International Journal of New Media Studies (IJNMS), ISSN: 2394-4331
Volume 10 Issue 2, July-December 2023, Impact Factor: 7.786

A Study on Seismic Design of Building

Dr. Rambha Thakur[1], Dalip[2]

[1]Assistant Professor, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India
[2]Research Scholar, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India

ABSTRACT

A performance-based design is aimed at controlling the structural damage based on precise estimations of proper response parameters. Performance-based seismic design explicitly evaluates how a building is likely to perform; given the potential hazard it is likely to experience, considering uncertainties inherent in the quantification of potential hazard and uncertainties in assessment of the actual building response. It is an iterative process that begins with the selection of performance objectives, followed by the development of a preliminary design, an assessment as to whether or not the design meets the performance objectives, and finally redesign and reassessment, if required, until the desired performance level is achieved. Then we have found the capacity spectrum, demand spectrum & performance point of the building. Finally I also did time history analysis of a building using a SAP2000V16. For time history analysis the time history of Bhuj earthquake & time history of IS code1893 for medium soil is taken. Very Rare chances are there for the building to cross Life safety performance level.

INTRODUCTION

The multi-storey building are designed for earthquake forces which are less than the actual earthquake force corresponding to design response spectrum as a result under the stipulated design earthquake the building undergoes inelastic vibration. This inelastic vibration leads to the formation of plastic hinges either in the column or beam ends. The formation of the plastic hinges with the earthquake vibration continues over the duration of the earthquake. During the oscillation a plastic hinge occurs & a reversal may take place at the plastic hinge causing it to close down Thus several plastic hinges may form & close down over the duration of the earthquake during a course of vibration maximum displacement i.e. rotation, drift etc which are caused to be obtained by performing inelastic analysis Since response spectrum method of analysis is elastic in nature the non linear behavior of the structure during the actual earthquake remains unknown its effect is included in the design by considering ductility factor. Performance-based design of buildings has been practiced since early in the twentieth century, England, New Zealand, and Australia had performance-based building codes in place for decades [2]. The International Code Council (ICC) [3] in the United States received a performance code available for voluntary adoption since 2001 (ICC, 2001). The Inter- Jurisdictional Regulatory Collaboration Committee (IRCC) is an international group representing the lead building regulatory organizations of 10 countries formed to facilitate international discussion of performance-based regulatory schemes with a focus on identifying public policies, regulatory infrastructure, training, and technology topics related to implementing and managing these organizations.

1989, the FEMA-funded project was launched to develop formal engineering guidelines for retrofit of existing buildings began (ATC, 1989), it was recommended that the rules and guidelines are sufficiently flexible to accommodate a much wider variety of local or even building-specific seismic risk reduction policies than has been traditional for new building construction. The initial design document, [4] NEHRP Guidelines for the Seismic Rehabilitation of Existing Buildings, FEMA 273, therefore contained a range of formal performance objectives that corresponded to specified levels of seismic shaking.

The performance-based seismic design process explicitly evaluates how a building is likely to perform; given the potential hazard it is likely to experience, considering uncertainties inherent in the quantification of potential hazard and uncertainties in assessment of the actual building response.

LITERATURE REVIEW

There have been no formal statements of the performance standards to which equivalence must be shown nor of acceptable methods of demonstrating equivalence. Therefore, design professionals taking the performance-based route were at risk of being unable to convince to the satisfaction of the authority having jurisdiction that equivalence existed. way into the building codes and their referenced standards. This paper describes some of the major milestones that have occurred in this regard.

R. K. Goel and A. K. Chopra
Presented an improved Direct Displacement-Based Design Procedure for Performance- Based seismic design of structures. Direct displacement-based design requires a simplified procedure to estimate the seismic deformation of an inelastic SDF system, representing

the first (elastic) mode of vibration of the structure. This step is usually accomplished by analysis of an equivalent linear system using elastic design spectra. In their work, an equally simple procedure is developed that is based on the well-known concepts of inelastic design spectra.

X.-K. Zou et al (2005) [19]
Present an effective computer-based technique that incorporates pushover analysis together with numerical optimization procedures to automate the pushover drift performance design of reinforced concrete (RC) buildings.

Shuraim et al., (2007)
summarized the nonlinear static analytical procedure (Pushover) as introduced by ATC- 40 has been utilized for the evaluation of existing design of a new reinforced concrete frame, in order to examine its applicability. Potential structural deficiencies in RC frame, when subjected to a moderate seismic loading, were estimated by the code seismic-resistant design and pushover approaches. In the first method the design was evaluated by redesigning under one selected seismic combination in order to show which members would require additional reinforcement. It was shown that most columns required significant additional reinforcement, indicating their vulnerability if subjected to seismic forces.

Dhileep. M et al., (2011)
Explained the practical difficulties associated with the non linear direct numerical integration of the equations of motion leads to the use of non linear static pushover analysis of structures. Pushover analysis is getting popular due to its simplicity.

High frequency modes and non linear effects may play an important role in stiff and irregular structures. The contribution of higher modes in pushover analysis is not fully developed. The behavior of high frequency model responses in non linear seismic analysis of structures is not known. In this paper an attempt is made to study the behavior of high frequency model responses in non linear seismic analysis of structures.

Vipul Prakash (2004)
Gives the prospects for Performance Based Engineering (PBE) in India. He lists the pre-requisites that made the emergence of PBE possible in California, compares the situation in India and discusses the tasks and difficulties for implementing PBE in India.

In India, the criteria for earthquake resistant design of structures are given in IS 1893, published by the Bureau of Indian Standards (BIS). IS 1893-2002 reduced the number of seismic zones to four by merging zone I with zone II and adopted a modified CIS-64 scale for seismic zoning and dropped references to the MMI scale.

METHODOLOGY

The process begins with the selection of design criteria stated in the form of one or more performance objectives. Performance objectives are statements of the acceptable risk of incurring different levels of damage and the consequential losses that occur as a result of this damage, at a specified level of seismic hazard. Since losses can be associated with structural damage, non-structural damage, or both, performance objectives must be expressed considering the potential performance of both structural and non-structural systems.

These are based largely on the building stakeholders, namely, the building owner. It is these stakeholders that will determine the initial cost investment in design and construction, and this will drive the level of performance and the associated consequences. PBD requires more effort in the early phases of design.

Performance Based Seismic Design Process

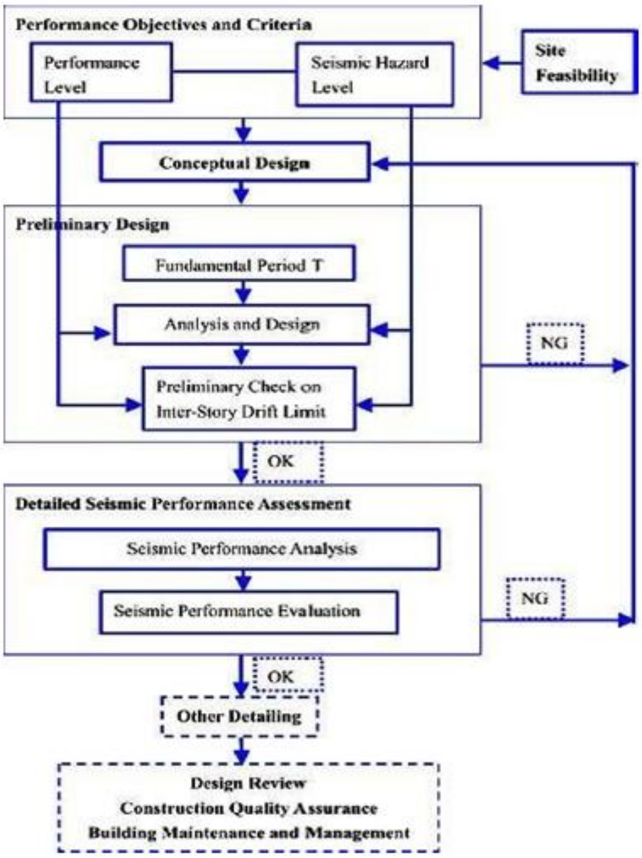
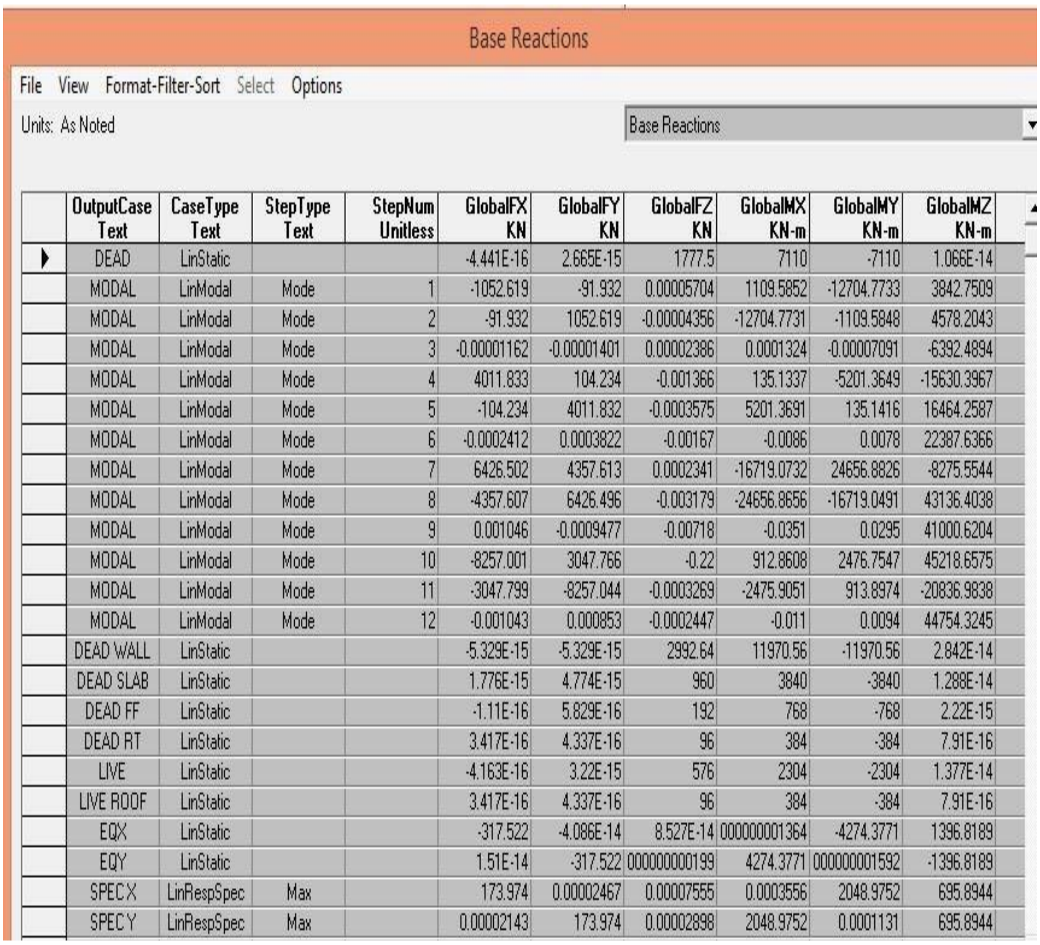


Figure 1 Performance Based Seismic Design for Buildings

RESULT

The following two-level performance objective is suggested for new ordinary structures. Under DBE, damage must be limited to Grade 2 (slight structural damage, moderate non- structural damage) in order to enable Immediate Occupancy after DBE. Under MCE, damage must be limited to Grade 3 (modern structural damage, heavy non- structural damage) in order to ensure collapse

Figure 2 Elevation Height of Each Storey Is 4m



Units: As Noted

Base Reactions

	OutputCase Text	CaseType Text	StepType Text	StepNum Unitless	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-m	GlobalMY KN-m	GlobalMZ KN-m
▶	DEAD	LinStatic			-4.441E-16	2.665E-15	1777.5	7110	-7110	1.066E-14
	MODAL	LinModal	Mode	1	-1052.619	-91.932	0.00005704	1109.5852	-12704.7733	3842.7509
	MODAL	LinModal	Mode	2	-91.932	1052.619	-0.00004356	-12704.7731	-1109.5848	4578.2043
	MODAL	LinModal	Mode	3	-0.00001162	-0.00001401	0.00002386	0.0001324	-0.00007091	-6392.4894
	MODAL	LinModal	Mode	4	4011.833	104.234	-0.001366	135.1337	-5201.3649	-15630.3967
	MODAL	LinModal	Mode	5	-104.234	4011.832	-0.0003575	5201.3691	135.1416	16464.2587
	MODAL	LinModal	Mode	6	-0.0002412	0.0003822	-0.00167	-0.0086	0.0078	22387.6366
	MODAL	LinModal	Mode	7	6426.502	4357.613	0.0002341	-16719.0732	24656.8826	-8275.5544
	MODAL	LinModal	Mode	8	-4357.607	6426.496	-0.003179	-24656.8656	-16719.0491	43136.4038
	MODAL	LinModal	Mode	9	0.001046	-0.0009477	-0.00718	-0.0351	0.0295	41000.6204
	MODAL	LinModal	Mode	10	-8257.001	3047.766	-0.22	912.8608	2476.7547	45218.6575
	MODAL	LinModal	Mode	11	-3047.799	-8257.044	-0.0003269	-2475.9051	913.8974	-20836.9838
	MODAL	LinModal	Mode	12	-0.001043	0.000853	-0.0002447	-0.011	0.0094	44754.3245
	DEAD WALL	LinStatic			-5.329E-15	-5.329E-15	2992.64	11970.56	-11970.56	2.842E-14
	DEAD SLAB	LinStatic			1.776E-15	4.774E-15	960	3840	-3840	1.288E-14
	DEAD FF	LinStatic			-1.11E-16	5.829E-16	192	768	-768	2.22E-15
	DEAD RT	LinStatic			3.417E-16	4.337E-16	96	384	-384	7.91E-16
	LIVE	LinStatic			-4.163E-16	3.22E-15	576	2304	-2304	1.377E-14
	LIVE ROOF	LinStatic			3.417E-16	4.337E-16	96	384	-384	7.91E-16
	EQX	LinStatic			-317.522	-4.086E-14	8.527E-14	000000001364	-4274.3771	1396.8189
	EQY	LinStatic			1.51E-14	-317.522	000000000199	4274.3771	000000001592	-1396.8189
	SPEC X	LinRespSpec	Max		173.974	0.00002467	0.00007555	0.0003556	2048.9752	695.8944
	SPEC Y	LinRespSpec	Max		0.00002143	173.974	0.00002898	2048.9752	0.0001131	695.8944

CONCLUSION

After studying all the curves and tables in the result section on push over curve I came to the following conclusion that the Pushover Analysis result shows that the Building was able to achieve the performance point along X direction within the elastic limit range in case of Designed Based Earthquake Pushover Analysis is an elegant tool to visualize the performance level of a building under a given earthquake the results in this study show that Indian Standard is very conservative in its approach.

The behavior of the frame has been observed to be linear up to the value of base shear around 208 KN. After reaching a base shear value of approximately 380 approx KN, the cracks at the base of the columns have been found to open wider and failures at other location like beams and beam – column joints started.

displacements have found to be increasing at fast rate Maximum deflection has been found to be more than 146 mm at 410 KN the severe damages have been observed at joints of lower floors whereas moderate damages have been observed in first and second floors. Minor damage is seen at floor level in both the cases.

REFERENCES

[1]. CEN 1995, Eurocode 8: Earthquake Resistant Design of Structures - Part 1: General Rules, ENV1998-1, Parts 1-3, CEN, Brussels, Belgium.
[2]. Parikh, H. (2021), "Diatom Biosilica as a source of Nanomaterials", International Journal of All Research Education and Scientific Methods (IJARESM), Volume 9, Issue 11
[3]. NEHRP, 2009, Research Required to Support Full Implementation of Performance- Based Seismic Design, prepared by The Building Seismic Safety Council of The National Institute of Building Sciences Washington, D.C.
[4]. ICC, 2001, International Performance Code for Buildings and Facilities, International Code Council, Whittier, California
[5]. ATC, 1997a, NEHRP Guidelines for the Seismic Rehabilitation of Buildings, FEMA 273 Report, prepared by the Applied Technology Council for the Building Seismic Safety Council, published by the Federal Emergency Management Agency, Washington, D.C.
[6]. Tilwani K., Patel A., Parikh H., Thakker D. J., & Dave G. (2022), "Investigation on anti-Corona viral potential of Yarrow tea", Journal of Biomolecular Structure and Dynamics, 1-13.
[7]. SEAOC, 1995, Vision 2000: Performance-Based Seismic Engineering of Buildings,
[8]. Structural Engineers Association of California, Sacramento, California.
[9]. Xue Q, Chia-Wei Wu, Cheng-Chung Chen, Kuo-Ching Chen, 2007, Civil and Hydraulic Engineering Research Center, Sinotech Engineering Consultants Inc., Taiwan, The draft code for performance-based seismic design of buildings in Taiwan. Available online at www.sciencedirect.com, Engineering Structures 30 (2008) 1535-1547
[10]. Parikh, H., Prajapati, B., Patel, M., & Dave, G. (2023), "A quick FT-IR method for estimation of α-amylase resistant starch from banana flour and the breadmaking process", Journal of Food Measurement and Characterization, 1-11.
[11]. Hamburger, R., and SECB SE. "Codes and Standards for Performance-Based Design." Proc. of. 2007.
[12]. B.E.Kehoe1, Performance Based Seismic Rehabilitation of Nonstructural Components, STRUCURES CONGREESS 2005, ASCE 2005
[13]. Hanson, R., et al. "Nonlinear Performance Based Seismic Assessment for Low- Rise Buildings." Proceedings of ATC & SEI 2009 Conference on Improving the Seismic Performance of Existing Buildings and Other Structures. 2009.
[14]. Patel, M., Parikh, H., & Dave, G. (2023), "Chitosan flakes-mediated diatom harvesting from natural water sources", Water Science and Technology, 87(7), 1732-1746.
[15]. Prakash, Vipul. "Whither performance-based engineering in India?" ISET Journal 41.1 (2004): 201-222.