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Seismic Analysis of Steel Frame Structure by Response Spectrum Method

Radhika S. Patil[1], H. S. Jadhav[2]
[1, 2]*Dept. of Civil Engineering, Rajarambapu Institute of Technology, Maharashtra, India*

Abstract: ***Seismic analysis is performed to evaluate the amount of stresses and sway generated due to vibration and drift that may results into collapse of the structure and causes severe damage. To perform seismic analysis there are different types of analysis by which the structure can be assess under earthquake forces. A steel framed structure has been analysis by using Etabs (Extended Three- Dimensional Analysis of Building System) software in which assessment of structure is carried out by response spectrum method. The results has been withdraw in terms of base shear, storey drift, storey displacement and time period.***

Keywords: Seismic analysis, Response spectrum, Steel frame structure, Base shear, Storey drift, Storey displacement, time period.

I. INTRODUCTION

The characteristics of steel offers many advantages for the modern constructing buildings of all sizes and shapes. The skeleton frame of building is made up by anchoring the beams to the columns at the joints. This system helps in effortless transmissions of loads to the foundations. This frame system is also effective to resist vibration cause by the earthquake motion. But to make structure safe it is necessary to evaluate the structural system for all possible external forces. So that the performance of structural system can be enhanced to withstand against estimated loads. For analysis of complex structure computer based software is used to analyse, assess seismic performance, stability of structure and checks the load-bearing capacity of structure based on prescript code and analysis method.

Earthquake forces being unpredictable have concerned many engineers. The seismic analysis of structure involves the parameters such as load carrying capacity, ductility, stiffness, damping and mass. There are different type of seismic analysis which are linear static analysis, non-linear static analysis, linear dynamic analysis and non-linear dynamic analysis. In present work response spectrum method (RSM) is used to assess a structure system. RSM is a linear dynamic analysis method. RSM is the most popular tool used to perform seismic analysis. It is based on modal frequency or model mass, combined they are used to estimate the response of the structure. This responses are combination of many modes shapes form due oscillation. These modes shape can be determine by using computer analysis.

II. STRUCTURAL DETAILS

A steel frame structure that studied in this paper have parameters as mentioned in table 1, 2 and 3. Its plan and elevation have been show in fig 1 and 2.

TABLE I
Building parameters

Plan of building	24 m x 22 m
Type of structure	Industrial
No. of stories	6
Height of each storey	4 m
Type of frame	Ordinary moment resisting Frame
No. of bays in x and y direction	4
Deck	200 mm

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A. Modelling with ETABS

Modelling is being done for the steel frame building using ETABS software by using response spectrum method.

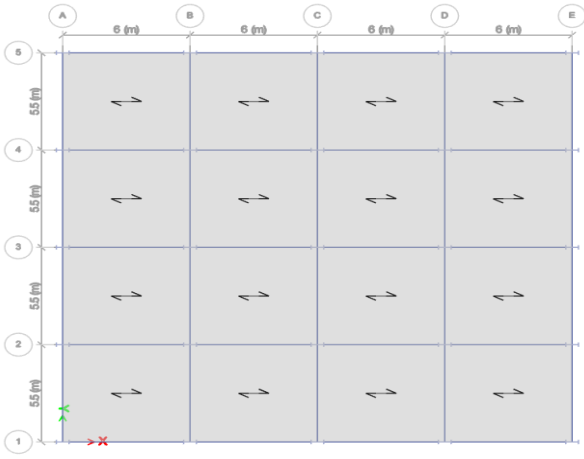

Fig -1: Plan view of building

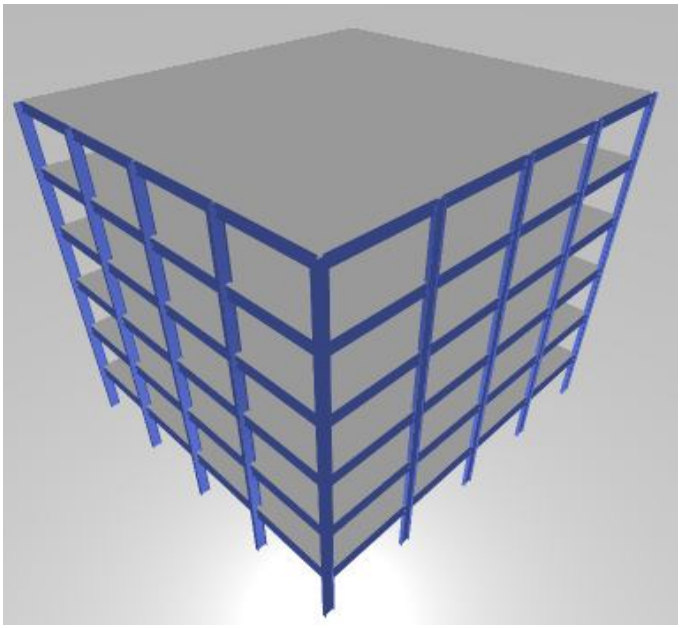

Fig -2: 3D view of building

B. Material Properties

TABLE II
Material data

Unit weight of steel	78 KN/m3
Grade of structural steel	Fe 250
Modulus of Elasticity of steel	210 KN/m3
Dead load	Self –weight of structural elements
Live load on floor	7 KN/m3
Live load on roof	3 KN/m3

C. Earthquake Parameters

TABLE III
Earthquake data

Seismic zone	V
Soil type	Hard
Importance factor	1
Response reduction factor	3
Damping factor	5%
Modal Combination Method	CQC
Directional combination type	SRSS
Type of diaphragm	Rigid
Diaphragm Eccentricity	0.05 for all diaphragm
Time period	Program calculated
Earthquake load in	X and Y direction

III.STEPS FOR PERFORMING ANALYSIS

Fig 3 shows the flow chart of steps used in analysis building in the software.

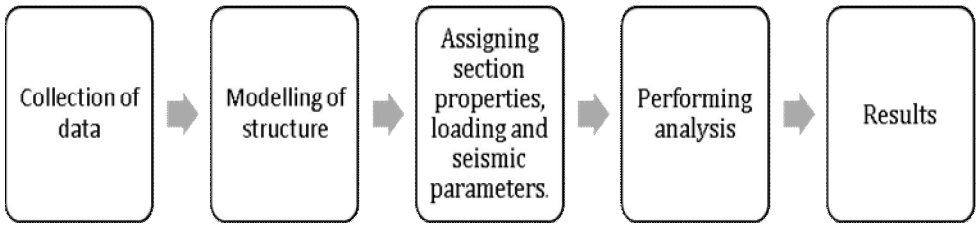

FIG -3. FLOW CHART

IV.RESULTS

In this study on steel frame building obtained results are shown in table IV, V, VI and VII in terms of base shear, story drift, story displacement and time period

A. Base Shear

TABLE IV
Maximum base shear in X and Y directions

Base shear	(KN)
In x-direction	1116.849
In Y- direction	457.3316

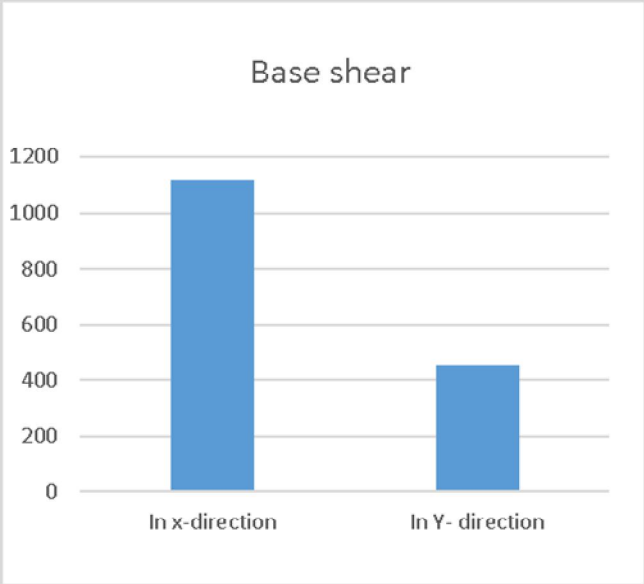

Fig 4. Base shear in KN

B. Storey Displacement

TABLE V
Storey displacement in X and Y directions

Storey	Elevation	X-Dir	Y-Dir
	(m)	(mm)	(mm)
Storey6	24	24.11	55.794
Storey5	20	22.157	52.642
Storey4	16	18.959	46.407
Storey3	12	14.631	37.591
Storey2	8	9.359	26.555
Storey1	4	3.68	13.571
Base	0	0	0

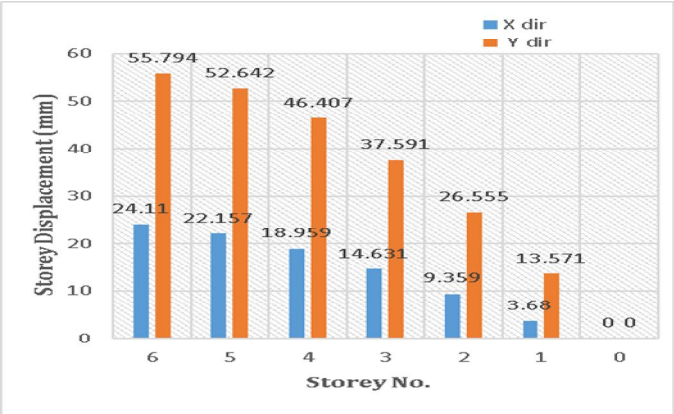

Fig 5. Storey displacement in mm

C. Storey Drift

TABLE VI
Storey drift in X and Y directions

Storey	Elevation	X-Dir	Y-Dir
	(m)	(mm)	(mm)
Storey6	24	2.493	4.653
Storey5	20	3.815	7.811
Storey4	16	4.759	10.03
Storey3	12	5.454	11.828
Storey2	8	5.708	13.373
Storey1	4	3.68	13.571
Base	0	0	0

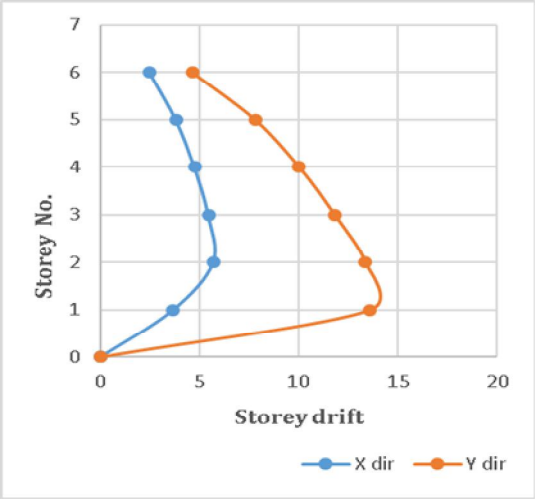

Fig 6. Curve obtained by Storey drift in mm

D. Time Period

TABLE VII
Time period

Mode	Period (sec)
1	3.329
2	1.595
3	1.363
4	1.125
5	0.694
6	0.521
7	0.508
8	0.437
9	0.428
10	0.396
11	0.284
12	0.235

V. CONCLUSIONS

The seismic analysis of steel framed structure has been performed in this work. All the results withdrawal are based on the response spectrum analysis performed in the Etabs software Version 18.1.1. Obtained results shows that as the number of storey increases the value of storey displacement increases similarly the value of time period increases as number of storey increases. The base shear is more in shorter side of the building. The results obtained are within permissible limits.

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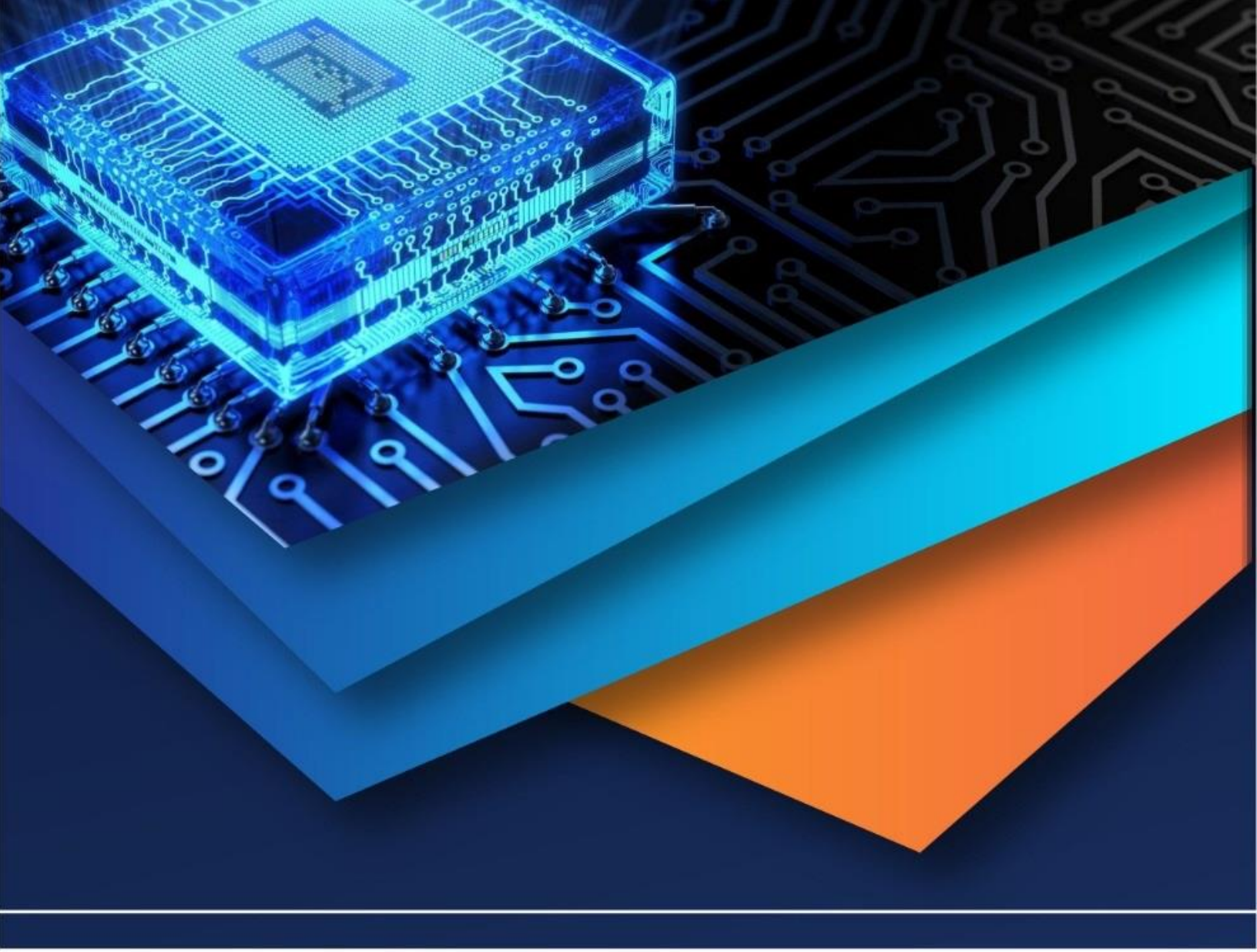

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