SONARGAON UNIVERSITY (SU)

Analysis and Design of a Six Storied Residential Building in Dhaka City by Using ETABS Software

This thesis is submitted to the Department of Civil Engineering of Sonargaon University in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Civil Engineering.

Submitted by:

MOHAMMED SHOHEL CHOWDHURY- ID: BCE 1402002814

ASHOKA KUMAR SARKER- ID: BCE 1402002804

SHILPY AKTER - ID: BCE 1402002816

AL ASMA UL HUSNA- ID: BCE 1402002815

ABDULLA AL MASUD- ID: BCE 1402002285

Submitted to:

Mr. Manzur Rahman

Lecturer,

Department of Civil Engineering

CONTENTS

CHAPTER-03: METHODOLOGY

CHAPTER-04: MODELING IN ETABS

CHAPTER-05: ARCHITECTURAL, STRUCTURAL, ELECTRICAL & PLUMBING DRAWING

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ACI =American Concrete Institute.

BNBC =Bangladesh National Building Code.

a =Depth of equivalent rectangular stress block, inch

A_g =Gross area of column, in^2.

A_s =Area of flexural tension steel, in^2.

A_{st} =Total area of longitudinal reinforcement, in^2.

b =Width of compression face of member, in.

b_e =Effective flange width, inch.

b_w =Web width, inch

β_t =Ratio from extreme compression fiber to neutral axis ,

c = Distance from extreme compression fiber to neutral axis, inch.

d = Distance from extreme compression fiber to centroid of non pre stressed tensile reinforcement, inch.

E_c = Modulus of elasticity of concrete = $33\ w^{1.5}\sqrt{f'c}$

f'_c = Compressive stress of concrete, psi.

f_y = Yield strength of steel reinforcement , psi.

h_f =T-beam flange thickness, inch.

S = Spacing of shear ties measured along longitudinal axis of member, inch.

V_c = Nominal shear strength provided by concrete, lb.

V_n = Nominal shear strength at section, lb.

$\Phi\ V_n$ = Design shear strength at section, lb.

V_s =Nominal shear strength provided by reinforcement, lb.

V_u =Factored shear force at a desired section, lb

LETTER OF TRANSMITTAL

December 2015

To

Manzur Rahman

Lecturer,

Department of Civil Engineering

Sonargaon University

Subject: Submission of project report.

Sir,

This is our great pleasure that we are submitting here with the project report on Design and analysis of six storied residential building in Dhaka City by using ETABS software. It is an important topic. The project report has been done according to the requirement and guidelines of the Sonargaon University.

We hope that this report will certainly help you in evaluating our project report on Design and analysis of six storied Residential Building. We would be very happy to provide any assistance in interpreting any part of the paper, whenever necessary.

Thanking you,

Sincerely yours,

Mohammed Shohel Chowdhury- ID: BCE 1402002814

Ashoka Kumar Sarker- ID: BCE 1402002804

Shilpy Akter- ID: BCE 1402002816

Al Asma Ul Husna- ID: BCE 1402002815

Abdulla Al Masud- ID: BCE 1402002285

DECLARATION

This is to declare that the work and material presented in the report has been carried out by us and has not previously been submitted to any University/College/Organization for any academic qualification.

We hereby ensure that the work that has been presented does not breach existing copyright.

We undertake to indemnity the university against any loss or damage arising from breach of the foregoing obligation.

Thanking you

Sincerely your

Mohammed Shohel Chowdhury- ID: BCE 1402002814

Ashoka Kumar Sarker- ID: BCE 1402002804

Shilpy Akter- ID: BCE 1402002816

Al Asma Ul Husna- ID: BCE 1402002815

Abdulla Al Masud- ID: BCE 1402002285

SONARGAON UNIVERSITY (SU)

CERTIFICATION

This is to certify that the Project report on "**Analysis and Design of a Six Storied Residential Building in Dhaka City**" is the bonafide record of Project work done by Mohammed Shohel Chowdhury- Id: BCE 1402002814, Ashoka Kumar Sarker- Id: BCE 1402002804, Shilpy Akter- Id: BCE 1402002816, Al Asma Ul Husna- Id: BCE 1402002815, Abdulla Al Masud- Id: BCE 1402002285

The project report may be accepted as it fulfills the requirements for the degree of B.Sc. in Civil Engineering from the Sonargaon University (SU).

This Project paper has been carried out under my guidance and is a record of a successful work.

Supervisor

(Manzur Rahman)

Lecturer,

Department of Civil Engineering

Sonargaon University

71 Kawran Bazar , Dhaka

Bangladesh

ACKNOWLEDGEMENT

All praises and profound gratitude to the almighty Allah who is the most beneficent and the most merciful for allowing great opportunity and ability to bring this effort to fruition safety and peacefully.

The authors are grateful to **Professor M.A Razzaque (The Honorable Vice Chancellor of the Sonargaon University)** for creating such opportunity for us to pursue studies in acquiring the degree of B.Sc. in Civil Engineering.

The authors would like to express his deepest gratitude, sincere appreciation to his supervisor **Md. Manzur Rahman** Lecturer, Department of Civil Engineering, Sonargaon University (SU), for his constant supervision, continuous guidance, helpful criticism, affectionate encouragement and invaluable suggestion, generous help and valuable advice was the source of the author's inspiration.

The authors are also grateful to Lecturer **MR. SAIFUDDIN AHMED,** Course coordinator, Department of Civil Engineering, Sonargaon University, for his inspiration and providing facilities to complete the project and thesis work.

The authors feel extremely privilege to thank the most respected teachers **MD. ARIFUZZAMAN, Assistant Professor, Sonargaon University, MD. SHAFIUL ALAM, Lecture, Sonargaon University , MD. NUR BASIT ZAMAN, Lecture, Sonargaon University , TAFSIROJJAMAN, Lecture, Sonargaon University , ABDULLAH AL HASIB, Lecture, Sonargaon University** for their proper guidance and encouragement in this thesis work.

Finally, the authors would like to express gratitude to all of the teachers of the University for their co-operation and dedicated teaching toward the achievement of the degree of B.Sc. in Civil Engineering. The co-operation and assistance of all the officers and staff of the Sonargaon University are heart fully acknowledged.

Last but not the least; the authors would like to express his deepest gratitude and appreciation to his parents, relatives and many friends for their constant inspiration and encouragement

Authors

ABSTRACT

Structural designing of a building is the responsibility of a Civil Engineer. Engineer must keep in mind the economic, aesthetics, safety and other aspects of any project. This study concentrates on designing structural parts of a six storied residential building of an arbitrary plan for the Dhaka zone. As per requirement, structural design and analysis of a six storied residential building has been done by considering all types of gravitational and lateral load.3d nonlinear computer aided analysis is done by using ETABS software (Extended Three Dimensional Analysis of Building System).

In this analysis, inputs those are required for the design of building structure have been successfully applied. After analysis we have got the values of bending moment, axial force, shear force etc. for the frame. By using these values, design of foundation, grade beam, column and slab has been done.

There is another thing to consider for the design of the building that is strength of the steel. Strength of the steel is largely dependent upon the strength of the concrete. Sometimes (for high rise building) high strength steel makes the design economic. When highly concentrated loading condition appears to a building then high strength steel makes design economic. Otherwise to resist such highly concentrated load larger section is required which will not be aesthetical and economical.

The results obtained from slabs, beams, columns after analysis and design, are used for preparing the reinforcement detailing and drawings by using Auto CAD.

CHAPTER -1

INTRODUCTION

CHAPTER-01

INTRODUCTION

1.1 GENERAL

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS Version 9 features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviors, making it the tool of choice for structural engineers in the building industry. The full meanings of ETABS is Extended 3D (Three Dimensional) Analysis of Building Systems.

1.2 HISTORY AND ADVANTAGE OF ETABS

Dating back more than 30 years to the original development of TABS, the predecessor of ETABS, it was clearly recognized that buildings constituted a very special class of structures. Early releases of ETABS provided input, output and numerical solution technique that took into consideration the characteristics unique to building type structures, providing a tool that offered significant savings in time and increased accuracy over general purpose programs. Welcome to ETABS.

As computers and computer interfaces evolved, ETABS added computationally complex analytical options such as dynamic nonlinear behavior, and powerful CAD-like drawing tools in a graphical and object-based interface. Although ETABS Version 9 looks radically different from its predecessors of 30 years ago, its mission remains the same: to provide the profession with the most efficient and comprehensive software for the analysis and design of buildings. To that end, the current release follows the same philosophical approach put forward by the original pro-grams, namely:

Most buildings are of straightforward geometry with horizontal beams and vertical columns. Although any building configuration is possible with ETABS, in most cases, a simple grid system defined by horizontal floors and vertical column lines can establish building geometry with minimal effort.

Many of the floor levels in buildings are similar. This commonality can be used to dramatically reduce modeling and design time.

The input and output conventions used correspond to common building terminology. With ETABS, the models are defined logically floor-by-floor, column-by-column, bay-by-bay and wall-by-wall and not as a stream of non-descript nodes and elements as in general purpose programs. Thus the structural definition is simple, concise and meaningful.

In most buildings, the dimensions of the members are large in relation to the bay widths and story heights. Those dimensions have a significant effect on the stiffness of the frame. ETABS corrects for such effects in the formulation of the member stiffness, unlike most general-purpose programs that work on center-line-to-centerline dimensions.

The results produced by the programs should be in a form directly usable by the engineer. General-purpose computer pro-grams produce results in a general form that may need additional processing before they are usable in structural design.

1.3 REINFORCED CONCRET

Reinforced concrete (RC) buildings are very common all over the world due to various advantages over other building. Reinforced concrete (RC) buildings have the advantage like durability, fire resistance, speed of construction, cost, availability of labour and materials. concrete is a stone like materials is made by mixing cement ,water, fine aggregate(often sand),course aggregate and frequently other additives into a workable mixture. Again the reinforce concrete is strongly bonded to the concrete, a strong, stiff, and ductile construction materials is called reinforced concrete. The reinforced concrete is used extensively to constructs. Foundations, structural frames, storage tanks, shells, walls, dams, canals, and innumerable other structures and building products.

The reinforced concrete is non- homogeneous material that creep, shrinks, and cracks, its stress cannot be accurately predicted by the traditional equations derived in a course in strength of materials for homogeneous elastic materials. Therefore the design equation and design method are based on experimental and time proven results instead of being derived exclusively from theoretical formulations.

In almost every branch of civil engineering and architectural, extensive use made of reinforced concrete for structure and foundations. Engineers and architects therefore require a basic knowledge of reinforced concrete design throughout their professional careers. Much of this text is directly concerned with the behavior and proportioning of the component that makes up typical reinforced concrete structures-beam, columns, and slabs. Once the behavior of these individual elements is understood, the designer will have the background to analyze and design a wide range of complex structure, such as foundation, buildings, and bridge, component of these elements.

1.4 OBJECTIVES OF THE STUDY

The main objectives of the present study are as follows:

1. To study about the various components of a six storied residential building.
2. To study on the different types of loads and their combination.
3. To analyze and design of a six storied residential building.
4. To Draw Architectural, Structural, Electrical & Plumbing drawing by using Auto Cad

1.5 SCOPE S OF THE STUDY

The main scopes of the present study are as follows:

- The study for residential building,
- The study includes for a particular soil properties and material properties,
- The study includes only for a particular architectural plan,
- The study the design of critical panels of slab, maximum loaded beams and columns under a particular loading condition for beam supported slab systems, foundation design.
- The beam supported slab are designed by using co-efficient method (ACI Code)

1.6 OUTLINE OF METHODOLOGY:

- The preparation of residential building architectural plan,
- Analysis,
- Structural design,
- Find out the amount of reinforcement.
- Conclusion and recommendations

CHAPTER -2

LITERATURE REVIEW

CHAPTER-02

LITERATURE REVIEW

2.1 GENERAL:

Concrete has its first modern record as early as 1760, when John Sheaton used it in the first lock on the river Calder [1].the walls of the lock were made of stones filled in with concrete. In 1796 J. Parker discovered roman natural cement, and 15 years later vacate burn a mixture of clay and lime to produce cement. In 1824 Joseph Aspdin manufactured Portland cement in wake field, Britain. it was called Portland cement because when it hardened, it resembled stone from the quarries of the Isle of Portland. In France, Francois mart le burn built a concrete house in 1832 in mosaic, in which he used concrete arches of 18 feet spans. He used concrete to build a school in St Aignan in 1834 and a church in Corbariece in 1835.

Joseph lousis lambot exhibited a small rowboat made of reinforced concrete at the Paris exposition in 1854.in the same year W.B. Wilkison of England obtained a patent of a concrete floor reinforced by twisted cables. The Frenchman Francois signet obtained his first patent in 1855 for the system he used of iron bars, embedded in concrete floors that that expended to the supports. One year later, he added nuts at the screw ends of the bars, and in 1869 he published a book describing the applications of reinforced concrete. Joseph Monier, who obtained his patent in Paris on July 16, 1876, was given credit for the invention of reinforced concrete. He made garden tubs and pots of concrete reinforced with iron mesh which he exhibited in Paris in 1867.

In 1873 he registered a patent to used reinforced concrete in tanks and bridges, and four years later he registered a patent to use it in a beams and columns. In the United States Thaddeus Hyatt conducted flexural tests on 0 beams that contained iron bars as tension reinforcement and published the result in 1877.He found that both concrete and steel can be assumed to behave in homogeneous manner in all practical purposes. This assumption was important for the design for reinforced concrete members using elastic theory. He used prefabricated slabs in this experiment and considered that prefabricated units were best cast of T-section placed side by side to form a floor slab. Hyatt is generally credited with developing the principles upon which the analysis and design of reinforced concrete is now based.

A reinforced concrete house was built by W.E. Ward near Port Chester, New York, in 1875.It used reinforced concrete for walls, beams, slabs and stair cases. P.B. Write wrote in the American Architect and building news in 1877, describing the application of reinforced concrete in Wards house as a new method building construction. E.L. Ransome, head of the concrete steel company in san Francisco, used reinforced concrete in 1879 deformed bars for first time in 1884.During 1889-1891, he build the two stories Leland Stanford Museum in san Francisco using reinforced concrete. He also built a reinforced concrete bridge in San Francisco. In 1900, after Ransom introduced the reinforced concrete skeleton, thick wall system started to disappear in construction. He registered the skeleton type of structure in 1902 using spiral reinforced in the column as was suggested by Armand consider of

France. A.N. Talbot of the university of Illinois, and F.E. Turneaure and M.O. Withney , of the University of Wisconsin, conducted extensive tests on concrete to determine its behavior, compressive strength, and modulus of elasticity . In Germany, G.A. Wayass bought the French Monier patent in 1879 and published his book on Monier methods of construction in 1887.Rudolph Schuster bought the patent right in Austria and the name of Monier spread throughout Europe, which is the main reason for crediting Monier as the inventor of reinforced concrete.

In 1900 the ministry of public works in France called for committee headed by Armand consider, chief engineer of roads and bridge, to established specification for reinforced concrete, which were published in 1906. Reinforced concrete was farther refined by introducing some pre-compression in the tension zone to decrease the excessive cracks. This refinement was the preliminary introduction of partial and full pre-stressing. In 1928 Eugune Fre yssnet established the practical technique of using pre-stressed concrete. From 1915 to research was conducted on axially loaded columns and creeps effect of concrete, in 1915 eccentrically loaded columns were investigated. Ultimate strength design started to receive special attention in addition to diagonal tension and pre-stressed concrete. The American concrete institute code (ACI) specified the use of ultimate strength design in 1963 and include this method in all later code. Building codes and specification for the design of reinforced concrete structures established in most countries and research continuous on developing new application and more economical design.

2.2 DESIGN CONSIDERATION:

In the big cities where pressure on land is too large due to rapid growth of industry and also cues to greater trend towards urbanization vertical expansion is the only answer. This necessitated the adaption of multistoried construction. The multistoried building may be the framed construction either with R.C.C or steel. Steel framed construction offer maximum economy in space and quicker progress of construction provided that availability of steel is required is assumed. The R.C.C framed type of construction is however much cheaper for building up to 7 to 8 story different being 7.5% to 12.5%.This takes into consideration the increasing of structural framework in R.C.C for the purpose of protection against oxidation and corrosion as well as fire resistance.

The design of a structural building is achieved by performing in general main two steps:

- Determining the different forces acting on the structure,
- Proportioning all structural members economically, safety, stability, serviceability and functionality,

Structural concrete is one of the materials commonly used to design all type of buildings. It has two component materials, concrete and steel work together to form structural members that can resist many types of loadings. Concrete resists indicate all types of concrete used in structural applications. Structural concrete may be plain, reinforced, pre-stressed or partially pre-stressed concrete.

In addition concrete is used in composite design. Composite design is used for any structural member, such as beams or columns, when the member contains combination of concrete and shapes.

2.3 ULTIMATE STRENGTH DESIGN (USD)

The design of reinforced concrete structure can be performed by either of two alternative methods. The first of these direct attention to stress conditions within the structural member under working loads and is known working stress design. The second focus on the strength capacity of conditioned corresponding to failure and is known as ultimate strength design.

U.S.D method

1. Members are proportioned so that the full strength of the cross section is just utilized when the ultimate loads is applied.

2. U.S.D Methods permit and accurate appraisal of strength capacities of member and so permit and evaluation of actual factory of safety of against failure.
3. U.S.D Methods include adequate safeguards to ensure that conditions at working loads.

2.4 ADVANTAGES AND DISADVANTAGES OF R.C.C

The advantages of reinforcement concrete can be summarized as follows:

- It has a relatively high compressible strength.
- It has better resistance to fire than steel.
- It has a long service life with low maintenance cost.
- In some type structure such as dams, pier sand footing it is the most economical structural material.

The disadvantages of reinforced concrete can be summarized as follows:

- It has low tensile strength of about one tenth of compressive strength.
- It needs mixing casting and curing all of which affect the final strength of concrete.
- The cost of the forms used to cast concrete is relatively high. The cast of form materials and artisan may equal the cost of concrete placed in the forms.
- It has a low compressive strength as compared to steel (the ratio is about 1:10 depending on materials) which leads to large section in column of multistory buildings.
- Cracks develop in concrete due to shrinkage and the application of live loads.

2.5 DIFFERENT TYPES OF LOADS FOR BUILDING

Structural members may be design to support specific loads. Loads are those forces which a given structure should be proportional. In general loads may be classified as follows.

- Dead loads.
- Live loads.
- Environmental loads (Wind loads & Earthquake loads).
- Miscellaneous loads.

(i)Dead load

Dead loads include the weight of structure (it's self-weight) and any permanent materials placed on the structure such as tiles, footing and walls. The following weights of the building materials to are considered. (BNBC-1993).

Table 2.1: Unit weight of building materials:

Material	Pcf
Floor tiles, pier in thickness	10
Stone, concrete walls per inch of thickness	12
Bricks masonry common	120
Concrete, bricks bars	120
Concrete, reinforced stone	150

(ii) Live load

The live loads are governed by the type of occupancy of the building. Minimum live load for floors and roofs are given the building regulations of the various cities and the designer to make his computations in accordance with the loads specified. In general live loads are due to human occupancy, furniture, equipment stored materials and occasionally movable partitions.

Table 2.2: Live loads for various occupancies:

Occupation or use	
Apparent	
(a) Private suites	40
(b) Corridors	100
(c) Room for assembly	100
Building for public assembly	
(a) Corridors	100
(b) Room with fixed seats	60
(c) Room with movable seats	100
Dwelling	40
Factories	125
Garages	100
Public rooms	100
Office building	
(a) Offices	80
(b) Public spaces	100

Restaurants	100
Schools or collages Assembly rooms Class rooms with fixed seat Class rooms with movable seats	 100 40 80
Stairways and fire towers	100
Stress (a) First floor (b) Upper floor	 125 75

2.6 COMPONENTS OF STRUCTURAL BUILDING

(i) Beam

Beam can be described as members that are mainly subjected to flexure and it is focus on the analysis of bending moment, shear, and deflection. When the bending moment acts on the beam, bending strain is produced. The resisting moment is developed by internal stresses. Under positive moment, compressive strains are produced in the top of the beam and tensile strains in the bottom. Concrete is a poor material for tensile strength and it is not suitable for flexure member by itself. The tensile side of the beam would fail before compression side failure when beam is subjected a bending moment without the reinforcement. For this reason, steel reinforcement is placed on the tension side. The steel reinforcement resists all tension bending stress because tensile strength of concrete is zero when cracks develop.

(ii) Column

Columns are vertical compression members of a structural frame intended to support the load-carrying beams. They transmit loads from the upper floors to the lower levels and then to the soil through the foundations. Since Columns are compression elements failure of one column in a critical location can cause the progressive collapse of the adjoining floors and the ultimate total collapse of the entire structure.

As in the cause of beams the strength of columns is evaluated on the basis of the following principles.

1. A linear strain distribution exists across the thickness of the column.
2. There is no slippage between the concrete and the steel (i.e, the strain in steel and in the adjoining concrete is the same).
3. The maximum allowable concrete strain at failure for the purpose strength calculation=0.003 in/in.
4. The tensile resistance of the concrete is negligible and is disregarded in computations

(iii) Slab

The slab provides a horizontal surface and is usually supported by columns, beams, or walls.

Based on load transfer to the supporting beam, there are two types:

I. One -way slab

II. Two-way slab

One-way slab: If the ratio of length. "L" to the width "S" of slab panel is larger than about 2 most of the load is carried in short direction to supporting beam and one way action is obtained in effect, weather support are provided on long sides or on both sides. Main reinforcement which will carry total bending moment due to loads on it is provided perpendicular to the beams i.e. in short direction only.

Two-way slabs: If the ratio of length "L" to the width "S" of slab panel is equal or less than about 2, the load is carried in both short and long direction to the supporting beams and two way actions is obtained in effect. Support should be provided on both sides.

iv) Footing

The foundation of a building is the part of a structure that transmit the load to ground to support the superstructure and it is usually the last element of building to pass the load in to soil, rock or pile. The primary purpose of the footing is to spread the loads in to supporting materials so the footing has designed not to be exceeded the load capacity of the soil or foundation bed. The footing compresses the soil and causes settlement .The amount of settlement depends on many factors.

The most common types of footing are strip footings under walls and single footings under column.

Common footings can be categorized as follows:

a. Individual column footing:

This footing is also called isolated or single footing. It can be square, rectangular or circular of uniform thickness, stepped or sloped top. This is one of the most economical types of footing. The most common types of individual column is square rectangular with uniform thickness.

b. Wall footing:

Wall footing is supper structural or nonstructural walls. This footing has limited width and a continuous length under the wall.

c. Combined footing:

They usually support two or three column not in a row and may be either rectangular or trapezoidal in shape depending on column. It a strap joint two isolated footings, the footing is called a cantilever footing.

v) Stair case:

Stair cases are provided for connecting successive floors. It is propertied with flights of steps with intermediate landing which provides rest to the user and support in flight. A passenger is provided at the start of staircase then for the vertical rise a flight is provided with riser and tread. Riser provided in the step is normally 6 inch which confirms with the comfort of the user. Tread provided is 9.5 inch which can be more if the number of user is more depending on the type of building. The width of stair can be between 3.5 ft to 5 ft depending of the user. Generally public building should be provided with large width. Going is the horizontal projection of the include flight between the first and the last rise. A flight is generally consists of two landings with going in between of 10 to 12 steps. Staircase can be designed in many forms as per the requirement of the user and the facility and space available in the construction. Design procedures of few types are discussed in this chapter. Stair can be of varying geometrical shapes and structural behavior. Some of the most common types of stair are shown is subsequent discussion.

(a) Dog legged stair case

(b) Open well stair case

(c) Tread rise stair case

(d) Cantilever stair case.

2.7 REINFORCEMENT GENERAL

Reinforcement bar

The most common types of reinforcing steel are in the form of round bars, often called rebar. Available in a large range of diameters form about 3/8 to $1\frac{3}{8}$ inch for ordinary applications and in two heavy bar size of about $1\frac{3}{8}$ and2 $\frac{3}{4}$ inch. These bars are furnished with surface deformations for the purpose of increasing resistance to slip between steel and concrete. Minimum requirements for these deformations have been develop in experimental research. Different bar producers, all of which satisfy these requirements.

Properties of reinforcement concrete

Concrete is a carefully mixture of cement, water, fine aggregate and course aggregate. The components of concrete have been mixed together and the cement and water react to producer cement gel that the bond the fine and course aggregate in to a stone like material. The chemical reaction between the cement and water an exothermic reaction producing significant quantities' of heat is termed hydration. During the initial stage of hydration when small amount of gel have formed, the concrete is in a plastic stage and flows easily. The rate at which gel form is influenced by the temperature at which require for the concrete to stiffen. At low temperature 10 to 12 hours may be required for the concrete to produce the same degree of stiffen.

Factors affecting the strength of concrete:

In general concrete consists of course and fine aggregate cement water and many cases some kind of admixtures. The strength of concrete depends upon many factures and may vary within wide limits with same production method. The main factors that affecting the strength of concrete are given below

i. **Water cement ratio:**

Water cement ratio is one of the most important factors affecting the strength of concrete. For complete hydration of a given amount of cement, water equal to 0.25 is needed. A water cement of about 0.35 or higher is needed for the concrete to be reasonably workable. Based on this water cement ratio a concrete strength of about 1000psi may be achieved.

ii. **Properties and proportion of concrete constitute:**

Concrete is mixture of cement aggregate and water. The contents in the mix and the use of well graded aggregated increases the strength of concrete.

iii. **Method of mixing and curing:**

The use of mechanical concrete mixture and the proper time of mixing both have favorable effects on the strength of concrete. Also the use of vibrators produces dense concrete with a minimum percentage of voids. A void ratio of 5% may reduce the concrete strength about 30%. The curing conditions excise an important influence on strength of concrete. Both moisture and temperature have a direct effect on the hydration of cement.

iv. **Age of concrete:**

The strength of concrete increase appreciably with age and hydration of cement continues for months. For a normal Portland cement, the increase of strength with time relative to 28 days strength may be assumed as follows:

Table-2.3: Strength of concrete with days.

Age	7 days	14days	28days	3month	6month	1year	2years	5years
Strength ratio	0.67	0.86	1.0	1.17	1.23	1.27	1.31	1.35

Reinforcement concrete Floor systems:

Slab may be considered as structural members whose depth “h” is small as compared to their length and width. Slab may be defined as structural elements that are subjected to distribute loads primarily in a plan transverse to the plan of slab thickness of slab varies from 4” to 20” depending upon the span and loading .

Types of slab:

RCC slab are provided in different ways depending upon the length and breadth of opening they are as follows:

1. One way slab
2. Two way slab
3. Flat slab
4. Flat plate slab

Two way slab system:

When the slab is supported on four sides and the ratio of the long side is less then to the will deflect in double curvature in both directions. The loads are carried in two directions to four beams supporting the slab.

The advantages and disadvantages of two way slab system:

Advantages of two way slab on beams are a follows,

- Construction process are easy
- Reinforcement placement are easy
- Overall stability is higher than any slab systems.

Disadvantages of two way slab:

- Require large amount of reinforcement than other slab.
- Failure due to heavy self-weight

Two way slab design by co- efficient method:

The slab panel is divided into a middle strips and column strips as show in following figure. The maximum positive bending moment is assumed to occur in at the middle strip and the maximum negative moment in column strip the support. The expression for the moment is given by $\boldsymbol{M = Cws^2}$

Where,

C= Moment co efficient for two way slab

W= Total uniform load per square foot, including the weight of slab

S= length of short span for two way slab.

Design of Reinforcement beam:

Beams are the horizontal parts of the structure which transfer the dead loads and live loads to the vertical member to the structure. The beams are subjected to bending. On any section of the beam bending causes compressive as well as tensile stress. In a simply supported beam the portion above the natural axis posse compressive stress and bellow it strong for carrying tensile stress the reinforcement are provided on the side of beam.

Types of beam:

Under the site requirement the beam may be following types:

- Simply supported beam
- Fixed beam
- Cantilever beam
- Continuous beam

Based on the flexural design the beam may be following types:

- Singly reinforcement beam
- Under reinforcement RCC beam
- Over reinforcement RCC beam
- Balanced RCC beam
- Doubly reinforcement beam
- T-beam
- L-beam

Assumptions for flexural design:

The analysis and design RCC beam is based on following assumption:

(a) The concrete is assume to be homogeneous

(b) All tensile stresses are taken by the steel reinforcement and the compressive stress is taken by concrete except where permitted.

(c) The concrete area the tension side of section is assumed to be infective

(d) The section which are plan before bending remain plan after bending

(e) The stress strain relationship of steel and concrete is straight line under the working load.

Singly reinforcement beams:

Beam in which the reinforcement is provided in the tension zone only called singly reinforcement beam. However there are situations in which compressive reinforcement is used for other than strength. It has been found that the inclusion of compression steel will reduce the long term deflections of members. In addition minimum bars are placed as stirrup support bars continuous throughout the beam span.

Advantages:

- ⇨ Cross section of beam is not limited
- ⇨ Span length and applied load is generally
- ⇨ Cross section of beam is greater so that area of steel is less
- ⇨ The construction method is very simple

Disadvantages:

- ⇨ The steel ratio is high the concrete will reach its ultimate capacity before the steel yields while failure due to crushing of the concrete is sudden and without warning.
- ⇨ Cross section of beam is large then amount of material and due to heavy weight of the structure and not economically.
- ⇨ Specifications for span length of beam according to BNBC code
- ⇨ The span length of member not built integrally with supports shall be considered as the clear span plus depth of members but not need to exceed distance between centers of supports.
- ⇨ For design of beam integrally with supports, the use of moments at faces of supports is permitted.

Provision of reinforcement for beam:

Minimum reinforcement: The ACI code requires the provided must not be less then AS min = $\frac{3\sqrt{f'c}}{2fy}$bd $\geq\frac{200}{2fy}$bd

For concrete protection: The BNBC code provided the following specifications for concrete protection

1. Surface not exposed to weather clear cover $\geq 1\frac{1}{2}$ inch
2. Surface exposed to weather clear covering ≥ 1 inch
3. The minimum clear spacing between parallel bars in a layer shall be equal to one bar diameter, but less than 1 inch
4. Placed directly above those in the bottom later with clear distance between layers not less than 1 inch

Web reinforcement:

The reinforcements which are used to protection the extra shearing stress over the concrete capacity in the beam this reinforcement is known as web reinforcement or shearing reinforcement or vertical reinforcement or stirrup.

<u>Specifications of web reinforcement are as follows (ACI):</u>

For USD Method:

If v<4$\sqrt{f'c}$ for no stirrup is required.

If v<8$\sqrt{f'c}$ for section change i.eIf v<4$\sqrt{f'c}$

Maximum spacing are as follows:

Smax = $\frac{Avfy}{50b}$ for vertical stirrup

Smax =$\frac{d}{2}$

Smax= 24 inch

Smax= $\frac{\Phi Avfyd}{Vvr\Phi Vc}$

2.8 BOND ANCHORAGE AND DEVELOPMENT LENGTH

Bond

The perfect adhesion force between the concrete and steel reinforcement is called bond force for which no crack or slip occurs when they are stressed.

Anchorage

In order to prevent slipping of the bars from the concrete there must be sufficient length of bar on each side of this point to be provided which is known as anchorage.

CHAPTER -3

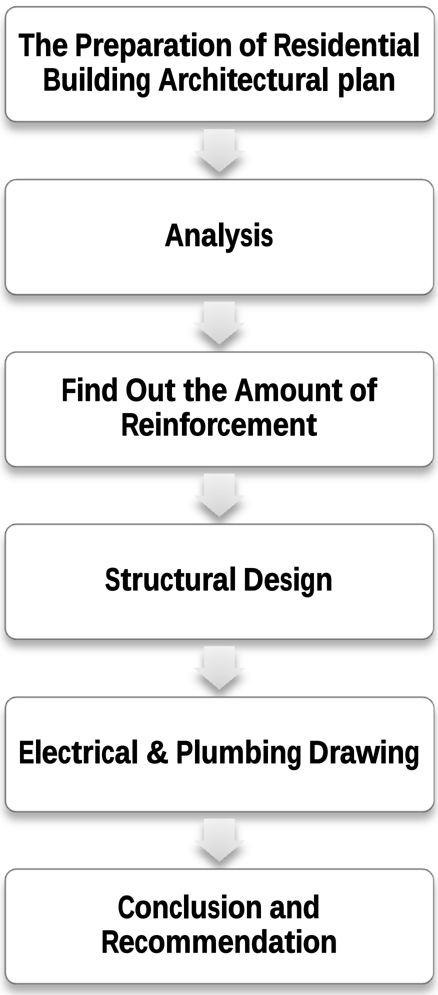
METHODOLOGY

CHAPTER-3

METHODOLOGY

3.1 GENERAL

This chapter gives the outlines of the procedure that were followed to complete this study. For the purpose an arbitrary frames of a six storied Reinforcement Cement Concrete frames structure building Have to select. Lateral load have to be considered to the building frames and analysis by ETABS software. Pile foundations have to design under the loads in sandy soil. Few steps will considered, many references will include through and ACI/BNBC Building Design Codes/Specifications will follow to get perfect result so that the objectives of this study will be fulfilled. In this project the methodology is divided into the following steps:



3.2 DESIGN DATA AND SPECIFICATION CONSIDERED IN THIS STUDY

The whole study was carried out based on few considerations and specifications which are summarized in below.

Table-3.1: Summary of the design considerations and specification of the study

Items	Description
Design method	Ultimate strength design (USD)
Design procedure	ACI moment coefficient method (MCM)
Design code	●American Concrete Institute (ACI) Building design code, 1999 ●Bangladesh National Building code (BNBC), 1993
Type of structures	Beam supported floor system
Building system	●Frame structure ●Low rise ●Residential (6 storied double unit) Dhaka zone
Material properties	●60 grade reinforcing bar having, f_Y=60 ksi ●concrete compressive strength, f_C=3.5 ksi ●Concrete unit weight=150 pcf ●Unit weight of soil=120 pcf
Loading	●Wall = 500 plf ●Floor finish=25 psf ●Partition wall=25 psf ●Live load=40 psf ●earthquake and wind loads are considered
Member Sectional properties	●Slab type=two way slab ●Beam type=rectangular ●Column type=tied ●Grade beam position=5 ft. from column base level ●Thickness of all wall=5 inch

3.3 BASIC DESIGN CRITERIA

Design Method: Ultimate Strength Design (USD).

Design Procedure: Manually design of six-storied building for all types of load.

3.4 LOAD FACTORS

Basic, U = 1.2×Dead load + 1.6×Live load

Dead plus Fluid, U = 1.4(D+F)

Snow, Rain, Temperature and Wind, U = 1.2(D+F+T)+1.6(L+H)10.5(L_r or S or R)

U = 1.2D+ 1.6 (L_r or S or R)+ (1.0L or 0.8W)

U = 1.2D+ 1.6W+1.0L+0.5(L_r or S or R)

U = 0.9D+ 1.6W+1.6H

Earthquake, U = 1.2D+ 1.0E─1.0L+0.2S

U = 0.9D+ 1.0E+1.6H

3.5 LOAD COMBINATION

1.4 X (DL+PW+FF+Wall)

1.4 X (DL+PW+FF+Wall) + 1.7 X LL

1.05 X (DL+PW+FF+Wall) + 1.275 X(LL +Wind X)

1.05 X (DL+PW+FF+Wall) + 1.275 X LL - 1.275 X Wind X

1.05 X (DL+PW+FF+Wall) + 1.275 X(LL +Wind Y)

1.05 X (DL+PW+FF+Wall) + 1.275 X LL - 1.275 X Wind Y

1.05 X (DL+PW+FF+Wall) + 1.275 X Wind X

1.05 X (DL+PW+FF+Wall) - 1.275 X Wind X

1.05 X (DL+PW+FF+Wall) + 1.275 X Wind Y

1.05 X (DL+PW+FF+Wall) - 1.275 X Wind Y

0.90 X (DL+PW+FF+Wall) + 1.3 X Wind X

0.90 X (DL+PW+FF+Wall) - 1.3 X Wind X

0.90 X (DL+PW+FF+Wall) + 1.3 X Wind Y

0.90 X (DL+PW+FF+Wall) - 1.3 X Wind Y

1.54 X (DL+PW+FF+Wall) + 0.55 X LL + 1.1 X EQX

1.54 X (DL+PW+FF+Wall) + 0.55 X LL - 1.1 X EQX

1.54 X (DL+PW+FF+Wall) + 0.55 X LL + 1.1 X EQY

1.54 X (DL+PW+FF+Wall) + 0.55 X LL - 1.1 X EQY

1.54 X (DL+PW+FF+Wall) + 1.1 X EQX

1.54 X (DL+PW+FF+Wall) - 1.1 X EQX

1.54 X (DL+PW+FF+Wall) + 1.1 X EQY

1.54 X (DL+PW+FF+Wall) - 1.1 X EQY

0.77 X (DL+PW+FF+Wall) + 1.1 X EQX

0.77 X (DL+PW+FF+Wall) - 1.1 X EQX

0.77 X (DL+PW+FF+Wall) + 1.1 X EQY

0.77 X (DL+PW+FF+Wall) - 1.1 X EQY

3.6 SLAB DESIGN CRITERIA

Design procedure of slab.

a) Select panel

b) Check panel as one or two way slab.

c) Determine slab thickness.

d) Determine interior, exterior & mid span moment for long direction.

e) Determine interior, exterior and mid span moment for short direction.

f) Determine steel area for long direction moment.

g) Determine steel area for short direction moment.

h) Showing reinforcement detailing for short and long direction moment

3.7 STAIR DESIGN CRITERIA

I. Assume the thickness of the slab (waist).

II. Calculate average slab thickness (waist+step)

III. Calculate total W_u (on stairs and landing)

IV. Calculate the bending moment and steel reinforcement:

$\pm M = wl^2/9$

Minimum, A_s = 0.0020×12× $\mathbf{7.5}$

Principal, $A_s = M/\boldsymbol{\varphi} f_y(d-a/2)$

Calculate No. of rod.

v. Stair beam design

Calculation mid span & support moment,

$+M = pl^2/24$ & $-M = pl^2/12$

Calculation for moment capacity of concrete<maximum moment

So, single approach ok.

Calculate, $A_s = M/\emptyset \boldsymbol{A_s} f_y(d-a/2)$

vi. Calculate shear reinforcement as proceeding above.

vii. Calculate spacing.

3.8 BEAM DESIGN CRITERIA

Design procedure for beam design:

1. Consider the Maximum Positive Moment, Maximum Interior Negative Moment, Maximum Exterior negative Moment
2. Determine the moment capacity of concrete:

   Reinforcement ratio, $\boldsymbol{\rho_{design} = 0.85 \times \beta_1} \times \frac{\boldsymbol{f'_c}}{\boldsymbol{f_y}} \times \frac{\boldsymbol{\epsilon_u}}{\boldsymbol{\epsilon_u + \epsilon_t}}$

   The flexural resistance factor, R= $\boldsymbol{\rho f}$y (1-0.588× $\frac{\boldsymbol{\rho f_y}}{\boldsymbol{f'_c}}$)

   Moment, $M_c = \emptyset \boldsymbol{Rb} d^2$

3. Calculation for Interior Negative Moment: $\boldsymbol{M_c} > \boldsymbol{M_{int}}^-$.

   Double design is not needed

   Assume the depth of the rectangular stress block, a

   Steel Area, $A_s = \boldsymbol{M} \Big/ \emptyset \boldsymbol{f_y}\left(\boldsymbol{d - \frac{a}{2}}\right)$

   Check, a = $\frac{\boldsymbol{A_s f_y}}{\boldsymbol{0.85 . f c' . b}}$

Calculate no. of rod.

4. Calculation for positive moment;

$M_u > \boldsymbol{M^+}$

So, Double design is not needed .Single approach is ok.

Assume, a

Steel area, $A_s = \boldsymbol{M} \Big/ \emptyset \boldsymbol{f}_{y(d-\frac{a}{2})}$

Check, a = $\frac{A_s f_y}{0.85.fc'.b}$

Minimum, A_s=200/f_y *b*d

T-beam check:

Calculate effective flange width, b_f

Take, a= t_f

Check, a = $\frac{As \times Fy}{0.85xf'cxb}$ < slab thickness

So it is not T-beam. It is rectangular beam.

Calculate No. & amount of rod.

5. Calculation for Exterior negative Moment:

Same as interior negative moment

6. Shear Reinforcement:

V_u=V-$\frac{d}{12} \times W$

$\varphi Vc = 2\lambda\phi\sqrt{f'}c_\times b_w \times d$

φVs = [$V_u - \varphi Vc$]

Spacing; S = $\frac{\varphi A_v f_{y}.d}{[V_{u-}\varphi Vc]}$

$S_{max} = \frac{d}{2}$

S_{max} = 24 in

3.9 COLUMN DESIGN CRITERIA

1. Axially loaded column:

   For tied column,

   $P_u = \emptyset P_n = \emptyset(0.80)[0.85 f'_c (A_g - A_{st}) + A_{st} f_y]$

   For spiral columns,

   $P_u = \emptyset P_n = \emptyset(0.85)[0.85 f'_c (A_g - A_{st}) + A_{st} f_y]$

   Where,

   A_g=gross concrete area

   A_{st}=Total steel compressive area

   Ø=0.65 for tied columns and 0.70 for spirally reinforced columns.

2. Eccentrically loaded column:

   $e = \frac{M_u}{p_u}$

   $\emptyset P_n = \emptyset[\frac{bhf'_c}{3he/d^2 + 1.18} + \frac{A'_s f_y}{\frac{e}{d - d'} + 0.5}]$

   Where,

   $\emptyset = 0.65$

   $A_s = A'_s$

   H= total depth of column

   d= Effective depth of column

   d'=clear cover 2.5”

   b=width of column

3. Bi-axially loaded column:

   $e_x = \frac{M_{xy}}{P_n}$

   $e_y = \frac{M_{xx}}{P_n}$

   Bresler Reciprocal Method,

   $\frac{1}{\emptyset P_n} = \frac{1}{\emptyset P_n x_0} + \frac{1}{\emptyset P_n y_0} - \frac{1}{\emptyset P_0}$

3.10 FOUNDATION DESIGN CRITERIA

Soil type: Cohesion less soil.

N_{cor}=0.77log(20/p) X N_{field}

Skin friction, Q_s = A X N_{cor} X A_s

End bearing capacity, Q_p = B X N_{cor} X A_p

Total ultimate load bearing capacity, Q_u = Q_s+ Q_p

Design bearing capacity, Q_d = Q_u/F.S

Number of pile = Total load /Q_d

Individual Action, Q_i = No. of pile × Allowable load

Cross-sectional area of pile = $\frac{\pi\times 18^2}{4}$

$P_u = \emptyset P_n = \emptyset(0.85)[0.85f'_c(A_g - A_{st}) + A_{st}f_y]$

CHAPTER -4

MODELING IN ETABS

CHAPTER-4

MODELING IN ETABS

4.1 Introduction

To create a successful model in ETABS, one must fully understand the first and most important "Building Plan Grid System and Story Data Definition" form. Due to this reason a separate chapter is included in this book to fully learn how to use this window properly and efficiently.

4.2 Objectives

- Know the type of structural members in ETABS
- Learn about the Global Axes and Planes in ETABS
- Learn how to count the number and spacing of grids in ETABS
- Learn how to count the number of story and its spacing in ETABS.
- Go through some examples to clearly understand "Building Plan Grid System and Story Data Definition Form" in ETABS.
- Get start with ETABS

4.3 Structural Members

Beams, Columns and Slabs are the major three structural components for typical building systems. Sometimes for several structural forms walls (load bearing) become vital structural element. In reality all the structural elements are three dimensional. But for simplicity, beams and columns are considered as one-dimensional members since the length is much greater than the width and breadth. In ETABS beams and columns are considered as ***line object*** since these can represent by lines. Slabs and walls are considered as two dimensional objects since the breadth is negligible compared to the length and width. In ETABS these are considered as ***area objects***.

Beam→	drawn as 1D member→	Line Object
Column→	drawn 1D member→	Line Object
Slab→	drawn 2D member→	Area Object
Wall→	drawn 2D member→	Area Object

4.4 Axes and Planes in ETABS

When there is a global system, there is always a local system of expressing anything. Hence there is also the local axes system for the line and area objects which will be discussed later where necessary. From basic engineering drawing one must be familiar with the orthographic views the buildings (i.e., top, bottom, right, left, front and rear). The side views (i.e., front, rear, right and left) are referred as ***elevation view*** and top view as ***plan view***. Inputs are given globally. That means in global axes are used in drawing and for the output purpose local axes is a must, otherwise may be confusing. At first, consider an oblique view of a typical building like Figure 4.1(a). In this figure front is in xz plane (sometimes called y=b plane or simply y plane) as well as rear view, right and left views are in yz plane (sometimes called x=a plane or simply x plane) and top and bottom view are in xy plane (sometimes called z=c plane or simply z plane) which is the most important plane for drawing.

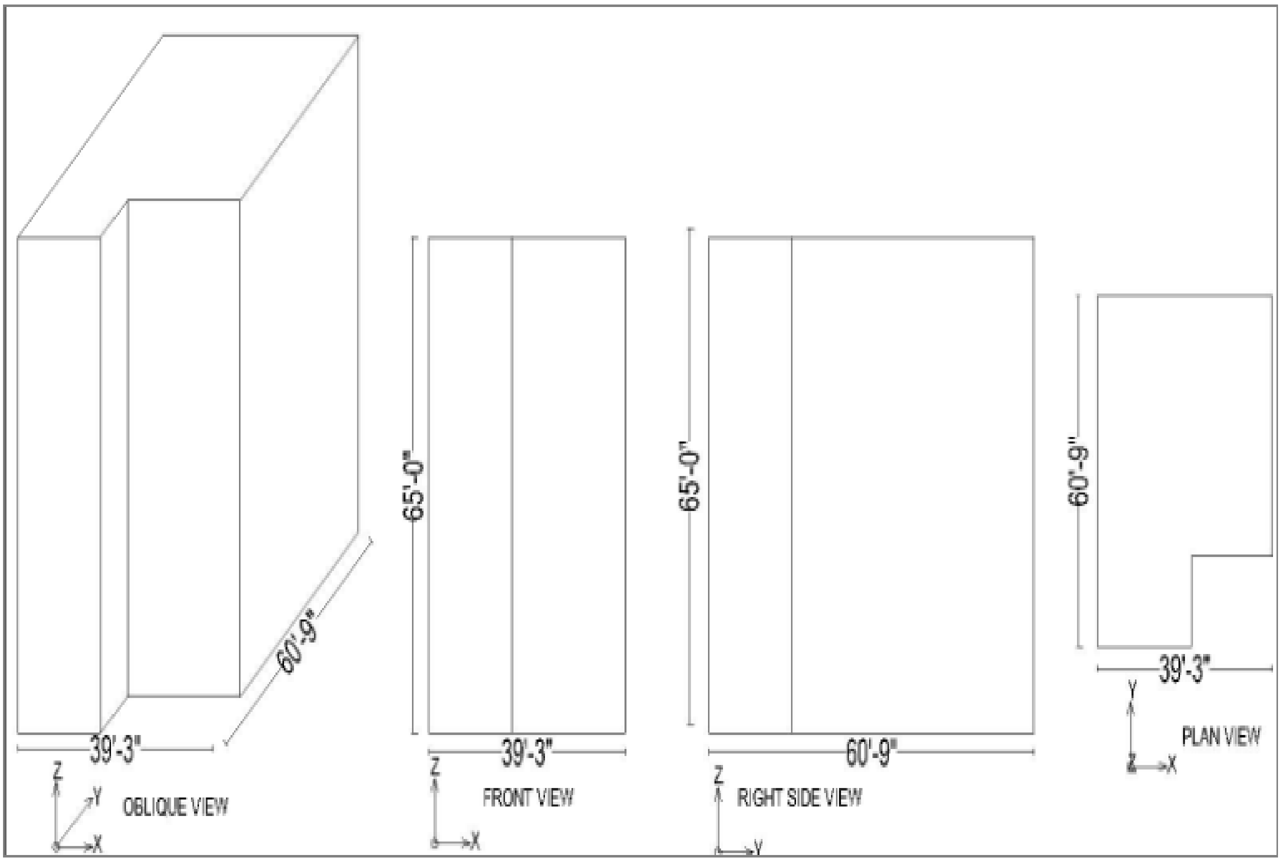


Figure 4.1: Views in Drawings

Oblique and/or Isometric view→	3-D view→	includes all the plane
Top and/or Bottom View→	Plan View→	xy plane or z=c plane or z plane
Left and/or Right View→	Elevation View→	yz plane or x=a plane or x plane
Front and/or Rear view→	Elevation View→	xz plane or y=b plane or y plane

Generally the drawing is made in xy plane following the beam column layout hence the plan view is the most important view.

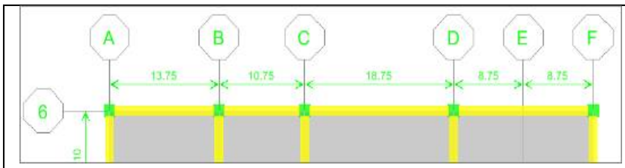
4.5 Grid Dimensions

To divide the x axis into 5 segments, (5+1= 6) lines are used (A, B, C, D, E and F) and to divide the y axis into 5 segments, (5+1= 6) lines are used (1, 2, 3, 4, 5 and 6). The spacing of the lines which divides the x axis (i.e., perpendicular to x axis) into segments are at 60'-9" ft irregular interval and lines which divides the y axis (i.e., perpendicular to y axis) are at 39'-3" ft irregular interval.

Figure 4.2 Beam column layout of a typical building with Deferent spacing

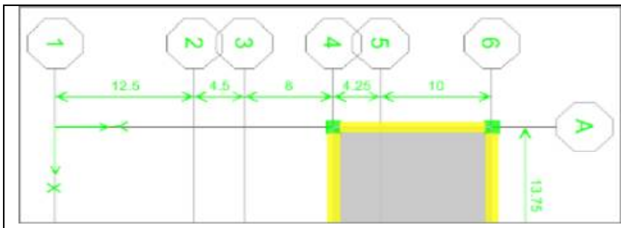
Number lines in X direction	No. of lines perpendicular to X axis	No. of gaps in X direction + 1=	6
Number lines in Y direction	No. of lines perpendicular to Y axis	No of gaps in Y direction + 1=	6
Spacing in X direction	Elevation View	uniform spacing between the lines perpendicular to X axis=	60’-9” ft
Spacing in Y direction	Elevation View	uniform spacing between the lines perpendicular to Y axis=	39’-3” ft

Example 4.1 See the Beam-Column Layout carefully and find out the following inputs for ETABS (a) Number of lines in X direction (b) Number of lines in Y direction (c) Spacing in X direction and (d) Spacing in Y direction. All the measurements are in feet.

<table>
<tr><td>
</td><td>Number lines in X direction=

Spacing in X direction=</td><td>6

13’-9” ft
10’-9” ft
18’-9” ft
8’-9” ft
8’-9” ft
0</td></tr>
</table>

	Number lines in Y direction= Spacing in Y direction=	6 12'-6" ft 4'-6" ft 8'-0" ft 4'-3" ft 10'-0" ft 0

3). In ETABS there are two methods to input these types of non-uniform grid spacing. One is ***Grid as Ordinate*** and other one is ***Grid as Spacing***.

Custom Grid as Spacing

Consider Figure4.3 again. The spacings between lines in X (A, B, C, D E and F) and Y (1, 2, 3, 4, 5 and 6) directions are considered in this case. It is simpler than Ordinate system since cumulative sums are not needed. The spacings are directly given in the beam column layout. But it is found sometimes confusing while giving input since spacing of A means spacing between A and B, spacing of B means spacing of B and C and so on. Similarly spacing of 1 means spacing between 1 and 2 and so on.. The last spacing is always zero.

Figure4.3 Beam column layout of a typical building with non-uniform spacing

The input for the Figure4.3 by both Ordinate and Spacing system is as follows

Line Direction	Grid ID	Grid as Coordinates	Grid as Spacing
X	A	0	13.75'
	B	13.75'	10.75'
	C	24.5'	18.25'
	D	43.25'	8.75'
	E	52'	8.75'

	F	60.75’	0
Y	1	0	12.5’
	2	12.5’	4.5’
	3	17’	8’
	4	25’	4.25’
	5	29.25’	10’
	6	39.25’	0

USES DATA (SECTION PROPERTIES)

MEMBER	DIMENSION
COLUMN (BELOW BASE)	18”X18”
COLUMN (UPPER BASE)	16”X16”
BEAM (BASE)	14”X22”
BEAM (SLAB)	12”X20”
SLAB (STAIR)	8” THICKNESS
SLAB (ALL)	5” THICKNESS

USES DATA (STORY HEIGHT)

STORY	HEIGHT
TYPICAL FLOOR	10’ HEIGHT
FOOTING TO BASE	5’ HEIGHT

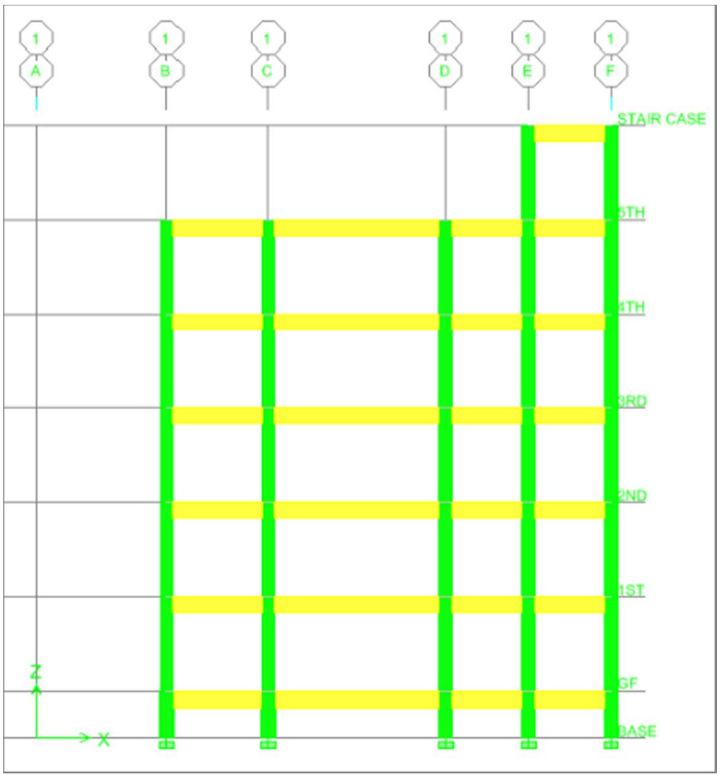
USES DATA (STATIC LOAD CASES)

LOAD NAME	LOAD TYPE	DETAILS	VALUE
DEAD	DEAD LOAD	SHELF WEIGHT AUTOMATICLY CALCULATR IN ETABS	-
	SUPER DEAD LOAD	FLOOR FINISF (UNIFORM)	25 plf
	SUPER DEAD LOAD	PARTITION WALL (UNIFORM)	25 plf
	SUPER DEAD LOAD	WALL LOAD (OUTER SIDE BEAM)	500 lb/ft
LIVE LOAD	LIVE LOAD	UNIFORMLY DISTRIBUTE IN SLAB	40 plf
	LIVE LOAD	UNIFORMLY DISTRIBUTE IN STAIR SLAB	100 plf

4.6 Story Dimensions

Till now the input for the plan view (x y plane) is discussed. Buildings also have elevation. ETABS require the data for elevation. To understand this clearly let us consider an elevation as Figure 4.4. Story information is often confusing. To us, it is a Six story building since the base to grade is below the ground but ETABS will not understand that. For ETABS since the elevation is divided into 8 segments so ***Number of Stories*** would be 8. *Never confuse with actual number of stories to ETABS number of stories*.

In Figure 4.4 the bottom segment is 5 ft and all the other segments are of 10 ft.



Level	Hight	Elevation
STAIR	10ft	65ft
5TH	10ft	55ft
4TH	10ft	45ft
3RD	10ft	35ft
2ND	10ft	25ft
1ST	10ft	15ft
GF	5ft	5ft
BASE	0	0 ft

Figure 4.4 Front elevation of a typical four story building

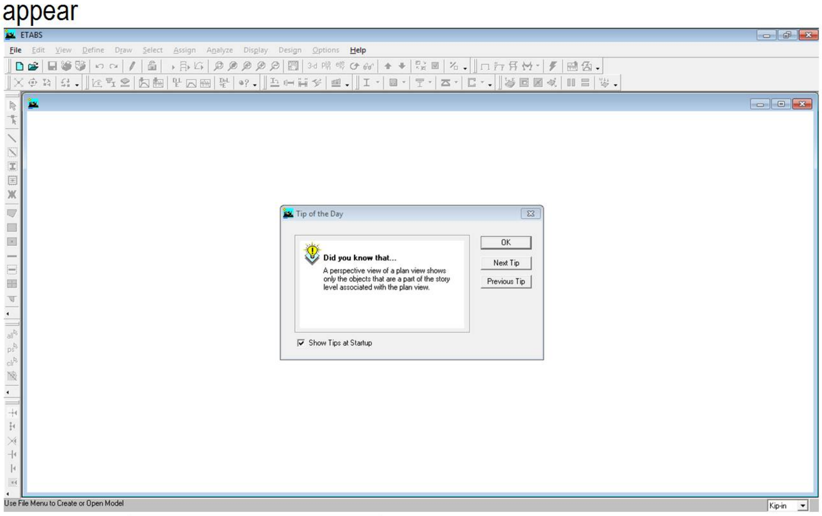
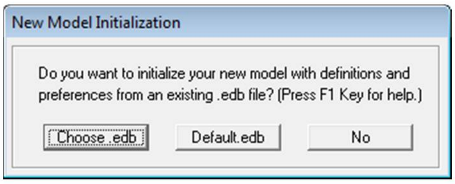
Hence the ***Typical Story Height*** would be 10 ft and ***Bottom Story Height*** would be 5 ft. If story height is different above the bottom story then story data need to be edited. See the following example to understand it clearly.

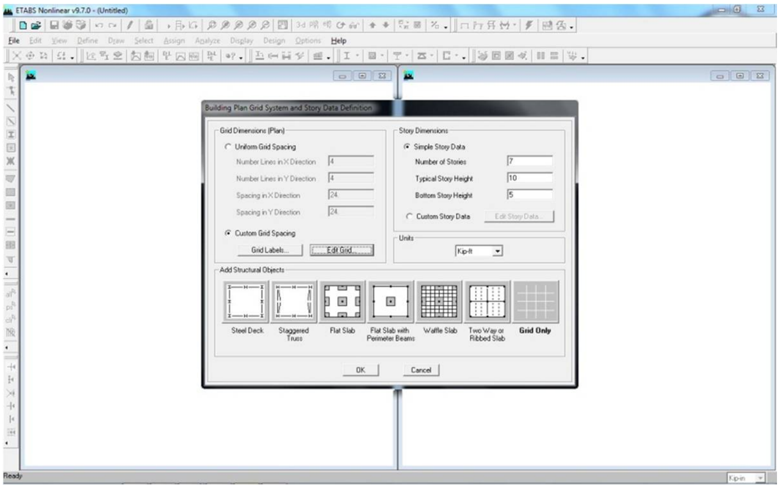
Number of Story = 7
Custom Story Data is required

The custom story data can be summarized as follows

Label	Height (ft)	Elevation (ft)
STAIR	10	65
5TH	10	55
4TH	10	45
3RD	10	35
2ND	10	25
1ST	10	15
GF	5	5
BASE	-	0

4.7 SUMMARIZED ETABS STEPS

Step	Action	Comments
1	**Double click** CSI ETABS from desktop or start menu to run the program. The window below will appear  	Starts ETABS software
2	**Click** over ☑ Show Tips at Startup to uncheck **Click** [OK] to close the ***Tip of the Day*** window. Do nothing if no Tip of the Day window appear	Tip of the Day window will not appear in future.
3	Menu Command: **File>New Model…** or Keyboard Shortcut: **Ctrl+N** or From Toolbar: **Click on** (top left corner) ***New Model Initialization*** window appear  	Creates a new model and New Model Initialization window appears [Choose .edb] for professional use when database from other file is used. [Default.edb] When default database is used. [No] for amateurs or beginners.
4	**Click** [No]. ***Building Plan Grid System and Story Data Definition*** window will appear. Units → **kip-ft** Number Lines in X Direction → **6** Number Lines in Y Direction → **6** Number of Stories → **7**	



5 **Click** over Custom Grid Spacing radio button

Grid Labels… and Edit Grid Button enabled

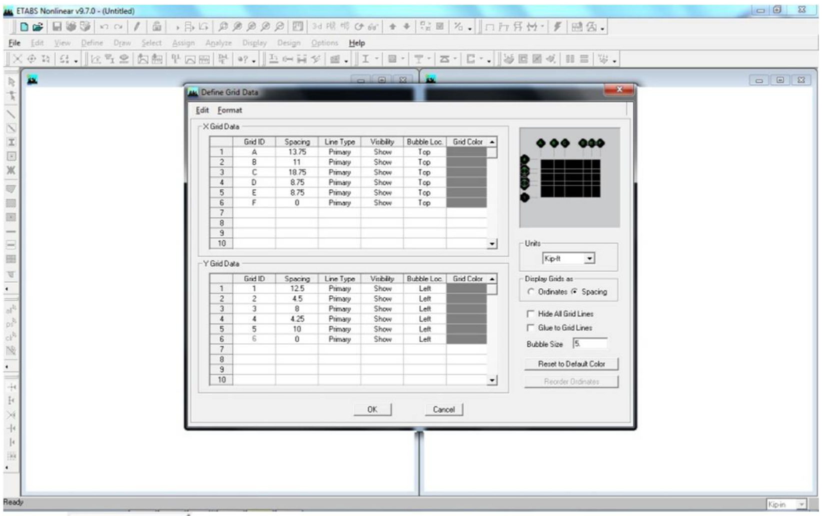
6 **Click** Edit Grid... button. **Define Grid Data** window will appear

Click on Spacing radio button

Input X Grid Data: A→**13.75**, B→**10.75**, C→**18.75,**D→ **8.75,** E→ **8.75,** F→**0**

Input Y Grid Data: 1→**12.50**, 2→**4.50**, 3→**8.00,** 4→ **4.25,** 5→ **10.00,** 6→ **0**

Sets the Grid as required with variable spacing in X and Y direction. Return to Building Plan Grid System and Story Data window



Click OK button

7 **Click** Custom Story Data Building Plan Grid System and Story Data window

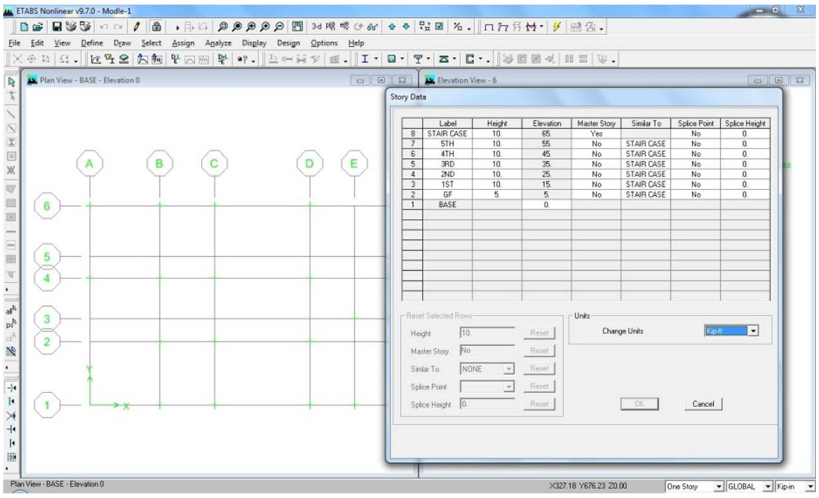
Edit Story Data… button will be enabled

8 **Click** Edit Story Data... button.

Set the Label and Height as below. Click over the Label and Height to change it.

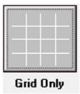
	Label	Height (ft)
8	Stair Case	10
7	5th	10
6	4th	10
5	3rd	10
4	2nd	10
3	1st	10
2	GF	5
1	BASE	-

Set the elevation as required and return to Building Plan Grid System and Story Data window.



Click 

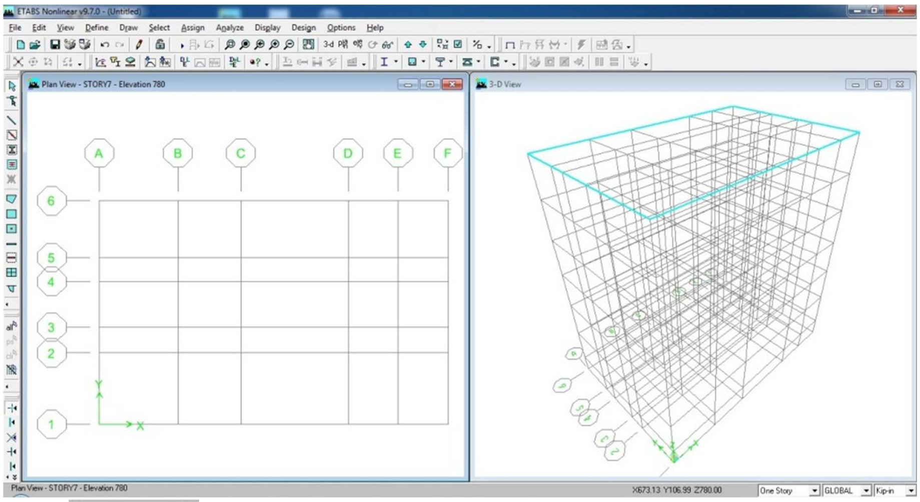
button

9 **Click** 

button. **Click** 

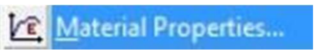
button. ETABS window appear as below.

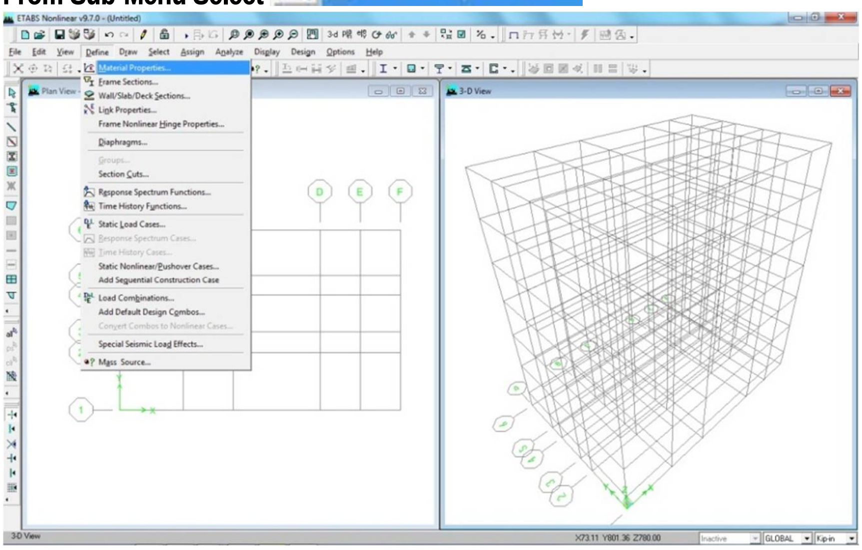
Creates only the grid for drawing. Returns to ETABS main window with Grid only



10 **Click** 

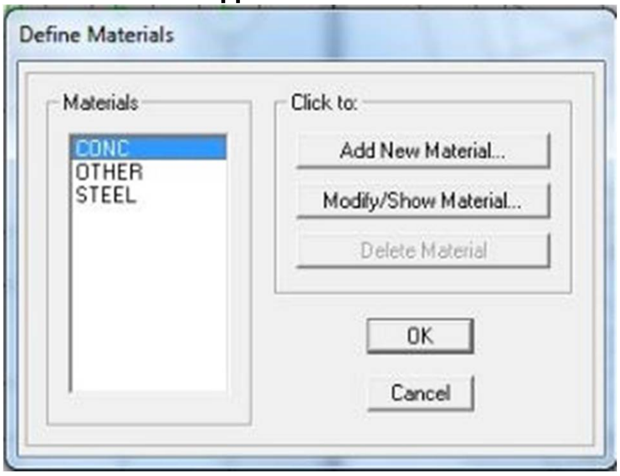
on Menu Bar

From Sub-Menu Select 



Set the Materials Properties for the structure

This Window will Appear



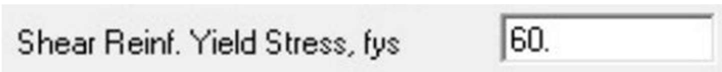
Select CONC > Modify / Show Materials

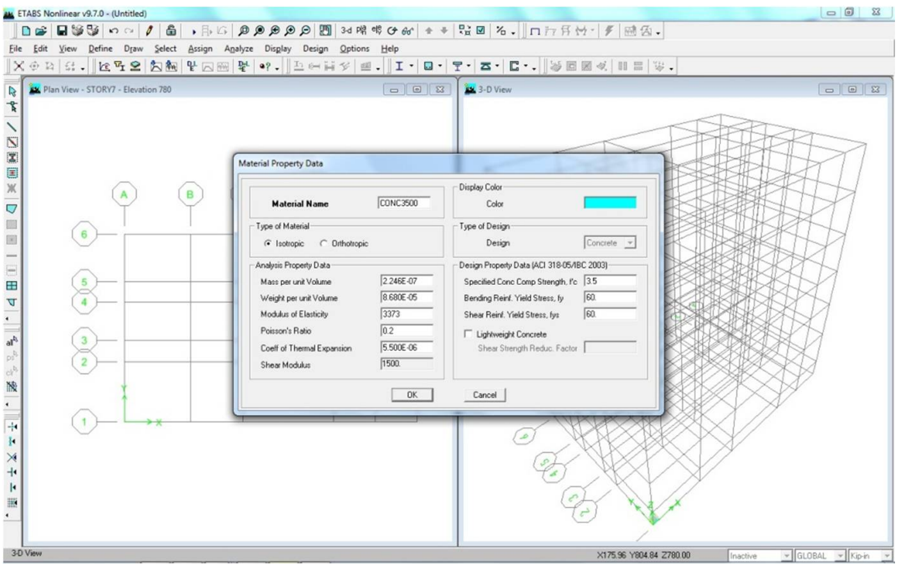
Change Materials Name as CONC 3500

Modulus of Elasticity Change as = 57000X√f'c=3373

Change 

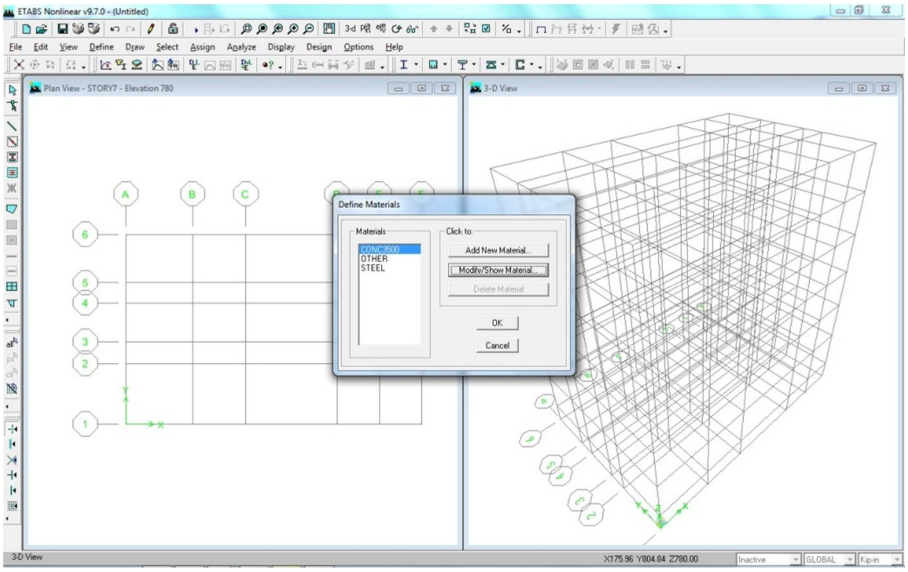
Change 

Change 



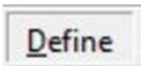
Click 

button



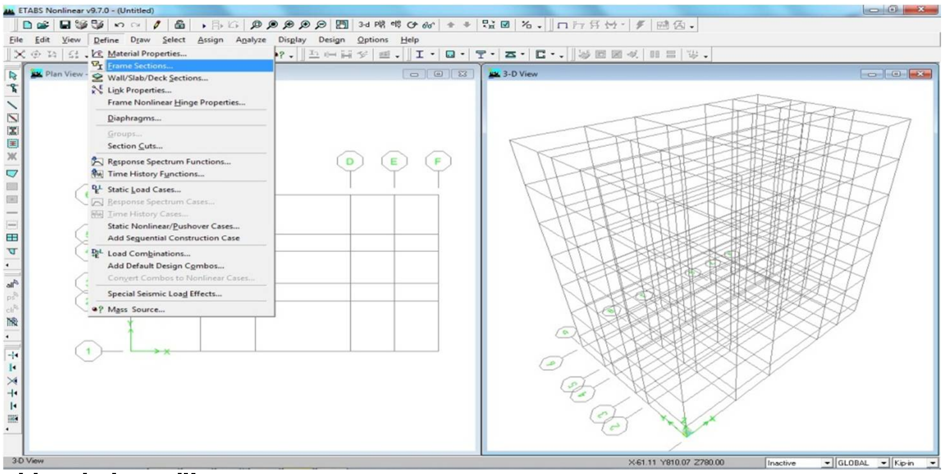
Click 

button

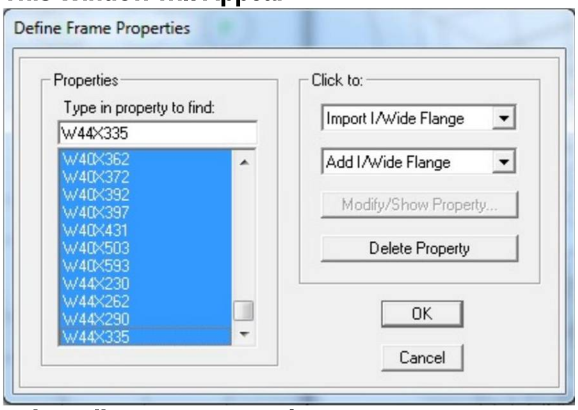
11 Click 

on Menu Bar

Select Frame Section



This Window will Appear



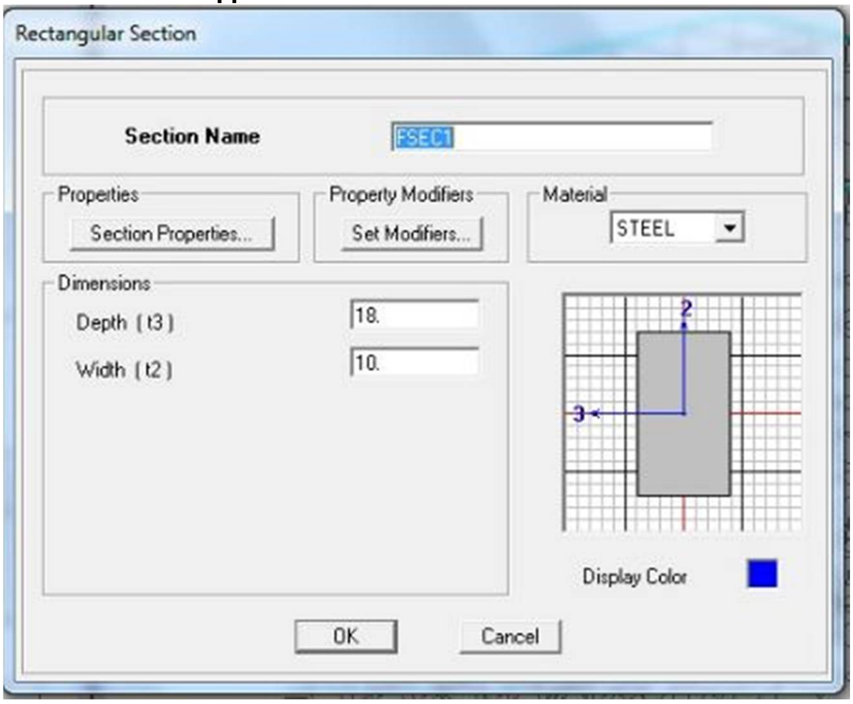
Select all Pre-set Properties

Click 

Click 

Create Frame Section Beam for the Structure

This Window will appear

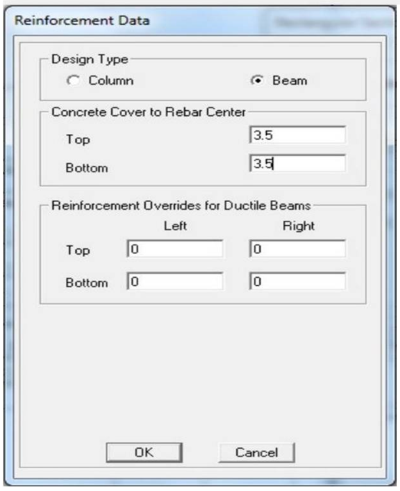


Change Section Name As BEAM – 14X22

Select Material as CONC 3500

Change Dimensions

Click on



Change Concrete Cover to Rebar Center
Top> 3.5, Bottom > 3.5

Click 

button

In Same Method we create BEAM – 12 X 20

Concrete Cover to Rebar Center will be 2.5

12 **Click** 

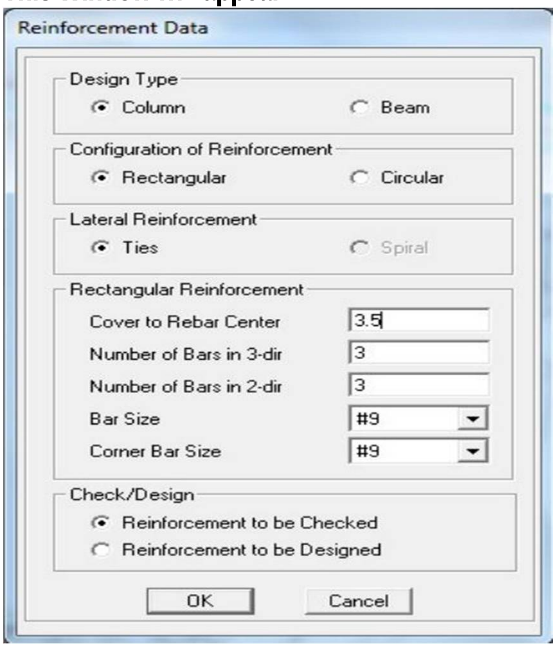
Change Section Name as COLM- 18X18

Select Material as CONC 3500

Change Column Diamension

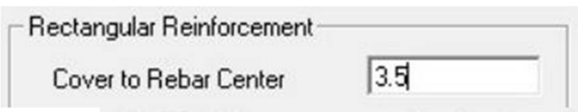
Click on Reinforcement

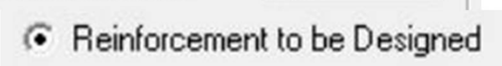
This Window will appear



Select Design Type Column

Change Rectangular Reinforcement ,
Cover to Rebar Center 3.5



Mark on 

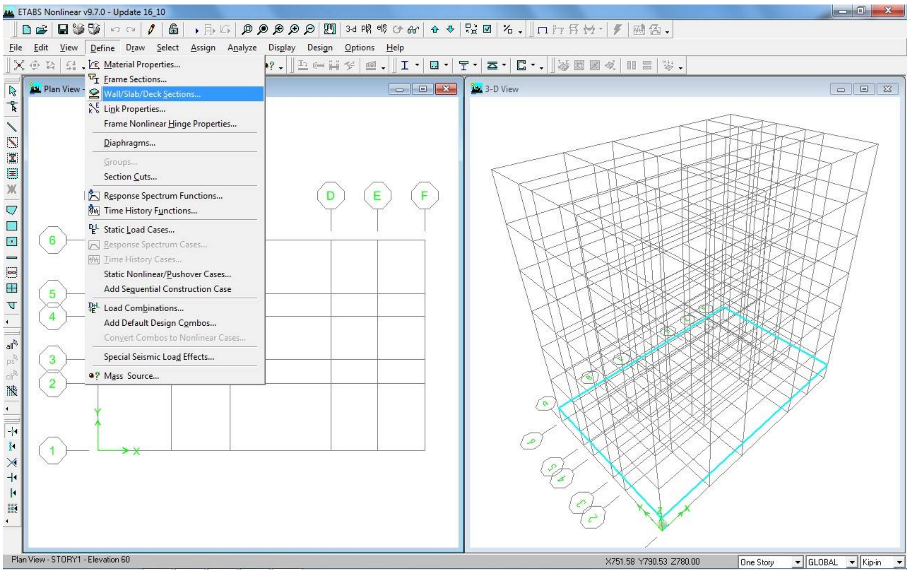
Click 

button

In Same Method we create COLM – 16 X 16
Change Cover to Rebar Center as 2.5

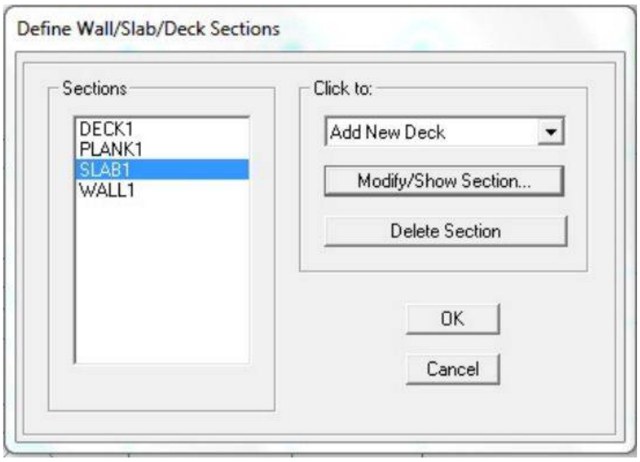
Create Frame Section COLM for the Structure

13 **Click**  **on Menu Bar**



Select Wall / Slab / Deck Sections,

This Window will Appear

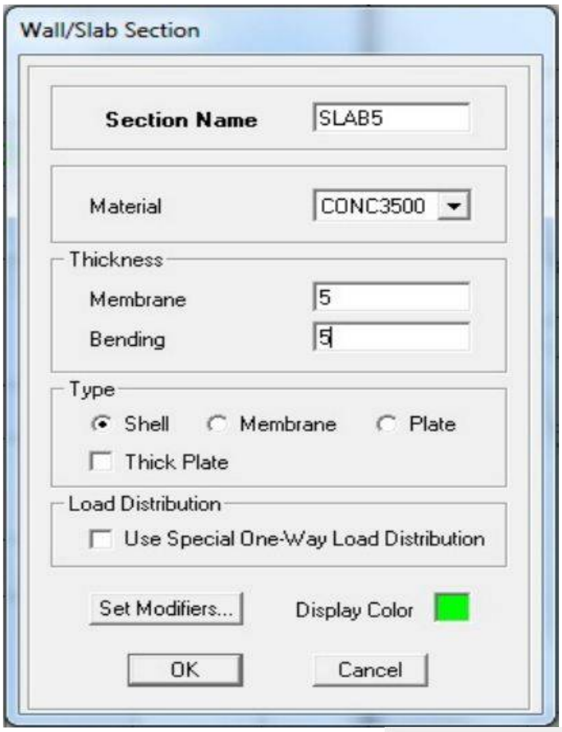


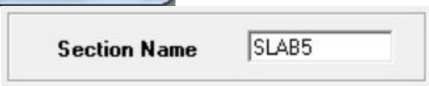
Select SLAB1

Click Modify / Show Section 

This Window will Appear

Define Wall/ Slab/ Deck Sections



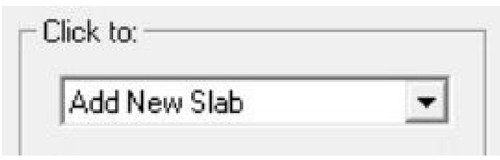


Change Section Name as **SLAB5**

Change Material Name as **CONC 3500**

Change Thickness ,
Membrance > 5, Bending > 5

Select Type > Shell



Click to Add New Slab

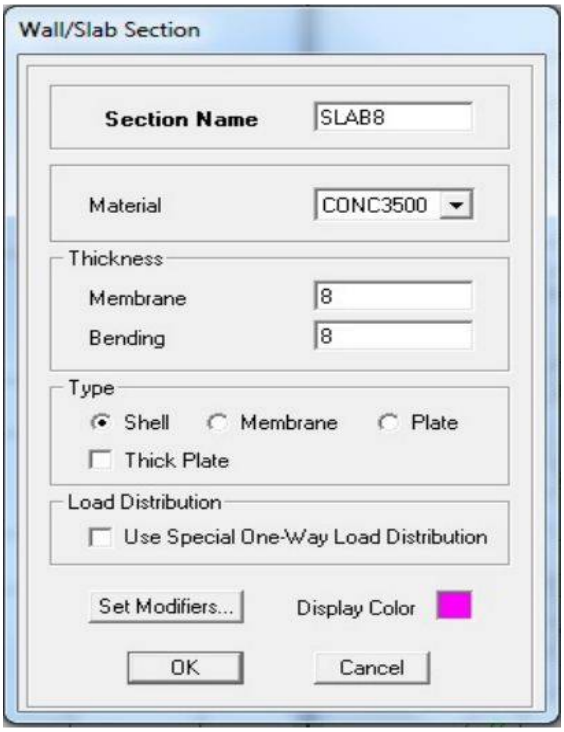
Change Section Name as SLAB8

Select Material as CONC 3500

Change Thickness ,
Membrane as 8, Bending as 8

Select Type Shell

This Window will appear



Click 

button

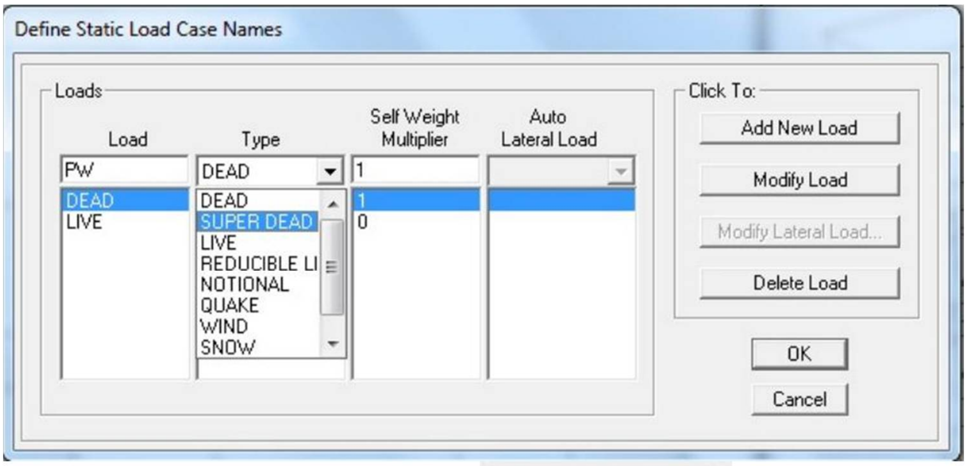
14 **From Menu Bar Click** 

button.

From Sub-Menu Select 

Click 

button,
ETABS window appear as below.



From Load Field Write Load Name as PW 

From Type Dropdown select Super Dead 

Click on 

In Same Method we add below Loads,

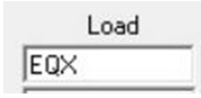
Sl. No	Load Case Name	Load Type	Self Weight Multiplier
1	**PW**	**Super Dead**	**0**
2	**FF**	**Super Dead**	**0**
3	**Wall**	**Super Dead**	**0**

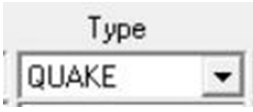
Click 

button

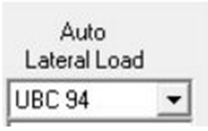
Super Dead Load Define

15

From Load Field Write Load Name as EQX 

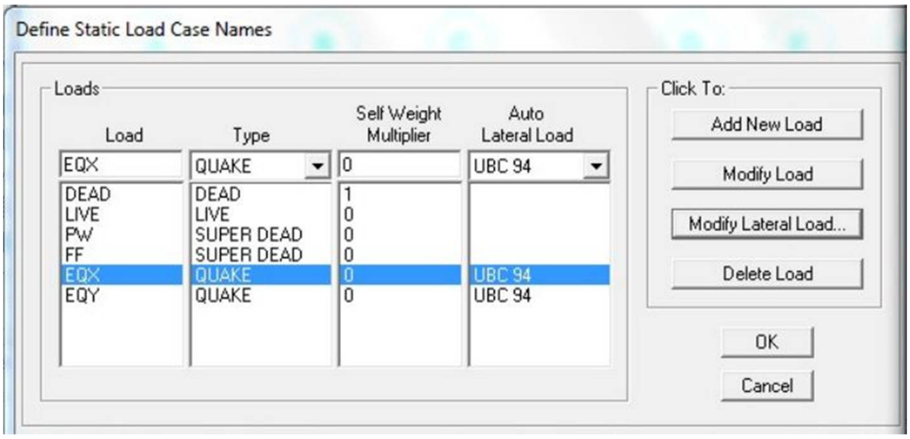
Select Load Type QUAKE 

Put “0” in Self Weight Multiplier 

In Auto Lateral Load Drop Down select UBC 94 

Click on 

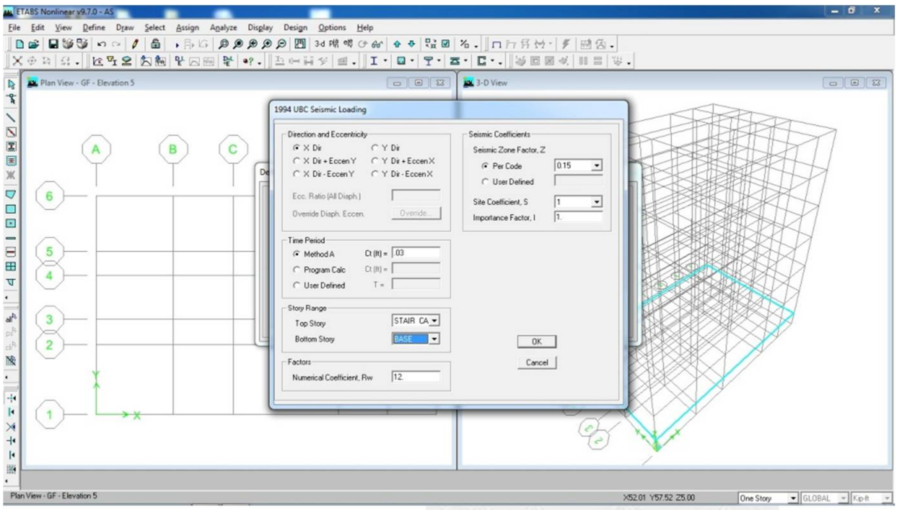
Below Window will Appear,



Seismic Load Define (Earth QUAKE)

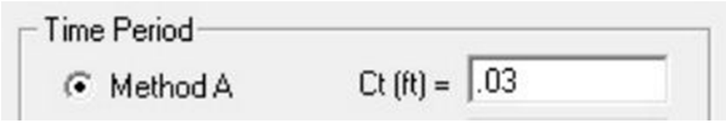
Click on 

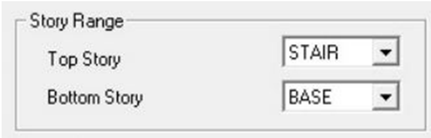
Below Window will appear,



From Direction & Eccentricity Select 

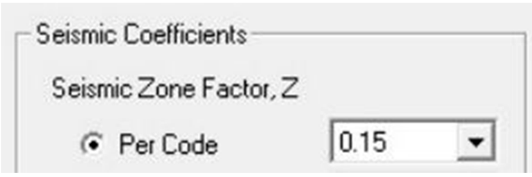
From Time Period Method A , Ct(ft)=0.03



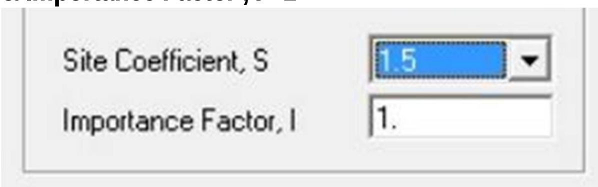
Select Story Range Base to Stair 

In Factors field Put Numerical Coefficient , Rw=8

In Seismic Coefficients Per Code Select 0.15



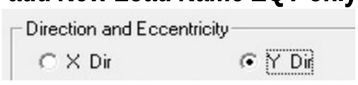
In Site Coefficient, S = 1.5
& Importance Factor , I= 1

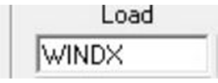


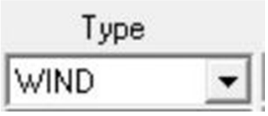
Click 

button,

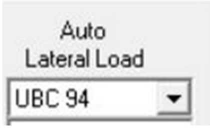
In same Method we add New Load Name EQY only Change From Direction &

Eccentricity Select 

From Load Field Write Load Name as WINDX 

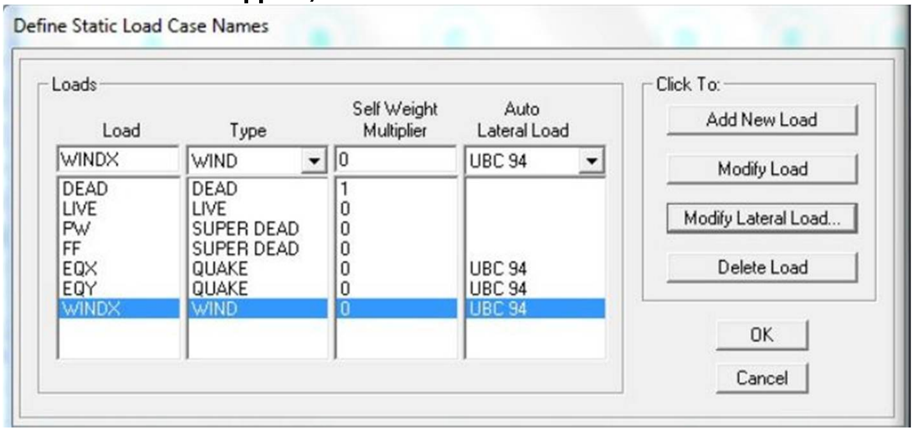
Select Load Type 

Put "0" in Self Weight Multiplier 

In Auto Lateral Load Drop Down select UBC 94 

Click on 

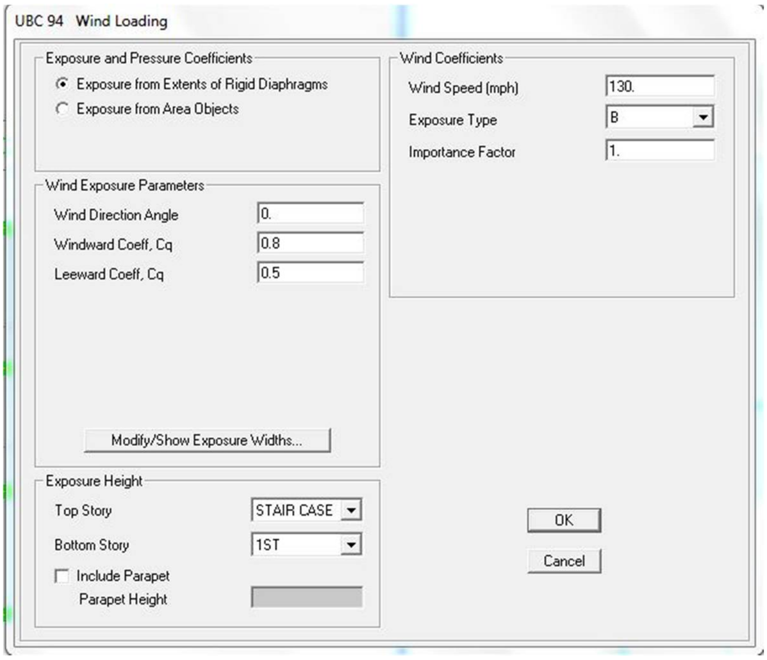
Below Window will Appear,



Define of Wind Load

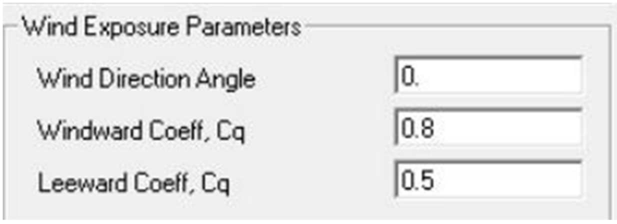
Click on 

Below Window will Appear,

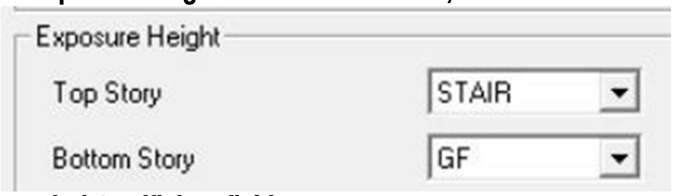


From Exposure & Pressure Coefficients,

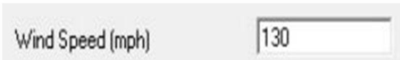
From Wind Exposure Parameters select ,
Wind Direction Angle = 0
Windward Coeff, Cq= 0.8
Leeward Coeff, Cq= 0.5



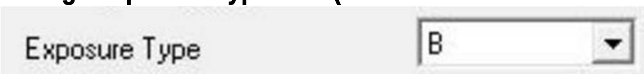
In Exposure Height Select GF to STAIR,

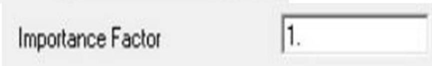


In Wind Coefficient field ,

Change Wind Speed(mph)= 130 

Change Exposure Type as C (As we consider the Structure in Dhaka City)



Change Inportance Factor as 1 

Click 

button

In same Method we add New Load Name WINDY only Change From Wind Exposure Parameters,
Wind Direction Angle= 90

Click 

button

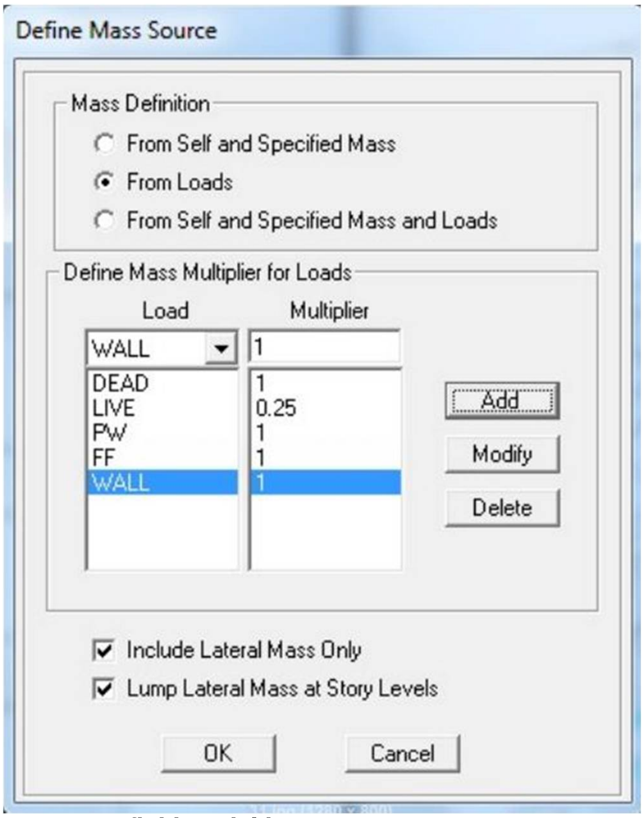
17

Select From Menu Bar 

button,

From Sub-Menu Select 

ETABS window appear as below,



Define of Mass Source

In Mass Definition Field ,

Select From Loads,

Define Mass Multiplier for Loads are as below,

Sl. No	Name Of Load	Multiplier
1	DEAD	1
2	LIVE	0.25
3	PW	1
4	FF	1
5	WALL	1

Define Mass Multiplier one by one and click 

Click 

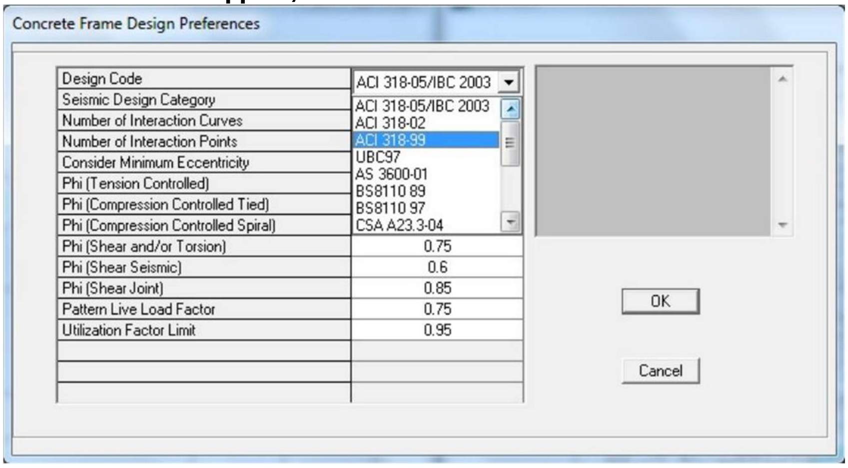
button.

18 From Menu Bar Select **Options** button,

Select Preferences...

From Sub-Menu Select Concrete Frame Design...

This Window Will Appear,



From Design Code Drop Down Design Code

Select ACI 318-99

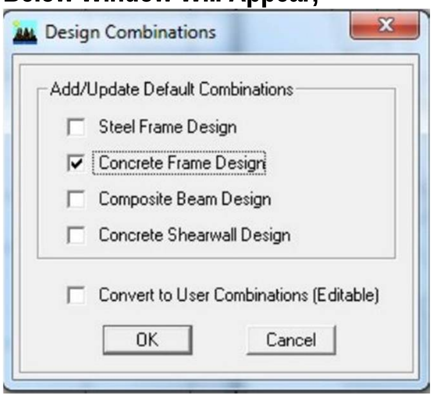
Click OK **button.**

Define Design Code

From Menu Bar Select Define

From Sub- Menu Select Add Default Design Combos...

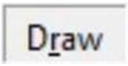
Below Window Will Appear,



Select ☑ Concrete Frame Design

Click OK **button.**

Define Default Design Combination

19 **From Menu Bar Click on**  **button;**

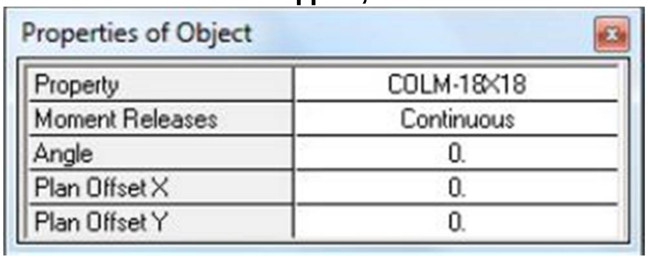
Select Sub-Menu 

Then Click on 

Or

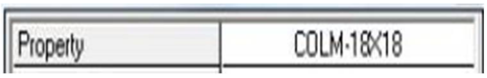
Directly Click on Draw Tool Bar 

Then below window will appear,



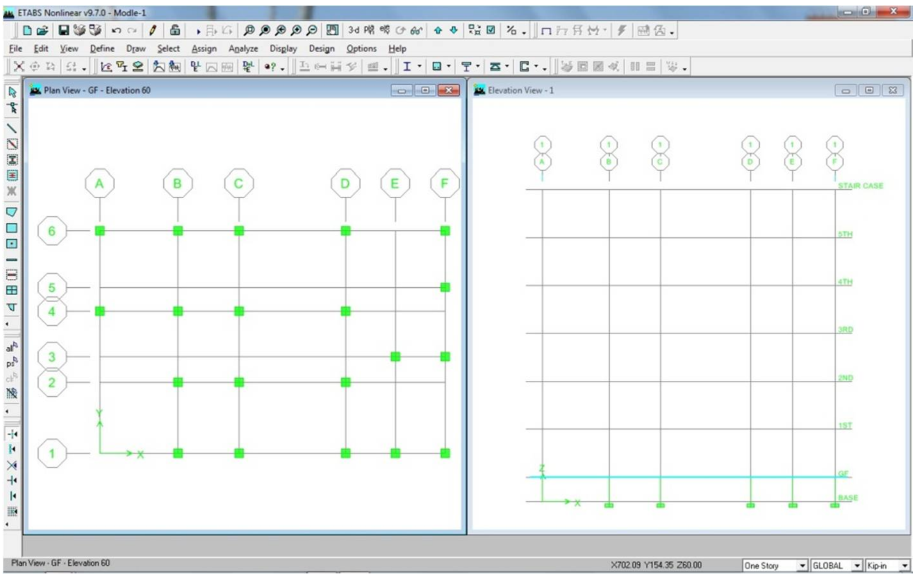
Properties of Object

Property	COLM-18X18
Moment Releases	Continuous
Angle	0.
Plan Offset X	0.
Plan Offset Y	0.

Change Object Property as 

Select Grid Intersection where Column will take place,

Below window will appear,

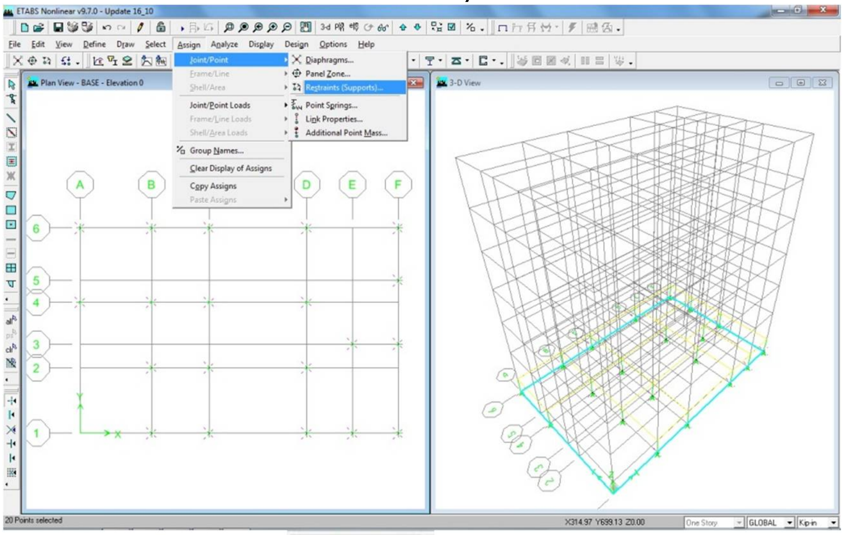


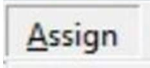
Draw of Sub-Structure Column

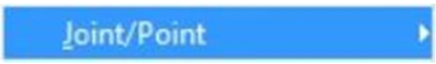
20

From Tool bar click 

All the Column will be selected as below,



From Menu Bar Click on 

From Sub-Menu Click on 

From Sub-Menu Click on 

Assign Support

Below Window will Appear,

Click on 

Click 

button.

The Support of the Structure will be Fixed.

21 **From Menu Bar Click on** Draw **button;**

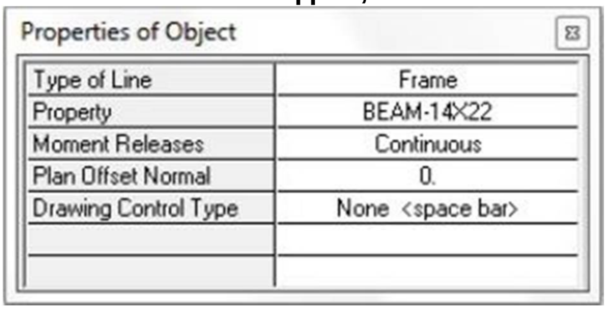
Select Sub-Menu Draw Line Objects

Then Click on Draw Lines (Plan, Elev, 3D)

Or

Directly Click on Draw Tool Bar 

Then below window will appear,



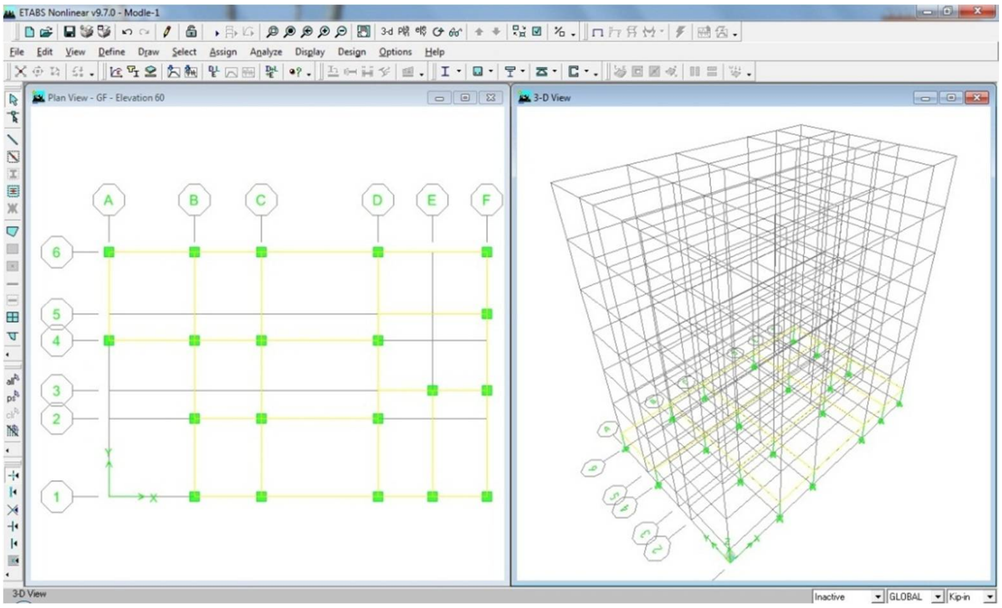
Properties of Object

Type of Line	Frame
Property	BEAM-14X22
Moment Releases	Continuous
Plan Offset Normal	0.
Drawing Control Type	None <space bar>

Change Object Property as 

Property	BEAM-14X22

Select Grid Intersection One Poient to Other and the Beam will be appear as Below,

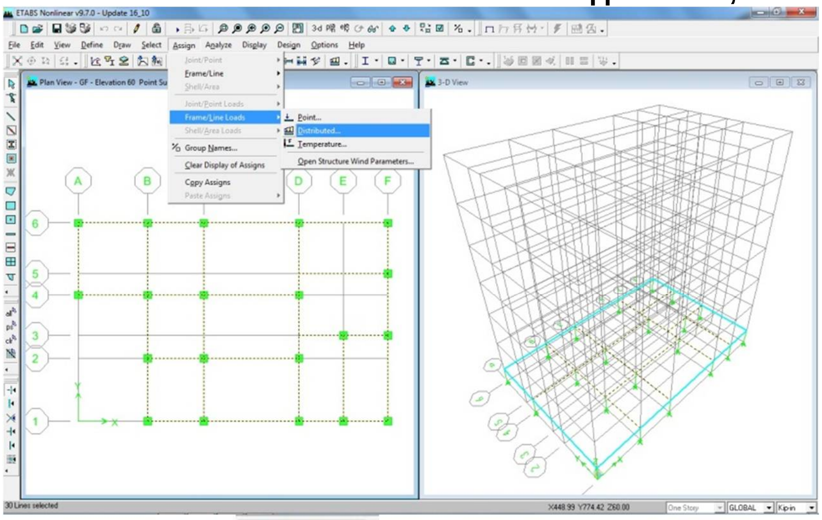


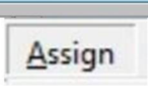
Draw of Sub-Structure Beam

From Menu Bar Click 

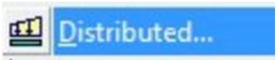
From Sub-Menu Click 

All the Beam will Be Selected and the window will appear below,

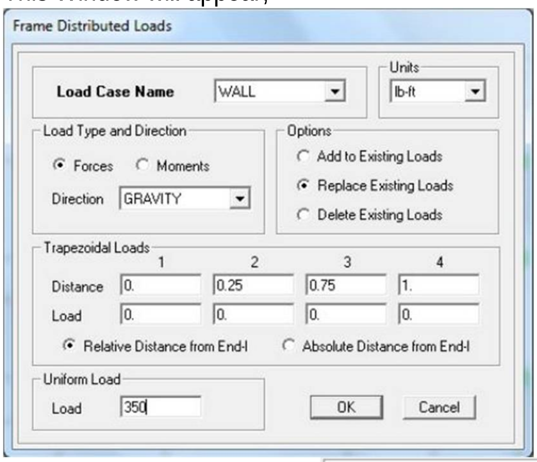


From Menu Bar Click 

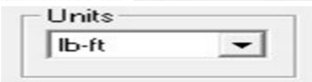
Select 

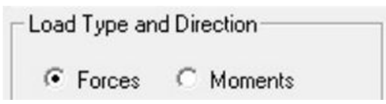
Select 

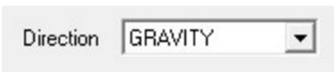
This Window will appear,



Change Load Case Name as 

Change Units as 

Set Load type from Load Type & Direction field, 

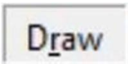
Set Load Direction as 

Set Uniform Load 

Click  button.

Apply Distributed Load on Sub-Structure Beam

23

From Menu Bar Click on 

button;

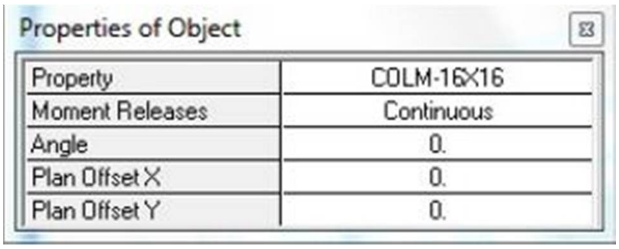
Select Sub-Menu 

Then Click on 

Or

Directly Click on Draw Tool Bar 

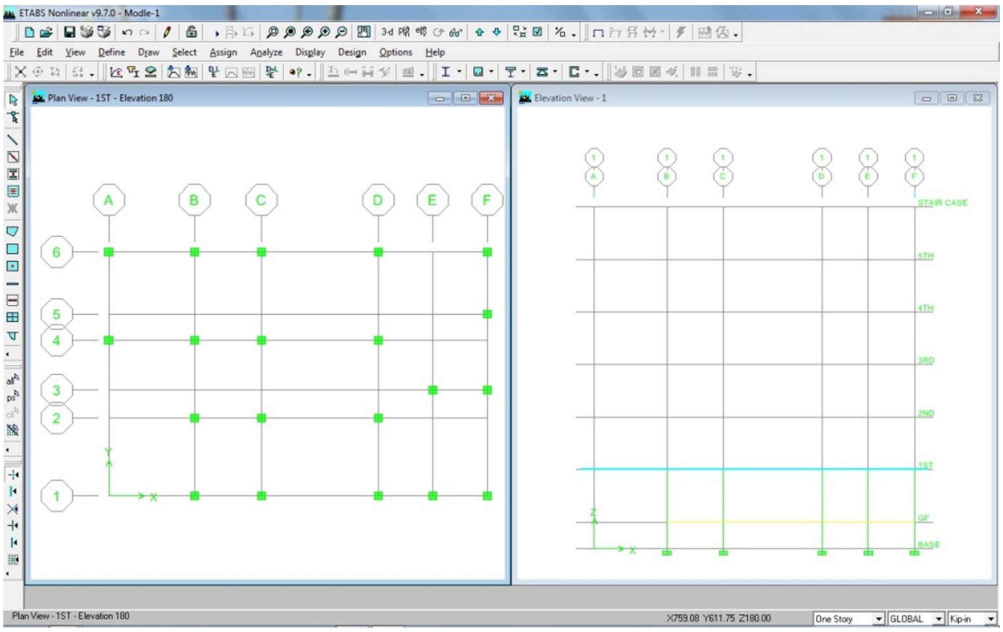
Then below window will appear,



Change Object Property as 

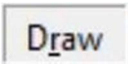
Select Grid Intersection where Column will take place,

Below window will appear,



Draw of Superstructure Column

24

From Menu Bar Click on 

button;

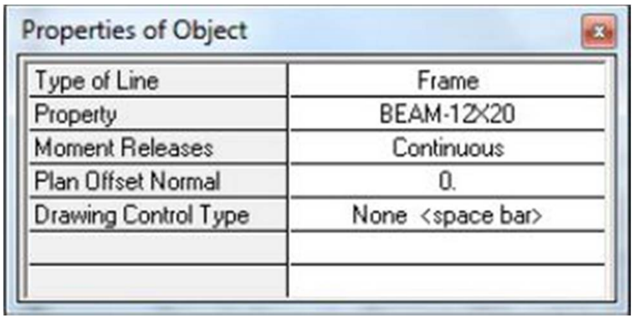
Select Sub-Menu 

Then Click on 

Or

Directly Click on Draw Tool Bar 

Then below window will appear,



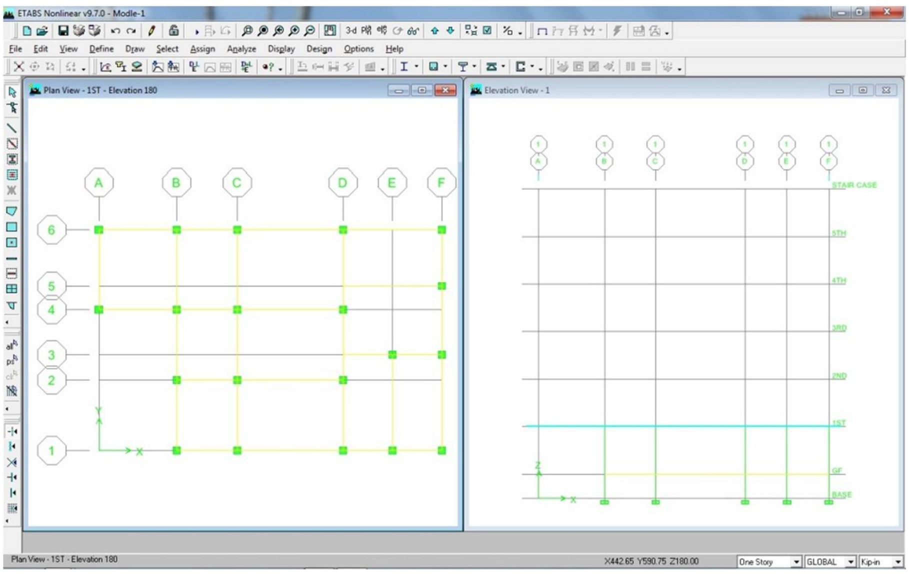
Properties of Object

Type of Line	Frame
Property	BEAM-12X20
Moment Releases	Continuous
Plan Offset Normal	0.
Drawing Control Type	None <space bar>

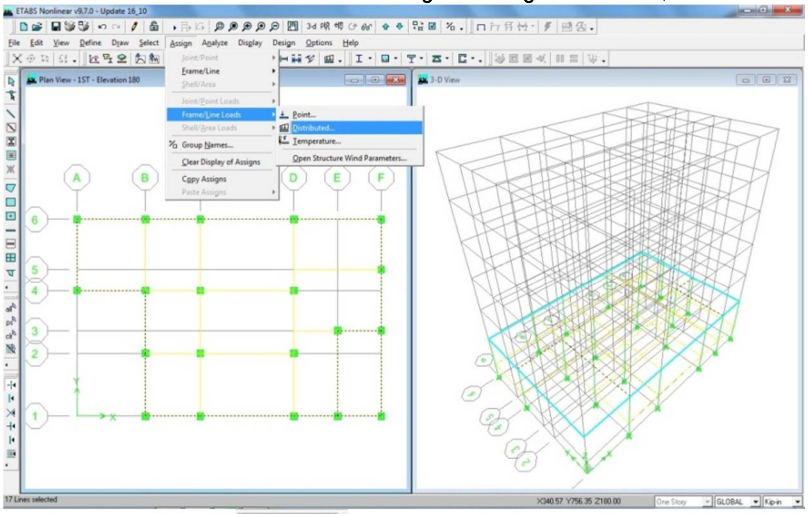
Change Object Property as 

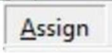
Draw of Superstructure Beam

Select Grid Intersection One Poient to Other and the Beam will be appear as Below,



25 Select all the Outside wall of the building including Stair Case ,

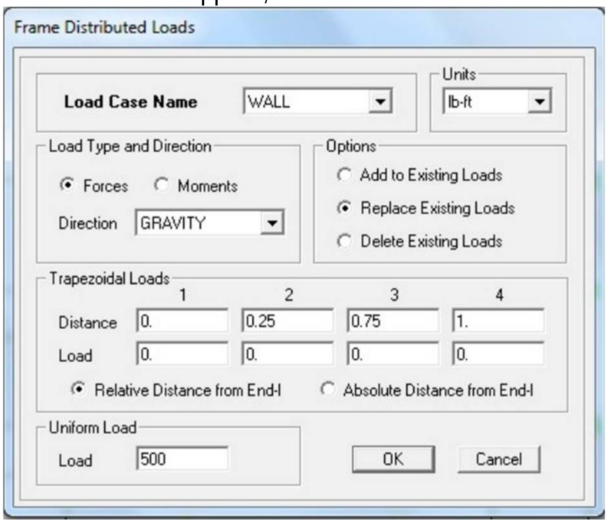


From Menu Bar Click 

Select 

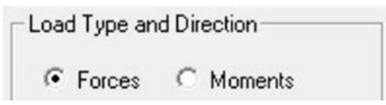
Select 

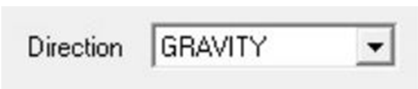
This Window will appear,



Change Load Case Name as 

Change Units as 

Set Load type from Load Type & Direction field, 

Set Load Direction as 

Set Uniform Load 

Click  button.

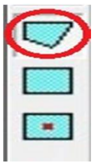
Applying Wall Loads

Draw Slab

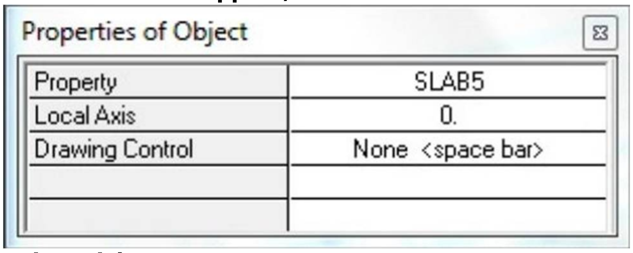
From Menu Bar Click 

From Sub-Menu 

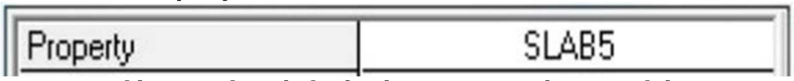
From Sub-Menu 

OR From Menu Bar Click 

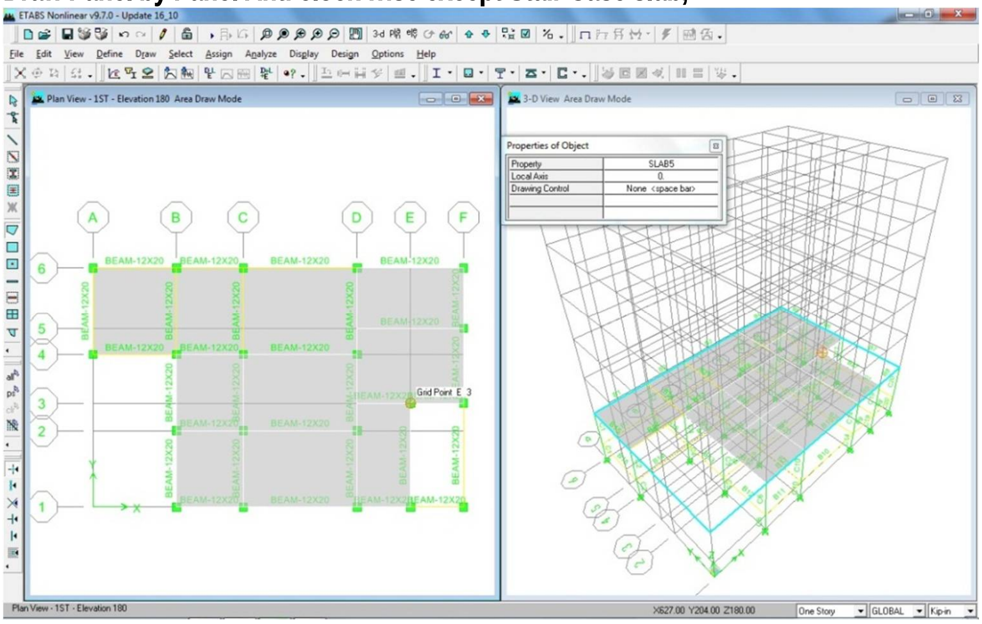
This Window will appear,



Select Slab Property as SLAB5



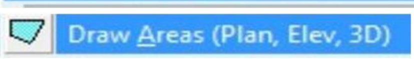
Draw Panel by Panel Anti clock wise except Stair Case slab,

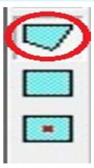


AGAIN,

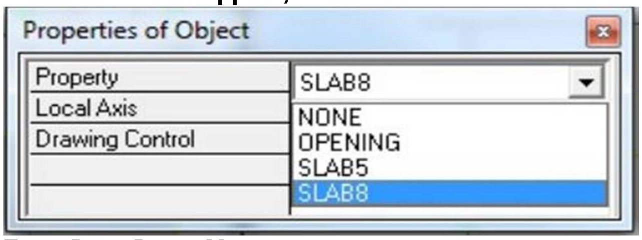
From Menu Bar Click 

From Sub-Menu 

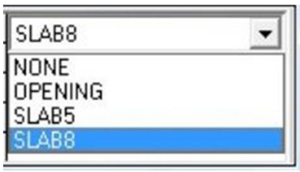
From Sub-Menu 

OR From Menu Bar Click 

This Window will appear,



From Drop Down Menu,



Select Slab Property as

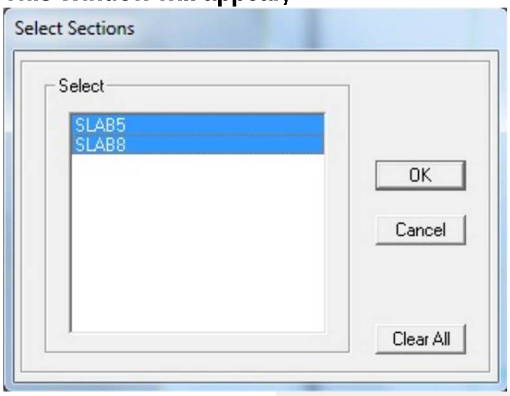
Draw Stair Case Slab inculding Roof

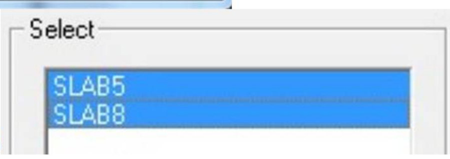
27

From Menu Bar select 

From Sub-Menu Seect 

This Window will appear,



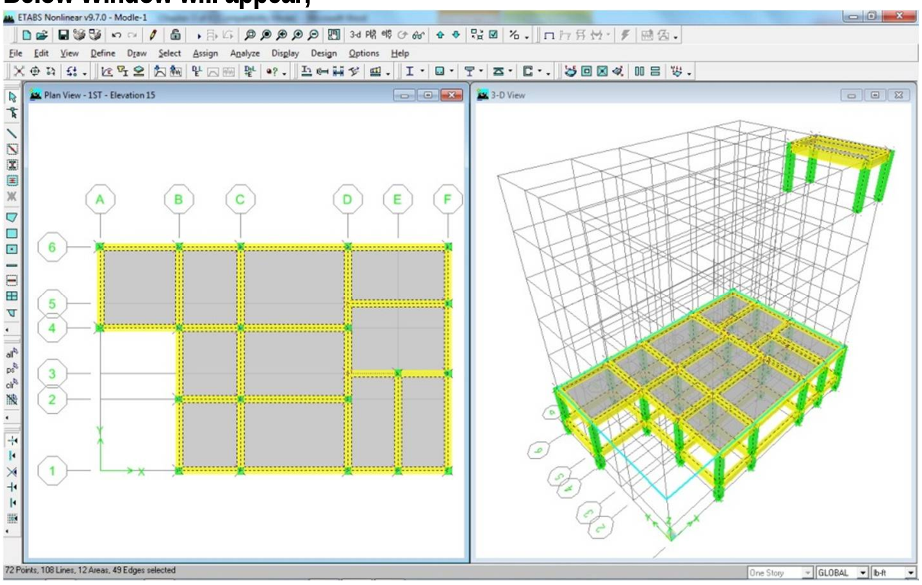


Select SLAB5 & SLAB 8

Click 

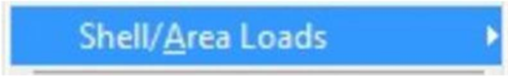
button.

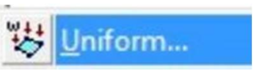
Below Window will appear,

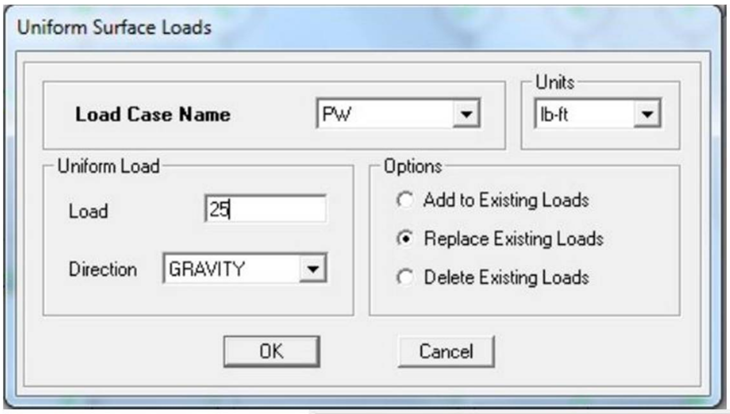


Assign Uniformly Distributed Load

From Menu Bar seect 

From Sub-Menu Select 

From Sub-Menu Select 

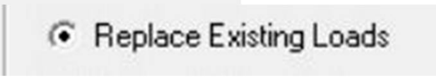


Select Load Case Name as 

Change Units Name as 

In Uniform Load Field put value as 25 

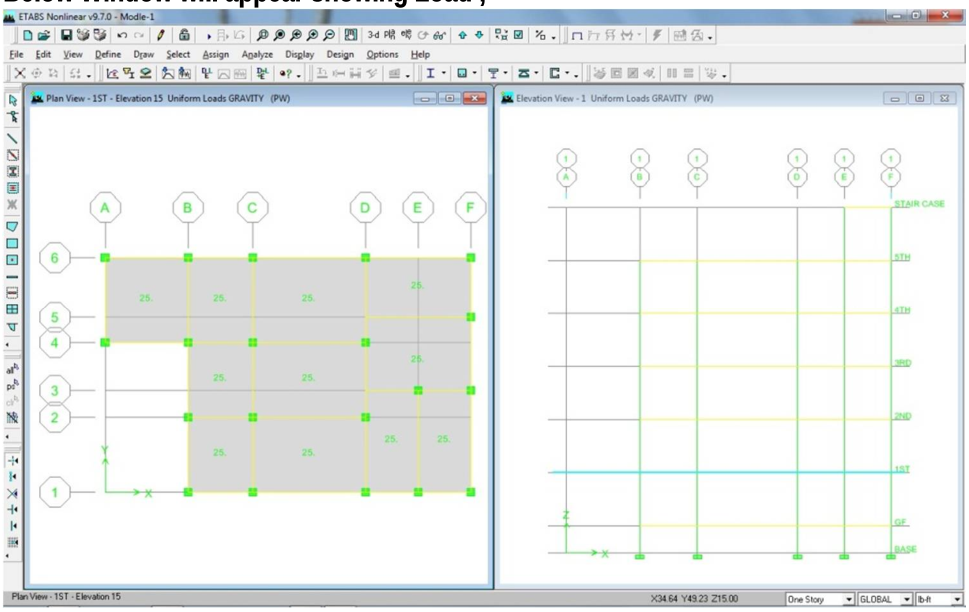
From Drop Down Menu Select Load Dircetion as GRAVITY,

From Options select 

Click 

button.

Below Window will appear showing Load ,

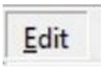


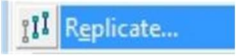
In same Method we apply the Below Loads,

SL. No	Name of Loads	ETABS Load Case Name	Load	Remarks
1	Pertation Wall	PW	25	
2	Floor Finish	FF	25	
3	Live Load Except Stair Case Area	LL	40	
4	Live Load In Stair Case Area Upto 5th Floor Level	LL	100	
5	Live Load In Stair Roof	LL	350	

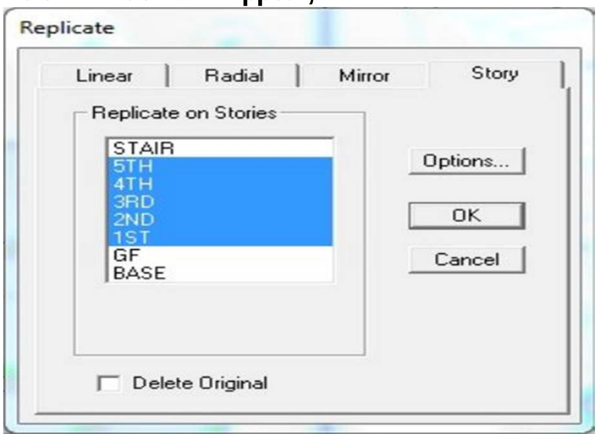
28 **Selcet all the Member of 1st Floor,**

Replicate of Structure

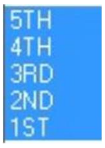
From Menu Bar Select 

From Sub-Menue Select 

Below Window will Appear,

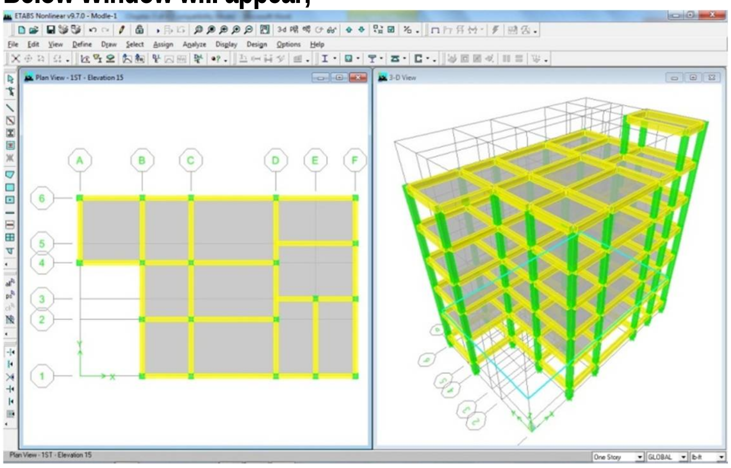


Click on 

Select 

Click  button.

Below Window will appear,

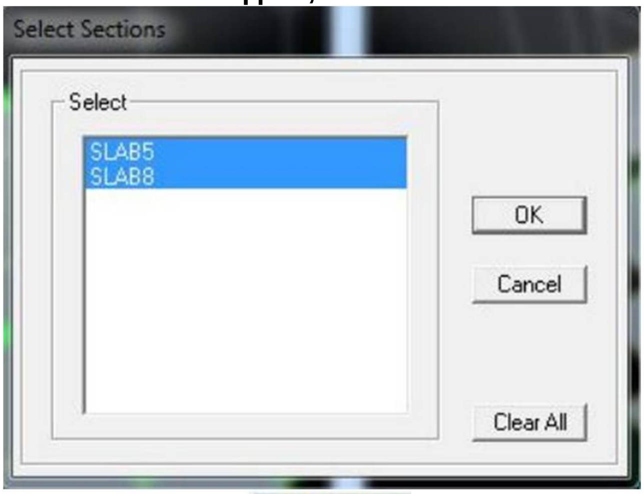


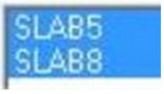
29

From Menu bar click 

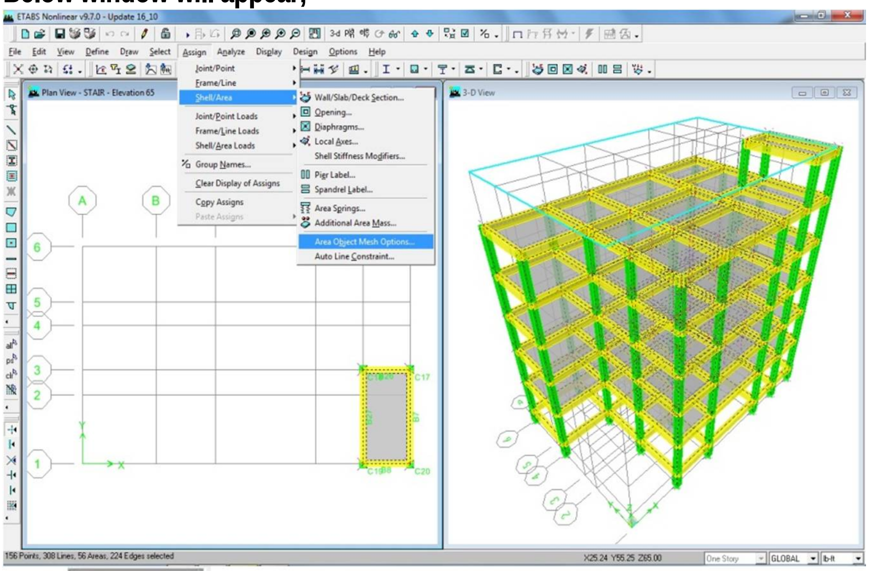
From Sub-Menu Select 

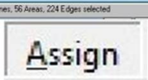
Below Window will Appear,



Select Slab5 & Slab8 

Below window will appear,



Click 

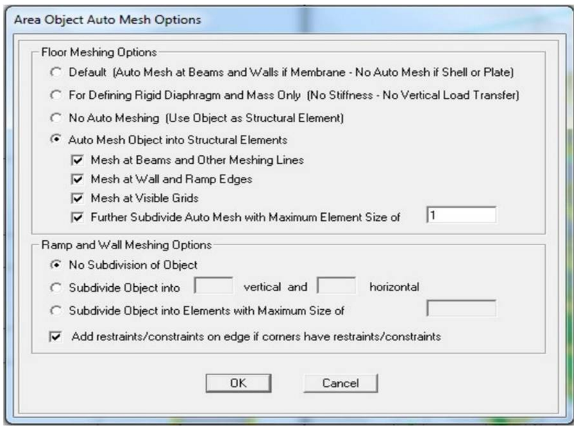
Menu

From Sub Menu Click 

From Sub- Menu Click 

ETABS window appear as below.

Creating Area Object Mesh



- **Click on Auto Mesh Object into Structural Elements,**

  Auto Mesh Object into Structural Elements

- **Mark all from Auto Mesh Object into Structural Elements.**

Mark on

Mesh at Beams and Other Meshing Lines
Mesh at Wall and Ramp Edges
Mesh at Visible Grids

Mark & Put Value 1 in “Further Subdivide Auto Mesh with Maximun Element Size of

Further Subdivide Auto Mesh with Maximum Element Size of 1

Mark on No Subdivision of Object

Mark Add restraints/constraints on edge if corners have restraints/constraints

Click OK **button.**

30

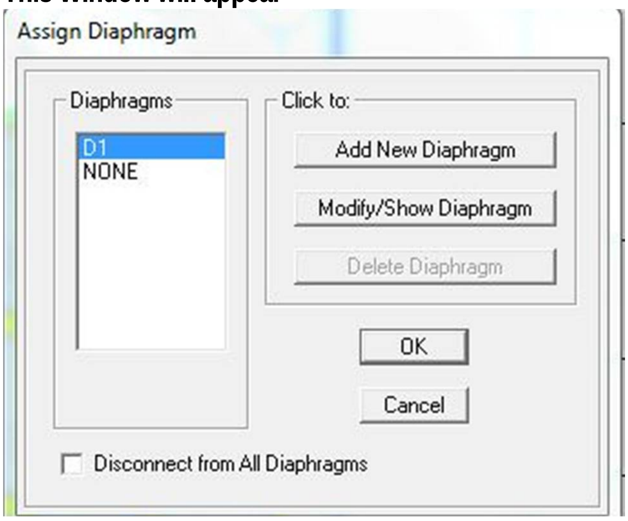
From Taks Bar Click on 

From Menu Bar Click on Assign

Select on Shell/Area

Select on Diaphragms...

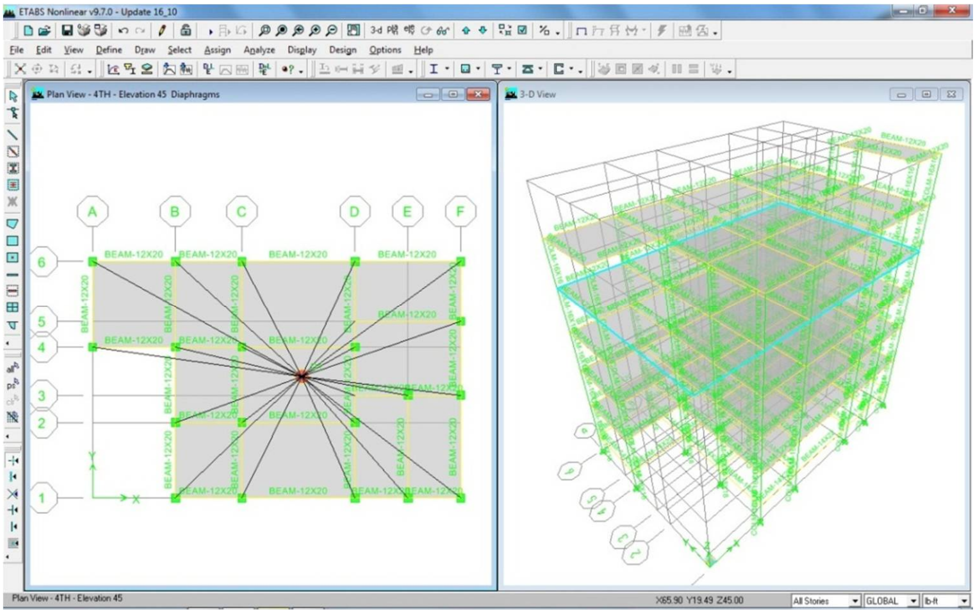
This Window will appear



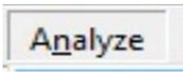
Select Diaphragms D1

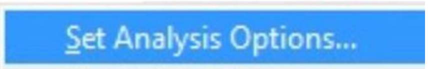
Click OK button.

This Window will Appear

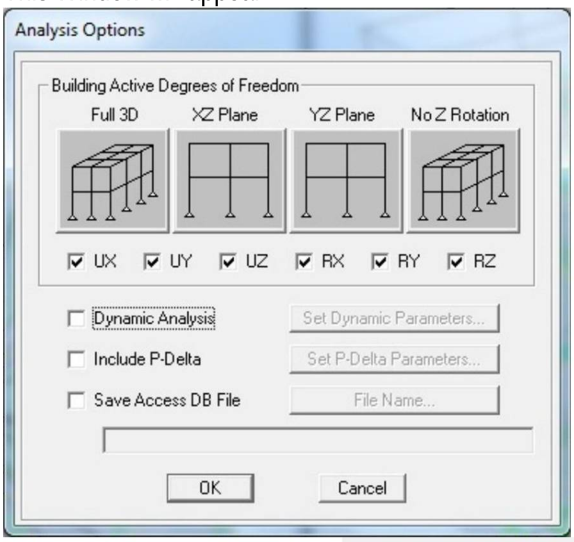


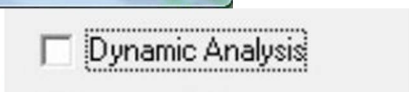
31

From Menu Bar Click on 

Click on 

This Window will appear

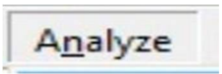


Uncheck in **Dynamic Analysis** 

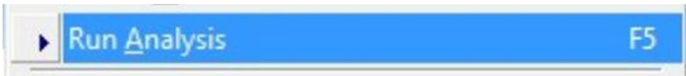
Click OK button.

Setting Analysis options

32

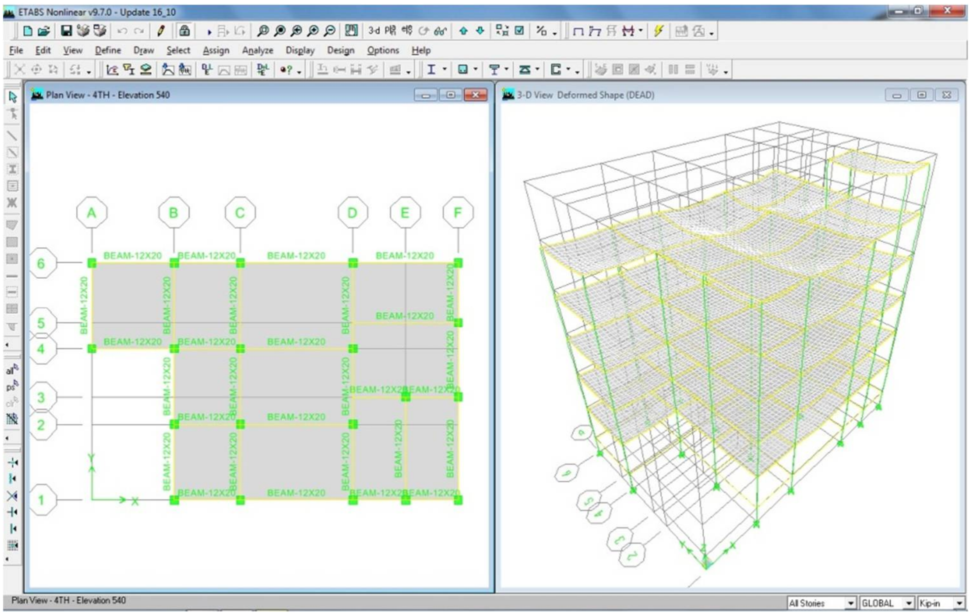
m Menu Bar Click on 

Click on Run Analysis or Press F5 from Keybord



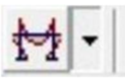
Analysis will start

After Completing Analysis below window will appear showing deformed shape



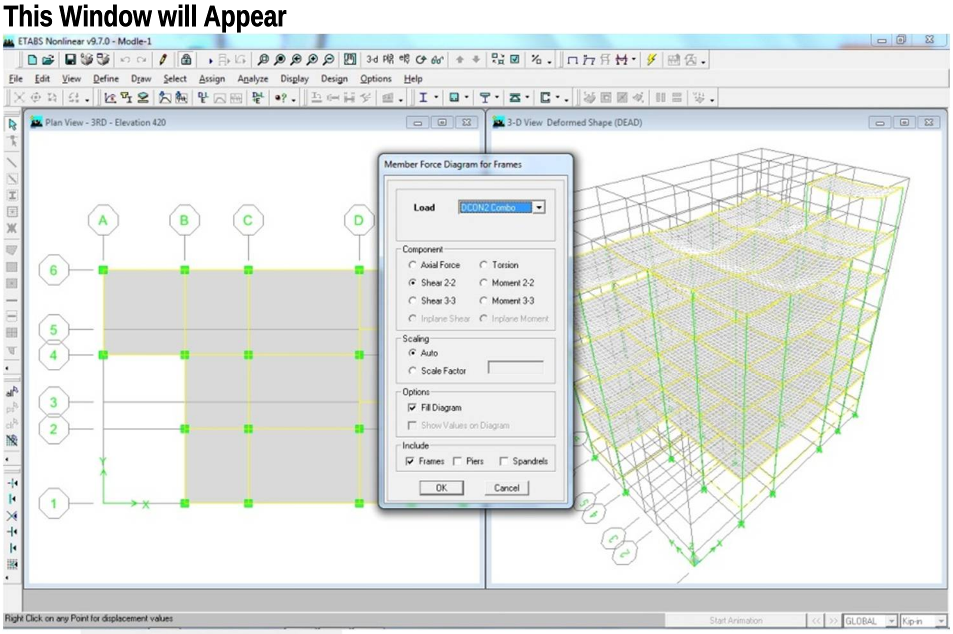
Run Analysis

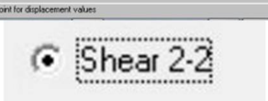
33

From Menu Tool Bar Click on 

Select 

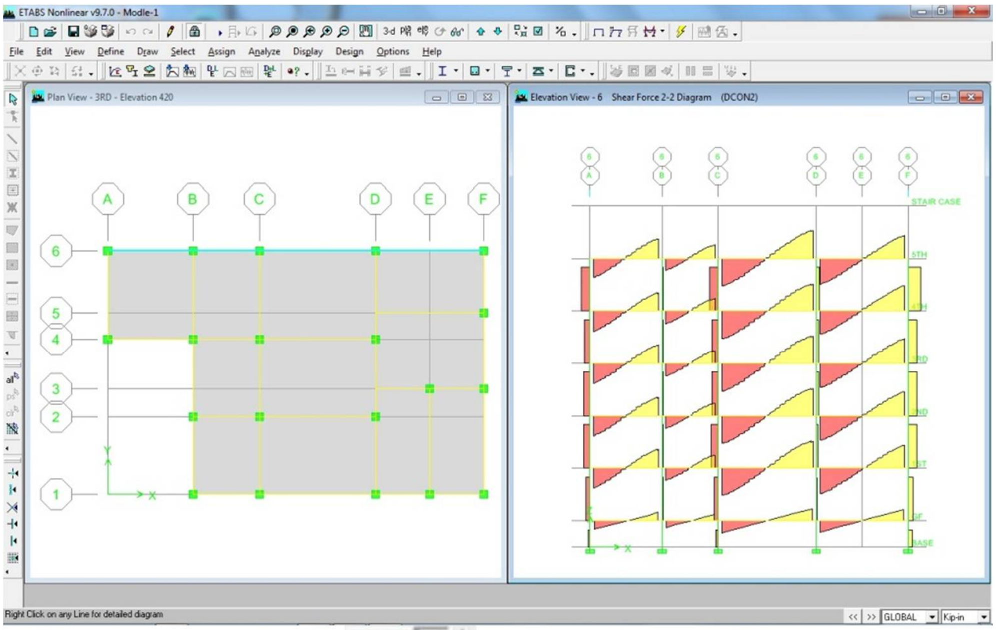
This Window will Appear

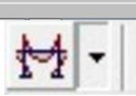


Select 

Display Shear & Moment Diagram

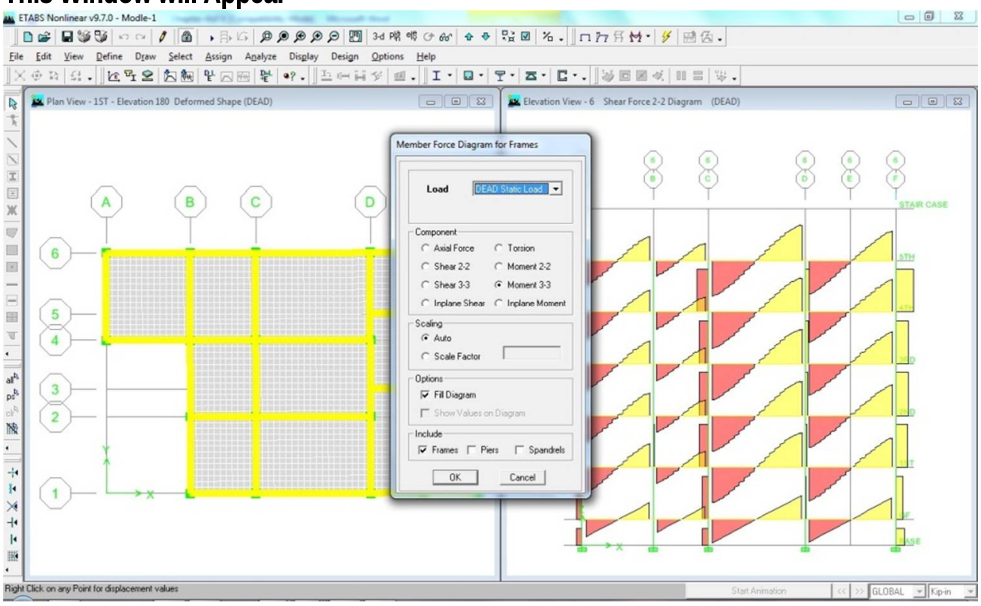
Click  button.
This Window will appear,



From Menu Tool Bar Click on 

Select 

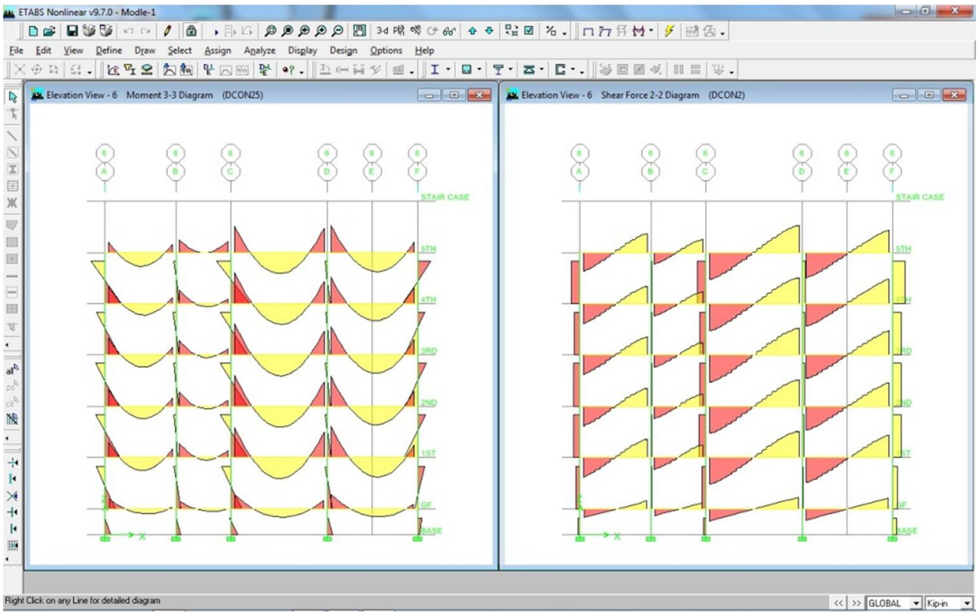
This Window will Appear

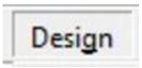


Select 

Click  button.

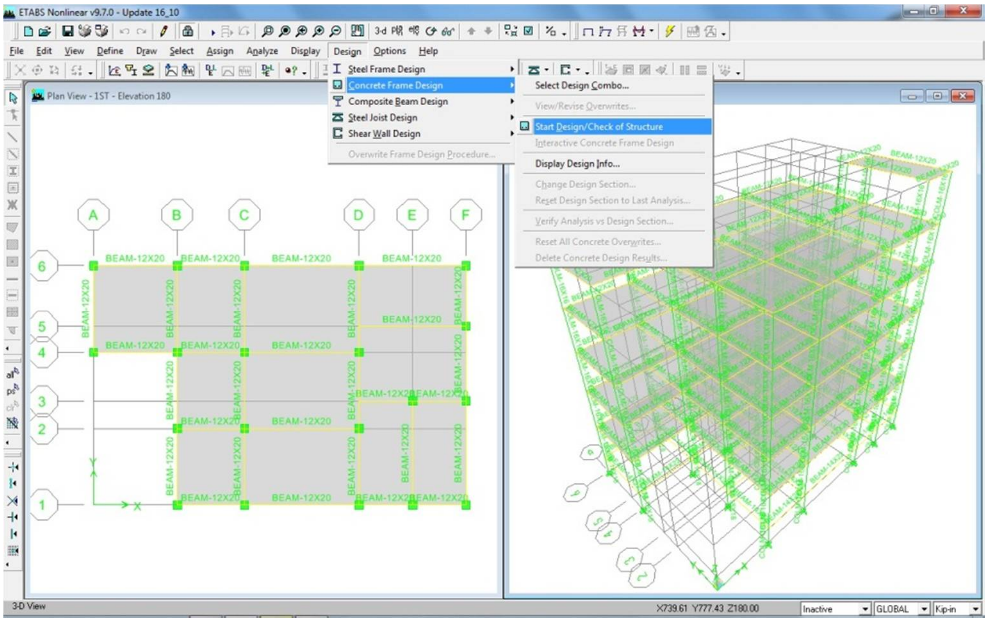
This Window will Appear showing Moment & Shear force Diagram,



34 From Menu Bar Click on 

Select 

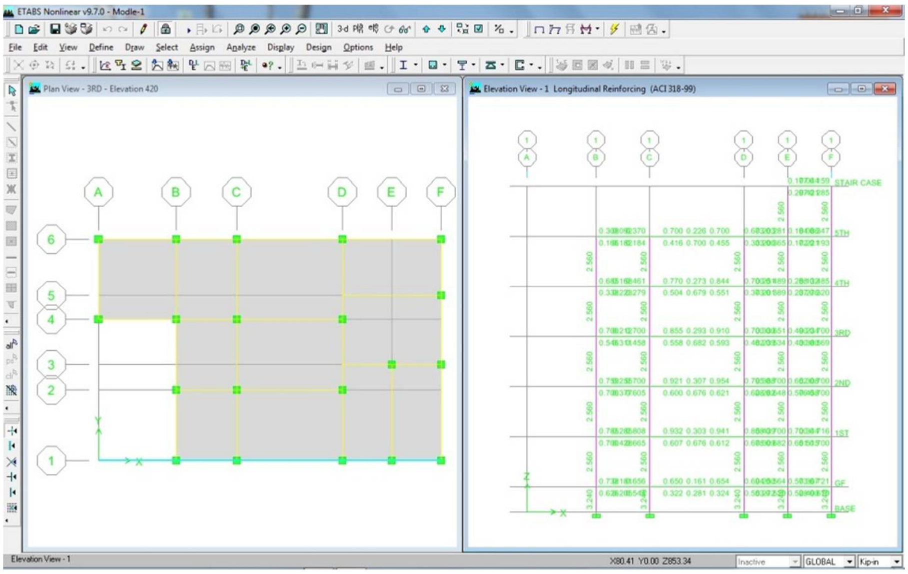
Select 



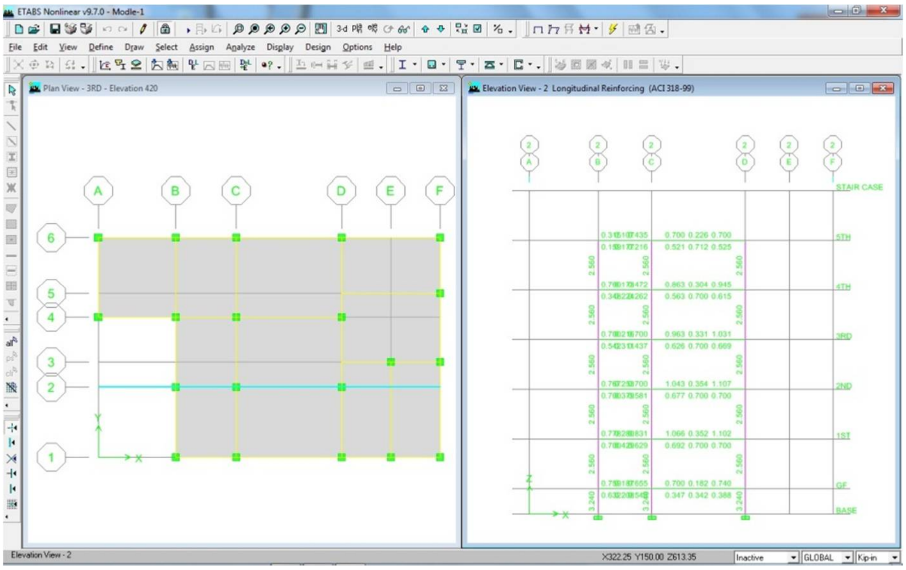
Concrete Frame Design

This window will appear Showing As

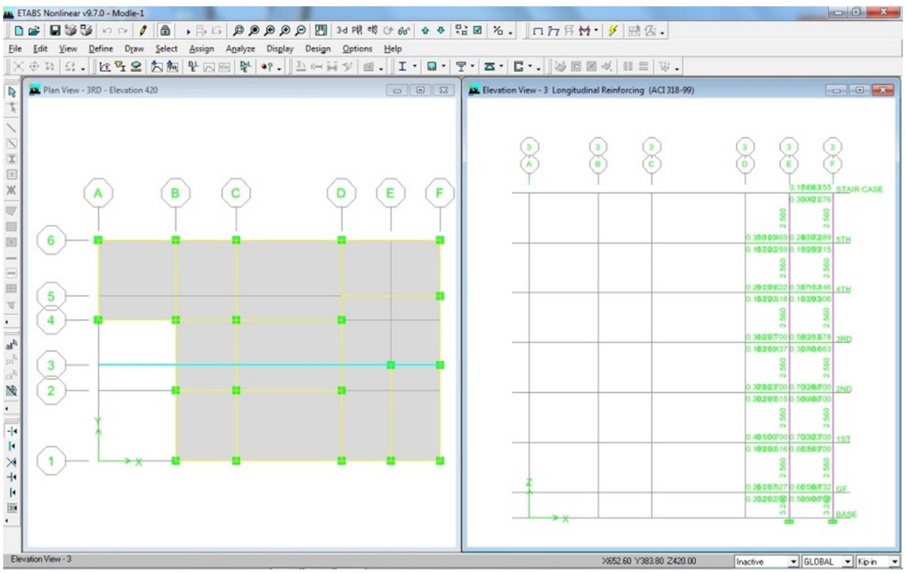
Elevation Grid -1



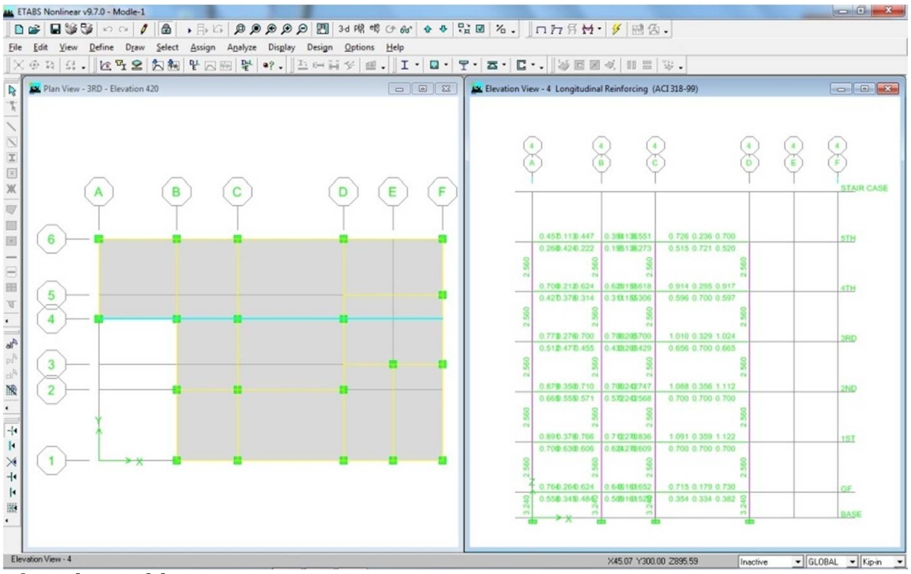
Elevation Grid -2



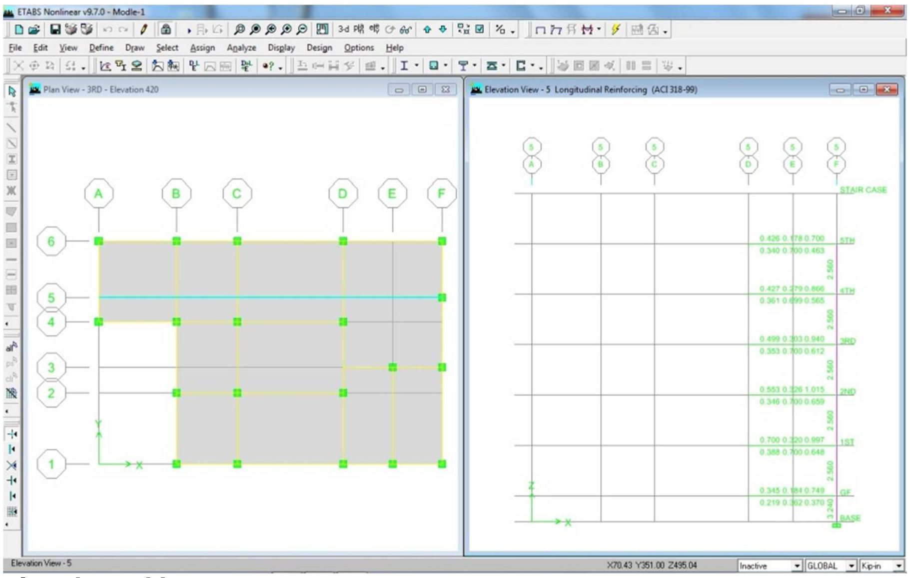
Elevation Grid -3



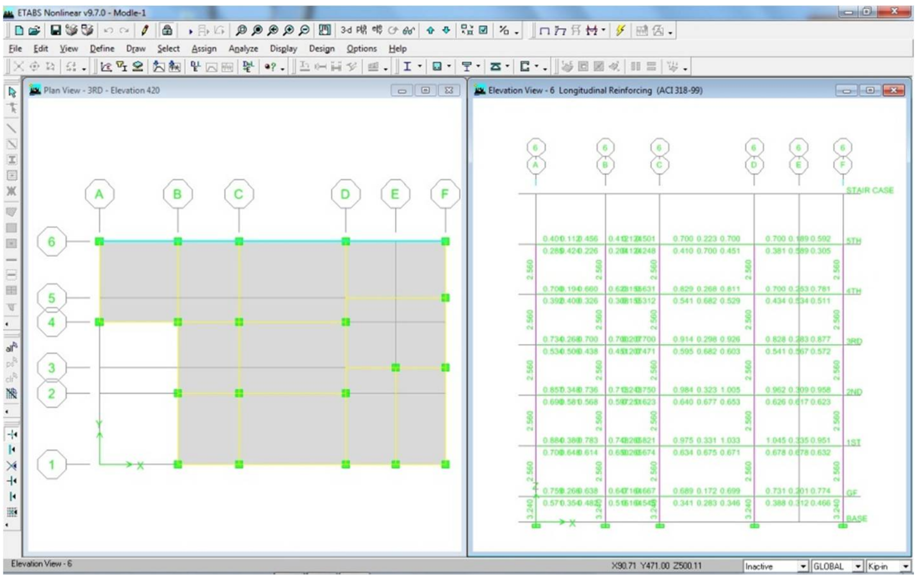
Elevation Grid-4



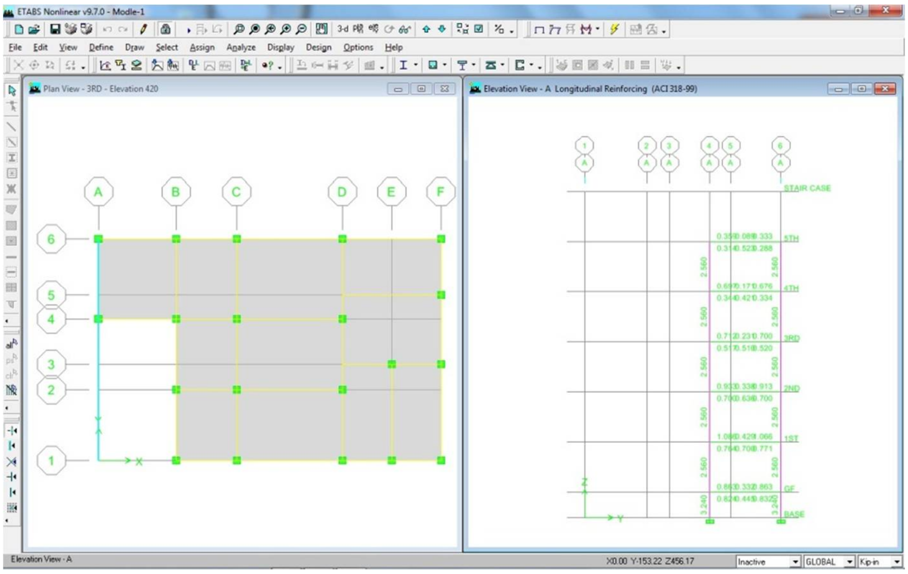
Elevation Grid-5



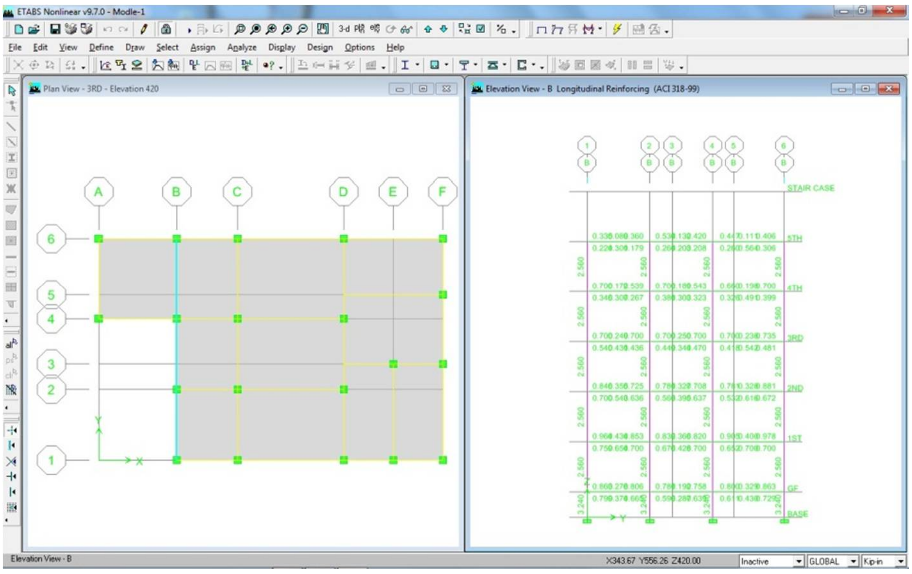
Elevation Grid-6



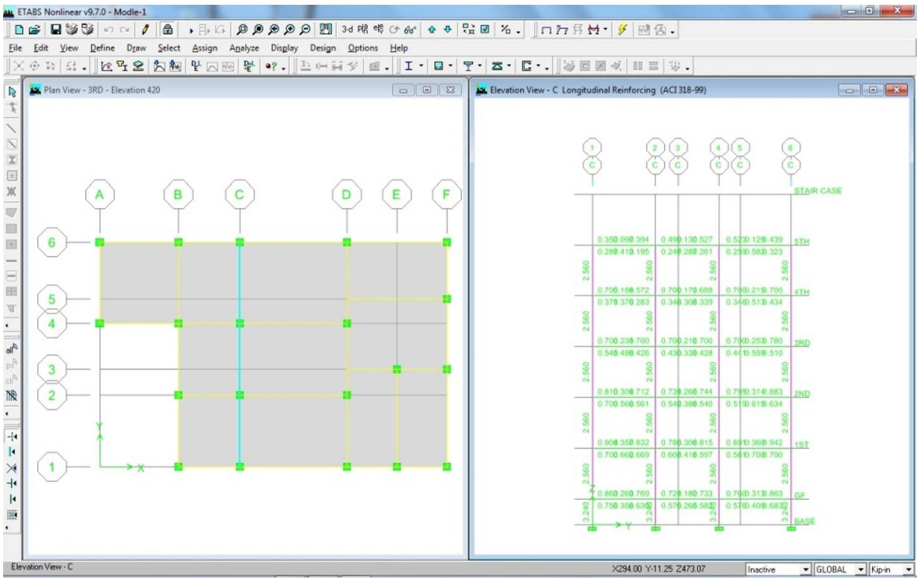
Elevation Grid- A



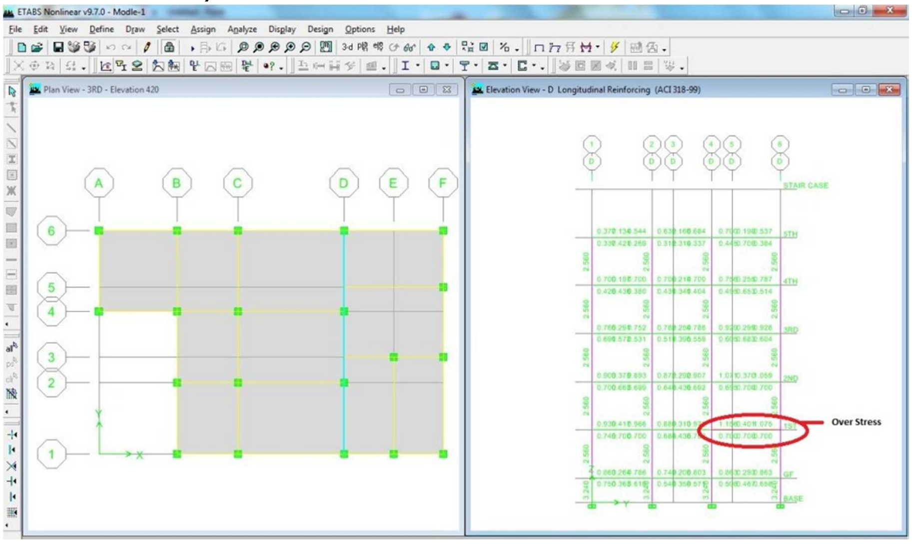
Elevation Grid-B



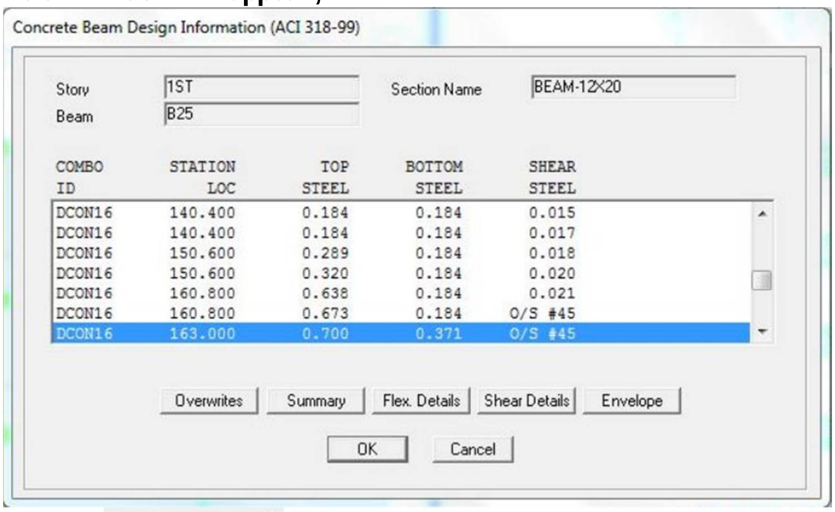
Elevation Grid-C



Elevation Grid –D,

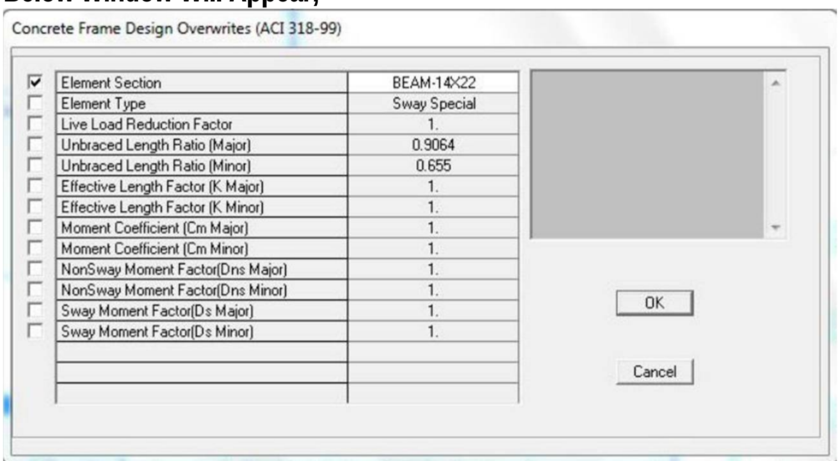


In Elevation D Level -1 (1st Floor) Beam showing Over Stressed,
Right Click on M\ouse on that Beam ,
Below Window Will appear ,



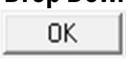
Click on 

Below Window Will Appear,



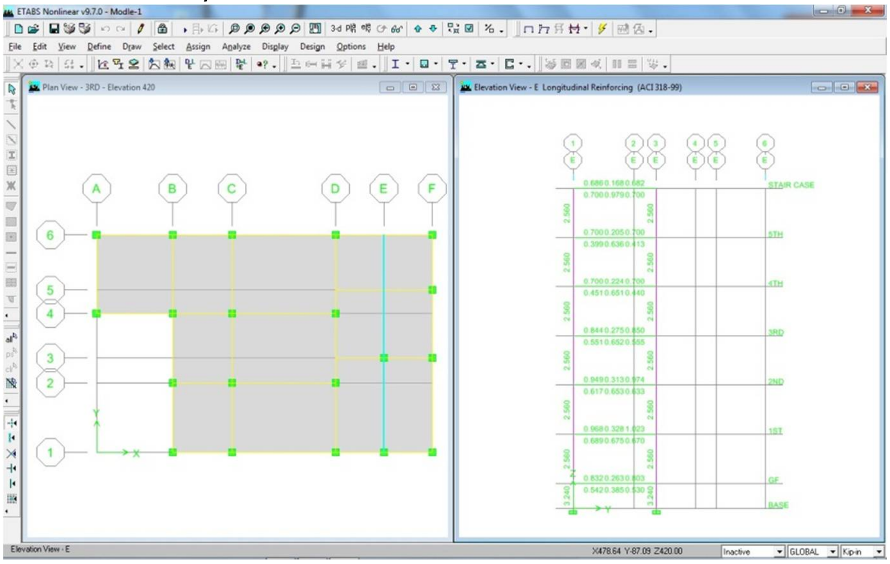
Click on 

From Drop Down Select Beam-14X22,

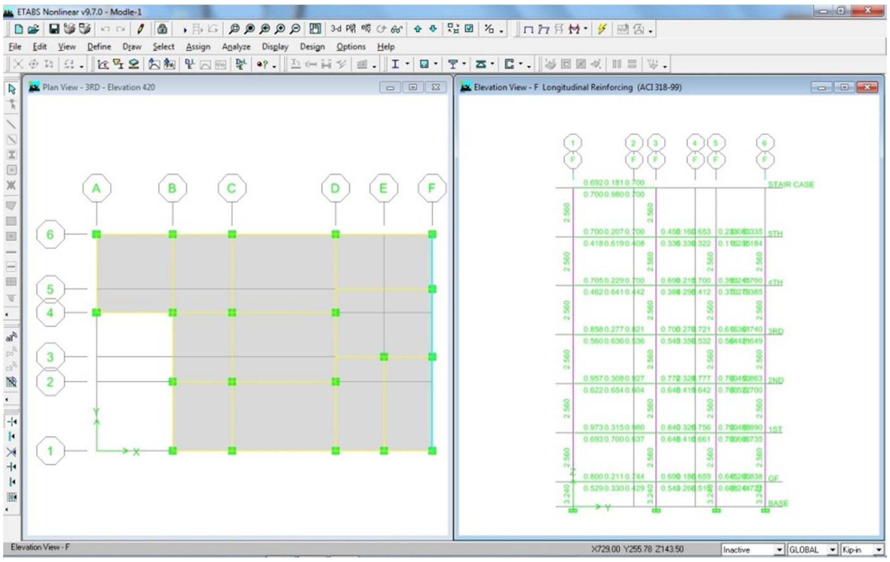
Click 

button.

Elevation Grid –E,

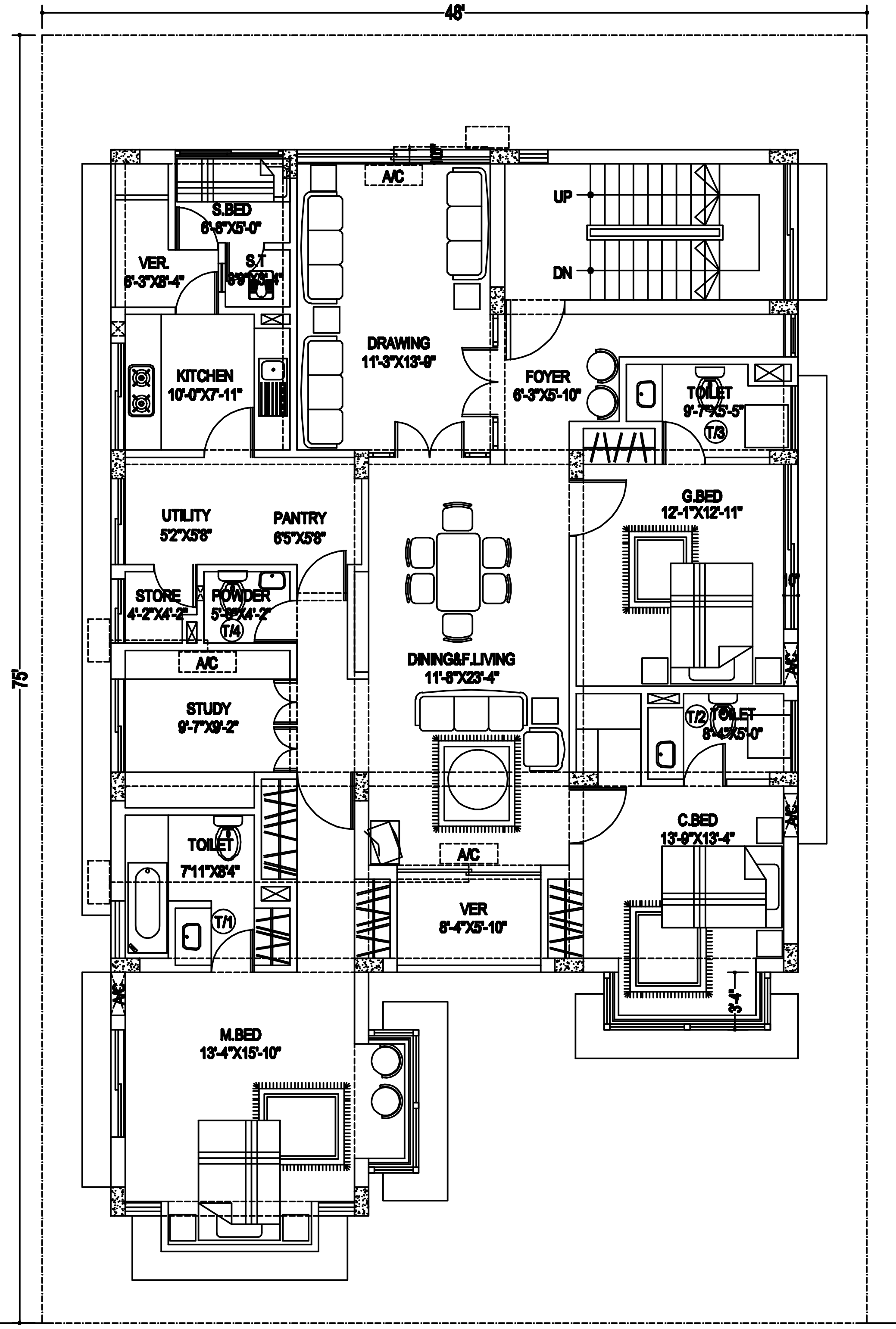


Elevation Grid-F,



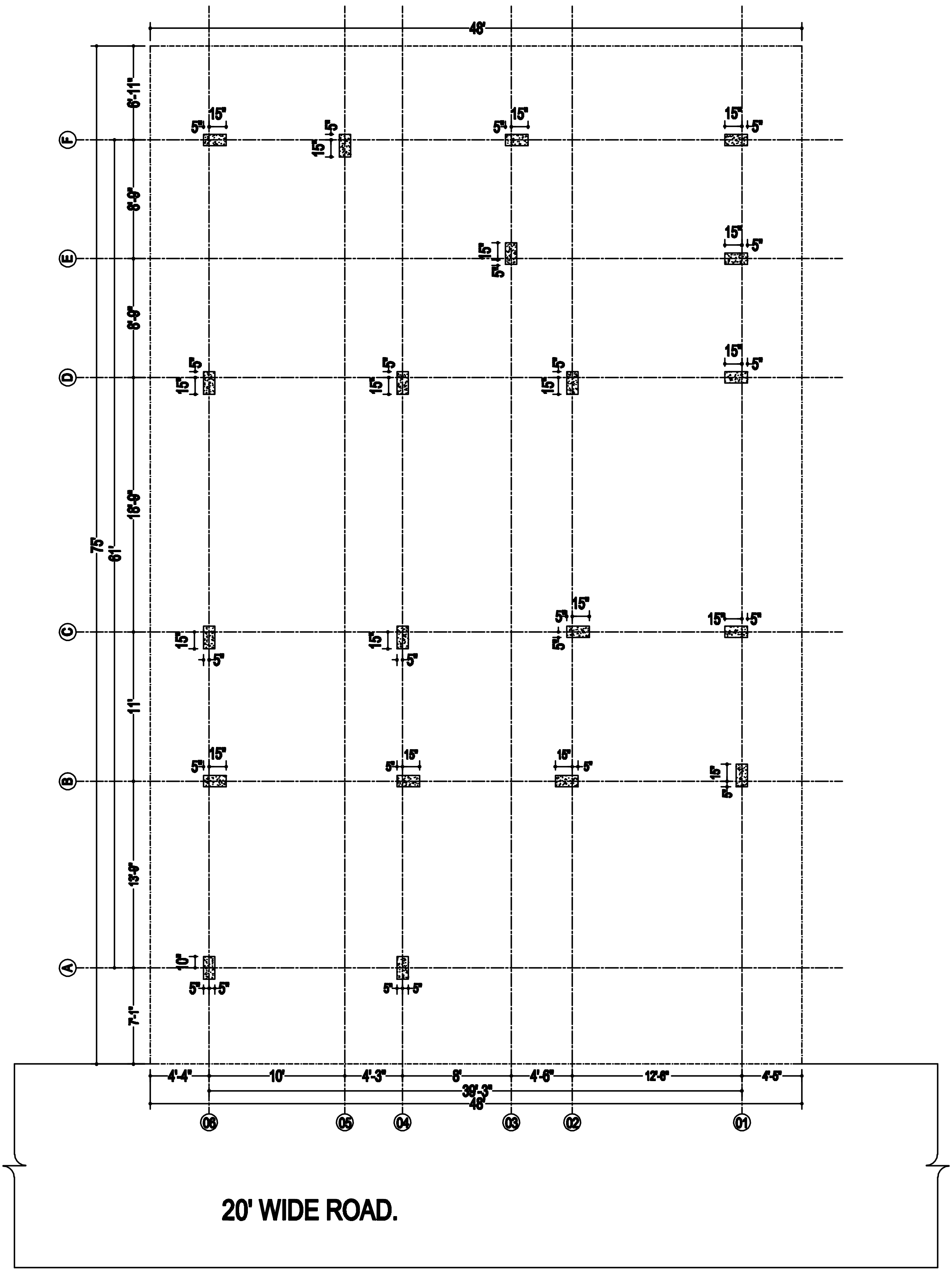
CHAPTER -5

ARCHITECTURAL
STRUCTURAL
ELECTRICAL
PLUMBING DRAWING



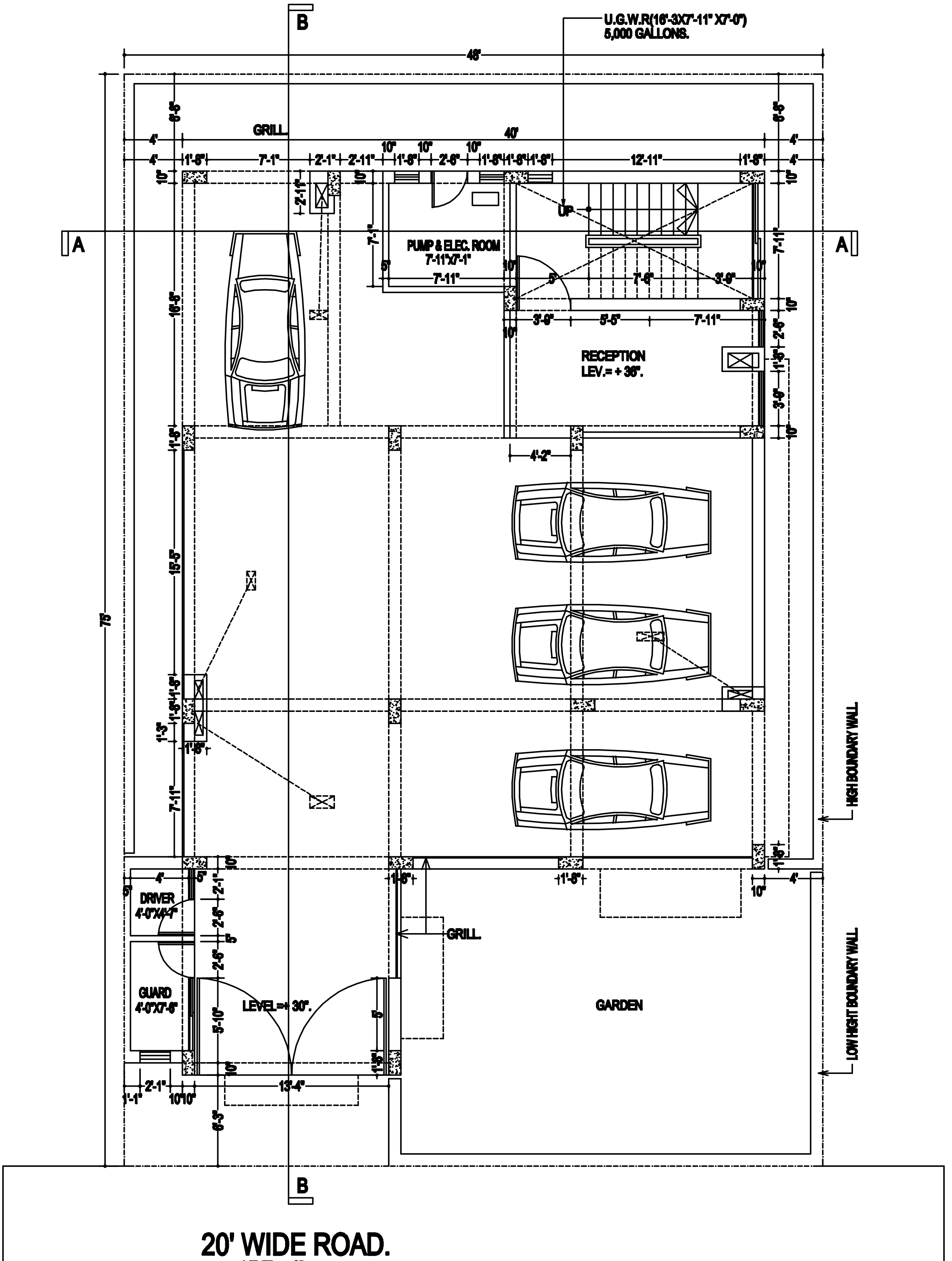
FURNITURE LAY OUT PLAN.

SCALE= 1/8"=1'-0"



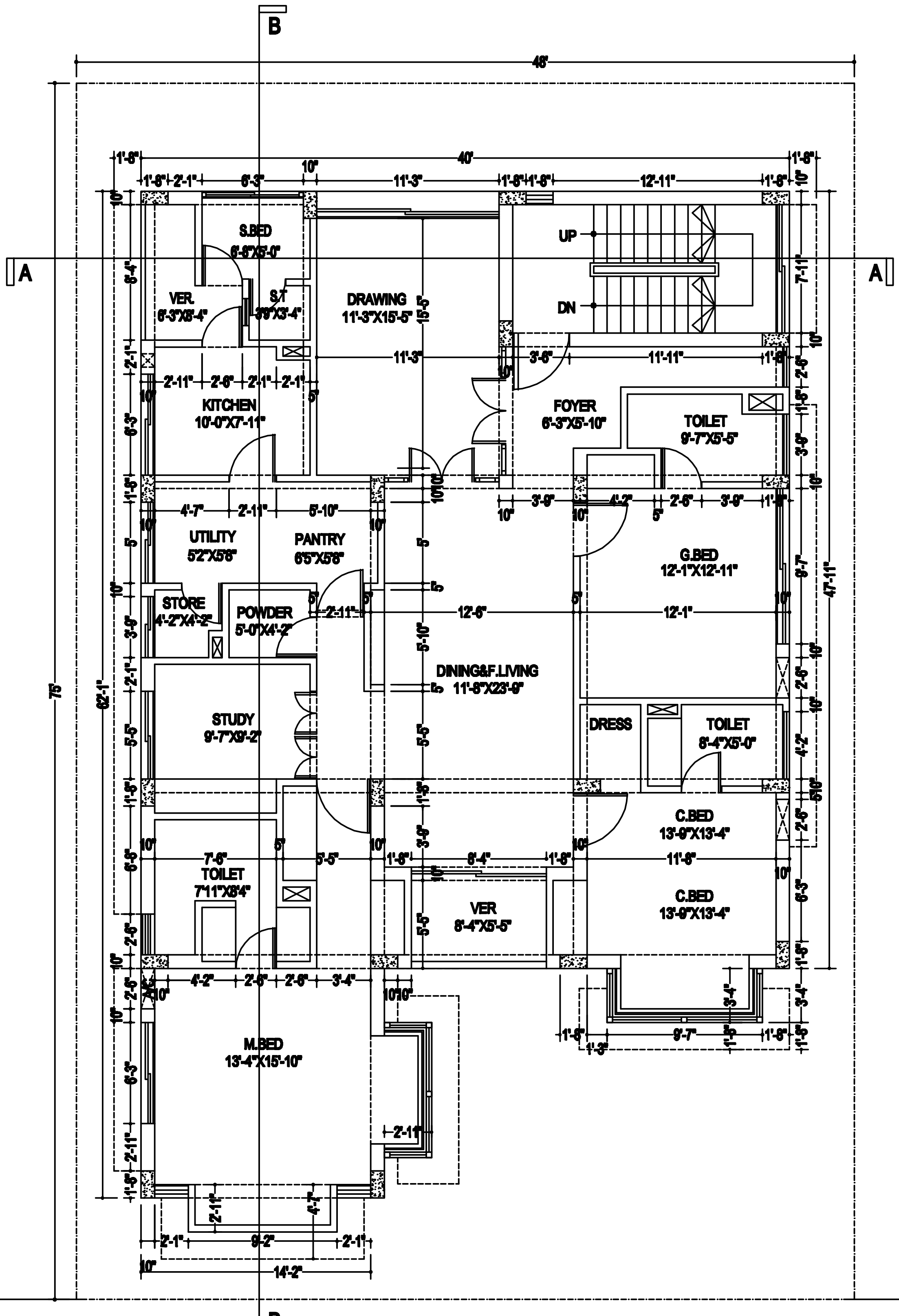
COLUMN LAY OUT PLAN.

SCALE= 1/8"=1'-0"



GROUND FLOOR PLAN.

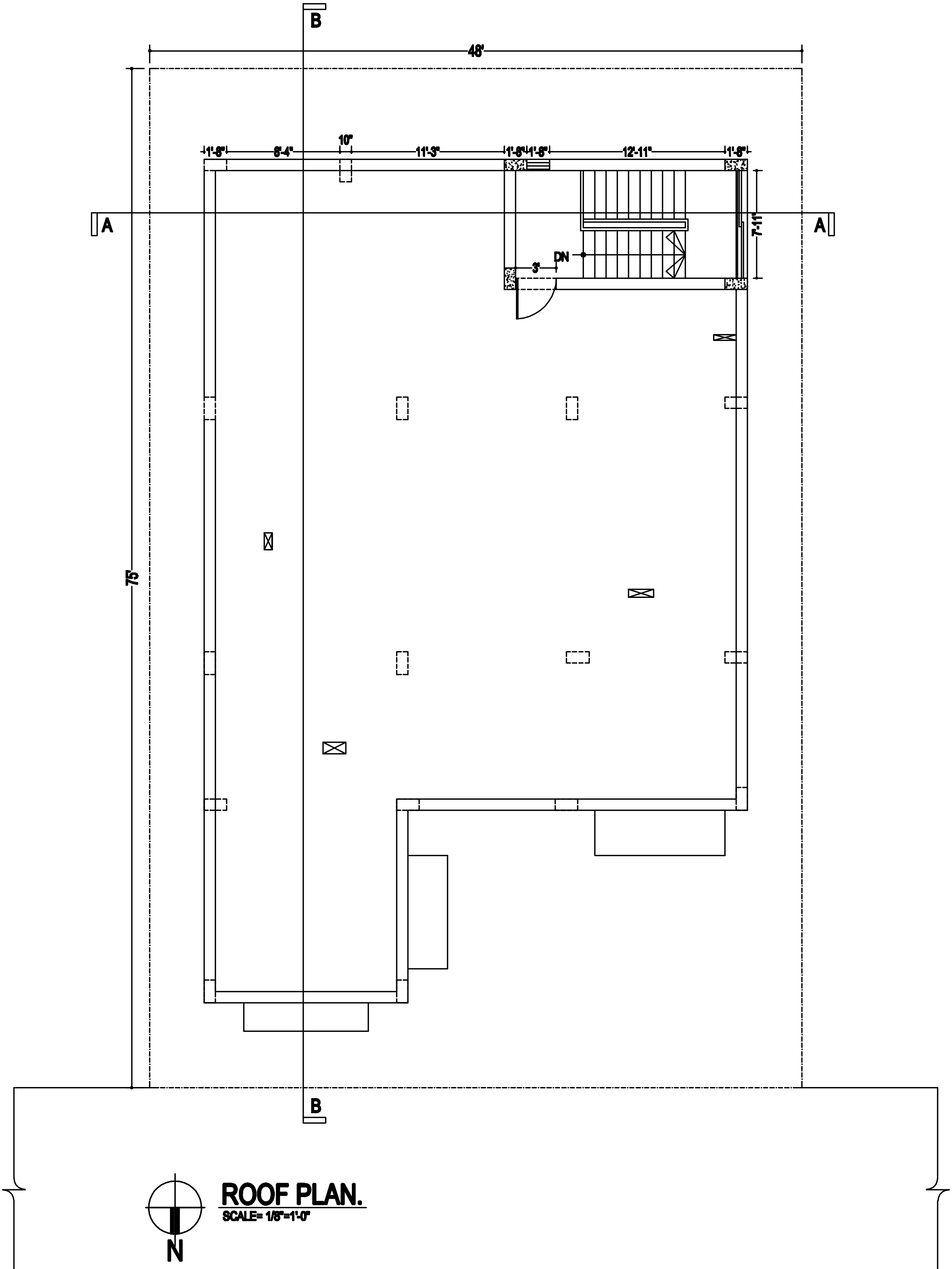
SCALE= 1/8"=1'-0"



1ST-5TH FLOOR PLAN.

SCALE= 1/8"=1'-0"

N



ROOF PLAN.

SCALE= 1/8"=1'-0"