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A STUDY ON RESPONSE REDUCTION FACTOR OF R.C. STRUCTURE CONSIDERING VISCOUS DAMPERS

Varun S. Trivedi[1], Mohit S. Vachhani[2], Dipak Jivani[3]

1P G Student, Civil Engineering Department, Darshan Institute of Engineering & Technology, Rajkot, Gujarat, INDIA. (varunt2011@gmail.com)
2Assistant Professor, Civil Engineering Department, Darshan Institute of Engineering & Technology, Rajkot, Gujarat, INDIA. (mohit.vachhani@darshan.ac.in)
3Head of Civil Department, Darshan Institute of Engineering & Technology, Rajkot, Gujarat, India. (dipak.jivani@darshan.ac.in)

ABSTRACT:-The main importance of a frame as well as flat slab building is its serviceability and stability with time after sustaining all the natural calamities occurred in their life span. Viscous damper are energy dissipating devices which act as shock absorbers. During seismic events, the devices become active and the seismic input energy is used to heat the fluid and is then dissipated. Apart from installation, the dampers are low cost maintenance. They have been shown better stability and dependable properties for seismic designs.
Nonlinear viscous dampers for different frame as well as flat slab buildings are designed with the help of certain equations and after that are oriented in two different locations of the buildings one is the periphery of the structure and the second is the central core of the structure and the comparison is carried out for the orientation of the viscous dampers and its effect on response modification factor of the structure. Prime Objective of work is to generate Response Reduction Factor for RC Frame Buildings and RC Flat-Slab Buildings with and without Viscous dampers with different damping percentages that are 3%, 6%, 9%, 12% & 15% addition to inherent damping i.e. 5%. To Evaluate Seismic Performance of RC Frame Building & RC Flat-Slab Building with and without viscous dampers by performing Nonlinear Static Pushover Analysis. Investigate the effect of different viscous damping on Response Reduction Factor for RC Frame and RC Flat slab structure. To Obtain the Response of Structure in form of Time Period, Mode Shapes, Storey Drift, Base Shear, Displacement, Roof Displacement, Performance Point and Failure Mechanism.

Keywords— Viscous Dampers, Nonlinear Static Pushover Analysis, Response Modification Factor, Reinforced Frame Structure, Flat Slab Structures

I. INTRODUCTION

With the increase in population and lack of space, the demand of high rise and tall structures i.e. sky scrapers have increased. For a structure or a building apart from its ambience and elevations, the main prospect for a structure to be safe and serviceable, the main aspect is the structural design.

No structure or structural designs are earthquake proof. The structures are design to withstand the intensity of the earthquake. The serviceability and the sustainability of a building during the earthquake and after the earthquake i.e. post-earthquake are the most important aspects to be taken into consideration.

The response modification factor is one of the seismic design parameter that determines the nonlinear performance of the building structures during strong earthquakes. The response modification factor depends upon a number of parameters. Plenty of researches have been performed on response modification factor of regular reinforced concrete structures, steel structures, composite structures as well as special structures such as Intze water tank, long span structures, tensile structures, structures with special loading conditions etc. The value of response modification factor differs in different codal provisions of different countries and as the codes are revised there are changes in the values of response modification factor.

RESPONSE MODIFICATION FACTOR

The response modification factor is a factor which is very much important and is used for the calculation of design acceleration Ah which directly affects the design base shear Vb and at the end results in the overall design of the structural building. The response reduction factor depends on different parameters of the structure as it consists of several components which are affected when there are changes observed in the structure. The key components of Response modification factor are Over Strength factor (Rs), Ductility factor (Rμ) and Redundancy factor (Rd). These components are discussed in brief as below. Mathematically representing the formula for response modification factor is as follows.

$R = R_s \times R_d \times R_\mu$

Where, R = Response modification factor

R_s = Over strength factor and

R_d = Redundancy factor.

The multiplication of all the key components is response modification factor. The detailed description and discussion of the key components and its values with mathematical representation are described below section wise.

OVER STRENGTH FACTOR R_s

The actual strength of a structure is always higher than its design strength because of overall design calculations and actual behaviour. Modern structural software allows to model and design structures that are almost close to practical behaviour of structure. The ratio of maximum base shear coefficient to design base shear is termed as over strength factor Rs. The mathematical representation of over strength factor R_s is as follows.

$R_s = V_0/V_d$

Where, V_0 = Maximum base shear coefficient,

V_d = Design base shear

The design base shear is obtained by calculating the total weight of the structure and the maximum base shear is obtained from the tables of the particular software data. By carrying out the mathematical equations the over strength factor of the structure is obtained.

REDUNDANCY FACTOR R_D

Redundancy is one of the component of response modification factor. It is commonly defined as what is essential in reality. In general redundancy in a structural system is active under an earthquake resistant design. Redundancy in a system may be active or on standby. All members of a system participate in load carrying for active redundant systems. By contrast some members are inactive and become active only when some active components fail for systems with standby boundaries. ATC 1995 explains that redundancy factor value is considered based on the line of vertical seismic framing. The following table depicts the values of the redundancy factors considered on the basis of vertical seismic framing.

TABLE 1 Details of Redundancy Factor [1]

Uses of Vertical Seismic Framing	Draft redundancy Factor
2	0.71
3	0.86
4	1

DUCTILITY FACTOR R_μ

Ductility factors are used to evaluate translate ductility ratios. The relationship between maximum elastic loads and maximum inelastic loads can define as the ductility factor for the same structural building under inelastic behaviour. The ductility ratio is sensitive to the natural time period of the structure. The calculation for the ductility factors is carried out with the equations derived by Newmark and Hall. Mathematically the equation can be represented as follows:

$T \leq 0.03$ s then, $R_\mu = 1.0$

$0.03 < T < 0.12$ s then, $R_\mu = 1 + (T - 0.03)[(2\mu - 1)-1]½ / 0.09$

$0.12 \leq T \leq 0.5$ s then, $R_\mu = (2\mu - 1)½$

$0.5 < T < 1$ s then, $R_\mu = (2\mu - 1)½ + 2(T- 0.5).[\mu - (2\mu - 1)½]$

$T \geq 1$ s then $R_\mu = \mu$

Also, calculating $\mu = \Delta max/\Delta y$

Where, Δmax = maximum roof displacement

Δy = yield displacement.

VISCOUS DAMPERS

Viscous dampers are a type of energy dissipation devices in which there is a piston in a hollow cylinder filled with silicone based fluid. As the damper rod and piston head are indulged, fluid is forced to flow through orifices either around or through the piston head. The fluid flows at high velocities in the development of friction between fluid particles and the piston head.

ADVANTAGES OF VISCOUS DAMPERS

- ✓ Activated at low displacements.
- ✓ For linear damper, modeling of damper is simplified.
- ✓ Properties are largely frequency and temperature independent
- ✓ Proven record of performance in military applications.

✓ Cheaper compared to other dampers.

OBJECTIVE OF STUDY

- Prime Objective of work is to generate Response Reduction Factor for RC Frame Buildings and RC Flat-Slab Buildings with and without viscous dampers.
- Evaluate Seismic Performance of RC Frame Building & RC Flat-Slab Building with and without viscous dampers by performing Nonlinear Static Pushover Analysis.
- Investigate the effect of different viscous damping on Response Reduction Factor for RC Frame and RC Flat slab structure.
- To Obtain the Response of Structure in form of Time Period, Mode Shapes, Storey Drift, Base Shear, Displacement, Roof Displacement, Performance Point and Failure Mechanism.

NONLINEAR VISCOUS DAMPER

Viscous dampers can be linear as well as nonlinear dampers. For the study of this research nonlinear viscous dampers are considered. The designing of nonlinear viscous dampers is carried out with the help of the equations obtained from earlier research study in paper titled as Seismic Design of Structures with Viscous dampers.[4].

$$\xi_{eff} = \xi_0 + \frac{\sum_j \lambda C_j \varphi_{rj}^{1+\alpha} \cos^{1+\alpha} \theta_j}{2\pi A^{1-\alpha} \omega^{2-\alpha} \sum_i m_i \varphi_i^2}$$

where , α = damping exponent,
φ_i = First modal Displacement of i^{th} DOF,
ω = Circular Frequency of the Structure,
A = Amplitude of the structure,
m_i = mass of ith floor
$\cos^{1+\alpha} \theta_j$ = angle at which damper is placed.

With the help of the above equation the dampers were designed for five different damping percentages 3%,6%,9%,12% and 15%. And the analysis was carried out.

II. MODELING AND ANALYSIS

The models considered for analysis are 15, 25 and 35 storey RC frame structures and 15 and 25 storey RC flat slab structures having 30m*30m plan dimension. Viscous dampers are provided at periphery of the structure and in the central core of the structure with varying damping percentage. Dimensions of main structural members with other seismic parameters are as shown in table below. Also the damping details and other damping criteria considered are shown below.

TABLE 2 Height Details of Model

Building Storey	Height of the Structure
15 Storey	45 m
25 Storey	75 m
35 Storey	105 m

TABLE 3 Structural Details of the Models

TABLE 3

Parameters	Unit & Description
Bay Length Bay Width Per Storey Height	6 m 6 m 3 m
Seismic Zone Factor(Z)	V
Impact Factor (I)	1
Soil Type	II
Live Load	5 kN/m^2
Floor Finish	1 kN/m^2
Earthquake Load	As per IS 1893: 2016
Seismic Weight	DL + 0.25LL
Steel Grade	HYFe415
Concrete Grade	M30

TABLE 4 Damping Details of the Frame Models

Damping Details for Frame Structure							
Damping Percentage	**Damping Exponent (α)**	**15 Storey Frame Structure**		**25 Storey Frame Structure**		**35 Storey Frame Structure**	
		Damping Coefficient C (kN.s/m)	**Damping Stiffness**	**Damping Coefficient C (kN.s/m)**	**Damping Stiffness**	**Damping Coefficient C (kN.s/m)**	**Damping Stiffness**
0.03	0.5	25.6519	311.1564	833.523	10110.5989	1780.42	21596.41964
0.06	0.5	51.3038	622.3129	1667.058	20221.2463	3560.84	43192.83928
0.09	0.5	76.9557	933.4694	2500.57	30331.8088	5341.27	64789.38022
0.12	0.5	102.608	1244.630772	3334.09	40442.3713	7121.69	86385.79986
0.15	0.5	128.26	1555.788464	4167.61	50552.9823	8902.11	107982.2195

TABLE 5 Damping details of the Flat Slab Structure

Damping Details for Flat Slab Structure					
Damping Percentage	**Damping Exponent (α)**	**15 Storey Flat Slab Structure**		**25 Storey Flat Slab Structure**	
		Damping Coefficient C (kN.s/m)	**Damping Stiffness**	**Damping Coefficient C (kN.s/m)**	**Damping Stiffness**
0.03	0.5	16.1184	195.5155215	880.422	10679.48179
0.06	0.5	32.2367	391.02983	1760.84	21358.91507
0.09	0.5	48.3551	586.5453514	2641.27	32038.4939
0.12	0.5	64.4734	782.0596599	3521.69	42717.95143
0.15	0.5	80.5918	977.5751814	4402.11	53397.40896

The above stated damping details were considered and nonlinear static pushover analysis was carried out for further analysis and results were obtained for frame as well as flat slab structures. Also, the effect of viscous damper was seen on other parameters of the structures and were discussed.

III. RESULTS AND DISCUSSION

A. NATURAL TIME PERIOD.

Nonlinear Static pushover analysis was carried out for 15, 25 and 35 storey frame structures as well as for 15 and 25 storey flat slab structures. Viscous dampers were introduced in the periphery as well as in the central core of the structure to obtain the results simultaneously and the results were compared. The following table gives us the results for natural time period with different viscous damping percentage other than the inherent damping.

TABLE 6 Natural Time Period of Frame Structure & Percentage increase w.r.t without Dampers.

Natural Time Period of Frame Structures(min.) & Percentage increase w.r.t without Dampers						
Damping Percentage	**15 Storey Frame Structure**		**25 Storey Frame Structure**		**35 Storey Frame Structure**	
	Periphery	**Central Core**	**Periphery**	**Central Core**	**Periphery**	**Central Core**
0	1.70546	1.70546	2.69304	2.69304	2.70362	2.70362
0.03	1.77445 (4.045%)	1.80745 (5.9802%)	2.78237 (3.317%)	2.82594 (4.935%)	2.74826 (1.651%)	2.7795 (2.807%)
0.06	1.77445 (4.045%)	1.80745 (5.9802%)	2.78237 (3.317%)	2.82594 (4.935%)	2.74826 (1.651%)	2.7795 (2.807%)
0.09	1.77445 (4.045%)	1.80745 (5.9802%)	2.78237 (3.317%)	2.82594 (4.935%)	2.74826 (1.651%)	2.7795 (2.807%)
0.12	1.77445 (4.045%)	1.80745 (5.9802%)	2.78237 (3.317%)	2.82594 (4.935%)	2.74826 (1.651%)	2.7795 (2.807%)
0.15	1.77445 (4.045%)	1.80745 (5.9802%)	2.78237 (3.317%)	2.82594 (4.935%)	2.74826 (1.651%)	2.7795 (2.807%)

TABLE 7 Natural Time Period of Flat Slab Structure & Percentage increase w.r.t without Dampers.

Natural Time Period of Flat Slab Structures(min.) & Percentage increase w.r.t without Damper				
Damping Percentage	15 Storey Flat Slab Structure		25 Storey Flat Slab Structure	
	Periphery	Central Core	Periphery	Central Core
0	2.78524	2.78524	2.73313	2.73313
0.03	2.8744 (3.201%)	2.91792 (4.764%)	2.80411 (2.597%)	2.84145 (3.963%)
0.06	2.8744 (3.201%)	2.91792 (4.764%)	2.80411 (2.597%)	2.84144 (3.963%)
0.09	2.8744 (3.201%)	2.91792 (4.764%)	2.80411 (2.597%)	2.84144 (3.963%)
0.12	2.8744 (3.201%)	2.91792 (4.764%)	2.80411 (2.597%)	2.84144 (3.963%)
0.15	2.8744 (3.201%)	2.91792 (4.764%)	2.80411 (2.597%)	2.84144 (3.963%)

YIELD DISPLACEMENT

Yield displacement of the structures decreases by introducing the viscous dampers in the structures. Also, with the increase in the damping percentage of the structure the yield displacement decreases. The table below shows the decrease in the yield displacement of the structure.

TABLE 8 Yield Displacement of Frame Structure & Percentage decrease w.r.t without Dampers.

Yield Displacement of Frame Structures(mm) & Percentage decrease wrt without dampers						
Damping Percentage	15 Storey Frame Structure		25 Storey Frame Structure		35 Storey Frame Structure	
	Periphery	Central Core	Periphery	Central Core	Periphery	Central Core
0	83.606	83.606	136.690	136.690	127.556	127.556
0.03	83.254 (0.42%)	83.254(0.42%)	136.176 (0.38%)	135.199(1.09%)	126.231 (1.039%)	125.662(1.48%)
0.06	81.928 (2.01%)	82.074(1.83%)	133.398 (2.41%)	132.730(2.90%)	126.226 (1.043%)	125.650(1.49%)
0.09	80.340 (3.91%)	80.655(3.53%)	130.961 (4.19%)	130.561(4.48%)	126.220 (1.047%)	125.640(1.50%)
0.12	78.643 (5.94%)	79.079(5.41%)	130.857 (4.27%)	128.259(6.17%)	126.213 (1.052%)	125.629(1.51%)
0.15	77.728 (7.03%)	77.881(6.85%)	130.775 (4.33%)	128.138(6.26%)	126.190 (1.071%)	125.617(1.52%)

TABLE 9 Yield Displacement of Flat Slab Structure & Percentage decrease w.r.t without Dampers.

Yield Displacement of Flat Slab Structures(mm) & Percentage Decrease w.r.t without damper				
Damping Percentage	15 Storey Flat Slab Structure		25 Storey Flat Slab Structure	
	Periphery	Central Core	Periphery	Central Core
0	313.178	313.178	86.086	86.086
0.03	298.792 (-4.59%)	296.528 (-5.32%)	86.055 (-0.04%)	84.627 (-1.70%)
0.06	288.086 (-8.01%)	285.323 (-8.89%)	85.807 (-0.32%)	82.449 (-4.23%)
0.09	274.780 (-12.26%)	270.775 (-13.54%)	84.597 (-1.73%)	80.594 (-6.38%)
0.12	242.096 (-22.70%)	223.365 (-28.68%)	83.344 (-3.19%)	78.670 (-8.61%)
0.15	212.879 (-32.03%)	208.488 (-33.43%)	82.043 (-4.70%)	75.944 (-11.78%)

B. Over strength factor (R_S)

Over strength factor of the structures increases by introducing the viscous dampers in the structures. Also, with the increase in the damping percentage of the structure the over strength factor increases. The table below shows the increase in the over strength of the structure with the increase in percentage w.r.t. the structures without viscous dampers.

TABLE 10 Over Strength Factor of Frame Structure & Percentage increase w.r.t without Dampers.

Over Strength factor of Frame Structures & Percentage increase w.r.t without Dampers						
Damping Percentage	**15 Storey Frame Structure**		**25 Storey Frame Structure**		**35 Storey Frame Structure**	
	Periphery	**Central Core**	**Periphery**	**Central Core**	**Periphery**	**Central Core**
0	3.941	3.941	4.487	4.487	3.514	3.514
0.03	3.962 (0.510%)	4.045 (2.617%)	4.531 (0.982%)	4.681 (4.325%)	3.608 (2.685%)	3.620 (3.011%)
0.06	3.962 (0.510%)	4.045 (2.617%)	4.531 (0.982%)	4.681 (4.325%)	3.608 (2.685%)	3.620 (3.011%)
0.09	3.962 (0.510%)	4.045 (2.617%)	4.531 (0.982%)	4.681 (4.325%)	3.608 (2.685%)	3.620 (3.011%)
0.12	3.962 (0.510%)	4.045 (2.617%)	4.531 (0.982%)	4.681 (4.325%)	3.608 (2.685%)	3.620 (3.011%)
0.15	3.962 (0.510%)	4.045 (2.617%)	4.531 (0.982%)	4.681 (4.325%)	3.608 (2.685%)	3.620 (3.011%)

TABLE 11 Over Strength Factor of Frame Structure & Percentage increase w.r.t without Dampers.

Over Strength factor of Flat Slab Structures & Percentage increase w.r.t without Dampers				
Damping Percentage	**15 Storey Flat Slab Structure**		**25 Storey Flat Slab Structure**	
	Periphery	**Central Core**	**Periphery**	**Central Core**
0	4.023	4.023	5.928	5.928
0.03	4.483 (11.819%)	4.498 (11.442%)	6.016 (1.486%)	6.047 (2.006%)
0.06	4.483 (11.819%)	4.498 (11.442%)	6.016 (1.486%)	6.047 (2.006%)
0.09	4.483 (11.819%)	4.498 (11.442%)	6.016 (1.486%)	6.047 (2.006%)
0.12	4.483 (11.819%)	4.498 (11.442%)	6.016 (1.486%)	6.047 (2.006%)
0.15	4.483 (11.819%)	4.498 (11.442%)	6.016 (1.486%)	6.047 (2.006%)

C. Ductility Factor R_μ

Ductility factor of the structures increases by introducing the viscous dampers in the structures. Also, with the increase in the damping percentage of the structure the ductility factor increases. The table below shows the increase in the ductility factor of the structure with the increase in percentage w.r.t. the structures without viscous dampers.

TABLE 12 Ductility Factor of Frame Structure & Percentage increase w.r.t without Dampers.

Ductility Factor of Frame Structures						
Damping Percentage	**15 Storey Frame Structure**		**25 Storey Frame Structure**		**35 Storey Frame Structure**	
	Periphery	**Central Core**	**Periphery**	**Central Core**	**Periphery**	**Central Core**
0	2.153	2.153	2.195	2.195	3.293	3.293
0.03	2.187 (0.887%)	2.172 (1.584%)	2.203 (0.378%)	2.219 (1.103%)	3.327 (1.051%)	3.342 (1.506%)
0.06	2.197 (1.867%)	2.193 (2.048%)	2.249 (2.470%)	2.260 (2.984%)	3.327 (1.054%)	3.343 (1.519%)
0.09	2.240 (3.660%)	2.232 (4.064%)	2.291 (4.374%)	2.298 (4.693%)	3.328 (1.060%)	3.343 (1.525%)
0.12	2.289 (5.727%)	2.276 (6.312%)	2.293 (4.456%)	2.339 (6.575%)	3.328 (1.063%)	3.343 (1.534%)
0.15	2.316 (7.353%)	2.311 (7.565%)	2.294 (4.525%)	2.341 (6.675%)	3.328 (1.084%)	3.343 (1.543%)

TABLE 13 Ductility Factor of Flat Slab Structure & Percentage increase w.r.t without Dampers

Ductility Factor of Flat Slab Structures				
Damping Percentage	15 Storey Flat Slab Structure		25 Storey Flat Slab Structure	
	Periphery	Central Core	Periphery	Central Core
0	1.939	1.939	3.485	3.485
0.03	1.941 (0.109%)	1.942 (0.161%)	3.492 (0.212%)	3.545 (1.725%)
0.06	1.949 (0.522%)	1.949 (0.512%)	3.496 (0.327%)	3.639 (4.413%)
0.09	1.958 (1.012%)	1.956 (0.899%)	3.546 (1.762%)	3.722 (6.815%)
0.12	1.971 (1.640%)	1.967 (1.441%)	3.600 (3.291%)	3.813 (9.430%)
0.15	1.990 (2.627%)	1.977 (1.988%)	3.657 (4.930%)	3.950 (13.358%)

D. RESPONSE MODIFICATION FACTOR

Response Modification factor of the structures increases by introducing the viscous dampers in the structures. Also, with the increase in the damping percentage of the structure the modification factor increases as the ductility and the over strength factor of the structure increases and the response modification factor is the multiplication of the over strength and the ductility factor. The table below shows the increase in the response modification factor of the structure with the increase in percentage w.r.t. the structures without viscous dampers.

TABLE 14 Response Modification Factor of Frame Structure & Percentage increase w.r.t without Dampers

Response Modification Factor of Frame Structures						
Damping Percentage	15 Storey Frame Structure		25 Storey Frame Structure		35 Storey Frame Structure	
	Periphery	Central Core	Periphery	Central Core	Periphery	Central Core
0	4.243	4.243	4.923	4.923	5.785	5.785
0.03	4.332 (2.102%)	4.392 (3.527%)	4.991 (1.364%)	5.193 (5.476%)	6.003 (3.764%)	6.049 (4.563%)
0.06	4.352 (2.569%)	4.435 (4.533%)	5.095 (3.476%)	5.290 (7.439%)	6.003 (3.767%)	6.050 (4.575%)
0.09	4.438 (4.595%)	4.513 (6.373%)	5.189 (5.399%)	5.377 (9.221%)	6.003 (3.773%)	6.050 (4.581%)
0.12	4.534 (6.855%)	4.603 (8.494%)	5.193 (5.482%)	5.474 (11.185%)	6.004 (3.776%)	6.051 (4.591%)
0.15	4.587 (8.114%)	4.674 (10.162%)	5.197 (5.551%)	5.479 (11.289%)	6.005 (3.798%)	6.051 (4.600%)

TABLE 15 Response Modification Factor of Flat Slab Structure & Percentage increase w.r.t without Dampers

Response Modification Factor of Flat Slab Structures				
Damping Percentage	15 Storey Flat Slab Structure		25 Storey Flat Slab Structure	
	Periphery	Central Core	Periphery	Central Core
0	3.900	3.900	10.330	10.330
0.03	4.351 (11.564%)	4.368 (11.999%)	10.505 (1.702%)	10.718 (3.765%)
0.06	4.369 (12.024%)	4.383 (12.391%)	10.517 (1.818%)	11.002 (6.508%)
0.09	4.390 (12.570%)	4.400 (12.824%)	10.668 (3.275%)	11.255 (8.958%)
0.12	4.417 (13.270%)	4.424 (13.430%)	10.828 (4.827%)	11.530 (11.625%)
0.15	4.460 (14.369%)	4.447 (14.042%)	11.000 (6.490%)	11.944 (15.632%)

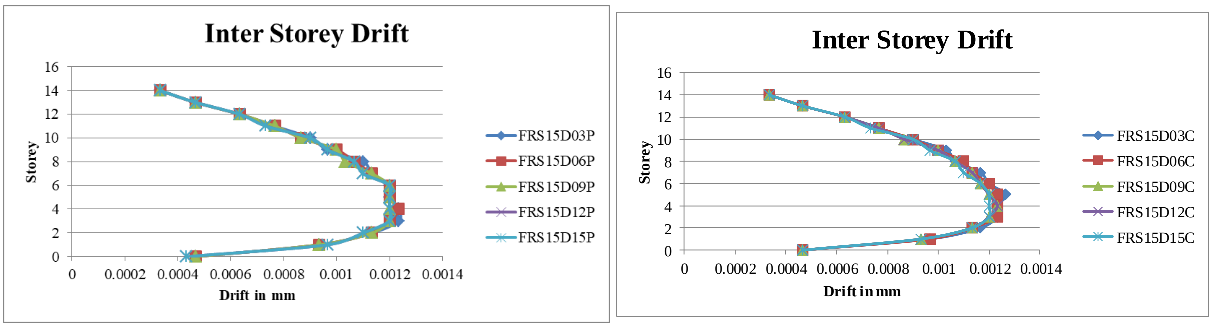

FIGURE 1 Inter Storey Drift of 15 Frame Models

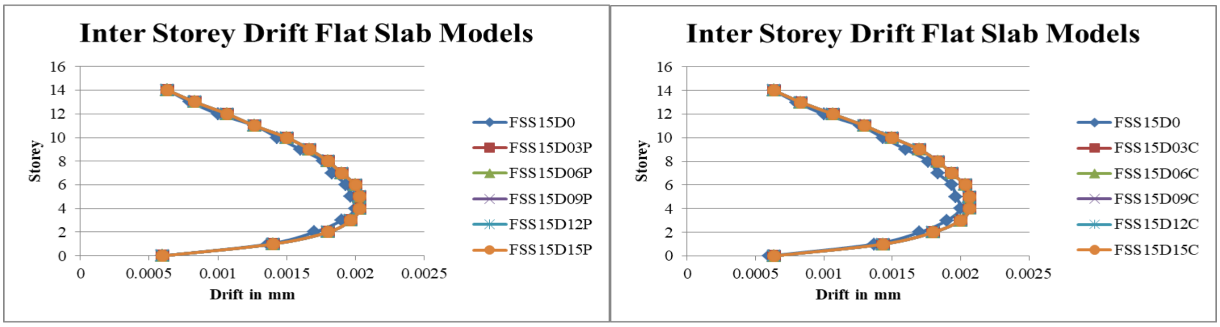

FIGURE 2 Inter Storey Drift of 15 Flat Slab Models

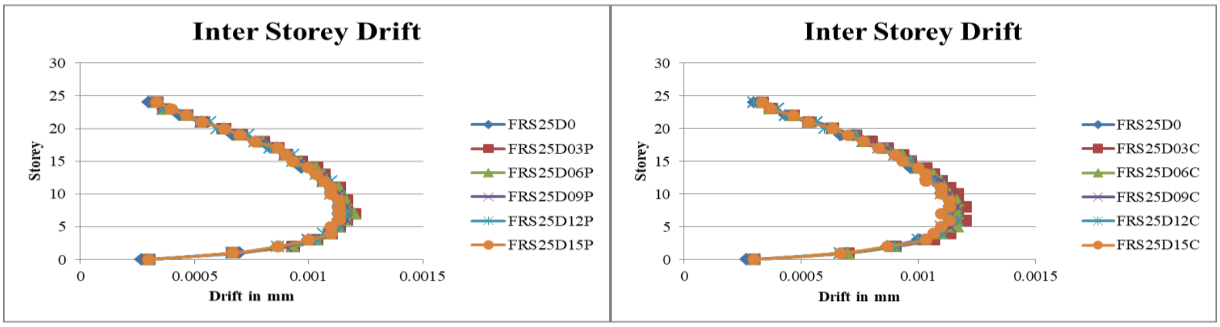

FIGURE 3 Inter Storey Drift of 25 Frame Models

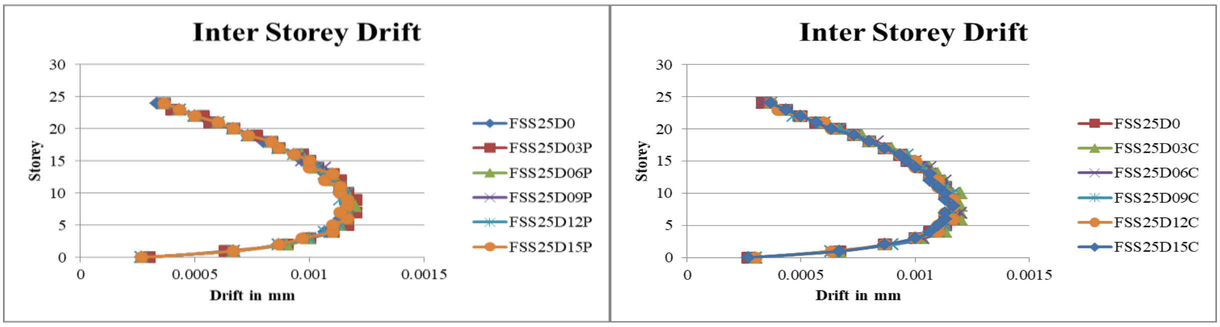

FIGURE 4 Inter Storey Drift of 25 Flat Slab Models

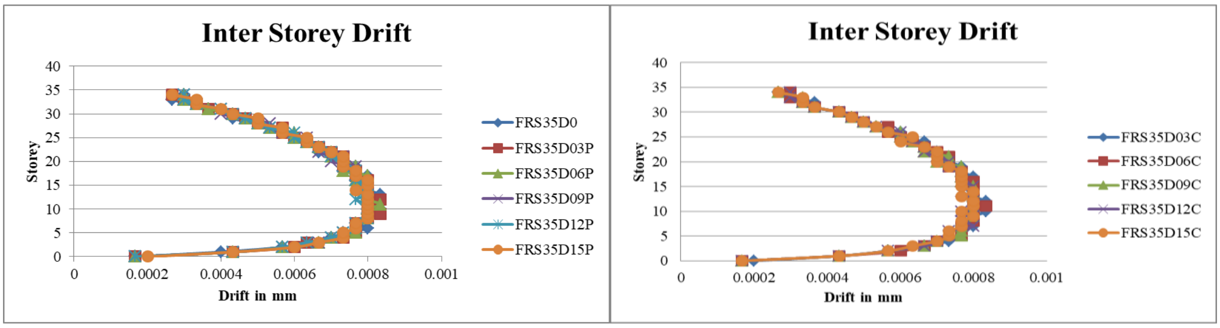

FIGURE 5 Inter Storey Drift of 35 Frame Models

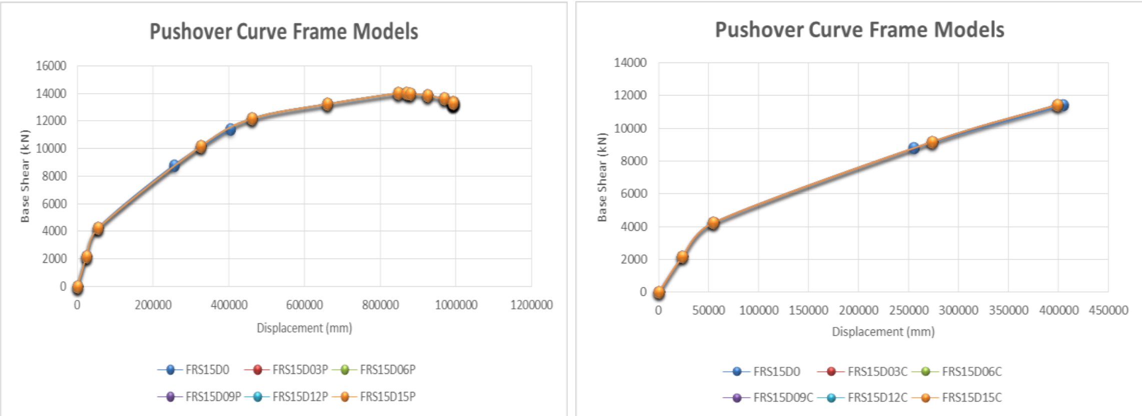

FIGURE 6 Pushover Curve of 15 Storey Frame Models

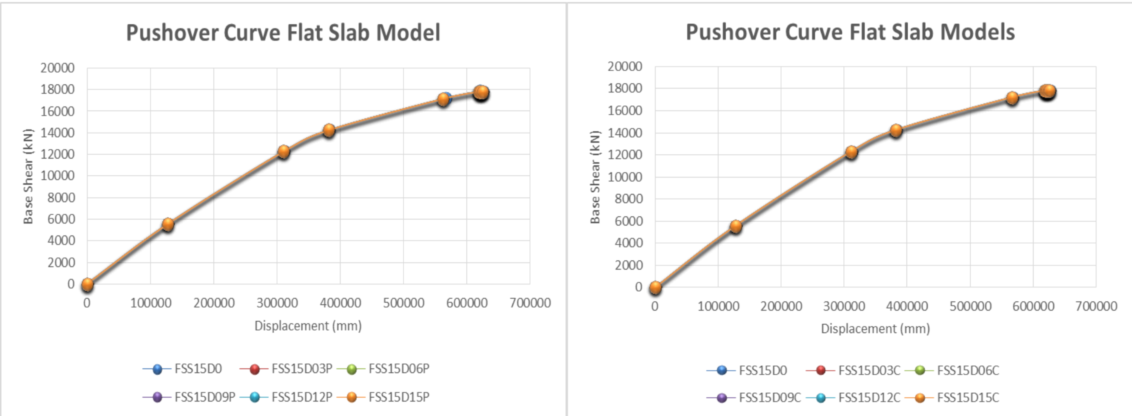

FIGURE 6 Pushover Curve of 15 Flat Slab Models

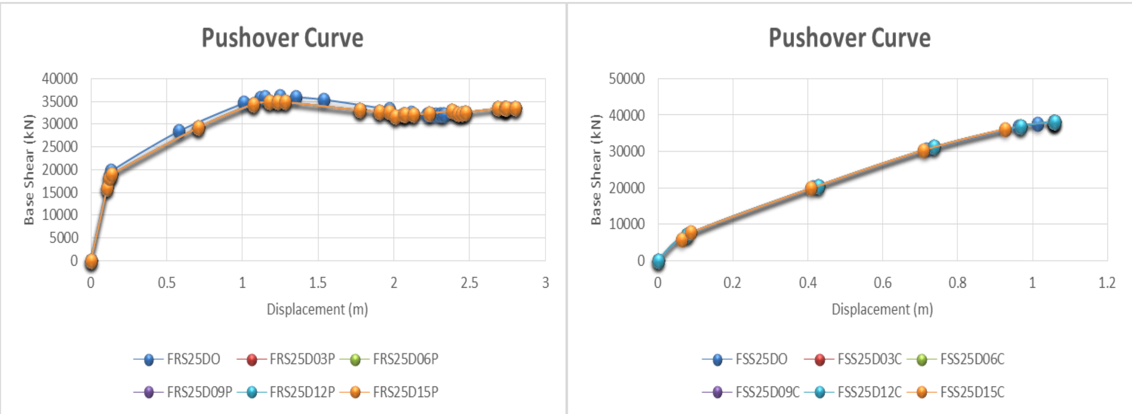

FIGURE 7 Pushover Curve of 25 Frame Models

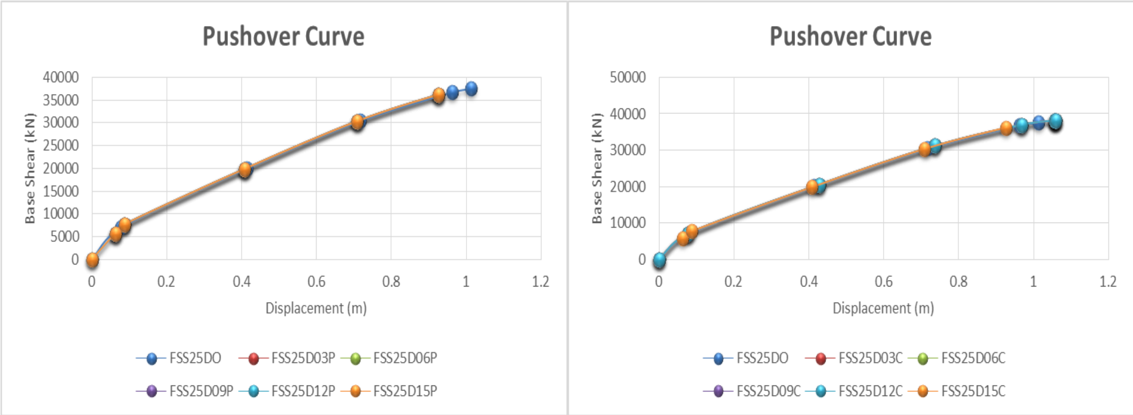

FIGURE 8 Pushover Curve of 25 Flat Slab Models

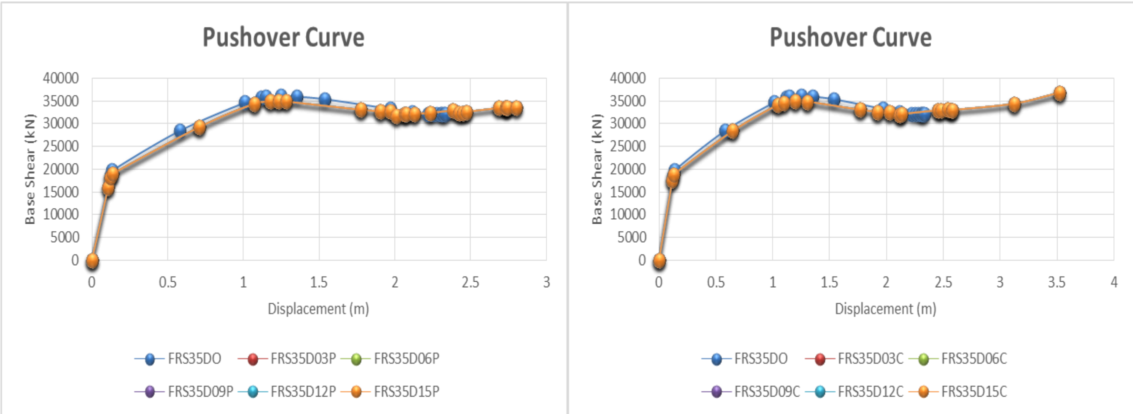

FIGURE 9 Pushover Curve of 35 Frame Models

IV. CONCLUSIONS

The use of viscous dampers in the reinforced concrete frame shows an increase in the response modification factor with the increase in the damping percentage of the structure. The overall research on this study concludes the following.

I. The natural time period of the structure increases with the increase in the percentage of the viscous damping and is stable after some point. Further study concludes that dampers provided in the central core of the structure shows more effect than the periphery of the structure.

II. Yield displacement decreases with the installation of viscous dampers so the roof displacement decreases of the structure. Also, the central core of the structure shows more effect than the periphery of the structure. The over strength factor of the structure also increases with the increase in the viscous damping as its components maximum base shear and design base shear increases. The central core structures shows better results for over strength factor compared to the periphery of the structure in both the cases frame as well as flat slab structures.

III. Ductility factor of the structures induced with viscous dampers increases with increase in the percentage of the viscous damping and the structures with central core equipped with viscous dampers are more effective than the ones installed in the periphery of the structure.

IV. Response modification factor of the structure increases by using viscous dampers in the structure. With the increase in damping percentage the response modification factor of frame as well as flat slab structure increases. The central core of the structure shows a better result compared to the periphery of the structure.

V. From the above all the parameters studied it concludes that the central core of the structure is the best orientation of viscous dampers for its maximum results with its comparison to the periphery of the structure.

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