The Study on Effectiveness of Different Framing Systems In Resisting Lateral Loads In Steel Framed Building with and without Bracing

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Abstract- *Now a day it is difficult in tall buildings to achieve the permissible lateral displacement that is seismic and wind displacements so that the building could be safe for its service life time. For this purpose, the different structural steel framing tube systems are used to satisfy the seismic loads, wind loads, storey drifts, storey shear etc. By keeping this point in a view the investigation is carried out. The investigation consists of effectiveness of different structural steel framing tube system with bracing and without bracing. The three different framing tube systems used are framed tube, tube-in-tube, and bundled tube system with bracing and without bracing for each tube system. The 80 storey building having height of each storey 3.2m is analyzed for different framing tube system. The building size is 54mx36m.The total of six models are analyzed in ETABS v2016 software that is 1) Framed tube building without bracing,2) Framed tube building with bracing,3) Tube-in tube building without bracing,4) Tube-in-tube building with bracing,5) Bundled tube building without bracing,6) Bundled tube building with bracing. The models were analyzed by considering equivalent static method and linear dynamic method (response spectrum consideration). The results conclude that the bundled tube building provided with bracing is much more stable in terms of reducing the lateral displacements, storey drifts when compared to remaining other five models.*

Keywords- Equivalent static analysis, response spectrum analysis, framed tube, tube-in-tube, bundled tube, ETABS.

I. INTRODUCTION

Now a day's tall buildings are becoming gradually slender, leading to the option of more sway in assessment with earlier high-rise buildings. This is the most tough task for the engineers to fulfill the gravity loads and lateral loads. In history the buildings were designed to resist for the gravity loads but now days because of the height and seismic zone factor the designers have to take care of lateral loads which includes earthquake forces and wind forces. In tall structures the height is comparative term. From structural engineering aspect, all the tall structures must be capable of resisting the gravity loads and also lateral loads.

For the study of designing in structural engineering the framing system and tube system should be designed as a hollow tube, which is cantilevered as perpendicular to the ground to withstand lateral loads (wind, seismic, etc.). Due to improvement in structural systems the use of high strength materials, slenderness, reduction of building weight, use of high strength materials, increase in building height etc., has considered the lateral loads such as wind and earthquake in the process of designing. Lateral forces developed in the building due to wind and seismic actions must be considered for designing purpose. Lateral displacement of high rise steel buildings must be restricted, not only for resident's comfort and safety, but also to take care of secondary structural effects.

There are many tubular structural systems, few of them are:

1. Shear-wall frame
2. Rigid frame
3. Tube in Tube
4. Bundled tube
1. 5.Braced frame

The concept of tube system is purely based on the idea that the building is designed for resisting the lateral loads (seismic, wind etc.) by designing it as a hollow cantilever tube perpendicular to the ground. For the simple construction of tube structure, the periphery of the building is provided with the closely spaced columns which are then connected to main beams to form equal distribution of moments. This connection of beams and columns makes the building more rigid and increases the structural strength.

Tube structural systems

The lateral loads mainly the seismic and wind loads start to effect the structural framing system and their effect increases as the building height increases and becomes slenderer. The seismic and wind loads are more important in tube structural system. Thus such loads (seismic, wind) are greatly resisted by the tubular designs. Tube structures are also provided for their stiffness property over the other framing system. Tubular structures also have the advantage of reducing the materials used for the frame construction. This decrease in material quantity makes building more economical with more efficiency and with the less effect on environment. Tubular framing system helps to provide good interior space for use with the well supported connections.

Some of the tube structural systems are

- Framed tube structure
- Tube-in-tube structure
- Bundled tube structure

Framed tube building

The framed tube structural system is one of the type framing system. It consists of the exterior columns which are closely spaced. These framing system is best suitable for the buildings provided with rectangular or regular plan configuration. The horizontal loads such as wind and seismic loads acting on the building are reduced to small amount by the peripheral framing system. The framed tube system provides good interior space.

The first framed tube structure built was Dewitt chestnut building located in Chicago. This construction helps and promotes the further construction of world trade Centre which is also a framed tube structure.

Tube in tube building

The most common type of tubular structure is tube in tube framing system. Tube in tube frame consists of inner tube therefore it is called as tube in tube. The internal tube can be used to provide staircase, fire safety room, etc. Most of the lateral loads (seismic, wind) are greatly resisted by peripheral tubes but due to presence of internal tube the structure becomes more rigid and hence there is reduction in storey displacement.

The first tube in tube structure built was one shell plaza located in Texas of United States of America.

Bundled tube building

Bundled tube framing system is the another type of tubular structure. It consists of the tubes bundled with each other vertically. This bundled tube causes the decrease in the lateral loads such as wind and seismic loads and also reduces the storey drifts. The bundled tube not only reduces the loads and material requirements but also it provides the good architectural and good aesthetic appearance. The bundled tube type of buildings constructed are Willis tower now days it is called as sears tower, one magnificent mile.

DESCRIPTION OF MODELS

MODEL 1 (M1): The 80 storey building is modeled without bracing as framed tube building in which the outer core is provided with columns spaced at every 2m intervals. The remaining inner columns are placed at 6m in X-direction and 4m in Y-direction.

MODEL 2 (M2): The 80 storey building is modeled with bracing as framed tube building in which the outer core is provided with columns spaced at every 2m intervals. The remaining inner columns are placed at 6m in X-direction and 4m in Y-direction.

MODEL 3 (M3): The 80 storey building is modeled without bracing as tube in tube building in which the outer tube peripheral columns are spaced at 2m intervals. The inner tube of size 30m*20m is formed. The peripheral columns of inner tube is also spaced at 2m intervals. The remaining columns of outer and inner tube are placed at 6m in X-direction and 4m in Y-direction.

MODEL 4 (M4): The 80 storey building is modeled with bracing as tube in tube building in which the outer tube peripheral columns are spaced at 2m intervals. The inner tube of size 30m*20m is formed. The peripheral columns of inner tube is also spaced at 2m intervals. The remaining columns of outer and inner tube are placed at 6m in X-direction and 4m in Y-direction.

MODEL 5 (M5): The 80 storey building is modeled without bracing as bundled tube building in which the building configuration changes with respect to the storeys vertically. This vertical change in area and size of the building for different storeys makes the tube bundled with each other.

MODEL 6 (M6): The 80 storey building is modeled with bracing as bundled tube building in which the building configuration changes with respect to the storeys vertically. This vertical change in area and size of the building for different storeys makes the tube bundled with each other.

Details of building:

- No of stories = 80(G+79)

- Plan area size = 54m x 36m
- Height of each story = 3.2m
- Slab section = Deck (composite) slab
- Size of columns = 800X800X50mm (steel tube)
- Size of main beams = ISMB 600
- Size of secondary beams = ISMB 225
- Grade of concrete = M40
- Grade of steel = Fe 345
- Live load = 3 KN/m
- Floor finish =1 KN/m
- Glazed wall load = 1 KN/m (Peripheral walls)
- Size of each main grid = 6m*4m

Properties of materials:

- Density of concrete =25 KN/m3
- Density of steel=76.59 KN/m3
- Density of glass= 25.408 KN/m3
- Young's modulus of concrete = 25*106 KN/m2

Details of bracings used:

- Type of bracing= X-bracing
- Bracing section = ISWB500
- Procedure: X-type bracing of ISWB500 is applied for each 10 storeys for model 2, model 4, model 6.

Seismic Data:

- Code book used= IS 1893:2002
- Seismic zone factor Z= 0.10 (Zone 2)
- Site type = Type 2 (medium)
- Importance factor =1.5
- Response reduction factor R = 5
- Time period =0.085*h0.75
  =0.085*2560.75
  =5.43 sec

Wind Data:

- Code book used =IS 875:1987 (part3)
- Wind Speed = 44m/s (Hyderabad)
- Terrain Category = 2
- Structure Class = A
- Risk coefficient factor K1 =1
- Topography factor K3 =1
- Windward coefficient =0.8
- Leeward coefficient =0.5

Codes referred for investigation:

Following code books were referred are as follows:

- For Concrete-IS 456:2000
- For Steel- IS 800:2007
- For wind loads- IS 875:1987
- For earthquake loads – IS 1893:2002

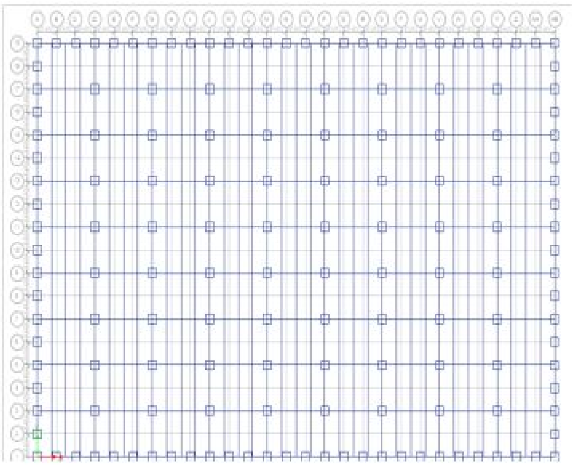
Column spacing for different models:

Model 1 and model 2: Spacing of peripheral columns is 2m and remaining columns are spaced at 6m and 4m in X-direction and Y-direction respectively.

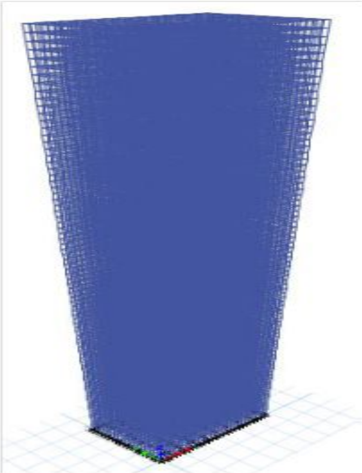
Model 3 and model 4: Spacing of outer and inner tube peripheral columns is 2m and remaining columns are spaced at 6m and 4m in X-direction and Y-direction respectively.

Size of the inner tube=30m*20m

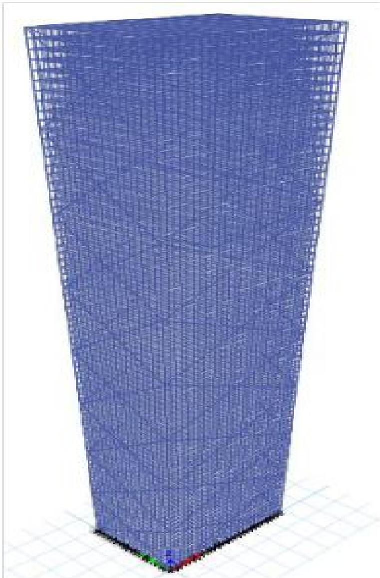
Model 5 and model 6: Spacing of peripheral columns is 2m and remaining columns are spaced at 6m and 4m in X-direction and Y-direction respectively. Here columns are eliminated for upper storeys to form bundled tube.



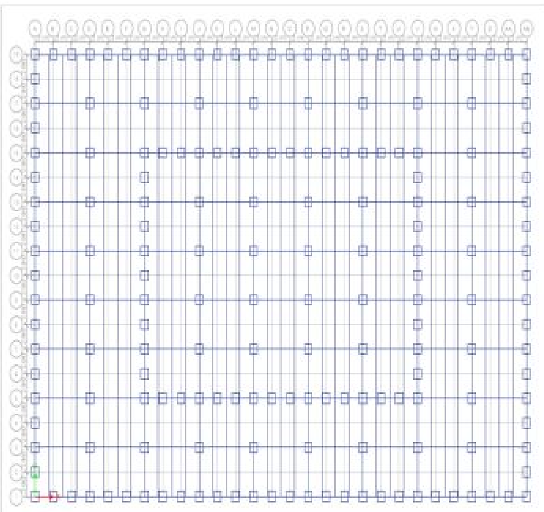
plan of model 1 and model 2



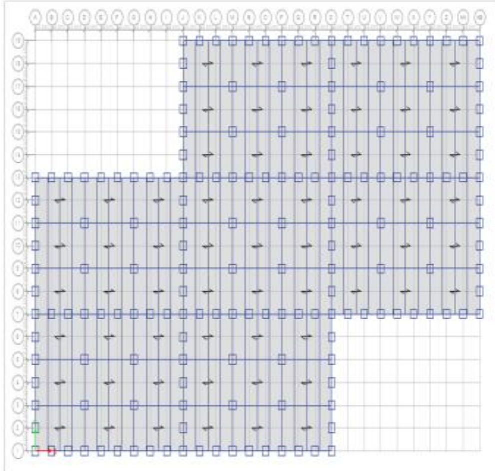
3-D view of model 1



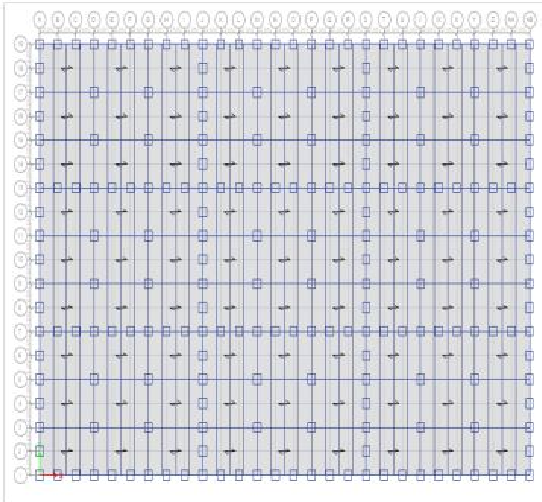
3-D view of model 2



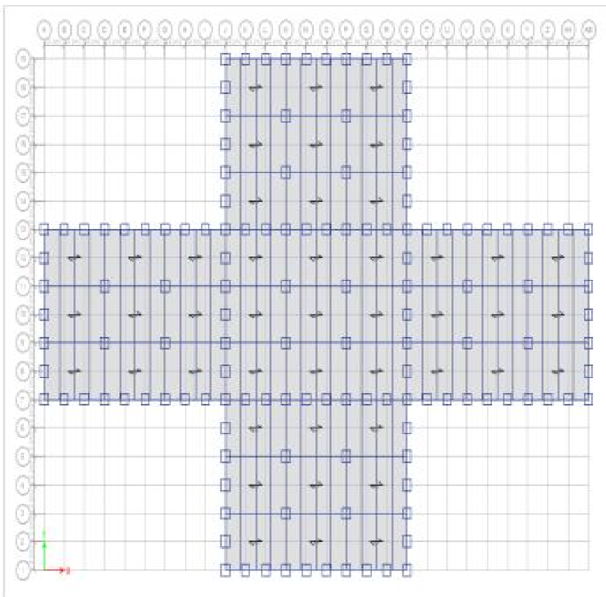
plan of model 3 and model 4



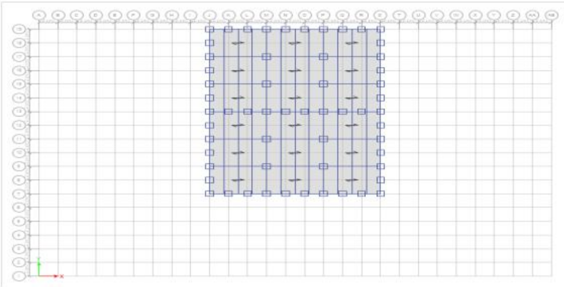
plan of model 5 and model 6 for storey 45-59



plan of model 5 and model 6 for storey 1-45



plan of model 5 and model 6 for storey 59-69



plan of model 5 and model 6 for storey 69-80

3-D view of model 5

3-D view of model 6

RESULTS AND DISCUSSIONS

Storey displacement:

The building is analyzed for each model and their corresponding displacement values are known. The displacement values include the seismic displacements and wind displacements. According to IS 1893:2002 codes the maximum permissible displacement for a building is (h/500), where “h” is the height of the building.

The models used for investigation should also well within the displacement values. For our investigation the total height of the 80 storey building is 256m with each storey height of storey height of 3.2m.

Therefore, the allowable displacement for our investigation should be less than or =h/500
=256/500=0.512m
=512mm

The seismic and wind displacements in X-direction and Y-direction for all the six models are shown in below tables. The max. seismic displacements and wind displacements obtained in X-direction and Y-direction for our investigation is observed in framed tube building without bracing (model 1) is 56.011mm and 65. 823mm for seismic, 208.114mm and 362.966mm for wind respectively. These obtained displacement values are well within the allowable displacement values.

Storey drift:

Storey drift is the displacement between two stories. According to the IS 1893:2002 code the maximum permissible storey drift is =0.004*h, where “h” is the height of one storey. For our investigation the building models analyzed are having height of 3.2m for each storey.

Therefore, the maximum permissible storey drift for our investigation should not exceed=0.004*3.2=0.0128m or 12.8mm

The storey drift due to seismic and wind effect in X-direction and Y-direction for all the six models are shown in the tables below. The maximum storey drifts due seismic and wind effect in X-direction and Y-direction for our investigation is observed in framed tube building without bracing (model 1) is 0.000066mm and 0.000108mm for seismic, 0.000208mm and 0.000521mm for wind respectively. The obtained values of storey drift are well within the maximum permissible drift values.

Table showing seismic and wind displacement for all models:

No. of storey	Seismic Displacement in mm						Wind Displacement in mm					
	M1	M2	M3	M4	M5	M6	M1	M2	M3	M4	M5	M6
80	118.536	103.254	113.699	100.6	84.723	75.22	362.966	313.784	324.938	285.506	260.975	229.588
79	117.878	102.602	113.055	99.96	84.22	74.748	361.298	312.12	323.41	283.979	259.758	228.456
78	117.192	101.927	112.384	99.298	83.688	74.247	359.58	310.414	321.837	282.413	258.495	227.278
77	116.467	101.224	111.677	98.608	83.117	73.706	357.791	308.657	320.204	280.801	257.168	226.037
76	115.7	100.49	110.93	97.888	82.503	73.122	355.923	306.844	318.5	279.137	255.769	224.723
75	114.887	99.723	110.141	97.136	81.844	72.494	353.969	304.968	316.72	277.414	254.294	223.332
74	114.03	98.918	109.309	96.347	81.142	71.822	351.926	303.019	314.862	275.626	252.741	221.864

73	113.128	98.075	108.435	95.521	80.398	71.11	349.793	300.99	312.923	273.766	251.112	220.319
72	112.182	97.189	107.518	94.655	79.619	70.361	347.569	298.873	310.904	271.829	249.413	218.703
71	111.192	96.262	106.561	93.749	78.812	69.585	345.253	296.67	308.804	269.815	247.652	217.029
70	110.161	95.296	105.563	92.807	77.993	68.797	342.846	294.383	306.622	267.727	245.847	215.309
69	109.088	94.297	104.527	91.832	77.206	68.045	340.347	292.022	304.359	265.572	244.05	213.584
68	107.976	93.27	103.452	90.83	76.438	67.307	337.757	289.598	302.014	263.358	242.249	211.858
67	106.825	92.22	102.341	89.805	75.651	66.553	335.075	287.116	299.589	261.089	240.385	210.074
66	105.637	91.147	101.194	88.755	74.836	65.774	332.303	284.576	297.083	258.765	238.435	208.212
65	104.412	90.05	100.013	87.681	73.988	64.966	329.44	281.973	294.496	256.382	236.389	206.263
64	103.152	88.924	98.798	86.58	73.106	64.128	326.487	279.298	291.829	253.934	234.241	204.222
63	101.859	87.767	97.552	85.449	72.19	63.26	323.444	276.541	289.083	251.413	231.991	202.09
62	100.533	86.576	96.274	84.285	71.242	62.364	320.312	273.692	286.257	248.811	229.643	199.872
61	99.176	85.349	94.966	83.089	70.268	61.447	317.091	270.748	283.352	246.127	227.206	197.579
60	97.788	84.089	93.63	81.862	69.275	60.519	313.781	267.714	280.368	243.363	224.699	195.233
59	96.372	82.805	92.266	80.611	68.277	59.596	310.383	264.608	277.306	240.534	222.153	192.875
58	94.927	81.508	90.876	79.347	67.283	58.692	306.898	261.452	274.167	237.657	219.596	190.541
57	93.456	80.2	89.46	78.071	66.274	57.782	303.325	258.252	270.95	234.737	216.986	188.179
56	91.959	78.883	88.02	76.783	65.242	56.859	299.667	255.007	267.656	231.772	214.309	185.775
55	90.438	77.551	86.556	75.482	64.186	55.919	295.922	251.707	264.287	228.756	211.557	183.323
54	88.894	76.202	85.071	74.163	63.103	54.957	292.092	248.341	260.842	225.68	208.728	180.803
53	87.327	74.83	83.565	72.823	61.995	53.968	288.178	244.893	257.321	222.531	205.819	178.205
52	85.74	73.431	82.038	71.458	60.863	52.955	284.18	241.351	253.727	219.301	202.831	175.528
51	84.132	72.004	80.493	70.067	59.707	51.922	280.098	237.709	250.058	215.984	199.767	172.789
50	82.506	70.549	78.93	68.651	58.531	50.878	275.934	233.97	246.316	212.584	196.628	170.004
49	80.861	69.079	77.35	67.221	57.336	49.825	271.688	230.164	242.502	209.124	193.42	167.179
48	79.2	67.607	75.754	65.788	56.128	48.764	267.36	226.323	238.615	205.628	190.153	164.312
47	77.524	66.139	74.143	64.356	54.913	47.696	262.953	222.457	234.658	202.104	186.844	161.404
46	75.833	64.671	72.519	62.923	53.702	46.626	258.466	218.561	230.63	198.548	183.518	158.466
45	74.128	63.2	70.882	61.486	52.514	45.57	253.9	214.622	226.532	194.952	180.224	155.537
44	72.41	61.721	69.233	60.041	51.363	44.545	249.257	210.624	222.366	191.302	177.003	152.663
43	70.681	60.228	67.573	58.583	50.216	43.53	244.537	206.55	218.132	187.585	173.771	149.799
42	68.942	58.716	65.903	57.108	49.064	42.519	239.741	202.382	213.831	183.788	170.506	146.93
41	67.193	57.181	64.225	55.613	47.904	41.502	234.871	198.111	209.464	179.902	167.194	144.03
40	65.435	55.625	62.538	54.101	46.732	40.477	229.928	193.741	205.033	175.933	163.829	141.088
39	63.67	54.061	60.844	52.581	45.549	39.442	224.912	189.31	200.537	171.909	160.408	138.099
38	61.898	52.507	59.144	51.068	44.355	38.395	219.825	184.863	195.978	167.865	156.929	135.05
37	60.12	50.966	57.438	49.566	43.15	37.331	214.668	180.411	191.357	163.812	153.393	131.926
36	58.337	49.436	55.728	48.073	41.935	36.249	209.442	175.948	186.676	159.742	149.797	128.727
35	56.55	47.913	54.015	46.586	40.71	35.159	204.148	171.457	181.934	155.645	146.145	125.478
34	54.761	46.39	52.299	45.098	39.476	34.071	198.787	166.919	177.134	151.505	142.434	122.21
33	52.969	44.861	50.581	43.606	38.235	32.986	193.362	162.313	172.277	147.306	138.668	118.927
32	51.176	43.32	48.862	42.104	36.987	31.902	187.872	157.621	167.363	143.033	134.846	115.619
31	49.382	41.763	47.142	40.589	35.733	30.815	182.32	152.826	162.394	138.675	130.969	112.275
30	47.588	40.191	45.424	39.061	34.473	29.725	176.707	147.934	157.371	134.235	127.039	108.885
29	45.796	38.619	43.706	37.534	33.21	28.627	171.034	142.99	152.296	129.749	123.057	105.435
28	44.006	37.064	41.991	36.022	31.943	27.517	165.303	138.05	147.169	125.261	119.023	101.913
27	42.219	35.532	40.278	34.529	30.674	26.397	159.515	133.129	141.993	120.782	114.94	98.32
26	40.435	34.018	38.57	33.053	29.403	25.274	153.673	128.214	136.769	116.305	110.808	94.685
25	38.655	32.519	36.866	31.589	28.132	24.161	147.778	123.289	131.498	111.814	106.628	91.044
24	36.881	31.027	35.166	30.133	26.86	23.059	141.831	118.333	126.183	107.296	102.403	87.403
23	35.112	29.538	33.473	28.68	25.589	21.966	135.835	113.325	120.823	102.732	98.133	83.752
22	33.35	28.045	31.786	27.225	24.319	20.877	129.791	108.244	115.422	98.108	93.821	80.078
21	31.596	26.543	30.107	25.764	23.052	19.791	123.701	103.073	109.981	93.409	89.466	76.369
20	29.849	25.033	28.435	24.297	21.788	18.704	117.566	97.811	104.502	88.636	85.071	72.61
19	28.111	23.528	26.773	22.835	20.528	17.612	111.39	92.509	98.986	83.828	80.638	68.79
18	26.383	22.046	25.119	21.396	19.272	16.515	105.173	87.236	93.434	79.039	76.168	64.906
17	24.665	20.593	23.475	19.981	18.021	15.421	98.919	82.001	87.85	74.277	71.662	60.991
16	22.957	19.165	21.843	18.588	16.776	14.342	92.628	76.791	82.235	69.534	67.123	57.085
15	21.261	17.756	20.221	17.214	15.538	13.28	86.305	71.59	76.592	64.795	62.552	53.194
14	19.578	16.363	18.612	15.855	14.307	12.233	79.95	66.378	70.922	60.046	57.952	49.307
13	17.907	14.98	17.015	14.506	13.084	11.196	73.567	61.14	65.229	55.276	53.326	45.413
12	16.25	13.603	15.432	13.165	11.87	10.169	67.161	55.858	59.515	50.47	48.675	41.501
11	14.608	12.227	13.864	11.827	10.665	9.147	60.734	50.517	53.786	45.618	44.004	37.562
10	12.982	10.852	12.311	10.491	9.472	8.128	54.292	45.111	48.046	40.715	39.318	33.585
9	11.374	9.487	10.777	9.166	8.291	7.112	47.844	39.689	42.302	35.801	34.623	29.57
8	9.786	8.152	9.262	7.87	7.125	6.106	41.401	34.324	36.566	30.934	29.929	25.549
7	8.222	6.851	7.772	6.606	5.976	5.122	34.98	29.03	30.856	26.128	25.252	21.569
6	6.688	5.584	6.312	5.375	4.851	4.165	28.613	23.812	25.2	21.393	20.616	17.647
5	5.197	4.356	4.895	4.183	3.759	3.238	22.352	18.688	19.648	16.749	16.064	13.804
4	3.767	3.177	3.54	3.041	2.716	2.352	16.289	13.711	14.284	12.25	11.667	10.084
3	2.436	2.072	2.282	1.976	1.748	1.526	10.588	8.996	9.256	8.004	7.55	6.579
2	1.269	1.093	1.184	1.036	0.905	0.798	5.543	4.77	4.827	4.221	3.93	3.461
1	0.385	0.337	0.357	0.317	0.272	0.244	1.69	1.48	1.464	1.3	1.189	1.063

Table showing storey shear by equivalent static analysis (E.S.A) and response spectrum analysis (R.S.A) for all models:

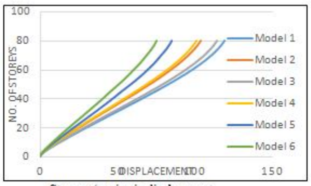
No. of storey	Storey Shear For E.S.A in KN						Storey Shear For R.S.A in KN					
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**
80	209.309	213.0746	221.1292	224.8961	74.3674	75.4536	121.4282	133.5062	133.4991	145.0229	63.7828	70.9491
79	465.8847	543.3121	495.9319	552.3897	171.0524	169.0628	271.4411	316.4843	300.5205	334.5386	145.9641	154.987
78	716.0059	650.4233	763.8216	692.1996	265.3051	255.813	418.3281	397.2584	463.8406	438.6916	224.8448	231.5367
77	959.7549	751.3344	1024.8864	849.4323	357.1565	334.2179	561.4713	482.201	622.7217	555.7041	299.8707	301.182
76	1197.214	964.1632	1279.2143	1089.6846	446.6377	406.6464	700.2404	622.0259	776.4122	714.1515	370.4799	365.1497
75	1428.465	1089.6799	1526.8934	1247.7019	533.7796	479.9174	834.059	706.2098	924.2247	818.8873	436.1687	425.6945
74	1653.591	1279.3055	1768.0118	1455.8463	618.6132	571.497	962.4478	816.5194	1065.5858	943.5513	496.5399	497.2141
73	1872.673	1605.6788	2002.6575	1770.9578	701.1695	636.9097	1085.051	1000.8233	1200.0688	1128.1408	551.3446	542.0715
72	2085.794	1811.1664	2230.9185	1969.6443	781.4795	709.9682	1201.656	1103.9996	1327.4148	1232.31	600.5259	588.6619
71	2293.036	2087.6998	2452.883	2253.3215	859.5741	786.3818	1312.2	1247.7956	1447.5436	1381.8134	644.2739	635.1332
70	2494.481	2503.7173	2668.639	2677.8501	935.4844	875.5607	1416.771	1509.7087	1560.5566	1648.6096	683.1053	688.277
69	2690.212	2454.771	2878.2746	2654.4655	1092.3906	1096.966	1515.607	1445.7896	1666.731	1597.9811	757.3324	813.8867
68	2880.311	2444.9211	3081.8779	2677.4883	1266.4344	1195.2337	1609.078	1435.036	1766.5068	1602.956	837.8551	844.1225
67	3064.86	2484.1018	3279.5368	2769.0925	1435.397	1324.3431	1697.67	1454.2127	1860.4646	1646.3303	914.8201	898.1192
66	3243.94	2709.2167	3471.3395	3010.0271	1599.3536	1450.813	1781.961	1569.6144	1949.2972	1767.8312	988.4695	953.0493
65	3417.636	2735.9189	3657.374	3068.5674	1758.3794	1573.1669	1862.588	1571.0578	2033.7743	1783.0608	1059.0264	1006.4498
64	3586.028	2859.5279	3837.7284	3207.689	1912.5498	1697.2784	1940.214	1622.4334	2114.7027	1840.1072	1126.7253	1061.4604
63	3749.198	3223.7378	4012.4908	3547.9907	2061.94	1828.9788	2015.498	1805.5371	2192.8838	2009.1287	1191.8183	1119.3677
62	3907.23	3325.2228	4181.7492	3642.8853	2206.6252	1968.8876	2089.054	1841.9706	2269.0721	2039.6379	1254.5716	1182.2297
61	4060.206	3571.1716	4345.5917	3891.2091	2346.6809	2112.204	2161.425	1959.7507	2343.9366	2155.7731	1315.2623	1247.3774
60	4208.206	4221.4562	4504.1063	4517.3115	2482.1822	2275.4914	2233.056	2313.5466	2418.0299	2495.2385	1374.1816	1323.8663
59	4351.315	3881.9618	4657.3811	4223.9304	2650.3171	2659.1468	2304.276	2112.8326	2491.7651	2315.4033	1448.436	1519.6944
58	4489.613	3766.303	4805.5043	4141.3365	2820.0712	2505.3761	2375.295	2047.6378	2565.4052	2265.5496	1525.5355	1408.3357
57	4623.184	3756.6411	4948.5637	4180.5902	2984.0222	2516.0461	2446.197	2042.5596	2639.0626	2284.3769	1602.0949	1408.6623
56	4752.109	3988.6442	5086.6476	4418.5441	3142.2711	2669.4346	2516.957	2168.0735	2712.711	2411.7357	1677.8272	1486.219
55	4876.471	3938.2238	5219.8439	4398.2535	3294.9186	2737.0517	2587.451	2142.6363	2786.2059	2401.1443	1752.3848	1516.2267
54	4996.351	4008.2026	5348.2407	4481.1028	3442.0658	3032.6839	2657.488	2182.7434	2859.3126	2447.2445	1825.3977	1669.0533
53	5111.833	4394.6474	5471.9262	4834.3768	3583.8135	3152.907	2726.827	2395.3017	2931.7384	2641.6408	1896.5051	1724.7032
52	5222.998	4415.2966	5590.9882	4847.8633	3720.2627	3731.9726	2795.209	2409.4085	3003.1662	2651.471	1965.3827	2038.3564
51	5329.928	4642.5366	5705.5151	5073.2544	3851.5144	3398.8464	2862.383	2535.4501	3073.2868	2775.4478	2031.7651	1847.3147
50	5432.707	5448.7388	5815.5947	5831.5679	3977.6694	3361.3302	2928.128	2988.1352	3141.8278	3201.491	2095.4646	1825.2823
49	5531.415	4902.1649	5921.3151	5345.1288	4098.8286	3505.8348	2992.27	2691.2071	3208.5766	2936.1812	2156.3856	1899.7326
48	5626.135	4697.0919	6022.7645	5173.146	4215.0931	3527.4933	3054.699	2588.8412	3273.3976	2851.3047	2214.5369	1905.565
47	5716.95	4648.0361	6120.0308	5169.3624	4326.5636	3819.2582	3115.373	2571.327	3336.2413	2857.1201	2270.0411	2053.3884
46	5803.942	4880.7049	6213.2022	5399.8047	4433.3412	3893.7597	3174.321	2707.517	3397.146	2990.5687	2323.1446	2084.2731
45	5887.192	4772.4664	6302.3667	5319.2419	4557.1163	4571.3564	3231.638	2655.2239	3456.2322	2952.4942	2385.3601	2442.0131
44	5966.784	4799.3337	6387.6123	5356.6788	4679.6355	4163.4359	3287.476	2676.5589	3513.6907	2978.5948	2448.6067	2218.6122
43	6042.799	5193.4515	6469.0272	5711.6807	4796.649	4113.0105	3342.026	2902.0881	3569.7643	3181.0782	2511.1073	2195.8397
42	6115.319	5150.1961	6546.6993	5661.2977	4908.2833	4275.937	3395.505	2883.955	3624.7265	3158.7576	2573.153	2275.7475
41	6184.427	5358.1928	6620.7169	5864.5714	5014.665	4380.4537	3448.132	3006.4342	3678.8569	3277.1267	2634.9774	2328.6331
40	6250.205	6268.0127	6691.1678	6708.907	5115.9205	4468.5548	3500.115	3533.2132	3732.4175	3763.6649	2696.7499	2381.2663
39	6312.735	5575.4293	6758.1402	6086.3834	5212.1766	4427.7765	3551.625	3150.7587	3785.6294	3422.258	2758.5665	2382.1104
38	6372.1	5304.619	6821.7222	5848.1038	5303.5598	4630.2497	3602.787	3013.8348	3838.6547	3304.3829	2820.4429	2495.1752
37	6428.382	5229.3863	6882.0018	5813.2676	5390.1966	4893.6055	3653.669	2988.1327	3891.5823	3301.1969	2882.3127	2643.971
36	6481.662	5459.0671	6939.0671	6034.0012	5472.2136	5488.205	3704.274	3136.5912	3944.4214	3444.0443	2944.0312	2981.5244
35	6532.023	5311.0799	6993.0061	5910.7012	5549.7375	4942.2296	3754.541	3069.3259	3997.1014	3392.2571	3005.3856	2703.5247
34	6579.548	5304.4266	7043.9069	5912.5932	5622.8946	4865.2239	3804.353	3082.5189	4049.4788	3411.8856	3066.1104	2685.3737
33	6624.318	5693.7079	7091.8576	6260.0315	5691.8117	4932.5537	3853.544	3325.9572	4101.3507	3632.0412	3125.9076	2732.2884
32	6666.416	5597.5411	7136.9462	6158.6427	5756.6153	5006.7909	3901.917	3286.2417	4152.4733	3592.6897	3184.4695	2785.9582
31	6705.924	5777.6807	7179.2608	6333.0495	5817.4319	5057.9089	3949.261	3407.5058	4202.5841	3712.0068	3241.503	2836.0467
30	6742.924	6761.7255	7218.8894	7237.6166	5874.3882	5061.4061	3995.369	4017.4381	4251.4252	4272.055	3296.7528	2871.3182
29	6777.499	5963.5351	7255.9202	6517.5144	5927.6107	5179.3442	4040.055	3557.0065	4298.767	3863.6521	3350.023	2953.5703
28	6809.73	5655.7675	7290.4412	6240.8694	5977.2259	5396.7688	4083.175	3398.8087	4344.4293	3726.8025	3401.1946	3088.3824
27	6839.7	5571.2146	7322.5404	6189.6554	6023.3605	6040.326	4124.64	3372.4022	4388.2989	3720.9739	3450.2377	3480.0277
26	6867.491	5796.9316	7352.3059	6400.9017	6066.141	5390.5439	4164.421	3530.2951	4430.3418	3870.5889	3497.2182	3124.861
25	6893.186	5625.937	7379.8258	6251.3962	6105.6939	5306.3054	4202.56	3446.3403	4470.6092	3801.8494	3542.297	3102.135
24	6916.866	5594.7085	7405.1881	6226.9255	6142.1459	5328.8741	4239.166	3444.2552	4509.2372	3805.9877	3585.7232	3127.607
23	6938.614	5969.1691	7428.481	6559.813	6175.6236	5363.8981	4274.409	3689.9592	4546.4384	4027.5838	3627.8186	3161.9328
22	6958.512	5826.2899	7449.7924	6416.5382	6206.2534	5391.9814	4308.507	3615.5545	4582.4879	3956.9369	3668.9574	3200.3861
21	6976.642	5958.9835	7469.2104	6545.0787	6234.162	5399.776	4341.714	3710.586	4617.7024	4050.9969	3709.5394	3234.9114
20	6993.086	7012.3248	7486.8232	7505.9843	6259.4759	5470.4311	4374.294	4395.6214	4652.4155	4674.6193	3749.9594	3296.2475
19	7007.928	6126.5137	7502.7187	6706.6856	6282.3216	5635.8344	4406.502	3850.883	4686.9493	4190.5682	3790.5749	3412.3987
18	7021.248	5819.573	7516.985	6428.0891	6302.8259	6320.214	4438.561	3685.3489	4721.585	4045.9172	3831.6743	3859.8885
17	7033.129	5745.197	7529.7102	6377.1544	6321.1152	5601.0145	4470.636	3665.7035	4756.5351	4042.3119	3873.4478	3447.1119
16	7043.653	5967.9812	7540.9823	6581.111	6337.3161	5524.856	4502.82	3833.4182	4791.9192	4199.8232	3915.9636	3438.5936
15	7052.903	5789.7589	7550.8895	6421.2278	6351.5552	5525.8588	4535.115	3744.5562	4827.7447	4126.6263	3959.1519	3469.1482
14	7060.961	5742.7778	7559.5197	6379.4711	6363.959	5535.6539	4567.423	3738.1623	4863.8954	4127.8095	4002.7973	3506.6545
13	7067.909	6095.4516	7566.9611	6693.3821	6374.6541	5549.9044	4599.545	3991.4484	4900.128	4359.8694	4046.5408	3552.9484
12	7073.829	5910.7474	7573.3017	6516.5814	6383.7671	5553.6197	4631.184	3893.4392	4936.078	4273.4828	4089.8916	3596.281
11	7078.804	5956.6171	7578.6295	6563.8321	6391.4246	5587.7872	4661.958	3943.9207	4971.2732	4329.29	4132.2475	3651.162
10	7082.915	7102.2581	7583.0327	7602.2978	6397.753	5683.6475	4691.415	4737.6391	5005.1561	5051.8555	4172.9227	3741.668
9	7086.245	6125.0846	7586.5993	6722.7202	6402.8791	6420.3638	4719.058	4100.7401	5037.1117	4487.324	4211.1808	4268.6487
8	7088.876	5878.0087	7589.4173	6498.3978	6406.9293	5659.1356	4744.371	3967.1296	5066.5015	4373.0163	4246.2734	3790.7229
7	7090.89	5838.9643	7591.5749	6469.6667	6410.0303	5617.2609	4766.85	3966.5814	5092.7011	4381.944	4277.4806	3798.5863
6	7092.37	6064.8285	7593.1601	6673.138	6412.3085	5621.8165	4786.039	4139.7712	5115.1427	4542.7078	4304.157	3826.2519
5	7093.398	5921.3488	7594.2609	6542.7569	6413.8906	5635.2491	4801.571	4057.6692	5133.3628	4472.6356	4325.7829	3854.8905
4	7094.056	5914.6357	7594.9654	6535.5908	6414.9032	5672.3409	4813.215	4063.834	5147.0624	4480.9437	4342.0293	3896.5929
3	7094.426	6263.4768	7595.3616	6847.9967	6415.4728	5732.0261	4820.949	4309.5839	5156.1876	4703.1845	4352.8495	3949.1805
2	7094.59	6231.881	7595.5378	6816.9234	6415.7259	5851.9662	4825.061	4292.1515	5161.0549	4687.4258	4358.625	4036.4711

1	7094.631	6514.3013	7595.5818	7072.5272	6415.7892	6076.7285	4826.329	4489.7601	5162.561	4866.247	4360.4153	4193.5195

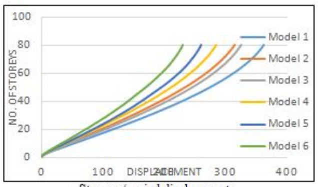
Table showing storey drift due to seismic and wind effect for all models:

No. of storey	Storey drift due to seismic effect						Storey drift due to wind effect					
	M1	M2	M3	M4	M5	M6	M1	M2	M3	M4	M5	M6
80	0.000205	0.000204	0.000201	0.0002	0.000157	0.000148	0.000521	0.00052	0.000477	0.000477	0.00038	0.000354
79	0.000215	0.000211	0.00021	0.000207	0.000166	0.000157	0.000537	0.000533	0.000491	0.000489	0.000395	0.000368
78	0.000227	0.00022	0.000221	0.000216	0.000178	0.000169	0.000559	0.000549	0.00051	0.000504	0.000415	0.000388
77	0.00024	0.000229	0.000233	0.000225	0.000192	0.000183	0.000584	0.000567	0.000533	0.00052	0.000437	0.000411
76	0.000254	0.00024	0.000247	0.000235	0.000206	0.000197	0.000611	0.000586	0.000556	0.000538	0.000461	0.000435
75	0.000268	0.000251	0.00026	0.000246	0.00022	0.00021	0.000638	0.000609	0.000581	0.000559	0.000485	0.000459
74	0.000282	0.000264	0.000273	0.000258	0.000232	0.000223	0.000667	0.000634	0.000606	0.000581	0.000509	0.000483
73	0.000296	0.000277	0.000286	0.000271	0.000244	0.000234	0.000695	0.000661	0.000631	0.000605	0.000531	0.000505
72	0.000309	0.00029	0.000299	0.000283	0.000252	0.000243	0.000724	0.000689	0.000656	0.000629	0.00055	0.000524
71	0.000322	0.000302	0.000312	0.000295	0.000256	0.000247	0.000752	0.000715	0.000682	0.000653	0.000564	0.000538
70	0.000335	0.000312	0.000324	0.000305	0.000252	0.000242	0.000781	0.000738	0.000707	0.000673	0.000568	0.000543
69	0.000348	0.000321	0.000336	0.000313	0.00024	0.000231	0.000809	0.000758	0.000733	0.000692	0.000564	0.00054
68	0.00036	0.000328	0.000347	0.000321	0.000246	0.000236	0.000838	0.000776	0.000758	0.000709	0.000583	0.000558
67	0.000371	0.000335	0.000358	0.000328	0.000255	0.000243	0.000866	0.000794	0.000783	0.000726	0.000609	0.000582
66	0.000383	0.000343	0.000369	0.000336	0.000265	0.000252	0.000895	0.000813	0.000808	0.000745	0.00064	0.000609
65	0.000394	0.000352	0.00038	0.000344	0.000276	0.000262	0.000923	0.000836	0.000833	0.000765	0.000671	0.000638
64	0.000404	0.000362	0.00039	0.000353	0.000286	0.000271	0.000951	0.000862	0.000858	0.000788	0.000703	0.000666
63	0.000414	0.000372	0.000399	0.000364	0.000296	0.00028	0.000979	0.00089	0.000883	0.000813	0.000734	0.000693
62	0.000424	0.000383	0.000409	0.000374	0.000304	0.000287	0.001007	0.00092	0.000908	0.000839	0.000761	0.000717
61	0.000434	0.000394	0.000418	0.000384	0.00031	0.00029	0.001034	0.000948	0.000932	0.000864	0.000783	0.000733
60	0.000443	0.000401	0.000426	0.000391	0.000312	0.000288	0.001062	0.00097	0.000957	0.000884	0.000796	0.000737
59	0.000451	0.000405	0.000435	0.000395	0.00031	0.000282	0.001089	0.000986	0.000981	0.000899	0.000799	0.000729
58	0.00046	0.000409	0.000442	0.000399	0.000315	0.000284	0.001116	0.001	0.001005	0.000913	0.000816	0.000738
57	0.000468	0.000412	0.00045	0.000402	0.000322	0.000288	0.001143	0.001014	0.001029	0.000926	0.000837	0.000751
56	0.000475	0.000416	0.000457	0.000407	0.00033	0.000294	0.00117	0.001031	0.001053	0.000942	0.00086	0.000768
55	0.000483	0.000422	0.000464	0.000412	0.000338	0.000301	0.001197	0.001052	0.001077	0.000962	0.000884	0.000789
54	0.00049	0.000429	0.000471	0.000419	0.000346	0.000309	0.001223	0.001077	0.0011	0.000984	0.000909	0.000813
53	0.000496	0.000437	0.000477	0.000426	0.000354	0.000317	0.001249	0.001107	0.001123	0.001009	0.000934	0.000837
52	0.000502	0.000446	0.000483	0.000435	0.000361	0.000323	0.001276	0.001138	0.001146	0.001037	0.000958	0.000857
51	0.000508	0.000455	0.000488	0.000442	0.000368	0.000326	0.001301	0.001168	0.001169	0.001063	0.000981	0.000871
50	0.000514	0.000459	0.000494	0.000447	0.000373	0.000329	0.001327	0.001189	0.001192	0.001081	0.001002	0.000884
49	0.000519	0.00046	0.000499	0.000448	0.000378	0.000332	0.001352	0.0012	0.001214	0.001093	0.001021	0.000897
48	0.000524	0.000459	0.000503	0.000448	0.00038	0.000334	0.001377	0.001208	0.001237	0.001101	0.001034	0.00091
47	0.000529	0.000459	0.000508	0.000448	0.000378	0.000334	0.001402	0.001218	0.001259	0.001111	0.001039	0.000919
46	0.000533	0.00046	0.000512	0.000449	0.000371	0.00033	0.001427	0.001231	0.00128	0.001124	0.001029	0.000916
45	0.000537	0.000462	0.000515	0.000452	0.00036	0.00032	0.001451	0.001249	0.001302	0.001141	0.001006	0.000898
44	0.00054	0.000467	0.000519	0.000456	0.000358	0.000317	0.001475	0.001273	0.001323	0.001162	0.00101	0.000895
43	0.000544	0.000473	0.000522	0.000461	0.00036	0.000316	0.001499	0.001302	0.001344	0.001187	0.001021	0.000897
42	0.000547	0.00048	0.000525	0.000467	0.000363	0.000318	0.001522	0.001335	0.001365	0.001214	0.001035	0.000906
41	0.000549	0.000486	0.000527	0.000473	0.000366	0.00032	0.001545	0.001366	0.001385	0.00124	0.001051	0.000919
40	0.000552	0.000489	0.000529	0.000475	0.00037	0.000323	0.001567	0.001385	0.001405	0.001257	0.001069	0.000934
39	0.000554	0.000486	0.000531	0.000473	0.000373	0.000327	0.00159	0.00139	0.001425	0.001264	0.001087	0.000953
38	0.000556	0.000482	0.000533	0.000469	0.000377	0.000333	0.001612	0.001391	0.001444	0.001267	0.001105	0.000976
37	0.000557	0.000478	0.000534	0.000467	0.00038	0.000338	0.001633	0.001395	0.001463	0.001272	0.001123	0.001
36	0.000558	0.000476	0.000535	0.000465	0.000383	0.000341	0.001654	0.001403	0.001482	0.00128	0.001142	0.001015
35	0.000559	0.000476	0.000536	0.000465	0.000385	0.00034	0.001675	0.001418	0.0015	0.001294	0.001159	0.001021
34	0.00056	0.000478	0.000537	0.000466	0.000388	0.000339	0.001695	0.001439	0.001518	0.001312	0.001177	0.001026
33	0.00056	0.000482	0.000537	0.000469	0.00039	0.000339	0.001715	0.001466	0.001536	0.001335	0.001194	0.001034
32	0.000561	0.000487	0.000537	0.000474	0.000392	0.000339	0.001735	0.001498	0.001553	0.001362	0.001211	0.001045
31	0.00056	0.000491	0.000537	0.000477	0.000393	0.000341	0.001754	0.001529	0.00157	0.001388	0.001228	0.001059
30	0.00056	0.000491	0.000537	0.000477	0.000395	0.000343	0.001773	0.001545	0.001586	0.001402	0.001244	0.001078
29	0.000559	0.000486	0.000536	0.000473	0.000396	0.000347	0.001791	0.001544	0.001602	0.001402	0.00126	0.001101
28	0.000559	0.000479	0.000535	0.000467	0.000397	0.00035	0.001809	0.001538	0.001618	0.0014	0.001276	0.001123
27	0.000557	0.000473	0.000534	0.000461	0.000397	0.000351	0.001826	0.001536	0.001633	0.001399	0.001291	0.001136
26	0.000556	0.000469	0.000533	0.000457	0.000397	0.000348	0.001842	0.001539	0.001647	0.001403	0.001306	0.001138
25	0.000554	0.000466	0.000531	0.000455	0.000397	0.000344	0.001858	0.001549	0.001661	0.001412	0.00132	0.001138
24	0.000553	0.000465	0.000529	0.000454	0.000397	0.000342	0.001874	0.001565	0.001675	0.001426	0.001334	0.001141
23	0.000551	0.000467	0.000527	0.000455	0.000397	0.00034	0.001889	0.001588	0.001688	0.001445	0.001348	0.001148
22	0.000548	0.000469	0.000525	0.000457	0.000396	0.000339	0.001903	0.001616	0.0017	0.001468	0.001361	0.001159
21	0.000546	0.000472	0.000522	0.000458	0.000395	0.00034	0.001917	0.001644	0.001712	0.001492	0.001373	0.001175
20	0.000543	0.00047	0.00052	0.000457	0.000394	0.000341	0.00193	0.001657	0.001724	0.001502	0.001385	0.001194
19	0.00054	0.000463	0.000517	0.00045	0.000392	0.000343	0.001943	0.001648	0.001735	0.001497	0.001397	0.001214
18	0.000537	0.000454	0.000514	0.000442	0.000391	0.000342	0.001955	0.001636	0.001745	0.001488	0.001408	0.001223
17	0.000534	0.000446	0.00051	0.000435	0.000389	0.000337	0.001966	0.001628	0.001755	0.001482	0.001418	0.00122
16	0.00053	0.00044	0.000507	0.000429	0.000387	0.000332	0.001976	0.001626	0.001764	0.001481	0.001428	0.001216
15	0.000526	0.000435	0.000503	0.000425	0.000385	0.000327	0.001986	0.001629	0.001772	0.001484	0.001437	0.001215
14	0.000522	0.000432	0.000499	0.000421	0.000382	0.000324	0.001995	0.001637	0.001779	0.001491	0.001446	0.001217
13	0.000518	0.00043	0.000495	0.000419	0.000379	0.000321	0.002002	0.00165	0.001785	0.001502	0.001453	0.001222
12	0.000513	0.00043	0.00049	0.000418	0.000376	0.000319	0.002008	0.001669	0.00179	0.001516	0.00146	0.001231
11	0.000508	0.00043	0.000485	0.000417	0.000373	0.000318	0.002013	0.001689	0.001794	0.001532	0.001464	0.001243
10	0.000503	0.000426	0.00048	0.000414	0.000369	0.000318	0.002015	0.001694	0.001795	0.001536	0.001467	0.001255
9	0.000496	0.000417	0.000473	0.000405	0.000364	0.000314	0.002014	0.001677	0.001792	0.001521	0.001467	0.001257
8	0.000489	0.000407	0.000466	0.000395	0.000359	0.000307	0.002006	0.001654	0.001784	0.001502	0.001462	0.001244
7	0.000479	0.000396	0.000456	0.000385	0.000352	0.000299	0.00199	0.001631	0.001767	0.00148	0.001449	0.001226

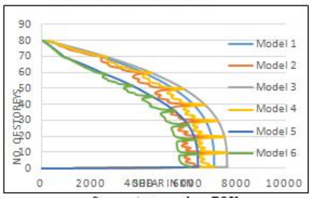
6	0.000466	0.000384	0.000443	0.000373	0.000341	0.00029	0.001957	0.001601	0.001735	0.001451	0.001423	0.001201
5	0.000447	0.000368	0.000423	0.000357	0.000326	0.000277	0.001895	0.001555	0.001676	0.001406	0.001374	0.001162
4	0.000416	0.000345	0.000393	0.000333	0.000302	0.000258	0.001782	0.001474	0.001571	0.001327	0.001287	0.001096
3	0.000365	0.000306	0.000343	0.000294	0.000263	0.000227	0.001576	0.001321	0.001384	0.001182	0.001131	0.000974
2	0.000276	0.000236	0.000258	0.000225	0.000198	0.000173	0.001204	0.001028	0.001051	0.000913	0.000857	0.00075
1	0.00012	0.000105	0.000112	0.000099	0.000085	0.000076	0.000528	0.000463	0.000458	0.000406	0.000371	0.000332



Storey v/s seismic displacement



Storey v/s wind displacement



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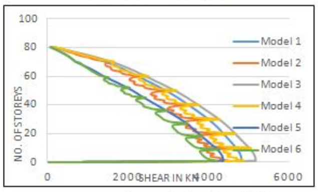

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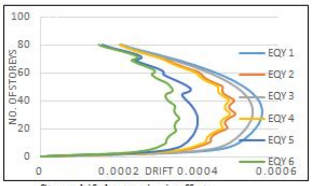
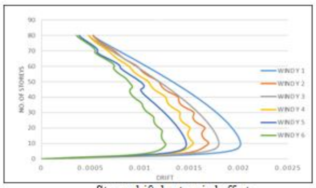


Storey drift due to seismic effect


Storey drift due to wind effect

VI. CONCLUSION

- The maximum displacement in X-direction due to seismic loads for tube-in-tube building without bracing (Model 3) and bundled tube building without bracing (Model 5) is reduced by 13% and 38% respectively when compared to framed tube building without bracing (Model 1). The corresponding amount of reductions for displacement due to wind loads is 18% and 26% respectively.
- The maximum displacement in Y-direction due to seismic loads for tube-in-tube building without bracing (Model 3) and bundled tube building without bracing (Model 5) is reduced by 5% and 33% respectively when compared to framed tube building without bracing (Model 1). The corresponding amount of reductions for displacement due to wind loads is 10% and 28% respectively.
- The maximum displacement in X-direction due to seismic loads for tube-in-tube building with bracing (Model 4) and bundled tube building with bracing (Model 6) is reduced by 25% and 47% respectively when compared to framed tube building with bracing (Model 2). The corresponding amount of reductions for displacement due to wind loads is 30% and 35% respectively.
- The maximum displacement in Y-direction due to seismic loads for tube-in-tube building with bracing (Model 4) and bundled tube building with bracing (Model 6) is reduced by 16% and 40% respectively

  when compared to framed tube building with bracing (Model 2). The corresponding amount of reductions for displacement due to wind loads is 21% and 36% respectively.
- The maximum storey drift in X-direction due to seismic loads for tube-in-tube building without bracing (Model 3) and bundled tube building without bracing (Model 5) is reduced by 8% and 10% respectively when compared to framed tube building without bracing (Model 1). The corresponding amount of reductions for storey drifts due to wind loads is 13% and 6% respectively.
- The maximum storey drift in Y-direction due to seismic loads for tube-in-tube building without bracing (Model 3) and bundled tube building without bracing (Model 5) is reduced by 2% and 3% respectively when compared to framed tube building without bracing (Model 1). The corresponding amount of reductions for storey drift due to wind loads is 8% and 27% respectively.
- The maximum storey drift in X-direction due to seismic loads for tube-in-tube building with bracing (Model 4) and bundled tube building with bracing (Model 6) is reduced by 9% and 8% respectively when compared to framed tube building with bracing (Model 2). The corresponding amount of reductions for storey drift due to wind loads is 15% and 5% respectively.
- The maximum storey drift in Y-direction due to seismic loads for tube-in-tube building with bracing (Model 4) and bundled tube building with bracing (Model 6) is reduced by 2% and 3% respectively when compared to framed tube building with bracing (Model 2). The corresponding amount of reductions for storey drift due to wind loads is 8% and 32% respectively.
- The storey shear obtained for this investigation for tube-in-tube building without bracing (Model 3) and bundled tube building without bracing (Model 5) is reduced by 9% and 47% respectively when compared with framed tube building without bracing (Model 1).
- The storey shear obtained for this investigation for tube-in-tube building with bracing (Model 4) and bundled tube building with bracing (Model 6) is

reduced by 16% and 41% respectively when compared with framed tube building with bracing (Model 2).

REFERENCES

[1] Neagle Samson" loss reduction from capacitor installed on primary feeders'' IEE transaction,vol PAS part iii,1986.
[2] Cook R.F ''analysis of capacitor application by load curve"IEE transaction vol.pas-78,950 0ctober (1959).
[3] Schmill,,J.v'' optimum size and location of shunt capacitor''AIEE transaction on power apparatus and system. Vol pas 84, august(1965)
[4] S.Bouri A. zebala 'optimization to shunt capacitor allocation in radial distribution system.
[5] fawzi ''new approach for application of shunt capacitor''acta(2005.).
[6] Duran ''optimum number location and size of shunt capacitor'',IEEE Transaction on power apparatus and and system.vol.PAS-87,no 9,1769-1774,September 1968.
[7] Abdel- Salem ,T.S chikiani ''a newe technique for loss reduction feeders''twenty first annual pp-269,1989.
[8] Hus ,kuo ''dispatch of capacitor in distribution system using dynamic programing''IEEproceeding,vol 140 November (1991).
[9] Samir azim "optimal capacitor allocation in radial distribution system''under APDRP,IEEE 20005 conference,India.
[10] k.prakash ''particle swarm optimization based capacitor placement on radial distribution system (2007).
[11] Cuckoo search-based algorithm for optimal shunt capacitor allocation in distribution network (2013)