EFFECT OF NON-UNIFORM HEIGHT OF HIGH RISE BUILDING ON MAT DESIGN

FATEMA ISLAM SANIA

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BOARD OF EXAMINERS

____

Dr. Md. Jahangir Alam — Chairman (Supervisor)
Associate Professor
Department of Civil Engineering
BUET, Dhaka - 1000

____

Dr. K. A. M. Abdul Muqtadir — Member
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Department of Civil Engineering,
BUET, Dhaka-1000

____

Dr. Mehedi Ahmed Ansary — Member
Professor
Department of Civil Engineering
BUET, Dhaka-1000

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(Fatema Islam Sania)

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ABSTRACT

The present study was carried out to investigate the effect of subgrade modulus and mat thickness on design of mat foundation. The Mat of beam-slab system and uniform thickness system were analyzed with loads from 25 story reinforced concrete building with uniform and non-uniform height. The mat subjected to gravity load was modeled in SAFE 12. The edges of mat were restrained by roller support. That means the mat was restrained in all edges horizontally. Vertically there was soil support under the mat. A comparative study has been made among some critical positions of the mat foundation in order to perceive the influence of soil subgrade modulus and mat thickness on mat design.

Effect of Subgrade modulus was found as (i) The value of negative bending moments (midpoint of panel) decreases with soil subgrade modulus, and positive bending moments (beneath of columns) increases with soil subgrade modulus for all cases; (ii) Mat deflection decreases exponentially with increasing modulus of sub-grade reaction at all positions; and (iii) At positions beneath the columns, the contact pressure increases with increase of subgrade modulus. Effect of mat thickness was found as (i) The value of shear (both positive and negative) increases with the increase of mat thickness for all cases. But the change is not significant; (ii) The value of negative moment (mid panel) increases with the increase of mat thickness. The positive moments (under column) decreases with mat thickness; (iii) At all points deflection increases with the increase of mat thickness. However, differential settlement decreases with the increase of mat thickness; and (iv) The value of contact pressure increases with the increase of mat thickness for all cases.

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CHAPTER 1
INTRODUCTION

1.1 General

High-rise buildings are the essential form of building structure, constructed extensively in the heart of the commercial zones of metropolitan cities. On the other hand scarcity of land supply encourages the construction of high-rise buildings. Many high-rise buildings are constructed in the major city of Bangladesh over the last 30 years. Now a day's for aesthetic reasons and functional requirements most of the high-rise buildings are constructed in irregular shape and non-uniform height. Residential buildings up to 6 storied are very common in Dhaka city, which most commonly use individual column footing foundation. But in the high-rise building like 9 to 30 stories residential cum commercial buildings, use of mat foundation with basement floors is a necessity [1].

In recent years mat foundations are very widely used in the construction of high-rise buildings as they are usually found to be economical in cases where the base soil has a low bearing capacity and column loads are very large [2]. Mat foundation is one of the effective shallow foundations, which carries the load to the soil without any differential settlement in the soil. It may be used where more than 50% of the area is covered by conventional spread footings [3].

It is common to use mat foundations for deep basements both to spread the column loads to a more uniform pressure distribution and to provide the floor slab for the basement. A particular advantage for basements at or below the ground water table is to provide a water barrier. Mat foundation may be supported by piles in situations such as high ground water to reduce the total settlement [4]. For many multi-story projects, a single mat foundation is more economical than constructing a multitude of smaller number of isolated foundations [5]. For all these advantages, mat foundations are becoming popular every day.

There are several types of Mat foundation are used currently. The two types of mat foundation commonly used are uniform thickness and beam-slab system. The uniform thickness mat is cast on a bed of blinding concrete and moisture-proof membrane to prevent damp rising through the slab. The slab is reinforced top and bottom and is of uniform thickness. Where the ground has poor compressibility the slab with beam/ beam-slab mat foundation which is to support the heavier loads of walls or columns a solid slab mat/ uniform thickness system require considerable thickness. To make the economical use of reinforced concrete in a mat foundation supporting heavier loads it is practice to form a beam-slab mat. This mat consists of up stand or down stand beams that take the loads of wall or column and spread them to the monolithically cast slab which bears on natural subsoil [6].

1.2 Background of the Study

The design of mat foundation is a difficult problem because the structure is highly indeterminate and the foundation soil is not elastic. Several methods are available to analyze and design mat foundation. The most simplified method is the conventional method which considers the mat strip by strip loaded by a line of columns and resisted by soil pressure. Each strip is then analyzed as a combined footing having linearly varying soil pressure under it. American Concrete Institute (ACI) Committee 336 [7] proposed that this method can be used for design if the adjacent spans and column loads do not vary by more than 20%. Conventional method (Teng [8], Bowles [9] and Arora [10]) assumes the mat to be rigid which is not true for most mats. ACI Committee 336 [7] also proposes a more general approach in which the mat is assumed to be flexible. This method, known as ACI Approximate Flexible Method which is essentially based on the analysis of Schleicher [11]. Shukla [12] presented design aids for using this method. Later, this method was further modified by Mician [13]. Bowles [9] has proposed Finite Grid Method in which the mat is reduced into a grid system consisting of beam-column elements resisting on Winkler medium. There is also Finite Difference method (Deryck and Severn [14], Bowles [9]) where the mat is modeled as large flat plate on elastic medium [2, 15].

Hossain [16] conducted a comparative study of the available analyzing methods for mat foundation and felt the need for a rigorous finite element study of the problem. Later Molla [17] tested the performance of Midline plate element in finite element analysis of mat foundation and also compared the results with those from other available methods. The study of Molla opened a wide horizon for a rigorous finite element study of problem with more appropriate and versatile element in search of a more economic design of mat. Rahman [2] compared the analysis of mat foundation by Finite Element Method using thick shell element with those of Conventional methods. Morshed [18] and Sutradhar [19] conducted a comparative analysis between finite element method, using Ahmad's thick shell element with ACI method and Conventional method and suggested a mat foundation with variable thickness. Similarly, Rahman [20] used plate element to study the behavior of mat foundation using the finite element software ANSYS. Based on his work, he suggested a more simplified method to design non-uniform mat foundations. Investigation of the effect of shear wall on mat foundation was done by Imam [7]. Amin [1] has attempted to evaluate the scheduling of mat construction using network based simulation techniques.

Ahmad et al [21] presented a simplified design guideline for mat with non-uniform thickness. One type of such configuration is by thickening the mat below the columns which saves a large volume of concrete as well as reinforcement. Alshrafa [5] carried out the dissimilarities of mat foundations design by applying the conventional rigid method and the approximate flexible method. Srilakshmi and Rekha [3] have studied the behavior of mat foundation was analysed for different sizes and thicknesses under compressive load by using finite element software ANSYS, by assuming that the mat-soil system as a 2-D axisymmetric. Investigation of the deflection characteristics of mat foundation for structural and soil parameters was carried out by Imam [22].

The previous studies have ignored the effect of non-uniform height of high-rise building on mat foundation. The majority of tall buildings, very often with asymmetric structural scheme and non-uniform height are used for aesthetic reasons and functional requirements. This results in eccentricity between the centers of mass and stiffness on mat foundation. So the effect of non-uniform height is an important factor in designing the mat foundation. With this ends in view, the present study was carried out.

1.3 Objectives of the Study

The objectives of the study are as follows:

i. To observe the effect of sub grade modulus on shear, moment, deflected shape and contact pressure of mat foundation for uniform and non-uniform height of building.

ii. To observe the effect of mat thickness on shear, moment, deflected shape and contact pressure of mat foundation for uniform and non-uniform height of building.

1.4 Methodology

i) A commercial moment resisting RCC frame building was modeled by using FEM software for uniform and non-uniform height.

ii) Mat thickness and modulus of subgrade reaction was varied

iii) Shear, moment, deflection and contact pressure at various points were observed for various thickness and subgrade modulus.

iv) Finally results were compared.

1.5 Organization of the Report

The report is arranged into five chapters and two appendixes. In Chapter One, background and objectives of the project is described. Chapter Two contains the literature review.

Chapter Three describe the analysis. Chapter Four contains results and discussion. Chapter Five contains the conclusion and recommendation for further research. Table of analysis are presented in Appendix A and Appendix B.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

A mat foundation is a large concrete slab used to interface columns in several lines with the base soil. It occupies the entire foundation area. A raft foundation may be used where the base soil has a low bearing capacity and/or the column loads are so large that more than 50 percent of the area is covered by conventional spread footings. The methods available for analysis of such rafts are rigid beam analysis (conventional method) and Non-rigid or Elastic method. Rigid beam analysis can be used when the settlements are small. This is the simplest approach. It assumes that mat is infinitely rigid with negligible flexural deflection and the soil is a linear elastic material. It also assumes the soil bearing pressure is uniform across the bottom of the footing if only concentric axial loads are present or it varies linearly across the footing if eccentric or moment loads are present. Although this type of analysis is appropriate for spread footing, it does not accurately model mat foundations.

Mats are not truly rigid, so the settlement beneath the columns will be greater than that beneath unloaded areas. These differential settlements will cause variations in the soil bearing pressure and corresponding changes in the flexural stresses in the mat. Mat can be analyzed by using various methods. Finite element analysis is the most accurate way of analyzing the raft in which raft can be considered as plate resting on elastic foundation. The soil below the raft is treated as either Winkler foundation or elastic continuum [23].

2.2 Types of Mat Foundation

Mat foundations are designed and constructed in different pattern and varying types. There are several types of mat foundation, namely

i. Flat plate: the mat is of uniform thickness,
ii. Flat plate thickened under columns,

iii. Beam-slab system: This mat consists of up stand or down stand beams,
iv. Slab with basement walls as a part of the mat.

Figure 2-1 illustrates several possible mat-foundation configurations. Probably the most common mat design consists of a flat concrete slab 0.75 to 2 m thick and with continuous two-way reinforcing top and bottom. This type of foundation tends to be heavily overdesigned for three major reasons [4]:

i. Additional costs of analysis methods, which are, however, not exact.
ii. The extra cost of a reasonable overdesign of this element of the structure will generally be quite small relative to total project cost.
iii. The extra margin of safety provided for the modest additional cost.

The two types of mat foundation commonly used are uniform thickness and beam-slab system.

Uniform thickness mat

The uniform thickness mat is cast on a bed of blinding concrete and moisture-proof membrane to prevent damp rising through the slab [6]. This type of mat can be used in ground conditions where large settlements are not anticipated and hence a high degree of stiffness is not required. The slab is of uniform thickness and is reinforced top and bottom to resists bending moment [2].

Beam-slab mat foundation

Where the ground has poor compressibility the slab with beam/ beam-slab mat foundation which is to support the heavier loads of walls or columns a solid slab mat/ uniform thickness system would require considerable thickness. To make the economical use of reinforced concrete in a mat foundation supporting heavier loads it is practice to form a beam-slab mat. This mat consists of up stand or down stand beams that take the loads of wall or column and spread them to the monolithically cast slab which bears on natural subsoil. Figure 2-2 shows the two type of Beam-slab mat foundation [6].

2.3 Mat Loading

i. Concentrated Loads Through Columns

Dead load and live load of the superstructure are transmitted to the columns through beams and floors. All these loads come to the mat foundation as concentrated force [2].

ii. Self Wight

Self weight of the mat is considered as uniformly distributed load throughout the whole area. The value of this distributed force is counted per unit area and depends on the thickness of the mat itself [2].

iii. Soil Pressure

Due to the action of the vertical downward force, the soil gives upward reaction as distributed force. The shape of this upward distributed reaction depends on the type of loading, soil type, end condition, etc. [2].

iv. Buoyancy Force

When the water table comes near to the ground surface (i.e., depth of water table is less than depth of foundation) during reason, the raft is subjected to upward buoyancy force [2].

v. Seismic Force

Due to earthquake, the mat foundation is subjected to a base shear, V. it depends on the following factors [2]

$$V = (ZIC/R)\ W$$

Where Z = Seismic zone coefficient,

I = Structure importance coefficient,

R = Response modification coefficient for structural system,

W = Total seismic dead load,

C = Numerical co-efficient given by the relation:

$$C = 1.25S/T2/3$$

S = Site coefficient for soil characteristics,

T = Fundamental period of vibration in seconds.

2.4 Mat Settlement

Mat foundation are commonly used where settlements may be a problem, for example, where a site contains erratic deposits or lenses of compressible materials, suspended boulders, etc. The settlement tends to be controlled via the followings:

i. Use of a larger foundation to produce lower contract pressure.
ii. Displaced volume of soil (floatation effect); theoretically if the weight of excavation equals the combined weight of the structure and mat, the system "floats" in the soil mass and no settlement occurs.
iii. Bridging effects attributable to
    a. Mat rigidity
    b. Contribution of superstructure rigidity to the mat.
iv. Allowing somewhat larger settlements, say, 50 instead of 25 mm.

The flotation effect should enable most mat settlements, even where consolidation is a problem or piles are used, to be limited to 50 to 80 mm. A problem of more considerable concern is differential settlement. Again the mat tends to reduce this value. We can see in Figure 2-3 that bending moments ($6EI\Delta/L^2$) and shear forces ($12\,EI\Delta/L^3$) induced in the superstructure depend on relative movement A between beam ends. Mat continuity results in a somewhat lower assumed amount of differential settlement relative to the total expected settlement versus a spread footing as shows Table 2.1.

Computer methods that incorporate frame-foundation interaction can allow one to estimate both total and differential settlements. The total settlements will be only as good as the soil data, however, and if other than a strip from the mat is used as a beam-on-elastic foundation type of analysis, the computational effort is substantial.

The differential settlement may be arbitrarily taken as 20 mm (0.75 in.) if the total expected settlement ΔH is not more than 50 mm or may be approximated using a rigidity factor K_r

ACI Committee 336 [7] defined rigidity factor K_r as

$$K_r = \frac{EI_b}{EsB^3}$$

EI_b may be taken as

$$EI_b = EI_f + \sum EI_{bi} + \sum \frac{Eah^3}{12}$$

Where EI_b = flexural rigidity of the superstructure and mat

E = composite modulus of elasticity of superstructure frame

EI_f = footing or mat flexural rigidity

E_s = modulus of elasticity of soil

$\sum\frac{Eah^3}{12}$ = effective rigidity of shear walls perpendicular to *B*; *h* = height; *a* = wall thickness

$\sum EI_{bi}$ = rigidity of the several members making up the frame resistance perpendicular to *B*

B = base width of foundation perpendicular to direction of interest

ACI Committee 336 [7] suggests that mat differential settlements are related to both the total estimated foundation settlement ΔH and the structure rigidity factor K_r [4].

2.5 Design of Mat Foundation

There are several methods to design a mat (or plate) foundation [4].

1. An approximate method: The mat is divided into strips loaded by a line of columns and resisted by soil pressure. This strip is then analyzed as a combined footing. This method can be used where the mat is very rigid and the column pattern is fairly uniform in both spacing and loads.

2. Approximate flexible method: This method was suggested by ACI Committee 336 [7].

3. Discrete element methods: In these the mat is divided into elements by gridding. These methods include the following:

   a. Finite-difference method (FDM)

   b. Finite-element method (FEM)

   c. Finite-grid method (FGM)

2.6 Sub Grade Modulus of Soil

To calculate moment, shear and deflections in a mat foundation subjected to given loads, one has to determine the modulus of subgrade reaction (also called soil spring constant or coefficient of subgrade modulus). The modulus of subgrade reaction is a conceptual relationship between soil pressure and deflection that is widely used in the structural analysis of foundation members. It is defined as the ratio of the intensity of soil pressure (q) to the soil deflection (δ) at a point of the surface of contact and expressed as [4],

$$K_s = \frac{q}{\delta}$$

The coefficient of sub grade reaction, K_s, identifies the characteristics of foundation supporting and has a dimension of force per length cubed. Many researches including Biot [24], Terzaghi [25], Vesic [26], and most recently Daloglu and Vallabhan [27] have investigated the effective factors and determination approaches of K_s. Geometry and dimensions of the foundation and soil layering are assigned to be the most important effective parameters on K_s. Generally K_s can be obtained by plate load test.

Many researchers have worked to develop a technique to evaluate the modulus of subgrade reaction, K_s. Terzaghi [25] made some recommendations where he suggested values of K_s for 1×1 ft rigid slab placed on a soil medium; however, the implementation or procedure to compute a value of K_s for use in a larger slab was not specified. Biot [24] solved the problem for an infinite beam with a concentrated load resting on a 3D elastic soil continuum. He found a correlation of the continuum elastic theory and Winkler model where the maximum moments in the beam are equated [23].

2.7 Deep Beam on Beam-Slab Mat

Beam-slab mat consists of up stand or down stand deep beams that take the loads of wall or column and spread them to the monolithically cast slab which bears on natural subsoil.

Some concrete members have depth much greater than normal, in relation to their span, while the thickness in the perpendicular direction in much smaller than either span or depth. The main loads and reactions act in the plane of the member and a state of plane stress in the concrete is approximated. Members of this type are called deep beams. They can be defined, as beams having a ratio of span to depth l_n/h of about 5 or less or having a shear span a less than about twice the depth.

Examples of members of this type are found in transfer girders used in multistory buildings to provide column offsets in foundation walls, walls of rectangular Tanks and bins, floor diaphragms and shear walls as well as in folded plate roof structures. The behaviors of deep beams are significantly different from that of beams of more normal proportions requiring special consideration in analysis, design and detailing of reinforcement.

Deep beams are usually loaded along the top edge as in the Figure 2-4 (a), with reactions provided at the bottom. However in some cases, e.g., the side walls of storage bins, the loads may be applied along the bottom edge, as in the Figure 2-4(b). Loads also be applied more or less uniformly throughout the depth, as in the Figure 2-4 (c), by other deep members framing in the right angles and reactions may also be distributed through the depth. Deep beams may be simply supported or continuous. Because of their proportions, they are likely to have strength controlled by shear. On the other hand, their shear strength is likely to significantly greater than predicted by the usual equations. Special design methods account for these differences [28].

Table 2-1: Total allowable settlement [4]

Foundation type	Allowable maximum settlement (mm)	Allowable differential settlement (mm)
Spread	25	20
Mat	50	20

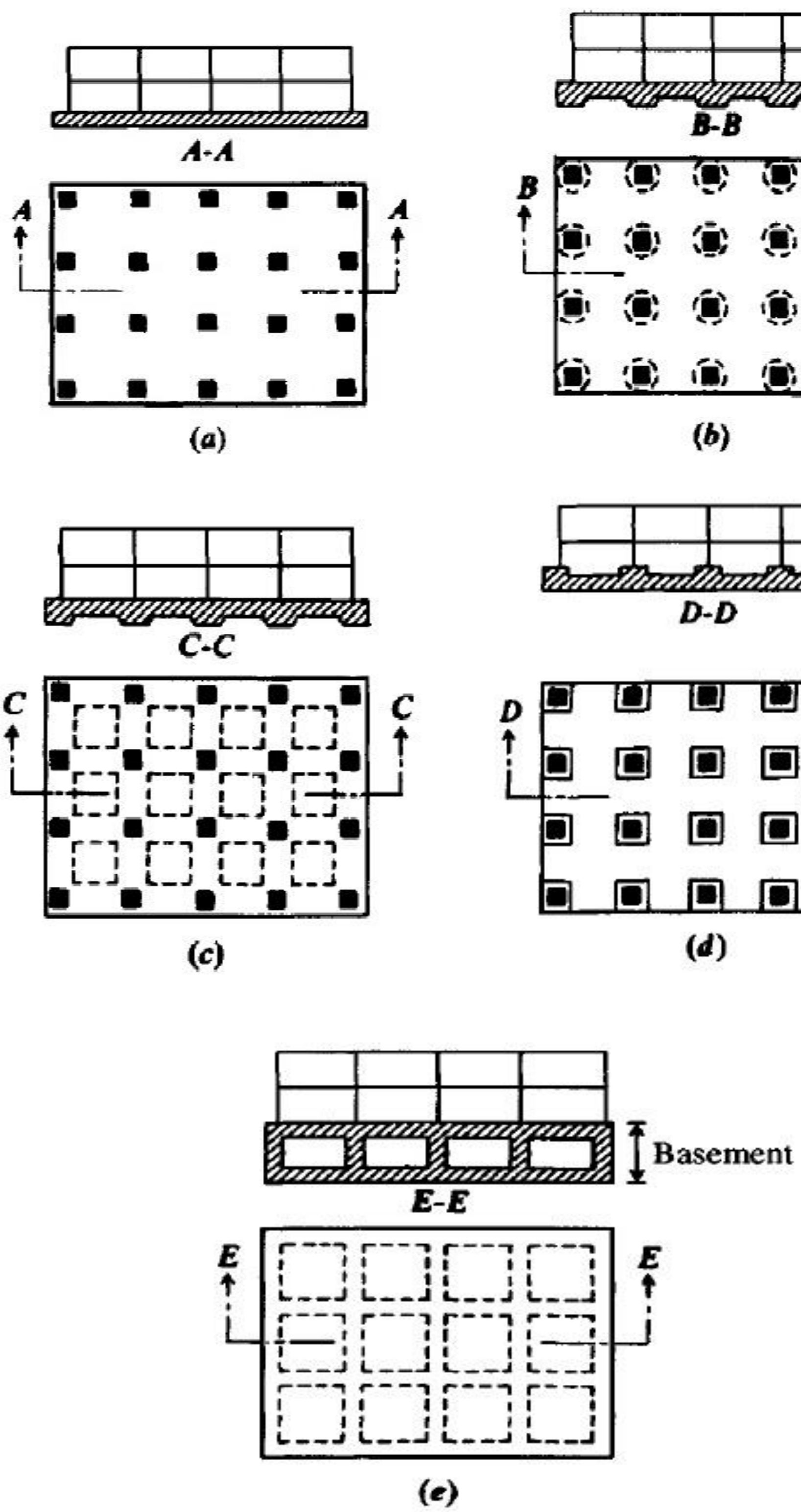

Figure 2-1: Common types of mat foundation. (a) Flat plate; (b) plate thickened under columns; (c) and (d) beam-slab system; (e) basement walls as part of mat [4].

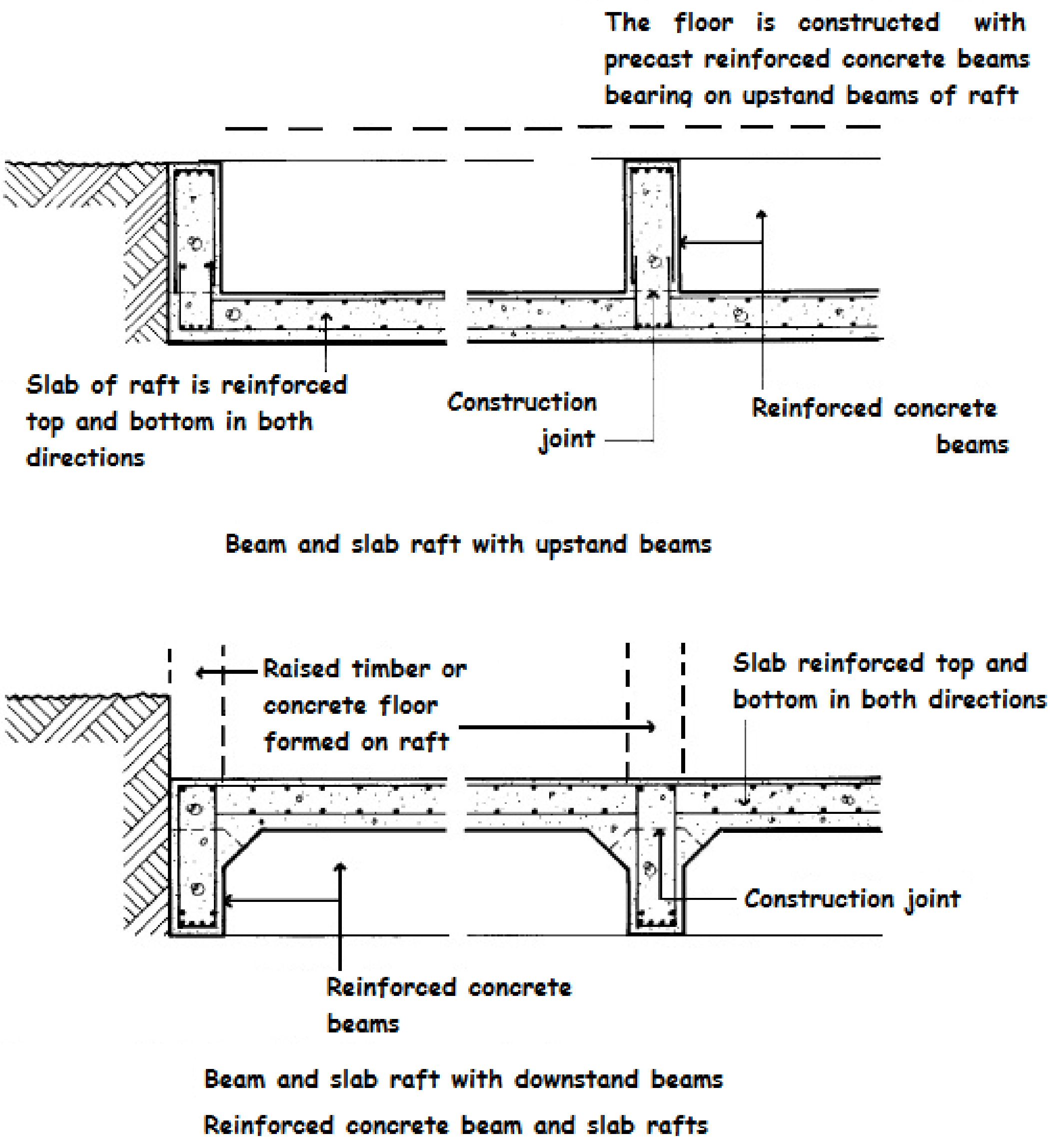

Figure 2-2: Beam-slab system mat foundation [6].

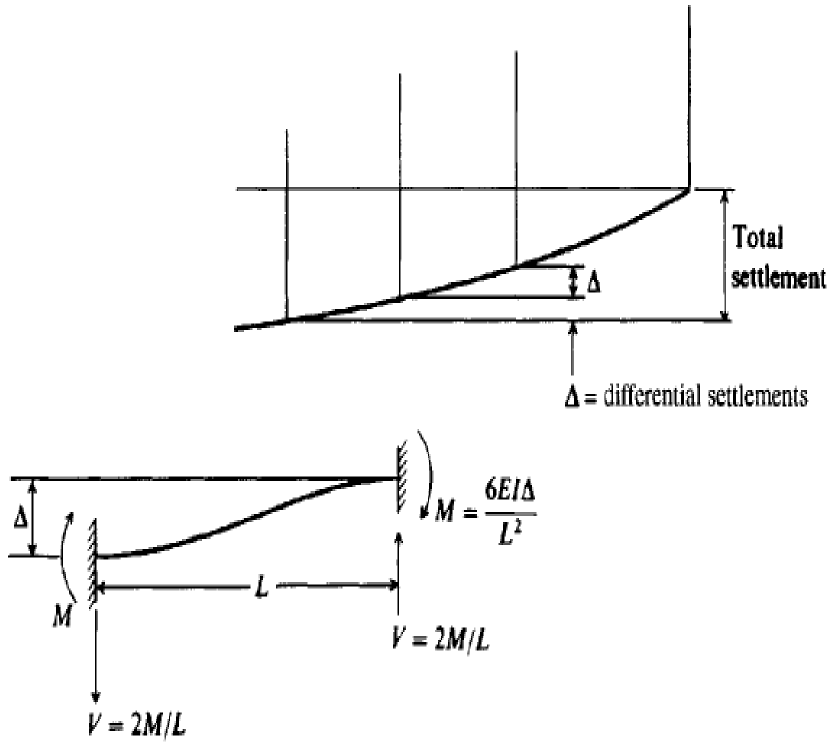

Figure 2-3: Reduction of bending moments in superstructure by using mat foundation. Bending moment M is based on differential settlement between columns and not on total settlement [4].

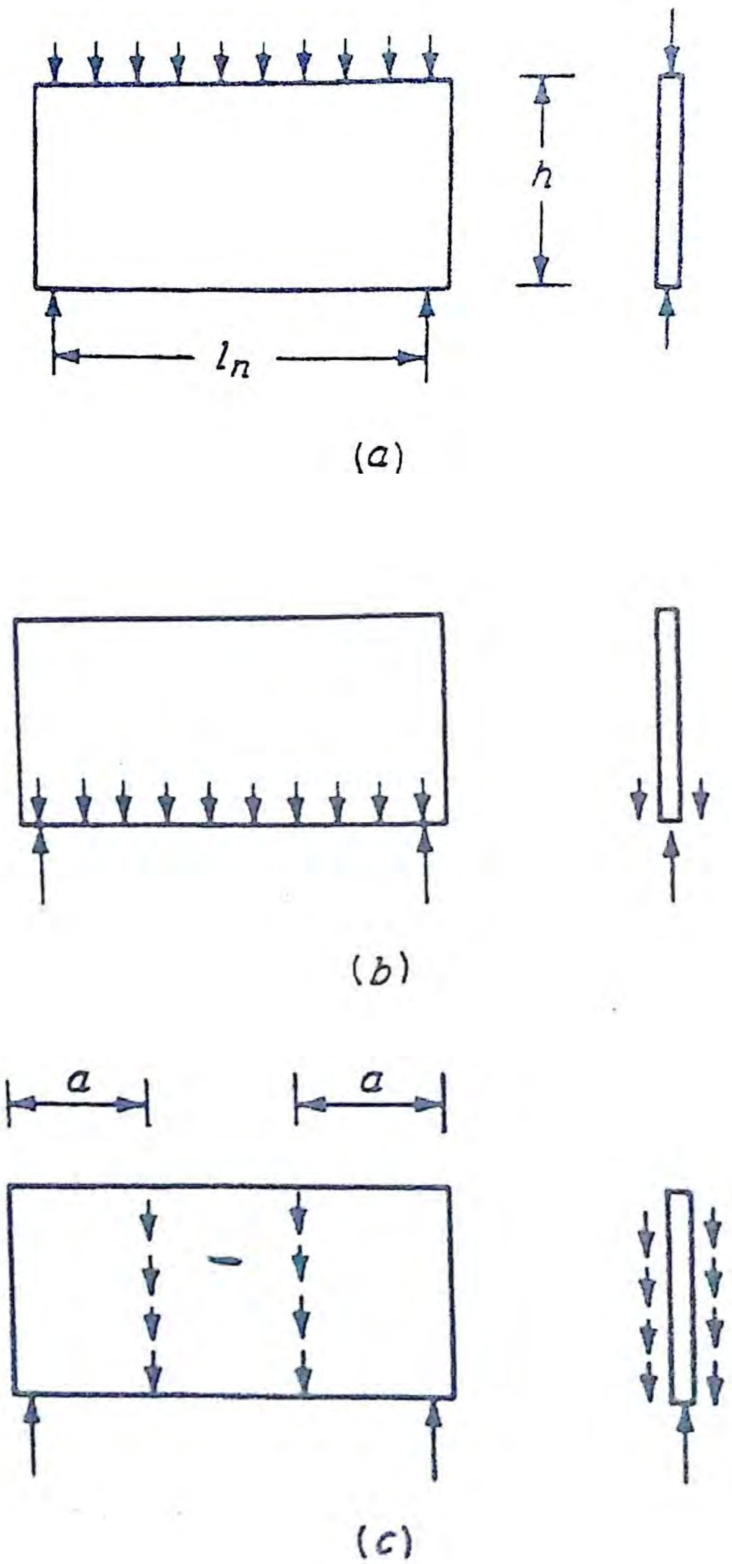

Figure 2-4: Placement of loads on deep beams: (a) loads applied along the compression edge; (b) loads suspended along the tension edge; (c) loads distributed through depth [28].

CHAPTER 3
NUMERICAL MODELING AND ANALYSIS

3.1 General

Finite element method is the most powerful and versatile of all the available numerical analysis techniques. In this method the structure to be analyzed is modeled as an assemblage of a finite number of elements and the displacements of the connecting points. Mat foundation is a three dimensional thick plate structure. When superstructure loads are being transferred, mat transverse bending moment and flexural shear are the most important internal forces produced in response to the loads. Superstructural loads are axial column forces and column base transferred moments. Thick plate option has been taken into considerations readily available in most recent and pioneer mat foundation analysis and design by Finite Element Method named SAFE. For the study, idealized 25 (twenty five) storey buildings with mat foundation of beam-slab system and uniform thickness system have been modeled and analyzed for gravity loads using three dimensional structural analysis software ETABS. Three dimensional analysis model support reactions i.e. axial forces and base moments have been transferred to finite element mat foundation analysis software SAFE.

3.2 Description of the Building

The structure consisted of a 25 storey commercial building with three underground basements having shear walls. This model had eight bays in X- direction and six bays in Y-direction. In this model column center to center spacing (7.62m) and beam cross sectional properties were taken uniform. Column size was varying with height of building. In the case with uniform height the building covered total land area whereas in the case with non-uniform height the building covered total land area from ground floor to 7 stories and after that it covered 75% of the total land area. Figure 3-1, 3-2, 3-3 and 3-4 shows the picture of the model of the structure.

3.3 Structural Idealization

The Mat of beam-slab system and uniform thickness system were analyzed with loads from 25 story reinforced concrete building with uniform and non-uniform height. While analyzing the mat effect of changing of the variable parameter was observed. The variations of parameters of these models were given in Table 3-1. The edges of mat were restrained by roller support. That means the mat was restrained in all edges horizontally. Vertically there was soil support under the mat. Soil support was directly given as subgrade modulus in the software. Boundary conditions of mat are shown in Figure 3-5.

The material properties of mat were taken as follows –

Poison's ratio, $\mu = 0.25$

Modulus of elasticity, E = 24.86 GPa (3604 ksi) and 27.78 GPa (4030 ksi)

Shear modulus, G = 10.36 GPa (1500 ksi) and 11.57 GPa (1680 ksi)

Concrete strength, f'c = 27.6 MN/m^2 (4 ksi) for slab

Concrete strength, f'c = 34.5 MN/m^2 (5 ksi) for column and beam

And steel yield strength, fy = 414 MN/m^2 (60 ksi).

3.4 Analysis of Mat Foundation

The Mats were analyzed by the Finite Element Method (FEM) using the software SAFE. Maximum mesh size 1.20 m (4 ft) has been taken to get satisfactory accuracy of results.

3.6 Geometry of the Mat Foundation

A 63 m x 47 m (206 ft x 156 ft) mat foundation was used to carry the loads from a 25 storied building. Figure 3-5 shows the layout of mat foundation. Mat thickness was 254 cm (100 inches) for uniform thickness and 91 cm (36 inch) and beam 137 cm x 213 cm (54 in X 84 in) for beam-slab system. Reference Modulus of sub grade reaction of soil is 16 MN/m^3 (100 k/ft^3). The Mat is extended by 91 cm (3 ft) from the centre of column. Column size is 137 x 137 cm^2 (54 x 54 in^2).

Table 3-1: Variations of parameters of the models

Parameters		Reference value	Ranges of variations
Modulus of sub grade Reaction		16 MN/m^3 (100 k/ft^3)	11, 16, 31, 63, 125. MN/m^3 (72, 100, 200, 400, 800 k/ft^3)
Mat thickness	Uniform thickness system	254 cm (100 inch)	213, 244, 254, 274, 305 cm (84, 96, 100, 108, 120 inch)
	Beam-slab system	91 cm (36 inch)	91, 152 cm (36, 60 inch)
Beam size for mat of beam-slab system		137 cm X 213 cm (54 in X 84 in)	137 cm X 213 cm (54 in X 84 in)

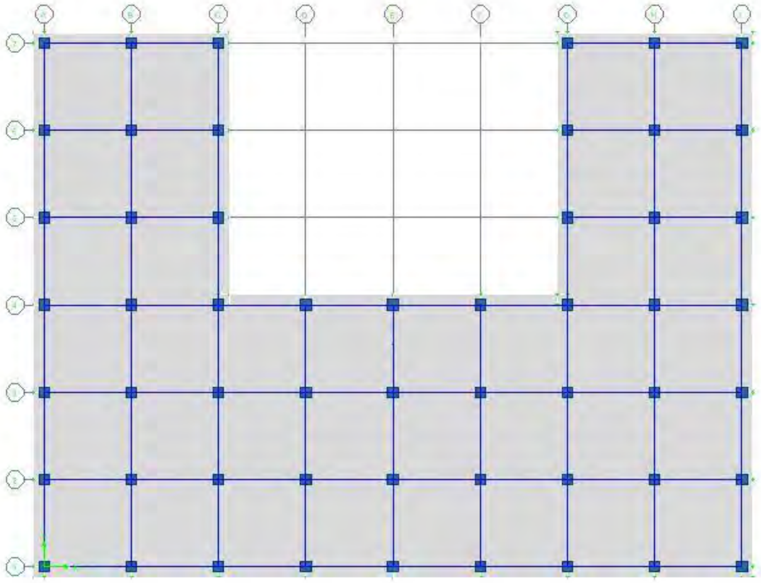

Figure 3-1: Column, beam and slab of non-uniform structure from story 8 to 25.

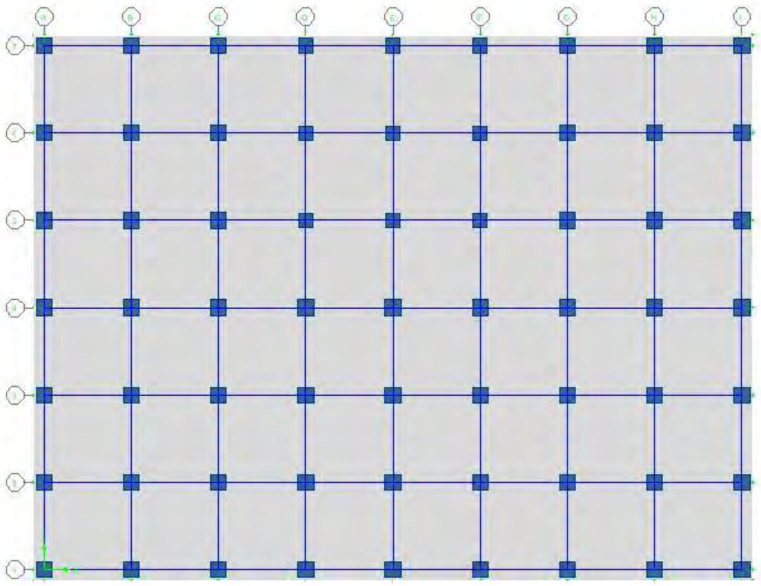

Figure 3-2: Column, beam and slab of non-uniform structure from Basement-3 to story 7.

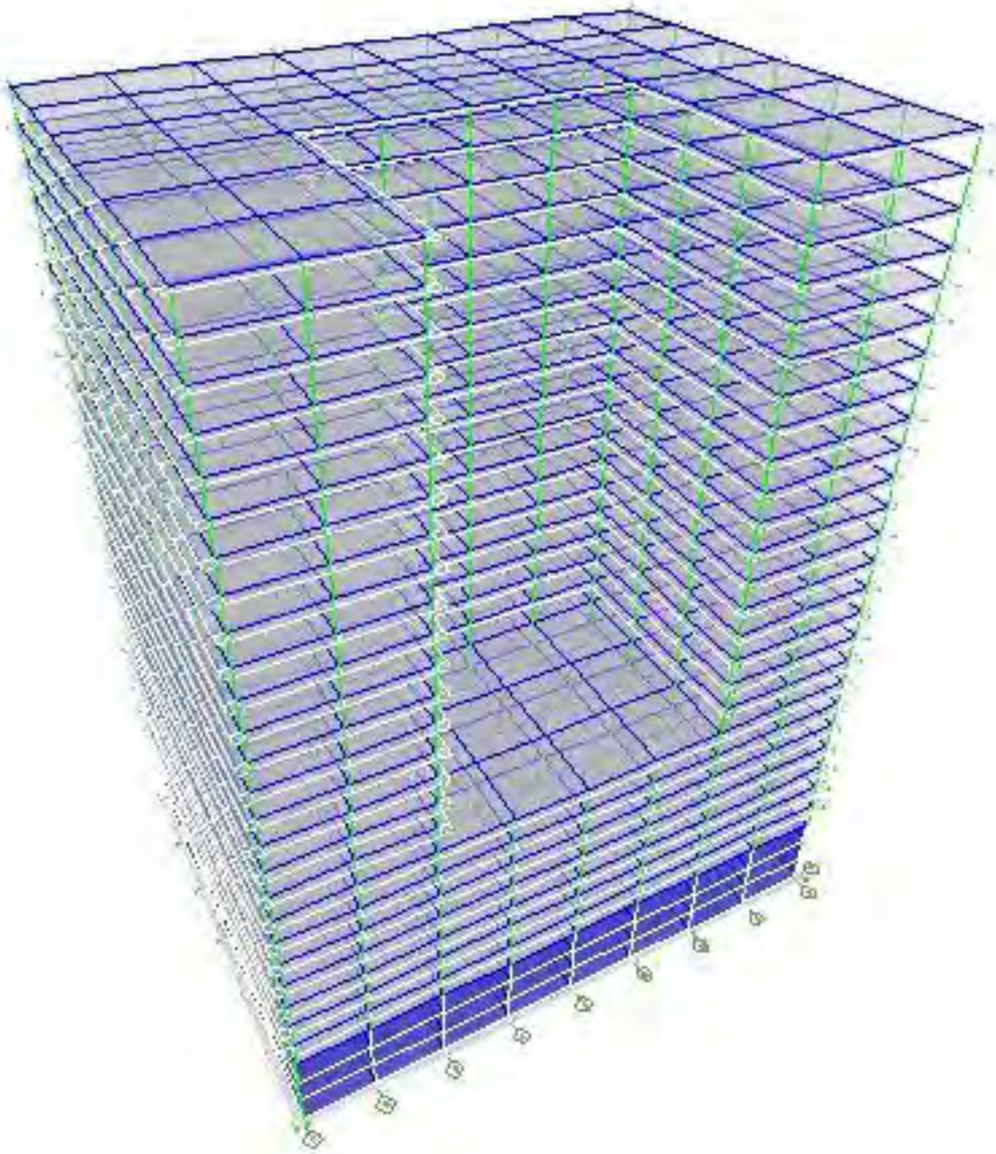

Figure 3-3: 3D view of the finite element model of non-uniform structure.

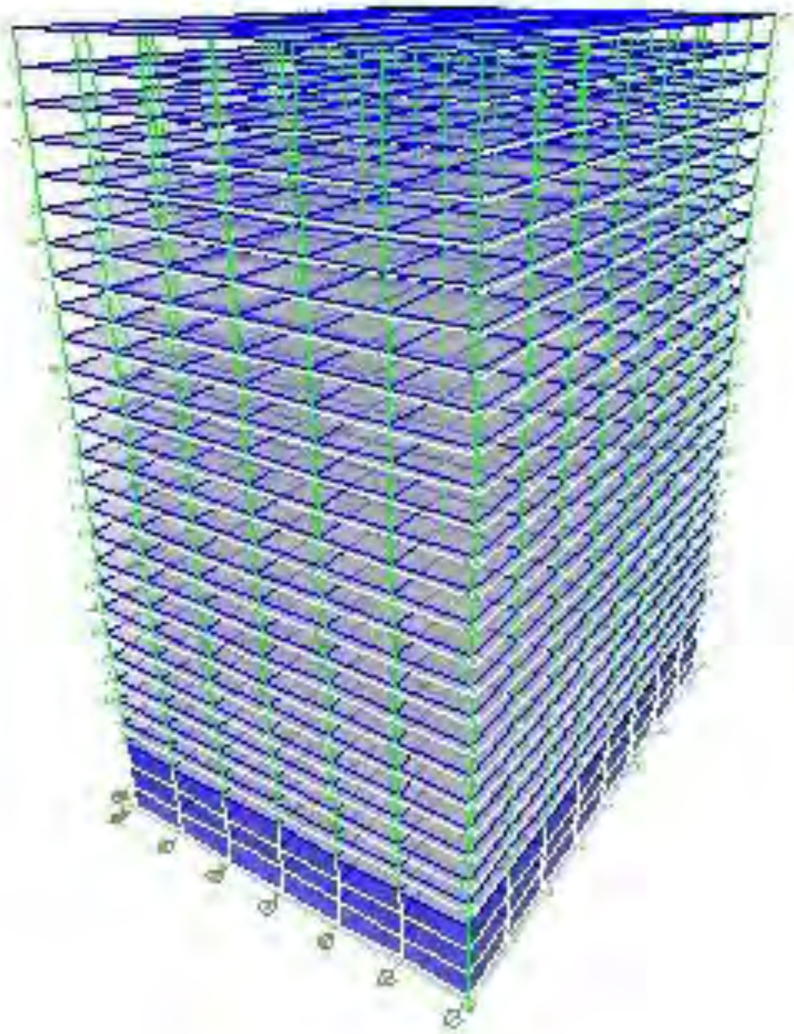

Figure 3-4: 3D view of the finite element model of uniform structure.

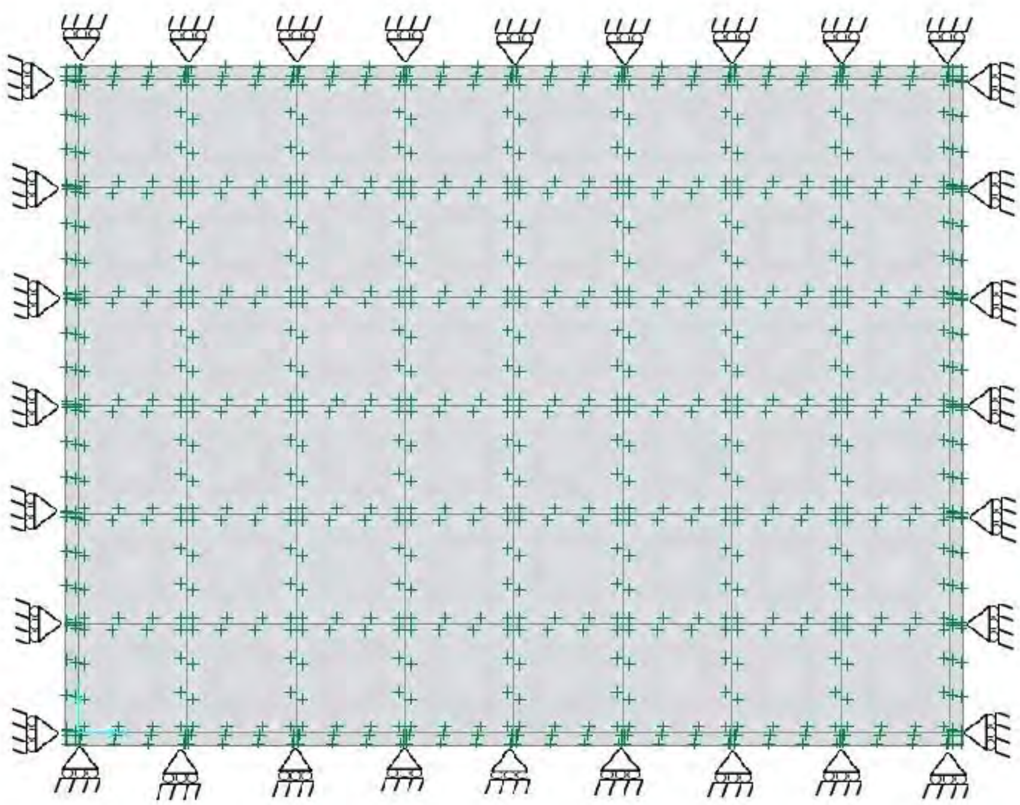

Figure 3-5: A 63 m x 47 m (206 ft x 156 ft) Mat Foundation with soil support and boundary condition

CHAPTER 4
RESULT AND DISCUSSION

4.1 General

Mat is a three dimensional thick plate structure that acts integrally with the building frame and supported by soil strata. Now-a-days, parking access for high rise building is totally dependent on underground basement. Available methods do not emphasis different structural parameters such as modulus of sub grade reaction, mat thickness, column spacing, column size and mat foundation interactions. Variation of these parameters can influence the behavior of mat significantly. For present study subgrade modulus and mat thickness were varied. The effect of subgrade modulus and mat thickness on shear, moment, deflected shape and contact pressure were observed.

4.2 Effect of Sub grade Modulus

To observe the "Effect of sub grade modulus" the mats were analyzed with different sub grade modulus (K_s) without changing the geometry and load condition. The variable parameter of sub grade modulus (K_s) are given in Table 3-1. Geometry of mat is as Shown in Figure 3-5.

Design parameters were observed for unfactored gravity load only. As the mats were asymmetric with geometry and load, so M11 and M22 were not similar. For same reason V13 and V23 were not similar. Where M11 and M22 are bending moments out of plane and V13 and V23 are transverse shear out of plane. Contact pressure and soil pressure are same. The mat must meet the punching shear criteria. For different sub grade modulus (K_s), the contour for shear, moment, deflected shape and contact pressure were obtained.

4.2.1 Defining observation points

From the contour diagram shear, moment, deflection and contact pressure/soil pressure were obtained at any point for different sub grade modulus. Some points were chosen for observation. Shear V13, moment M11, deflection and contact pressure/soil pressure were taken directly under interior columns line (GLY-6), (GLY-3), (GLX-5), and along middle of an interior panel (GLY-56), (GLX-45). The various observation points along column line for moment, shear, deflection and contact pressure/soil pressure are shown in Figure 4-1.

4.2.2 Influence of subgrade modulus on Shear

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various values of subgrade modulus, shear was obtained from shear contour. These values were obtained from the finite element analysis by SAFE. Shears are represented both in tabular form and graphically. Figure 4-2 to Figure 4-13 represent shear force diagrams for columns line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of shear are shown in Table A-1 to Table A-10.

It is observed that the values of negative shear increase and positive shear decrease with the increase of subgrade modulus for all cases. But from the analysis, it has been seen that the shear value of uniform height of building is greater than that of non-uniform height of building. It has been also seen that the shear value of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.2.3 Influence of subgrade modulus on Moment

Moment for an interior column line (GLY-6), (GLY-3) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various values of subgrade modulus was obtained from moment contour. These values were obtained from the finite element analysis by SAFE. Moments are represented both in tabular form and graphically. Figure 4-14 to Figure 4-27 represent moment diagrams for columns line (GLY-6), (GLY-3) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of moment are shown in Table A-11 to Table A-22.

It is observed that the value of negative moment decreases and positive moment increase with the increase of subgrade modulus for all cases. But from the analysis results it has been seen that the moment of uniform height of building is greater than that of non-uniform height of building. It has been also seen that the moment of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.2.4 Influence of sub grade modulus on Deflection

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various values of subgrade modulus, deflection was obtained from deflection contour. These values were obtained from the finite element analysis by SAFE. Deflections are represented both in tabular form and graphically. Figure 4-28 to Figure 4-39 represent deflection diagrams for column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of deflection are shown in Table A-23 to Table A-32.

It is observed that deflection decreases with the increase of subgrade modulus for all cases. But from the analysis results it has been seen that deflection of uniform height of building is greater than that of non-uniform height of building. It has been also seen that deflection of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building. But the change is not significant.

4.2.5 Influence of sub grade modulus on contact pressure

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various values of subgrade modulus, contact pressure was obtained from contact pressure contour. These values were obtained from the finite element analysis by SAFE. Contact pressure is represented both in tabular form and graphically. Figure 4-40 to Figure 4-51 represent contact pressure diagrams for column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of contact pressure are shown in Table A-33 to Table A-42.

It is observed that contact pressure increases with the increase of subgrade modulus for all cases. From the analysis results it has been seen that contact pressure of uniform height of building is greater than that of non-uniform height of building. It has been also seen that contact pressure of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.3 Effect of Mat Thickness

To observe the "Effect of mat thickness" the mats were analyzed with different mat thickness without changing the sub grade modulus, area and load condition. Modulus of sub grade reaction has been taken 16 MN/m^3 (100 k/ft^3).

Shear, moment, deflected shape and contact pressure or soil pressure was observed to assess the effect of change in mat thickness. Increasing mat thickness results in increase of self-weight of mat. Table 3-1 represented the variation of mat thickness in analysis.

Design parameters were observed for unfactored gravity load only. As the mat was asymmetric with geometry and load, so M11 and M22 were not similar. For same reason V13 and V23 were not similar. The mat must meet the punching shear criteria. For different mat thickness the contour for shear, moment, deflection and contact pressure were obtained from the finite element analysis by SAFE program.

4.3.1 Defining observation points

From the contour diagram shear, moment, deflection and contact pressure/soil pressure were obtained at any point for different mat thickness. Some points were chosen for observation. Shear V13, moment M11, deflection and contact pressure/soil pressure were taken directly under an interior columns line (GLY-6), (GLY-3) and (GLX-5) and along middle of an interior panel (GLY-56) and (GLX-45). The various observation points along column line for moment, shear, deflection and contact pressure are shown in Figure 4-1.

4.3.2 Influence of mat thickness on Shear

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various mat thickness, shear values were obtained from shear contour. These values were obtained from the finite element analysis by SAFE. Shears are represented both in tabular form and graphically. Figure 4-52 to Figure 4-61 represent shear force diagrams for column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of shear are shown in Table B-1 to Table B-8.

It is observed that the values of shear (both positive and negative) increases with the increase of mat thickness as self-weight of mat increases with thickness for all cases. From the analysis, it has been seen that the shear value of uniform height of building is greater than that of non-uniform height of building. It has been also seen that the shear value of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.3.3 Influence of mat thickness on Moment

Moment for an interior column line (GLY-6), (GLY-3) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various values mat thickness was obtained from moment contour. These values were obtained from the finite element analysis by SAFE. Moments are represented both in tabular form and graphically. Figure 4-62 and Figure 4-73 represent moment diagrams for column line (GLY-6), (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of moment are shown in Table B-9 to Table B-18.

It is observed that the value of negative moment increases with the increase of mat thickness as self-weight increases with thickness and positive moment decreases with mat thickness for all cases. From the analysis results it has been seen that the moment of uniform height of building is greater than that of non-uniform height of building. It has been also seen that the moment of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.3.4 Influence of mat thickness on Deflection

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various mat thicknesses, deflection was obtained from deflection contour. These values were obtained from the finite element analysis by SAFE. Deflections are represented both in tabular form and graphically. Figure 4-74 to Figure 4-83 represent deflection diagrams for column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of deflection are shown in Table B-19 to Table B-26.

To increase mat thickness results in increase of self-weight of mat. So deflection increases with the increase of mat thickness. From the analysis results it has been seen that deflection of uniform height of building is greater than that of non-uniform height of building. It has been also seen that deflection of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building. But the change is not significant.

4.3.5 Influence of mat thickness on contact pressure

For an interior column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) of the mat, with various mat thickness, contact pressure was obtained from contact pressure contour. These values were obtained from the finite element analysis by SAFE. Contact pressure is represented both in tabular form and graphically. Figure 4-84 to Figure 4-93 represent contact pressure diagrams for column line (GLY-6) and (GLX-5) and middle of an interior panel (GLY-56) and (GLX-45) for uniform thickness mat and beam-slab mat of both uniform height and non-uniform height. The tabular forms of contact pressure are shown in Table B-27 to Table B-34.

It has been observed that contact pressure increase with the increase of mat thickness for all cases. From the analysis results it has been seen that contact pressure of uniform height of building is greater than that of non-uniform height of building. It has been also seen that contact pressure of uniform thickness mat is greater than that of beam-slab mat for both uniform height and non-uniform height of building.

4.5 Concluding Remarks

The uniform height and non-uniform height of idealized 25 (twenty five) storey buildings with mat foundation of beam-slab system and uniform thickness system were modeled and analyzed both for vertical and lateral loads with renowned three dimensional structural analysis software ETABS. Three dimensional analysis model support reactions i.e. axial forces and base moments were transferred to finite element mat foundation analysis software SAFE. It has been observed that the effects of sub grade modulus and mat thickness on the values of shear, moment, deflected shape and contact pressure of mat foundation for uniform height of building are higher than those of non-uniform height of building. It has been observed that the effects of sub grade modulus and mat thickness on the values of shear, moment, deflected shape and contact pressure of mat foundation of uniform thickness mat is higher than those of beam-slab mat for both uniform height and non-uniform height of building.

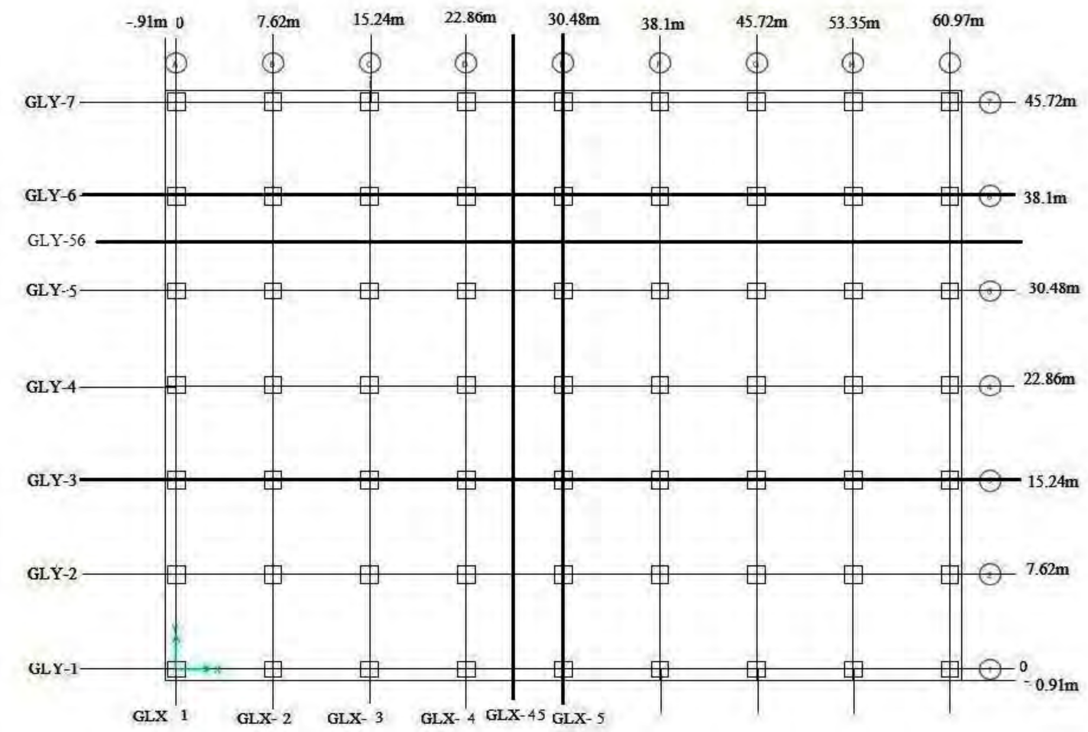

Figure 4-1: Plan of mat-defining grid lines and coordinates.

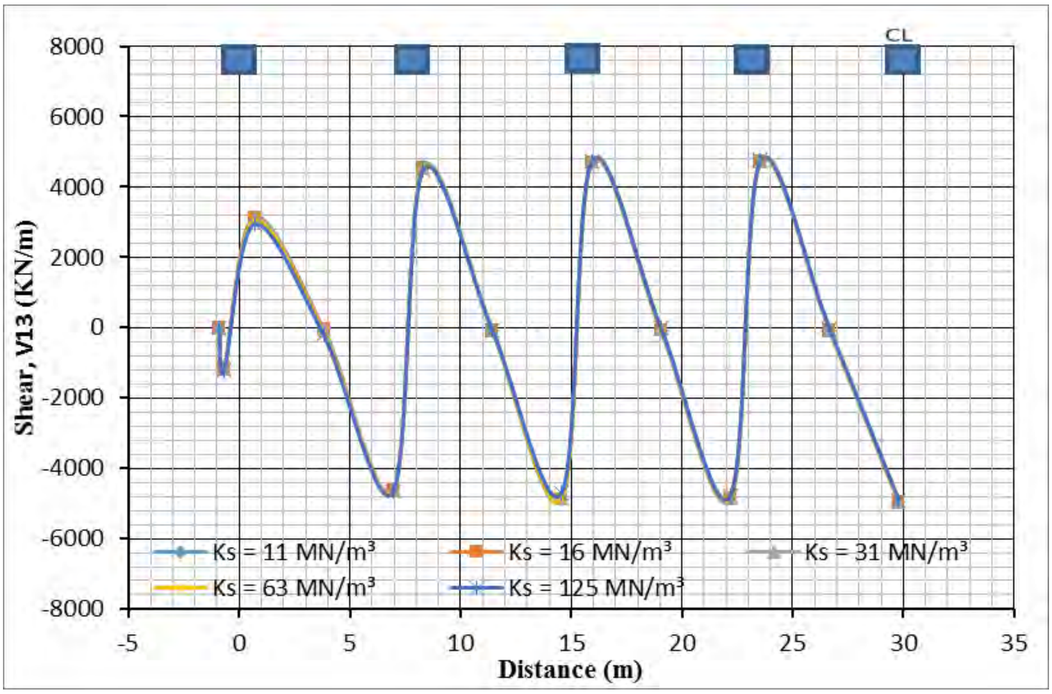

Figure 4-2: Shear along column line (GLY-6) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

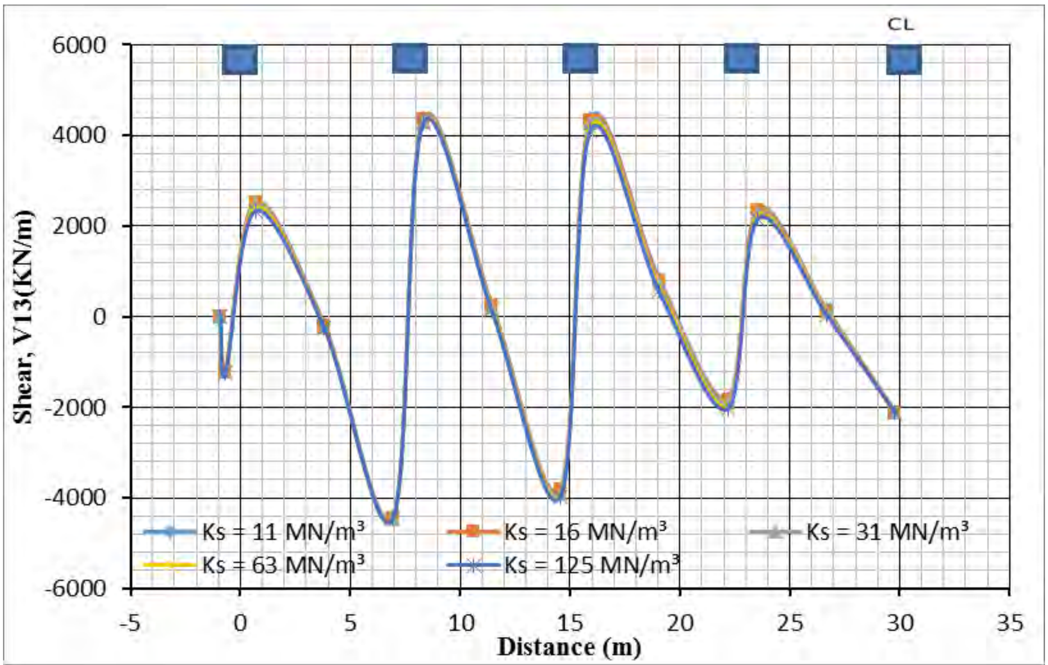

Figure 4-3: Shear along column line (GLY-6) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

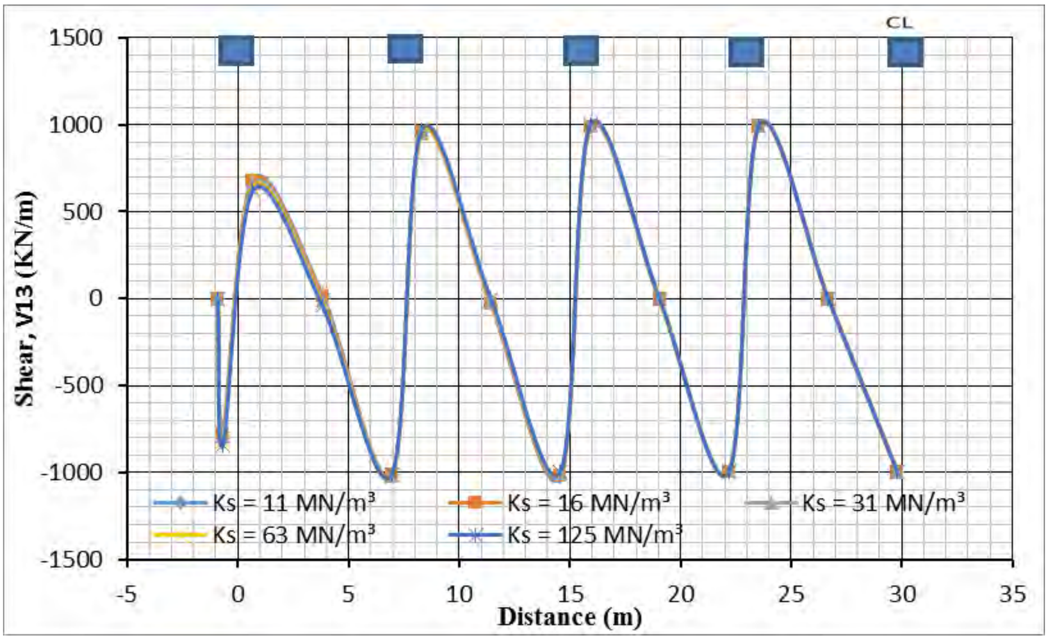

Figure 4-4: Shear along column line (GLY-6) for beam-slab mat of uniform height building at different subgrade modulus of foundation soil.

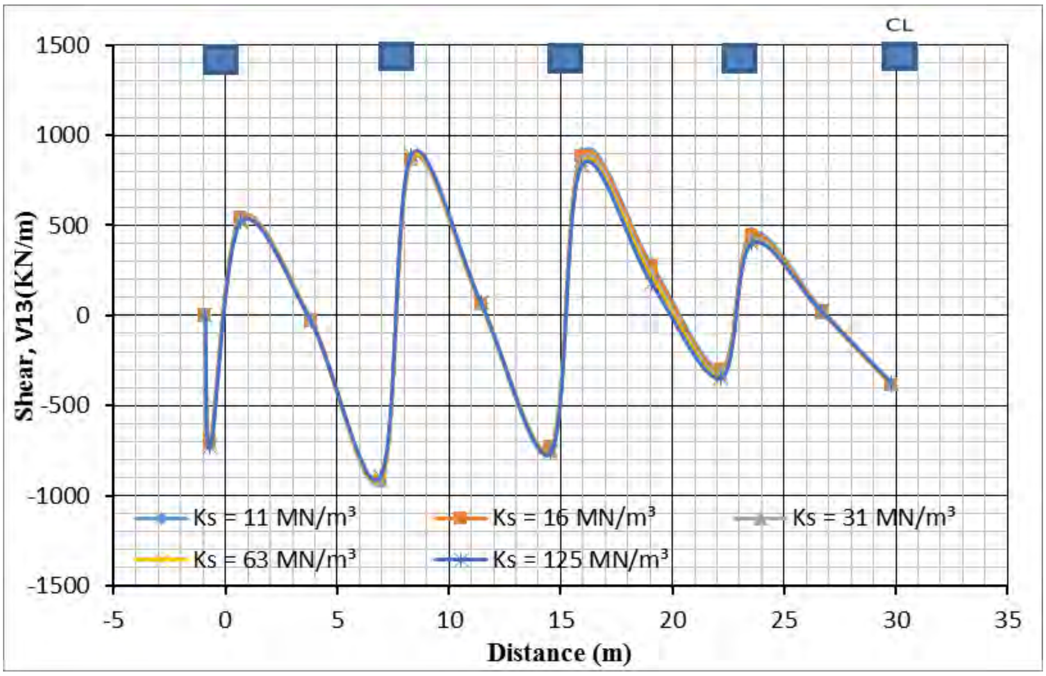

Figure 4-5: Shear along column line (GLY-6) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

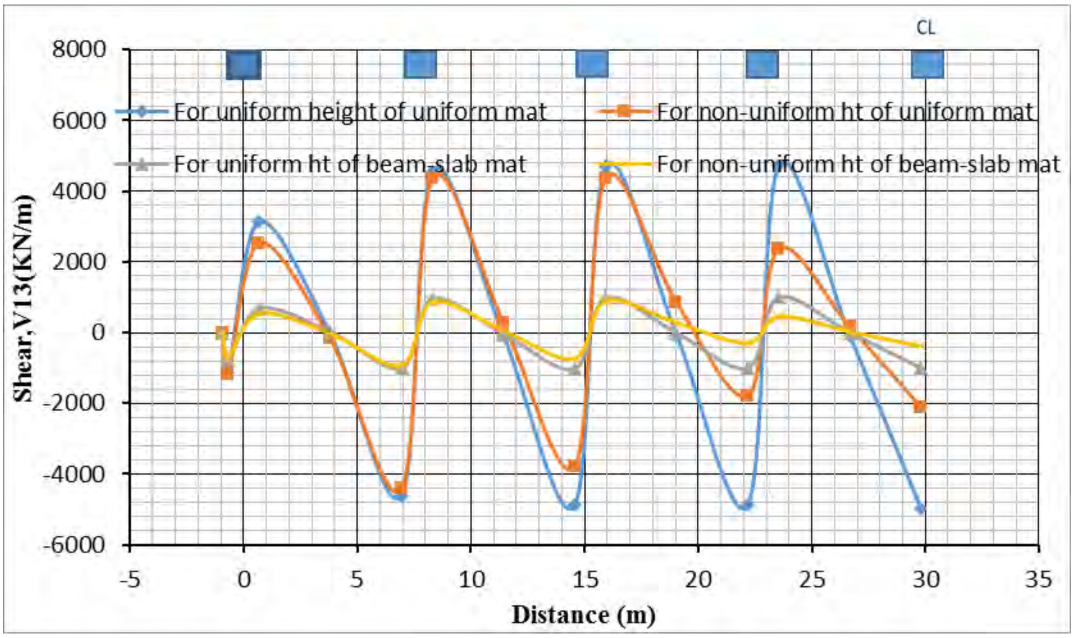

Figure 4-6: Shear along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

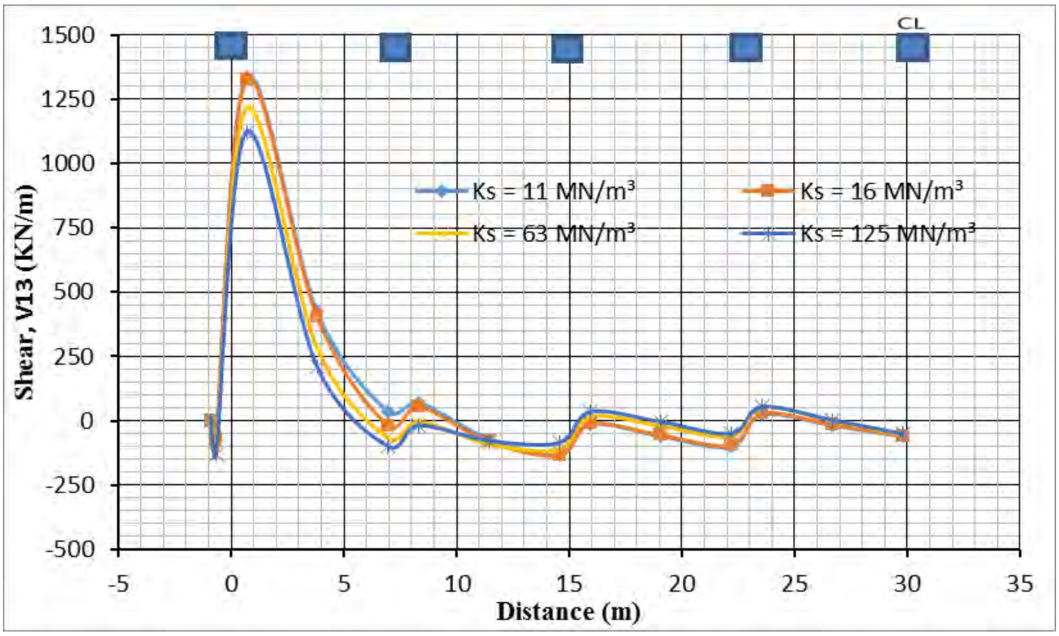

Figure 4-7: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

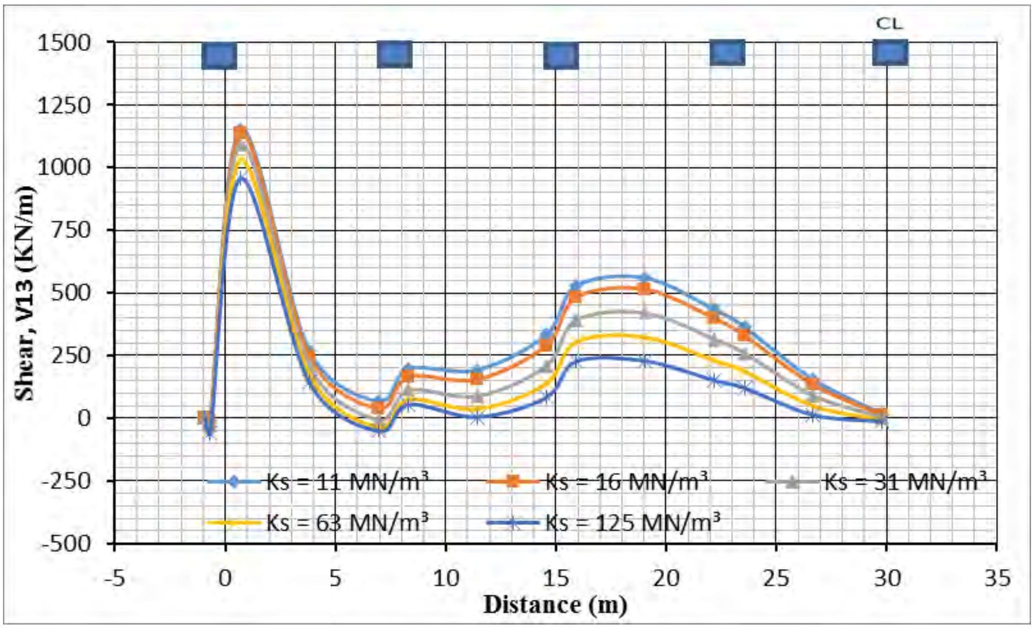

Figure 4-8: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

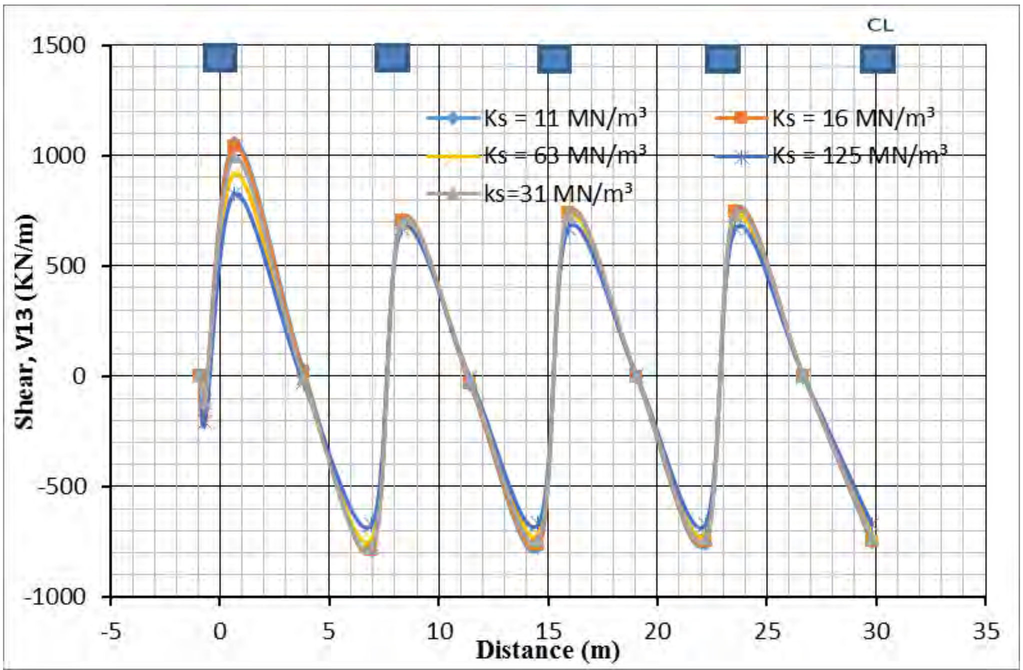

Figure 4-9: Shear along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

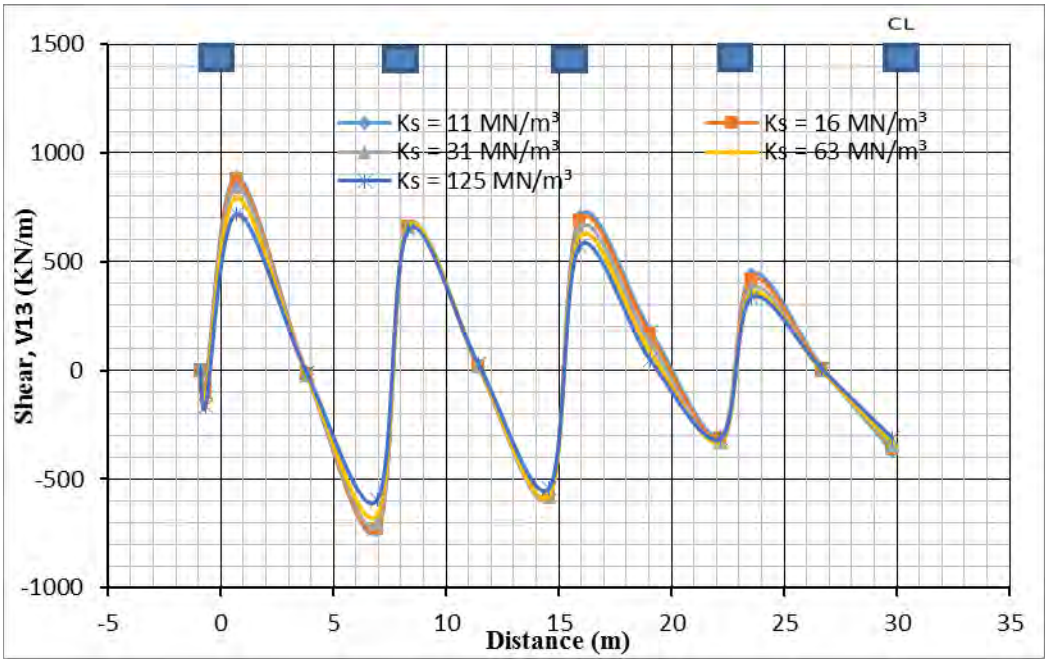

Figure 4-10: Shear along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

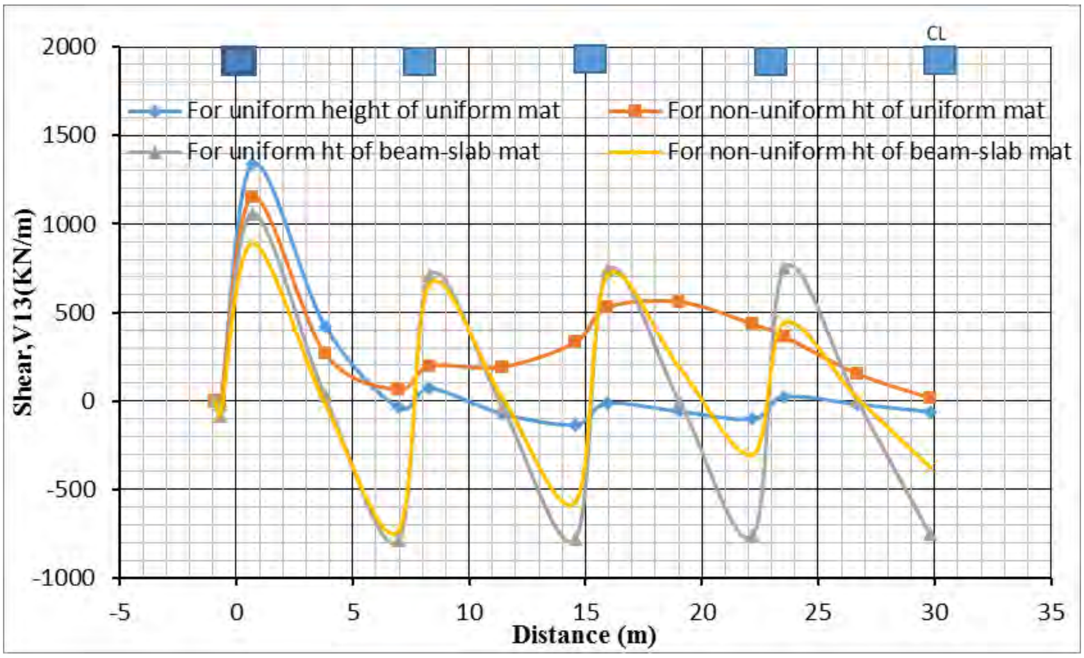

Figure 4-11: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

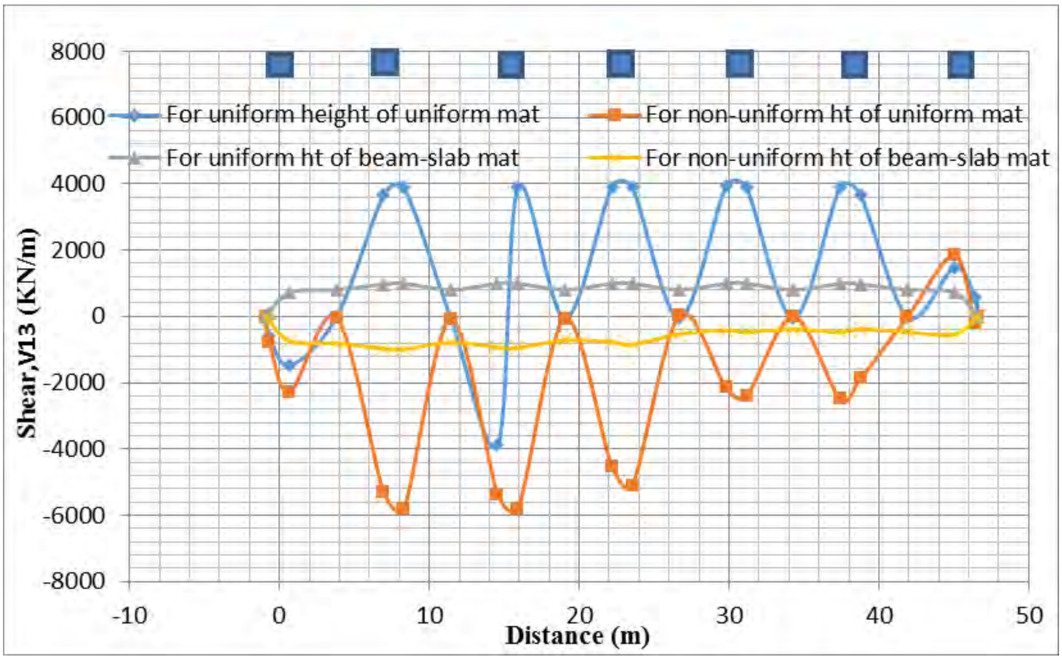

Figure 4-12: Shear along column line (GLX-5) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

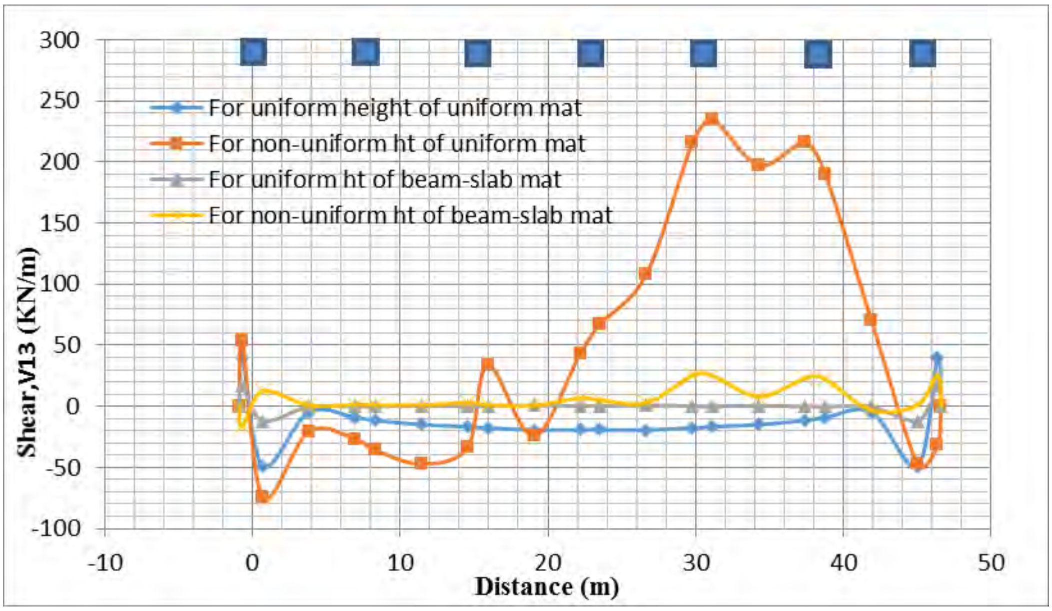

Figure 4-13: Shear along middle of an interior panel (GLX-45) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

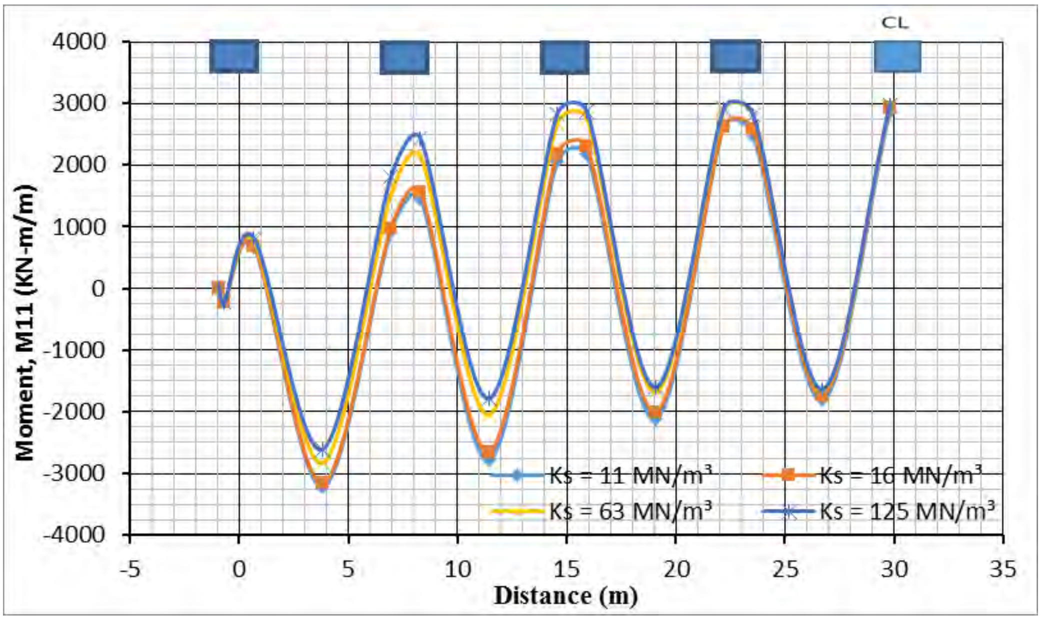

Figure 4-14: Moment along column line (GLY-6) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

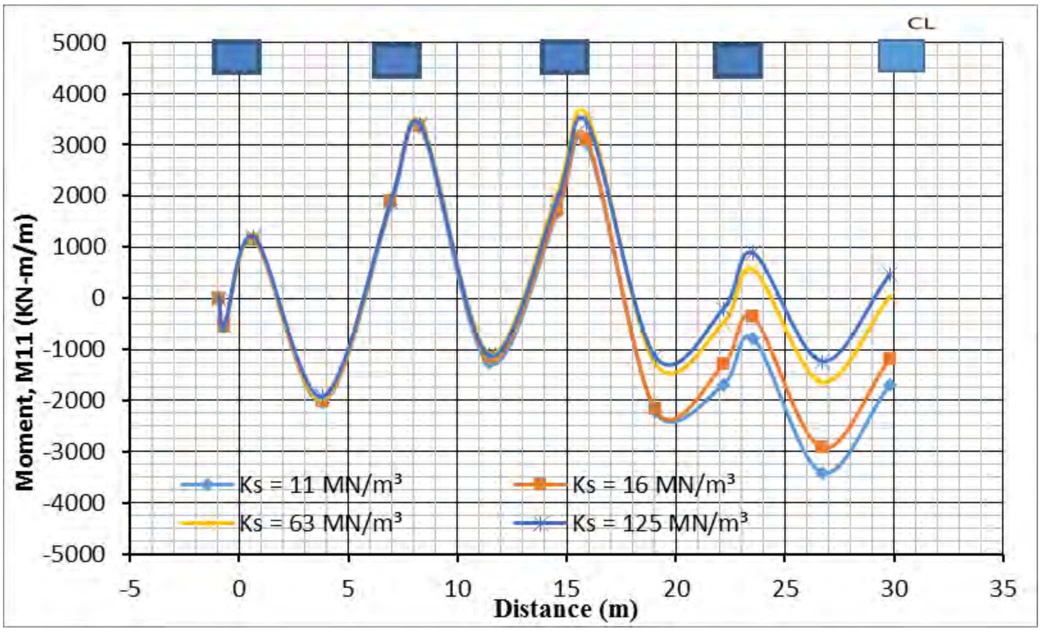

Figure 4-15: Moment along column line (GLY-6) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

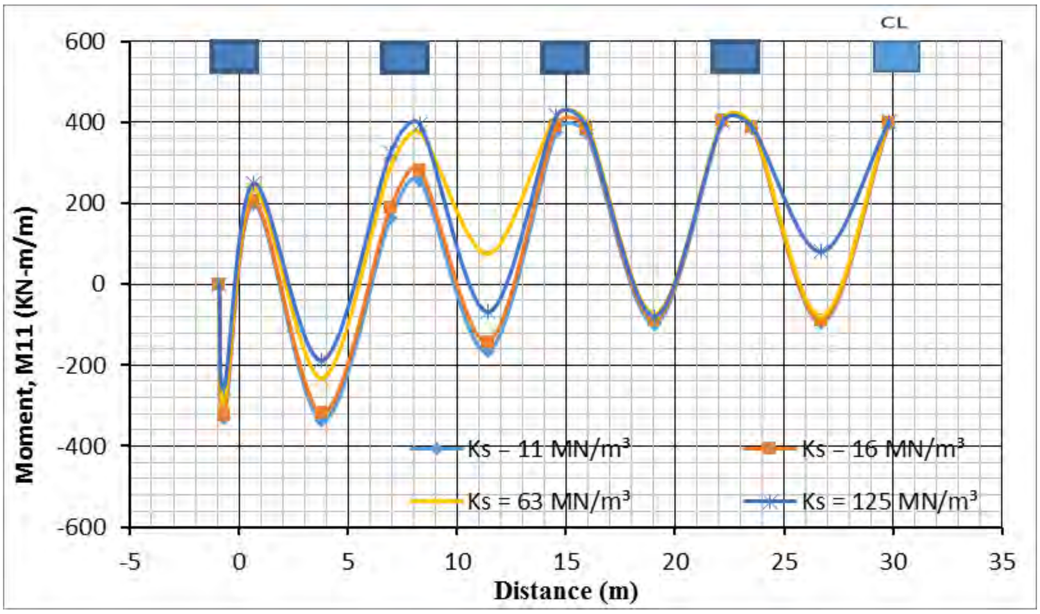

Figure 4-16: Moment along column line (GLY-6) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

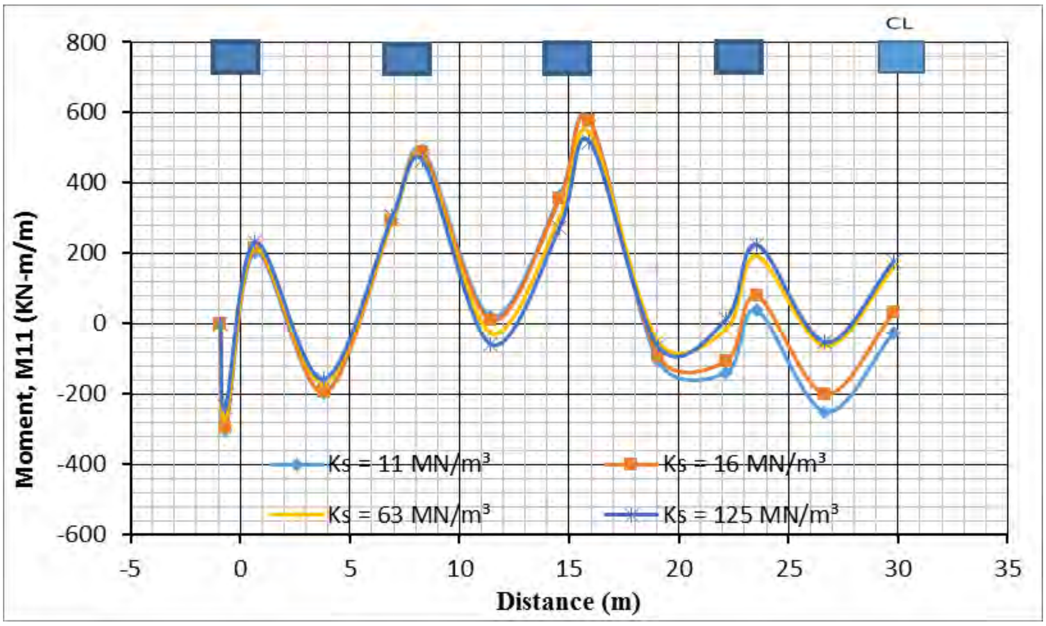

Figure 4-17: Moment along column line (GLY-6) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

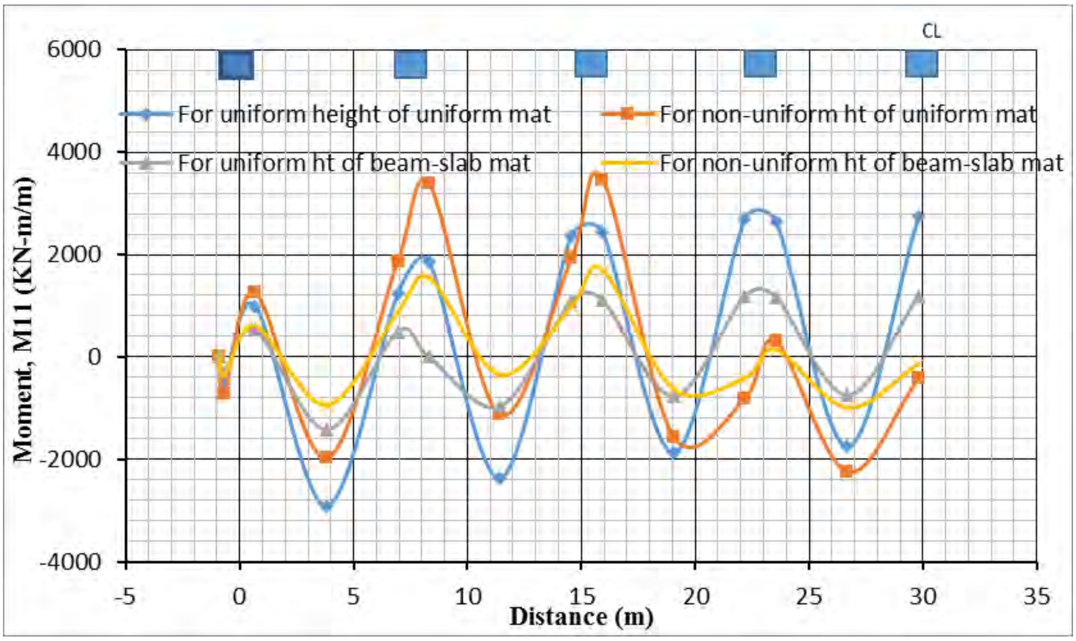

Figure 4-18: Moment along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

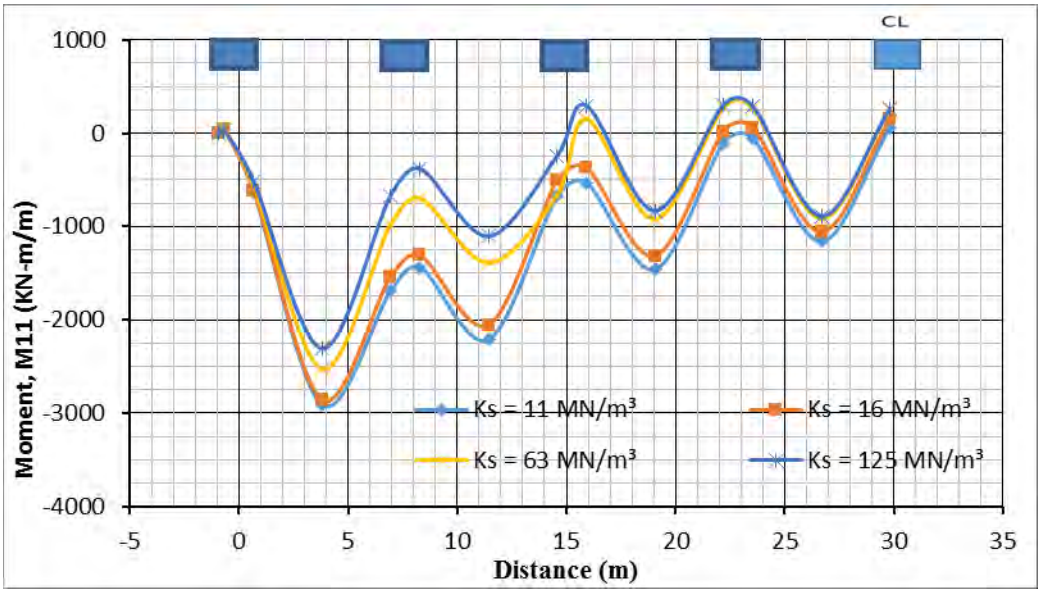

Figure 4-19: Moment along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

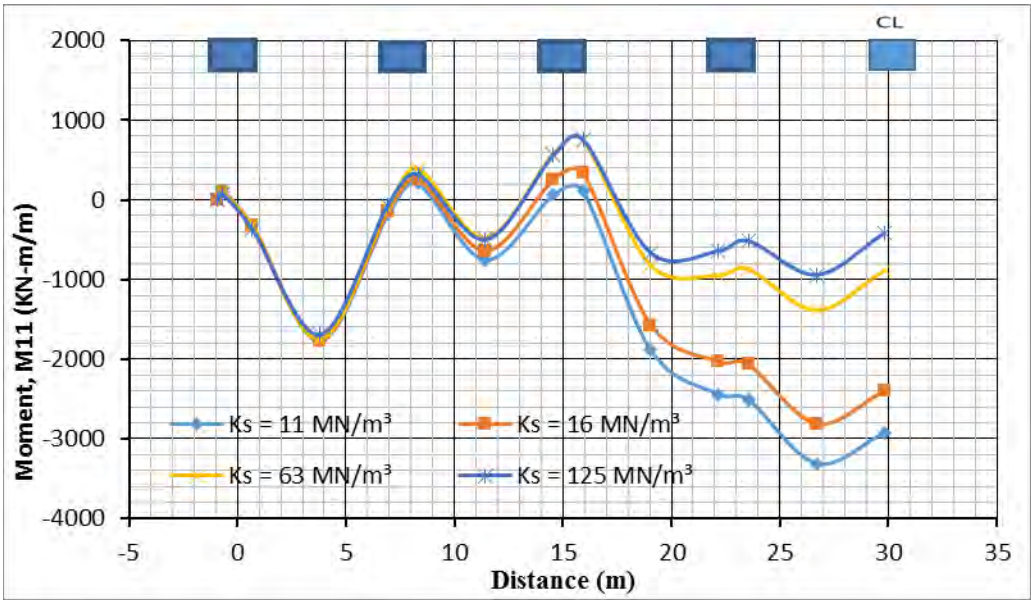

Figure 4-20: Moment along middle of an interior panel (GLY-56) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

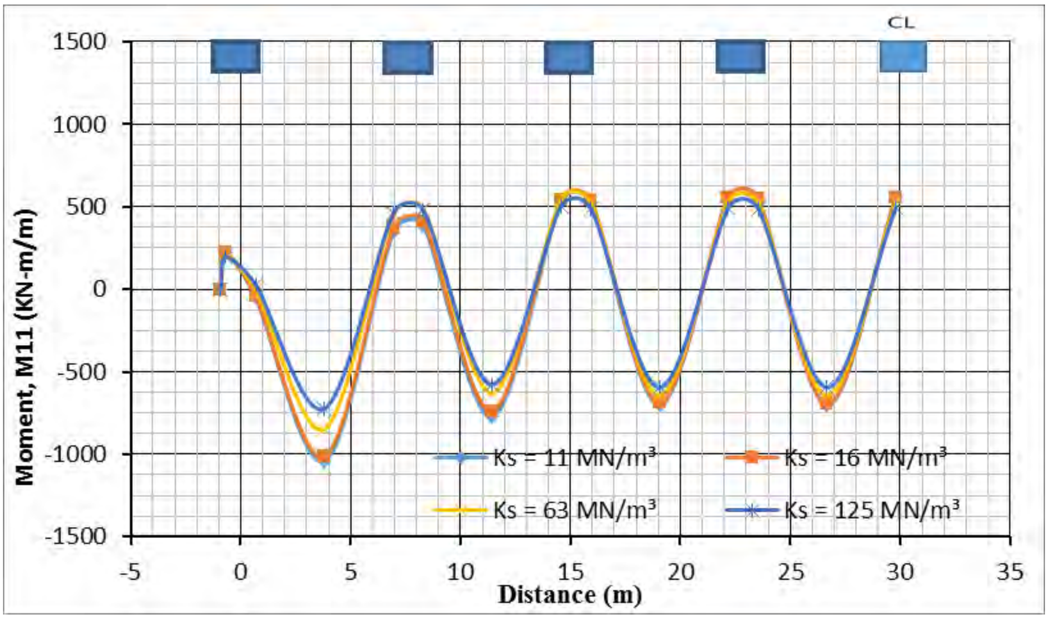

Figure 4-21: Moment along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

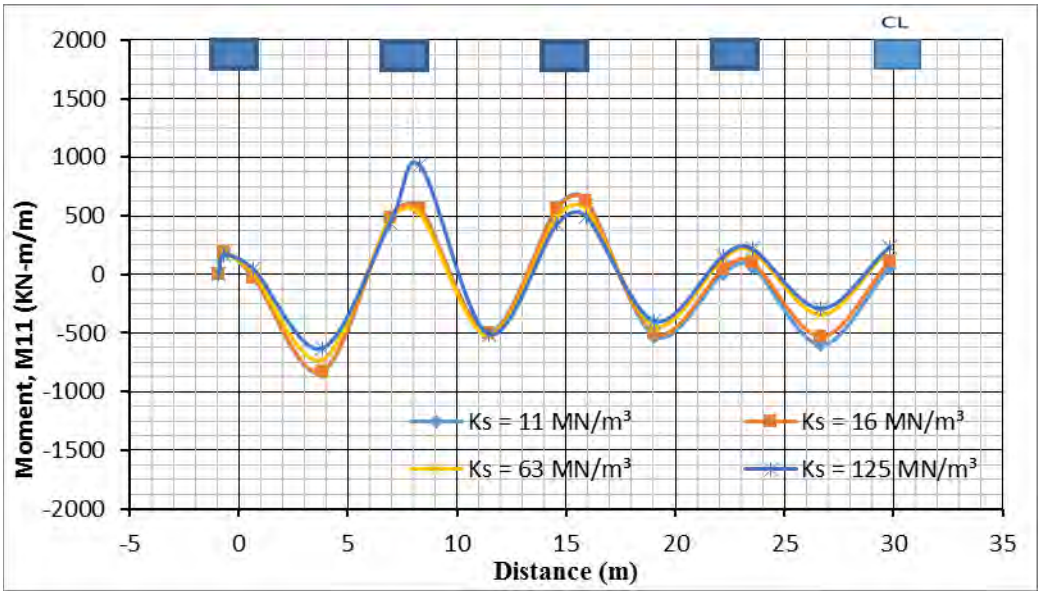

Figure 4-22: Moment along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

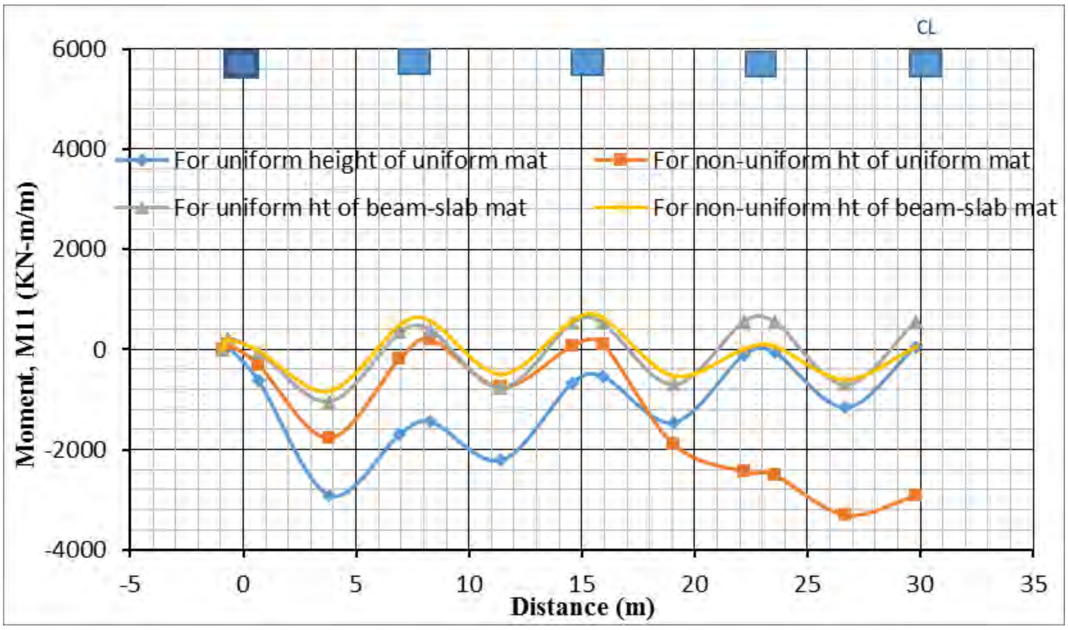

Figure 4-23: Moment along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

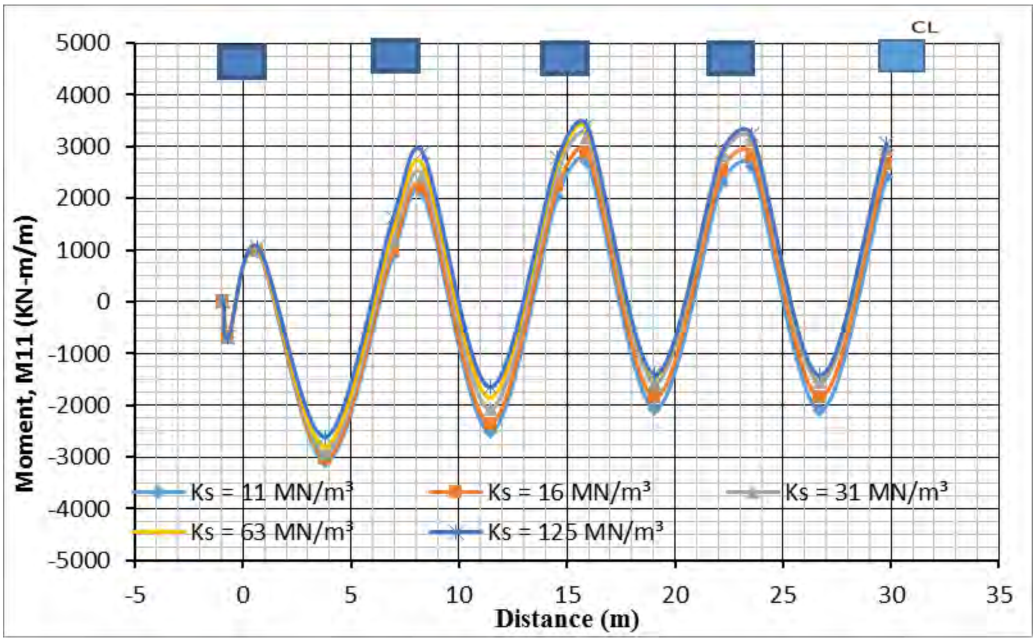

Figure 4-24: Moment along column line (GLY-3) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

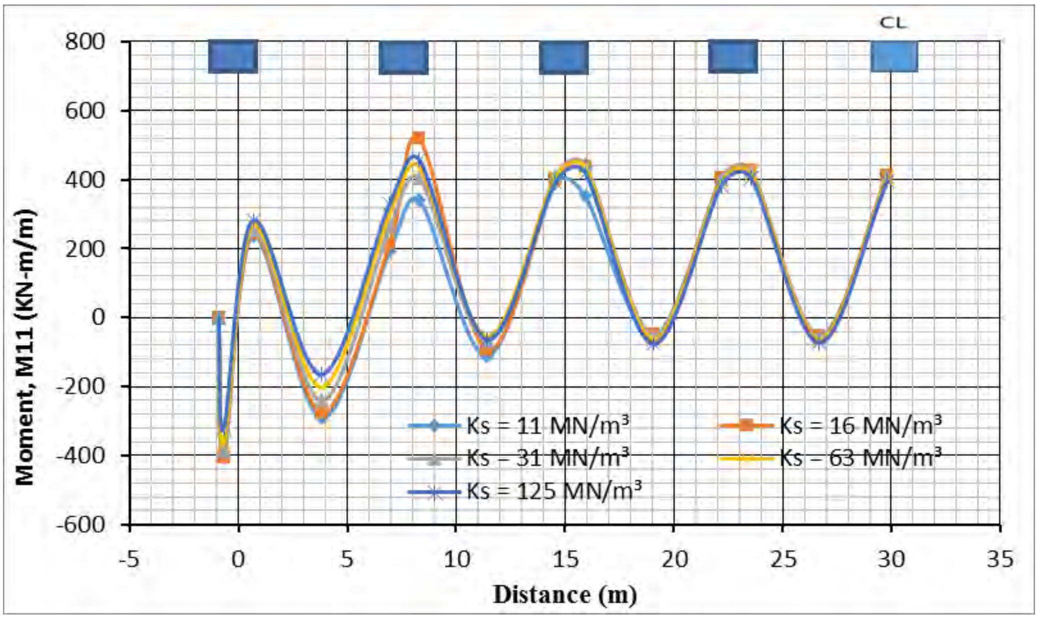

Figure 4-25: Moment along column line (GLY-3)
for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

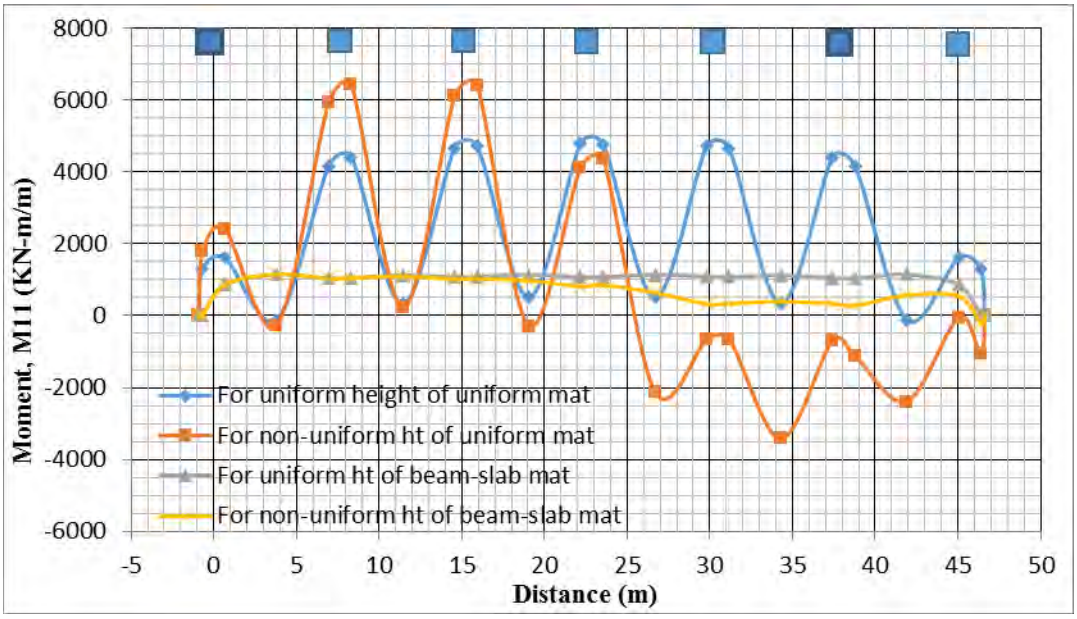

Figure 4-26: Moment along column line (GLX-5) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

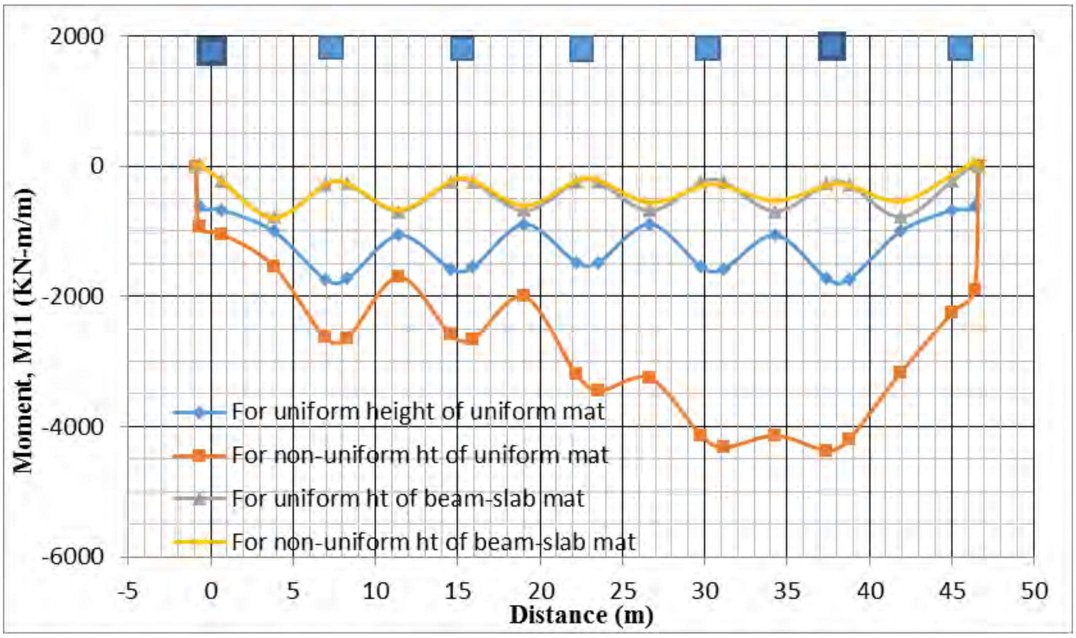

Figure 4-27: Moment along middle of an interior panel (GLX-45) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

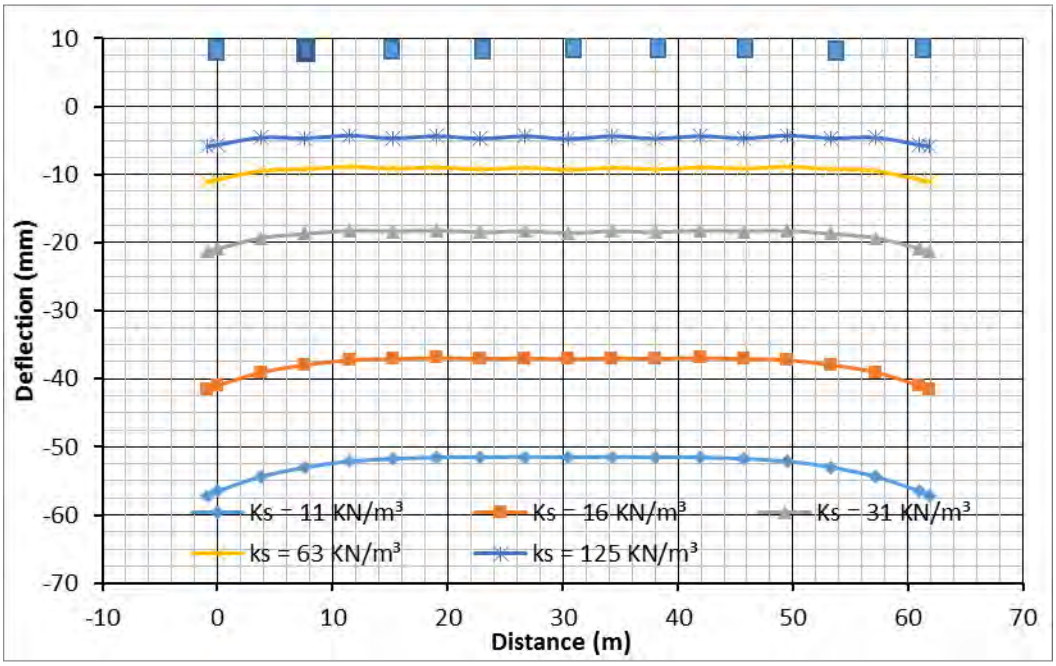

Figure 4-28: Deflection along column line (GLY-6) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

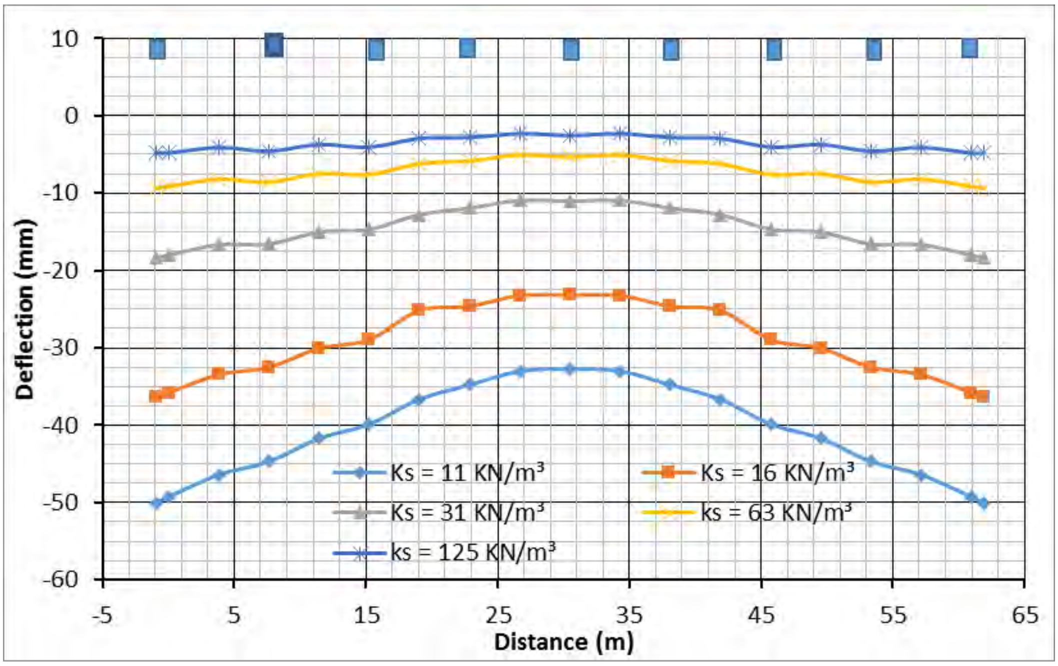

Figure 4-29: Deflection along column line (GLY-6) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

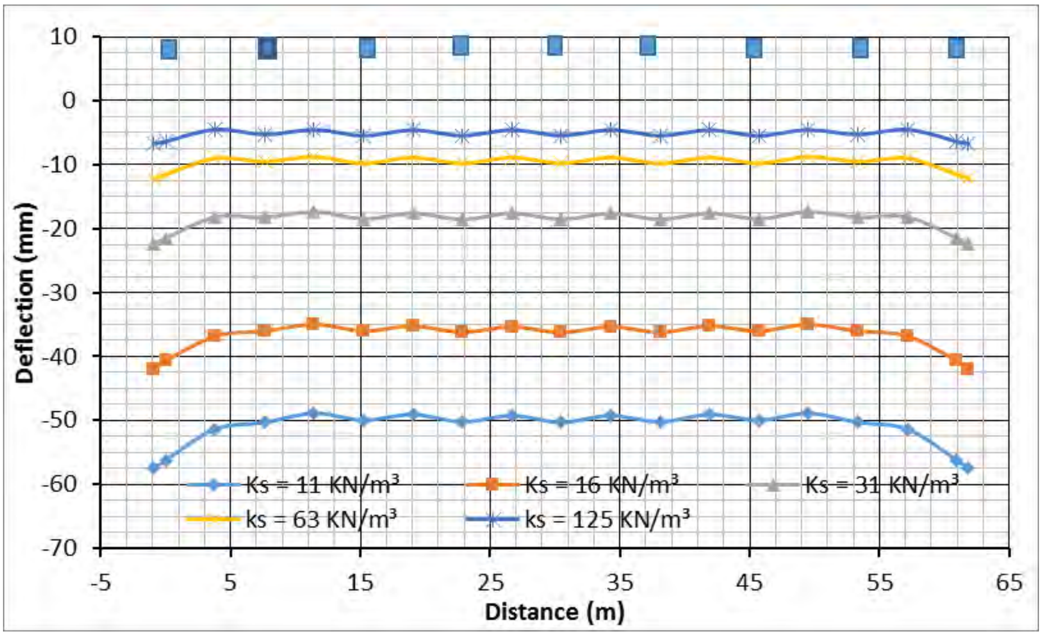

Figure 4-30: Deflection along column line (GLY-6) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

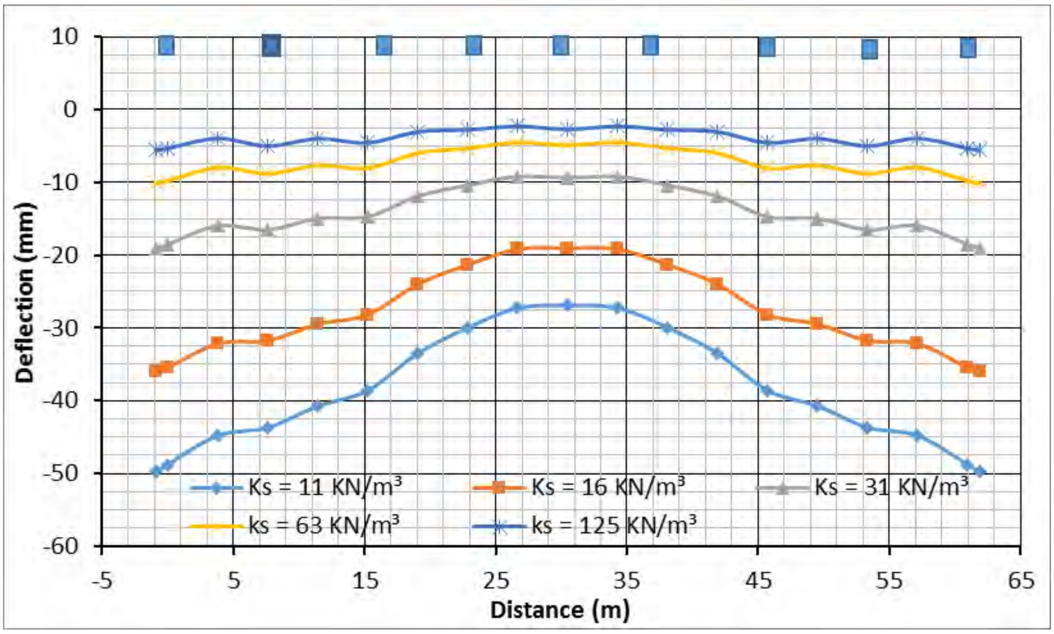

Figure 4-31: Deflection along column line (GLY-6) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

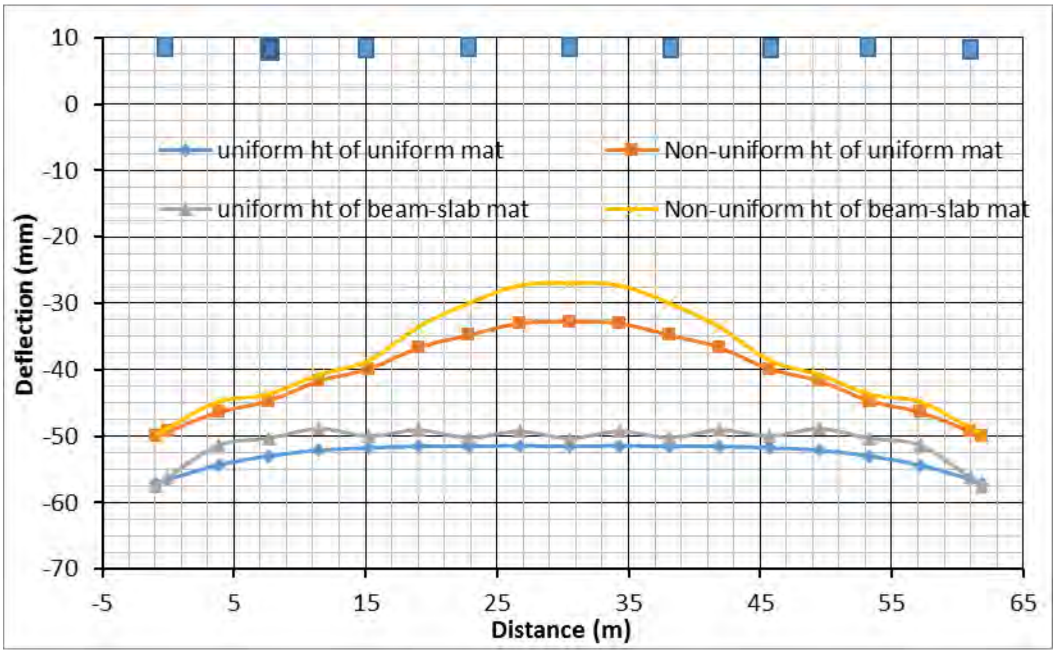

Figure 4-32: Deflection along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

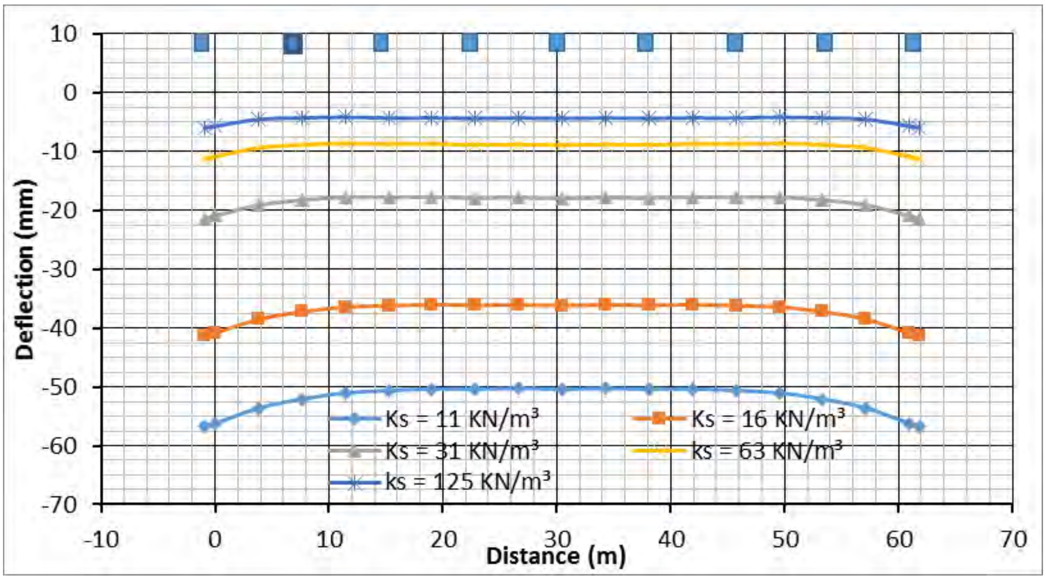

Figure 4-33: Deflection along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

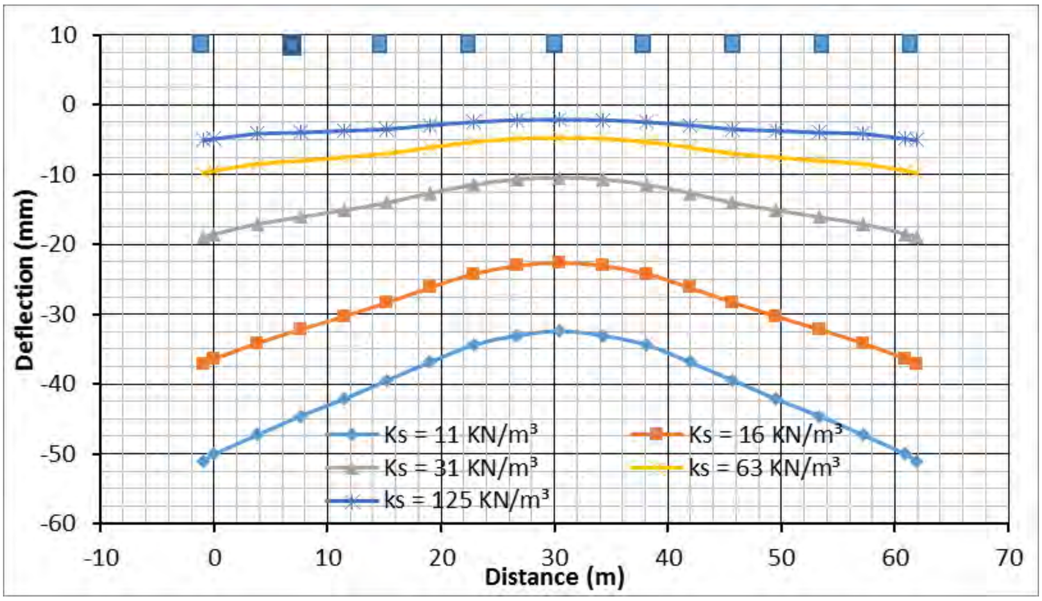

Figure 4-34: Deflection along middle of an interior panel (GLY-56) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

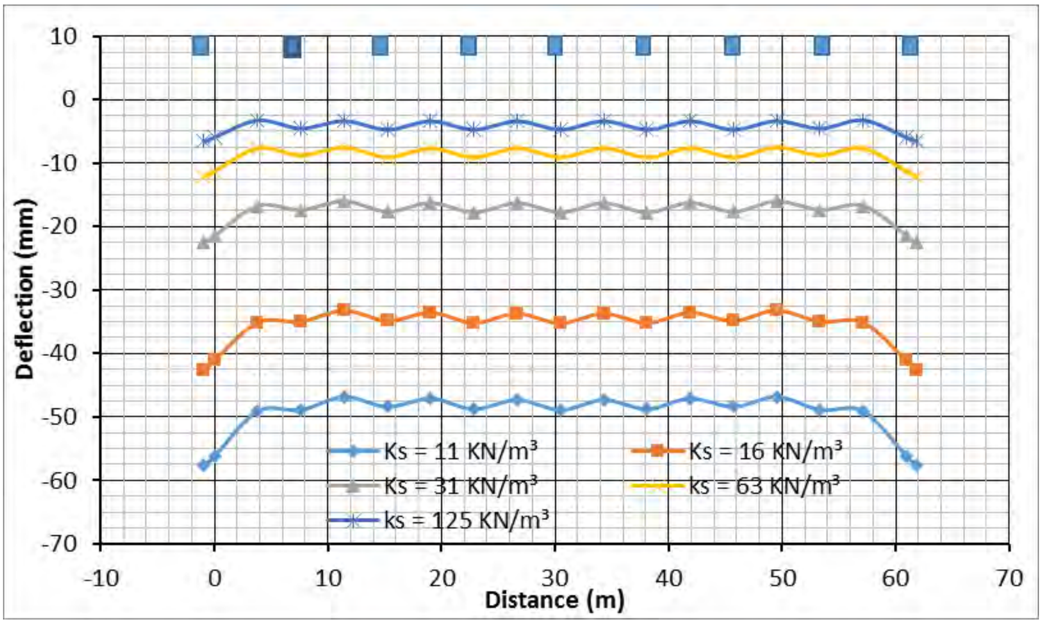

Figure 4-35: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

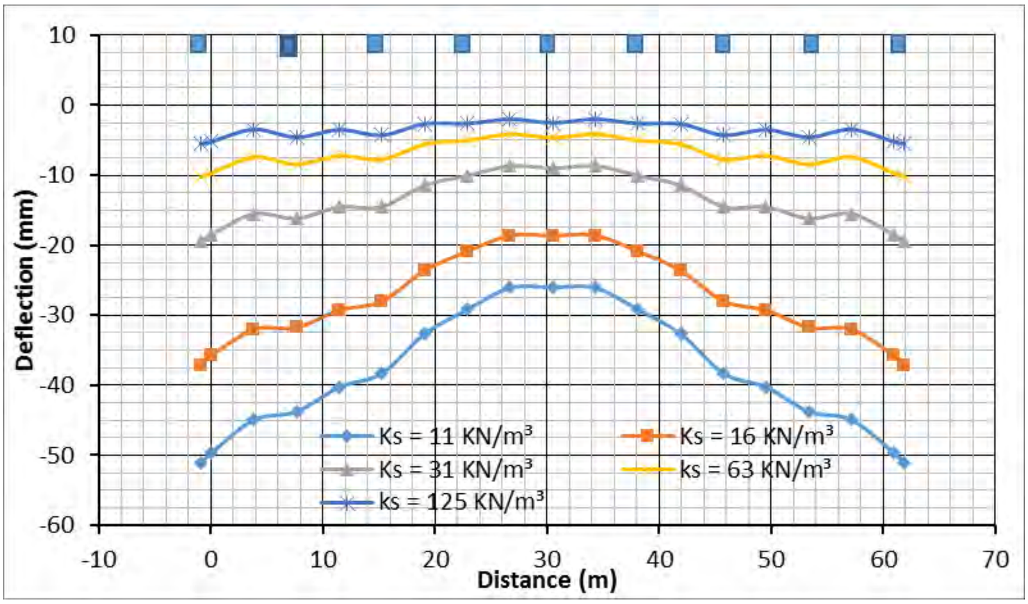

Figure 4-36: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

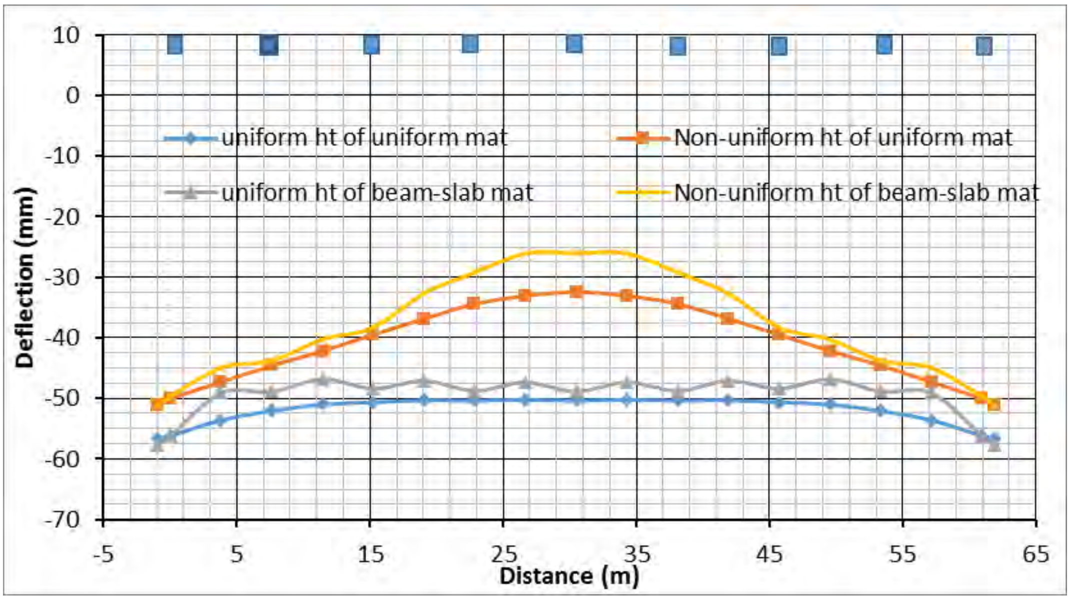

Figure 4-37: Deflection along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

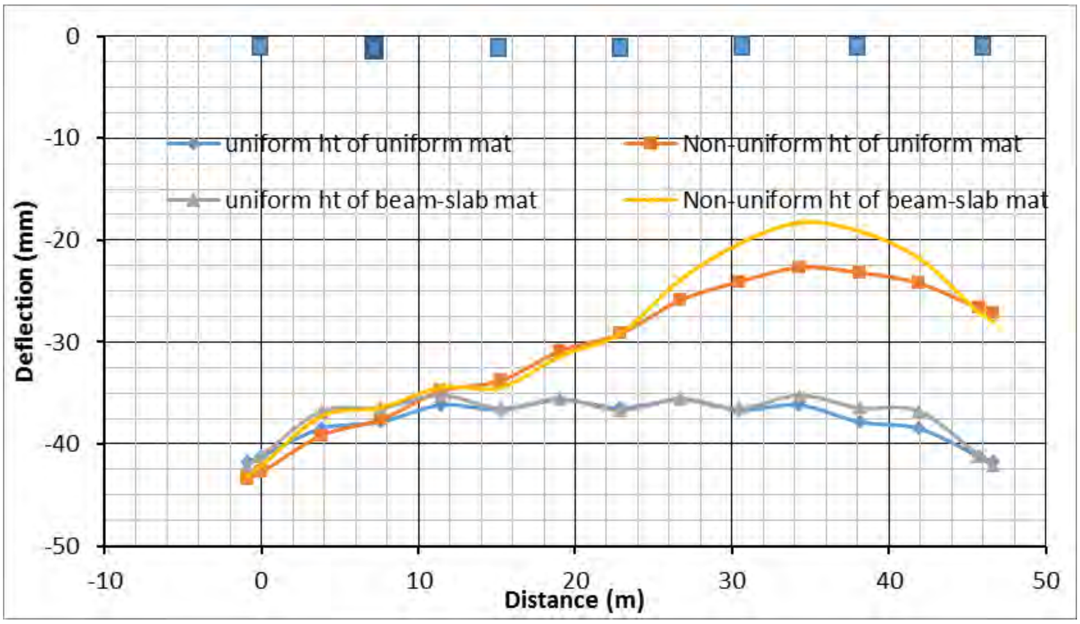

Figure 4-38: Deflection along column line (GLX-5) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

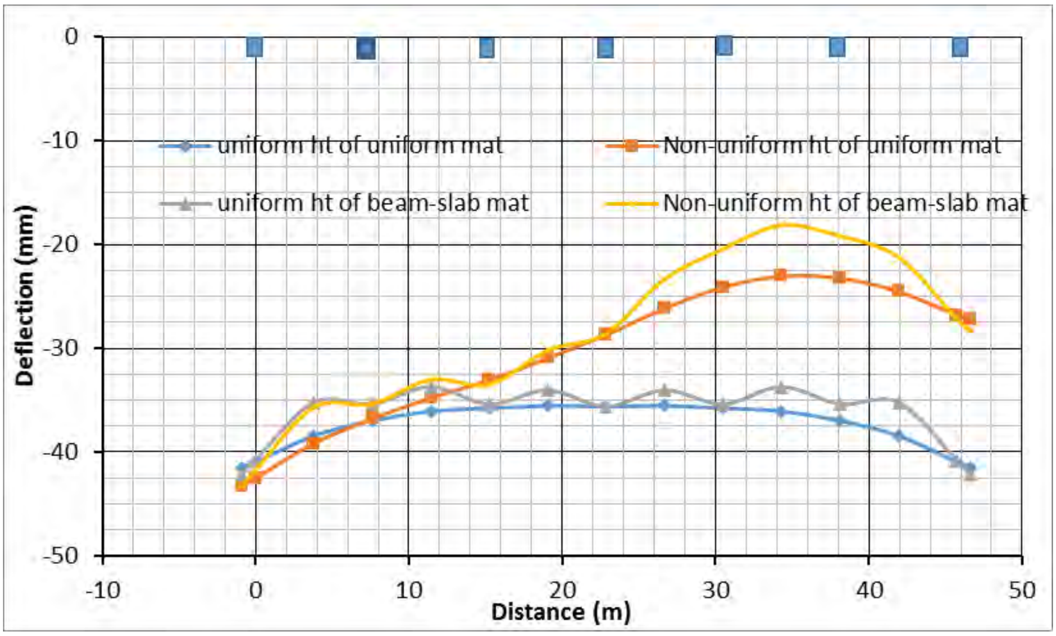

Figure 4-39: Deflection along middle of an interior panel (GLX-45) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

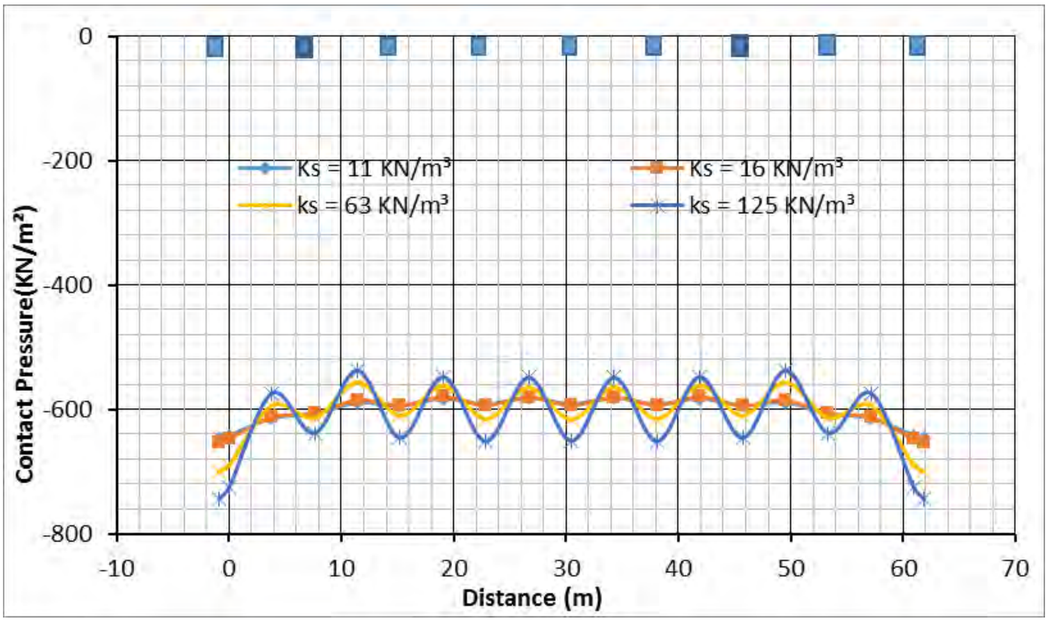

Figure 4-40: Contact pressure along column line (GLY-6) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

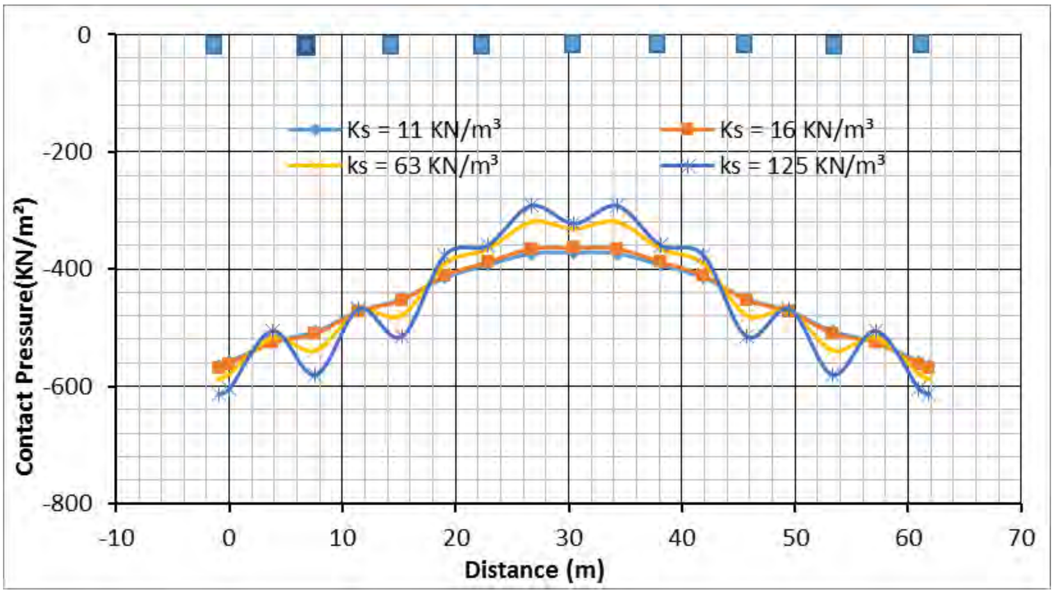

Figure 4-41: Contact pressure along column line (GLY-6) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

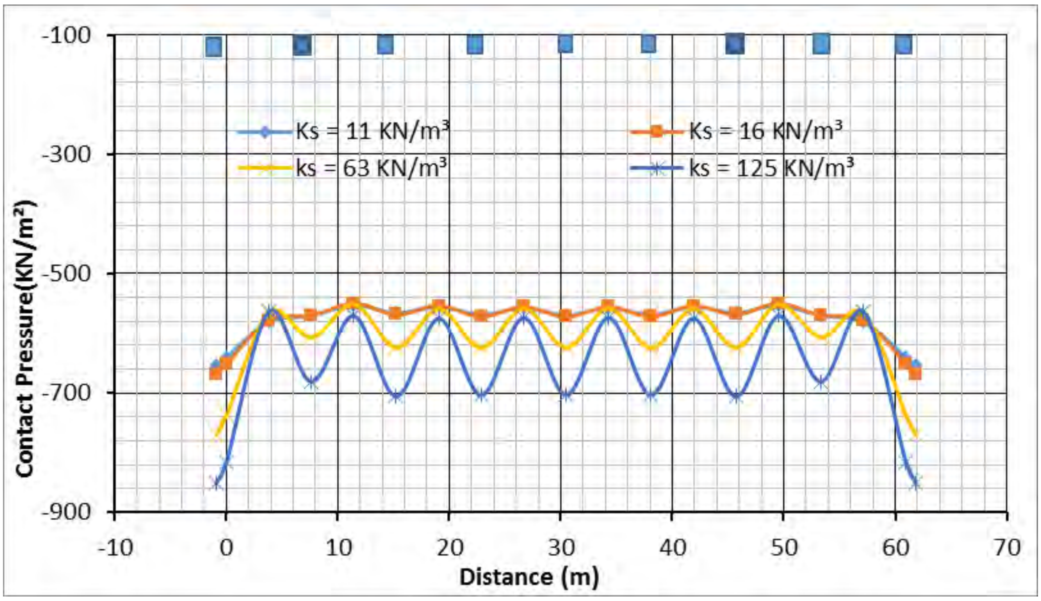

Figure 4-42: Contact pressure along column line (GLY-6) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

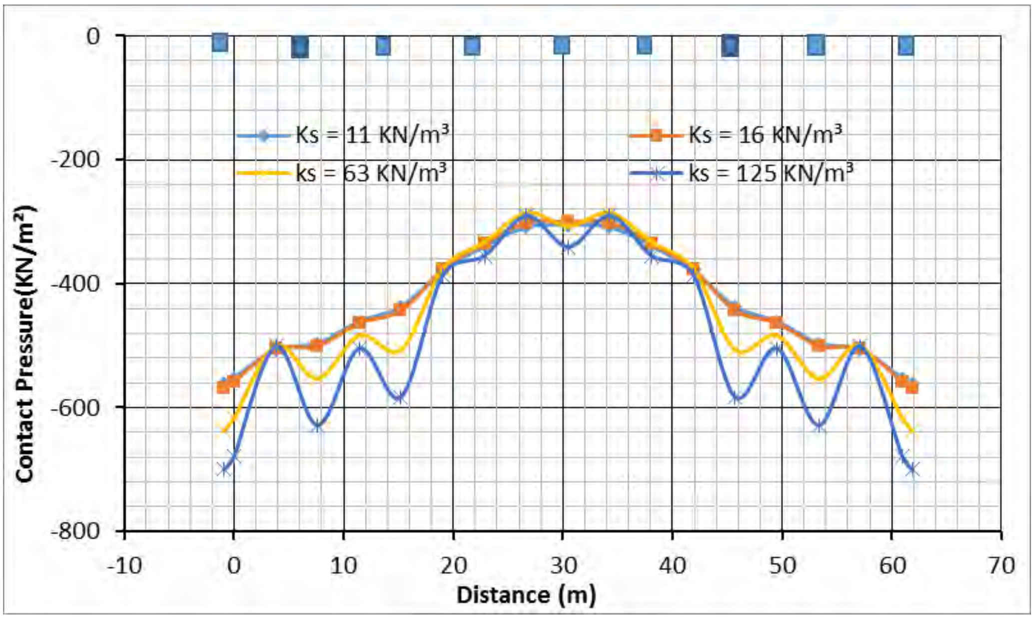

Figure 4-43: Contact pressure along column line (GLY-6) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

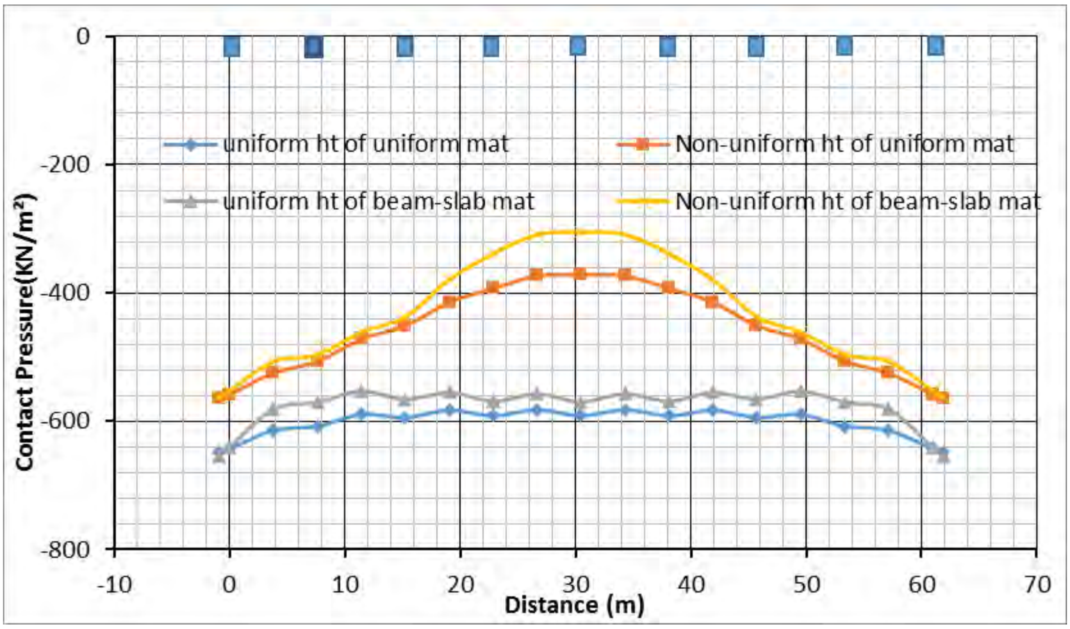

Figure 4-44: Contact pressure along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

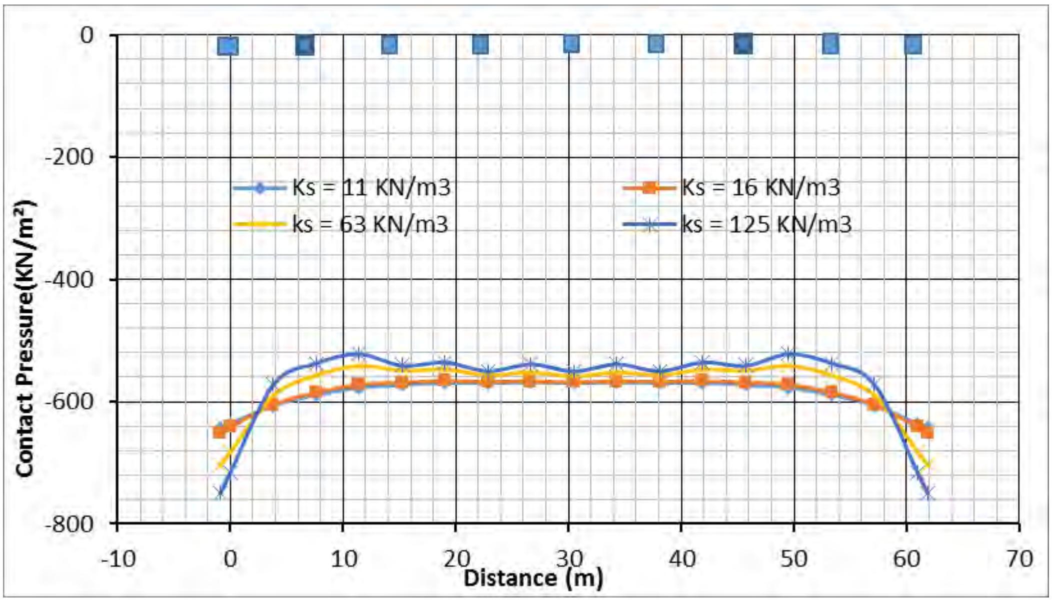

Figure 4-45: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height of building at different subgrade modulus of foundation soil.

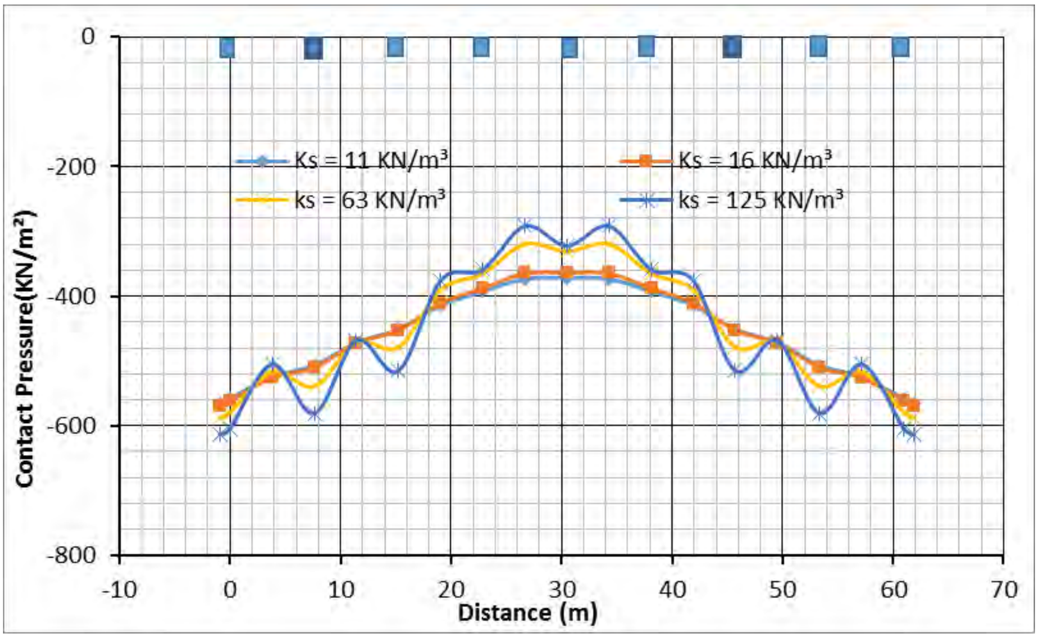

Figure 4-46: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness of mat of non-uniform height of building at different subgrade modulus of foundation soil.

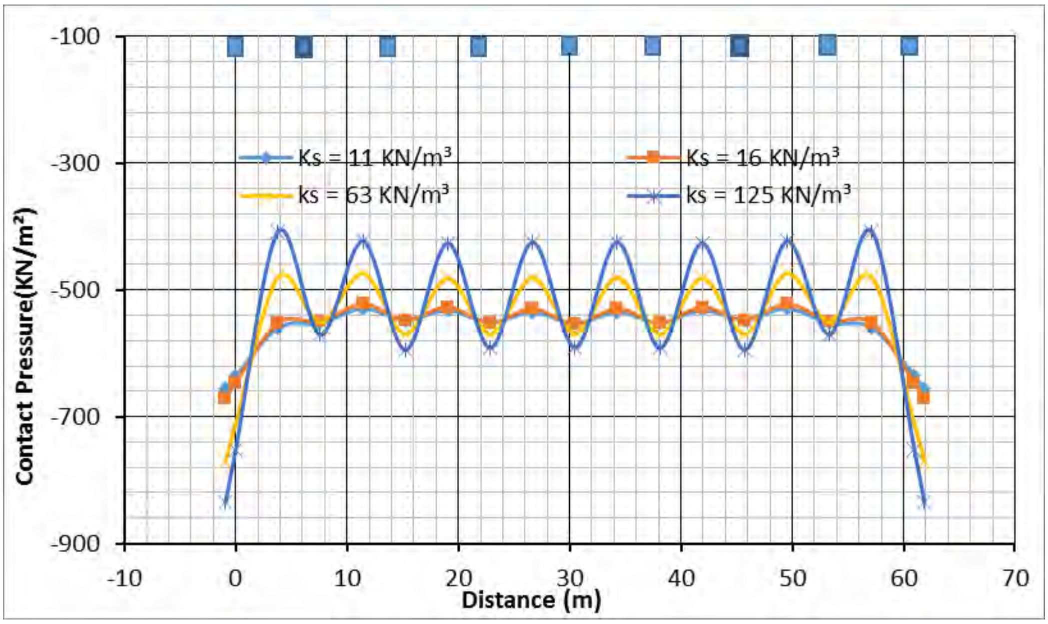

Figure 4-47: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different subgrade modulus of foundation soil.

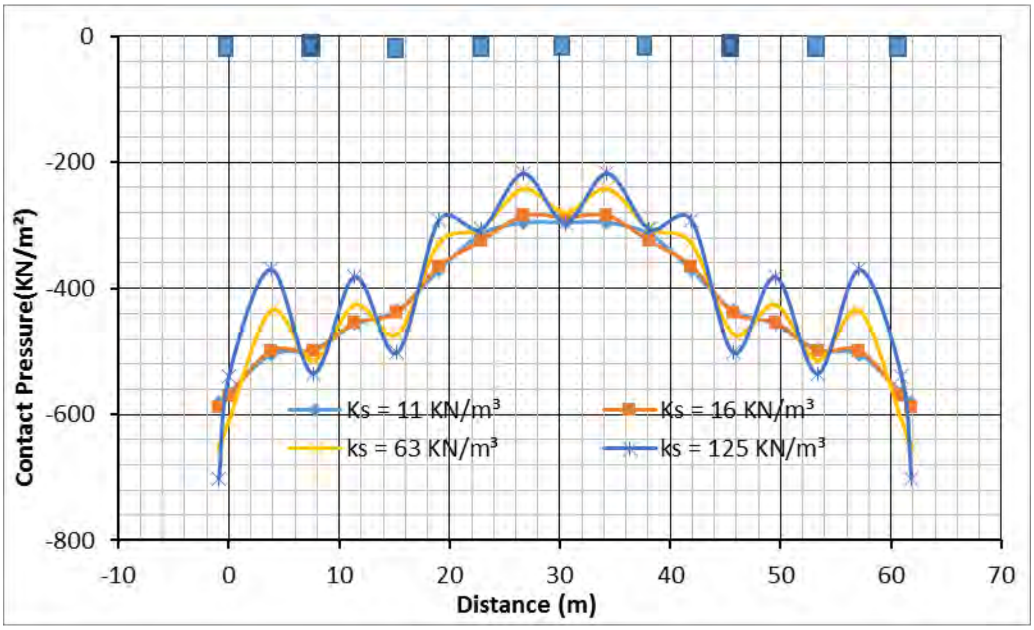

Figure 4-48: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different subgrade modulus of foundation soil.

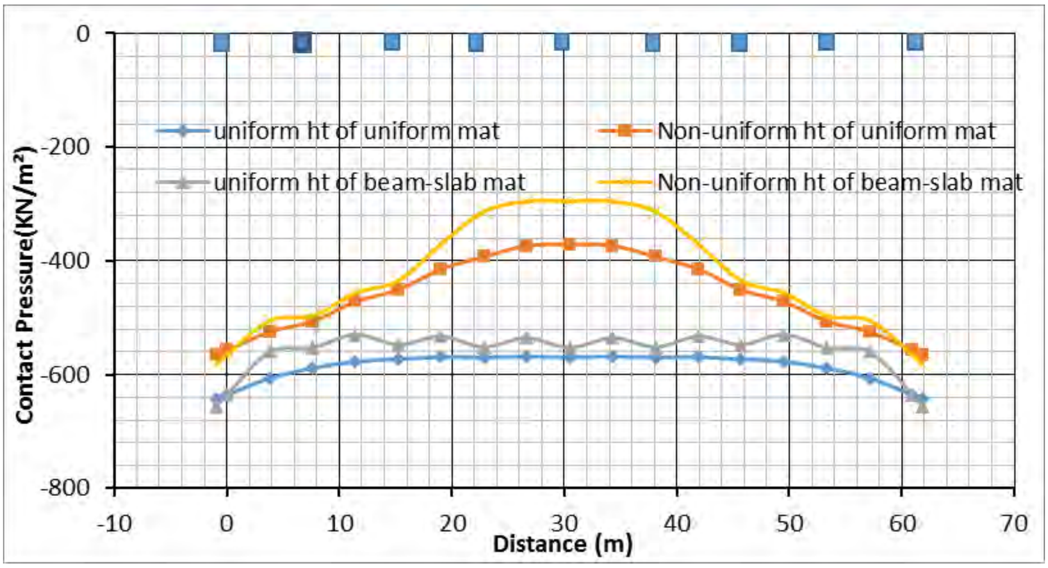

Figure 4-49: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

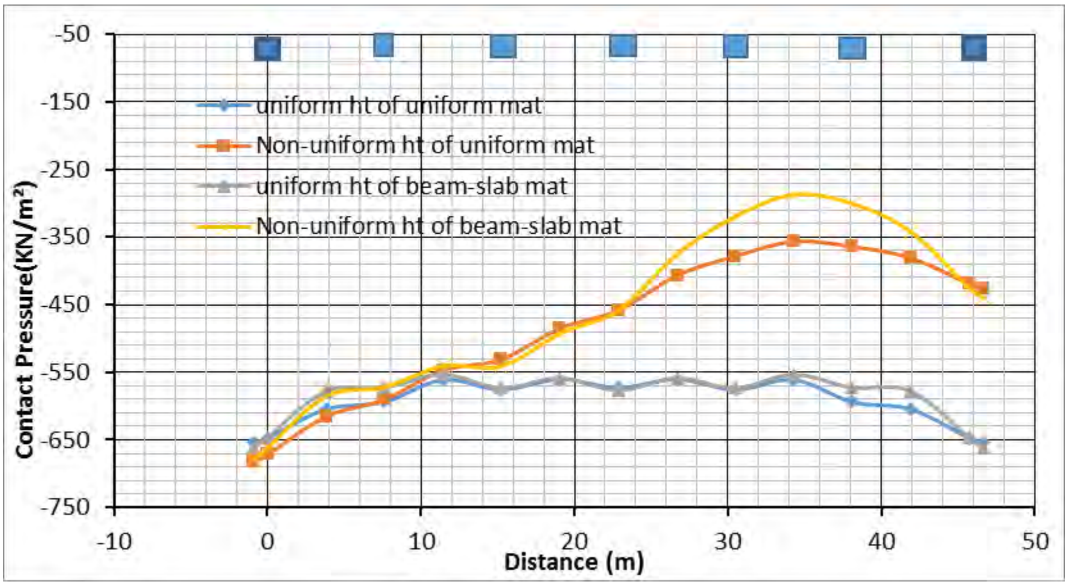

Figure 4-50: Contact pressure along column line (GLX-5) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

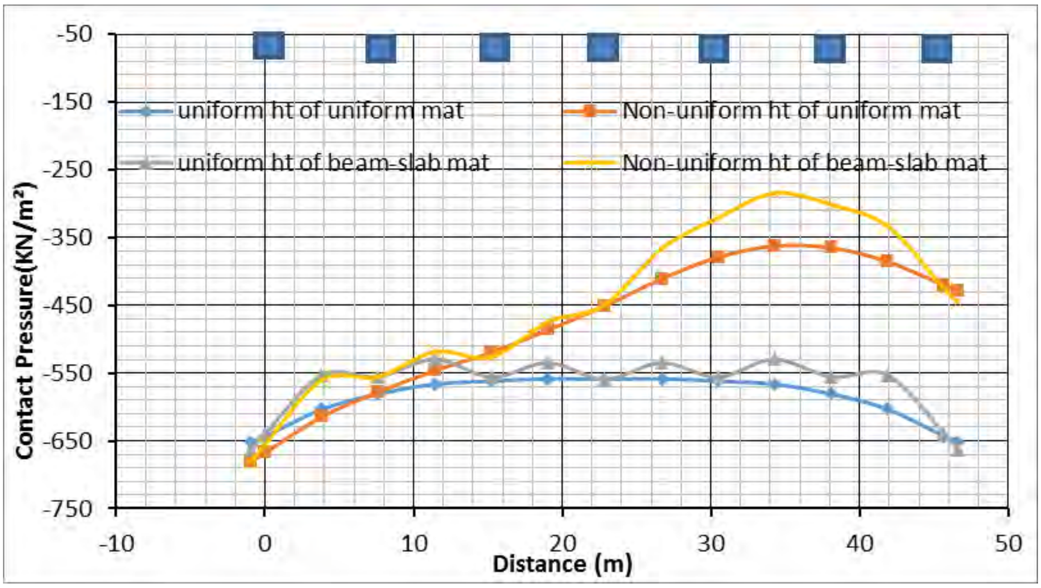

Figure 4-51: Contact pressure along middle of an interior panel (GLX-45) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at constant subgrade modulus of foundation soil.

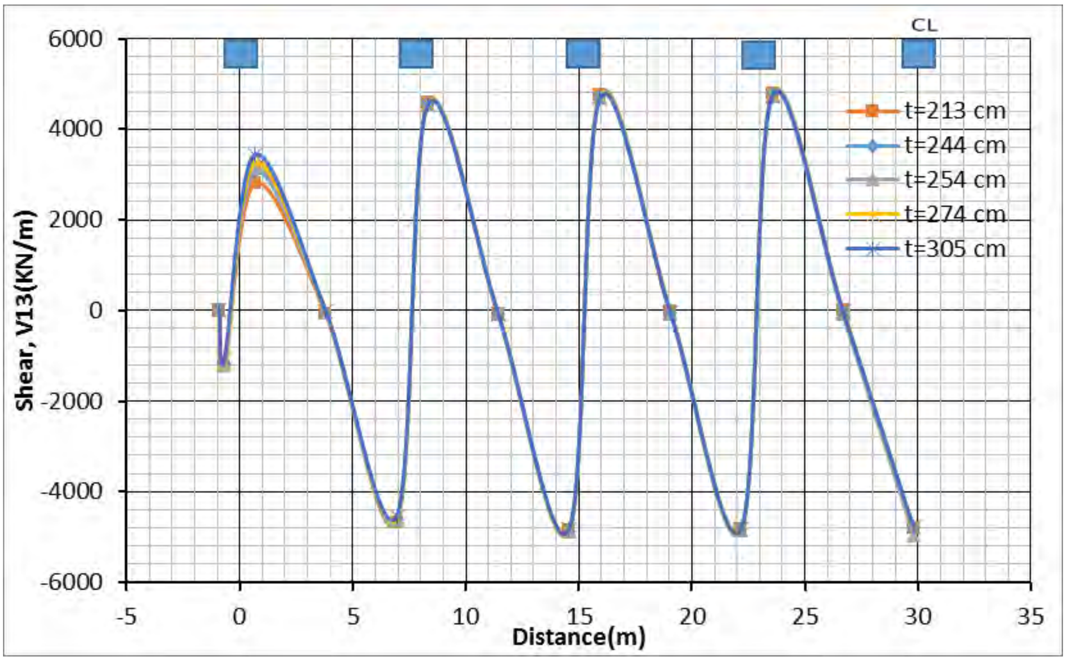

Figure 4-52: Shear along column line (GLY-6) for uniform thickness of mat of uniform height of building at different thickness of mat.

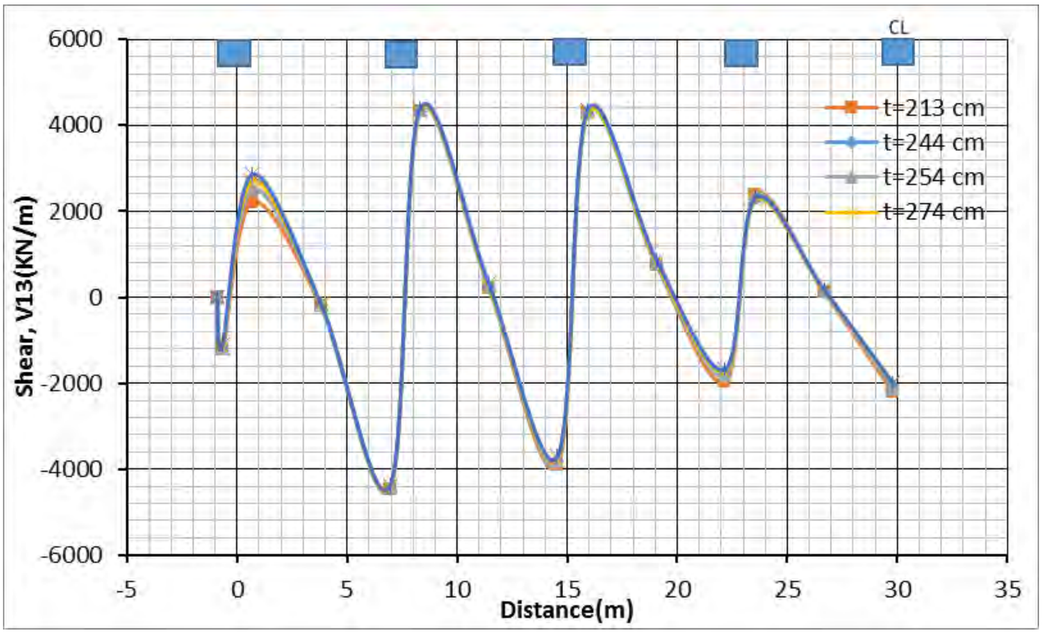

Figure 4-53: Shear along column line (GLY-6) for uniform thickness mat of non-uniform height of building at different thickness of mat.

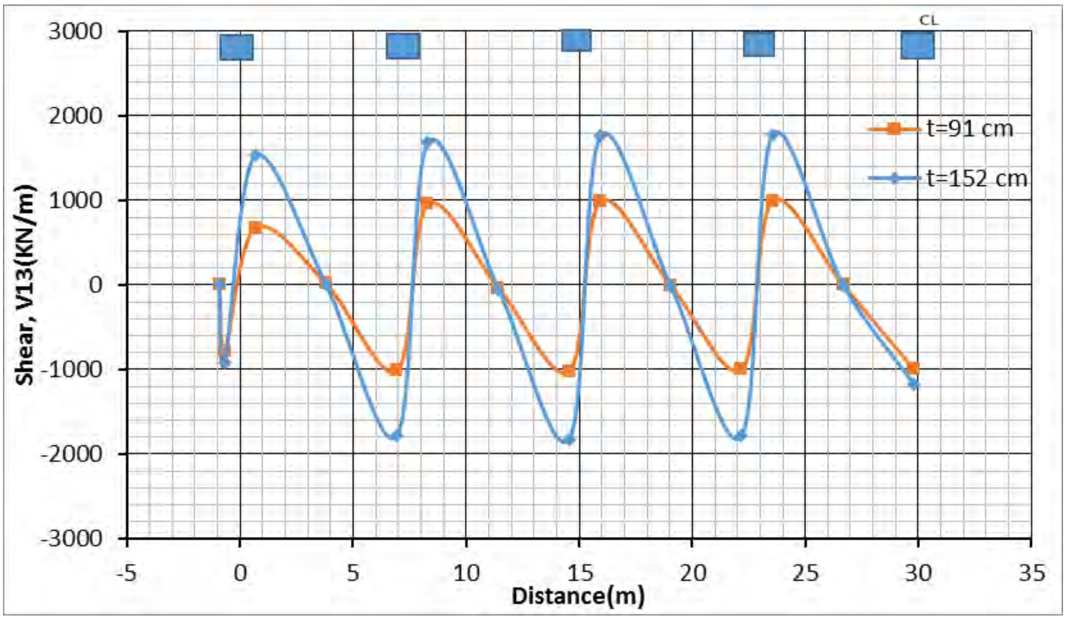

Figure 4-54: Shear along column line (GLY-6) for beam-slab mat of uniform height of building at different thickness of mat.

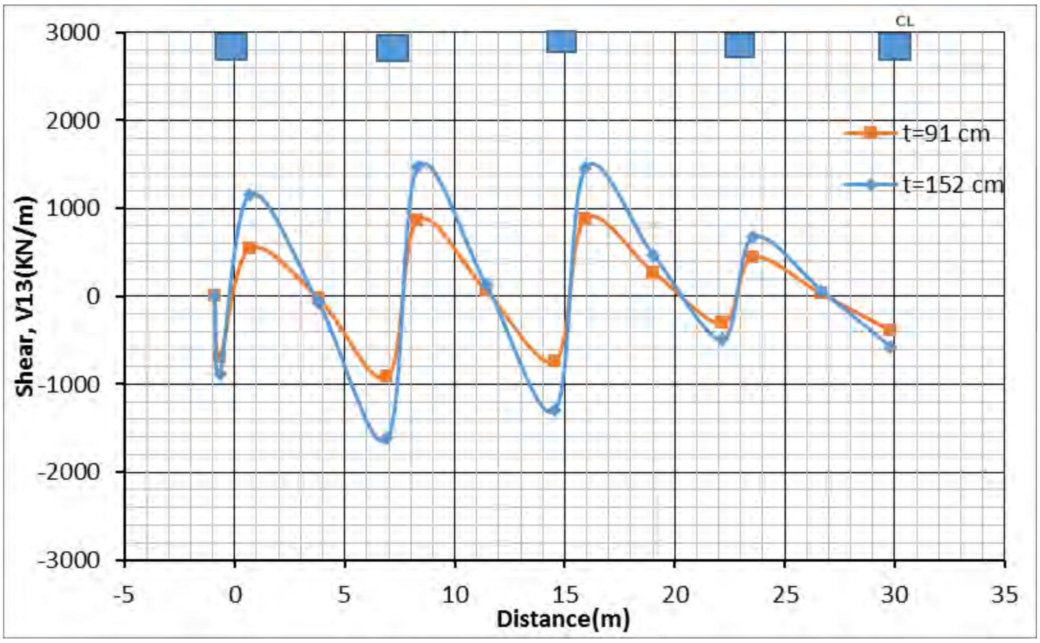

Figure 4-55: Shear along column line (GLY-6) for Beam-slab mat of non-uniform height of building at different thickness of mat.

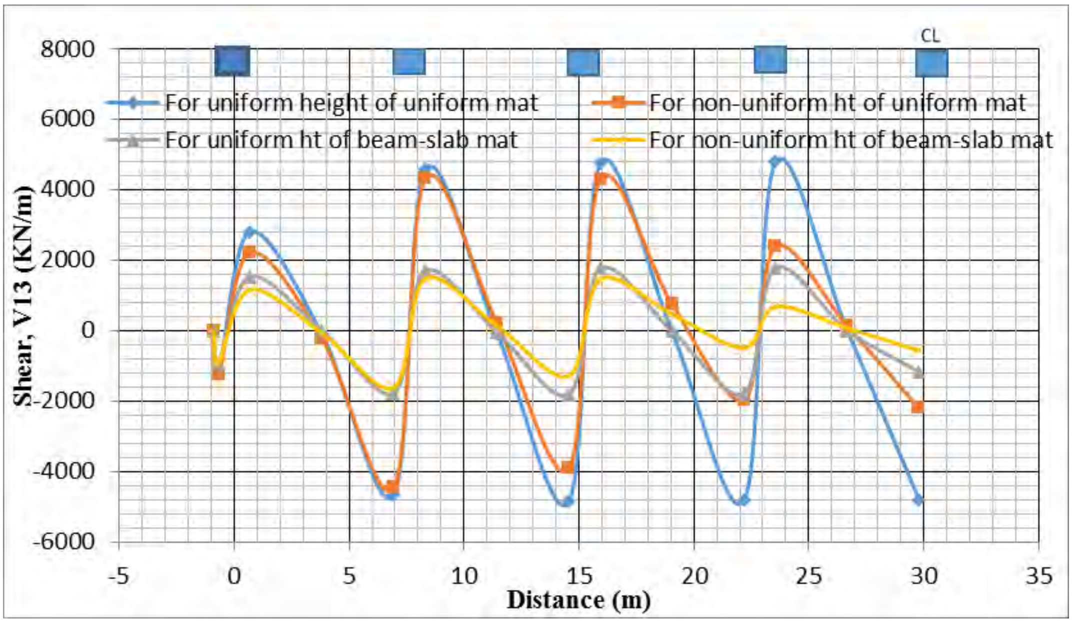

Figure 4-56: Shear along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

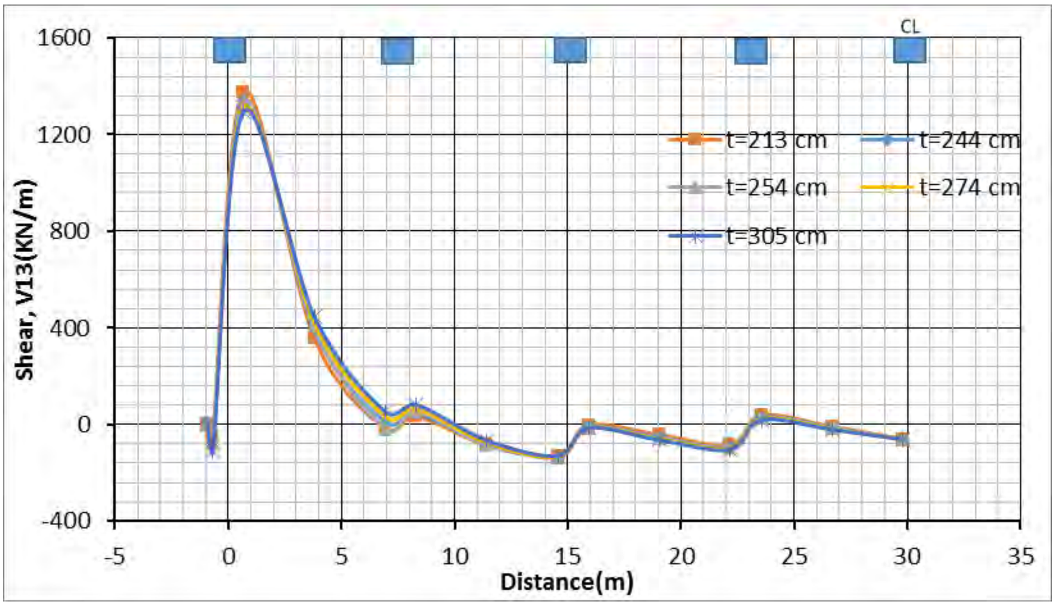

Figure 4-57: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height of building at different thickness of mat.

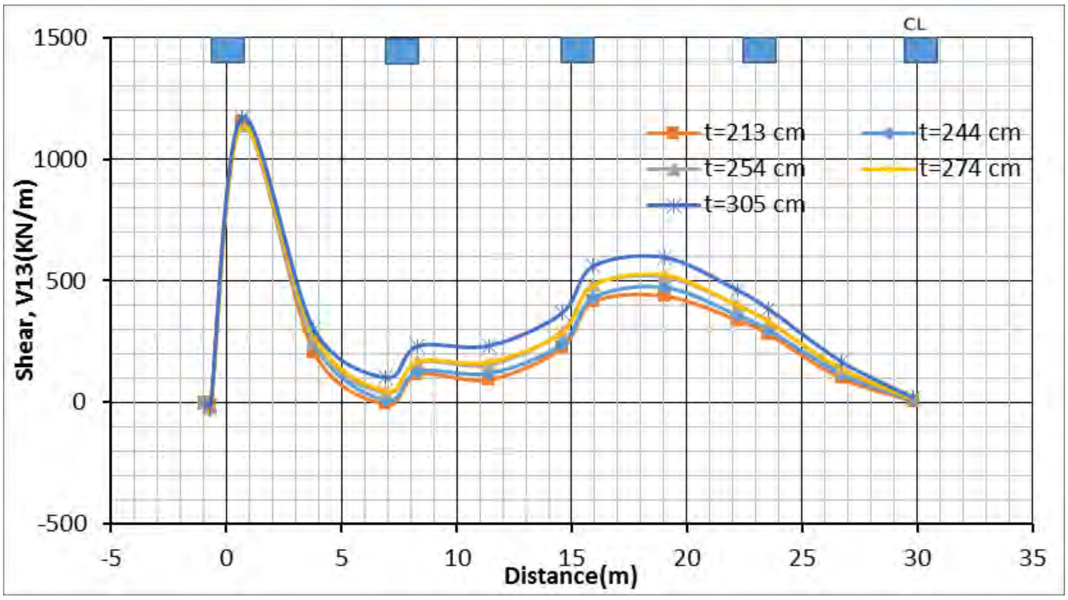

Figure 4-58: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of non-uniform height of building at different thickness of mat.

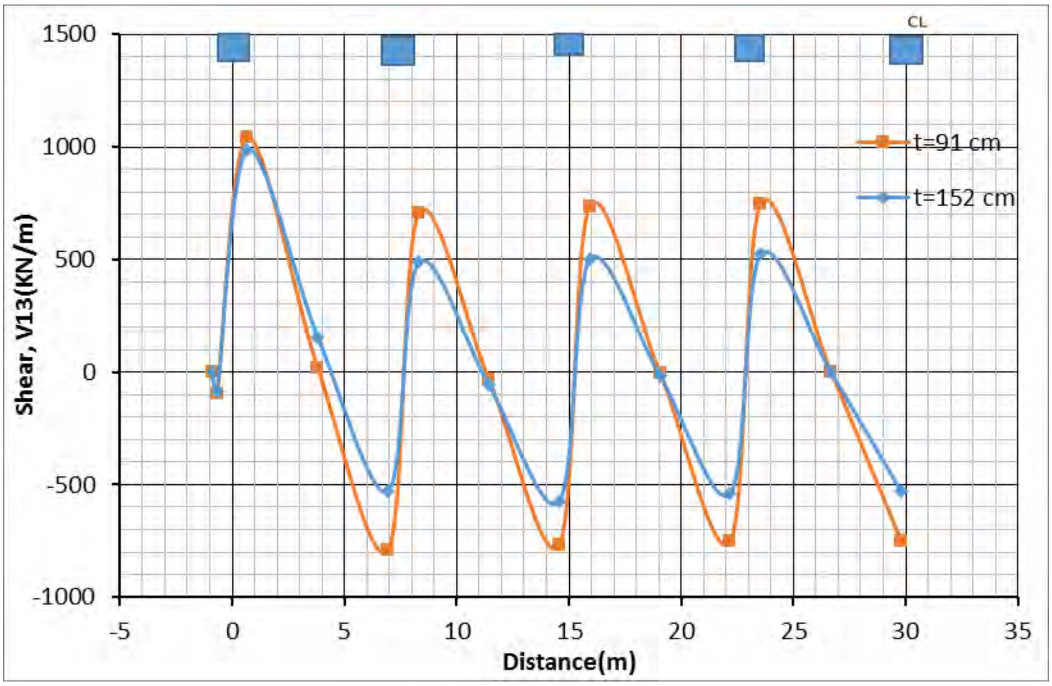

Figure 4-59: Shear along middle of an interior panel (GLY-56) for Beam-slab mat of uniform height of building at different thickness of mat.

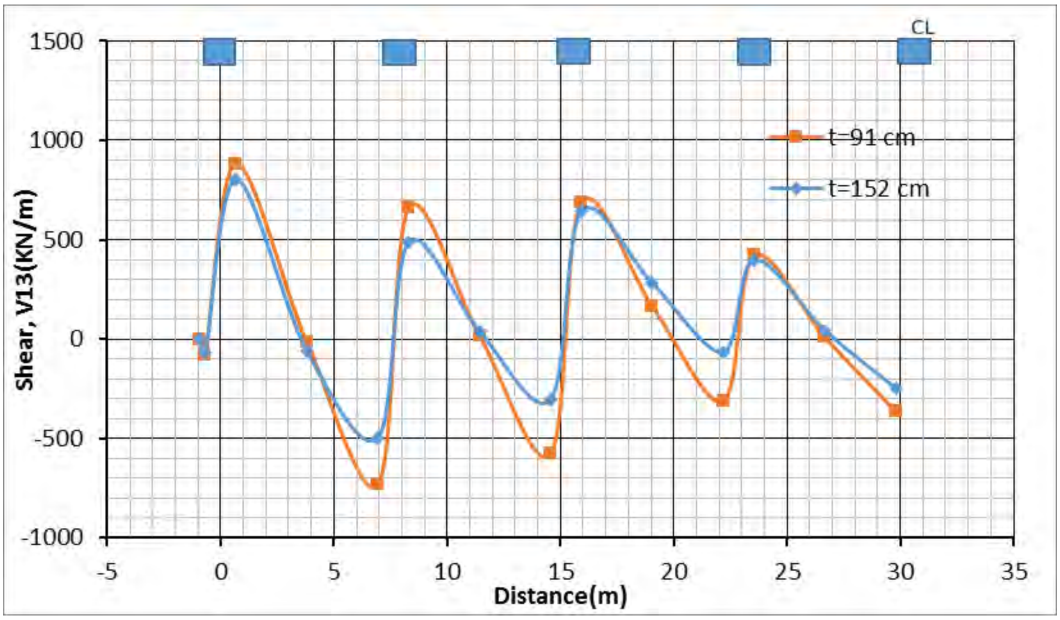

Figure 4-60: Shear along middle of an interior panel (GLY-56) for Beam-slab mat of non-uniform height of building at different thickness of mat.

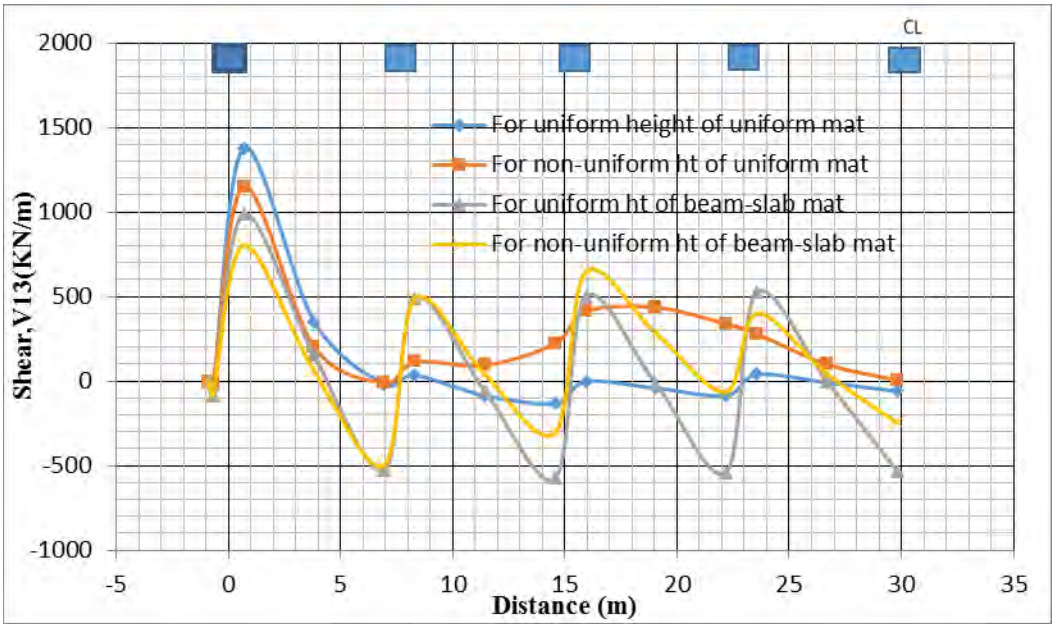

Figure 4-61: Shear along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

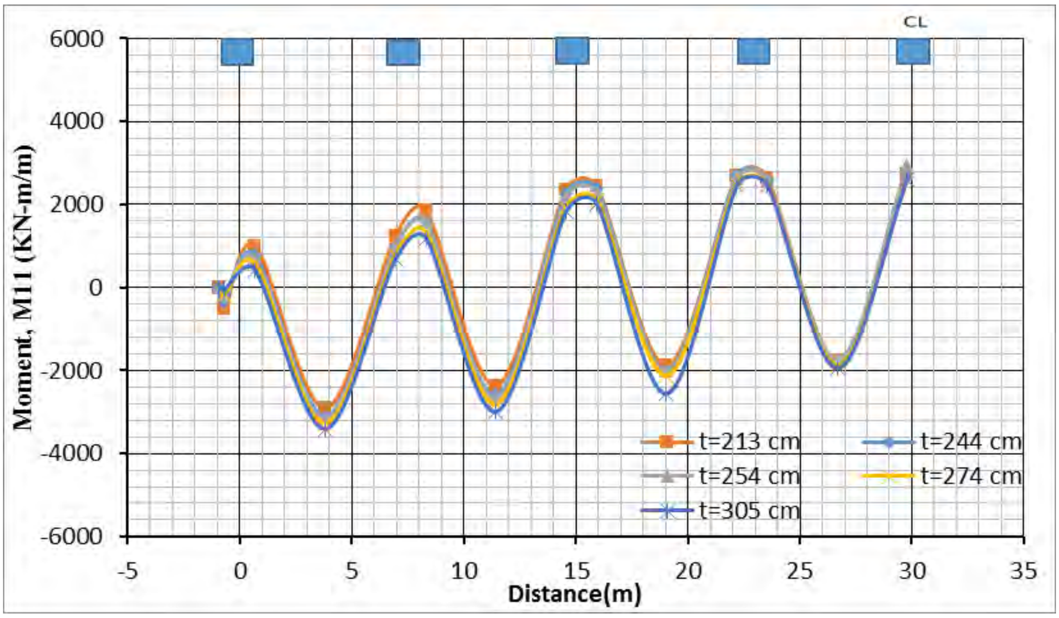

Figure 4-62: Moment along column line (GLY-6) for uniform thickness of uniform height of building at different thickness of mat.

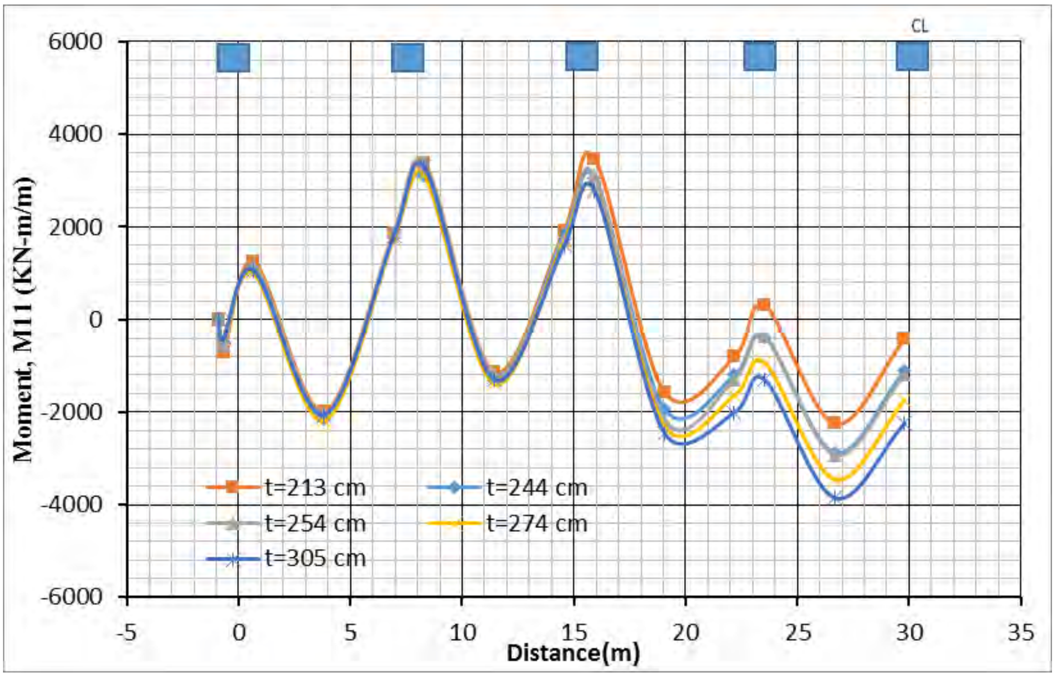

Figure 4-63: Moment along column line (GLY-6) for uniform thicknesses of non-uniform height of building at different thickness of mat.

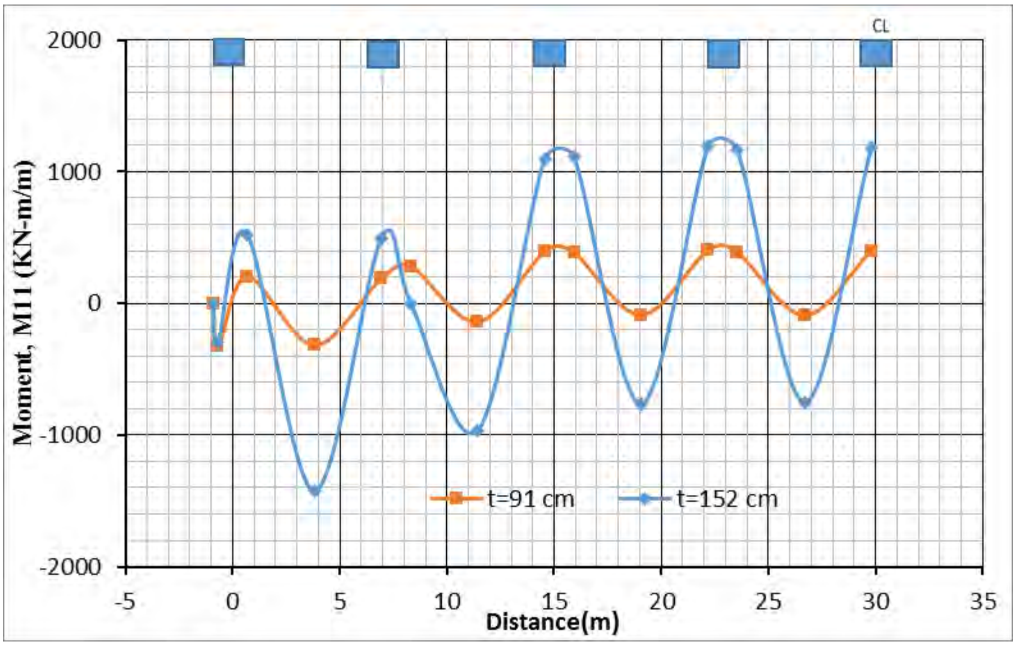

Figure 4-64: Moment along column line (GLY-6) for beam-slab mat of uniform height of building at different thickness of mat.

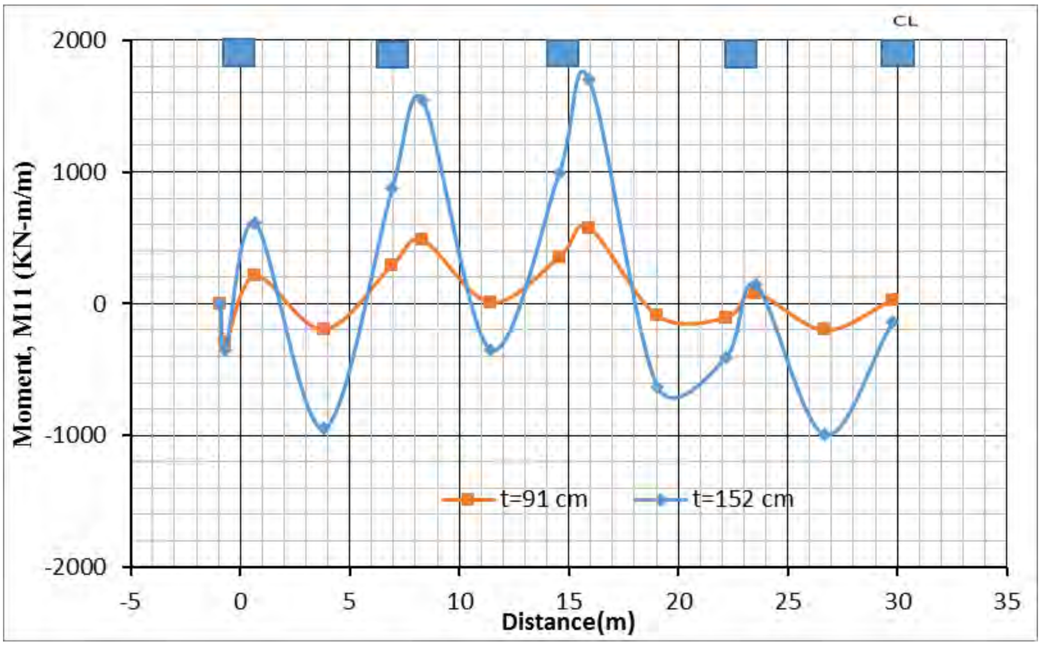

Figure 4-65: Moment along column line (GLY-6) for beam-slab mat of non-uniform height of building at different thickness of mat.

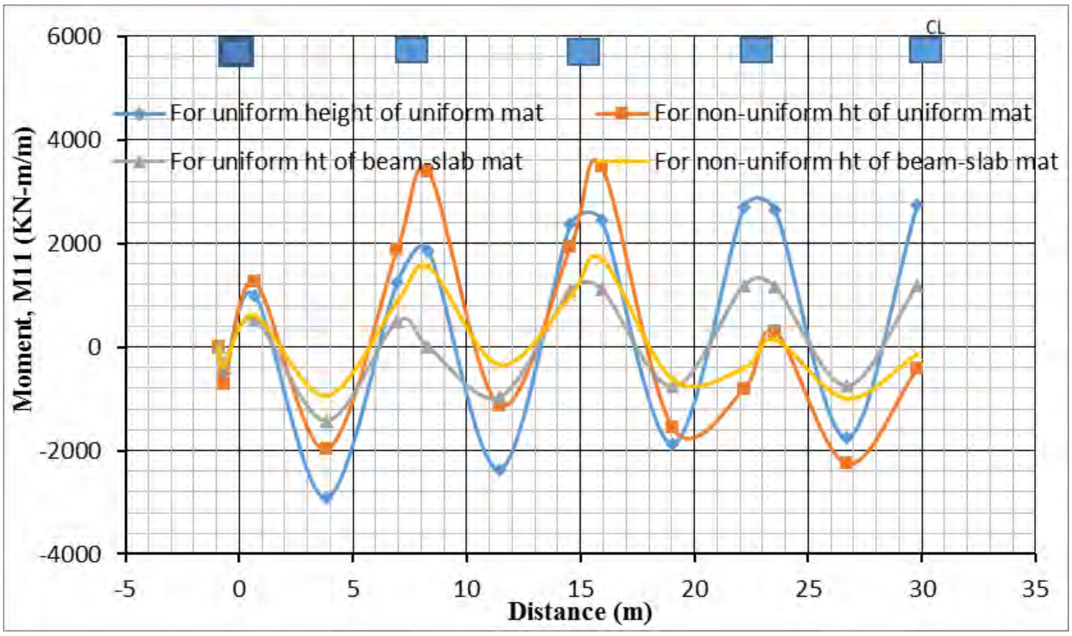

Figure 4-66: Moment along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

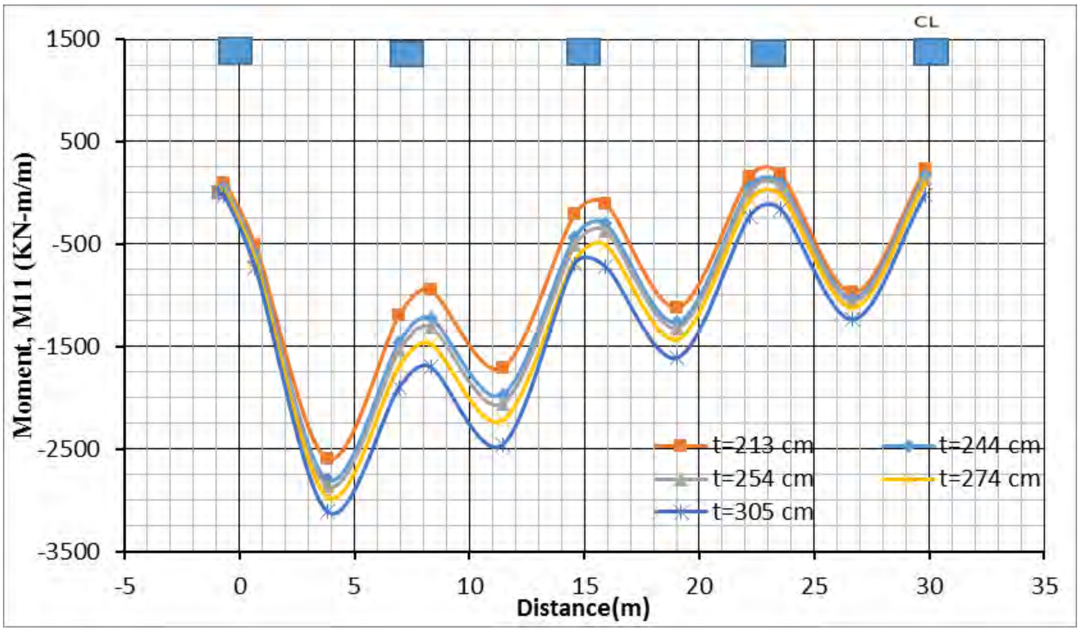

Figure 4-67: Moment along middle of an interior panel (GLY-56) for uniform thicknesses of uniform height of building at different thickness of mat.

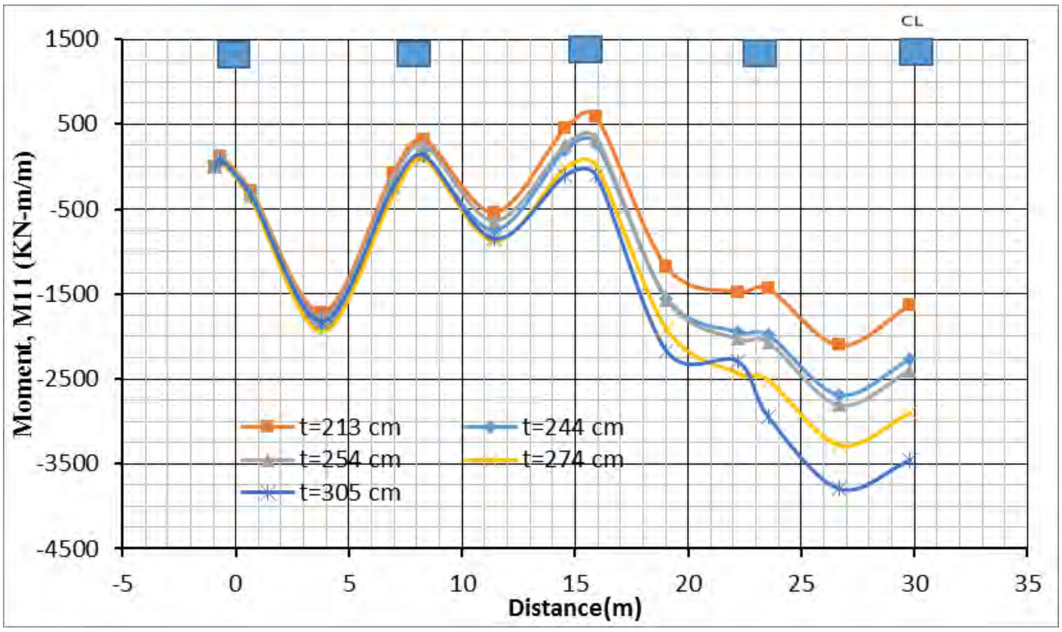

Figure 4-68: Moment along middle of an interior panel (GLY-56) for uniform thicknesses of non-uniform height of building at different thickness of mat.

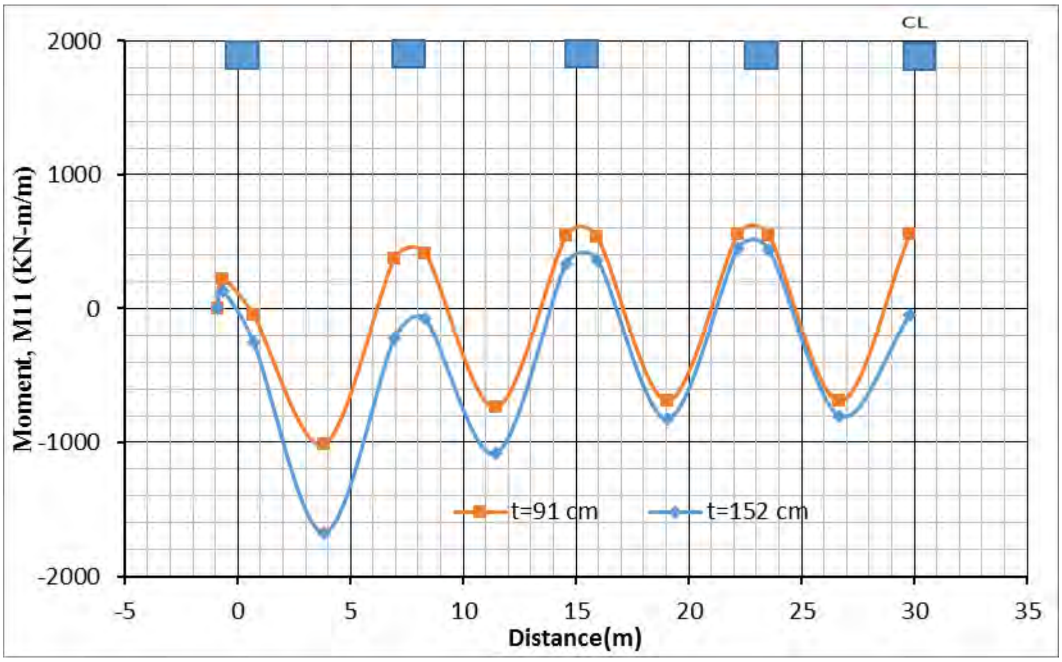

Figure 4-69: Moment along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different thickness of mat.

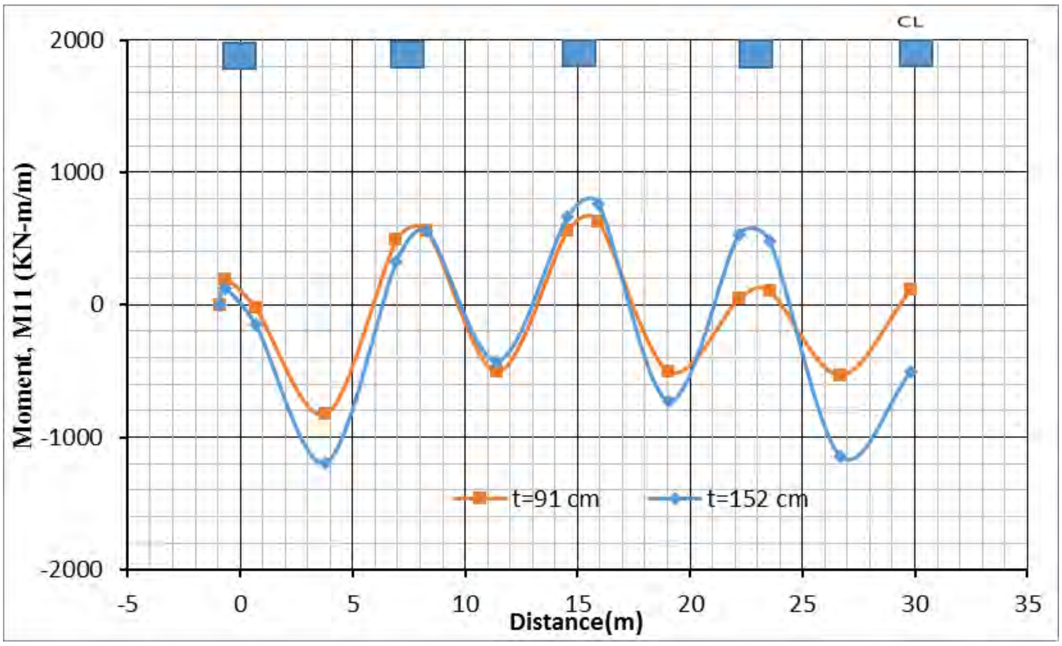

Figure 4-70: Moment along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different thickness of mat.

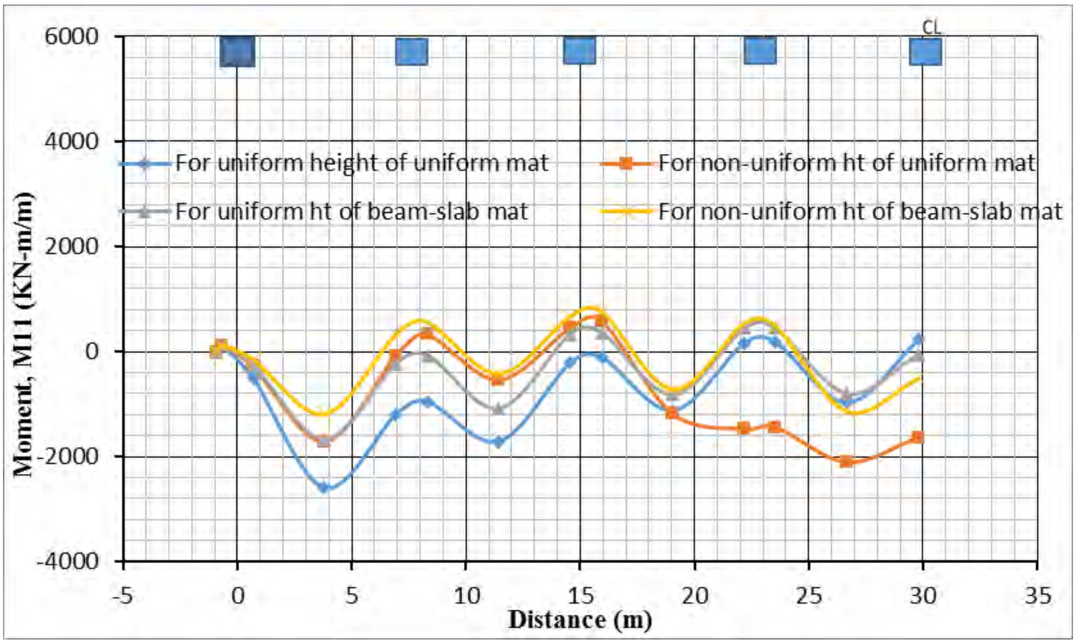

Figure 4-71: Moment along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

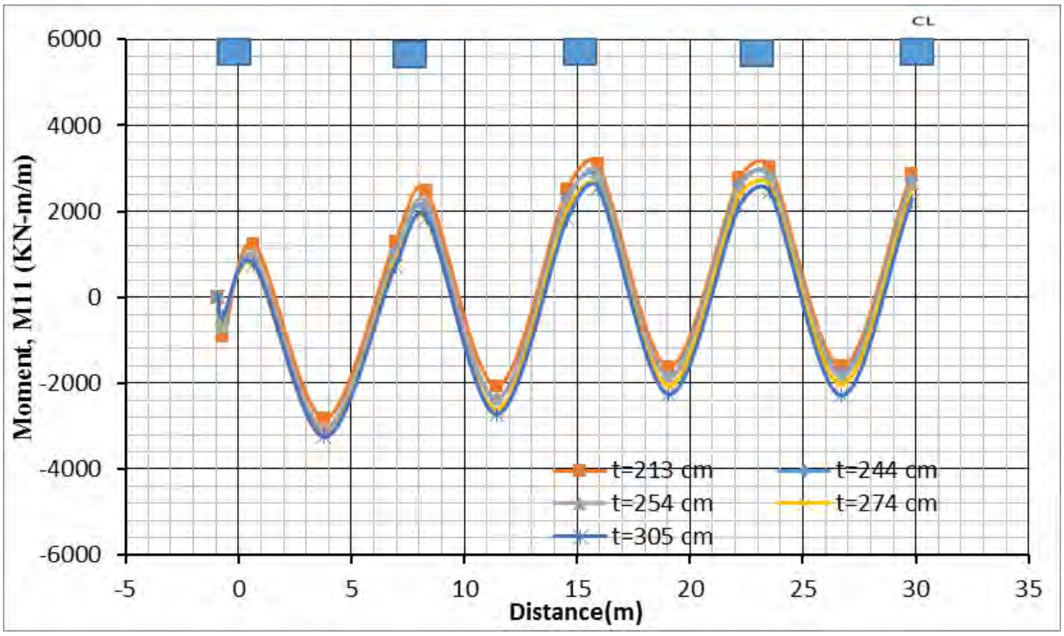

Figure 4-72: Moment along column line (GLY-3) for uniform thicknesses of non-uniform height of building at different thickness of mat.

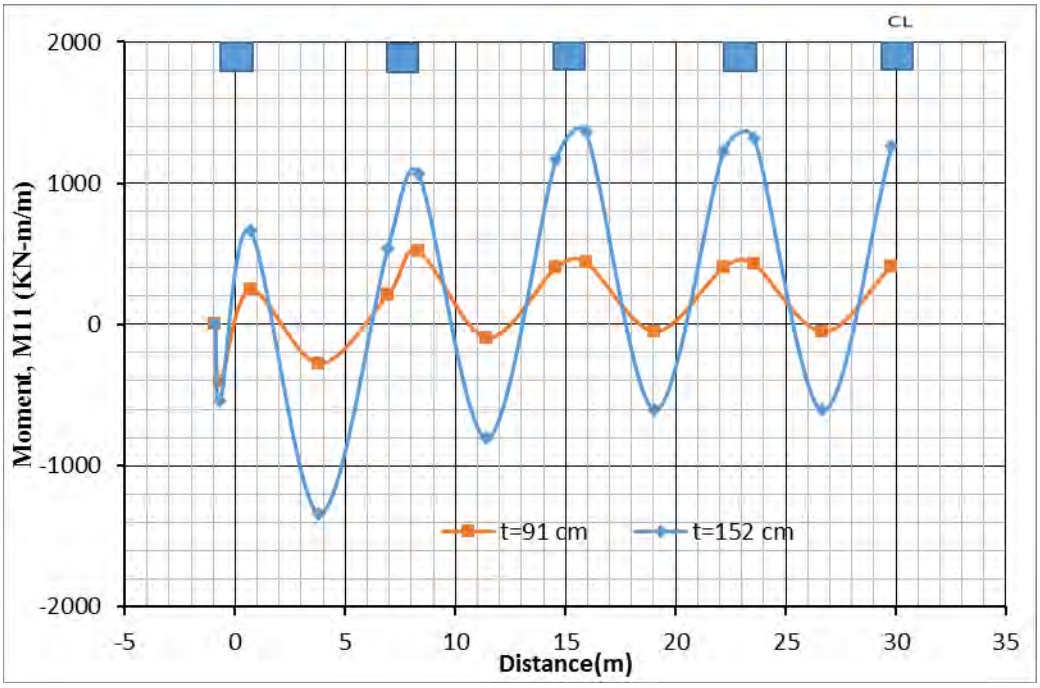

Figure 4-73: Moment along column line (GLY-3) for beam-slab mat of non-uniform height of building at different thickness of mat.

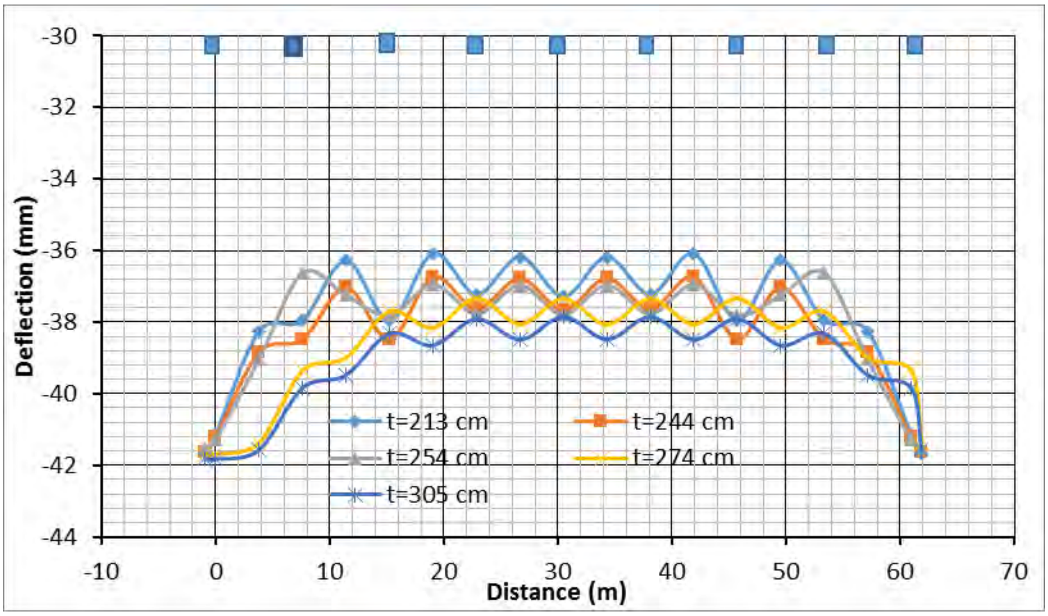

Figure 4-74: Deflection along column line (GL-6) for uniform thicknesses mat of uniform height of building at different thickness of mat.

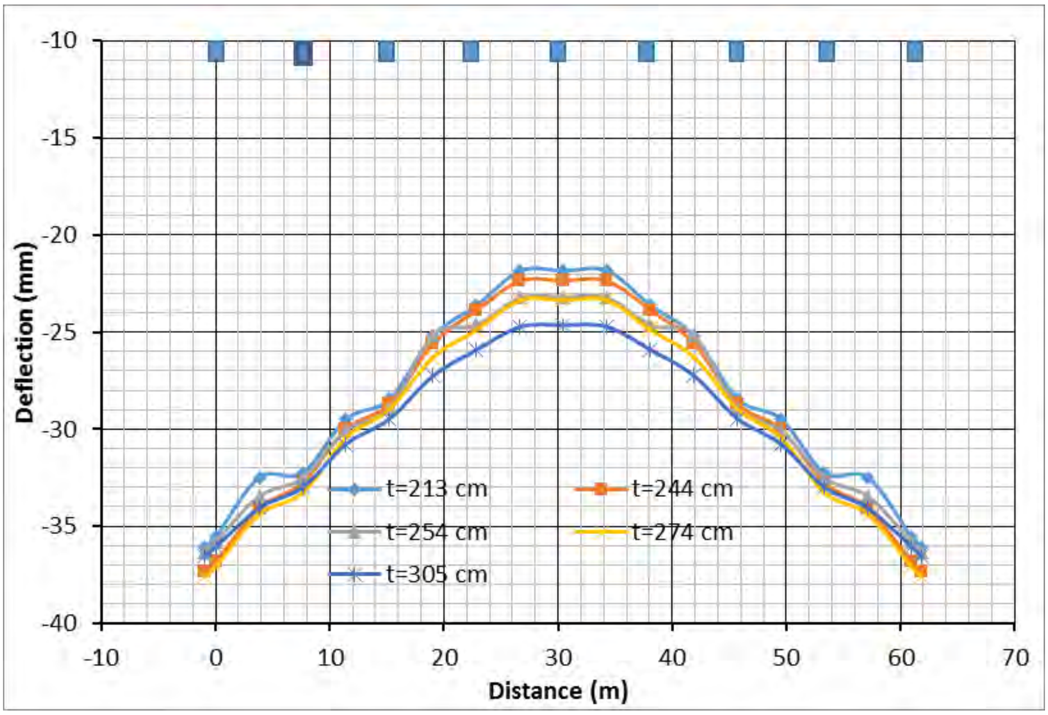

Figure 4-75: Deflection along column line (GLY-6) for uniform thicknesses of non-uniform height of building at different thickness of mat.

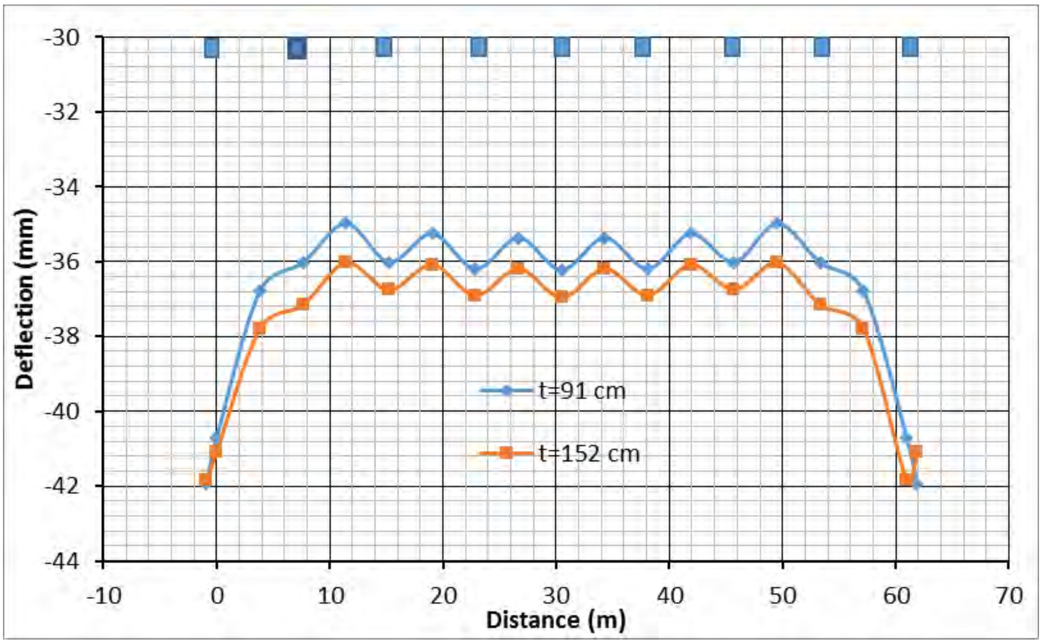

Figure 4-76: Deflection along column line (GLY-6) for beam-slab mat of uniform height of building at different thickness of mat.

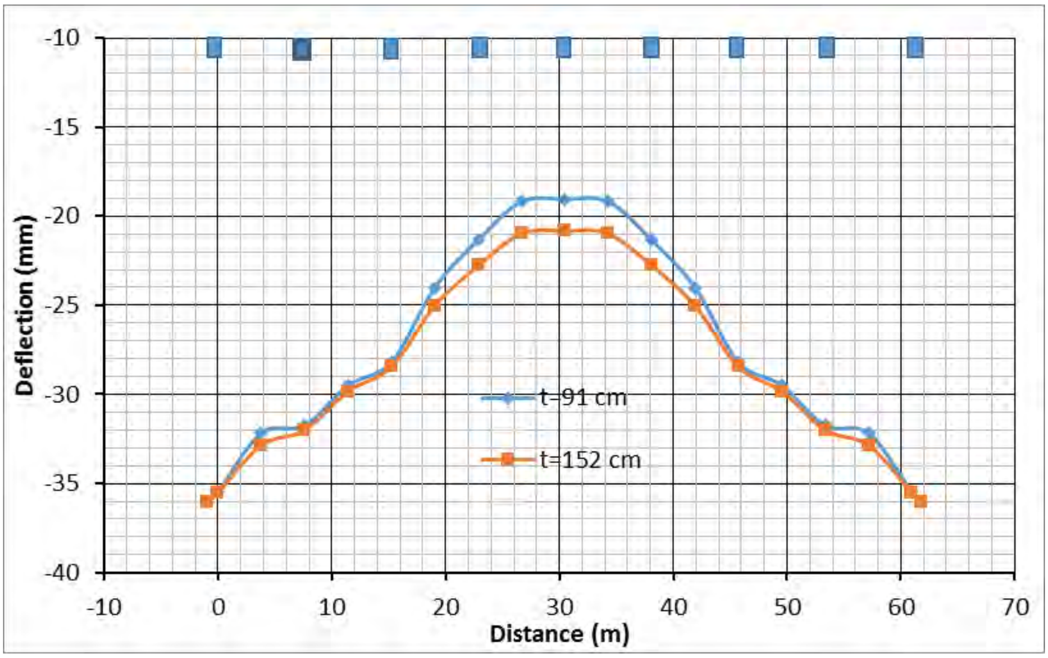

Figure 4-77: Deflection along column line (GLY-6) for beam-slab mat of non-uniform height of building at different thickness of mat.

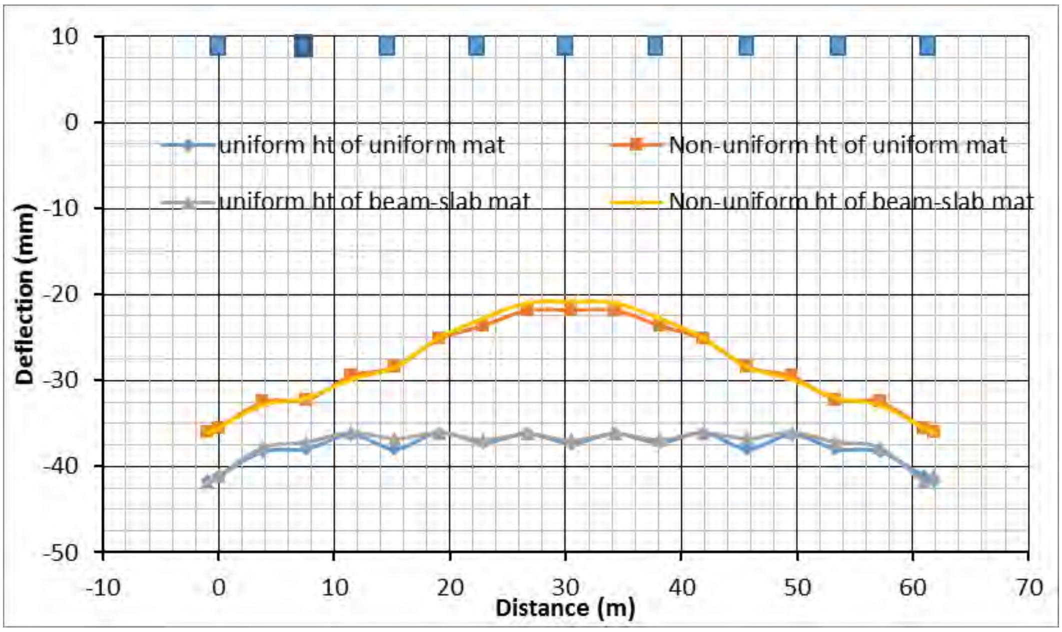

Figure 4-78: Deflection along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

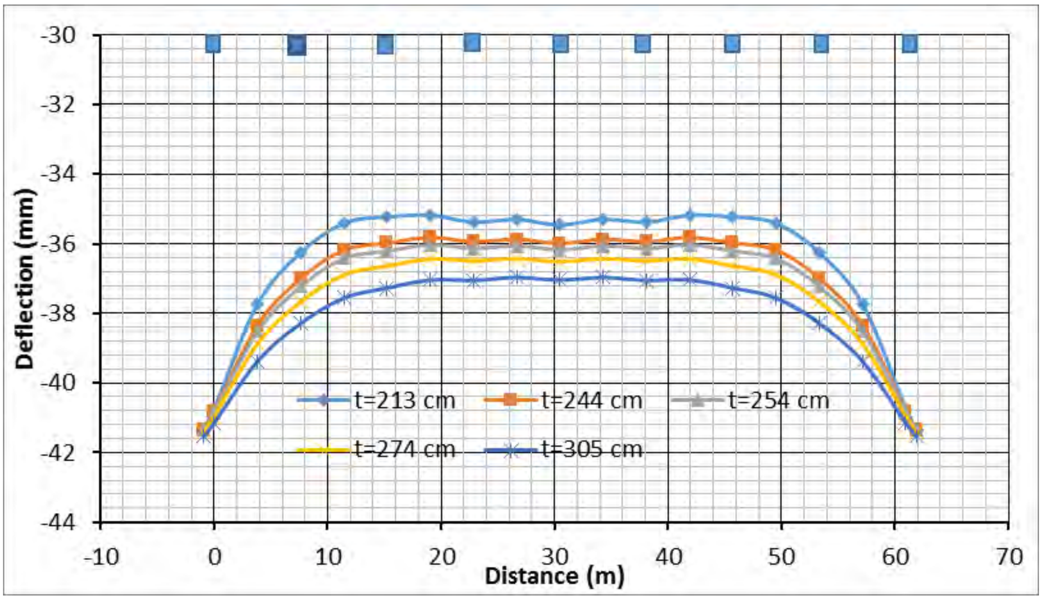

Figure 4-79: Deflection along middle of an interior panel (GLY-56) for uniform thicknesses of uniform height of building at different thickness of mat.

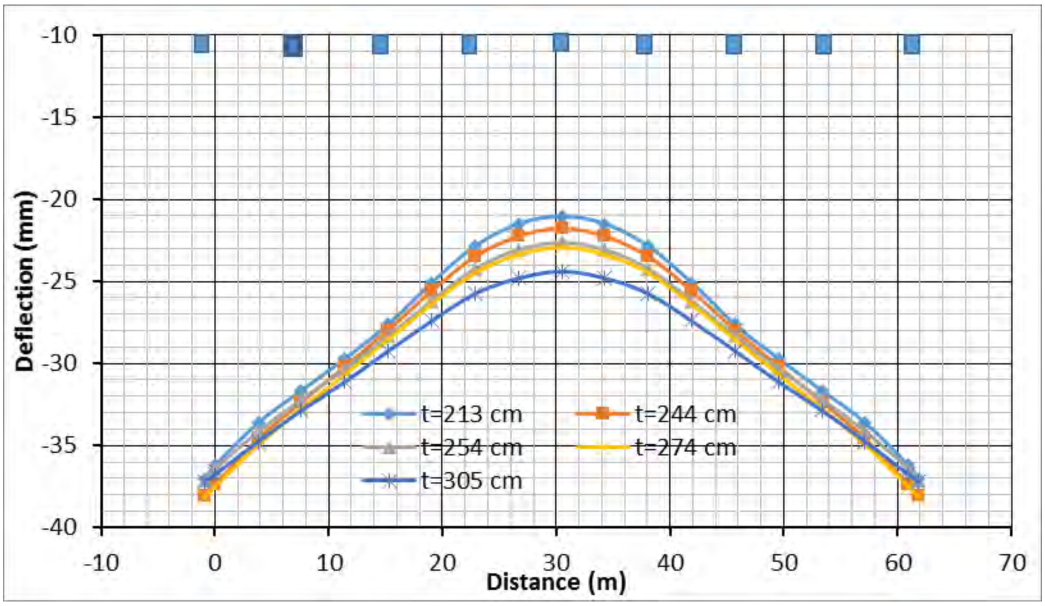

Figure 4-80: Deflection along middle of an interior panel (GLY-56) for uniform thicknesses of non-uniform height of building at different thickness of mat.

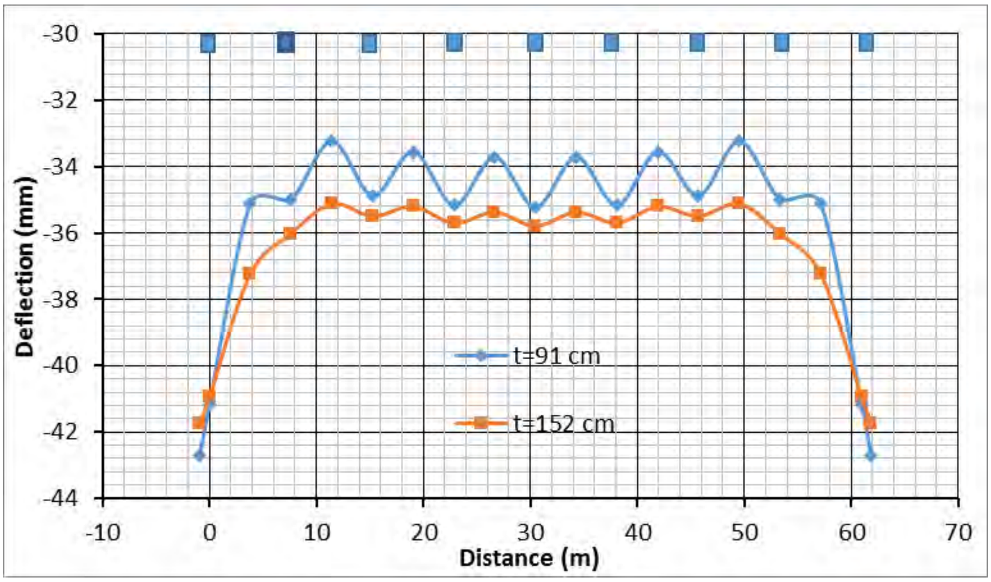

Figure 4-81: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different thickness of mat.

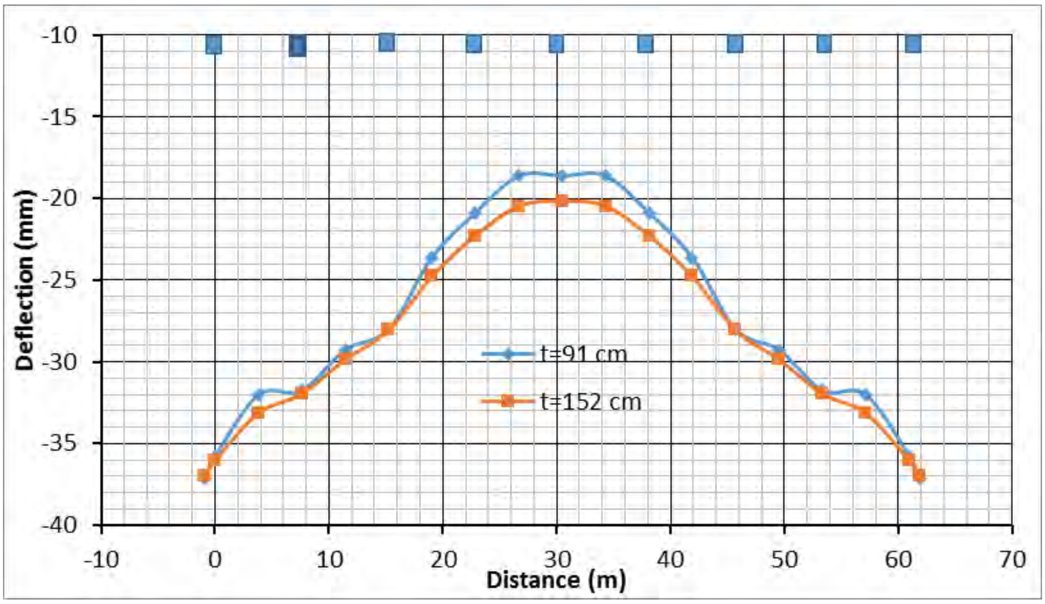

Figure 4-82: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different thickness of mat.

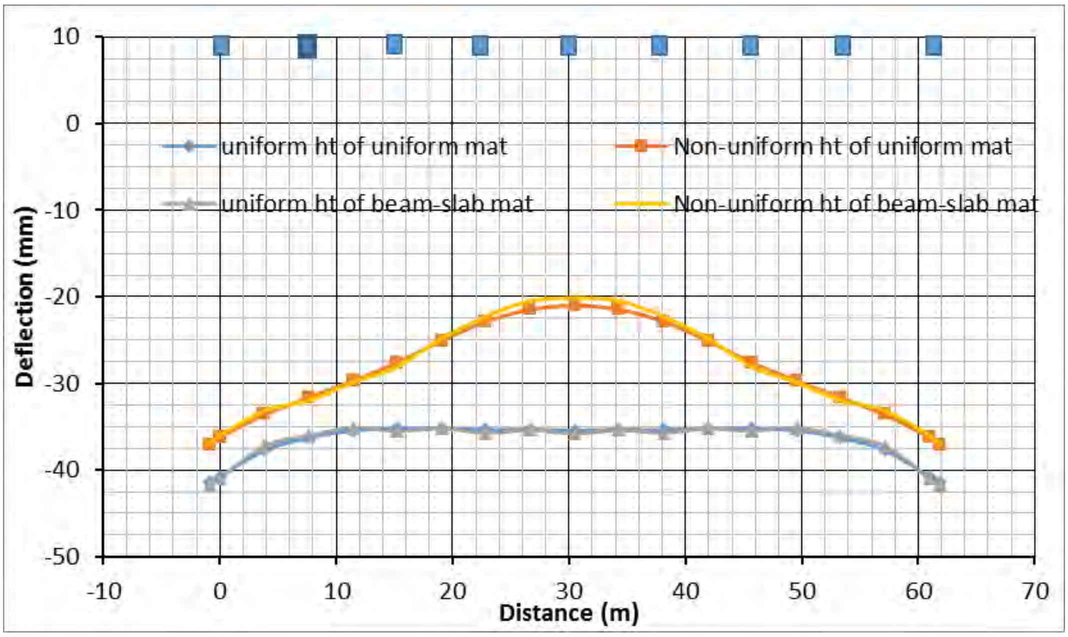

Figure 4-83: Deflection along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

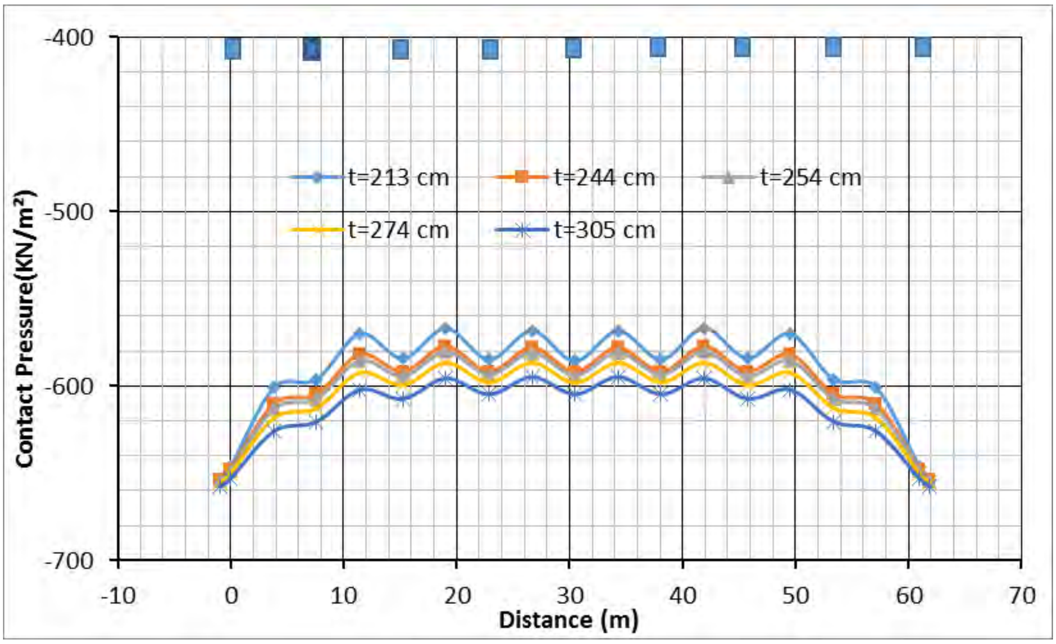

Figure 4-84: Contact pressure along column line (GLY-6) for uniform thicknesses of uniform height of building at different thickness of mat.

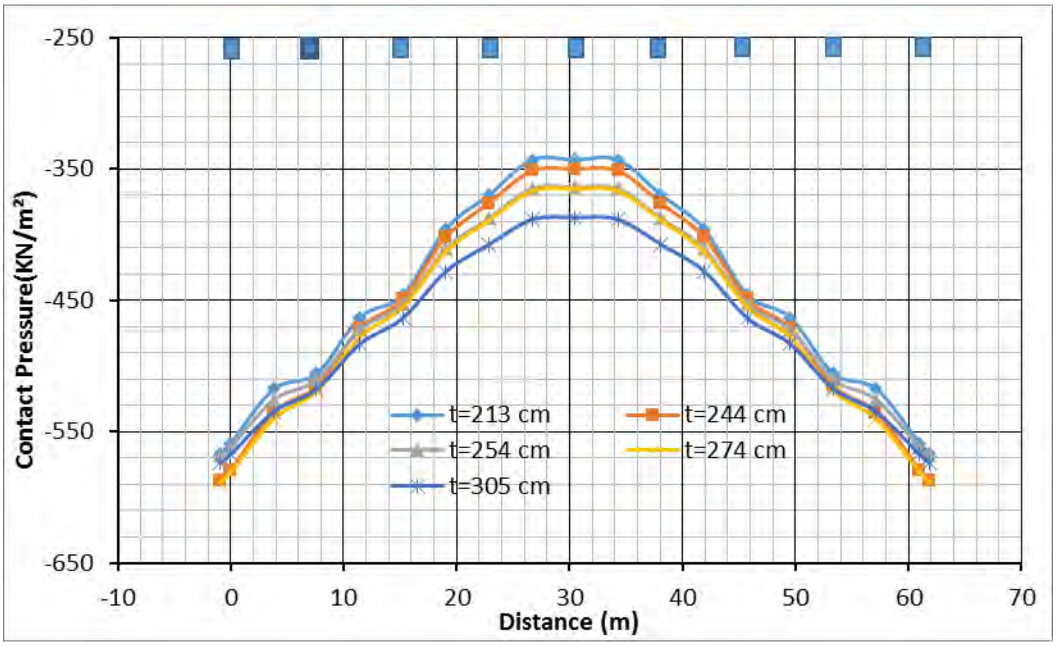

Figure 4-85: Contact pressure along column line (GLY-6) for uniform thicknesses of non-uniform height of building at different thickness of mat.

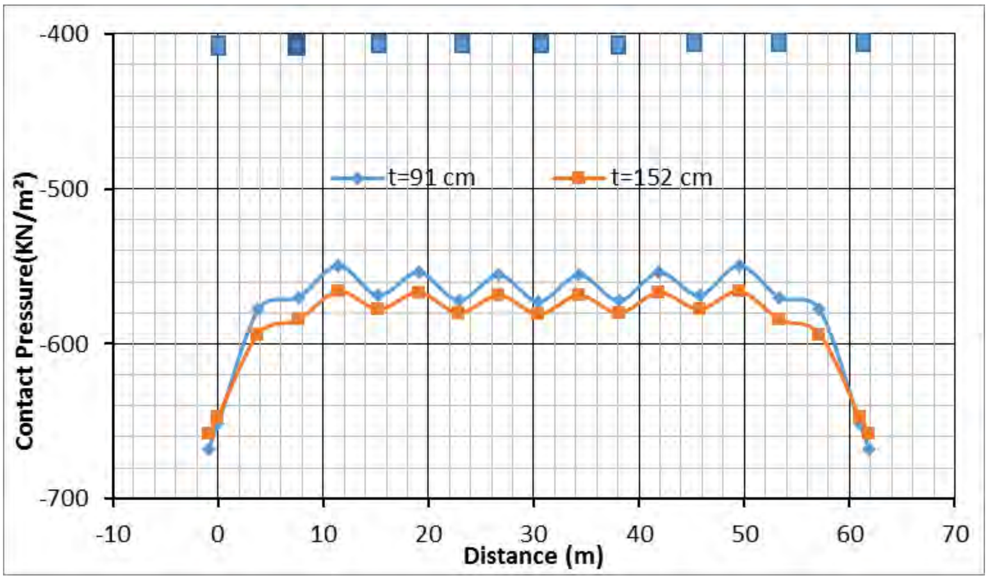

Figure 4-86: Contact pressure along column line (GLY-6) for beam-slab mat of uniform height of building at different thickness of mat.

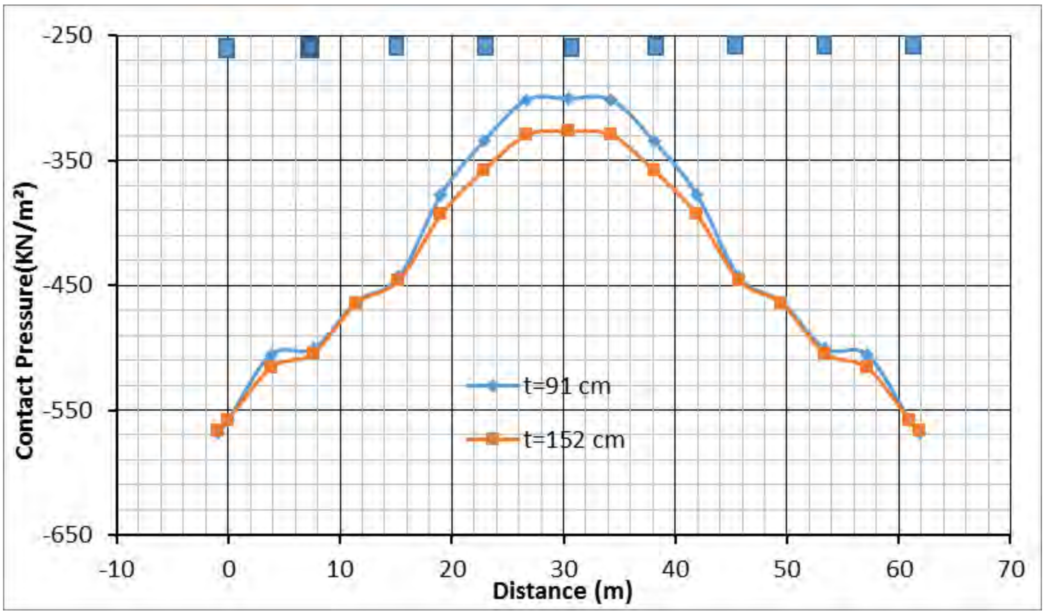

Figure 4-87: Contact pressure along column line (GLY-6) for beam-slab mat of non-uniform height of building at different thickness of mat.

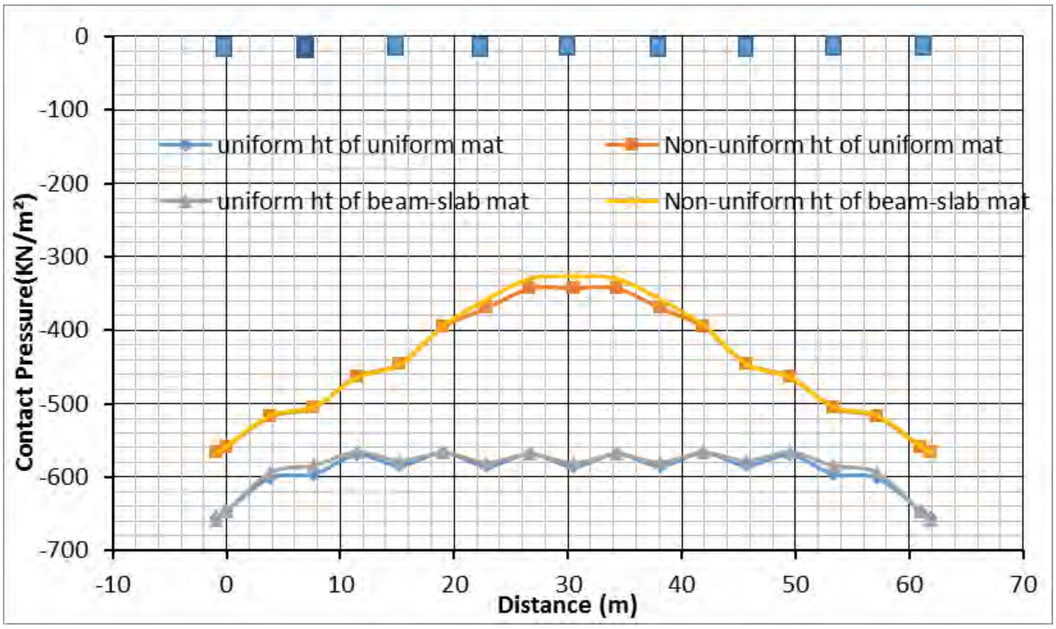

Figure 4-88: Contact pressure along column line (GLY-6) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

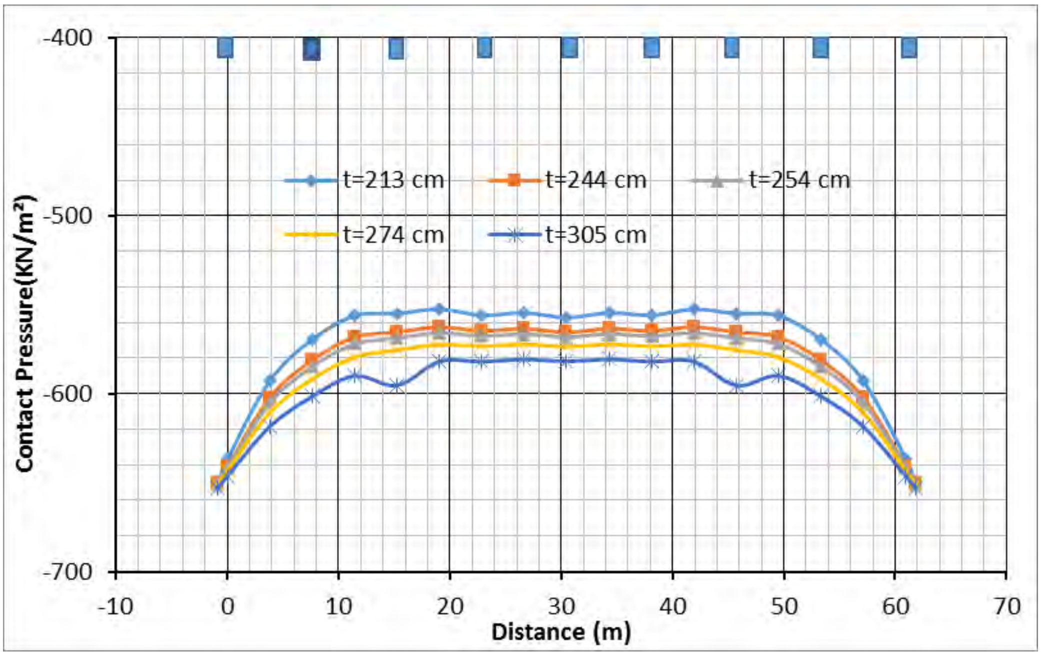

Figure 4-89: Contact pressure along middle of an interior panel (GLY-56) for uniform thicknesses of uniform height of building at different thickness of mat.

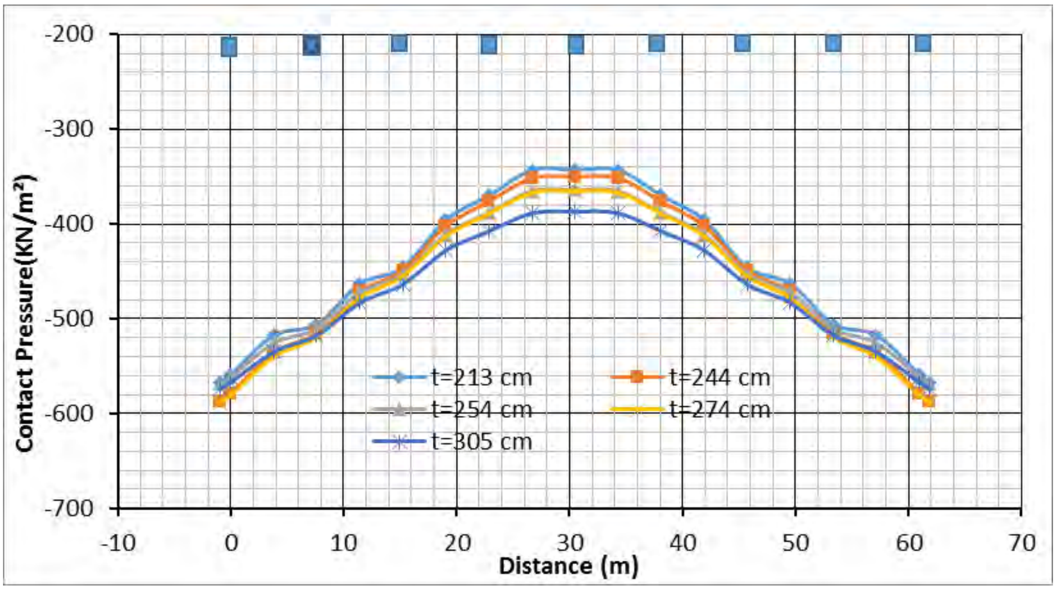

Figure 4-90: Contact pressure along middle of an interior panel (GLY-56) for uniform thicknesses of non-uniform height of building at different thickness of mat.

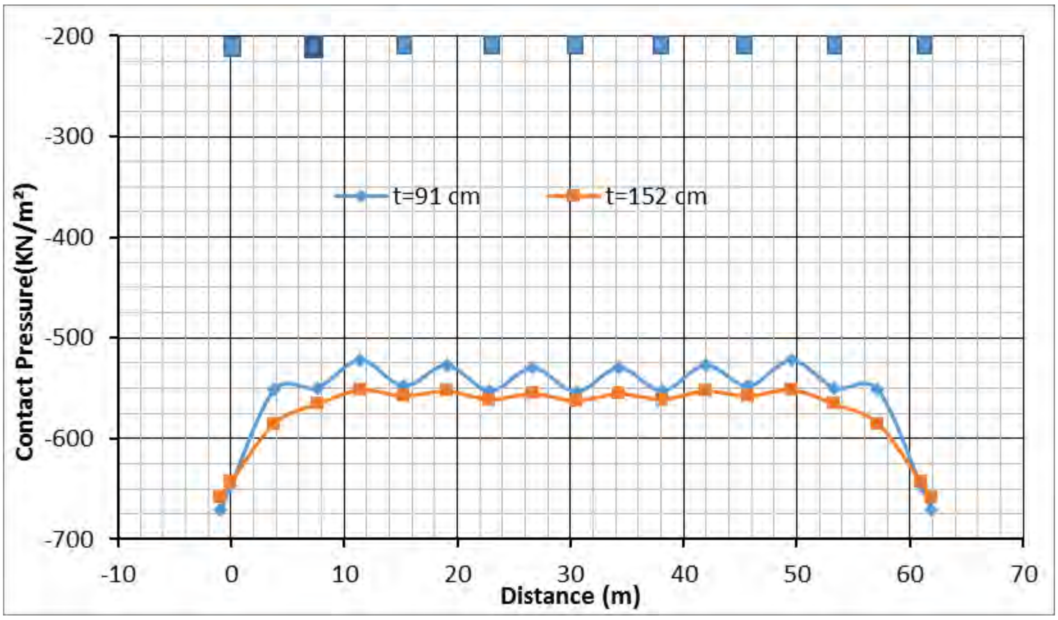

Figure 4-91: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of uniform height of building at different thickness of mat.

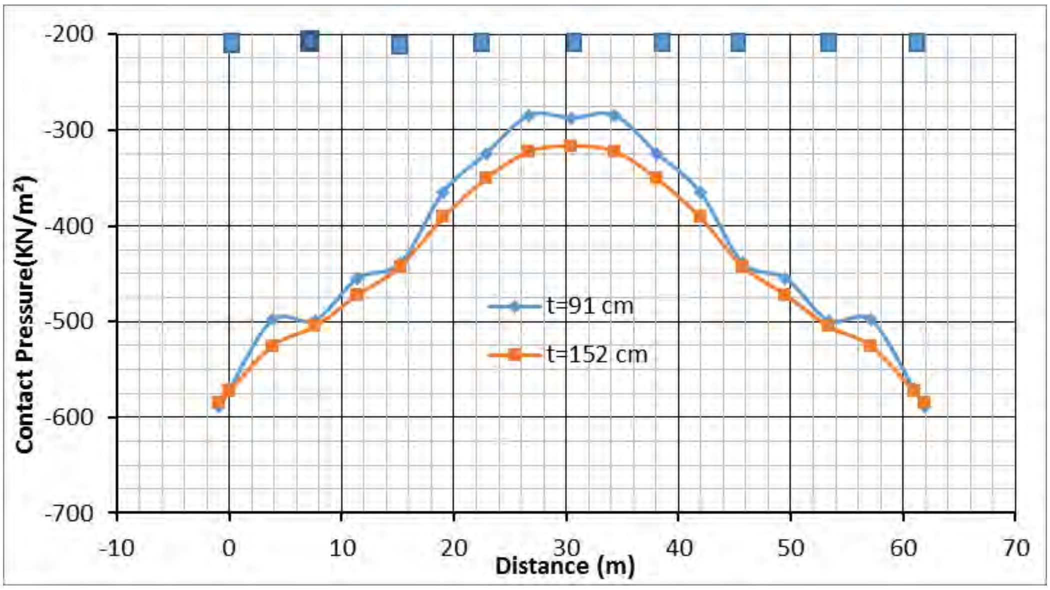

Figure 4-92: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of building at different thickness of mat.

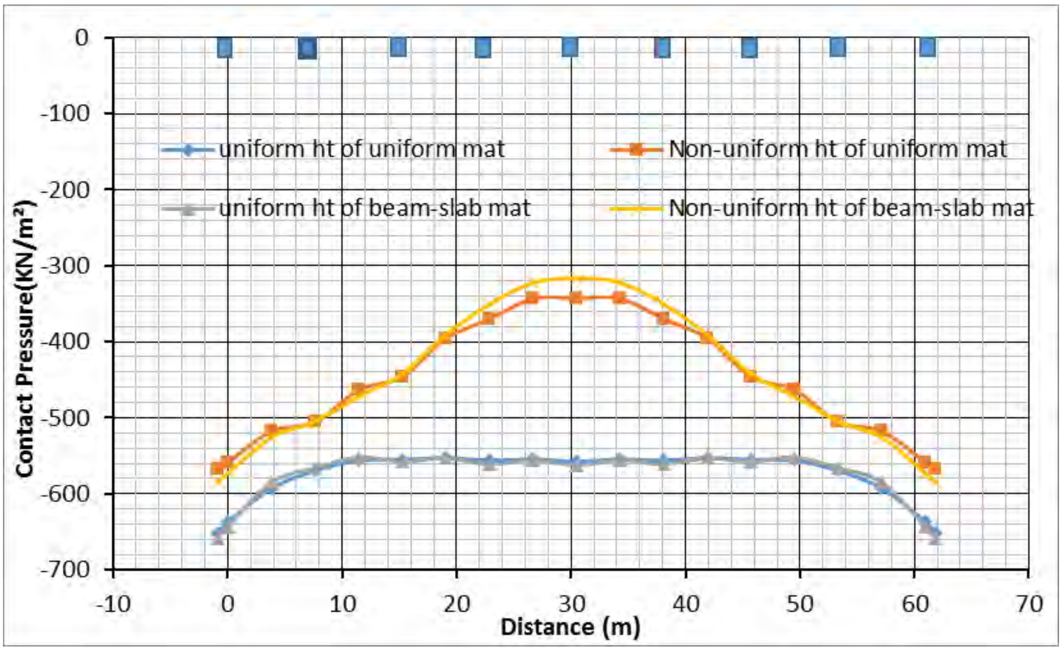

Figure 4-93: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness of mat of uniform height and non-uniform height and beam-slab mat of uniform height and non-uniform height of building at same thickness of mat.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 General

Mat foundation is relatively heavy and costly structure. Optimum design of mat foundation has always been engineer's dream. Various analysis and design methods and guidelines focused on structural behavior of mat but variation in mat behavior in case of non-uniform height of the high-rise building was not appropriately addressed. The objective of the study was to understand the behavior of mat foundation with non-uniform height of the high-rise building. A thorough analytical and comparative study on mat foundation is conducted where the effect of subgrade modulus & mat thickness is worked out in this work.

5.2 Conclusions

<u>Effect of Subgrade modulus:</u>

On the basis of the results described in chapter four, the following conclusions may be drawn:

- The value of negative bending moments (midpoint of panel) decreases with soil subgrade modulus, and positive bending moments (beneath of columns) increases with soil subgrade modulus for all cases.
- Mat deflection decreases exponentially with increasing modulus of sub-grade reaction at all positions.
- At positions beneath the columns, the contact pressure increases with increase of subgrade modulus.

<u>Effect of Mat thickness</u>

- The value of shear (both positive & negative) increases with the increase of mat thickness for all cases. But the change is not significant.
- The value of negative moment (mid panel) increases with the increase of mat thickness. The positive moments (under column) decreases with mat thickness.

- At all points deflection increases with the increase of mat thickness. However, differential settlement decreases with the increase of mat thickness.
- The value of contact pressure increases with the increase of mat thickness for all cases.

5.3 Recommendations for the Future Study

It is recommended that-

1. Further analysis should be performed with irregularly shaped mat, mat with punches and non-uniform column spacing.
2. Further study may include the effect of irregular location of shear wall loading from lift core on mat design.
3. An independent study should be performed on the effect of thermal expansion and its contribution on mat foundation.
4. Dynamic soil-mat interaction may be analyzed using FEM.

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APPENDIX A

A.1 Effect of Sub grade Modulus

Table A-1: Shear along column line (GLY-6) for uniform thickness mat of uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-1150.06	-1151.81	-1159.79	-1175.39	-1202.41
0.68	3143.49	3135.2	3098.74	3035.14	2940.5
3.81	-35.64	-51.79	-93.15	-144.85	-204.28
6.94	-4605.78	-4618.34	-4645.29	-4670.14	-4678.6
8.31	4565.98	4555.07	4532.45	4510.21	4482.53
11.43	-79.37	-83	-84.73	-78.91	-65.85
14.56	-4879.89	-4877.14	-4862.29	-4837.22	-4703.38
15.93	4703.32	4707.03	4720.07	4734.78	4741.21
19.05	-72.33	-65.95	-45.84	-23.82	-7.45
22.18	-4869.39	-4869.39	-4838.86	-4812.73	-4786.32
23.55	4723.09	4723.09	4720.19	4752.24	4750.38
26.68	-88.63	-88.63	-72.3	-59.53	-48.11
29.8	-4963.53	-4963.53	-4951.83	-4936.68	-4911.47

Table A-2: Shear along column line (GLY-6) for uniform thickness mat of non-uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-1184.56	-1189.65	-1201.47	-1217.24	-1240.56
0.68	2534.25	2521.33	2478.82	2416.54	2335.38
3.81	-174.21	-187.38	-210.44	-227.71	-244.82
6.94	-4405.44	-4424.64	-4459.16	-4459.75	-4454.93
8.31	4374.2	4349.8	4312	4285.93	4264.69
11.43	291.33	261.55	212.3	176.29	150.66
14.56	-3789.48	-3824.04	-3886	-3936.52	-3973.71
15.93	4375.62	4336.96	4260.8	4186.15	4110.08
19.05	849.04	810.17	729.72	647.09	562.59
22.18	-1791.57	-1825.02	-1894.9	-1964.87	-2029.07
23.55	2380.99	2352.02	2290.56	2227.37	2166.9
26.68	164.16	146.92	110.52	74.64	44.16
29.8	-2102.05	-2105.81	-2113.17	-2118.93	-2120.44

Table A-3: Shear along column line (GLY-6) for beam-slab mat of uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-768.15	-775.2	-794.02	-817.59	-843.7
0.68	686.26	678.68	660.12	640.25	623.74
3.81	24.26	14.82	-6.69	-26.44	-39.26
6.94	-1010.19	-1013.77	-1018.88	-1019.28	-1013.84
8.31	956.04	953.79	952.93	959.17	972.76
11.43	-35.02	-31.82	-22.19	-10.32	0.34
14.56	-1025.59	-1019.96	-1008.01	-999.31	-997.26
15.93	985.36	987.87	992.77	997.16	1001.36
19.05	-7.6	-4.51	-0.42	-0.48	-0.54
22.18	-1000.91	-997.53	-993..47	-993.74	-997.45
23.55	996.28	996.25	994.82	994	996.11
26.68	-0.7	-0.14	-0.26	-0.88	-1.01
29.8	-997.81	-996.34	-994.24	-994.25	996.92

Table A-4: Shear along column line (GLY-6) for beam-slab mat of non-uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-689.96	-692.42	-700.61	-713.37	-729.4
0.68	543.84	540.69	533.21	525.08	518.88
3.81	-22.17	-22.32	-24.22	-28.01	-29.47
6.94	-919.46	-917.85	-912.45	-903.41	-893.49
8.31	863.87	864.60	869.27	876.71	890.14
11.43	64.19	62.74	63.32	67.69	72.36
14.56	-731.54	-731.54	-748.03	-752.69	-757.07
15.93	895.83	883.42	860.81	842.28	830.75
19.05	283.63	271.81	240.15	213.45	182.95
22.18	-294.28	-305.36	-324.48	-337.32	-346.65
23.55	456.82	443.83	421.51	407.06	401.08
26.68	33.55	26.99	18.96	17.36	20.72
29.8	-388.38	-387.07	-382.84	-376.86	-371.32

Table A-5: Shear along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0
-0.68	-51.57	-76.17	-104.54	-129.91
0.68	1337.69	1326.13	1215.36	1123.75
3.81	423.98	402.09	281.92	209.44
6.94	-37.03	-17.86	-65.86	-97.79
8.31	71.18	55.38	-3.03	-18.08
11.43	-72.31	-80.87	-90.89	-77.15
14.56	-132.98	-134.5	-111.35	-85.46
15.93	-12.75	-11.87	16.46	34.91
19.05	3.23	5.72	36.82	56
22.18	-59.97	-55.72	-19.6	-4.04
23.55	-90.93	-85.57	-52.51	-42.43
26.68	23.45	28.05	52.27	54.03
29.8	-18.08	-14.88	0.89	2.56

Table A-6: Shear along middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-7.31	-14.97	-28.71	-42.52	-61.04
0.68	1152.05	1137.62	1091.95	1029.37	955.37
3.81	268.3	246.64	207.77	174.22	142.37
6.94	66.86	39.22	-6.54	-37.15	-51.96
8.31	197.26	165.47	111.79	74.57	54.28
11.43	192.46	154.6	87.42	36.56	4.14
14.56	332.71	289.63	207.77	137.44	82.23
15.93	528.45	482.79	391.57	305.55	227.08
19.05	559.77	514.33	418.94	322.49	228.17
22.18	434.72	399.51	315.76	230.67	150.7
23.55	363.63	330.51	259.32	187.04	120.49
26.68	153.4	133.54	90.01	48.53	12.15
29.8	16.96	12.31	2.49	-6.82	-13.75

Table A-7: Shear along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-84.12	-94.53	-120.67	-157.6	-204.99
0.68	1059	1041.14	993.17	920.12	826.97
3.81	28.85	16.7	-7.79	-25.12	-27.11
6.94	-790.51	-788.79	-773.9	-736.1	-669.41
8.31	710.61	704.37	694.73	686.87	667.24
11.43	-36.28	-32.03	-19.24	-4.26	-7.22
14.56	-777.21	-766.24	-740.42	-710.57	-668.8
15.93	737.62	737.57	732.71	714.61	672.14
19.05	-6.53	-3.01	1.25	1.26	0.87
22.18	-756.86	-749.56	-734.86	-713.78	-673.31
23.55	752.49	748.33	735.46	710.56	667.82
26.68	0.16	0.42	0.007	-0.78	-0.87
29.8	-754.52	-749.84	-735.78	-712.86	-670.94

Table A-8: Shear along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height

Distance (m)	Shear for Ks=11	Shear for Ks=16	Shear for Ks=31	Shear for Ks=63	Shear for Ks=125
-0.91	0	0	0	0	0
-0.68	-72.85	-78.76	-96.62	-124.1	-161.88
0.68	891.14	880.14	846.36	793.89	720.78
3.81	-15.86	-17.44	-20.07	-19.71	-10.97
6.94	-735.22	-728.89	-704.75	-661.86	-594.61
8.31	661.69	60.92	662.47	662.5	646.7
11.43	18.65	15.85	16.47	23.15	30.13
14.56	-570.92	-577.98	-584.28	-575.27	-541.66
15.93	708.76	689.23	651.4	615.11	573.81
19.05	186.41	165.9	124.61	85.58	49.08
22.18	-302.8	-312.96	-327.9	-330.23	-313.77
23.55	443.02	420.26	380.4	353.64	335.68
26.68	15.24	8.0	-1.43	-1.67	5.19
29.8	-372.09	-363.89	-346.91	-330.03	-309.42

Table A-9: Shear along column line (GLX-5) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Non-Uniform height of beam-slab mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of uniform thickness mat for Ks=16	Distance (m)
0	0	0	0	-0.91
-116.99	120.17	-765.27	-590.05	-0.68
-744.49	727.78	-2278.76	-1476.72	0.68
-816.31	807.24	-30.18	-18.64	3.81
-964.63	971.28	-5289.9	--3651.94	6.94
-989.6	995.36	-5791.6	--3884.46	8.31
-785.42	804.95	-77.61	-50.78	11.43
-932.54	994.62	-5377.65	-3879.61	14.56
-950.44	989.64	-5801.16	--3906.06	15.93
-716.57	811.94	-69.57	-52.44	19.05
-772.12	991.42	-4514.14	3904.77	22.18
-851.26	991.42	-5099.22	3878.83	23.55
-532.02	811.94	28.49	-52.44	26.68
-423.17	989.64	-2147.98	3932.28	29.8
-471.65	994.62	-2403.8	3879.62	31.16
-390.41	804.95	1.5	-50.78	34.29
-474.58	995.36	-2498.36	3910.94	37.42
-382.9	971.28	-1876.2	3651.94	38.78
-473.44	807.24	-3.82	-18.64	41.91
-542.37	727.78	1842.53	1476.72	45.04
-89.1	120.17	-218.65	590.05	46.38
0	0	0	0	46.63

Table A-10: Shear along middle of an interior panel (GLX-45) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Non-Uniform height of beam-slab mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of uniform thickness mat for Ks=16	Distance (m)
0	0	0	0	-0.91
-16.66	16.44	53.43	39.88	-0.68
12.49	-12.05	-74.23	-49.1	0.68
0.9	-0.21	-20.41	-4.64	3.81
1.55	-0.3	-26.61	-9.09	6.94
1.3	0.06	-35.83	-11.51	8.31
1.08	0.42	-47.12	-14.88	11.43
3.13	0.15	-33.4	-16.64	14.56
1.27	0.27	34.06	-17.62	15.93
0.77	0.75	-24.18	-19.26	19.05
6.86	0.31	42.97	-19.19	22.18
5.1	0.31	67.33	-19.19	23.55
3.07	0.75	108.38	-19.26	26.68
25.29	0.27	216.18	-17.62	29.8
25.04	0.15	234.67	-16.63	31.16
8	0.42	197.18	-14.88	34.29
23.01	0.06	216.13	-11.49	37.42
22.41	-0.3	190.13	-9.08	38.78
-3.3	-0.21	70.16	-4.64	41.91
1.36	-12.05	-47.45	-49.1	45.04
25.41	16.44	-31.71	39.88	46.38
0	0	0	0	46.63

Table A-11: Moment along column line (GLY-6) for uniform thickness mat of uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	-219.21	-217.61	-217.42	-217.35
0.68	673.25	684.09	763.84	810.32
3.81	-3215.98	3159.96	-2829.53	-2609.54
6.94	912.4	981.75	1520.51	1801.58
8.31	1458.98	1566.49	2144.36	2427.26
11.43	-2784.33	-2646.47	-2050.77	-1788.42
14.56	2058.35	2184.42	2676.07	2830.86
15.93	2175.4	2300.42	2751.98	2872.71
19.05	-2121.56	-2003.84	-1686.53	-1601.87
22.18	2616.95	2621.72	2886.43	2905.19
23.55	2483.7	2571.51	2805.93	2816.85
26.68	-1812.62	-1737.28	-1657.47	-1631.78
29.8	2876.99	2936.59	2980.97	2978.35

Table A-12: Moment along column line (GLY-6) for uniform thickness mat of non-uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	-549.59	-549.06	-548.13	-528.2
0.68	1160.44	1154.88	1170.05	1201.18
3.81	-2033.98	-2026.69	-1982.43	-1924.92
6.94	1810.74	1885.46	1890.62	1887.02
8.31	3336.62	3379.90	3433.14	3390.53
11.43	-1274.22	-1173.03	-1075.44	-1110
14.56	1658.84	1721.19	2046.39	1927.14
15.93	3015.03	3102.21	3572.5	3432.25
19.05	-2209.28	-2175.21	-1272.8	-1136.69
22.18	-1681.7	-1292.81	-475.667	-200.52
23.55	-788.72	-368.12	558.76	885.95
26.68	-3405.92	-2924.16	-1637.09	-1228.94
29.8	-1684.37	-1183.08	38.92	471.75

Table A-13: Moment along column line (GLY-6) for beam-slab mat of uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	-328.88	-325.28	-290.27	-253.58
0.68	198.64	204.58	233.28	249.61
3.81	-336.79	-318.22	-231.8	-188.92
6.94	162.72	188.21	289.14	324.74
8.31	255.79	281.89	374.93	394.13
11.43	-165.45	-141.91	75.82	-68.57
14.56	377.4	392.91	418.51	416.42
15.93	371.43	383.36	398.38	389.81
19.05	-97.85	-88.86	-75.22	-79.63
22.18	400.01	403.71	406.46	401.68
23.55	385.18	387.57	391.13	387.16
26.68	-94.48	-91.19	-79.11	80.32
29.8	397.19	398.37	404.21	400.68

Table A-14: Moment along column line (GLY-6) for beam-slab mat of non-uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	-303.57	-294.68	-269.50	-239.35
0.68	203.67	212.04	217.37	230.89
3.81	-196.56	-195.89	-170.01	-157.95
6.94	297.26	293.88	297.84	305.53
8.31	492.35	485.14	469.44	464.19
11.43	20.77	8.72	-27.04	-58.80
14.56	360.91	353.71	301.53	271.99
15.93	578.68	576.55	541.81	516.90
19.05	-105.55	-91.23	-50.17	-64.58
22.18	-138.96	-105.15	-14.28	14.28
23.55	37.45	79.04	192.51	224.49
26.68	-250.87	-199.80	-63.34	-52.88
29.8	-25.57	30.51	159.59	177.16

Table A-15: Moment along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	37.72	37.84	36.86	34.54
0.68	-627.17	-618.47	-561.16	-517.27
3.81	-2914.05	-2856.97	-2530.02	-2307.78
6.94	-1691.71	-1539.24	-980.92	-668.82
8.31	-1438.71	-1310.35	-693.82	-377.55
11.43	-2214.36	-2057.04	-1389.48	-1104.37
14.56	-675.84	-513.69	-666.4	-247.41
15.93	-528.71	-370.07	153.49	294.69
19.05	-1461.73	-1317.08	-919.65	-832.15
22.18	-108.34	15.0	271.42	303.35
23.55	-58.92	55.61	264.11	286.69
26.68	-1159.67	-1059.57	-916.42	-887.99
29.8	56.75	148.46	246.51	257.42

Table A-16: Moment along middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0
-0.68	100.42	95.32	75.43	66.92
0.68	-314.36	-319.81	-328.34	-366.1
3.81	-1773.08	-1768.92	-1749.76	-1694.45
6.94	-182.06	-144.75	-89.0	-59.39
8.31	204.24	258.08	391.83	323.17
11.43	-754.33	-640.45	-481.44	-500.25
14.56	63.53	253.33	577.55	562.58
15.93	106.99	331.54	747.04	754.89
19.05	-1890.08	-1570.17	-823.58	-667.81
22.18	-2439.05	-2028.93	-945.79	-639.78
23.55	-2508.12	-2066.35	-867.55	-514.58
26.68	-3309.89	-2809.05	-1384.52	-940.73
29.8	-2925.55	-2399.69	-885.98	-416.67

Table A-17: Moment along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Moment for Ks=125	Moment for Ks=63	Moment for Ks=16	Moment for Ks=11	Distance (m)
0	0	0	0	-0.91
196.21	208.73	221.76	223.35	-0.68
26.42	-4.83	-45.48	-52.57	0.68
-722.86	-846.46	-1013.47	-1041.69	3.81
460.05	456.3	370.68	344.93	6.94
477.32	484.02	411.29	386.18	8.31
-578.35	-629.34	-738.84	-771.68	11.43
500.26	539.88	543.77	531.2	14.56
488.02	527.27	538.27	528.26	15.93
-595.93	-642.14	-688.55	-701.71	19.05
491.92	528.28	557.36	558.37	22.18
486.93	518.49	546.6	548.27	23.55
-594.5	-644.96	-693.9	-700.53	26.68
491.94	526.6	552.73	556.65	29.8

Table A-18: Moment along middle of an interior panel (GLY-56) For beam-slab mat of non-uniform height

Moment for Ks=125	Moment for Ks=63	Moment for Ks=16	Moment for Ks=11	Distance (m)
0	0	0	0	-0.91
170.48	181.51	193.6	195.58	-0.68
42.84	-0.28	-25.55	-27.23	0.68
-631	-729.14	-826.76	-834.72	3.81
445.2	469.7	487.19	492.65	6.94
927.16	518.69	558.02	567.53	8.31
-507.95	-525.87	-503.52	-495.44	11.43
426.2	483.19	559.7	569.21	14.56
491.42	551.79	627.43	635.53	15.93
-399.25	-437.66	-504.61	-528.37	19.05
158.11	134.51	42.67	8.04	22.18
216.88	197.22	99.69	61.48	23.55
-291.47	-342.65	-530.85	-600.15	26.68
235.67	229.43	109.75	55.31	29.8

Table A-19: Moment along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks =31	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0	0
-0.68	-669.34	-671.60	-680.94	-683.35	-688.68
0.68	972.0659	984.1645	1008.717	1027.977	1058.224
3.81	-3089.45	-3037.94	-2926.21	-2792.41	-2611.38
6.94	900.54	1001.86	1204.47	1409.88	1621.52
8.31	2081.17	2203.45	2439.64	2659.77	2888.71
11.43	-2511.56	-2354.19	-2079.13	-1852.73	-1654.08
14.56	2043.67	2229.03	2514.09	2685.66	2776.66
15.93	2700.78	2897.34	3187.66	3341.83	3405.26
19.05	-2066.18	-1851.7	-1563.21	-1433.1	-1394.94
22.18	2308.78	2538.61	2828.39	2923.09	2920.02
23.55	2605.19	2841.69	3136.55	3229.56	3229.92
26.68	-2086.25	-1842.05	-1545.72	-1444.04	-1426.12
29.8	2420.34	2669.91	2969.84	3056.88	3058.27

Table A-20: Moment along middle of an interior panel (GLY-3) for beam-slab mat of non-uniform height

Distance (m)	Moment for Ks=11	Moment for Ks=16	Moment for Ks =31	Moment for Ks=63	Moment for Ks=125
-0.91	0	0	0	0	0
-0.68	-407.57	-404.81	-388.89	-362.38	-321.19
0.68	238.46	244.68	255.14	267.99	282.76
3.81	-292.55	-275.55	-240.21	-201.81	-165.86
6.94	190.64	212.57	259.94	301.71	329.28
8.31	339.65	517.52	404.37	436.17	457.16
11.43	-112.05	-93.72	-67.47	-56.67	-63.78
14.56	388.71	399.61	410.95	407.08	392.31
15.93	352.06	439.06	443.28	434.93	419.22
19.05	-55.77	-49.15	-52.22	-62.54	-76.86
22.18	401.96	404.01	400.45	392.44	382.62
23.55	424.25	425.72	421.98	414.86	405.52
26.68	-52.31	-51.11	-55.91	-62.63	-72.90
29.8	408.15	409.79	408.37	403.75	394.94

Table A-21: Moment along column line (GLX-5) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Non-Uniform height of beam-slab mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of uniform thickness mat for Ks=16	Distance (m)
0	0	0	0	-0.91
-116.99	120.17	-765.27	-590.05	-0.68
-744.49	727.78	-2278.76	-1476.72	0.68
-816.31	807.24	-30.18	-18.64	3.81
-964.63	971.28	-5289.9	--3651.94	6.94
-989.6	995.36	-5791.6	--3884.46	8.31
-785.42	804.95	-77.61	-50.78	11.43
-932.54	994.62	-5377.65	-3879.61	14.56
-950.44	989.64	-5801.16	--3906.06	15.93
-716.57	811.94	-69.57	-52.44	19.05
-772.12	991.42	-4514.14	3904.77	22.18
-851.26	991.42	-5099.22	3878.83	23.55
-532.02	811.94	28.49	-52.44	26.68
-423.17	989.64	-2147.98	3932.28	29.8
-471.65	994.62	-2403.8	3879.62	31.16
-390.41	804.95	1.5	-50.78	34.29
-474.58	995.36	-2498.36	3910.94	37.42
-382.9	971.28	-1876.2	3651.94	38.78
-473.44	807.24	-3.82	-18.64	41.91
-542.37	727.78	1842.53	1476.72	45.04
-89.1	120.17	-218.65	590.05	46.38
0	0	0	0	46.63

Table A-22: Moment along middle of an interior panel (GLX-45) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Non-Uniform height of beam-slab mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of uniform thickness mat for Ks=16	Distance (m)
0	0	0	0	-0.91
-16.66	16.44	53.43	39.88	-0.68
12.49	-12.05	-74.23	-49.1	0.68
0.9	-0.21	-20.41	-4.64	3.81
1.55	-0.3	-26.61	-9.09	6.94
1.3	0.06	-35.83	-11.51	8.31
1.08	0.42	-47.12	-14.88	11.43
3.13	0.15	-33.4	-16.64	14.56
1.27	0.27	34.06	-17.62	15.93
0.77	0.75	-24.18	-19.26	19.05
6.86	0.31	42.97	-19.19	22.18
5.1	0.31	67.33	-19.19	23.55
3.07	0.75	108.38	-19.26	26.68
25.29	0.27	216.18	-17.62	29.8
25.04	0.15	234.67	-16.63	31.16
8	0.42	197.18	-14.88	34.29
23.01	0.06	216.13	-11.49	37.42
22.41	-0.3	190.13	-9.08	38.78
-3.3	-0.21	70.16	-4.64	41.91
1.36	-12.05	-47.45	-49.1	45.04
25.41	16.44	-31.71	39.88	46.38
0	0	0	0	46.63

Table A-23: Deflection along column line (GLY-6) for uniform thickness mat of uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-5.91	-11.09	-21.32	-41.52	-57.11	-0.91
-5.71	-10.93	-21.12	-41.29	-56.85	0
-4.57	-9.46	-19.31	-39.04	-54.34	3.81
-5.08	-9.77	-19.33	-36.63	-53.73	7.62
-4.27	-8.85	-18.25	-37.25	-52.10	11.43
-5.14	-9.71	-19.01	-37.82	-52.56	15.24
-4.36	-8.94	-18.23	-36.94	-51.52	19.05
-5.19	-9.79	-19.11	-37.77	-52.28	22.86
-4,37	-8.99	-18.32	-36.97	51.45-	26.68
-5.18	-9.18	-19.15	-37.8	-52.27	30.48
-4,37	-8.99	-18.32	-36.97	51.45-	34.29
-5.19	-9.79	-19.11	-37.77	-52.28	38.1
-4.36	-8.94	-18.23	-36.94	-51.52	41.91
-5.14	-9.71	-19.01	-37.82	-52.56	45.72
-4.27	-8.85	-18.25	-37.25	-52.10	49.53
-5.08	-9.77	-19.33	-36.63	-53.73	53.34
-4.57	-9.46	-19.31	-39.04	-54.34	57.15
-5.71	-10.93	-21.12	-41.29	-56.85	60.96
-5.91	-11.09	-21.32	-41.52	-57.11	61.87

Table A-24: Deflection along column line (GLY-6) for uniform thickness mat of non-uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-4.82	-9.39	-18.34	-36.32	-50.04	-0.91
-4.80	-9.14	-18.03	-35.81	-49.27	0
-4.11	-8.22	-16.67	-33.46	-46.39	3.81
-4.572	-8.58	-16.58	-32.51	-44.70	7.62
-3.72	-7.49	-15.04	-30.06	-41.69	11.43
-4.06	-7.59	-14.68	-28.95	-39.87	15.24
-2.93	-6.21	-12.79	-25.16	-36.64	19.05
-2.79	-5.84	-11.93	-24.63	-34.79	22.86
-2.32	-5.08	-10.96	-23.24	-33.01	26.68
-2.54	-5.33	-11.05	-23.19	-32.76	30.48
-2.32	-5.08	-10.96	-23.24	-33.01	34.29
-2.79	-5.84	-11.93	-24.63	-34.79	38.1
-2.93	-6.21	-12.79	-25.16	-36.64	41.91
-4.06	-7.59	-14.68	-28.95	-39.87	45.72
-3.72	-7.49	-15.04	-30.06	-41.69	49.53
-4.572	-8.58	-16.58	-32.51	-44.70	53.34
-4.11	-8.22	-16.67	-33.46	-46.39	57.15
-4.80	-9.14	-18.03	-35.81	-49.27	60.96
-4.82	-9.39	-18.34	-36.32	-50.04	61.87

Table A-25: Deflection along column line (GLY-6) for beam-slab mat of uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-6.73	-12.13	-22.35	-41.93	-57.49	-0.91
-6.37	-11.54	-21.49	-40.7	-56.23	0
-4.49	-8.99	-18.18	-36.79	-51.36	3.81
-5.28	-9.52	-18.23	-36.03	-50.31	7.62
-4.54	-8.77	-17.37	-34.98	-48.88	11.43
-5.46	-9.78	-18.46	-36.01	-49.96	15.24
-4.58	-8.89	-17.61	-35.25	-49.08	19.05
-5.44	-9.79	-18.54	-36.19	-50.21	22.86
-4.56	-8.88	-17.62	-35.36	-49.26	26.68
-5.43	-9.77	-18.53	-36.22	-50.29	30.48
-4.56	-8.88	-17.62	-35.36	-49.26	34.29
-5.44	-9.79	-18.54	-36.19	-50.21	38.1
-4.58	-8.89	-17.61	-35.25	-49.08	41.91
-5.46	-9.78	-18.46	-36.01	-49.96	45.72
-4.54	-8.77	-17.37	-34.98	-48.88	49.53
-5.28	-9.52	-18.23	-36.03	-50.31	53.34
-4.49	-8.99	-18.18	-36.79	-51.36	57.15
-6.37	-11.54	-21.49	-40.7	-56.23	60.96
-6.73	-12.13	-22.35	-41.93	-57.49	61.87

Table A-26: Deflection along column line (GLY-6) for beam-slab mat of non-uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-5.58	-10.13	-19.05	-36.06	-49.78	-0.91
-5.33	-9.83	-18.54	-35.48	-48.76	0
-3.98	-7.95	-15.98	-32.17	-44.8	3.81
-5.01	-8.81	-16.51	-31.75	-43.68	7.62
-4.01	-7.69	-14.98	-29.49	-40.75	11.43
-4.57	-8.05	-14.73	-28.19	-38.60	15.24
-3.07	-5.99	-11.92	-24.01	-33.52	19.05
-2.79	-5.33	-10.41	-21.33	-29.97	22.86
-2.3	-4.53	-9.22	-19.19	-27.29	26.68
-2.72	-4.9	-9.39	-19.05	-26.92	30.48
-2.3	-4.53	-9.22	-19.19	-27.29	34.29
-2.79	-5.33	-10.41	-21.33	-29.97	38.1
-3.07	-5.99	-11.92	-24.01	-33.52	41.91
-4.57	-8.05	-14.73	-28.19	-38.60	45.72
-4.01	-7.69	-14.98	-29.49	-40.75	49.53
-5.01	-8.81	-16.51	-31.75	-43.68	53.34
-3.98	-7.95	-15.98	-32.17	-44.8	57.15
-5.33	-9.83	-18.54	-35.48	-48.76	60.96
-5.58	-10.13	-19.05	-36.06	-49.78	61.87

Table A-27: Deflection along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-5.97	-11.21	-21.38	-41.35	-56.73	-0.91
-5.69	-10.85	-20.92	-40.86	-56.21	0
-4.53	-9.38	-19.1	-38.52	-53.61	3.81
-4.28	-8.86	-18.23	-37.23	-52.06	7.62
-4.15	-8.62	-17.78	-36.42	-51.02	11.43
-4.3	-8.73	-17.81	-36.21	-50.63	15.24
-4.26	-8.71	-17.74	-36.03	-50.33	19.05
-4.37	-8.85	-17.9	-36.13	-50.36	22.86
-4.29	-8.78	-17.85	-36.06	-50.25	26.68
-4.38	-8.88	-17.96	-36.17	-50.35	30.48
-4.29	-8.78	-17.85	-36.06	-50.25	34.29
-4.37	-8.85	-17.9	-36.13	-50.36	38.1
-4.26	-8.71	-17.74	-36.03	-50.33	41.91
-4.3	-8.73	-17.81	-36.21	-50.63	45.72
-4.15	-8.62	-17.78	-36.42	-51.02	49.53
-4.28	-8.86	-18.23	-37.23	-52.06	53.34
-4.53	-9.38	-19.1	-38.52	-53.61	57.15
-5.69	-10.85	-20.92	-40.86	-56.21	60.96
-5.97	-11.21	-21.38	-41.35	-56.73	61.87

Table A-28: Deflection along middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height

Distance (m)	Deflection for Ks=11	Deflection for Ks=16	Deflection for Ks=31	Deflection for Ks=63	Deflection for Ks=125
-0.91	-51.04	-37.15	-18.9	-9.72	-5.08
0	-50.06	-36.42	-18.51	-9.45	-4.88
3.81	-47.29	-34.15	-17.08	-8.47	-4.15
7.62	-44.58	-32.18	-16.09	-8.02	-3.98
11.43	-42.17	-30.33	-15.10	-7.51	-3.72
15.24	-39.47	-28.32	-14.04	-6.98	-3.5
19.05	-36.85	-26.18	-12.64	-6.09	-2.92
22.86	-34.41	-24.23	-11.44	-5.33	-2.47
26.68	-33.05	-23.07	-10.66	-4.84	-2.18
30.48	-32.44	-22.64	-10.44	-4.73	-2.14
34.29	-33.05	-23.07	-10.66	-4.84	-2.18
38.1	-34.41	-24.23	-11.44	-5.33	-2.47
41.91	-36.85	-26.18	-12.64	-6.09	-2.92
45.72	-39.47	-28.32	-14.04	-6.98	-3.5
49.53	-42.17	-30.33	-15.10	-7.51	-3.72
53.34	-44.58	-32.18	-16.09	-8.02	-3.98
57.15	-47.29	-34.15	-17.08	-8.47	-4.15
60.96	-50.06	-36.42	-18.51	-9.45	-4.88
61.87	-51.04	-37.15	-18.9	-9.72	-5.08

Table A-29: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Deflection for Ks=125	Deflection for Ks=63	Deflection for Ks=31	Deflection for Ks=16	Deflection for Ks=11	Distance (m)
-6.59	-12.16	-22.51	-42.71	-57.6	-0.91
-5.99	-11.32	-21.48	-41.15	-56.22	0
-3.25	-7.64	-16.72	-35.12	-49.1	3.81
-4.54	-8.76	-17.36	-34.98	-48.87	7.62
-3.36	-7.54	-15.99	-33.23	-46.83	11.43
-4.73	-9.07	-17.64	-34.87	-48.39	15.24
-3.39	-7.66	-16.26	-33.55	-47.09	19.05
-4.71	-9.07	-17.75	-35.16	-48.76	22.86
-3.38	-7.64	-16.28	-33.71	-47.33	26.68
-4.71	-9.06	-17.75	-35.22	-48.88	30.48
-3.38	-7.64	-16.28	-33.71	-47.33	34.29
-4.71	-9.07	-17.75	-35.16	-48.76	38.1
-3.39	-7.66	-16.26	-33.55	-47.09	41.91
-4.73	-9.07	-17.64	-34.87	-48.39	45.72
-3.36	-7.54	-15.99	-33.23	-46.83	49.53
-4.54	-8.76	-17.36	-34.98	-48.87	53.34
-3.25	-7.64	-16.72	-35.12	-49.1	57.15
-5.99	-11.32	-21.48	-41.15	-56.22	60.96
-6.59	-12.16	-22.51	-42.71	-57.6	61.87

Table A-30: Deflection along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height

Distance (m)	Deflection for Ks=11	Deflection for Ks=16	Deflection for Ks=31	Deflection for Ks=63	Deflection for Ks=125
-0.91	-51.03	-37.11	-19.38	-10.26	-5.53
0	-49.7	-35.79	-18.54	-9.76	-5.23
3.81	-44.94	-32.02	-15.52	-7.42	-3.45
7.62	-43.77	-31.75	-16.18	-8.45	-4.58
11.43	-40.25	-29.27	-14.54	-7.21	-3.51
15.24	-38.31	-28.01	-14.5	-7.75	-4.28
19.05	-32.66	-23.61	-11.45	-5.57	-2.68
22.86	-29.2	-20.88	-10.08	-5.03	-2.62
26.68	-26.08	-18.61	-8.67	-4.14	-2.00
30.48	-26.02	-18.61	-9.00	-4.62	-2.52
34.29	-26.08	-18.61	-8.67	-4.14	-2.00
38.1	-29.2	-20.88	-10.08	-5.03	-2.62
41.91	-32.66	-23.61	-11.45	-5.57	-2.68
45.72	-38.31	-28.01	-14.5	-7.75	-4.28
49.53	-40.25	-29.27	-14.54	-7.21	-3.51
53.34	-43.77	-31.75	-16.18	-8.45	-4.58
57.15	-44.94	-32.02	-15.52	-7.42	-3.45
60.96	-49.7	-35.79	-18.54	-9.76	-5.23
61.87	-51.03	-37.11	-19.38	-10.26	-5.53

Table A-31: Deflection along column line (GLX-5) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Distance (m)	Uniform height of uniform thickness mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-Uniform height of beam-slab mat for Ks=16
-0.91	-41.66	-43.48	-42.13	-43.18
0	-41.21	-42.76	-41.17	-42.13
3.81	-38.48	-39.18	-36.78	-37.27
7.62	-37.83	-37.57	-36.45	-36.41
11.43	-36.17	-34.82	-35.23	-34.43
15.24	-36.64	-33.79	-36.48	34.44
19.05	-35.66	-30.87	-35.56	31.36
22.86	-36.47	-29.18	-36.69	29.18
26.68	-35.66	-25.89	-35.56	23.89
30.48	-36.64	-24.08	-36.48	20.35
34.29	-36.17	-22.69	-35.23	18.27
38.1	-37.83	-23.18	-36.45	19.12
41.91	-38.48	-24.24	-36.78	21.78
45.72	-41.21	-26.68	-41.17	27.09
46.63	-41.66	-27.09	-42.13	28

Table A-32: Deflection along middle of an interior panel (GLX-45) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Distance (m)	Uniform height of uniform thickness mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-Uniform height of beam-slab mat for Ks=16
-0.91	-41.49	-43.33	-42.21	-43.3
0	-40.96	-42.52	-40.76	-41.74
3.81	-38.42	-39.14	-35.19	35.67
7.62	-36.97	-36.79	-35.37	35.35
11.43	-36.06	-34.78	-33.71	33.01
15.24	-35.78	-33.07	-35.39	33.49
19.05	-35.54	-30.95	-34.03	30.2
22.86	-35.61	-28.71	-35.6	-28.59
26.68	-35.54	-26.16	-34.03	23.33
30.48	-35.78	-24.14	-35.39	20.43
34.29	-36.06	-23.07	-33.71	18.14
38.1	-36.97	-23.25	-35.37	19.19
41.91	-38.42	-24.54	-35.19	21.23
45.72	-40.96	-26.79	-40.76	27.15
46.63	-41.49	-27.27	-42.21	28.37

Table A-33: Contact pressure along column line (GLY-6) for uniform thickness mat of uniform height

Contact Pressure for Ks=125	Contact Pressure for Ks=63	Contact Pressure for Ks=16	Contact Pressure for Ks=11	Distance (m)
-743.85	-700.04	-654.5	-647.82	-0.91
-725.73	-689.87	-648.3	-642.67	0
-574.38	-594.13	-612.93	-614.29	3.81
-638.43	-613.63	-607.17	-607.39	7.62
-537.21	-556.7	-585.3	-589.32	11.43
-646.02	-610.07	-594.25	-593.99	15.24
-547.93	-562	-580.32	-582.74	19.05
-651.63	-615.61	-593.32	-591.37	22.86
-548.87	-565.07	-580.78	-581.96	26.68
-650.99	-616.68	-593.84	-591.24	30.48
-548.87	-565.07	-580.78	-581.96	34.29
-651.63	-615.61	-593.32	-591.37	38.1
-547.93	-562	-580.32	-582.74	41.91
-646.02	-610.07	-594.25	-593.99	45.72
-537.21	-556.7	-585.3	-589.32	49.53
-638.43	-613.63	-607.17	-607.39	53.34
-574.38	-594.13	-612.93	-614.29	57.15
-725.73	-689.87	-648.3	-642.67	60.96
-743.85	-700.04	-654.5	-647.82	61.87

Table A-34: Contact pressure along column line (GLY-6) for uniform thickness mat of non-uniform height

Contact Pressure for Ks=125	Contact Pressure for Ks=63	Contact Pressure for Ks=16	Contact Pressure for Ks=11	Distance (m)
-743.85	-700.04	-654.5	-647.82	-0.91
-725.73	-689.87	-648.3	-642.67	0
-574.38	-594.13	-612.93	-614.29	3.81
-638.43	-613.63	-607.17	-607.39	7.62
-537.21	-556.7	-585.3	-589.32	11.43
-646.02	-610.07	-594.25	-593.99	15.24
-547.93	-562	-580.32	-582.74	19.05
-651.63	-615.61	-593.32	-591.37	22.86
-548.87	-565.07	-580.78	-581.96	26.68
-650.99	-616.68	-593.84	-591.24	30.48
-548.87	-565.07	-580.78	-581.96	34.29
-651.63	-615.61	-593.32	-591.37	38.1
-547.93	-562	-580.32	-582.74	41.91
-646.02	-610.07	-594.25	-593.99	45.72
-537.21	-556.7	-585.3	-589.32	49.53
-638.43	-613.63	-607.17	-607.39	53.34
-574.38	-594.13	-612.93	-614.29	57.15
-725.73	-689.87	-648.3	-642.67	60.96
-743.85	-700.04	-654.5	-647.82	61.87

Table A-35: Contact pressure along column line (GLY-6) for beam-slab mat of uniform height

Distance (m)	Contact Pressure for Ks=11	Contact Pressure for Ks=16	Contact Pressure for Ks=63	Contact Pressure for Ks=125
-0.91	-653.46	-667.51	-769.29	-851.52
0	-640.21	-651.4	-737.6	-816.31
3.81	-580.85	-577.98	-565.14	-563.74
7.62	-570.25	-570.03	-606.69	-681.02
11.43	-552.85	-549.57	-550.89	-570.6
15.24	-565.74	-568.61	-623.97	-706.1
19.05	-555.17	-553.81	-558.86	-574.94
22.86	-568.74	-571.99	-624.45	-703.81
26.68	-557.21	-555.55	-557.79	-573.46
30.48	-569.68	-572.61	-623.89	-703.56
34.29	-557.21	-555.55	-557.79	-573.46
38.1	-568.74	-571.99	-624.45	-703.81
41.91	-555.17	-553.81	-558.86	-574.94
45.72	-565.74	-568.61	-623.97	-706.1
49.53	-552.85	-549.57	-550.89	-570.6
53.34	-570.25	-570.03	-606.69	-681.02
57.15	-580.85	-577.98	-565.14	-563.74
60.96	-640.21	-651.4	-737.6	-816.31
61.87	-653.46	-667.51	-769.29	-851.52

Table A-36: Contact pressure along column line (GLY-6) for beam-slab mat of non-uniform height

Distance (m)	Contact Pressure for Ks=11	Contact Pressure for Ks=16	Contact Pressure for Ks=63	Contact Pressure for Ks=125
-0.91	-561.68	-568.73	-637.39	-700.55
0	-552.2	-558.04	-617.06	-678.74
3.81	-506.71	-505.41	-499.88	-501.06
7.62	-495.91	-500.66	-553.63	-628.62
11.43	-460.92	-463.36	-483.42	-504.2
15.24	-437.19	-443.49	-506.68	-582.85
19.05	-379.13	-377.18	-375.87	-386.24
22.86	-338.85	-334.57	-332.65	-355.08
26.68	-308.73	-301.57	-285.02	-290.11
30.48	-305.36	-300.38	-307.49	-340.63
34.29	-308.73	-301.57	-285.02	-290.11
38.1	-338.85	-334.57	-332.65	-355.08
41.91	-379.13	-377.18	-375.87	-386.24
45.72	-437.19	-443.49	-506.68	-582.85
49.53	-460.92	-463.36	-483.42	-504.2
53.34	-495.91	-500.66	-553.63	-628.62
57.15	-506.71	-505.41	-499.88	-501.06
60.96	-552.2	-558.04	-617.06	-678.74
61.87	-561.68	-568.73	-637.39	-700.55

Table A-37: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Contact Pressure for Ks=125	Contact Pressure for Ks=63	Contact Pressure for Ks=16	Contact Pressure for Ks=11	Distance (m)
-750.65	-704.28	-650.67	-642.93	-0.91
-715. 89	-681.99	-641.86	-635.86	0
-572.22	-589.88	-605.21	-606.38	3.81
-537.29	-556.98	-584.86	-588.77	7.62
-522.14	-541.41	-572.13	-577.08	11.43
-541.28	-549.08	-568.76	-572.71	15.24
-535.63	-547.33	-565.93	-569.33	19.05
-550	-556.38	-567.52	-569.65	22.86
-538.74	-551.95	-566.44	-568.44	26.68
-550.43	-558.34	-568.15	-569.54	30.48
-538.74	-551.95	-566.44	-568.44	34.29
-550	-556.38	-567.52	-569.65	38.1
-535.63	-547.33	-565.93	-569.33	41.91
-541.28	-549.08	-568.76	-572.71	45.72
-522.14	-541.41	-572.13	-577.08	49.53
-537.29	-556.98	-584.86	-588.77	53.34
-572.22	-589.88	-605.21	-606.38	57.15
-715. 89	-681.99	-641.86	-635.86	60.96
-750.65	-704.28	-650.67	-642.93	61.87

Table A-38: Contact pressure along middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height

Contact Pressure for Ks=125	Contact Pressure for Ks=63	Contact Pressure for Ks=16	Contact Pressure for Ks=11	Distance (m)
-644.08	-615.88	-584.83	-578.87	-0.91
-620.75	-599.9	-575.57	-570.46	0
-521.32	-532.25	-536.44	-532.25	3.81
-501.02	-505.35	-507.32	-506.54	7.62
-467.42	-471.62	-476.37	-476.25	11.43
-439.75	-439.21	-446	-448.15	15.24
-367.05	-382.4	-410.9	-416.74	19.05
-310.3	-335.28	-381.66	-390.79	22.86
-274.16	-304.37	-364.45	-373.84	26.68
-269.29	-297.29	-356.57	-368.49	30.48
-274.16	-304.37	-364.45	-373.84	34.29
-310.3	-335.28	-381.66	-390.79	38.1
-367.05	-382.4	-410.9	-416.74	41.91
-439.75	-439.21	-446	-448.15	45.72
-467.42	-471.62	-476.37	-476.25	49.53
-501.02	-505.35	-507.32	-506.54	53.34
-521.32	-532.25	-536.44	-532.25	57.15
-620.75	-599.9	-575.57	-570.46	60.96
-644.08	-615.88	-584.83	-578.87	61.87

Table A-39: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Distance (m)	Contact Pressure for Ks=11	Contact Pressure for Ks=16	Contact Pressure for Ks=63	Contact Pressure for Ks=125
-0.91	- 655.44	-670.88	-769.84	-835.34
0	-635.91	-646.44	-711.15	-752.15
3.81	-559.95	-551.7	-480.37	-407.98
7.62	-552.7	-549.47	-550.76	-570.47
11.43	-529.68	-522.03	-473.94	-423.49
15.24	-547.41	-547.83	-569.69	-594.67
19.05	-532.61	-527.14	-481.71	-426.4
22.86	-551.47	-552.38	-570.14	-591.61
26.68	-535.4	-529.59	-480.62	-425
30.48	-552.8	-553.34	-569.42	-591.28
34.29	-535.4	-529.59	-480.62	-425
38.1	-551.47	-552.38	-570.14	-591.61
41.91	-532.61	-527.14	-481.71	-426.4
45.72	-547.41	-547.83	-569.69	-594.67
49.53	-529.68	-522.03	-473.94	-423.49
53.34	-552.7	-549.47	-550.76	-570.47
57.15	-559.95	-551.7	-480.37	-407.98
60.96	-635.91	-646.44	-711.15	-752.15
61.87	- 655.44	-670.88	-769.84	-835.34

Table A-40: Contact pressure along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height

Distance (m)	Contact Pressure for Ks=11	Contact Pressure for Ks=16	Contact Pressure for Ks=63	Contact Pressure for Ks=125
-0.91	-581.04	-589.1	-653.88	-703.33
0	-565.57	-570.53	-609.63	-538.94
3.81	-504.97	-498.3	-435.33	-369.91
7.62	-497.11	-498.64	-514.3	-535.19
11.43	-456.55	-454.65	-425.86	-381.4
15.24	-434.99	-438.64	-472.43	-501.95
19.05	-370.41	-364.51	-327.93	-291.41
22.86	-313.5	-324.35	-304.91	-306.19
26.68	-295.57	-284.4	-241.89	-217.42
30.48	-295.25	-287.09	-279.24	-295.41
34.29	-295.57	-284.4	-241.89	-217.42
38.1	-313.5	-324.35	-304.91	-306.19
41.91	-370.41	-364.51	-327.93	-291.41
45.72	-434.99	-438.64	-472.43	-501.95
49.53	-456.55	-454.65	-425.86	-381.4
53.34	-497.11	-498.64	-514.3	-535.19
57.15	-504.97	-498.3	-435.33	-369.91
60.96	-565.57	-570.53	-609.63	-538.94
61.87	-581.04	-589.1	-653.88	-703.33

Table A-41: Contact pressure along column line (GLX-5) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Distance (m)	Uniform height of uniform thickness mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-Uniform height of beam-slab mat for Ks=16
-0.91	-654.39	-683.01	-661.73	-678.44
0	-647.35	-671.65	-646.71	-661.87
3.81	-604.6	-615.52	-577.82	-585.42
7.62	-593.84	-590.27	-572.64	-571.93
11.43	-561.15	-546.96	-553.35	-540.92
15.24	-575.56	-530.91	-573.09	-541.06
19.05	-560.1	-485.02	-558.53	-492.67
22.86	-572.91	-458.38	-576.48	-458.46
26.68	-560.1	-406.78	-558.53	-375.38
30.48	-575.56	-378.3	-573.09	-319.71
34.29	-561.15	-356.57	-553.35	-287.09
38.1	-593.84	-364.1	-572.64	-300.37
41.91	-604.6	-380.89	-577.82	-342.15
45.72	-647.35	-419.21	-646.71	-425.58
46.63	-654.39	-425.65	-661.73	-439.77

Table A-40: Contact pre2ssure along middle of an interior panel (GLX-45) for uniform thickness mat and beam-slab mat of uniform height & non-uniform height

Distance (m)	Uniform height of uniform thickness mat for Ks=16	Non-uniform height of uniform thickness mat for Ks=16	Uniform height of beam-slab mat for Ks=16	Non-Uniform height of beam-slab mat for Ks=16
-0.91	-651.02	-680.79	-663	-680.19
0	-643.51	-667.9	-640.32	-655.75
3.81	-603.54	-614.77	-552.88	-560.46
7.62	-580.78	-577.88	-555.58	-555.38
11.43	-566.44	-546.34	-529.6	-518.53
15.24	-561.99	-519.51	-555.89	-526.18
19.05	-558.34	-486.19	-534.64	-474.46
22.86	-559.32	-451.02	-559.26	-449.23
26.68	-558.34	-410.94	-534.64	-366.44
30.48	-561.99	-379.15	-555.89	-320.99
34.29	-566.44	-362.45	-529.6	-284.4
38.1	-580.78	-365.18	-555.58	-301.57
41.91	-603.54	-385.63	-552.88	-333.53
45.72	-643.51	-420.9	-640.32	-426.53
46.63	-651.02	-428.31	-663	-445.33

APPENDIX B:
B.1 Effect of Mat Thickness

Table B-1: Shear along column line (GLY-6) for uniform thickness mat of uniform height

Distance (m)	Shear for 213 cm	Shear for 244 cm	Shear for 254cm	Shear for 274 cm	Shear for 305 cm
-0.91	0	0	0	0	0
-0.68	-1228.55	-1169.4	-1151.81	-1118.36	-1076.95
0.68	2808.08	3066.04	3135.2	3275.16	3441.32
3.81	-88.06	-57.51	-51.79	-35.99	-20.55
6.94	-4672.22	-4629.68	-4618.34	-4586.13	-4540.23
8.31	4576.79	4563	4555.07	4550.55	4540.94
11.43	-76.65	-76.7	-83	-73.93	-68.96
14.56	-4866.97	-4874.81	-4877.14	-4860.08	-4840.51
15.93	4753.33	4731.56	4707.03	4707.52	4685.12
19.05	-31.7	-40.62	-65.95	-47.37	-51.46
22.18	-4827.84	-4832.8	-4869.39	-4829.73	-4821.18
23.55	4784.12	4773.26	4723.09	4756.57	4738.01
26.68	-6.14	-9.87	-88.63	-13.25	-15.84
29.8	-4804.13	-4802.76	-4963.53	-4795.25	-4784.05

Table B-2: Shear along column line (GLY-6) for uniform thickness mat of non-uniform height of non-uniform height

Distance (m)	Shear for 213 cm	Shear for 244 cm	Shear for 254cm	Shear for 274 cm	Shear for 305 cm
-0.91	0	0	0	0	0
-0.68	-1234.62	-1189.99	-1189.65	-1152.96	-1115.24
0.68	2219.97	2518.3	2521.33	2717.74	2856.08
3.81	-218.07	-190.92	-187.38	-167.73	-153.25
6.94	-4458.75	-4455.7	-4424.64	-4422.23	4393.8
8.31	4313.25	4324.08	4349.8	4351.25	4391.68
11.43	214.04	224.49	261.55	261.49	320.19
14.56	-3914.2	-3806.79	-3824.04	-3742.92	-3704.72
15.93	3300.15	4256.21	4336.96	4282.13	4360.37
19.05	749.14	763.81	810.17	805.05	870.6
22.18	1967.92	-1803.09	-1825.02	-1717.88	-1673.92
23.55	2380.64	2280.97	2352.02	2270.52	2316.21
26.68	120.02	129.47	146.92	147.58	173.91
29.8	-2211.58	-2053.09	-2105.81	-1994.82	-1993.16

Table B-3: Shear along column line (GLY-6) for beam-slab mat of uniform height

Shear for 152 cm	Shear for 91 cm	Distance (m)
0	0	-0.91
-918.82	-775.2	-0.68
1529.63	678.68	0.68
2.52	14.82	3.81
-1781.47	-101377	6.94
1685.79	953.79	8.31
-47.96	-31.82	11.43
-1819.82	-1019.96	14.56
1757.81	987.87	15.93
-13.57	-4.51	19.05
-1781.76	-997.53	22.18
1774.11	996.25	23.55
-1.57	-0.14	26.68
-1174.48	-996.34	29.8

Table B-4: Shear along column line (GLY-6) for beam-slab mat of non-uniform height of non-uniform height

Shear for 152 cm	Shear for 91 cm	Distance (m)
0	0	-0.91
-880.04	-692.42	-0.68
1159.02	540.69	0.68
-72.65	-22.32	3.81
-1615.99	-917.85	6.94
1468.77	864.60	8.31
130.14	62.73	11.43
-1291.07	-731.54	14.56
1455.35	883.43	15.93
463.37	271.81	19.05
-490.37	-305.36	22.18
672.45	443.83	23.55
67.55	26.99	26.68
-573.09	-387.07	29.8

Table B-5: Shear along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Shear for 305 cm	Shear for 274 cm	Shear for 254cm	Shear for 244 cm	Shear for 213 cm	Distance (m)
0	0	0	0	0	-0.91
-108.26	-89.18	-76.17	-69.63	-50.1	-0.68
1295.46	1310.88	1326.13	1335.97	1376.93	0.68
445.71	421.26	402.09	391.54	355.8	3.81
53.97	33.15	-17.86	9.77	-16.2	6.94
82.3	66.1	55.38	50.04	34.64	8.31
-65.67	-75.45	-80.87	-82.58	-85.74	11.43
-129.34	-133.54	-134.5	-134.38	-131.23	14.56
-13.88	-13.72	-11.87	-10.24	-2.41	15.93
1.1	2.4	5.72	8.08	17.41	19.05
-64.01	-6028	-55.72	-52.82	-41.81	22.18
-92.95	-89.39	-85.57	-83.26	-75	23.55
20.14	24.09	28.05	30.42	38.81	26.68
-20.56	-17.58	-14.88	-13.34	-8.31	29.8

Table B-6: Shear along column middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height of non-uniform height

Shear for 305 cm	Shear for 274 cm	Shear for 254cm	Shear for 244 cm	Shear for 213 cm	Distance (m)
0	0	0	0	0	-0.91
-18.71	-35.01	-14.97	-33.48	-12.96	-0.68
1170.62	1135.05	1137.62	1137.49	1152.04	0.68
300.83	275.3	246.64	242.64	205.27	3.81
101.22	46.12	39.22	7.45	-8.98	6.94
231.54	168.21	165.47	127.5	114.81	8.31
232.35	165.88	154.6	119.07	93.36	11.43
366.38	287.63	289.63	238.91	222.91	14.56
560.02	480.26	482.79	430.56	412.53	15.93
595.33	524.15	514.33	472.15	436.18	19.05
461.19	399.38	399.51	358.47	338.28	22.18
382.37	330.94	330.51	296.68	279.18	23.55
168.22	139.3	133.54	116.98	99.32	26.68
19.59	12.75	12.31	7.93	5.02	29.8

Table B-7: Shear along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Distance (m)	Shear for 91 cm	Shear for 152 cm
-0.91	0	0
-0.68	-94.53	-87.24
0.68	1041.14	986.35
3.81	16.7	154.75
6.94	-788.79	-529.3
8.31	704.37	488.24
11.43	-32.03	-58
14.56	-766.24	-572.72
15.93	737.57	500.56
19.05	-3.01	-15.16
22.18	-749.56	-538.08
23.55	748.33	524.26
26.68	0.42	-1.16
29.8	-749.84	-529.86

Table B-8: Shear along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height of non-uniform height

Distance (m)	Shear for 91 cm	Shear for 152 cm
-0.91	0	0
-0.68	-78.76	-70.23
0.68	880.14	802.01
3.81	-17.44	-61.77
6.94	-728.89	-497.64
8.31	60.92	489.63
11.43	15.85	38.82
14.56	-577.98	-303.84
15.93	689.23	644.81
19.05	165.9	282.67
22.18	-312.96	-64.96
23.55	420.26	399.78
26.68	8.0	42.51
29.8	-363.89	-247.27

Table B-9: Moment along column line (GLY-6) for uniform thickness mat of uniform height

Moment for 305 cm	Moment for 274 cm	Moment for 254cm	Moment for 244 cm	Moment for 213 cm	Distance (m)
0	0	0	0	0	-0.91
-52.61	-170.11	-217.61	-324.67	-526.62	-0.68
420.68	584.2	684.09	769.66	994.52	0.68
-3410.4	-3275.57	3159.96	-3107.02	-2911.16	3.81
673.93	784.73	981.75	996.86	1240.41	6.94
1188.83	1338.49	1566.49	1590.67	1862.68	8.31
-2996.1	-2810.67	-2646.47	2592.49	-2367.71	11.43
1820.96	1929.7	2184.42	2144.3	2361.87	14.56
2025.72	2104.68	2300.42	2382.79	2440.56	15.93
-2558.28	-2132.15	-2003.84	-1996.11	-1873.6	19.05
2439.96	2471.34	2621.72	2699.11	2699.39	22.18
2456.56	2464.63	2571.51	2557.08	2638.89	23.55
-1949.62	-1878.64	-1737.28	-1807.71	-1752.35	26.68
2615.05	2603.53	2936.59	2675.83	2737.06	29.8

Table B-10: Moment along column line (GLY-6) for uniform thickness mat of non-uniform height

Moment for 305 cm	Moment for 274 cm	Moment for 254cm	Moment for 244 cm	Moment for 213 cm	Distance (m)
0	0	0	0	0	-0.91
-396.54	-399.87	-549.06	-504.72	-708.47	-0.68
1058.80	990.70	1154.87	1057.42	1251.94	0.68
-2065.83	-2190.51	-2026.69	-2157.01	-1981.41	3.81
1809.09	1759.63	1885.46	1804.11	1872.07	6.94
3297.57	3109.99	3379.90	3100.03	3392.31	8.31
-1302.69	-1385.2	-1173.03	-1298.73	-1126.68	11.43
1604.75	1684.37	1721.19	1835.65	1926.61	14.56
2781.60	2798.19	3102.21	3053.59	3473.84	15.93
-2453.03	-2308.56	-2175.21	-1937.46	-1566.14	19.05
-2009.07	-1642.11	-1292.81	-1199.63	-812 .61	22.18
-1305.89	-940.62	-368.12	-379.10	303.26	23.55
-3855.79	-3455.47	-2924.16	-2876.57	-2251.31	26.68
-2244.24	-1740.9	-1183.08	-1101.64	-424.74	29.8

Table B-11: Moment along column line (GLY-6) for beam-slab mat of uniform height

Distance (m)	Moment for 91 cm	Moment for 152 cm
-0.91	0	0
-0.68	-325.28	-295.09
0.68	204.58	524.81
3.81	-318.22	-1423.7
6.94	188.21	496.39
8.31	281.89	812.82
11.43	-141.91	-967
14.56	392.91	1097.5
15.93	383.36	1111.03
19.05	-88.86	-765.84
22.18	403.71	1191.92
23.55	387.57	1160.15
26.68	-91.19	-749.96
29.8	398.37	1183.84

Table B-12: Moment along column line (GLY-6) for beam-slab mat of non-uniform height

Distance (m)	Moment for 91 cm	Moment for 152 cm
-0.91	0	0
-0.68	-294.68	-350.86
0.68	212.04	608.84
3.81	-195.89	-946.62
6.94	293.87	874.74
8.31	485.14	1546.84
11.43	8.72	-347.7
14.56	353.71	986.52
15.93	576.55	1699.27
19.05	-91.23	-629.53
22.18	-105.15	-406.59
23.55	79.04	142.43
26.68	-199.80	-993.82
29.8	30.51	-135.93

Table B-13: Moment along middle of an interior panel (GLY-56) for uniform thickness mat of uniform height

Distance (m)	Moment for 213 cm	Moment for 244 cm	Moment for 254cm	Moment for 274 cm	Moment for 305 cm
-0.91	0	0	0	0	0
-0.68	96.99	51.37	37.84	12.99	-19.42
0.68	-504.6	-592.44	-618.47	-666.18	-728.1
3.81	-2596.52	-2797.14	-2856.97	-2967.07	-3111.1
6.94	-1192.94	-1457.84	-1539.24	-1692.07	-1898.13
8.31	-949.99	-1224.28	-1310.35	-1474.07	-1699.15
11.43	-1710.92	-1972.03	-2057.04	-2222.73	-2459.18
14.56	-212.36	-437.27	-513.69	-666.84	-694.6
15.93	-104.86	-301.61	-370.07	-509.49	-721.92
19.05	-1120.31	-1264.3	-1317.08	-1428.55	-1608.01
22.18	160.79	55.81	15.0	-74.66	-227.43
23.55	178.21	90.64	55.61	-22.98	-161.05
26.68	-973.05	-1033.62	-1059.57	-1120.75	-1235.67
29.8	225.43	172.11	148.46	91.63	-17.74

Table B-14: Moment along middle of an interior panel (GLY-56) for uniform thickness mat of non-uniform height

Distance (m)	Moment for 213 cm	Moment for 244 cm	Moment for 254cm	Moment for 274 cm	Moment for 305 cm
-0.91	0	0	0	0	0
-0.68	120.78	84.02	95.32	68.07	77.71
0.68	-283.91	-368.13	-319.81	-392.01	-351.27
3.81	-1715.63	-1897.34	-1768.92	-1941.32	-1823.24
6.94	-78.85	-272.41	-144.75	-345.99	-245.54
8.31	321.08	112.15	258.08	84.32	133.74
11.43	-539.84	-745.11	-640.45	-878.05	-850.66
14.56	449.42	197.19	253.33	-19.45	-103.26
15.93	584.81	271.88	331.54	10.28	-107.19
19.05	-1183.94	-1552.51	-1570.17	-1916.67	-2175.61
22.18	-1473.71	-1947.72	-2028.93	-2431.32	-2289.84
23.55	-1441.03	-1983.28	-2066.35	-2515.55	-2952.11
26.68	-2104.22	-2688.62	-2809.05	-3281.97	-3795.13
29.8	-1633.44	-2266.37	-2399.69	-2901.14	-3455.55

Table B-15: Moment along middle of an interior panel (GLY-56) for beam-slab mat of uniform height

Distance (m)	Moment for 91 cm	Moment for 152 cm
-0.91	0	0
-0.68	221.76	134.32
0.68	-45.48	-244.68
3.81	-1013.47	-1674.37
6.94	370.68	-223.3
8.31	411.29	-72.84
11.43	-738.84	-1082.95
14.56	543.77	335.59
15.93	538.27	366.94
19.05	-688.55	-821.72
22.18	557.36	448.23
23.55	546.6	440.67
26.68	-693.9	-800.95
29.8	552.73	-47.91

Table B-16: Moment along middle of an interior panel (GLY-56) for beam-slab mat of non-uniform height

Distance (m)	Moment for 91 cm	Moment for 152 cm
-0.91	0	0
-0.68	193.6	123.05
0.68	-25.55	-149.19
3.81	-826.76	-1191.64
6.94	487.19	327.71
8.31	558.02	558.97
11.43	-503.52	-424.92
14.56	559.7	664.68
15.93	627.43	761.39
19.05	-504.61	-726.81
22.18	42.67	534.12
23.55	99.69	480.45
26.68	-530.85	-1141.92
29.8	109.75	-509.89

Table B-17: Moment along column line (GLY-3) for uniform thickness mat of non-uniform height

Distance (m)	Moment for 213 cm	Moment for 244 cm	Moment for 254cm	Moment for 274 cm	Moment for 305 cm
-0.91	0	0	0	0	0
-0.68	-921.58	-635.79	-671.60	-476.78	-438.04
0.68	1223.6	889.82	984.16	724.94	765.8
3.81	-2817.27	-3085.89	-3037.94	-3239.57	-3256.2
6.94	1291.96	1056.4	1001.87	829.77	719.82
8.31	2483.14	2077.75	2203.45	1829.82	1862.47
11.43	-2074.24	-2373.1	-2354.19	-2612.71	-2727.34
14.56	2517.96	23052	2229.03	2027.79	1827.73
15.93	3088.65	2798.19	2897.34	2567.43	2537.36
19.05	-1620.35	-1830.49	-1851.7	-2067.7	-2264.97
22.18	2761.41	2609.95	2538.61	2347.12	2122.18
23.55	3026.33	2809.46	2841.69	2570.98	2442.75
26.68	-1611.47	-1790.59	-1842.05	-2033.58	-2288.41
29.8	2876.78	2700.60	2669.91	2447.46	2242.82

Table B-18: Moment along column line (GLY-3) for beam-slab mat of non-uniform height

Distance (m)	Moment for 91 cm	Moment for 152 cm
-0.91	-51 .94	-677.47
-0.68	-404.81	-536.83
0.68	244.68	662.53
3.81	-275.55	-1337.42
6.94	212.57	542.70
8.31	517.52	1069.7
11.43	-93.72	-805.13
14.56	399.61	1164.66
15.93	439.06	1361.39
19.05	-49.15	-603.55
22.18	404.01	1229.69
23.55	425.72	1323.90
26.68	-51.12	-608.17
29.8	409.79	1260.92

Table B-19: Deflection along column line (GLY-6) for various thickness of uniform thickness mat of uniform height

Deflection for 305 cm	Deflection for 274 cm	Deflection for 254cm	Deflection for 244 cm	Deflection for 213 cm	Distance (m)
-41.83	-41.69	-41.52	-41.63	-41.66	-0.91
-41.57	-41.37	-41.29	-41.22	-41.14	0
-39.84	-39.36	-39.04	-38.84	-38.26	3.81
-39.48	-38.99	-36.63	-38.48	-37.95	7.62
-38.32	-37.7	-37.25	-37.03	-36.28	11.43
-38.65	-38.16	-37.82	-38.48	-37.95	15.24
-37.91	-37.33	-36.94	-36.74	-36.08	19.05
-38.49	-38.06	-37.77	-37.63	-37.22	22.86
-37.85	-37.34	-36.97	-36.78	-36.18	26.68
-38.48	-38.07	-37.8	-37.66	-37.28	30.48
-37.85	-37.34	-36.97	-36.78	-36.18	34.29
-38.49	-38.06	-37.77	-37.63	-37.22	38.1
-37.91	-37.33	-36.94	-36.74	-36.08	41.91
-38.65	-38.16	-37.82	-38.48	-37.95	45.72
-38.32	-37.7	-37.25	-37.03	-36.28	49.53
-39.48	-38.99	-36.63	-38.48	-37.95	53.34
-39.84	-39.36	-39.04	-38.84	-38.26	57.15
-41.57	-41.37	-41.29	-41.22	-41.14	60.96
-41.83	-41.69	-41.52	-41.63	-41.66	61.87

Table B-20: Deflection along column line (GLY-6) for various thickness of uniform thickness mat of non-uniform height

Deflection for 305 cm	Deflection for 274 cm	Deflection for 254cm	Deflection for 244 cm	Deflection for 213 cm	Distance (m)
-36.57	-37.59	-36.32	-37.34	-36.07	-0.91
-36.07	-37.08	-35.81	-36.83	-35.56	0
-34.06	-34.4	-33.46	-34.08	-32.49	3.81
-32.99	-33.27	-32.51	-32.76	-32.25	7.62
-30.77	-30.44	-30.06	-30.00	-29.48	11.43
-29.46	-28.95	-28.95	-28.70	-28.45	15.24
-27.25	-26.29	-25.16	-25.59	-25.19	19.05
-25.91	-24.89	-24.63	-23.87	-23.62	22.86
-24.73	-23.36	-23.24	-22.37	-21.84	26.68
-24.64	-23.36	-23.19	-22.35	-21.84	30.48
-24.73	-23.36	-23.24	-22.37	-21.84	34.29
-25.91	-24.89	-24.63	-23.87	-23.62	38.1
-27.25	-26.29	-25.16	-25.59	-25.19	41.91
-29.46	-28.95	-28.95	-28.70	-28.45	45.72
-30.77	-30.44	-30.06	-30.00	-29.48	49.53
-32.99	-33.27	-32.51	-32.76	-32.25	53.34
-34.06	-34.4	-33.46	-34.08	-32.49	57.15
-36.07	-37.08	-35.81	-36.83	-35.56	60.96
-36.57	-37.59	-36.32	-37.34	-36.07	61.87

Table B-21: Deflection along column line (GLY-6) for various thickness of beam-slab mat of uniform height

Distance (m)	Deflection for 91 cm	Deflection for 152 cm
-0.91	-41.93	-41.84
0	-40.7	-41.09
3.81	-36.79	-37.8
7.62	-36.03	-37.16
11.43	-34.98	-36.03
15.24	-36.01	-36.75
19.05	-35.25	-36.08
22.86	-36.19	-36.9
26.68	-35.36	-36.19
30.48	-36.22	-36.96
34.29	-35.36	-36.19
38.1	-36.19	-36.9
41.91	-35.25	-36.08
45.72	-36.01	-36.75
49.53	-34.98	-36.03
53.34	-36.03	-37.16
57.15	-36.79	-37.8
60.96	-40.7	-41.84
61.87	-41.93	-41.09

Table B-22: Deflection along column line (GLY-6) for various thickness of beam-slab mat of non-uniform height

Distance (m)	Deflection for 91 cm	Deflection for 152 cm
-0.91	-36.06	-36.07
0	-35.48	-35.51
3.81	-32.17	-32.85
7.62	-31.75	-32.01
11.43	-29.49	-29.83
15.24	-28.19	-28.45
19.05	-24.01	-25.03
22.86	-21.33	-22.78
26.68	-19.19	-20.98
30.48	-19.05	-20.83
34.29	-19.19	-20.98
38.1	-21.33	-22.78
41.91	-24.01	-25.03
45.72	-28.19	-28.45
49.53	-29.49	-29.83
53.34	-31.75	-32.01
57.15	-32.17	-32.85
60.96	-35.48	-35.51
61.87	-36.06	-36.07

Table B-23: Deflection along middle of an interior panel (GLY-56) for various thickness of uniform thickness mat of uniform height

Deflection for 305 cm	Deflection for 274 cm	Deflection for 254cm	Deflection for 244 cm	Deflection for 213 cm	Distance (m)
-41.54	-41.42	-41.35	-41.35	-41.36	-0.91
-41.15	-40.96	-40.86	-40.82	-40.74	0
-39.38	-38.88	-38.52	-38.34	-37.74	3.81
-38.29	-37.67	-37.23	-37.00	-36.26	7.62
-37.56	-36.89	-36.42	-36.18	-35.41	11.43
-37.27	-36.64	-36.21	-35.98	-35.23	15.24
-37.04	-36.44	-36.03	-35.82	-35.18	19.05
-37.05	-36.49	-36.13	-35.94	-35.38	22.86
-36.97	-36.43	-36.06	-35.87	-35.3	26.68
-37.04	-36.51	-36.17	-35.99	-35.46	30.48
-36.97	-36.43	-36.06	-35.87	-35.3	34.29
-37.05	-36.49	-36.13	-35.94	-35.38	38.1
-37.04	-36.44	-36.03	-35.82	-35.18	41.91
-37.27	-36.64	-36.21	-35.98	-35.23	45.72
-37.56	-36.89	-36.42	-36.18	-35.41	49.53
-38.29	-37.67	-37.23	-37.00	-36.26	53.34
-39.38	-38.88	-38.52	-38.34	-37.74	57.15
-41.15	-40.96	-40.86	-40.82	-40.74	60.96
-41.54	-41.42	-41.35	-41.35	-41.36	61.87

Table B-24: Deflection along middle of an interior panel (GLY-56) for various thickness of uniform thickness mat of non-uniform height

Deflection for 305 cm	Deflection for 274 cm	Deflection for 254cm	Deflection for 244 cm	Deflection for 213 cm	Distance (m)
-37.17	-38.13	-37.15	-38.08	--37.04	-0.91
-36.77	-37.51	-36.42	-37.4	-36.22	0
-34.75	-34.95	-34.15	-34.59	-33.61	3.81
-32.86	-32.74	-32.18	-32.34	-31.64	7.62
-31.12	-30.67	-30.33	-30.18	-29.7	11.43
-29.24	-28.54	-28.32	-27.96	-27.61	15.24
-27.41	-26.39	-26.18	-25.58	-25.08	19.05
-25.75	-24.48	-24.23	-23.49	-22.85	22.86
-24.81	-23.37	-23.07	-22.25	-21.48	26.68
-24.39	-22.92	-22.64	-21.76	-21.03	30.48
-24.81	-23.37	-23.07	-22.25	-21.48	34.29
-25.75	-24.48	-24.23	-23.49	-22.85	38.1
-27.41	-26.39	-26.18	-25.58	-25.08	41.91
-29.24	-28.54	-28.32	-27.96	-27.61	45.72
-31.12	-30.67	-30.33	-30.18	-29.7	49.53
-32.86	-32.74	-32.18	-32.34	-31.64	53.34
-34.75	-34.95	-34.15	-34.59	-33.61	57.15
-36.77	-37.51	-36.42	-37.4	-36.22	60.96
-37.17	-38.13	-37.15	-38.08	--37.04	61.87

Table B-25: Deflection along middle of an interior panel (GLY-56) for various thickness of beam-slab mat of uniform height

Distance (m)	Deflection for 91 cm	Deflection for 152 cm
-0.91	-42.71	-41.74
0	-41.15	-40.94
3.81	-35.12	-37.24
7.62	-34.98	-36.02
11.43	-33.23	-35.12
15.24	-34.87	-35.49
19.05	-33.55	-35.2
22.86	-35.16	-35.7
26.68	-33.71	-35.37
30.48	-35.22	-35.79
34.29	-33.71	-35.37
38.1	-35.16	-35.7
41.91	-33.55	-35.2
45.72	-34.87	-35.49
49.53	-33.23	-35.12
53.34	-34.98	-36.02
57.15	-35.12	-37.24
60.96	-41.15	-40.94
61.87	-42.71	-41.74

Table B-26: Deflection along middle of an interior panel (GLY-56) for various thickness of beam-slab mat of non-uniform height

Distance (m)	Deflection for 91 cm	Deflection for 152 cm
-0.91	-37.11	-36.96
0	-35.79	-36.03
3.81	-32.02	-33.14
7.62	-31.75	-31.96
11.43	-29.27	-29.86
15.24	-28.01	-28.06
19.05	-23.61	-24.77
22.86	-20.88	-22.28
26.68	-18.61	-20.46
30.48	-18.61	-20.15
34.29	-18.61	-20.46
38.1	-20.88	-22.28
41.91	-23.61	-24.77
45.72	-28.01	-28.06
49.53	-29.27	-29.86
53.34	-31.75	-31.96
57.15	-32.02	-33.14
60.96	-35.79	-36.03
61.87	-37.11	-36.96

Table B-27: Contact pressure along column line (GLY-6) for various thickness of uniform thickness mat of uniform height

Distance (m)	Contact Pressure for 213 cm	Contact Pressure for 244 cm	Contact Pressure for 254cm	Contact Pressure for 274 cm	Contact Pressure for 305 cm
-0.91	-654.58	-653.92	-654.5	-655.36	-657.48
0	-646.29	-647.62	-648.3	-649.96	-653.03
3.81	-601.02	-610.12	-612.93	-618.3	-625.87
7.62	-596.12	-604.44	-607.17	-612.54	-620.33
11.43	-570.02	-581.67	-585.3	-592.25	-601.97
15.24	-584.02	-591.64	-594.25	-599.49	-607.3
19.05	-566.9	-577.09	-580.32	-586.56	-595.48
22.86	-584.72	-591.74	-593.32	-597.84	-604.7
26.68	-568.4	-577.82	-580.78	-586.51	-594.7
30.48	-585.7	-591.74	-593.84	-598.1	-604.59
34.29	-568.4	-577.82	-580.78	-586.51	-594.7
38.1	-584.72	-591.74	-593.32	-597.84	-604.7
41.91	-566.9	-577.09	-580.32	-586.56	-595.48
45.72	-584.02	-591.64	-594.25	-599.49	-607.3
49.53	-570.02	-581.67	-585.3	-592.25	-601.97
53.34	-596.12	-604.44	-607.17	-612.54	-620.33
57.15	-601.02	-610.12	-612.93	-618.3	-625.87
60.96	-646.29	-647.62	-648.3	-649.96	-653.03
61.87	-654.58	-653.92	-654.5	-655.36	-657.48

Table B-28: Contact pressure along column line (GLY-6) for various thickness of uniform thickness mat of non-uniform height

Distance (m)	Contact Pressure for 213 cm	Contact Pressure for 244 cm	Contact Pressure for 254cm	Contact Pressure for 274 cm	Contact Pressure for 305 cm
-0.91	-567.06	-587.82	-569.11	-588.48	-573.91
0	-558.98	-579.19	-561.95	-580.72	-567.25
3.81	-517.57	-535.32	-525.69	-540.43	-535
7.62	-505.79	-515.31	-510.38	-519.12	-517.55
11.43	-463.21	-471.33	-472.24	-478.1	-483.3
15.24	-445.86	-448.87	-453.13	-455.17	-463.62
19.05	-395.81	-402.11	-410.95	-413.14	-428.03
22.86	-369.93	-376.28	-387.85	-389.23	-407.62
26.68	-343.18	-351.52	-365.18	-367.02	-388.63
30.48	-343.07	-350.15	-364.16	-365.26	-387.08
34.29	-343.18	-351.52	-365.18	-367.02	-388.63
38.1	-369.93	-376.28	-387.85	-389.23	-407.62
41.91	-395.81	-402.11	-410.95	-413.14	-428.03
45.72	-445.86	-448.87	-453.13	-455.17	-463.62
49.53	-463.21	-471.33	-472.24	-478.1	-483.3
53.34	-505.79	-515.31	-510.38	-519.12	-517.55
57.15	-517.57	-535.32	-525.69	-540.43	-535
60.96	-558.98	-579.19	-561.95	-580.72	-567.25
61.87	-567.06	-587.82	-569.11	-588.48	-573.91

Table B-29: Contact pressure along column line (GLY-6) for various thickness of beam-slab mat of uniform height

Distance (m)	Contact Pressure for 91 cm	Contact Pressure for 152 cm
-0.91	-667.51	-657.86
0	-651.4	-646.8
3.81	-577.98	-593.84
7.62	-570.03	-584.22
11.43	-549.57	-565.95
15.24	-568.61	-577.56
19.05	-553.81	-566.74
22.86	-571.99	-579.92
26.68	-555.55	-568.55
30.48	-572.61	-580.8
34.29	-555.55	-568.55
38.1	-571.99	-579.92
41.91	-553.81	-566.74
45.72	-568.61	-577.56
49.53	-549.57	-565.95
53.34	-570.03	-584.22
57.15	-577.98	-593.84
60.96	-651.4	-646.8
61.87	-667.51	-657.86

Table B-30: Contact pressure along column line (GLY-6) for various thickness of beam- slab mat of non-uniform height

Distance (m)	Contact Pressure for 91 cm	Contact Pressure for 152 cm
-0.91	-568.73	-566.75
0	-558.04	-557.77
3.81	-505.41	-516.08
7.62	-500.66	-504.34
11.43	-463.36	-464.74
15.24	-443.49	-446.15
19.05	-377.18	-393.24
22.86	-334.57	-358.05
26.68	-301.57	-329.69
30.48	-300.38	-326.65
34.29	-301.57	-329.69
38.1	-334.57	-358.05
41.91	-377.18	-393.24
45.72	-443.49	-446.15
49.53	-463.36	-464.74
53.34	-500.66	-504.34
57.15	-505.41	-516.08
60.96	-558.04	-557.77
61.87	-568.73	-566.75

Table B-31: Contact pressure along middle of an interior panel (GLY-56) for various thickness of uniform thickness mat of uniform height

Distance (m)	Contact Pressure for 213 cm	Contact Pressure for 244 cm	Contact Pressure for 254cm	Contact Pressure for 274 cm	Contact Pressure for 305 cm
-0.91	-651.48	-650.61	-650.67	-651.22	-652.92
0	-636.93	-641.21	-641.86	-643.45	-646.41
3.81	-592.87	-602.3	-605.21	-610.76	-618.56
7.62	-569.64	-581.23	-584.86	-591.81	-601.56
11.43	-556.17	-568.29	-572.13	-579.53	-590.01
15.24	-554.89	-565.33	-568.76	-575.53	-595.39
19.05	-552.6	-562.64	-565.93	-572.4	-581.91
22.86	-555.91	-564.62	-567.52	-573.32	-582
26.68	-554.53	-563.52	-566.44	-572.22	-580.8
30.48	-557.17	-565.42	-568.15	-573.59	-581.78
34.29	-554.53	-563.52	-566.44	-572.22	-580.8
38.1	-555.91	-564.62	-567.52	-573.32	-582
41.91	-552.6	-562.64	-565.93	-572.4	-581.91
45.72	-554.89	-565.33	-568.76	-575.53	-595.39
49.53	-556.17	-568.29	-572.13	-579.53	-590.01
53.34	-569.64	-581.23	-584.86	-591.81	-601.56
57.15	-592.87	-602.3	-605.21	-610.76	-618.56
60.96	-636.93	-641.21	-641.86	-643.45	-646.41
61.87	-651.48	-650.61	-650.67	-651.22	-652.92

Table B-32: Contact pressure along middle of an interior panel (GLY-56)) for various thickness of uniform thickness mat of non-uniform height

Contact Pressure for 305 cm	Contact Pressure for 274 cm	Contact Pressure for 254cm	Contact Pressure for 244 cm	Contact Pressure for 213 cm	Distance (m)
-588.82	-601.22	-584.83	-600.58	-583.17	-0.91
-580.46	-591.22	-575.57	-589.57	-572.44	0
-545.93	-548.98	-536.44	-543.46	-527.91	3.81
-517.91	-515.72	-507.32	-509.29	-498.69	7.62
-488.79	-481.84	-476.37	-474.13	-466.6	11.43
-460.66	-449.5	-446	-440.39	-434.75	15.24
-430.56	-414.55	-410.9	-401.98	-394.07	19.05
-405.82	-385.88	-381.66	-370.22	-359.93	22.86
-389.66	-367.18	-364.45	-349.46	-337.48	26.68
-384.52	-361.33	-356.57	-343.14	-330.99	30.48
-389.66	-367.18	-364.45	-349.46	-337.48	34.29
-405.82	-385.88	-381.66	-370.22	-359.93	38.1
-430.56	-414.55	-410.9	-401.98	-394.07	41.91
-460.66	-449.5	-446	-440.39	-434.75	45.72
-488.79	-481.84	-476.37	-474.13	-466.6	49.53
-517.91	-515.72	-507.32	-509.29	-498.69	53.34
-545.93	-548.98	-536.44	-543.46	-527.91	57.15
-580.46	-591.22	-575.57	-589.57	-572.44	60.96
-588.82	-601.22	-584.83	-600.58	-583.17	61.87

Table B-33: Contact pressure along middle of an interior panel (GLY-56) for various thickness of beam-slab mat of uniform height

Contact Pressure for 152 cm	Contact Pressure for 91 cm	Distance (m)
-657.91	-670.88	-0.91
-643.11	-646.44	0
-585.01	-551.7	3.81
-565.79	-549.47	7.62
-551.76	-522.03	11.43
-557.57	-547.83	15.24
-553.01	-527.14	19.05
-560.95	-552.38	22.86
-555.67	-529.59	26.68
-562.28	-553.34	30.48
-555.67	-529.59	34.29
-560.95	-552.38	38.1
-553.01	-527.14	41.91
-557.57	-547.83	45.72
-551.76	-522.03	49.53
-565.79	-549.47	53.34
-585.01	-551.7	57.15
-643.11	-646.44	60.96
-657.91	-670.88	61.87

Table B-34: Contact pressure along middle of an interior panel (GLY-56) for various thickness of beam- slab mat of non-uniform height

Contact Pressure for 152 cm	Contact Pressure for 91 cm	Distance (m)
-584.88	-589.1	-0.91
-573	-570.53	0
-525.57	-498.3	3.81
-504.68	-498.64	7.62
-472.08	-454.65	11.43
-442.24	-438.64	15.24
-390.89	-364.51	19.05
-350.77	-324.35	22.86
-322.09	-284.4	26.68
-316.53	-287.09	30.48
-322.09	-284.4	34.29
-350.77	-324.35	38.1
-390.89	-364.51	41.91
-442.24	-438.64	45.72
-472.08	-454.65	49.53
-504.68	-498.64	53.34
-525.57	-498.3	57.15
-573	-570.53	60.96
-584.88	-589.1	61.87