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Performance Based Seismic Analysis of Shear wall for Tall Building

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Abstract:
The main objective of this project work is to present a detailed 3 dimensional seismic analysis and performance based seismic analysis of G+ 9 storied reinforced concrete frames with shear wall. The report provides an introduction to the earthquake, effects, designing of the buildings and studies review of literature pertaining to performance based seismic analysis. It highlights various aspects related to the Performance based Seismic analysis and explains about Limit State design which an old method of building designing. The study reveals modeling and analysis. The performance based seismic analysis of G+9 of old and new building design methods have been modeled and analyzed. The report draws out the result of study and provides a comparative study. The project report also provides a comprehensive conclusion and offers a scope for future research as well.

Keywords: Performance Based Seismic analysis and design, SAP 200, Shear Wall, FEMA, ATC

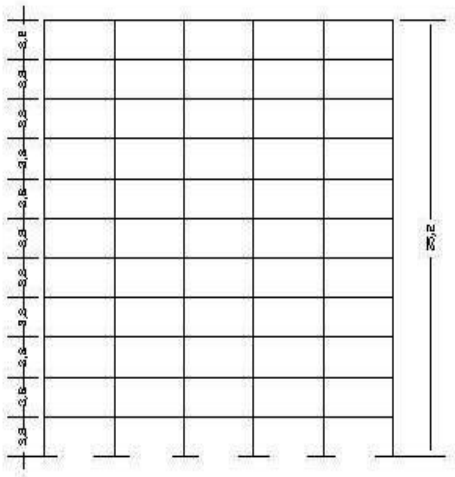
I. INTRODUCTION

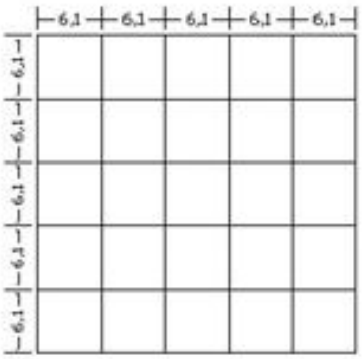
The Existing Building codes define the minimum design require¬ments that ensures the safety of occupants during specific designed earthquake. Recent natural disasters such as Bhuj, Nepal, etc have prompted recognition that significant damage can occur even when buildings are compliant with the building code. Many facilities like school buildings, hospitals, community halls etc are closed after natural disasters, even the damages are relatively minor, which tells us that satisfying the minimum criteria of the building codes may not be sufficient to ensure continued durability and functionality. Communities also depend on school buildings, hospitals, community halls etc to provide reliable shelter and critical services at critical time. In order to meet that need, school buildings, hospitals, community halls etc should be designed and constructed according to criteria that best result to continued and uninterrupted functionality. The performance based Sesmic analysis and design approach is not an immediate substitute for design to traditional codes. But, it can be viewed as an opportunity to enhance and tailor the design to match the objectives of the durability and the continued availability of services and community's stakeholders. The design team is made up of the architects, engineers, and other design professionals and consultants. Pushover analysis is the preferred tool for seismic performance evaluation of structures by the major rehabilitation guidelines and codes because it is conceptually and computationally simple. Pushover analysis allows tracing the sequence of yielding and failure on member and structural level as well as the progress of overall capacity curve of the structure

II. CASE STUDY DETAILS

For obtaining performance point a building frame of G+10 floors is considered.

1	Type of structure	---	Multi storey rigid joint frame with shear wall.
2	Seismic zone	---	V
3	No. of stories	---	(G+9)
4	Imposed Load	---	6 KN/m2 at roof 7 KN/m2 at floors
5	Live Load	---	3.75 KN/m2
6	Depth of slab	---	200 mm
7	Depth of Shear wall	---	200 mm
8	Materials	---	M 40 concrete and Fe 500 steel
9	Unit weight of RCC	---	25 KN/m2
10	Unit wt. of Masonry	---	20 KN/m2
11	Bay width of plane frame		--- 6.1 m.
12	Total height of building frame		---35.2 m.
13	Height of each storey		---3.2 m.
14	Beams		---800 × 700 mm.
15	Columns		---1000 × 1400 mm
16	Clear cover of beam		---25 mm.
17	Clear cover of column		---40 mm.





CALCULATION OF DESIGN BASE SHEAR

For obtaining the performance point of the building frame in terms of base shear the design base shear is calculated for determining the safety of the frame. The intersection of demand spectrum and capacity spectrum is the performance point of the structure. If the base shear at performance point is greater than design base shear then the structure is safer. Thedesign base shear is calculated as per IS: 1893:2002 as follows:

The seismic weight of building is found to be 128784 KN (Wi). The infill walls in upper floors may contain large openings, although the solid walls are considered in load calculations. Therefore, fundamental time period T is obtained by using the following formula

$Ta = 0.075\ h^{0.75}$ IS 1893 (Part 1):2002, Clause 7.6.1

$Ta = 0.075 \times (35.2)^{0.75}$

Ta = 0.96 sec.

Zone factor, Z = 0.36 for Zone IV IS: 1893 (Part1):2002, Table 2

Importance factor, I = 1.0 , Medium soil site and 5% damping Sa/g=2.5 IS: 1893 (Part 1): 2002, Figure 2.

Ductile detailing is assumed for the structure. Hence, Response Reduction Factor, R, is taken equal to 5.0. It may be noted however, that ductile detailing is mandatory in Zones III, IV and V. Hence, horizontal seismic coefficient is calculated as

Ah=(Z/2)×(I/R) ×(Sa/g) IS: 1893 (Part 1): 2002,clause 6.4.2

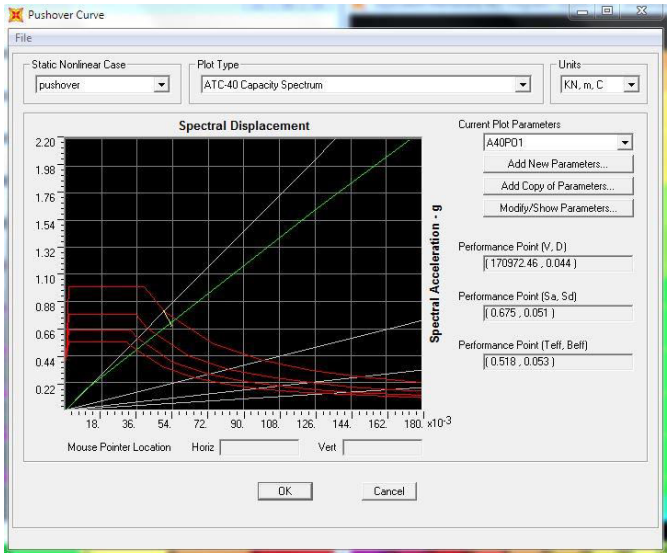
Ah = 2.25

The design Base shear, VB = Ah×W IS: 1893 (Part 1): 2002,clause 7.7.1

$V_B = 2.25 \times 128784 = 289765.665$ KN

III. ANALYSIS

On the above building frame the non linear static pushover analysis is performed to investigate the performance point of the building frame in terms of base shear and displacement. For pushover analysis the various pushover cases are considered such as push gravity, push X (i.e. loads are applied in X direction), push Y (i.e. loads are applied in Y direction). The various load combinations are also used for this purpose. After pushover analysis the demand curve and capacity curves are obtained to get the performance point of the structure. The performance point is obtained as per ATC 40 capacity spectrum method. paper. The base shear for PUSH X load case is (170972.46 KN). And for PUSH Y base shear at performance point is (915.197) as shown in figure



A table is also obtained which gives the coordinates of each step of the pushover curve and summarizes the number of hinges in each state (for example, between IO, LS, CP)

Yield Values (V,D) = 170972.46, 0.044

Ultimate Values (V.D) = 246606.26, 0.064

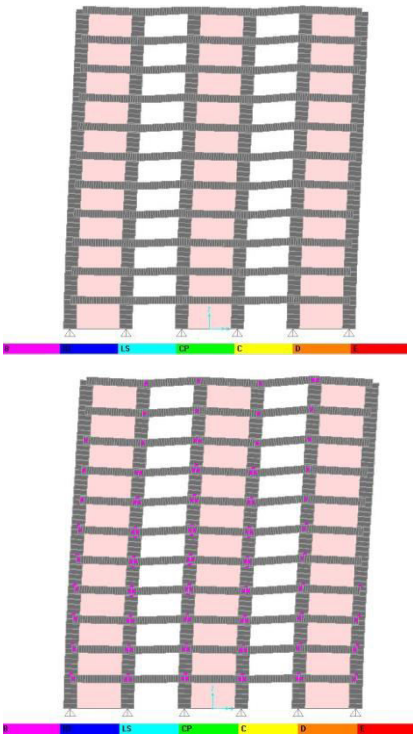
Performance point is the intersection of capacity and demand spectra.

V, D = 170972.46, 0.044

Sa, Sd = 0.675, 0.051

Teff, Beff = 0.518, 0053

The performance point of the structure can be now determined by using the pushover curves obtained. The performance point is the point where the performance capacity and performance demand of the structure are equal. The performance point is determined automatically by SAP 2000, using the procedure as mentioned in ATC-40. The Performance point at which the capacity curve intersects the reduced demand curve represents the performance point at which capacity and demand are equal. As the displacement increase, the period of the structure lengthens and reduces demands. Hence, optimum point should have a higher capacity for a lesser displacement. Figure 46 shows that performance point is at Teff = 0.518 sec which is close value of Teff. Hence, it is required to see the hinge formations. It also becomes clear that hinges formed in beams and columns are below immediate occupation level. Hence, structure is very safe to use.

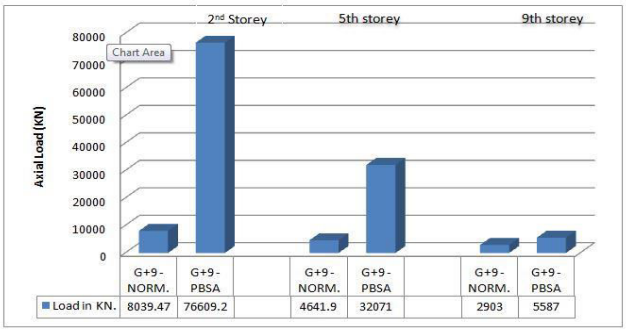


Figurew.1. Hinges Mechanism(Pushover Analysis)

IV. RESULT

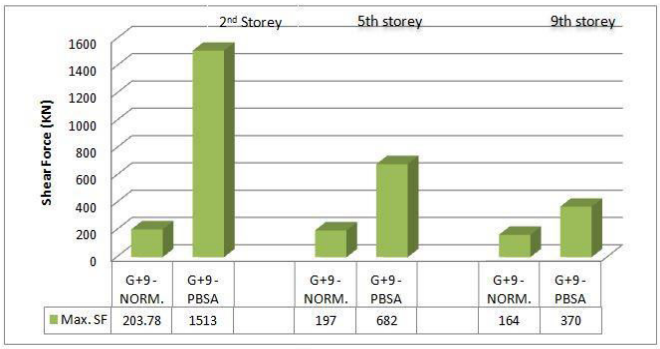
The Analysis of a G+9 RC frame building with shear wall is done on the basis of both limit state and performance based analysis. At present Performance based analysis concept is applied for the solution of a Shear wall problem with a view to avoid the concentration of ductility demand in Multi storied building with shear wall elements by distributing it throughout the structure by proportionate design. The possibility of failure can be eliminated by this method of Performance Based Seismic Analysis. The above details have been given for G+9 frame using the same and the result has been figured as below:-

Comparative study of PBSA and LSM (Normal) on Axial Load on columns.



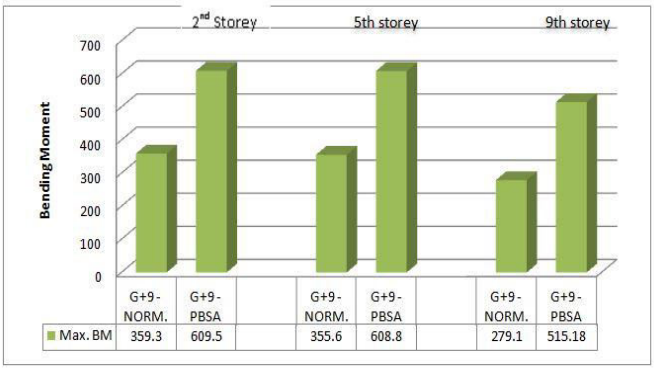
Source: Based on Data Analysis

Comparative study of PBSA and LSM (Normal) on Shear Force on columns.



Source: Based on Data Analysis

Comparative study of PBSA and LSM (Normal) on Max. Bending Moment in BEAMS



Source: Based on Data Analysis

V. CONCLUSION

1. Performance Based Seismic Analysis (PBSA) with Shear Wall is futuristic approach to analysis and design of reinforced concrete structures especially for multi-bay multi storied reinforced concrete buildings.
2. This concept is restrict to the formation of plastic hinges in the beams only, hence collapse occurs through the beam mechanism only, which localize the failure and hence leads to less destruction and loss of lives.
3. Collapse due to sway mechanism can cause failure of Structures. As its approach is to eliminate the sway mechanism by making columns stronger than beams, this method is very effective in design for lateral loads.
4. The Performance Based Seismic analysis and Design method also eliminates the possibility of shear mode of failure by making shear capacity of elements more than their moment capacity.
5. Compared with the conventional design methods for earthquake resisting structures although performance based seismic analysis method is little costlier but is more effective in resisting the earthquake forces.
6. The performance based seismic analysis and design method is more realistic because the calculations are based on provided reinforcement and the over strength of the structure which takes into account the reserve strength beyond elastic limit.
7. As the building can be reused after minimal repairs after occurrence of earthquake, hence performance based method of analysis and design should be adopted for public utility buildings like schools, colleges, hospitals etc.
8. Multilevel seismic hazards are considered with an emphasis on the transparency of performance objectives.
9. Building performance is guaranteed through limited inelastic deformation in addition to strength and ductility.
10. Seismic design is oriented by performance objectives interpreted by engineering parameters as performance criteria.
11. An analytical method through which the structural behavior, particularly the nonlinear behavior is rationally obtained.
12. The building will meet the prescribed performance objectives reliably with accepted confidence and the analysis and design will ensure the minimum lifecycle cost.
13. The Performance based seismic analysis and design process, it can be concluded that Reinforced Concrete Structures with Shear Walls are able to resist more base-shear than that of normal Reinforced Concrete Frames. It can be concluded that shear wall placing at adequate locations is more significant in case of base shear and displacement. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.

VI. ACKNOWLEMENT

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VII. REFERENCES

[1].Agarwal Pankaj and Shrikhande Manish, "Earthquake resistant design of structures", Prentice Hall of India Private Limited

[2].Bruce R. Ellingwood, Earthquake risk assessment of building structures Reliability Engineering & System Safety Volume 74, Issue 3, December 2001, Pages 251–262

[3]. Filiatrault, A. and Folz, B. (2002), "Performance-Based Seismic Design of Wood Framed Buildings", ASCE Journal of Structural Engineering, Vol. 128, No. 1.

[4].I.S. 1893, "Criteria for Earthquake Resistant Design of Structures (part 1) General Provisions and Buildings (Fifth Revision)", Bureau of Indian Standards, 2002.

[5].I.S.456, "Plain and Reinforced Concrete- Code of Practice", Bureau of Indian Standards, 2000.

[6]. I.S 13920, "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice", Bureau of Indian Standards, 1993.

[7]. Jack W. Baker and c. Allin Cornell (2006), "Spectral shape, epsilon and record selection", earthquake engineering and structural dynamics earthquake eng. struct. dyn. 2006; 35:1077–1095 published online 12 April 2006 in wiley interscience.

[8]. K Rama Raju, ACinitha and Nagesh R Iyer (2012), "Seismic performance evaluation of existing RC buildings designed as per past codes of practice", Sadhana¯ Vol. 37.

[9]. M.C. Kunde &R.S. Jangid, "Seismic behavior of isolated bridges: A-state-of-the-art review, Electronic Journal of Structural Engineering, 3 (2003)

[10].Prabuddha Dasgupta, Subhash C. Goel, Gustavo Parra-montesinos, and K. C. Tsai (2004), Performance based Seismic design and behavior of Composite Buckling Restrained Braced Frame, 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004.

[11].Savan Javiya, Asst. prof. Bibhu Bibhuti," Performance Based Analysis if RCC Building," International Journal of Advance Engineering and Research Development, e-ISSN (O): 2348-4470 p-ISSN (P): 2348-6406, Volume 4, Issue 4, April 2017.

[12]. Rajan L. Wankhade, Amarsinh B. Landage, "Performance Based Analysis and Design of Building Frames with Earthquake Loading," International Journal of Engineering Research, ISSN: 2319-6890 (online), 2347-5013 (print), volume No.5, Issue Special 1 pp : 106-110, Jan 2016.

[13]. Ranjit V. Surve, Prof. D. S. Jagtap, Prof. Y. P. Pawar, "Performance based Analysis of Multistoried Building with Soft Storey at Different Levels," International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 4 Issue 04, April-2015.

[14].Prof. Rekha Shinde, Prof. Mukesh Shinde, "Performance Based Seismic Analysis of a Building with Soft Storey,", International Journal for Innovative Research in Science & Technology ISSN(online) : 2349-6010, Volume 1 , Issue 3, August 2014