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EFFECT OF A DIAPHRAGM IRREGULARITY ON SEISMIC ANALYSIS OF RC BUILDING USING PUSHOVER ANALYSIS

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Abstract

Diaphragm irregularities are one of the major causes of damage under seismic forces. Buildings with irregular Diaphragm or asymmetrical distribution of structural member and properties are subjected to an increase in seismic forces, causing greater damages to the structures. Diaphragm irregular building leads to often development of brittle collapse mechanisms due to a local increase of the seismic demand in particular members. Diaphragm irregular structures appears to have the most adverse effects on the applicability of the classical nonlinear static procedures, precisely because such methods have been developed for the seismic assessment of structures whose behavior is primarily translational. In this paper an attempt has been made to study and understand the critical behavior of Diaphragm irregular structures subject to seismic forces located at zone V as er IS 1893 2002. Four models has been modeled in SAP 2000 software and conclusions have been made on the basis of static and pushover analysis.

Keywords: Pushover analysis, plan irregularity, pushover curve, performance point, SAP 2000

1 Introduction

An irregularity in diaphragm leads to increase in torsional effect in building when structure is exposed to lateral forces. Irregularity in any building can be categorized as mass and lateral stiffness, variations in plan, presence of set-backs, in-plan stiffness of the floors, continuity of the structural system from the foundations to the top of the building although this list does not cover all the possible causes of irregularity. Irregularities due to the combination of both plan and vertical irregularities are not mentioned in code definitions. The ATC-40 and FEMA-356 documents explain procedure for simplified nonlinear analysis for determining the displacement demand imposed on a building expected to deform.

3 Methodology

In pushover analysis structure is analyzed by increasing lateral forces with an invariable distribution along height until a target displacement is achieved. Pushover analysis is widely accepted by the designers for the estimation of design and seismic performance of structures. Using pushover analysis for structures certain analysis parameters related to seismic demands like performance of non linear analysis, mode effects, estimation of lateral load patterns, and precise estimation of displacement can be executed.

4 Structural Modeling

Building is modeled in done SAP 2000 with the help of different modeling sections like beam and column which are modeled as a frame element and slab as shell element. Property of all structural elements used in this study is listed in table below.

Four different types of structure have been modeled using SAP 2000 in this study models are modeled under two different approaches.

G+4 Regular Diaphragm Building	Model 1
G+4 Irregular Diaphragm Building	Model2
G+10 Regular Diaphragm Building	Model 3
G+10 Irregular Diaphragm Building	Model 4

Table 1: Load Data

Live Load	2 KN/m^2
Floor Finish	0.75 KN/m^2

Table 2: Seismic Definition

Earthquake Zone	V
Damping Ratio	5%
Importance factor	1
Type of Soil	Medium
Type of structure	All General RC frame
Response reduction Factor	5
Time Period	Program calculated
Foundation Depth	1.5 m

Table 3: Geometric Data

Density of RCC considered	25 kN/m^2
Thickness of slab	150 mm
Depth of beam	600mm
Width of beam	250mm
Dimension of column	250 mm x 600 mm
Height of each floor	3.5 m
Conc. Cube Comp. Strength, fck	25 kN
Bending Reinforcement yield strength	500N/mm^2

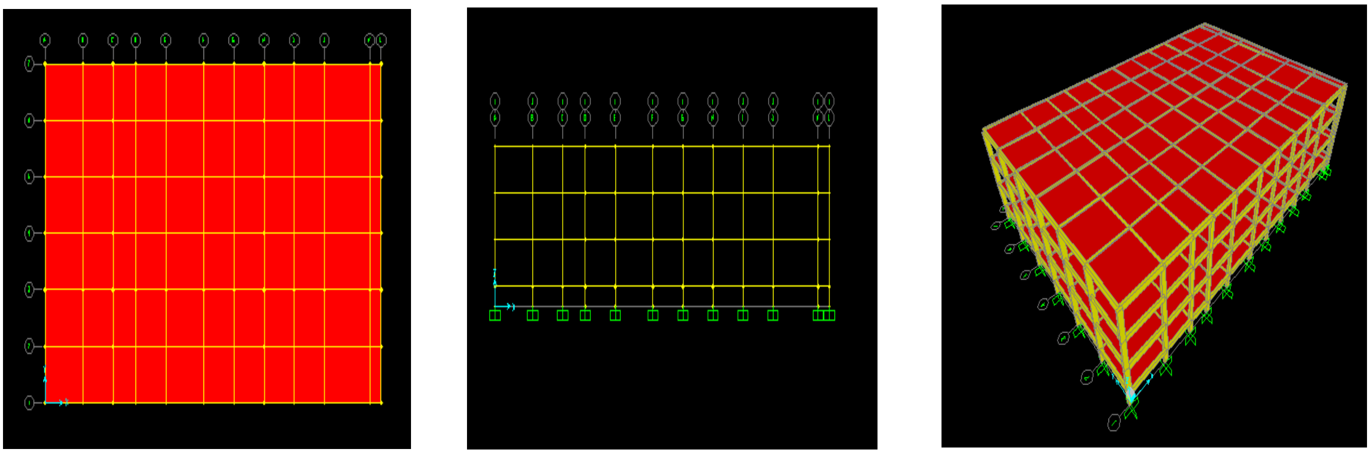


Fig. 1 Plan, Elevation and 3D View (MODEL 1)

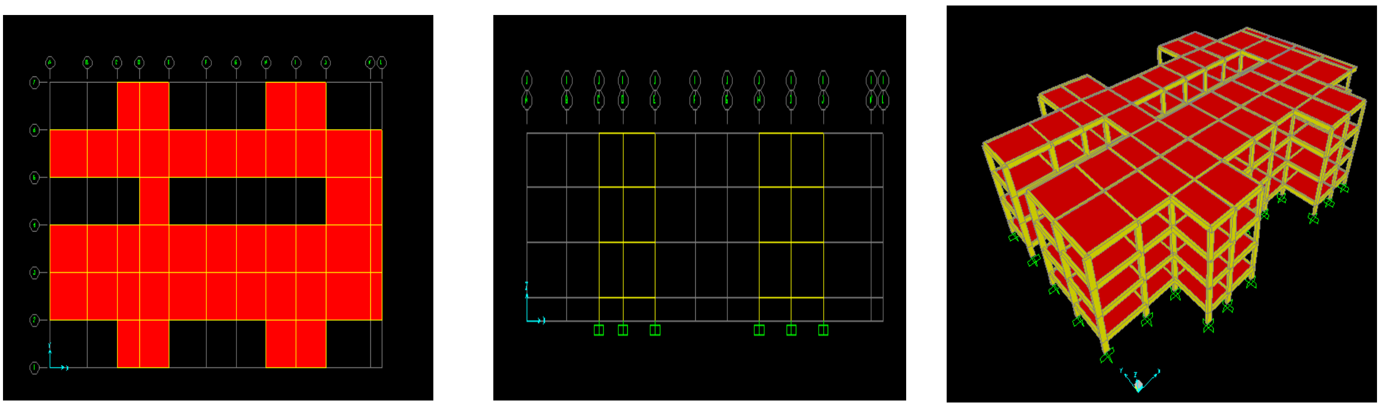


Fig. 2 Plan, Elevation and 3 D View (MODEL 2)

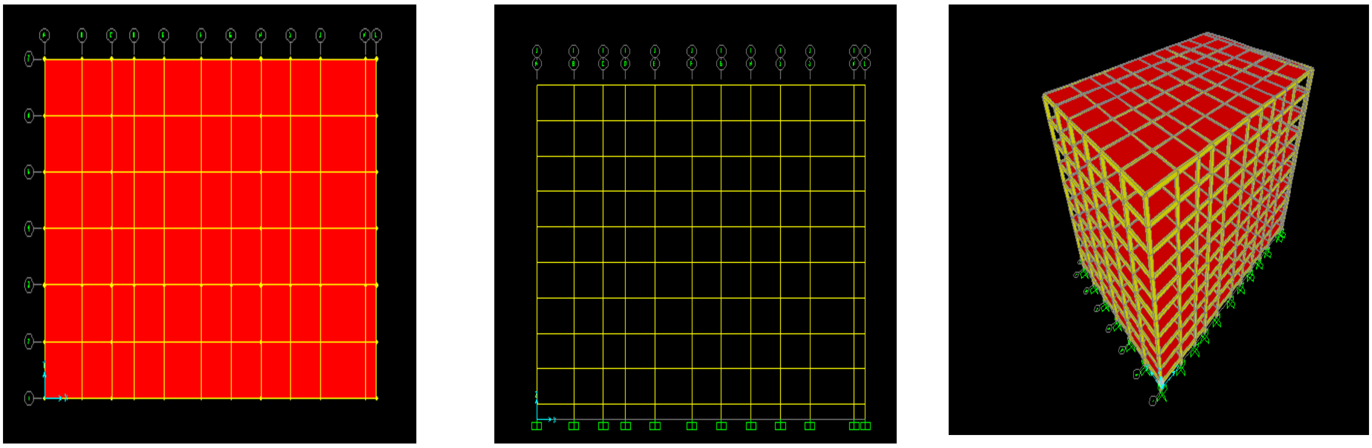


Fig. 3 Plan, Elevation and 3 D View (MODEL 3)

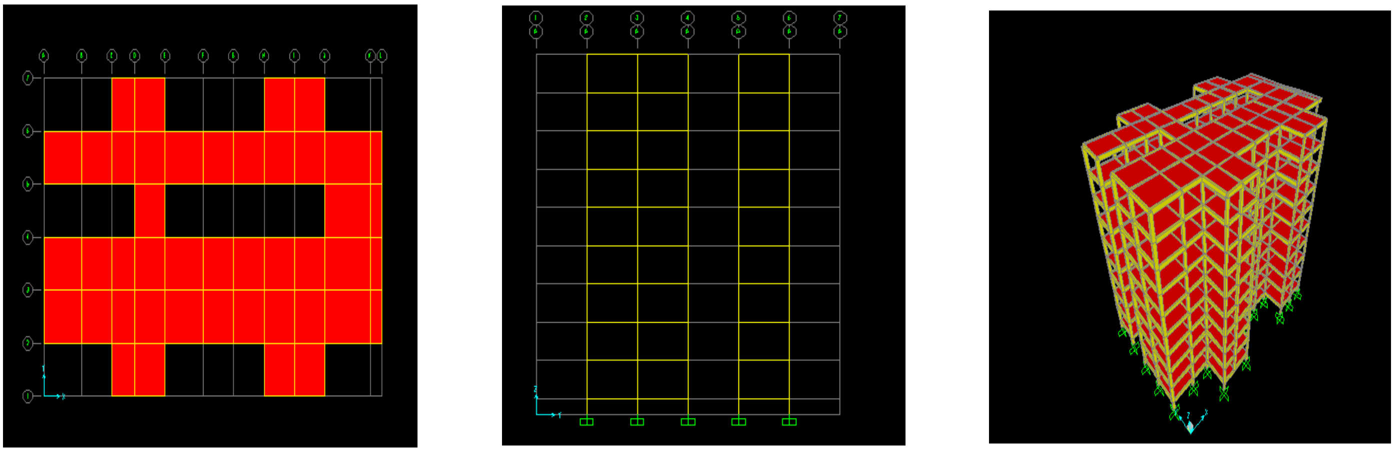


Fig. 4 Plan, Elevation and 3 D View (MODEL 4)

5 Results and Discussion

G+4 and G+10 regular and irregular diaphragm buildings have been analyzed using pushover analysis and results are categorized on performance point, displacement and hinge results.

Pushover analysis results

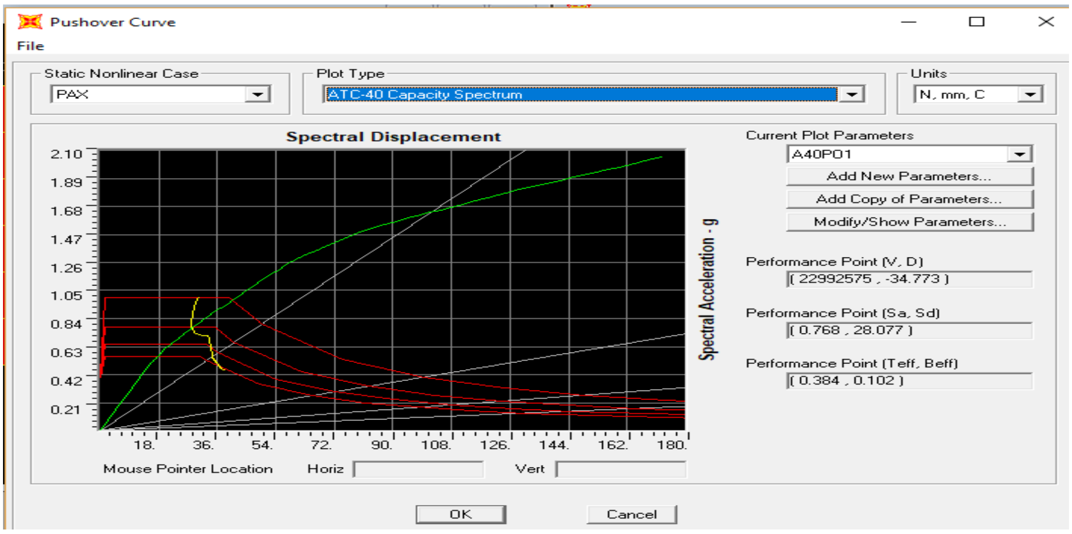


Fig. 5 Model 1 Performance Point

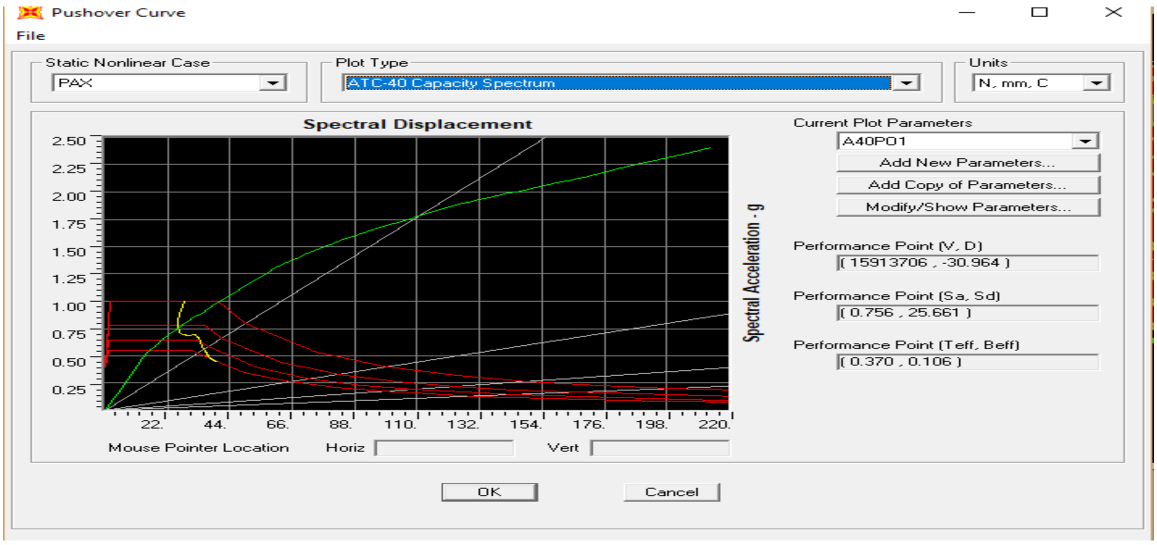


Fig. 6 Model 2 Performance Point

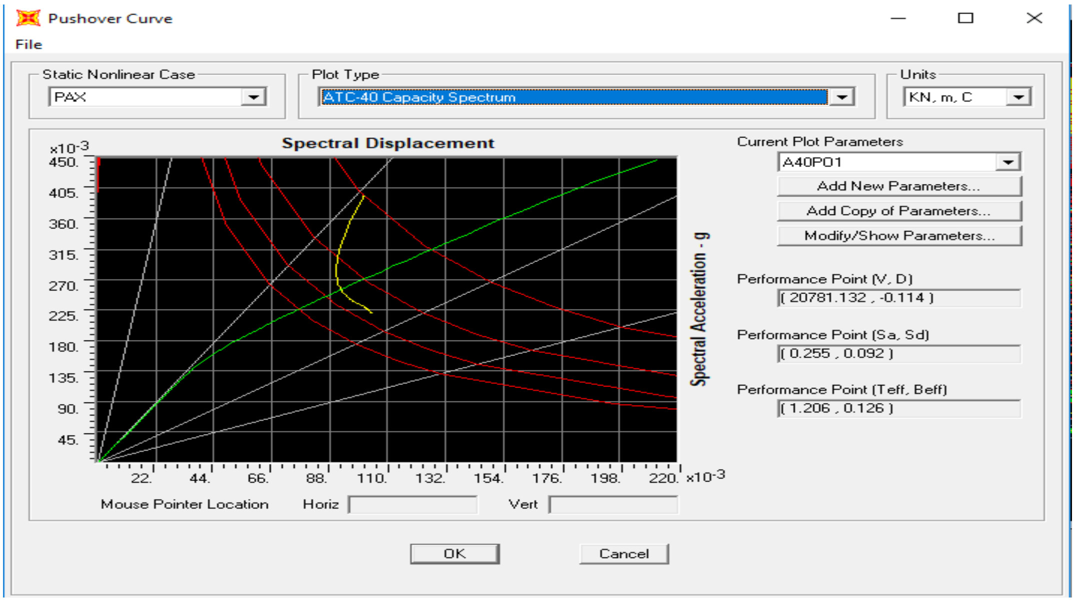


Fig. 7 Model 3 Performance Point

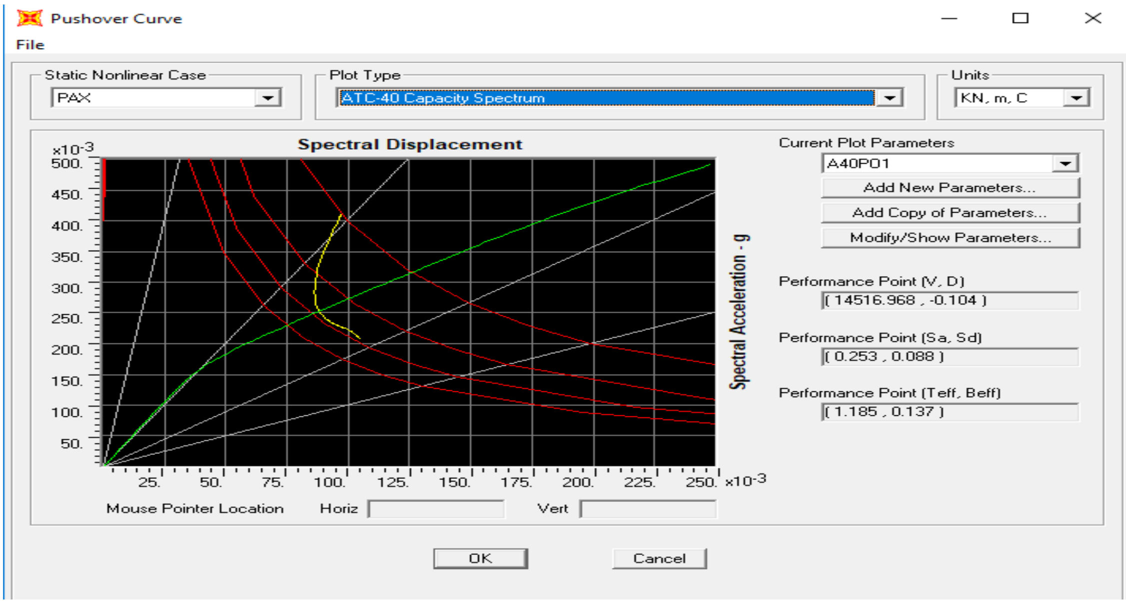
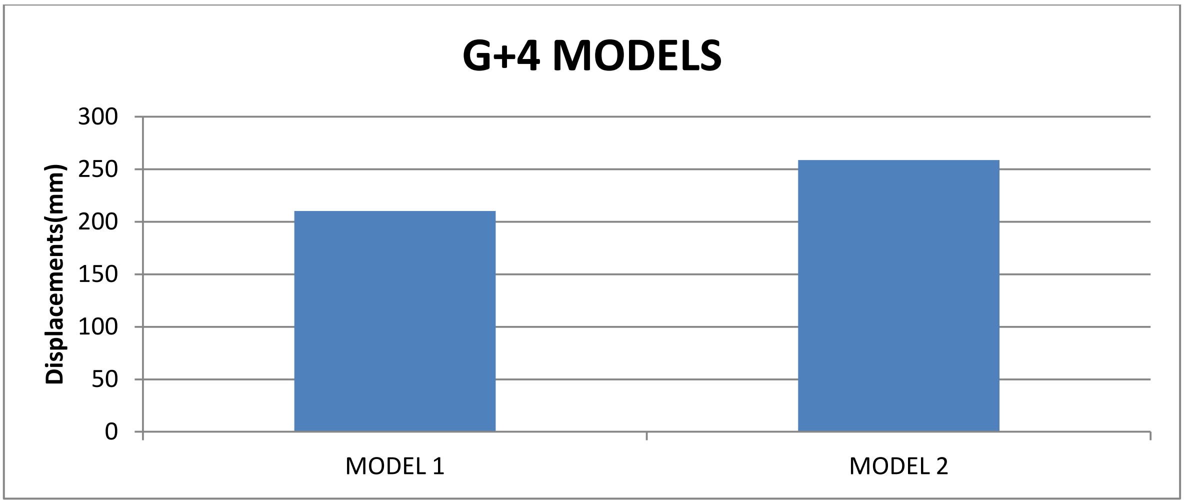
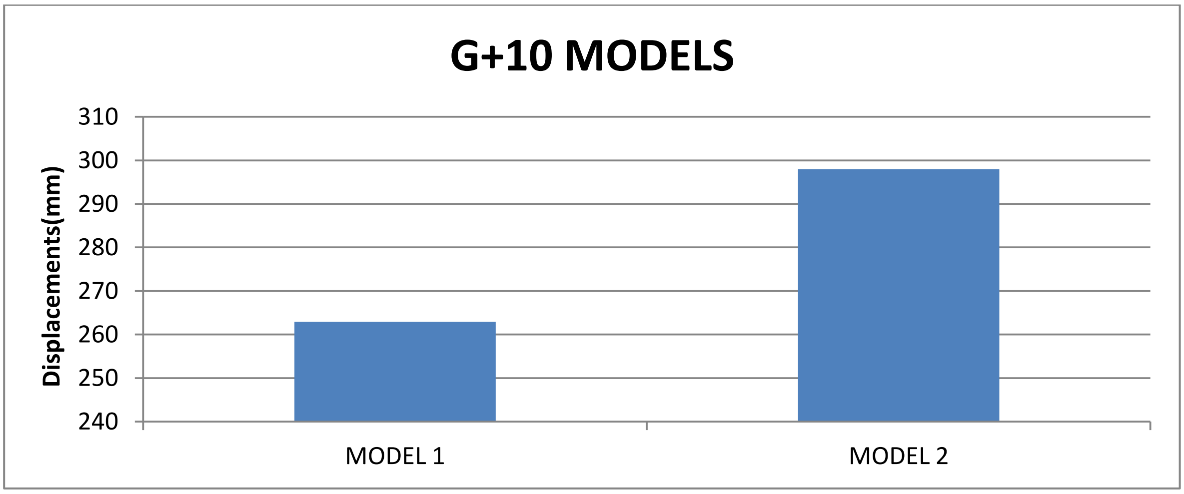


Fig. 8 Model 4 Performance Point

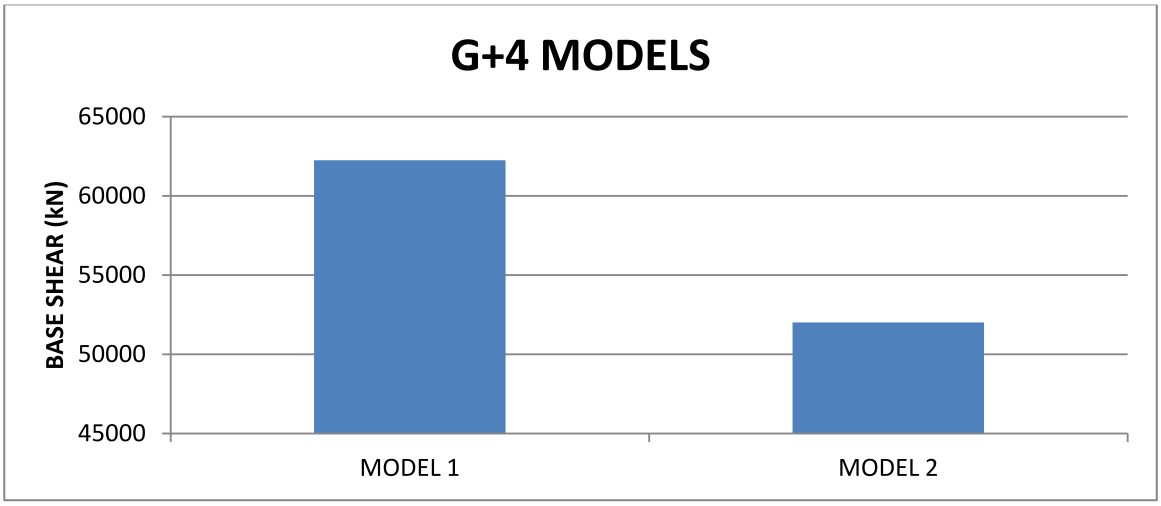
From the above graph we have seen that the push over results of both the models. Pushover results obtained from this study shows that there is a performance point base shear in regular model is more than the irregular model .

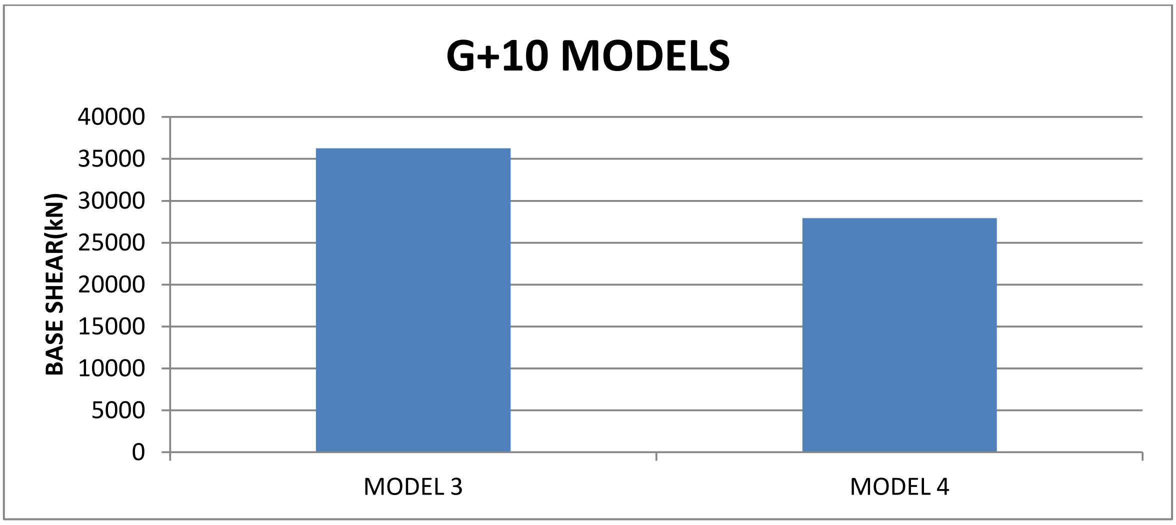
Maximum displacements in G+4 and G+10 models.





Maximum base shear in G+4 and G+10 models





Hinge formation results

Table 4 G+4 MODELS

MODELS	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
MODEL 1	1706	1172	752	98	0	0	0	0	3728
MODEL 2	1344	630	732	222	0	0	0	0	2928

Table.4 Shows the hinge state details of G+4 models. It can be seen that for model 1 the Performance level, taken as actually are within CP 99% and 97% within LS performance level and 77% within IO. For model 2 the Performance Point, taken as actually are within CP 100% and 92% within LS performance level and 67% within IO.

Table 5 G+10 MODELS

MODELS	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
MODEL 3	6444	2876	0	0	0	0	0	0	9320
MODEL 4	5048	2268	0	0	0	0	0	0	7316

Table.5 Shows the hinge state details of G+4 models. It can be seen that for model 1 the Performance Point, taken as actually are within IO 100%. For model 2 the Performance Point, taken as actually are within IO 100%

Conclusion

From the analysis of regular and irregular plan for different models, following results have been observed

1. From pushover analysis it can be seen that displacement of irregular model is 18.75% more than the regular model for G+4 building.
2. Displacement in G+10 building for irregular building is 11.77% more than the regular building.
3. Base shear for regular building is 16.44% more than the irregular in G+4 building.
4. Base shear for regular building is 22.98% more than the irregular in G+10 building.
5. In model 1 hinges lies between the LS to CP level is 2.62 % of total hinges. On the other hand in model 2 hinges lies between the LS to CP level is 7.58% of total hinges.
6. In model 3 hinges lies between the B to IO level is 30.85 % of total hinges whereas in model 4 hinges lies between the B to IO level is 31% of total hinges.

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