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EARTHQUAKE PERFORMANCE OF G+FOUR EXISTING R.C.C BUILDING BY USING E-TABS SOFTWARE

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Abstract

In many past earthquakes many R.C.C concrete structures have been severely damaged have indicated the need for evaluating the seismic adequacy of existing buildings. The structures venerable to damage must be identified and an acceptable level of safety must be determined to make such assessment, simplified linear-elastic methods are not adequate. The push over analysis, is a method for evaluating the performance. on this study, the method is used to evaluate the performances of RC plane frames The static pushover analysis is becoming a popular tool for seismic performance evaluation of existing structures. The purpose of the paper is to summarize the basic concepts on which the pushover analysis can be used. The paper deals with non-linear analysis of an Existing RCC frame. The main aim is to carry out the pushover curves of the RCC frame and to calculate the displacement of the frame. The analysis is carried out by using ETABS software. Push-over curves for the frame are obtained and carried out.

Keyword: Analysis, Limit state Method, Pushover Analysis, E-TABS Software

1.INTRODUCTION

Now-a-days in designing of RCC structures in seismic zones is control of lateral displacement resulting from lateral forces. In this study effort has been made to investigate the lateral displacement and Base Shear of RCC Frames. RCC Frames with G+Four RCC Building are considered.Non-linear static analysis (pushover analysis) was carried out for the frames and the frames were then compared with the push over curves. Displacement and Base shear are calculated from the curves. The nonlinear analysis of a frame has become an important tool for the study of the concrete behaviour including its load-deflection pattern. It helps in the study of various characteristics of concrete member under different load condition.

2. METHODOLOGY

In our study, a plan of G+Four buildings were considered. For push over study, RC plane frames in each floor were analysed and designed for gravity loads as per IS 456:2000 and lateral loads (earthquake loads) as per IS 1893 (part-1):2002.

3. PRELIMINARY DATA

TYPE OF THE STRUCTURE	: MULTI-STOREY RIGID JOINED FRAME
ZONE	: 3
NUMBER OF STORIES	: FOUR (G+4)
Ground Storey Height	:3 meters
Floor To Floor Height	:3 meters
External Walls	: 230 mm (Including Plastering)
Internal Walls	: 150 mm (Including Plastering)
Live Load	: 2 KN/m^2
Materials	: M25 and Fe 415 steel.
Seismic Analysis [Is: 1983 Part 1:2002]	: Equivalent Static Method
Design Philosophy	: Limits State Method [IS :1983 Part 1:2002]

Ductility Design as Per :[IS 13920:1993]

Size of Exterior Column : 300x300 Mm

Size of Interior Column : 300x300 Mm

Size of the Beam in

Longitudinal and

Transverse Direction : 300x450 Mm

Total Depth of Slab : 140 mm

3.1. Earthquake Load Analysis

Total Base shear

= αh *w

=0.06 * 31,186

=1872 KN

Base Shear at each frame

Vb = 1872/12 = 156 KN

3.2. Structural Analysis

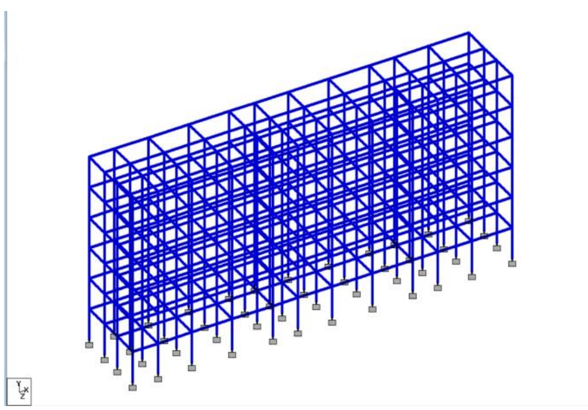

Fig-1 RCC Frame with Beams and Columns in (STAAD Pro)

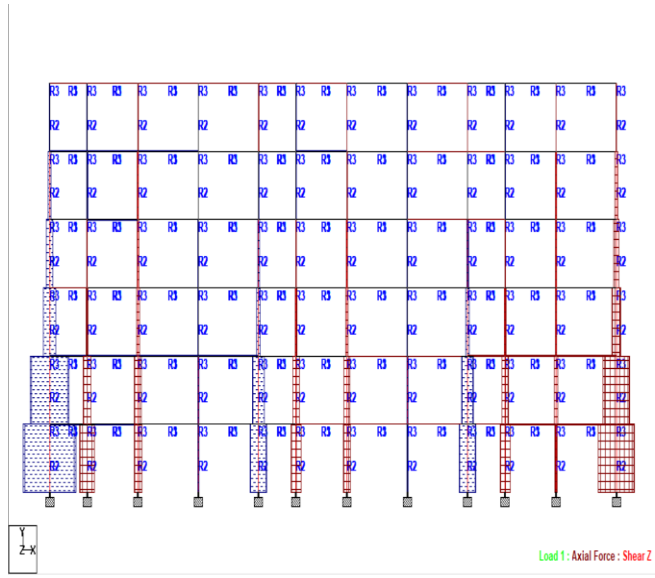

Fig-3 RCC Frame with Axial Force in (STAAD Pro)

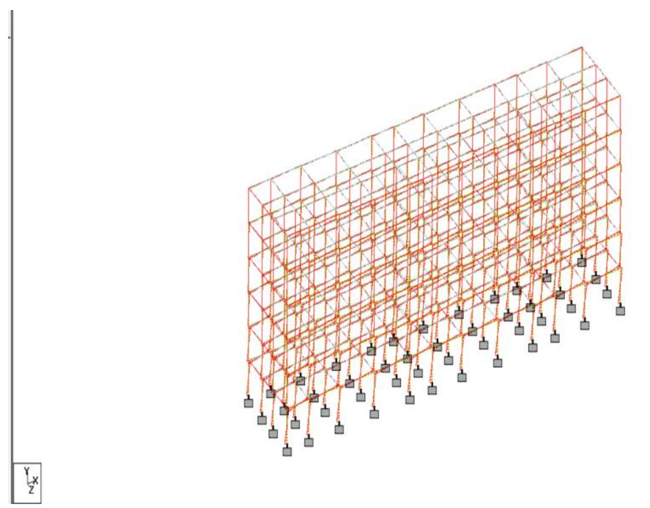

Fig-4 RCC Frame with Bending Moment in (STADD Pro)

3.3. Structural Design

Grade of concrete= M25

Steel= Fe 415

Axial Load=1700KN

Bending Moment=56 KN-m

The general required of the column for ductility will follow from IS-13920:1993

Vertical reinforced of the column in designed according to IS:456-2000.

Main Steel: 6 bars of 20mm dia.

Use 8mm dia two legged stirrups.

Design of Beam

Assuming 25mm dia bars with 25mm clear cover

Effective depth(d) = 450 – 25 – 25/2 = 412.5mm

d' / d = (25+12.5) / (412.5) = 0.091 =0.10

Reinforcement from From Table-D, SP16 1980

Mulim /bdsq = 3.45 [for M25 and Fe415]

= 3.45 *300*412.5sq = 176.11KNm

Beam 1

Actual moment = 49.32KNm

Mulim = 176.11KNm

Actual moment is less than Mulim, so the section is a singly reinforced section.

Reinforcement from Table 2, SP16 1980

Mu / bd^2 = (49.32x10^6) / 300 *412.5sq = 0.96

Referring table3, sp16 1980 corresponding to Mu /bd^2

& M25 = Pt = 0.291

Area = 0.291/100 *300*412.5 = 360.112sqmm

Provide [4 @ 16mm dia bars = 804.24sqmm]

1. Top and bottom reinforcement shall consist of at least 2 bars throughout the member length.
2. Tension steel ratio
   Min ≤ 0.24 *sqrt(fck/fy)
   = 0.058 given 0.291
   Hence ok
3. Max = 3.45 given 0.291
   Maximum ratio at any section should not exceed = 3.45

4.PUSHOVER ANALYSIS

Pushover analysis is a static, nonlinear procedure in which the magnitude of the lateral loads is incrementally increased, maintaining a predefined distribution pattern along the height of the building. Pushover analysis can determine the behaviour of a building, including the ultimate load and the maximum inelastic deflection. Local nonlinear effects are modelled, and the structure is pushed until a collapse mechanism is developed. At each step, the base shear and the roof displacement can be plotted to generate the pushover curve.

4.1 NON –Linear Static AnalysiS For Building

Seismic analysis of buildings can be categorized depending upon the sophistication of modelling adopted for the analysis. Buildings loaded beyond the elastic range can be analysed using Non-Linear static analysis, but in this method, one would not be able to capture the dynamic response, especially the higher mode effects. This is pushover analysis. There is no specific code for NLSA. This procedure leads to the capacity curve which can be compared with design spectrum/DCR of members and one can determine whether the building is safe or needs strengthening and its extent.

The capacity of structure is represented by pushover curve. The most convenient way to plot the load deformation curve is by tracking the base shear and the roof displacement. The pushover procedure can be presented in various forms can be used in a variety of forms for the use in a variety of methodologies. As the name implies it is a process of pushing horizontally, with a prescribed loading pattern, incrementally, until the structure reaches the limit state.

4.2 Seismic Load Distribution

Pushover analysis requires the seismic load distribution with which the structure will be displaced incrementally. The load distribution is based on the first three mode shapes.

5. MODELING OF FRAME

All the preliminary modelling was done in staad.pro and the modelled frame was imported into E-Tabs. A four-storey frame was modelled in STAAD Pro. and imported to E-Tabs. The main aim is to derive the difference in displacement & Base Shear.

5.2 Member Properties

- All the beams in the frame were sized to 0.30m X 0.45m
- All the columns in the frame were sized to 0.3m X 0.3m in case-1
- The slab of 0.15m thickness was taken for the analysis purpose and assigned to each floor.
- Default M3hinge was assigned to beams.
- Default P-M-M hinge was assigned to columns.

5.3 Member Loading

All the members were assigned the following loadings.

- Self-Weight
- External Wall Load--- 17.8 KN/m
- Internal Wall Load--- 14 KN/m
- Live Load----------- 2 KN/m
- Earth Quake Loading----- as per IS-code:1893-2002
- It was assumed that the wind force was not governing the frame efficiency.

5.4 Push Over Case

Two pushover cases were defined for the analysis

- ✓ Push1 also known as gravity pish which is done for gravity loading (DL+LL) for which it is done in Load defined pattern.
- Push-2also known as lateral push in which the governing load is lateral load (EQ) for which it is done in displacement defined pattern.

6. RESULTS

The results from the analysis are the deflected shape and the formation of hinges with increasing load and their performance levels. The frames can be found from the displacement and base shear plots i.e., push-over curve. Capacity Spectrum curve can be drawn from the analysed plot.From the capacity spectrum curve the existence of performance point can be noted. If the performance point doesn't exist, the structure fails to achieve the target performance level.

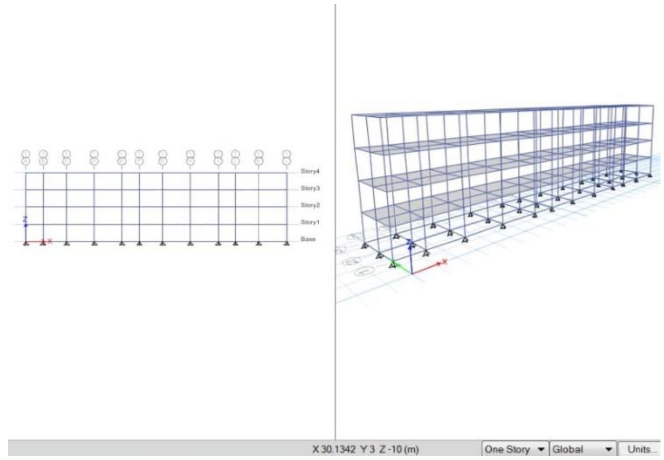

Fig-5 RCC frame (3D view)

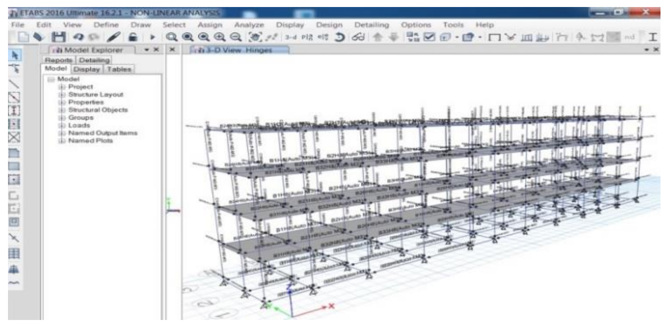

Fig-6 RCC frame with user defined Hinges

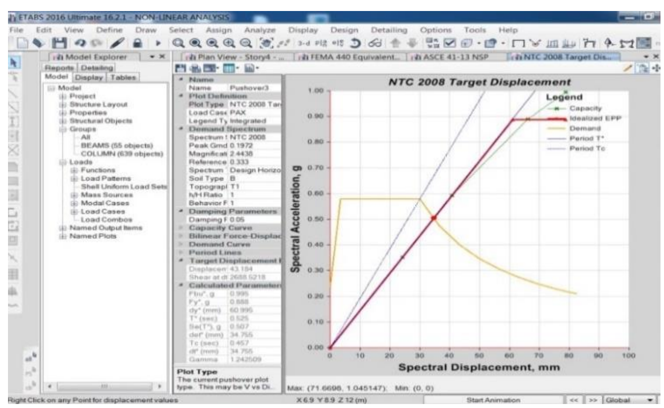

Fig-7 RCC frame Capacity spectrum curve

Maximum Base shear and Roof displacement for the G+Four storey building		
case	Base shear (kN)	Roof Displacement (mm)
Case-1	4065	65.00

Table-1 Base shear and Roof displacement.

6.1 Summary And Conclusions

Modelling of building for performance evaluation is necessitates the knowledge about the section and reinforcement details of existing buildings. In this paper, the evolution of RC design procedure of limit state method as given in different versions of IS: 456 are discussed. Various provisions in detailing such as minimum and maximum compression / tension reinforcement, transverses reinforcement for flexural and compression members with appropriate spacing of rectangular stirrups are carried out and reviewed.Design steps for Reinforced concrete beams and columns as per LSM are presented. Spread sheets are developed for the design of RC beams and columns as per limit state method.

In this thesis one typical designs have been carried out as per present codes of practice. The nonlinear static analyses are carried out and the capacity curves are generated. The actual values of maximum base shear and roof displacement capacities for the frame are brought out clearly. The performance points are obtained, and the corresponding base shear and roof displacements are arrived for NTC 2008 Target Displacement. It is clearly found that the frame to meet the performance point.

REFERENCES

[1] Chopra A.K and Goel R.K (2001), A modal pushover analysis procedure for estimating seismic demands buildings, Earthquake Engineering and Structural Dynamics, Vol.31, pp.561-582.

[2] CSI, Computers and Structures Inc., SAP 2000- Static and dynamic finite element analysis of structures. Berkely, USA, 20005.

[3] Fajfar P (1999), Capacity Spectrum Method based on Inelastic demand Spectra, Earthquake Engineering & Structural Dynamics Vol.28, pp.979-993.

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

[5] FEMA -356 (2000), Pre-standards and commentary for the seismic rehabilitation of buildings", Federal Emergency Management Agency, Washington DC,1997.

[6] Ghobarah A, KalKan E, Kunnath S.K (2001), Performance-based design in earthquake engineering: State of development, Engineering Structures, Vol.23, pp.878-884.

[7] IS: 456:2000 Indian standard for plain and Reinforced Concrete Code of Practice, Bureau of Indian Standards, New Delhi-110002.

[8] Kappos A.J and Panagopoulos G (2004), Performance- Based seismic design of 3D RC Building using inelastic static and dynamic analysis procedures, ISET Journal of Earthquake Technology, paper No444, Vol.41, No 1, March 2004, pp.141-158.

[9] KalKan E and Kunnath S.K (2007), Assessment of current nonlinear static procedure for seismic evaluation of Building Structures, Vol.29, pp305-316.

[10] Lin Y.Y, Chang K.C and Wang YL (2004), Comparison of displacement coefficient method and capacity spectrum method with experiment results of RC Columns, Earthquake Engineering structure. Dyn.2004: Vol. 33: pp.35-48.

[11] Moghadam A.S and Tso W.K (2000), 3-D Pushover Analysis for Damage Assessment of Buildings, JSEE: Summer 2000, Vol. 2, No.3.

[12] Mario Paz (2004), Structural Dynamics (Theory and Computation), Second Edition, CBS Publishers.

[13] Pinho R, Antoniou S, Casarotti C, Lopez M (2005), An Innovative Displacement- Based Adaptive Pushover Algorithm for Assessment of Building and Bridges, Advances in Earthquake Engineering for urban risk reduction. NATO Workshop, Istanbul, 30 May 01 June 2005.

[14] Pan P and Ohsaki M(2006), Nonlinear multimodal pushover analysis method for spatial structure, IASS-APSC 2006, Beijing, China, Int. Assoc. Shell and spatial Structure.