Seismic Risk Assessment of regular and irregular Polygonal (hexagon) Structure with Mass and Stiffness Irregularity

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Abstract- *Nowadays structure are made keeping in mind it's aesthetic or architectural value and also according to our client requirement i:e aesthetic or functional requirement which sometimes makes the structure weak to rest the seismic effect which are random in nature. There are various ways of analyzing the fact that whether the structure will be able to resist the seismic effect. As per IS: 1893:2002 there are two ways of analysis i:e static and dynamic analysis. In this paper we'll find the max. storey drift of G+8 r.c multi-storey polygonal structure by static analysis using ETAB-CSI software.*

Keywords- Etab, storey drift, vertical irregularity, hexagonal structure, stiffness, mass.

I. INTRODUCTION

Earthquake are random in nature, an uninvited force if greater in magnitude can cause massive loss of life and property. As a civil engineer one can only minimize the effect of seismic effect to some extent. As discussed above the structure with more aesthetic value may effect it's stability during seismic loading. In this paper a G+8 storied polygonal R.C structure is considered with regular and irregular plan also comparing their maximum drifts in X and Y directions. Structures with different geometrical shape plan like square and polygon are considered during study.

II. RESEARCH GAP

Any structure follows a particular geometrical shape plan like square, rectangle, circle, ellipse etc. Many past researches on various irregularity has been made when comparing it with regular model plan like rectangle, square as part of geometrical shapes which is now very common. This paper comes with a concept of a multi-storey hexagon, which is also a part of geometry by making it regular and irregular so as to compare the results of maximum storey displacement.

III. METHODOLOGY

a) All hexagonal plan was created in Autocad and then it was imported to ETAB-CSI in dxf format.
b) 3D and 2D modeling was automatically created by etab software.
c) A G+8 R.C polygonal structure was then considered for analysis of result.

IV. TYPES OF MAJOR STRUCTURAL IRREGULARITY

Stiffness irregularity- soft storey- a soft storey is one in which the lateral stiffness is less than 70% of the storey above or less than the 80% of the average lateral stiffness of the three storeys above.

Mass irregularity- It shall be considered to exist where the seismic weight of any storey is more than 150% of it's adjacent storey. Roof irregularity is not be considered.

Plan irregularity- A sort of geometric irregularity where the physical discontinuity is present or when plan does not behave like a enclose loop. Example of such plans are L-shape plan, T, shape plan etc.

Setback irregularity- These type of irregularity are found where there are space constraints or where the buildings are closely spaced so as to provide proper ventilation to lower floor such irregularities are preferred.

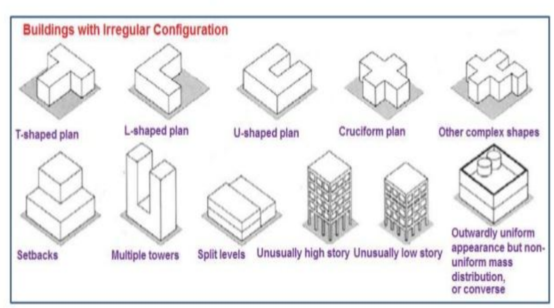

Figure 1.

V. MATERIAL PROPERTIES

Table 1.

Grade of concrete	M25
Rebar	HYSD 415

VI. PRELIMINARY DATA

(For N1 regular model)

Table 2.

Beam size	(300x350) mm
Column diameter	300 mm
Slab thickness	150 mm
Storey height	3 m
Dead load (including 230 mm wall load)	20 KN/m
Live load	15 KN/m^2

(For N2 mass and stiffness irregular model)

Table 3.

Beam size	(300x350) mm
Column diameter	300 mm
Slab thickness	150 mm
Height of story 1	4m
Height of storeys above 1	3 m
Live load of swimming pool on 8^{th} storey	(2x15) KN/m^2

(For N3 plan irregular model)

Table 4.

Beam size	(300x350) mm
Column diameter	300 mm
Slab thickness	150 mm
Storey height	3 m
Dead load	5 KN/m
Live load	15 KN/m^2

VII. IS1893 2002 Auto Seismic Load Calculation

The calculations presented are automatically generated lateral seismic loads for load pattern seismic according to IS1893 2002, as calculated by ETABS:

Direction and Eccentricity

Direction = Multiple
Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated
Factors and coefficient:
Zone factor- 0.36
Reduction Factor- 5
Importance factor- 1
Site type- II

Spectral acceleration coefficient:

Sa/g- 0.34

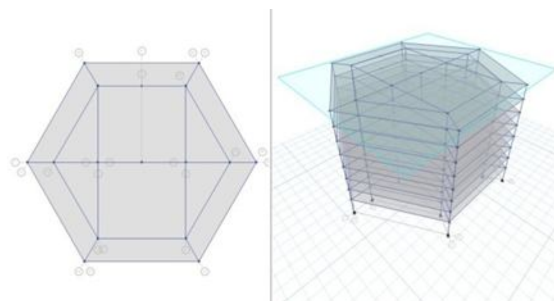

Figure 2. 2D and 3D view of hexagonal structure as modeled by ETABS.

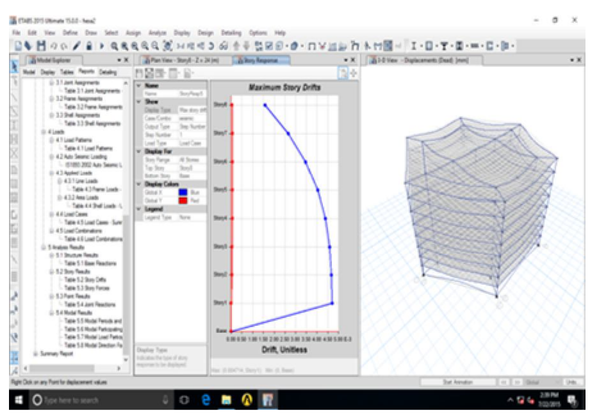

Figure 3. N1: 3D view with max. drift as modeled by ETABS for regular model.

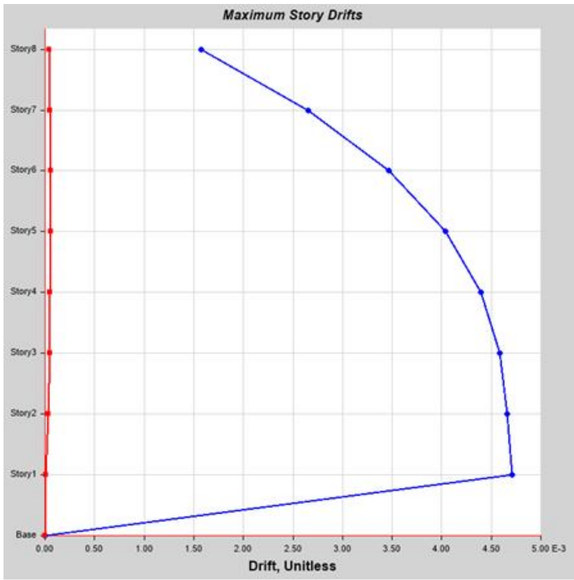

Figure 3.

Storey response plot- max. drift for regular N1 structure.

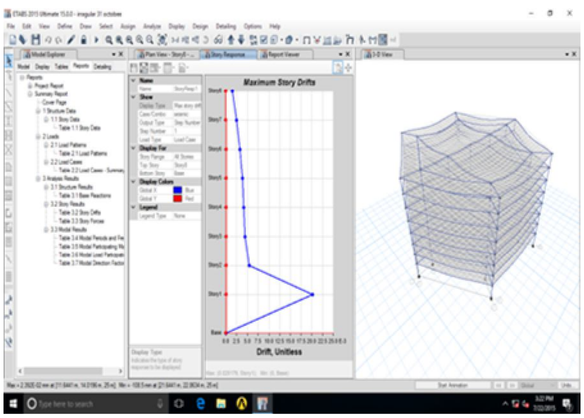

Figure 4. N2: 3D view with max. drifts as modeled by ETABS for irregular model

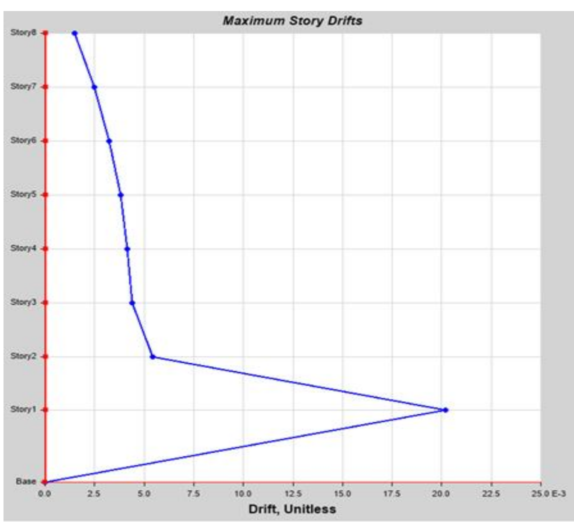

Figure 5.

Storey response plot- max. drift for irregular N2 structure.

Tabulated Plot Coordinates (regular) N1
Story Response Values:

Table 5.

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story8	24	Top	0.001574	0.000044
Story7	21	Top	0.00265	0.000051
Story6	18	Top	0.003469	0.000055
Story5	15	Top	0.004036	0.000055
Story4	12	Top	0.004392	0.000053
Story3	9	Top	0.004583	0.000047
Story2	6	Top	0.004658	0.000033
Story1	3	Top	**0.004714**	0.000004
Base	0	Top	0	0

Tabulated Plot Coordinates (mass and stiffness irregular) N2
Story Response Values

Table 6.

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story8	25	Top	0.001472	0.000046
Story7	22	Top	0.002476	0.000049
Story6	19	Top	0.003253	0.000052
Story5	16	Top	0.003801	0.000053
Story4	13	Top	0.004163	0.000052
Story3	10	Top	0.004403	0.000052
Story2	7	Top	0.005412	0.00006
Story1	4	Top	**0.020179**	0.000053
Base	0	Top	0	0

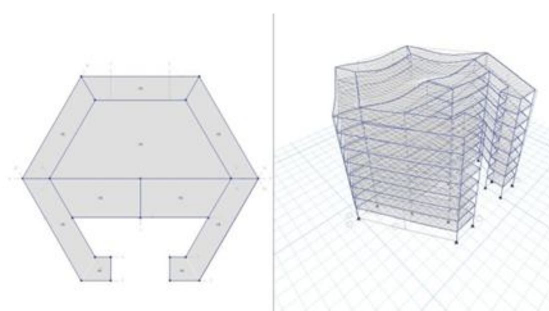

Figure 6. B: 2D and 3D view of hexagonal plan irregular with deformed shape.

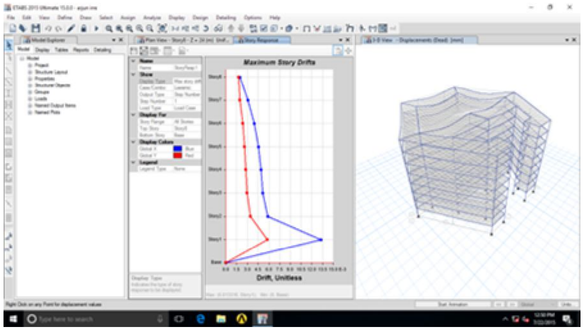

Figure 7. N3: 3D view with max drift for pan irregular as modeled by ETABS.

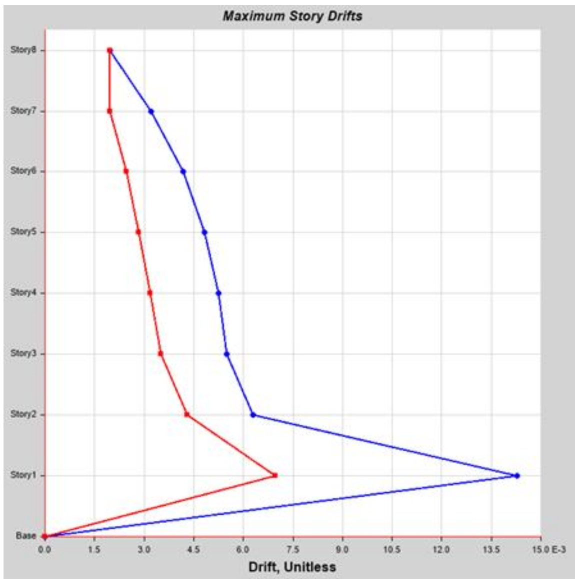

Figure 8.

Storey response plot- plan irregular

Tabulated Plot Coordinates (Plan irregular) N3
Story Response Values

Table 7.

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story8	24	Top	0.001958	0.001971
Story7	21	Top	0.003215	0.001959
Story6	18	Top	0.004171	0.002454
Story5	15	Top	0.00483	0.002836
Story4	12	Top	0.005242	0.003176
Story3	9	Top	0.005503	0.0035
Story2	6	Top	0.006282	0.004292
Story1	3	Top	**0.014291**	0.006976
Base	0	Top	0	0

VIII. RESULT

As per IS 1893:2002 max drift shall not exceed 0.004h, where ‘h’ is the storey height.

- Max drift permissible for regular model N1, 0.004x3= 0.012
- Observed max drift for N1 is 0.00471 at storey 1.
- Max drift permissible for model N2,
- 0.004x4=0.016
- Observed max drift for N2 is 0.020179 at storey 1.
- Max drift permissible for model N3, 0.004x3=0.012
- Observed max drift for N3 is 0.014291 at storey 1.

IX. CONCLUSION

It is quite clear from above analysis that structure with regular configuration posses more stability than irregular configuration. So any geometrical plan whether it is square, rectangle, circular or polygon it should be regular in every way i.e without any physical discontinuity or varying mass.

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