iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** IX **Month of publication:** September 2025

DOI: https://doi.org/10.22214/ijraset.2025.74324

An Analysis of the Structural Behaviour of Irregular Structures in Response to Earthquake Monitoring

Chengala Krishnaveni[1], Dr. Aruna Prasur[2]
[1]*M-Tech scholar Department of Civil Engineering Bharat Institute of Engineering and Technology Hyderabad - 501 510, Telangana, India*
[2]*Professor Department of Civil Engineering Bharat Institute of Engineering and Technology Hyderabad - 501 510, Telangana, India*

Abstract: Since the existence of lace in horizontal space has encouraged people to soar higher, there has been a consistent trend towards the creation of taller structures. However, pushing the vertical limit further increases the hazard factor. We must assess the building for a range of loads to ensure safety. An examination of a building is required to ascertain its seismic resistance because the behavior of a structure is critical during an earthquake. An earthquake may bring a high-rise structure to the ground, a risk that is difficult to predict. Therefore, it is necessary to do a seismic force assessment on different types of buildings. The seismic officious can use the seismic coefficient technique to analyses small and medium-sized buildings up to a height of forty meters. d of analysis that requires less manual computation. The overall shape, size, and geometry of a structure all have a significant role in defining its behavior. since asymmetry is because asymmetrical structures are more likely to exhibit critical behavior during an earthquake than symmetrical ones. of the characteristics of symmetrical, L-shaped, and T-shaped and build RC structures during earthquakes to better understand the variations in seismic loading and behavior that may arise due to form variances. The seismic ETABS software aids in the seismic coefficient study of a ten-story building with three-meter-tall levels and a varied plan shape, including symmetrical, L-shaped, and T-shaped configurations. al inspection of a ten-story structure takes a long time and increases the chance of errors. ETABS can simplify, improve efficiency, and increase the accuracy of a structure's analysis. The analysis is conducting the analysis by adhering to IS 1893:2002 (Part 1). shaped RC structures have their own response, which includes, among other things, lateral pressures, base shear, storey drift, and storey shear. We use the reaction of the variously shaped buildings to compare the findings.

Keyword: Earthquakes, L-shaped, and T-shaped, ETABS software, IS 1893:2002 (Part 1), Lateral pressures, Base shear, Storey drift, and Storey shear

I. INTRODUCTIONS

A tremor that may be felt across the earth is referred to as an earthquake. There is a possibility that earthquakes might be sufficiently dangerous, leading to the destruction of huge buildings and the loss of a significant number of people. The intensity of the shaking that occurs during an earthquake may vary from being hardly detectable to being so powerful that it completely displaces a person bodily. Therefore, it is vital to do research on earthquakes and the structural reactions of buildings during seismic occurrences in order to reduce the number of human lives that are lost as a result of earthquakes. Seismic waves are produced when there is a sudden release of energy in the crust of the earth, which results in the occurrence of an earthquake. The most common component that contributes to the occurrence of earthquakes is the rupture of geological faults, which is the primary cause of earthquakes. Other factors that contribute to this phenomenon include nuclear testing, landslides, volcanic activity, and explosions from mines. Through the course of the last several decades, there has been a substantial rise in the use of reinforced concrete structures in India, notably in metropolitan regions and cities. When an earthquake occurs, any structure that is supported by the ground will feel movement at its foundation because of the seismic activity that occurs during the earthquake. The top of the structure has a tendency to remain in the same position it was in when it was initially constructed, in contrast to the foundation of the building, which moves in line with the first law of motion proposed by Newton. When seen from the opposite perspective, the walls and columns generate a force that causes the roof to move in tandem with them. This is due to their connection. This condition is comparable to the predicament you find yourself in when the bus you are standing in suddenly begins to move: your feet begin to move in time with the motion of the bus, but your upper body resists and wants to remain in place, which ultimately results in a fall backward.

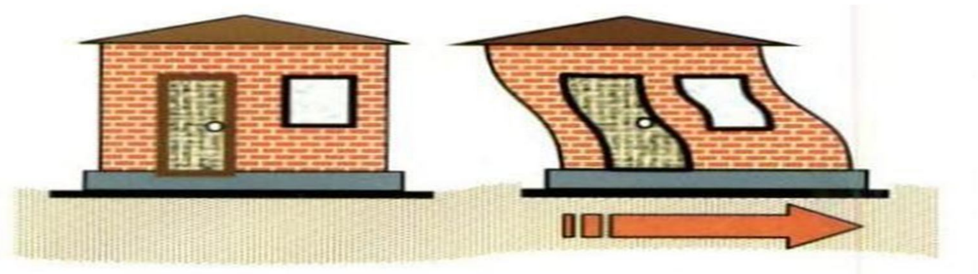


Figure 1: Effect on Inertia in building during earthquake

A. Objectives

1) This research aims to investigate the movement of high-rise buildings composed of reinforced concrete structures during an earthquake.
2) The seismic load affects the structure because of design flaws.
3) The equation enables the computation of the seismic force's lateral force at each level.
4) The aim of this is to ascertain the maximum reaction that the structure can have.
5) The purpose of this research is to evaluate the features of various types of buildings in terms of their behavior during earthquakes.
6) Determine the torsional movement that occurs inside the structure as a result of the unequal distribution of mass and stiffness. The uneven distribution of the load causes this movement.
7) By using ETABS, we can achieve the objectives of conducting a program analysis and delivering research findings that are more precise and efficient.

II. METHODOLOGY AND INPUT DATA

It is possible to use a wide variety of procedures while doing seismic analysis on structures. These methodologies include a wide range of approaches. For the purpose of carrying out the investigation, the seismic coefficient approach of analysis is used. This is due to the fact that it is a method that is both straightforward and applicable. In the vast majority of cases, method analysis is used for buildings that are between ten and twelve stories tall and that are up to forty metres in height altogether Using the seismic coefficient, which is the most fundamental way, it is possible to calculate the seismic forces that are applied to a structure. This is a rather straightforward procedure. First, the design base shear is computed for the whole building by using this approach. After that, it is spread over the height of the structure, as will be detailed in further detail in the following paragraphs. The procedure is carried out once again with each successive level of construction.

A. Input Data

Rectangular

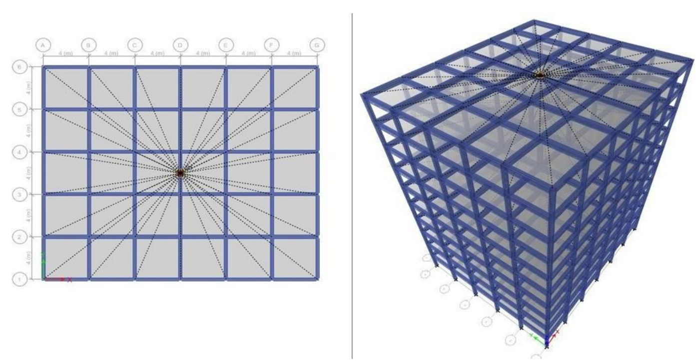


Figure 2: Rectangular building

L- Shaped

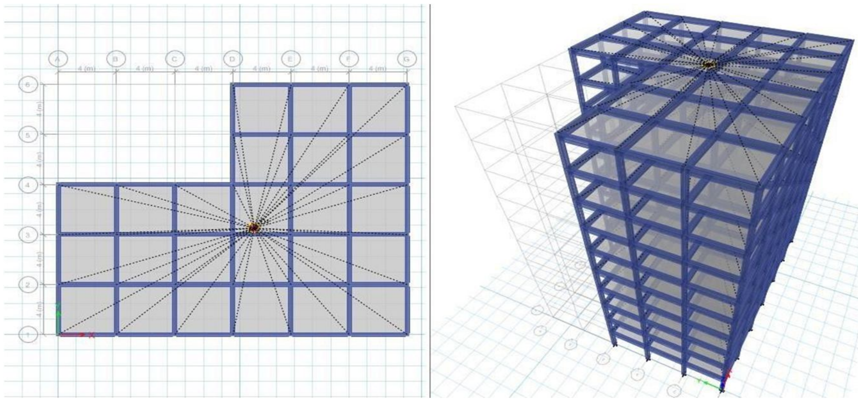


Figure 3: L- shape building

T- Shaped

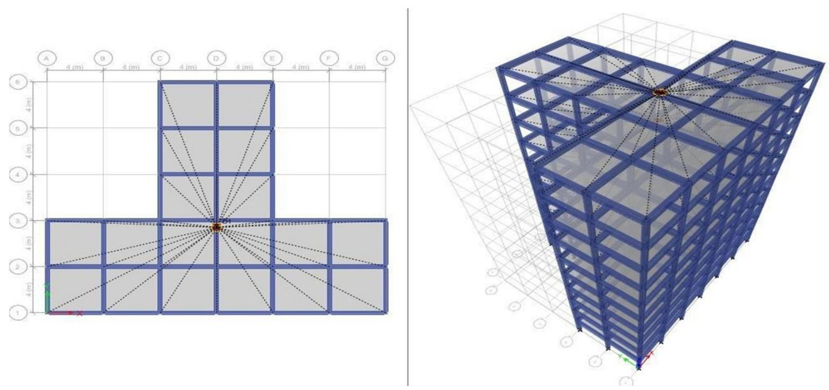


Figure 4: T- shape building

Concrete- M 25, Steel- Fe 415

1) Direction of earthquake (X & Y)
2) Accidental eccentricity to be considered or not (5% as per code)
3) Response reduction factor (R) as per IS 1893 (Part-1):2002
4) Zone factor (Z) as per IS 1893 (Part-1):2002
5) Type of soil as per IS 1893 (Part-1):2002
6) Importance Factor as per IS 1893 (Part-1):2002
7) Time period as per IS 1893 (Part-1):2002

   T= 0.09h/Sqrt (d)
8) Defining mass sources as per IS 1893 (Part-1):2002

III. RESULTS AND EVALUATION

When you have finished modelling a building or structure in ETABS, the next step is to do an analysis on the model that you have just finished creating. The findings of the study are included in a report that is provided by ETABS. This report contains the full results of the analysis. According to the results of the research, this report has been compiled. Following the conclusion of the examination, the following findings were found to be present:

A. *Center of Mass & Stiffness*

Table 1- Center of Mass & Center of Rigidity

Shape (m)											
Rectangular				T- Shape				L- Shape			
Center of mass		Center of Rigidity		Center of mass		Center of Rigidity		Center of mass		Center of Rigidity	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
12	10	12	10	12	7.406	12	7.532	13.46	8.547	13.54	8.637

B. *Seismic Weight of Building*

Table 2: Seismic weight of building

Shapes	Rectangular	T- shape	L- Shape
Weight (Kn)	118022.96	75078.63	96550.76

C. *Story Shear*

Table 3: Story Shear

Story- Shear (Kn)						
Store	Shape					
	Rectangular		T- Shape		L- Shape	
	X	Y	X	Y	X	Y
Store 10	1783.109	1627.748	1131.757	1033.148	1457.433	1330.449
Store 9	3262.877	2978.586	2073.813	1893.123	2668.345	2435.855
Store 8	4432.076	4045.914	2818.153	2572.61	3625.115	3309.262
Store 7	5327.244	4863.087	3388.039	3092.842	4357.642	3977.965
Store 6	5984.919	5463.459	3806.731	3475.054	4895.825	4469.256
Store 5	6441.638	5880.384	4097.489	3740.478	5269.563	4810.431
Store 4	6733.937	6147.216	4283.574	3910.35	5508.756	5028.783
Store 3	6898.356	6297.309	4388.247	4005.903	5643.301	5151.606
Store 2	6971.431	6364.017	4434.768	4048.371	5703.1	5206.194
Store 1	6989.7	6380.694	4446.398	4058.988	5718.049	5219.841

D. *Story Drift*

Table 4: Story Drift

Story- Drift (Story shear/Story stiffness) (mm)						
Store	Shape					
	Rectangular		T- Shape		L- Shape	
	X	Y	X	Y	X	Y
Store 10	9.84	9.42	9.91	9.53	9.83	9.49
Store 9	16.39	15.45	15.89	15.06	16.14	15.32
Store 8	21.62	20.27	20.66	19.47	21.18	19.97
Store 7	25.59	23.92	24.25	22.79	25	23.49
Store 6	28.45	26.54	26.81	25.14	27.73	25.99
Store 5	30.35	28.27	28.47	26.64	29.54	27.63
Store 4	31.46	29.25	29.37	27.44	30.57	28.53
Store 3	31.92	29.63	29.66	27.65	30.96	28.83
Store 2	31.82	29.46	29.38	27.33	30.79	28.59
Store 1	27.23	25.04	24.67	22.8	26.16	24.1

As value of store drift falls under 0.004*h = 0.004*30 = 120mm as per Indian Standard requirement thus building is safe against drift.

E. *Story Displacement*

Table 5: Story Displacement

Story- Displacement (mm)						
Store	Shape					
	Rectangular		T- Shape		L- Shape	
	X	Y	X	Y	X	Y
Store 10	254.67	237.25	239.07	223.85	247.9	231.94
Store 9	244.83	227.83	229.16	214.32	238.07	222.45
Store 8	228.44	212.38	213.27	199.26	221.93	207.13
Store 7	206.82	192.11	192.61	179.79	200.75	187.16
Store 6	181.23	168.19	168.36	157	175.75	163.67
Store 5	152.78	141.65	141.55	131.86	148.02	137.68
Store 4	122.43	113.38	113.08	105.22	118.48	110.05
Store 3	90.97	84.13	83.71	77.78	87.91	81.52
Store 2	59.05	54.5	54.05	50.13	56.95	52.69
Store 1	27.23	25.04	24.67	22.8	26.16	24.1

F. *Design Eccentricity*

Eccentricity due to asymmetrical shape of building is calculated as per IS 1893 (Part-1): 2002, Cl. 7.9.1

Table 6: Design Eccentricity

Eccentricity	Shape (m)					
	Rectangular		T- Shape		L- Shape	
	X	Y	X	Y	X	Y
Static Eccentricity (esi)	0	0	0	0.1251	0.0879	0.0903
1) Design Eccentricity (edi)	1	1.2	1	1.38765	0.86815	1.33545
2) Design Eccentricity (edi)	-1	-1.2	-1	-1.0749	-0.9121	-1.1097

Whichever of both design eccentricity gives more severe effect in shear of frame.

G. *Torsion Movement*

Torsional movement, which is often referred to as rotation in a plan, is created as a result of the asymmetrical organisation of the structure. It is essential to multiply base shear by design eccentricity a number of times in order to calculate torsional movement. This is done for the purpose of calculating torsional movement.

Table 7: Torsional Movement

Directions	Shape (Kn*m)		
	Rect.	T-Shape	L- Shape
X	6989.70	4446.39	- 5215.43
Y	7656.83	5632.45	6970.84

H. *Discussions*

A conversation will be held concerning the behaviour of the building and the seismic forces that are operating on the structure, and it will be based on the findings of the study that was conducted. There will be a conversation about this topic. The following findings are provided for your consideration, and they are based on the conversation that previously took place.

1) The phenomenon of eccentricity in buildings may be attributed to a broad number of factors, including the suitable distribution of mass, the orientation of rectangular columns, the design of the structure, and other factors. It is probable that these factors are all responsible for the phenomenon. Static eccentricity is the term used to describe the kind of eccentricity that is being addressed in this context.
2) For the purpose of ensuring that a structure is safe throughout the entire building process, it is essential to compute the design eccentricity in accordance with the codal requirement. By doing this calculation, we are able to acquire a multiplication factor of 1.5 as well as an addition factor of 0.05*bi. These aspects are taken into consideration in order to take into account dynamic amplification and accidental eccentricity.
3) It is possible for a symmetrical structure that has an equal distribution of mass to display a certain degree of eccentricity. This is because of the multiplication and addition factors, which make it possible for such a structure to show eccentricity. Because of this, the provision of increased safety and the elimination of accidental eccentricity brought about by changes in the function of the structure, the soft story effect, and other factors are both contributed to. Moreover, this factor also contributes to the elimination of unintentional eccentricity.
4) The degree of eccentricity that the structure has is mostly determined by the form of the structure, which is the most important component. When compared to the other
5) From the graph it is evident that the degree of eccentricity is much higher in T-shaped buildings in comparison to rectangular or L-shaped structures. This is the case when comparing the two types of construction. This is particularly true when two different kinds of structures are compared to one another.

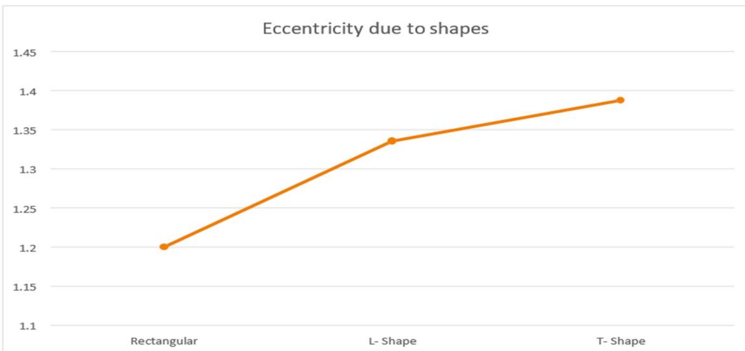


Figure 5: Eccentricity due to different shapes

6) During the course of the investigation, one thing that becomes abundantly evident is that the torsional movement is reliant upon the mass of the structure. This is something that becomes incredibly clear. This is something that is made extremely clear to everyone who sees it.
7) The base shear and the mass of the structure are immediately connected to one another, and as a consequence, it follows that the higher the mass, the larger the base shear, and the greater the torsional movement. This is because the base shear is directly tied to the mass of the building.
8) Due to the existence of mass throughout the structure, a rectangular design is subject to a greater amount of torsional movement than other types of construction.
9) when it comes to the torsional movement of structures that exhibit eccentricity, the graph makes it plainly evident that mass plays a significant role. An examination of the graph reveals this to be the case.

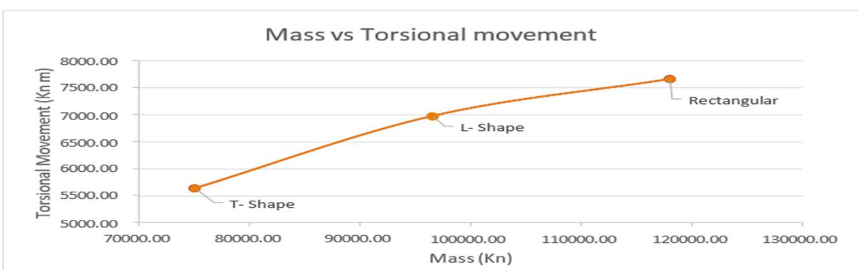


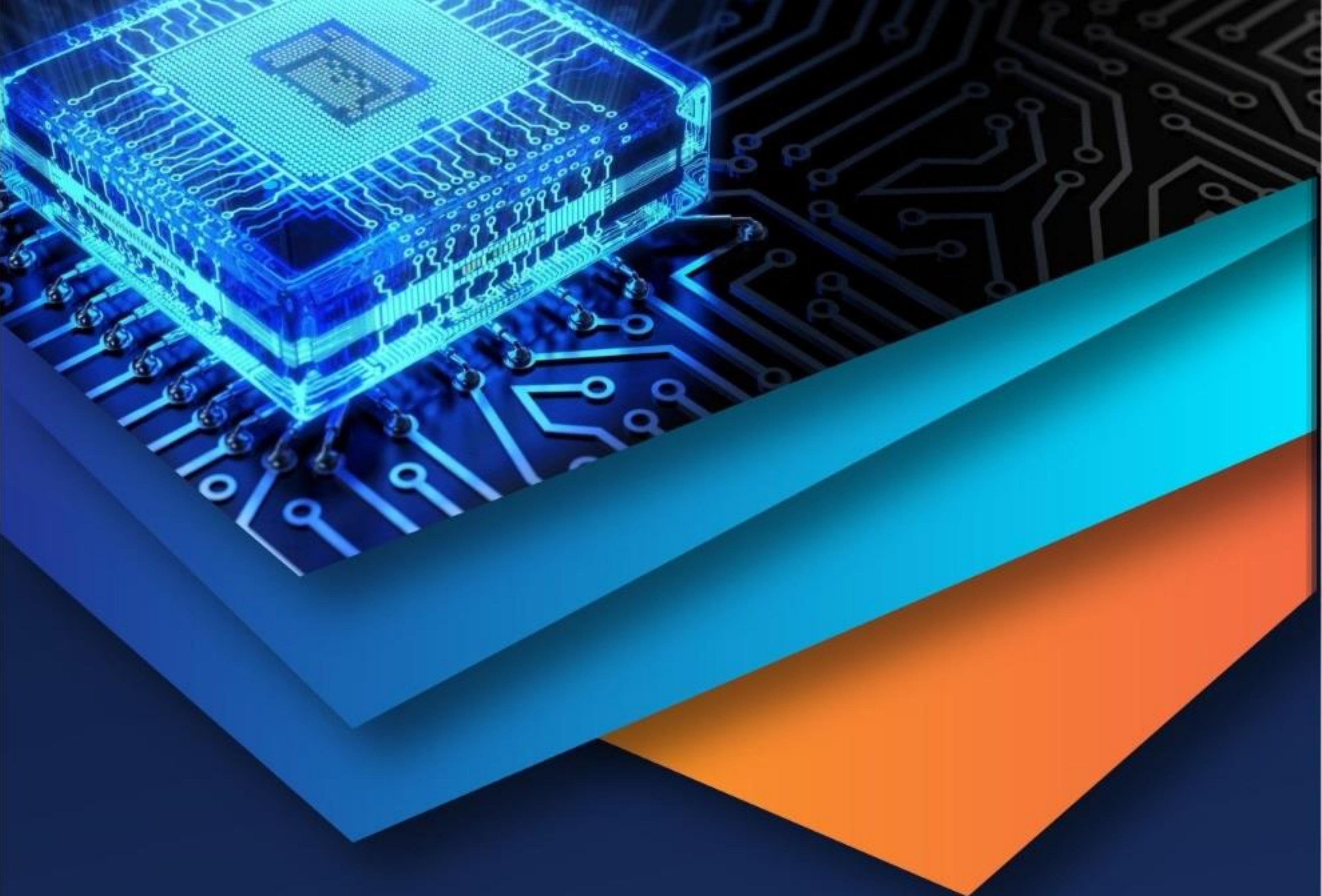
Figure 6: Mass v/s Torsional Movement

IV. CONCLUSION'S

1) The underlying mass of the structure is necessary for base shear to occur in a building. Base shear is performed by the building's foundation.
2) In the event that the suggested construction has an irregularity, the centre of mass and the centre of stiffness will take on an eccentricity as a consequence. Given the irregularity, this eccentricity will be the result of the irregularity.
3) There is a difference in the behaviour of all three-shaped buildings in both directions due to the fact that the size of the building changes in both directions. The reason for this is because the dimensions of the structure change in a different way in each direction.
4) When compared to the patterns of the rectangular and L-shaped constructions, the T- shaped construction has a greater degree of irregularity in its arrangement. This is because the T-shaped construction is divided into three sections.
5) It has been shown via thorough observation that the three levels of all three-shaped buildings exhibit a larger drift value than any other level. This is true regardless of the direction in which the three-shaped constructions stand. It does not matter which way you go; this is always the case.
6) The displacement of the building is found to be greater when the direction of the earthquake is perpendicular to the longer face of the structure. This is something that has been discovered. The reason for this is that the earthquake is having an effect on the longer face of the construction of the building. Within the context of this particular circumstance, there is a considerable amount of displacement originating from the x- direction.
7) The torque movement that is created as a result of eccentricity is proven to have a direct link with mass, as evidenced by the observations that have been made. An increase in the torsional movement of a structure occurs in a manner that is directly proportional to the mass of the building.
8) There is a substantial amount of base shear that takes place in buildings that have a rectangular shape. Rectangular structures are capable of suffering large torsional movements since they are exposed to a huge amount of base shear. This is because they are rectangular in shape.
9) When an earthquake strikes in a direction that is perpendicular to the shorter face of a structure, the rotational movement of the building is relatively bigger than when the earthquake strikes in a vertical direction. This is because the shorter face of the structure is facing the direction of the earthquake. In this particular instance, the direction that displays the largest degree of torsional movement is the Y-direction.
10) In addition, we are able to establish a direct relationship between eccentricity and shape, in addition to the connection that exists between mass and torsion inside anything.

REFERENCES

[1] MOHAMMED YOUSUF, P.M. SHIMPALE; Dynamic Analysis of Reinforced Concrete Building with Plan Irregularities. International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 3, Issue 9, September 2013.
[2] RUCHA S. BANGINWAR, M. R. VYAWAHARE, P. O. MODANI; Effect of Plans Configurations on the Seismic Behavior of the Structure by Response Spectrum Method. International Journal of Engineering Research and Applications, ISSN: 2248- 9622, Vol. 2, Issue 3, May-Jun 2012, pp.1439-1443.
[3] DEEPAK SUTHAR, H.S.CHORE, P.A. DODE; High rise structure subjected to seismic forces and its behavior. 12th IRF International Conference, ISBN: 978-93-84209-31 -5.
[4] Mr. Sandesh N. Suryawanshi, Prof. S. B. Kadam, Dr. S. N. Tande; Torsional Behavior of Asymmetrical Buildings in Plan under Seismic Forces. International Journal of Emerging Engineering Research and Technology, Volume 2, Issue 4, July 2014, PP 170-176, ISSN 2349- 4395 (Print) & ISSN 2349-4409 (Online).
[5] Prof. Wakchaure M. R, Nagare Y U; Effect of Torsion Consideration in Analysis of Multi Storey frame. International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Vol. 3, Issue 4, Jul-Aug 2013, pp.1828-1832.
[6] C. Justine Jose, T. P. Somasundaran, V. Mustafa; prediction of seismic torsional effects in tall symmetric buildings. IJRRAS 5 (2), November 2010.
[7] Neha P. Modakwar, Sangita S. Meshram, Dinesh W. Gawatre; Seismic Analysis of Structures with Irregularities. IOSR Journal of Mechanical and Civil Engineering (IOSR- JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, PP 63-66.
[8] Dr. S.K. Dubey, P.D. Sangamnerkar; Seismic behavior of asymmetric RC buildings. International Journal of Advanced Engineering Technology, E-ISSN 0976-3945.
[9] Shantanu S. Magdum, Dr.P.S.Patil; Study of seismic behaviour of vertical asymmetric multi- storied building. International Journal of Advanced Technology in Engineering and Science, Volume No.02, Issue No. 06, June 2014, ISSN (online): 2348 – 7550.
Sachin G. Maske, Dr. P. S. Pajgade; Torsional Behaviour of Asymmetrical Buildings. International Journal of Modern Engineering Research (IJMER), Vol.3, Issue.2, March- April. 2013, pp-1146-1149 ISSN: 2249-6645.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY