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A Comparative study on Seismic Analysis and Behaviour of Multi-Story Building Using IS 1893:2002 and IS 1893:2016

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Abstract— The purpose of this research work is to compare the behaviour of Multi-storey building using IS 1893:2002(CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES) and IS 1893:2016(CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES) for various parameters such as storey drift, stiffness, base shear, max storey displacement, etc. This will be done using ETABS 16.2 and ETABS 17.1 version software. ETABS 16.2 is based on IS 1893:2002 and ETABS 17.1 is based on IS 1893:2016. In new Code (IS 1893:2016) many modifications have been done considering standard and practice existing in India, such modification are done in various sections such as importance factor, design acceleration spectrum, soft storey, weak storey etc. In this paper analysis of G+14 Multi-storey building is done under seismic loading and the result outcomes are compared using both seismic codes (IS 1893:2002 and IS 1893:2016.The aim of this research paper is to observe the response of multi-storey building under the modified values or parameters as per new version of seismic code (IS 1893:2016). This will help us to understand the behaviour of structure as per latest design criteria and codal values.

Keywords— IS 1893:2002, IS 1893:2016, RC multi-story structure, ETABS 16.2, ETABS 17.2, Seismic Analysis, Revised clauses

I. INTRODUCTION

Seismic analysis of structure plays a very crucial role in the load analysis of any structure, as generally buildings are only designed for vertical loading that is due to is self weight, live load, impact load, etc. But during an earthquake dynamic loads especially dynamic lateral or horizontal loading effects the structure, which is a major issue of concern from the point of safety of structure. The seismic analysis have became more important in the especially since recent decades especially after the occurance of Bhuj Earthquake that occurs in 2001 after which many faults and design deficiencies were studied in the structures that failed during the earthquake. Sadly it created a big loss to both life and economy. After Bhuj earthquake old Seismic code was revised to IS 1893:2002 which includes major modifications in the Seismic codes for more efficient design of earthquake resistant structures. It also focuses on the retrofitting methods and its requirement for structures. Hence we can realise the importance of seismic code and its revision for seismic analysis of structures. Another revision to IS 1893:2002 was done in the year 2016 and the old code was revised to IS 1893:2016. This research work will focus on the comparing the behaviour of Multi-storey building using IS 1893:2002 and IS 1893:2016 for various parameters such as storey drift, stiffness, base shear, max storey displacement, etc. This will be done using ETABS 16.2 and ETABS 17.1 version software . So, this paper deals with comparative study of IS 1893-2002 and IS 1893-2016. Two different G+14 storied residential building models were considered for analysis using ETABS software. This will be done using ETABS 16.2 and ETABS 17.1 version software. ETABS 16.2 is based on IS 1893:2002 and ETABS 17.1 is based on IS 1893:2016**.** The height of each storey is taken as 3.5 m and base height also 3.5 m making the total height of the structure 52.5 meter. Dynamic analysis of the structure is done and results generated by software are compared as per IS 1893:2002 and IS 1893-2016**.**

II. PROBLEM FORMULATION

Consider the residential multi-storey building details are as follows

*Building Plan***:**

a) Colum Size: 450 mm x 300 mm
b) Beam size: 300 mm x300 mm
c) Storey Height: base height 3.5 m, 3.5 m each floor
d) Live load: 3 KN/m^2
e) Dead Load: 15KN/ m^2
f) Seismic Zone: V (Zone five)
g) Colum Material Grade: M30
h) Beam and slab concrete Grade: M30
i) Steel grade Fe 500
j) Soil Type medium soil

Load Combinations for code IS 1893:2002.

- 1.5 (DL + IL)
- 1.2 [DL + LL + (EL_x+ 0.3 El_y)]
- 1.2 [DL + LL - (ELx + 0.3 El_y)]
- 1.2 [DL + LL + (EL_y + 0.3 El_x)]
- 1.2 [DL + LL - (El_y + 0.3 El_x)]
- 1.5 [DL + (EL_x+ 0.3 El_y)]
- 1.5 [DL - (EL_x + 0.3 El_y)]
- 1.5 [DL + (EL_y + 0.3 El_x)]
- 1.5 [DL - (El_y + 0.3 El_x)]
- 0.9 DL + 1.5 (EL_x + 0.3 El_y)]
- 0.9 DL - 1.5 (EL_x + 0.3 El_y)]
- 0.9 DL + 1.5 (EL_y + 0.3 El_x)]
- 0.9 DL - 1.5 (El_y + 0.3 El_x)]

Load Combinations for code IS 1893:2016.

- 1.2 [DL + LL + (EL_x+ 0.3 El_y + 0.3 EL_z)]
- 1.2 [DL + LL - (EL_x+ 0.3 El_y + 0.3 EL_z)]
- 1.2 [DL + LL+ (EL_y+ 0.3 El_x + 0.3 EL_z)]
- 1.2 [DL + LL - (El_y + 0.3 El_x + 0.3 EL_z)]
- 1.5 [DL + (EL_x + 0.3 El_y + 0.3 EL_z)]
- 1.5 [DL - (EL_x + 0.3 El_y + 0.3 EL_z)
- 1.5 [DL + (El_y + 0.3 EL_x + 0.3 EL_z)]
- 1.5 [DL - (El_y + 0.3 EL_x + 0.3 EL_z)] 0.9 DL + 1.5 (EL_x + 0.3EL_y + 0.3EL_z)
- 0.9 DL - 1.5 (EL_x + 0.3El_y + 0.3 EL_z) 0.9 DL + 1.5 (El_y + 0.3EL_x+ 0.3EL_z)
- 0.9 DL - 1.5 (El_y + 0.3EL_x + 0.3 EL_z)

III. MODELING AND ANALYSIS

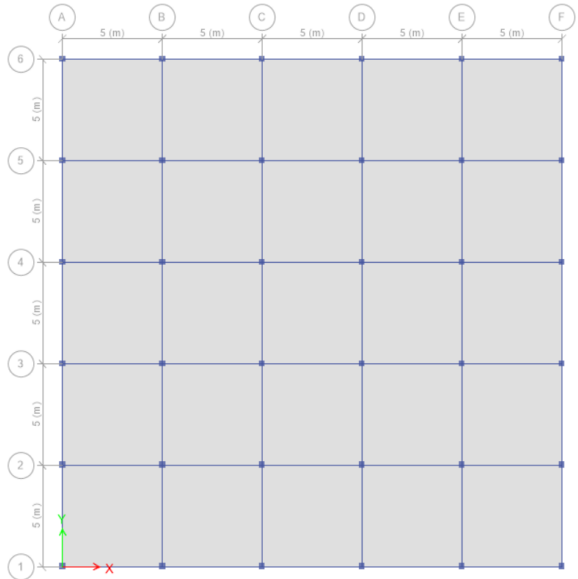

Fig -1: structural plan of G+14 multi - story building

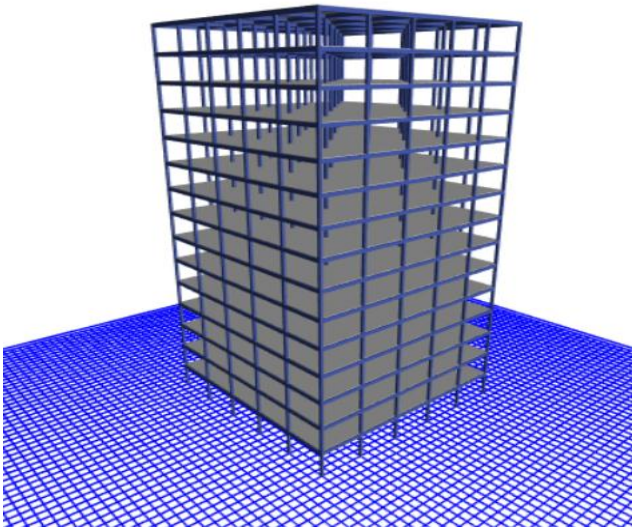

Fig -2: 3D view G+14 multi-story building

IV. RESULTS

Lateral load distribution:

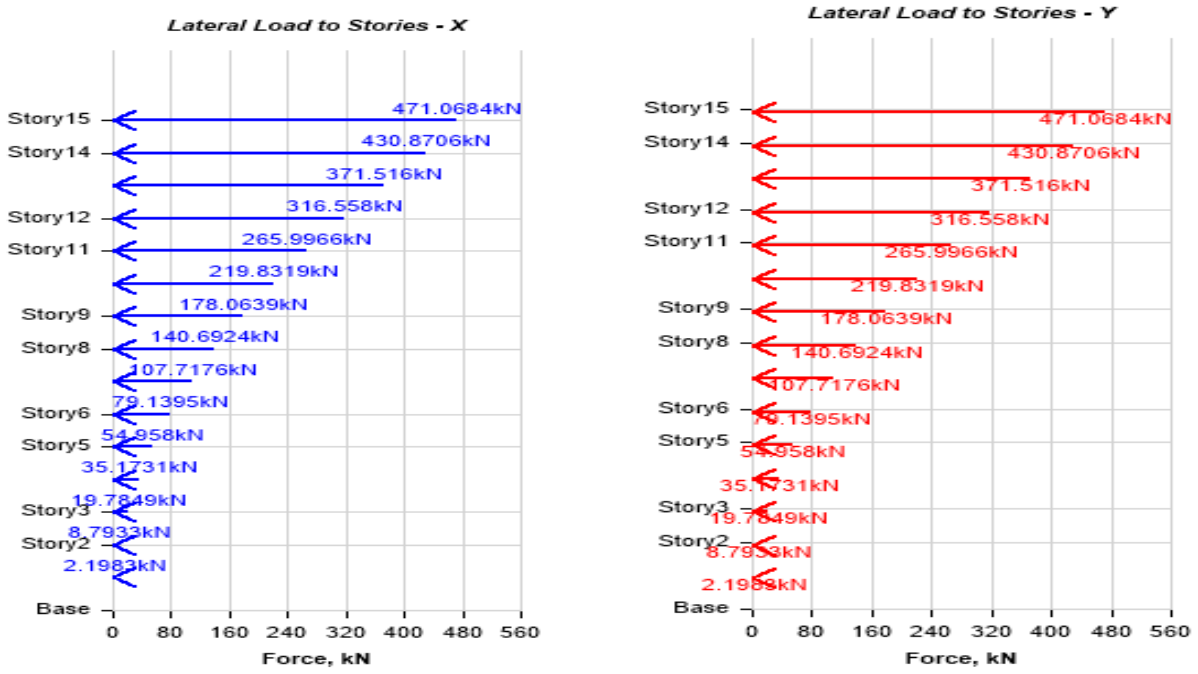

Fig-3: Lateral load for different stories x and y direction as per IS 1893:2002

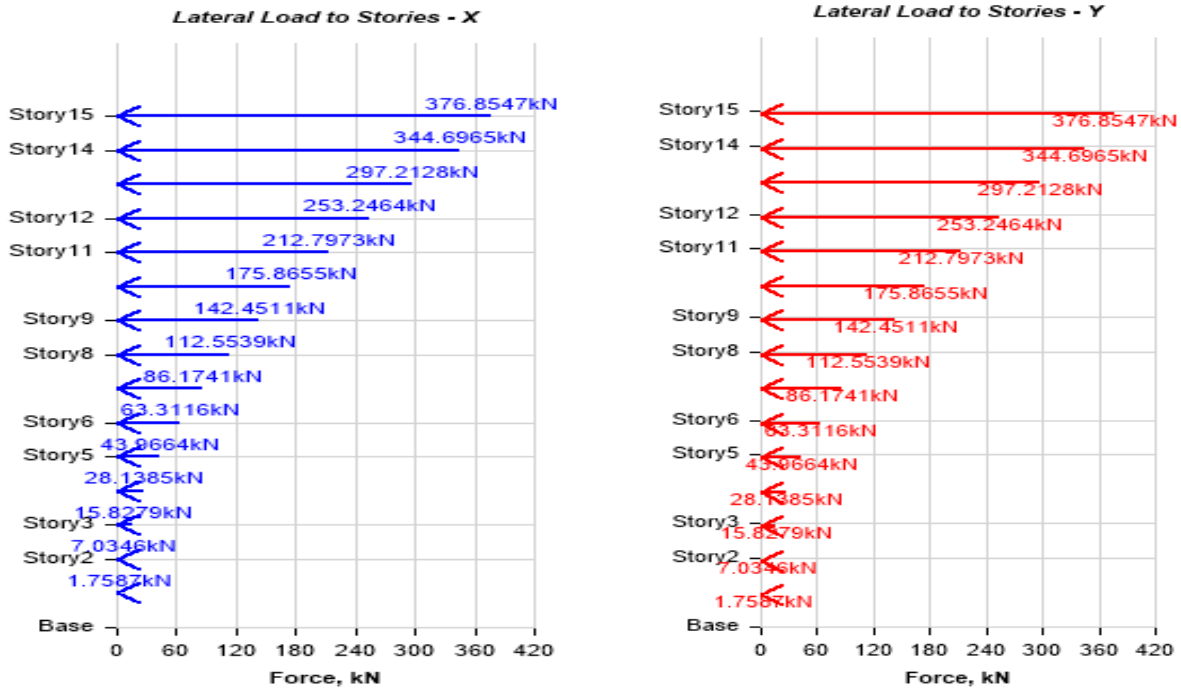

Fig-4: Lateral load for different stories x and y direction as per IS 1893:2016

Table 1 Lateral load for different stories x

Lateral load IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X-Direction (kN)**
Story 15(max)	52.5	Top	471.06
Story 1 (min)	3.5	Top	2.1983

Table 2 Lateral load for different stories x

Lateral load IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	376.85
Story 1 (min)	3.5	Top	1.758

- Comparison of Lateral load distribution as per IS 1893:2002 and IS 1893:2016 the value found to be decreased by 19%.

Base shear:

Table 3 Base shear in X- Direction

Sr. N	IS CODE	A_h	W (kN)	V_b X-Direction
1	IS 1893:2002	0.01836	147187.5	2702.36
2	IS 1893:2016	0.01468	147187.5	2161.89
3	% Decrease	20	0	20

- As per modification of importance factor in new code(IS 1893:2002), its value changes from 1.5 to 1.2 for Residential or commercial buildings, with occupancy more than 200 persons, the same will significantly changes the horizontal seismic coefficient A_h and due to change in horizontal seismic coefficient, the value for the base shear and lateral load distribution will change.

Story stiffness due to response spectrum:

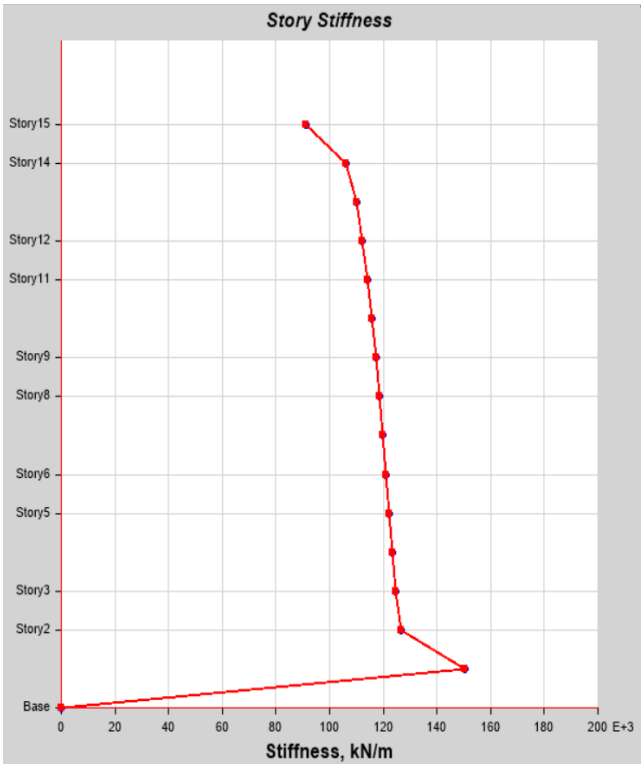

Fig-5
Fig-5: Story stiffness due to response spectrum as per IS 1893:2002

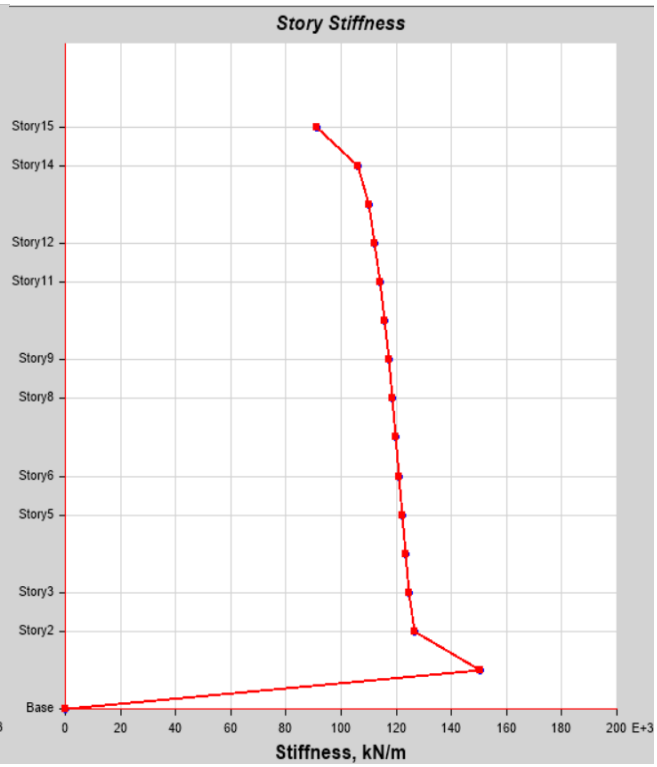

Fig-6
Fig-6: Story stiffness due to response spectrum as per IS 1893:2016

Table 4 Story stiffness due to response spectrum

stiffness due to response spectrum IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(min)	52.5	Top	91007.427
Story 1 (max)	3.5	Top	150461.623

Table 5 Story stiffness due to response spectrum

stiffness due to response spectrum IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(min)	52.5	Top	91007.374
Story 1 (max)	3.5	Top	150461.625

- On Comparing the stiffness of two models due to response spectrum as per IS 1893:2002 and IS 1893:2016 the stiffness was found to be decreased by very small values for the respective stories of the two models, example for story 15 (0.0000026%) and story 1 (0.0000023%).
- As per the tables data of each story the value of lateral stiffness is almost same for both the models (as per IS1893:2002 & IS 1893:2016). As per modification made in 1893:2016 only definition for soft storey is change.
- It means there is no criteria changing hence the value for all story will be same by analysing using both codes.
- Only the parameter to decide the soft story changes in term of lateral stiffness.

Maximum Story displacement:

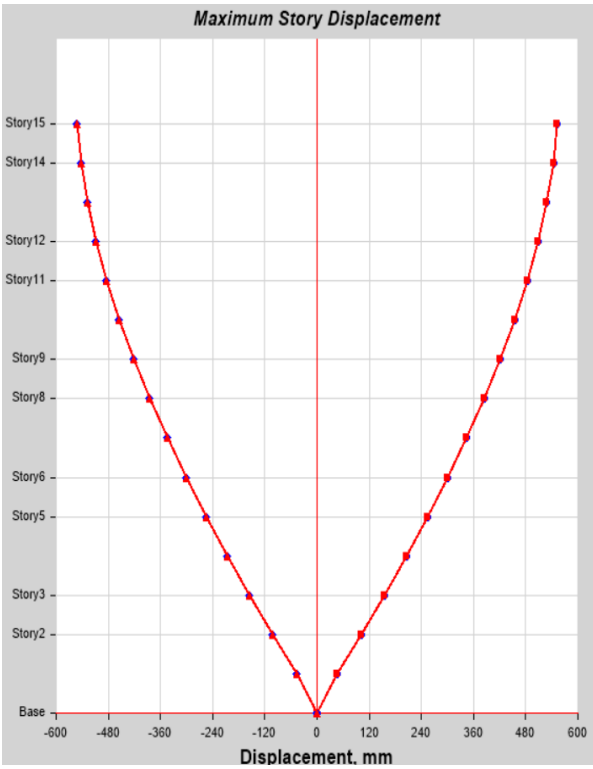

Fig-7

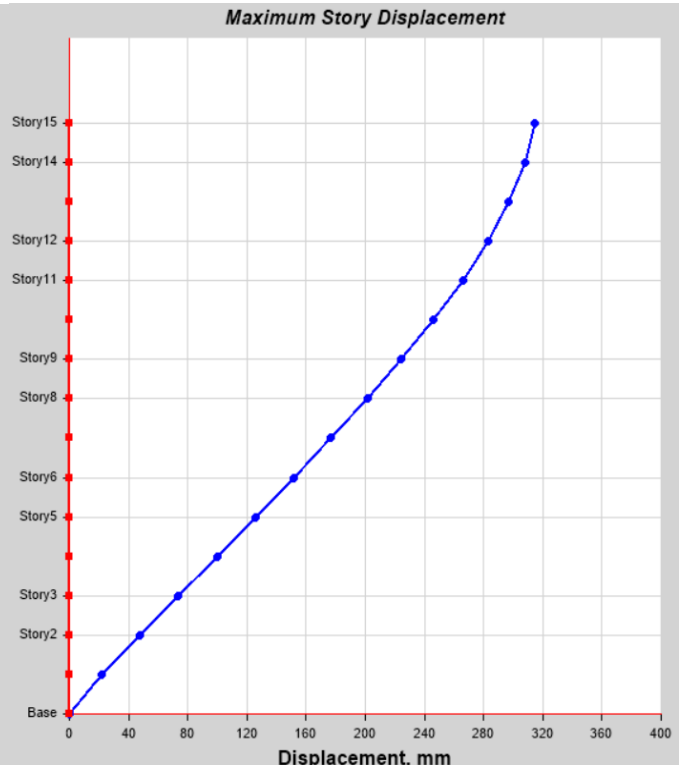

Fig-8

Fig-7: maximum Story displacement due to load combination 28 as per IS 1893:2002,
Fig-8:maximum Story displacement due to load combination 29 as per IS 1893:2016

Table 6 maximum Story displacement due to load combination 29 as per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	552.694
Story 1 (min)	3.5	Top	46.634

Table 7 maximum Story displacement due to load combination 29 as per IS 1893:2016

maximum Story displacement IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	314.57
Story 1 (min)	3.5	Top	21.651

- Comparison of Story displacement due to Load combination 1.5 (DL + Response spectrum) was found maximum at story 15 as per IS 1893:2002 and for load combination (0.9 DL + 1.5 EQ_x) found the maximum story displacement at story 15 as per IS 1893:2016.
- Story displacement due to Load combination 1.5 (DL + Response spectrum) was found minimum at story 1 as per IS 1893:2002 and for load combination (0.9 DL + 1.5 EQ_x) Story displacement was found at story 1 as per IS 1893:2016. The value was found to be decreased by 43% for story 15 (max) and 53.56% for story 1 (min).

Maximum Story drift:

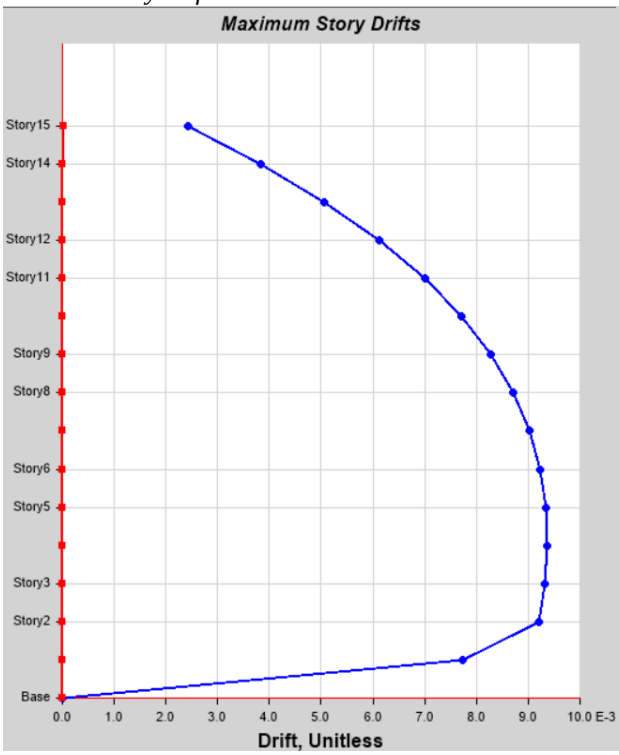

Fig-9

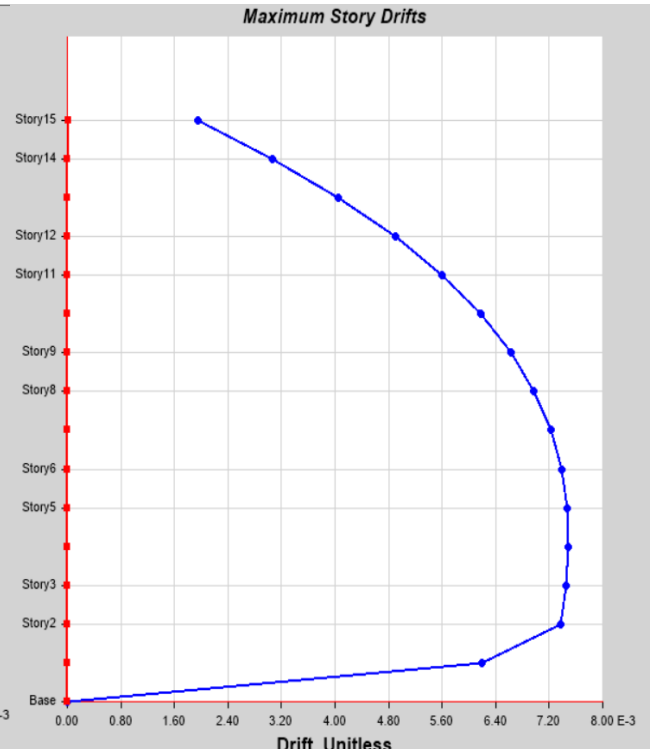

Fig-10

Fig-9: Maximum Story displacement due to load combination 20 1.5 (DL - EQ_x) as per IS 1893:2002,
Fig-10: maximum Story displacement due to load combination 25 1.5 (DL + EQ_x) as per IS 1893:2002

Table 8 Maximum Story displacement due to load combination 20 , 1.5 (DL - EQx) as per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction**
Story 15(min)	52.5	Top	0.00243
Story 1 (max)	3.5	Top	0.00773

Table 9 Maximum Story displacement due to load combination 25, 1.5(DL+EQx) as per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction**
Story 15(min)	52.5	Top	0.001953
Story 1 (max)	3.5	Top	0.006187

- Comparison of Story drift due to Load combination 1.5(DL - EQ_x) was found minimum at story 15 as per IS 1893:2002 and for load combination 1.5(DL + EQ_x) was found the minimum story drift at story 15 as per IS 1893:2016 .
- For maximum Story drift due to Load combination 1.5(DL - EQ_x) was found maximum at story 1 as per IS 1893:2002 and for load combination 1.5(DL+ EQ_x) was found the maximum story drift at story 1 as per IS 1893:2016 the value found decrease story 15 (min) 19% for story 1 (max) value decrease 19% compare of both code parameter.

V. CONCLUSIONS

[1] As per modification of importance factor in new code(IS 1893:2002), its value changes from 1.5 to 1.2 for Residential or commercial buildings, with occupancy more than 200 persons, the same will significantly changes the horizontal

seismic coefficient A_h and due to change in horizontal seismic coefficient, the value for the base shear and lateral load distribution will change.

[2] Comparison of Lateral load distribution as per IS 1893:2002 and IS 1893:2016 the value found to be decreased 19%.

[3] On Comparing the stiffness of two models due to response spectrum as per IS 1893:2002 and IS 1893:2016 the stiffness was found to be decreased by very small values for the respective stories of the two models, example for story 15 (0.0000026%) and story 1 (0.0000023%).As per the tables data of each story the value of lateral stiffness is almost same for both the models (as per IS1893:2002 & IS 1893:2016). As per modification made in 1893:2016 only definition for soft storey is change. It means there is no criteria changing hence the value for all story will be same by analysing using both codes. Only the parameter to decide the soft story changes in term of lateral stiffness.

[4] Comparison of Story displacement due to Load combination 1.5 (DL + Response spectrum) was found maximum at story 15 as per IS 1893:2002 and for load combination (0.9 DL+1.5 EQ_x) found the maximum story displacement at story 15 as per IS 1893:2016. Story displacement due to Load combination 1.5 (DL +Response spectrum) was found minimum at story 1 as per IS 1893:2002 and for load combination (0.9 DL+1.5 EQ_x) Story displacement was found at story 1 as per IS 1893:2016. The value was found to be decreased by 43% for story 15 (max) and 53.56% for story 1 (min).

[5] Maximum lateral displacement and lateral increases when storey height increases.

[6] Minimum story drift will increase with increase in the story height and maximum at the bottom story.

[7] Comparison of Story drift due to Load combination 1.5(DL - EQ_x) was found minimum at story 15 as per IS 1893:2002 and for load combination 1.5 (DL + EQ_x) was found the minimum story drift at story 15 as per IS 1893:2016.For maximum Story drift due to Load combination 1.5 (DL - EQ_x) was found maximum at story 1 as per IS 1893:2002 and for load combination 1.5 (DL + EQ_x) was found the maximum story drift at story 1 as per IS 1893:2016 the value found decrease story 15 (min) 19% for story 1 (max) value decrease 19% compare of both code parameter.

REFERENCES

[1] IS 1893:2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, India.

[2] IS 1893:2000, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, India.

[3] Ratnesh Pathak, Shubhranshu Jaiswal, Behaviour of Asymmetric Building During Earthquake, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 05 | May 2019, www.irjet.net

[4] Mayur R. Rethaliya,Bhavik R. Patel , Dr. R. P.Rethaliya A Comparative Study of Various Clauses of New IS 1893 (Part 1):2016 and Old IS 1893 (Part 1):2002, International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887 Volume 6 Issue I, January 2018- Available at www.ijraset.com

[5] P.S. Girigosavi ,Prof. M.S. Kakamare Static analysis of multistoried building as per IS 1893-2002 AND IS 1893-2016, Volume: 05 Issue: 04 | Apr-2018 ,International Research Journal of Engineering and Technology (IRJET).

[6] Anoj Surwase, Dr. Sanjay K. Kulkarni , Prof. Manoj Deosarkar, Seismic Analysis and Comparison of IS 1893 (Part-1) 2002 and 2016 of (G+4) Regular and Irregular Building, Vol. 7, Issue 6, June 2018,International Journal of Innovative Research in Science, Engineering and Technology .

[7] Mayur R. Rethaliya, Nirav S. Patel , Dr. R.P. Rethaliya, Seismic Analysis of Multistory Buildings Using ETABS-A Review , Volume 4, Issue 12, December -2017, International Journal of Advance Engineering and Research Development

[8] Ravikant Singh and Vinay Kumar Singh, Analysis of Seismic Loads acting on multistory Building as per IS: 1893-2002 and IS: 1893-2016 :- A comparative Study, Volume 4, Issue 5; July – September,2017, pp. 405-408, Journal of Civil Engineering and Environmental Technology, Krishi Sanskriti http://www.krishisanskriti.org/Publication.html.

[9] Rakesh kumar Gupta, Prof. D.L. Budhlani, Review of IS 1893:2016 with IS1893:2002 for high rise structure with irregularities , Vol. 3, No.7 2018, International Journal of Innovations in Engineering and Science, www.ijies.net

[10] Ali Kadhim Sallal, Design and analysis ten storied building using ETABS software-2016, Volume 4; Issue 2; May 2018; Page No. 21-27, International Journal of Research in Advanced Engineering and Technology, www.newengineeringjournal.in

[11] Ajay Kumar, A Comprative study of static analysis (as per IS: 1893-2002) & dynamic analysis (as per IS:1893-2016) of a building for zone V, Volume 10, Issue 04, April 2019, pp. 1001-1012. Article ID: IJCIET_10_04_105 , International Journal of Civil Engineering and Technology (IJCIET), Available online at http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=10&IType=04

[12] Mahesh N. Patil, Yogesh N.Sonawane, Seismic Analysis of multistoried Building, Volume 4, Issue 9, March 2015, International Journal of Engineering and Innovative Technology (IJEIT).

[13] Girum Mindaye Dr. Shaik Yajdani, Seismic Analysis of aMultistorey RC Frame Building in Different Seismic Zone Vol. 5, Issue 9, September 2016, International Journal of Innovative Research in Science, Engineering and Technology.