

STUDY OF DUCTILITY OF BUILDING WITH STEEL AND CONCRETE SHEAR WALL.

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ABSTRACT: A number of earthquakes occurred in and around India over the past century. Some of them occurred in dense populated areas thus causing great damage. Behaviour of RC buildings during earthquakes depends upon the number of factors like architectural features, structural design, location of building, soil condition etc. Many of the RC buildings constructed with bottom storey left open for the purpose of parking, such type of buildings are subjected to more damage during earthquakes. Such type of buildings can be strengthened by providing the vertical plate like wall called as a shear wall. Properly designed and detailed shear walls have a very good performance during earthquakes. However, it is interesting to know how a shear wall constructed with different materials behaves differently. In this paper, the author demonstrates the behavior of concrete and steel shear walls by using the software STAAD-Pro 2006 and it was observed that though the weight of shear wall kept constant in both cases, the ductility of steel shear wall buildings is more than the concrete shear wall buildings.

Keywords: Shear wall, Earthquake, Deflection, Ductility.

I. INTRODUCTION

Earthquake is one of the major natural disasters which results in sudden release of energy in the earth's crust that creates seismic waves. Many of buildings constructed have a ground storey left open such buildings are more vulnerable in earthquakes. During the earthquake, displacement of ground surface or shaking of ground surface takes place which results in damage to structures. Shear walls are relatively thin reinforced vertical walls. Shear walls are used in a building to resist the effect of gravity loads and story shear due to seismic forces. Buildings designed with typical methods of construction lack in resistance of lateral forces developed during earthquakes. Properly designed and detailed buildings with shear walls have shown good performance in the past earthquakes. Shear walls are easy to construct, because the reinforcement detailing of walls is relatively simple and therefore easily implemented at site. Shear walls start from the foundation of building and extend up to the full height of building.

II. LITERATURE REVIEW

M.Y. Kaltakci, M.H. Arslan & G. Yavuz [1] studied the effect of external and internal shear wall location on strengthening weak RC frames. They concluded that shear walls and frame columns worked monolithically and any anchorage debonding was not seen at column-shear joint.

Abolhassan Astaneha [2] about the seismic behavior and design of steel shear walls. The author divides the steel shear wall system into two categories namely singular shear wall system and dual shear wall system.

Based on the results of tests reported, steel seismic design provisions were developed and proposed by the author.

Philip Line[3] demonstrates the example of two storey building. In the example sufficient strength to resist applied load is provided by perforated shear wall without the use of typical stamping and anchor required by other method. However no study was conducted on the difference of behavior of a RC building between the steel and concrete shear wall. In this paper author compare the behavior of building with steel and concrete shear wall.

III. MODELING

The STAAD Pro 2006 software is utilized for 3D modeling and analysis of structure. Data assumed for modeling of building is given in table.1.1.

Two model namely A and B were analyzed I STAAD-Pro 2006. Model A is having a RC frame and concrete infill wall utilized as a shear wall whereas in model B steel plates served the function of shear wall. Load cases applied on the structures are as per the IS 1893(part 1):2002

Other geometrical and structural features of the model A and model B are same.

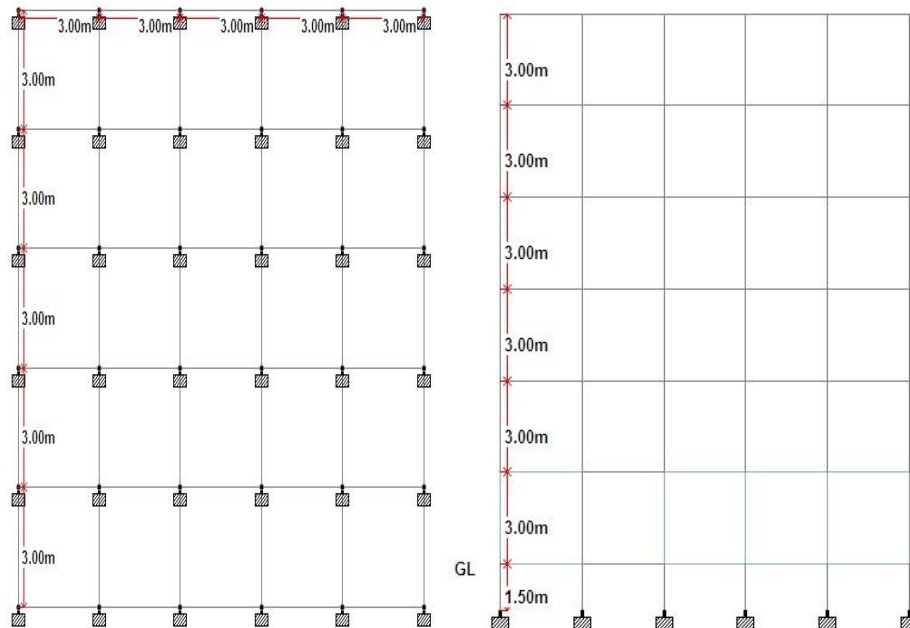


Fig. 1-1 Plan of Building Fig. 1-2 Elevation of Building

Table 1.1 Modeling Data

Type of building	Residential
Type of structure	R.C.C. Frame Structure
Type of frame	
No. of stories	G+5
Storey height	3.00 m
Foundation type	Isolated
Seismic zone	II
Material Properties.	

Young's modulus of elasticity	2 X 10 ⁵
Grade of concrete	M 20
Grade of Steel	Fe 415
Density of reinforced concrete	25 KN/m ³
Density of brick masonry	20 KN/m ³
Member Properties	
Thickness of slab	0.125 m
Beam size	0.23 X 0.30 m
Column size	0.23 X 0.45 m
Thickness of wall	0.23 m
Loads	
Dead load	
Slab load	3.125 KN/m ²
Floor Finish	1 KN/m ²
Live load	
Imposed load	3.0 KN/m ²
Earthquake load	Calculated using seismic coefficient method
Seismic zone	
Zone factor (Z)	0.1
Importance factor (I)	1
Response reduction factor (R)	3

IV. CALCULATIONS

Area of floor $A_f = 15 \times 15 = 225 \text{ m}^2$

Wall load = volume of wall x density of brick
 $= 180 \times 0.23 \times 3 \times 20$
 $= 2484 \text{ KN}$

Parapet waoo load = $0.1 \times 0.9 \times 60 \times 20$
 $= 108 \text{ KN}$

Floor Load = $[(25 \times 0.125) + (1) + (0.5 \times 3)] \times 225$
 $= 1265.62 \text{ KN}$

Load at plinth (W_p) = 50% wall + Floor load
 $= 2484/2 + 1265.62$
 $= 2507.62 \text{ KN}$

Load at intermediate floor (W_1, W_2, W_3, W_4 & W_5) = $2484 + 1262.5$
 $= 3749.62 \text{ KN}$

Load at topmost storey (W_t) = $2507.62 + 108$
 $= 2615.62 \text{ KN}$

Total seismic weight of building (W) = $\sum W_i$
 $= 2507.62 + (5 \times 3749.62) + 2615.62$
 $= 23871.34 \text{ KN}$

$T_x = T_y = 0.009h/\sqrt{d}$
 $= 0.009 \times 19.5 / \sqrt{15}$
 $= 0.453 \text{ sec}$

Floor Load = $[(25 \times 0.125) + (1) + (0.5 \times 3)] \times 225$

=1265.62 KN
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 $Tax = T_{ay} = 0.009h/\sqrt{d}$
 = 0.009 x 19.5 / $\sqrt{15}$ = 0.453 sec

Table 1.2 Vertical Distribution of Base shear to different floor level.

Storey Level	W_i (KN)	H_i (m)	$W_i \cdot h_i^2$ (KN.m ²)	$\frac{W_i \cdot h_i^2}{\sum_{j=1}^5 W_j \cdot h_j^2}$	Lateral force at i th level for EL in x or z direction $Q_i = 978.72 \times \frac{W_i \cdot h_i^2}{\sum W_j \cdot h_j}$
6 th	2615.62	19.5	994589.5	0.29	283.82
5 th	3749.62	16.5	1020834	0.30	293.616
4 th	3749.62	13.5	683368.2	0.20	195.744
3 rd	3749.62	10.5	413395.6	0.121	118.42
2 nd	3749.62	7.5	210916.12	0.006	58.72
1 st	3749.62	4.5	72929.8	0.02	19.57
P.L.	2507.62	1.5	5642.14	0.009	8.8

Load combinations used for analysis of building are as per IS 1893(part1):2002

- 1) 1.5 (DL + IL)
- 2) 1.2 (DL+IL±EL)
- 3) 1.5 (DL±EL)
- 4) 0.9DL ± 1.5EL.

v. RESULT AND DISCUSSION

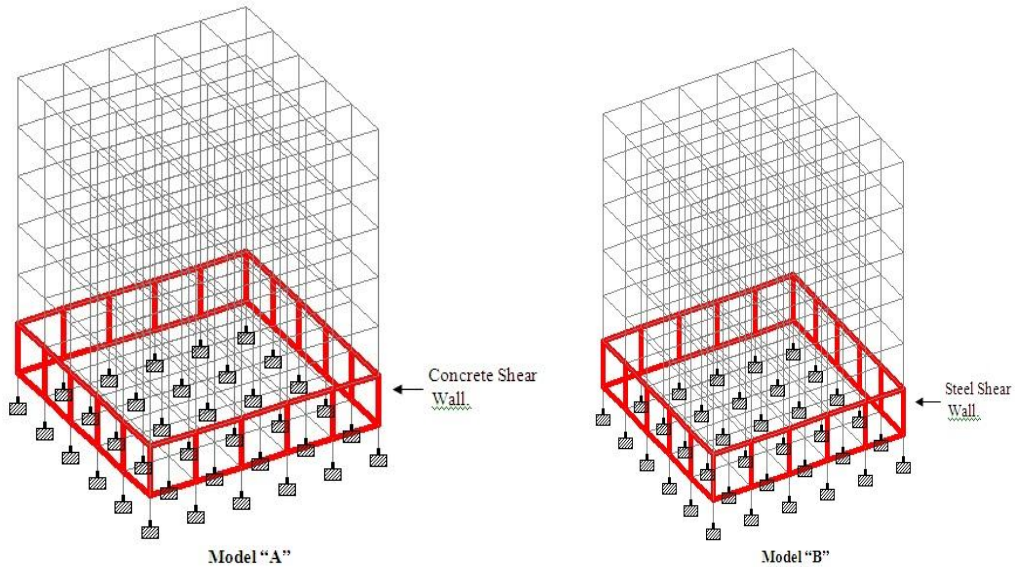


Fig.1-3 Model A with shear wall highlighted Fig.1-4 Model B with shear wall highlighted

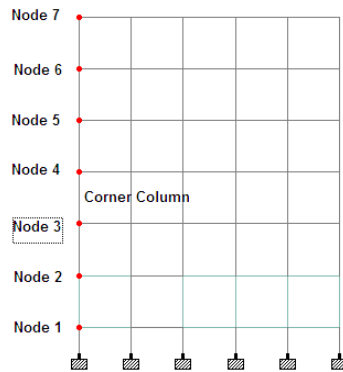


Fig.1-5 Model with node numbers

For the purpose of investigating the behavior of building, deflection result of corner column was studied. From the deflection of node deflected shape of the column was plotted. Deflection and deflected shape for different load combination are presented below:

For Model “A”

Table 1.3 Deflection in column for Load combination 1 Table 1.4 Deflection in column for Load combination 2

NODE NO.	DEFLECTION(mm)
0	0
1	0.121
2	0.069
3	0.029
4	-0.002
5	0.002
6	-0.002
7	-0.041

NODE NO.	DEFLECTION(mm)
0	0
1	6.045
2	7.144
3	57.186
4	121.041
5	175.685
6	215.611
7	238.068

Table 1.5 Deflection in column for Load combination 3

NODE NO.	DEFLECTION(mm)
0	0
1	7.574
2	8.935
3	71.487
4	151.302
5	219.607
6	269.517
7	297.575

Table 1.6 Deflection in column for Load combination 4

NODE NO.	DEFLECTION(mm)
0	0
1	7.723
2	9.006
3	71.097
4	150.407
5	218.127
6	267.336
7	295.384

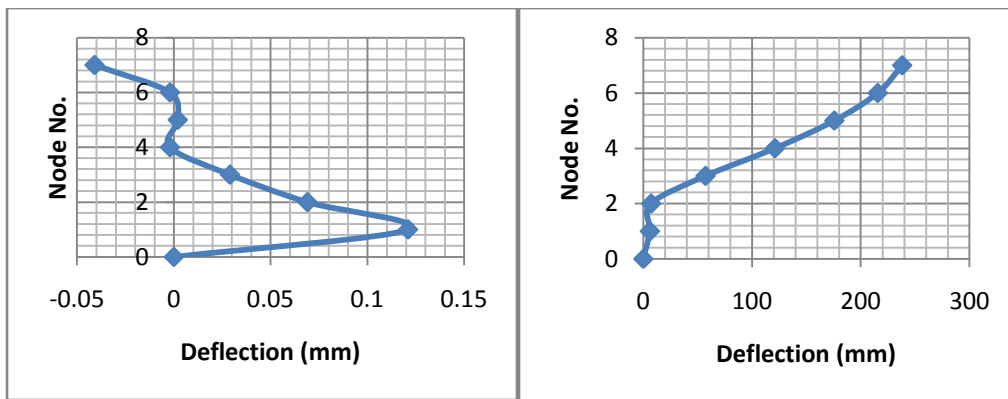


Fig 1-6 Deflected Shape of Column for load combination 1 Fig 1-7 Deflected Shape of Column for load combination 2

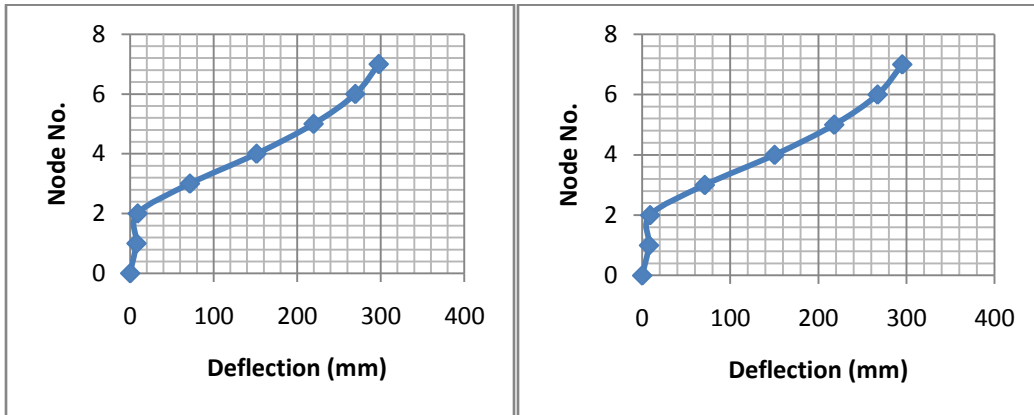


Fig 1-8 Deflected Shape of Column for load combination 3 Fig 1-9 Deflected Shape of Column for load combination 4

For Model “B”

Table 1.7 Deflection in column for Load combination 1 Table 1.8 Deflection in column for Load combination 2

NODE NO.	DEFLECTION(mm)
0	0
1	0.104
2	0.059
3	0.025
4	-0.001
5	0.002
6	-0.002
7	-0.041

NODE NO.	DEFLECTION(mm)
0	0
1	0.602
2	6.866
3	58.221
4	122.903
5	177.912
6	217.971
7	240.446

Table 1.10 Deflection in column for Load combination 4

Table 1.9 Deflection in column for Load combination 3

NODE NO.	DEFLECTION(mm)
0	0
1	7.768
2	8.587
3	72.779
4	153.629
5	222.39
6	272.467
7	300.548

NODE NO.	DEFLECTION(mm)
0	0
1	7.903
2	8.657
3	72.384
4	152.734
5	220.91
6	270.286
7	298.357

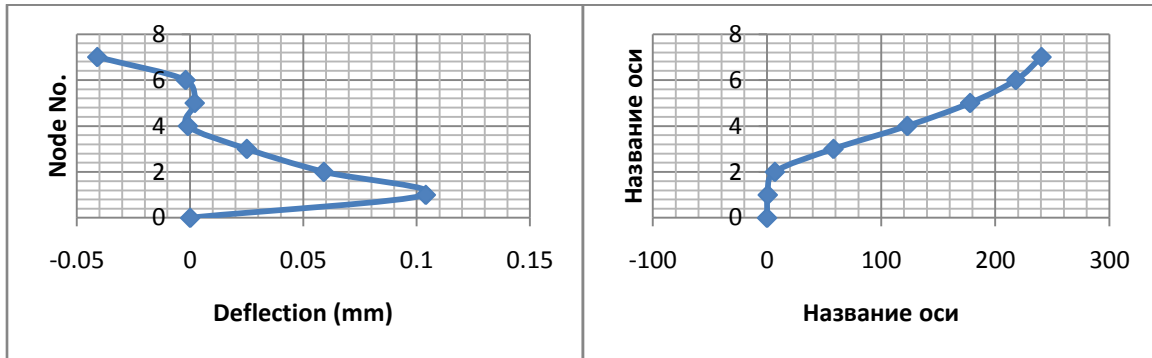


Fig 1-10 Deflected Shape of Column for load combination 1 Fig 1-11 Deflected Shape of Column for load combination 2

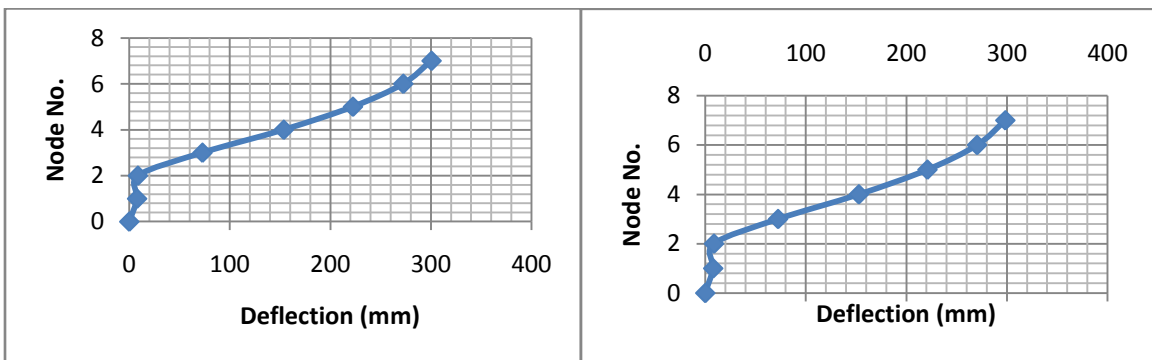


Fig 1-12 Deflected Shape of Column for load combination 3 Fig 1-13 Deflected Shape of Column for load combination 4

From the graphs show above it is clear that for each of the load combination column in building B deflected more than A. This behavior of column indicate that the model B is more ductile than model A

VI. CONCLUSION

Earthquake resisting building particularly their main element need to be built in ductility in them. Such building which have a ability to sway withstand in the earthquake with some damage but without collapse. Ductility of building is one of the important parameter to access the performance of building during earthquake.

In above study it is observed that behaviour of a building having the steel plate shear wall is ductile than the infill concrete shear wall this property of building makes it more consistant during the earthquake. During the earthquake this type of building may subjected to damage but not collapse. As the weight of shear wall kept constant in both the configuration, this change in behaviour of building is mainly due to the durability of steel. However the economics involved in the construction of building is not studied.

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