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Comparative study of Reinforced Concrete Structure and Steel Structure by Non-Linear Static Pushover Analysis

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Abstract :- Recent earthquakes in which many concrete structures have been severely damaged or collapsed. About 60% of the land area of our country is susceptible to damaging levels of seismic hazard. We can't avoid future earthquakes The research concentrates on a computer based push-over analysis technique for performance-based design of reinforced concrete building and steel building works subjected to earthquake loading. In the investigation, nonlinear static analysis of analytical model of four story Reinforced concrete building and steel building is conducted for local seismic conditions. Pushover analysis is an advanced tool to carry out static nonlinear analysis of framed structures. It is used to evaluate non linear behavior and gives the sequence and mechanism of plastic hinge formation. The pushover curve which is a plot of base shear versus roof displacement, gives the actual capacity of the structure in the non linear range.

Keyword:-*Pushover, Roof Displacement, Base Shear*.

I. LITERATURE SURVEY

- S. Elavenil (2014) had been discussed about The analytical procedure developed is to estimate the inelastic deformations of beams, columns and connections are validated by incorporating the same in pushover analysis. The research concentrates on a computer based push-over analysis technique for performance-based design of steel building frame works subjected to earthquake loading.

- Dr.P.Eswaramoorthi1 P.Magudeaswaran2 A. Dinesh2 In the scenario, Steel framed structures plays an important role in construction industry because they are cost efficient, sustainable, durable, ductile and safe. To analyze the structure under seismic loads, the deformed geometry and the non-linear behavior of the structure is to be considered. Hence to determine the performance of the structure, non-linear or pushover analysis is performed. The pushover testing has been carried out on two frames namely bare frame and Steel braced frame. The research concentrates on a computer based push-over analysis technique In this present study, nonlinear analysis of Steel frame using ANSYS 14.5 under the horizontal loading has been carried out.

- M.K Rahman, M. Ajmal & M.H Baluch (2012) This paper presents a nonlinear static analysis for seismic performance evaluation of an existing eight-story reinforced concrete frame-shear wall building in Madinah. The building has a dome, reinforced concrete frame systems at different floor levels. The seismic displacement response of the RC frame-shear wall building is obtained using the 3D pushover analysis.

- S.P. Akshara (2015) The scope of the present study aims at evaluation of RC buildings designed according to IS 456:2000. The non-linear static pushover analysis procedure has been used in this regard The non-linear methods can give an Idea regarding the pattern of the plastic hinge formations and thus aid in the performance based seismic design of the structure.

II. COMPARATIVE STUDY

A. Material specification

- Floor to floor height: 3.5 m.
- Imposed load on typical floor: 4 KN/m^2.
- Floor finish on typical floor: 1.5 KN/m^2.
- Imposed load on roof: 1.5 KN/m^2.
- Floor finish on roof: 4 KN/m^2
- Type of soil: Medium.
- Specific weight of concrete: 25 KN/m3

III. MODELING APPROACH

The general finite element package SAP 2000 (Version.14) has been used for the analyses. A three dimensional model of each structure has been created to undertake the non linear analysis. Beams and columns are modeled as nonlinear frame elements with lumped plasticity at the start and the end of each element.

IV. BUILDING GEOMETRY

The structural analysis program, SAP2000-Version 14 was used to perform analyses. Fig. 6.1 shows 3D Computer models of the building of 5 storeys, 12 storeys

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Beams And Column Dimensions			
Buildings	Beam	Level	Columns
5 Storey	0.3 X 0.5	1-3	0.5 x 0.5
		4-5	0.4 x 0.4
12 Storey	0.3 X 0.5	1-9	0.7 x 0.7
		10-12	0.5 x 0.5

Table 6.1: Beams and Column Description

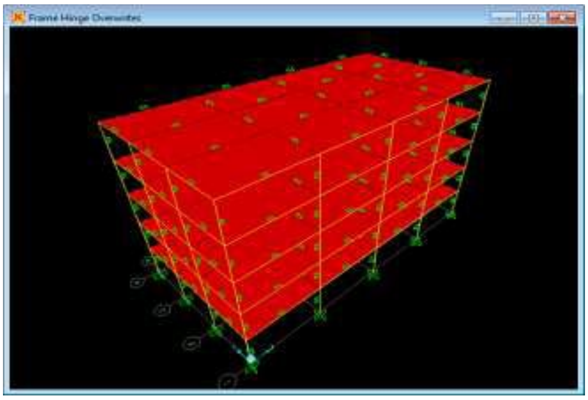

Fig 6.1: 3D Computer Model of 5 Storey Building

V. RESULTS FOR PUSHOVER ANALYSIS

Building	Target Displacement(m)	Elastic base shear(KN)	Inelastic base shear(KN)
5 storey	0.28 m	1621.9	1946.3
12 storey	0.5 m	1707.09	2646

Table 7.1: Pushover Analysis Results

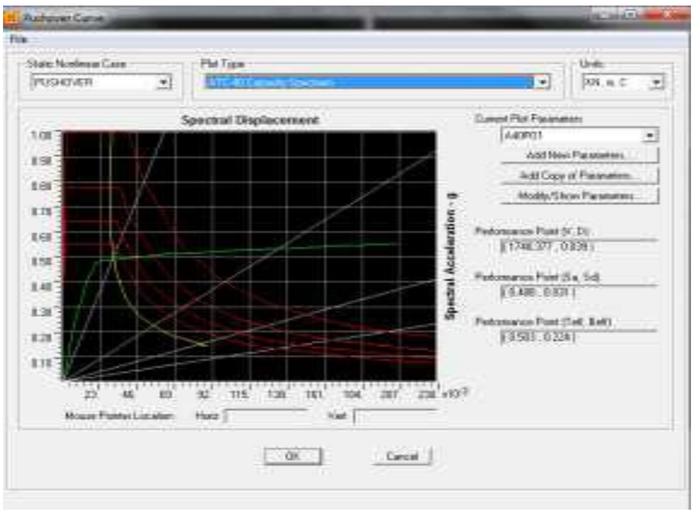

Fig 7.1: Demand Capacity Curve for 5 Storey Building

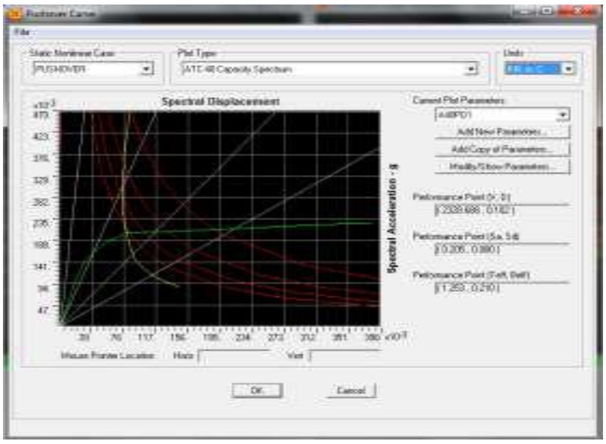

Fig 7.2: Demand Capacity Curve for 12 Storey Building

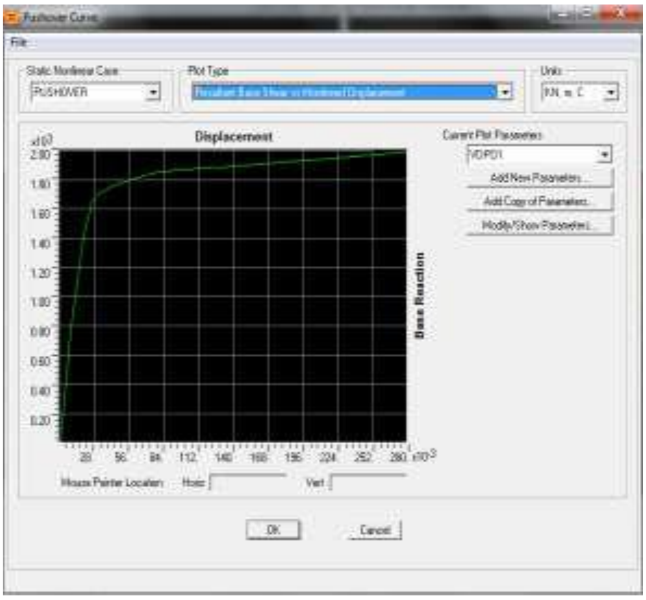

Fig 7.3: Pushover Curve for 5 Storey Building.

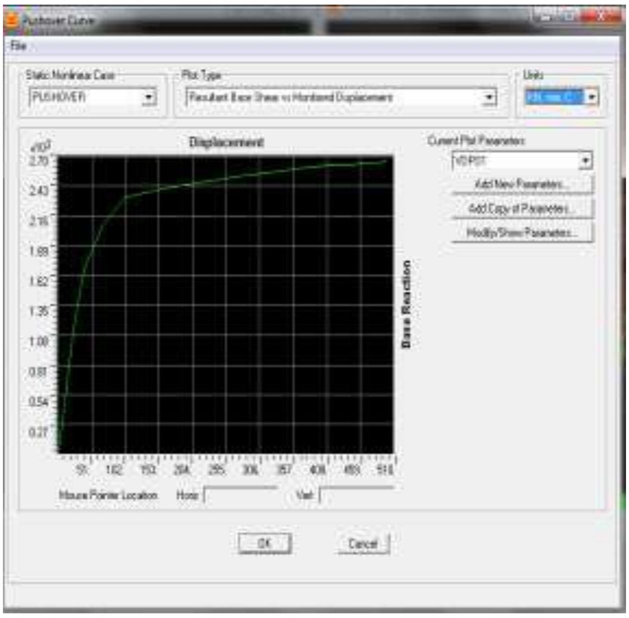

Fig 7.4: Pushover Curve for 12 Storey Building.

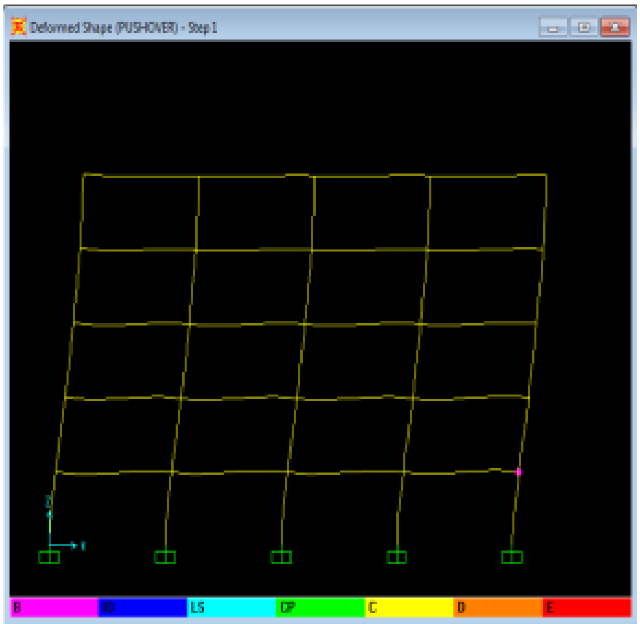

Fig 7.5: Plastic hinge pattern formation for 5 Storey Building

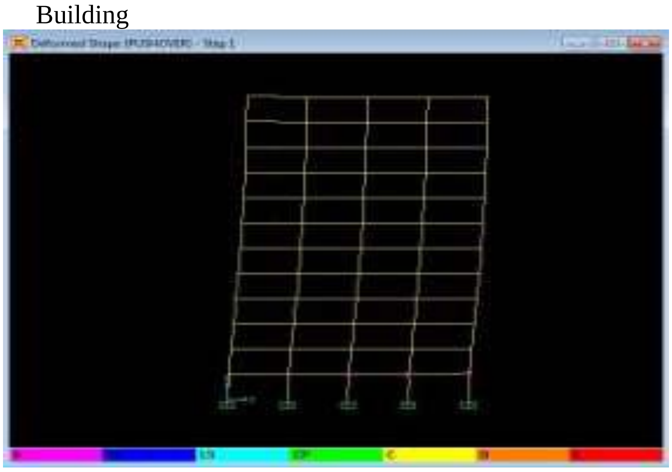

Fig 7.6: Plastic hinge pattern formation for 12 Storey Building

A. Material specification of steel building

Member Properties	
Thickness of slab	0.15 m
Beam size	ISMB 0.3m
Column size	ISMB 0.6m

Assumed Dead load intensities	
Floor finishes	1.0 kN/m2
Live load intensities	3.0 kN/m2
Earthquake LL on slabs as per clause 7.3.1 and 7.3.2 of IS 1893 (Part 1):2002	
Roof	0 kN/m2
Floor	0.25 X 3= 0.75 kN/m2
As per IS 1893 (Part 1) :2002	
	Zone V
Zone factor, Z	0.36
Importance factor, I	1
Response reduction factor, R	5
Soil/Rock type	Medium

Table 7.2: Description of Building for 5 Storeys

B. Description of Building for 12 Storey

Member	Storey	Section
Beam	1-5	ISMB 250
Beam	6-12	ISMB 225
Column	1-5	ISMB 500
Column	6-12	ISMB 450

Table 7.3: Description of Building for 12 Storeys

SNo.	Building Description	
1	Zone	IV
2	Zone Factor	0.24
3	Response Reduction Factor	SMF
4	Importance Factor	1.0
5	Height of building	35 m

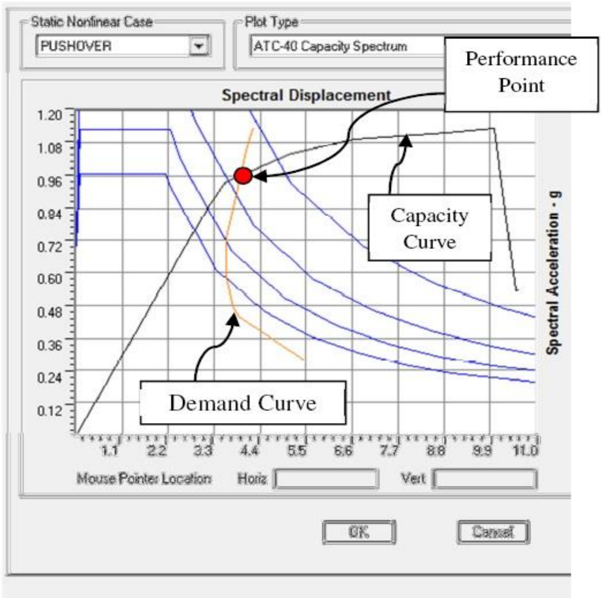

Fig. 7.7 Capacity/Demand Spectrum for 5 Storey Building

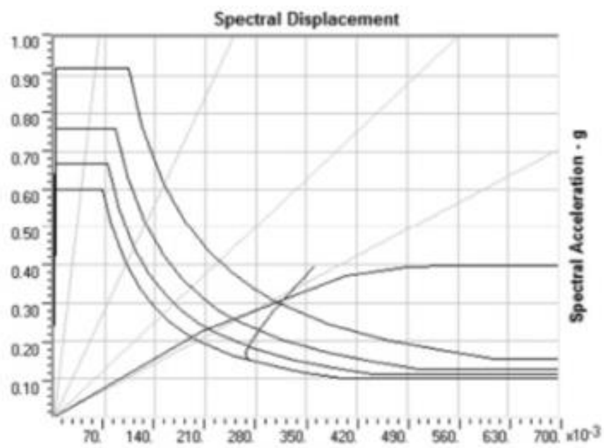

Fig. 7.8: Capacity/Demand Spectrum for 12 Storey Building

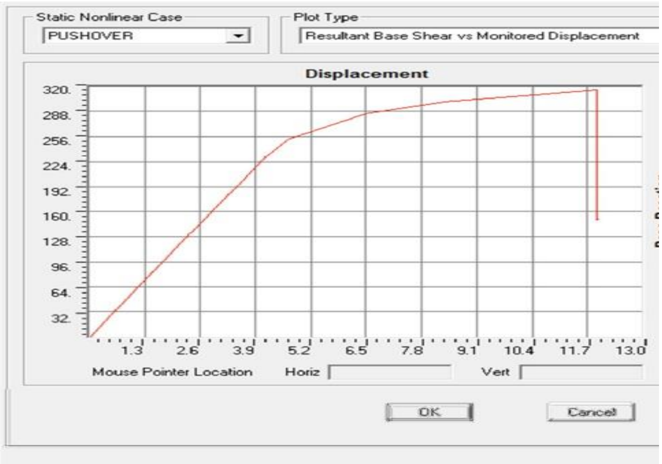

Fig 7.9: Base Shear Vs Roof Displacement for 5 Storey Building

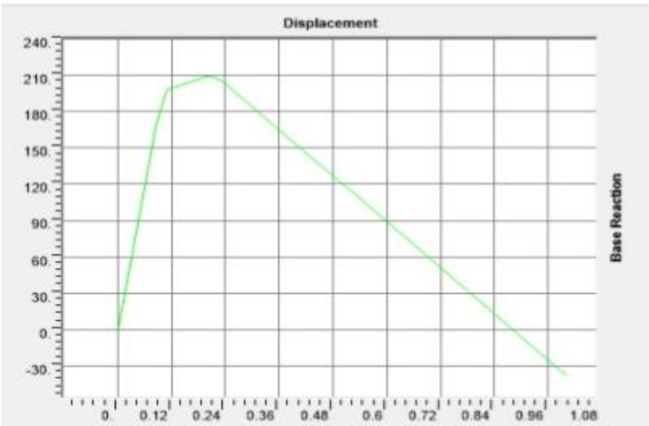

Fig 7.10: Base Shear Vs Roof Displacement for 12 Storey Building

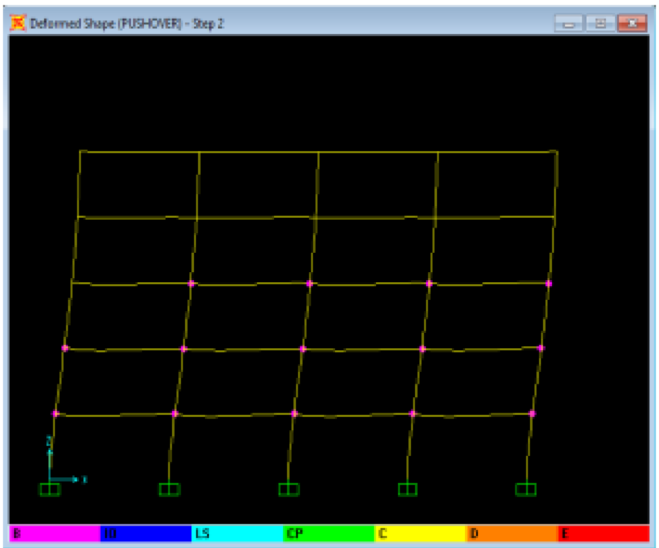

Fig 7.11: Plastic hinge pattern formation for 5 Storey Building

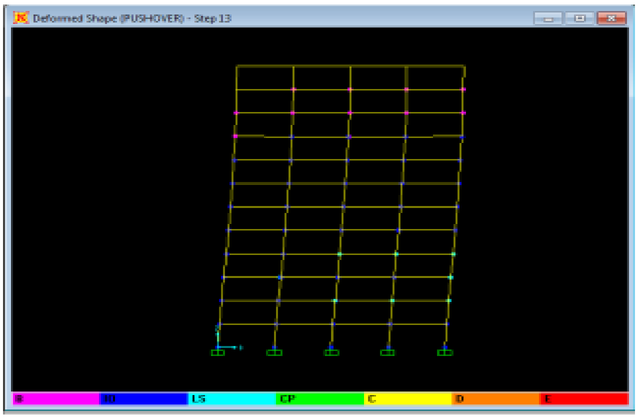

Fig 7.12: Plastic hinge pattern formation for 12 Storey Building

VI. CONCLUDING REMARK

- Base shear for steel frame is less than reinforced concrete frame as the self-weight of steel frame is less.
- Target displacement for steel frame is more than that of reinforced concrete frame as the stiffness for RC frame is much higher than steel frame
- For component-wise evaluation of response reduction factor, the participation of ductility factor is significant in RC frame whereas that of over-strength factor is significant in steel frame.

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