Abstract

Every human has desire to own comfortable house and on an average, generally one spends his two-third of lifetime in the house. Therefore there is an increased trend towards the construction of multi-storeyed buildings for residential as well as for non-residential purposes in the urban areas. Hence nowadays the building construction has become a major work which indicates the social progress of the county. In order to compete with the ever growing competent market it is very important for a structural engineer to save time. It is emphasized that any structure to be constructed must satisfy the need efficiently for which it is intended and shall be durable for its desired life span. But in the modern scenario, it is not possible to analyze sophisticated structures manually, as even a structure of modest proportion involves many skills and literally hundreds of different operations. This calls for the use of specialized software packages for the efficient planning, analysis, design, drafting, estimation and project management. “CYPECAD” is one such software which has been used for analysis of complicated structures more efficiently and rapidly. The present project deals with the analysis and design of a multi storied residential building of G+4 consisting of 8 apartments in each floor using “CYPECAD”.
1. INTRODUCTION

CYPECAD is the software for reinforced concrete, steel, timber and aluminum structures which provides the spatial analysis, structural element design, reinforcement and section edition, and construction drawings of the structure. It carries out the analysis of three dimensional structures composed of supports and floor slabs, including their foundations, and the automatic design of reinforced concrete and steel elements. With CYPECAD, the engineer holds a precise and efficient tool to resolve all the aspects related to the analysis of the structure of any type of concrete as well as being adapted to the latest international Codes. A R.C building of G+4 storey framework is taken up for the design using CYPECAD. It is a residential Apartment of height 19.5mts, includes 50 numbers of column. The building is subjected to both vertical loads as well as horizontal loads as per IS 875. It is as two dimensional vertical frames and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per IS456-2000. The help is taken by software and the computations of loads, moments and shear forces are obtained from this software.

2. DESIGN NECESSITY

The function of any structure is to withstand stresses due to imposed load, dead load, wind load, seismic load, temperature changes, shrinkage etc. Design of any structure includes functional design and structural design. The trial and error procedure, through which an engineer puts together an acceptable structure, constitutes “STRUCTURAL DESIGN”. The various stages involved in the structural design are as follows:

- Structural Planning i.e. planning the layout of columns, beams and spanning of slabs, foundations
- Determination of action of forces and computation of loads
- Determination of member sizes and reinforcement and then analysing
- Design of the structural members
- Detailing, drawing as per designed results and preparation of schedules

3. SOFTWARE DETAILS

3.1. CYPECAD

This project involves analysis and design of multistoried [G + 4] residential building using a design software CYPECAD. We have chosen CYPECAD because of its following advantages:

i. Program that carries out the analysis and design of reinforced concrete and steel structures, subject to horizontal and vertical loads, for homes, buildings and civil project works.
ii. Its use guarantees maximum analysis reliability and optimum drawing design.
iii. The geometry of the structure can be introduced automatically.
iv. The user can personalize the design and edit the elements that have been introduced, with the on-screen support provided such as, help options and error and warning texts.
v. Provides very complete and precise construction drawings of the structure.
vi. CYPECAD is adapted to the latest national and international construction codes.

vii. Seismic analysis with force amplification.

viii. From model generation, analysis and design to visualization and result verification, CYPECAD is the professional’s choice for steel, concrete, timber, aluminium and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

3.2. AutoCAD

i. AutoCAD is powerful software licensed by auto desk. The word auto came from auto desk Company and CAD stands for computer aided design. AutoCAD is used for drawing different layouts, details, plans, elevations, sections and different sections can be shown in auto cad.

ii. The importance of this software makes every engineer a compulsion to learn this software’s. We used AutoCAD for drawing the plan, elevation of a residential building.

4. STATEMENT OF PROJECT

4.1. Salient features

Utility of building : Residential Apartment
No of stories : G+4
Shape of the building : Rectangle
No of staircases : 1
No. of flats : 40
No of lifts : 2
Type of construction : R.C.C framed structure
Types of walls : Concrete block wall
Foundation Type : Isolated and Combined Footing
Table 1: Geometric Details

<table>
<thead>
<tr>
<th>Group</th>
<th>Group Name</th>
<th>Floor</th>
<th>Floor Name</th>
<th>Height</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Roof</td>
<td>7</td>
<td>Roof</td>
<td>3.00</td>
<td>18.30</td>
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<tr>
<td>2</td>
<td>Floors 2 To 6</td>
<td>6</td>
<td>Floor 4</td>
<td>3.00</td>
<td>15.30</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>Floor 3</td>
<td>3.00</td>
<td>12.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Floor 2</td>
<td>3.00</td>
<td>9.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Floor 1</td>
<td>3.00</td>
<td>6.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Ground Floor</td>
<td>3.00</td>
<td>3.30</td>
</tr>
<tr>
<td>1</td>
<td>Stilt Floor</td>
<td>1</td>
<td>Stilt Floor</td>
<td>1.50</td>
<td>0.30</td>
</tr>
<tr>
<td>0</td>
<td>Basement 2</td>
<td></td>
<td></td>
<td></td>
<td>-1.20</td>
</tr>
</tbody>
</table>

I. **Materials**

Concrete grade: M25
All steel grades: Fe415 grade

II. **Assumptions made**

ON FLOOR
- Dead Load = 1.5KN/m²
- Live Load = 2KN/m²

ON ROOF
- Dead Load = 3KN/m²
- Live Load = 1.5KN/m²

Wall load for 0.2m wall = 12KN/m (25*0.2*2.55)
Depth of foundation = 1.5mtrs
Foundation Type = Isolated and Combined Footing

5. **MODELING IN CYPECAD**

Modeling in CYPECAD involves following steps:

i.) Automatic job introduction

ii.) Specifying structure details.

iii.) Importing of architectural drawings.

iv.) Specifying loads on the structure.

v.) Defining Structure geometry.

vi.) Defining special loads on the structure.

Using CYPECAD’s Automatic job introduction, the user has two options which allow for a structure to be generated automatically either by means of importing a file in IFC format, generated by the main CAD/BIM programs (Archicad, Revit Architecture); or by using a file in DXF or DWG format. For the current project we imported plan of the building in DWG format. Specifying Structure details involves entering of details such as numbers of floors, height of the floors etc. The architectural drawings that are to be imported should be edited such that it fulfills the software requirements. Editing of drawing involves creating layers which indicates the positioning of columns and its
dimensions. These different floor drawings which are edited are imported to the software for further modeling.

After importing the architectural drawings the floor loads which are calculated earlier are feed to the software. The dead loads and live loads are entered separately. The software allows usage of different load cases. After giving all the data the layout of Column, Beam &Slab is done and we get the 3D view of the structure i.e. The Modeled Structure.

A vast amount of analysis and reinforcement options are available to be able to take into account those aspects that are deemed most adequate. Additionally, for each structural element and each reinforcement position, personalized reinforcement tables may be defined. For all design elements, their geometry and reinforcement can be edited and
modified, with multiple tools to carry out the task. Drawings can be personalized according to the user’s needs, as the program allows configuring all the drawing layers and elements and generating them via DXF, DWG, printer and plotter.

6. RESULT AND ANALYSIS

6.1. Design Reports

Table 2: The code check for roof column no.8

<table>
<thead>
<tr>
<th>Column data</th>
<th>Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>30x60 cm</td>
</tr>
<tr>
<td>Span</td>
<td>15.300/18.300 m</td>
</tr>
<tr>
<td>Free height</td>
<td>2.55 m</td>
</tr>
<tr>
<td>Geometric cover</td>
<td>4.0 cm</td>
</tr>
<tr>
<td>Maximum aggregate size</td>
<td>20 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials</th>
<th>Buckling length</th>
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</thead>
<tbody>
<tr>
<td>Concrete : M 25</td>
<td>ZX plane : 2.55 m</td>
</tr>
<tr>
<td>Steel : Fe 415</td>
<td>ZY plane : 2.55 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Longitudinal reinforcement</th>
<th>Stirrups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corner : 4Ø20</td>
<td>Perimeter : 1sØ8</td>
</tr>
<tr>
<td>Y Face : 2Ø12</td>
<td>Spacing : 15 cm</td>
</tr>
<tr>
<td>Steel area : 0.82 %</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: Beam reinforcement report of frame 14
Table 4: Slab 55 and 51 reinforcement report

<table>
<thead>
<tr>
<th>Slab</th>
<th>Dir</th>
<th>Depth</th>
<th>Moments</th>
<th>Steel areas</th>
<th>Additional reinforcement</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left</td>
<td>Centre</td>
<td>Right</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Left</td>
<td>Centre</td>
</tr>
<tr>
<td>L55</td>
<td>X</td>
<td>0.15</td>
<td>4.98</td>
<td>0.99</td>
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<tr>
<td></td>
<td>Y</td>
<td>2.54</td>
<td>1.05</td>
<td>4.89</td>
<td>1.03</td>
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<tr>
<td>L51</td>
<td>X</td>
<td>0.15</td>
<td>------</td>
<td>1.14</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>9.93</td>
<td>2.56</td>
<td>5.73</td>
<td>4.01</td>
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</tbody>
</table>

Table 5: Foundation reinforcement report of Column 3 and 4

<table>
<thead>
<tr>
<th>References</th>
<th>Geometry</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
<td>Centered rectangular footing&lt;br&gt;Footing width X: 215.0 cm&lt;br&gt;Footing width Y: 150.0 cm&lt;br&gt;Depth: 50.0 cm</td>
<td>X: 10Ø12@15&lt;br&gt;Y: 16Ø10@13</td>
</tr>
<tr>
<td>C4</td>
<td>Centered rectangular footing&lt;br&gt;Footing width X: 265.0 cm&lt;br&gt;Footing width Y: 180.0 cm&lt;br&gt;Depth: 60.0 cm</td>
<td>X: 16Ø12@11&lt;br&gt;Y: 17Ø12@15</td>
</tr>
</tbody>
</table>

7. CONCLUSION AND SCOPE FOR FURTHER STUDIES

**Conclusion**

i. Analysis and Design conducted using CYPECAD satisfies the permissible deflection limit.

ii. Analysis and design by using CYPECAD consumes less time hence this can be highly useful for quicker work & time bound projects.

iii. Reinforcement Detailing, Drawing are generated along with the result automatically by CYPECAD whereas in other relevant software the drawing have to be generated separately.

iv. Quantity of steel (Length & total weight) is generated by the software which reduces labour time.

v. Reinforcement area graph helps in achieving economy in material used.

vi. CYPECAD enables to check the safety of design and modification in individual structural element.

**Scope**

i. Analysis and design can be done using different available software to compare the accuracy of the results obtained.

ii. Analysis and Design was done for Cast in situ, it can be done for precast member which is economical and consumes less time for structure to put in service.
iii. Tall building with several floors can be analysed and designed in a short time.
iv. Provision for circular beam and slab are available in CYPE hence as per aesthetic it can be adopted.
v. As per site condition if the sloping area is present then the retaining wall can be analysed and designed easily.
vi. Depending upon the soil bearing capacity of soil different types of footings can be tried.

8. REFERENCES

[8] SP16&SP34 - BUREAU OF INDIAN STANDARDS, manak bhavan, 9 bahadur shah zafar marg, New Delhi.