American Journal of Psychiatric Rehabilitation

Expert Opinion Article

"Evaluation Of Response Reduction Factor For High Rise Irregular RC Building Structure"

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ABSTRACT-The prime purpose of evaluation of response reduction factor for high rise irregular RC building structure by considering various factors into account. As we are aware about that there is significant difference in The forces that are produced during earthquake than the structure is actually to be made in order to with stand against these forces. We cannot de sign the structures for real values of seismic forces as it is uneconomical from various aspects. Is a necessity to minimum the actual severity of earthquake and to achieve this, The response reduction factor is applied. It is the amount that should be subtracted from the actual base shear force in order to achieve the design lateral force during the shaking of the design basic earthquake (DBE). The main factors influencing the response reduction factor (R) include over strength (Rs), ductility (Rμ),Redundancy (RR).There is no explanation given in (IS: 1893-2000) code for various Response reduction factor values Used in, so it is difficult to precede the execution of seismic design without firm basis. Also Regarding various factors like over-strength and ductility, IS code does not separate the component explicitly of the response reduction factor (R). In the current work, an attempt has been made to assess the actual value of the response reduction factor for RC buildings with irregular plans, building height variations, and the impact of different seismic zones. Additionally, non-linear static pushover analysis using SAP2000 is used to compare in terms of important factor, type of foundation soil, and lateral load resisting system. The results are compared with values provided in IS code 1893(2000). IS 456:2000 requirements were followed in the design of the frames? The lateral loads operating on the frames were extracted from IS 1893:2002 (Part 1) requirements.

Keywords: *Vertical irregularity, Plan irregularity, over strength factor,* Pushover analysis, zone factor, ductility factor, and design basis shear response reduction factor

INTRODUCTION

An earthquake the result is a sudden release of stored energy in the Earth's crust that creates seismic waves. The destructive

Effect of an earthquake cans cause verse effect on infrastructure as well as social and economic life of society. The community related seismology and earthquake has been reviewing its processes in recent years as a result of earthquakes that have resulted in dangerous damage, fatalities, and property loss. In order for the structure to survive the applied activities, these studies first evaluate the seismic force demands on the structure before creating design methods. In the majority of structures, elastic force is a crucial component in seismic design. Now a day's many existing Structures are created and to be constructed containing irregularities in their plan as well as in elevation, but some of them are designed and purposefully constructed to be irregular of fulfill various needs and functions such as basements for mercantile purposes created by eliminating central columns. Also, by adjusting the sizes of structural members in the upper story's to fulfill necessary requirements and for other functions like storing heavy machines and equipments etc. This difference in usage of a particular floor with respect to adjacent floors results in uneven distributions of mass, stiffness and strength along the building dimensions. The design process typically does not account for the nonlinear response of a structure; however, its impact is taken into account through the use of a reduction factor known as the Response Reduction factor (R). There are differences in how different codes provide the response reduction factor (R). The current study uses a logical method to calculate the response reduction factor (R factor) for structures with irregularities, which ranges from 3 to 5 in IS code. R, the response reduction factor Symbolizes the greatest lateral force ratio.

If structure remains elastic to the lateral force which has been designed to widths and. commonly, The factor that reduces responses is expressed as a function of various parameters of the structural system, such as strength, ductility, damping and redundancy.

Objectives

1.To analyze the effect of various irregularities of structure on Response Reduction Factor.
2.To compare the computed Response Reduction Factor values with those values specified inIS1893.
3.To analyze the result of seismic zone factor and height of structure on Response Reduction Factor
4.To Analysis various irregularities of structure on Response Reduction Factor By using software

LITERATURE REVIEW

General In The current research literature review is discussed about the various methods of estimating factor for response reduction and also effect of the various elements such the redundancy factor, ductility factor, over strength factor, seismic zone factor, and importance factor of the building.

Over view of papers studied

1.Bholebhavi Rahul D. et.al [2016] [8] Evaluated that the The nonlinear static (pushover) analysis of structures with horizontal irregularities yielded a value of "R" in this work that is less than that prescribed in IS 1893. Additionally, the response reduction factor continues to decline as the proportion of horizontal abnormalities rises.

2.Jisha P. et.al [2019] [15] Evaluated The value of the response reduction factor keeps rising as the number of stories rises. The T-shaped and L-shaped plan irregularity performance points are nearly identical. The same base area could be the cause.

3.Keerthi S. et.al [2017] [11] Calculated that the ductility factor increases with number of bays in x directions. In y direction it looks like there is no definite trend for ductility factor. It is found out that value of 'R' obtained is critical in the direction with less number of bays. 'R' values must be taken as the least from both directions during design purposes considering Redundancy and ductility.

4.Ruhullah Amiriet.al [2018] [13] When the number of bays increases additionally, redundancy factories are growing and Response reduction factor shows an increasing trend for all frames. Hence higher redundancy is seen in frames with more bays. With the quantity of bays in x directions ductility factor is increasing but in y direction it looks like there is no flow for that.

5.Prashant R. Barbude et.al [2017] [12] the majority of seismic design algorithms always employ the response reduction factor to account for the structure's non-linear response. This factor allows the designer to apply a linear elastic force-based design by accounting for the structure's non-linear behavior.

6.Kunal P Shukla, Sejal [2016] [9] The method of plastic design based on performance uses pre-selected target drift and yield mechanism as performance criteria due to which total collapse of structure can be prevented. A fifteen storied reinforced cement concrete The force-based limit state design method and the displacement-based performance-based plastic design method were utilized to design the frame. The frame's comparative seismic performance assessment was then completed by assessing the response decrease factor as well as
Failure pattern.

7.Jagat Kumar Shrestha et.al [2020] [17] The majority of seismic codes in use today include then on a structure's linear reaction by to enable the employment of a linear elastic force-based technique in designs by offering a suitable response reduction factor. The response reduction factor, which is utilized in contemporary regulations to reduce the elastic response of the structure, is evaluated in this study for masonry buildings with various mechanical characteristics. In the finite element analysis program SAP2000 v 20.0.0, a on linear static pushover study is performed on the analytical models of brick buildings using a similar frame-approach.

METHODOLOGY

1.Analysis of the necessity of the seismic design response reduction factor for **buildings:** We have to analyze the necessity of the component that reduces responses by considering various design aspects and consideration taking into account so that the design should safe against seismic forces.

2.Modeling of stiff low-, mid-, and high-rise reinforced concrete structures and structural irregularities: The response reduction factor is computed for buildings with different rises so that one can able to figure out that response reduction factor for specific height of structure, also consideration of different irregularities of buildings are taken in to account.

3.Variation in Response reduction factor values
From code provisions are to be determined:
We have to compare the various response reduction factor values which we are going to calculate from the code for seismic design provisions. The location and seismic zone and importance factor are also to be considered.

4.Analysis is to be done by using software:
The analysis of the response decrease factor as well as various aspects related with seismic layout of building such as effect of height of building as well as irregularities on It is necessary to implement the response reduction factor. By using software's such asSAP2000.

RESULTS AND DISCUSSION

Estimation of Performance point:-

It is noticed that the capacity curve is supposed to be intersected by the demand curve within the structural performance level, it means significant damage is takes place to the building, so it may be possible to lose considerable quantity of its actual stiffness.
However, a significant margin rests for supplementary horizontal deformation before actual There would be collapse. For instance, in a three- story symmetrical building, the normal building frames the non Push-over analysis of linear static is conducted to evaluate the structural frame's point of performance in terms of displacement and base shear. For this, the various load combinations are also employed. The demand and capacity curves are obtained to determine the buildings' performance point after the nonlinear pushover analysis. Using the ATC 40 capacity spectrum approach, the performance point is determined. The figure below displays the capacity and demand curves for symmetrical buildings.

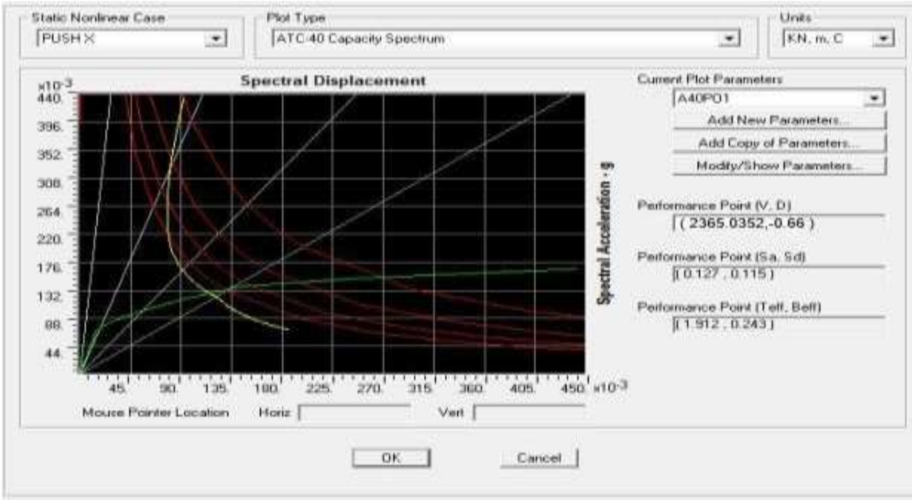

Figure 4.1 Spectrum of ATC 40 Capacity (Graph of Demand curve VS Capacity curve

Performance point=2365.0352KN.
The table that follows lists all of the buildings' performance points. The table displays the base shear as well as the performance points of each building and their labels. Values of different type of buildings based on which the comparison between the code response reduction factor values and Estimated values are also specifies.

Type	VB (KN)	Performance point	Rs	Ru	Rr	R	R (IS
SYM3	730.4	2365.0352	3.238	1.23	1	3.98274	5
LI3	398.67	1138.60152	2.856	1.248	1	3.564288	5
TI3	398.67	1187.23926	2.978	1.178	1	3.508084	5
SI3	486.928	1337.591216	2.747	1.07	1	2.93929	5
SYM7	852.968	3127.833656	3.667	1.196	1	4.385732	5
LI7	473.871	1095.589752	2.312	1.334	1	3.084208	5
TI7	473.871	1413.083322	2.982	1.187	1	3.539634	5
SI7	568.645	1376.1209	2.42	1.256	1	3.03952	5
SYM11	970.859	3198.009546	3.294	1.429	1	4.707126	5
LI11	539.366	1360.281052	2.522	1.512	1	3.813264	5
TI11	539.366	1337.62768	2.48	1.441	1	3.57368	5
SI11	647.239	1746.250822	2.698	1.422	1	3.836556	5

Table 4.1 Estimated response reduction factor values

Comparative results of response reduction factor determined by seismic zone:-
As location the construction changes it may influence the seismic behavior of the construction in different ways in other words we can say that as the seismic zone the construction where the

construction is actually to be located changes, the zone factor of the respective seismic zone also changes which may turn to affect on the base shear value. We know that the base shear is a projection of the highest expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations. The table below shows results based on seismic zone II, zone III and zone IV.

Type	VB(KN)	Performance point	Rs	Ru	Rr	R	R (IS Code)
SYM3	202.886	657.959298	3.243	1.13	1	3.66459	5
LI3	110.739	345.50568	3.12	1.228	1	3.83136	5
TI3	110.739	284.267013	2.567	1.148	1	2.946916	5
SI3	135.257	411.18128	3.04	1.02	1	3.1008	5
SYM7	236.935	276.26621	1.166	1.196	1	1.394536	5
LI7	131.63	178.22702	1.354	1.334	1	1.806236	5
TI7	131.63	151.24287	1.149	1.187	1	1.363863	5
SI7	157.957	229.827435	1.455	1.256	1	1.82748	5
SYM11	269.683	1024.256034	3.798	1.429	1	5.427342	5
LI11	14.823	40.689135	2.745	1.625	1	4.460625	5
TI11	149.823	446.47254	2.98	1.121	1	3.34058	5
SI11	179.788	547.45446	3.045	1.42	1	4.3239	5

Table 4.2 Results based on seismic zone II

Type	VB(KN)	Performance point	Rs	Ru	Rr	R	R (IS Code)
SYM3	324.619	1025.471421	3.159	1.23	1	3.88557	5
LI3	177.183	503.731269	2.843	1.248	1	3.548064	5
TI3	177.183	504.262818	2.846	1.178	1	3.352588	5
SI3	216.412	555.09678	2.565	1.07	1	2.74455	5
SYM7	379.096	1426.917344	3.764	1.196	1	4.501744	5
LI7	210.609	531.787725	2.525	1.334	1	3.36835	5
TI7	210.609	586.546065	2.785	1.187	1	3.305795	5
SI7	252.731	639.40943	2.53	1.256	1	3.17768	5
SYM11	431.492	1373.439036	3.183	1.429	1	4.548507	5
LI11	239.718	634.533546	2.647	1.512	1	4.002264	5
TI11	239.718	630.45834	2.63	1.441	1	3.78983	5
SI11	287.661	858.380424	2.984	1.422	1	4.243248	5

Table 4.3 Results based on seismic zone III

Type	VB(KN)	Performance point	Rs	Ru	Rr	R	R(IS Code)
SYM3	486.928	1535.770912	3.154	1.13	1	3.56402	5
L3	265.775	805.29825	3.03	1.228	1	3.72084	5

T3	265.775	652.7434	2.456	1.148	1	2.819488	5
S3	324.619	972.233905	2.995	1.02	1	3.0549	5
SYM7	568.645	2018.121105	3.549	1.166	1	4.138134	5
L7	315.914	900.670814	2.851	1.354	1	3.860254	5
T7	315.914	966.69684	3.06	1.149	1	3.51594	5
S7	379.096	1006.120784	2.654	1.455	1	3.86157	5
SYM11	647.239	2386.370193	3.687	1.429	1	5.268723	5
L11	359.577	947.125818	2.634	1.625	1	4.28025	5
T11	359.577	1031.98599	2.87	1.121	1	3.21727	5
S11	431.492	1273.764384	2.952	1.42	1	4.19184	5

Table 4.4 Results based on seismic zone

Discussion on other elements that could fluency the importance of response reduction Factor:-

As we analyze how seismic zone may affect the importance of response reduction Factor Similarly, there are a few other factors which may influence the R-factor. Some of these factors are discussed in the introductory part also such as importance factor which based on the functionality structure, (Sa/g) factor which based on the type of foundation soil of the site on which structure is to be constructed and various types of systems that resist lateral loads, like OMRF, steel frames etc.

1) Based on use of building:-

EFFECT OF IMPORTANCE FACTOR ON R- FACTOR		
SR.NO	Type of structure	I-factor
1.	Important buildings	1.5
2.	Residential or commercial	1.2
3.	All other buildings	1

Table 4.5 I-factor based on use of building

2) Based on type of foundation soil of building:-

EFFECT OF SOIL TYPE ON R-FACTOR					
Type of soil	Conditions	[Sa/g] (code formula)	Number of storey's (m)	Ta' calculated(s)	Sa/g (calculated value)
	0.0<T<0.10s	1+15T	3	0.2333	2.5
Rocky & Hard	0.10s<T<0.40s	2.5	7	0.4879	2.0496
	0.4<T<4.0s	1/T	11	0.74246	1.3468
	0.0<T<0.10s	1+15T	3	0.2333	2.5
Medium stiff	0.10s<T<0.55s	2.5	7	0.4879	2.5
	0.55<T<4.0s	1.36/T	11	0.74246	1.8317[2.5]
	0.0<T<0.10s	1+15T	3	0.2333	2.5
Soft	0.10s<T<0.67s	2.5	7	0.4879	2.5
	0.67<T<4.0s	1.67/T	11	0.74246	2.2492

Table 4.6 [Sa/g]-factor based on soil type

[NOTE: As calculated value of design base shear for medium stiff soil and 11-storey building is less as comparison with 3-storey and 7-storey which cannot be done. in actual seismic behavior so value of Sa/g is interpreted as 2.5 because ultimate shear base is depends on many other elements like wind pressure and many more which we are not considered in the analysis.]

3) Based on lateral load resisting frame types:-

EFFECT OF LATERAL LOAD RESISTINGSYSTEMONR-FACTOR		
SR.NO.	Lateral load resisting system	R

1	Ordinary RC moment-resisting frame(OMRF)	3
2	Special RC moment-resisting frame(SMRF)	5
3	Steel frame with	
	i) Concentric braces	4
	i) Eccentric braces	5
4	Design of a steel moment-resistant frame as per SP6 (6)Building with Shear Walls	5
5	structures with load-bearing masonry walls that	
6	i) Unreinforced	1.5
	ii) RC bands arranged horizontally for reinforcement	2.5
	iii) reinforced at room corners and doorway jambs with vertical bars and horizontal RC bands	3
7	Standard shear walls made of reinforced concrete	3
8	Shear walls that are ductile	4
9	OMRF on a typical shear wall	3
10	SMRF on a typical shear wall	4
11	Shear wall ductility using OMRF	4.5
12	Shear wall ductility using OMRF	5

Table 4.7 R-factor based on mechanism that resists lateral loads

[NOTE: - Only highlighted conditions must be taken into consideration in this analysis.]

CONCLUSION

The key findings from the current study are as follows: study:-

1. A persistent Response reduction factor value For any of above case of construction is not justified. Precise methodology is essential to estimate for a given building type, the "R" number accounts for strength, ductility, and redundancy; current work makes attempts in the same direction.
2. On behalf of results obtained we can conclude that the Response reduction factor value is overestimated in IS-1893 (2000), which may results in the design base shear being underestimated, which could be dangerous.
3. As number of storey that is The response reduction factor value continues to rise as building height increases.
4. The performance point of T-shaped and L-shaped plan irregularity is almost alike might be due to the same base area.
5. From the obtained results we can conclude that seismic zone may cause considerable effect on values of response reduction factor.
6. There is a necessity to estimate the accurate Response reduction factor value as, many factors causes substantial effect on R-factor. Also It is necessary to specify concern values ductility and over strength factors.
7. The obtained results are based on only few considerations and methodology such as we performed our analysis by considering specific seismic zone specific soil type etc and only The analysis of nonlinear static pushover is conducted
8. If we changes our above specifications and will adopted other modes of analysis such as nonlinear dynamic temporal history analysis, pushover analysis, etc. then there may be a possibility to obtain different types of results based

REFERENCES

1. Denis Mitchell ‘‘*Ductility and over strength in seismic design of reinforced concrete structures’’.* Department of Civil Engineering and Applied Mechanics, Mc Gill University, 817 Sherbrook Street West, Montreal QCH3A2K6, Canada .May,1994.
2. Chi-Chang Lin , Jin-Min Ueng, Teng-Ching Huang "Using passive tuned mass to reduce seismic response in irregular buildings dampers’’ Engineering Structures 513–524 Department of Civil Engineering, National Chung-Hsing University, Taichung, Taiwan, ROC, 40227, volume2(1999)
3. S.Chan-Esquivel ‘‘Over strength f elements for the seismic design of AAC structures’’ .Av. Industries No Contaminants s/n por Anillo Periférico Norte, Merida, Yucatan, Mexico.C.P.93710. |2012|
4. Vijay Namdev Khose ‘‘A Comparative Study of Design Shear Base for RC Buildings in Selected Seismic Design Codes’’. Article in Earthquake Spectra·August2012
5. Kruti Tamboli, J. A. Amin's "analysis of the RC Braced Frame's Response Reduction Factor and Ductility Factor." 2015 Sardar Vallabhbhai Patel Institute of Technology, Vasad, India, Department of Civil Engineering.
6. Tia Toby, Ajesh K. Kottuppillil "Nonlinear Analysis for Response Reduction Factor

Evaluation." International JIRST Journal for Innovative Research in Science & Technology|Volume2 | Issue 06 | November 2015.

7. Bholebhavi Rahul D. and Inamdar V.M. ''An Assessment of the Seismic Response Reduction Factor for Non-Linear Static Structures Analysis' 'International Innovative Research in Science, Engineering, and Technology Journal Technology, Vol.5, Issue5,May2016
8. N. U. Mate ''Elastic and in elastic Response of Structural Systems in Seismic Pounding''. Civil Engineering Department, Amrutvahini College of Engineering, Sangamner, India, published 29 February2016.
9. Keerthi S. and Vivek Philip "Reaction Reduction Factor Evaluation" Redundancy-based for high-rise Buildings''. Engineering and Technology Research Journal (IRJET), Volume: 04 Issue: 05 |May-2017
10. Prashant R. Barbude, Amol S. Jadhav, Dr. T.N.Boob ''Evaluation of Response Reduction Factor for Reinforced Concrete Frames With Shear Wall''. © 2017 IJCRT .ISSN:2320-2882 IJCRT 1704080, | Volume 5, Issue 4 October2017|
11. Ruhullah Amiri and T. N. Patel ''Assessment of Seismic Response Reduction Factor According to Redundancy of RC Buildings'', Online ISSN: 2394- 4099 Themed Section: Engineering and Technology .IJSRSET. Print ISSN: 2395- 1990|Volume4|Issue4|2018
12. Jagat Kumar Shrestha ''Response Reduction Factor for Masonry Buildings''. Nepal Journal of Science and Technology (NJST) (2020),.Department of Civil Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University, Nepal, 19(1):196-203,2020
13. 13.IS 13920: 1993, Ductile Detailing Of. Reinforced Concrete Structures Subjected To Seismic Forces.- CodeOf Practice.UDC69.059.25(026).
14. ATC40 (1996) "Seismic Evaluation and Retrofit of existing concrete buildings", Applied Technical Council, Redwood City (CA),1996
15. Jisha P. Sharjuban "Seismic Response Reduction Factor'. Evaluation for Irregular RC Structures" ,International Journal of Engineering Research &Technology