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COMPARATIVE STUDY ON ANALYSIS AND DESIGN OF G+ 12 STOREYS BUILDING WITH AND WITHOUT BASEMENT WALLS OF TWO BASEMENTS

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Abstract:

The earthquake phenomenon represents one of the maximum devastating forces that reasons no longer only loss to human lifestyles but cripples the economic system of a country as properly. Hence this project work is aimed to study the effect of basements with and without basement walls on seismic behaviour of multi storey building. In the present study seismic analysis has been done for a G+12 storey buildings with and without basement walls of two basements by using Strap (structural analysis programme) software.

Keywords — **Basements with & without basement walls, Seismic behaviour of multi storey building, G+12 storey building, Strap software.**

I. INTRODUCTION

A basement or cellar is one or more floors of a building that are either consummately or partially below the ground floor. The word cellar or cellars is utilized to apply to the whole underground level or to any sizably voluminous underground room. A sub cellar is a cellar that lies further underneath. A basement can be utilized in virtually precisely the same manner as an adscititious above-ground floor of a house or other building. However, the utilization of basements depends largely on factors categorical to a particular geographical area such as climate, soil, seismic activity, building technology, and authentic estate economics. There has been a growing trend to construct basements in the expedient of elongating accommodation and parking. Basements are additionally built as a component of both incipient residential and commercial developments however this is not an incipient trend. Recently, most of the high-elevate buildings may have basements utilized as parking lots or shopping malls etc. In general, it is commonly surmised that the building is fine-tuned at the ground level in the analysis and the basement is not included in the analytical model when the basement walls are connected to the floor deck and in between columns. Utilizing this posit, the natural periods may be abbreviated due to the flexibility introduced by the basements.

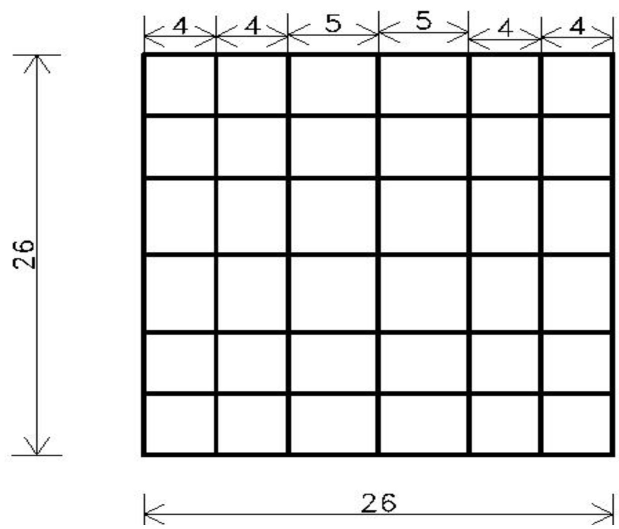


Fig 1: Layout of building (All dimensions in meters)

II. ANALYSIS OF G+ 12 STOREYS BUILDING WITH AND WITHOUT BASEMENT WALLS OF TWO BASEMENTS:

1	Type of structure	Multi storey special moment resisting frame
2	Zone	3
3	Layout	As shown in fig.1
4	Number of stories	G+12 storey building
5	Number of basements	2
6	Floor to floor height	3 m
7	External walls	230 mm
8	Internal walls	150 mm
9	Live load	3 kN/m^2
10	Material	M 25 and Fe415
11	Seismic analysis	Response Spectrum Method (IS 1893 (Part 1): 2002
12	Design philosophy	Limit state method conforming to IS 456 : 2000
13	Size of column	0.45 × 0.60 m
14	Size of beams in longitudinal and transverse direction	0.3 × 0.45 m
15	Thickness of slab	0.15 m
16	Thickness of basement wall	0.20 m
17	Response reduction factor	5
18	Importance factor	1

Table 1: Important features of building

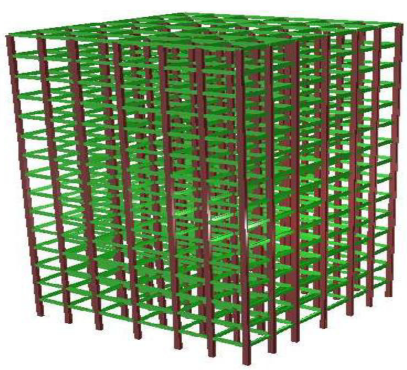


Fig 2: Isometric view of G+12 storey building including two basements without basement walls in strap software.

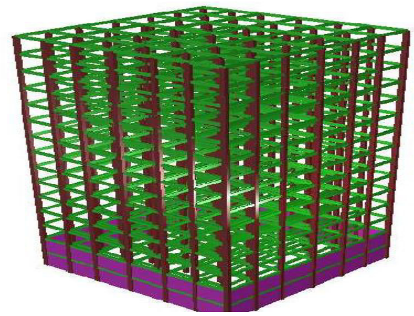


Fig 3: Isometric view of G+12 storey building including two basements with basement wall in strap software

III. Load combinations

The load combinations used for the seismic analysis are

1) 1.5(DL+LL)
2) 1.2(DL+LL+EQX1)
3) 1.2(DL+LL-EQX1)
4) 1.2(DL+LL+EQX3)
5) 1.2(DL+LL-EQX3)
6) DL+1.5EQX1
7) DL-1.5EQX1
8) DL+1.5EQX3
9) DL-1.5EQX3

IV. COMPARISON OF RESULTS:

Comparison of Modal results

Mode	Mass Participation	Time period	Frequency
1	0.788	2.3030	0.4342
2	0.014	2.0303	0.4925
3	0.098	0.7585	1.3184

Table 2: Modal results of G+12 storey building including two basements without basement walls

Mode	Mass Participation	Time period	Frequency
1	0.851	1.9693	0.4833
2	0.008	1.7563	0.5694
3	0.089	0.6910	1.4473

Table 3: Modal results of G+12 storey building including two basements with basement walls

It is observed that G+12 storey building without basement walls gives slightly higher time period when compared to building with basement walls. Due to inclusion of basement walls the stiffness is introduced to the building, hence time period is reduced.

Comparison of storey forces and storey shears

Storey	Without basement walls		With basement walls	
	Storey shears	Storey forces	Storey shears	Storey forces
2 Basement	1177.72	32.62	1054.09	0
1 Basement	1161.81	85.19	1054.09	1.8
Ground	1121.86	127.84	1054.09	64.03
1	1066.94	149.75	1017.09	92.85
2	1009.64	151.57	966.86	113.80
3	956.36	143.11	909.10	124.45
4	905.11	137.58	850.93	124.69
5	851.16	139.55	795.61	116.78
6	792.91	141.14	741.17	105.77
7	731.33	134.91	681.24	99.44
8	663.74	125.48	607.74	104.54
9	580.12	129.23	514.12	120.15
10	467.34	153.48	397.37	139.38
11	317.65	184.28	258.74	155.83
12	133.82	133.82	103.00	103.00

Table 4: Storey shears and Storey forces (kN) in X1 Direction

Storey	Without basement walls		With basement walls	
	Storey shears	Storey forces	Storey shears	Storey forces
2 Basement	1177.71	38.29	1054.08	0
1 Basement	1159.32	93.81	1054.08	1.8
Storey	Without basement walls		With basement walls	
	Storey shears	Storey forces	Storey shears	Storey forces
Ground	1116.53	135.45	1054.08	65.32
1	1060.97	153.45	1016.58	94.11
2	1005.54	151.03	965.20	114.54
3	954.81	140.15	907.14	124.55
4	904.62	135.81	849.05	124.25
5	849.58	140.95	793.57	116.01
6	789.34	144.43	739.57	104.98
7	726.70	137.67	679.47	98.95
8	659.78	126.16	605.62	104.41
9	577.76	128.53	511.62	120.11
10	466.10	153.25	394.69	139.05
11	316.48	184.29	256.31	154.78
12	132.56	132.56	101.60	101.60

Table 5: Storey shears (kN) in X3 Direction

From the above results it is observed that due to inclusion of basement walls the base shear is reduced because it is assumed that basements are fixed at ground level hence no lateral forces acting on basement storey's with basement walls.

Comparison of Lateral deflections

Storey	Without basement walls	With basement walls
2 Basement	0.9	0
1 Basement	2.4	0
Ground floor	4.2	0.7
1	5.8	1.9
2	7.4	3.3
3	8.9	4.7
4	10.3	6.1
5	11.6	7.4
Storey	**Without basement walls**	**With basement walls**
6	12.7	8.6
7	13.8	9.8
8	14.7	10.8
9	15.5	11.8

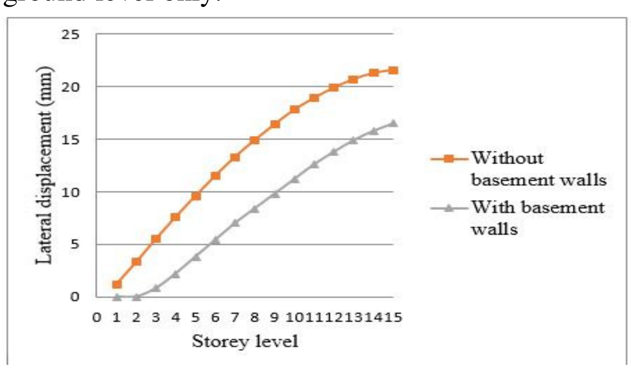
10	16.2	12.6
11	16.7	13.3
12	17.0	13.9

Table 6: Maximum Lateral deflection (mm) in X1 direction

Storey	Without basement walls	With basement walls
2 Basement	1.2	0
1 Basement	3.3	0
Ground floor	5.5	0.8
1	7.6	2.2
2	9.6	3.8
3	11.5	5.4
4	13.3	7.0
5	14.9	8.4
6	16.4	9.8
7	17.8	11.2
8	18.9	12.6
9	19.9	13.8
10	20.7	14.9
11	21.3	15.8
12	21.6	16.5

Table 7: Maximum Lateral deflection (mm) in X3 direction

A graph is plotted taking displacement on the ordinate and the storey level on the abscissa for both buildings with and without basements as shown in above figures. From the displacement profiles it is observed that due to inclusion of basement walls roof displacements are much reduced. When the basement walls are provided in the basements no lateral deflection is observed in basements due to building is assumed to be fixed at ground level only.



Graph 1: Graph plotted for Lateral displacement vs storey

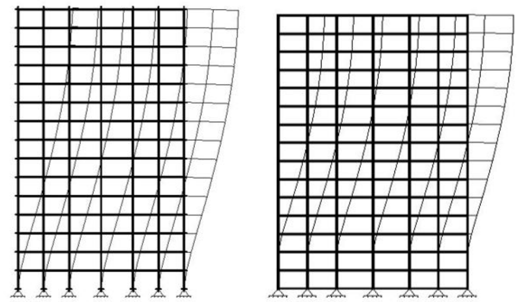


Fig 4: Mode shapes of building without and with basement wall

Comparison of storey drift

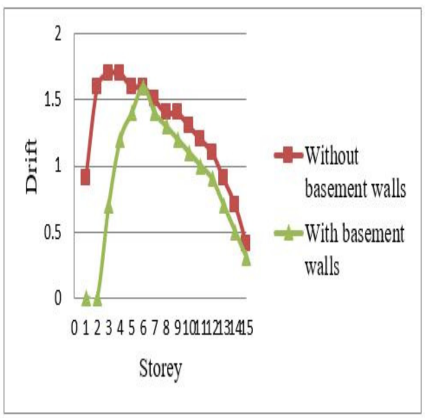
Storey	Without basement walls	With basement walls
2 Basement	0.9	0
1 Basement	1.6	0
Ground floor	1.7	0.7
1	1.7	1.2
2	1.6	1.4
3	1.6	1.6
4	1.5	1.4
5	1.4	1.3
6	1.4	1.2
7	1.3	1.1
8	1.2	1.0
9	1.1	0.9
10	0.9	0.7
11	0.7	0.5
12	0.4	0.3

Table 8: Storey Drift (mm) in X1 direction

Storey	Without basement walls	With basement walls
2 Basement	1.2	0
1 Basement	2.1	0
Ground floor	2.2	0.8
1	2.1	1.4
2	2.1	1.8
3	2.0	1.9

4	1.9	1.9
5	1.8	1.7
6	1.6	1.6
7	1.5	1.4
Storey	**Without basement walls**	**With basement walls**
8	1.4	1.3
9	1.2	1.0
10	1.0	0.8
11	0.7	0.5
12	0.4	0.3

Table 9: Storey Drift (mm) in X3 direction



Graph 2: Graph plotted for Storey drift vs Storey

A graph is plotted taking Storey drift on ordinate and the floor level on abscissa for both with and without basement walls. An abrupt change in drift profile indicates the stiffness irregularity. There is sudden change in the slope at first storey. The graph shows the storey drift is maximum for building without basement walls which are having soft storey's, this indicates ductility demand in basement storey column for this model is largest. However the storey drift profile becomes smoother right for building with basement walls indicating large stiffness and less ductility demand.

Storey	Member	Axial force		Moments		% of Reinforcement	Capacity
		Design	Actual	M2	M3		
Basement 2	122	4085	4019	44.6	18.4	1.86	1.01
Basement 1	255	3769	3714	58.9	8.5	1.40	1.01
Ground	288	3537	3411	64.1	3.9	1.16	1.03
1	521	3330	3134	65.3	4.12	0.93	1.06
2	654	3354	2882	65.4	5.79	0.93	1.16
3	787	3319	2607	64.9	6.3	0.93	1.27
4	920	3278	2334	64	6.7	0.93	1.40
5	1053	3224	2062.2	63	9	0.93	1.56
6	1186	3204.8	1791.1	62.1	11.1	0.93	1.78
7	1319	3119	1520	61	13.2	0.93	2.04
8	1452	2938	1227	59.3	15.2	0.93	2.38
9	1585	2721	957	53.8	41.8	0.93	2.83
10	1718	2430	690	49.6	40.7	0.93	3.50
11	1851	1873	422	45	40.2	0.93	4.41
12	1984	654	154	38.4	52.5	0.93	4.28

Table 10: Design results of typical column of G+12 storey building without

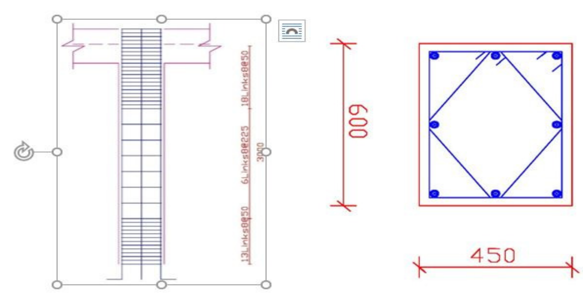


Fig 5: Typical reinforcement arrangement of column with basement wall

From the above results it is observed that the ductility demand in the basement columns is more when basement walls are not provided hence more percentage of steel is required in the columns without basement walls.

V. Conclusion

By studying all the above results it is concluded that due to inclusion of basement walls it is observed that there is a change in behaviour of basement columns. They requirement of ductility demand is reduced. It is also observed that due to basement walls roof displacements and base shears are also reduced under seismic forces. Therefore the effect of soft story damage is less observed in building with basement walls due to the stiffness obtained by the basement walls.

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