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Seismic Analysis of Buildings with Different Architectures

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Abstract:- Recent earthquakes in India show that not only non-engineered but also engineered buildings in our country are susceptible even to moderate earthquakes. Indian Standard IS 1893 is revised in 2002. A number of buildings those were designed as per the previous code may not comply with the present code. Therefore evaluating seismic performance of a building is an important area of study in this context. In the present study an attempt has been made to evaluate a structure located in Nagpur (seismic zone II) using equivalent static analysis. Indian Standard IS-1893:2002 (Part-1) is followed for the equivalent static analysis procedure. Building is modeled in commercial software STAAD Pro. Seismic force demand for each individual member is calculated for the design base shear as required by IS-1893:2002 Corresponding member capacity is calculated as per Indian Standard IS456:2000.The comparative study is made between a structure having long column and short column respectively by the seismic analysis using the structural software STAAD Pro.

Keywords: - architecture, axial load, high rise structures, long and short column, seismic analysis

I INTRODUCTION

A large portion of India is susceptible to damaging levels of seismic hazards. Hence, it is necessary to take in to account the seismic load for the design of high-rise structure. In tall building the lateral loads due to earthquake are a matter of concern. These lateral forces can produce critical stresses in the structure, induce undesirable stresses in the structure [1], induce undesirable vibrations or cause excessive lateral sway of the structure.

The effect of earthquake is different on various kinds of buildings with varying architecture like building on a sloping ground [2] or with a number of short and long columns. The majority of reinforced concrete columns are subjected to primary stresses caused by flexure, axial force, and shear. Secondary stresses associated with deformations are usually very small in most columns used in practice. These columns are referred to as 'short columns'. Long columns, columns with small cross-sectional dimensions, and columns with little end restraints may develop secondary stresses associated with column deformations, especially if they are not braced laterally [3]. These columns are referred to as slender columns. Failure of a slender column is initiated either by the material failure of a section, or instability of the column as a member, depending on the level of slenderness. The latter is known as column buckling.

A seismic design of high rise buildings has assumed considerable importance in recent times. In traditional methods adopted based on fundamental mode of the structure and distribution of earthquake forces as static forces at various stories may be adequate for structures of small height subjected to earthquake of very low intensity but as the number of stories increases or architecture changes, the seismic design demands more rigorous.

II ABOUT STAAD PRO

Our project involves analysis and design of multi storeyed [G +4] using a very popular designing software STAAD Pro. We have chosen STAAD Pro because of its following advantages:

Easy to use interface
Conformation with the Indian Standard Codes
Versatile nature of solving any type of problem
Accuracy of the solution

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The STAAD Pro Graphical User Interface: It is used to generate the model, which can then be analyzed using the STAAD engine. After analysis and design is completed, the GUI can also be used to view the results graphically.

To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure.

The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for Dead loads, Imposed loads, and Earthquake loads, the structure would be required to bear. Strict conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.

III ABOUT STRUCTURE

We have considered G+4 RCC framed structure for the seismic analysis purpose on STAAD Pro. The structure is of the residential building which having four stories and having two bedroom, hall, kitchen apartment on each floor.

At ground floor, slabs are not provided and the floor will directly rest on the ground. The floor beams and the tie beams are thus absent in the ground floor to obtain the critical result during the seismic analysis of the structure. The main beams rest centrally on columns to avoid local eccentricity. For all structural elements, M25 grade concrete will be used. However, higher M20 grade of concrete is used in the footing. Dimensions of all beams in upper floors are kept the same; however, for column the dimensions are different. The floor diaphragms are assumed to be rigid. Centre-line dimensions are followed for analysis and design. In practice, it is advisable to consider finite size joint width. Seismic loads will be considered acting in the horizontal direction (along either of the two principal directions) and not along the vertical direction, since it is not considered to be significant. The further information about the structure is as follows;

IV DETAILS OF STRUCTURE

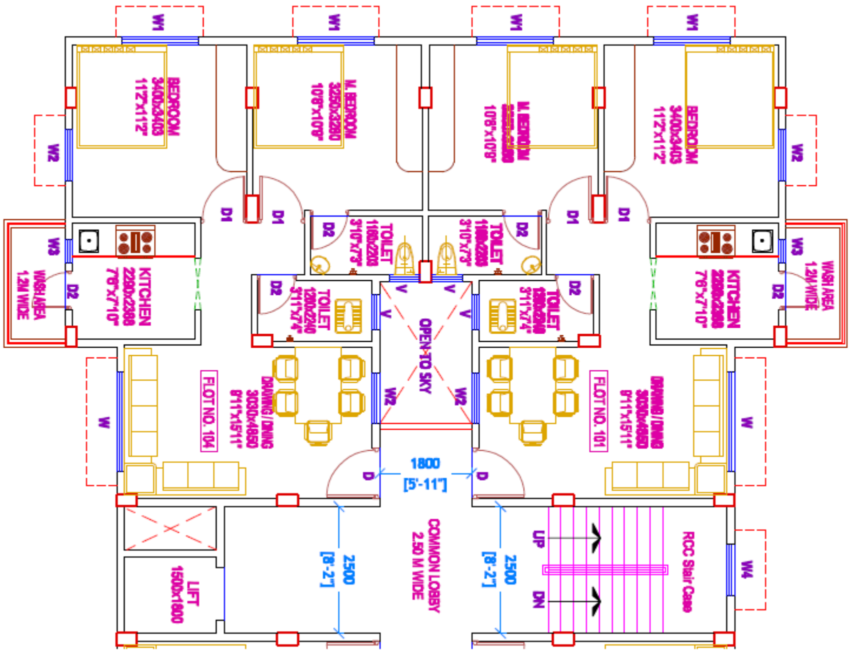

Figure 1

Type of structure	R.C.C. (G+4) residential building with brick infill and parking at basement	
Location	Nagpur city	
Area of one floor of building	160 m^2	
Total number of column	19	
Size of Column	(0.45 x 0.6) m (9 nos.)	
	(0.6 x 0.45) m (8 nos.)	
	(0.7 x 0.45) m (2 nos.)	
Size of Beam	(0.6 x 0.8) m	
Thickness of Shear Wall	0.2 m	
Thickness of slab	0.1 m	
Story height	Typical Floor 3m	
Type of soil	Type II, Medium as per IS:1893	
Type of Support	Fixed	
Depth of foundation below ground	2m	
Live load	2.5 KN/m^2 at typical floor	
Floor finish	1 KN/ m^2	
Brick infill wall	230 mm thick brick masonry walls at periphery and half brick walls internally	
Earthquake load	As per IS-1893 (Part 1) – 2002	
Importance factor	1.0	
Grade of concrete	Slab-M25	Column-M25
	Beam-M25	Footing-M30
Allowable bearing pressure	200 KN/ m^2	
Density of brick	19 KN/ m^2	
Density of RCC	25 KN/ m^2	

Table 1: Details of Structure

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V ARCHITECT OF STRUCTURE

- Two models of same buildings with different architecture are made on STAAD-PRO
- MODEL 1- Building with long column at the basement.
- MODEL 2- Building with short column at the basement

VI COMPARISION OF RESULTS FOR AXIAL FORCE

	Column No.	46	47	48	49	52	53	54	55	56	72	94	95	152
	Load Combination	AXIAL FORCE FY IN KN												
Long Column	5 1.5DL+1.5LL	929	893	1072	987	993	1133	1023	1169	1294	1382	1020	1071	1088
	6 1.5EQX+1.5DL	921	902	1008	915	1021	1097	1013	1097	1149	1233	911	974	1011
Short Column	5 1.5DL+1.5LL	912	878	1061	992	977	1128	1007	1156	1284	1391	1011	1056	1090
	6 1.5EQX+1.5DL	903	884	994	914	1003	1088	997	1085	1141	1239	901	960	1013

Table 2: COMPARISION OF RESULTS FOR AXIAL FORCE

VII OBSERVATIONS

- The critical earthquake load combination in case of long column is found to be 1.5(DL+LL).
- The critical earthquake load combination in case of Short column is found to be 1.5(DL+LL).
- The axial force in long column is found to be more than short column due to critical earthquake load combination.

VIII CONCLUSION

- In this project, it is found that the axial load is more in case of long column than short column.
- In the seismic analysis, earthquake forces normal to the longer base dimension of building is found to be more prominent.

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