International Journal of Research in Advent Technology, Vol.3, No.3, March 2015
E-ISSN: 2321-9637

Planning, Analysis and Design of an Apartment Building

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Abstract-The design process of structural planning and design requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by ample experience, intuition and judgment. In the present study G+7 residential building at Ernakulam, Kerala, India is designed (Slabs, Beams, Columns and Footings) using STAAD Pro software. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms 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. Footings are designed based on the safe bearing capacity of soil. For designing of columns and beams, it is necessary to know the moments they are subjected to. For this purpose, frame analysis is done by limit state method. Designing of slabs depends upon whether it is a one - way or a two- way slab, the end conditions and the loading. From the slabs, the loads are transferred to the beam. Thereafter, the loads (mainly shear) from the beams are taken by the columns. Finally, the sections must be checked for all the four components with regard to strength and serviceability.

Index Terms- planning; analysis; design ; Staad Pro

1. INTRODUCTION

Buildings come in a wide amount of shapes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. A Multi-Storied building is a building that has multiple floors above ground in the building. Multi-storey buildings aim to increase the floor area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases, money (depending on material used and land prices in the area). The design process of multi-stored building requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by ample experience, intuition and judgment. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety . In the present study G+7 apartment building at Ernakulam, Kerala, India is designed (Slabs, Beams, Columns and Footings) using STAAD Pro software

2. GEOMETRY OF BUILDING

The building is regular in plan and in elevation having storey height of H = 3.0m where all storey's are of the same height. The building consist of seven floors each with 5 flats. Total floor area is 5306.6m^2 with floor area ratio 1.6. Grid floor is provided on utility area to avoid the obstructions. The building is planned in such a way that sufficient ventilation will be available, since it is very much essential for the comfort of inhabitants. The building consist of rectangular columns, beams of width 0.23m with a maximum depth of 0.6m and slab thickness of 120mm. the size of column is constant throughout all storey. A fire escape of width 1.2m is provided considering safety.

3. ANALYSIS

STAAD Pro software is used for analysis. STAAD Pro 2008 for windows is most popular and widely used structural engineering software. STAAD Pro is an advanced window version, which offers general purpose structural analysis and design along with extensive model generation and post processing facilities.

Analysis was done by considering dead load, live load, wind and seismic loads and 25 load combinations were used. For calculating dead loads the unit weights were taken from IS: 875 Part I and the live loads from IS: 875 Part 2. Wind load was calculated using IS: 875 Part 3. The basic wind speed of the locality is 39m/s. Design wind speed depends on Risk coefficient, Terrain, height and structure factor, Topography factor and Design wind pressure. The building is located at earthquake zone III and therefore seismic analysis was also done using IS: 1893

4. DESIGN

In case of structural engineer/ consultants, the task involved are selection of most appropriate structural system and initial proportioning of members, estimation of loads on the structures, structural analysis for the determination of the stress resultants (member forces and displacement induced by various load combination), structural design of actual proportions (member sizes, reinforcement detail) and grades of materials required for safety and serviceability. IS 456:2000 and SP 16 was used for designing.

In the present paper two types of slabs are designed namely roof slab and floor slab. Roof slab is a continuous slab on the top of the building which is also known as terrace. In designing the roof slab dead loads (i.e., due to water proofing=2.5KN/m^2, self-weight of the slab= 1×1×required depth ×25) and live loads (roof=1.5KN/m^2) are considered. The slabs are designed as two way slabs. In designing of floor slab dead loads (i.e., due to floor finish = 1KN/m^2 and self-weight of the slab = 1×1×required depth ×25) and Live loads (i.e., bed room = 2kN/m^2, balcony = 3 KN/m^2) are considered. Loads were taken from IS: 875-Part1 and II codes.

The designing of the beam mainly consist of fixing the breadth and depth of the beam and arriving at the area of steel and the diameters of bars to be used. The breadth of the beam is generally kept equal to the thickness of the wall to avoid offset inside the room. It shall also not exceed the width of the column for effective transfer of the load from beam to column. The depth of the beam is taken by L/10 . Therefore in the present design all beams are in rectangular shape having breadth 230mm and depth varying up to a maximum of 600mm.

A column in general may be defined as a member carrying direct axial load which causes compressive stresses of such magnitude that these stresses largely control its design. The loads and moments in the three columns in a frame are different. Each of the columns is required to be designed separately. However when entire building is to be designed, there will be a number of other columns along with each of the above columns to form a group. All the columns are subjected to axial loads (P_u) and uniaxial bending moment (M_u). The column section shall be designed just above and just below the beam column joint and larger of the two reinforcements shall be adopted. This is similar to what is done for design of continuous beam reinforcement at the support. The design moment is followed IS 456:2000 code

For heavy structures, the ideal foundation will be bored cast in situ D.M.C. piles terminating in the medium to very dense sand strata at a depth of about 34m. Safe vertical load carrying capacity of D.M.C. piles end bearing with adequate anchorage in the dense sand strata terminating at a depth of about 35m may be assessed as for pile diameters 50cm, 60cm and 70cm are 70t, 90t and 115t respectively.

4.1 *Design of Grid Floor*

A grid floor is provided in the utility area so as to avoid the obstructions in the area. Grid floor consists of closely spaced intersecting beams in two directions with monolithic slab on the top. Size of grid floor is 11.4 X 12meters

5. CONCLUSION

The project was aimed at the design of an apartment building at Ernakulam, Kerala, India
Various load combinations as per IS code were used, considering wind load and seismic load as major load apart from other loads. Analysis and design were done using STAAD Pro.V8i. This paper concludes that the structure is capable of taking external loads and moments as far as design is concerned.

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