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Study of High Rise Building having mass irregularity using ETAB (2016).

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ABSTRACT: Growth of the population is increasing day by day. To meet the requirements of the population, high rise buildings are very much needed. The high rise buildings are to be designed to resist earthquake forces. Today, architectural application and economic constraints require that vertical-irregular structures be constructed in urban areas. Proposing methods to minimize damage to these structures during earthquakes is therefore crucial. Strict regulations have been enforced for the design and analysis of irregular structures given their higher vulnerability to damage compared to that of regular structures. Mass irregularity is considered to exist where the seismic weight of any storey is more than 200 % of that of its adjacent storey. Mass irregularity is an important factor which affects the response of the structure under seismic loads. This is introduced by increasing the weight of some floors relative to the other floors. The effect of irregularity depends on the structural model used, location of irregularity and analysis method. Suitable codes are used for analysis and design.

I. INTRODUCTION

In the 2005 National Building Code of Canada (NBCC), the method of analysis and applicable requirements for seismic design will depend whether the structure is regular or irregular. Eight types of irregularity are defined of which one is related to the vertical distribution of the seismic weight or mass [1]. According to Fig. 1.1, such irregularities inflict unpredictable and abrupt damages on the structures reducing the reliability on gaining the predefined performance level. Unforeseen measures such as change in use of some of the building's stories, altering the interior architecture, demolition or construction of additional infill walls as well as evacuated stories are usually main causes of mass irregularity [1].If the mass of any storey is more than 150% of the mass of the adjacent storey, the structure has a weight irregularity and a dynamic analysis procedure must be used if the structure is more than 20 m in height or has a fundamental period longer than 0.5 s [2]. Conversely, the simpler static equivalent force procedure is permitted for regular structures of up to 60 m in height and with a fundamental period of up to 2.0 s [3].

Fig.1 Deterioration of Fifth Storey of a Building in the Kobe Earthquake, Japan, 1995
(Source- Poncet L. and Tremblay R., 2004)

Irregular distribution of mass, stiffness or strength in elevation of multi-storey buildings is considered as an influential factor exciting the higher modes, which is in breach of the common code-based design approaches whose main focus is on the first vibration mode [4]. Mass irregularities are considered to exist where the effective mass of any storey is more than 150% of effective mass of an adjacent storey [5]. There are various types of irregularities in the buildings depending upon their location and scope, but mainly, they are divided into two groups―plan irregularities and vertical irregularities [7].

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A. Vertical Irregularities-
- Stiffness irregularity
- Mass irregularity
- Geometric irregularity
- In-plan irregularity
- Regular irregularity

B. Plan Irregularities-
- Torsion irregularity
- Re-entrant corners irregularity
- Diaphragm discontinuity
- Out-of-Plane Offset
- Non-parallel Systems

II. AIM

The aim of the project is to study the effect of irregularity by using different structural models, location of irregularity and analysis method.

III. OBJECTIVES

- Modelling of regular and irregular building using ETabs.
- To analyze the regular and irregular building for Response Spectrum and Time History methods
- To analyze a mass irregular building for base shear, mode shapes, storey drift, storey displacement and torsion.
- To study the response parameters at different storey heights.

IV. METHODOLOGY

In the present study a RCC framed structure of irregular building having an elevation of 35.2 m. Plan dimensions of the building is 17.36m x 14.75m. The location of the building is selected in Nashik, Maharashtra.

Sr.No	Parameter	Values
1.	Plan dimension	17.36m X 14.75m
2.	Elevation from depth of fixity	35.2m
3.	Floor to floor height	3.2m
4.	Total no. of story	G+10
5.	Size of columns	0.23m X 0.45m 0.23m X 0.5m 0.23m X 0.55m 0.23m X 0.6m
6.	Size of beams	0.15m X 0.55m
7.	Depth of slab	0.15m

V. STRUCTURE RESULTS & OBSERVATIONS

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQx according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Eccentricity Ratio = 0% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period,
T = 0.76 sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2]
Z = 0.16

Response Reduction Factor, R [IS Table 7]
R = 5

Importance Factor, I [IS Table 6]
I = 1.2

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, $S_a/g=1+15T$
$S_a/g=1$
S_a/g [IS 6.4.5]

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2], $A_h = \frac{Z\ I\ S_a/g}{2R}$

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VI. TABLES & GRAPHS

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	0	0	38641.3595	298838.9095	-339282.8626	0
Live	0	0	5232.15	40142.4288	-44896.5564	0
WLx 1	-516.2947	0	0	-4.4214	-12470.6317	3794.7658
WLx 2	516.2947	0	0	4.4214	12470.6317	-3794.7658
WLy 1	0	-604.0999	0	13525.466	3.2396	-5118.2509
WLy 2	0	604.0999	0	-13525.466	-3.2396	5118.2509
EQx	-1402.0383	0	0	-10.4241	-43711.2133	10474.6063
EQy	0	-1299.4489	0	37774.7744	9.4637	-11125.1056
RSA Max	1100.2181	1313.3249	335.9772	30967.5871	27884.2087	12236.5895
RSY Max	48.5132	1019.6621	172.0947	24643.2243	1014.0728	5448.8008
FACTORED LOA...	2103.0594	1949.1733	67310.2982	503973.024	-235767.9564	16687.6583
FACTORED LOA...	-2103.0594	-1949.1733	35677.2198	209592.857	-570306.6536	-16687.6583
UNFACTORED L...	1402.0383	1299.4489	44873.5055	375756.1237	-298545.6483	11125.1056
UNFACTORED L...	-1402.0383	-1299.4489	38641.3595	250084.1381	-427963.5824	-11125.1056

Table 1. Base reactions

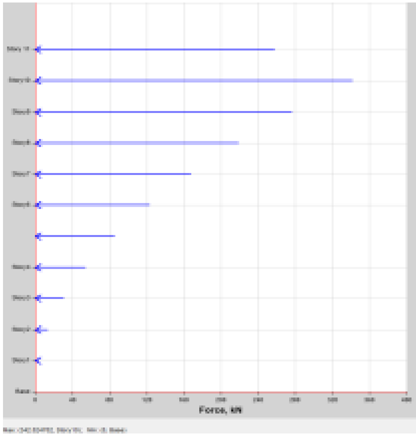

Fig.2 Base reactions

Story	Load Case/Combo	Direction	Drift	Label	X m	Y m	Z m
Story11	RSY Max	Y	0.000771	41	0	14.7	35.2
Story10	RSY Max	X	0.00015	48	17.2	14.7	32
Story10	RSY Max	Y	0.001161	41	0	14.7	32
Story9	RSY Max	X	0.0002	48	17.2	14.7	28.8
Story9	RSY Max	Y	0.001525	41	0	14.7	28.8
Story8	RSY Max	X	0.000215	48	17.2	14.7	25.6
Story8	RSY Max	Y	0.001798	41	0	14.7	25.6
Story7	RSY Max	Y	0.001984	41	0	14.7	22.4
Story6	RSY Max	Y	0.002118	41	0	14.7	19.2
Story5	RSY Max	Y	0.002242	41	0	14.7	16
Story4	RSY Max	Y	0.002375	41	0	14.7	12.8
Story3	RSY Max	Y	0.002475	41	0	14.7	9.6
Story2	RSY Max	Y	0.002388	41	0	14.7	6.4
Story1	RSY Max	X	0.00016	48	17.2	14.7	3.2
Story1	RSY Max	Y	0.001473	41	0	14.7	3.2

Table 2. Response spectrum on Y direction

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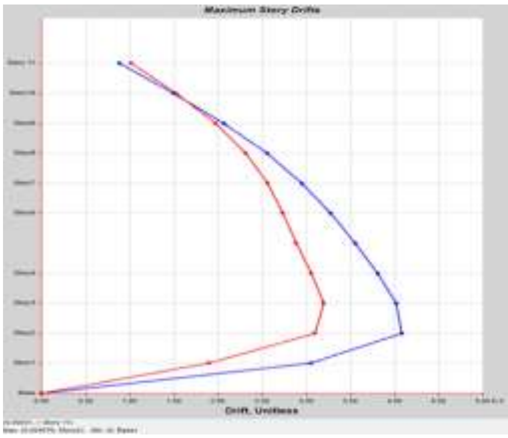

Fig.3 Maximum storey drift of Response spectrum in X direction

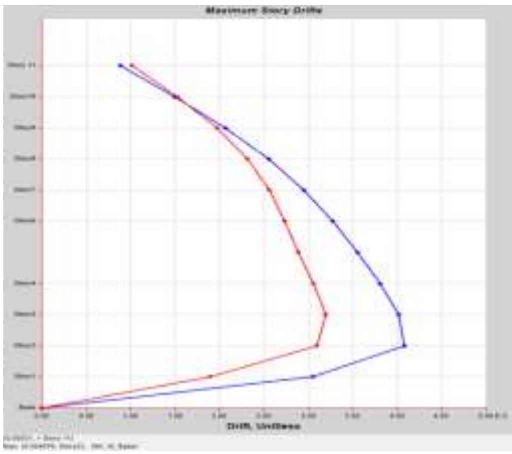

Fig.4 Maximum storey drift of Response spectrum in Y direction

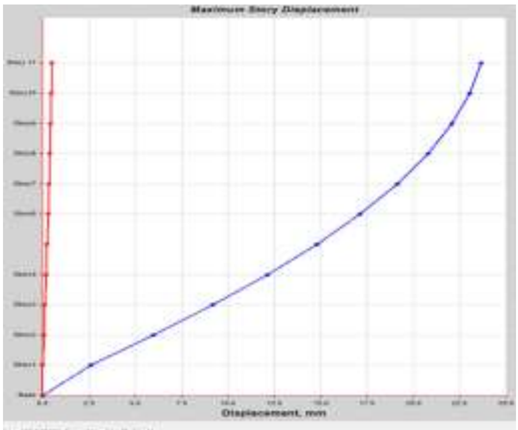

Fig.5 Maximum Story displacement for wind load in X direction

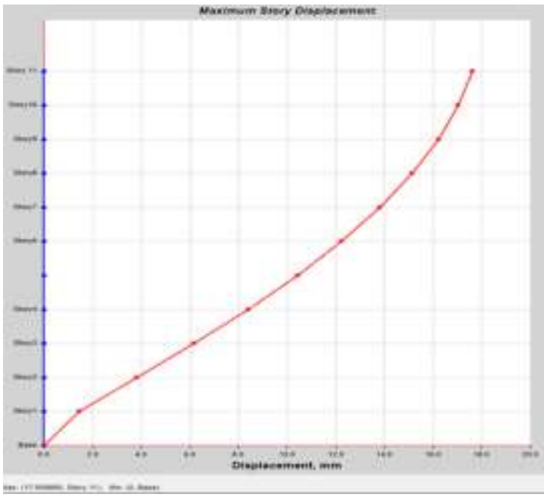

Fig.6 Maximum Story displacement for wind load in Y direction

VII. FUTURE SCOPE

1. We have done only the analysis of the building, so for future, use the above analyzed data for the continuation of designing of the building using software like ETAB, STADD PRO &SAP 2000 etc.
2. The analysis should be done for different irregular structure as well as steel structure.

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