Seismic Analysis of multistoried building using STAAD Pro software

[1] Riddhima Singh, [2]Manoj Kumar, [3]Siddhant Singh, [4]Shorya Rathi, [5]Zohaib Ahmed Khan

[1,2,3,4]Student, [5]Assistant Professor, Department of Civil Engineering, KIET Group of Institutions, Ghaziabad, Uttar Pradesh, India, [1]riddhima.1822ce1066@kiet.edu, [2]manoj.1822ce1118@kiet.edu, [3]siddhant.1822ce1081@kiet.edu, [4]shorya.1822ce1079@kiet.edu, [5]zohaib.khan@kiet.edu

Abstract: Any building to be constructed needs to be structurally examined before its construction. This analysis becomes more crucial for the high-rise buildings which are constructed nowadays as they possess more critical combination of forces than ordinary buildings. The force which acts on the structural body i.e. buildings, bridges, roads, etc. may be static or dynamic. The static forces are time independent, such as the dead load of the building, whereas the dynamic forces are time dependent like wind forces and earthquake forces. Seismic forces being more vulnerable for the buildings lying in the active seismic zones needs to be considered while doing the structural analysis of the building. The complex nature of dynamic forces acting on buildings makes it complicated to do manual calculations, to overcome this software such as STAAD.Pro, ETABS, and SAFE developed to generate better results and easy analysis. This project mainly aims at doing Seismic analysis of the multistoried building using the software STAAD.Pro. We have considered a G+6 building situated on Seismic zone 4 according to the seismic Map of India as provided in IS 1893:2016 for analysis. The load combinations are according to the IS 875:1987 and for seismic analysis, we referred to IS 1893:2016. The frame used is a special moment-resisting frame. The soil below the foundation is taken as medium soil. The analysis involves several steps as assigning member properties, generating load cases, and then running analysis. This analysis enabled us to evaluate the lateral base shear on each floor.

Keywords —: Lateral base shear, bending moment, Equivalent static analysis method, modelling, Seismic Analysis, STAAD.Pro

I. INTRODUCTION

The scarcity of land for the construction of houses leads to the need for multistoried buildings and apartments. These multistoried buildings need to be seismically checked before construction for the safety of the structure. The structures which are built in the seismic active zones are very vulnerable to the damage and destruction caused by these forces is huge, so to make the structures well equipped and ready to bear the loads seismology is the branch that deals with the study of the earthquake and it's after-effects caused by the seismic waves and helps to make the structure seismic proof. These waves are the form of energy that travels from one point to another and beneath the earth's surface. The point of origin of these waves on the surface of the earth is called the epicenter. The intensity of these earthquakes is measured on a scale and their behavior is noted on graphs called seismographs. With the help of seismology, it became easy for structural engineers to study its effect on the existing structure and make more advancements in the structure analysis of multistoried buildings. The manual calculation of the responses of the seismic loads is very tedious so to make it simpler the software stand pro is used which makes the calculations easy and accurate. In this project, we will be discussing the effect of seismic load on the G+6 story building which is situated in zone 4.

STAAD.Pro software deals with the structural modeling of the building and calculated load cases are easier and more readable. This is also the time-saving software that does complex calculations easily. It is also used for the ductile detailing of the structure. This provides a user-friendly interface that is very easy to use

II. LITERATURE REVIEW

Sangeeta Uikey et.al [5] In this paper the seismic calculations are done manually and then they are compared with the results obtained by the analysis of the same building using STAAD.Pro software. Thereafter the accuracy of the software was checked. The results proved to be very precise and accurate. After that G+4, G+9, G+14, & G+19 story buildings was analyzed under seismic condition and designed and checked it for all possible load combinations for zone II & III for different soil strata below buildings.

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Parameter like story drift and deflection are compared for different zones and different soil strata. All the design are done by Limit State method of design and all the details are mentioned properly.

Prof. Komal S. Meshram et.al [6] This paper presents the study which death ls with a seismic analysis of multistoried residential building G+7. The dead load and live load applied and the design of beam, column, slab and footings are obtained from analyzing the Total structure by using STAAD.Pro software using Equivalent Static Lateral Force Method. The result shows the variation in calculation of base shear by manually and using STAAD.Pro Design Base Shear (Manually) = 2345.71 KN Design Base Shear (STAAD Pro) = 1634.43 KN .It finally concluded that STAAD.Pro is the versatile software that can be used for the analysis of the deflections of nodes of the buildings.

R. Deshmukh et.al [7] This paper presents the analysis and design the of G+19 Story building using STAAD.Pro. The design was based on Indian Standards and the analysis was done on STAAD. Pro and was then compared with respect to the one, made from the manual calculation. The design loads considered were dead load, live, load, seismic load and wind load and were calculated on the basis of Indian Standards. It was seen that the load was maximum when applied in the x-direction (parallel to shorter span) increasing deflection increases as the increased building increases. Take-off regarding take-off for the material was provided. The results obtained for base shear were 5% more in the case of STAAD.Pro as compared to manually. It was concluded in the study that STAAD.Pro is a versatile software that can be used to analyze building and compute reinforcement.

B. Gireesh [8] This paper studied the structural and seismic analysis of G+7 structure using the STAAD.Pro software. In this study the design was based on the Indian standard codes namely: IS 1893:2002 for the earthquake resistant criteria which stated the different analysis criteria based on Zone of area in which building is situated, the height of building and Importance of the building. After starting the project various dead load, live load, wind load, snow load and earthquake load was imposed and the analysis was done for the same. The building was designed for Hyderabad area which is situated on zone was II. From the analysis, it was concluded that the steel quantity needs to be increased by 1.517% compared to the conventional concrete design buildings. The earthquake load was more dominant than wind load in the selected area but according to the results obtained, there was no need for a shear wall and braced column as the base drift at every storey is 0.0, hence the structure was safe under the drift condition.

Aman et.al [9] The analysis and design of C+G+5 residential cum commercial building based on the criteria defined by the IS codes was done on Stadd.Pro software. The load imposed were only dead and live load hence the load combination generated was 1.5(D.L. + L.L.) after which the analysis of the building was done for the Frame and the resulting Bending moments and shear forces were studied. The detail of all the building members was represented along with the functions of slab, beam, column, footing and staircase. From which it was concluded that the horizontal deflections were within 20mm and the structure was safe and economical. And the result obtained by Kani's method and STAAD.Pro were quite similar.

III. METHODOLOGY

3.1 Making plan on STAAD. Pro
3.2 Assigning member properties and support
3.3 Generating load case
3.4 Run Static Analysis

Making plan on STAAD.PRO

Defining nodes as per the plan and making the plan of the building. The dimensions of distance between different coloumns are mentioned in the plan using tool of STAAD.Pro.

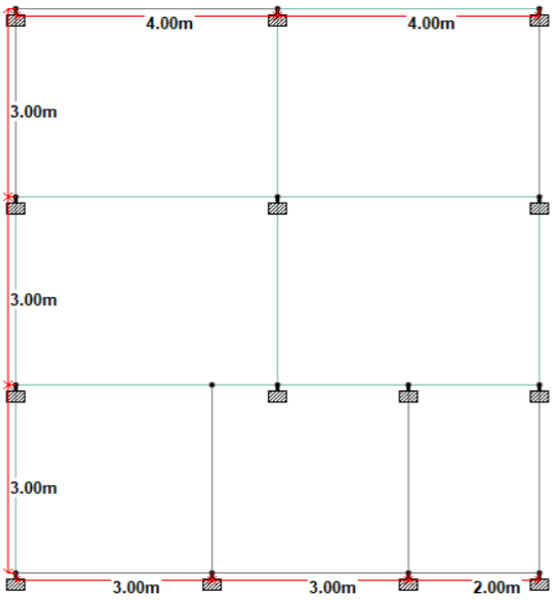

Fig: 1 Plan of the Structure

Assigning member properties

The breadth and depth of the beam is 0.30m and 0.40m respectively.

The dimensions of the column are 0.35m*0.25m

The thickness of the plate is 0.15m

The material is concrete.

The size of the beams and columns are taken as per the experience basis for the analysis to be performed.

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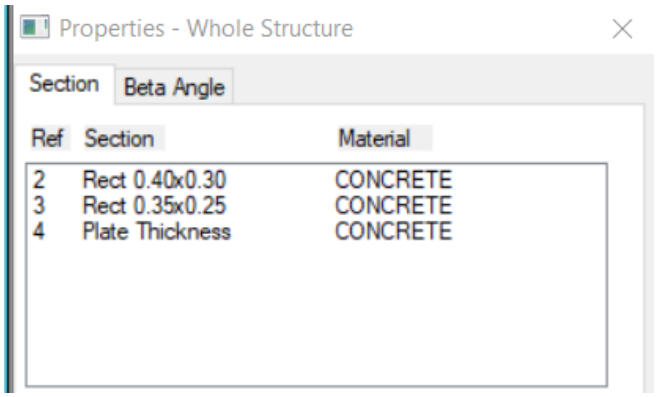

Fig: 2 Member properties

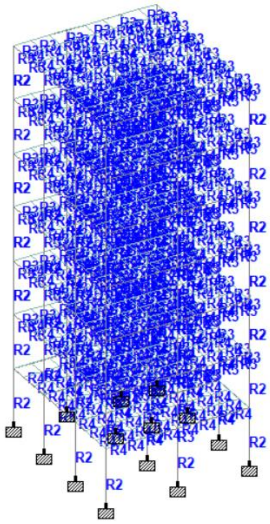

Fig: 03 Assigned view of the structure

Generating load cases and seismic definitions

The values of loads thus mentioned are by IS 875 Part 1 and Part 2

SEISMIC DEAD LOAD	6KN/M^2
SEISMIC LIVE LOAD	2KN/M^2
WALL LOAD	4KN/M^2
DEAD LOAD	4KN/M^2
PLATE LOAD	4KN/M^2
LIVE LOAD	2KN/M^2
FLOOR FINISHING LOAD	1KN/M^2

Table 1: Applied loads

All the seismic definitions given to STAAD.Pro are per IS 1893: 2016

Zone factor is taken as 0.24

Response reduction factor is taken as 5 because we have considered Special RC moment Resisting frame.

Importance factor is 1 for all general buildings.

Time period in X direction is 0.573 sec and time period in z direction is 0.540 sec.

The soil below the foundation is taken as medium soil.

Structure type is RC frame building.

Damping ratio is taken as 5%.

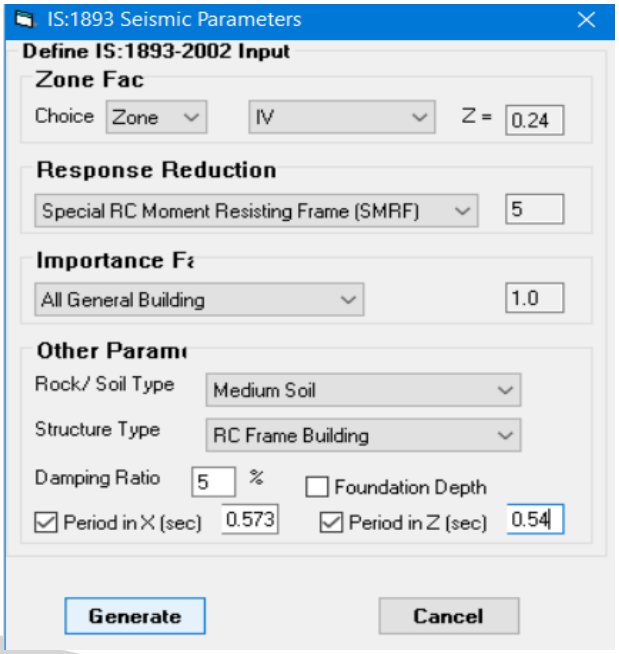

Fig 3: Seismic Definitions

Analyzing the result

After giving the run analysis command to STAAD.Pro, the analysis of the entire structure is done and the inferences are drawn from them. Fig no 4 gives the value of seismic weights and Spectral acceleration of the building. The values of spectral acceleration and seismic weight are used to find out the equivalent lateral base shear in the respective directions.

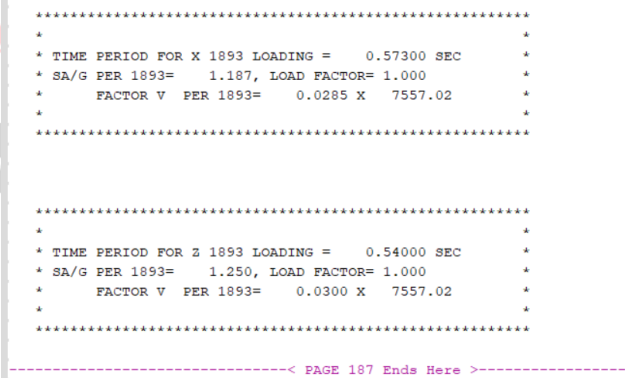

Fig 04: Factor V as per STAAD.Pro

Fig no 05 tells about the variation of bending moment in the columns and beams where it is maximum and minimum respectively. These values of bending moment will be further used for the designing of the structure and its detailing. The node on which the max and min bending moment are also mentioned. The load combinations corresponding to differ bending moment are also given.

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	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	34	5 GENERATE	28	**2555.225**	0.625	1.394	-0.036	2.205	-0.488
Min Fx	31	2 EQZ	10	**-117.585**	-0.481	15.222	-0.109	-18.941	-0.458
Max Fy	16	5 GENERATE	13	-1.486	**98.284**	0.006	-0.158	-0.010	70.452
Min Fy	20	13 GENERAT	12	-1.481	**-157.135**	-1.525	-12.980	-0.770	88.656
Max Fz	48	19 GENERAT	13	1166.005	-0.441	**33.148**	0.158	-50.745	-0.815
Min Fz	48	13 GENERAT	13	1987.772	1.173	**-37.331**	-0.319	56.984	1.619
Max Mx	106	15 GENERAT	59	1.101	-78.070	-0.206	**11.458**	0.092	-33.988
Min Mx	20	13 GENERAT	15	-1.481	-120.667	-1.525	**-12.980**	0.755	-50.245
Max My	48	13 GENERAT	13	1987.772	1.173	-37.331	-0.319	**56.984**	1.619
Min My	48	13 GENERAT	42	1975.049	1.173	-37.331	-0.319	**-55.008**	-1.901
Max Mz	20	12 GENERAT	12	-3.140	-151.185	-1.201	-3.155	-0.570	**100.067**
Min Mz	47	12 GENERAT	41	1551.274	46.116	7.290	-0.775	10.852	**-66.285**

Fig 05 Maximum and minimum beam end forces and bending moment in the structure

IV. CONCLUSION

The value of lateral base shear obtained by performing the Equivalent static analysis method are given as follows:

VALUE OF X (ELEVATION)	LATERAL BASE FORCE
0.00 m	0.707 KN
3.00m	6.414KN
6.00m	15.187KN
9.00m	26.999KN
12.00m	42.185KN
15.00m	60.707KN
18.00m	74.472KN

Table 02: Values of Lateral Base Shear

The values of maximum and minimum beam end forces in X directions are 2555.225 KN and -117.585 KN respectively. The values of maximum and minimum beam end forces in Y directions are 98.284 KN and –157.135 KN respectively. The values of maximum and minimum beam end forces in Z directions are 33.148 KN and -37.331 KN respectively. The values of maximum and minimum bending moment in X directions are 11.258 KN-m and -12.980 KN-m respectively. The values of maximum and minimum bending moment in Y directions are 56.984 KN-m and -55.008 KN-m respectively. The values of maximum and minimum bending moment in Z directions are 100.067 KN-m and -66.285 KN-m respectively.

The value of seismic weight and spectral acceleration of the structure is 7557.02 KN and 0.0285 in the X direction. The value of seismic weight and spectral acceleration are 7557.02 and 0.0300 in the z direction. These both the values are used to find the lateral base shear of the building in each floor. The use of STAAD.Pro software made the calculations very easy and it has very easy user interface. This software can be used for performing dynamic analysis and designing the structure as per the results obtained. This can also be done for preliminary detailing.

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