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TIME HISTORY RESPONSES OF HIGH RISE FRAMED BUILDING WITH SHEAR WALL OPTIMIZATION

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Abstract

In the seismic design of buildings, shear walls, reinforced concrete structural walls act as a major earthquake resisting members. This paper reviews the evolution of high rise building's structural systems. In this present study, main focus is on checking the feasibility of the new scheme (optimal placing of shear wall positions in the structure) and its effectiveness. The residential high rise building is analyzed for seismic forces with respective positions of shear wall. Analysis is carried out by using standard package ETABS. The comparison of these models for different parameters like Story Displacement and Storey shear, Storey drifts are presented for various load cases. Time history responses for the three models with shear walls are evaluated.

Introduction

Shear wall are one of the excellent means of providing earthquake resistance to high rise reinforced concrete building. Behavior of the structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the earthquake effect on reinforced concrete frames, shear walls are used in the building. The provision of shear wall in building is to achieve rigidity, and found to be effective and economical. When shear wall are situated in advantageous positions in the building, they form a efficient lateral force resisting system. In this present paper three models with different positions of shear wall in the structural system are generated with the help of ETAB and effectiveness has been checked.
shear wall structure:

Shear wall structures: - A shear wall is a structural system providing stability against earthquake, wind and blast deriving its stiffness from structural forms. The shear wall can be either open sections, or closed sections around elevators. These systems either can be constructed with steel or concrete or may either be solid or perforated. The shear walls behave as deep and slender cantilevers. Structurally these shear walls can be divided into coupled shear walls, shear panel and staggered wall, shear wall frames into two walls coupled by beams at each floor. There are two methods for analyzing and determining earthquake effects on structures. (I) static method (II) dynamic method.

Static method: - The seismic actions on the portion of structures are evaluated by equivalent Static analysis by considering a design seismic coefficient. The design seismic coefficient include factor such as, -Response reduction factor -Zone factor for shear wall frames. In order to simplify the methods of analysis for determining earthquake effects on structures IS code recommended seismic coefficient method. This method having such a limitations as below.

1. It does not consider dynamic character of ground motion and damping effects in structure.
2. It does not consider effect of higher modes.
3. Soil structure interaction cannot be considered.

Dynamic method: - Dynamic analysis of structure involves free vibration analysis to determining the mode shapes and frequencies of the structure .The structure can be analyzed for seismic loading in form of response Spectrum or acceleration/force time history. The Dynamic Analysis Procedures can be characterized as:

1. Response Spectrum Analysis for Linear Structures
2. Time History Analysis for Linear and Non Linear Structures.

Literature review

Li.Xiaofen et al 2010 studied on seismic behavior analysis of high rise connected framed structure The building under consideration is modeled with the help of SAP2000-15 software. The results of the study shows similar variations pattern in Seismic responses such as base shear and storey displacements. This high-rise connected structure have good seismic behaviour, is economic and reasonable, and can satisfy the engineering requirement. Deepak suthar et al 2011studied on the high rise structure subjected to seismic forces and behaviour . It was observed that the results are more conservative in Static analysis as compared to the dynamic method resulting uneconomical structure. The building being irregular &"L-shape" the behaviour in both direction is not similar. Further, the comparison between regular and modular type indicates the overall feasibility of the scheme without affecting its stability in gravity as well as lateral loads. Tao Wang et al 2012 studied on seismic behaviour of high rise concrete framed shear wall building with hybrid coupling beams, they showed that the proposed hybrid coupling beam is more efficient in dissipating seismic energy. The RC part of the hybrid beam was well protected by concentrating the damage on the metallic damper. The metallic damper was installed by bolts on the embedded steel plates, thus being easily replaced. These features rendered the shear wall structure higher seismic performance.

Building configuration

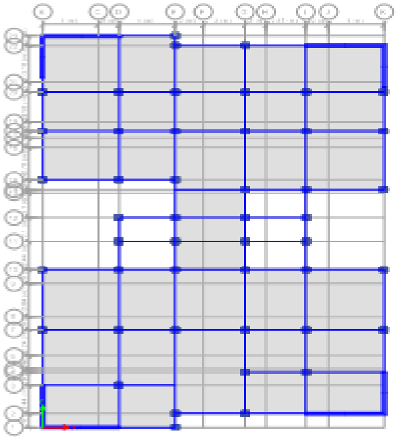
The project is a 14 storied structure in seismic zone V and founded on medium soil, which is the reference ground condition. The structural configuration and dimension of the building structure are given below:

The thickness of wall is 230 mm and the foot print of building 24.4 m X 33.6 m. In this case the earthquake force is predominant then the calculated wind pressure, hence the structure is analyzed & designed for the seismic loading.

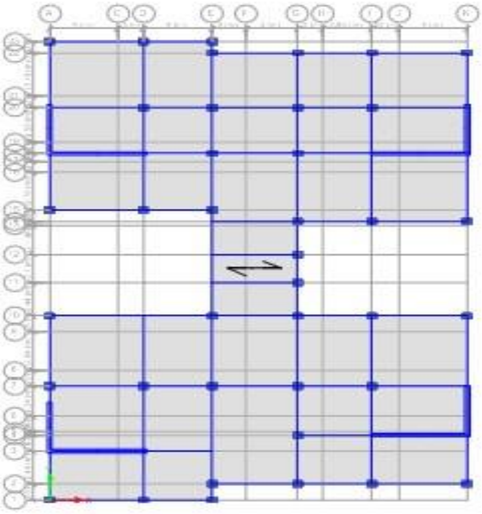
Dead load due to slab=2.5kN/m²
Dead load due to floor finish=1.0kN/ m²
Live load =2.0 KN/m²
Building type =Residential.
Grade of steel = Fe 415
Grade of concrete=M30
Building situated in zone =V
Zone factor =0.36 Reduction factor =5.0
Importance factor =1.0 .

Three different models with three different positions of shear wall:

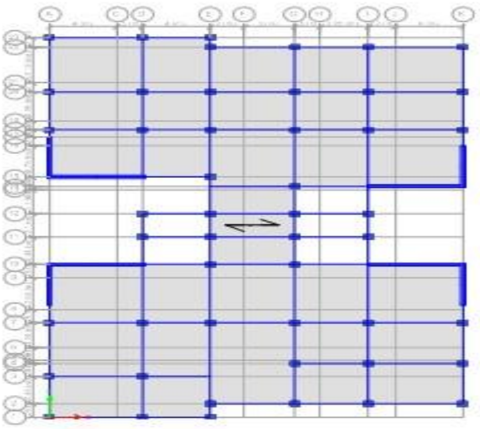
Model-1



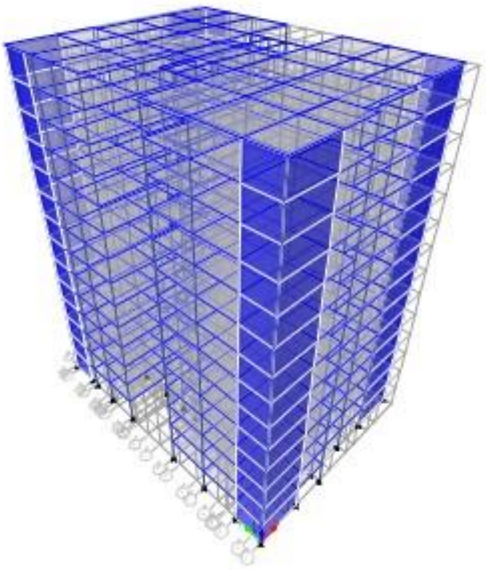
Model-2



Model-3



3-D-MODEL:



Analysis

Equivalent static analysis :

The natural period of the building is calculated by the expressions T= 0.075 x h0.75 for bare frame and T □ 0.09h d for in filled frame as given in IS 1893 (Part 1) -2002, wherein h is the height and d is the base dimension of the building in the considered direction of vibration. The lateral load calculation and its distribution along the height are done as per IS: 1893 (part 1)-2002. The seismic weight is calculated using full dead load plus 25% of live load.

Time history analysis:

Time-History analysis is a step-by-step procedure where the loading and the response history are evaluated at successive time increments, Δt – steps. During each step the response is evaluated from the initial conditions existing at the beginning of the step (displacements and velocities) and the loading history in the interval. With this method the non-linear behaviour may be easily considered by changing the structural properties (e.g. stiffness, k) from one step to the next. The parameters provided are Z=0.36 ,considering zone factor V, I=1 ,considering residential building. R=5.0, considering special RC moment resisting frame.(SMRF).

Results and discussions

Comparison between equivalent static method and response spectrum method

From the analysis results obtained following parameters are taken into consideration for the present study

Storey drift:

Story drift can be defined as the lateral displacement of one level relative to the level above or below it: As per Clause no. 7.11.1 of IS 1893 (Part 1): 2002, the storey drift in any storey due to specified design lateral force with partial load factor of 1.0. By comparing the drift values obtained for all models obtained, it could be seen that in models with shear wall provided at core as well as in corners the inter story drift has considerably been reduced when compared to the bare frame model as well as those models in which shear walls are provided only in longitudinal or transverse directions.

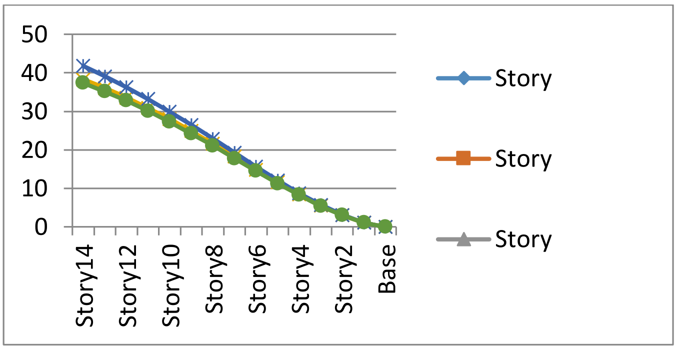


fig: Story drift comparison of the models

Table: Storey drift			
Storey	MODEL-I	MODEL-II	MODEL-III
	mm	mm	mm
Story14	38.3	41.8	37.4
Story13	36.1	39.1	35.2
Story12	33.6	36.3	32.8
Story11	30.9	33.2	30.1
Story10	28	29.9	27.3
Story9	24.9	26.5	24.2
Story8	21.6	22.9	21.1
Story7	18.3	19.3	17.8
Story6	14.9	15.6	14.5
Story5	11.6	12.1	11.3
Story4	8.4	8.7	8.3
Story3	5.5	5.7	5.4
Story2	3	3.1	3
Story1	1.1	1.1	1.1
Base	0	0	0

Base shear

Base shear is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure.

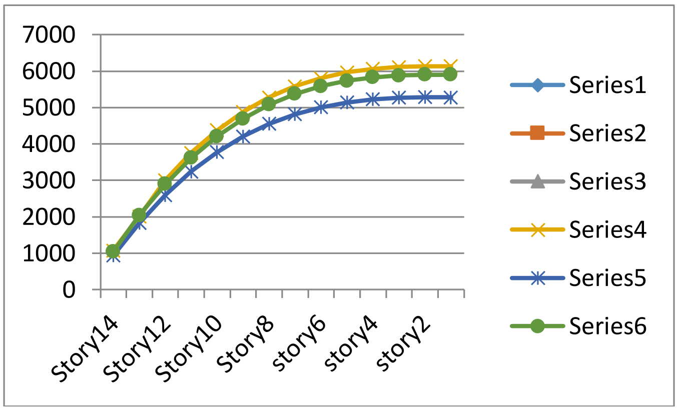


fig: Comparison of base shear values

Table: Base shear	**model-III**	**model-II**	model-I
Storey No	kN	kN	kN
Story14	1080.4	936.9641	1040.3048
Story13	2012.32	1833.9506	2042.996
Story12	3012.5	2599.24	2898.1478
Story11	3760.24	3243.3425	3617.5704
Story10	4379.35	3776.6462	4212.965
Story9	4881.78	4209.4907	4695.9847
Story8	5279.24	4552.1801	5078.2478
Story7	5584.84	4814.9892	5371.3433
story6	5808.95	5008.1563	5586.8271
story5	5964.18	5141.8646	5736.2081
story4	6062.84	5226.1991	5830.9187
story3	6116.84	5271.0611	5882.252
story2	6135.5	5285.9095	5901.1726
story1	6138.24	5280.1768	5898.7008

Storey displacements:comparison of storey displacements for the three models

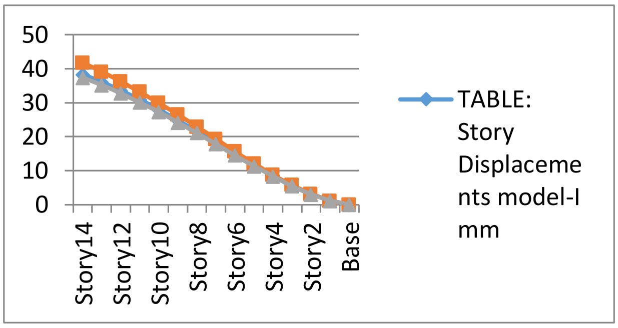


fig:Comparison of storey displacements

Table: Storey Displacements			
Storey	**model-I**	**model-II**	model-III
	mm	mm	mm
Story14	38.3	41.8	37.4
Story13	36.1	39.1	35.2
Story12	33.6	36.3	32.8
Story11	30.9	33.2	30.1
Story10	28	29.9	27.3
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Story6	14.9	15.6	14.5
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Story4	8.4	8.7	8.3
Story3	5.5	5.7	5.4
Story2	3	3.1	3
Story1	1.1	1.1	1.1

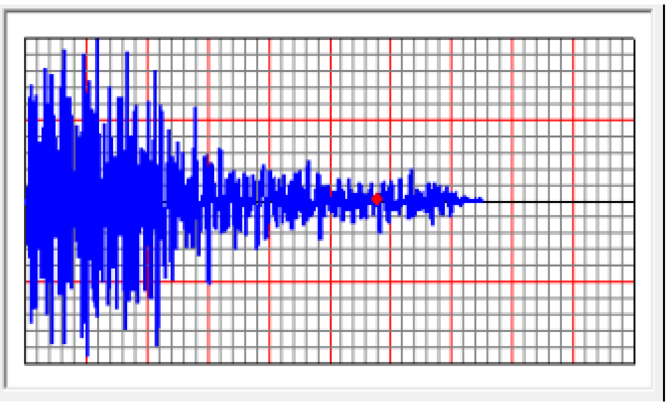

fig: Elcentro graph.

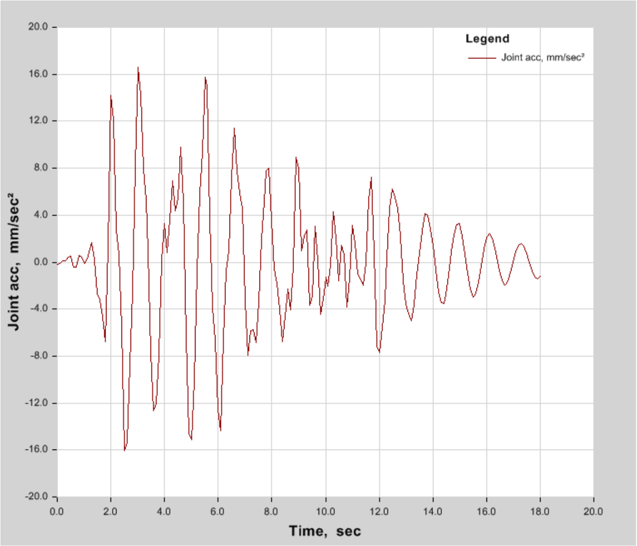

fig: Time vs Acc graph.

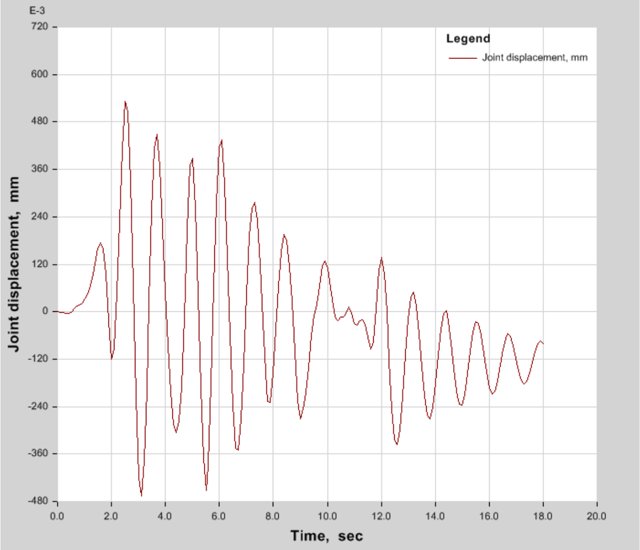

fig: Time vs Displacement graph.

Conclusion

From all the above analysis, it is observed that in 14 storey building, constructing building with shear wall in short span as in (model 3) is economical as compared with other models. From this it can be concluded that large dimension of shear wall is not effective in 14 stories or below 14 stories buildings. It is observed that the shear wall is economical and effective in high rise building.

Also observed that

1. Altering the position of shear wall will affect the attraction of forces, so that wall must be in proper position.
2. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.
3. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake

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