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ANALYSIS AND DESIGN OF MULTI-STORY BUILDING USING INDIAN AND BRITISH CODE

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ABSTRACT

The present's study is seismic behavior of various structures using different codal provision as given Indian code and British code for earthquake analysis. This study is carried out on residential building of G+10 story Special RC structure. Modeling of the structure is done as per ETAB software Reinforced concrete frames are the most commonly adopted buildings construction practices in cities. With growing economy, urbanization and unavailability of horizontal space increasing cost of land and need for agricultural land, high-rise sprawling structures have become highly preferable in cities. With high-rise structures, not only the building has to take up gravity loads, but as well as lateral forces. Many important cities fall under high risk seismic zones; hence strengthening of buildings for lateral forces is a prerequisite. Hence the aim of present study is to compare seismic performance of G+10 story structures situated in earthquake zones III. All frames are designed under same gravity loading. Response spectrum method of analysis used for seismic analysis. Etabs software is

used and the results are compared. A comparative analysis is performed in terms of base shear, deflection and story drift at linearly static using response spectrum method.
***Key words**: ETABS, Earthquake loading, high-rise, response spectrum method.*

1 INTRODUCTION –

In all over country's most of the structures are low rise buildings. Now a day due to greater migration towards cities, results in increase in the population in most of the major cities. In order to fulfill the requirement of this increased population in limited land the height of building becomes medium to have high rise buildings Structural planning and design is an art and science of designing with economy and elegance, serviceable and durable structure. The entire process of structural planning and designing requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and byelaws backed up by example experience.

The process of design commence with planning of structural primarily to meet the defined as he is not aware of various implications involved in the process of planning and design. The functional requirements and aspects of aesthetics are locked into normally be the architect while the aspect of the safety, serviceability, durability and economy of the structure are attended by structural designer. ETABS 2016 features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, ETABS 2016 is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more. Etabes 2016 consists of the following: The Etabs 2016 Graphical User Interface: It is used to generate the model, which can then be analyzed using the Etabs 2016 engine. After analysis and design is completed, the GUI can also be used to view the results graphically. The Etabs 2016 analysis and design engine.

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, displacements. This information is then compared to criteria that indicate the conditions of failure.

I. RESEARCH METHODOLOGY

Response spectrum method

This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure. In this method the response of multi degree of freedom system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of single degree of freedom system, which is then combined to compare the total response. Modal analysis of the response history of structure to specified ground motion; however, the method is usually used in conjunction with a response spectrum.

Seismic Base Shear

According to IS 1893 (Part-I): 2002, Clause 7.5.3 the total design lateral force or design seismic base shear (VB) along any principal direction is determined by

$$V_b = A_h * W$$

Where,

Ah is the design horizontal acceleration spectrum

W is the seismic weight of building

Design Horizontal seismic coefficient

For the purpose of determining the design seismic forces, the country (India) is classified into four seismic zones (II, III, IV, and V). Previously, there were five zones, of which Zone I and II are merged into Zone II in fifth revision of code. According to IS 1893: 2002 (Part 1), Clause6.4.2 Design Horizontal Seismic Forces coefficient Ah for a structure shall be determined by following expression

$$A_h = (Z/2)*(I/R)*(Sa/2g)$$

Where,

Z = Zone factor seismic intensity **Seismic Base Shear**

According to IS 1893 (Part-I): 2016, Clause 7.5.3 the total design lateral force or design seismicbase shear (VB) along any principal direction is determined by

$$VB = A_h*W$$

Where

Ah, is the design horizontal acceleration spectrum, *W is* the seismic weight of building

Design Horizontal Acceleration Spectrum Value

For determining the design seismic forces, the country (India) classified into four seismic

zones (II, III, IV, and V). Previously, there were five zones, of which Zone I and II Are merged into Zone II in fifth revision of code. According to IS 1893: 2016 (Part 1), Clause6.4.2 Design Horizontal Seismic Forces coefficient Ah for a structure shall be determined by following expression:

$$Ah = (Z/2) * (I/R) * (Sa/2g)$$

Where,

Z = Zone factor seismic intensity

I. PROBLEM FORMULATION

Multi-storied Reinforced concrete, moment resisting space frame have been analyzed using professional software. Model G+10 of building frame with three bays in horizontal and three bays in lateral direction is analyzed by Response Spectrum Method. The plan dimensions of buildings are shown in table below. The plan view of building, elevation of different frames is shown in figures below.

Sr .No	**Parameters**	**Values**
1	Material Used	Concrete-M25 &M30 Reinforcement Fe-415Mpa
2	Plan Dimension	
3	Height Of Each Story	3.0m
4	Height Of Ground story	1.2m
5	Density Of Concrete	25KN/M^3
6	Poisson Ratio	0.2-Concrete And 0.15-Steel
7	Density Of Masonry	20KN/M^3
9	Code Of Practice Adopted	IS456:2000 , IS1893:2002 & BS 8110-1997 [40}
10	Seismic Zone For IS1893:2016	III
12	Importance Factor	1
13	Response Reduction Factor	5
14	Foundation Soil	Medium
15	Slab Thickness	150mm
17	Floor Finish	1KN/M^2
18	Live Load	2KN/M^2
19	Earthquake Load	As Per IS 1893-2016& BS 8110-1997 40
20	Size Of Beam	380X230 & 450X230mm
21	Column Size	450X230 & 520X230mm
23	Model To Be Design	G+10
24	Ductility Class	IS1893:2016 SMRF

1. **G+10 Story Building 3d Model:**

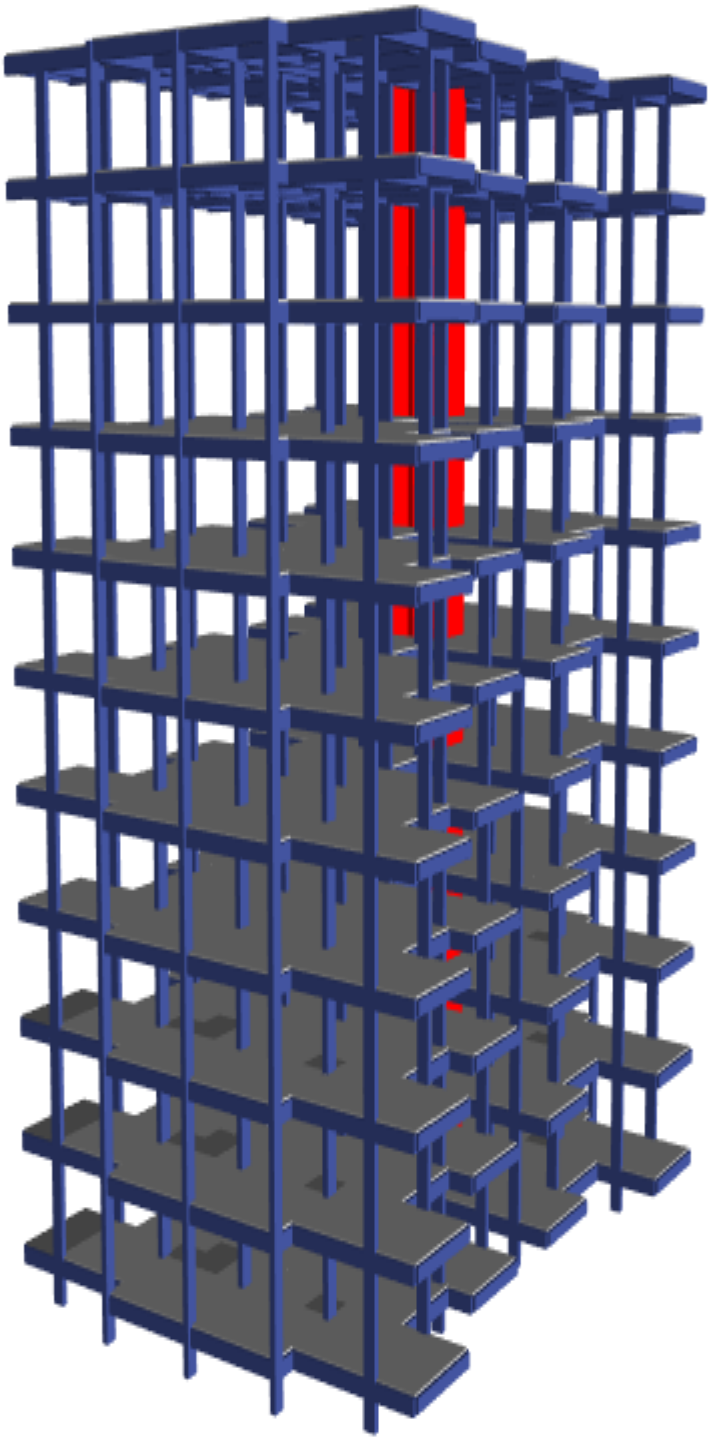

Fig. G+10 Building Software Rendering Model

1. **G+10 Story Floor Plan Model:**

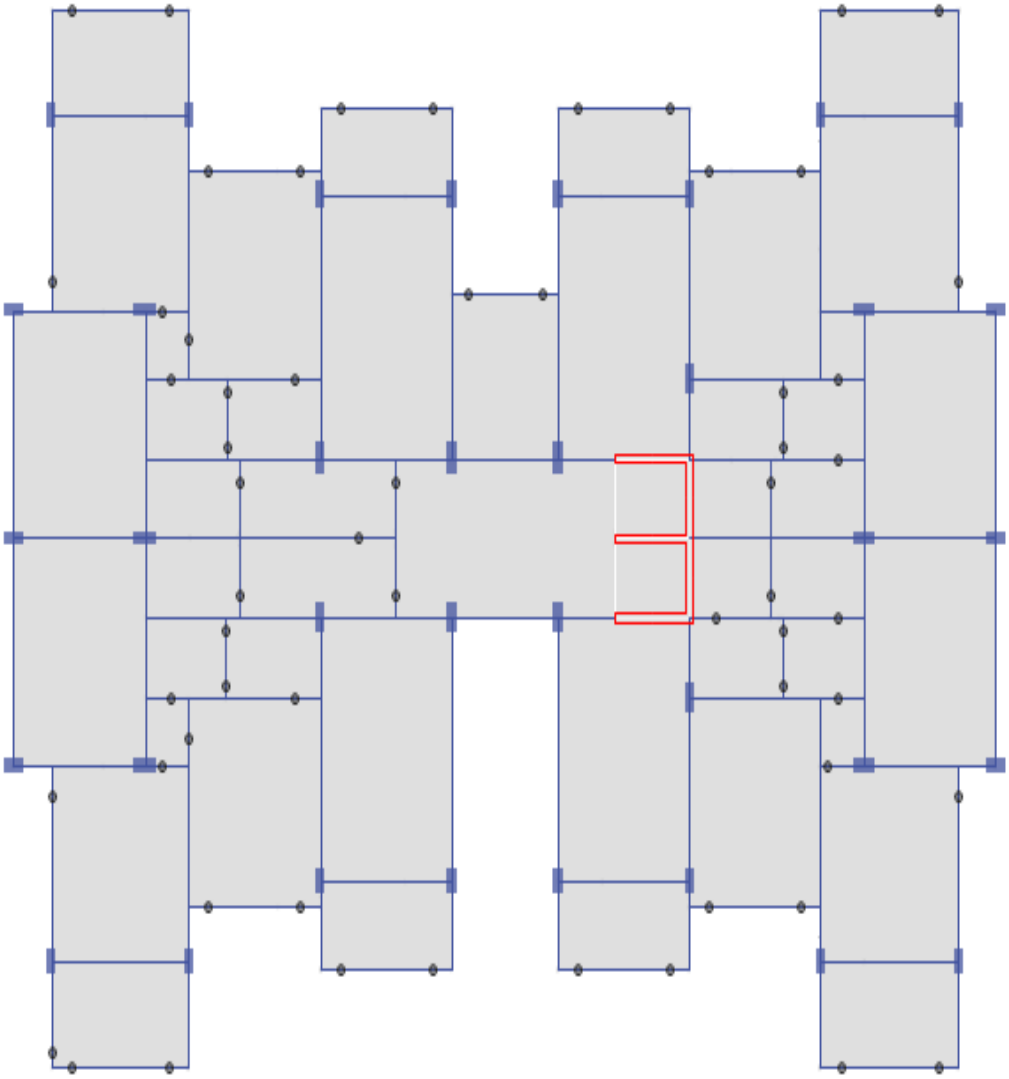

Fig. G+10 Building Software floor plan Model

2. G+10 story building moment release:

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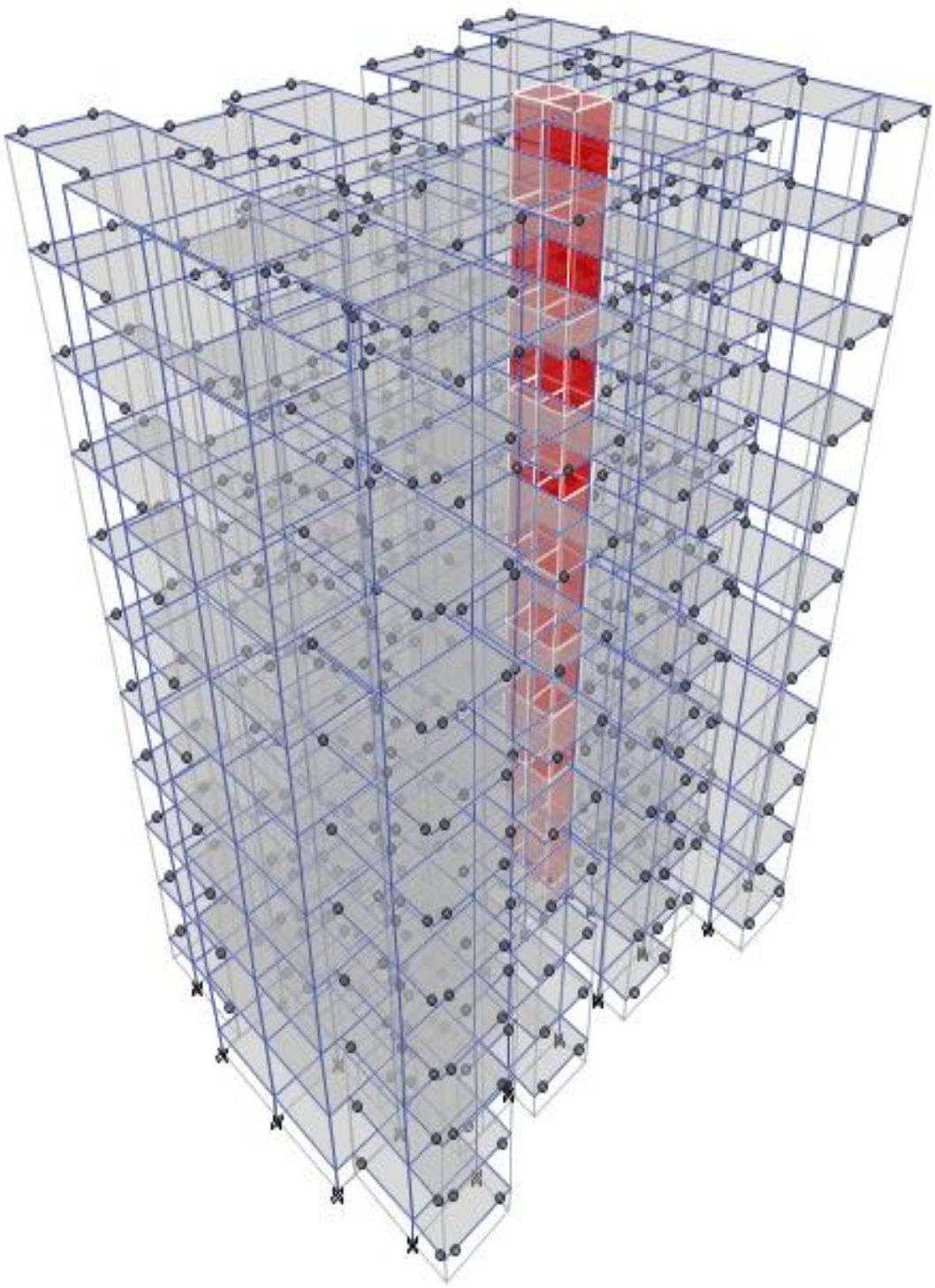


Fig. G+10 Building Software line Model

Table No: II Base Shear G+15 Story Building

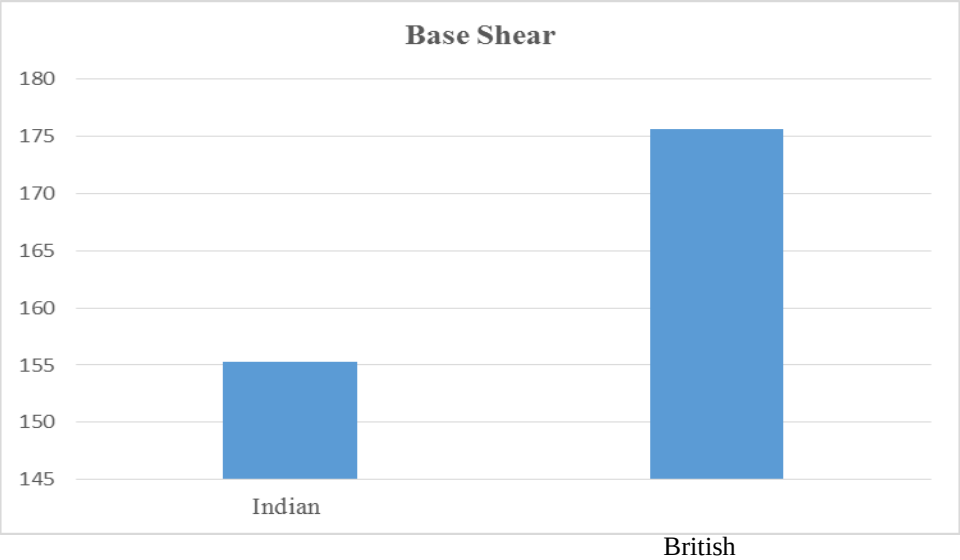
Table 4.1 Base Shear Indian Code

TABLE: Auto Seismic - IS 1893:2002					
Load Pattern	Z	Period Used	Co eff Used	Weight Used	Base Shear
		sec		kN	kN
EQ+X	0.16	0.407	0.04	3882.75	155.31
EQ-X	0.16	0.407	0.04	3882.75	155.31
EQ +Y	0.16	0.327	0.04	3882.75	155.31
EQ-Y	0.16	0.327	0.04	3882.75	155.31

Table 4.2 base shear British code

TABLE: Auto Seismic - UBC 94					
Load Pattern	Z	Period Used	Co eff Used	Weight Used	Base Shear
		sec		kN	kN
EQ+X	0.2	0.411	2.714049	3882.75	175.6329
EQ-X	0.2	0.411	2.714049	3882.75	175.6329
EQ +Y	0.2	0.337	2.75	3882.75	177.9594
EQ-Y	0.2	0.337	2.75	3882.75	177.9594

Graph 4.1 Base shear vs. code (Indian & British)



Base shear vs. code (Indian & British)

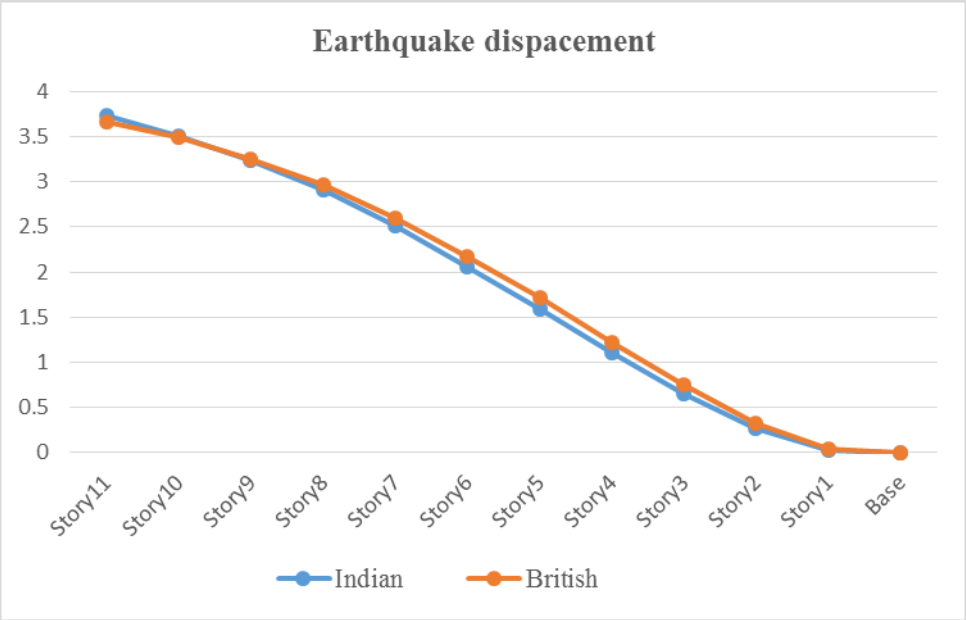
Table 4.3 Earthquake Displacement Indian Code

TABLE: Diaphragm Center of Mass Displacements				
Story	Load Case/Combo	UX	UY	RZ
		mm	mm	rad
Story11	EQ+X	3.731	-0.009	-0.000003
Story10	EQ+X	3.515	-0.007	-0.000003
Story9	EQ+X	3.245	-0.005	-0.000003
Story8	EQ+X	2.907	-0.004	-0.000003
Story7	EQ+X	2.508	-0.003	-0.000002
Story6	EQ+X	2.061	-0.001	-0.000002
Story5	EQ+X	1.586	-0.000384	-0.000002
Story4	EQ+X	1.107	0.0004449	-0.000001
Story3	EQ+X	0.655	0.001	-0.000001
Story2	EQ+X	0.271	0.001	-4.47E-07
Story1	EQ+X	0.03	9.953E-05	-5.03E-08
Base	EQ+X	0	0	0

Table 4.4 Earthquake Displacement British Code

TABLE: Diaphragm Center of Mass Displacements				
Story	Load Case/Combo	UX	UY	RZ
		mm	mm	rad
Story11	EQ+X	3.666	-0.01	-0.000003
Story10	EQ+X	3.487	-0.009	-0.000003
Story9	EQ+X	3.257	-0.007	-0.000003
Story8	EQ+X	2.961	-0.006	-0.000003
Story7	EQ+X	2.597	-0.004	-0.000002
Story6	EQ+X	2.177	-0.003	-0.000002
Story5	EQ+X	1.713	-0.002	-0.000002
Story4	EQ+X	1.226	-0.000403	-0.000001
Story3	EQ+X	0.745	0.0004199	-0.000001
Story2	EQ+X	0.319	0.001	-4.96E-07
Story1	EQ+X	0.037	8.303E-05	-5.61E-08
Base	EQ+X	0	0	0

Graph 4.2 Earthquake Displacement vs. Story



Earthquake Displacement vs. Story

Table 4.5 Wind displacement Indian code

TABLE: Diaphragm Center of Mass Displacements				
Story	Load Case/Combo	UX	UY	RZ
		mm	mm	rad
Story11	WL+X	12.866	-0.067	0.000006
Story10	WL+X	12.087	-0.062	0.000005
Story9	WL+X	11.184	-0.056	0.000005
Story8	WL+X	10.112	-0.05	0.000004
Story7	WL+X	8.859	-0.043	0.000003
Story6	WL+X	7.436	-0.035	0.000003
Story5	WL+X	5.872	-0.027	0.000002
Story4	WL+X	4.221	-0.019	0.000001
Story3	WL+X	2.575	-0.011	0.000001
Story2	WL+X	1.104	-0.004	3.21E-07
Story1	WL+X	0.13	-0.00031	2.01E-08
Base	WL+X	0	0	0

Table 4.6 Wind displacement British code

TABLE: Diaphragm Center of Mass Displacements				
Story	Load Case/Combo	UX	UY	RZ
		mm	mm	rad
Story11	WL+X	10.258	-0.057	0.000005
Story10	WL+X	9.699	-0.053	0.000004
Story9	WL+X	9.037	-0.049	0.000004
Story8	WL+X	8.235	-0.044	0.000003
Story7	WL+X	7.281	-0.038	0.000003
Story6	WL+X	6.18	-0.032	0.000002
Story5	WL+X	4.948	-0.025	0.000002
Story4	WL+X	3.617	-0.017	0.000001
Story3	WL+X	2.254	-0.01	0.000001
Story2	WL+X	0.992	-0.004	2.73E-07
Story1	WL+X	0.12	-0.000303	1.68E-08
Base	WL+X	0	0	0

IV CONCLUSION

In the present study, comparative evaluation of high rise structure with soils has been carried out for different code i.e. Indian and British code. The buildings are analyses for earthquake load (zone III). Comparison has been made on different structural parameters viz. base shear, Earthquake displacement, wind displacement, story force and modal time period etc.

Based on the analysis results following conclusions have been drawn:

1. Compare the results and behavior of structures using Indian and British code.
2. Studied the perform dynamic analysis of the building using response spectrum method.
3. Base shear is maximum in X-direction at British code in zones III. Also in British code, the base shear is increases approximate 15% as compare to Indian code in medium soil.
4. In British code, the earthquake displacement and wind displacement is maximum up to 1.16 times as compare to Indian code in G+10 story building at zone III.

5. Comparing Indian code and British code with RCC building models, the Indian and British code time period story forces results are closely spaced, the Indian and British code shows quite good performance in natural time periods.

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