HBRP PUBLICATION

Journal of Earthquake Science and Soil Dynamics Engineering
Volume 3 Issue 3

Study on High Rise (G+32) Cluster Shaped Building under Earthquake with the help of IS 1893, UBC Codal Provisions

D.N. Kakade[1], Shaikh Shahzain Faheem[2*]
[1]Associate Professor, [2]P.G. Student
Department of Civil Engineering, P.E.S College of Engineering, Aurangabad, Maharashtra, India.

****Corresponding Author***
E-mail Id:*-shahzain44@gmail.com*

ABSTRACT

Construction is a vital part of every developing country in this area. The tallness of a building is relative and cannot be defined in absolute terms either in relation to height or the number of stories. But, from a structural engineer's point of view the tall building or multi-storeyed building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. The utmost country has own specific code for structure design to help the structure engineer to provide more stable, durable structure as to feasible in country topography and environment. In this paper presents the comparative study of analysis of high rise structure with considering dynamic force for three codal Guidelines (IS 1893:2002, UBC-1997, and ASCE: 7-10) using E-TAB. The comparative study includes the analysis of high rise (g+32) cluster shaped building under earthquake with the help of IS-1893, ASCE-7-10 UBC-1997 codal provisions in the terms of model time period , base shear, story drift and displacement as shown in the graphical representation of the results is shown below.

Keywords:*-Seismic analysis, Multi-storied RC building (G+32), IS-1893, UBC-1997 and ASCE 7-10, E-TAB.*

INTRODUCTION

'Structure' refers to anything that is constructed or built from different interrelated parts with a fixed location on the ground. In earthquake-prone zones, to make the homes earthquake-resistant, keep the walls and the partitions light. Constructing thin concrete floors also helps. Shear walls with a panelling system and braces channelling a side-to-side force downward into the foundations of the building also make the construction earthquake-resistant. There is major earthquake have been recorded in India, Japan, Europe, and the U.S. Natural calamities such as earthquakes, Tsunamis, Landslides, Floods etc. causes severe damage and suffering to human being by collapsing many structures, trapping or killing persons, cutting off transport systems, blocking of navigation systems, animals hazards etc. Such natural disasters are big challenges to the progress of development. However, civil engineers play a major role in minimizing the damages by proper designing the structures or by proper material selections or proper Constructions procedure and taking other useful decisions. This includes understanding the earthquakes, behavior of the materials of construction. Seismic building codes are guidelines to design and construct the buildings and civil engineering works in seismic regions. Reasons behind is to protect human lives from worst conditions which occurs during earthquake, to limit damage, and to sustain operations of important structures for civil protection.

LITERATURE REVIEW

Analysis and design of reinforced concrete building under seismic forces for four codal Guidelines (IS 1893:2002, Euro code 8, Japan-2007 and ASCE: 7-10) using STAAD Pro. The study shows the difference results of building behaviour in term of building base shear, bending moment, displacement and storey drift [1]. Seismic response of RCC multi-storeyed buildings by using new code IS 1893:2016, IS 16700:2017 and its comparison with IS 1893:2002", analytical study is carried out on a G+12 and G+16 storey building[4]. This study focus on the performance of different storey structure to find out the variation of result by using IS code and IBC code and Canada code. The obtained results helps in understanding the main parameter which is affect the structure while earthquake which is give more suitable design of the structure in seismic zone[14].

BUILDING DETAILS

The building considered here is a commercial building. The plan dimension is 19.54M X 51.26M. The research is carried out on the same building plan for under seismic forces for three codal Guidelines (IS 1893:2002, UBC-1997, and ASCE: 7-10) using E-TAB. Structural system as shown in Figure 1. The basic loading on all types of structures are kept same.

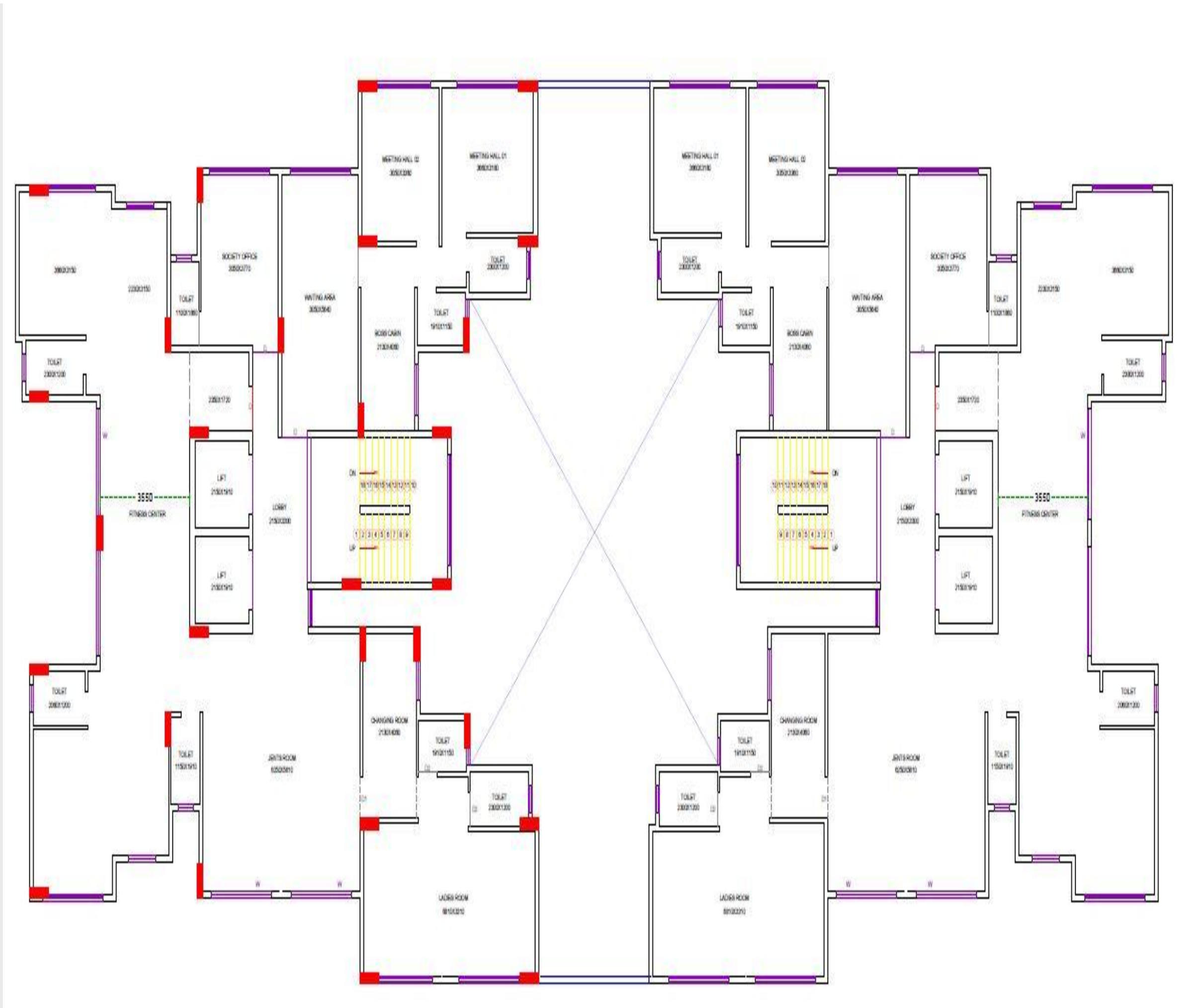

***Fig.1:**-Plan showing typical floor*

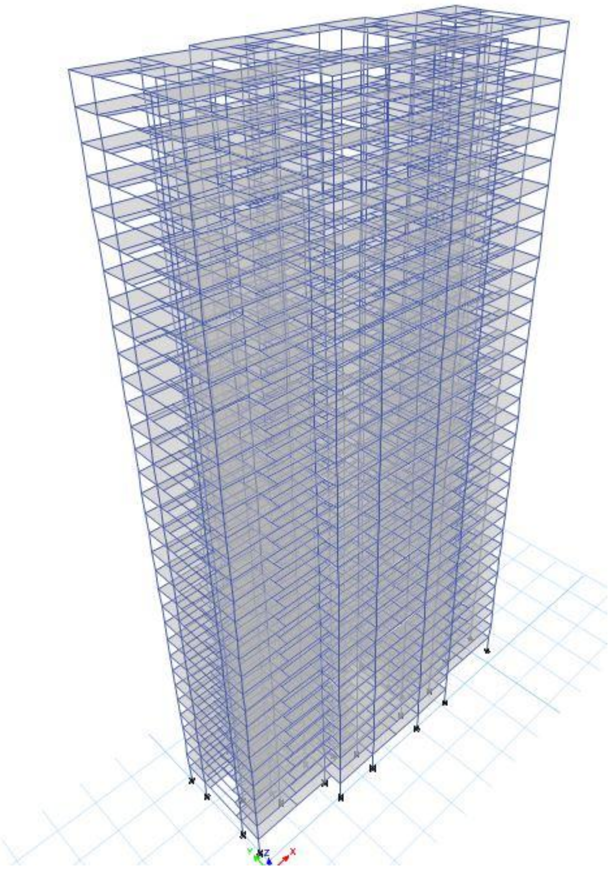

Fig.2:-*Etabs model of G+36*

Table 1:- *Data for Analysis*

Sr.No.	Site location	Delhi in Seismic
1	Plan Dimension	19.54X51.26 m
2	No. of Story	G+32
3	Total Height of the building	98.6m
4	Floor to Floor Height	2.9m
5	Inner and outer Wall thickness	0.23
6	Slab Thickness	125 mm
7	Characteristic compressive strength of concrete	25 N/mm2
8	Column Details • Foundation to 10^{th} • 10^{th} floor to 20^{th} • 20^{th} to32th floor	 300mmx750mm 300mmx600mm 300mmx530mm
9	Beams Details • Foundation to 10^{th} • 10^{th} floor to 20^{th} • 20^{th} to32th floor	 300mmx750mm 300mmx600mm 300mmx530mm
10	Grade of steel	fy500
11	Modulus elasticity of concrete	5.5 N/mm2
12	Seismic code	IS 1893 UBC-1997 ASCE 7-10
13	Damping Ratio	10
14	Seismic Zone Soil type Importance factor Frame Type	Iv 2 , medium 1.5 OMRF
15	Live load on floor area	2 kN/sq m

PERFORMANCE ANALYSIS

The analysis of high rise (g+32) cluster shaped building under earthquake with the help of IS-1893, ASCE-7-10 UBC-1997 codal provisions in the terms of model time period, base shear, story drift and displacement as shown in the graphical representation of the results is shown below

MODEL TIME PERIOD

Modal Time Period is the absolute value of Modal Time Period of the storey

Table 2:- *Performance analysis of high rise (g+32) at different codal provision*

Mode	**IS 1893**	**UBC**	**ASCE**
Mode-1	7.289	6.70	6.5
Mode-2	5.637	5.14	5.1
Mode-3	5.583	5.11	5.0

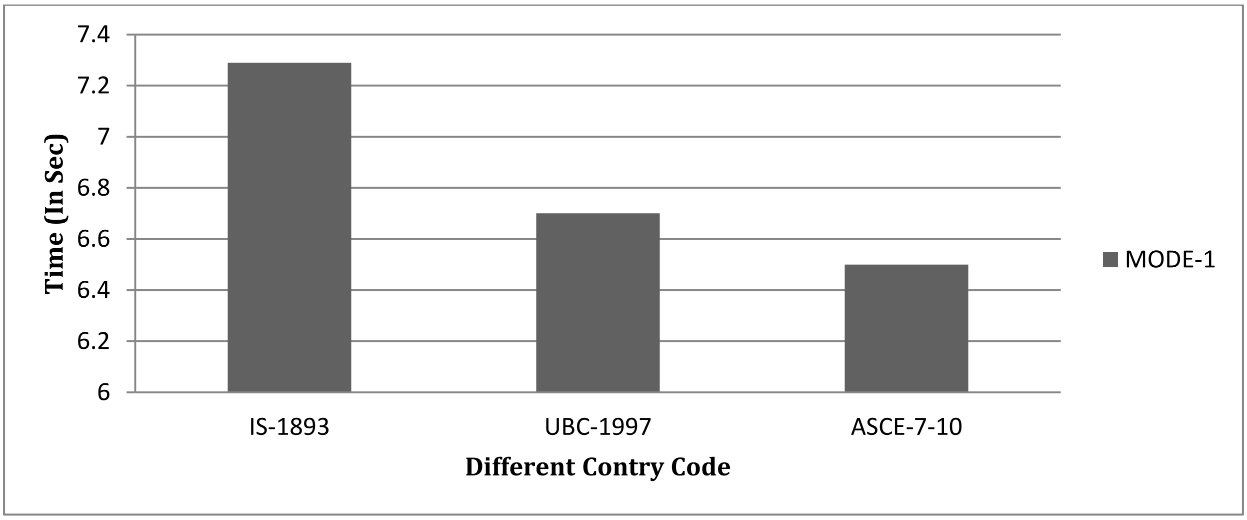

Fig.3:-*Modal Time Period for Mode-1*

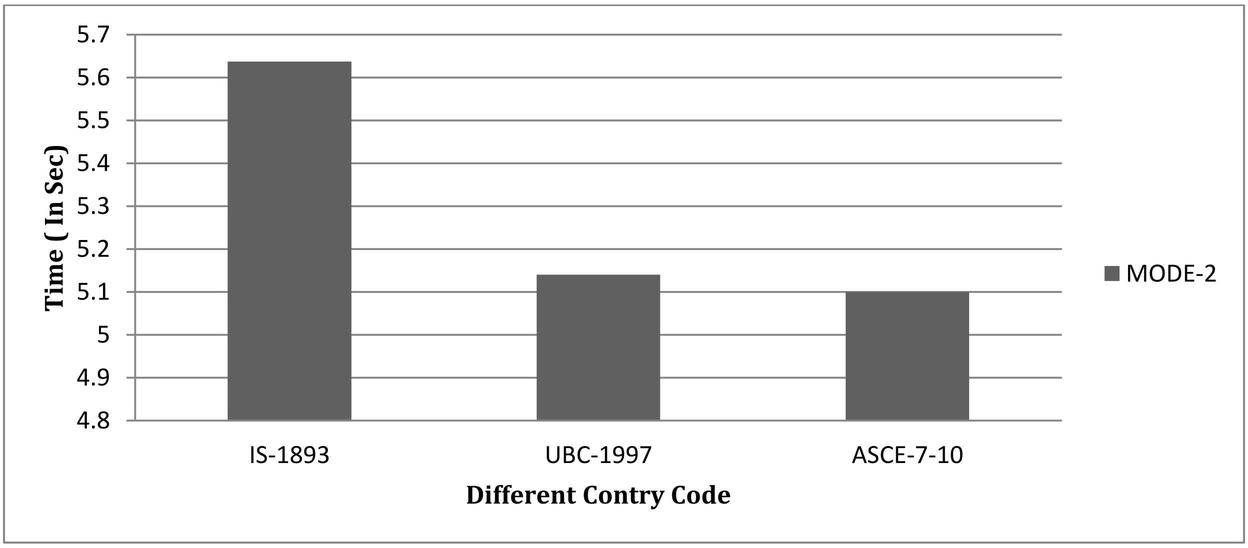

Fig.4:-*Modal Time Period for Mode-2*

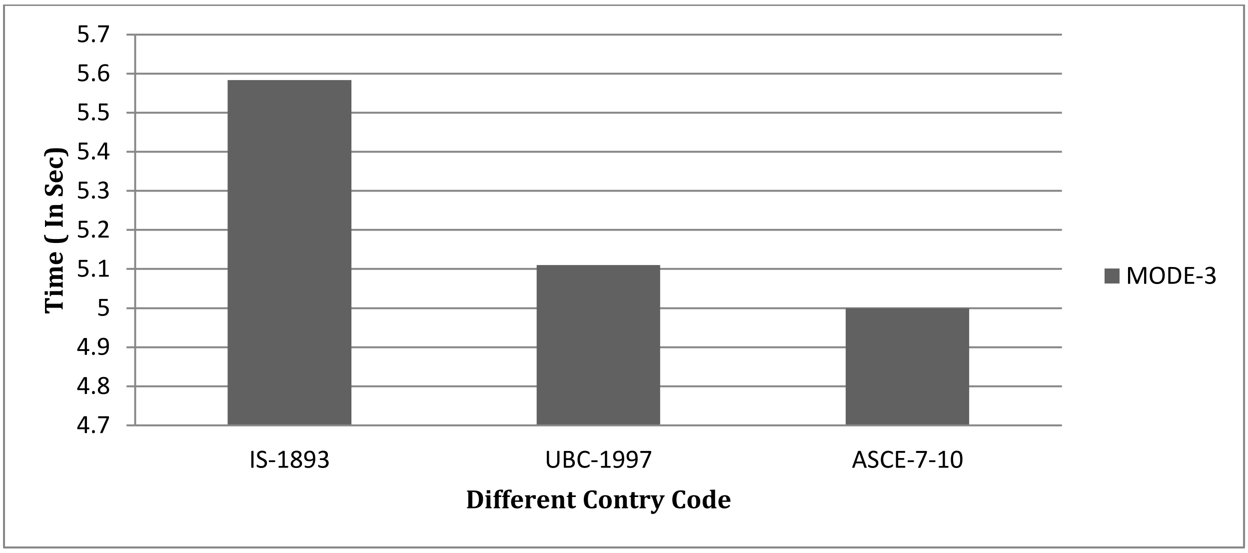

***Fig.5:-**Modal Time Period for Mode-3*

STOREY SHEAR

Base Shear is an estimate of the maximum Expected Seismic force that will occur due to seismic ground motion at the base of structure.

***Table 3:-** Base shear analysis of high rise (g+32) at different codal provision*

Base Shear	**IS 1893**	**UBC**	**ASCE**
Static Ex	6592.89	8846.48	16848
Static Ey	11174	8846.48	16848
DynamicEx	1757.89	768.14	2183.33
DynamicEy	1909.79	1060.96	3350.96

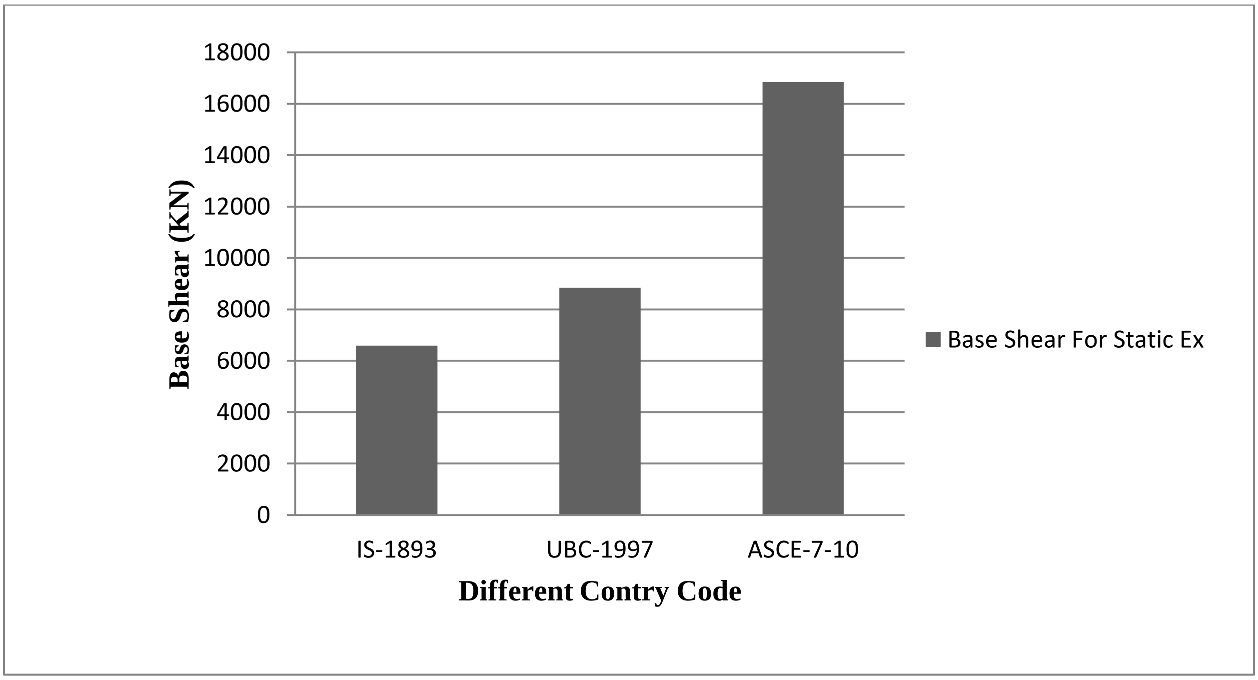

***Fig.6:-**Base Shear For Static Ex*

Journal of Earthquake Science and Soil Dynamics Engineering
Volume 3 Issue 3

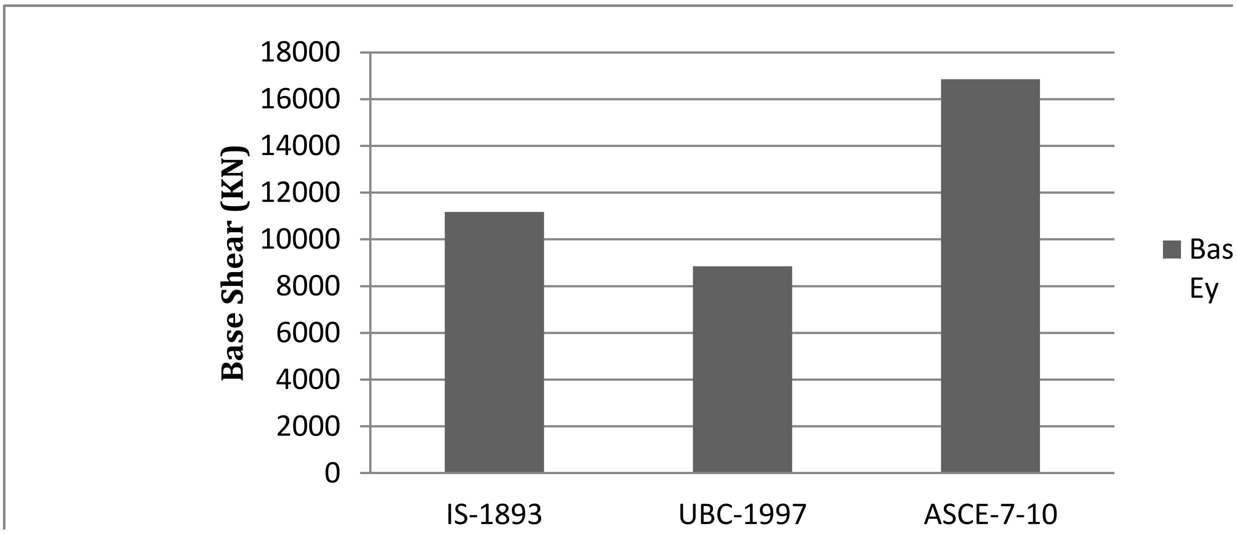

Fig.7:-*Base Shear For Static EY*

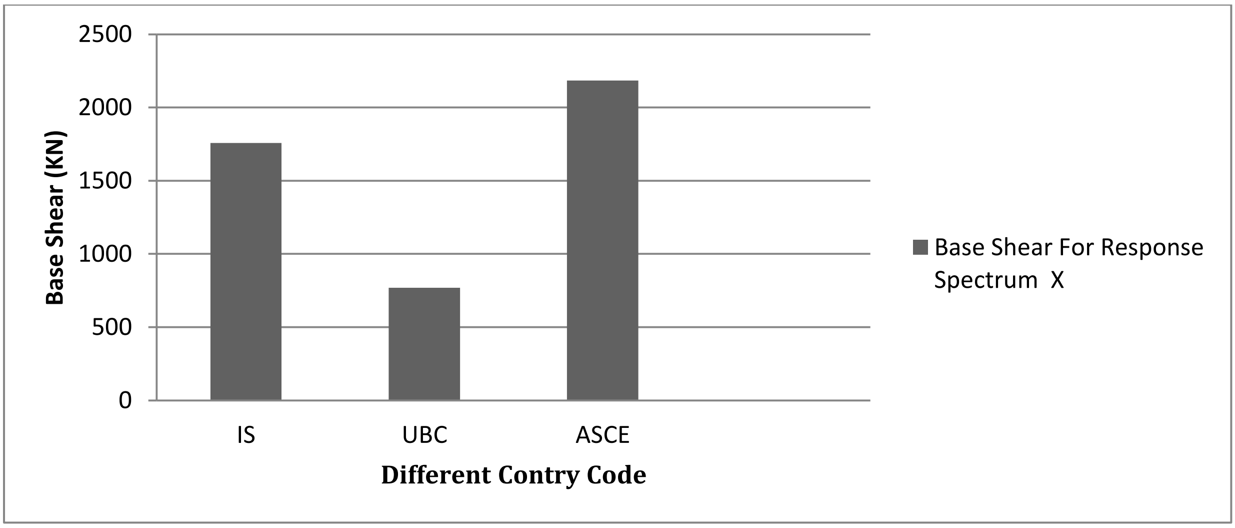

Fig.8:-*Base Shear For Response Spectrum X*

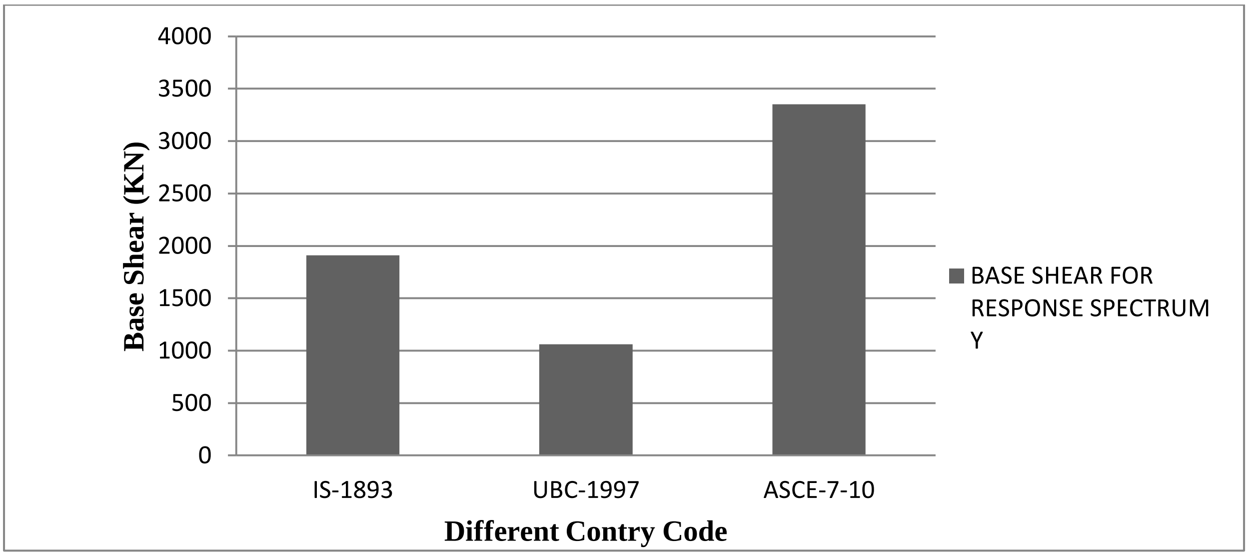

Fig.9:-*Base Shear For Response Spectrum Y*

Journal of Earthquake Science and Soil Dynamics Engineering
Volume 3 Issue 3

DISPLACEMENT DETAILS
Displacement Details in X and Y Direction for Seismic Condition

Storey Displacement is the absolute value of Displacement of the storey under action of the seismic forces.

Table 4:- *Displacement Details in X and Y Direction for seismic condition*

Displacement	**IS 1893**	**UBC**	**ASCE**
Static Ex	0.733	0.732	1.38
Static Ey	0.770	0.464	0.90
Dynamic Ex	0.159	0.048	0.112
Dynamic Ey	0.094	0.037	0.114

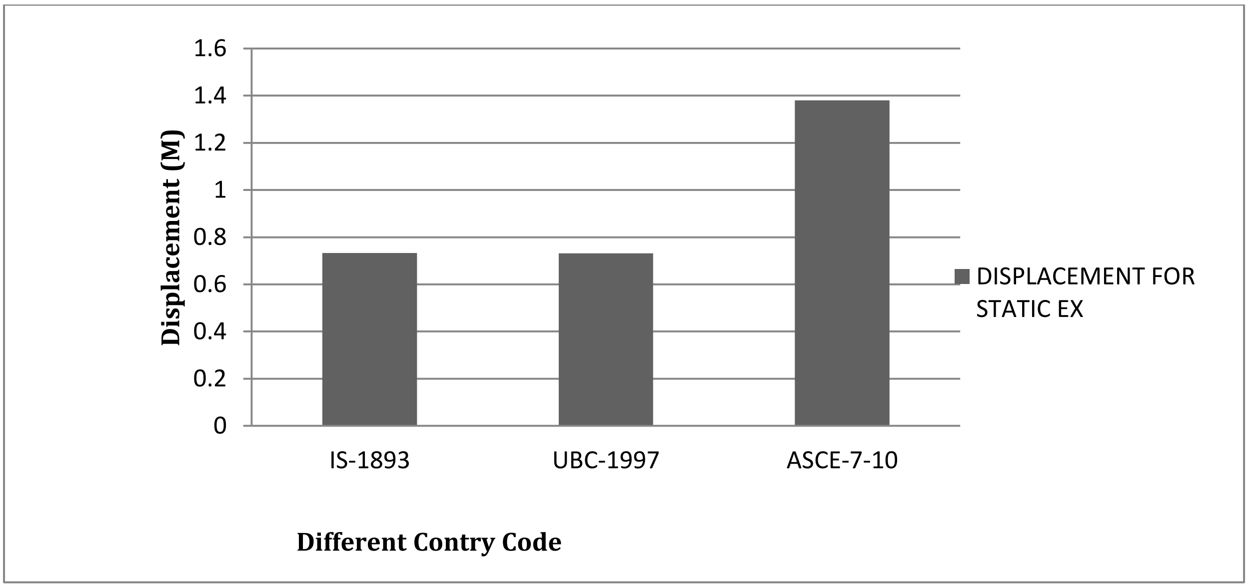

Fig.10:-*Displacement Details for static Ex*

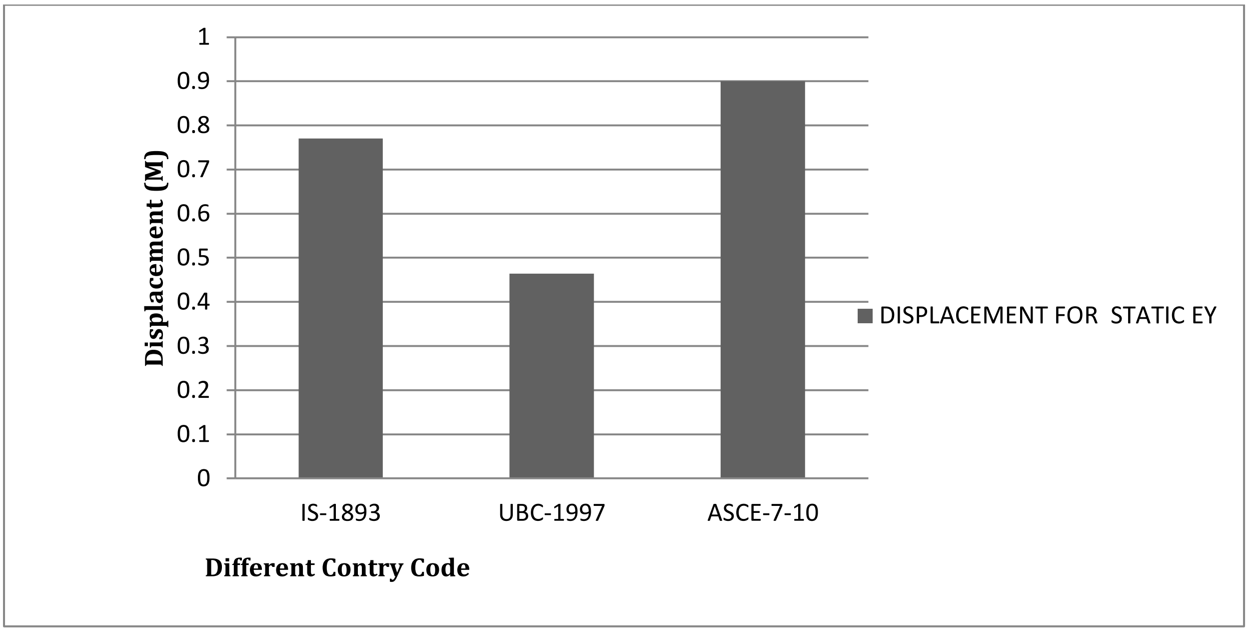

Fig.11:-*Displacement Details for static Ey*

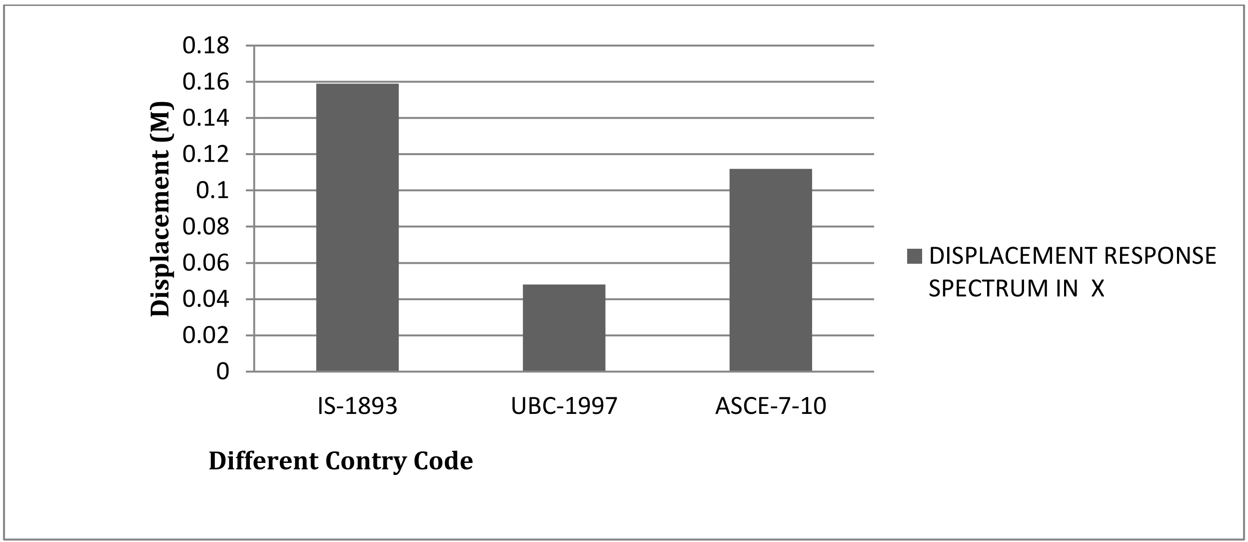

Fig.12:-*Displacement Details for Response Spectrum in Ex*

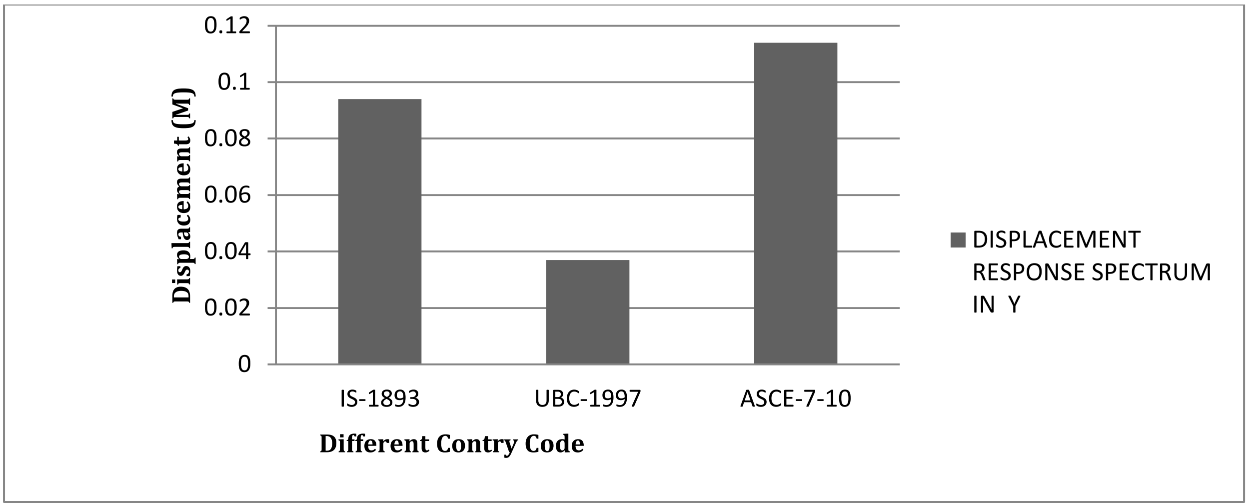

Fig.13:-*Displacement Detail for Response Spectrum Ey*

Table 5:- *Displacement Details in X and Y Direction for Wind Condition*

Direction	**IS 1893**	**UBC**	**ASCE**
Ex	0.220	0.129	0.300
Ey	0.289	0.138	0.141

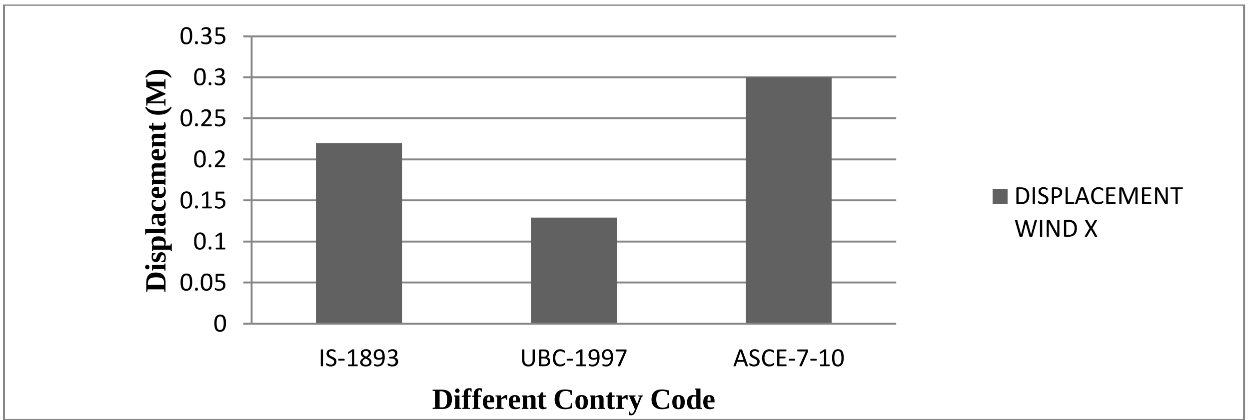

Fig.14:-*Displacement Details in Ex (Wind Condition)*

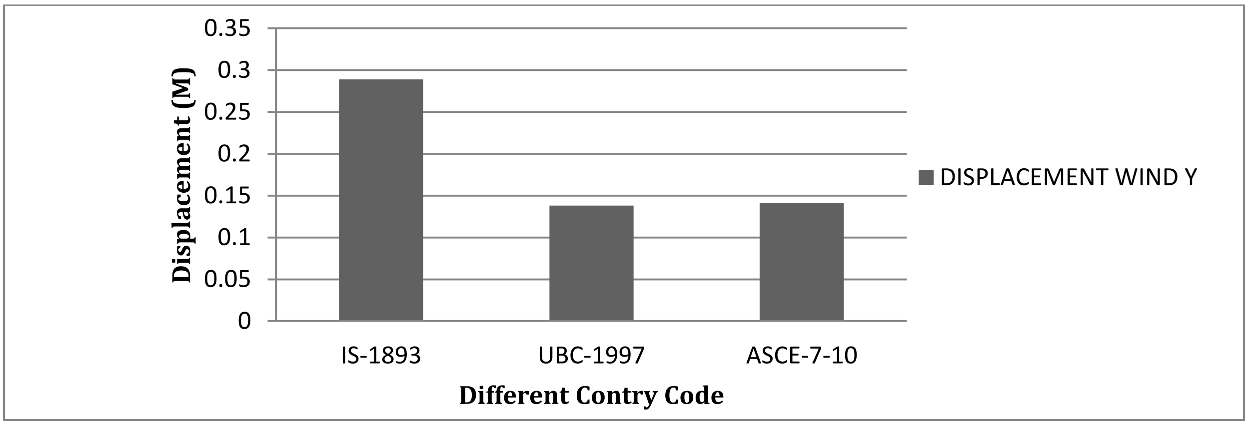

Fig.15:-*Displacement Details in Ey (Wind Condition)*

Drift Details
Storey Drift is the drift of one level of a multi-storey building relative to the level below.

Table 6:-*Drift Details in X and Y Direction*

Drift	**IS 1893**	**UBC**	**ASCE**
Static Ex	0.012	0.0097	0.019
Static Ey	0.011	0.0063	0.012
Dynamic Ex	0.002	0.000711	0.0017
Dynamic Ey	0.0014	0.000577	0.0016

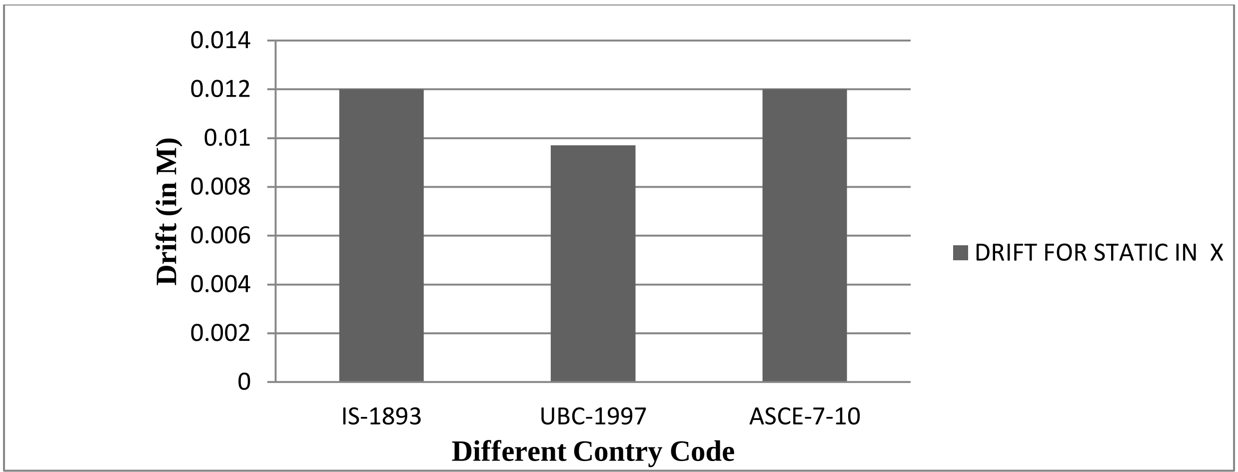

Fig.16:-*Drift Details For Static Ex*

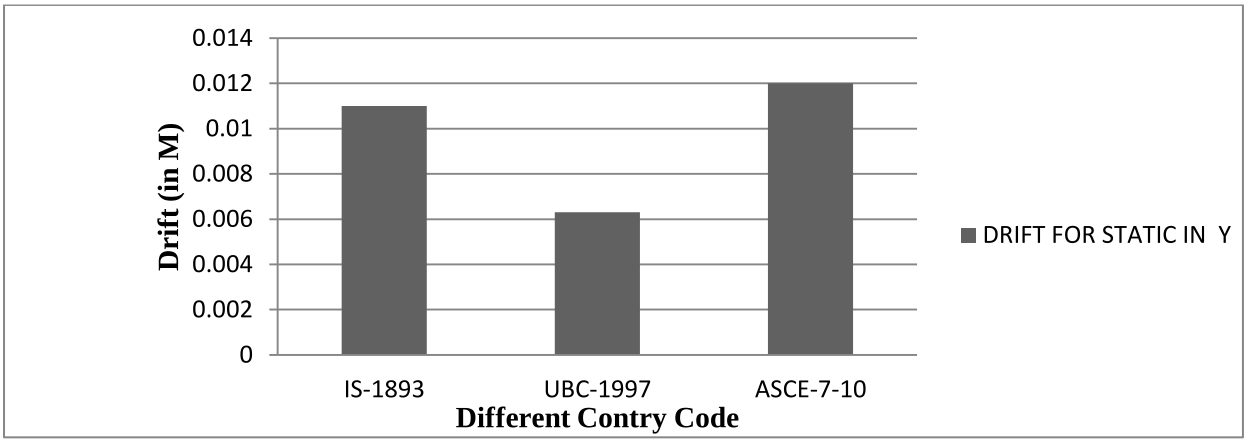

***Fig.17:**-Drift Details For Static Ey*

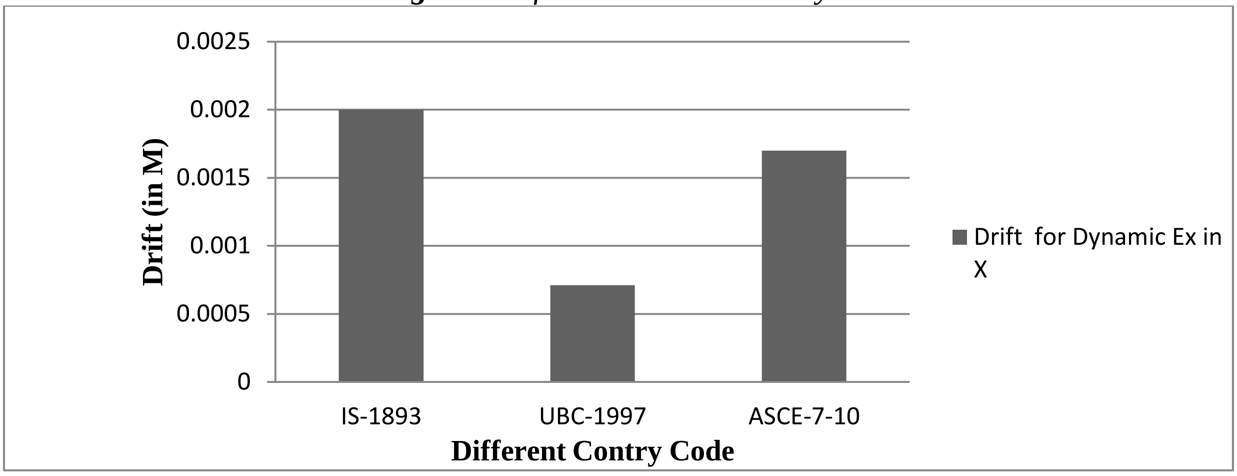

***Fig.18:**-Drift Details For Response Spectrum In X*

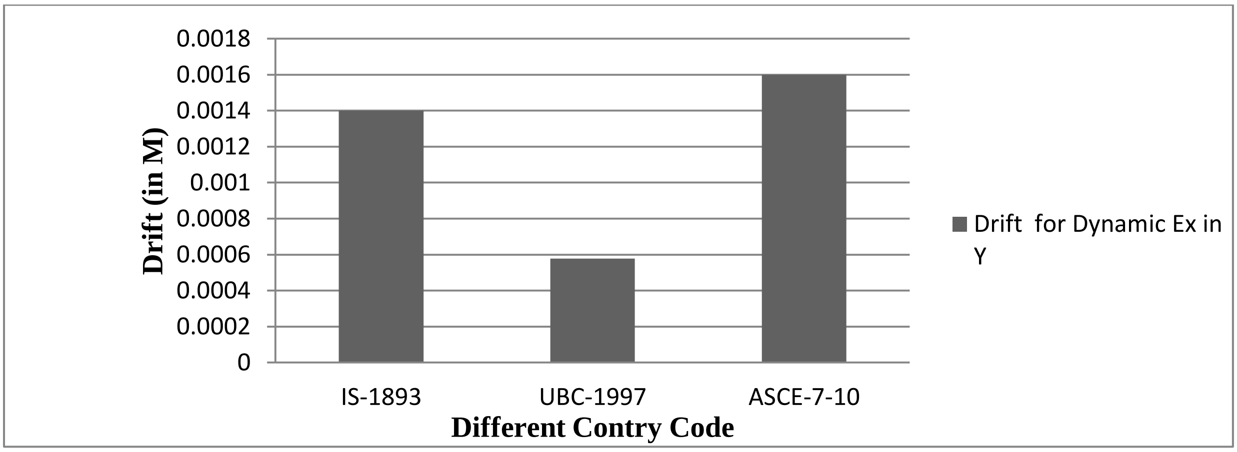

***Fig.19:**-Drift Details For Response Spectrum In Y*

CONCLUSION

Following are the conclusion we have obtained from above analysis results are: -

Time Period

In case of Time period the values where obtained for IS 1893 is 7.28,5.6, & 5.58 in first, second and third mode is higher than the Model time period obtained in ASCE 7-10 [6.5,5.1,5] and UBC-97 code [6.7,5.1,5.1 for First, second and third mode respectively as shown in Table 1. This means that while using is 1893 code for the Earthquake analysis the building will take more time to oscillate for all three modes when comparing with ASCE 7-10 and UBC-97 codes.

Base Shear
Base shear values are in Static X direction is 16848 kN while using ASCE code and 8846.4kn for UBC -97 and 6592.89kn for IS 1893 code which means the base shear values are increasing While using ASCE 7-10 code similarly in static y, Dynamic x and y directions as shown in Table 2.

Displacement
S similarly, the displacement values for EX, EY, Dx, Dy are [1.3,0.9,0.112,0.113] in ASCE code is higher in then IS 1893 and UBC-97 code. As shown in Table 3.
And if we compare the UBC 97 and IS 1893 the displacement values are quite similar in both Codes as shown in Table 3.
In case of wind the displacement In WX and WY is 0.3 and 0.14 which is more than those IS 1893 and UBC 97.

Drift
As the base shear is more in case of ASCE the drift will also be higher in ASCE Results and from the graph it is clearly indicated that the results obtained from the ASCE code are higher and needs to provide more stiffness in the modes for this code.

From the above conclusion it is obtained that The Time period values are more in case of IS 1893 and other parameters such as Base shear , Story displacement , Story Drift etc. are more in ASCE 7-10 Code and lesser in IS 1893 and UBC 97 code.
There for the parameters such as [Zone factor, Soil type, Earthquake Direction, Type of Building , Importance factor, Response reduction factor etc.] which we have selected for the analysis are quite similar in all three codes but not exactly similar there for the results which we obtained are having difference in all three codes. Hence it is possible to use the different codes for the analysis of Multi-storey building with the help of ASCE 7-10, IS 1893 and UBC-97.but the parameters should be similar while comparing analysis results.

REFERENCES
1. Izhar, T., Bano, S., & Mumtaz, N. (2019). Comparative Study on Analysis and Design of Reinforced Concrete Building under Seismic Forces for Different Codal Guidelines..
2. Jayalekshmi, B. R., & Chinmayi, H. K. (2015). Soil–Structure Interaction Effect on Seismic Force Evaluation of RC Framed Buildings with Various Shapes of Shear Wall: As Per IS 1893 and IBC. *Indian Geotechnical Journal*, *45*(3), 254-266.
3. Ge, Q., Xiong, F., Xie, L., Chen, J., & Yu, M. (2019). Dynamic interaction of soil–Structure cluster. *Soil Dynamics and Earthquake Engineering*, *123*, 16-30.
4. Shinde, B. H. Seismic Analysis of RCC Multistoried Building by IS 1893: 2016 and it's Comparison with IS 1893: 2002.
5. Kohli, A. R., & Gore, N. G. (2017). Analysis and Design of an Earthquake Resistant Structure using STADD. Pro.
6. Charavande, G., Maru, S. Earthquake Analysis, of RC Structure using Different Codes and Different Countries.
7. Liu, T., & Zhong, W. (2017). Earthquake responses of near-fault building clusters in mountain city considering viscoelasticity of earth medium and process of fault rupture. *Soil Dynamics and Earthquake Engineering*, *99*, 137-141.
8. Titiksh, A. (2017). Effects of Irregularities on the Seismic Response of a Medium Rise Structure. *Asian Journal of Civil Engineering (BHRC)*, *18*(8), 1307-1314.
9. Malviya, N., & Pahwa, S. (2017). Seismic analysis of high rise building

with is code 1893-2002 and is code 1893-2016.

10. Nahhas, T. M. (2017). A Comparison of Saudi Building Code with 1997 UBC for Provisions of Modal Response Spectrum Analysis Using a Real Building. *Open Journal of Earthquake Research*, *6*(02), 98.
11. Nahhas, T. M. (2017). A Comparison of Saudi Building Code with 1997 UBC for Provisions of Modal Response Spectrum Analysis Using a Real Building. *Open Journal of Earthquake Research*, *6*(02), 98.
12. Mohammed, M. A. Seismic Analysis of Structures By Etabs in BS Code & IS Code.
13. Mignan, A., Danciu, L., & Giardini, D. (2018). Considering large earthquake clustering in seismic risk analysis. *Natural hazards*, *91*(1), 149-172.
14. Anwade, A.,B., Aher S.B, Barate A. D., Raghuvanshi S., Kuralkar S. Seismic Analysis, Design and Comparative Study of RC Structure Using Different Codes.
15. Daterao, M. S. P., & Banarase, M. A. (2018). Seismic Analysis and Design of Multistoried Steel Structure Using IS.