DESIGN AND SCHEDULING OF A MAJOR BUILDING PROJECT

A

THESIS

Submitted in partial fulfillment of the requirements for the award of the degree

of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

With specialization in

CONSTRUCTION MANAGEMENT

Under the supervision

of

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HIMACHAL PRADESH, INDIA

MAY – 2019

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **“Design and Scheduling of a Major Building Project”** submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Dr. Ashok Kumar Gupta**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Signature of Student
Anil Kumar
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Date:

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Design and Scheduling of a Major Building Project"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Anil Kumar (172607)** during a period from August, 2018 to May, 2019 under the supervision of **Dr. Ashok Kumar Gupta,** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat. The above statement made is correct to the best of my knowledge.

Date: …………………

Signature of Supervisor	Signature of HOD	Signature of External Examiner
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JUIT, Waknaghat	JUIT, Waknaghat	

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ABSTRACT

The key objective of this research is to analyze and design a multistoried building project complex using STAAD Pro and then schedule the prime and necessary activities involved in the construction of the building complex with the help of Microsoft Project 2013 and then in the end using Autodesk Revit 2013 we are going to make 3d model of the buildings and take material takeoff for estimate of construction cost .The plan of building complex consists of 4 residential apartments of Six storey building. The design involves load calculations and generating load combinations and analysis of the structure with the help of STAAD Pro. IS: 456(2000) confirms all the design methods used in STAAD-Pro. Different work associated with the project are estimated and the activities are scheduled. Planned cost, time, and materials of the project are acquired by resource allocation. Various activities involved in the construction of this residential building project are estimated and the activities are scheduled, as project starts. Budgeted cost, time, and materials of the project are obtained by resource allocation.

Keywords: STAAD PRO, MSP 2013, Analysis, Design, Revit, Estimation.

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CHAPTER 1

INTRODUCTION

1.1 Outline of the Chapter

We humans from the beginning of era required buildings or structures for live in and to acquire that we want from time to time. But then again it's not only buildings but also to build structure efficiently so that it can fulfill its main purpose. So here comes the role of civil engineering and the role of design and analysis of structure.

This project is of analysis, design, scheduling and estimating construction cost of multistoried building project using a very popular designing software STAAD Pro, Microsoft Project 2013, Revit 2013. We are using STAAD Pro because of its listed below benefits:

1. Simple to utilize interface.
2. Verification with the IS codes.
3. Solving errors in a versatile manner.
4. Planning Precision.

STAAD Pro shows a modern UI, powerful analysis and design engines and picturing tools with advanced finite element and dynamic analysis capabilities. STAAD Pro is every professional's option for concrete design, steel design and cold-formed steel design of low and high-rise buildings for model generation, analysis and design and result verification.

Similarly Microsoft Project 2013 is chosen because of the following advantages:

1. It empowers the undertaking the executive's experts to deal with task portfolio speculations dependent on need, start ventures at the most punctual, and create result inside pre-decided spending plan.
2. Microsoft Project 2013 conveys precise outcomes and furthermore gets ready for the future to deal with monstrous and deficiencies over a skyline.
3. Microsoft Project 2013 conveys extends on time and pursues plan the board adequately. It additionally conveys a system to track the advancement of the undertaking.

Also and for designing the 3d project Revit software is chosen because of its following advantages:

1. Intelligent 3D-model-based design tools
2. BIM programming for designers, contractors, engineers and architects
3. Create an integrated model that contains genuine data
4. Great for demonstrating, clash recognition and change the management
5. Contains all important structure components just as maker, model, cost, and structure and phase data, among others.

1.2 Steps involved in Structural Design

1. Structural design.
2. Calculation of load.
3. Analysis Technique.
4. Member design and Detailing.

1.3 Loads Considered

1.3.1 Imposed Loads

1. Floor Load = 4 Kn/m^2
2. Roof Live Load = 2 Kn/m^2

1.3.2 Dead Loads

1. Self-Weight of Slab = 0.15*25 = 3.75 Kn/m^2
2. DL due to External Wall = 0.35*2.45*20 = 19.15 Kn/m^2
3. DL due to Partition Wall = 0.2*2.5*20 = 11.8 Kn/m^2
4. DL due to Parapet Wall = 0.2*1.5*20 = 8 Kn/m^2
5. Plaster for two face = 0.02*2.45*1*18*2 = 2 Kn/m^2

1.3.3 Wind Load

Design Wind Speed, V_z

The design wind speed, V_z for any place is obtained from:

1. Terrain Roughness, height and size of structure.
2. Local Topography.
3. Risk Level.

Mathematically

$$V_z = V_b * K_1 * K_2 * K_3 \qquad \text{eq.1}$$

Where:

V_b = Basic wind speed at any height in m/s;

K_1 = probability factor (risk coefficient)

K_2 = terrain, height and structure size factor

K_3 = topography factor

1.3.4 Seismic Load

Method for Analysis –

1. Equivalent Static Method
2. Lumped Mass Model Method
3. Response Spectrum Method

In this report equivalent static method is used.

Code Used = IS 1893 (Part I), 2002

Total design seismic base shear, V_b at any main direction is determined from the given below expression:

$$V_b = Ah * W \qquad \text{eq.2}$$

Where,

V_b = Total Seismic design base shear

W = seismic weight of all the floors (W=DL+50%LL)

Ah = horizontal acceleration spectrum

$$Ah = \frac{Z}{2} * \frac{I}{R} * \frac{Sa}{g} \qquad \text{eq.3}$$

Where, I = Importance Factor

Z = Zone Factor

R = Response Reduction Factor

$\frac{Sa}{g}$ = Design Acceleration Spectrum

1.3.5 Loads Combination

For Beams and columns

1. 1.5(DL+LL)
2. 1.2(DL+LL+EQX)
3. 1.2(DL+LL-EQX)
4. 1.2(DL+LL+EQZ)
5. 1.2(DL+LL-EQZ)
6. 1.5(DL+EQX)
7. 1.5(DL-EQX)
8. 1.5(DL+EQZ)
9. 1.5(DL-EQZ)

For Foundation

1. DL+LL
2. DL+0.5LL+EQX
3. DL+0.5LL-EQX
4. DL+0.5LL+EQZ
5. DL+0.5LL-EQZ

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

In this thesis main goal is to schedule a project from its beginning till its completion, then analyze the structure for seismic, wind loading and load combinations and after that estimation of cost incurred in the project. So this literature study so far consists of all such research papers that include design of structures, analysis or scheduling of projects.

2.2 LITERATURE STUDY

Wale et al [1] Project Managing is information using efficiently, aptitudes and methods to spread maneuvers to see job requirements. It's a vital ability to achieve something efficiently for affiliations, engaging them to fix the project results to Organizational goals. It is often characterized as process & movement of arranging out, sorting, moving, and monitoring assets, frameworks to accomplish explicit objectives in sound or everyday concerns. A project is an impermanent point projected to create an exceptional thing, organization or result with a described beginning & finish, embraced to meet unconventional goals. In usage, the organization of these two structures is routinely truly indisputable, and everything considered requires the improvement of extraordinary particular aptitudes and the board strategies.

Kumar K et al [2] Nations around the globe give significant inclination to the development business, as it contribute inconceivably to the development of a country, however utilization of conventional practices and ill-advised arranging diminishes the effectiveness of the development business which influences the venture as expanded span of the undertaking, this prompts the expanded overhead expense of the task and low quality of work. With the end goal to dispose of these imperfections in development venture, a powerful undertaking administration device is presented as Microsoft Project 2013 programming. In this investigation venture planning, estimation and asset designation are adjusted in MK Apartment private development venture utilizing MSP 2013 programming. Different work associated with the development of MK condo venture are evaluated and the exercises are planned, as undertaking beginning structure first Aug 2016 and completing on 29th July 2017. Planned cost, time, and materials of the venture are acquired by asset portion.

Nalwadgi et al [3] presently multi day expansive number of utilization programming's are accessible in the structural building field. All these products are created as the premise of cutting edge. Limited component examination which incorporate the impact of dynamic load, for example, wind impact, earth tremor impact wagers and also in the today's work, an endeavor has been made to consider the adequacy of certain basic planning application programming hence an on-going task has been picked. This undertaking has a spot with the solidarity producers to be executed in the Gulbarga City. Bharat pride is the name of the undertaking.

Rani.H and Babu [4] their work included the study and planning of multistory (G+4) building with the help of STAAD Pro. They used STAAD Pro coz of its favorable features like easy to use interface, IS code confirmation, adaptable nature of solving problems, the precision of arrangement. Staad Pro is everyone's choice for design of concrete, steel, timber, aluminum and cold shaped steel structure of low & elevated structure. In their work, a G+4 storey private building is broke down using E-Tabs and traditional building material are replaced by green material making the building eco-friendly, energy efficient and economical.

Hussian et al [5] their work was to plan a multi-storied working of G+ 5 stories, at kalakode around 4 km from paravoor. The plan is finished by considering the necessities and principles suggested by IS code, Kerala building standards and national building rules. Arranging is finished utilizing the 3D demonstrating programming Revit 2011 with the assistance of Auto CAD 2014. The structure examination and configuration is finished utilizing STAAD.PRO.V8i and a cross-check is improved the situation chosen individuals utilizing limit state technique for plan according to IS 456-2000. STAAD. Professional uses a direction dialect based info arrange, which can be made through an editorial manager called the supervisor document, the incredible STAAD.Pro illustrations input generator or through CAD based information generators like AutoCAD. The yield produced by staad.pro comprises of point by point numerical outcomes for examination what's more, design.

Sharma & Maru [6] Investigation and plan of structures for static powers is a standard issue nowadays due to the approachability of reasonable specific projects which can be utilized for the investigation. Then again, the dynamic investigation is a tiresome procedure and needs spare info identified with the form of the structure, and a conception of basic elements for the elucidation of diagnostic consequences. Strengthened cement structures are the most well-known sort of development in city areas, which are exposed to a few kinds of influences amid their period of lifespan, for example, static powers because of DL & LL and dynamic powers because of the breeze and tremor. Here the present works (the issue has taken) are on a G+30 storied normal building. These structures have the arrangement region of 30m x 45m with a story tallness 3.8m each and profundity of the establishment is 3.0 m. and add to the stature of a picked building together with profundity of the establishment as 120 m.

Shivashaankar & Yashwant [7] the paper presents the various limitations in design and construction practices along with the feedback to overcome the limitations and make the structures safer to take the earthquake forces. The paper focuses on software used in the civil engineering for analysis and design, construction methods/practices, use of materials, types of structures, experiments for earthquake studies, quality control parameters etc.

Sharma, Abhishek & Pathak, K. K. [8] Improper planning, scheduling and execution works that results in several issues like reduction in quality of construction, delay in providing facilities, development, and making the project more expensive. A report suggested that the supply of manpower is inversely proportional to time required to complete the project. As the manpower is increased, the completion time of the project is decreased and vice versa. Present study deals with the manpower planning, scheduling and tracking of “Construction of a Residential Block at Shakti Kunj, Ahmedabad”, a six storied (G+6) building project whose construction is in progress at Shakti Kunj, Ahmedabad, Gujarat. An evaluation between the baseline duration and cost to actual duration and cost of manpower of project is also determined using MSP 2013.

Paulay, T. and Priestley, M.N. [9] underscores genuine structure design, not analysis of multistory structures for seismic obstruction. Solid prominence is set on explicit specifying necessities for development. Key plan standards are introduced to make structures that react to a wide scope of potential seismic powers, which are outlined by various nitty gritty models. The discourse incorporates the plan of strengthened cement flexible casings, auxiliary dividers, double frameworks, and fortified stone work structures, structures with confined malleability and establishment dividers. Notwithstanding the precedents, full plan figuring’s are given for three model structures.

Clough Ray W. and King Ian P. [10] an effective advanced PC strategy for the auxiliary investigation of huge, multistory building outlines is displayed. The structure might be exposed to both vertical and sidelong loadings and may incorporate a subjective arrangement of shear dividers. Hub and shear contortions, and in addition flexural twists of the individuals, might be considered. The strategy depends on the improvement of a tri-corner to corner firmness network of each casing in the building, its decrease by recursion connections to the parallel casing solidness, lastly the super stiffness of the total building. Results acquired for a precedent structure are assessed.

Chopra Anil K. and Gutierrez Jorge A. [11] in view of the Ritz idea, for dynamic investigation of the reaction of multistorey structures including establishment communication to seismic tremor ground movement, is displayed. The framework considered is a shear expanding on an unbending round circle balance joined to the surface of a directly versatile halfspace. In this strategy, the basic relocations are changed to ordinary methods of vibration of the expanding on an inflexible establishment. The investigation method is created and numerical outcomes are exhibited to show that phenomenal outcomes can be acquired by considering just the initial couple of methods of vibration. As the quantity of questions is diminished by changing to summed up directions, the technique introduced is substantially more proficient than direct strategies.

Choi, C., Chung, H., Lee, D., & Wilson, E. L. 12] the impact of the consecutive utilization of dead load due to the successive nature of development is an essential factor to be considered in the multistory edge examination. Shockingly, nonetheless, this impact has been disregarded by numerous designers practically speaking previously. One of the approaches to incorporate this impact legitimately in the examination is to bring out the investigation through well-ordered techniques as per the successful utilization of dead loads as the development continues. These systems, nonetheless, require explained calculations and more arrangement time. A streamlined methodology, named as adjustment factor strategy (CFM), to take care of the issue without explained well-ordered examinations has been proposed in this paper. This strategy uses the rectification factors built up by a relapse from the information got from the current structures to change the outcomes from the standard investigation to deliver more precise arrangements. Some numerical tests are exhibited to demonstrate the legitimacy and adequacy of the technique.

Abishek and Pathak [13] Investigated the connection between the task finish time and the labor accessibility as contrarily relative that is the fruition time of the undertaking can be diminished, by expanding the labor. For the present investigation, the creator considered a multi-story building development named "Mahadev Parisar at Shivaji nagar Bhopal". The venture characteristics comprises of G+6 floors private condos with 92 pads in it. With an accessible land territory of 2.64 sections of land at Shivajinagar Bhopal with, he evaluated the length of culmination of two years, however the task was postponed. In this venture, MSP2013 is utilized as the task the board device, and two-stage system is received in this undertaking planning process. In the principal stage, the data accessible from the site and every one of the illustrations accessible are gathered, the amounts of materials going into the venture are evaluated and arranged. For the second stage, different exercises engaged with the development of the flat are recorded in the MSP 2013, these exercises are separated utilizing WBS application in MSP into subtasks. The movement begin and complete dates are characterized physically or utilizing auto plan choice, different assets accessible for the development of the venture are distributed and the basic way of the task is given by MSP2013,the gauge of the undertaking was set and the exercises are followed for finishing the fragmented exercises were rescheduled accordingly the evaluated time of fulfillment was surpassed from 693 days to 1424 days, the expense of labor was surpassed from 2.5 crores to 3.1 crores . The fluctuation cost of 67 lakhs and the difference time of 731 days were found because of the utilization of planning.

Rhuta and Patil [14] examine the development venture the board in different nations like USA, Canada, and Australia. Looks at the development venture arranging situation over the development venture at ground execution organize, where a portion of the thing that matters is seen as in the event of the arranging procedure, it is accepted that everything runs easily, it isn't the equivalent if there should be an occurrence of genuine undertaking situation, accessibility of assets might be restricted Resolving this utilizing a task the board programming MSP 2013. This is settled by leveling the assets and contrasting the time cost usage and a booked time and assessed cost. Venture the board strategies like CPM/PERT are adjusted with the end goal to determine different deformities, for example, over allotment, lopsided utilization of assets and to anticipate the cutting edge issues emerging in the undertaking. for this situation ponder, the two-stage strategy was received in the main stage different undertaking related information are gathered from the site, the amount of work that should be performed was determined and the computations were arranged, in the second stage all the task related exercises are recorded consecutively utilizing MSP2013 .

Suresh and Nanduri [15] the sentiment that structuring quake resistant structures will cause considerable further costs. In a Swiss outline assesses some place in the scope of 3 and 17% of the hard and fast structure and their costs are specified. The investigation method is created and numerical outcomes are exhibited to show that phenomenal outcomes can be acquired by considering just the initial couple of methods of vibration. As the quantity of questions is diminished by changing to summed up directions, the technique introduced is substantially more proficient than direct strategies.

Behera and Debeshish [16] in todays advanced time the structures are made to fulfill our fundamental points of view. It's definitely not a problem to build up a Structure regardless it is basic to fabricate a viable structure which will serve for quite a while without showing any mistake. This study focuses in searching good strategy for making geomtry, defining the cross zones of segment & shaft. Creating assurance and supports (to describe an assistance atmosphere it is fixed or pinned) & after it the loads are portrayed. Then the model is explored by run analysis, after it keep an eye on the loading screen and look for errors & warnings and if not any ,then the structure is safe for design.

Adiyanto and Zaini [17] the impact of the consecutive utilization of dead load due to the successive nature of development is an essential factor to be considered in the multistory edge examination. Shockingly, nonetheless, this impact has been disregarded by numerous designers practically speaking previously. One of the approaches to incorporate this impact legitimately in the examination is to bring out the investigation through well-ordered techniques as per the successful utilization of dead loads as the development continues. These systems, nonetheless, require explained calculations and more arrangement time. A streamlined methodology, named as adjustment factor strategy (CFM), to take care of the issue without explained well-ordered examinations has been proposed in this paper. This strategy uses the rectification factors built up by a relapse from the information got from the current structures to change the outcomes from the standard investigation to deliver more precise arrangements. Some numerical tests are exhibited to demonstrate the legitimacy and adequacy of the technique.

Thakur and Singh [18] Shear divider frameworks are a standout amongst the most ordinarily utilized parallel burden opposing framework in tall structures, Shear divider has extremely high in plane solidness and quality which could be utilized to all the while oppose expansive even loads and bolster vertical or gravity loads making them very worthwhile in numerous basic designing applications. In multistory structure to oppose parallel powers joining of Shear dividers has turned out to be inescapable. It is important to decide successful, effective and perfect area of shear divider. This analysis of G+4 Story (Zone IV) is specified some primer consideration that is dissected through change in different position of shear divider with various shapes to decide factor i.e. storey drift & minutes. Thus investigation is finished by operating Software pack STAAD Pro.

Ambadkar and Bawner [19] studied the effects of wind on structures. Wind loads as specified in IS: 875 (Part 3) - 1987 were considered in the analysis. In this project analysis of G +11 building. Analysis is done for various variations such as 1) Terrain with few or no obstructions having heights below 1.5 m. 2) Terrain with obstructions having heights between 2.0 to 10 m. 3) Terrain with many close spaced obstacles having the size of building structures up to 10 m high. 4) Terrain with many hefty high close spaced obstacles. Conferring to Internal Pressure Coefficients (Cpi) providing for that many variations. This analysis is done for wind speed 45 m/s, 48 m/s, 52 m/s. Results gotten from STAAD-PRO analysis are used for finding major associations of moments, forces and displacement with wind speeds. Moments, forces and displacement obtained from all cases are related with wind speeds, conferring to their percentage of opening if for many variations.

Arya and Khan [20] in this examination paper, the impact of wind speed and auxiliary reaction of structure outline on slanting ground has been contemplated. Thinking about different casing geometries and incline of grounds. Blend of static and wind loads are considered. For blend, 60 cases in various breeze zones and three distinct statures of structure outlines are broke down. STAAD-Pro v8i programming has been utilized for investigation reason. Results are gathered as far as pivotal power, Shear power, minute, bolster response, Story-wise float and Displacement which are fundamentally examined to evaluate the impacts of different slant of ground.

2.2 OBJECTIVE OF STUDY

The fundamental target of this examination is:

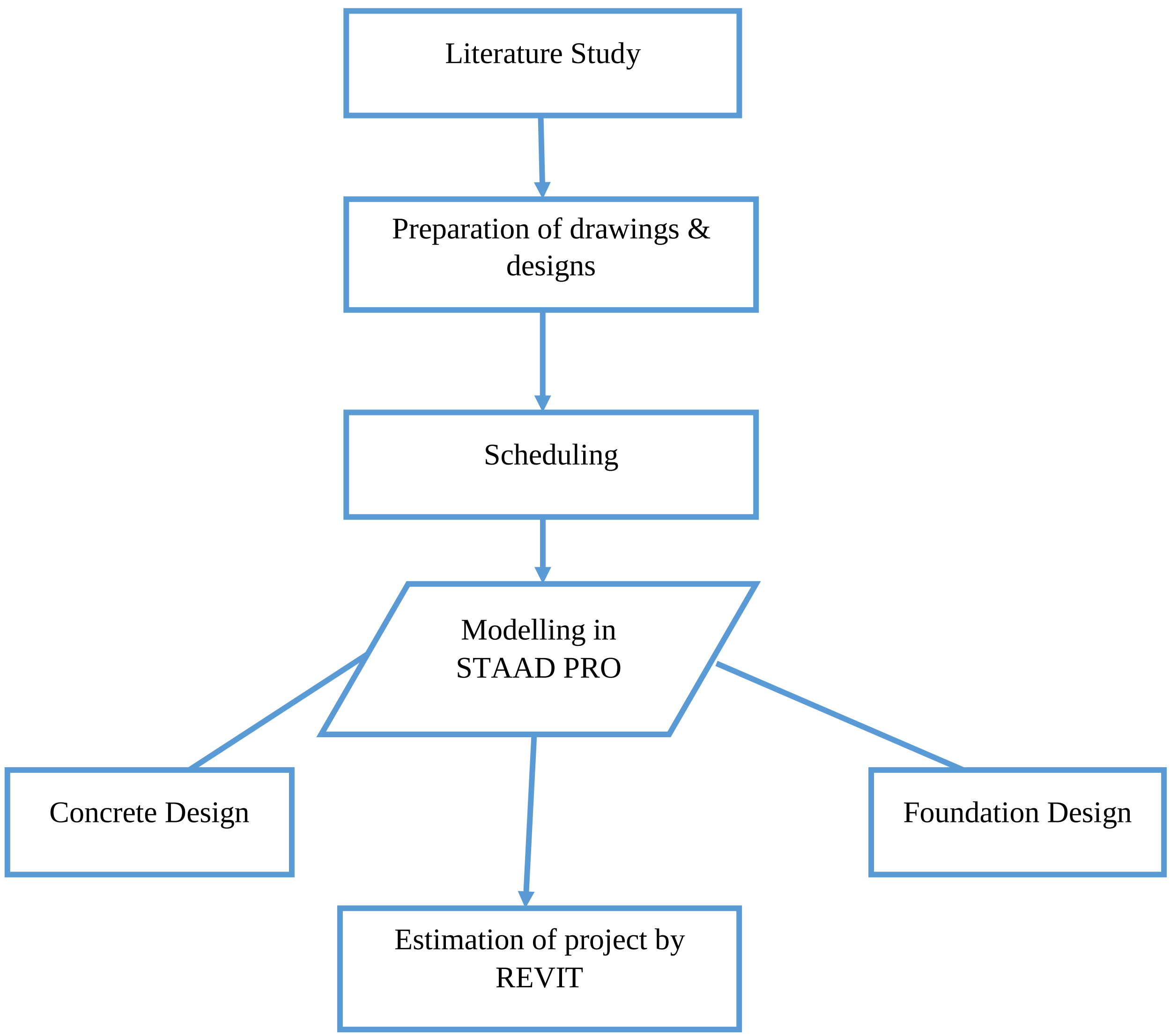
1. Analysis and Design of different basic parts of the modular building.
2. To schedule various activities included in the overall construction of a building
3. To evaluate the cost required to finish the task with effectiveness.

CHAPTER 3

Methodology

3.1 Outline of Chapter

The fundamental step in the methodology includes designing, scheduling and cost optimization of the project. Designing phase includes Six storey building design in Staad pro which further includes loads calculations and concrete design. Then the scheduling phase is carried out by using Microsoft Project 2013, in which all the important activities occurring in a construction project are listed and a calendar is created specifying start date, finish date and exceptions etc. And lastly after all the resources and activities are allocated and scheduled respectively, cost of the materials, labor, and construction are calculated.



3.2 MODELLING:

3.2.1 Structure Generation

Plan of the building is designed in STAAD and after applying translational repeat no. of floor is given and frame model is generated. Fig. 3.2.1.1 shows the 3d frame model of structure.

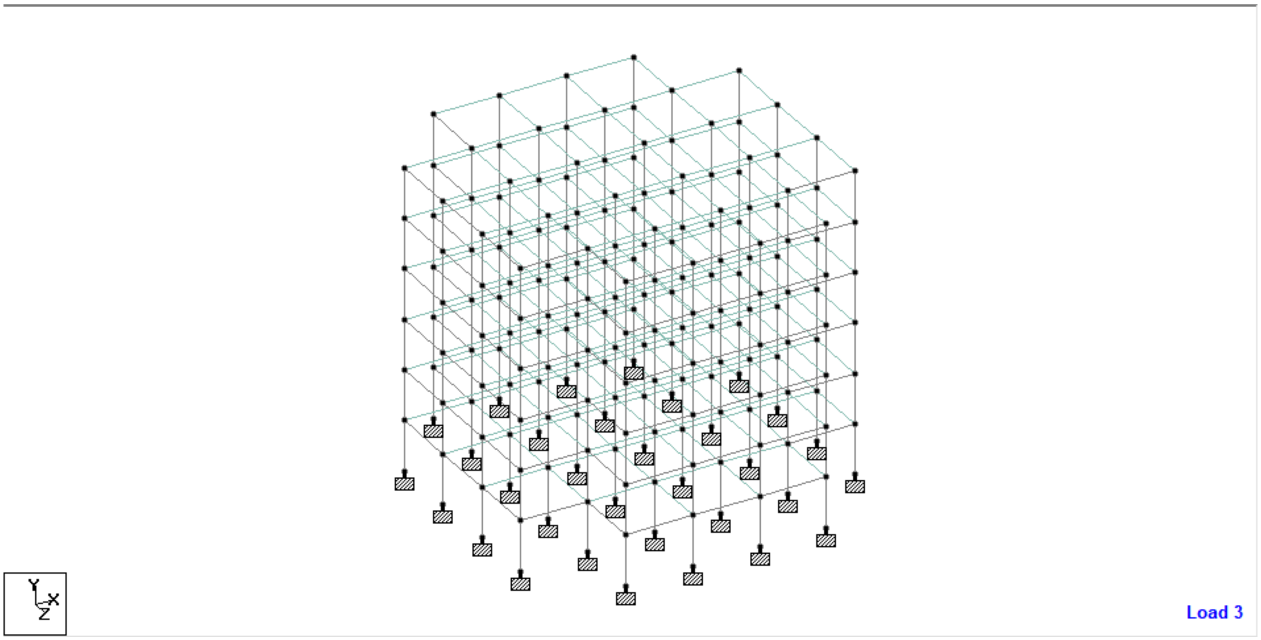


Fig 3.2.1.1 3d view of frame model

3.2.2 Assigning Properties

1. Size of Beam – 0.3*0.3m
2. Size of Column – 0.6*0.6m
3. Slab Thickness – 150mm
4. Height of each Floor – 3m
5. Material – Concrete
6. Support – Fixed

As above mentioned specifications property for beams and columns and thickness of plate are defined and assigned. Supports are assigned as shown in Fig. 3.2.2.1 & Fig. 3.2.2.2 shows beams, columns and slabs assigned to the project.

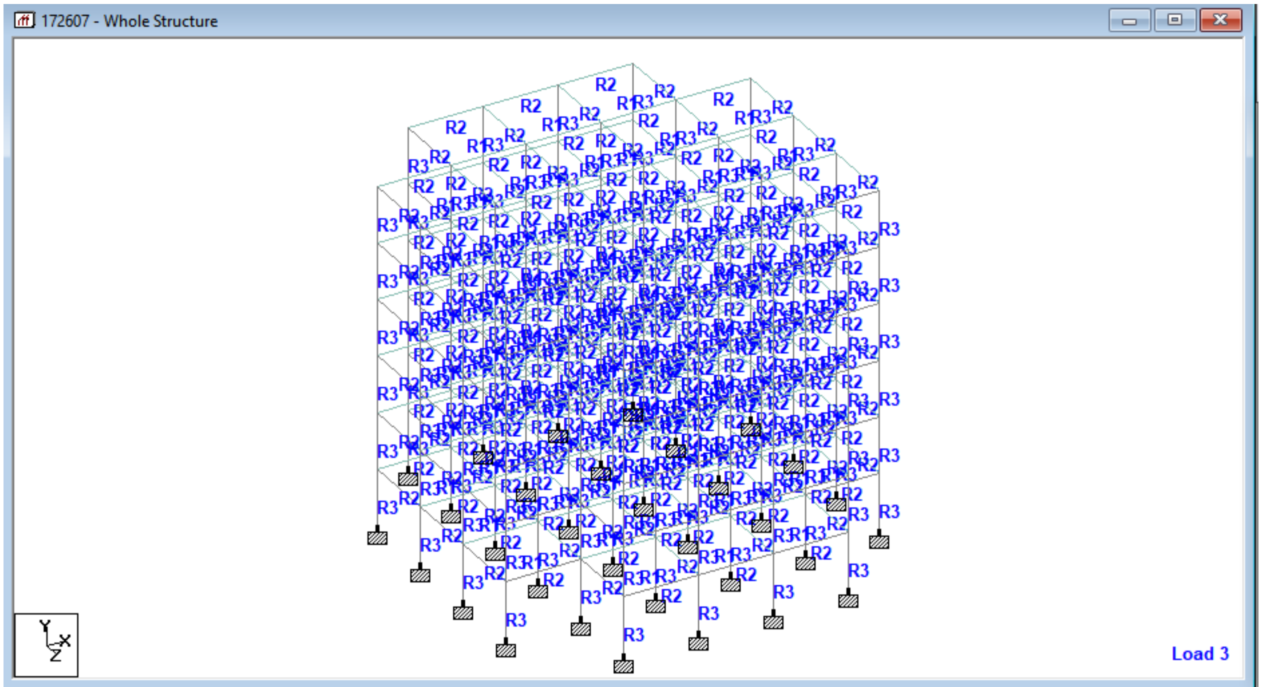


Fig. 3.2.2.1 showing columns beams and supports

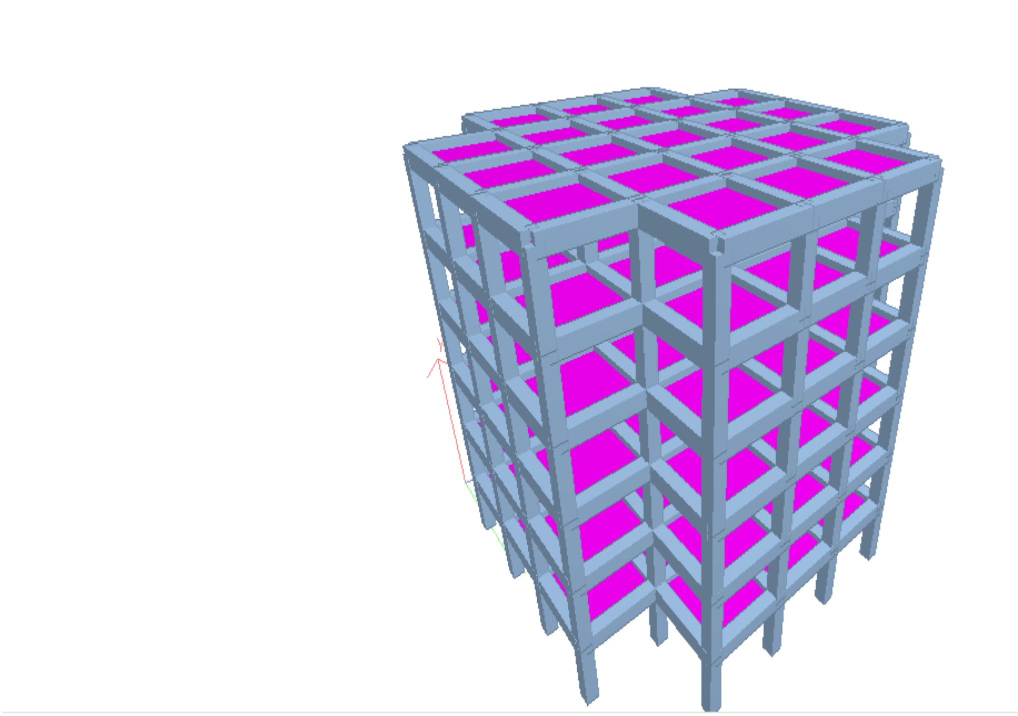


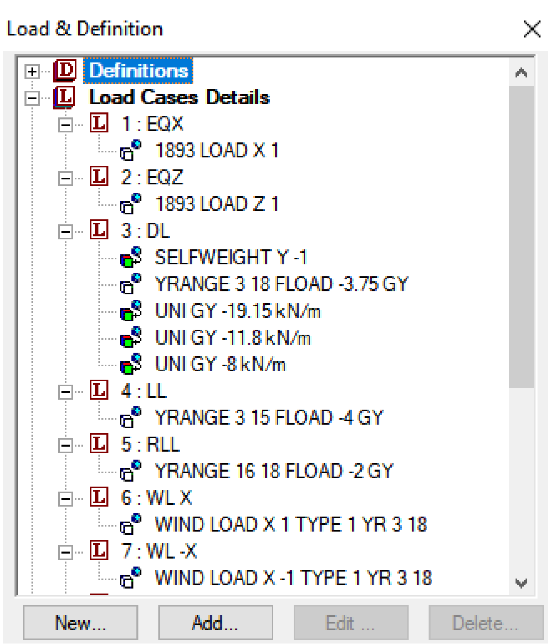
Fig.3.2.2.2 3D picture showing beams, columns and plates

3.2.3 Load and Definitions

Before assigning any loads to the structure firstly we need to define seismic and wind definitions for seismic and wind load to act on the structure. For specifying the wind definition Go to wind definitions and click Add after it is added, add Intensity and exposure manually as per IS 875 Part-3 Intensity provided is given in Table 3.2.3.1, After this definition is added. Go to seismic definition , Click add, Select Code, after clicking on (IS 1893-2002) fill the zone factor importance factor structure type etc. as per code . Applied loads definitions and combinations as per Fig. 3.2.3.1, Fig. 3.2.3.2, Fig. 3.2.3.3.

Table 3.2.3.1 Wind load intensity at different heights

S.No.	Height (m)	Intensity
1	3	0.75
2	6	0.9
3	9	0.99
4	12	1.10
5	15	1.25
6	18	1.37



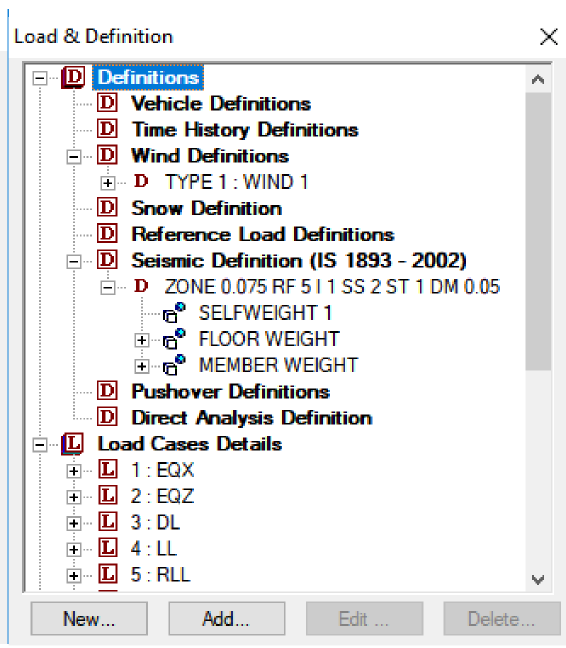


Fig.3.2.3.1 Dialog box showing Load cases details & Load Definitions

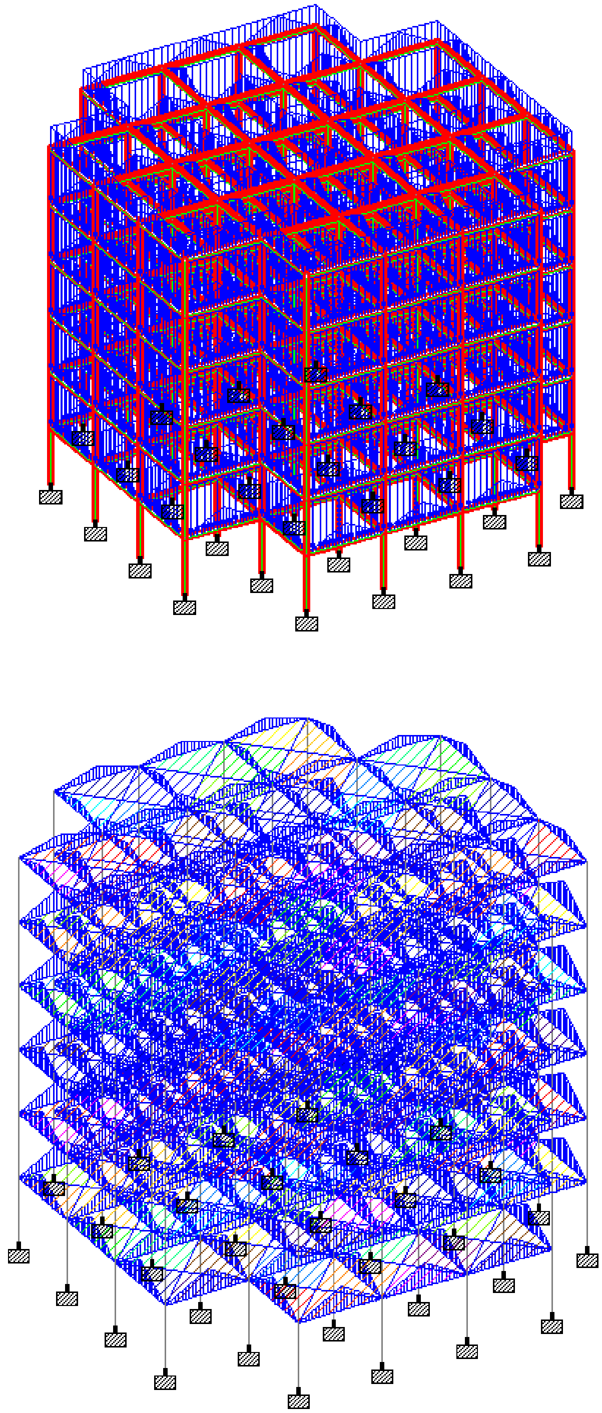


Fig. 3.2.3.2 Showing Dead load & Live Load acting on structure

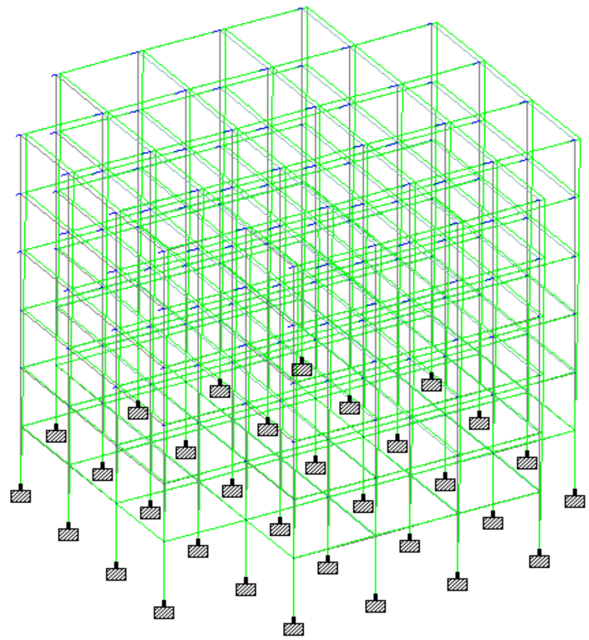


Fig.3.2.3.3 showing seismic load acting in X direction with displacement

3.2.4 Concrete Design

After creating and assigning loads definitions and combinations, design for concrete is started. It is done as per IS 456(2000) with the help of code important parameters are defined like CLEAR, FC, FYMAIN, MAXMAIN. After filling these parameters commands for designing beam, column, slab, and for takeoff is given and after that all these are assigned to the project.

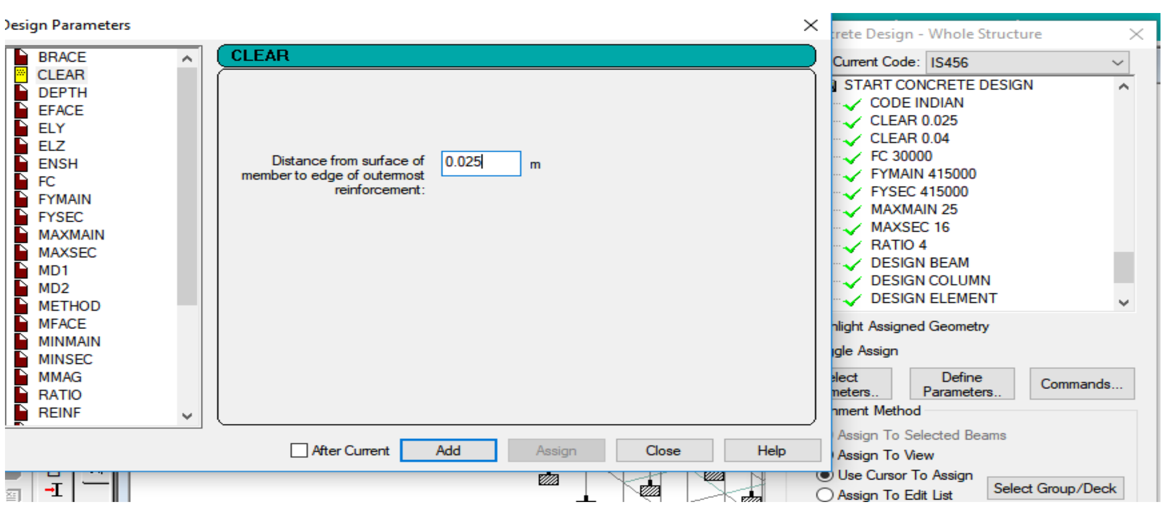


Fig. 3.2.4.1 Dialog box showing concrete design

3.2.5 Design Analysis/Print

In the last step analysis/print command is given and assigned and then analysis is run for possible errors or warnings as shown in Fig. 3.2.5.1

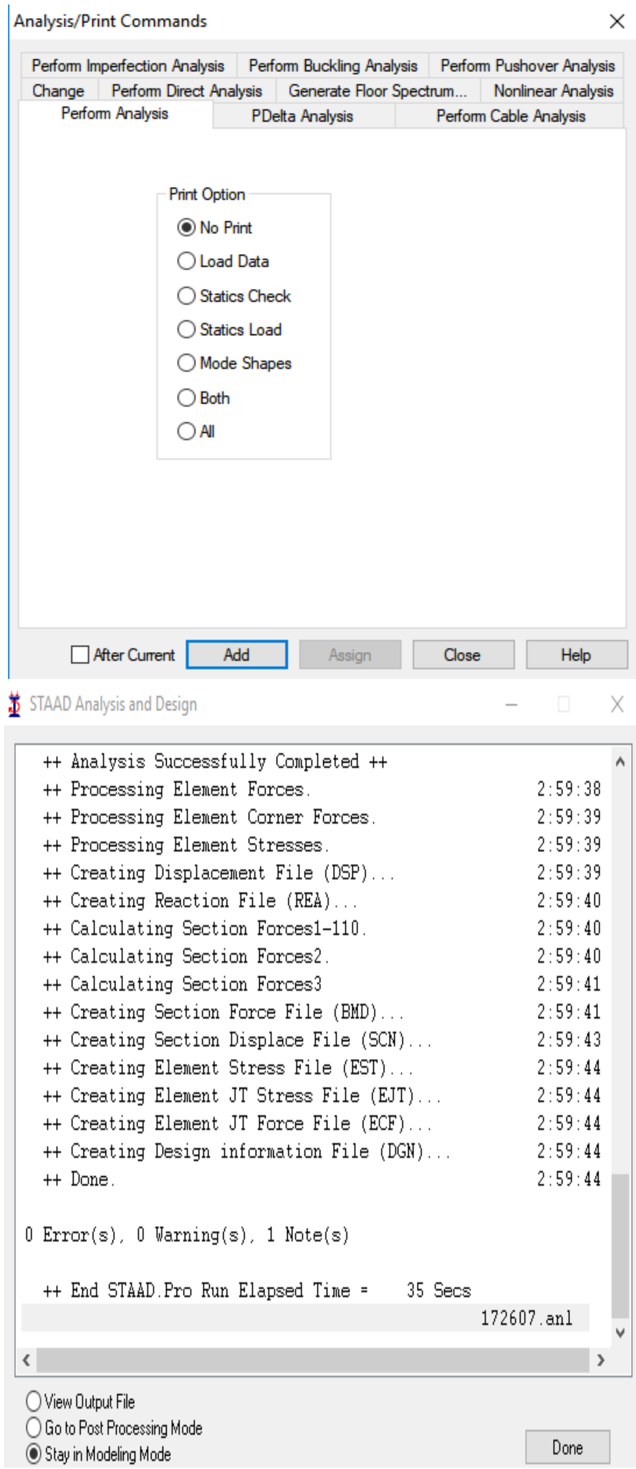


Fig. 3.2.5.1 Dialog box showing analysis print and result

3.2.6 Interactive Concrete design

After analysis is done, we go for concrete design mode in Staad Pro for design of beam, column and slabs. For this open concrete design tab, and once window is open.

1. Create Envelope and name it as it suits us.
2. After this select the load cases you would like to design the project for, Fig. 3.2.6.1 shows window of envelope.

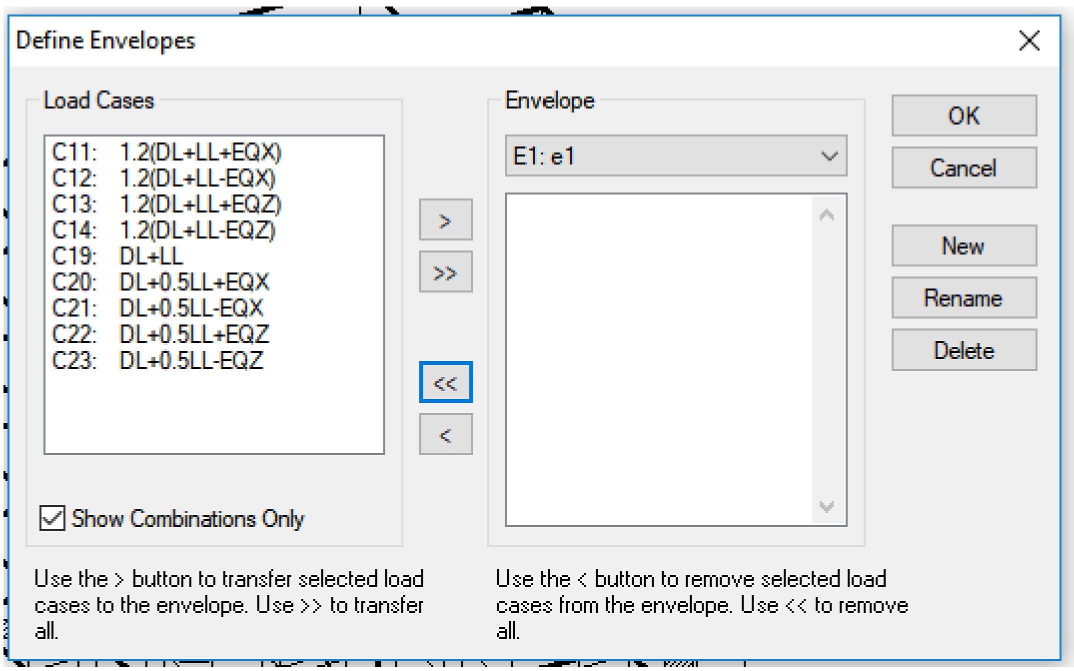
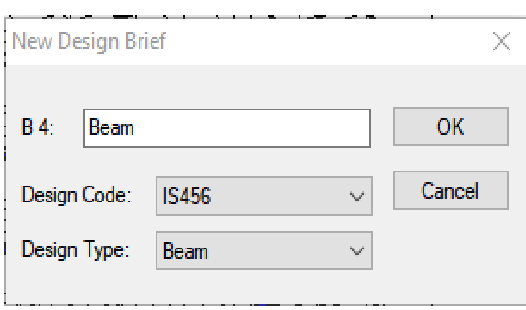


Fig.3.2.6.1 Envelope window in concrete design

3. After envelope is created, select the beams and columns and form members.
4. Then members are created, go to Groups/Briefs and add new briefs for beams, columns and slab as shown in Fig. 3.2.6.2 (a) (b) (c).



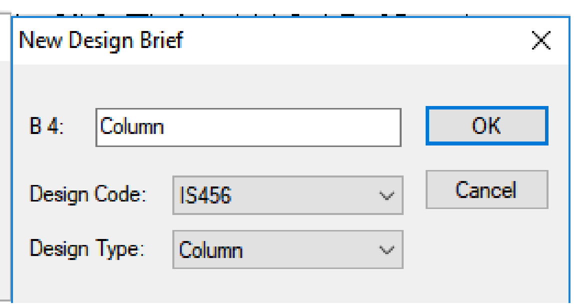


Fig. 3.2.6.2 (a) Design brief for beam **Fig. 3.2.6.2 (b)** Design brief for column

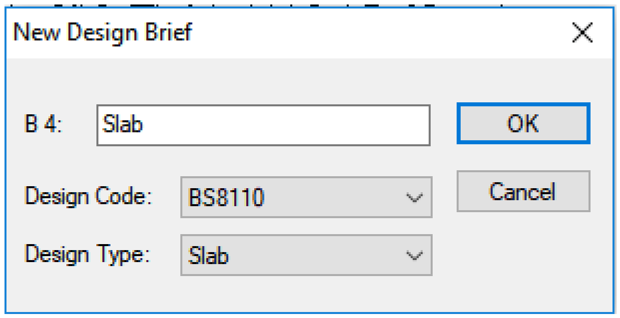
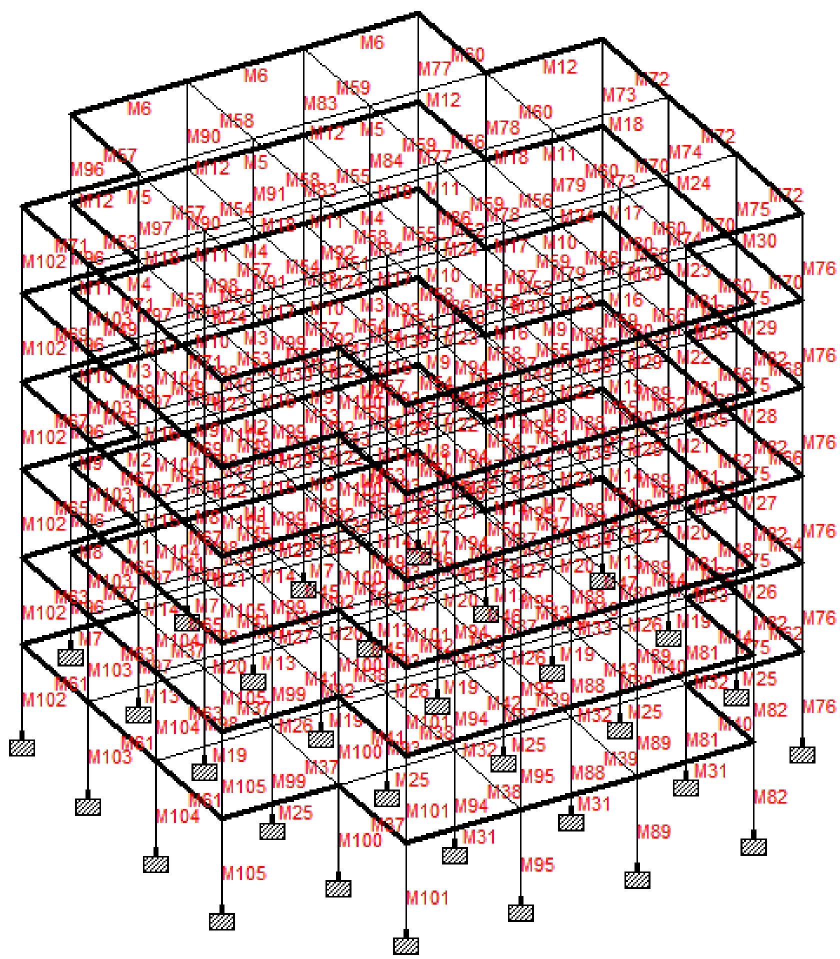
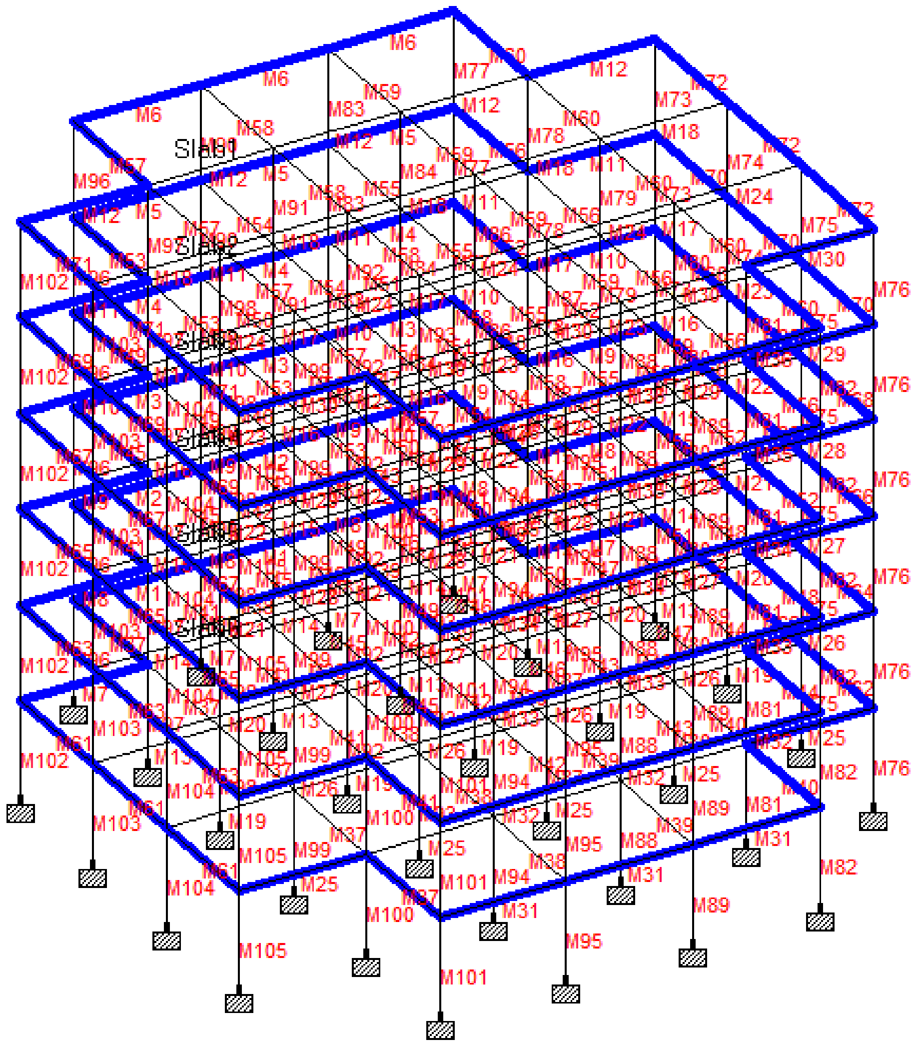


Fig. 3.2.6.2 (c) Design Brief for slabs

4. After designing briefs add the members into design groups and slabs into slab design group.



Showing beams and columns as members



Showing slabs

5. Then after designing groups and briefs, go to concrete member tab and start designing beam, columns and slab as shown in Fig. 3.2.6.3 (a), (b), (c).

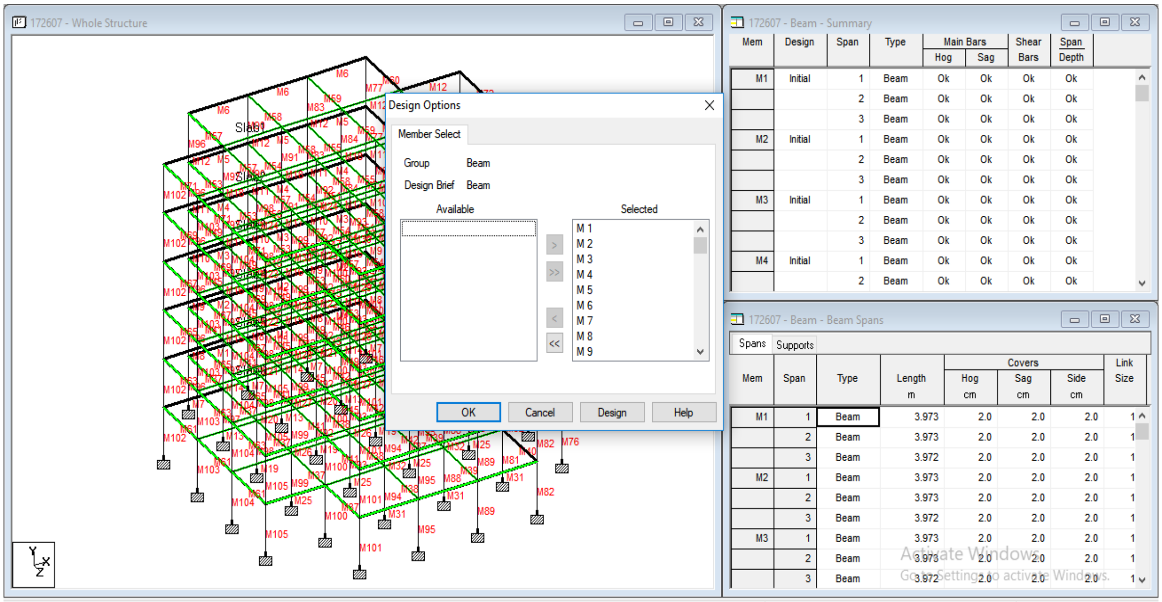


Fig. 3.2.6.3(a) Beam design window

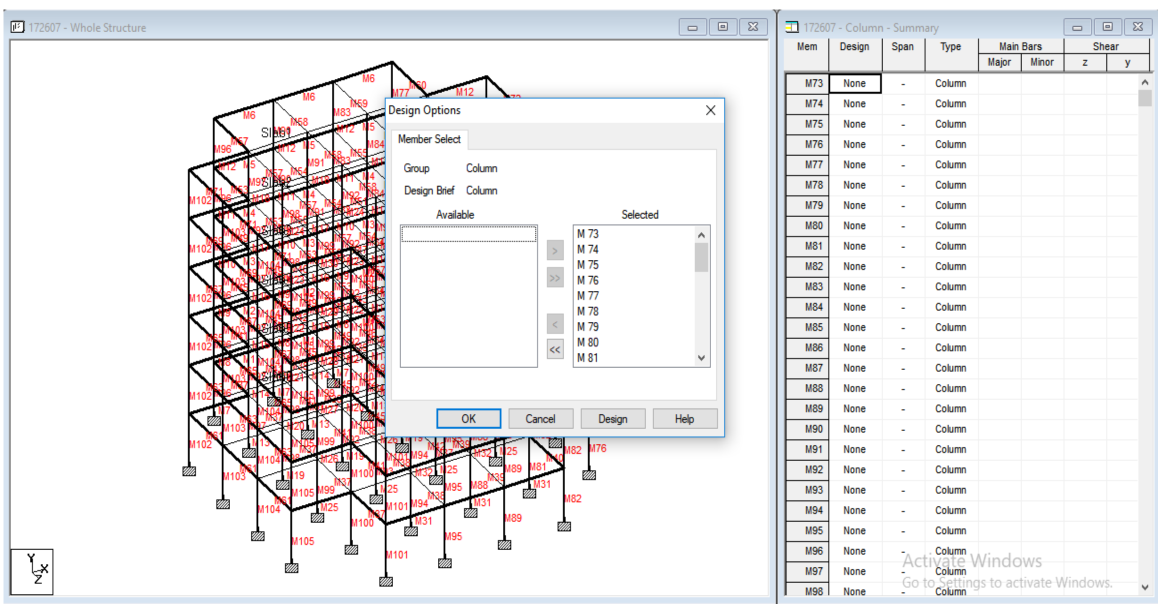


Fig. 3.2.6.3(b) Column design window

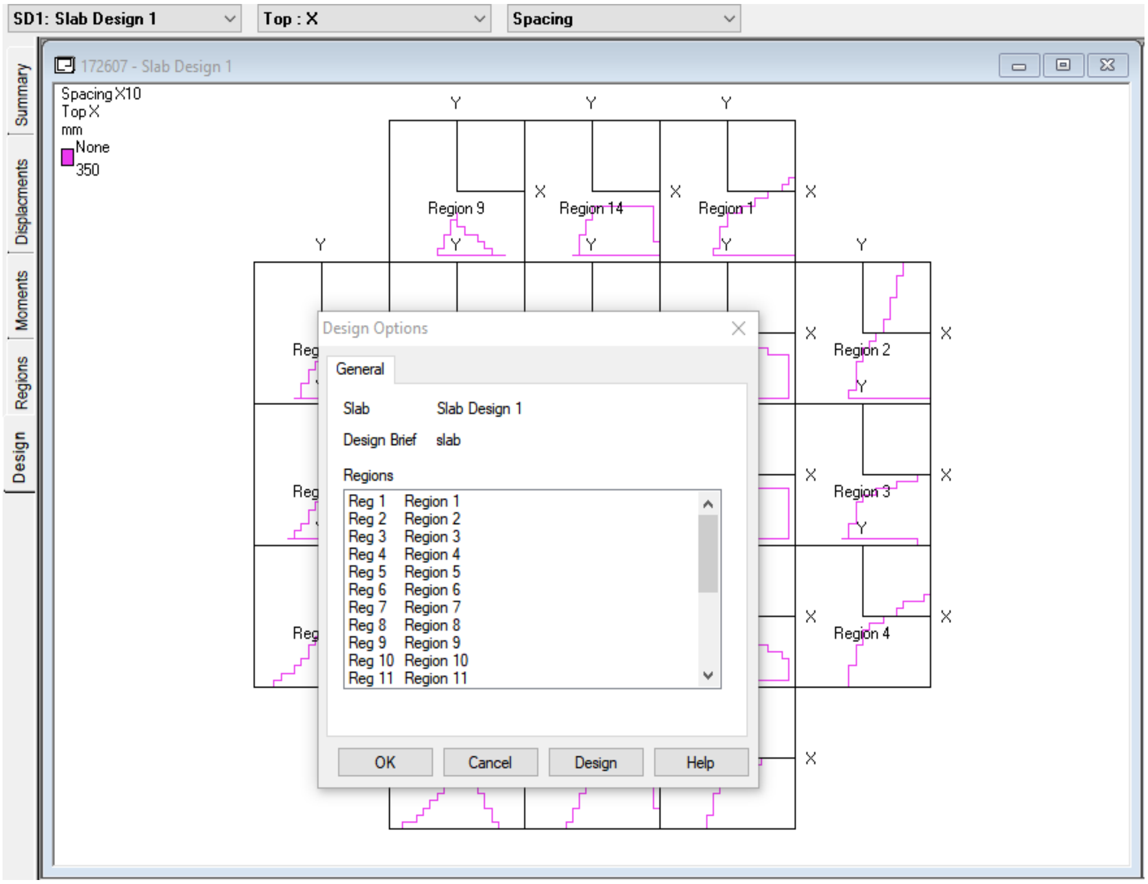


Fig. 3.2.6.3(c) Slab design window

6. Beams, column and slab design is done then foundation design is started. For it go to foundation design wizard and include the load cases for foundation design and run STAAD Foundation as shown in Fig. 3.2.6.4

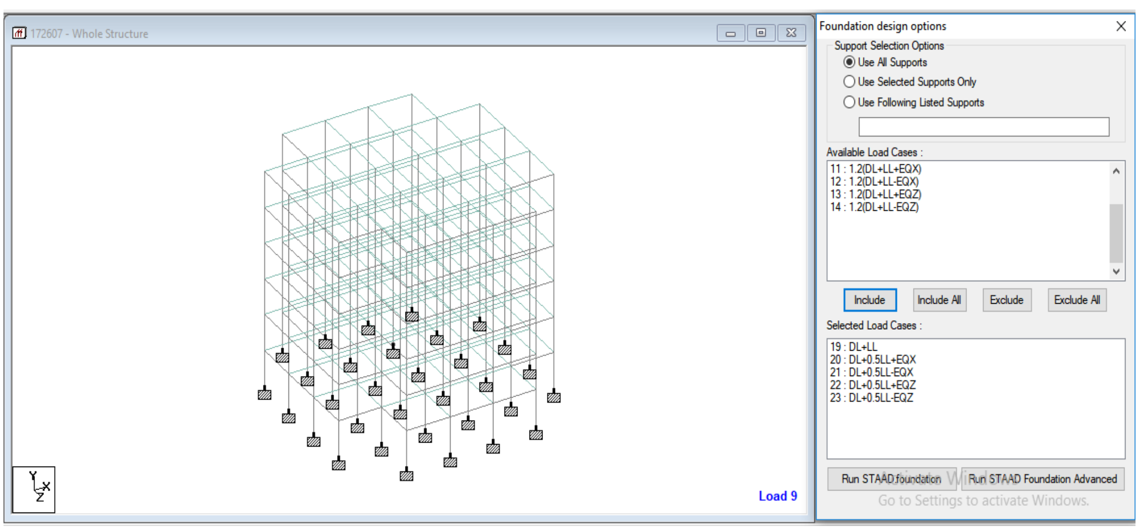


Fig. 3.2.6.4 Showing Foundation design window

7. Once STAAD Foundation opens, create Job for isolated foundation and set parameters as shown in Fig 3.2.6.5(a) (b) (c) (d) (e).

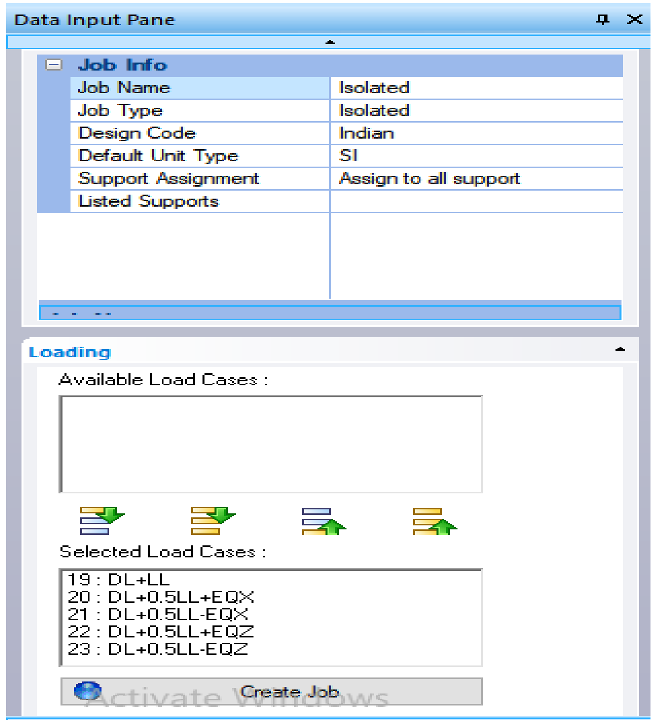


Fig. 3.2.6.5(a) Job setup window

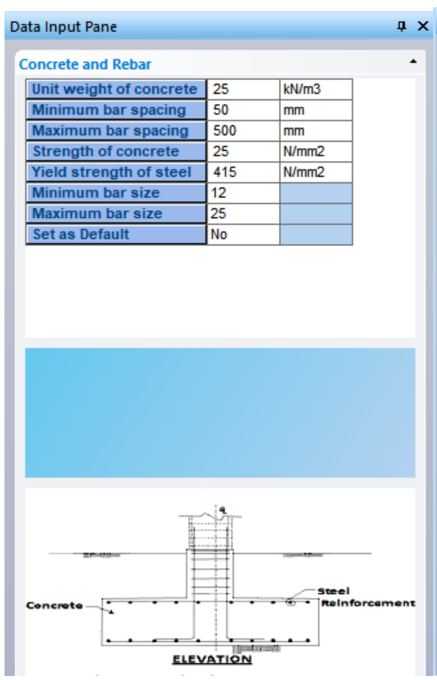


Fig. 3.2.6.5(b) Concrete &rebar input window

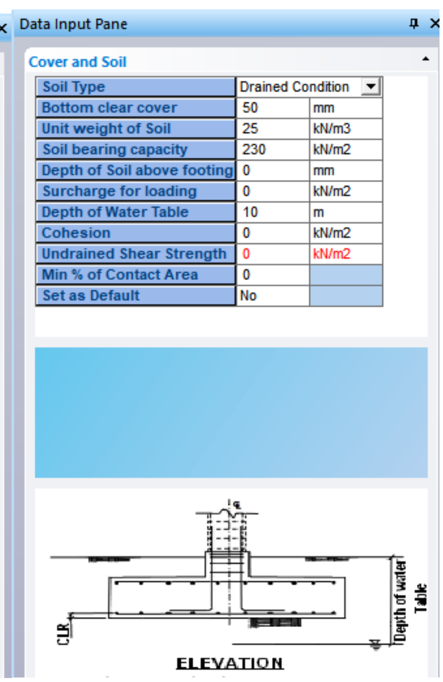


Fig. 3.2.6.5(c) Cover & soil input window

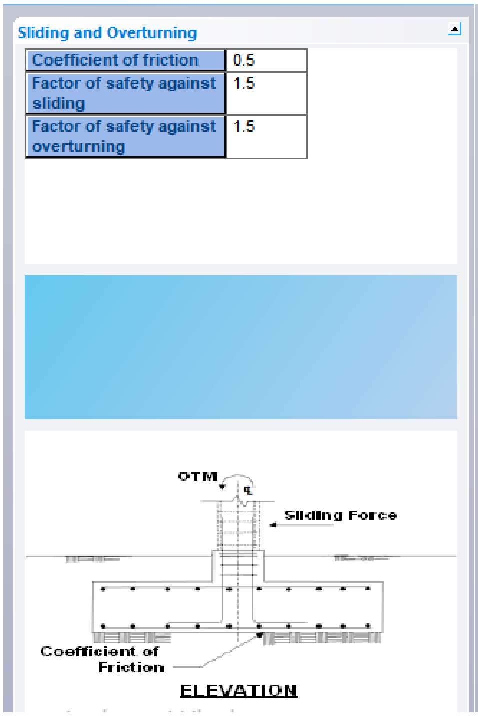


Fig.3.2.6.5 (d) Sliding & overturning window

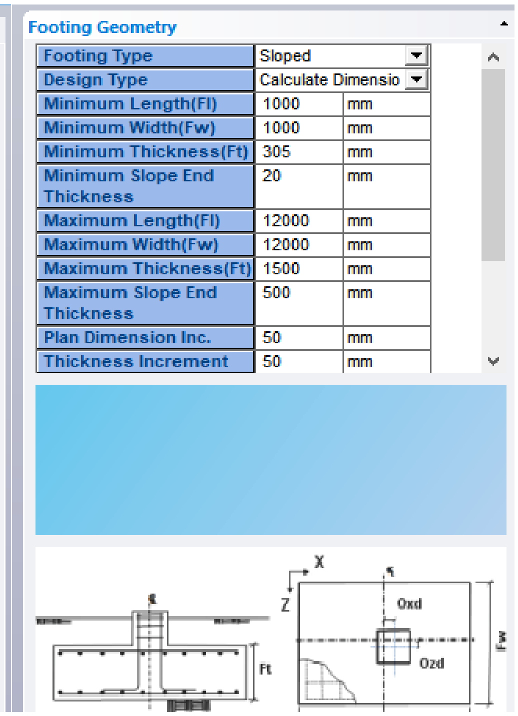


Fig. 3.2.6.5(e) Footing Geometry window

8. After setting and defining all the parameters for foundation design, run the design and analyze.

3.3 SCHEDULING

Create and schedule a new project

1. Open MSP 2013 software.
2. First of all before starting listing activities, we need to specify the calendar for the project.
3. For that click on “Project” option and then select “Change Working Time” and design the calendar as per your desire like here as shown in Fig. 3.3.1.
4. And after that start listing all the activities with start date or finish date and MSP will schedule it automatically or manually.

Preparing calendar for project with exceptions and holidays till start and finish date

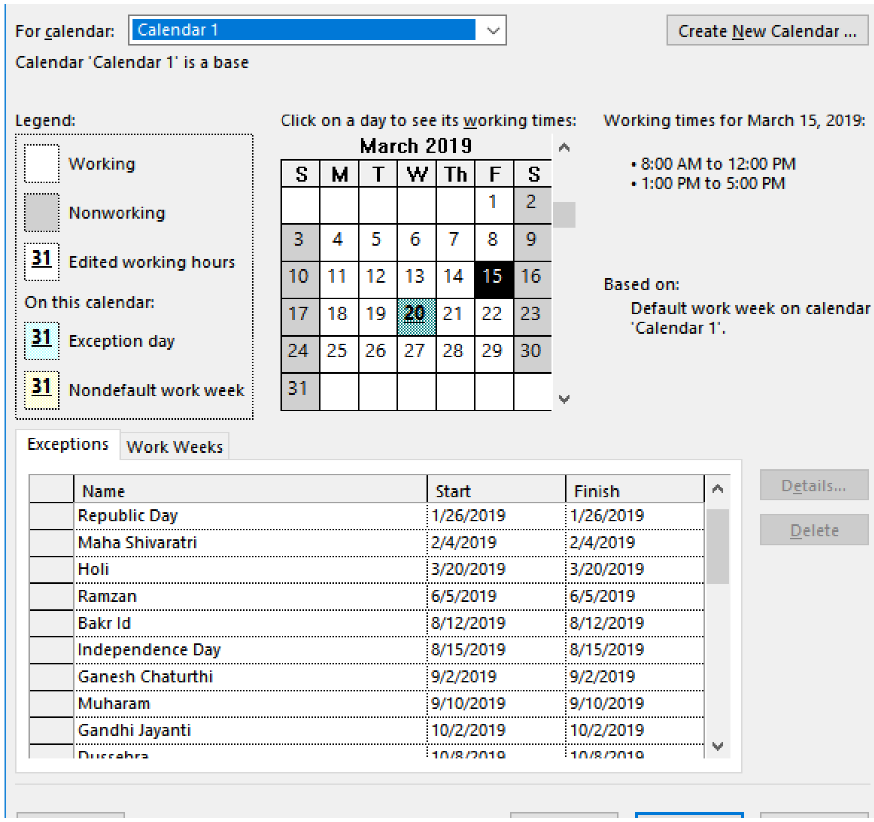


Fig.3.3.1 Dialog box showing project calendar

In the project calendar, working hours are set to 8 hours with 1 hour break for rest and lunch for laborers and employees etc.

After calendar is set, start listing all the activities and duration and specify schedule auto/manual based on your convenience, here it is set on auto schedule means it will adjust duration and start and finish dates itself. Below fig.3.3.2 shows activities listed

WBS	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Start**	**516,4 days**	**Tue 1/1/19**	**Thu 1/7/21**	
1.1		Prepare Contract Drawings	38 days	**Tue 1/1/19**	**Mon 2/25/19**	
1.2		**Project Procurment**	**524,3 days**	**Tue 1/1/19**	**Tue 1/19/21**	
1.2.1		Subcontractor Bid & Interview Period	15 days	Tue 1/1/19	Mon 1/21/19	
1.2.2		Recommendati & Approval of Subcontractors	15 days	Tue 3/26/19	Mon 4/15/19	2
1.2.3		Other Material Procurment	191 days	Tue 2/26/19	Mon 12/2/19	2
1.2.4		**Construction**	**475,3 days**	**Wed 3/13/19**	**Tue 1/19/21**	
1.2.4.1		Foundation	70 days	Wed 3/13/19	Thu 6/20/19	
1.2.4.2		Concrete Columns (1st Floor)	15 days	Wed 3/13/19	Wed 4/3/19	

Fig.3.3.2 WBS in MSP 2013

After this relations are decided for activities. Generally there are 4 types of relations in MSP 2013.

1. Start to Finish
2. Start to-Start
3. Finish to-Finish.
4. Finish to Start

As shown above in Fig.3.3.2 activities listed are assigned relations based on predecessors and successors. After assigning relations critical path is shown in the Fig.3.3.3 below

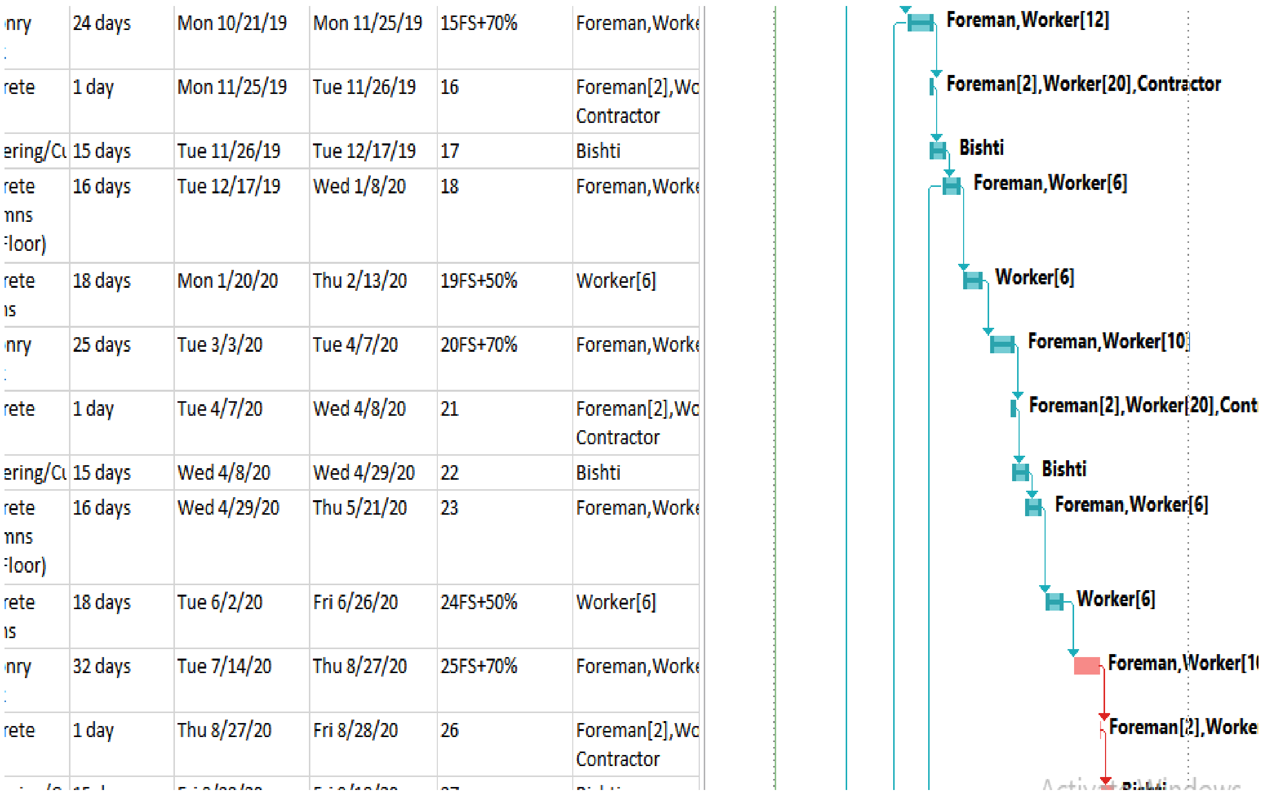


Fig.3.3.3 Networking of the Activities by Critical Path Method

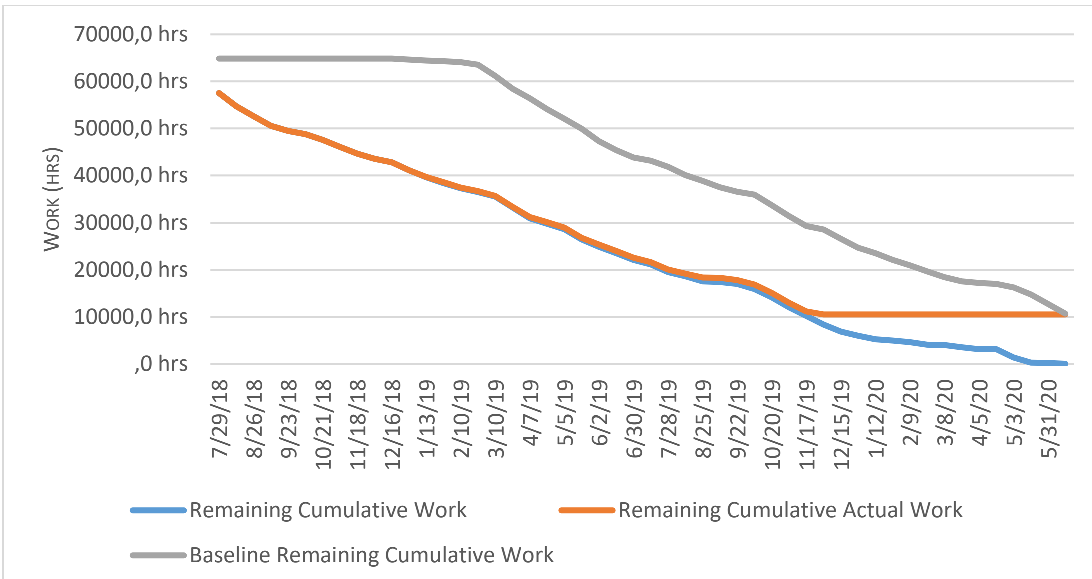
And adding all the activities in the MSP 2013 Activities are scheduled and project duration is calculated. Also resources used can be easily monitored and handled with it.

CHAPTER 4

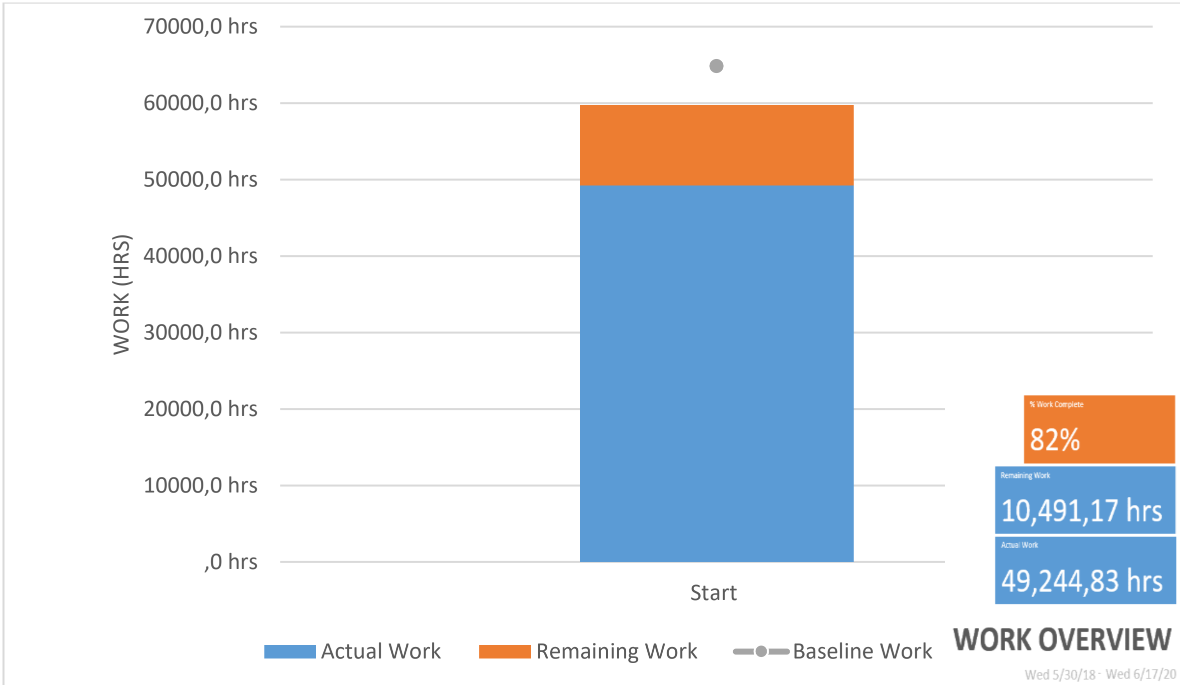
Results and Discussions

4.1 SCHEDULING

Work Burndown - Shows how much work you have completed and how much you have left. If the remaining cumulative work line is steeper, then the project may be late.



From the beginning of the Project the resources are on use and track can be kept on it easily with the help of graphs and bar charts.



In the above bar chart 82% work shown is completed and only 18% work is left.

With the help of software after shifting the project start date and scheduling and levelling the resources it is known that the Project ends in 524 days using all the available resources.

4.2 Loads Considered

Dead Loads

1 DL due to Plate/Slab = 0.15*25 = 3.75 kN/m^2

2 DL due to External Wall = 0.35*2.45*20 = 19.15 kN/m^2

3 DL due to Partition Wall = 0.2*2.5*20 = 11.8 kN/m^2

4 DL due to Parapet Wall = 0.2*1.5*20 = 8 kN/m^2

5 Plaster for two face = 0.02*2.45*1*18*2 = 2 kN/m^2

Imposed Loads

1. Roof Live Load = 2 kN/m^2
2. Floor Load = 4 kN/m^2

Design Load

For the design of the beam, column and slab we've considered load combination

L/C #14 which is 1.2(DL+LL-EQZ).

4.3 Deflected Shape

Below shown figure is the deflected shape of the building under Load combination L/C = 1.2(DL+LL-EQZ).

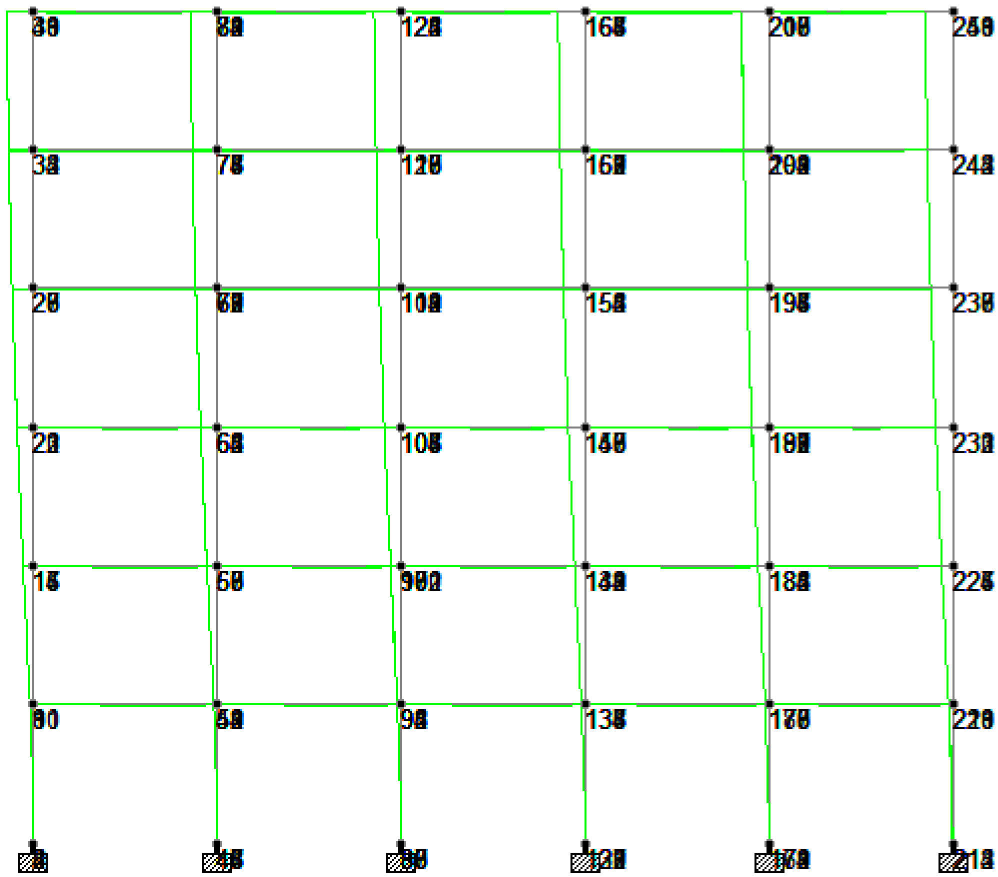


Fig. 4.3.1 Deflected shape

4.4 Max Displacement at nodes

Table 4.4.1 Max Displacement at different nodes

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	54	14 1.2(DL+LL-EQZ)	0.029	-0.408	-4.218	4.238	-0.002	-0.000	0.000
Min X	49	14 1.2(DL+LL-EQZ)	-0.029	-0.408	-4.218	4.238	-0.002	0.000	-0.000
Max Y	2	14 1.2(DL+LL-EQZ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Y	80	14 1.2(DL+LL-EQZ)	0.007	-2.018	-29.432	29.501	-0.000	0.000	-0.000
Max Z	2	14 1.2(DL+LL-EQZ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Z	248	14 1.2(DL+LL-EQZ)	0.004	-0.880	-29.458	29.471	-0.001	-0.000	-0.000
Max rX	2	14 1.2(DL+LL-EQZ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rX	181	14 1.2(DL+LL-EQZ)	0.012	-0.459	-11.457	11.466	-0.002	0.000	-0.000
Max rY	218	14 1.2(DL+LL-EQZ)	0.017	-0.248	-4.230	4.237	-0.002	0.000	-0.000
Min rY	221	14 1.2(DL+LL-EQZ)	-0.017	-0.248	-4.230	4.237	-0.002	-0.000	0.000
Max rZ	126	14 1.2(DL+LL-EQZ)	-0.012	-1.523	-29.436	29.475	-0.001	-0.000	0.000
Min rZ	121	14 1.2(DL+LL-EQZ)	0.012	-1.523	-29.436	29.475	-0.001	0.000	-0.000
Max Rst	207	14 1.2(DL+LL-EQZ)	0.003	-1.934	-29.447	29.510	-0.000	-0.000	-0.000

From the above table it is shown that what is the displacement at different nodes and it is concluded that max. Displacement at different nodes is less than 30 mm.

4.5 Max S.F & B.M at Different nodes

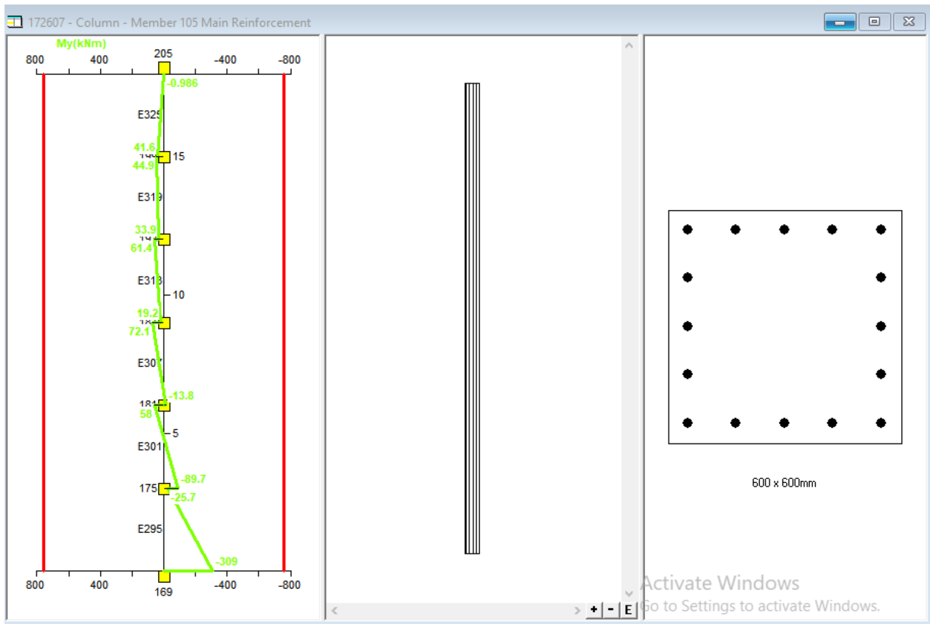
Table 4.5.1 Max SF & BM at different nodes

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	98	14 1.2(DL+LL-EQZ)	44	1551.114	6.097	129.665	0.252	-344.366	5.240
Min Fx	542	14 1.2(DL+LL-EQZ)	176	-11.911	71.511	-0.051	-0.008	0.018	74.625
Max Fy	166	14 1.2(DL+LL-EQZ)	88	1429.768	141.236	-0.218	-0.002	0.286	356.097
Min Fy	289	14 1.2(DL+LL-EQZ)	204	1.362	-52.368	-0.017	0.315	-0.018	37.394
Max Fz	99	14 1.2(DL+LL-EQZ)	45	1416.382	-0.327	141.833	-0.015	-356.536	-0.435
Min Fz	392	14 1.2(DL+LL-EQZ)	242	104.492	-11.689	-15.402	0.475	43.073	-15.277
Max Mx	365	14 1.2(DL+LL-EQZ)	215	661.520	0.790	95.251	1.013	-310.489	-0.116
Min Mx	362	14 1.2(DL+LL-EQZ)	212	661.523	-0.791	95.251	-1.013	-310.490	0.115
Max My	111	14 1.2(DL+LL-EQZ)	63	940.678	-0.274	105.025	0.008	183.101	0.408
Min My	99	14 1.2(DL+LL-EQZ)	45	1416.382	-0.327	141.833	-0.015	-356.536	-0.435
Max Mz	166	14 1.2(DL+LL-EQZ)	88	1429.768	141.236	-0.218	-0.002	0.286	356.097
Min Mz	166	14 1.2(DL+LL-EQZ)	94	1399.162	141.236	-0.218	-0.002	-0.367	-67.612

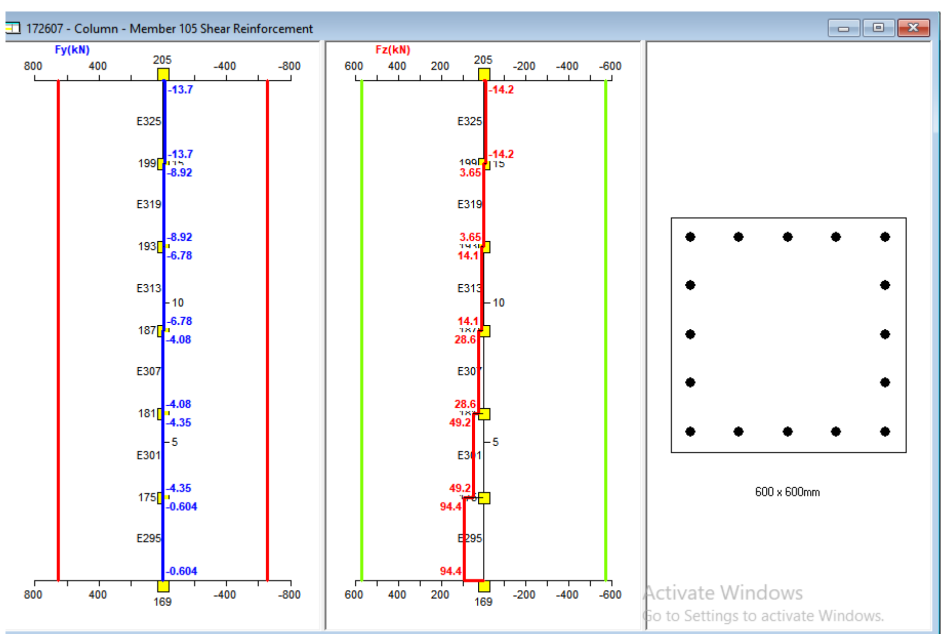
4.6 Column Design

Design Load for which columns are designed = 1.2(DL+LL-EQZ)

Member 105 (Main reinforcement layout)



Member 105 (Shear Reinforcement layout)



Below here is the table of main reinforcement for all columns.

Table 4.6.1 Main Reinforcement

Mem	L/C	Axial kN	Major kNm	Minor kNm	Design Axis	As Req. mm^2	Total Bars	As Prov. mm^2
M73	C14	1078.424	351.566	613.464	Biaxl min	11781	24T25	11781
M74	C14	1168.933	381.072	650.976	Biaxl min	11781	24T25	11781
M75	C14	1168.994	381.092	650.722	Biaxl min	11781	24T25	11781
M76	C14	664.245	216.544	488.094	Biaxl min	7854	16T25	7854
M77	C14	1081.148	352.454	616.366	Biaxl min	11781	24T25	11781
M78	C14	1551.108	505.661	763.164	Biaxl min	15708	32T25	15708
M79	C14	1417.863	462.223	737.912	Biaxl min	15708	32T25	15708
M80	C14	1417.336	462.052	737.546	Biaxl min	15708	32T25	15708
M81	C14	1344.986	438.466	711.287	Biaxl min	13744	28T25	13744
M82	C14	661.520	215.656	489.100	Biaxl min	7854	16T25	7854
M83	C14	1479.229	482.229	733.612	Biaxl min	15708	32T25	15708
M84	C14	1416.380	461.740	738.958	Biaxl min	15708	32T25	15708
M85	C14	1429.768	356.097	0.367	Biaxl maj	3927	8T25	3927
M86	C14	1204.389	286.042	435.048	Biaxl min	7854	16T25	7854
M87	C14	1430.450	466.327	742.138	Biaxl min	15708	32T25	15708
M88	C14	1418.821	462.536	738.876	Biaxl min	15708	32T25	15708
M89	C14	858.693	279.934	557.189	Biaxl min	9817	20T25	9817
M90	C14	1479.232	482.229	733.613	Biaxl min	15708	32T25	15708
M91	C14	1416.382	461.741	738.959	Biaxl min	15708	32T25	15708
M92	C14	1429.770	466.105	742.135	Biaxl min	15708	32T25	15708
M93	C14	1430.452	466.327	742.139	Biaxl min	15708	32T25	15708
M94	C14	1418.823	462.536	738.877	Biaxl min	15708	32T25	15708
M95	C14	858.695	279.935	557.190	Biaxl min	9817	20T25	9817
M96	C14	1081.150	352.455	616.367	Biaxl min	11781	24T25	11781
M97	C14	1551.114	505.663	763.166	Biaxl min	15708	32T25	15708
M98	C14	1417.868	462.225	737.914	Biaxl min	15708	32T25	15708
M99	C14	1417.342	462.053	737.548	Biaxl min	15708	32T25	15708
M100	C14	1344.991	438.467	711.289	Biaxl min	13744	28T25	13744
M101	C14	661.523	215.656	489.101	Biaxl min	7854	16T25	7854
M102	C14	1078.427	351.567	613.466	Biaxl min	11781	24T25	11781
M103	C14	1168.936	381.073	650.978	Biaxl min	11781	24T25	11781
M104	C14	1168.997	381.093	650.724	Biaxl min	11781	24T25	11781
M105	C14	664.247	216.544	488.096	Biaxl min	7854	16T25	7854

And given below table here shows the shear reinforcement for all the columns

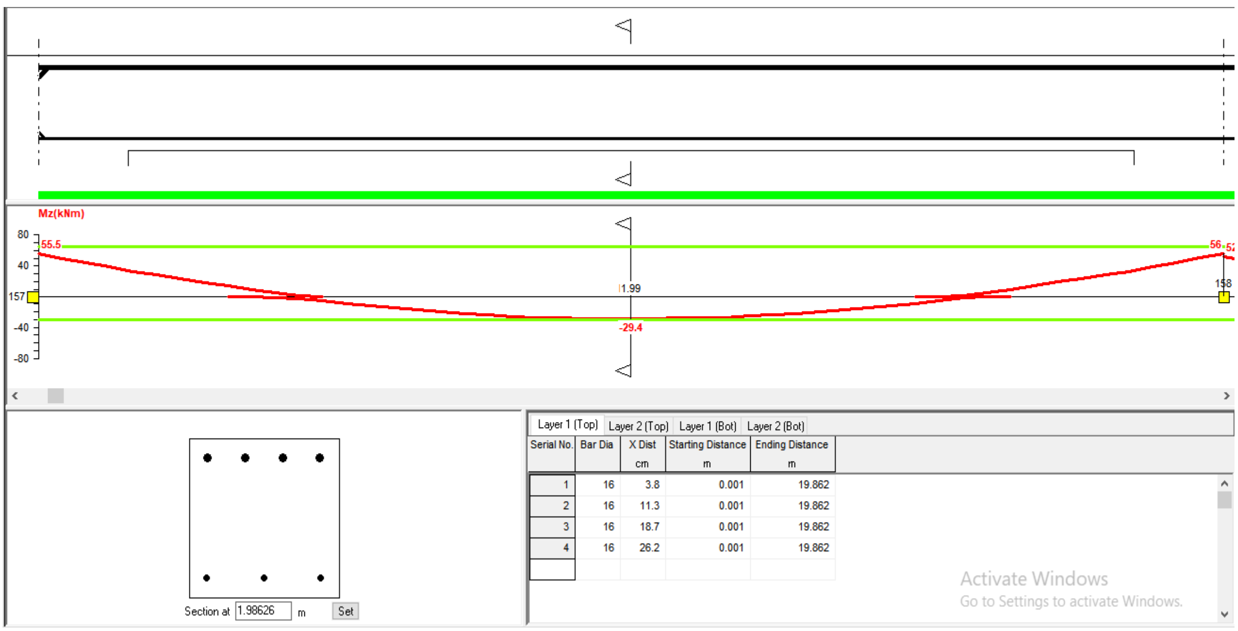
Table 4.6.2 Shear Reinforcement

Mem	Max Shear in Local y L/C	Max Shear in Local y Value kN	Max Shear in Local y Position m	Max Shear in Local z L/C	Max Shear in Local z Value kN	Max Shear in Local z Position m	Asv Req. mm^2	Link Size	Spacing cm
M73	C14	20.630	3.000	C14	108.373	0.000	0	10	7.1
M74	C14	19.002	15.000	C14	121.263	0.000	0	10	7.1
M75	C14	18.936	15.000	C14	121.072	0.000	0	10	7.1
M76	C14	13.692	15.000	C14	94.359	0.000	0	10	7.1
M77	C14	20.441	3.000	C14	109.669	0.000	0	10	7.1
M78	C14	13.025	3.000	C14	129.665	0.000	0	10	7.1
M79	C14	2.409	12.000	C14	140.819	0.000	0	10	7.1
M80	C14	2.784	15.000	C14	140.641	0.000	0	10	7.1
M81	C14	10.056	15.000	C14	133.761	0.000	0	10	7.1
M82	C14	11.689	15.000	C14	95.251	0.000	0	10	7.1
M83	C14	1.159	15.000	C14	118.629	0.000	0	10	7.1
M84	C14	0.497	12.000	C14	141.833	0.000	0	10	7.1
M85	C14	141.236	0.000	C14	0.218	0.000	0	10	7.1
M86	C14	0.374	12.000	C14	128.890	0.000	0	10	7.1
M87	C14	0.310	12.000	C14	141.095	0.000	0	10	7.1
M88	C14	0.699	12.000	C14	141.237	0.000	0	10	7.1
M89	C14	1.134	15.000	C14	109.496	0.000	0	10	7.1
M90	C14	1.159	15.000	C14	118.629	0.000	0	10	7.1
M91	C14	0.497	12.000	C14	141.833	0.000	0	10	7.1
M92	C14	0.374	15.000	C14	141.237	0.000	0	10	7.1
M93	C14	0.310	12.000	C14	141.095	0.000	0	10	7.1
M94	C14	0.699	12.000	C14	141.237	0.000	0	10	7.1
M95	C14	1.134	15.000	C14	109.496	0.000	0	10	7.1
M96	C14	20.441	3.000	C14	109.669	0.000	0	10	7.1
M97	C14	13.025	3.000	C14	129.665	0.000	0	10	7.1
M98	C14	2.409	12.000	C14	140.819	0.000	0	10	7.1
M99	C14	2.784	15.000	C14	140.641	0.000	0	10	7.1
M100	C14	10.056	15.000	C14	133.761	0.000	0	10	7.1
M101	C14	11.689	15.000	C14	95.251	0.000	0	10	7.1
M102	C14	20.630	3.000	C14	108.373	0.000	0	10	7.1
M103	C14	19.003	15.000	C14	121.263	0.000	0	10	7.1
M104	C14	18.936	15.000	C14	121.072	0.000	0	10	7.1
M105	C14	13.692	15.000	C14	94.359	0.000	0	10	7.1

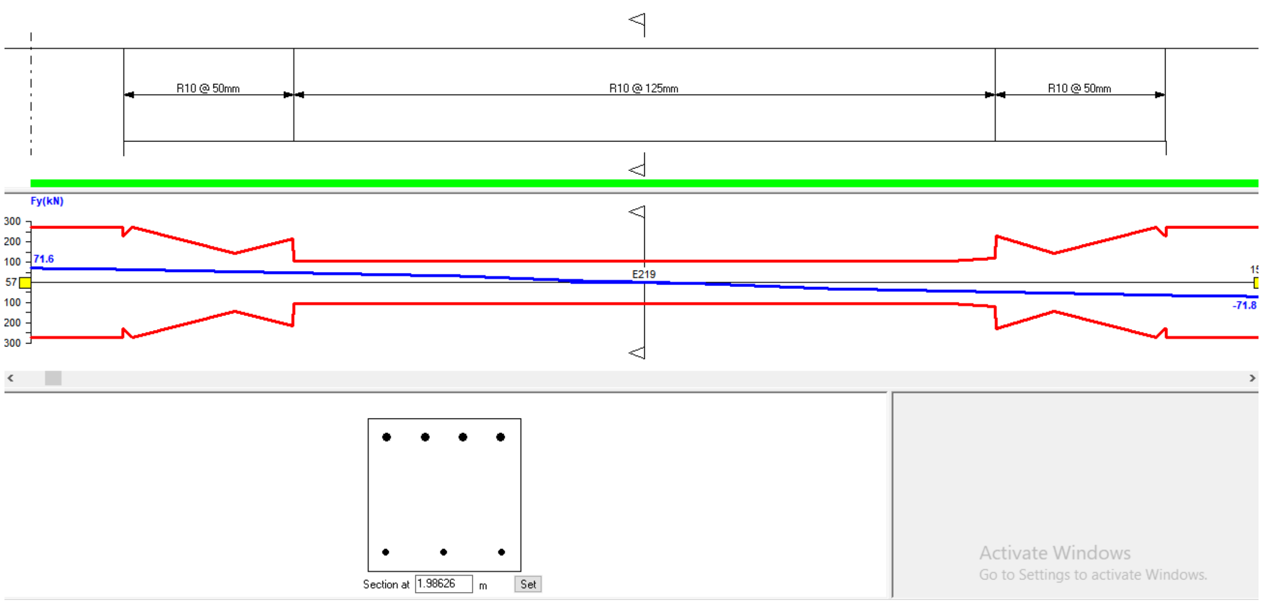
4.7 Beam Design

Design Load for which beams are designed = 1.2(DL+LL-EQZ)

Member 23 (Main Reinforcement layout)



Member 23 (Shear Reinforcement layout)



4.8 Slab Design

Slab 6, specified Design load = 1.2(DL+LL-EQZ)

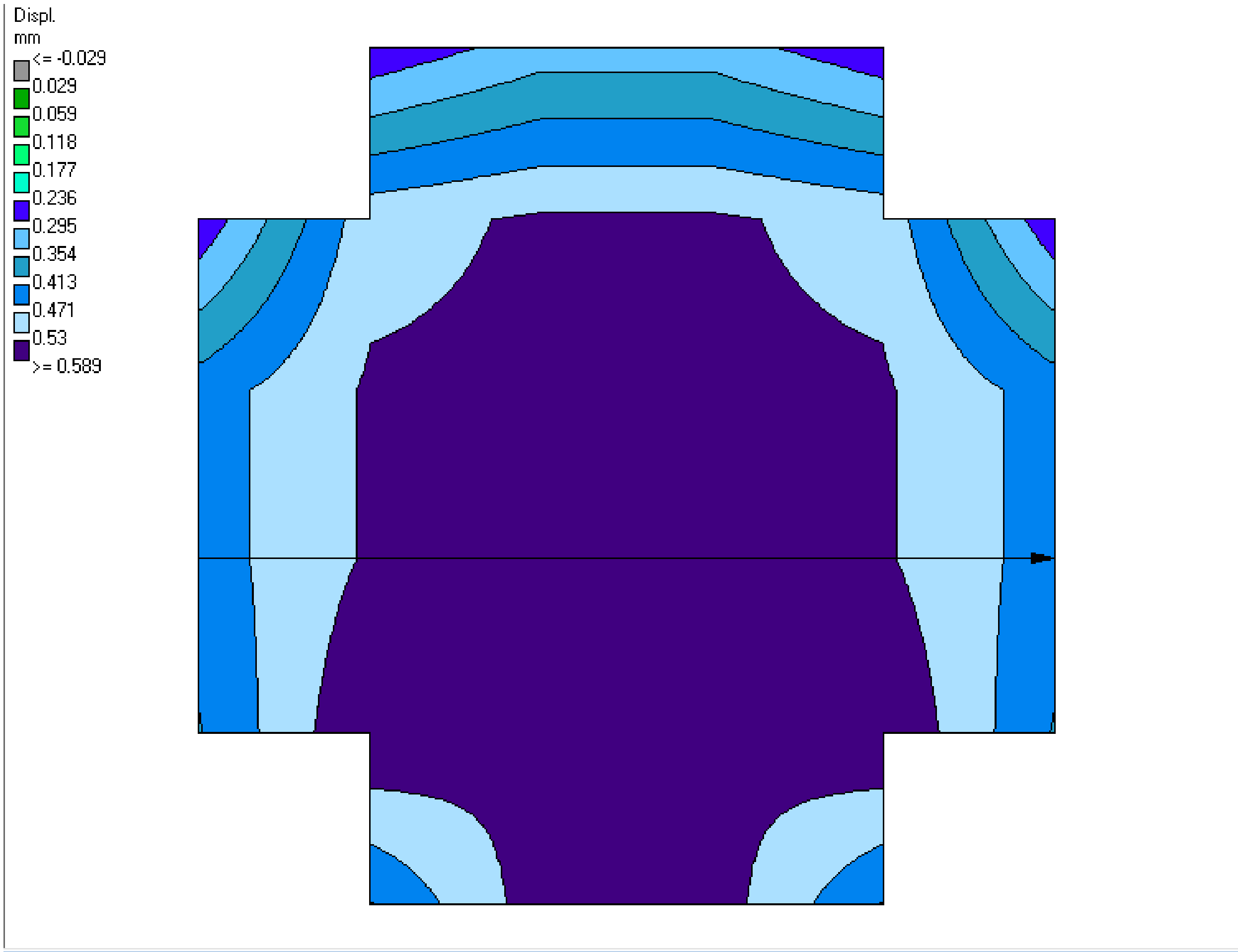


Fig. 4.8.1 Showing Displacement Contour

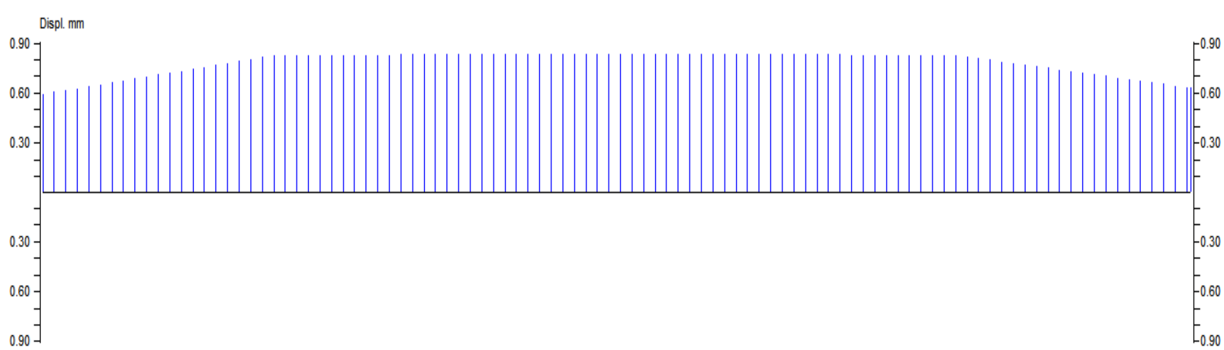


Fig. 4.8.2 Result line graph showing displacement over the span

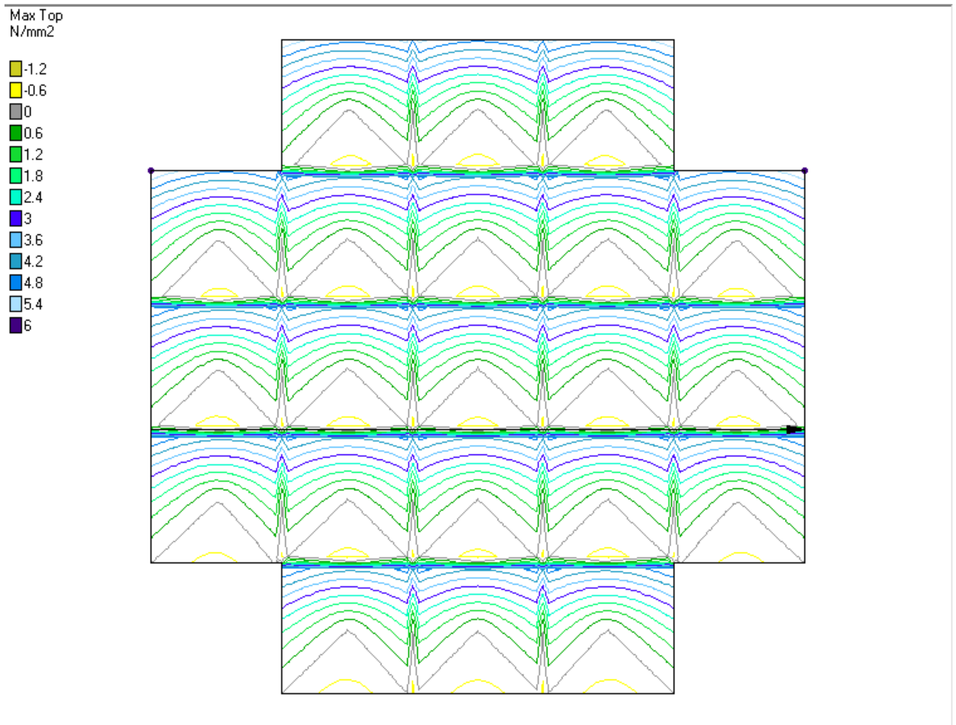


Fig. 4.8.3 Principal Major Stress (Top Reinforcement)

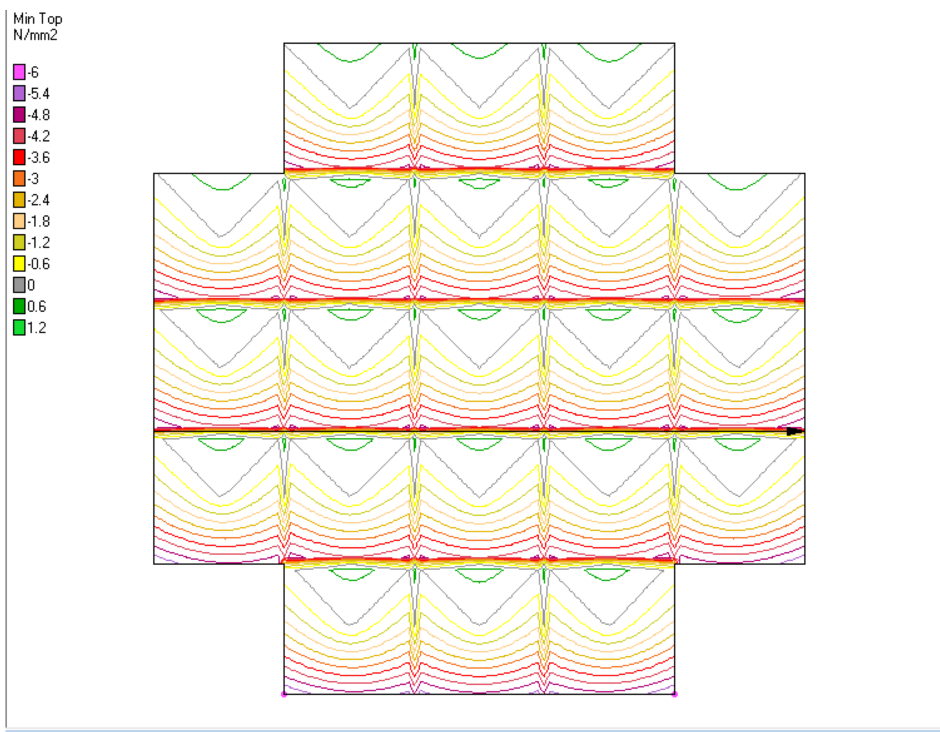


Fig. 4.8.4 Principal Minor Stress (Top Reinforcement)

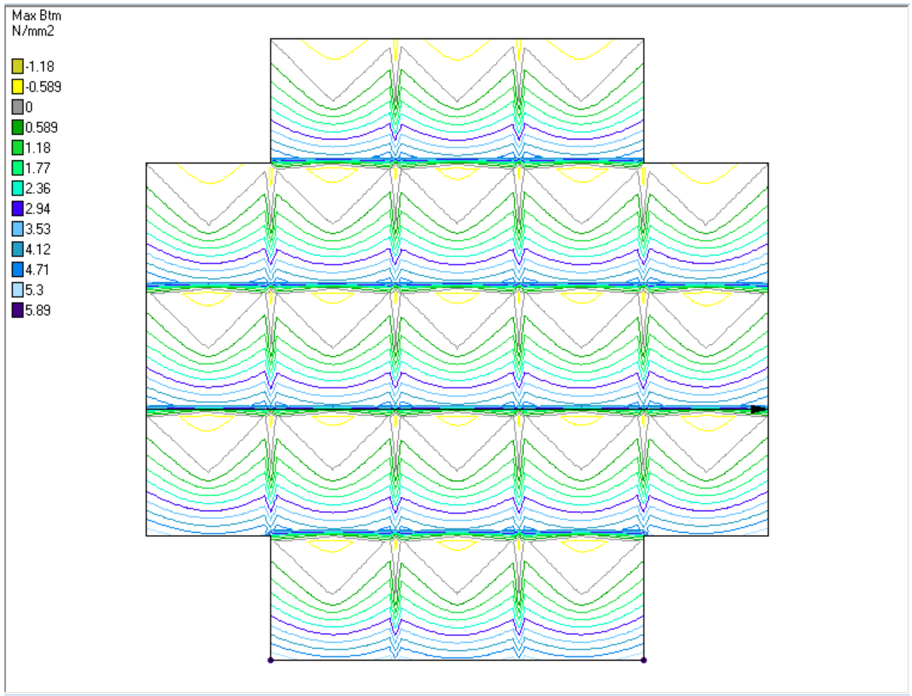


Fig. 4.8.5 Principal Major Stress (Bottom reinforcement)

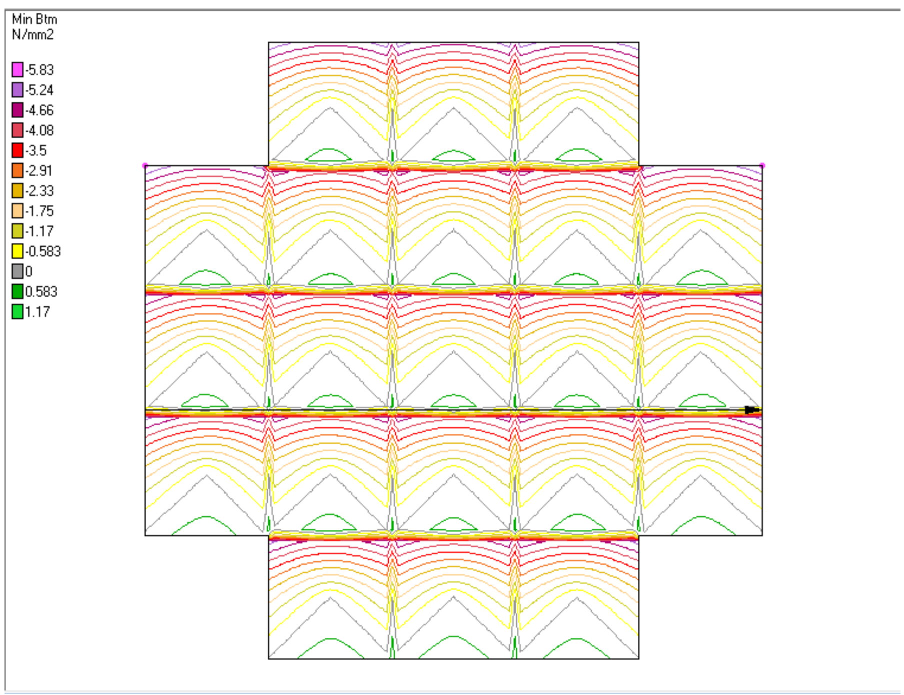


Fig. 4.8.6 Principal Minor Stress (Bottom Reinforcement)

4.9 Foundation Design

1. Foundation Type – Isolated
2. Soil Bearing Capacity – 230 kN/m^2

4.9.1 Parameters for Design

Unit Weight of Concrete	25.00 kN/m^3
Strength of concrete	25.00 N/mm^2
Yield strength of concrete	415.00 N/mm^2
Minimum Bar Dia.	Ø12
Maximum Bar Dia.	Ø25
Minimum Bar Spacing	50.00 mm
Maximum Bar Spacing	500.00 mm

Load Combination/s- Service Stress Level	
Load Combination Number	Load Combination Title
19	DL+LL
20	DL+0.5LL+EQX
21	DL+0.5LL-EQX
22	DL+0.5LL+EQZ
23	DL+0.5LL-EQZ
Load Combination/s- Strength Level	
Load Combination Number	Load Combination Title
19	DL+LL
20	DL+0.5LL+EQX
21	DL+0.5LL-EQX
22	DL+0.5LL+EQZ
23	DL+0.5LL-EQZ

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
19	879.951	-8.592	-8.821	-8.600	8.316
20	828.023	7.556	-7.570	-7.212	-49.791
21	660.207	10.415	-4.611	-4.293	-52.564
22	827.390	-7.384	7.468	49.751	7.006
23	659.574	-4.524	10.427	52.671	4.233

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
19	879.951	-8.592	-8.821	-8.600	8.316
20	828.023	7.556	-7.570	-7.212	-49.791
21	660.207	10.415	-4.611	-4.293	-52.564
22	827.390	-7.384	7.468	49.751	7.006
23	659.574	-4.524	10.427	52.671	4.233

4.9.2 Calculations for Design

Size of Footing

Initial Length : L_o - 1.00 m

Initial Width : W_o - 1.00 m

Initial length and width area : A_o - $L_o * W_o = 1.00\ m^2$

Min. required area for bearing pressure : A_{min} - P/q max = 3.859 m^2

Final dimensions for design

Length, L_2 -	3.35	m	Governing Load Case : 20
Width, W_2 -	3.35	m	Governing Load Case : 20
Area, A_2 -	11.223	m^2	

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
19	1592.566	6.995	7.570	2779.248
20	41.539	6.994	7.569	42.351
21	33.945	5.955	6.270	34.507
22	1665.358	7.854	8.703	2933.068
23	1723.520	6.667	7.154	2850.872

Critical load case and the governing factor of safety for overturning and sliding

Critical Load Case for Sliding along X-Direction :	21
Governing Disturbing Force :	20.623 kN
Governing Restoring Force :	700.039 kN
Minimum Sliding Ratio for the Critical Load Case :	33.945 kN
Critical Load Case for Overturning about X-Direction :	21
Governing Overturning Moment :	-374.045 kNm
Governing Resisting Moment :	2345.088 kNm
Minimum Overturning Ratio for the Critical Load Case :	6.270

Critical load case and the governing factor of safety for overturning and sliding

Critical Load Case for Sliding along Z-Direction :	21
Governing Disturbing Force :	-117.561 kN
Governing Restoring Force :	700.039 kN
Minimum Sliding Ratio for the Critical Load Case :	5.955
Critical Load Case for Overturning about Z-Direction :	21
Governing Overturning Moment :	-67.960 kNm
Governing Resisting Moment :	2345.088 kNm
Minimum Overturning Ratio for the Critical Load Case :	34.507

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case	**= #20**		
Effective Depth =	$D - (cc + 0.5 \times d_b)$	= 0.449	m
Effective End Depth =	Initial End Depth - $D - (cc + 0.5 \times d_b)$	= 0.256	m
Effective Width of Equivalent Rectangle =	Col. Width + (Footing Width - Col. Width)/8.0	= 0.944	m
Governing moment (M_u)		= 601.771	kNm
As Per IS 456 2000 ANNEX G G-1.1C			
Limiting Factor1 (K_{umax}) =	$\frac{700}{(1100 + 0.87 \times f_y)}$	= 0.479107	
Limiting Factor2 (R_{umax}) =	$0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$	= 3444.291146	kN/m2
Limit Moment Of Resistance (M_{umax}) =	$R_{umax} \times B \times d_e^2$	= 655.302109	kNm
M_u <= M_{umax}	hence, safe		

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case	**= #20**		
Effective Depth =	$D - (cc + 0.5 \times d_b)$	= 0.449	m
Effective End Depth		= 0.256	m
Effective Width		= 0.944	m
Governing moment (M_u) =		= 486.922	kNm
As Per IS 456 2000 ANNEX G G-1.1C			
Limiting Factor1 (K_{umax}) =	$\frac{700}{(1100 + 0.87 \times f_y)}$	= 0.479107	
Limiting Factor2 (R_{umax}) =	$0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$	= 3444.291146	kN/m2
Limit Moment Of Resistance (M_{umax}) =	$R_{umax} \times B \times d_e^2$	= 655.302109	kNm
$M_u <= M_{umax}$	hence, safe		

4.9.3 Foundation Geometry for all footings:

Table 4.9.3.1 Foundation Geometry

Footing No.	Group ID	Foundation Geometry			
-	-	Length	Width	Thickness	Slope End Thickness
2	1	2.950 m	2.950 m	0.455 m	0.212 m
3	2	3.350 m	3.350 m	0.505 m	0.312 m
4	3	3.350 m	3.350 m	0.505 m	0.312 m
5	4	3.050 m	3.050 m	0.455 m	0.262 m
43	5	2.950 m	2.950 m	0.455 m	0.212 m
44	6	3.400 m	3.400 m	0.555 m	0.312 m
45	7	3.450 m	3.450 m	0.555 m	0.312 m
46	8	3.450 m	3.450 m	0.555 m	0.312 m
47	9	3.450 m	3.450 m	0.555 m	0.362 m
48	10	3.050 m	3.050 m	0.455 m	0.262 m
85	11	3.050 m	3.050 m	0.455 m	0.262 m
86	12	3.450 m	3.450 m	0.555 m	0.312 m
87	13	3.450 m	3.450 m	0.555 m	0.312 m
88	14	3.450 m	3.450 m	0.555 m	0.312 m
89	15	3.450 m	3.450 m	0.555 m	0.312 m
90	16	3.200 m	3.200 m	0.455 m	0.262 m
127	17	3.050 m	3.050 m	0.455 m	0.262 m
128	18	3.450 m	3.450 m	0.555 m	0.312 m
129	19	3.450 m	3.450 m	0.555 m	0.312 m
130	20	3.450 m	3.450 m	0.555 m	0.312 m
131	21	3.450 m	3.450 m	0.555 m	0.312 m
132	22	3.200 m	3.200 m	0.455 m	0.262 m
169	23	2.850 m	2.850 m	0.405 m	0.162 m
170	24	3.300 m	3.300 m	0.505 m	0.312 m
171	25	3.450 m	3.450 m	0.555 m	0.312 m
172	26	3.450 m	3.450 m	0.555 m	0.312 m
173	27	3.300 m	3.300 m	0.505 m	0.312 m
174	28	2.700 m	2.700 m	0.405 m	0.212 m
212	29	2.850 m	2.850 m	0.405 m	0.162 m
213	30	2.900 m	2.900 m	0.405 m	0.212 m
214	31	2.900 m	2.900 m	0.405 m	0.212 m
215	32	2.700 m	2.700 m	0.405 m	0.212 m

4.9.4 Foundation R/F of whole building

Table 4.9.4.1 Foundation reinforcement

Footing No.	Footing Reinforcement			
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)
2	Ø12 @ 140 mm c/c	Ø12 @ 90 mm c/c	Ø12 @ 175 mm c/c	Ø12 @ 235 mm c/c
3	Ø12 @ 105 mm c/c	Ø12 @ 80 mm c/c	Ø12 @ 130 mm c/c	Ø12 @ 200 mm c/c
4	Ø12 @ 105 mm c/c	Ø12 @ 80 mm c/c	Ø12 @ 130 mm c/c	Ø12 @ 200 mm c/c
5	Ø12 @ 130 mm c/c	Ø12 @ 90 mm c/c	Ø12 @ 170 mm c/c	Ø12 @ 225 mm c/c
43	Ø12 @ 140 mm c/c	Ø12 @ 90 mm c/c	Ø12 @ 175 mm c/c	Ø12 @ 235 mm c/c
44	Ø12 @ 95 mm c/c	Ø12 @ 70 mm c/c	Ø12 @ 125 mm c/c	Ø12 @ 205 mm c/c
45	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
46	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
47	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 120 mm c/c	Ø12 @ 205 mm c/c
48	Ø12 @ 130 mm c/c	Ø12 @ 90 mm c/c	Ø12 @ 170 mm c/c	Ø12 @ 225 mm c/c
85	Ø12 @ 130 mm c/c	Ø12 @ 85 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 225 mm c/c
86	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
87	Ø12 @ 95 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
88	Ø12 @ 95 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
89	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
90	Ø12 @ 110 mm c/c	Ø12 @ 80 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 235 mm c/c
127	Ø12 @ 130 mm c/c	Ø12 @ 90 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 225 mm c/c
128	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
129	Ø12 @ 95 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
130	Ø12 @ 95 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
131	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
132	Ø12 @ 110 mm c/c	Ø12 @ 80 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 235 mm c/c
169	Ø12 @ 195 mm c/c	Ø12 @ 105 mm c/c	Ø12 @ 270 mm c/c	Ø12 @ 270 mm c/c
170	Ø12 @ 115 mm c/c	Ø12 @ 85 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 210 mm c/c
171	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
172	Ø12 @ 100 mm c/c	Ø12 @ 75 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 205 mm c/c
173	Ø12 @ 105 mm c/c	Ø12 @ 80 mm c/c	Ø12 @ 150 mm c/c	Ø12 @ 210 mm c/c
174	Ø12 @ 235 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 255 mm c/c	Ø12 @ 255 mm c/c
212	Ø12 @ 195 mm c/c	Ø12 @ 105 mm c/c	Ø12 @ 270 mm c/c	Ø12 @ 270 mm c/c
213	Ø12 @ 145 mm c/c	Ø12 @ 95 mm c/c	Ø12 @ 195 mm c/c	Ø12 @ 275 mm c/c
214	Ø12 @ 145 mm c/c	Ø12 @ 95 mm c/c	Ø12 @ 195 mm c/c	Ø12 @ 275 mm c/c
215	Ø12 @ 235 mm c/c	Ø12 @ 135 mm c/c	Ø12 @ 255 mm c/c	Ø12 @ 255 mm c/c

4.10 Cost Analysis

4.10.1 Construction cost

Table 4.10.1.1 Built-Up Area of 1 Building

Over-all Built-Up area	21824 ft^2
Ground Floor	3704 ft^2
First Floor	3624 ft^2
Second Floor	3624 ft^2
Third Floor	3624 ft^2
Fourth Floor	3624 ft^2
Fifth Floor	3624 ft^2

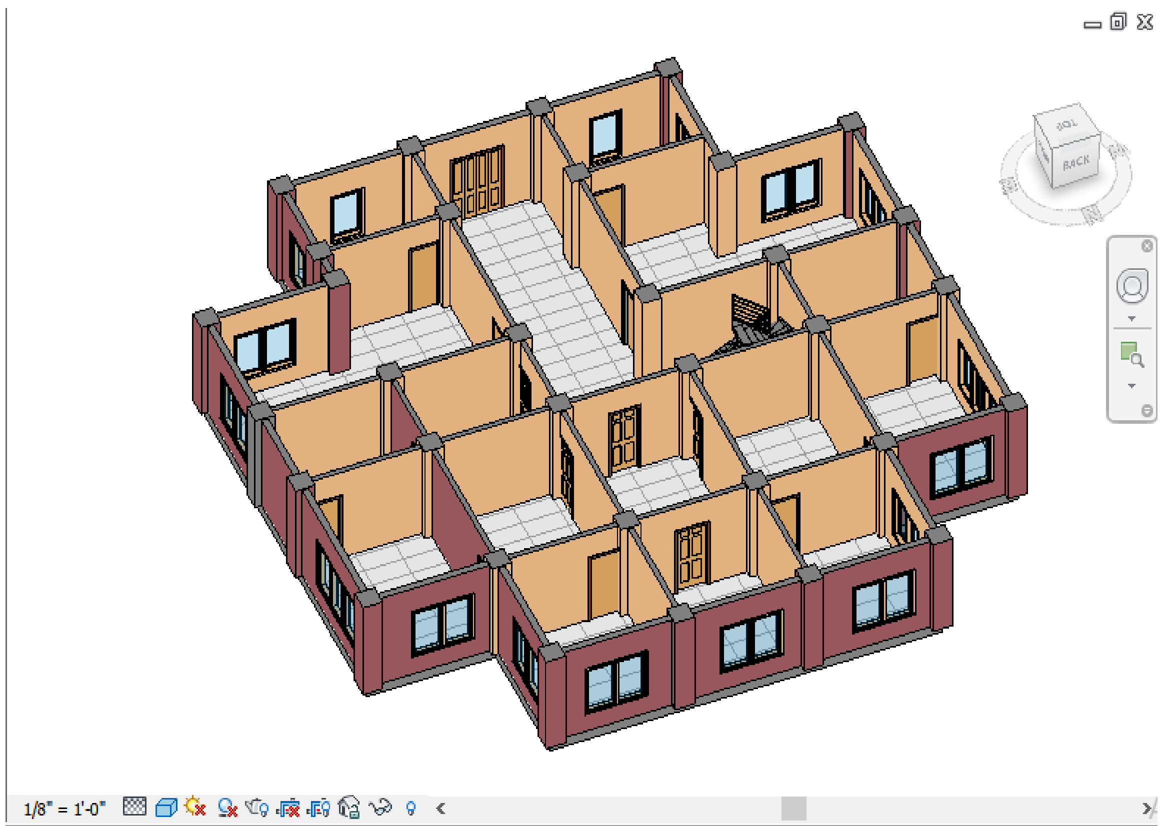


Fig. 4.10.1.1 Model of Ground floor of building

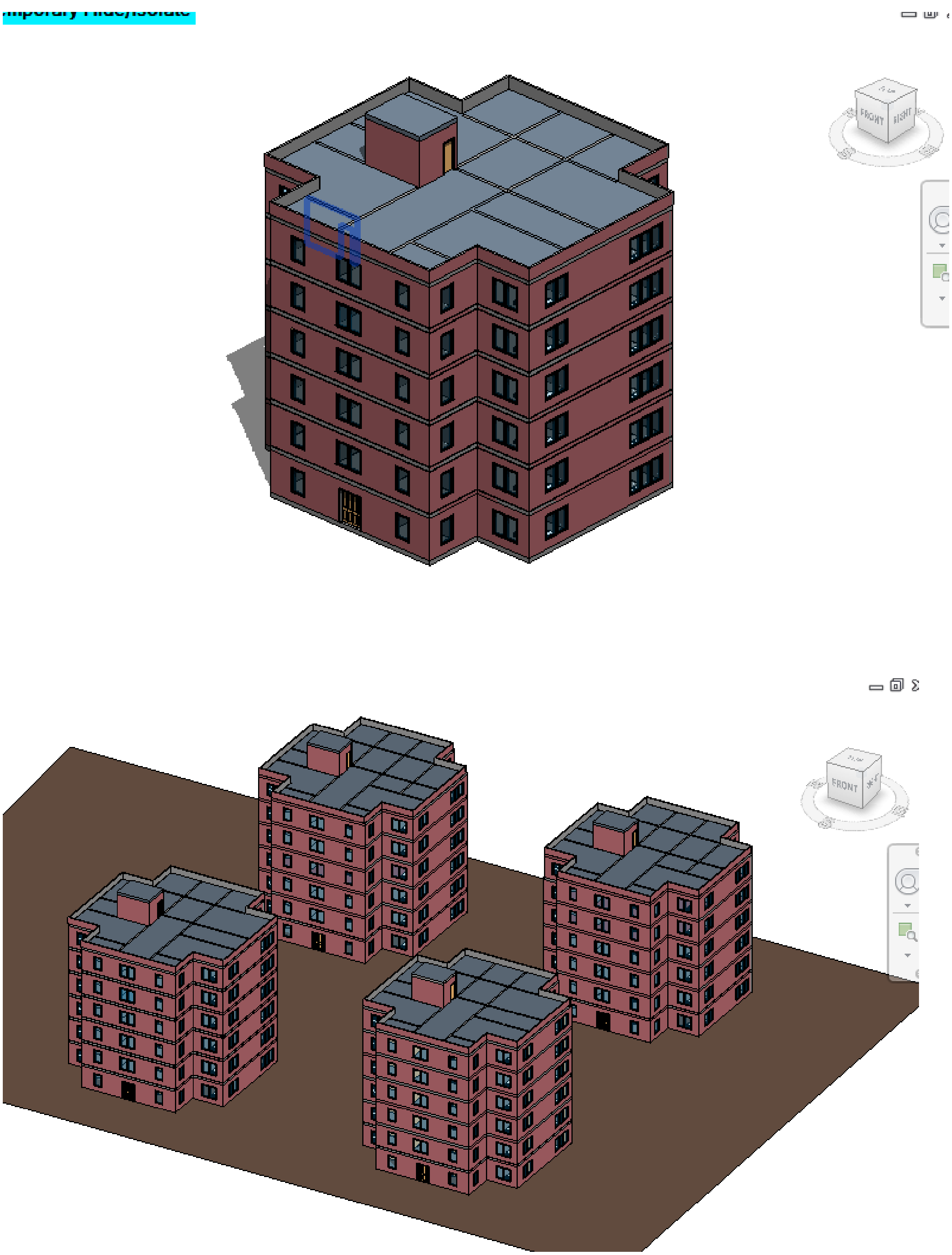


Fig. 4.10.1.2 Model of building complex

Table 4.10.1.2 Estimate of one Building

S. No.	Family & Category	Name of Material	Area of Material	Cost of Material(₹)	Overall Cost
1	Floor Tile 24*48 (Ground Floor) :1	Floor Tile 24*48	3704 SF	250	₹ 926000
2	Floor Tile 24 X 48 :5	Floor Tile 24 X 48	18120 SF	300	₹ 5436000
3	Exterior wall 8" : 108	Concrete Masonry Units	4770 SF	140	₹ 667800
4	Interior Wall 6" :162	Common Brick	7464 SF	110	₹ 821040
5	Generic Basic Roof 6" :1	Default Roof	3624 SF	300	₹ 1087200
6	Column 24" X 24" : 192	Default Wall	16512 SF	110	₹ 1816320
7	Flush Door: 34"X 84" :60	Door Frame	1380 SF	200	₹ 276000
8	Flush Door: 34"X 84" : 60	Door Panel	2700 SF	200	₹ 540000
9	Panel Door: 34" X 84" : 36	Door Frame	828 SF	280	₹ 231840
10	Panel Door: 34" X 84" : 36	Door Panel	1800 SF	280	₹ 504000
11	Glass : 192	Glass	4608 SF	90	₹ 414720
12	Sash : 96	Sash	1632 SF	180	₹ 293760
13	Trim : 96	Trim	960 SF	230	₹ 220800
				Total	₹ 13235480

Table 4.10.1.3 Estimate of all buildings

S. No.	Family & Category	Name of Material	Area of Material	Cost of Material(₹)	Overall Cost
1	Floor Tile 24*48 (Ground Floor) :4	Floor Tile 24*48	14816 SF	250	₹ 3704000
2	Floor Tile 24 X 48 :20	Floor Tile 24 X 48	72480 SF	300	₹ 21744000
3	Exterior wall 8" : 432	Concrete Masonry Units	19080 SF	140	₹ 2671200
4	Interior Wall 6" : 648	Common Brick	29856 SF	110	₹ 3284160
5	Generic Basic Roof 6" : 4	Default Roof	14496 SF	300	₹ 4348800
6	Column 24" X 24" : 768	Default Wall	66048 SF	110	₹ 7265280
7	Flush Door: 34"X 84" :240	Door Frame	5520 SF	200	₹ 1104000
8	Flush Door: 34"X 84" : 240	Door Panel	10800 SF	200	₹ 2160000
9	Panel Door: 34" X 84" : 144	Door Frame	3312 SF	280	₹ 927360
10	Panel Door: 34" X 84" : 144	Door Panel	7200 SF	280	₹ 2016000
11	Glass : 768	Glass	18432 SF	90	₹ 1658880
12	Sash : 384	Sash	6528 SF	180	₹ 1175040
13	Trim : 384	Trim	3840 SF	230	₹ 883200
				Total	₹ 52941920

Table 4.10.1.4 Total Constructing Cost of all Buildings

Constructing Cost	₹ 52941920
Painting cost per sq. ft.	₹ 30
Total painting cost	₹ 5545440
Total constructing cost	₹ 58487360
1% of total cost (Tools & Tackles)	₹ 584873.60
2% of total cost (Water Charges)	₹ 1169747.20
5% of total cost (Sanitary fittings)	₹ 2924368
10% of total cost (Contractor's Profit)	₹ 5848736
30% of total cost17546208 (Labor charges)	₹ 17546208
Total Construction Cost of whole Project	₹ 86561292.8

CHAPTER 5

CONCLUSION

5.1 General

STAAD PRO gives us reinforcement requirement for concrete members and the project contains many members all designed as per IS: 456 (2000).

1. Max. Hogging and sagging moments are calculated for the design load and other active load cases. And every section is designed to resist the critical hogging and sagging moment.
2. Shear R/F is calculated to resist both S.F & torsional moments.

   2.1 Max. Deflection at different nodes < 30 mm.

   2.2 In shear & flexure structural components are safe of the building.

3. Increment in the quantity of analysis tools is an indication to the expanding significance of manageable plan in engineering and the need to enhance building execution is appropriate for conveying the sort of data that can be utilized to improve plan and building execution. REVIT arch. Systematizes the hard work of activities like Material Takeoff, Schedule/Quantities etc. whilst taking and coordinating data in the documents set.

   Total Construction Cost of whole Project = ₹ 86561292.8

   Total Project Duration = 524 days

4. Construction of structure utilizing Traditional path ends up being uneconomical and expends additional time with numerous complexibility and gigantic mistake which affects actual execution of the Project. Customary way for planning doesn't sub separate the primary task like over allocation of assets, inappropriate judgment of assets for specific activities and so forth.

5.2 Future Scope

An effective construction project management must have varied plans & advanced concepts to benefit in advancing and managing numerous projects. It offers the basis for a career path in the construction industry and offers a good understanding of the theoretic ideas of construction practices.

And since technology is changing always and advancing similarly it is changing in the architecture, civil engineering or design field also. And since software play a very major role so having good knowledge of software like AutoCAD, STAAD Pro, 3ds Max, Revit, Primavera, Rhino etc. can help in a great way.

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APPENDIX A

A.1 STAAD INPUT FILE

STAAD SPACE

START JOB INFORMATION

ENGINEER DATE 10-Feb-19

END JOB INFORMATION

INPUT WIDTH 79

SET PRINT 5

UNIT METER KN

JOINT COORDINATES

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9 7.94505 3 0; 10 11.9176 3 0; 11 15.8901 3 0; 14 3.97253 6 0; 15 7.94505 6 0;

16 11.9176 6 0; 17 15.8901 6 0; 20 3.97253 9 0; 21 7.94505 9 0; 22 11.9176 9 0;

23 15.8901 9 0; 26 3.97253 12 0; 27 7.94505 12 0; 28 11.9176 12 0;

29 15.8901 12 0; 32 3.97253 15 0; 33 7.94505 15 0; 34 11.9176 15 0;

35 15.8901 15 0; 38 3.97253 18 0; 39 7.94505 18 0; 40 11.9176 18 0;

41 15.8901 18 0; 43 0 0 3.97253; 44 3.97253 0 3.97253; 45 7.94505 0 3.97253;

46 11.9176 0 3.97253; 47 15.8901 0 3.97253; 48 19.8626 0 3.97253;

49 0 3 3.97253; 50 3.97253 3 3.97253; 51 7.94505 3 3.97253;

52 11.9176 3 3.97253; 53 15.8901 3 3.97253; 54 19.8626 3 3.97253;

55 0 6 3.97253; 56 3.97253 6 3.97253; 57 7.94505 6 3.97253;

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MEMBER INCIDENCES

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ELEMENT INCIDENCES SHELL

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698 202 203 245 244; 699 206 207 249 248; 700 207 208 250 249;
701 208 209 251 250;

ELEMENT PROPERTY

576 TO 701 THICKNESS 0.15

DEFINE MATERIAL START

ISOTROPIC CONCRETE

E 2.17184e+007

POISSON 0.17

DENSITY 23.6158

ALPHA 5e-006

DAMP 0.05

TYPE CONCRETE

STRENGTH FCU 27578.9

END DEFINE MATERIAL

MEMBER PROPERTY AMERICAN

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2 TO 4 7 TO 9 12 TO 14 17 TO 19 22 TO 24 27 TO 29 67 TO 96 133 TO 162 199 -
200 TO 228 265 TO 294 332 TO 334 337 TO 339 342 TO 344 347 TO 349 352 TO 354 -
357 TO 359 398 TO 401 404 TO 407 410 TO 413 416 TO 419 422 TO 425 -
428 TO 431 433 TO 540 542 TO 545 548 TO 551 554 TO 557 560 TO 563 -
566 TO 569 572 TO 575 PRIS YD 0.3 ZD 0.3
32 TO 35 38 TO 41 44 TO 47 50 TO 53 56 TO 59 62 TO 65 97 TO 132 163 TO 198 -
229 TO 264 295 TO 330 362 TO 365 368 TO 371 374 TO 377 380 TO 383 -
386 TO 389 392 TO 395 PRIS YD 0.6 ZD 0.6
CONSTANTS
BETA 90 MEMB 166
MATERIAL CONCRETE ALL
SUPPORTS
2 TO 5 43 TO 48 85 TO 90 127 TO 132 169 TO 174 212 TO 215 FIXED
DEFINE 1893 LOAD
ZONE 0.075 RF 5 I 1 SS 2 ST 1 DM 0.05
SELFWEIGHT 1
FLOOR WEIGHT
YRANGE 3 18 FLOAD 3.75
YRANGE 3 15 FLOAD 2
MEMBER WEIGHT
2 TO 4 7 TO 9 12 TO 14 17 TO 19 22 TO 24 67 71 72 76 77 81 82 86 87 91 265 -
269 270 274 275 279 280 284 285 289 332 TO 334 337 TO 339 342 TO 344 347 -
348 TO 349 352 TO 354 398 401 404 407 410 413 416 419 422 425 433 438 439 -
444 445 450 451 456 457 462 469 474 475 480 481 486 487 492 493 498 505 510 -
511 516 517 522 523 528 529 534 542 545 548 551 554 557 560 563 566 -
569 UNI 19.15
27 TO 29 92 96 290 294 357 TO 359 428 431 463 468 499 504 535 540 572 575 UNI 8
68 TO 70 73 TO 75 78 TO 80 83 TO 85 88 TO 90 93 TO 95 133 TO 162 199 TO 228 -
266 TO 268 271 TO 273 276 TO 278 281 TO 283 286 TO 288 291 TO 293 399 400 -
405 406 411 412 417 418 423 424 429 430 434 TO 437 440 TO 443 446 TO 449 -
452 TO 455 458 TO 461 464 TO 467 470 TO 473 476 TO 479 482 TO 485 -
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488 TO 491 494 TO 497 500 TO 503 506 TO 509 512 TO 515 518 TO 521 -
524 TO 527 530 TO 533 536 TO 539 543 544 549 550 555 556 561 562 567 568 -
573 574 UNI 11.8
DEFINE WIND LOAD
TYPE 1 WIND 1
INT 0.75 0.9 0.99 1.1 1.25 1.37 HEIG 3 6 9 12 15 18
EXP 1 JOINT 2 TO 5 8 TO 11 14 TO 17 20 TO 23 26 TO 29 32 TO 35 38 TO 41 43 -
44 TO 210 212 TO 215 218 TO 221 224 TO 227 230 TO 233 236 TO 239 242 TO 245 -
248 TO 251
LOAD 1 LOADTYPE Seismic TITLE EQX
1893 LOAD X 1
LOAD 2 LOADTYPE Seismic TITLE EQZ
1893 LOAD Z 1
LOAD 3 LOADTYPE Dead TITLE DL
SELFWEIGHT Y -1
FLOOR LOAD
YRANGE 3 18 FLOAD -3.75 GY
MEMBER LOAD
2 TO 4 7 TO 9 12 TO 14 17 TO 19 22 TO 24 67 71 72 76 77 81 82 86 87 91 265 -
269 270 274 275 279 280 284 285 289 332 TO 334 337 TO 339 342 TO 344 347 -
348 TO 349 352 TO 354 398 401 404 407 410 413 416 419 422 425 433 438 439 -
444 445 450 451 456 457 462 469 474 475 480 481 486 487 492 493 498 505 510 -
511 516 517 522 523 528 529 534 542 545 548 551 554 557 560 563 566 -
569 UNI GY -19.15
27 TO 29 92 96 290 294 357 TO 359 428 431 463 468 499 504 535 540 572 -
575 UNI GY -8
68 TO 70 73 TO 75 78 TO 80 83 TO 85 88 TO 90 93 TO 95 133 TO 162 199 TO 228 -
266 TO 268 271 TO 273 276 TO 278 281 TO 283 286 TO 288 291 TO 293 399 400 -
405 406 411 412 417 418 423 424 429 430 434 TO 437 440 TO 443 446 TO 449 -
452 TO 455 458 TO 461 464 TO 467 470 TO 473 476 TO 479 482 TO 485 -
488 TO 491 494 TO 497 500 TO 503 506 TO 509 512 TO 515 518 TO 521 -

524 TO 527 530 TO 533 536 TO 539 543 544 549 550 555 556 561 562 567 568 -

573 574 UNI GY -11.8

ELEMENT LOAD

576 TO 701 PR LY -2

LOAD 4 LOADTYPE Live REDUCIBLE TITLE LL

FLOOR LOAD

YRANGE 3 15 FLOAD -4 GY

LOAD 5 LOADTYPE Roof Live REDUCIBLE TITLE RLL

FLOOR LOAD

YRANGE 16 18 FLOAD -2 GY

LOAD 6 LOADTYPE Wind TITLE WL X

WIND LOAD X 1 TYPE 1 YR 3 18

LOAD 7 LOADTYPE Wind TITLE WL -X

WIND LOAD X -1 TYPE 1 YR 3 18

LOAD 8 LOADTYPE Wind TITLE WL Z

WIND LOAD Z 1 TYPE 1 YR 3 18

LOAD 9 LOADTYPE Wind TITLE WL -Z

WIND LOAD Z -1 TYPE 1 YR 3 18

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***Load Combination for frame design

LOAD COMB 11 1.2(DL+LL+EQX)

1 1.2 3 1.2 4 1.2

LOAD COMB 12 1.2(DL+LL-EQX)

1 1.2 3 1.2 4 -1.2

LOAD COMB 13 1.2(DL+LL+EQZ)

2 1.2 3 1.2 4 1.2

LOAD COMB 14 1.2(DL+LL-EQZ)

2 1.2 3 1.2 4 -1.2

LOAD COMB 19 DL+LL

3 1.0 4 1.0

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LOAD COMB 20 DL+0.5LL+EQX
1 1.0 3 1.0 4 1.0
LOAD COMB 21 DL+0.5LL-EQX
1 1.0 3 1.0 4 -1.0
LOAD COMB 22 DL+0.5LL+EQZ
2 1.0 3 1.0 4 1.0
LOAD COMB 23 DL+0.5LL-EQZ
2 1.0 3 1.0 4 -1.0
PERFORM ANALYSIS
START CONCRETE DESIGN
CODE INDIAN
FC 25000 ALL
FYMAIN 415000 ALL
DESIGN BEAM 2 TO 4 7 TO 9 12 TO 14 17 TO 19 22 TO 24 27 TO 29 67 TO 96 133 -
134 TO 162 199 TO 228 265 TO 294 332 TO 334 337 TO 339 342 TO 344 347 TO 349 -
352 TO 354 357 TO 359 398 TO 401 404 TO 407 410 TO 413 416 TO 419 -
422 TO 425 428 TO 431 433 TO 540 542 TO 545 548 TO 551 554 TO 557 -
560 TO 563 566 TO 569 572 TO 575
DESIGN COLUMN 32 TO 35 38 TO 41 44 TO 47 50 TO 53 56 TO 59 62 TO 65 -
97 TO 132 163 TO 198 229 TO 264 295 TO 330 362 TO 365 368 TO 371 374 TO 377 -
380 TO 383 386 TO 389 392 TO 395
DESIGN ELEMENT 576 TO 701
CONCRETE TAKE
FYSEC 415000 ALL
MAXMAIN 16 ALL
MAXSEC 10 ALL
START BAR COMBINATION
MD1 10 ALL
MD2 12 ALL
END BAR COMBINATION
MINMAIN 12 ALL
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MINSEC 8 ALL
RATIO 4 ALL
REINF 0 ALL
END CONCRETE DESIGN
PERFORM ANALYSIS
FINISH
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