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MANUAL CALCULATION ANALYSIS AND DESIGN OF MULTISTOREY (G+6) RESIDENTIAL BUILDING

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Abstract

Structural design is the primary aspect of civil engineering. The very basis of construction of any building, residential house or dams, bridges, culverts, canals etc. is designing. The foremost basic in structural engineering is the design of simple basic components and members of a building viz., Slabs, Beams, Columns and Footings. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms (Drawing room, bed room, kitchen toilet etc.) such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants. Thereby depending on the suitability; plan layout of beams and the position of columns are fixed. Thereafter, the loads are calculated namely the dead loads, which depend on the unit weight of the materials used (concrete, brick), live loads, which according to the code IS:875-1987 is around 2kN/m2, and the earthquake load according to IS 1893(PART 1):2002. Once the loads are obtained, the component takes the load first i.e the slabs can be designed. Designing of slabs depends upon whether it is a one-way or a two-way in slab, the end conditions and the loading. From the slabs, the loads are transferred to the beam. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this, the beam may be designed. Thereafter, the loads (mainly shear) from the beams are taken by the columns. For designing columns, it is necessary to know the moments they are subjected to. For this purpose, frame analysis is done by Moment Distribution Method. After this, the designing of columns is taken up depending on end conditions, moments, eccentricity and if it is a short or slender column. Finally, the footings are designed based on the loading from the column and also the soil bearing capacity value for that particular area. Most importantly, the sections must be checked for all the four components with regard to strength and serviceability

1 .INTRODUCTION

Engineering is a professional art of applying science to the efficient conversion of natural resources for the benefit of man. Engineering therefore requires above all creative imagination to innovative useful application for natural phenomenon. The basics needs of human existences are food, clothing's & shelter. From times immemorial man has been making efforts in improving their standard of living. The point of his efforts has been to provide an economic and efficient shelter. The possession of shelter besides being a basic, used, gives a feeling of security, responsibility and shown the social status of man. Every human being has an inherent liking for a peaceful environment needed for his pleasant living, this object is achieved by having a place of living situated at the safe and convenient location, such a place for comfortable and pleasant living requires considered and kept in view.

2. DESIGN Of MULTISTOREY BUILDIN METHODOLOGY:

2.1 Design: To design a structure with less anomalies and errors, it is very necessary to choose a suitable design method. A structure is embedded with no of elements and components hence any error in design can lead to failure of the entire structure. There are two design methods available as given below: i) Working stress method, ii) Limit state design method

2.1.1 Working Stress Method : i) This method is based on the condition that the stresses caused by service loads without load factors are not to exceed the allowable stresses which are taken as a fraction of the ultimate stresses of the materials, fc' for concrete and 'fy' for steel.

ii) It deals only with elastic behaviour of member perfectly elastic at all stages of loading; Stress-strain relations obey hooks law (linear).

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2.1.2 Limit State Method : The object of design based on the limit state concept is to achieve an acceptability that at 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.

Limit state: The acceptable limit for the safety and serviceability requirements before failure occurs is called a limit state.

Limit state of collapse: This is corresponds to the maximum load carrying capacity. Violation of collapse limit state implies failures in the source that a clearly defined limit state of structural usefulness has been exceeded. However it does not mean complete collapse. This limit state corresponds to : a) Flexural b) Compression c) Shear, d) Torsion.

Limit state of servicability: This state corresponds to development of excessive deformation and is used for checking member in which magnitude of deformations may limit the rise of the structure of its components .a) Deflection b) Cracking c) Vibratio

3. LOADING

3.1 Load Conditions and Structural System Response : The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classification of loads are described in the following sections.

3.2 Building Loads Categorized by Orientation:

Types of loads on an hypothetical building are as follows.

1)Vertical Loads 2)Dead (gravity) 3)Live (gravity) 4)Snow(gravity) 5)Wind(uplift on roof) 6)Seismic and wind (overturning) 7)Seismic(vertical ground motion)

3.2.1 Horizontal (Lateral) Loads:

Direction of loads is horizontal w.r.t to the building.

1)Wind 2)Seismic(horizontal ground motion) 3)Flood(static and dynamic hydraulic forces 4)Soil(active lateral pressure)

3.2.2 Vertical Loads :

Gravity loads act in the same direction as gravity (i.e., downward or vertically) and include dead, live, and snow loads. They are generally static in nature and usually considered a uniformly distributed or concentrated load. Thus, determining a gravity load on a beam or column is a relatively simple exercise that uses the concept of tributary areas to assign loads to structural elements, including the dead load (i.e., weight of the construction) and any applied loads(i.e., live load).

3.2.3 Lateral Loads:

The primary loads that produce lateral forces on buildings are attributable to forces associated with wind, seismic ground motion, floods, and soil. Wind and seismic lateral loads apply to the entire building. Lateral forces from wind are generated by positive wind pressureson the windward face of the building and by negative pressures on the leeward face of the building, creating a combined push and-pull effect. Seismic lateral forces are generated by a structure's dynamic inertial response to cyclic ground movement.

3.4 Design loads for residential buildings :

General: Loads are a primary consideration in any building design because they define the nature and magnitude of hazards are external forces that a building must resist to provide a reasonable performance (i.e., safety and serviceability) throughout the structure's useful life.The guide provides supplemental design assistance to address aspects of residential construction where current practice is either silent or in need of improvement.

3.4.5 Load combinations: All the load cases are tested by taking load factors and analyzing the building in different load combination as per IS456 and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design Load factors as per IS456-2000

Live load	Dead load	Wind load
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9

When the building is designed for both wind and seismic loads maximum of both is taken. Because wind and seismic do not come at same time as per code. Structure is analyzed by taking all the above combination.

4. SLAB

4.1 Slab design: Slab is plate elements forming floor and roofs of buildings carrying distributed loads primarily by flexure.

- **One way slab:** One way slab are those in which the length is more than twice the breadth it can be simply supported beam or continuous beam.
- **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 reduces as compared to those in one way slab.
- **Check:** There is no need to check serviceability conditions, because design satisfying the span for depth ratio a.) Simply supported slab b) Continuous beam

5. BEAMS : Beam design (Grouping)

Beams transfer load from slabs to columns .beams are designed for bending. In general we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned. Design beam command is assigned and analysis is carried out, now reinforcement details are taken.

5.1 Beam design: a reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam.

There are three types of reinforeced concrete beams

1.) single reinforced beams, 2.) double reinforced concrete, 3.) flanged beams

5.1.1 Singly reinforced beams: In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are more effective in resisting in the tensile bending stress.

5.1.2 Doubly reinforced concrete beams*:* It is reinforced under compression tension regions. The necessity of steel of compression region arises due to two reasons. When depth of beam is restricted. The strength availability singly reinforced beam is in adequate.

6. COLUMN & FOOTING

6.1 Positioning of columns: Some of the guiding principles which help the positioning of the columns are as follows:-

A) Columns should be preferably located at or near the corners of the building and at the intersection of the wall, but for the columns on the property line as the following requirements some area beyond the column, the column can be shifted inside along a cross wall to provide the required area for the footing with in the property line. alternatively a combined or a strap footing may be provided.

B) The spacing between the column is governed by the lamination on spans of supported beams, as the spanning of the column decides the span of the beam. As the span of the of the beam increases, the depth of the beam, and hence the self weight of the beam and the total.

Effective length:

The effective length of the column is defined as the length between the points of contraflexure of the buckled column. The code has given certain values of the effective length for normal usage assuming idealized and conditions shown in appendix D of IS - 456(table 24)

A column may be classified based as follows based on the type of loading:

1) Axially loaded column, 2) A column subjected to axial load and uniaxial bending, 3) A column subjected to axial load and biaxial bending.

6.2 FOOTING:-

GENERAL:

1.) Footing shall be designed to sustain the applied loads, moments and forces and the induced reactions and to assure that any settlements which may occur will be as nearly uniform as possible and the safe bearing capacity of soil is not exceeded.

2.) Thickness at the edge of the footing: in reinforced and plain concrete footing at the edge shall be not less than 150 mm for footing on the soil nor less than 300mm above the tops of the pile for footing on piles.

BEARING CAPACITY OF SOIL:

The size foundation depends on permissible bearing capacity of soil. The total load per unit area under the footing must be less than the permissible bearing capacity of soil to the excessive settlements.

6.2.1 Foundation design:

Foundations are structure elements that transfer loads from building or individual column to earth this loads are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlements and to provide adequate safety isolated footings for multi storey buildings. These may be square rectangle are circular in plan that the choice of type of foundation to be used in a given situation depends on a number of factors.

1) Bearing capacity of soil, 2) Type of structure, 3.) Type of loads, 4) Permissible differential settlements, 5) economy

A footing is the bottom most part of the structure and last member to transfer the load. These are the types of foundations

Shallow (D<B)

1. Isolated (Spread) Footing, 2.Combined (Strip) Footing, 3.Mat (Raft) Foundation.

Deep (D>B)

1.Pile Cap 2. Driller Pier.

7. STAIRCASE

7.1Design of stair case :

The purpose of a stair case to provide access to pedestrian in a building. The geometrical forms of staircase may be quite different depending on the individual circumstances involved.

EARTHQUAKE FORCES

Earthquakes generate waves which move from the origin of its location with velocity depending on the intensity and magnitude of the earthquake. The impact of earthquake on the structures depends on the stiffness of the structure, stiffness of the soil media, height and location of the structure, etc. the earthquake forces are prescribed in IS 1893:2002 (part-I). Since the building is located in Solapur, it is included in the zone III. And the seismic base shear calculation and its distribution was done as per IS 1893:2002 (part-I). The base shear or total design lateral force along any principle direction shall be determined by the following expression:

VB = Ah X W

Where,

VB = Design base shear, Ah = Design horizontal seismic coefficient based on
fundamental natural period, and type of soil, W = Seismic weight of the building

The design horizontal seismic coefficient, Ah= ZIS a÷2Rg

Where, Z = Zone factor given in table 2, for the maximum considered earthquake (MCE) and service life of the structure in a zone. The factor 2 in the denominator is used so as to reduce the MCE zone factor to the factor for design basic earthquake (DBE). ISSN 2348 – 7968

I = Importance factor, depending upon the functional use of structures, characterized by hazardous consequences of failure, post-earthquake functional needs, historical value or economic importance (Table 6 of IS 1893 (Part 1): 2002).

R = Response reduction factor, However, the ratio (I/R) shall not be greater than 1.0. The values for buildings are given in Table7 of IS 1893 (Part 1): 2002.

Sa/g = Average response acceleration coefficient.

$Ta=(0.09Xh)\div\sqrt{d}$

Distribution of design Force

The design base shear was distributed along the height of the building as per the following expression**,**

$Qi=VB((wihi^2)\div(wjhj^2))$

Where,

Wi = Seismic weight at floor i, hi = Height of floor i, n = Number of stories in the building (i.e. the number of levels at which the masses are located).

References

[1] Shashank B.S (2013)- "Analysis And Design Of Multi-Storeyed Load Bearing Reinforced Masonry Structure And Framed Rc Structure", "International Journal of Advanced Technology in Civil Engineering" ,volume no:3 , no of pages :92 to 97

[2] S.A. Raj & O. F. Ajala (2016)- "Computer Aided Design of A Twin Reinforced Concrete Multi-Storey Tower"," Journal of Multidisciplinary Engineering Science and Technology" volume no:3, page no:4584 to 4588

[3] IS: 875 (Part 1)-1987 "Indian Standard Code of Practice for Design Loads (Other than earthquake) for Buildings and Structures", Bureau of Indian Standards, New Delhi,