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Non-Linear Analysis of RC Building Considering Soil Structure Interaction

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Abstract- **Pushover analysis which is also stated as Non-linear static analysis is widely used procedures for the seismic assessment or evaluation of the structures. The pushover model is used to measure the new structure's seismic demand or for current structures. Within this research pushover review is carried out to consider G+10 multi-storeyed building in zones using SAP 2000 software From the results of the study it was discovered that the hinges are established between IO (Immediate Occupancy) and LS (Life Safety) suggesting that the building is secure. The structural model analysed in this state is therefore safe. Therefore, the structural model studied in this State is safe. The effect of interaction of the Soil Structure on the seismic efficiency of the construction is considered and the building is built with and without considering interaction of soil-structure (SSI).The RC building symmetric plan and These buildings are modelled, designed according to IS 456:2000 and evaluated using SAP2000 software under two separate boundary conditions, namely fixed-base, and considering nonlinear dynamic analysis soil-structure relationship.**

Keywords— Seismic analysis, SAP 2000, Different plan configuration, pushover analysis, Soil structure interaction

I. INTRODUCTION

A structure must have four primary qualities, primarily easy and natural structure, sufficient lateral strength , stiffness and ductility .Buildings with simple standard configuration encounter significantly less harm in both design and elevation than irregular configuration. If a construction project requires uniformity and has inconsistency in configuration, mass or capacity-resistant elements, it is considered as irregular as per IS 1893-2002. These irregularities can cause problems in the continuity of the concentrations of force flow and stress.

Present study is primarily focused on identifying a structure 's behavior when it is exposed to certain action. The components of the complex include air, vibrations, traffic, blasts and earthquakes. Any design can be subjected to unpredictable load.Structural configuration may be an important problem for weak performance of buildings performance of the building serious earthquakes, imbalance certainly lead to high lateral load, excessive capacity of the structure and eventually the buildings damage.

2. OBJECTIVE OF THE STUDY

- Generation of 3D building models using SAP 2000 software. ˆ
- To evaluate the lateral load on various construction models
- To study comparison between regular and Irregularities building of the structures pushover analysis and soil structure interactions
- To carry out pushover analysis as per document (FEMA 356)
- Along with code as per IS 1893:2002 (part- 1) for regular RC and different plan irregularities
- To study behavior of the structure due to formation of hinges under different stages

3. METHODOLOGY

The following approach is considered in the present study in order to achieve the objectives mentioned above.

1.Development of G+10 storied RC bare frame model

RC bare frame model (G+10) having different plan irregularities viz, Rectangular, shape L shape ,H shape, U shape are developed using SAP 2000 (Ver 14) M25 grade concrete for beams, M25 grade concrete for columns and Fe 500 Mpa grade of steel for reinforcement are taken as material properties. Dead load and Live load acting on the frame are taken as per IS 875 (Part1) and IS 875 (Part 2) , codal provisions respectively. and zone IV of IS 1893 (Part 1 2002) is considered in the development of RC frame models.

2.Seismic Analysis for the developed RC frame models

The RC frame models developed are receptively subject to Pushover's study and soil structure interaction (SSI).It also performs equivalent static and response spectrum test to evaluate the model's seismic response.

3.Comparison of Analysis results

Comparison is made for this with the response of interaction with and without soil characteristics such as (Hard, Medium, Soft) on the performance of developed RC frame models with Pushover analysis in mind.

4.Description of the Building

In the various different lateral force resisting system is considered for building RC frame with interaction of soil structure.The design and elevations of the considered construction designs are shown in figure

Model 1: Rectangular model Bare frame With and without soil structure interaction

Model 2: H model bare frame with and without soil structure interaction

Model 3: L model bare frame with and without soil structure interaction

Model 4: U model bare frame with and without soil structure interaction

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41. Material Properties

The materials used during construction is concrete reinforced with concrete gradeM-25 and steel gradeFe-415.The basic properties of the material are given in table 5.1

Material Properties	Values
Characteristic strength of concrete , f_{ck}	25 Mpa
Yield stress for steel , F_y	500 Mpa
Modulus of Elasticity of steel, Es	20,000Mpa
Modulus of Elasticity of concrete , Ec	25000 Mpa

4.2 Structural details

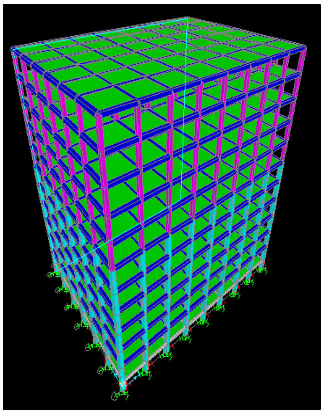
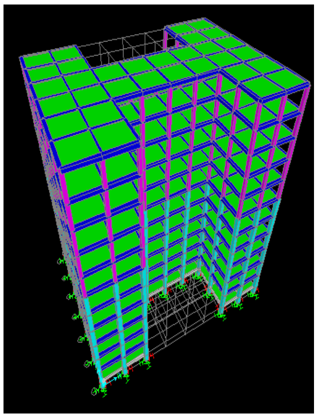
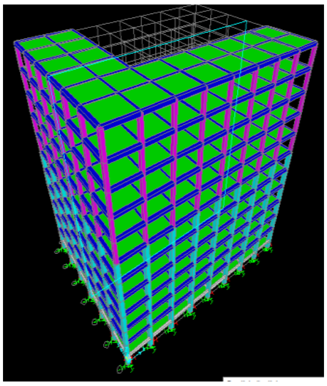
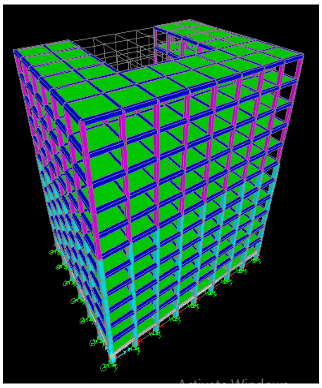
Plan Dimensions	32 x 24 m
No. of bays in x direction	9
No .of bays in y direction	7
Spacing in x direction	4
Spacing in y direction	4
No of storey	10
Plinth beam size	230 x 450 mm
Beam size	450 x 450 mm
Column size	600 x 600 mm (basement to 5th storey)
	450 x 450 mm (6th to 10th storey)
Slab thickness	125 mm
Height of each storey	3.0 m
Foundation height	1.5 m

4.3 Seismic design data

Live load	3.0 kN/m2 on floor
	1.5 kN/m2 on roof
Wall load	11.73 kN/m
Parapet load	4.6 kN/m
Seismic load	IS 1893:2002 (Part 1)
Seismic zone	IV
Importance factor (I)	1
Response reduction (R)	3

4.4 Calculated soil spring values as per Richart and Lysmer

Type of soil	Equivalent radius	Spring values
Hard	r_z =9.59	K_z =4215384.78
	r_x =9.59	$K_x = K_y$ =3592240.94
	$r_{Øx}$ = 9.70	$K_{Øx}$ =284249.95
	$r_{Øy}$ =9.70	$K_{Øy}$ =2842490.95
	$r_{Øz}$ =9.70	$k_{Øz}$ =3979487.33
Medium	r_z =9.59	K_z =684999.63
	r_x =9.59	$K_x = K_y$ =519157.61
	$r_{Øx}$ = 9.70	$K_{Øx}$ =461904.51
	$r_{Øy}$ =9.70	$K_{Øy}$ =461904.51
	$r_{Øz}$ =9.70	$k_{Øz}$ =554285.41
Soft	r_z =9.59	K_z =288601.80
	r_x =9.59	$K_x = K_y$ =205416.58
	$r_{Øx}$ = 9.70	$K_{Øx}$ =194608.10
	$r_{Øy}$ =9.70	$K_{Øy}$ =194608.10
	$r_{Øz}$ =9.70	$k_{Øz}$ =214068.91

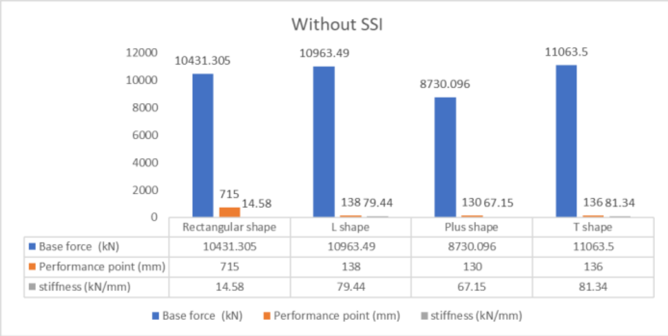





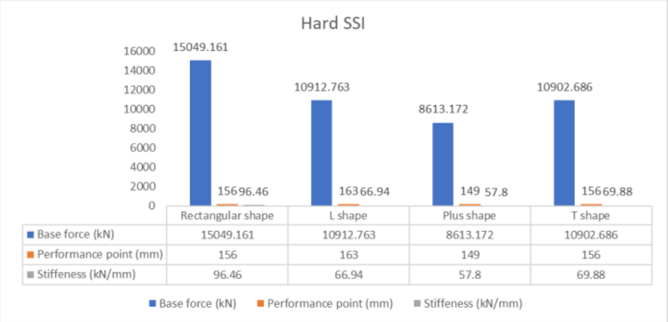
4.5 Global Stiffness

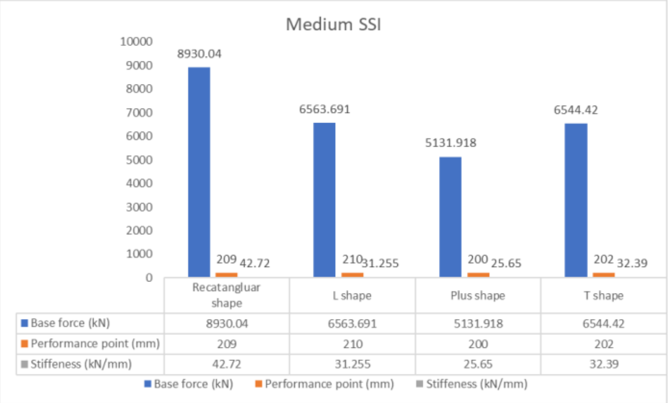
The ratio of base force and displacement at the performance point is known as global stiffness of the structure. The stiffness of building is computed to study the deformations in the building models.

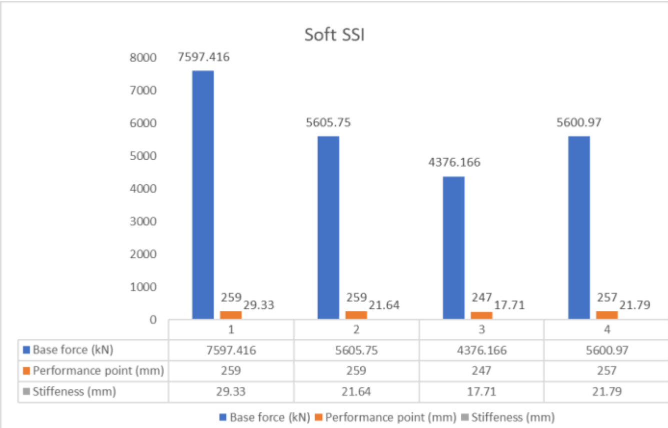
Table 5.4Global stiffness

Model No.	Base force (F) at performance point	Displacement (δ) at performance point	Stiffness (F/δ) kN/mm
1	10431.305	115	90.77
2	10963.490	138	79.44
3	8730.096	130	67.15
4	11063.500	136	81.34
5	15049.161	156	96.46
6	10912.763	163	66.94
7	8613.172	149	57.80
8	10902.686	156	69.88
9	8930.040	209	42.72
10	6563.691	210	31.255
11	5131.918	200	25.65
12	6544.42	202	32.39
13	7597.416	259	29.33
14	5605.750	259	21.64
15	4376.166	247	17.71
16	5600.970	257	21.79









5 .CONCLUSION

The report is concluded for each of the building models assumed for the linear and non-linear analysis performed by SAP 2000. The conclusion is presented on the undamped natural period, base force, roof displacement, hinges area and global rigidity for different construction models.

Compared with results reported for the various building models from different analyzes.

- Taking into Take account of the earthquake codes described in the ways to reduce risk to earthquake shaking, RCC framed multi-story building must be designed.
- Codal and analytical time periods do not match each other as codal estimation is based on empirical formulae.
- The minimum natural period from following building considerations
  - Without soil structure interaction
  - Types of soil considerations i.e for hard sec, medium sec, and soft sec
- The performance point for the various buildings as the base force increases the roof displacement decreases building can be performed from the following considerations a)Types of soil consideration for

  Hard V= 15049.0161kN and D=156 mm
  Medium V= 8930.040 kN and D=210 mm
  Soft V= 7597.417 kN and D= 258 mm
- The maximum number of hinges have formed between IO-LS which means, very limited structural damage and risk to life is negligible and significant damage to structural elements with some residual strength, risk to life from structural damage is very low.
- It is found that rectangular structures are more deformed than symmetrical designs and thus, when building a new structure in a high seismic environment, it is more likely to create a structure that is symmetrical in shape in order to provide greater stability.

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