An investigational study of commercial building- case study

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Abstract - In our project we have analyzed and designed various components of commercial building(Basement+G+3) using Etabs which is compressive analysis, design and detailing software for superstructure (Beams, Columns) of any building. Substructure of the building(Footing) and slab is designed using SAFE software which can be directly integrated with Etabs for load and reaction transfer. For the design of commercial building we have considered dead load, live load and earthquake load along with their combination on each structural element of the building. Although software is capable of doing linear-static, linear-dynamic, nonlinear-static, nonlinear-dynamic analysis. We limited our scope of study to only linear static analysis. Software is even capable of detailing each structural element in substructure and superstructure but we have attempted to do detailing using AUTOCAD. Furthermore, manual design was done for critical structural element and the results were compared with Etabs and SAFE.

Key Words: ETABS, Manual design, Safe.

1. INTRODUCTION

A structure is the one which consists of various components which are interconnected to one another in order to carry the overcoming loads[1]. As per civil engineering examples for structures includes bridges, culverts, dams etc[4]. Structures are designed to withstand forces and moments due to different causes while some structures like aircraft structures, machine foundation etc[2], necessarily have to be designed for forces due to motion, many are designed considering them to be equilibrium or at rest[3]. These structures have to be designed and analysed before the structure has been put in use so has to withstand the oncoming loads on the structure without any failure during its design life. Several software packages are available these days for analysis and design of the structure like STAADPRO, ETABS, SAP, RAM etc[5]. ETABS is one such software which is being widely used for the purpose of analysis and design of a high-raised buildings[6].

2. LITERATURE REVIEW

The present investigation deals with the analysis and design of commercial building using ETABS. The relevant literature available in this area has been critically studied and discussed.
object temporarily placed on the structure, moving vehicle or the natural forces. Live load for residential building is taken as per IS-875(part-2). The loads from the slab get distributed to the beams which is further distributed to the columns. From column this load gets distributed to the footing.

2.1. Present Study

In this paper a Basement+G+3 commercial building which is of about 9400sq.ft located at Basaveshwara Nagar, Bangalore.

2.2. Objectives

- To analyze and design with an aid of Extended3D Analysis of building System (ETABS) and SAFE.
- To highlight the advantages of using ETABS and SAFE over manual method in practical or live project.
- To understand the limitations of ETABS and SAFE (if any) and methods to overcome that limitation.
- To compare results obtained from Etabs and SAFE with manual method.

3. METHODOLOGY

4. BUILDING DATA

Features
- Type of building: Commercial building
- Size of the site: 100*94 [ft]
- Building height:
- Number of storey: Basement +G+3
- Type of construction: R.C.C framed structure
- No. of stairs: one
- No. of lift: Two
- Type of wall: Brick wall

<table>
<thead>
<tr>
<th>Dimension of Beams</th>
<th>B1=230*600mm</th>
<th>B2=230*450mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension of columns</td>
<td>C1=230*450mm</td>
<td>C2=230*600m</td>
</tr>
<tr>
<td>Thickness of slab</td>
<td>150mm</td>
<td></td>
</tr>
<tr>
<td>Live load</td>
<td>4KN/m²</td>
<td></td>
</tr>
<tr>
<td>Floor finish</td>
<td>1KN/m²</td>
<td></td>
</tr>
<tr>
<td>Wall load</td>
<td>13KN/m</td>
<td></td>
</tr>
</tbody>
</table>

4.1. Plan of the building

![Fig 1: Basement floor plan](image1)

![Fig 2: First floor plan](image2)
5. ETABS MODELING AND ANALYSIS

Fig 3: Second and Third floor plan

Fig 4: Modeling of the structure

Fig 5: Analysis of the structure

Fig 6: Design of the structure

Fig 7: Bending Moment diagram of the structure

Fig 8: Shear force diagram of the structure
Fig 9: Foundation Layout

Fig 10: Analysis and Design of Foundation

Fig 11: Slab Layout

Fig 12: Analysis and design of slab

6. Comparison of Reinforcement details of Software and manual method

Footing Reinforcement details

<table>
<thead>
<tr>
<th>Column load</th>
<th>Manual Method</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>1340.372 KN</td>
<td>1104 mm$^2$</td>
<td>1104 mm$^2$</td>
</tr>
</tbody>
</table>

Column Reinforcement details

<table>
<thead>
<tr>
<th>SBC of Soil</th>
<th>Manual Method</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>339 KN/m$^2$</td>
<td>1407.43 mm$^2$</td>
<td>1104 mm$^2$</td>
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</tbody>
</table>

Beam details

<table>
<thead>
<tr>
<th>Area of the Steel required</th>
<th>Manual Method</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>402 mm$^2$</td>
<td>1104 mm$^2$</td>
<td>1104 mm$^2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area of the Steel required</th>
<th>Manual Method</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>505 mm$^2$</td>
<td>1104 mm$^2$</td>
<td>1104 mm$^2$</td>
</tr>
</tbody>
</table>
7. CONCLUSIONS

- It takes less time to design a building accurately in ETABS and SAFE.
- Revision of loads and redesigning of structural elements is easier in ETABS compared to manual design.
- Documentation of result is systematic, effective and in a proper sequence which lags in case of manual design.
- Creating and saving of reports in ETABS in digital format is much more safe and efficient way.

8. REFERENCES

[1] Ragy Jose1, Restina Mathew, Sandra Devan, SankeerthanaVenu, Mohith Y S “Analysis And Design Of Commercial Building Using Etabs”

[2] Puneet Mittal, Nishant Kad “A Comparison of the analysis and design results of 4 storey using STAAD Pro and ETABS Software”


### Slab details

<table>
<thead>
<tr>
<th>Area of the steel required:</th>
<th>Manual method</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Along longer direction</td>
<td>261.799mm²</td>
<td>250mm²</td>
</tr>
<tr>
<td></td>
<td>393.01mm²</td>
<td>310mm²</td>
</tr>
<tr>
<td>(b) Along shorter direction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>