STUDY THE EFFECT OF RESPONSE REDUCTION FACTOR ON RC FRAMED STRUCTURE

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Abstract: *An important consideration in the design of structures is seismic analysis. In seismic design, the strength and ductility of frame members depend on the reduction factor (R). In this plan, different heights of our frame structure in the fourth area conditions were considered. The primary purpose of this study is to calculate the response reduction coefficient values obtained from the RC frame design. The results were interpreted using nonlinear analysis. ETABS software was used to analyze the nonlinear behavior of the samples. Therefore, this study attempted to evaluate the adequacy of the rule-based "R" factor in the seismic evaluation of structural design using nonlinear dynamic analysis (NLD). The results clearly show the effect of structural changes on ductility and strength values. It is distinctly seen that the 'R' value written by the code for a particular type of model indicates that importance should be given to the error and adequate prediction. In this we studied the different response reduction coefficients are used to define models with different processes to obtain the most economical and stable models. And examining the influence of behavior factor on changes in displacement and drift of structure.*

Key Words: **dynamic analysis1, extreme strength 2, impact ductility3, seismic response analysis 4.**

1. INTRODUCTION

While there are many natural disasters in the world, earthquakes are one of the worst and can have a significant impact on trade and business. Therefore, in recent years, earthquake engineering has been established as a branch of engineering related to earthquake prediction. years. Most seismic design rules for buildings consider and assume the nonlinear response of earthquake-exposed objects in terms of seismic intensity. Measure the seismic force required in the structure and then develop a design process to ensure the structure can withstand this force. Durability is a key factor in the seismic design of most structures. The reduced response factor provides an easy-to-understand view and plays a crucial role in seismic design. The negative response of the model is not included in the design process, but its impact is considered using a reduction called the reduction factor (R). In seismic design, the seismic coefficient method uses the R factor to reduce the base shear force to obtain the external design. We know that actual seismic forces are greater than the models were designed for. The structure cannot be built according to the importance of the earthquake intensity because the construction costs will be too high. The actual intensity of the earthquake is reduced by a factor called R factor. The method for determining the reduction factor (R) varies from code to code. The value of the reduced response reduction factor in the IS code varies from 3 to 5. IS 1893 2016 (Part I) depends on the type of moment resisting frame (OMRF), specific moment resisting frame (SMRF) and moment resisting frame with actual mean resistance (IMRF). Most previous work in this field has focused on finding the ductility and super strength components in response to the reduction coefficient.

Response reduction coefficient: -
Reaction reduction coefficient, R, represents the ratio of the maximum external force to the lateral force carried when the structure is elastic. Last build. In general, response reduction points are expressed as a function of various structural parameters such as strength, ductility, damping and redundancy.

$$R = R_s \times R_\mu \times R_r$$

Where "Rs" is the strength coefficient, "Rr" is the hardness coefficient and "Rμ" is the ductility coefficient.

1.1 Strength Factor (Rs):

The strength factor is calculated as the ratio of the maximum base shear force (Vo) obtained from the pushover curve to the base shear force (Vb) of the structure.

$$R_S = {}^{Vo}/_{Vb}$$

$$V_b = W \times A_h$$

Where, $A_h = {S_a}/{g} \times {I}/{R} \times {Z}/{2}$

Where, W = total weight of the building.
R = response reduction value.
I = important.

1.2 Coefficient of ductility (Rμ):

In seismic design, the term "ductility" is used to indicate structure's capacity to withstand significant cyclic deformations in the inelastic range without reducing strength.

Coefficient of ductility = maximum elasticity / yield strength

$$\mu = {\Delta m}/{\Delta y}$$

1.3 Redundancy factor (Rr)

The redundancy factor depends on the number of vertical lines involved in the earthquake. The fact that a part of a sample is removed does not mean that the entire sample is removed. Therefore, load distribution provides additional safety due to the repetition of the structure. The redundancy factor is assumed to be 1 in this study.

1.4 Damping coefficient (Rxi):

Since no damper was used in this research, the damping coefficient was assumed to be equal to 1.

Ferraioli [1] he studied the behavior factor for RC framed structure of 3,5,7 & 9 Storey height, For investigating he used the relationship between code prescribed value and calculated value of behavior factor. Thomas and Trezos [2] they attempted to study the behavior factor of various buildings considering the random character of their characteristic Elnashai, Broderick [3] they selected the response criteria and earthquake ground motions in a companion study and are applied to the evaluation of the actual behavior factor of a number of movement registering composite frame designed to the requirements of the structural eurocodes.. Toby, Kottuppill,[4] they studied Evaluation of response reduction points using nonlinear analysis. Parsaci and K Rama [5] this paper has studed the influence of location of laterial force registering system on the response reduction factor R, ductility and plastic hinge status at performance point of the RC building. Mondal, Ghosh, Reddy, [6] This paper carried out research work focusing estimation of actual R values for realistic RC movement registering frame building design and Performance-based analysis of response mitigation members of ductile RC frames. Ferraioli, Lavino, and Mandara [7] they investigated the behavior factor i.e. related to the non-linear dynamic response with simplified linear design response of movement registering frames. Han and Jee [8] they performed Seismic Performance of Normal and Medium Flexural Strength Concrete Columns in Frames. Sunagar and Shivananda [9] This paper carried out studies investigation lateral load carrying capacity of RC frame and analysis of response modification factor for individual frames. Anwaruddin, Akberuddin, Zameeruddin and Saleemuddin [10] this paper carried out another study on Pushback analysis of mid-rise multi-storey RCC frame with and without vertical irregularities using ETabs software. IS 13920 [11] Code of Practice for Ductility Detailing of Reinforced Concrete Structures Subject to Seismic Forces,1993. IS 456 [12] "Indian standard code of practice for general and reinforced concrete." Bureau of Indian Standards, New Delhi, 2000. IS 1893 (Part I) [13] "Standards for seismic design of structures."

2. ANALYSIS PROCEDURES

By reviewing the previous literature, the effect of the reduction coefficient on the reinforced concrete frame structure was examined.

1. For the standard model, the floor height for each floor of 5x4m length is 3m. Three models will be created with different response reduction coefficients R1 R2 R3 R4 R5 depending on the number of layers.
2. Define the properties of the frame structure and use E-tabs software to create the structure. Several types of loading are considered in the analysis. For static behavior, dead load of the building is taken into consideration as per IS 875 Part I and live load as per IS 875 Part III. 1893: 2016 for Seismic Loading, IS456: 2000 for Reinforced Concrete Structures
3. The three-dimensional reinforced concrete structures of floors G+4, G+8 and G+12 was analyzed using response spectrum analysis in E-tabs software. This evaluation includes the building's floor change, floor interactions, floor intersections, etc. focuses on learning how to analyze its structure.
4.Compare the analysis results of different responses in R1 R2 R3 R4 R5. Cover layer movement, displacement, and shear forces to shape the building symmetrically.

3. MODEL FEATURES

This research considers three RC frames with the same number of compartments but different floors. Four-storey, eight-storey, twelve-storey models are designed for R = 1,2,3,4,5. The height of each floor is 3m, the building's overall width in the X direction is 20m, the bay window width is 5m, the total width in the Y direction is 12m, the total width is 4m. M-25 quality concrete and Fe-500 quality steel bars are used in all models in this study. For example, the floor thickness is 150 mm, the wall thickness is 230 mm, and the height is 3 m, the parapet height is 1.2 m and the thickness is 230 mm. Dead load is distributed as per IS 875 (Part 1) 12 and live load is distributed as per IS 875 (Part 2) 3. Seismic loads are calculated as per IS 1893 2016. Assumed seismic load zone IV, intermediate ground conditions, OMRF, R = 1.3, SMRF, R = 5, damping 5%, critical factor 1.

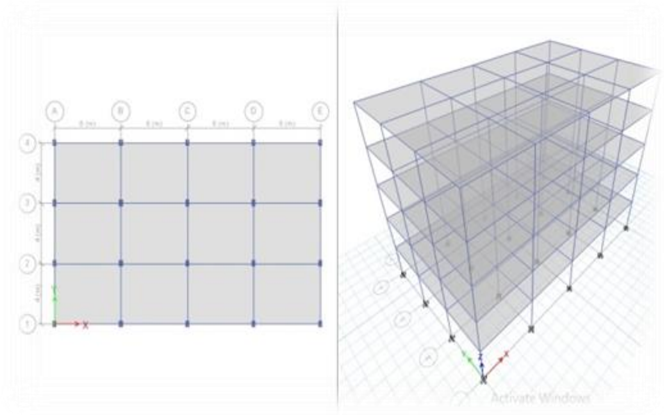

Fig.-1: G+4 STORY BUILDING MODEL.

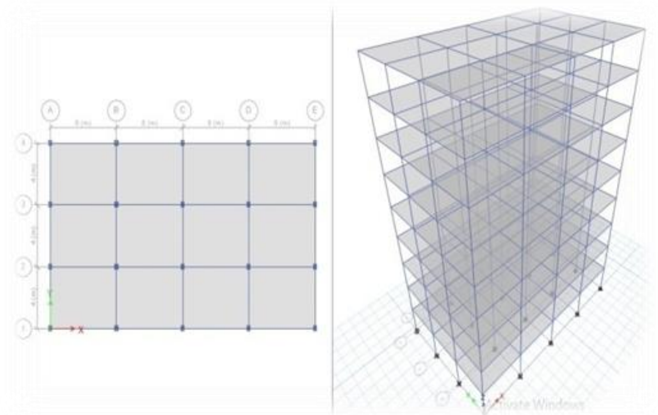

Fig.-2: G+8 STORY BUILDING MODEL.

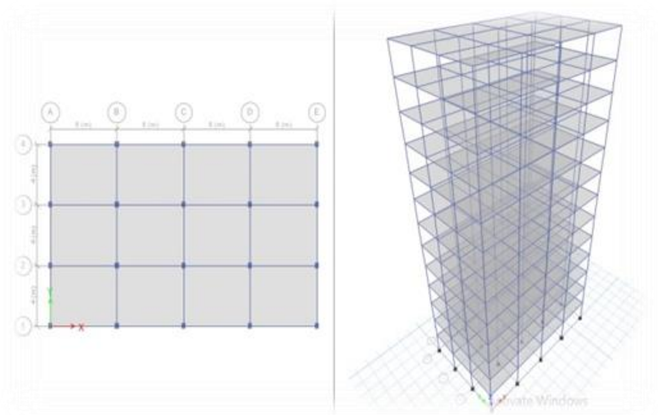

Fig.- 3: G+12 STORY BUILDING MODEL

4. RESULTS AND DISCUSSION

In this study, RCC G+4, G+8, G+ 12-storey buildings were analyzed from the response spectrum using reduced response (i.e., from 1 to 5) for magnitude III earthquakes. The effect of R on RCC samples at heights G+4, G+8 and G+12 was obtained through the design and analysis of each model in ETABS. Compare soft tissue and response (including displacement, compression, and basal shear) for R = 1 to R = 5.

4.1 Dynamic Analysis Method

Table-1 G+4 story building Displacement Results for different Response Reductions Factor.

TABLE: Story Response						
Story	**Elevation (m)**	**R=1**	**R=2**	**R=3**	**R=4**	**R=5**
Base	0	0	0	0	0	0
GF	3	12	3.85	2.27	2.23	1.6
1	6	28.01	10	6.2	4.81	4
2	9	44	15	10	7.25	6
3	12	55.75	18.75	12.35	9.4	7.5
4	15	61.03	21.6	13.75	10.7	8.2

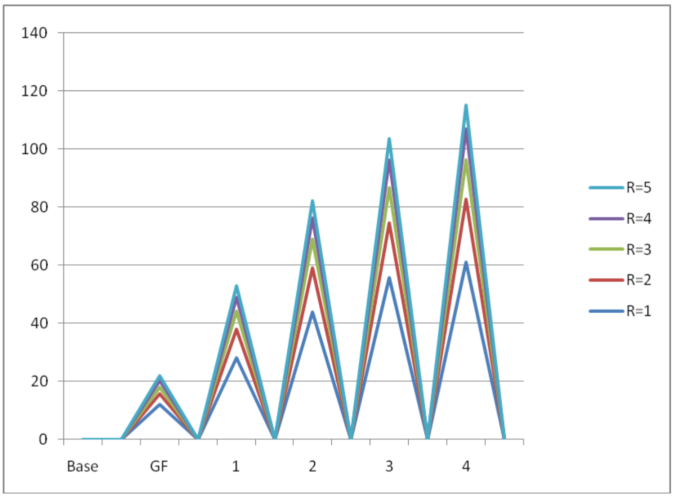

Fig.4 G+4 story building Displacement Results for different Response Reductions factor

Comparing the displacement result of G+4 story building for response reduction factor 1, 2, 3, 4 & 5. Results indicate variation of displacement is 2.5%, 3.05%, 7.85% and 38% displacement are increased as compared to 5 factor.

Table-2 G+4 story building Drift Results for different Response Reductions Factor

TABLE: Story Response						
Story	**Elevation (m)**	**R=1**	**R=2**	**R=3**	**R=4**	**R=5**
Base	0	0	0	0	0	0
GF	3	3.9	1.3	0.9	0.68	0.55
1	6	5.7	1.9	1.29	0.98	0.79
2	9	4.9	1.7	1.12	0.85	0.68
3	3	3.8	1.3	0.84	0.64	0.51
4	6	1.9	0.63	0.45	0.33	0.26

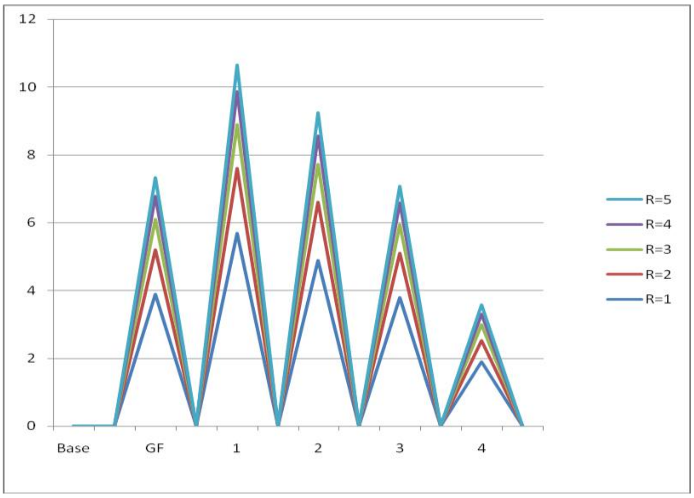

Fig.5 G+4 story building Drift Results for different Response Reductions.

The change in % difference for drift results shows 1.27%, 0.18%, 0.12%, 0.07% for the value of R=1to R=5.

Table-3 G+4 story Shear Results for different Response Reductions Factor.

TABLE: Story Response						
Story	**Elevation (m)**	**R=1**	**R=2**	**R=3**	**R=4**	**R=5**
Base	0	0	0	0	0	0
GF	3	1500	510	340	255	206.5
1	6	1390	478	310	238	187.5
2	9	1170	388	260	195	152
3	3	790	270	180	135	112
4	6	320	120	78	58	48

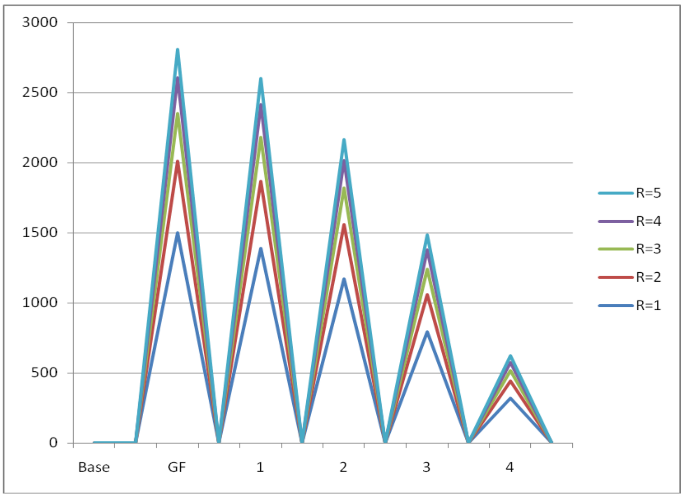

Fig.6 G+4 story shear Results for different Response Reductions.

Analysis of G+4 story building in response spectrum method, Story stiffness is 50%, 34%, 25%, 19.67% in different response reduction factor. i.e., 1, 2, 3, 4, 5. hence structure shows maximum stiffness in response factor 1, 2.

5. CONCLUSIONS

1. Comparing the displacement results for G+4, G+8, G+12 story building in different response reductions factor i.e., 1,2,3,4 & 5 results indicate that variations of displacement are increased as response Reductions factor decreases. So, for 3 to 5 response reduction factor performance is better.

2. Drift is decreased with proportional to response reductions factor, i.e., 1, 2, 3, 4 & 5 hence structure show linear behaviors in response reductions factor 3, 4 &5. And response reductions factor 1 & 2 show nonlinear behaviors. Hence structure shows satisfactory performance in Response reductions factor 3, 4 & 5.

3. The displacement is increased as compared to height, but percentage variations are same in all different height of structure.

4.Analysis of RCC building with different response reductions factor for different height structure G+5, G+7 and G+9 story, R factor is decreased with proportional to increased height of structure and response reductions factors 3 & 5 show satisfactory performance in pushover analysis.

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