DESIGN & ANALYSIS OF G+5 BUILDING WITH SHEAR WALL USING ETABS

Gurrampally Abhayeshwar, B Surya Teja, Badgani Dhanunjay, Koppanuri Shireeja, M Sairam, Dr. Aftab Tanveer

Dept. of Civil Engineering, SVITS, Mahbubnagar, Telangana, India.

Abstract: *The main objective of this project is to check response of multi-storied building for different location of shear wall, so that one can choose the best alternative for construction in earthquake-prone area. Different location of shear wall in R.C. Building will be modeled in E-TABS software and the results in terms of natural period, frequency, Base shear, and joint reactions, storey shear is compared.*

Building which can be fulfilled by providing the shear wall systems must be taken into consideration. Also due to the major earthquakes in the recent pasts the codal provisions revised and implementing more weightage on design of structure. The shear walls are mainly provided for the lateral stability of the structure. The decision regarding provision of shear wall to resist lateral forces play most important role in choosing the appropriate structural system for given project. Generally structures are subjected to two types of loads i.e. Static and Dynamic. Static loads are constant while dynamic loads are varying with time. In majority civil structures only static loads are considered while dynamic loads are not calculated because the calculations are more complicated. In the present project G+5 building consider to analysis and design for gravity and lateral loads as per Indian standards. By using the software building can be analyzed and we can check for any failures in the analysis and redesign them, so that we can prevent failures after construction. By using the output building can be constructed according to the design

.

I- INTRODUCTION

Shear walls are structural members used to elongate the strength of R.C.C. structures. These shear walls will be construct in each level of the structure, to form an effective box structure. Equal length shear walls are placed symmetrically on opposite sides of outer walls of the building. Shear walls are added to the building interior to provide more strength and stiffness to the building when the exterior walls cannot provide sufficient strength and stiffness.

The practice before 1960s has been to design buildings primarily for gravity loads and check the adequacy of the structure for safety against lateral loads. It is established that the design of a multi-storey building is governed by lateral loads and it should be the prime concern of designer to provide adequate safety to structure against lateral loads. Many existing RC frame buildings located in seismic zones are deficient to withstand earthquakes. Insufficient lateral resistances and poor detailing of reinforcement are the main reasons for inadequate seismic performance. Shear wall system is one of the most commonly used lateral-load resisting technique for high-rise buildings. Shear walls have very high in-plane strength and stiffness, which can be used simultaneously for resisting large horizontal and gravity loads. In tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load.

In this project, an effort made on planning, analysis and design of commercial building. For analysis and design of building, the plan draft by AUTO-CAD software is used to import in Etabs.

1.1 CONCEPT SHEAR WALL

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In Commercial construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building.When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces.

In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces.

In the last two decades, shear walls became an important part of mid and high-rise commercial buildings. As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So shear-wall frame structures are obtained.

Shear wall buildings are usually regular in plan and in elevation. However, in some buildings, lower floors are used for commercial purposes and the buildings are characterized with larger plan dimensions at those floors. In other cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for commercial purposes and can house from 100 to 500 inhabitants per building

1.2 OBJECTIVE

The main objective of this study is to identify various parameters to design the structure. Analysis and Design of Multi Storeyed commercial Building using ETABS with shear lateral walls. The ETABS stands for extended 3D analysis for building system. This is based on the stiffness matrix and finite element based software. The analysis and design is done to satisfy all the checks as per Indian standards. Finally data base is prepared for various structural responses.

1.3 SCOPE OF WORK

The analysis is implemented for Analysis and Design of Multi Storeyed l Building using ETABS. The structure is analyzed for the loading systems in addition with the shear walls as per the IS 456- 2000 codal provisions.

1.4 PURPOSE OF CONSTRUCTING SHEAR WALLS

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structures.

Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures.

Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building.

II - LITERATURE REVIEW

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to

 ISSN: 2320-1363

design the structural elements and the final was to detail the structural elements. In this project Etabs software is used for analysing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.

Mayuri D. Bhagwat. In this work dynamic analysis of G+12 multistoried practiced RCC building considering for Koyna and Bhuj earthquake is carried out by time history analysis and response spectrum analysis and seismic responses of such building are comparatively studied and modeled with the help of ETABS software. Two time histories (i.e. Koyna and Bhuj) have been used to develop different acceptable criteria (base shear, storey displacement, storey drifts).

Himanshu Bansal. In this study the story shear force was found to be maximum for the first storey and it decreased to a minimum in the top storey in all cases. It was found that mass irregular building frames experience larger base shear than similar regular building frames. Irregular building experienced lesser base shear and has larger inter storey drifts.

A. B. M. Sinful Islam et al In this study analyses results show that isolation system considerably reduce earthquake induced load on building. Furthermore, method of analysis has been found to have considerable effect on the response of low to medium rise buildings. Time history analysis shows significant less base shear than that from response spectrum analysis .Also, less isolator displacement is obtained from time history analysis than that from response spectrum analysis.

A S Patel et al this study shows similar variations pattern in Seismic responses such as base shear and story displacements with intensities V to X. From the study it is recommended that analysis of multistoried RCC building using Time History method becomes necessary to ensure safety against earthquake force.

Prof. S.S. Patel et al This study gives seismic analysis of high rise building using program in STAAD Pro. With considering different conditions of the lateral stiffness system. Analysis is carried out by response spectrum method. This analysis gives the effect of higher modes of vibration and actual distribution of force in elastic range in good way. These results include base shear, storey drift and storey deflection are presented.

III - LAYOUT OF G+5 STRUCTURE USING AUTOCAD

3.1 General

AutoCAD or Computer Aided Design is a very helpful tool in drafting and designing any structure. AutoCAD uses a Graphical User Interface for the purpose of drafting and designing any structure. The software has various inbuilt tools for complex drafting. Also AutoCAD can be used for 2D, 3D and for perspective design.

With the help of AutoCAD all the drafting for the project has been done.

3.2 Details of the Project:

The plot size for the project was 25x20 mts accordingly the building has been laid in the centre of the plot leaving ample space on all the sides for landscaping and pathways for cars and for visitors parking.

The complete structure is of 600 sqyards and the numbers of floors are G+5 with column orientation, beam placements and slabs as per different floors.

3.3 Layout Using AutoCAD

The layout has been mostly completed using the Line command. The unit for the layout is metres with accuracy of “0.000”. Below is a screen shot of the line diagram showing the centre line for beam and column layout.

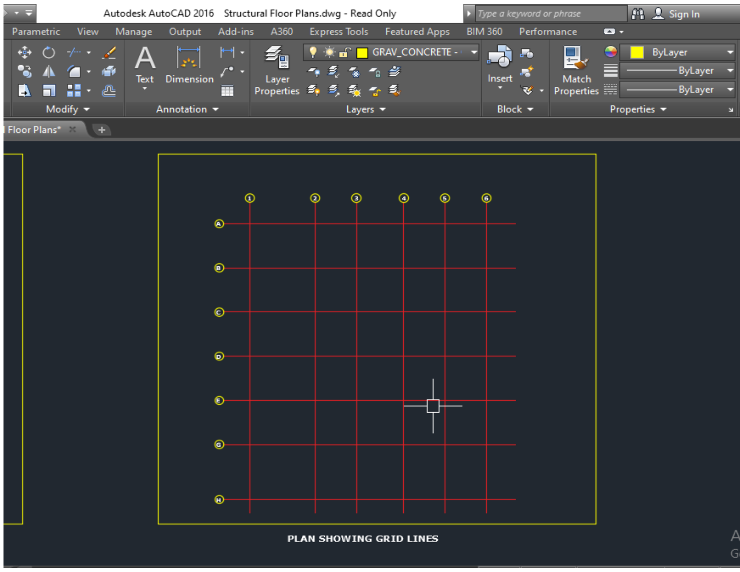


Fig 1 Shows grid lines of the building

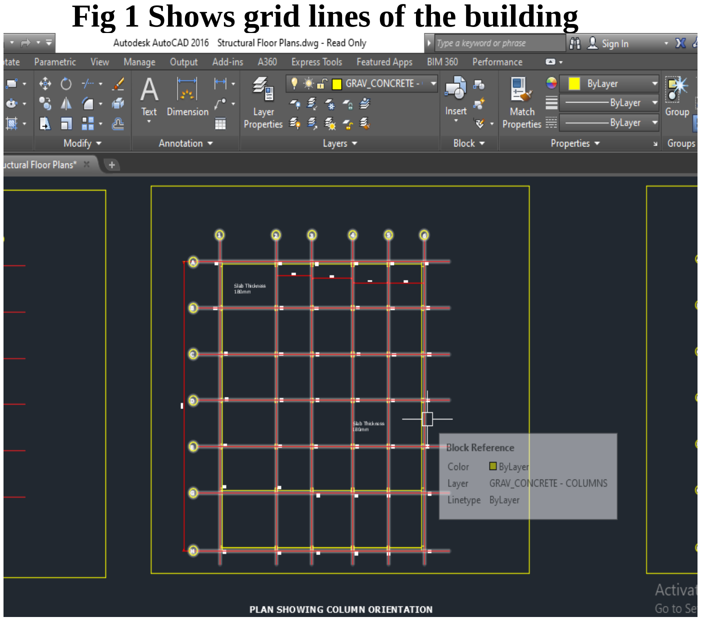


Fig 2 shows the column orientation of the building

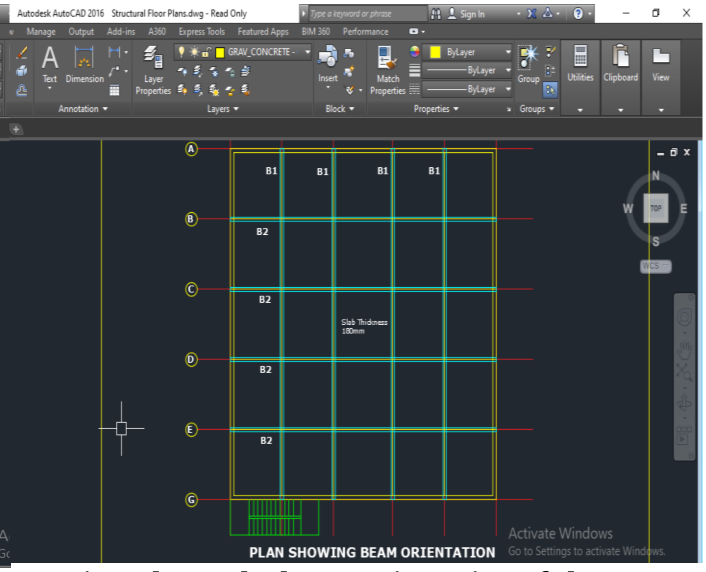


Fig 3 shows the beam orientation of the structure.

IV - DESIGN PARAMETERS

4.1 Etabs Inputs statement

Concrete Grade = M25

Clear Cover = 25mm

Fc = 25 mpa

Fy main = 500mpa

Fy Section/ Stirrups = 500mpa

Density of Concrete = 23.5Kn/m^3

Loading Considerations for elements

Consider Finishes of 75mm with 20 Kn/m^3 Density of concrete

Brick wall/Partition walls Moderate Grade = 20 Kn/m^3

Live Load = 2.0Kn/m^2 commercial

4.2 Properties of elements

a). Beam Sizes

300 mm × 400 mm G to 2nd Floor

250 mm × 350 mm 3rd to 4th Floor

225 mm × 300 mm Roof Beam Size

b). Column Sizes

250 mm × 400 mm G to 2nd Floor

230 mm × 400 mm 3rd to 4th Floor

230 mm × 350 mm Secondary Columns

c). Slabs Thickness

Floors G to 1st = 200mm

Floors 2nd to 4th Slab = 150mm

ISSN: 2320-1363

Roof Slab = 125mm

d). Wall Thickness

Partition wall = 115mm

Outer Main wall = 230mm

Parapet wall = 75mm thick / Height= 1.2m

V - ANALYSIS OF STRUCTURE

ANALYSIS OF STRUCTURE

5.1 Modelling of structure

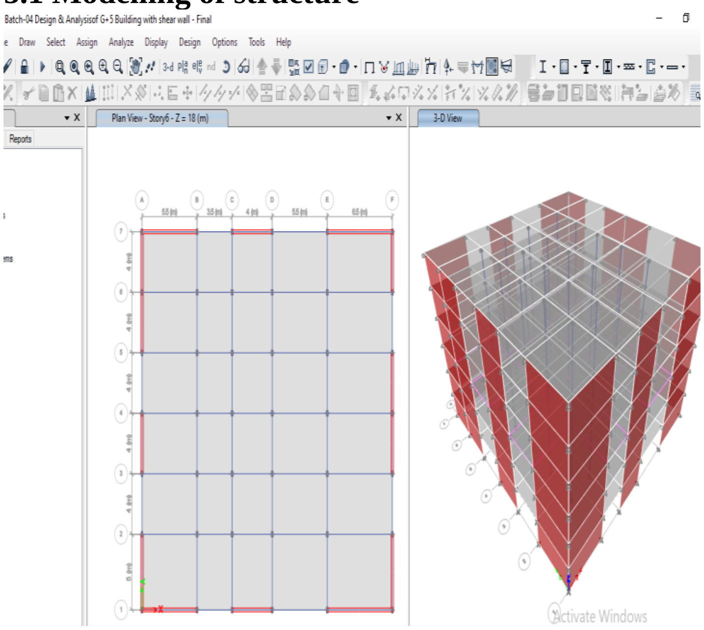


Fig 4 shows the geometry of the structure.

5.2 Member property assigning to the structural elements

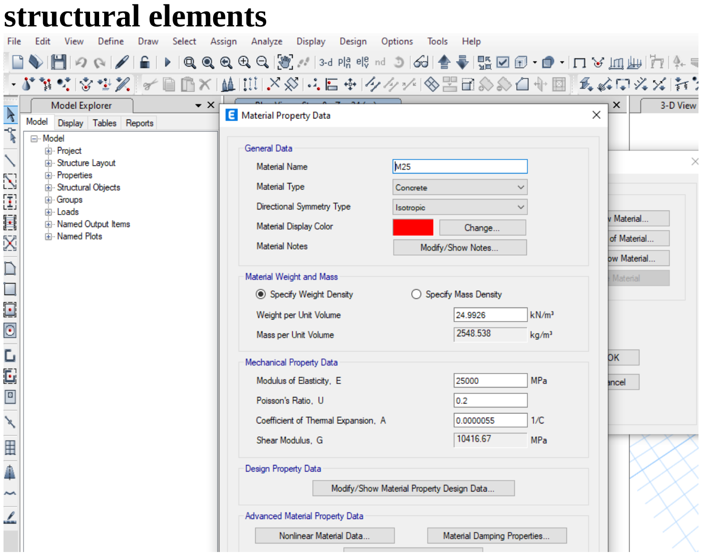


Fig 5 shows the member property of the elements.

a) Slab Properties

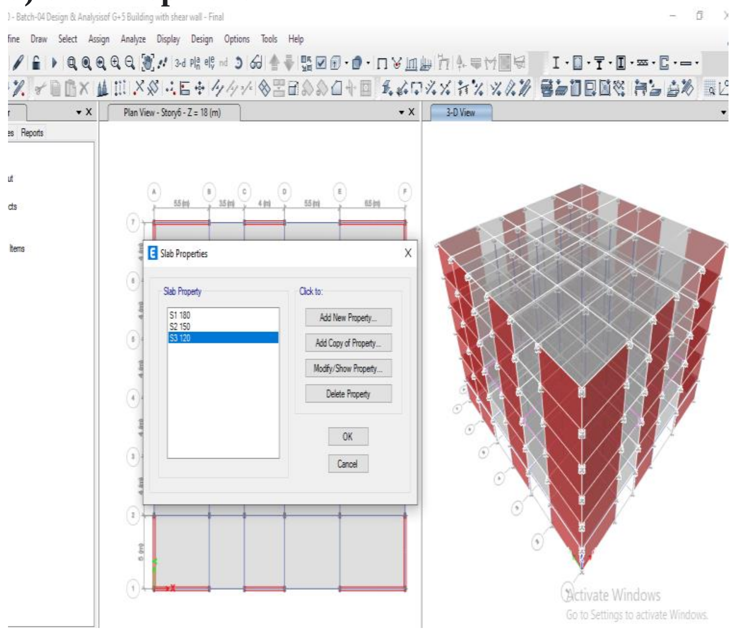


Fig 6 shows the slab member property

b). Beams and column Property

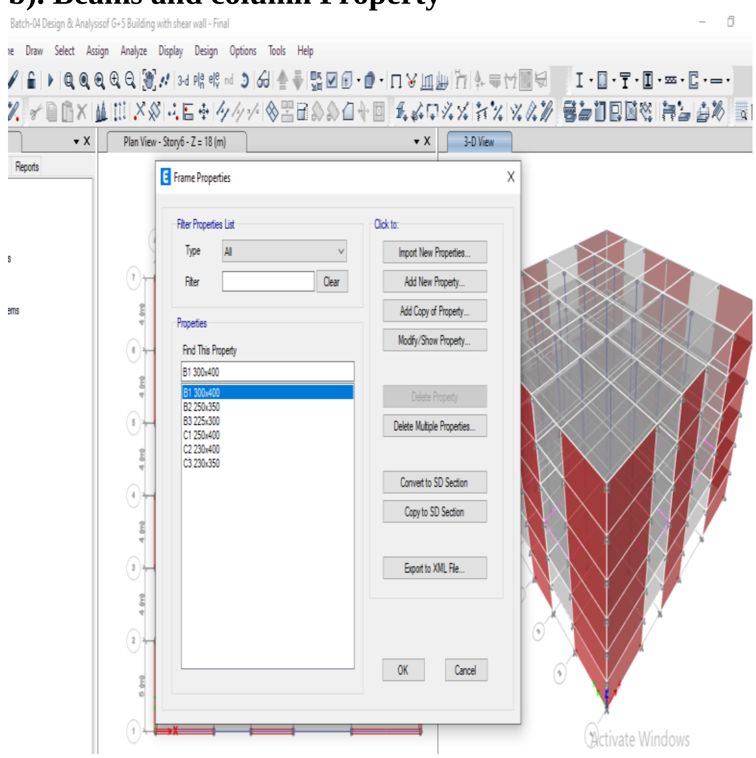


Fig 7 shows the Beam member property

ISSN: 2320-1363

c). Column Property

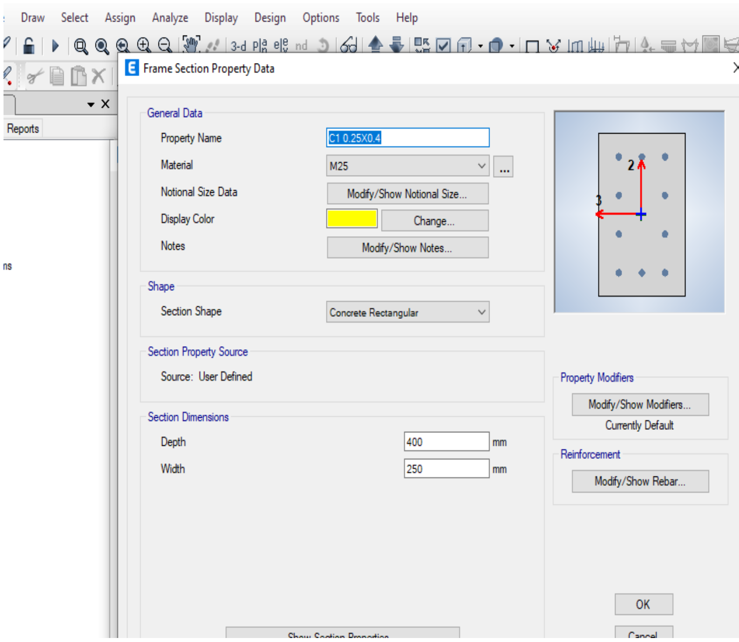


Fig 8 shows the column member property 1

d) Shear walls property

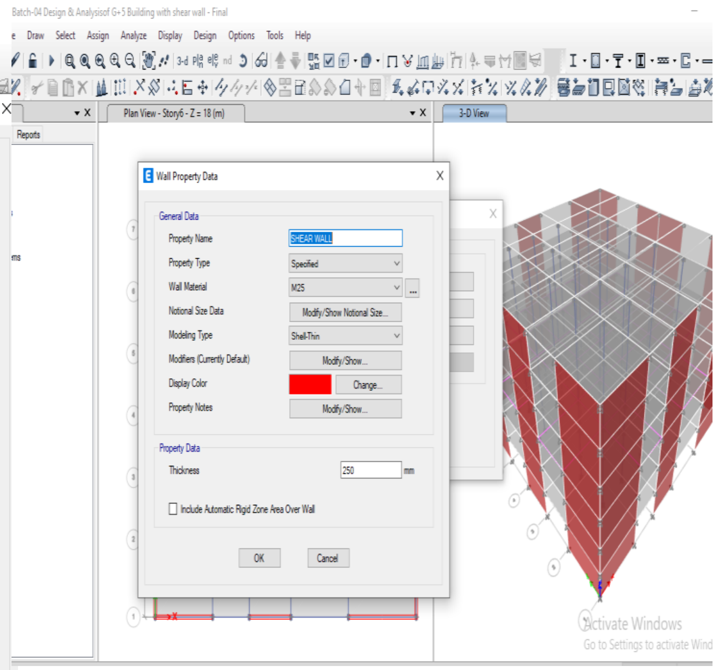


Fig 9 shows the shear wall member property

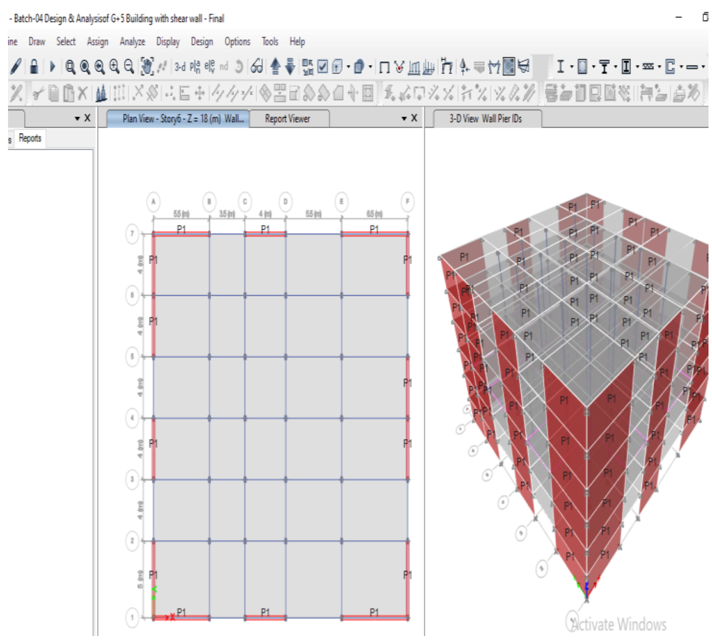


Fig 10 Assigned Shear walls property in the walls

INTERNATIONAL JOURNAL OF MERGING TECHNOLOGY AND ADVANCED RESEARCH IN COMPUTING

IJMTARC – VOLUME – IX – ISSUE – 38, APR - JUN, 2022 ISSN: 2320-1363

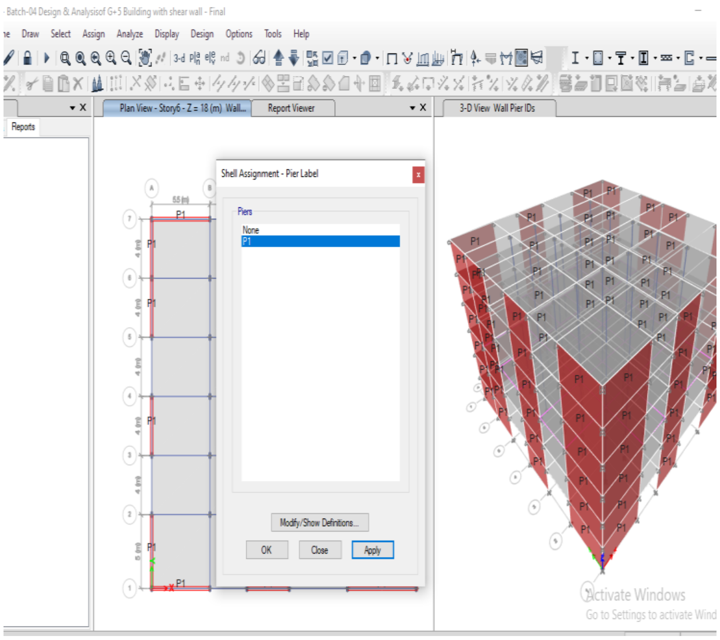


Fig 11 Labeled Piers which is consisting of SW property

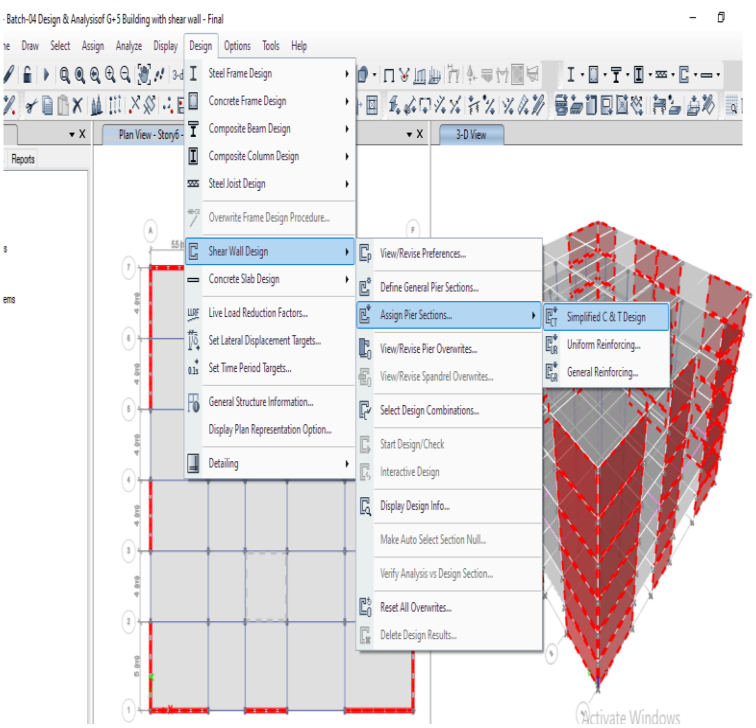


Fig 10 Shear wall Design Command

5.3 Assigning of Loads (Load Cases)

- Dead Load
- Live Load
- Floor Finishes
- Brick Wall Load
- Inner Partition Wall Loads
- Roof Loads

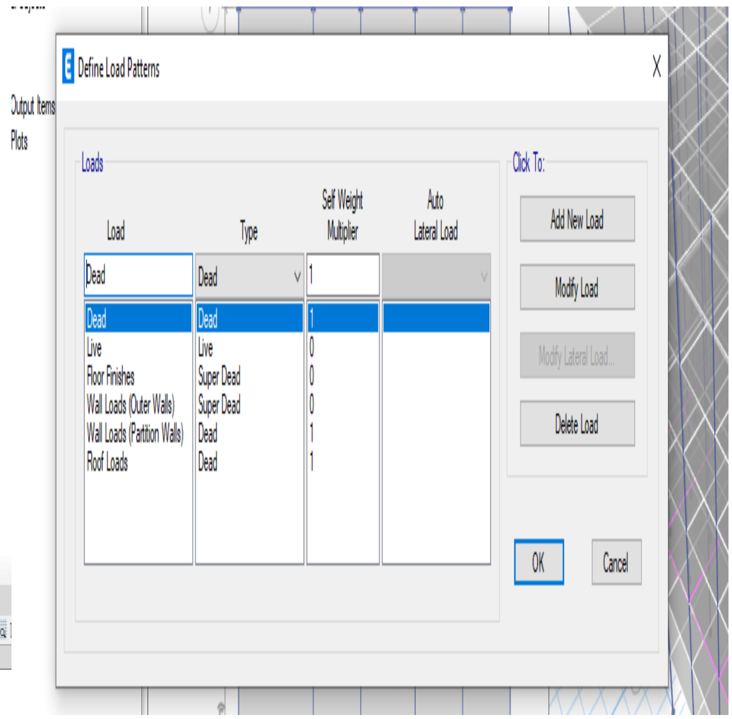


Fig 11 load patterns for the structure

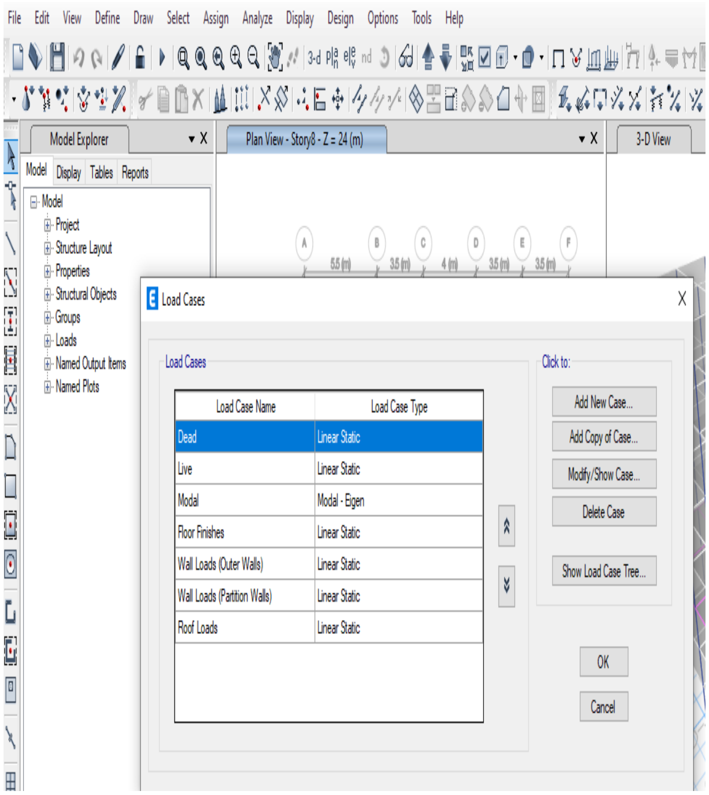


Fig 12 load cases for the structure

CHAPTER 6
ETABS RESULTS

6.1 Etabs result output.

The analysis done from considering all the above parameters state that the structure is safe without any errors

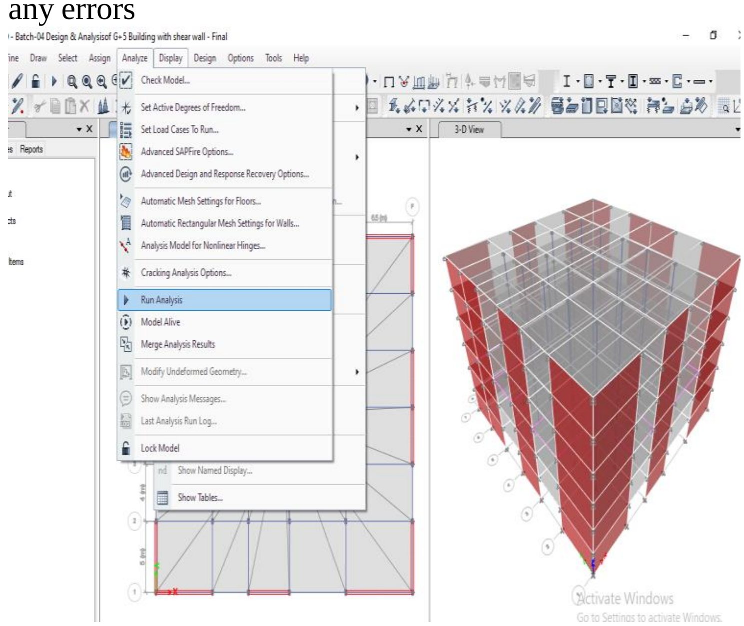


Fig 14 Running the analysis of the model

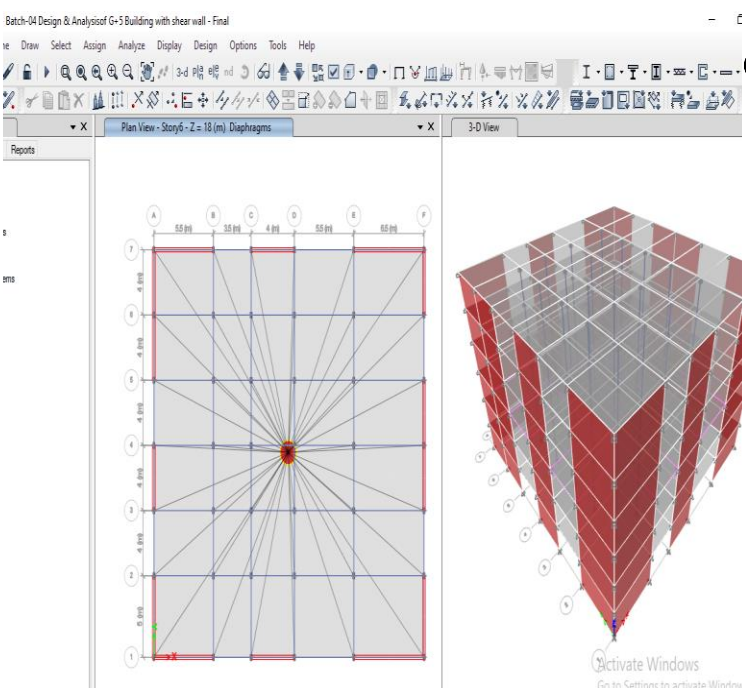
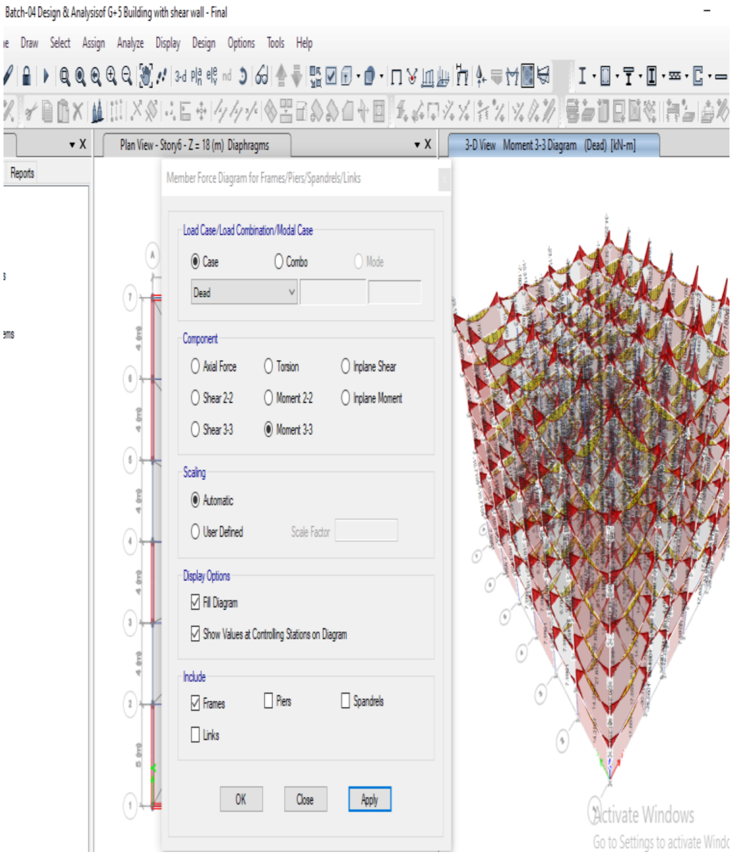
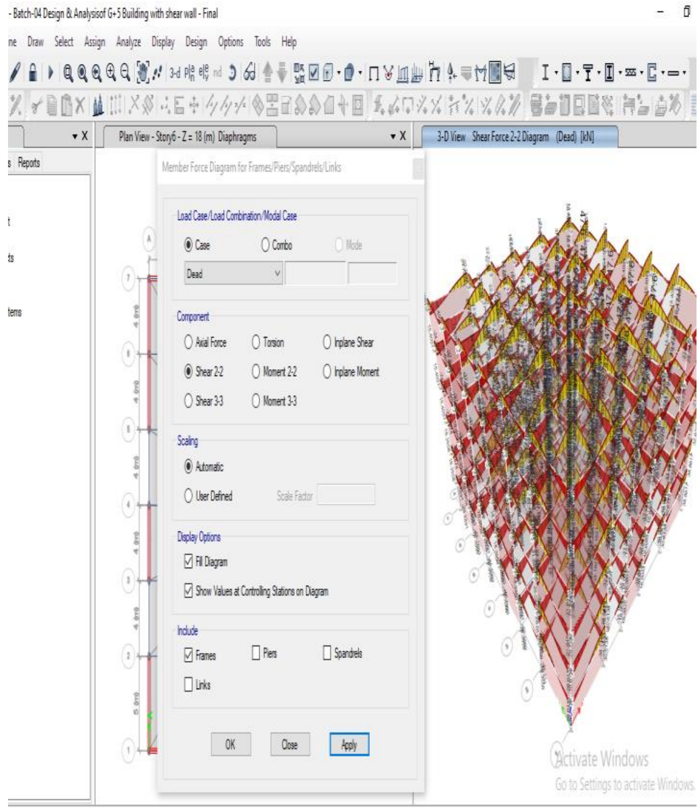


Fig 13 Diaphragm assigned for the whole structure

6.2 Bending Moment Results

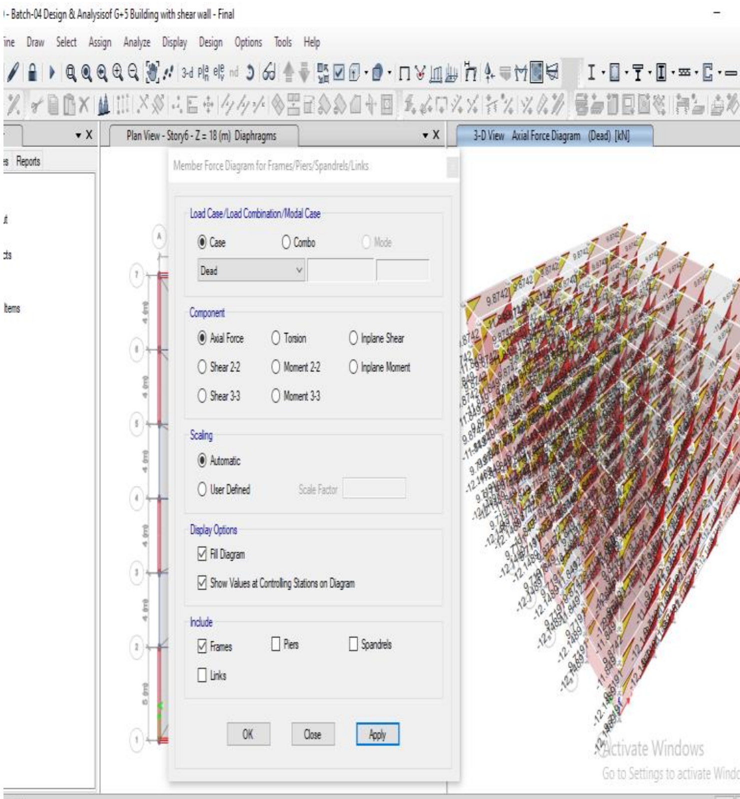
ISSN: 2320-1363





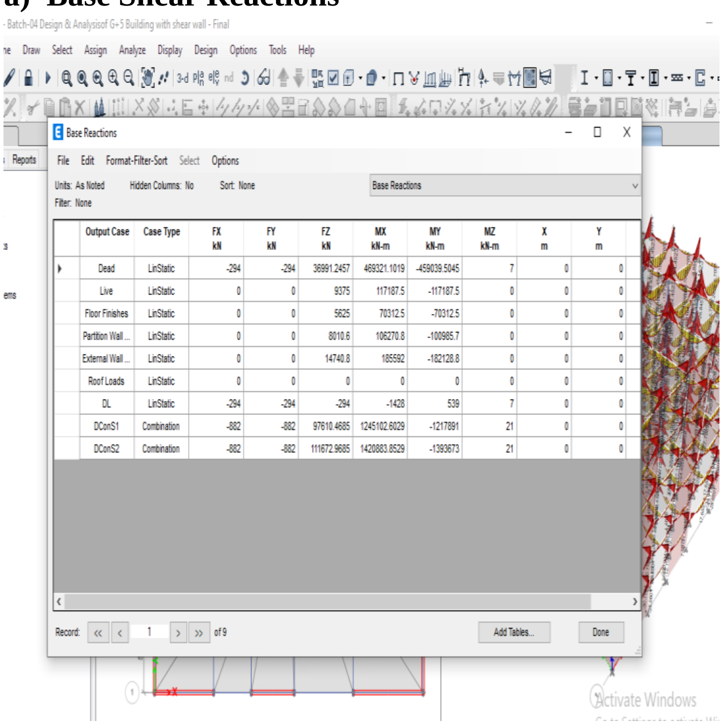
6.4 Torsion Force Results

6.3 Shear Force Results



6.5 Design Outputs

a) Base Shear Reactions



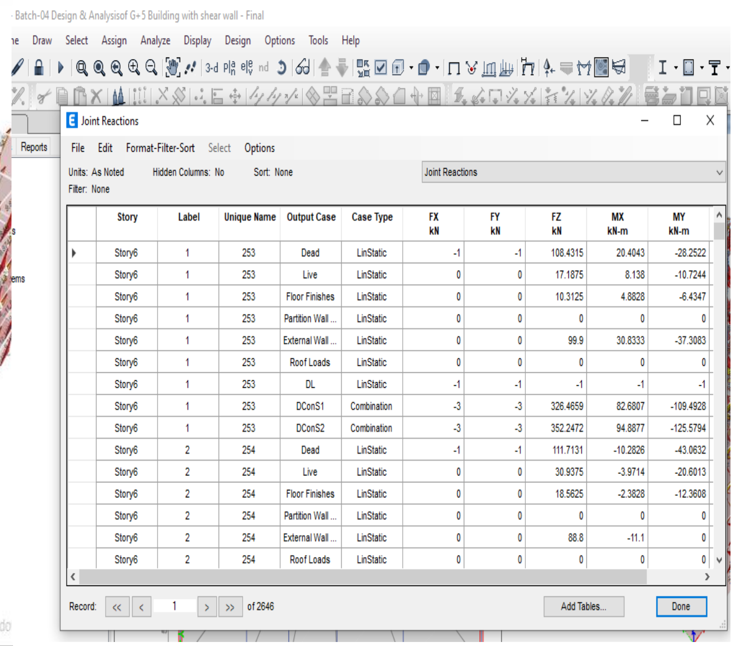
Base Reactions

Units: As Noted Hidden Columns: No Sort: None Filter: None

Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m
Dead	LinStatic	-294	-294	36991.2457	469321.1019	-459039.5045	7	0	0
Live	LinStatic	0	0	9375	117187.5	-117187.5	0	0	0
Floor Finishes	LinStatic	0	0	5625	70312.5	-70312.5	0	0	0
Partition Wall ...	LinStatic	0	0	8010.6	106270.8	-100985.7	0	0	0
External Wall ...	LinStatic	0	0	14740.8	185592	-182128.8	0	0	0
Roof Loads	LinStatic	0	0	0	0	0	0	0	0
DL	LinStatic	-294	-294	-294	-1428	539	7	0	0
DConS1	Combination	-882	-882	97610.4685	1245102.6029	-1217891	21	0	0
DConS2	Combination	-882	-882	111672.9685	1420883.8529	-1393673	21	0	0

Record: 1 of 9

b). Joint Reactions



Joint Reactions

Units: As Noted Hidden Columns: No Sort: None Filter: None

Story	Label	Unique Name	Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m
Story6	1	253	Dead	LinStatic	-1	-1	108.4315	20.4043	-28.2522
Story6	1	253	Live	LinStatic	0	0	17.1875	8.138	-10.7244
Story6	1	253	Floor Finishes	LinStatic	0	0	10.3125	4.8828	-6.4347
Story6	1	253	Partition Wall ...	LinStatic	0	0	0	0	0
Story6	1	253	External Wall ...	LinStatic	0	0	99.9	30.8333	-37.3083
Story6	1	253	Roof Loads	LinStatic	0	0	0	0	0
Story6	1	253	DL	LinStatic	-1	-1	-1	-1	-1
Story6	1	253	DConS1	Combination	-3	-3	326.4659	82.6807	-109.4928
Story6	1	253	DConS2	Combination	-3	-3	352.2472	94.8877	-125.5794
Story6	2	254	Dead	LinStatic	-1	-1	111.7131	-10.2826	-43.0632
Story6	2	254	Live	LinStatic	0	0	30.9375	-3.9714	-20.6013
Story6	2	254	Floor Finishes	LinStatic	0	0	18.5625	-2.3828	-12.3608
Story6	2	254	Partition Wall ...	LinStatic	0	0	0	0	0
Story6	2	254	External Wall ...	LinStatic	0	0	88.8	-11.1	0
Story6	2	254	Roof Loads	LinStatic	0	0	0	0	0

Record: 1 of 2646

VII-CONCLUSION

Building plan was develop and draft in Auto-CAD with required dimension. During designing G+5 storeys commercial building structure is capable to sustain all loads acting on building. The design of slab, beam, column, shear walls is done with IS 456-2000 as limit state method in addition to that IS code 875 were also used for other loading parameters.

Providing shear walls at adequate locations substantially reduces the displacements due to earthquake. Thus shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earthquake and high winds can be minimized. Shear walls construction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents.

tabs has the ability to calculate the Reinforcement needed for any concrete section. The design output gives the complete detail of the Base reaction/ moment i.e. in -Y direction is to be in negative so that the structure may withstand against the lateral forces and as per result; structure is safe without any errors as per output given by Etabs.

REFERENCES

- S. V. Venkatesh EFFECT OF INTERNAL & EXTERNAL SHEAR WALL ON PERFORMANCE OF BUILDING FRAME SUBJECTED TO LATERAL LOAD. International Journal of Earth Sciences and Engineering, ISSN 0974-5904, Volume 04, No 06 SPL, October 2011.
- Anshuman.S. SOLUTION OF SHEAR WALL LOCATION IN MULTI-STOREY BUILDING. International Journal of Civil And Structural Engineering, ISSN 0976 – 4399, Volume 2, No 2, 2011.
- Indian standard codal IS 875: Part 3 for load considerations. "Code of practice for Design loads for buildings and structures."
- Indian standard codal 456: 2000, "Indian Standard code of practice for general structural use of plain and reinforced.
- Design of R.C.C. Structures by Nirali Prakashan.
- ATC. Seismic evaluation and retrofit of concrete buildings—volume 1 (ATC-40). Report No. SSC 96-01. Redwood City (CA): Applied Technology Council; 1996.
- FEMA. NEHRP guidelines for the seismic rehabilitation of buildings (FEMA 273). Washington (DC): Building Seismic Safety Council; 1997.
- FEMA 356 NEHRP Pre standard and commentary for the seismic rehabilitation of buildings. (2000).
- Mrugesh D. Shah NONLINEAR STATIC ANALYSIS OF R.C.C. FRAMES (Software Implementation ETABS 9.7) National Conference on Recent Trends in Engineering & Technology.
- 7. Mangulkar Madhuri N. REVIEW ON SHEAR WALL FOR SOFT STORY HIGH-RISE BUILDINGS. International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958.
- Anoop.A, Fousiya Hussian, Neeraja.R, Rahul Chandran, Shabina.S, Varsha.S, 'Planning Analysis and Design of Multi Storied Building by .PRO.V8i', International Journal of Scientific & Engineering Research, Volume 7, Issue 4, ISSN 2229-5518, April-2016.

AUTHOR PROFILE

Gurrampally Abhayeshwar B.Tech student in the Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR.

B Surya Teja B.Tech student in the Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR

Badgani Dhanunjay B.Tech student in the Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR.

Koppanuri Shireeja B.Tech student in the Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR.

M Sairam B.Tech student in the Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR

Dr. Aftab Tanveer, **PROFESSOR & HOD** Civil Engineering from Sree Visvesvaraya institute of technology and science, MBNR