SEISMIC PERFORMANCE ASSESSMENT OF THE TORSIONAL EFFECT IN ASYMMETRIC STRUCTURES USING PUSHOVER AND NON-LINEAR TIME HISTORY METHOD

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Abstract

In the recent time we come across many structures which are irregular in shape, this type of cannot be avoided due to the functional and architectural requirements. These type of structures have irregular distribution of centre of mass and centre of rigidity which causes the torsional effect on the structures which is one of the most important factor influencing the seismic damage of the structure. Structures with asymmetric distribution of mass and rigidity undergoes torsional motions during earthquake. To assess the torsional effect on the structures in the present study four types of structures are considered with varying eccentricity subjected to Pushover Analysis and Non-Linear Time History Analysis. The performance of the structures are assessed as per the procedure prescribe in ATC-40 and FEMA-356. The analysis of the structural models is done in ETABS. The results have shown that the structures with less eccentricity and in the direction of the columns orientation are performing well, also ductility, drift, and lateral displacement depends on the eccentricity of the structures.

Key Words: Symmetric Structure, Asymmetric Structure, Pushover Analysis, Non-Linear Time History Analysis.

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1. INTRODUCTION

Earthquake is a manifestation of rapid release of stress waves during a brittle rupture of rock. The complexity of earthquake ground motion is primarily due to factors such as source effect, path effect and local site effect. Earthquake causes ground to vibrate and structures supported on ground in turn are subjected to this motion. Thus the dynamic loading on the structure during an earthquake is not external loading, but due to motion of support. The various factors contributing to the structural damage during earthquake are vertical irregularities, irregularity in strength and stiffness, mass irregularity, torsional irregularity etc.

1.1. Symmetric and Asymmetric Structures

Asymmetric structures are almost unavoidable in present day construction due to the functional and architectural requirements. In Asymmetric structures, the lateral torsional coupling due to eccentricity between Centre of Mass (CM) and Centre of Rigidity (CR) generates torsional vibration even under purely translational ground shaking. During shaking inertial forces act through the centre of mass (CM) and the resistive forces act through the centre of rigidity (CR) due to this non-concurrency of these points inertial force and resistive force induces twisting of the structure in additional to the lateral vibration. [5] Dr.Tande, S.B.Kadam
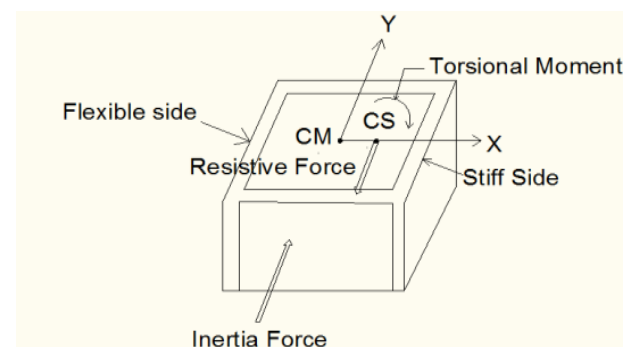

Fig 1: Generation of Torsional Moment in Asymmetric Structures.

a) Symmetric Structures:

Structures where the centre of mass coincides with the centre of resistance are called symmetric structures. In this type of structures the eccentricity will be zero i.e. centre of mass and centre of resistance is at the centre, it is difficult to obtain these type of structures everywhere due to aesthetical conditions, architectural and functional requirements. The strength and the stiffness will be equally distributed. Seismic effect on these types of structures is very less.

b) Asymmetric Structures:

Structures where the centre of mass does not coincide with the centre of resistance are called asymmetric structures. In this type of structures eccentricity exists i.e. centre of mass does not coincide with centre of resistance. Due to the

architectural and functional requirement this type of structures are gaining popularity. During an earthquake building with an asymmetric distribution of strength and stiffness undergo coupled lateral and torsional motions.

2. SEISMIC PERFORMANCE EVALUATION OF STRUCTURES

Buildings subjected to earthquake ground motions undergo varying oscillatory motions, which may cause failure or major structural damage. The performance evaluation based approach is an alternative to that approach, which is based on quantifying the inelastic deformations of the members and the building as a whole, under the seismic loads. The deformations or strains are considered to be better measures than stresses or forces to assess damage. Thus, such a configuration induces a torsional moment that in turn invokes torsional rotation of the floor diaphragm.

The seismic performance of a building is measured by the state of damage under a certain level of seismic hazard. The state of damage is quantified by the drift of the roof and the displacement of the structural elements. Pushover analysis and Non-Linear Time History Analysis gives an insight into the maximum base shear that the structure is capable of resisting. [4] Rama Raju K, Cinitha A

2.1 Pushover Analysis

Pushover analysis is defined as an analysis where a mathematical model directly incorporating the nonlinear load-deformation characteristics of individual components and elements of the structure shall be subjected to monotonically increasing lateral loads representing inertia forces of an earthquake until a target displacement is reached. Target displacement is the maximum displacement of the structure at top expected under applied earthquake ground motion. Pushover analysis is conducted to find out the performance points that are Immediate Occupancy, Life Safety, and Collapse Prevention of symmetric and asymmetric structures using static pushover curve.
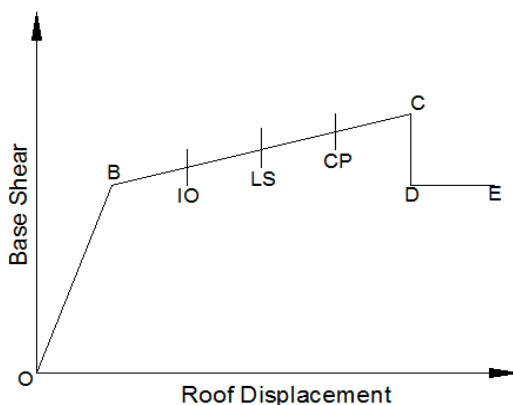

Fig 2: Static Pushover Curve

Response characteristics that can be obtained from the pushover analysis are summarized as follows:

a) Estimates force and displacement capacities of the structure and sequence of the member yielding and the progress of the overall capacity curve.

b) Estimates force demands on potentially brittle elements and deformation demands on ductile elements.

c) Estimates target displacement demand, corresponding inter-storey drift.

d) Identification of the critical regions, where the inelastic deformations are expected to be high and identification of strength irregularities of the structure.

2.2 Non-Linear Time History Analysis.

The time history analysis is an actual dynamic analysis that can be done for both linear and nonlinear systems. It is found that this analysis incorporates the real time earthquake ground motions and gives the true picture of the possible deformation and collapse mechanism in a structure. But, at the same time, it is a very tedious and complex analysis having a lot of mathematical calculations. Although non-linear dynamic analysis is generally considered to be the most accurate of the available analysis methods, it is cumbersome for design. This is the most sophisticated analysis procedure for predicting forces and displacements under seismic input. [6] G S Hiremath and Kushappa M Kabade

3. DESCRIPTION OF MODELS
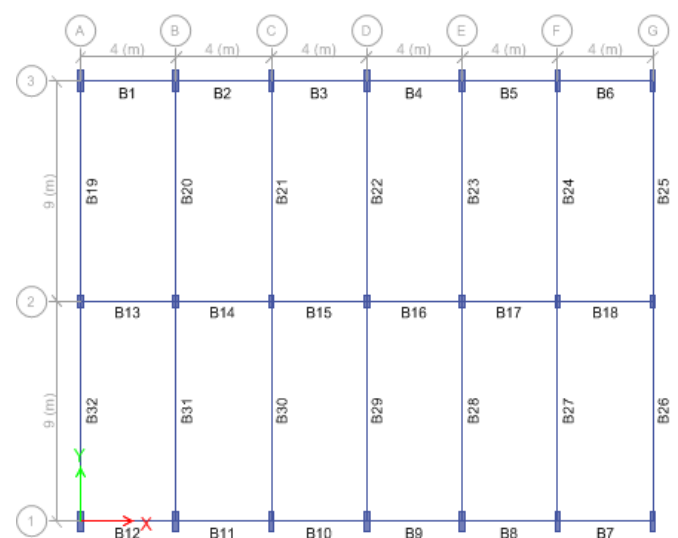
Model-1: Sym Structure

Fig 3: Plan of SYM Structure.

Table 1: Seismic details of the Structures.

Type of Structures	Multi-Storey RC Building	
Number of Stories	G+8	
Materials	Concrete	M25
	Steel	Fe415
Slab Section	Slab	125 mm
Zonal Considerations	Soil Type	II
	Zone	IV
	Importance factor	1
	Reduction Factor	3
	Zone Factor	0.24
Live Load	3kN/m^2	

Table 2: Details of SYM Structure

Frame Sections	Beam-1	230X450 mm
	Beam-2	230X850 mm
	Column-1	230X850 mm
	Column-2	230X500 mm
Eccentricity	$e_x = 0\%$	$e_y = 0\%$

Model-2: Asym-1 Structure
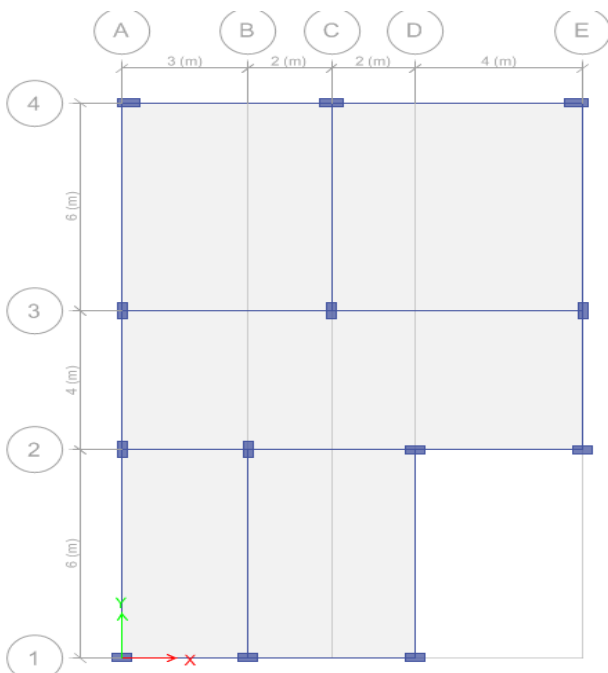
Fig 4: Plan of ASYM-1 Structure.

Table 3: Details of ASYM-1 Structure.

Frame Sections	Beam-1	230X400 mm
	Beam-2	230X550 mm
	Column-1	230X450 mm
	Column-2	230X550 mm
Eccentricity	$e_x = 5\%$	$e_y = 4.33\%$

Model-3: Asym-2 Structure
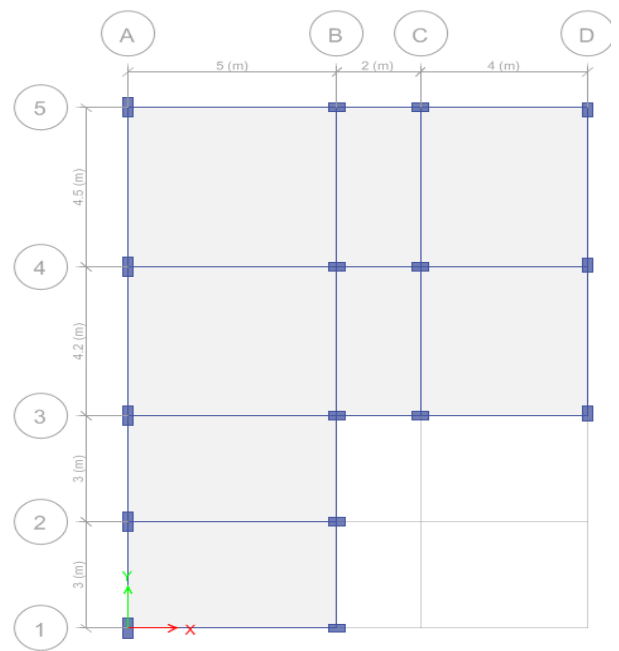
Fig 5: Plan of ASYM-2 Structure.

Table 4: Details of ASYM-2 Structure.

Frame Sections	Beam-1	230X500 mm
	Column-1	230X400 mm
	Column-2	230X550 mm
Eccentricity	$e_x = 14\%$	$e_y = 0.06\%$

Model-4: Asym-3 Structure.
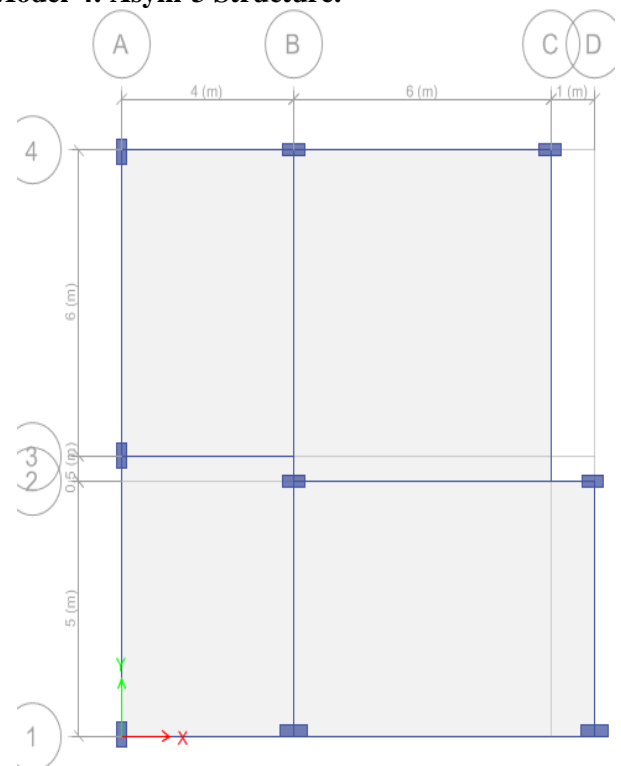
Fig 6: Plan of ASYM-3 Structure.

Table 5: Details of ASYM-3 Structure.

Frame Sections	Beam-1	230X600 mm
	Column-1	230X500 mm
	Column-2	230X650 mm
Eccentricity	e_x = 20%	e_y = 1.25%

4. RESULTS AND DISCUSSIONS

4.1 PUSHOVER ANALYSIS

4.1.2 Base Shear and Roof Displacement Graph:

The graph of Base Shear v/s Displacement is obtained by Non-linear Static Analysis i.e. Pushover Analysis which involves incrementally applying the calculated lateral load on Symmetric and Asymmetric structure till it fails to withstand the applied lateral load. The values of Base Shear and Displacement obtained by Pushover Analysis in X-direction and Y-direction are tabulated below and shown in graphs.

Table 6: Base Shear v/s Roof Displacement in X-Direction.

Model	Design Base Shear V_B (kN)	Base Shear in kN	Roof Displacement in mm
SYM	2309.76	1530.10	308.10
ASYM-1	888.41	1254.06	381.40
ASYM-2	884.71	1368.07	356.10
ASYM-3	741.61	668.30	240.90

Table 7: Base Shear v/s Roof Displacement in Y-Direction.

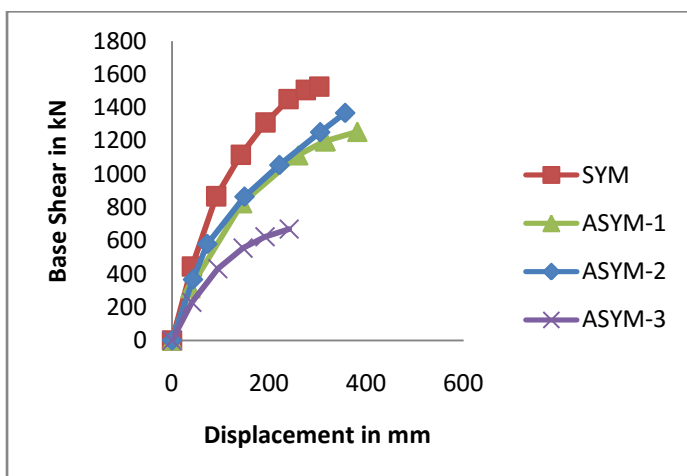| Model	Design Base Shear V_B (kN)	Base Shear in kN	Roof Displacement in mm
SYM	2309.76	3611.22	385.8
ASYM-1	888.41	1244.85	429.40
ASYM-2	884.71	1876.65	374.50
ASYM-3	741.61	478.96	110.70

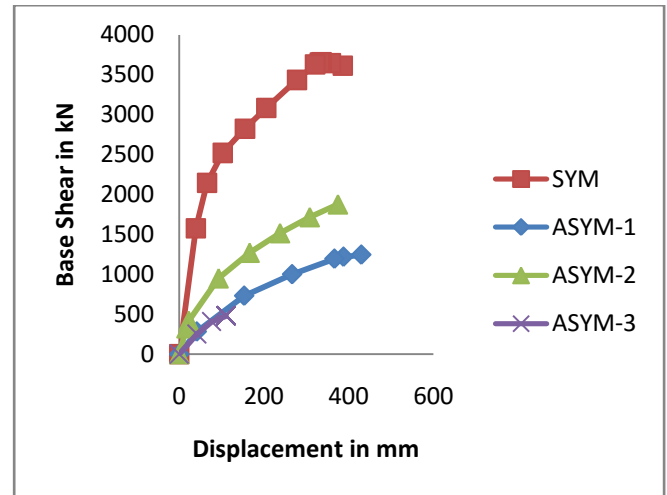**Fig 7:** Pushover Curve in X-Direction.

Fig 8: Pushover Curve in Y-Direction

From the above Tables 6 and 7, it is observed that the lateral load resisting capacity of the SYM structure is lesser by 33.77%, ASYM-1 is greater by 41.15%, ASYM-2 is greater by 54.63% and ASYM-3 is lesser by 10% in X-direction.

Also the lateral load resisting capacity of the SYM structure is greater by 53.05%, ASYM-1 is greater by 40.12%, ASYM-2 is greater by 112.12% and ASYM-3 is lesser by 35.41% Y-direction.

The Symmetric structure has the greater lateral load resisting capacity in Y-direction than in the X-direction this is because all the columns are oriented in Y-direction, both Asymmetrical-1 and Asymmetrical-2 can withstand base shear greater than that of the design base shear.Asymmetrical-3 has the lower lateral load resisting capacity than that of the design base shear because of the highest eccentricity provided.

4.1.2 Lateral Displacements:

This represents the displacement of Centre of Mass from its point of acting due to the applied lateral loads. The maximum displacement of all the SYM and ASYM structures at each floor with respect to ground floor in X-direction and Y-direction obtained from Pushover analysis are shown in graphs and tables representing maximum displacements.

**Table 8:** Maximum Lateral Displacement in X-Direction.

Model	Storey	Displacement in mm
SYM	Top Storey	308.10
ASYM-1	Top Storey	387.70
ASYM-2	Top Storey	357.90
ASYM-3	Top Storey	237.50

Table 9: Maximum Lateral Displacement in Y-Direction.

Model	Storey	Displacement in mm
SYM	Top Storey	385.80
ASYM-1	Top Storey	429.40
ASYM-2	Top Storey	456.90
ASYM-3	Top Storey	166.80

From the table 8 and 9, the lateral displacement w.r.t. SYM structure, ASYM-1 increases by 25.83%, ASYM-2 increases by 16.16% and ASYM-3 reduces by 22.91% in X-direction.

Similarly, lateral displacement w.r.t. SYM structure, ASYM-1 increases by 11.30%, ASYM-2 increases by 18.42% and ASYM-3 reduces by 56.76% in Y-direction.
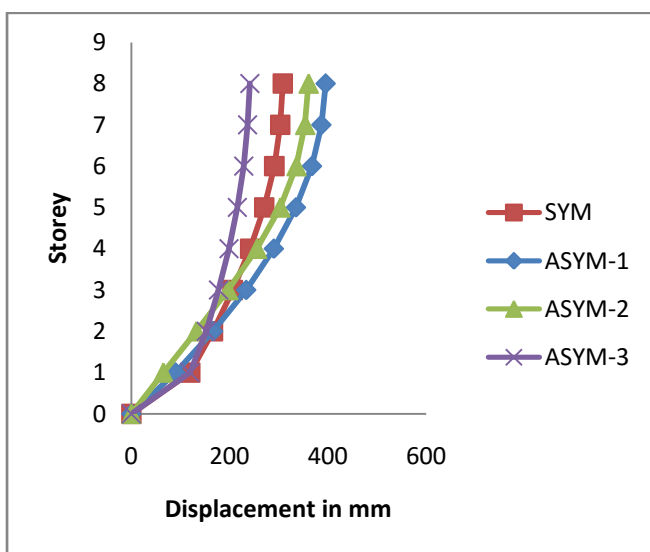
Fig 9: Lateral Displacement of Roof in X-Direction.
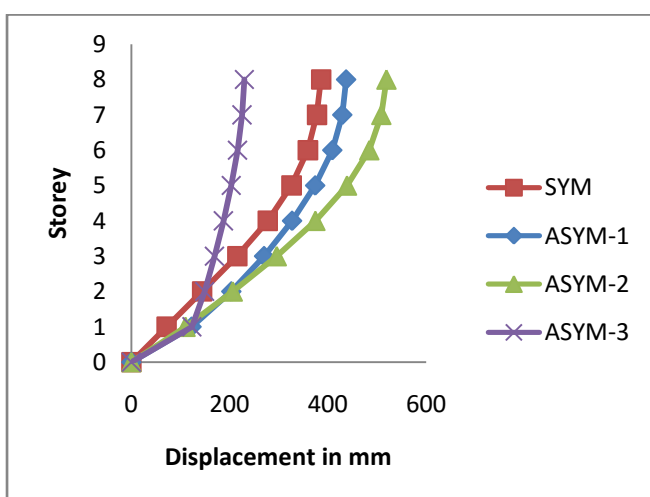
Fig 10: Lateral Displacement of Roof in Y-Direction.

The lateral displacement for SYM structure is greater in Y-direction than in X-direction because all the columns are oriented in Y-direction. The lateral displacement for ASYM-

1 and ASYM-2 is greater in Y-direction and ASYM-3 in X-direction.

4.1.3 Ductility Ratio

Ductility of the structure is the capacity to undergo large inelastic deformation without significant loss of strength or stiffness of the structure. If the structure is non-ductile in nature the structure will collapse without yielding. Reinforced Concrete structures for seismic resistance must be designed, detailed and constructed in such a way that the ductility factor should be at least equal to 3 up to the point of beginning of visible damage or even greater, to point of beginning of structural damage. The ductility ratio of Symmetric and Asymmetric structures analyzed is tabulated.

Table 10: Ductility Ratio in X-Direction.

Model	Δy	Δmax	μ
SYM	166	308.10	1.85
ASYM-1	88.90	387.70	4.36
ASYM-2	130.60	357.90	2.74
ASYM-3	102.90	237.50	1.69

Table 11: Ductility Ratio in Y-Direction.

Model	Δy	Δmax	μ
SYM	142.70	384.50	2.69
ASYM-1	119.40	429.40	3.59
ASYM-2	96.40	456.90	4.73
ASYM-3	98.50	166.80	1.69

Table 10 and 11, Symmetric structure is more ductile in Y-direction compared to that of in X-direction because all the columns are oriented in Y-direction, Asymmetrical-1 is more ductile in X-direction when compared to that of Y-direction with a maximum displacement of 387.70mm , Asymmetrical-2 is more ductile in Y-direction when compared to that of X-direction with a maximum displacement of 456.90mm and Asymmetrical-3 with identical ductility ratio value fails at a displacement of 166.80mm in Y-direction.

4.1.4 Maximum Storey Drifts

Story drift is the difference in lateral deflection between two adjacent stories of the structure. Drift affects both the structural elements that are part of the lateral force resisting system and structural elements that are not part of the lateral force resisting system. Drifts obtained from Pushover analysis is tabulated and shown in graph.

Table 12: Maximum Storey Drift in X-Direction.

Model	Storey	Drift
SYM	1st Storey	0.0286
ASYM-1	1st Storey	0.0213
ASYM-2	2nd Storey	0.0191
ASYM-3	1st Storey	0.0284

Table 13: Maximum Storey Drift in Y-Direction.

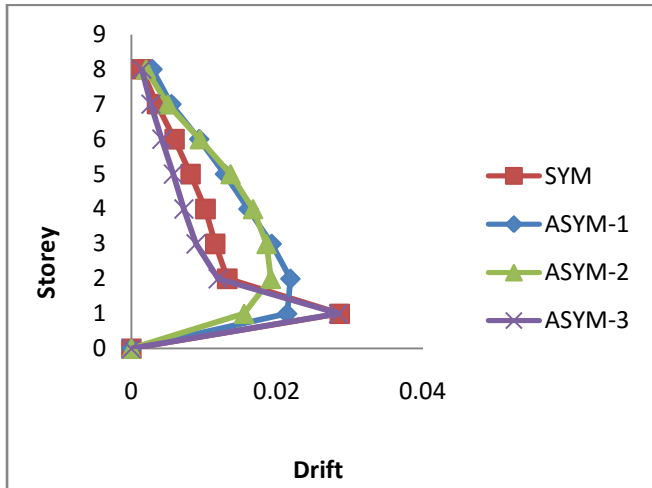| Model	Storey	Drift
SYM	3rd Storey	0.0202
ASYM-1	1st Storey	0.0291
ASYM-2	2nd Storey	0.0274
ASYM-3	1st Storey	0.0292

Fig 11: Maximum Storey Drift in X-Direction.

From Table 12, it is evident that the SYM and ASYM-3 have almost equal values of drift, followed by ASYM-1 and ASYM-2 has a lesser drift compared to all the other structures in 1st storey, also its drift is greater in 2nd storey in X-direction.
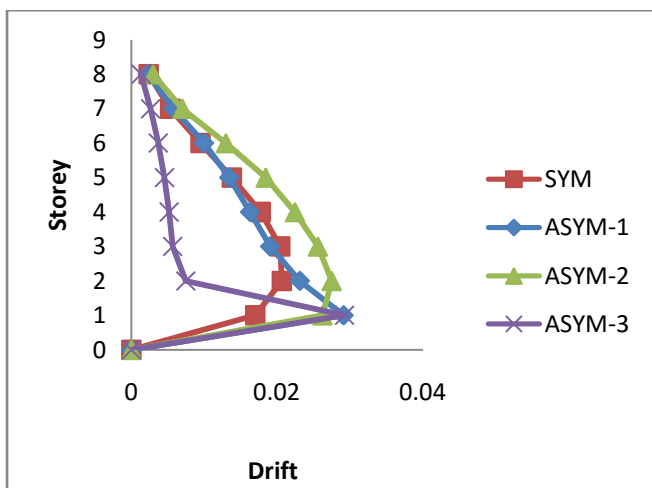

Fig 12: Maximum Storey Drift in Y-Direction.

From Table 13, SYM structure has a maximum drift in 3rd storey, ASYM-1 has a maximum drift in 1st strorey, ASYM-2 has a maximum drift in 2nd storey and ASYM-3 has a maximum drift in 1st storey in Y-direction.

From above it can be seen that SYM structure is performing well in Y-direction with its maximum drift in 3rd storey, ASYM-1 in Y-direction, ASYM-2 in Y-direction and ASYM-3 have almost equal values of drift in both the direction.

4.1.5 Target Displacement Point.

Target displacement point defines the maximum base shear the structure can withstand at the point of yielding of the structure, also the displacement the corresponding structure will undergo when subjected to Pushover analysis.

Table 14: Target Displacement Results in X-Direction.

Model	Shear in kN	Displacement in mm
SYM	1184.94	159.80
ASYM-1	553.25	87.60
ASYM-2	633.63	86.80
ASYM-3	474.63	112.60

Table 15: Target Displacement Results in Y-Direction.

Model	Shear in kN	Displacement in mm
SYM	1807.20	50.20
ASYM-1	554.57	109.20
ASYM-2	684.87	57.90
ASYM-3	478.96	120.60

From Table 14 and 15, SYM structure performs well in Y-direction with greater base shear resistance and minimum displacement, ASYM-1performs well in Y-direction almost with equal base shear acting but more ductile in Y-direction, ASYM-2 performs well in Y-direction with greater base shear and lesser displacement and ASYM-3 have almost equal value of base shear and displacement performs badly to the seismic loading compared to all the structures in both the directions.

4.2 NON-LINEAR TIME HISTORY ANALYSIS

4.2.1 Maximum Storey Displacement

This represents the maximum displacement of the roof from its position due to he applied seismic loading on the structure. Performance of the structure due to he applied seismic loading can be assessed.

Table 16: Maximum Storey Displacement in X-Direction.

Model	Storey	Displacement in mm
SYM	2nd Storey	80.10
ASYM-1	1st Storey	2421.00
ASYM-2	5th Storey	1072.00
ASYM-3	1st Storey	1364.70

Table 17: Maximum Storey Displacement in Y-Direction.

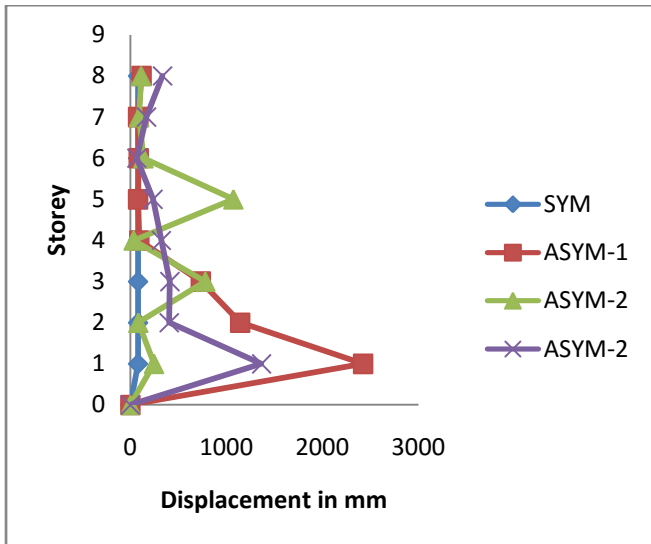| Model	Storey	Displacement in mm
SYM	2nd Storey	102.90
ASYM-1	5th Storey	1000.30
ASYM-2	Top Storey	382.30
ASYM-3	5th Storey	1558.40

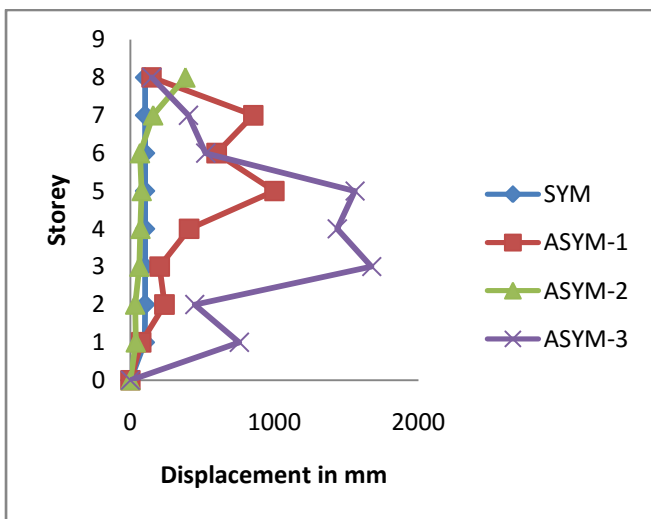**Fig 13:** Maximum Storey Displacement in X-Direction.

Fig 14: Maximum Storey Displacement in Y-Direction.

From Table 16, it can be observed as the eccentricity increases that the maximum storey displacement compared to that of SYM structure, ASYM-1 has 30 times more displacement, ASYM-2 has 14 times more displacement, and ASYM-3 has 18 times more displacement in X-direction.

Similarly from Table 17, the maximum storey displacement compared to that of SYM structure, ASYM-1 has 10 times more displacement, ASYM-2 has 4 times more displacement and Asymmterical-3 has 16 times more displacement in Y-direction.

It can be observed that the SYM structure is performing well in Y-direction than in that of X-direction, ASYM-1 is performing well in Y-direction than in X-direction, and ASYM-2 is performing well in Y-direction than in X-direction and ASYM-3 has almost equal values of displacements in both the directions leading to the brittle failure of the structure.

4.2.2 Lateral Displacements of Roof

This is the displacement of Centre of Mass from its point of acting. The maximum displacement of all the symmetrical and asymmetrical structures at each floor with respect to ground floor in X-direction and Y-direction obtained from Non-linear Time History analysis are shown in graphs and tables representing maximum lateral displacements of roof.

Table 18: Lateral Displacement of Roof in X-Direction.

Model	Storey	Displacement in mm
SYM	2nd Storey	-80.10
ASYM-1	1st Storey	1244.10
ASYM-2	5th Storey	-192.30
ASYM-3	1st Storey	-941.80

Table 19: Lateral Displacement of Roof in Y-Direction.

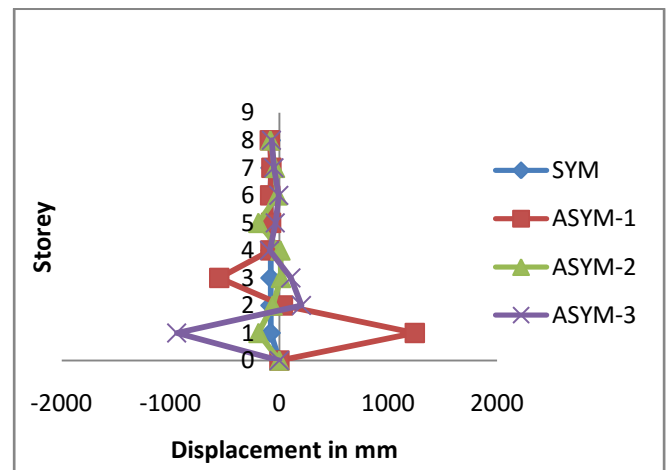| Model	Storey	Displacement in mm
SYM	2nd Storey	-102.90
ASYM-1	7th Storey	-512.50
ASYM-2	Top Storey	-91.40
ASYM-3	4th Storey	1028.70

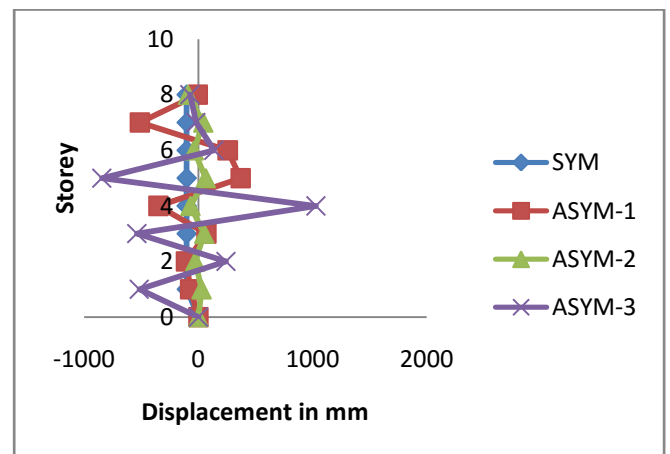**Fig 15:** Lateral Displacement of Roof in X-Direction.

Fig 16: Lateral Displacement of Roof in Y-Direction.

From Table18, It can be observed that as the eccentricity increases that the maximum storey displacement compared to that of SYM structure, ASYM-1 has 16 times more displacement, ASYM-2 has 2.5 times more displacement, and ASYM-3 has 12 times more displacement in X-direction.

From Table 19, It can be observed that as the eccentricity increases that the maximum storey displacement compared to that of SYM structure, ASYM-1 has 5 times more displacement, ASYM-2 has less displacement, and ASYM-3 has 10 times more displacement in Y-direction.

4.2.3 Maximum Storey Drifts.

Story drift is the difference in lateral deflection between two adjacent stories of the structure. Drift affects both the structural elements that are part of the lateral force resisting system and structural elements that are not part of the lateral force resisting system. Drifts obtained from Pushover analysis is tabulated and shown in graph.

Table 20: Maximum Storey Drift in X-Direction.

Model	Storey	Drift
SYM	1st Storey	0.0190
ASYM-1	2nd Storey	0.9454
ASYM-2	6th Storey	0.3450
ASYM-3	2nd Storey	0.8677

Table 21: Maximum Storey Drift in Y-Direction.

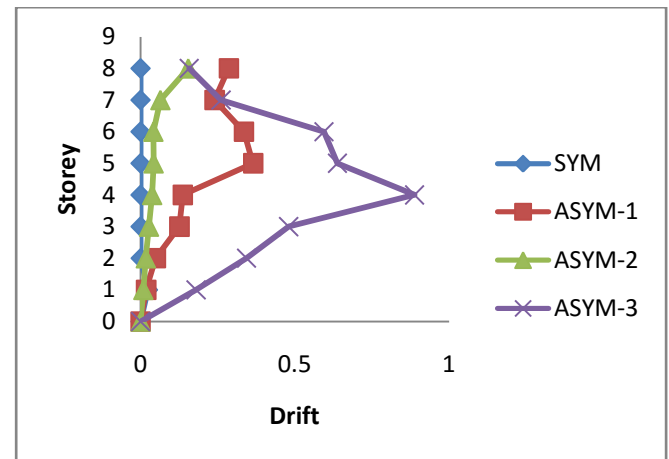| Model	Storey	Drift
SYM	1st Storey	0.0240
ASYM-1	5th Storey	0.3647
ASYM-2	8th Storey	0.1546
ASYM-3	4th Storey	0.8884

Fig 17: Maximum Storey Drift in X-Direction.

Fig 18: Maximum Storey Drift in Y-Direction

From Table 20 and 21, it can be seen that SYM structure is performing well in both X and Y-direction with its minimum drift in 1st storey, ASYM-1 with maximum drift at 5th storey in Y-direction, ASYM-2 with maximum drift at 8th storey in Y-direction and ASYM-3 has almost equal value of drift in both X and Y-directions.

4.2.4 Spectral Displacement v/s Period.

This represents the maximum or peak response of a single degree of freedom system to a particular seismic input as a function of natural frequency. The tables represents the spectral displacement of the SYM and ASYM structures in X and Y-directions and its corresponding graphs.

Table 22: Spectral Displacement in X-Direction.

Model	Period in sec	Spectral Displacement in mm
SYM	1.429	456.20
ASYM-1	1.429	245.00
ASYM-2	1.429	275.50
ASYM-3	1.429	347.20

Table 23: Spectral Displacement in Y-Direction.

Model	Period in sec	Spectral Displacement in mm
SYM	1.429	31.30
ASYM-1	1.429	95.70
ASYM-2	1.429	340.60
ASYM-3	1.429	579.60
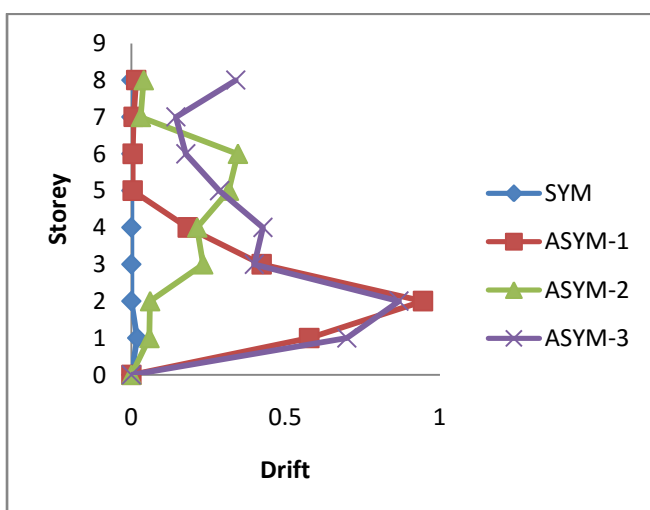
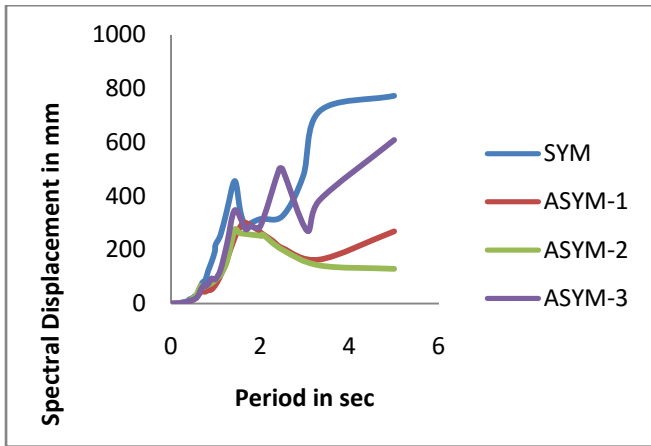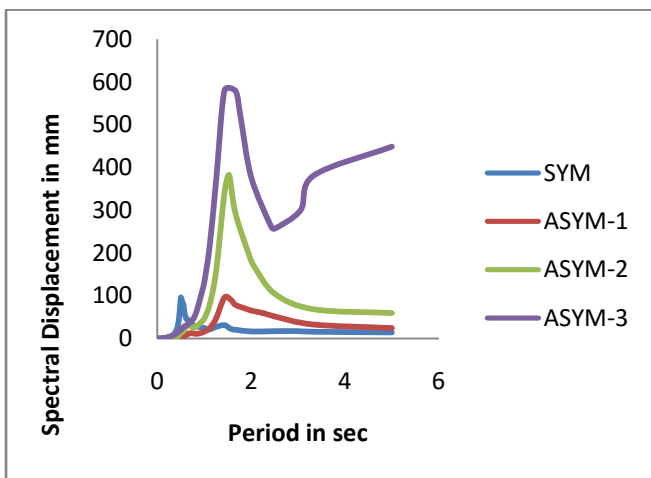**Fig 19:** Spectral Displacement in X-Direction.

Fig 20: Spectral Displacement in Y-Direction.

From Table 22, it can be observed that the Asymmetrical-1 and Asymmetrical-2 are behaving as flexible structure, and in the case of Symmetrical and with the highest percentage of eccentricity in Asymmetrical-3 structures are behaving as more rigid in nature causing the torsional effect on the structure which makes the structure to undergo huge displacement within in a short period of time in X-direction.

From Table 23, it can be observed that the Symmetrical and Asymmetrical-1 are behaving as flexible structure, as the eccentricity increases Asymmetrical-2 and Asymmetrical-3 structures are behaving as more rigid in nature causing the torsional effect on the structure which makes the structure to undergo huge displacement within in a short period of time in Y-direction.

From the above inference it can be observed that the Symmetrical structure is performing well in Y-direction, Asymmetrical-1 in Y-direction, and Asymmetrical-2 and Asymmetrical-3 is behaving as a rigid structure in both the directions.

4.2.5 Spectral Acceleration v/s Period.

This represents the maximum or peak response of a single degree of freedom system to a particular seismic input as a function of natural frequency. The tables represents the

spectral acceleration experienced by the SYM and ASYM structures in X and Y-directions and its corresponding graphs.

Table 24: Spectral Acceleration in X-Direction.

Model	Period in sec	Spectral Acceleration in m/sec^2	Spectral Displacement in mm
SYM	1.429	8.940	456.20
ASYM-1	1.429	4.790	245.00
ASYM-2	0.667	5.968	65.00
ASYM-3	0.429	6.768	12.00

Table 25: Spectral Acceleration in Y-Direction.

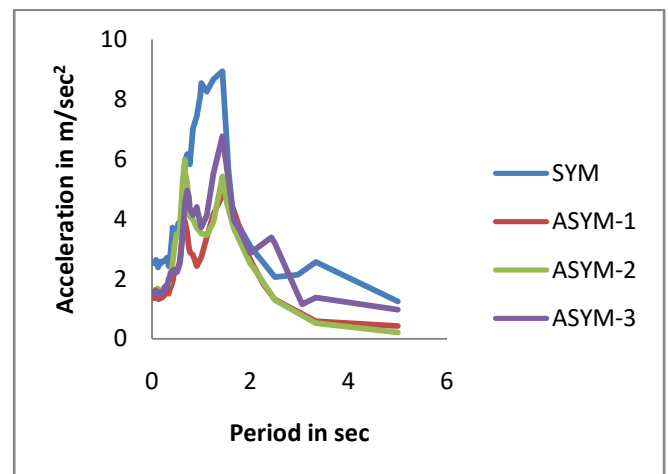| Model	Period in sec	Spectral Acceleration in m/sec^2	Spectral Displacement in mm
SYM	0.493	14.294	88.40
ASYM-1	1.429	7.671	95.70
ASYM-2	1.429	11.633	340.60
ASYM-3	1.429	11.169	579.60

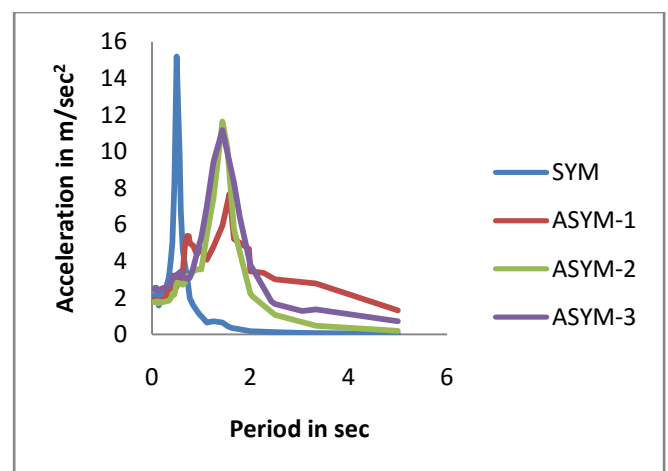**Fig 21:** Spectral Acceleration in X-Direction.

Fig 22: Spectral Acceleration in Y-Direction.

From Table 24, it can be observed that the Symmetrical structure is behaving as a flexible structure, as the eccentricity increases in Asymmetrical-1 structure for a less acceleration compared to Symmetrical Structure it has a displacement of 245.00mm causing a brittle failure of the structure, with the further increase in eccentricity in Asymmetrical-2 it experiences a greater acceleration at very less period of time causing failure of the structure with a displacement of 65.00mm and with further increase in eccentricity in Asymmetrical-3 it experiences a greater acceleration and displacement compared to all the structure causing the structure to fail at the earliest in X-direction.

Also from Table 25, it can be observed that the Symmetrical structure can with stand more acceleration with a displacement of 88.40mm, as the eccentricity increases in Asymmetrical-1 structure for an acceleration compared to Symmetrical Structure it has a displacement of 95.70mm behaving as flexible structure, with the further increase in eccentricity in Asymmetrical-2 it experiences a greater acceleration at same period of time causing the failure of the structure, and with further increase in eccentricity in Asymmetrical-3 it experiences a greater acceleration and huge displacement compared to all the structure causing the structure to fail at the earliest.

From the above, it can be observed that the Symmetric structure is performing well in Y-direction, Asymmetrical-1 is performing well in Y-direction, Asymmetrical-2 is performing well in Y-direction and Aymmetrical-3 is failing at the earliest in both the directions.

4. CONCLUSIONS

4.1 Pushover Analysis:

The column orientation has a great effect on the lateral resisting capacity of the structures, Symmetrical structure shows greater capacity than all the Asymmetric structures, the structures are behaving ductile in lateral displacement up to an eccentricity of 14% of the base width, further increase in eccentricity makes the structure to behave as brittle, ductility of the building depends on the eccentricity of the structure, early collapse of the structure is observed in Asym-3 model having highest eccentricity which makes it more brittle, minimum storey drifts are seen in Sym, Asym-1 and Asym-2 structure with less amount of eccentricity and Asym-3 with highest eccentricity greater drifts can be seen and the target displacement is least for the Sym structure, Asym-1 and Asym-2 with less eccentricity and increases in Asym-3; also it is very less in the direction of orientation of the columns in Symmetrical structure.

4.2 Non-Linear Time History Analysis:

Maximum Storey Displacement is very less in the case of Sym structure and slightly higher for Asym-1, Asym-2 and greater displacement is observed in Asym-3 structure which makes the structure to collapse earlier. Maximum Lateral Displacement is less in case of Sym Structure, Asym-1 and Asym-2 structure particularly in the direction of less

percentage of eccentricity of the same structure and in Asym-3 huge displacements are seen. Maximum Spectral Displacement is observed in Asymmetrical-3 structure with highest eccentricity.

Maximum Spectral Acceleration with corresponding displacement is observed in the structure with greater eccentricity and less in Symmetrical structure particularly in the direction of orientation of the columns.

4.3 Overall Outcome of the Study:

Seismic Performance of the structure depends on mainly on the eccentricity between centre of mass and centre of rigidity of that structure. Structures are performing well in the direction of orientation of the columns. Greater displacement is seen the structure with highest eccentricity. Structure with highest eccentricity collapse earlier than the symmetrical and with minimum eccentricity. The percentage of eccentricity of the structure should be limited to 14%. Symmetrical, Asymmetrical-1 and Asymmetrical-2 structures are performing well in the direction with less eccentricity compared to that of the same structure in the other direction and in the direction of orientation of the columns in Symmetrical structure considered. Non-Linear Time History Analysis gives better and actual behavior of the structure subjected to Seismic load compared to that of Non-Linear Static Analysis (Pushover Analysis).

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