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STUDY ON ANALYSIS OF SYMMETRIC AND ASYMMETRICAL BUILDING

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ABSTRACT

It is very important to find out the behavior of the buildings and the damage that originates from the places of structural weak levels in the building systems, which is due to the different shape of the building, ie. rectangular, square, L-shaped and T. -shaped building. The contribution of the lateral load resistance system, the number of layers, the type and the different types of analysis method must be properly evaluated to avoid the twisting effect and collapse of the structure. The behavior of a building during an earthquake depends significantly on its overall shape, size and geometry. Buildings with irregular geometries react differently to seismic impact. The geometry of the design is the parameter that determines its performance under various load conditions. The effects of irregularity (plan and shape) on the structures were performed using the structural analysis software ETABS 2018.The aim of the study is to compare the seismic performance of Equivalent Static Method, Response Spectrum Method and Push Over. Analytical method using soil as medium. G+24 floor structures are located in earthquake zone III. All frames are designed with the same gravity. The response spectrum method and the thrust analysis method are used for seismic analysis. ETABS software is used and the results are compared. of. The results were obtained in the form of Earthquake Displacement, Story Force, Base Shear and Modal Mass Participations.

Keywords: ETABS, Earthquake Load, Torsion, Response Spectrum, Push Over Modal Mass Participation.

1. INTRODUCTION

General Introduction

Recent earthquakes have shown that uneven distribution of mass, stiffness and strength can seriously damage structural systems. Structures become asymmetric for a number of reasons. The asymmetry of structures makes the analysis of seismic behavior difficult. Seismic demand for edge elements is increasing. Even distribution of the load is disturbed. The torsional behavior of an asymmetric building is one of the most common causes of structural damage and failure under strong ground motions. The torsional reactions of structures arise from two sources: Eccentricity in the mass and stiffness distribution, which causes a torsional reaction together with a translational reaction; and torsion due to random causes, including uncertainties in masses and stiffnesses, differences in the connection of the structural foundation to the subsoil or rock, and the effect of wave propagation on seismic motion that causes torque input to the ground, and torsional motion during an earthquake to ground himself..

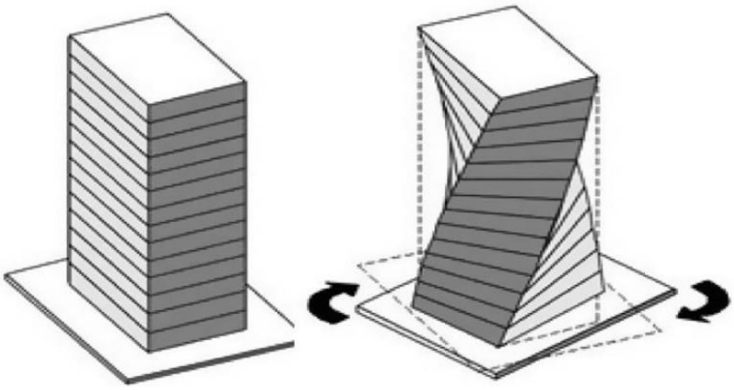


Fig 1: Tortional Moment in Structure.

Seismic damage surveys and analyses conducted on modes of failure of building structures during past severe earthquakes concluded that most vulnerable building structures are those, which are symmetrical and asymmetric in nature. Asymmetric-plan buildings, namely buildings with in-plan asymmetric mass and strength distributions, are systems characterized by a coupled torsional-translational seismic response.

Torsion in buildings during earthquake shaking may be caused from a variety of reasons, the most common of which are non-symmetric distributions of mass and stiffness.

Earthquake load acts at the center of mass of the structure. However, resisting force acts at a point called center of rigidity on the structure, which is the center of lateral resistance. Torsional problems take place when the mass center and center of rigidity are not located at the same place. By increasing distance between center of mass and center of rigidity, building is forced to twist around the rigid structural section (rigid core) and subjected to great torsional moments. The lateral-torsional coupling due to eccentricity between center of mass (CM) and center of rigidity (CR) in asymmetric building structures generates torsional vibration even under purely translational ground shaking. During seismic shaking of the structural systems, inertia force acts through the Centre of mass while the resistive force acts through the Centre of rigidity.

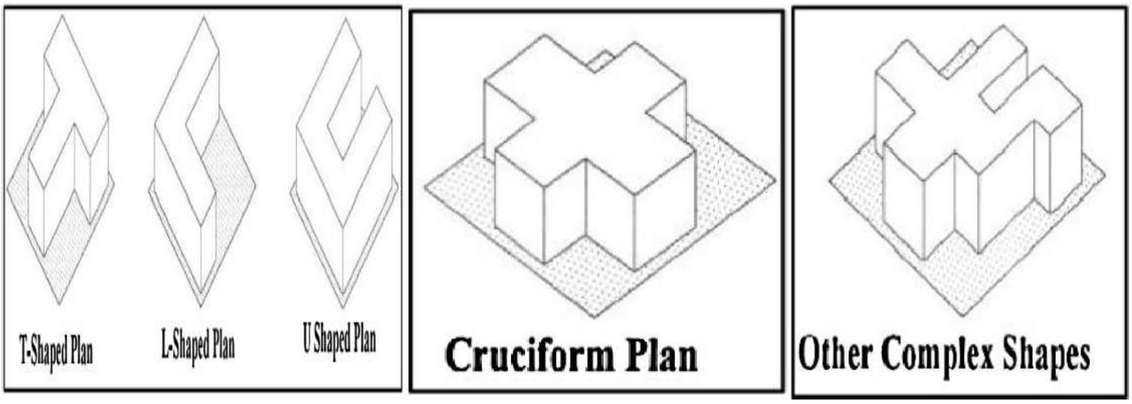


Fig 2: Structural Asymmetry

2. RESEARCH OBJECTIVE

Based on the literature review presented in Chapter 2, the salient objectives of the Present study have been identified as follows

1) Analysis of G+24 story building with IS456-2007 Design of Concrete structure using ETABS 2016.
2) To study behavior of RCC building G+24 story with different shape of plan using equivalent statics method, response spectrum method and pushover analysis method.
3) To study the effect torsional analysis of symmetrical and asymmetrical building, study on the influence of the torsional moment effects on the behavior of structure is done by using Response spectrum method.
4) Then simplified nonlinear pushover analysis has been used to find structural descriptors required in seismic vulnerability assessment.

3. PROJECT STATEMENT

The study will give more knowledge which result into benefits for future implementation with the help of RCC building actual design. To study the effect of shape and position of shear wall on structural behavior.

Response Spectrum Method

A response spectrum is simply a plot or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by same base vibration. The resulting plot can then be used to pick off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the peak response of building to earthquake. The science of strong ground motion may use some values from the ground response spectrum for correlation with seismic damage.

In technical terms it can be said that it is the representation of the maximum response of idealized single degree of freedom having certain period and damping during earthquake ground motion. The maximum response is plotted against the undammed natural period and for various damping values can be expressed in terms of maximum relative velocity or maximum relative displacement. The characteristics of seismic ground vibrations expected at any location depends upon the magnitude of earthquake, its depth of focus, distance from the epicenter, characteristics of the path through which the seismic waves travel, and soil strata on which

the structure stands. The random earthquake ground motions, which cause the structure to vibrate, can be resolved in any three mutually perpendicular directions.

Non-Linear Static Push-over Analysis

The pushover analysis of a structure is a static nonlinear analysis under permanent vertical loads and gradually increasing lateral loads. The equivalent static lateral loads approximately represent earthquake induced forces. A plot of the total base shear versus top displacement in a structure is obtained by this analysis that would indicate any premature failure or weakness. The analysis is carried out up to failure, thus it enables determination of collapse load and ductility capacity. On a building frame, plastic rotation is monitored, and lateral inelastic forces versus displacement response for the complete structure are analytically computed. This type of analysis enables weakness in the structure to be identified.

The decision to retrofit can be taken in such studies. Two key elements of a performance-based design procedure are demand and capacity. Demand is a representation of the earthquake ground motion. Capacity is a representation of the structures ability to resist the seismic demand. The performance is dependent on the manner that the capacity is able to handle the demand. In other words, the structure must have the capacity to resist the demands of the earthquake such that the performance of the structure is compatible with the objectives of the design. Once the capacity curve and demand displacement are defined, a performance check can be done. A performance check verifies that structural and non-structural components are not damaged beyond the acceptable limit of the performance objective for the forces and displacements implied by the displacement demand. In this study, nonlinear static pushover analysis was used to evaluate the seismic performance of the structures.

4. PROBLEM FORMULATION

Multi-storied ferroconcrete, moment defying space frame are anatomized using professional software ETABS2016. Model G+24 of erecting frame with three kudos in vertical and three kudos in side direction is anatomized by Response spectrum method.

The plan confines of structures are shown in table below.

The plan view of structure, elevation of colorful frames is shown in numbers below.

Table No 1: Detail Features of Building G+24 Story

Type of structure	Frame structure
Moment-Resisting frame	SMRF
Type of soil	Medium
No of Stories	G+24
Height of each story	3m
Height of ground story	5m
Thickness of slab	150mm
Thickness of outer wall	150mm
Thickness of inner wall	150mm
Grade of reinforcing steel	Fe 415
Concrete Poisons ratios	0.2
Density of concrete	25 kN/m3
Density of wall	20 kN/m3
Grade of concrete in slab	M35
Beam size	300x450mm
Response reduction factor	3
Damping	5%
Grade of concrete in beam	M35
Grade of concrete in column	M35
Grade of concrete in footing	M35
Seismic zone	3
Seismic intensity	0.16
Analysis type	Dynamics (Response Spectrum Analysis)

Different building shape plan

A. Rectangular shape building

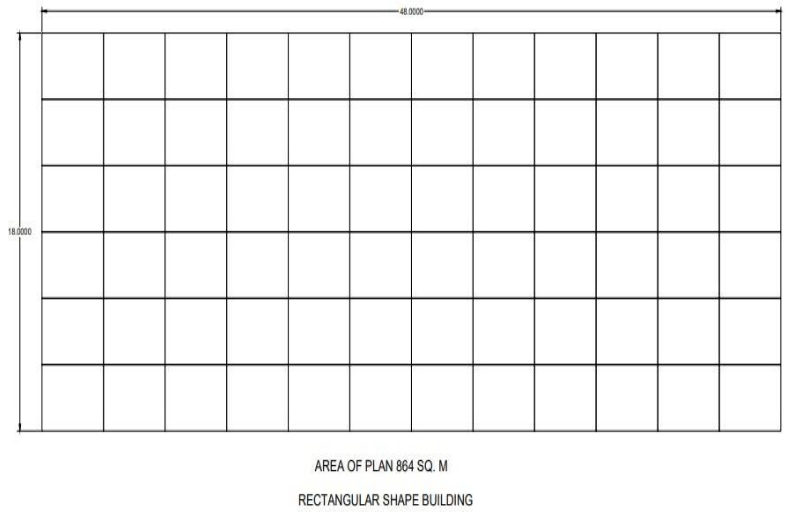


Fig. G+24 Story Rectangular Building Plan

B. Square Shape Building Plan:

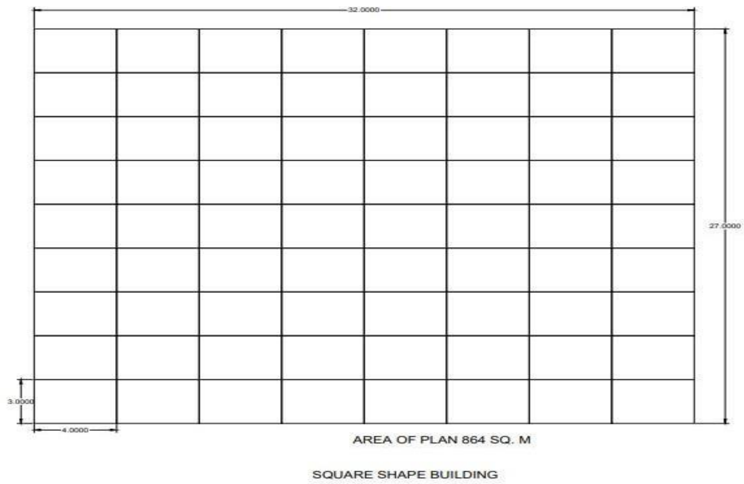


Fig. G+24 Story Square Shape Building

C. T-shape building

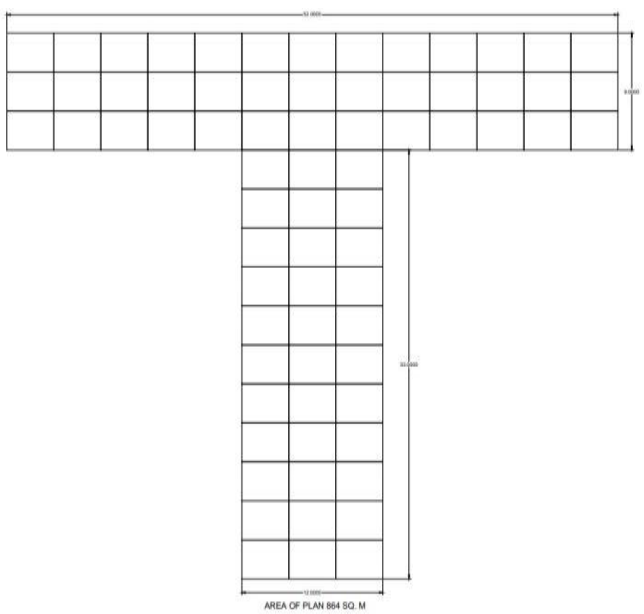


Fig. G+24 Story T-Shape Building Plan

D. L- Shape Building Plan:

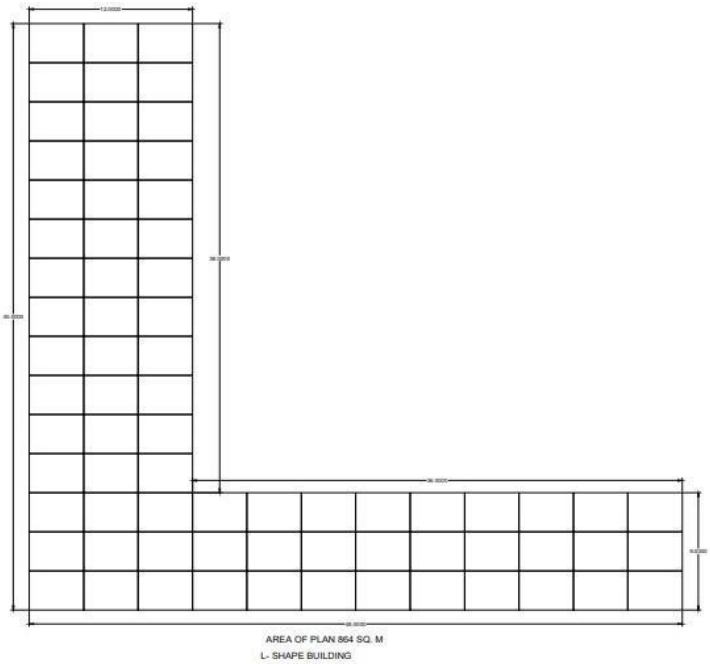
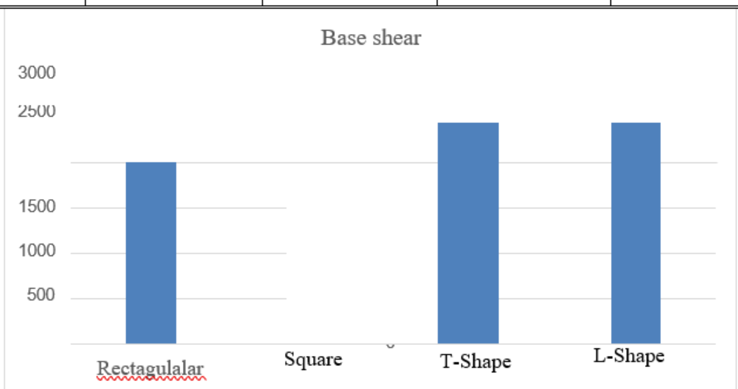


Fig. G+24 Story L- Shape Building

5. RESULTS

Table 1. Base Shear Different Shape of Building in Equivalent and Response Spectrum Analysis method

TABLE: Load Pattern Definitions - Auto Seismic - IS 1893 2002				
Name	Base Shear (KN)	Base Shear (KN)	Base Shear (KN)	Base Shear (KN)
	Rectangular	Square	T-shape	L-shape
EQ+X	2044.7012	2435.2058	2706.8163	2441.5662
EQ+Y	1623.2175	2321.9512	2356.4383	2336.0909
EQ-X	2044.7012	2435.2058	2706.8163	2441.5662
EQ-Y	1623.2175	2321.9512	2356.4383	2336.0909



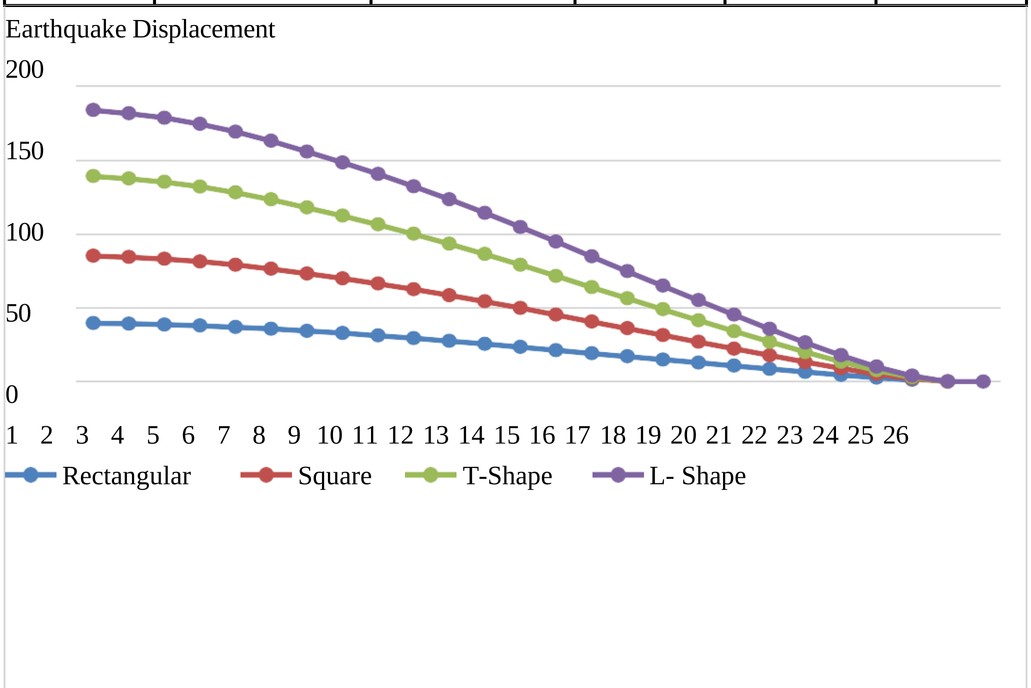
Graph 1: Base Shear Vs. Different Shape of Building

Earthquake Displacement Results

Table 2. Earthquake Displacement Vs. Different Shape of Building in Response Spectrum Analysis Method

TABLE: Diaphragm Center of Mass Displacements					
Story	Load Case/Combo	UX (mm)	UX (mm)	UX (mm)	UX (mm)
		Rect.	Square	T-shape	L-shape
Story25	EQ+X	39.633	45.59	53.997	44.777
Story24	EQ+X	39.277	45.147	53.157	44.225

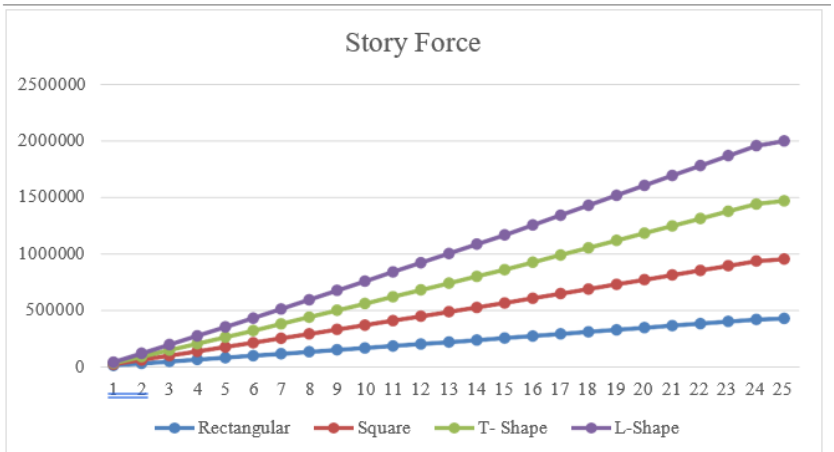
Story23	EQ+X	38.73	44.439	52.115	43.494
Story22	EQ+X	37.964	43.441	50.735	42.491
Story21	EQ+X	36.983	42.164	49.031	41.219
Story20	EQ+X	35.805	40.622	47.023	39.693
Story19	EQ+X	34.447	38.808	44.721	37.906
Story18	EQ+X	32.927	37.031	42.45	36.137
Story17	EQ+X	31.263	35.139	40.053	34.256
Story16	EQ+X	29.473	33.123	37.525	32.257
Story15	EQ+X	27.571	30.989	34.869	30.146
Story14	EQ+X	25.575	28.75	32.101	27.935
Story13	EQ+X	23.496	26.418	29.24	25.637
Story12	EQ+X	21.349	24.008	26.31	23.268
Story11	EQ+X	19.142	21.533	23.327	20.843
Story10	EQ+X	17.075	19.02	20.363	18.378
Story9	EQ+X	14.985	16.536	17.504	15.949
Story8	EQ+X	12.876	14.048	14.673	13.521
Story7	EQ+X	10.759	11.573	11.904	11.112
Story6	EQ+X	8.648	9.138	9.232	8.75
Story5	EQ+X	6.566	6.785	6.711	6.476
Story4	EQ+X	4.555	4.574	4.413	4.349
Story3	EQ+X	2.689	2.604	2.439	2.464
Story2	EQ+X	1.114	1.029	0.93	0.968
Story1			0	0	0.093
Story0					0



Graph 2: Earthquake Displacement Vs. Different Shape of Building in Response Spectrum Analysis

Table 3. Story Force Results Response Spectrum Analysis Method

TABLE: Story Forces					
Story	Load Case/Combo	P (kN)	P (kN)	P (kN)	P (kN)
		Rect.	Square	T-shape	L-shape
Story25	1.5(DL+LL)	7827.995	11392.21	9473.724	8006.3687
Story24	1.5(DL+LL)	25057.66	32066.3	29004.89	28494.0274
Story23	1.5(DL+LL)	42287.33	52740.38	48536.06	48981.6862
Story22	1.5(DL+LL)	59516.99	73414.46	68067.23	69469.3449
Story21	1.5(DL+LL)	76746.66	94088.55	87598.4	89957.0036
Story20	1.5(DL+LL)	93976.32	114762.6	107129.6	110444.6623
Story19	1.5(DL+LL)	111206	136676	128042.4	132314.7681
Story18	1.5(DL+LL)	128435.7	158589.3	148955.3	154184.8738
Story17	1.5(DL+LL)	145665.3	180502.7	169868.2	176054.9796
Story16	1.5(DL+LL)	162895	202416	190781	197925.0853
Story15	1.5(DL+LL)	180124.6	224329.3	211693.9	219795.1911
Story14	1.5(DL+LL)	197354.3	246242.7	232606.7	241665.2968
Story13	1.5(DL+LL)	214584	268156	253519.6	263535.4026
Story12	1.5(DL+LL)	231813.6	290069.4	274432.5	285405.5083
Story11	1.5(DL+LL)	250147.7	311298.4	295079.9	306734.451
Story10	1.5(DL+LL)	268481.7	334108.7	318522.4	330018.0955
Story9	1.5(DL+LL)	286815.8	356919	341964.9	353301.7338
Story8	1.5(DL+LL)	305149.8	379729.3	365407.5	376585.3802
Story7	1.5(DL+LL)	323483.8	402539.6	388850	399869.0226
Story6	1.5(DL+LL)	341817.9	425349.9	412292.5	423152.665
Story5	1.5(DL+LL)	360151.9	448160.3	435735	446436.3073
Story4	1.5(DL+LL)	378486	470970.6	459177.5	469719.9497
Story3	1.5(DL+LL)	396820	493780.9	482620	493003.5921
Story2	1.5(DL+LL)	415154	516591.2	506062.5	516287.2345
Story1	1.5(DL+LL)	423865.3	525913.6	516387.6	529506.2011



Graph 3: Story Force Vs. Story in Response Spectrum Analysis

In the present study, Relative Analysis of RCC structure with different shape of building i. e Rectangular, Square, T-Shape and L-shape building with G+24 story building.

The structures are analyses for earthquake zone III with medium soil and Results Compare. It has been made on different structural parameters viz. base shear, Earthquake displacement, story force and modal mass participations etc. Grounded on the analysis results following conclusions are drawn.

1. Analysis of RCC building with different shape of structure i.e. Rectangular, Square, T- shape and L- shape with medium soil condition at zone III. the base shear in x- direction, square, T- shape and L- shape building structure base shear is increased 1.2435, 1.2706,1.24 and 1.24 times increased as compare to rectangular shape building.
2. The Structure, Square, T-shape and L- shape structure with analysis at zone III. But results indicate that variation of base shear increase or drop in Square, T- shape and L-shape nearly close as compare to rectangular shape building.
3. Comparing The modal mass participating results in Response spectrum analysis method with rectangular shape building in 1st mode shape mass participant 73% and 2nd mode shape in z-direction means building are in torsion, rectangular shape building failed in mass participant check as compare to Square And L-Shape building, Square and L-shape building 1st and 2nd mode are translation and 3rd mode shape are in torsion as compare to rectangular shape and T- shape building, but Square and T-shape building are good performance torsion

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