Design of Commercial Building

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Abstract:

Commercial buildings are supposed to be of engineered construction in the sense that they might have been analyzed and designed to meet the provisions of the relevant codes of practice and building bye-laws; the construction might have been supervised by trained persons. In such cases, even if earth quake forces have not been considered precisely, the structures would have adequate in-built strength and ductility to withstand some level of earthquake intensity. In this project a Commercial building of three storey that is G+3 building is designed for the maximum lateral forces with the help of equivalent static analysis which is mentioned in IS: 1893-2002, part 1.

The major steps involved in construction of a structure apart from analysis and design are site selection, survey of the site, orientation of the building. Selection of site plays a major role in any construction. The factors effecting site selection are topography, nature of soil, position of ground water table, facilities, neighbourhood, vegetation, shape of the site. Surveying includes preliminary survey and quadratic survey. Levelling of the site is also done in surveying. Orientation of a building is the proper placement of the building and its component rooms with respect to the weathering elements. Three parameters which govern the orientation of the building are temperature, wind and humidity.

Location of beams and columns, grid line marking also play a major role in the construction of building with which the stiffness of structure depends. Therefore all the above parameters are taken into consideration in this project.

The structural components in a typical multi-storied building consist of a floor system which transfers the floor loads to a set of plane frames in one or both directions. The floor system also acts as a diaphragm to transfer lateral loads from wind and earthquakes. The frames consist of beams and columns and in some cases braces and shear walls. As the height of the building increases beyond ten stories, it becomes necessary to reduce the weight of the structure for both functionality and economy.

Moment Resisting Frames rely on the ability of the frame itself to act as a partially or fully rigid jointed frame while resisting the lateral loads. Due to their flexibility, moment resisting frames can be used for medium rise buildings having up to ten stories. Ordinary moment resisting frames doesn't meet special detailing requirements for ductile detailing.

CODE BOOKS

Code books play a major role in the analysis and design of any structure. A building has to perform many functions satisfactorily. Amongst these functions are the utility of the building for the intended use and occupancy, structural safety, fire safety and compliance with hygienic, sanitation, ventilation and daylight standards. The design of the building is dependent upon the minimum requirements prescribed for each of the above functions. The minimum requirements pertaining to the structural safety of the buildings are being covered in different codes. Code books are referred to reduce the hazards to life and property caused by unsafe structures, but also eliminates the wastage caused by assuming unnecessarily heavy loadings without proper assessment.

The code books referred for this project are:

- IS 456:2000 (reinforced concrete for general building construction)
- IS 875, part 1, 1987(dead loads for building and structures)

● IS 875, part 2, 1987(imposed loads for buildings and structures)
● IS 875, part 3, 1987(wind loads for buildings and structures)
● IS 875, part 4, 1987(design loads for buildings and structures)
● IS 875, part 5(special loads and combinations for buildings and structures)
● SP 16 (design aids for IS 456)
● SP24 (explanatory handbook for IS 456)
● SP34 (handbook on reinforcement and detailing)
● IS 1893, part 1(A seismic Design Of Multi-storied Reinforced Concrete buildings)
● Proposed Draft Provisions and Commentary on Indian seismic Code IS 1893, part 1, 2002
● Review of Geotechnical Provisions in Indian Seismic Code IS 1893, part 1: 2002
● Explanatory Examples on Indian Seismic Code IS 1893, part 1

ELEVATION:

Elevation is a graphical representation, to some scale, of the features on, near or below the surface of the earth is projected on a vertical plane which is represented by plane of the paper on which elevation is drawn. Simply, elevation is the front view of the structure.

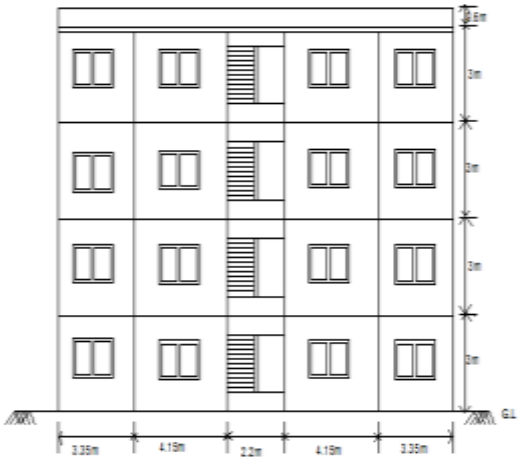
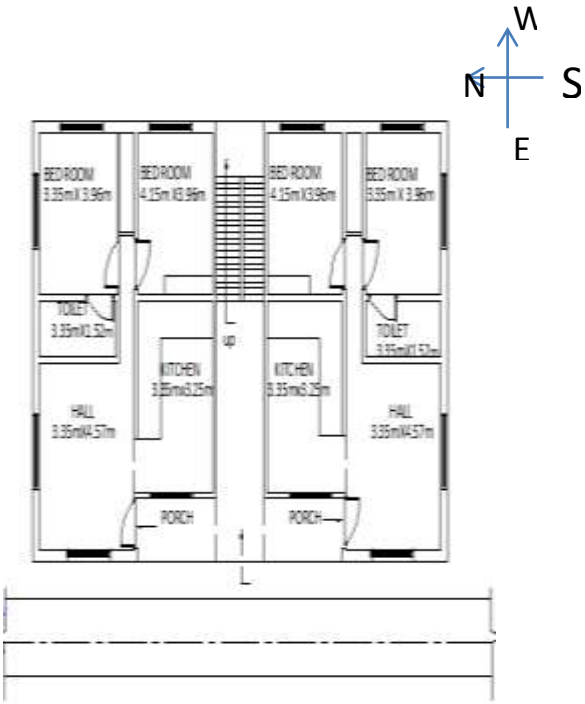


Figure 1.1 Elevation of the structure

PLAN AND ELEVATION OF THE STRUCTURE:

A plan is a graphical representation, to some scale, of the features on, near or below the surface of the earth is projected on a horizontal plane which is represented by plane of the paper on which plan is drawn. Simply, a plan is the top view of



GRAVITY LOAD ANALYSIS:

A shear force diagram can be constructed from the loading diagram of the beam. In order to draw this, first the reactions must be determined always. Then the vertical components of forces and reactions are successively summed from the left end of the beam to preserve the mathematical sign conventions adopted. The shear at a section is simply equal to the sum of all the vertical forces to the left of the section.

When the successive summation process is used, the shear force diagram

should end up with the previously calculated shear (reaction at right end of the beam. No shear force acts through the beam just beyond the last vertical force or reaction. If the shear force diagram closes in this fashion, then it gives an important check on mathematical calculations.

The bending moment diagram is obtained by proceeding continuously along the length of beam from the left hand end and summing up the areas of shear force diagrams giving due regard to sign. The process of obtaining the moment diagram from the shear force diagram by summation is exactly the same as that for drawing shear force diagram from load diagram.

It may also be observed that a constant shear force produces a uniform change in the bending moment, resulting in straight line in the moment diagram. If no shear force exists along a certain portion of a beam, then it indicates that there is no change in moment takes place. It may also further observe that d_m/d_x= F therefore, from the fundamental theorem of calculus the maximum or minimum moment occurs where the shear is zero. In order to check the validity of the bending moment diagram, the terminal conditions for the moment must be satisfied. If the end is free or pinned, the computed sum must be equal to zero. If the end is built in, the moment computed by the summation must be equal to the one calculated initially for the reaction. These conditions must always be satisfied.

Now as explained above, shear force and bending moment values can be calculated using various approximate methods namely substitute frame method, stiffness matrix method, moment distribution method, Kani's method. All these methods are approximate methods.

The bending moment and shear force values are also calculated using a package SAP. The bending moment diagrams and shear force diagram for gravity loads has been shown in figures 1.8(a) and 1.8(b).

Clearly from the shear force diagram, the force applied perpendicular to the axis of a beam is transmitted along the length of that beam whereas the bending moment diagram shows how the applied loads on the beam create moment variation along the beam. The uniformly distributed loads on the beams correspond to an inclined line in shear force diagram and a quadratic curve in bending moment diagram.

CONCLUSIONS

The complete details of the residential building have been explained in this chapter. Location of beams and columns, grid line marking are clearly explained. Only gravity loads are taken into consideration and analysis is done manually and using a package SAP2000. Manual analysis

The complete details of the residential building have been explained in chapter 1. Location of beams and columns, grid line marking are clearly explained. Only gravity loads are taken into consideration and analysis is done manually and using a package SAP2000. Manual analysis comprises of load distribution of slabs on to beams and calculation of bending moment and shear force values by any approximate method. The steps for analysis by SAP are also explained in this chapter. The lateral load analysis is carried out in further chapters and compared with that of gravity load analysis.

beams and calculation of bending moment and shear force values by any approximate method. The lateral load analysis is carried out and compared with that of gravity load analysis.

In addition to gravity loads, lateral loads are calculated in this chapter as per the procedure in IS: 1893-2002; Equivalent

Static Analysis (ESA). Many factors, such as seismic weight of the structure, zone factor, importance factor, response reduction factor, have a great influence on the structure. Hence all these factors are taken into consideration for the calculation of lateral loads. With the above mentioned factors, the design base shear is calculated. Later this base shear is distributed to each floor and then to each frame of the structure.

Lateral loads, torsion forces also act on the structure if the structure is not symmetric. The structure clearly is not symmetric, that is the centre of mass and centre of stiffness doesn't coincide. Hence there is eccentricity in Y-direction. Therefore torque is developed in the structure. Due to this torque torsion forces are developed. As the eccentricity produced is minimum, the torsion forces are also minimum. When analysis is done for any building including torsion, the bending moment values were almost similar to that of bending moment values obtained only for lateral loads. Hence these torsion forces are negligible and the design of frame section is done only for lateral loads.

Analysis for lateral loads is done using portal frame method and SAP in this chapter. The bending moment values and shear force values obtained by portal frame method are similar to that obtained by SAP. Comparison of bending moment values has been tabulated in this chapter. As mentioned in chapter 3, the bending moment values for lateral loads were almost similar to that of lateral loads with torsion. Using different load combinations, the bending moments are found and for the worst case, the structure is designed.

The design method adopted is limit state method. The bending moments obtained from chapter 4 are used in calculating the area of steel in each frame section. The percentage of steel obtained by limit state method is minimum as mentioned in limit state method of IS 456:2000. The design has been done using the package SAP and the percentage of steel is minimum and is equal to that obtained by limit state design.

The last chapter deals with dynamic analysis. Time History Analysis is a type of dynamic analysis where ground motion is required without applying any lateral loads. Time History Analysis has been done only in SAP2000 to check the analysis values with that obtained from static analysis and to check the response history that is acceleration, velocity, and displacement etc of every node in the structure. Response history for different ground motions (Uttarkasi, Chamoli, Bhuj) is done in this chapter.

BIBILIOGRAPHY:

i) Illustrated Design of Reinforced Concrete Buildings by Dr. S. R. Karve and Dr. V. L. Shah

ii) Strength of Materials by S. Ramamrutham.

iii) Design of Reinforced Concrete Structures by A. K. Jain

iv) Structural Analysis by V. N. Vazirani, M. M. Ratwani and S. K. Duggal

v) The code books referred for this project are:

- IS 456:2000 (reinforced concrete for general building construction)
- IS 875, part 1, 1987(dead loads for building and structures)
- IS 875, part 2, 1987(imposed loads for buildings and structures)
- IS 875, part 3, 1987(wind loads for buildings and structures)
- IS 875, part 4, 1987(design loads for buildings and structures)
- IS 875, part 5(special loads and combinations for buildings and structures)

- SP 16 (design aids for IS 456)
- SP24 (explanatory handbook for IS 456)
- SP34 (handbook on reinforcement and detailing)
- IS 1893,part 1(Aseismic Design Of Multi-storied Reinforced Concrete buildings)
- Proposed Draft Provisions And Commentary On Indian seismic Code IS 1893, part 1, 2002
- Review Of Geotechnical Provisions In Indian Seismic Code IS 1893, part 1 : 2002
- Explanatory Examples On Indian Seismic Code IS 1893, part 1

vi) SAP2000, version 14.0, Static and Dynamic finite Element Analysis Programme;
A product of computers and structures, Inc, 1995 university of Ave, Berkeley, CA, 94704