ANALYSIS & DESIGN OF A MULTISTORIED RESIDENTIAL BUILDING BY USING ETABS

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ABSTRACT
Most of the buildings are straight forward geometry with horizontal beams and vertical columns. Although any building configuration is possible with ETABS version 2018, in most cases, a simple grid system defined by horizontal floors and vertical column lines can establish building geometry with minimum effort. Many of the floor level in buildings are similar. This commonality can be used to reduce modelling and design time. The present work deals with the analysis and design of a multi storied residential building by using most economical beam to column method. The dead load &live loads are applied and the design for beams, columns, footing is obtained from ETABS (Extended Three-Dimensional Analysis of Building System) with its new features surpassed its predecessors with its data sharing.

Our main aim is to complete a multi-storey building and to ensure that the structure is safe and economical against gravity loading conditions and to fulfil the function for which the structures have been built for. For the design of the structure, the dead load and live load are considered. The analysis and design of the structure is done by using a software package ETABS.The design is in confirmation with IS 456-2000.The results of analysis are used to verify the fitness of structure for use. Computer software's are also being used for the calculation of forces, bending moment, stress, strain & deformation or deflection for a complex structural system. The principle objective of this project is to compare the design and analysis of multi-storeyed building by ETABS 2018 with manual calculations.

Keyword: Dynamic Analysis Reinforced Concrete (RC) Buildings, Irregular Structures

I. INTRODUCTION

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS 2018 features an intuitive and powerful graphical interface coupled with unmatched modelling, analytical, design, and detailing 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 behaviour's, making it the tool of choice for structural engineers in the building industry.

History and Advantages of ETABS

Dating back more than 40 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 techniques 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.

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 2018 looks radically different from its predecessors of 40 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 programs, 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 modelling and design time.
- 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 forsuch effects in the formulation of the member stiffness, unlike most general-purpose programs that work on centreline- to-centreline dimensions.
- The results produced by the programs should be in a form directly usable by the engineer. General-purpose computer programs produce results in a general form that may need additional processing before they are usable in structural design.
- The input and output conventions used corresponding to common building terminology with ETABS, the models are defined logically floor-by-floor, column-by-column, bay-by-bay and wall-by-wall & not as a stream of non-descript nodes and elements as in general purpose program. Thus, the structural definition is simple, concise and meaningful.

METHODOLOGY

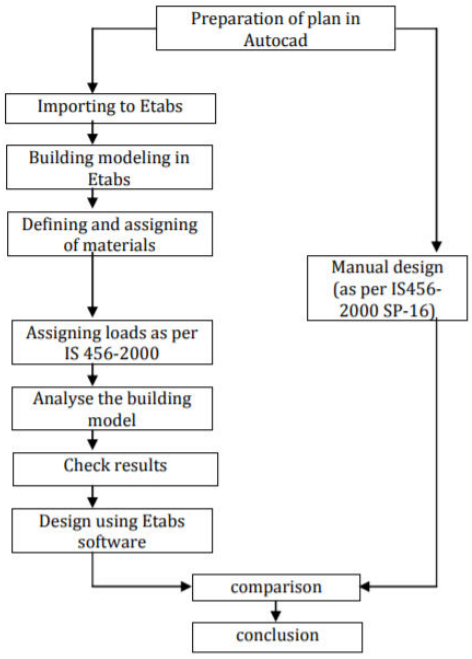


Fig 3.3- Flow chart for analysis procedure

3.1 PREPARING PLAN IN AUTOCAD

Depending upon the area prepare a plan based on the requirements. The below shown plan is of area 5280 sft of 39m height i.e., G+12 and each floor consists of 5 flats each flat with 3BHK. Software used to draw the plan is AUTOCAD 2019.

Fig3.1 -Floor Plan in AutoCAD

3.2 BEAM CENTRE LINE DIAGRAM

Draw beam centre line diagram using a different layer. After completing centre line diagram turn off all the layers except beam layer then save file as .dxf format.

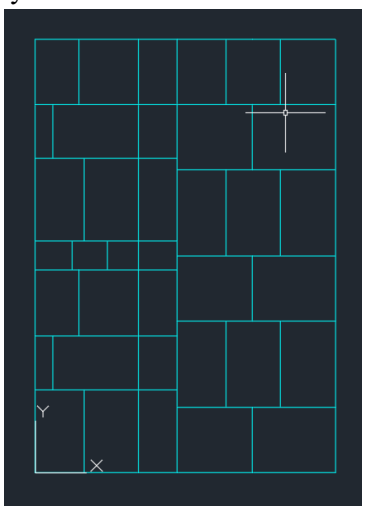


Fig3.2 -Beam centre line diagra

PROCEDURE FOR ANALYSIS AND DESIGN

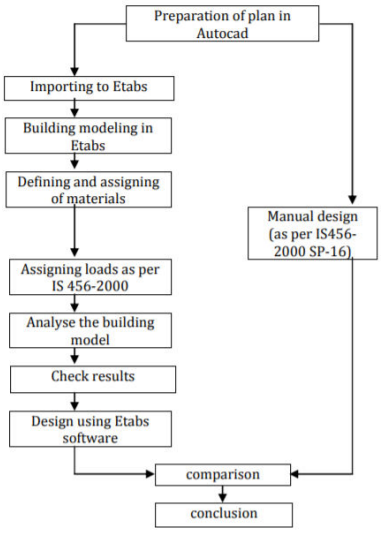


Fig 3.3- Flow chartfor analysis procedure

Step 1: Import dxf file- After step 2 go to file menu select new model then import dxf file which was saved from autocad software.

Fig 3.4 - Importing .dxf file

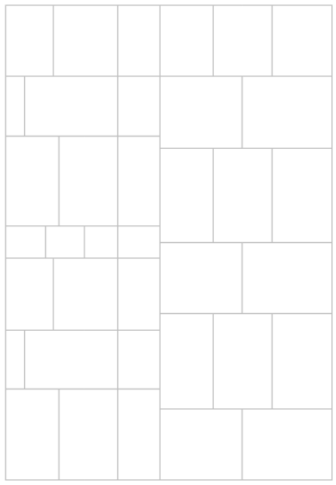


Fig 3.4 - Top view of imported file

- Define property
- Assigning of Dead loads-
- Assigning of Live loads- finishing.
- Assigning of load combinations - Load combinations are given based on IS 875 1987 PART 5 (Indian code) using load combinations command in define menu

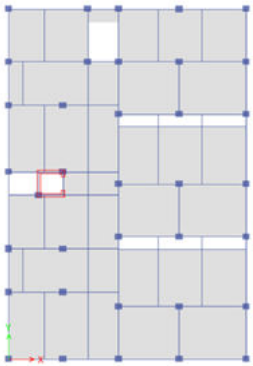


Fig 3.5 - Defining load combinations

3.4 3D VIEW

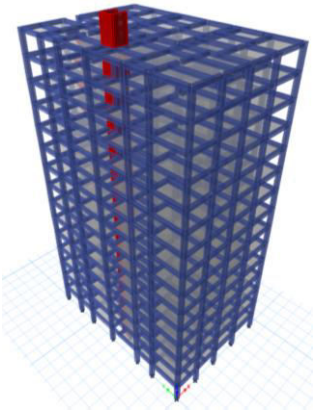


Fig3.6- 3d view of structure

IV LITERATURE REVIEW

ROHITKUMAR.B.R. et al, (2017)studied the analysis and design of a multi storied residential building of (G+2) by using most economical beam to column method. The results of analysis are used to verify the fitness of structure for use.The preparation of the project has provided an excellent opportunity to emerge in planning and designing of multi-storeyed hostel building.This project has given an opportunity to re-collect and co-ordinate the various methods of designing and engineering principles which we have learnt in our lower classes.

RAGY JOSE et al, (2017)their study was to analyse and design a G+3 storey commercial building of 3441. 87sq.ft floor area located at Jatipalaya, Sullia (2km from KVG campus, Sullia). Analysis is carried out by static method and design is done as per IS 456:2000 guidelines.Analysis was done by using ETABS software and successfully verified manually as per IS456.Calculation by both manual work as well as software analysis gives almost same result.As the 4-storey building has similar floors ETABS is the perfect software which can be adopted for analysis and design.

BALAJI.U.A et al, (2016)has presented a journal on residential of G+13 multi-story building for earthquake loads using ETABS software. Assuming that material property is linear static and dynamic, analysis is performed. This non-linear analysis is carried out by considering severe seismic zones and the behavior is assessed by taking types II soil condition.From this work, it's observed that, in first five stories, the difference between the results obtained with different methods is insignificant. It's observed that, the maximum displacement is increasing from first storey to last one.

MAHESH N. PATIL et al, (2015)has studied on earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The responses obtained by manual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well as software analysis of seismic coefficient method. From the results it was observed that there is a gradual increase in the value of lateral forces from bottom floor to top floor in both manual as well as software analysis. There is slight variation in the values of base shear in manual analysis as well as software analysis. Base shear values obtained by manual analysis are slightly higher than software analysis.

BENDING MOMENT OF STRUCTURE

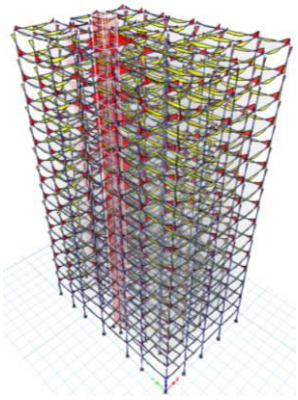


Fig 5.1 - Bending moment of structure

5.5 SHEAR FORCE OF STRUCTURE

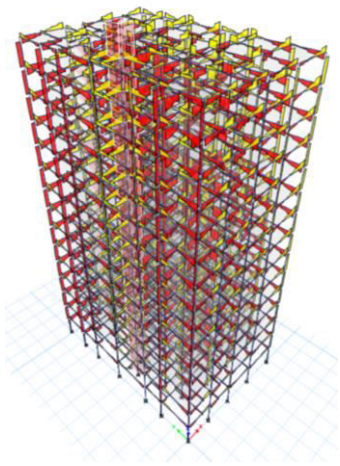


Fig 5.2 - Shear force of structure

ANALYSIS RESULTS

This chapter provides analysis results.

5.7.1 Structure Results

Table 5.13 - Base Reactions

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	-0.0104	-0.0003	88358.7727	1139238	-743733	0.1447	0	0	0
Live	-0.0023	-3.134E-05	11762.201	150725.8601	-98544.2895	0.03	0	0	0
EQx	-1122.9533	-2.97E-05	0	0.0004	-38528.9126	14451.533	0	0	0
EQy	0.0018	-1074.21	-7.544E-07	36856.6165	0.042	-9043.0425	0	0	0
Wx 1	-2383.2084	-4.99E-05	-5.131E-07	0.0004	-63613.3129	30387.9681	0	0	0
Wx 2	0.0027	-1611.6817	-7.868E-07	43019.1229	0.0625	-13898.1154	0	0	0
Wy 1	-2383.2084	-4.99E-05	-5.131E-07	0.0004	-63613.3129	30387.9681	0	0	0
Wy 2	0.0027	-1611.6817	-7.868E-07	43019.1229	0.0625	-13898.1154	0	0	0
1.5DL	-0.0157	-0.0005	132538.159	1708858	-1115600	0.217	0	0	0
1.5(DL+LL)	-0.0192	-0.0005	150181.4605	1934946	-1263417	0.262	0	0	0

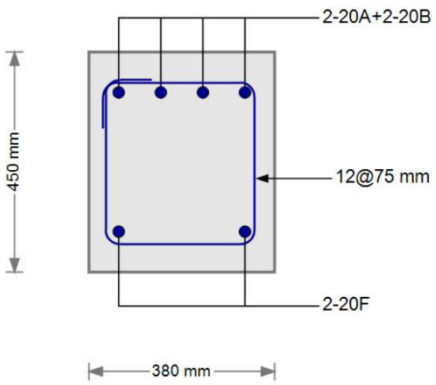
1.2(DL+LL+Wx) Max	-0.0121	-0.0005	120145.1684	1599580	-1010733	36465.7713	0	0	0
1.2(DL+LL+Wx) Min	-2859.8654	-1934.0185	120145.1684	1547957	-1087069	-16677.5289	0	0	0
1.2(DL+LL-Wx) Max	2859.8348	1934.0177	120145.1684	1547957	-934397	16677.9482	0	0	0
1.2(DL+LL-Wx) Min	-0.0186	-0.0004	120145.1684	1496334	-1010733	-36465.3521	0	0	0
1.2(DL+LL+Wy) Max	-0.0121	-0.0005	120145.1684	1599580	-1010733	36465.7713	0	0	0
1.2(DL+LL+Wy) Min	-2859.8654	-1934.0185	120145.1684	1547957	-1087069	-16677.5289	0	0	0
1.2(DL+LL-Wy) Max	2859.8348	1934.0177	120145.1684	1547957	-934397	16677.9482	0	0	0
1.2(DL+LL-Wy) Min	-0.0186	-0.0004	120145.1684	1496334	-1010733	-36465.3521	0	0	0
1.5(DL+Wx) Max	-0.0116	-0.0006	132538.159	1773386	-1115600	45582.1691	0	0	0
1.5(DL+Wx) Min	-3574.8283	-2417.5231	132538.159	1708858	-1211020	-20846.9562	0	0	0
1.5(DL-Wx) Max	3574.797	2417.5221	132538.159	1708858	-1020180	20847.3902	0	0	0
1.5(DL-Wx) Min	-0.0197	-0.0004	132538.159	1644329	-1115600	-45581.7352	0	0	0
1.5(DL+Wy) Max	-0.0116	-0.0006	132538.159	1773386	-1115600	45582.1691	0	0	0
1.5(DL+Wy) Min	-3574.8283	-2417.5231	132538.159	1708858	-1211020	-20846.9562	0	0	0
1.5(DL-Wy) Max	3574.797	2417.5221	132538.159	1708858	-1020180	20847.3902	0	0	0
1.5(DL-Wy) Min	-0.0197	-0.0004	132538.159	1644329	-1115600	-45581.7352	0	0	0
0.9DL+1.5Wx Max	-0.0053	-0.0004	79522.8954	1089843	-669360	45582.0823	0	0	0
0.9DL+1.5Wx Min	-3574.822	-2417.5229	79522.8954	1025315	-764780	-20847.043	0	0	0
0.9DL-1.5Wx Max	3574.8033	2417.5223	79522.8954	1025315	-573940	20847.3034	0	0	0

0.9DL-1.5Wx Min	-0.0134	-0.0002	79522.8954	960785.8834	-669360	-45581.822	0	0	0
0.9DL+1.5Wy Max	-0.0053	-0.0004	79522.8954	1089843	-669360	45582.0823	0	0	0
0.9DL+1.5Wy Min	-3574.822	-2417.5229	79522.8954	1025315	-764780	-20847.043	0	0	0
0.9DL-1.5Wy Max	3574.8033	2417.5223	79522.8954	1025315	-573940	20847.3034	0	0	0
0.9DL-1.5Wy Min	-0.0134	-0.0002	79522.8954	960785.8834	-669360	-45581.822	0	0	0
1.2(DL+LL+EQx)	-1347.5592	-0.0005	120145.1684	1547957	-1056968	17342.0493	0	0	0
1.2(DL+LL-EQx)	1347.5286	-0.0004	120145.1684	1547957	-964499	-17341.63	0	0	0
1.2(DL+LL+EQy)	-0.0132	-1289.0524	120145.1684	1592185	-1010733	-10851.4414	0	0	0
1.2(DL+LL-EQy)	-0.0175	1289.0516	120145.1684	1503729	-1010733	10851.8606	0	0	0
1.5(DL+EQx)	-1684.4455	-0.0005	132538.159	1708858	-1173394	21677.5165	0	0	0
1.5(DL-EQx)	1684.4142	-0.0004	132538.159	1708858	-1057807	-21677.0826	0	0	0
1.5(DL+EQy)	-0.013	-1611.3155	132538.159	1764143	-1115600	-13564.3468	0	0	0
1.5(DL-EQy)	-0.0183	1611.3145	132538.159	1653573	-1115600	13564.7807	0	0	0
0.9DL+1.5EQx	-1684.4393	-0.0003	79522.8954	1025315	-727154	21677.4297	0	0	0
0.9DL-1.5EQx	1684.4205	-0.0002	79522.8954	1025315	-611567	-21677.1694	0	0	0
0.9DL+1.5EQy	-0.0067	-1611.3153	79522.8954	1080599	-669360	-13564.4336	0	0	0
0.9DL-1.5EQy	-0.0121	1611.3147	79522.8954	970029.6429	-669360	13564.694	0	0	0

Design Results

ETABS 2018 Concrete Frame Design

IS 456:2000 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
6F	B44	852	BEAM 380X450	1.5(DL-Wy)	3835.4	4876.8	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
380	450	380	0	60	60

Material Properties

E_c (MPa)	Fck (MPa)	Lt. Wt. Factor (Unitless)	F_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	550

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-155.8068	18.6164	114.2694	0