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Analysis of Seismic Loads acting on Multistory Building as per IS: 1893-2002 and IS: 1893-2016 :- A comparative Study

Ravikant Singh[1] and Vinay Kumar Singh[2]

[1,2]*Department of Civil Engineering, MMM University of Technology, Gorakhpur*

Abstract—*Many changes and improvement in the Earthquake resistant design of structure is done in past recent years. It results in the changes in the Indian seismic code IS 1893 which is revised and drafted in year 2016, after a time elapsed of nearly 14 years.*
In this paper we represents the seismic load assessment for multistory building as per IS: 1893-2002 and IS: 1893-2016 recommendations. Considering and analyzing the four storey RC framed multistorey building.
It is concluded that such study is done on individual RC framed building structure which is designed using earlier code. To predict the seismic vulnerability of building structure and to check due to revisions and changes in the IS codal provisions the structure is safe or unsafe.

Keywords*: - seismic loads, IS: 1893-2002 RC framed buildings, IS: 1893-2016, IS codal recommendations*

1. INTRODUCTION

Seismic code help designer to construct and improve the behavior of structure. So it can withstand during Earthquake effect and reduce loses. Seismic code are unique for particular country and region.

Seismic code consider the local seismology with recognized level of Earthquake risk, properties of raw material, methods and technique used in design and construction of building. It shows the country progress and development in the field of Earthquake Engineering.

The changes made in the IS code based on the observation and data collected from past Earthquakes, and Experimental and logical studies done by engineers, researchers, and seismologists.

As the continuous analysis and efforts put by researchers to study the behavior and performance of structure during past earthquake leads to development and advancement in designing earthquake resistant structure. Therefore, it is required to revise the seismic code time to time. IS: 1893-2016 revised after 14 years in year 2016.

The building design according to previous code are also checked according to revised code as per IS code recommendations. Comparison of building designed according earlier code is done as per revised code recommendation to check whether the building is safe or not safe. If any structural deficiency is found the building is retrofitted to withstand expected design earthquake vibration.

The goal of this paper is to calculate the seismic forces acting on the building as per IS: 1893-2002 and IS: 1893-2016. And also comparison of seismic forces is done using both codes.

2. CHANGES DONE IN IS: 1893-2016

IS 1893 was first published in 1962 and it has been revised 5 times. Last revision was done in 2002 and presently, draft code of part I has been released. The following significant changes have been included in this revised code:

(i) Design spectra are defined for natural time period up to 6 s;
(ii) for all building structures same design response spectra are specified;
(iii) Bases of various load combinations are made consistent, with other codes;
(iv) Temporary structures are brought under the insight of this code.
(v) Importance Factor provisions are modified in code;
(vi) A provision is introduced to ensure that all buildings are designed and constructed for at least a minimum lateral force;
(vii) Buildings with flat slabs are brought under the insight of this code;
(viii) Additional clarity is brought in consideration how to handle different types of irregularity of structural system;
(ix) Effect of masonry infill walls has been contained in design of building frame structure;
(x) Method is introduced for determining approximate natural time period of building

structures with basements, step back buildings and buildings on hill slopes;

(xi) Torsional provisions are made easier; and

(xii) liquefaction potential analysis method is Simplified

3. DETAILS OF BUILDINGS

The multi storey RC buildings are considered for analysis. The building structure is analyzed as individually distinct system.. The structural load calculated on each floor are Permanent load (include all the load on each floor), Weight of one – half of the columns , Weight of the walls above and below the floor , Some amount of live load which always act on the building structure

The geometrical detail of the building is given and we find the fundamental time period of the building structure by using empirical relation as per IS: 1893-2002 and IS: 1893-2016.

Four storey building

Considering RC framed building with 3 x 4 bay configuration. Consider a four-storey RC framed office building as shown in Fig. 1.1. The RC framed building is situated in seismic zone III and soil is medium stiff. The RC framed building is supported on a raft foundation. The reinforced concrete frames of building are infilled with brick-masonry. The dead and live load acting on the floor of building is 12 kN/m^2 and 4 kN/m^2 respectively. The dead and live load acting on the roof of the building is 10 kN/m^2 and 1.5 kN/m^2 respectively. Increase the no. of storey and Calculate seismic load acting on the RC framed building structure as per old and new code.

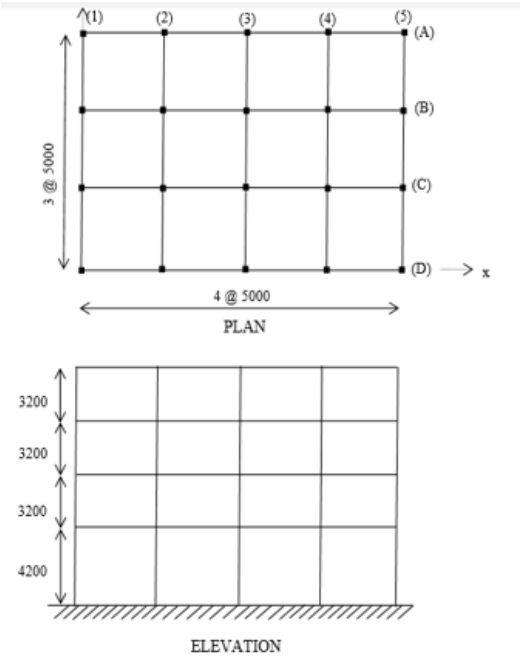

Figure 1: Building Configuration

The detailing of the building is done according to the IS: 13920-1993 and also provided with moment resisting frame (MRF). Moment resisting frame provided for lateral load resistance and also infilled with brick masonry panels.

The Zone factor, Z is 0.16 for seismic zone III. As the building is official building, the Importance Factor, I is 1. The response reduction factor, R is 5. The values of Zone factor, Importance Factor, response reduction factor are given same in the both IS codes.

The fundamental time period calculated using previous and revised code is same as 0.28 sec. and base shear calculated from both code as 832 kN.

Table 1 - Lateral Load acting on building with height by the Static method

Storey Level	W_i (kN)	h_i (m)	$W_i h_i^2$ x 1000	$\frac{W_i h_i^2}{\sum W_i h_i^2}$	Lateral Force at i^{th} Level for EL in direction (kN)	
					X	Y
4	4000	13.8	761.76	0.424	352.768	352.768
3	5600	10.6	629.216	0.350	291.2	291.2
2	5600	7.4	306.656	0.171	142.272	142.272
1	5600	4.2	98.784	0.055	45.76	45.76
			1796.416		832	832

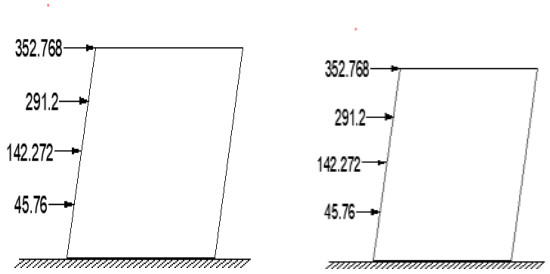

Figure 2 . Design seismic force acting on the building for X and Y direction

Five storey building

The fundamental time period calculated using previous and revised code is same as 0.3421 sec. and base shear calculated from both code as 1056 kN.

Table 2 . Lateral Load acting on building with height by the Static Method

Storey Level	W_i (kN)	h_i (m)	$W_i h_i^2$ x 1000	$\frac{W_i h_i^2}{\sum W_i h_i^2}$	Lateral Force at i^{th} Level for EL in direction (kN)	
					X	Y
5	4000	17	1156	0.3549	374.774	374.774

4	5600	13.8	1066.464	0.3274	345.734	345.734
3	5600	10.6	629.216	0.1931	203.914	203.914
2	5600	7.4	306.656	0.0941	99.37	99.37
1	5600	4.2	98.784	0.0303	31.99	31.99
			3257.12		1056	1056

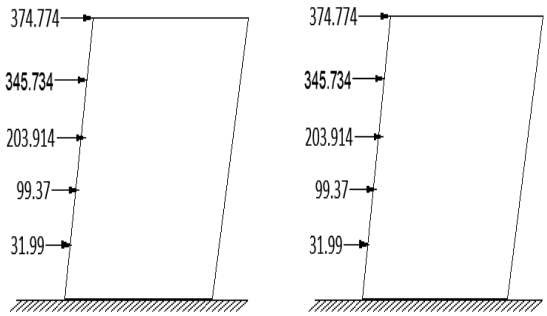

Figure 3. Design seismic force acting on the building for X and Y direction

Six storey building

The fundamental time period calculated using previous and revised code is same as 0.4065 sec. and base shear calculated from both code as 1280 kN.

Table 3 - Lateral Load acting on building with height by the Static Method

Storey Level	W_i (kN)	h_i (m)	$W_i h_i^2$ x 1000	$\frac{W_i h_i^2}{\sum W_i h_i^2}$	Lateral Force at i^{th} Level for EL in direction (kN)	
					X	Y
6	4000	20.2	1632.160	0.305	390.4	390.4
5	5600	17	1618.400	0.3024	387.072	387.072
4	5600	13.8	1066.464	0.1992	254.976	254.976
3	5600	10.6	629.216	0.1175	150.4	150.4
2	5600	7.4	306.656	0.0573	73.344	73.344
1	5600	4.2	98.784	0.0184	23.552	23.552
			5351.68		1280	1280

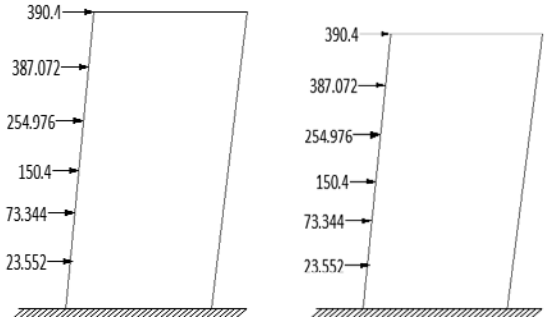

Figure 3 . Design seismic force acting on the building for X and Y direction

4. LOAD CALCULATION AS PER IS: 1893-2016 RECOMMENDATIONS

The aim of the various IS codal recommendation of IS: 1893 is to make sure that structure is able to respond to the earthquake vibration without any structural damage to the structure at moderate intensity and not entirely collapse at the vibrations of high intensities.

As for given building the codal provision for designing the building is similar. So the load calculated for given four storey building is same.

5. CONCLUSIONS

As the analysis of the building structure is carried out from both IS codes to inspect the changes done in latest IS code for calculating lateral force of the multistorey building. The strong and ductile structure is designed as per seismic design approach of both IS codes. The lateral forces acting on the upper storey are more than the lower storey of the building. As we increases the no. of storey in the building the lateral forces acting on the upper storey of the building increases with increase in the base shear of the building .The lateral load and seismic force calculated is same. The building is safe as per revised code and no any structural deficiency is found. There is no need retrofitting of building to withstand expected design earthquake vibration..

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