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Comparative analysis betweenStatic and Non Linear Dynamic analysis of irregular and regular building

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ABSTRACT:*The magnitude and intensity of earthquake is cannot be predict but we can reduced the damages and failure of structure by adopting plan Regularity and Irregularity. The Regular and Irregular plan of building for G+15 storey by using rectangular symmetrical and Unsymmetrical Channel shape building create models by using Etab software for study thebehavior of structure for Equivalent static and Non linear dynamic analysis i.e. Time history analysis for two different earthquake records.*

In present study, Multi-storeyRegular and Irregular with different plan area for G+15 stories have been modeled using software ETABS for seismic zone IV in India. This paper studies the performance of the building static analysis and performance of building during earthquakes shakes, Kobe and Bhujbeen investigated. This paper enlightens the exactness of Time History analysis in comparison with the most commonlyadopted Dynamic analysis and Equivalent Static Analysis by using IS 1893: 2002 part 1 codal provision in Etab software with regards time period, maximum displacement, stiffness and drift.

Key Words:*Regular plan, Irregular plan, G+15 storey regular and irregular building,Equivalent static analysis, IS 1893:2002 part 1 provisions, Etab software.*

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I. Introduction

Earthquake is generated by sudden release of energy in earth's crust that creates seismic waves. In nature, earthquake forces are accidental & uncertain natural hazards. An engineer requires the tools for analyzing structures under the effect of these types of forces. Earthquake loads are modeled to assess the action of structure with a clear understanding that hazard is to be anticipated but it should be regulated. In this paper an analytical study is made to find response of different regular and irregular structures by static and dynamic methods. The study includes the equivalent static and Non linear dynamic analysis Time History Analysis of G+15 storied regular and irregular structures in Etabsoftware. For time history analysis past earthquake ground motion record –Kobe and Bhuj is taken to study response of the structures. For analyzing seismic behavior of structures, mathematical model of the structures are required to determine the parameter is Time period, maximum displacement, storey drift and base shear in kN characteristics in various components of the structure. Behaviors of structures were found by comparing responses in the form of above parameter for regular and irregular structures.

II. Methodology

The seismic analyses methods so far used in estimating the demand on the structure can be classified in the following four groups

I) Linearequivalent Static Analysis
II) Linear Dynamic Analysis
III) Nonlinear Static Analysis
IV) Nonlinear Dynamic Analysis.

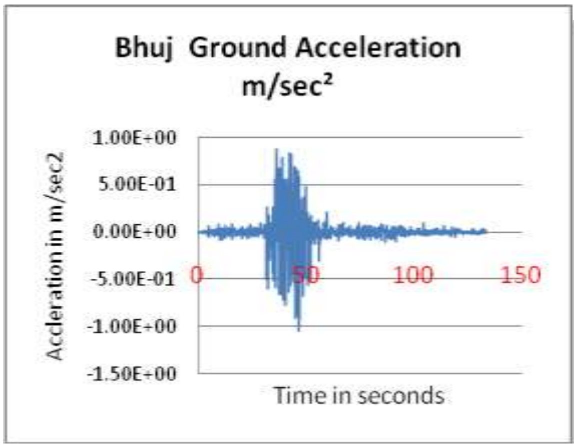
It is seen from the basics of the Structural static that the response of the structure can be estimated as the sum of modal responses. For majority of the structures, consideration of first three or four modal contributions yields sufficiently accurate results. This forms the basis for all the above mentioned analysis procedures.

a. Equivalent static analysis: -

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures,analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildingswithout significant coupled lateral modes, in which only the first mode in each direction is considered. Tall buildings (over, say, 45 m), where second and higher modes can be important, or buildings with are much less suitable for the method, and require more complex methods to be used in these circumstances.

b. Non linear time history analysis: -

Time-History analysis is a step-by-step procedure where the loading and the response history are evaluated at successive time increments, Δt – steps and provides more detailed information regarding the seismic behavior of a structures. The most common way to describe a ground motion is with a time history record. The motion parameters may be acceleration, velocity, or displacement, or all the three combined together. Time histories of ground motions are used directly for the time domain analysis of structures subjected to deterministic seismic inputs. At any measuring station, ground motions are recorded in three orthogonal directions; two of them are in horizontal directions and the third is in the vertical direction. Thus, three components of ground motions are available from any measuring station. The Time Vs Acceleration of Kobe and Bhuj is plotted in Figure 1 and 2. The Time-History function is used to perform Linear and Non – Linear Time-History Analysis of structures to understand the actual behaviour of structures under Seismic Excitation.



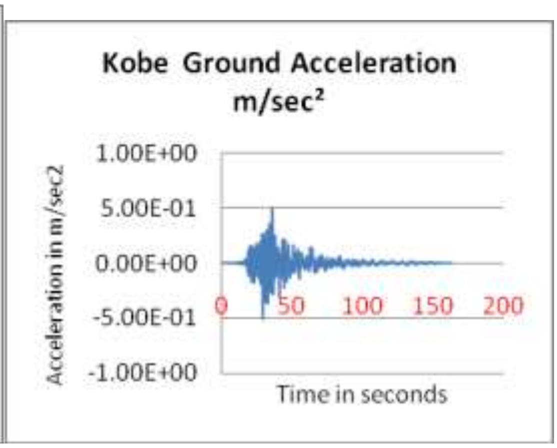


Figure No. 1 Bhuj ground acceleration **Figure No.2 Kobe ground acceleration**

III. Problem statement

3.1 General

The main objective of this paper is to study the performance of structure under static and nonlinear dynamic analysis to failure of structure. For this purpose Static equivalent static Analysis and Time History Analysis is used to evaluate the real behavior of the structure.

3.2 Description of structure

G+15 storied R.C. buildings with Case I – regular plan and Case II – Irregular plan are considered for seismic analysis. The plan and isometric view of buildings are shown in Figure No. 3 to Figure No. 4. The structural models are description is shown in Table No. 3.1.

Table 3.1: General Characteristics of the Analyzed Structural Systems

Type of Structural system	G+15 Irregular Building	G+15 Regular Building
Slab (mm)	150 mm thick	
Column (mm)	300mm X 650 mm	
Beam size (mm)	250 mm X 550 mm	
Material Properties	For Concrete M 25 and For Steel Fe 415	
External wall	230 mm thick	
Internal wall	115 mm thick	
Height of each floor (m	3	
Density (kN/m³)	25	
Live load (kN/m²)	3	
Floor finish (kN/m²)	1	
Seismic Zone	IV	
Soil type	Medium hard rock	

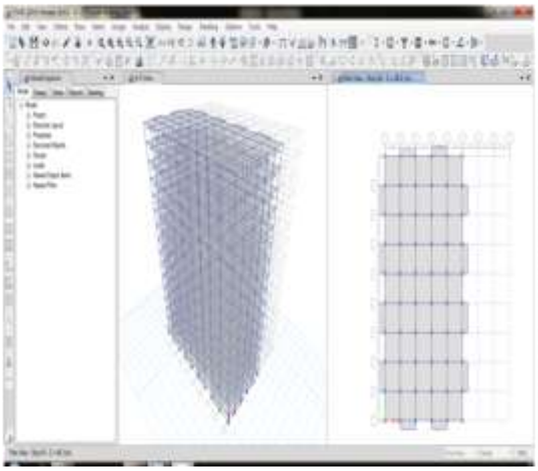


Figure No. 3.1 Regular Building

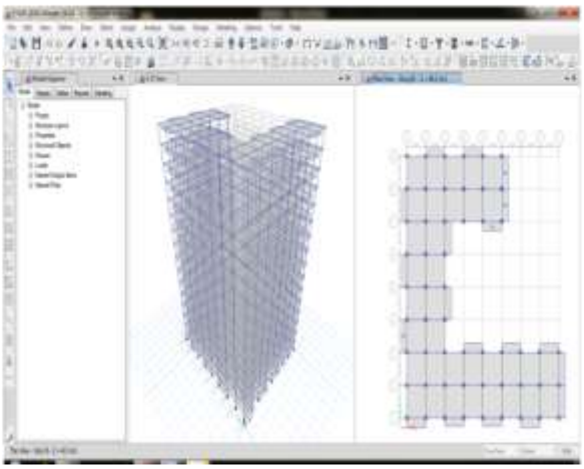


Figure No. 3.2 Irregular Building

3.2 Modeling of Building

For the comparative study, Regular and Irregular buildings are considered;the total plan dimension of building Regular Building is 472.5 m^2 and Irregular building plan area are 357 m^2.The Regular and Irregular building are different and analyzed by equivalent static analysis by IS 1893;2002 part 1and Non linear dynamic analysis method. The designation used for the building models is as given in following Table 3.2

Table 3.2: Description of a building model

Model No.	Type of Structure	Designation
1	Irregular Building G+15 storey	Irregular
2	Regular Building G+15 storey	Regular

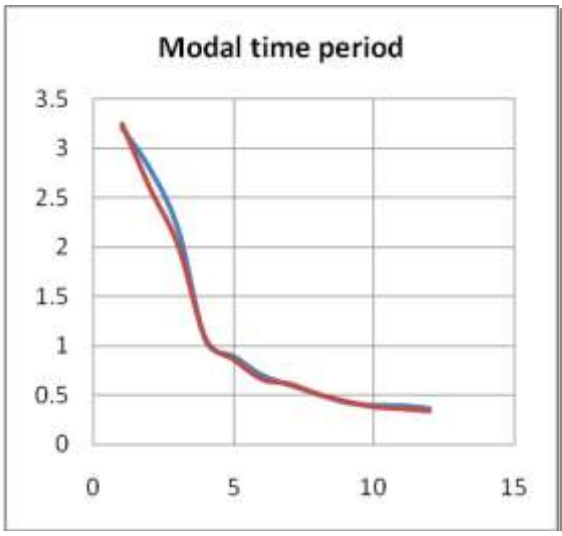
Above data and models are used for analysis of structures with respect to different parameters like time period, displacement against height, storey drift and base shear for static analysis. But only base shear and maximum displacement at top floor are considered for time history i.e. non linear dynamic analysis.

IV. Result and Discussion

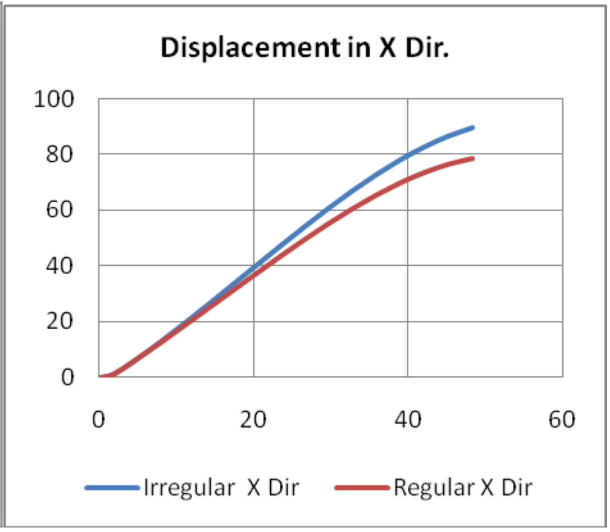
The maximum displacements of building in different stories for Equivalent Static Analysis and Time History Analysis have been compared and shown individually results of static and dynamic analysis. Also, the maximum roof displacement is considered to indicate the difference between equivalent static and nonlinear dynamic analysis. It is observed that with two different earthquake records are shown in graphs as follows

Results of equivalent static analysis

1. Time period
2. Maximum displacement in X direction



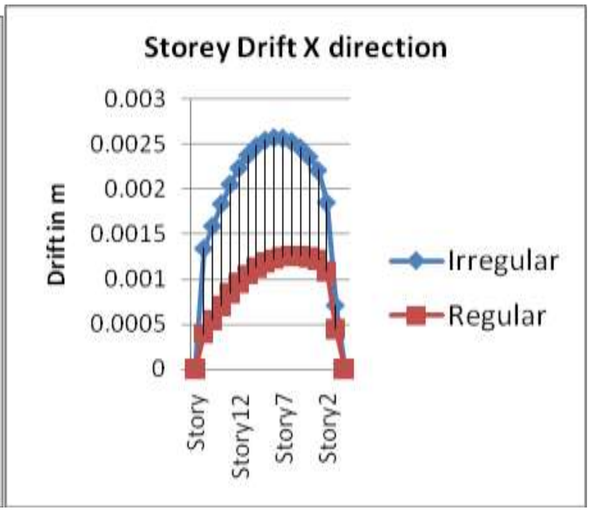
Graph No.1 Modal time period in seconds



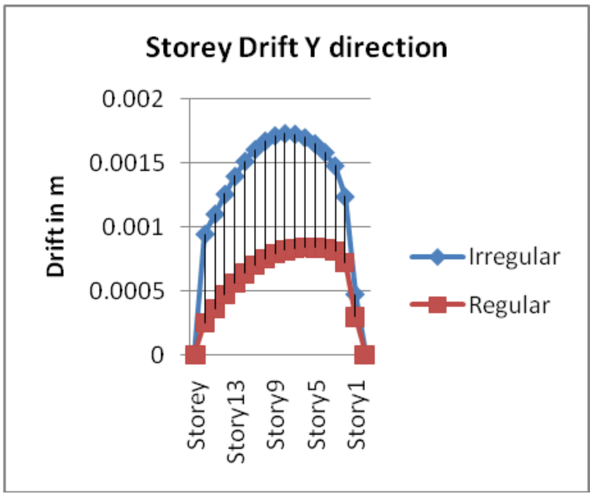
Graph No.2 Maximum displacement in x direction

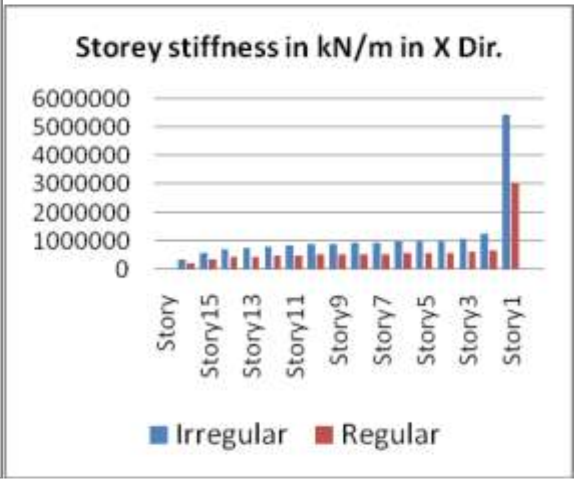
3. Maximum displacement in Y direction4. Storey drift in X direction

Graph No.3 Maximum displacement in Y direction

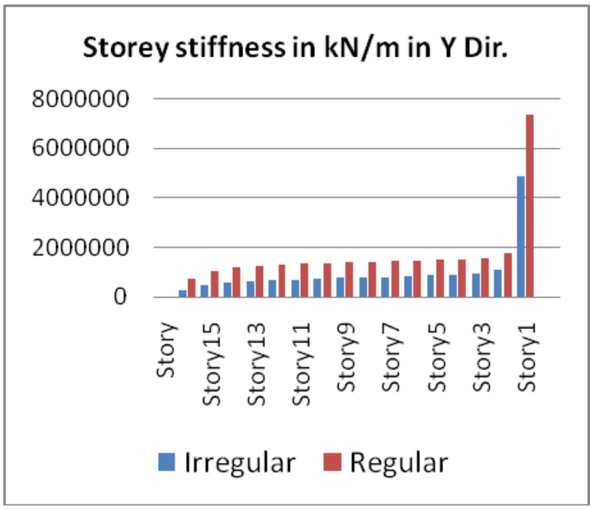


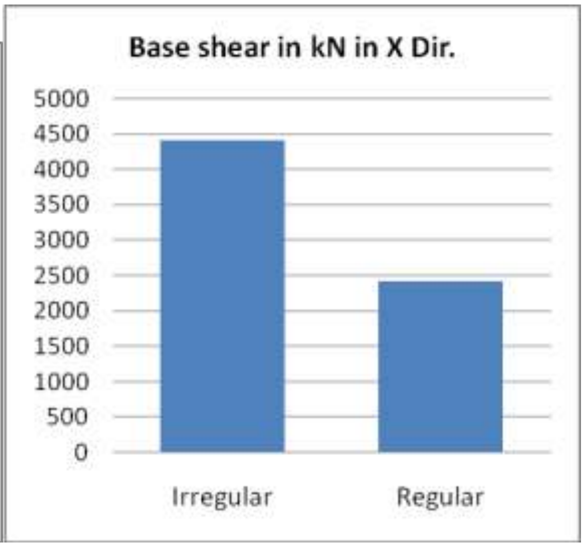
Graph No.4 Storey drift in m in X direction



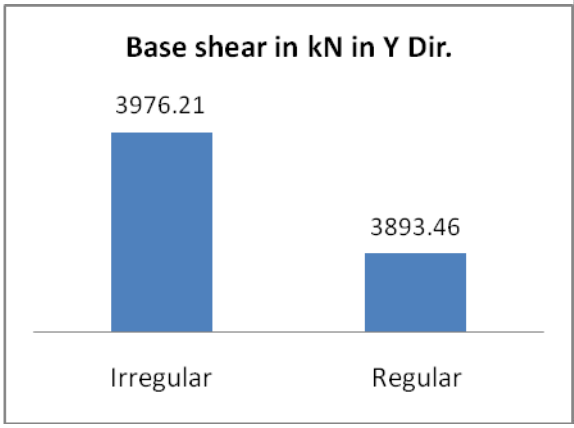


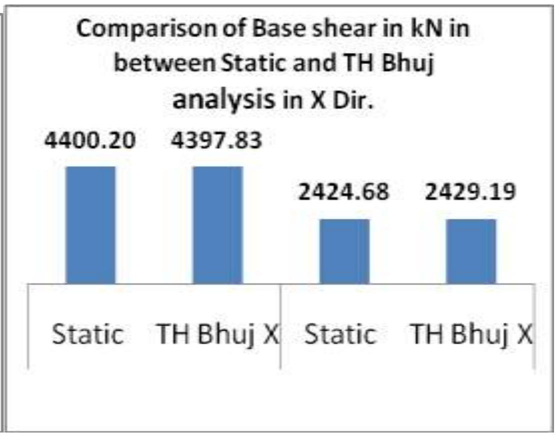
Graph No.5Stores drift in m in Y directionGraph No. 6Storesstiffness in Kn/m in X direction



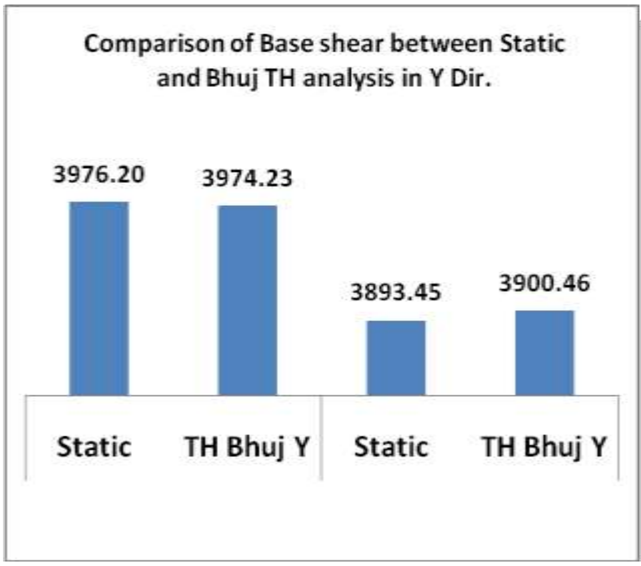


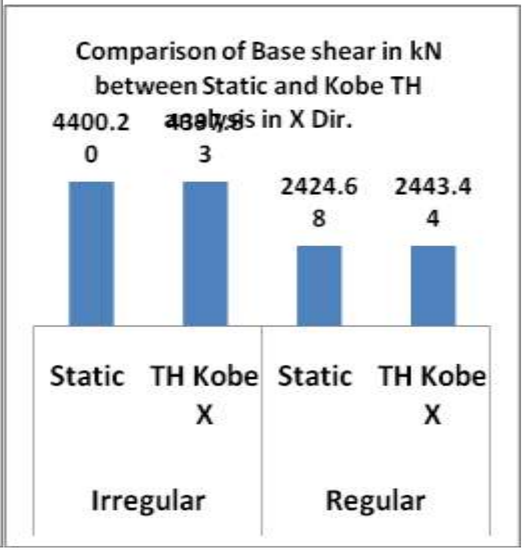
Graph No.7Storesstiffness in Kn/m in Y directionGraph No. 8Base shear in kN in X direction



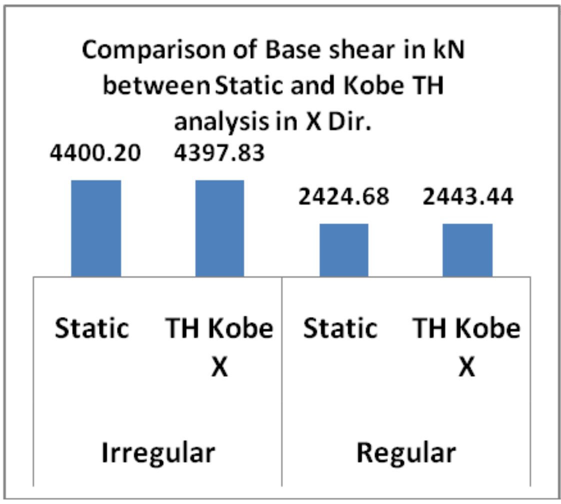


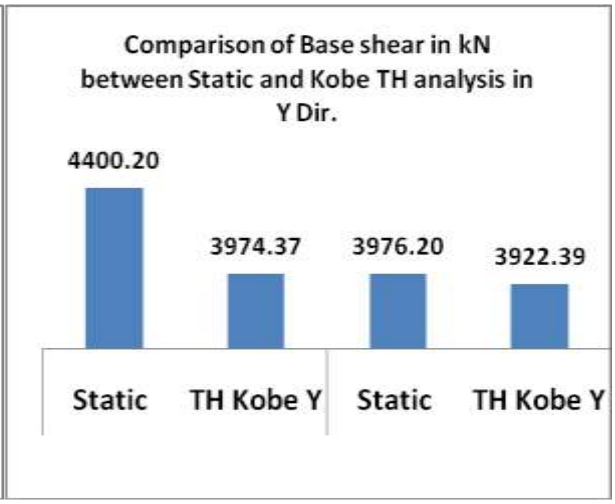
Graph No. 9Base shear in kN in Y directionGraph No.10Base shear in kN in Xdirection



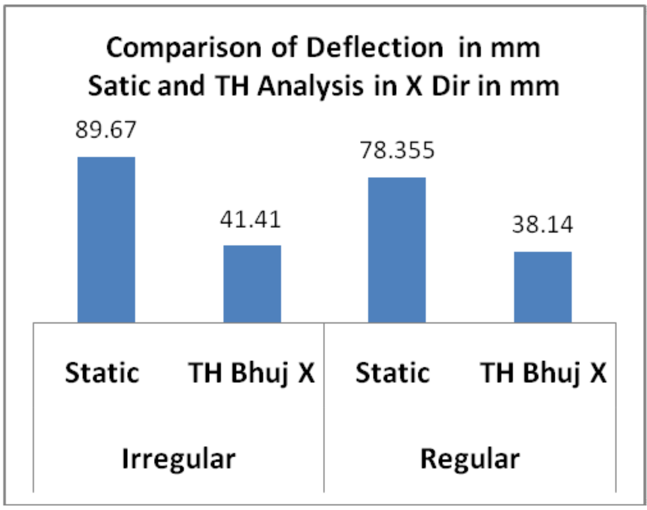


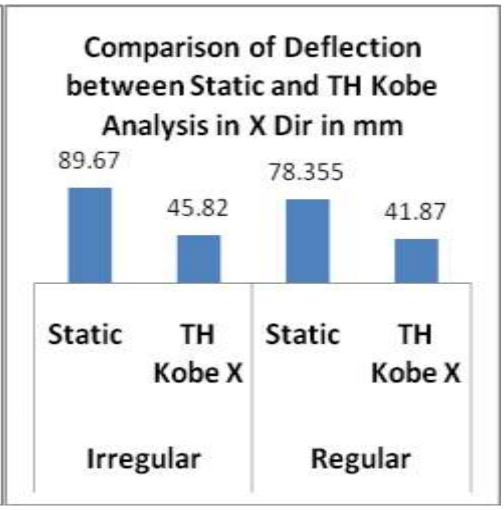
Graph No. 11Base shear in kN in Y directionGraph No. 12Base shear in kN in Y direction



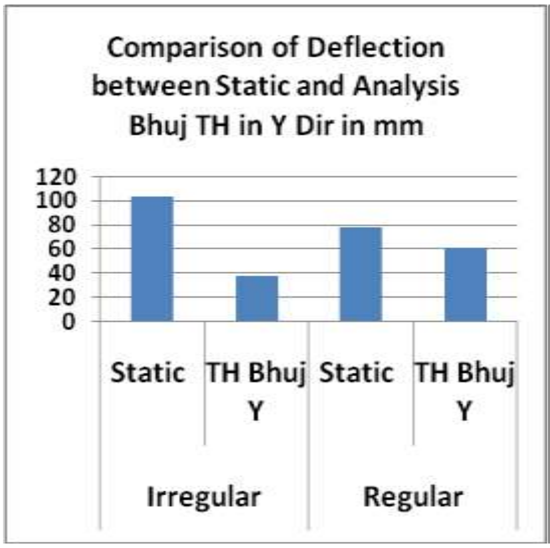


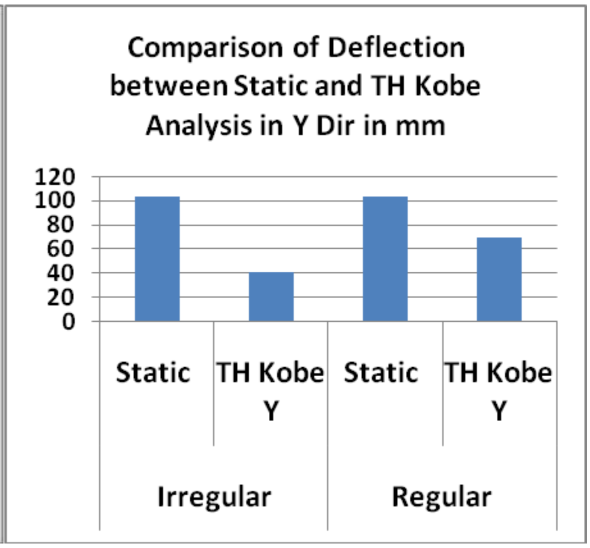
Graph No.13Base shear in kN in Y directionGraph No. 14Base shear in kN in Y direction





Graph No. 15Maximum deflection in mmX directionGraph No. 16Maximum deflection in mm Y direction





Graph No. 17Maximum deflection in mm X directionGraph No. 18Maximum deflection in mm Y direction

4.2 Discussion:

1. From Graph 1 the modal time period was decreased by 1.03% in Irregular building as compare to Regular building.
2. From Graph 2 and 3 The maximum deflection occurs in X and Y direction are increased by 12.62% and 53.36% in Irregular building as compare to Regular building respectively.
3. From 4 to 5 the maximum drift is average increascdin X and Y direction 53.25% and 53.79% Irregular building as compared to Regular building respectively.
4. From 6 to 7 the stiffness is increased in x direction and decreased in Y direction.
5. Graoh 8 to 9 the base shear are increased in X direction by 44.90% and increased in Y direction are 2.09% respectively.
6. Graph 10 to 13 th base shear are as compare with static and dynamic analysis is are shown in tabular form

	Irregular			**Regular**	
	Static	TH Bhuj X		Static	TH Bhuj X
Base shear in kN	4400.209	4397.836		2424.68	2429.19
Decreased by	0.054 %		Increased by	0.19%	
	Irregular			**Regular**	
	Static	**TH Bhuj Y**		**Static**	**TH Bhuj Y**
Base shear in kN	3976.21	3974.23		3893.46	3900.468
Decreased by	0.05%		Increased by	0.18%	
	Irregular			**Regular**	
	Static	TH Kobe X		Static	TH Kobe X
Base shear in kN	4400.209	4397.836		2424.68	2443.445
Decreased by	0.054%		Increased by	0.77%	
	Irregular			**Regular**	
	Static	TH Kobe Y		Static	TH Kobe Y
Base shear in kN	4400.209	3974.375		3976.21	3922.39
Decreased by	**9.68 %**		**Decreased by**	**1.35%**	

7. Graph 14 to 18 the maximum deflection in mm are compare with static and dynamic analysis as shown tabular form

	Irregular		Regular	
	Static	TH Bhuj X	Static	TH Bhuj X
Deflection in mm	89.67	41.41	78.355	38.14
Decreased by	**46.18%**		**48.68%**	
	Irregular		**Regular**	
	Static	TH Bhuj Y	Static	TH Bhuj Y
Deflection in mm	103.611	37.43	78.355	61.25
Decreased by	**36.13%**		**78.17%**	
	Irregular		**Regular**	
	Static	TH Kobe X	Static	TH Kobe X
Deflection in mm	89.67	45.82	78.355	41.87
Decreased by	**51.10%**		**53.44%**	
	Irregular		**Regular**	
	Static	TH Kobe Y	Static	TH Kobe Y
Deflection in mm	103.611	41.4	103.611	69.455
Decreased by	**39.96%**		**67.03%**	

V. CONCLUSION

1. As a result of comparison between static and nonlinear dynamic analysis it is observed that the base shear obtained by static analysis are higher than dynamic analysis for irregular structure and base shear obtained by dynamic analysis are higher than static analysis for regular structure.
2. As a result of comparison between static and nonlinear dynamic analysis it is observed that the deflection obtained by static analysis are higher than dynamic analysis for irregular structure and analysis for regular structure.
3. The difference of displacement values between static and dynamic analysis lower stories are insignificant but it increased in higher stories reached at its peak in top storey or roof.
4. Time History analysis is an important tool to summarised the performance of a building under a given earthquake. Seismic Analysis of structure is done by selecting an adequate record of ground motion for time history analysis.

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