"Evaluation and Comparison of Seismic Parameters of Multistoried Building by Different International Codes"

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Abstract— The present's study is on seismic behavior of structure using different codal provision Indian code, American code and British code for earthquake analysis. This study is carried out on residential building of G+20 story Special RC structure. Modelling of the structure is done using ETABS 2018 software.

The RCC frames are the most commonly adopted buildings construction practices in cities areas. With growing economically, urbanization and non-available of more horizontal space, increasing cost of land and need for agricultural land, high-rise structure 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.

In the present study, relative seismic performance of G+20 story RCC structures for zone III for medium soil condition using ETABS 2018 software is carried out for different Earthquake Code i.e., IS 1893 2016, ASCE 7-10 and UBC 94. The structures are analyzed and results are compared with different structural parameters viz. Base Shear, Displacement, and Modal Mass Participations etc. Based on results overall performance of building using Indian code and British code are same for earthquake loading, but ASCE code shows 3 times increase in seismic parameters as compare to Indian and British code.

Key Words: ETABS, Earthquake Loading, High-Rise, Response Spectrum Method.

I. Introduction

General Introduction

In all over country's most of the structures are low rise Structure. Now a day due to greater migration towards cities/towns, results in increase in the population of the major cities. In order to fulfill the requirement of this increased population in limited land the height of building becomes a 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 structural engineering besides knowledge of practical aspects, such as relevant design codes and bye laws backed up by example experience.

The ETABS 2018 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. ETABS 2018 consists of the following: The Graphical User Interface of ETABS 2018 is used to generate the model, which can then be analyzed. After analysis and design is completed, the GUI can also be used to view the results graphically.

To perform an accurate analysis of structure engineer must determine information such as structural loads, structural framing, support conditions, and materials properties i.e. grade of concrete. The results include parameters like base reactions, displacements, and modal mass participations. This information is then compared to criteria that indicate the code is best for analysis.

Research Objective

Around the world have their respective seismic codes for the designing, detailing, constructing and planning of structures. Multistory structure will be designed in a manner to withstand the forces and deformations that are caused due to ground vibrations occurring during an earthquake.

- 1. The main objective of this project is to present a study depicting the various differences in the Seismic Design Codes used for analysis namely Indian, British and American standards.
- Seismic codes help to improve the behavior of the structure to withstand the earthquake effects without significant loss of life and property. In order to design such an earthquake resistant structure, one must have a great knowledge about various seismic design codes, their parameters, the differences and their effects on the structure.
- 3. The objective of the project is to compare the seismic analysis results of multistoried building between Indian Standard codes, British Standard Code & American Standard code.
- 4. The comparative analysis will be performed in terms of Base shear, Displacement for different codes, Modal Mass Participations and Story force.

Problem Statement

The study will give more knowledge of Indian code, ASCE code and British code result into benefits for future implementation

II. PROBLEM FORMULATION

In this title of parametric investigation, a detailed study of analysis of RCC structure using IS codes, ASCE Code and British code has been presented. Study has been done on Reinforced concrete structure (RCC). Analysis of all the above-mentioned structures has been carried out by using Indian and British Standard with response spectrum Method. Cost effectiveness of structures has also been studied only from material point of view.

Table 1. Detailed Features of Building

Sr. No	Parameters	Values
		Concrete-M25, M30&M40
1	Material Used	Reinforcement Fe-415Mpa
2	Plan Dimension	
3	Height Of Each Story	3.0m
4	Height Of Ground Story	1.2m
5	Density Of Concrete	25 KN/M ³
6	Poisson Ratio	0.2-Concrete And 0.15-Steel
7	Density Of Masonry	20 KN/M ³
		IS456:2000, IS1893:2016 & BS 8110-
9	Code Of Practice Adopted	1997 [40}
10	Seismic Zone for IS1893:2016	III
11	Importance Factor	1
12	Response Reduction Factor	5
13	Foundation Soil	Medium
14	Slab Thickness	150mm
15	Floor Finish	1KN/M ²
16	Live Load	2KN/M ²
		As Per IS 1893-2016& BS 8110-1997
17	Earthquake Load	40
18	Model To Be Design	G+20

Load Case and Load Combination

Unless otherwise specified, all loads listed, shall be considered in design for the Indian Code, British code, American code following load combinations shall be considered,

Load Case

- 1) DL: Dead load
- 2) LL: Live load
- 3) EQ: Earthquake load
- 4) W: Wind Load

Load Combination (Cl. No 6.3)

- 1) 1.5DL+1.5LL
- 2) 1.2DL+1.2LL + 1.2EX
- 3) 1.2DL+1.2LL-1.2EX
- 4) 1.2DL+1.2LL+1.2EY
- 5) 1.2DL+1.2LL 1.2EY
- 6) 1.2DL+1.2LL+1.2WLX
- 7) 1.2DL+1.2LL-1.2WLX
- 8) 1.2DL+1.2LL+1.2WLY
- 9) 1.2DL+1.2LL-1.2WL

A. Building Plan

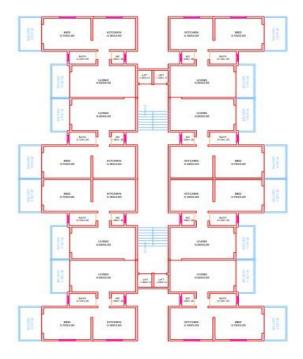


Fig. 1 Building Plan Considered for Structural Analysis

B. Plan & 3D Structure Modeled in ETABS

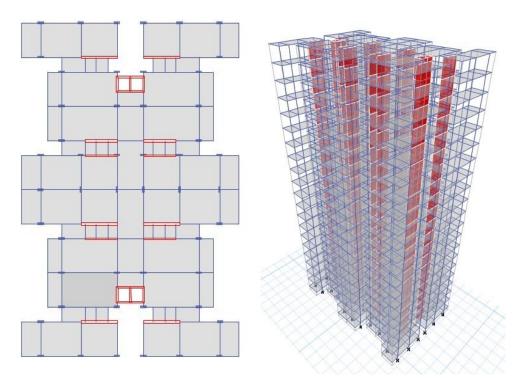


Fig. 2 Software Plan and 3D Line Model

III. Methodology

The Analysis Is Done by Response Spectrum Method

A. Response Spectrum Method

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

In technical terms it can be said that it is the representation of the maximum response of idealized single degree of freedom having certain period and damping during earthquake ground motion. The maximum response is plotted against the undammed natural period and for various damping values can be expressed in terms of maximum relative velocity or maximum relative displacement. The characteristics of seismic ground vibrations expected at any location depends upon the magnitude of earthquake, its depth of focus, distance from the epicenter, characteristics of the path through which the seismic waves travel, and soil strata on which the structure stands. The random earthquake ground motions, which cause the structure to vibrate, can be resolved in any three mutually perpendicular directions.

• Seismic Base Shear as per IS 1893 2016

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

$$V_b = A_h * W$$

Where,

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A_h 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: 2016 (Part 1), Clause 6.4.2 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 as per UBC 94 1994

This example uses the total building weight W applied to each respective direction. The results shown will be slightly conservative since W includes the wall weights for the direction of load, which can be subtracted out. This approach is simpler than using a separated building weight W for each axis under consideration.

Design base shear

Design base shear is:

$$V = {^CV}I$$

Period using Method A (see Figure 1-5 for section through structure):

$$T = Ct \left(h_n \right)^{3/4}$$

 h_n is the center of gravity (average height) of diaphragm above the first floor.

Seismic Base Shear as per ASCE 7-16

The seismic load calculation in accordance with ASCE7-16. This involves integrating the USGS Seismic Data and processing it to generate the seismic base shear using Section 12.8 Equivalent Lateral Procedure. In this article, we will dive deeper into the process of calculating the seismic loads for a building using ASCE 7-16.

Lateral Force Procedure

The seismic design base shear can be calculated using Equation 12.8-1 of ASCE 7-16:

V=CSWV=CS W (Eq. 12.8-1)

Where:

VV is the seismic design base shear Cs is the seismic response coefficient based on Section 12.8.1.1 WW is the effective seismic weight as per Section 12.7.2 The formula for determining the seismic response coefficient is:

Cs=SDS* RIe Cs=SDS RIe (Eq. 12.8-2)

Where,

SDS is the design spectral response acceleration parameter in the short period range (from USGS Data) R is the response modification factor as per Table 12.2-1 Ie is the importance factor determined from Section 11.5.1 However, we need to satisfy Equations 12.8-3 to 12.8-6: The value of Cs should not exceed 12.8-3 or 12.8-4 For T \leq TLT \leq TL:

Cs, max=SD1TRIeCs, max=SD1TRIe (Eq. 12.8-3)

For T>TLT>TL:

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Cs, max=SD1TLT2RIeCs, max=SD1TLT2RIe (Eq. 12.8-4)

Moreover, Cs shall not be less than Equation 12.8-5

Cs, min=0.044SDSIe\ge 0.01Cs, min=0.044SDSIe\ge 0.01 (Eq. 12.8-5)

In addition, for structures located where S1≥0.6gS1≥0.6g:

Cs, min=0.5S1 RIe, Cs, min=0.5S1RIe (Eq. 12.8-6)

Where,

SD1 is the design spectral response acceleration parameter at period of 1.0 s (from USGS Data) T is the fundamental period of the structure TL is the long period transition period (from USGS Data) S1 is the mapped maximum considered earthquake spectral response acceleration parameter (from USGS Data)

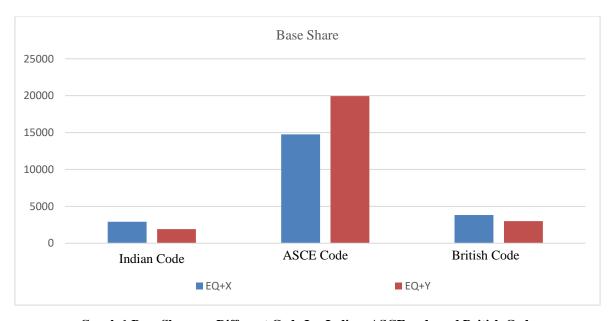
IV. Results

• Base Shear

Base shear is an estimate of the maximum lateral force that will occur at the base of the structure due to the seismic ground motion. During the analysis, the codes required for the use of the dynamic lateral force procedure.

Table 2 Base shear Results as Per IS 1893 2016, ASCE and UBC Code Seismic Analysis of RCC Building.

Load Pattern	Indian code Base Shear	ASCE CODE Base Shear	British code Base Shear
	kN	kN	kN
EQ+X	2917.2393	14750.4525	3831.434
EQ-X	2917.2393	23600.724	3831.434
EQ+Y	1924.8594	19948.5947	3004.2006
EQ-Y	1924.8594	19948.5947	3004.2006



Graph 1 Base Share vs. Different Code I.e. Indian, ASCE code and British Code

The base shear in x- direction, in IS 1893 2016 code building structure, in Table No. 1 base shear is increased 5.056 times in ASCE 7-10 code and 1.3133 times in UBC 7-10 increased as compare to IS 1893 2016 code, base shear is increased due to Zone Factor and Importance factor.

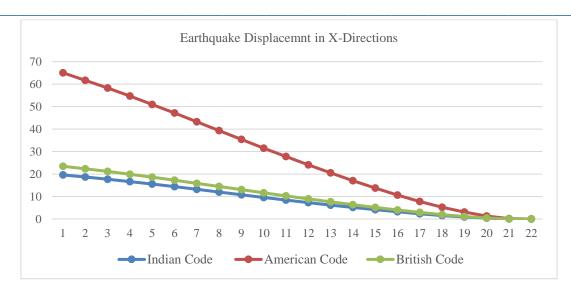
• Earthquake Displacement

In Earthquake Code, Earthquake resisting design structure, for displacement limit H/250 is allowable displacement limit in earthquake force, if displacement limit beound the H/250, the structure is safe and displacement limit is exceeding, structure is unsafe for displacement.

Table 3 Earthquake Displacement(UX) in X- Directions Results for IS 1893 2016, ASCE and UBC Code.

		TABLE: Diaphragm Centre of Mass Displacements						
	Load	IS 1893	ASCE	UBC				
Story	Case/Combo	2016 (UX)	(UX)	UX	X	Y	Z	
		mm	mm	mm	m	m	m	
20th slab	EQ+X	19.598	65.033	23.48	64.5083	24.3053	61.2	
19th slab	EQ+X	18.671	61.727	22.339	64.5092	24.2939	58.2	
18th slab	EQ+X	17.69	58.283	21.147	64.5092	24.2939	55.2	
17th slab	EQ+X	16.647	54.694	19.898	64.5092	24.2939	52.2	
16th slab	EQ+X	15.545	50.97	18.595	64.5092	24.2939	49.2	
15th slab	EQ+X	14.394	47.14	17.246	64.5094	24.293	46.2	
14th slab	EQ+X	13.217	43.257	15.875	64.5095	24.293	43.2	
13th slab	EQ+X	12.016	39.334	14.481	64.5095	24.293	40.2	
12th slab	EQ+X	10.807	35.41	13.077	64.5095	24.293	37.2	
11th slab	EQ+X	9.602	31.507	11.672	64.5097	24.2917	34.2	
10th slab	EQ+X	8.438	27.771	10.308	64.5099	24.2919	31.2	
9th slab	EQ+X	7.295	24.09	8.961	64.5099	24.2919	28.2	
8th slab	EQ+X	6.191	20.508	7.648	64.5099	24.2919	25.2	
7th slab	EQ+X	5.128	17.052	6.371	64.51	24.2905	22.2	
6th slab	EQ+X	4.143	13.766	5.177	64.5104	24.2909	19.2	
5th slab	EQ+X	3.207	10.671	4.03	64.5104	24.2909	16.2	
4th slab	EQ+X	2.34	7.814	2.957	64.5104	24.2909	13.2	
3rd slab	EQ+X	1.558	5.245	1.98	64.511	24.292	10.2	
2nd slab	EQ+X	0.891	3.064	1.138	64.5113	24.2579	7.2	
1st slab	EQ+X	0.365	1.309	0.469	64.5113	24.2579	4.2	
PL	EQ+X	0.043	0.164	0.055	64.5362	24.2521	1.2	
FL	EQ+X	0	0	0	64.5212	23.5047	0	

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Graph 2 Earthquake Displacement in X Directions vs. Different Country I.e. Indian, ASCE code and British Code

In Earthquake displacement in X-directions, Table No. 2 shows in IS 1893 2016 code building as compare to ASCE 7-10 and UBC 94 code building, displacement increased 3.32 times in ASCE 7-10 Code and 1.1918 times in UBC 94 code building as compare to IS 1893 2016 code building.

Wind Load Analysis

Basic Wind Speed - gives basic wind speed map of India, as applicable to 10 m height above mean ground level for different zones of the country. Basic wind speed is based on peak gust velocity averaged over a short time interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain (Category 2). Basic wind speeds presented in Fig. 1 have been worked out for a 50-year return period. Basic wind speed for some important cities/towns is also given in Appendix A.,

Design wind speed (Vz):

Design wind speed is given by the equation

V_z= V_b. K1. K2. K3. K4

Where,

Vz =Design wind velocity (m/sec)

V_b= Basic wind speed in m/sec

(Based on Appendix -A of various cities in IS 875 –Part 3) Basic wind speed Vb, depends on the location of the building. For this purpose, the country is divided in to six zones with specified wind speeds ranging from 33m/s to 55 m/s. Basic wind speed is based on gust velocity averaged over a short time interval of 3 seconds at 10m height from mean ground level in an open terrain and for 50 years return period. Appendix A (Fig.1) of the code specified for some important cities/ towns is given. V_b has 6 values 33, 39,44,47,50 &55 m/sec.)

Design Wind Pressure - The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

$$P_z = 0.6 \ V_z^2$$

Where,

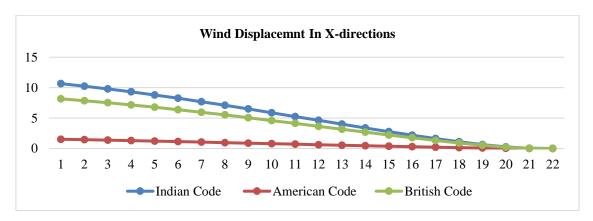
Pz - design wind pressure in N/ms at height Z, and

 $V_{\boldsymbol{z}}$ - design wind velocity in m/s at height \boldsymbol{Z}

In IS 875 2015 Wind resisting design force, for displacement limit H/500 is allowable displacement limit in Wind force, if displacement limit beound the H/500, the structure is safe and displacement limit is exceeding, structure is unsafe for displacement.

Table 4 Wind Displacement in (UX) in X- Directions Results for IS 875 2015, ASCE and UBC Code.

	TABLE: Diaphragm Centre of Mass Displacements							
		IS 875	ASCE	UBC				
Story	Load Case/Combo	2015(UX)	UX	UX	X	Y	Z	
		mm	mm	mm	mm	mm	mm	
20th slab	WL+X	10.663	1.518	8.173	64479.22	24192.63	61200	
19th slab	WL+X	10.238	1.446	7.856	64482	24190.44	58200	
18th slab	WL+X	9.788	1.371	7.521	64482	24190.44	55200	
17th slab	WL+X	9.309	1.294	7.165	64482	24190.44	52200	
16th slab	WL+X	8.798	1.215	6.785	64482	24190.44	49200	
15th slab	WL+X	8.256	1.132	6.382	64481.86	24189.11	46200	
14th slab	WL+X	7.692	1.048	5.961	64482.07	24189.3	43200	
13th slab	WL+X	7.105	0.963	5.522	64482.07	24189.3	40200	
12th slab	WL+X	6.498	0.877	5.066	64482.07	24189.3	37200	
11th slab	WL+X	5.875	0.79	4.597	64482.1	24189.31	34200	
10th slab	WL+X	5.256	0.705	4.128	64482.85	24191.91	31200	
9th slab	WL+X	4.629	0.62	3.651	64482.85	24191.91	28200	
8th slab	WL+X	4.004	0.536	3.172	64482.85	24191.91	25200	
7th slab	WL+X	3.38	0.453	2.69	64482.8	24191.63	22200	
6th slab	WL+X	2.783	0.372	2.226	64482.9	24191.93	19200	
5th slab	WL+X	2.196	0.294	1.766	64482.9	24191.93	16200	
4th slab	WL+X	1.634	0.22	1.322	64482.9	24191.93	13200	
3rd slab	WL+X	1.11	0.151	0.903	64483.74	24195.32	10200	
2nd slab	WL+X	0.648	0.09	0.53	64484.3	24166.1	7200	
1st slab	WL+X	0.272	0.04	0.224	64484.3	24166.1	4200	
P L	WL+X	0.033	0.005	0.027	64503.91	24145.22	1200	
FL	WL+X	0	0	0	64521.24	23414.39	0	



Graph 3 Wind Displacement in X Directions vs. Different Country I.e. Indian, ASCE code and British Code

in ASCE 7-10 code building as compare to IS 875 2015 and UBC 94 code building, in Graph 3, displacement increased 7.024 times in IS 875 2015 Code and 1.3046 times in UBC 94 code building as compare to ASCE 7-10 code building.

• Modal Mass Participation (Table No. 6)

0.174

0.118

0.101

0.00001918

0.0603

0.0022

10

11

12

It is part of the total mass of structure that is effective in natural mode of oscillations during horizontal ground motions.

• Time period

The time taken by the structure to complete one cycle of oscillations in its natural mode (k) of Oscillations.

It is longest time taken by the structure to complete one cycle of oscillations in its laterals translational mode in oscillations in considered directions of earthquake shaking, this mode of oscillations is called the fundamental lateral translational mode of oscillations.

- a. The first three modes contribute less than 65% mass participation factor in each principal plan directions and
- b. The fundamental natural period of the building in the two principal plan directions are closer to each other by 10% of the larger value.

In building located in seismic zone II and III it shall be ensured that the first three modes together contribute at least 65% mass participations factor in each principal plan directions an in building located in seismic zone IV and V, it shall be ensured that,

- 1) The first three modes together contribute at least 65% mass participations factor in each principal plan directions, and
- 2) The fundamental lateral natural periods of the building in the two principal plan directions are away from each other by at least 10% of the large Value

Sum Sum Mode Period UX UY Sum UX UY RZRZsec 2.264 0.00003414 0.6816 0.00003414 0.6816 0.0009 0.0009 1 2 1.704 0.0014 0.001 0.0015 0.6826 0.6659 0.6669 3 1.494 0.6601 0.0001 0.6615 0.0013 0.6681 0.6827 4 0.816 0.000001022 0.149 0.6615 0.0001 0.6682 0.8317 5 0.555 0.0005 0.0001 0.662 0.8318 0.1536 0.8218 0.473 0.1579 0.00002092 0.82 0.8318 0.0006 0.8224 6 0.00003345 0.0001 7 0.456 0.0542 0.82 0.8861 0.8225 0.236 0.0231 0.0336 0.8431 0.000002019 0.8225 8 0.9197 9 0.233 0.0342 0.0246 0.0001 0.8226 0.8773 0.9443

0.8773

0.9375

0.9397

0.9443

0.9444

0.9444

0.0000133

0.0002

0.0003

0.000001413

0.0001

0

Table 5 Modal Mass Participations Ratios for Indian Code IS 1893 2016

0.8226

0.8228

0.8232

Table 6 Modal Mass Participations Ratios Results for American code ASCE 10-16

Mode	Period	UX	UY	Sum UX	Sum UY	RZ	Sum RZ
	sec						
1	1.804	0.000005369	0.7072	0.000005369	0.7072	0.0052	0.0052
2	1.464	0.0002	0.0057	0.0002	0.7129	0.6698	0.6749
3	1.352	0.6549	0.00001233	0.6551	0.7129	0.0001	0.675
4	0.653	0	0.1342	0.6551	0.8472	0.0004	0.6754
5	0.455	0.0001	0.0002	0.6551	0.8474	0.1584	0.8339
6	0.394	0.1782	9.974E-07	0.8334	0.8474	0.0001	0.834
7	0.358	0	0.0479	0.8334	0.8953	0.00004211	0.834
8	0.193	0.0141	0.0415	0.8475	0.9369	0.00000136	0.834
9	0.193	0.0416	0.0144	0.889	0.9512	0.000002437	0.834
10	0.18	8.917E-07	0.00001616	0.889	0.9512	0.000003717	0.834
11	0.099	0.0596	0.000004086	0.9486	0.9513	0.00002646	0.834
12	0.08	0.0001	0.000008097	0.9488	0.9513	0.0003	0.8343

Table 7 Modal Mass Participations Ratios Results for British Code UBC 94

Mode	Period	UX	UY	Sum UX	Sum UY	RZ	Sum RZ
	sec						
1	2.264	0.00003414	0.6816	0.00003414	0.6816	0.0009	0.0009
2	1.704	0.0014	0.001	0.0015	0.6826	0.6659	0.6669
3	1.494	0.6601	0.0001	0.6615	0.6827	0.0013	0.6681
4	0.816	0.000001022	0.149	0.6615	0.8317	0.0001	0.6682
5	0.555	0.0005	0.0001	0.662	0.8318	0.1536	0.8218
6	0.473	0.1579	0.00002092	0.82	0.8318	0.0006	0.8224
7	0.456	0.00003345	0.0542	0.82	0.8861	0.0001	0.8225
8	0.236	0.0231	0.0336	0.8431	0.9197	0.000002019	0.8225
9	0.233	0.0342	0.0246	0.8773	0.9443	0.0001	0.8226
10	0.174	0.00001918	0.000001413	0.8773	0.9443	0.0000133	0.8226
11	0.118	0.0603	0.0001	0.9375	0.9444	0.0002	0.8228

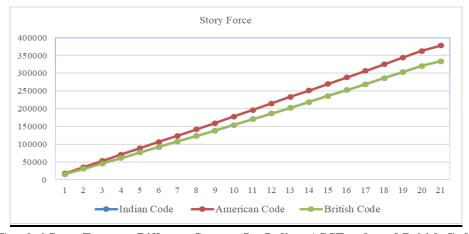
12	0.101	0.0022	0	0.9397	0.9444	0.0003	0.8232	

Story Force

Story force (clause No. 4.20.1) means load acting vertical i.e. Gravitational force on structure for self-weight of structure, wall load, live load etc.

Table 8 Story Force Results for IS 456 2000, ASCE and UBC Code.

TABLE: Story Forces								
		IS 456 2000	ASCE	UBC				
Story	Load Case/Combo	P(kN)	P (kN)	P(kN)				
		Indian Code	ASCE Code	British code				
20th slab	1.5(DL+LL)	15315.8806	17681.9154	15315.8806				
19th slab	1.5(DL+LL)	30631.7612	35363.8307	30631.7612				
18th slab	1.5(DL+LL)	45947.6419	53045.7461	45947.6419				
17th slab	1.5(DL+LL)	61263.5225	70727.6615	61263.5225				
16th slab	1.5(DL+LL)	76579.4031	88409.5768	76579.4031				
15th slab	1.5(DL+LL)	92057.5327	106215.4441	92057.5327				
14th slab	1.5(DL+LL)	107535.6622	124021.3113	107535.6622				
13th slab	1.5(DL+LL)	123013.7917	141827.1785	123013.7917				
12th slab	1.5(DL+LL)	138491.9212	159633.0458	138491.9212				
11th slab	1.5(DL+LL)	154414.8094	177988.5031	154414.8094				
10th slab	1.5(DL+LL)	170337.6976	196343.9604	170337.6976				
9th slab	1.5(DL+LL)	186260.5857	214699.4177	186260.5857				
8th slab	1.5(DL+LL)	202183.4739	233054.875	202183.4739				
7th slab	1.5(DL+LL)	218943.9561	251480.2859	218943.9561				
6th slab	1.5(DL+LL)	235704.4383	269905.6968	235704.4383				
5th slab	1.5(DL+LL)	252464.9205	288331.1077	252464.9205				
4th slab	1.5(DL+LL)	269225.4027	306756.5187	269225.4027				
3rd slab	1.5(DL+LL)	286331.1597	325451.9071	286331.1597				
2nd slab	1.5(DL+LL)	303487.6935	344198.0725	303487.6935				
1st slab	1.5(DL+LL)	320644.2274	362944.2378	320644.2274				
PL	1.5(DL+LL)	334002.1629	377851.0629	334002.1629				



Graph 4 Story Force vs. Different Country I.e. Indian, ASCE code and British Code

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All building is analysis for Dead Load, Live Load, Wind Loads and Earthquake Loads the Story force in IS 1893 216 & UBC 98 1994 Code building Story force same in Both building in Table No. 5, in ASCE 7-10 code building story force is increased in 15.54%.

V. Conclusions

- 1. Analysis of RCC building with different Earthquake Code i.e. IS 1893 2016, ASCE 7-10 and UBC 94 with medium soil condition at zone III. The base shear in x- direction, base shear is increased 5.056 times in ASCE 7-10 code and 1.3133 times in UBC 7-10 increased as compare to IS 1893 2016 code building structure.
- 2. Due to earthquake, displacement increased 3.32 times in ASCE 7-10 Code and 1.1918 times in UBC 94 code building as compare to IS 1893 2016 code building. Also same in Y- directions displacement increased 5.29 times in ASCE 7-10 Code and 1.48 times in UBC 94 code building as compare to IS 1893 2016 code building. But relatively IS 1893 2016 And UBC 94 1994 shows good performance in earthquake displacement.
- 3. In ASCE 7-10 code building as compare to IS1893 2016 and UBC 94 code building, in Graph 3, displacement increased 7.024 times in IS 1893 2016 Code and 1.3046 times in UBC 94 code building as compare to ASCE 7-10 code building. Also same in Y- directions displacement increased 5.29 times in ASCE 7-10 Code and 1.48 times in UBC 94 code building as compare to IS 1893 2016 code building. But relatively both building shows good performance in Wind displacement.
- 4. Comparing the modal mass participating results in IS 1893 2016 code building in 1st mode shape, mass participant in Y-directions 68.16% and 2nd mode shape in RZ-direction 66.59% and 3rd mode shape in X-directions 66.01%. Also in ASCE 7-10 code building in 1st mode shape, mass participant in Y-directions 70.72% and 2nd mode shape in RZ-direction 66.98% and 3rd mode shape in X-directions 65.49%. Similarly, in UBC code Building in 1st mode shape, mass participant in Y-directions 68.16% and 2nd mode shape in RZ-direction 66.59% and 3rd mode shape in X-directions 66.01%. Means in different Code building, in Modal Mass participant check Building structure are torsions Mode, and also in all code building, in 1st mode is translation, and 2nd mode shape in torsions and 3rd mode shape is in Again in Translations'. Means both building is fails is in torsions.
- 5. Both building is analysis for Dead Load, Live Load, Wind Loads and Earthquake Loads the Story force in ASCE 7-10 & UBC 98 1994 code building Story force same in Both building in Table No. 5, in ASCE 7-10 code building story force is increased in 15.54%, as compare to IS 1893& UBC 94 code building.
- **6.** Overall performance of Indian code and British code are almost same results i.e. Base Shear, Earthquake Displacement, Wind Displacement and Modal Mass Participations in earthquake loading, but as compare to ASCE code results, Results is increased 3 to 4 time increased in ASCE code as compare to other code.

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