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A Research Study on Dynamic Time History Analysis of Vertical Irregular Building

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ABSTRACT*:* When a structure is supported by High Loads, which include both seismic and wind loads, a catastrophic building collapse occurs. It is quite difficult to plan with a standard design since so many modern structures are engaged in the value of buildings. This mismatch is the reason why buildings with flexible loads fall. Therefore, much study is required to obtain both high performance and bad configuration. This paper investigates the effect of vertical alignment and bulk instability on multi-story structures under variable loads. The selection of three RC building frames has been made, and it is suggested that all framed and changed frames be evaluated. It is advised that all parties utilise the ETABS analysis system to identify all migrations. In this analysis, the 3-D frames of the G+20 floor with a uniform height configuration over its whole length and the precise uneven configuration beginning on the 9th floor are studied. It is proposed that answers from all preceding frames be restricted to all upload combinations. The method of response spectrum analysis is recommended to identify lateral loads and floor inspections of all three frames owing to earthquake loads, and IS 1893 (Part 1): 2016 supports dynamic analysis (direct dynamic analysis).

KEYWORDS: RCC, Irregularity, ETABS, IS 1893, G+20 storied, Earthquake

I. INTRODUCTION

During an earthquake, weakened areas of a structure fail first. The mass's instability, the structure's rigidity, and its shape all contribute to this susceptibility. Buildings with this suspension are unusual constructions. The influence of unusual constructions on urban infrastructure is important. Inadequate placement is one of the primary causes of structural collapse during an earthquake. The most prominent of the collapses are, for example, soft flooring. As a result, the influence of direct negative repercussions on seismic activity is becoming even more crucial. These constructions are distinguished from typical structures by the changeable components that their height and dimension variations provide. (Thowdoju et al. 2016)

The atypical distribution of size, strength, and durability of construction materials is the source of their issues. When these buildings are constructed at high heights, analysis and design are extraordinarily challenging. There are two types of deficiencies.

A structure is termed regular if its configurations are roughly symmetrical along the axis, whereas it is irregular if there is no symmetry and discontinuity in geometry, mass, or load-bearing materials. Asymmetrical configurations amplify torsion forces. IS 1893: 2016 (part 1) describes the building configuration approach for improving the seismic performance of RC buildings. The configuration of a building has been classified as regular or irregular based on its size and shape, the arrangement of its structural components, and its mass. Two distinct sorts of irregularities exist. 1) Horizontal irregularities consist of asymmetrical plan shapes (L, T, U, and F) or discontinuities in horizontal resistant parts such as re-entrant corners, broad apertures, cut outs, and other alterations including torsion, deformations, and stress concentrations. 2) Vertical irregularities are rapid variations in the vertical direction of a structure's strength, stiffness, geometry, and mass. This project's major objective is to explore the response of irregular structures to dynamic loads. In this study, it is recommended to consider building frames with uneven elevations and analyse the response and behaviour of buildings under earthquake and wind loads. For this aim, three RC building frames are selected, and it is advised to evaluate all of the considered and modeled frames. For the investigation of all structures in order to get all displacements, the ETABS analysis programme is suggested. This work investigates G+20 storied three-dimensional frames with symmetrical elevation arrangement throughout their height and asymmetrical vertical layout commencing on the ninth floor. It is recommended that the responses of all previous frames be estimated for all possible load combinations. The response spectrum analysis method is proposed for estimating the lateral loads and storey shears of all three frames due to seismic loads, and IS 1893(Part 1): 2016 has authorized dynamic analysis (linear dynamic analysis).

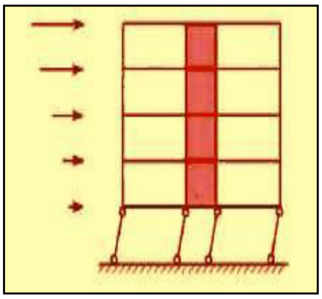

Fig 1 Stiffness Irregularities

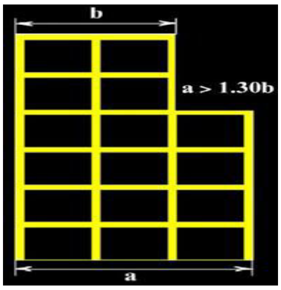

Fig 2 Vertical Geometric Irregularities in Building

1.1. Scope For Research

Modern urban infrastructures are mostly composed on irregular structures. Because buildings are never perfectly regular, designers must continually evaluate the predicted degree of irregularity and its influence on a structure during an earthquake. There is a need for research to provide a low-cost and effective lateral stiffness solution for areas with a high seismic hazard. For the optimization and design of seismically loaded high-rise structures with diverse structural and frame systems. To get a deeper understanding of the seismic behaviour of structures with vertical flaws.

II. PROBLEM STATEMENT

Two phases comprised the project study. The primary data were obtained by doing a literature review, which included web searches and the evaluation of e-books, manuals, codes, and journal articles. Following a review, a problem statement is formulated, and three samples are chosen for in-depth investigation and analysis. This project is executed according to the flowchart shown below: The diagram below offers an overview of the project's structure. In addition, reaction spectrum analyses are performed on the models.

Table 1 Model Input Data

Number of Stories	G+20
Total Height Of building	61.9 m
Height of Stories	Base to Storey 1 – 1.5m Storey 2 to Storey 9 – 3.2m Storey 10 to Storey 15 -3 m Storey 15 to Storey 21 – 2.8 m
Dimension of building	55m X 55m
Size of Beam	300 x 550 mm
Slab Thickness	S150 mm
Location	Pune
Seismic Zone	Zone IV – 0.16

Response Reduction Factor	5.0
Importance Factor	1.2
Grade Of Concrete	M 30
Grade Of Reinforcing Steel	Fe500
Supports at base	Fixed
Diaphragm	Rigid
Load Description	DL-Dead Load LL-Live load – 3 KN SDL- Super Dead load - 1KN EQX- Earthquake in X direction EQXN- Earthquake in X Negative direction EQY- Earthquake in Y direction EQYN- Earthquake in Y Negative direction Response Spectrum
Load Combinations	1.2 (DL + LL + EQX) 1.2 (DL + LL + RS X)

III. MODELING

Table 2 Models Description

MODEL 1	Vertical Irregularity At One Side
MODEL 2	Vertical Irregularity At Center
MODEL 3	Vertical Irregularity At Corner

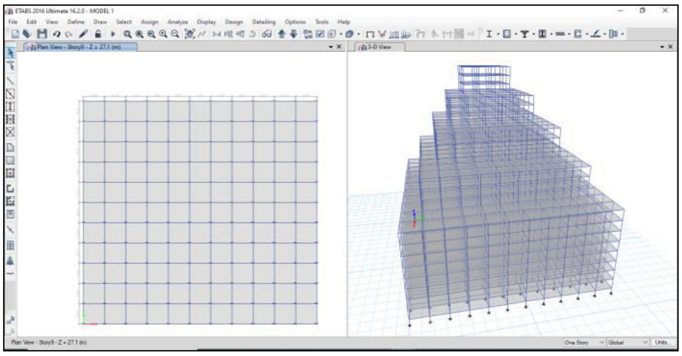

Fig 3 Model 1 Irregularity At One Side

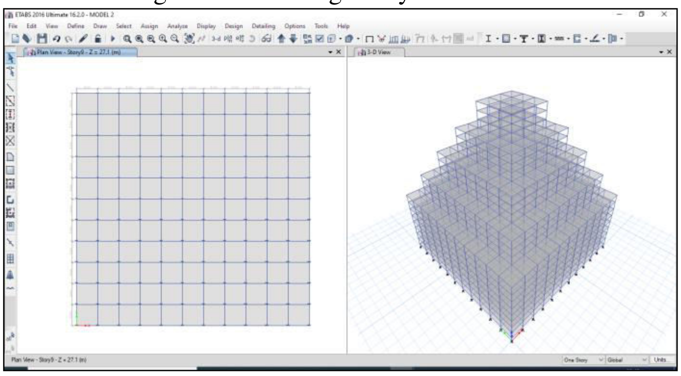

Fig 4 Model 2 Irregularity At Center

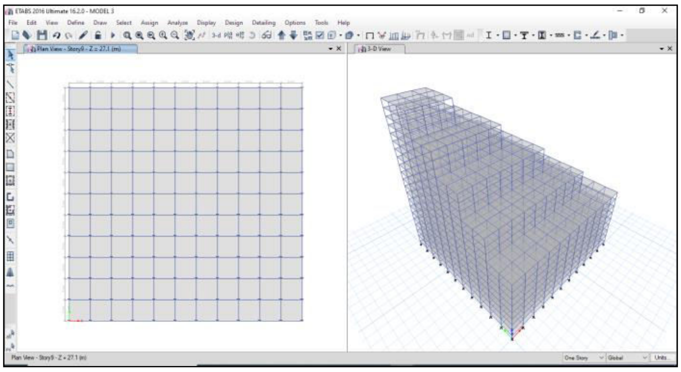

Fig 5 Model 3 Irregularity At Corner

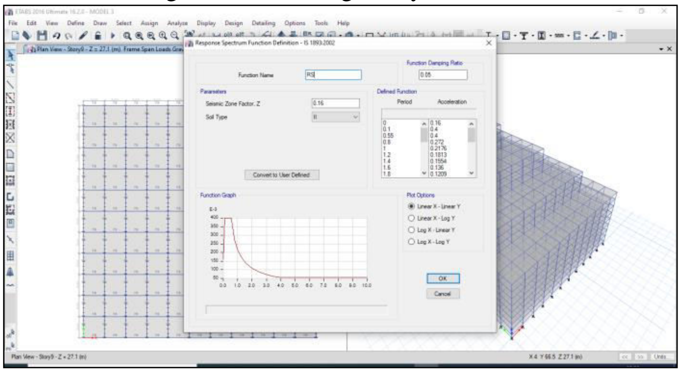

Fig 5 Response spectrum Case Added

IV. RESULTS AND DISCUSSION

4.1. Results for Equivalent Static Analysis

- **Time Period:**

Every building has a set of natural frequencies at which it provides the least resistance to external causes (such as earthquakes and wind) and internal variables that cause it to shake (like motors fixed on it). A Natural Mode of Oscillation is comprised of each of these natural frequencies and the structure's associated deformation shape.

Table 3 Time Period

Time Period			
MODE NO	Model 1	Model 2	Model 3
1	2.075	2.016	2.097
2	1.389	1.379	1.556
3	1.283	1.237	1.192
4	0.856	0.889	0.867
5	0.63	0.62	0.691
6	0.626	0.578	0.586

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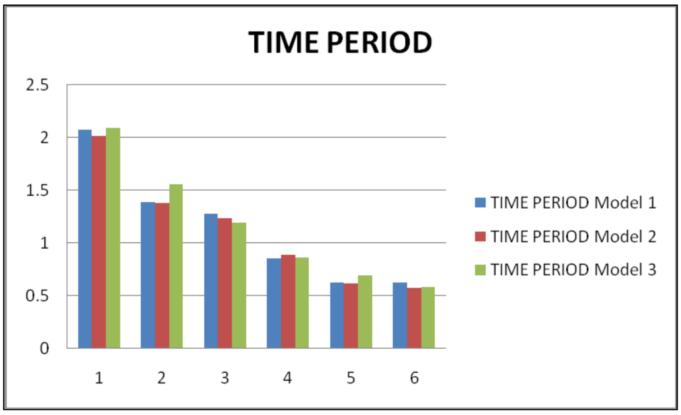


Graph 1 Time Period

The following table and graph demonstrate that the percentage variance for Time Period for Equivalent Static Analysis is reduced for model 2 compared to models 1 and 3. 15–20 percent less variation is seen for the model with Vertical Irregularity at Center compared to the other two models.

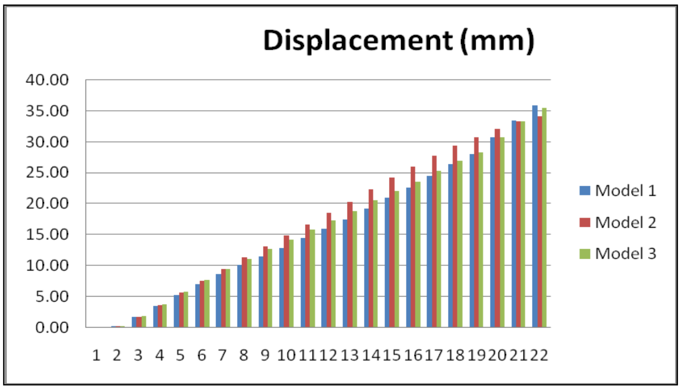
4.2. Results for Response Spectrum Analysis

- **Displacement (mm)**

Displacement can be defined as "It is the displacement of a storey with respect to the base of a structure

Table 4 Displacement

Displacement (mm)			
Storey	Model 1	Model 2	Model 3
21	35.89	34.16	35.536
20	33.51	33.37	33.302
19	30.79	32.17	30.798
18	28.11	30.76	28.348
17	26.48	29.42	26.948
16	24.58	27.77	25.299
15	22.58	25.99	23.553
14	21.05	24.28	22.158
13	19.30	22.35	20.557
12	17.48	20.38	18.853
11	16.03	18.60	17.397
10	14.46	16.73	15.816
9	12.89	14.87	14.194
8	11.56	13.14	12.713
7	10.18	11.38	11.175
6	8.65	9.53	9.492
5	7.01	7.61	7.691
4	5.28	5.65	5.799
3	3.49	3.69	3.842
2	1.71	1.79	1.888
1	0.25	0.25	0.274
Base	0	0	0



Graph 2 Displacements (mm)

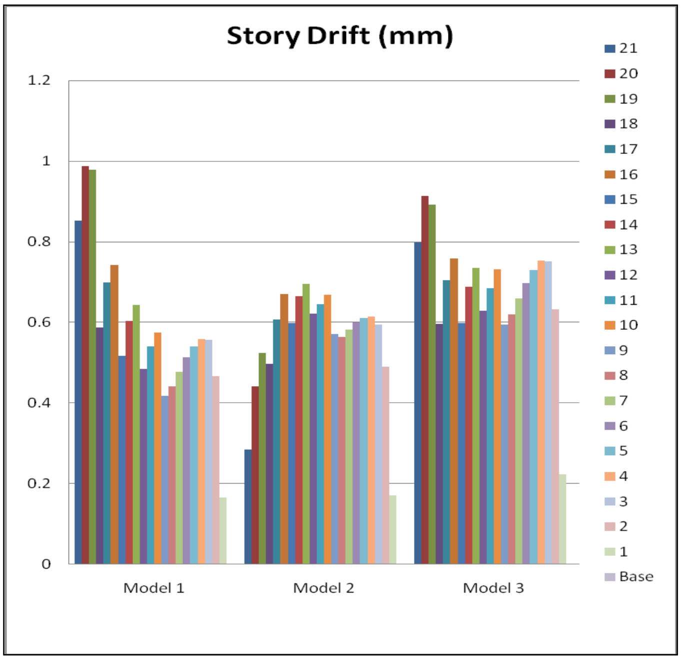
The percentage variation of displacements for analogous static analysis for model 2 is less than that of models 1 and 3, as shown in the accompanying table and graph. After the ninth floor, the variance of the model with Vertical Irregularity at Center is 1 to 5 percent less than that of the other two models.

- **Story Drift (mm)**

Story drift is the difference of displacements between two consecutive stories divided by the height of that story.

Table 5 Story Drift (mm)

Story Drift (mm)			
Storey	Model 1	Model 2	Model 3
21	0.852	0.285	0.798
20	0.988	0.442	0.913
19	0.978	0.524	0.892
18	0.588	0.497	0.597
17	0.699	0.608	0.704
16	0.743	0.67	0.758
15	0.517	0.599	0.599
14	0.603	0.665	0.688
13	0.643	0.696	0.736
12	0.485	0.621	0.628
11	0.54	0.645	0.684
10	0.574	0.669	0.731
9	0.418	0.572	0.594
8	0.441	0.564	0.619
7	0.478	0.582	0.66
6	0.513	0.6	0.698
5	0.54	0.611	0.73
4	0.559	0.614	0.753
3	0.557	0.595	0.752
2	0.467	0.49	0.632
1	0.166	0.172	0.223
Base	0	0	0



Graph 3 Story Drift (mm)

The percentage variance of Story Drift for Equivalent Static Analysis is reduced for model 2 compared to models 1 and 3. This is evident from the table and graph presented above. The variance is 15 to 25 percent smaller for the model with Vertical Irregularity at the Center than for the other two models beyond the ninth story.

V. CONCLUSION

The primary objective of this study is to analyse Vertical irregular high rise buildings using ETABS Dynamic analysis to determine time period, storey drift, displacements, and floor responses using Different Vertical irregularities models while maintaining the same mass of the entire building and stiffness irregularities of the floors for the analysis. The investigation covers the participation of 90 percent of the building mass in each principal horizontal direction of response as described by IS 1893(Part-I)-2016 by complete quadratic combination (CQC). In the study, high performance concrete and advanced structural framings, such as moment-resistant frames, are utilized. The structure's Equivalent Static and response spectrum have been examined. According to FEA findings, storey share was greatest in the first storey and decreased to a minimum in the top storey, whereas storey drift/displacements were smallest in the first story and rose in the top storey. Type 2 (vertical irregularity in the middle) is the most cost-effective model, followed by models 1 (vertical irregularity on one side) and 3. (with vertical irregularity at the corner). The subsequent discussion has concluded all of the results.

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ii. **IS 1893 : 2000 -** Criteria For Earthquake Resistant Design Of Structures