

Research Article

Determination of Efficient Twin Tower High Rise Building Subjected to Seismic Loading

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Abstract

The architectural vision in this era of multistoried building design has seen a demanding growth. Various competitors among them used to make the structure with their own choices and it has been proved that the high-rise buildings act as very vital role in new and modern cities. It should solve the problem of construction area along with the architectural view. With complex and different plan on same land needs the dependability on the structural point of view. Such types of structures are Twin tower buildings used in this modern world. In this study, the parametric comparison of results such as displacement and storey drift are obtained in terms of the twin tower multistoried building situated in seismic Zone-IV, seismic effects are acting on the structure under 13 different cases and analyze with the help of Staad pro program.

Keywords: Efficient case, Lateral Loads, Response spectrum, Seismic Effects, Staad pro, Twin Tower.

1. Introduction

The use of high rise structure led the structural engineer to analyze and design as per drastic earthquake effects. Now days, Twin towers are highly in demand due to its archi-structural design, individual plan along with more space with same foundation support. For that, we should know the efficient point parameters when these kinds of structures are in the contact of seismic loads.

2. Objective

This study examines different parameters like displacements in longitudinal and transverse direction. After this, storey drift is calculated in both X as well as Z direction. The most efficient case will be analyzed after all parameters. There are total 13 cases of twin tower multistoried building at medium soil condition under seismic forces for earthquake zone IV exist.

3. Structure Modeling

The space frame has been modeled in Staad pro software. The twin tower descriptions of the multi storey structure are listed in Table 1 and Table 2 and

shown graphically with the help of graphs. Top view and front view of various cases of G+12 building shown by the help of figures. Table 3 shows various cases used in this paper up to 12 floor twin with 13 different cases. After than efficient cases for each parameter along with its remarks has drawn below each parameters.

Table 1 Details of building

Building configuration	G + 12 (I shaped)
No. of bays in X direction	4
No. of bays in Z direction	5
Height of building	50.58 m
Dimensions of building	15 m x 12 m
Size of beam	500 mm x 350 mm
Size of column	500 mm x 500 mm
Concrete and Steel Grade	M25 & Fe 415 grade

Table 2 Details of loading

Earthquake parameters	Zone IV with RF 5 & 5% damping ratio
Period in X & Z direction	0.3393 & 1.1753 seconds
Dead load for floor and roof	12 KN/m ² & 10 KN/m ²
Live load for floor and roof	4 KN/m ² & 2 KN/m ²

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Table 3 Details of twin tower cases

CASE A	G + 12 (no floor twin)
CASE B	G + 12 (1 floor twin)
CASE C	G + 12 (2 floor twin)
CASE D	G + 12 (3 floor twin)
CASE E	G + 12 (4 floor twin)
CASE F	G + 12 (5 floor twin)
CASE G	G + 12 (6 floor twin)
CASE H	G + 12 (7 floor twin)
CASE I	G + 12 (8 floor twin)
CASE J	G + 12 (9 floor twin)
CASE K	G + 12 (10 floor twin)
CASE L	G + 12 (11 floor twin)
CASE M	G + 12 (12 floor twin)

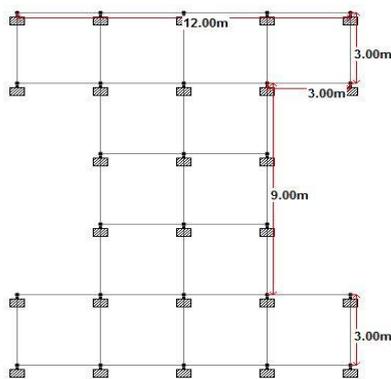


Fig. 1 Twin tower plan

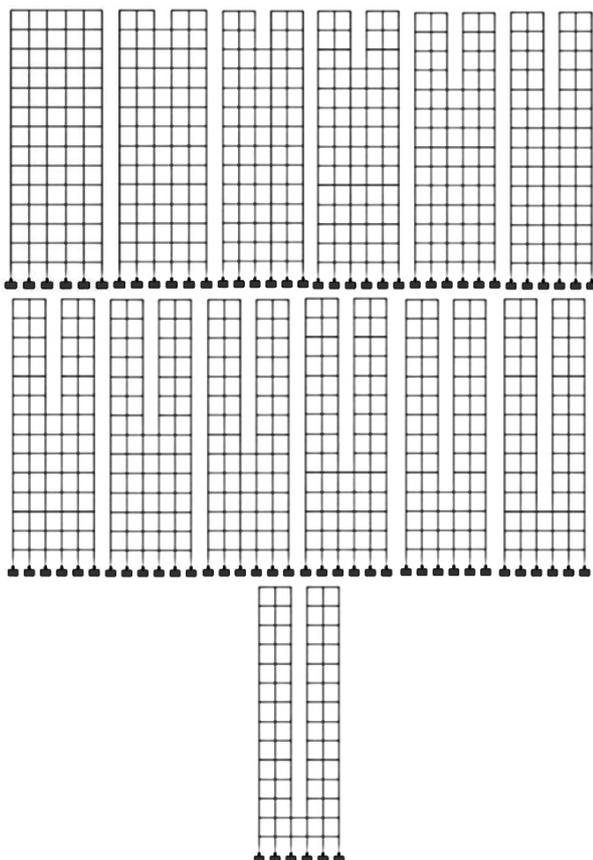


Fig. 2 Multi-storey building with different twin tower cases

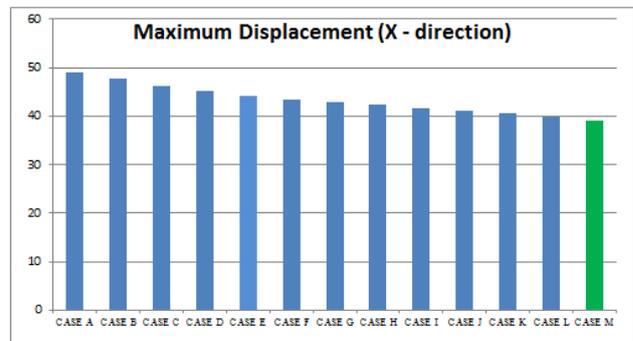
4. Results and Discussion

The analysis was done for seismic ZONE IV. Analytic results for medium soil condition for different twin tower cases are as follows:-

Results due to Seismic force definitions

Table 4 Maximum Displacement in X direction for all 13 cases in Zone IV

Twin Tower Cases	Maximum Displacement in X - direction(mm)
CASE A	49.051
CASE B	47.8
CASE C	46.345
CASE D	45.183
CASE E	44.257
CASE F	43.507
CASE G	42.873
CASE H	42.297
CASE I	41.734
CASE J	41.146
CASE K	40.51
CASE L	39.814
CASE M	39.059



Graph 1 Maximum Displacement in X direction for various twin tower cases

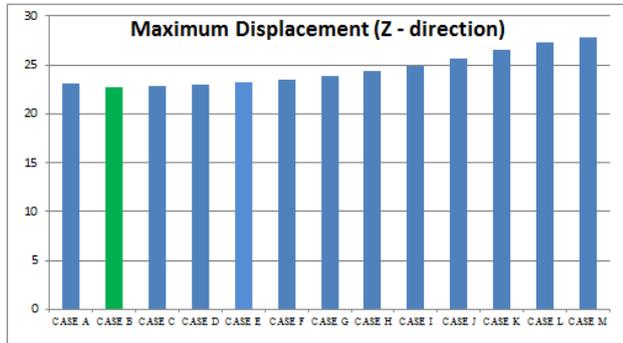
Table 5 Efficient Displacement case

Efficient case	Remarks
Case M	Whenever 12 floor twin are used in G+12 storey effective point case for displacement parameter in X direction will be Case M

Table 6 Maximum Displacement in Z direction for all 13 cases in Zone IV

Twin Tower Cases	Maximum Displacement in Z - direction (mm)
CASE A	23.151
CASE B	22.776
CASE C	22.81
CASE D	22.947
CASE E	23.189
CASE F	23.521

CASE G	23.926
CASE H	24.383
CASE I	24.873
CASE J	25.614
CASE K	26.552
CASE L	27.326
CASE M	27.817



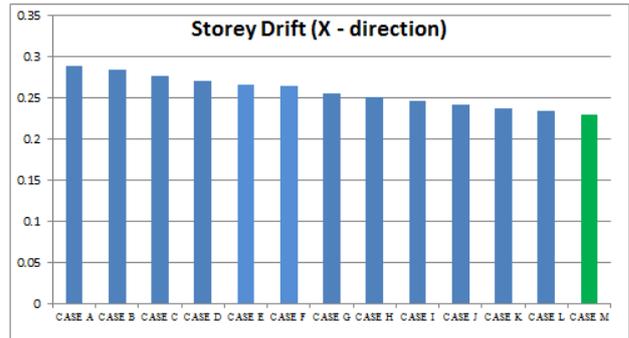
Graph 2 Maximum Displacement in Z direction for various twin tower cases

Table 7 Efficient Displacement case

Efficient case	Remarks
Case B	Whenever 1 floor twin are used in G+12 storey effective point case for displacement parameter in Z direction will be Case B

Table 8 Storey Drift in X direction for all 13 cases in Zone IV

S. No.	Height (m)	Storey Drift (cm)						
		For X Direction						
		CASE A	CASE B	CASE C	CASE D	CASE E	CASE F	CASE G
1	0	0	0	0	0	0	0	
2	3	0.104	0.1027	0.1008	0.099	0.0972	0.945	0.0936
3	6.66	0.2404	0.2373	0.2329	0.2286	0.2244	0.2203	0.2162
4	10.32	0.268	0.2643	0.2592	0.2543	0.2496	0.245	0.2405
5	13.98	0.2796	0.2754	0.2699	0.2646	0.2596	0.2547	0.25
6	17.64	0.2862	0.2817	0.2757	0.27	0.2647	0.2597	0.2548
7	21.30	0.2888	0.2838	0.2773	0.2713	0.2657	0.2604	0.2554
8	24.96	0.287	0.2815	0.2745	0.268	0.2621	0.2566	0.2515
9	28.62	0.2804	0.2744	0.2667	0.2598	0.2536	0.2479	0.2427
10	32.28	0.2687	0.2621	0.2537	0.2462	0.2396	0.2338	0.2294
11	35.94	0.2514	0.2441	0.2349	0.2269	0.22	0.2149	0.214
12	39.60	0.2281	0.2201	0.2101	0.2015	0.1954	0.1945	0.1942
13	43.26	0.1988	0.1899	0.1791	0.1712	0.1698	0.1696	0.1693
14	46.92	0.1633	0.1536	0.1433	0.1408	0.1401	0.1397	0.1393
15	50.58	0.1255	0.1159	0.1116	0.1098	0.1087	0.108	0.1073
S. No.	Height (m)	CASE H	CASE I	CASE J	CASE K	CASE L	CASE M	
1	0	0	0	0	0	0	0	
2	3	0.0918	0.0901	0.0883	0.0865	0.0847	0.083	
3	6.66	0.2121	0.2081	0.204	0.1999	0.1958	0.1917	
4	10.32	0.236	0.2315	0.227	0.2226	0.2181	0.2136	
5	13.98	0.2454	0.2407	0.2361	0.2315	0.227	0.2227	
6	17.64	0.25	0.2453	0.2407	0.2363	0.2323	0.228	
7	21.30	0.2506	0.2459	0.2416	0.2382	0.2344	0.23	
8	24.96	0.2467	0.2425	0.2398	0.2367	0.2329	0.2286	
9	28.62	0.2386	0.2366	0.2342	0.2312	0.2275	0.2233	
10	32.28	0.228	0.2266	0.2244	0.2215	0.218	0.2139	
11	35.94	0.2133	0.2119	0.2099	0.2072	0.2039	0.2001	
12	39.60	0.1936	0.1923	0.1904	0.188	0.185	0.1815	
13	43.26	0.1687	0.1675	0.1658	0.1637	0.1611	0.1581	
14	46.92	0.1386	0.1376	0.1362	0.1344	0.1322	0.1297	
15	50.58	0.1066	0.1057	0.1045	0.1031	0.1015	0.0996	



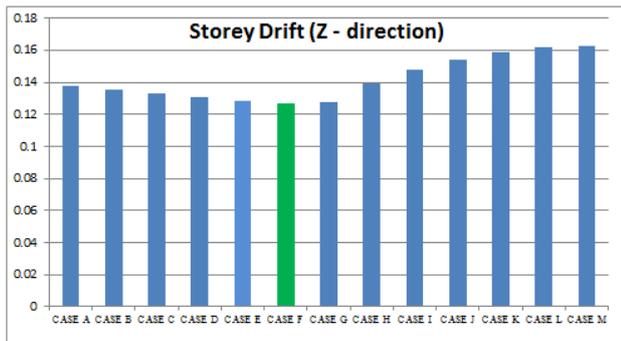
Graph 3 Storey drift in X direction

Table 9 Efficient Displacement case

Efficient case	Remarks
Case M	Whenever 12 floor twin are used in G+12 storey effective point case for storey drift parameter in X direction will be Case M

Table 10 Storey Drift in Z direction for all 13 cases in Zone IV

S. No.	Height (m)	Storey Drift (cm)						
		For Z Direction						
		CASE A	CASE B	CASE C	CASE D	CASE E	CASE F	CASE G
1	0	0	0	0	0	0	0	
2	3	0.0493	0.0487	0.0479	0.047	0.0462	0.0454	0.0446
3	6.66	0.1149	0.1135	0.1114	0.1095	0.1076	0.1058	0.1041
4	10.32	0.1286	0.1269	0.1246	0.1224	0.1204	0.1185	0.1168
5	13.98	0.1341	0.1322	0.1298	0.1275	0.1254	0.1236	0.122
6	17.64	0.1371	0.135	0.1324	0.13	0.1279	0.1261	0.1247
7	21.30	0.1379	0.1357	0.1329	0.1304	0.1283	0.1266	0.1253
8	24.96	0.1365	0.1341	0.1311	0.1285	0.1264	0.1248	0.1239
9	28.62	0.1328	0.1301	0.1269	0.1242	0.1221	0.1207	0.1212
10	32.28	0.1266	0.1236	0.1201	0.1173	0.1153	0.1151	0.1249
11	35.94	0.1177	0.1144	0.1106	0.1077	0.1066	0.1144	0.1275
12	39.60	0.106	0.1024	0.0983	0.0959	0.1014	0.1126	0.1194
13	43.26	0.0914	0.0875	0.0836	0.0863	0.0951	0.1011	0.1071
14	46.92	0.0741	0.0701	0.0699	0.076	0.0806	0.0858	0.0917
15	50.58	0.0563	0.0544	0.0577	0.0605	0.0645	0.0694	0.0751
S. No.	Height (m)	CASE H	CASE I	CASE J	CASE K	CASE L	CASE M	
1	0	0	0	0	0	0	0	
2	3	0.0439	0.0431	0.0424	0.0417	0.041	0.0403	
3	6.66	0.1025	0.101	0.0995	0.0981	0.0968	0.0967	
4	10.32	0.1152	0.1138	0.1124	0.1113	0.1117	0.1215	
5	13.98	0.1206	0.1194	0.1185	0.1193	0.1308	0.1415	
6	17.64	0.1235	0.1228	0.1238	0.1363	0.1494	0.1515	
7	21.30	0.1246	0.1257	0.1384	0.153	0.1569	0.158	
8	24.96	0.1248	0.1372	0.1525	0.1579	0.1608	0.1616	
9	28.62	0.1326	0.1479	0.1544	0.1588	0.1616	0.1624	
10	32.28	0.1394	0.1465	0.1521	0.1565	0.1593	0.1601	
11	35.94	0.1347	0.141	0.1465	0.1509	0.1538	0.1548	
12	39.60	0.1258	0.132	0.1376	0.1421	0.1452	0.1464	
13	43.26	0.1134	0.1197	0.1254	0.1301	0.1333	0.1347	
14	46.92	0.098	0.1043	0.1101	0.1151	0.1185	0.1202	
15	50.58	0.0814	0.0878	0.0938	0.0989	0.1026	0.1046	



Graph 4 Storey drift in Z direction

Table 11 Efficient Displacement case

Efficient case	Remarks
Case F	Whenever 5 floor twin are used in G+12 storey effective point case for storey drift parameter in Z direction will be Case F

Conclusions

- 1) The design of twin towers building subjected to seismic effects cannot be based on analytical results obtained from general multistoried structure. As seen in results, the displacement values for twin tower cases for X direction gradually decrease to a lesser value of 39.059 mm i.e. Case M. Percentage decrease seems to be 20.37%.
- 2) Displacement values for Z direction seem to be decrease by 18.12 %.
- 3) Mass participation factor as per clause 7.8.4.2 of IS 1893, it has been noted that at least 90% of total seismic mass should be achieved to evaluate the response quantities and required mode shapes. So, Case A to D gives the satisfied values and beyond that, cutoff mode shape commands with maximum modal values have to be used.

- 4) When storey take part in drift, for X direction, maximum case will be Case A while comparing with minimum case i.e. Case M, it seems to be downfall of 20.37%.
- 5) The plan of building which divides the whole structure into two parts for various cases, storey drift values seems to be maximum Case value of M and minimum value of F with a fall of 22.04%.

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