A THESIS ON
EFFECTIVENESS OF PEDESTRIAN OVERPASSES IN METROPOLITAN DHAKA

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ABSTRACT

A study has been made on the effectiveness of pedestrian Overpasses in the Dhaka Metropolitan area. On this aspect, the pedestrian overpasses at Farmgate and at Zia-International Airport were investigated. This research includes both the field investigations and data analyses. The field investigation includes site surveys, pedestrian volume counts, pedestrian interviews at each of the overpasses.

Based on the collected data, the selected pedestrian overpasses are analysed to evaluate the effectiveness in terms of their usage. The percentage of pedestrian using overpass, zebra crossing and violators were determined. At Farmgate, it was found that about 50 percent are using the overpass, 37 percent using the zebra crossing and the remaining 13 percent are crossing illegally. At Zia-International Airport, about 53 percent are using overpass and the remaining 47 percent are crossing illegally. The pedestrian interview data were collected and analysed to find out the causes of not-using the existing overpasses. Some of the reasons for not-using the overpasses were difficult to climb-up (23%), overpass were too high (22%), and too far from the pedestrian travel route (17%). These data were also analysed to see the pedestrian distribution for different causes like pedestrian preference, occupation, age group etc.

The actual peak hour volume was compared with the design capacity for the present and the future conditions. It was found that at Farmgate, the facility would experience sporadic and unstable condition after 20 years.

Due to limitations of time, it is not possible to focus on all aspects of pedestrian travel in detail. In order to get a more detailed and comprehensive results, a long term pedestrian research programme may be contemplated in the future.

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CHAPTER - I

INTRODUCTION

1.1 GENERAL

Many Asian Cities have made available only 5 to 10% of their urban area for transportation facilities, as against 20 to 30% of the urban land space in the Western Cities (Abraham, 1974). Under this situation, there is inadequate transportation facilities for both vehicular traffic and pedestrian traffic. As a result, the vehicular traffic have had to force their way through narrow, unpaved streets, crowded with bi-cycles, horse drawn carts etc. As such the pedestrian traffic have to face different types of difficulties during their movement.

In context of Bangladesh, pedestrians form the largest single road user group. This is primarily because of lack of sufficient transportation facilities and poor economic condition of the people. The increasing trend of population due to population growth and urbanization tend to generate additional pedestrian volume and hence the pedestrian problems associated with their movement.

In an uncontrolled traffic area, as observed, pedestrians try to cross the roadway across the pavement surface hapazardly. This sort of movement can be reduced to some extent with the provision of pedestrian facilities such as Zebra crossing, pedestrian overpass, pedestrian subways etc. The regulation and control of pedestrian is an important factor that must be considered in the context of overall urban transportation planning and management process.

Out of these different pedestrian facilities that are available in our country, pedestrian overpasses are important devices because they provide clear separation of pedestrians confrontation with vehicular traffic. The primary aims of an overpass are :

(i) to separate pedestrian movement

(ii) to minimize conflicts and hence has the potential to reduce accidents.

(iii) to reduce any delay and hazards to both the vehicular and pedestrian traffic.

As such properly planned, designed and operation of pedestrian overpasses may contribute towards better operation of traffic and thereby enhance road safety.

1.2 THE NEED FOR RESEARCH

Being physically unprotected, pedestrians are very vulnerable group. A large portion of the pedestrian community is either young or elderly each of which have specific problems associated with their respective age group.

These problems involve either the lack of fully developed faculties or a reduction in optimum faculties due to the ageing process (Moses, 1988).

Accident type analysis of 4514 road accidents over three and half years (January, 1977 to June, 1980) has been made in the Dhaka Metropolitan area, it was found that the pedestrian involved accidents constitute the largest category of accidents type accounting for about 17 percent (747 accidents) of the total. The second highest category was rear-end accidents at mid-

blocks accounted for approximately 14 percent (647 accidents) (Hoque, 1981). The areawise pedestrian accidents distribution disclosed that higher percentage occured where pedestrian facilities are seriously lacking as shown in Table 1.1. (Hoque, 1981).

From Table 1.2, it is evident that the pedestrian accident while crossing the roads is the greatest problem. This had clearly indicated that the problem is associated with ignorance of rights of pedestrians as well as the lack of road sense of the road users. It was also observed that pedestrian crosswalks are lacking at locations where these are urgently needed (near Kawran bazar for instance) because of extensive pedestrain movements. This had necessitated to study the behavious of drivers and pedestrians to assess their attitudes towards development of effective measures for the safe movements with least interference (Hoque, 1981). This also shows that about 59% of pedestrian accidents occur while crossing the roads.

Examination of all pedestrian accidents by hour of day disclosed two district peaks during 8 A.M. to 10 A.M. with a later peak during 4 P.M. to 8 P.M. The result is shown in Fig. 1.1. This showed a little early peak hour to pedestrian accidents in morning compared to that of all accidents. This is primarily due to the reason of greater pedestrian activities at these hours particularly for the generation of trips to schools, markets as well as to work (Hoque, 1981).

The above findings and statements indicate that pedestrians accident problems are the greatest problem in Dhaka Metropolitan area. Particularly in urban areas, the pedestrians present an element of sharp conflict with vehicular traffic resulting in high accident rates and traffic delay.

The pedestrian movement and characteristic therefore, need to be well studied. This task is not so simple and need considerable research investigations towards development of effective devices for the mobility and safety of pedestrians. To this end study of the specific devices will provide knowledge about the status of their usage.

Table - 1.1 Pedestrian Accidents (Police stationwise) in Dhaka Metropolitan area.

(Source : Hoque, Traffic Accidents in Dhaka, 1981)

Police Station	Total Accidents (all types)	Pedestrian Accidents	Percentage
Tejgaon	899	147	16.35
Ramna	957	107	11.18
Motijheel	573	77	13.43
Dhanmondi	476	39	8.19
Mohammadpur	359	72	20.06
Mirpur	212	64	30.18
Gulshan	261	45	17.24
Cantonment	136	24	17.65
Demra	345	91	26.38
Sutrapur	118	45	38.13
Kotwali	88	19	21.59
Lalbagh	90	17	18.88

Table 1.2 Types of Pedestrian Collisions

Type	Fatal	Injury	Properly damage only	Total	%
Near side	74	254	13	341	45.65
Walking with Traffic	53	144	7	204	27.31
Playing, working standing on carriage way	24	71	0	95	12.72
Far side	27	61	6	94	12.60
Emerging	1	5	0	6	0.80
On Footpath	0	5	0	5	0.66
Facing Traffic	0	2	0	2	0.26
Total	179	542	26	747	100.00

(Source : Hoque, Traffic Accidents in Dhaka, 1981)

Legend : Vehicle

Pedestrian

Parked Vehicle

1.3 THE STUDY SITES

In the Dhaka Metropolitan area the pedestrian movement is seen hazardous. This hazard to some extent aggravates due to inadequate and improper management of the existing facilities that have been provided. Lack of willingness of the pedestrian to use these facilities may be one of the major factors.

There are four overpasses in Metropolitan Dhaka. these are :-

(i) on Nawabpur road, near Dhaka Zilla Parishad

(ii) on Mirpur road, near New Market

(iii) on Airport road, near Farmgate and

(iv) on Airport road, near Zia International Airport.

In this study, out of the above four overpasses, two overpass have been selected for detailed investigations. There are :

(i) on Airport road, near Farmgate and

(ii) on Airport road, near Zia International Airport.

The location of these overpasses are shown in Figure - 3.1. Their site survey maps are also shown in Fig. 4.1 and Fig. 4.3 respectively.

1.4 STUDY OUTLINE

Field investigations and analysis of relevant data are the major task of this research. The overall task of the study involves the following important phases :

A. Survey phase. This includes the following steps :

(i) Preliminary survey of the area where the overpasses are located.

(ii) Measurements of the geometric characteristics such as length, width and height of the overpasses.

(iii) Preliminary observation of the area before data collection phase.

B. Data collection phase. This includes the following steps :

(i) Pedestrian volume counts on each of the overpasses, in the adjacent Zebra Crossings and their adjacent areas at different periods.

(ii) Pedestrian interview data regarding their charactistics openions at each of the locations.

C. Analysis phase. This includes :

(i) Analysis of the collected data for different purposes.

(ii) Comparing the capacity of the existing overpasses with the present pedestrian flow.

D. Evaluation phase

To determine the effectiveness of these overpasses in terms of their usage.

CHAPTER - 2

THE PEDESTRIAN TRAFFIC

2.1 INTRODUCTION

This chapter deals with the general understanding of the pedestrian traffic. Different sources of pedestrain traffic and their increasing trend are reviewed.

2.2 DEFINITION OF PEDESTRAIN

Pedestrain may be defined as those human traffic who are supposed to walk as a part of their movement and to use those facilities such as overpass, zebra crossing, subways, footpath etc. at any stage of their travel in order to accomplish their activities with which they are engaged in. They are single road user and physically unprotected.

2.3 PEDESTRIAN TRAFFIC GENERATION

The population especially inthe urban sector is exploding at an unprecented scale in the Asia Region. While the population growth in the developed countries is in the range 0 to 1 percent per annum, the corresponding figures in the developing countries are 2 to 3 percent.

Table 2.1 shows population data for Bangladesh and Dhaka. It is found that the average population growth rate of the nation is approximately 2.5 percent. The corresponding average population growth rate in metropolitan Dhaka is about 7.8 percent(Ahsan,1990).

From this data it can be considered that with this high rate of urban population growth, pedestrian traffic will continue to increase possibly in the same rate.

Urban migration is another cause of such higher rate of pedestrian traffic generation. In urban areas, since there are increasing opportunities for people, better employment and education opportunities, better health programme, higher income etc., people migrate from rural areas to urban areas to satisfy their needs.

Table 2.1 GROWTH OF POPULATION IN METROPOLITAN DHAKA

YEAR YEAR	POPULATION OF BANGLADESH (MILLIONS)	URBAN POPULATION (%)	POPULATION OF METROPO-LITAN DHAKA (% OF U.POP)	POPULATION OF METROPOLITAN DHAKA (MILLIONS)	ANNUAL GROWTH RATE(%)
1951	44.166	4.34	14.03	0.269	-
1961	55.223	5.19	15.56	0.446	5.18
1965	-	-	-	0.561	5.88
1974	76.398	8.78	20.04	1.344	10.20
1978	-	-	-	2.163	12.60
1981	89.912	15.67	19.50	2.747	8.30
1986	102.860	18.40	18.92	3.580	5.44
1988	107.756	20.00	22.23	4.790	15.67
2000	139.690	27.00	20.10	7.580	3.90
2025	-	-	-	15.000	2.77
				Average	7.77

Source : Hasib M. Ahsan (1990) "A Study of Mass transit in Metropolitan Dhaka.

2.4 PEDESTRIAN TRAVEL CHARACTERISTICS

The movement of people and goods are linked with distribution and intensity of land use. People do not of course move about the roads for nothing. People move because of activities with which they are engaged in. As such pedestrian is, therefore, a function of activities. They are concentrated in town because activities are concentrated there. The more the pedestrians, the more they travel, the more is the pedestrian trips that constitute a significant portion of total trips.

It is desirable to study the pedestrian travel patterns and attitudes, and recognise them in the design of pedestrian facilities. Some of the features of pedestrian travel are as below : (Victor, 1979).

(a) Transit stop to work place/shop building or parking space to building trips are more important than trips between buildings.

(b) Pedestrian travel is localised and is highly concentrated in industrial and commercial areas.

(c) Pedestrian trip purposes vary by location and time of day.

(d) Pedestrains tend to keep walking distance as short as possible.

(e) The number of people walking for recreation or pleasure in major activity centres is less than those for other purposes.

(f) Pedestrian speeds on level ground varies considerably from 0.8m to 2.5m/sec. in cross walks and to about 1.3 m/sec. on side walks.

(g) Pedestrian speeds decrease as grade rise,from about 1.4 m/sec. on level ground to about 1.0m/sec. at 10 percent grade and to about 0.8m/sec. at 15 percent grade.

(h) Pedestrian capacities and space requirements depend on the acceptable degree of crowding.

An understanding of the various purposes of the trips can facilitate the effective design of the pedestrian facilities.

2.5 PEDESTRIAN ACCESSIBILITY

Accessibility : i.e., the case (in terms of time, comfort, safety and cost) of getting to the activities desired, is what transport planning is about. Yet, few studies have been made often. Pedestrian accessibility is only a part of it. Most of the major transportation studies have ignored trips on foot or by pedal cycle; they saw no importance in them, nor their relevance to the big transport issues. (Victor, 1979).

Nevertheless, it is obvious that the proportion of trips made on foot or bicycle is much higher in Dhaka Metropolitan area than others. People often walk, not because they want to but because they can ill afford the fares on buses or trams which are too crowded and slow. Even in European and American Cities, there are people who walk in order to save the fare or because public transport is inadequate. Therefore, in all cities, it is difficult to interpret the significance of pedestrian volumes.

2.6 PEDESTRIAN SAFETY

The road safety problem seems to be a growing national problem in Bangladesh. In developing countries in 1974, it was estimated that there were over 1,00,000 peoples killed and 15,00,000 injured in road accidents. This appeared to be worsening situation compared to that in Western Europe and North America. The annual figure of road accident fatalities in Bangladesh exceeds 744 in 1979, while that for Dhaka Metropolitan area was 136 in 1980. Recent study of road accidents in Dhaka has indicated that the total accidents rose by 19 percent per annum while the fatalities and injures increased by 31 percent and 32 percent respectively every year. The pedestrians account for 56 percent of the traffic fatalities (Hoque, 1981). By way of comparison the corresponding figure in India was 50-55 percent. It is therefore, important in our context to examine the pedestrian accident situation and the road user behaviour for their safety.

2.7 AN OVERVIEW

The above articles in this chapter pinpoint the various aspects regarding pedestrian traffic, the pedestrian sources and movement. These also showed that the population growth and urbanization are the primary sources of pedestrian traffic generation. These problems are analysed in the following chapter.

CHAPTER - 3

THE PEDESTRIAN FACILITIES

3.1 INTRODUCTION

This chapter discusses the general types of pedestrian facilities as described below. Also discusses those facilities available in Dhaka City. To identify the different existing facilities in Dhaka city a survey was carried out throughout the area and facilities such as major intersection, signals for exclusive pedestrian crossing and overpasses are located in the map as shown in Figure 3.1.

3.2 GENERAL FACILITIES

The various types of pedestrian facilities that have already been practiced throughout the world is basically to ensure safety and comfort for the pedestrians. These facilities may be classified into three major groups, depending on whether or not pedestrian and vehicles are separated. (Victor, 1979). These are discussed below :

3.2.1 Integrated System

These are currently adopted system with side walk provided parallel with the carriageway and cross walks provided at intervals. These are :

(i) Zebra Crossing
(ii) Signalized Zebra Crossings
(iii) Side Walks and
(iv) Islands.

3.2.2 Horizontal Separation system

These are systems located away from the vehicle network and accommodate pedestrian movement along pathways that are independent of vehicular paths. these include :-

(i) Widened sidewalks
(ii) Full Malls
(iii) Auto free Zones and
(iv) Displaced Grids.

3.2.3 Vertical Separation Systems

Vertical separation system is perhaps the most efficient in pedestrian systems. The three primary elements of vertical separation are :-

(i) Underground
(ii) Elevated and
(iii) At-grade systems.

In this system, conflicts with other road users are eliminated.

In the underground systems the vehicular movement is above and the pedestrain movement is below in tunnels or underground concourses. Pedestrian subways can be constructed by cut-and-cover method, by tunnelling, which is prohibitively expensive and not often required for pedestrian subways. The advantages of underground systems include : complete elimination of conflicts with vehicles; built-in protection from sun and inclement weather; least disturbance to normal city-scape; and provision of direct linkage

to existing underground systems and major activity centres. The disadvantage are : high cost of construction; need for changes in grade and numerous entry points; loss of visual contact with the city surroundings; and potential security problems. It is seen that the subways have been vary successful, attracting nearly 99 percent of the pedestrains wishing to cross the road (Victor, 1979).

In the elevated systems the pedestrain movement is above and the vehicular movement is below, at grade level. There are a wide variety of pedestrain overpass, which require segregated right-of-way for pedestrians and may be supported independently or attahced to or made integral with buildings abutting the roadway. The advantages of pedestrain overpass include; elimination of conflicts with vehicles direct and convenient connections to activity centres, elevated visual vantage point for the pedestrian and improved vehicular circulation by avoiding pedestrians at the vehicle level. The dis-advantages are : high cost of construction; need for many changes in grade and entry points; need for co-ordination with property owners, possible security problems; and difficult emergency operation (Victor, 1979).

3.3 TYPES OF PEDESTRIAN FACILITIES IN DHAKA CITY

In developing country like Bangladesh, where the overall economic condition of the nation is poor, the allocation of resources

for pedestrian facilities has been far short of the desirable level. Fortunately, there is now a growing awareness of the need for adequate pedestrian facilities. this can be seen from the increasing number of Zebra crossing, signalized zebra crossing, and overpass in Dhaka Metropolitan City.

Figure 3.1 represents some of the different types of facilities available in Dhaka City. these are discussed in the following sections.

3.3.1 Controlled Intersection for Pedestrians and Vehicles

There are 69 major inter-sections, till now, in Dhaka City. Out of these, 40 intersections are signal controlled, 14 are controlled by round about and remaining are controlled by traffic police (Alam, 1989). These controlled systems are installed to provide facilities for vehicular traffic and as well as for pedestrian traffic.

3.3.2 Signals for Exclusive Pedestrian Crossing

There are only 5-traffic signals which are mainly installed to function exclusively for the pedestrian traffic. These signals are generally located away from the intersections and at places where pedestrian volume are considerable. These signals are more safe than major intersections. This is because when pedestrian traffic used to cross the roadway across the road, all vehicular traffic remain standing till the cycle is completed.

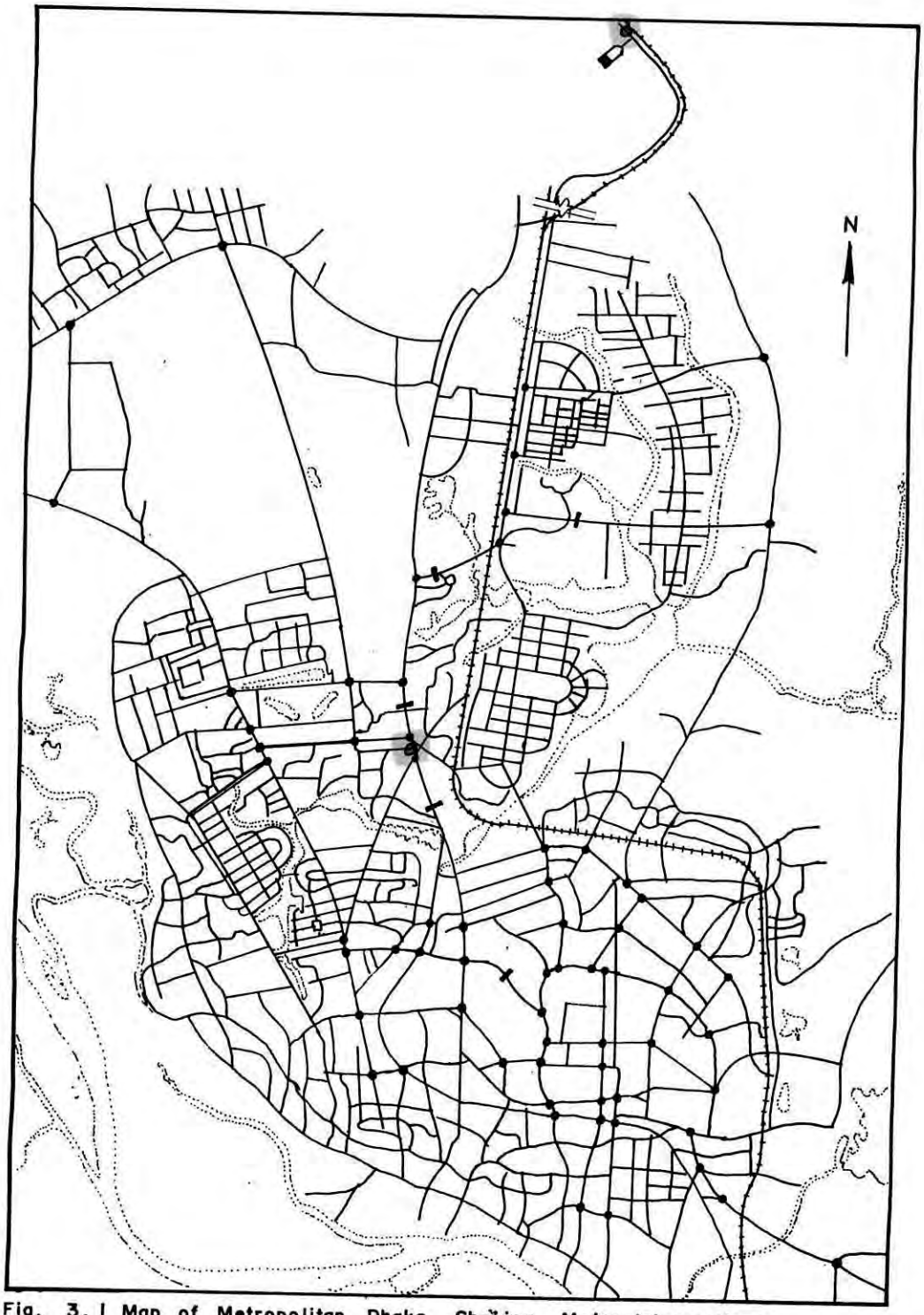


Fig. 3. 1 Map of Metropolitan Dhaka Showing Major Intersections.

- • Major Intersections.
- I Signal for Exclusive Pedestrian Crossing.
- ⊙ Study Area.

3.3.3 School Crossing

There are some Zebra-crossings found in Metropolitan Dhaka City adjacent to the schools. These are primary installed mainly for the safety of School childrens, e.g. Farmgate Zebra crossing adjacent to Holicross School and Polytechnique Girls High School; Zebra crossing adjacent to Dhanmondi High School etc. etc. Pedestrain movement in such crossings are highest during the begining and end of School and Colleges.

3.3.4 Pedestrain Overpasses

These are the vertical separation system for pedestrian movement. This provides less conflicts with other road users. There are only 4-number of pedestrian overpasses in Dhaka City. These are :

(i) Overpass at Farmgate
(ii) Overpass at New Market
(iii) Overpass at Nawabpur Road
(iv) Overpass at Zia-International Airport.

Out of these four-overpasses, overpass at Farmgate and overpass at Zia-International Airport have been take into consideration for our study. Their location,orientation and detailed description are included in the following chapter.

3.4 OVERVIEW

This chapter reviewed the general types of pedestrian facilities available in general and those available in the Dhaka Metropolitan area. In particular is described the different facilities with their location in the map of Dhaka City. It is observed that all types of pedestrain facilities,as available in other countries are not available in Dhaka City. Those which are available are inadequate in number and not well operated and well maintained.

CHAPTER - 4

SITE SURVEY AND PEDESTRIAN DATA COLLECTION

4.1 INTRODUCTION

This chapter deals with the site survey and collection of pedestrian data necessary for the study. The site survey shows the location of overpass including its adjacent area. The pedestrian data is necessary to find out the pedestrian volume at different hours. These data are then used for analysis.

4.2 SITE SURVEY

Site survey is an important component of planning process in order to understand the existing conditions. It reflects the existing areas around the overpass under study and help to know the different sources of pedestrian e.g. the aresidential area, Schools, Colleges, Shopping areas, Hospital, the roadway system etc. etc. Two different survey was carried out for this purposes.

4.2.1 Site Survey for Farmgate Overpass

Figure 4.1 shows the location and configuration of overpass at Farmgate with its dimensions, the roadway system around it, the location of Hospital, School,College, Cinema Hall, Shoping areas, parks, and other permanent structures, and existing Zebra crossing. The main activity areas are the Nakhalpara residential area, Holicross College and School, Tejgaon Polytechnique Govt. Girls School, Hospital, the Super Market, Kalabagan residential area, Kathal bagan

LOCATION OF FARMGATE OVERPASS

LENGTH = 100'-0"
WIDTH = 10'-0"
HIGHT = 20'-0"

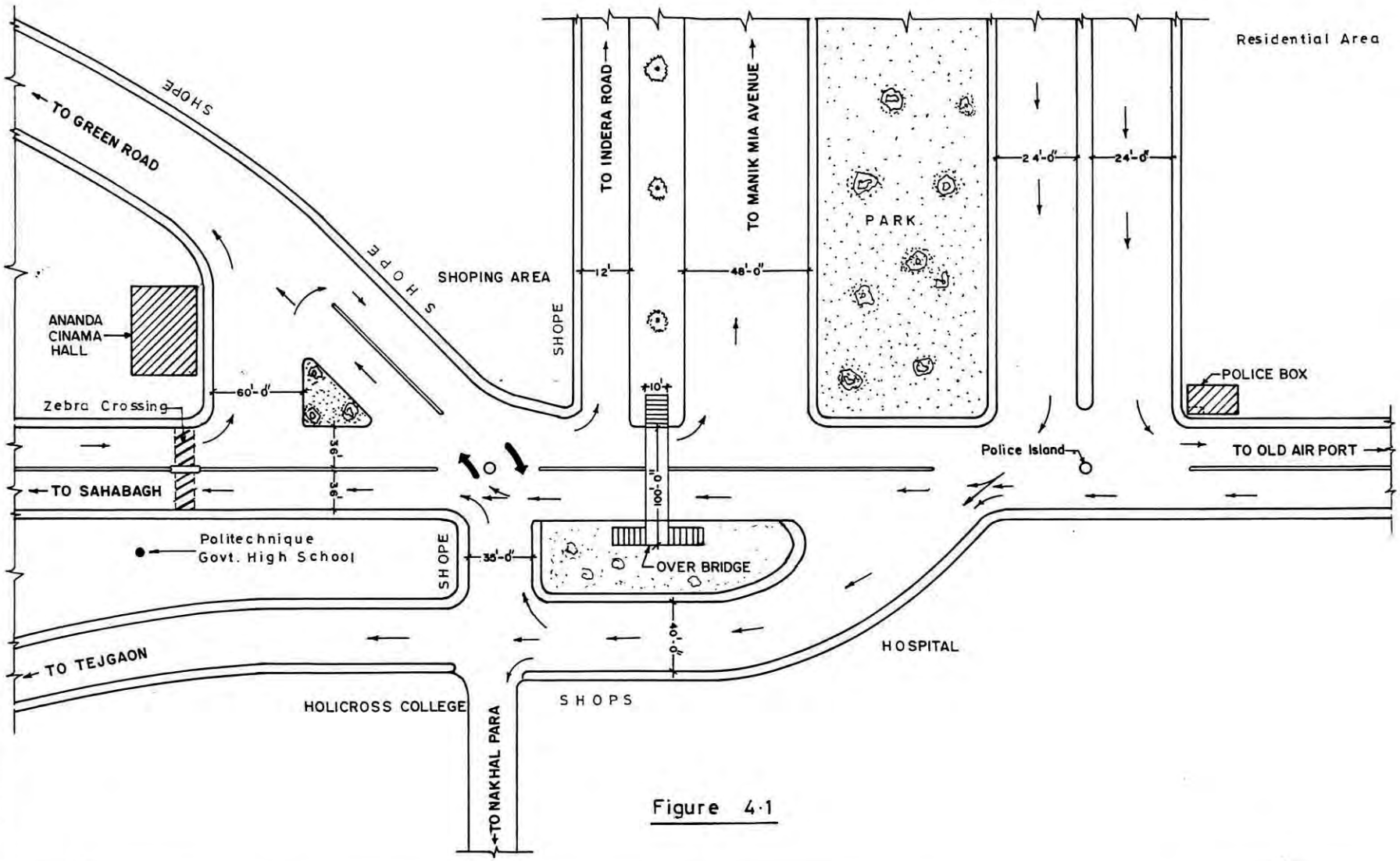
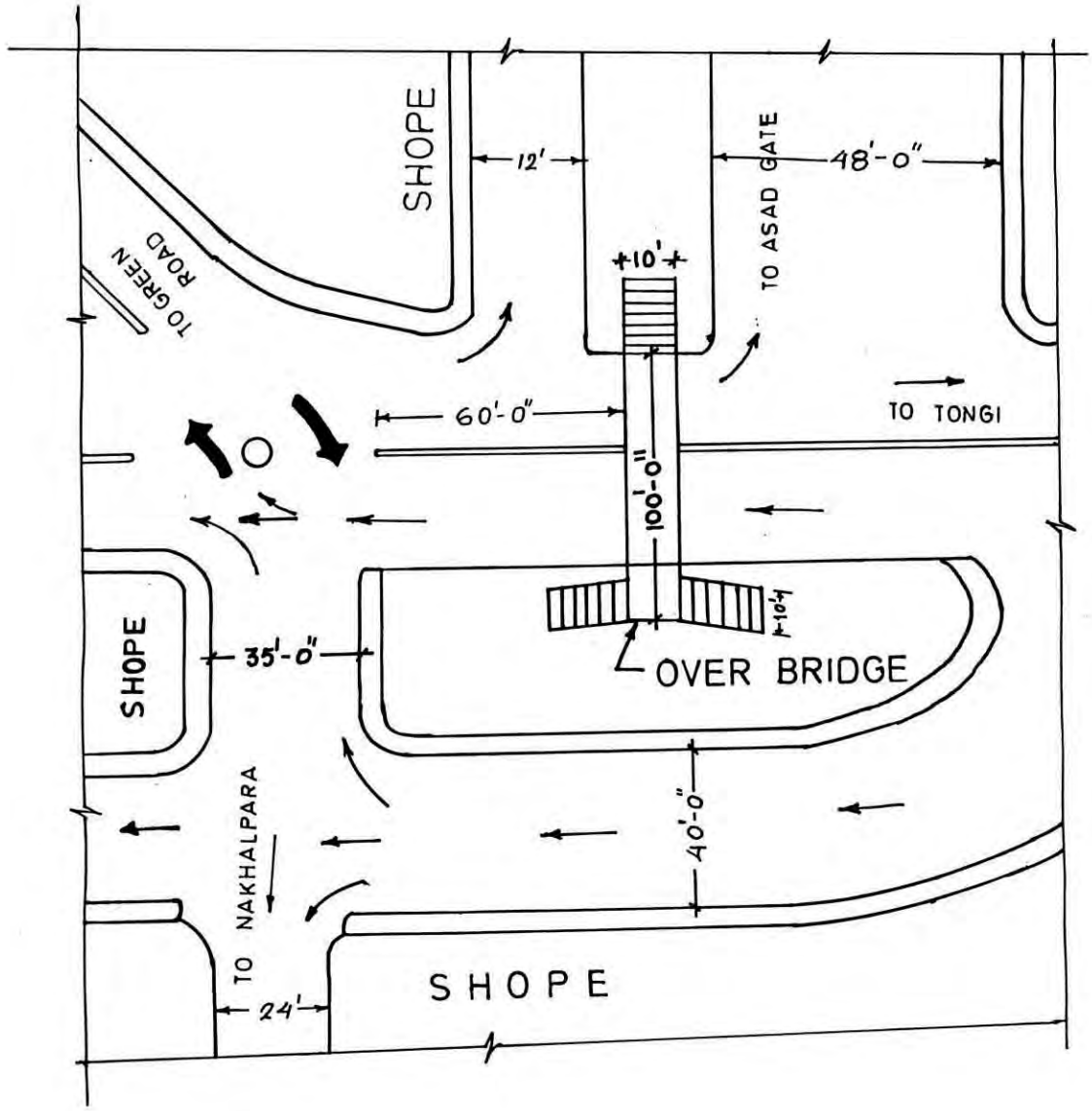


Figure 4·1



FIGARE – 4.2

VIOLATORS

ENLARGED VIEW OF OVER PASS AT FARMGATE

residential area, Indira road residential area and the Cinema hall. A considerable number of temporary shops are found on this overpass which occupy nearly half of the bridge width. In excess of these there are also hawkers and baggerman on this bridge working on it.

4.2.2. Site Survey for Zia-International Airport Overpass

Figure 4.3 represents the Zia-International Airport overpass and its surrounding areas. This is a newly constructed overpass under Roads and Highways Department. Within one Kilometer radius of this overpass, there is no residential area except some Government Staff Quarter. So the pedestrian volume is less here.

4.3 DATA COLLECTION

The pedestrian data is essential to determine the effectiveness of the overpasses. Different data tables has been prepared for two overpasses. Their construction cost data also collected from the concerned authority.

4.3.1 Data Collection for Overpass at Farmgate

4.3.1.1 Cost Data

This overpass was constructed under the authority of Roads and Highways Department in the year 1977, as reported from the concerned office. No feasibility reports is available there. Its construction cost was approximately 950,000.00

(Nine lacs and fifty thousands) taka only. then after construction, it is handed over to Dhaka Municipal Corporation.

4.3.1.2 Pedestrian Data

Pedestrian data for overpass as well as for Zebra crossing has been collected as shown in the following chapter in Table 5-1 and 5.2. Pedestrian data for violators are also shown in Table 5.1. A team of 7 persons was engaged to count pedestrian volume in each direction of flow for different time period. The pedestrian volume data were gathered by age, sex, occupation etc.

4.3.2 Data collection for overpass at Zia International Airport

4.3.2.1 Cost data

This overpass was constructed under the authority of Roads and Highways Department in the year 1989. This was constructed by the order of Hon'ble President and so no feasibility report was prepared. As reported from the concerned office, the project estimated cost was 24,54,600.00 (Twenty four lacs, fifty four thousand and six hundred) taka only. Its maintenance and operation is still under the same Department.

LOCATION OF NEWAIRPORT OVERPASS

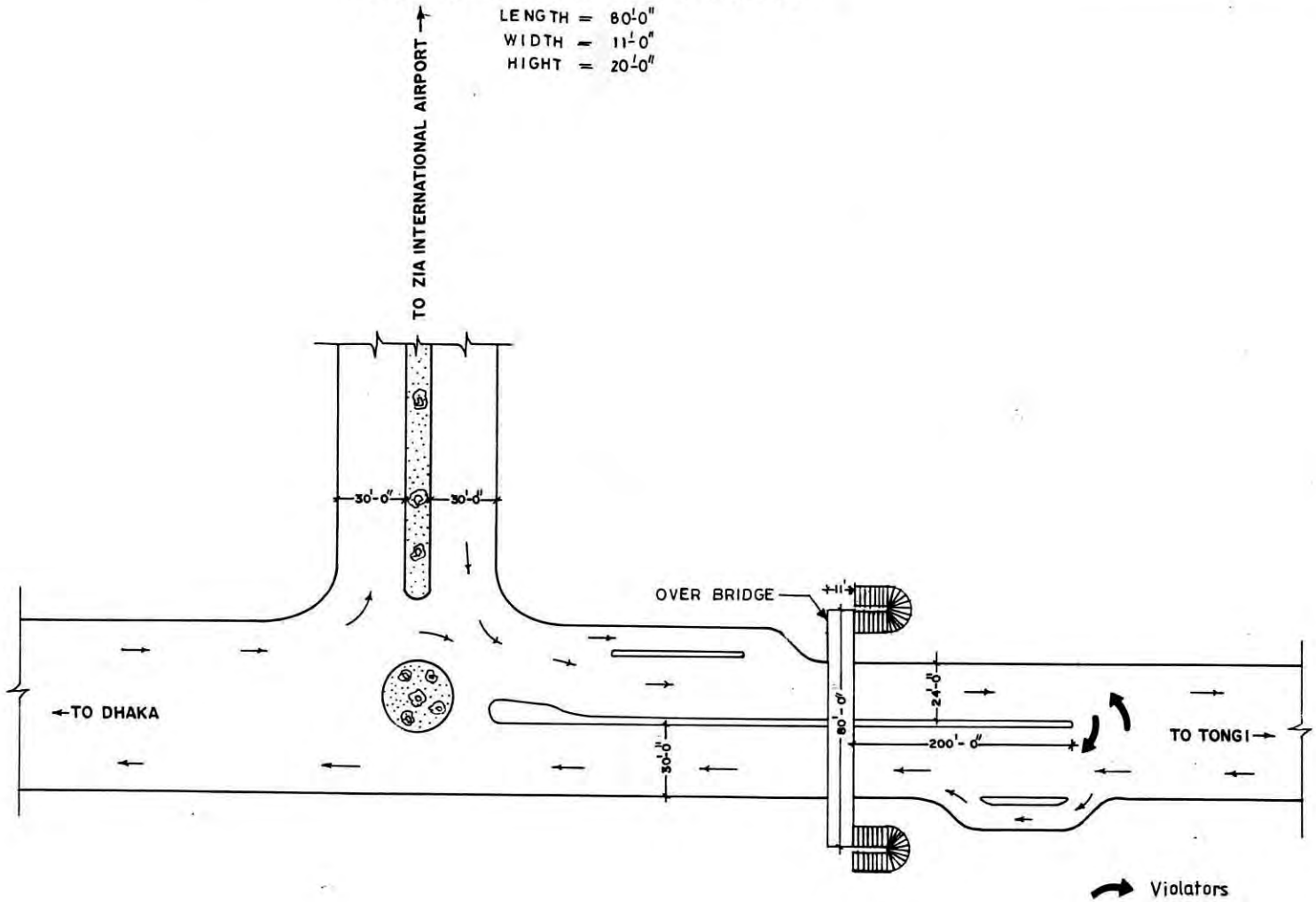


Figure 4.3

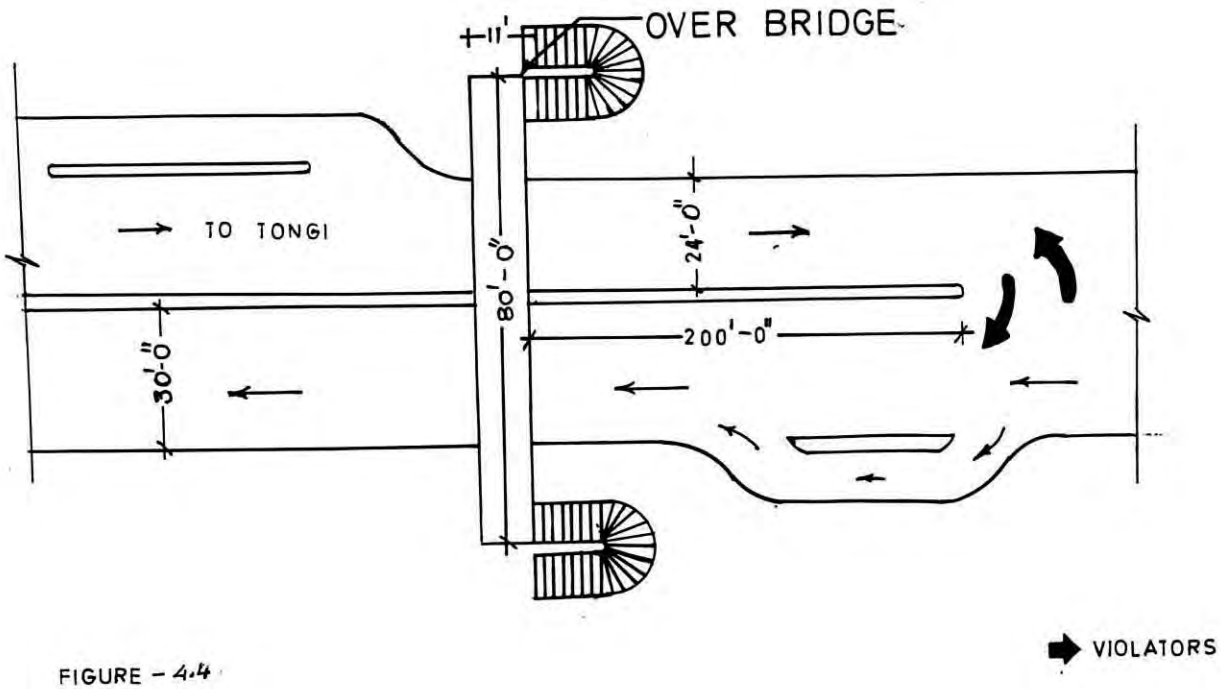


FIGURE - 4.4

ENLARGED VIEW OF OVER PASS AT ZIA INTERNATIONAL AIRPORT

4.3.2.2. Pedestrian Data

Pedestrian volume on overpass in each direction has been counted as shown in Table 5.4. The same table contains the volume of violators. A team of 5 persons was engaged for this purpose. Volume was measured at different time period of the day as indicated in the table.

4.4 PEDESTRIAN WALKING SPEED

Walking speeds have long been recognised as an important factor in designing pedestrian facilities. With increasing age the walking speed of the individual decreases, which means that more time is required to cross the road, which in turn leads to a longer exposure time to traffic. The development of knowledge in this field is shown in the following relevant research results, (MOSES, 1988).

German data of the late 1940's showed walking speeds as follows :-

Youths	...	1.8	m/sec.
Men under 50	...	1.6	m/sec.
Men over 50	...	1.4	m/sec.
Women under 50	...	1.4	m/sec.
Women over 50	...	1.3	m/sec.
Women with small children	...	0.7	m/sec.
Children 6-10 years	...	1.1	m/sec.

From this table an average operating speed of 1.4 m/sec. or any adjustable figure may be used to design pedestrian facilities. This table also shows that average men speed is 11% higher than average women speed. Similarly adolescents speed is 20% higher than average men speed.

Empercial research has shown that under free-flow conditions pedestrian walking speeds tend to be approximately normally distributed. Under such conditions, pedestrian walking speeds range from about 2.0 to 6.0 ft./sec. (0.6 to 1.8 m/sec.). Typical mean walking speeds are in the 4.0 to 4.5 ft/sec. (1.2 to 1.3 m/sec. range. A pedestrian walking speed of 4.0 ft/sec. (1.2 m/sec.) is generally assumed for calculating timings of pedestrian traffic signals. In areas where there are large numbers of elderly pedestrians, AASHTO recommends the use of a 3.0 ft./sec. walking rate. The presence of significant numbers of handicapped persons would also dictate the use of a lower rate of movement (Wright & Paquette, 1979).

Free-flow walking speeds vary with the pedestrians' age and sex as well as trip purpose. Grades less than about 5 percent seem to have little effect on walking speed, and pedestrians carrying baggage tend to walk about as fast as those without baggage.

Walking speeds decrease with increase in pedestrian density. This aspect is discussed further in Section 4.5.

4.5 PEDESTRIAN SPEED DENSITY RELATIONSHIPS

The fundamental relationship between speed, density, and volume for pedestrian flow is analogous to vehicular flow. As volume and density increase, pedestrian speed declines. As density increases, and pedestrian space decreases, the degree of mobility afforded the individual pedestrian declines, as does the average speed of the pedestrian stream.

Figure 4.5 shows the relationship between speed and density for a variety of pedestrian classes as determined by four researchers, including two European sources. The density term, when uses to describe pedestrian streams and specified in persons per square foot will have small values, generally under 0.50 (Highway Capacity Manual, 1985).

4.6 FLOW-DENSITY RELATIONSHIPS

The relationship between density, speed, and flow for pedestrians is of the same form as for vehicular traffic stream, that is :

Flow = Speed x Density

$$v = S \times D$$

Where flow is expressed as pedestrians per minute per foot, speed is expressed as feet per minute, and density is expressed as pedestrians per square foot. (Highway Capacity Manual, 1985).

The flow variable used in this expression is the "unit width flow" defined earlier. An alternative and more useful

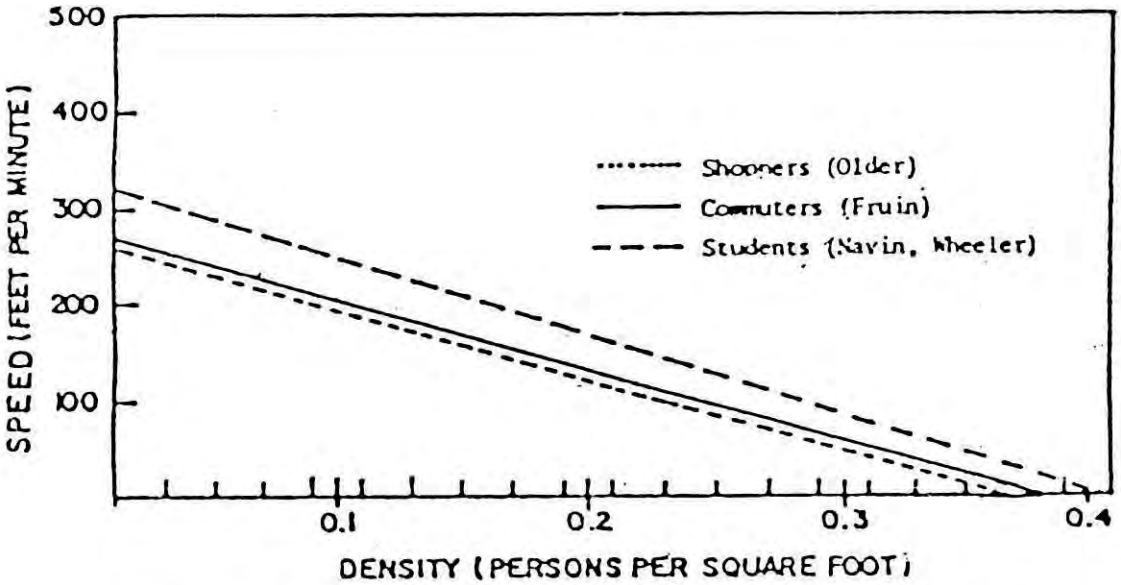


Figure 4.5 Relationships between Pedestrian Speed and Density.

(Source : H.C.M., 1985)

expression can be developed using the reciprocal of density, or space, as follows :

$$\text{Flow} = \text{Speed/space}$$

$$v = S/M$$

The basic relationship between flow and space, as recorded by several researchers, is illustrated in figure 4.6.

The conditions at maximum flow are of interest because this represents the capacity of the walkway facility. From figure 4.6 it is apparent that all observations of maximum unit flow fall within a very narrow range of density - that is, with the average space per pedestrian varying between 5 and 9 sq. ft/ped. Even the outer range of these observations indicates that maximum flow occurs at this density, although the actual flow in this study is considerably high than the others.

These relationships show that pedestrian traffic can be evaluated qualitatively by using level-of-service concepts similar to vehicular traffic analysis. At flows near capacity, an average of 5 to 9 sq. ft/ped is required for each moving pedestrian. However, at this level of flow, the limited area available restricts pedestrian speed and the pedestrian's freedom to meneuver within the pedestrian stream.

4.7 SPEED-FLOW RELATIONSHIPS

Figure 4·7 illustrates the relationship between pedestrian speed and flow. These curves, similar to vehicular flow curves,

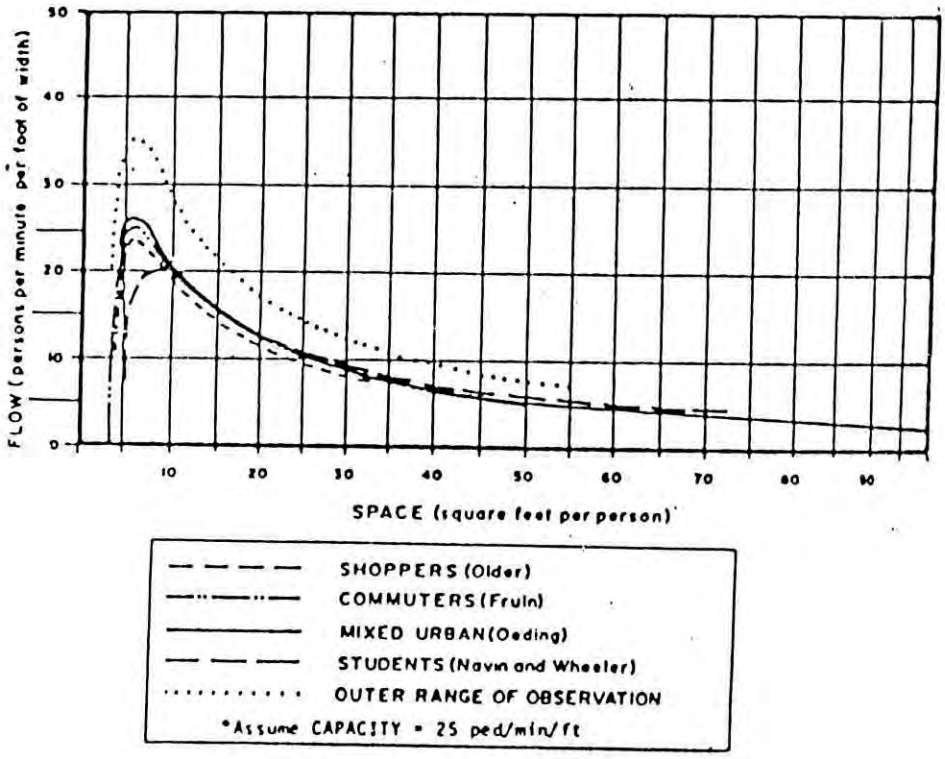


Figure 4.6 Relationships between Pedestrian Flow and space.

(Source H.C.M., 1985)

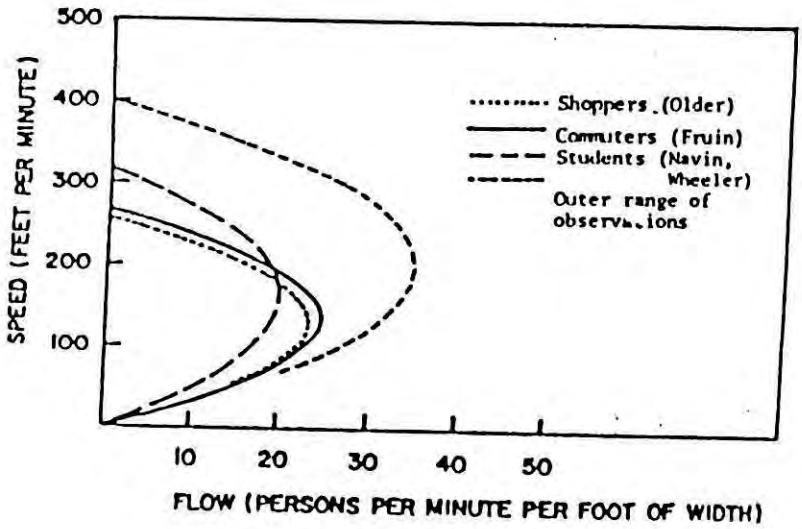


Figure 4.7 Relationships between Pedestrian Speed and Flow.

(Source : H.C.M., 1985)

show that when there are few pedestrians on a walkway (low flow levels), space is available to choose higher walking speeds. As flow increase, speeds decline because of closer interactions with other pedestrians. When a critical level of crowding occurs, movement becomes more difficult, and both flow and speed decline. (Highway Capacity Manual, 1985).

4.8 SPEED-SPACE RELATIONSHIPS

Figure 4-8 further confirms the relationships of walking speed and available space, and suggests some points of demarcation that can be used to develope level-of-service criteria. The outer range of observations shown on figure 4.8 indicates that at an average space of about 15 sq. ft/ped, even the slowest pedestrians can not achieve their desired walking speed. Faster pedestrians wishing to walk at speeds up to 350 ft/min. are not able to achieve such speeds until average space is 40 sq. ft/ped. or more. The space values of 15 and 40 sq. ft/ped. become critical points in defining level-of-service boundaries, (Highway Capacity Manual, 1985).

4.9 LEVELS OF SERVICE IN WALKWAYS

The criteria for various levels of service (LOS) for pedestrian flow are based on subjective measures that may be somewhat imprecise. However, it is possible to define ranges of space per pedestrian, flow rates, and speeds which can be used to develop quality of flow criteria.

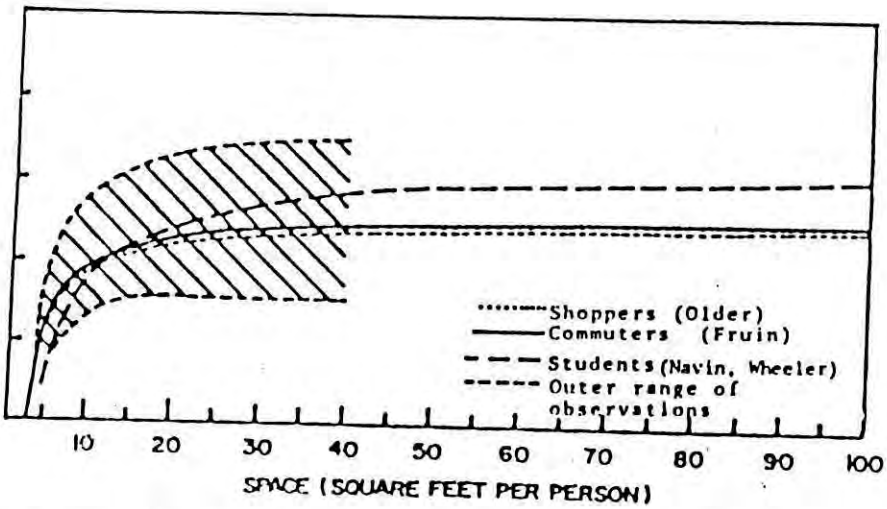


Figure 4.8 Relationships between Pedestrian Speed and Space.

(Source : H.C.M., 1985)

Speed is an important level-of-service criterion because it can be easily observed and measured, and because it is a descriptor of the service pedestrians perceive. At speeds of 150 ft/min or less, most pedestrians resort to an unnatural "shuffling" gait. Figure 4.8 shows that this speed corresponds to a space per pedestrian in the range of 6 to 8 sq. ft/ped. At 15 sq ft/ped or less, even the slowest walkers are forced to slow down (shown by the cross-hatching in Figure 4.8). The fastest walkers can not much their chosen speed of 350 ft/min until areas are over 40 ft^2/ped. Further, from Figure 4.6 it is evident that these three space values, 6,15 and 40 sq. ft/ped. correspond approximately to the maximum flow at capacity, two-thirds of capacity, and one-third of capacity, respectively.

There are other significant indicators of service levels. For example, the ability of the pedestrian to cross a pedestrian stream shown by Fruin (3) in Figure 4.9 to be impaired at areas below the 35 to 40 sq. ft/ped range. Above that level, Fruin states that the probability of "stopping or breaking the normal walking gait" is reduced to zero. Below 15 sq ft/ped, virtually every crossing movement encounters a conflict. Similarly, the ability to pass slower pedestrians is unimpaired above 35 sq. ft/ped, but becomes progressively more difficult as space allocations drop to 18 sq. ft/ped, a point at which passing becomes virtually impossible.

Another level-of-service indicator is the ability to maintain flow in the minor direction in opposition to a major pedestrian flow. Here the quantitative evidence is somewhat less precise.

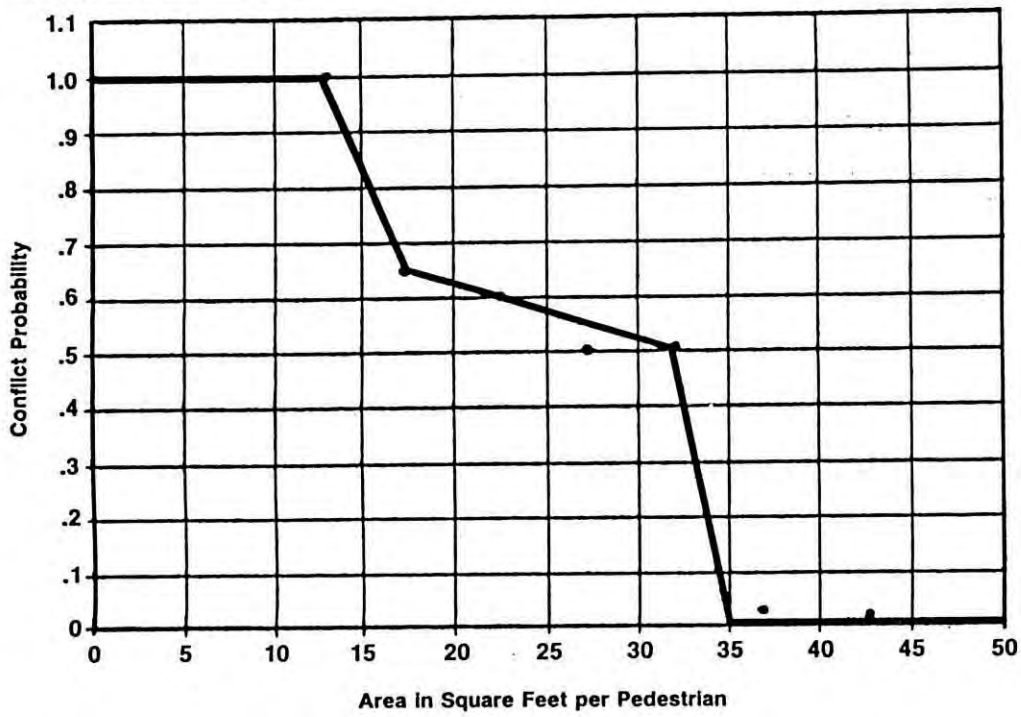


Figure 4.9 Cross-flow Traffic Probability of Conflict.
(Source : H.C.M, 1985)

For pedestrian streams of roughly equal flow in each direction, there is little reduction in the capacity of the walkway compared with one-way flow, because the directional streams tend to separate and occupy a proportional share of the walkway. However, if the bidirectional split is 90-10, and space is 10 sq. ft/ped, capacity reductions of about 15 percent have been observed. This reduction is a consequence of the inability of the minority flow to utilize a proportional share of the walkway.

Photographic studies show that pedestrian movement on sidewalks is affected by the presence of other pedestrians, even at areas above 40 sq. ft/ped. At 60 sq. ft/ped, pedestrains have been observed walking in a "checkerboard" pattern, rather than directly behind or alongside each other. These same observations suggest that up to 100 sq. ft./ped. are required before completely free movement occurs without conflicts, and that at 130 sq. ft./ped, individual pedestrians are no longer influenced by others. Bunching or "platooning" does not completely disappear until space is about 500 sq.ft/ped or higher. (Highway Capacity Manual).

4.10 WALKWAY LEVEL-OF-SERVICE CRITERIA

Table 4.1 shows the criteria for pedestrian level of service. The primary measure of effectiveness used in defining pedestrian level of service is space, the inverse of density. Mean speed and flow rate are shown as supplementary criteria. Capacity is taken to be 25 ped/min/ft, a representative value from Figures 4.6 and 4.7.

TABLE 4.1 PEDESTRIAN LEVEL OF SERVICE ON WALKWAYS*

LEVEL OF SERVICE	SPACE (SQ FT/PED)	EXPECTED FLOWS AND SPEEDS		
		AVE. SPEED, S (FT/MIN)	FLOW RATE, v (PED/MIN/FT)	VOL/CAP RATIO, v/c
A	≥ 130	≥ 260	≤ 2	≤ 0.08
B	≥ 40	≥ 250	≤ 7	≤ 0.28
C	≥ 24	≥ 240	≤ 10	≤ 0.40
D	≥ 15	≥ 225	≤ 15	≤ 0.60
E	≥ 6	≥ 150	≤ 25	≤ 1.00
F	< 6	< 150	----Variable----	

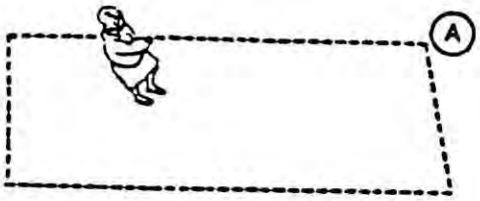
* Average conditions for 15 min.

(Source : H.C.M.,1985)

LEVEL OF SERVICE A

Pedestrian Space: ≥ 130 sq ft/ped Flow Rate: ≤ 2 ped/min/ft

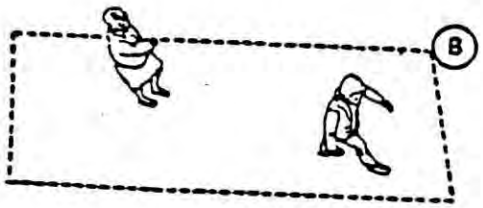
At walkway LOS A, pedestrians basically move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely.



LEVEL OF SERVICE B

Pedestrian Space: ≥ 40 sq ft/ped Flow Rate: ≤ 7 ped/min/ft

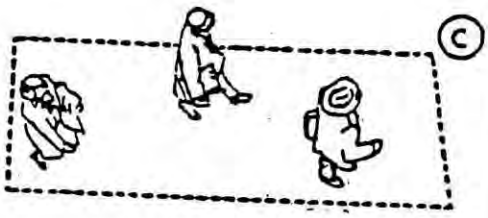
At LOS B, sufficient area is provided to allow pedestrians to freely select walking speeds, to bypass other pedestrians, and to avoid crossing conflicts with others. At this level, pedestrians begin to be aware of other pedestrians, and to respond to their presence in the selection of walking path.



LEVEL OF SERVICE C

Pedestrian Space: ≥ 24 sq ft/ped Flow Rate: ≤ 10 ped/min/ft

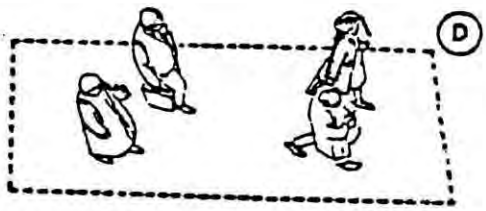
At LOS C, sufficient space is available to select normal walking speeds, and to bypass other pedestrians in primarily unidirectional streams. Where reverse-direction or crossing movements exist, minor conflicts will occur, and speeds and volume will be somewhat lower.



LEVEL OF SERVICE D

Pedestrian Space: ≥ 15 sq ft/ped Flow Rate: ≤ 15 ped/min/ft

At LOS D, freedom to select individual walking speed and to bypass other pedestrians is restricted. Where crossing or reverse-flow movements exist, the probability of conflict is high, and its avoidance requires frequent changes in speed and position. The LOS provides reasonably fluid flow; however, considerable friction and interaction between pedestrians is likely to occur.



LEVEL OF SERVICE E

Pedestrian Space: ≥ 6 sq ft/ped Flow Rate: ≤ 25 ped/min/ft

At LOS E, virtually all pedestrians would have their normal walking speed restricted, requiring frequent adjustment of gait. At the lower range of this LOS, forward movement is possible only by "shuffling." Insufficient space is provided for passing of slower pedestrians. Cross- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with resulting stoppages and interruptions to flow.

LEVEL OF SERVICE F

Pedestrian Space: ≤ 6 sq ft/ped Flow Rate: variable

At LOS F, all walking speeds are severely restricted, and forward progress is made only by "shuffling." There is frequent, unavoidable contact with other pedestrians. Cross- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Figure 4.10 *Illustration of walkway levels of service.*
(Source : H.C.M., 1985)

Graphic illustrations and descriptions of walkway levels of service are shown in Figure 4.10.

It should be noted that the pedestrian LOS, according to the criteria of Table 4.1, is quite good in most areas. Design of walkways is based on the minimum widths required for voluntary pedestrian groups to pass each other and similar factors, rather than on the flow rate.

The LOS criteria apply to pedestrian flow and the space provided for that flow. Pedestrian facilities may also include extensive space intended to enhance the general environment that is not used or intended to handle basic pedestrian movements. When analyzing pedestrian flow rates per unit width of walkway, such space should not be included. Thus, pedestrian space intended to provide for window shopping, browsing, or simply sitting or standing in informal groups should not be considered to be part of the effective walkway width.

4.11 PEDESTRIAN OPINION SURVEY

The pedestrian opinion survey is an important component of this research. The purpose of this is to findout the causes of not using the existing overpasses and also to evaluate their choice on either of the two alternatives, the overpass and the subways. For this purpose about 200 pedestrian were interviewed. The method used was random sampling. We have selected that person who was infront of us just at the moment of completion of one's

interview . A prepared questionnaire was used. We stared the colomn(s) just after their openion on particular question. Since the sampling was random, different age group of pedestrian are found in this collection. These are shown in Appendix-A.

4.12 OVERVIEW

This chapter discussed in detail the site survey and pedestrian data collection for two different overpasses in our study. Pedestrian volume count and their interviewing were the basic objectives which will be very helpful for analysis. A group of persons worked for this purposes. Peak hour traffic volume, choiser group etc. are found. Field investigation was the only source of data collection.

CHAPTER - 5

DATA ANALYSIS

5.1 INTRODUCTION

This chapter deals with the pedestrian movement and their behaviour. The field observation data, the pedestrian volume count data and pedestrian interview data will now be analysed and discussed in detail.

5.2 PEDESTRIAN ATTITUDE

Tables 5.1 to 5.5 show the hourly pedestrian volume on two overpasses and on Zebra crossing. Also shows the pedestrian who do not use any of these facilities. This groups of pedestrians are designated as violators.

Tables 5.1, 5.2 and 5.3 are the data and results for overpass at Farmgate. Table 5.1 shows that the pedestrian volume is maximum in between 5 p.m. to 6 p.m. The same time is true for the violators. By age groups, pedestrian volume is minimum for childrens having age less than 5 years which is equal to 2.80%. Volume is maximum for age groups 19-20 years and 31-50 years which are equal to 23.60% and 38.93% respectively.

PEDESTRIAN DATA

Table 5.1 Pedestrian Volume on Overpass and Violators at Farmgate

Time	Direction	Below-5	5-12	13-18	19-30	31-50	Above 50	Total	Hourly volume	Violators (per hour)
		Pedestrain Volume on Overpass and Violators at Farmgate								
8-9 AM	W-E	14	290	366	709	1171	432	2982	4656	1082
	E-W	31	154	211	467	644	167	1674		
9-10 AM	W-E	54	195	208	547	958	354	2316	4372	1207
	E-W	80	205	331	439	786	215	2056		
10-11 AM	W-E	72	157	277	384	745	194	1829	3882	1154
	E-W	65	212	217	429	897	233	2053		
12-1 PM	W-E	17	218	217	212	500	264	1428	2985	756
	E-W	46	275	174	334	526	202	1557		
1-2 PM	W-E	52	175	110	357	619	312	1625	3313	772
	E-W	37	188	97	244	712	410	1688		
4-5 PM	W-E	59	224	314	721	1018	227	2563	4577	992
	E-W	118	185	114	598	575	242	2014		
5-6 PM	W-E	88	225	200	679	865	193	2280	4851	1048
	E-W	74	206	397	635	955	304	2571		
Total Volume		807	2939	3233	6755	11153	3749	28636	28636	7011
%		2.82	10.26	11.29	23.60	38.93	13.10	100.00	-	-

In this particular study area, the predominant flow occurs from west to eastern direction in the morning. This is due to the trips generated by service holders, students, shop-keepers, workers etc. Predominent flow is reverse in the evening and is the highest. The flow is nearly equal from both direction at noon. The same cases are true for pedestrian flow through Zebra crossing at Farmgate.

Table 5.2 Pedestrian Volume through Zebra crossing at Farmgate

Time		Pedestrian volume by age group (using Zebra crossing)								
		Direc-tion	Below - 5	5-12	13-18	19-30	31-50	Above - 50	Total	Hourly volume
8-9	AM	W-E	23	228	194	690	560	276	1971	3486
		E-W	12	150	214	406	540	193	1515	
9-10	AM	W-E	37	274	226	570	709	312	2128	3653
		E-W	49	157	127	312	614	266	1525	
10-11	AM	W-E	21	126	157	400	603	210	1517	2910
		E-W	43	161	145	331	518	195	1393	
12-1	PM	W-E	11	94	112	352	525	141	1235	2347
		E-W	18	113	125	276	511	69	1112	
1-2	PM	W-E	7	138	166	253	492	88	1144	2472
		E-W	23	120	147	258	610	170	1328	
4-5	PM	W-E	9	117	89	292	540	93	1140	2991
		E-W	12	274	188	429	723	225	1851	
5-6	PM	W-E	29	160	148	386	482	198	1403	3359
		E-W	19	212	227	715	546	237	1956	
Total Volume			313	2324	2265	5670	7973	2673	21218	21218
%			1.47	10.95	10.67	26.71	37.60	12.60	100.00	-

Table 5.3 Total flow characteristics at Farmgate Overpass, Zebra crossing and Violation.

Movement	Pedestrian on			Gross Taotal
	Overpass	Zebra Crossing	Violation	
Individual Total	28636	21218	7011	56865
% of Gross Total	50.36	37.31	12.33	100.00

(Source : Table 5.1 and Table 5.2)

Table 5.2 shows data and results for Zebra Crossing at Farmgate. Here the maximum volume is found in between 9-10 A.M. Age groups 19-30 and 31-50 years contribute maximum volume.

Table 5.3 reflects the total flow characteristics through overpass, zebra crossing and violation. The result shows that out of the total pedestrian flow across the roadway at Farmgate, 50.36% of pedestrian use overpass, 37.31% use zebra crossing and 12.33% are violators. So we see that about 49.64% of pedestrians do not use the existing overpass.

Table 5.4 Pedestrian Volume on overpass and Violators at Zia International Airport

Time	Direction	Pedestrian Volume by age group (on overpass) Below - 5	5-12	13-18	19-30	31-50	Above - 50	Total	Hourly volume	Violators
8-9 AM	E-W	-	30	75	70	100	15	290	550	615
	W-E	-	25	55	72	96	12	260		
9-10 AM	E-W	-	20	60	86	141	28	335	610	635
	W-E	-	25	45	75	110	20	275		
10-11 AM	E-W	-	25	50	78	112	15	280	570	585
	W-E	-	30	75	75	95	15	290		
12-1 PM	E-W	-	15	58	58	86	8	225	435	510
	W-E	-	12	45	74	74	5	210		
1-2 PM	E-W	-	9	35	49	95	7	195	385	415
	W-E	-	11	40	39	92	8	190		
4-5 PM	E-W	5	35	75	155	175	25	470	875	515
	W-E	1	42	86	90	165	21	405		
5-6 PM	E-W	12	40	70	131	205	27	485	900	500
	W-E	3	28	50	126	188	20	415		
Total Volume		21	347	819	1178	1734	226	4325	4325	3775
%		0.48	8.02	18.93	27.24	40.10	5.23	-	-	-

Table 5.5 Total flow characteristics at Zia International Airport Overpass and violation

Movement	Pedestrian on Overpass	Violation	Gross Total
Individual Total	4325	3775	8100
% of Gross Total	53.40	46.60	100

(Source : Table 5.4)

Table 5.4. Shows the pedestrian volume data and results for overpass at Zia International Airport. 5-6 p.m. is the peak hour volume period. Age group 31-50 contributes the maximum flow volume. Table 5.5 represents the total flow characteristics through the overpass and the violation. It shows that 53.48% of total pedestrians use the existing overpass and 46.60% are the violators. The violation is maximum here.

A continuous median barrier over a long distance can reduce violation as observed in the field. Unless compelled, a significant portion of the crossing pedestrians will violate the overpass compliance rule. Situational constraints strongly influence pedestrian behaviours at overpass, as evidenced by the locations. The median barrier is continuous and sufficiently long to intercept the pedestrian short-cut desire lines.

5.3 PEDESTRIAN COMPLIANCE

Pedestrian overpasses in urban areas are often associated with such weakness of the longer travel time, physical weakness of the pedestrians, climbing up etc. We obtained these attitudes from the pedestrain interview data. As listed in Appendix-A, 200 pedestrians were interviewed and the respondant were asked to give the predominant reason (s) for not using the overpass.

The causes for not using the existing overpass by the pedestrians and the pedestrians preference to different facilities are shown in Tables 5.6 and 5.7 respectively.

Table 5.6 Causes of not using the overpass by pedestrians

Causes		Percentage
Difficult to climb-up the overpass	..	22.97
Travel through overpass take longer time	..	13.52
Overpass is too high	..	20.27
Physical weakness	..	10.81
Overpass is far away from their route	..	16.67
Other factors	..	4.05
Who response nothing	..	11.71

(Reference : Appendix - A)

Table 5.7 Pedestrian preference to different facilities

User Type		Percentage
Pedestrians prefering overpass	..	15.0
Pedestrians prefering subways	..	49.5
Pedestrians not too sure	..	35.5

(Reference : Appendix - A)

From Table 5.6, it is observed that the highest (22.97%) number of pedestrians felt difficulty to climb-up the overpass. The next group (20.27%) of pedestrians said that the overpass is too high. These two groups thus resulted in that a large part of pedestrians do not like to face this sort of additional effort to climb-up the overpass and to spent their energy.

From Table 5.7, the result shows that only 15% of people prefer using overpass. 49.5% of pedestrians prefer use of subway. This indicates that pedestrians are not afraid of climb-up last.

In other words they prefer downward movement in the begining and do not account for climb-up at the end. That is why they prefer subways. The result also shows that 35.50% of people do not know about the subways, that is why they could response nothing.

5.4 PEDESTRIAN DISTRIBUTION BY AGE GROUP FROM FIELD INTERVIEW DATA

Table 5.8, shows that age group 19-31 years contribute maximum pedestrian volume. The next highest group is 31-40 years. Zero volume for age group less than 5 years is not the actual figure. This is because during interview, we have intensionally avoided them. That is why it is zero. The least contribution to volume is by group having age more than 61 years.

Table 5.8 Pedestrian Distribution by age group.

Age Group	Pedestrian Volume	
	Number	Percentage
Less than 5 Years	0	0.0
5-12 Years	12	6.0
13-18 Years	29	14.5
19-30 Years	54	27.0
31-40 Years	42	21.0
41-50 Years	30	15.0
51-60 Years	23	11.5
61 and above	10	5.0
Total	200	100.00

(Reference : Appendix - A)

5.5 PEDESTRIAN DISTRIBUTION BY THEIR PREFERENCE

From Table 5.7 and 5.9, it is reflected that out of 200 pedestrians 49.5 percents prefer underpass. Out of this 49.5 percentage of pedestrians who prefer underpass 26.27 percentage comes from age group 31-40 years. Again, from 15 percentage of pedestrians, who prefer overpass, 26.67 percentage are from age group 13-18 years. Major part of pedestrians who could response nothing are from age group 19-30 years.

Table 5.9 Pedestrian Distribution by their preference

Age Group	Pedestrian Volume						
	on underpass		on overpass		not too sure		
	No.	%	No.	%	No.	%	Total
Less than 5 Years	0	0	0	0	0	0	
5-12 Years	6	6.06	2	6.67	4	5.63	12
13-18 Years	11	11.11	8	26.67	9	12.68	28
19-30 Years	24	24.24	9	30.00	22	30.98	55
31-40 Years	26	26.27	4	13.33	12	16.90	42
41-50 Years	18	18.18	4	13.33	9	12.68	31
51-60 Years	12	12.12	1	3.33	9	12.68	22
61 & above	2	2.02	2	6.67	6	8.45	10
Total	99	100	30	100	71	100	200
Percentage	49.5	-	15.0	-	35.5	-	100

(Reference : Appendix - A)

5.6 PEDESTRIAN DISTRIBUTION BY THEIR OCCUPATION

By occupation we mean the type of work with which the person concern is engaged in. Table 5.10 represent the pedestrian distribution by their occupation. The results here shows that 30 percent of people are engaged with their personal activities. 23.5 percent are with service either in Government, Semi-Government or in private organisations. It also shows that most of the service holders have their age between 19 and 60 years. Out of 19.5 percentage of students major part are from age group 13-18 years. Major part of people who are engaged with their personal activities come from age group 31-40 years.

Table 5.10 Pedestrian Distribution by their Occupation

Age Group	Pedestrian Occupation						Total	Percentage
	Service	Student	Shopping	Personal	Recreation	Other		
Less than 5 years	-	-	-	-	-	-	-	-
5-12 years	-	6	-	4	-	2	12	6.0
13-18 "	1	19	3	2	1	3	29	14.5
19-30 "	14	14	8	9	3	6	54	27.0
31-40 "	10	-	6	20	1	5	42	27.0
41-50	14	-	5	9	1	1	30	15.0
51-60 "	8	-	3	10	-	2	23	11.5
61 and above	-	-	3	6	1	-	10	5.0
Total	47	39	28	60	7	19	200	-
Percentage	23.50	19.50	14.00	30.00	3.50	9.50	-	100.00

(Reference : Appendix - A)

5.7 LEVEL OF SERVICE STANDARD AND CAPACITY OF OVERPASSES

The capacity of an overpass may be defined as the maximum volume that can be accommodated for a particular level of service standard. Capacity is a function of width of the section and the pedestrian speed. From these considerations we will see the conditions of existing overpasses in terms of their capacity and level of service standard.

5.7.1 Level of Service standard and capacity of overpass at Farmgate

The actual capacity of an overpass can be computed by using information of pedestrian speed and pedestrian module. From this information the following formula can be established.

Thus :-

$$\text{Capacity/Hour} = \frac{\text{Width(ft.)} \quad \text{Speed(ft/min.)} \times 60}{\text{Pedestrian Module(ft}^2\text{/Ped)}}$$

Since pedestrian walking speed data, at different level of service standard, is available, we can use the above formula. Thus, using this formula, the capacity of overpass at different level of service standard with minimum module is shown in the following table. (Table 5-11).

Table 5.11 Capacity of Overpass at different level of service standard (at Farmgate)

Width (ft)	Speed (ft/min)	Level of Service	Pedestrian Module (ft^2/Ped.)	Capacity per hour
10'-0"	260	A	130	1200
	250	B	40	3750
	240	C	25	5760
	225	D	16	8440
	150	E	8	11250
	<150	F	5	Variable

(Ref : Table 4.1)

The actual peak hour volume (present and future) is shown in the Table 5.12

Table 5.12 Actual peak hour volume at Farmgate Overpass

Present actual peak hour volume (1990)			Future Peak hour Volume (2010)		
Overpass	Violation	Total	Overpass	Violation	Total
4851	1048	5899	13874	2997	16871

(Ref : Table 5.1)

To compute the future growth rate and growth factor for Dhaka Metropolitan area, data has been used from Table 2.1. With population 2.80 millions in 1981 and 8.00 millions in 2000, the growth factor is 2.86. The present peak hour volume is multiplied by 2.86 to find future peak hour volume. Information found in Table 5.11 and 5.12 is described in the following sections,

5.7.1.1 Present Situation

If we consider that violation is permitted, the present actual peak hour volume through overpass is 4851 pedestrians. This volume shows that a level of service standard C is maintained. Again, if all the violators are compelled to use the overpass, then the total actual peak hour volume through the overpass would be 5899 pedestrians. This volume indicates that a level of service standard exist very close to the capacity at level C,5760.

5.7.1.2 Future Situation

If the Zebra crossing is used and the violation is permitted, then the future peak hour volume through overpass will be 13874 pedestrians. This shows that a level of service standard below F is found i.e. a breakdown flow is invited. Again, if all the violators are compelled to use the existing overpass, then the total actual peak hour volume will be about 16871 pedestrians. This indicates that no operating condition exists and the facility would experience sporadic and unstable condition.

5.7.2 Level of service standard and capacity of overpass at Zia International Airport.

Similar to the overpass at Farmgate, the capacity of this overpass at different level of service standard with minimum module, present and future peak hour volume are shown in Table 5.13 and 5.14.

Table 5.13 Capacity of Overpass at different level of service standard (at Zia International Airport)

Width (ft)	Speed (ft/min.)	Level of Service	Pedestrian Module (ft^2/Ped)	Capacity per hour
11'-0"	260	A	130	1320
	250	B	40	4125
	240	C	25	6336
	225	D	16	9284
	150	E	8	12375
	< 150	F	5	Variable

(Ref : Table 4.1)

Table 5.14 Actual Peak hour volume at Zia International Airport

Present actual peak hour volume (1990)			Future peak hour volume (2010)		
Overpass	Violation	Total	Overpass	Violation	Total
900	500	1400	2574	1430	4004

(Ref : Table 5.4)

From Table 5.13 and 5.14, we get the following informations :

5.7.2.1 Present Situation

Assuming that the violators are not using the overpass, then the actual peak hour volume through overpass is 900 pedestrians. This volume is much lower than the capacity of facility at level of service A. Again, if all the violators are also compelled to use the overpass, then the total peak hour volume become 1400 pedestrians. This is shortly higher than the capacity at level A, 1320.

5.7.2.2 Future Situation

Excluding the violators, the future peak hour volume through the overpass is 2574 pedestrian. In this case, level of service standard exist between A & B. Again assuming that there is no violators and all pedestrians are using the existing overpass, then, the total peak hour volume become 4004 pedestrians. In this cases, level of service standard is very close to level of service B, 4125.

5.8 OVERVIEW

This chapter analysed the effectiveness of two pedestrian overpasses, at Farmgate and at Zia International Airport. This analysis has been made based on the collected data. Data and analysis showed that a large part of pedestrians tend to avoid the use of overpass or Zebra crossing. The study reflect that the existing overpasses could be more effective if the pedestrians are compelled to use the overpass either by installing continuous median barrier or by traffic police. Research on pedestrian's option showed that a considerable percentage of pedestrians are interested for subways rather than overpass. A portion of pedestrians do not have any knowledge about the subways.

CHAPTER - 6

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The aim of this study was to investigate the effectiveness of pedestrian overpasses in Metropolitan Dhaka. The location of the overpasses studied were at Farmgate and at Zia International Airport. Results of detailed studies on the effectiveness of those overpasses have been discussed so far. An understanding of the factors contributing to the effectiveness of the overpasses may lead to better design of these facilities in the future.

It was found that of the total pedestrian crossing the road near Farmgate overpass, about 50 percent are using overpass, 37 percent using Zebra crossing and the remaining 13 percent are crossing illegally. It is significant that about 87 percent of the pedestrians are using legal facilities. This greater number is achieved due to the existance of median barrier, presence of traffic police, better control and better regulation.

For overpass at Zia International Airport, it was found that of the total pedestrians crossing the road near it, about 53 percent are using overpass and the remaining 47 percent are crossing illegally. This showed higher rate of violation. The level of effectiveness at this overpass is not achieved due to discontinuous median barrier, absence of traffic police, unregulatory situation.

The reasons for not using the overpass showed that 22.97 percent of pedestrain face difficult to climbup, 13.52 percent take longer travel time, 20.27 percent say that the overpasses are too high, 10.81 percent physically weak, and 16.67 percent respond that the overpass is far away from the travel route.

Capacity analysis for overpass at Farmgate identified that it will be inadequate after 20 years. The facility would experience sporadic and unstable condition. In that case, additional pedestrian subway may be provided as because 49.5 percent of pedestrian prefer subway.

Capacity analysis for overpass at Zia International Airport identified that even after 20 years, a level of service standard B could be maintained there.

The study also conducted a pedestrian attitude survey regarding the preferences on different facilities. It revealed that the majority preferred subways to overpass. The distribution of the preferences were 49.5 percent subways, 15 percent overpass and 35.5 percent undecided.

Pedestrian distribution on different characteristics showed that the age group 19-31 years represented the greatest number of pedestrians. The next highest category was the pedestrians of age group 31-40 years. The distribution of pedestrians by occupation identified that 30 percent in personal business, 23.50 percent in work/service, 19.50 percent schooling and 3.50 percent recreation.

6.2 RECOMMENDATION

During the research study, particularly in the analysis of the informations, a number of drawbacks against the effectiveness of the pedestrian overpasses have been identified and observed. Some of these drawbacks are discontinuous median barrier, lack of traffic knowledge, lack of willingness to use the existing facilities, etc. From the above point of view and to achieve greater pedestrian safety and their orderly movements, the following recommendations are made :-

(i) Road safety education is essential to gather knowledge, judgement and physical skillness. It is essential for achieving reduction of accidents by promoting the creation of better road users with improved behaviour. An itegrated road safety education programme covering children between 3 and 16 years may be included in the school curriculum as an effective counter measures against road accidents, (Victor, 1980).

ii) Pedestrian movement system should be carefully related to rapid transit lines, bus stops etc.

iii) Pedestrians ways should be safe, attractive and convenient to use. Safety should be ensured by having good lighting, long lines of sight etc.

iv) Continuity of movement should be maintained.

v) Depending on the volume of pedestrian movement, a variety of facilities should be adopted.

vi) Where overpass or subways have been provided, other facilities like Zebra crossing. Signalized Zebra crossing etc. should be avoided adjacent to this areas.

vii) Particular attention should be given for pedestrian facilities near schools, as children are likely to run across the road.

viii) Continuous median barrier is effective to reduce violation significantly. Hence it should be installed whereever possible.

ix) The pedestrians should be compelled to use the overpass either by traffic policeman or by other means.

The overpasses could be effective more in terms of their usage provided that the above recommendations are implemented.

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PEDESTRIAN INTERVIEW

APPENDIX-A

LOCATION : ZEBRA CROSSING AT FARMGATE

Sl. No.	Age (Yr.)	Origin	Destination	Occupation.	Factors of not-using existing overpass							Which one you prefer		
					Difficult to climbup	Too high	Time consuming	Physically weak	Far away	Others	No response	Overpass	Subways	Not too sure
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	38	Indira Rd.R/A	Motijheel C/A	Service		*				*				*
2.	23	Kathalbagan	Tejgaon Food office	Labour			*							*
3.	46	" "	MotijheelC/A	Service	*				*				*	
4.	54	Nakhalpara	Dhanmondi	"				*						*
5.	36	Kalabagan	Motijheel	"			*		*				*	
6.	37	Nakhalpara	Mohd.pur	Housewife						*			*	
7.	45	Gulistan	Tajgaon Food office	Labour					*					*
8.	14	Nakhalpara	Kathalbagan School.	Student							*		*	
9.	31	Azimpur	Nakhalpara	Personal			*		*					*
10.	18	Nakhalpara	Kathalbagan	Student	*							*		
11.	11	"	"	"							*			*
12.	52	Green Rd.	M.C/A.	Service				*					*	
13.	23	Tejgaon	F/Gate.	Cook							*	*		
14.	16	Mohakhali	Azimpur	Student	*							*		
15.	24	Azimpur	Food office	Labour		*							*	
16.	38	Mirpur	Airport	Personal	*				*				*	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17.	14	Nakhalpara	Sup.market	Tour		*							*	
18.	49	Kalabagan	M.C/A.	Service	*		*							*
19.	13	Nakhalpara	Model School	Student	*							*		
20.	55	Mirpur	Green Rd.	Service			*	*						*
21.	21	Mohakhali	Tej.college	Student		*							*	
22.	19	Mohd.pur	Newmarket	Shoping							*			*
23.	15	Tejgaon	Kalabagan	Student					*					*
24.	51	Mirpur	Green Rd.	Service	*								*	
25.	30	Kathalbagan	M.C.A.	"					*				*	
26.	12	Mirpur	Green Rd.	Personal	*								*	
27.	21	Tejgaon	Tej.college	Student		*								*
28.	40	Green Rd.	Hospital	Personal				*				*		
29.	19	Tejgaon	Tej.college	Student	*									*
30.	38	Nakhalpara	Mirpur	Service							*		*	
31.	22	Green Rd.	Bus stop	Driver		*								*
32.	33	Shahjahanpur	Indira Rd.	Tutor					*				*	
33.	46	Banani	Green Rd.	Service			*							*
34.	35	Mohakhali	Mord.pur	Personal	*								*	
35.	58	Khilgaon	Tejgaon	"				*						*
36.	27	Gulistan	Food office	Labour			*					*		
37.	37	Kathalbagan	Poly.School (with child)	Service					*				*	
38.	13	Tejgaon	Farmgate	Tokai	*							*		
39.	66	Hospital	Mohd.pur	Personal		*								*
40.	32.	Tejgaon	Newmarket	Shoping			*						*	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
41.	23	Mohakhali	Tej.college	Student		*								*
42.	42	Nakhalpara	Sup.market	Shopkeeper	*									*
43.	62	Kallyanpur	Sup.market	Shoping	*			*						*
44.	12	Nakhalpara	Kalabagan	Student					*			*		
45.	19	"	"	"					*				*	
46.	23	Azimpur	Food office	Personal					*					*
47.	48	F/gate sup. market	Kawranbazar	"		*							*	
48.	20	Mot.colony	F.gate	Shopkeeper			*						*	
49.	73	Asadgate	Sup.market	Shoping		*						*		
50.	25	Azampur	"	"			*							*
51.	30	Newmarket	Hospital	Personal	*				*				*	
52.	45	Mirpur	Kathalbagan	"		*								*
53.	24	Nakhalpara	Kalabagan	Labour		*							*	
54.	23	"	Indira Rd.	Student							*			*
55.	53	Hatirpool	Tejgaon	Personal		*		*						*
56.	41	Motijheel	Nakhalpara	Service			*						*	
57.	27	Mirpur	Green Rd.	"	*								*	
58.	61	Banani	Dhanmondi	Personal				*						*
59.	37	Zigatola	Food office	Service							*		*	
60.	47	Khilkhet	Hatirpool	Personal		*						*		
61.	19	Kallyanpur	Sup,market	Shopkeeper							*			*
62.	58	Shahjahanpur	Nakhalpara	Personal	*			*					*	
63.	50	Indira Rd.	M.C.A.	Service			*						*	
64.	22	Nakhalpara	Newmarket	Shoping						*				*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
65.	38	Taltola	Newmarket	Shoping						*				*
66.	19	Hatirpool	Kawranbazar	"					*				*	
67.	62	Kallyanpur	Farmgate	Cinemashow,		*						*		
68.	48	Bashaboo	Tejgaon	Service				*						*
69.	41	Chairmanbari	Farmgate	Chinema	*								*	
70.	25	Mohd.pur	Sup.market	Shopkeeper							*			*
71.	12	Nakhalpara	"	Tour							*		*	
72.	33	Newmarket	Nakhalpara	Personal		*							*	
73.	17	Green Rd.	"	Tutorial					*					*
74.	18	Nakhalpara	Newmarket	Tour							*		*	
75.	46	M.C.A.	Nakhalpara	Service	*				*				*	
76.	38	Nayapaltan	Tejgaon	"			*						*	
77.	24	M.C.A.	Nakhalpara	"			*							*
78.	35	Banani	Dhanmondi	Personal		*								*
79.	15	Khilkhet	F.gate	Shoping							*	*		
80.	60	Dhaka coll.	Nakhalpara	Service				*					*	
81.	32	Green Rd.	Satmasjid Rd.	Personal					*					*
82.	18	M.C.A.	Tejgaon	Student	*								*	
83.	59	Paltan	Nakhalpara	Service						*				*
84.	23	Mirpur	Kalabagan	Student					*				*	
85.	39	Asadgate	Farmgate	Shoping	*									*
86.	44	M.C.A.	Tejgaon	Personal		*						*		
87.	15	Mohakhali	Farmgate	Cinema					*					*
88.	20	Mohakhali	"	"							*		*	
89.	28	Paltan	Tejgaon	Service		*							*	
90.	9	Green Rd.	Nakhalpara	Student							*		*	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
91	31	Press club	Nakhalpara	Service	*									*
92.	17	Green Rd.	Holicross school	Student	*				*				*	
93.	61	Dhanmondi	M.C.A.	Personal				*						*
94.	36	Food office	Zikatola	"		*			*					*
95.	13	Nakhalpara	Sup.market	Shoping	*							*		
96.	25	Ramna	Tejgaon	Service			*					*		
97.	11	Green Rd.	Nakhalpara	Tokai	*								*	
98.	43	Food office	Kalabagan	Personal		*							*	
99.	71	Shahbag	Nakhalpara	"			*							*
100.	21	Kathalbagan	Holi cross School	Student			*		*				*	
101.	29	Mohd.pur	Indira Rd.	Personal							*			*
102.	49	Zikatola	Farmgate	"		*							*	
103.	61	Nakhalpara	Kalabagan	"			*						*	
104.	31	"	Sup.market	Shoping	*									*
105.	17	Kalabagan	Holi cross School	Student					*				*	
106.	24	Banani	Sup.market	Shoping		*								*
107.	33	Tejgaon	New market	"							*		*	
108.	13	Kallyanpur	Airport	Student			*						*	
109	10	M.C.A.	Tejgaon	"					*					*
110.	38	Paltan	Nakhalpara	Personal	*								*	
111.	15	Satmasjid	Green Rd.	Student		*								*
112.	9	Zikatola	Food office	Personal	*							*		
113.	34	Mohakhali	Mod.pur	"			*						*	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
114.	42	Kachukhet	Sup.market	Shoping		*							*	
115.	52	Nakhalpara	"	"		*		*					*	
116.	20	Mohd.pur	Airport	Personal							*			*
117.	25	Kalabagan	M.C.A.	Service	*								*	
118.	32	Holi cross col.	Kalabagan	Personal						*			*	
119.	36	Indira Rd.	M.C.A.	Service		*						*		
120.	45	Mohd.pur	"	"				*						*
121.	12	Holi cross College	Green Rd.	Student					*					*
122.	76	M.C.A.	Nakhalpara	Personal	*			*						*
123.	32	Mirpur	Green Rd.	"					*				*	
124.	16	Holi cross College	Kalabagan	Student		*						*		
125.	53	M.C.A.	Nakhalpara	Personal		*							*	
126.	22	Food office	Mirpur	Service			*							*
127.	27	Nakhalpara	Sup.market	Shoping		*							*	
128.	53	Satmasjid	Green Rd.	Personal				*					*	
129.	24	Holi cross College	Kathalbagan	"						*		*		
130.	15	" School	Green Rd.	Student					**				*	
131.	37	Shamoli	Kalabagan	Personal					*					*
132.	22	Mirpur	Green sup. market	Shoping					*				*	
133.	28	Tajgaon	Green Rd.	"					*					*
134.	59	Malibag	Nakhalpara	Personal		*							*	
135.	31	Mohakhali	Kalabagan	"					*			*		
136.	59	Chairmanbari	Mirpur	"		*							*	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
137.	21	Asadgate	Chinema Hall	Recreation							*			*
138.	26	Nakhalpara	New market	Shoping					*				*	
139.	57	Mohd.pur	Sup.market	"	*							*		
140.	38	Taltola	"	"		*							*	
141.	55	Segunbagicha	Hospital	Personal				*						*
142.	28	Tongi	Mohd.pur	"			*						*	
143.	32	Banani	Asadgate	Hospital	*								*	
144.	45	Mohd.pur	Sup.market	Shoping				*				*		
145.	36	Airport	Green Rd.	Personal			*						*	
146.	71	Kawranbazar	Nakhalpara	Shoping	*		*						*	
147.	38	Uttara	Kalabagan	Personal							*			*
148.	25	Mogbazar	Nakhalpara	Recreation							*		*	
149.	54	Hatirpool	Hospital	Personal		*								*
150.	12	Elephant Rd.	Tejgaon	"							*		*	
151.	59	Kalabagan	Poly Tech. H.School.	To School	*					*			*	
152.	45	Kalabagan	M.C.A.	Service					*				*	
153.	25	Green Rd.	"	"		*								*
154.	12	Kathalbagan	Malibag	Student							**			*
155.	40	Nakhalpara	Newmarket	Shoping	*								*	
156.	10	Mohakhali	Green Rd.	Personal							*			*
157.	44	Indira Rd.	Satmosjid	Service				*					*	
158.	30	Green Rd.	M.C.A.	"		*						*		
159.	51	Kalabagan	B.Bank	"		*							*	
160.	48	"	Ramna	"	*				*					*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
161.	33	Hatirpool	Poly. School	To School						*			*	
162.	21	Banani	Mohd.pur	Student		*							*	
163.	31	"	Green Rd.	Personal		*								*
164.	41	Tejgaon	Sup.market	Shoping	*							*		
165.	58	Nakhalpara	New market	"				*						*
166.	19	"	Green Rd.	Personal			*					*		
167.	34	Shamoli	Kalabagan	"					*				*	
168.	14	Mohd.pur	Indira Rd.	Student		*							*	
169.	35	Kawranbazar	Nakhalpara	Personal	*		*						*	
170.	59	Hospital	Mirpue	"				*					*	
171.	55	Food office	Mohd.pur	Service				*						*
172.	13	Satmosjid Rd.	Kalabagan	Student							*			*
173.	18	Nakhalpara	Mohd.pur	"	*								*	
174.	40	Indira Rd.	M.C.A.	Service	*								*	
175.	22	Kathalbagan	"	"					*				*	
176.	18	Farmgate	Kawranbazar	Personal	*								*	
177.	41	Sup.market	Nakhalpara	"		*							*	
178.	21	Nakhalpara	Mohd.pur	Student							*			*
179.	47	"	Green Rd.	Personal			*						*	
180.	18	Tejgaon	Sup.market	Shoping	*							*		
181.	19	Azimpur	Nakhalpara	Student					*				*	
182.	60	Bashaboo	Hospital	Personal	*			*						*
183.	44	M.C.A.	Tejgaon	Service		*							*	
184.	48	Uttara	Sup.market	Shoping	*									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
185.	17	Hatirpool	Hospital	Personal	*									*
186.	21	Indira Rd.	Nakhalpara	Student	*							*		
187.	43	Shamoli	Sup.market	Shoping	*								*	
188.	23	M.C.A.	Nakhalpara	Personal			*						*	
189.	17	Nakhalpara	Tejgaon col.	Student		*						*		
190.	45	M.C.A.	Nakhalpara	Personal	*								*	
191.	29	M.C.A.	"	Service	*								*	
192.	39	Shahbagh	Tejgaon	Personal		*						*		
193.	13	Nakhalpara	Green Rd.	Student			*							*
194.	37	Green Rd.	Passport off.	Personal			*						*	
195.	15	Sup.market	Nakhalpara	Student	*									*
196.	29	Palton	Tejgaon	Service	*							*		
197.	37	"	"	Personal	*								*	
198.	21	Sup.market	Kawranbazar	Student		*							*	
199.	15	Kalabagan	Moghbazar	"							*			*
200.	50	M.C.A.	Tejgaon	Service				*					*	
		Gross Total :			51	45	30	24	37	9	26	30	99	71

PEDESTRIAN FLOW THROUGH OVERPASS
AT ZIA INTERNATIONAL AIRPORT

(SIDE VIEW)

PEDESTRIAN FLOW THROUGH OVERPASS
AT ZIA INTERNATIONAL AIRPORT

(TOP VIEW)

PEDESTRIAN FLOW THROUGH OVERPASS AT FARMGATE
(SIDE VIEW)

SHOPS AND SHOPI G ON FARMGATE OVERPASS

PEDESTRIAN FLOW THROUGH OVERPASS AT FARMGATE
(TOP VIEW)

PEDESTRIANS NOT USING OVERPASS
AT ZIA INTERNATIONAL AIRPORT

(THE VIOLATORS)

PEDESTRIAN NOT USING OVERPASS
AND ZEBRA CROSSING AT FARMGATE

(THE VIOLATORS)

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