Analysis and Design of shopping mall against lateral forces

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ABSTRACT: The paper presents the plan, model, analyze and design of a vertical irregular shopping mall structure of G+10 storey and investigate its performance under various lateral loading conditions. The main goal is to assess current Indian Standard design practice and to provide design guidelines using ETABS and to find a detailing strategy which will ensure a sufficient level of safety for various levels of loading demands.

KEYWORDS: RCC structure, multi-storey building, AutoCAD, seismic co-efficient method, ETABS

I. INTRODUCTION

In metropolitan cities, very limited areas are available and sold at high cost. This paper will help to built buildings within this limited area satisfying each of every need of the people. It is also designed in such a way that it would be economical. The civil engineers have to think of construction of high rise structures, instead of the traditional type of reinforced concrete skeletal structure enclosed by thick walls of bricks or any other construction materials. A civil engineer must be familiar with planning, analysis and design of such structures against various loading such as lateral forces, etc. Hence it was proposed to choose a problem, involving analysis and design of multistoried framed structure as the project work. The proposed site is approximately flat i.e. Tambaram, Chennai. Good soil having sufficient bearing capacity is available at shallow depth. The proposed site accommodates proper important facilities such as 24 hours transport facilities, proper drinking water facilities, communication facilities, electrical facilities, nearest railway station available at Tambaram, underground drainage facilities, etc.

II. PLANNING

The proposed ten storied commercial building consist of area of floor is 1220 m² with 3000m² plot size. A building should be planned to make it comfortable, economical and to meet all the requirements of the people. The efforts of the planner should be to obtain maximum comfort with limited available resources. The shopping mall to be analyzed and designed as per BIS specifications is plan and drawn using computer-aided drafting software program, AutoCAD, to create precise drawings used in construction and manufacturing.

1) In ground and first floor entrance foyer, coffee shop, various shops, escalator, lift, toilet blocks are provided. With entrance foyer of 25 m², coffee shop 120 m², and 20 shops of 500 m². (fig.1)
2) In second and third floor various shops, super market, food court, escalator, lift, toilet blocks are provided with super market and food court of 200 m² and shops of 300 m². (fig.2)
3) In fourth and fifth floor office with conference hall and store, escalator, lift, toilet blocks are provided with office area about 300 m², conference hall area about 80 m². (fig.3)
4) In sixth to tenth floor net point, Table tennis court, Snooker corner, various Shops, Escalator, Lift, Toilet blocks are provided. With Table tennis court and Snooker corner of 150sq.m, net point of 220 m², and shops of 150 m². (fig.4)
The minimum width of staircase should be 0.9m clear of railing and many ranges up to 1.5m. There should be a clear headway of 2.1m above each step and landing. The soil at the site is hard soil having a safe bearing of 200KN/m² in Tambaram. Two pipe systems have to be provided to remove and treat the sullage and human excreta, one septic tank were provided in the commercial building for economical and efficient treatment of waste. The quality of water is calculated as per IS 1172-1963. The tank is provided at the terrace of the
building with a capacity of 50000 liters. The water form corporation main line is stored in the ground level sump and pumped to the over head tanks. The electrical installation shall generally be carried out in conformity with the requirements of Indian electricity act 1910 and Indian electricity rule 1956. In all buildings, sufficient automatic fire detecting and alarm facilities shall be provided, where necessary to warn out occupant existence of fire so that they may escape.

III. MODELING AND ANALYSIS USING ETABS

The salient features of the G+10 storied building consist of basement floor of 1.20m above the existing ground level and remaining floors with 3.60m ceiling height which is modeled using ETABS.

3.1 Input analysis using ETABS
a) Material:
   Grade of reinforcement: Fe415, Grade of concrete: M25, Density of concrete: 2500Kg/m^3
b) Loading:
   Dead load: Partition wall and other external walls, floor finish etc. as per the provisions of IS: 875-1987(part I)
   Superimposed load: As per the provisions of IS: 875-1987(part II), uniformly distributed load of 4.0 KN/m^2
   Seismic load: Dead load + part of live load = DL+0.5LL
c) Partial safety factors:
   Load factors: For dead load= 1.50; for live load= 1.50;
   Material safety factor: For reinforcement steel= 0.15; for concrete = 1.50.
d) Seismic coefficient:
   Seismic zone factor= 0.16; soil type= II; Importance factor= 1; Response reduction(R) =5

Fig. 5 Isometric view

Fig. 6 3D Rendered view
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Fig. 1 DL static load

Fig. 7 Loading diagram

Fig. 8 Shear forces diagram

Fig. 9 Bending moment diagram
Designing

The entire limit state that are relevant are considered in the design to ensure an adequate degree of safety and serviceability, the structure in general shall be designed on the basis of the most critical state and shall also be checked for other limit states.

4.1 The Indian Standard (IS) code used for the design:
Minimum design loads for Buildings other than seismic loads
a) IS 875 (Part 1): 1987 Dead loads
b) IS 875 (Part 2): 1987 Imposed loads
c) IS 875 (Part 3): 1987 Wind loads
d) IS 875 (Part 5): 1987 Special loads and load combinations

Seismic Provisions for buildings
a) IS 1893: 2002 Criteria for earthquake resistance design of structure
b) IS 13920: 1993 Ductile Detailing of Reinforced concrete Structures subjected for Seismic forces- Code of Practice

Building code requirements for Structural Concrete:

a) IS 456: 2000 Plain and Reinforced Concrete - Code of practice
b) SP 16: Structural use of concrete. Design charts for singly reinforced beams, doubly reinforced beams and columns.
c) SP 34: Handbook on Concrete Reinforcement & Detailing.

### 4.2 ETABS design output of beam and column:

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| Gamma(Concrete): | 1.500 |
| Gamma(Steel): | 1.150 |

**Fig. 3 Flexural detailing of a beam section**

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**Fig. 4 Shear detailing of a beam section**
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#### Manual Design Result of the Parts of the Structures with Reference to the Indian Standard Codes

The following AutoCAD drawings show the manual design result of a particular two way slab, beam, column, foundation and staircase of the shopping mall.
Reinforcement details of Two way slab

Fig. 7 Design of two way slab

CROSS SECTION AT MID SPAN
CROSS SECTION AT SUPPORT

Reinforcement details of beam

Fig. 8 Design of beam

Reinforcement details for columns

Fig. 9 Design of column
V. CONCLUSION

The plan using AutoCAD, modeling of the structure, analysis by seismic coefficient method and design of some selective parts of the shopping mall using ETABS and manual design calculation satisfying the necessary requirements as per BIS specification as well as various Indian standard code specifications have been presented above.

REFERENCES