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Earthquake Analysis of Multi-storey building by Two Different Mathematical models

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Abstract: **-- In recent years various software are available for earthquake analysis of buildings like STAAD.Pro, ETabs and many more. There are multiple methods for earthquake analysis of a multi-storey building by this software. The aim of the paper is to compare two such methods by STAAD.Pro software. These two methods are when seismic weight is applied to the nodes and when applied on the beams. From this analysis comparison of storey shear at the different storey is observed. Moreover, storey drift and storey displacements at different floor level are compared.**

***Keywords*:-** **Storey shear, displacement, drift.**

I. INTRODUCTION

Earthquakes are one of the most disastrous natural catastrophes which cause loss of lives and money. With the increasing need of earthquake designing of structure various softwares are coming up with different ways of mathematically calculating the forces on structure because of earthquake. In this paper we are using the STAAD.Pro software for comparing the results of static earthquake analysis on the multi-storey building. For the software to perform analysis weight of the structure is to be assigned. We have assigned the weight on i) Joints/Nodes of the structure (i.e. beam column junctions) and ii) Beam of the structure.

II. DETAILS OF THE STRUCTURE

In general building construction, medium-rise structure is very common. So, G+5-storey RCC structure is used for the analysis. It is a hospital building. The plan dimension of the building is 21.3m x 12.7m. The plan of a typical floor is shown in the figure below.

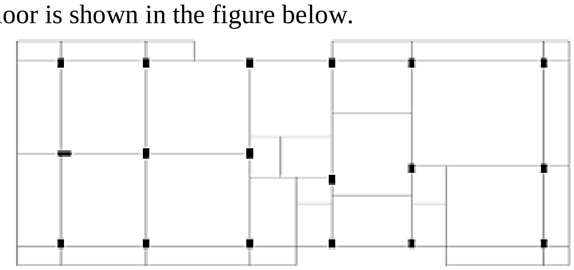

Figure 1. Typical plan of the building model

All columns are of the size 300mm x 600mm. All beams are 300mm x 750mm except for roof beams and plinth beams which are 300mm x 600mm and 300mm x 450mm respectively. Depth of foundation top is 2.5m. Thickness of slab is 150mm. 230mm exterior walls and 150mm interior walls. Density of concrete is 25kN/m2. Grade of steel is Fe415 and concrete is M25. Building lies in Zone II with type of soil medium soil. It is a special RC moment-resisting frame. Total height of the structure above ground level is 16m.Time period of structure in X direction is 0.333sec and Z direction is 0.443sec. Sa/g is 2.5 same for both X and Z direction.

III. PROCEDURE

Geometry of the structure is modeled in STAAD.Pro. Property of beams and columns is given, moreover fixed support is provided at 2.5m below ground level. Dead and live loads acting on the structure are defined and applied accordingly.

A. Seismic weight applied on beam of the structure.

Earthquake parameters are defined for the structure. Weight of the structure is assigned as floor weight, member weight and self-weight. Live load of roof is not considered while assigning weight moreover weight because of live load is reduced to 50% for live load >3kN/m2 and by 25% if <3kN/m2. Earthquake analysis for these weights is analyzed.

B. Seismic weight applied on joints/nodes of the structure

For calculating the joint weights of the structure, all the beam-column joints are provided hinge suppot. A load

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case is prepared which has total dead load and live load with respect to IS 1893(Part I):2016.Perform the analysis and find the reactions at all the hinged supports. The reactions in X, Y and Z are added with their absolute values and applied at respective joint as joint weight where earthquake is defined. Removing the hinge supports and performing analysis for earthquake for these weights.

IV. RESULTS AND DISCUSSION

Seismic weight of the structure by beam weight method is observed to be more than joint weight method. Total seismic weight of structure is shown in Table 1.

Table 1. Total seismic weight in kN

Beam Weight	Joint Weight
35406.68	33008.39

Base shear in the structure by beam weight method is observed to be more than joint weight method. Total base shear of structure is shown in Table II.

Table II. Total base shear in kN

Beam Weight	Joint Weight
1327.75	1237.81

Storey shear of the structure by beam weight method is observed to be more than joint weight method. The results of storey shear are shown in Table III and graphically represented in Figure 2.

Table III. Storey shear in kN at different storey

Storey	Height (m)	Beam Weight	Joint Weight
6	16	504.5	489.4
5	12.8	390.63	358.55
4	9.6	244.32	218.78
3	6.4	132.18	118.45
2	3.2	54.22	50.08
1	0	1.90	2.543
0	-2.5	0	0

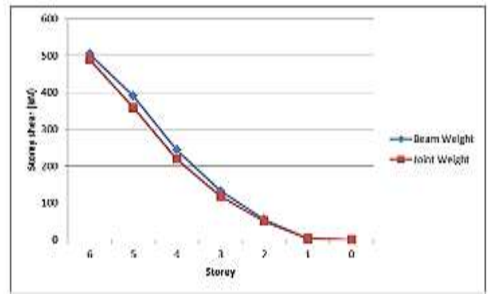

Fig. 2. Storey shear in kN at different storey

The storey displacements and drifts of the structure by beam weight method are observed to be more than joint weight method. The results of storey displacement and storey drift of both the methods for different storey are given in Table IV and Table V respectively and graphically represented Figure 3, Figure 4, Figure 5 and Figure 6.

Table IV. Storey displacement in mm at different storey

	In X		In Z	
Storey	Beam weight	Joint weight	Beam weight	Joint weight
6	24.211	22.698	38.71	36.31
5	21.812	20.396	35.16	32.89
4	18.352	17.124	29.53	27.56
3	14.08	13.122	22.49	20.97
2	9.277	8.642	14.67	13.67
1	3.095	2.88	4.94	4.61
0	0	0	0	0

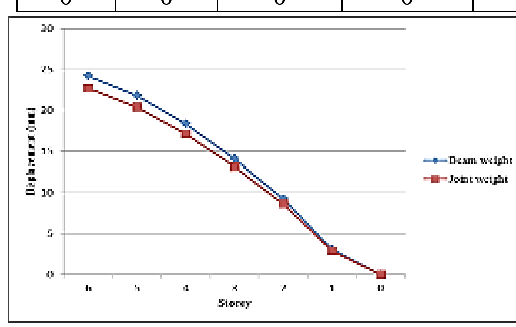

Fig. 3. Storey displacement in X in mm

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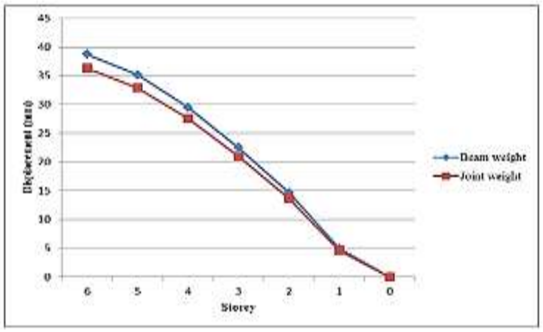

Fig. 4. Storey displacement in Z in mm

Table V. Storey drift in mm at different storey

	In X		In Z	
Storey	Beam weight	Joint weight	Beam weight	Joint weight
6	2.399	2.302	3.55	3.42
5	3.46	3.272	5.63	5.33
4	4.272	4.002	7.04	6.59
3	4.803	4.48	7.82	7.3
2	6.182	5.762	9.73	9.06
1	3.095	2.88	4.94	4.61
0	0	0	0	0

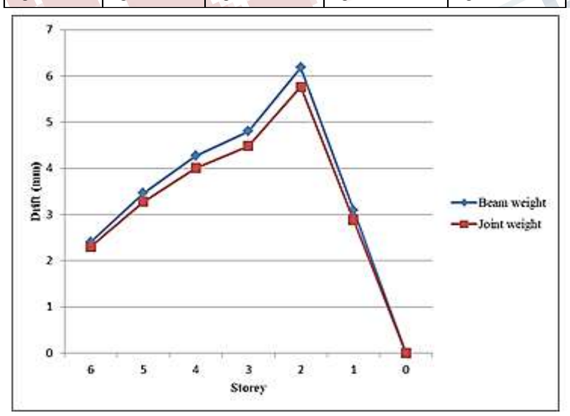

Fig. 5. Storey drift in X in mm

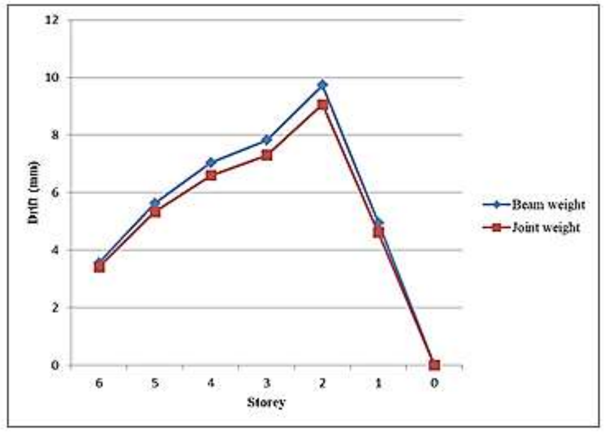

Fig. 6. Storey drift in Z in mm

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