ARCHITECTURAL, STRUCTURAL DESIGNS AND QUANTITIES ESTIMATION OF NEW TECHNICAL CADETS BLOCK

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This is to certify that the

Project titled

Architectural, Structural Designs And Quantities Estimation Of Technical Cadets Block

Submitted by

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Has been accepted towards the partial fulfillment

of the requirements for the degree

of

Bachelor of Engineering in Civil Engineering

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DEDICATED

TO

OUR PARENTS AND PAKISTAN ARMY.

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All thanks and praises to Allah Almighty.

We bow our heads with all humility before God for giving opportunity to complete our research work .Completion of this thesis is the result of cooperation of many dedicated and helpful people. It is difficult to gauge their contribution in helping us to complete this research work.

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LIST OF ABBREVIATIONS

ACI	American concrete institute
E_C	Elastic modulus of Concrete
F'_c	Compressive strength of concrete
F_y	Yield strength of steel
Psi	Pound per square inch
CP	Cement plaster
FF	Finish Floor
k-ft	kips feet

ABSTRACT

Technical Cadets Block of Military College of Engineering Risalpur; home to twenty-five Cadet Engineering Degrees was constructed in 1966. The masonry structure of the block has completed its design life and is now facing severe structural failure despite regular maintenance over the years. The emergence of cracks in the walls and roof slabs, spalling of concrete cover in the slabs and seepage of water through the walls are some of the main evidences of the structural failure. The block being home to a hundred potential officers of Pakistan Army demands an immediate reconstruction of the block in line with the international standards and building code. This project hence focuses on the Architectural and Structural Design of a new Technical Cadets Block with the former being based on Modern Architectural Design Theory of "*Less is More*" while the latter based on the *American Concrete Institute Code 318-08*. The existence of Mosque, Gymnasium, Lawns, and Stationary Shop epitomizes the Architectural Design Concept. The structural design of the block is carried out as a frame structure in *ETABS*™ and supplemented with manual calculations. A Bill of Quantities has been drafted for the project using *Military Engineering Services Schedule of Rates* in order to ascertain the cost of the project. Furthermore, a Project Management Plan drawn up using PRIMAVERA™ has been augmented with the project in order to enable the project managers to make informed decisions and develop working strategies. The project is executed with the hope of securing a better future for the Technical Cadets and providing them a firm base for personal development.

Chapter 1

INTRODUCTION

1.1 BACKGROUND

Technical cadet's block is situated in Risalpur cantonment. Currently the situation of block architecturally and structurally is not up to the engineering standards because of spalling of concrete from the slab, cracks in the wall as well as in the slabs, bond breakage between steel and concrete and due to presence of porous cement spalling of white wash also occurred. So in this regard we have opted a project to re-design the block architecturally and structurally. Recently occurred earthquake had a significant effect on the condition of block which caused separation cracks and other structural failures. This accommodation was basically used by the officers as BOQs but after the starting of Technical Graduate Course this was given to the cadets. Till now total 25 TGC courses have been passed this place. Significant changes have been occurred in this block due to natural calamity like earthquake. Recently one year back the road was constructed in the block; this was the one of the main reason of sudden structural changes in the block because once compaction in the block was being done by the compacting rollers, then by its vibrating effects the major changes occurred significantly and suddenly.

1.2 PROBLEM STATEMENT

The current accommodation for the Technical Cadets at Military College of Engineering is overdue its design life and has undergone structural failure. The accommodation is no longer capable of providing the serviceability requirements. Hence there is an urgent need for designing a new Technical Cadets block equipped with state-of-the-art and latest design features.

1.3 SCOPE

In order to accomplish the above mentioned objectives the comprehensive proceeding plan is made to cover the all of aspects of project.The proposed tasks are briefly described below:

- Auto- CAD 2014 will be used to make all the drawings.
- To extract all the data for design purpose we will use ACI 318-08.
- Preparation of 3-D model by Google Sketch up.
- Rendering of 3-D model will be done by the software LUMION.
- Carry out analysis and design of frame structures in ETABS.
- Perform manual calculations for brick masonry by moment coefficient method.
- Extracting the best possible structural and architectural combination to make an effective Plan.

1.4 OBJECTIVES

Now considering the above mentioned facts we have decided to re-design the block to provide all the needs which is being required by the inhabitants of this block. We propose to design the block of 104 x rooms having all the allied facilities that will be used by the cadets. Keeping in view all the aspects we have concluded our objectives as follow.

To carryout Architectural and structural design of block focusing on following:

- Perform 3-D modelling of designed block.
- Carry out Frame structures design by using ETABS software.
- Manually design the masonry structures of new block.
- Estimation of quantities and materials.
- To make the project management plan and scheduling of activities.

1.5 METHODOLOGY

Architecturally the block is design by making first of all a compatible 3-D model and after that by making of drawings that will include plumbing, electrification, sewage and general plans and sections of the block by using following software:

- Auto-CAD™ 2014.
- Google Sketch™ up.
- Lumion™ for rendering of 3-D model.

Structural design of the block will be comprising of two designs including frame structures and other will be brick masonry structures. We will do the frame structure design by using software ETABS and we will design the brick masonry structures by using manual calculation. The method which we are going to utilize in the composite structures would be moment co-efficient method.

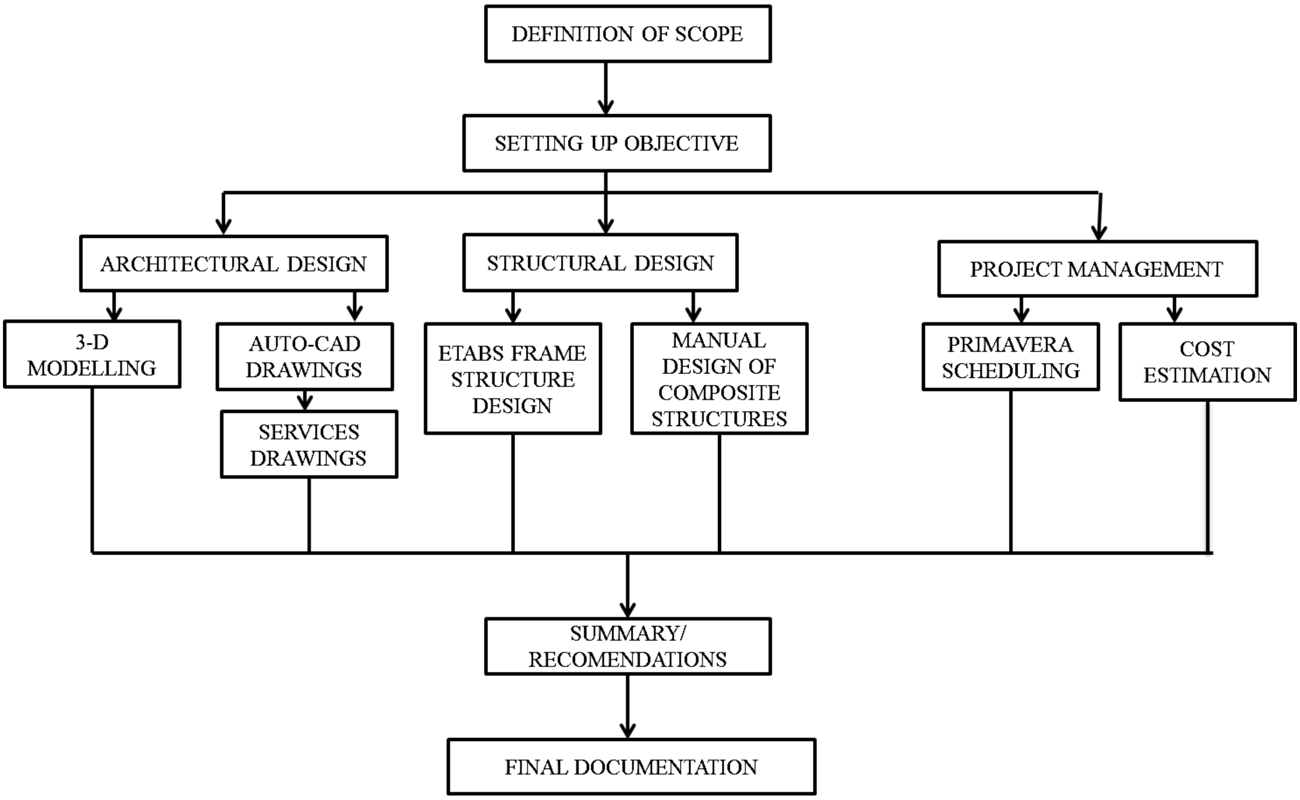

FIGURE 1.2: Methodology of project

1.6 ORGANISATION OF THESIS

Chapter 1 describes the research need and purpose, its objectives along with scope.

Chapter 2 explains the plumbing drawing, electrification drawing, sanitary fixtures and 3-D model of the block.

Chapter 3 elaborates the structural design by using ETABS software, steps involving in design. It explains shear force and bending moment requirements in beams, column and slabs. It covers reinforcement detailing in beams, column and slabs.

The *fourth Chapter*presents the manual design of brick masonry structure by designing its slab, then transfer its load to the wall and ultimately to the footing. Finally the design of footing has been done.

*Chapter 5*It shows the calculation of all quantities of materials and bill of quantities.

Chapter 6 It elaborates the project management plan, planning and scheduling of current project.

REFERENCES are augmented at after the Chapter 7.

Annex A has been attached been which will present the outputs of PRIMAVERA.

Chapter 2

ARCHITECTURAL DESIGN

2.1 GENERAL

Why do people create built environments of such elaborateness? What are the possible purposes of architecture? Its purpose goes beyond the shelter function of modifying the microclimate (Fielding, 2000). Architecture settings for certain activities, remind people of what these activities are, signify power status, or privacy , express and support cosmological beliefs, communicate information, help establish individual or group identity, and encode value systems. It can also separate domains and differentiate between here and there, sacred and profane. Men and women front and back, private and public, habitable and inhabitable, and so on. Although the differentiation among places is central, the purpose for which it is done and means employed to do it may be many.

2.2 DEFINITION

In simple words architecture is defined as an "Art" and "Science" of building construction. It is an art in the sense that everything designed in architecture should give pleasing effect to the user/observer (Lang, J. T., &Moleski, W. 2010). The spaces planned are sometimes reflecting the imagination of the designer, which is an art. For this purpose architect learn art in the universities for proper imagination and visualization spaces and the building forms. It can be said as science in the sense that there are so many mathematical calculations involved in designing, like insulation, acoustics shadows, solar energy, and spaces and standards etc.

2.3 VISULIZATION TECHNIQUES

There are some visualization techniques used in architecture to make the building more pleasing to the observer. The term beauty of aesthetics is widely used in the daily life, but the people do not understand its proper meaning, so they give comments about this term without knowing what they are saying (Kostof, S. 1995). For the proper understanding the concept of beauty, is necessary to know the basic.

Factors that its standard is changed in one’s mind, which three are basically:

- Age.
- Education level.
- Environment.

The architects, who design different buildings, should give a touch of beauty to every one regardless of his age, education level or any environment from which he belongs. Now this is important that how the touch of beauty or so called aesthetics can be given. This is only possible by those arrangements in design which provide some feelings psychology, that a person think about its order that how it is arranged. These are the visualization techniques, which are not only practiced in architecture, but in other arts also (Day, C. 2004). Some of the common visualization techniques used in the preparation of the proposed plan of the building is as following:

2.3.1 Balance

Balance is an effect of equality; it is not same as taken in the pure sciences like Two-pain balance, but a feeling that one should not feel that any element in the design is additional or missing.

2.3.2 Symmetry

Symmetry is considered as a mirror image on the other side of the common axis. It is the same meaning taken in the pure sciences and is common in the general people. Symmetry can be made with one, two, three axis.

2.3.3 Contrast

Contrast is defined as a clear difference or opposite in size, masses, volume, texture, material, and color etc.

2.3.4 Hierarchy

Hierarchy can be defined as the gradual change or different steps on some order between the two different extremes. For example, "Black" and "White" are different extremes, if, light gray, gray, and dark gray are added between black and white, it becomes hierarchy.

2.3.5 Rhythm

Rhythm is the repetition of different elements or repetition of set of elements in the buildings, the continuation of different masses, one after another like columns, doors or windows etc. is called rhythm in the form of the building.

2.4 ARCHITECTURAL PLAN OF BLOCK

2.4.1 Introduction

We have designed the block of 104 x room's capacity. There are three block in total two blocks having the capacity of 32 rooms and one block is having capacity of 40 x rooms. The block is indeed a master piece of master mind. It has state of class facilities. Having all the allied facilities of mosque, gymnasium, cafeteria and Photostat shop. The block has been designed keeping in view all the needs of cadets. And well-furnished lawn is provided for sitting purpose. And footpath of tuff tiles is provided in order to save the lawn's greenery. And fountain is provided in the middle of lawn which has the logo of corps of engineers, the emblem of pride for the cadets. Block has been designed at its best in accordance to architecture and structures. We have 1 x block of size 118'-6" x43'-6" almost 1 x kanal. Total covered area for one block of 32 x rooms = 118'-6" x 43'-6" = 5155 ft^2

For proper ventilation purpose 2x windows are provided in each room one will open in the corridor and other will open in balcony which has the sitting facility. Electric cooler facility is also provided on each floor for cool water in the summers. Fire extinguishers are very important in the building in order to reduce the fire risk. Carbon dioxide fire extinguishers are provided having capacity of 8 kg carbon dioxide placed on each floor.

As we know that for proper ventilation opening is very important so that opening is provided on all sides of room. Rooms are placed in such a way that sunlight will be minimum in summers. To reduce the effect of sunlight tree will be sown to provide the shadow. In our architectural design mosque is of 30' x30' having area 900sqft. Gym is of size 20'x20' having area 400 sq.ft. Cafeteria is in the start of block just close to the entrance of block having size of 20' x 20'.

2.4.2 Room dimensions

Room dimensions are 12' x 13'-9". It has two windows one is opening in the balcony of size 4' x 6' and having sill height 1'. So that a inhabitant will have access to the balcony as well for better architectural purposes and other is opening in corridor of size 4'x4' having sill height 3'.

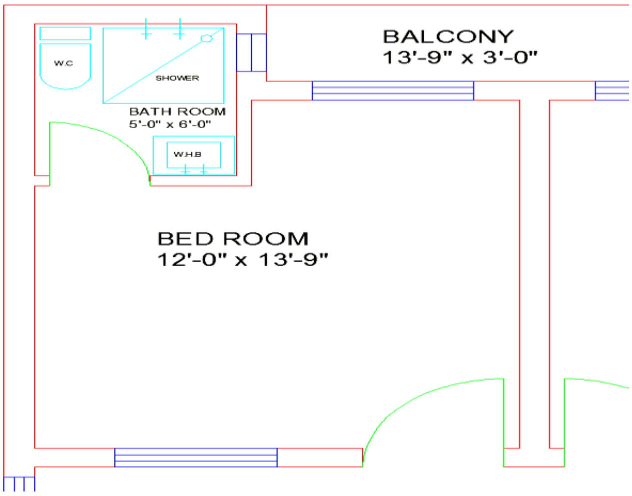

Figure 2.1: Plan of a room

2.4.3 Washroom fixtures

Washroom dimensions are 5' x 6' having area 30 sq.-ft. it has ventilator provided which has opening in balcony and having size of 2' x 2'. In bathroom care has been taken to provide every facility to the user according to their need. As shown in figure that towel rail, a mirror, hand shower, water closet and wash hand basin is provided for the ease of user. And as you can see hot and cold water line are running through the walls and geysers are provided at the end of washroom, and one geyser will be utilized by 8 rooms.

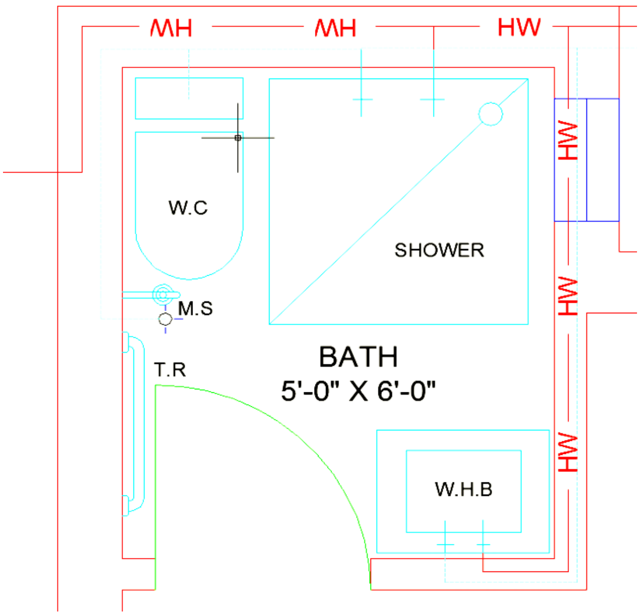

Figure 2.2: Bathroom fixtures' layout.

2.4.4 Electrification of a room

In an electrification plan of a bath room one tube light, an energy saver and exhaust fan is provided in the ventilator. While in the room a fan, 2 x tube lights, 2 x 15 ampere sockets, 2 x 5 ampere sockets an energy saver is provided. While in balcony there is balcony light is provide to facilitate the inhabitant in the night.

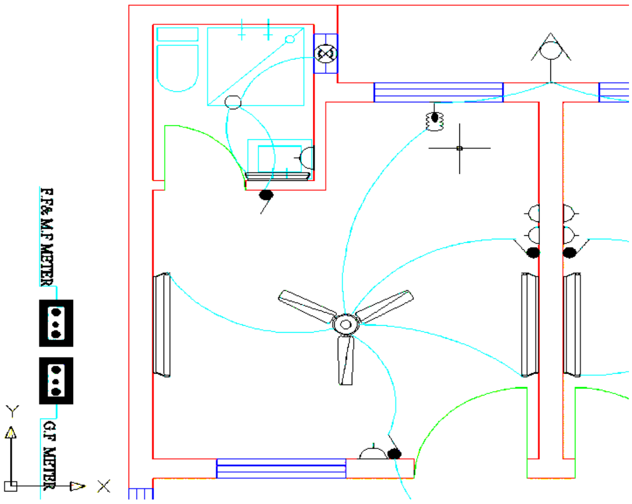

Figure 2.3: Electrification plan of room, terrace & bathroom

2.4.5 Corridor electrification

Corridor is 7’ wide and having two windows at each end and dimensions are 6 ’x 6’ and having sill height as 1’. And a water cooler is fitted in these windows to cool the corridor because of environment of Risalpur.

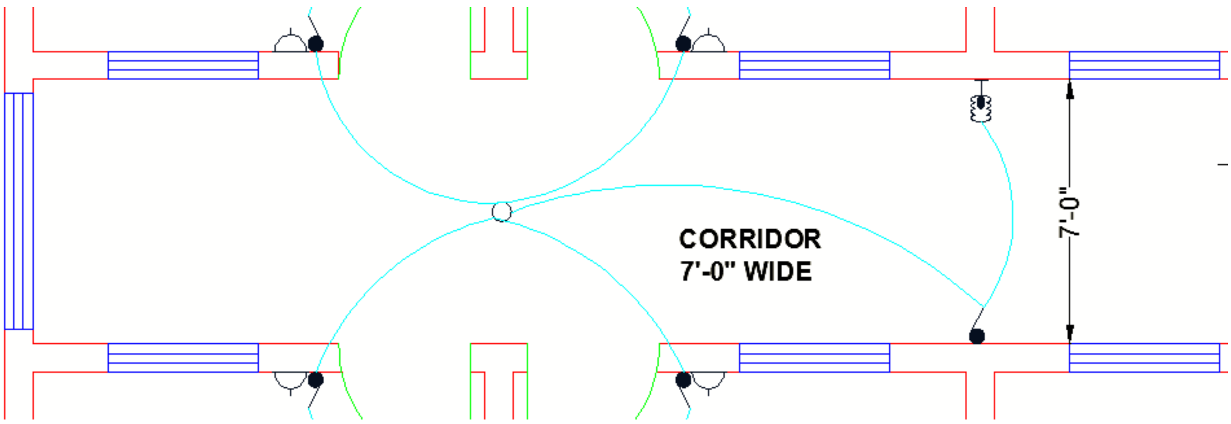

Figure 2.4: Electrification plan of a corridor

2.4.6 Electrification drawing

This is the complete electrification plan of the building comprises of area 118’-6” x 43’-6”.

Table 2.1: List of electric fixtures of block

S/No	Electric Fixtures	Quantities (each)
1	Tube lights	220
2	Energy saver	250
3	3 pin socket 5A	110
4	Fancy gate light	4
5	Ceiling Fan	110
6	Dimmer for fan	110
7	3pin 15A socket	110
8	Balcony Light	110
9	Main Distribution board	8
10	Bracket Fan	8
11	Pedestal Fan	4
12	Exhaust	110
13	Split air conditioner	4
14	Flood Lights	6
15	Electric water cooler	12

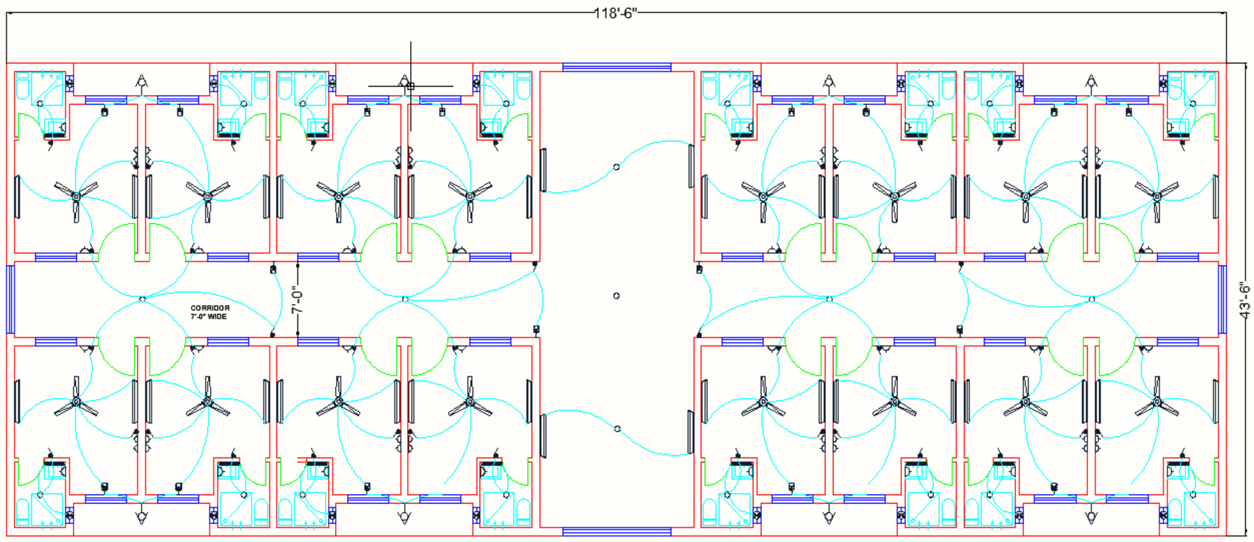

Figure 2.5: Electrification plan of block

2.4.7 Plumbing drawing

This is the complete plumbing plan of 1x block having 32 rooms.

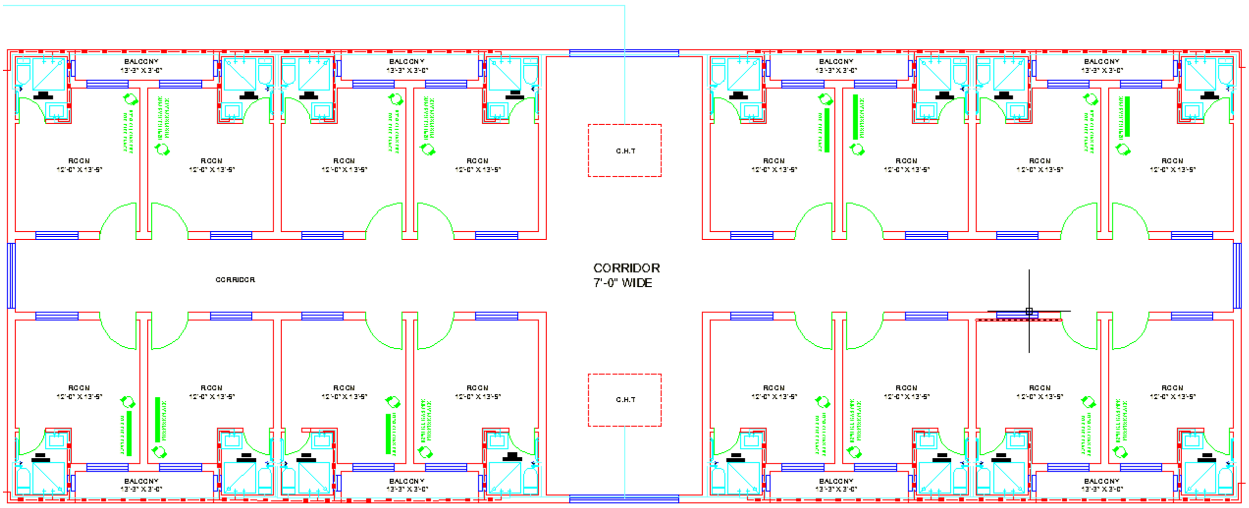

Figure2.6 Plumbing drawing of block

2.5 3-D MODELLING OF BLOCK

3-D modelling of block has been done by using software Google sketch up and after that rendering is done by LUMION render. While making the 3-d model all the facilities has been provided to make block architecturally aesthetic. In figure below the lawn is provided with the bench and beautiful fountain has been provided in the middle of the lawn. That fountain has been embedded in the logo of Corps of Engineers. Beauty of lawn is enhanced by the beautiful and colourful flowers planted in the lawn.

Figure 2.7: Corps of Engineers logo in the centre of lawn

2.6 FACILITIES PROVIDED IN THE BLOCK

Block is facilitated with the Mosque, Gymnasium and cafeteria. While entering in the block cafeteria is present to facilitate cadets. Size of cafeteria is 20’ x 20’. And in each end of the corridor is provided with the air cooler to keep the temperature of the rooms and corridor low. Furthermore all the rooms have the balcony at the outer side of the rooms which allows the inhabitants to sit in the balcony and to enjoy the weather. The most aspect of design is that blocks are mostly covered with the shades of trees; as in the hot weather of Risalpur it is very necessary to maintain the temperature of the block.

Figure2.8: 3-D views of block

2.7 SUMMARY

The architectural design of block has been made to cater all the climatic issues of Risalpur. All of the architectural aspects are covered to provide a feasible and healthy design.

Chapter 3

DESIGN OF FRAME STRUCTURES BY USING ETABS

3.1 INTRODUCTION

ETABS stands for “Extended 3-D analysis of building systems”. This software is based on finite element modelling. In which it assign, analyse and design the elements. And ultimately by designing the element it design the structures ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS 2013 features an intuitive and powerful graphical interface coupled with unmatched modelling, analytical, design, and detailing procedures, all integrated using a common database (HassanienSerror, M et.al 2008). Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviours, making it the tool of choice for structural engineers in the building industry. Following are the steps to while proceeding to design of structures.

- Modelling
- Properties assigning
- Loading
- Design

In this Step, the story height and girds are set. Then a list of sections that fit the parameters set by the architect for the design is defined. The New Model Quick Templates form is used to specify horizontal grid line spacing, story data, and template models. Template models provide a quick, easy way of starting a model. They automatically add structural objects with appropriate properties to the model. We highly recommend that you start your models using templates when- ever possible.

3.2 PROCEDURE

3.2.1 Define load cases

- Define static load cases.
- Type load name.
- Set weight multiplier.

- Select all slabs and assign them loads uniformly.

3.2.2 Analyse and design

- Run analysis.
- Check all the frames and sections.
- Start design checks.
- Start detailing to get all the outputs.

3.3 3-D FRAMES OF BEAMS AND COLOUMNS

This is the 3-D framework of slabs, beams and columns as shown in figure below. This is showing the different names of beams and columns and thickness of slab as 6”. As B20 it means where ever in the structures is B20 its reinforcement and size will be same. Here in B20 means beam number 20. “B” stands for beam and “C” stands for column. One block comprises of 48 columns on both floors and beams are running between every two column. Slab is resting on 4 columns, and two rooms comprises of a single slab which is resting on 4 columns. All the supports provided are fixed because these supports are economical. First of all make grids according to the requirements of your drawing. Selection or drawing of grid depends upon where you have to locate the beams and column. As we have selected the grids of size 25.5’ x 17.5’. It means we have 5 beams running in one direction. These beams will be casted continuously and monolithically with the slab. So no of grids along horizontal are 5 and number of grids along vertical are 3. So bay of 5x3 is created.

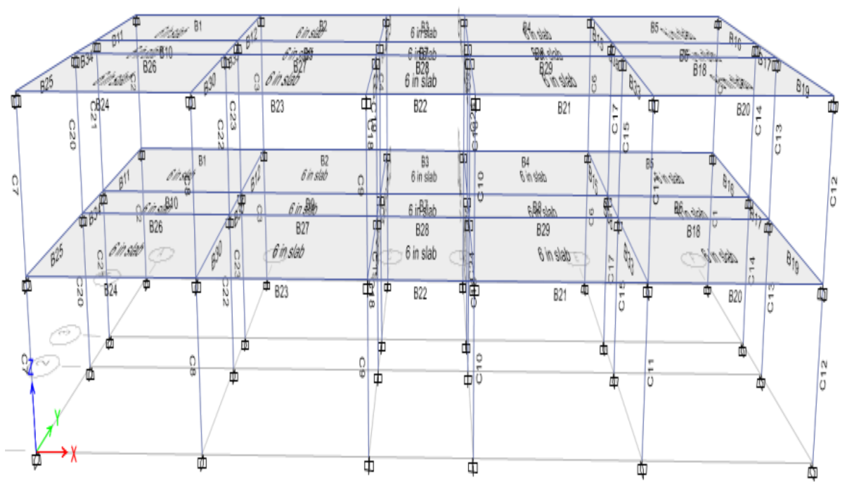

Figure 3.1: 3-D framework of beams and column

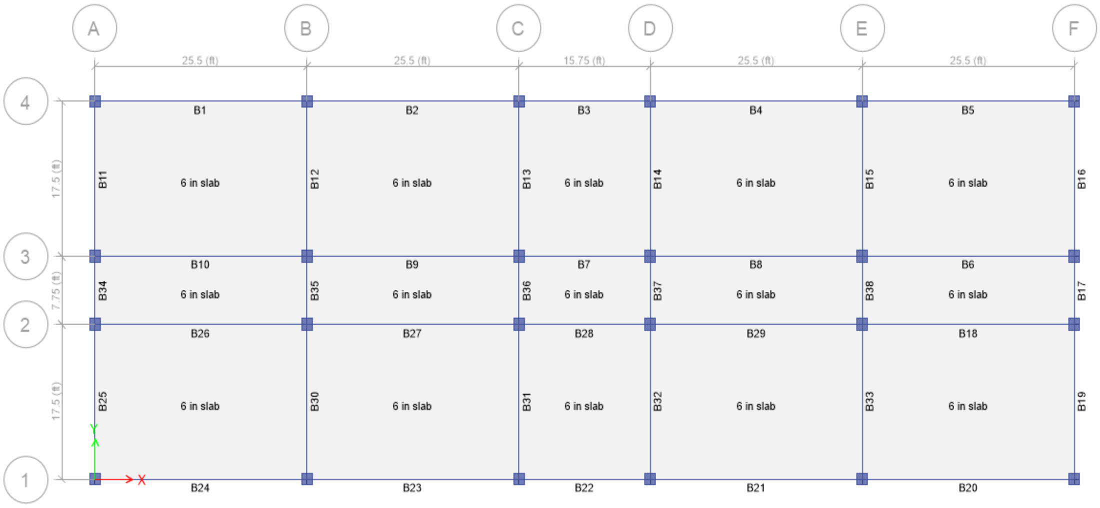

Figure 3.2: Plan of second floor slab

3.4 STEPS INVOLVED IN DESIGN

Following are the steps in proceeding of design on ETABS

3.4.1 Data input of beams

As you can see in the snapshot that we have selected concrete beam strength of beam is 4000psi and we have kept the shape of beam as rectangular. You have to assign manually the dimensions of beam and then afterwards run analysis to check it that your beam is satisfying all the checks or not, if it is not satisfying then you have to change the dimensions. In our case we have taken the dimension of beam as 14” x 18”.

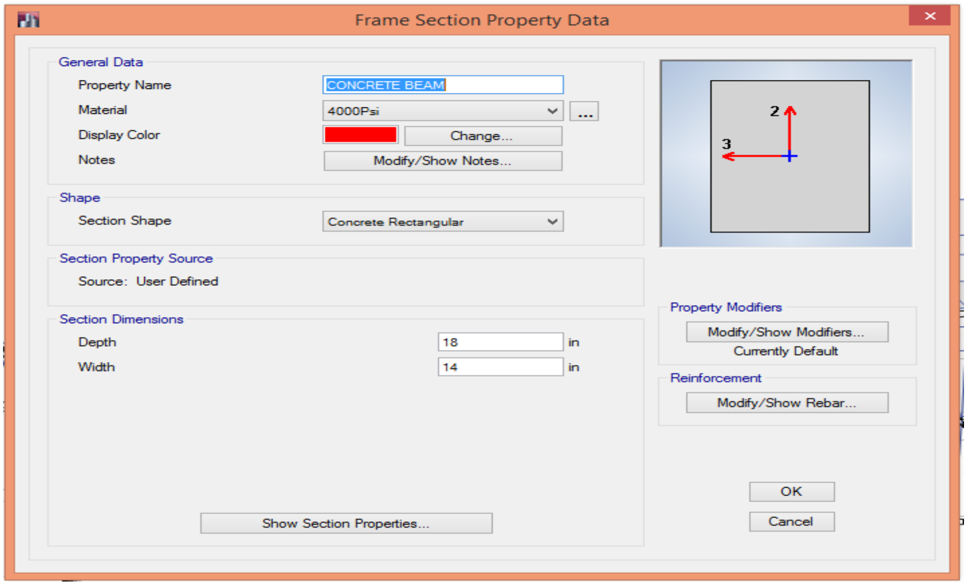

Figure 3.3: Data input of beam

3.4.2 Data inputs for columns

As shape of column is placed rectangular ant type of column is concrete. Otherwise type of column can be of steel. And strength of concrete is 4000psi. And one main thing here is placement of bars we have selected the placement as the formations of 8 bars in the columns. You can change the configuration of bars as per you requirements. And the dimension of column is kept as 16” x 14”.

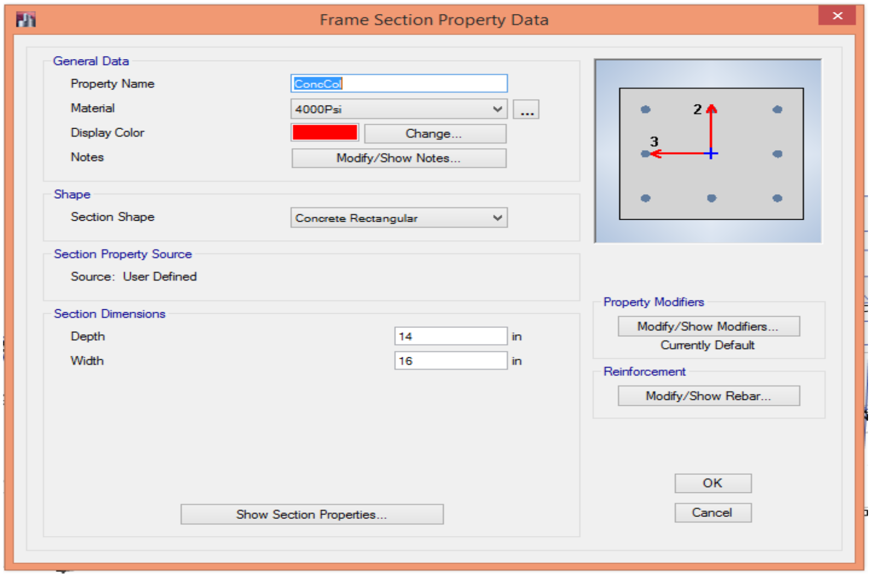

Figure 3.4: Data input of column

3.4.3 Assigning load combinations

Here you have to consider the factors for the load as we have selected dead load is factored with 1.2 and live load is factored with 1.6. We have not allowed auto combination of loads. And linear addition is selected because of linear response to structures of loadings.

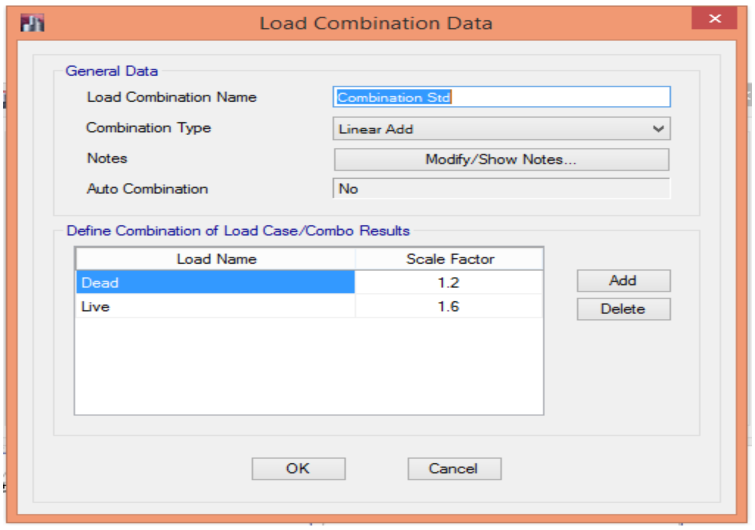

Figure 3.5: Assigning of load combinations.

3.4.4 Dead and live loads for first floor

As we know that loads on first floor are less than ground floor. So we have assigned different loads to the first floor and ground floor. We have assigned 30psf DL and 60psf live load. One thing must be kept in mind that all loads will be in gravity directions.

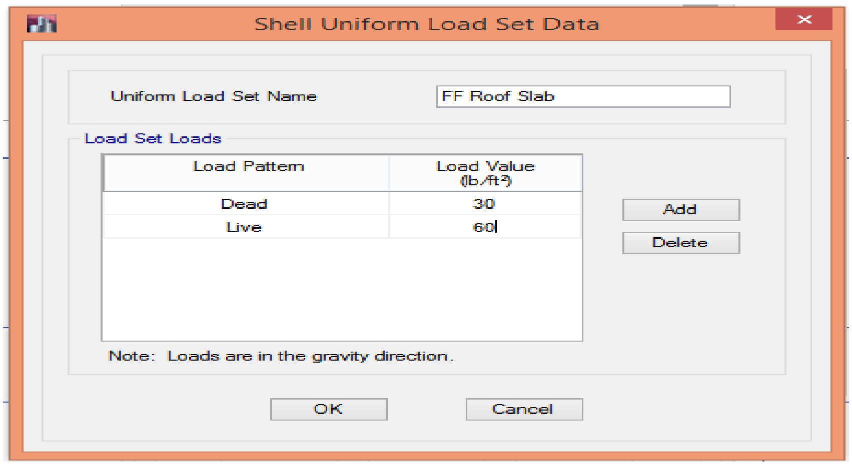

Figure 3.6: Assigning of dead loads and live loads to first floor.

3.4.5 Dead and live loads for ground floor

As loads on ground floor slabs are higher than first floor so we have assigned 50psf dead load and 80psf live load. All the loads will be in gravity direction.

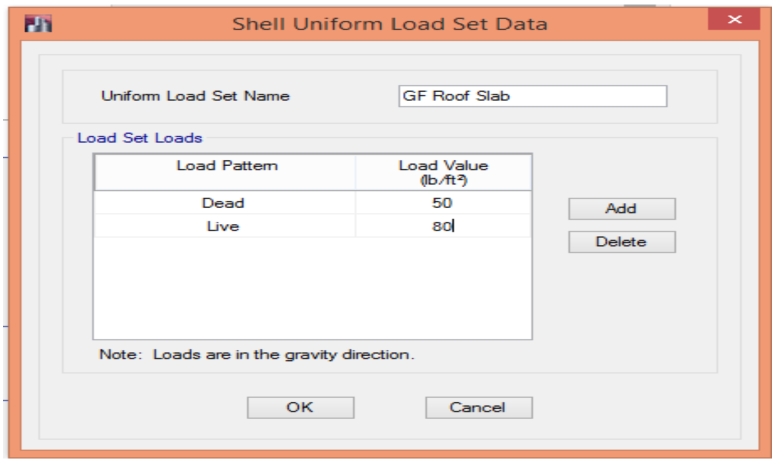

Figure 3.7: Dead and live loads for ground floor.

3.4.6 Defining the load patterns

As there is no live load related to structural element so self-weight multiplier for live load is zero while as we know that for every structural element there is self-weight which dead load is, so self-weight multiplier for dead load will be 1.

3.4.7 Assigning property to the slab

We have taken thickness of slab as 6” and similarly concrete strength will be 4000psi.

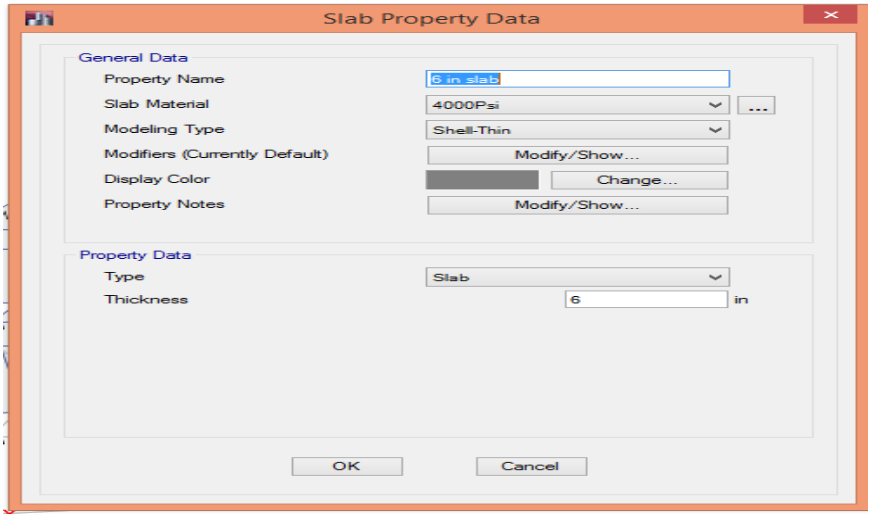

Figure 3.8: Assigning property to slab.

3.4.8 Material property for 40 grade steel

We have used grade 40- steel because it is easily available, its modulus of elasticity is 29000ksi and density is 490pcf .we can modify the properties of bar as well from here by modify design data. And grade 40-steel has greater ultimate yield strength. And on failure it gives greater reaction time for failure.

3.4.9 Material property data for concrete

Put concrete strength as 4000psi and density as 150pcf as for normal weight concrete keep the Poisson ratio 0.2.we can modify the properties of concrete at any time of analysis and design. We use Poisson ratio because ETABS works on FEM finite element modelling so in this process it needs the Poisson ration of that material to incorporate results.

3.4.10 Analysis pass bar

After providing all the details to the elements check all the frame section in your design that either they are satisfying the current loadings or not.

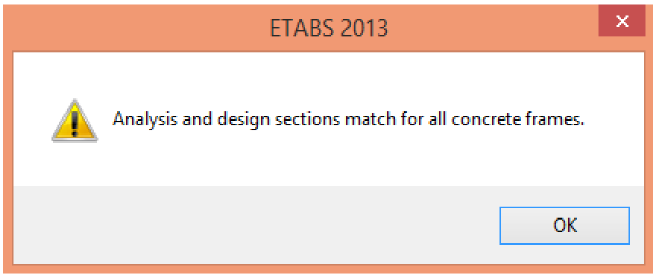

Figure 3.9: Analysis bar.

3.5 OUTPUTS FROM ETABS OF DESIGN

3.5.1 Floor framing plan

This is the flooring plan of our design in which we have divided our buildings into grids of 5 x 3. Room slab is of 25.5’ x 17.5’; which is typical two way slab. Stair hall slab is of 15.75’ x 17.5’.

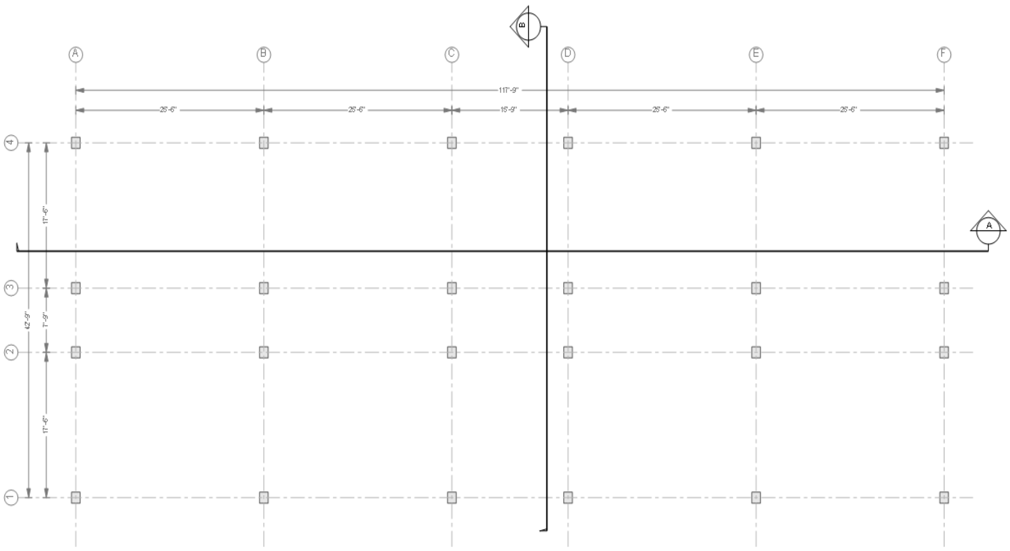

Figure 3.10: Floor faming plan, showing location of columns & beams.

We have place columns at the end of two rooms. And beams are running towards all the periphery of slab. It is a simple mechanism of transferring of loads through slab to the beams and ultimately to the columns. So in total we have provided 24 columns in one block. Each of size 16” x 14”. And beams are of size of 14” x 20”.

3.5.2 Longitudinal reinforcement along elevation 4

These are the area of steel in inch^2/ft. longitudinal reinforcement is provided at top and bottom of beam. The horizontal lines shown are beams and value written above them is area of steel of top bar or negative steel. And value written below the line is area of steel of bottom bar or positive reinforcement. If we take the one point on the beam it is showing that top bar has area 3.2637 in^2 /ft and bottom bar has area of 1.552 in^2 /ft. Maximum steel in column is at the corner column because corner column is under the eccentric loading that is 6.672in^2/ft. At ground floor columns steel is equal to 1.96 in^2/ft.

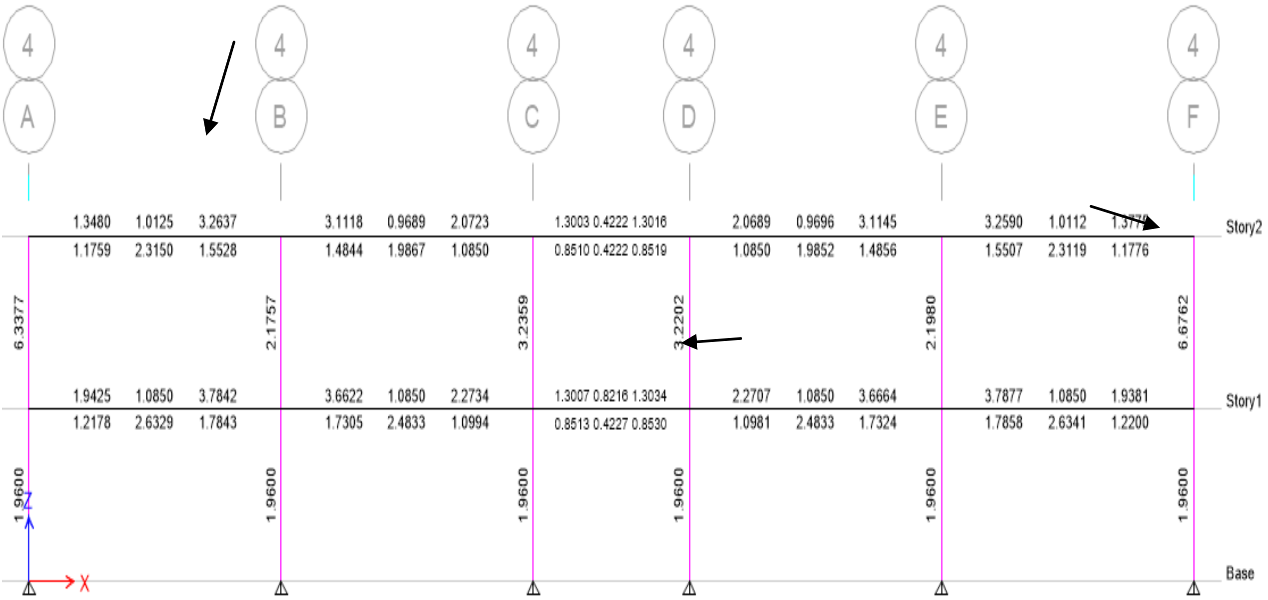

Figure 3.11: longitudinal reinforcement along elevation 4 (in^2/ft)

3.5.3 Longitudinal reinforcement along elevation-3

Given below in figure longitudinal reinforcement along elevation 3 is shown where all the values are showing area of steel at bottom and top of the beam. Maximum area for top bars in the beam is coming out to be 4.8002in^2/ft. As the beam on the first floor slab will be having more moments so that more steel will be required.

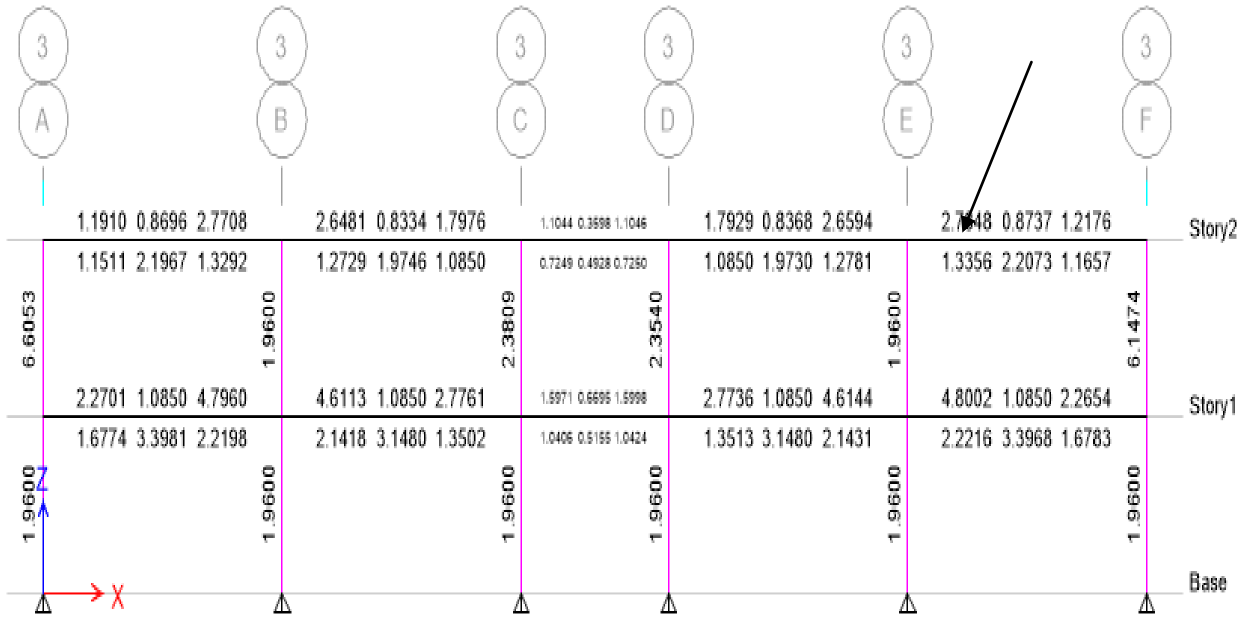

Figure 3.12: Longitudinal reinforcement along elevation 3.

3.5.4 Longitudinal reinforcement along elevation-D

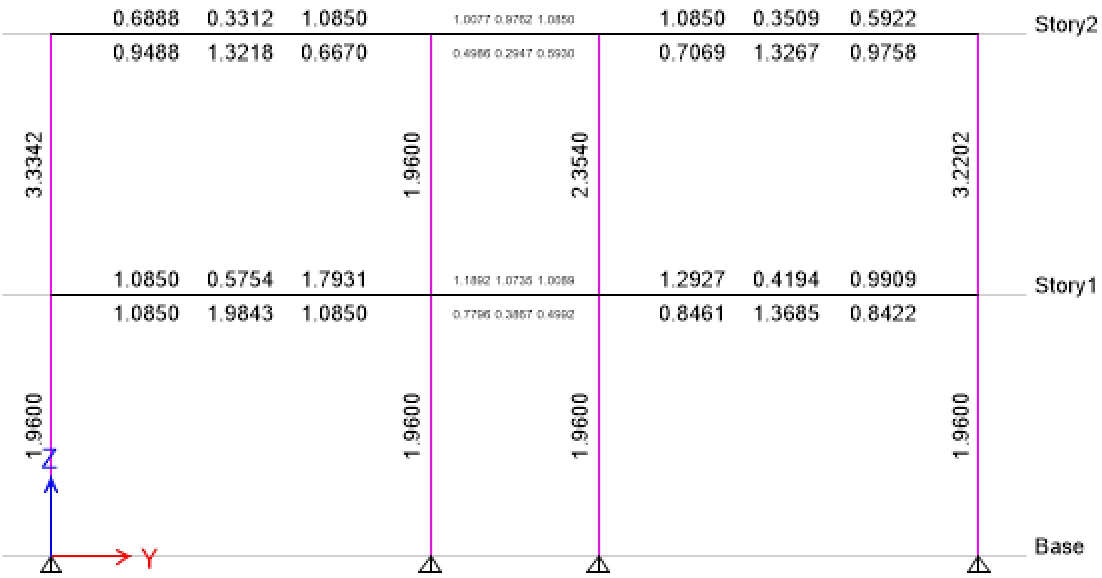

Figure 3.13: Longitudinal reinforcement along elevation-D.

In the above figure area of steel is given in beams and columns as we can see the area of steel in column of second floor is more than of column on first floor it is just because of eccentric loading and if we see a comparison between column of just one floor then we will see that corner column has area of steel greater than of interior column. Which shows that interior column is less critical than corner column because they don’t have eccentric loading.

3.6 CONCRETE BEAM REBAR TABLE

Beam size is kept as 14” x 18” as maximum number of bar used is # 6 bar and minimum no bar used is # 4 bar. No of bar is reduced according to the section requirements and load requirements. Maximum span length is of 24’-4” and minimum span length is 6’-5”. As we can see that reinforcement along zone F is maximum that is 8 #6 bars. This schedule of beam rebar tells about the bars at every vary location of beam sections. There are different span lengths while considering the section of beam. Below table shows that in different span length there is different reinforcement placed.

Table 3.1: Concrete beam reinforcement schedule

Beam ID	span length	Section		Longitudinal Bars						L1	L2
		Width(in)	Depth(in)	A	B	C	D	F	H		
3CB1	16'4"	14	18	2#6(1.59in^2)	2#6	-	-	6#6	-	4'1"	-
	8'7"	14	18	-	-	3#6	2#6	4#4	2#6	-	1'7"
	16'4"	14	18	2#8(1.60in^2)	2#6	3#6	2#6	6#6	-	4'1"	4'1"
3CB2	24'4"	14	18	3#8(2.13in^2)	2#6			8#6	-	6'1"	
	24'4"	14	18	-	-	5#6	5#6	5#6	1#6	-	6'1"
	12'7"	14	18	-	-	4#6	3#6	3#6	2#6	-	3'-7 3/4"
	24'4"	14	18	-	-	4#6	3#6	5#6	-	-	6'1"
	24'4"	14	18	3#6(2.15in^2)	2#6	5#6	5#6	6#6	-	6'1"	6'1"
2CB1	16'4"	14	18	3#6(2.03in^2)	2#6	-	-	7#6	-	4'1"	
	6'7"	14	18	-	-	4#6	3#6	3#6	2#6	-	1'-7 3/4"
	16'4"	14	18	3#6(2.07in^2)	2#6	4#6	3#6	7#6	-	4'1"	4'1"
2CB2	24'4"	14	18	4#8(3.05in^2)	3#6			10#6	-	6'1"	
	24'4"	14	18	-	-	7#6	6#6	9#6	-		6'1"
	14'7"	14	18	-	-	5#6	4#6	4#6	2#6	-	3'7 3/4"
	24'4"	14	18	-	-	5#6	4#6	9#6	-	-	6'1"
	24'4"	14	18	4#6(3.05in^2)	3#6	7#6	6#6	10#6	-	6'1"	6'1"
2CB3	24'4"	14	18	4#6(2.67)	3#6			8#6	-	6'1"	
	24'4"	14	18	--	-	6#6	5#6	8#6	-	-	6'1"
	14'7"	14	18	-	-	4#6	3#6	4#4	3#6	-	3'-7 3/4"
	24'4"	14	18			4#6	3#6	8#6	-	-	6'1"
	24'4"	14	18	4#6(2.69)	3#6	6#6	5#6	8#6	-	6'1"	6'1"

Table 3.2: Stirrups schedule in the beam

		STIRRUPS		
L1	L2	ZONE A	ZONE B	ZONE C
4'1"		3#3@6" c/c	-	#3@12"
	1'-7 3/4"	3#3@6" c/c	-	#3@18"
4'1"	4'1"	3#3@6" c/c	-	#3@12"
6'1"		3#3@6" c/c	-	#3@12"
	6'1"	3#3@6" c/c	-	#3@12"
	3'-7 3/4"	3#3@6" c/c	-	#3@18"
	6'1"	3#3@6" c/c	-	#3@12"
6'1"	6'1"	3#3@6" c/c	-	#3@12"
4'1"	-	3#3@6" c/c	4#3@6"c/c	#3@12"
-	1'-7 3/4"	3#3@6" c/c	-	#3@18"
4'1"	4'1"	3#3@6" c/c	-	#3@12"
6'1"	-	3#3@6" c/c	5#3@6"c/c	#3@12"
-	6'1"	3#3@6" c/c	-	#3@12"
-	3'7 3/4"	3#3@6" c/c	-	#3@12"
-	6'1"	3#3@6" c/c	10#3@6"c/c	#3@12"
6'1"	6'1"	3#3@6" c/c	-	#3@12"
6'1"	-	3#3@6" c/c	-	#3@12"
-	6'1"	3#3@6" c/c	-	#3@12"
-	3'-7 3/4"	3#3@6" c/c	-	#3@12"
-	6'1"	3#3@6" c/c	-	#3@12"
6'1"	6'1"	3#3@6" c/c	-	#3@12"

3.6.1 First end span of beam

If we consider span 1 having length 16’-2”; the height of the beam is 18”. And there are no stirrups in zone B as per the designed by software. At L/4 distance from the support that negative steel placed that is 4’-1/2”. Reinforcement will be provided at the top 2#6(T) bars. Similarly in 2#6(T) bars will be provided. Stirrups are provided as in zone A 3#3 @6”c/c. and in zone C stirrups are provided 3#3 @ 7” c/c. Shown in fig

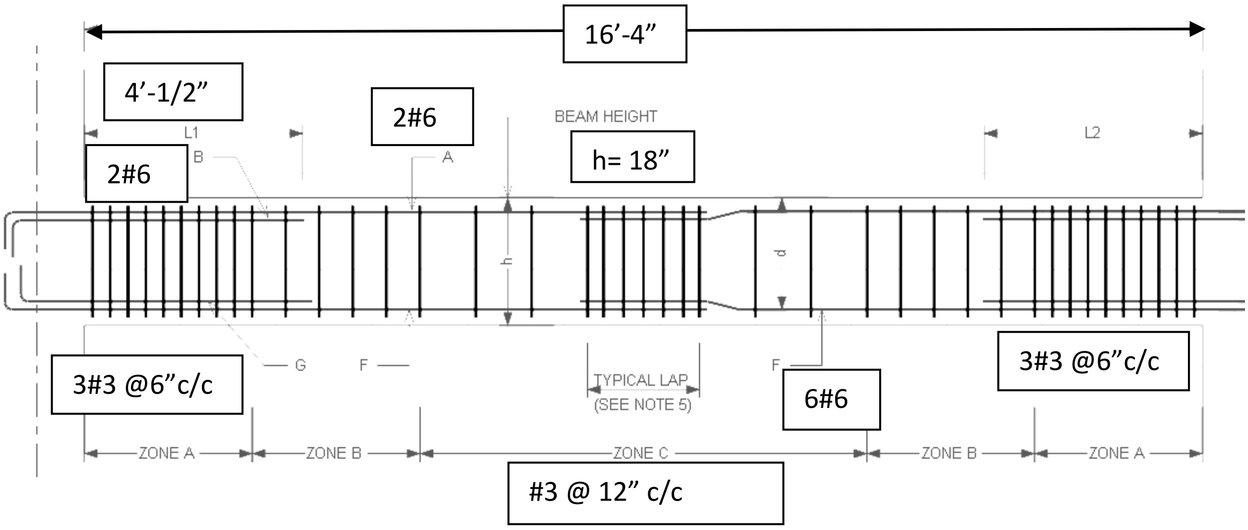

Figure 3.14:First end span beam reinforcement details.

3.6.2 Middle span of beam

Below shown figure is the middle span where span length is 6.5’. At L/4 distance from the support negative reinforcement is provided. Similarly stirrups are provided in zone A and zone C but there are no stirrups in zone B. At F 4 #4(B) positive steel is provided in this there are no bars at H will be provided as it is a typical section of design in ETABS. So we have to eliminate these bars in our design. At C 3#6 (T) bars are provided which shows that negative reinforcement is placed at point C. the overlap of bar will occur when span changes. Spacing of stirrups will be less near the face of support and it will be maximum in the middle because shear will be maximum near the supports. While in centre shear requirement is less that’s why spacing in the middle is high that is 7”.

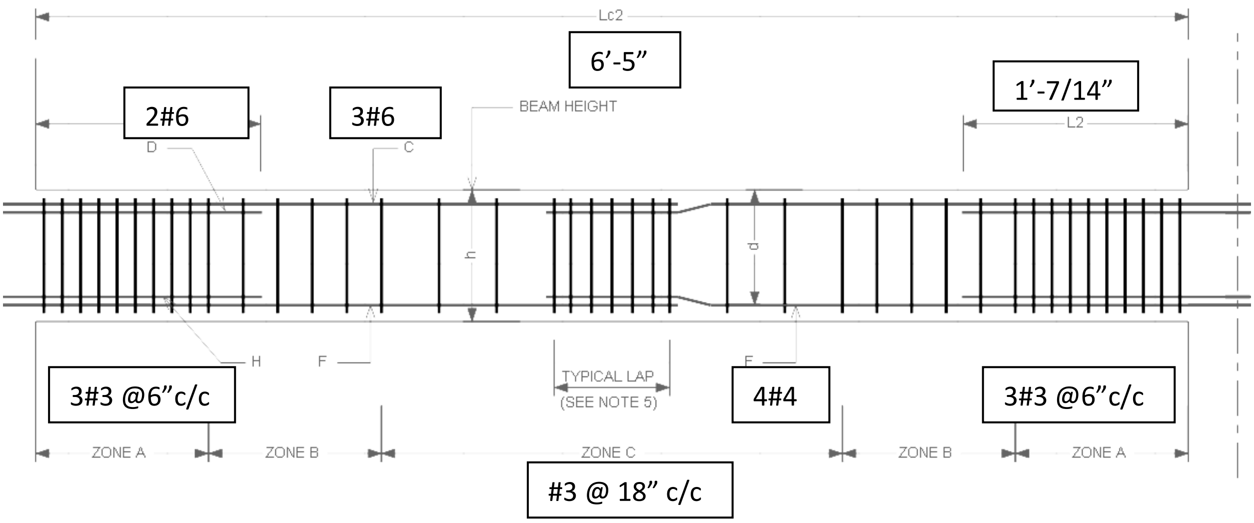

Figure 3.15: Middle span section of beam

3.6.3 Second end span of beam

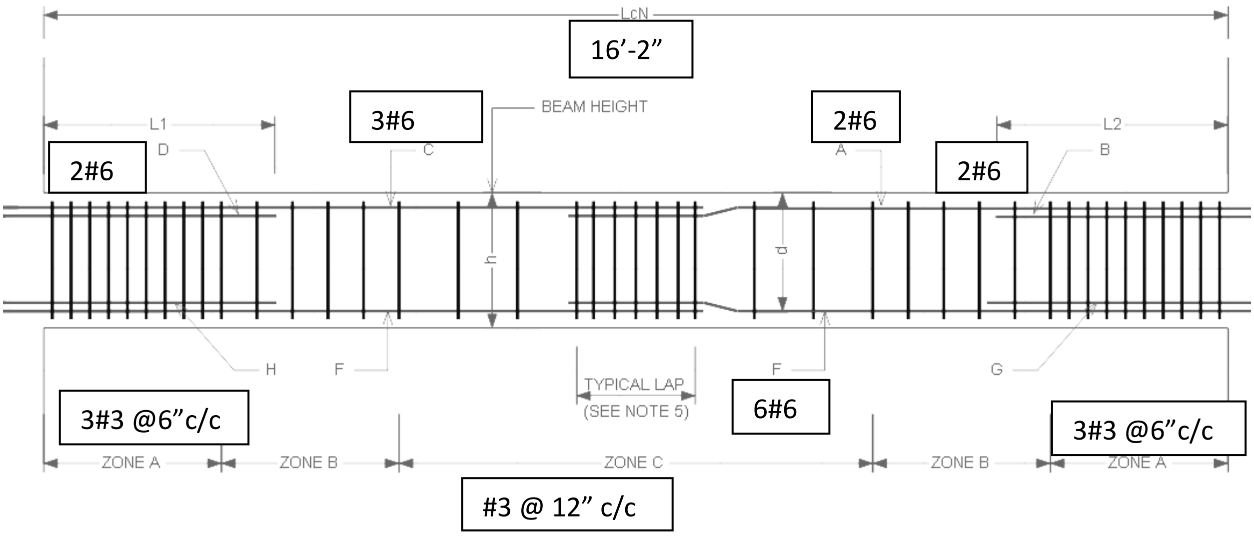

Figure 3.16: End span section of beam

3.6.4 STIRRUPS IN THE BEAM

Stirrups are provided in the beam to cater the effect of shear in the beam. In ETABS typical cross section has been defined by the software after which the zoning has been done by the software for the placement of stirrups. According to ACI 318-08 11.3.1.2 when $V_u < ½ ØV_c$ then there is no requirement of stirrups. As in zone B there is no requirement of stirrups.

3.7 COLOUMN SHCHEDULE OF BARS

Column bar schedule shows the distribution of bar along different sections of column. As ETABS works on FEM (Finite element modelling) so there is different requirement of steel at different sections. Size of column is 16" x 14". 8#7 bars have been provided. Ties are also provided to hold the column bars. For ties #3 @ 4" bars is provided. And for CC2 8#8 bars for CC3 8#5 bars. Ties in second floor are provided #3@6"c/c.

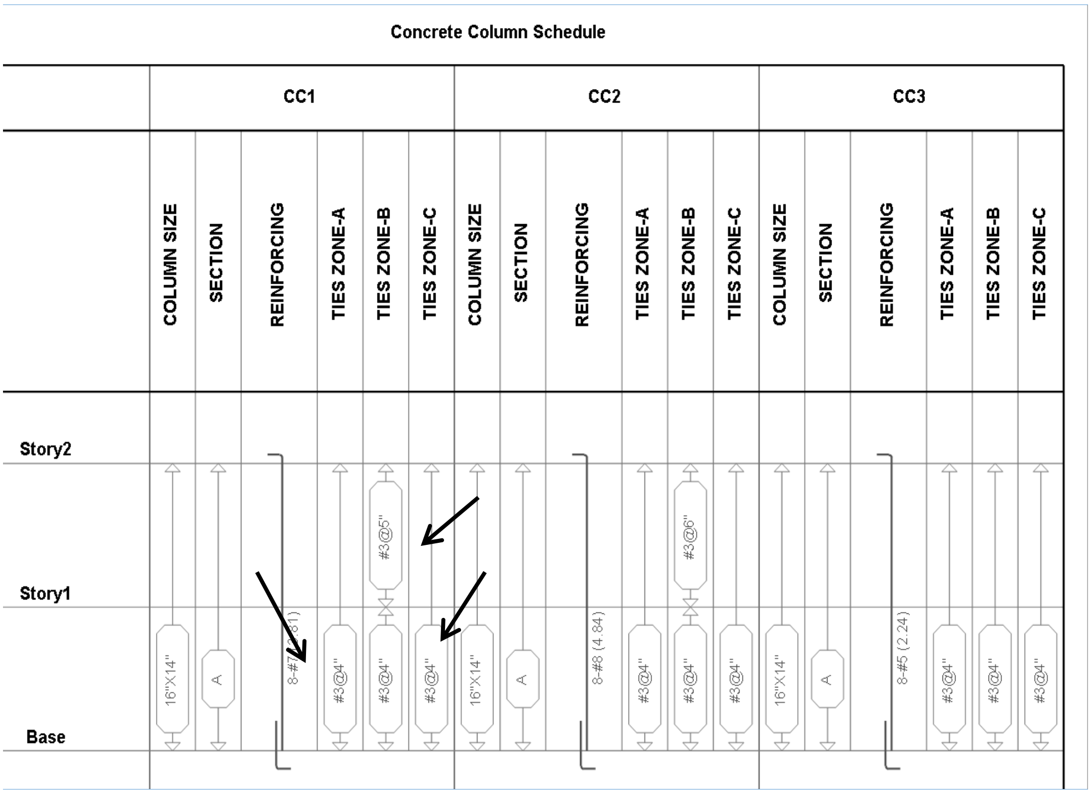

Figure 3.17: Column schedule of bars

3.7.1 Ground floor column

Ties are provided in three different zones as near the support the spacing of the tie bar will be less and in the centre of column the spacing will be more. As spacing near the support is 4" c/c while in the middle of the column the spacing is 6" c/c. there are different zones of ties in the column as we know that in the middle there is less requirement of ties that's why spacing of ties in the middle of column is more while at the ends of column near the next support spacing of ties will be less which shows more requirements of the ties. Longitudinal bar provided throughout the length of column is 8#7 bars.

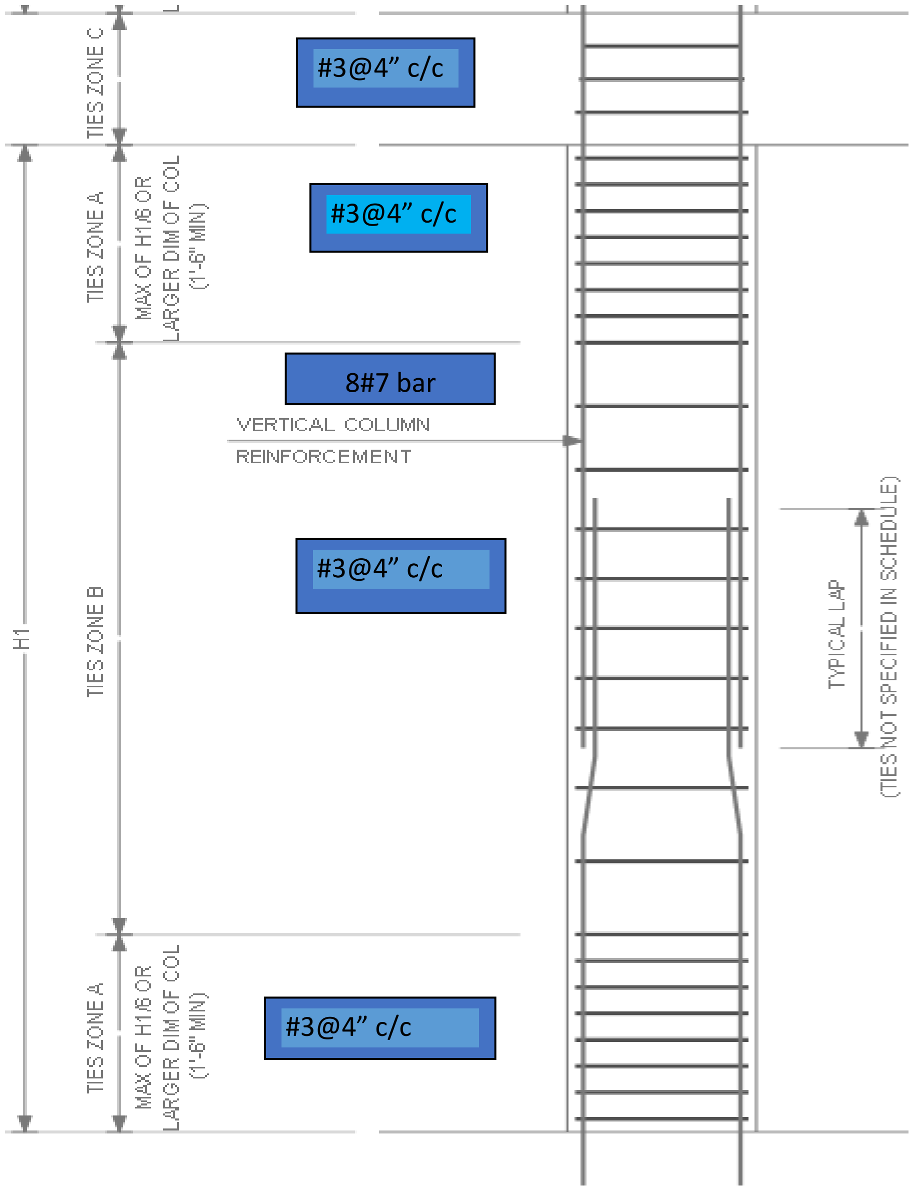

Figure 3.18: Concrete column typical elevation

3.7.2 First floor column section

Ties are provided in three different zones as near the support the spacing of the tie bar will be less and in the centre of column the spacing will be more. As spacing near the support is 4" c/c while in the middle of the column the spacing is 6" c/c. ties in zone B are provided but spacing of ties are more than the ground floor so it means that there is less requirements of ties in the first floor as compared to ground floor.

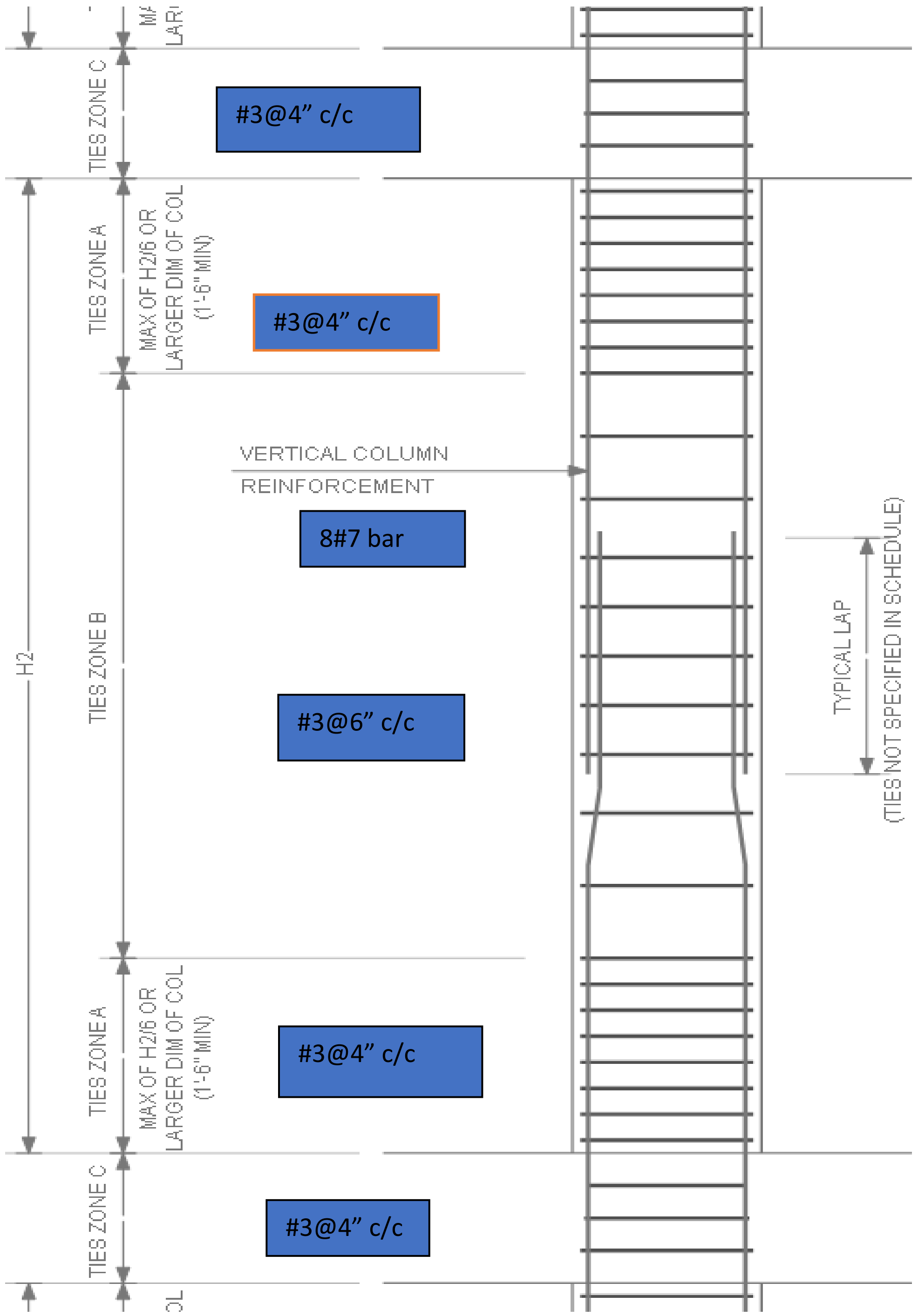

Figure 3.19: Typical elevation of column of first floor

3.8 MAXIMUM MOMENT OF FIRST FLOOR SLAB IN K-ft

As we can see the maximum value of positive moments is seen in the centre of most of the slabs while maximum value of negative moments can be seen near the supports, in this case near the columns. So maximum value of positive moment is 6 k-ft. while maximum value of negative moment is 9.60k-ft.

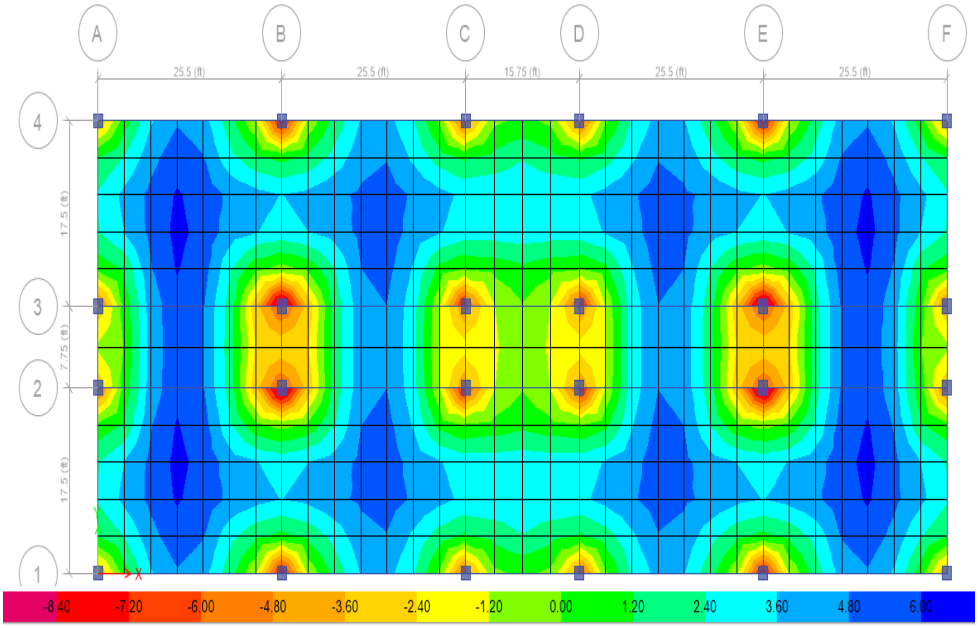

Figure 3.20: Maximum moment first floor slab (k-ft)

3.9 Maximum moment of floor 2 in k-ft

It is found that on second floor slab moments will be less than ground floor slab, as you can see maximum positive moment is 5 k-ft. while maximum negative moment is 8 k-ft. which is less than the first floor.

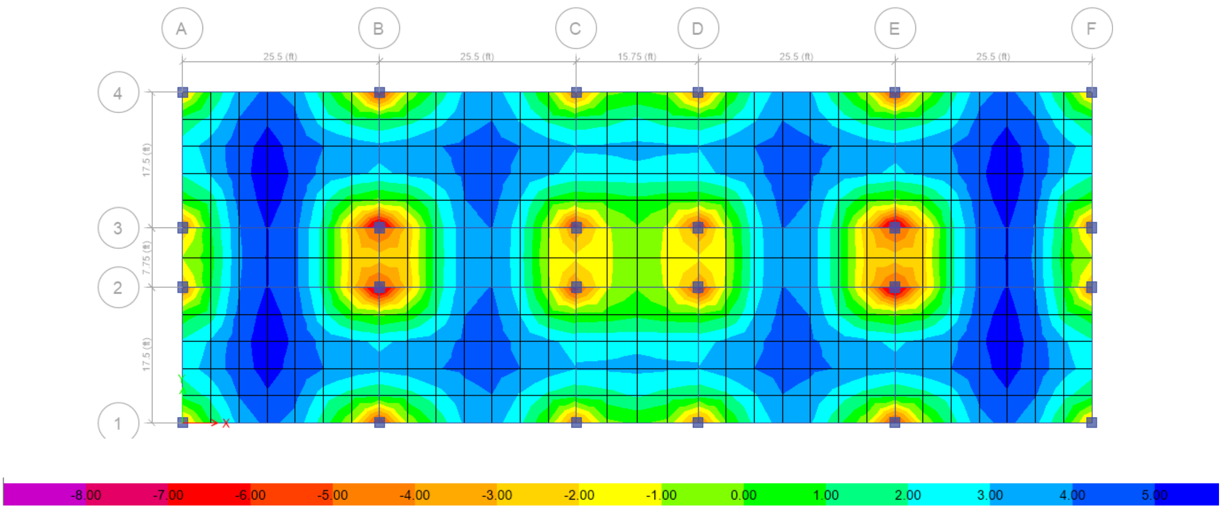

Figure 3.21: Maximum moment of floor 2 (k-ft)

3.10 Maximum shear in floor 1 in kips

Maximum shear is near the supports so as we got value of maximum shear as 4.03kips. Shear will be maximum value near the supports as blue colour is near the support as shown in the figure below. Shear will be minimum in the centre that's why spacing of stirrups in the middle is greater. Minimum shear value will be in the middle that is 0.37 kips.

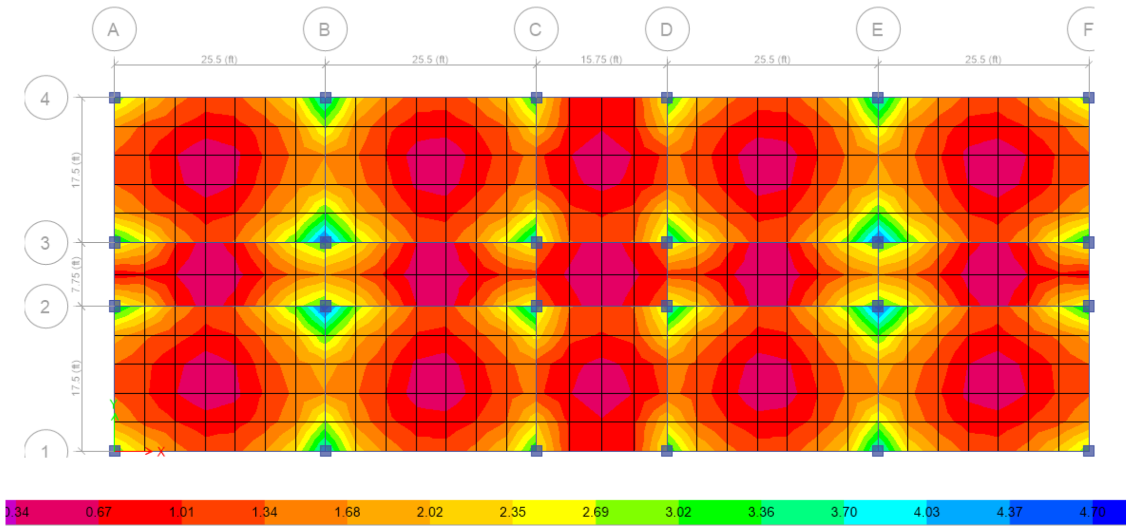

Figure 3.22: Maximum shear in floor 1in kips

3.11 Maximum shear in floor 2 in kips

Value of shear will be less than ground floor slab as we got value 3.46 kips which is less than 4.03kips. So it concludes that shear will be less in floor as compared to first floor.

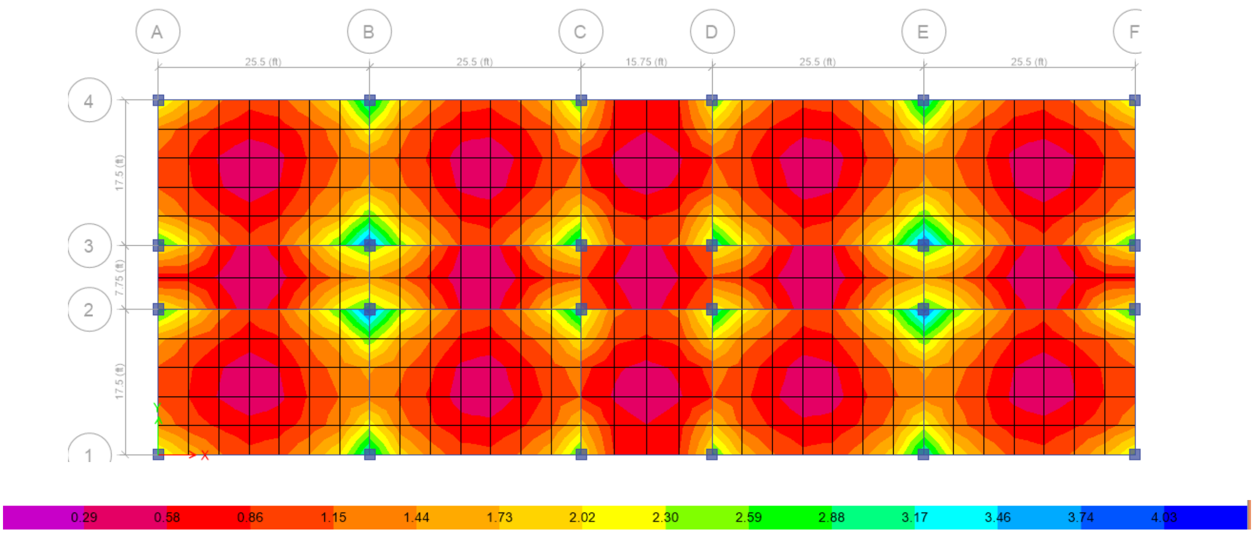

Figure 3.23: Maximum shear in floor 2 in kips

3.12 Area of steel required in slab in^2/ft

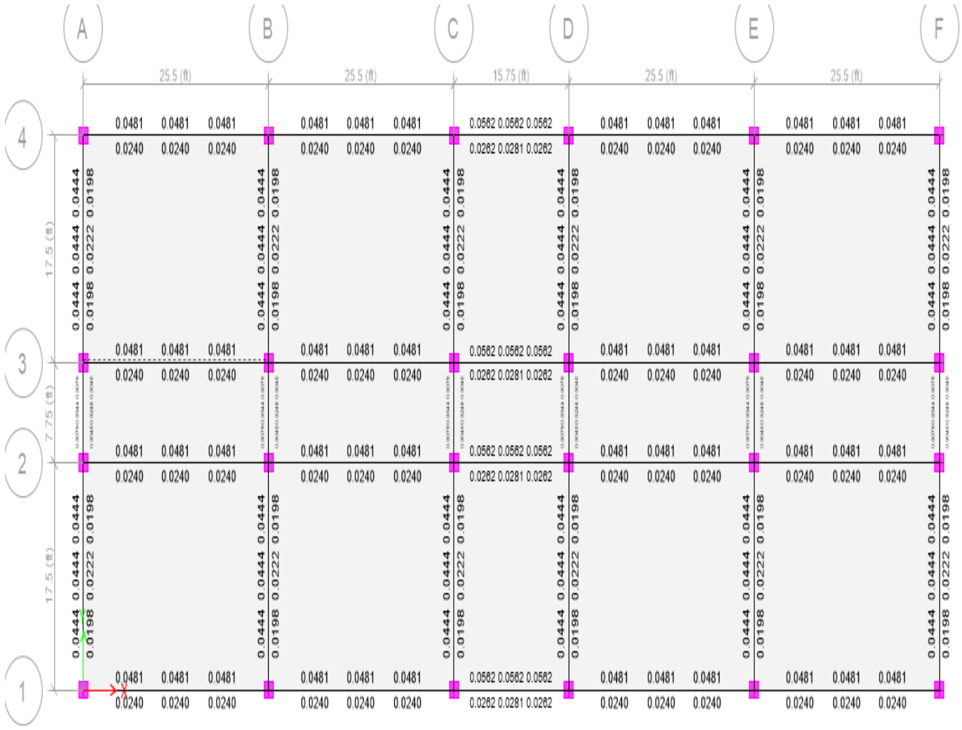

Figure 3.24: Area of steel required (in^2/ft.)

3.13 Moments in beams of floor 2

The top view of the slab of floor 2 is shown below where bending moment diagram of beams is shown. As moment is having high value at the corner beams as compare to the interior beams. Because in interior beams there is symmetric loading while in the corner and edge beams there is non-uniform loading. That's why bending moment value at the corner beam will be maximum. For negative moment we will have to provide the at the top of beam while for positive moment reinforcement will be provided in the bottom of beam. As maximum value of positive reinforcement is 90.5k- ft. and maximum value of negative value is 139 k-ft. yellow colour in the diagram is showing positive moment and red colour is showing negative bending moment.

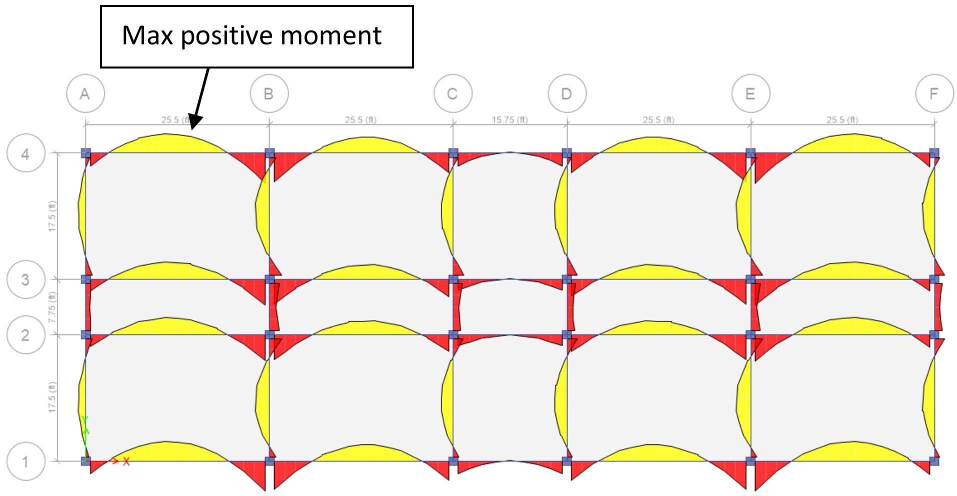

Figure 3.25: Bending moment diagram of beams of first floor.

3.14 DISPLACEMENT CHECK

ACI 318-08 permits the maximum criteria for deflection as displayed in table 9.5(c) of the ACI Code. It permits the maximum displacement of L/480. Our maximum span length is 25.5’ so maximum permitted deflection comes out to be:

$$= \frac{25.5 \times 12}{480} = 0.6375''$$

In our case maximum deflection is coming out to be 0.004596” which is less than the 0.6375”. So our check for maximum displacement is satisfied.

3.15 SUMMARY

In this chapter we have designed the frame super structure of new technical cadets’ block. After designing all of the deflections and displacement in the beams joint and column are satisfying the limits of the ACI code. Our all members including beams column and slabs satisfy all the design checks ad analysis was also successful. Beam size designed out to be 14” x 18” and column size designed out to be 16” x 14”. Moments and shear in the columns and beams are not exceeding the limits. By using ETABS our design is passing all the criteria so it proves to be the viable design of frame structures.

Chapter 4

MANNUAL DESIGN OF COMPOSITE SRUCTURES

4.1 HISTORICAL BACKGROUND

Much has been written about the numerous significant buildings of Roman Empire constructed using "concrete" as the primary structural material. Many researchers believe that the first use of a truly cementation building agent (*as opposed to the ordinary lime commonly used in ancient mortars) occurred in southern Italy in about second century B.C***.** A special type of volcanic sand called pozzolona, first found near Pozzuoli in the bay of Naples, was used extensively by the Romans in their cement. It is certain that to build the Porticos Amelia, a large warehouse constructed in 193 B.C., pozzolona was used to bind stones together to make concrete. This unusual sand reacts chemically with lime and water to solidify into a rocklike mass even when fully submerged (Somayaji, S. 2001). The Romans used it for bridges, docks, storm drains and aqueducts as well as buildings.

4.2 TYPES OF SLABS

In general, RCC slabs can be classified as one-way and two way slab.

4.2.1 One-way slab

A slab supported on two opposite edges or a slab supported on all sides but the ratio of length to width exceeding 2 is termed as one way slab. A slab supported on two opposite sides carries the load in short direction and transfers it to the supporting beams and thus one way action is obtained even through the supports are provided on all the sides.

4.2.2 Two way slab

For slab supported on all sides when the ratio of longer span to the shorter span is less than or equal to 2 than the slabs bend in the both directions to prevent excessive deflections and cracking. Such types of slabs are termed as two-way slabs.

Normally the slabs are designed in conjunction to the floor or roof system chosen by the designer. Floor systems of each type can be identified.

- One-way slab supported by monolithic concrete beams and girders.
- One way slab supported by steel beams.
- One way slab with cold formed steel decking.
- One way joist floor (Ribbed slab).
- Two way slabs supported by edge beams.
- Flat slab.
- Flat plate.
- Two way joist floor.

4.2.3 Strength reduction factors

The strength reduction factor Ø are applied on the specified strength to obtain the design strength provided by the member the factor for flexure and shear are as follows:

- Ø =0.90 for flexure.
- Ø = 0.85 for shear.

4.2.4 Design load combination

The design load combination is the various combinations of the prescribed load cases for which the structure needs to be checked. For the ACI 318-99 code , if a structure is subjected to dead load (DL) and live load (LL) only the stresses check may only one load combinations namely 1.4 DL+1.7 LL . However in addition to the DL and LL if the structure is subjected to wind (WL) and earthquake (EL) then the following combinations have to be considered: 6

- 1.4 DL.
- 1.4 DL ± 1.77 LL.
- 0.9 DL ± 1.3 WL.
- 0.75 (1.4 DL + 1.7 LL ± 1.7 WL).
- 0.9DL ± 1.3 x 1.1 EL.
- 0.75 (1.4 DL + 1.7 LL ± 1.7 x 1.1 EL).

4.3 COEFFICENT METHOD OF DESIGNING TWO WAY SLAB

We have used moment coefficient method to design masonry structure of our block. We have opted to design the block by two methods frame structures and masonry. We have performed calculations manually of masonry structures. In masonry structures simply load will be transferred to walls and then to the footing. We have provided 9” wall between the rooms to reduce the effects of sound disturbance. All 9” walls are load bearing walls and 4.5” walls are partition walls.It is a method used to design two way slab. The ACI Code provides tables of moment coefficient for a variety of conditions. These coefficients are based on elastic analysis but also account for inelastic redistribution. The expressions for moment take the form of coefficient multiplied by total factored load per unit length on the span & the length of the clear span.

4.3.1 Advantages of moment coefficient method

- The coefficients give more exact analysis.
- Significant economy can be achieved by making a more precise analysis.
- There should be no reversal of moments at the critical design sections near mid span or at the support faces**.**

4.4 DESIGN OF CORNER ROOM SLAB

Use the following parameters throughout the design

F’c = 3ksi

Fy = 40 ksi

Floor Finish = 2.5”

Concrete Cover for Slabs = 0.75”

Ceiling Plaster = 0.5”

Water Proofing = 5 psf

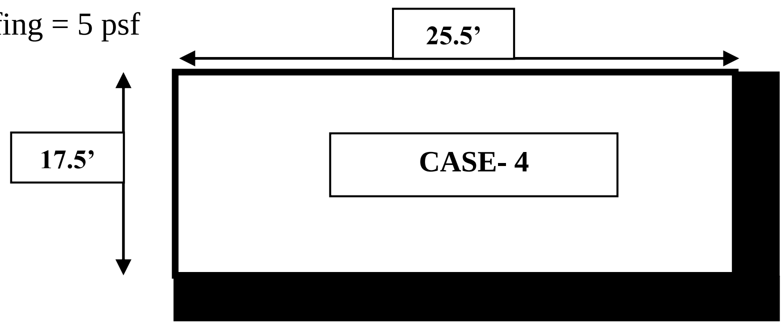

Figure 4.1: Corner room slab panel

4.4.1 Solution

Length of slab = L = 25.5’

Width of Slab = W = 17.5’

L/W = 25.5’ / 17.5’ = 1.45 < 2.0 (TWO WAY SLAB)

4.4.2 Slab Thickness

For grade 40 steel

h = Perimeter / 180 = 2(25.5 + 17.5) x 12 / 180 = 5.73” ~ 6”

4.4.3 Loads

Dead Load

Self-weight of slab = 6/12 *150 = 75 psf

Finish Floor + Cement Plaster = (2.5+0.5)/12*144 = 36 psf

Dead Load= 60 psf

Water proofing = 5 psf

Total dead load = W_{du} = 1.2 (75+36 + 5+60) = 211.2 psf

Live Load

W_{lu}=1.6*80 = 128 psf

Total factored Load = 211.2 +32 = 243.2 psf

4.4.4 Bending Moment Coefficients

m = Aspect ratio = Lx/Ly = 17.5/25.5 = 0.70

x= shorter dimension

y = longer dimension

Table 4.1: Moments of corner room slab

BENDING MOMENT TYPE	COEFFICIENT	CASE 4	M_u(k.ft)=C.W_u.l^2
- ve moment	C_x	0.073	2.77
- ve moment	C_y	0.017	2.69
+ve moment	C_{xDL}	0.058	3.75
+ve moment	C_{yDL}	0.014	1.92
+ve moment	C_{xLL}	0.071	2.78
+ve moment	C_{yLL}	0.018	1.49

4.4.5 Area of Steel and Detailing

Max spacing = 2x h = 2 x 6 = 12”

d_x = h – cover – (diameter of bar)/2 = 6 – 0.75- 0.5/2 = 5”

d_y = d_x - (diameter of bar) = 5 – 0.5 = 4.5”

$A_{s\,(min)}$ = 0.0020 x b x h = 0.0020 x12 x 6 = 0.144 in^2

Table 4.2: Detailed reinforcement schedule

DIRECTION	MOMENT k-ft	d (inches)	ρ (inches)	A_s (in^2/ft)	Detail Remarks
SHORT (-VE)	2.77	5	0.0032	0.192	#4@ 10”C/C
SHORT (+VE)	6.53	5	0.0077	0.462	#4@ 6” C/C
LONG (-VE)	2.69	4.5	0.0038	0.144	#4@ 10” C/C
LONG (+VE)	3.41	4.5	0.0049	0.2646	#4@ 9” C/C

4.4.6 Torsion Steel

Same as max +ve steel (#4 bar @ 4” c/c) at L/5 distance from every cover at 45^0.

4.4.7 Reinforcement for Shade

Extend Negative reinforcement into 3’ overhanging shade at the top.

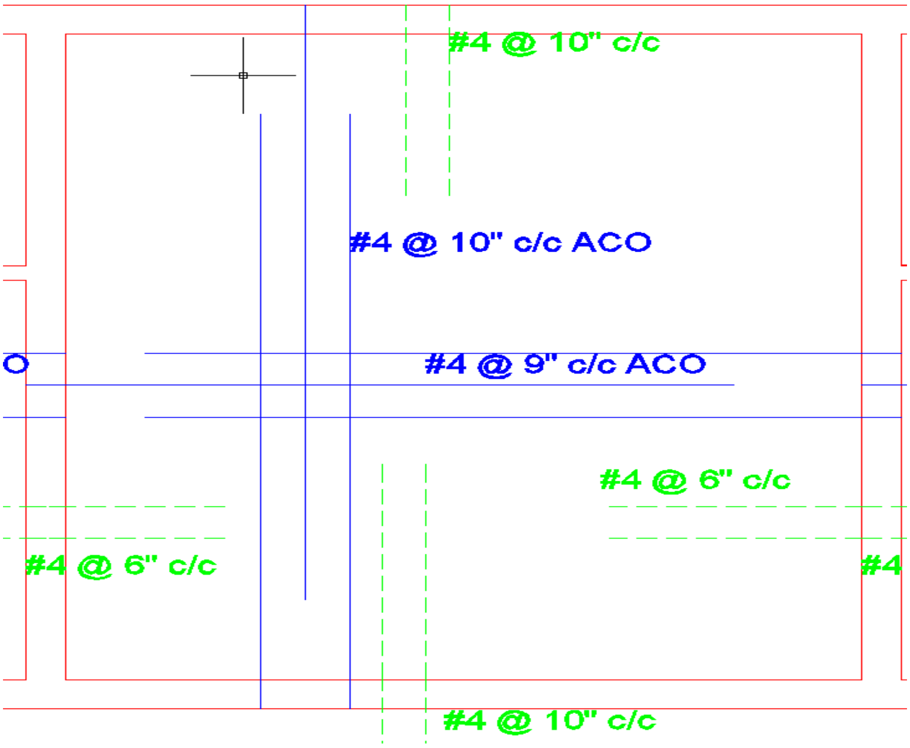

Figure 4.2: Layout of bar in stair hall slab

Blue colour is showing positive reinforcement having #4bar @10"c/c. And green colour bars are showing negative reinforcement. ACO stands for "alternative cut off". Bars are alternatively cut off and at the support bar are embedded in the support to cater negative moment at the support. As we know that bars parallel to short side are below and bars parallel to long side are above these bars. As this is the slab of interior stair hall so its thickness is come out to be 5". Calculation of moment has been done at the continuous and discontinuous edges. We will select the thickness of slab as the maximum thickness of slab panel will be having. Then we will design the rest of the portion on that thickness.

4.5 DESIGN OF INTERIOR ROOM SLAB

Now the corner slab of room will be designed in by moment coefficient method. As it is two way slab so will select the coefficient from the table by using the aspect ratio 'm'. We have taken LL 80psf and DL as 40psf. As the slab is of ground floor then we are using high loads. For first floor we will use less loads.

F'c = 3ksi

Fy = 40 ksi

Floor Finish = 2.5"

Concrete Cover for Slabs = 0.75”

Ceiling Plaster = 0.5”

Water Proofing = 5 psf

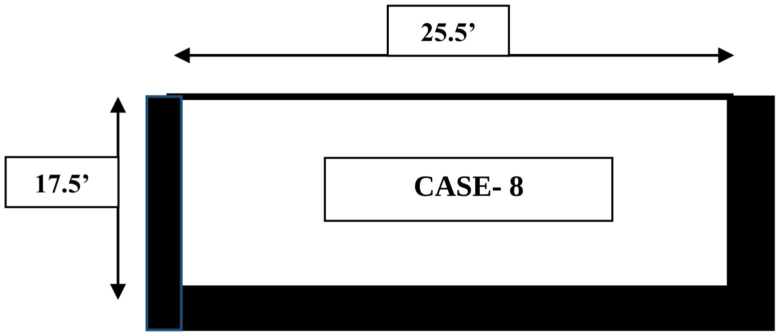

Figure 4.3: Dimensions of interior room slab

4.5.1 Solution

Length of slab = L = 25’ 6” = 25.5’

Width of Slab = W = 17.5’-0”

L/W = 25.5’ / 17.5’ = 1.45 < 2.0 (Two way slab)

4.5.2 Slab Thickness

For grade 40 steel

h = Perimeter / 180 = 2(25.5 + 17.5) x 12 / 180 = 5.73 ~ 6” (to keep uniformity in slabs and easy of formwork, the thickness shall govern over the complete floor design.)

4.5.3 Loads

Dead Load

Self-weight of slab = 6/12 *150 = 75 psf

Finish Floor + Cement Plaster = (2.5+0.5)/12*144 = 36 psf

Dead Load on accessible roof = 20 psf

Dead Load= 60

Water proofing = 5 psf

Total dead load = W_{dl} = 1.2 (75+ 20 + 36 + 5+60) = 235.2 psf

Live Load

W_{lu}=1.6 x 80 = 128 psf

Total factored Load = 235.2 + 128 = 363.2 psf

4.5.4 Bending Moment Coefficients

m = Lx/Ly = 17.5/25.5 = 0.70

x= shorter dimension

y = longer dimension

Table 4.3: Reinforcement schedule

BENDING MOMENT TYPE	COEFFICIENT	CASE 4	M_u(k.ft)=C.W_u.l^2
- ve moment	C_x	0.061	6.78
- ve moment	C_y	0.026	6.14
+ve moment	C_{xDL}	0.050	3.60
+ve moment	C_{yDL}	0.014	2.14
+ve moment	C_{xLL}	0.068	2.66
+ve moment	C_{yLL}	0.018	1.49

4.5.5 Area of Steel and Detailing

Max spacing = 2x h = 2 x 6 = 12”

d_x = h – cover – (diameter of bar)/2 = 6 – 0.75- 0.5/2 = 5”

d_y = dx - (diameter of bar) = 5 – 0.5 = 4.5”

As (min) = 0.0020 x b x h = 0.0020 x12 x 6 = 0.14 in^2

Table 4.4: Reinforcement schedule of interior slab

DIRECTION	MOMENT k-ft	d (inches)	ρ (inches)	A_s (in^2/ft)	Detail Remarks
SHORT (-VE)	6.78	5	0.008	0.48	#4@ 6"C/C
SHORT (+VE)	6.26	5	0.0074	0.44	#4@ 6" C/C
LONG (-VE)	6.14	4.5	0.0091	0.4914	#4@ 6" C/C
LONG (+VE)	3.63	4.5	0.0052	0.2808	#4@ 10" C/C

4.5.6 Reinforcement for Shade

Extend Negative reinforcement into 3' overhanging shade at the top.

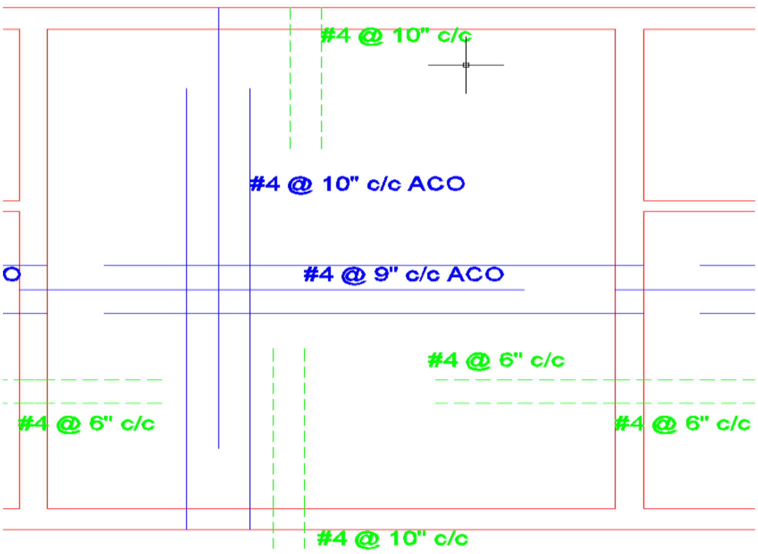

Figure 4.4: Layout of bars in interior slab of room

As maximum spacing between the bars is 2h that is 10". So where the spacing will exceed the value 10" at that place we will provide 10"c/c spacing between the bars. Minimum spacing that we have provided is 6" c/c. thickness of slab is come out to be 4.5" which is less than the stair hall slab.

4.6 DESIGN OF INTERIOR STAIR CASE HALL SLAB

Design method is moment coefficient method. On interior slab the coefficients are having high value because the loading is high at the interior slab because loading is being transferred from all the sides of slab. In our case slab is continuous from three sides and discontinuous from one side.

F'c = 3ksi

Fy = 40 ksi

Floor Finish = 2.5"

Concrete Cover for Slabs = 0.75"

Ceiling Plaster = 0.5"

Water Proofing = 5 psf

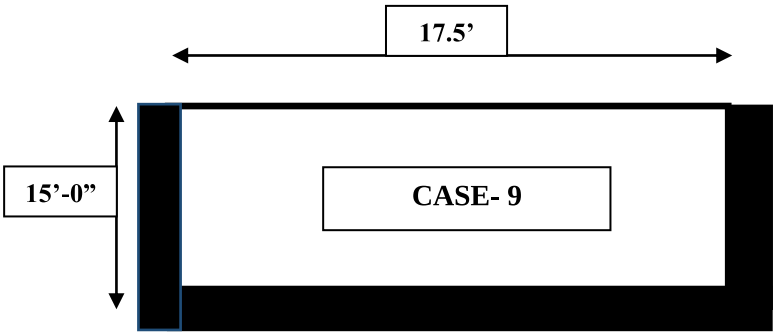

Figure 4.5: Dimensions of slab of stair case hall

4.6.1 Solution

Length of slab = L = 17'6" = 17.5'

Width of Slab = W = 15'-0"

L/W = 17.5' / 15' = 1.17 < 2.0 (TWO WAY SLAB)

4.6.2 Slab Thickness

For grade 40 steel h = Perimeter / 180 = 2(17.5 + 15) x 12 / 180 = 4.35 ~ 5"

4.6.3 Loads

Dead Load

Self-weight of slab = 5/12 *150 = 62.5 psf

Finish Floor + Cement Plaster = (2.5+0.5)/12*144 = 36 psf

Dead Load on accessible roof = 20 psf

Dead Load= 60

Water proofing = 5 psf

Total dead load = W_{du} = 1.2 (62.5+ 20 + 36 + 5+60) = 220.2 psf

Live Load

W_{lu}=1.6 x 80 = 128 psf

Total factored Load = 220.2 + 128 = 348.2 psf

4.6.4 Bending Moment Coefficients

m = Lx/Ly = 15/17.5 = 0.85

x= shorter dimension

y = longer dimension

Table 4.5 Moments in the slab of room

BENDING MOMENT TYPE	COEFFICIENT	CASE 9	M_u(k.ft)=C.W_u.l^2
- ve moment	C_x	0.065	5.09
- ve moment	C_y	0.019	2.02
+ve moment	C_{xDL}	0.035	1.73
+ve moment	C_{yDL}	0.016	1.07
+ve moment	C_{xLL}	0.049	1.44
+ve moment	C_{yLL}	0.025	0.98

4.6.5 Area of Steel and Detailing

Max spacing = 2x h = 2 x 5 = 10”

d_x = h – cover – (dia of bar)/2 = 5 – 0.75- 0.5/2 = 4”

d_y = dx - (dia of bar) = 4 – 0.5 = 3.5”

$A_{s\,(min)}$ = 0.0020 x b x h = 0.0020 x 12 x 5 = 0.12 in^2

Table 4.6: Reinforcement schedule

DIRECTION	MOMENT k-ft	d (inches)	ρ (inches)	A_s (in^2/ft)	Detail Remarks
SHORT (-VE)	5.09	4	0.0096	0.4608	#4@ 5"C/C
SHORT (+VE)	3.41	4	0.0063	0.2976	#4@ 6" C/C
LONG (-VE)	2.02	3.5	0.0048	0.2016	#4@ 6" C/C
LONG (+VE)	2.05	3.5	0.0048	0.2016	#4@ 10" C/C

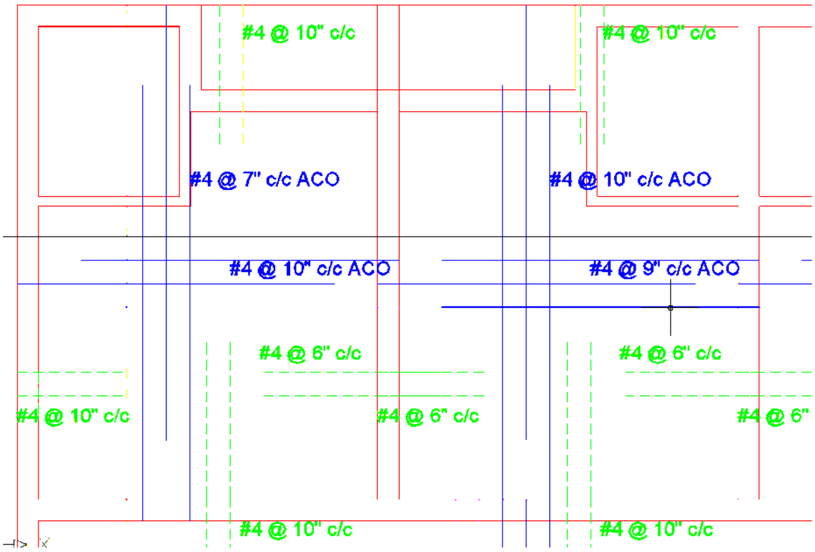

Figure 4.6: Layout of bars in corner slab of room

Slab thickness is come out to be 4.5". So it is also less than the slab thickness of stair case hall. So in short,maximum thickness of slab is 5". And the maximum reinforcement is provided as #4@ 6" c/c.

4.7. DESIGN OF MASONRY WALL FOOTING

4.7.1 Transfer of loadings

The loads are transferred from slab to the wall and finally to the wall and then to the ground floor and ultimately to the footing. We have designed typical three steps foundation. Load will be transferred to the footing un-factored. Load will be factored after transferring the load to the footing. We have taken 0.5tsf as bearing capacity of the soil which is taken from the lab. Depth of foundation has been taken as 3'. And the density of the soil is 100pcf.

While density of concrete is taken as 150pcf. Over burden of the soil will also be taken into account while transferring the loads. And special care would be taken to add the self-weight of the foundation step itself. When the load is transferred to the step of increased width, the load pressure will be decreased that's why increased in width if steps is provided to reduce the pressure on the footing pad.

4.7.2 Load transferring from of stair case hall slab

Load= $(\frac{1.75+16.75}{2}) \times 7.5 \times \frac{5}{12} \times 150$

Load on wall=4335.93lb

Per foot load on wall by slab 1 $=\frac{4335.95}{16.75}$

=258.86lb/ft.

For CP and FP

$= (\frac{4.5}{12} \times 144) \times \frac{1.75+16.75}{2} \times 7.5$

=3746.25lb

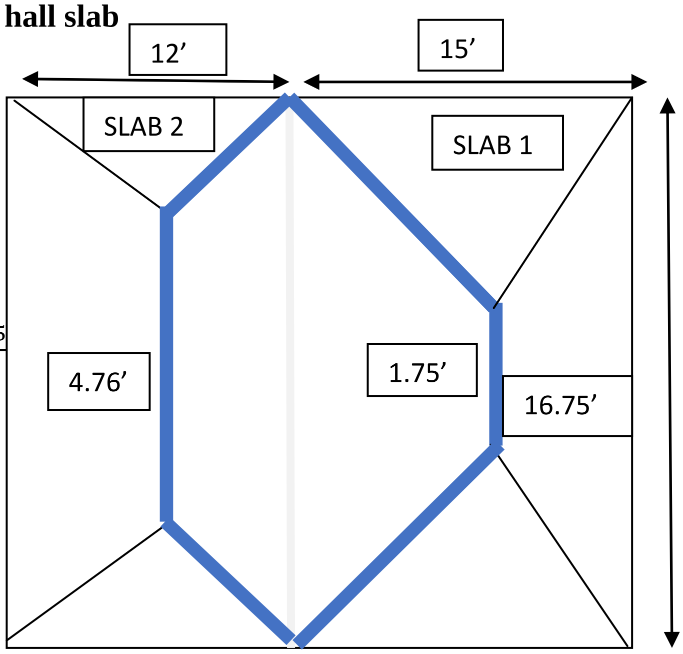

Figure 4.7: Showing tributary area for transferring of load

Per foot$=\frac{3746.25}{16.75}$=223.66 lbs/ft

Add=223.66+258.86

=482.52 lb/ft

For DL

=A$\times$ 50 psf

=69.375$\times$ 50

=3468.75 lbs

Per foot$=\frac{3468.75}{16.75}=$ 207.11lb/ft.

Total DL on wall

=482.52+207.1

=689.61 lb/ft

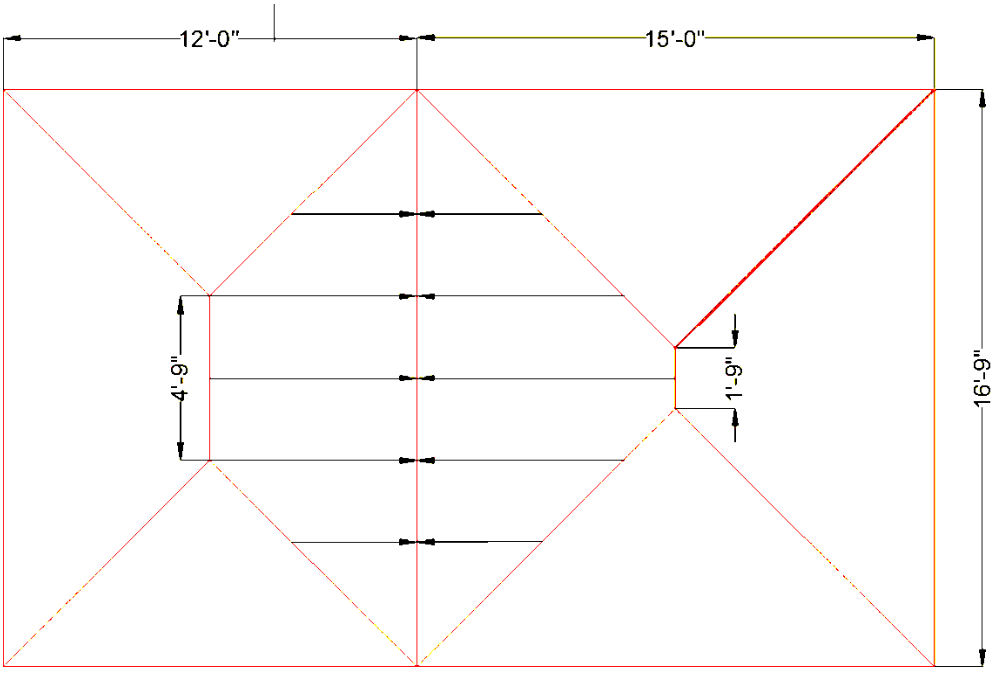

Figure 4.8 Load transferring area to the footing

For LL

$=80\times A$

$=80\times 69.37$

=5550 lbs.

Per foot = $\frac{5550}{16.75}$ = 331.34 lbs./ft.

4.7.3 Transferring of dead and live loads of second floor slab 2:

$A_2= (\frac{16.75+4.75}{2})$ x 6

$A_2=64.5ft^2$

Slab DL

$=(\frac{5}{12}\times 150)\ \times\ 64.5$

=4031.25 lbs.

Per foot=$\frac{4031.25}{16.75}$=240.67 lb/ft

Cement Plaster +Finish Floor

$= (\frac{4.5}{12}\times 144)\ x\ 64.5$

=3483lbs

Per foot =$\frac{3483}{16.75}$

=207.87lb/ft.

Dead load

$=50\times A_2$

50×64.5

Per foot$=\frac{3225}{16.75}=192.54\frac{lb}{ft}$

Total DL=192.54+207.54+240.67

=641.15 lb./ft.

Live load

$LL\times A_2$

$=80\times 64.5$

=5160 lbs

Per foot $=\frac{5160}{16.75}$

=308.1 lb/ft

Total DL from both slab

=slab 1+slab 2

=689.61+641.15

=1330.76lb/ft

Total live load from both slab

=308.1+641.15

=1330.76 lb/ft

Total LL from both slab

=308.1+6331.34

=639.44 lbs/ft

Plinth height=1'6"

DL of wall$=(11+1.5)\times\frac{9}{12}\times$12o

=1125 lb/ft

$=2.5'\times\frac{13.5}{12}\times 120$

=337.5 lb/ft

Total DL by wall=337.5+1125

=1462.5 lb/ft

Total DL on footing

=1462.5+1330.76

=2793.26 lb/ft

Now again Area 1=69.37ft^2 slab 1

Load$=(\frac{1.75+6.75}{2})\times 7.5\times 150\times\frac{5}{12}$

=4335.93 lbs

Load on wall per foot $=\frac{4335.95}{16.75}$

=258.80lb/ft

For CP+FF$=(\frac{4.5}{12}\times 144)\times$Area

$=69.375\times\frac{4.5}{12}\times 144$

=3746.25 lbs.

Per foot$=\frac{3746.25}{16.75}$=223.6 lb/ft

Insulation$=\frac{3}{12}\times 114\times 69.375$

=1977.2 lbs

Per foot$=\frac{1977.2}{16.75}$=118.04 lb/ft

DL=50 psf

$=A_1\times 50\quad = 69.375\times 50$

=3468.75 lbs

Per foot=$\frac{3468.75}{16.75}$

=207.11 lb/ft

Total DL on wall=207.11+118.04 +223.6 +258.66

=807.41lbs./ft.

For first floor LL=40

=LL×A_1

=40× 69.375

=2775 lbs

Per foot=$\frac{2775}{16.75}$=165.7 lb/ft

4.7.4 Transfer of load from Slab 2:

Insulation=($\frac{3}{12} \times 114)64.5$

=1838.25 lbs

Per foot=$\frac{1838.25}{16.75}$=109.75lb/ft

Total DL=from slab 2

=641.15+109.75

=750.9 lb/ft

Live loads

=40×A_2

=40×64.5

=2570

Per foot=$\frac{2570}{16.75}$

=1543.43 lb/ft

4.7.5 Load transfer by wall:

=($\frac{9}{12} \times 11) \times 120$

=990 lb/ft

Total DL on footing= 990+750.9+807.41+2793.61 lb/ft

So Total DL on footing =5.341 k/ft

Total LL on footing

=153.43+308.1

Transfer DL to 13.5” wall

=5341.92× $\frac{9}{13.5}$=3561.28 lb/ft

Total DL to 13.5” wall

=3561.28 +$\frac{13.5\times6}{144}$lb/ft

Transfer DL to 18” wall

=3628.78 × $\frac{13.5}{18}$lb/ ft

=2721.58 lb/ft

Total DL on 18” wall step

=2721.58+× $\frac{18\times6}{144} \times 120$=2811.6 lb/ft

Transfer DL to 22.5” step

=2811.6× $\frac{18}{22.5}$=2250 lb/ft

Total load on 22.5”Step 2

=2250+$\frac{22.5\times6}{144} \times 120$

=2361 lb/ft

Now transfer of live load to footing

Total live load on 9” wall =461.53 lb/ft

Transfer it to 13.5 “ wall

=461.53$\times \frac{9}{13.5}$=307.68 lb/ft

Transfer LL to 18” step

=307.68$\times \frac{13.5}{18}$=230.76 lb/ft

Transfer LL to 22.5”ste

=230.76$\times \frac{18}{22.5}$=184.6 lb/ft

4.7.6 Design of footing

Total Dl on footing =2361.8 lb/ft

Total LL 0n footing=184.6 lb/ft

q_a=1k/ft^2

Wall width 22.5”

Depth of footing=3’

f’c=3ksi *f*$_{y=}$60ksi

Assume footing thickness =6”

$q_{ef\,f}$ = q_a- (unit wt. of footing +unit wt. of soil)

=1000-$(0.5 \times 150 + 2 \times 100)$

=1000-(75+200)

= 725 lb/ft^2

Width of footing=B= $\frac{2.361+0.1846}{0.725}$=3.51’=4’

Design of soil pressure= $q_{u=}\frac{1.2\times2.361+1.6\times0.1846}{4}$= 3.12k/ft^2

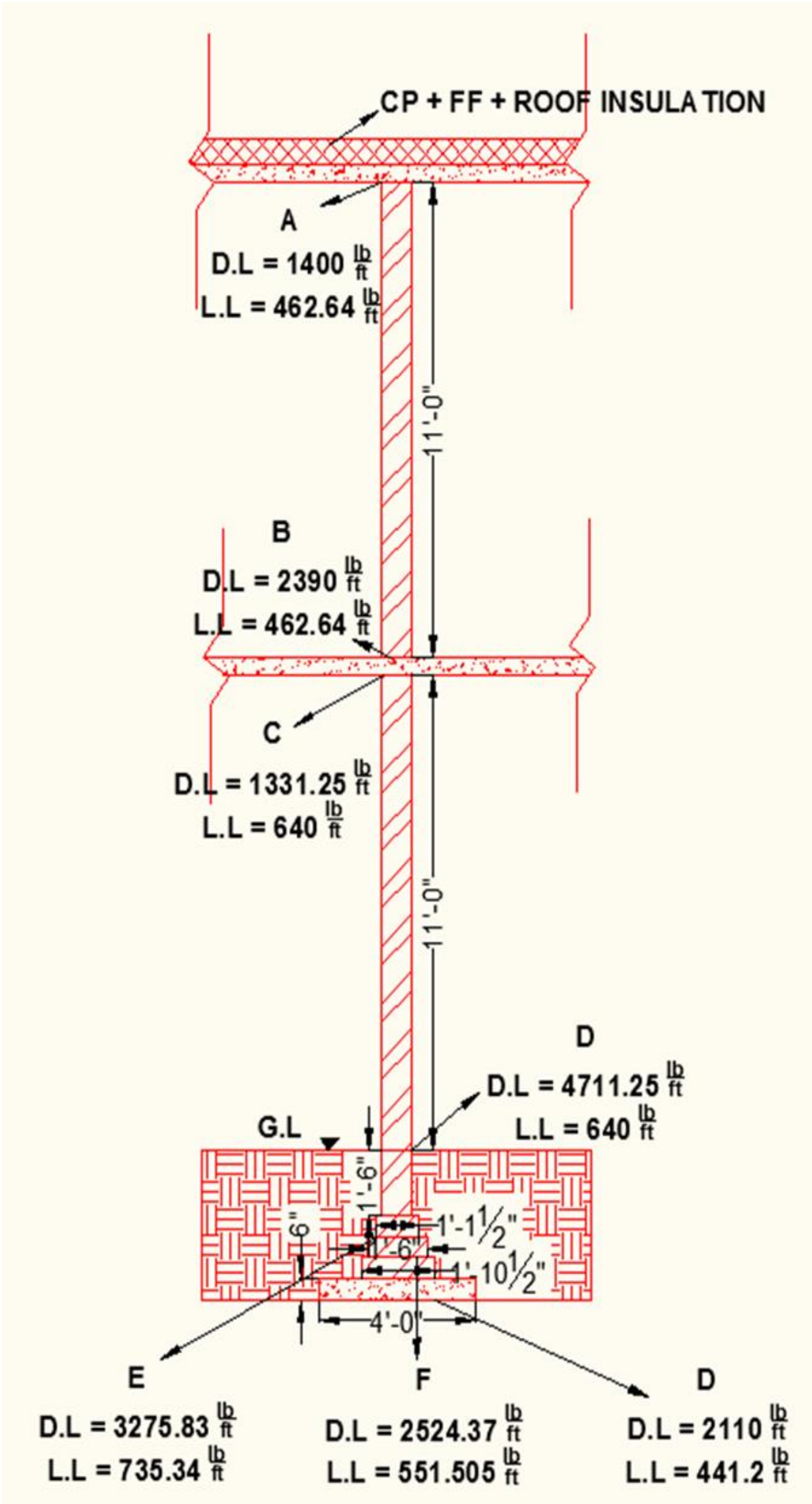

Figure 4.9: Values of transferred loads till end of footing.

4.7.7 Thickness of footing

$V_u=q_u(\frac{B-a/2}{2} - \frac{d}{12})$

$=2.1(\frac{4}{1.875} - \frac{d}{12})$…………(1)

$V_u=2.1(1.0625-\frac{d}{12})$

$V_u=2.23 - 0.175d$

$\varphi V_c=\frac{0.75\times2\times\sqrt{3000}\times12\times d}{1000}$

$\varphi V_c=0.986d$……..(2)

2.23- 0.175d=0.986d

2.23=1.16d

d=1.92

$h=1.922+3+0.5(\frac{6}{8})$

h=5.29”

Take h=6”

4.7.8 Calculation for bending moment of footing

$M_u=\frac{qu}{32}(2B-\frac{a}{12})^2$

$=\frac{3.12}{32}(8-1.875)^2$

=3.65k-ft

M_u=43.89 k-in

4.7.9 Area of steel for footing

$43.89=0.9\times 12\times\rho\times 60(1-11.8\times\rho)1.92^2$

$0.0187=\rho-11.8\rho^2$

$11.8\rho-\rho^2+0.0187=0$

ρ=0.027

$A_s=\rho bd$

$=0.62in^2$

$A_{s\,min}=\frac{200\times12\times1.92}{60000}$

$A_{s\,min}=0.0768$

$A_s>A_{s\,min}$ hence ok

Use #5 *bar*

$Spacing=\frac{0.31}{0.62}X12$

S=6”

Use #5@ c/c

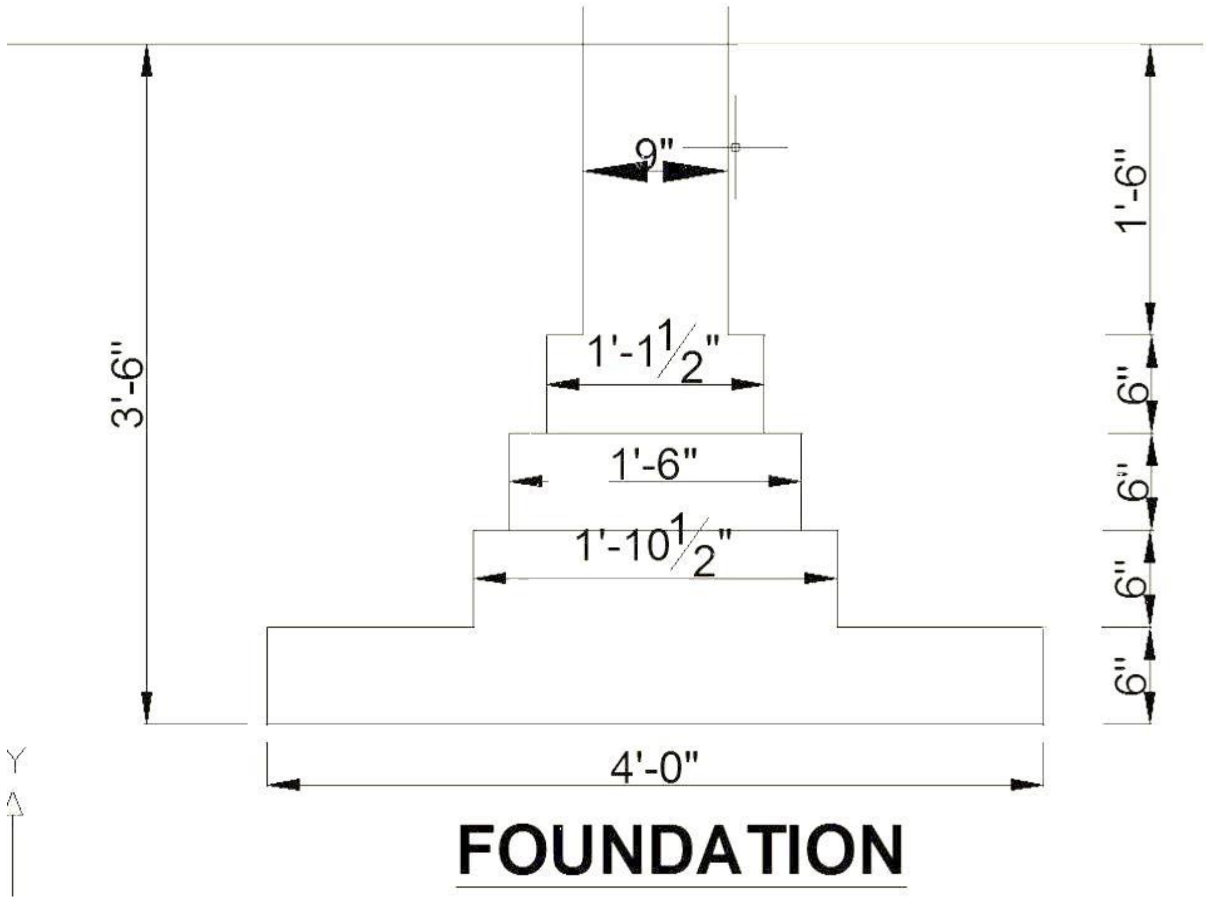

Figure 4.10: Final foundation dimensions

4.8 SUMMARY

In our manual calculation the maximum thickness of slab is found to be 5”. So we have designed our block with 5” thickness of slab. As we know that the maximum thickness of slab is provided in whole building. After wards the dead load and live load transfer to the wall which was carrying the maximum load by 45 degree tributary area method. Then load transferred to below ground level. We have kept 1.5’ plinth height and depth of foundation as 3.5’. We have found that maximum un-factored load coming on footing was 2.6 k/ft. and we found the width of the footing as 4’ and thickness of footing pad is 6”.

4.9 COMPARISON OF FRAME STRUCTURE AND COMPOSITE DESIGN OF BLOCK

As design has been carried out for two methods of construction; for both the design there are critical parameters like slab thickness, bending moments, shear force, reinforcement, area of steel etc. so in this section we will discuss this aspect of design by comparing critical parameters of both designs.

As the maximum slab thickness will govern the design consideration for whole of the building. Maximum slab thickness in frame structures is found to be 6”, while in the composite structures the same thickness is calculated as 7”.

Maximum bending moment is the criteria to select the steel requirement in the section. So the maximum Bending moment in the slab in frame design is estimated as 6 k-ft. which is negative moment, while in composite structures this value comes out to be 6.78k-ft. so here we can conclude two things that negative bending is the design moment and bending moment in the slab of composite structures is more than the frame design of the structures.

As we know that where value of moment is higher at that part more reinforcement will be required. So in the case of composite structures the value of bending moment is maximum, so that maximum reinforcement will be required in the composite structures.

Table 4.11:Comparison of properties of frame and composite structures

PROPERTIES	FRAME STRUCTURE	COMPOSITE STRUCTURES
MAX BENDING MOMENT (k-ft.)	6	6.78
SLAB THICKNES (inches)	6	7
STEEL AREA (in^2/ft.)	0.36	0.48
MAX STEEL RFT IN SLAB	#4 bar @8”c/c	#4 bar @6”c/c
SHEAR FORCE (kips)	4.37	5.03
COLUMN SIZE	14” x 16”	No column
BEAM SIZE	14” x 18”	No Beam
TOTAL LOAD ON FOOTING (k/ft.)	2.97	2.56

Chapter 5

BILL OF QUANTITIES

5.1 INTRODUCTION

5.1.1 Building construction estimation

It is the determination of probable construction cost of any given project. Many items influence and contribute to the cost of project, each item must be analysed, quantified and priced. Because the estimate is prepared before the actual construction, must study and though must be put into actual construction document (Adeli, H., & Wu, M. 1998). The estimator who can visualize the project and accurately determine its cost will become one of the most important people in any construction company.

5.1.2 The working drawings

It usually contains information relative to the design, location dimensions and construction of the project, while the project manual is a written supplement to the drawings and includes information pertaining to materials and workmanship, as well as information about the bidding process. The working drawing the project manuals constitutes the majority of the contract documents, defines the scope of work, and must be considered together when preparing an estimate.

Estimating the ultimate cost of the project requires the integration of many variables. These variables fall into either direct field costs or indirect field cost. **The indirect field cost** is also referred to as general conditions or project overhead costs in building construction. **The direct field cost** are the material, labour, equipment, or subcontracted items that are permanently and physically integrated into the building (Murat Guanidine, H., &Zeynep Dorgan, S. 2004). For example, the labour and materials for the foundation of the buildings would be a direct field cost. The indirect field costs are the cost for the items that are required to support the field construction efforts. For example, the project site office would be a general conditions cost. In addition, factors such as weather, transportation, soil conditions, labour strike, and material availability need to be integrated into the estimate.

5.2 TYPES OF ESITIMATES:

5.2.1 Detailed estimate:

The detailed estimate includes determination of the quantity and costs of everything that is required to complete the project. This includes materials, labour, equipment, insurance, bonds, and overhead, as well as an estimate of the profit.

5.2.2 Assembly estimating:

In **assembly estimating,** rather than bidding each of the individual components of the project, the estimator bids the components in groups known as **assemblies.** The installation of the components of an assembly may be limited to a single trade or may be installed by many different trades. An example of a simple assembly would be a residential light switch.

5.2.3 Square foot estimates:

Square foot estimates are prepared by multiplying the square footage of a building by a cost per square foot and then adjusting the price to compensate for differences in the building heights, length of the building parameter, and other building components. In some cases, a unit other than square footage is used to measure the size of the building. For example, the size of parking garage may be measure by the number if parking stalls in the garage. The information required to produce a square-foot estimate is much less than is needed to prepare a detailed estimate.

5.2.4 Parametric estimates:

Parametric estimates use equations that express the statistical relationship between building parameters and the cost of the building. The building parameters used in the equation may include the gross square-footage, number of floors, length of perimeter, percentage of the building that is common space, and so forth. For an equation to be useable the parameters used in equations must be parameters that can be determined early in the design process; otherwise the equation is useless (Kaming, P. et al. 1997). Parametric estimates are similar to square-footage estimates; however, the equations used in parametric estimates are more complex and may use log functions, ratios of parameters, and multiplication of parameters.

5.2.5 Model estimating:

Model estimating uses computers to prepare an estimate based on number of questions answered by the estimator. Model estimating is similar to assembly estimating, but it requires less input from the estimator. For example, an estimate may be prepared for a warehouse by answering the following questions:

- What is the length of the building?
- How many bays are along the building?
- What is the width of building?

5.2.6 Excel sheet:

Software, such as **Microsoft excel,** is a powerful tool for the construction estimator. Its usage ranges from simple spread sheets that are used to add up quantities to complex spread sheets that take hundreds of hours to develop and continue evolving over time spread sheets are often used to augment specialized estimating software packages. In 2003, the American society of professional estimators reported that 29% of construction companies used Excel as an estimating tool.

5.2.7 Benefits of computerized estimating:

- They can take off a group of items at the same time. For example, all of the components of an interior wall can be taken off by entering the length and height of the wall. The software then uses formulas to determine the materials needed (number of studs, length of track, rolls of insulation, sheets of dry wall, gallons of dry wall mud, pounds of screws, gallons of paints, etc. and the labour and equipment needed to install them.

- The estimate can be easily and quickly viewed in different formats. For Example the sales tax client with little preparation time.

- The software can prepare standard and custom reports such as material lists

- Changes can be made quickly to the estimates.

Following quantities has been estimated by using excel sheet:

5.3 EXCAVATION:

Calculating the quantities of earth that must be excavated is considered to be one of the most difficult aspects of the estimator's task. Calculating the excavation for the project often involves a great deal of work. The number of cubic yards to excavate is sometimes easy enough to compute but calculating the cost for this portion of the wall is difficult because of the various hidden items that may affect the costs. These include such variables as the type of soil. The required slope of the bank in the excavated area, weather, bracing, and sheet piling wall is required and whether ground water will be encountered and pumping will be required.

5.4 BACKFILL SOIL:

One of the first items the estimators must consider is the type of soil that will be encountered at the site. The estimator may be beginning by investigating the soil borings shown on drawings or included in the specification. When soil borings are provided, the contract documents often absorb the architect/engineer and the owner of any responsibility for their correctness. The estimator must be certain to check any notes on the drawings and the specifications in this regard. Because of such notes and because the specifications for some projects provide no soil in formation, it is a common practice for the estimator to investigate the soil conditions when visiting the site. .

5.5 ESTIMATING BRICK:

The first thing to be determined in estimating the quantity of brick is the size of the brick and the width of the mortar joint. They are both necessary to determine the number of bricks per cubic foot of wall volume and the quantity of mortar. Brick is sold by the thousand units, so the final estimate of materials required must be in the number of units required.

To determine the number of bricks required for a given project, the first step is to obtain the length, width and height of all walls to be faced with brick and then calculate the volume of wall. Make deductions for all openings so that the estimate will be as accurate as possible. Check the jamb detail of the opening to determine whether extra brick will be required for the reveal; generally if the reveal is 4 inches deep, extra brick will be required.

Once the number of cubic feet has been determined, the number of bricks can be calculated. This calculation varies depending upon the size of the brick, width of mortar joint and style of bond required.

5.6 CONCRETE WORK:

Concrete is estimated by the cubic meter or cubic foot. Concrete quantities are measured in cubic meter as it is the pricing unit of the concrete. Roof and floor slabs, slab on grade, pavements and sidewalks are most commonly measured and taken off in length, width and thickness are converted to cubic feet and cubic meter. Often irregularly shaped projects are broken down into smaller areas for more accurate and convenient manipulation.

When estimating footings, columns, beams and girders, their volume is determined by taking the linear footage of each item times its cross-sectional area. When estimating footings for buildings with irregular shapes and jogs, the estimator must be careful to include the corners only once.

5.7 REINFORCEMENT:

- We calculate the weight of steel by using the bar bending schedule. In bar bending schedule we separately list down every type of steel i.e. tie bars, binder bars, positive steel etc...
- Calculate the total length of every type of steel.
- Total length is multiplied with nominal weight of the steel which is obtained by ACI code, giving weight of steel in lbs.
- Convert lbs. into kg or ton depending upon the cost/weight of steel in the market.

5.8 DPC:

DPC is Damp Proof Course which is placed at floor level on walls; it is mostly 2 inches thick. It is used to cut off moisture movement from ground to the structure. It is measured in square feet or square meter. In MES schedule of rate its price is given in square meter. Its area is obtained by multiplying length with the breadth of top surface of wall at floor level. It is usually placed on thin layer of asphalt. Sometimes thin talc sheet is used instead of asphalt.

5.9 PLASTER

Plaster is used for aesthetics of building. It is used to give a smooth surface to walls for painting and tiling. Plaster is always measured in square meter or square feet. In MES schedule of rates it is given in square meter. Its thickness is mostly ½”. Net plastering area is obtained by deducing the openings from the total area.

Struck pointing is placed on outer face of wall. It is also calculated in square meter. Net area is obtained by subtracting openings from the total area. It should be noted that height of the wall used for calculating the struck point is from ground to the top of slab.

5.10 BILL OF QUNATITIES (BQ)

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
1	As in ordinary soil up to 1.5M depth.in foundation and pipe trenches up to 1.5 M wide, in shafts, wells and independent holes up to 30sqm each and throw earth clear of edges of excavation within 10m. Timbering to be paid extra.	1646.1	Cum	01-1 & 01-15	205.67	338565.727
2	Providing and laying RCC Type B, using shingle or gravel in columns, beams, stairs, lintels and the like requiring shuttering, as specified. Reinforcement measured and paid separately supply and fixing.	659.28	Cum	003-023	6222.84	4102593.96
3	Burnt Brick work, in wall 115mm thick, laid and jointed in CM 1:6 straight or to curve with inner radius of 6m and over up to 4.25m depth.	315.68	Kg	004-23	5884.1	1857492.69
5	Burnt brick work, in walls 155mm thick , laid and jointed in CM 1:6 straight or to curve with inner radius of 6M and over, up to G.F roof level.	661.37	Cum	004-12	5448.54	3603500.9

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
6	Burnt brick work, in wall 115mm thick, laid and jointed in CM 1:6 straight or to curve with inner radius of 6M and over, up to 1st floor roof level.	661.37	Cum	4-102	5558.61	3676297.9
7	50mm thick P.C.C 1:2:4 using 3mm aggregate and finished smooth with steel float, covered with two coats each of hot bitumen0.75 kg per sq.m	60.12	Sqm	008-003	434.6	26128.152
8	50mm thick P.C.C 1:2:4 using 3mm aggregate and finished smooth with steel float, covered with two coats each of hot bitumen0.75 kg per sq.m.	480.99	Cum	008-003	3246.78	1561668.71
9	Flood light, luminaries complete with 1×400W, Mercury vapor lamp, choke capacitor, mounting bracket, supply	6	Each	24-738	15816.2	94897.2
10	Gate fancy lights.	4	Each	28-320	460	1840
11	Installation AC unit, wall mounted split type	4	Each	24-812	3686.7	14746.8
12	One fan point, one bell point, controlled by one switch, wiring complete with PVC single core cable 1.5mm in concealed PVC conduit.	576	Each	24-12	1193	687168
13	One fan point, one bell point, controlled by one switch, wiring complete with PVC core cable 1.5 mm^2 in surface PVC conduit.	110	Each	24-13	832.97	91626.7

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
14	Fan electric, AC. Exhaust fresh air circulation 220/230V, SP 50 Cycle, having plastic frame body and plates ,complete with cord operated switch shutter and fixing screw 30cm Pak made, supply and fixing.	110	Each	24-708	2215.13	243664.3
15	3x pin socket One three pin socket outlet, 5 A, point controlled by one switch, wiring complete PVC with single core cable 1.5mm² in concealed PVC conduit	110	Each	24-150	1340.96	147505.6
16	Wall bracket fan fancy plastic body 12" (300mm) YUNAS fan	8	Each	28-201	1735	13880
17	Glazed/non-skid tiles in any colour printed /textured but not exc. 1000 sq. cm. Imported (Asian-origin, China, Malaysia.	971.19	Sqm	27-130	700	679833
18	One three pin socket outlet, 15A, point controlled by one switch, wiring complete with PVC single core cable2.5mm²in concealed PVC conduit.	110	Each	24-166	1535.45	168899.5
19	Switch SP ,5A ,piano type single or two way mounted in cast or malleable iron galvanized conduit box,with solid metal or Bakelite plate , supply and fixing	416	Each	24-246	74.49	30987.84
20	Copper conductor 14 SWG for three pin 5A ,or 3A ,15A,socket outlet point in concealed or surface conduit, but without conduit, supply.	110	Each	24-185	147.96	16275.6

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
21	Fan electric with blades, canopy and rod incl. connection, provision of cable and ceiling rose, for fan 140cm sweep, without regulator, supply and fixing.	110	Each	24-533	3147.02	346172.2
22	Dimmer, for ceiling fan, any sweep, supply and fixing	110	Each	24-546	114.29	12571.9
23	PVC conduit, 20mm dia, complete with all bends, tees, boxes, saddles, etc.. For surface wiring supply and fixing.	3000	m	24-493	59.58	178740
24	Cut out, IC, SP, fussed 15 A supplies and fixing.	4	Each	24-447	131.8	527.2
25	Wiring in conduit surface, concealed, flame proof, with single core PVC insulated cable installed and connected complete one single core cable, $4mm^2$ and supply and fixing.	6000	m	24-664	55.5	333000
26	Steel box (16BG) for main switch distribution board and meter, type B duly painted with premier and two ports of synthetic enamel paint supply and fixing.	110	Each	25-343	5232.45	575569.5
27	PVC straight joint, HT ,11 KV for XLPE cable, consisting of mould resin, HT tape, semi conducting tape, ferrules and earth wire etc... suitable for HT cables three core $120mm^2$ to $185mm^2$	110	Each	24-299	2189.94	240893.4
28	Bathroom light fitting complete with fluorescent tube, 0.3M, 10 W, choke, starter, and plastic cover.	110	Each	24-222	396.01	43561.1

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
29	Telephone cable, two pairs copper conductor 0.6mm dia, PE insulated, PVC sheathed, supply and fixing.	1220	m	24-779	33.56	40943.2
30	Energy saver, plain ,14W	2500	Each	28-241	195	48750
32	Union socket GI /MS screwed BSP, 15mm dia, supply and fixing.	110	Each	18-148	69.9	7689
33	Gas water heater, complete with burner pilot, thermostat and safety valve, 68 lit , capacity , supply and fixing.	27	Each	26-55	14353.7 8	387552.06
34	Gas water heater, complete with burner pilot, thermostat and safety valve, 68 lit, capacity, supply and fixing.	110	Each	26-63	3907.96	429875.6
35	Sui gas meter, commercial, complete with brass coupling supply and fixing.	1	Each	26-96	7267.83	7267.83
36	Fire extinguisher CO_2, 6 kg capacity.	6	Each	28-335	4500	27000
37	Fire extinguisher dry powder type, 6 kg capacity	6	Each	28-336	1600	9600
38	Electric water cooler 30 lit, TASFA Model TS-033.	6	Each	28-248	22000	132000
39	Pedestal fan DELUXE 20" YUNAS.	4	Each	28-222	3165	12660
40	Supply of aluminium sliding window of anodized Champagne extruded sections exc... 1524mm, but not exc... 3048mm height as specified wood or steel frames with all necessary equipment’s.	163.56	sqm	07-50 & 16-5	5572.79	911485.532

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
41	Supply of aluminium sliding window of anodized Champagne extruded sections exc... 1524mm, but not exc... 3048mm height as specified wood or steel frames with all necessary equipment. Supply and fix, 3 mm thick Milky glass fixed to timber with putty as specified.	245.3	Sq.m.	07-50 & 16-6	5572.79	1367005.39
42	Supply of aluminium sliding window of anodized Champagne extruded sections exc. 1524mm, but not exc. 3048mm height as specified wood or steel frames with all necessary equipment.	40.14	sqm	07-50 & 16-7	5572.79	223691.791
43	Wood door panels single panel.	214.5	sqm	003-124	3829.49	821425.605
44	Wood door panels single panel.	178.9	sqm	003-124	3829.49	685095.761
45	Main entrance gate.	72	sqft	003-41	11987	11987
46	Supply and fix, CP locks, rim or latch, 150mm with two bolts and two levers, in any shape, best quality, 2 keys.	110	Each	08-94	380.44	41848.4
47	Fix, CP locks, rim or latch, 150mm with two bolts and two levers, in any shape, best quality,2 keys	110	Each	08-95	380.44	41848.4

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
48	Supply and fix, 150mm patent Helical Japanese make, steel spring for doors.	110	Each	08-243	248.48	27332.8
50	Supply and fix, WC apparatus European pattern ,complete ,comprising closet, 13 lit flushing cistern ,glazed, low down flush pipe , seat cover etc... (non coupled)	110	Each	17-4	5047.17	555188.7
53	Supply and fix, plastic shelf complete, in any size and shape, PAK made, with plugs and screws fixed to concrete, brick, stone or wood work.	110	Each	17-101	763.16	83947.6
54	Supply and fix, toilet paper holder, any shape pattern and size, imported, with plugs screws etc... Complete, fixed to concrete, brick, stone and woodwork.	110	Each	17-104	1914.66	210612.6
55	Supply and fix, towel rail ,CP , single rod, any pattern, shape and size, PAK made, with plugs, screws etc.., fixed to concrete, brick, stone or wood work.	110	Each	17-112	800.03	88003.3
56	Supply and fix, shower tray of fibre glass acrylic, including coupling etc... 940 mm ×940 mm in any colour, best quality, PAK made.	106	Each	17-71	6132	649992

S/No	Description of work	Qty.	Units	Code	Rate	Amount (PKR)
58	Supply and fix, WI hat pegs strong make 125mm or over.	440	Each	08-185	39.27	17278.8
59	Supply and fix, curtain rail C type with fitting complete best quality as specified.	220	Each	08-253	99.13	21808.6
60	Supply and fix, knobs 30 mm cupboard plain, with screwed end.	330	Each	08-224	43.77	14444.1
61	13mm thick cement plaster 1:6 finished as specified.	12257.724	sqm	13-7	130.03	1593871.85
					TOTAL	***39409475.8/-***
						39.4 millions

Chapter 6

PROJECT MANAGEMENT PLAN BY USING PRIMAVERA

6.1 PROJECT SCHEDULING

Project scheduling deals with planning of time and establishment of dates during which various resources will perform the activities required to complete the project (Liberatore, M. J., et. al, 2001). The scheduling activities integrate info on several aspects of project including estimated duration of activities, the technological precedence relations among activities, constraints imposed by the availability of resources and the budget, and if applicable, due date requirements. This info is processed into an acceptable schedule by appropriate models, most often the network type. By developing a schedule the project manager is planning the project and by comparing the actual execution dates of tasks with the schedule dates he monitors the projects and thus increasing control over the projects.

6.2 INTRODUCTION TO PRIMAVERA PROJECT PLANNER P6:

The project management module provides

- An enterprise project structure which enables project managers to manage multiple projects from the highest level of organization to the individuals that perform specific project tasks.
- Integrated risk management
- Issue tracking
- Management by threshold
- Work products and documents that can be assigned to activities and managed centrally
- A report wizard that help us to create customized report to extract any data.

6.3 PLANNING

- Establish project objectives and the scope of work
- Delineate project organization
- Define work

- Determine timing
- Establish resource requirement
- Establish cost budget
- Evaluate, optimize and freeze the baseline plane
- Distribute info to all others who are responsible for execution of work.

6.4 CONTROL

- Monitor work in progress and actual costs after fixed intervals
- Compare with actual progress and cost data to baseline
- Analyze and evaluate performance
- Recommend action and reforecast the situation
- Check continuously whether the project is in the scope or not

6.5 PROJECT SCHEDULING METHODS

The schedule can be presented in various ways

6.5.1 Gantt Chart or Bar Chart:

A Gantt chart is used to view a graphical display of the open project's schedule information of the order in which activities occur over the course of the project. The Gantt chart shows each activity's duration as a horizontal bar. A line connecting activity bars indicates the relationship.

6.5.2 Network arrow diagram:

A diagram showing logical flow of activities to be done to complete a project is called network logic diagram. Network Logic diagram is created by first defining activities in a project and developing relationships

6.6 NETWORK SCHEDULING TECHNIQUES USED IN CONSTRUCTION PLANNING:

The basic approach to all project scheduling is to form an actual or implied network that graphically portrays the relationship between the tasks and the milestones in the project. Several techniques were evolved during the 1950s for organizing and representing this basic information. The best known today are PERT and CPM. The major difference between the two is that CPM assumes that activity durations are deterministic, while PERT views the time to complete an activity as a random variable that can be characterized by an optimistic and pessimistic and a most likely estimate of durations. PERT/CPM is based on a diagram that represents the entire project as a network of arrows and nodes. The resulting diagram can be used to identify potential scheduling difficulties, to estimate the time needed to finish the entire projects and to improve coordination amongst the participants. To apply PERT/CPM a thorough understanding of project requirements and structure is needed. The efforts spent in identifying activity relationships and constraints yield valuable insight of projects.

Four things should be known before beginning modeling:

- What are the main project activities?
- What are the sequencing requirements or constraints of these activities?
- Which activity can be conducted simultaneously?
- What are the estimated duration requirements for each activity?

PERT/CPM are easy to understand and use. And while computerized version is available for both small and large projects, manual calculations are also suitable for many everyday situations. That is why these network scheduling techniques and generally used for planning and construction projects

6.6.1 Critical path method (CPM):

CPM is a useful technique that determines the longest path in a network diagram. It is more popular due to its advantageous features as compared to construction planning and scheduling techniques. Some of the key advantages and disadvantages are as follows:

- CPM can handle very large and complex projects having large number of activities
- There is a logical thinking of the sequence of events that must take place on site
- It can effectively handle the relationship between activities whereas traditional techniques don’t support it
- CPM not only sets up a discipline in planning and scheduling of a project but they also enable the control of a project to be carried out within strictly defined limits
- The use enables the attention to be focused on a few critical activities that are likely to have most effect on the duration of the project
- The Network diagram provides an effective means to clear arid certain communications and coordination between the parties bound together by a contract

- The use of a Network diagram can show the effect of non-delivery of items on the whole of the project duration
- It can be used with a computer and this permits the integration of project management information system

Following are some of the disadvantages of CPM:

- Current status of the project cannot be seen easily
- There is no need to include dummy activities
- The presentation of network diagram can be very time consuming.

6.6.2 Program evaluation and review technique:

PERT was developed to overcome the difficulty associated with planning projects for which duration with specific activities could not be estimated reliably. PERT, like traditional CPM, assumes that specific activities and then precedence relationships can be clearly defined for a particular project PERT makes use of powerful mathematical tools of probability and statistics.

6.7 METHODOLGY

For planning and scheduling of multi- story building PRIMA VERA P6 has been used.

6.7.1 Data input stage:

6.7.1.1 Making a work breakdown structure:

To enter the data into primavera project planner P6 we organized the data collected from BG in such a way that we were able to make an overview of all activities. We made a logical work breakdown structure so that work can be divided in an intelligent way. We have divided the construction activities of whole building into small manageable activities. This splitting of work is called work break down structure.

6.7.1.2 Enteringactivities:

Then activities were clearly identified and inserted in p5.Every activities is given a unique activity id by which software recognizes that particular activities. Subsequently every activity was given WBS code and activity code to recognize activities in a way we want.

6.7.1.3 Assigning durations:

From daily progress reports we concluded the amount of work contractor firm can do with limited resources available on site. Based on these duration we calculated the duration required for all type of structural work .Durations of all other work is based on amount of work and work that can be done in one day with a limited amount of resources.

6.7.1.4 Activity relationships:

Activities in each group are such that first steel for columns and shear wall is fixed and then form work is placed and concrete is poured. And sequence is such that any activity in successor group will not start unless same activity is finished in predecessor group.

Once structure on any floor is completed formwork will be removed after 14 days as per specification. And brick work will start on that floor. After completion of brick work first fix the electrical works and sanitary system is done simultaneously.

Then plastering done on bricks followed by second fix of electrical works then skim coat is done after which final fix of all work is done. Marble work and metal work is done just when brick work is finished. Then a final coat of paint will be applied.

6.8 PROJECT CALENDARS:

Work week calendar for whole project is also as per specification. According to specifications all national holidays of Pakistan will be observed as none work time. Sundays will also be observed as a holiday. Concreting can be done at nights so calendar followed by concreting is of 24 hrs.

6.9 TERMINOLOGY INVOLVED IN P6:

6.9.1 Activity:

Activity represents work to be done in order to complete a project.

6.9.2 Durations:

The estimated time required to complete an activity is called original duration .the amount of time left to complete an activity after it has started is known as remaining duration

6.9.3 Predecessor:

An activity that must be done before starting another activity is called predecessor activity. A predecessor activity controls the start or finish date of its successor.

6.9.4 Successor:

An activity that must occur after another activity is known as successor activity. An activity can have multiple successors each with different relationship to it.

6.9.5 Lag

Delay from an activity to its successor is known as its lag. Lag can be positive or negative .it is measured in planning units for the projects.

6.9.6 Relationships:

Any sort of connection between two activities is known as relationship. There are four different steps of relationship.

6.9.7 Start to start relationship:

Relationship between activities in which the start of the successor activities depend on the start of its predecessor is called as start to start relationship.

6.9.8 Finish to start relationship :

Relationship in which the start of successor activity depends upon the completion of its predecessor activity

6.9.9 Finish to finish relationship :

Relationship in which the finish of successor activity depends on the finish of its predecessor activity

6.9.10 Early start and early finish dates :

Earliest possible dates by which an activity can be started/finished are called early start/finish dates. Early dates are calculated in forward pass

6.9.11 Late start and late finish dates :

Latest possible dates by which an activity can be started/finished are called late start/finish dates. Late dates can be calculated in backward pass.

6.9.12 Forward pass :

The process of calculating start and finish dates of each activity starting from the project start date is called forward pass. This process generates early start and early finish dates for each activity.

6.9.13 Backward pass :

The process of calculating start and finish date of each activity starting from the project finish date is called backward pass.

6.9.14 Actual start and actual finish dates:

Actual start and actual finish dates are the dates on which the activity has actually started and finished are called actual start and actual finish dates

6.9.15 Total float:

The activity can be delayed without affecting the project finish date its duration is measured in planning units. Negative or zero total float indicates that timely completion of the activity is critical to the completion of project.

6.9.16 Free float:

The early start of an activity can be delayed without delaying early start of a successor activity. Such activities are called non critical activities. Free float is measured in planning units.

6.9.17 Constraints:

A restriction imposed on an activity in the form of early or last date is known as constraints.

6.9.18 Critical path:

Critical path is chain of activity that has potential of delaying a project both total float and free float for critical activities are zero

6.9.19 Forward pass :

The process of calculating start and finish dates of each activity starting from the project start date is called forward pass. This process generates early start and early finish dates for each activity.

6.10 SUMMARY

Effective management plan has been made for construction of block. Project has been categorized as ground floor work and first floor work. After assigning predecessors and successors to required activities, the total project duration comes out to be 310 working days. Outputs are annexed. Project will start at 5th April 2014, and it will end at 8th April 2015.

Chapter 7

SUMMARY OF FINDINGS AND RECOMMENDATIONS

7.1 SUMMARY

Keeping in view the perspective of architecture and structure block has been designed. Architecturally climatic conditions and requirements of the inhabitants have been taken care of. Allied facilities like gymnasium, Mosque has been provided in the block as well. A beautiful lawn at the Centre of the block is provided. And lawn is decorated with the beautiful flowers and plants. Desired motive of design the block's frame structure by using ETABS has also been achieved. In frame structures the design of beam and column has been incorporated. Manual calculation of composite structures has been done by using moment coefficient method. Design consideration for both methods has been satisfied the ACI 318-08 requirements. Footing has also been designed by using 0.5TSF as bearing capacity of Risalpur soil. The foundation provided is typical three steps foundation. Width of footing pad comes out to be 4'. The cost of composite structures has been estimated as 39.4 million. After that, bill of quantities has also been prepared by using MES schedule of rate 2010. A project management plan has been made by using PRIMAVERA 6.0. Project has been scheduled according to the proceeding of activities during construction of block. Total working days during planning and scheduling of project come out to be 310 working days. The proposed and planned project objectives completed successfully and will be an asset for Corps of Engineers and Technical Graduate Courses.

- Designed block consists of three blocks in total; 2 x blocks consist of 32 rooms and one block consists of 40 rooms. Total numbers of rooms are 104.
- Total area (Land) is 250' x 200' = 50,000 sq. ft.
- Mosque, Gymnasium and Cafeteria is incorporated as allied facilities.
- Total construction cost of project is estimated as RS 39.4 million with cost per square foot calculated as PKR 1877.
- Total project completion duration is calculated by using PRIMAVERA as 310 working days.
- Lawns are also provided to add the architectural beauty of the block.

7.2 RECOMMENDATIONS

Value can be added to the project by incorporating the following into the project as future work:

- The Energy Efficiency Analysis of the proposed structure of the new Technical Cadets Block could be carried out to ensure an energy conservative design.
- Fire-Safety Analysis of the proposed structure could be incorporated into the design procedure.
- Design of the new building could incorporate the effect of Seismic Loading according to the zoning of the area of Risalpur.
- Risk Management Plan could be drafted in order to facilitate the project manager(s) to take informed decisions and develop preparedness.

References

Adeli, H., & Wu, M. (1998). Regularization neural network for construction cost estimation. Journal of Construction Engineering and Management, 124(1), 18-24.

Day, C. (2004). Places of the soul: Architecture and environmental design as a healing art. Routledge.

Fielding, R. T., (2000). Architectural styles and the design of network-based software architectures (Doctoral dissertation, University of California).

HassanienSerror, M., Inoue, J., Adachi, Y., &Fujino, Y. (2008).Shared computer-aided structural design model for construction industry (infrastructure).Computer-Aided Design, 40(7), 778-788.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997).Factors influencing construction time and cost overruns on high-rise projects in Indonesia.Construction Management & Economics, 15(1), 83-94.

Kostof, S. (1995). A history of architecture: settings and rituals. New York: Oxford.

Lang, J. T., &Moleski, W. (2010).Functionalism Revisited: Architectural Theory and Practice and the Behavioral Sciences. Ash gate Publishing, Ltd.

Liberatore, M. J., Pollack-Johnson, B., & Smith, C. A. (2001). Project management in construction: Software use and research directions. Journal of Construction Engineering and Management, 127(2), 101-107.

Murat Guanidine, H., &ZeyneDoğan, S. (2004). A neutral network approach for early cost estimation of structural systems of buildings.International Journal of Project Management, 22(7), 595-602

Somayaji, S. (2001).Civil engineering materials. Pearson Education India