COST COMPARISON BETWEEN CONVENTIONAL AND FLAT SLAB STRUCTURES

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Abstract- In present era, conventional Reinforced Concrete (RC) frame buildings are commonly used for the construction. The use of flat slab building provides many advantages over conventional RC frame building in terms of architectural flexibility, use of space, easier formwork and shorter construction time.

In the present work conventional and flat slab B+G+3 storey building is considered for cost comparison. The building is considered to be situated in earthquake zone 2. For earthquake loading, the provisions of IS:1893 (Part-1)-2002 are considered. For modeling and analysis of conventional and flat slab structures, ETABS 09 software is used. The dead load, live load and wind load are considered as per Indian codes 875-1987. The design is carried out as per IS 456-2000 and for reinforcement detailing SP 34 is used.

The investigation shows that, the weight of flat slab structure is less compared to conventional slab structure. The cost of flat slab structure is less by 15.8% as compared to conventional slab. The study concludes, flat slab structures are the best solution for high rise structure as compared to conventional slab structure when compared with cost of material.

Key Words: Conventional slab, Flat slab, Multi storey building, ETABS, and Cost comparison.

1. INTRODUCTION

With rapid growth in population along with development of industrial and commercial activities rapid urbanization has taken place which has resulted into continues influx of rural people to metro cities. So obviously the horizontal space constraint is reaching an alarming situation for metros. To cope with the situation maximum utilization of space vertically calls for the construction of multi-storey buildings in large numbers but the question of affordability of the target customers mainly the middle income group of our country necessitates efficient and cost effect design of such buildings.

Objective of the Study

To investigate the cost effectiveness of flat slab over conventional slab for multi storey building.

2. CONVENTIONAL SLAB

Slabs supported on walls or on beams are classified as conventional slab. Conventional slab are generally rectangle in shape, but it can be of any shape such as triangular, circular, trapezoidal, etc. Loads are transferred by the slab by flexural; shear and torsion to the supports such slabs supported on two parallel sides carry loads by bending in the direction perpendicular to the supports. They are known as one way slab and are virtually shallow beam with large width.

Slabs supported on four sides also behave as one way slab if the length is very large as compared to the width of the slab. Rectangular slabs with the length not very large as compared to width or square slab supported on four sides carrying loads by bending in two perpendicular directions such slabs are known as two way slabs.
3. FLAT SLAB

Common practice of design and construction is to support the slabs by beams and support the beams by columns. This may be called as beam-slab construction. The beams reduce the available net clear ceiling height. Hence in warehouses, offices and public halls sometimes beams are avoided and slabs are directly supported by columns. These types of construction are aesthetically appealing also. Flat slabs which are directly supported by columns.

4. BUILDING MODEL

The study has been carried out with some basic assumptions in design criteria or parameters for (B+G+3) storeyed building for conventional slab as well as flat slab including relevant soil parameters, wind speed, earthquake zone and values of coefficients and acceleration based on available local data and stipulations of Indian Standards codes. The dead load and live load has been considered based on the IS 875 (Part 1&2), wind load is based on IS 875( Part 3). For earthquake loading, the provisions of IS 1893:2002 was considered.

In this study, B+G+3 building models is considered which having floor plan of 30m x 30m in square. The floor plan of is divided into 7.5m x 7.5m bays. Figure 3 shows the details of floor plan adopted for the present study.

The study has been carried out for the two variants.

- B+G+3 conventional slab building and 3.6m floor height.
- B+G+3 flat slab building and 3.6m floor height.

4.1. Specification of Supports

The base nodes of all the columns are restrained against translation and rotation about all the 3 global axes. The fixed support is assigned.

4.2 Load Calculations

The load considered for the following Study is mentioned below which are in accordance with IS 1893(Part 1):2002

1) Dead Load

i. The self-weight of the structural members is calculated according to the codal provision's and taken care in the software.
ii. Dead load on floor finishing: 1.5kN/m²

2) Live Load

i. Live load on Floor: 3 kN/m²
ii. Live load on Roof: 3 kN/m²

3) Seismic Load

i. Seismic Zone : Zone-II (As per IS 1893(Part-1): 2002
iii. Damping ratio: 5% for RC frame structure.
iv. Seismic zone factor (Z): 0.16 (Table 2 of IS 1893(Part-1): 2002.
v. Response reduction factor (R): 5.0 (Table 7 of IS 1893(Part-1): 2002.
vii. Fundamental natural period: 0.075 h \(0.75\) for RC frame building of vibration (Ta) As per IS 1893(Part-1): 2002.

viii. Foundation soil type: Type-1(Hard Soil), Type-2(Medium Soil), and Type-3(Soft Soil) (As per IS 1893(Part-1):2002.

### 4.3 Material Properties

The properties of material used given in Table 1.

**Table 1: Material properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade of Concrete</td>
<td>M25, M20</td>
</tr>
<tr>
<td>Density of Concrete</td>
<td>25kN/m(^3)</td>
</tr>
<tr>
<td>Modulus of Elasticity of concrete</td>
<td>5000(\sqrt{f_{ck}}) (IS 456:2000)</td>
</tr>
<tr>
<td>Grade of Steel</td>
<td>Fe 500 HYSD</td>
</tr>
</tbody>
</table>

#### 5. PROCEDURE FOR MODELING AND ANALYSIS OF FRAMED STRUCTURE USING ETABS

The modeling of the reinforced concrete structure has been done using commercially available structural software ‘ETAB 2013’. Member dimension adopted for modeling are presented in Table 2. Step by step procedure is adopted in ‘ETAB’ to analyze the building for gravity and seismatic loads.

**Table 2: Member dimensions**

<table>
<thead>
<tr>
<th>Type</th>
<th>Slab thickness</th>
<th>Size of beam</th>
<th>Column size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Slab</td>
<td>250 mm</td>
<td>230 mm (\times) 750 mm</td>
<td>300 mm (\times) 900 mm</td>
</tr>
<tr>
<td>Flat Slab</td>
<td>250 mm</td>
<td>230 mm (\times) 600 mm</td>
<td>230 mm (\times) 750 mm, 300mm (\times) 750 mm</td>
</tr>
</tbody>
</table>

Figure 4 shows plan and elevation view of building adopted for this study. Detailed step by step procedure adopted for modeling and analysis is presented below.

### 6. RESULTS AND CONCLUSION

#### 6.1 Estimation and costing

From the analysis of structure, area of reinforcement has been obtained. Based on area of reinforcement the number and size of bar have been finalized. The IS standard detailing is used to find out the length required. Market rates have been used to find out the total cost of steel reinforcement and concrete used in various elements of structures. In the present study to find out cost of structure rate of steel and concrete is considered Rs. 50 per kg and Rs. 4000 per m\(^3\) respectively.
6.2 Cost Comparisons

Figure 5-10 shows the variation in quantity of steel, and quantity of concrete and cost between conventional and flat slab framed structure.

**Fig. 5:** Quantity of Concrete Variation for conventional and flat slab framed structure

<table>
<thead>
<tr>
<th>Quantity in m³</th>
<th>Beam</th>
<th>Column</th>
<th>Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convetional slab building</td>
<td>258.75</td>
<td>121.5</td>
<td>1125</td>
</tr>
<tr>
<td>Flat slab building</td>
<td>82.8</td>
<td>86.13</td>
<td>1125</td>
</tr>
</tbody>
</table>

**Fig. 6:** Cost of Concrete Variation for conventional and flat slab framed structure

<table>
<thead>
<tr>
<th>Cost in thousand Rs</th>
<th>Beam</th>
<th>Column</th>
<th>Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convetional slab building</td>
<td>40.8</td>
<td>13.43</td>
<td>28.88</td>
</tr>
<tr>
<td>Flat slab building</td>
<td>6.33</td>
<td>11.35</td>
<td>50.16</td>
</tr>
</tbody>
</table>

**Fig. 7:** Quantity of Steel Variation For conventional and flat slab framed structure

<table>
<thead>
<tr>
<th>Quantity in ton</th>
<th>Beam</th>
<th>Column</th>
<th>Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convetional slab building</td>
<td>1035000</td>
<td>486000</td>
<td>4500000</td>
</tr>
<tr>
<td>Flat slab building</td>
<td>331200</td>
<td>344520</td>
<td>4500000</td>
</tr>
</tbody>
</table>

**Fig. 8:** Cost of Steel Variation For conventional and flat slab framed structure

<table>
<thead>
<tr>
<th>Cost in Thousand Rs</th>
<th>Beam</th>
<th>Column</th>
<th>Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convetional slab building</td>
<td>2040000</td>
<td>671500</td>
<td>1424500</td>
</tr>
<tr>
<td>Flat slab building</td>
<td>316500</td>
<td>565200</td>
<td>2508000</td>
</tr>
</tbody>
</table>
respectively, but quantity and cost of concrete and steel for conventional slab is 42.42% less than flat slab.

From Figure 9 and 10 it is clear that the quantity and cost of steel and concrete for flat slab structure is 15.8% less than the conventional slab structure.

9. CONCLUSIONS

The comparative study of conventional and flat slab framed structure (B+G+3) is presented. The parameters considered are quantity and cost of beam, column and slab. Thus, based on the analysis the following conclusions are drawn.

Weight of Flat slab structure is quite low as compared to conventional slab structure.

Flat slab structure is more economical than that of conventional slab structure. The cost of flat slab structure is reduced by 15.8% compared to conventional slab structures.

Flat slab structure leads to economic saving, aesthetic view and yet allow the architect from great freedom of form works as compared to conventional slab structure.

Flat slab structures are the best solution for high rise structure as compared to conventional slab structure.

REFERENCES

[1] IS: 875(Part 1-3)-1987, “Code of practice for design loads(other than earthquake) for buildings and structures”, published by Bureau of Indian standards, New Delhi,


[4] IS 1893-2002 “Indian standard criteria for earthquake resistant design of structures”, published by Bureau of Indian Standards NEW Delhi,


BIOGRAPHIES

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