Pushover Analysis of Multistoried Reinforced Concrete Buildings with Dual System

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Abstract- *In the present study, analytical investigation of plane frame and space frame building of (G+7) storey is situated in seismic Zone V in India , in accordance with IS 1893-2002 (Part-1) various analytical approaches i.e. linear static and nonlinear static analysis are performed on the building, to identify the seismic demand and pushover analysis has been performed to determine the performance levels and capacity spectrum curve of the considered buildings, also base shear is compared for the both the direction i.e. X and Y direction. As the world moves toward the implementation of Performance Based Engineering philosophies in seismic design of Civil Engg structure, new seismic design provision required for Structural Engineers to perform both linear and nonlinear analysis for the design of structure. In present work (G+7) storey building models like bare frame, bare frame with Shear wall, frame with Brick Masonry Infill and frame with Brick Masonry Infill and Shear wall has been considered and analysis has been done by using ETABS. Seismic performance is assessed by pushover analysis as per ATC 40 guideline for earthquake Zone V in India.*

Keywords- Earthquake, Pushover analysis, symmetrical building ,Performance levels, Capacity, Demand, Performance point.

I. INTRODUCTION

Pushover analysis has been developed over the past twenty years and has become the preferred analysis procedure for design and seismic performance evaluation purposes as the procedure is relatively simple and considers post elastic behavior. However, the procedure involves certain approximations and simplifications that some amount of variation is always expected to exist in seismic demand prediction of pushover analysis.

As per the conventional earthquake-resistant design philosophy, the structures are designed for forces, which are much less than the expected design earthquake forces. Hence, when a structure is struck with severe earthquake ground motion, it undergoes inelastic deformations. Even though the structure may not collapse but the damages can be beyond repairs. In reinforced cement concrete (RCC) structures, a structural system can be made ductile, by providing reinforcing steel according to the IS: 13920-1993 code. A sufficiently ductile structural system undergoes large deformations in the inelastic region. In order to understand the complete behavior of structures, pushover analysis of different Single Degree of Freedom (SDOF) and Multi Degree of Freedom (MDOF) structures having non-linear characteristics is required to be performed. The results of pushover analysis, i.e. non-linear static analysis of these structures will help in understanding their true behavior. From the results, it can be predicted, whether the structure will not collapse / partially collapse or totally collapse by taking RCC building for analysis.

II.PARAMETRIC VARIATIONS

The plane and space frame analysis is done by linear and non-linear analysis methods. After carrying out different investigations on models the results for various models for seismic Zone V are tabulated. The observations for each model are stated as under respective tables and graphs.

III. PROBLEM FORMULATION

A multistoried Reinforced Cement Concrete (G+7) Storey moment resisting plane and space frame is analyzed using software ETABS. The dimension of building is length 17.5 m and width is 17.5m. This building is assumed to be located in zone V.

IV. PARAMETRIC STUDY ON PLANE FRAMES

Types of Models

Model No.1: Bare Frame
Model No.2: Bare Frame with Shear Wall
Model No.3: Frame with Brick Masonry Infill
Model No.4: Frame with Brick Masonry Infill and Shear Wall

Detailed Features of Plane Frame and Space Frame

Sr. No.	Data summary for building frame	
1.	Structural steel	TOR Steel
2.	Concrete	M-25
3.	Main Steel Reinforcement	Fe500
4.	Stirrups and links	Fe-415
5.	Number of storey	8
6.	Height of storey	4 m
7.	Density of concrete	25kN/m^3
8.	Poisson Ratio	0.2
9.	Damping	0.05
10.	Seismic zone	V
11.	Importance Factor	1
12.	Response Reduction Factor	5
13.	Foundation	Medium Soil
14.	Beam Size (mm)	230 x 450
15.	Column Size (mm)	300X600
16.	Slab Thickness	150
17.	Density of Brick Masonry	20 kN/m^3
18.	Thickness of Peripheral wall	150 mm
19.	Floor Finish load	1.25 kN/m^2
20.	Live Load on Slab	4 kN/ m^2

V. MODEL *GEOMETRY*

The structure analyzed is an eight -storied, the concrete floors are modelled as rigid. The details of the model are given as:

Number of stories = 8
Number of bays along X-direction =5
Number of bays along Y-direction = 1
Storey height = 4.0 meters
Bay width along X-direction = 3.5 meters
Bay width along Y-direction = 3.5 meters

VI. PARAMETRIC STUDY ON SPACE FRAME

Types of Models

Model No.1: Bare Frame
Model No.2: Bare Frame with Shear Wall
Model No.3: Frame with Brick Masonry Infill
Model No.4: Frame with Brick Masonry Infill and Shear Wall

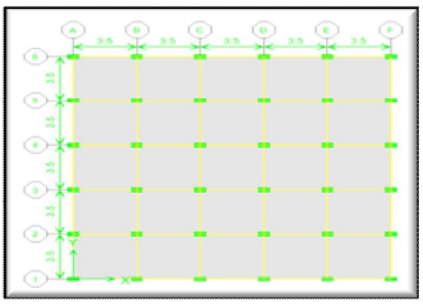


Fig 1: Plan of (G+7) Storey RCC Building (Space Frame)

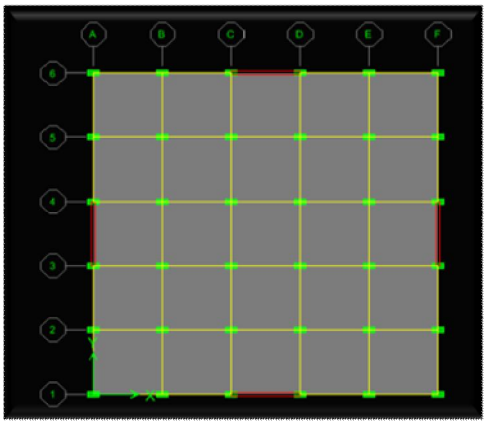
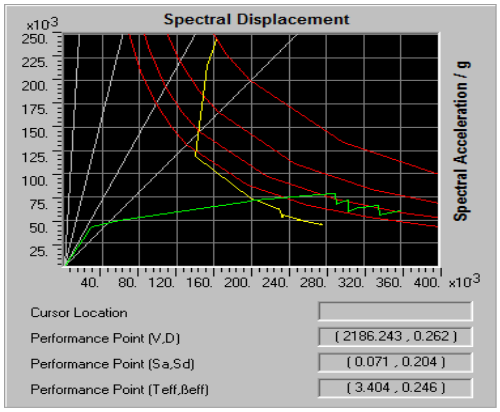
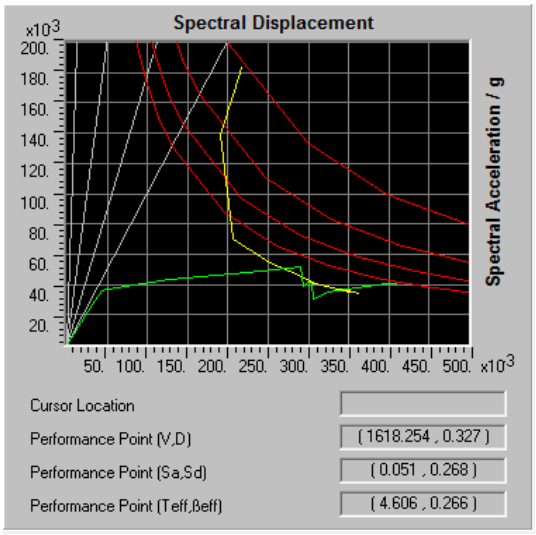


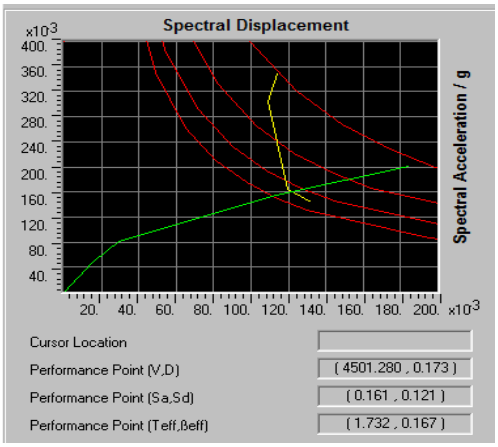
Fig 2:Plan of (G+7) Storey RCC Building with Dual System

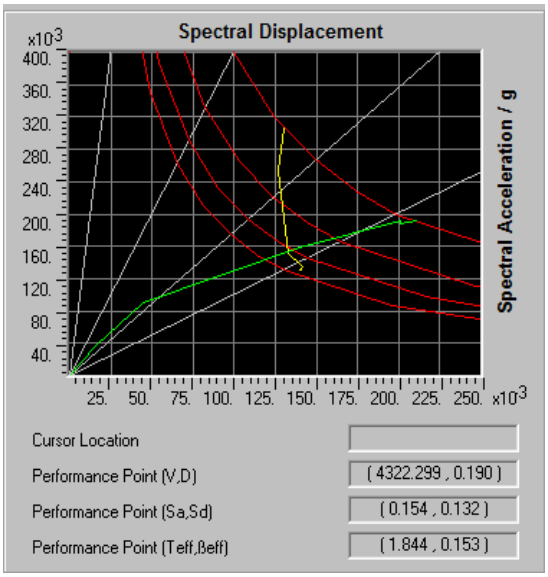
Performance Based Analysis Results for Space Frame
Pushover Results of Space Frame

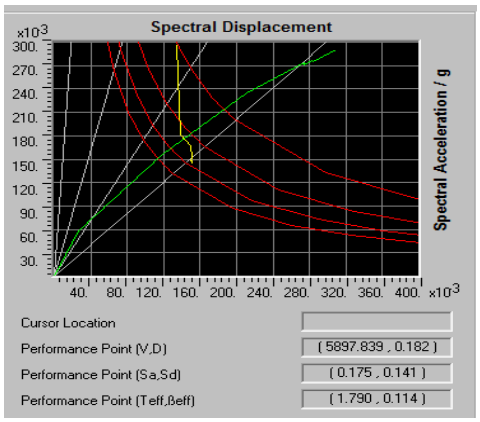
Types of Model	Performance Point (kN)		Displacement in (m)	
	Push X	Push Y	Disp X	Disp Y
Bare Frame	2186.24	1618.25	0.262	0.327
Bare Frame with Shear Wall	4501.28	4322.24	0.173	0.19
Frame with Brick Masonry Infill	5897.84	5710.05	0.182	0.206
Frame with Brick Masonry Infill Shear	8783.32	8806.24	0.148	0.157

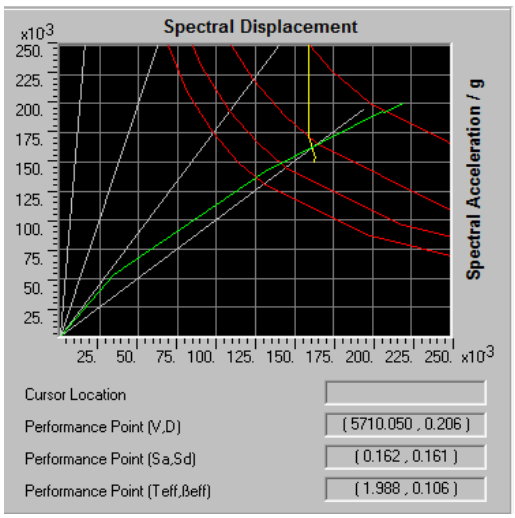












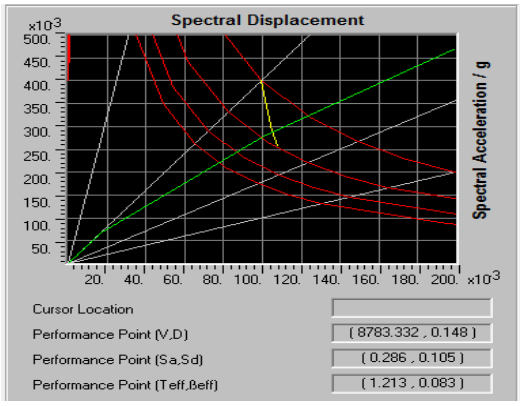


Fig 3 : Capacity Spectrum for (G+7) Storey Building Models in X Direction for Different Type of Models

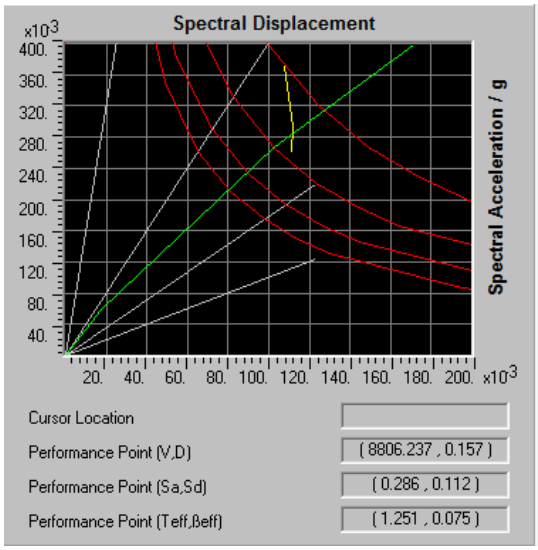


Fig 4: Capacity Spectrum for (G+7) Storey Building Models in Y Direction for Different Types of Models

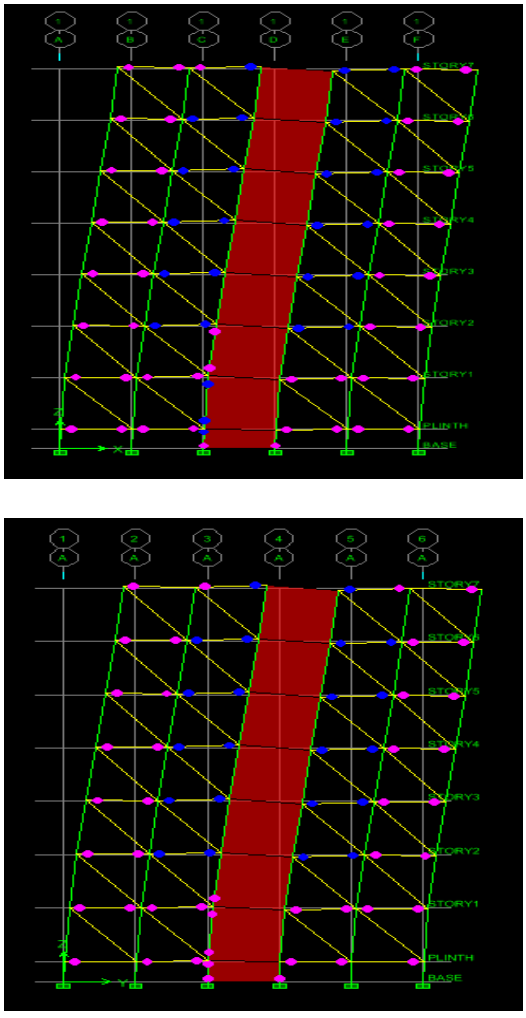


Fig 5: Plastic Hinges Formed in Frame with Brick Masonry Infill and Shear wall in X And Direction.

VII. CONCLUSION

1. Comparison of linear and nonlinear static analysis for different parameters is studied and it is observed that base shear is increasing in case of nonlinear static analysis as compared to linear analysis
2. In case of nonlinear static analysis i.e. pushover analysis, it is performance based analysis and the results obtained in terms of demand, capacity and plastic hinges give an insight into the real behavior of structures.
3. Capacity spectrum curve obtained from performance based analysis, it is observed that base shear is more and top displacement is less for model no. four i.e. frame with brick masonry infill and shear wall and effective time period is also less.
4. From analysis it is observed that, the dual system is effectively resisting the earth- quake forces because stiffness of such system is more.

REFERENCES

[1] Sarosh H. Lodi, Aslam F.Mohammed, Rashid A. Khan, M. Selim Gunay presented paper on “A Practical Guide to Nonlinear Static Analysis of Reinforced Concrete Buildings with Masonry Infill Walls”

[2] Mrugesh D. Shahand Sumant B.Patel (2011) on “Non linear static analysis of R.C.C. Frames”

[3] Rahul Rana, Limin Jin and Atila Zekioglu (2004)on “Pushover analysis of a 19 story concrete shears wall building”

[4] Federal Emergency Management Agency (FEMA)(1997)NEHRP Guidelines for Seismic Rehabilitation of Buildings.FEMA-273, Washington, D.C.

[5] Applied Technology Council (ATC). (1996). “Seismic Evaluation and Retrofit of concrete Buildings.”Rep.No.SSC96-01; ATC40, Redwood City, Calif.

[6] P.C.Vaghese, “Advanced Reinforced Concrete Design”, Text Book, New Delhi.

[7] Chopra AK, Goel RK. “A modal pushover analysis procedure to estimate seismic demands for buildings: theory and preliminary evaluation.” PEER Report 2001/03, Pacific Earthquake Engineering Research Center, College of Engineering, University of California Berkeley, 2001.

[8] Chopra AK, Goel RK. “A modal pushover analysis procedure for estimating seismic demands for Buildings.”Earthquake Engineering Structural Dynamics, 2002, 31(3): 561-582.

[9] Manish shrikhande and Pankaj Agrawal Earthquake resistant Design of structures, PHI learning publication.

[10] Mario Paz " Structural Dynamics"
[11] Syed Ahamed, Dr. Jagadish.G.Kori (2013) on "Performance Based Seismic Analysis Of An Unsymmetrical Building "Using Pushover Analysis"
[12] Kasliwal Sagar K, Prof. M.R.Wakchaure , Anantwad Shirish (2012) on "Effects Of Numbers And Positions Of Shear Walls On Seismic Behaviour Of Multistorey Structure"