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Structural Design & Analysis RCC, L Shape, C Shape, Using Response Spectrum Analysis

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ABSTRACT: Architects like buildings that aren't straight up and down, mostly because they look better. Earthquake codes not only say that these kinds of buildings need to be designed with extra care, but they also say that they can't be built in active seismic zones because of how irregular they are. When a building's mass or stiffness aren't the same on both sides, it has irregularities that will be bad during seismic excitation. When compared to a symmetrical building, this causes the edges of the asymmetrical building to bend and shear forces to be too high. In this paper, a linear time history analysis is done for an atypical ten-story asymmetrical building with and without the Torsion effect. The paper also looks at how the response ratio changes with the eccentricity ratio and frequency ratio for four different earthquakes. One of the most destructive natural disasters is an earthquake. Earthquakes happen when elastic energy is released quickly and causes the ground to move quickly for a short time. The event is most traumatic because it affects a large area, happens all at once, and is hard to plan for. They can cause a lot of damage and loss of life. Every day, there are hundreds of small earthquakes all over the world. Some of them are so small that people can't feel them, but seismographs and other sensitive machines can record them. Buildings are one of the most important things that people make, so it is important to control how asymmetric buildings respond to earthquake ground motion. Basic technologies are used to make buildings stiffer so that the structural response of the building can be controlled. Base Isolation, Passive Energy Dissipation Devices, and Active Control Devices are the basic technologies that make these work. The main goal of this paper is to control the earthquake response of buildings that aren't the same size all the way around. Four different types: regular shape, C shape, L shape, and T shape. Buildings with a viscoelastic effect are compared to buildings that don't have any control over them. Compared to uncontrolled building, controlled building shows moderate range of reduction for all response quantities.

KEYWORDS: ETABS, Industrial Towers, Dynamic Analysis, Static Analysis.

I. INTRODUCTION

1.1 GENERAL

Earthquakes are one of the most dangerous natural events. They kill thousands of people and cause damage to buildings. Buildings are one of the most important things that people make, so they must be made to withstand the forces of an earthquake. Since 1953, universities, government agencies, businesses, and other places in Japan have been keeping track of strong ground motion. But it wasn't until 1962 that a Strong Motion Earthquake Observation Council (SMEOC) was set up. Its goal was to provide basic guidelines for getting strong motion records on a national scale and make it easy for different agencies to share information about strong motion records. People are starting to see that earthquake-resistant buildings are a new idea that can meet the needs of society in the 21st century. One area of research that looks promising for reducing structural vibrations caused by things like earthquakes and strong winds is structural control. Installing a mechanical system in a structure makes it less likely that the structure will shake.

This study is about how to control how different kinds of buildings react to earthquakes. It has been seen that when there are strong earthquakes, asymmetric buildings are more damaged than symmetric buildings. When a building is asymmetric, the centre of mass and the centre of rigidity are not in the same place. There are many ways to control structural vibration, such as with a base isolation system, an active control system, a semi-active control system, or a hybrid control system. The main goal of structural control devices is to lessen the shaking of structures caused by things like earthquakes and strong winds. In this paper, the main goal is to study how the visco-elastic effect can be used to reduce the response of a building to different types of earthquake vibrations.

In this study, a three-story building with irregular shapes (regular, C, L, and T) is looked at and designed using the E-Tabs software. Using the viscoelastic effect, you can get both uncontrolled and controlled responses from



asymmetric buildings. Response numbers for buildings that are not controlled and buildings that are controlled are compared to find out how well the visco-elastic effect works.

C-SHAPED STRUCTURE



L-SHAPED BUILDING



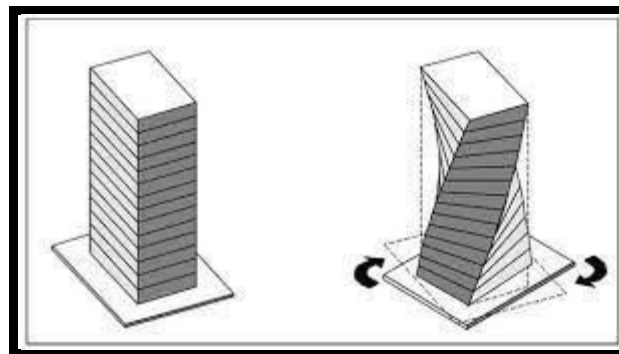
A new study looked into the seismic response of asymmetric systems with the Torsion effect. It was found that effect nonlinearity has a small effect on structural response, and that effect achieves the same reduction in response with much less force than linear effect. Also, the earthquake response of asymmetric systems with effect can be estimated with enough accuracy by looking at the same asymmetric systems with equivalent linear effect. A simpler way to analyse asymmetric plan systems with effects has also been made. Even though the above studies helped us learn more about how nonlinear effects affect the way asymmetric systems respond to earthquakes, they were only done on systems with lateral load resisting systems. responding in the range of behaviour that is linear and elastic.

It would also be helpful to study these effects on systems where elements that resist lateral loads are bent past their elastic limit. So, the main goals of this research are to figure out how the effects of nonlinearity affect the seismic response of asymmetric systems and how the effects of nonlinearity affect the effects of plan-asymmetry. The responses of linear systems are also included as a point of reference. First, a summary of the theory behind the viscoelastic effect is given so that you can understand how fluids behave. Based on the amount of energy lost during one harmonic cycle, an equivalent ratio is found for systems with a viscous effect.

The hysteretic behaviour of effects is looked at, and then the relationships between the forces and speeds of effects are looked at. In particular, the relationships between force and effect velocity that give variable or constant effects over a range of effect velocities are looked at. The effects of nonlinearity are studied by comparing the normalised values of seismic responses (edge deformations, base shear and torque, and total force and torque at the base) of one-story, one-way asymmetric linear and systems with "fluid viscous effect" with those of systems with "linear fluid viscous effect." The ratios of these responses in systems with an effect and in systems with a linear effect are also looked at. The effects of plan-asymmetry are studied by comparing the response of asymmetric-plan systems with supplemental effects to the response of the corresponding symmetric-plan system. This is a system with the same location and stiffness of all resisting elements and the same location, coefficient, and exponent of all supplemental effects as the asymmetric-plan system, but with the rotational degree-of-freedom limited. We compare these normalised responses in systems with effects to those in systems with linear effects to see how the effects of plan-asymmetry are changed by the fact that effects are not linear. For the SAC studies, a set of 20 ground motions is used to calculate the seismic responses.

TORSIONAL IRREGULARITIES:

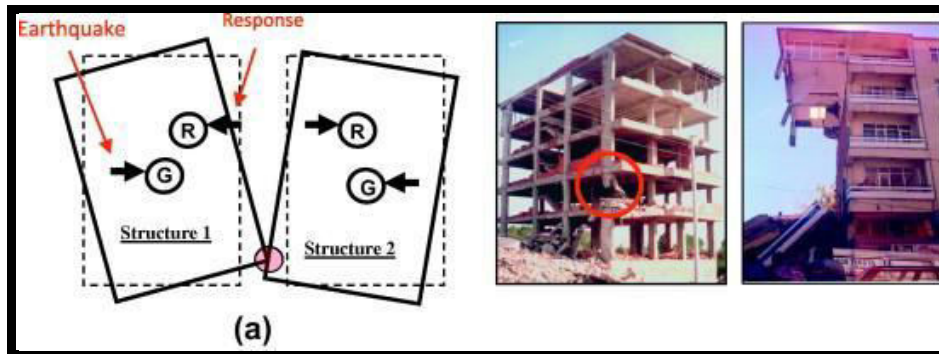
Among categorizations of seismic behavior that have been adopted in modern codes is extreme torsional irregularity. Torsional irregularity is not an unfamiliar concept, having been expressed in codes in various forms for decades. It is an issue that engineers have learned to deal with, particularly in seismically active areas. Extreme torsional irregularity, however, is a somewhat newer concept and subset within the larger issue of torsional behavior. It is something that can greatly limit and restrict flexibility in choosing seismic force-resisting systems and configurations.



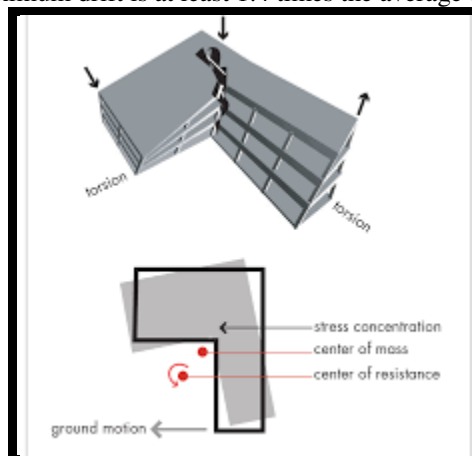
Recent building codes define torsional irregularity as when the maximum story drift, including accidental torsion, at one end of the structure perpendicular to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. With a little math, you can see that this means that torsional irregularity exists if one end of a rectangular structure moves more than 1.5 times more than the other end. For the newer category of "extreme torsional irregularity," the steps for calculating are mostly the same, but this label is given to structures where the maximum story drift, including accidental torsion, at one end of the structure perpendicular to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Again, in simple terms, this means that there is extreme torsional irregularity if one end of a square structure moves more than 2.33 times more than the other end.

Because of recent changes to long-period spectral accelerations, values have gone down in many parts of the country. This had a huge effect on seismic design in areas with moderate to high earthquake activity and a "trigger boundary" for S_1 of 0.75g. At one time, this code provision meant that there were limits on what could be done about the torsional issue. Engineers had less freedom and had to help clients understand the limits of geometries that used to be fine but were no longer because of things like torsion. In the field of seismic design, which is always changing, only time will tell where spectral acceleration maps will go in the future. Those who design structures in areas where the long-period spectral acceleration response is close to 0.75g should keep a close eye on any changes to these criteria, because this is

a very important issue that affects a lot of things, such as the assignment of the SDC and the limits on some irregularities.



Many engineers have brought up the fact that the method for classifying torsional irregularity doesn't take into account how much the relative story drifts as a point of discussion. If one end of a rectangular structure drifts 0.8 inches and the other end drifts 1.2 inches, the average drift is 1.0 inches. Since the maximum drift is at least 1.2 times the average drift, the structure is said to have torsional irregularity. For the same model, if one end of the structure drifts 0.6 inches and the other end drifts 1.4 inches, the average drift is still 1 inch, but the structure is now said to have extreme torsional irregularity because the maximum drift is at least 1.4 times the average drift.



OBJECTIVES

Following are a unit target of this study has three specific objectives which are:

1. To model Normal Rcc structure and L shape, along with C shaped structure which should be taken in to the response spectrum analysis.
2. Response spectrum analysis .without effect and there after checking the results of response spectrum analysis for under displacement, story drift and story shear.
3. Checking for the results of Torsional irregularities which structure model is better to consider for the construction feature later after getting the analysis results.
4. Finally plotting the graph to get the exact comparison for all the models and suggesting the suitable models for analysis

II. RELATED WORK

In the next few paragraphs, we'll take a quick look at what's been written about the Torsion effect, paying special attention to the Torsion materials used in these Torsion effect.

Mike Montgomery (2014) In this paper, the Torsion Coupling Effect (VCD) and the Torsion-Plastic Coupling Effect were looked at as ways to improve the performance of tall reinforced concrete (RC) buildings that have to deal with both wind and earthquake loads. Instead of RC coupling beams, VCDs are used to take advantage of the different shear



deformations of adjacent walls when the structure is loaded from the side. The VCDs are made of several layers of Torsion material that are bonded to alternating steel plates. Each successive steel layer extends to the other side and is connected to the walls in different ways.

Rober Samuel (2015) Here, a new system called the Torsion coupling effect (VCD) has been made and studied to improve the wind and seismic performance of high-rise buildings with connected shear walls by adding high elements instead of reinforced concrete coupling beams. VCDs replace structural parts like outriggers or coupling beams, so they don't take up any space that could be used for something else. When they are set up right in high-rise buildings, they add extra viscosity to all lateral modes of vibration. This helps tenants feel less vibration and reduces the building's response to both wind and earthquakes. The results of tests done on five small Torsion (VE) effect specimens that were between 5 and 10 mm.

Rajneesh Kakar (2016) Analytical and numerical methods were used to study the spread of Love waves in an inhomogeneous Torsion layer above a gravitational half-space when the upper boundary plane was assumed to be free. With Whitaker's function, the relationship between the Love wave's spread and its closed form was found. In this study, graphs were used to show how different nondimensional inhomogeneity factors, the gravity factor, and internal friction affect the speed of nondimensional Love waves. The researcher saw that the Love wave's dispersion curve goes up as the inhomogeneity factor goes up. Love waves slow down when there is more gravity, inhomogeneity, or internal friction, but this is most noticeable when there is more internal friction. The surface plot of Love waves showed that the velocity ratio goes up as the nondimensional phase velocity and nondimensional wave number go up. These results may be interesting to seismologists and geologists.

Yutaka Nakamura (2016), In this study, a Torsion effect is made by using a Torsion material that doesn't change much with temperature. Also, a performance-based placement-design procedure for the Torsion effect in a building is made so that each peak interstory drift matches the required value. The necessary number of Torsion effects at each story is found by dividing the area of the Torsion material by the area of the VE material of the used single-wall-type VED and rounding the result to a whole number.

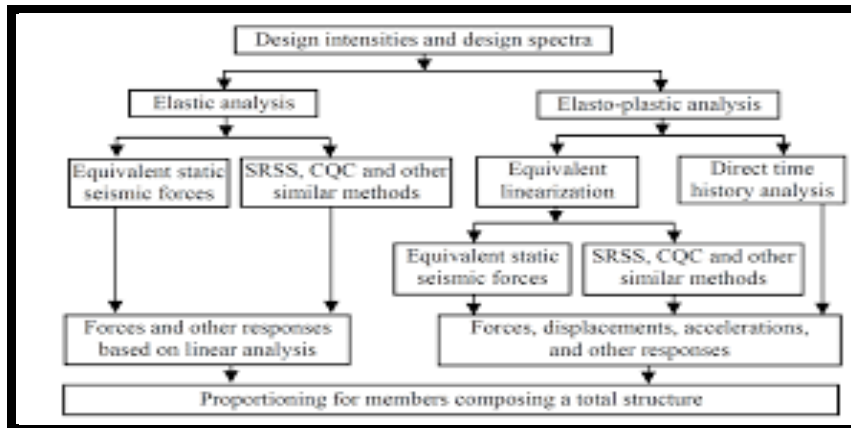
Renata G. Faisca (2001) In this paper, we talk about how to do experiments to figure out the physical properties of Torsion materials. The method proposed here, which uses direct measurements of forces and responses in terms of displacements or accelerations, is compared to two well-known methods: the standard ASTM method and the method based on indirect measurements. These three ways were used to test two different kinds of materials. The ASTM method gave the most reliable results based on the results of the experiments used to describe Torsion materials using the three methods that were looked at (ASTM 1993). It's important to point out that using thin Torsion materials can lead to small flaws in the final assembly. But the problems that were seen in the tests should be kept to a minimum in real life, since thicker materials are needed for that.

David W. Dinehart (2001) Twelve Torsion effects were put to the test until they broke under static loading. Half of the effects were made of VE material and A36 steel, which is what most VE effects are made of, and the other half were made of wood instead of steel. For each of the three thicknesses of VE material used, tests were done on two pieces of wood and steel. The replicate effect showed that there was no difference in how well the steel effect and the wood effect worked. The tests on the effects showed that VE material could be put right on wood. The first full-scale results showed that putting Torsion sheet material between the wall sheathing and the wall frame could be a good way to improve the way wood-frame shear walls release energy. Also, the sheet material was put up in such a way that it didn't change the size of the wall. This new way to use VE material could be used in the design of new buildings or to fix up old ones made of wood. But it should be noted that only a small amount of testing was done on the effect and the wall. More testing is needed to confirm these initial results and look into things like environmental effects, the best thickness and type of material, and repeatability.



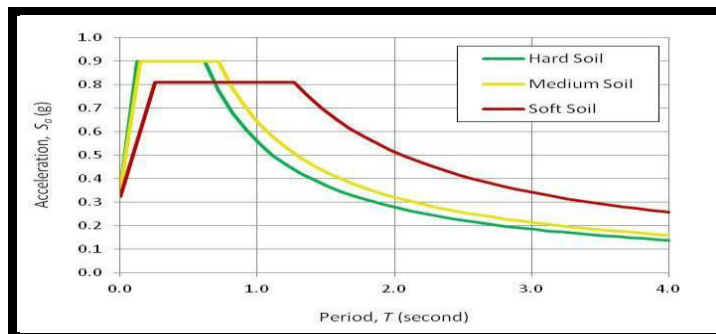
III. METHODOLOGY

RESPONSE SPECTRUM METHODOLOGY:-

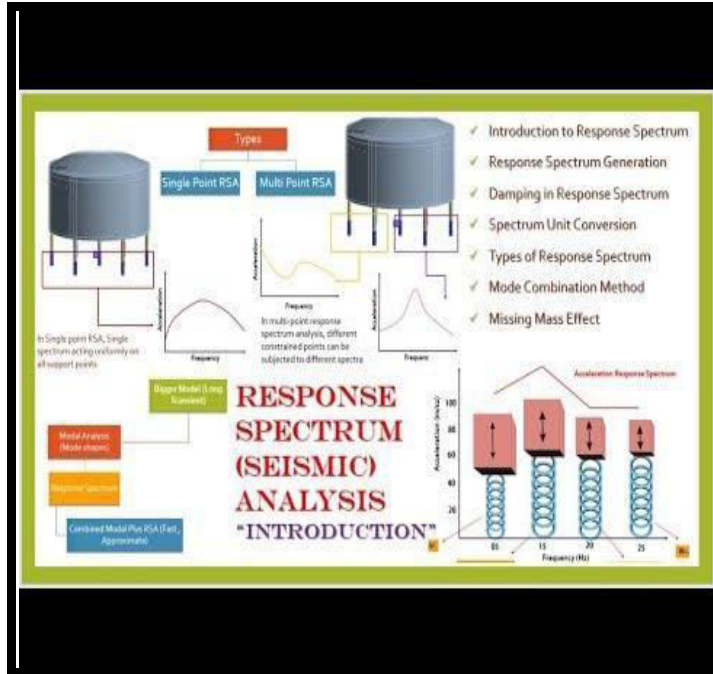


Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis method that measures the contribution from each natural mode of vibration to predict the likely maximum seismic response of a mostly elastic structure. Response-spectrum analysis gives information about dynamic behaviour by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. It is possible to wrap response spectra so that the peak response for each realisation of the structural period is shown by a smooth curve.

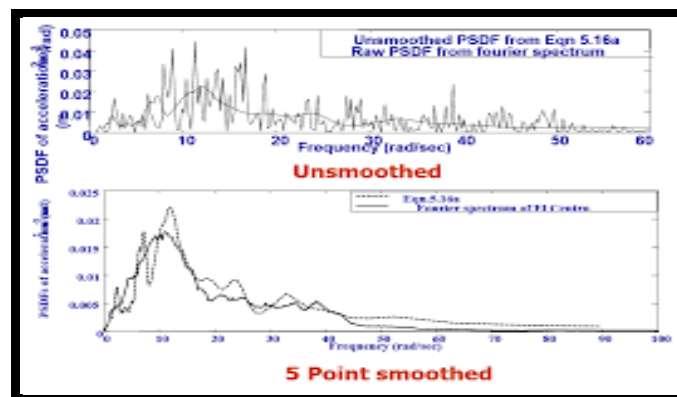
Response-spectrum analysis is helpful for making design decisions because it shows how the type of structure you choose affects how well it moves. Structures with shorter periods have more acceleration, while structures with longer periods have more displacement. During preliminary design and response-spectrum analysis, performance goals for the structure should be taken into account.



A response spectrum is a graph of the peak or steady-state response (displacement, velocity, or acceleration) of a group of oscillators with different natural frequencies that are set in motion by the same base vibration or shock. If you know the natural frequency of oscillation of a linear system, you can use the resulting plot to figure out what it will do. One way it is used is to figure out how buildings react at their worst during earthquakes. Scientists who study strong ground motion may be able to use some values from the ground response spectrum, which is calculated from seismograph recordings of surface ground motion, to figure out how seismic damage is caused. If the input used to calculate a response spectrum is steady-state periodic, then the steady-state result is recorded. If there is no damping, the response will be infinite. For inputs that change over time, like seismic ground motion, the peak response is given. Most of the time, some level of damping is assumed, but even if there is no damping, a value will be found.



Response spectra can also be used to measure the response of linear systems with more than one way to oscillate (systems with more than one degree of freedom), but they are only accurate for low levels of damping. Modal analysis is used to find the modes, and from the response spectrum, the response in that mode can be chosen. The total response is then estimated by adding up all of these peak responses. If the modal frequencies are not close together, the square root of the sum of the squares (SRSS) is a common way to combine them. Since phase information is lost in the process of making the response spectrum, the result is often different from what would be calculated directly from the input. The main problem with response spectra is that they can only be used for linear systems in general. Response spectra can be made for non-linear systems, but they only work for systems with the same level of non-linearity. However, people have tried to make non-linear seismic design spectra that can be used for a wider range of structures. This means that the results can't be put together directly for a multi-mode response.

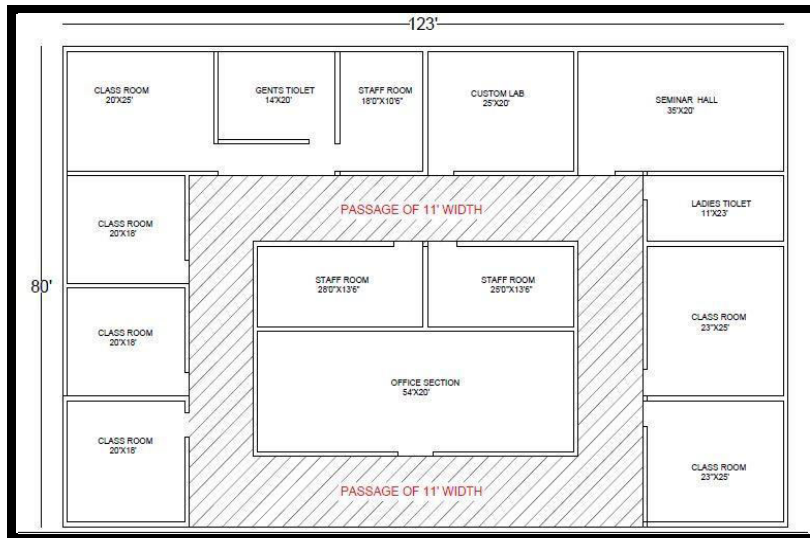


Response spectra are very useful in earthquake engineering for figuring out how buildings and other things work during quakes, since many of them act mostly like simple oscillators. So, if you can figure out the structure's natural frequency, you can estimate the building's peak response by reading the value for that frequency from the ground response spectrum. In most building codes in areas prone to earthquakes, this number is used to figure out how much force a building must be able to withstand. As was already said, the ground response spectrum is the plot of the response at the earth's free surface. If the building's response is "in tune" with parts of the ground motion (resonance), which can be seen in the response spectrum, it could cause a lot of damage.

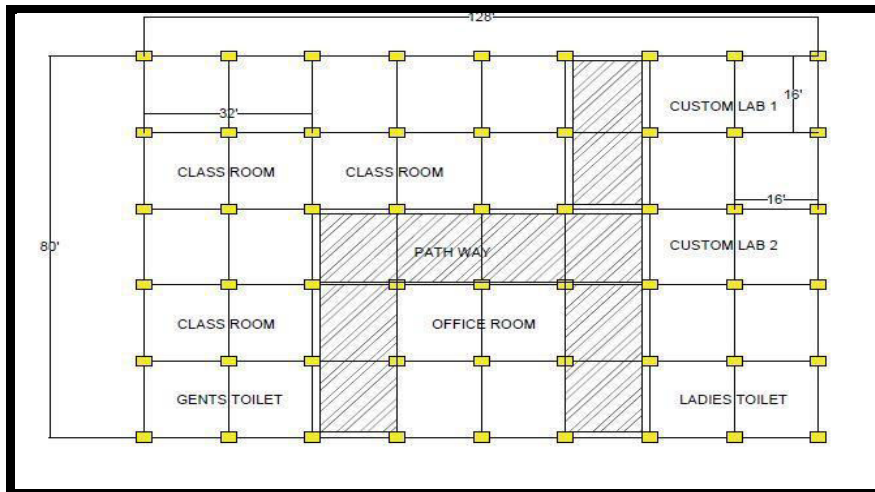


For "regular" low-rise buildings, the structural response to earthquakes is characterised by the fundamental mode (a "waving" back and forth), and most building codes allow design forces to be calculated from the design spectrum based on this frequency. However, for more complex structures, it is often necessary to combine the results for many modes (calculated through modal analysis). When buildings are too oddly shaped, too tall, or important to a community during a disaster, the response spectrum approach isn't enough. Instead, a more complex analysis is needed, such as a non-linear static or dynamic analysis, as in the seismic performance analysis technique.

BUILDING DESCRIPTION



2D PLAN LAYOUT



2D BEAM & COLUMN LAYOUT

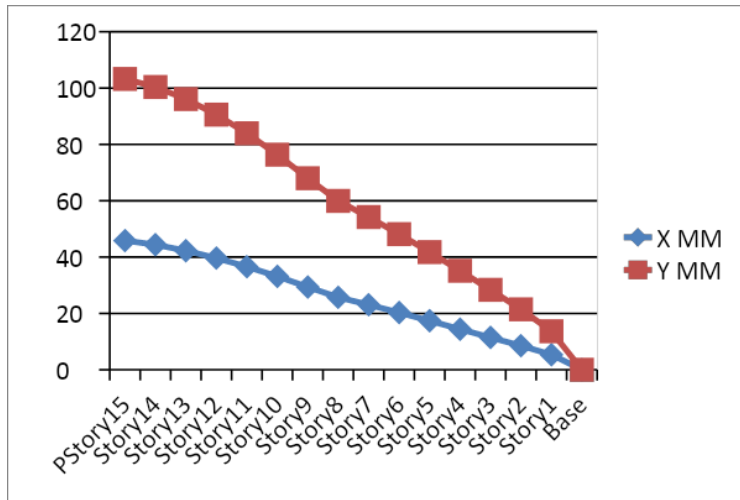
This study is based on an eight-story building. All building plans are the same, but the bracing is different.



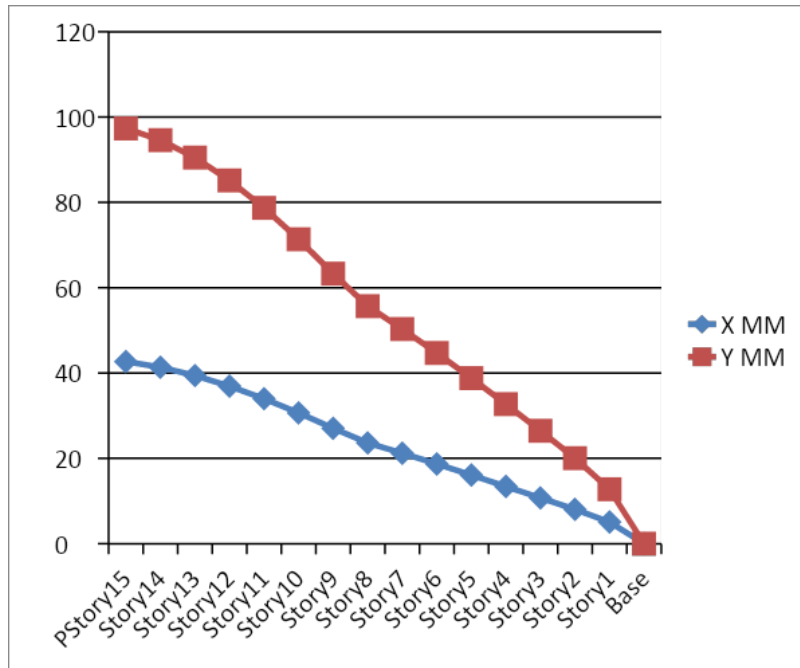
IV. EXPERIMENTAL RESULTS

DISPLACEMENT

MODEL 1: RCC

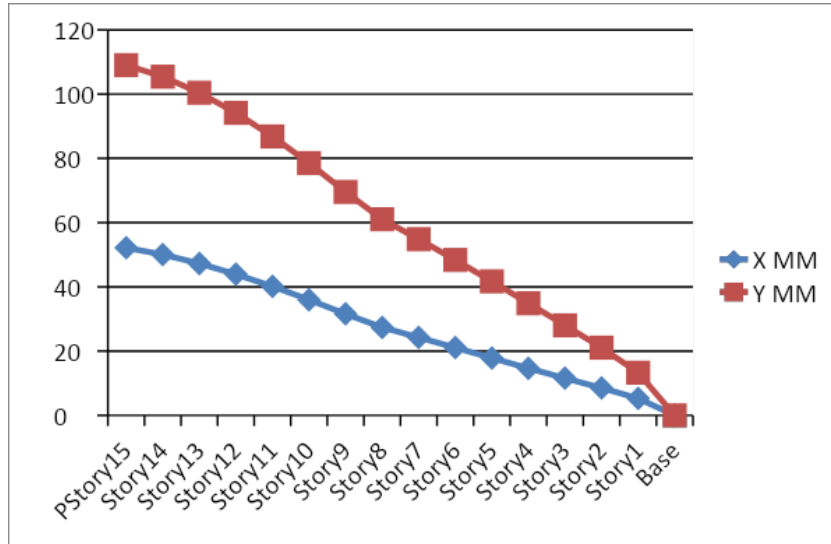


MODEL 2: C-SHAPE



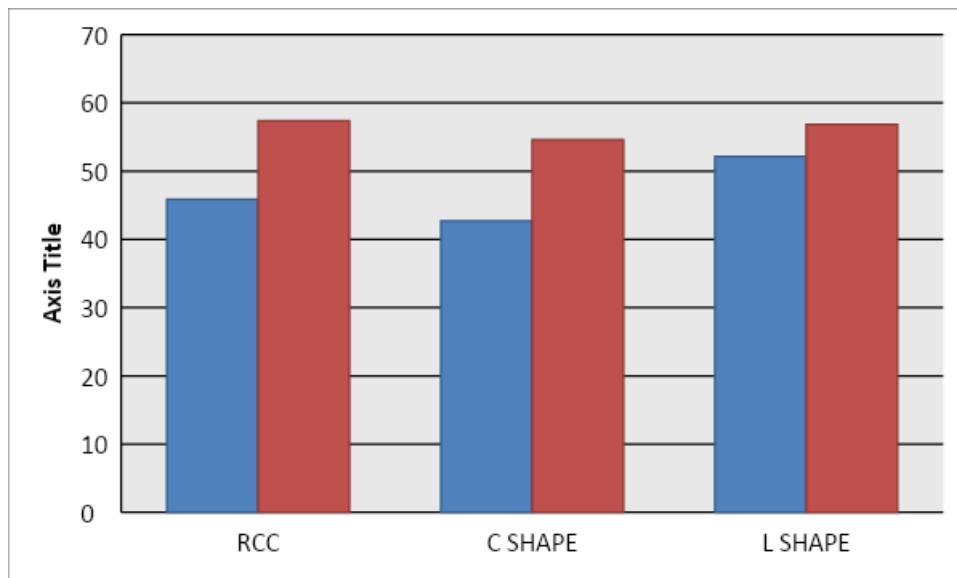


MODEL 3: L SHAPED



FINAL DISPLACEMENT COMPARISON

MODEL	X	Y
RCC	45.846	57.387
C SHAPE	42.691	54.629
L SHAPE	52.166	56.844

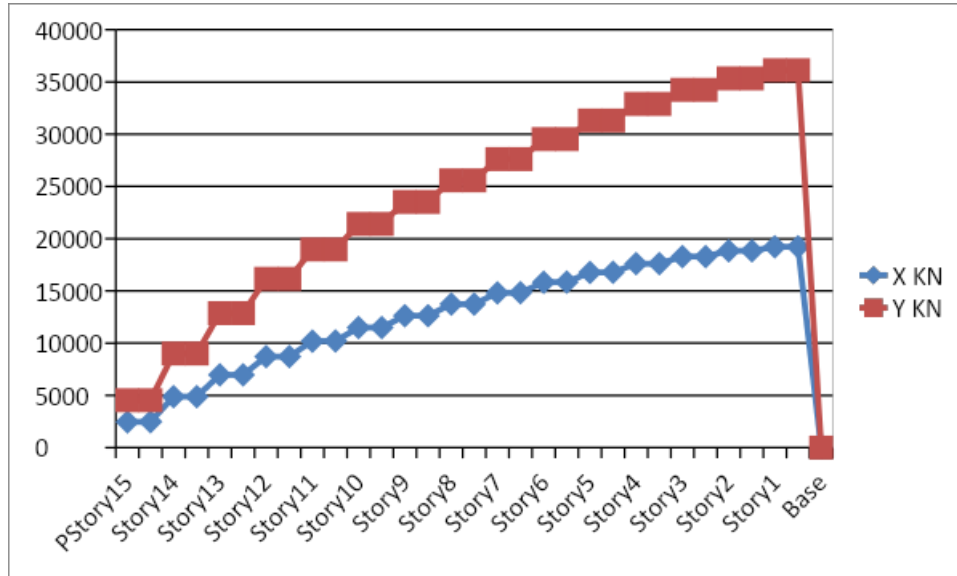


1. Considering Rcc the maximum story displacement of the story is found to be around 45.846 in X direction and 57.387 in Y direction and it is found to be the displacement is little bit maximum at Y direction .
2. Considering C- Shape the maximum story displacement of the story is found to be around 42.691 in X direction and 54.629 in Y direction and it is found to be the displacement is little bit maximum at Y direction .
3. Considering L- Shape the maximum story displacement of the story is found to be around 52.166 in X direction and 56.844 in Y direction and it is found to be the displacement is little bit maximum at Y direction .
4. In final comparison that is placement for the L Shape he is found to be greater than that of the RCC and also as well as C shaped structure while considering in X direction.

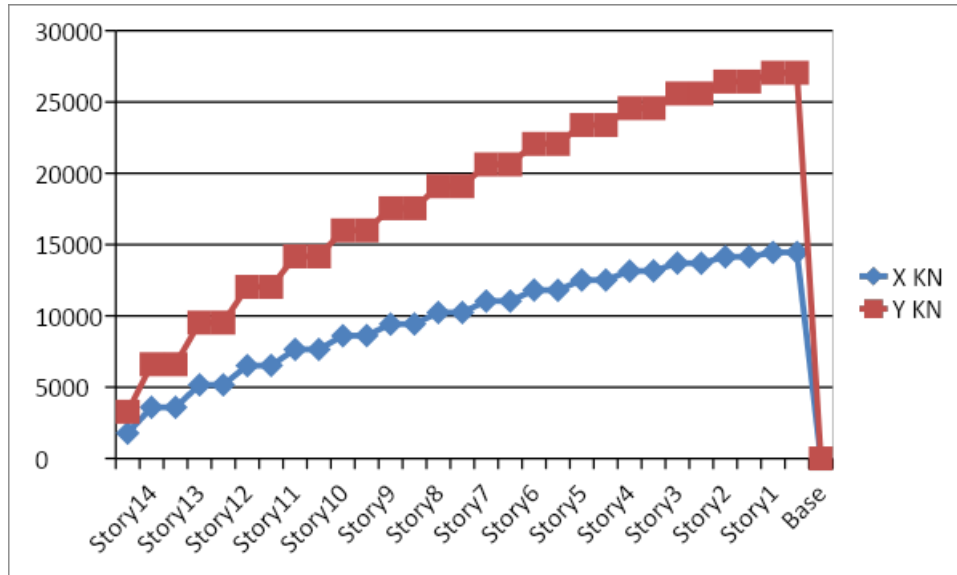


- considering the values in Y direction the maximum story displacement takes place in RCC structure, while L shaped structure is better when compared to that of the three shaped structure will remain the second choice in my direction.

**SHEAR
MODEL 1: RCC**

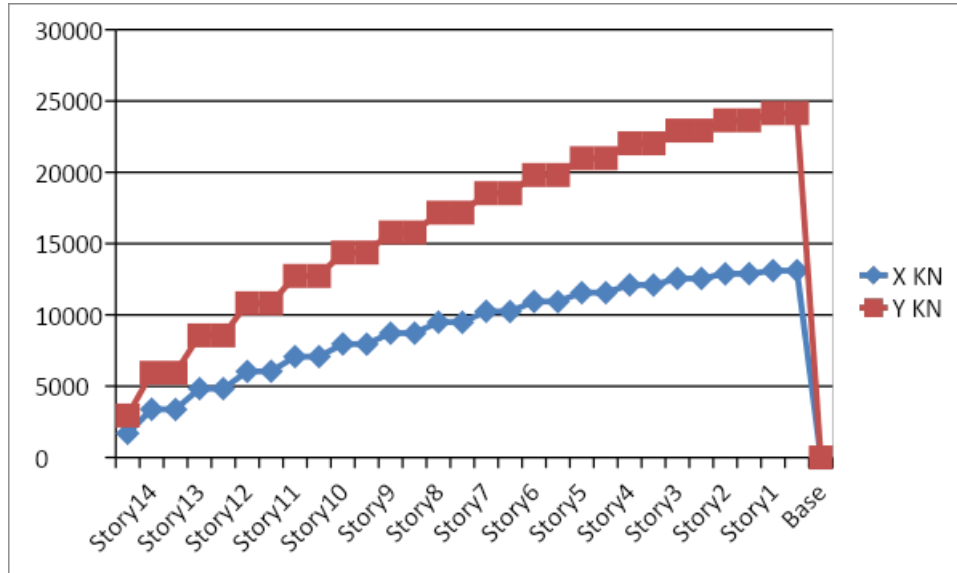


MODEL 2: C-SHAPE



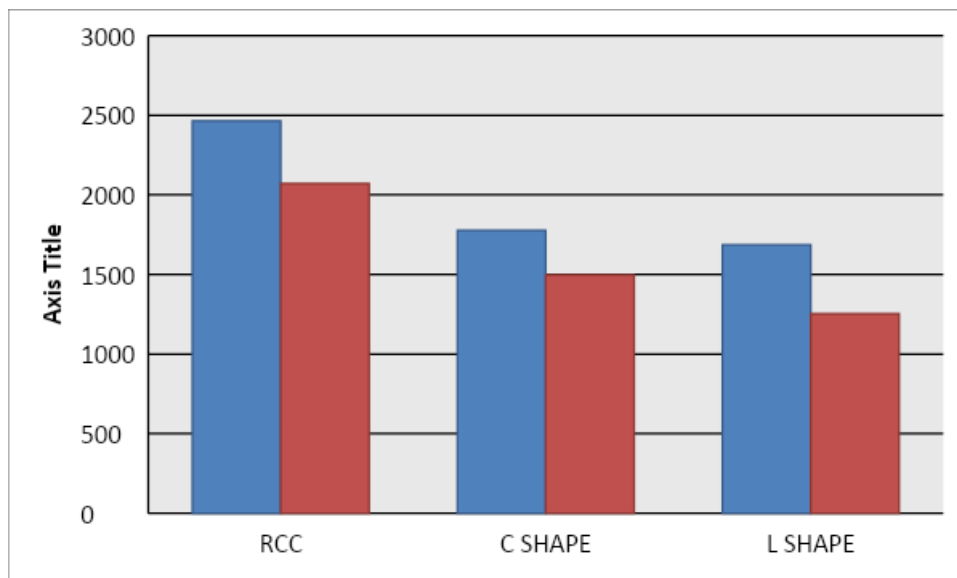


MODEL 3: L SHAPED



FINAL SHEAR RESULTS COMPARIOSN

MODEL	X	Y
RCC	2464.5337	2070.787
C SHAPE	1777.6116	1499.033
L SHAPE	1685.9227	1254.511



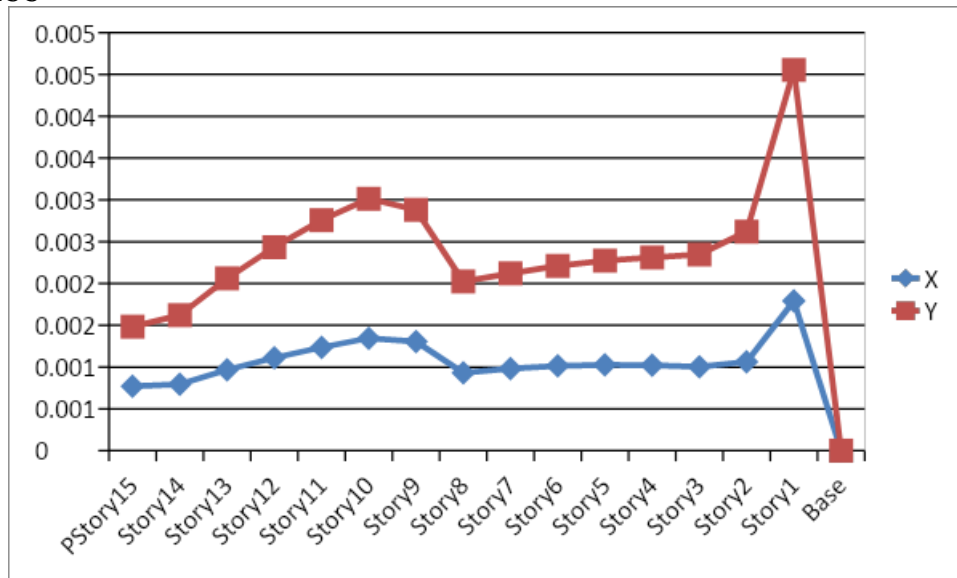
1. Considering Rcc the maximum story shear is found to be around 2464.5337in X direction and 2070.787in Y direction and it is found to be the displacement is little bit maximum at X direction .
2. Considering C-Shaped the maximum story shear is found to be around 1777.6116 in X direction and 1499.033 in Y direction and it is found to be the displacement is little bit maximum at X direction .



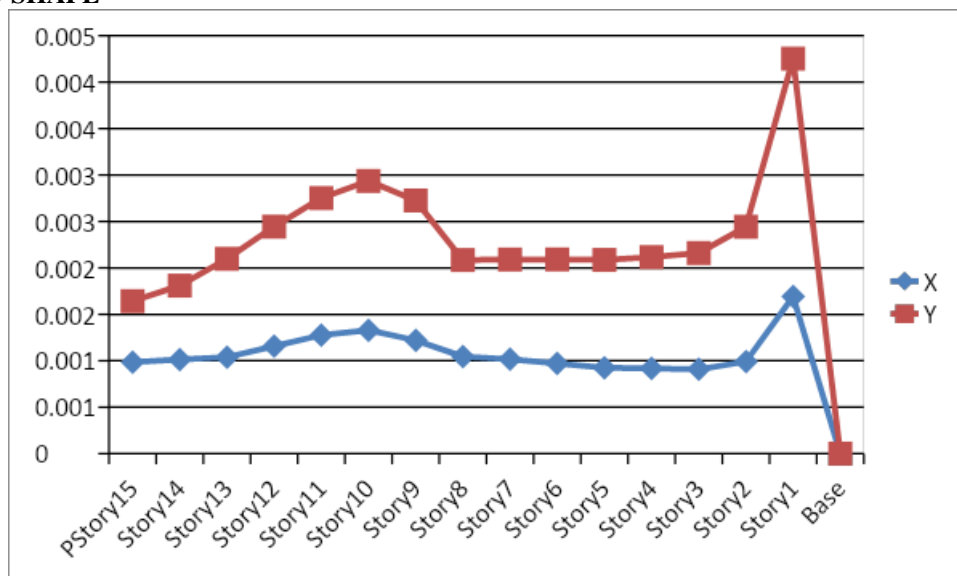
3. Considering L-Shaped the maximum story shear is found to be around 1685.9227in X direction and 1254.511in Y direction and it is found to be the displacement is little bit maximum at X direction .
4. In final comparison that is Shear for the L Shape he is found to be less than that of the RCC and also as well as C shaped structure while considering in X direction.
5. considering in Y direction Shear for the L Shape he is found to be less than that of the RCC and also as well as C shaped structure while considering in Y direction.

DRIFT

MODEL 1: RCC

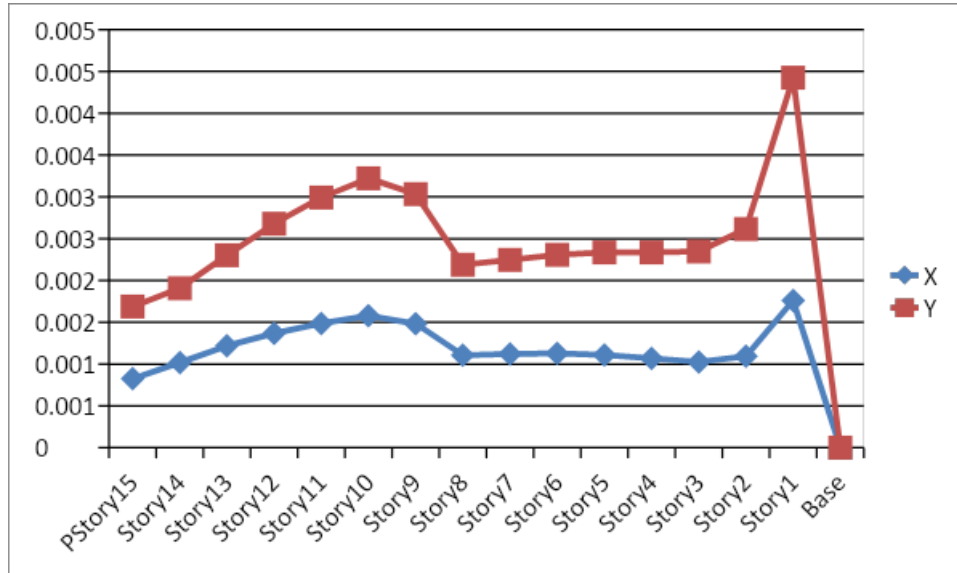


MODEL 2: C-SHAPE



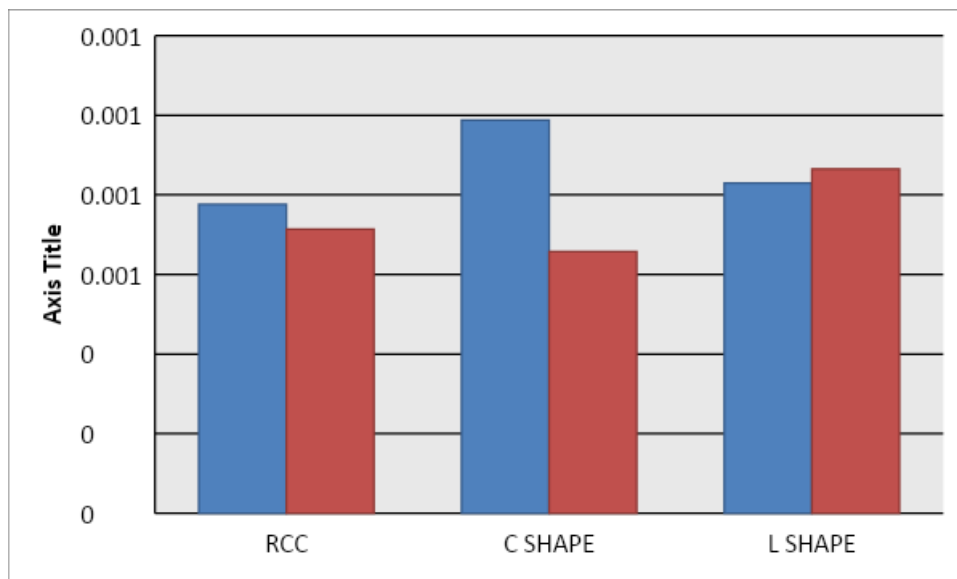


MODEL 3: L SHAPED



FINAL DRIFT RESULTS COMPARISON

MODEL	X	Y
RCC	0.000776	0.000714
C SHAPE	0.000988	0.000658
L SHAPE	0.00083	0.000865



1. Considering Rcc the maximum story drift is found to be around 0.000776 in X direction and 0.000714 in Y direction and it is found to be the little bit maximum at X direction.
2. Considering C-shaped the maximum story drift is found to be around 0.000988 in X direction and 0.000658 in Y direction and it is found to be the little bit maximum at X direction.
3. Considering L-shaped the maximum story drift is found to be around 0.00083 in X direction and 0.000865 in Y direction and it is found to be the little bit maximum at Y direction.



4. In final comparison that is Drift for the RCC is found to be less than that of the C & L Shape and also as well as L shaped structure while considering in X direction.
5. Considering in Y direction Drift for the L Shape he is found to be more than that of the RCC and also as well as C shaped structure while considering in Y direction.

RESONCE SPECTRUM:

MODEL	SCALE FACTOR	BASE>85%	RRF>90%
RCC	2599	85	99.22
C SHAPE	2581	85	99.36
L SHAPE	2794	85	99.39

1. Under the response spectrum analysis all model has been passed the base reaction value which is greater than 85 % and also the response reduction factor using the modal participating mass ratio is found to be for all model above 90%.
2. Hence the base reaction and the response reduction factor passes all the criteria according to the highest standard and also the scale factor is found to be around nominal conditions validating all the required criteria.

TORSIONAL IRREGULARITIES:

RCC

LOAD	MAX	MIN	AVERAGE>1.2
EQX	62.206	53.755	1.157213282
EQY	67.497	45.379	1.487406069

C SHAPE

LOAD	MAX	MIN	AVERAGE>1.2
EQX	61.585	57.765	1.06613001
EQY	64.252	42.994	1.494441085

L SHAPE

LOAD	MAX	MIN	AVERAGE>1.2
EQX	62.463	52.201	1.196586272
EQY	66.044	43.315	1.524737389

1. After the analysis we have checked the torsional irregularities for each models and the result as shown above in the table for RCC and C shape and also as well as in shape.
2. structure there is no torsional irregularity present in X direction but there is certain kind of irregularity present in Y direction taking the average of these values we will get around 1.32 this value is greater than that of the prescribed value 1.2.



3. Hence for RCC structure there is a little bit torsional irregularity present in Y direction and also getting the average of a total model there is a some sort of torsional irregularity present in the structure.
4. considering the c-shaped structure that irregularities values is as follows for X direction the torsional irregularity is low when compared to that of Y more. Hence we can say that in X direction there is no torsional but in y-direction it crosses the value 1.2.
5. Considering the shape for the torsional irregularities in both the direction that is in x direction there is no torsional the regularity but in y direction there is some sort of torsional value is present.
6. considering all the three models in X direction there is no torsional irregularity and the value is found to be less than that of 1.2 but in Y direction there is certain torsional irregularity why we recommend that using any kind of retrofitting methodology in order to reduce the Torsion

V. CONCLUSION

1. Considering all the three models in X direction there is no torsional irregularity and the value is found to be less than that of 1.2 but in Y direction there is certain torsional irregularity why we recommend that using any kind of retrofitting methodology in order to reduce the Torsion.
2. Under the response spectrum analysis all model has been passed the base reaction value which is greater than 85 % and also the response reduction factor using the modal participating mass ratio is found to be for all model above 90%.
3. In final comparison that is Drift for the RCC is found to be more than that of the C & L Shape and also as well as L shaped structure while considering in X direction.
4. Considering in Y direction Shear for the L Shape he is found to be less than that of the RCC and also as well as C shaped structure while considering in Y direction.
5. In final comparison that is Drift for the RCC is found to be less than that of the C & L Shape and also as well as L shaped structure while considering in X direction.
6. Considering in Y direction Shear for the L Shape he is found to be more than that of the RCC and also as well as C shaped structure while considering in Y direction.
7. In final comparison that is Shear for the L Shape he is found to be less than that of the RCC and also as well as C shaped structure while considering in X direction.
8. Considering in Y direction Shear for the L Shape he is found to be less than that of the RCC and also as well as C shaped structure while considering in Y direction.
9. In final comparison that is placement for the l Shape he is found to be greater than that of the RCC and also as well as C shaped structure while considering in X direction.
10. considering the values in Y direction the maximum story displacement takes place in RCC structure, while L shaped structure is better when compared to that of the three shaped structure will remain the second choice in my direction.

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