

Design and analysis of chourasia sapphire building using etabs

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Abstract— Structural Analysis is a branch which involves in the determination of behaviour of structures in order to predict the responses of different structural components due to effect of loads. Each and every structure will be subjected to either one or the groups of loads, the various kinds of loads normally considered are dead load, live load, earth quake load and wind load. ETABS (Extended Three Dimensional Analysis of Building System) is a software which is incorporated with all the major analysis engines that is static, dynamic, Linear and non-linear, etc. and especially this Software is used to analyze and design the buildings. Our project “Analysis and Design of Chourasia sapphire building using ETABS software” is an attempt to analyze and design a residential building using ETABS. A G+10 storey building is considered for this study. Analysis is carried out by static method and design is done as per IS 456:2000 guidelines. Also an attempt has been made to design the structural elements manually. Drawing and detailing are done using Auto CAD as per SP 34.

Index Terms— Analysis, Dead Load, Earth Quake Load, Etabs, G+10 Storey, Live Load, Sp 34

1 INTRODUCTION

1.1 General

The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design is used to produce a structure capable of resisting all applied loads without failure during its intended life. Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation.

A geotechnical site investigation is the process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation for a structure. Structural engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. Now a days various software packages are available in market for analyzing and designing practically all types of structures viz. RISA, STAADPRO, ETABS, STRUDL, MIDAS, SAP and RAM etc.

The proposed M/s Chourasia Sapphire is a Residential Apartment at Mahadevapura; Bangalore developed by VKC Developers Pvt Ltd is approximately around 10560 Sqm in Built-up area. The architectural plans and elevations for this project are developed using Revit Software and the said building is analyzed using E-TABS Structural Analysis Package Software. In the 3D Model, Loads are applied and Analyzed for various Load Combinations.

The results of all Load Combinations are reviewed and Members are designed. The building is to accommodate residential units with general amenities and is analyzed and designed as a Multi storey (2 B+G+10) Building.

1.2 Objectives

The main objective of this study is to analyze and design a (2 B+G+10) building using ETABS software. To design structural components like beam, slab, column and footing manually.

Comparison of results obtained from ETABS software with a manual method. To draw and give reinforcement details of structural components by using Auto CAD. Understanding of design and detailing concept. To decide various cross section parameters by manual calculation for the respective structure. Learning of analysis and design methodology which can be very useful in the field. Approach for professional practice in the field of structural engineering. Make conclusion that structure is better under seismic loading.

2 METHODOLOGY

To achieve the objectives of the study that is to analyze and design building using ETABS and by manual method, which meets the basic requirements such as safety, durability, economy, aesthetic appearance, feasibility, practicability and acceptability. It has been proposed to follow the following methodology.

- Site survey
- Soil investigation
- Structural planning
- Analysis and design in ETABS
- Verification by manual method
- Detailing

Surveying is a basic tool for a Civil engineering science. Before any civil engineering work has to start, surveying has to be done and then we must prepare a plan or map of the area showing topographical details related to design of structure etc. Good planning and management of a geotechnical site investigation is the key to obtaining sufficient site information

for designing a structure in a timely manner and with minimum cost for the effort needed. The engineering properties of soil like water content, density and SBC are calculated by conducting tests in laboratory. The structural plan is prepared using auto cad.

2.1 Design Philosophy

RCC design of buildings is being carried out mainly by three methods of design

1. Working stress method.
2. Ultimate load method.
3. Limit state method.

The limit state method is now in vogue in all Design offices and premier private consulting firms. The BIS has published IS 456 – 2000 incorporating the use of limit state method of design, hence one should therefore get well verse with the theory of Limit state method of design.

2.2 Steps Involved in RCC Design

The RCC design of a building is carried out in following steps.

- Study the architectural drawing and field data.
- Decide the imposed live load and other loads such as wind, seismic and other miscellaneous loads as per IS 875, considering the contemplated use of space, and seismic zone of the site of proposed building.
- Fix the tentative slab and beam sizes and then prepare preliminary beam design. Using values of support reactions from preliminary beam design, prepare preliminary column design and based on these load calculations, fix tentative column design and its concrete. As far as possible, for public buildings, the same column size and column mix should be used for at least two stories so as to avoid frequent changes in column size and concrete mix facilities easy and quick construction. Concrete Mix to be adopted for beams and slabs at all floors is M25.
- Prepare RCC layouts and get approval from the architect to the RCC layouts and tentative sizes of beam and columns and other structural members if any. In the RCC layout, show the structural and orientation of columns, layout of beams, and type of slab at different floor levels. Also indicate how the different structural members will transfer the load of each floor successively to the foundation level.
- Design slabs manually.
- Design beams by using the frames by using the frames analysis output.
- Design column manually.
- Design footings manually.
- Preparations of RCC schedules for footing, slabs, beams and columns at various levels on completion of respective design. As these RCC schedules are to be

used during the execution, designer should take maximum care in preparing them. Schedules should be prepared by an Engineer, and thoroughly cross checked by another Engineer, before submitting the same for approval to the competent authority.

2.3 Code Books Referred

1. IS 456: 2000 and SP 16:- For Designing RC Building
2. IS 875-1987 (Part 1) – Dead loads
3. IS 875-1987 (Part 2) – Live loads/ Design loads
4. IS 875-1987 (Part 3) – Wind loads
5. IS 875-1987 (Part 5) – Loads combinations
6. IS 1893 (Part 1): 2002 – Criteria for Earthquake resistant Design
7. SP 34: Hand book for concrete and reinforcement and detailing

2.4 PROCEDURE IN ETABS

Step - 1 : Step by Step procedure for ETABS Analysis The procedure carried out for Modelling and analyzing the structure involves the following flow chart.

Step - 2 : Creation of Grid points & Generation of structure After getting opened with ETABS we select a new model and a window appears where we had entered the grid dimensions and story dimensions of our building. Here itself we had generated our 3D structure by specifying the building details in the following window.

Step - 3: Defining of property Here we had first defined the material property by selecting define menu material properties. We add new material for our structural components (beams, columns, slabs) by giving the specified details in defining. After that we define section size by selecting frame sections as shown below & added the required section for beams, columns etc.

Step - 4: Assigning of Property After defining the property we draw the structural components using command menu Draw line for beam for beams and create columns in region for columns by which property assigning is completed for beams and columns.

Step - 5: Assigning of Supports By keeping the selection at the base of the structure and selecting all the columns we assigned supports by going to assign menu joint\frame Restraints (supports) fixed.

Step - 6: Defining of loads. In STAAD program we define only seismic and wind loads where as in ETABS all the load considerations are first defined and then assigned. The loads in ETABS are defined as using static load cases command in define menu .

Step - 7: Assigning of Dead loads. After defining all the loads dead loads are assigned for external walls (D230) , internal

walls Step - 8: Assigning of Live loads Live loads are assigned for the entire structure including floor finishing.

Step - 9: Assigning of wind loads Wind loads are defined and assigned as per IS 875: 1987 PART 3 by giving wind speed and wind angle in X,X1,Z & Z1 directions as 0 , 180 , 90 , 270 respectively

Step - 10: Assigning of Seismic loads Seismic loads are defined and assigned as per IS 1893: 2002 by giving zone, soil type, and response reduction factor in X and Y directions

Step - 11: Assigning of load combinations :Load combinations are based on IS 875 1987 PART 5 using load combinations command in define menu

Step - 12: Analysis : After the completion of all the above steps we have performed the analysis and checked for errors.

Step - 13: Design : After the completion of analysis we had performed concrete design on the structure as per IS 456:2000. For this go to Design menu concrete design select design combo. After this again go to design menu concrete frame design .start design \ check of structure then ETABS performs the design for every structural element.

2.4.1 MATERIAL AND SECTION PROPERTIES

- Grade of concrete = M40
- Grade of Steel = Fe500
- Size of Column = C1 700 X 500 mm
C2 650 X 650 mm
C3 600 X 550 mm
- Size of beam =B1-700 X 300 mm
- Thickness of Slab = 150 mm
- Restraints = All columns are fixed at base.

2.5 DESIGN LOADS

Loads and properties of material constitute the basic parameters affecting the design of R.C. structure. Both of them are basically of varying in nature. For such a quantity of varying nature, it is necessary to arrive at a single representative value. Such a value is known as Characteristic value. The value to be taken in design which provides appropriate or desired margin of safety is known as Design Value. The ratio of two greater than unity is known as partial safety factor.

The structure must be designed to resist both gravitational and the lateral forces, both permanent and transient that will be carried by the structure during its entire life span. These forces will depend on the size and the shape of the building, as well as on the geographic location of the building, and maximum probable values must be established before design can be preceded.

The probable estimating the live load and the dead load, and probability of the simultaneous occurrence of the various combination of gravitational loading, both dead and the live load with the earthquake forces, is included in the limit states design through the use of the prescribed factors.

2.5.1 DEAD LOADS

Dead loads are the loads which are constant in magnitude and fixed in position throughout the life span of the structure. Dead loads in a building include the weight of all permanent constructions, like roof, floors, walls, partition walls etc. These loads shall be assessed by estimating the quantity of each material and then multiplying it with unit weight. The unit weight of various materials used in building constructions are given in the code IS 875 (part-1) – 1987.

Unit weight of steel	: 78.5 kN/m ³ .
Plain Concrete, Screed concrete	: 24 kN/m ³ .
Unit weight of Concrete Block Masonry	: 18 kN/m ³
Unit weight of Porotherm Block Masonry	: 8 kN/m ³
Unit Weight of Soil	: 19 kN/m ³
Unit weight of concrete	: 25 kN/m ³ .
Slab Thickness (Typical)	: 150 mm

Other than Self-weight of the structure, the following Dead loads are considered:

- a. Floor Finish (All Floors) : 1.5 kN/m²
- b. 200 thk. Wall Load (Wherever applicable) : 3.0 kN/m²
- c. 100 thk. Wall Load (Wherever applicable) : 2.5 kN/m²
- d. Balcony Handrail : 0.5 kN/m

2.5.2 LIVE LOADS

Live loads are the loads which vary in magnitude and/or in position. Live load includes any external load imposed on the structure when it is serving its normal purpose. Live loads are assumed to be produced by intended use of occupancy in buildings including distributed, concentrated, impact and vibration loads. Live loads are expressed as uniformly distributed static loads. IS 875 (part-2) – 1987.

LIVE LOAD CALCULATION

FLOOR LIVE LOAD	=2	kN/m ²
ROOF LIVE LOAD	=1.5	kN/m ²

2.5.3 SEISMIC LOADS

Building are susceptible to earthquake forces because of the fact that during earthquake the very ground on which a building stands starts shaking. This ground motion is characterized by displacement, velocities and accelerations that are erratic in direction, magnitude, duration and sequence. As these ground accelerations are imposed on every unit of mass, the resulting earthquake forces are body forces proportional to the mass of building. Exact determination of the earthquake forces in almost impossible. Since the nature of earthquake motion cannot be predicted with any degree of certainty for the lifetime of the structure, further the response of the structural elements to these complicated ground motions, is not quite known.

According to IS: 1893 (Part 1), the resulting earthquake forces are distributed parabolically, being zero at the ground level and maximum at the top.

As per IS: 1893 (Part 1)

- Zone =2 (Table 2, cl 6.4.2)
- Importance factor = 1.75 (Table 6, cl 6.4.2)
- Reduction Factor = 5 (Table 7, cl 6.4.2) for OMRF.
- Soil type = Hard.
- Damping = 5 %
- Imposed load reduction = 25% upto 3 kN/m² and 50% for above 3 kN/m².

2.5.4 WIND LOADS

A mass of air moving at a certain velocity has a kinetic energy equal to ½ mv², where m and v are the mass and velocity of air in motion. When an obstacle like a building is met in its path, a part of the kinetic energy of air in motion gets converted to potential energy of pressure. The actual intensity of wind pressure depends on a number of factors like angle of incidence of wind, roughness of the surrounding area, effects of architectural features, i.e. shape of structure etc., and lateral resistance of structure. Apart from the above factors, the maximum design wind pressure depends on the duration and dimension of the gusts and the probability of occurrence of an exceptional wind in the life time of a building. It is possible to take into account the above factors in determining the wind pressure. However, for most of the buildings, the wind pressure specified in the IS: 875 (Part 3) is usually sufficient.

As per IS: 875 (part 3) -1987, from cl 5.2, wind speed, Basic wind speed = 33 m/s

2.5.5 LOAD COMBINATION

Load combination for design purpose shall be those that produce maximum forces and effects and consequently maximum stress and deformations.

As per IS: 456 (Table 18), IS:875(part 5) and IS:1893 (Table 6.3.1.2) the following load combinations are considered.

Table 3.5 Load Combinations
LOAD COMBINATIONS

- 1 DL+0.5LL
- 2 1.5(DL+LL)
- 3 1.2(DL+LL+WL(+X+0.5))
- 4 1.2(DL+LL+WL(+X-0.5))
- 5 1.2(DL+LL+WL(-X+0.5))
- 6 1.2(DL+LL+WL(-X-0.5))
- 7 1.2(DL+LL+WL(+Z+0.5))
- 8 1.2(DL+LL+WL(+Z-0.5))
- 9 1.2(DL+LL+WL(-Z+0.5))
- 10 1.2(DL+LL+WL(-Z-0.5))

- 11 1.2(DL+0.5LL+SL(X))
- 12 1.2(DL+0.5LL-SL(X))
- 13 1.2(DL+0.5LL+SL(Z))
- 14 1.2(DL+0.5LL-SL(Z))
- 15 1.5(DL+WL(+X+0.5))
- 16 1.5(DL+WL(+X-0.5))
- 23 1.5(DL+SL(X))
- 24 1.5(DL-SL(X))
- 25 1.5(DL+SL(Z))
- 26 1.5(DL-SL(Z))
- 27 1(DL+LL)
- 36 1(DL+0.5LL+SL(X))
- 37 1(DL+0.5LL-SL(X))
- 38 1(DL+0.5LL+SL(Z))
- 39 1(DL+0.5LL-SL(Z))
- 48 1(DL+SL(X))
- 49 1(DL-SL(X))
- 50 1(DL+SL(Z))
- 51 1(DL-SL(Z))

3 RESULTS AND ANALYSIS

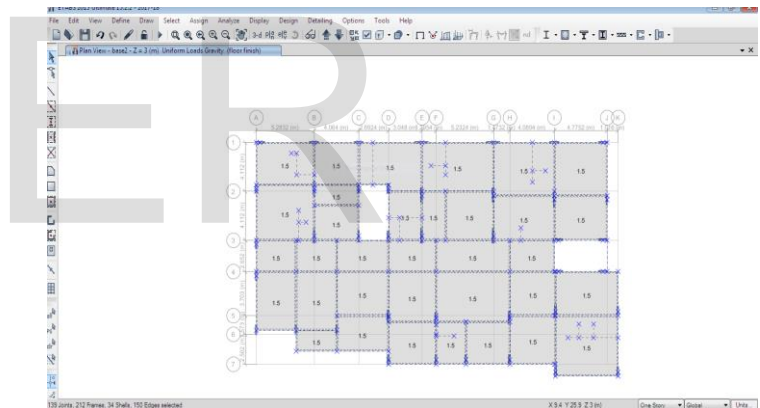


Fig3.1 slab load

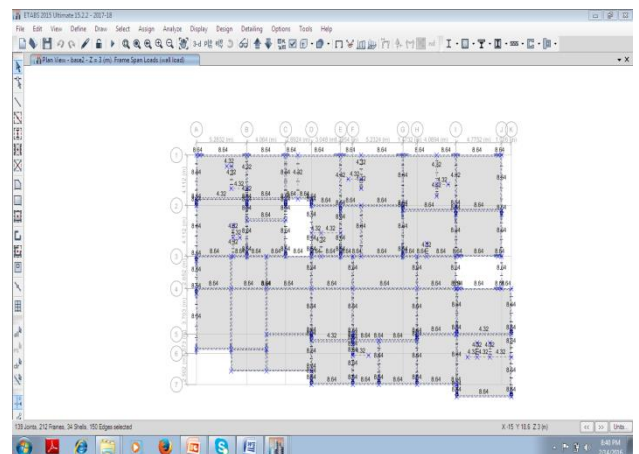


Fig 3.2 wall load

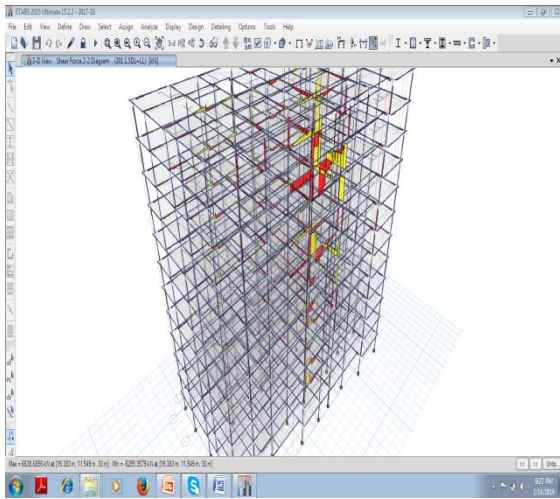


Fig 3.3 shear force

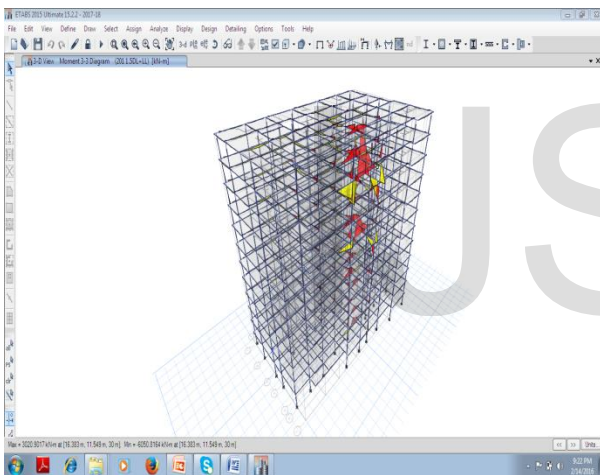


Fig 3.4 bending moment

4 CONCLUSION

Based on the above analysis results the following observations have been done

- Exposed to various codes (IS 456-2000, SP-16, SP-34) and design standards that form the basis for structural design work.
- The number of columns could be increased by reducing the cross sectional dimensions for better performance.
- Spacing between columns could be minimized so that thickness of slab can be reduced to 150mm instead of providing 200mm as given in the manual design

- Isolated footing will be economical instead of raft foundation as recommended in the manual design
- Detailing of various members as per relevant standards and preparation of the drawings.
- Complete analysis is carried out using ETABS for various load cases and their combinations as per relevant Indian standards.
- Thorough study of the relevant drawings to understand the nature of the project.

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