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Review of IS 1893:2016 with IS 1893:2002 with Plan Irregularity

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Abstract: ***The national building code of India (NBC) 2015 was released by bureau of Indian standards during December 2016/january2017. The various sections of this NBC have undergone changes as per latest technologies and user requirements. It is necessary to identify the performance of the structures to withstand against disaster for both new and existing one. The paper discusses the performance evaluation of RC (Reinforced Concrete) Buildings with plan irregularity. Structural irregularities are important factors which decrease the seismic performance of the structures. This study as a whole makes an effort to evaluate the effect of plan irregularity on RC buildings using IS 1893:2002 and IS 1893:2016 in terms of dynamic characteristics.***

Keywords: Seismic performance, Plan Irregularity, IS 1893:2002, IS1893:2016

1. Introduction

During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. But nowadays need and demand of the latest generation and growing population has made the architects or engineers inevitable towards planning of irregular configurations. Hence earthquake engineering has developed the key issues in understanding the role of building configurations.

2. Methodology

2.1 As per revised code IS 1893 (Part 1): 2016

Structures designed as per this standard are expected to sustain damage during strong earthquake ground shaking. The provisions of this standard are intended for earthquake resistant design of only normal structures. It is not intended in this standard to laydown regulation so that no structure shall suffer any damage during earthquake of all magnitudes. It has been endeavored to ensure that, as far as possible, structures are able to respond, without structural damage to shocks of moderate intensities and without total collapse to shocks of heavy intensities. To control the serious loss of life and property, base isolation or other advanced techniques may be adopted. Currently, the Indian standard is under preparation for design of such buildings; until the standard becomes available, specialist literature should be consulted for design, detail, installation and maintenance of such buildings.

2.2 As per existing code IS 1893 (Part 1) : 2002

Base isolation and energy absorbing devices may be used for earthquake resistant design. Only standard devices having detailed experimental data on the performance should be used. The designer must demonstrate by detailed analyses that these devices provide sufficient protection to the buildings and equipment as envisaged in this standard. Performance of locally assembled isolation and energy absorbing devices should be evaluated experimentally before they are used in practice. Design of buildings and equipment using such device should be reviewed by the competent authority.

To study the effect of earthquake on a high-rise RC framed structure by considering plan irregularities in earthquake seismic zone IV as per IS code 1893 (Part I):2002 and IS code 1893 (Part I):2016

Following steps of methods of analysis are adopted in this study:

- Step-1: Selection of the structures with plan irregularities.
- Step-2: Selection of seismic zone (IV).
- Step-3: Formation of load combinations.
- Step-4: Modeling of building frames using STAAD-Pro software.
- Step-5: Response Spectrum Analysis of all the models.
- Step-6: Comparative study of results (seismic parameters) in terms of Storey lateral displacement and Base shear.

3. Problem Statement

The building is analyzed is G+10 R.C framed building of symmetrical rectangular plan configuration. Complete analysis is carried out for dead load, live load & seismic load using STAAD-Pro software. Response Spectrum Method of seismic analysis is used. All combinations are considered as per IS 1893-(part I).

Typical regular plan of building is shown in Figure 4.1

Typical irregular plan of building is shown in Figure 4.2

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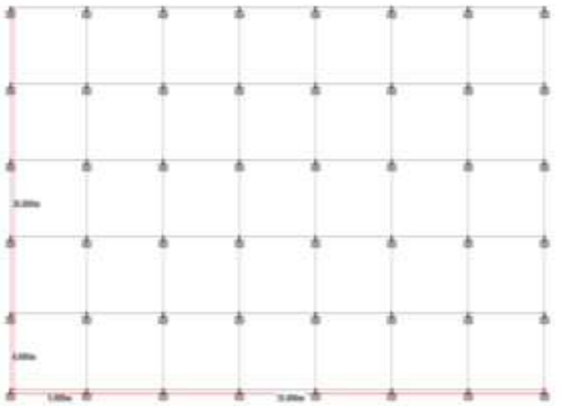

Figure 1: G+ 10 RC frame regular plan building

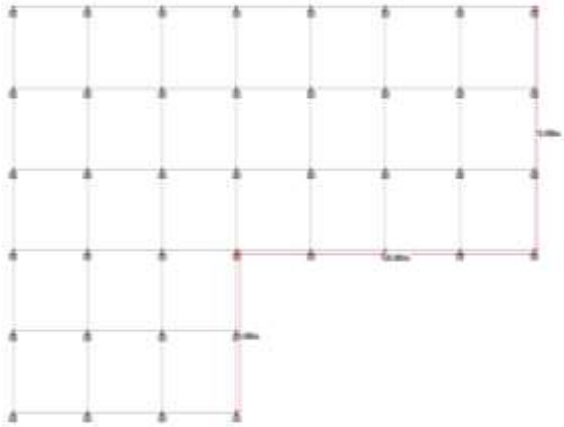

Figure 2: G+ 10 RC frame irregular plan building

3.1 Building properties

Site Properties:

Details of building:: G+10 RC framed structure
Plan Dimension:: 35m x 20m , 5m span in each direction.
Outer wall thickness:: 230mm
Inner wall thickness:: 230mm
Floor height ::3 m
Parking floor height :: 3m

Material Properties

Material grades of M35 & Fe500 is used for the design.

Loading on structure

Dead load: self-weight of structure
Weight of 230mm wall: 13.8 kN/m²
Live load: Floor:: 2.5 kN/m²
Roof: 1.5 kN/m²
Seismic load:: Seismic Zone IV

Table 1: Preliminary Geometric & Seismic data

	As per IS 1893:2002	As per IS 1893:2016
Column size	850mmX400mm	850mmX400mm
Beam size	600mmX300mm	600mmX300mm
Slab thickness	120mm	120mm
Seismic Zone Z	IV=0.24	IV=0.24
Importance factor I	1.0	1.2

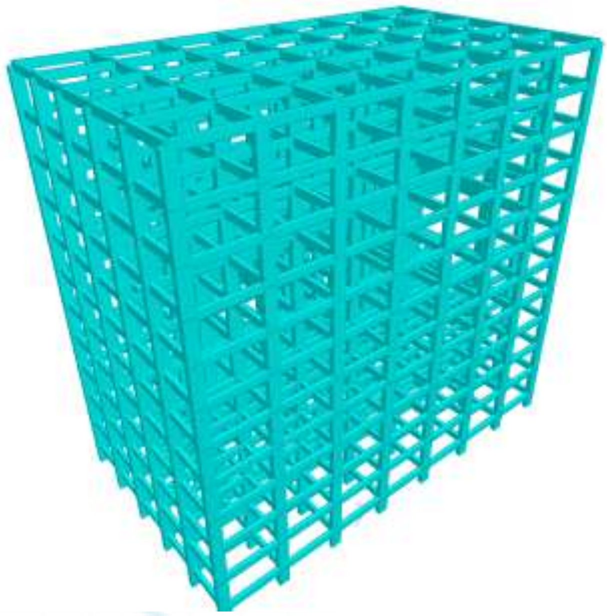

Figure 3: 3D View of G+ 10 RC frame regular plan building

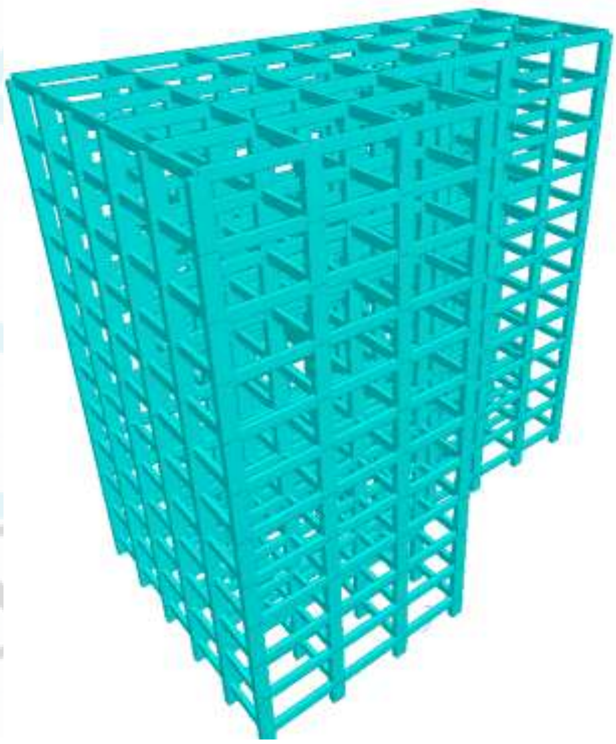

Figure 4: 3D View of G+ 10 RC frame irregular plan building

4. Results and Discussions

Response spectrum method is carried out to evaluate the seismic performance of special moment resisting (SMRF) structures. In this seismic loading is applied to the structure as per IS 1893:2002 and IS 1893:2016 for regular and with plan irregularity building. STAAD.pro software is used for analysis.

Table 2 represents comparison between base shear in X direction for regular frame and frame with plan irregularity.

Table 2: Base shear (kN) in X direction

Base shear (kN) in X-direction		
IS codes	Regular Frame	Plan Irregularity
1893:2002	5786.01	5465.6
1893:2016	8143.27	6575.8

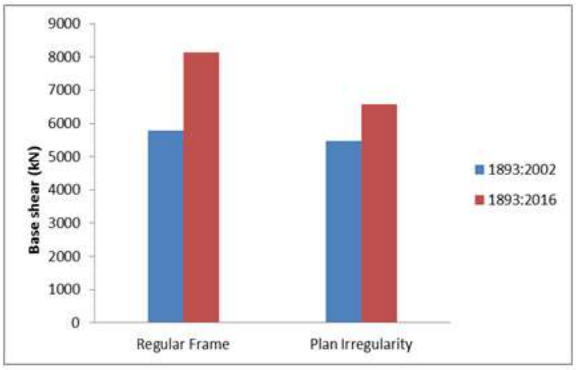

Figure 5: Comparison of base shear in kN in X direction

Figure 5 shows graphical representation between base shear in X direction for regular frame and frame with plan irregularity by response spectrum method using IS 1893:2002 and IS 1893:2016. It shows that base shear is increased up to 30% by using IS 1893:2016 in both geometry.

Table 3 represents comparison between base shear in Y direction for regular frame and frame with plan irregularity.

Table 3: Base shear (kN) in Y direction

Base shear (kN) in Y-direction		
IS codes	Regular Frame	Plan Irregularity
1893:2002	5722.98	5007.98
1893:2016	7448.96	6009.57

Figure 6 shows graphical representation between base shear in Y direction for regular frame and frame with plan irregularity by response spectrum method using IS 1893:2002 and IS 1893:2016. It shows that base shear is increased up to 30% by using IS 1893:2016 in both geometry.

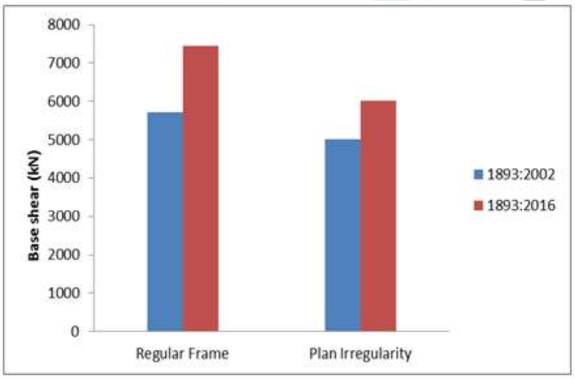

Figure 6: Comparison of base shear in kN in Y direction

Table 4 represents comparison between maximum lateral displacement in X direction for regular frame and frame with plan irregularity.

Table 4: Maximum Lateral Displacement (mm) in X direction

Maximum Lateral Displacement (mm) in X-direction		
IS codes	Regular Frame	Plan Irregularity
1893:2002	49.85	49.863
1893:2016	78.014	79.927

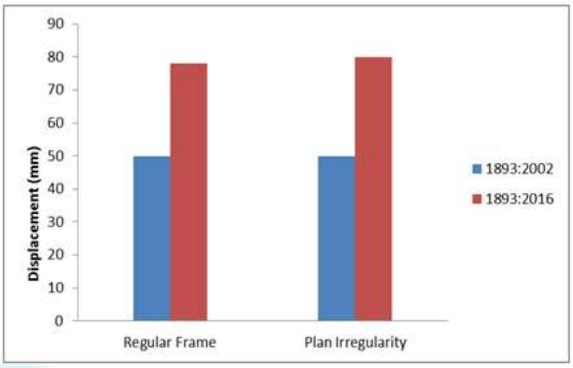

Figure 7: Maximum lateral displacement in mm in X direction

Figure 7 shows graphical representation between maximum lateral displacement in X direction for regular frame and frame with plan irregularity by response spectrum method using IS 1893:2002 and IS 1893:2016. It shows that displacement is increased up to 40% by using IS 1893:2016 in both geometry.

Table 5 represents comparison between maximum lateral displacement in Y direction for regular frame and frame with plan irregularity.

Table 5: Maximum Lateral Displacement (mm) in Y direction

Maximum Lateral Displacement (mm) in Y-direction		
IS codes	Regular Frame	Plan Irregularity
1893:2002	7.372	7.493
1893:2016	8.265	8.604

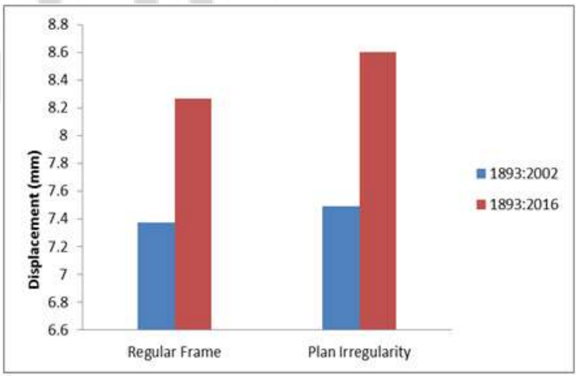

Figure 8: Maximum lateral displacement in mm in Y direction

Figure 8 shows graphical representation between maximum lateral displacement in Y direction for regular frame and frame with plan irregularity by response spectrum method using IS 1893:2002 and IS 1893:2016. It shows that displacement is increased up to 60% by using IS 1893:2016 in both geometry.

Table 6 represents comparison between maximum lateral displacement in Z direction for regular frame and frame with plan irregularity.

Table 6: Maximum Lateral Displacement (mm) in Z direction

Maximum Lateral Displacement (mm) in Z-direction		
IS codes	Regular Frame	Plan Irregularity
1893:2002	65.255	72.907
1893:2016	104.412	119.567

Figure 9 shows graphical representation between maximum lateral displacement in Z direction for regular frame and frame with plan irregularity by response spectrum method using IS 1893:2002 and IS 1893:2016. It shows that displacement is increased up to 40% by using IS 1893:2016 in both geometry

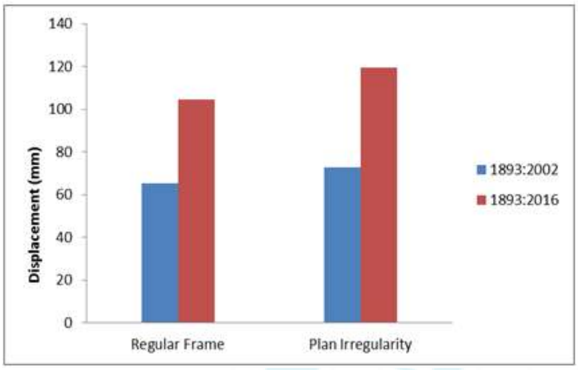

Figure 9: Maximum lateral displacement in mm in Z direction

5. Conclusions

- Study concluded that seismic analysis as per guidelines of IS 1893:2016 shows higher value of base shear than as per IS 1893:2002.
- Also maximum lateral displacement in horizontal directions shows large value by response spectrum method as per IS 1893:2016.

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