STUDIES ON EFFECT OF FRICTION DAMPERS ON THE SEISMIC PERFORMANCE OF RC MULTISTOREY BUILDINGS

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***Abstract** - Among all the natural disasters such as flood, earthquake, drought, tornadoes, hurricanes the least understood and the most destructive one is earthquake. Since, they cause plenty of injuries and economical losses leaving behind a series of signs of panic. Necessity to implement seismic codes in building design, the earthquakes is like wake up call. For this a better method of analysis such as static analysis, dynamic analysis and time history analysis has to be adopted for performing the structures seismic risk assessment. This dissertation work is concerned with the "Studies on Effect of Friction Dampers on the Seismic Performance of RC Multistorey Buildings" According to IS 1893 (part 1): 2002 codal provisions the structures are analyzed by Equivalent Static method, Response Spectrum method and Time History method. The modeling and analysis is done with SAP 2000 v 14 software and the results that is, seismic parameters such as Time period, Base shear, Lateral displacement and Inter storey drift are tabulated and then comparative study of structures with and without Friction dampers has been done.*

Key Words: Friction dampers; Fundamental natural time period, Base shear, Lateral displacement and Storey drift.

1. INTRODUCTION

From the past few decades world has experienced numerous devastating earthquakes resulting in increased loss of life due to collapse of buildings and severe structural damage. Occurrence of these damages during earthquakes clearly demonstrate the high seismic hazards and the structures like residential buildings, life line structures, historical structures and industrial structures are need to be designed very carefully to protect from earthquakes. now a days the structural design approach using seismic response control is now widely accepted and frequently applied in civil engineering.in these days much attention has been paid to the research and development of structural control techniques such as passive control system, active control system and semi-active control system giving special importance on improvement of wind and seismic response of buildings.

The passive control system doesn't need any external power supply. Active control systems need external power supply and operate based on sensors which are attached within the structures. Semi-active control systems are the combination of both the passive and active control systems which requires external power supply and they operate based on sensors attached within the structures. But if the power supply is not their then they operate based on sensors attached within the structures. But if the power supply is not their then the passive control systems control the vibration of structures. Both of these systems can be used for strong wind motion and earthquakes. The major effects have been undertaken to develop the structural control concept in to a workable technology and such devices are installed in structures.

Dampers have become more popular recently for vibration control of structures, because of their safe, effective and economical design. Under these earthquake activities buildings have known to suffer extensive damage and even total collapse. In the aim of achieving satisfactory earthquake responses of structures, there are three methods can be identified as being practical and efficient. These are structural isolation energy absorption at plastic hinges and use of mechanical devices to provide structural control.in recent times there has been interested in the use of mechanical energy absorbing devices located within the structures. These mechanical energy absorbers have been found to be quite promising and they form the focus of the present study.

These devices absorb the energy from the earthquakes, reducing the effects on the critical components of the structures. Which do not themselves support the normal loads of the structures, can be replaced leaving the building Undamped. There are types of structural control provided by the addition of mechanical devices; active and passive control. Active control need a power supply to activate the dampers and hence may be not dependable on seismic events where the power supply could be disrupted. For this reason, dampers with active control have been tested on tall buildings subjected to wind induced loading rather than the more unpredictable cyclic loading caused by earthquakes. On the other hand, passive energy dissipation systems have emerged as special devices that are incorporated within the structure to absorb a portion of the input seismic energy.by the result of these the energy dissipation demand on primary structural members in often considerably reduced, along with the potential of the structural damage. The idea of utilizing separate passive energy dissipating dampers within a structure to absorb a large portion of the seismic energy began with the conceptual and experimental work.

2. METHODOLOGIES

In IS method of analysis is followed by using a code – IS1893 (Part 1):2002

The seismic Analysis of building connected with and without friction dampers is done by Equivalent static analysis, Response spectrum analysis.

Table 1 combinations of loads as per IS 1893-2002 & IS875(part-3)-1987.

Combination of loads	Loads factor
Equivalentstatic method(ESM)	1.2 (DL+LL+EQX)
	1.2 (DL+LL+EQY)
	1.5 (DL+EQX)
	1.5 (DL+EQY)
Response spectrum method(RSM)	1.2 (DL+LL+RSX)
	1.2 (DL+LL+RSY)
	1.5 (DL+RSX)
	1.5 (DL+RSY)

3. DETAILS OF SELECTED BUILDING

The selected building is reinforced concrete moments resisting frame building of G+3 & G+7 are taken. building plans , elevation & 3 D views building with and without the friction damper is there in below fig. seismic zone v is taken & building Type is commercial purposes.

Mode1 1: Building without friction damper
Mode1 2: building with friction damper

Sl. No	**Design data for all buildings**		
1]	**Details of building**		
i)	Structure		OMRF
ii)	Number of storey		G+3 & G+7
iii)	Type of building		Regular & symmetric plan
iv)	Storey heights		3.5
v)	Type of building use		Commercial
vi)	Seismic Zone		V
2]	**Material Properties**		
i)	Concrete Grade		M20 & M25
ii)	Steel Grade		Fe415
iii)	Concrete Density		25KN/M^3
iv)	Steel Density		22360680KN/m^3
v)	Youngs modulus of M20 concrete		25000000KN/m^2
vi)	Youngs modulus of M25 concrete		25000000KN/m^2
vii)	Youngs modulus of steel		2X10^8KN/m^2
viii)	poissions ratio of concrete		0.2
ix)	poissions ratio of steel		0.3
3]	**member property**		
i)	**Slab**	Grade	M20
		Thickness	0.15m
ii)	**Beam**	Grade	M20
		size (for all beams)	0.23X0.4m
iii)	**Column**	Grade	M25
		size up to 4th floor	0.40X0.40m
		size up to 8th floor	0.35X0.35m
4]	**Types of load and their intensities**		
A)	Assumed dead load intensities		
i)	floor finish		1.75KN/m^2
ii)	roof finish DPC		2KN/m^2
B)	Live load intensity		
i)	Live load		4KN/m^2
5]	**Seismic properties from code IS1893(part I):2002**		
i)	Importance factor(I)		1
ii)	Zone factor(Z)		0.36
iii)	Response Reduction Factor R		5
iv)	Soil Type		II
v)	Damping Ratio		5%(RC frame buildings)
6]	**Link Properties**		
G+3	Ke		109198.28KN/m
	De		3570.50KN-S/m
G+7	Ke		70464.38KN/m
	De		3954.00KN-S/m

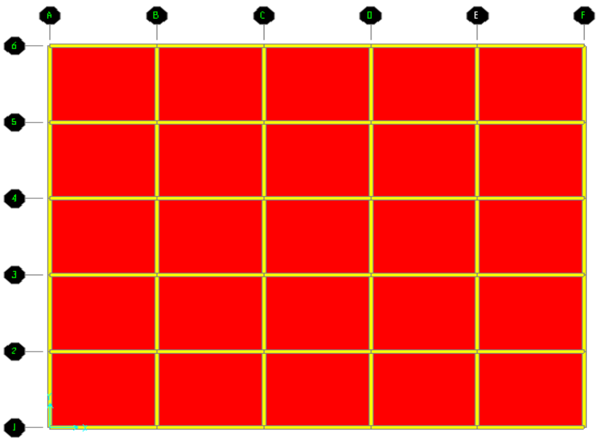

Fig1: Plan of Selected Multi-Storey Building

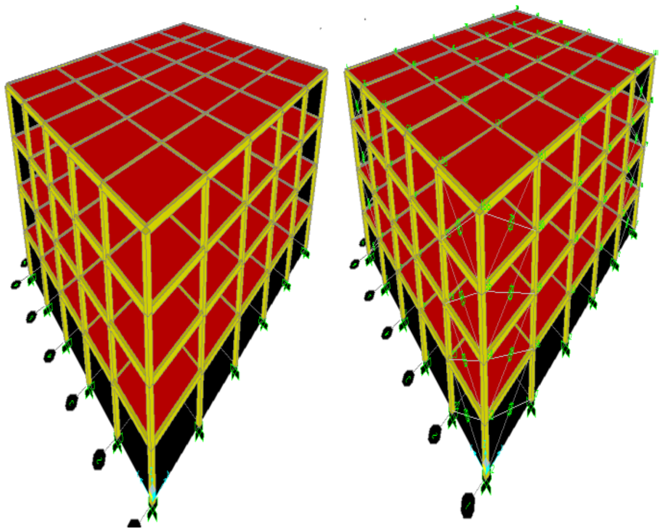

Fig2: G+3 Building with & without friction damper

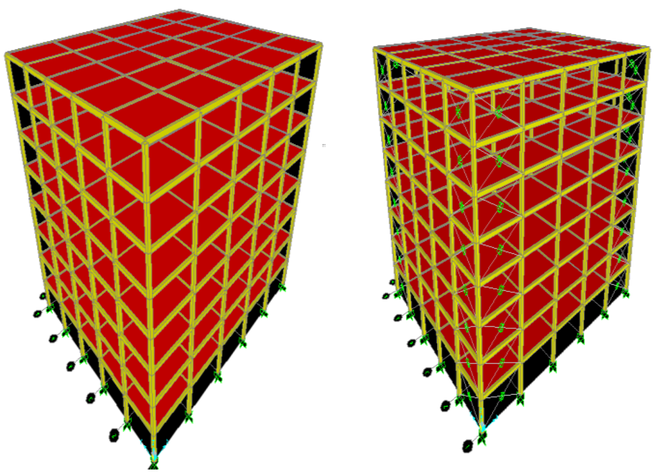

Fig3: G+7 Building with & without friction damper

4. RESULTS AND DISCUSSIONS

The result obtained from different types Seismic analysis carried out namely Equivalent static analysis & Response spectrum analysis with considering the different symmetric building models. Here is the present study, the behaviour of each models are captured and results are tabulated 1ike Natural time period, base shear, displacement & storey drift in linear analysis has done.

4.1 Natural Time Period

The time period to get from the Seismic Code iS1893(part-1):2002 & Analytical result get by using SAP-2000 r given in table 1

Table -1: Codal and analytical time period for all storey buildings

Building	Models	Seismic analysis	
		Codal	Analysis
G+3	Model I	0.5428	1.3534
	Model II	0.5428	0.7715
G+7	Model I	0.9129	5.6410
	Model II	0.9129	4.0910

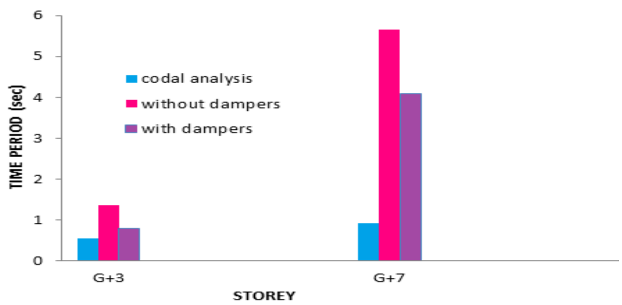

Fig4:Profile for all Storey Buildings for Codal and Analytical Load Combination as per IS1893 (Part-I)-2000

4.2 Base Shear

The equivalent static analysis method and responses spectrum method is to find the base shear that is tabulated below. Base shear and scaling factors for all models for1.2(DL+LL+EQL) combination

Model-I: Without Friction Dampers Building and
Model-II: With Friction Dampers Building

Hence base shears obtained from the equivalent static method are larger than the dynamic response spectrum method. seismic analysis of 1.2(DL+LL+EQL) combination for G+3 and G+7 storey for model I and II for static base shear is more for same models response base shear is less compared to static base shear.

4.3 Lateral Displacement

The lateral displacement attained from equistatic method & response spectrum method, along X & Y direction are tabulated in figures.

Table 2 Lateral displacement of G+3 storey for seismic combination 1.2 EQX & RSX

Storey	ESM		RSM	
	Model I	Model II	Model I	Model II
4	80.4	28.6	53.2	17.1
3	71.8	23.0	47.5	13.5
2	47.6	14.9	35.1	9.0
1	19.4	5.90	17.8	4.2
0	0.0	0.0	0.0	0.0

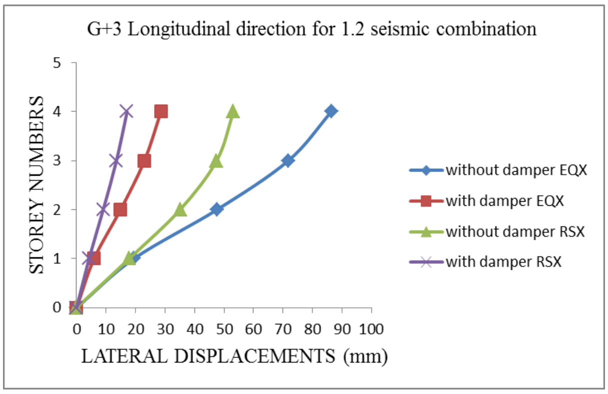

Fig5:Lateral Displacement of G+3 storey for seismic combination 1.2EQX & RSX

Table 3 Lateral displacement of G+3 storey for seismic combination 1.2 EQX & RSX

Storey	ESM		RSM	
	Model I	Model II	Model I	Model II
8	98.5	34.0	60.76	23.4
7	93.61	30.0	57.82	22.8
6	82.85	25.7	50.45	20.4
5	67.78	20.5	39.35	17.9
4	49.75	14.5	25.39	12.6
3	37.84	9.03	19.76	6.30
2	25.35	3.80	13.53	2.50
1	12.64	1.20	6.89	1.00
0	0.0	0.0	0.0	0.0

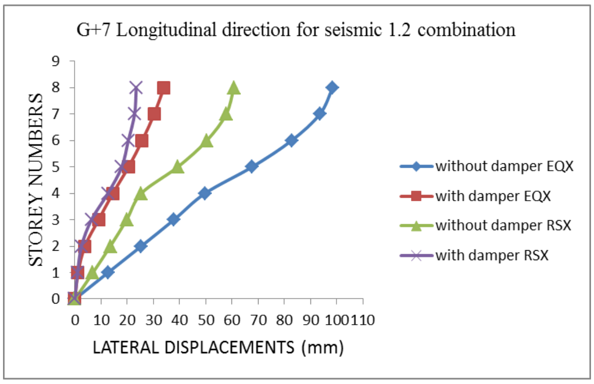

Fig6:Lateral Displacement of G+7 storey for seismic combination 1.2EQX & RSX

From the tables and figs. it is Shows that lateral displacement for model displaced more than model II and they vary have a roof displacement for equivalent static and response spectrum method

4.4Storey Drift

IS1893(part I) :2002 clause 7.11.1 Storey drift Explained , Storey drift In the building storey due t0 minimum Specified design Lateral load , with Partial Load factor of 1. 0 shall not be exceed 0. 0 0 4 times of the Storey Height of the building

Table 4 Storey Drift of G+10 storey for seismic combination 1.2 EQX & RSX

Storey	ESM		RSM	
	Model I	Model II	Model I	Model II
4	4.17	1.6	1.63	1.03
3	6.90	2.3	3.5	1.23
2	8.05	2.5	4.9	1.4
1	5.50	1.68	5.0	1.2
0	0.0	0.0	0.0	0.0

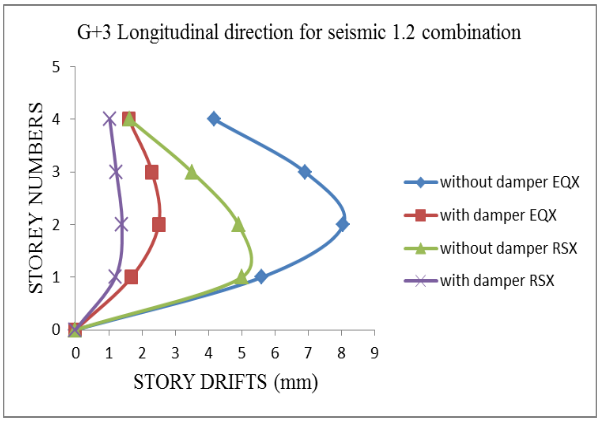

Fig7:Story Drift of G+3 storey for seismic combination 1.2EQX & RSX

Table 5 Storey Drift of G+10 storey for seismic combination 1.2 EQX & RSX

Storey	ESM		RSM	
	Model I	Model II	Model I	Model II
8	1.4	1.2	0.84	0.6
7	3.1	1.3	2.1	0.9
6	4.3	1.5	3.2	1.0
5	5.2	1.7	3.9	1.3
4	3.4	1.6	1.6	1.4
3	3.4	1.5	1.8	1.4
2	3.5	0.7	1.9	1.2
1	3.6	0.3	1.9	0.8
0	0.0	0.0	0.0	0.0

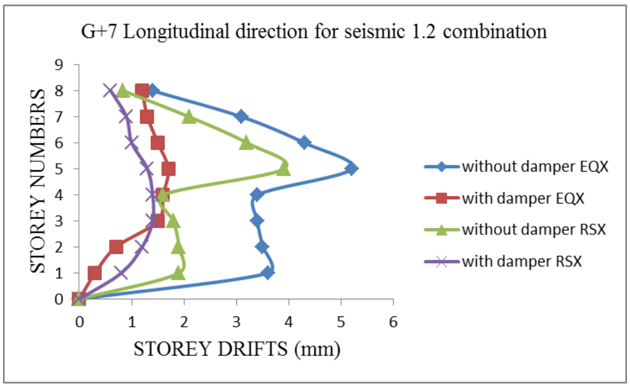

Fig8:Storey Drift of G+7 storey for seismic combination 1.2EQX & RSX

From the table and fig. it is shows that storey drift for model I drift more than model II and they vary have a roof displacement for equivalent static and response spectrum method.

5. CONCLUSIONS

In this study the focus is made on the study of seismic demands of different RC buildings i.e, low rise and medium rise buildings using different analytical techniques for the buildings situated in seismic zone v of Indian medium soil (soil type II). That the performance of building is studied in terms of time period, base shear, lateral displacements; storey drifts in linear static and linear dynamic analysis with and without friction damper building G+3 and G+7 storey models. For the G+3 and G+7 storey building with symmetrical in plan the seismic analysis carried by equivalent static method and response spectrum method. From the analysis and results obtained we can conclude the present study.

1. Lateral displacements due to earthquake forces reduce by providing friction dampers.
2. Storey drift also reduces thus shear resistance of the building increases.
3. Base shear of the building increases by providing friction dampers.
4. The effectiveness of friction dampers in controlling lateral displacements storey drifts due to earthquake force is observed in equivalent static method, response spectrum and time history analysis method.

REFERENCES

1. Amir shirkhani, Naser Shabakhty, Seyed Roohollah Mousavi (2014) "An Investigation into the Influence of Friction Damper Device on the Performance of Steel Moment Frames" American Journal of Engineering Research, 3(3): 230-237.

2. Bhaskararao A.V and Jangid R.S (2004) "Seismic Response of Adjacent Buildings Connected with Dampers", 13th World Conference On Earthquake Engineering 3143.

3. Bhaskararao A.V and Jangid R.S (2007) "Optimum Viscous Damper for Connecting Adjacent SDOF Structures for Harmonic and Stationary White-Noise Random Excitations", earthquake engineering and structural dynamics, vol 36,

4. Dong –Dong GE, Hong-ping ZHU. And Dan- sheng WANG(2010) "Seismic Response Analysis of Dampers-Connected Adjacent Structures with stochastic parameters", Journal of Zhejiang University, Vol 11, No 6, 402-414.

5. Dynamics of structure theory and applications to Earthquake Engineering,- A.K.Chopra.

6. Earthquake Resistance Design of Structures,- Dr.S.K.Duggal.

7. Huang S and Linuo C (2011) "connecting parameter study on adjacent structures linked by Dampers", Advanced material Reserche, 243-249, 3832-3838.
8. Bureau of Indian Standards, "Criteria for Earthquake Resistance Design of Structures" IS 1893(part I) 2002, New Dheli.

9. Bureau of Indian Standards, Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.

10. Passive Energy Dissipation Systems in Structural Engineering.

11. Pettinga J.D Oliver S and Kelly T.E, (2013) "A design for approach to supplemental damping using fluid viscous dampers", steel innovations conference vol 2, No 22,February.

12. Landi L Diotallevi P.P & Castellari G (2012), “A Procedure for the design of viscous dampers to be inserted in existing plan-A symmetric Buildings”, 15 WCELISBOA.

13. Patil C.C and Jangid R.S (2010) “Seismic Response of Dynamically similar adjacent structures connected with viscous dampers”, The JES journal of civil & structural engineering, vol 3, No 1, 1-13, Febraury.

14. Xu Y.L He, Q and KQ, J.M (1999), Dynamically response of dampers-connected adjacent buildings under earthquake excitation, “Engineering structures, vol 21, 135-148.

15. Yang, Z, Xu W_L and Lu XL(2003), “Experimental seismic study of adjacent buildings with fluid viscous dampers”, journals of structural Engineering, 197-2005.