PERFORMNCE OF BUILDING USING FLUID VISCOUS DAMPERS AND SHEAR WALL

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Abstract - *Earthquake is one of the most terrifying and damaging phenomena of nature the after effects are terrible, during an earthquake, an abundance quantity of energy is pumped into the structure. The damage degree of the structure is determined by the way that this energy is consumed. The main purpose of a structural design is based on guaranteeing the safety and functionality of the designed buildings, in order to avoid collapse by allowing the structural elements to take and dissipate energy*

The current study focused on the seismic response of high rise RC structures along with structural systems bordering on shear wall and fluid viscous dampers at various location. The building is analyzed, accordance with Indian standard code IS 1983(Part1) 2002, seismic zone V and medium soil. Equivalent static method and Response Spectrum has been employed for each model, ETABS software is used to examine the effect of structural systems on seismic parameters. From the results it's concluded that building with shear wall at core and dampers at edge have time period of 54%. Lateral displacement of 38% in x direction and 40% in y direction story drift of 48.4% .Hence shear wall at core and dampers located at edges can be used in RC multi-story buildings to reduce the response effectively

***Key Words*: ETABS, lateral load, dissipate energy, structural systems, Response spectrum, story drift, story displacement, dampers, Fluid viscous damper etc.**

1. INTRODUCTION

India is developing country with a population of 1,380,004,385 (nearly 139 crores) according 2020 census. This rapid increase in population and low land availability have forced engineers to go for high rise building even in high seismicity zones.

Tall buildings are exposed to vibrations caused by seismic activity and wind speed due these forces huge displacement and moments are generated which lead to ultimate failure of in structure. The adobe and time of occurrence of earthquake are unpredictable, this categories them as ruin natural phenomenon.

Earth wavering caused by tectonic plates induce flouting and evolution which swifts energy rapidly discharge inside earth. During earthquake abundance amount of energy is pumped to structures, which forces the structure to sway. The extreme force produced through the earthquake is determined by extent of damage in he uilding The intensity Of damage of structures can be reduce to by adopting various structural systems like Shear walls, dampers, bracing, etc which are usually used to oppose forces.

Dampers are the devices or any materials which are employed to absorb vibrations. Seismic dampers are mainly designed to dissipate these vibration so as to reduce the response of structures. The RC shear walls are relatively rigid in their individual plane. These transmit vibration throughout body to resist the failure.

1.1 Fluid Viscous Dampers

The function of this device follows principle based on flow of fluid through orifices; in a various structural applications these instruments are mounted. To withstand pressure of seismic and improve response of structure generally passive energy dissipation device is used.

Damping force is produced by flow of fluid which shifts from one case to the other case within cylinder as piston slip during earthquake. Therefore mechanical energy is transformed to thermal causing expansion and contraction of fluid. Generally highly viscous fluid like a compound of silicone or a similar kind of oil is filled in cylinder of a piston head along with orifices. While the damper undergoes compressive force it reduces the volume of fluid in cylinder due to motion of piston rod.

Viscous dampers deliver a force which can always resists the structure motion. This force stays directly proportional to relative velocity bet ween ends of damper. The damping equation stands as follows:

$$F = C|\dot{u}|\alpha \mathrm{sgn}(\dot{u}) = CV\alpha$$

Where:

- F: amping force
- C: coefficient of amping
- V: velocity
- α: Damping exponent that can range from 0.01 to 1.00. (Linear behaviour equal to 1.00).

1.2 Shear wall

Shear walls are vertically positioned supports additionally to slabs, beams and columns, capable of resisting the lateral loads. They start at the beginning of foundation and runs from end to end of the structure. The thickness of the shear walls of size in the range of 150mm to 400mm depending on vertical elevation of the structure. RCC shear wall has high in plane stiffness, at the same time resist massive horizontal masses and support gravity masses in the direction of orientation of the walls, thereby serving merits in most of the engineering Structural applications and reducing the risk of damage in structure. Shear walls in addition gives a lateral stiffness to avoid the roof or floor on top commencing excessive side-sway.

2. OBJECTIVES

- To analyse the high rise buildings for seismic response, with and without FVD and shear wall.
- To study the variations in time period for different structures with combination of shear wall and FVD.
- To determine the optimum location for shear wall for a building.
- To determine displacements, storey drift, base shear variations in the structure due to introduction of FVD and shear wall.

3. METHODOLOGY

The forces and response of structures during seismic excitations analysed by employing response spectrum method. Analysis of the response spectrum (RSA) is an approach mainly used for design of buildings. Conceptually this method is an alternate form of modal analysis, i.e. Response History Analysis (RHA) by modal decomposition that benefits from the properties of the theory of response spectra. The goal of the approach is to provide fast peak response assessments without having to undergo historical response analysis. This is very important because the response spectrum analysis (RSA) is dependent on a set of quick and simple calculations. This approach is approximate in nature but is very beneficial because it makes the use of response spectrum to explain seismic hazard in a very comfortable manner.

4. MODEL DISCRIPTION

A multistory of G+14(15) reinforced cement concrete(RCC) framed structures with plan of 5184 m^2.The structures is analyzed in ETABS software using response spectrum method for Indian standards .The structure presumed to be located Bhuj, Gujarat which lies in seismic and cyclone prone areas

Table -1: Building details

Geometric Details	
Plan dimensions	35 X25 m
Type of building plan	Regular
Height of building (m)	45
No of stores	15
Material properties	
Grade of concrete	M 30
Grade of steel	Fe 500
density of concrete	25 lKN/m^3
Density of brick	19 KN/m^3
Section properties	
Beam size (mm)	230x500
Column size (mm)	600 x600
Slab thickness (mm)	150
Seismic properties	
Seismic zone (IS 1893-2002)	V
Seismic zone factor (Z)	0.36
Importance factor (I)	1.5
Response reduction factor(I)	5
Soil type	II
Damping ratio	0.05
Link properties	FVD
Translational mass(kg)	44
Force (KN)	250

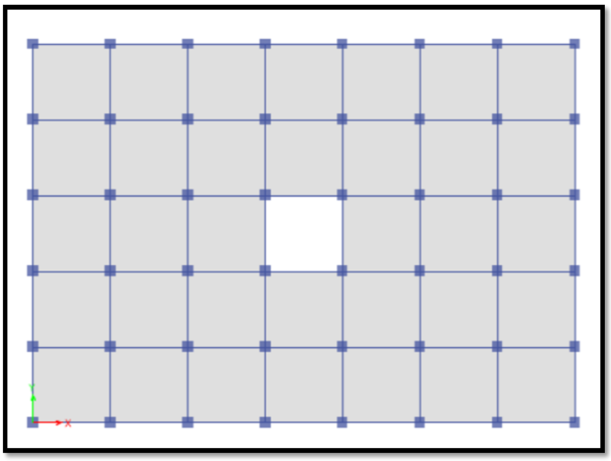

Fig -1: Plan of building

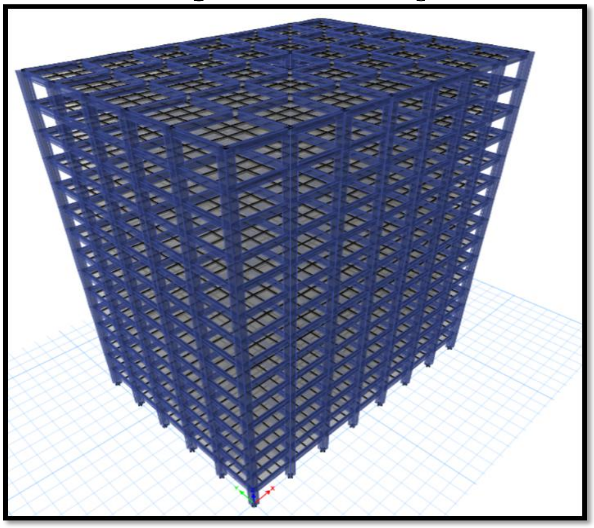

Fig -2: 3D view of building

5. RESULTS

A. Time Period

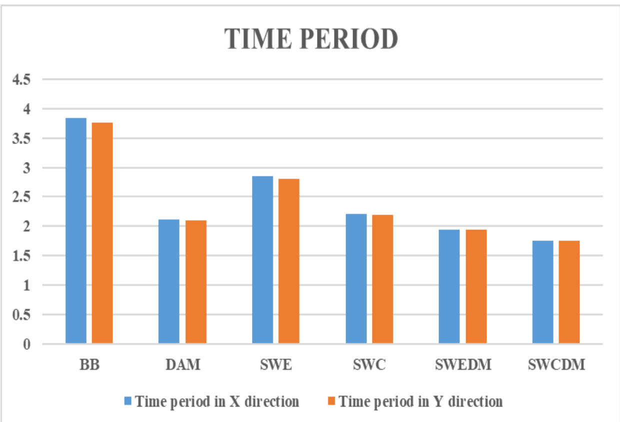

Chart -1: Time period values in X and Y direction

Table -2: Time period values in X and Y direction

Type of building	Time period in X direction	Time period in Y direction
BB	3.841	3.765
DAM	2.113	2.093
SWE	2.844	2.803
SWC	2.207	2.184
SWEDM	1.943	1.932
SWCDM	1.758	1.746

B. Base Shear

Table -3: Base shear along X and Y direction

Type of building	X	Y
BB	5099.33	4997.38
DAM	4389.97	4240.11
SWE	6776.45	6678.74
SWC	8773.72	8683.74
SWEDM	4162.34	4116.97
SWCDM	6512.76	6426.75

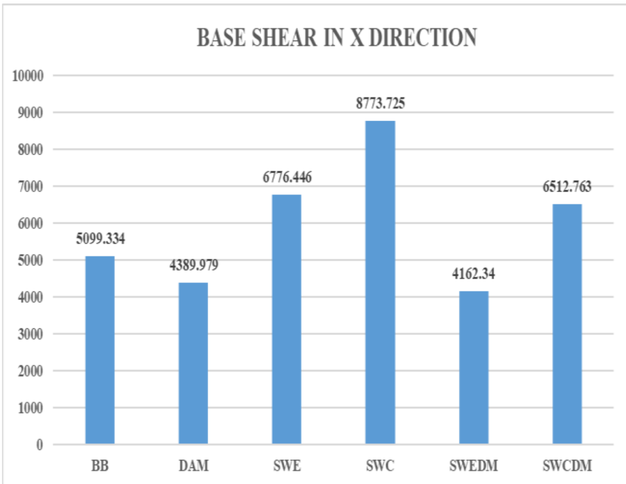

Chart -2: Base shear along X direction

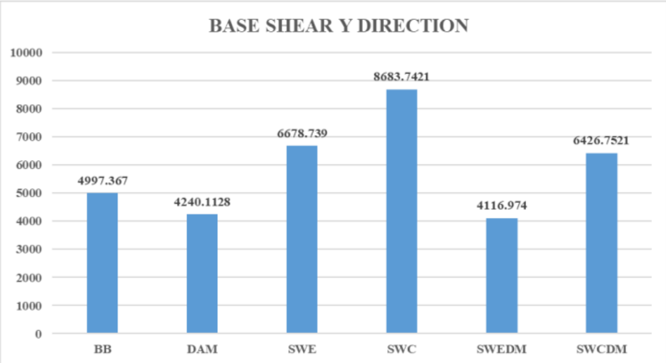

Chart -3: Base shear along Y direction

C. Story Drift

Story drift can be outlined as relative transverse displacement with respect to rates, i.e. above or below them: according to Clause No. 7.11.1 of IS 1893 (Part 1): 2002, the Story drift in any story owing a particular design oblique force with a partial load factor 1.0 hall not outstrip 0.004 times the story elevation. Regardless of column axial eformations, iagonal and girder deformations, drift in edifice frames is an outcome of flexural and shear mode contributions. Maximum permissible drift is 12 mm per modelled story height of 3 m E.g. Maximum permissible drift = 0.004 x 3000 = 12 mm.

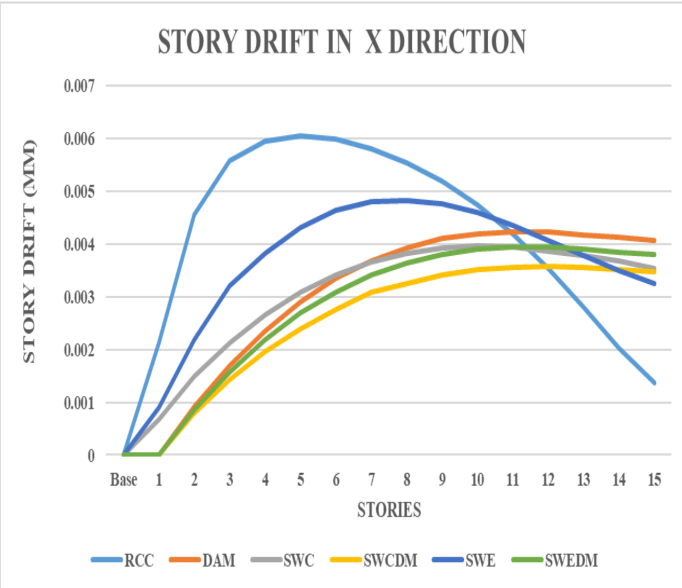

Chart -4: Story Drift along X Direction

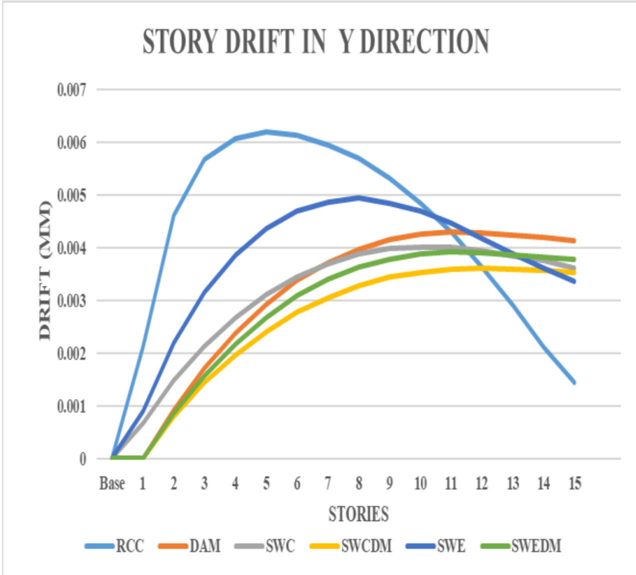

Chart -5: Story Drift along Y Direction

Table -4: Story Drift along X Direction

Story Drift along X directiOn						
STORY NO	**RCC**	**DAM**	**SWE**	**SWC**	**SWEDM**	**SWCDM**
15	0.00136	0.004068	0.003251	0.003536	0.003806	0.003483
14	0.00202	0.004124	0.0035	0.003681	0.003855	0.003522
13	0.00279	0.004181	0.003778	0.003781	0.003904	0.003555
12	0.00353	0.004225	0.004078	0.003875	0.003939	0.003573
11	0.00418	0.004236	0.00436	0.003938	0.003943	0.00356
10	0.00474	0.00420	0.004595	0.003959	0.003904	0.003509
9	0.00519	0.004104	0.00476	0.003927	0.003809	0.00341
8	0.00555	0.003936	0.004834	0.003831	0.003649	0.003255
7	0.00582	0.003686	0.004799	0.003663	0.003414	0.003039
6	0.00599	0.003346	0.004635	0.003415	0.003097	0.002755
5	0.00606	0.002907	0.00432	0.00308	0.00269	0.002398
4	0.00597	0.002361	0.003829	0.002651	0.002187	0.00196
3	0.00558	0.0017	0.003128	0.002119	0.00158	0.001432
2	0.00456	0.000913	0.002181	0.001483	0.000856	0.000791
1	0.00213	0.000000	0.000906	0.000678	0.000000	0.000000
BASE	0.0000	0.00000	0.000000	0.000000	0.000000	0.000000

Table -5: Story Drift along Y Direction

Story Drift along Y Direction						
STORY NO	**RCC**	**DAM**	**SWE**	**SWC**	**SWEDM**	**SWCDM**
15	0.00145	0.00414	0.003365	0.003608	0.003769	0.003522
14	0.00212	0.00419	0.003613	0.00375	0.003819	0.00356
13	0.00289	0.00424	0.003887	0.003848	0.00387	0.003592
12	0.00364	0.00428	0.004184	0.003938	0.003908	0.003607
11	0.00430	0.00429	0.004461	0.003998	0.003915	0.003592
10	0.00486	0.00425	0.004691	0.004014	0.003878	0.003538
9	0.00533	0.00415	0.004849	0.003977	0.003786	0.003436
8	0.00569	0.00397	0.004915	0.003875	0.003629	0.003278
7	0.00596	0.00372	0.004871	0.003701	0.003397	0.003058
6	0.00613	0.00337	0.004697	0.003448	0.003083	0.002771
5	0.00619	0.00293	0.00437	0.003106	0.00268	0.00241
4	0.00608	0.00238	0.003867	0.00267	0.00218	0.001969
3	0.00567	0.00171	0.003153	0.002132	0.001575	0.001438
2	0.00462	0.00092	0.002193	0.001489	0.000854	0.000794
1	0.00214	0.00000	0.000908	0.000679	0.000000	0.000000
Base	0.00000	0.00000	0.000000	0.000000	0.000000	0.000000

D. Lateral Displacement

According to IS 1893-2002, permissible deflection is calculated as h/250, where ‘h’ is total height of edifice in millimeters (mm). Adopting the above practice, the displacements in X and Y command essential be inside 180mm.i.e. (45000 / 250 = 180) where 45000 mm is the height of construction

Table -6: Lateral displacement along X direction

Lateral displacement along Y direction						
Story No	**RCC**	**DAM**	**SWE**	**SWC**	**SWEDM**	**SWCDM**
15	201.16	145.62	174.07	144.7	133.029	121.693
14	196.83	133.21	163.98	133.87	121.722	111.127
13	190.48	120.64	153.14	122.62	110.264	100.448
12	181.80	107.91	141.48	111.08	98.653	89.673
11	170.89	95.059	128.92	99.266	86.93	78.852
10	157.99	82.186	115.54	87.273	75.187	68.075
9	143.34	69.435	101.47	75.23	63.553	57.46
8	127.43	56.99	86.924	63.3	52.195	47.152
7	110.36	45.066	72.178	51.675	41.309	37.318
6	92.488	33.909	57.564	40.57	31.118	28.144
5	74.098	23.79	43.474	30.228	21.867	19.831
4	55.529	15.007	30.363	20.909	13.827	12.601
3	37.282	7.879	18.763	12.899	7.288	6.693
2	20.273	2.752	9.304	6.504	2.563	2.381
1	6.421	0	2.725	2.036	0	0
Base	0	0	0	0	0	0

Table -7: Lateral displacement along X direction

Lateral Displacement along X direction						
STORY NO	RCC	DAM	SWE	SWC	SWEDM	SWCDM
15	196.44	143.967	170.856	142.857	133.896	120.72
14	192.35	131.763	161.105	132.249	122.478	110.27
13	186.26	119.392	150.604	121.205	110.914	99.708
12	177.88	106.847	139.271	109.861	99.203	89.042
11	167.28	94.171	127.036	98.236	87.387	78.325
10	154.73	81.462	113.956	86.422	75.558	67.643
9	140.53	68.861	100.172	74.544	63.846	57.116
8	124.95	56.55	85.892	62.763	52.419	46.887
7	108.30	44.743	71.391	51.27	41.473	37.122
6	90.853	33.684	56.994	40.281	31.231	28.006
5	72.878	23.646	43.09	30.034	21.94	19.742
4	54.703	14.924	30.131	20.793	13.869	12.549
3	36.808	7.841	18.645	12.84	7.307	6.669
2	20.076	2.74	9.261	6.483	2.569	2.373
1	6.385	0	2.719	2.034	0	0
Base	0	0	0	0	0	0

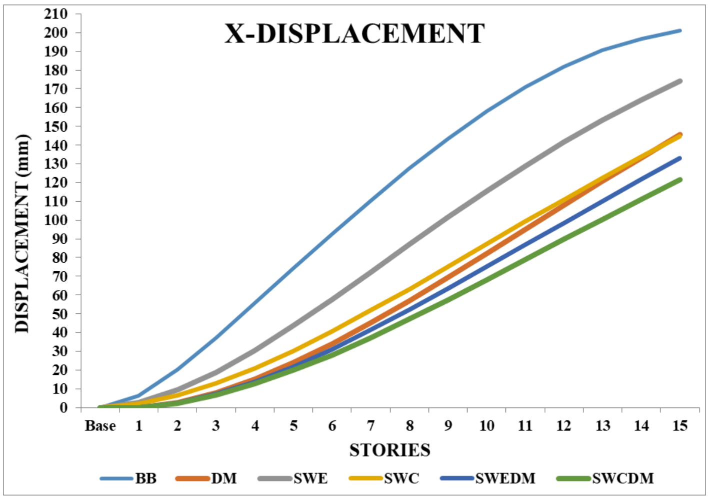

Chart -6: Lateral displacement along X direction

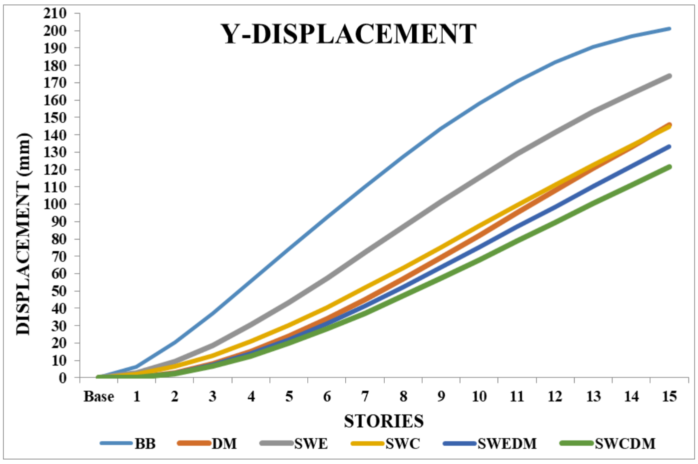

Chart -7: Lateral displacement along Y direction

6. CONCLUSIONS

1. The fundamental time period decreases with increasing story stiffness due to presence of different structural systems such as shear wall and fluid viscous dampers.

2. The time period of edifice with is shear wall at core and dampers is 54.23% less in x direction and 53.62% in y direction comparison to others model.

3. Base shear is increased by 20% for building with shear wall at core and dampers on comparison with bare building.

4. Lateral displacement of edifice with shear wall at core and dampers at edges is abridged by 38.5%, shear wall and dampers at edges is 31%, shear wall at core is 27.2%, and shear wall at edges is 13% and for edifice with only dampers at edges is 26.7% in x direc tion in comparison to bare building.

5. Lateral displacement of edifice with shear wall at core and dampers at edges is abridged by 40%, shear wall and dampers at edges is 33%, shear wall at core is 28%, shear wall at edges is 15% and for edifice with only dampers at edges is 27.6% in y direction in comparison to bare building.

6. Maximum storey drift is obtained for edifice with shear wall at core in company with dampers at corners is 48%(10.71 mm), with shear wall and dampers at edges is 35% (11.82mm), shear wall at core is 34.2% (12.03mm), shear wall at edges is 20%(14.5mm) and edifice with only dampers at corners 30% (12.7mm) along x direction.

7. Maximum storey drift is obtained for edifice with shear wall at core in company with dampers at corners is 49.08%(10.71 mm), with shear wall and dampers at edges is 36%(11.7mm) , shear wall at core is 35.15%(12.04mm),shear wall at edges is 20.59%(14.70mm) and edifice with only dampers at corners is 30.67%(12.8mm) along y direction.

8. By comparison of lateral displacement, maximum story drift, and time period for edifice with shear wall at core in company with dampers at corners provides effective results.

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