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"Seismic analysis of RC framed building with different positioning of viscous dampers"

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***ABSTRACT-* The role of damping becomes important when it comes to reducing the response of structures to earthquake loads designing them as earthquake resistant structures. Different types of dampers are in use in the industry. Fluid Viscous dampers are used in this study to evaluate the behavior of RC framed building. Main objective of structural system is sustain and transfer the lateral loads to the ground. The vibrations are caused in the structures as the lateral loads are dynamic in nature. Fluid viscous dampers are used in order to make building as earthquake resistant structure. Different building models with various positioning of FVD are studied in thesis. The models are analysed with Etabs 2016 version by Equivalent static analysis and Response spectrum analysis. It has been observed that the building with FVD at centre of exterior frame performed better than other models considered.**

Keywords: Dampers, Fluid Viscous Damper, Displacement, Drift, Response spectrum method.

I. INTRODUCTION

In each part of human development we required structures to live in or to get what we require. Be that as it may, it isn't just building structures however to assemble productive structures with the goal that it can satisfy the principle reason for what it was made for. Here comes the part of structural building and all the more absolutely the part of examination of structure. There are numerous established strategies to take care of outline issue, and with time new programming's likewise becoming an integral factor. In exhibit numerous number of structures or structures have unpredictable arrangement in the arrangement and rise. Structures or Buildings with sporadic dispersion in firmness, mass and quality declines because of which significant harms happens amid seismic earthquakes. This has been seen in the past earthquakes. Such structures will be under torsional movement. A perfect multistory building intended to oppose the sidelong loads because of seismic earthquake would comprise of just symmetric appropriation of mass and firmness in design at each story and a uniform dispersion along tallness of the building. Such a building would oppose just along the side and is considered as torsionally adjusted (TB) building. It is exceptionally hard to get such a condition because of limitations such design necessity and practical needs.

The thick viscous fiquid dampers (VFD) are the more connected devices for controlling reactions of the structures. These devices are connected in light of various development advances keeping in mind the end goal to diminish the basic reactions to the seismic excitation. Despite the fact that over the ongoing years substantial expenses have been paid for exact acknowledgment of power of a seismic earthquake in the examination establishments of the world with the motivation behind diminishing its harm, the expanding requirement for more research ponders on the impacts came about because of the quake is felt in the hypothetical and laboratorial scales. In the course of the most recent fifty years, the seismic earthquakes are classified into two gatherings of close field quakes and far-field seismic earthquakes in light of the separation of the place of chronicle the earthquake from the blame. Afterward, this definition was changed and different factors likewise affected this arrangement. Over the ongoing years, the exploration thinks about focused on the investigation of effects of ground movement in the close field seismic earthquake on the basic execution.

OBJECTIVES OF STUDY

The objectives of current study are as listed/follows below:

To get the best position of viscous damper to oppose the seismic loads in a rectangular RC framed building working by equivalent static analysis and Response spectrum method in Etabs programming.

- Preparation of 3D models and Analysis of the following different models of 25 storey RC framed building
  - Model 1-bare frame
  - Model 2-bare frame with vd at corners in exterior frame
  - Model 3-bare frame with vd at centre in exterior frame
  - Model 4-bare frame with vd at corners in interior frame
  - Model 5- bare frame with vd at corners in exterior frame
- To check the effect of dampers in seismic prone areas.
- To check the displacement, drift and base shear.
- Comparing base shear, lateral displacement and drift estimations of previously mentioned system to decide the best design system for resisting lateral loads.

LITERATURE REVIEW

Anita Tippanagoudar's investigation is centered around adequacy of vitality dis-sipation gadget and horizontal firmness framework. Numerical in-vestigation is done, considering the seismic reaction of fifteen story solid minute opposing edge with regu-lar and unpredictable in design. Gooey damper, propping and com-bination of thick damper and supporting are associated with building outline at various areas and game plans. Study is directed to lessen the reaction of building effec-tively and ideal number of dampers by utilizing propping with dampers. Dynamic investigation and static nonlinear analy-sister are completed utilizing ETABS programming. Consequences of different courses of action are considered From the above investigations led for symmetrical and unsymmetrical building, associated with Viscous Damper, Bracing and blend of Damper and Bracing, can be presumed that gooey damper successfully lessens reaction of the construct ing like dislodging and story float up to 70% and much of the time building associated with thick soggy er and supporting additionally diminishes the reaction of the structure around 65%. Day and age diminishes around 45-55% of building con-nected with thick damper and damper and propping com-pared to exposed casing.

Naziya Ghanchi and Shilpa Kewate clarifies seismic execution and additionally reaction of the structure will be generously enhanced if this vitality is dispersed in a way free of basic parts. Reaction range investigation of 25 story RCC building which will be utilized as business working, with solid shear divider center and average floor zone 735 sq. meters was performed. The structure is displayed utilizing the limited component program ETABS and is broke down reaction range investigation. In their outcomes unmistakably by including thick dampers in a building reaction of a structure get decreased by noteworthy sum. They have seen that for reaction range investigation in X and Y heading, the reaction of the structure, for example, the story float and story removal decreases more as contrast with the story shear. Lessening of story float is around 29% to 30%, diminishment of story dislodging is around 20% to 23%, and decrease of story shear is around 0% to 2%.

DESCRIPTION OF MODEL

No of stories = 25(G+24)

Dimensions of plan area = 54m x 54m

Height of each story = 3.2m

Type of damper = viscous damper

Material Properties

PROPERTIES	**VALUES**
Young's modulus of concrete	$25X10^6$ kN/m^2
Density of reinforced concrete	25 kN/m^3
Density of steel	76.59 kN/m^3
Poisson's ratio of steel	0.3
Assumed floor finishes	1.2 kN/m^2

Cross sections of structural elements of the frame

- Column size
- 1. From 1st to 12th floor-450mmx1000mm
- 2. From 13th to 25 floor-450mmx750mm
- Beam – 300mmx600mm
- Slab thickness-200mm

Seismic Data

- Zone factor =0.36(Zone V)
- Importance factor = 1.5
- Response reduction factor =5
- Soil type = Type 2 (medium)

DIFFERENT TYPES OF MODELS CONSIDERED FOR PRESENT STUDY

MODEL 1: The building is modeled as a bare frame with rectangular plan of dimensions .

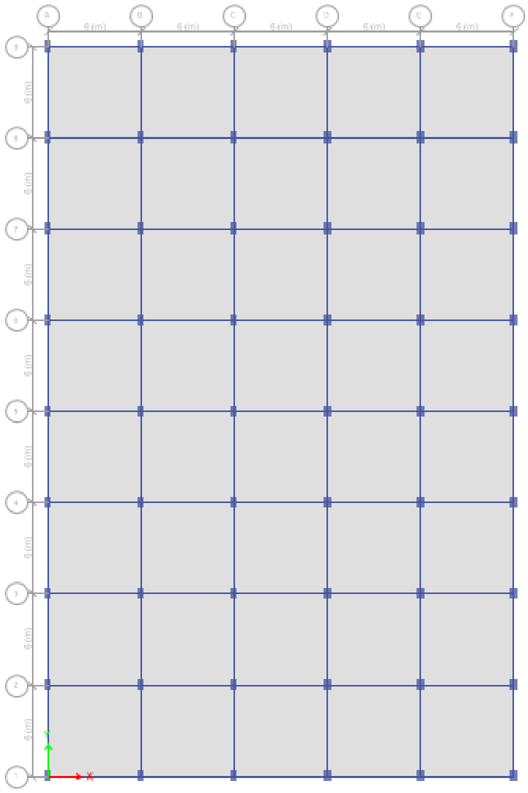
MODEL 2: The building is modeled as bare frame having viscous dampers at corners of most exterior frame .

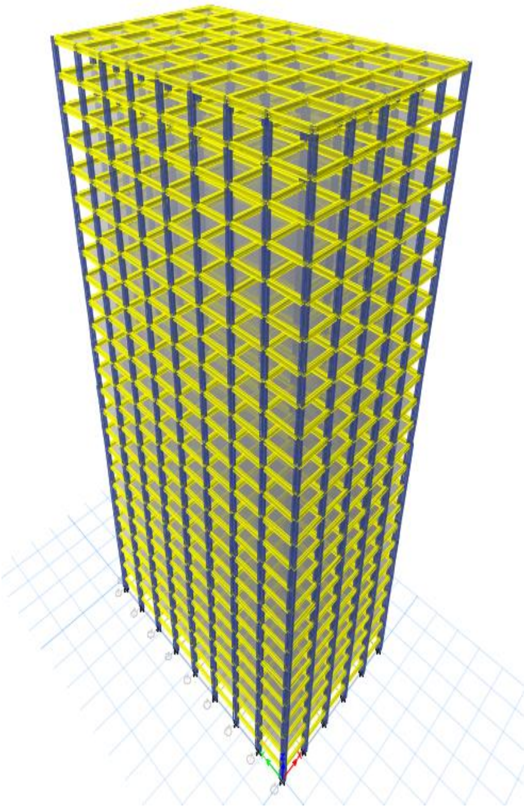
MODEL 3: The building is modeled as bare frame having viscous dampers at centre of most exterior frame.

MODEL 4: The building is modeled as bare frame having viscous dampers at corners of interior frame.

MODEL 5: The building is modeled as bare frame having viscous dampers at corners of interior frame.

PLAN USED IN ANALYSIS





RESULTS AND DISCUSSION

For the analysis of all five building models earthquake loads are applied. The analysis of all the different building models is done by using ETABs 2016 software. The analysis results such as displacements, story drifts and base shear of all building models are presented and compared.

Displacement

The performance of the models under the application of lateral loads is studied to understand the effect of viscous dampers in resisting lateral movements of buildings. The displacement is the measurement of movement of an object from its original position in linear direction. The displacements which are likely to happen due to lateral loads are calculated and tabulated.
As the building is unsymmetrical about X and Y axis the displacements along longitudinal and transverse direction are tabulated for both X and Y directions. The displacements along X and Y directions due to seismic loads by ESA are presented in Tables 4.1, 4.3, 4.5, 4.7 and 4.9 and by RSA are reprented in Tables 4.2, 4.4, 4.6, 4.8 and 4.10 for models 1, 2, 3, 4 and 5 respectively. Max displacements of all models by Equivalent static analysis are compared in Table 4.21 and by Response Spectrum analysis are compared in table 4.22.

Storey Drifts

Story drift is the comparative movement of one floor with respect to the movement of its just lower floor. Story drift is calculated as ratio of difference of displacement of two successive stories to the height of that story . The building is unsymmetrical about X and Y axis the story drifts along longitudinal and transverse direction are tabulated for both X and Y directions. The story drifts along X and Y directions due to seismic loads by ESA are presented in Tables 4.11, 4.13, 4.15, 4.17 and 4.19 and by RSA are reprented in Tables 4.12, 4.14, 4.16, 4.18 and 4.20 for models 1, 2, 3, 4 and 5 respectively.

RESULTS OF ANALYSIS

MODEL	MAX DIS IN X-DIRECTION	% REDUCTION COMPARED TO MODEL 1	MAX DIS IN Y-DIRECTION	% REDUCTION COMPARED TO MODEL 1
MODEL 1	111.795	0	89.176	0
MODEL 2	73.713	34	79.835	23
MODEL 3	74.648	33	51.409	40
MODEL 4	73.683	34	62.895	36
MODEL 5	76.569	32	40.989	29

Table 4.21 Max displacements by ESA for all models

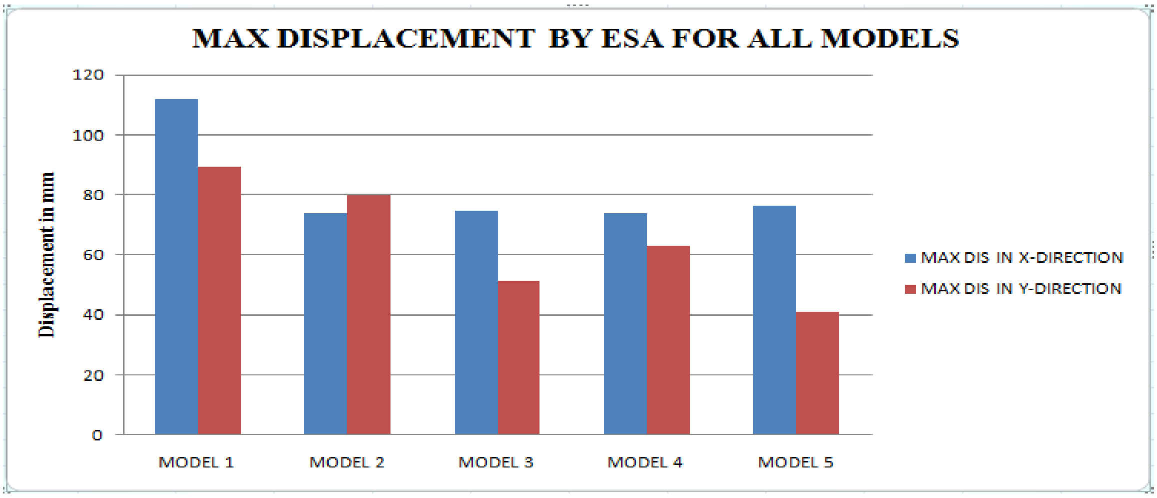


Chart 4.21 Max displacements by ESA for all models

MODEL	MAX DIS IN X-DIRECTION	% REDUCTION COMPARED TO MODEL 1	MAX DIS IN Y-DIRECTION	% REDUCTION COMPARED TO MODEL 1
MODEL 1	91.318	0	76.408	0
MODEL 2	70.015	21	52.936	31
MODEL 3	54.723	43	43.769	43
MODEL 4	58.363	29	56.969	25
MODEL 5	64.474	55	32.411	57

Table 4.22 Max displacements by RSA for all models

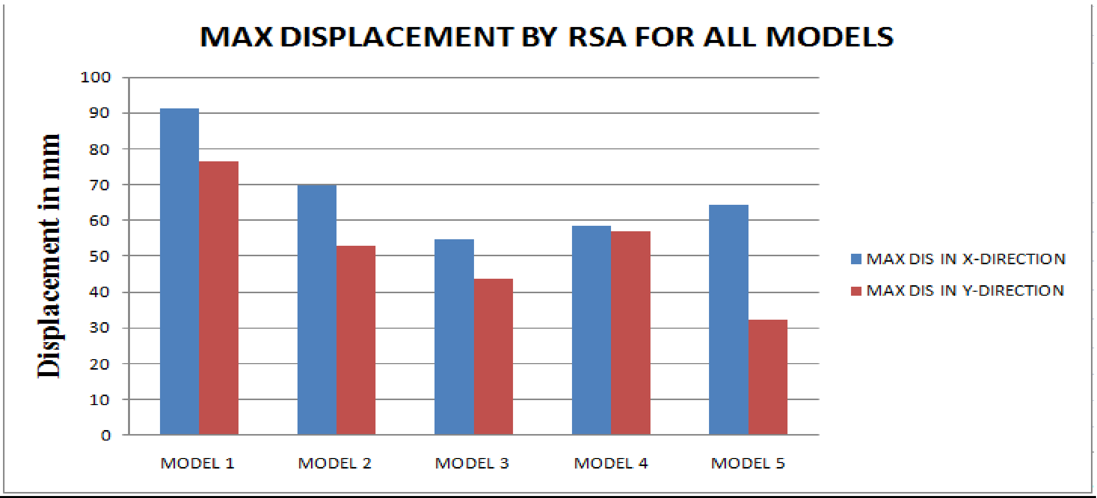


Chart 4.22 Max displacements by RSA for all models

MODEL	MAX Drift IN X-DIRECTION	% REDUCTION COMPARED TO MODEL 1	MAX Drift IN Y-DIRECTION	% REDUCTION COMPARED TO MODEL 1
MODEL 1	0.00175	0	0.001441	0
MODEL 2	0.001198	32	0.00141	22
MODEL 3	0.001156	34	0.000808	44
MODEL 4	0.001191	32	0.001018	30
MODEL 5	0.001236	30	0.000646	56

Table 4.23 Max story drifts by ESA for all models

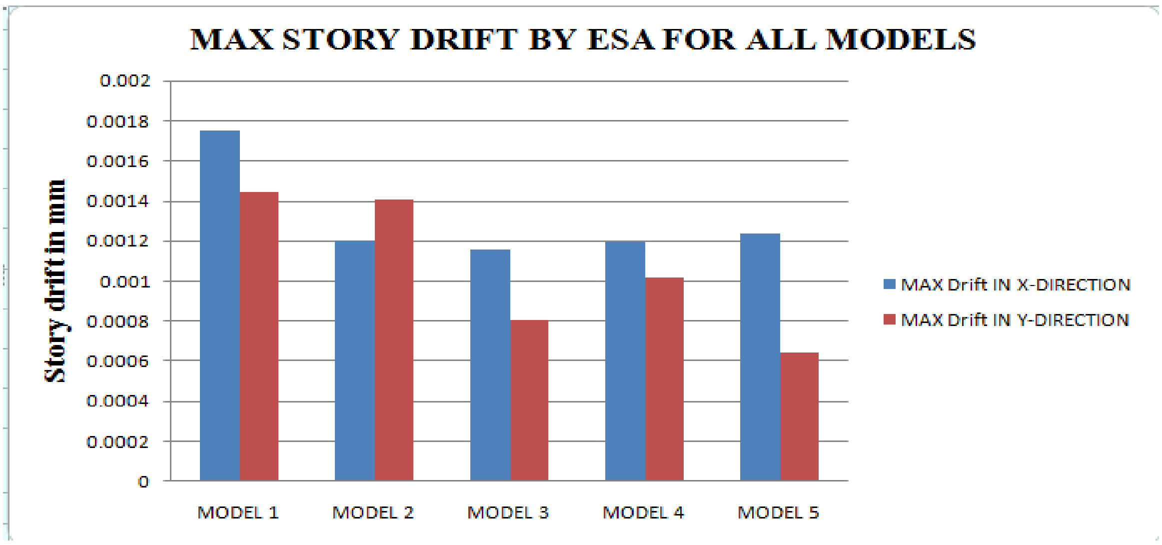


Chart 4.23 Max story drifts by ESA for all models

MODEL by RSA	MAX Drift IN X-DIRECTION	% REDUCTION COMPARED TO MODEL 1	MAX Drift IN Y-DIRECTION	% REDUCTION COMPARED TO MODEL 1
MODEL 1	0.00169	0	0.001403	0
MODEL 2	0.001092	35	0.001408	36
MODEL 3	0.000828	51	0.000673	52
MODEL 4	0.000919	54	0.000904	36
MODEL 5	0.001015	40	0.000495	65

Table 4.24 Max story drifts by RSA for all models

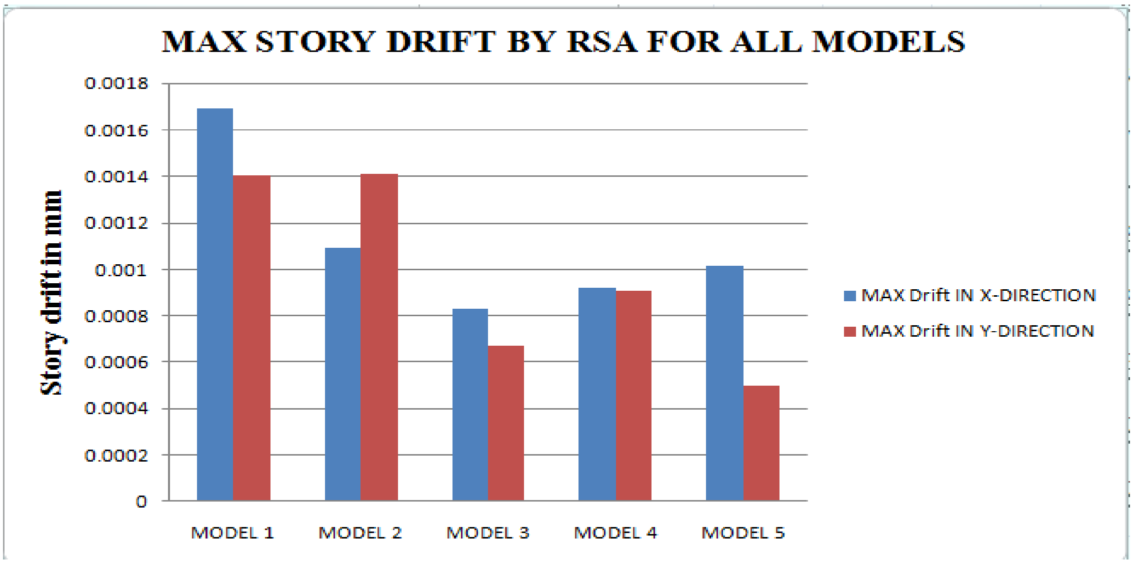


Chart 4.24 Max story drifts by RSA for all models

MODEL	BASE SHEAR IN X-DIRECTION IN kN		BASE SHEAR IN Y-DIRECTION IN kN	
	BY ESA	BY RSA	BY ESA	BY RSA
MODEL 1	-3857.4289	4598.4165	-4604.4352	5449.9599
MODEL 2	-1291.2686	1880.4285	-2407.5197	3406.3743
MODEL 3	-1278.3069	1531.5428	-2140.9736	2649.7198
MODEL 4	-1105.5831	1481.4421	-2385.1094	2921.3586
MODEL 5	-1093.3792	1409.0682	-1692.6917	2252.6393

Table 4.25 Base shear values in both directions for all models

CONCLUSIONS

- The models 1, 2, 3, 4 and 5 when compared for displacements in X-direction by equivalent static analysis, the displacements of model 2, model 3, model 4 and model 5 are reduced by 34%, 33%, 34%, and 32% respectively and in Y-direction by 23%, 40%, 36%, and 29% respectively when compared with model1.
- The models 1, 2, 3, 4 and 5 when compared for displacements in Y-direction by Response spectrum analysis, the displacements of model 2, model 3, model 4 and model 5 are reduced by 21%, 43%, 29%, and 55% respectively and in Y-direction by 31%, 43%, 25%, and 57% respectively when compared with model1.
- The models 1, 2, 3, 4 and 5 when compared for story drifts in X-direction by equivalent static analysis, the displacements of model 2, model 3, model 4 and model 5 are reduced by 32%, 34%, 32%, and 30% respectively and in Y-direction by 22%, 44%, 30%, and 56% respectively when compared with model1.
- The models 1, 2, 3, 4 and 5 when compared for story drifts in Y-direction by Response spectrum analysis, the displacements of model 2, model 3, model 4 and model 5 are reduced by 35%, 51%, 54%, and 40% respectively and in Y-direction by 36%, 52%, 36%, and 65% respectively when compared with model1.
- Along with the decrease in displacement and story drift values the other major advantage found is that the base shear values of models with viscous dampers i.e., model 2, model 3, model 4 and model 5 has considerably reduced when compared to model without viscous damper i.e., model 1.
- The model 3 i.e., bare frame along with viscous dampers at middle position of exterior frame is found to be most efficient in resisting seismic effects among the all models considered in study.

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FUTURE SCOPE

1. This study is limited to the use of FVD250, various FVD like FVD500 can be utilized in future studies to see their effect and values can be compared with FVD250 also so as to see their inter-relationships.
2. The FVD can be used in different alignments in future studies like diagonal, Diamond etc.
3. The study can be continued for unsymmetrical, irregular and working plans.
4. The study can be taken through steel structures also to see compatibility.
5. The FVD can be used along with different structural systems also.

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