DYNAMIC ANALYSIS OF MULTI-STORIED BUILDING AS PER IS 1893-2002 AND IS 1893-2016

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Abstract - *This paper concerned with study on revision of IS 1893-2016.The dynamic analysis of multi-storied building is done by using FEM based software. In present study, the dynamic analysis is carried out as per IS 1893-2016 and results such as lateral displacement, base shear, storey drift are compared with IS1893-2002. This paper deals with the comparison of design forces for multi-storied buildings, obtained by using IS 1893-2016 code, with those obtained by the previous IS1893-2002 version. From the results of dynamic analysis of buildings it is concluded that the IS1893-2016 is more conservative for earthquake analysis of multi-storey buildings.*

Key Words: Multi-storied building, dynamic analysis, IS1893-2016, IS1893-2002.

1. INTRODUCTION

When earthquakes occur, a building undergoes dynamic motion. This is because the building is subjected to inertia forces that act in opposite direction to the acceleration of earthquake excitations. These inertia forces, called seismic loads, are usually dealt with by assuming forces external to the building. So, apart from gravity loads, the structure will experience dominant lateral forces of considerable magnitude during earthquake shaking. It is essential to estimate and specify these lateral forces on the structure in order to design the structure to resist an earthquake. Indian seismic code IS: 1893 has also been revised in year 2016. This paper presents the seismic load estimation of multi storied buildings as per IS: 1893(part) -2016. The process gives dynamic analysis of multi-storied building by using FEM based software and the results are used to compare old codal provions viz. lateral displacement, base shear, storey drift computed as per the two versions of seismic code. So, this paper deals with comparative study of IS 1893-2002 and IS 1893-2016. Model considered for this paper is 15 storied residential building using FEM based software. The height of each storey is taken as 3 meter and base story height 0.45 m making the total height of the structure 45.45 meter. Dynamic Analysis of the structure is done and results generated by software are compared as per IS 1893:2002 and IS 1893-2016.

2. LITERATURE SURVEY

S. Farrukh Anwar, A. K. Asthana (2013) "Evaluation of Seismic Design Forces of Indian Building Code" [1]: The recent fifth revision of Indian Seismic Code, IS: 1893 has been split into five separate parts for different types of structures. The new code IS: 1893 (Part-1)? 2002 contains provisions specific to buildings only, along with general provisions applicable to all structures. This paper deals with the comparison of seismic design forces for multi-storied buildings, obtained by using the new code, with those obtained by the previous 1984 version. From the results of seismic analysis of buildings it is concluded that the new code is more conservative for buildings resting on soft and medium soils.

S.K. Ahirwar, S.K. Jain and M. M. Pande (2008) "earthquake loads on multistorey buildings as per is: 1893-1984 and is: 1893-2002: a comparative study" [2]: As a result Indian seismic code IS: 1893 has also been revised in year 2002.This paper presents the seismic load estimation for multi-storey buildings as per IS: 1893-1984 and IS: 1893-2002 recommendations. Four multistorey RC framed buildings ranging from three storied to nine storied are considered and analyzed. The process gives a set of five individual analysis sequences for each building and the results are used to compare the seismic response viz. storey shear and base shear computed as per the two versions of seismic code. The seismic forces, computed by IS: 1893-2002 are found to be significantly higher, the difference varies with structure properties. It is concluded that such study needs to be carried out for individual structure to predict seismic vulnerability of RC framed buildings that were designed using earlier code and due to revisions in the codal provisions may have rendered unsafe.

Sudhir K Jain (2003) "Review of Indian seismic code, IS 1893 (Part 1) : 2002"[3] : The Indian seismic code IS 1893 has now been split into a number of parts and the first part containing general provisions and those pertaining to buildings has been released in 2002. There has been a gap of 18 years since the previous edition in 1984. Considering the advancements in understanding of earthquake-resistant design during these years, the new edition is a major upgradation of the previous version. This paper reviews the new code; it contains a discussion on Clauses that are confusing or vague and need clarifications immediately. The typographical and editorial errors are pointed out. Suggestions are also included for next revision of the code.

C.V.S. Lavanya, Emily.P.Pailey, Md. Mansha Sabreen (2017) “Analysis and design of g+4 residential building using Etabs” [4]: ETABS stands for Extended Three Dimensional Analysis of Building Systems. The main purpose of this software is to design multi-storied building in a systematic process. The effective design and construction of earthquake resistant structures have great importance all over the world. This project presents multi-storied residential building analysed and designed with lateral loading effect of earthquake using ETABS. This project is designed as per INDIAN CODES- IS 1893-part2:2002, IS 456:2000 and analysis is carried out by considering severe seismic zones and behaviour is assessed by taking type-II Soil condition,

Mahesh Patil, Yogesh Sonawane (2015) “Seismic Analysis of Multistoried Building”[5] : The effective design and the construction of earthquake resistant structures have much greater importance in all over the world. In this paper, the earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The responses obtained by manual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well software analysis of seismic coefficient method.

Following methods are adopted for analysis of building for design earthquake loads.

1. Equivalent Static Method, and

2. Dynamic Analysis Method.

Dynamic analysis can be performed in three ways,

1. Response Spectrum Method,

2. Modal Time History Method, and

3. Time History Method.

For Tall Buildings, Response Spectrum Method and Time History Method are adopted

3. PROBLEM FORMULATION

Consider the residential multi-storey building having strength greater than 200 people. Building details are as follows.

Building Plan:

a) Colum Size: 400mm x 600mm up to 8 storeys.
   400 mm x 400mm up to 15 storeys.

b) Beam size: 230mm x 450 mm

c) Storey Height: base height 0.45 m,3 m each floor

d) Live load: 2 KN/m2

e) Floor finish: 1KN/m2

f) Seismic: V

g) Colum Material Grade: M30

h) Beam and slab concrete Grade: M25

Load Combinations for code IS 1893-2002.

1.5(DL +IL)

1.2[DL + LL + (ELx+0.3Ely)]

1.2[DL + LL - (ELx+0.3Ely)]

1.2[DL + LL + (ELy+0.3Elx)]

1.2[DL + LL - (Ely+0.3Elx)]

1.5[DL+ (ELx+0.3Ely)]

1.5[DL- (ELx+0.3Ely)]

1.5[DL+ (ELy+0.3Elx)]

1.5[DL- (Ely+0.3Elx)]

0.9DL+1.5(ELx+0.3Ely)]

0.9DL-1.5(ELx+0.3Ely)]

0.9DL+1.5(ELy+0.3Elx)]

0.9DL-1.5(Ely+0.3Elx)]

Load Combinations for code IS 1893-2016.

1.2[DL+LL+ (ELx+0.3Ely+0.3ELz)]

1.2[DL+LL-(ELx+0.3Ely+0.3ELz)]

1.2[DL+LL+ (ELy+0.3Elx+0.3ELz)]

1.2[DL+LL-(Ely+0.3Elx+0.3ELz)]

1.5[DL+ (ELx+0.3Ely+0.3ELz)]

1.5[DL-(ELx+0.3Ely+0.3ELz)

1.5[DL+ (Ely+0.3ELx+0.3ELz)]

1.5[DL-(Ely+0.3ELx+0.3ELz)]

0.9DL+1.5(ELx+0.3ELy+0.3ELz)

0.9DL-1.5(ELx+0.3Ely+0.3ELz)

0.9DL+1.5(Ely+0.3ELx+0.3ELz)

0.9DL-1.5(Ely+0.3ELx+0.3ELz)

4. OBJECTIVES:

1. To study behaviour of multi-storied building as per IS1893-2002 and revision of IS 1893 Part1-2016.

2. To dynamic analyse G+ 14 residential multi-storey building having capacity greater than 200 people.

3. To study parameters such as lateral displacement,Base shear, storey drifts multi-storied building.

4. To compare analysis results obtained for new and old codes.

5. MODELING AND ANALYSIS

Consider G+14 residential multi-storey building having strength greater than 200 people. Building details are as follows.

Fig -1: Building typical floor plan.

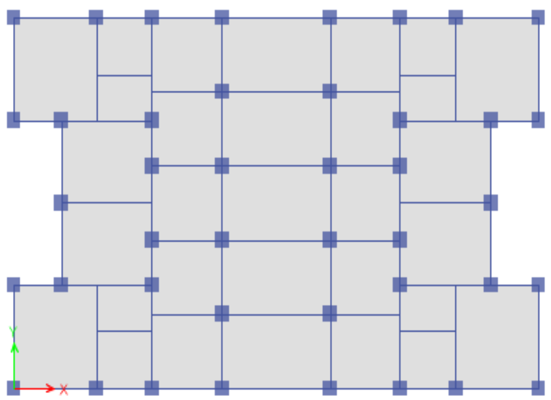

Fig -2: structural plan of G+14 residential building

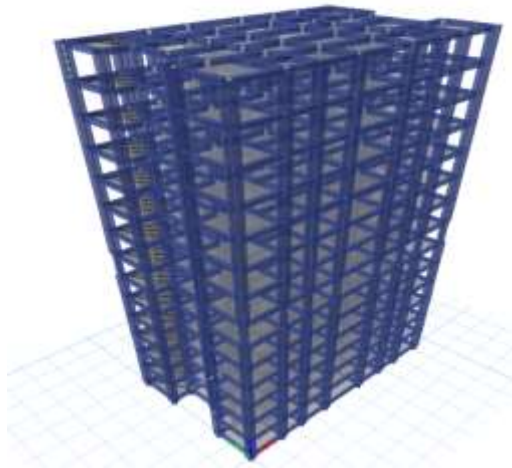

Fig -3: 3D view G+14 residential building

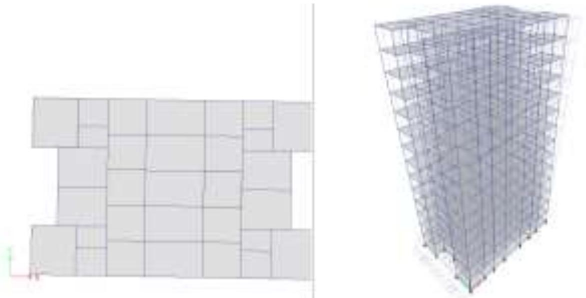

Fig -4: Displacement along X direction.

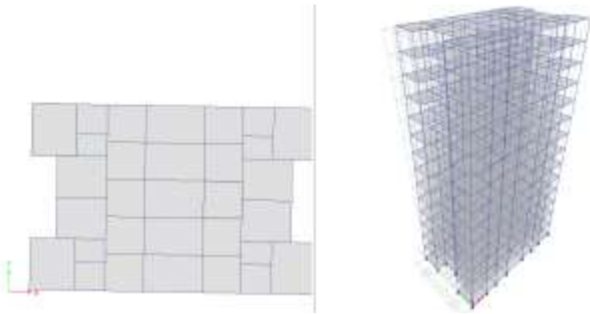

Fig -5: Displacement along Y direction.

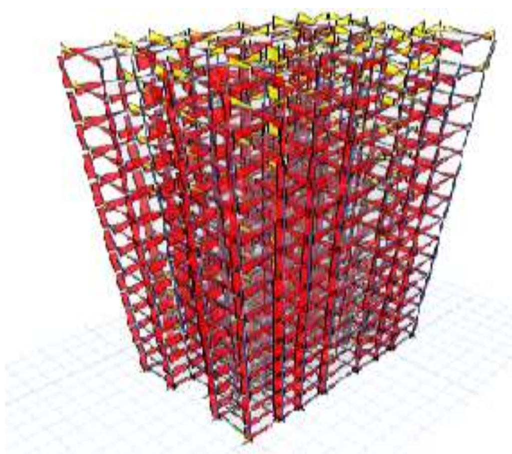

Fig -5: Shear force of G+14 residential building

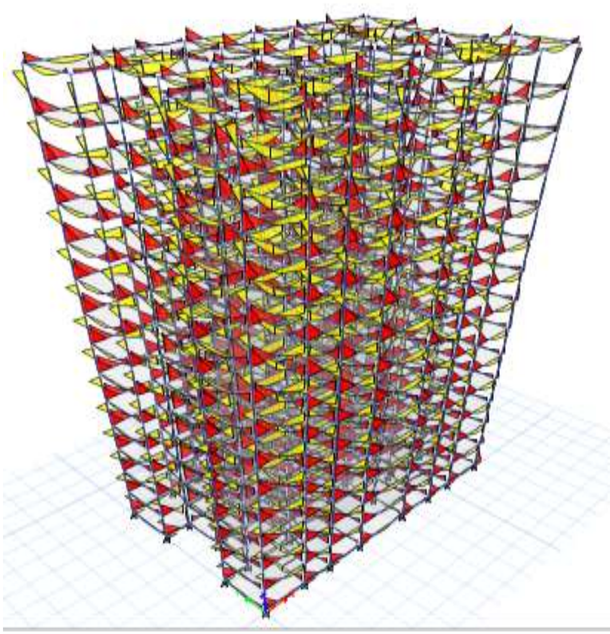

Fig -6: Bending moment of G+14 residential building

6. RESULTS

Consider results for Equivalent static method

Table: seismic load in X- direction and Y Direction

Story	**Elevation m**	**X KN**	**Y KN**
Story15	42.45	534.6903	525.7386
Story14	39.45	494.5573	486.2775
Story13	36.45	422.1994	415.131
Story12	33.45	355.5616	349.6088
Story11	30.45	294.6437	289.7108
Story10	27.45	239.4458	235.4371
Story9	24.45	189.9679	186.7875
Story8	21.45	141.3847	139.0176
Story7	18.45	104.19	102.4456
Story6	15.45	75.8542	74.5842
Story5	12.45	49.2562	48.4316
Story4	9.45	28.3783	27.9032
Story3	6.45	13.2203	12.999
Story2	3.45	3.7823	3.719
Story1	0.45	0.0608	0.0598
Base	0	0	0

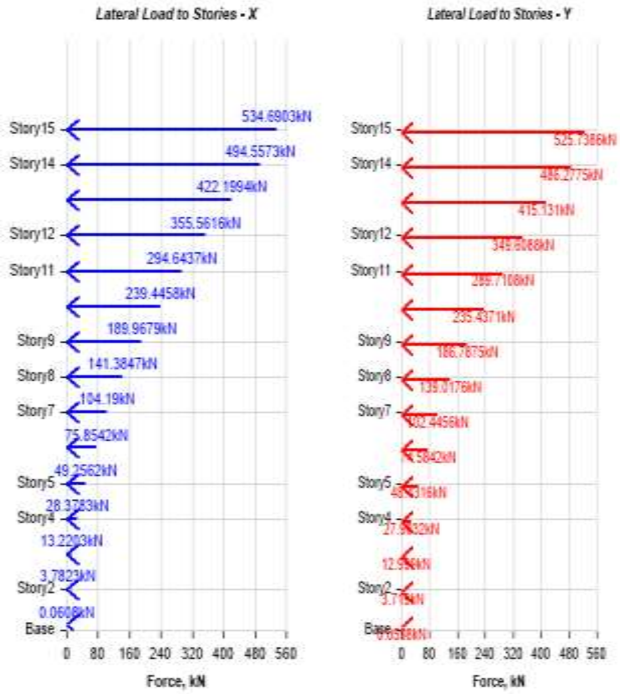

Fig-7: Seismic load for different stories as per IS 1893-2002.

Table: seismic load in X- direction and Y Direction

Story	**Elevation m**	**X KN**	**Y KN**
Story15	42.45	642.215	631.4712
Story14	39.45	593.9298	583.9938
Story13	36.45	507.033	498.5506
Story12	33.45	427.0054	419.8619
Story11	30.45	353.8472	347.9275
Story10	27.45	287.5582	282.7476
Story9	24.45	228.1386	224.322
Story8	21.45	169.7834	166.9431
Story7	18.45	125.1344	123.0409
Story6	15.45	91.0957	89.5718
Story5	12.45	59.1534	58.1638
Story4	9.45	34.0804	33.5103
Story3	6.45	15.8767	15.6111
Story2	3.45	4.5423	4.4663
Story1	0.45	0.0729	0.0717
Base	0	0	0

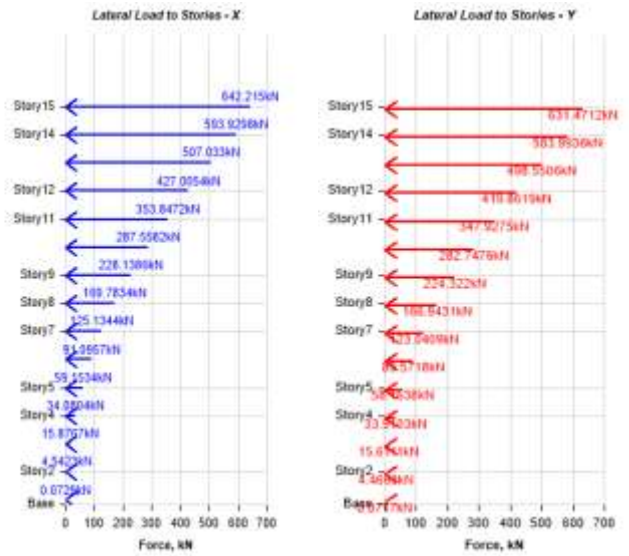

Fig-8: seismic load for different stories as per IS 1893-2016.

Base shear

Table: Base shear in X- direction and Y Direction

Sr. No	IS Codes	Direction X	Direction Y
1	IS 1893-2002	2575.46	2404.52
2	IS 1893-2016	3092.92	2887.73
3	% INCREASE	20.09	20.09

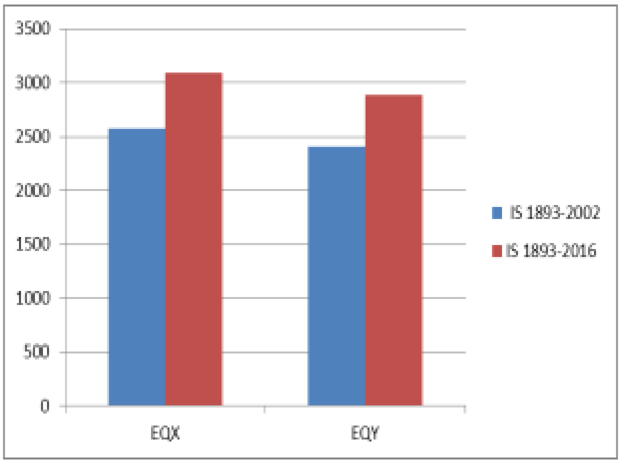

Fig-9: Graph for Base shear for Dynamic analysis as per is 1893-2002 and IS 1893-2016

Chart 1: Maximum displacement along EQx as per IS 1893-2002

Chart 2: Maximum displacement along EQy as per IS 1893-2002

Chart 3: Maximum displacement along EQx as per IS 1893-2016

Chart 4: Maximum displacement along EQy as per IS 1893-2016

Maximum Lateral displacement

Table: maximum lateral displacement along EQx and EQy

Storey	IS Codes	EQX(mm)	EQY(mm)
15	IS1893-2002	88.09	94
15	IS1893-2016	106.9	112.8
	% INCREASE	20.25	20.00

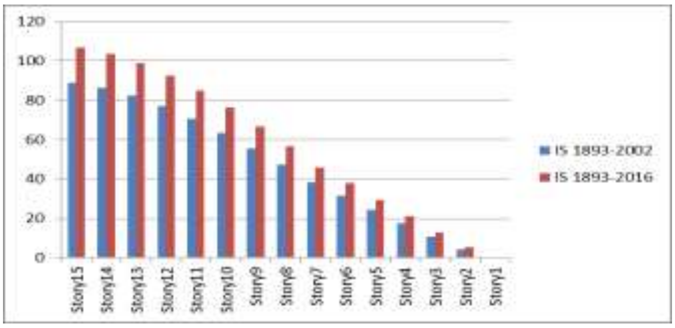

Fig-10: Graph for maximum lateral displacement along X-direction as per is 1893-2002 and IS 1893-2016.

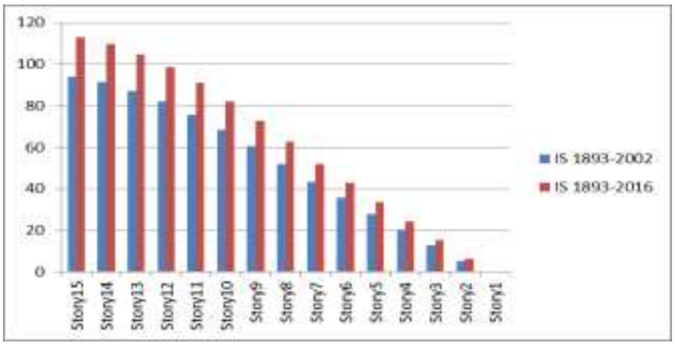

Fig-11: Graph for maximum lateral displacement along Y-direction per is 1893-2002 and IS 1893-2016.

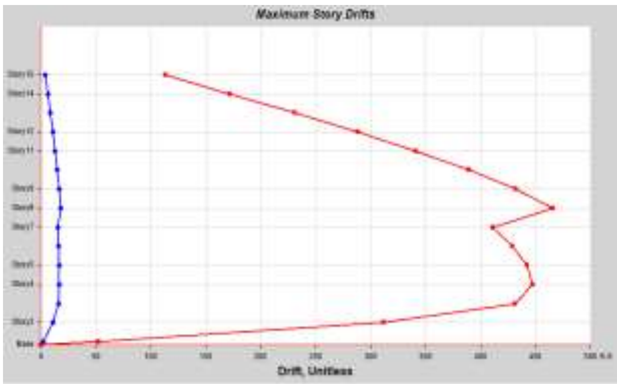

Chart 5: storey drift as per IS 1893- 2002

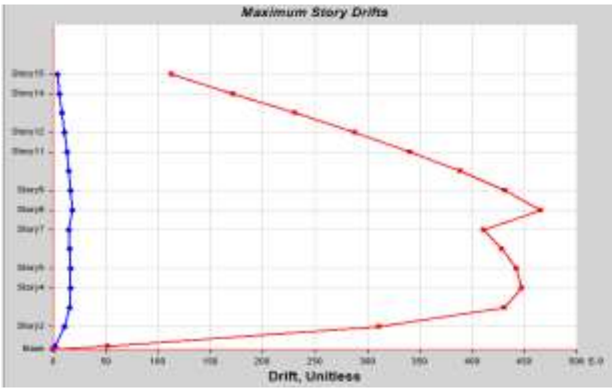

Chart 6: Storey drift as per IS 1893- 2016.

Storey Drift

Table: Storey Drift in X- direction and Y Direction

Storey	IS Codes	X (mm)	Y (mm)
15	IS1893-2002	0.001287	0.001358
8	IS1893-2016	0.001889	0.002002
	% INCREASE	46.78	47.42

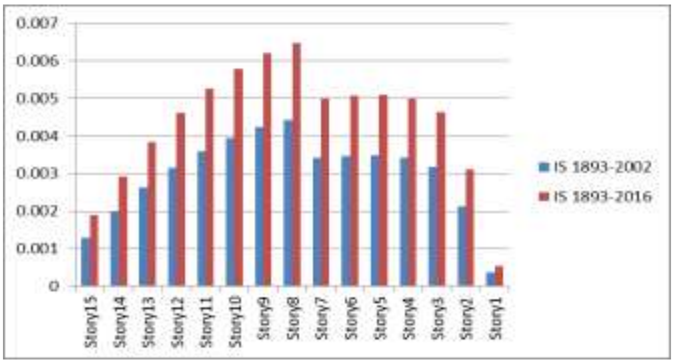

Fig-12: Graph for storey drift along X-direction as per is 1893-2002 and IS 1893-2016.

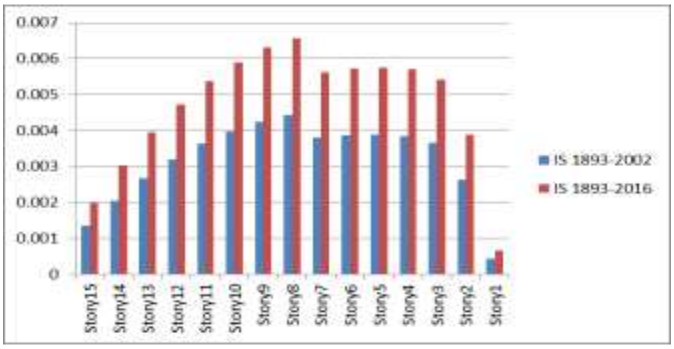

Fig-10: Graph for storey drift along Y-direction as per is 1893-2002 and IS 1893-2016.

Design reaction at base

Table: Design Forces along X and Y direction

IS 1893-2002			
Joint label	Load combination	Fx(max) KN	Fy(max) KN
14	1.5[DL- (ELx+0.3Ely)]	258.6289	
20	1.5[DL- (Ely+0.3Elx)]	-	310.05
IS 1893-2016			
Joint label	Load combination	Fx(max) KN	Fy(max) KN
14	1.5[DL-(ELx+0.3Ely+0.3ELz)	314.2302	
12	1.5[DL-(Ely+0.3ELx+0.3ELz)]		379.0894

Design moment

Table: Design moment along X and Y direction.

IS 1893-2002			
Joint label	Load combination	Mx(max) KN-m	My(max) KN-m
39	1.5[DL+ (ELy+0.3Elx)]	262.301	
27	1.5[DL- (ELx+0.3Ely)]	-	229.4918
IS 1893-2016			
Joint label	Load combination	Mx(max) KN-m	My(max) KN-m
15	1.5[DL+(Ely+0.3ELx+0.3ELz)]	385.7304	
12	1.5[DL-(ELx+0.3Ely+0.3ELz)		326.3409

7. CONCLUSIONS

1. Maximum lateral displacement, lateral load to stories increases when storey height increases. In case of storey drift displacement value is high at top storey as compare to bottom storey.

2. Maximum displacement found along EQx and EQy.As per IS1893-2002 is 88.90 mm and 94 mm and as per IS 1893-2016 is 106.90 mm and 112.80 mm.

3. Storey drift found along x and y direction. As per IS1893-2002 is 0.001273 mm and 0.001358 mm and as per IS 1893-2016 is 0.001889 mm and 0.002002mm.

4. Design forces obtained at base along x and y direction. As per IS1893- 2002 is 258.63 KN and 310.05 KN whereas for new code IS1893-2016 is obtained is 314.23 KN and 379.08 KN along x and Y direction

5. Design moment obtained at base along x and y direction as per IS1893- 2002 is 262.30 KN-m and 229.49 KN-m whereas for new code IS1893-2016 it is 385.73 KN-m and 326.34 KN-m along x and Y direction

8. REFERENCES

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