The structural design of the multistorey building

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ABSTRACT

The rapid growth in the rate of construction of multi-storey blocks has been an important feature of the building industry over the past fifteen years. Much of this construction has occurred in areas underlain by the cyclothemic rocks of the Coal Measures. The anisotropic properties of this sequence lead to rapid horizontal and vertical variations in foundation conditions, which must be assessed in selecting the type and depth of foundation and the allowable bearing pressure. Special problems occur in areas which have been undermined by shallow mineral workings. Such sites require special investigations, careful evaluation of the site conditions and the design of appropriate foundations. The desirable approach in many instances is to plan developments on a large scale so that the greatest economic advantage may be taken of the best site conditions. In order to compete in the ever-growing competent market, it is very important for a structural engineer to save time. As a sequel to this, an attempt is made to analyze and design a Multistoried building by using a software package staad. For analyzing a multi-storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. There are several methods for analysis of different frames like kani’s method, cantilever method, portal method, Matrix method.

Keywords: Cyclothymic, Anisotropic, Bearing pressure, Foundations.

1. INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In the early ancient times, humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses. Buildings are the important indicator of the social progress of the county. Every human has the desire to own comfortable homes on an average generally one spends his two-third life times in the houses. The security civic sense of the responsibility. These are the few reasons which are responsible that the person does utmost effort and spend hard earned saving in owning houses.

Nowadays the house building is major work of the social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements of the community engineers and architects do the design work, planning, and layout, etc. of the buildings. Draughtsman is responsible for doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know his job and should be able to follow the instruction of the engineer and should be able to draw the required drawing of the building, site plans and layout plans etc, as for the requirements.
building frame consists of a number of bays and storey. A multi-storey, multi-paneled frame is a complicated statically intermediate structure. A design of R.C building of G+5 storey frame work is taken up.

2. DESIGN

The design is made using IS 456:2000. The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of a dead load of structural components such as beams, columns, slabs etc and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as per IS 875. The building is designed 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 available in the institute and the computations of loads, moments and shear forces and obtained from this software.

3. EARLY, MODERN AND INDUSTRIAL AGE

With the emerging knowledge in scientific fields and the rise of new materials and technology, architecture engineering began to separate, and the architect began to concentrate on aesthetics and the humanist aspects, often at the expense of technical aspects of building design. Meanwhile, the industrial revolution laid open the door for mass production and consumption. Aesthetics became a criterion for the middle class as ornamental products, once within the province of expensive craftsmanship, became cheaper under machine production. Vernacular architecture became increasingly ornamental. House builders could use current architectural design in their work by combining features found in pattern books and architectural journals.

4. STATEMENT

The utility of building: Residential complex

<table>
<thead>
<tr>
<th>No. of stories</th>
<th>G+5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of stair cases</td>
<td>2</td>
</tr>
<tr>
<td>No. of flats</td>
<td>30</td>
</tr>
<tr>
<td>No. of lifts</td>
<td>2</td>
</tr>
<tr>
<td>Type of construction</td>
<td>RCC framed structure</td>
</tr>
<tr>
<td>Types of walls</td>
<td>brick wall geometric details</td>
</tr>
<tr>
<td>Ground floor</td>
<td>3m</td>
</tr>
<tr>
<td>Floor to floor height</td>
<td>3m</td>
</tr>
<tr>
<td>Height of plinth</td>
<td>0.6m</td>
</tr>
<tr>
<td>The depth of foundation</td>
<td>500 mm materials</td>
</tr>
<tr>
<td>Concrete grade</td>
<td>M20</td>
</tr>
<tr>
<td>All steel grades</td>
<td>Fe415 grade</td>
</tr>
<tr>
<td>Bearing capacity of soil</td>
<td>200kN/m2</td>
</tr>
</tbody>
</table>

5. LITERATURE REVIEW

Givoni 1994 et al, Found that a roof painted with a gray or dark color records a higher ceiling temperature compared with a roof painted with a lighter color. It was also justified that a dark colored roof has a higher indoor temperature than the outdoor climate. The study concluded that the incidence of solar radiation on the roof surface depends on the color and thermo-physical properties of the roof.

Al-Obaidi et al., 2014. A black aluminum sheet for a flat roof or a 0° roof pitch records the highest indoor temperature. Ibrahim et al. (2014) showed that the indoor temperature reading is higher than the outdoor temperature for a lower roof pitch because of the large amount of heat it absorbed. Looking at the current modern house design in Malaysia, most parts of the roof are constructed within a 10° roof angle.

Abdul Rahman et al. (2009) wrote that a flat roof design in the tropical climate could not be considered as a good elemental design because of some factors that would lead to leakages, such as the ponding of water on the flat roof surface, and would require additional costs for major restructuring. Apart from saving construction costs, developers prefer the easiest and simplest method to design and construct the houses, especially in the upper part of the structure.

6. MATERIALS

The building material is any material which is used for construction purpose and many naturally occurring substances such as clay, rock, sand, wood etc. The construction material area of study gives the student a comprehensive understanding of the composition, micro structure and engineering behavior of material used in civil engineering application.

6.1 Material Used

The following are some of the materials used for the construction purpose.

1. Rocks
2. Cement
3. Aggregates
4. Admixtures

5. Steel

6. Bricks

7. METHODOLOGY

This project is mostly based on software and it is essential to know the details about these software.

List of the software’s used

- Staad pro(v8i)
- Staad foundations 5(v8i)
- Auto cad

7.1 STAAD

Staad is powerful design software licensed by Bentley .Staad stands for structural analysis and design Any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, where as analysis is the estimation of what is the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. this we do after the analysis. To calculate s.f.d and b.m.d of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very powerful tool which does this job in just an hour’s staad is a best alternative for high rise buildings. Now a days most of the high rise buildings are designed by staad which makes a compulsion for a civil engineer to know about this software. These software can be used to carry rcc , steel, bridge , truss etc according to various country codes.

Staad has the very great advantage to other software’s i.e., staad editor. staad editor is the programming.For the structure we created and loads we took all details are presented in programming format in staad editor. This program can be used to analyze another structures also by just making some modifications, but this require some programming skills. So load cases created for a structure can be used for another structure using staad editor.

7.2 STAAD FOUNDATION

Staad foundation is a powerful tool used to calculate different types of foundations. It is also licensed by Bentley softwares. All Bentley software’s cost about 10 lakhs and so all engineers can’t use it due to heavy cost. Analysis and design carried in Staad and post-processing in staad give the load at various supports. These supports are to be imported into this software to calculate the footing details i.e., regarding the geometry and reinforcement details. This software can deal different types of foundations.

SHALLOW (D<B)

- Isolated (Spread) Footing
- Combined (Strip) Footing
- Mat (Raft) Foundation

7.3 AutoCAD

AutoCAD is powerful software licensed by the 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. It is very useful software for civil, mechanical and also electrical engineer. The importance of this software makes every engineer a compulsion to learn this software. We used AutoCAD for drawing the plan, elevation of a residential building. We also used AutoCAD to show the reinforcement details and design details of a stair case. AutoCAD is a very easy software to learn and many users friendly for anyone to handle and can be learned quickly. Learning of certain commands is required to draw in AutoCAD.

7.4 LIMIT STATE METHOD

The object of design based on the limit state concept is to achieve an acceptability that a structure will not become unserviceable in its life time for the use for which it is intended. I.e it will not rech a limit state. In this limit state method, all relevant states must be considered in design to ensure a degree of safety and serviceability.

7.5 METHOD OF FLEXIBILITY COEFFICIENTS

The method of analysis comprises reducing the hyper static structure to a determinate structure form by Removing the redundant support (or) introducing adequate cuts (or) hinges.

7.6 SLOPE DEFLECTION EQUATION
It is advantageous when kinematic indeterminacy < static indeterminacy. This procedure was first formulated by axle bender in 1914 based on the applications of compatibility and equilibrium conditions. The method derives its name from the fact that support slopes and displacements are explicitly comported. Set up simultaneous equations is formed the solution of these parameters and the joint moment in each element or computed from these values.

7.7 KANI’S METHOD

This method overcomes some of the disadvantages of the hardy cross method. Kani’s approach is similar to H.C.M to that extent it also involves the repeated distribution of moments at successive joints in frames and continues beams. However, there is a major difference in the distribution process of two methods. H.C.M distributes only the total joint moment at any stage of iteration. The most significant feature of kani’s method is that process of iteration is self-corrective. Any error at any stage of iterations corrected in subsequent steps consequently skipping a few steps error at any stage of iteration is corrected in subsequent consequently skipping a few steps of iterations either by over sight of by intention does not lead to error in final end moments.

8. ANALYSIS

8.1 SLAB DESIGN

The slab is plate elements forming floor and roofs of buildings carrying distributed loads primarily by flexure.

a) One way slab

One way slab is those in which the length is more than twice the breadth it can be simply supported beam or continuous beam.

b) Two-way slab

When slabs are supported to four sides two ways spanning action occurs. Such as slab are simply supported on any or continuous or all sides the deflections and bending moments are considerably reduced as compared to those in one way slab.

![Fig 1 Diagrams of slab deflection in one way and two-way slabs](image)

8.2 BEAMS

Beams transfer load from slabs to columns. Beams are designed for bending perimeters of the beams are assigned. Design beam command is assigned and analysis is carried out, now reinforcement details are taken.

a) Singly reinforced beam

In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are more effective in resisting the tensile bending stress. Cantilever beams reinforcing bars placed near the top of the beam, for the same reason as in the case of the simply supported beam.

b) Doubly reinforced concrete beams

It is reinforced under compression tension regions. The necessity of steel compression region arises due to two reasons. When the depth of beam is restricted. The strength availability singly reinforced beam is in adequate. At a support of continuous beam where bending moment changes sign such as situation may also arise in the design of a beam circular in plan.

![Fig 2 Reinforcement details](image)

8.3 COLUMN

A column or strut is a compression member, which is used primarily to support axial compressive loads and with a height of at least three, it is a least lateral dimension.

A reinforced concrete column is said to be subjected to axially loaded when the line of the resultant thrust of loads supported by column is coincident with the line of C.G 0 of the column the longitudinal direction.
Depending upon the architectural requirements and loads to be supported, R.C columns may be cast in various shapes i.e., square, rectangle, and hexagonal, octagonal, circular. Columns of L shaped or T shaped are also sometimes used in multistoried buildings.

The longitudinal bars in columns help to bear the load in the combination with the concrete. The longitudinal bars are held in position by transverse reinforcement or lateral binders.

The binders prevent displacement of longitudinal bars during concreting operation and also check the tendency of their buckling towards under loads.

• Column design

A column may be defined as an element used primarily to support axial compressive loads and with a height of at least three times its lateral dimension. The strength of column depends upon the strength of materials, shape, and size of the cross-section, length and degree of proportional and dedication restrain at its ends.

A column may be classified based on different criteria such as

1.) shape of the section
2.) slenderness ratio(A=L+D)
3.) type of loading, land
4.) pattern of lateral reinforcement.

8.4 FOUNDATION

Foundations are structural elements that transfer loads from the building or individual column to the earth. If these loads are to be properly transmitted, foundations must be designed to prevent excessive settlement or rotation, to minimize differential settlement and to provide adequate safety against sliding and overturning.

9. CONCLUSION

• Designing using Software’s like Staad reduces a lot of time in design work.
• Details of each and every member can be obtained using staad pro.
• All the List of failed beams can be Obtained and also Better Section is given by the software.
• Accuracy is Improved by using the software.
• Structure analysis involves the determination of the forces and displacements of the structures or components of a structure.
• The design process involves the selection and detailing of the components that make up the structural system.
• The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes.
• AutoCAD is useful to show the reinforcement details and design details of a stair case. AutoCAD is a very easy software to learn and much user-friendly for anyone to handle and can be learned quickly. Learning of certain commands is required to draw in AutoCAD.
• STAAD program can be used to analyze another structure also by just making some modifications, but this requires some programming skills. So load cases created for a structure can be used for another structure using staad editor.

10. REFERENCES

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