SEISMIC EVALUATION OF RC MULTISTOREY BUILDING OF ASYMMETRIC PLAN WITH VISCO-ELASTIC DAMPER

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Abstract- The dissertation work is concerned with the seismic evaluation of RC multi-storey asymmetric building plan with visco- elastic damper. According to IS 1893 (part -1) :2002 code is used to Analyse the structures by equivalent static analysis and response spectrum method and Time history anlysis. "L" shape and "T" shape buildings are analysed. To find out the lateral displacement at point -1 and point -2 . Point -1 and point -2 displacements are different that indicates the structures will be rotated to create the torsion. That torsion is effectively reduced by visco- elastic damper. To use the different load combinations by IS 1893 (part -1) :2002. In this study to prepare the " L" shape and " T" shape building in SAP 2000 software. The results are tabulated in terms of lateral displacement a, inter storey drift, Natural period and Base shear.

Key Words: *Torsion, SAP, Asymmetric plan, eccentricity, visco-elastic damper, centre of mass, centre of stiffness.*

1. INTRODUCTION

One of the most frequent source of structural damage is the Torsional effects on Asymmetrical building plan. During the strong ground shaking the torsional moment will be occur. The most vulnerable building structures are asymmetric in nature. Asymmetric mass and stiffness distribution. In modern construction Asymmetric plan Buildings are almost unavoidable. Because requirements of arthitectures and functions. Earthquake shakes the ground to cause the torsional effects on buildings. The most effective factors like unsymmetric distribution of stiffness and mass of the building.

The main reason for the poor performance of the building is the structures are symmetrical in nature. Asymmetrical distribution of rigidity and mass in the building to cause the torsional moment in the building. This torsional couple to increased the lateral deflection , members forces and finally collapse the building. The Asymmetric building plans like Y , L , H ,U and T shape Building plans. The maximum force formed at the junction of the arms.

The modern codes explain the torsional moment by placing restrictions of building designs with Asymmetrical layouts. In the design to considered the accidental eccentricity. The torsional vibration is caused due to eccentricity between centre of stiffness or centre of rigidity and centre of mass. During ground shaking of the structural systems, the resistive force acts through centre of stiffness and Inertia force acts through centre of mass. The torsional vibration in structures as shown in figure 1.1

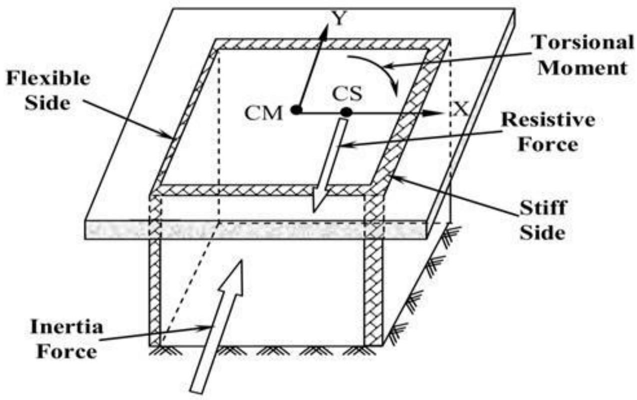


fig 1-.Torsional moment developed in the building.

2. METHODOLOGY

To determine the basic components like lateral displacement, storey drift and base shear this analysis has been carried using the software SAP 2000. for the analysis purpose Equivalent static method, Response spectrum method and time history methods are adopted.

2.1 BUILDING MODELING

In this building model RC multi storied structures of 10 storey "L" shape and "T" shape buildings are considered.

Height of the all stories 3.6m . properties of the considered building models are detailed below here.

2.2 Material Properties

The materials used for analysis of building models construction is reinforced concrete with m-20and m-25grade of concrete and fe-415 grade of steel. and the stress-strain relationship is used as per is 456:2000.
the basic material properties are in given table 1.

Material properties	values
Characteristic strength of concrete .fck(slab,beam)	20 Mpa
Characteristic strength of concrete .fck(column)	25 Mpa
Yield stress for steel (fy)	415 Mpa
Modulus of elasticity of steel ,Es	200000 Mpa
Modulus of elasticity of concreate ,Ec (slab,beam)	20000 Mpa
Modulus of elasticity of concreate ,Ec (column)	25000 Mpa

2.3 SECTION PROPERTIES:

The section properties of four storied building model are given in table 2.

Grade of the slab	M20
Thickness of the slab	0.15m
Grade of the beam	M20
Size of the all beam	0.23 x0.4 m
Grade of the column	M25
Column size upto 3rd floor	0.40 x0.40 m
Column size 3rd to 6th floor	0.35 x0.35 m
Column size 6th to 11th floor	0.30 x0.30 m
Assumed dead load intensities	
Roof finishes	2 KN/m2
Floor finishes	1.75 KN/m2
Live load intensities	
Floor	3.5 KN/m2
Link properties	
For " L"shape building	
Effective stiffness (ke)	85745.7 KN/m
Effective damping (De)	2451.4 KN-S/m
For "T"shape building	
Effective stiffness (Ke)	91892.30KN/m
Effective damping (De)	2005.10KN-s/m
Earthquake data	
Seismic zone	V
Importance factor	1.0
Response reduction factor	5.0
Type of soil	TYPE II(medium)
Damping	5%

2.4 Geometry of the Considered Model:

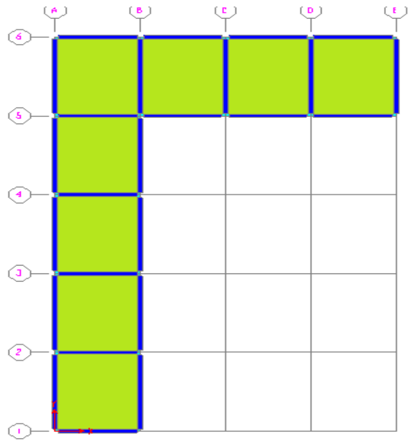
The geometry of the 10 storied " L" shape and " T"shape building model are given below.

Number of storey =10
Number of bays in X- direction =01
Bay width in X –direction =4m
Number of bays in Y- direction =05
Bay width in Y- direction =5 m

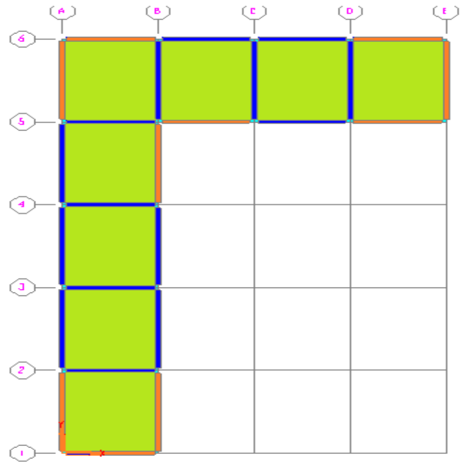
2.5 Plans and models

Plans and 3D models of "L "shape and " T" shape building considered for the analysis .

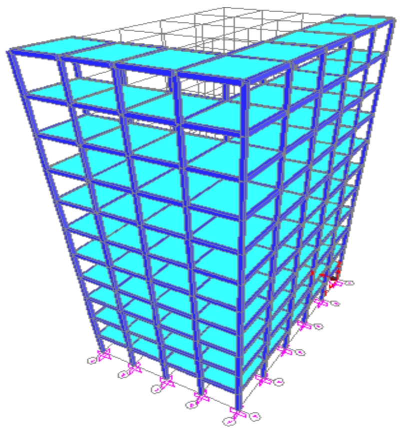
MODEL-I : building without VE dampers.
MODEL-II : building with VE dampers.



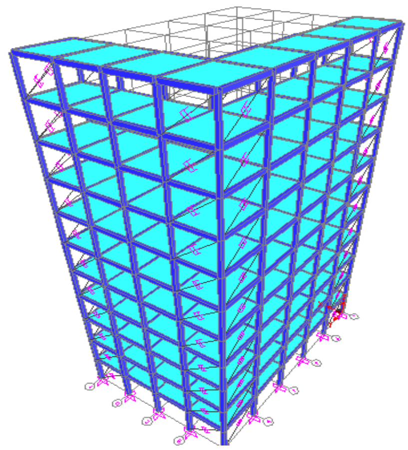
Plan of " L" shape building without Visco-elastic Damper Model- I.



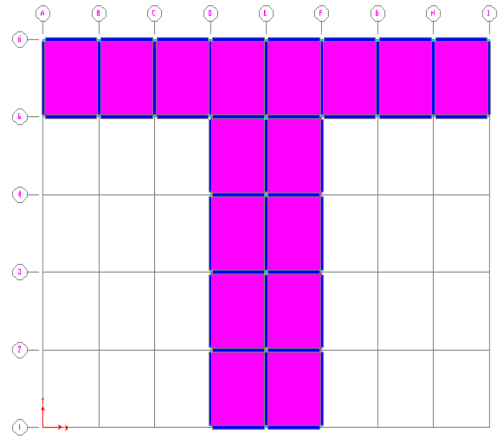
Plan of " L" shape building with visco-elastic Daper model-II.



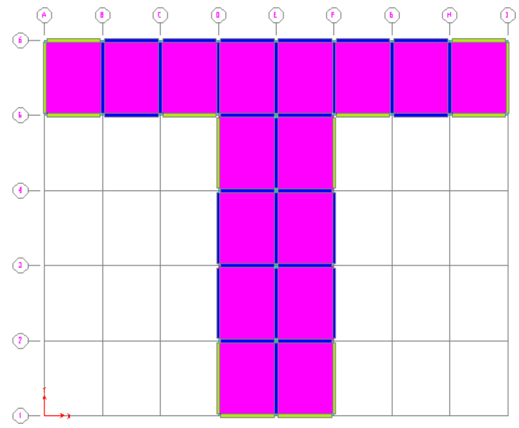
3D view of " L"shape building without visco-elastic Damper Model-I.



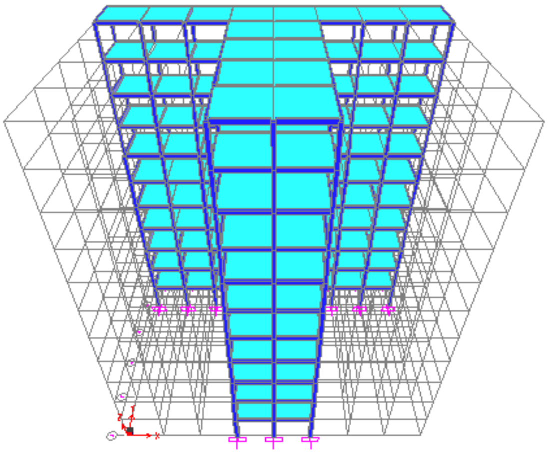
3D view of " L" shape building with visco-elastic Damper Model –II.



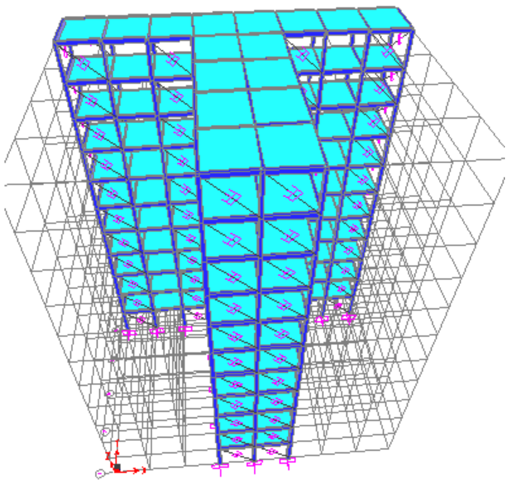
Plan of " T" shape building without visco-elastic Damper Model-I.



Plan of " T " shape building with visco-elastic damper Model- II



3D view of " T" shape building without Visco-elastic damper Model-I.



3D view of "T" shape building with visco-elastic damper Model-II.

2.6 LOAD COMBINATIONS CONSIDERED FOR THE BUILDING ANALYSIS

The following are the load combinations are adopted For the analysis and design of the building as per IS 1893 (part-1) :2002, as shown in table:4

LOAD COMBINATION	LOAD FACTOR
EQUIVALENT STATIC METHOD	1.2 (DL+LL+EQX)
	1.2(DL+LL+EQY)
	1.5 (DL+LL+EQX)
	1.5 (DL+LL+EQY)
	0.9 (DL+EQX)
	0.9(DL+EQY)
RESPONSE SPECTRUM METHOD	1.2 (DL+LL+RSX)
	1.2 (DL+LL+RSY)
	1.5 (DL+RSX)
	1.5 (DL+RSY)
	0.9 (DL+RSX)
	0.9 (DL+RSY)

Where,
DL =dead load
LL = live load

EQX and EQY =earthquake load in X and Y direction
RSX and RSY = earthquake load in X and Y direction.

3.RESULTS AND DISCUSSIONS

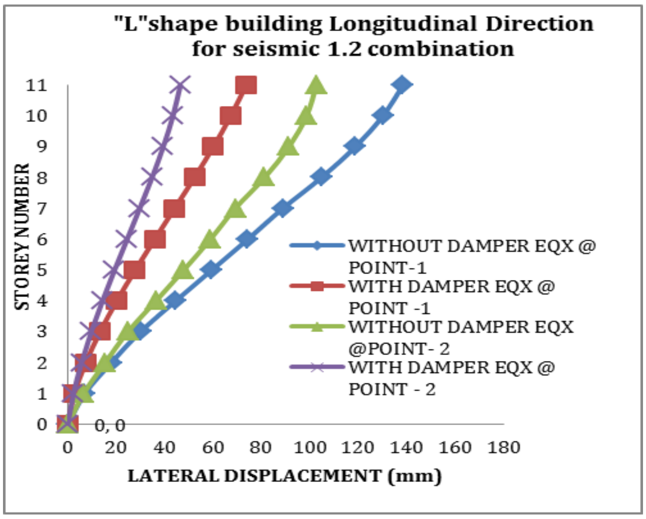
lateral displacement profile for building models obtained from the equivalent static method,response spectrum method and time history methods are shown in table 5.

Longitudinal direction for seismic combination 1.2(DL+LL+EQX)

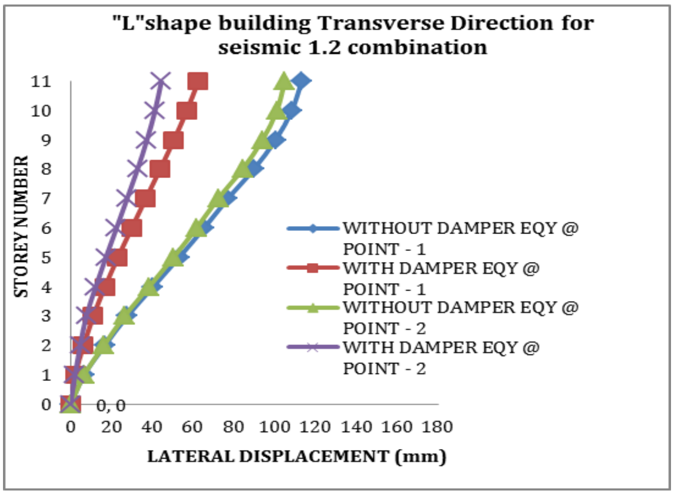
STOREY	Equivalent static method			
	Lateral Displacement (mm) @ point -1		Lateral Displacement (mm) @ point -2	
	Model -I	Model -II	Model -I	Model -II
11	138.38	73.62	102.60	46.46
10	130.07	67.25	98.58	43.38
9	118.72	60.08	91.28	39.41
8	104.69	52.27	81.24	34.77
7	88.73	44.07	69.10	29.67
6	74.31	35.86	58.85	24.48
5	59.41	27.79	47.82	19.27
4	44.46	20.18	36.35	14.28
3	29.96	13.31	24.79	9.67
2	17.92	7.44	15.44	5.68
1	7.04	2.69	6.51	2.34
BASE	0.00	0.00	0.00	0.00

Transverse direction for seismic combination 1.2(DL+LL+EQY)

STOREY	Equivalent static method			
	Lateral Displacement (mm) @ point -1		Lateral Displacement (mm) @ point -2	
	Model -I	Model -II	Model -I	Model -II
11	113.24	62.56	104.89	44.46
10	108.36	56.96	101.03	41.38
9	100.42	50.64	94.00	37.41
8	89.70	43.84	84.17	32.77
7	76.98	36.81	72.22	27.67
6	65.39	29.90	61.69	22.48
5	53.10	23.14	50.34	17.27
4	40.39	16.80	38.44	12.28
3	27.69	11.11	26.38	7.67
2	16.75	6.27	16.25	4.68
1	6.56	2.30	6.62	2.12
BASE	0.00	0.00	0.00	0.00



Lateral displacement (mm) profile for "L" shape building in Longitudinal direction by seismic 1.2 EQX @ point -1 and point - 2



Lateral displacement (mm) profile for "L" shape building in Transverse direction by seismic 1.2 EQY @ point -1 and point - 2

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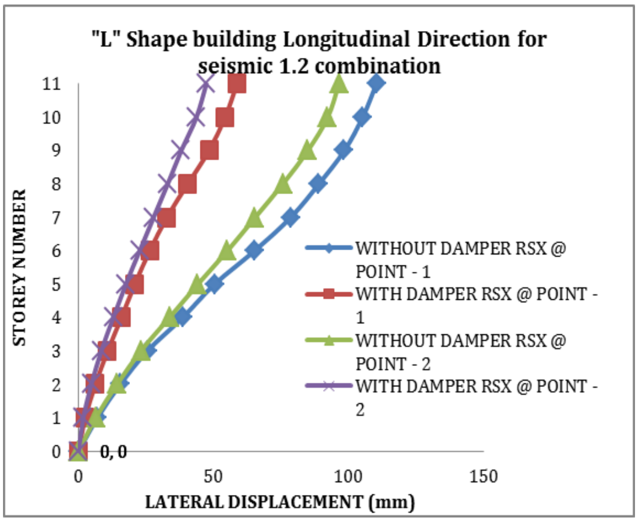
STOREY	Response Spectrum Method			
	Lateral Displacement (mm) @ point -1		Lateral Displacement (mm) @ point -2	
	Model -I	Model -II	Model -I	Model -II
11	110.18	58.62	96.35	47.28
10	105.14	54.24	92.23	43.63
9	98.34	48.26	84.82	38.01
8	88.92	40.38	75.58	32.99
7	78.53	32.67	65.35	27.76
6	65.15	26.34	55.12	22.63
5	50.34	20.81	44.13	17.51
4	38.49	15.84	33.65	12.84
3	25.45	10.75	23.02	8.04
2	15.36	6.25	14.23	4.73
1	6.98	2.44	6.34	1.74
BASE	0.00	0.00	0.00	0.00

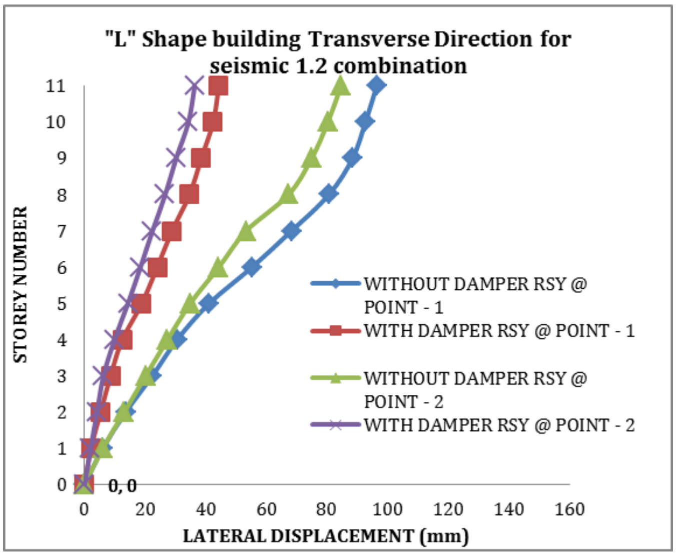
Longitudinal direction for seismic combination 1.2(DL+LL+RSX)



Lateral displacement (mm) profile for "L"shape building in Longitudinal direction by seismic 1.2 RSX @ point – 1 and point – 2.

Transverse direction for seismic combination 1.2(DL+LL+RSY)

STOREY	Response Spectrum Method			
	Lateral Displacement (mm) @ point -1		Lateral Displacement (mm) @ point -2	
	Model -I	Model -II	Model -I	Model -II
11	96.31	44.27	84.54	36.27
10	92.58	42.38	80.21	34.24
9	88.34	38.43	74.87	30.17
8	80.56	34.58	67.23	26.58
7	68.21	28.81	53.28	22.38
6	55.24	23.93	44.27	18.42
5	41.10	18.89	34.88	14.32
4	30.56	12.45	27.35	9.88
3	22.34	8.56	20.14	6.20
2	13.56	5.31	13.12	4.12
1	6.02	2.10	5.98	1.98
BASE	0.00	0.00	0.00	0.00



Lateral displacement (mm) profile for "L"shape building in Transverse direction by seismic 1.2 RSY @ point – 1 and point – 2.

3.4 summary

It can be noted that for equivalent static, response spectrum and time history analysis the lateral displacement @ point-1 and point-2 are different that indicates the torsion in L shape and T shape building. That torsion is reduced by visco-elastic dampers.

3.5 CALCULATION OF BASESHEAR

Building	Model - I					
	EQX (KN)	RSX (KN)	Scale factor	EQY (KN)	RSY (KN)	Scale factor
L	952.69	851.76	1.11	860.98	798.15	1.08
T	1665.7	1427.15	1.16	1443.5	1341.3	1.07

Building	Model - II					
	EQX (KN)	RSX (KN)	Scale factor	EQY (KN)	RSY (KN)	Scale factor
L	1244.9	1024.1	1.21	1370.9	1121.1	1.22
T	2593.6	2150.6	1.20	1945.2	1816.3	1.07

4. CONCLUSIONS

In the present study Asymmetric building plans like " L" shape and "T" shape building modeled and analysed by SAP 2000 software. The three types of Analysis has been done. i.e. linear static analysis and Response Spectrum Method and Time history Analysis . the buildings are placed on seismic zone V. The seismic response of the "L" and "T" shape building are obsereved. A new type of energy dissipation devices are applied to the buildings i.e. visco-elastic dampers.

The following are the conclusions based on the seismic response of "L" shaped and "T" shaped buildings.

- ➢ The Fundamental Natural time period of the structures is reduced by using visco-elastic dampers in the buildings.
- ➢ Torsion in the Asymmetric building plan likes "L" shaped and "T" shaped buildings are reduced by adding the visco-elastic damper.
- ➢ The Torsional effect in the Asymmetric plans buildings in the form of lateral displacement at corner points are different. this torsional effects is reduced by providing visco-elastic dampers in suitable location in the buildings.
- ➢ Base shear of the structures is more in the buildings with visco-elastic dampers.
- ➢ Larger torsional effect is observed in "L" shaped building compared to the "T" shaped building.
- ➢ The use of visco-elastic dampers reduce the storey drift in the buildings.

From the above conclusion it is clear that visco-elastic dampers are effective in controlling the Torsion in the Asymmetric plan buildings.

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