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NON LINEAR ANALYSIS OF DIFFERENT TYPES OF BUILDING WITH SOFT STOREY AND WITHOUT SOFT STOREY

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***Abstract*— In urban India, now a day's large number of multi story RC framed residential buildings are constructing with different ideas like soft storey or without soft story. The present paper investigates about the performance of non linear analysis of different RC framed models such as bare frame and open first storey and without soft storey. A soft story is an apartment building of three or more story located over a ground level with large openings such as parking area and soft storey is also called as open first storey. The study is carried out on G+4 storey buildings were considered as residential building which is located on zone III and the push over analysis and time history analysis are performed in the present study using sap 2000 v15.1.0 software. User defined hinge are assigned for beams and columns. Seismic performances of the frames were compared and effects of using different models were investigated. Results show a general changing pattern in performance point, capacity curve, demand spectrum curve.**

Keywords*— *capacity, demand curve, open first storey, push over analysis, performance point, seismic performance stiffness, time history analysis.

I. INTRODUCTION

In the present scenario in India many of urban area are developing and constructing the tall structures for residential and commercial use because the country population was increasing day by day. From past statistical reports of India shows that the country is subjected to earthquake prone area so to counterattack the earthquake the structures need to be improved. Many of the structures in India are not earthquake resistant structures, to avoid the major failure from earthquake structures are to be designed as earthquake resistance structures .To avoid earth quakes the inelastic behaviour should be implemented to the structure and to observe the performance, the non linear analysis has to be assigned for the structure.

For seismic performance, In elastic static analysis or non linear push over analysis and In elastic dynamic analysis or non linear time history analysis has to be performed. The mathematical model should be developed according to the soft first storey and without soft storey and materials should be assigned as nonlinear materials.

The main Objectives of the present study is

- To know the effect of brick infill in the open first storey frame
- To know the effect of open first soft storey.
- And also to compare the effects of all the models base shear and base displacement and behaviour of the models

II. PUSHOVER ANALYSIS

Nonlinear static analysis or pushover analysis. Pushover analysis is a viable method to assess damage vulnerability of buildings. Pushover (nonlinear static) analysis is performed to identify damage venerability of structures and to determine an acceptable level of safety. Pushover analysis is a series of incremental static analysis carried out to develop a capacity curve for the building. Based on the Force- Displacement curve, a target displacement which is an estimate of the displacement that the design earthquake will produce on the building is determined. The major damage experienced by the structure at this target displacement is considered representative of the damage experienced by the building when subjected to design level ground shaking. Stiffness change where IO, LS and CP stand for immediate occupancy, life safety and collapse prevention respectively.

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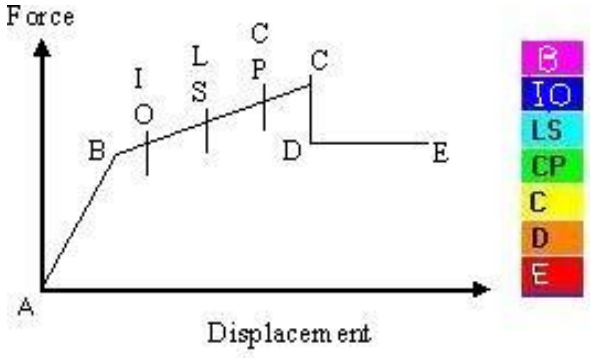

Fig.1. Load- displacement curve

III. TIME-HISTORY ANALYSIS

Nonlinear dynamic analysis or Time history Analysis is the combination of ground motion records with a structural model, therefore results are obtained. In Time history Analysis, the structural model subjected to a ground-motion record produces estimates of every component deformations for each degree of freedom in the model and the modal responses of the structure

In this Paper the EL-CENTRO Ground Motion Data of North-South Component, time (sec) & Acceleration (G) data has been assigned for different structures

IV. DESCRIPTION OF THE STRUCTURE

A. Material properties

The material used for construction is Reinforced concrete with M-25 grade concrete and Fe415 grade reinforcing steel. The Stress-Strain relationship used is as per I.S.456:2000. The basic material properties used are as follows:

Modulus of Elasticity of steel, Es = $2x10^5 N/mm^2$

B. Modelling geometry

The structure analyzed is a five-storied, five bays along X-direction and five bays along Y direction moment-resisting frame of reinforced concrete with properties as specified above.

The concrete floors are modelled as rigid. The details of the model are given as:

Number of stories = 5
Number of bays along X-direction =5
Number of bays along Y-direction = 5
First Storey height = 4 meters
Remaining Storey height = 3.5 meters /each storey
Bay width along X-direction = 5 meters
Bay width along Y-direction = 5 meters
The following are the input data of the analytical model:
A G+4 building is taken for analysis. The salient features of the building are:

1. Type of structure--- Special RC Moment Frame.
2. Seismic Zone --- III
3. Type of soil --- Medium
4. No. of stories --- (G+4)
5. Live Load --- 3.5 KN/ m^2
6. Load on Roof --- 1.5 KN/m^2
7. Floor finishes --- 1 KN/ m^2
8. Depth of slab --- 120 mm
9. Materials --- M 25 concrete and Fe 415 steel
10. Unit weight of RCC --- 25 kN/m^2
11. Beams --- 230 × 350 mm
12. Column (C1) ---300×400mm(outer)
    (C2) ---230 x 350 mm (inner)
13. Clear cover of beam --- 30 mm
14. Clear cover of column --- 40mm
15. Wall thickness --- 230mm.

C. Different types of structures are considered in this paper for analysis

- **Bare Frame**: Frame which has no Slabs, External and internal Walls.(model-1)
- **Frame with Open First Storey:** Frame which has no External and Internal Walls in ground Storey. Average Stiffness of the remaining storeys will be

  80% high in upper Storeys Compare to first Storey.(model-2)
- **Frame without Soft Storey:** Frame which has no opening throughout the structure. Stiffness will be same in all storeys.(model-3)

V. DISTRUBUTION OF TOTAL HORIZONTAL LOAD TO DIFFERENT FLOOR LEVELS

The lateral force should be assigned in X and Y direction to the models so that the displacement will be known for the given lateral force applied. The calculation lateral force will be done according to seismic weight calculation for every model depends upon the type of building and zone of the building and response reduction factor R and also importance factor .For every storey the total mass will be calculated according to calculation lateral force will applied .The lateral force table below is for bare frame similarly for model-2 and model-3 forces should also calculated.

TABLE1: CALCULATION OF LATERAL FORCES

STOREY	W_i (KN)	h_i (m)	$W_i \times h_i^2$	Q_i (KN)	FORCE(KN)
ROOF	2697.6	18	874.02	0.340	397.61
4^{TH} FLOOR	4198.45	14.5	882.72	0.343	401.12
3^{RD} FLOOR	4198.45	11	508.01	0.198	231.55
2^{ND} FLOOR	4198.45	7.5	236.16	0.092	107.59
1^{ST} FLOOR	4198.45	4	67.17	0.026	30.40
TOTAL	∑=19491.1		∑=2568.08	1.0	1168.27

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VI. HINGE MECHANIS

For Non linear analysis, non linear property should be implemented to the all models for this assignment hinges should be assigned for both beams and columns. In SAP 2000 default hinge properties are defined automatically. Beams should be assigned as M3 and Columns should be assigned as P-M-M properties. Below figure 2 shows assignment of hinges on SAP for model-1, similarly hinges should assign for model-2 and model-3.

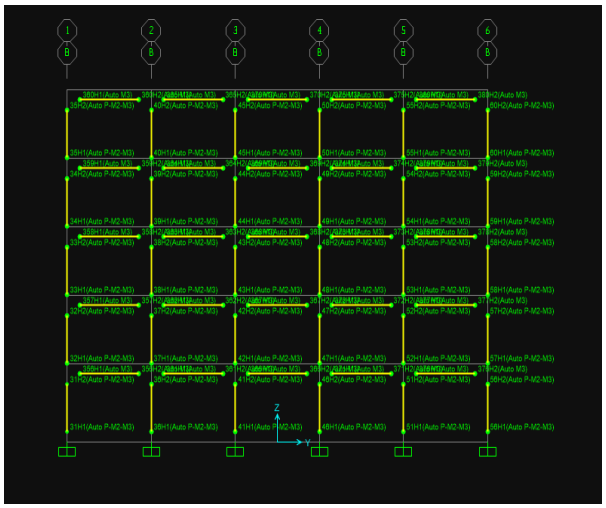


Fig.2. Assignment of hinges for beams and columns

VII. RESULTS AND DISCUSSIONS

Push over curve results are displayed below for all the models. In Initial stage curve will be in linear after the hinge mechanism starts the curve will undergo non linearity and starts inelastic actions, after applying lateral forces the results obtained as target displacement as 1180.379 m and the base shear as 650KN.

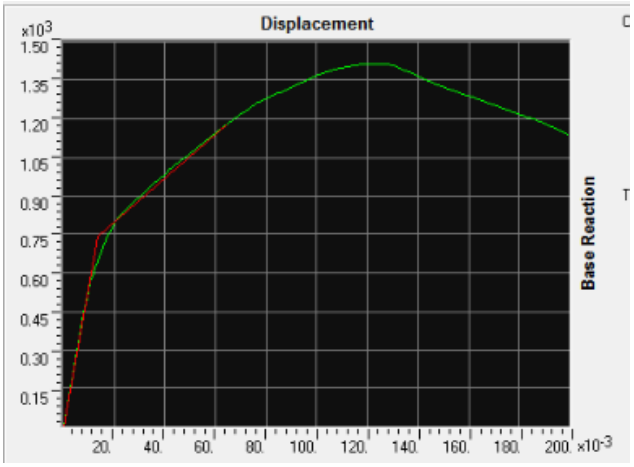


Fig.3. pushover curve for model-1 according to FEMA-356

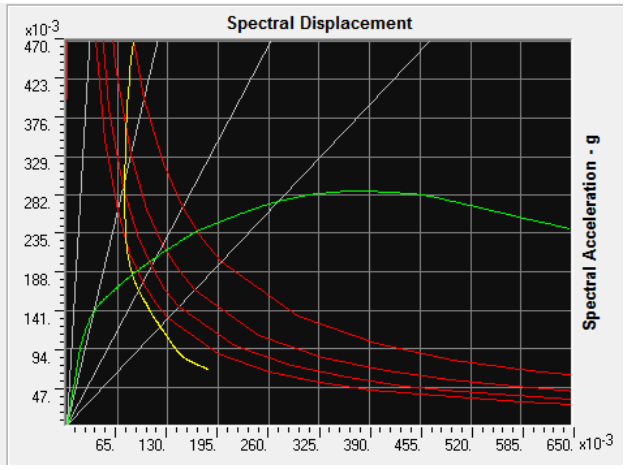


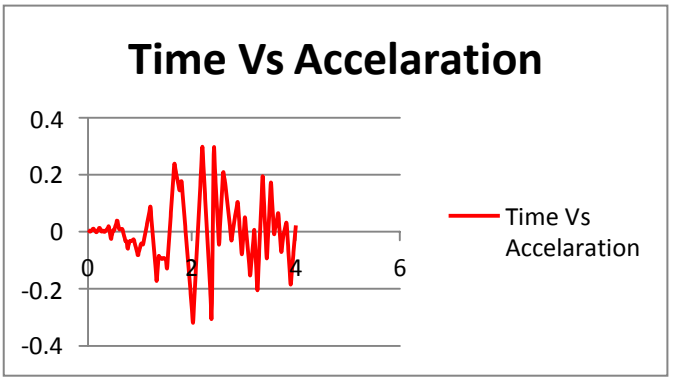
Fig.4. pushover curve for model-1 according to ATC-40 capacity spectrum

TABLE 2: CALCULATION OF LATERAL FORCES

Frame type	G+4 storey RC frames	
	Performance point(KN)	*Displacement (KN)*
Model-1	1016.364	0.044
Model-2	1664.957	0.275
Model-3	2764.040	0.229

- By comparing the table 2. In bare frame without walls and slabs having lesser lateral forces/load when compare to soft storey with brick infill and walls and frame with brick infill without soft storey.
- We can conclude that as the stiffness increases, lateral load and also displacement is also increases. The non- linear static analysis is the easiest way to evaluate the behaviour of the structure.
- As the stiffness is less in open first storey structures tends to fails easily.

Time history results of various models are explained below, from each model a specific joint has been selected and compared the values of the different models. Time – acceleration was compared in the results.



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El-Centro North-South Component has been implemented in analysis. Joint 37 has been considered from model1 and results has been shown in below figures

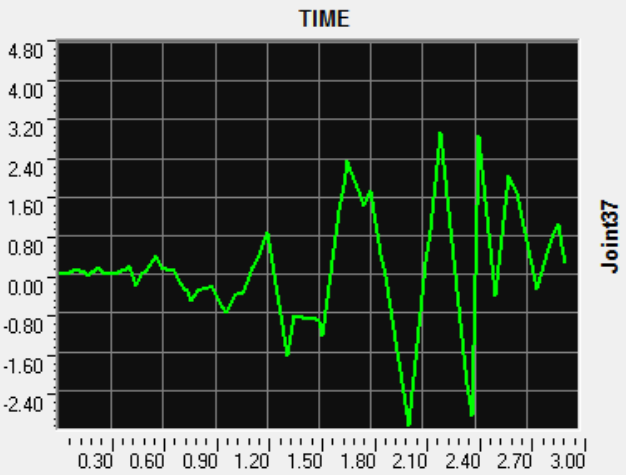

Fig.5. Time –Acceleration for joint 37

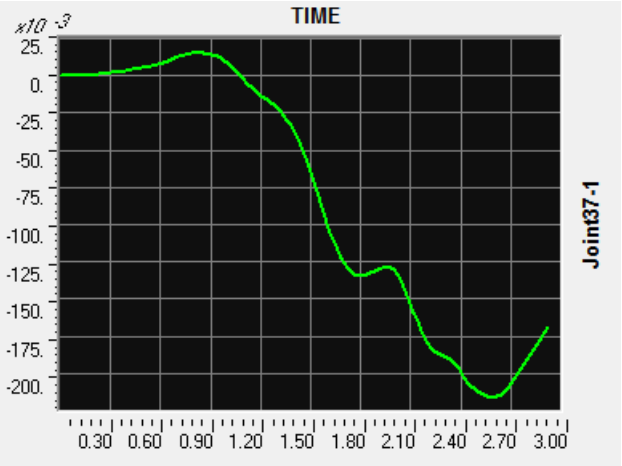

Fig.6. Time –Displacement for joint 37

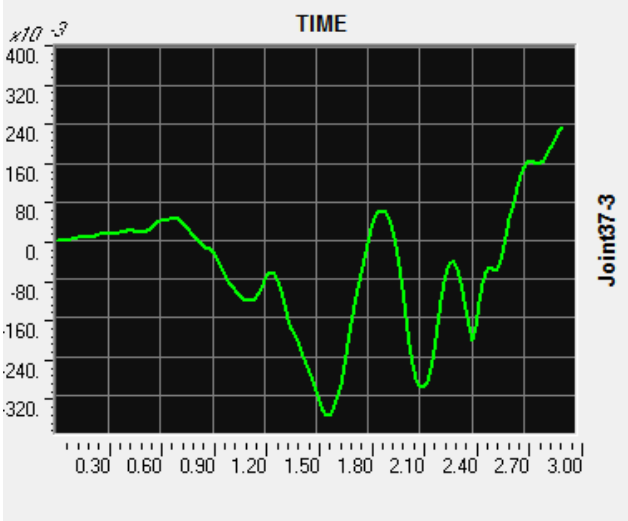

Fig.7. Time –Velocity for joint 37

The above figures explains about the behaviour of the joint when it is effected with the give ground motions .Usually for the building up to 4 sec the time history ground motion period will be considered.

VIII. CONCLUSIONS

1. Study of this paper concludes the performance based seismic analysis of the various RC models having soft storey in the building using pushover analysis and time history analysis
2. The building is designed for the load as per IS 456-2000, using SAP2000 V 14.1**.**
3. The structures are located in the assessment of seismic vulnerability under various earthquake resistant techniques in order to protect the human life for future earthquakes.
4. Non linear pushover analysis emphasize the effect of lateral load pattern, which can regulate detrimental influence on seismic performance of buildings, also pushover analysis is performed for the various building models located in zone-III in accordance with IS-1893-2002(part-1)
5. To study the performance levels and performance points of the building.
6. After analysis many of the hinges are located in the lower storeys in all the models. Thus the performance point depends upon the hinge mechanism
7. Time history analysis show the ground motions of different joints, so according to the velocity and displacement results models should be constructed for future earthquake

IX. REFERENCE

[1] Chopra, A.K., and R.K. Goel. 2002. A modal pushover analysis procedure for estimating seismic demands for buildings. Earthquake Engineering and Structural Dynamics 31: 561-582.
[2] Bureau of Indian standards; IS 1893 part 1 : criteria for earthquake resistant design of structures; Genaral provisions and buildings (2002)
[3] Ray W.Clough Joseph Penizen; Dynamics of Structures(1993);McGraw Hill publishers.
[4]IS456:2000- Plain and reinforced concrete code for practice.
[5]IS875 (part 1):1987-codes for practice Dead loads.
[6]IS875 (part 2):1987-codes for practice Imposed loads.
[7]IS875 (part 3):1987-codes for practice wind loads.
[8]IS1893 (part 1):2002-Criteria for earth quake resistant design of structures.
[9]FEMA-356:Pre standard and commentary for the seismic rehabilitation of structures. Reinforced concrete Design- S.Unnikrishnan.