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SEISMIC ANALYSIS OF G+6 FRAME BUILDING USING ETABS

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Abstract – *Seismic Analysis of any type of structure is an important consideration while working in high earthquake prone areas. With the help of seismic analysis, the structure can be designed and constructed to withstand the high lateral moment if earth crust during an earthquake. Any type of basic or highly advanced structure which may be under static or dynamic conditions can be evaluated by using ETABS.ETABS is a coordinated and productive tool for analysis and designs which range from simple 2D frames to modern high rises which makes it one of the best structural software for building software for building systems. A G+6 storey building of different shaped frame structures is considered for this study.*

Key Words: *ETABS-2015, Seismic Analysis, Time Period, Story Drift, Base Shear, Story Stiffness.*

1. INTRODUCTION

The main aim is to generate and perform linear static analysis of 4 different shapes of structure: Rectangular, H-Shaped, C-Shaped, L-Shaped and to compare their results for Time period, Base shear, Story drift, Story stiffness. It is expected that these structures will sustain all the loads and deformations of normal construction and have adequate durability and resistance to seismic effects.

Generally structural designers are prone to use linear static analysis which is also known as first order analysis to compute the response of a structure such as design force, moments and displacements resulting from loads acting on the structure. In case of first order analysis only the small deflections moments are considered. Additional effect due to the deformation of the structure under vertical loads are neglected.

2. MODELLING OF RCC FRAME

We have considered a 3D RCC frame with the dimensions for 4 different shapes. These shapes have same area. The 4 shapes are as follows:

1. Rectangular plan
2. H-shaped plan
3. C-shaped plan
4. L-shaped plan

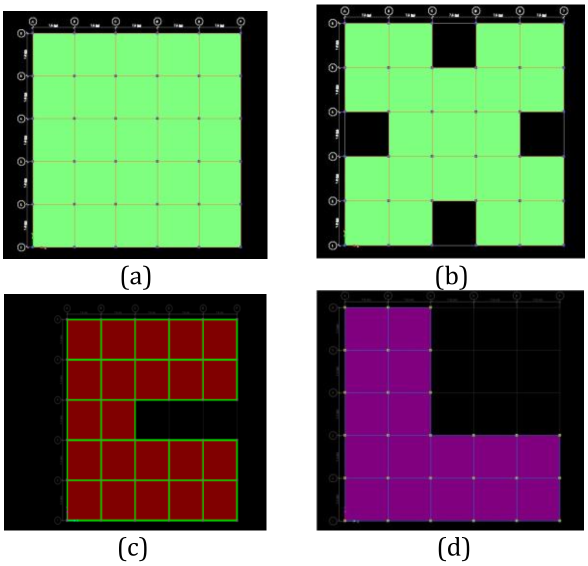

Fig 1: Plan (a) Rectangular shaped (b) H-shaped (c) C- shaped (d) L-shaped of the building.

Table 1

Building Description And Material Specification	
Number of storey	6
Support condition	Fixed
Storey height	3m
Height of building	18m
Grade of concrete Beam Column Slab	 25 N/mm2 30 N/mm2 20 N/mm2
Grade of steel	Fe500
Size of column	450mm X 450mm
Size of beam	250mm X 400mm
Thickness of wall	230mm
Thickness of slab	150mm
Density of concrete	25KN/m3
Density of brick walls consider	22.5KN/m3

3. LOADING

The structures are acted upon by different loads such as dead load, live load, earthquake load.

1. Self-weight of structure comprises of weight of the beam, column and slab of the structure.
2. Dead load of the structure consists of wall load, parapet wall load and floor load according to IS 875 – part 1.
   I. Wall load = (weight unit of brick masonry * thickness of wall * height of wall)
   = 22.5kN/m3 * 0.23m * 3m
   = 15.525kN/m3.
   II. Wall load (parapet wall at top floor)
   = (weight unit of brick masonry * thickness of wall * height of wall)
   = 22.5kN/m3 * 0.115m * 1.5m
   = 3.88KN/m.
3. Live load: It consists of floor load which is taken as 3KN/m2 and roof load as 1.5kN/m2 according to IS 875 part-2.
4. Seismic load: The different seismic parameters are taken as follows, IS 1893 part 1 : 2002
   1. Seismic zone : II (Z=0.10)
   2. Soil type : II
   3. Importance factor : 1
   4. Response reduction factor: 3
   5. Dumping : 5%

4. LOADING COMBINATION

The structural systems were subjected following load combinations as per provisions of **IS 1893-2002 (Part I),** Clause 6.3.1, that deals with "Criteria for Earthquake Resistant Design of Structures".

Analysis is carried out for gravity loads using partial safety factor as 1.5. The following Loads have been considered in the structural analysis and design as per IS code 456-2000.

1. D-Dead load
2. LL- live load
3. EQ- Earthquake

Table 2

LOAD COMBINATIONS	REMARKS
1.5(DL+LL)	* DL - Dead load of the structure * LL - Live load of the structure * EQX - Earthquake load along X direction * EQY - Earthquake load along Y direction 1
1.5(DL ± EQX)	
1.5(DL ± EQY)	
(0.9DL ± 1.5EQX)	
(0.9DL ± 1.5EQY)	
1.2(DL+LL±EQX)	
1.2(DL+LL±EQY)	

5. MODELLING IN ETABS

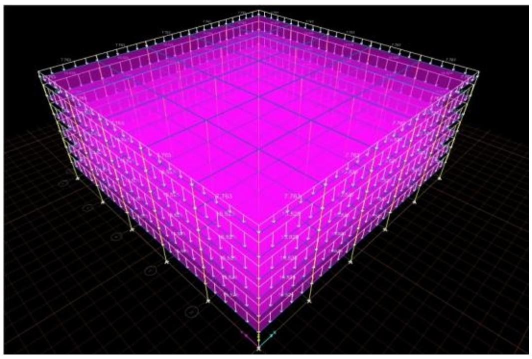

Fig 2: 3-D view of 6-storeys Rectangular shape building

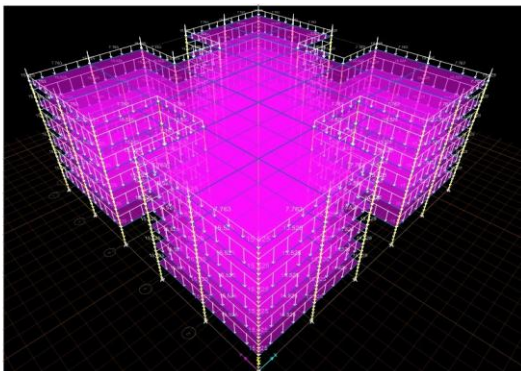

Fig 3: 3-D view of 6-storeys H-shape building

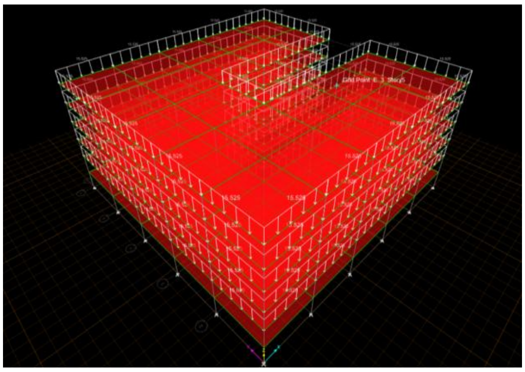

Fig 4: 3-D view of 6-storeys C-shape building

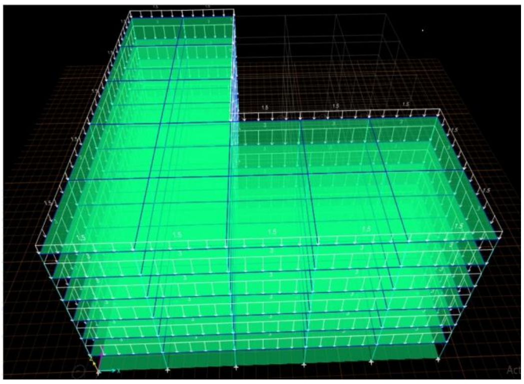

Fig 5: 3-D view of 6-storeys L-shape building

6. RESULTS AND DISCUSSIONS

1. Time Period: It is the time needed for one complete cycle of vibration to pass a given point. As the frequency of a wave increases, the time period of the wave decreases. Frequency and time period are in a reciprocal relationship that can be expressed mathematically as, T = 1/f or as, f = 1/T. Table 3 represents the fundamental period of first three modes of all structure systems.

Table 3

STRUCTURAL SYSTEM	MODE 1	MODE 2	MODE 3
Rectangle shape	0.174	0.173	0.173
H shape	0.126	0.126	0.126
L shape	0.108	0.104	0.071
C shape	0.098	0.098	0.098

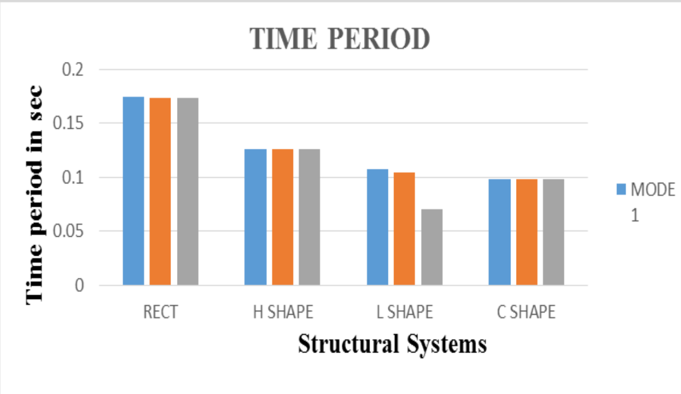

Chart 1: Time Period

The result of structural section L is having variation in values in three modes.The structural system like rectangular section , H section, C section is having the values same for first three modes.

2. Base Shear: It stands an assessment of the extreme predictable lateral force that will arise at the base of a building due to applied loads. Variation of base shear for different structural systems observed and the results for seismic zone II in EQX, EQY are tabulated in below table.

Table 4

Structural Shape	EQX	EQY
Rectangular shape	3200.27	3200.27
H shape	3112.55	3112.55
L shape	1860.9404	1860.9404
C shape	2230.3828	2230.3828

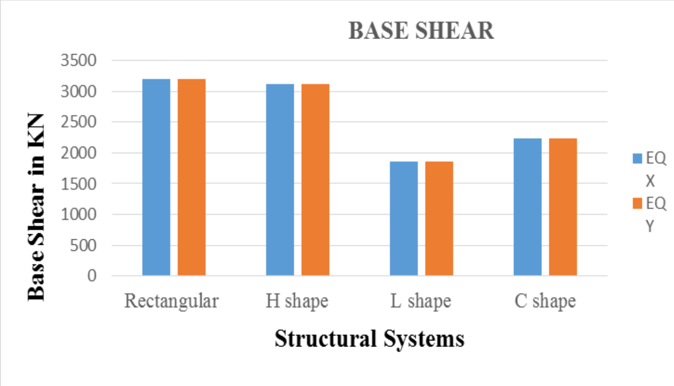

Chart 2: Base Shear

The result of rectangular shaped structure can able to resist maximum base shear compare to other three systems considered in study.
L shape structure resist a minimum base shear compared to other three systems considered in study.

3. Storey Drift: It is defined as the ratio of displacement of two successive floors to height of that floor. It is unit less. The permissible limit storey drift of any based IS 1893 – 2002.

Table 4(a): Story Drift along X direction

STOREY	RECTANGLE SHAPE	H SHAPE	L SHAPE	C SHAPE
6	0.000008	1.00E-06	0.000014	0.000002
5	0.000007	1.00E-06	0.000017	0.000002
4	0.000006	1.00E-06	0.000017	0.000002
3	0.000004	1.00E-06	0.000016	0.000001
2	0.000003	1.00E-06	0.000015	0.000001
1	0.000002	3.66E-07	0.000012	4.26E-07
BASE	0	0.00E+0	0	0

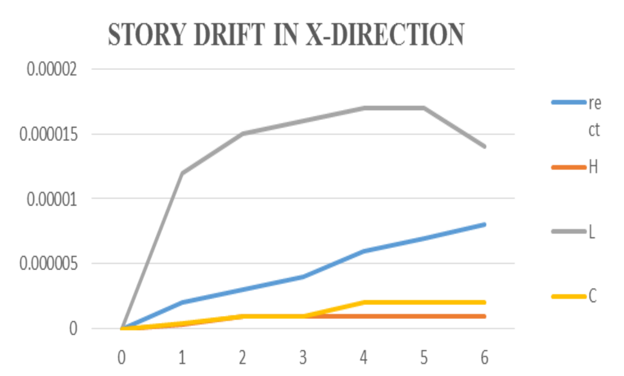

Chart 3(a): Storey Drift along X- direction

The results of structural system L section can able to resist maximum storey drift compared to other three structures. H shaped structure resist a Minimum storey drift compared to the other three structures.

Table 3(b): Storey Drift along Y-direction

STOREY	RECTANGLE SHAPE	H SHAPE	L SHAPE	C SHAPE
6	0.000008	1.00E-06	0.000014	0.000003
5	0.000007	1.00E-06	0.000017	0.000003
4	0.000006	1.00E-06	0.000017	0.000003
3	0.000004	1.00E-06	0.000016	0.000002
2	0.000003	1.00E-06	0.000015	0.000001
1	0.000002	3.66E-07	0.000012	0.000001
BASE	0	0.00E+0	0	0

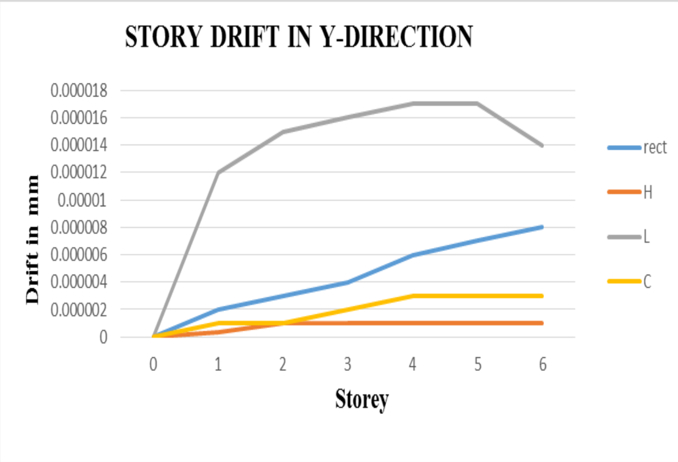

Chart 3(b): Storey Drift along Y-direction

The results of structural system L section can able to resist maximum storey drift compared to other three structures. H shaped structure resist a Minimum storey drift compared to the other three structures.

4. Storey Stiffness: The storey stiffness of a storey is a generally defined has ratio of to storey drift. storey shear

Table 4(a): Storey Stiffness along X-direction

STOREY	RECTANGLE SHAPE	H SHAPE	L SHAPE	C SHAPE
6	10214568	480026947	23246957	311052534
5	20024831	924988550	32408146	543893206
4	30203010	1311373114	38911094	763504459
3	45802246	1876998099	44831417	1125486771
2	74930868	2936140459	49684829	1855317010
1	12127123	4839695511	61624446	3152826453

Chart 4(a): Storey Stiffness along X-direction

Storey stiffness value is maximum in X direction. H shape structure is increases as compared to all other shapes like rectangle shape, L shape, C shape.

Table 4(b): Storey Stiffness along Y-direction

STOREY	RECTANGLE SHAPE	H SHAPE	L SHAPE	C SHAPE
6	101890653	480026947	23246957	167633354
5	200176325	924988550	32408146	314326710
4	302034550	1311373114	38911094	442522783
3	458147917	1876998099	44831417	633080494
2	750073560	2936140459	49684829	976377911
1	1216522871	4839695511	61624446	1472863079

Chart 4(b): Storey Stiffness along Y-direction

Storey stiffness value is maximum in Y direction. H shape structure is increases as compared to all other shapes like rectangle shape, L shape, C shape.

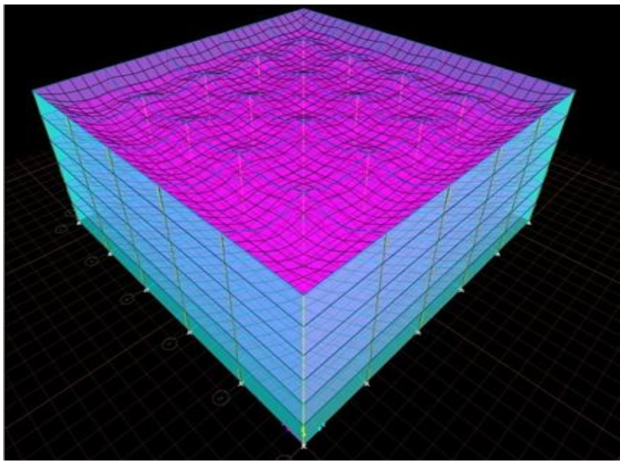

Fig 6: 3D view of Rectangular Section after Seismic analysis

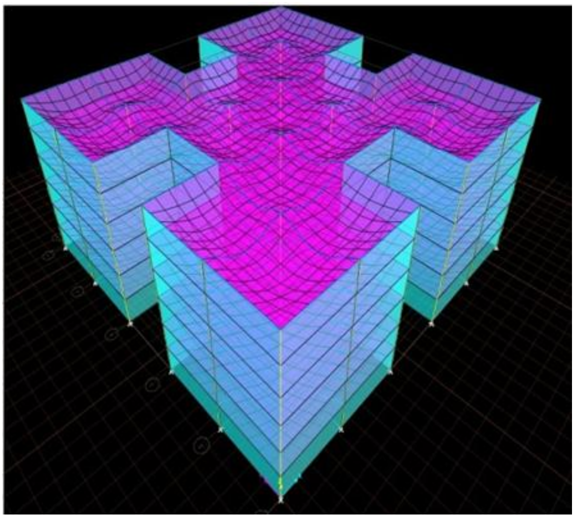

Fig 7: 3D view of H-Section after Seismic Analysis

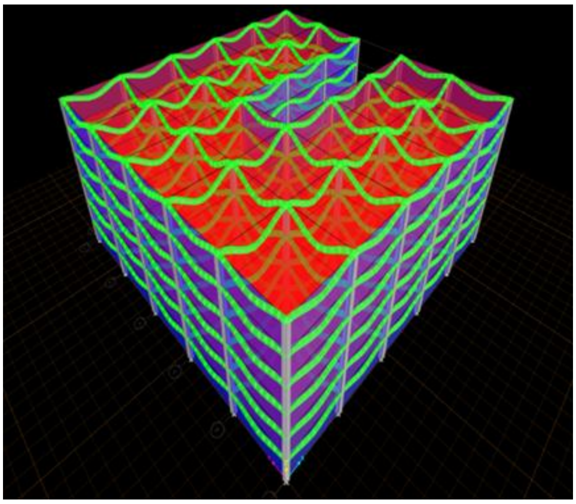

Fig 8: 3D view of C-Section after Seismic Analysis

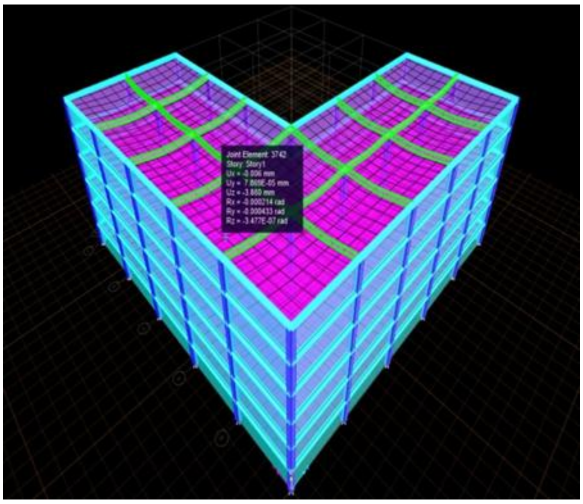

Fig 9: 3D view of L-Section after Seismic Analysis

7. CONCLUSIONS

1. Analysis was done by using ETABS software successfully verified manually as per IS456:2000 and IS 1893-2002 (Part I), Clause 6.3.1, that deals with "Criteria for Earthquake Resistant Design of Structures".

2. Calculation by both manual work as well as software analysis gives almost same result.

3. Usage of ETABS software minimizes the required for analysis design.

4. The plan configurations of structure has significant impact on the seismic response of structure in terms of displacement, story drift, story shear, time period.

5. As the result, in X and y direction the story displacement/drift is increased in L structure as compared with other structure like rectangular, H –shape, and C shape and it is observed that the storey drift for the stories are found to be within the permissible limits.

6. In X and Y direction the story stiffness is increased in L structure as compared with other structure like rectangular, H –shape, and C shape.

7. Base shear in X and Y direction is same for all structures like rectangular, H –shape, and C shape, with increase in load.

8. Story stiffness valve is maximum in X and Y direction of H shape structure compared to other structure.

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