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STUDY OF SEISMIC BEHAVIOUR OF TUNNEL FORM BUILDINGS

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Abstract - *Tunnel form building technology invented over 50 year ago. Tunnel form buildings have been increasingly employed mass construction industry in many countries. The main components of tunnel form building technique system are walls and flat plate slabs. In this paper it deals about the performance of the buildings with tunnel form structure for seismic loading. It deals about the theoretical aspects of tunnel building and also the seismic loads acting on the building with different storey heights and different wall thickness. And finally deals about different parameters. Here the storey heights are taken as 6, 8, and 10storey with different wall thickness of 120mm, 150mm and 180mm and comparing with different parameters like Lateral displacement, Storey Drift and Stiffness. The models are done by making two different walls i.e. with wall opening and without wall opening. Using ETABS-2015 version software the building modeling of tunnel form building was carried out. The models are compared according to their results obtained from the analysis.*

Key Words: **Tunnel Form Buildings, Response spectrum Analysis, Shear wall.**

1. INTRODUCTION

Tunnel form building technology invented over 50 year ago. Tunnel form buildings have been increasingly employed mass construction industry in many countries. This system is widely recognized as modern construction method and it is very attractive for the medium to high-rise buildings with respective plans due to satisfactory performance during past earthquake, industrialized modular construction technique, it is low cost high quality and saving construction time period also. The main components of tunnel form building technique system are walls and flat plate slabs. Walls and the slabs having the same thickness and also cast in a single operation, so because of this reduces the number of joists in construction and results the monolithic structures provide a high seismic resistance.

Angitha Sasidharan, Mohammed Aslam (2015)[1] studied about the performance of tunnel form building is compared to that of framed building by linear dynamic response spectrum analysis by using SAP2000 software. N. H. Hamid, S. M. Saleh, S. A. Anuar (2014)[2] According to this paper, the tunnel form building was designed using BS 8110, constructed in heavy structural laboratory and using displacement control method, test is conducted under in-plane lateral cyclic loading. S Bahadir Yuksel (2014)[3] In this study it presents the experimental investigation on the inelastic seismic behaviour of the shear wall of the tunnel form buildings.

2. OBJECTIVES

The main objectives of the work is

1 Modeling of the tunnel form building with 3 different storeys that is 6, 8, and 10story with 3 different wall thicknesses that is 120, 150, and 180mm.
2 To study the lateral displacement, stiffness, story drift of the building and comparing with graphs.
3 To study the effect of thickness of shear wall for different building heights.
4 To comparing the above parameter both tunnel form building with seismic loads between opening and without opening.

3. ANALYTICAL MODEL

3.1. Tunnel form building model

In this work, tunnel form building of a plan was adopted. 3d models of 6, 8, and 10 story buildings were subjected to response spectrum analysis in ETABS 2015. Floor to floor height is 3.2m. Models are comprised to shear wall and 150mm thick slab. Typical wall thickness for 6, 8, and 10 storey models is 120mm, 150mm and 180mm respectively. Basically the tunnel form building model considered in two ways like no openings and with openings. Here for the wall opening model the size of opening is 1.2m x 1.2m. A minimum of 0.25% steel is provided for shear walls as vertical and horizontal reinforcement in accordance with IS 456:2000. Yield strength of the steel is taken as 415 MPa. M25 grade concrete was opted throughout the height of all models. Overall live load considered 2kN/m^2.

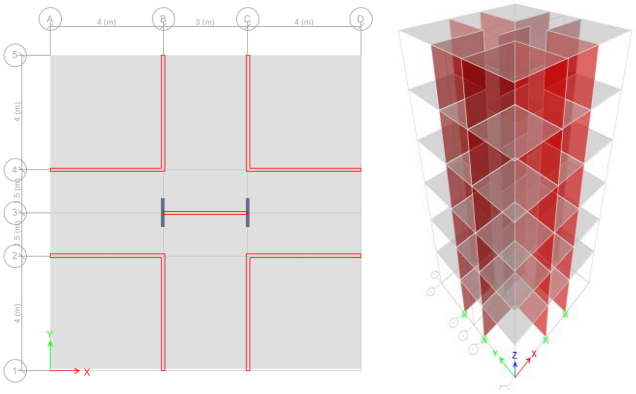

Fig 1 Plan and 3D view of the building (6 storey 120mm) without opening

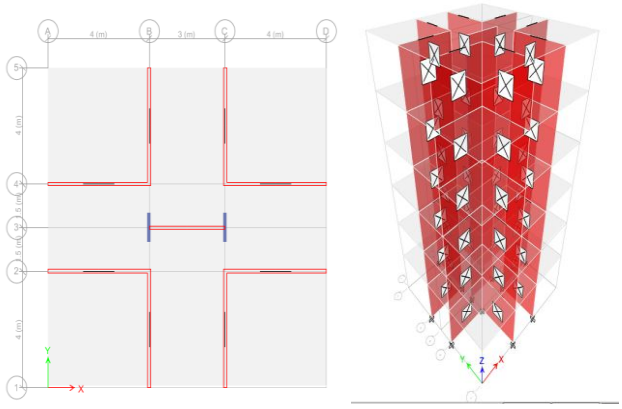

Fig 2 Plan and 3D view of building (6 storey 120mm) with opening

4. RESULTS AND DISCUSSIONS

4.1 Response Spectrum Analysis results for building model without wall opening

4.1.1 Comparison on Displacement For 6 storey building

Table 1 Storey displacement of 6 storey building

Storey	Displacement (mm)		
	120mm	150mm	180mm
Base	0	0	0
Story 1	0.00022	0.00018	0.00016
Story 2	0.00063	0.00052	0.00048
Story 3	0.00116	0.00097	0.00089
Story 4	0.00176	0.00147	0.00136
Story 5	0.00237	0.002	0.00184
Story 6	0.00298	0.00251	0.00232

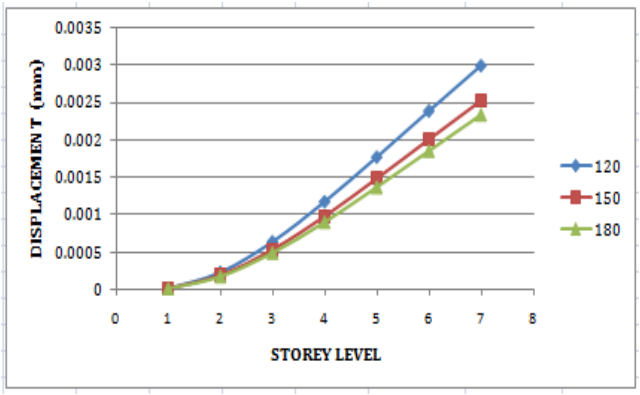

Chart -1: Storey displacement for 6 storey building

4.1.2 Comparison on Storey Drift for 6 storey building

Table 2 Storey drift of 6 storey building

Storey	Storey drift		
	120mm	150mm	180mm
Base	0	0	0
Story 1	6.029E-08	4.993E-08	4.6E-08
Story 2	1.279E-07	1.068E-07	9.8E-08
Story 3	1.668E-07	0.00000014	1.3E-07
Story 4	1.869E-07	1.577E-07	1.5E-07
Story 5	1.931E-07	1.636E-07	1.5E-07
Story 6	1.898E-07	1.622E-07	1.5E-07

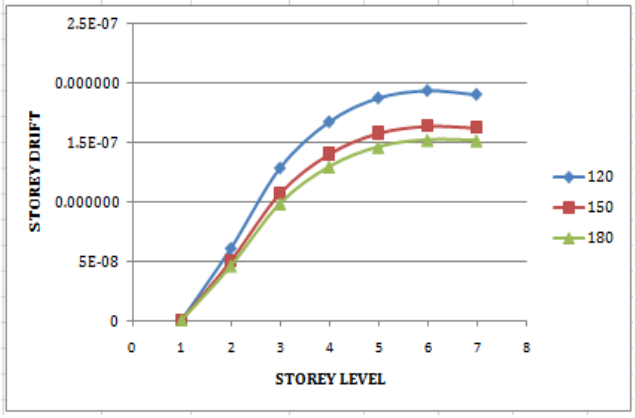

Chart -2: Storey drift for 6 storey building

4.1.3 Comparison on Storey Stiffness for 6 storey building

Table 3 Storey stiffness of 6 storey building

Storey	Storey stiffness (kN/m)		
	120mm	150mm	180mm
Base	0	0	0
Story 1	2040206.055	248628.07	2921254.739
Story 2	1042366.896	1259095.719	1472053.466
Story 3	735393.701	878879.834	1023977.912
Story 4	556309.527	662070.232	767914.732
Story 5	100540.716	474332.556	546699.93
Story 6	213693.466	250999.589	284058.977

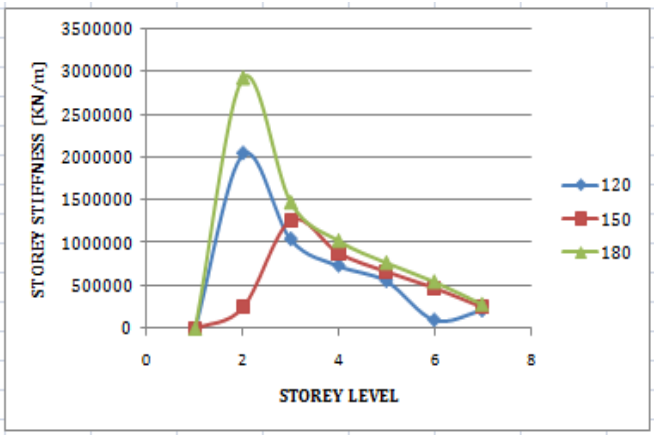

Chart -3: Storey stiffness in for 6 storey building

4.2 Response spectrum analysis results for building model with wall opening

4.2.1Comparison on Displacement For 6 storey building

Table 4 Storey displacement of 6 storey building

Storey	Displacement (mm)		
	120mm	150mm	180mm
Base	0	0	0
Story 1	0.0002029	0.0001798	0.0001638
Story 2	0.0005854	0.0005214	0.0004773
Story 3	0.001084	0.000969	0.0008894
Story 4	0.001642	0.001473	0.001355
Story 5	0.002219	0.001996	0.001839
Story 6	0.002786	0.002514	0.002322

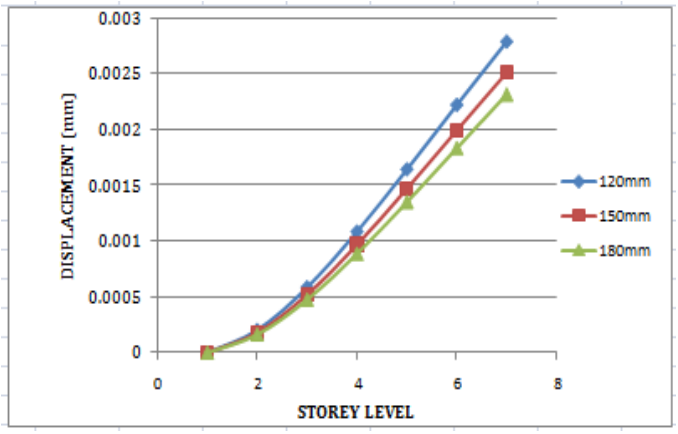

Chart -4: Storey displacement for 6 storey building

4.2.2 Comparison on Storey Drift for 6 storey building

Table 5 Storey drift of 6 storey building

Storey	Storey drift		
	120mm	150mm	180mm
Base	0	0	0
Story 1	5.637E-08	4.993E-08	4.551E-08
Story 2	1.196E-07	1.068E-07	0.000000981
Story 3	1.558E-07	0.00000014	1.289E-07
Story 4	1.747E-07	1.577E-07	1.457E-07
Story 5	1.806E-07	1.636E-07	1.516E-07
Story 6	1.778E-07	1.622E-07	1.511E-07

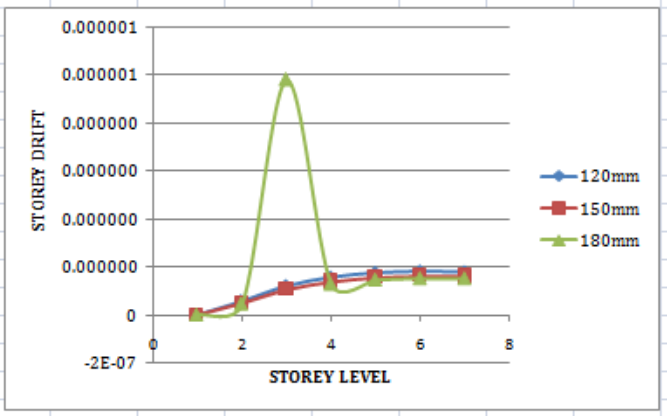

Chart -5: Storey drift for 6 storey building

4.2.3 Comparison on Storey Stiffness for 6 storey building

Table 6 Storey stiffness of 6 storey building

Storey	Storey stiffness (kN/m)		
	120mm	150mm	180mm
Base	0	0	0
Story 1	2041360.2	2482628.07	2921253.739
Story 2	1043684.3	1259094.72	1472053.466
Story 3	1460440.7	1753406.49	1531746.852
Story 4	1106316.3	1320463.48	2042698.97
Story 5	798982.73	945960.417	1090439.875
Story 6	429529.01	497323.206	562469.368

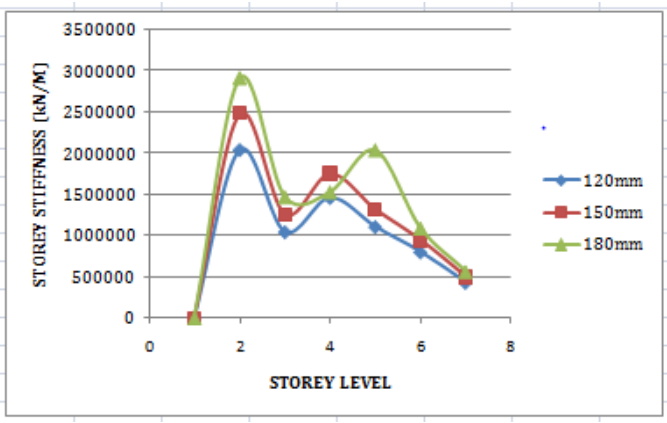

Chart -6: Storey stiffness for 6 storey building

4.3 Comparison on wall thickness

4.3.1 Comparison on displacement for 120mm wall thickness

Table 6 Displacement value for 120mm wall thickness

120mm wall thickness (values in mm)		
6 storey	8storey	10storey
0	0	0
0.000217	0.0003059	0.0004198
0.0006263	0.0009112	0.001277
0.00116	0.001732	0.002467
0.001757	0.002698	0.003906
0.002373	0.003748	0.005514
0.002979	0.004833	0.007227
	0.005918	0.008988
	0.006959	0.01074
		0.01248
		0.01415

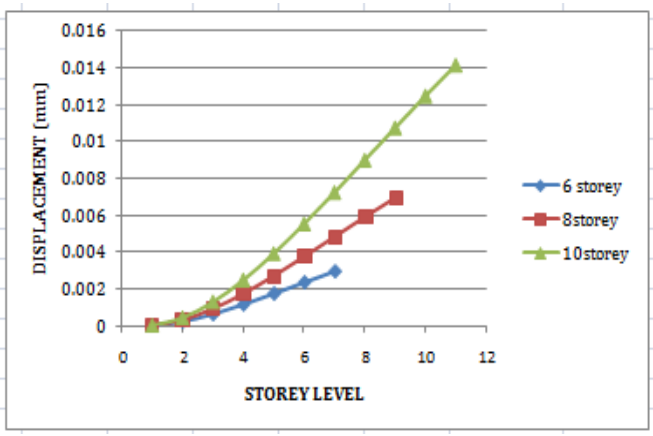

Chart -7: Displacement for 120mm wall thickness

4.3.2 Comparison on Storey Drift for 120mm wall thickness

Table 7 Storey drifts value for 120mm wall thickness

120mm wall thickness		
6 storey	8 storey	10 storey
0	0	0
6.029E-08	8.498E-08	1.166E-07
1.279E-07	1.892E-07	2.678E-07
1.668E-07	2.569E-07	3.723E-07
1.869E-07	3.023E-07	4.501E-07
1.931E-07	3.289E-07	0.000001
1.898E-07	0.00000034	0.000001
	3.407E-07	0.000001
	3.282E-07	0.000001
		0.00001
		0.00001

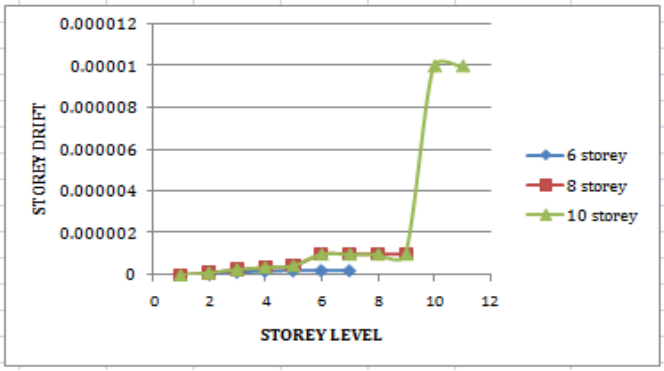

Chart -8: Displacement for 120mm wall thickness

4.3.3 Comparison on storey stiffness for 120mm wall thickness

Table 8 Storey stiffness value for 120mm wall thickness

120mm wall thickness		
6 storey	8 storey	10 storey
0	0	0
2040206.055	1796716.273	1621448.421
1042365.896	889228.246	784762.437
735392.701	622342.751	547397.433
556308.527	485665.588	429990.995
100539.716	393362.35	356775.485
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	230714.035	254310.534
	124202.232	207953.062
		150266.484
		78818.429

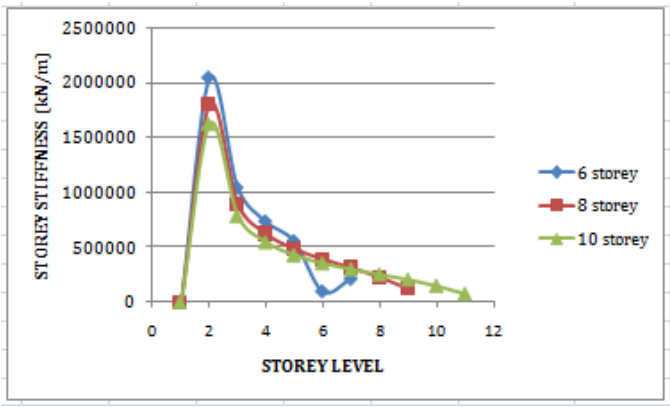

Chart -9: Storey stiffness for 120mm wall thickness

4.4 DISCUSSIONS

- When comparing the all values, the displacement for 120mm wall thickness is more at 10 storey building than 6 storey building
- The storey drift is more at 10 storey than 6 storey building.
- The storey stiffness is more at 6 storey than 8 and 10 storey building.

5. CONCLUSIONS

- From the displacement discussion for both storey height and wall thickness comparison for with and without wall opening, it is concluded that the storey height is increasing the storey displacement is also increasing. i.e. 6 storeys, 8 storey and 10 storey building, the displacement is more at 10 storey than 6 storey. And also concluded that, displacement is also depends on wall thickness. If the wall thickness is more the displacement is comparatively less.

- From the storey drift discussion it concluded that, the storey drift in tunnel form building is higher for the top stories. If the storey height is increases the storey drift also increase i.e. 10 storey building has more drift than 6 storey building. It also concluded that if wall thickness is more the storey drift is less.

- From the storey stiffness discussion for tunnel form building, it concluded that storey stiffness is gradually decreases when the storey height is increases. From the comparison of the storey height i.e. 6 storey, 8 storey and 10 storey, the stiffness is more at 6 storey building than 10 storey building. 4

- So it concluded that if the storey height is less it will give more stiffness. And also concluded that stiffness is mainly depends on the thickness of the wall. If the wall thickness is more the stiffness is also more.

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