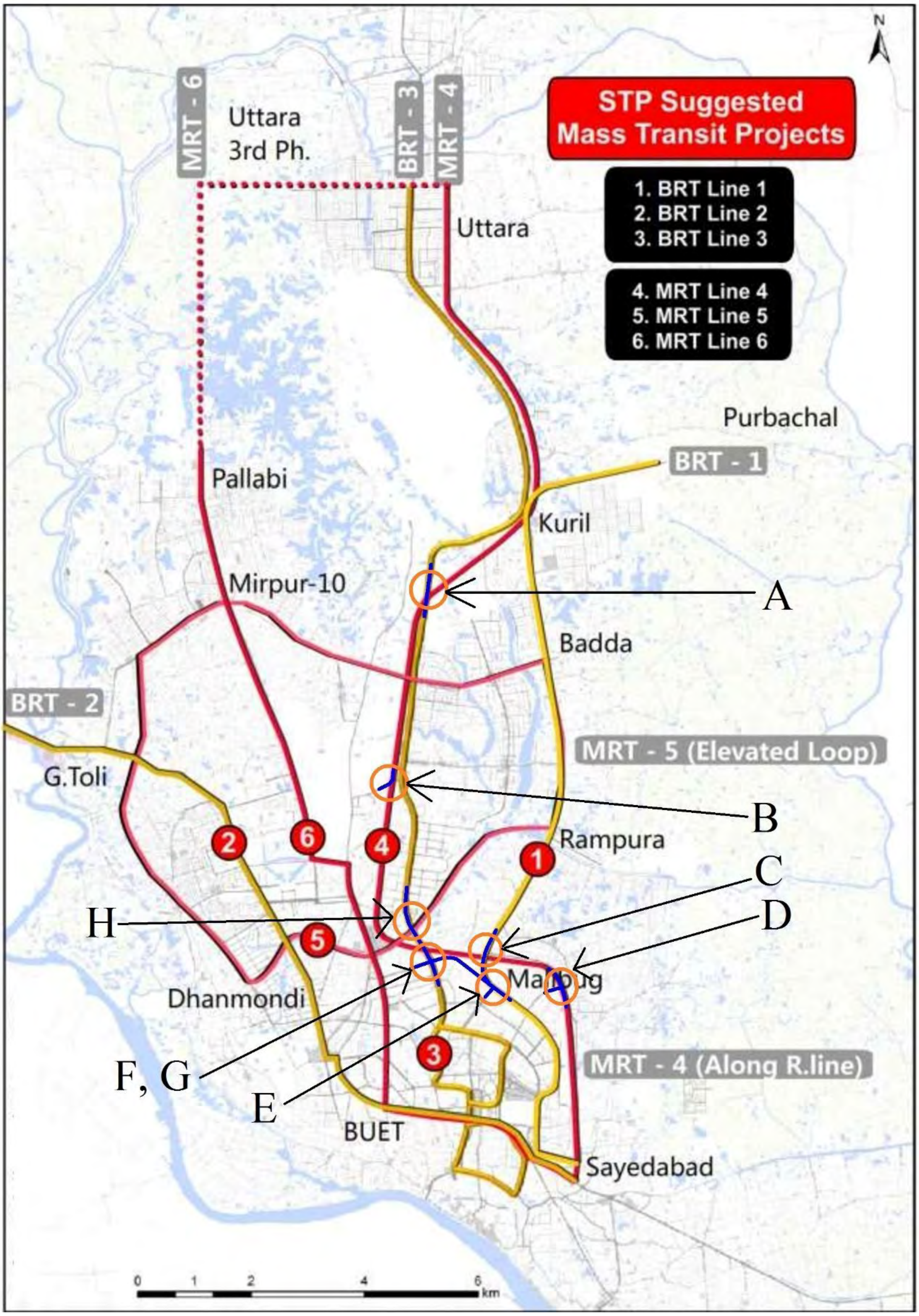


Figure 4.27: Conflict Points between Constructed Flyovers and Planned Projects

4.11.1 Specific deficiencies of major flyovers

Jatrabari-Gulistan Flyover (Mayor Mohammad Hanif Flyover) and Moghbazar-Mouchak Flyover are the two longest flyovers in Dhaka city, hence they are the two major flyovers in Dhaka city. The design authorities had to overcome numerous problems and constraints to design and construct these two flyovers. As a result, their designs were reviewed multiple times in by related experts before construction began. The consulted institutions include BUET, who gave its observations and subsequent recommendations to correct deficiencies. However, post-construction observations reveal that all deficiencies have not been addressed. Thus the flyover deficiencies that have been observed by BUET, but still have not been corrected and have been confirmed by author are presented in the following sections.

Jatrabari-Gulistan Flyover

BRTC (2008) identified deficiencies in proposed flyover design and suggested some recommendations. Even after following the recommendations, some deficiencies remain after construction. These are provided below [86].

1. Critical observations of the proposed layout configuration revealed that the flyover is planned giving minimum attention to the at-grade road users and most importantly layout is arranged in such a way that the motorists are forced to use the flyover even at off-peak period. The overall layout planning of the flyover shows that instead of being a true flyover it would merely be a road-overpass i.e. it will augment roadway capacity by deducting the capacity of existing at-grade road.

2. The flyover seriously affects the traffic movement pattern particularly at the Gulistan-end, Wari-link road and Park Road. Will disturb the existing well performing one-way operation within the road network of Rajdhani Supermarket – Wari – Tikatuli.

3. Traffic load distribution within the project adjoining road network has been imbalanced. This will seriously obstruct vehicular as well as pedestrian movements at grade.

4. Inbound traffic is forced to converge at Kaptan Bazar junction and thereby discharge of flyover users will be seriously interrupted initially by the presence of toll plaza at the exit point and then by the traffic signal

5. In order to achieve better performance, the flyover which is considered as a broadband roadway element, should meet with a compatible high capacity at-grade roadway facility like one-way road or access controlled two-way road and must be terminated far away from the junction for gradual dispersion of traffic load. However, post-construction observation reveals that the main flyover is terminated very near to the busy Kaptan Bazar intersection without any transition for gradual capacity drop and as such it will definitely make a short-circuit in the road network.

6. The high-capacity differential between flyover and at-grate road with closely spaced multiple junctions particularly at Gulistan end impairs the expected performance of the flyover.

7. Placement of nearly one km long ramps at Chittagong and Narayanganj Roads will obstruct at-grade road users (both vehicle and pedestrian movements) and virtually compartmentalize the road adjacent neighborhood.

8. In consideration of high pedestrian traffic flow throughout the proposed alignment, provision of 1.5m footpath is nowhere near to the requirement.

9. The proposed flyover has demolished the important and widely used foot over-bridge at Jatrabari intersection. The flyover would be a constraint for the development of future grade-separated pedestrian crossing facilities along this corridor.

Moghbazar-Mouchak Flyover

BUET (2014) have thoroughly assessed geometrical configuration Moghbazar-Mouchak Flyover. Their observations about the flyover are summarized in the following paragraphs, which has also been confirmed by author’s observations on field [104].

Configuration Issues:

1. Double decker flyover configuration has been created without any proper integration; virtually two levels are distinctively independent. Consequently exclusive right turning facility provided by the 2nd level deck at Malibag intersection can only be used by the traffic from Rampura road. Besides, the 2nd level descending ramp towards the Rajarbag-end was not warranted in consideration of low level traffic demand and most importantly this movement is left turning at Mouchak and straight at Malibag intersections.
2. The 2nd level ramp towards Eskaton-end was not warranted in consideration of low straight traffic flow volume.
3. Staggering of up-ramp and down-ramp at Eskaton-end and Tejgaon-end is made following a faulty layout configuration (shorter ramp is assigned for Up-ramp; whereas longer or milder ramp is provided for Down-ramp which should have been otherwise).
4. No dedicated right turning ramp is considered at any of the seven junctions it has crossed (other than a partial solution provided at Malibag intersection).
5. No apparent rational was found for providing relatively a long and dedicated flyover (partially 2nd level and nearly 1.5 km) only to accommodate Eskaton bound traffic. As a whole, it appeared that the flyover has not been configured matching with the dominating traffic stream as well as right turning movements, in particular considering the mass transit stream.
6. Mainly due to unplanned and haphazard road network as well as roadside abutting landuse development of Dhaka city, this flyover would not be able to provide full-grade separation facility at Moghbazar and Malibag Level Crossings and as such traffic safety problems would not be solved at these level crossings. On the other hand, the level crossing at FDC will remain untouched and apparently scope of future grade-separation provision would be lost forever due to presence of MMF ramp in close proximity. Resulting, as a whole the Railway operation would not be benefited much.
7. No integration with road network of Hatirjheel development has occurred (where existing Tongi diversion T-Junction has become cross Junction and a new left-merging type junction has created just before the Moghbazar level crossing.

Public Transport Issues:

1. Ramps placed along flyover corridor have reduced existing right-of-way significantly at various locations, including at Shantinagar, Rajarbag approaches. Carriageway width has become inconsistent while public transport has not benefited much.
2. No provision of bus stoppage along this 8.5 km long flyover, no signal-free facility along Shantinagar-Rampura Bus route and most importantly, there is no right turning facility at all along Moghbazar-Tejgaon Bus route.

Pedestrian Issues:

5.5 m headroom restriction has eliminated prospects of future grade-separated pedestrian crossing facilities as well as forced to demolish previously constructed ones.

4.12 Overview

This chapter has extensively presented the data required to fulfill the objectives of the study and thoroughly analyzed them to observe whether or not existing constructed flyovers have benefited the study area or not. Assessment of grade-wise space usage of road space under and over the flyover has shown that almost all the flyovers are segregating a large percentage of vehicles from at-grade to above-grade, yet, a significant portion of vehicles use at-grade roads and are forced to deal with at-grade conflicts and related complexities of congestion, accidents and reduced mobility. This has warranted a comprehensive analysis of the impact of flyovers both along the corridor and on the surrounding area. Assessment of at-grade roadway conditions around the flyover have revealed uncontrolled on-street parking, uncontrolled bus stoppages and unrestrained pedestrians as the main causes for obstruction of vehicle movement and capacity reduction in the study areas. This has reduced capacity to such low values as to not be able to accommodate the entire traffic demand.

As a result, flow-capacity ratio is significantly greater than one in urban street segments in all periods of measurement, as revealed in determination of LOS. This is supported by the assessment of congestion level in study areas, which revealed that both above-grade and at-grade congestion has increased over time. It essentially means that existing flyovers have failed to achieve their objectives of improving mobility, reducing congestion and minimizing conflicts in the flyover. The chapter concludes with a summary on observed deficiencies of existing flyovers and particularly highlights deficiencies of the two major flyovers, namely Jatrabari-Gulistan Flyover and Moghbazar-Mouchak Flyover.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 General

The major aim of this study is to assess the at-grade roadway condition along and around partially grade-separated flyovers in Dhaka city, and in the process evaluate how far flyovers have achieved their primary purpose of eliminating vehicle conflicts, accommodating traffic demand and increasing mobility. A range of extensive field data collected from six flyovers were analyzed using prescribed guidelines from transportation authority and with the help of Microsoft Excel. Google Map was used to illustrate the study area and clarify existing conditions in those areas. Based on these, the summary of critical findings of this study, conclusions and understanding of the factors evaluating the present at-grade road network around studied flyovers are presented in this chapter.

5.2 Conclusions

The crucial findings of this thesis are presented in the following sub-section:

1. Based on observation of grade-wise relative space usage, it can be said that Banani Overpass has the best performance among the six flyovers, followed by Jatrabari-Gulistan Flyover, Moghbazar-Mouchak Flyover, Mohakhali Flyover, Khilgaon Flyover, while Shaheed Ahsanullah Master Flyover has performed the worst.
2. Comparison with previous studies [101] have revealed that flyovers have been successful in diverting an increasing proportion of vehicles above grade. However, it is also observed that vehicle flow has increased in absolute terms both above grade and at grade. Thus it may not be possible to completely eliminate at grade flow.
3. At all studied flyovers, weekday flow was found to be greater than weekend flow. In particular, weekday, day was generally found to accommodate the greatest flow in most flyovers.

4. Considering average segment directional flow, Khilgaon Flyover and Banani Overpass were observed to have the highest and lowest traffic flows respectively.
5. Parking maneuver rate and bus stoppage rate were observed to be higher at weekday compared to weekend at all flyovers except Moghbazar-Mouchak Flyover.
6. Considering average segment directional parking maneuver rate, Shaheed Ahsanullah Master Flyover and Moghbazar-Mouchak Flyover had the highest and lowest parking maneuver rates respectively.
7. Considering average segment directional bus stoppage rate, Shaheed Ahsanullah Master Flyover and Khilgaon Flyover had the highest and lowest bus stoppage rates respectively.
8. Considering average segment directional saturation flow rates, Shaheed Ahsanullah Master Flyover had the highest flow rate, while Jatrabari-Gulistan Flyover had the lowest flow rate.
9. There was little temporal variation in saturation flow rates calculated at all flyovers and averaged over the four periods of measurement. This may imply that period of measurement does not affect saturation flow rate.
10. Night had higher saturation flow rate than day across all studied flyovers.
11. Travel speed is only slightly higher than average walking speed of 5 km/h across all flyovers and all periods of measurement. This indicates that low mobility is a serious problem prevalent at all times and across all flyovers.
12. It is alarming to note that LOS F has been found at all urban street segments at all study periods and across all considered flyovers. It indicates that flyovers have failed to improve mobility there.
13. At multilane highways, LOS varied from A to C, indicating that travelling is more comfortable in multilane highways compared to urban street segments.
14. Based on average congestion levels, Banani Overpass provided the best at-grade traffic conditions, while Jatrabari-Gulistan Flyover provided the worst conditions.
15. Traffic congestion level has generally increased across the flyovers over the years, while congestion has also developed above grade. It indicates that use of flyovers as a remedy to congestion in Dhaka city is not a justified solution.
16. Nearly one-fifths of pedestrians using level crossings are under excessive risk.

17. Pedestrian flow is higher at weekday compared to weekend, and at day compared to night. So, there is higher chance of collisions between pedestrians and traffic during day in absolute terms.

5.3 Recommendations

Target-oriented and research based sustainable programs considering condition of developing countries need to be followed to improve mobility of existing at-grade road network in Dhaka. The following measures are strongly recommended for implementation:

1. Pedestrians should be given the topmost priority in developing road networks. Footpath conditions need to be improved and must be provided at all at-grade roads. If required, the government needs to acquire land from owners of surrounding land and increase the right of way of existing roads.
2. It is difficult to acquire land from built-up areas. So, the government needs to give top priority in ensuring adequate right of way for existing roads. It is easier to acquire right of way in newly developing areas around Dhaka city, such as Uttara, Bashundhara, Khilkhet, Aftab Nagar, etc. The government and related transportation authorities need to constantly monitor those areas and ensure strict enforcement so that adequate right of way remains available in future to develop footpaths.
3. Zebra crossings need to be provided at all intersections and pedestrian signals need to be synced with motor vehicle signal to reduce intersection delay. If pedestrian volumes are very large, all-red signals may be required at certain intersections. Although all-red signals may increase intersection delay, this is addressed in later recommendations.
4. Picket rails need to be provided at footpath and medians to prevent pedestrians from crossing randomly at mid-block. Main crossings should occur at intersections as mentioned earlier. If there is high demand for pedestrians to cross mid-block at a particular segment, government needs to provide underpasses or overpasses with escalators. Enforcement is required to ensure pedestrians to not try to cross mid-block at grade. Studies have found that pedestrians tend to avoid grade separated facilities and often prefer to travel further upstream or downstream to cross road if given chance [105]. Therefore,

it is imperative from point of view safety for pedestrians (the most vulnerable road user group) and mobility of vehicles to ensure that medians be blocked at all places and grade-separated facilities be installed at mid-block only where critically warranted.

5. Pedestrian benches can be installed along footpath to provide rest for pedestrians while more trees can be planted along footpath to provide shade to pedestrians. However, this needs adequate right of way on footpath. Hence, it is preferable to implement this in the newly developing areas of Dhaka city as mentioned previously.
6. Safe bicycle lane needs to be ensured for people wishing to travel longer distances than is possible by just walking. However, this again needs adequate right of way on roadway. Hence, it is preferable to implement this in the newly developing areas of Dhaka city as mentioned previously.
7. Side friction has been observed to be a significant factor in reducing capacity of at-grade roads. On-street parking needs to be restricted. More off-street parking facilities need to be developed. Stricter parking enforcement is required.
8. Random and freestyle bus stoppage needs to be prohibited. Strict enforcement is required to ensure buses pick up and drop off passengers at only designated bus stops.
9. Where possible, bus bays need to be developed to ensure stopped buses do not interfere with moving traffic.
10. Construction of isolated flyovers need to be stopped. Flyovers should be constructed to ensure there is coordination among each other. Through vehicles should not be directed to at-grade primary roads. They should remain above grade as long as required. Vehicles wishing to reach at-grade roads should be directed via ramps connected to secondary or local roads. It is expected that all vehicles do not have the same destination, hence only few vehicles will use a particular ramp and the corresponding at-grade local road. So, local roads should be able to handle the traffic flow. Besides, it has already been mentioned that flyover ramps occupy a large part of at-grade roads and reduce their road width. This is a further reason for not connecting flyover ramps to primary at-grade roads.
11. The root cause of all problems identified throughout the thesis has been linked to excessive use of privately owned vehicles such as cars, jeep and microbus.

Construction of flyovers without restricted access to private vehicles will only encourage more people to buy cars, increasing congestion and decreasing mobility in the long run. Given the prevalent growth of private vehicles in Dhaka city, it is little wonder that congestion increases at-grade after an initial recovery, and even starts developing above grade as revealed in this study. This completely nullifies flyovers objectives make discredit their construction. Since flyovers are expensive structures, their construction costs need to be justified through a sustainable solution. Therefore there is a crying need to shift people from private vehicles to public transport system.

12. As mentioned in previous point, it is urgently required to shift people from private vehicles to public transport system. However, existing public transportation system do not have the characteristics to attract people from the private transportation system, because existing public transportation system lacks safety, reliability and good mobility. One of the reasons identified for these drawbacks is the current franchise system where buses are owned by many private individuals, leading to unhealthy competition among buses. It is seen that most buses operate at peak time, but remain idle at off-peak time, creating artificial shortage. Therefore, to make bus service safe, reliable and fast, it is imperative to abolish the current franchise system and bring the ownership under a single entity who will not capitalize on the monopoly of buses, but rather work to improve welfare of the general public. The government fits that description perfectly.
13. It is laudable that the Government of Bangladesh is trying to implement Bus Rapid Transit (BRT) into the country. However, current BRT 3 line is an isolated facility that serves only a particular segment of the population. There is always the option for people to use private vehicles if required. Hence government needs a good justification to implement this expensive structure, whose cost has already been nearly doubled to Tk 44.41 billion with respect to previous estimates [106]. In this regard, it is strongly advised to integrate BRT 3 route and future BRT routes with the rest of the constructed flyovers. Only buses should be allowed to travel above grade and they should never travel on at grade. This will ensure minimal conflicts among buses. Bus stops should be provided in the medians of flyovers above grade. Pedestrians will first travel from at-grade footpath to at-grade median using underpasses or overpasses, then

travel to above-grade bus stops via escalators or lifts. Lifts, although more expensive, are preferable as they leave a smaller footprint. People will wait on raised platforms whose height is aligned with floor of bus. Buses should not have steps at their doors. Removing steps will increase bus capacity as well as reduce dwelling time per bus stop by facilitating embarking and disembarking action of passengers. This will improve mobility and reliability of buses. On the other hand, private vehicles should be restricted to at-grade facilities, where they are expected to face higher congestion, longer delays and lower mobility. When general people start comparing this situation with the improved travel experience provided by buses, they will start shifting to buses. This is a sustainable solution because when demand for buses increase, more buses can be deployed at flyovers.

14. In the short run, taxes can be levied on road usage. License restrictions and increased taxes on car ownership will limit usage of privately owned vehicles. However, these moves may be politically unpopular, and hence should only be used to tackle growth of private vehicles in the short run. In the long run a safe, reliable and fast public transit system will be required.
15. Coordination among different government entities is essential to build a fully integrated above-grade road facility that can truly benefit people. As mentioned earlier, construction of flyovers require huge investments. Such costs have increased in the past because of poor planning and mismanagement among different entities. This coordination will also mitigate excessive instances of road cutting to lay or mend utility lines, which often extends to footpath and obstructs pedestrians. Reduced road cutting will improve capacity of both roads and footpaths and help pedestrians stay on footpath.
16. As population of Dhaka city is rising rapidly, number of road users will also increase in future. Therefore, it is high time to convert the road users from private vehicle users to public transit system users. In the very long run, if buses are unable to meet demand fully, Mass Rapid Transit (MRT) can also be introduced to address the demand.
17. With respect to previous recommendations, and putting emphasis on BRT, it is evident that future flyovers should be built along bus routes. In the short run, emphasis should be given to the most critical road segments, after conducting traffic impact assessment of the entire facility, not just the target flyover

corridor. Importance should be given to road segments based on LOS, flow-capacity ratio and travel speed. A detailed master plan will be required to identify when and where flyovers should be built so that they are integrated seamlessly with other traffic facilities such as foot overpasses, elevated expressways, etc. Instead of thinking as separate constructed facilities, the government should regard each construction as an extension of previously constructed flyover, which will ultimately connect with each other.

18. NMVs and para-transit vehicles to connect the remainder part of the journey after buses, i.e. from initial place to bus stop, and from bus stop to final destination.

5.4 Limitations of the Study

Because of time and economic constraints, several important aspects of the study could not be covered. If the following limitations of the study were overcome, the study could have been more comprehensive and concrete.

1. HCM (2010) recommends reporting LOS separately for each vehicle class. This means, travel speed needs to be determined separately for each vehicle class. However, in this study, travel speed of only cars was used, which was then used to calculate combined LOS for all motorized vehicles.
2. Pedestrian LOS was not calculated.
3. HCM (2010) has a specific section for calculating LOS for bicycles, but does not cover LOS determination of rickshaws. Since bicycles occupy a negligible portion of traffic and there were no dedicated bike paths along the study area, NMVs were omitted from LOS calculations.
4. The study covers only the study areas of partially grade-separated flyovers. To assess overall impact of flyovers, full grade-separated flyovers should also be considered.
5. Even though traffic demand exceeded capacity at many road segments during the study period, only a single 15-minute analysis window was chosen, instead of conducting multiple 15-minute analysis and finding LOS for multiple periods of analysis.

6. Vehicle-pedestrian interaction at road segments and intersections could not be fully modeled. A more comprehensive analysis is required to determine pedestrian bicycle adjustment factors.
7. Vehicle turning movement could not be fully realized. Although in this study, all turning movements were assumed to be protected, field observations reveal that turning movements were a mixture of protected and permitted movements of varying degrees.
8. As per HCM (2010) the default value of 1900 pc/h was used for base saturation flow rate at urban street segments. However, some research reveal that this value may overestimate or underestimate base saturation flow rates in local conditions [107], [108].
9. Secondary and local roads were not considered.
10. Congestion level was not measured at all intersections in the study area. It was only measured at level crossings.
11. Pedestrian flow was not measured in the study area. It was only measured at level crossings without differentiating between parallel and transverse walking behavior.

5.5 Recommendation for Future Studies

Based on the stated limitations of the research, the following could be the likely research topics for the future:

1. Comprehensive economic and financial studies to conduct post-construction cost-benefit analysis of flyovers and its adjacent study areas.
2. Separate determination of LOS of studied areas for different vehicle classes and pedestrians.
3. Development of LOS procedure for NMVs and subsequent evaluation of road segments through the developed method.
4. Impact assessment of both partially grade-separate and full grade-separated flyovers both along flyover corridor and in the adjacent area considering all types of roads: primary, secondary and tertiary.
5. Comprehensive analysis of pedestrian-vehicle interaction and vehicle turning movements and their incorporation in LOS calculations.

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APPENDIX A

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR ASSESSMENT OF GRADE-WISE SPACE USAGE IN STUDIED AREAS

Table A.1: 15-Minute Classified Traffic Count at Studied Flyover Corridors

(a) Shaheed Ahsanullah Master Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	32	0	60	21	73	7	17	12	841	23.83	0.31:1
	Under	311	3	6	12	7	45	0	31	7	2687	76.17	
Weekend, Night	Over	0	26	0	54	17	61	5	25	12	765	23.58	0.31:1
	Under	297	5	5	11	8	45	0	17	2	2475	76.42	
Weekday, Day	Over	0	36	0	60	29	141	14	57	39	1584	35.66	0.55:1
	Under	344	10	5	12	6	27	0	21	7	2858	64.34	
Weekday, Night	Over	0	12	0	22	13	87	8	22	19	769	44.33	0.80:1
	Under	70	15	10	23	59	16	0	15	4	966	55.67	

(b) Banani Overpass

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	49	0	463	178	0	90	46	6	3559	83.37	5.01:1
	Under	2	20	20	123	23	1	2	11	2	710	16.63	
Weekend, Night	Over	0	180	2	1351	558	0	98	50	15	8444	87.74	7.16:1
	Under	1	19	19	278	9	0	2	1	1	1179	12.26	
Weekday, Day	Over	0	73	0	1490	133	0	114	83	18	7814	82.97	4.87:1
	Under	4	39	25	339	23	0	3	6	5	1604	17.03	
Weekday, Night	Over	0	80	0	1355	263	1	80	120	84	8188	88.72	7.86:1
	Under	6	10	5	229	8	0	8	2	0	1041	11.28	

(c) Mohakhali Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	79	0	916	184	0	39	33	1	4660	74.08	2.86:1
	Under	2	35	17	213	56	55	28	9	5	1630	25.92	
Weekend, Night	Over	0	74	0	780	277	0	41	28	4	4439	69.69	2.30:1
	Under	3	47	20	187	112	74	40	15	4	1931	30.31	
Weekday, Day	Over	0	93	0	813	304	13	42	31	6	4767	67.74	2.10:1
	Under	8	69	8	329	85	62	24	22	4	2271	32.26	
Weekday, Night	Over	0	57	0	592	167	0	42	37	5	3452	59.46	1.47:1
	Under	9	49	27	375	63	72	26	17	0	2353	40.54	

(d) Khilgaon Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	424	1	589	366	1	196	23	3	6634	43.69	0.78:1
	Under	1091	27	51	51	14	18	4	6	1	8551	56.31	
Weekend, Night	Over	0	289	0	857	438	0	190	35	0	7387	59.61	1.48:1
	Under	622	31	18	26	40	36	0	1	0	5006	40.39	
Weekday, Day	Over	0	329	0	1719	254	0	358	69	2	12163	53.24	1.14:1
	Under	1376	37	33	42	33	32	2	4	2	10683	46.76	
Weekday, Night	Over	0	215	0	2253	238	0	353	58	5	13707	63.08	1.71:1
	Under	1015	46	54	23	37	40	0	8	0	8023	36.92	

(e) Jatrabari-Gulistan Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	341	0	485	222	59	175	54	0	5632	79.78	3.95:1
	Under	130	21	7	7	5	0	31	5	0	1428	20.22	
Weekend, Night	Over	2	327	2	556	504	213	181	84	27	7551	74.13	2.87:1
	Under	259	26	11	9	12	0	51	2	0	2635	25.87	
Weekday, Day	Over	0	359	0	268	67	66	479	120	0	8074	68.51	2.16:1
	Under	171	20	3	113	21	24	157	17	5	3710	31.49	
Weekday, Night	Over	0	479	0	391	150	185	528	181	0	10181	66.08	1.94:1
	Under	340	25	5	146	37	15	166	27	3	5227	33.92	

(f) Moghbazar-Mouchak Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	97	1	592	222	0	141	39	17	4949	63.16	1.71:1
	Under	107	69	0	301	106	7	23	25	13	2887	36.84	
Weekend, Night	Over	0	119	1	690	302	0	161	43	31	5981	79.45	3.87:1
	Under	81	19	1	133	30	8	25	4	1	1547	20.55	
Weekday, Day	Over	0	150	1	998	512	0	39	54	37	6539	70.42	2.38:1
	Under	131	30	2	369	49	3	15	8	0	2747	29.58	
Weekday, Night	Over	0	73	0	446	218	0	33	41	25	3236	64.87	1.85:1
	Under	108	20	1	171	32	9	12	7	0	1753	35.13	

APPENDIX B

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR ASSESSMENT OF TRAFFIC FLOW IN STUDIED AREAS

Shaheed Ahsanullah Master Flyover

Table B.1: Segment Directional Traffic Flow at SAMF

(a) Weekend, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	15	6	0	73	12	0	62	81	5	1466	53.24	1.14
	2-1	25	5	1	104	9	0	44	41	4	1288	46.76	
2-3	2-3	64	1	2	29	4	8	28	22	3	721	53.22	1.14
	3-2	59	2	2	46	12	17	23	34	2	633	46.78	
1-4	1-4	21	4	0	106	2	2	38	40	2	1156	50.08	1.00
	4-1	18	3	0	81	5	4	40	55	4	1152	49.92	
1-5	1-5	134	1	4	12	2	18	24	16	3	1453	53.34	1.14
	5-1	155	2	3	20	4	26	37	30	6	1271	46.66	
5-6	5-6	141	2	2	5	5	28	0	19	4	1417	52.52	1.11
	6-5	170	1	4	7	2	17	0	12	3	1281	47.48	
f	f1	28	2	3	55	8	3	37	35	3	1020	44.56	0.80
	f2	21	5	1	51	9	4	48	70	8	1270	55.44	
g	g1	69	1	3	38	4	7	17	12	5	973	48.24	0.93
	g2	50	2	3	34	8	21	21	38	8	1044	51.76	

(b) Weekend, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	24	8	1	91	8	0	22	22	1	892	53.38	1.15
	2-1	12	1	0	52	12	0	34	21	1	779	46.62	
2-3	2-3	57	2	2	35	9	12	17	8	1	844	45.62	0.84
	3-2	71	1	2	28	11	11	22	16	1	1006	54.38	

(Table B.1 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-4	1-4	15	4	0	86	3	2	26	12	1	794	47.39	0.90
	4-1	25	2	0	65	6	2	32	15	2	881	52.61	
1-5	1-5	102	4	3	14	3	12	28	7	2	1217	45.26	0.83
	5-1	128	2	3	9	5	27	31	12	1	1472	54.74	
5-6	5-6	153	3	2	4	3	18	0	5	1	1240	50.00	1.00
	6-5	144	2	3	7	5	27	0	12	1	1240	50.00	
f	f1	25	6	0	42	6	2	22	19	3	723	47.44	0.90
	f2	17	6	2	46	15	4	31	22	1	801	52.56	
g	g1	56	5	2	32	5	13	15	13	3	844	53.85	1.17
	g2	54	2	3	24	10	8	12	6	2	723	46.15	

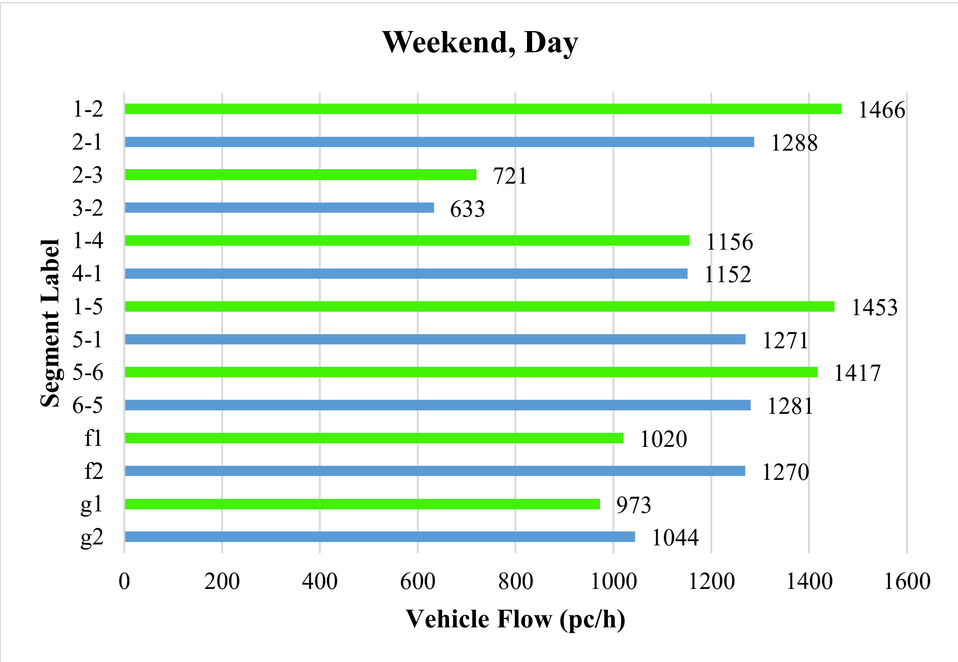
(c) Weekday, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	24	12	0	81	6	0	61	35	3	1360	52.04	1.09
	2-1	12	11	0	32	7	0	75	31	5	1253	47.96	
2-3	2-3	61	7	2	41	5	7	31	17	1	1072	46.98	0.89
	3-2	73	3	1	27	5	7	39	24	1	1210	53.02	
1-4	1-4	18	6	0	66	3	2	51	28	7	1149	50.24	1.01
	4-1	21	4	0	51	1	2	61	25	1	1138	49.76	
1-5	1-5	132	6	2	14	3	15	57	14	4	1818	49.34	0.97
	5-1	150	7	2	11	2	18	49	19	3	1867	50.66	
5-6	5-6	164	5	2	4	3	12	0	9	3	1347	47.12	0.89
	6-5	180	5	3	8	3	15	0	12	4	1512	52.88	
f	f1	21	9	0	42	5	1	55	32	5	1131	47.65	0.91
	f2	17	8	1	71	6	2	61	28	3	1242	52.35	
g	g1	71	7	2	22	5	7	21	15	8	1035	45.45	0.99
	g2	58	7	2	38	4	7	29	12	6	1051	50.37	

(Table B.1 continued)

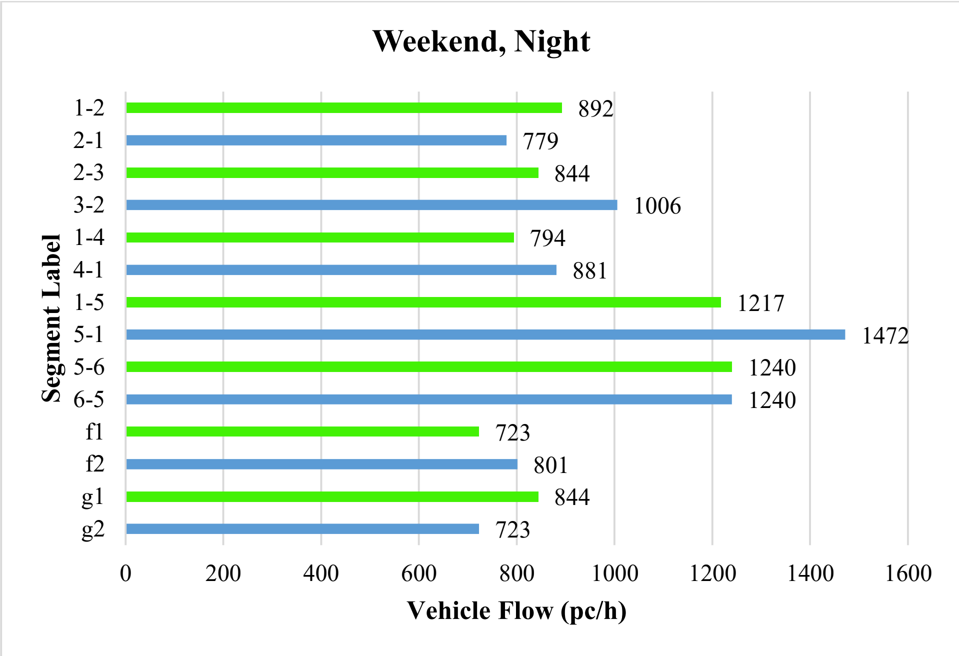
(d) Weekday, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	24	12	0	81	6	0	61	35	3	1360	52.04	1.09
	2-1	12	11	0	32	7	0	75	31	5	1253	47.96	
2-3	2-3	61	7	2	41	5	7	31	17	1	1072	46.98	0.89
	3-2	73	3	1	27	5	7	39	24	1	1210	53.02	
1-4	1-4	18	6	0	66	3	2	51	28	7	1149	50.24	1.01
	4-1	21	4	0	51	1	2	61	25	1	1138	49.76	
1-5	1-5	132	6	2	14	3	15	57	14	4	1818	49.34	0.97
	5-1	150	7	2	11	2	18	49	19	3	1867	50.66	
5-6	5-6	164	5	2	4	3	12	0	9	3	1347	47.12	0.89
	6-5	180	5	3	8	3	15	0	12	4	1512	52.88	
f	f1	21	9	0	42	5	1	55	32	5	1131	47.65	0.91
	f2	17	8	1	71	6	2	61	28	3	1242	52.35	
g	g1	71	7	2	22	5	7	21	15	8	1035	45.45	0.99
	g2	58	7	2	38	4	7	29	12	6	1051	50.37	

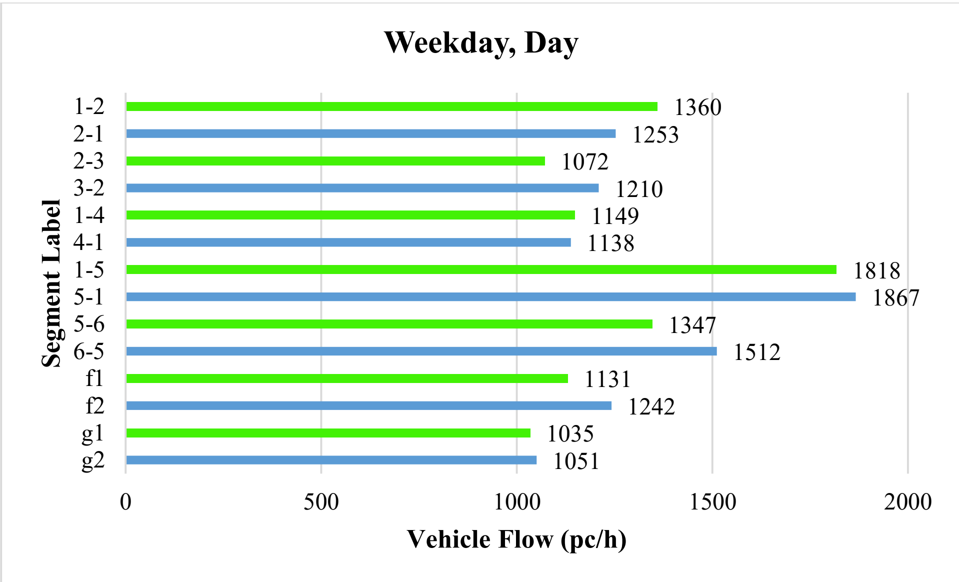


(a) Weekend, Day

(Figure B.1 continued)

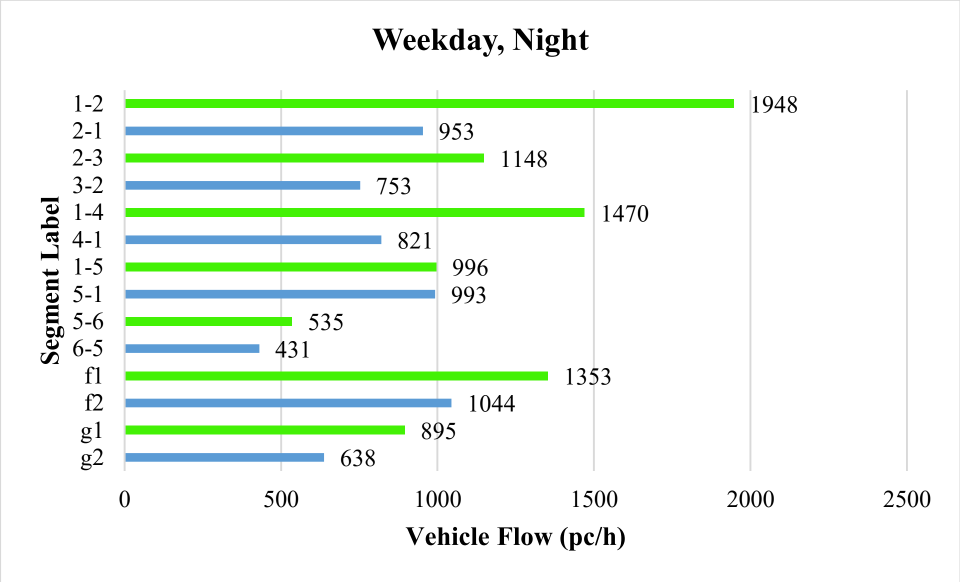


(b) Weekend, Night

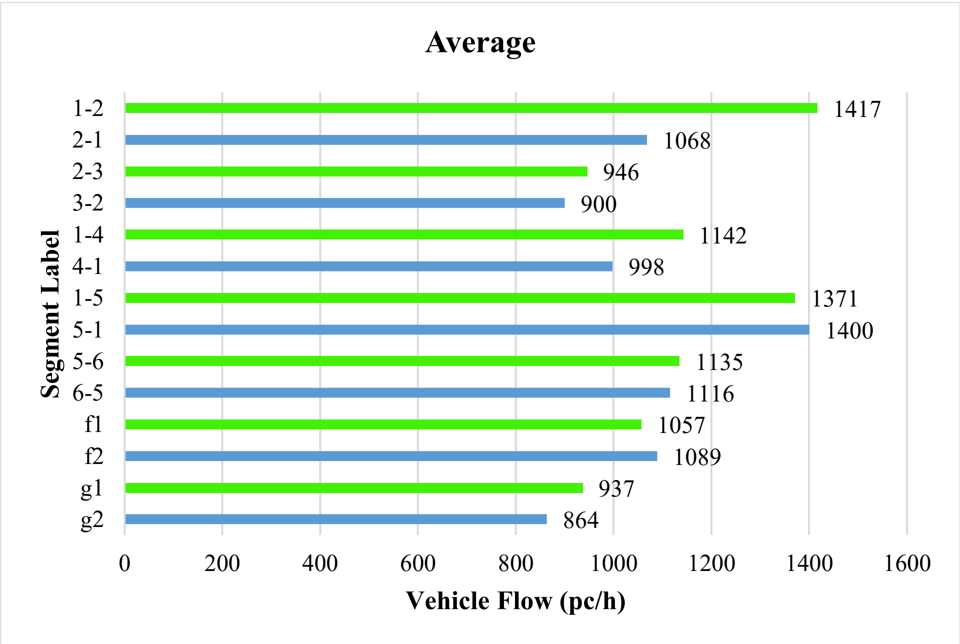


(c) Weekday, Day

(Figure B.1 continued)



(d) Weekday, Night



(e) Average

Figure B.1: Segment Directional Flow Variation at SAMF

Banani Overpass

Table B.2: Segment Directional Traffic Flow at Banani Overpass

Time Period	Segment	Segment Label	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Ratio of Vehicles Passing over to those
Weekend, Day	a	a1	1	13	6	55	11	1	2	7	1	349	49.09	0.96
		a2	1	7	14	68	12	0	0	4	1	362	50.91	
Weekend, Night	a	a1	1	6	8	138	5	0	0	1	1	575	48.75	0.95
		a2	0	13	11	140	4	0	2	0	0	604	51.25	
Weekday, Day	a	a1	2	27	8	206	15	0	2	2	3	966	60.21	1.51
		a2	2	12	17	133	8	0	1	4	2	638	39.79	
Weekday, Night	a	a1	2	6	3	119	5	0	4	0	0	533	51.15	1.05
		a2	4	4	2	110	3	0	4	2	0	509	48.85	

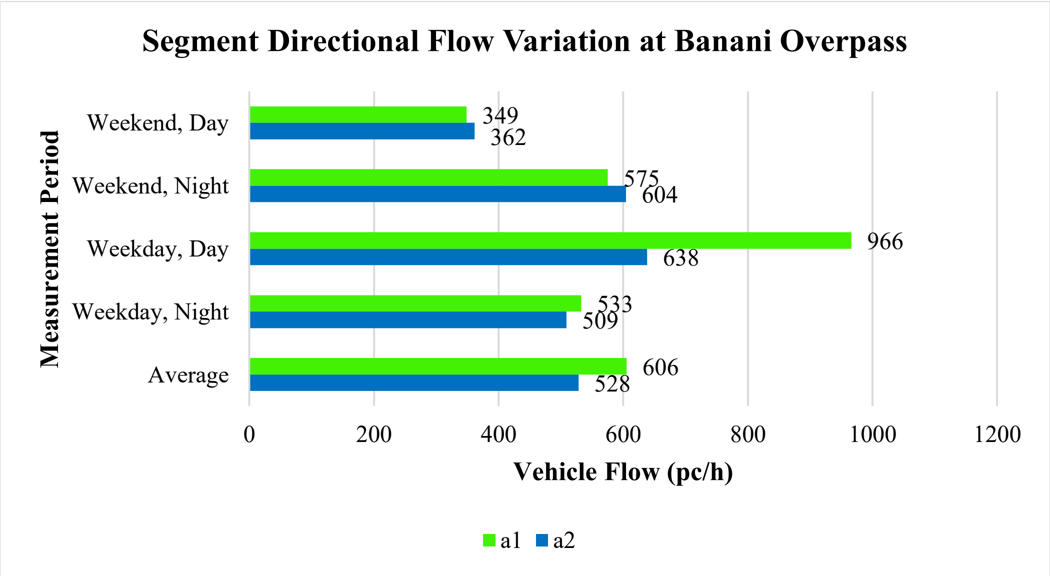


Figure B.2: Segment Directional Flow Variation at Banani Overpass

Mohakhali Flyover

Table B.3: Segment Directional Traffic Flow at Mohakhali Flyover

(a) Weekend, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	0	7	6	102	13	15	50	4	12	1182	51.75	1.07
	2-1	0	2	18	80	7	13	42	14	18	1102	48.25	
2-3	2-3	0	5	3	122	4	12	43	9	8	1109	51.83	1.08
	3-2	0	6	3	122	7	9	31	5	14	1030	48.17	
3-4	3-4	4	9	4	108	11	7	18	5	4	770	51.41	1.06
	4-3	2	4	3	107	20	3	14	14	3	728	48.59	
4-5	4-5	0	18	8	113	26	26	12	4	2	793	49.09	0.96
	5-4	0	17	9	100	30	29	16	5	3	822	50.91	
5-6	5-6	0	11	2	191	8	11	15	3	0	966	46.54	0.87
	6-5	0	7	0	152	16	3	40	10	0	1110	53.46	
6-1	6-1	0	11	5	129	13	11	2	6	6	691	51.44	1.06
	1-6	0	7	6	112	16	12	1	9	8	652	48.56	
4-7	4-7	0	7	3	95	10	4	13	6	3	612	44.10	0.79
	7-4	0	5	3	116	23	3	15	16	3	776	55.90	
7-8	7-8	5	10	5	120	13	11	34	6	5	1034	47.03	0.89
	8-7	6	7	6	112	17	10	43	11	8	1165	52.97	
7-11	7-11	0	7	5	95	4	9	15	3	0	591	52.58	1.11
	11-7	0	7	0	75	15	3	16	3	0	533	47.42	
8-9	8-9	3	7	0	117	17	25	61	6	2	1305	50.61	1.02
	9-8	1	5	3	118	27	17	56	11	3	1274	49.39	
8-13	8-13	2	7	5	112	8	8	0	2	0	507	51.21	1.05
	13-8	2	9	0	93	15	11	0	8	0	483	48.79	
9-10	9-10	0	7	5	107	6	9	8	2	0	559	52.37	1.10
	10-9	0	9	0	85	15	7	8	6	0	509	47.63	
10-11	10-11	0	17	2	133	8	0	13	5	0	724	52.26	1.09
	11-10	0	11	0	113	14	0	13	9	0	661	47.74	
11-12	11-12	0	12	0	107	12	0	18	4	0	673	51.26	1.05
	12-11	0	12	0	114	16	0	10	9	0	640	48.74	

(Table B.3 continued)

(b) Weekend, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	0	8	7	87	25	18	95	7	12	1681	60.12	1.51
	2-1	0	3	20	73	14	19	45	22	12	1115	39.88	
2-3	2-3	0	6	4	104	7	15	82	15	8	1516	60.04	1.50
	3-2	0	9	3	111	15	13	33	8	9	1009	39.96	
3-4	3-4	5	11	5	92	21	9	35	8	4	958	54.50	1.20
	4-3	3	6	3	97	43	4	15	22	2	799	45.50	
4-5	4-5	2	22	10	96	49	32	23	7	2	972	50.36	1.01
	5-4	1	25	10	91	63	42	17	8	2	959	49.64	
5-6	5-6	0	14	2	162	15	14	29	6	0	1061	47.59	0.91
	6-5	0	11	0	138	34	5	42	16	0	1168	52.41	
6-1	6-1	0	13	6	110	24	14	3	10	6	693	50.44	1.02
	1-6	0	11	7	102	34	17	1	15	5	681	49.56	
4-7	4-7	0	9	4	81	19	5	25	11	3	746	46.77	0.88
	7-4	0	7	3	106	48	4	16	25	2	849	53.23	
7-8	7-8	2	12	6	102	25	14	65	10	5	1351	52.94	1.12
	8-7	3	10	7	102	36	14	46	17	5	1202	47.06	
7-11	7-11	0	9	6	81	7	11	28	6	0	715	55.07	1.23
	11-7	0	11	0	68	31	4	17	5	0	583	44.93	
8-9	8-9	4	8	0	99	32	31	117	11	2	1944	58.07	1.38
	9-8	3	7	3	107	56	25	59	18	2	1404	41.93	
8-13	8-13	2	9	6	95	15	10	0	3	0	480	47.20	0.89
	13-8	2	13	0	85	31	16	0	12	0	537	52.80	
9-10	9-10	0	9	6	91	12	11	15	4	0	615	52.11	1.09
	10-9	0	13	0	77	31	10	9	9	0	565	47.89	
10-11	10-11	0	21	2	113	15	0	25	9	0	828	53.86	1.17
	11-10	0	16	0	103	29	0	14	14	0	709	46.14	
11-12	11-12	0	15	0	91	22	0	35	7	0	849	54.94	1.22
	12-11	0	17	0	104	34	0	11	14	0	696	45.06	

(Table B.3 continued)

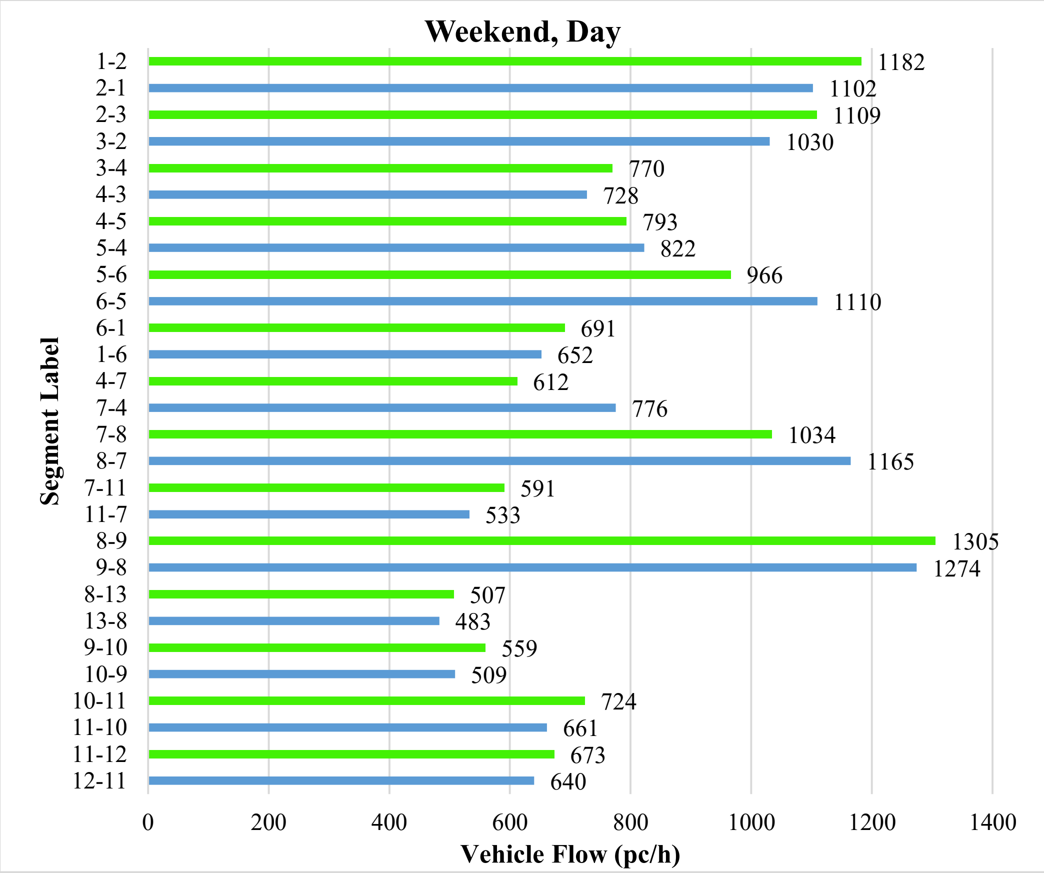
(c) Weekday, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	0	11	4	150	24	15	37	15	17	2009	53.01	1.13
	2-1	0	4	6	128	8	16	40	28	12	1781	46.99	
2-3	2-3	0	8	2	184	7	12	32	24	6	2024	49.82	0.99
	3-2	0	13	1	195	9	11	29	10	9	2039	50.18	
3-4	3-4	0	15	2	165	20	7	12	20	3	1796	49.29	0.97
	4-3	0	9	1	170	25	3	13	28	2	1847	50.71	
4-5	4-5	3	31	5	169	48	27	9	12	2	2252	50.08	1.00
	5-4	5	38	3	160	37	35	15	10	2	2245	49.92	
5-6	5-6	0	19	2	285	15	12	11	13	0	2628	51.29	1.05
	6-5	0	16	0	242	20	4	37	20	0	2495	48.71	
6-1	6-1	0	17	3	191	23	15	1	17	6	2009	51.61	1.07
	1-6	0	16	2	179	20	14	1	19	5	1884	48.39	
4-7	4-7	0	14	2	149	18	6	11	18	3	1627	44.47	0.80
	7-4	0	10	1	187	28	3	14	31	2	2031	55.53	
7-8	7-8	0	16	3	185	22	13	26	17	5	2112	49.14	0.97
	8-7	0	15	2	180	21	12	41	21	5	2186	50.86	
7-11	7-11	2	12	3	151	7	9	12	9	0	1509	52.97	1.13
	11-7	3	17	0	120	18	3	15	6	0	1340	47.03	
8-9	8-9	0	12	0	174	31	25	48	18	2	2282	48.36	0.94
	9-8	0	11	1	189	33	21	52	22	2	2436	51.64	
8-13	8-13	15	13	3	168	15	8	0	5	0	1671	48.82	0.95
	13-8	22	20	0	150	18	13	0	15	0	1752	51.18	
9-10	9-10	2	13	3	160	11	9	6	7	0	1553	51.21	1.05
	10-9	2	19	0	135	18	8	8	11	0	1479	48.79	
10-11	10-11	0	32	1	212	14	0	8	14	0	2068	52.72	1.12
	11-10	0	24	0	181	17	0	12	18	0	1855	47.28	
11-12	11-12	0	20	0	174	21	0	15	12	0	1781	48.59	0.95
	12-11	0	26	0	183	20	0	10	17	0	1884	51.41	

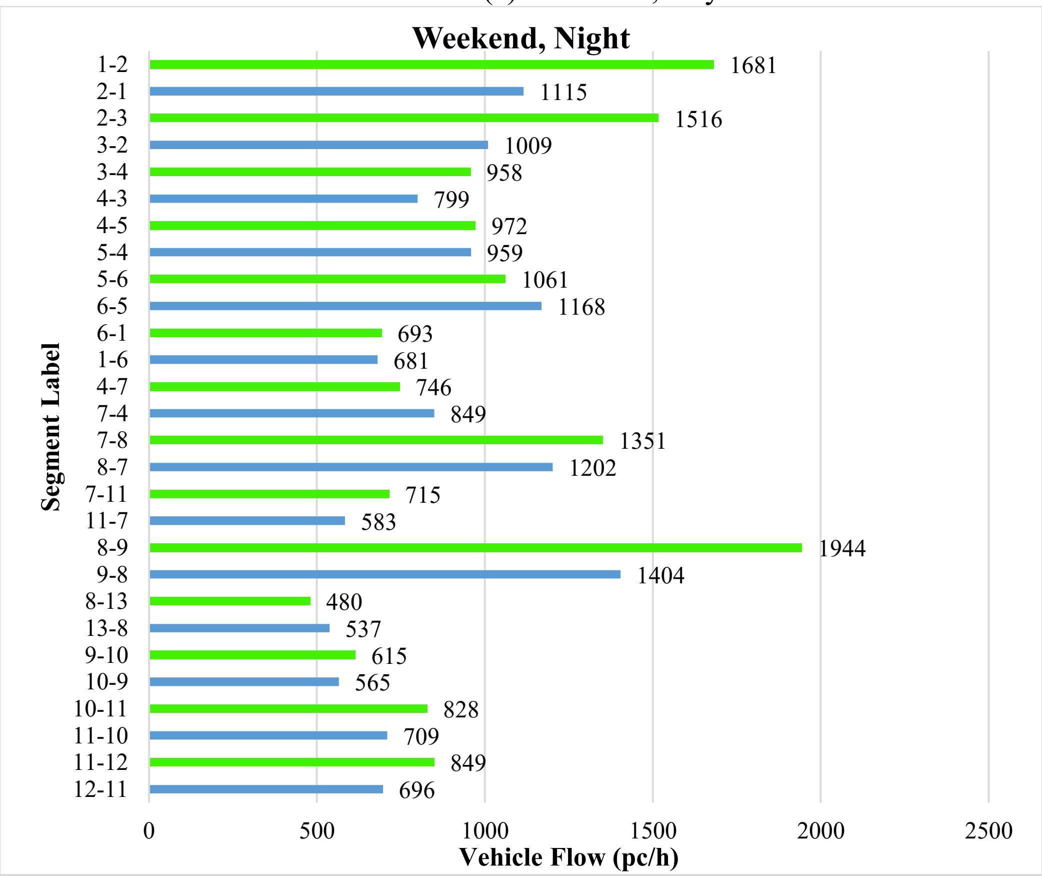
(Table B.3 continued)

(d) Weekday, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	0	10	10	192	17	16	41	9	0	1329	53.28	1.14
	2-1	0	2	26	128	7	20	43	25	0	1166	46.72	
2-3	2-3	0	7	6	234	5	13	36	16	0	1397	54.33	1.19
	3-2	0	7	4	195	7	13	31	9	0	1175	45.67	
3-4	3-4	4	14	7	209	14	8	15	12	0	1121	53.30	1.14
	4-3	3	5	4	170	20	4	14	25	0	982	46.70	
4-5	4-5	4	28	14	215	33	29	10	8	0	1235	52.46	1.10
	5-4	5	21	13	160	30	43	16	9	0	1119	47.54	
5-6	5-6	0	17	4	363	10	13	13	8	0	1627	52.34	1.10
	6-5	0	9	0	242	16	5	40	18	0	1481	47.66	
6-1	6-1	0	16	8	244	16	14	1	11	0	1091	55.79	1.26
	1-6	0	9	9	179	16	17	1	17	0	865	44.21	
4-7	4-7	0	12	6	187	13	5	11	12	0	948	47.31	0.90
	7-4	0	6	4	187	23	4	15	28	0	1055	52.69	
7-8	7-8	2	15	8	233	16	13	28	11	0	1358	49.83	0.99
	8-7	3	8	9	180	17	15	44	19	0	1367	50.17	
7-11	7-11	2	11	8	188	5	10	13	6	0	959	56.45	1.30
	11-7	3	9	0	120	15	4	16	6	0	740	43.55	
8-9	8-9	3	11	0	221	21	28	52	12	0	1619	50.62	1.03
	9-8	3	6	4	189	27	26	56	20	0	1580	49.38	
8-13	8-13	14	12	8	213	10	9	0	3	0	998	53.53	1.15
	13-8	20	11	0	150	15	16	0	14	0	867	46.47	
9-10	9-10	2	12	8	204	8	10	7	5	0	959	56.20	1.28
	10-9	2	11	0	135	15	10	9	10	0	747	43.80	
10-11	10-11	0	28	3	264	10	0	10	10	0	1229	56.59	1.30
	11-10	0	13	0	181	14	0	13	16	0	943	43.41	
11-12	11-12	0	18	0	215	15	0	16	8	0	1088	53.75	1.16
	12-11	0	14	0	183	16	0	11	16	0	937	46.25	

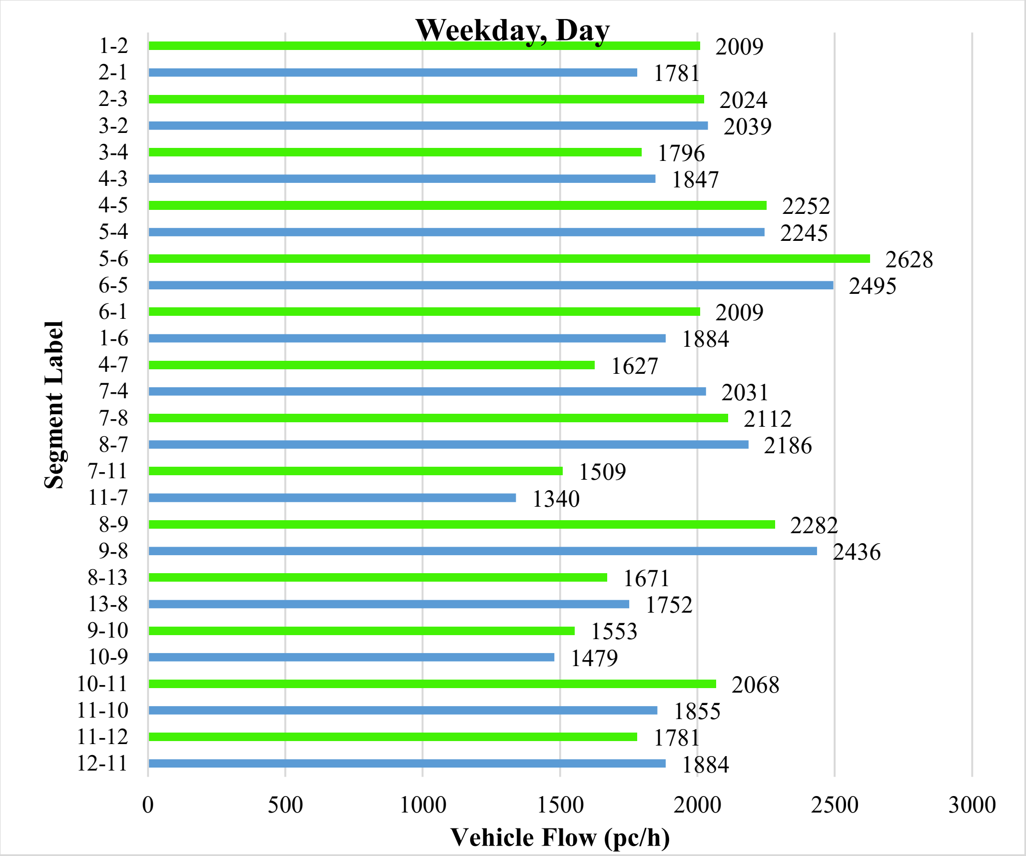


(a) Weekend, Day

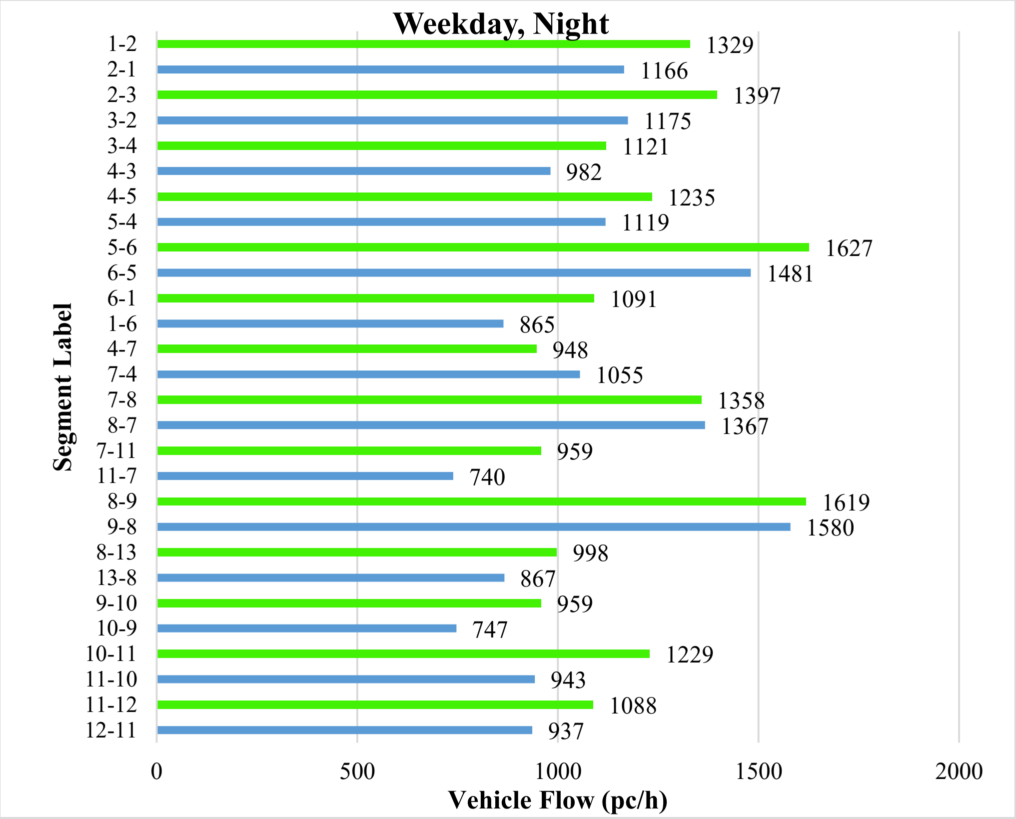


(b) Weekend, Night

(Figure B.3 continued)

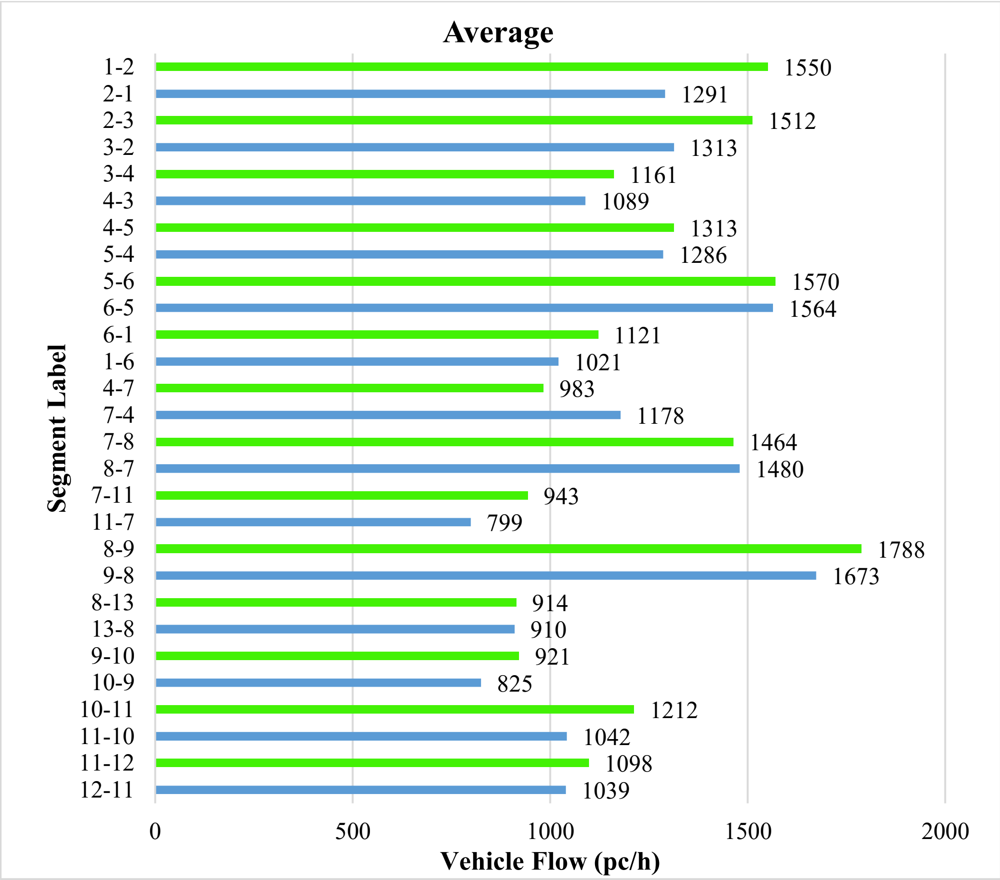


(c) Weekday, Day



(d) Weekday, Night

(Table B.3 continued)



(e) Average

Figure B.3: Segment Directional Flow Variation at Mohahali Flyover

Khilgaon Flyover

Table B.4: Segment Directional Traffic Flow at Khilgaon Flyover

(a) Weekend, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	491	22	22	61	4	11	1	6	0	4014	51.49	1.06
	2-1	470	26	17	37	8	5	2	7	0	3782	48.51	
2-3	2-3	319	22	19	46	8	14	1	13	0	2732	45.70	0.84
	3-2	382	60	40	31	4	7	1	11	0	3247	54.30	
3-4	3-4	421	30	36	37	8	9	0	5	0	3449	52.16	1.09
	4-3	379	53	21	28	6	9	0	12	0	3163	47.84	
4-5	4-5	335	9	19	22	6	9	0	7	0	2674	48.25	0.93
	5-4	352	43	12	18	8	12	0	4	0	2868	51.75	
5-6	5-6	254	38	24	71	8	6	6	3	0	2396	42.38	0.74
	6-5	330	87	22	68	6	14	21	3	0	3258	57.62	
6-7	6-7	433	17	21	79	7	8	6	4	0	3686	49.03	0.96
	7-6	386	102	19	87	6	14	25	6	0	3831	50.97	
7-8	7-8	429	25	25	91	6	6	5	11	0	3736	54.52	1.20
	8-7	333	31	26	85	7	15	9	16	0	3116	45.48	
8-9	8-9	338	13	15	93	8	8	9	16	0	3096	44.10	0.79
	9-8	426	48	25	68	11	14	8	55	0	3924	55.90	
9-10	9-10	374	15	78	105	10	7	28	19	0	3750	57.10	1.33
	10-9	279	49	33	84	9	10	12	20	0	2817	42.90	
10-11	10-11	261	15	22	116	7	5	6	8	0	2559	53.16	1.14
	11-10	192	48	21	84	8	12	21	20	0	2254	46.84	
11-12	11-12	257	8	14	135	8	7	3	9	0	2544	49.90	1.00
	12-11	246	20	33	124	12	14	2	21	0	2554	50.10	
12-1	12-1	321	8	41	49	9	7	5	6	0	2762	44.85	0.81
	1-12	386	27	17	65	8	12	12	6	0	3396	55.15	
1-8	1-8	551	13	25	31	8	8	2	3	1	4340	50.75	1.03
	8-1	540	14	26	20	6	10	2	3	0	4212	49.25	
11-13	11-13	268	38	11	36	8	9	8	4	0	2380	44.35	0.80
	13-11	326	66	15	14	11	11	16	24	0	2986	55.65	
13-14	13-14	71	34	13	24	5	2	0	5	0	766	46.10	0.86
	14-13	84	47	8	19	6	5	0	9	0	896	53.90	
14-15	14-15	180	21	12	21	4	3	0	4	0	1516	45.99	0.85
	15-14	211	31	6	11	4	6	0	17	0	1780	54.01	

(Table B.4 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
15-16	15-16	200	14	12	12	5	2	0	3	0	1607	54.27	1.19
	16-15	151	48	5	6	6	4	0	14	0	1354	45.73	
16-17	16-17	168	16	10	8	3	4	0	5	0	1366	50.41	1.02
	17-16	157	36	4	9	4	3	0	8	0	1344	49.59	
17-18	17-18	92	12	7	7	4	2	0	3	0	776	47.34	0.90
	18-17	91	38	6	6	3	4	0	10	0	864	52.66	
18-2	18-2	107	14	9	4	5	2	0	6	0	899	45.53	0.84
	2-18	112	16	8	14	8	7	0	27	0	1075	54.47	
18-3	18-3	124	10	9	23	4	3	0	6	0	1083	50.34	1.01
	3-18	121	17	7	16	3	5	0	10	0	1068	49.66	

(b) Weekend, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	270	35	4	26	17	12	0	4	0	2282	48.48	0.94
	2-1	281	44	6	32	18	18	0	2	0	2425	51.52	
2-3	2-3	230	28	12	25	26	16	0	3	0	2011	43.78	0.78
	3-2	288	64	8	44	9	24	0	5	0	2582	56.22	
3-4	3-4	218	23	14	23	22	15	0	3	0	1892	47.05	0.89
	4-3	229	78	11	33	14	16	0	1	0	2129	52.95	
4-5	4-5	209	8	21	18	16	13	0	4	0	1760	51.05	1.04
	5-4	191	35	11	15	22	15	0	2	0	1687	48.95	
5-6	5-6	140	29	23	33	18	13	7	6	0	1459	41.19	0.70
	6-5	196	130	7	26	14	22	6	2	0	2083	58.81	
6-7	6-7	229	13	17	35	21	21	9	4	2	2133	44.57	0.80
	7-6	236	198	7	41	14	22	7	5	1	2653	55.43	

(Table B.4 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
7-8	7-8	234	17	16	39	18	16	7	1	0	2117	46.94	0.88
	8-7	251	47	7	51	17	25	8	3	0	2393	53.06	
8-9	8-9	184	24	5	40	26	19	12	5	2	1874	46.94	0.88
	9-8	190	72	8	53	25	24	15	3	0	2119	53.06	
9-10	9-10	205	12	24	44	32	17	12	2	0	2023	54.30	1.19
	10-9	160	34	9	55	24	17	7	6	0	1703	45.70	
10-11	10-11	115	15	16	47	21	12	7	3	0	1270	42.75	0.75
	11-10	151	44	11	63	22	20	9	0	0	1700	57.25	
11-12	11-12	153	35	9	45	26	18	2	3	0	1559	50.03	1.00
	12-11	158	33	8	29	34	24	1	0	1	1558	49.97	
12-1	12-1	187	35	22	28	30	16	0	2	0	1751	48.17	0.93
	1-12	212	39	5	22	22	21	0	2	0	1884	51.83	
1-8	1-8	300	10	9	10	25	19	0	1	0	2414	48.23	0.93
	8-1	322	21	9	16	15	17	0	0	0	2592	51.77	
11-13	11-13	93	13	21	4	20	13	0	2	0	872	35.41	0.55
	13-11	182	32	13	7	13	28	0	0	0	1591	64.59	
13-14	13-14	140	18	8	7	14	5	0	1	0	1177	54.40	1.19
	14-13	110	31	5	5	15	8	0	0	0	986	45.60	
14-15	14-15	98	25	5	7	11	7	0	2	0	882	45.56	0.84
	15-14	126	16	3	6	9	11	0	0	0	1054	54.44	
15-16	15-16	109	36	5	5	14	5	0	1	0	985	53.55	1.15
	16-15	87	43	3	8	15	7	0	0	0	855	46.45	
16-17	16-17	87	41	4	7	7	8	0	1	0	832	48.29	0.93
	17-16	95	45	3	7	7	6	0	0	0	891	51.71	
17-18	17-18	51	44	2	7	10	3	0	1	0	566	49.24	0.97
	18-17	52	48	3	5	9	7	0	0	0	583	50.76	
18-2	18-2	57	25	3	9	12	6	0	2	0	584	42.67	0.74
	2-18	79	35	4	9	12	12	0	0	0	785	57.33	
18-3	18-3	80	17	7	7	13	7	0	2	0	737	54.01	1.17
	3-18	58	44	6	5	9	9	0	0	0	627	45.99	

(Table B.4 continued)

(c) Weekday, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	613	54	15	32	13	11	1	1	0	4887	50.53	1.02
	2-1	602	26	16	38	16	14	1	5	0	4784	49.47	
2-3	2-3	522	44	18	31	21	16	1	2	0	4231	46.02	0.85
	3-2	617	36	26	44	8	18	1	8	0	4962	53.98	
3-4	3-4	524	62	24	26	17	15	0	2	0	4263	53.17	1.14
	4-3	468	38	10	29	12	12	0	4	0	3755	46.83	
4-5	4-5	437	16	11	16	13	13	0	7	0	3437	48.87	0.96
	5-4	449	24	27	19	19	11	0	6	0	3595	51.13	
5-6	5-6	318	78	23	47	14	13	8	3	0	2945	44.45	0.80
	6-5	421	62	16	51	12	17	10	1	0	3681	55.55	
6-7	6-7	539	34	18	53	17	21	8	4	0	4497	51.39	1.06
	7-6	492	66	17	54	12	17	12	2	0	4253	48.61	
7-8	7-8	534	45	16	61	14	16	6	11	0	4498	51.40	1.22
	8-7	426	22	23	66	15	19	8	5	0	3682	45.01	
8-9	8-9	421	27	4	63	21	19	13	16	0	3725	50.29	0.79
	9-8	539	34	22	69	22	18	14	18	0	4686	55.71	
9-10	9-10	471	31	24	71	25	17	11	19	0	4165	47.05	1.33
	10-9	344	35	21	72	21	13	6	8	0	3122	42.84	
10-11	10-11	347	29	26	78	17	12	8	8	0	3167	50.36	1.27
	11-10	247	34	29	82	19	15	10	7	0	2497	44.09	
11-12	11-12	345	16	23	112	21	18	2	9	0	3201	56.18	1.02
	12-11	328	14	21	131	29	18	1	7	0	3140	49.52	
12-1	12-1	429	16	10	33	24	16	9	6	0	3573	53.23	0.92
	1-12	455	19	15	68	18	15	8	2	0	3866	51.97	
1-8	1-8	686	27	9	21	20	19	3	3	1	5380	58.19	1.01
	8-1	690	10	24	21	13	13	1	1	1	5325	49.74	
11-13	11-13	322	33	22	24	16	13	11	4	0	2806	34.51	0.84
	13-11	391	47	27	12	28	22	8	8	0	3357	54.47	
13-14	13-14	214	19	8	17	11	4	0	2	0	1754	34.31	0.88
	14-13	237	34	9	19	12	6	0	3	0	1985	53.10	
14-15	14-15	223	41	5	13	9	7	0	4	0	1870	48.51	0.86
	15-14	269	22	7	14	8	8	0	6	0	2171	53.72	
15-16	15-16	249	27	5	25	11	4	0	2	0	2057	48.65	1.24
	16-15	188	34	6	27	13	5	0	5	0	1656	44.60	

(Table B.4 continued)

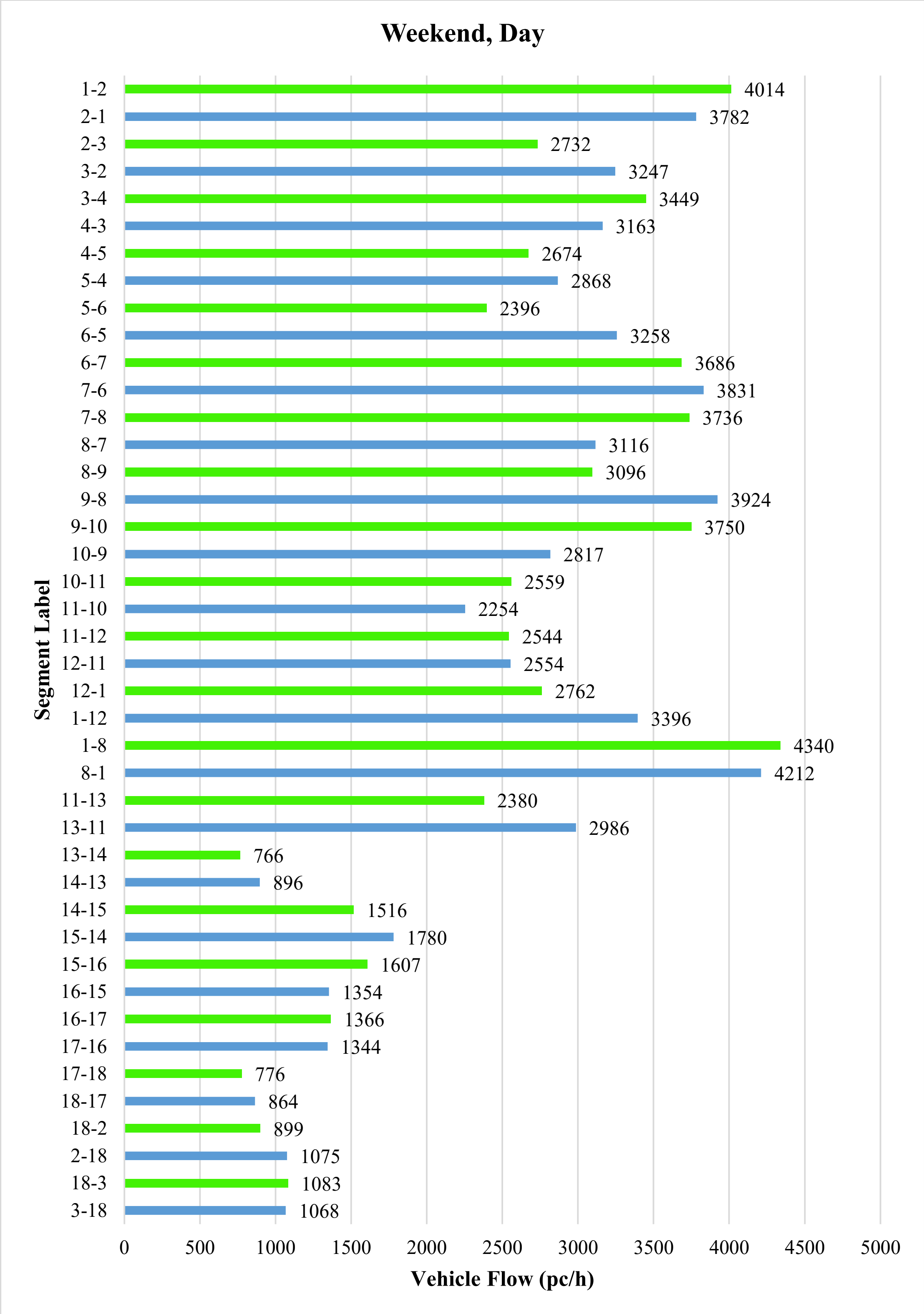
Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
16-17	16-17	197	31	4	18	5	8	0	4	0	1660	50.06	0.97
	17-16	203	35	6	19	6	4	0	3	0	1710	50.75	
17-18	17-18	114	21	2	11	8	3	0	2	0	979	36.40	0.92
	18-17	122	23	7	12	7	5	0	3	0	1063	52.05	
18-2	18-2	132	29	3	17	9	5	0	5	0	1177	52.55	0.81
	2-18	169	26	9	13	10	8	0	8	0	1459	55.36	
18-3	18-3	181	24	5	15	10	8	0	4	0	1527	51.14	1.39
	3-18	124	21	4	16	8	7	0	6	0	1100	41.88	

(d) Weekday, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	367	41	21	13	21	10	1	3	0	3008	53.02	1.13
	2-1	320	47	15	10	12	14	0	12	0	2665	46.98	
2-3	2-3	398	33	12	12	19	14	0	3	0	3189	47.73	0.91
	3-2	431	38	14	22	13	21	0	4	0	3492	52.27	
3-4	3-4	399	44	22	24	14	13	0	4	0	3276	52.84	1.12
	4-3	342	41	17	35	10	21	1	10	0	2924	47.16	
4-5	4-5	232	22	12	14	11	12	0	12	0	1949	48.79	0.95
	5-4	220	32	8	29	23	29	0	20	0	2046	51.21	
5-6	5-6	242	58	9	12	14	12	0	5	0	2092	43.84	0.78
	6-5	311	61	5	22	19	25	0	3	0	2680	56.16	
6-7	6-7	410	29	7	31	13	19	6	7	2	3427	51.11	1.05
	7-6	352	54	3	78	19	30	8	6	0	3278	48.89	
7-8	7-8	407	39	4	75	11	15	5	18	0	3580	55.04	1.22
	8-7	305	22	13	85	21	33	11	3	0	2924	44.96	
8-9	8-9	330	20	14	96	11	17	4	11	1	3036	45.38	0.83
	9-8	386	89	7	73	25	32	7	14	0	3654	54.62	

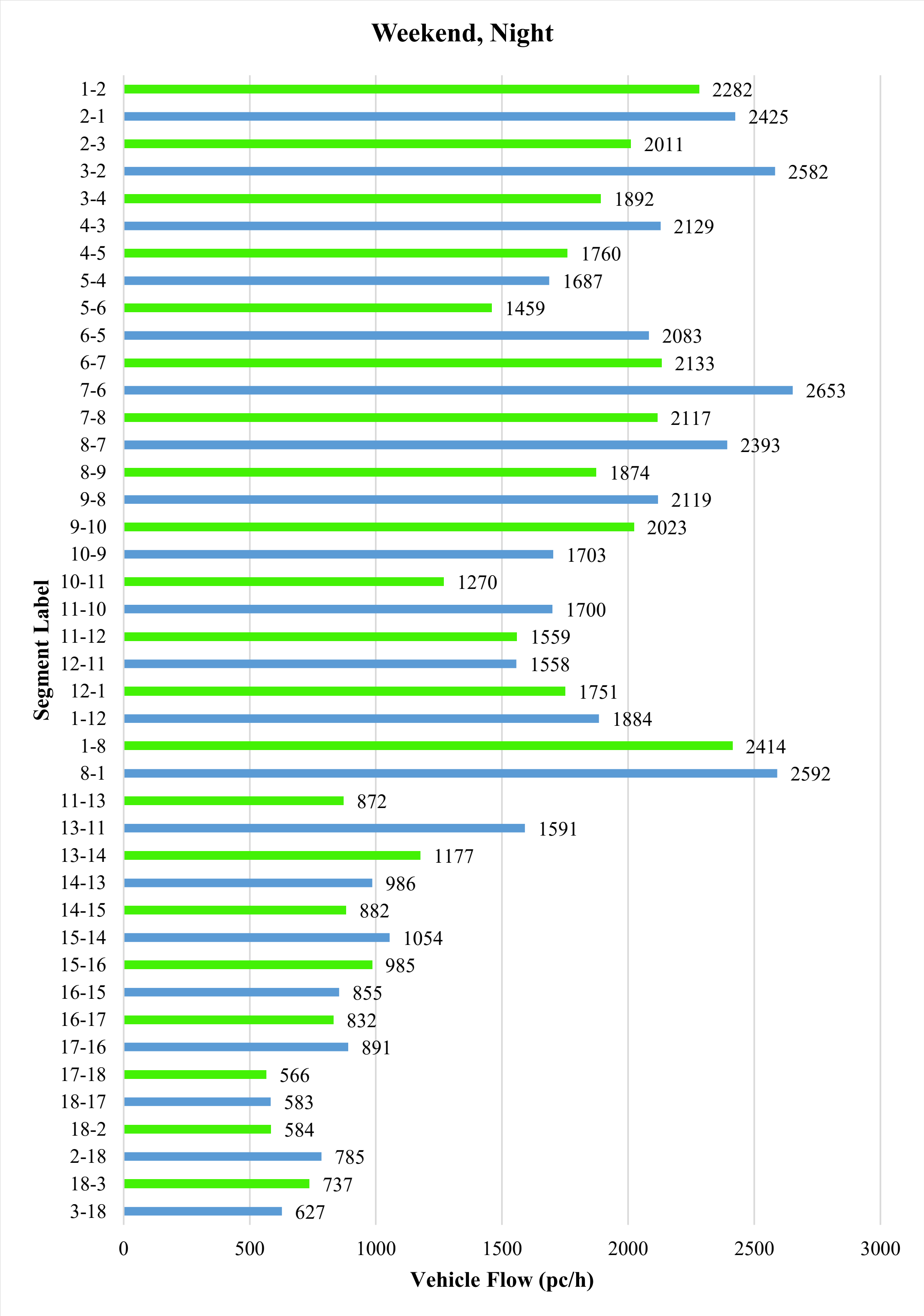
(Table B.4 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
9-10	9-10	471	31	24	71	25	17	11	19	0	2467	49.13	0.97
	10-9	344	35	21	72	21	13	6	8	0	2554	50.87	
10-11	10-11	347	29	26	78	17	12	8	8	0	3219	61.82	1.62
	11-10	247	34	29	82	19	15	10	7	0	1988	38.18	
11-12	11-12	345	16	23	112	21	18	2	9	0	2466	50.95	1.04
	12-11	328	14	21	131	29	18	1	7	0	2374	49.05	
12-1	12-1	429	16	10	33	24	16	9	6	0	2726	49.17	0.97
	1-12	455	19	15	68	18	15	8	2	0	2818	50.83	
1-8	1-8	686	27	9	21	20	19	3	3	1	4108	51.13	1.05
	8-1	690	10	24	21	13	13	1	1	1	3927	48.87	
11-13	11-13	322	33	22	24	16	13	11	4	0	2053	45.48	0.83
	13-11	391	47	27	12	28	22	8	8	0	2462	54.52	
13-14	13-14	214	19	8	17	11	4	0	2	0	1339	48.44	0.94
	14-13	237	34	9	19	12	6	0	3	0	1425	51.56	
14-15	14-15	223	41	5	13	9	7	0	4	0	1358	46.39	0.87
	15-14	269	22	7	14	8	8	0	6	0	1570	53.61	
15-16	15-16	249	27	5	25	11	4	0	2	0	1525	57.41	1.35
	16-15	188	34	6	27	13	5	0	5	0	1132	42.59	
16-17	16-17	197	31	4	18	5	8	0	4	0	1251	50.94	1.04
	17-16	203	35	6	19	6	4	0	3	0	1205	49.06	
17-18	17-18	114	21	2	11	8	3	0	2	0	767	49.88	1.00
	18-17	122	23	7	12	7	5	0	3	0	771	50.12	
18-2	18-2	132	29	3	17	9	5	0	5	0	872	46.86	0.88
	2-18	169	26	9	13	10	8	0	8	0	989	53.14	
18-3	18-3	181	24	5	15	10	8	0	4	0	1140	57.95	1.38
	3-18	124	21	4	16	8	7	0	6	0	827	42.05	



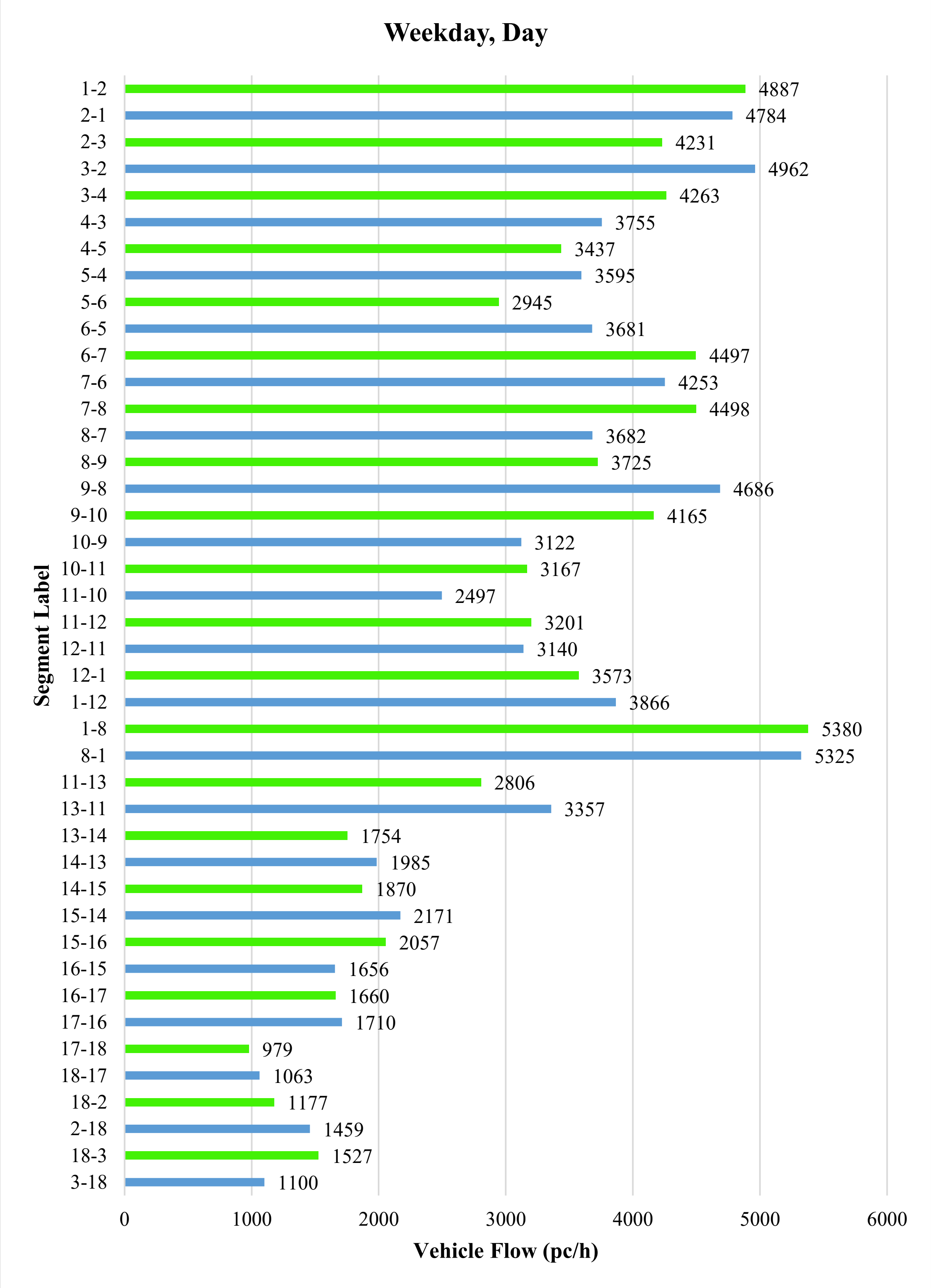
(a) Weekend, Day

(Figure B.4 continued)



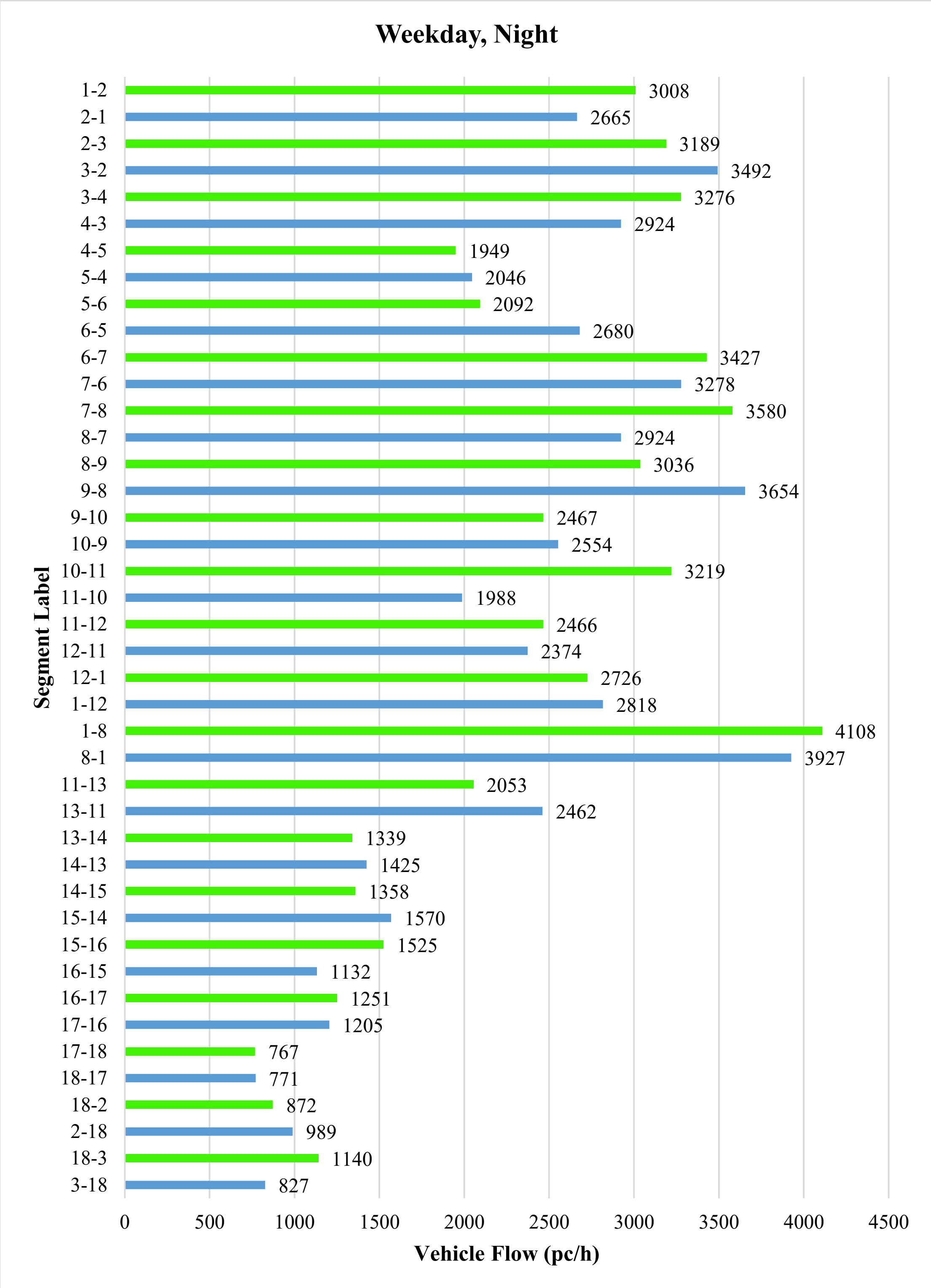
(b) Weekend, Night

(Figure B.4 continued)



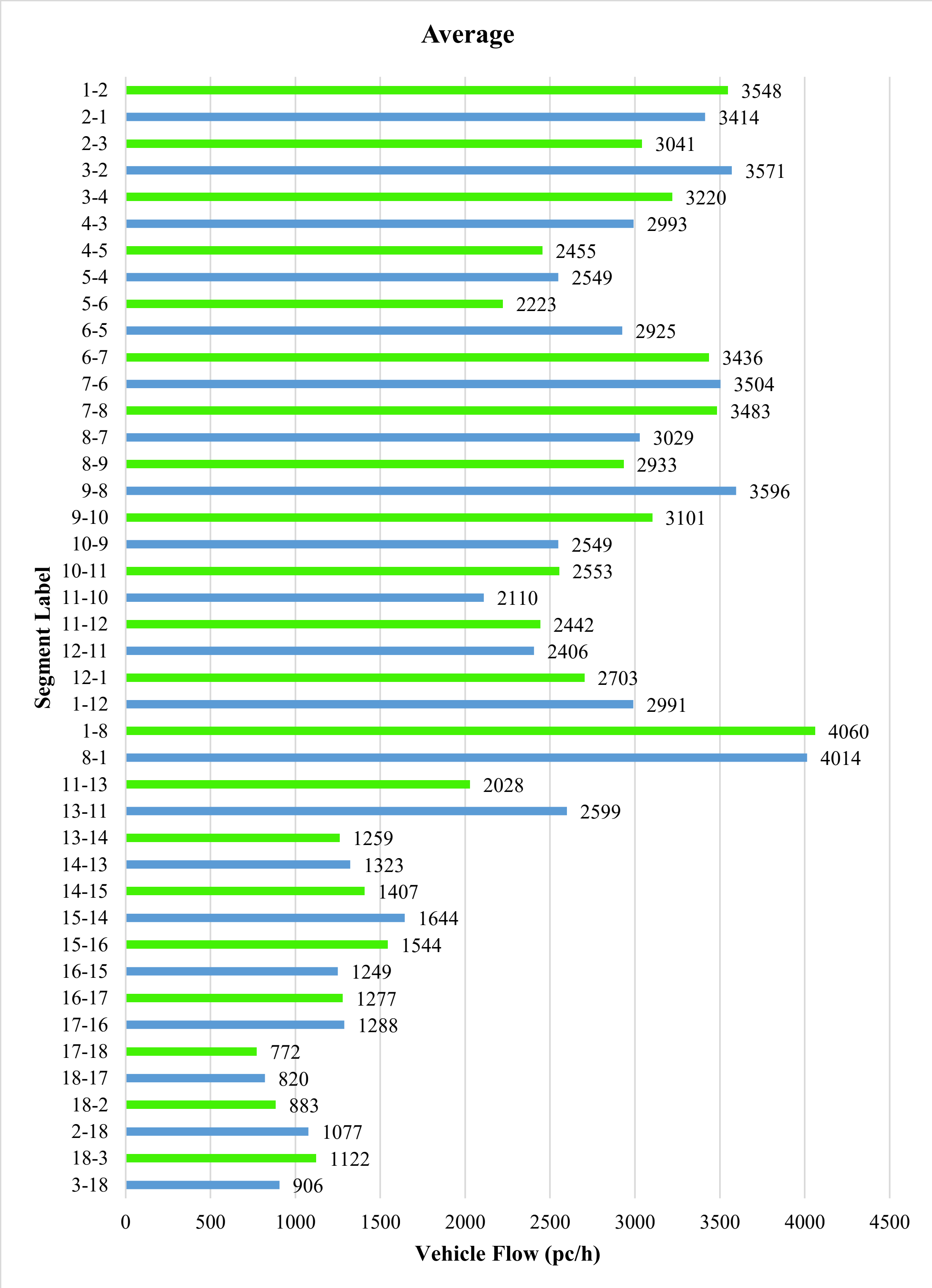
(c) Weekday, Day

(Figure B.4 continued)



(d) Weekday, Night

(Figure B.4 continued)



(e) Average

Figure B.4: Segment Directional Flow Variation at Khilgaon Flyover

Jatrabari-Gulistan Flyover

Table B.5: Segment Directional Traffic Flow at MMHF

(a) Weekend, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	367	41	21	13	21	10	1	3	0	3008	53.02	1.20
	2-1	320	47	15	10	12	14	0	12	0	2665	46.98	
2-3	2-3	398	33	12	12	19	14	0	3	0	3189	47.73	1.14
	3-2	431	38	14	22	13	21	0	4	0	3492	52.27	
3-4	3-4	399	44	22	24	14	13	0	4	0	3276	52.84	1.24
	4-3	342	41	17	35	10	21	1	10	0	2924	47.16	
4-5	4-5	232	22	12	14	11	12	0	12	0	1949	48.79	0.82
	5-4	220	32	8	29	23	29	0	20	0	2046	51.21	
5-6	5-6	242	58	9	12	14	12	0	5	0	2092	43.84	0.75
	6-5	311	61	5	22	19	25	0	3	0	2680	56.16	
6-7	6-7	410	29	7	31	13	19	6	7	2	3427	51.11	1.11
	7-6	352	54	3	78	19	30	8	6	0	3278	48.89	
7-8	7-8	407	39	4	75	11	15	5	18	0	3580	55.04	1.07
	8-7	305	22	13	85	21	33	11	3	0	2924	44.96	
8-9	8-9	330	20	14	96	11	17	4	11	1	3036	45.38	0.90
	9-8	386	89	7	73	25	32	7	14	0	3654	54.62	
9-10	9-10	471	31	24	71	25	17	11	19	0	2467	49.13	1.14
	10-9	344	35	21	72	21	13	6	8	0	2554	50.87	
10-11	10-11	347	29	26	78	17	12	8	8	0	3219	61.82	1.22
	11-10	247	34	29	82	19	15	10	7	0	1988	38.18	
11-12	11-12	345	16	23	112	21	18	2	9	0	2466	50.95	1.24
	12-11	328	14	21	131	29	18	1	7	0	2374	49.05	
12-1	12-1	429	16	10	33	24	16	9	6	0	2726	49.17	1.09
	1-12	455	19	15	68	18	15	8	2	0	2818	50.83	
1-8	1-8	686	27	9	21	20	19	3	3	1	4108	51.13	1.26
	8-1	690	10	24	21	13	13	1	1	1	3927	48.87	
11-13	11-13	322	33	22	24	16	13	11	4	0	2053	45.48	1.29
	13-11	391	47	27	12	28	22	8	8	0	2462	54.52	
13-14	13-14	214	19	8	17	11	4	0	2	0	1339	48.44	1.17
	14-13	237	34	9	19	12	6	0	3	0	1425	51.56	
14-15	14-15	223	41	5	13	9	7	0	4	0	1358	46.39	1.20
	15-14	269	22	7	14	8	8	0	6	0	1570	53.61	

(Table B.5 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
15-16	15-16	249	27	5	25	11	4	0	2	0	1525	57.41	1.14
	16-15	188	34	6	27	13	5	0	5	0	1132	42.59	
16-17	16-17	197	31	4	18	5	8	0	4	0	1251	50.94	1.24
	17-16	203	35	6	19	6	4	0	3	0	1205	49.06	
17-18	17-18	114	21	2	11	8	3	0	2	0	767	49.88	0.82
	18-17	122	23	7	12	7	5	0	3	0	771	50.12	
18-2	18-2	132	29	3	17	9	5	0	5	0	872	46.86	0.75
	2-18	169	26	9	13	10	8	0	8	0	989	53.14	
18-3	18-3	181	24	5	15	10	8	0	4	0	1140	57.95	1.11
	3-18	124	21	4	16	8	7	0	6	0	827	42.05	

(b) Weekend, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	125	26	7	4	8	9	9	1	0	1169	54.04	1.18
	2-1	99	13	8	8	10	8	11	4	0	995	45.96	
2-3	2-3	137	33	8	3	6	6	21	2	0	1397	47.32	0.90
	3-2	176	15	12	8	6	16	8	5	0	1556	52.68	
3-4	3-4	122	14	6	4	6	5	14	2	0	1155	44.44	0.80
	4-3	149	28	5	7	15	14	13	3	0	1443	55.56	
4-5	4-5	150	25	6	3	6	9	16	2	0	1420	46.51	0.87
	5-4	177	26	8	7	15	3	14	4	0	1634	53.49	
5-6	5-6	146	38	6	2	12	8	16	3	0	1441	54.72	1.21
	6-5	122	18	0	3	8	10	15	5	0	1192	45.28	
6-7	6-7	119	21	6	5	10	18	19	3	0	1261	51.62	1.07
	7-6	111	20	12	6	17	2	17	7	0	1182	48.38	
7-8	7-8	149	16	3	3	3	6	29	1	0	1506	56.33	1.29
	8-7	110	10	8	6	9	8	22	1	0	1167	43.67	

(Table B.5 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
8-9	8-9	85	11	8	2	3	0	6	1	0	756	54.65	1.21
	9-8	65	10	12	8	8	0	4	1	0	627	45.35	
9-10	9-10	144	32	6	9	10	6	22	2	0	1487	53.05	1.13
	10-9	134	16	5	13	12	8	14	5	0	1316	46.95	
10-11	10-11	114	46	6	7	9	11	21	2	0	1297	49.16	0.97
	11-10	129	14	8	11	26	14	15	6	0	1341	50.84	
11-12	11-12	113	32	6	4	5	16	0	3	0	1015	45.22	0.83
	12-11	136	18	8	9	19	19	0	7	0	1229	54.78	
12-1	12-1	130	15	6	8	11	12	28	4	0	1426	52.96	1.13
	1-12	138	5	0	9	20	18	8	3	0	1267	47.04	
1-8	1-8	128	40	6	6	7	12	18	2	0	1344	45.80	0.84
	8-1	165	20	0	12	12	11	18	4	0	1591	54.20	
11-13	11-13	163	33	6	8	6	10	13	3	0	1530	58.99	1.44
	13-11	104	16	8	13	12	4	12	4	0	1064	41.01	
13-14	13-14	115	33	6	8	10	8	22	2	0	1278	52.57	1.11
	14-13	110	26	0	14	12	5	14	5	0	1153	47.43	
14-15	14-15	125	26	7	4	8	9	9	1	0	1169	54.04	1.18
	15-14	99	13	8	8	10	8	11	4	0	995	45.96	
15-16	15-16	137	33	8	3	6	6	21	2	0	1397	47.32	0.90
	16-15	176	15	12	8	6	16	8	5	0	1556	52.68	
16-17	16-17	122	14	6	4	6	5	14	2	0	1155	44.44	0.80
	17-16	149	28	5	7	15	14	13	3	0	1443	55.56	
17-18	17-18	150	25	6	3	6	9	16	2	0	1420	46.51	0.87
	18-17	177	26	8	7	15	3	14	4	0	1634	53.49	
18-2	18-2	146	38	6	2	12	8	16	3	0	1441	54.72	1.21
	2-18	122	18	0	3	8	10	15	5	0	1192	45.28	
18-3	18-3	119	21	6	5	10	18	19	3	0	1261	51.62	1.07
	3-18	111	20	12	6	17	2	17	7	0	1182	48.38	

(Table B.5 continued)

(c) Weekday, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	82	12	4	33	21	21	24	16	0	1205	46.44	0.87
	2-1	73	16	2	53	15	18	39	21	1	1390	53.56	
2-3	2-3	108	12	6	41	15	25	55	21	0	1785	53.12	1.13
	3-2	100	21	3	72	8	25	29	27	0	1575	46.88	
3-4	3-4	91	19	4	47	15	22	37	21	0	1490	46.43	0.87
	4-3	89	14	3	71	22	29	49	18	1	1719	53.57	
4-5	4-5	108	18	6	49	15	25	43	23	0	1706	49.44	0.98
	5-4	113	13	1	62	21	4	45	22	0	1744	50.56	
5-6	5-6	93	18	3	40	32	17	46	29	1	1648	52.37	1.10
	6-5	74	16	0	22	12	11	57	31	2	1499	47.63	
6-7	6-7	73	22	2	48	27	16	50	34	1	1585	46.21	0.86
	7-6	81	20	5	70	25	15	61	39	0	1846	53.79	
7-8	7-8	91	8	2	63	8	9	76	11	4	1898	51.15	1.05
	8-7	80	12	1	50	13	15	81	6	1	1812	48.85	
8-9	8-9	51	6	4	26	9	9	15	11	0	751	51.74	1.07
	9-8	46	12	5	28	11	14	11	7	0	700	48.26	
9-10	9-10	95	16	0	85	26	35	59	22	1	1968	52.68	1.11
	10-9	93	19	2	59	18	30	52	28	0	1767	47.32	
10-11	10-11	76	23	3	74	25	5	54	26	0	1584	49.24	0.97
	11-10	84	18	1	48	38	20	55	35	1	1633	50.76	
11-12	11-12	76	16	3	26	14	13	0	37	6	982	43.93	0.78
	12-11	83	22	1	58	27	19	0	41	8	1253	56.07	
12-1	12-1	91	8	2	84	30	18	73	47	0	2116	59.90	1.49
	1-12	97	6	0	40	29	25	29	19	0	1417	40.10	
1-8	1-8	77	22	2	64	18	22	47	25	1	1599	47.00	0.89
	8-1	82	24	0	49	18	30	66	25	0	1803	53.00	
11-13	11-13	113	15	0	86	15	30	35	32	0	1768	54.42	1.19
	13-11	76	20	6	56	18	26	44	25	0	1481	45.58	
13-14	13-14	70	17	2	85	26	35	59	22	1	1790	52.23	1.09
	14-13	80	8	0	59	18	30	52	28	0	1638	47.77	
14-15	14-15	82	12	4	33	21	21	24	16	0	1205	46.44	0.87
	15-14	73	16	2	53	15	18	39	21	1	1390	53.56	
15-16	15-16	108	12	6	41	15	25	55	21	0	1785	53.12	1.13
	16-15	100	21	3	72	8	25	29	27	0	1575	46.88	

(Table B.5 continued)

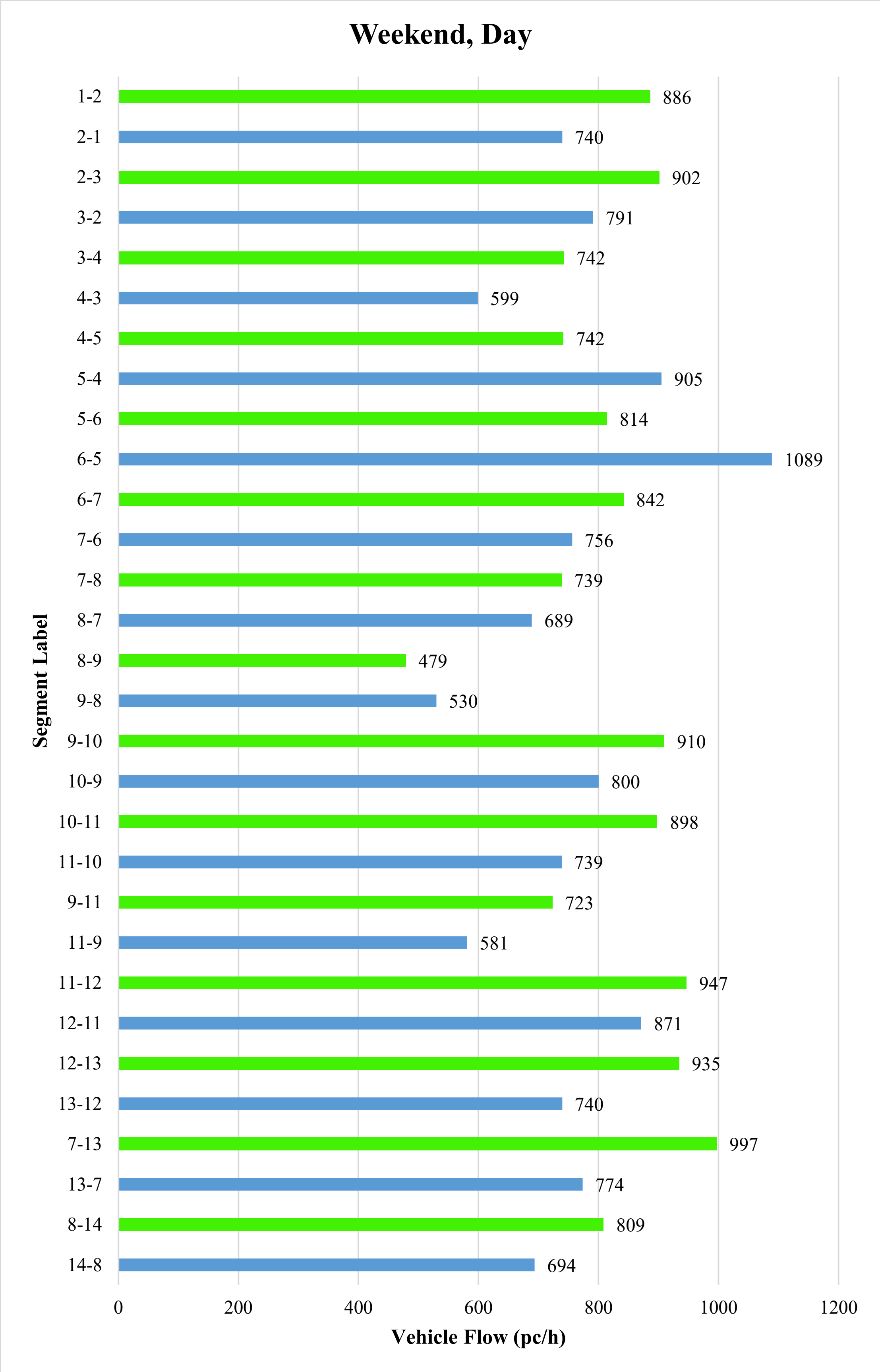
Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
16-17	16-17	91	19	4	47	15	22	37	21	0	1490	46.43	0.87
	17-16	89	14	3	71	22	29	49	18	1	1719	53.57	
17-18	17-18	108	18	6	49	15	25	43	23	0	1706	49.44	0.98
	18-17	113	13	1	62	21	4	45	22	0	1744	50.56	
18-2	18-2	93	18	3	40	32	17	46	29	1	1648	52.37	1.10
	2-18	74	16	0	22	12	11	57	31	2	1499	47.63	
18-3	18-3	73	22	2	48	27	16	50	34	1	1585	46.21	0.86
	3-18	81	20	5	70	25	15	61	39	0	1846	53.79	

(d) Weekday, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	172	18	8	69	34	26	28	28	0	2162	53.12	1.13
	2-1	133	17	2	72	28	5	37	28	1	1908	46.88	
2-3	2-3	224	25	12	81	24	31	64	36	0	3029	56.64	1.31
	3-2	188	16	3	104	15	7	28	36	0	2318	43.36	
3-4	3-4	190	16	8	113	24	27	43	36	0	2621	52.47	1.10
	4-3	167	24	3	87	41	8	47	24	1	2375	47.53	
4-5	4-5	226	25	12	49	24	31	50	40	0	2786	50.33	1.01
	5-4	202	26	1	102	39	1	54	29	0	2749	49.67	
5-6	5-6	184	27	6	39	52	21	43	50	1	2455	50.88	1.04
	6-5	183	19	0	36	22	3	54	41	2	2370	49.12	
6-7	6-7	152	15	4	48	44	20	59	59	1	2400	49.52	0.98
	7-6	151	32	5	73	46	4	58	52	0	2447	50.48	
7-8	7-8	190	11	4	63	13	11	89	19	2	2809	53.74	1.16
	8-7	150	14	1	83	24	4	77	8	1	2418	46.26	
8-9	8-9	108	9	8	26	15	11	19	19	0	1282	52.19	1.09
	9-8	88	14	5	58	20	4	15	9	0	1174	47.81	

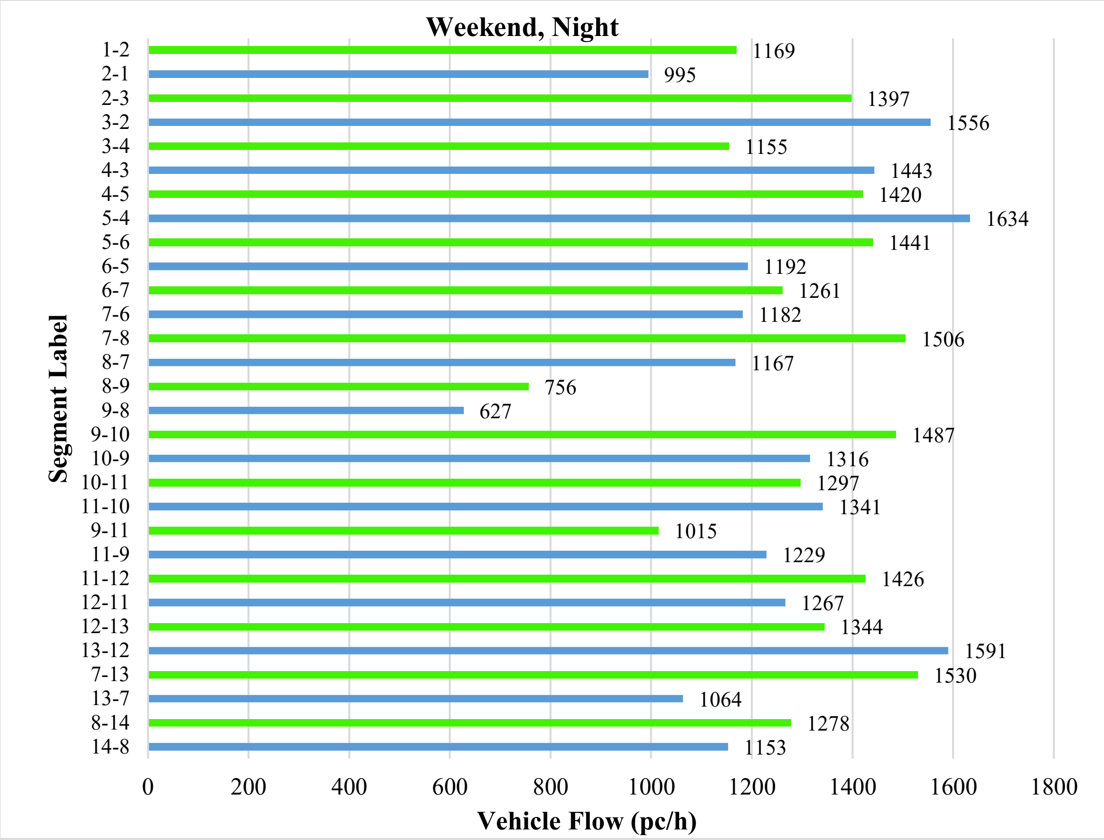
(Table B.5 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
9-10	9-10	175	22	0	97	42	23	69	38	1	2798	51.59	1.07
	10-9	198	22	2	85	33	8	49	37	0	2625	48.41	
10-11	10-11	159	32	6	79	41	6	63	45	0	2551	50.57	1.02
	11-10	163	20	1	74	70	5	52	47	1	2494	49.43	
11-12	11-12	182	22	6	56	23	16	0	64	3	1994	52.33	1.10
	12-11	155	25	1	44	50	5	0	55	8	1816	47.67	
12-1	12-1	155	10	4	80	49	22	85	81	0	2903	56.80	1.31
	1-12	190	7	0	60	54	7	28	25	0	2208	43.20	
1-8	1-8	163	30	4	60	29	27	55	43	1	2442	49.65	0.99
	8-1	159	28	0	81	33	8	63	33	0	2476	50.35	
11-13	11-13	233	25	0	86	24	37	41	55	0	2924	57.46	1.35
	13-11	143	23	6	93	33	7	42	33	0	2165	42.54	
13-14	13-14	146	23	4	85	42	43	69	38	1	2605	53.37	1.14
	14-13	150	9	0	97	33	8	49	37	0	2276	46.63	
14-15	14-15	172	18	8	69	34	26	28	28	0	2162	53.12	1.13
	15-14	133	17	2	72	28	5	37	28	1	1908	46.88	
15-16	15-16	224	25	12	81	24	31	64	36	0	3029	56.64	1.31
	16-15	188	16	3	104	15	7	28	36	0	2318	43.36	
16-17	16-17	190	16	8	113	24	27	43	36	0	2621	52.47	1.10
	17-16	167	24	3	87	41	8	47	24	1	2375	47.53	
17-18	17-18	226	25	12	49	24	31	50	40	0	2786	50.33	1.01
	18-17	202	26	1	102	39	1	54	29	0	2749	49.67	
18-2	18-2	184	27	6	39	52	21	43	50	1	2455	50.88	1.04
	2-18	183	19	0	36	22	3	54	41	2	2370	49.12	
18-3	18-3	152	15	4	48	44	20	59	59	1	2400	49.52	0.98
	3-18	151	32	5	73	46	4	58	52	0	2447	50.48	

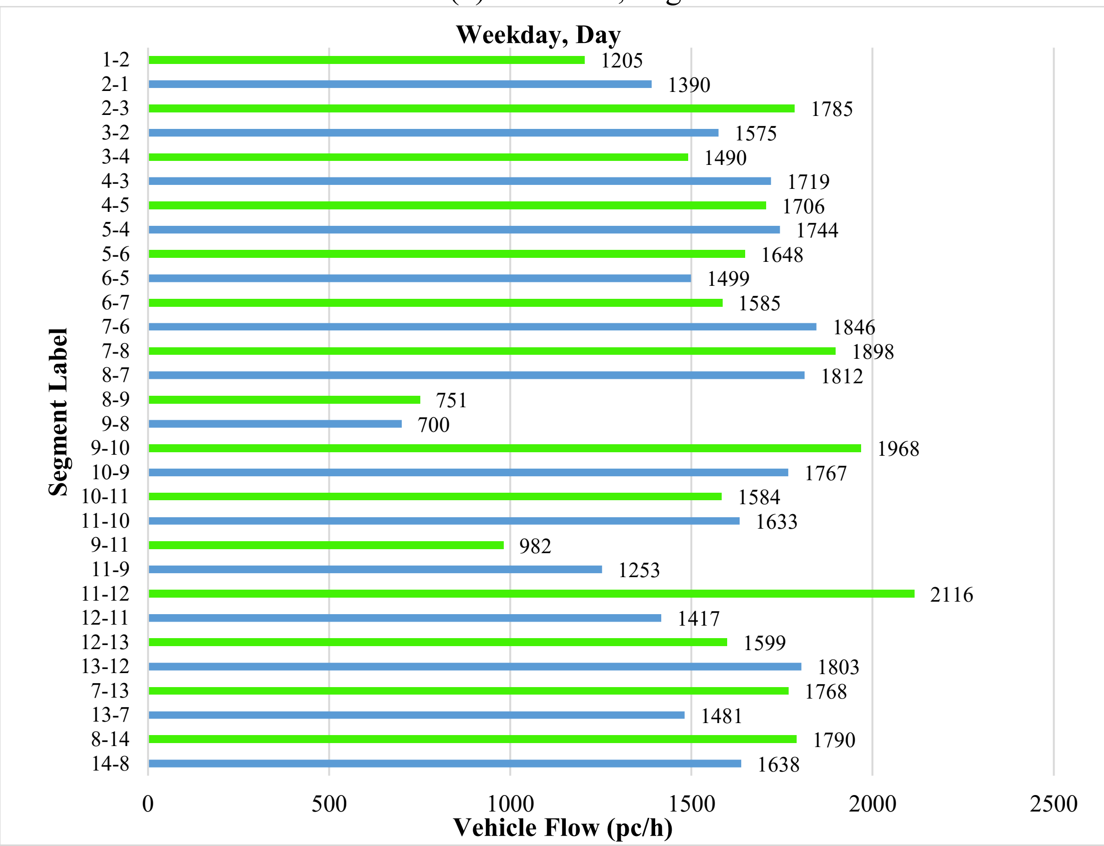


(a) Weekend, Day

(Figure B.5 continued)

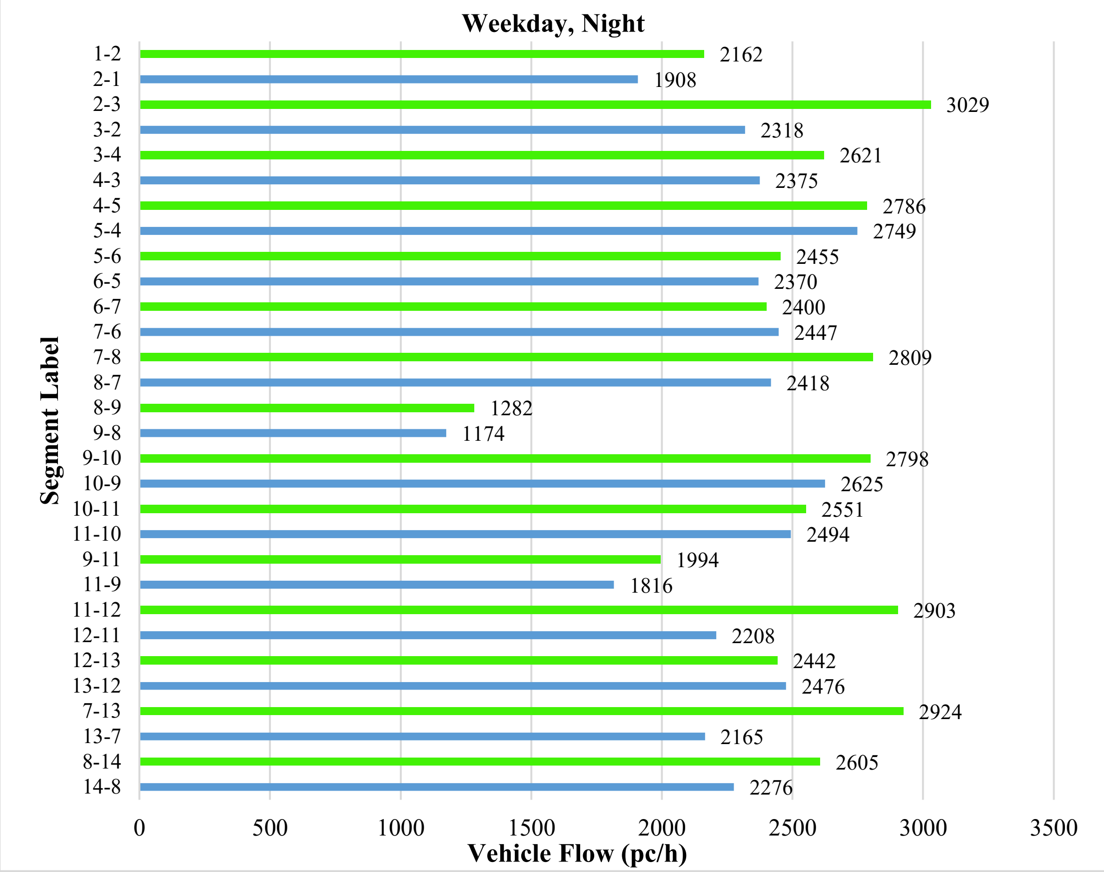


(b) Weekend, Night

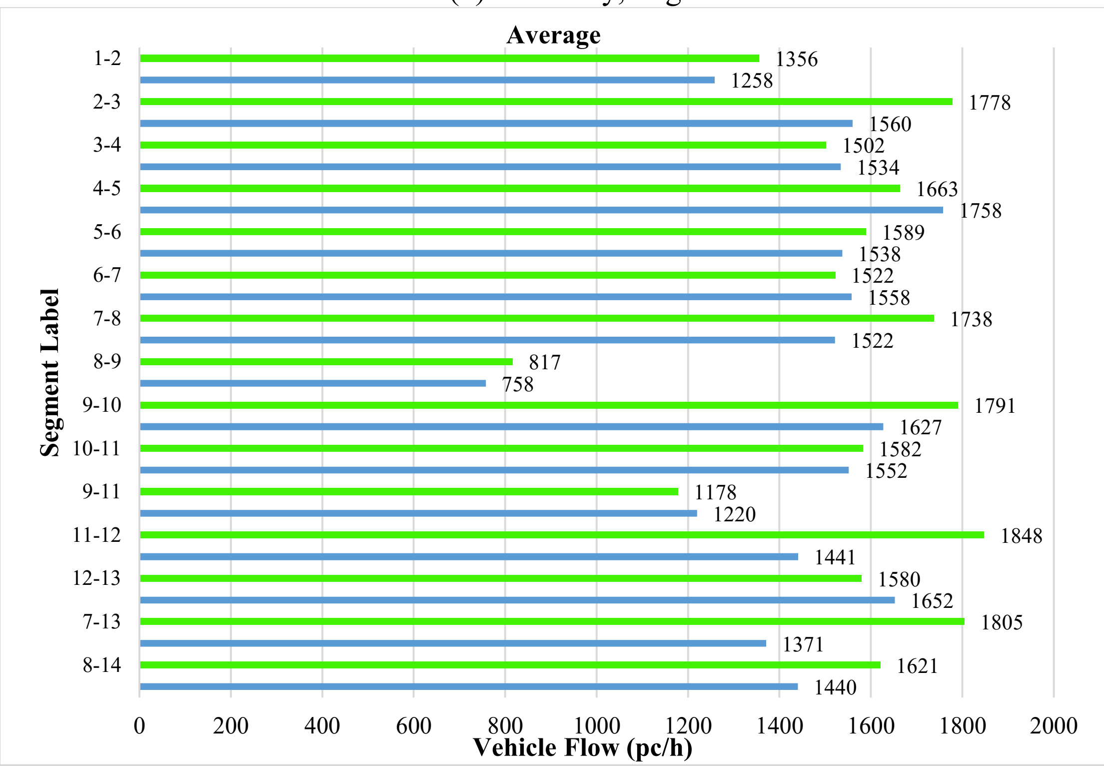


(c) Weekday, Day

(Figure B.5 continued)



(d) Weekday, Night



(e) Average

Figure B.5: Segment Directional Flow Variation at MMHF

Moghbazar-Mouchak Flyover

Table B.6: Segment Directional Traffic Flow at MMF

(a) Weekend, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	2	32	0	221	69	46	49	36	0	1907	54.70	1.21
	2-1	3	56	0	157	63	84	19	57	0	1580	45.30	
2-3	2-3	2	41	0	201	69	42	65	34	0	2017	58.83	1.43
	3-2	3	33	0	148	54	75	17	57	0	1411	41.17	
2-25	2-25	64	29	0	21	109	76	0	110	12	1676	49.11	0.97
	25-2	77	14	0	22	76	90	0	161	0	1737	50.89	
3-4	3-4	49	38	0	162	56	4	14	12	6	1492	51.69	1.07
	4-3	58	31	0	139	50	3	9	13	7	1395	48.31	
3-23	3-23	9	33	0	186	92	10	30	29	6	1627	52.95	1.13
	23-3	13	45	0	149	45	30	28	44	0	1446	47.05	
4-5	4-5	8	36	0	178	79	8	72	38	0	1988	54.16	1.18
	5-4	3	42	0	178	55	18	38	73	0	1683	45.84	
4-15	4-15	19	27	0	132	85	0	19	38	0	1284	51.59	1.07
	15-4	30	36	0	108	70	0	12	44	0	1205	48.41	
4-22	4-22	12	29	0	114	63	0	0	36	0	894	45.00	0.82
	22-4	24	17	0	121	39	0	0	86	0	1093	55.00	
5-6	5-6	5	46	0	183	79	10	89	43	0	2224	54.12	1.18
	6-5	3	47	0	196	70	18	42	83	0	1885	45.88	
6-7	6-7	1	24	0	150	66	0	63	26	0	1599	56.34	1.29
	7-6	0	31	0	92	30	0	30	109	0	1239	43.66	
6-14	6-14	28	14	0	116	66	0	0	50	0	1038	50.72	1.03
	14-6	25	33	0	116	59	0	0	39	0	1008	49.28	
7-8	7-8	0	52	0	216	76	6	28	19	0	1544	56.23	1.28
	8-7	0	42	0	184	58	6	15	18	0	1202	43.77	
7-19	7-19	0	36	0	196	62	0	12	7	0	1150	51.19	1.05
	19-7	0	31	0	180	49	0	9	31	0	1097	48.81	
8-9	8-9	3	52	0	118	66	8	40	65	0	1485	54.90	1.22
	9-8	1	47	0	120	51	0	28	52	0	1220	45.10	
8-14	8-14	114	19	0	36	33	26	19	55	0	1599	49.28	0.97
	14-8	108	37	0	41	30	24	19	65	0	1646	50.72	
9-10	9-10	19	41	0	224	73	16	72	31	0	2232	53.92	1.17
	10-9	10	51	0	216	74	6	18	130	0	1907	46.08	

(Table B.6 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
10-11	10-11	95	36	0	50	63	26	0	36	0	1361	49.66	0.99
	11-10	96	47	0	59	15	27	0	57	0	1379	50.34	
11-12	11-12	99	32	0	52	62	20	0	31	0	1349	47.03	0.89
	12-11	119	42	0	73	11	24	0	44	0	1519	52.97	
11-14	11-14	48	13	0	39	43	0	0	29	0	758	48.24	0.93
	14-11	43	17	0	49	35	0	0	47	0	813	51.76	
12-13	12-13	338	13	15	93	8	8	9	16	0	3096	44.10	0.79
	13-12	426	48	25	68	11	14	8	55	0	3924	55.90	
12-18	12-18	540	14	26	20	6	10	2	3	0	4212	49.25	0.97
	18-12	551	13	25	31	8	8	2	3	1	4340	50.75	
13-14	13-14	93	19	0	136	17	0	21	31	0	1630	53.75	1.16
	14-13	83	33	0	82	30	0	7	65	0	1403	46.25	
13-15	13-15	374	15	78	105	10	7	28	19	0	3750	57.10	1.33
	15-13	279	49	33	84	9	10	12	20	0	2817	42.90	
15-16	15-16	261	15	22	116	7	5	6	8	0	2559	53.16	1.14
	16-15	192	48	21	84	8	12	21	20	0	2254	46.84	
16-17	16-17	257	8	14	135	8	7	3	9	0	2544	49.90	1.00
	17-16	246	20	33	124	12	14	2	21	0	2554	50.10	
17-18	17-18	321	8	41	49	9	7	5	6	0	2762	44.85	0.81
	18-17	386	27	17	65	8	12	12	6	0	3396	55.15	
19-20	19-20	0	55	0	172	66	0	5	60	3	1276	49.59	0.98
	20-19	0	36	0	178	58	0	6	86	0	1297	50.41	
20-21	20-21	0	60	0	159	72	0	16	55	0	1328	48.13	0.93
	21-20	0	37	0	170	55	0	11	117	0	1432	51.87	
21-22	21-22	0	90	0	229	95	24	37	14	0	1880	57.60	1.36
	22-21	0	47	0	226	39	54	9	18	0	1384	42.40	
22-23	22-23	0	131	0	267	106	58	70	46	5	2794	53.65	1.16
	23-22	0	79	0	259	120	93	22	112	0	2414	46.35	
23-24	23-24	0	89	0	298	95	44	65	62	0	2672	53.47	1.15
	24-23	0	93	0	239	109	87	37	65	0	2325	46.53	

(Table B.6 continued)

(b) Weekend, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	2	7	0	85	21	58	39	6	0	1018	50.32	1.01
	2-1	2	20	0	80	16	84	30	9	0	1005	49.68	
2-3	2-3	2	9	0	77	21	53	51	6	0	1112	55.46	1.25
	3-2	2	12	0	76	14	75	26	9	0	893	44.54	
2-25	2-25	51	6	0	8	33	95	0	18	0	841	49.38	0.98
	25-2	56	5	0	11	20	90	0	25	0	862	50.62	
3-4	3-4	39	8	0	62	17	5	11	2	1	738	47.71	0.91
	4-3	42	11	1	71	13	3	14	2	0	809	52.29	
3-23	3-23	7	7	0	71	28	13	24	5	0	729	41.68	0.71
	23-3	9	16	1	76	12	30	44	7	0	1019	58.32	
4-5	4-5	6	8	0	68	24	10	57	6	0	1062	47.55	0.91
	5-4	2	15	0	91	14	18	59	11	0	1171	52.45	
4-15	4-15	15	6	0	51	26	0	15	6	0	574	45.38	0.83
	15-4	22	13	3	55	18	0	19	7	0	691	54.62	
4-22	4-22	9	6	0	44	19	0	0	6	0	319	41.76	0.72
	22-4	17	6	0	62	10	0	0	13	0	445	58.24	
5-6	5-6	4	10	0	70	24	13	70	7	0	1215	48.42	0.94
	6-5	2	17	0	100	18	18	65	13	0	1294	51.58	
6-7	6-7	1	5	0	57	20	0	50	4	0	853	51.33	1.05
	7-6	0	11	1	47	8	0	47	17	0	809	48.67	
6-14	6-14	22	3	0	44	20	0	0	8	0	417	48.19	0.93
	14-6	18	12	1	59	15	0	0	6	0	448	51.81	
7-8	7-8	0	11	0	83	23	8	22	3	0	675	48.74	0.95
	8-7	0	15	0	94	15	6	23	3	0	710	51.26	
7-19	7-19	0	8	0	75	19	0	9	1	0	454	43.98	0.79
	19-7	0	11	0	92	13	0	14	5	0	578	56.02	
8-9	8-9	2	11	0	45	20	10	31	11	0	676	44.79	0.81
	9-8	1	17	2	61	13	0	44	8	0	834	55.21	
8-14	8-14	91	4	0	14	10	33	15	9	0	1050	47.86	0.92
	14-8	78	13	0	21	8	24	30	10	0	1144	52.14	
9-10	9-10	15	9	0	86	22	20	57	5	0	1215	55.93	1.27
	10-9	7	18	0	110	19	6	28	20	0	958	44.07	
10-11	10-11	76	8	0	19	19	33	0	6	0	817	50.80	1.03
	11-10	70	17	0	30	4	27	0	9	0	791	49.20	
11-12	11-12	79	7	0	20	19	25	0	5	0	814	47.05	0.89
	12-11	86	15	3	37	3	24	0	7	0	916	52.95	

(Table B.6 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
11-14	11-14	38	3	0	15	13	0	0	5	0	397	50.64	1.03
	14-11	31	6	0	25	9	0	0	7	0	387	49.36	
12-13	12-13	184	24	5	40	26	19	12	5	2	1874	46.94	0.88
	13-12	190	72	8	53	25	24	15	3	0	2119	53.06	
12-18	12-18	322	21	9	16	15	17	0	0	0	2592	51.77	1.07
	18-12	300	10	9	10	25	19	0	1	0	2414	48.23	
13-14	13-14	74	4	0	52	5	0	17	5	0	967	54.32	1.19
	14-13	60	12	2	42	8	0	11	10	0	813	45.68	
13-15	13-15	205	12	24	44	32	17	12	2	0	2023	54.30	1.19
	15-13	160	34	9	55	24	17	7	6	0	1703	45.70	
15-16	15-16	115	15	16	47	21	12	7	3	0	1270	42.75	0.75
	16-15	151	44	11	63	22	20	9	0	0	1700	57.25	
16-17	16-17	153	35	9	45	26	18	2	3	0	1559	50.03	1.00
	17-16	158	33	8	29	34	24	1	0	1	1558	49.97	
17-18	17-18	187	35	22	28	30	16	0	2	0	1751	48.17	0.93
	18-17	212	39	5	22	22	21	0	2	0	1884	51.83	
19-20	19-20	0	12	0	66	20	0	4	10	0	412	42.42	0.74
	20-19	0	13	0	91	15	0	9	13	0	559	57.58	
20-21	20-21	0	13	0	61	22	0	13	9	0	498	43.42	0.77
	21-20	0	13	0	87	14	0	17	18	0	649	56.58	
21-22	21-22	0	19	0	88	29	30	29	2	0	867	51.50	1.06
	22-21	0	17	0	116	10	54	14	3	0	816	48.50	
22-23	22-23	0	28	0	102	32	73	55	8	0	1379	50.66	1.03
	23-22	0	28	0	132	31	93	34	17	0	1343	49.34	
23-24	23-24	0	19	0	114	29	55	51	10	0	1304	45.84	0.85
	22-21	0	17	0	116	10	54	14	3	0	816	48.50	

(Table B.6 continued)

(c) Weekday, Day

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	3	13	0	258	27	23	21	15	0	2650	52.48	1.10
	2-1	4	25	0	203	34	28	19	13	0	2399	47.52	
2-3	2-3	3	17	0	234	27	21	28	14	0	2532	53.83	1.17
	3-2	4	15	0	192	29	25	17	13	0	2171	46.17	
2-25	2-25	82	12	1	24	43	38	0	46	2	1825	51.45	1.06
	25-2	90	6	0	29	41	30	0	37	1	1722	48.55	
3-4	3-4	63	16	1	189	22	2	19	5	0	2333	49.84	0.99
	4-3	68	14	1	180	27	1	25	3	0	2348	50.16	
3-23	3-23	11	14	3	217	36	5	13	12	1	2296	50.90	1.04
	23-3	15	20	1	193	24	10	28	10	0	2215	49.10	
4-5	4-5	10	15	0	208	31	4	31	16	0	2318	47.87	0.92
	5-4	3	19	0	230	30	6	38	17	0	2524	52.13	
4-15	4-15	24	11	2	154	33	0	8	16	0	1825	49.40	0.98
	15-4	35	16	3	140	38	0	12	10	0	1869	50.60	
4-22	4-22	15	12	0	133	25	0	0	15	0	1472	46.19	0.86
	22-4	28	8	0	156	21	0	0	20	0	1715	53.81	
5-6	5-6	6	19	0	213	31	5	38	18	0	2429	46.28	0.86
	6-5	3	21	0	254	38	6	42	19	0	2819	53.72	
6-7	6-7	1	10	0	175	26	0	27	11	0	1840	54.82	1.21
	7-6	0	14	1	120	16	0	30	25	0	1516	45.18	
6-14	6-14	36	6	0	135	26	0	0	21	0	1649	48.70	0.95
	14-6	29	15	1	150	32	0	0	9	0	1737	51.30	
7-8	7-8	0	22	2	252	30	3	12	8	0	2421	51.49	1.06
	8-7	0	19	0	239	31	2	15	4	0	2282	48.51	
7-19	7-19	0	15	4	228	24	0	5	3	0	2053	49.12	0.97
	19-7	0	14	0	233	26	0	9	7	0	2127	50.88	
8-9	8-9	4	22	1	138	26	4	17	27	0	1759	49.18	0.97
	9-8	1	21	2	155	28	0	28	12	0	1818	50.82	
8-14	8-14	147	8	0	42	13	13	8	23	0	1869	50.00	1.00
	14-8	126	17	0	53	16	8	19	15	0	1869	50.00	
9-10	9-10	25	17	1	261	29	8	31	13	0	2834	48.73	0.95
	10-9	12	23	0	280	40	2	18	30	0	2981	51.27	
10-11	10-11	122	15	2	58	25	13	0	15	0	1840	51.02	1.04
	11-10	113	21	0	76	8	9	0	13	0	1766	48.98	

(Table B.6 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
11-12	11-12	128	13	0	60	24	10	0	13	0	1825	46.88	0.88
	12-11	140	19	3	95	6	8	0	10	0	2068	53.12	
11-14	11-14	61	5	0	45	17	0	0	12	0	1030	48.11	0.93
	14-11	50	8	0	63	19	0	0	11	0	1111	51.89	
12-13	12-13	421	27	4	63	21	19	13	16	0	4298	44.24	0.79
	13-12	539	34	22	69	22	18	14	18	0	5417	55.76	
12-18	12-18	690	10	24	21	13	13	1	1	1	5697	49.52	0.98
	18-12	686	27	9	21	20	19	3	3	1	5807	50.48	
13-14	13-14	120	8	0	159	7	0	9	13	0	2326	55.05	1.22
	14-13	97	15	2	106	16	0	7	15	0	1899	44.95	
13-15	13-15	471	31	24	71	25	17	11	19	0	4924	56.27	1.29
	15-13	344	35	21	72	21	13	6	8	0	3827	43.73	
15-16	15-16	347	29	26	78	17	12	8	8	0	3864	54.24	1.19
	16-15	247	34	29	82	19	15	10	7	0	3260	45.76	
16-17	16-17	345	16	23	112	21	18	2	9	0	4019	49.86	0.99
	17-16	328	14	21	131	29	18	1	7	0	4041	50.14	
17-18	17-18	429	16	10	33	24	16	9	6	0	3996	47.51	0.91
	18-17	455	19	15	68	18	15	8	2	0	4416	52.49	
19-20	19-20	0	23	0	201	26	0	2	25	1	2046	47.77	0.91
	20-19	0	16	0	230	31	0	6	20	1	2237	52.23	
20-21	20-21	0	25	0	186	28	0	7	23	0	1980	46.78	0.88
	21-20	0	17	0	220	30	0	11	27	1	2252	53.22	
21-22	21-22	0	38	0	267	37	12	16	6	0	2767	50.67	1.03
	22-21	0	21	0	293	21	18	9	4	0	2694	49.33	
22-23	22-23	0	55	0	312	42	29	30	19	2	3599	48.66	0.95
	23-22	0	36	0	335	65	31	22	26	1	3798	51.34	
23-24	23-24	0	37	1	348	37	22	28	26	0	3673	50.15	1.01
	24-23	0	42	3	310	59	29	37	15	1	3651	49.85	

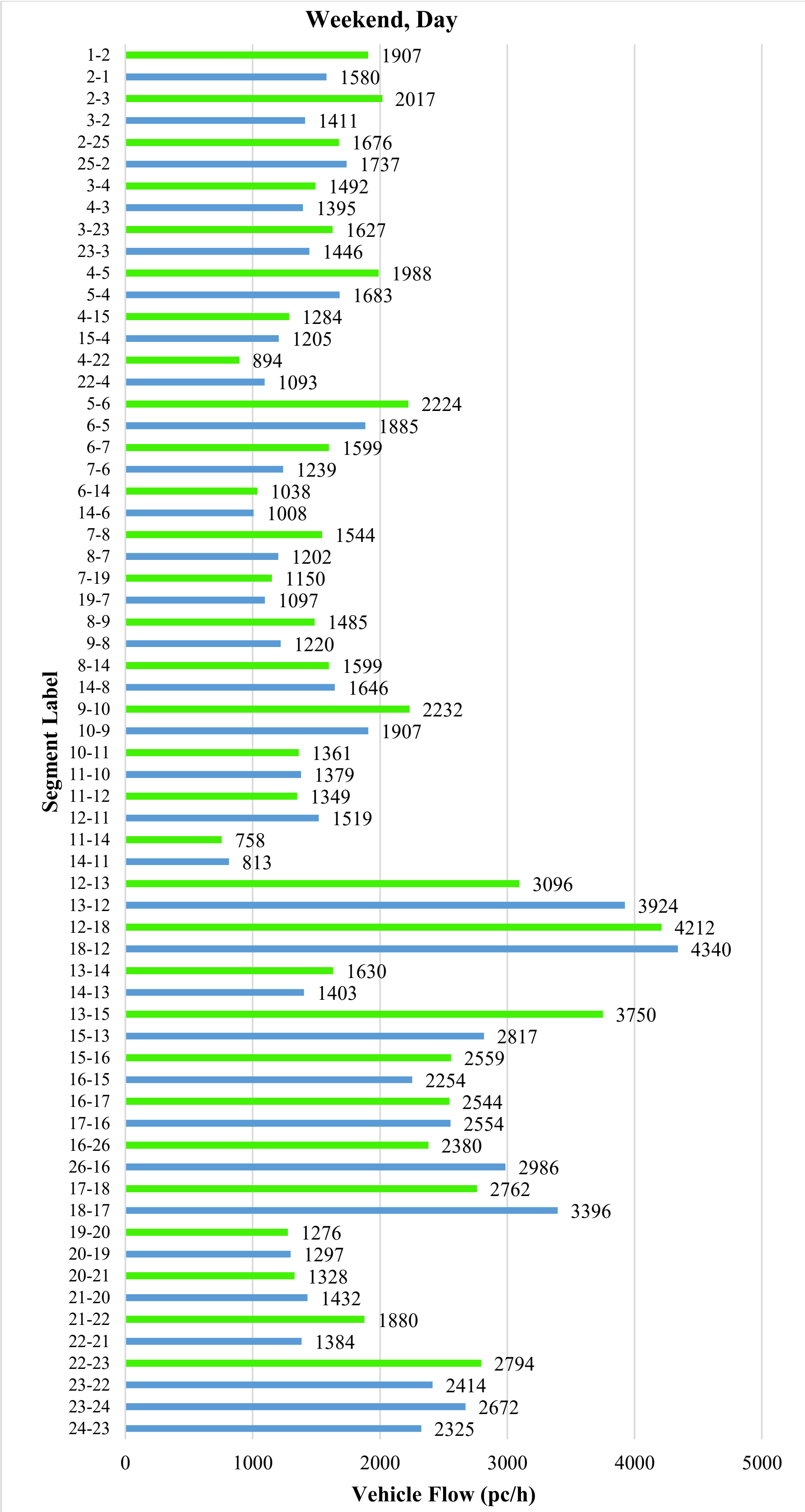
(Table B.6 continued)

(d) Weekday, Night

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
1-2	1-2	3	10	0	172	28	41	19	13	0	1131	48.65	0.95
	2-1	4	30	0	126	26	103	15	26	0	1193	51.35	
2-3	2-3	3	12	0	156	28	38	25	13	0	1135	51.20	1.05
	3-2	4	18	0	119	22	92	14	26	0	1082	48.80	
2-25	2-25	78	9	0	16	45	68	0	41	0	1121	43.22	0.76
	25-2	99	7	0	18	31	110	0	73	0	1472	56.78	
3-4	3-4	49	8	0	90	17	4	5	3	0	838	47.82	0.92
	4-3	59	12	1	81	15	5	7	4	0	914	52.18	
3-23	3-23	11	10	0	145	38	9	11	11	0	934	45.80	0.85
	23-3	17	24	2	120	18	37	22	20	0	1105	54.20	
4-5	4-5	10	11	0	139	32	7	27	14	0	1073	47.34	0.90
	5-4	4	23	0	143	22	22	30	33	0	1193	52.66	
4-15	4-15	23	8	0	103	35	0	7	14	0	796	46.31	0.86
	15-4	38	19	5	87	28	0	10	20	0	923	53.69	
4-22	4-22	14	9	0	89	26	0	0	13	0	575	41.89	0.72
	22-4	31	9	0	97	16	0	0	39	0	798	58.11	
5-6	5-6	6	14	0	142	32	9	34	16	0	1153	46.65	0.87
	6-5	4	25	0	158	28	22	33	37	0	1318	53.35	
6-7	6-7	1	7	0	117	27	0	24	10	0	834	50.98	1.04
	7-6	0	17	2	74	12	0	24	49	0	801	49.02	
6-14	6-14	34	4	0	90	27	0	0	18	0	733	48.99	0.96
	14-6	32	18	2	93	24	0	0	18	0	764	51.01	
7-8	7-8	0	16	0	168	31	5	11	7	0	909	51.59	1.07
	8-7	0	23	0	148	23	7	12	8	0	853	48.41	
7-19	7-19	0	11	0	152	25	0	5	3	0	725	48.67	0.95
	19-7	0	17	0	145	20	0	7	14	0	765	51.33	
8-9	8-9	4	16	0	92	27	7	15	24	0	760	48.08	0.93
	9-8	1	25	3	96	21	0	22	23	0	821	51.92	
8-14	8-14	140	6	0	28	14	23	7	20	0	1403	47.07	0.89
	14-8	138	20	0	33	12	29	15	29	0	1578	52.93	
9-10	9-10	24	12	0	174	30	14	27	11	0	1310	50.44	1.02
	10-9	13	28	0	174	30	7	14	59	0	1287	49.56	
10-11	10-11	116	11	0	39	26	23	0	13	0	1211	47.27	0.90
	11-10	123	25	0	47	6	33	0	26	0	1351	52.73	

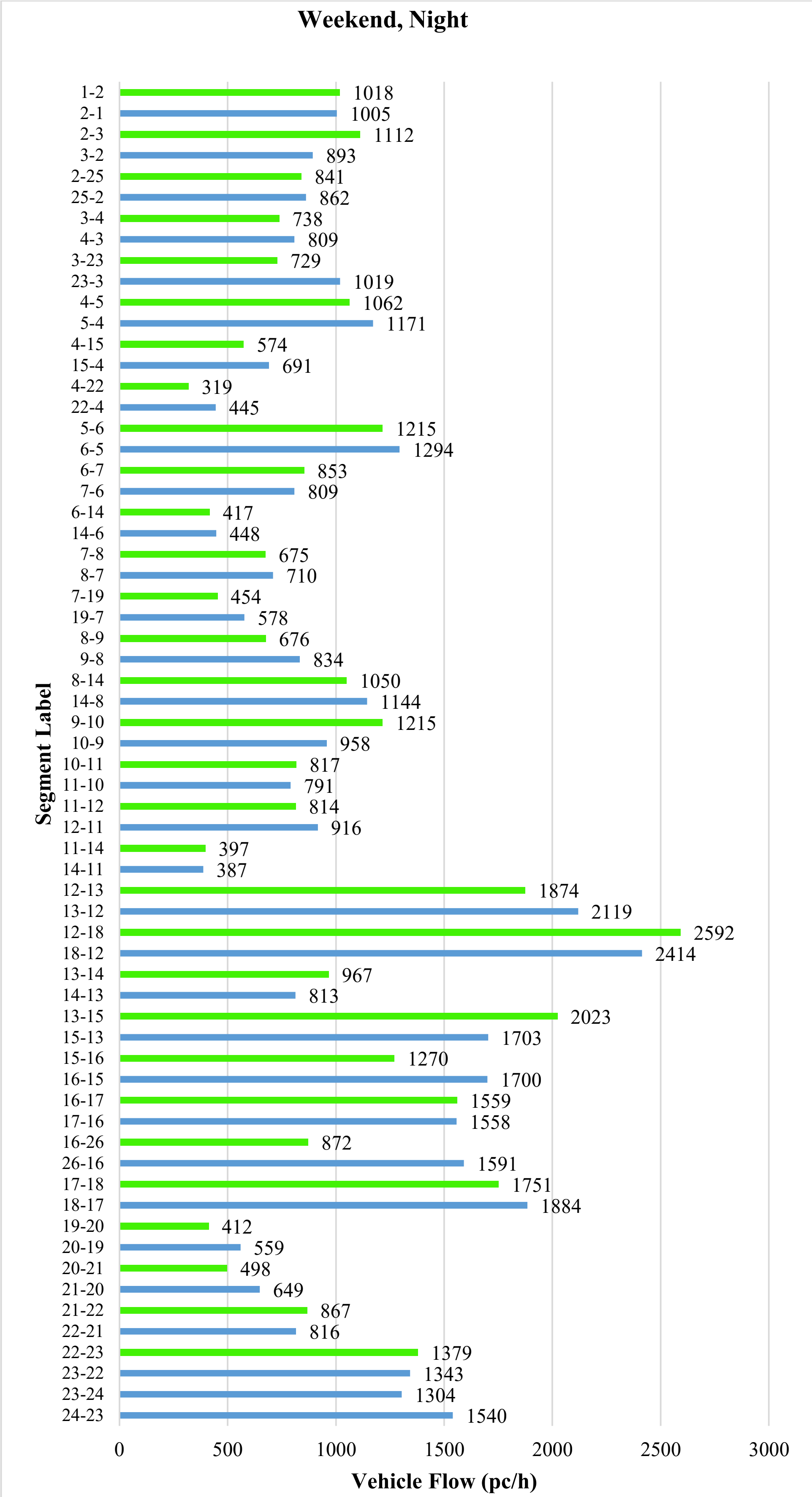
(Table B.6 continued)

Segment Label	Direction	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total Equivalent Hourly Flow (pc/h)	Percentage of Total (%)	Directional Distribution Ratio
11-12	11-12	122	10	0	40	25	18	0	11	0	1232	43.80	0.78
	12-11	153	23	5	59	4	29	0	20	0	1581	56.20	
11-14	11-14	58	4	0	30	18	0	0	11	0	638	48.09	0.93
	14-11	55	9	0	39	14	0	0	21	0	689	51.91	
12-13	12-13	330	20	14	96	11	17	4	11	1	3036	45.38	0.83
	13-12	386	89	7	73	25	32	7	14	0	3654	54.62	
12-18	12-18	493	26	23	11	21	23	0	3	1	3927	48.87	0.96
	18-12	522	20	31	12	16	17	0	5	0	4108	51.13	
13-14	13-14	114	6	0	106	7	0	8	11	0	1394	52.04	1.09
	14-13	106	18	3	66	12	0	6	29	0	1284	47.96	
13-15	13-15	258	28	6	71	20	15	3	21	1	2467	49.13	0.97
	15-13	245	91	4	61	23	22	5	24	0	2554	50.87	
15-16	15-16	364	22	5	84	14	11	4	13	0	3219	61.82	1.62
	16-15	176	54	4	73	31	26	3	21	0	1988	38.18	
16-17	16-17	263	39	3	66	19	16	2	15	0	2466	50.95	1.04
	17-16	234	36	12	69	36	32	1	21	0	2374	49.05	
17-18	17-18	326	31	13	22	21	15	0	10	0	2726	49.17	0.97
	18-17	325	49	10	17	42	26	0	6	0	2818	50.83	
19-20	19-20	0	17	0	134	27	0	2	22	0	718	46.04	0.85
	20-19	0	19	0	143	23	0	5	39	0	841	53.96	
20-21	20-21	0	18	0	124	30	0	6	20	0	729	44.34	0.80
	21-20	0	20	0	137	22	0	9	53	0	914	55.66	
21-22	21-22	0	27	0	178	39	22	14	5	0	1071	49.98	1.00
	22-21	0	25	0	182	16	66	7	8	0	1072	50.02	
22-23	22-23	0	40	0	208	44	52	27	17	0	1501	46.60	0.87
	23-22	0	43	0	208	49	114	18	51	0	1720	53.40	
23-24	23-24	0	27	0	232	39	40	25	23	0	1507	47.01	0.89
	24-23	0	50	5	193	44	106	29	29	0	1698	52.99	



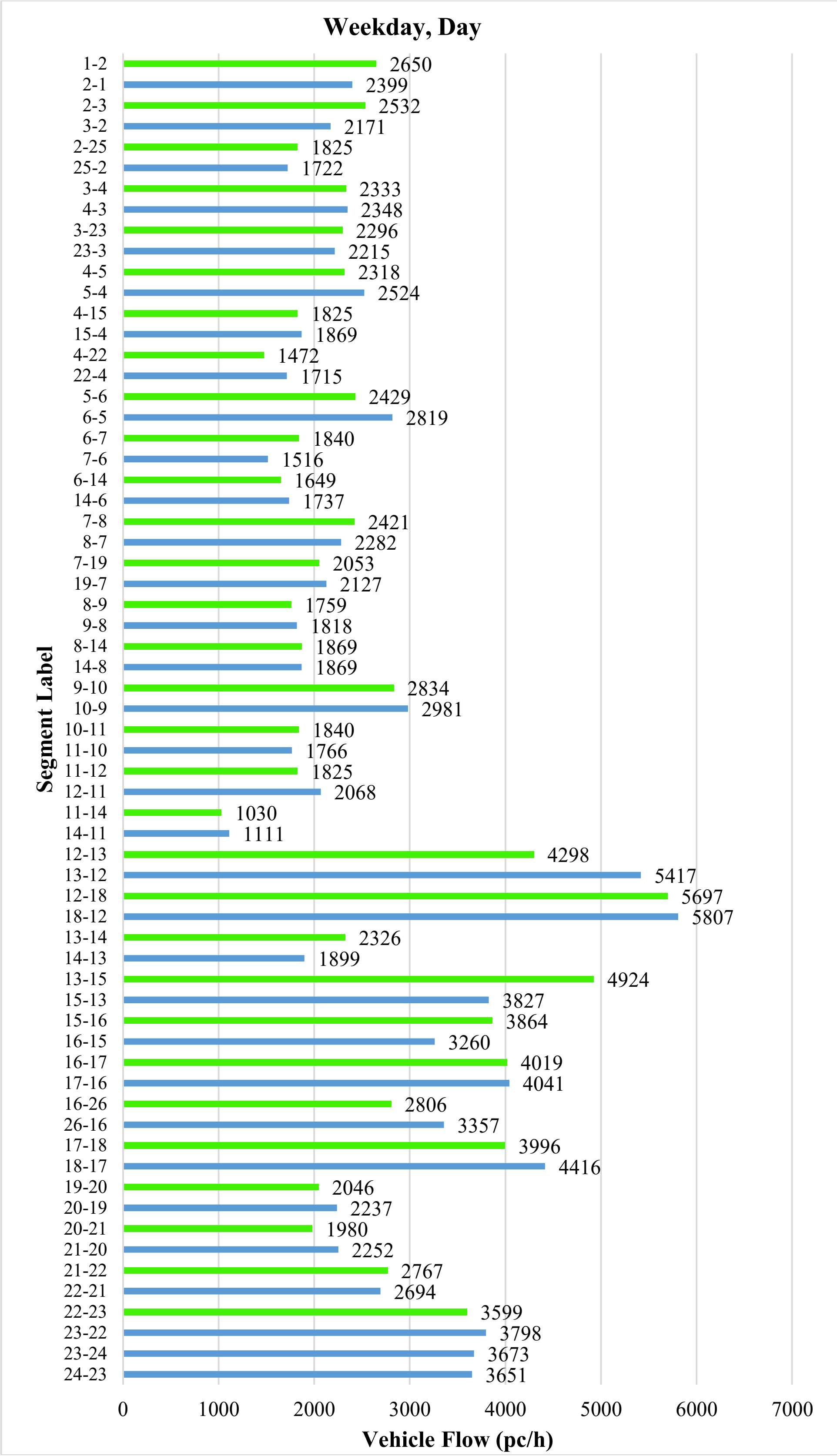
(a) Weekend, Day

(Figure B.6 continued)



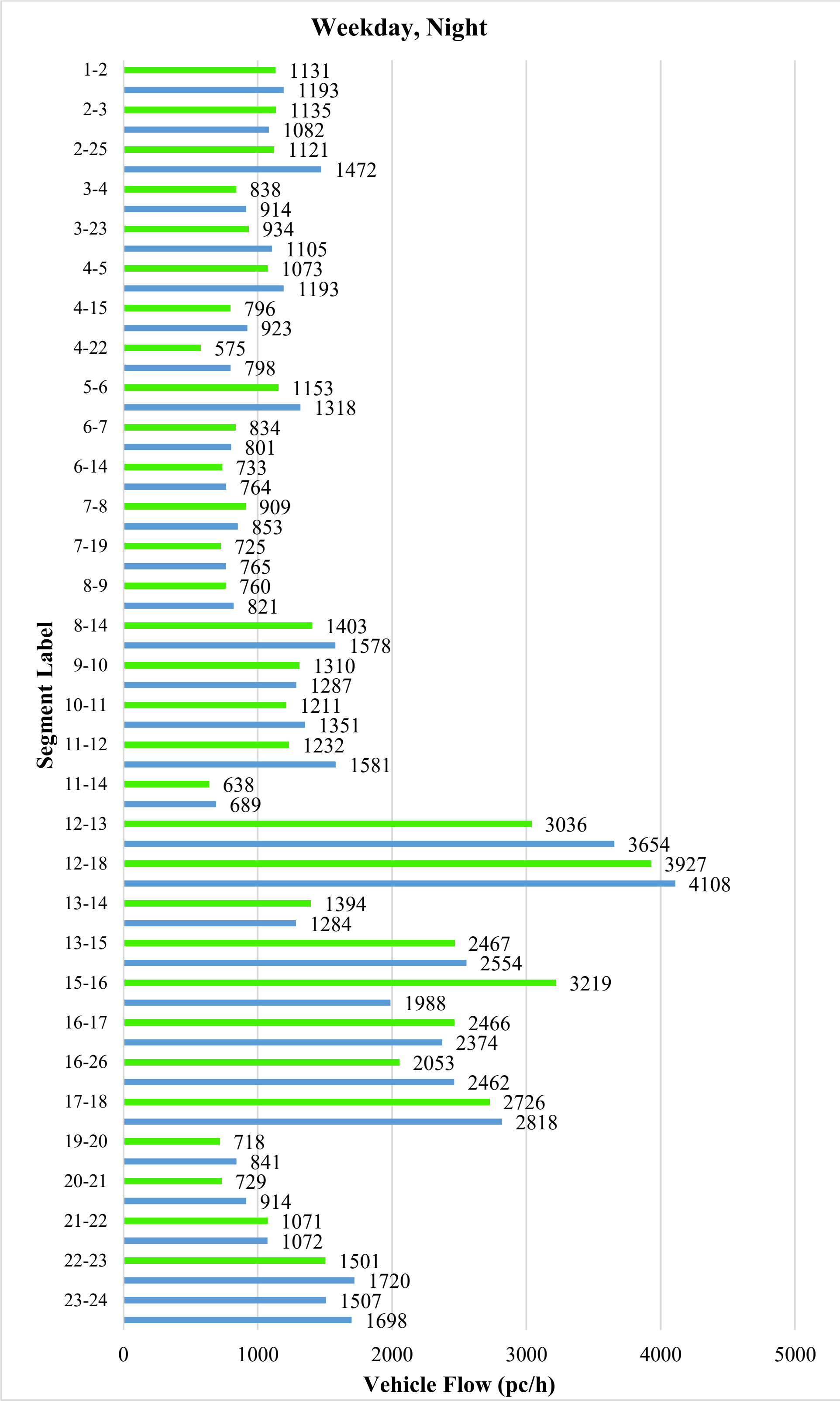
(b) Weekend, Night

(Figure B.6 continued)



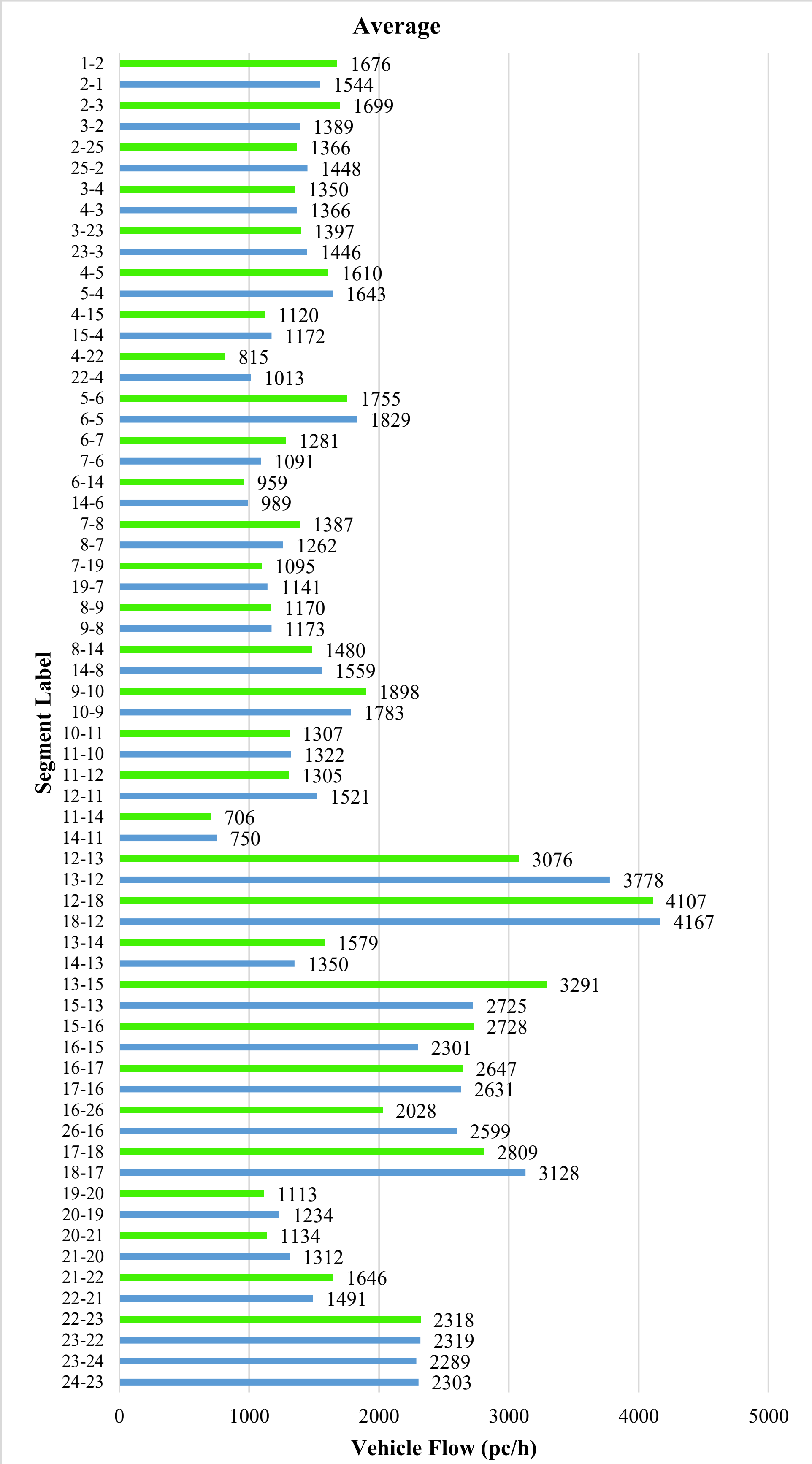
(c) Weekday, Day

(Figure B.6 continued)



(d) Weekday, Night

(Figure B.6 continued)



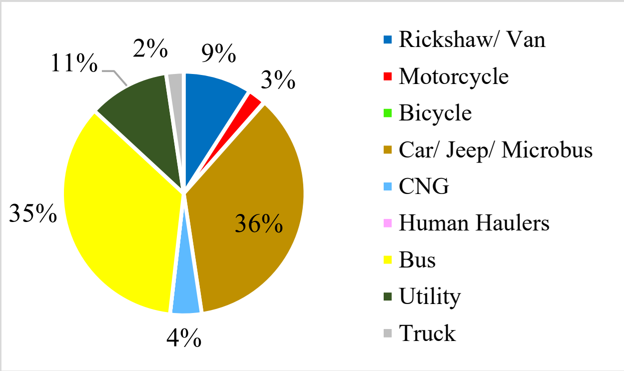
(e) Average

Figure B.6: Segment Directional Flow Variation at MMF

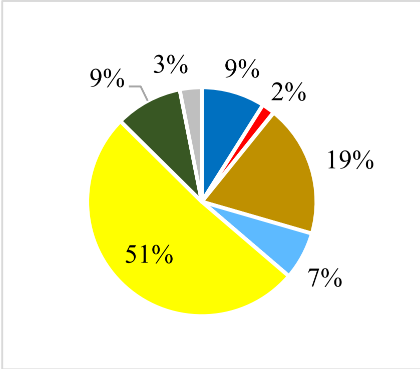
APPENDIX C

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR MODAL COMPOSITION OF TRAFFIC FLOW

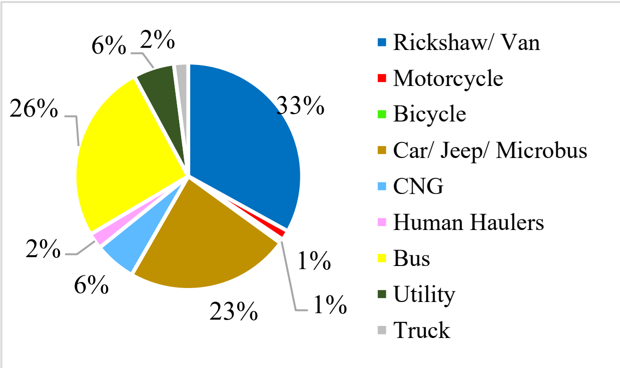
Shaheed Ahsanullah Master Flyover



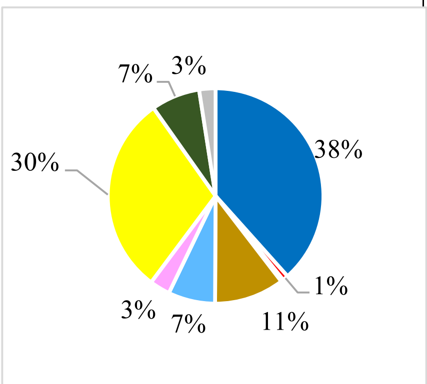
1-2



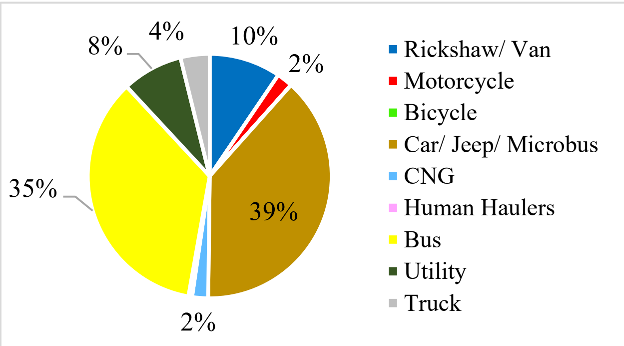
2-1



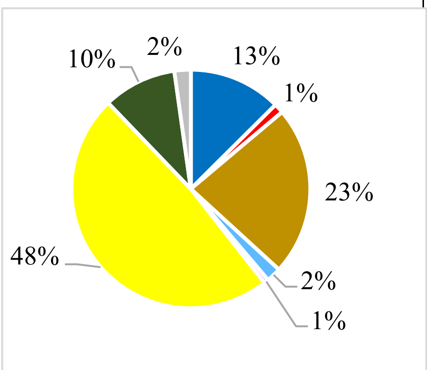
2-3



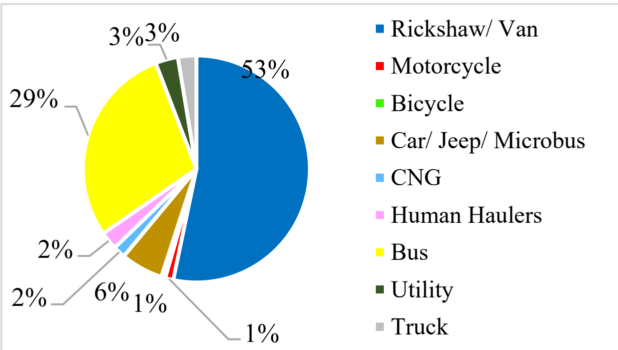
3-2



1-4



4-1



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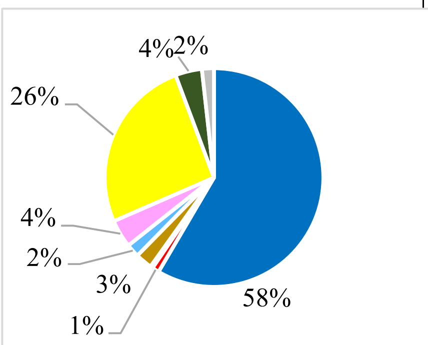


5-1

(Figure C.1 continued)

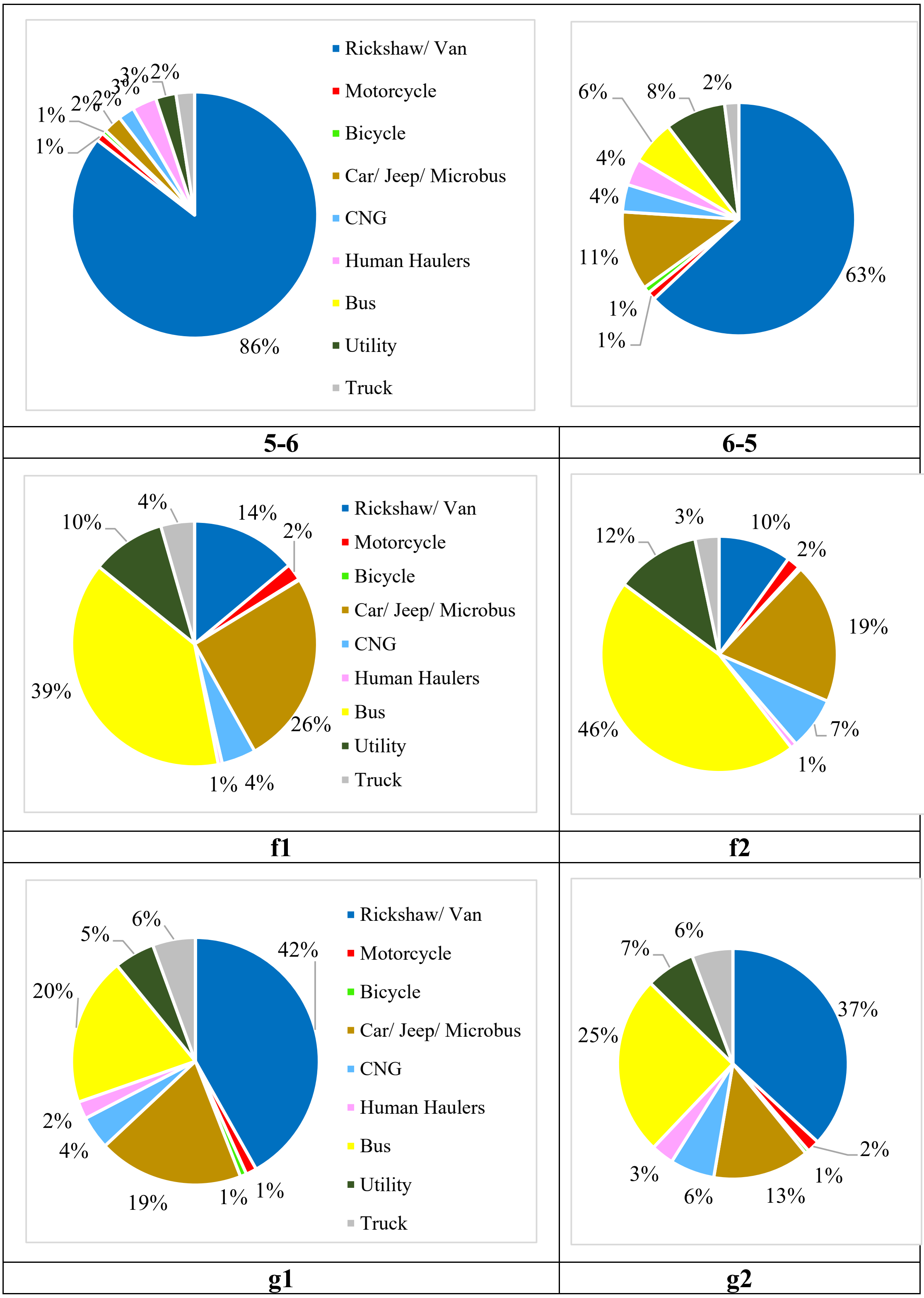
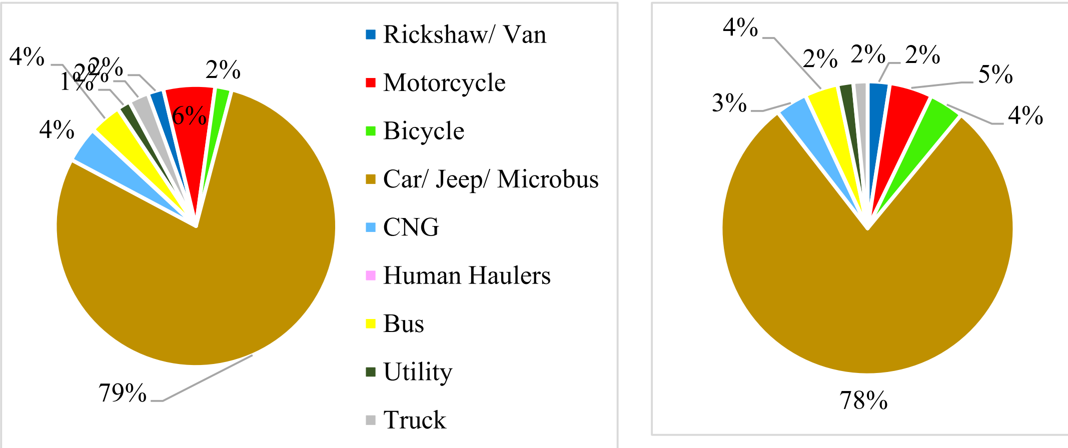


Figure C.1: Segment Direction Modal Comparison at SAMF

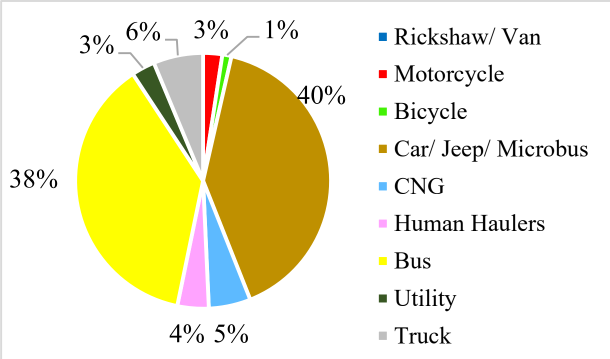
Banani Overpass



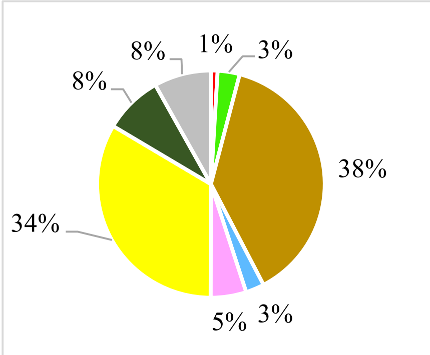
a1	a2

Figure C.2: Segment Direction Modal Comparison at Banani Overpass

Mohakhali Flyover



1-2



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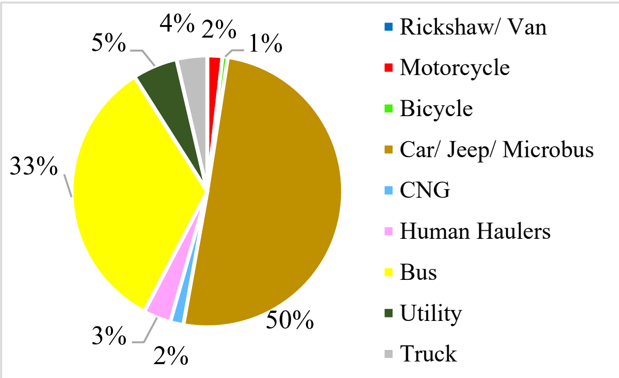

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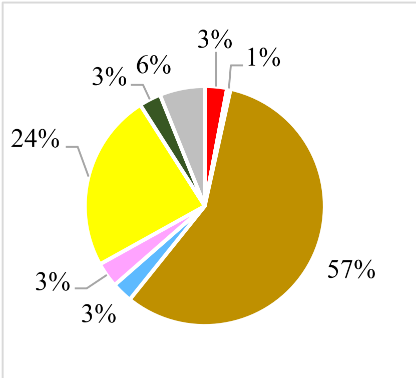

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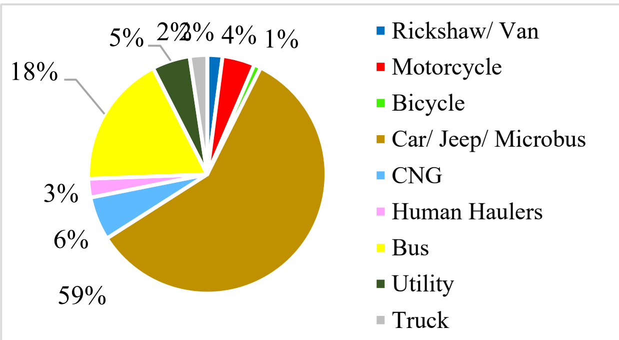

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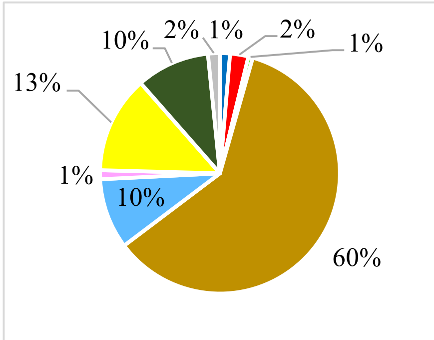

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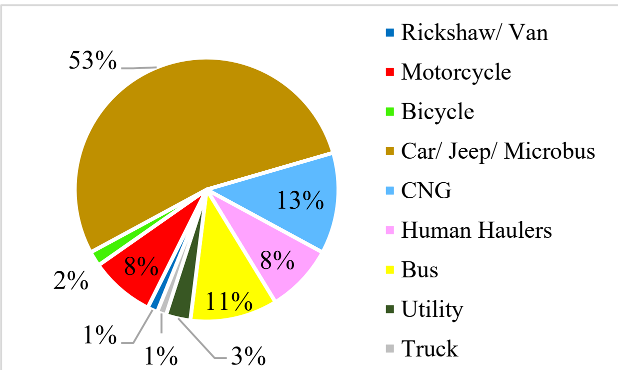

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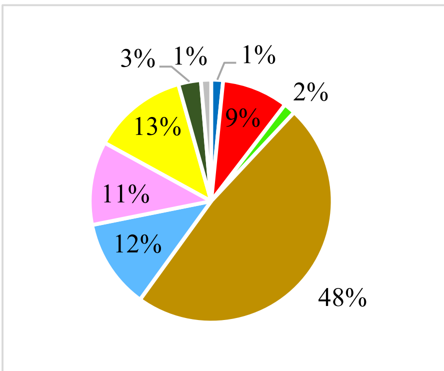

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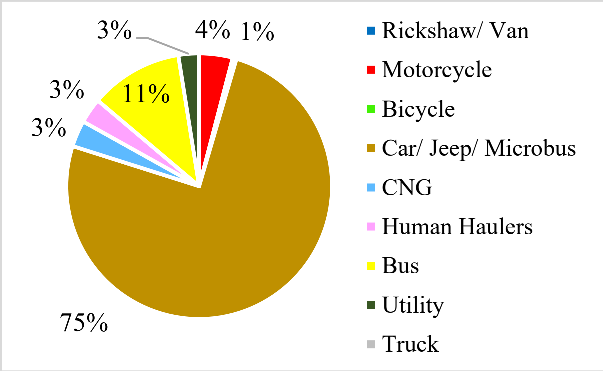

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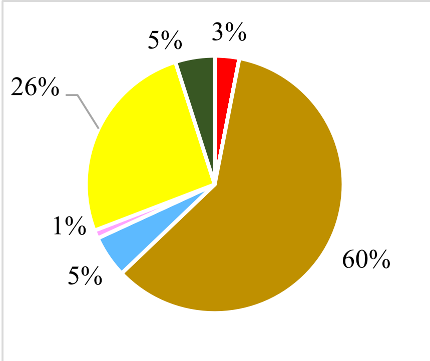

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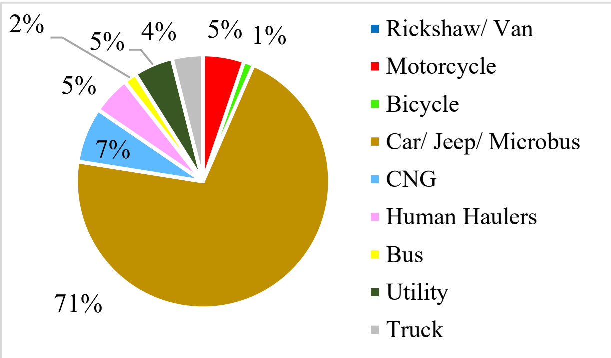

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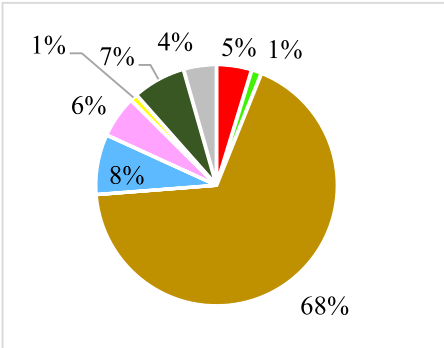

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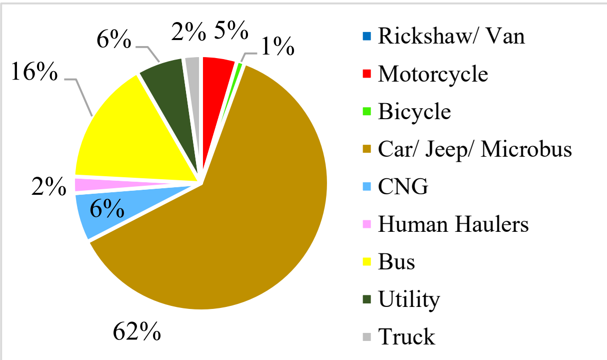

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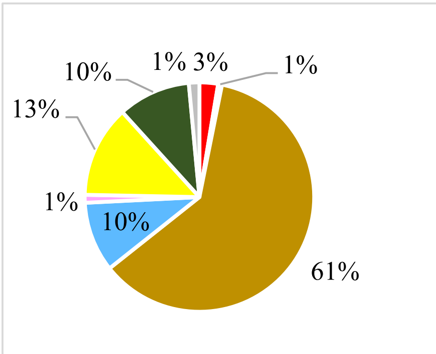

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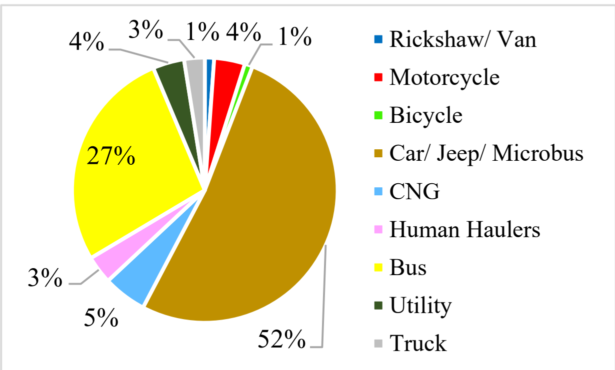

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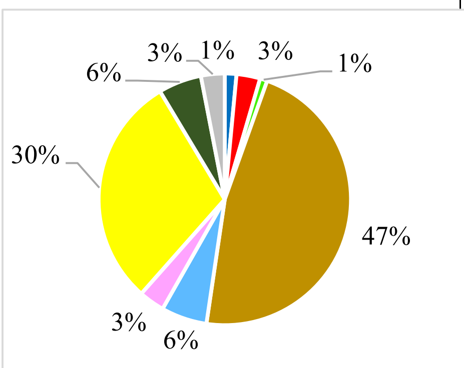

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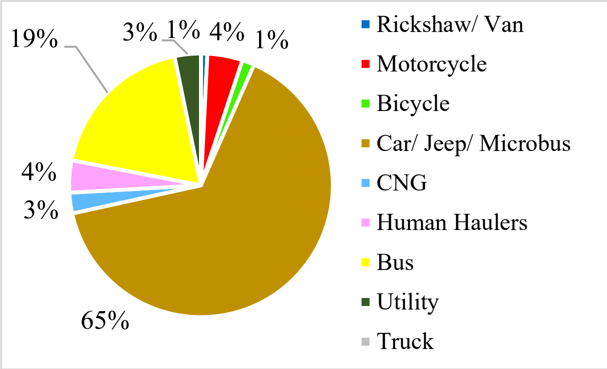

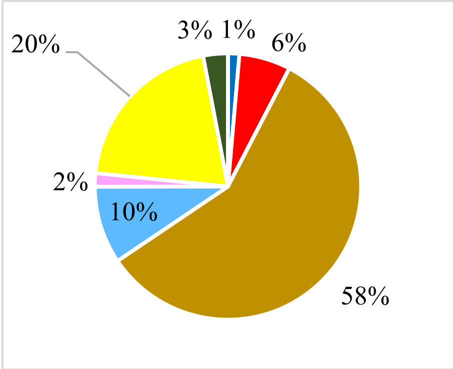

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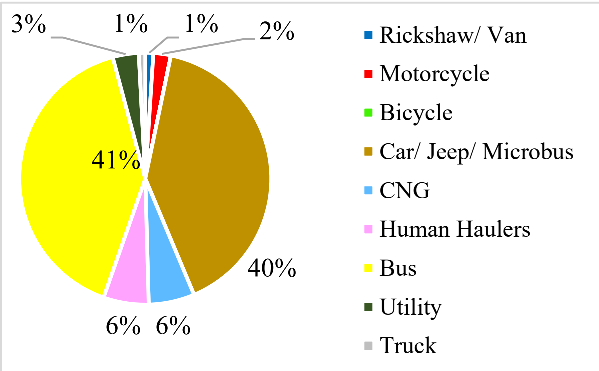

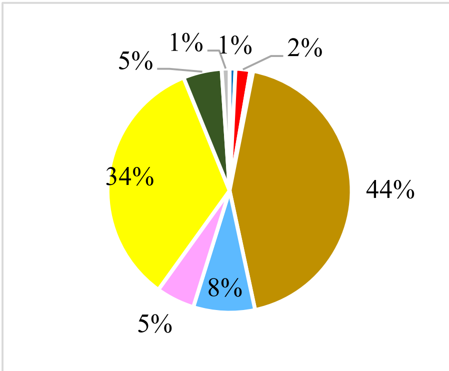

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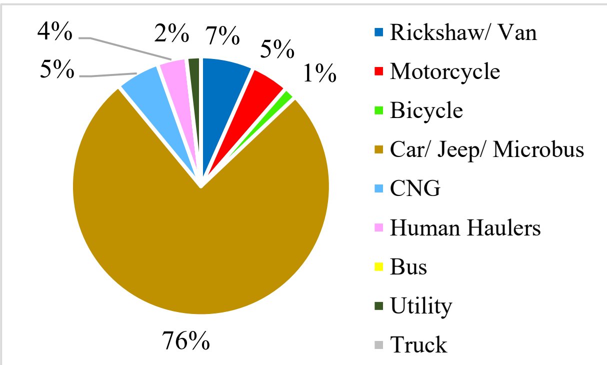

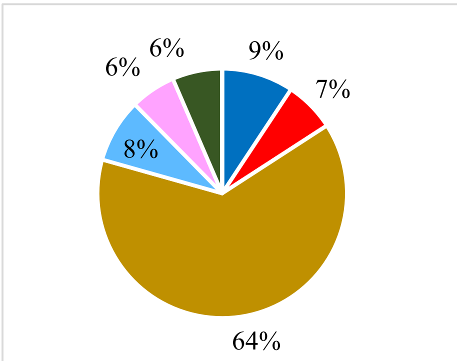

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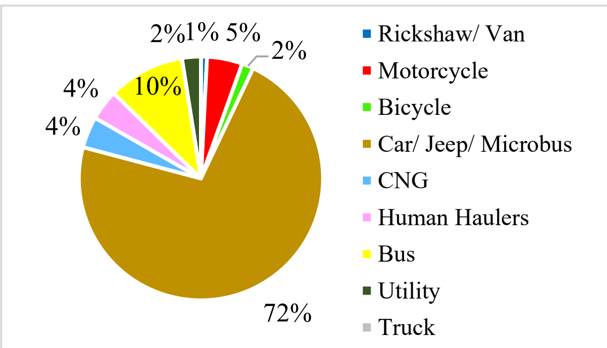

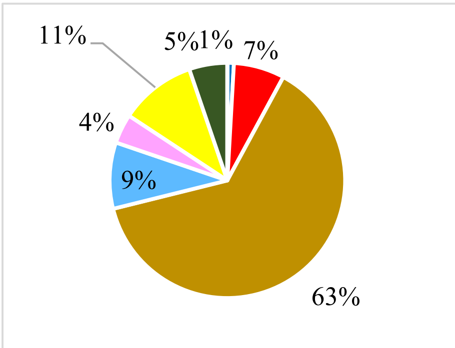

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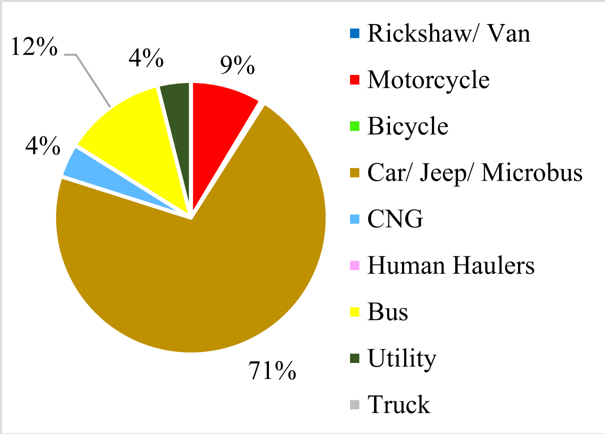

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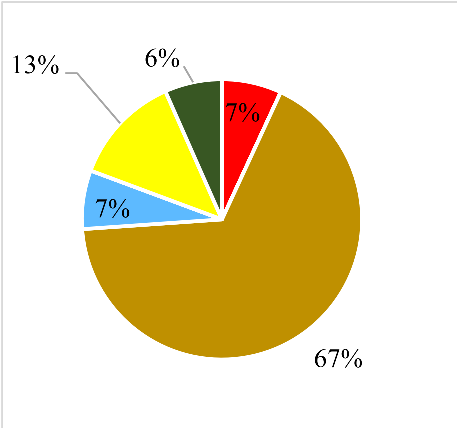

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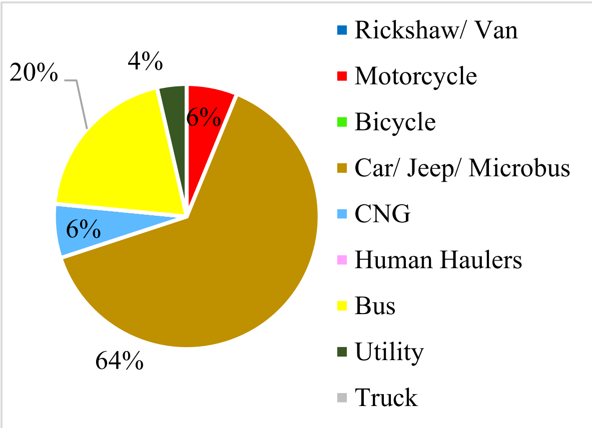

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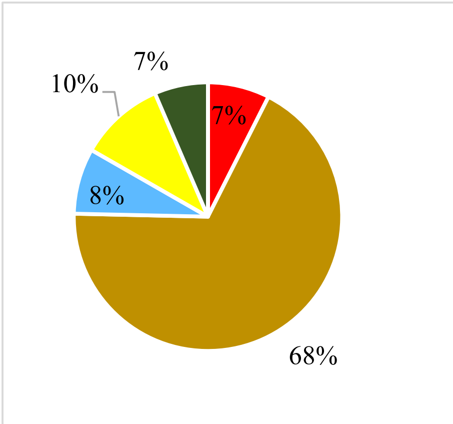

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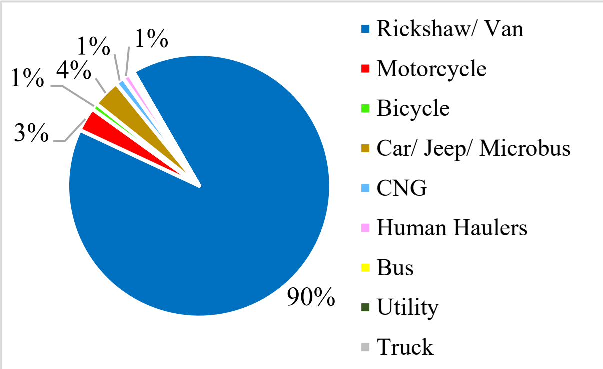
Figure C.3: Segment Direction Modal Comparison at Mohakhali Flyover

Khilgaon Flyover



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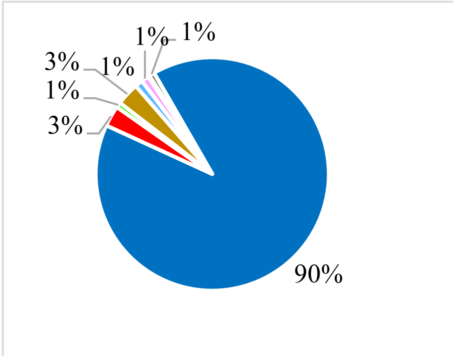

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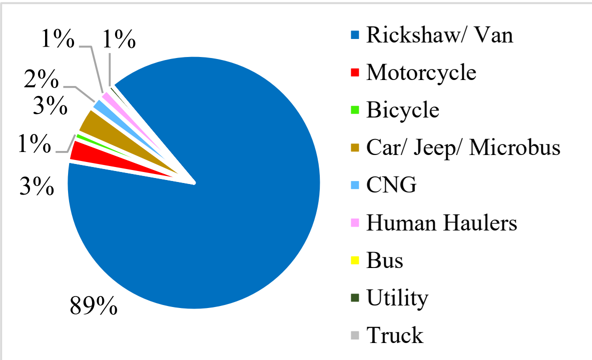

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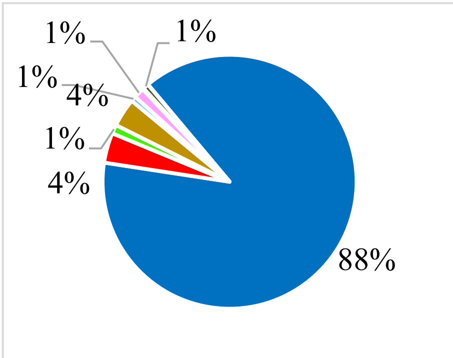

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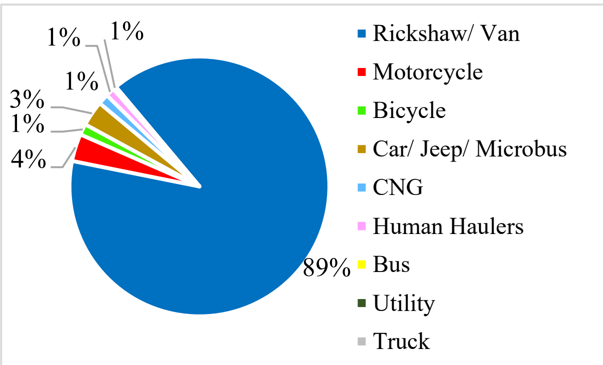

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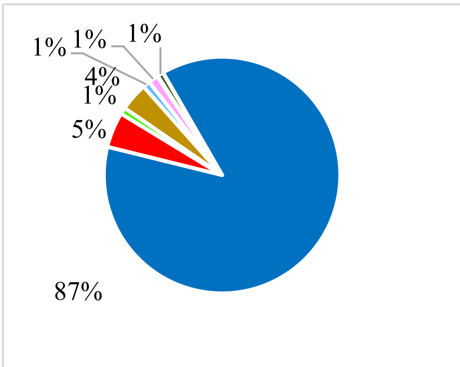

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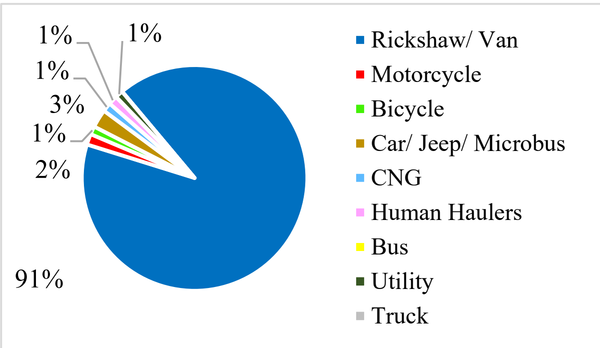

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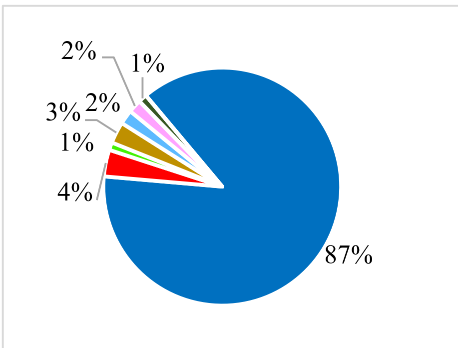

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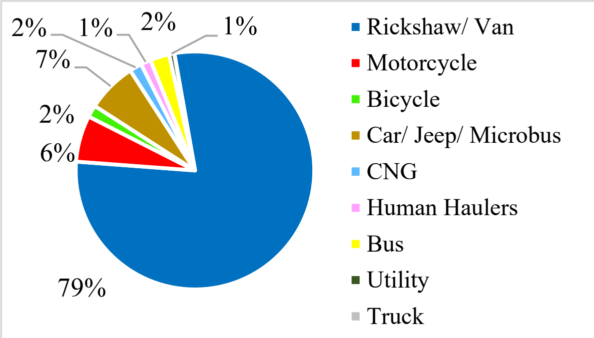

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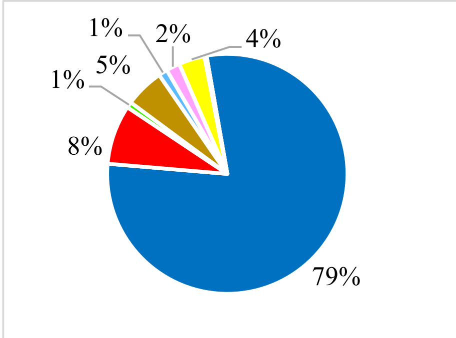

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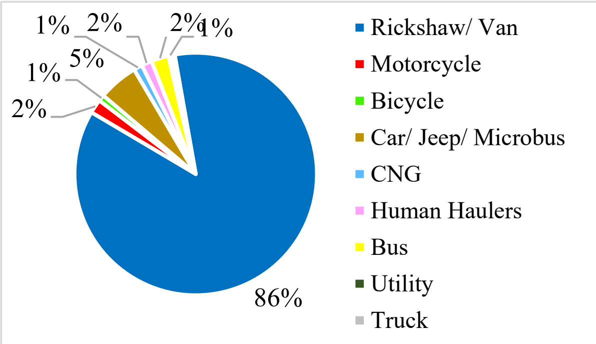

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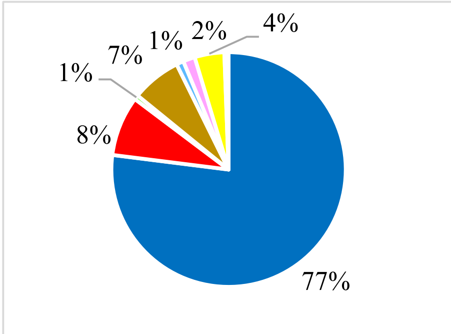

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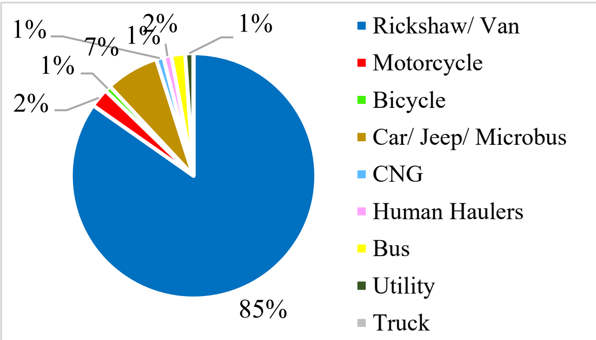

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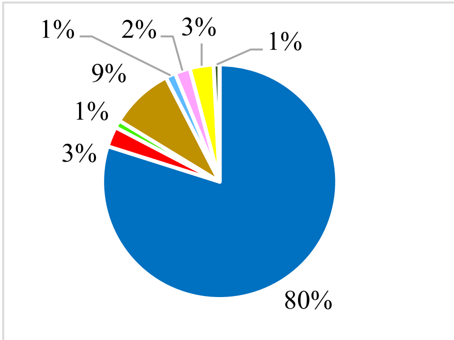

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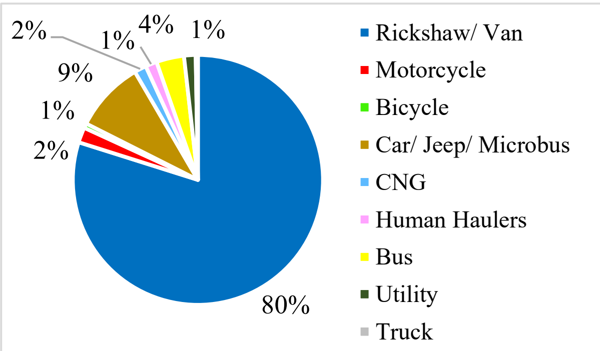

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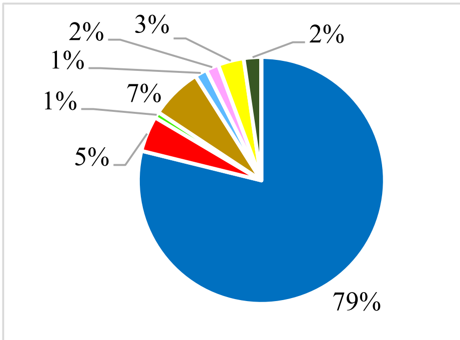

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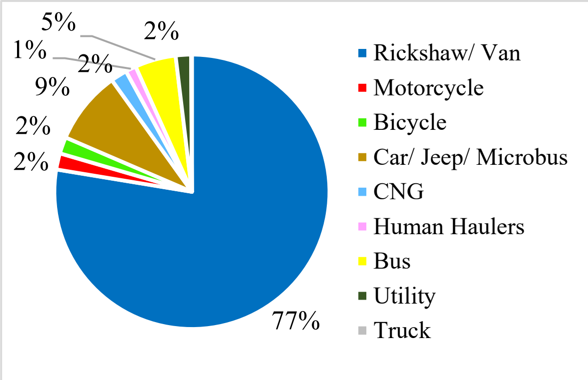

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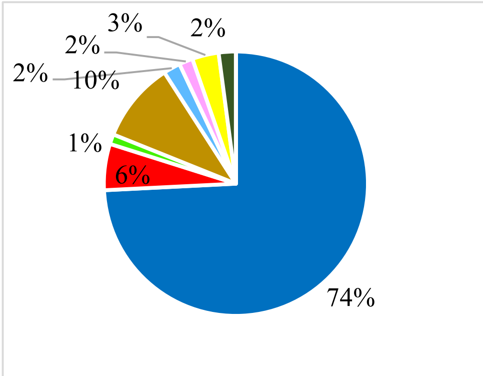

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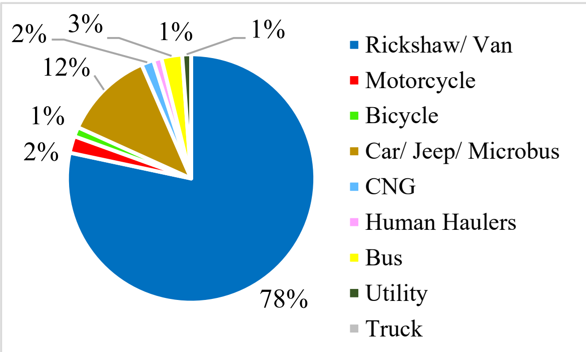

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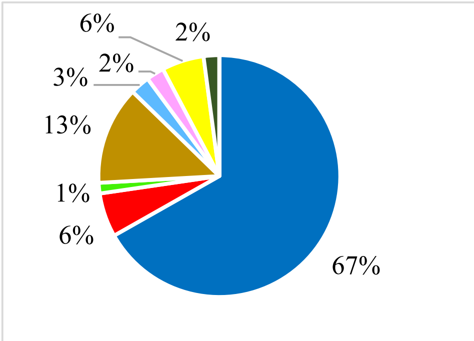

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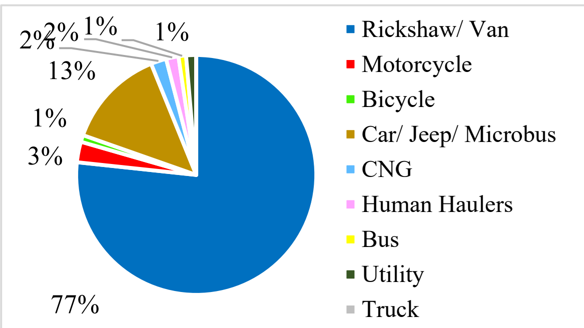

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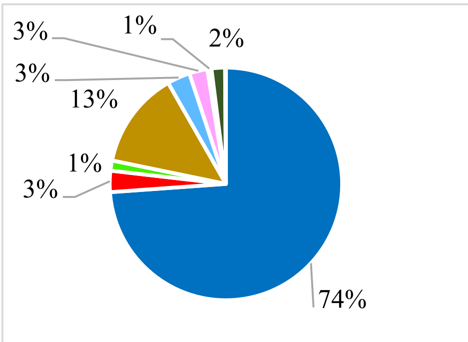

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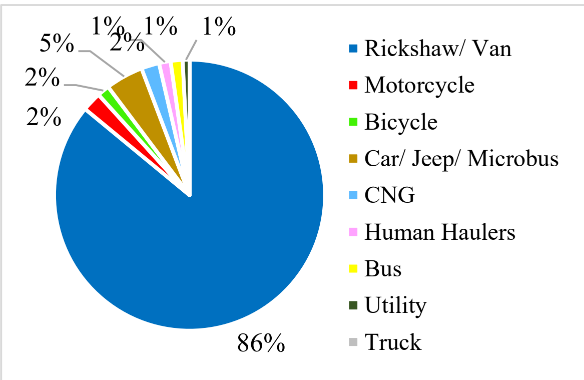

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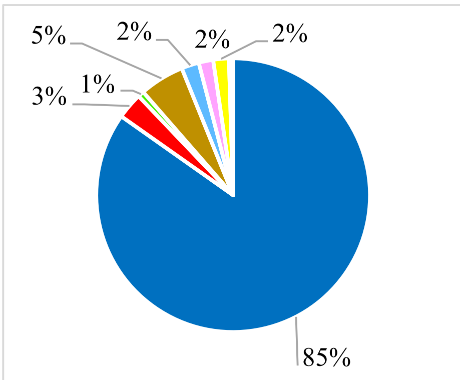

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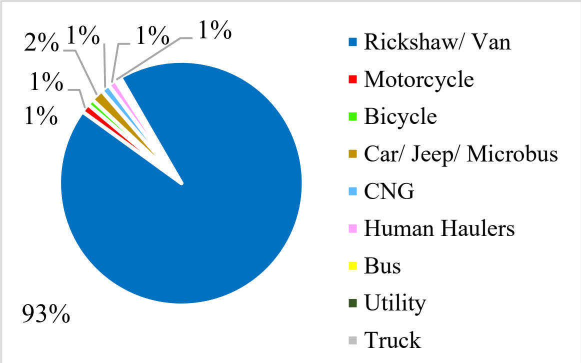

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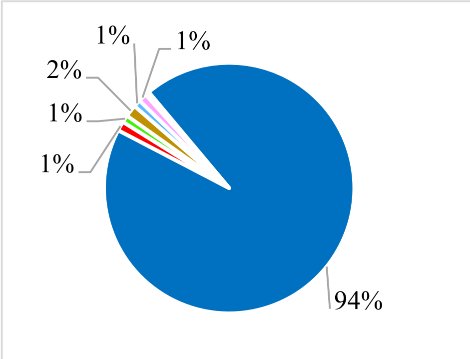

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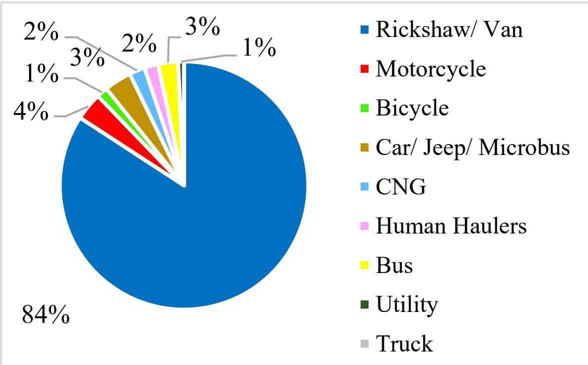

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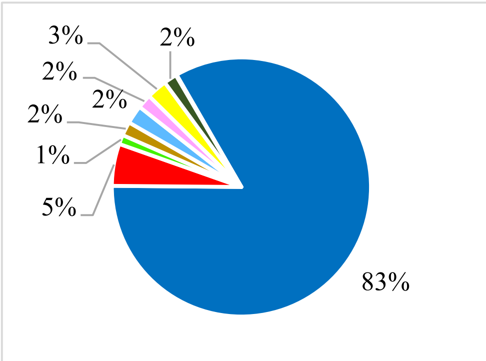

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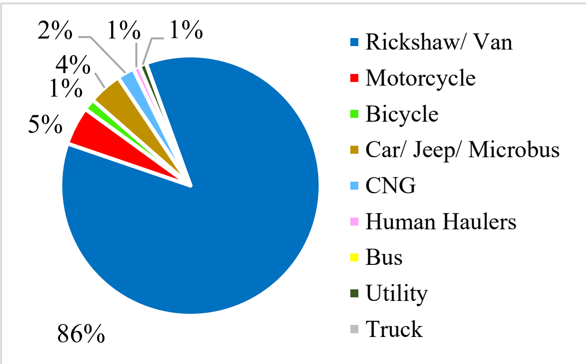

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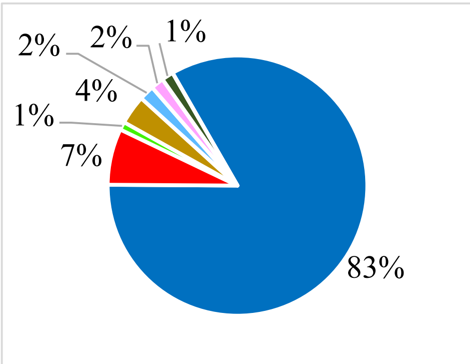

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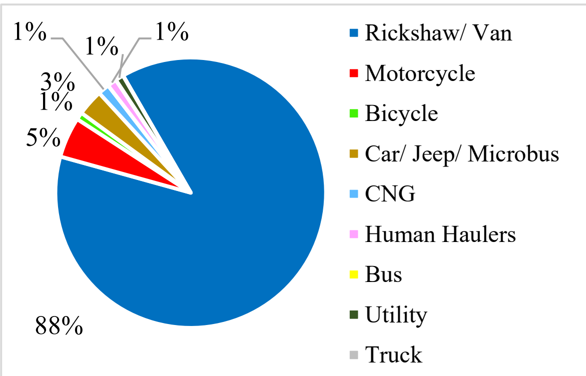

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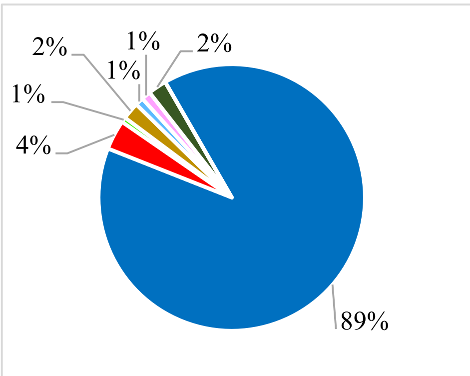

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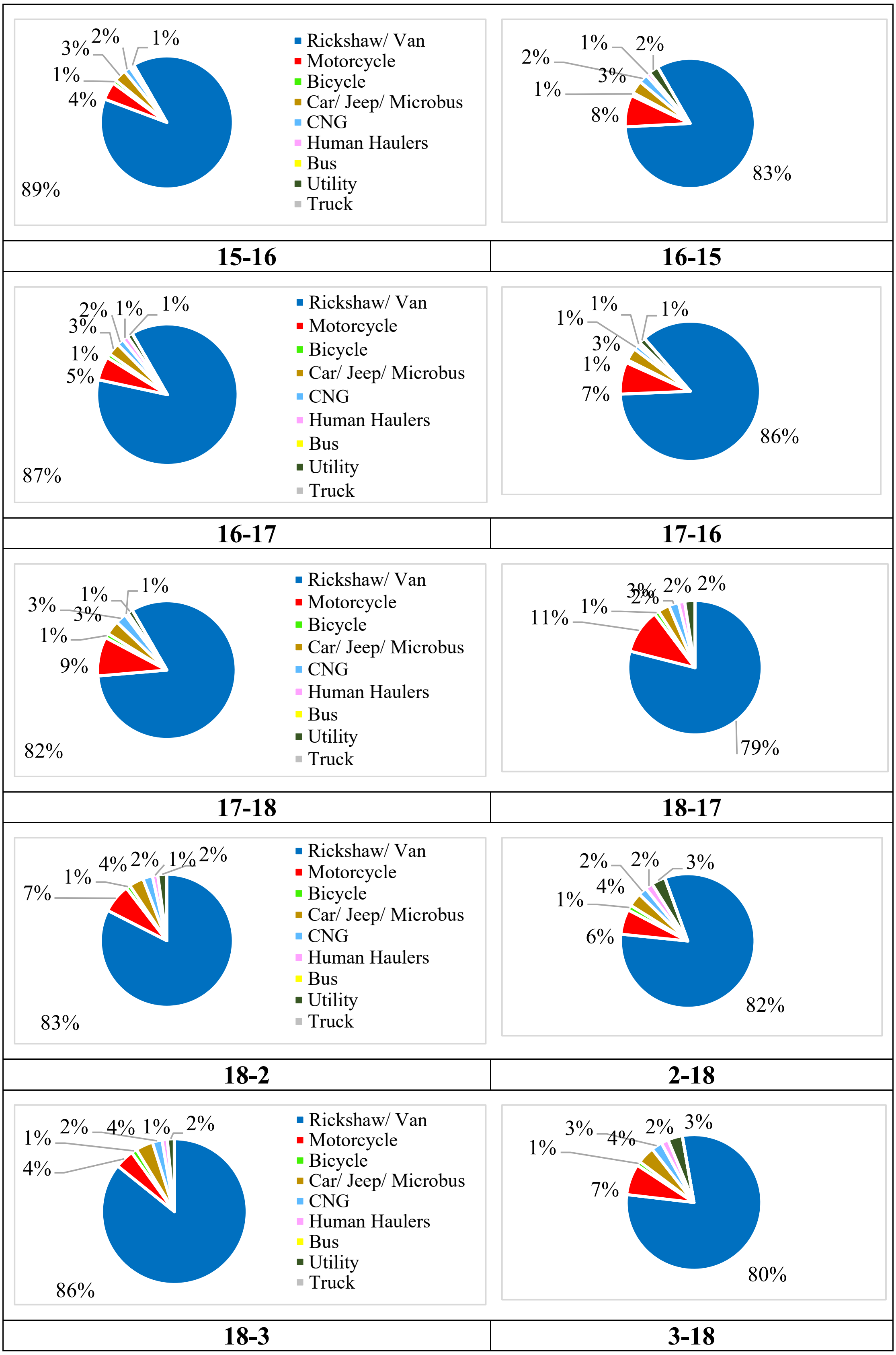
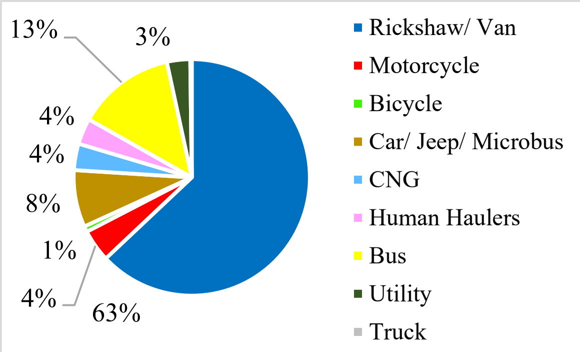


Figure C.4: Segment Direction Modal Comparison at Khilgaon Flyover

Jatrabari-Gulistan Flyover



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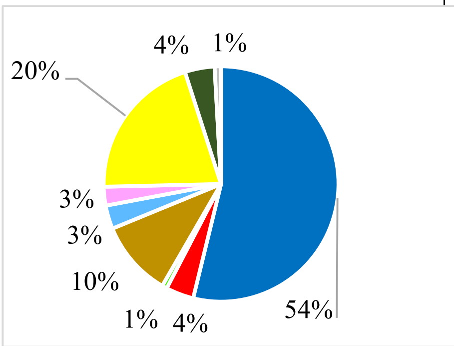

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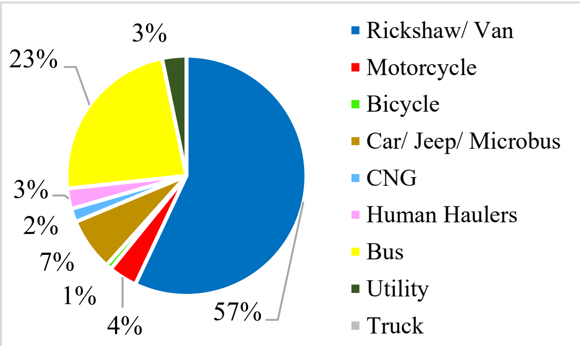

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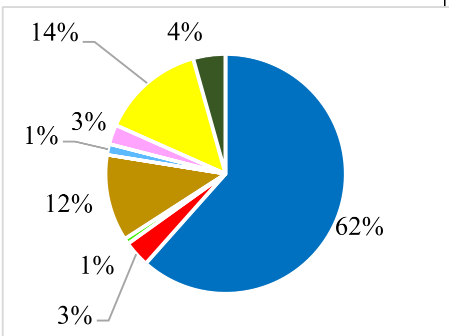

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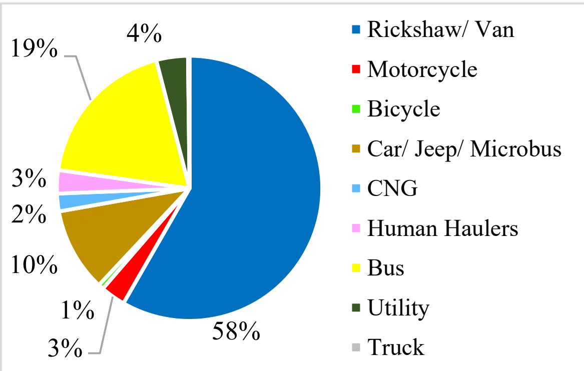

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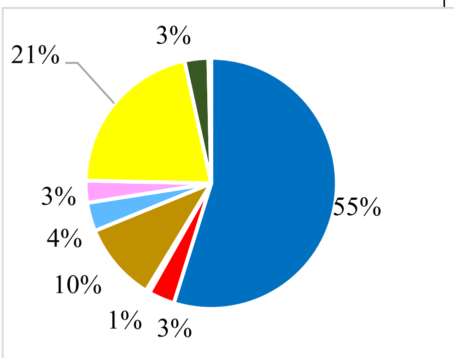

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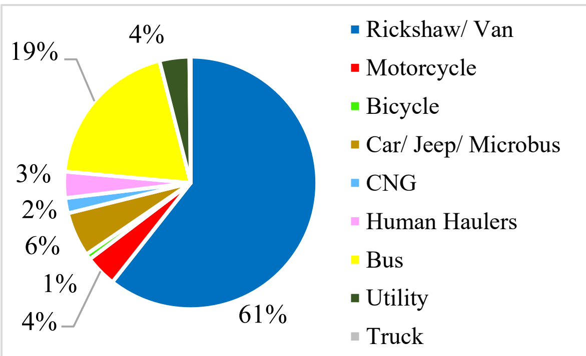

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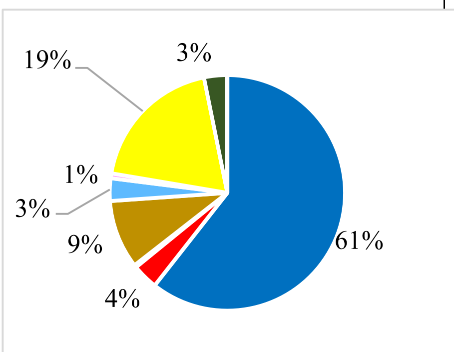

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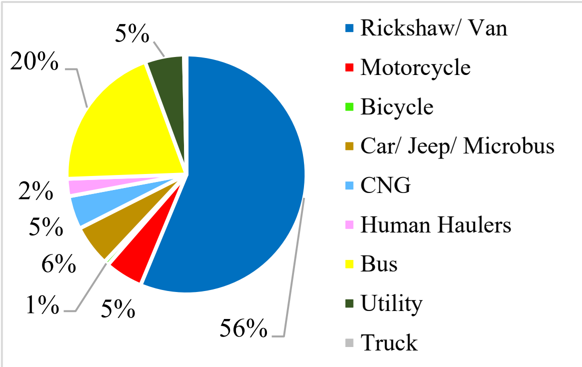

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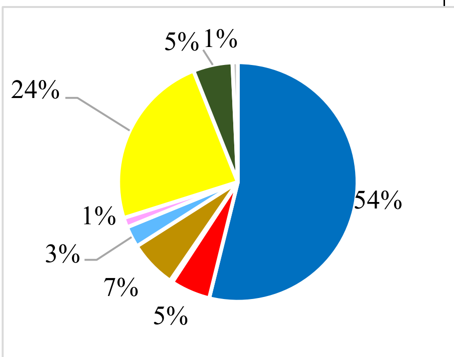

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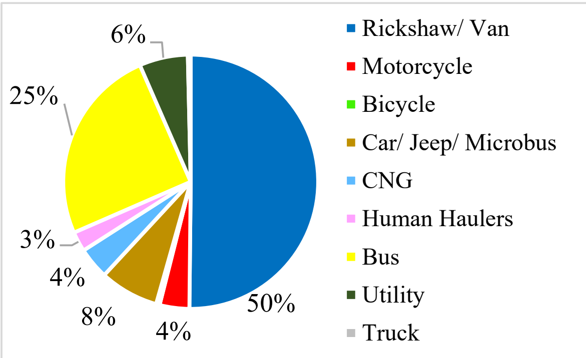

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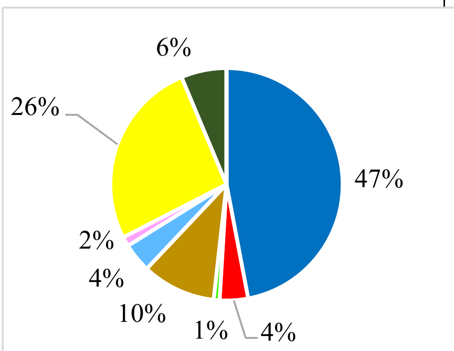

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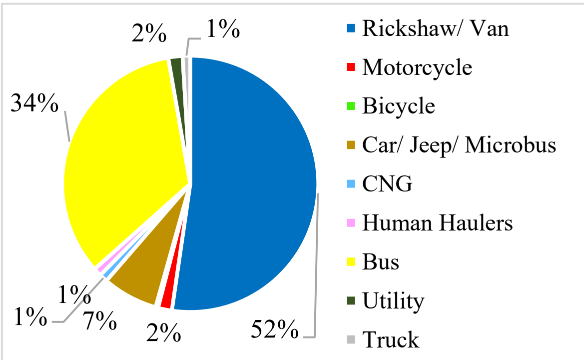

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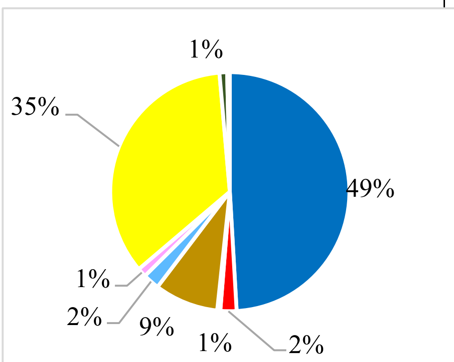

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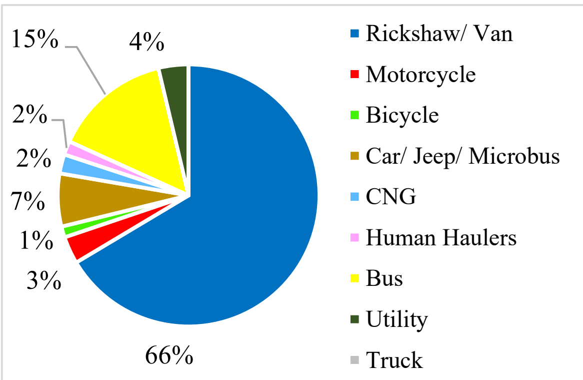

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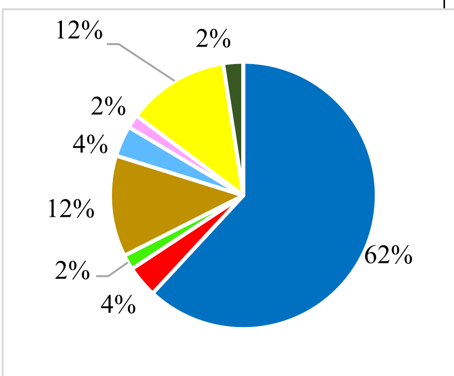

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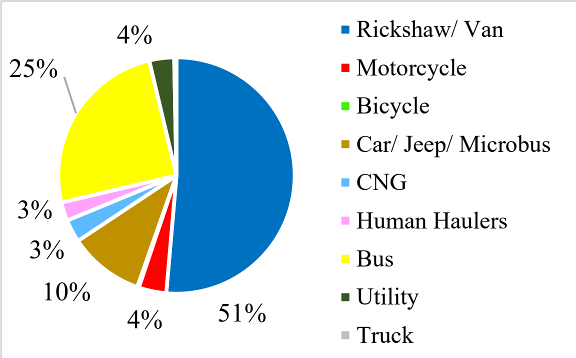

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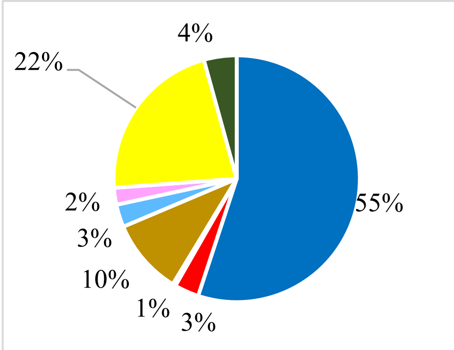

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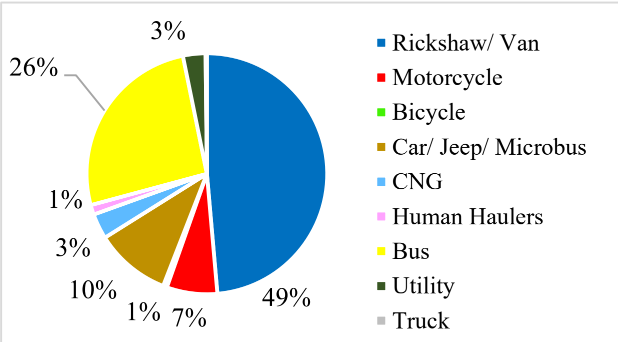

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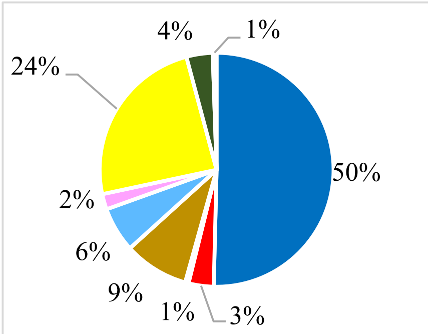

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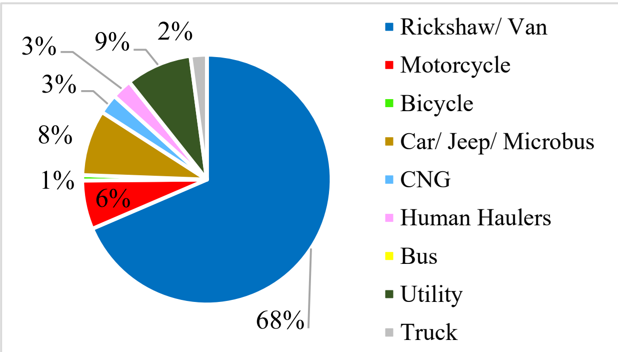

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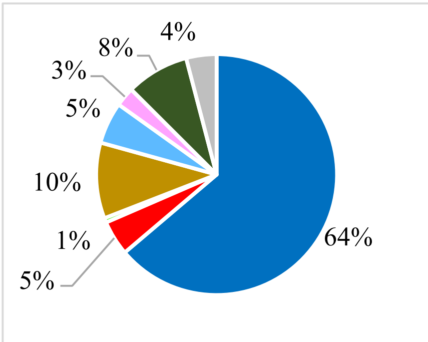

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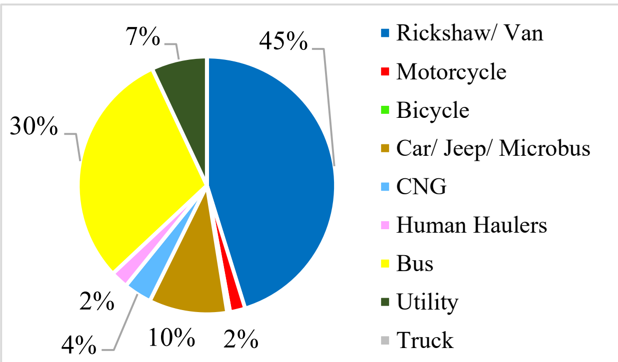

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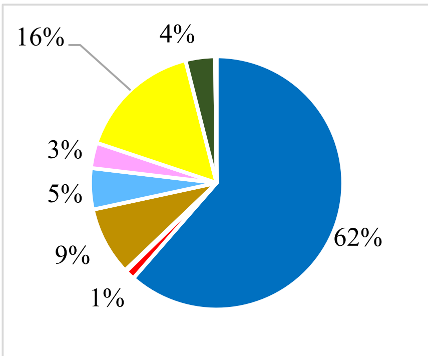

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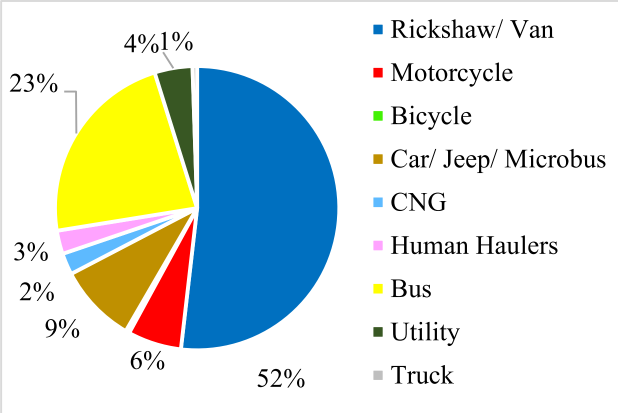

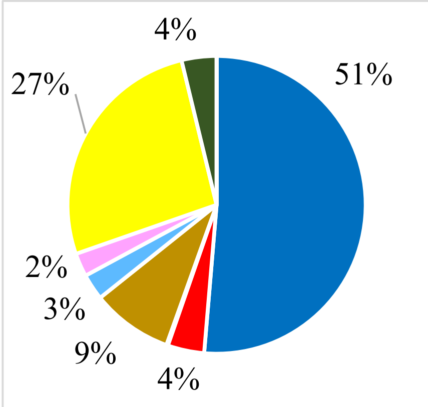

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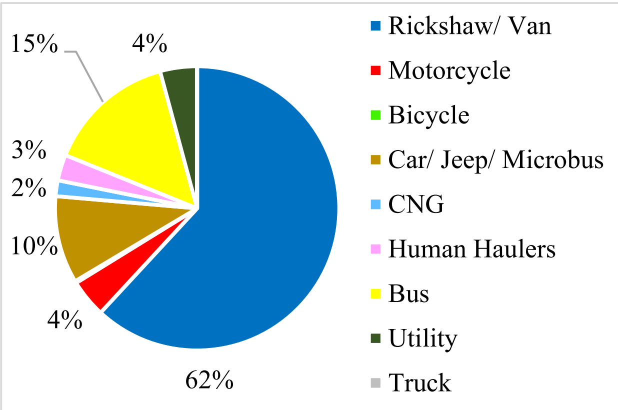

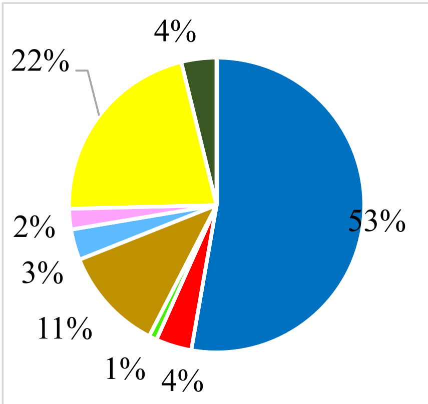

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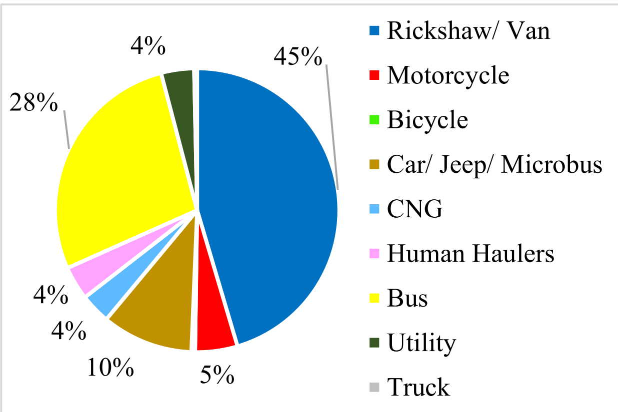
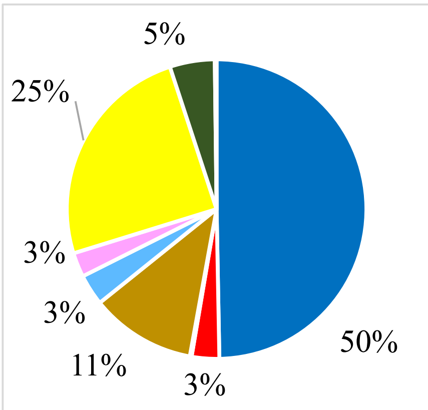
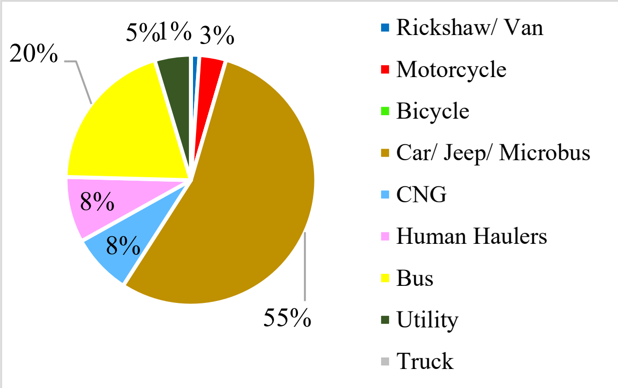




8-14	14-8

Figure C.5: Segment Direction Modal Comparison at MMHF

Moghbazar-Mouchak Flyover



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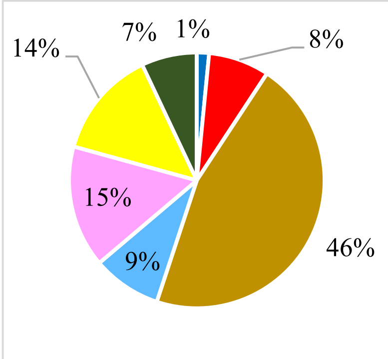

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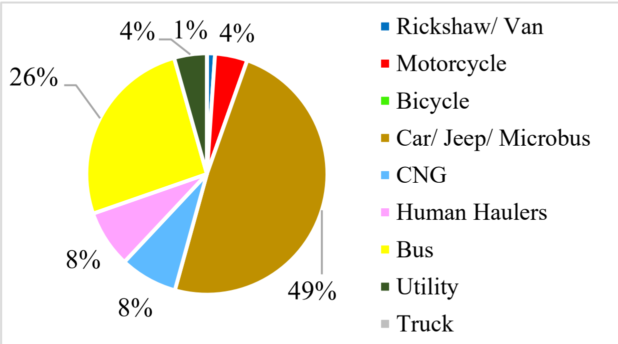

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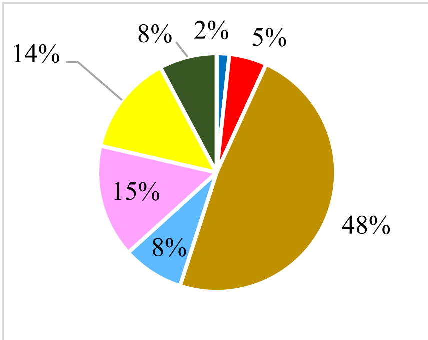

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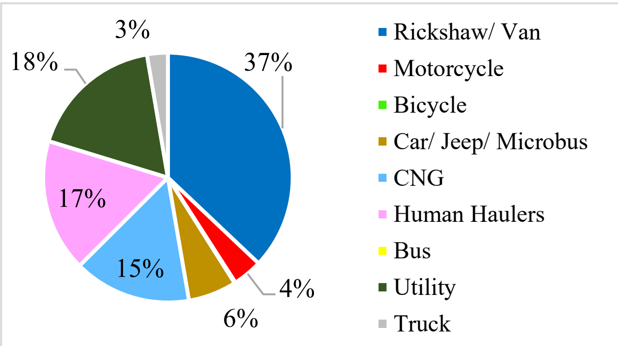

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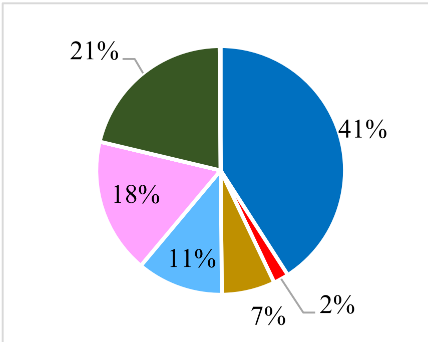

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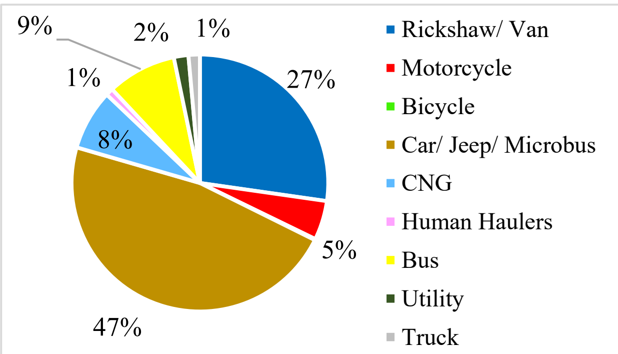

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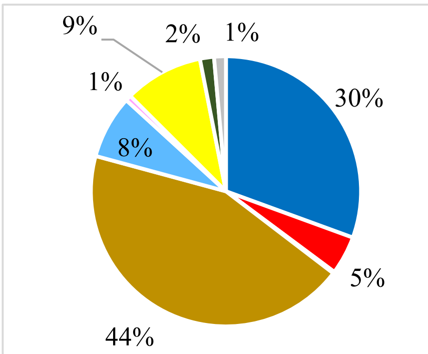

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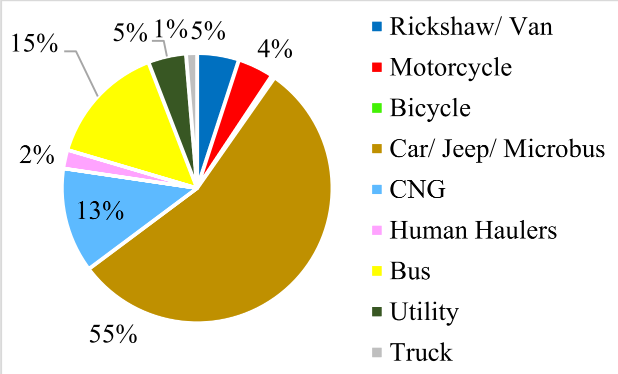

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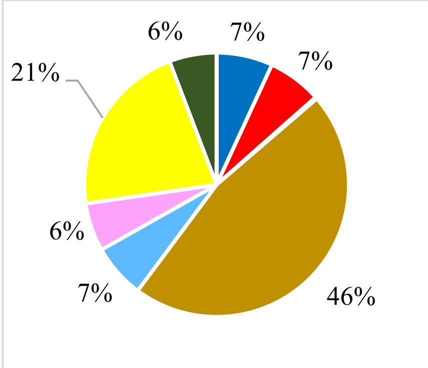

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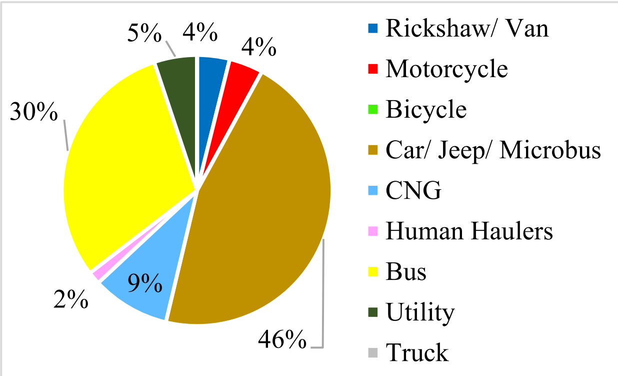

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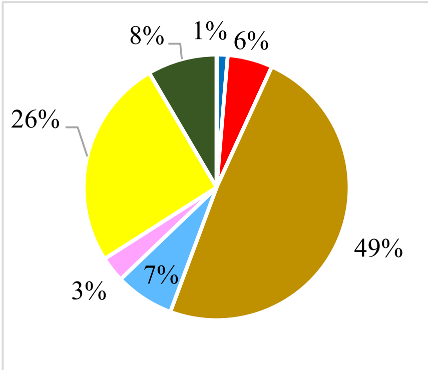

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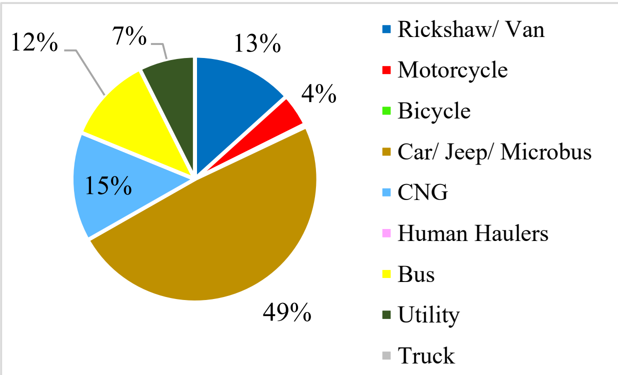

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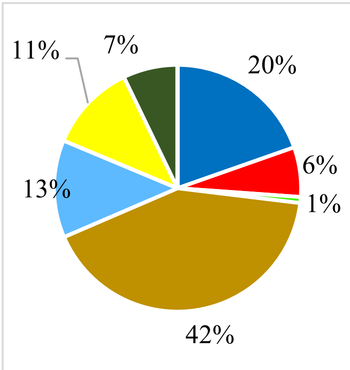

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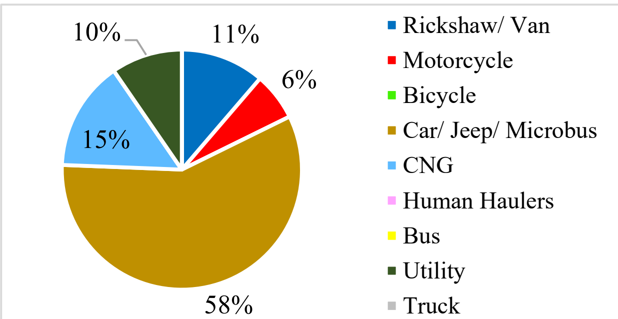

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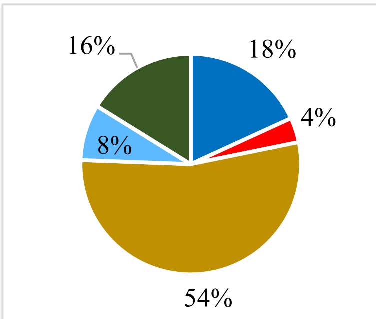

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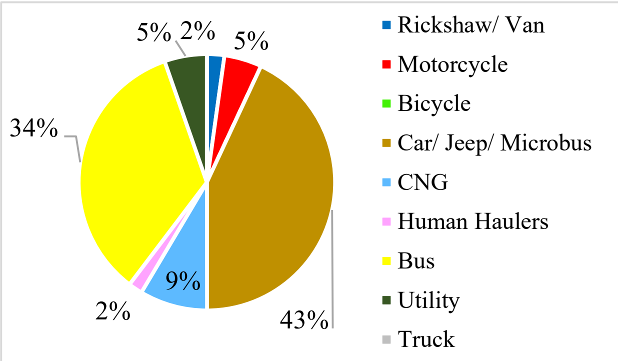

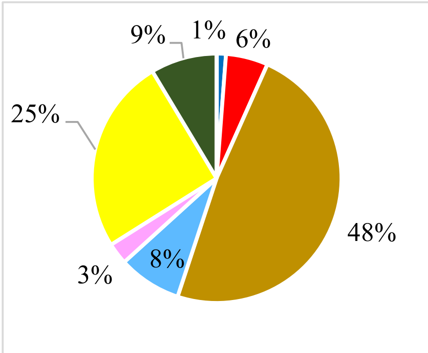

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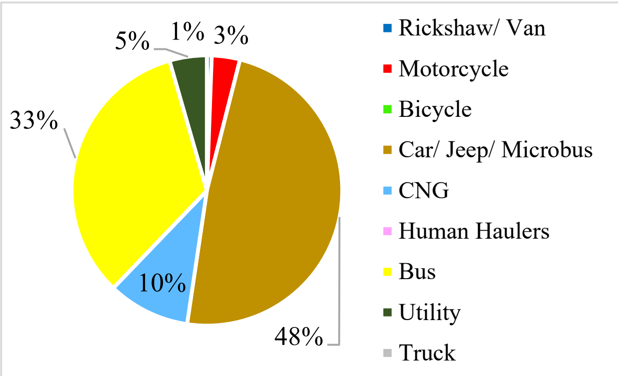

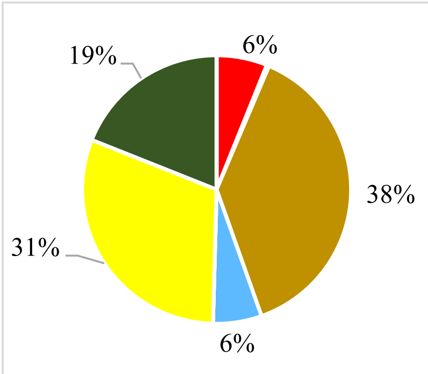

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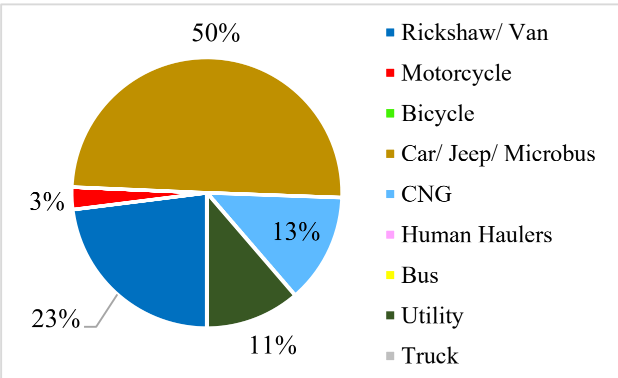

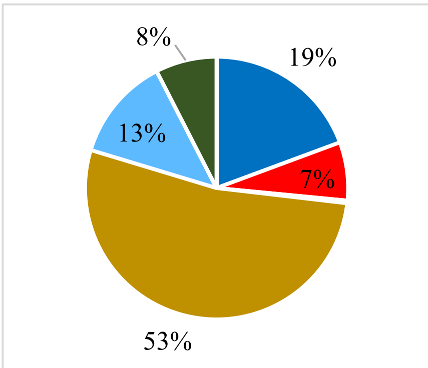

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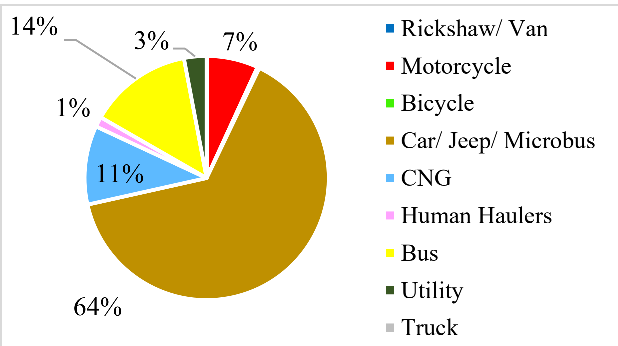

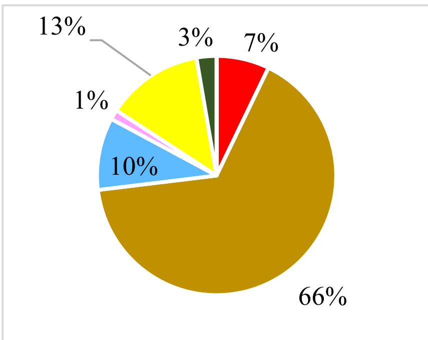

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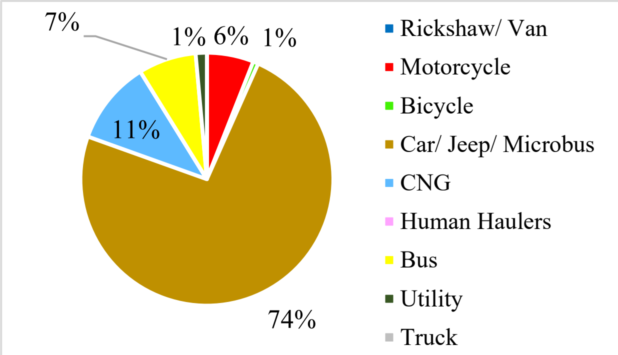

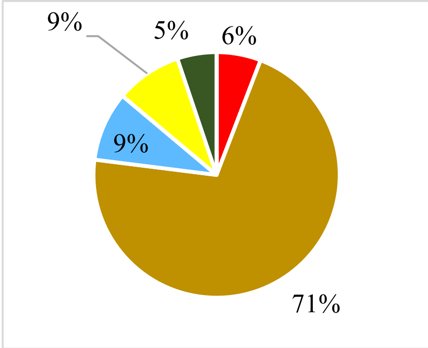

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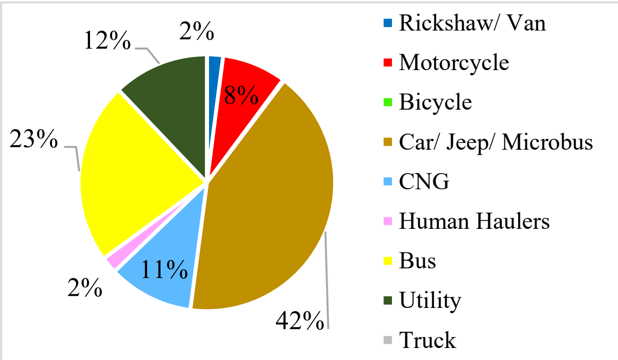

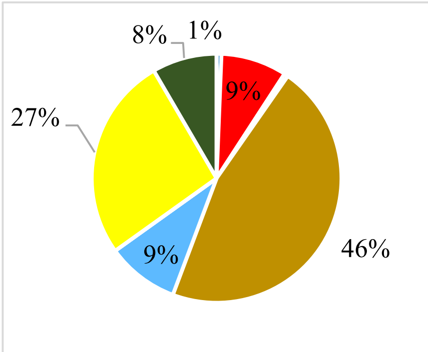

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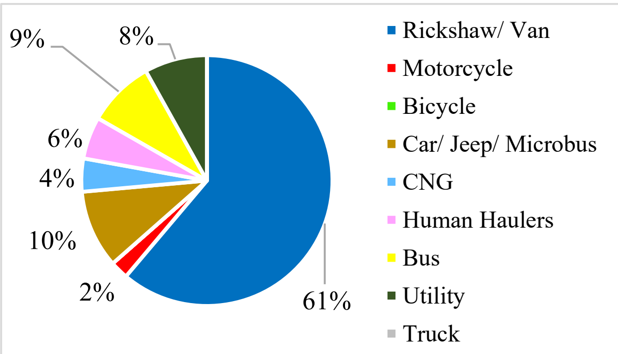

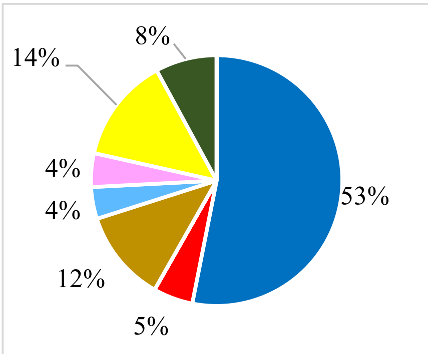

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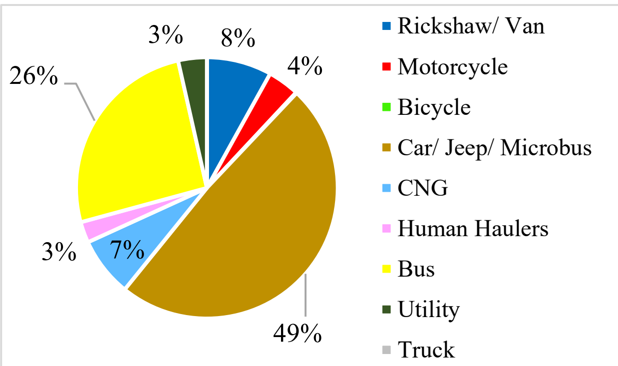

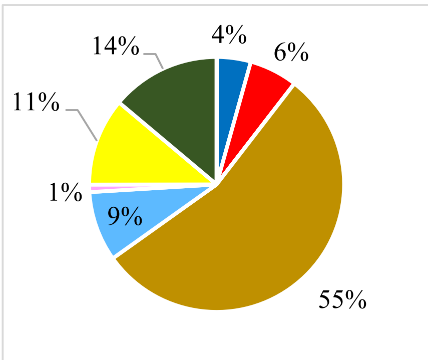

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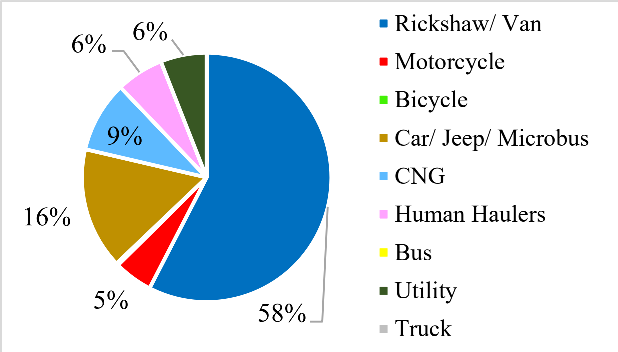

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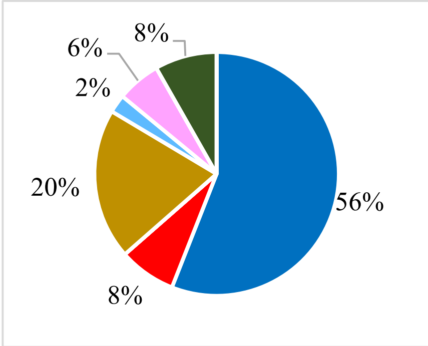

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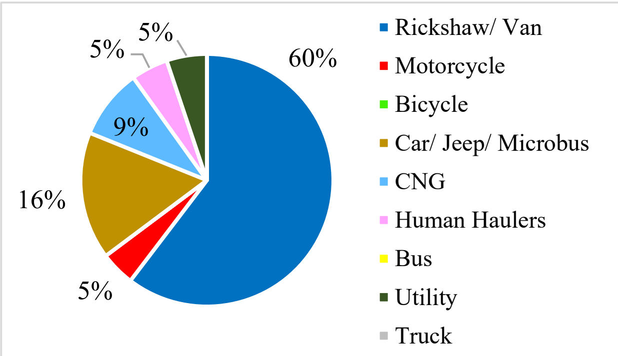

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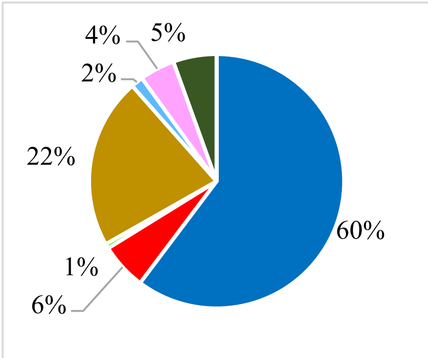

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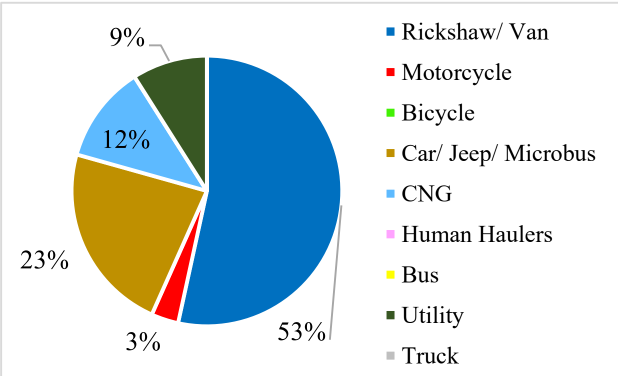

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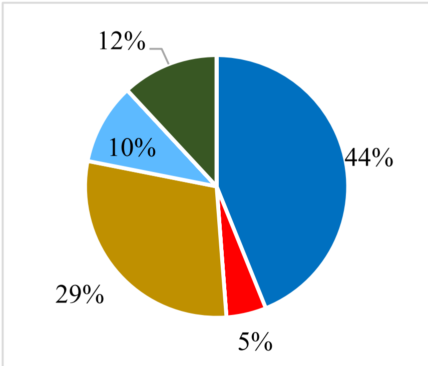

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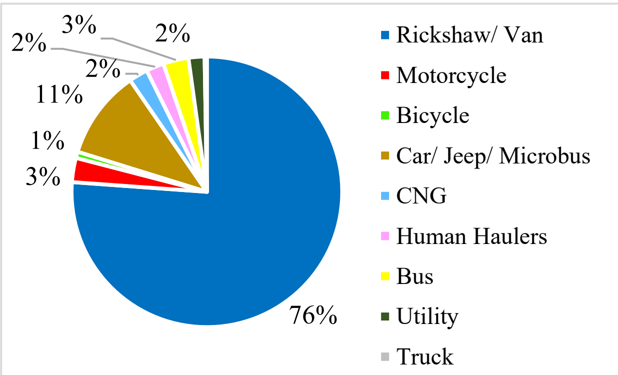

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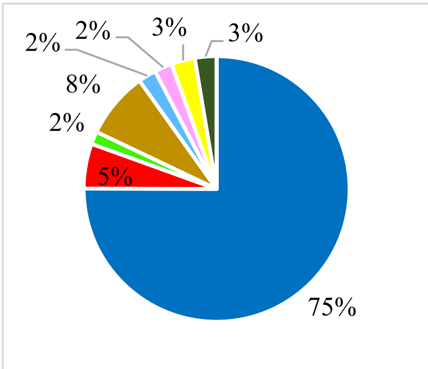

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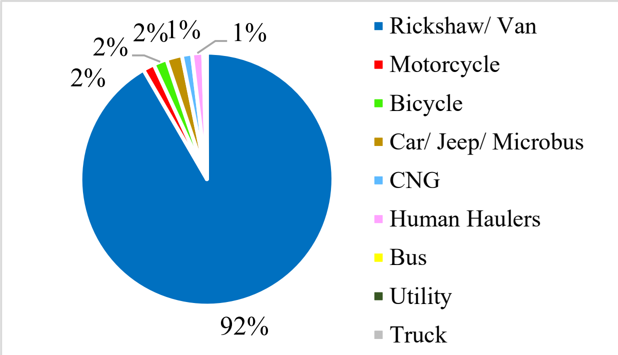

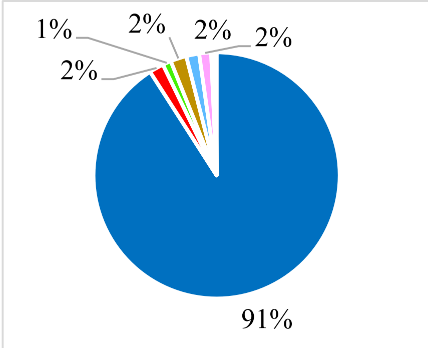

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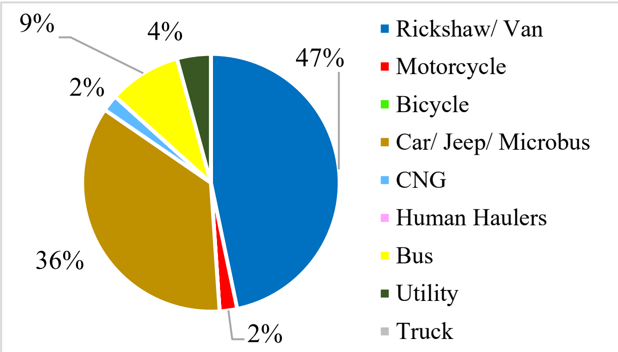

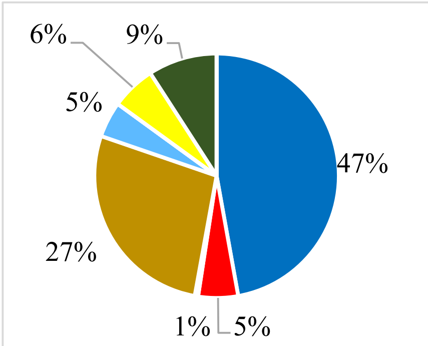

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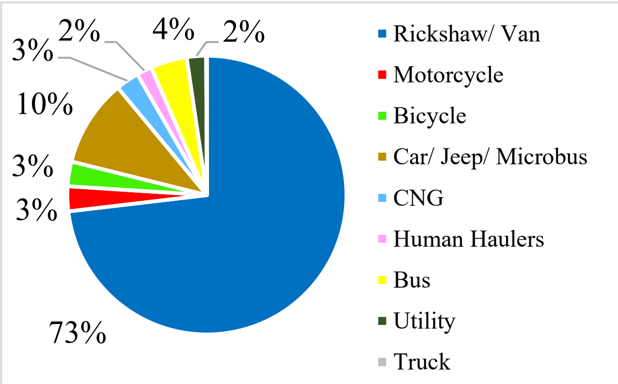

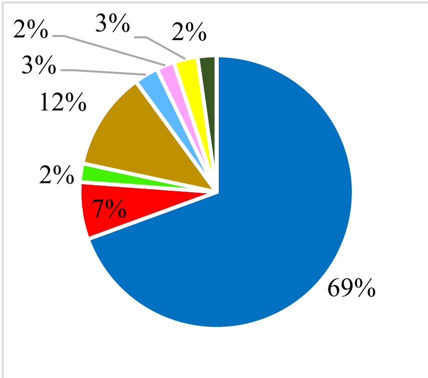

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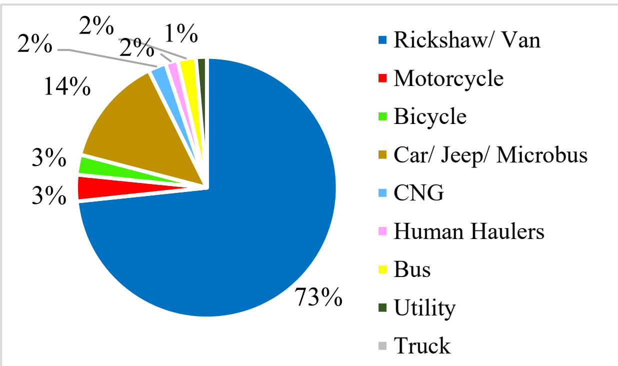

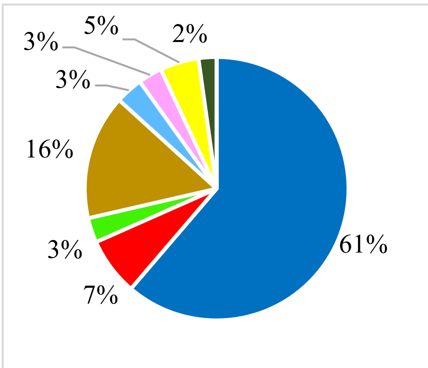

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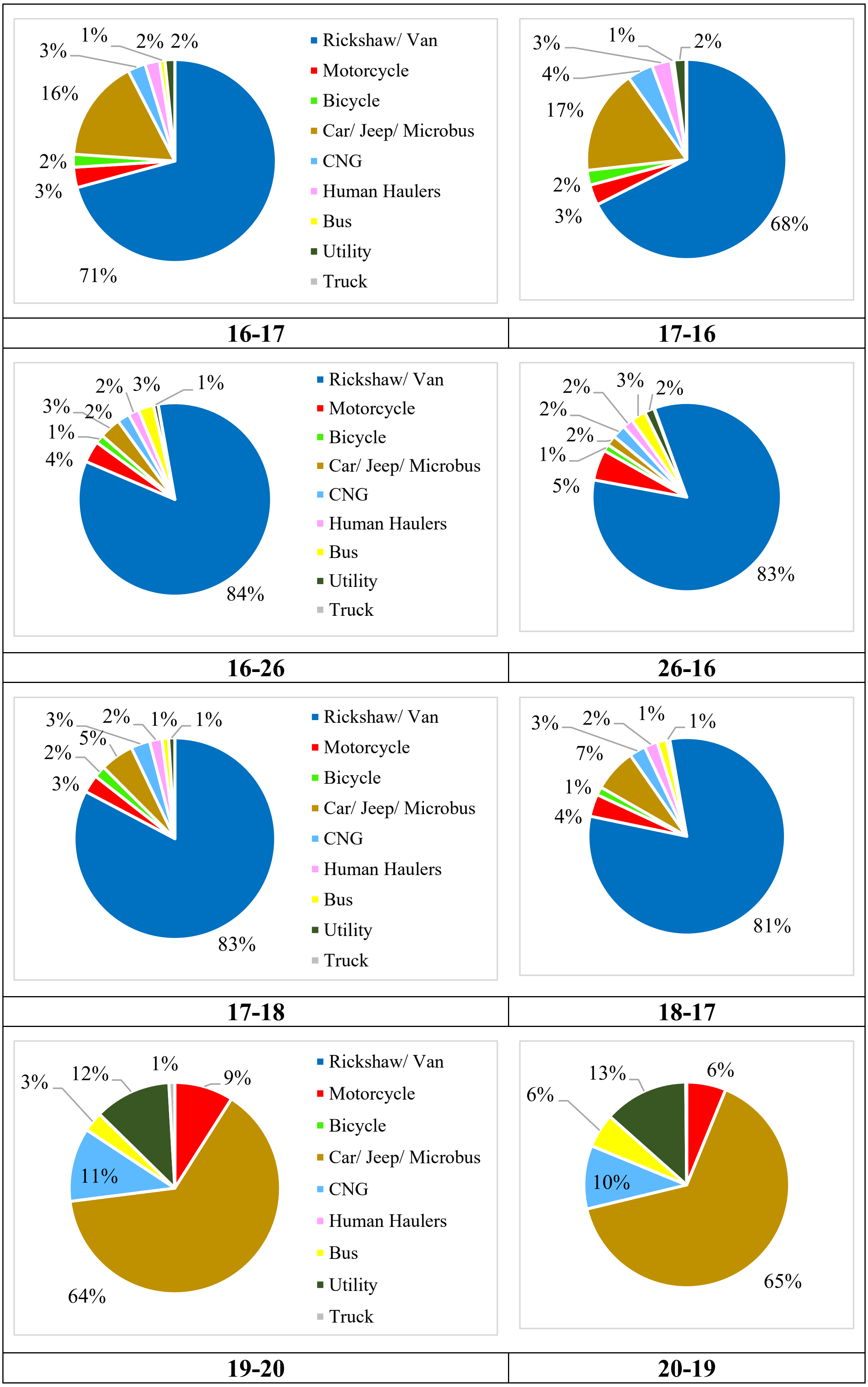

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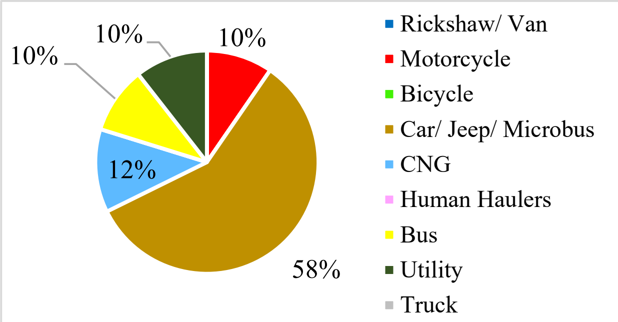

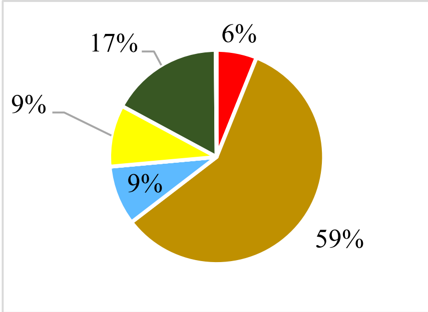

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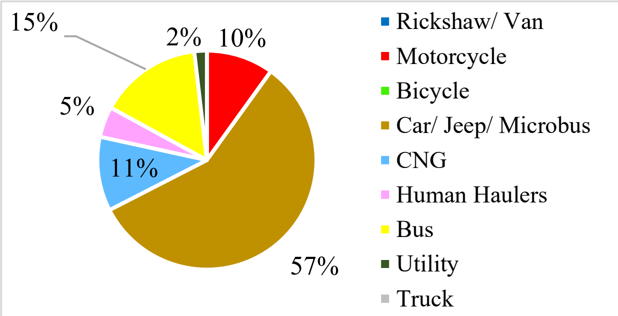

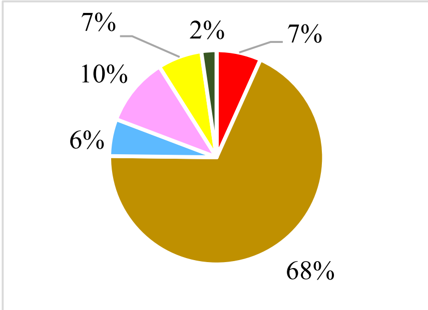

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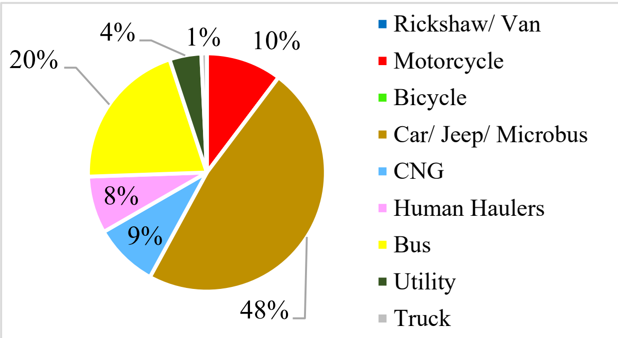
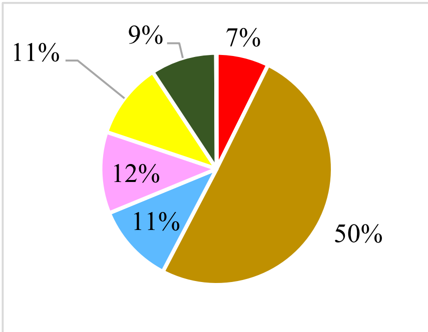
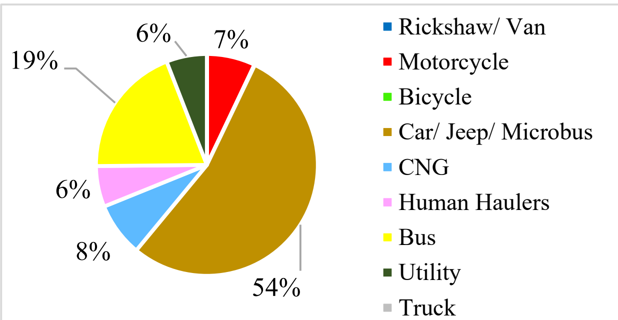
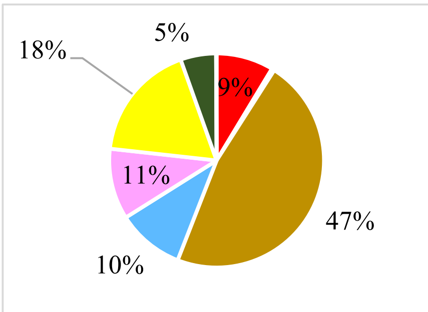




22-23	23-22





23-24	24-23

Figure C.6: Segment Direction Modal Comparison at MMF

APPENDIX D

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR ASSESSMENT OF ROADWAY CONDITIONS AND PARAMETERS

Table D.1: Lane Width Adjustment Factor at SAMF

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
1-2	1-2	32	3	10.67	1
	2-1	32	3	10.67	1
2-3	2-3	11	1	11.00	1
	3-2	11	1	11.00	1
1-4	1-4	35	3	11.67	1
	4-1	35	3	11.67	1
1-5	1-5	22	2	11.00	1
	5-1	22	2	11.00	1
5-6	5-6	22	2	11.00	1
	6-5	22	2	11.00	1
f	f1	23	2	11.50	1
	f2	23	2	11.50	1
g	g1	23	2	11.50	1
	g2	23	2	11.50	1

Table D.2: Parking and Bus Stoppage Adjustment Factors at SAMF

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
1-2	1-2	6	0.96	39	0.92	8	0.95	43	0.91
	2-1	5	0.96	32	0.94	7	0.96	49	0.90
2-3	2-3	2	0.89	35	0.86	2	0.89	6	0.98
	3-2	2	0.89	35	0.86	1	0.90	8	0.97
1-4	1-4	15	0.94	61	0.88	10	0.95	45	0.91
	4-1	11	0.95	72	0.86	5	0.96	42	0.92
1-5	1-5	15	0.91	13	0.97	4	0.94	24	0.95
	5-1	10	0.93	17	0.97	6	0.94	23	0.95
5-6	5-6	1	0.95	0	1.00	3	0.94	0	1.00
	6-5	1	0.95	0	1.00	4	0.94	0	1.00
		Weekday, Day				Weekday, Night			
1-2	1-2	8	0.95	15	0.97	17	0.94	24	0.95
	2-1	10	0.95	12	0.98	22	0.93	37	0.93
2-3	2-3	8	0.86	7	0.97	6	0.87	6	0.98
	3-2	7	0.87	9	0.96	7	0.87	6	0.98
1-4	1-4	14	0.94	34	0.93	14	0.94	31	0.94
	4-1	11	0.95	53	0.89	23	0.93	38	0.92
1-5	1-5	9	0.93	27	0.95	11	0.92	22	0.96
	5-1	12	0.92	42	0.92	10	0.93	21	0.96
5-6	5-6	2	0.95	0	1.00	2	0.95	0	1.00
	6-5	2	0.95	0	1.00	1	0.95	0	1.00

Table D.3: Lane Width Adjustment Factor at Banani Overpass

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
a	a1	24	2	12.00	1
	a2	24	2	12.00	1

Table D.4: Lane Width Adjustment Factor at Mohakhali Flyover

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
1-2	1-2	33	3	11.00	1
	2-1	33	3	11.00	1
2-3	2-3	34	3	11.33	1
	3-2	34	3	11.33	1
3-4	3-4	30	3	10.00	1
	4-3	30	3	10.00	1
4-5	4-5	32	3	10.67	1
	5-4	32	3	10.67	1
5-6	5-6	44	4	11.00	1
	6-5	44	4	11.00	1
6-1	6-1	21	2	10.50	1
	1-6	21	2	10.50	1
4-7	4-7	32	3	10.67	1
	7-4	32	3	10.67	1
7-8	7-8	33	3	11.00	1
	8-7	33	3	11.00	1
7-11	7-11	21	2	10.50	1
	11-7	21	2	10.50	1
8-9	8-9	36	3	12.00	1
	9-8	36	3	12.00	1
8-13	8-13	24	2	12.00	1
	13-8	24	2	12.00	1
9-10	9-10	31	3	10.33	1
	10-9	31	3	10.33	1
10-11	10-11	30	3	10.00	1
	11-10	30	3	10.00	1
11-12	11-12	30	3	10.00	1
	12-11	30	3	10.00	1

Table D.5: Parking and Bus Stoppage Adjustment Factors at Mohakhali Flyover

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
1-2	1-2	12	0.95	17	0.97	2	0.96	18	0.96
	2-1	10	0.95	22	0.96	7	0.96	17	0.97
2-3	2-3	8	0.95	24	0.95	6	0.96	11	0.98
	3-2	6	0.96	21	0.96	10	0.95	19	0.96
3-4	3-4	8	0.95	12	0.98	4	0.96	20	0.96
	4-3	1	0.97	14	0.97	8	0.95	32	0.94
4-5	4-5	2	0.96	16	0.97	6	0.96	37	0.93
	5-4	7	0.96	8	0.98	0	0.97	29	0.94
5-6	5-6	2	0.97	7	0.99	8	0.97	12	0.98
	6-5	2	0.97	8	0.98	4	0.97	6	0.99
6-1	6-1	3	0.94	0	1.00	0	0.95	0	1.00
	1-6	4	0.94	0	1.00	0	0.95	0	1.00
4-7	4-7	4	0.96	12	0.98	4	0.96	29	0.94
	7-4	5	0.96	22	0.96	9	0.95	37	0.93
7-8	7-8	6	0.96	14	0.97	12	0.95	22	0.96
	8-7	7	0.96	33	0.93	7	0.96	25	0.95
7-11	7-11	8	0.93	22	0.96	8	0.93	20	0.96
	11-7	4	0.94	15	0.97	2	0.95	29	0.94
8-9	8-9	6	0.96	20	0.96	4	0.96	44	0.91
	9-8	8	0.95	30	0.94	8	0.95	49	0.90
8-13	8-13	6	0.94	0	1.00	9	0.93	0	1.00
	13-8	5	0.94	0	1.00	6	0.94	0	1.00
9-10	9-10	1	0.97	8	0.98	4	0.96	14	0.97
	10-9	6	0.96	7	0.99	5	0.96	20	0.96
10-11	10-11	10	0.95	8	0.98	8	0.95	12	0.98
	11-10	11	0.95	6	0.99	2	0.96	16	0.97
11-12	11-12	4	0.96	7	0.99	7	0.96	18	0.96
	12-11	4	0.96	7	0.99	10	0.95	22	0.96
		Weekday, Day				Weekday, Night			
1-2	1-2	8	0.95	15	0.97	4	0.96	14	0.97
	2-1	15	0.94	15	0.97	5	0.96	11	0.98
2-3	2-3	11	0.95	11	0.98	4	0.96	15	0.97
	3-2	12	0.95	11	0.98	9	0.95	24	0.95
3-4	3-4	16	0.94	18	0.96	7	0.96	17	0.97
	4-3	11	0.95	19	0.96	6	0.96	8	0.98
4-5	4-5	5	0.96	8	0.98	2	0.96	13	0.97
	5-4	9	0.95	17	0.97	2	0.96	10	0.98
5-6	5-6	3	0.97	4	0.99	3	0.97	5	0.99
	6-5	3	0.97	6	0.99	4	0.97	4	0.99
6-1	6-1	2	0.95	0	1.00	1	0.95	0	1.00
	1-6	2	0.95	0	1.00	1	0.95	0	1.00
4-7	4-7	8	0.95	19	0.96	4	0.96	8	0.98
	7-4	5	0.96	18	0.96	2	0.96	4	0.99

(Table D.5 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekday, Day				Weekday, Night			
7-8	7-8	4	0.96	17	0.97	3	0.96	6	0.99
	8-7	3	0.96	11	0.98	4	0.96	7	0.99
7-11	7-11	7	0.93	19	0.96	6	0.94	15	0.97
	11-7	10	0.93	20	0.96	9	0.93	12	0.98
8-9	8-9	2	0.96	42	0.92	2	0.96	34	0.93
	9-8	3	0.96	47	0.91	2	0.96	30	0.94
8-13	8-13	11	0.92	0	1.00	10	0.93	0	1.00
	13-8	4	0.94	0	1.00	7	0.93	0	1.00
9-10	9-10	5	0.96	23	0.95	8	0.95	8	0.98
	10-9	6	0.96	32	0.94	10	0.95	6	0.99
10-11	10-11	7	0.96	19	0.96	6	0.96	14	0.97
	11-10	9	0.95	25	0.95	5	0.96	20	0.96
11-12	11-12	5	0.96	20	0.96	4	0.96	11	0.98
	12-11	5	0.96	10	0.98	5	0.96	9	0.98

Table D.6: Lane Width Adjustment Factor at Khilgaon Flyover

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
1-2	1-2	34	3	11.33	1
	2-1	34	3	11.33	1
2-3	2-3	33	3	11.00	1
	3-2	33	3	11.00	1
3-4	3-4	32	3	10.67	1
	4-3	32	3	10.67	1
4-5	4-5	24	2	12.00	1
	5-4	24	2	12.00	1
5-6	5-6	23	2	11.50	1
	6-5	23	2	11.50	1
6-7	6-7	25	2	12.50	1
	7-6	25	2	12.50	1
7-8	7-8	25	2	12.50	1
	8-7	25	2	12.50	1
8-9	8-9	25	2	12.50	1
	9-8	25	2	12.50	1
9-10	9-10	24	2	12.00	1
	10-9	24	2	12.00	1
10-11	10-11	31	3	10.33	1
	11-10	31	3	10.33	1
11-12	11-12	32	3	10.67	1
	12-11	32	3	10.67	1

(Table D.6 continued)

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
12-1	12-1	35	3	11.67	1
	1-12	35	3	11.67	1
1-8	1-8	22	2	11.00	1
	8-1	22	2	11.00	1
11-13	11-13	32	3	10.67	1
	13-11	32	3	10.67	1
13-14	13-14	11	1	11.00	1
	14-13	11	1	11.00	1
14-15	14-15	10	1	10.00	1
	15-14	10	1	10.00	1
15-16	15-16	12	1	12.00	1
	16-15	12	1	12.00	1
16-17	16-17	11	1	11.00	1
	17-16	11	1	11.00	1
17-18	17-18	11	1	11.00	1
	18-17	11	1	11.00	1
18-2	18-2	10	1	10.00	1
	2-18	10	1	10.00	1
18-3	18-3	11	1	11.00	1
	3-18	11	1	11.00	1

Table D.7: Parking and Bus Stoppage Adjustment Factors at Khilgaon Flyover

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
1-2	1-2	6	0.96	2	1.00	8	0.95	0	1.00
	2-1	2	0.96	1	1.00	5	0.96	0	1.00
2-3	2-3	4	0.96	1	1.00	6	0.96	0	1.00
	3-2	8	0.95	1	1.00	4	0.96	0	1.00
3-4	3-4	6	0.96	0	1.00	6	0.96	0	1.00
	4-3	4	0.96	0	1.00	4	0.96	0	1.00
4-5	4-5	3	0.94	0	1.00	7	0.93	0	1.00
	5-4	3	0.94	0	1.00	5	0.94	0	1.00
5-6	5-6	2	0.95	1	1.00	4	0.94	8	0.98
	6-5	7	0.93	6	0.99	6	0.94	6	0.99
6-7	6-7	2	0.95	4	0.99	3	0.94	4	0.99
	7-6	3	0.94	4	0.99	4	0.94	10	0.98
7-8	7-8	8	0.93	4	0.99	1	0.95	12	0.98
	8-7	7	0.93	4	0.99	2	0.95	7	0.99
8-9	8-9	4	0.94	7	0.99	6	0.94	8	0.98
	9-8	5	0.94	7	0.99	8	0.93	15	0.97
9-10	9-10	6	0.94	15	0.97	7	0.93	12	0.98
	10-9	3	0.94	11	0.98	5	0.94	8	0.98

(Table D.7 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
10-11	10-11	5	0.96	5	0.99	7	0.96	8	0.98
	11-10	4	0.96	15	0.97	8	0.95	7	0.99
11-12	11-12	5	0.96	3	0.99	12	0.95	4	0.99
	12-11	2	0.96	2	1.00	11	0.95	1	1.00
12-1	12-1	7	0.96	1	1.00	4	0.96	0	1.00
	1-12	6	0.96	6	0.99	3	0.96	0	1.00
1-8	1-8	4	0.94	2	1.00	8	0.93	0	1.00
	8-1	2	0.95	1	1.00	7	0.93	0	1.00
11-13	11-13	4	0.96	4	0.99	8	0.95	0	1.00
	13-11	6	0.96	2	1.00	9	0.95	0	1.00
13-14	13-14	1	0.90	0	1.00	0	0.90	0	1.00
	14-13	1	0.90	0	1.00	0	0.90	0	1.00
14-15	14-15	1	0.90	0	1.00	0	0.90	0	1.00
	15-14	1	0.90	0	1.00	0	0.90	0	1.00
15-16	15-16	1	0.90	0	1.00	0	0.90	0	1.00
	16-15	1	0.90	0	1.00	0	0.90	0	1.00
16-17	16-17	1	0.90	0	1.00	0	0.90	0	1.00
	17-16	2	0.89	0	1.00	0	0.90	0	1.00
17-18	17-18	1	0.90	0	1.00	0	0.90	0	1.00
	18-17	1	0.90	0	1.00	0	0.90	0	1.00
18-2	18-2	1	0.90	0	1.00	0	0.90	0	1.00
	2-18	1	0.90	0	1.00	0	0.90	0	1.00
18-3	18-3	1	0.90	0	1.00	0	0.90	0	1.00
	3-18	2	0.89	0	1.00	0	0.90	0	1.00
		Weekday, Day				Weekday, Night			
1-2	1-2	12	0.95	12	0.98	7	0.96	5	0.99
	2-1	12	0.95	12	0.98	6	0.96	0	1.00
2-3	2-3	15	0.94	10	0.98	9	0.95	0	1.00
	3-2	15	0.94	10	0.98	12	0.95	0	1.00
3-4	3-4	13	0.95	0	1.00	15	0.94	0	1.00
	4-3	13	0.95	0	1.00	8	0.95	6	0.99
4-5	4-5	14	0.92	0	1.00	7	0.93	0	1.00
	5-4	14	0.92	0	1.00	6	0.94	0	1.00
5-6	5-6	12	0.92	11	0.98	12	0.92	0	1.00
	6-5	12	0.92	11	0.98	12	0.92	0	1.00
6-7	6-7	17	0.91	15	0.97	17	0.91	12	0.98
	7-6	17	0.91	15	0.97	17	0.91	13	0.97
7-8	7-8	18	0.91	11	0.98	18	0.91	11	0.98
	8-7	18	0.91	11	0.98	18	0.91	14	0.97
8-9	8-9	20	0.90	7	0.99	20	0.90	19	0.96
	9-8	20	0.90	7	0.99	20	0.90	21	0.96
9-10	9-10	10	0.93	15	0.97	10	0.93	13	0.97
	10-9	10	0.93	15	0.97	10	0.93	14	0.97

(Table D.7 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekday, Day				Weekday, Night			
10-11	10-11	12	0.95	15	0.97	12	0.95	17	0.97
	11-10	12	0.95	15	0.97	12	0.95	15	0.97
11-12	11-12	25	0.93	15	0.97	25	0.93	13	0.97
	12-11	25	0.93	5	0.99	25	0.93	6	0.99
12-1	12-1	5	0.96	6	0.99	5	0.96	0	1.00
	1-12	5	0.96	6	0.99	5	0.96	0	1.00
1-8	1-8	15	0.91	20	0.96	15	0.91	0	1.00
	8-1	15	0.91	7	0.99	15	0.91	0	1.00
11-13	11-13	12	0.95	21	0.96	12	0.95	0	1.00
	13-11	12	0.95	21	0.96	12	0.95	0	1.00
13-14	13-14	4	0.88	0	1.00	4	0.88	0	1.00
	14-13	4	0.88	0	1.00	4	0.88	0	1.00
14-15	14-15	8	0.86	0	1.00	8	0.86	0	1.00
	15-14	8	0.86	0	1.00	8	0.86	0	1.00
15-16	15-16	5	0.88	0	1.00	5	0.88	0	1.00
	16-15	5	0.88	0	1.00	5	0.88	0	1.00
16-17	16-17	6	0.87	0	1.00	6	0.87	0	1.00
	17-16	6	0.87	0	1.00	6	0.87	0	1.00
17-18	17-18	6	0.87	0	1.00	6	0.87	0	1.00
	18-17	6	0.87	0	1.00	6	0.87	0	1.00
18-2	18-2	5	0.88	0	1.00	5	0.88	0	1.00
	2-18	5	0.88	0	1.00	5	0.88	0	1.00
18-3	18-3	8	0.86	0	1.00	8	0.86	0	1.00
	3-18	8	0.86	0	1.00	8	0.86	0	1.00

Table D.8: Lane Width Adjustment Factor at MMHF

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
1-2	1-2	22	2	11.00	1
	2-1	22	2	11.00	1
2-3	2-3	24	2	12.00	1
	3-2	24	2	12.00	1
3-4	3-4	22	2	11.00	1
	4-3	22	2	11.00	1
4-5	4-5	22	2	11.00	1
	5-4	22	2	11.00	1
5-6	5-6	22	2	11.00	1
	6-5	22	2	11.00	1
6-7	6-7	22	2	11.00	1
	7-6	22	2	11.00	1
7-8	7-8	22	2	11.00	1
	8-7	22	2	11.00	1

(Table D.8 continued)

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
8-9	8-9	11	1	11.00	1
	9-8	11	1	11.00	1
9-10	9-10	23	2	11.50	1
	10-9	23	2	11.50	1
10-11	10-11	22	2	11.00	1
	11-10	22	2	11.00	1
9-11	9-11	21	2	10.50	1
	11-9	21	2	10.50	1
11-12	11-12	24	2	12.00	1
	12-11	24	2	12.00	1
12-13	12-13	24	2	12.00	1
	13-12	24	2	12.00	1
7-13	7-13	20	2	10.00	1
	13-7	20	2	10.00	1
8-14	8-14	20	2	10.00	1
	14-8	20	2	10.00	1

Table D.9: Parking and Bus Stoppage Adjustment Factors at MMHF

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
1-2	1-2	5	0.94	12	0.98	8	0.93	17	0.97
	2-1	4	0.94	15	0.97	7	0.93	22	0.96
2-3	2-3	8	0.93	19	0.96	8	0.93	28	0.94
	3-2	1	0.95	21	0.96	6	0.94	8	0.98
3-4	3-4	6	0.94	6	0.99	2	0.95	14	0.97
	4-3	8	0.93	5	0.99	8	0.93	17	0.97
4-5	4-5	1	0.95	2	1.00	0	0.95	0	1.00
	5-4	2	0.95	2	1.00	0	0.95	0	1.00
5-6	5-6	7	0.93	4	0.99	10	0.93	8	0.98
	6-5	6	0.94	9	0.98	8	0.93	7	0.99
6-7	6-7	10	0.93	22	0.96	11	0.92	8	0.98
	7-6	4	0.94	31	0.94	10	0.93	9	0.98
7-8	7-8	8	0.93	41	0.92	12	0.92	14	0.97
	8-7	1	0.95	37	0.93	10	0.93	7	0.99
8-9	8-9	0	0.90	6	0.98	0	0.90	0	1.00
	9-8	0	0.90	5	0.98	1	0.90	0	1.00
9-10	9-10	4	0.94	18	0.96	8	0.93	7	0.99
	10-9	2	0.95	19	0.96	9	0.93	8	0.98
10-11	10-11	1	0.95	25	0.95	6	0.94	7	0.99
	11-10	2	0.95	17	0.97	11	0.92	9	0.98
9-11	9-11	4	0.94	0	1.00	5	0.94	0	1.00
	11-9	3	0.94	0	1.00	6	0.94	0	1.00

(Table D.9 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				**Weekend, Night**			
11-12	11-12	2	0.95	35	0.93	5	0.94	21	0.96
	12-11	1	0.95	30	0.94	7	0.93	10	0.98
12-13	12-13	2	0.95	20	0.96	10	0.93	10	0.98
	13-12	9	0.93	15	0.97	11	0.92	14	0.97
7-13	7-13	2	0.95	9	0.98	9	0.93	12	0.98
	13-7	7	0.93	9	0.98	8	0.93	17	0.97
8-14	8-14	3	0.94	10	0.98	12	0.92	7	0.99
	14-8	2	0.95	17	0.97	6	0.94	8	0.98
		Weekday, Day				**Weekday, Night**			
1-2	1-2	18	0.91	15	0.97	4	0.94	18	0.96
	2-1	15	0.91	25	0.95	2	0.95	28	0.94
2-3	2-3	15	0.91	12	0.98	3	0.94	24	0.95
	3-2	12	0.92	15	0.97	4	0.94	11	0.98
3-4	3-4	10	0.93	18	0.96	7	0.93	10	0.98
	4-3	11	0.92	15	0.97	5	0.94	12	0.98
4-5	4-5	2	0.95	1	1.00	2	0.95	1	1.00
	5-4	1	0.95	1	1.00	1	0.95	1	1.00
5-6	5-6	18	0.91	15	0.97	4	0.94	8	0.98
	6-5	15	0.91	12	0.98	6	0.94	7	0.99
6-7	6-7	18	0.91	15	0.97	5	0.94	12	0.98
	7-6	17	0.91	12	0.98	6	0.94	13	0.97
7-8	7-8	18	0.91	12	0.98	6	0.94	15	0.97
	8-7	18	0.91	17	0.97	6	0.94	11	0.98
8-9	8-9	17	0.82	0	1.00	0	0.90	12	0.95
	9-8	18	0.81	0	1.00	0	0.90	7	0.97
9-10	9-10	5	0.94	15	0.97	5	0.94	25	0.95
	10-9	18	0.91	12	0.98	4	0.94	28	0.94
10-11	10-11	6	0.94	17	0.97	3	0.94	32	0.94
	11-10	19	0.90	15	0.97	2	0.95	39	0.92
9-11	9-11	21	0.90	15	0.97	2	0.95	0	1.00
	11-9	13	0.92	12	0.98	3	0.94	0	1.00
11-12	11-12	13	0.92	12	0.98	4	0.94	19	0.96
	12-11	13	0.92	12	0.98	2	0.95	20	0.96
12-13	12-13	10	0.93	4	0.99	5	0.94	30	0.94
	13-12	17	0.91	4	0.99	2	0.95	24	0.95
7-13	7-13	4	0.94	11	0.98	3	0.94	23	0.95
	13-7	12	0.92	12	0.98	6	0.94	12	0.98
8-14	8-14	12	0.92	15	0.97	7	0.93	17	0.97
	14-8	12	0.92	15	0.97	2	0.95	10	0.98

Table D.10: Lane Width Adjustment Factor at MMF

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
1-2	1-2	41	4	10.25	1
	2-1	41	4	10.25	1
2-3	2-3	32	3	10.67	1
	3-2	32	3	10.67	1
2-25	2-25	32	3	10.67	1
	25-2	32	3	10.67	1
3-4	3-4	32	3	10.67	1
	4-3	32	3	10.67	1
3-23	3-23	34	3	11.33	1
	23-3	34	3	11.33	1
4-5	4-5	34	3	11.33	1
	5-4	34	3	11.33	1
4-15	4-15	22	2	11.00	1
	15-4	22	2	11.00	1
4-22	4-22	20	2	10.00	1
	22-4	20	2	10.00	1
5-6	5-6	22	2	11.00	1
	6-5	22	2	11.00	1
6-7	6-7	23	2	11.50	1
	7-6	23	2	11.50	1
6-14	6-14	20	2	10.00	1
	14-6	20	2	10.00	1
7-8	7-8	42	4	10.50	1
	8-7	42	4	10.50	1
7-19	7-19	31	3	10.33	1
	19-7	31	3	10.33	1
8-9	8-9	42	4	10.50	1
	9-8	42	4	10.50	1
8-14	8-14	33	3	11.00	1
	14-8	33	3	11.00	1
9-10	9-10	42	4	10.50	1
	10-9	42	4	10.50	1
10-11	10-11	22	2	11.00	1
	11-10	22	2	11.00	1
11-12	11-12	23	2	11.50	1
	12-11	23	2	11.50	1
11-14	11-14	22	2	11.00	1
	14-11	22	2	11.00	1
12-13	12-13	25	2	12.50	1
	13-12	25	2	12.50	1
12-18	12-18	22	2	11.00	1
	18-12	22	2	11.00	1
13-14	13-14	33	3	11.00	1
	14-13	33	3	11.00	1

(Table D.10 continued)

Segment	Segment Label	Directional Width (ft)	No. of Lanes	Lane Width (ft)	f_w
13-15	13-15	24	2	12.00	1
	15-13	24	2	12.00	1
15-16	15-16	31	3	10.33	1
	16-15	31	3	10.33	1
16-17	16-17	32	3	10.67	1
	17-16	32	3	10.67	1
16-26	16-26	32	3	10.67	1
	26-16	32	3	10.67	1
17-18	17-18	35	3	11.67	1
	18-17	35	3	11.67	1
19-20	19-20	21	2	10.50	1
	20-19	21	2	10.50	1
20-21	20-21	33	3	11.00	1
	21-20	44	4	11.00	1
21-22	21-22	42	4	10.50	1
	22-21	42	4	10.50	1
22-23	22-23	45	4	11.25	1
	23-22	45	4	11.25	1
23-24	23-24	46	4	11.50	1
	24-23	46	4	11.50	1

Table D.11: Parking and Bus Stoppage Adjustment Factors at MMF

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
1-2	1-2	2	0.97	40	0.92	4	0.97	29	0.94
	2-1	3	0.97	53	0.89	6	0.97	38	0.92
2-3	2-3	2	0.96	56	0.89	4	0.96	42	0.92
	3-2	5	0.96	50	0.90	9	0.95	53	0.89
2-25	2-25	1	0.97	0	1.00	2	0.96	0	1.00
	25-2	3	0.96	0	1.00	9	0.95	0	1.00
3-4	3-4	5	0.96	18	0.96	10	0.95	15	0.97
	4-3	4	0.96	12	0.98	6	0.96	26	0.95
3-23	3-23	5	0.96	6	0.99	9	0.95	14	0.97
	23-3	1	0.97	20	0.96	2	0.96	7	0.99
4-5	4-5	2	0.96	15	0.97	4	0.96	38	0.92
	5-4	4	0.96	21	0.96	6	0.96	49	0.90
4-15	4-15	4	0.94	15	0.97	3	0.94	12	0.98
	15-4	5	0.94	20	0.96	7	0.93	20	0.96
4-22	4-22	5	0.94	0	1.00	8	0.93	0	1.00
	22-4	4	0.94	0	1.00	6	0.94	0	1.00
5-6	5-6	2	0.95	35	0.93	1	0.95	28	0.94
	6-5	2	0.95	36	0.93	5	0.94	36	0.93
6-7	6-7	1	0.95	24	0.95	2	0.95	20	0.96
	7-6	2	0.95	30	0.94	6	0.94	20	0.96
6-14	6-14	2	0.95	0	1.00	9	0.93	0	1.00
	14-6	2	0.95	0	1.00	7	0.93	0	1.00
7-8	7-8	0	0.98	0	1.00	0	0.98	0	1.00
	8-7	0	0.98	0	1.00	0	0.98	0	1.00

(Table D.11 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekend, Day				Weekend, Night			
7-19	7-19	0	0.97	0	1.00	4	0.96	0	1.00
	19-7	0	0.97	0	1.00	2	0.96	0	1.00
8-9	8-9	0	0.98	0	1.00	0	0.98	0	1.00
	9-8	0	0.98	0	1.00	0	0.98	0	1.00
8-14	8-14	1	0.97	12	0.98	1	0.97	19	0.96
	14-8	2	0.96	22	0.96	1	0.97	26	0.95
9-10	9-10	3	0.97	10	0.98	1	0.97	15	0.97
	10-9	5	0.97	8	0.98	2	0.97	15	0.97
10-11	10-11	1	0.95	0	1.00	3	0.94	0	1.00
	11-10	4	0.94	0	1.00	6	0.94	0	1.00
11-12	11-12	0	0.95	0	1.00	1	0.95	0	1.00
	12-11	1	0.95	0	1.00	2	0.95	0	1.00
11-14	11-14	4	0.94	0	1.00	2	0.95	0	1.00
	14-11	2	0.95	0	1.00	3	0.94	0	1.00
12-13	12-13	4	0.94	7	0.99	6	0.94	8	0.98
	13-12	5	0.94	7	0.99	8	0.93	15	0.97
12-18	12-18	2	0.95	0	1.00	7	0.93	0	1.00
	18-12	4	0.94	0	1.00	8	0.93	0	1.00
13-14	13-14	2	0.96	12	0.98	4	0.96	23	0.95
	14-13	2	0.96	8	0.98	5	0.96	15	0.97
13-15	13-15	6	0.94	15	0.97	7	0.93	12	0.98
	15-13	3	0.94	11	0.98	5	0.94	8	0.98
15-16	15-16	5	0.96	5	0.99	7	0.96	8	0.98
	16-15	4	0.96	15	0.97	8	0.95	7	0.99
16-17	16-17	5	0.96	3	0.99	12	0.95	4	0.99
	17-16	2	0.96	2	1.00	11	0.95	1	1.00
16-26	16-26	4	0.96	4	0.99	8	0.95	0	1.00
	26-16	6	0.96	2	1.00	9	0.95	0	1.00
17-18	17-18	7	0.96	1	1.00	4	0.96	0	1.00
	18-17	6	0.96	6	0.99	3	0.96	0	1.00
19-20	19-20	0	0.95	0	1.00	2	0.95	0	1.00
	20-19	2	0.95	0	1.00	2	0.95	0	1.00
20-21	20-21	1	0.97	0	1.00	0	0.97	0	1.00
	21-20	0	0.98	0	1.00	0	0.98	0	1.00
21-22	21-22	0	0.98	4	0.99	4	0.97	9	0.98
	22-21	3	0.97	6	0.99	9	0.96	12	0.98
22-23	22-23	2	0.97	8	0.98	7	0.97	18	0.96
	23-22	1	0.97	9	0.98	6	0.97	15	0.97
23-24	23-24	0	0.98	40	0.92	4	0.97	42	0.92
	24-23	0	0.98	35	0.93	2	0.97	46	0.91
		Weekday, Day				Weekday, Night			
1-2	1-2	2	0.97	23	0.95	5	0.97	25	0.95
	2-1	1	0.97	25	0.95	7	0.97	12	0.98
2-3	2-3	1	0.97	37	0.93	6	0.96	31	0.94
	3-2	3	0.96	39	0.92	9	0.95	28	0.94
2-25	2-25	4	0.96	0	1.00	4	0.96	0	1.00
	25-2	5	0.96	0	1.00	2	0.96	0	1.00
3-4	3-4	6	0.96	22	0.96	4	0.96	24	0.95
	4-3	5	0.96	27	0.95	8	0.95	23	0.95
3-23	3-23	8	0.95	5	0.99	5	0.96	8	0.98
	23-3	6	0.96	3	0.99	2	0.96	4	0.99
4-5	4-5	3	0.96	16	0.97	4	0.96	11	0.98
	5-4	4	0.96	15	0.97	9	0.95	16	0.97

(Table D.11 continued)

Segment	Segment Label	N_m	f_P	N_b	f_{bb}	N_m	f_P	N_b	f_{bb}
		Weekday, Day				Weekday, Night			
4-15	4-15	7	0.93	19	0.96	8	0.93	24	0.95
	15-4	6	0.94	22	0.96	7	0.93	17	0.97
4-22	4-22	3	0.94	0	1.00	9	0.93	0	1.00
	22-4	10	0.93	0	1.00	3	0.94	0	1.00
5-6	5-6	4	0.94	12	0.98	6	0.94	15	0.97
	6-5	2	0.95	15	0.97	4	0.94	12	0.98
6-7	6-7	1	0.95	7	0.99	6	0.94	9	0.98
	7-6	1	0.95	12	0.98	4	0.94	15	0.97
6-14	6-14	2	0.95	0	1.00	2	0.95	0	1.00
	14-6	3	0.94	0	1.00	1	0.95	0	1.00
7-8	7-8	0	0.98	10	0.98	0	0.98	10	0.98
	8-7	0	0.98	7	0.99	0	0.98	4	0.99
7-19	7-19	0	0.97	0	1.00	0	0.97	0	1.00
	19-7	0	0.97	0	1.00	0	0.97	0	1.00
8-9	8-9	0	0.98	0	1.00	0	0.98	0	1.00
	9-8	0	0.98	0	1.00	0	0.98	0	1.00
8-14	8-14	3	0.96	6	0.99	6	0.96	3	0.99
	14-8	4	0.96	10	0.98	7	0.96	4	0.99
9-10	9-10	6	0.97	36	0.93	8	0.97	29	0.94
	10-9	10	0.96	30	0.94	9	0.96	33	0.93
10-11	10-11	5	0.94	0	1.00	2	0.95	0	1.00
	11-10	6	0.94	0	1.00	6	0.94	0	1.00
11-12	11-12	3	0.94	0	1.00	1	0.95	0	1.00
	12-11	3	0.94	0	1.00	5	0.94	0	1.00
11-14	11-14	5	0.94	0	1.00	10	0.93	0	1.00
	14-11	1	0.95	0	1.00	8	0.93	0	1.00
12-13	12-13	20	0.90	7	0.99	20	0.90	19	0.96
	13-12	20	0.90	7	0.99	20	0.90	21	0.96
12-18	12-18	15	0.91	7	0.99	15	0.91	0	1.00
	18-12	15	0.91	20	0.96	15	0.91	0	1.00
13-14	13-14	6	0.96	10	0.98	2	0.96	6	0.99
	14-13	3	0.96	11	0.98	3	0.96	4	0.99
13-15	13-15	10	0.93	15	0.97	10	0.93	13	0.97
	15-13	10	0.93	15	0.97	10	0.93	14	0.97
15-16	15-16	12	0.95	15	0.97	12	0.95	17	0.97
	16-15	12	0.95	15	0.97	12	0.95	15	0.97
16-17	16-17	25	0.93	15	0.97	25	0.93	13	0.97
	17-16	25	0.93	5	0.99	25	0.93	6	0.99
16-26	16-26	12	0.95	21	0.96	12	0.95	0	1.00
	26-16	12	0.95	21	0.96	12	0.95	0	1.00
17-18	17-18	5	0.96	6	0.99	5	0.96	0	1.00
	18-17	5	0.96	6	0.99	5	0.96	0	1.00
19-20	19-20	1	0.95	1	1.00	4	0.94	1	1.00
	20-19	1	0.95	1	1.00	8	0.93	1	1.00
20-21	20-21	0	0.97	0	1.00	3	0.96	0	1.00
	21-20	0	0.98	0	1.00	1	0.97	0	1.00
21-22	21-22	0	0.98	14	0.97	2	0.97	11	0.98
	22-21	0	0.98	20	0.96	7	0.97	15	0.97
22-23	22-23	0	0.98	26	0.95	4	0.97	19	0.96
	23-22	0	0.98	27	0.95	2	0.97	15	0.97
23-24	23-24	2	0.97	32	0.94	1	0.97	20	0.96
	24-23	2	0.97	25	0.95	1	0.97	20	0.96

APPENDIX E

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR DETERMINATION OF SATURATION FLOW RATE

Table E.1: Saturation Flow Rate Calculation at SAMF

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
1-2	1-2	0.96	1304	0.99	1320	0.98	1384	0.98	1347
	2-1	0.97	1330	0.99	1303	0.96	1362	0.98	1291
2-3	2-3	0.96	1122	0.99	1315	0.99	1269	0.98	1278
	3-2	0.97	1134	0.99	1314	0.99	1267	0.94	1223
1-4	1-4	0.98	1244	0.99	1308	0.94	1263	0.96	1298
	4-1	0.96	1199	0.98	1313	0.99	1288	0.99	1298
1-5	1-5	0.98	1333	0.98	1348	0.98	1314	0.96	1295
	5-1	0.97	1324	0.99	1358	0.98	1270	0.99	1344
5-6	5-6	0.98	1420	0.99	1433	0.98	1414	0.94	1365
	6-5	0.98	1428	0.99	1429	0.97	1408	0.98	1417

Table E.2: Saturation Flow Rate Calculation at Mohakhali Flyover

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
1-2	1-2	0.90	1135	0.93	1188	0.94	1201	1.00	1288
	2-1	0.85	1062	0.89	1138	0.95	1201	1.00	1294
2-3	2-3	0.93	1160	0.94	1220	0.98	1253	1.00	1285
	3-2	0.87	1100	0.91	1148	0.97	1238	1.00	1250
3-4	3-4	0.95	1215	0.96	1216	0.99	1235	1.00	1273
	4-3	0.96	1238	0.97	1198	0.99	1249	1.00	1299
4-5	4-5	0.97	1252	0.98	1195	0.99	1293	1.00	1295
	5-4	0.96	1247	0.98	1228	0.99	1261	1.00	1303
5-6	5-6	1.00	1323	1.00	1300	1.00	1330	1.00	1327
	6-5	1.00	1321	1.00	1323	1.00	1324	1.00	1328
6-1	6-1	0.91	1187	0.91	1197	0.98	1276	1.00	1308
	1-6	0.88	1143	0.93	1213	0.98	1279	1.00	1308
4-7	4-7	0.95	1227	0.96	1195	0.99	1249	1.00	1304
	7-4	0.96	1213	0.97	1185	0.99	1266	1.00	1319
7-8	7-8	0.95	1218	0.96	1200	0.98	1258	1.00	1311
	8-7	0.93	1144	0.96	1197	0.98	1277	1.00	1306
7-11	7-11	1.00	1227	1.00	1232	1.00	1238	1.00	1252
	11-7	1.00	1258	1.00	1229	1.00	1226	1.00	1249
8-9	8-9	0.98	1246	0.99	1195	0.99	1210	1.00	1239
	9-8	0.97	1205	0.98	1168	0.99	1195	1.00	1250
8-13	8-13	1.00	1290	1.00	1280	1.00	1273	1.00	1277
	13-8	1.00	1294	1.00	1290	1.00	1297	1.00	1287
9-10	9-10	1.00	1311	1.00	1288	1.00	1262	1.00	1295
	10-9	1.00	1302	1.00	1270	1.00	1236	1.00	1295
10-11	10-11	1.00	1290	1.00	1284	1.00	1268	1.00	1283
	11-10	1.00	1293	1.00	1287	1.00	1248	1.00	1270
11-12	11-12	1.00	1306	1.00	1271	1.00	1270	1.00	1296
	12-11	1.00	1306	1.00	1253	1.00	1296	1.00	1299

Table E.3: Saturation Flow Rate Calculation at Khilgaon Flyover

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
1-2	1-2	1.00	1315	1.00	1316	1.00	1275	1.00	1305
	2-1	1.00	1327	1.00	1323	1.00	1275	1.00	1320
2-3	2-3	1.00	1322	1.00	1320	1.00	1274	1.00	1313
	3-2	1.00	1313	1.00	1325	1.00	1274	1.00	1307
3-4	3-4	1.00	1320	1.00	1320	1.00	1304	1.00	1300
	4-3	1.00	1325	1.00	1325	1.00	1304	1.00	1300
4-5	4-5	1.00	1301	1.00	1287	1.00	1263	1.00	1287
	5-4	1.00	1301	1.00	1294	1.00	1263	1.00	1290
5-6	5-6	1.00	1302	1.00	1277	1.00	1242	1.00	1270
	6-5	1.00	1272	1.00	1275	1.00	1242	1.00	1270
6-7	6-7	1.00	1294	0.99	1277	1.00	1215	0.99	1215
	7-6	1.00	1290	1.00	1266	1.00	1215	1.00	1220
7-8	7-8	1.00	1273	1.00	1276	1.00	1222	1.00	1222
	8-7	1.00	1277	1.00	1286	1.00	1222	1.00	1214
8-9	8-9	1.00	1279	0.99	1255	1.00	1225	1.00	1191
	9-8	1.00	1276	1.00	1245	1.00	1225	1.00	1190
9-10	9-10	1.00	1252	1.00	1256	1.00	1238	1.00	1238
	10-9	1.00	1272	1.00	1273	1.00	1238	1.00	1241
10-11	10-11	1.00	1309	1.00	1297	1.00	1267	1.00	1262
	11-10	1.00	1285	1.00	1297	1.00	1267	1.00	1267
11-12	11-12	1.00	1315	1.00	1296	1.00	1238	1.00	1243
	12-11	1.00	1324	0.99	1297	1.00	1264	1.00	1261
12-1	12-1	1.00	1315	1.00	1325	1.00	1307	1.00	1323
	1-12	1.00	1304	1.00	1327	1.00	1307	1.00	1323
1-8	1-8	1.00	1289	1.00	1284	1.00	1207	1.00	1259
	8-1	1.00	1302	1.00	1287	1.00	1239	1.00	1256
11-13	11-13	1.00	1314	1.00	1316	1.00	1252	1.00	1307
	13-11	1.00	1315	1.00	1313	1.00	1252	1.00	1301
13-14	13-14	1.00	1235	1.00	1242	1.00	1215	1.00	1215
	14-13	1.00	1235	1.00	1242	1.00	1215	1.00	1215
14-15	14-15	1.00	1235	1.00	1242	1.00	1187	1.00	1187
	15-14	1.00	1235	1.00	1242	1.00	1187	1.00	1187
15-16	15-16	1.00	1235	1.00	1242	1.00	1208	1.00	1208
	16-15	1.00	1235	1.00	1242	1.00	1208	1.00	1208
16-17	16-17	1.00	1235	1.00	1242	1.00	1201	1.00	1201
	17-16	1.00	1228	1.00	1242	1.00	1201	1.00	1201
17-18	17-18	1.00	1235	1.00	1242	1.00	1201	1.00	1201
	18-17	1.00	1235	1.00	1242	1.00	1201	1.00	1201
18-2	18-2	1.00	1235	1.00	1242	1.00	1208	1.00	1208
	2-18	1.00	1235	1.00	1242	1.00	1208	1.00	1208
18-3	18-3	1.00	1235	1.00	1242	1.00	1187	1.00	1187
	3-18	1.00	1228	1.00	1242	1.00	1187	1.00	1187

Table E.4: Saturation Flow Rate Calculation at MMHF

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
1-2	1-2	0.99	1247	1.00	1240	1.00	1212	1.00	1251
	2-1	0.97	1222	1.00	1230	0.99	1187	0.99	1224
2-3	2-3	1.00	1235	1.00	1212	1.00	1229	1.00	1238
	3-2	1.00	1253	1.00	1270	1.00	1232	1.00	1269
3-4	3-4	0.99	1256	1.00	1268	1.00	1231	1.00	1261
	4-3	1.00	1271	1.00	1240	0.99	1227	1.00	1257
4-5	4-5	0.99	1283	1.00	1311	1.00	1302	1.00	1302
	5-4	1.00	1299	1.00	1311	1.00	1305	1.00	1305
5-6	5-6	1.00	1277	1.00	1256	0.99	1203	1.00	1271
	6-5	1.00	1267	1.00	1266	0.99	1211	0.99	1261
6-7	6-7	1.00	1220	1.00	1253	0.99	1203	1.00	1257
	7-6	1.00	1217	1.00	1254	1.00	1222	1.00	1257
7-8	7-8	1.00	1178	1.00	1234	0.98	1191	0.99	1242
	8-7	1.00	1211	1.00	1259	0.99	1199	1.00	1256
8-9	8-9	1.00	1212	1.00	1242	1.00	1125	1.00	1183
	9-8	1.00	1217	1.00	1235	1.00	1118	1.00	1207
9-10	9-10	1.00	1251	1.00	1266	0.99	1248	1.00	1224
	10-9	1.00	1255	1.00	1260	1.00	1219	1.00	1225
10-11	10-11	0.99	1227	1.00	1272	1.00	1247	1.00	1218
	11-10	0.99	1241	1.00	1250	0.99	1200	1.00	1197
9-11	9-11	1.00	1297	1.00	1294	0.94	1126	0.98	1283
	11-9	0.96	1253	1.00	1290	0.93	1155	0.95	1240
11-12	11-12	1.00	1213	1.00	1240	1.00	1236	1.00	1248
	12-11	0.99	1214	1.00	1261	1.00	1236	1.00	1252
12-13	12-13	0.99	1237	1.00	1251	0.99	1258	1.00	1211
	13-12	1.00	1242	1.00	1238	1.00	1242	1.00	1242
7-13	7-13	1.00	1281	1.00	1249	1.00	1269	1.00	1241
	13-7	1.00	1264	1.00	1240	1.00	1239	1.00	1259
8-14	8-14	1.00	1275	1.00	1252	0.99	1224	1.00	1238
	14-8	0.98	1240	1.00	1270	1.00	1232	1.00	1278

Table E.5: Saturation Flow Rate Calculation at MMF

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
1-2	1-2	1.00	1235	1.00	1261	1.00	1280	1.00	1270
	2-1	1.00	1198	1.00	1234	1.00	1277	1.00	1302
2-3	2-3	1.00	1181	1.00	1214	1.00	1233	1.00	1238
	3-2	1.00	1190	1.00	1174	1.00	1224	1.00	1240
2-25	2-25	0.93	1234	1.00	1330	0.99	1314	1.00	1325
	25-2	1.00	1327	1.00	1313	1.00	1317	1.00	1330
3-4	3-4	0.96	1221	0.99	1253	1.00	1262	1.00	1261
	4-3	0.95	1225	1.00	1252	1.00	1251	1.00	1255
3-23	3-23	0.96	1256	1.00	1277	1.00	1298	1.00	1301
	23-3	1.00	1279	1.00	1311	1.00	1312	1.00	1319
4-5	4-5	1.00	1290	1.00	1224	1.00	1285	1.00	1296
	5-4	1.00	1269	1.00	1191	1.00	1285	1.00	1271
4-15	4-15	1.00	1258	1.00	1270	1.00	1238	1.00	1222
	15-4	1.00	1242	1.00	1236	1.00	1234	1.00	1243

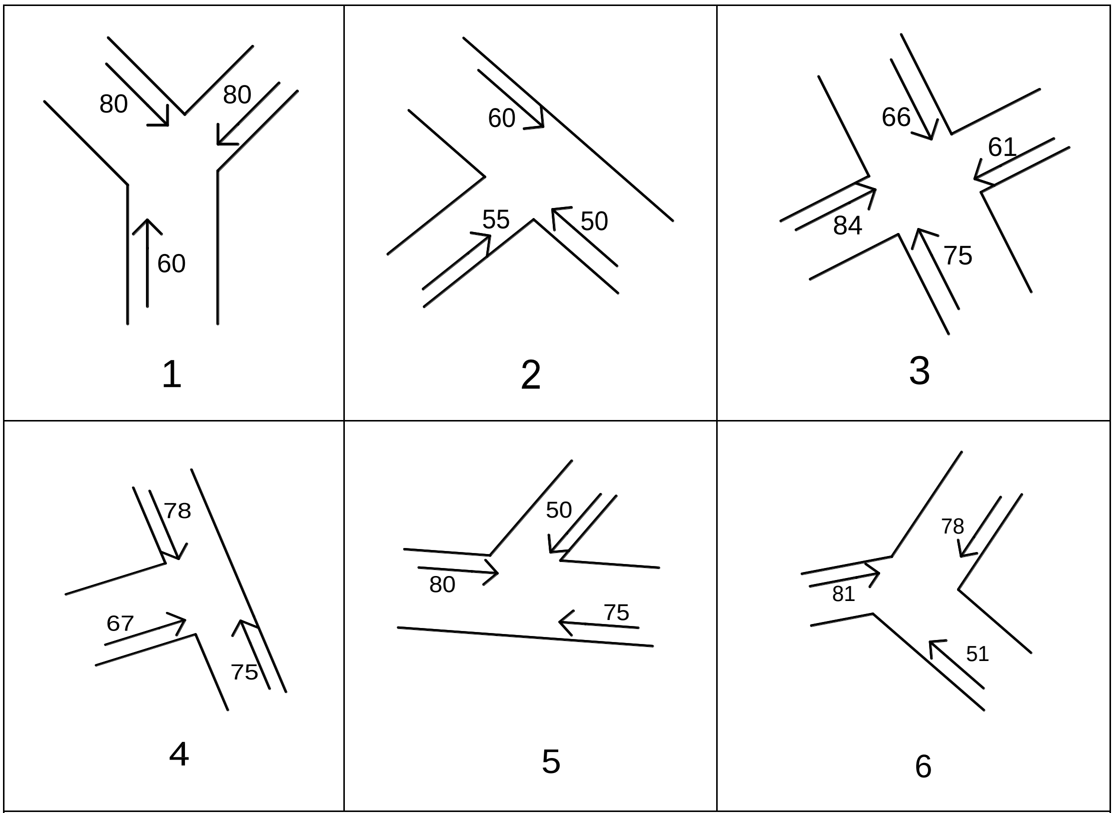
(Table E.5 continued)

Segment	Segment Label	Time Period							
		Weekend, Day		Weekend, Night		Weekday, Day		Weekday, Night	
		f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)	f_{HV}	s (pc/h/ln)
4-22	4-22	1.00	1294	1.00	1284	1.00	1301	1.00	1280
	22-4	1.00	1297	1.00	1290	1.00	1277	1.00	1301
5-6	5-6	1.00	1213	1.00	1234	1.00	1266	1.00	1252
	6-5	1.00	1210	1.00	1201	1.00	1265	1.00	1266
6-7	6-7	1.00	1245	1.00	1252	1.00	1289	1.00	1267
	7-6	1.00	1226	1.00	1239	1.00	1276	1.00	1258
6-14	6-14	1.00	1304	1.00	1280	1.00	1304	1.00	1304
	14-6	1.00	1304	1.00	1287	1.00	1301	1.00	1308
7-8	7-8	1.00	1346	1.00	1346	1.00	1319	1.00	1319
	8-7	1.00	1346	1.00	1346	1.00	1327	1.00	1335
7-19	7-19	1.00	1334	1.00	1325	1.00	1334	1.00	1334
	19-7	1.00	1334	1.00	1330	1.00	1334	1.00	1334
8-9	8-9	1.00	1346	1.00	1346	1.00	1346	1.00	1346
	9-8	1.00	1346	1.00	1346	1.00	1346	1.00	1346
8-14	8-14	1.00	1300	1.00	1281	1.00	1311	1.00	1312
	14-8	1.00	1271	1.00	1263	1.00	1298	1.00	1307
9-10	9-10	1.00	1314	1.00	1304	1.00	1239	1.00	1255
	10-9	1.00	1316	1.00	1302	1.00	1249	1.00	1242
10-11	10-11	1.00	1308	1.00	1301	1.00	1294	1.00	1304
	11-10	1.00	1297	1.00	1290	1.00	1290	1.00	1290
11-12	11-12	1.00	1311	1.00	1308	1.00	1301	1.00	1308
	12-11	1.00	1308	1.00	1304	1.00	1301	1.00	1294
11-14	11-14	1.00	1297	1.00	1304	1.00	1294	1.00	1277
	14-11	1.00	1304	1.00	1301	1.00	1308	1.00	1284
12-13	12-13	1.00	1279	0.99	1255	1.00	1225	1.00	1191
	13-12	1.00	1276	1.00	1245	1.00	1225	1.00	1190
12-18	12-18	1.00	1304	1.00	1287	1.00	1240	1.00	1256
	18-12	1.00	1294	1.00	1284	1.00	1207	1.00	1259
13-14	13-14	1.00	1298	1.00	1264	1.00	1294	1.00	1314
	14-13	1.00	1308	1.00	1283	1.00	1298	1.00	1317
13-15	13-15	1.00	1252	1.00	1256	1.00	1238	1.00	1238
	15-13	1.00	1272	1.00	1273	1.00	1238	1.00	1241
15-16	15-16	1.00	1309	1.00	1297	1.00	1267	1.00	1262
	16-15	1.00	1285	1.00	1297	1.00	1267	1.00	1267
16-17	16-17	1.00	1315	1.00	1296	1.00	1238	1.00	1243
	17-16	1.00	1324	0.99	1297	1.00	1264	1.00	1261
16-26	16-26	1.00	1314	1.00	1312	1.00	1252	1.00	1307
	26-16	1.00	1315	1.00	1313	1.00	1252	1.00	1307
17-18	17-18	1.00	1315	1.00	1325	1.00	1307	1.00	1323
	18-17	1.00	1304	1.00	1327	1.00	1307	1.00	1323
19-20	19-20	0.97	1278	1.00	1304	1.00	1300	1.00	1295
	20-19	1.00	1304	1.00	1304	1.00	1301	1.00	1281
20-21	20-21	1.00	1332	1.00	1334	1.00	1334	1.00	1327
	21-20	1.00	1346	1.00	1346	1.00	1341	1.00	1344
21-22	21-22	1.00	1335	1.00	1315	1.00	1308	1.00	1313
	22-21	1.00	1324	1.00	1298	1.00	1292	1.00	1294
22-23	22-23	0.98	1295	1.00	1286	1.00	1270	1.00	1288
	23-22	1.00	1320	1.00	1295	1.00	1271	1.00	1302
23-24	23-24	1.00	1238	1.00	1226	1.00	1256	1.00	1290
	24-23	1.00	1251	1.00	1219	1.00	1273	1.00	1290

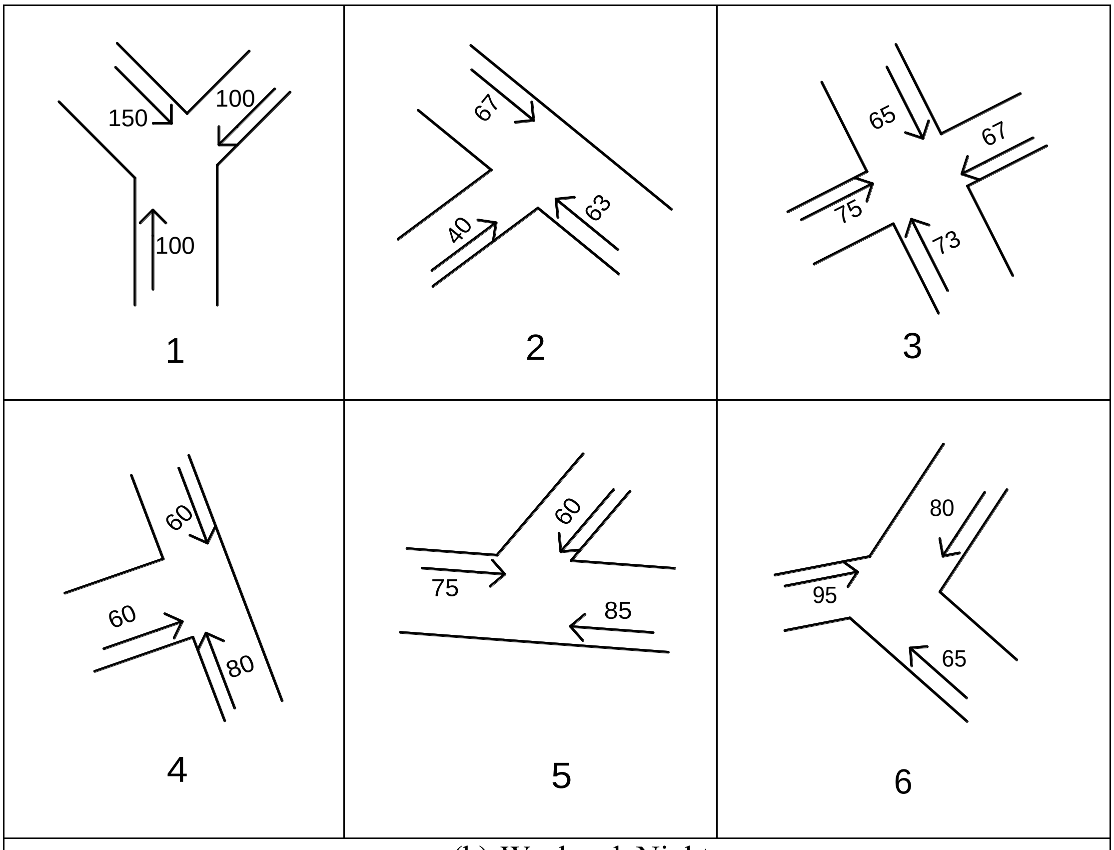
APPENDIX F

FIELD OBSERVATION RESULTS FOR SIGNAL TIMES FOR DETERMINATION OF SEGMENT CAPACITY

Shaheed Ahsanullah Master Flyover

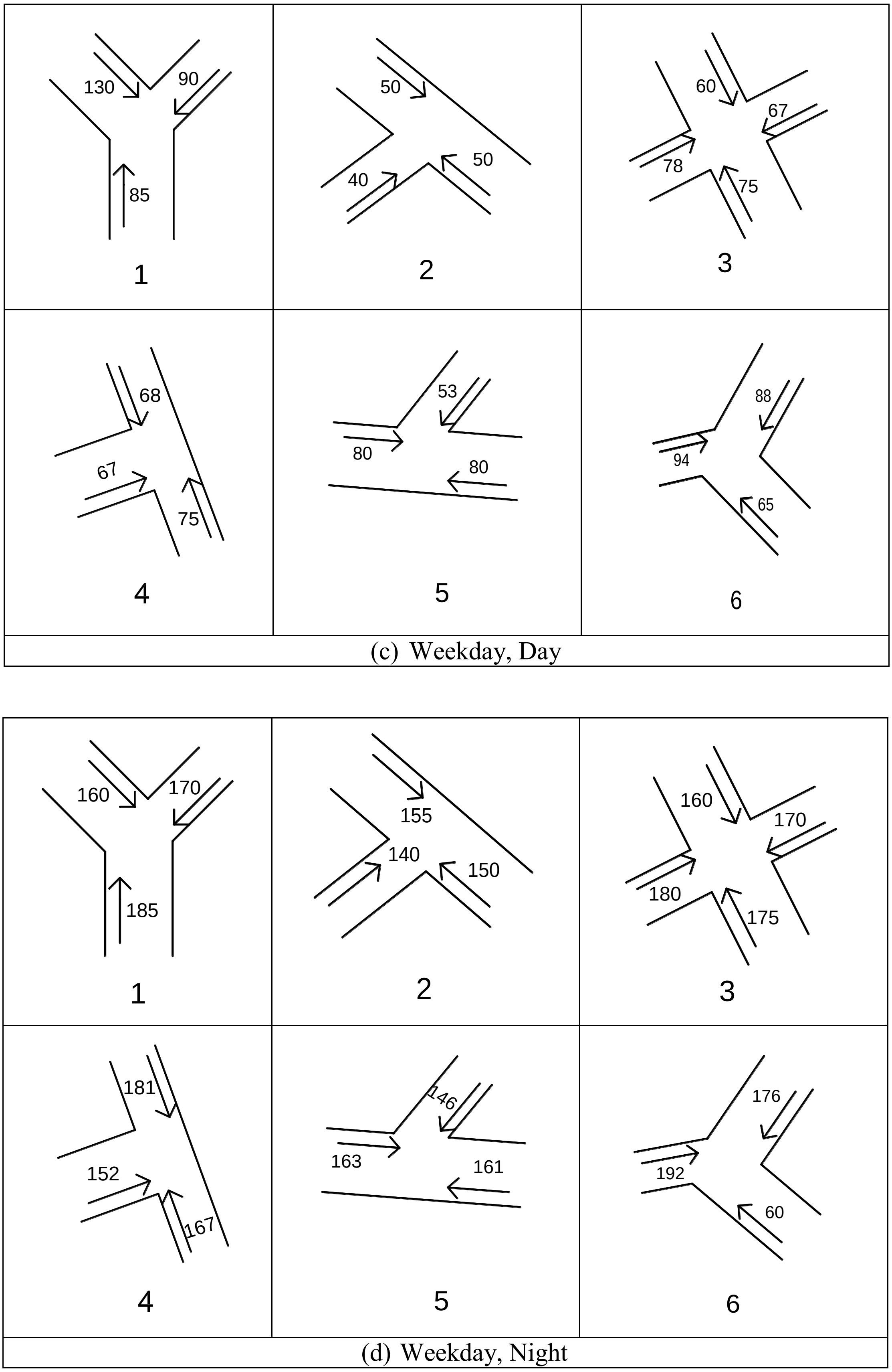


(a) Weekend, Day



(b) Weekend, Night

(Figure F.1 continued)

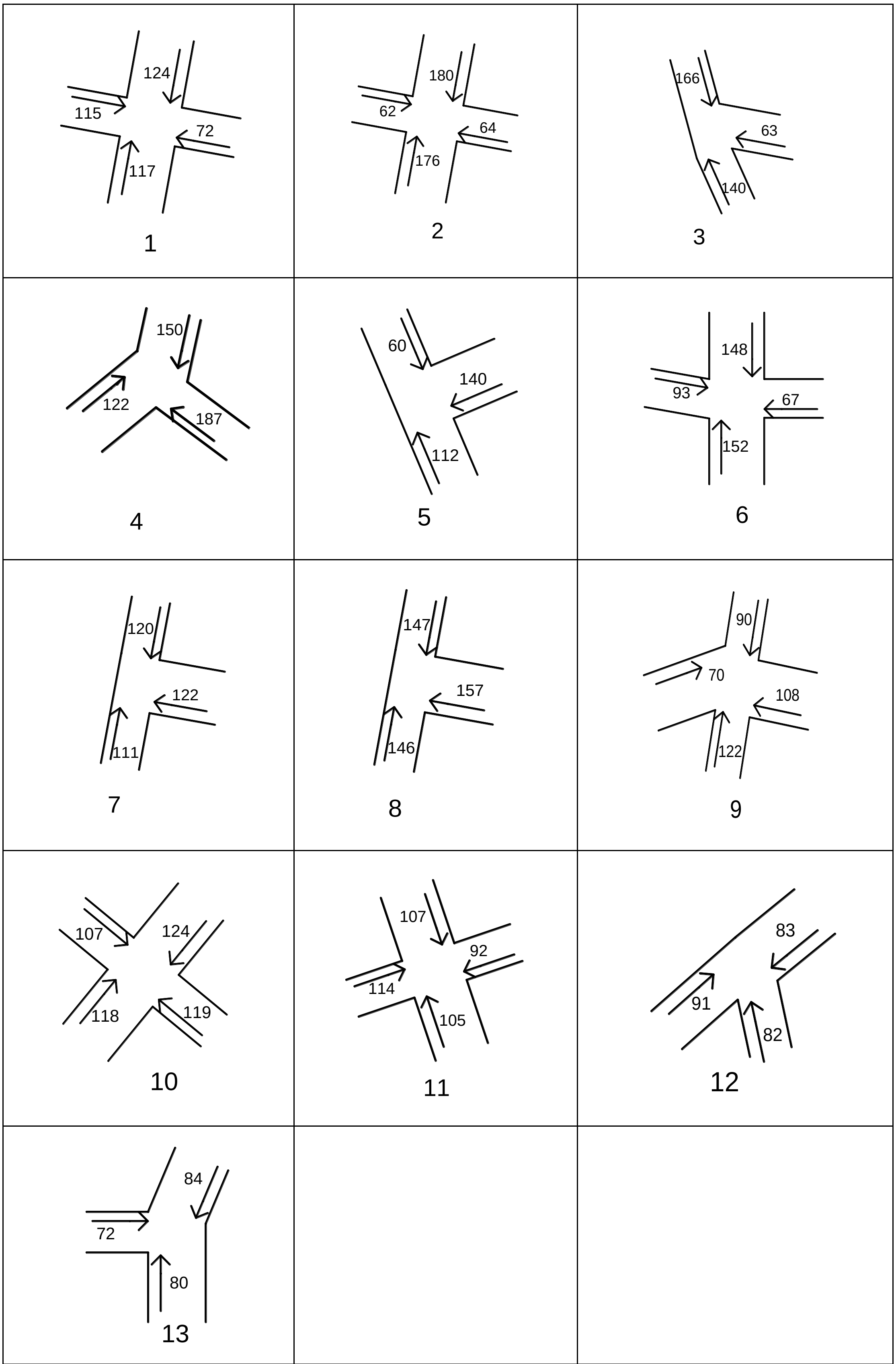


(c) Weekday, Day

(d) Weekday, Night

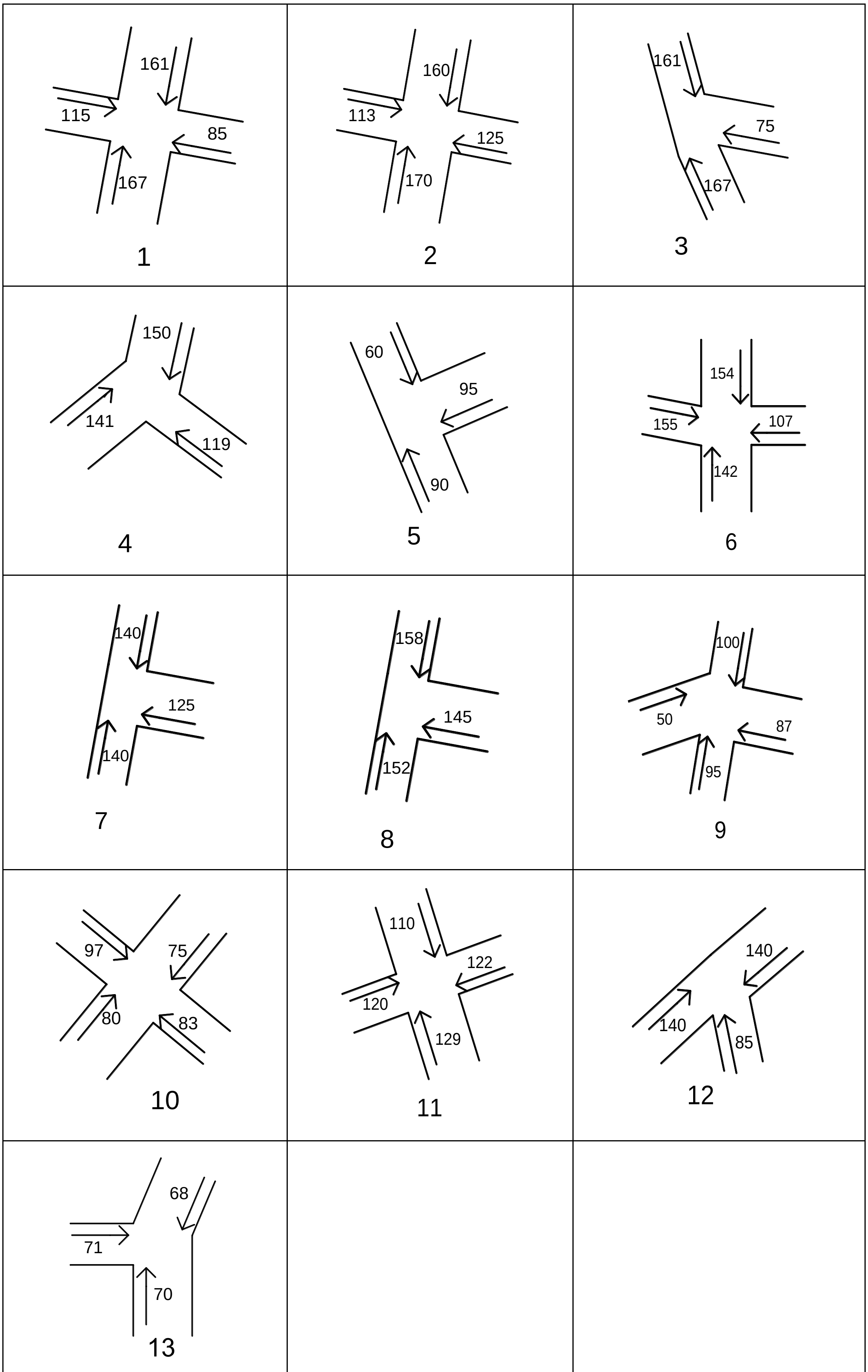
Figure F.1: Intersection Approach Green Times at SAMF

Mohakhali Flyover



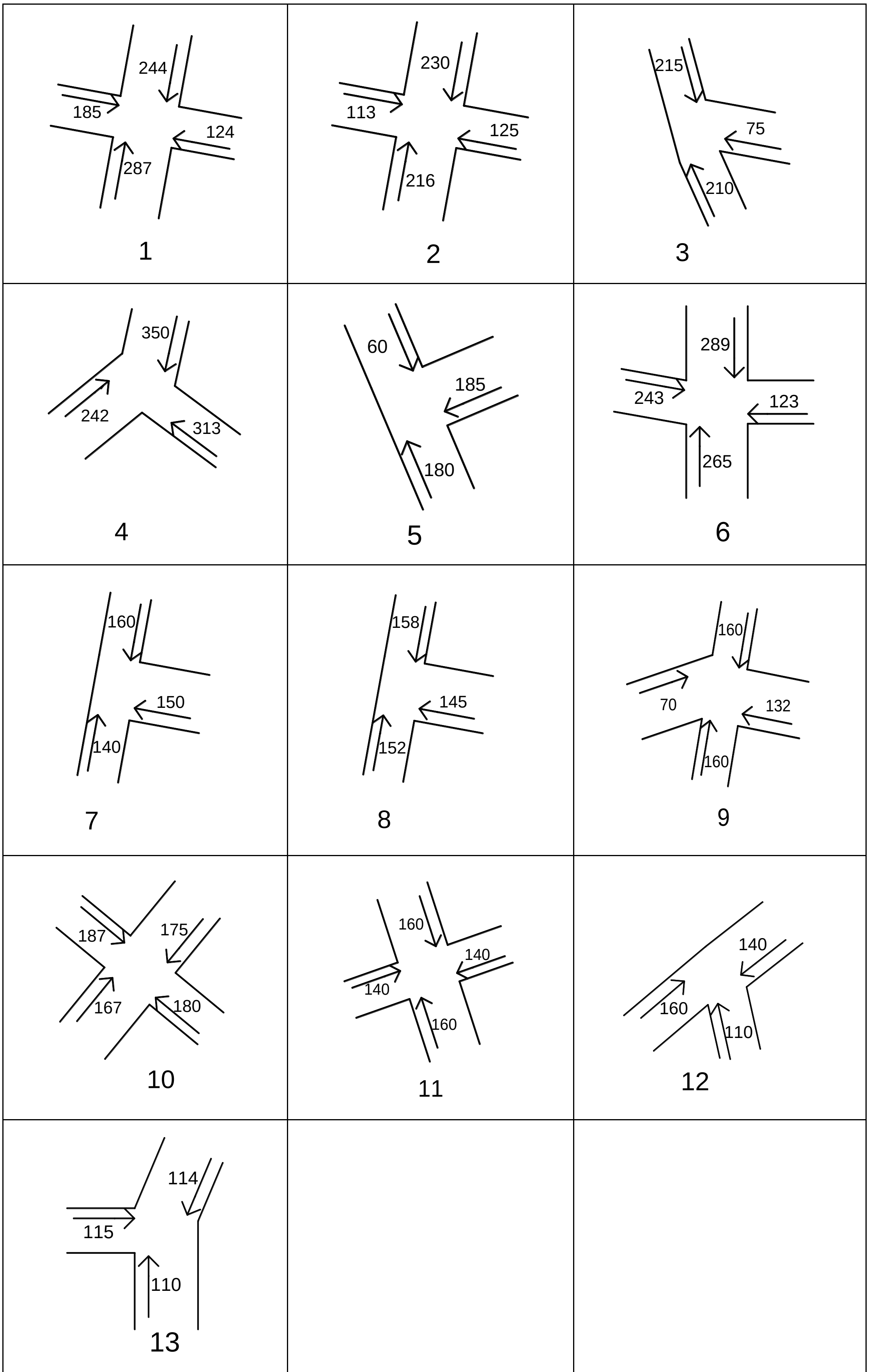
(a) Weekend, Day

(Figure F.2 continued)



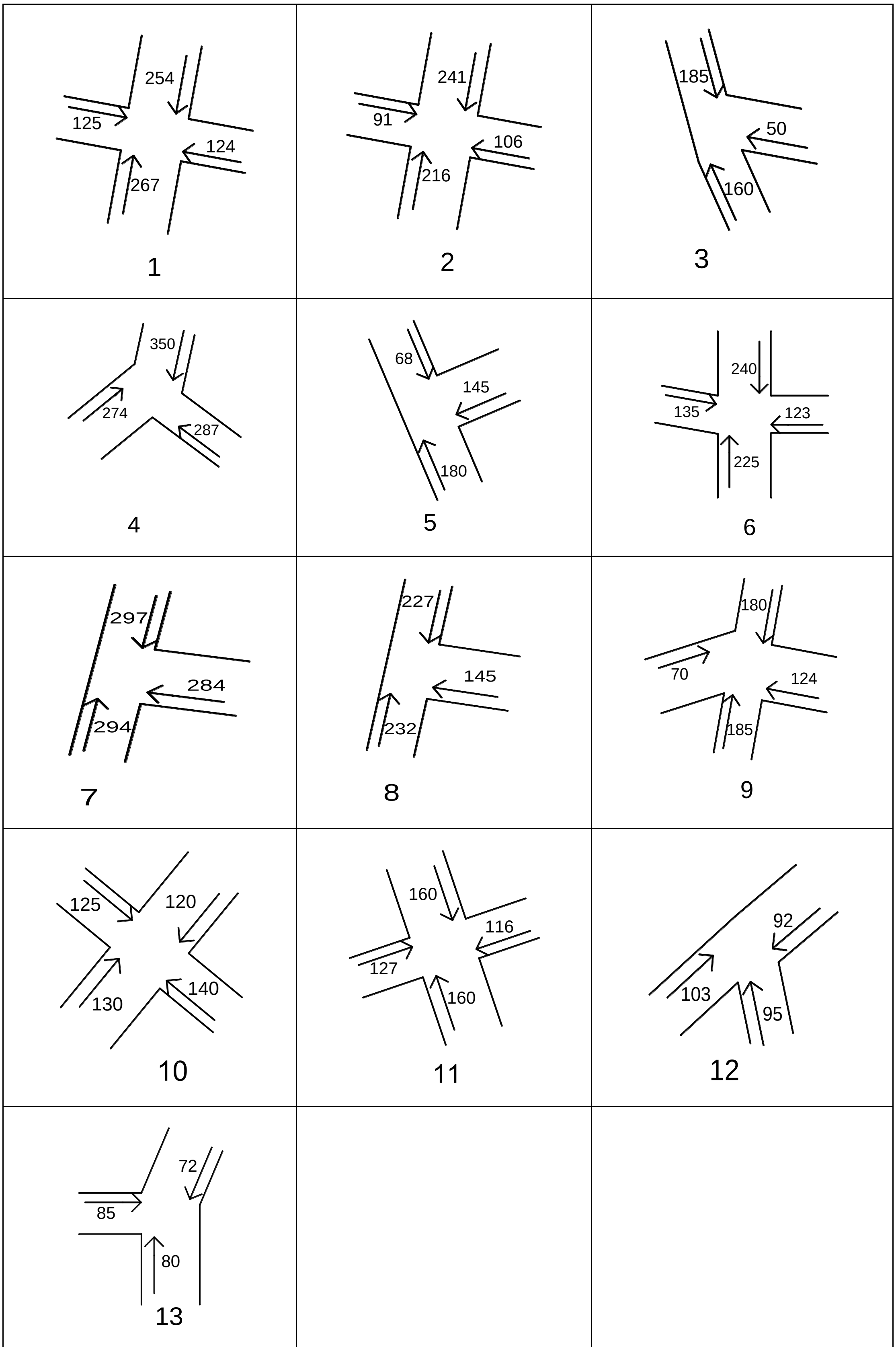
(b) Weekend, Night

(Figure F.2 continued)



(c) Weekday, Day

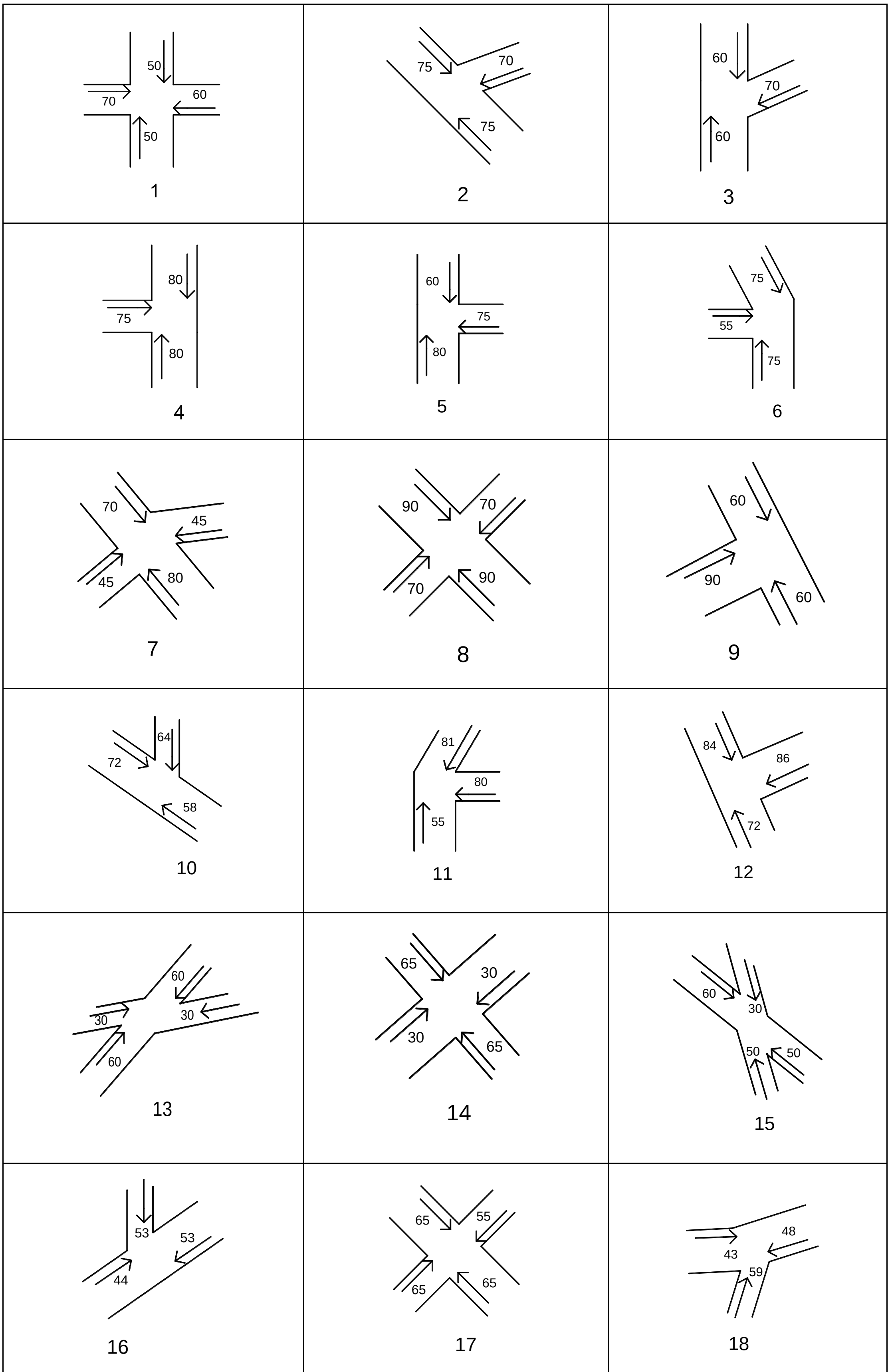
(Figure F.2 continued)



(d) Weekday, Night

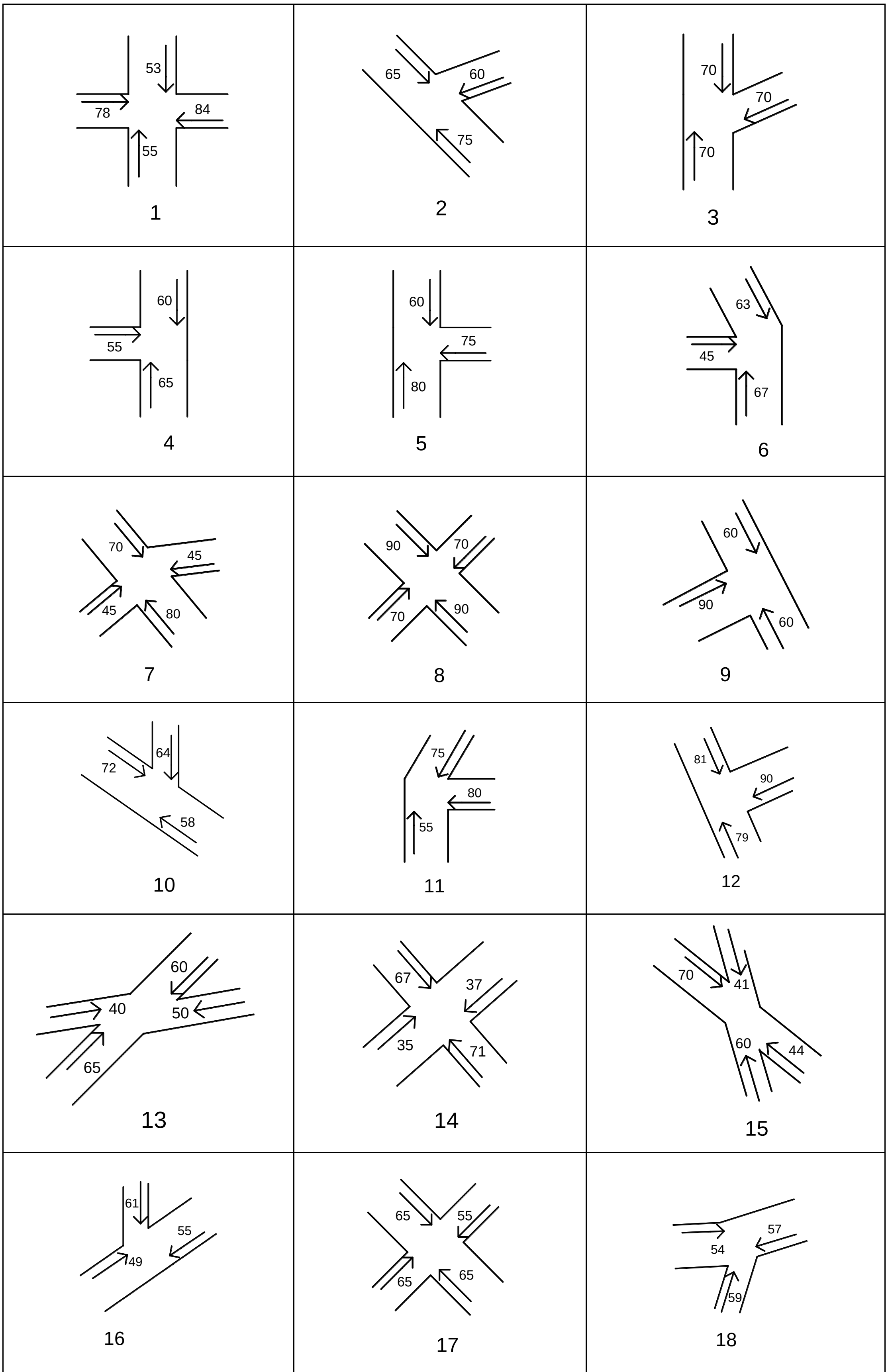
Figure F.2: Intersection Approach Green Times at Mohakhali Flyover

Khilgaon Flyover



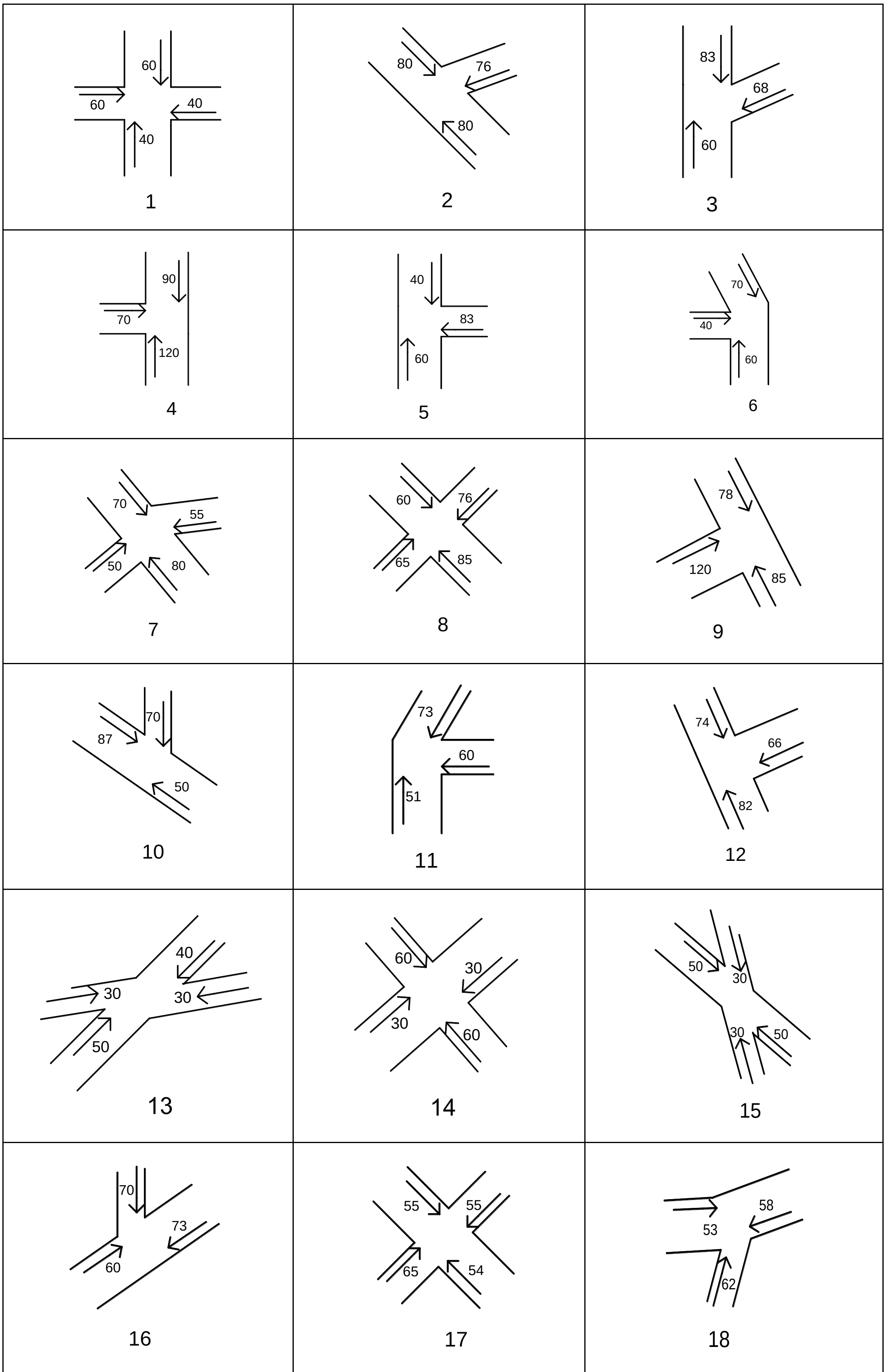
(a) Weekend, Day

(Figure F.3 continued)



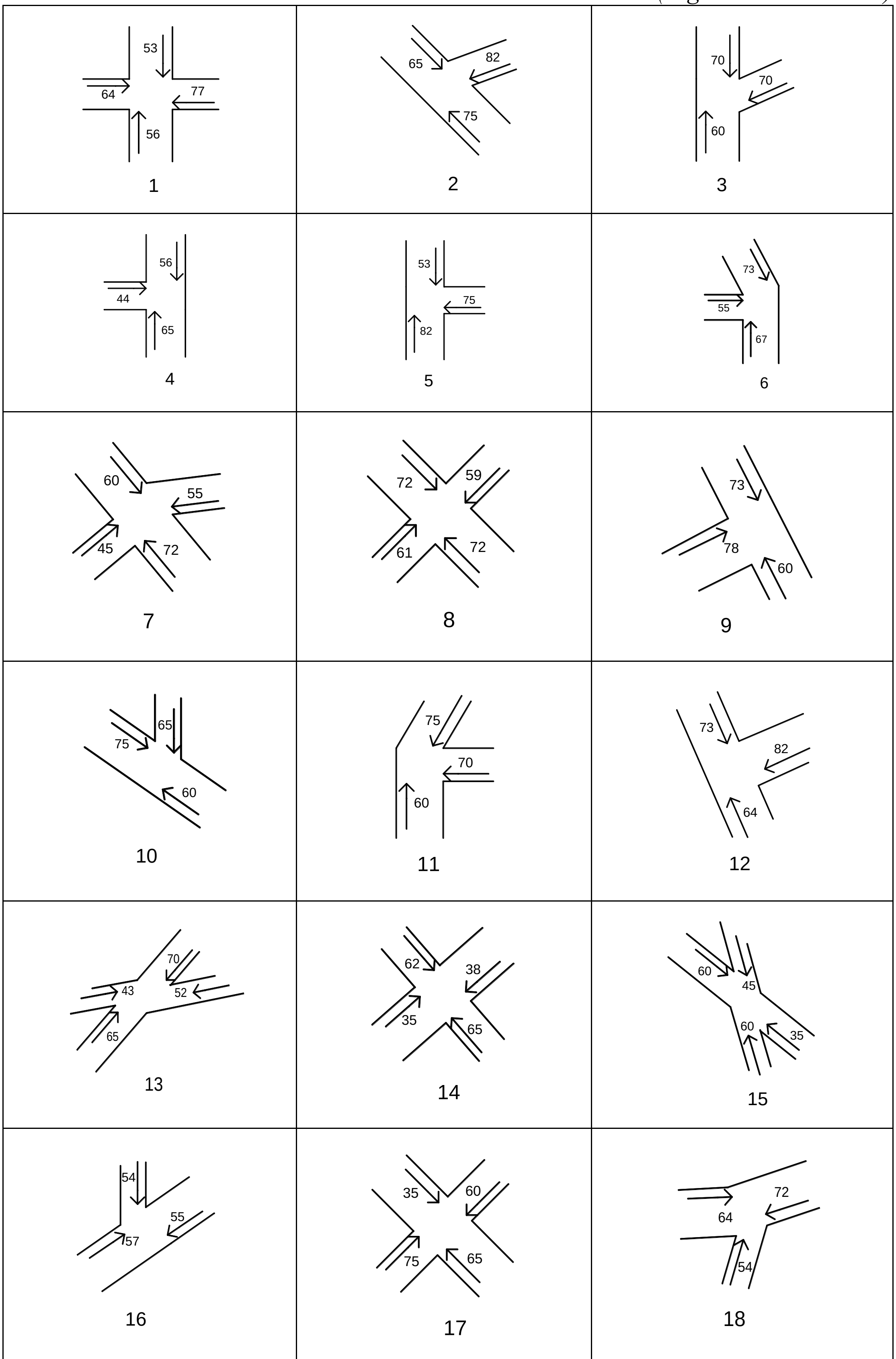
(b) Weekend, Night

(Figure F.3 continued)



(c) Weekday, Day

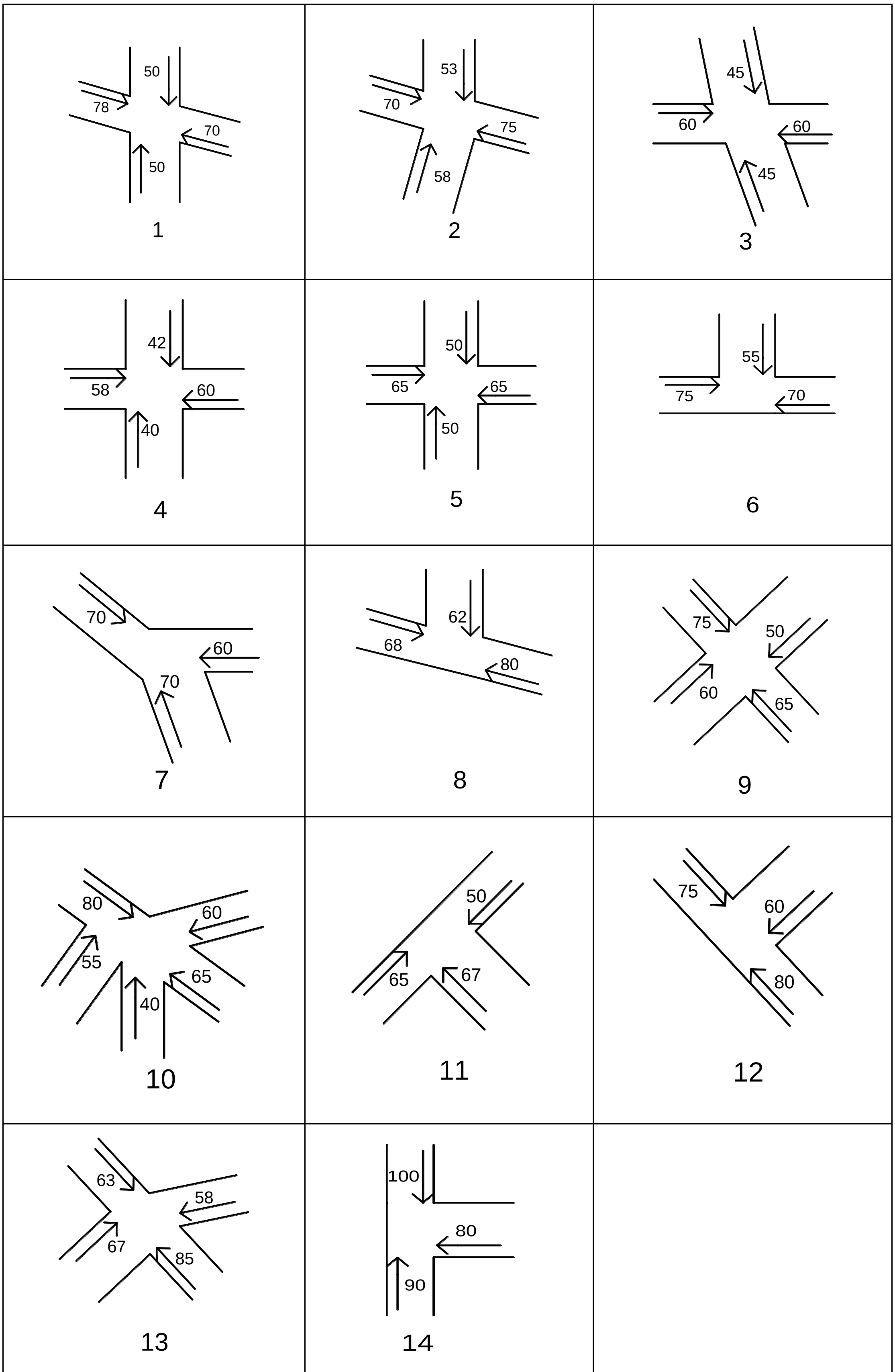
(Figure F.3 continued)



(d) Weekday, Night

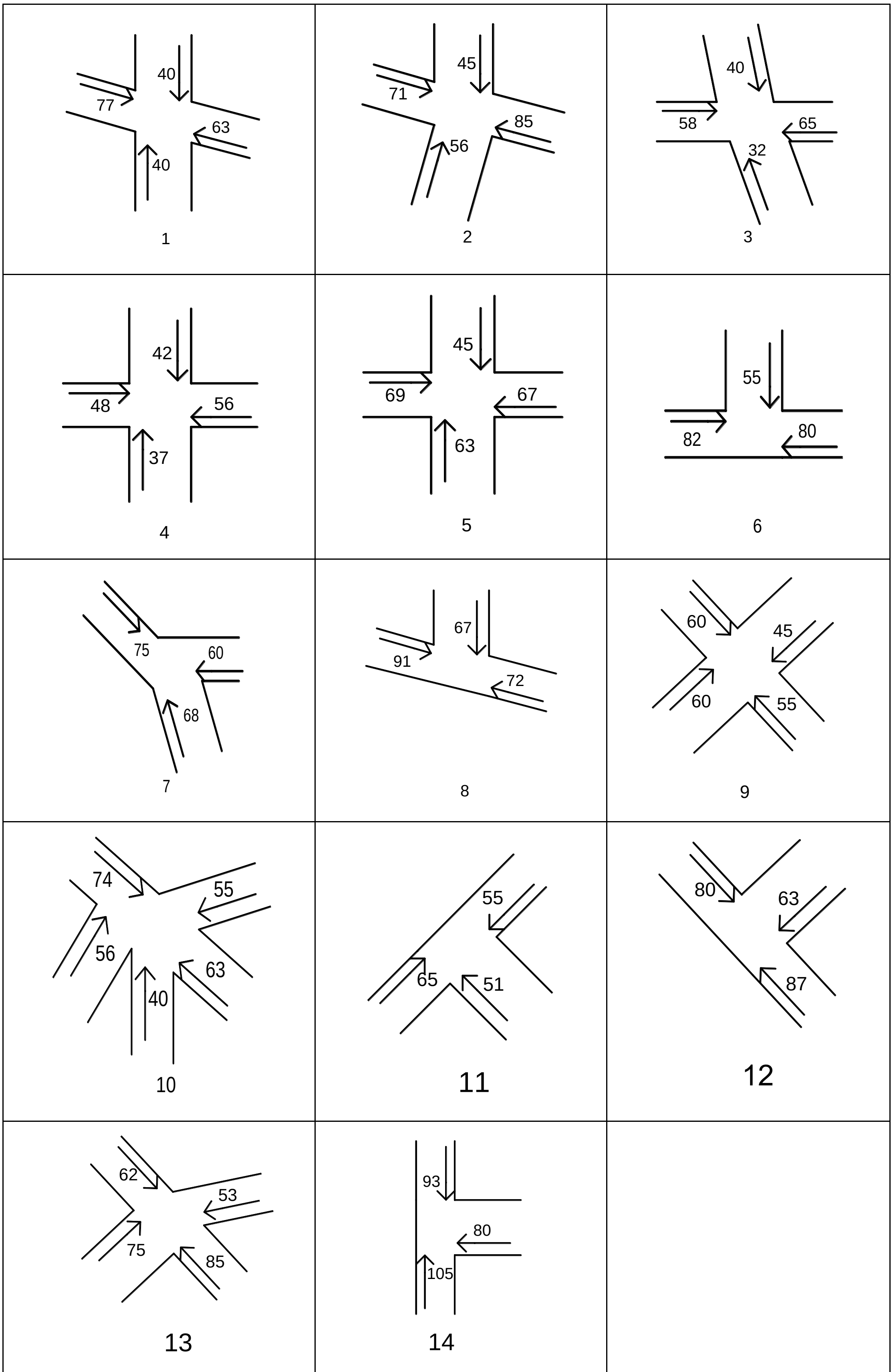
Figure F.3: Intersection Approach Green Times at Khilgaon Flyover

Jatrabari-Gulistan Flyover



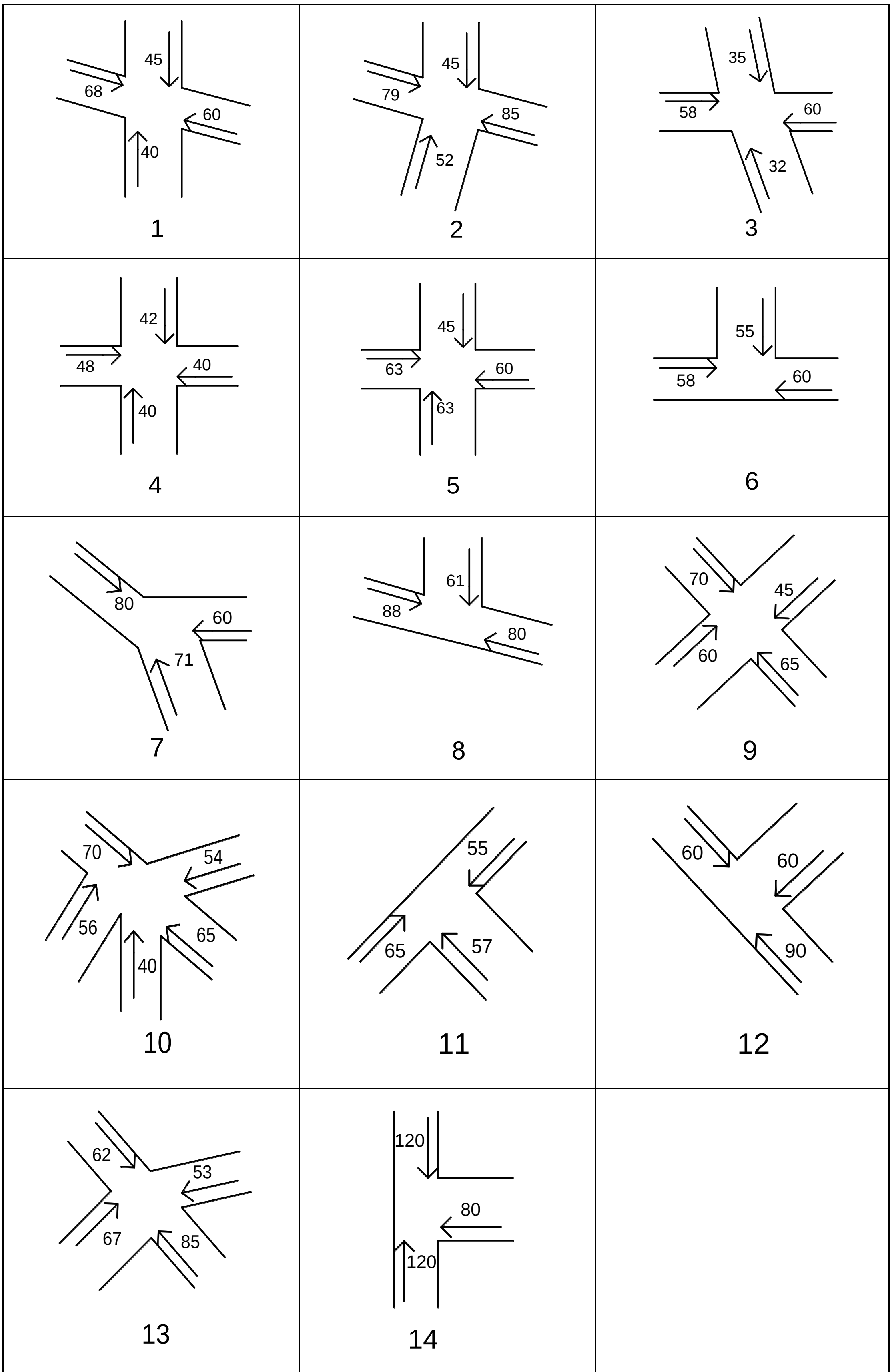
(a) Weekend, Day

(Figure F.4 continued)



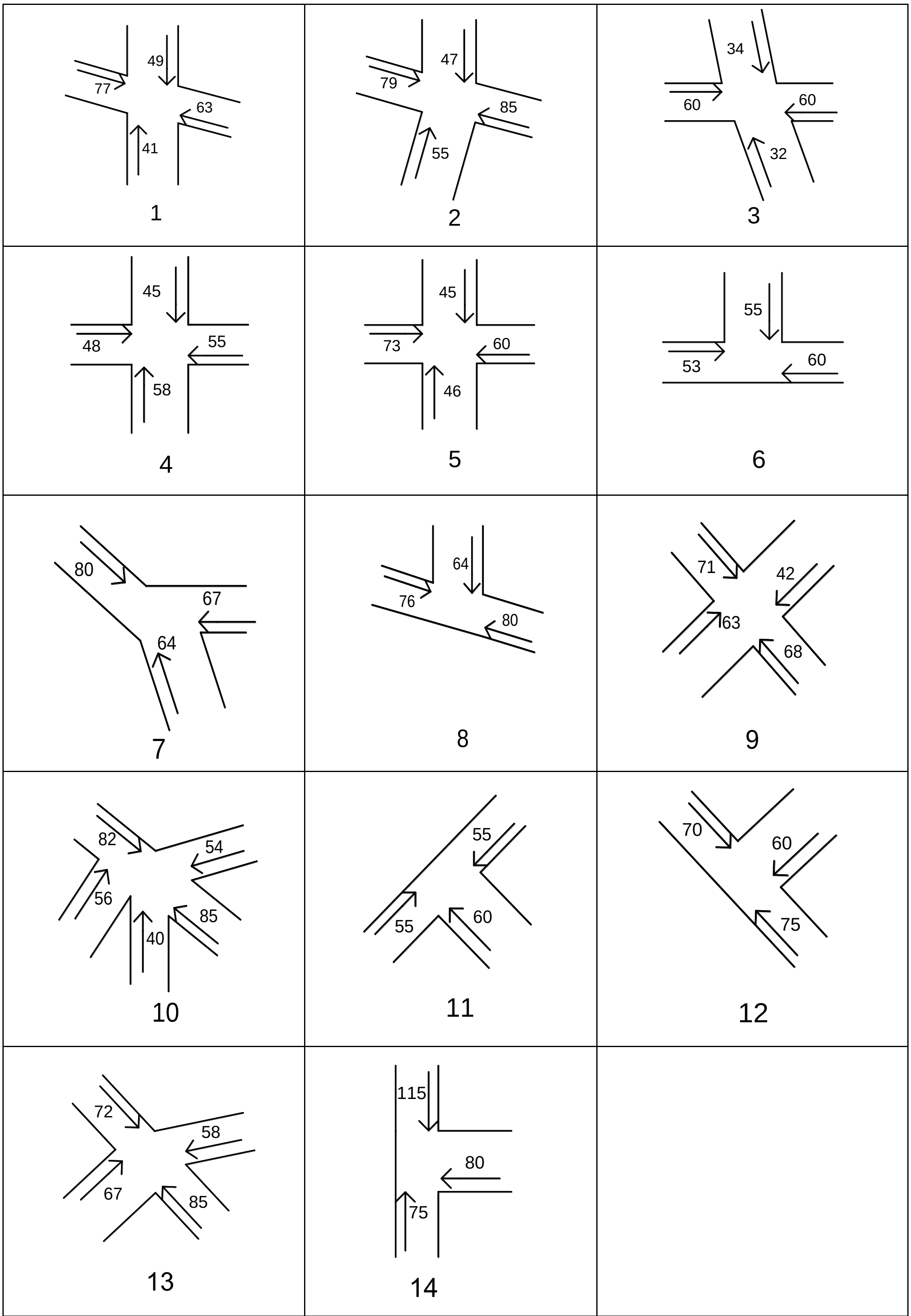
(b) Weekend, Night

(Figure F.4 continued)



(c) Weekday, Day

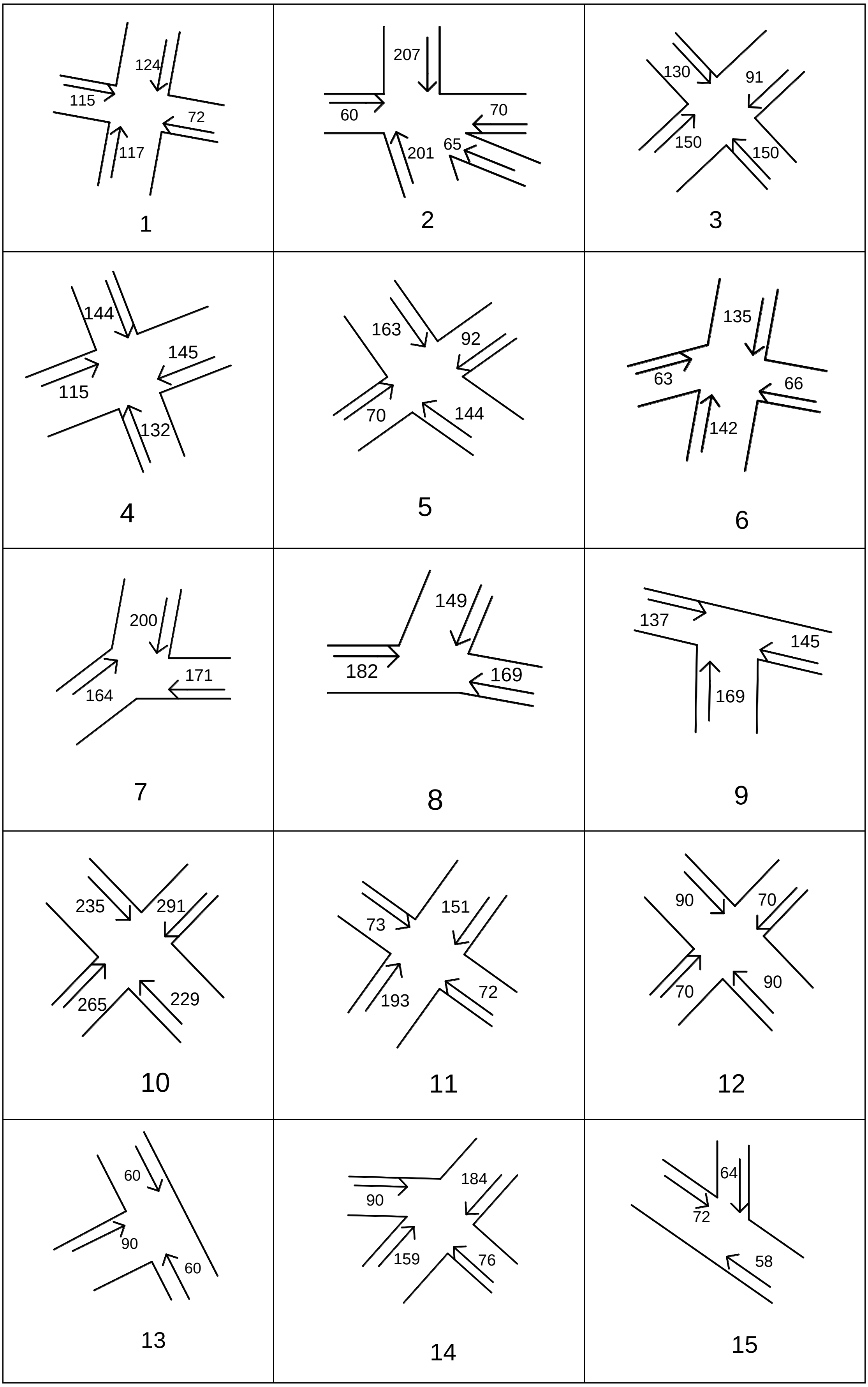
(Figure F.4 continued)



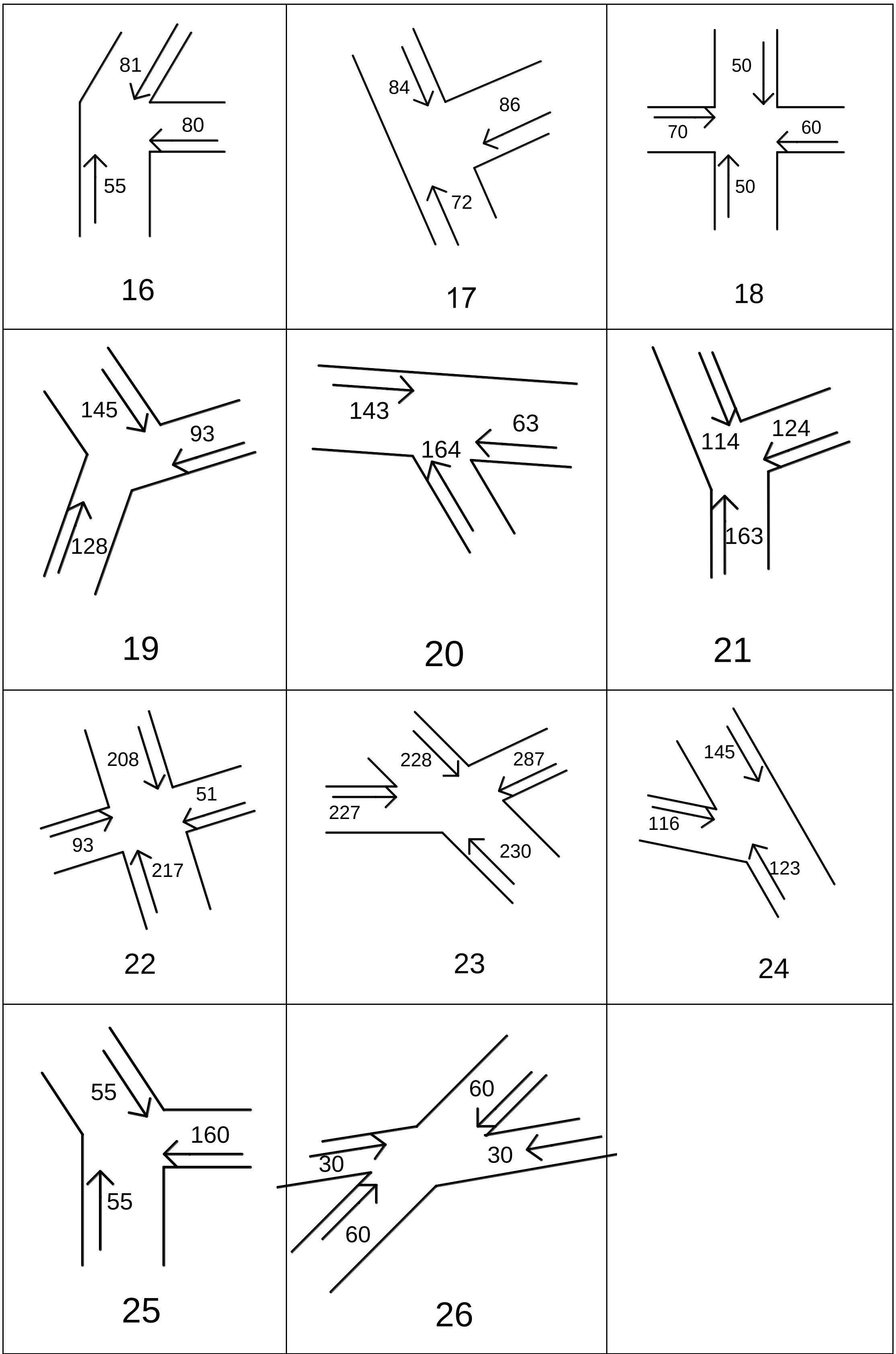
(d) Weekday, Night

Figure F.4: Intersection Approach Green Times at MMHF

Moghbazar-Mouchak Flyover

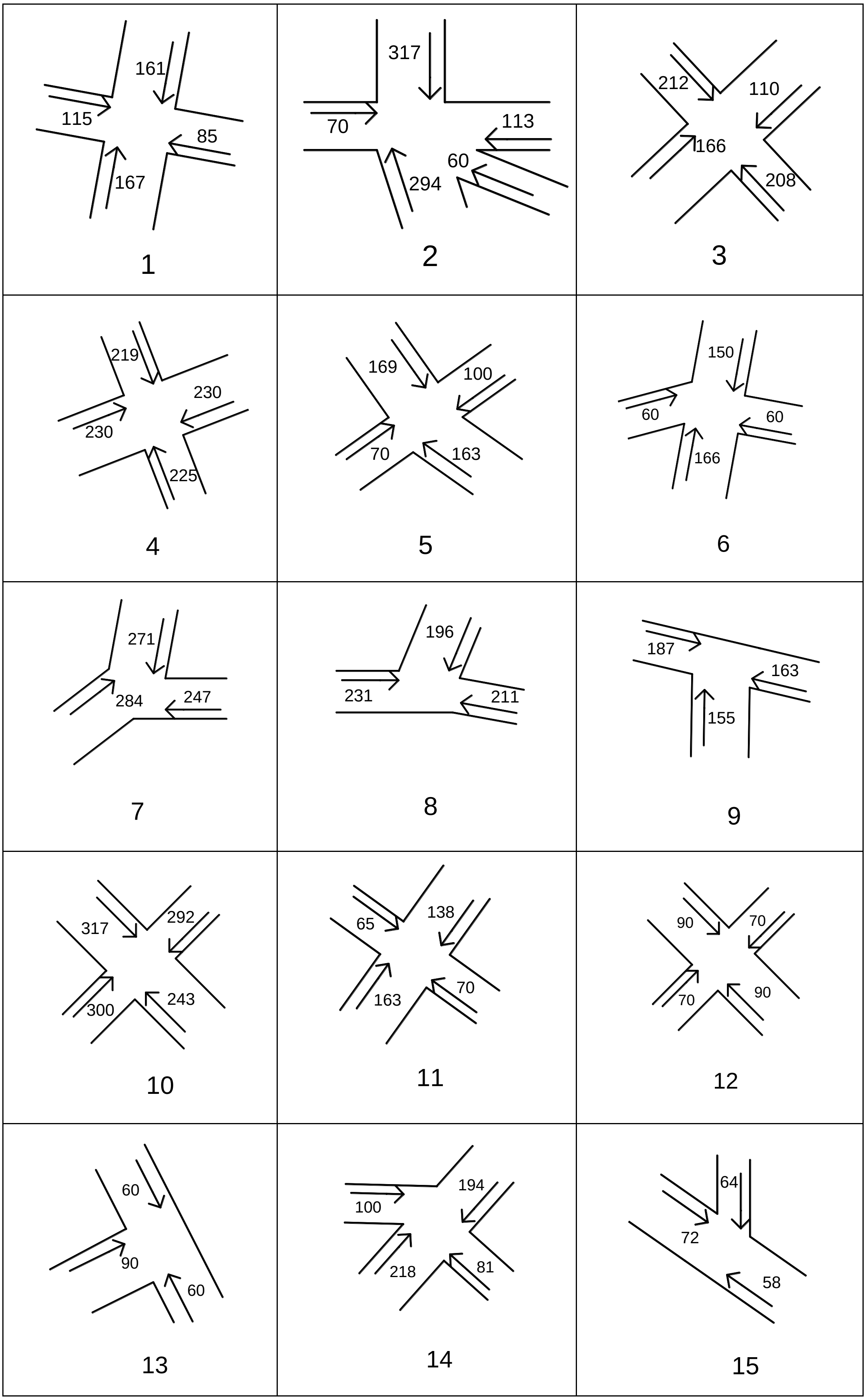


(Figure F.5 continued)

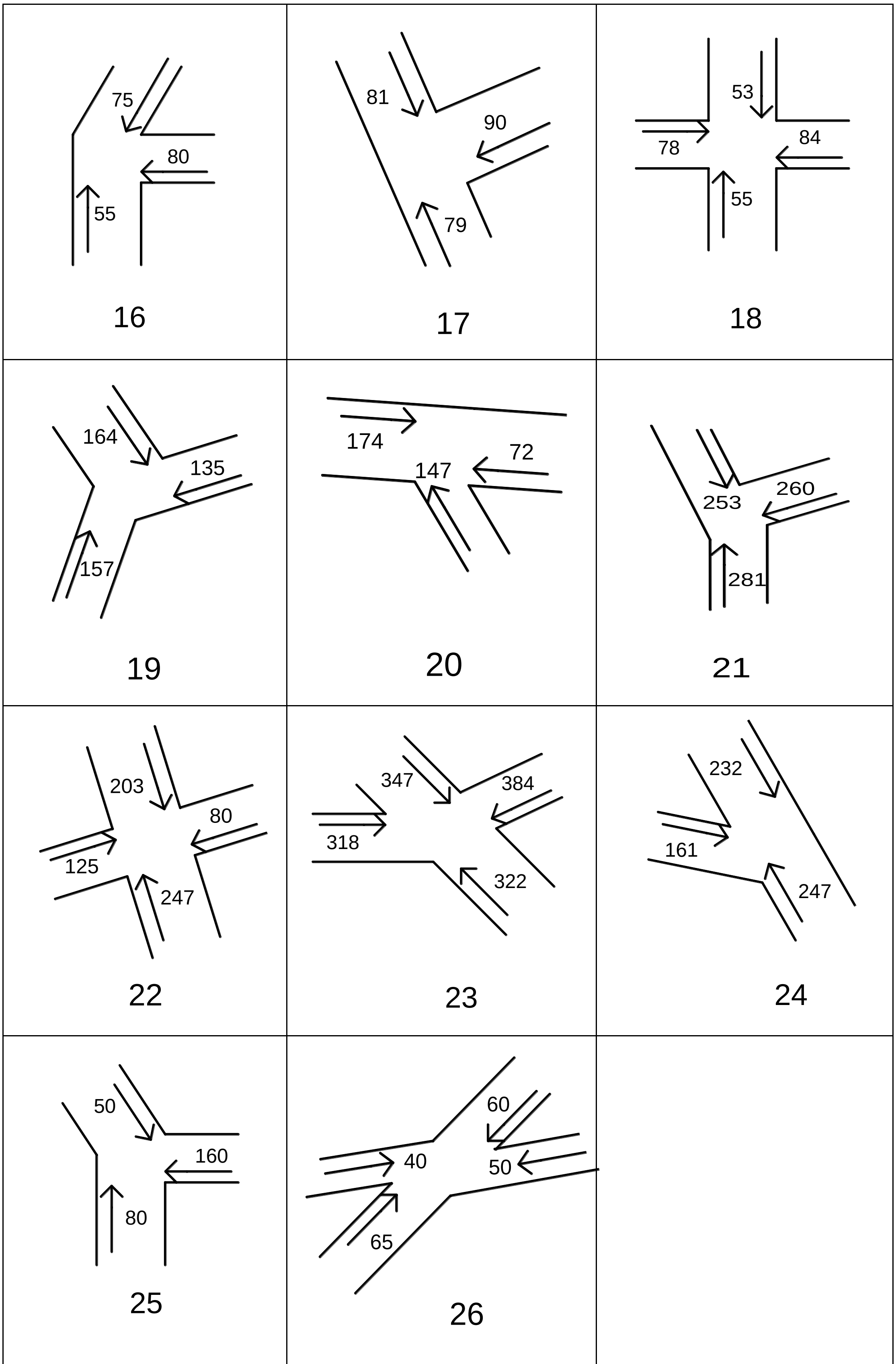


(a) Weekend, Day

(Figure F.5 continued)

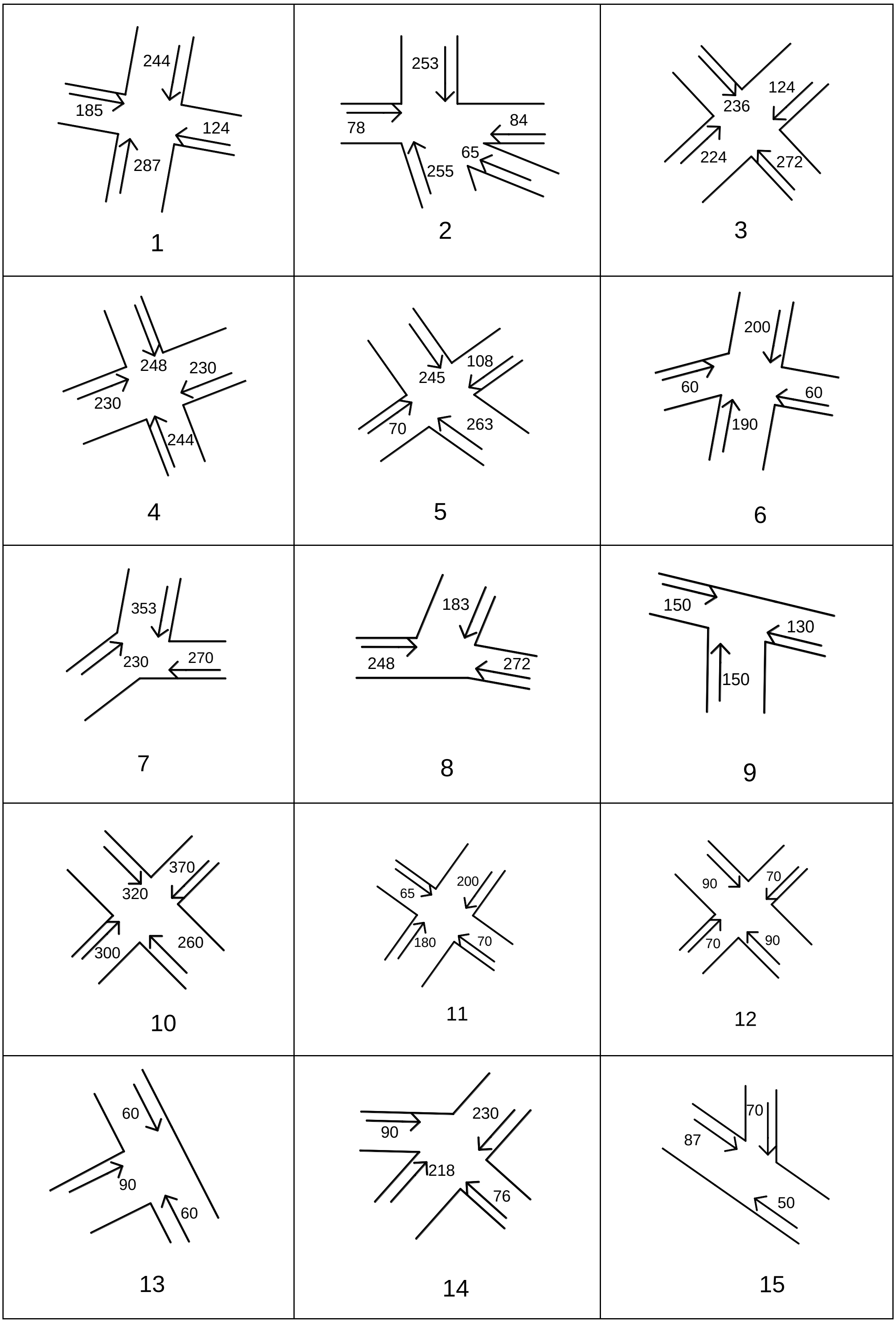


(Figure F.5 continued)

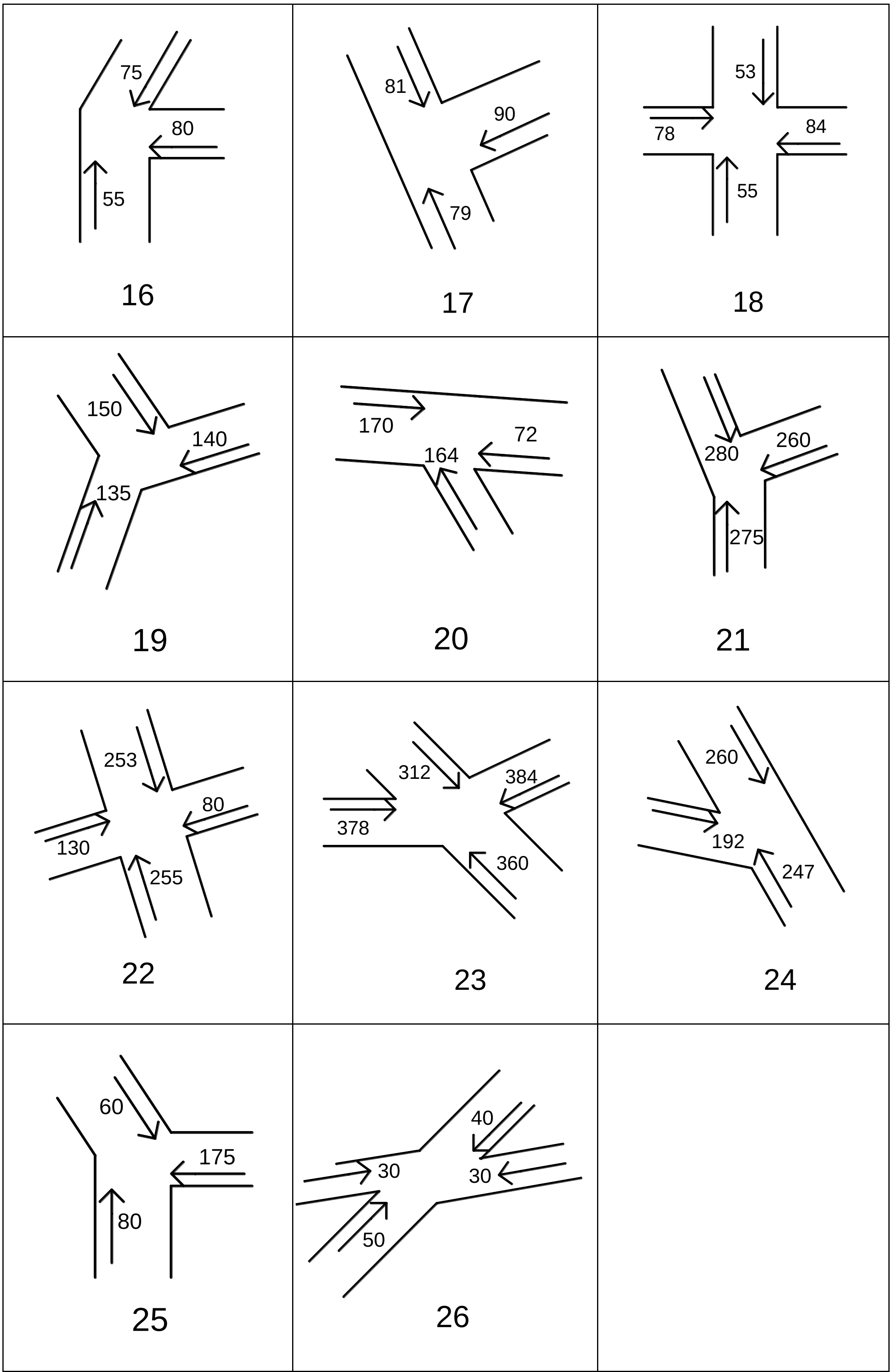


(b) Weekend, Night

(Figure F.5 continued)

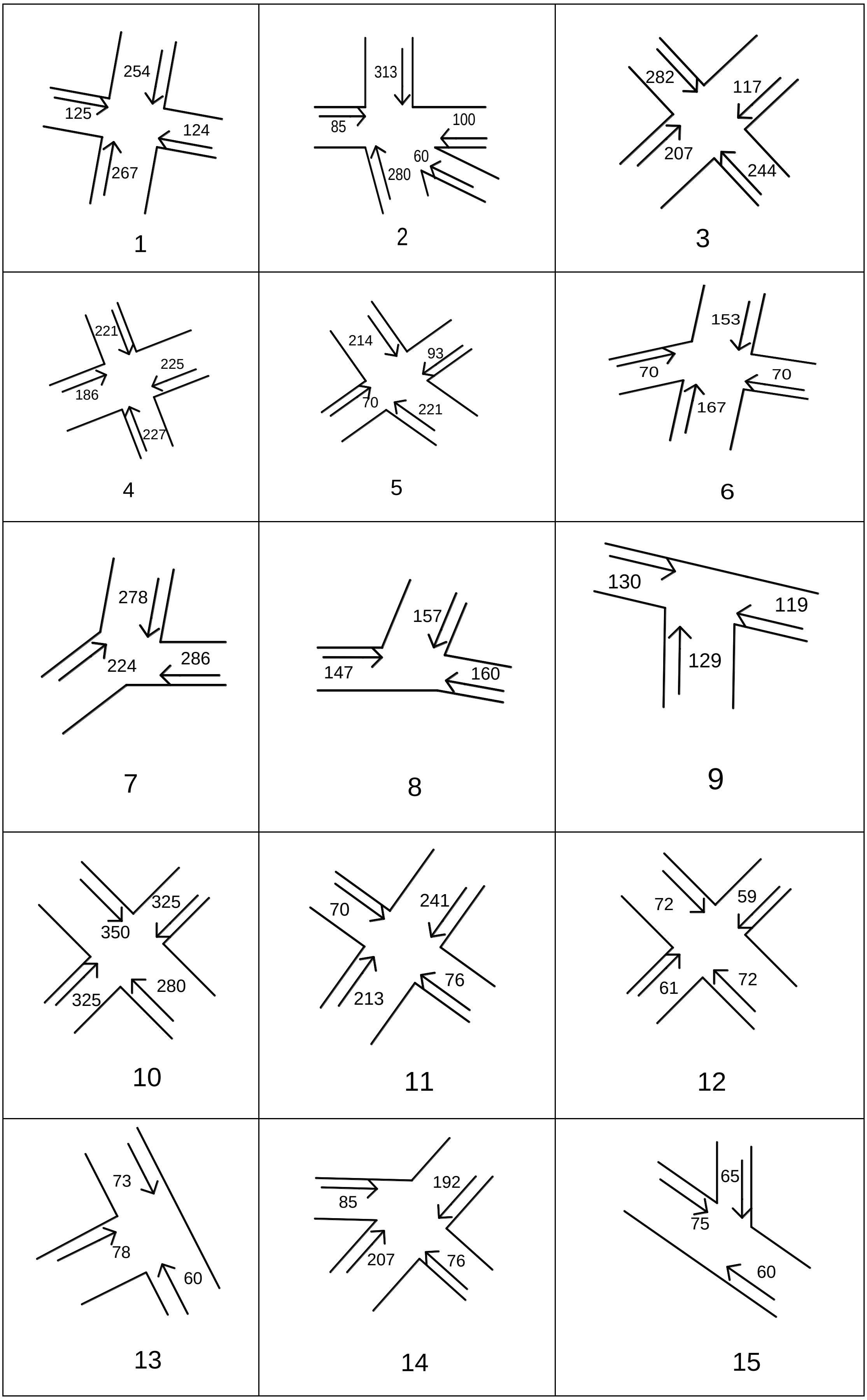


(Figure F.5 continued)

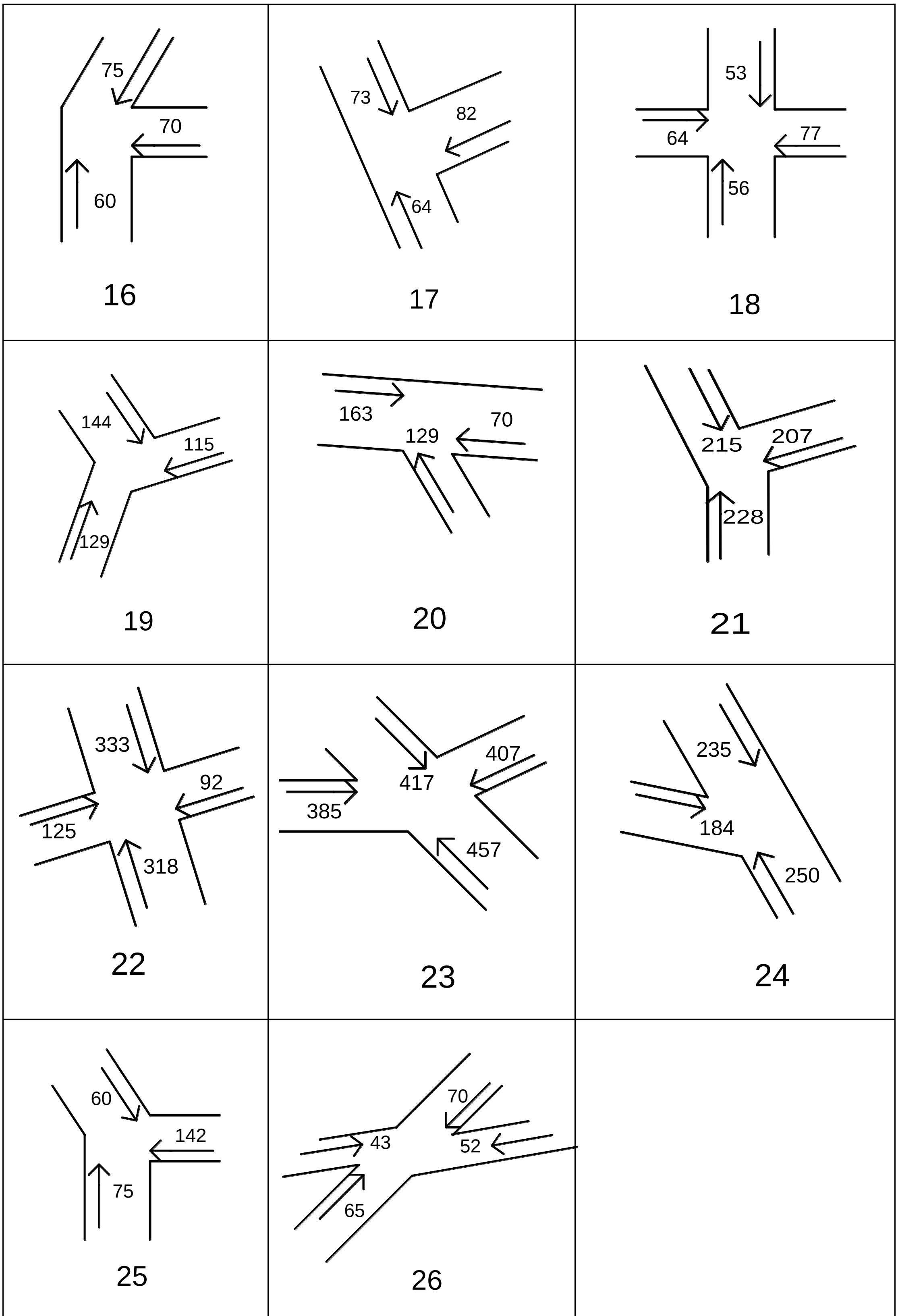


(c) Weekday, Day

(Figure F.5 continued)



(Figure F.5 continued)



(d) Weekday, Night

Figure F.5: Intersection Approach Green Times at MMF

APPENDIX G

CALCULATIONS FOR DETERMINATION OF SEGMENT CAPACITY

Table G.1: Segment Capacity Calculation at SAMF

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					Weekend, Night				
1-2	1-2	1304	165	45	3	1067	1320	170	58	3	1351
	2-1	1330	220	75	3	1360	1303	350	145	3	1619
2-3	2-3	1122	286	56	1	220	1315	280	62	1	291
	3-2	1134	165	50	1	344	1314	170	35	1	271
1-4	1-4	1244	220	73	3	1238	1308	200	55	3	1079
	4-1	1199	220	55	3	899	1313	350	95	3	1069
1-5	1-5	1333	205	75	2	975	1348	220	70	2	858
	5-1	1324	220	75	2	903	1358	350	95	2	737
5-6	5-6	1420	210	76	2	1028	1433	240	90	2	1074
	6-5	1428	205	70	2	975	1429	220	80	2	1039
		Weekday, Day					Weekday, Night				
1-2	1-2	1384	140	45	3	1335	1347	445	145	3	1317
	2-1	1362	305	125	3	1674	1291	515	155	3	1165
2-3	2-3	1269	280	62	1	281	1278	685	165	1	308
	3-2	1267	140	35	1	317	1223	445	135	1	371
1-4	1-4	1263	210	63	3	1137	1298	500	176	3	1371
	4-1	1288	305	80	3	1013	1298	515	180	3	1361
1-5	1-5	1314	213	80	2	987	1295	470	158	2	871
	5-1	1270	305	85	2	708	1344	515	165	2	861
5-6	5-6	1414	247	89	2	1019	1365	428	187	2	1193
	6-5	1408	213	75	2	992	1417	470	156	2	940

Table G.2: Segment Capacity Calculation at Mohakhali Flyover

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					Weekend, Night				
1-2	1-2	1135	482	176	3	1243	1188	568	165	3	1035
	2-1	1062	428	119	3	886	1138	528	156	3	1009
2-3	2-3	1160	369	135	3	1273	1220	403	162	3	1472
	3-2	1100	482	175	3	1198	1148	568	150	3	910
3-4	3-4	1215	459	182	3	1445	1216	410	114	3	1014
	4-3	1238	369	161	3	1621	1198	403	156	3	1392
4-5	4-5	1252	312	135	3	1625	1195	245	90	3	1317
	5-4	1247	459	117	3	953	1228	410	136	3	1222
5-6	5-6	1323	460	143	4	1646	1300	558	149	4	1388
	6-5	1321	312	107	4	1812	1323	245	85	4	1836
6-1	6-1	1187	428	110	2	610	1197	528	110	2	499
	1-6	1143	460	62	2	308	1213	558	102	2	443
4-7	4-7	1227	353	106	3	1105	1195	405	135	3	1195
	7-4	1213	459	145	3	1149	1185	410	145	3	1258
7-8	7-8	1218	450	139	3	1129	1200	455	147	3	1163
	8-7	1144	353	115	3	1118	1197	405	135	3	1197
7-11	7-11	1227	418	109	2	640	1232	481	115	2	589
	11-7	1258	353	117	2	834	1229	405	120	2	728
8-9	8-9	1246	390	117	3	1122	1195	332	90	3	972
	9-8	1205	450	142	3	1141	1168	455	153	3	1179
8-13	8-13	1290	236	67	2	733	1280	209	56	2	686
	13-8	1294	450	152	2	874	1290	455	140	2	794

(Table G.2 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					**Weekend, Night**				
9-10	9-10	1311	468	113	3	949	1288	335	75	3	865
	10-9	1302	390	103	3	1031	1270	332	82	3	941
10-11	10-11	1290	418	102	3	944	1284	481	105	3	841
	11-10	1293	468	114	3	945	1287	335	78	3	899
11-12	11-12	1306	256	78	3	1194	1271	365	135	3	1410
	12-11	1306	418	100	3	938	1253	481	124	3	969
		Weekday, Day					**Weekday, Night**				
1-2	1-2	1201	684	211	3	1112	1288	654	215	3	1270
	2-1	1201	840	239	3	1025	1294	770	249	3	1255
2-3	2-3	1253	500	205	3	1541	1285	395	155	3	1513
	3-2	1238	684	225	3	1221	1250	654	236	3	1354
3-4	3-4	1235	905	308	3	1261	1273	911	282	3	1182
	4-3	1249	500	210	3	1574	1299	395	180	3	1776
4-5	4-5	1293	425	180	3	1643	1295	393	140	3	1384
	5-4	1261	905	237	3	990	1303	911	269	3	1154
5-6	5-6	1330	920	284	4	1642	1327	723	235	4	1725
	6-5	1324	425	175	4	2181	1328	393	175	4	2365
6-1	6-1	1276	840	180	2	547	1308	770	120	2	408
	1-6	1279	920	118	2	328	1308	723	118	2	427
4-7	4-7	1249	450	135	3	1124	1304	875	289	3	1292
	7-4	1266	905	345	3	1448	1319	911	345	3	1498
7-8	7-8	1258	455	147	3	1219	1311	604	227	3	1478
	8-7	1277	450	155	3	1319	1306	875	292	3	1308
7-11	7-11	1238	600	135	2	557	1252	563	122	2	542
	11-7	1226	450	145	2	790	1249	875	279	2	797
8-9	8-9	1210	522	155	3	1078	1239	559	180	3	1197
	9-8	1195	455	153	3	1206	1250	604	222	3	1378
8-13	8-13	1273	339	110	2	826	1277	237	80	2	862
	13-8	1297	455	140	2	798	1287	604	140	2	597
9-10	9-10	1262	709	162	3	865	1295	515	125	3	943
	10-9	1236	522	127	3	902	1295	559	119	3	827
10-11	10-11	1268	600	155	3	983	1283	563	155	3	1060
	11-10	1248	709	175	3	924	1270	515	135	3	999
11-12	11-12	1270	410	135	3	1254	1296	290	87	3	1166
	12-11	1296	600	155	3	1005	1299	563	155	3	1073

Table G.3: Segment Capacity Calculation at Khilgaon Flyover

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					**Weekend, Night**				
1-2	1-2	1315	220	70	3	1255	1316	200	60	3	1184
	2-1	1327	230	45	3	779	1323	270	50	3	735
2-3	2-3	1322	190	55	3	1148	1320	210	65	3	1226
	3-2	1313	220	70	3	1253	1325	200	70	3	1391
3-4	3-4	1320	235	75	3	1264	1320	180	55	3	1210
	4-3	1325	190	55	3	1151	1325	210	65	3	1230
4-5	4-5	1301	215	70	2	847	1287	215	70	2	838
	5-4	1301	235	70	2	775	1294	180	50	2	719
5-6	5-6	1302	205	70	2	889	1277	175	62	2	905
	6-5	1272	215	55	2	651	1275	215	55	2	652

(Table G.3 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					**Weekend, Night**				
6-7	6-7	1294	240	75	2	809	1277	240	75	2	798
	7-6	1290	205	70	2	881	1266	175	58	2	839
7-8	7-8	1273	320	85	2	676	1276	320	85	2	678
	8-7	1277	240	65	2	692	1286	240	65	2	697
8-9	8-9	1279	210	55	2	670	1255	210	55	2	657
	9-8	1276	320	85	2	678	1245	320	85	2	661
9-10	9-10	1252	194	53	2	684	1256	194	53	2	686
	10-9	1272	210	55	2	666	1273	210	55	2	667
10-11	10-11	1309	216	50	3	909	1297	210	50	3	926
	11-10	1285	194	59	3	1173	1297	194	59	3	1184
11-12	11-12	1315	242	79	3	1288	1296	250	76	3	1182
	12-11	1324	216	75	3	1379	1297	210	75	3	1390
12-1	12-1	1315	230	45	3	772	1325	270	48	3	707
	1-12	1304	242	67	3	1083	1327	250	74	3	1179
1-8	1-8	1289	320	65	2	524	1284	320	65	2	521
	8-1	1302	230	65	2	736	1287	270	73	2	696
11-13	11-13	1314	180	55	3	1205	1316	215	60	3	1102
	13-11	1315	216	76	3	1388	1313	210	70	3	1313
13-14	13-14	1235	190	60	1	390	1242	210	62	1	367
	14-13	1235	180	25	1	172	1242	215	45	1	260
14-15	14-15	1235	190	55	1	358	1242	215	65	1	376
	15-14	1235	190	60	1	390	1242	210	66	1	390
15-16	15-16	1235	150	48	1	395	1242	165	56	1	422
	16-15	1235	190	45	1	293	1242	215	55	1	318
16-17	16-17	1235	250	50	1	247	1242	250	50	1	248
	17-16	1228	150	39	1	319	1242	165	44	1	331
17-18	17-18	1235	150	43	1	354	1242	170	52	1	380
	18-17	1235	250	60	1	296	1242	250	60	1	298
18-2	18-2	1235	220	65	1	365	1242	200	55	1	342
	2-18	1235	150	38	1	313	1242	170	49	1	358
18-3	18-3	1235	190	65	1	423	1242	210	65	1	384
	3-18	1228	150	54	1	442	1242	170	54	1	395
		Weekday, Day					**Weekday, Night**				
1-2	1-2	1275	236	75	3	1216	1305	222	60	3	1058
	2-1	1275	200	35	3	669	1320	250	51	3	808
2-3	2-3	1274	211	78	3	1412	1313	200	65	3	1281
	3-2	1274	236	75	3	1214	1307	222	70	3	1236
3-4	3-4	1304	280	85	3	1188	1300	165	51	3	1205
	4-3	1304	211	55	3	1020	1300	200	55	3	1072
4-5	4-5	1263	183	83	2	1146	1287	210	70	2	858
	5-4	1263	280	70	2	631	1290	165	39	2	610
5-6	5-6	1242	170	55	2	804	1270	195	62	2	807
	6-5	1242	183	35	2	475	1270	210	48	2	580
6-7	6-7	1215	255	75	2	715	1215	232	67	2	702
	7-6	1215	170	65	2	929	1220	195	68	2	851
7-8	7-8	1222	286	80	2	683	1222	264	67	2	620
	8-7	1222	255	65	2	623	1214	232	55	2	576
8-9	8-9	1225	283	80	2	692	1191	211	55	2	621
	9-8	1225	286	55	2	471	1190	264	67	2	604
9-10	9-10	1238	207	45	2	538	1238	200	55	2	681
	10-9	1238	283	73	2	639	1241	211	68	2	800

(Table G.3 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekday, Day					Weekday, Night				
10-11	10-11	1267	184	46	3	951	1262	205	55	3	1016
	11-10	1267	207	45	3	827	1267	200	60	3	1141
11-12	11-12	1238	222	69	3	1155	1243	219	68	3	1158
	12-11	1264	184	55	3	1133	1261	205	65	3	1200
12-1	12-1	1307	200	55	3	1078	1323	250	48	3	762
	1-12	1307	222	77	3	1360	1323	219	59	3	1069
1-8	1-8	1207	286	71	2	599	1259	264	54	2	515
	8-1	1239	200	55	2	682	1256	250	59	2	593
11-13	11-13	1252	150	45	3	1126	1307	230	60	3	1023
	13-11	1252	184	68	3	1388	1301	205	70	3	1332
13-14	13-14	1215	180	55	1	371	1215	200	57	1	346
	14-13	1215	150	25	1	202	1215	230	47	1	248
14-15	14-15	1187	160	45	1	334	1187	200	55	1	326
	15-14	1187	180	55	1	363	1187	200	60	1	356
15-16	15-16	1208	203	65	1	387	1208	166	49	1	356
	16-15	1208	160	45	1	340	1208	200	55	1	332
16-17	16-17	1201	229	55	1	288	1201	235	55	1	281
	17-16	1201	203	55	1	325	1201	166	52	1	376
17-18	17-18	1201	173	53	1	368	1201	190	67	1	423
	18-17	1201	229	60	1	315	1201	235	70	1	358
18-2	18-2	1208	236	71	1	363	1208	222	77	1	419
	2-18	1208	173	48	1	335	1208	190	59	1	375
18-3	18-3	1187	211	63	1	354	1187	200	65	1	386
	3-18	1187	173	57	1	391	1187	190	49	1	306

Table G.4: Segment Capacity Calculation at MMHF

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					Weekend, Night				
1-2	1-2	1247	256	65	2	633	1240	257	65	2	627
	2-1	1222	248	65	2	641	1230	220	58	2	649
2-3	2-3	1235	210	55	2	647	1212	195	53	2	659
	3-2	1253	248	70	2	707	1270	257	80	2	791
3-4	3-4	1256	200	53	2	666	1268	183	43	2	596
	4-3	1271	210	55	2	666	1240	195	60	2	763
4-5	4-5	1283	230	60	2	670	1311	244	64	2	688
	5-4	1299	200	55	2	714	1311	183	51	2	731
5-6	5-6	1277	200	70	2	894	1256	217	77	2	892
	6-5	1267	230	60	2	661	1266	244	62	2	643
6-7	6-7	1220	200	65	2	793	1253	203	70	2	864
	7-6	1217	200	65	2	791	1254	217	75	2	867
7-8	7-8	1178	210	63	2	707	1234	230	86	2	923
	8-7	1211	200	55	2	666	1259	203	55	2	682
8-9	8-9	1212	250	70	1	339	1242	220	55	1	311
	9-8	1217	210	75	1	435	1235	230	67	1	360
9-10	9-10	1251	300	75	2	625	1266	288	69	2	606
	10-9	1255	250	60	2	602	1260	220	50	2	573
10-11	10-11	1227	182	62	2	836	1272	171	46	2	685
	11-10	1241	300	50	2	414	1250	288	51	2	443

(Table G.4 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					Weekend, Night				
9-11	9-11	1297	182	45	2	642	1294	171	50	2	757
	11-9	1253	250	55	2	551	1290	220	55	2	645
11-12	11-12	1213	215	55	2	621	1240	230	58	2	625
	12-11	1214	182	60	2	800	1261	171	60	2	885
12-13	12-13	1237	273	53	2	480	1251	275	48	2	437
	13-12	1242	215	70	2	809	1238	230	75	2	807
7-13	7-13	1281	273	58	2	544	1249	275	57	2	518
	13-7	1264	200	65	2	821	1240	203	63	2	770
8-14	8-14	1275	270	85	2	803	1252	278	100	2	901
	14-8	1240	210	57	2	673	1270	230	62	2	685
		Weekday, Day					Weekday, Night				
1-2	1-2	1212	261	74	2	687	1251	265	74	2	698
	2-1	1187	213	55	2	613	1224	230	58	2	617
2-3	2-3	1229	185	53	2	704	1238	186	55	2	732
	3-2	1232	261	80	2	755	1269	266	80	2	763
3-4	3-4	1231	170	43	2	623	1261	206	43	2	527
	4-3	1227	185	55	2	730	1257	186	55	2	743
4-5	4-5	1302	231	58	2	654	1302	224	68	2	790
	5-4	1305	170	35	2	537	1305	206	50	2	634
5-6	5-6	1203	173	53	2	737	1271	168	48	2	726
	6-5	1211	231	55	2	577	1261	224	55	2	619
6-7	6-7	1203	211	75	2	855	1257	211	75	2	894
	7-6	1222	173	55	2	777	1257	168	55	2	823
7-8	7-8	1191	229	83	2	864	1242	220	71	2	802
	8-7	1199	211	55	2	625	1256	211	62	2	738
8-9	8-9	1125	240	65	1	305	1183	244	66	1	320
	9-8	1118	229	75	1	366	1207	220	75	1	412
9-10	9-10	1248	285	65	2	569	1224	317	77	2	595
	10-9	1219	240	60	2	610	1225	244	63	2	632
10-11	10-11	1247	177	52	2	732	1218	170	55	2	788
	11-10	1200	285	51	2	430	1197	317	51	2	385
9-11	9-11	1126	177	50	2	636	1283	170	50	2	755
	11-9	1155	240	55	2	529	1240	244	58	2	590
11-12	11-12	1236	210	55	2	647	1248	205	55	2	670
	12-11	1236	177	60	2	838	1252	170	50	2	737
12-13	12-13	1258	267	48	2	452	1211	282	53	2	455
	13-12	1242	210	55	2	651	1242	205	65	2	787
7-13	7-13	1269	267	57	2	542	1241	282	67	2	590
	13-7	1239	211	66	2	775	1259	211	59	2	704
8-14	8-14	1224	320	115	2	880	1238	270	70	2	642
	14-8	1232	229	56	2	602	1278	220	59	2	686

Table G.5: Segment Capacity Calculation at MMF

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					Weekend, Night				
1-2	1-2	1235	603	202	4	1655	1261	854	312	4	1843
	2-1	1198	428	112	4	1254	1234	528	162	4	1514
2-3	2-3	1181	521	125	3	850	1214	696	207	3	1083
	3-2	1190	603	196	3	1161	1174	854	289	3	1192
2-25	2-25	1234	270	155	3	2126	1330	290	155	3	2132
	25-2	1327	603	55	3	363	1313	854	65	3	300
3-4	3-4	1221	536	139	3	950	1253	904	214	3	890
	4-3	1225	521	145	3	1023	1252	696	203	3	1095
3-23	3-23	1256	972	282	3	1093	1277	1371	379	3	1059
	23-3	1279	521	145	3	1068	1311	696	161	3	910
4-5	4-5	1290	469	158	3	1303	1224	502	164	3	1200
	5-4	1269	536	127	3	902	1191	904	220	3	869
4-15	4-15	1258	194	67	2	869	1270	194	67	2	877
	15-4	1242	536	140	2	649	1236	904	225	2	615
4-22	4-22	1294	569	46	2	209	1284	655	75	2	294
	22-4	1297	536	110	2	532	1290	904	225	2	642
5-6	5-6	1213	406	130	2	777	1234	436	145	2	821
	6-5	1210	469	139	2	717	1201	502	158	2	756
6-7	6-7	1245	535	195	2	908	1252	802	266	2	831
	7-6	1226	406	137	2	827	1239	436	161	2	915
6-14	6-14	1304	509	85	2	436	1280	593	95	2	410
	14-6	1304	406	61	2	392	1287	436	55	2	325
7-8	7-8	1346	500	177	4	1905	1346	638	226	4	1907
	8-7	1346	535	165	4	1660	1346	802	242	4	1624
7-19	7-19	1334	366	88	3	962	1325	456	130	3	1133
	19-7	1334	535	159	3	1190	1330	802	279	3	1388
8-9	8-9	1346	451	132	4	1575	1346	505	182	4	1940
	9-8	1346	500	164	4	1765	1346	638	206	4	1738
8-14	8-14	1300	509	154	3	1180	1281	593	213	3	1381
	14-8	1271	500	144	3	1098	1263	638	191	3	1134
9-10	9-10	1314	1020	230	4	1185	1304	1152	312	4	1412
	10-9	1316	451	140	4	1634	1302	505	158	4	1629
10-11	10-11	1308	489	188	2	1006	1301	436	158	2	943
	11-10	1297	1020	286	2	728	1290	1152	287	2	643
11-12	11-12	1311	320	65	2	533	1308	320	65	2	531
	12-11	1308	489	146	2	781	1304	436	133	2	796
11-14	11-14	1297	509	71	2	362	1304	593	76	2	334
	14-11	1304	489	68	2	363	1301	436	60	2	358
12-13	12-13	1279	210	55	2	670	1255	210	55	2	657
	13-12	1276	320	85	2	678	1245	320	85	2	661
12-18	12-18	1304	428	110	2	670	1287	270	73	2	696
	18-12	1294	320	65	2	526	1284	320	65	2	521
13-14	13-14	1298	509	179	3	1369	1264	593	189	3	1209
	14-13	1308	210	85	3	1589	1283	210	85	3	1558
13-15	13-15	1252	194	53	2	684	1256	194	53	2	686
	15-13	1272	210	55	2	666	1273	210	55	2	667
15-16	15-16	1309	216	50	3	909	1297	210	50	3	926
	16-15	1285	194	59	3	1173	1297	194	59	3	1184
16-17	16-17	1315	242	79	3	1288	1296	250	76	3	1182
	17-16	1324	216	75	3	1379	1297	210	75	3	1390
16-26	16-26	1314	180	55	3	1205	1312	215	60	3	1098
	26-16	1315	216	76	3	1388	1313	210	70	3	1313

(Table G.5 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekend, Day					**Weekend, Night**				
17-18	17-18	1315	230	45	3	772	1325	270	48	3	707
	18-17	1304	242	67	3	1083	1327	250	74	3	1179
19-20	19-20	1278	370	159	2	1098	1304	393	142	2	943
	20-19	1304	366	140	2	998	1304	456	159	2	910
20-21	20-21	1332	401	119	3	1186	1334	794	255	3	1285
	21-20	1346	370	138	4	2008	1346	393	169	4	2315
21-22	21-22	1335	569	212	4	1989	1315	651	242	4	1955
	22-21	1324	401	109	4	1440	1298	794	248	4	1622
22-23	22-23	1295	972	225	4	1199	1286	1371	317	4	1189
	23-22	1320	569	203	4	1883	1295	651	198	4	1576
23-24	23-24	1238	384	118	4	1522	1226	640	242	4	1855
	24-23	1251	972	223	4	1148	1219	1371	342	4	1216
		Weekday, Day					**Weekday, Night**				
1-2	1-2	1280	735	248	4	1728	1270	838	308	4	1867
	2-1	1277	840	282	4	1714	1302	770	262	4	1771
2-3	2-3	1233	856	231	3	998	1238	850	277	3	1211
	3-2	1224	735	250	3	1249	1240	838	275	3	1221
2-25	2-25	1314	315	170	3	2128	1325	277	137	3	1966
	25-2	1317	735	73	3	392	1330	838	80	3	381
3-4	3-4	1262	952	243	3	967	1261	859	216	3	952
	4-3	1251	856	267	3	1171	1255	850	239	3	1059
3-23	3-23	1298	1434	379	3	1029	1301	1666	402	3	942
	23-3	1312	856	219	3	1007	1319	850	202	3	940
4-5	4-5	1285	686	240	3	1348	1296	598	209	3	1359
	5-4	1285	952	239	3	968	1271	859	222	3	986
4-15	4-15	1238	207	82	2	981	1222	200	70	2	855
	15-4	1234	952	225	2	583	1243	859	220	2	637
4-22	4-22	1301	718	75	2	272	1280	868	87	2	257
	22-4	1277	952	225	2	603	1301	859	181	2	548
5-6	5-6	1266	510	195	2	968	1252	460	148	2	805
	6-5	1265	686	258	2	952	1266	598	216	2	915
6-7	6-7	1289	853	348	2	1052	1267	788	273	2	878
	7-6	1276	510	185	2	926	1258	460	162	2	886
6-14	6-14	1304	624	85	2	355	1304	560	80	2	373
	14-6	1301	510	55	2	281	1308	460	65	2	370
7-8	7-8	1319	703	243	4	1823	1319	464	142	4	1614
	8-7	1327	853	265	4	1649	1335	788	281	4	1904
7-19	7-19	1334	425	135	3	1271	1334	688	110	3	640
	19-7	1334	853	225	3	1056	1334	788	219	3	1112
8-9	8-9	1346	630	145	4	1239	1346	378	125	4	1780
	9-8	1346	703	267	4	2044	1346	464	155	4	1798
8-14	8-14	1311	614	213	3	1365	1312	560	202	3	1420
	14-8	1298	703	178	3	986	1307	464	152	3	1285
9-10	9-10	1239	1250	315	4	1249	1255	1280	345	4	1353
	10-9	1249	630	125	4	991	1242	378	114	4	1499
10-11	10-11	1294	515	175	2	879	1304	600	208	2	904
	11-10	1290	1250	365	2	754	1290	1280	320	2	645
11-12	11-12	1301	320	65	2	528	1308	264	56	2	555
	12-11	1301	515	195	2	985	1294	600	236	2	1018
11-14	11-14	1294	614	71	2	299	1277	560	71	2	324
	14-11	1308	515	60	2	305	1284	600	65	2	278

(Table G.5 continued)

Segment	Segment Label	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)	s (pc/h/ln)	C (s)	g (s)	N (ln)	c (pc/h)
		Weekday, Day					Weekday, Night				
12-13	12-13	1225	210	55	2	642	1191	211	55	2	621
	13-12	1225	320	85	2	651	1190	264	67	2	604
12-18	12-18	1240	270	73	2	671	1256	250	59	2	593
	18-12	1207	320	65	2	491	1259	264	54	2	515
13-14	13-14	1294	614	225	3	1422	1314	560	187	3	1316
	14-13	1298	210	85	3	1576	1317	211	73	3	1367
13-15	13-15	1238	207	45	2	538	1238	200	55	2	681
	15-13	1238	210	55	2	649	1241	211	68	2	800
15-16	15-16	1267	210	50	3	905	1262	205	55	3	1016
	16-15	1267	207	65	3	1194	1267	200	60	3	1141
16-17	16-17	1238	250	76	3	1129	1243	219	68	3	1158
	17-16	1264	210	75	3	1354	1261	205	65	3	1200
16-26	16-26	1252	150	45	3	1126	1307	230	60	3	1023
	26-16	1252	184	68	3	1388	1307	205	70	3	1338
17-18	17-18	1307	270	48	3	697	1323	250	48	3	762
	18-17	1307	250	74	3	1160	1323	219	59	3	1069
19-20	19-20	1300	406	159	2	1019	1295	362	124	2	887
	20-19	1301	425	145	2	888	1281	388	139	2	918
20-21	20-21	1334	815	255	3	1252	1327	650	202	3	1237
	21-20	1341	406	165	4	2180	1344	362	158	4	2346
21-22	21-22	1308	718	250	4	1822	1313	868	313	4	1893
	22-21	1292	815	275	4	1744	1294	650	210	4	1672
22-23	22-23	1270	1434	355	4	1258	1288	1666	452	4	1398
	23-22	1271	718	248	4	1755	1302	868	328	4	1968
23-24	23-24	1256	699	242	4	1740	1290	669	245	4	1890
	24-23	1273	1434	307	4	1090	1290	1666	412	4	1276

APPENDIX H

FIELD OBSERVATION RESULTS AND CALCULATIONS FOR ASSESSMENT OF MOBILITY CONDITIONS

Table H.1: Travel Times at Free Flow Conditions at SAMF

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.54	-	1.21	1.72	1.97	1.99	1.56	1.82
	Under	9.00	1.59	6.60	1.26	1.75	1.62	-	1.4	1.85
Weekend, Night	Over	-	1.15	-	1.22	1.64	1.77	1.44	1.41	1.44
	Under	10.50	1.22	6.90	1.27	1.88	1.66	-	1.48	1.8
Weekday, Day	Over	-	1.53	-	1.18	1.66	2.07	1.63	1.56	1.78
	Under	10.66	1.59	5.90	1.3	1.64	2.13	-	1.45	1.63
Weekday, Night	Over	-	1.27	-	1.11	1.78	1.31	1.22	1.4	1.37
	Under	12.91	1.24	7.30	1.19	1.67	1.7	-	1.3	1.56

Table H.2: Travel Times at Operating Conditions for SAMF

(a) Weekend, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	14	6	20	133	5.18	18	8	26	122	5.35
2-3	1.29	89	6	95	184	16.65	106	12	118	229	13.38
1-4	1.38	96	5	101	531	7.86	98	9	107	413	9.55
1-5	0.68	41	4	45	330	6.53	45	10	55	249	8.05
5-6	0.14	11	12	23	125	3.41	17	7	24	121	3.48
		Trial 3					Trial 4				
1-2	0.22	18	3	21	105	6.29	17	5	22	111	5.95
2-3	1.29	129	13	142	155	15.64	100	6	106	202	15.08
1-4	1.38	85	10	95	475	8.72	96	8	104	505	8.16
1-5	0.68	43	2	45	229	8.93	48	2	50	285	7.31
5-6	0.14	23	3	26	130	3.23	13	9	22	105	3.97
		Trial 5					Trial 6				
1-2	0.22	16	9	25	129	16	18	7	25	117	5.58
2-3	1.29	122	3	125	217	122	99	16	115	177	15.90
1-4	1.38	100	8	108	437	100	84	18	102	496	8.31
1-5	0.68	43	8	51	299	43	40	5	45	241	8.56
5-6	0.14	15	13	28	111	15	18	7	25	117	5.58
		Trial 7					Trial 8				
1-2	0.22	12	7	19	106	6.34	16	8	24	114	5.74
2-3	1.29	88	14	102	222	14.33	112	12	124	215	13.70
1-4	1.38	87	13	100	496	8.34	87	14	101	440	9.18
1-5	0.68	46	9	55	322	6.49	41	11	52	321	6.56
5-6	0.14	16	10	26	119	3.48	11	6	17	108	4.03

(Table H.2 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	11	5	16	123	5.70	15	6	21	109	6.09
2-3	1.29	102	13	115	182	15.64	100	12	112	194	15.18
1-4	1.38	84	19	103	410	9.68	83	12	95	467	8.84
1-5	0.68	44	4	48	330	6.48	40	2	42	215	9.53
5-6	0.14	17	5	22	96	4.27	18	3	21	154	2.88

(b) Weekend, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	22	9	31	141	4.60	15	9	24	179	3.90
2-3	1.29	114	10	124	193	14.65	110	20	130	263	11.82
1-4	1.38	93	10	103	512	8.08	95	14	109	382	10.12
1-5	0.68	58	12	70	318	6.31	45	15	60	280	7.20
5-6	0.14	14	4	18	91	4.62	22	5	27	117	3.50
		Trial 3					Trial 4				
1-2	0.22	14	10	24	156	4.40	23	8	31	149	4.40
2-3	1.29	110	18	128	201	14.12	115	19	134	200	13.90
1-4	1.38	94	12	106	444	9.03	93	9	102	520	7.99
1-5	0.68	50	15	65	305	6.62	58	10	68	277	7.10
5-6	0.14	20	4	24	110	3.76	15	3	18	90	4.67
		Trial 5					Trial 6				
1-2	0.22	20	9	29	177	3.84	22	13	35	166	3.94
2-3	1.29	112	16	128	227	13.08	118	12	130	265	11.76
1-4	1.38	96	11	107	466	8.67	95	13	108	487	8.35
1-5	0.68	44	9	53	299	6.95	52	14	66	315	6.43
5-6	0.14	18	6	24	104	3.94	21	8	29	115	3.50
		Trial 7					Trial 8				
1-2	0.22	16	11	27	137	4.83	17	8	25	159	4.30
2-3	1.29	114	13	127	254	12.19	108	17	125	221	13.42
1-4	1.38	92	15	107	390	10.00	98	15	113	402	9.65
1-5	0.68	47	13	60	330	6.28	55	12	67	284	6.97
5-6	0.14	13	4	17	77	5.36	12	7	19	115	3.76
		Trial 9					Trial 10				
1-2	0.22	13	9	22	172	4.08	15	12	27	180	3.83
2-3	1.29	109	9	118	239	13.01	108	18	126	237	12.79
1-4	1.38	94	14	108	509	8.05	95	10	105	500	8.21
1-5	0.68	56	18	74	247	7.63	41	16	57	337	6.21
5-6	0.14	17	2	19	107	4.00	19	4	23	119	3.55

(Table H.2 continued)

(c) Weekday, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	16	3	19	90	7.27	17	2	19	175	4.08
2-3	1.29	91	9	100	213	14.84	95	14	109	184	15.85
1-4	1.38	99	7	106	482	8.45	104	13	117	420	9.25
1-5	0.68	49	5	54	325	6.46	44	8	52	285	7.26
5-6	0.14	10	7	17	143	3.15	12	6	18	134	3.32
		Trial 3					Trial 4				
1-2	0.22	12	2	14	94	7.33	13	2	15	117	6.00
2-3	1.29	92	16	108	191	15.53	99	11	110	172	16.47
1-4	1.38	101	19	120	451	8.70	107	12	119	410	9.39
1-5	0.68	47	4	51	270	7.63	48	8	56	244	8.16
5-6	0.14	10	4	14	130	3.50	10	2	12	145	3.21
		Trial 5					Trial 6				
1-2	0.22	13	3	16	112	6.19	12	4	16	100	6.83
2-3	1.29	84	8	92	204	15.69	87	10	97	172	17.26
1-4	1.38	84	15	99	423	9.52	88	12	100	410	9.74
1-5	0.68	44	6	50	257	7.97	49	8	57	300	6.86
5-6	0.14	11	3	14	118	3.82	12	9	21	136	3.21
		Trial 7					Trial 8				
1-2	0.22	13	5	18	119	5.78	12	3	15	152	4.74
2-3	1.29	92	15	107	165	17.07	84	19	103	200	15.33
1-4	1.38	95	9	104	439	9.15	85	12	97	477	8.66
1-5	0.68	49	11	60	271	7.40	47	6	53	321	6.55
5-6	0.14	10	9	19	154	2.91	11	11	22	130	3.32
		Trial 9					Trial 10				
1-2	0.22	13	2	15	144	4.98	12	6	18	162	4.40
2-3	1.29	95	14	109	188	15.64	91	18	109	211	14.51
1-4	1.38	91	10	101	431	9.34	99	8	107	458	8.79
1-5	0.68	44	8	52	298	6.99	48	5	53	289	7.16
5-6	0.14	12	4	16	119	3.73	10	6	16	139	3.25

(d) Weekday, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	19	2	21	112	5.95	14	6	20	139	4.98
2-3	1.29	98	10	108	197	15.23	93	17	110	212	14.42
1-4	1.38	104	11	115	509	7.96	96	8	104	461	8.79
1-5	0.68	51	4	55	359	5.91	56	5	61	257	7.70
5-6	0.14	11	9	20	116	3.71	17	4	21	90	4.54

(Table H.2 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.22	16	2	18	120	5.74	20	3	23	145	4.71
2-3	1.29	98	13	111	208	14.56	99	17	116	220	13.82
1-4	1.38	99	9	108	497	8.21	104	11	115	515	7.89
1-5	0.68	55	3	58	341	6.14	52	2	54	322	6.51
5-6	0.14	14	8	22	99	4.17	13	3	16	120	3.71
		Trial 5					Trial 6				
1-2	0.22	24	2	26	119	5.46	10	8	18	101	6.66
2-3	1.29	90	15	105	197	15.38	95	14	109	199	15.08
1-4	1.38	100	6	106	467	8.67	105	7	112	478	8.42
1-5	0.68	51	7	58	286	7.12	50	5	55	271	7.51
5-6	0.14	16	2	18	88	4.75	15	7	22	101	4.10
		Trial 7					Trial 8				
1-2	0.22	15	6	21	135	5.08	17	3	20	127	5.39
2-3	1.29	88	13	101	217	14.60	89	20	109	200	15.03
1-4	1.38	95	12	107	462	8.73	94	15	109	492	8.27
1-5	0.68	59	6	65	264	7.44	48	2	50	257	7.97
5-6	0.14	10	12	22	123	3.48	18	6	24	112	3.71
		Trial 9					Trial 10				
1-2	0.22	19	2	21	139	4.95	20	4	24	102	6.29
2-3	1.29	96	12	108	194	15.38	92	10	102	211	14.84
1-4	1.38	103	10	113	499	8.12	110	5	115	508	7.97
1-5	0.68	53	9	62	357	5.84	59	8	67	329	6.18
5-6	0.14	13	5	18	94	4.50	11	10	21	120	3.57

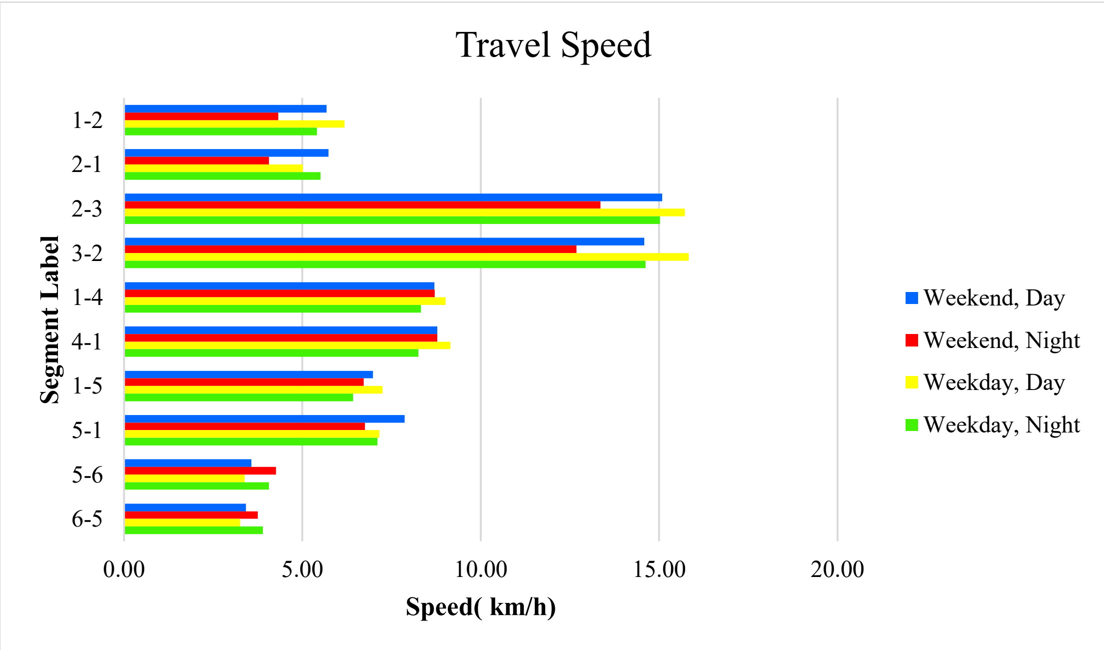


Figure H.1: Observed Travel Speed at SAMF

Table H.3: Travel Times at Free Flow Conditions at Banani Overpass

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.27	-	1.08	2.16	-	1.67	2.75	2.62
	Under	11.46	1.33	5.21	1.14	2.43	1.92	1.95	1.48	1.47
Weekend, Night	Over	-	1.32	-	1.08	2.14	1.61	1.22	2.21	1.62
	Under	-	1.78	-	1.19	2.03	-	-	1.68	-
Weekday, Day	Over	-	1.69	-	1.5	2.24	3.19	1.47	1.64	1.83
	Under	9.17	1.64	5.28	1.42	2.28	1.75	1.77	1.72	
Weekday, Night	Over	-	1.07	-	1.05	1.92	1.3	1.47	1.16	1.36
	Under	6.53	1.21	9.55	1.23	2.04	-	1.67	-	-

Table H.4: Travel Times at Free Flow Conditions at Mohakhali Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.28	-	1.26	2.19	-	1.96	2.23	1.94
	Under	9.65	1.26	6.59	1.37	1.97	5.67	2.13	1.98	2.52
Weekend, Night	Over	-	1.16	-	1.21	2.24	-	1.42	1.49	1.53
	Under	14.14	1.35	6.47	1.44	2.18	1.44	1.73	1.26	-
Weekday, Day	Over	-	1.47	-	1.22	2.17	1.46	1.15	1.51	1.72
	Under	8.42	1.22	10.01	1.38	2.13	1.78	1.33	1.84	1.43
Weekday, Night	Over	-	1.24	-	1.18	1.99	-	1.33	1.37	1.91
	Under	9.27	1.22	10.17	1.26	2.12	1.62	1.66	1.19	-

Table H.5: Travel Time at Operating Conditions for Mohakhali Flyover

(a) Weekend, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.27	31	7	38	101	6.99	27	7	34	104	7.04
2-3	0.59	61	8	69	229	7.13	54	3	57	212	7.90
3-4	0.85	90	7	97	272	8.29	80	8	88	203	10.52
4-5	0.91	101	9	110	312	7.76	97	0	97	337	7.55
5-6	1.22	101	2	103	351	9.67	132	1	133	300	10.14

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
6-1	1.13	73	2	75	463	7.56	84	9	93	383	8.55
4-7	0.30	23	4	27	142	6.39	31	4	35	99	8.06
7-8	1.15	117	9	126	306	9.58	116	2	118	233	11.79
7-11	1.83	178	1	179	304	13.64	176	7	183	331	12.82
8-9	0.35	38	2	40	268	4.09	46	5	51	303	3.56
8-13	1.22	151	7	158	164	13.64	131	2	133	293	10.31
9-10	1.38	136	2	138	350	10.18	125	1	126	282	12.18
10-11	1.66	162	3	165	311	12.55	171	7	178	349	11.34
11-12	0.85	86	1	87	183	11.33	90	2	92	313	7.56
Total Facility	**13.71**	**1348**	**64**	**1412**	**3756**	**9.55**	**1360**	**58**	**1418**	**3742**	**9.57**
		Trial 3					Trial 4				
1-2	0.27	31	5	36	152	5.17	33	6	39	133	5.65
2-3	0.59	61	2	63	358	5.05	68	3	71	243	6.76
3-4	0.85	86	7	93	361	6.74	108	5	113	315	7.15
4-5	0.91	91	9	100	264	9.00	114	7	121	321	7.41
5-6	1.22	121	4	125	442	7.75	164	9	173	329	8.75
6-1	1.13	72	2	74	447	7.81	65	3	68	658	5.60
4-7	0.30	30	1	31	119	7.20	38	4	42	179	4.89
7-8	1.15	102	6	108	286	10.51	128	9	137	318	9.10
7-11	1.83	178	9	187	379	11.64	236	7	243	390	10.41
8-9	0.35	29	0	29	176	6.15	46	5	51	244	4.27
8-13	1.22	121	5	126	301	10.29	152	4	156	287	9.91
9-10	1.38	136	9	145	445	8.42	169	2	171	332	9.88
10-11	1.66	110	4	114	489	9.91	152	2	154	524	8.81
11-12	0.85	86	2	88	301	7.87	99	2	101	337	6.99
Total Facility	**13.71**	**1254**	**65**	**1319**	**4520**	**8.45**	**1572**	**68**	**1640**	**4610**	**7.90**
		Trial 5					Trial 6				
1-2	0.27	38	7	45	151	4.96	46	1	47	114	6.04
2-3	0.59	80	1	81	212	7.25	88	6	94	194	7.38
3-4	0.85	133	4	137	325	6.62	121	4	125	261	7.93
4-5	0.91	139	4	143	223	8.95	128	9	137	234	8.83
5-6	1.22	207	6	213	264	9.21	169	6	175	327	8.75
6-1	1.13	69	9	78	404	8.44	67	4	71	461	7.65
4-7	0.30	42	5	47	155	5.35	45	1	46	167	5.07
7-8	1.15	126	1	127	338	8.90	137	2	139	320	9.02
7-11	1.83	296	6	302	356	10.01	247	7	254	406	9.98
8-9	0.35	45	7	52	119	7.37	49	5	54	175	5.50
8-13	1.22	188	8	196	222	10.51	169	3	172	303	9.25
9-10	1.38	208	2	210	396	8.20	189	2	191	321	9.70
10-11	1.66	160	0	160	474	9.43	152	0	152	518	8.92
11-12	0.85	119	2	121	287	7.50	121	2	123	289	7.43
Total Facility	**13.71**	**1850**	**62**	**1912**	**3926**	**8.45**	**1728**	**52**	**1780**	**4090**	**8.41**
		Trial 7					Trial 8				
1-2	0.27	34	9	43	121	5.93	40	3	43	160	4.79
2-3	0.59	76	5	81	259	6.25	80	4	84	277	5.88

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
3-4	0.85	109	1	110	240	8.74	108	9	117	285	7.61
4-5	0.91	117	6	123	284	8.05	114	6	120	313	7.57
5-6	1.22	158	7	165	383	8.01	146	7	153	396	8.00
6-1	1.13	76	7	83	414	8.19	67	1	68	426	8.23
4-7	0.30	28	9	37	170	5.22	35	0	35	160	5.54
7-8	1.15	116	3	119	236	11.66	109	3	112	324	9.50
7-11	1.83	237	1	238	366	10.91	211	2	213	384	11.04
8-9	0.35	34	4	38	162	6.30	39	2	41	189	5.48
8-13	1.22	158	2	160	289	9.78	146	1	147	326	9.29
9-10	1.38	178	4	182	256	11.34	163	4	167	350	9.61
10-11	1.66	143	6	149	421	10.48	127	6	133	463	10.03
11-12	0.85	112	7	119	226	8.87	108	2	110	287	7.71
Total Facility	**13.71**	**1576**	**71**	**1647**	**3827**	**9.02**	**1493**	**50**	**1543**	**4340**	**8.39**
		Trial 9					Trial 10				
1-2	0.27	26	4	30	107	7.09	29	7	36	108	6.75
2-3	0.59	77	5	82	216	7.13	71	4	75	206	7.56
3-4	0.85	109	6	115	256	8.25	104	1	105	242	8.82
4-5	0.91	114	7	121	280	8.17	120	3	123	264	8.47
5-6	1.22	153	6	159	310	9.36	147	4	151	291	9.94
6-1	1.13	74	8	82	449	7.66	67	3	70	416	8.37
4-7	0.30	32	6	38	134	6.28	28	7	35	133	6.43
7-8	1.15	117	4	121	271	10.56	126	8	134	256	10.62
7-11	1.83	220	8	228	334	11.72	209	2	211	415	10.52
8-9	0.35	36	3	39	204	5.19	38	1	39	196	5.36
8-13	1.22	150	7	157	236	11.18	138	2	140	224	12.07
9-10	1.38	166	9	175	308	10.29	149	5	154	289	11.21
10-11	1.66	123	1	124	401	11.38	134	4	138	373	11.69
11-12	0.85	102	1	103	254	8.57	134	7	141	241	8.01
Total Facility	**13.71**	**1499**	**75**	**1574**	**3760**	**9.25**	**1494**	**58**	**1552**	**3654**	**9.48**

(b) Weekend, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.27	34	2	36	398	2.24	18	2	20	367	2.51
2-3	0.59	69	6	75	236	6.83	51	9	60	413	4.49
3-4	0.85	98	5	103	291	7.77	77	7	84	242	9.39
4-5	0.91	104	7	111	150	12.55	84	8	92	269	9.07
5-6	1.22	148	9	157	404	7.83	115	7	122	355	9.21
6-1	1.13	128	2	130	413	7.49	106	9	115	451	7.19
4-7	0.30	38	1	39	265	3.55	21	2	23	260	3.82
7-8	1.15	140	4	144	303	9.26	108	2	110	265	11.04

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
7-11	1.83	215	2	217	361	11.40	178	4	182	280	14.26
8-9	0.35	38	0	38	237	4.58	26	9	35	297	3.80
8-13	1.22	128	2	130	188	13.81	115	1	116	310	10.31
9-10	1.38	145	5	150	255	12.27	132	2	134	245	13.11
10-11	1.66	186	7	193	371	10.60	161	7	168	352	11.49
11-12	0.85	98	0	98	225	9.47	77	1	78	352	7.12
Total Facility	**13.71**	**1569**	**52**	**1621**	**4097**	**8.63**	**1269**	**70**	**1339**	**4458**	**8.51**
		Trial 3					Trial 4				
1-2	0.27	31	2	33	170	4.79	49	1	50	124	5.59
2-3	0.59	61	4	65	440	4.21	88	4	92	226	6.68
3-4	0.85	86	7	93	323	7.36	121	6	127	339	6.57
4-5	0.91	91	9	100	282	8.58	128	4	132	273	8.09
5-6	1.22	121	6	127	346	9.29	166	8	174	376	7.99
6-1	1.13	112	3	115	432	7.44	155	3	158	613	5.28
4-7	0.30	33	1	34	121	6.97	52	7	59	216	3.93
7-8	1.15	114	4	118	242	11.50	158	5	163	309	8.77
7-11	1.83	178	6	184	261	14.80	242	7	249	340	11.19
8-9	0.35	38	8	46	183	5.50	58	0	58	315	3.38
8-13	1.22	121	7	128	272	10.98	166	4	170	257	10.29
9-10	1.38	136	9	145	341	10.22	186	1	187	268	10.92
10-11	1.66	162	1	163	431	10.06	221	4	225	512	8.11
11-12	0.85	86	4	90	260	8.74	121	1	122	238	8.50
Total Facility	**13.71**	**1370**	**71**	**1441**	**4104**	**8.90**	**1911**	**55**	**1966**	**4406**	**7.75**
		Trial 5					Trial 6				
1-2	0.27	50	8	58	115	5.62	52	2	54	118	5.65
2-3	0.59	86	9	95	186	7.56	92	6	98	170	7.93
3-4	0.85	116	6	122	288	7.46	125	4	129	311	6.95
4-5	0.91	122	0	122	229	9.33	131	2	133	253	8.49
5-6	1.22	157	2	159	321	9.15	170	2	172	353	8.37
6-1	1.13	147	3	150	535	5.94	159	0	159	578	5.52
4-7	0.30	54	4	58	177	4.60	56	5	61	201	4.12
7-8	1.15	149	7	156	261	9.93	161	4	165	289	9.12
7-11	1.83	226	8	234	289	12.60	246	8	254	319	11.50
8-9	0.35	59	0	59	125	6.85	62	7	69	224	4.30
8-13	1.22	157	5	162	214	11.68	170	2	172	240	10.66
9-10	1.38	175	2	177	224	12.39	190	5	195	250	11.16
10-11	1.66	207	5	212	444	9.11	225	0	225	482	8.45
11-12	0.85	116	3	119	197	9.68	125	1	126	222	8.79
Total Facility	**13.71**	**1821**	**62**	**1883**	**3605**	**8.99**	**1964**	**48**	**2012**	**4010**	**8.20**
		Trial 7					Trial 8				
1-2	0.27	19	2	21	149	5.72	27	7	34	218	3.86
2-3	0.59	57	5	62	275	6.30	67	3	70	290	5.90
3-4	0.85	87	8	95	246	8.97	90	8	98	303	7.63
4-5	0.91	94	5	99	217	10.37	95	0	95	251	9.47
5-6	1.22	130	9	139	267	10.82	122	1	123	358	9.13

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
6-1	1.13	119	4	123	379	8.10	114	4	118	498	6.60
4-7	0.30	23	7	30	191	4.89	41	9	50	216	4.06
7-8	1.15	122	3	125	235	11.50	116	2	118	284	10.30
7-11	1.83	201	8	209	250	14.35	176	7	183	312	13.31
8-9	0.35	29	0	29	202	5.45	46	6	52	238	4.34
8-13	1.22	130	1	131	210	12.88	122	2	124	254	11.62
9-10	1.38	148	4	152	215	13.54	136	1	137	269	12.24
10-11	1.66	181	2	183	331	11.63	161	7	168	430	9.99
11-12	0.85	87	1	88	201	10.59	90	2	92	254	8.84
Total Facility	**13.71**	**1427**	**59**	**1486**	**3368**	**10.17**	**1403**	**59**	**1462**	**4175**	**8.76**
		Trial 9					Trial 10				
1-2	0.27	41	0	41	223	3.68	23	4	27	153	5.40
2-3	0.59	72	5	77	317	5.39	59	3	62	227	7.35
3-4	0.85	93	4	97	234	9.24	89	6	95	221	9.68
4-5	0.91	98	6	104	256	9.10	95	4	99	238	9.72
5-6	1.22	123	8	131	405	8.19	130	2	132	466	7.34
6-1	1.13	115	1	116	587	5.79	120	6	126	375	8.12
4-7	0.30	29	0	29	221	4.32	27	8	35	143	6.07
7-8	1.15	117	2	119	309	9.67	122	1	123	302	9.74
7-11	1.83	171	5	176	346	12.62	199	2	201	365	11.64
8-9	0.35	33	6	39	249	4.38	32	3	35	156	6.60
8-13	1.22	123	4	127	270	11.06	130	0	130	236	12.00
9-10	1.38	135	8	143	290	11.47	148	2	150	270	11.83
10-11	1.66	158	3	161	499	9.05	180	4	184	525	8.43
11-12	0.85	93	1	94	270	8.41	89	2	91	236	9.36
Total Facility	**13.71**	**1401**	**53**	**1454**	**4476**	**8.32**	**1443**	**47**	**1490**	**3913**	**9.13**

(c) Weekday, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.27	28	2	30	94	7.84	44	4	48	101	6.52
2-3	0.59	61	7	68	184	8.43	73	6	79	261	6.25
3-4	0.85	87	6	93	270	8.43	104	3	107	433	5.67
4-5	0.91	91	2	93	275	8.90	109	5	114	216	9.93
5-6	1.22	122	4	126	321	9.83	146	7	153	568	6.09
6-1	1.13	116	5	121	317	9.29	139	9	148	490	6.38
4-7	0.30	25	2	27	108	8.00	24	2	26	84	9.82
7-8	1.15	95	8	103	315	9.90	90	6	96	322	9.90
7-11	1.83	188	4	192	479	9.82	226	4	230	514	8.85
8-9	0.35	32	1	33	112	8.69	14	0	14	115	9.77
8-13	1.22	126	6	132	358	8.96	161	7	168	287	9.65

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
9-10	1.38	142	7	149	374	9.50	170	6	176	488	7.48
10-11	1.66	74	4	78	535	9.75	84	8	92	557	9.21
11-12	0.85	72	7	79	250	9.30	65	4	69	334	7.59
Total Facility	**13.71**	**1259**	**65**	**1324**	**3992**	**9.28**	**1449**	**71**	**1520**	**4770**	**7.85**
		Trial 3					Trial 4				
1-2	0.27	26	2	28	128	6.23	13	4	17	136	6.35
2-3	0.59	56	9	65	270	6.34	43	7	50	254	6.99
3-4	0.85	81	6	87	392	6.39	91	2	93	285	8.10
4-5	0.91	86	4	90	240	9.93	95	8	103	363	7.03
5-6	1.22	116	0	116	531	6.79	158	9	167	275	9.94
6-1	1.13	107	10	117	455	7.11	91	8	99	697	5.11
4-7	0.30	22	2	24	110	8.06	20	8	28	135	6.63
7-8	1.15	86	7	93	323	9.95	94	4	98	320	9.90
7-11	1.83	173	6	179	490	9.85	226	5	231	433	9.92
8-9	0.35	15	0	15	162	7.12	30	1	31	167	6.36
8-13	1.22	116	8	124	324	9.80	134	5	139	310	9.78
9-10	1.38	131	4	135	542	7.34	148	6	154	390	9.13
10-11	1.66	54	7	91	540	9.47	78	15	93	529	9.61
11-12	0.85	81	6	87	335	7.25	73	6	79	430	6.01
Total Facility	**13.71**	**1150**	**71**	**1251**	**4842**	**8.10**	**1294**	**88**	**1382**	**4724**	**8.08**
		Trial 5					Trial 6				
1-2	0.27	21	9	30	180	4.63	36	7	43	104	6.61
2-3	0.59	69	2	71	231	7.03	79	8	87	212	7.10
3-4	0.85	146	7	153	355	6.02	113	1	114	205	9.59
4-5	0.91	152	3	155	210	8.98	121	5	126	208	9.81
5-6	1.22	253	9	262	200	9.51	163	6	169	294	9.49
6-1	1.13	146	4	150	267	9.76	151	4	155	337	8.27
4-7	0.30	26	6	32	127	6.79	29	8	37	127	6.59
7-8	1.15	98	1	99	408	8.17	109	9	118	345	8.94
7-11	1.83	362	8	370	416	8.38	244	6	250	486	8.95
8-9	0.35	26	2	28	106	9.40	32	0	32	120	8.29
8-13	1.22	214	6	220	224	9.89	163	2	165	359	8.38
9-10	1.38	237	4	241	561	6.19	184	3	187	386	8.67
10-11	1.66	108	8	116	498	9.73	75	18	93	547	9.34
11-12	0.85	117	9	126	371	6.16	113	4	117	350	6.55
Total Facility	**13.71**	**1975**	**78**	**2053**	**4154**	**7.95**	**1612**	**81**	**1693**	**4080**	**8.55**
		Trial 7					Trial 8				
1-2	0.27	44	9	53	86	6.99	49	8	57	95	6.39
2-3	0.59	90	4	94	237	6.42	88	7	95	258	6.02
3-4	0.85	127	2	129	227	8.60	121	6	127	261	7.89
4-5	0.91	136	6	142	345	6.73	128	4	132	369	6.54
5-6	1.22	181	4	185	493	6.48	166	2	168	427	7.38
6-1	1.13	168	7	175	442	6.59	155	5	160	347	8.02
4-7	0.30	28	1	29	143	6.28	25	2	27	97	8.71
7-8	1.15	105	8	113	231	12.03	98	9	107	358	8.90
7-11	1.83	269	0	269	476	8.84	242	0	242	450	9.52

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
8-9	0.35	34	0	34	115	8.46	27	0	27	134	7.83
8-13	1.22	181	6	187	362	8.00	166	9	175	391	7.76
9-10	1.38	204	7	211	290	9.92	186	2	188	425	8.10
10-11	1.66	101	8	109	505	9.73	88	22	110	489	9.98
11-12	0.85	127	2	129	244	8.20	121	7	128	313	6.94
Total Facility	**13.71**	**1795**	**64**	**1859**	**4196**	**8.15**	**1660**	**83**	**1743**	**4414**	**8.02**
		Trial 9					Trial 10				
1-2	0.27	27	9	36	120	6.23	31	4	35	110	6.70
2-3	0.59	77	4	81	264	6.16	78	8	86	166	8.43
3-4	0.85	120	6	126	291	7.34	115	9	124	272	7.73
4-5	0.91	126	1	127	324	7.26	140	6	146	318	7.06
5-6	1.22	179	8	187	420	7.24	160	2	162	405	7.75
6-1	1.13	148	2	150	340	8.30	130	4	134	432	7.19
4-7	0.30	30	6	36	81	9.23	25	1	26	147	6.24
7-8	1.15	113	2	115	366	8.61	126	8	134	346	8.63
7-11	1.83	265	2	267	434	9.40	214	6	220	526	8.83
8-9	0.35	34	2	36	173	6.03	39	2	41	155	6.43
8-13	1.22	173	4	177	380	7.89	142	7	149	396	8.06
9-10	1.38	193	7	200	420	8.01	145	8	153	431	8.51
10-11	1.66	84	5	89	513	9.93	84	5	89	523	9.76
11-12	0.85	106	3	109	320	7.13	92	1	93	316	7.48
Total Facility	**13.71**	**1675**	**61**	**1736**	**4446**	**7.98**	**1521**	**71**	**1592**	**4543**	**8.04**

(d) Weekday, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.27	23	2	25	134	6.11	27	6	33	116	6.52
2-3	0.59	76	4	80	235	6.74	84	3	87	413	4.25
3-4	0.85	104	6	110	424	5.73	117	3	120	210	9.27
4-5	0.91	111	9	120	248	8.90	122	2	124	437	5.84
5-6	1.22	136	7	143	483	7.02	162	4	166	253	10.48
6-1	1.13	118	4	122	645	5.30	108	6	114	600	5.70
4-7	0.30	31	6	37	181	4.95	52	5	57	261	3.40
7-8	1.15	129	2	131	372	8.23	129	1	130	578	5.85
7-11	1.83	206	1	207	436	10.25	227	7	234	491	9.09
8-9	0.35	48	0	48	174	5.68	53	2	55	177	5.43
8-13	1.22	147	1	148	252	10.98	156	3	159	459	7.11
9-10	1.38	153	4	157	385	9.17	172	4	176	435	8.13
10-11	1.66	153	6	159	403	10.63	125	5	130	375	11.83
11-12	0.85	97	3	100	218	9.62	112	5	117	303	7.29
Total Facility	**13.71**	**1532**	**55**	**1587**	**4590**	**7.99**	**1646**	**56**	**1702**	**5108**	**7.25**

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.27	45	8	53	95	6.57	16	5	21	94	8.45
2-3	0.59	76	8	84	274	5.93	46	6	52	261	6.79
3-4	0.85	105	4	109	282	7.83	80	4	84	224	9.94
4-5	0.91	110	5	115	315	7.62	89	9	98	264	9.05
5-6	1.22	144	3	147	273	10.46	132	7	139	277	10.56
6-1	1.13	122	5	127	437	7.21	91	4	95	422	7.87
4-7	0.30	39	6	45	167	5.09	21	8	29	156	5.84
7-8	1.15	117	4	121	348	8.83	103	2	105	363	8.85
7-11	1.83	213	0	213	340	11.91	190	6	196	329	12.55
8-9	0.35	37	7	44	194	5.29	31	0	31	179	6.00
8-13	1.22	149	6	155	252	10.79	124	4	128	272	10.98
9-10	1.38	163	4	167	357	9.48	132	2	134	284	11.89
10-11	1.66	137	2	139	436	10.39	134	0	134	355	12.22
11-12	0.85	92	3	95	236	9.24	77	5	82	312	7.77
Total Facility	**13.71**	**1549**	**65**	**1614**	**4006**	**8.78**	**1266**	**62**	**1328**	**3792**	**9.64**
		Trial 5					Trial 6				
1-2	0.27	37	5	42	101	6.80	34	4	38	71	8.92
2-3	0.59	89	4	93	212	6.96	77	3	80	257	6.30
3-4	0.85	122	6	128	234	8.45	109	6	115	266	8.03
4-5	0.91	129	8	137	284	7.78	115	9	124	303	7.67
5-6	1.22	168	5	173	252	10.33	153	7	160	256	10.56
6-1	1.13	133	2	135	374	7.99	119	1	120	437	7.30
4-7	0.30	42	1	43	141	5.87	30	2	32	140	6.28
7-8	1.15	127	5	132	387	7.98	115	5	120	349	8.83
7-11	1.83	244	6	250	328	11.40	224	4	228	330	11.81
8-9	0.35	47	7	54	153	6.09	34	3	37	169	6.12
8-13	1.22	168	5	173	299	9.31	152	0	152	253	10.84
9-10	1.38	188	2	190	305	10.04	170	5	175	349	9.48
10-11	1.66	163	1	164	291	13.13	134	4	138	436	10.41
11-12	0.85	122	0	122	219	8.97	106	7	113	216	9.30
Total Facility	**13.71**	**1779**	**57**	**1836**	**3580**	**9.11**	**1572**	**60**	**1632**	**3832**	**9.03**
		Trial 7					Trial 8				
1-2	0.27	22	3	25	93	8.24	39	2	41	126	5.82
2-3	0.59	63	3	66	244	6.85	83	1	84	285	5.76
3-4	0.85	90	3	93	238	9.24	116	2	118	280	7.69
4-5	0.91	93	7	100	350	7.28	123	6	129	322	7.26
5-6	1.22	128	5	133	268	10.95	163	2	165	354	8.46
6-1	1.13	85	6	91	389	8.48	123	4	127	487	6.63
4-7	0.30	44	4	48	117	6.55	43	2	45	190	4.60
7-8	1.15	87	2	89	412	8.26	125	7	132	380	8.09
7-11	1.83	174	1	175	384	11.79	236	8	244	434	9.72
8-9	0.35	38	1	39	113	8.29	48	3	51	181	5.43
8-13	1.22	118	3	121	352	9.29	161	4	165	344	8.63
9-10	1.38	129	7	136	319	10.92	179	5	184	371	8.95
10-11	1.66	105	5	110	328	13.64	139	2	141	438	10.32

(Table H.5 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
11-12	0.85	83	6	89	235	9.44	113	8	121	291	7.43
Total Facility	**13.71**	**1259**	**56**	**1315**	**3842**	**9.57**	**1691**	**56**	**1747**	**4483**	**7.92**
		Trial 9					Trial 10				
1-2	0.27	34	2	36	136	5.65	37	2	39	132	5.68
2-3	0.59	68	6	74	266	6.25	75	7	82	189	7.84
3-4	0.85	98	4	102	274	8.14	106	4	110	193	10.10
4-5	0.91	113	7	120	283	8.13	112	3	115	222	9.72
5-6	1.22	142	1	143	394	8.18	149	1	150	248	11.04
6-1	1.13	113	3	116	427	7.49	140	2	142	287	9.48
4-7	0.30	34	4	38	139	6.10	32	4	36	140	6.14
7-8	1.15	123	8	131	293	9.76	112	6	118	307	9.74
7-11	1.83	193	9	202	376	11.40	224	2	226	281	12.99
8-9	0.35	45	2	47	178	5.60	38	3	41	158	6.33
8-13	1.22	135	3	138	306	9.89	151	7	158	251	10.74
9-10	1.38	139	6	145	315	10.80	170	10	180	319	9.96
10-11	1.66	143	4	147	468	9.72	123	1	124	304	13.96
11-12	0.85	93	2	95	261	8.60	101	2	103	184	10.66
Total Facility	**13.71**	**1473**	**61**	**1534**	**4116**	**8.74**	**1570**	**54**	**1624**	**3215**	**10.20**

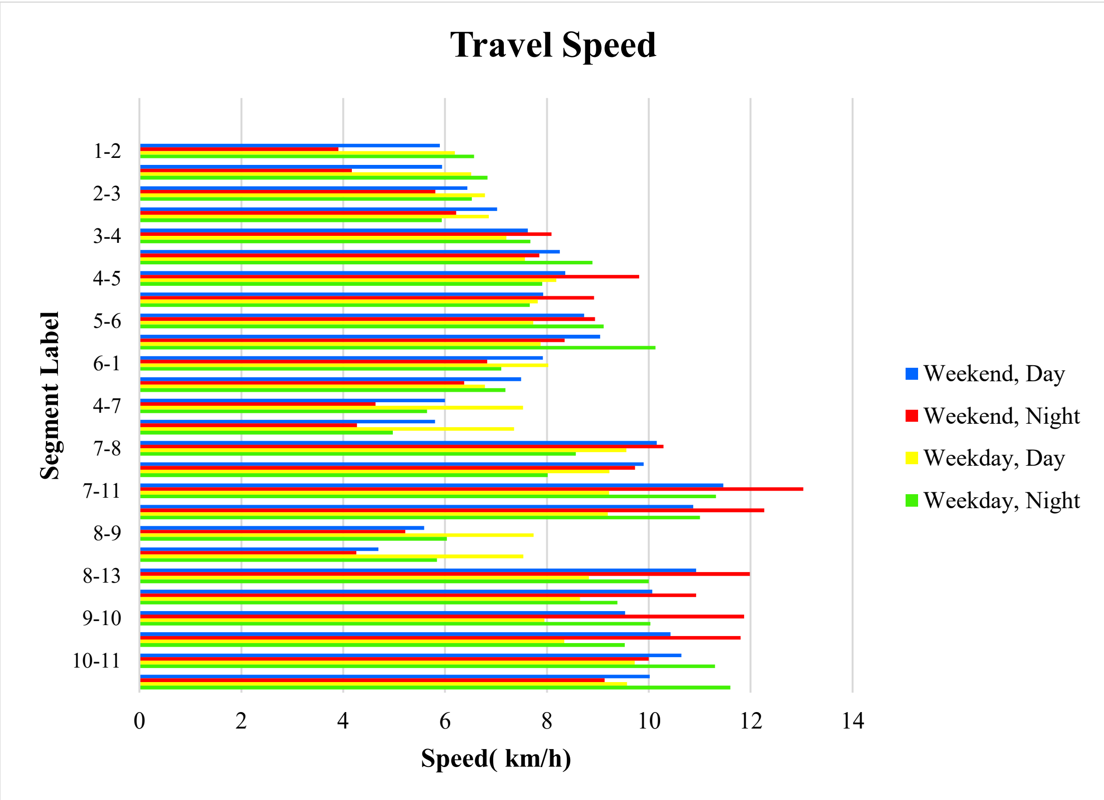


Figure H.2: Observed Travel Speed at Mohakhali Flyover

Table H.6: Travel Times at Free Flow Conditions at Khilgaon Flyover

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.21	5.43	1.19	1.82	1.68	2.23	1.46	2.05
	Under	10.22	1.37	6.16	1.52	2.15	2.55	1.83	1.55	1.9
Weekend, Night	Over	-	1.42	-	1.32	2.21	-	1.62	3.61	-
	Under	9.54	1.65	4.13	1.69	2.13	1.79	-	1.77	-
Weekday, Day	Over	-	1.42	-	1.17	1.92	-	1.26	1.65	1.57
	Under	8.19	1.37	4.47	1.33	2.11	1.87	1.9	1.52	1.78
Weekday, Night	Over	-	1.38	-	1.03	2.07	-	1.28	1.15	1.48
	Under	11.87	1.16	4.78	1.22	2.12	1.36	-	1.26	-

Table H.7: Travel Time at Operating Conditions at Khilgaon Flyover

(a) Weekend, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	44	7	51	130	10.40	47	4	51	114	11.41
2-3	0.41	38	6	44	120	9.09	36	6	42	109	9.87
3-4	1.25	76	9	85	163	18.19	71	9	80	151	19.53
4-5	0.32	25	2	27	86	10.19	28	7	35	72	10.77
5-6	0.81	48	7	55	101	18.69	51	1	52	106	18.46
6-7	0.49	37	8	45	150	9.05	36	3	39	124	10.82
7-8	0.52	26	8	34	164	9.53	22	5	27	145	10.97
8-9	0.74	72	9	81	202	9.35	71	6	77	184	10.14
9-10	0.28	33	7	40	148	5.36	31	4	35	109	7.00
10-11	0.47	41	8	49	143	8.81	42	8	50	121	9.89
11-12	1.52	115	7	122	188	17.65	148	9	157	143	18.24
12-1	0.14	24	2	26	22	10.50	17	7	24	22	10.96
1-8	0.89	22	8	30	250	11.44	61	1	62	187	12.87
11-13	1.09	24	7	31	204	16.70	138	3	141	91	16.91
13-14	1.69	342	8	350	150	12.17	389	2	391	139	11.48
14-15	1.17	281	8	289	132	10.00	274	6	280	103	11.00
15-16	0.30	39	4	43	120	6.63	29	4	33	98	8.24
16-17	0.84	37	7	44	154	15.27	62	6	68	126	15.59
17-18	0.13	17	0	17	74	5.14	24	7	31	48	5.92
18-2	0.64	47	2	49	138	12.32	47	8	55	120	13.17
18-3	0.74	59	2	61	155	12.27	62	5	67	126	13.73
Total Facility	**14.97**	**1447**	**126**	**1573**	**2994**	**11.80**	**1686**	**111**	**1797**	**2438**	**12.72**

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	47	5	52	121	10.88	34	7	41	128	11.14
2-3	0.41	36	2	38	127	9.03	28	6	34	124	9.43
3-4	1.25	71	5	76	156	19.44	82	9	91	148	18.87
4-5	0.32	28	7	35	77	10.29	21	2	23	80	11.18
5-6	0.81	51	3	54	110	17.78	64	7	71	92	17.89
6-7	0.49	37	9	46	135	9.75	33	8	41	144	9.54
7-8	0.52	22	2	24	154	10.60	34	8	42	165	9.11
8-9	0.74	71	2	73	161	11.31	76	9	85	162	10.71
9-10	0.28	31	4	35	118	6.59	38	7	45	130	5.76
10-11	0.47	42	6	48	128	9.61	48	8	56	110	10.19
11-12	1.52	138	8	146	162	17.77	156	7	163	148	17.59
12-1	0.14	17	9	26	19	11.20	15	2	17	27	11.45
1-8	0.89	61	5	66	204	11.87	78	8	86	180	12.05
11-13	1.09	128	3	131	105	16.63	134	7	141	95	16.63
13-14	1.69	329	5	334	155	12.44	387	8	395	100	12.29
14-15	1.17	281	4	285	126	10.25	252	8	260	108	11.45
15-16	0.30	28	8	36	107	7.55	34	4	38	111	7.25
16-17	0.84	51	9	60	143	14.90	64	7	71	138	14.47
17-18	0.13	29	2	31	57	5.32	12	6	18	75	5.03
18-2	0.64	42	1	43	134	13.02	52	2	54	130	12.52
18-3	0.74	54	4	58	136	13.66	79	2	81	118	13.31
Total Facility	**14.97**	**1594**	**103**	**1697**	**2635**	**12.44**	**1721**	**132**	**1853**	**2513**	**12.34**
		Trial 5					Trial 6				
1-2	0.52	54	7	61	126	10.07	44	7	51	116	11.27
2-3	0.41	38	6	44	99	10.42	38	6	44	102	10.21
3-4	1.25	76	8	84	144	19.78	76	5	81	145	19.96
4-5	0.32	28	1	29	69	11.76	25	2	27	77	11.08
5-6	0.81	57	4	61	100	18.11	48	5	53	110	17.89
6-7	0.49	39	6	45	117	10.89	37	8	45	131	10.02
7-8	0.52	24	8	32	140	10.97	26	5	31	144	10.78
8-9	0.74	79	4	83	154	11.16	72	9	81	189	9.80
9-10	0.28	33	6	39	100	7.25	33	5	38	133	5.89
10-11	0.47	67	3	70	104	9.72	41	8	49	125	9.72
11-12	1.52	134	5	139	153	18.74	115	7	122	165	19.07
12-1	0.14	18	7	25	22	10.72	27	2	29	21	10.08
1-8	0.89	64	9	73	189	12.23	22	9	31	230	12.28
11-13	1.09	132	2	134	110	16.08	24	7	31	200	16.99
13-14	1.69	368	4	372	105	12.75	368	8	376	131	12.00
14-15	1.17	278	9	287	96	11.00	288	6	294	116	10.27
15-16	0.30	39	7	46	81	8.50	39	4	43	110	7.06
16-17	0.84	62	5	67	127	15.59	62	6	68	135	14.90
17-18	0.13	17	6	23	55	6.00	17	2	19	64	5.64
18-2	0.64	47	5	52	124	13.09	47	2	49	120	13.63
18-3	0.74	69	2	71	141	12.50	79	2	81	113	13.66
Total Facility	**14.97**	**1723**	**114**	**1837**	**2356**	**12.85**	**1528**	**115**	**1643**	**2677**	**12.47**

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	44	3	47	137	10.23	33	7	40	121	11.69
2-3	0.41	38	9	47	109	9.55	33	6	39	99	10.80
3-4	1.25	76	3	79	156	19.19	75	9	84	144	19.78
4-5	0.32	25	4	29	77	10.87	26	2	28	69	11.88
5-6	0.81	48	2	50	108	18.46	52	7	59	95	18.94
6-7	0.49	37	9	46	132	9.91	38	8	46	117	10.82
7-8	0.52	26	7	33	151	10.25	34	8	42	135	10.66
8-9	0.74	72	3	75	192	9.91	76	9	85	171	10.34
9-10	0.28	33	4	37	145	5.54	40	7	47	129	5.73
10-11	0.47	41	6	47	124	9.89	47	8	55	112	10.13
11-12	1.52	133	7	140	160	18.24	148	7	155	136	18.80
12-1	0.14	22	8	30	17	10.72	12	2	14	35	10.29
1-8	0.89	83	7	90	200	11.05	74	8	82	172	12.61
11-13	1.09	137	5	142	97	16.42	93	7	100	119	17.92
13-14	1.69	333	6	339	138	12.75	357	8	365	125	12.42
14-15	1.17	301	4	305	132	9.64	275	8	283	124	10.35
15-16	0.30	42	3	45	109	7.01	42	4	46	96	7.61
16-17	0.84	75	5	80	129	14.47	75	7	82	124	14.68
17-18	0.13	15	8	23	64	5.38	15	0	15	55	6.69
18-2	0.64	61	9	70	114	12.52	52	2	54	120	13.24
18-3	0.74	89	2	91	122	12.44	75	2	77	113	13.95
Total Facility	**14.97**	**1731**	**114**	**1845**	**2613**	**12.08**	**1672**	**126**	**1798**	**2411**	**12.80**
		Trial 9					Trial 10				
1-2	0.52	33	8	41	124	11.41	47	6	53	113	11.34
2-3	0.41	33	4	37	101	10.80	36	4	40	120	9.32
3-4	1.25	75	7	82	143	20.05	71	3	74	155	19.70
4-5	0.32	36	2	38	58	12.00	28	8	36	66	11.29
5-6	0.81	68	4	72	86	18.46	51	9	60	110	17.15
6-7	0.49	38	3	41	121	10.89	36	1	37	141	9.91
7-8	0.52	34	9	43	137	10.48	22	6	28	152	10.48
8-9	0.74	82	6	88	153	10.98	71	7	78	161	11.07
9-10	0.28	40	9	49	113	6.22	31	2	33	115	6.81
10-11	0.47	47	7	54	107	10.51	42	6	48	133	9.35
11-12	1.52	148	8	156	140	18.49	148	8	156	158	17.43
12-1	0.14	12	7	19	25	11.45	17	3	20	25	11.20
1-8	0.89	74	2	76	189	12.09	61	6	67	226	10.94
11-13	1.09	123	8	131	96	17.29	158	9	167	71	16.49
13-14	1.69	382	7	389	114	12.10	364	2	366	150	11.79
14-15	1.17	275	8	283	99	11.03	261	0	261	146	10.35
15-16	0.30	42	6	48	92	7.71	29	3	32	110	7.61
16-17	0.84	61	7	68	122	15.92	51	7	58	143	15.04
17-18	0.13	15	9	24	55	5.92	24	8	32	55	5.38
18-2	0.64	51	8	59	110	13.63	42	4	46	145	12.06
18-3	0.74	85	6	91	104	13.59	51	5	56	136	13.80
Total Facility	**14.97**	**1754**	**135**	**1889**	**2289**	**12.89**	**1641**	**107**	**1748**	**2631**	**12.30**

(b) Weekend, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	47	6	53	215	7.03	44	7	51	221	6.92
2-3	0.41	36	4	40	228	5.56	38	6	44	204	6.01
3-4	1.25	71	3	74	295	12.22	76	9	85	277	12.46
4-5	0.32	28	8	36	125	7.16	25	2	27	146	6.66
5-6	0.81	51	9	60	201	11.17	48	7	55	172	12.85
6-7	0.49	36	1	37	267	5.80	37	8	45	255	5.88
7-8	0.52	22	6	28	289	5.95	26	8	34	279	6.03
8-9	0.74	71	7	78	306	6.89	72	9	81	343	6.24
9-10	0.28	31	2	33	219	4.00	33	7	40	251	3.46
10-11	0.47	42	6	48	253	5.62	41	8	49	243	5.79
11-12	1.52	148	8	156	300	12.00	115	7	122	324	12.27
12-1	0.14	17	3	20	48	7.41	25	3	28	31	8.54
1-8	0.89	61	6	67	429	6.46	22	8	30	425	7.04
11-13	1.09	158	9	167	157	12.11	24	7	31	347	10.38
13-14	1.69	364	2	366	285	9.35	342	8	350	255	10.06
14-15	1.17	261	0	261	277	7.83	281	8	289	225	8.19
15-16	0.30	29	3	32	209	4.48	39	4	43	204	4.37
16-17	0.84	51	7	58	272	9.16	37	7	44	262	9.88
17-18	0.13	24	8	32	105	3.42	17	0	17	126	3.27
18-2	0.64	42	4	46	276	7.16	47	2	49	235	8.11
18-3	0.74	51	5	56	258	8.44	59	2	61	264	8.15
Total Facility	**14.97**	**1641**	**107**	**1748**	**5014**	**7.97**	**1448**	**127**	**1575**	**5089**	**8.08**
		Trial 3					Trial 4				
1-2	0.52	30	7	37	223	7.24	44	7	51	177	8.26
2-3	0.41	29	4	33	182	6.93	38	6	44	163	7.20
3-4	1.25	68	6	74	257	13.63	98	5	103	223	13.84
4-5	0.32	32	2	34	104	8.35	25	2	27	108	8.53
5-6	0.81	61	4	65	157	13.14	58	8	66	157	13.08
6-7	0.49	34	3	37	218	6.92	37	8	45	183	7.74
7-8	0.52	31	8	39	247	6.60	29	9	38	205	7.76
8-9	0.74	74	5	79	275	7.47	72	9	81	265	7.65
9-10	0.28	36	8	44	203	4.08	33	5	38	186	4.50
10-11	0.47	43	6	49	193	6.99	41	8	49	175	7.55
11-12	1.52	133	7	140	252	13.96	125	12	137	261	13.75
12-1	0.14	11	6	17	45	8.13	28	2	30	29	8.54
1-8	0.89	66	2	68	340	7.85	27	10	37	343	8.43
11-13	1.09	111	7	118	215	11.78	24	9	33	285	12.34
13-14	1.69	344	6	350	205	10.96	368	8	376	183	10.88
14-15	1.17	248	7	255	178	9.73	288	6	294	162	9.24
15-16	0.30	38	5	43	166	5.17	39	4	43	154	5.48
16-17	0.84	55	6	61	220	10.76	72	8	80	191	11.16
17-18	0.13	14	8	22	99	3.87	17	2	19	90	4.29
18-2	0.64	46	7	53	200	9.11	57	4	61	194	9.04
18-3	0.74	77	5	82	187	9.85	90	3	93	173	9.96
Total Facility	**14.97**	**1581**	**119**	**1700**	**4166**	**9.18**	**1610**	**135**	**1745**	**3907**	**9.53**

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	44	3	47	247	6.40	47	5	52	206	7.30
2-3	0.41	38	9	47	196	6.13	36	2	38	216	5.87
3-4	1.25	76	3	79	281	12.53	71	5	76	265	13.23
4-5	0.32	25	4	29	139	6.86	28	7	35	131	6.94
5-6	0.81	48	2	50	194	11.95	51	3	54	187	12.10
6-7	0.49	37	9	46	238	6.21	37	9	46	230	6.39
7-8	0.52	26	7	33	272	6.18	22	2	24	262	6.60
8-9	0.74	72	3	75	346	6.29	71	2	73	274	7.63
9-10	0.28	33	4	37	261	3.38	31	4	35	201	4.27
10-11	0.47	41	6	47	223	6.27	42	6	48	218	6.36
11-12	1.52	133	7	140	288	12.79	138	8	146	275	13.00
12-1	0.14	22	8	30	31	8.26	19	9	28	32	8.40
1-8	0.89	58	57	115	315	7.45	61	5	66	347	7.76
11-13	1.09	137	5	142	175	12.38	134	3	137	186	12.15
13-14	1.69	333	6	339	248	10.36	329	5	334	264	10.17
14-15	1.17	301	4	305	238	7.76	281	4	285	214	8.44
15-16	0.30	42	3	45	196	4.48	28	8	36	182	4.95
16-17	0.84	75	5	80	232	9.69	51	9	60	243	9.98
17-18	0.13	15	8	23	115	3.39	29	2	31	97	3.66
18-2	0.64	61	9	70	205	8.38	42	1	43	228	8.50
18-3	0.74	89	2	91	220	8.52	54	4	58	231	9.17
Total Facility	**14.97**	**1706**	**164**	**1870**	**4660**	**8.25**	**1602**	**103**	**1705**	**4489**	**8.70**
		Trial 7					Trial 8				
1-2	0.52	33	7	40	218	7.30	34	7	41	218	7.27
2-3	0.41	33	6	39	178	6.87	28	6	34	211	6.08
3-4	1.25	75	9	84	259	13.15	82	9	91	252	13.15
4-5	0.32	26	2	28	124	7.58	21	2	23	136	7.25
5-6	0.81	52	7	59	171	12.68	64	7	71	156	12.85
6-7	0.49	38	8	46	211	6.86	33	8	41	245	6.17
7-8	0.52	34	8	42	243	6.62	34	8	42	281	5.84
8-9	0.74	76	9	85	308	6.73	76	9	85	275	7.35
9-10	0.28	40	7	47	232	3.61	38	7	45	221	3.79
10-11	0.47	47	8	55	202	6.58	48	8	56	187	6.96
11-12	1.52	148	7	155	245	13.68	156	7	163	252	13.19
12-1	0.14	12	2	14	63	6.55	15	2	17	46	8.00
1-8	0.89	74	8	82	310	8.17	78	8	86	306	8.17
11-13	1.09	99	7	106	214	12.26	145	9	154	165	12.30
13-14	1.69	357	8	365	225	10.31	387	8	395	170	10.77
14-15	1.17	275	8	283	223	8.32	252	8	260	184	9.49
15-16	0.30	42	4	46	173	4.93	34	4	38	189	4.76
16-17	0.84	75	7	82	223	9.91	64	7	71	235	9.88
17-18	0.13	15	0	15	99	4.11	12	6	18	128	3.21
18-2	0.64	52	2	54	216	8.53	52	2	54	221	8.38
18-3	0.74	75	2	77	203	9.46	79	2	81	201	9.40
Total Facility	**14.97**	**1678**	**126**	**1804**	**4340**	**8.77**	**1732**	**134**	**1866**	**4279**	**8.77**

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	33	8	41	212	7.44	54	7	61	214	6.85
2-3	0.41	33	4	37	161	7.53	38	6	44	168	7.03
3-4	1.25	101	6	107	211	14.18	76	8	84	245	13.71
4-5	0.32	31	2	33	101	8.60	28	1	29	117	7.89
5-6	0.81	61	4	65	158	13.08	57	4	61	170	12.62
6-7	0.49	36	8	44	184	7.74	39	6	45	199	7.23
7-8	0.52	34	9	43	203	7.67	24	8	32	238	6.99
8-9	0.74	76	6	82	258	7.78	79	4	83	262	7.67
9-10	0.28	40	9	49	153	4.99	33	6	39	170	4.82
10-11	0.47	47	7	54	169	7.59	67	3	70	177	6.85
11-12	1.52	167	10	177	220	13.78	134	5	139	260	13.71
12-1	0.14	15	7	22	41	8.00	18	7	25	37	8.13
1-8	0.89	84	3	87	292	8.45	64	9	73	321	8.13
11-13	1.09	133	12	145	177	12.19	132	2	134	187	12.22
13-14	1.69	382	7	389	195	10.42	368	4	372	179	11.04
14-15	1.17	285	8	293	144	9.64	278	9	287	163	9.36
15-16	0.30	42	6	48	137	5.84	39	7	46	138	5.87
16-17	0.84	71	7	78	196	11.04	62	5	67	216	10.69
17-18	0.13	15	9	24	67	5.14	17	6	23	94	4.00
18-2	0.64	62	8	70	189	8.90	47	5	52	211	8.76
18-3	0.74	85	6	91	176	9.92	69	2	71	240	8.52
Total Facility	**14.97**	**1833**	**146**	**1979**	**3644**	**9.58**	**1723**	**114**	**1837**	**4006**	**9.22**

(c) Weekday, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	34	7	41	160	9.37	33	8	41	140	10.40
2-3	0.41	28	6	34	155	7.89	33	4	37	154	7.80
3-4	1.25	82	9	91	185	16.34	75	7	82	188	16.71
4-5	0.32	21	2	23	100	9.37	26	2	28	87	10.02
5-6	0.81	53	7	60	115	16.66	52	4	56	129	15.76
6-7	0.49	33	8	41	180	7.98	34	3	37	181	8.09
7-8	0.52	34	8	42	206	7.61	34	9	43	207	7.55
8-9	0.74	76	9	85	203	9.19	76	6	82	201	9.35
9-10	0.28	38	7	45	162	4.87	40	9	49	170	4.60
10-11	0.47	48	8	56	138	8.72	47	7	54	160	7.91
11-12	1.52	156	7	163	184	15.77	148	8	156	210	14.95
12-1	0.14	15	2	17	33	10.08	12	7	19	36	9.16
1-8	0.89	78	8	86	215	10.64	74	2	76	238	10.20
11-13	1.09	134	7	141	105	15.95	123	8	131	115	15.95

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
13-14	1.69	387	8	395	125	11.70	382	7	389	168	10.92
14-15	1.17	252	8	260	135	10.66	275	8	283	148	9.77
15-16	0.30	34	4	38	138	6.14	42	6	48	137	5.84
16-17	0.84	64	7	71	174	12.34	61	7	68	171	12.65
17-18	0.13	14	0	14	120	3.49	15	9	24	81	4.46
18-2	0.64	52	2	54	165	10.52	51	8	59	153	10.87
18-3	0.74	79	2	81	148	11.57	85	6	91	132	11.88
Total Facility	**14.97**	**1712**	**126**	**1838**	**3146**	**10.81**	**1718**	**135**	**1853**	**3206**	**10.65**
		Trial 3					Trial 4				
1-2	0.52	44	7	51	144	9.66	47	6	53	125	10.58
2-3	0.41	35	6	41	160	7.41	36	4	40	150	7.84
3-4	1.25	76	8	84	178	17.22	71	3	74	181	17.69
4-5	0.32	22	1	23	93	9.93	28	8	36	83	9.68
5-6	0.81	47	4	51	133	15.85	51	9	60	125	15.76
6-7	0.49	39	6	45	164	8.44	36	1	37	174	8.36
7-8	0.52	24	8	32	186	8.65	22	6	28	201	8.24
8-9	0.74	72	4	76	189	9.98	71	7	78	207	9.28
9-10	0.28	33	6	39	144	5.51	31	2	33	136	5.96
10-11	0.47	41	3	44	156	8.46	42	6	48	165	7.94
11-12	1.52	134	5	139	204	15.95	148	8	156	197	15.50
12-1	0.14	18	7	25	29	9.33	17	3	20	31	9.88
1-8	0.89	64	9	73	257	9.71	61	6	67	281	9.21
11-13	1.09	132	2	134	117	15.63	158	9	167	81	15.82
13-14	1.69	368	4	372	166	11.31	364	2	366	187	11.00
14-15	1.17	278	9	287	152	9.59	261	0	261	182	9.51
15-16	0.30	39	7	46	142	5.74	29	3	32	136	6.43
16-17	0.84	62	5	67	177	12.39	51	7	58	178	12.81
17-18	0.13	17	6	23	74	4.82	24	8	32	67	4.73
18-2	0.64	47	5	52	168	10.47	42	4	46	181	10.15
18-3	0.74	69	2	71	151	11.94	51	5	56	169	11.78
Total Facility	**14.97**	**1661**	**114**	**1775**	**3184**	**10.86**	**1641**	**107**	**1748**	**3237**	**10.81**
		Trial 5					Trial 6				
1-2	0.52	44	3	47	135	10.35	33	7	40	133	10.88
2-3	0.41	38	9	47	121	8.87	33	6	39	137	8.47
3-4	1.25	76	3	79	172	17.97	75	9	84	169	17.83
4-5	0.32	25	4	29	91	9.60	26	2	28	98	9.14
5-6	0.81	48	2	50	148	14.73	52	7	59	136	14.95
6-7	0.49	37	9	46	142	9.38	33	8	41	167	8.48
7-8	0.52	26	7	33	190	8.46	34	8	42	191	8.10
8-9	0.74	72	3	75	231	8.65	76	9	85	244	8.04
9-10	0.28	33	4	37	210	4.08	40	7	47	183	4.38
10-11	0.47	41	6	47	162	8.10	47	8	55	161	7.83
11-12	1.52	115	2	117	229	15.82	148	7	155	194	15.68
12-1	0.14	22	8	30	22	9.69	12	2	14	41	9.16
1-8	0.89	58	7	65	255	10.01	74	8	82	245	9.80

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
11-13	1.09	137	5	142	116	15.21	93	7	100	168	14.64
13-14	1.69	333	6	339	187	11.57	357	8	365	174	11.29
14-15	1.17	301	4	305	125	9.80	275	8	283	182	9.06
15-16	0.30	42	3	45	115	6.75	42	4	46	136	5.93
16-17	0.84	75	5	80	148	13.26	75	7	82	178	11.63
17-18	0.13	15	8	23	129	3.08	15	0	15	79	4.98
18-2	0.64	61	9	70	125	11.82	52	2	54	170	10.29
18-3	0.74	89	2	91	155	10.77	75	2	77	154	11.47
Total Facility	**14.97**	**1688**	**109**	**1797**	**3208**	**10.76**	**1667**	**126**	**1793**	**3340**	**10.50**
		Trial 7					Trial 8				
1-2	0.52	44	7	51	148	9.46	47	5	52	147	9.46
2-3	0.41	38	6	44	122	8.98	36	2	38	153	7.80
3-4	1.25	76	5	81	185	16.96	71	5	76	178	17.76
4-5	0.32	25	2	27	97	9.29	28	7	35	93	9.00
5-6	0.81	48	5	53	141	15.03	51	3	54	133	15.59
6-7	0.49	37	8	45	167	8.32	37	9	46	164	8.40
7-8	0.52	26	5	31	184	8.77	22	2	24	186	8.98
8-9	0.74	72	9	81	242	8.19	71	2	73	194	9.91
9-10	0.28	33	5	38	170	4.85	31	4	35	144	5.63
10-11	0.47	41	8	49	160	8.10	42	6	48	156	8.29
11-12	1.52	115	7	122	210	16.48	138	8	146	214	15.20
12-1	0.14	27	2	29	26	9.16	17	9	26	29	9.16
1-8	0.89	22	9	31	294	9.86	61	5	66	247	10.24
11-13	1.09	24	7	31	225	15.33	128	3	131	127	15.21
13-14	1.69	368	8	376	168	11.18	329	5	334	187	11.68
14-15	1.17	288	6	294	148	9.53	281	4	285	152	9.64
15-16	0.30	39	4	43	137	6.00	28	8	36	132	6.43
16-17	0.84	62	6	68	171	12.65	51	9	60	177	12.76
17-18	0.13	17	2	19	81	4.68	29	2	31	69	4.68
18-2	0.64	47	2	49	153	11.41	42	1	43	168	10.92
18-3	0.74	79	2	81	144	11.78	54	4	58	167	11.78
Total Facility	**14.97**	**1528**	**115**	**1643**	**3373**	**10.74**	**1594**	**103**	**1697**	**3217**	**10.96**
		Trial 9					Trial 10				
1-2	0.52	44	7	51	148	9.46	47	4	51	132	10.29
2-3	0.41	38	6	44	122	8.98	36	6	42	150	7.76
3-4	1.25	76	9	85	182	16.89	71	9	80	181	17.28
4-5	0.32	25	2	27	96	9.37	28	7	35	83	9.76
5-6	0.81	48	7	55	135	15.35	51	1	52	125	16.47
6-7	0.49	37	8	45	168	8.28	36	3	39	174	8.28
7-8	0.52	26	8	34	184	8.65	22	5	27	201	8.27
8-9	0.74	72	9	81	242	8.19	71	6	77	207	9.32
9-10	0.28	33	7	40	170	4.80	31	4	35	136	5.89
10-11	0.47	41	8	49	160	8.10	42	8	50	165	7.87
11-12	1.52	115	7	122	210	16.48	148	9	157	197	15.46
12-1	0.14	27	2	29	24	9.51	17	7	24	31	9.16

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-8	0.89	22	8	30	279	10.37	61	1	62	231	10.94
11-13	1.09	24	7	31	228	15.15	138	3	141	124	14.81
13-14	1.69	342	8	350	168	11.75	389	2	391	192	10.44
14-15	1.17	281	8	289	148	9.64	274	6	280	142	9.98
15-16	0.30	39	4	43	134	6.10	29	4	33	136	6.39
16-17	0.84	62	7	69	171	12.60	51	6	57	178	12.87
17-18	0.13	17	0	17	81	4.78	24	7	31	67	4.78
18-2	0.64	47	2	49	147	11.76	47	8	55	164	10.52
18-3	0.74	59	2	61	173	11.32	51	5	56	174	11.52
Total Facility	**14.97**	**1475**	**126**	**1601**	**3370**	**10.84**	**1664**	**111**	**1775**	**3190**	**10.85**

(d) Weekday, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.52	34	7	41	228	7.00	54	7	61	154	8.76
2-3	0.41	28	6	34	222	5.82	38	6	44	177	6.74
3-4	1.25	82	9	91	264	12.71	76	8	84	257	13.23
4-5	0.32	21	2	23	143	6.94	22	1	23	123	7.89
5-6	0.81	53	7	60	165	12.96	47	4	51	183	12.46
6-7	0.49	33	8	41	257	5.92	39	6	45	191	7.47
7-8	0.52	34	8	42	295	5.60	24	8	32	251	6.67
8-9	0.74	76	9	85	290	7.06	72	4	76	269	7.67
9-10	0.28	38	7	45	232	3.64	33	6	39	178	4.65
10-11	0.47	48	8	56	196	6.71	67	3	70	187	6.58
11-12	1.52	156	7	163	264	12.81	134	5	139	274	13.25
12-1	0.14	15	2	17	48	7.75	18	7	25	39	7.88
1-8	0.89	78	8	86	321	7.87	64	9	73	337	7.81
11-13	1.09	134	7	141	188	11.93	132	2	134	197	11.85
13-14	1.69	387	8	395	179	10.60	368	4	372	186	10.90
14-15	1.17	252	8	260	194	9.28	278	9	287	172	9.18
15-16	0.30	34	4	38	198	4.58	39	7	46	142	5.74
16-17	0.84	64	7	71	248	9.48	62	5	67	227	10.29
17-18	0.13	14	0	14	172	2.52	17	6	23	99	3.84
18-2	0.64	52	2	54	236	7.94	47	5	52	221	8.44
18-3	0.74	79	2	81	211	9.07	69	2	71	251	8.23
Total Facility	**14.97**	**1712**	**126**	**1838**	**4551**	**8.43**	**1700**	**114**	**1814**	**4115**	**9.09**
		Trial 3					Trial 4				
1-2	0.52	44	7	51	207	7.30	33	7	40	181	8.52
2-3	0.41	38	6	44	182	6.59	33	6	39	185	6.65
3-4	1.25	76	5	81	259	13.27	75	9	84	241	13.88

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
4-5	0.32	25	2	27	136	7.07	26	2	28	132	7.20
5-6	0.81	48	5	53	197	11.66	52	7	59	184	12.00
6-7	0.49	37	8	45	234	6.32	33	8	41	226	6.61
7-8	0.52	26	5	31	257	6.55	34	8	42	258	6.29
8-9	0.74	72	9	81	339	6.30	76	9	85	330	6.38
9-10	0.28	33	5	38	238	3.65	40	7	47	247	3.43
10-11	0.47	41	8	49	224	6.20	47	8	55	217	6.22
11-12	1.52	115	7	122	294	13.15	148	7	155	262	13.12
12-1	0.14	27	2	29	37	7.64	12	2	14	55	7.30
1-8	0.89	22	9	31	412	7.23	74	8	82	331	7.76
11-13	1.09	24	7	31	315	11.34	93	7	100	227	12.00
13-14	1.69	368	8	376	235	9.96	357	8	365	235	10.14
14-15	1.17	288	6	294	207	8.41	275	8	283	246	7.96
15-16	0.30	39	4	43	192	4.60	42	4	46	184	4.70
16-17	0.84	62	6	68	240	9.82	75	7	82	240	9.39
17-18	0.13	17	2	19	113	3.55	15	0	15	107	3.84
18-2	0.64	47	2	49	214	8.76	52	2	54	230	8.11
18-3	0.74	79	2	81	202	9.36	75	2	77	207	9.33
Total Facility	**14.97**	**1528**	**115**	**1643**	**4734**	**8.45**	**1667**	**126**	**1793**	**4525**	**8.53**
		Trial 5					Trial 6				
1-2	0.52	33	8	41	198	7.88	47	6	53	192	7.68
2-3	0.41	33	4	37	219	5.82	36	4	40	237	5.38
3-4	1.25	75	7	82	266	12.96	71	3	74	286	12.53
4-5	0.32	26	2	28	124	7.58	28	8	36	131	6.90
5-6	0.81	52	4	56	183	12.20	51	9	60	198	11.30
6-7	0.49	34	3	37	258	5.98	36	1	37	275	5.65
7-8	0.52	34	9	43	292	5.63	22	6	28	318	5.45
8-9	0.74	76	6	82	286	7.19	71	7	78	327	6.53
9-10	0.28	40	9	49	242	3.46	31	2	33	215	4.06
10-11	0.47	47	7	54	228	6.00	42	6	48	261	5.48
11-12	1.52	148	8	156	298	12.05	148	8	156	311	11.72
12-1	0.14	12	7	19	52	7.10	17	3	20	49	7.30
1-8	0.89	74	2	76	338	7.74	61	6	67	444	6.27
11-13	1.09	123	8	131	184	12.46	158	9	167	158	12.07
13-14	1.69	382	7	389	242	9.64	364	2	366	295	9.20
14-15	1.17	275	8	283	211	8.53	261	0	261	288	7.67
15-16	0.30	42	6	48	195	4.44	29	3	32	215	4.37
16-17	0.84	61	7	68	243	9.72	51	7	58	281	8.92
17-18	0.13	15	9	24	115	3.37	24	8	32	106	3.39
18-2	0.64	51	8	59	210	8.57	42	4	46	286	6.94
18-3	0.74	85	6	91	191	9.40	51	5	56	267	8.20
Total Facility	**14.97**	**1718**	**135**	**1853**	**4575**	**8.38**	**1641**	**107**	**1748**	**5140**	**7.82**
		Trial 7					Trial 8				
1-2	0.52	47	4	51	184	8.01	44	7	51	201	7.47
2-3	0.41	36	6	42	210	5.91	38	6	44	187	6.45

(Table H.7 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
3-4	1.25	71	9	80	253	13.55	76	9	85	255	13.27
4-5	0.32	28	7	35	138	6.66	25	2	27	134	7.16
5-6	0.81	51	1	52	185	12.30	48	7	55	189	11.95
6-7	0.49	36	3	39	244	6.23	37	8	45	235	6.30
7-8	0.52	22	5	27	281	6.12	26	8	34	257	6.48
8-9	0.74	71	6	77	290	7.21	72	9	81	331	6.42
9-10	0.28	31	4	35	190	4.48	33	7	40	231	3.72
10-11	0.47	42	8	50	231	6.02	41	8	49	224	6.20
11-12	1.52	148	9	157	275	12.67	115	7	122	294	13.15
12-1	0.14	17	7	24	43	7.52	27	2	29	34	8.00
1-8	0.89	61	1	62	342	7.93	22	8	30	391	7.61
11-13	1.09	138	3	141	174	12.46	24	7	31	319	11.21
13-14	1.69	389	2	391	268	9.23	342	8	350	235	10.40
14-15	1.17	274	6	280	199	8.79	281	8	289	207	8.49
15-16	0.30	29	4	33	190	4.84	39	4	43	188	4.68
16-17	0.84	51	6	57	250	9.85	62	7	69	240	9.79
17-18	0.13	24	7	31	94	3.74	17	0	17	115	3.55
18-2	0.64	47	8	55	230	8.08	47	2	49	216	8.69
18-3	0.74	51	5	56	244	8.83	59	2	61	242	8.74
Total Facility	**14.97**	**1664**	**111**	**1775**	**4515**	**8.57**	**1475**	**126**	**1601**	**4725**	**8.52**
		Trial 9					Trial 10				
1-2	0.52	47	5	52	221	6.90	44	3	47	189	7.98
2-3	0.41	36	2	38	230	5.56	38	9	47	195	6.16
3-4	1.25	71	5	76	267	13.15	76	3	79	284	12.43
4-5	0.32	28	7	35	140	6.58	25	4	29	138	6.90
5-6	0.81	51	3	54	200	11.48	48	2	50	193	12.00
6-7	0.49	37	9	46	246	6.04	37	9	46	237	6.23
7-8	0.52	22	2	24	279	6.23	26	7	33	271	6.21
8-9	0.74	71	2	73	291	7.27	72	3	75	344	6.32
9-10	0.28	31	4	35	216	4.02	33	4	37	260	3.39
10-11	0.47	42	6	48	234	6.00	41	6	47	228	6.15
11-12	1.52	138	8	146	321	11.72	133	7	140	285	12.88
12-1	0.14	17	9	26	44	7.20	22	8	30	48	6.46
1-8	0.89	61	5	66	371	7.33	58	7	65	398	6.92
11-13	1.09	128	3	131	191	12.19	137	5	142	210	11.15
13-14	1.69	329	5	334	281	9.89	333	6	339	247	10.38
14-15	1.17	281	4	285	228	8.21	301	4	305	258	7.48
15-16	0.30	28	8	36	198	4.62	42	3	45	193	4.54
16-17	0.84	51	9	60	266	9.28	75	5	80	253	9.08
17-18	0.13	29	2	31	104	3.47	15	8	23	113	3.44
18-2	0.64	42	1	43	250	7.86	61	9	70	239	7.46
18-3	0.74	54	4	58	247	8.69	89	2	91	219	8.55
Total Facility	**14.97**	**1594**	**103**	**1697**	**4825**	**8.26**	**1706**	**114**	**1820**	**4802**	**8.14**

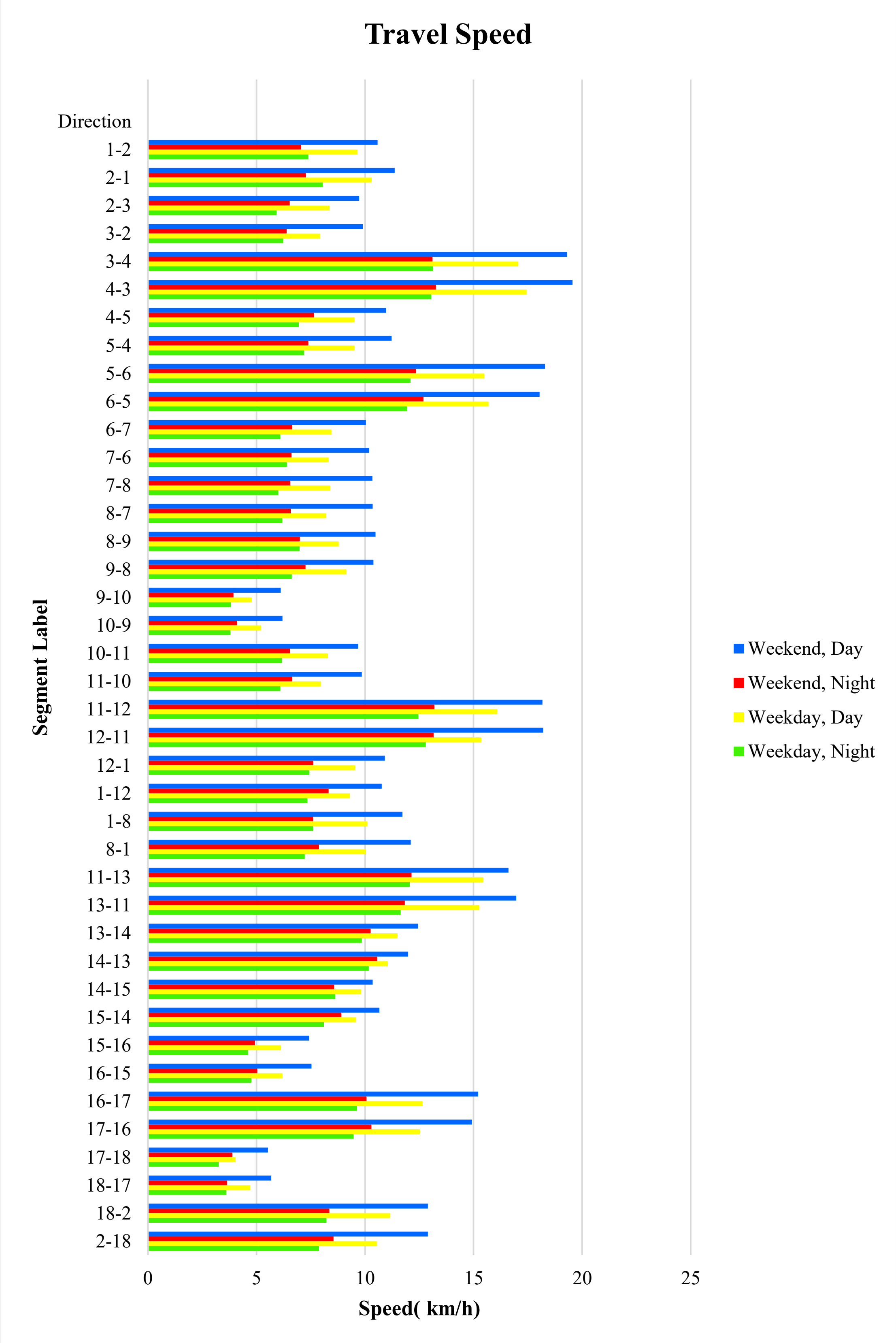


Figure H.3: Observed Travel Speed at Khilgaon Flyover

Table H.8: Travel Times at Free Flow Conditions at MMHF

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.21	5.43	1.19	1.82	1.68	2.23	1.46	2.05
	Under	10.22	1.37	6.16	1.52	2.15	2.55	1.83	1.55	1.9
Weekend, Night	Over	-	1.42	-	1.32	2.21	-	1.62	3.61	-
	Under	9.54	1.65	4.13	1.69	2.13	1.79	-	1.77	-
Weekday, Day	Over	-	1.42	-	1.17	1.92	-	1.26	1.65	1.57
	Under	8.19	1.37	4.47	1.33	2.11	1.87	1.9	1.52	1.78
Weekday, Night	Over	-	1.38	-	1.03	2.07	-	1.28	1.15	1.48
	Under	11.87	1.16	4.78	1.22	2.12	1.36	-	1.26	-

Table H.9 Travel Time at Operating Conditions at MMHF

(a) Weekend, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	45	8	53	186	7.46	51	5	56	178	7.62
2-3	0.54	44	9	53	150	9.58	51	9	60	173	8.34
3-4	0.54	49	7	56	142	9.82	56	5	61	150	9.21
4-5	0.12	11	2	13	165	2.43	12	8	20	140	2.70
5-6	0.26	29	3	32	125	5.96	27	7	34	165	4.70
6-7	1.00	81	2	83	130	16.90	113	2	115	130	14.69
7-8	0.86	77	5	82	142	13.82	88	9	97	140	13.06
8-9	0.17	15	4	19	175	3.15	17	7	24	130	3.97
9-10	0.53	58	6	64	220	6.72	55	8	63	185	7.69
10-11	0.85	77	8	85	165	12.24	83	7	90	245	9.13
9-11	0.37	33	4	37	132	7.88	38	9	47	190	5.62
11-12	0.10	9	7	16	155	2.11	10	2	12	117	2.79
12-13	0.17	15	1	16	215	2.65	17	4	21	140	3.80
7-13	0.73	61	2	63	210	9.63	71	4	75	130	12.82
8-14	0.52	47	6	53	180	8.03	53	10	63	148	8.87
Total Facility	**7.26**	**651**	**74**	**725**	**2492**	**8.12**	**742**	**96**	**838**	**2361**	**8.16**
		Trial 3					Trial 4				
1-2	0.50	50	4	54	180	7.62	47	11	58	170	7.82
2-3	0.54	42	8	50	162	9.17	47	10	57	174	8.42
3-4	0.54	45	6	51	145	9.92	53	8	61	149	9.26
4-5	0.12	13	8	21	135	2.77	11	6	17	147	2.63
5-6	0.26	28	4	32	120	6.16	29	8	37	157	4.82
6-7	1.00	90	3	93	125	16.51	102	2	104	126	15.65

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
7-8	0.86	79	8	87	150	13.06	84	6	90	132	13.95
8-9	0.17	16	6	22	165	3.27	17	8	25	135	3.83
9-10	0.53	57	7	64	200	7.23	56	9	65	221	6.67
10-11	0.85	82	6	88	240	9.33	79	7	86	169	12.00
9-11	0.37	35	5	40	188	5.84	32	8	40	154	6.87
11-12	0.10	12	5	17	142	2.26	7	4	11	132	2.52
12-13	0.17	16	2	18	145	3.75	19	0	19	210	2.67
7-13	0.73	65	3	68	198	9.88	74	4	78	143	11.89
8-14	0.52	51	5	56	166	8.43	47	4	51	179	8.14
Total Facility	**7.26**	**681**	**80**	**761**	**2461**	**8.11**	**704**	**95**	**799**	**2398**	**8.17**
		Trial 5					Trial 6				
1-2	0.50	55	7	62	189	7.10	41	6	47	184	7.71
2-3	0.54	49	8	57	179	8.24	43	9	52	165	8.96
3-4	0.54	50	7	57	155	9.17	52	5	57	140	9.87
4-5	0.12	12	7	19	156	2.47	10	5	15	140	2.79
5-6	0.26	27	5	32	138	5.51	25	4	29	171	4.68
6-7	1.00	114	4	118	128	14.63	120	3	123	134	14.01
7-8	0.86	83	7	90	143	13.29	82	7	89	144	13.29
8-9	0.17	12	7	19	130	4.11	18	4	22	170	3.19
9-10	0.53	52	3	55	213	7.12	62	2	64	195	7.37
10-11	0.85	72	5	77	165	12.64	81	4	85	188	11.21
9-11	0.37	39	10	49	169	6.11	37	7	44	133	7.53
11-12	0.10	6	10	16	145	2.24	5	7	12	133	2.48
12-13	0.17	13	4	17	195	2.89	17	0	17	177	3.15
7-13	0.73	65	6	71	132	12.95	65	5	70	177	10.64
8-14	0.52	54	3	57	181	7.87	52	4	56	154	8.91
Total Facility	**7.26**	**703**	**93**	**796**	**2418**	**8.13**	**710**	**72**	**782**	**2405**	**8.20**
		Trial 7					Trial 8				
1-2	0.50	45	11	56	182	7.49	49	10	59	174	7.65
2-3	0.54	52	10	62	155	8.96	51	8	59	152	9.21
3-4	0.54	43	9	52	145	9.87	48	7	55	148	9.58
4-5	0.12	15	7	22	166	2.30	14	5	19	158	2.44
5-6	0.26	26	9	35	152	5.01	24	6	30	169	4.70
6-7	1.00	107	3	110	131	14.94	90	2	92	127	16.44
7-8	0.86	80	5	85	141	13.70	84	10	94	139	13.29
8-9	0.17	13	5	18	155	3.54	14	9	23	149	3.56
9-10	0.53	70	2	72	187	7.37	55	6	61	183	7.82
10-11	0.85	78	3	81	195	11.09	74	2	76	178	12.05
9-11	0.37	34	6	40	178	6.11	33	9	42	198	5.55
11-12	0.10	10	9	19	165	1.96	8	12	20	122	2.54
12-13	0.17	12	4	16	187	3.01	15	3	18	155	3.54
7-13	0.73	61	1	62	182	10.77	67	2	69	184	10.39
8-14	0.52	50	1	51	137	9.96	55	9	64	145	8.96
Total Facility	**7.26**	**696**	**85**	**781**	**2458**	**8.06**	**681**	**100**	**781**	**2381**	**8.26**

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	48	7	55	175	7.75	53	9	62	192	7.02
2-3	0.54	55	9	64	177	8.07	45	6	51	169	8.84
3-4	0.54	51	5	56	144	9.72	47	7	54	145	9.77
4-5	0.12	13	5	18	157	2.47	9	6	15	139	2.81
5-6	0.26	29	8	37	148	5.06	30	5	35	134	5.54
6-7	1.00	88	3	91	126	16.59	82	2	84	129	16.90
7-8	0.86	85	11	96	141	13.06	78	6	84	142	13.70
8-9	0.17	17	3	20	195	2.85	15	9	24	164	3.26
9-10	0.53	53	8	61	175	8.08	59	4	63	177	7.95
10-11	0.85	75	4	79	211	10.55	85	2	87	195	10.85
9-11	0.37	36	5	41	120	8.27	38	3	41	148	7.05
11-12	0.10	13	6	19	145	2.20	9	8	17	154	2.11
12-13	0.17	18	2	20	147	3.66	15	6	21	165	3.29
7-13	0.73	68	3	71	210	9.35	64	7	71	201	9.66
8-14	0.52	56	6	62	132	9.65	47	10	57	152	8.96
Total Facility	**7.26**	**705**	**85**	**790**	**2403**	**8.18**	**676**	**90**	**766**	**2406**	**8.23**

(b) Weekend, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	61	7	68	187	6.99	76	8	84	157	7.39
2-3	0.54	67	3	70	137	9.39	83	8	91	172	7.39
3-4	0.54	67	6	73	135	9.35	83	9	92	130	8.76
4-5	0.12	11	0	11	175	2.32	16	7	23	127	2.88
5-6	0.26	30	1	31	135	5.64	39	8	47	177	4.18
6-7	1.00	128	2	130	128	13.95	157	7	164	137	11.96
7-8	0.86	110	2	112	139	12.33	135	3	138	143	11.02
8-9	0.17	18	2	20	160	3.40	25	8	33	158	3.20
9-10	0.53	66	1	67	214	6.79	82	7	89	165	7.51
10-11	0.85	108	6	114	120	13.08	133	1	134	232	8.36
9-11	0.37	44	9	53	116	7.88	56	4	60	160	6.05
11-12	0.10	8	1	9	167	2.05	13	5	18	106	2.90
12-13	0.17	18	2	20	222	2.53	25	7	32	150	3.36
7-13	0.73	92	7	99	213	8.42	113	6	119	135	10.35
8-14	0.52	64	1	65	173	7.87	80	2	82	163	7.64
Total Facility	**7.26**	**892**	**50**	**942**	**2421**	**7.77**	**1116**	**90**	**1206**	**2312**	**7.42**
		Trial 3					Trial 4				
1-2	0.50	74	8	82	185	6.67	64	6	70	158	7.82
2-3	0.54	80	7	87	165	7.71	85	5	90	145	8.27
3-4	0.54	65	8	73	128	9.67	73	6	79	136	9.04

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
4-5	0.12	15	5	20	130	2.88	15	4	19	180	2.17
5-6	0.26	32	2	34	164	4.73	35	7	42	136	5.26
6-7	1.00	154	5	159	136	12.20	160	3	163	140	11.88
7-8	0.86	132	1	133	145	11.14	111	2	113	150	11.77
8-9	0.17	24	6	30	157	3.27	23	3	26	158	3.33
9-10	0.53	77	6	83	200	6.74	75	2	77	210	6.65
10-11	0.85	130	5	135	200	9.13	127	2	129	133	11.68
9-11	0.37	50	4	54	120	7.66	41	3	44	139	7.28
11-12	0.10	10	4	14	101	3.13	7	3	10	113	2.93
12-13	0.17	22	5	27	177	3.00	19	4	23	202	2.72
7-13	0.73	110	4	114	140	10.35	120	2	122	210	7.92
8-14	0.52	77	2	79	172	7.46	84	0	84	162	7.61
Total Facility	**7.26**	**1052**	**72**	**1124**	**2320**	**7.58**	**1039**	**52**	**1091**	**2372**	**7.54**
		Trial 5					Trial 6				
1-2	0.50	82	6	88	162	7.13	60	4	64	179	7.33
2-3	0.54	71	5	76	169	7.93	79	4	83	171	7.65
3-4	0.54	84	7	91	133	8.68	89	10	99	130	8.49
4-5	0.12	13	6	19	163	2.37	10	7	17	158	2.47
5-6	0.26	31	3	34	123	5.96	39	6	45	144	4.95
6-7	1.00	133	7	140	141	12.81	124	4	128	132	13.85
7-8	0.86	124	3	127	141	11.55	135	1	136	142	11.14
8-9	0.17	17	1	18	159	3.46	16	4	20	165	3.31
9-10	0.53	74	8	82	174	7.45	73	6	79	198	6.89
10-11	0.85	119	4	123	189	9.81	118	3	121	212	9.19
9-11	0.37	51	6	57	145	6.59	53	4	57	155	6.28
11-12	0.10	12	2	14	164	2.02	11	1	12	122	2.69
12-13	0.17	14	7	21	233	2.41	16	6	22	210	2.64
7-13	0.73	90	6	96	201	8.85	117	7	124	199	8.14
8-14	0.52	56	1	57	170	8.25	65	5	70	175	7.64
Total Facility	**7.26**	**971**	**72**	**1043**	**2467**	**7.44**	**1005**	**72**	**1077**	**2492**	**7.32**
		Trial 7					Trial 8				
1-2	0.50	69	4	73	148	8.06	75	8	83	169	7.07
2-3	0.54	70	3	73	164	8.20	62	10	72	133	9.48
3-4	0.54	65	5	70	134	9.53	64	4	68	139	9.39
4-5	0.12	16	1	17	149	2.60	15	1	16	172	2.30
5-6	0.26	40	2	42	152	4.82	38	4	42	182	4.18
6-7	1.00	135	7	142	137	12.90	151	3	154	129	12.72
7-8	0.86	126	4	130	154	10.90	132	1	133	132	11.68
8-9	0.17	15	3	18	160	3.44	19	2	21	161	3.36
9-10	0.53	74	4	78	210	6.63	64	5	69	197	7.17
10-11	0.85	132	7	139	154	10.44	131	2	133	163	10.34
9-11	0.37	62	8	70	162	5.74	51	7	58	142	6.66
11-12	0.10	10	4	14	129	2.52	12	5	17	134	2.38
12-13	0.17	13	7	20	211	2.65	11	3	14	197	2.90
7-13	0.73	89	7	96	184	9.39	104	8	112	176	9.13

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
8-14	0.52	71	3	74	164	7.87	62	4	66	167	8.03
Total Facility	**7.26**	**987**	**69**	**1056**	**2412**	**7.53**	**991**	**67**	**1058**	**2393**	**7.57**
		Trial 9					Trial 10				
1-2	0.50	62	10	72	176	7.19	67	8	75	174	7.16
2-3	0.54	75	5	80	152	8.38	55	9	64	167	8.42
3-4	0.54	71	8	79	137	9.00	69	7	76	132	9.35
4-5	0.12	14	6	20	173	2.24	13	2	15	182	2.19
5-6	0.26	32	7	39	127	5.64	37	4	41	136	5.29
6-7	1.00	159	2	161	125	12.59	152	5	157	129	12.59
7-8	0.86	139	4	143	133	11.22	119	3	122	144	11.64
8-9	0.17	21	4	25	154	3.42	14	2	16	160	3.48
9-10	0.53	75	2	77	194	7.04	56	1	57	187	7.82
10-11	0.85	114	4	118	201	9.59	110	8	118	143	11.72
9-11	0.37	50	6	56	157	6.25	55	9	64	123	7.12
11-12	0.10	9	3	12	119	2.75	15	1	16	174	1.89
12-13	0.17	21	2	23	184	2.96	24	1	25	176	3.04
7-13	0.73	109	6	115	156	9.70	124	1	125	163	9.13
8-14	0.52	55	8	63	161	8.36	84	1	85	156	7.77
Total Facility	**7.26**	**1006**	**77**	**1083**	**2349**	**7.61**	**994**	**62**	**1056**	**2346**	**7.68**

(c) Weekday, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	59	6	65	182	7.21	71	8	79	153	7.68
2-3	0.54	65	9	74	127	9.67	78	9	87	176	7.39
3-4	0.54	65	7	72	122	10.02	78	7	85	125	9.26
4-5	0.12	14	2	16	168	2.35	17	8	25	130	2.79
5-6	0.26	31	7	38	115	6.12	37	7	44	171	4.35
6-7	1.00	143	19	162	131	12.29	172	2	174	113	12.54
7-8	0.86	136	7	143	141	10.90	163	8	171	151	9.61
8-9	0.17	20	8	28	170	3.09	22	7	29	149	3.44
9-10	0.53	64	8	72	215	6.65	69	8	77	175	7.57
10-11	0.85	102	6	108	120	13.42	110	4	114	229	8.92
9-11	0.37	44	4	48	122	7.84	48	7	55	180	5.67
11-12	0.10	10	8	18	150	2.14	11	0	11	112	2.93
12-13	0.17	12	6	18	214	2.64	13	2	15	150	3.71
7-13	0.73	88	7	95	205	8.76	95	2	97	140	11.09
8-14	0.52	62	8	70	200	6.93	67	3	70	168	7.87
Total Facility	**7.26**	**915**	**112**	**1027**	**2382**	**7.66**	**1051**	**82**	**1133**	**2322**	**7.56**

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	64	7	71	175	7.24	70	6	76	150	7.88
2-3	0.54	68	9	77	130	9.39	82	8	90	180	7.20
3-4	0.54	61	6	67	130	9.87	84	6	90	120	9.26
4-5	0.12	16	6	22	172	2.23	12	7	19	164	2.36
5-6	0.26	32	6	38	165	4.61	33	5	38	177	4.35
6-7	1.00	152	12	164	132	12.16	165	18	183	124	11.73
7-8	0.86	141	8	149	156	10.15	163	7	170	140	9.99
8-9	0.17	24	7	31	150	3.38	20	8	28	170	3.09
9-10	0.53	77	7	84	200	6.72	74	9	83	201	6.72
10-11	0.85	110	10	120	202	9.50	116	3	119	201	9.56
9-11	0.37	53	6	59	177	5.64	50	8	58	123	7.36
11-12	0.10	12	6	18	113	2.75	10	2	12	117	2.79
12-13	0.17	14	4	18	134	4.03	11	5	16	196	2.89
7-13	0.73	106	6	112	143	10.31	99	4	103	149	10.43
8-14	0.52	74	2	76	172	7.55	69	10	79	205	6.59
Total Facility	**7.26**	**1004**	**102**	**1106**	**2351**	**7.56**	**1058**	**106**	**1164**	**2417**	**7.29**
		Trial 5					Trial 6				
1-2	0.50	56	5	61	154	8.29	65	9	74	172	7.24
2-3	0.54	75	10	85	165	7.78	53	9	62	164	8.60
3-4	0.54	71	5	76	122	9.82	76	10	86	125	9.21
4-5	0.12	19	6	25	170	2.22	18	4	22	134	2.77
5-6	0.26	39	7	46	152	4.73	32	9	41	139	5.20
6-7	1.00	177	3	180	119	12.04	159	7	166	129	12.20
7-8	0.86	142	3	145	136	11.02	157	9	166	150	9.80
8-9	0.17	23	6	29	159	3.26	21	9	30	164	3.15
9-10	0.53	65	9	74	188	7.28	70	8	78	211	6.60
10-11	0.85	107	4	111	192	10.10	113	6	119	127	12.44
9-11	0.37	42	8	50	154	6.53	40	6	46	164	6.34
11-12	0.10	9	1	10	123	2.71	14	3	17	132	2.42
12-13	0.17	10	7	17	191	2.94	15	9	24	184	2.94
7-13	0.73	102	6	108	152	10.11	87	5	92	161	10.39
8-14	0.52	59	11	70	197	7.01	56	9	65	186	7.46
Total Facility	**7.26**	**996**	**91**	**1087**	**2374**	**7.55**	**976**	**112**	**1088**	**2342**	**7.61**
		Trial 7					Trial 8				
1-2	0.50	74	5	79	167	7.24	69	8	77	170	7.21
2-3	0.54	61	7	68	154	8.76	73	5	78	122	9.72
3-4	0.54	56	7	63	124	10.40	50	6	56	127	10.62
4-5	0.12	17	7	24	139	2.65	18	8	26	149	2.47
5-6	0.26	36	4	40	152	4.88	39	6	45	124	5.54
6-7	1.00	160	13	173	135	11.69	173	4	177	136	11.50
7-8	0.86	162	6	168	152	9.68	169	7	176	147	9.59
8-9	0.17	25	7	32	169	3.04	24	8	32	177	2.93
9-10	0.53	73	6	79	216	6.47	63	5	68	186	7.51
10-11	0.85	109	7	116	196	9.81	117	8	125	122	12.39
9-11	0.37	45	6	51	123	7.66	47	8	55	133	7.09

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
11-12	0.10	13	8	21	114	2.67	15	6	21	136	2.29
12-13	0.17	12	6	18	153	3.58	13	5	18	156	3.52
7-13	0.73	89	7	96	164	10.11	95	9	104	152	10.27
8-14	0.52	64	6	70	179	7.52	68	4	72	191	7.12
Total Facility	**7.26**	**996**	**102**	**1098**	**2337**	**7.60**	**1033**	**97**	**1130**	**2228**	**7.78**
		Trial 9					Trial 10				
1-2	0.50	52	7	59	184	7.33	59	6	65	158	7.99
2-3	0.54	82	6	88	144	8.38	84	5	89	154	8.00
3-4	0.54	86	7	93	129	8.76	77	4	81	144	8.64
4-5	0.12	12	6	18	143	2.68	10	7	17	156	2.50
5-6	0.26	41	8	49	128	5.29	45	6	51	138	4.95
6-7	1.00	165	15	180	122	11.92	170	2	172	112	12.68
7-8	0.86	170	5	175	143	9.74	150	9	159	139	10.39
8-9	0.17	26	9	35	182	2.82	25	7	32	142	3.52
9-10	0.53	60	12	72	173	7.79	56	9	65	196	7.31
10-11	0.85	98	9	107	132	12.80	105	12	117	186	10.10
9-11	0.37	46	3	49	145	6.87	48	4	52	164	6.17
11-12	0.10	12	5	17	111	2.81	9	7	16	156	2.09
12-13	0.17	11	4	15	164	3.42	14	3	17	175	3.19
7-13	0.73	93	12	105	170	9.56	99	8	107	180	9.16
8-14	0.52	63	6	69	205	6.83	71	2	73	200	6.86
Total Facility	**7.26**	**1017**	**114**	**1131**	**2275**	**7.67**	**1022**	**91**	**1113**	**2400**	**7.43**

(d) Weekday, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	51	8	59	186	7.27	46	7	53	167	8.10
2-3	0.54	65	6	71	126	9.87	59	6	65	181	7.90
3-4	0.54	61	9	70	158	8.53	55	8	63	126	10.29
4-5	0.12	14	7	21	151	2.51	13	2	15	151	2.60
5-6	0.26	28	9	37	115	6.16	25	4	29	164	4.85
6-7	1.00	102	15	117	131	14.52	82	6	88	108	18.37
7-8	0.86	95	2	97	144	12.85	71	8	79	144	13.88
8-9	0.17	18	9	27	173	3.06	16	4	20	140	3.83
9-10	0.53	61	2	63	235	6.40	55	6	61	176	8.05
10-11	0.85	127	8	135	110	12.49	96	3	99	261	8.50
9-11	0.37	43	4	47	115	8.22	39	2	41	181	6.00
11-12	0.10	11	2	13	145	2.28	10	6	16	115	2.75
12-13	0.17	19	12	31	224	2.40	17	4	21	135	3.92
7-13	0.73	82	8	90	210	8.76	65	6	71	147	12.06
8-14	0.52	56	9	65	195	7.20	50	6	56	156	8.83
Total Facility	**7.26**	**833**	**110**	**943**	**2418**	**7.77**	**699**	**78**	**777**	**2352**	**8.35**

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 3					Trial 4				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.50	45	8	53	170	7.99	55	9	64	173	7.52
2-3	0.54	60	7	67	122	10.29	64	8	72	133	9.48
3-4	0.54	57	10	67	130	9.87	52	7	59	165	8.68
4-5	0.12	12	5	17	159	2.45	14	3	17	144	2.68
5-6	0.26	22	3	25	116	6.64	29	4	33	156	4.95
6-7	1.00	89	9	98	111	17.22	87	14	101	135	15.25
7-8	0.86	70	6	76	148	13.82	78	4	82	142	13.82
8-9	0.17	15	6	21	145	3.69	19	4	23	154	3.46
9-10	0.53	56	4	60	199	7.37	61	8	69	141	9.09
10-11	0.85	100	5	105	185	10.55	110	4	114	185	10.23
9-11	0.37	45	2	47	165	6.28	47	2	49	154	6.56
11-12	0.10	9	5	14	131	2.48	12	4	16	144	2.25
12-13	0.17	16	9	25	230	2.40	17	7	24	126	4.08
7-13	0.73	85	4	89	161	10.51	81	5	86	198	9.25
8-14	0.52	48	7	55	174	8.17	54	6	60	195	7.34
Total Facility	**7.26**	**729**	**90**	**819**	**2346**	**8.25**	**780**	**89**	**869**	**2345**	**8.13**
		Trial 5					Trial 6				
1-2	0.50	49	6	55	175	7.75	47	10	57	179	7.55
2-3	0.54	66	5	71	130	9.67	63	6	69	166	8.27
3-4	0.54	62	9	71	160	8.42	63	6	69	141	9.26
4-5	0.12	15	5	20	140	2.70	13	6	19	151	2.54
5-6	0.26	26	6	32	143	5.35	26	7	33	148	5.17
6-7	1.00	95	8	103	122	16.00	97	5	102	115	16.59
7-8	0.86	79	8	87	140	13.64	90	2	92	151	12.74
8-9	0.17	20	3	23	161	3.33	11	9	20	140	3.83
9-10	0.53	64	6	70	226	6.45	57	7	64	219	6.74
10-11	0.85	94	5	99	196	10.37	96	8	104	231	9.13
9-11	0.37	41	5	46	148	6.87	39	6	45	134	7.44
11-12	0.10	11	6	17	135	2.37	7	3	10	120	2.77
12-13	0.17	15	6	21	154	3.50	18	5	23	182	2.99
7-13	0.73	70	3	73	181	10.35	76	8	84	164	10.60
8-14	0.52	57	8	65	200	7.06	61	7	68	167	7.97
Total Facility	**7.26**	**764**	**89**	**853**	**2411**	**8.00**	**764**	**95**	**859**	**2408**	**7.99**
		Trial 7					Trial 8				
1-2	0.50	51	5	56	181	7.52	50	6	56	170	7.88
2-3	0.54	58	5	63	170	8.34	70	6	76	155	8.42
3-4	0.54	60	10	70	149	8.88	57	10	67	153	8.84
4-5	0.12	12	3	15	155	2.54	15	4	19	149	2.57
5-6	0.26	24	8	32	154	5.03	23	10	33	167	4.68
6-7	1.00	84	14	98	108	17.48	88	13	101	110	17.06
7-8	0.86	89	3	92	156	12.48	81	9	90	147	13.06
8-9	0.17	14	7	21	170	3.20	13	8	21	169	3.22
9-10	0.53	59	9	68	208	6.91	60	3	63	203	7.17
10-11	0.85	107	3	110	222	9.22	104	6	110	244	8.64
9-11	0.37	35	4	39	127	8.02	45	2	47	126	7.70

(Table H.9 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
11-12	0.10	12	4	16	117	2.71	10	5	15	136	2.38
12-13	0.17	14	9	23	221	2.51	20	7	27	197	2.73
7-13	0.73	62	10	72	210	9.32	69	7	76	200	9.52
8-14	0.52	53	8	61	159	8.51	48	10	58	151	8.96
Total Facility	**7.26**	**734**	**102**	**836**	**2507**	**7.81**	**753**	**106**	**859**	**2477**	**7.83**
		Trial 9					Trial 10				
1-2	0.50	46	6	52	165	8.21	53	4	57	171	7.82
2-3	0.54	61	7	68	169	8.20	66	6	72	144	9.00
3-4	0.54	58	5	63	159	8.76	55	6	61	131	10.13
4-5	0.12	12	5	17	155	2.51	13	3	16	147	2.65
5-6	0.26	27	9	36	147	5.11	26	8	34	143	5.29
6-7	1.00	83	15	98	123	16.29	86	12	98	133	15.58
7-8	0.86	77	7	84	144	13.58	96	2	98	148	12.59
8-9	0.17	17	6	23	175	3.09	16	5	21	156	3.46
9-10	0.53	70	2	72	225	6.42	51	5	56	179	8.12
10-11	0.85	94	5	99	254	8.67	95	3	98	261	8.52
9-11	0.37	46	3	49	131	7.40	43	4	47	137	7.24
11-12	0.10	8	5	13	127	2.57	7	4	11	119	2.77
12-13	0.17	17	11	28	183	2.90	16	10	26	176	3.03
7-13	0.73	63	8	71	169	10.95	79	4	83	154	11.09
8-14	0.52	51	6	57	156	8.79	45	6	51	184	7.97
Total Facility	**7.26**	**730**	**100**	**830**	**2482**	**7.89**	**747**	**82**	**829**	**2383**	**8.13**

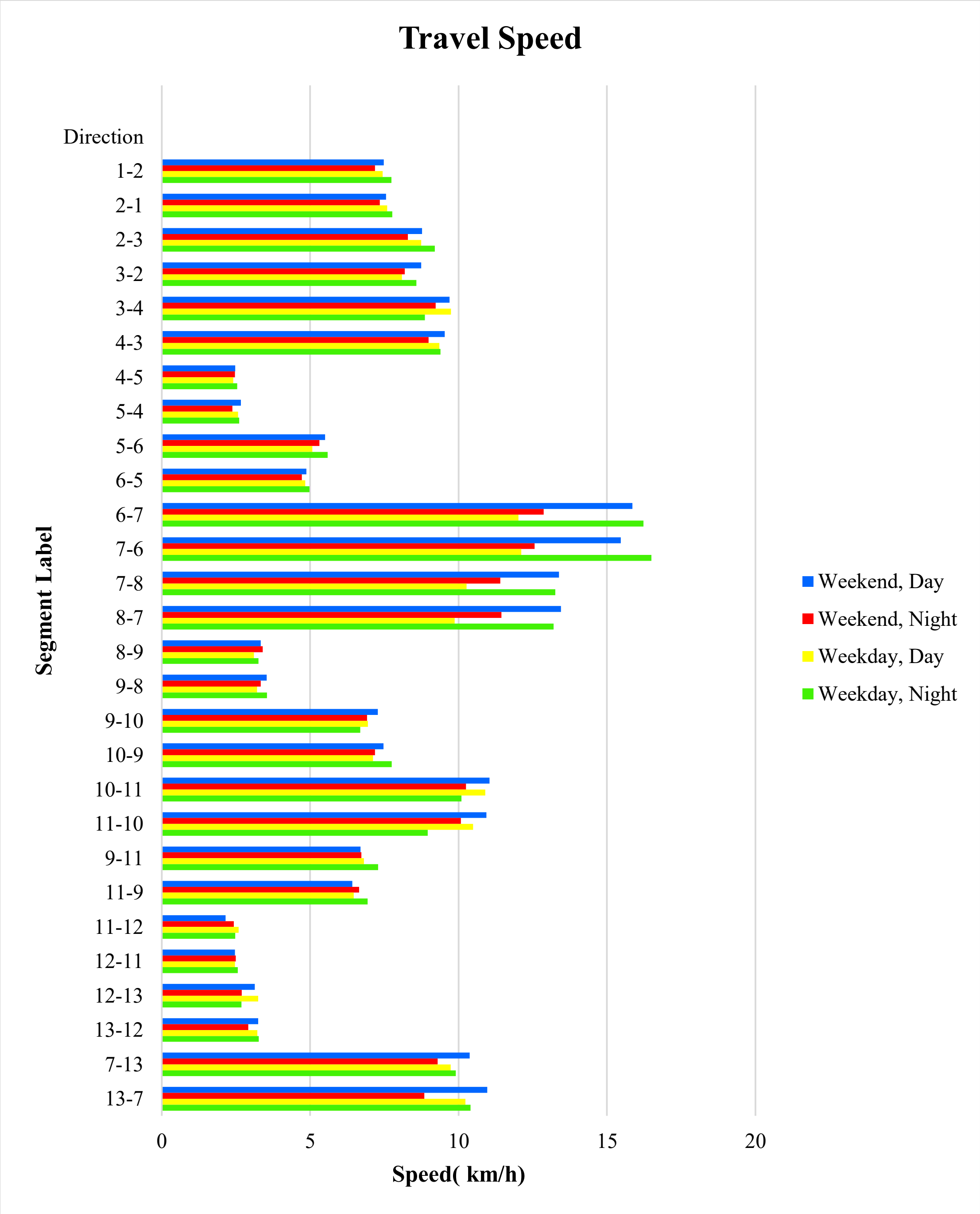


Figure H.4: Observed Travel Speed at MMHF

Table H.10: Travel Times at Free Flow Conditions at MMF

Time Period	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck
Weekend, Day	Over	-	1.75	7.98	1.11	1.87	-	1.6	2.11	2.6
	Under	9.26	1.26	8.1	1.52	1.89	2.14	2.05	2.54	-
Weekend, Night	Over	-	1.48	-	1.04	1.96	-	1.31	1.32	-
	Under	9.47	1.59	6.1	1.15	2.11	1.46	1.55	1.53	-
Weekday, Day	Over	-	1.28	7.24	1.16	2.29	-	1.38	1.34	1.44
	Under	8.5	1.24	5.21	1.25	2.37	1.81	1.59	1.15	-
Weekday, Night	Over	-	1.66	-	1.06	1.97	-	1.25	1.41	1.46
	Under	10.4	1.14	7.6	1.29	1.99	1.85	1.61	1.46	-

Table H.11: Travel Time at Operating Conditions at MMF

(a) Weekend, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.75	85	2	87	396	5.59	92	5	97	311	6.62
2-3	0.43	50	7	57	391	3.46	55	1	56	402	3.38
2-25	0.54	62	4	66	110	11.05	68	2	70	143	9.13
3-4	0.61	70	8	78	392	4.67	76	1	77	371	4.90
3-23	0.87	98	2	100	685	3.99	106	2	108	371	6.54
4-5	0.4	47	1	48	306	4.07	51	0	51	404	3.16
4-15	1.01	183	3	186	145	10.98	122	2	124	391	7.06
4-22	0.97	109	4	113	518	5.53	118	3	121	421	6.44
5-6	0.43	50	2	52	271	4.79	55	1	56	225	5.51
6-7	0.47	54	1	55	335	4.34	60	1	61	264	5.21
6-14	0.63	72	2	74	419	4.60	78	2	80	340	5.40
7-8	0.37	43	1	44	318	3.68	48	1	49	365	3.22
7-19	0.1	14	0	14	73	4.14	17	1	18	101	3.03
8-9	0.15	19	0	19	114	4.06	22	0	22	131	3.53
8-14	0.55	63	0	63	350	4.79	69	0	69	351	4.71
9-10	0.73	83	1	84	785	3.02	90	0	90	306	6.64
10-11	0.27	32	0	32	276	3.16	36	0	36	229	3.67
11-12	0.34	40	0	40	250	4.22	44	2	46	338	3.19
11-14	0.82	92	1	93	433	5.61	100	5	105	416	5.67
12-13	0.74	72	9	81	202	9.35	71	6	77	184	10.14
12-18	0.89	61	1	62	187	12.87	22	8	30	250	11.44
13-14	0.37	43	0	43	325	3.62	48	3	51	250	4.43
13-15	0.28	33	7	40	148	5.36	31	4	35	109	7.00

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
15-16	0.47	41	8	49	143	8.81	42	8	50	121	9.89
16-17	1.52	115	7	122	188	17.65	148	9	157	143	18.24
16-26	1.09	24	7	31	204	16.70	138	3	141	91	16.91
17-18	0.14	24	2	26	22	10.50	17	7	24	22	10.96
19-20	0.8	90	3	93	206	9.63	98	1	99	221	9.00
20-21	0.27	32	1	33	277	3.14	36	6	42	227	3.61
21-22	0.51	59	1	60	352	4.46	64	2	66	287	5.20
22-23	0.47	54	2	56	742	2.12	60	3	63	361	3.99
23-24	1.09	122	4	126	261	10.14	132	2	134	344	8.21
Total Facility	**19.08**	**2036**	**91**	**2127**	**9824**	**5.75**	**2214**	**91**	**2305**	**8490**	**6.36**
		Trial 3					Trial 4				
1-2	0.75	70	2	72	253	8.31	83	2	85	209	9.18
2-3	0.43	38	2	40	214	6.09	51	4	55	156	7.34
2-25	0.54	49	2	51	126	10.98	62	2	64	163	8.56
3-4	0.61	56	3	59	234	7.49	69	2	71	251	6.82
3-23	0.87	82	0	82	530	5.12	95	1	96	425	6.01
4-5	0.4	35	1	36	257	4.91	48	6	54	298	4.09
4-15	1.01	96	1	97	259	10.21	109	2	111	360	7.72
4-22	0.97	92	2	94	472	6.17	105	1	106	417	6.68
5-6	0.43	38	2	40	300	4.55	51	2	53	220	5.67
6-7	0.47	42	3	45	302	4.88	55	1	56	256	5.42
6-14	0.63	58	0	58	382	5.15	71	2	73	233	7.41
7-8	0.37	32	0	32	344	3.54	45	4	49	311	3.70
7-19	0.1	5	0	5	94	3.64	17	0	17	92	3.30
8-9	0.15	10	0	10	125	4.00	22	0	22	115	3.94
8-14	0.55	50	1	51	353	4.90	63	1	64	225	6.85
9-10	0.73	68	2	70	548	4.25	81	2	83	310	6.69
10-11	0.27	22	3	25	515	1.80	34	1	35	218	3.84
11-12	0.34	29	1	30	296	3.75	41	1	42	230	4.50
11-14	0.82	77	4	81	427	5.81	90	2	92	252	8.58
12-13	0.74	71	2	73	161	11.31	76	9	85	162	10.71
12-18	0.89	78	8	86	180	12.05	61	5	66	204	11.87
13-14	0.37	32	1	33	290	4.12	45	3	48	157	6.50
13-15	0.28	31	4	35	118	6.59	38	7	45	130	5.76
15-16	0.47	42	6	48	128	9.61	48	8	56	110	10.19
16-17	1.52	138	8	146	162	17.77	156	7	163	148	17.59
16-26	1.09	128	3	131	105	16.63	134	7	141	95	16.63
17-18	0.14	17	9	26	19	11.20	15	2	17	27	11.45
19-20	0.8	75	3	78	216	9.80	88	2	90	182	10.59
20-21	0.27	22	4	26	254	3.47	34	1	35	194	4.24
21-22	0.51	46	7	53	322	4.90	59	5	64	337	4.58
22-23	0.47	42	2	44	554	2.83	55	1	56	446	3.37
23-24	1.09	104	1	105	505	6.43	118	1	119	270	10.09
Total Facility	**19.08**	**1775**	**87**	**1862**	**9045**	**6.30**	**2119**	**94**	**2213**	**7203**	**7.29**

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.75	64	4	68	224	9.25	89	4	93	274	7.36
2-3	0.43	35	3	38	183	7.00	36	1	37	242	5.55
2-25	0.54	45	2	47	144	10.18	63	0	63	124	10.40
3-4	0.61	51	2	53	231	7.73	95	1	96	260	6.17
3-23	0.87	75	3	78	425	6.23	84	2	86	310	7.91
4-5	0.4	32	0	32	209	5.98	97	0	97	157	5.67
4-15	1.01	88	2	90	317	8.93	80	1	81	311	9.28
4-22	0.97	85	3	88	422	6.85	113	2	115	363	7.31
5-6	0.43	35	2	37	214	6.17	70	3	73	159	6.67
6-7	0.47	38	1	39	230	6.29	26	1	27	267	5.76
6-14	0.63	53	3	56	257	7.25	34	5	39	281	7.09
7-8	0.37	29	2	31	316	3.84	41	0	41	210	5.31
7-19	0.1	4	0	4	81	4.24	12	0	12	53	5.54
8-9	0.15	9	0	9	122	4.12	51	0	51	124	3.09
8-14	0.55	46	1	47	223	7.33	31	1	32	240	7.28
9-10	0.73	62	2	64	326	6.74	42	0	42	339	6.90
10-11	0.27	20	0	20	213	4.17	38	1	39	156	4.98
11-12	0.34	26	1	27	260	4.26	42	0	42	183	5.44
11-14	0.82	71	1	72	280	8.39	83	2	85	265	8.43
12-13	0.74	79	4	83	154	11.16	72	9	81	189	9.80
12-18	0.89	22	9	31	230	12.28	64	9	73	189	12.23
13-14	0.37	29	1	30	275	4.37	26	1	27	230	5.18
13-15	0.28	33	6	39	100	7.25	33	5	38	133	5.89
15-16	0.47	67	3	70	104	9.72	41	8	49	125	9.72
16-17	1.52	134	5	139	153	18.74	115	7	122	165	19.07
16-26	1.09	132	2	134	110	16.08	24	7	31	200	16.99
17-18	0.14	18	7	25	22	10.72	27	2	29	21	10.08
19-20	0.8	69	2	71	243	9.17	42	1	43	217	11.08
20-21	0.27	20	3	23	231	3.83	35	0	35	136	5.68
21-22	0.51	42	4	46	252	6.16	39	3	42	214	7.17
22-23	0.47	38	2	40	294	5.07	40	2	42	323	4.64
23-24	1.09	96	1	97	300	9.88	95	2	97	324	9.32
Total Facility	**19.08**	**1647**	**81**	**1728**	**7145**	**7.74**	**1780**	**80**	**1860**	**6784**	**7.94**
		Trial 7					Trial 8				
1-2	0.75	73	2	75	228	8.91	70	1	71	308	7.12
2-3	0.43	47	5	52	226	5.57	26	2	28	206	6.62
2-25	0.54	56	1	57	141	9.82	37	0	37	230	7.28
3-4	0.61	62	2	64	282	6.35	43	1	44	257	7.30
3-23	0.87	83	3	86	383	6.68	69	2	71	348	7.47
4-5	0.4	45	0	45	141	7.74	23	3	26	211	6.08
4-15	1.01	94	2	96	280	9.67	82	1	83	255	10.76
4-22	0.97	91	4	95	427	6.69	78	5	83	387	7.43
5-6	0.43	47	3	50	143	8.02	26	3	29	162	8.10
6-7	0.47	51	1	52	240	5.79	30	4	34	219	6.69
6-14	0.63	63	2	65	253	7.13	45	2	47	231	8.16
7-8	0.37	43	7	50	189	5.57	20	1	21	173	6.87

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
7-19	0.1	21	0	21	48	5.22	9	0	9	46	6.55
8-9	0.15	25	1	26	107	4.06	25	0	25	99	4.35
8-14	0.55	57	1	58	216	7.23	38	3	41	197	8.32
9-10	0.73	71	2	73	305	6.95	55	7	62	344	6.47
10-11	0.27	35	6	41	140	5.37	10	2	12	129	6.89
11-12	0.34	40	0	40	165	5.97	17	4	21	152	7.08
11-14	0.82	79	1	80	249	8.97	64	1	65	327	7.53
12-13	0.74	72	3	75	192	9.91	76	9	85	171	10.34
12-18	0.89	74	8	82	172	12.61	83	7	90	200	11.05
13-14	0.37	43	2	45	220	5.03	20	0	20	201	6.03
13-15	0.28	33	4	37	145	5.54	40	7	47	129	5.73
15-16	0.47	41	6	47	124	9.89	47	8	55	112	10.13
16-17	1.52	133	7	140	160	18.24	148	7	155	136	18.80
16-26	1.09	137	5	142	97	16.42	93	7	100	119	17.92
17-18	0.14	22	8	30	17	10.72	12	2	14	35	10.29
19-20	0.8	77	2	79	221	9.60	62	5	67	202	10.71
20-21	0.27	35	3	38	158	4.96	30	1	31	145	5.52
21-22	0.51	54	2	56	192	7.40	34	2	36	186	8.27
22-23	0.47	51	1	52	361	4.10	30	1	31	328	4.71
23-24	1.09	100	1	101	341	8.88	90	3	93	310	9.74
Total Facility	**19.08**	**1955**	**95**	**2050**	**6563**	**7.97**	**1532**	**101**	**1633**	**6555**	**8.39**
		Trial 9					Trial 10				
1-2	0.75	38	4	42	331	7.24	79	7	86	316	6.72
2-3	0.43	53	1	54	282	4.61	45	2	47	253	5.16
2-25	0.54	29	2	31	183	9.08	56	6	62	172	8.31
3-4	0.61	40	6	46	315	6.08	64	1	65	285	6.27
3-23	0.87	90	3	93	508	5.21	91	3	94	320	7.57
4-5	0.4	46	1	47	264	4.63	41	0	41	234	5.24
4-15	1.01	62	4	66	261	11.12	124	2	126	243	9.85
4-22	0.97	60	7	67	464	6.58	102	1	103	270	9.36
5-6	0.43	32	2	34	238	5.69	45	3	48	242	5.34
6-7	0.47	40	3	43	283	5.19	49	6	55	230	5.94
6-14	0.63	92	6	98	324	5.37	66	4	70	201	8.37
7-8	0.37	72	1	73	291	3.66	38	2	40	185	5.92
7-19	0.1	12	4	16	89	3.43	9	1	10	84	3.83
8-9	0.15	13	2	15	134	3.62	14	0	14	133	3.67
8-14	0.55	36	3	39	279	6.23	57	1	58	217	7.20
9-10	0.73	42	0	42	507	4.79	77	2	79	301	6.92
10-11	0.27	37	1	38	228	3.65	27	3	30	140	5.72
11-12	0.34	36	2	38	243	4.36	35	1	36	152	6.51
11-14	0.82	63	1	64	369	6.82	86	4	90	291	7.75
12-13	0.74	82	6	88	153	10.98	71	7	78	161	11.07
12-18	0.89	61	6	67	226	10.94	74	2	76	189	12.09
13-14	0.37	28	1	29	289	4.19	38	2	40	214	5.24
13-15	0.28	40	9	49	113	6.22	31	2	33	115	6.81

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
15-16	0.47	47	7	54	107	10.51	42	6	48	133	9.35
16-17	1.52	148	8	156	140	18.49	148	8	156	158	17.43
16-26	1.09	123	8	131	96	17.29	158	9	167	71	16.49
17-18	0.14	12	7	19	25	11.45	17	3	20	25	11.20
19-20	0.8	46	1	47	239	10.07	84	1	85	184	10.71
20-21	0.27	18	2	20	240	3.74	27	0	27	152	5.43
21-22	0.51	30	1	31	285	5.81	53	0	53	180	7.88
22-23	0.47	54	3	57	477	3.17	69	3	72	212	5.96
23-24	1.09	80	1	81	312	9.98	125	2	127	462	6.66
Total Facility	**19.08**	**1662**	**113**	**1775**	**8295**	**6.82**	**2042**	**94**	**2136**	**6525**	**7.93**

(b) Weekend, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.75	81	2	83	537	4.35	76	2	78	361	6.15
2-3	0.43	29	1	30	484	3.01	29	0	29	460	3.17
2-25	0.54	61	2	63	130	10.07	58	2	60	184	7.97
3-4	0.61	68	1	69	385	4.84	64	1	65	388	4.85
3-23	0.87	92	3	95	687	4.01	86	3	89	530	5.06
4-5	0.4	48	0	48	333	3.78	46	1	47	279	4.42
4-15	1.01	106	5	111	322	8.40	98	2	100	474	6.33
4-22	0.97	102	4	106	575	5.13	95	2	97	674	4.53
5-6	0.43	51	1	52	286	4.58	49	1	50	329	4.08
6-7	0.47	55	3	58	331	4.35	53	3	56	270	5.19
6-14	0.63	70	2	72	493	4.01	66	2	68	376	5.11
7-8	0.37	45	0	45	397	3.01	44	0	44	355	3.34
7-19	0.1	19	0	19	61	4.50	20	0	20	118	2.61
8-9	0.15	24	0	24	218	2.23	25	0	25	145	3.18
8-14	0.55	62	3	65	375	4.50	59	2	61	442	3.94
9-10	0.73	79	2	81	335	6.32	74	1	75	342	6.30
10-11	0.27	36	0	36	223	3.75	35	0	35	160	4.98
11-12	0.34	42	0	42	250	4.19	41	0	41	298	3.61
11-14	0.82	88	1	89	512	4.91	82	1	83	371	6.50
12-13	0.74	71	7	78	306	6.89	72	9	81	343	6.24
12-18	0.89	22	8	30	425	7.04	61	6	67	429	6.46
13-14	0.37	45	1	46	299	3.86	44	3	47	140	7.12
13-15	0.28	31	2	33	219	4.00	33	7	40	251	3.46
15-16	0.47	42	6	48	253	5.62	41	8	49	243	5.79
16-17	1.52	148	8	156	300	12.00	115	7	122	324	12.27
16-26	1.09	158	9	167	157	12.11	24	7	31	347	10.38

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
17-18	0.14	17	3	20	48	7.41	25	3	28	31	8.54
19-20	0.8	86	4	90	246	8.57	80	2	82	292	7.70
20-21	0.27	36	0	36	284	3.04	35	0	35	219	3.83
21-22	0.51	58	1	59	394	4.05	55	1	56	341	4.62
22-23	0.47	55	1	56	389	3.80	53	1	54	448	3.37
23-24	1.09	113	2	115	393	7.72	105	1	106	384	8.01
Total Facility	**19.08**	**2040**	**82**	**2122**	**10647**	**5.38**	**1843**	**78**	**1921**	**10348**	**5.60**
		Trial 3					Trial 4				
1-2	0.75	87	2	89	298	6.98	67	4	71	256	8.26
2-3	0.43	53	3	56	258	4.93	36	2	38	237	5.63
2-25	0.54	65	1	66	156	8.76	47	2	49	169	8.92
3-4	0.61	72	2	74	282	6.17	54	3	57	272	6.67
3-23	0.87	99	8	107	461	5.51	79	4	83	351	7.22
4-5	0.4	50	7	57	238	4.88	34	1	35	282	4.54
4-15	1.01	114	9	123	289	8.83	116	5	121	310	8.44
4-22	0.97	110	9	119	445	6.19	89	2	91	376	7.48
5-6	0.43	53	5	58	244	5.13	36	0	36	190	6.85
6-7	0.47	57	1	58	296	4.78	40	0	40	230	6.27
6-14	0.63	74	2	76	341	5.44	56	1	57	249	7.41
7-8	0.37	47	0	47	294	3.91	31	0	31	263	4.53
7-19	0.1	18	0	18	91	3.30	14	0	14	80	3.83
8-9	0.15	23	0	23	140	3.31	19	0	19	112	4.12
8-14	0.55	66	1	67	303	5.35	48	2	50	240	6.83
9-10	0.73	85	2	87	377	5.66	65	3	68	296	7.22
10-11	0.27	36	0	36	212	3.92	21	0	21	181	4.81
11-12	0.34	43	0	43	253	4.14	27	0	27	224	4.88
11-14	0.82	94	3	97	366	6.38	74	1	75	307	7.73
12-13	0.74	74	5	79	275	7.47	72	9	81	265	7.65
12-18	0.89	27	10	37	343	8.43	66	2	68	340	7.85
13-14	0.37	47	0	47	282	4.05	31	2	33	190	5.97
13-15	0.28	36	8	44	203	4.08	33	5	38	186	4.50
15-16	0.47	43	6	49	193	6.99	41	8	49	175	7.55
16-17	1.52	133	7	140	252	13.96	125	12	137	261	13.75
16-26	1.09	111	7	118	215	11.78	24	9	33	285	12.34
17-18	0.14	11	6	17	45	8.13	28	2	30	29	8.54
19-20	0.8	92	2	94	236	8.73	72	3	75	190	10.87
20-21	0.27	36	0	36	222	3.77	21	0	21	178	4.88
21-22	0.51	61	1	62	286	5.28	44	2	46	251	6.18
22-23	0.47	57	1	58	452	3.32	40	1	41	349	4.34
23-24	1.09	123	4	127	392	7.56	100	4	104	285	10.09
Total Facility	**19.08**	**2097**	**112**	**2209**	**8740**	**6.27**	**1650**	**89**	**1739**	**7609**	**7.35**
		Trial 5					Trial 6				
1-2	0.75	66	4	70	261	8.16	63	4	67	352	6.44
2-3	0.43	50	2	52	263	4.91	33	2	35	242	5.59

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
2-25	0.54	49	3	52	119	11.37	49	4	53	158	9.21
3-4	0.61	58	2	60	268	6.70	55	1	56	254	7.08
3-23	0.87	91	2	93	398	6.38	76	2	78	322	7.83
4-5	0.4	46	0	46	248	4.90	41	0	41	239	5.14
4-15	1.01	97	3	100	315	8.76	84	2	86	290	9.67
4-22	0.97	88	2	90	366	7.66	80	2	82	398	7.28
5-6	0.43	43	2	45	192	6.53	42	0	42	226	5.78
6-7	0.47	48	2	50	224	6.18	46	0	46	169	7.87
6-14	0.63	76	2	78	274	6.44	61	2	63	258	7.07
7-8	0.37	52	2	54	269	4.12	42	0	42	157	6.69
7-19	0.1	14	1	15	71	4.19	18	0	18	78	3.75
8-9	0.15	18	0	18	101	4.54	22	0	22	93	4.70
8-14	0.55	52	2	54	249	6.53	50	2	52	245	6.67
9-10	0.73	66	1	67	381	5.87	62	2	64	213	9.49
10-11	0.27	34	1	35	194	4.24	32	0	32	126	6.15
11-12	0.34	38	0	38	229	4.58	36	0	36	128	7.46
11-14	0.82	79	2	81	304	7.67	70	2	72	260	8.89
12-13	0.74	72	3	75	346	6.29	71	2	73	274	7.63
12-18	0.89	61	5	66	347	7.76	58	57	115	315	7.45
13-14	0.37	38	2	40	230	4.93	38	0	38	133	7.79
13-15	0.28	33	4	37	261	3.38	31	4	35	201	4.27
15-16	0.47	41	6	47	223	6.27	42	6	48	218	6.36
16-17	1.52	133	7	140	288	12.79	138	8	146	275	13.00
16-26	1.09	137	5	142	175	12.38	134	3	137	186	12.15
17-18	0.14	22	8	30	31	8.26	19	9	28	32	8.40
19-20	0.8	72	2	74	182	11.25	67	2	69	221	9.93
20-21	0.27	28	0	28	199	4.28	30	0	30	121	6.44
21-22	0.51	48	0	48	241	6.35	47	1	48	184	7.91
22-23	0.47	60	0	60	376	3.88	49	3	52	222	6.18
23-24	1.09	106	3	109	244	11.12	90	2	92	249	11.51
Total Facility	**19.08**	**1916**	**78**	**1994**	**7869**	**6.96**	**1776**	**122**	**1898**	**6839**	**7.86**
		Trial 7					Trial 8				
1-2	0.75	97	2	99	265	7.42	92	3	95	254	7.74
2-3	0.43	61	3	64	266	4.69	57	0	57	198	6.07
2-25	0.54	74	2	76	144	8.84	69	3	72	130	9.62
3-4	0.61	82	2	84	309	5.59	77	3	80	177	8.54
3-23	0.87	111	3	114	396	6.14	105	3	108	290	7.87
4-5	0.4	58	0	58	274	4.34	54	0	54	141	7.38
4-15	1.01	127	2	129	247	9.67	120	4	124	303	8.52
4-22	0.97	122	3	125	348	7.38	116	3	119	297	8.39
5-6	0.43	61	1	62	211	5.67	57	2	59	135	7.98
6-7	0.47	66	0	66	249	5.37	61	3	64	156	7.69
6-14	0.63	84	2	86	268	6.41	79	3	82	243	6.98
7-8	0.37	55	0	55	275	4.04	50	0	50	154	6.53
7-19	0.1	24	0	24	124	2.43	21	0	21	50	5.07

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
8-9	0.15	30	0	30	214	2.21	26	0	26	73	5.45
8-14	0.55	75	2	77	253	6.00	70	3	73	182	7.76
9-10	0.73	95	3	98	342	5.97	90	0	90	263	7.44
10-11	0.27	43	0	43	207	3.89	39	0	39	96	7.20
11-12	0.34	51	0	51	200	4.88	47	0	47	120	7.33
11-14	0.82	105	3	108	274	7.73	99	2	101	270	7.96
12-13	0.74	76	9	85	308	6.73	76	9	85	275	7.35
12-18	0.89	78	8	86	306	8.17	74	8	82	310	8.17
13-14	0.37	55	0	55	200	5.22	50	2	52	125	7.53
13-15	0.28	40	7	47	232	3.61	38	7	45	221	3.79
15-16	0.47	47	8	55	202	6.58	48	8	56	187	6.96
16-17	1.52	148	7	155	245	13.68	156	7	163	252	13.19
16-26	1.09	99	7	106	214	12.26	145	9	154	165	12.30
17-18	0.14	12	2	14	63	6.55	15	2	17	46	8.00
19-20	0.8	103	2	105	195	9.60	97	1	98	215	9.20
20-21	0.27	43	0	43	229	3.57	39	2	41	101	6.85
21-22	0.51	70	0	70	271	5.38	66	3	69	221	6.33
22-23	0.47	66	3	69	393	3.66	61	2	63	174	7.14
23-24	1.09	136	2	138	368	7.75	129	2	131	212	11.44
Total Facility	**19.08**	**2394**	**83**	**2477**	**8092**	**6.50**	**2323**	**94**	**2417**	**6036**	**8.12**
		Trial 9					Trial 10				
1-2	0.75	67	2	69	354	6.38	89	2	91	289	7.11
2-3	0.43	39	1	40	223	5.89	54	3	57	254	4.98
2-25	0.54	50	3	53	147	9.72	66	1	67	166	8.34
3-4	0.61	56	6	62	244	7.18	74	4	78	174	8.71
3-23	0.87	88	2	90	342	7.25	101	1	102	301	7.77
4-5	0.4	40	0	40	230	5.33	51	2	53	251	4.74
4-15	1.01	96	3	99	325	8.58	117	3	120	327	8.13
4-22	0.97	86	0	86	368	7.69	112	1	113	312	8.22
5-6	0.43	41	2	43	200	6.37	54	2	56	154	7.37
6-7	0.47	45	0	45	211	6.61	59	2	61	159	7.69
6-14	0.63	59	0	59	256	7.20	76	0	76	216	7.77
7-8	0.37	38	0	38	216	5.24	48	0	48	168	6.17
7-19	0.1	17	0	17	245	1.37	19	0	19	87	3.40
8-9	0.15	21	2	23	178	2.69	24	3	27	64	5.93
8-14	0.55	61	2	63	187	7.92	67	2	69	187	7.73
9-10	0.73	66	3	69	333	6.54	86	1	87	186	9.63
10-11	0.27	29	2	31	230	3.72	37	1	38	137	5.55
11-12	0.34	34	1	35	288	3.79	45	2	47	145	6.38
11-14	0.82	83	1	84	270	8.34	96	4	100	296	7.45
12-13	0.74	76	6	82	473	4.77	79	4	83	262	7.67
12-18	0.89	64	9	73	321	8.13	84	3	87	292	8.45
13-14	0.37	37	2	39	184	5.97	48	6	54	148	6.59
13-15	0.28	40	9	49	350	2.53	33	6	39	170	4.82
15-16	0.47	47	7	54	350	4.19	67	3	70	177	6.85

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
16-17	1.52	167	10	177	220	13.78	134	5	139	260	13.71
16-26	1.09	133	12	145	177	12.19	132	2	134	187	12.22
17-18	0.14	15	7	22	41	8.00	18	7	25	37	8.13
19-20	0.8	71	2	73	186	11.12	94	2	96	194	9.93
20-21	0.27	28	0	28	158	5.23	37	1	38	137	5.55
21-22	0.51	48	3	51	218	6.83	63	3	66	163	8.02
22-23	0.47	46	3	49	309	4.73	59	3	62	170	7.29
23-24	1.09	96	4	100	280	10.33	125	3	128	225	11.12
Total Facility	**19.08**	**1884**	**104**	**1988**	**8114**	**6.80**	**2248**	**82**	**2330**	**6295**	**7.96**

(c) Weekday, Day

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.75	71	1	72	482	4.87	81	4	85	553	4.23
2-3	0.43	42	2	44	520	2.74	50	1	51	480	2.92
2-25	0.54	52	4	56	140	9.92	61	2	63	200	7.39
3-4	0.61	58	6	64	384	4.90	67	2	69	380	4.89
3-23	0.87	81	7	88	650	4.24	93	0	93	632	4.32
4-5	0.4	39	2	41	441	2.99	47	2	49	608	2.19
4-15	1.01	94	6	100	320	8.66	106	5	111	464	6.32
4-22	0.97	90	7	97	638	4.75	102	4	106	722	4.22
5-6	0.43	42	2	44	310	4.37	50	3	53	308	4.29
6-7	0.47	45	4	49	500	3.08	54	4	58	320	4.48
6-14	0.63	60	6	66	534	3.78	69	2	71	450	4.35
7-8	0.37	36	1	37	355	3.40	44	1	45	380	3.13
7-19	0.1	12	0	12	285	1.21	18	1	19	623	0.56
8-9	0.15	17	1	18	280	1.81	23	0	23	231	2.13
8-14	0.55	53	2	55	396	4.39	62	0	62	420	4.11
9-10	0.73	69	3	72	330	6.54	79	1	80	350	6.11
10-11	0.27	27	1	28	335	2.68	34	1	35	240	3.53
11-12	0.34	34	0	34	250	4.31	41	3	44	315	3.41
11-14	0.82	77	1	78	538	4.79	88	1	89	450	5.48
12-13	0.74	76	9	85	203	9.19	76	6	82	201	9.35
12-18	0.89	74	2	76	238	10.20	78	8	86	215	10.64
13-14	0.37	36	1	37	214	5.31	44	1	45	120	8.07
13-15	0.28	38	7	45	162	4.87	40	9	49	170	4.60
15-16	0.47	48	8	56	138	8.72	47	7	54	160	7.91
16-17	1.52	156	7	163	184	15.77	148	8	156	210	14.95
16-26	1.09	134	7	141	105	15.95	123	8	131	115	15.95
17-18	0.14	15	2	17	33	10.08	12	7	19	36	9.16

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
19-20	0.8	75	0	75	242	9.09	86	3	89	275	7.91
20-21	0.27	27	0	27	335	2.69	34	0	34	236	3.60
21-22	0.51	49	1	50	263	5.87	58	1	59	235	6.24
22-23	0.47	45	1	46	374	4.03	54	1	55	395	3.76
23-24	1.09	101	3	104	352	8.61	114	4	118	321	8.94
Total Facility	**19.08**	**1873**	**104**	**1977**	**10531**	**5.49**	**2083**	**100**	**2183**	**10815**	**5.28**
		Trial 3					Trial 4				
1-2	0.75	76	4	80	253	8.11	62	5	67	313	7.11
2-3	0.43	40	2	42	219	5.93	62	2	64	221	5.43
2-25	0.54	39	3	42	162	9.53	81	3	84	145	8.49
3-4	0.61	56	2	58	230	7.63	23	2	25	232	8.54
3-23	0.87	84	2	86	294	8.24	45	1	46	393	7.13
4-5	0.4	42	0	42	272	4.59	104	0	104	218	4.47
4-15	1.01	97	3	100	315	8.76	96	2	98	284	9.52
4-22	0.97	88	2	90	344	8.05	49	1	50	381	8.10
5-6	0.43	43	2	45	145	8.15	56	3	59	206	5.84
6-7	0.47	49	2	51	234	5.94	82	2	84	155	7.08
6-14	0.63	76	2	78	262	6.67	102	1	103	235	6.71
7-8	0.37	52	2	54	274	4.06	27	2	29	164	6.90
7-19	0.1	12	1	13	92	3.43	19	0	19	73	3.91
8-9	0.15	18	0	18	92	4.91	12	0	12	87	5.45
8-14	0.55	47	2	49	213	7.56	60	1	61	224	6.95
9-10	0.73	54	2	56	313	7.12	63	2	65	200	9.92
10-11	0.27	29	1	30	134	5.93	32	1	33	116	6.52
11-12	0.34	23	2	25	212	5.16	54	2	56	118	7.03
11-14	0.82	60	3	63	274	8.76	63	2	65	277	8.63
12-13	0.74	72	4	76	189	9.98	71	7	78	207	9.28
12-18	0.89	61	6	67	281	9.21	64	9	73	257	9.71
13-14	0.37	40	2	42	236	4.79	29	1	30	123	8.71
13-15	0.28	33	6	39	144	5.51	31	2	33	136	5.96
15-16	0.47	41	3	44	156	8.46	42	6	48	165	7.94
16-17	1.52	134	5	139	204	15.95	148	8	156	197	15.50
16-26	1.09	132	2	134	117	15.63	158	9	167	81	15.82
17-18	0.14	18	7	25	29	9.33	17	3	20	31	9.88
19-20	0.8	44	2	46	236	10.21	47	2	49	202	11.47
20-21	0.27	41	3	44	128	5.65	33	1	34	112	6.66
21-22	0.51	36	1	37	164	9.13	34	2	36	169	8.96
22-23	0.47	42	1	43	175	7.76	46	2	48	203	6.74
23-24	1.09	87	3	90	287	10.41	82	3	85	247	11.82
Total Facility	**19.08**	**1766**	**82**	**1848**	**6680**	**8.05**	**1894**	**87**	**1981**	**6172**	**8.42**
		Trial 5					Trial 6				
1-2	0.75	72	2	74	340	6.52	77	3	80	254	8.08
2-3	0.43	44	4	48	184	6.67	47	6	53	208	5.93
2-25	0.54	53	2	55	134	10.29	57	4	61	153	9.08

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
3-4	0.61	60	1	61	192	8.68	64	7	71	189	8.45
3-23	0.87	82	3	85	300	8.14	88	2	90	302	7.99
4-5	0.4	41	6	47	188	6.13	44	3	47	195	5.95
4-15	1.01	95	4	99	313	8.83	102	2	104	273	9.64
4-22	0.97	91	7	98	330	8.16	98	1	99	354	7.71
5-6	0.43	44	2	46	161	7.48	47	3	50	164	7.23
6-7	0.47	47	3	50	200	6.77	51	4	55	273	5.16
6-14	0.63	61	6	67	236	7.49	66	5	71	227	7.61
7-8	0.37	38	1	39	175	6.22	41	7	48	176	5.95
7-19	0.1	15	2	17	98	3.13	15	6	21	139	2.25
8-9	0.15	19	0	19	111	4.15	20	1	21	124	3.72
8-14	0.55	54	1	55	232	6.90	58	8	66	190	7.73
9-10	0.73	70	1	71	208	9.42	75	1	76	232	8.53
10-11	0.27	30	1	31	144	5.55	32	2	34	158	5.06
11-12	0.34	36	2	38	160	6.18	38	1	39	179	5.61
11-14	0.82	78	0	78	258	8.79	84	0	84	265	8.46
12-13	0.74	72	3	75	231	8.65	76	9	85	244	8.04
12-18	0.89	74	8	82	245	9.80	58	7	65	255	10.01
13-14	0.37	38	0	38	152	7.01	41	1	42	157	6.69
13-15	0.28	33	4	37	210	4.08	40	7	47	183	4.38
15-16	0.47	41	6	47	162	8.10	47	8	55	161	7.83
16-17	1.52	115	2	117	229	15.82	148	7	155	194	15.68
16-26	1.09	137	5	142	116	15.21	93	7	100	168	14.64
17-18	0.14	22	8	30	22	9.69	12	2	14	41	9.16
19-20	0.8	76	1	77	169	11.71	82	0	82	189	10.63
20-21	0.27	30	0	30	143	5.62	32	1	33	142	5.55
21-22	0.51	51	1	52	173	8.16	54	2	56	190	7.46
22-23	0.47	47	2	49	218	6.34	51	1	52	202	6.66
23-24	1.09	102	3	105	250	11.05	109	0	109	227	11.68
Total Facility	**19.08**	**1868**	**91**	**1959**	**6284**	**8.33**	**1947**	**118**	**2065**	**6408**	**8.10**
		Trial 7					Trial 8				
1-2	0.75	88	3	91	290	7.09	79	2	81	320	6.73
2-3	0.43	53	3	56	241	5.21	57	2	59	261	4.84
2-25	0.54	65	3	68	181	7.81	65	2	67	172	8.13
3-4	0.61	73	3	76	261	6.52	53	2	55	283	6.50
3-23	0.87	101	0	101	337	7.15	78	3	81	414	6.33
4-5	0.4	50	3	53	234	5.02	41	0	41	264	4.72
4-15	1.01	116	0	116	257	9.75	114	3	117	339	7.97
4-22	0.97	112	2	114	321	8.03	74	2	76	427	6.94
5-6	0.43	53	2	55	223	5.57	62	2	64	243	5.04
6-7	0.47	57	1	58	233	5.81	84	0	84	240	5.22
6-14	0.63	75	0	75	246	7.07	71	3	74	295	6.15
7-8	0.37	46	0	46	225	4.92	38	0	38	279	4.20
7-19	0.1	17	0	17	162	2.01	11	0	11	109	3.00
8-9	0.15	22	0	22	168	2.84	20	0	20	137	3.44

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
8-14	0.55	66	2	68	223	6.80	68	3	71	271	5.79
9-10	0.73	86	3	89	330	6.27	84	2	86	339	6.18
10-11	0.27	35	0	35	204	4.07	40	3	43	210	3.84
11-12	0.34	43	2	45	223	4.57	46	2	48	238	4.28
11-14	0.82	95	4	99	281	7.77	89	2	91	313	7.31
12-13	0.74	72	9	81	242	8.19	71	2	73	194	9.91
12-18	0.89	61	5	66	247	10.24	22	9	31	294	9.86
13-14	0.37	46	2	48	224	4.90	58	3	61	215	4.83
13-15	0.28	33	5	38	170	4.85	31	4	35	144	5.63
15-16	0.47	41	8	49	160	8.10	42	6	48	156	8.29
16-17	1.52	115	7	122	210	16.48	138	8	146	214	15.20
16-26	1.09	24	7	31	225	15.33	128	3	131	127	15.21
17-18	0.14	27	2	29	26	9.16	17	9	26	29	9.16
19-20	0.8	93	4	97	206	9.50	99	2	101	247	8.28
20-21	0.27	35	4	39	192	4.21	47	3	50	216	3.65
21-22	0.51	62	4	66	223	6.35	64	2	66	258	5.67
22-23	0.47	57	1	58	297	4.77	69	2	71	329	4.23
23-24	1.09	125	1	126	310	9.00	95	4	99	296	9.93
Total Facility	**19.08**	**2044**	**90**	**2134**	**7372**	**7.22**	**2055**	**90**	**2145**	**7873**	**6.85**
		Trial 9					Trial 10				
1-2	0.75	60	3	63	315	7.14	68	4	72	310	7.07
2-3	0.43	44	4	48	194	6.40	44	2	46	211	6.02
2-25	0.54	59	2	61	161	8.76	63	3	66	125	10.18
3-4	0.61	39	2	41	235	7.96	52	2	54	216	8.13
3-23	0.87	61	3	64	395	6.82	79	3	82	357	7.13
4-5	0.4	54	2	56	231	5.02	44	0	44	191	6.13
4-15	1.01	73	4	77	342	8.68	76	2	78	275	10.30
4-22	0.97	71	2	73	394	7.48	88	2	90	361	7.74
5-6	0.43	43	2	45	205	6.19	43	0	43	162	7.55
6-7	0.47	52	2	54	229	5.98	56	0	56	206	6.46
6-14	0.63	87	3	90	259	6.50	86	0	86	241	6.94
7-8	0.37	33	2	35	275	4.30	36	0	36	217	5.26
7-19	0.1	8	0	8	89	3.71	35	0	35	49	4.29
8-9	0.15	44	0	44	118	3.33	48	0	48	82	4.15
8-14	0.55	62	3	65	225	6.83	54	0	54	203	7.70
9-10	0.73	58	2	60	315	7.01	74	3	77	311	6.77
10-11	0.27	32	0	32	191	4.36	37	0	37	155	5.06
11-12	0.34	21	2	23	218	5.08	47	0	47	179	5.42
11-14	0.82	52	4	56	282	8.73	64	2	66	274	8.68
12-13	0.74	72	9	81	242	8.19	71	6	77	207	9.32
12-18	0.89	61	1	62	231	10.94	22	8	30	279	10.37
13-14	0.37	25	2	27	201	5.84	27	0	27	207	5.69
13-15	0.28	33	7	40	170	4.80	31	4	35	136	5.89
15-16	0.47	41	8	49	160	8.10	42	8	50	165	7.87
16-17	1.52	115	7	122	210	16.48	148	9	157	197	15.46

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
16-26	1.09	24	7	31	228	15.15	138	3	141	124	14.81
17-18	0.14	27	2	29	24	9.51	17	7	24	31	9.16
19-20	0.8	56	5	61	228	9.97	71	2	73	194	10.79
20-21	0.27	40	2	42	190	4.19	25	0	25	157	5.34
21-22	0.51	34	1	35	285	5.74	42	0	42	200	7.59
22-23	0.47	41	1	42	320	4.67	48	0	48	287	5.05
23-24	1.09	98	1	99	276	10.46	117	2	119	261	10.33
Total Facility	**19.08**	**1620**	**95**	**1715**	**7438**	**7.50**	**1893**	**72**	**1965**	**6570**	**8.05**

(d) Weekday, Night

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
1-2	0.75	102	1	103	325	6.31	90	4	94	303	6.80
2-3	0.43	64	8	72	268	4.55	54	2	56	258	4.93
2-25	0.54	77	3	80	135	9.04	67	3	70	153	8.72
3-4	0.61	85	4	89	211	7.32	75	4	79	206	7.71
3-23	0.87	116	2	118	259	8.31	104	1	105	343	6.99
4-5	0.4	60	7	67	384	3.19	51	0	51	396	3.22
4-15	1.01	133	3	136	125	13.93	120	2	122	234	10.21
4-22	0.97	128	2	130	276	8.60	115	3	118	273	8.93
5-6	0.43	64	2	66	127	8.02	54	1	55	177	6.67
6-7	0.47	68	3	71	205	6.13	59	2	61	193	6.66
6-14	0.63	88	4	92	264	6.37	77	1	78	278	6.37
7-8	0.37	56	2	58	217	4.84	48	3	51	260	4.28
7-19	0.1	24	6	30	103	2.71	17	0	17	124	2.55
8-9	0.15	30	7	37	220	2.10	23	4	27	204	2.34
8-14	0.55	78	3	81	153	8.46	68	3	71	207	7.12
9-10	0.73	100	6	106	230	7.82	88	2	90	259	7.53
10-11	0.27	44	7	51	187	4.08	36	4	40	215	3.81
11-12	0.34	53	5	58	203	4.69	44	1	45	359	3.03
11-14	0.82	110	2	112	273	7.67	98	0	98	293	7.55
12-13	0.74	76	9	85	290	7.06	72	4	76	269	7.67
12-18	0.89	64	9	73	337	7.81	78	8	86	321	7.87
13-14	0.37	56	2	58	358	3.20	48	1	49	143	6.94
13-15	0.28	38	7	45	232	3.64	33	6	39	178	4.65
15-16	0.47	48	8	56	196	6.71	67	3	70	187	6.58
16-17	1.52	156	7	163	264	12.81	134	5	139	274	13.25
16-26	1.09	134	7	141	188	11.93	132	2	134	197	11.85
17-18	0.14	15	2	17	48	7.75	18	7	25	39	7.88
19-20	0.8	108	4	112	233	8.35	96	1	97	244	8.45

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 1					Trial 2				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
20-21	0.27	44	0	44	223	3.64	36	0	36	199	4.14
21-22	0.51	73	1	74	150	8.20	63	2	65	175	7.65
22-23	0.47	68	1	69	319	4.36	59	1	60	325	4.39
23-24	1.09	143	1	144	319	8.48	129	1	130	349	8.19
Total Facility	**19.08**	**2503**	**135**	**2638**	**7322**	**6.89**	**2253**	**81**	**2334**	**7635**	**6.89**
		Trial 3					Trial 4				
1-2	0.75	72	2	74	213	9.41	52	3	55	234	9.34
2-3	0.43	45	2	47	229	5.61	31	2	33	177	7.37
2-25	0.54	47	1	48	118	11.71	40	1	41	116	12.38
3-4	0.61	58	2	60	216	7.96	44	2	46	188	9.38
3-23	0.87	86	3	89	294	8.18	58	3	61	283	9.10
4-5	0.4	43	4	47	195	5.95	33	1	34	171	7.02
4-15	1.01	97	2	99	207	11.88	67	2	69	210	13.03
4-22	0.97	90	2	92	332	8.24	64	4	68	295	9.62
5-6	0.43	43	2	45	164	7.41	34	7	41	167	7.44
6-7	0.47	48	2	50	179	7.39	37	6	43	154	8.59
6-14	0.63	71	3	74	222	7.66	46	1	47	204	9.04
7-8	0.37	47	0	47	219	5.01	32	9	41	153	6.87
7-19	0.1	13	0	13	75	4.09	10	8	18	65	4.34
8-9	0.15	18	0	18	88	5.09	18	4	22	84	5.09
8-14	0.55	51	0	51	220	7.31	40	3	43	189	8.53
9-10	0.73	64	0	64	251	8.34	50	2	52	213	9.92
10-11	0.27	31	0	31	123	6.31	25	1	26	115	6.89
11-12	0.34	32	1	33	181	5.72	30	0	30	195	5.44
11-14	0.82	73	1	74	230	9.71	55	0	55	220	10.73
12-13	0.74	72	9	81	339	6.30	76	9	85	330	6.38
12-18	0.89	74	8	82	331	7.76	22	9	31	412	7.23
13-14	0.37	39	1	40	210	5.33	31	1	32	159	6.97
13-15	0.28	33	5	38	238	3.65	40	7	47	247	3.43
15-16	0.47	41	8	49	224	6.20	47	8	55	217	6.22
16-17	1.52	115	7	122	294	13.15	148	7	155	262	13.12
16-26	1.09	24	7	31	315	11.34	93	7	100	227	12.00
17-18	0.14	27	2	29	37	7.64	12	2	14	55	7.30
19-20	0.8	65	0	65	187	11.43	54	0	54	224	10.36
20-21	0.27	33	1	34	144	5.46	25	0	25	113	7.04
21-22	0.51	45	1	46	132	10.31	38	7	45	148	9.51
22-23	0.47	50	1	51	220	6.24	37	4	41	300	4.96
23-24	1.09	99	2	101	300	9.79	71	1	72	374	8.80
Total Facility	**19.08**	**1746**	**79**	**1825**	**6727**	**8.03**	**1460**	**121**	**1581**	**6501**	**8.50**
		Trial 5					Trial 6				
1-2	0.75	74	1	75	210	9.47	52	2	54	218	9.93
2-3	0.43	56	4	60	169	6.76	36	1	37	165	7.66
2-25	0.54	69	2	71	113	10.57	44	7	51	103	12.62
3-4	0.61	78	3	81	189	8.13	40	4	44	157	10.93

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 5					Trial 6				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
3-23	0.87	107	6	113	253	8.56	55	1	56	240	10.58
4-5	0.4	67	1	68	183	5.74	37	3	40	245	5.05
4-15	1.01	97	2	99	212	11.69	64	6	70	217	12.67
4-22	0.97	106	2	108	255	9.62	61	1	62	246	11.34
5-6	0.43	91	7	98	140	6.50	36	2	38	124	9.56
6-7	0.47	51	1	52	167	7.73	40	4	44	161	8.25
6-14	0.63	94	2	96	185	8.07	55	1	56	183	9.49
7-8	0.37	78	2	80	175	5.22	31	2	33	149	7.32
7-19	0.1	50	1	51	79	2.77	14	3	17	70	4.14
8-9	0.15	43	3	46	111	3.44	26	4	30	79	4.95
8-14	0.55	33	2	35	178	9.30	45	1	46	154	9.90
9-10	0.73	73	1	74	206	9.39	50	1	51	213	9.95
10-11	0.27	34	0	34	133	5.82	27	0	27	114	6.89
11-12	0.34	36	0	36	145	6.76	26	0	26	162	6.51
11-14	0.82	81	0	81	205	10.32	51	0	51	205	11.53
12-13	0.74	76	6	82	286	7.19	71	7	78	327	6.53
12-18	0.89	61	6	67	444	6.27	74	2	76	338	7.74
13-14	0.37	54	0	54	135	7.05	28	0	28	226	5.24
13-15	0.28	40	9	49	242	3.46	31	2	33	215	4.06
15-16	0.47	47	7	54	228	6.00	42	6	48	261	5.48
16-17	1.52	148	8	156	298	12.05	148	8	156	311	11.72
16-26	1.09	123	8	131	184	12.46	158	9	167	158	12.07
17-18	0.14	12	7	19	52	7.10	17	3	20	49	7.30
19-20	0.8	75	2	77	168	11.76	52	1	53	186	12.05
20-21	0.27	38	0	38	137	5.55	29	0	29	112	6.89
21-22	0.51	51	3	54	171	8.16	36	0	36	161	9.32
22-23	0.47	69	4	73	233	5.53	36	2	38	184	7.62
23-24	1.09	89	1	90	320	9.57	74	3	77	368	8.82
Total Facility	**19.08**	**2201**	**101**	**2302**	**6206**	**8.07**	**1586**	**86**	**1672**	**6101**	**8.83**
		Trial 7					Trial 8				
1-2	0.75	65	1	66	241	8.79	69	3	72	217	9.34
2-3	0.43	59	7	66	174	6.45	32	5	37	203	6.45
2-25	0.54	73	4	77	122	9.77	44	6	50	117	11.64
3-4	0.61	81	3	84	186	8.13	45	4	49	241	7.57
3-23	0.87	109	6	115	243	8.75	80	8	88	349	7.17
4-5	0.4	70	3	73	173	5.85	46	1	47	176	6.46
4-15	1.01	85	6	91	212	12.00	87	7	94	207	12.08
4-22	0.97	102	9	111	263	9.34	93	2	95	335	8.12
5-6	0.43	98	7	105	150	6.07	54	1	55	152	7.48
6-7	0.47	52	1	53	152	8.25	52	4	56	203	6.53
6-14	0.63	97	7	104	186	7.82	50	6	56	223	8.13
7-8	0.37	85	1	86	149	5.67	43	7	50	198	5.37
7-19	0.1	58	4	62	78	2.57	18	6	24	58	4.39
8-9	0.15	50	3	53	111	3.29	25	0	25	113	3.91
8-14	0.55	38	2	40	162	9.80	88	0	88	196	6.97

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 7					Trial 8				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
9-10	0.73	71	1	72	213	9.22	116	0	116	311	6.15
10-11	0.27	37	4	41	140	5.37	44	7	51	147	4.91
11-12	0.34	42	0	42	158	6.12	55	9	64	156	5.56
11-14	0.82	81	0	81	198	10.58	140	0	140	237	7.83
12-13	0.74	71	6	77	290	7.21	72	9	81	331	6.42
12-18	0.89	22	8	30	391	7.61	61	1	62	342	7.93
13-14	0.37	25	0	25	160	7.20	60	2	62	185	5.39
13-15	0.28	31	4	35	190	4.48	33	7	40	231	3.72
15-16	0.47	42	8	50	231	6.02	41	8	49	224	6.20
16-17	1.52	148	9	157	275	12.67	115	7	122	294	13.15
16-26	1.09	138	3	141	174	12.46	24	7	31	319	11.21
17-18	0.14	17	7	24	43	7.52	27	2	29	34	8.00
19-20	0.8	78	0	78	183	11.03	127	3	130	170	9.60
20-21	0.27	37	0	37	114	6.44	44	2	46	162	4.67
21-22	0.51	53	1	54	126	10.20	82	1	83	196	6.58
22-23	0.47	81	2	83	140	7.59	76	4	80	333	4.10
23-24	1.09	83	0	83	315	9.86	173	2	175	273	8.76
Total Facility	**19.08**	**2179**	**117**	**2296**	**5943**	**8.33**	**2116**	**131**	**2247**	**6933**	**7.48**
		Trial 9					Trial 10				
1-2	0.75	62	4	66	233	9.03	71	4	75	189	10.23
2-3	0.43	38	1	39	170	7.41	45	1	46	148	7.98
2-25	0.54	45	4	49	135	10.57	52	7	59	158	8.96
3-4	0.61	47	2	49	188	9.27	60	6	66	143	10.51
3-23	0.87	70	3	73	255	9.55	83	3	86	226	10.04
4-5	0.4	42	7	49	160	6.89	52	1	53	225	5.18
4-15	1.01	78	4	82	211	12.41	74	4	78	251	11.05
4-22	0.97	77	1	78	254	10.52	87	2	89	220	11.30
5-6	0.43	44	4	48	137	8.37	45	3	48	109	9.86
6-7	0.47	46	2	48	155	8.33	37	6	43	125	10.07
6-14	0.63	57	3	60	175	9.65	63	7	70	149	10.36
7-8	0.37	40	1	41	129	7.84	32	1	33	128	8.27
7-19	0.1	18	2	20	35	6.55	12	2	14	79	3.87
8-9	0.15	25	1	26	70	5.63	15	1	16	73	6.07
8-14	0.55	59	2	61	153	9.25	50	2	52	129	10.94
9-10	0.73	73	1	74	241	8.34	64	3	67	223	9.06
10-11	0.27	35	2	37	89	7.71	29	1	30	115	6.70
11-12	0.34	38	4	42	134	6.95	35	4	39	135	7.03
11-14	0.82	83	0	83	236	9.25	76	1	77	186	11.22
12-13	0.74	71	2	73	291	7.27	72	3	75	344	6.32
12-18	0.89	58	7	65	398	6.92	61	5	66	371	7.33
13-14	0.37	42	2	44	162	6.47	25	0	25	173	6.73
13-15	0.28	31	4	35	216	4.02	33	4	37	260	3.39
15-16	0.47	42	6	48	234	6.00	41	6	47	228	6.15
16-17	1.52	138	8	146	321	11.72	133	7	140	285	12.88
16-26	1.09	128	3	131	191	12.19	137	5	142	210	11.15

(Table H.11 continued)

Segment Label	Segment Length (km)	Trial 9					Trial 10				
		Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)	Time in motion (s)	Segment delay (s)	Running time (s)	Through vehicle delay (s)	Average travel speed (km/h)
17-18	0.14	17	9	26	44	7.20	22	8	30	48	6.46
19-20	0.8	77	4	81	155	12.20	66	0	66	205	10.63
20-21	0.27	36	1	37	97	7.25	30	1	31	97	7.59
21-22	0.51	53	4	57	150	8.87	51	4	55	127	10.09
22-23	0.47	53	2	55	186	7.02	48	7	55	208	6.43
23-24	1.09	108	2	110	263	10.52	94	0	94	253	11.31
Total Facility	**19.08**	**1831**	**102**	**1933**	**5868**	**8.80**	**1795**	**109**	**1904**	**5820**	**8.89**

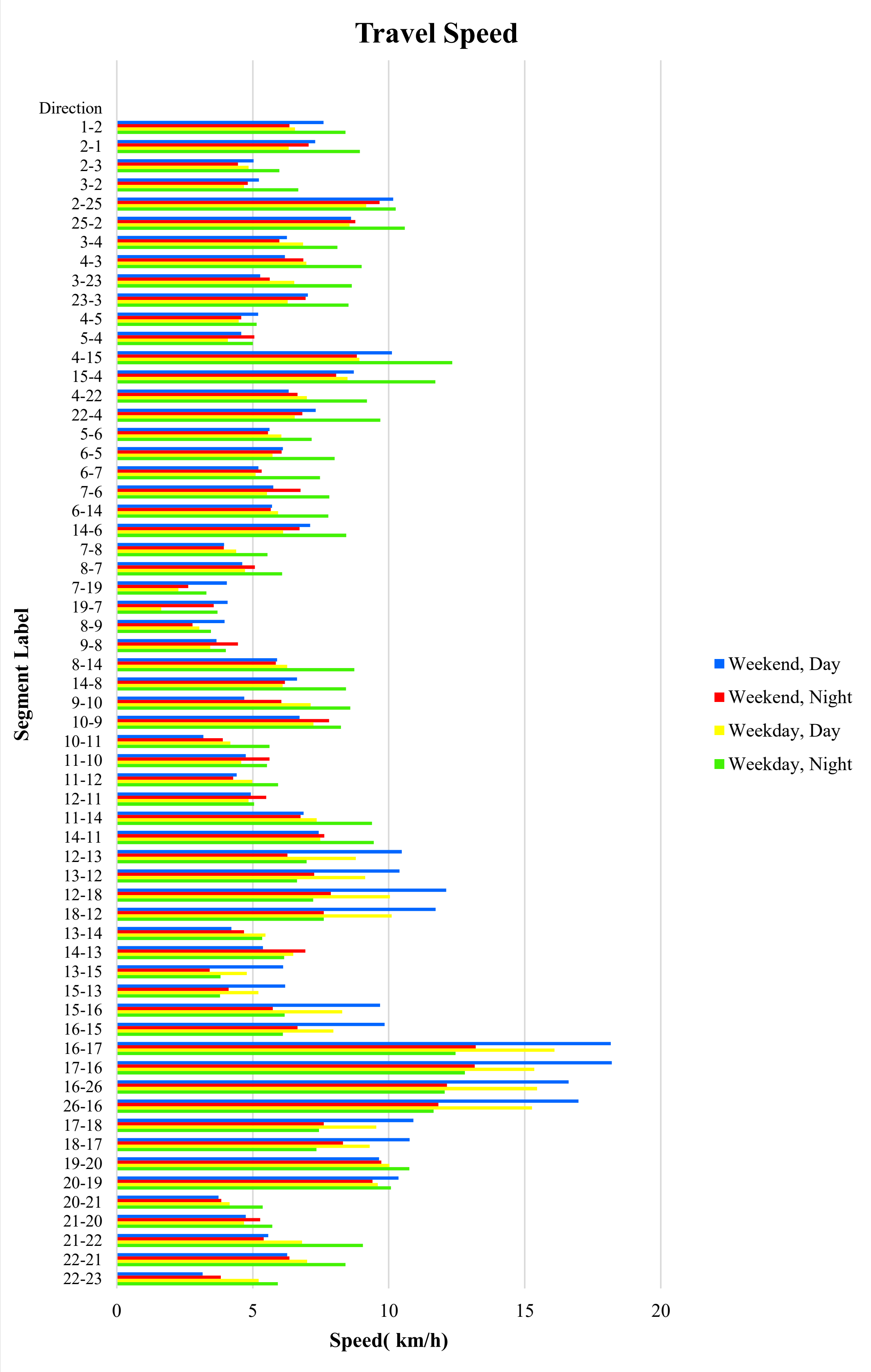


Figure H.5: Observed Travel Speed at MMF