ISSN : 2455-9679
Impact Factor : 4.256

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"MODELINGAND NONLINEAR SEISMIC ANALYSIS OF MASONRY BUILDING: WITHOUT OPENING"

Yash Kumrawat [1], Sambhav Gangwal [2]
[1-2,]Department of Civil Engineering, Malwa Institute of Science and Technology, Indore

ABSTRACT

In the present work, Incremental Dynamic Analysis (IDA)method is adopted for the analysis of sample building.A suite of 7 selected ground motion time histories used to analyse Masonry Structure for performing IDA. The seismic performance of the Masonry Structure is quantified in terms of yield and collapse capacities in terms of various ground motion indices, which are derived from IDA curves.

SAP2000 (version-14) is used for analyzing the Masonry structure. Pushover analysis, Incremental dynamic Analysis and Fragility Analysis has been applied on Masonry structure.

Keyword: *Seismic analysis, IDA method, Mansory Structure*

I. INTRODUCTION

Masonry is the most important construction material in the history of mankind. Masonry has been used, in a wide variety of forms, as a basic construction material for public and residential buildings in the past several thousand years.
Many of the existing buildings, which do not fulfil the current seismic requirements, may suffer extensive damage or even collapse if shaken by a severe ground motion. The aim of evaluation is to assess the seismic capacity of earthquake vulnerable buildings or earthquake damaged buildings for future use. The evaluation may also prove helpful for degree of intervention required in seismically deficient structures. The aim of seismic evaluation is to assess the possible seismic response of buildings, which may be seismically deficient or earthquake damage for its possible future use. The seismic evaluation is helpful for retrofitting of the structure.
Seismic evaluation of existing building is mainly carried out through Qualitative and Analytical methods.
Rita bento *et al* (2005)performed analysis for each solution and the discussion regarding its qualitatively and quantitatively effects in the seismic structural behaviour: the identification of the expected collapse mechanism after strengthening and the seismic intensity for which it occurs.
Magenes (2000) presents method for the nonlinear static analysis of masonry buildings, suitable for seismic assessment procedures based on pushover analyses. The method is based on an equivalent frame idealization of the structure, and on simplified constitutive laws for the structural elements. SAM (Simplified Analysis of Masonry buildings) was conceived for the global analysis of new and existing masonry buildings, in which the resisting mechanism is governed by in plane response of walls.
Moghadam and Tso (2000) presents the use of the pushover analysis to assess seismic damage to buildings has been extended to include the three dimensional effect of building responses. This extension has enlarged the scope of pushover analysis to include plan-eccentric buildings which are very susceptible to seismic damages. A limitation of the proposed 3-D pushover analysis method is that for plan-eccentric buildings, the vibration modes are coupled modes consisting of both translational and torsional motions.
Galasco et.al (2006) adopted the non-linear static analysis procedure both for design and assessment, which is based on

ISSN : 2455-9679
Impact Factor : 4.256

a maximum displacement prediction, which depends on the definition of an equivalent elastic perfectly plastic single degree of freedom structure, derived from a capacity curve obtained by a pushover analysis.

The seismic performance of shell structures which essentially comprises of analysis and design of the structure when subjected to earthquake loading is to be studied in the current project. The specific aims and objectives of the present problem are:

1) To study the existing methods and procedures given for the analysis and design of Masonry Building with and without opening subjected to seismic loading.
2) To use non linear seismic analysis on Masonry Building.
3) To explore Incremental Dynamic Analysis with reference to the Masonry Building under consideration using SAP 2000.
4) To determine drift ratio of Masonry building under consideration.
5) To perform fragility Analysis on Masonry Building. To execute performance assessment of representative sample frame from fragility curves in terms of various ground motion parameters.
6) To develop hazard survival curves and determine probabilities of surviving specified damage states.

The structural analysis program SAP2000 based on the finite element method is used for modeling and analysis.

II. METHODOLOGY

The seismic performance i.e. analysis of masonry structures is attempted in the current problem. For this, the proposed methodology is as follows:

1) An extensive survey of the literature on the response of Masonry structures to seismic loading is performed.
2) Based on the numerical and parametric study, a step-by-step procedure for the simplified seismic analysis of Masonry structure has been suggested.
3) Perform linear static and linear dynamic analysis (RSP) in SAP2000 for evaluating Base shear of masonry frame and compare with base shear from IS: 1893 which calculated manually.
4) A problem of a Masonry Building is taken and analyzed by the Pushover analysis.
5) Based on the numerical and parametric study, a step by step procedure for the simplified seismic analysis of masonry frame has been suggested.
6) A problem of a Masonry structure is taken and analyzed by Non-Linear Time History Analysis for 7 selected ground motions.
7) IDA Curves between PGA and Drift ratio for selected 7 Ground Motion has been plotted & with the help of these IDA curves Fragility and Hazard Survival Curves are obtained.

SAP2000 software is used to perform the Nonlinear Dynamic Analysis of Masonry Structure using displacement control strategy, where gravity load applied prior to the pushover analysis. Yielding and collapse can be determined analytically with reasonable accuracy from the IDA curves for a particular building against a particular ground motion. The yield capacity of the structure is defined as the IM point at which the IDA curve leaves the linear path. When the structure reaches its collapse capacity, practically, an increase in IM produces an infinite increase in EDP.It is clear from IDA curves that there exist variations in EDP-IM relationship with respect to different ground motions.

2.1 Parameter of Masonry Building Used

Table 1: Parameter of Masonry Building

Span in X direction	3.6 m
Wall Thickness	0.2 m
Live load	3kN/m^2

ISSN : 2455-9679
Impact Factor : 4.256

Grade of Concrete	M-20
Type of Steel	HYSD bars
Column Height	6.0 m
Column Size	0.2m X 0.2m
Column Longitudinal reinforcement	1 % reinforcement
Column transverse reinforcement	10d @ 150 centre to centre
Column Support condition	Fixed
Beam Size	0.20 m x 0.10m
Opening Size	1mx2m

III. RESULTS AND DISCUSSION

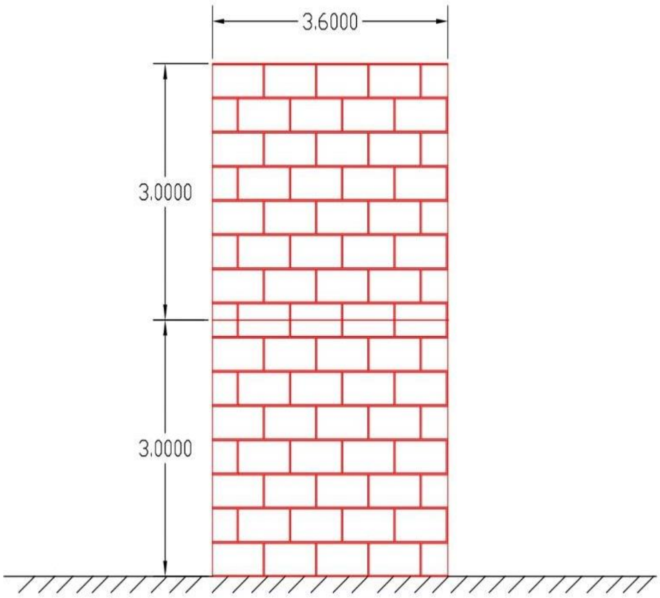
3.1 Comparison of Base Shear and Displacement from Different Analysis without Opening

Table 2 : caption

Analysis Case Results	LSP (Equivalent Static Load)	LDP (RSP)	IS: 1893
Base Shear	178kN	188kN	150kN
Displacement	4.2mm	4.8mm	6.5mm

3.2 Result from Nonlinear Time History

A modal time-history analysis uses the method of mode superposition, compared with a direct-integration time-history, which solves equations for the entire structure at each time step. Nonlinear modal time-history analysis is also called Fast Nonlinear Analysis (FNA). It is a highly efficient, special-purpose algorithm for analyzing structures with limited nonlinearities.



WITHOUT OPENING

ISSN : 2455-9679
Impact Factor : 4.256

Table 3: Selection of 7 Ground Motions for IDA

Record Id	Earthquake event	Station	Component	Magnitude	Range (Km)	PGA (g)
P1540	Duzce, Turkey 1999/11/12	Duzce	DUZCE/DZC270	7.1	8.2	0.535
P0178	Imperial Valley 1979/10/15 23:16	942 El Centro Array #6	IMPVALL/H-E06-UP	6.5	1	1.655
P0454	Morgan Hill 1984/04/24 21:15	57191 Halls Valley	MORGAN/HVR240	6.2	3.4	0.312
P0052	San Fernando 1971/02/09 14:00	135 LA - Hollywood Stor Lot	SFERN/PEL180	6.6	24.6	0.174
P0266	Victoria, Mexico 1980/06/09 03:28	6604 Cerro Prieto	VICT/CPE045	6.4	34.8	0.621
P1040	Kobe 1995/01/16 20:46	0 HIK	90	6.9	94.2	0.148
P0141	Tabas, Iran 1978/09/16	71 Ferdows	FER-T1	7.7	94.4	0.108

3.3 IDA Curve For 7 Time Histories Without Opening

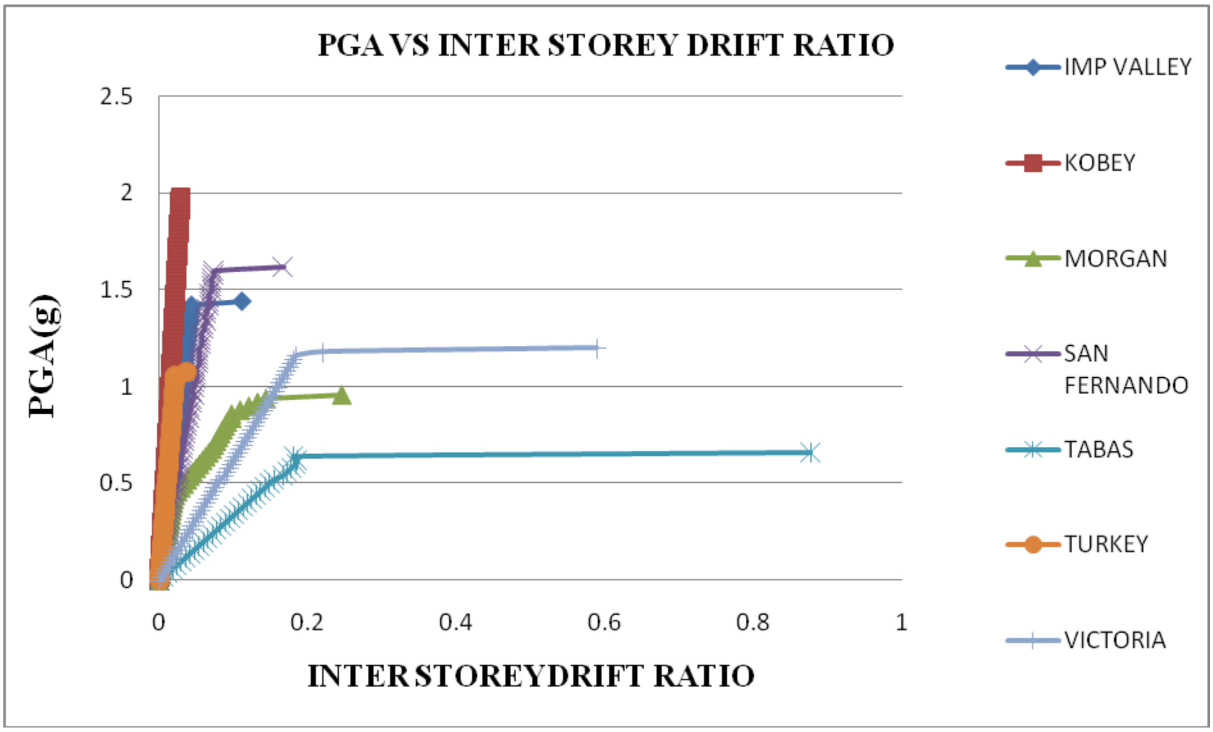


Fig 1: **IDA Curve for 7 Time Histories Without opening**

3.4Fragility Curve of Masonry Building for Without Opening From (SAP-2000)

ISSN : 2455-9679
Impact Factor : 4.256

Table 4: Yield Values of masonry building frame w.r.t PGA for generation of Fragility Curves

Yield Values				
Eqk	**PGA**	**ISD (DRIFT)**	**LN(PGA)**	**LN(DRIFT)**
Imp Valley	0.42	0.0133	-8.67500568	-4.31999
Morgan	0.46	0.01966	-0.776528789	-3.92916
San Fernando	0.48	0.2307	-0.733969175	-3.76922
Tabas	0.64	0.1806	-0.446287103	-1.711470
Turkey	0.46	0.0090	-0.776528789	-4.71053
Victoria	1.12	0.1775	-0.113328685	-1.72878
Kobey	0.46	0.01966	-0.776528789	-3.92916
MED			-.776528789	-3.92916
STDV			0.345174254	1.21734
BCD			0.373021803	1.2255

Table 5:Collapse values of Masonry frame w.r.t PGA for generation of Fragility Curves Without opening: -

Collapse Values				
Eqk	**PGA**	**ISD (DRIFT)**	**LN(PGA)**	**LN(DRIFT)**
Imp Valley	1.42	0.0428	0.3506568	-3.151217176
Morgan	0.96	0.246	-0.040821995	-1.402423743
San Fernando	1.62	0.1666	0.482426149	-1.792159549
Tabas	0.66	0.8761	-415515444	-0.132275039
Turkey	1.08	0.0365	0.076961041	-3.310443018
Victoria	1.2	0.5884	0.182321557	-0.53034829
Kobey	.96	0.246	-0.040821995	-1.402423743
MED			0.076961041	-1.402423743
STDV			0.294458622	1.204604976
BCD			0.32665866	1.212878043

ISSN : 2455-9679
Impact Factor : 4.256

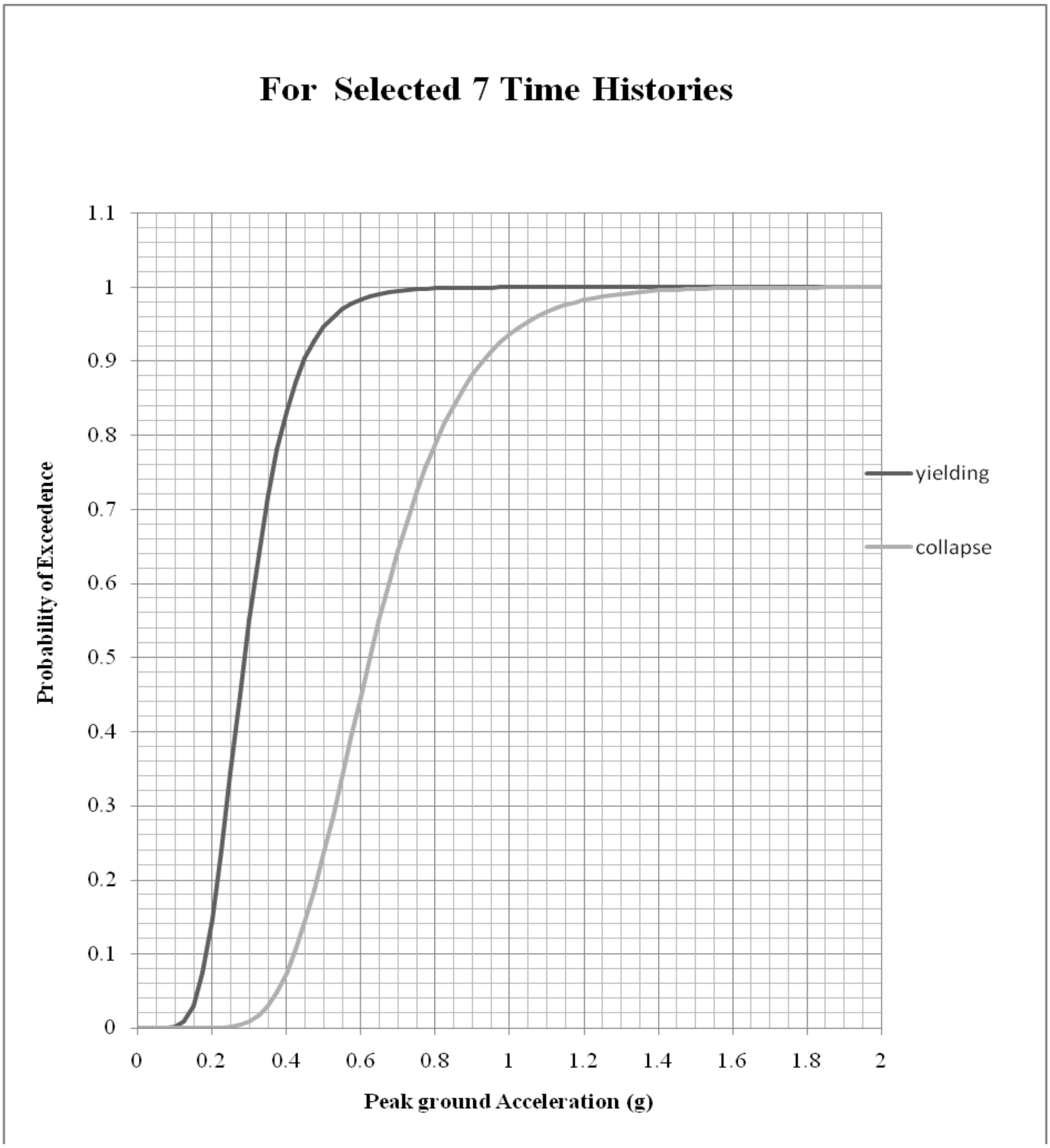


Fig 2: Fragility Curve for Selected Ground Motion for without opening model

3.5 Performance Assessment of Masonry frame without opening for fragility curves:-
Selected Ground Motion:

Table 6: Performance Assessment of Masonry frame without opening

Ground Motion Idicies	Damage State	Capacity with 5% Probability of exceeding damage state
PGA	Yield	0.4 g
	Collapse	1.08 g

ISSN : 2455-9679
Impact Factor : 4.256

3.6 Probability of Surviving at different Damage States:

Table 7: Probability of surviving at different Damage States

Return Period	Probability of Survival	
	Yield	Collapse
50	0.63453	0.9153
100	0.5123	0.8923
475	0.2354	0.6123
1000	0.1234	0.4123
2500	0.0923	0.3012

The fourth row means that if a ground motion of return period of 475 years i.e. DBE with annual frequency of 0.002 occurs, the probability of surviving against yielding is 22% and probability of surviving against collapse is 60% for Masonry Structure.

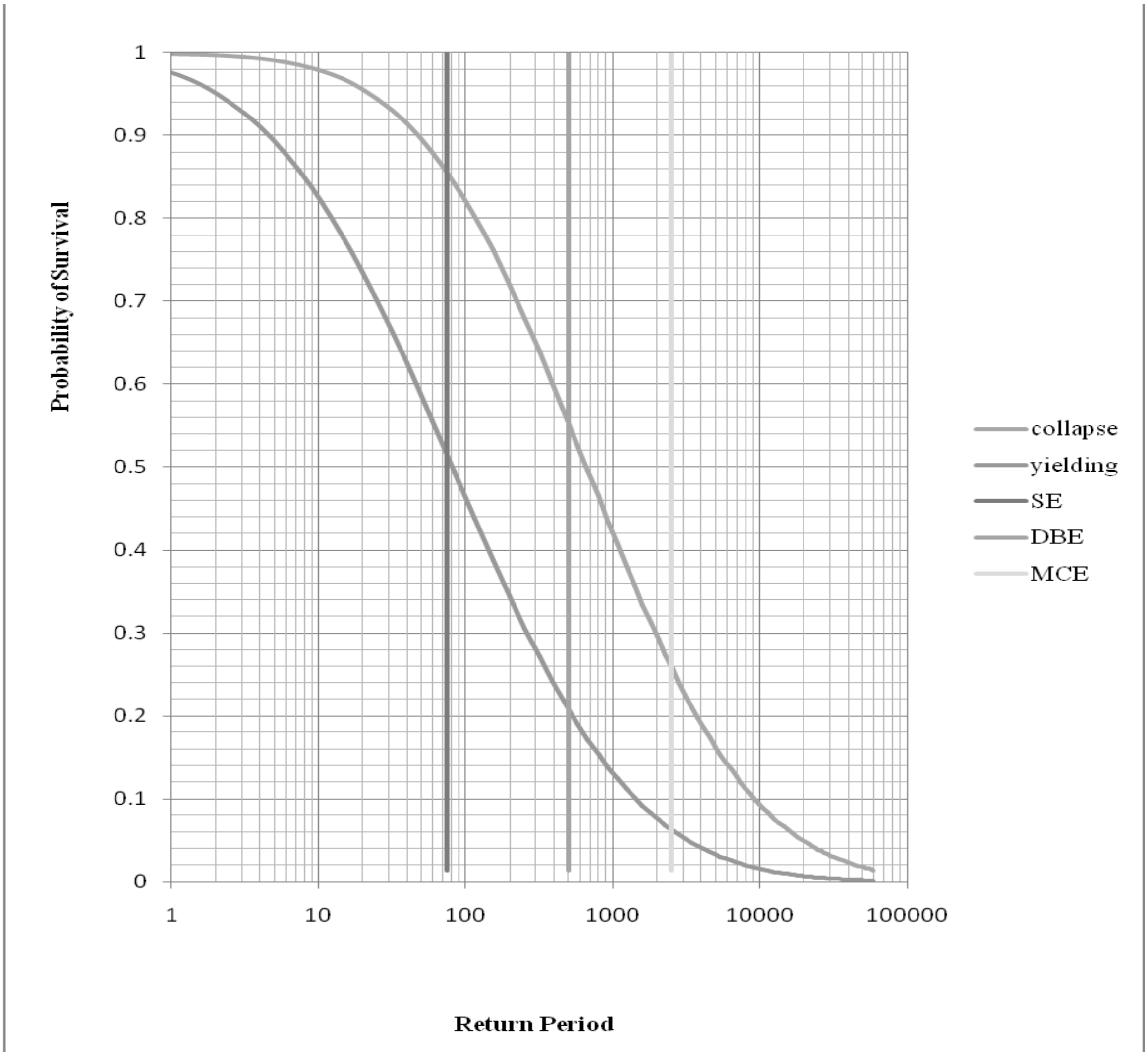


Fig 3: Hazard Survival Curve

 ISSN : 2455-9679
Impact Factor : 4.256

IV. Conclusion

From the basis of Fragility Analysis of Masonry Building conclusions are –

1) Masonry infill frame with opening gives lesser value of PGA (g) as compare to without opening.
2) From the results obtained it can be concluded that .72g (2MCE) is most vulnerable earthquake for masonry infill frames which gives almost more than 90% damage.
3) Therefore, looking at recent earthquake scenario it is very much essential to have seismic evaluation of existing masonry frames based on IDA.
4) The effect of infill masonry material should be incorporated in Indian seismic code in terms of improved seismic design coefficient as it is significant when compare with bare frame.
5) Infill masonry material improves significantly lateral resistance capacity of the building as compare to bare frame.
6) Nonlinear seismic analysis methods must be incorporated in Indian seismic codes for realistic performance-based earthquake design of structures.

REFERENCES

[1] IS:13920, (1993) Indian standard code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces", Indian Standards Institution, New Delhi.
[2] A.Melani, R.K.Khare, R.P.Dhakal and S.R.Uma, Seismic evaluation of low rise rc frame structures designed as per IS 1893 (Part1): 2002 for zone-V. ICSSD-2012 (accepted 2011).
[3] IS:1893, (2002) Indian standard criteria for earthquake resistant design of structures, Part 1- General provisions and buildings, Indian Standards Institution, New Delhi.
[4] A. M. Reinhorn, S. K. Kunnath., and Valles-Mattox R., (2004), IDARC 2D Version 6.0: user's manual. Departament of Civil Engineering, State University of New York at Buffalo.
[5] A. M. Reinhorn, and A. Madan, R. E. Valles, Y. Reichman, J. B. Mander, Modelling of masonry infill panels for modeling of frame structures, (1995) Tech. Rep. NCEER-95-018, National Center. For Earthquake Engrg. Res., State University of New York at Buffalo, N.Y.
[6] A. Saneinejad and B. Hobbs, Inelastic design of infilled frames. American Society of Civil Engineers, 121(4), (1995), 634-649.
[7] M. M. Maniyar, R. K. Khare, R. P. Dhakal, Probabilistic seismic performance evaluation of non-seismic RC frame buildings, Structural Engineering and Mechanics, 33(6), (2009) 22p.
[8] IS:456, (2000) Indian standard code of practice for plain and reinforced concrete for general building construction, Indian Standards Institution, New Delhi.
[9] ACI 318-08, American concrete institute standard building code requirements for structural concrete and commentary, reported by ACI committee 318.
[10] G.V. Mulgund and A.B. Kulkarni, Seismic assessment of RC frame buildings with brick masonry infills, International Journal of Advanced Engineering Sciences and Technologies, 2(2), (2011), 140-147.
[11] M. Ghalehnovi and H. Shahraki , Masonry infilling effect on seismic vulnerability and performance level of high ductility RC frames". AIP Conference 1020 (2008), 1721-1737.
[12] J. K. Bothara, J. B. Mander, R. P. Dhakal, R. K. Khare, M. M. Maniyar, Seismic performance and financial risk of masonary house, ISET Journal of Earthquake Technology 44(3-4), (2007), 421-444.
[13] Anil K. Chopra and Rakesh K. Goel (2001) "A modal pushover analysis procedure for estimating seismic demands for buildings" Earthquake Engineering and Structural Dynamics.
[14] Erol Kalkan and Sashi K. Kunnath (2004) "Method of modal combinations for pushover analysis of buildings" 13th World Conference on Earthquake Engineering.
[15] Goutam Mondal and Sudhir k Jain (2006) "Lateral stiffness of unreinforced brick infilled RC frames with central openings" Proceedings of the 8th U.S. National conference on Earthquake Engineering San Francisco, California, USA.
[16] Ashraf Habibullah, S.E., and Stephen Pyle, S.E.(1998) "Practical Three Dimensional Nonlinear Static Pushover Analysis" Structure Magazine, Winter.

ISSN : 2455-9679
Impact Factor : 4.256

[17] A. Kadid* and A. Boumrkik (2008) "Pushover analysis of reinforced concrete frame structures" Asian journal of civil engineering (building and housing) Vol. 9, no. 1 pages 75-83.
[18] Paulay, T., and Priestley, M. J. N. (1992). "Seismic Design of Masonry and Reinforced Concrete Buildings." John Wiley & Sons, USA.
[19] TomazevicMiha(1999) "Earthquake – Resistant Design Of Masonry Buildings." Imperial College Press, London.
[20] Agarwal Pankaj , Shrikhande Manish (2006) "Earthquake Resistant Design Of Structures." Prentice Hall of India pvt. Ltd., New Delhi.