International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 7, Issue 8, August 2018 ISSN 2319 - 4847

SEISMIC ANALYSIS AND COMPARISON OF VERTICAL IRREGULAR BUILDING CASES USING RESPONSE SPECTRUM METHOD

[1]Vinay Verma, [2]Prof. J.N.Vyas

Research Scholar, Civil Engineering, MITMUjjain
Professor, Civil Engineering, MITMUjjain

Abstract

Present paper analyses vertical irregular buildings seismic structural analysis and calculate response of building to earthquakes. The deflection and induced stresses causing failure of buildings can be calculated analytically or with the help of designing software. This analysis plays important role in designing building for seismic effective zones and areas all-around the world. Response Spectrum Analysis method is used which is based on ideal predefined data which are not real time data's collected from real earthquake in the area.

Keywords: Seismic analysis, vertical irregularity, ETABS, RSM, Building design, Moment, Torsion, Displacement, Drift.

Introduction

Researchers continuously studied response of earthquakes, still earthquakes are unpredicted. Time and place of earthquake is still unpredicted. Researchers tried to predict the frequency and intensity of earthquake. Earthquakes of KilIari 1993, Bhuj 2001, Kashmir 2005 and Haiti 2010 are the examples of unpredicted earthquakes. It results in loss of life, infrastructure, economy and society.

In the past, a number of major earthquakes have uncovered the deficiency in buildings. This weakness causes deterioration of the building which leads to the collapse. This weakness mostly occurs due to the presence of irregularities in a building system. It has been observed that regular buildings perform better than irregular buildings under seismic loading. The irregularities in the buildings are present due to irregular distribution of mass, strength and stiffness along the height and plan of building.

Poncetand Tremblay (2004) proposed the impact and effect of mass irregularity considering case of an eight-storey concentrically braced steel frame structure with different setback configurations. Methods used in present paper are equivalent static load method and the response spectrum analysis method. **Soni (2006)** The research paper considered several vertical irregular buildings for analysis. The studies suggested that for combined-stiffness-and-strength irregularity large seismic demands are found.

Patil and Kumbhar (2013) Ten story building is considered and tested against nonlinear dynamic response under seismic effect with SAP 2000 for different time histories and it is suggested that the high-rise RCC buildings must be tested using time history method confirm safety against seismic effects. **Aijaj and Rahman (2013)** researchers in this paper tried to analyze the proportional distribution of lateral forces involved in earthquake for individual storey due to changes in stiffness of vertically irregular structure. Drift, deflection and shear under seismic force through linear static & dynamic analysis is analyzed.

Varadharajan et al. (2013) Paper review existing works regarding plan irregularities and justified the preference of multistorey building models over single storey building models. It was found that strength irregularity had the maximum impact and mass irregularity had the minimum impact on seismic response. **Ramesh Konakalla et al.(2014)** Research focused to study "Linear Behavior of the Buildings with Plan Irregularities under Earthquake and Wind Loads". Linear Static Analysis method is used

Bansal (2014) Vertical irregular building is analysed with Response spectrum analysis and Time history Analysis. Irregularities considered are mass irregularity, stiffness irregularity and vertical geometry irregularity. **Harshitha (2014)** Dynamic behavior of high-rise building is studied using IS1893-2002 code recommended response spectrum method and time history method. STAAD Pro software is used and it is found that the base shear obtained from Time history analysis is higher than Response Spectrum analysis.

Bansal and Gagandeep (2014) Ductility based design is carried considering vertical irregular building and methods used are RSA and THA. The mass irregular structures were observed to experience larger base shear than similar regular structures. The stiffness irregular structure experienced lesser base shear and has larger inter-storey drifts. **Konakalla (2014)** Four different 20 story building are analysed for effect of vertical irregularity under Dynamic Loads Using Linear Static Analysis. Response of all cases is compared and concluded that in regular structure there is no tensional effect in the frame because of symmetry.

Reddy and Fernandes (2015) Analytical study is conducted for regular and irregular buildings to analyze response of buildings in seismic zone V. Paper concluded behavior of irregular structures as compared to regular structure. **Mukundan (2015)** A building in Zone IV is tested to reduce the effect of earthquake using reinforced concrete shear walls in the building. It is concluded that shear walls are more resistant to lateral loads in regular/Irregular structure and for safer design, the thickness of the shear wall should range between 150mm to 400mm.

Sagar et al. (2015) analysed the performance on various type of irregularity with Time history Analysis & Response spectrum analysis method were carried out. **Khan &Dhamge (2016)** highlighted the effect of mass irregularity on different floor in RCC buildings with Response Spectrum analysis. Models are compared with each other for response in terms of drift and deflection.

Salunkhe and Kanase (2017 In this paper researcher deal with RCC framed structure in both regular and mass irregular manner with different analysis methods. **Sayyed (2017)** focused his study on the effect of infill and mass irregularity on different floor in RC buildings.

PROBLEM

Model Specifications and boundary conditions

In this research G+60 multi.storeybuilding of plan dimensions 30m x 30m, beam size =650mmx650mm,is modelled with different vertical irregularities.

The setback irregularities considered in the modeling are as follows:

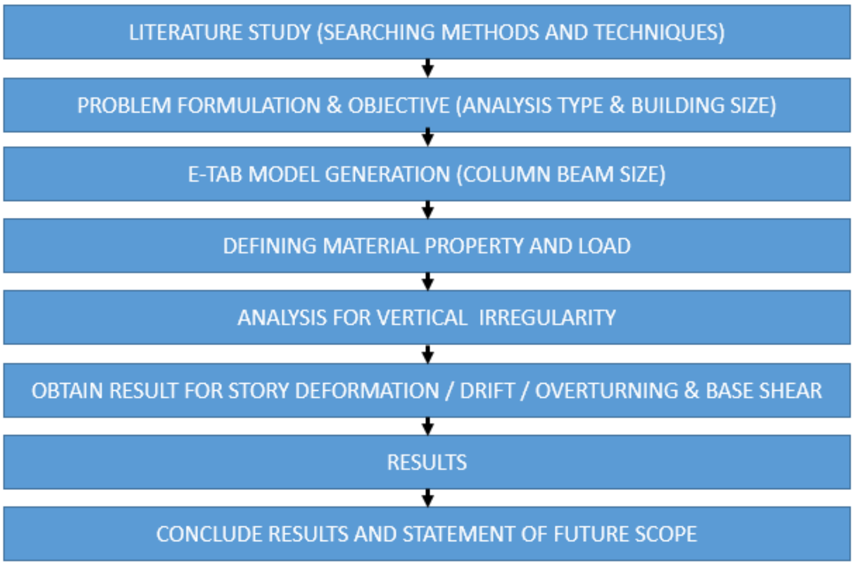
- Model A consist of 6x6 bay up to top floor.
- Model B consist of 6x6 bay up to 40 floor. 3x3 bay up to top floor (corner position).
- Model C consist of 6x6 bay up to 40 floor. 3x3 bay up to top floor (center position).
- Model D consist of 6x6 bay up to 40 floor. 3x3 bay up to top floor (edge position).

The material properties used in the Critical data considered during whole problem analysis are given in table below:

Table : Input parameters to be used

Specification	Details
Type of structure	Multi-storey rigid jointed plane frame(Special RC moment resisting frame)
Seismic zone	V
Zone Factor	0.36
Importance factor	1
Response Spectrum Analysis	Method
Type of soil	Medium soil
Number of storey	G+60
Dimension of building	30X30m
Floor Height (Typical)	3m
Base floor height	5m
Materials	Concrete (M50) and Reinforcement Fe415
Size of Column	900X600mm (1 to 20) , 700X600 (21 to 40), 600X600 (41 to 60)
Size of Beam	600X500 mm

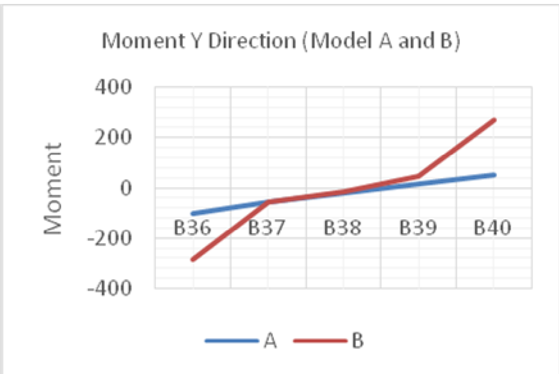
Methodology

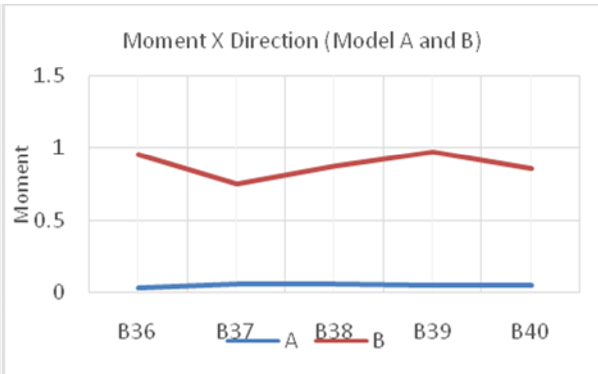


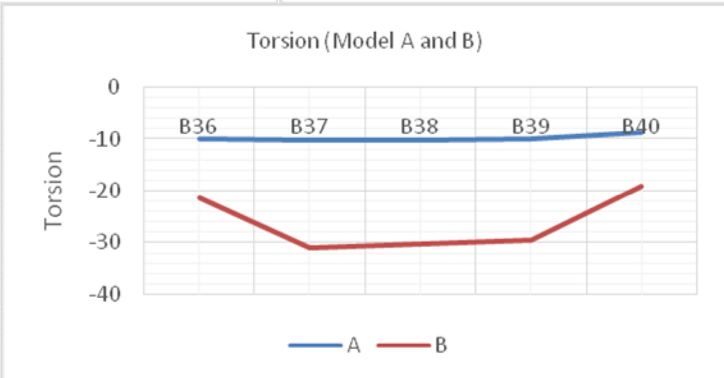
Data Collection and Analysis

Model A and B

	T		M2		M3	
Beam	A	B	A	B	A	B
B36	-9.9319	-21.3318	0.0344	0.9541	-102.596	-284.103
B37	-10.1709	-31.0819	0.0552	0.751	-58.8141	-56.7922
B38	-10.2526	-30.4418	0.0543	0.8714	-22.7145	-14.3806
B39	-9.9164	-29.4929	0.0496	0.9678	13.6128	48.1289
B40	-8.8699	-19.1538	0.0456	0.8511	51.2817	269.7216

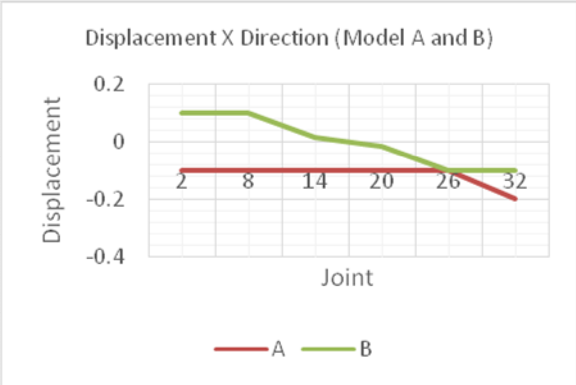


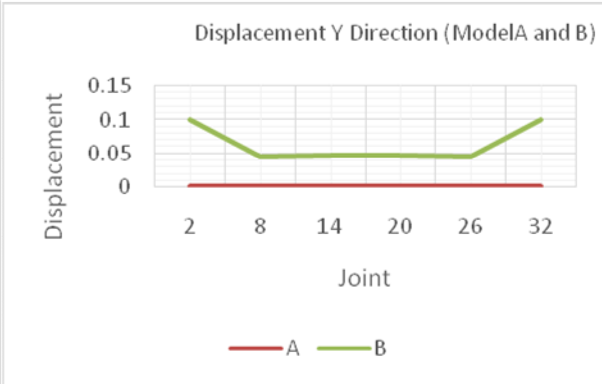


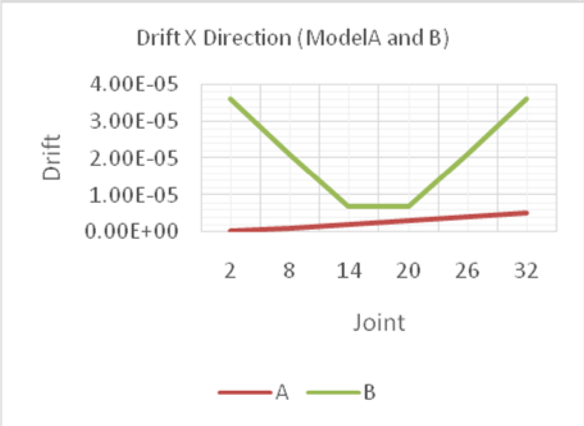


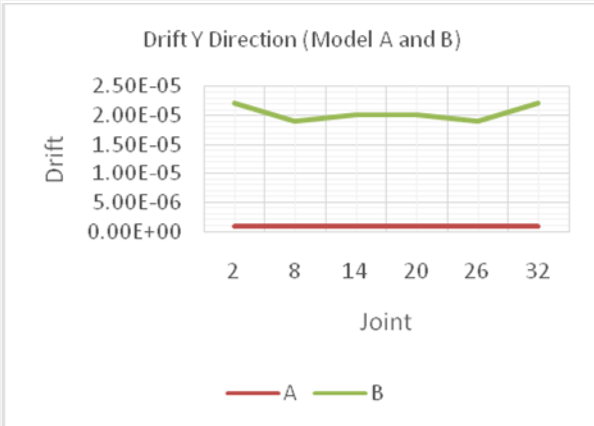
International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 7, Issue 8, August 2018 **ISSN 2319 - 4847**

	Displacement in X		Displacement in Y		Drift X		Drift Y	
Joint	A	B	A	B	A	B	A	B
2	-0.1	0.1	0.001251	0.1	1.94E-07	3.60E-05	1.00E-06	2.20E-05
8	-0.1	0.1	0.001224	0.04483	1.00E-06	2.10E-05	1.00E-06	1.90E-05
14	-0.1	0.01601	0.001199	0.04611	2.00E-06	7.00E-06	1.00E-06	2.00E-05
20	-0.1	-0.01601	0.001199	0.04611	3.00E-06	7.00E-06	1.00E-06	2.00E-05
26	-0.1	-0.1	0.001224	0.04483	4.00E-06	2.10E-05	1.00E-06	1.90E-05
32	-0.2	-0.1	0.001249	0.1	5.00E-06	3.60E-05	1.00E-06	2.20E-05



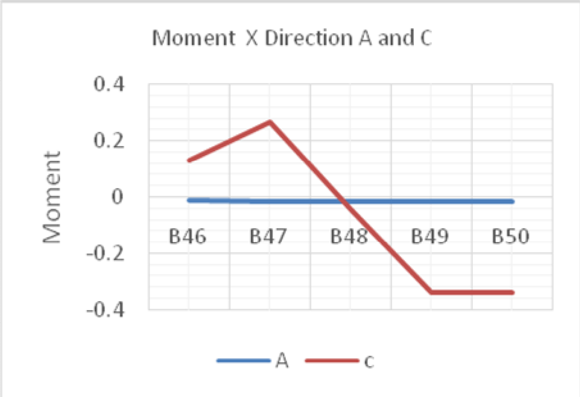


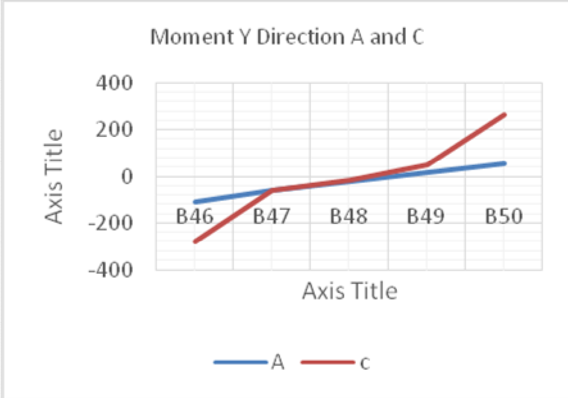


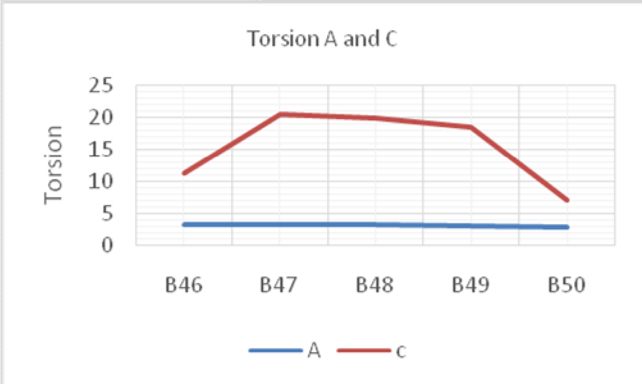


Model A and C

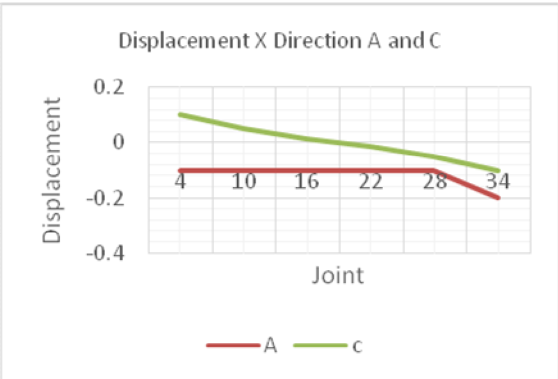
	T		M2		M3	
Beam	A	c	A	c	A	c
B46	3.2742	11.226	-0.0113	0.129	-106.421	-279.139
B47	3.3191	20.4771	-0.0167	0.2643	-60.7466	-57.0211
B48	3.3589	19.8005	-0.0172	-0.0417	-22.7884	-14.3615
B49	3.2423	18.5282	-0.0167	-0.3378	15.3646	47.7745
B50	2.9715	7.033	-0.0154	-0.3356	54.6634	264.2359

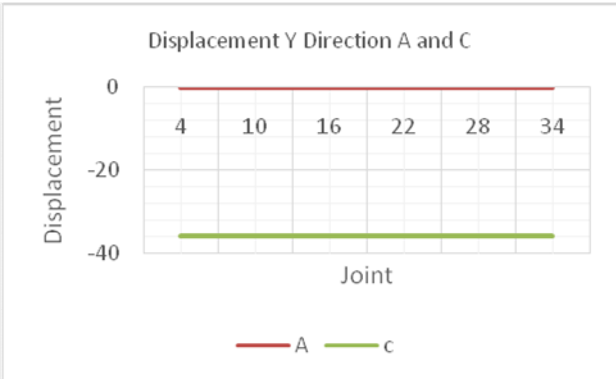


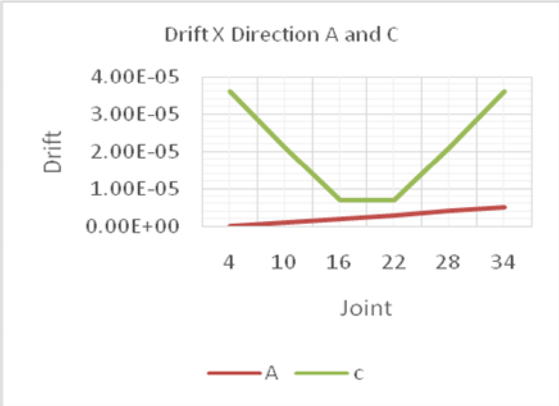


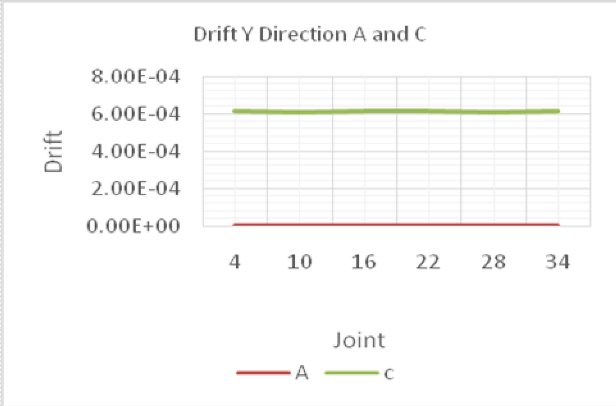


	Displacement in X		Displacement in Y		Drift X		Drift Y	
Joint	A	c	A	c	A	c	A	c
4	-0.1	0.1	-0.00048	-35.8	1.92E-07	3.60E-05	2.21E-07	0.000613
10	-0.1	0.04953	-0.00046	-35.8	1.00E-06	2.10E-05	2.07E-07	0.000612
16	-0.1	0.01564	-0.00045	-35.8	2.00E-06	7.00E-06	2.05E-07	0.000613
22	-0.1	-0.01564	-0.00045	-35.8	3.00E-06	7.00E-06	2.05E-07	0.000613
28	-0.1	-0.04953	-0.00046	-35.8	4.00E-06	2.10E-05	2.07E-07	0.000612
34	-0.2	-0.1	-0.00048	-35.8	5.00E-06	3.60E-05	2.21E-07	0.000613



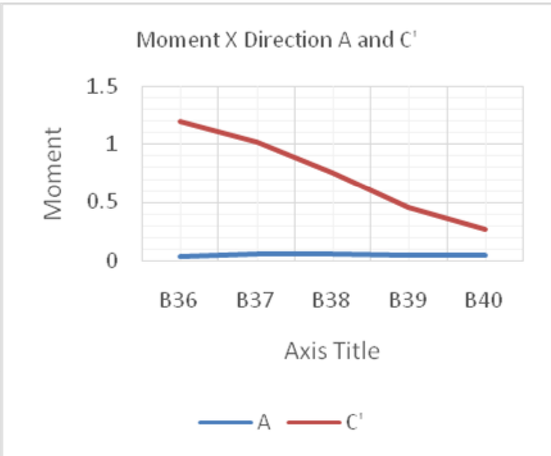


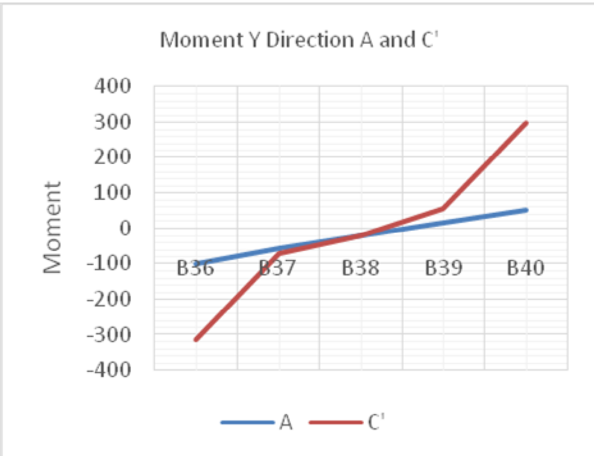


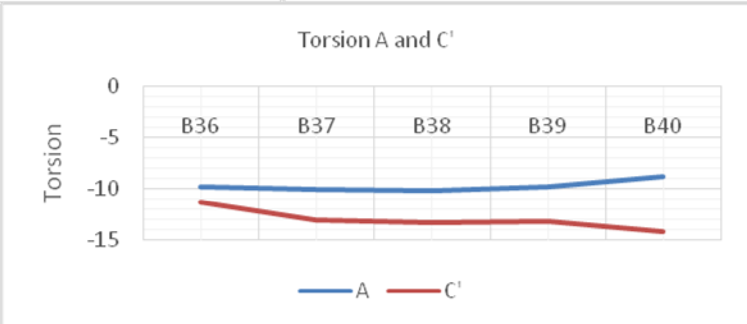


Model A and C'

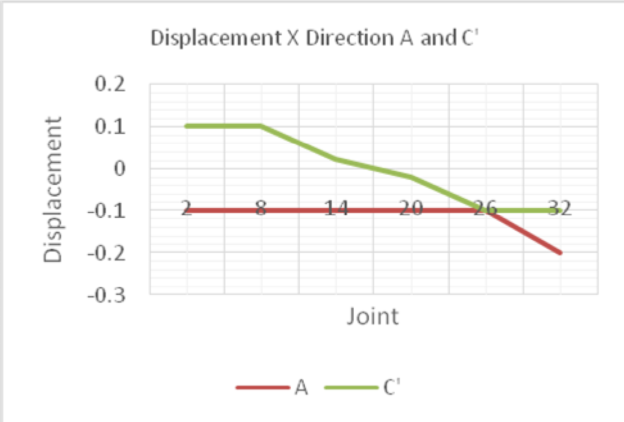
	T		M2		M3	
Beam	A	C'	A	C'	A	C'
B36	-9.9319	-11.3849	0.0344	1.1929	-102.596	-315.389
B37	-10.1709	-13.1165	0.0552	1.0201	-58.8141	-72.0114
B38	-10.2526	-13.3878	0.0543	0.7537	-22.7145	-19.8749
B39	-9.9164	-13.216	0.0496	0.4611	13.6128	53.2746
B40	-8.8699	-14.2301	0.0456	0.2716	51.2817	297.6925

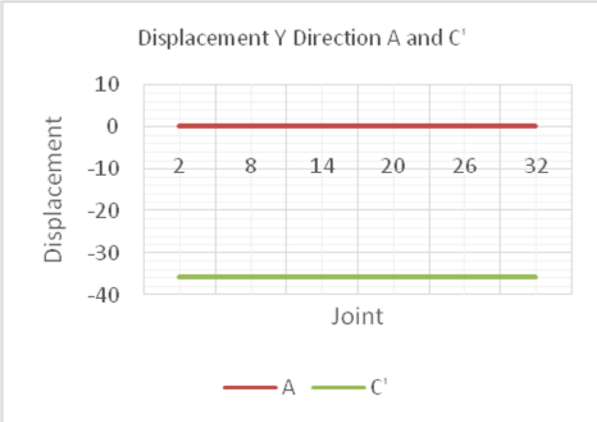


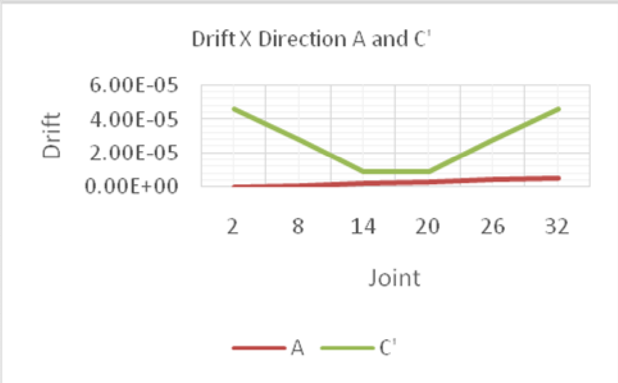


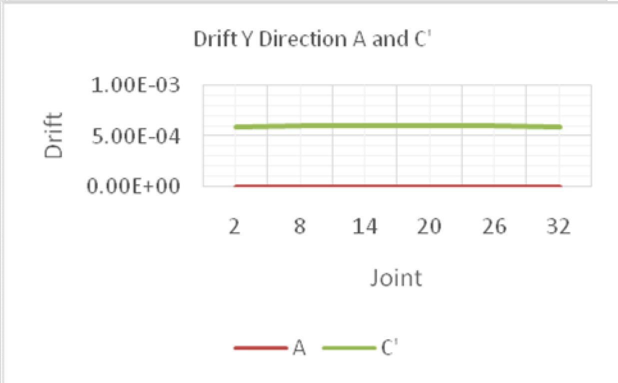


	Displacement in X		Displacement in Y		Drift X		Drift Y	
Joint	A	C'	A	C'	A	C'	A	C'
2	-0.1	0.1	0.001251	-35.7	1.94E-07	4.60E-05	1.00E-06	0.000595
8	-0.1	0.1	0.001224	-35.7	1.00E-06	2.80E-05	1.00E-06	0.000598
14	-0.1	0.02061	0.001199	-35.7	2.00E-06	9.00E-06	1.00E-06	0.0006
20	-0.1	-0.02061	0.001199	-35.7	3.00E-06	9.00E-06	1.00E-06	0.0006
26	-0.1	-0.1	0.001224	-35.7	4.00E-06	2.80E-05	1.00E-06	0.000598
32	-0.2	-0.1	0.001249	-35.7	5.00E-06	4.60E-05	1.00E-06	0.000595









Result

Three models were modeled A, B, C where A is a regular building and B/C are irregular buildings. All models were analyzed for seismic with ETABS software. The deflection, drift torsion and moment were compared from the floor where vertical irregularity starts. The results concluded that the regular building A possess greater moment torsion and deflection compared to irregular building. But the building irregular from corner (C) possess greater deflection where as Model B possess lesser results valued and hence it is concluded that Model B is the best building analyzed and it is because the building B is eccentric whereas building C is not eccentric. It is suggested as conclusion that while designing irregular building it must be considered eccentric vertically as much as possible.

References

[1] Aijaj, S.A. and Rahman A., (2013). "Seismic Response of Vertically Irregular RC Frame with Stiffness Irregularity at Fourth Floor." *International Journal of Emerging Technology and Advanced Engineering*, 3(8), 377-385.

[2] Bansal H., (2014). "Seismic Analysis and Design of Vertically Irregular RC Building Frames." *International Journal of Science and Research (IJSR),* 3(8), 207-215

[3] Bansal H., Gagandeep, (2014). "Seismic Analysis and Design of Vertically Irregular RC Building Frames." *International Journal of Science and Research (IJSR)*, 3 (8)

[4] IS 1893 (Part 1):2002 Design Criteria for Earthquake Resistant design of Structure.

[5] Konakalla R., (2014). "Effect of Vertical Irregularity in Multi-Storied Buildings under Dynamic Loads Using Linear Static Analysis." *IJEAR 4(2)*, 29-34

[6] Konakalla R., Dutt R., Dr. Raparla H., (2014) "Response Study Of Multi-Storied Buildings With Plan Irregularity Subjected To Earthquake And Wind Loads Using Linear Static Analysis." *Journal of Mechanical and Civil Engineering (IOSR-JMCE)* 12-19

[7] Khan, P. I., and Dhamge, N.R., (2016). "Seismic analysis of multistoried rcc building due to mass irregularity." *IJEDR* 4(3)

[8] Mukundan H., and Manivel S., (2015). "Effect of Vertical Stiffness Irregularity on Multi-Storey Shear Wall-framed Structures using Response Spectrum Analysis", *International Journal of Innovative Research in Science, Engineering and Technology*, 4(3)

[9] Patil, A.S., and Kumbhar, P. D., (2013). "Time History Analysis Of Multistoried RCC Buildings For Different Seismic Intensities." *Int. J. Struct. & Civil Engg. Res.*, 2(3)

[10] PEER (Pacific Earthquake Engineering Research center) www.peer.berkely.edu.

[11] Poncet, L., And Tremblay, R., (2004). "Influence Of Mass Irregularity On The Seismic Design And Performance Of Multi-Storey Braced Steel Frames." *13th World Conference On Earthquake Engineering Vancouver, B.C.,* Canada Paper No. 2896

[12] Reddy A., Fernandez R.J., (2015). “Seismic analysis of RC regular and irregular frame structures.” *International Research Journal of Engineering and Technology (IRJET),* 02(5)

[13] Sagar, Patil B., Prof.KattiGururaj B., (2015) “Study of Behaviour of Plan & Vertical Irregularity by Seismic Analysis.” *International Journal for Scientific Research & Development (IJSRD)*, 03(4)

[14] Salunkhe, U., and Kanase, J.S., (2017). “Seismic Demand of Framed Structure with Mass Irregularity International Journal of Science.” *Engineering and Technology Research (IJSETR)* 6(1)

[15] Sayyed O., Kushwah S.S., Rawat A., (2017). “Effect of Infill and Mass Irregularity on RC Building under Seismic Loading.” *International Research Journal of Engineering and Technology (IRJET)* 04 (2)

[16] Soni P. Divesh, (2006). “Qualitative Review Of Seismic Response Of Vertically Irregular Building Frames.” *ISET Journal of Earthquake Technology, Technical Note,* Vol. 43(4).

[17] Soundarya R., Reddy K.G., Harshitha, Prathima, and Guruprasad, (2014). “Seismic Analysis of Symmetric RC Frame Using Response Spectrum Method and Time History Method.” *International Journal Of Scientific Research And Education,* 2(3), 483-499

[18] Varadharajan S., Sehgal V. K., and Saini B., (2012). “Review of different Structural irregularities in buildings.” *Journal of Structural Engineering (ISR),* 39(5), 393-418.

[19] USGS (United State Geological Survey) http://earthquake.usgs.gov.