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Comparative Study between Symmetric and Asymmetric Structures in Seismic Zone

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Abstract: In present scenario, most of the buildings are obtain constructed with irregularities such as soft storey ,torsional irregularity, vertical and plan irregularity, etc. Past earthquake studies shows that the most of the RC buildings having such irregularities were severely damaged under the seismic ground motion. This paper presents an overview of performance of the torsionally balanced and unbalanced buildings also called as symmetric and asymmetric buildings subjected to seismic analysis. ETABs software is used to analyse the structural behaviour of RCC building. It gives the comparative information between the symmetric structures and asymmetric structures. Comparative study between symmetric and asymmetric structure in high seismic zone is analysed. In this paper Etabs software is used to study the different structural parameters such as lateral displacement, time period. Structural analysis of different building elements like columns, beams, slab is done and there behavior in different seismic zones is determined. We can use such software to prepare the model for structural systems under the various loads.
Keyword: ETABs software, structural analysis of symmetric structure and asymmetric structures.

I. INTRODUCTION

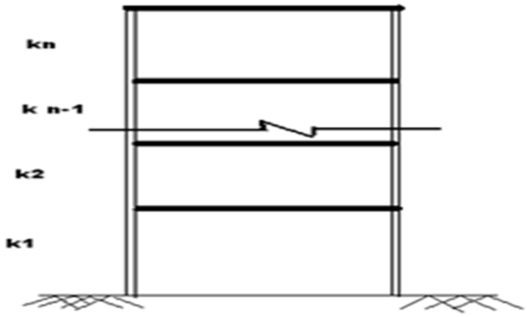
Torsion has been the cause of major damage to buildings subjected to strong earthquakes, ranging from visible distortion of the structure to structural collapse. Torsion occurs under the action of earthquake forces when the centre of mass of a building does not coincide with it centre of rigidity. column, weak beam, shear wall, base isolation. The behaviors of each of these factors are unique. The performance of a structure for these factors can be studied analytically and experimentally. Behavior of a simple structure for these factors will gives good vision about the importance of these factors. This paper will give a brief idea about Strong column, Weak beam, Shear wall and Brick infill placed in a simple structure. The building rotates about its centre of rigidity. This causes large increase in the lateral forces and displacement demands in lateral load resisting element in proportion to their distance from the centre of rotation.

A. Asymmetric Structure

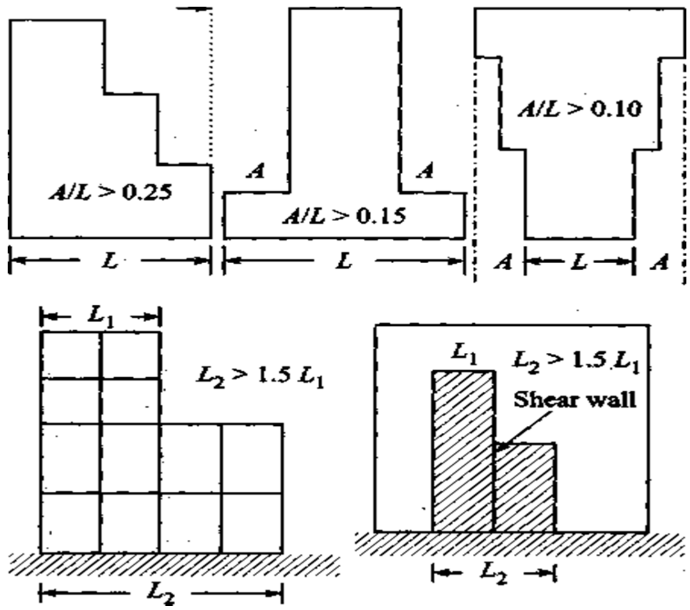
Types of Irregularities: these irregularities are categorised in two types: 1. Vertical Irregularity 2. Horizontal Irregularity

1) *vertical irregularity :* It refers to sudden change of strength, stiffness, geometry and mass results in irregular distribution of forces and deformation over height of building
2) *Horizontal/Plan Irregularity:* Horizontal Irregularities which refers to asymmetrical plan shapes (e.g.-L,T,U,F.) or discontinuities in the horizontal resisting elements (diaphragms) such as cut-outs, large openings, reentrant corners and other abrupt changes resulting torsion, diaphragm deformation and stress concentration.

B. Vertical Irregularity



Stiffness Irregularities-Soft Storey



Vertical geometric irregular

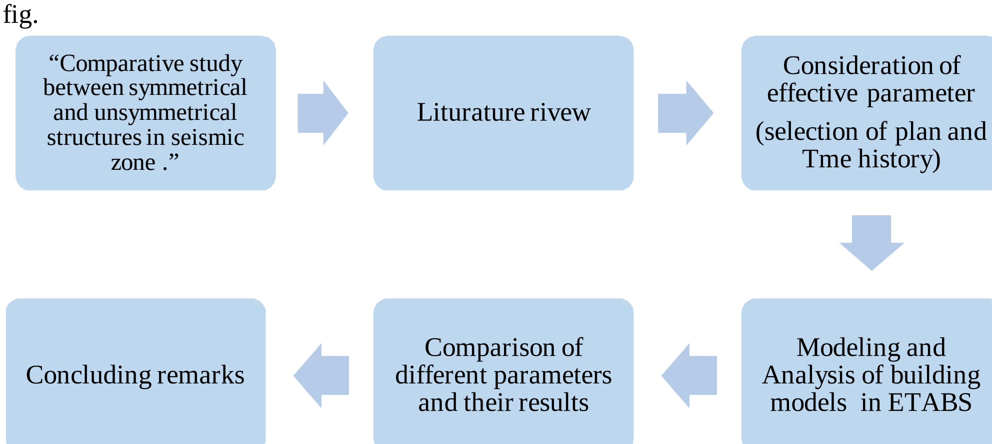
II. METHODOLOGY

A. *Time History Method*

Building response is calculated by time history method in dynamic analysis. Previous earthquake time history data is used in this method. If three or more time history method performed, only maximum responses of parameter of interested are selected.

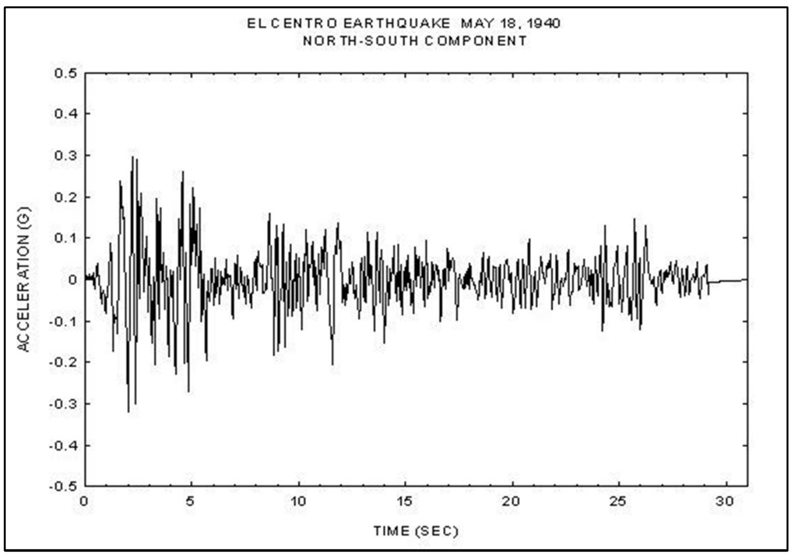
B. *Applied Approach*

The succeeding approach is adopted for this thesis to accomplish the objective. Adopted approach has been represented in the form of flowchart as shown in fig.



C. *Time History Function*

1) *El Centro earthquake :* El Centro earthquake occurred at 21:35 Pacific time on 18th May 1940 in the Imperial Valley in Southern California near the international border of the United States and Mexico. It had a moment magnitude of 6.9. It was the first major earthquake recorded by a strong-motion seismograph located next to a fault rupture. The earthquake was characterized as a typical moderate-sized destructive event with a complex energy release signature. It was the strongest recorded earthquake to hit the Imperial Valley, and caused widespread damage to irrigation systems and led to the deaths of nine people.



D. Modelling of Building

Modeling and analysis of building is done by using ETABS software.In modeling of G+9 building involves defining material properties of building first, defining of section properties and assigning it to the model at structural elements like column, beam, etc. Loading and load combinations are considered as per IS 1893:2002 (part I).After the pre-processing of model done, structure is ready for the analysis. For analysis there is option of Run analysis. As per requirement specific analysis case selected and analysis performed. Analysis of model is carried out by using zones III as per IS 1893:2002, In such case zone factors are taken as 0.16.After analysis performed as per required analysis case without any warning and errors software display deformed shapes, various results such as story displacement, base shear, story drift etc. After following above procedure analysis of 10 story building with different arrangement is carried out.

E. Plan And Dimension Details

The Following are the specification of buildings located in seismic zone III. For the modelling purpose vertically unsymmetric building is selected. The plan of building is symmetrical in shape and its dimensions are 15x15 m in size.

We are taken Commercial Building G + 9 of seismic zones III for the analysis & design of symmetric and asymmetric structures by using ETABs Software. Floor height taken as 3.2 m. Properties are defined as per IS. 1893:2002.

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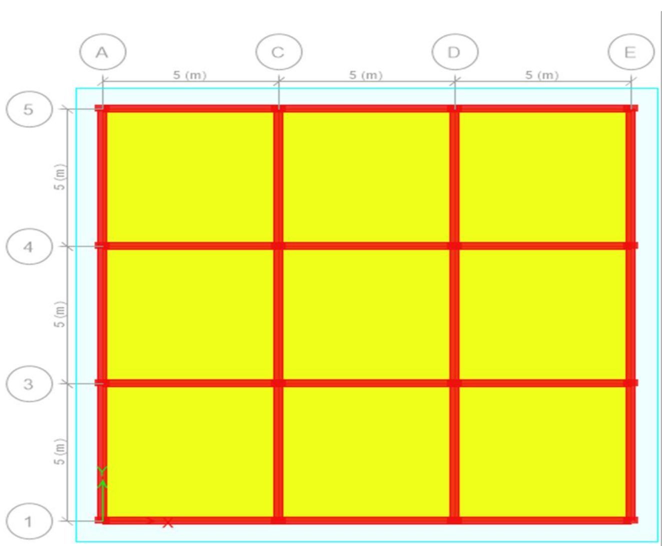
F. High rise building (g+9)

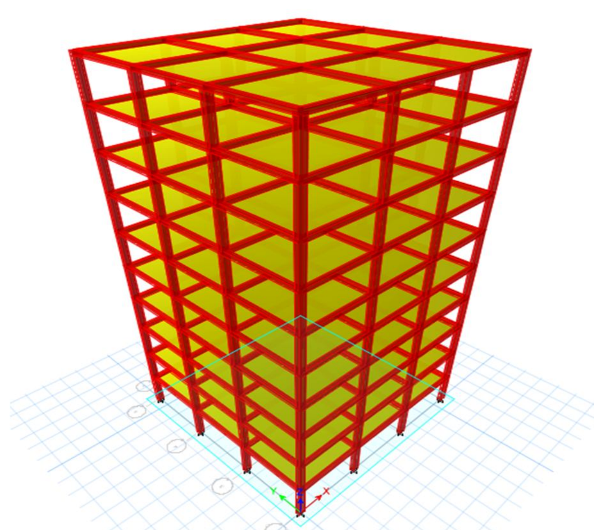
1) Model Geometry

G+09SYMMETRIC	G+09 ASYMMETRIC
Number of Stories = G +09 Storey Height = 3.2 meters Number of Bays along X-direction = 3 Number of bays along Y-direction = 3 Bay Width along X-direction = 5 meters Bay Width along Y-direction = 5 meters Size of 'Column'– 450X250 mm Size of Beam – 300X250mm Depth of Slab – 140 mm	Number of Stories = G+09 Storey Height = 3.2 meters Number of Bays along X-direction = 3 Number of bays along Y-direction = 3 Bay Width along X-direction = 5 meters Bay Width along Y-direction = 5 meters Size of 'Column0'– 450X250 mm Size of Beam – 300X250mm Depth of Slab – 150 mm

TYPE OF STRUCTURE	TYPE OF STRUCTURE
Frame Type – Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1 Response Spectrum – As per IS1893 (Part-I) 2002	Frame Type –Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1 Response Spectrum – As per IS1893(Part-I)2002
LOADING	LOADING
Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2	Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2



PLAN



3D VIEW

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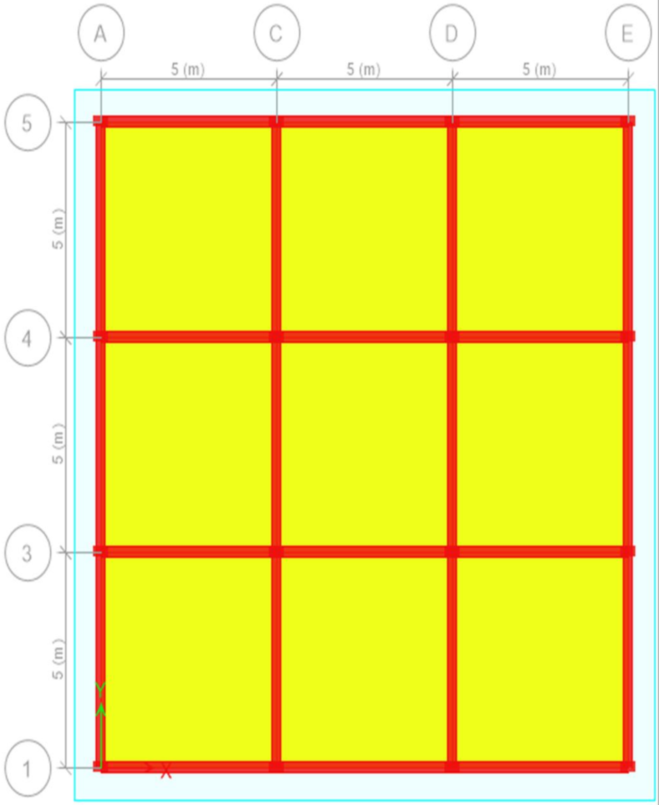
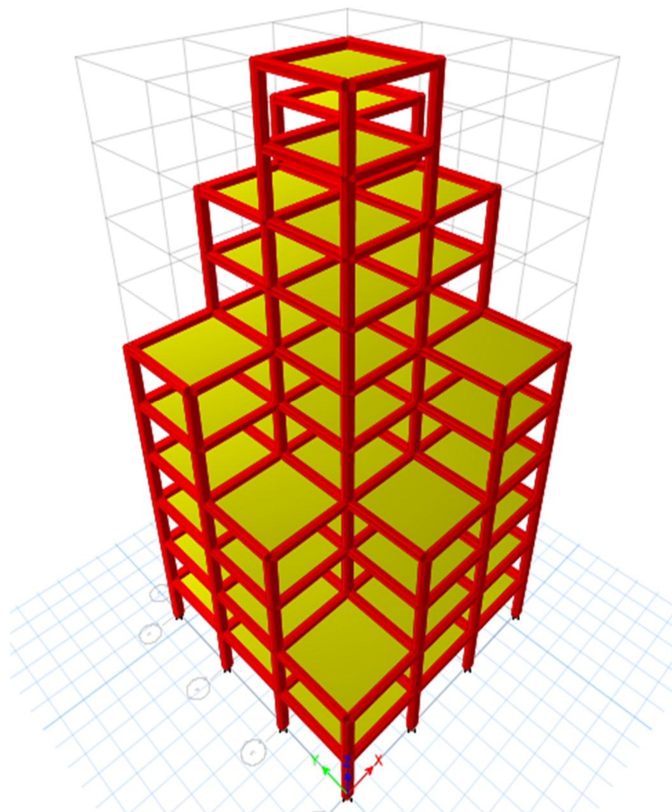
Vertically Symmetric Building



Plan



3d View

Vertically Asymmetric Building

TIME PERIOD G+09 ASYMMETRIC	TIME PERIOD G+09 SYMMETRIC
1.71978 Seconds	1.25385 Seconds

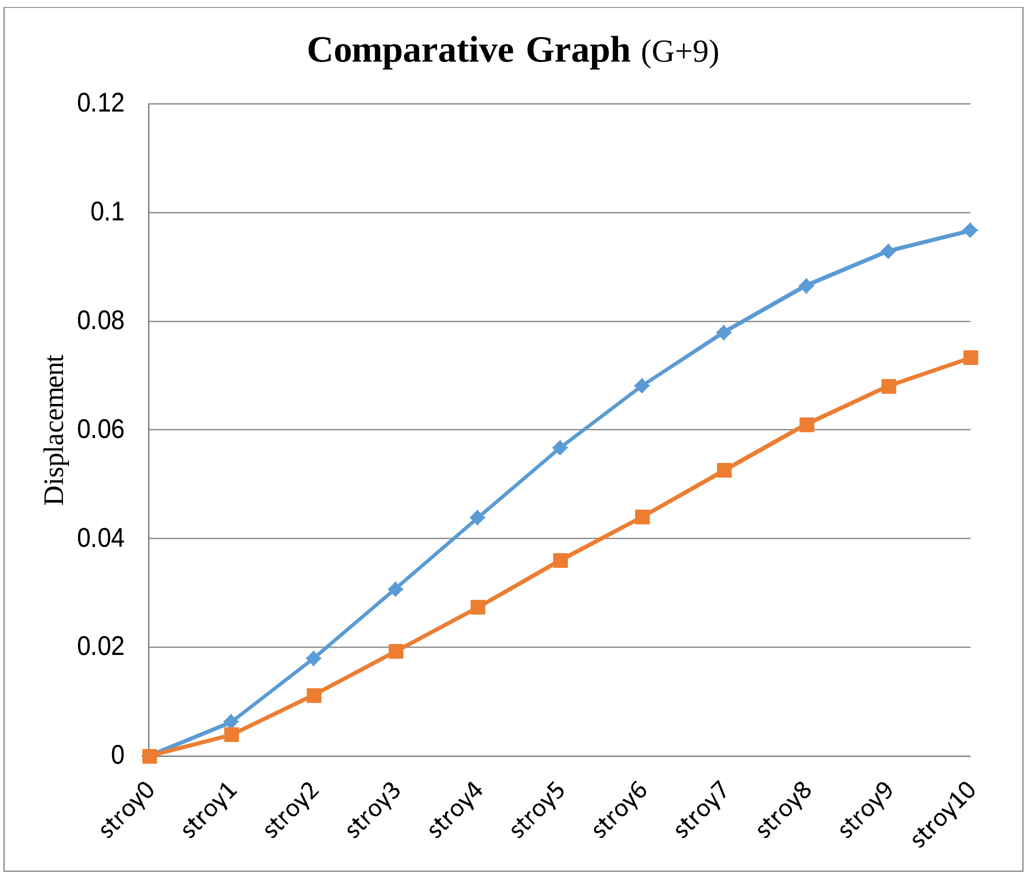
(Table Of Time Period for G+ 09 models)

LATERAL DISPLACEMENT (in mm)		
STORY	G+9 ASYMMETRIC	G+9 SYMMETRIC
STORY 10	98.123	75.262
STORY 09	96.248	71.025
STORY 08	90.456	61.754
STORY 07	80.565	53.465
STORY 06	71.235	44.165
STORY 05	59.465	38.937
STORY 04	45.861	30.632
STORY 03	32.451	21.231
STORY 02	19.958	13.888
STORY 01	8.271	5.953
STORY 00	0	0

(Lateral displacement for G+09 model)

STORY DRIFT (in mm)		
STORY	G+09 ASYMMETRIC	G+09 SYMMETRIC
STORY 09	1.305	1.748
STORY 08	2.139	2.367
STORY 07	2.898	2.794
STORY 06	3.298	2.864
STORY 05	3.825	2.679
STORY 04	4.298	2.868
STORY 03	4.415	2.700
STORY 02	4.283	2.681
STORY 01	3.915	2.415
STORY 00	2.188	1.314

(Table for Story Drift for G+09 Model**)**



(Comparative Graph of Displacement for G+09 Model)

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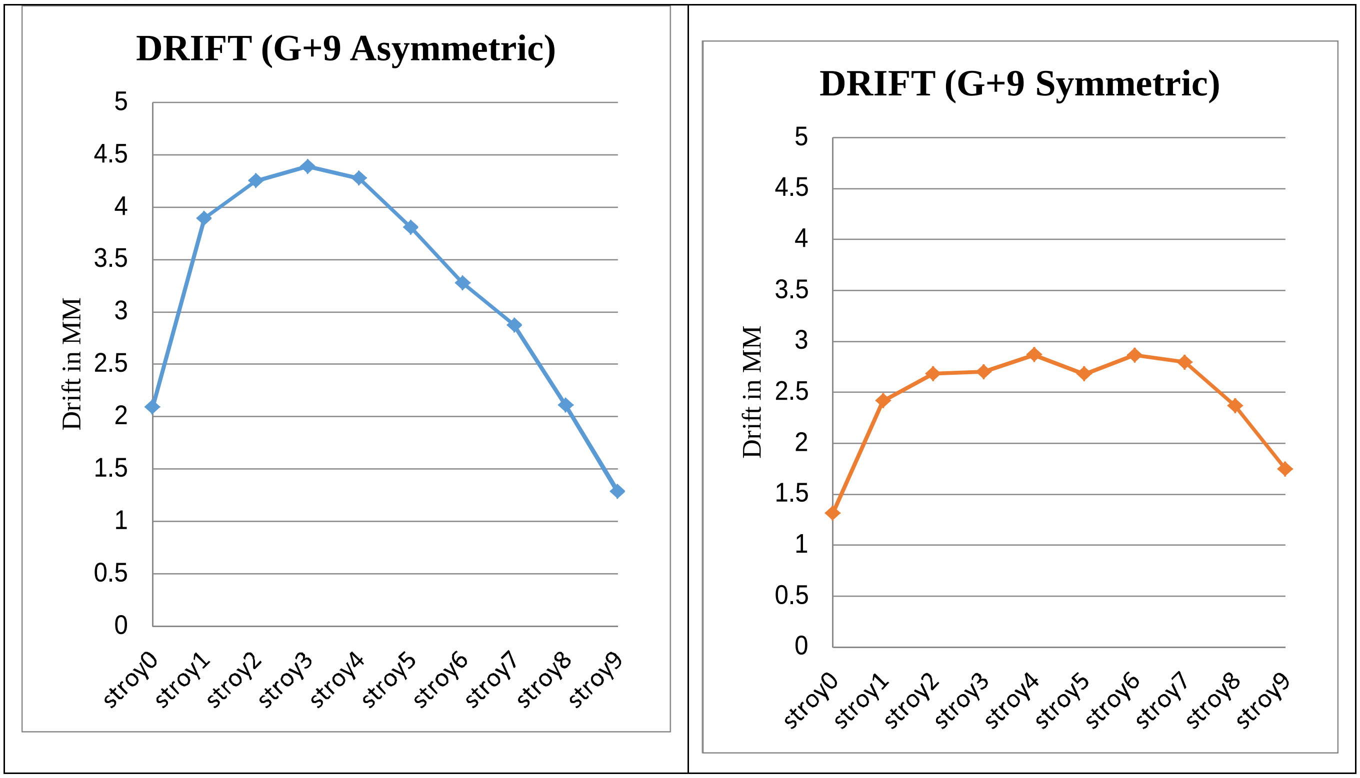
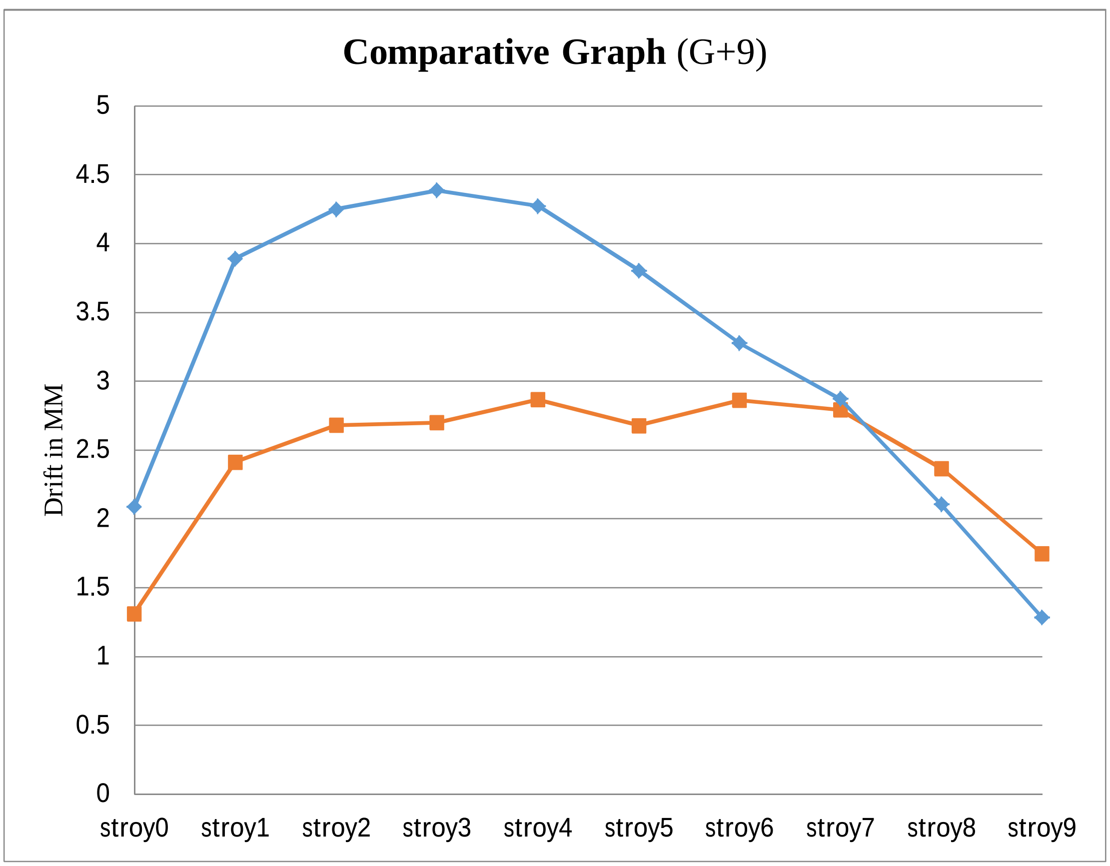


(Graph for Story Drift for G+09 Model)



(Comparative Graph for Story Drift for G+09 Model)

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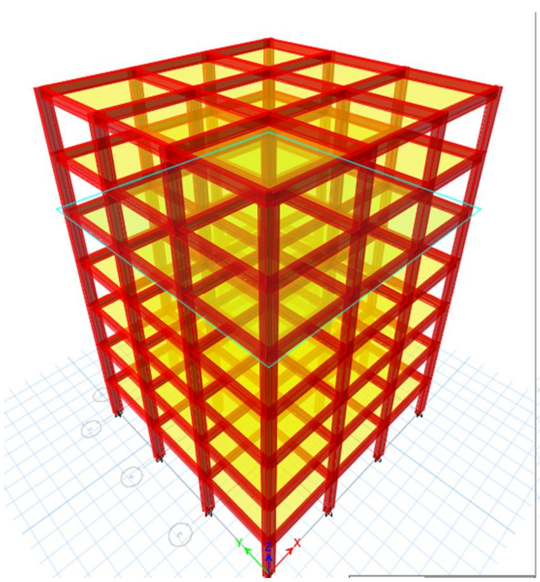
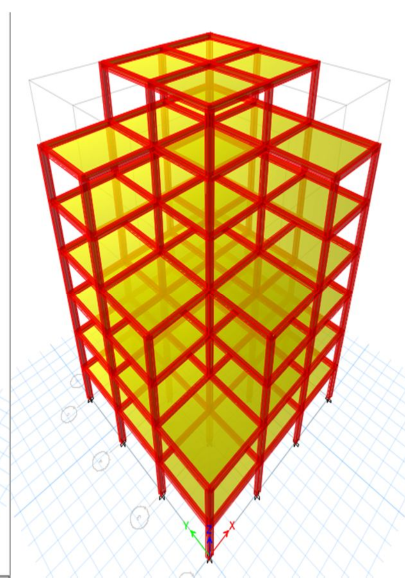
G. Model Geometry (G+6)

G+06 SYMMETRIC	G+06 ASYMMETRIC
Number of Stories = G +06 Storey Height = 3.2 meters Number of Bays along X-direction = 3 Number of bays along Y-direction = 3 Bay Width along X-direction = 5 meters Bay Width along Y-direction = 5 meters Size of 'Column' – 450X250 mm Size of Beam – 300X250mm Depth of Slab – 140 mm	Number of Stories = G+06 Storey Height = 3.2 meters Number of Bays along X-direction = 3 Number of bays along Y-direction = 3 Bay Width along X-direction = 5 meters Bay Width along Y-direction = 5 meters Size of 'Column' – 450X250 mm Size of Beam – 300X250mm Depth of Slab – 140 mm
TYPE OF STRUCTURE	TYPE OF STRUCTURE
Frame Type – Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1	Frame Type – Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1

LOADING	LOADING
Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2	Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2


Vertical Symmetric Building


Vertical Asymmetric Building

TIME PERIOD G+06 ASYMMETRIC	TIME PERIOD G+6 SYMMETRIC
1.24207 Seconds	1.08485 Seconds

LATERAL DISPLACEMENT (in mm)		
STORY	G+6 ASYMMETRIC	G+6 SYMMETRIC
STORY 07	70.257	55.935
STORY 06	66.562	52.456
STORY 05	59.256	45.616
STORY 04	48.787	35.896
STORY 03	36.956	27.173
STORY 02	23.268	16.853
STORY 01	9.572	7.629
STORY 00	0	0

STORY DRIFT (in mm)		
STORY	G+6 SYMMETRIC	G+6 SYMMETRIC
STORY 06	1.508	1.493
STORY 05	2.550	2.278
STORY 04	3.514	2.907
STORY 03	4.298	3.238
STORY 02	4.582	3.440
STORY 01	4.251	3.080
STORY 00	2.559	1.874

(Table of Story Drift for G+06)

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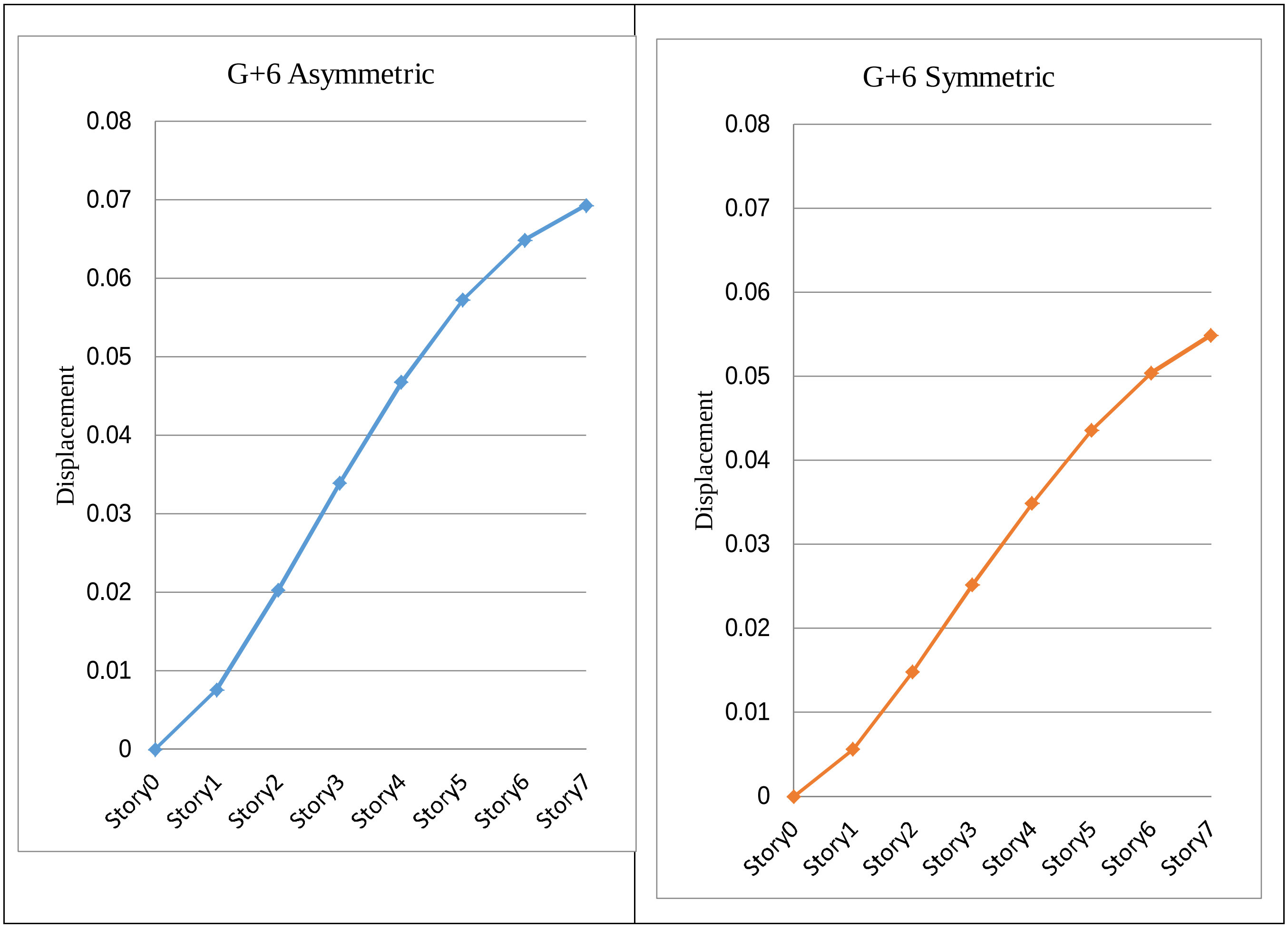
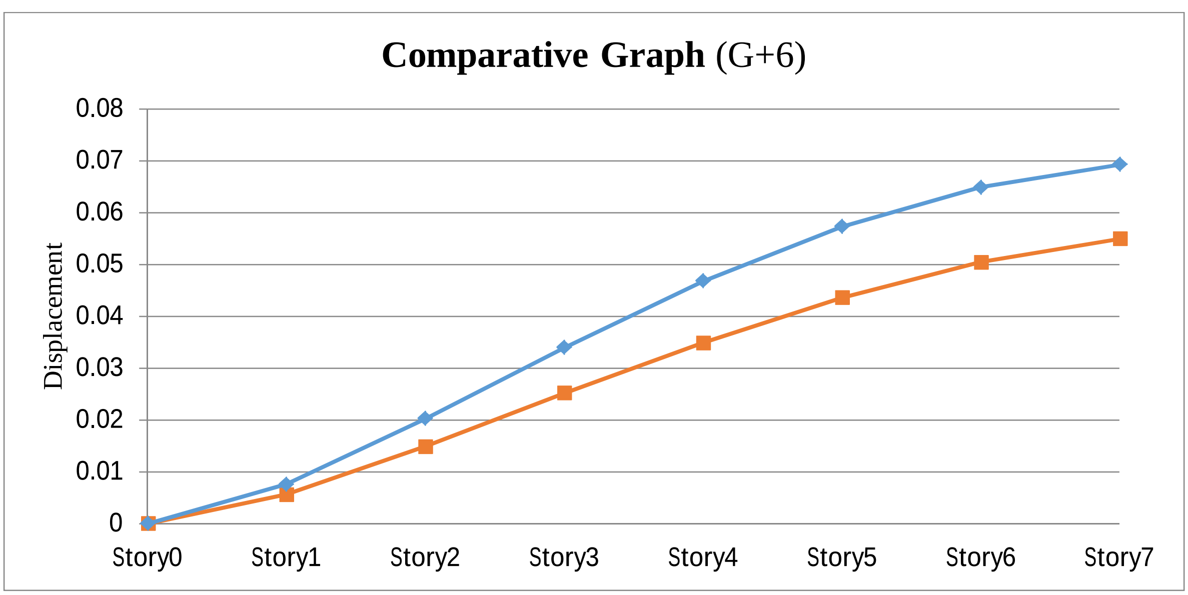


(Graph for Displacement G+6 Models)



(Comparative Graph Displacement for G+6 Model)

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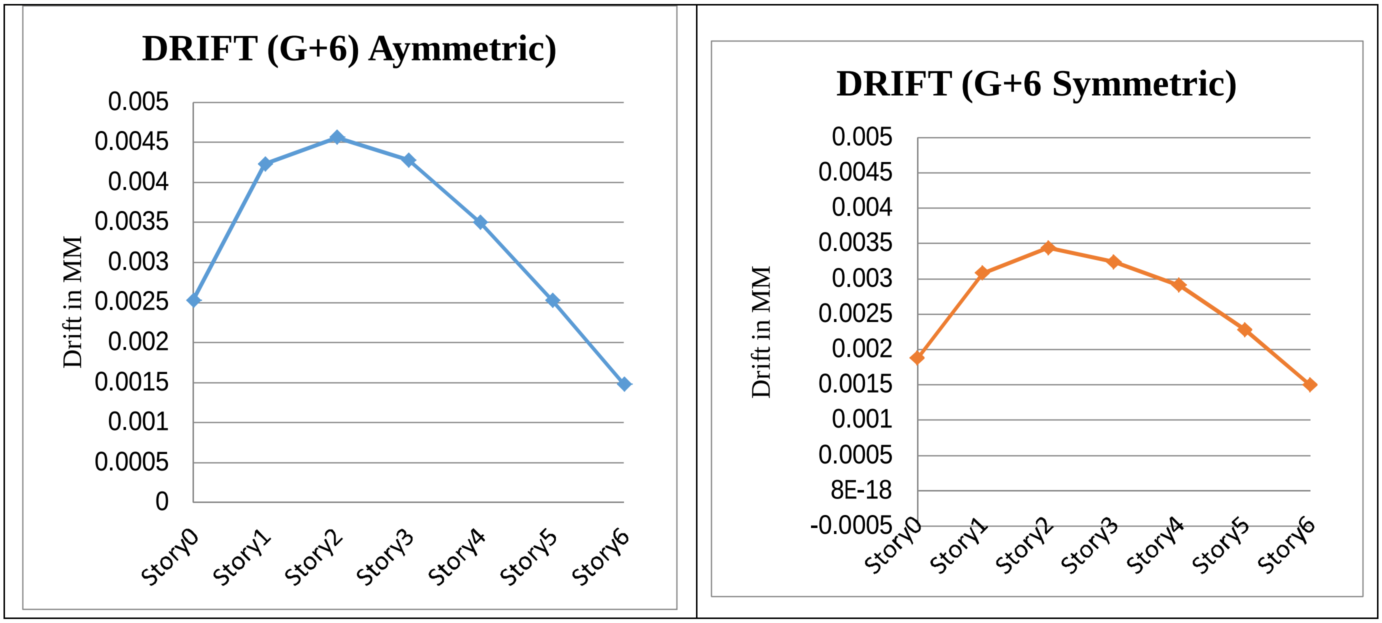
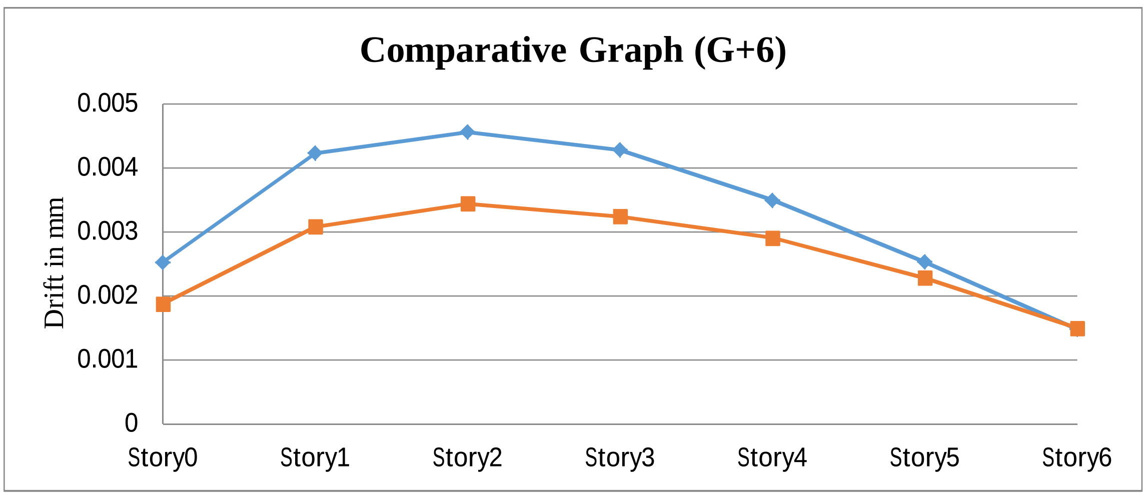


(Graph 5.7 story drift for G+06 Model)



(Comparative Graph for story drift for G+06 Model)

G+03 SYMMETRIC	G+03 ASYMMETRIC
Number of Stories = G +03	Number of Stories = G+03
Storey Height = 3.2 meters	Storey Height = 3.2 meters
Number of Bays along X-direction = 3	Number of Bays along X-direction = 3
Number of bays along Y-direction = 3	Number of bays along Y-direction = 3
Bay Width along X-direction = 5 meters	Bay Width along X-direction = 5 meters
Bay Width along Y-direction = 5 meters	Bay Width along Y-direction = 5 meters
Size of 'Column'– 450X250 mm	Size of 'Column0'– 450X250 mm
Size of Beam – 300X250mm	Size of Beam – 300X250mm
Depth of Slab – 140 mm	Depth of Slab – 150 mm

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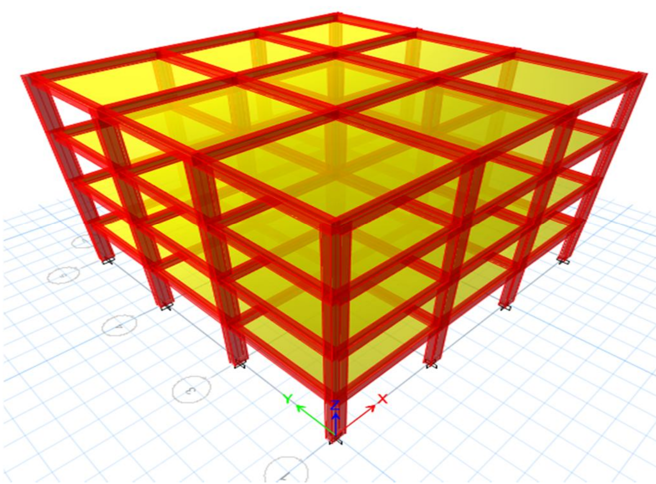
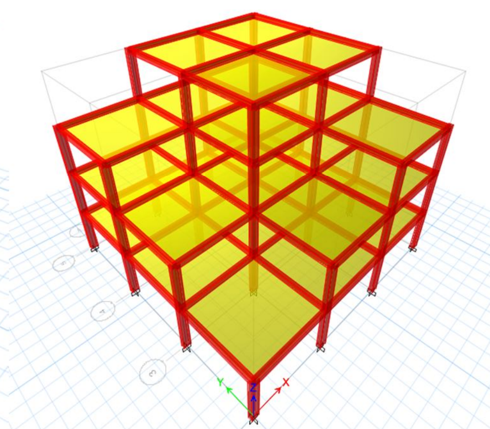
TYPE OF STRUCTURE	TYPE OF STRUCTURE
Frame Type – Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1 Response Spectrum – As per IS1893 (Part-I) 2002	Frame Type –Special Moment Resisting Frame Seismic Zone (Z) – III Type of Soil – Moderate (Type-II) Response Reduction Factor (R) – 3.0 (SMRF) Importance Factor (I) – 1 Response Spectrum – As per IS1893(Part-I)2002
LOADING	LOADING
Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2	Dead Load - 1.5 KN/m^2 Live Load – 3.5 KN/m^2 Floor Finish Load – 0.5 KN/m^2





TIME PERIOD G+03 ASYMMETRIC	TIME PERIOD G+03 SYMMETRIC
1.34175 Seconds	1.58705 Seconds

Vertical Symmetric Building Vertical Asymmetric Building

(Table for time period for G+03 model)

LATERAL DISPLACEMENT (in mm)		
STORY	G+3 ASYMMETRIC	G+3 SYMMETRIC
STORY 04	40.195	25.912
STORY 03	35.468	21.612
STORY 02	26.639	14.338
STORY 01	12.355	7.335
STORY 00	0	0

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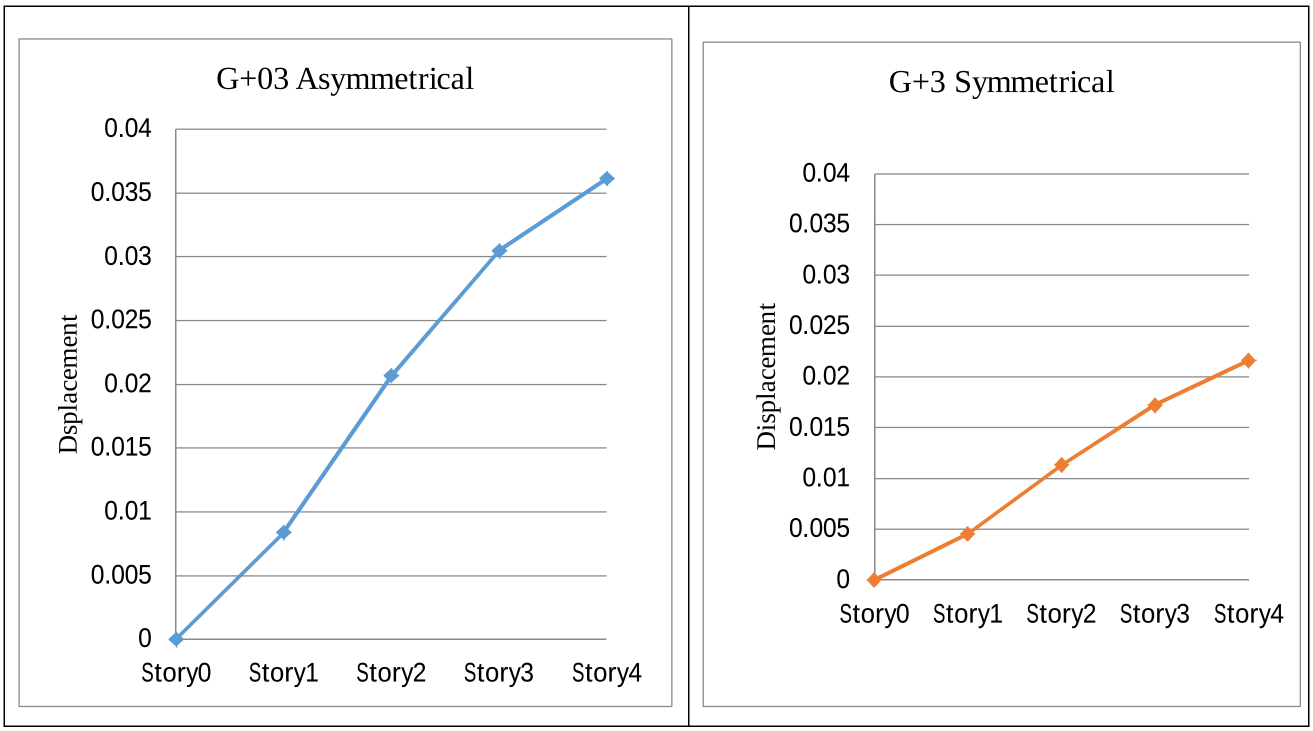
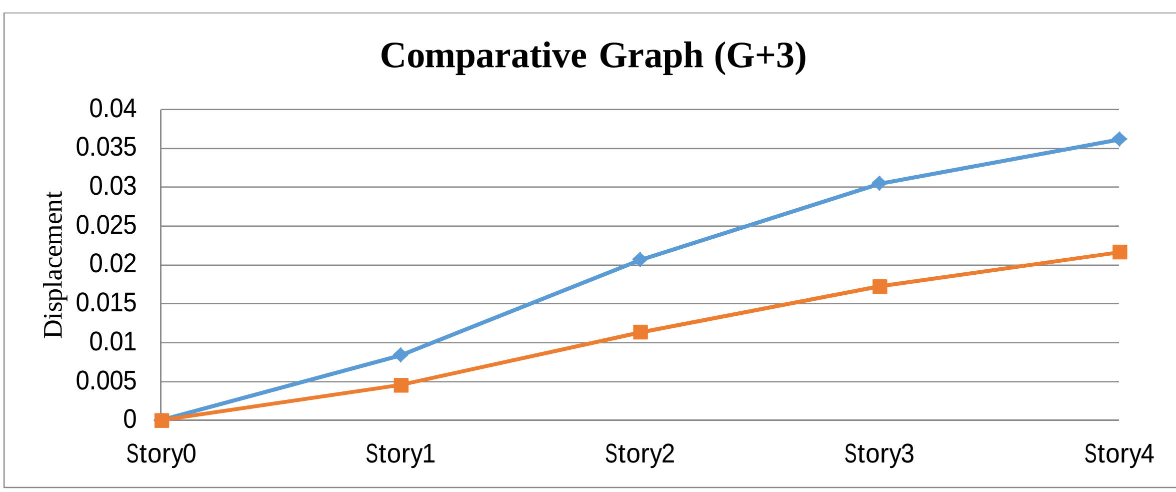
(Table for Lateral displacement for G+03 model)

STORY DRIFT (in mm)		
STORY	G+03 ASYMMETRIC	G+03 SYMMETRIC
STORY 03	1.905	1.467
STORY 02	3.295	1.958
STORY 01	4.105	2.267
STORY 00	2.825	1.512

(Table for Story Drift for G+03 Model)



(Graph of Displacement for G+03 Model)



(Comparative Graph of Displacement for G+03 Model)

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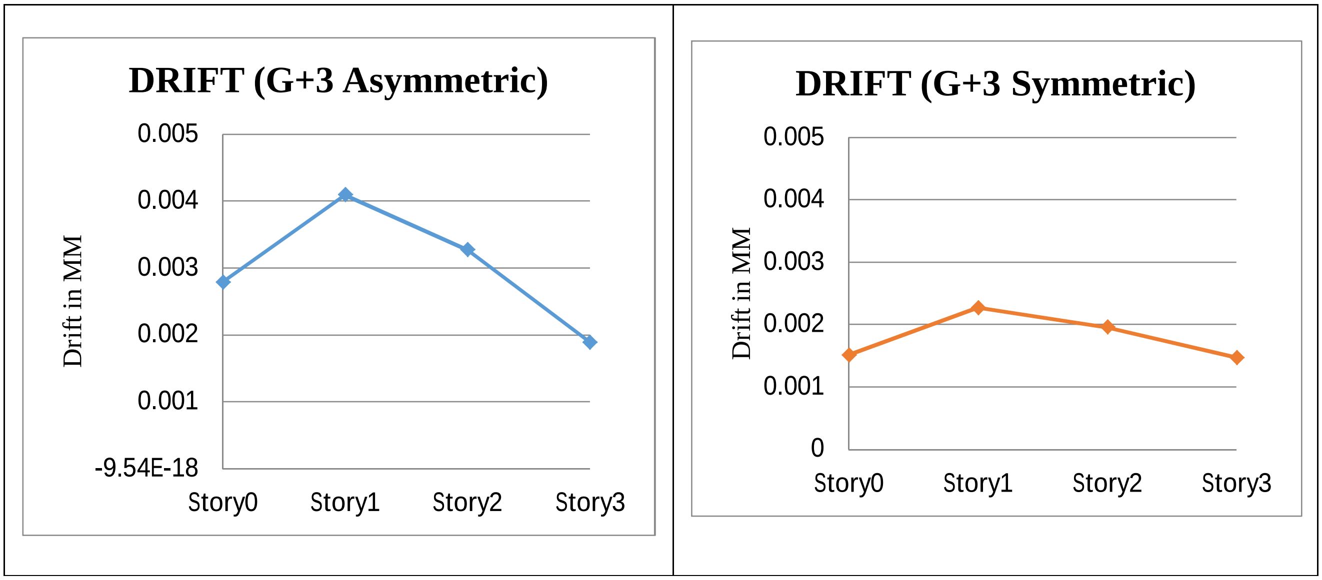
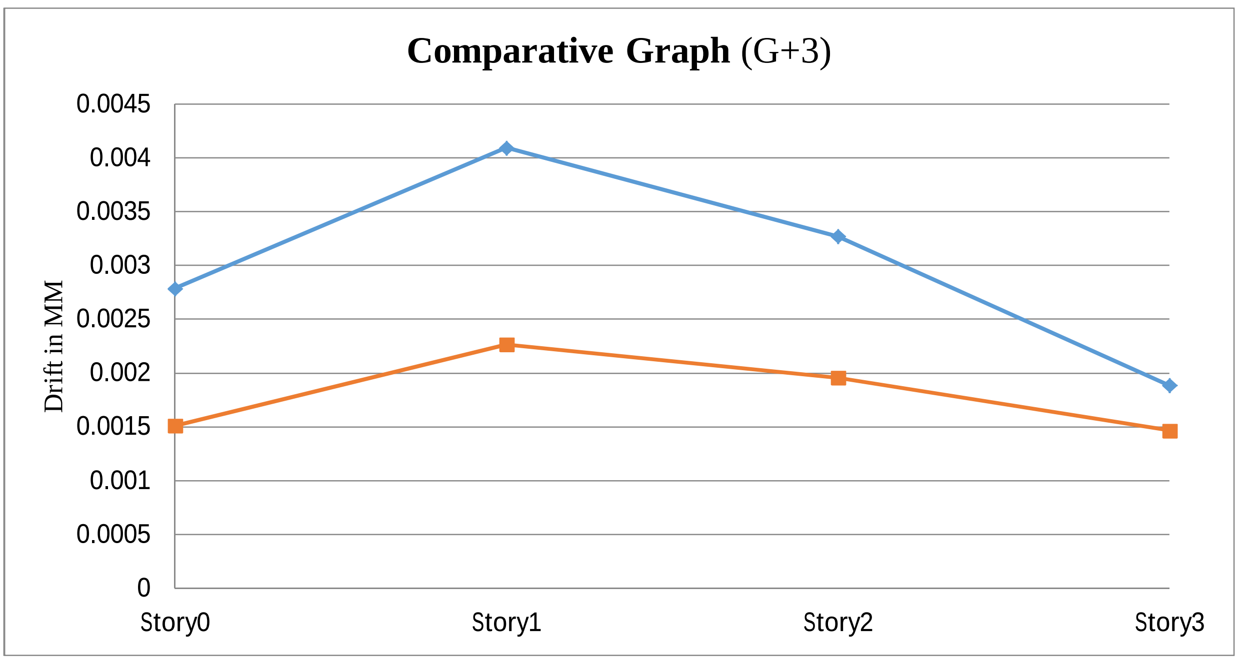


(Graph of Story Drift for G+03 Model)



(Graph for story drift of G+03)

III. CONCLUSIONS

A. There are the Following Conclusions Made from The Current Study,

1) Performance of Symmetrical building is better than Asymmetrical building.
2) Maximum displacement for irregular shapes and minimum for regular shapes.
3) The column behaviour changes differently for Symmetrical and asymmetrical structure, as height of building increases.
4) In comparison of torsional moment in beam the result shows that for asymmetrical building the torsional moment is more than symmetrical therefore it is necessary to design the beam and column for torsional moment.
5) Structural parameters such as lateral displacement, time period for Asymmetrical structure is higher as compared to Symmetrical structure.
6) Total reinforcement cost of Asymmetrical is more as compare to symmetrical structure.
7) shapes building are severely affected undergo more deformation during earthquake especially in high seismic zones.

IV. ACKNOWLEDGMENT

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We have to express out -appreciation to the Prof. A. A. Mahajan for shearing their pearls of wisdom with us during the course of research.

REFERENCES

[1] IS:1893–2002,(Part 1),Criteria for Earthquake Resistant Design of Structures, part 1-General provisions and buildings, fifth revision, Bureau of Indian Standard, New Delhi, India.

[2] IS: 456(2000), Plain Reinforced Concrete-code of practice, Bureau of Indian standards, India.

[3] Agarwal, P. and Shrikhande, M, earthquake resistant design of structures Prentice-Hall of India Private Limited New Delhi India, 2008.

[4] Dr. B. G. Naresh Kumar[1], AvinashGornale[2] and Abdullah Mubashir[3], Presented "Seismic Performance Evaluation of R.C.- Framed Buildings International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181 IJERTV4IS061059 www.ijert.org (This work is licensed under a Creative Commons Attribution 4.0 International License.) Vol. 4 Issue 06, June-2015

[5] Ajay Kumar sinha[1],Pratima rani bose[2] "Seismic vulnerability assessment of asymmetric Structures" 13th World YConference on Earthquake Engineering Vancouver, B.C. ,Canada ,August 1-6, 2004 [Paper No. 1478]

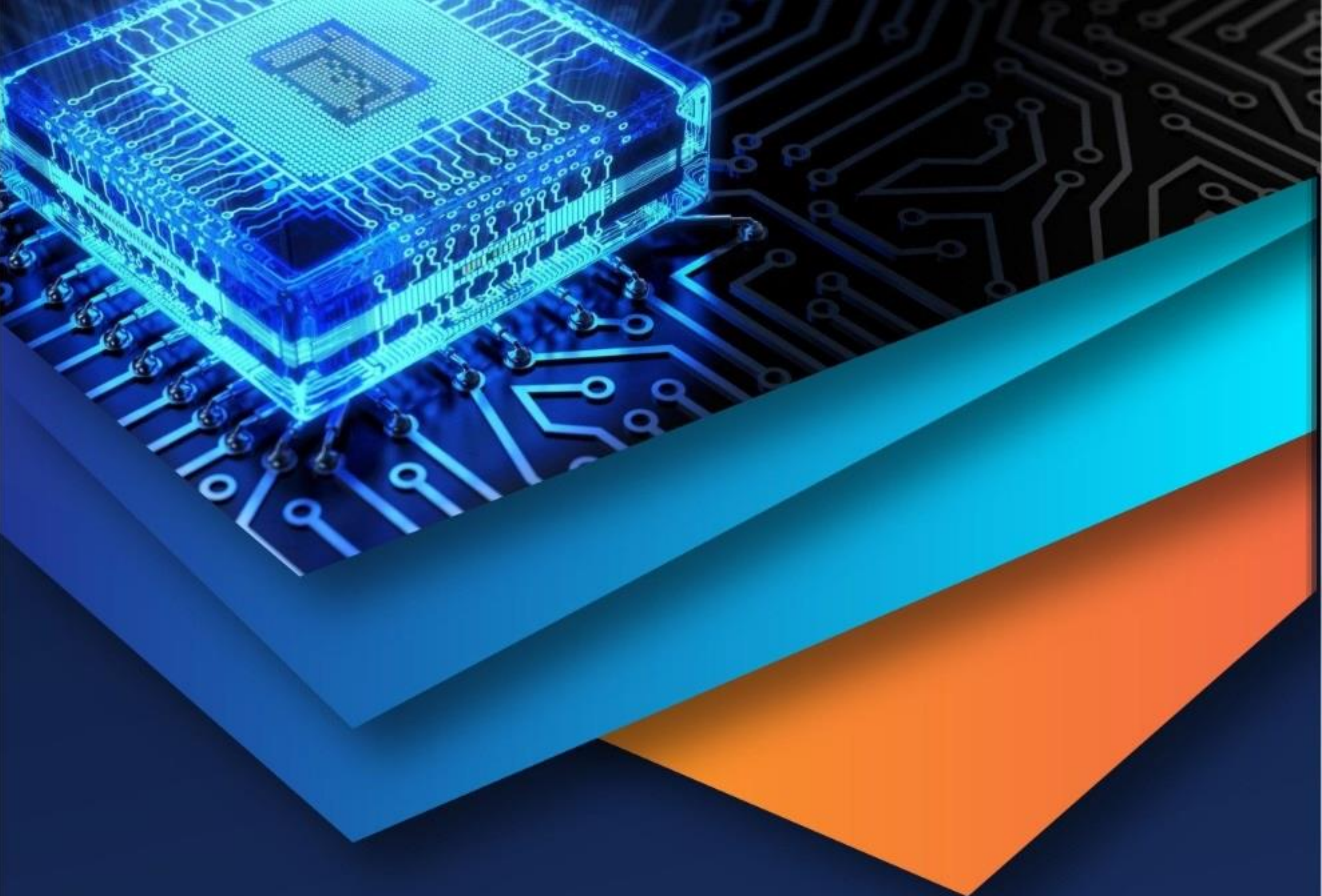
[6] Khante.S.N[1], LavkeshR.Wankhade[2] Presented "Study of seismic response of symmetric and asymmetric base isolated building with mass asymmetry in plan" ISSN 0976 – 4399 , Amravati, India [khante.suraj@gcoea.ac.in]

[7] Dr. S. K. Dubey[1],Prakash Sangamnerkar[2],Deepak Soni[3] Presented "Dynamic behavior of Reinforced Concrete Framed Buildings under Non Linear Analysis" 2014 IJEDR | Volume 2, Issue 4 | ISSN: 2321-9939

[8] Dj. Z. Ladjinovic[1] and R. J. Folic[2] presented-"Seismic analysis of asymmetric in plan buildings" The 1[4th] World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China Email: djordje.ladjinovic@gmail.com, folic@uns.ns.ac.yu

[9] Sachin G. Maske[1] , Dr. P. S. Pajgade[2] presented-" Torsional behavior of asymmetrical buildings" Vol.3, Issue[.2], March-April. 2013 pp-1146-1149 ISSN: 2249-6645

[10] Sarkar, P., Prasad, A. M., and Menon, D., Vertical geometric irregularity in stepped building frames, Engineering Structures 32, pp 2175–2182. (2010).



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