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Comparative Study of Different Lateral Load Resisting System on Different Shapes of Building

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ABSTRACT

For quake safe plan the ordinary structure ought to have the option to oppose minor, moderate, cut off shaking. In the conditions of the structure, basic shape arrangement building move the seismic tremor power in the immediate way to the base while fit as a fiddle constructing, the heap moving way is roundabout which prompts age of worries at the corners Structure architects need to plan and assemble a structure wherein the harm to the structure and its structure part by quake is limited. From the past investigations and structure originator's explores, they discovered different parallel burden opposing frameworks ; like Shear wall systems, Bracing systems, Flat slab systems, etc. lateral load has great significance in design as the height of building increases; parallel burden turns out to be more prevailing than gravity burden or vertical heap of building. Horizontal burden, for example, Wind load and Seismic Load are follow up on the tall structure. These loads are resisted by various lateral load resisting systems. The primary boundaries considered in this report is to contrasting the seismic presentation of various models for direct static investigation are; Top storey displacements, Storey drift ratios, Storey shears and for dynamic analysis are; Torsion moments, Time Period and Response Spectrum.

KEYWORDS: *lateral resisting system, Response spectrum method, storey drift, shear wall, bracing system*

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1. INTRODUCTION

Today's high rise buildings become plenty of and plenty of slim, prompting the probability of plenty of influence the same as compared plenty of challenges for the specialists to provide with what is needed every enormity masses still the same as tangential masses, prior structures were intended for the gravity masses. other than presently as results of variation in buildings structure and seismic zone that the architects need to watch out of lateral masses as a result of wind and earth quake forces. Seismic zones play a role at intervals the earthquake resistant style of building as results of the zone issue change the same as a result of the seismic intensity changes from low to terribly severe. one more necessary side within the planning of earthquake resistant structures is soil type as a result of the soil type as a result of soil type changes the whole behavior and magnificence of the structure changes. Parallel power opposing framework ingests the horizontal powers acting all through the tremor and can build the firmness of the structure and to make the structure seismic tremors safe.

A. Moment Frame Systems

Second edges conveys with it a lattice of vertical and even individuals. These moment resisting frames resist lateral masses generated in each columns and beams. In moment resisting frame lateral stiffness is greatly depends on bending stiffness of beams and columns. These frames will helps in easy planning and fixing of windows and doors. These frames are economical up to 25 stories, if it will be more than that leads to be uneconomical in order to minimize the storey displacement and drift.

B. Shear Wall

Shear dividers are vertical components of the even power opposing framework. These dividers are developed around elevator, step and repair shafts. Because of their plentiful stiffer on a level plane than unbending edges, shear divider structures will be affordable up to with respect to thirty five stories They're all around coordinated to inns and private structures any place the ground by floor tedious planning licenses the dividers to be vertically nonstop and any place they serve simultaneously as wonderful acoustic and chimney encasings among rooms and habitations. In Shear divider structures are appeared to perform well in seismic tremor that flexibility turns into an exceptionally critical idea in their style. Shear divider might be a help won't to oppose parallel powers for example corresponding to the plane of the divider. Shear divider opposes the majority due to Cantilever activity for brief dividers any place the shear distortion is a great deal of it opposes the majority due to Support Activity.

C. Bracing System

A supported edge is a basic framework generally utilized in structures exposed to sidelong loads, for example, wind and seismic burdens. The propped outlines by and large act in a similar way of shear divider and are made of basic steel, which can work viably both in strain and pressure. These frames offer low resistance depending on their design and construction. In a structure, shafts and segments convey a vertical loads and supports convey a horizontal burdens. The principle capacity of propping in structure is, parallel loads because of wind and earth shake are communicated productively to the establishment of building so that giving x supporting is to keep the structure from turning under the activity of wind.

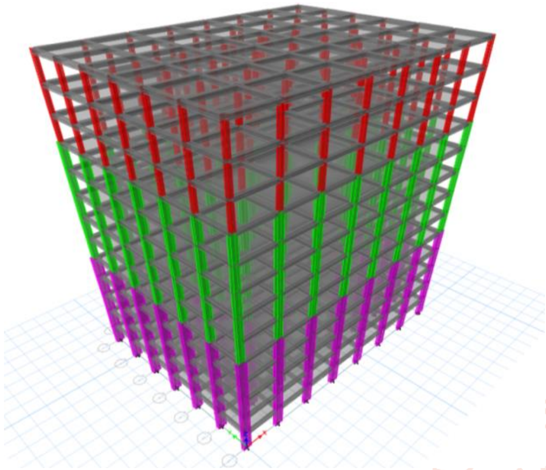


Fig.1 Moment resisting frames

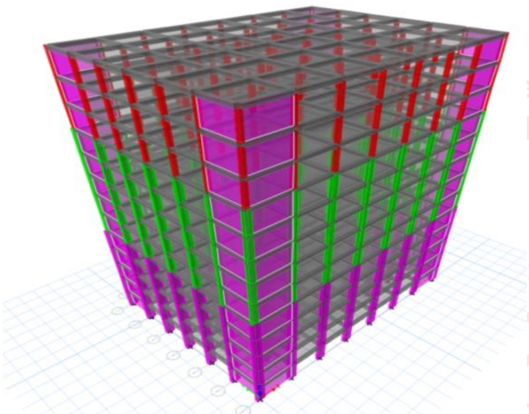


Fig.2 Building with shear wall at corner

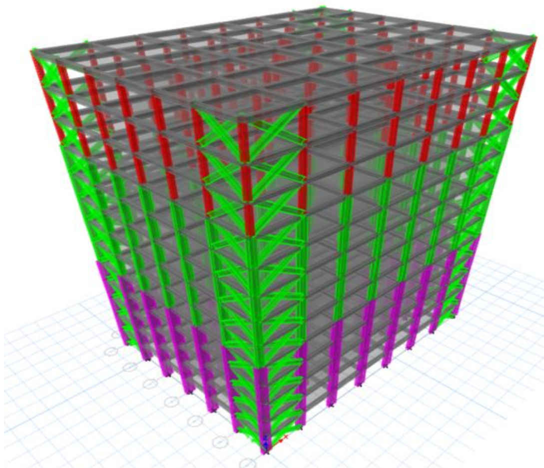


Fig.3 Building with x bracing at corner

D. Objectives

- The objective of this examination is taking a gander at the changed level weight restricting structures; shear divider and propping system on different conditions of building, such as C, H, L, T, and Rectangular of 13 storey height using response spectrum analysis in ETABS software.
- Comparing the boundaries like story removal, Story float, time span and frequencies, plan sidelong powers, base shear with various state of building.
- Analysis will be for both wind and earth quake zone V as per code IS 875(Part -3): 2015 and IS 1893 (Part -1):2016.

2. Methodology

- A 13-storey building model will be done using ETABS software this should be used to present the analysis results.
- Dynamic analysis should be completed to get the investigation of seismic powers by response spectrum method according to code May be: 1893(Part - 1):2016 and wind by IS 875(Part - 3): 2015.
- Analysis of frame structure shall be carried out considering fixed support at base. The load, and load combination are considered as per code IS 875(Part -2): 2015 (live load), part 3-for wind load, IS 1893 (Part -1):2016 for earth quake.

A. Response Spectrum methodology:

Reaction range strategy is generally significant in seismic investigation of structure. This is utilized to get the plan seismic powers and these powers are conveyed to various level along the pivot of the structure. Also, this technique includes the computation of most extreme story removal and part powers in every method of vibration utilizing smooth plan spectra. This strategy helps in acquiring the pinnacle reaction of the structure under direct range, which can be used for getting sidelong powers made in structure in light of earth quake along these lines energizes in earth shake safe arrangement of structure.

3. MODELLING AND ANALYSIS

G+13 storey building is considere for the analysis and modeling is done in ETABs software.

A. Description of building model

plan Area	28mx21m
Shape of building	T,C,H,L,RECTANGULAR
Bay In x Direction Y Direction	4m 3.5m
No of stories	13
Floor TO Floor Height	3m
Grade of Concrete	30N/mm^2
Grade of steel	HYSD 415 N/mm62
Beam size	300mmx450mm
Column Sizes: GF-Storey 4:C1 Storey 5-Storey9:C2 Storey 10-Storey12:C3	300mmx900mm 300mmx600mm 300mmx300mm
Thickness of shear Wall	230mm
Steel bracing	ISMB 300
Slab Thickness	150mm
Seismic zone	v
Zone factor	0.36
Importance factor	1
Response factor	5
Damping	5%
Live load as per Is 875 Part-2 LL below Roof	2.5 KN/m^2

B. Load combinations:

Different structural members are loaded with various styles of loads and load combinations during its service life. These loads on structure are taken for analysis and design as per the relevant is codal provisions.

- Dead loads are as per IS 875 – 1987 (Part-I)
- Imposed loads are as per IS 875 – 1987 (Part-II)
- Wind loads are as per IS 875 – 2015 (Part-III)
- Seismic loads are as per IS 1893 – 2016 (Part-I)

The structure is designed for earthquake resistant as per IS: 1893:2016 with an importance factor of 1.The analysis of the reinforced concrete structure shall be carried out using ETABS software. The analysis shall be carried out for the dead loads (DL), live loads (LL), wind loads (WL) and earthquake loads (EL) and their combination as given in the table above.

I. Dead Loads IS: 875 (Part-I)

Table1: Dead loads considered

ITEMS	Intensity in KN/m^2 of plan area
Foor finishes	Minimum 1.2 or actual unit weight of screed & finishing material whichever is greater
Screed in sunken portion of toilets	Minimum 3.0 or actual unit weight whichever is greater

II. Imposed Loads IS: 875 (Part-II)

Table 2: Imposed loads considered

Sl. No	Description	Loads	Units
1	Corridors	3.0	KN/m^2
2	staircases	3.0	KN/m^2
3	Rooms	2.0	KN/m^2
4	Toilet area	1.5	KN/m^2
5	Terrace area	3.0	KN/m^2
6	utility	3.0	KN/m^2
7	Balcony area	2.0	KN/m^2

C. STRUCTURAL MODELING

I. Building plans of moment Resisting Frame:

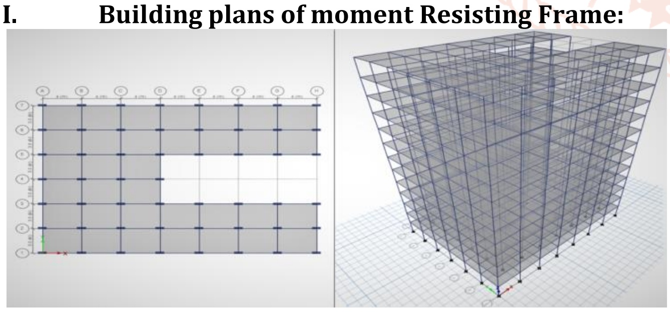


Fig 4: plan and 3D view of C shape building

II. Building with shear wall AT Corner:

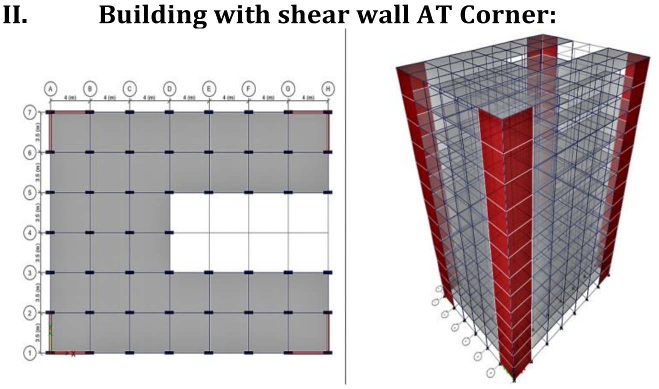


Fig5: Plan and 3D view of C shape building with shear wall at corner

III. Building with bracing system at Corner:

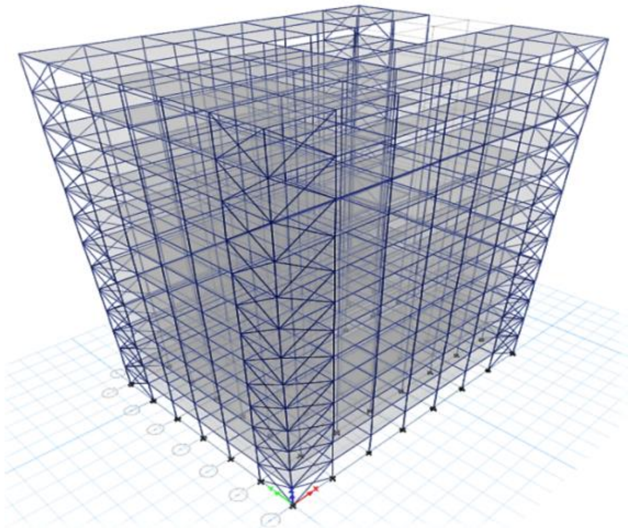
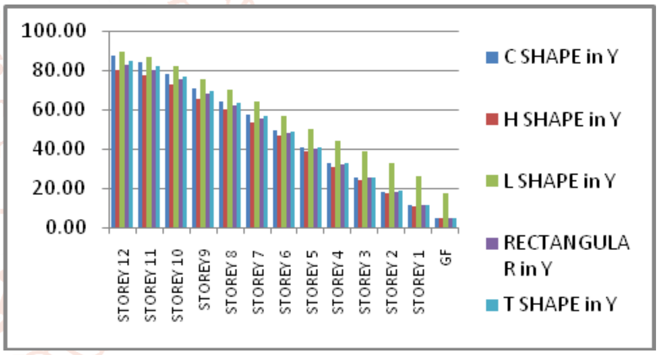


Fig 6: 3D View of C shape building with bracing at corner

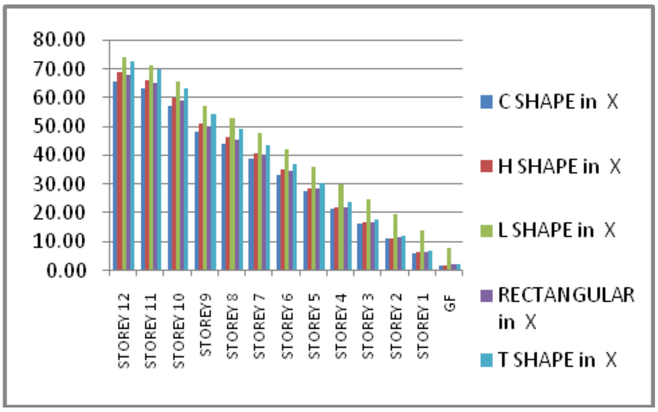
4. RESULTS AND DISCUSSIONS:

A. Storey Displacement

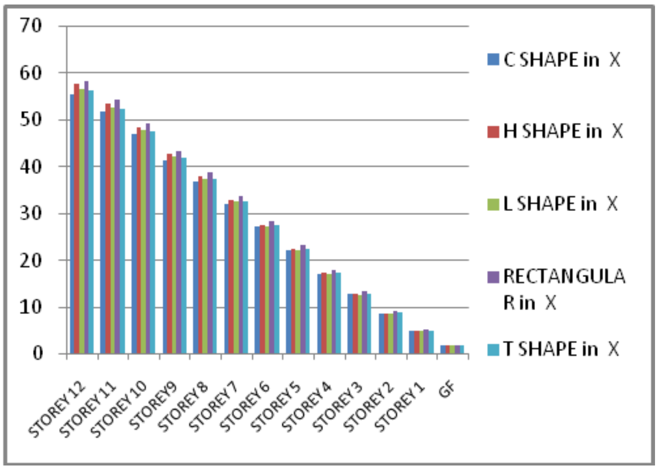
Storey displacement is a overall displacement of i^{th} storey with respect to relative to ground and there is maximum permissible limit prescribed in IS codes for building. The storey displacement profile increases non-linearly as the storey level gets higher regardless the type of the dynamic analysis.



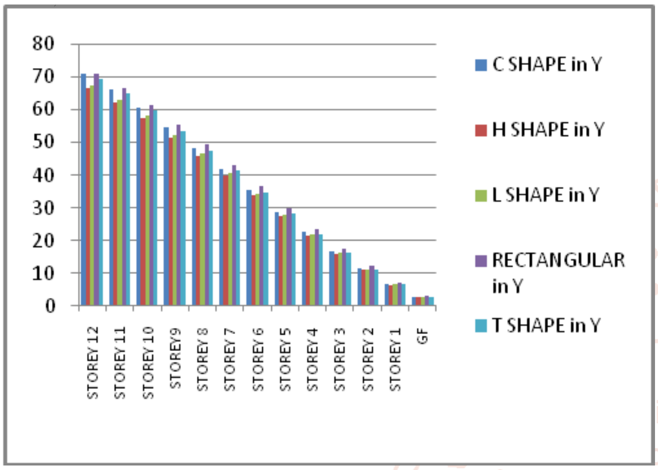
Graph 1: Storey displacement in y direction without shear wall and bracing system



Graph 2: Storey Displacement in x direction without Shear Wall and Bracing System



Graph 3: Storey displacement in x direction of building with shear wall

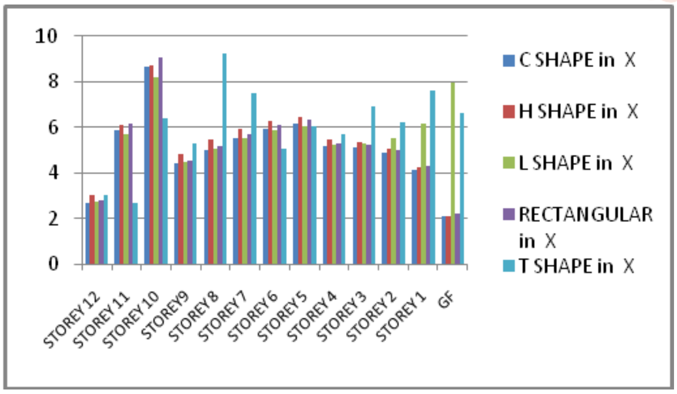


Graph 4: Storey displacement in y direction of buil with shear wall

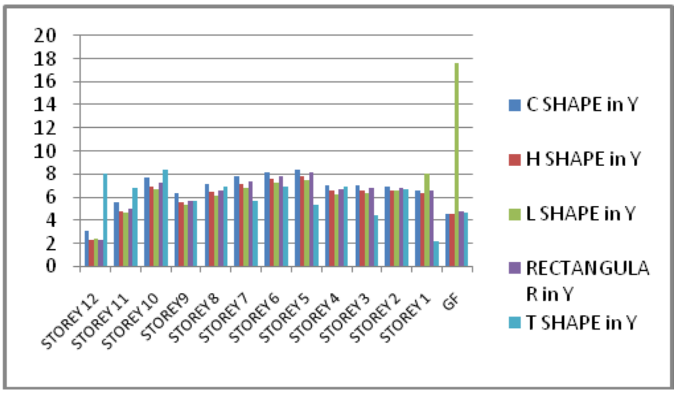
B. Storey Drift

It is defined as the difference in lateral deflection between two adjacent stories.

Storey drift ratio = (difference between displacement of two stories / height of one store)

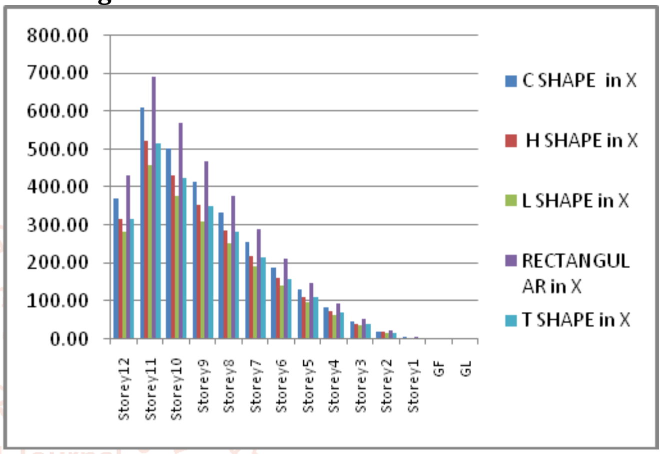


Graph 5: Storey drift in x direction without shear wall and bracing system

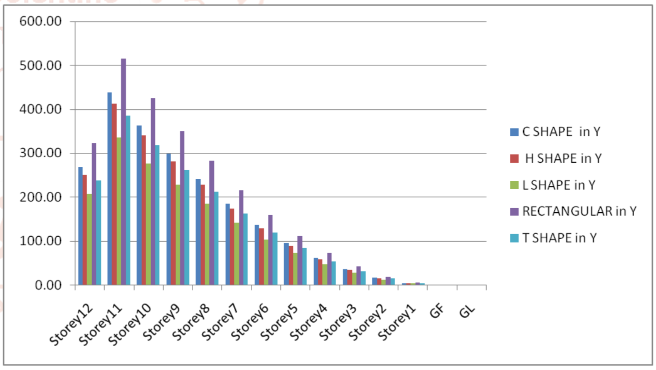


Graph 6: Storey drift in Y direction without shear wall and bracing system

C. Design Lateral Forces



Graph 7: design lateral forces in x direction



Graph 8: design lateral forces in Y direction

D. Base Shear

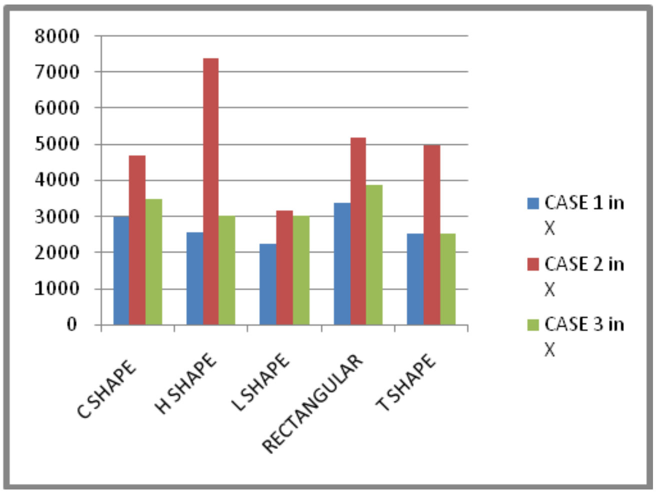
CASE i- Building without Shear Wall and Bracing System
CASE ii- Building with Shear Wall
CASE iii- Building with Bracing System

Table 3. Base Shear direction

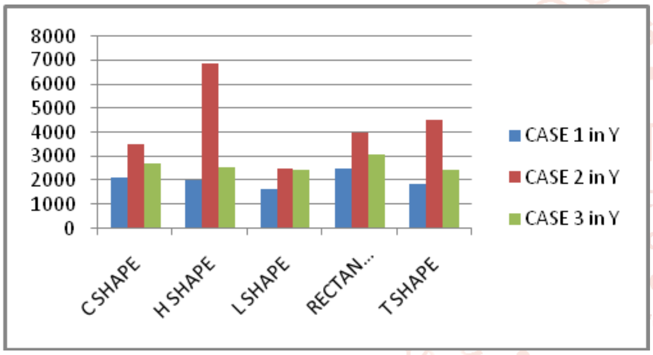
Cases in x	C shape	H Shape	L shape	Rectangular	T shape
Case1	2974	2545.8	2238.36	3377.06	2518.94
Case2	4688.5	7397.56	3174.28	5190	4974.89
Case3	3470.52	3028.28	3008.49	3882.62	2518.94

Table 4. Base Shear in y direction

Cases in Y	C shape	H shape	L shape	Rectangular	T shape
Case1	2137.98	2009.55	1633.69	2512.74	1879.62
Case2	3529.64	6898.37	2515.16	3983.67	4527.75
Case3	2713.25	2568.55	2444.47	3101.53	2444.74



Graph 9. Base shear in x direction



Graph 10. Base shear in y direction

E. Time Period And Frequencies:

Fundamental natural amount is 1st greatest modal fundamental measure of vibration. The results of natural fundamental measure used for various LLRS are given in charts for medium varieties of soils. A frequency of a building is reciprocally proportional to fundamental measure. Because the fundamental measure will increase frequencies are reduced. Fundamental measure means that response of the building throughout earthquake. Fundamental measure a lot of means that it shows a lot of response throughout earthquake. Fundamental measure low means that it shows less response throughout earthquake.

Fundamental natural amount of vibration (Ta) of a MRF building

➢ Without infill panels

$T_a = 0.075h^{0.75}$ for RC frame building

$T_a = 0.085h^{0.75}$ for steel frame building

➢ With infill panels

$T_a = (0.09/\sqrt{d})$

Where, h = height of the building

D = base dimension of the building at the plinth level

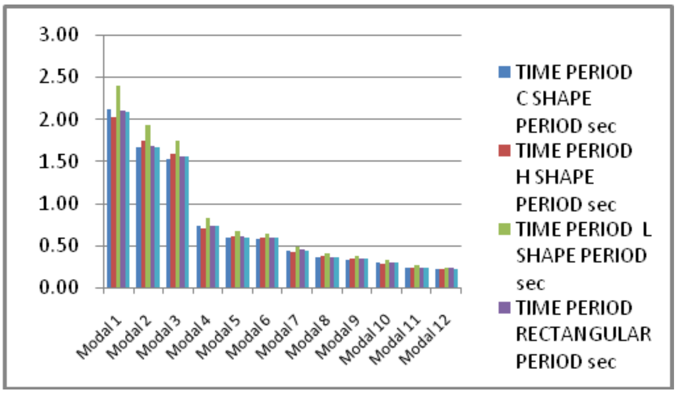


Fig 9. Time period of building without shear wall and bracing system.

Summary:

A. Storey Displacement:

➢ Building without shear wall and bracing system show a maximum storey displacement in L shape i.e. 73.73 mm in x direction and 89.46 mm in y direction and minimum storey displacement in C shape i.e. 65.58 mm in x direction and 87.11 mm in y direction.

➢ Building with shear wall at corner show a maximum storey displacement in Rectangular shape i.e. 53.53 mm in x direction and 63.87 mm in y direction and minimum storey displacement in L shape i.e. 32.47 mm in x direction and 38.34 mm in y direction.

➢ Building with X bracing at corner show a maximum storey displacement in Rectangular shape i.e. 58.351 mm in x direction and 70.706 mm in y direction and minimum storey displacement in T shape i.e. 55.5 mm in x direction and 64.401 mm in y direction

B. Storey Drift:

➢ Building without shear wall and bracing system show a maximum storey drift in Rectangular shape i.e. 9.063 in x direction and 7.275 in y direction and for T shape is 6.385 in x direction and 8.384 in y direction and minimum storey drift in T shape i.e. 6.385 in x direction and 8.384 in y direction.

➢ Building with shear wall at corner show a maximum storey drift in Rectangular shape i.e. 5.187 in x direction and 5.965 in y direction and T shape i.e. 5.097 in x direction and 5.948 in y direction for minimum storey drift in L shape i.e. 3.175 in x direction and 3.677 in y direction.

➢ Building with X bracing at corner show a maximum storey drift in Rectangular shape i.e. 5.925 in x direction and 6.064 in y direction and minimum storey drift in L shape i.e. 5.546 in x direction and 5.769 in y direction.

C. Design Lateral Forces

➢ Building without shear wall and bracing system show a maximum Design Lateral Forces in Rectangular shape i.e. 691.05 kN in x direction and 514.18 kN in y direction and minimum Design Lateral Forces in L shape i.e. 458.55 kN in x direction 334.68 kN in y direction.

- Building with shear wall at corner show a maximum show a maximum Design Lateral Forces in H shape i.e. 1464.50 kN in x direction and 1365.68 kN in y direction and minimum Design Lateral Forces in L shape i.e. 554.92 kN in x direction and 468.34 kN in y direction.
- Building with X bracing at corner show a maximum show a maximum Design Lateral Forces in Rectangular shape i.e. 794.57 kN in x direction and 634.72 kN in y direction and minimum Design Lateral Forces in L shape i.e. 616.39 kN in x direction and 500.83 kN in y direction.

D. Time Period

- Building without shear wall and bracing system show a maximum Time period in L shape is 2.40 sec and for L shape is 2.11 sec and minimum time period in H shape is 2.02 sec.
- Building with shear wall at corner show a maximum Time period in Rectangular shape is 1.358 sec and minimum Storey Time period in L shape is 0.838 sec.
- Building with X bracing at corner show a maximum Time period in Rectangular shape is 1.715 sec and for L shape is 1.613 sec and minimum Time period in H shape is 1.588 sec.

5. CONCLUSIONS

- On comparing the results of storey displacement, storey drift, design lateral forces, base shear, time period and frequencies of all the shapes of building such as C, H, L, Rectangular, T for all three cases such as case-1 (building without shear wall and bracing system), case-2 (building with shear wall at corner), case-3 (building with X bracing at corner).
- Storey displacement of L shape building shows a maximum storey displacement in case-1 i.e. 73.73 mm in x direction and 89.46 mm in y direction. After providing shear wall at corner it will reduces storey displacement i.e. 55.96% in x direction and 57.14% in y direction. After providing bracing system at corner of building it reduces storey displacement up to 23.06% in x direction and 24.98 % in y direction.
- Storey displacement of Rectangular shape building shows a maximum storey displacement in case-1 i.e. 67.91 mm in x and 82.41 mm in y direction. After providing shear wall at corner it will reduces storey displacement i.e. 21.17% in x direction and 22.5% in y direction. After providing bracing system at corner of building it reduces storey displacement up to 14.07% in x direction and 17.50% in y direction.
- Storey drift of L and rectangular shape building shows a maximum storey drift in case-1 i.e. for L shape 8.197 in x and 6.739 in y direction and for rectangular shape building 9.063 in x and 7.275 in y direction. On comparing the above results L shape building with shear wall at corner shows maximum percentage of reduction in storey drift i.e. 61.26% in x and 45.43% in y direction. For bracing system, it will reduce storey drift of 32.34% in x and 14.4% in y direction.
- Storey drift for rectangular shape building with shear wall at corner shows maximum percentage of reduction in storey drift i.e. 42.76% in x and 18% in y direction. For bracing system, it will reduce storey drift of 34.62% in x and 16.64% in y direction.
- Design lateral forces for rectangular, H, L shape building shows a maximum design lateral forces i.e. for rectangular shape 691.05 kN in x and 514.18 kN in y direction and minimum for L shape building is 458.55 kN in x and 334.68 kN in y direction. For H shape in case 2, 1464.50 kN in x and 1365.68 kN in y direction.
- Time period in case 1 has a maximum value in L shape ,case 2 has a maximum value in H shape , case 3 has a maximum value in rectangular shape building. Providing shear wall at corner shows a maximum percentage reduction in L shape i.e. 65.08% comparing with rectangular shape i.e. 35.64% and H shape is 34.80%.
- On comparing the results obtain for different lateral load resisting system shear wall at corner is more effective in resisting lateral loads. And L shape building is more effective is more effective in comparing with other shapes of building.

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