

Dynamic Analysis of R.C.C. Frame Structure for Looms Industry

Sarathi B. Bhavsar *, Yogesh D. Rathod, Sunil H. Kukadiya **,
Gaurang A. Parmar**, Jigar K. Sevalia*****

* (UG Student, Civil Engineering Department, Sarvajanic College of Engineering & Technology, Surat,
Gujarat, India,)

** (UG Student, Civil Engineering Department, Sarvajanic College of Engineering & Technology, Surat,
Gujarat, India,)

*** (Assistant Professor, Civil Engineering Department, Sarvajanic College of Engineering & Technology,
Surat, Gujarat, India,)

ABSTRACT

All real physical structures, when subjected to loads or displacements, behave dynamically. Industrial Building which are equipped with machineries are bound to be subjected to vibrations. Problems of the dynamics of bases and foundations are important from an economic standpoint as well therefore, to understand the response characteristics of the power looms industry structure, dynamic analysis was carried out for Ground + One Storey industry framed structure using STAAD.Pro software. In this paper, an attempt has been made to study the effects of various structural parameters like Beam Size, Column Size and Storey Height variation on Frequency and Displacement of the industry building which will fill the lacunae by serving as guidelines to structural engineers and industry people.

Keywords: Looms Industry, Vibration, Time History, Displacement, Modes, Frequency, Storey Height.

1.INTRODUCTION

Technical and industrial progress is accompanied by an increase in the number of machines in use and the growth of their power. Looms Machines are one of the vital part of Textile Industries. Moreover the serviceability of the building structure plays a vital role on the production rate of materials. Rapid industrialization of the country involves production of new machineries with high operating speed of Looms Machine. The high operating speed of machines imparts vibration on the building structure which leads to the development of new branch of mechanics as industrial seismology.

ACI Committee (2004) has presented various design criteria, analysis procedure and construction practice for dynamic equipment for industry people. Bhatia K. G.(2008) states that the need of dynamic analysis arose due to the high ratings of machines in industry which poses higher problems with respect to safety. European Forum Reciprocating Compressors (EFRC) (2009) has established certain procedures and guidelines for the measurement and

Classification of vibrations generated due to the reciprocating machines. Hasmukh Rai B (1996) explains about the beating-up motion which is the main source of vibration in Looms Machine. IS:2974 (Part I) – 1982 (Reaffirmed 1998) covers the design and construction of foundations for machines of the reciprocating type which normally generate steady state vibration and is of a size for which a rigid block type foundation is normally used. It also aids in the guidelines that are necessary for the design and analysis of foundations for reciprocating machines. Wachel J.C. and Tison J.D (1994) has described about the adverse effect due to the reciprocating machines which can be the main reason of fatigue failure on structural members, and the lateral forces are generated on the building structure. Reciprocating machines generates numerous harmonics, and vibration problems in building. John Wolf P. and Andrew Deeks J. (1988) explain about the simplification of ground response for dynamic analysis through a lumped mass model and assuming the nature of soil in plastic form. Nurdeen Raja A. (2011) has explained about the beat-up mechanism which includes impulse-momentum method for analysis of the narrow loom with impulsive force and discontinuous velocities. Sen Huang (2007) states that for dynamic analysis of structural system a mathematical model is to be made for generating accurate, efficient response of the structure. Srinavasulu P. and Vaidyanath C.V. (2003) states the reason for the dynamic force that is generated in looms machines is due to the reciprocating movement of sley and the impact force of the shuttle. Snowden D.C (1967) has explained the harmonic force generated due the working of plain power looms. Victor Wowk has presented his ideas on deciding the strategy in analysing the vibrations produced by machines. His strategy of analysis includes: identifying source of vibration, calculating its frequency and amplitude and analyse the severity of this amplitude. The source of vibration was identified to be as the beating-up motion. Vijay K. Puri and Shamsher Prakash (2006) describes about the special considerations to be taken for machine foundation and classifies machines in mainly three categories which are

Reciprocating, Rotary and Impact. Looms Machine in this study lies under reciprocating machines having speed less than 600 rpm.

2.METHODOLOGY

The methodology of this paper includes reconnaissance survey, collection of necessary machine data, preparation of drawing of industrial floor plan showing machine position of existing building using CAD Software, modeling of R.C.C Frame of Ground + One Storey structure using STAAD.Pro, graphical presentation of results for

various mode shapes, frequency and displacement with respect to various Beam sizes, Column sizes and Storey height.

The structure has a single bay having plan dimension of standard size 5.130 m x 25.685 m as shown in the fig. 1 and 2. The foundation is assumed to be resting at 3.0 m depth below Ground Level and plinth level is assumed to be 0.7 m above ground level. The floor heights considered in this course of study are varying as it is described in the Table 1. The dynamic analysis is done for Ground floor + First floor with single bay.

Table 1 A Building Unit having various Parameters and their Sizes

Various Parameters	Sizes
Beam Size (mm x mm)	230 x 460, 230 x 540, 230 x 610, 230 x 685, 230 x 765
Column Size (mm x mm)	230 x 460, 230 x 540, 230 x 610, 230 x 685, 230 x 765
Storey Height (m)	3.000, 3.660, 4.267, 4.870
Slab Thickness (mm)	130

2.1 Shuttle Loom Machine Data

- Size of Machine = 2.69 m x 1.65 m x 1.54 m
- Operating Speed = 160 rpm
- Dimensions of Sley = 171 cm x 4.5 cm x 7.5 cm
- Mass of Sley = 15kg
- Operating Frequency = 2.67 Hz

2.2 Loads acting on the Structure

- Self-Weight considering density of R.C.C. as 25 kN/m^3
- Water-proofing Load = 1.5 kN/m^2
- Weight of Floor-Finishing Load = 0.8 kN/m^2
- Live Load = 2 kN/m^2
- Weight of Machine = 10 kN
- Time History Load as a function of sine wave having an amplitude of 1.67 kN and frequency of 2.67 Hz.

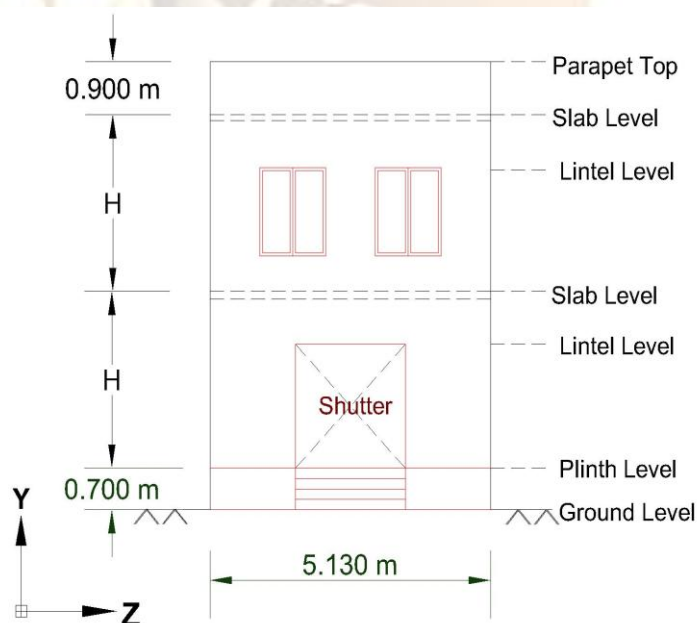


Fig.1 Front Elevation of Looms Industry

Storey Height (H) = 3.000 m, 3.660 m, 4.267 m, 4.870 m

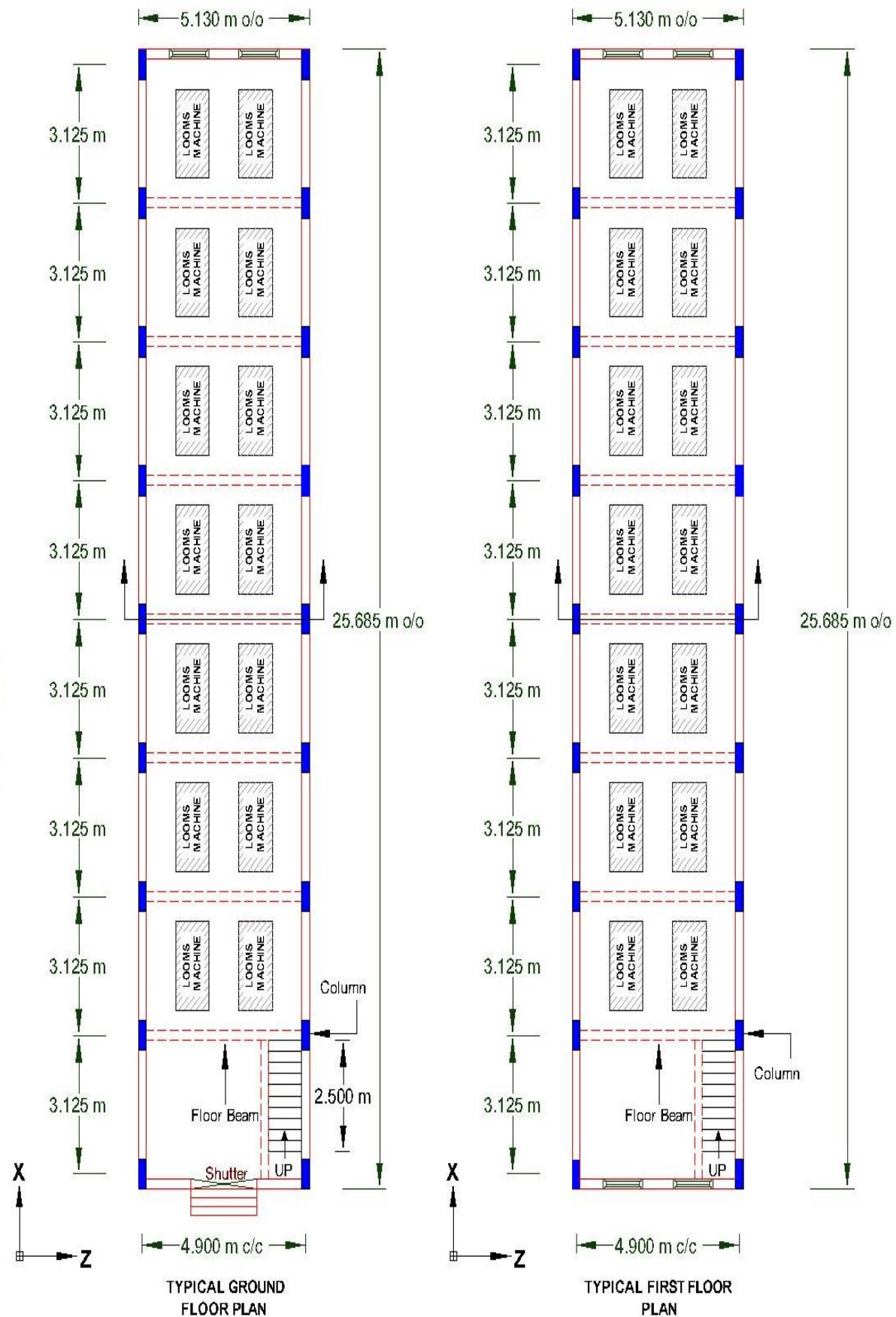


Fig.2 Typical Floor Plan of Looms Industry of Ground Floor and First Floor

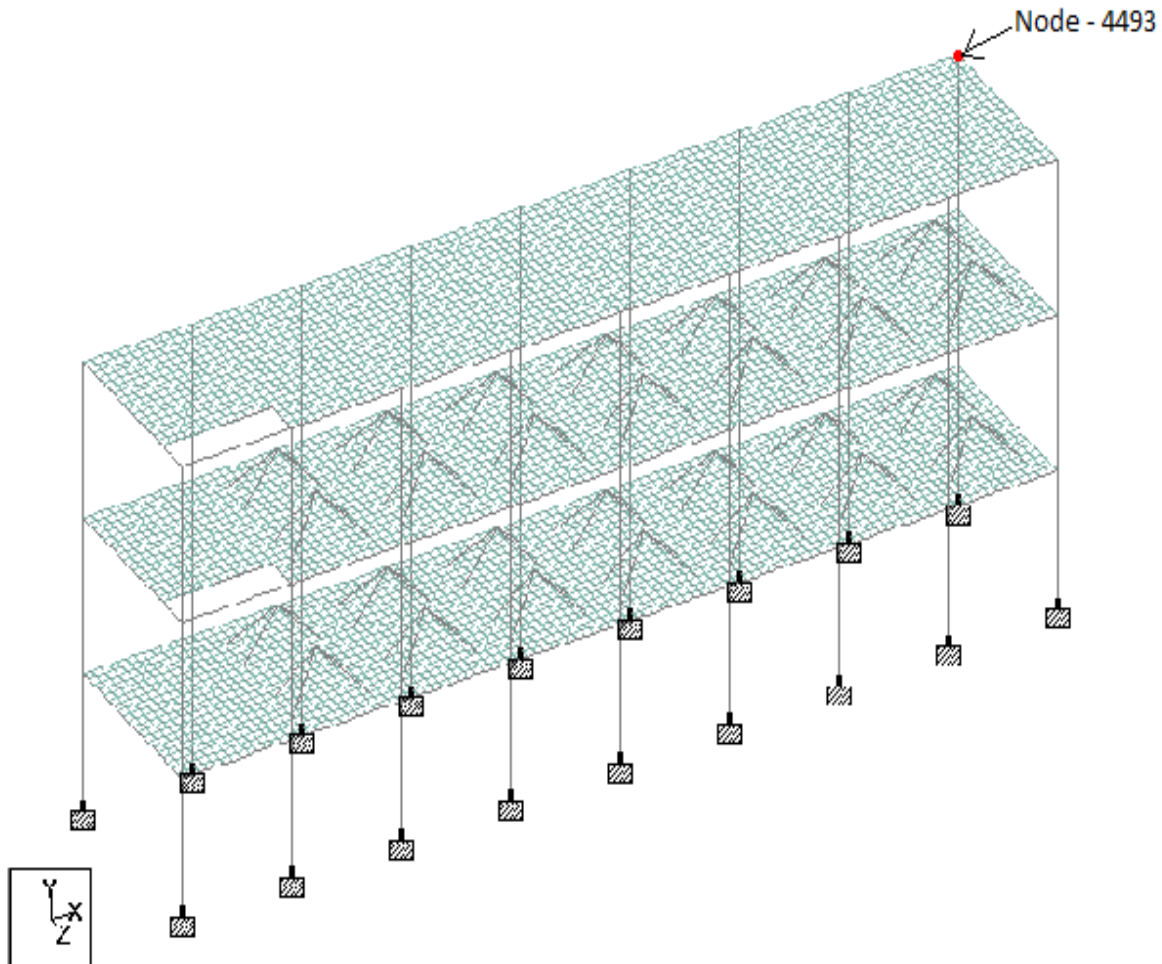


Fig. 3 3D View of a Building Structure Model for Looms Industry in STAAD.Pro

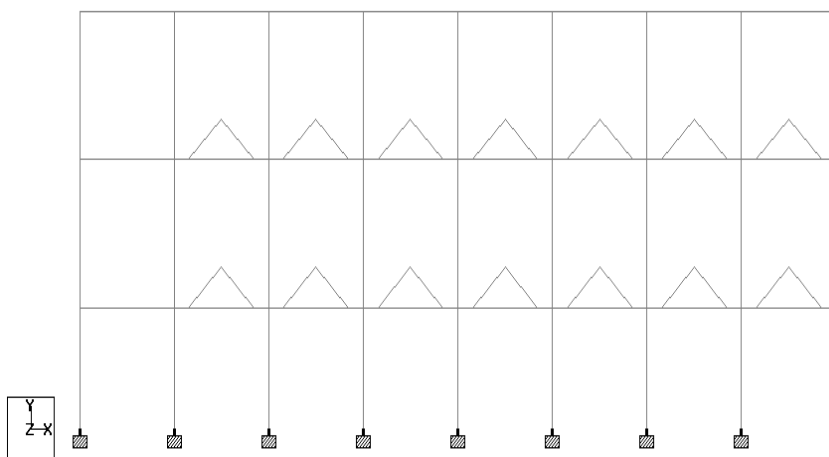


Fig. 4 2D View of a Building Structure Model for Looms Industry in X-Y Plane in STAAD.Pro

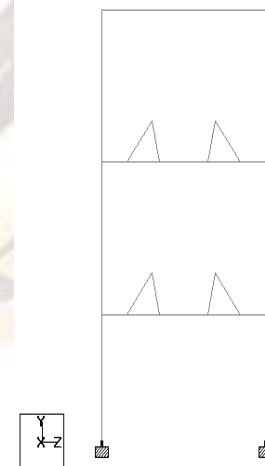


Fig. 5 2D View of a Building Structure Model in Y-Z Plane in STAAD.Pro

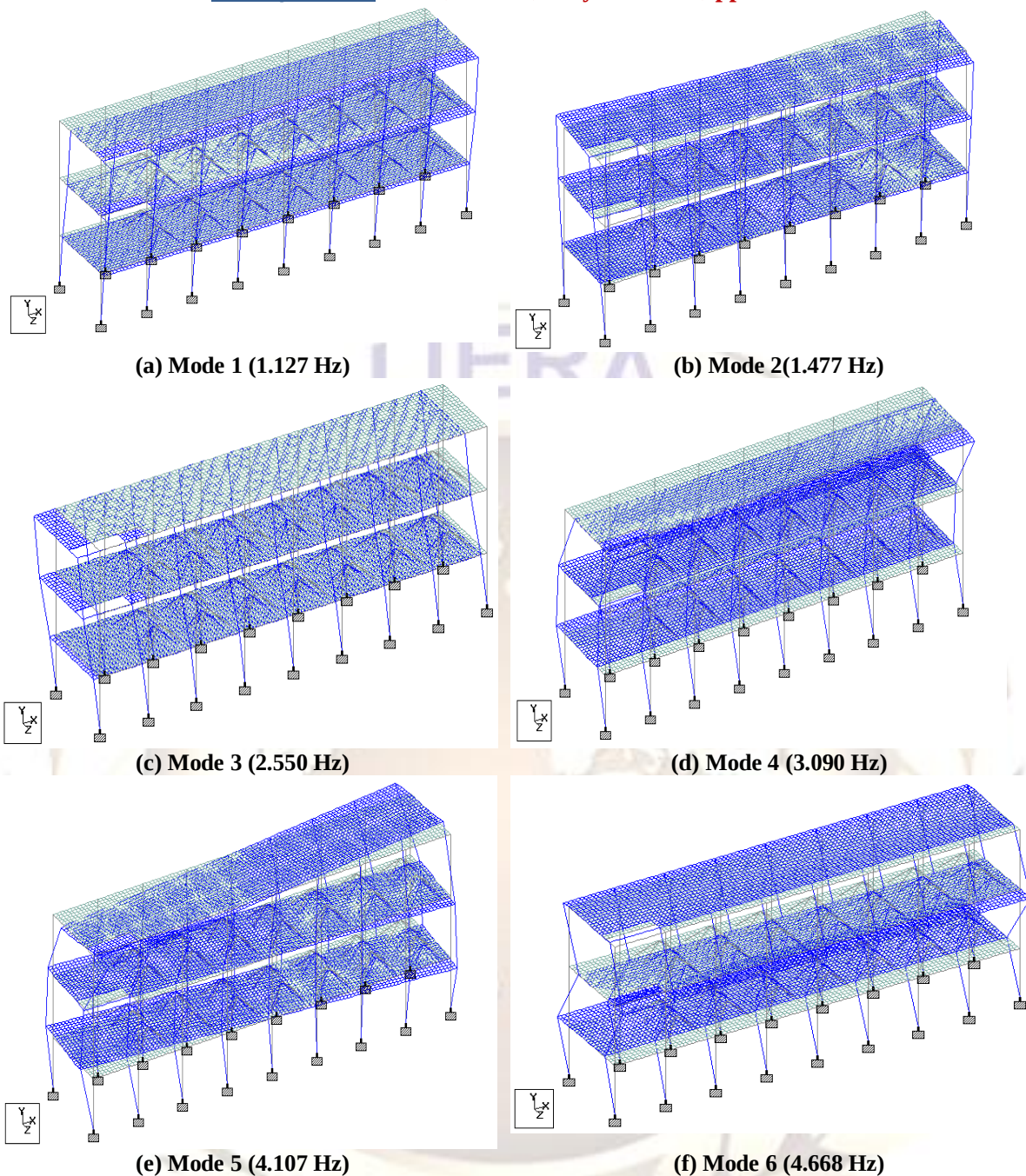


Fig.6 Typical Modes Shapes of the Building Unit

3. Result:

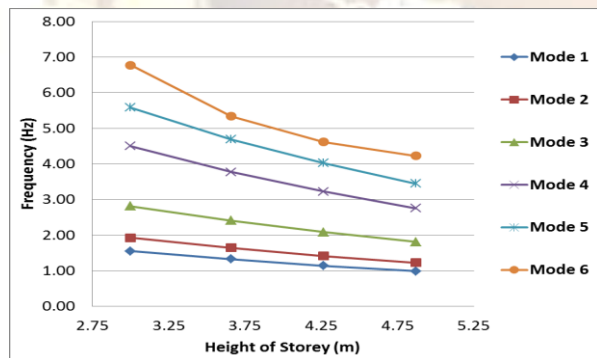
Table 2 Effect of Beam Size and Storey Height on Horizontal Frequency in Z - Direction
 (For Column size 230 mm x 460 mm)

Beam Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.552	1.922	2.810	4.501	5.582	6.772
	3.660	1.326	1.642	2.407	3.767	4.684	5.333
	4.267	1.141	1.415	2.082	3.224	4.021	4.614
	4.870	0.985	1.225	1.808	2.753	3.446	4.222

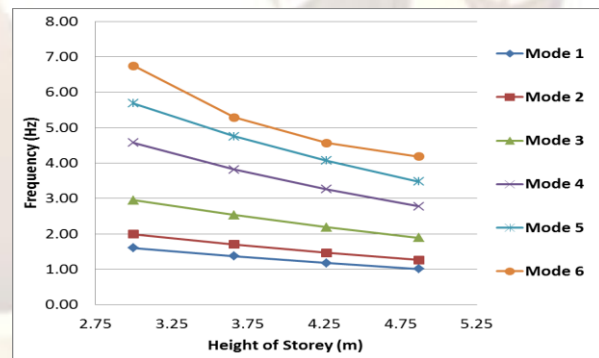
230 x 540	3.000	1.601	1.989	2.951	4.572	5.682	6.742
	3.660	1.367	1.699	2.528	3.815	4.752	5.283
	4.267	1.173	1.461	2.181	3.257	4.069	4.565
	4.870	1.009	1.260	1.888	2.772	3.475	4.183
230 x 610	3.000	1.625	2.022	3.029	4.597	5.717	6.698
	3.660	1.387	1.726	2.594	3.827	4.770	5.232
	4.267	1.188	1.481	2.234	3.262	4.077	4.518
	4.870	1.020	1.275	1.929	2.771	3.474	4.146
230 x 685	3.000	1.636	2.036	3.077	4.597	5.716	6.639
	3.660	1.396	1.738	2.634	3.820	4.760	5.175
	4.267	1.194	1.489	2.265	3.252	4.063	4.467
	4.870	1.024	1.280	1.952	2.758	3.456	4.103
230 x 765	3.000	1.637	2.037	3.100	4.576	5.689	6.569
	3.660	1.396	1.738	2.654	3.797	4.729	5.112
	4.267	1.193	1.488	2.280	3.230	4.032	4.413
	4.870	1.022	1.277	1.962	2.736	3.426	4.057

**Table 3 Effect of Beam Size and Storey Height on Horizontal Displacement in Z - Direction
 (For Column Size 230 mm x 460 mm)**

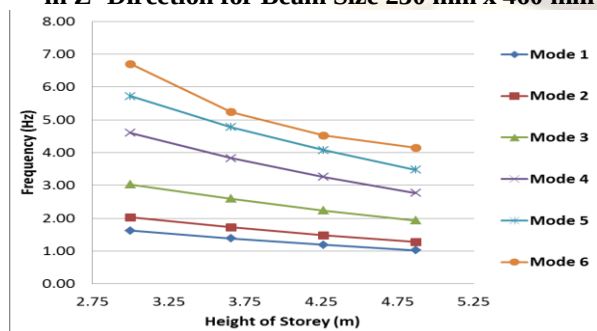
Height of Storey (m)	Beam Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.405	2.330	2.267	2.205	2.144
3.660	2.503	2.451	2.402	2.350	2.297
4.267	2.816	2.617	2.510	2.447	2.417
4.870	4.644	4.271	4.111	4.019	4.010



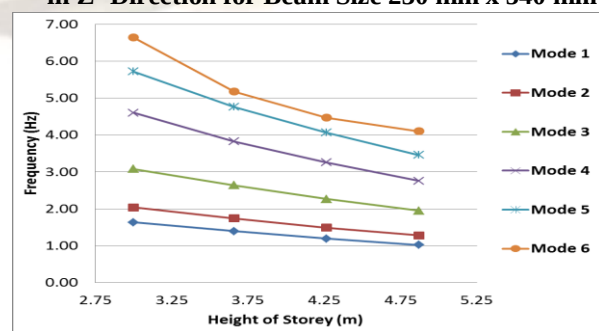
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 460 mm



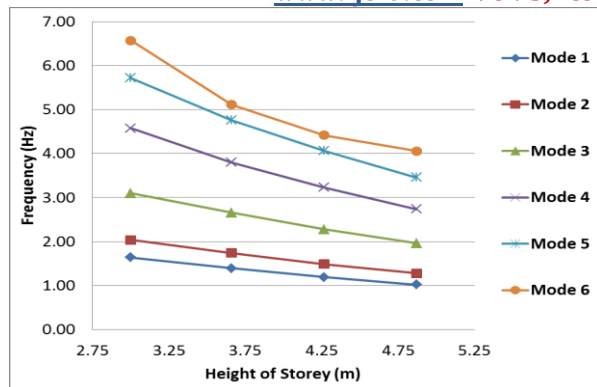
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 540 mm



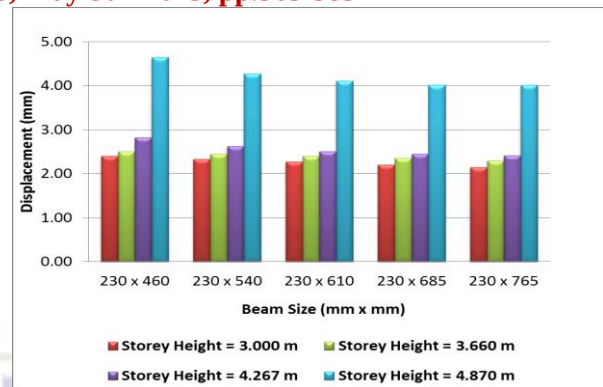
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 765 mm



(f) Effect of Beam Size and Storey Height on Horizontal Displacement in Z – Direction

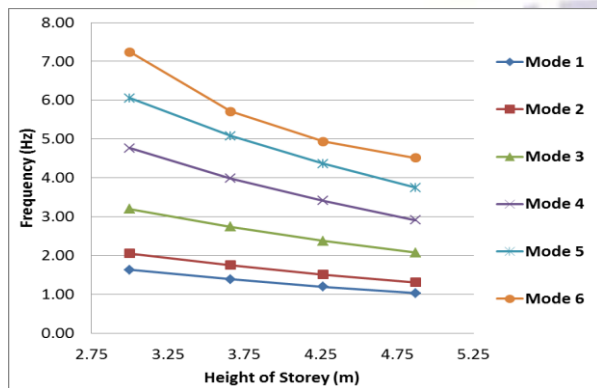
**Fig.7 Effect of Beam Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Column size 230 mm x 460 mm)**

**Table 4 Effect of Beam Size and Storey Height on Horizontal Frequency in Z - Direction
 (For Column Size 230 mm x 540 mm)**

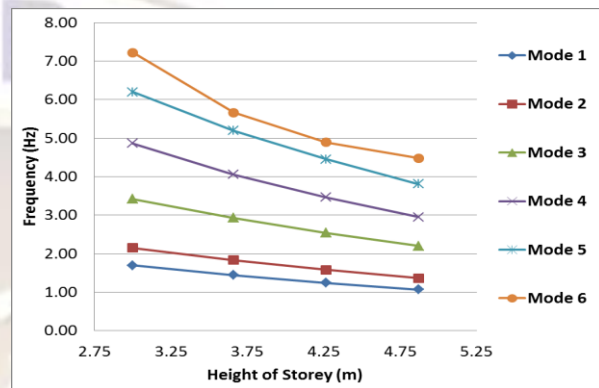
Beam Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.630	2.056	3.200	4.763	6.048	7.237
	3.660	1.391	1.755	2.740	3.988	5.081	5.707
	4.267	1.197	1.514	2.376	3.413	4.366	4.937
	4.870	1.033	1.312	2.072	2.915	3.749	4.512
230 x 540	3.000	1.691	2.149	3.419	4.858	6.197	7.215
	3.660	1.443	1.833	2.929	4.054	5.191	5.659
	4.267	1.238	1.577	2.534	3.461	4.449	4.889
	4.870	1.065	1.363	2.202	2.945	3.806	4.475
230 x 610	3.000	1.723	2.199	3.554	4.898	6.264	7.176
	3.660	1.469	1.876	3.044	4.078	5.235	5.609
	4.267	1.259	1.611	2.629	3.475	4.479	4.842
	4.870	1.081	1.388	2.279	2.951	3.822	4.438
230 x 685	3.000	1.741	2.228	3.650	4.909	6.289	7.120
	3.660	1.484	1.900	3.127	4.079	5.246	5.551
	4.267	1.269	1.630	2.697	3.471	4.481	4.790
	4.870	1.088	1.402	2.331	2.942	3.817	4.395
230 x 765	3.000	1.747	2.241	3.713	4.896	6.280	7.050
	3.660	1.488	1.910	3.180	4.062	5.230	5.486
	4.267	1.272	1.636	2.739	3.453	4.462	4.733
	4.870	1.088	1.405	2.364	2.923	3.795	4.347

Table 5 Effect of Beam Size and Storey Height on Horizontal Displacement in Z - Direction
 (For Column Size 230 mm x 540 mm)

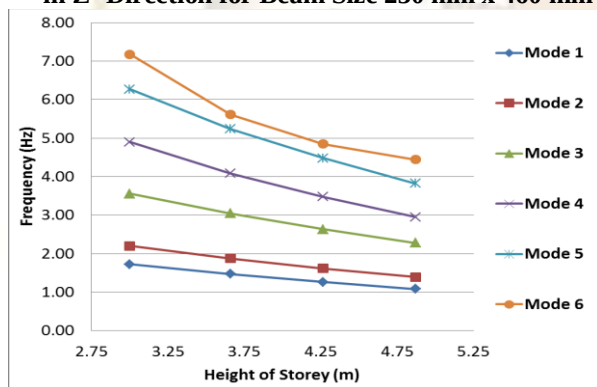
Height of Storey (m)	Beam Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.309	2.221	2.149	2.081	2.017
3.660	2.369	2.312	2.260	2.206	2.153
4.267	2.315	2.280	2.240	2.194	2.144
4.870	3.406	3.142	3.004	2.928	2.896



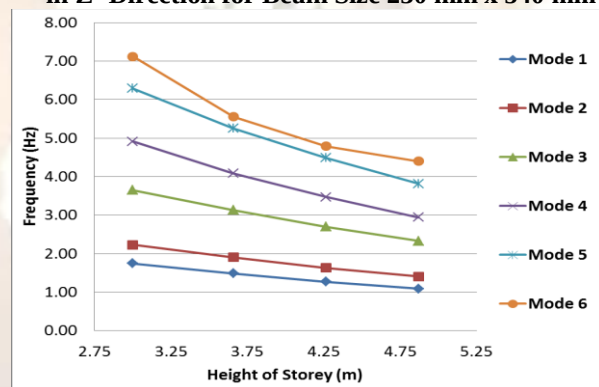
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 460 mm



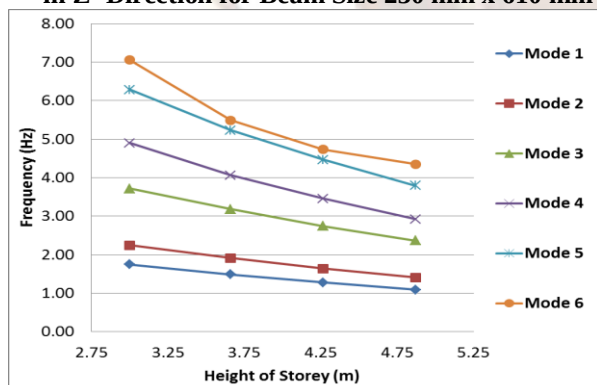
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 540 mm



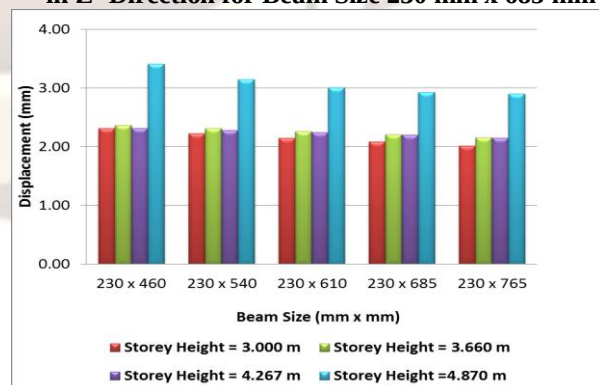
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 765 mm



(f) Effect of Beam Size and Storey Height on Horizontal Displacement in Z – Direction

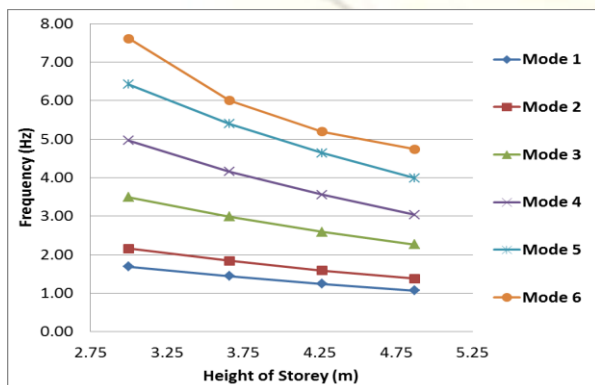
Fig.8 Effect of Beam Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Column size 230 mm x 540 mm)

Table 6 Effect of Beam Size and Storey Height on Horizontal Frequency in Z - Direction
(For Column Size 230 mm x 610 mm)

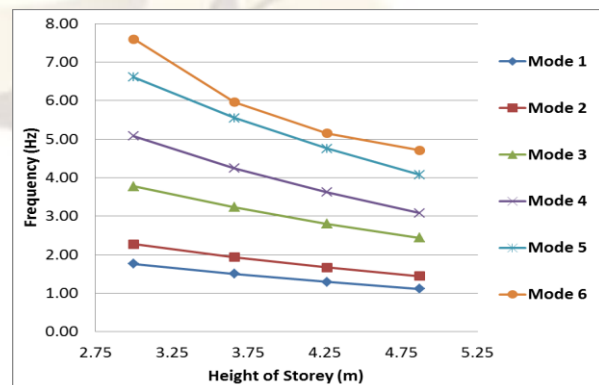
Beam Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.688	2.158	3.487	4.963	6.416	7.604
	3.660	1.439	1.838	2.983	4.156	5.395	6.002
	4.267	1.238	1.586	2.591	3.556	4.638	5.192
	4.870	1.069	1.377	2.265	3.037	3.988	4.740
230 x 50	3.000	1.760	2.271	3.770	5.079	6.607	7.590
	3.660	1.500	1.935	3.228	4.239	5.542	5.956
	4.267	1.287	1.666	2.799	3.617	4.753	5.145
	4.870	1.107	1.441	2.439	3.078	4.073	4.705
230 x 610	3.000	1.799	2.337	3.957	5.132	6.704	7.555
	3.660	1.533	1.992	3.390	4.273	5.612	5.907
	4.267	1.312	1.712	2.934	3.640	4.806	5.098
	4.870	1.127	1.477	2.550	3.090	4.107	4.668
230 x 685	3.000	1.823	2.381	4.102	5.153	6.755	7.505
	3.660	1.552	2.029	3.515	4.282	5.644	5.848
	4.267	1.327	1.741	3.038	3.642	4.826	5.045
	4.870	1.137	1.499	2.634	3.086	4.117	4.626
230 x 765	3.000	1.833	2.405	4.206	5.148	6.767	7.432
	3.660	1.560	2.049	3.605	4.270	5.645	5.783
	4.267	1.332	1.756	3.111	3.628	4.821	4.988
	4.870	1.140	1.510	2.692	3.070	4.105	4.577

Table 7 Effect of Beam Size and Storey Height on Horizontal Displacement in Z - Direction
(For Column Size 230 mm x 610 mm)

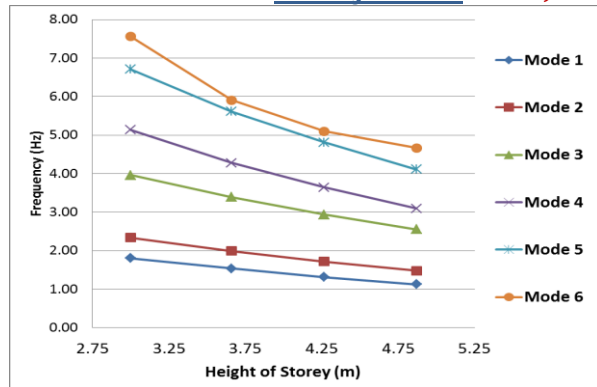
Height of Storey (m)	Beam Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.234	2.134	2.092	2.056	2.012
3.660	2.270	2.208	2.151	2.093	2.038
4.267	2.216	2.179	2.138	2.092	2.044
4.870	2.893	2.713	2.596	2.511	2.452



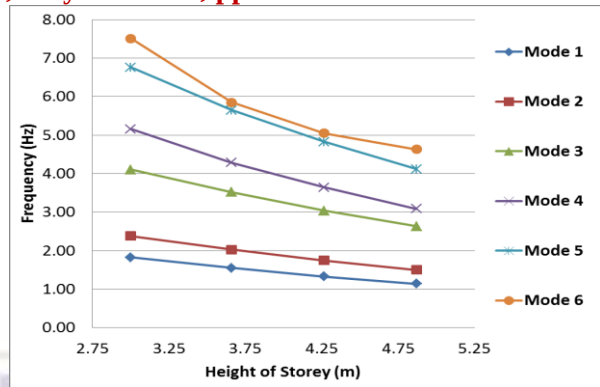
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 460 mm



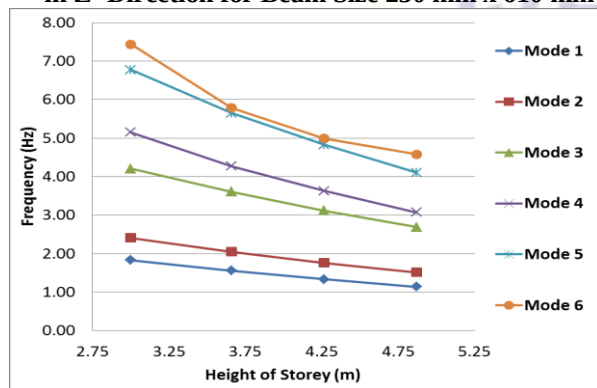
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 540 mm



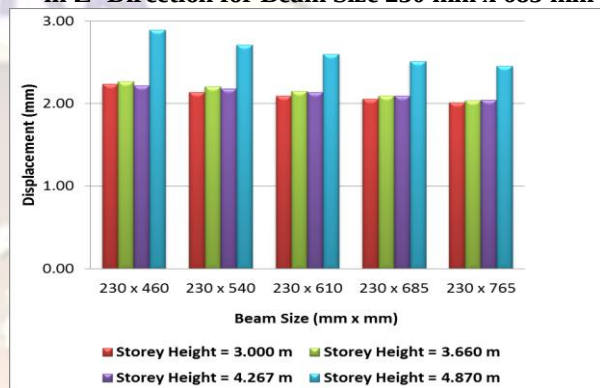
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 765 mm



(f) Effect of Beam Size and Storey Height on Horizontal Displacement in Z – Direction

Fig.9 Effect of Beam Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Column size 230 mm x 610 mm)

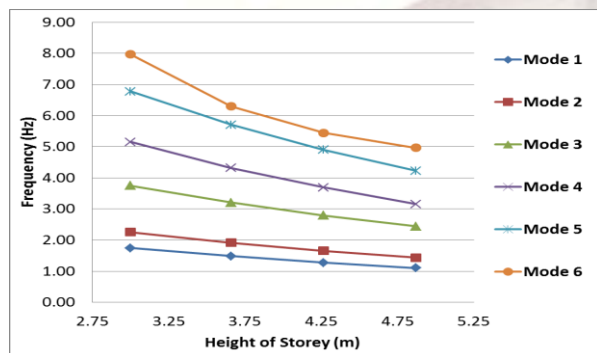
Table 8 Effect of Beam Size and Storey Height on Horizontal Frequency in Z - Direction
 (For Column Size 230 mm x 685 mm)

Beam Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.742	2.253	3.751	5.154	6.777	7.962
	3.660	1.484	1.916	3.205	4.315	5.700	6.291
	4.267	1.276	1.653	2.786	3.692	4.903	5.441
	4.870	1.102	1.436	2.440	3.153	4.222	4.962
230 x 540	3.000	1.824	2.386	4.094	5.290	7.009	7.956
	3.660	1.553	2.031	3.503	4.415	5.885	6.248
	4.267	1.332	1.748	3.042	3.767	5.052	5.395
	4.870	1.147	1.514	2.657	3.205	4.336	4.929
230 x 610	3.000	1.871	2.469	4.334	5.358	7.139	7.926
	3.660	1.592	2.102	3.711	4.461	5.984	6.199
	4.267	1.363	1.807	3.219	3.798	5.130	5.349
	4.870	1.170	1.560	2.805	3.224	4.392	4.894
230 x 685	3.000	1.901	2.528	4.531	5.390	7.218	7.876
	3.660	1.617	2.153	3.883	4.478	6.042	6.141
	4.267	1.382	1.848	3.363	3.807	5.173	5.296
	4.870	1.184	1.593	2.924	3.225	4.420	4.851

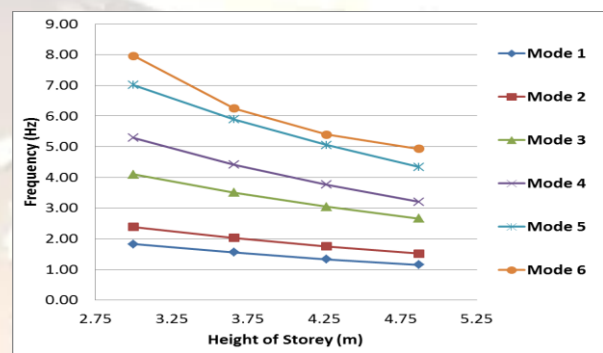
	3.000	1.916	2.566	4.684	5.394	7.254	7.809
230 x 765	3.660	1.629	2.185	4.016	4.473	6.062	6.077
	4.267	1.391	1.874	3.473	3.798	5.185	5.238
	4.870	1.190	1.613	3.014	3.212	4.423	4.803

Table 9 Effect of Beam Size and Storey Height on Horizontal Displacement in Z - Direction
 (For Column Size 230 mm x 685 mm)

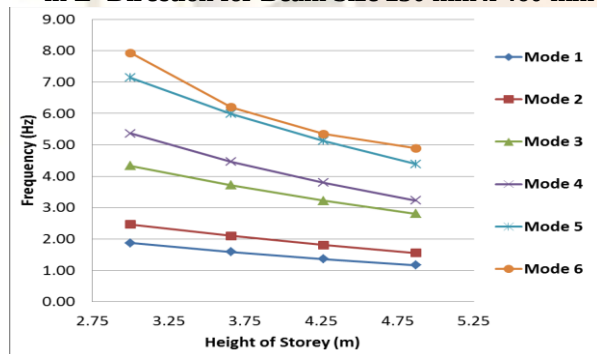
Height of Storey (m)	Beam Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.160	2.116	2.113	2.045	1.982
3.660	2.179	2.109	2.046	1.983	1.924
4.267	2.121	2.082	2.039	1.992	1.943
4.870	2.539	2.319	2.188	2.100	2.049



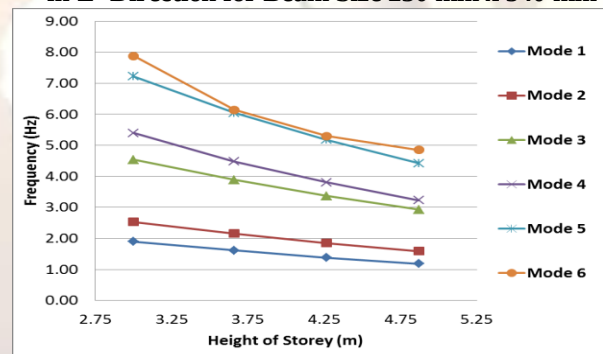
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 460 mm



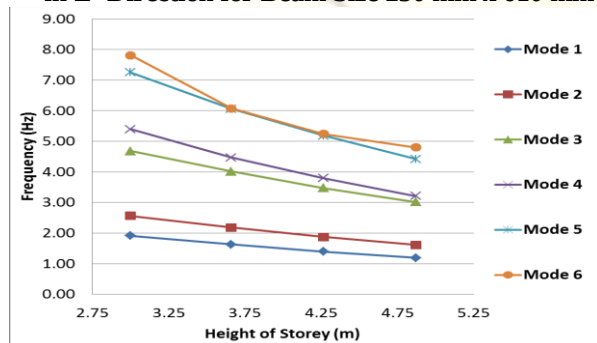
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 540 mm



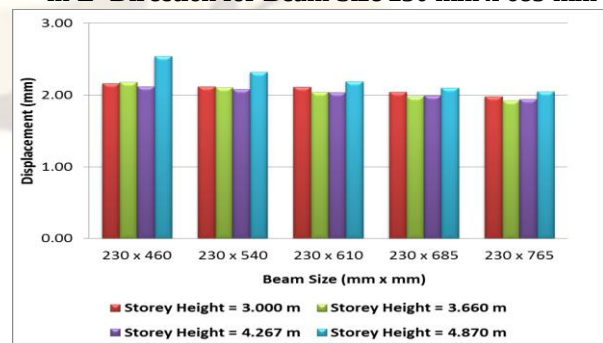
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 765 mm



(f) Effect of Beam Size and Storey Height on Horizontal Displacement in Z – Direction

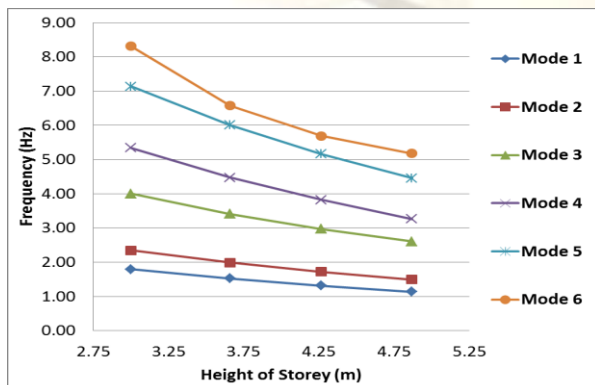
Fig.10 Effect of Beam Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Column size 230 mm x 685 mm)

Table 10 Effect of Beam Size and Storey Height on Horizontal Frequency in Z - Direction
(For Column Size 230 mm x 765 mm)

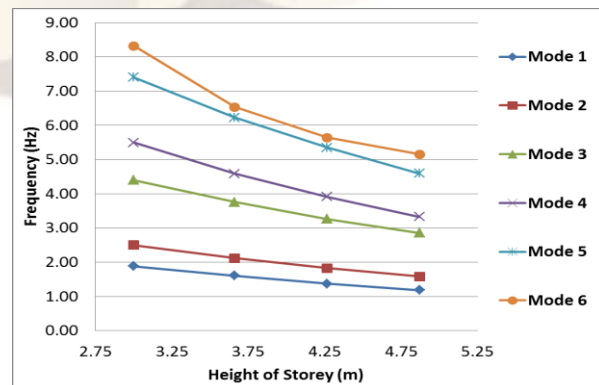
Beam Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.791	2.342	3.999	5.334	7.131	8.310
	3.660	1.524	1.988	3.410	4.466	5.999	6.573
	4.267	1.311	1.715	2.966	3.819	5.160	5.684
	4.870	1.132	1.490	2.600	3.262	4.449	5.178
230 x 540	3.000	1.884	2.495	4.393	5.492	7.401	8.313
	3.660	1.603	2.119	3.755	4.583	6.219	6.533
	4.267	1.374	1.825	3.263	3.909	5.342	5.640
	4.870	1.183	1.581	2.856	3.326	4.593	5.148
230 x 610	3.000	1.938	2.593	4.682	5.574	7.562	8.289
	3.660	1.648	2.204	4.007	4.641	6.347	6.486
	4.267	1.411	1.895	3.480	3.950	5.446	5.594
	4.870	1.211	1.639	3.040	3.352	4.672	5.113
230 x 685	3.000	1.975	2.669	4.932	5.619	7.672	8.243
	3.660	1.679	2.270	4.226	4.668	6.428	6.433
	4.267	1.435	1.950	3.666	3.967	5.514	5.541
	4.870	1.229	1.682	3.196	3.359	4.721	5.072
230 x 765	3.000	1.995	2.721	5.137	5.632	7.734	8.179
	3.660	1.696	2.316	4.405	4.670	6.362	6.478
	4.267	1.447	1.987	3.817	3.963	5.482	5.548
	4.870	1.237	1.712	3.321	3.350	4.742	5.024

Table 11 Effect of Beam Size and Storey Height on Horizontal Displacement in Z-Direction
(For Column Size 230 mm x 765 mm)

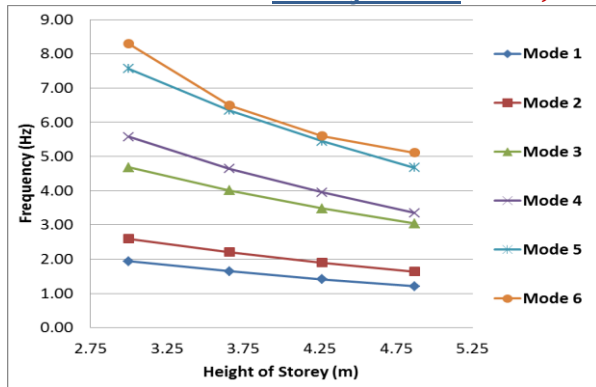
Height of Storey (m)	Beam Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.087	2.103	2.065	2.003	1.931
3.660	2.093	2.016	1.947	1.879	1.815
4.267	2.031	1.988	1.942	1.892	1.842
4.870	2.195	2.000	1.968	1.927	1.880



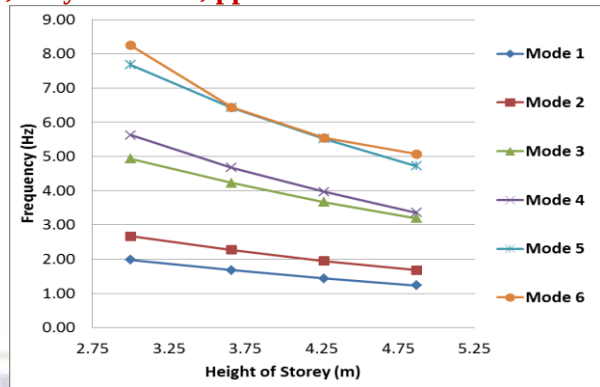
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 460 mm



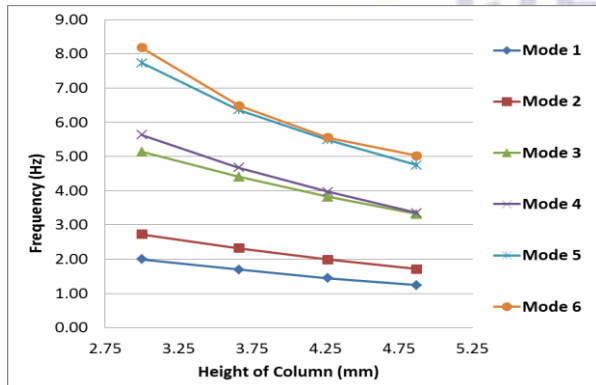
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 540 mm



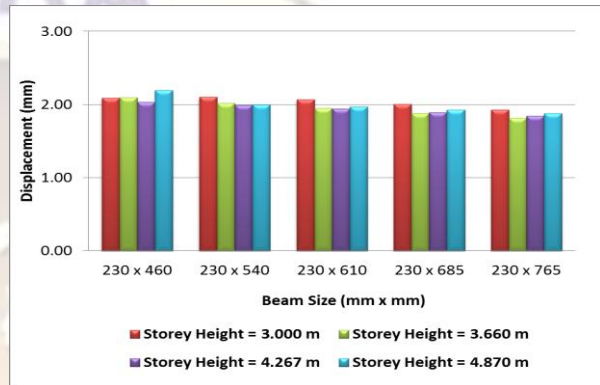
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Beam Size 230 mm x 765 mm



(f) Effect of Beam Size and Storey Height on Horizontal Displacement in Z – Direction

Fig.11 Effect of Beam Size and Storey Height on Horizontal Frequency and Horizontal Displacement
(For Column size 230 mm x 765 mm)

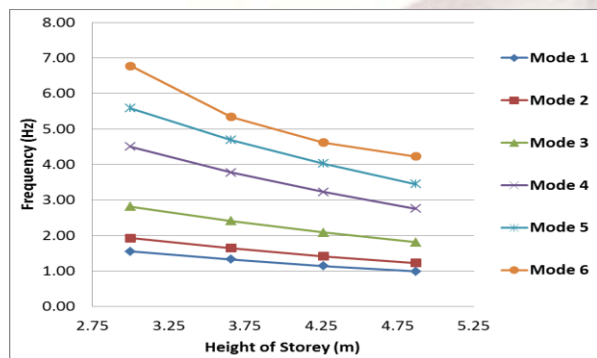
Table 12 Effect of Column Size and Storey Height on Horizontal Frequency in Z -Direction
(For Beam Size 230 mm x 460 mm)

Column Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.552	1.922	2.810	4.501	5.582	6.772
	3.660	1.326	1.642	2.407	3.767	4.684	5.333
	4.267	1.141	1.415	2.082	3.224	4.021	4.614
	4.870	0.985	1.225	1.808	2.753	3.446	4.222
230 x 540	3.000	1.630	2.056	3.200	4.763	6.048	7.237
	3.660	1.391	1.755	2.740	3.988	5.081	5.707
	4.267	1.197	1.514	2.376	3.413	4.366	4.937
	4.870	1.033	1.312	2.072	2.915	3.749	4.512
230 x 610	3.000	1.688	2.158	3.487	4.963	6.416	7.604
	3.660	1.439	1.838	2.983	4.156	5.395	6.002
	4.267	1.238	1.586	2.591	3.556	4.638	5.192
	4.870	1.069	1.377	2.265	3.037	3.988	4.740
230 x 685	3.000	1.742	2.253	3.751	5.154	6.777	7.962
	3.660	1.484	1.916	3.205	4.315	5.700	6.291
	4.267	1.276	1.653	2.786	3.692	4.903	5.441
	4.870	1.102	1.436	2.440	3.153	4.222	4.962

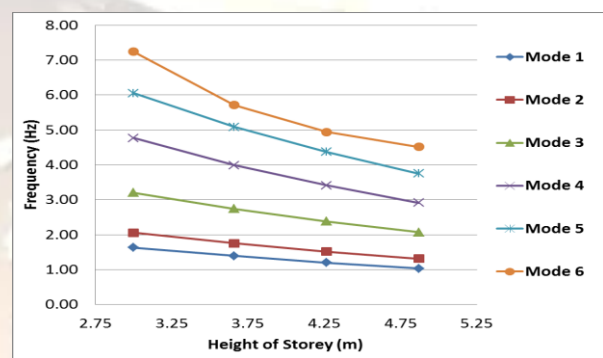
	3.000	1.791	2.342	3.999	5.334	7.131	8.310
230 x 765	3.660	1.524	1.988	3.410	4.466	5.999	6.573
	4.267	1.311	1.715	2.966	3.819	5.160	5.684
	4.870	1.132	1.490	2.600	3.262	4.449	5.178

Table 13 Effect of Column Size and Storey Height on Horizontal Displacement in Z-Direction
 (For Beam Size 230 mm x 460 mm)

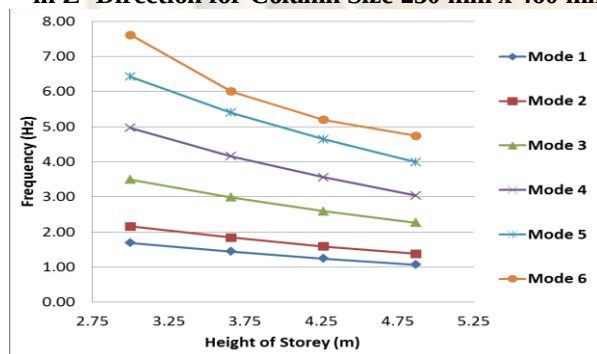
Height of Storey (m)	Column Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.405	2.309	2.234	2.160	2.087
3.660	2.503	2.369	2.270	2.179	2.093
4.267	2.816	2.315	2.216	2.121	2.031
4.870	4.644	3.406	2.893	2.539	2.195



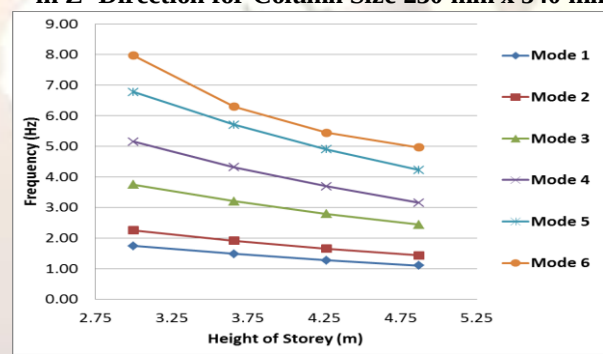
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 460 mm



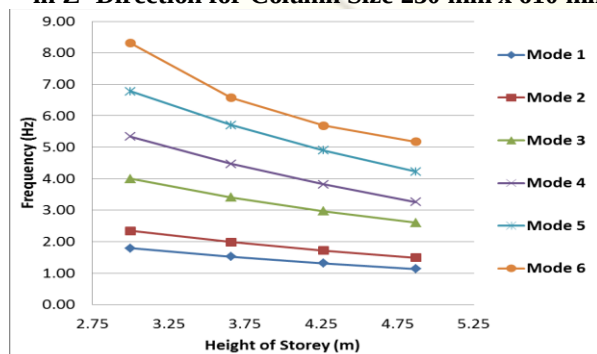
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 540 mm



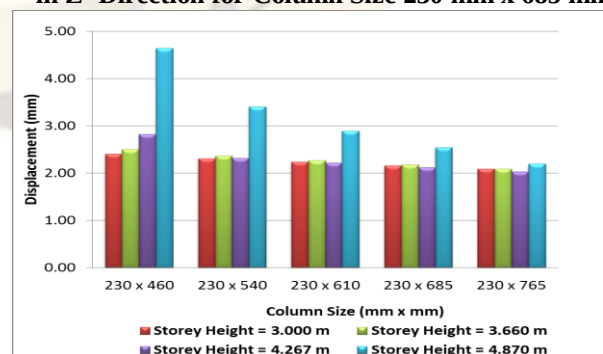
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 765 mm



(f) Effect of Column Size and Storey Height on Horizontal Displacement in Z - Direction

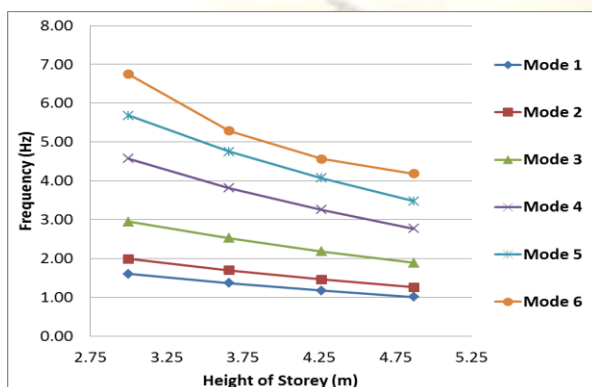
Fig.12 Effect of Column Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Beam size 230 mm x 460 mm)

**Table 14 Effect of Column Size and Storey Height on Horizontal Frequency in Z -Direction
 (For Beam Size 230 mm x 540 mm)**

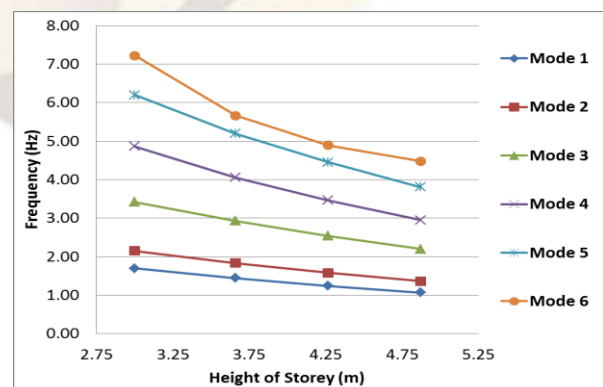
Column Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.601	1.989	2.951	4.572	5.682	6.742
	3.660	1.367	1.699	2.528	3.815	4.752	5.283
	4.267	1.173	1.461	2.181	3.257	4.069	4.565
	4.870	1.009	1.260	1.888	2.772	3.475	4.183
230 x 540	3.000	1.691	2.149	3.419	4.858	6.197	7.215
	3.660	1.443	1.833	2.929	4.054	5.191	5.659
	4.267	1.238	1.577	2.534	3.461	4.449	4.889
	4.870	1.065	1.363	2.202	2.945	3.806	4.475
230 x 610	3.000	1.760	2.271	3.770	5.079	6.607	7.590
	3.660	1.500	1.935	3.228	4.239	5.542	5.956
	4.267	1.287	1.666	2.799	3.617	4.753	5.145
	4.870	1.107	1.441	2.439	3.078	4.073	4.705
230 x 685	3.000	1.824	2.386	4.094	5.290	7.009	7.956
	3.660	1.553	2.031	3.503	4.415	5.885	6.248
	4.267	1.332	1.748	3.042	3.767	5.052	5.395
	4.870	1.147	1.514	2.657	3.205	4.336	4.929
230 x 765	3.000	1.884	2.495	4.393	5.492	7.401	8.313
	3.660	1.603	2.119	3.755	4.583	6.219	6.533
	4.267	1.374	1.825	3.263	3.909	5.342	5.640
	4.870	1.183	1.581	2.856	3.326	4.593	5.148

**Table 15 Effect of Column Size and Storey Height on Horizontal Displacement in Z-Direction
 (For Beam Size 230 mm x 540 mm)**

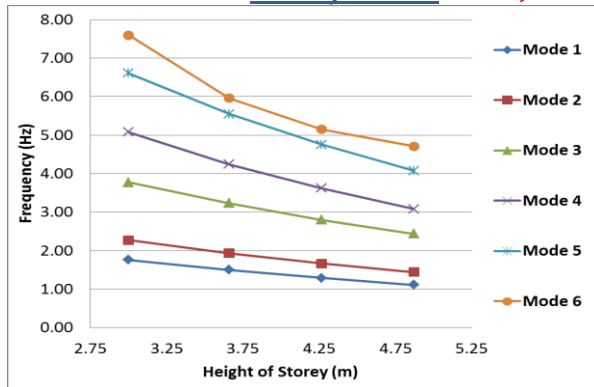
Height of Storey (m)	Column Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.330	2.221	2.134	2.116	2.103
3.660	2.451	2.312	2.208	2.109	2.016
4.267	2.617	2.280	2.179	2.082	1.988
4.870	4.271	3.142	2.713	2.319	2.000



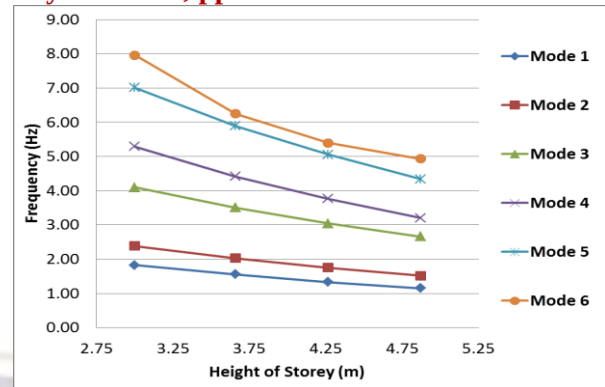
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 460 mm



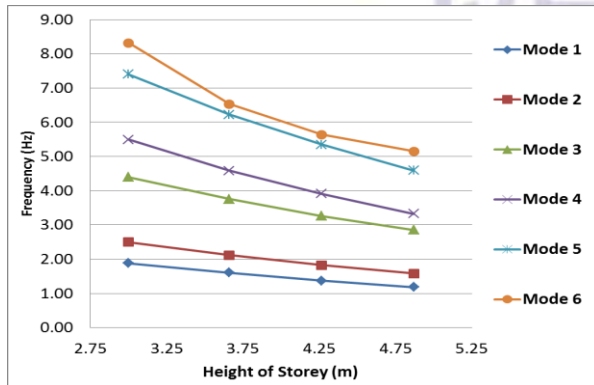
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 540 mm



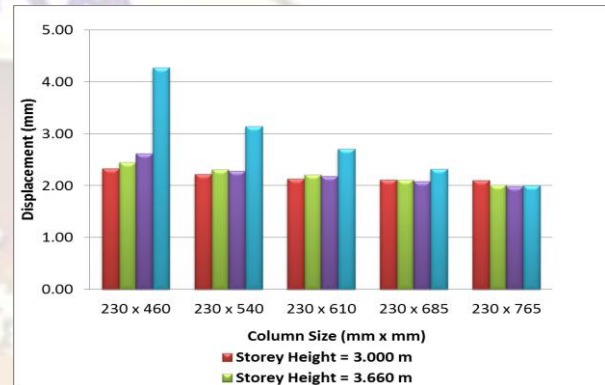
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 765 mm



(f) Effect of Column Size and Storey Height on Horizontal Displacement in Z - Direction

Fig.13 Effect of Column Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Beam size 230 mm x 540 mm)

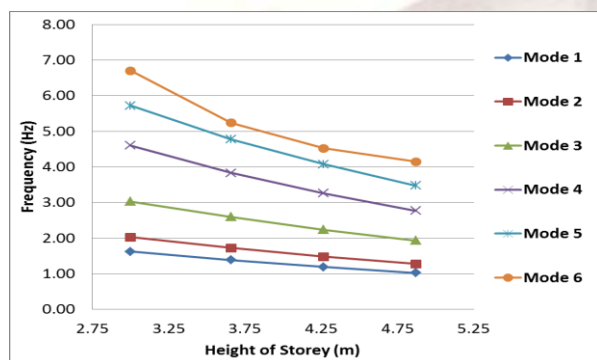
Table 16 Effect of Column Size and Storey Height on Horizontal Frequency in Z -Direction
 (For Beam Size 230 mm x 610 mm)

Column Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.625	2.022	3.029	4.597	5.717	6.698
	3.660	1.387	1.726	2.594	3.827	4.770	5.232
	4.267	1.188	1.481	2.234	3.262	4.077	4.518
	4.870	1.020	1.275	1.929	2.771	3.474	4.146
230 x 540	3.000	1.723	2.199	3.554	4.898	6.264	7.176
	3.660	1.469	1.876	3.044	4.078	5.235	5.609
	4.267	1.259	1.611	2.629	3.475	4.479	4.842
	4.870	1.081	1.388	2.279	2.951	3.822	4.438
230 x 610	3.000	1.799	2.337	3.957	5.132	6.704	7.555
	3.660	1.533	1.992	3.390	4.273	5.612	5.907
	4.267	1.312	1.712	2.934	3.640	4.806	5.098
	4.870	1.127	1.477	2.550	3.090	4.107	4.668
230 x 685	3.000	1.871	2.469	4.334	5.358	7.139	7.926
	3.660	1.592	2.102	3.711	4.461	5.984	6.199
	4.267	1.363	1.807	3.219	3.798	5.130	5.349
	4.870	1.170	1.560	2.805	3.224	4.392	4.894

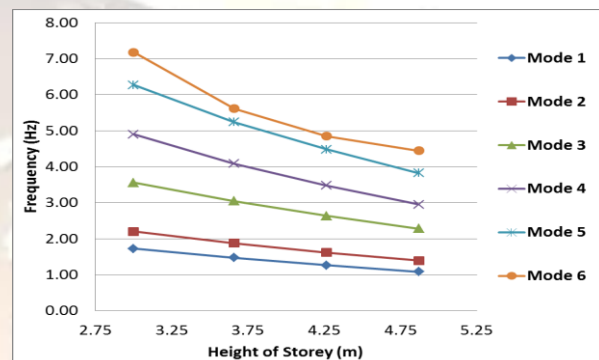
	3.000	1.938	2.593	4.682	5.574	7.562	8.289
230 x 765	3.660	1.648	2.204	4.007	4.641	6.347	6.486
	4.267	1.411	1.895	3.480	3.950	5.446	5.594
	4.870	1.211	1.639	3.040	3.352	4.672	5.113

Table 17 Effect of Column Size and Storey Height on Horizontal Displacement in Z-Direction
 (For Beam Size 230 mm x 610 mm)

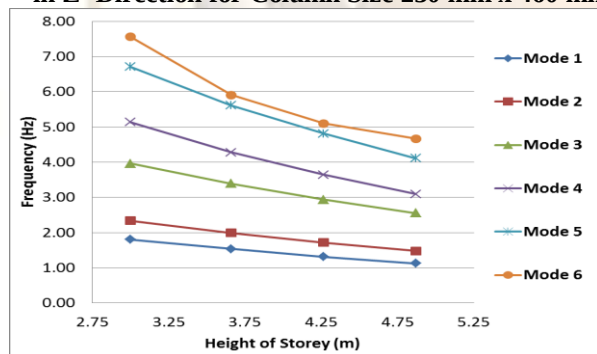
Height of Storey (m)	Column Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.267	2.149	2.092	2.113	2.065
3.660	2.402	2.260	2.151	2.046	1.947
4.267	2.510	2.240	2.138	2.039	1.942
4.870	4.111	3.004	2.596	2.188	1.968



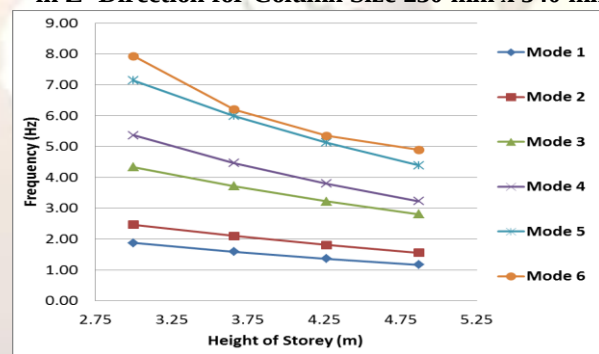
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 460 mm



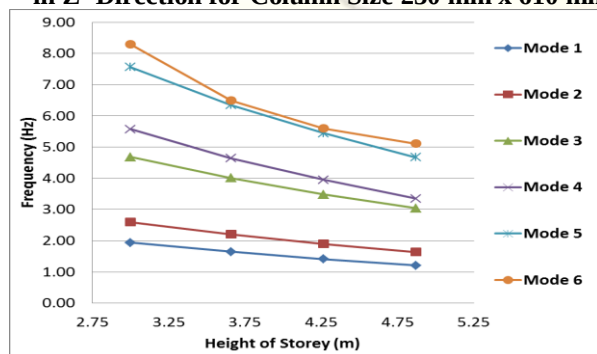
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 540 mm



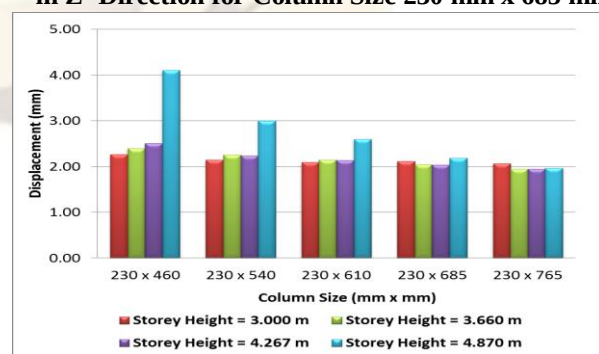
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 765 mm



(f) Effect of Column Size and Storey Height on Horizontal Displacement in Z - Direction

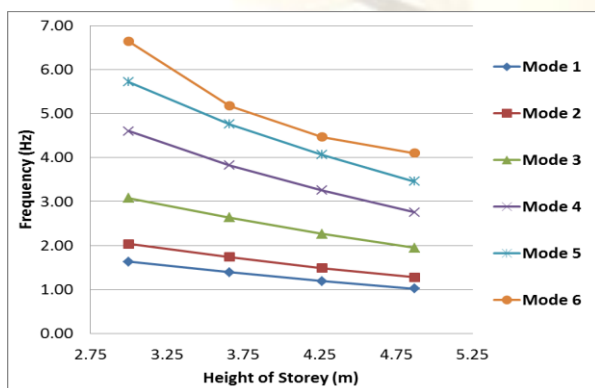
Fig.14 Effect of Column Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Beam size 230 mm x 610 mm)

**Table 18 Effect of Column Size and Storey Height on Horizontal Frequency in Z -Direction
 (For Beam Size 230 mm x 685 mm)**

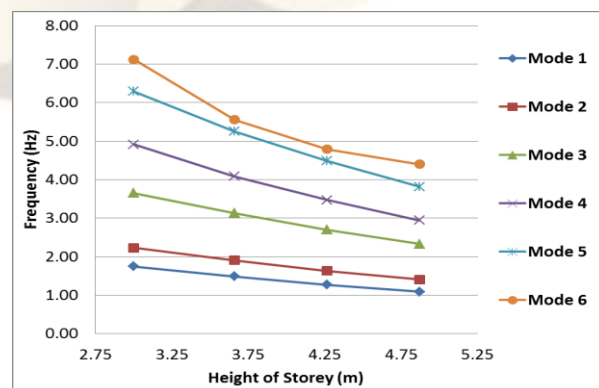
Column Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.636	2.036	3.077	4.597	5.716	6.639
	3.660	1.396	1.738	2.634	3.820	4.760	5.175
	4.267	1.194	1.489	2.265	3.252	4.063	4.467
	4.870	1.024	1.280	1.952	2.758	3.456	4.103
230 x 540	3.000	1.741	2.228	3.650	4.909	6.289	7.120
	3.660	1.484	1.900	3.127	4.079	5.246	5.551
	4.267	1.269	1.630	2.697	3.471	4.481	4.790
	4.870	1.088	1.402	2.331	2.942	3.817	4.395
230 x 610	3.000	1.823	2.381	4.102	5.153	6.755	7.505
	3.660	1.552	2.029	3.515	4.282	5.644	5.848
	4.267	1.327	1.741	3.038	3.642	4.826	5.045
	4.870	1.137	1.499	2.634	3.086	4.117	4.626
230 x 685	3.000	1.901	2.528	4.531	5.390	7.218	7.876
	3.660	1.617	2.153	3.883	4.478	6.042	6.141
	4.267	1.382	1.848	3.363	3.807	5.173	5.296
	4.870	1.184	1.593	2.924	3.225	4.420	4.851
230 x 765	3.000	1.975	2.669	4.932	5.619	7.672	8.243
	3.660	1.679	2.270	4.226	4.668	6.428	6.433
	4.267	1.435	1.950	3.666	3.967	5.514	5.541
	4.870	1.229	1.682	3.196	3.359	4.721	5.072

**Table 19 Effect of Beam Size and Storey Height on Horizontal Displacement in Z-Direction
 (For Beam Size 230 mm x 685 mm)**

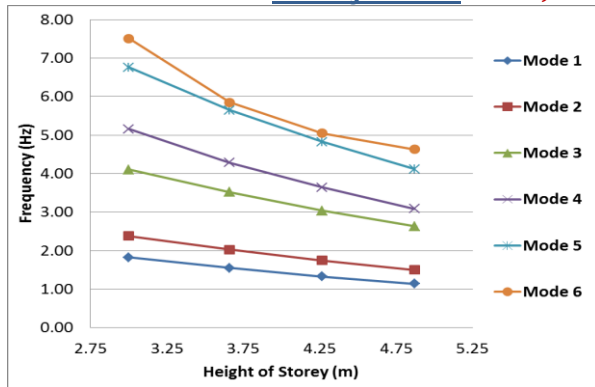
Height of Storey (m)	Column Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.205	2.081	2.056	2.045	2.003
3.660	2.350	2.206	2.093	1.983	1.879
4.267	2.447	2.194	2.092	1.992	1.892
4.870	4.019	2.928	2.511	2.100	1.927



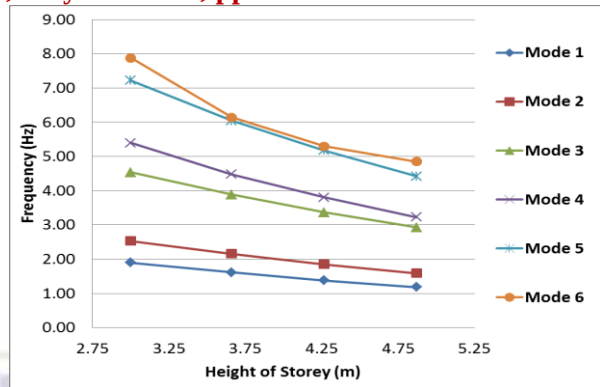
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 460 mm



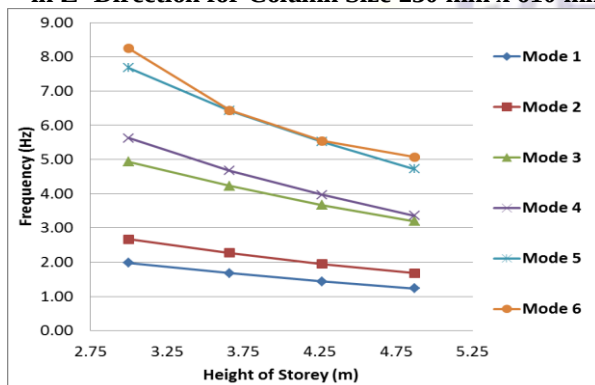
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 540 mm



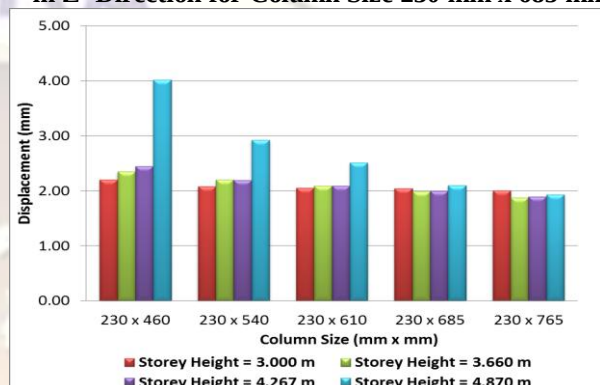
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 765 mm



(f) Effect of Column Size and Storey Height on Horizontal Displacement in Z - Direction

Fig.15 Effect of Column Size and Storey Height on Horizontal Frequency and Horizontal Displacement (For Beam size 230 mm x 685 mm)

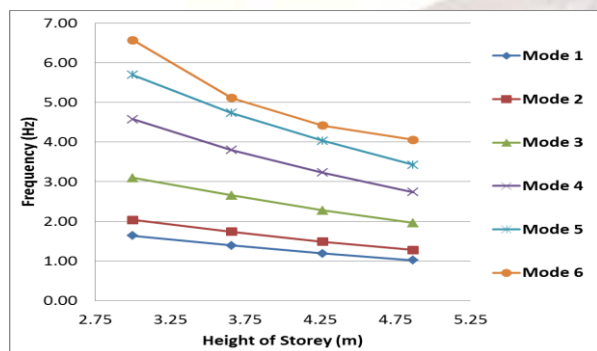
Table 20 Effect of Column Size and Storey Height on Horizontal Frequency in Z-Direction (For Beam Size 230 mm x 765 mm)

Column Size (mm x mm)	Height of Storey (m)	Frequency (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
230 x 460	3.000	1.637	2.037	3.100	4.576	5.689	6.569
	3.660	1.396	1.738	2.654	3.797	4.729	5.112
	4.267	1.193	1.488	2.280	3.230	4.032	4.413
	4.870	1.022	1.277	1.962	2.736	3.426	4.057
230 x 540	3.000	1.747	2.241	3.713	4.896	6.280	7.050
	3.660	1.488	1.910	3.180	4.062	5.230	5.486
	4.267	1.272	1.636	2.739	3.453	4.462	4.733
	4.870	1.088	1.405	2.364	2.923	3.795	4.347
230 x 610	3.000	1.833	2.405	4.206	5.148	6.767	7.432
	3.660	1.560	2.049	3.605	4.270	5.645	5.783
	4.267	1.332	1.756	3.111	3.628	4.821	4.988
	4.870	1.140	1.510	2.692	3.070	4.105	4.577
230 x 685	3.000	1.916	2.566	4.684	5.394	7.254	7.809
	3.660	1.629	2.185	4.016	4.473	6.062	6.077
	4.267	1.391	1.874	3.473	3.798	5.185	5.238
	4.870	1.190	1.613	3.014	3.212	4.423	4.803

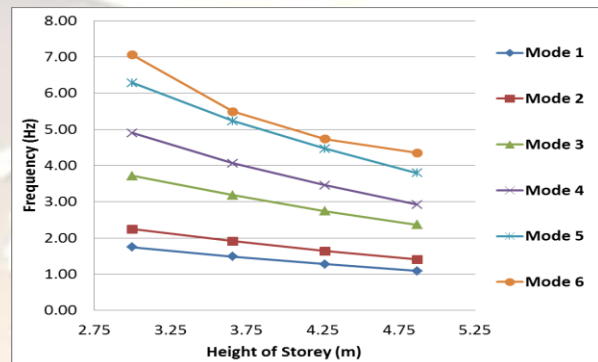
	3.000	1.995	2.721	5.137	5.632	7.734	8.179
230 x 765	3.660	1.696	2.316	4.405	4.670	6.362	6.478
	4.267	1.447	1.987	3.817	3.963	5.482	5.548
	4.870	1.237	1.712	3.321	3.350	4.742	5.024

**Table 21 Effect of Column Size and Storey Height on Horizontal Displacement in Z-Direction
 (For Beam Size 230 mm x 765 mm)**

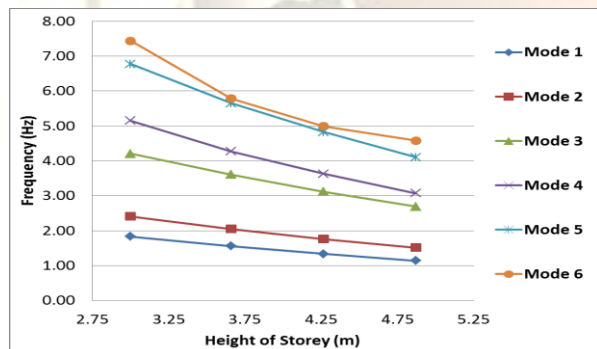
Height of Storey (m)	Column Size (mm x mm)				
	230 x 460	230 x 540	230 x 610	230 x 685	230 x 765
3.000	2.144	2.017	2.012	1.982	1.931
3.660	2.297	2.153	2.038	1.924	1.815
4.267	2.417	2.144	2.044	1.943	1.842
4.870	4.010	2.896	2.452	2.049	1.880



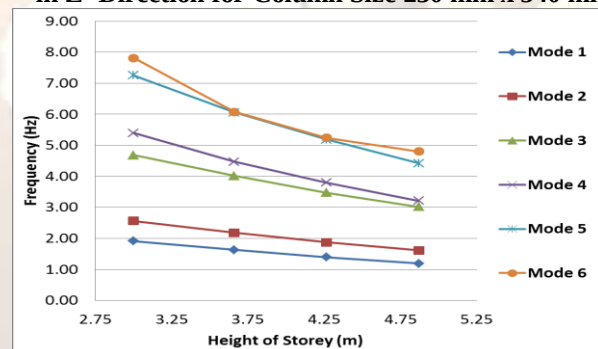
(a) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 460 mm



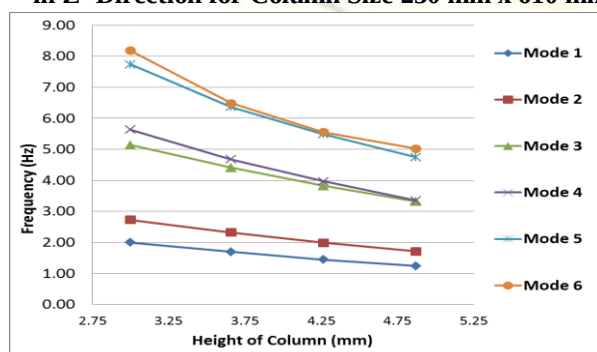
(b) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 540 mm



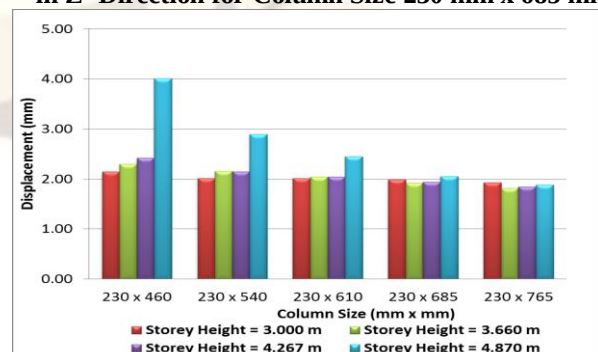
(c) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 610 mm



(d) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 685 mm



(e) Effect of Storey Height on Horizontal Frequency in Z- Direction for Column Size 230 mm x 765 mm



(f) Effect of Column Size and Storey Height on Horizontal Displacement in Z - Direction

**Fig.16 Effect of Column Size and Storey Height on Horizontal Frequency and Horizontal Displacement
 (For Beam size 230 mm x 765 mm)**

CONCLUSION

1. From fig 7 to fig 16, it can be seen that for a particular beam and column size, the frequency of structure reduces with any increase in storey height. The structure becomes flexible with increase in storey height and hence the displacement increases for larger storey height.
2. However, for a particular storey height, the frequency of a structure increases by increasing the beam size or column size, which in turn, reduces the magnitude of displacement as seen from fig 7 to fig 16. When the column sizes is increasing the displacement trend is decreasing in nature. The reason behind it is that the increase in column sizes increases the lateral stiffness of the building which reduces the displacement of the building.
3. Furthermore, the percentage increase in frequency is obtained more by varying the column size rather than beam size. For example, consider table 2 and table 12, for storey height 3.0m, the frequency changes from 1.552Hz to 1.791Hz in mode 1 for beam size 230 mm x 460 mm and column size varying from 230 mm x 460 mm to 230 mm x 765 mm. Again, for the same storey the frequency changes from 1.552Hz to 1.637Hz only by varying beam size from 230 mm x 765 mm.
4. Consider table 3, it can be observed that for a particular beam size, say 230 mm x 460 mm, the displacement is maximum for storey height 4.87m. this phenomenon can be understood by looking into table 2, for storey height 3.0m to 4.267m the frequency of structure is getting closer to the operating frequency of machine in mode 3 whereas for storey height 4.67 m the structure is resonating in mode 4. From fig. 6(c) and fig. 6(d), it can be seen that in mode 3 the structure resonates in x-direction and in mode 4 it resonates in z-direction. The magnitude of displacement is less in mode 3 as structure has adequate stiffness in x-direction rather than z-direction and hence is displacement is more in 4th mode of vibration.
5. The percentage difference in frequency of structure is less in lower modes of vibration and high in higher modes of vibration. Consider table 10, for column size 230 mm x 765 mm and beam Size 230 mm x 460 mm, the change in frequency by increasing the storey height is 14.91 % in mode 1 and 20.90 % in mode 6.
6. When column size is kept constant and beam sizes are varying and vice-versa, a stage comes when column size is equal to the beam sizes and any further increasing of beam size or column sizes, there is not much change over the dynamic behaviour of the building.

7. For larger column and beam size. There is no appreciable change in the displacement of the structure as even though there is a significant change in the frequency as the structure in reaching the resonance condition in mode 3, which does exhibit a considerable vibration in z-direction.

REFERENCES

- [1] ACI Committee, "Foundations for Dynamic Equipment", ACI 351.3R-04.
- [2] Bhatia K. G., "Foundations For Industrial Machines And Earthquake Effects", 28th ISET Annual Lecture.
- [3] Cyril M. Harris, 2002, "Harris' Shock and Vibration Handbook.
- [4] George Gazetas, 1983, "Analysis of Machine Foundation Vibration: State of Art", Soil Dynamics and Earthquake Engineering, Vol 2, No 1.
- [5] Hasmukhray B., 1996, "Fabric Forming", Co-operative Stores Ltd.
- [6] IS 2974 (Part I) – 1982, Edition 3.1 Indian Standard Code of Practice for Design and Construction of Machine Foundation.
- [7] Nurudeen A. Raji, "Impact Analysis of Narrow Loom Beat-up Mechanism", Research Journal of Applied Sciences, Engineering and Technology 3(9): 923-927, 2011, ISSN: 2040-7467
- [8] Snowden D. C., 1967, "Power-Loom Weaving of Woollen and Worsted Fabrics", C. Nicholls and Company Ltd.
- [9] Srinivasulu P. And Vaidyanathan C.V, 2003, "Handbook of Machine Foundations", Tata Mcgraw –Hill Publishing Company, New Delhi.
- [10] Victor Wowk, "A Brief Tutorial on Machine Vibration", Machine Dynamics, Inc.
- [11] Vijay K. Puri and Shamsher Prakash, 2006, "Foundations For Vibrating Machines", Special Issue, April-May, of the Journal of Structural Engineering, SERC, Madras. INDIA.