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Non-Linear Analysis of Asymmetric Shear Wall with Openings

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***Abstract*— Shear walls are one of the excellent means for providing lateral load resistance to high reinforced (RC) buildings. The contribution of shear wall is significant in increasing the stiffness of structure, especially, in Non-linear analysis because shear walls contribute considerable in lateral load resisting system. There are several types of analyses methods available for analyzing shear walls of the building structures. Analysis of structure consists of uniformly distributed lateral loading, triangularly distributed lateral loading with a maximum value at the top.**

In this work seismic analysis of shear wall building in zone III is done and study for shear walls with various percentages of openings is done. Such as mode shape, fundamental frequency base shear, drift, shear force, stiffness. The performance of shear wall is compared with various percentages of openings of shear wall area. In this project the software, ETABS 2013 is used for the analysis of the structure.

Keywords*— *Shear Wall, Non-Linear Static Analysis, Asymmetrical, Performance Point, Spectral Accelerations, And Base Shear

I. INTRODUCTION

The aim of this paper is to investigate the influence non-linear static behavior of asymmetric shear wall and comparison of the result using E-TABS 2013 software.
Special attention is paid to:

a. The behavior of asymmetric plan in shear wall system.
b. The implications of openings in shear wall with 10%, 20%, 30% and 40% openings and without openings. The building is located in North Karnataka zone III, India.

II. IDEALIZATION OF THE SYSTEM

a. Structural Idealization

A twelve-storey public buildings located in zone 3 as per Indian code is considered. The building models having shear wall and without shear walls are modeled, and with different percentages of openings. the column 300 x 900 mm, dimensions of beam 230x 500 mm the thickness of slab is 120mm and thickness of wall is 230mm.

b. Idealization behavior of model

The function of the shear wall is to resist the lateral loads in the system. During earthquake, a rigid base may be subjected to displacement in six degrees of freedom, and the resistance of soil may be expressed by the six corresponding resultant force components. Hence the structural behavior of the elastic half space is presented completely by a set of force displacement relationships defined for these degrees of freedom. Appropriate static spring constants can be evaluated for the elastic half space by the method of continuum mechanics.

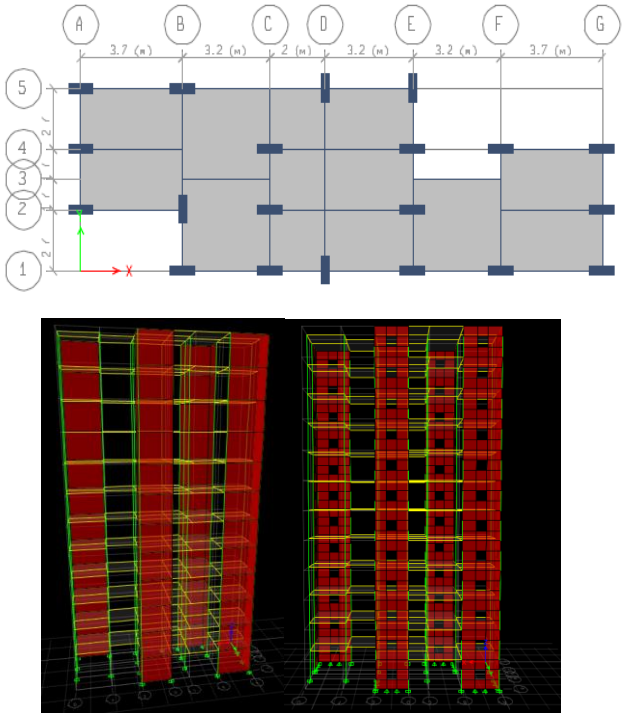

Fig 1.Plan and Elevation of shear wall Building

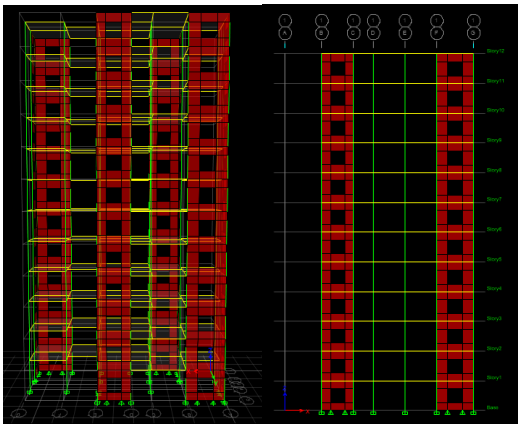

Fig 2 Elevation of Bay Building

III. METHOD OF ANALYSIS

The model is prepared in Etaab 2013 and non-linear static analysis id performed for the models.six models are prepared and the analysis is performed. various result values are listed in tables below.

Floor level	Height (m)	Storey shear in X – dir (kN)	Storey shear in Y – dir (kN)	Max drift in X – dir (m)	Max drift in Y – dir (m)
12	36	72.8203	72.8203	0.000751	0.00108
11	33	238.848	238.848	0.001103	0.001383
10	30	376.069	376.0609	0.001635	0.001758
9	27	487.204	487.2034	0.002287	0.002254
8	24	575.017	575.0197	0.002941	0.002853
7	21	642.251	642.2541	0.003495	0.003411
6	18	691.658	691.6508	0.00388	0.003837
5	15	725.954	725.954	0.004038	0.004086
4	12	747.901	747.9081	0.003918	0.004119
3	9	760.252	760.2572	0.003458	0.003873
2	6	765.748	765.7458	0.002571	0.003207
1	3	767.119	767.1179	0.001108	0.001773

Table 1 Seismic analysis parameters for shear wall without opening by using ESA

Floor level	Height (m)	Storey shear in X – dir (kN)	Storey shear in Y – dir (kN)	Max drift in X – dir (m)	Max drift in Y – dir (m)
12	36	84.4309	84.4309	0.001736	0.002815
11	33	269.8672	269.8672	0.001801	0.002956
10	30	423.1203	423.1203	0.001854	0.003091
9	27	547.2554	547.2554	0.00189	0.003204
8	24	645.3374	645.3374	0.001894	0.003263
7	21	720.4314	720.4314	0.001858	0.003246
6	18	775.6026	775.6026	0.001774	0.003138
5	15	813.9158	813.9158	0.001636	0.002924
4	12	838.4363	838.4363	0.001441	0.002593
3	9	852.2291	852.2291	0.00118	0.002133
2	6	858.3593	858.3593	0.00084	0.001511
1	3	859.8918	859.8918	0.000379	0.000657

Table 2 Seismic analysis parameters for shear wall with 10% opening by using ESA

Floor level	Height (m)	Storey shear in X – dir (kN)	Storey shear in Y – dir (kN)	Max drift in X – dir (m)	Max drift in Y – dir (m)
12	36	83.2689	83.2689	0.001967	0.003624
11	33	266.762	266.762	0.002039	0.00382
10	30	418.4093	418.4093	0.002093	0.004093
9	27	541.2435	541.2435	0.002116	0.004105
8	24	638.2977	638.2977	0.002113	0.004114
7	21	712.6049	712.6049	0.002078	0.004096
6	18	767.1979	767.1979	0.001991	0.003746
5	15	805.1097	805.1097	0.001845	0.003352
4	12	829.3732	829.3732	0.001636	0.002783
3	9	843.0215	843.0215	0.001351	0.002093
2	6	849.0874	849.0874	0.000977	0.002193
1	3	850.6039	850.6039	0.000464	0.000646

Table 3 Seismic analysis parameters for shear wall with 20% opening by using ESA

Floor level	Height (m)	Storey shear in X – dir (kN)	Storey shear in Y – dir (kN)	Max drift in X – dir (m)	Max drift in Y – dir (m)
12	36	82.1754	82.1754	0.000277	0.003735
11	33	263.8023	263.8023	0.000258	0.003931
10	30	413.9072	413.9072	0.000244	0.004104
9	27	535.4922	535.4922	0.000226	0.004216
8	24	631.5593	631.5593	0.000206	0.004225
7	21	705.1107	705.1107	0.000183	0.004107
6	18	759.1485	759.1485	0.000158	0.003857
5	15	796.6747	796.6747	0.000131	0.003463
4	12	820.6915	820.6915	0.000104	0.002894
3	9	834.201	834.201	0.000075	0.002104
2	6	840.2052	840.2052	0.000034	0.002204
1	3	841.7062	841.7062	0.000277	0.000757

Table 4 Seismic analysis parameters for shear wall with 30% opening by using ESA

Floor level	Height (m)	Storey shear in X – dir (kN)	Storey shear in Y – dir (kN)	Max drift in X – dir (m)	Max drift in Y – dir (m)
12	36	81.0882	81.0882	0.001962	0.002909
11	33	260.8664	260.8664	0.00027	0.003108
10	30	409.4433	409.4433	0.000261	0.000081
9	27	529.7906	529.7906	0.002197	0.003401
8	24	624.8799	624.8799	0.000234	0.000074
7	21	697.6826	697.6826	0.000217	0.003433
6	18	751.1703	751.1703	0.000197	0.003355
5	15	788.3145	788.3145	0.000175	0.003164
4	12	812.0869	812.0869	0.000152	0.002848
3	9	825.4588	825.4588	0.000128	0.002395
2	6	831.4019	831.4019	0.000097	0.00178
1	3	832.8876	832.8876	0.000043	0.000909

Table 5 Seismic analysis parameters for shear wall with 40% opening by using ESA

IV. INPUT DESIGN DATA FOR BUILDING

Material Properties :

Concrete

i. $E_c = 25 \times 10^6$ KN/m^2

ii. $\rho_c = 25$ KN/m^3

Brick masonry

i. $E_m = 13.8 \times 10^6$ KN/m^2

ii. $P_m = 20$ KN/m^3

Assumed Dead load intensities :

i. Floor finishes = 1.0 KN/m^2

ii. Roof finishes = 2.0 KN/m^2

Member properties :

i. Thickness of Slab = 0.200 m

ii. Column size = (0.230 m × 0.500 m)

iii. Beam size = (0.30 m × 0.400 m)

iv. Thickness of wall = 0.250 m

Earthquake load : As per IS-1893 (Part 1) – 2002
Type of soil : Type II, Medium as per IS: 1893
Seismic Zone = Zone III

Type of Building = Public

V. RESULTS OF PARAMETRIC STUDY

a. Natural Time Period

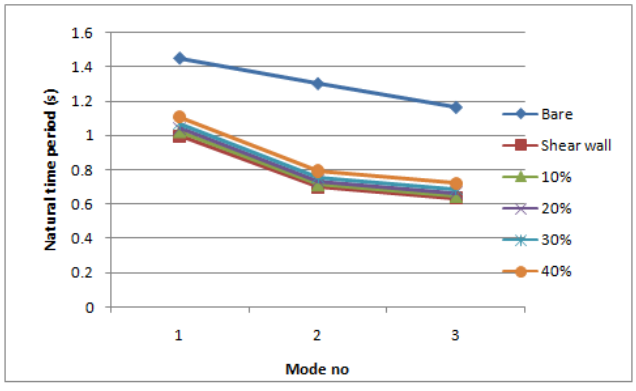

Figure 3 Variation of Time period and Frequency

b. *Story Stiffness*

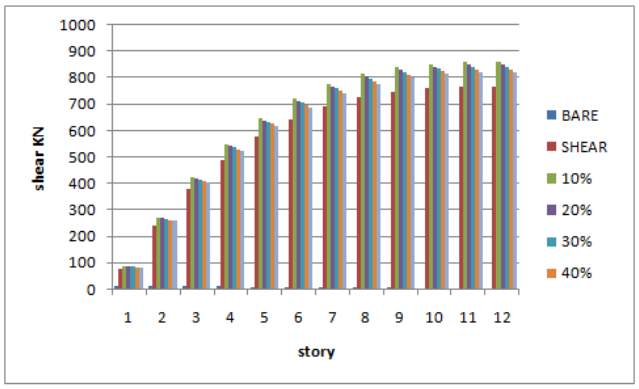

Figure 4 Variation of story stiffness for bare, with shear wall and with openings of 10%, 20%, 30% and 40%

c. *Centre of Mass Displacement*

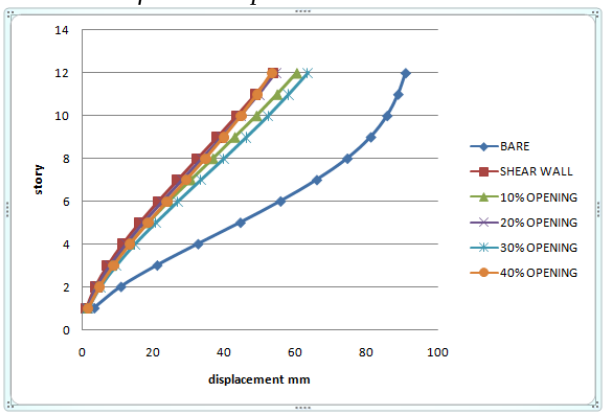

Figure 5 Variation of centre of mass displacement in X direction for bare, with shear wall and with openings of 10%, 20%, 30% and 40%

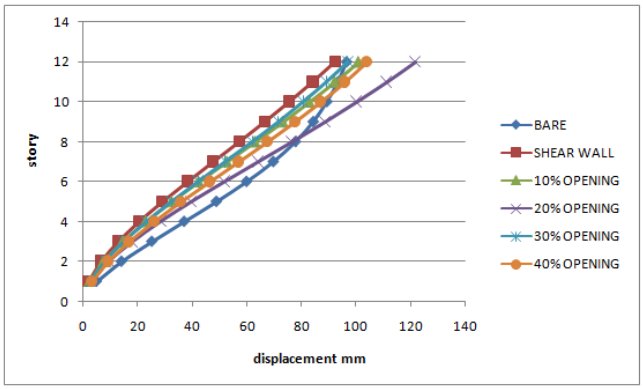

Figure 6 Variation of centre of mass displacement in Y direction for bare, with shear wall and with openings of 10%, 20%, 30% and 40%

d. *Story Drift*

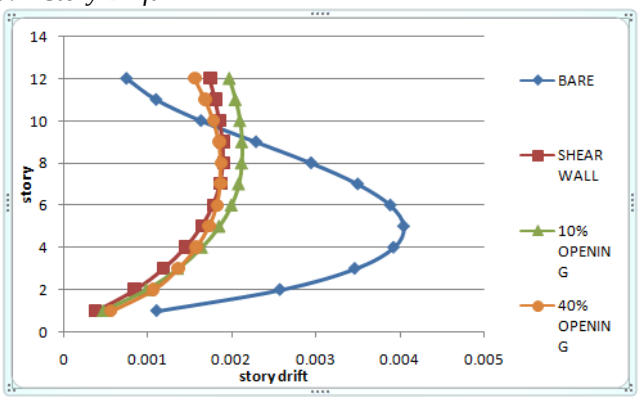

Figure 7 Variation of story drift X direction for bare, with shear wall and with openings of 10%, 20% and 40%

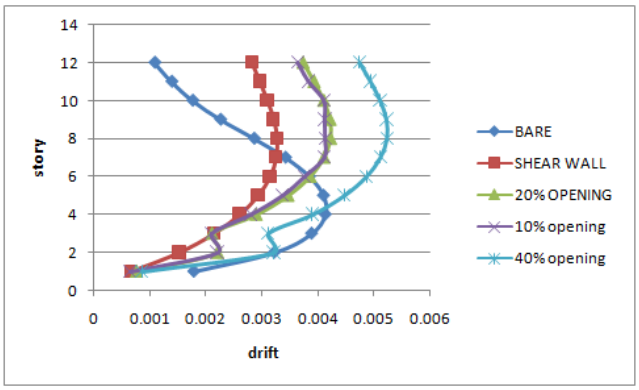

Figure 8 Variation of story drift Y direction for bare, with shear wall and with openings of 10%, 20% and 40%

e. *Location of Performance Points*

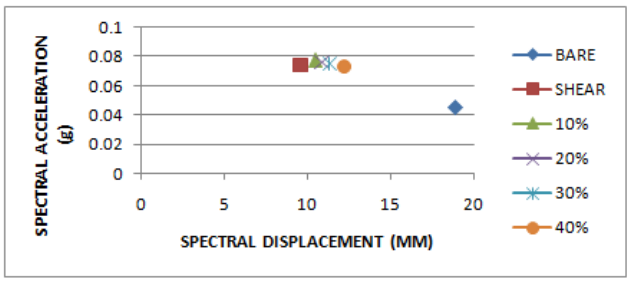

Figure 9 Variation of performance point in X for bare, with shear wall and with openings of 10%, 20%, 30% and 40%

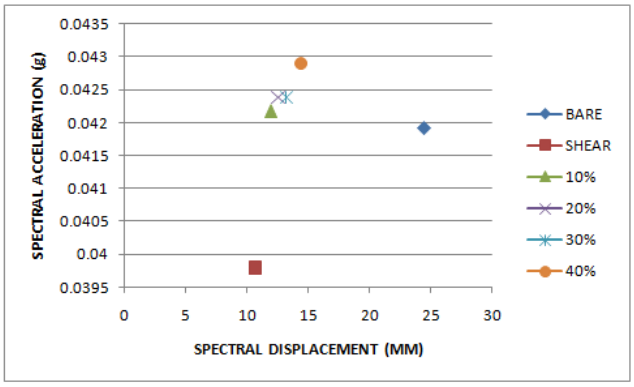

Figure 10 Variation of performance point in X for bare, with shear wall and with openings of 10%, 20%, 30% and 40%

f. Maximum Axial Loads

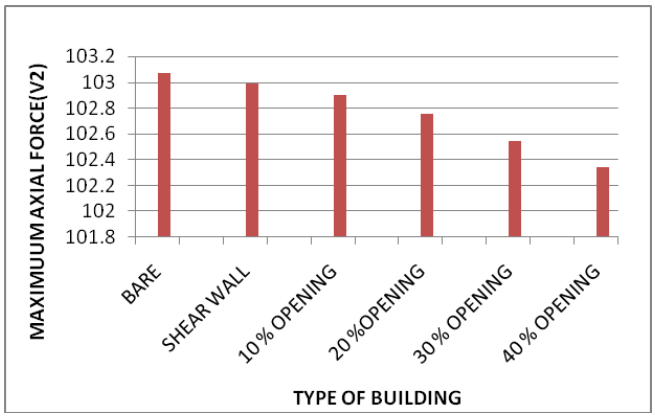

Figure 11 Maximum Axial Load Variations for Different Building Models

g. Maximum Bending Moment

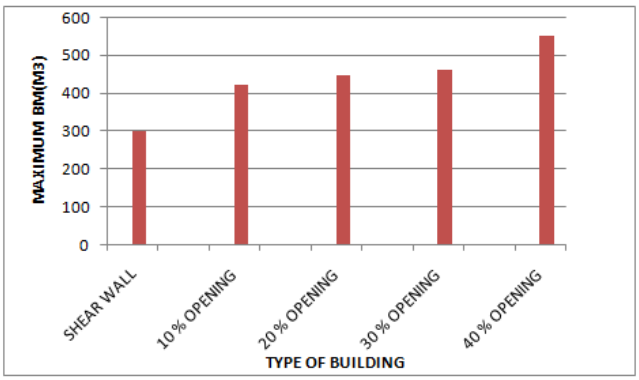

Figure 12 Variation of moments in column for Shear wall without opening and with 10%, 20%, 30% and 40% openings.

CONCLUSION

i. The study shows that It is found that the base shear for 10%, 20%, 30% and 40% is less than base shear for shear wall without opening..

ii. Frequency for 10%, 20% 30% and 40% is less than shear wall without opening. Frequency decreases with increase in opening.

iii. The time period for 10%, 20%, 30% and 40% openings is greater than shear wall without opening. Time period increases with increase in opening.

iv. If we compare the storey drift of building with 10%, 20%, 30% and 40% opening in shear wall and without opening in shear wall, storey drift of 10%, 20%, 30% and 40% opening is greater than without opening.

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