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SEISMIC ANALYSIS OF HIGH RISE BUILDING WITH IS CODE 1893-2002 and IS CODE 1893-2016

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Abstract – *This project is concerned with the study of seismic analysis and design of high-rise building. The structural analysis of high rise multistory storey reinforced concrete symmetrical and asymmetrical frame building is done with the help of SAP software. In the present study, The Response spectrum analysis (RSA) of regular RC building frames is compare with Response spectrum analysis of regular building and carry out the ductility based design. as per IS 1893:2002 and IS 1893:2016.*

1. INTRODUCTION

An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter -connected to each other as a unit. The load transfer, in such a structure takes place from the slabs to the beams, from the beams to the columns and then to the lower columns and finally to the foundation which in turn transfers it to the soil. The floor area of a R.C.C framed structure building is 10 to 12 percent more than that of a load bearing walled building. Monolithic construction is possible with R.C.C framed structures and they can resist vibrations, earthquakes and shocks more effectively than load bearing walled buildings. Speed of construction for RCC framed structures is more rapid.

Reinforced concrete is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and ductility. The reinforcement is usually embedded passively in the concrete before the concrete sets. The reinforcement needs to have the following properties at least for the strong and durable construction:

- High relative strength
- High toleration of tensile strain
- Good bond to the concrete, irrespective of pH, moisture, and similar factor.
- Thermal compatibility, not causing unacceptable stresses in response to changing temperatures.

A building shall be considered as irregular as per is IS code, if it lacks symmetry and has discontinuity in geometry, mass or load resisting elements. These irregularities may cause problem in continuity of force flow and stress concentrations. A building should possess four main attributes, mainly having simple and regular configuration, adequate lateral strength, stiffness and ductility. Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some action. The dynamic loads include wind, waves, traffic, earthquakes, and blasts.

To perform well in an earth, quake a building should possess four main attributes namely simple and regular configuration and adequate lateral Strength, stiffness and ductility. Current earthquake codes define structural configuration as either regular or irregular in terms of size and shape of the building, arrangement of the structural and non-structural elements within the structure, distribution of mass in the building etc. A building shall be considered as irregular for the purposes of this standard, if at least one of the conditions is applicable as per IS 1893:2002 or IS 1893:2016.

2. Literature Review

A. A. Kale, S. A. Rasal, (2017) In this proposed study four different shapes of same area multistorey model is generated & tested by the ETABS under the guideline of IS-875-Part3 & IS1893-2002-Part1. The behavior of 15, 30 & 45 storey building has been studied. The Dynamic effects also find by Response spectrum method. All the parameters like Story displacement, Story drift, Base shear, Overturning moments, Acceleration and Time period are calculated. After comparing all building shapes results concluded that which section is convenient & either seismic or wind effect is critical.

N.Veerababu, B Anil Kumar, (2016) In the present study an endeavor has been made to produce reaction spectra utilizing site particular soil parameters for a few destinations in seismic zone V, i.e. Arunachal Pradesh and Meghalaya and the produced reaction spectra is utilized to break down a few structures utilizing business programming STAAD Pro. The impact of soil properties, its sorts and the profundity of soil in the reaction range is talked about.At long last examinations have been made in the middle of the structure outlined by taking IS 1893:2002 reaction spectra under thought with the structure planned by considering the created reaction spectra for different sorts of soil for the seismic zone as far as twisting minute, shear powers and fortification.

K VenuManikanta, Dr. DumpaVenkateswarlu, (2016) The main purpose of this study is to carry out a detailed analysis on simulation tools ETABS and STAAD PRO, which have been used for analysis and design of rectangular Plan with vertical regular and rectangular Plan with Vertical geometrically irregular multi-storey building. This study is focused on bringing out advantages of using ETABS over current practices of STAAD PRO versions to light. It was observed that ETABS is more user friendly, accurate, compatible for analysing design results and many more advantages to be discussed in this study over STAADPRO. Pros and cons of using these software's also mentioned in this study.

This paper focuses on the effect of both Vertical Aspect Ratio (H/B ratio i.e. Slenderness Ratio) and Horizontal or Plan Aspect Ratio (L/B ratio), where H is the total Height of the building frame, B is the Base width and L is the Length of the building frame with different Plan Configurations on the Seismic Analysis of Multistoried Regular R.C.C. Buildings.

The test structures are kept regular in elevation and in plan. Here, height and the base dimension of the buildings are varied according to the Aspect Ratios. The values of Aspect Ratios are so assigned that it provides different configurations for Low, Medium and High-rise building models.

Total 16 building models are analyzed for different load combinations by Linear Elastic Static Analysis (Equivalent static force analysis) with the help of ETABS-2015 software and the results obtained on seismic response of buildings have been summarized.

Gauri G. Kakpure, Ashok R. Mundhada (2016) This paper presents a review of the previous work done on multistoried buildings vis-à-vis earthquake analysis. It focuses on static and dynamic analysis of buildings. This paper presents a review of the comparison of static and dynamic analysis multistoried building. Design parameters such as Displacement, Bending moment, Base shear, Storey drift, Torsion, Axial Force were the focus of the study.

Pardeshi Sameer (2016) In this study, 3D analytical model of G+15 storied buildings have been generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. Mass and stiffness are two basic parameters to evaluate the dynamic response of a structural system.

This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time history Analysis (THA) of regular RC building frames and carry out the ductility based design using IS 13920 corresponding to response spectrum analysis. Comparison of the results of analysis of irregular structures with regular structure is done.

S.Mahesh, B.Panduranga Rao (2014) In this paper a residential of G+11 multi-story building is studied for earth quake and wind load using ETABS and STAAS PRO V8i .Assuming that material property is linear static and dynamic analysis are performed. These analysis are carried out by considering different seismic zones and for each zone the behaviour is assessed by taking three different types of soils namely Hard , Medium and Soft .Different response like story drift, displacements base shear are plotted for different zones and different types of soils.

Prashanth.P, Anshuman.S, Pandey.R.K (2012) STAADPro and ETABS are the present day leading design software's in the market. Many design companies use these software's for their project design purposes. So, this project mainly deals with the comparative analysis of the results obtained from the design of a regular and a plan irregular (as per IS 1893) multi storey building structure when designed using STAADPro and ETABS software's separately. These results will also be compared with manual calculations of a sample beam and column of the same structure designed as per IS 456.

From the design results of beams, it may conclude that ETABS gave lesser area of required steel as compared to STAAD PRO. It is found out from previous studies on comparison of STAAD results with manual calculations that STAADPro gives conservative design results which is again proved in this study by comparing the results of STAADPro, ETABS and Manual calculations (refer below table). Form the design results of column; since the required steel for the column forces in this particular problem is less than the minimum steel limit of column (i.e., 0.8%), the amount of steel calculated by both the softwares is equal. So comparison of results for this case is not possible.

S.K. Ahirwar, S.K. Jain and M. M. Pande (2008) This paper presents the seismic load estimation for multistorey buildings as per IS: 1893-1984 and IS: 1893-2002 recommendations. Four multistorey RC framed buildings ranging from three storeyed to nine storeyed 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.

Dr. D. K. Paul (2016), IS 1893-Part 1: 2016 is revised in 2016, with basic design philosophy same the structures designed as per this Standard is expected to sustain damage under strong earthquake.

The in plane stiffness of the floor and roof slabs shall be assumed rigid. Each rigid floor shall be modeled as SDOFS in the direction earthquake excitation. The beam and column members shall be modeled as beam and column elements with appropriate sectional properties. The structural walls shall be modeled as plane stress/ shell elements. The URM infill walls shall be modeled by using equivalent diagonal struts taken to be pin jointed on either end.

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,

i. Response Spectrum Method,
ii. Modal Time History Method, and

iii. Time History Method.

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

3. Problem Formulation

The problem is defined and considered as the design of building with Code IS 1893 – 2002 and IS 1893 – 2016. The building specifications are taken as follows:

Building Plan = 45m x 45 m

Beam Colum Size: 750mm x 850 mm

Storey Height: 3 m each floor

Live load: 2.5 KN/m2

Number of bays: Each 9 bay

Bay Distance: 5 m

Seismic : V

Material Grade: M30

Load Combinations in Old Code:

0.9DL + 1.5EL

0.9DL – 1.5EL

1.2DL + LL + EL

1.2DL + LL – EL

1.5DL + EL

1.5DL – EL

1.5DL +LL

Load Combinations in New Code

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

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

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

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

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

1.2(DL+LL-(ELy+0.3Elx+0.3ELz))

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

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

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

1.5((DL-(ELy+0.3Elx+0.3ELz))

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

1.5((DL+ (ELy+0.3Elx+0.3ELz))

4. Objective

1. To study IS1893 – 2002 and IS1893 – 2016 for the difference introduced in new code.
2. To design and analyze G+50 building structure with old and new design code.
3. To compare analysis results obtained for old and new design codes.
4. To remark the improvements and differences in results using new design code IS1893 – 2016.

5. Modeling and Analysis

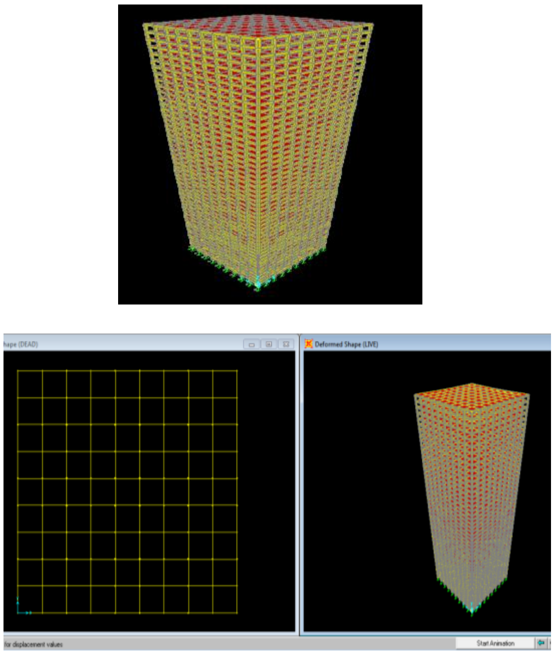

Fig: Building Model and Deformaton Analysis

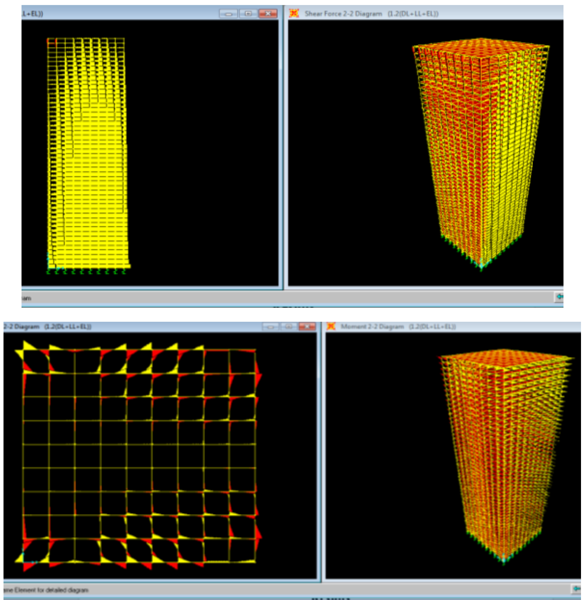

Figure: Shear Force and Bending Moment Analysis

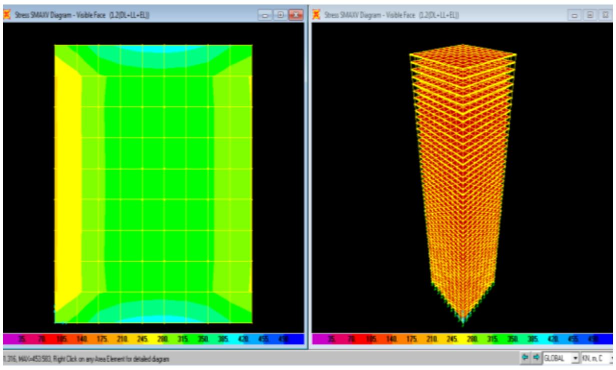

Figure: Stress Analysis

6. Results

Displacement Old Code (IS 1893-2002)

Table: Displacement (Old)

Joint	Load Combination	CaseType	Step Type	U (Mtr)
1	1.5(DL+EL)	Combination	Max	1.086529
10	1.5(DL+EL)	Combination	Max	1.086529
2	1.5(DL+EL)	Combination	Max	1.086508
9	1.5(DL+EL)	Combination	Max	1.086508
3	1.5(DL+EL)	Combination	Max	1.086501

Displacement New Code (IS 1893-2016)

Table: Displacement (New)

Joint	Load Combination	CaseType	StepType	U (Mtr)
97	1.5((DL+(ELx+0.3ELy+0.3ELz))	Combination	Max	-0.161888
97	1.5((DL-(ELx+0.3ELy+0.3ELz))	Combination	Max	-0.161888
7	1.5((DL+(ELx+0.3ELy+0.3ELz))	Combination	Max	-0.161888
7	1.5((DL-(ELx+0.3ELy+0.3ELz))	Combination	Max	-0.161888
94	1.5((DL+(ELx+0.3ELy+0.3ELz))	Combination	Max	-0.161888

Shear Force Old Code (IS 1893-2002)

Table: Shear Force (Old)

TABLE: Element Forces – Frames				
FRAME	Load Combination	CaseType	StepType	F (KN)
174	0.9DL-1.5EL	Combination	Max	-334.178
93	0.9DL-1.5EL	Combination	Max	-334.178
174	0.9DL-1.5EL	Combination	Max	-334.178
93	0.9DL-1.5EL	Combination	Max	-334.178
174	0.9DL-1.5EL	Combination	Max	-334.178

Shear Force New Code (IS 1893-2016)

Table: Shear Force (New)

TABLE: Element Forces – Frames				
FRAME	Load Combination	CaseType	StepType	F (KN)
177	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	Max	-188.483
177	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	Max	-188.483
94	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	Max	-188.483
94	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	Max	-188.483
96	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	Max	-188.483

Bending Moment Old Code (IS 1893-2002)

Table: Bending Moment (Old)

Frame	Load case	Case Type	Bending Moment KN-m
Text	Text	Text	
815	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	-1023.9694
815	1.5((DL-(ELy+0.3ELx+0.3ELz))	Combination	-1006.6641
815	1.5((DL+(ELy+0.3ELx+0.3ELz))	Combination	-992.5539
816	1.5((DL-(ELy+0.3ELx+0.3ELz))	Combination	-992.5539
814	1.2(DL+LL+(ELy+0.3ELx+0.3ELz	Combination	-985.3532

Bending Moment New Code (IS 1893-2016)

Table: Bending Moment (New)

Frame	Load case	CaseType	Bending Moment KN-m
Text	Text	Text	
189	0.9DL+1.5EL	Combination	-361.9106
189	0.9DL-1.5EL	Combination	-361.9106
181	1.5(DL+EL)	Combination	-361.9106
181	1.5(DL+EL)	Combination	-361.9106
181	0.9DL-1.5EL	Combination	-342.2185

7. CONCLUSIONS

1. Maximum deflection found with old code IS 1893-2002 for considered building is 1.0865 Meter and for new code IS 1893-2016 is 0.161888.
2. Shear force obtained with old code IS 1893-2002 for considered building is 334.178 KN whereas for new code IS 1893-2016 is obtained is 188.483 KN.

3. Bending moment obtained with old code IS 1893-2002 for considered building is 1023.9694KN-m whereas for new code IS 1893-2016 is obtained is 361.9106 KN-m.
4. Response spectrum results shows that acceleration against time is higher in case of revised code.

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