RESEARCH ARTICLE

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Seismic Analysis of Unsymmetrical Buildings Compering with Regular Building

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Abstract

Structural analysis of building is taken into account for finding out the behaviors of a structure when subjected to some external force acting on building. Building structural design for seismic loads is critical for structural safety during large ground movementsBuildings with symmetrical and unsymmetrical plan geometry, strength, and stiffness are also varied. During earthquakes, structures with a symmetric distribution of stiffness and strength in plan experience combined lateral and torsional motions.Previous earthquakes, in which many reinforced concrete structures were badly damaged or collapsed, highlighted the need to assess building seismic performance. Earthquakes can cause irregular distribution of mass, stiffness and strengths i.e., unsymmetrical buildings may cause heavy damage in structural members. Buy referring this paper it is concluded that symmetric buildings perform better than un-symmetric buildings when subjected to earthquake forces.

Keywords: Unsymmetrical building, mass, stiffness, deflection of building, irregular shapes.

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Introduction

The response of buildings to earthquakes is a complicated, it is difficult due to limitations in technology and depth of understanding the problem due to this many problems are created for analysis.

The building is designed as SMRF for better performance it just has to be constructed to withstand lower force then it is designed as an OMRF. Asymmetry can be reason for a building's poor performance under severe seismic loading. The buildings with vertical setbacks and L, H, U or T shaped in plans are more affected during seismic event. The poor performance of building under strong seismic loading can be attributed to structural asymmetry. Seismological data from many earthquakes were collected and analysed to map and understand the phenomena of earthquakes.

Loading on buildings can vary from normal commercial loads to heavy loads for special buildings used for specific purpose, such as Data canter buildings.

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Plan layout of all the analytical models is kept same for symmetrical buildings on plain grounds and asymmetrical buildings on sloping grounds for better results. To understand the seismic effects of symmetrical and asymmetrical models, seismic analysis is performed using linear dynamic (Response spectrum method) and nonlinear static methods (Pushover analysis) equivalent static analysis and Nonlinear dynamic analysis.

METHODOLOGY

To study behaviour of unsymmetrical building for that compering symmetrical building models with symmetrical shapes and with each other. For accurate results keeping stiffness and mass of building as similar as possible for that changing the column beam sizes. For better comparing and accurate results.

Taking different commonly used unsymmetrical shapes for comparing like C, +, L, T and making model on Staad-pro for defection of model.

Finally compere the deflation of model as main factor to known how unsymmetrical building give results as of symmetrical building.

MODELLING

Seismic zone: 2
Number of stories: 8(G+7)
Floor height: 3.2m
Spacing between frames-
4M along X-Axis
4m along Y-Axis
Materials Used: M20 grade concrete, Fe 415.
Density of Concrete: 25 kg/m3.
Type of soil: Hard
Live Load: 6 KN/m2

REACTANGULAR STRUCTURE:
Beam- 0.35 m x 0.65m (1st, 2nd floor)
0.3m x 0.65m (3rd, 4th, 5th, 6th, 7th, 8th)
Column- 0.6m x 0.6m (1st, 2nd, 3rd floor)
0.5m x 0.5m (4th, 5th, 6th floor)
0.4m x 0.4m (7th, 8th floor)
No. of columns: 16

C-SHAPED STRUCTURE:
Beam- 0.23m x 0.4m
Column- 0.6m x 0.55m (1st, 2nd floor)
0.65m x 0.55m (3rd floor)
0.55m x 0.45m (4th, 5th, 6th floor)
0.45m x 0.35m (7th, 8th floor)
No. of columns: 20

PLUS, SHAPED STRUCTURE:
Beam- 0.23m x 0.4m
Column- 0.6m x 0.55m (1st, 2nd floor)
0.65m x 0.55m (3rd floor)
0.55m x 0.45m (4th, 5th, 6th floor)
0.45m x 0.35m (7th, 8th floor)
No. of columns: 20

L SHAPED STRUCTURE:
Beam- 0.23m x 0.4m
Column- 0.6m x 0.55m (1st , 2nd floor)
0.65m x 0.55m (3rd floor)
0.55m x 0.45m (4th, 5th, 6th floor)
0.45m x 0.35m (7th , 8th floor)
No. of columns: 20

T SHAPED STRUCTURE:
Beam- 0.23m x 0.4m
Column- 0.6m x 0.55m (1st, 2nd floor)
0.65m x 0.55m (3rd floor)
0.55m x 0.45m (4th, 5th, 6th floor)
0.45m x 0.35m (7th, 8th floor)
No. of columns: 20

I SHAPED STRUCTURE:
Beam- 0.23m x 0.4m
Column- 0.6m x 0.55m (1st, 2nd floor)
0.65m x 0.55m (3rd floor)
0.55m x 0.45m (4th, 5th, 6th floor)
0.45m x 0.35m (7th, 8th floor)
No. of columns: 20

SAMPLE CALCULATION FOR STIFFNESS OF COLUMNS AT A SINGLE FLOOR

Given:
Shape of structure- Rectangular
Floor No.- 2nd
Height of column- 3.2m
Modulus of elasticity- 22360000
Column size- 0.6m x 0.6m
Moment of inertia-

$$0.0108 \times \frac{(b \times d^3)}{12}$$

Solution-
Formula-

$$k = \left(\frac{12E \times 1}{L^3} \right)$$

= (12 x 22360000 x 0.0108) / (3.23)
= 2282993.75 N/m
This value of stiffness is for only for one column. As we know all columns are in parallel.

$$= \frac{1}{2282993.75}$$

=0.000879
There is total 16 number of columns hence

$$= \frac{0.000879}{16}$$

=1137.81 N/m

Table-1: Floor wise mass and stiffness of structure

FLOOR	STIFFNESS OF OTHER SHAPES (IN N/m)	STIFFNESS OF RECTANGULAR SHAPE (IN N/m)
1	1092.294	1137.81
2	5158.425	5066.31
3	5158.425	5526.88
4	2558.743	2665.36
5	2558.743	2665.36
6	2558.743	2665.36
7	982.5572	1091.73
8	982.5572	1091.73

Table-2: Stiffness comparison of rectangular structure and other shaped buildings

FLOOR	STIFFNESS OF OTHER SHAPES (IN N/m)	STIFFNESS OF RECTANGULAR SHAPE (IN N/m)
1	2925.245	2920.908
2	2284.954	2297.284
3	2284.954	2297.284
4	2248.02	2249.42
5	2196.052	2205.896
6	2196.052	2205.896
7	2174.796	2170.832
8	1926.792	1932.368

RESULTS

Results of Deflection of Building with Different Shapes

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Table-3: Rectangular Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.008	0.008
2	0.018	0.018
3	0.018	0.018
4	0.036	0.036
5	0.031	0.031
6	0.041	0.041
7	0.089	0.089
8	0.125	0.125
9	0.299	0.299

Table-4: C- Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.021	0.011
2	0.022	0.183
3	0.033	0.429
4	0.036	0.717
5	0.044	1.154
6	0.053	1.661
7	0.221	2.281
8	0.379	3.073
9	0.849	3.548

Table-5: L- Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.027	0.025
2	0.083	0.098
3	0.225	0.218
4	0.353	0.351
5	0.602	0.606
6	0.923	0.906
7	1.129	1.143
8	1.815	1.786
9	1.89	1.884

Table-6: PLUS-Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.012	0.028
2	0.03	0.003
3	0.035	0.024
4	0.059	0.046
5	0.041	0.037
6	0.058	0.046
7	0.133	0.1
8	0.216	0.212
9	0.541	0.564

Table-7: I- Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.001	0.001
2	0.001	0.001
3	0.001	0.001
4	0.001	0.001
5	0.002	0.001
6	0.002	0.002
7	0.005	0.003
8	0.007	0.006
9	0.023	0.014

Table-8: T- Shape

No. of Floor	Deflection in X-direction	Deflection in Z-direction
1	0.002	0.001
2	0.008	0.001
3	0.018	0.001
4	0.032	0.002
5	0.048	0.002
6	0.066	0.002
7	0.089	0.021
8	0.108	0.04
9	0.142	0.08

CHARTS

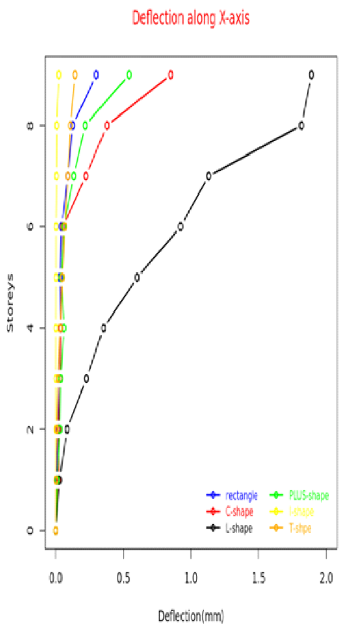

Chart-1: Deflection in X direction

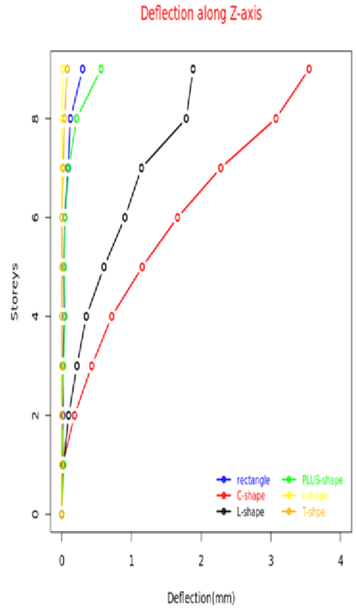

Chart-2: Deflection in Z direction

CONCLUSION

1. As we go from ground floor to upper floors, the deflection increases gradually in every shape.
2. Symmetrical shapes such as Rectangular, I-shape and PLUS- shape shows minimum deflection compared to unsymmetrical shapes.
3. Unsymmetrical structures like L-shape, C-shape, T-shape are less stable than symmetrical structure.
4. Deflection of shapes in increasing order-

Sr. No.	Shapes
1	Rectangular
2	I-shape
3	PLUS-shape
4	T-shape
5	L-shape
6	C-shape

Rectangular, PLUS-shape and I shaped buildings (symmetrical in both direction) are more stable than other unsymmetrical structure.

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