A Comparative Analysis on Absolute and SRSS Methods of Response Spectrum using STAAD-PRO

[1]A. Eugene Victor
UG Scholar,
Department of Civil Engineering
Sri Muthukumaran Institute of Technology, Chennai, India

[2]S. Yokesh
UG Scholar,
Department of Civil Engineering
Sri Muthukumaran Institute of Technology, Chennai, India

[3]K. Preethi
Assistant Professor,
Department of Civil Engineering
Sri Muthukumaran Institute of Technology, Chennai, India

Abstract— **Here is the present study, describes the effect of earthquake load which is one of the most important dynamic loads along with its consideration during the analysis of the structure. In this Comparative study, the seismic response of the structures is investigated under ABSOLUTE AND SRSS methods of dynamic analysis and earthquake excitation expressed in the form of member forces, joint displacement, support reaction, and story drift. The response is investigated for G+5 Educational building structures by using STAAD PRO designing software. We observed the response reduction of cases ordinary moment resisting frame. In this case, we have taken earthquake zone 5, Response factor 5 for ordinary moment resisting frame and Importance factor 1.5. A comparison is done between the response spectrum methods, the results such as story drift, average Displacements, Mode shapes are observed, compared and summarized for Beams, Columns, and Structure as a whole during both the analysis.**

Keywords— Dynamic analysis, Response spectrum method, ABSOLUTE Method, SRSS Method, Joint displacement, Story drift, STAAD PRO Analysis, STAAD Generic Method.

I. INTRODUCTION

Analysis and design of buildings for static forces is a routine affair these days because of the availability of affordable computers and specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time-consuming process and requires additional input related to the mass of the structure, and an understanding of structural dynamics for the interpretation of analytical results. Reinforced Concrete (RC) frame buildings are a most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to the earthquake. Here the present study describes the effect of earthquake load which is one of the most important dynamic loads along with its consideration during the analysis of the structure.

STAAD.Pro is structural engineering software widely used for the design of multistoried buildings. It is comprehensive structural engineering software that addresses all aspects of structural engineering including model development, verification, analysis, design and review of results. It includes advanced dynamic analysis and push over analysis for wind load and earthquake load. STAAD.Pro is a comprehensive, integrated design and finite element analysis tool. The exponential growth of India, as well as the global construction industry, has directly impacted the demand for structural engineers. It has become important for civil design engineers to be well equipped with structural software like STAAD.Pro, since most of the companies are using STAAD as a tool for designing massive structures, it is imperative that professionals should get trained in this field too to gain an advantage in the highly competitive construction market. It's a known fact that computers reduce man-hours required to complete a project, and knowledge of STAAD will ensure fast and efficient planning as well as accurate execution. The commercial version STAAD.Pro is one of the most widely used structural analysis and design software. It supports several steel, concrete, and timber design codes. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

The detailed comparative study on dynamic analysis is been made to ensure the seismic design for major and frequent shaking intensity without any damage, To eliminate the problem faced by the unsigned Response Spectrum and SRSS method in STAAD- pro due to the interaction of axial force with its corresponding bending moment. This Study Will provides complete guidelines for STAAD-Pro software analysis to give the accurate results for dynamic analysis of response spectrum in absolute and SRSS methods, to show joint displacements, support reactions, Member forces, base shear, and lateral load.

II. METHODS OF ANALYSIS

STAAD-based procedure for seismic analysis

Main features of the seismic method of analysis based on Indian standard 1893(Part 1): 2002 are described as follows

A. Equivalent static lateral force method

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low-to medium-rise buildings. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Equivalent static analysis can, therefore, work well for low to medium-rise buildings without significant coupled lateral-torsional effects, are much less suitable for the method, and require more complex methods to be used in these circumstances

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 12, December-2018

B. Response Spectrum Analysis method

This approach permits the multiple modes of response of a building to be taken into account (in the frequency domain). This is required in many building codes for all except for very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonics". Computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this, we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building.

Combination methods include the following:

- **Absolute - peak values are added together**
- **Square root of the sum of the squares (SRSS)**
- **Complete quadratic combination (CQC)**

In this Study, the result of a response spectrum analysis was analyzed using the Absolute and SRSS Generic methods, and the results were compared.

III. MODELING AND ANALYSIS

These buildings were designed in conformity to the Indian Code of Practice for Earthquake load (Seismic) Resistant Design of Buildings. The buildings were assumed to be fixed at the base. The buildings were modeled using software STAAD Pro. Models were studied in 5th zones comparing lateral displacement and story drift for all structural models under consideration.

TABLE I. GENERAL DIMENSIONS OF THE BUILDING

S.NO	PARTICULAR	DIMENSION
1	Length of building	79.857m
2	Width of building	46.939m
3	Height of building	21m
4	Typical story height	G+5
5	Live load on the floor	4kN/m^2
6	Wall load	18.6kN/m^2
7	Floor finishing	1kN/m^2
8	Density of concrete	25kN/m^3
9	Density of wall	20kN/m^2
10	Grade of concrete	M30
11	Grade of steel	Fe500
12	Thickness of slab	220mm
13	Zone	V

TABLE II. SEISMIC LOAD PARAMETERS

Zone factor	0.36
Response Reduction factor	5
Importance Factor	1.5
Type of soil strata	medium
Damping ratio	0.05

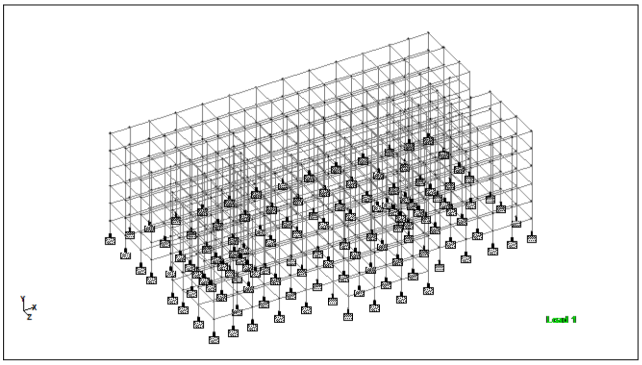

Fig. 1. plan of the Model

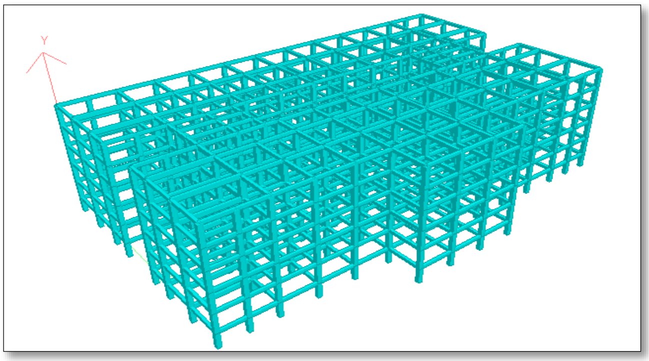

Fig. 2. Rendered View of the Model

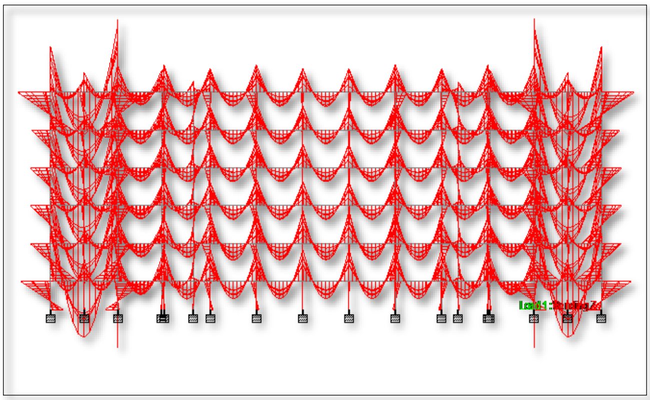

Fig. 3. Bending Moment of the Critical Beam

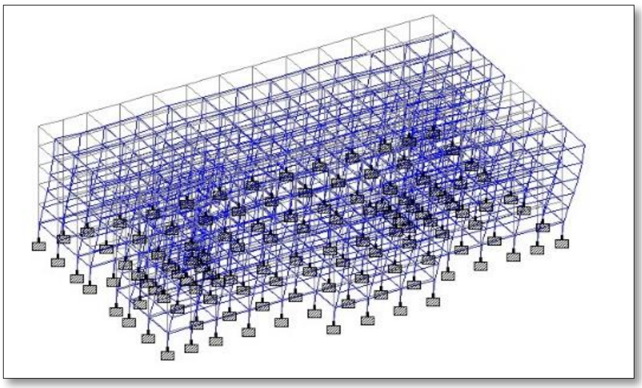

Fig. 4. Mode Shapes

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 12, December-2018

IV. RESULT

By performing different methods of Analysis in STAAD PRO, the results are obtained for different parameters, which are discussed below.

1) Average Displacement

TABLE III. COMPARISON OF AVERAGE DISPLACEMENT

S.NO	STORY	AVG. DISP (CM)			
		SRSS		ABSOLUTE	
		X	Z	X	Z
1	0	0.2091	0.0353	0.2445	0.0584
2	4	0.7953	0.1374	0.9302	0.2279
3	8	1.4134	0.2473	1.6533	0.412
4	12	1.9438	0.3407	2.274	0.5707
5	16	2.3329	0.4068	2.7293	0.6867
6	20	2.564	0.4443	2.998	0.7567

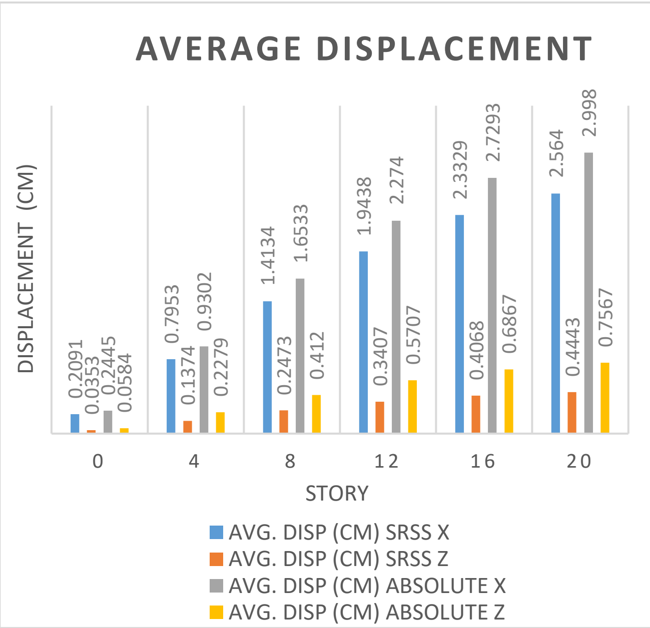

Fig. 5. Average Displacement Comparison

2) Story Drift

TABLE IV. STORY DRIFT COMPARISON

S.NO	STORY	DRIFT (CM)			
		SRSS		ABSOLUTE	
		X	Z	X	Z
1	0	0	0	0	0
2	4	0.5862	0.1021	0.6857	0.1695
3	8	0.6181	0.11	0.7231	0.184
4	12	0.5304	0.0933	0.6207	0.1587
5	16	0.3891	0.0662	0.4553	0.116
6	20	0.231	0.0375	0.2705	0.0701

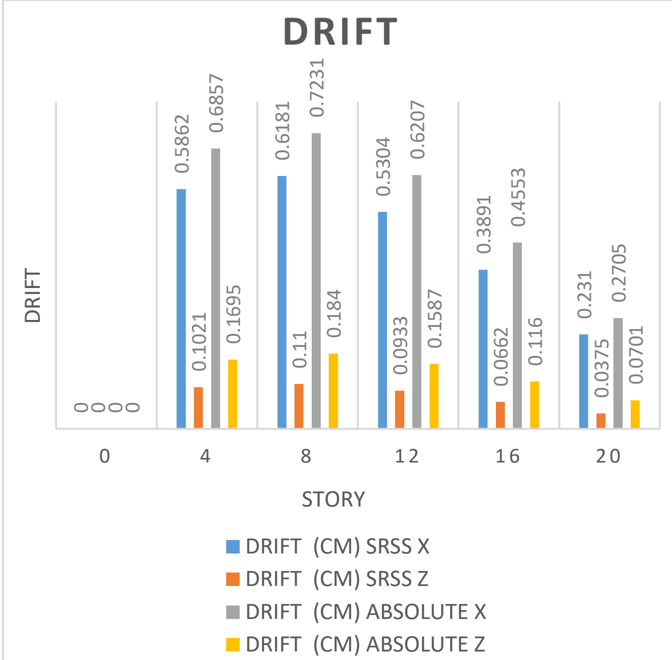

Fig. 6. Story Drift Comparison

3) Base Shear Comparison

TABLE V. BASE SHEAR COMPARISON

	Total Seismic Weight of the Building	Base Shear in X Direction	Base Shear in Z direction
Manually Calculated	235000kN	28224.5 kN	28224.5 kN
Equivalent static lateral force method	445085kN	19095.04 KN	17235.17 KN
SRSS Method	445085kN	15506.86 KN	14624.63 KN
ABSOLUTE Method	445085kN	16311.91 KN	14802.52 KN

4) Quantity Take-off Comparison

```
TOTAL VOLUME OF CONCRETE =        3159.6 CU.METER

              BAR DIA         WEIGHT
              (in mm)        (in New)
              --------       --------
                  8            361950
                 12            687575
                 16            543653
                 20            501718
                 25            303141
                 32             50652
                          ------------
            *** TOTAL=        2448689
```

Fig. 7. The quantity of Steel Take- off by SRSS

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 12, December-2018

TOTAL VOLUME OF CONCRETE = 3159.6 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	365613
12	699423
16	661912
20	571092
25	342608
32	60356
*** TOTAL=	2701003

Fig. 8. The Quantity of Steel Take- off by Absolute

5) STAAD Design Comparison

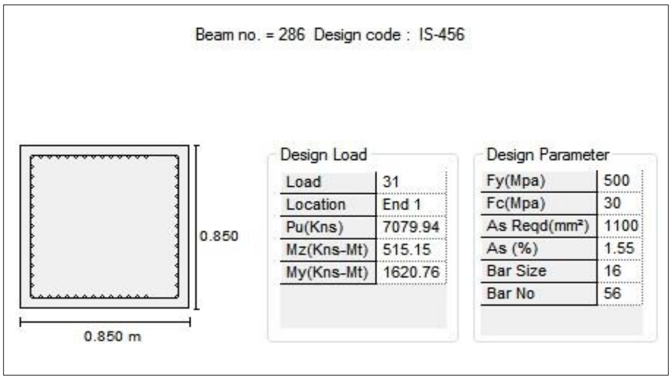

Fig. 9. Column Design by SRSS Method

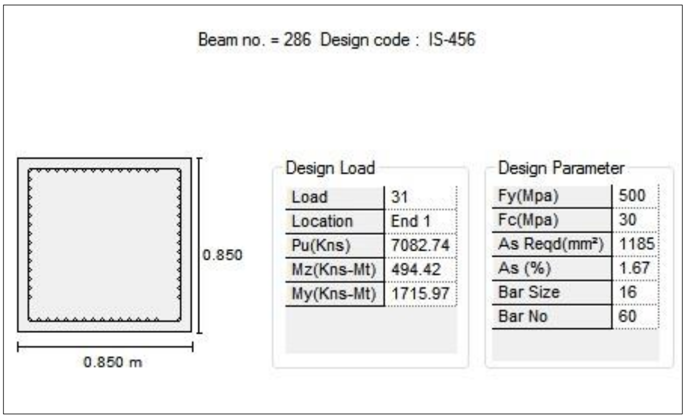

Fig. 10. Column Design by Absolute Method

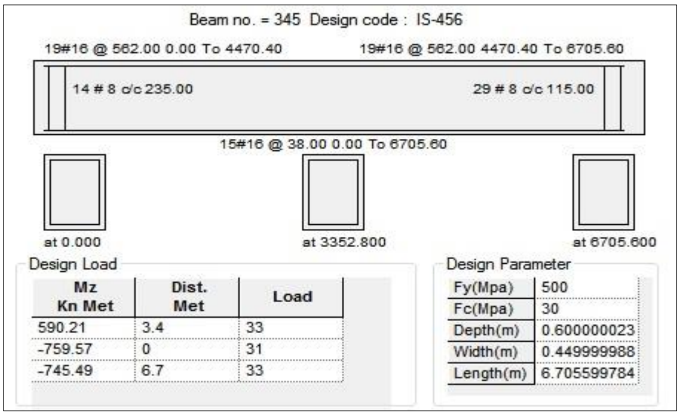

Fig. 11. Beam Design by SRSS Method

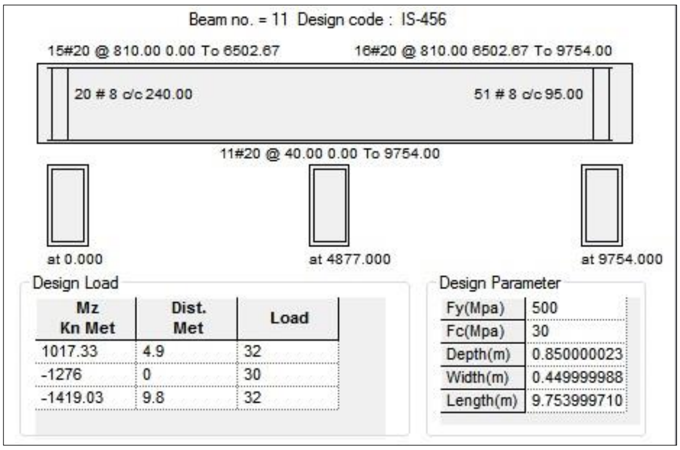

Fig. 12. Beam Design by Absolute Method

V. CONCLUSION

The aim of this study is to design and to perform the comparative analysis of response spectrum methods for the economic design for the seismic building, and the results are discussed below,

1) Short term deflection of all horizontal members is within 5 mm.

2) The structural components of the building are safe in shear and flexure.

3) AVERAGE DISPLACEMENT AND STOREY DRIFT is minimum in SRSS method than ABSOLUTE method.

4) BASE SHEAR is minimum in SRSS method than ABSOLUTE method.

5) Amount of steel provided for the structure is economic in SRSS METHOD only.

Hence, it is safer and economic to construct any Aseismic structure by designing in SRSS method.

REFERENCES

[1] IS 1893 (Part 1):2002, "Criteria for earthquake resistant design of structures", Bureau of Indian standards, New Delhi, 2002.

[2] IS: 456-2000 (Indian Standard Plain Reinforced Concrete Code of Practice) –Fourth Revision.

[3] IS: 875-1987 (part-1) for Dead Loads, code of practice of Design loads (other than earthquake) for buildings and structures.

[4] IS: 875-1987 (part-2) for Live Loads or Imposed Loads, code of practice of Design loads (other than earthquake) for buildings and structures.

[5] IS: 875-1987 (part-3) for Wind Loads, code of practice of Design loads (other than earthquake) for buildings and structures.

[6] Dr. S.K Duggal, Earthquake Resistance Design of Structure.

[7] Use of Signed response quantities in Response Spectrum Analysis, Sanjib Das (2014)

[8] Dynamic Seismic Analysis of RCC Building as per IS 1893:2002 by Using STAAD-Pro, Hiteshkumar D. Mishra, Prof. D.L.Budhlani (2017).

[9] Study of Comparison of Applying Modes in Response Spectrum Analysis, Kiran Somasundar M, Rahul Leslie, Belarmin Xavier (2018).

[10] STAADPro2004 v8i–Getting started & tutorials- Published by: R .E.I.

[11] STAADPro2004v8i–Technical reference manual"- Published by: R.E.I.