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Effect of AAC Block and Clay Burned Brick on Response Reduction Factor

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ABSTRACT

This paper describes the actual value of response reduction factor (R) for light weight infill material with the help of over strength, redundancy, damping and ductility. The analysis carried out by static nonlinear (pushover) analysis and this analysis is carried out by ETABS. For calculation of Response reduction factor(R) procedure is using as per Applied Technology Council (ATC)-19 which is the product of Strength factor (Rs), Ductility factor (Rμ) and Redundancy factor (R_R). after evaluating R value find out the shear forces and displacement for clay brick and light weight infill material. The study conclude that the the response reduction factor is decreases when we use clay burned bricks and increases when we use light weight infill material.

Keywords— *Response Reduction Factor, pushover analysis, light weight infill material, capacity curve.*

1. INTRODUCTION

In general design practices in India, the strength and stiffness of infill walls are ignored with the assumption of conservative design. In actual, infill walls add considerably to the strength and rigidity of the structures and their negligence will cause failure of many of multistoried buildings. (Goel, 2015)

For the functional and architectural requirements Masonry walls are provided in R.C. structures. The term infilled frame is used to represent a composite structure formed by the combination of a moment resisting R.C. frame & Infill walls. The Infill walls can be of conventional clay brick (CB), concrete block or AAC block. It has been recognized that infill materials significantly affect the seismic performance of the resulting in-filled frame structures. (Goel, 2015). For seismic design of structure is indirectly based on response reduction factor(R). Response reduction factor is defined differently in different countries for different types of structural systems. R is termed as the “response reduction factor” in the Indian standard IS 1893 and “response modification coefficient” in ASCE. In Eurocode the same factor is called “Behaviour factor” (Arunkumar 2016). According to Indian code the value of R is varies from 3 to 5 (i.e., OMRF and SMRF). In the present study, for safe economical design it is necessary to find out actual value of R.

2. METHODOLOGY

In this paper same building is used for pushover analysis. Only different is that four out of two is modeled for light weight infill material (AAC block) and remaining for normal clay burned brick. Four storied building having 5 bays in Y direction and 4 bays in X direction. To avoid effect of column sizes as well as effect of irregularity the RCC building model as column and beam section is used same throughout the building. Plastic hinges are assigned to the beam and column sections. So that the collapse mechanism is takes place. For pushover analysis the whole building is modeled as per ATC-19 (displacement control method). From pushover analysis capacity curve is getting out, with the help of that over strength factor and ductility factor calculated. All other modelling parameters are given below table

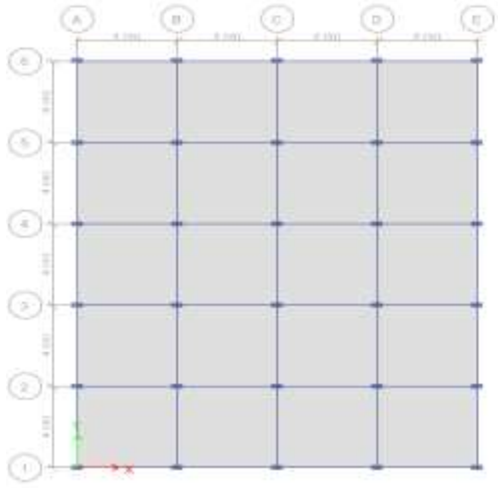

Fig 01. Plan view of G+4 story building considered for analysis

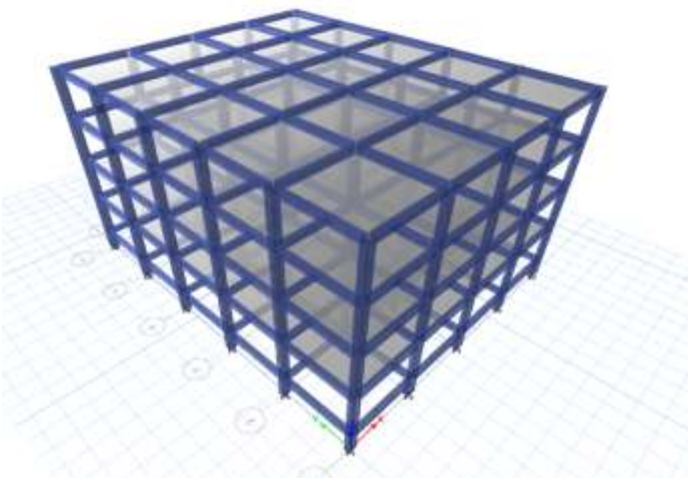

Fig 02. 3D view of G+4 story building considered for analysis

Sr. No.	DESCRIPTION	SIZE
1	Dimensions	16m X 20m
4	Spacing in X-directions	4m
5	Spacing in Y-directions	4m
6	Height of story	3m
7	Number of story	G+4
8	Height of building	13.5m
9	Materials	M-25, Fe 500
10	Beam	0.23m X 0.38m
11	Column	0.23m X 0.45m
12	Thickness of slab	0.125
13	Live load	2
14	Floor finish	1
15	Zone factor (Z)	0.16 (III)
16	Response reduction factor (R)	5 (SMRF)
17	Soil type	II
18	Importance factor (I)	1

Table 01. Modelling parameters

Load combination:

Sr. No.	**Load Combinations**	**Case**
1	Combo 1	1.5 (DL + IL)
2	Combo 2	1.2 (DL + IL$\underline{+}$ EL)
3	Combo 2	1.5(DL $\underline{+}$ EL)
4	Combo 2	0.9 DL + 1.5 EL)

Table 02. Loading combinations as per IS 1893:2016 (part-1)

3. Analysis and discussion

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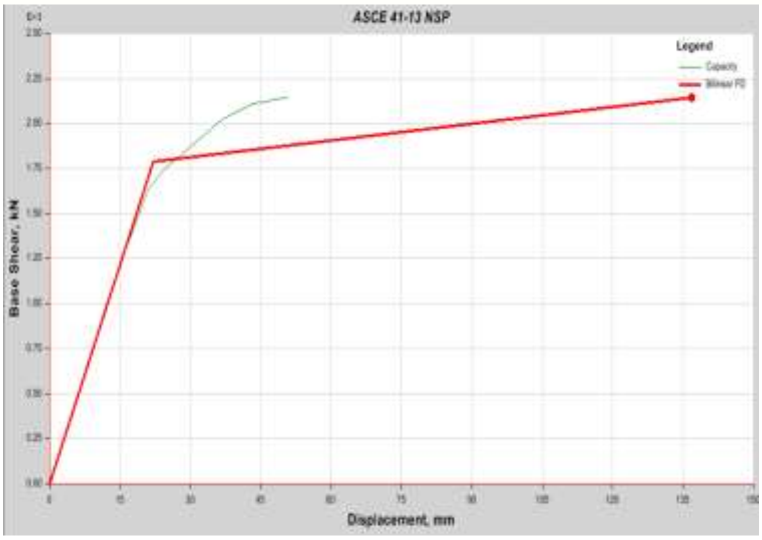


Graph 01: Pushover curve for 1st model

The above capacity curve is obtained from pushover analysis. With the help of this curve the following results have been taken.

Ultimate base shear (V_u) = 1623.51 KN

Design base shear (V_u) = 1207.27 KN

Ultimate displacement (Δ_{max}) = 50.67 mm

Yield displacement (Δ_u) = 14.95 mm

Overstrength factor (R_s) $= \frac{\text{Ultimate base shear (Vu)}}{\text{Design base shear (Vu)}}$

$= \frac{1623.51}{1207.27}$

$= 1.344$

Ductility reduction factor (R_μ) $= \frac{\Delta max}{\Delta u}$

$= \frac{50.67}{14.95}$

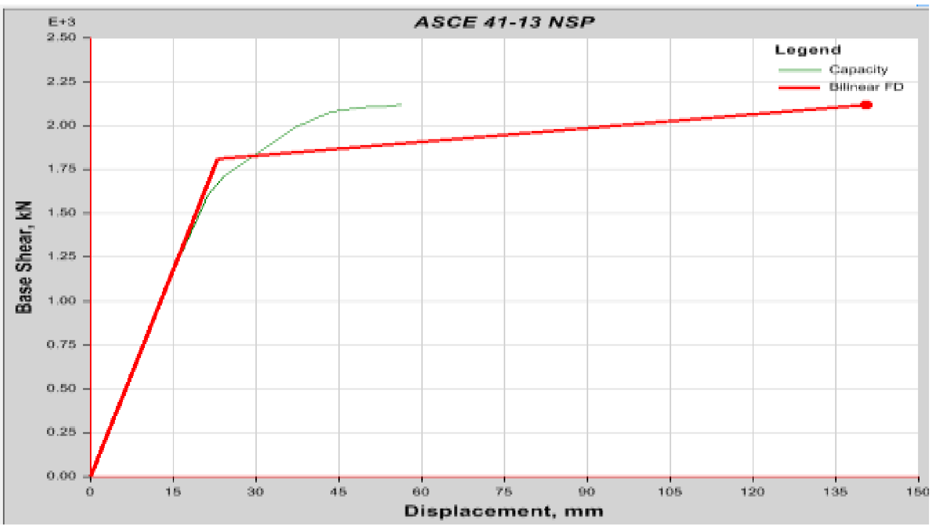
$= 3.389$

Redundancy factor (R_R) = 1

Response reduction factor = R_s X R_μ X R_R

= 1.344 X 3.389 X 1

= 4.554



Graph 02: Pushover curve for 2nd model

The above capacity curve is obtained from pushover analysis. With the help of this curve the following results have been taken.

Ultimate base shear (V_u) = 1606.29 KN

Design base shear (V_u) = 1171.84 KN

Ultimate displacement (Δ_{max}) = 56.32 mm

Yield displacement (Δ_u) = 14.90 mm

Overstrength factor (R_s) $= \dfrac{\text{Ultimate base shear (Vu)}}{\text{Design base shear (Vu)}}$

$= \dfrac{1606.29}{1171.84}$

$= 1.371$

Ductility reduction factor (R_μ) $= \frac{\Delta max}{\Delta u}$

$$= \frac{56.32}{14.90}$$

$= 3.77$

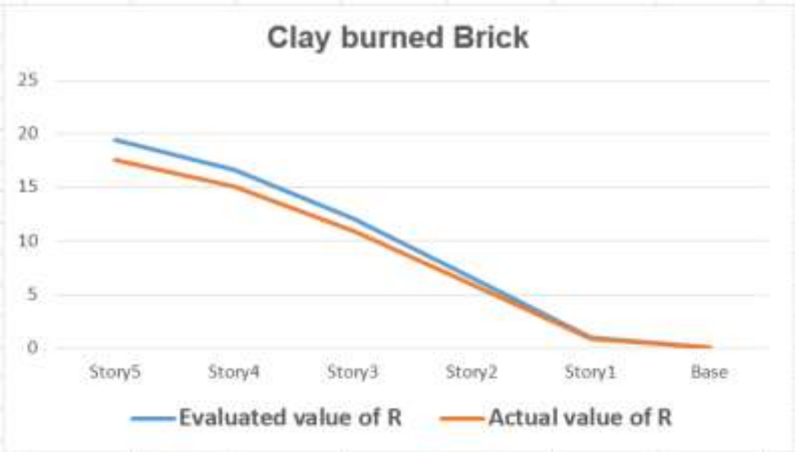
Redundancy factor (R_R) $= 1$

Response reduction factor $= R_s \text{ X } R_\mu \text{ X } R_R$

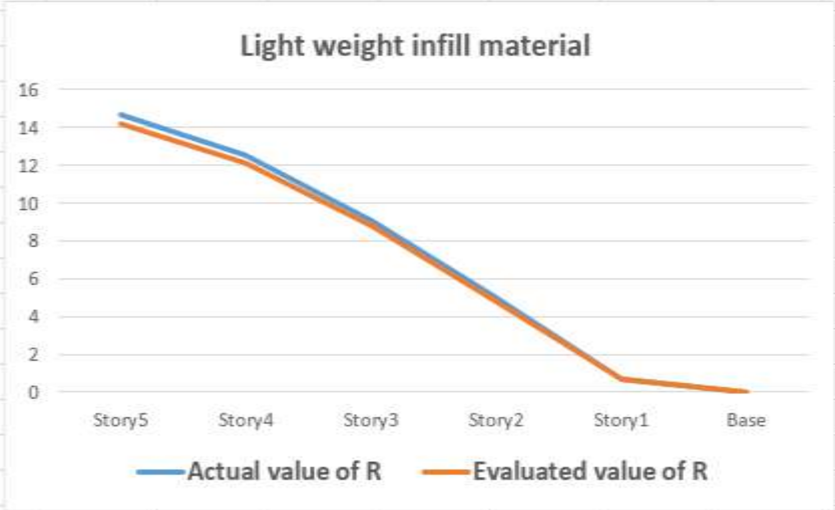
$= 1.371 \text{ X } 3.77 \text{ X } 1$

$= 5.17$

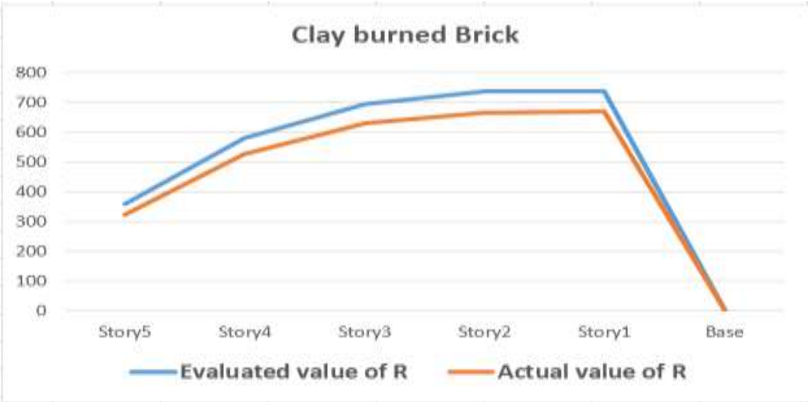
Comparison of evaluated response reduction factor with actual response reduction factor:



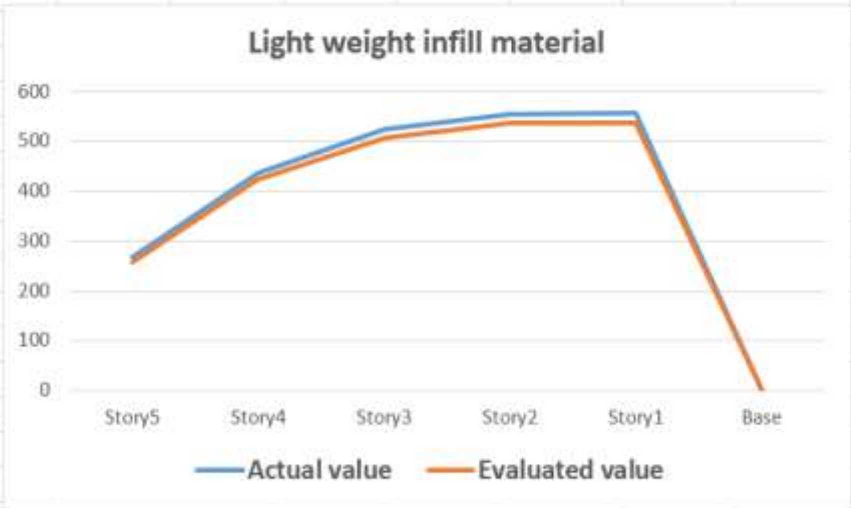
Graph 03: Story Displacement Vs No. of Story.



Graph 04: Story Displacement Vs No. of Story.



Graph 05: Base shear Vs No. of Story.



Graph 06: Base shear Vs No. of Story.

4. RESULT AND DISCUSSION

Based on software analysis, response reduction factor, story shear and story displacement are compared. In case of clay burned brick the evaluated response reduction factor is less than the actual (codal) response reduction factor therefore, the value shear force is increased by 10% as compared to that of actual R factor. But in case of light weight infill material (AAC block) evaluated response reduction is more than actual value of R therefore, story shear is decreased by 4% as compare to that of actual value of R factor.

Similarly, the is increases by 10% in clay burned brick and 4% decrease in case of light weight infill material (AAC block).

	Clay burned brick Model 1		Light weight infill material Model 2	
	Evaluated value of R	Actual value of R	Evaluated value of R	Actual value of R
Response reduction factor R	4.55	5	5.17	5
story shear	737.05 KN	667.62 KN	537.71 KN	555.99 KN
story displacement	19.41 mm	17.60 mm	14.154 mm	14.63 mm

Table No.03. Comparison of clay burned brick and light weight infill material (AAC block).

5. CONCLUSION

1. From the nonlinear static pushover analysis, it is found that for clay burned brick the evaluated response reduction factor (R) is 9% smaller than actual value of R.
2. For light weight infill material (AAC block) the evaluated response reduction factor is increased by 3.5% than actual value of R.
3. In case of light weight infill material (AAC block): Effect of evaluated response reduction factor (R) on story shear and story displacement are decreased by 3%.
4. In case of clay burned bricks:

Effect of evaluated response reduction factor (R) on story shear and story displacement are increased by 10% and 9% respectively.

5. It is more dangerous when the value of response reduction factor R decreases. Because the value of base shear and story displacement are increases.

6. ACKNOWLEDGEMENT

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