International Journal of Research in Engineering, Science and Management
Volume-1, Issue-10, October-2018
www.ijresm.com | ISSN (Online): 2581-5782

Behaviour of Dual System for Irregular Structure

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***Abstract*—Various research studies have been conducted on the design of shear wall and its performance in different zones. In this paper the analytical study is done on dual structural system for irregular plan of multistoried building (G+18) in the zone III of Indore. Concrete shear walls are used to resist the lateral displacement owning to earthquake vibrations. Shear walls are placed around the building as periphery walls, around the lift core, and beside the staircase and analysis is done with varying shear wall thickness for different model. The study also concentrates on architectural aspects.**

***Index Terms*—Dual system, Equivalent Static Analysis, Shear wall, Drift, Contribution, Lateral Displacement.**

I. Introduction

The primary purpose for all types of structural systems used in the building type of structures is to support gravity loads. The most common loads resulting from the effect of gravity are dead load, live load, and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind or earthquake which in turn can develop high stress, producing lateral sway movement or causes vibration.

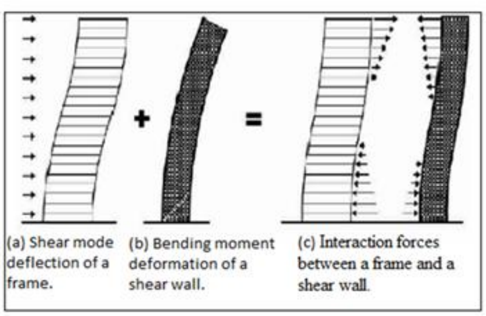

Fig. 1. Dual structural system

Building with dual system consists of shear walls and moment resisting frame (Fig. 1). They are designed to resist the total designed lateral force in proportion to their relative stiffness. Shear walls and frames in combination normally provide the required stiffness and strength to withstand lateral loads effectively in high rise buildings. The moment resisting frames must be capable of resisting at least 25 percent of the base shear, and the two systems must be designed to resist the total lateral load in proportion to their relative rigidities.

II. Classification of Shear Wall

Shear walls of varying cross sections i.e. rectangular shapes to more irregular cores such as channel, T, L, barbell shape, box etc. can be used. Provision of walls helps to divide an enclose space, whereas of cores to contain and convey services such as elevator. Wall openings are inevitably required for windows in external walls and for doors or corridors in inner walls or in lift cores. The size and location of openings may vary from architectural and functional point of view. The use of shear wall structure has gained popularity in high rise building structure, especially in the construction of service apartment or office/ commercial tower. There are many types of reinforced concrete shear walls,

1. Simple rectangular types
2. Coupled shear walls
3. Rigid frame shear walls
4. Framed walls with Infilled frames
5. Column supported shear wall
6. Core type shear walls

III. Load Combinations

The gravity loads and earthquake loads will be taken for analysis. The basic loads are Dead loads (DL), Imposed load (LL), Earthquake load (EQ) along X and Z in positive and negative direction. As per IS 1893 (Part I): 2002 Clause no. 6.3.1.2, the following Earthquake load cases have to be considered for analysis.

1.5(DL + LL)	0.9DL ± 1.5EQX
0.9DL ± 1.5EQZ	1.5(DL ± EQZ)
1.5(DL ± EQX)	1.2(DL + LL ± EQX)
1.2(DL + LL ± EQZ)	

IV. Analysis of Building

The Multi-Storied Building design for Hard soil Located in seismic zone III, for Earthquake loading, the provisions of the IS: 1893(Part1) - 2002 is considered. The plan of building is shown in figure. The plan dimension of the building is 23.86m X 29.58 m. Height of each storey is 3 m. Following models are considered:

B-S (W) - Bare Frame without Share wall (Table-1).

B-S (F) - Frame having 250 mm thick RC shear wall throughout full height of building (Table-2).

B-S (1) - Frame having 250 mm upto 10 floor, 200 mm upto next 5 floors and 150 mm for remaining floors (Table-3).

B-S (2) - Frame having 250mm upto 10 floors, 150 mm thickness stepped RC shear wall for 5 floors and no shear wall for remaining 4 floors (Table-4).

V. Building Details

A. Description of Building

Size of building: 23.86 m x 29.58 m
Type of structure: Multi-storey RC frame structure
Number of stories: 19 (G+18) Residential
Storey height: 3 m
Type of Soil: Hard Soil
Site location: Super Corridor, Indore
Live load considered: 3 KN/m^2

B. Materials

Grade of concrete: M25
Grade of steel: Fe500

C. Member Dimensions

Column size: 500 mm x 500 mm
Beam size: 300 mm x 500 mm
Slab thickness: 125 mm
Wall thickness: 200 mm external wall, 100 mm internal wall
Shear wall thickness: 250 mm, 200 mm, and 150 mm.
All supports are assumed to be fixed in nature.

D. Model of Structure

The modeling and analysis are done using STAAD ProV8i software and then results are compared.

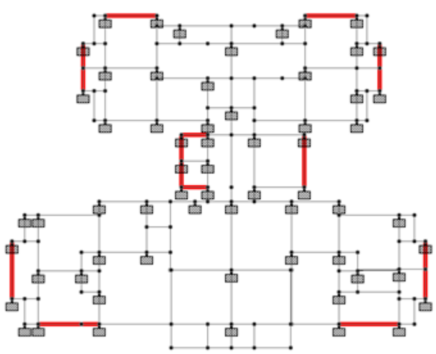

Fig. 2. Plan with shear wall location

VI. Results and Graphs

TABLE I
B-S (W)

S. No.	Storey Height	Drift	Lateral Displacement
1	0	2.059	2.059
2	3	1.961	4.02
3	6	2.04	6.06
4	9	2.1	8.16
5	12	2.15	10.31
6	15	2.19	12.5
7	18	2.22	14.72
8	21	2.232	16.952
9	24	2.227	19.179
10	27	2.211	21.39
11	30	2.182	23.572
12	33	2.136	25.708
13	36	2.07	27.778
14	39	1.978	29.756
15	42	1.865	31.621
16	45	1.726	33.347
17	48	1.562	34.909
18	51	1.374	36.283
19	54	1.199	37.482
20	57	1.158	38.64

TABLE II
B-S (F)

S. No.	Storey Height	Drift	Lateral Displacement	Contribution
1	0	0.799	0.799	61.19
2	3	1.112	1.911	43.29
3	6	1.736	3.647	14.90
4	9	1.187	4.834	43.48
5	12	1.082	5.916	49.67
6	15	1.254	7.17	42.74
7	18	1.41	8.58	36.49
8	21	1.533	10.113	31.32
9	24	1.617	11.73	27.39
10	27	1.687	13.417	23.70
11	30	1.751	15.168	19.75
12	33	1.809	16.977	15.31
13	36	1.863	18.84	10.00
14	39	1.904	20.744	3.74
15	42	1.932	22.676	-3.59
16	45	1.952	24.628	-13.09
17	48	1.977	26.605	-26.57
18	51	2.022	28.627	-47.16
19	54	2.08	30.707	-73.48
20	57	2.2	32.907	-89.98

TABLE III

B-S (1)				
S.No	Storey Height	Drift	Lateral Displacement	Contribution
1	0	0.77	0.77	62.60
2	3	1.075	1.845	45.18
3	6	1.681	3.526	17.60
4	9	1.154	4.68	45.05
5	12	1.055	5.735	50.93
6	15	1.226	6.961	44.02
7	18	1.379	8.34	37.88
8	21	1.503	9.843	32.66
9	24	1.589	11.432	28.65
10	27	1.662	13.094	24.83
11	30	1.74	14.834	20.26
12	33	1.802	16.636	15.64
13	36	1.864	18.5	9.95
14	39	1.907	20.407	3.59
15	42	1.938	22.345	-3.91
16	45	1.966	24.311	-13.90
17	48	1.988	26.299	-27.27
18	51	2.047	28.346	-48.98
19	54	2.116	30.462	-76.48
20	57	2.238	32.7	-93.26

TABLE IV

B-S (2)				
S.No	Storey Height	Drift	Lateral Displacement	Contribution
1	0	0.836	0.836	16.40
2	3	1.094	1.93	45.30
3	6	1.644	3.574	45.20
4	9	1.212	4.786	69.70
5	12	1.147	5.933	77.06
6	15	1.313	7.246	78.12
7	18	1.467	8.713	79.04
8	21	1.586	10.299	80.18
9	24	1.67	11.969	81.44
10	27	1.741	13.71	82.59
11	30	1.817	15.527	83.48
12	33	1.88	17.407	84.33
13	36	1.934	19.341	85.12
14	39	1.969	21.31	85.94
15	42	1.988	23.298	86.75
16	45	2	25.298	87.50
17	48	2.021	27.319	88.11
18	51	2.068	29.387	88.51
19	54	2.136	31.523	88.76
20	57	2.253	33.776	88.74

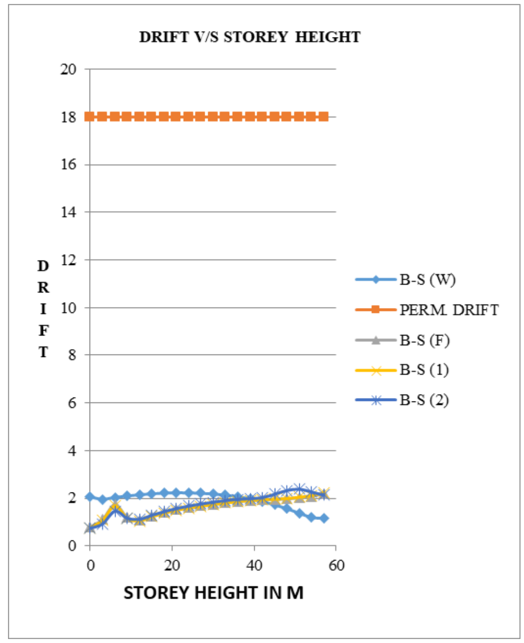

Fig. 3. Graph between Drift vs. Storey Height

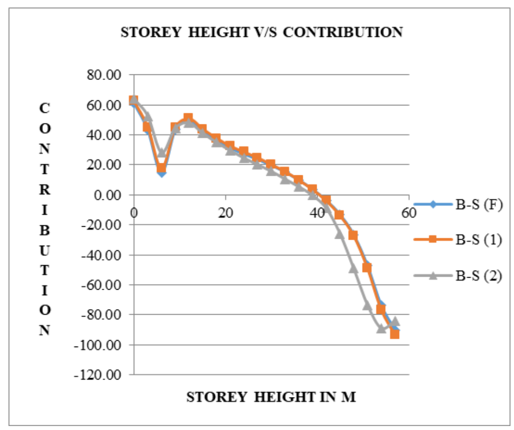

Fig. 4. Graph between Contribution vs. Storey Height

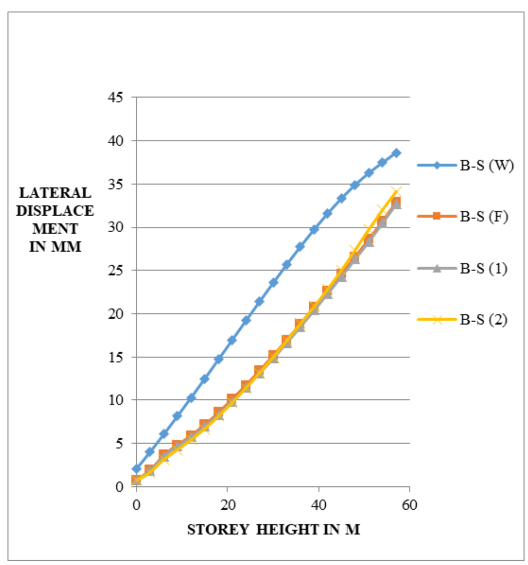

Fig. 5. Graph between Lateral Displacement vs. Storey Height

VII. Conclusion

Lateral load of multi storied building is studied by equivalent static analysis. Following conclusions are derived after the study of experimental and analytical results carefully:

1. In building having no shear wall, drift increases to the overall stories there after it remain constant about 2/3 of total height and then it decreases for last 4 stories.
2. Irrespective of type of provision of shear wall. In case of 60m drift increases gradually up to ½ of total height and thereafter it will increase in all the cases. In all the cases it is well within permissible limit. Removal of top five stories has no significant effect on drift.
3. In the case where shear wall is curtailed there after drift is less than that in frame having shear wall (in higher stories) though in lower stories it has increased still it does not result in soft storey. Hence investment in shear wall may be saved without impairing the structural strength.
4. Gradual reduction in thickness of shear wall has better drift control.

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