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Dynamic Seismic Analysis of RCC Building as per IS 1893:2002 by Using STAAD-Pro Software

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Abstract – *In this paper seismic response of (G+7)R.C. framed building is analyses for seismic load case by using STAAD-Pro software as per IS1893:2002 part-1.This paper consider different seismic parameter like seismic zone(IV), response reduction factor(R), importance factor(I)& other parameters like rock/soil type, structure type, damping ratio etc. This paper provides complete guidelines for STAAD-Pro software analysis & STAAD –Pro gives the results after run analysis in the STAAD output viewer which shows joint displacements, support reactions, member forces, base shear and lateral load.*

Keywords- dynamic analysis, IS 1893:2002, reinforced structure, Earthquake, STAAD-Pro, Seismic loads, multistory building, RCC building.

INTRODUCTION

In general, for design of multistory buildings seismic loads need to be considered. According to IS 1893(Part -1):2002 height of the structure, seismic zone, vertical and horizontal irregularities, soft and weak storey necessitates dynamic analysis for seismic load. Structural engineer's role becomes challenging when the building is located in a seismic zone. So, it is to design the structure to resist an earthquake. Seismic design stated, as the structure should be able to ensure the minor and frequent shaking intensity without any damage. In Response Spectrum Method, the Time Periods, Natural Frequencies and Mode Shape Coefficients are calculated by STAAD-Pro Software and remaining process will be done by manually. The modal combination rule for Response Spectrum Analysis is SRSS (Square Root Sum of Squares). The main parameters considered in this Study are seismic zone IV, response reduction factor(R), importance factor (I) and medium soil type.

METHODOLOGY

Consider (G+7) storey building located in new Delhi zone IV, the soil conditions is medium stiff soil, entire building is supported on raft foundation, RC frame infill with brick masonry, lumped weight due to dead load is 12kN/m^2 on floors and 10kN/m^2 on roof, floors carry live load of 4kN/m^2 on floors and 1.5kN/m^2 on roof, span of building 5m in X and Z direction, Floor to floor height is 3.1m, bottom floor height is 4.2m, size of beam is assume to be as 0.35X0.45m And size of column as 0.35X0.5m, material assume to be concrete. All the supports are assigning as fixed supports,

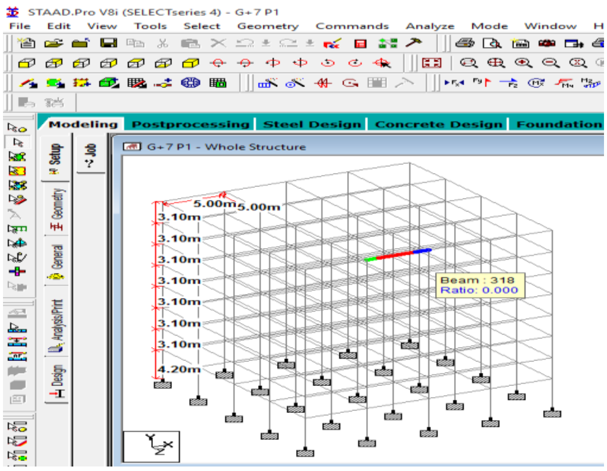


Fig. 1- fig shows the Structural model of building in STAAD-Pro software.

Calculation of design seismic force by (dynamic) Response spectrum analysis method by using STAAD-PRO software:-

The design lateral shear force is at each floor in each mode is computed by STAAD equation in accordance with equation (7.8.4.5c and7.8.4.5d) from IS 1893-2002.

$$Q_{ik} = A_k \times \phi_{ik} \times P_k \times W_i$$

Where A_k , W_i are user inputs

STAAD utilizes the following procedure to generate the lateral seismic load.

1) User provides the value for $\frac{Z}{2} \times \frac{I}{R}$ as factors for input spectrum.
2) Program calculate time periods for first six modes or as specified by the user.
3) Program calculates $\frac{Sa}{g}$ for each mode utilizing time period and damping ratio for each mode.
4) The program calculates design horizontal acceleration spectrum A_k for different modes.
5) The program then calculates mode participation factor for different modes.
6) The peak lateral seismic force at each floor in each mode is calculated.
7) All response quantities for each mode are calculated.
8) The peak response quantities are then combined as per method (CQC or SRSS or ABS or TEN or CSM) as defined by the user to get the final results.

In order to calculate Base shear value V_b: -

$$V_b = A_h \times W$$

Seismic parameter:-

1) Seismic zone IV, zone factor Z is 0.24 ………… (Table no. 2 of IS1893:2002 Part-1)
2) Response reduction factor, R is 5 ………… (Table no. 7 of IS1893:2002 Part-1)
3) Importance factor, I is 1.0 ………... (Table no. 6 of IS1893:2002 Part-1)

Building is made of moment resisting frame with brick in fill panels; we should use empirical expression the fundamental natural period is as follows:

T=0.09h/sqrt (d)……… (Clause 7.6.2 of IS 1893:2002)

Hence approximate fundamental natural period in both X and Z direction is as follows:

$$T = 0.09(25.9) / \text{sqrt}(20)$$

T = 0.5212 sec… (Since X and Z direction value D = 20)

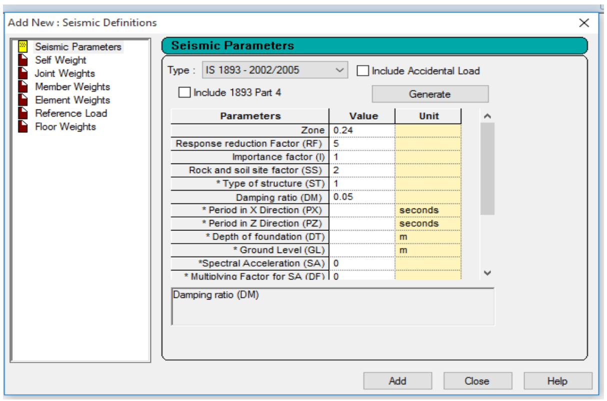


Fig. 2- fig shows the seismic load definition

Floor Loads in Seismic definition

Dead loads and Live loads

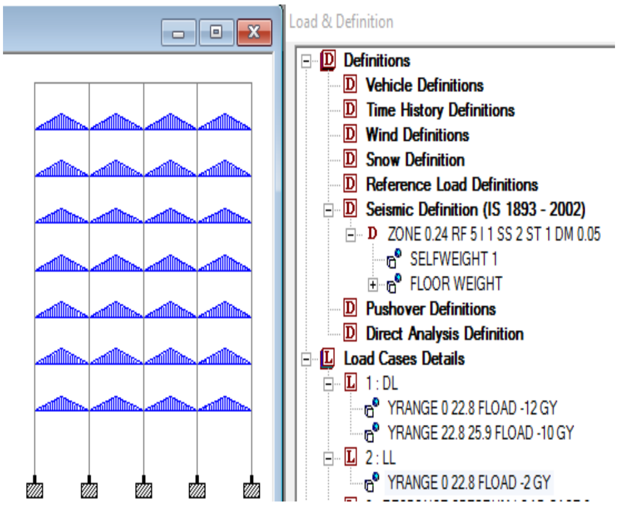


Fig. 3- fig shows the D.L. and L.L.

Defining Response Spectrum load Case:-

First Add Response spectrum load case to load cases. We will have to specify values attach to be considered to calculate the value of Wi.

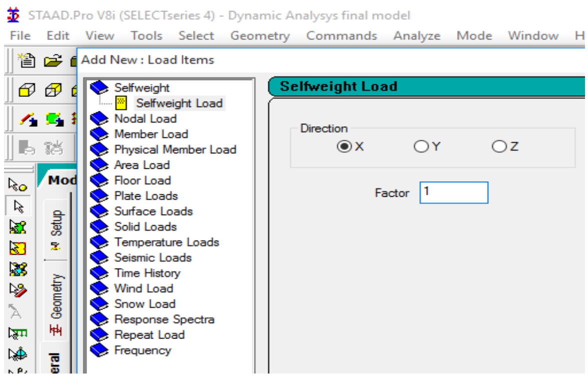


Fig. 4- fig shows self weight load in X, Y AND Z-direction

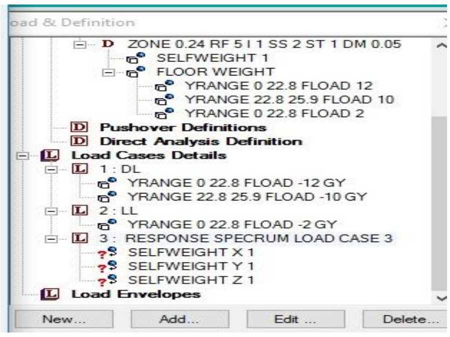


Fig. 5- fig shows response spectrum load case

Same way for add self weight load in **Y** and **Z** direction

In Response Spectrum analysis we will have to add floor load (Dead load) in all three direction

Floor load in X-direction:-

Fig. 6- fig shows floor load in X-direction

Floor load in Y-Direction:-

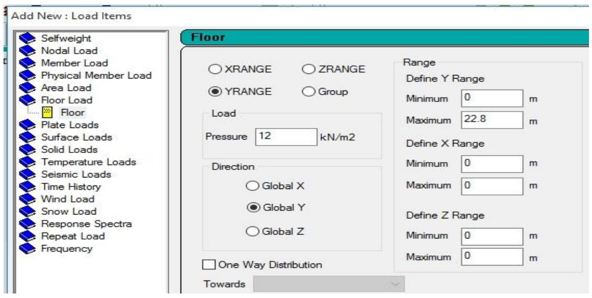


Fig. 7- fig shows floor load in Y-direction

Floor load in Z- direction:-

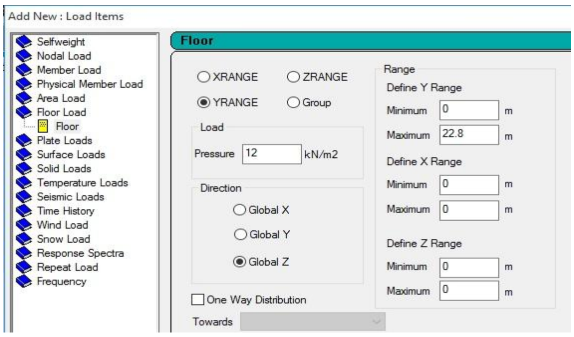


Fig. 8- fig shows floor load in Z-direction

Roof load in X- direction:-

Fig. 9- fig shows roof load in X-direction

Roof load in Y- direction:-

Fig. 10- fig shows roof load in Y-direction

Roof load in Z- direction:-

Fig. 11- fig shows roof load in Z-direction

Adding Live loads in all directions

X- Direction:-

Fig. 12- fig shows L.L. in X-direction

Y- Direction-

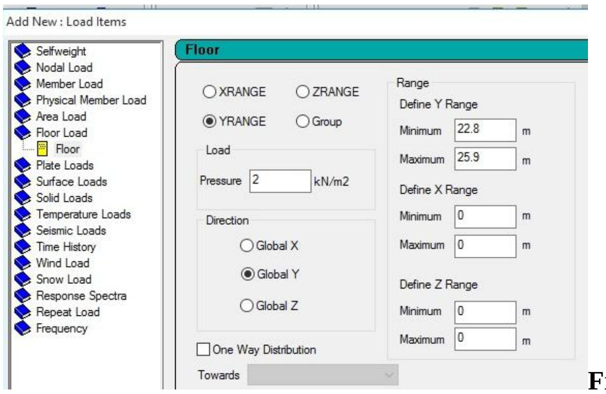


Fig. 13- fig shows L.L. in Y-direction

Z- Direction-

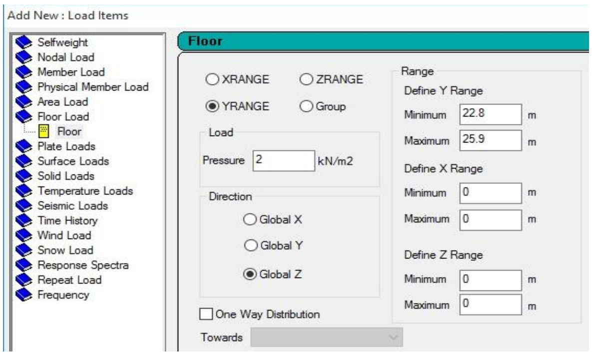
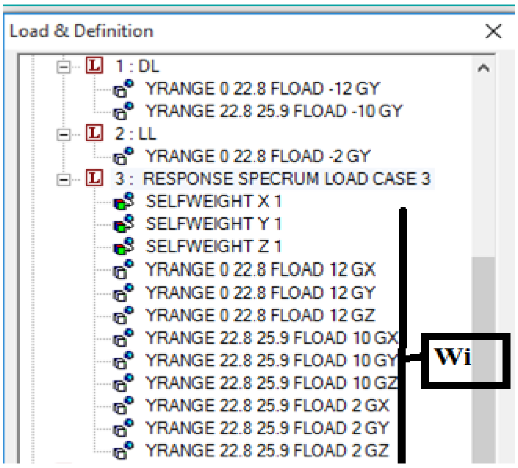


Fig. 14- fig shows L.L. in Z-direction

All this plates will be considered for calculating Wi so to calculate Floor Shear



Wi for design base shear Vb for the calculation floor shear

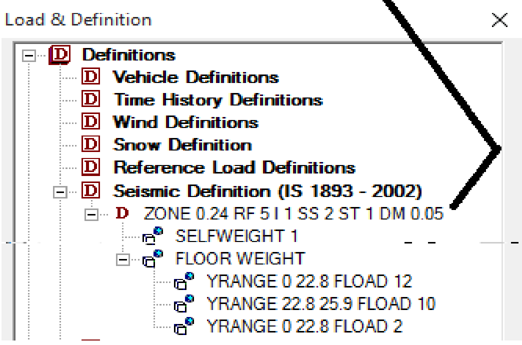


Fig. 15- fig shows the load and definition

Apply Self weight in X, Y and Z to structure

- **Response Spectrum Command**

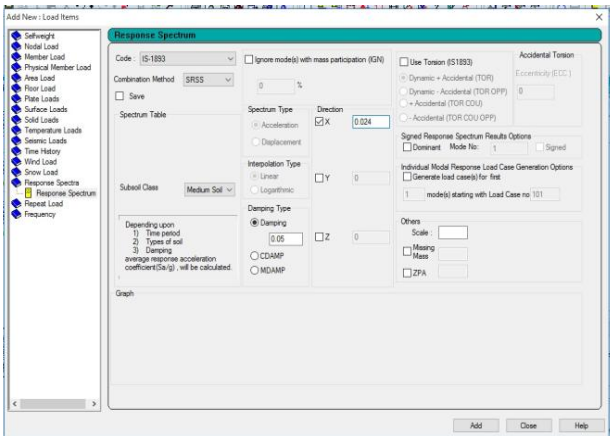


Fig. 16- fig shows the response spectrum

$$\frac{Z}{2} \times \frac{I}{R} = \frac{0.24}{2} \times \frac{1}{5} = 0.024$$

- **Analysis / Print--Mode Shapes**

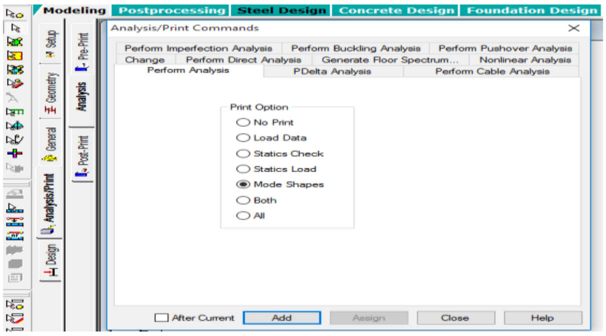


Fig. 17- fig shows the analyses the mode shapes

- Click Post Print Command
- Define Commands
- Add-Print Analysis Results
- Add-Storey drift

Analyze the Structure

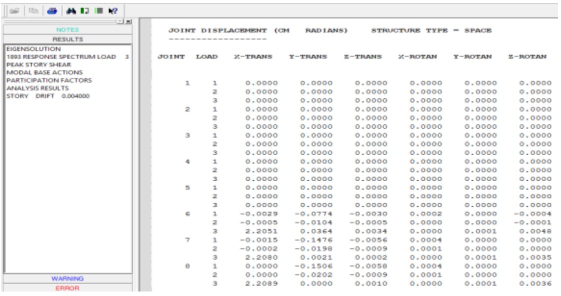


Fig. 18- fig shows the Joint displacement

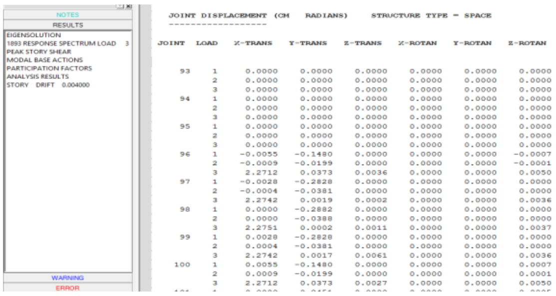


Fig. 19- fig shows the Joint displacement

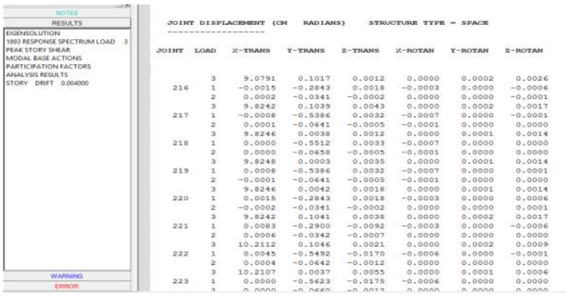


Fig. 20- fig shows the Joint displacement

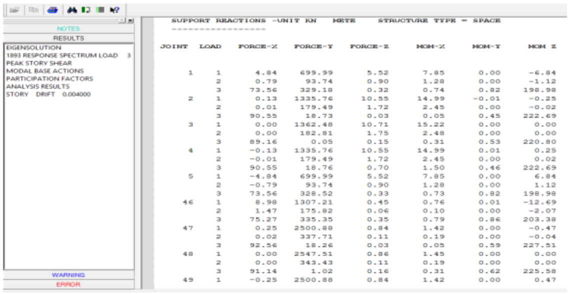


Fig. 21 fig shows the support reaction

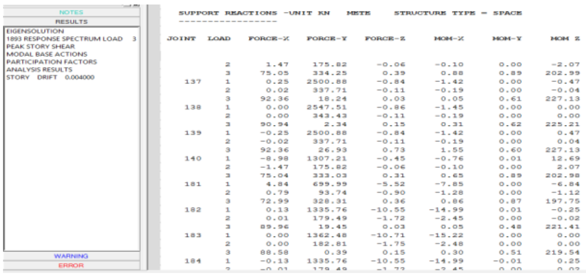


Fig. 22- fig shows the support reaction

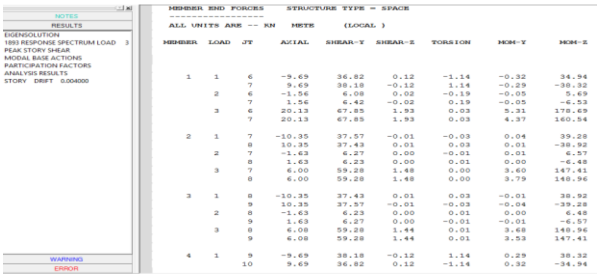


Fig. 23- fig shows the member forces

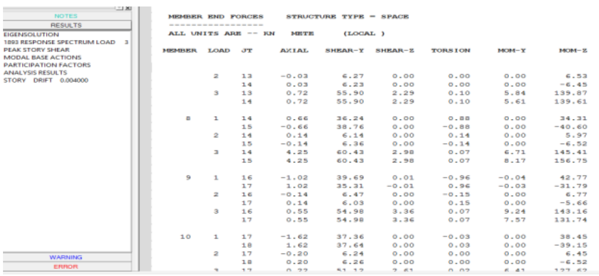


Fig. 24- fig shows the member forces

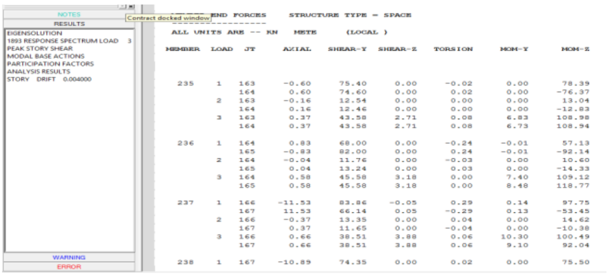


Fig. 25- fig shows the member forces

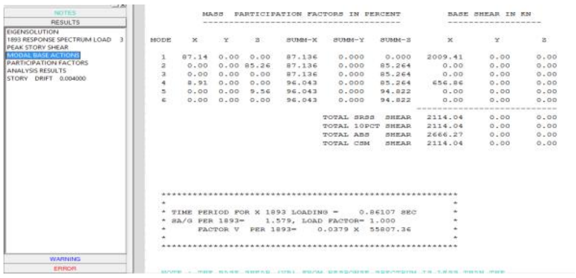


Fig. 25- fig shows the base shear

CONCLUSION

The response of (G+7) storey RC building under seismic load as per IS1893:2002 (Part-1) by using software STAAD -Pro has been studied. This analysis provides complete guidelines for STAAD-Pro software analysis of dynamic method. STAAD-Pro gives result very quickly as compared to manual calculation. Also Base shear, Lateral load, Joint displacement, support reaction and member forces for all the joints of a building has been calculated in STAAD output viewer.

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[22] Staad. Pro Help Menu & Bentley Student Server.

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