Analysis of G+2 building with seismic load using Etabs

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Abstract— Civil Engineers are facing a great challenge in structural designing. The design must fulfil various parameters which include economical structure, durability and serviceability. But taking these points in mind it becomes very difficult for an Engineer to fulfil all these requirements at a time when a design is performed manually. This dissertation presents research on digital tools used in civil engineering and comparing their results by taking in mind the requirements of the above points. In this research process a building is taken for analysis and design on well-known Software ETABS. Based on the results taken from the Software some comparison is done with manual analysis for residential building.

Nowadays every designing organisation is using these Software but there is a question mark to which software we must go for designing. The parent organisations which have developed these designing tools promote their Software by showing all the positive points. In addition to this they are trying to fill all the loop holes which they found in their products but it will never happen that another developing company will put the points in light what the negative points are there in existing products. They keep on improving to deliver their best. In this project work I will present the difference for future users to which tool you must go through to acquire your needs. I am not saying that some products are not ok at all. I have designed a residential building with proper loading which is being designed on both ETABS. Manual calculations make it crystal clear the difference between the Software.

Key word: Etabs Software, structural design, residential building.

1. INTRODUCTION

In designing an economical and stable RCC framed building for residential use involves a comprehensive approach, considering both computer-based software tools like CSI-Etabs and manual calculations. Here's a general outline of the steps is might undertake.

1. Load calculation and selection

Determine the various loads acting on the structure, including dead loads, live loads, wind loads and seismic loads based on the local building codes and standards.

2. Selection of structural system

Choose an appropriate structural system, such as a reinforced concrete (RCC) framed structure, considering factors like material availability, local construction practices and the buildings intended use.

3. Structural analysis using Etabs

Utilize the Etabs software to perform a detailed structural analysis of the building. Input the building geometry, materials, loads and constraints. The software will provide a various output including structural reactions, internal forces and deflection.

4. Manual calculation validation

Perform manual calculations for critical section of the building, such as beams, columns and slabs to validate the results obtained from the software this helps ensure the accuracy of the analysis and design.

5. Design of structural element

Based on the analysis design, design the various structural element such as beams, columns, slabs and footings. Ensure that they are sized appropriately to carry the calculated loads and satisfy the safety and serviceability criteria.

6. Reinforcement details

Provide detailed reinforcement layouts for each structural element, ensuring proper cover, spacing and arrangements of reinforcement bars. This is crucial for the structural integrity and durability of the building.

2. LITERATURE REVIEW

Abhay Guleria (2014): it's interesting to observe that in the analysis of a multi-storey building, the storey overturning moment varies inversely with the storey height. Additionally, the similarity in between L shape and I shape buildings regarding overturn moment in noteworthy. This insight emphasizes the importance of considering both dynamic factor during analysis and design of multi-storey buildings, contributing to better understanding and optimization of their structural performance.

Varikuppala Krishna et.al (2015): Absolutely, considering the layout and design of a multi-storey building based on natural factors such as sun light and wind direction can have significant benefits. Using light weigh concrete and materials is indeed a smart approach to reduce the dead load of the structure. This reduction in dead load allows structural designer to optimize the sizing of load bearing elements like columns and footings it not only improves the overall structural efficiency but also contributes to cost saving and potential shorter construction time.

Sayyed Feroz Sikander et.al (2019): this study deals the analysis and design of an apartment building having G+10 storeys are done by using ETABS V-15.2 software. Which proved to premium of great potential in the analysis and the design of various section the structural element like RCC, shear wall and retaining wall are provided. As per soil investigation report, an isolated footing provided the various difficulties encountered in the design process and various constraints faced by the structural engineers in designing up to an architectural drawing were also understood.

Shivkumar Deshmukh and Nithesh Kushwaha (2020): the study compares the analysis design of structural different shapes that includes squares, H, plus and T-shape. Displacement, drift, shear and bending moments are compared and displacement is found maximum in T-shape and minimum in square. In comparison to other shapes, square shape shows least storey drift. Simple geometrical shape attracts less force and performance well.

Chinmay Padole et.al (2021): the study was to evaluate the variations percentage increase in each floor of particular beam and column in the analysis and design of G+4 of residential building using ETABS. The percentage increase in axial load and bending moment, of each floor and that of the front column, central columns and back columns and beam of right, centre and back of each floor. Later concluding the analysis to be safe as the variation didn't exceed 10% after evaluating all the bending moment and axial loads and taking the difference and converting into percentage.

3. METHODOLOGY

The project provided to us is completed performing each section works mentioned in the contents before the following stages are involved in the analysis and design

BUILDING CONFIGURATION AND FEATURES

The arrangements of beams, Columns, Balcony slab, Room floors are done according as the figures shown below. Storey height of all floors is taken as 3200mm.

Building type : RCC Framed

Structural system : Residential Building

Plinth area covered : 145 sqm

Column : 200*200mm, 200*450mm & dia 280mm.

Beam :200*350mm, 200*400mm, 200*600mm, 200*750mm, 200*900mm, &200*1200mm.

Slab : 125mm, 150mm & 200mm.

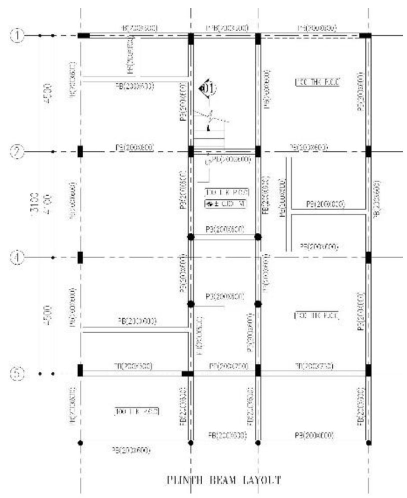
Type of foundation : Isolated Footing.

No. of storey : 3

Wall : 200mm

Type of sub soil : Zone II

PLAN LAYOUT:



4. RESULTS AND DISCUSSION

Here the analyzed results of G+2 residential building from ETABS software have been tabulated and discussed about the behavior of the structure the parameter considered from the analysis of G+2 multistorey structure is defined below

Base Reaction: it is defined as the horizontal reactions at the supports. It is represented in term of 'kN'.

Table. Base Reaction in kN

Column	Size	u (KN)
C1	200*450mm	459.34
C2	200*450mm	797.09
C3	200*450mm	708.38
C4	200*450mm	487.13
C5	200*450mm	769.00
C6	200*450mm	904.93
C7	200*450mm	953.80
C8	200*450mm	859.65
C9	Dia 200mm	498.71
C10	Dia 200mm	572.10
C11	200*450mm	703.28
C12	200*450mm	795.38
C13	Dia 200mm	369.32
C14	Dia 200mm	422.52
C15	200*450mm	397.07
C16	200*450mm	372.44
C17	200*450mm	383.61
C18	200*450mm	405.19
C19	Dia 200mm	65.90
C20	Dia 200mm	121.72
C21	Dia 200mm	137.49
C22	Dia 200mm	91.14

Storey Shear: the storey shear is defined as sum of design lateral forces at all level above the storey under consideration. It is represented in term of 'kN'.

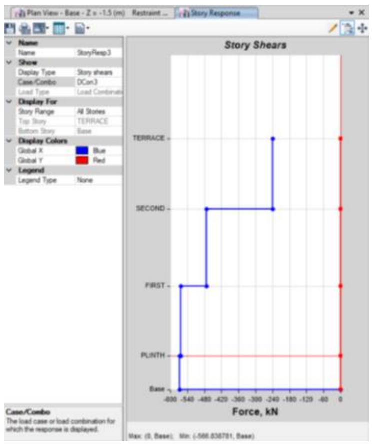


Fig. Story shear 1.2(DL+LL+EQX)

Table. Story shear 1.2(DL+LL+EQX)

Story	Elevation in m	Location	X-Direction in kN	Y-Direction in kN
Terrace	9.75	Top	-238.62	0
		Bottom	-238.62	0
Second	6.6	Top	-472.56	0
		Bottom	-472.56	0
First	3.15	Top	-562.99	0
		Bottom	-562.99	0
Plinth	0	Top	-566.83	0
		Bottom	-566.83	0
Foundation	-1.5	Top	0	0
		Bottom	0	0

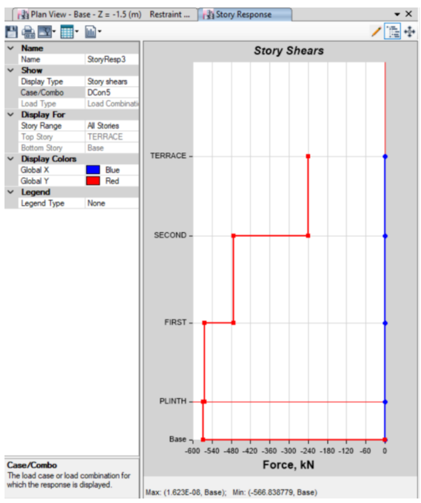


Fig. Story shear 1.2(DL+LL+EQY)

Table. Story shear 1.2(DL+LL+EQY)

Story	Elevation in m	Location	X-Direction in kN	Y-Direction in kN
Terrace	9.75	Top	0	-238.62
		Bottom	0	-238.62
Second	6.6	Top	0	-472.56
		Bottom	0	-472.56
First	3.15	Top	0	-562.99
		Bottom	0	-562.99
Plinth	0	Top	0	-566.83
		Bottom	0	-566.83
Foundation	-1.5	Top	0	0
		Bottom	0	0

Storey Drift: the drift is defined as ratio of displacement of two consecutive floors to height. The maximum permissible drift is limited to 0.004 times the height of the storey. It is very important term used for research purpose an earthquake engineering. The storey drift in any storey due to maximum specified design lateral force, with partial load factor of 1.

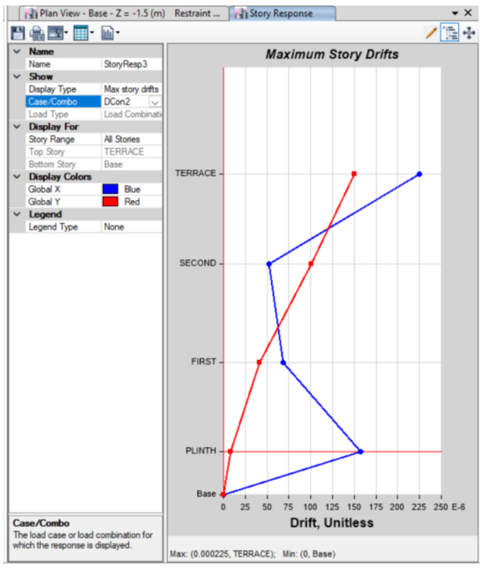


Fig. Maximum Storey Drift

Table. Maximum Storey Drift

Story	Elevation in m	X-Direction	Y-Direction
Terrace	9.75	0.000225	0.000151
Second	6.6	5.2E-05	0.0001
First	3.15	6.8E-05	4.1E-05
Plinth	0	0.000157	8E-06
Foundation	-1.5	0	0

Storey Displacement: it is defined as the displacement of the storey with respect to the base of the structure. The maximum permissible displacement is limited to height of the building by 500(H/500) and it is represented in term of 'mm'.

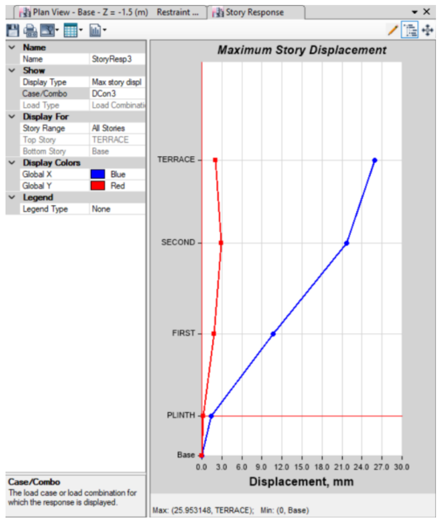


Fig. Maximum Storey Displacement 1.2 (DL+LL+EQX)

Table. Maximum Storey Displacement 1.2 (DL+LL+EQX)

Story	Elevation in m	X-Direction	Y-Direction
Terrace	9.75	25.95	2.04
Second	6.6	21.70	2.94
First	3.15	10.69	1.81
Plinth	0	1.43	0.21
Foundation	-1.5	0	0

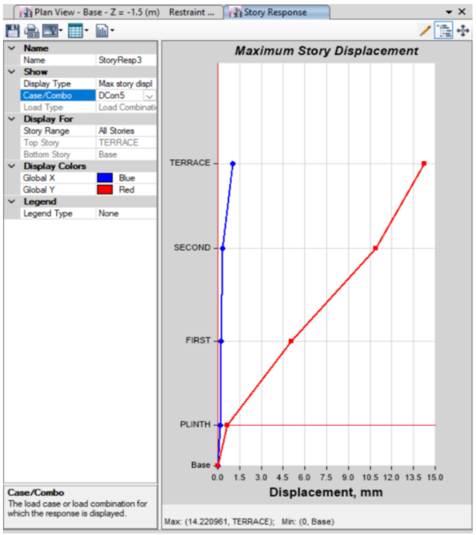


Fig. Maximum Storey Displacement 1.2 (DL+LL+EQX)

Table. Maximum Storey Displacement 1.2 (DL+LL+EQX)

Story	Elevation in m	X-Direction	Y-Direction
Terrace	9.75	1.00	14.22
Second	6.6	0.30	10.88
First	3.15	0.223	5.05
Plinth	0	0.184	0.637
Foundation	-1.5	0	0

Bending Moment: BM is a measure of the building effect that occurs when an external force or moment is applied to a structural element. This concept is very important in structural engineering as it can be used to calculate where and how much bending may be occur when forces are applied. It is represented in term of ‘kN-m’.

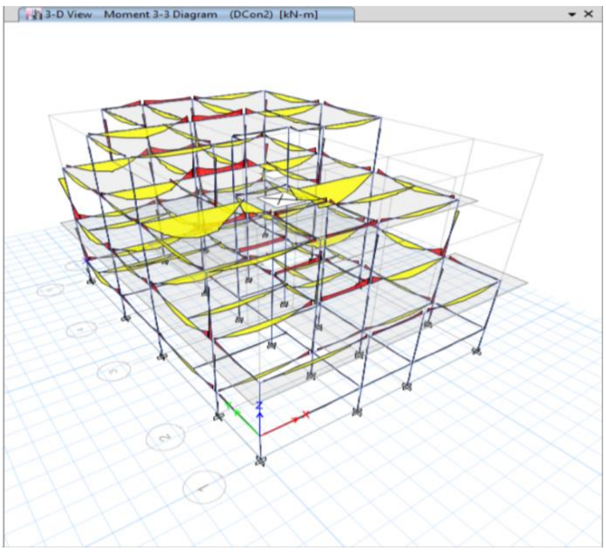


Fig. Bending Moment

Shear Force: SF is applied perpendicular to a surface, in opposition to an offset force acting in opposite direction. This results in a shear strain. In simple term, one part of the surface is pushed in one direction, while another part of the surface pushed in the opposite direction. It is represented in term of ‘kN’.

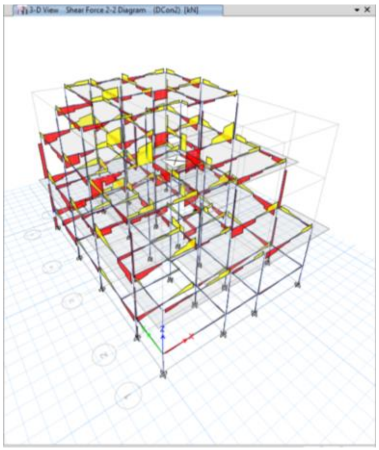


Fig. Shear Force Diagram

5. CONCLUSION

- If any beam fails, they dimension of the beam and column should be changed and reinforced detailing can be produced.
- Analyse and design and results obtained from ETABS are compared with that of manual design the compared results obtained from software are safe with manual calculation and designs.
- The structural elements are design to be safe.
- The column was designed for critical section with maximum axial load of 950 kN.
- The beam design for maximum bending moment and shear force of 176 kN-m and 157 kN respectively
- Footing is designed for column with maximum axial load.

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