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Assessment on Human Comfort Criteria of Tall Building under Dynamic Wind Loading

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Abstract*: *The tall, light, flexible buildings may have large oscillating motions induced by wind or other causes that affect the comfort of the occupants. Wind induced motion in buildings may result in excessive vibrations such vibrations can cause discomfort conditions for occupants or damage to non structural elements. So it is essential to analysis the dynamic behavior of the tall building under the wind excitation which influences the human comfort. The purpose of present study is to anysied the range of human perception criteria associated with human comfort that is applied for serviceability limit state design. The design criteria were proposed based on the subjective perception test. The guideline for evaluating the acceptability of wind-induced tall buildings motions was defined by the expected value of motion perception acceleration. In this Project, human comfort condition of a tall building under wind excitation is assessed using estimation of peak acceleration by using Indian standard code IS 875(part3) :2015. Considering Four different Framed Tubes tall building circular structure having a G+20, G+30, G+40, and G+50 with different condition i.e. Normal Slab, Secondary Beam, Waffle Slab & Ribbed Slab are taken. Typical circular floor is 50 m in diameter and symmetrical in plan in both major directions. Then using ETABS-2013 software maximum displacement is evaluated using dynamic wind analysis of building by applying the gust factor method. With the help of maximum Displacement Peak acceleration will be calculated using is IS-875(part3); 2015 for different Framed Tubes structure conditions and modes of building. The peak acceleration obtained in the analysis is compared with the reference data given by Smith. S.B. and Coull book and human comfort perception level is calculating for Indian tertiary of the described location of India from which assessment of effective tall building under dynamic wind load is anysied.

Keywords:* *Framed Tubes, Gust factor, Human Comfort, Maximum displacement, modes of building, Normal Slab, Peak Acceleration, perception level. Ribbed Slab, Secondary Beam, Waffle Slab.

I. INTRODUCTION

From the public point of view a building should remain stationary, and so movement that other circumstance might be quite acceptable can in a tall building induce a wide range of responses, ranging from anxiety to acute nausea in its occupants.

Motions that have psychological or physiological effect on the desirable building, with a resulting reputation that may produce difficulties in renting the floor space.

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It is thus not sufficient to provide a structure capable of resisting the stresses induced by the design loading , with sufficient stiffness to prevent excessive movement and damage to non-structural element, the designer must ensure also the there are no undesirable motion that could adversely affect the occupants. There is generally no accepted international standard for comfort criteria in tall buildings but some reference data should be given on the basis of past building analysis by which we can interlink the data of perception level. Human response to wind-induced vibration in tall buildings has traditionally been evaluated by the acceleration in the horizontal plane. Two different measures of acceleration have been used: the peak value which occurs during a period of time or the root mean square value averaged over this same period. The building perception are depends on the different time periods, frequency, maximum displacement, structural forms, place of building etc. buildings, and must therefore be checked to ensure that accelerations in a structure subjected to vibrations is not uncomfortable for the occupants. Design of buildings is concerned with human response to vibration and perception of motion. At this point it will suffice to note that humans are surprisingly sensitive to vibration to the extent that motions may feel uncomfortable even if they correspond to relatively low levels of stress and strain. In this project an investigation has been made to study the assessment of human comfort criteria by dynamic gust method using IS 875(PART 3) 2015 in terms of peak acceleration. In this project ETABS software is used to obtain maximum story displacement with respect to different mode and time period. On the basis of obtained peak acceleration for different structural form condition, impact of perception level can be defined with respect to reference data.

II. HUMAN COMFORT CRITERIA AND DYNAMIC GUST FACTOR

A. Human Comfort Criteria:- Human comfort can be defined as the comfort of human response under building motion. The motion can be produced by wind, earthquake machinery, nearby industrial plant, various types of transportation etc mode of behavior of building**.** It would be prohibitively expensive to construct a building that would not move perceptibly in worst storm ,during a severe earthquake or wind effect consequently since some motion is inevitable the goal is to determine level of motion and rates of occurrence that are both economic and acceptable to the building occupants.

Based on an examination of available reference data a curves are produced to give recommended upper limit and lower limit of acceleration or range for various frequency depending upon the building use. The peak acceleration is calculated as per Indian standard IS 875 (PART3) 2015, Clause no 10.2.1 The peak acceleration along the wind direction at the top of the structure is given by the following formula:-

$$a = (2 \pi f_o)^2 g_f \times r (SE/\beta)^{(1/2)}$$

f_o = Natural frequency of the structure

x= mean deflection at the position where the acceleration is required

g_r = peak factor defined as the ratio of expected peak value to the root mean value of a fluctuating load

r= roughness factor which is depend on size of structure in relation to ground roughness.

β = damping coefficient

S=size reduction factor

E= spectrum of turbulence in the approaching wind stream

B. Dynamic Gust Method: -Tall building which is wind sensitive shall be designed for dynamic wind loads. Hourly wind speed is used as a reference wind speed to be used in dynamic wind analysis. For calculation of along wind loads response (bending moment, shear force and tip deflection) the gust factor method is used.

According to gust factor method the gust force are calculated are as follow:-

$$F_Z = C_{f,z} * P_d * A_Z * G$$

F_Z = design peak along wind load on the building/ structure at any height z

A_Z = the effective frontal area of the building/structure at any hright z in m^2

P_d = design hourly mean wind pressure corresponding to Vz and obtained as $0.6(V_z)^2$

Table- I: Human Perception level

level	Acceleration (m/s^2)	Effects
1	< 0.05	Humans cannot perceive motion.
2	0.05 - 0.1	Sensitive people can perceive motion. Hanging objects may move slightly.
3	0.1 - 0.25	Majority of people will perceive motion, Level of motion may affect desk work. Long term exposure may produce motion sickness
4	0.25 - 0.4	Desk work becomes difficult or almost impossible
5	0.4 - 0.5	Difficult to walk naturally and standing people may lose balance.
6	0.5 - 0.6	Unable to walk naturally.
7	0.6 - 0.7	People cannot tolerate motion or walk.
8	> 0.85	Objects begin to fall and people may be injured

III. STRUCTURAL MODELING

For modeling of Structure Circular Framed Tubes structure having a G+20, G+30, G+40, and G+50 Story for terrain category 1,2,3 & 4 with four different conditions are as follows:-

1) Framed Tubes Structure with Normal Slab
2) Framed Tubes Structure with Secondary Beam, Waffle
3) Framed Tubes Structure with Ribbed Slab
4) Framed Tubes Structure with Waffle Slab

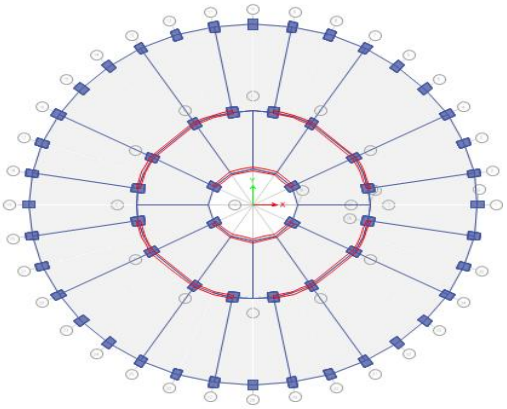

Fig 1: Plan of circular Framed Tubes Structure

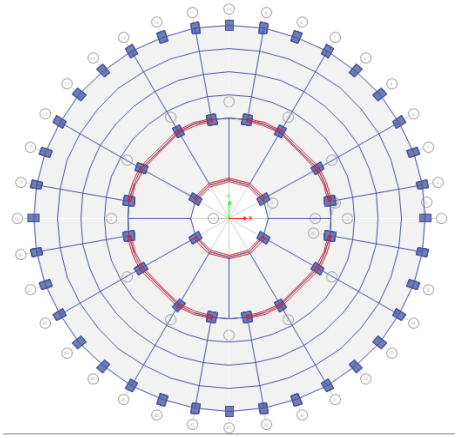

Fig 2: Plan of circular Framed Tubes Structure with Secondary Beam

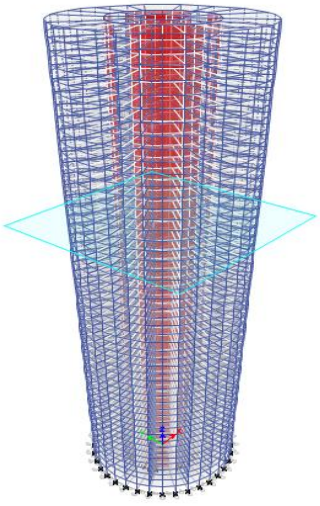

Fig 3: 3D View of circular Framed Tubes Structure

Table- II: Geometrical Properties of Building

Geometrical Properties of Building			
S. No	Particular	Dimensions of G+50 & G+40	Dimensions of G+30 & G+20
1	Type of frame	Framed Tube Structure	Framed Tube Structure
2	No of story	50,40	30, 20
3	Location	Bhubaneswar	Bhubaneswar
4	Building Plan Area	1962.50 m2	1962.50 m2

5	Height of building	174 m.(G+50), 140.50 m.(G+40)	107 m.(G+40), 72 m.(G+30)
6	Column size	1200mm x 1400mm (1-30 story) 1000mm x 1200mm (31-50 story)	600mm x 1000mm (1-30 story)
7	Spandrel Beam Size	1200mm x 1400mm (1-30 story) 1000mm x 1200mm (31-50 story)	800mm x 1200mm (1-30 story)
8	Main Beam Size	800mm x 1200mm (1-30 story) 600mm x 1000mm (31-50 story)	600mm x 1200mm (1-30 story)
9	Inner Beam Size	550mm x 900mm (1-30 story) 500mm x 900mm (31-50 story)	600mm x 1000mm (1-30 story)
10	Slab thickness	200mm (1-30 story) 180mm(31-50 story)	160mm (1-30 story)
11	Shear Wall Thickness	500mm (1-30 story) 400mm(31-50 story)	350mm (1-30 story)
12	Density of concrete	25 KN/M^3	25 KN/M^3
13	Density of steel	78.50KN/M^3	78.50KN/M^3
14	Density of brick wall with plaster	20 KN/M^3	20 KN/M^3
15	Terrain category	1,2,3 &4	1,2,3 &4
16	Structural class	C	C
17	secondary beam size	500mm x 800 mm	300mm x 600 mm
18	Waffle slab size	100 mm depth with 150 mm stem width at top and bottom	100 mm depth with 150 mm stem width at top and bottom
19	Ribbed slab size	100 mm depth with 150 mm stem width at top and bottom	100 mm depth with 150 mm stem width at top and bottom
20	Foundation	Fixed at Ground Level	Fixed at Ground Level

Table- III: Material Properties of Buildings

Material Properties of Buildings		
S.No.	Material	Grade
1	Concrete (Beam Column)	M40
2	Concrete (Shear Wall)	M40
3	Concrete (Slab)	M40
4	Reinforcement (Rebar)	HYSD-500

IV. RESULT AND DISCUSSIONS

A. Maximum Story Displacement:-

A.1 G+50 Story:-

Table- IV: Maximum Story Displacement

Maximum Story Displacement Results (mm)					
G+50 Story					
S.No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure with Normal Slab	47.918	45.587	40.804	37.071
2	Framed Tube Structure with Secondary Beam	48.01	45.678	40.896	37.776
3	Framed Tube Structure with Waffle Slab	47.97	45.645	40.863	37.13
4	Framed Tube Structure with Ribbed Slab	47.912	45.58	40.798	36.916

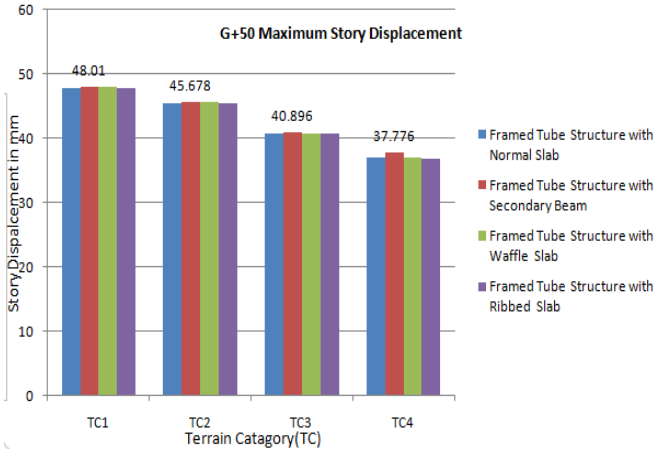

Fig 4: G+ 50 maximum Story displacements

Discussion: -

1) In G+50 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Maximum Story displacement is obtained at framed tube with secondary beam and minimum Displacement is obtained at framed tube with Ribbed Slab.

2) Framed Tube Structure with secondary beam are dominant in Story Displacement due to the self weight (dead weight) of the structure are increases due to secondary beam.

3) Terrain Category 1 (TC1) obtained the maximum Displacement and Terrain Category 4 (TC4) obtained the minimum Displacement from the TC1, TC2, TC3 & TC4.

4) As per above result the Framed Tube Structure with Ribbed Slab lies in TC4 will be safer side from the all the structural from models.

A.2 G+40 Story:-

Table- V: Maximum Story Displacement

Maximum Story Displacement Results (mm)					
G+40 Story					
S.No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure with Normal Slab	24.385	23.118	20.535	18.531
2	Framed Tube Structure with Secondary Beam	24.452	23.185	20.602	18.597
3	Framed Tube Structure with Waffle Slab	24.405	23.139	20.556	18.551
4	Framed Tube Structure with Ribbed Slab	24.385	23.118	20.535	18.531

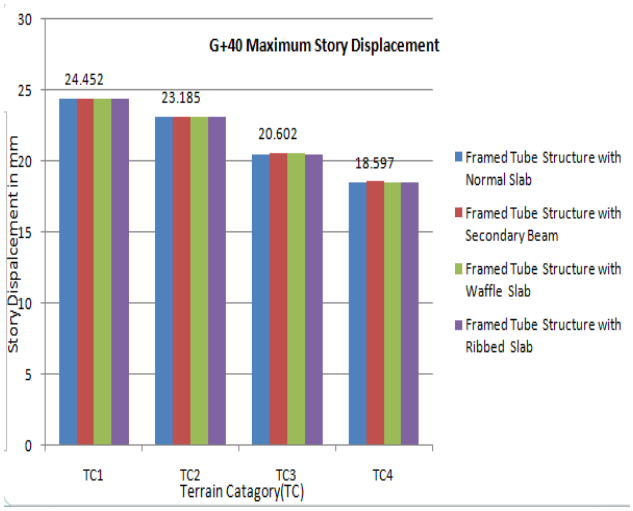

Fig 5: G+ 40 maximum Story displacements

Discussion: -

1) In G+40 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Maximum Story displacement is obtained at framed tube with secondary beam and minimum Displacement is obtained at framed tube with Ribbed Slab.

2) Framed Tube Structure with secondary beam are dominant in Story Displacement due to the self weight (dead weight) of the structure are increases due to secondary beam.

3) Terrain Category 1 (TC1) obtained the maximum Displacement and Terrain Category 4 (TC4) obtained the minimum Displacement from the TC1, TC2, TC3 & TC4.

4) As per above result the Framed Tube Structure with Ribbed Slab lies in TC4 will be safer side from the all the sixteen structural model

A.3 G+30 Story:-

Table- VI: Maximum Story Displacement

Maximum Story Displacement Results (mm)					
G+30 Story					
S.NO.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure with Normal Slab	13.822	13.075	11.582	10.354
2	Framed Tube Structure with Secondary Beam	13.96	13.102	11.62	10.524
3	Framed Tube Structure with Waffle Slab	13.861	13.121	11.644	10.428
4	Framed Tube Structure with Ribbed Slab	13.787	13.051	11.581	10.371

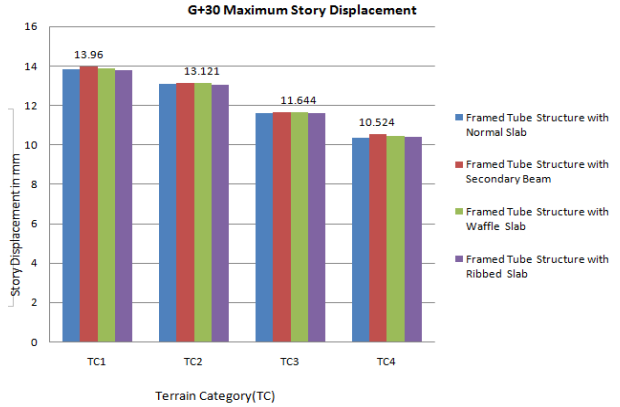

Fig 6: G+ 30 maximum Story displacements

Discussion: -

1) In G+30 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Maximum Story displacement is obtained at framed tube Structure with secondary beam in TC1 & TC4 and framed tube Structure with Waffle Slab in TC2 & TC3. Minimum Displacement is obtained at framed tube with Ribbed Slab in TC1 TC2, TC3 & framed tube with Normal beam in TC4.

2) Framed Tube Structure with secondary in TC1 & TC4 are dominant in Story Displacement due to the self weight (dead weight) of the structure are increases due to secondary beam. Framed Tube Structure with Ribbed Slab in TC2 & TC3 are dominant in Story Displacement due to its Ribbed Slab

A.4 G+20 Story:-

Table- VII: Maximum Story Displacement

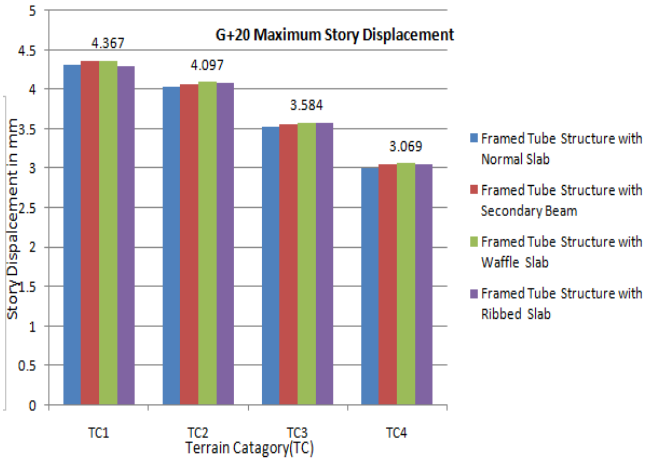

Fig 7: G+ 20 maximum Story displacements

Maximum Displacement Results (Mm)					
G+20 Story					
S.NO.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure with Normal Slab	4.32	4.042	3.526	3.008
2	Framed Tube Structure with Secondary Beam	4.358	4.073	3.565	3.053
3	Framed Tube Structure with Waffle Slab	4.367	4.097	3.584	3.069
4	Framed Tube Structure with Ribbed Slab	4.3	4.083	3.573	3.061

Discussion: -

1) In G+20 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Maximum Story displacement is obtained at framed tube with Waffle Slab and minimum Displacement is obtained at framed tube with Ribbed Slab in TC1 & framed tube with Normal Slab in TC2, TC3 & TC4.

2) Framed Tube Structure with Waffle Slab is dominant in Story Displacement.

3) Terrain Category 1 (TC1) obtained the maximum Displacement and Terrain Category 4 (TC4) obtained the minimum Displacement from the TC1, TC2, TC3 & TC4.

4) As per above result the Framed Tube Structure with Ribbed Slab lies in TC1 and framed tube with Normal Slab in TC2, TC3 & TC4.will be safer side from the all the structural form models.

B. Peak Acceleration:-

B.1 G+50 Story:-

Table- VIII: Peak Acceleration Results

Peak Acceleration Results (m/s^2)					
G+50 Story					
S. No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure With Normal Slab	0.1143	0.1211	0.1336	0.1345
2	Framed Tube Structure With Secondary Beam	0.1145	0.1213	0.1339	0.1354
3	Framed Tube Structure With Waffle Slab	0.1143	0.1211	0.1336	0.1339
4	Framed Tube Structure With Ribbed Slab	0.1144	0.1212	0.1338	0.1347

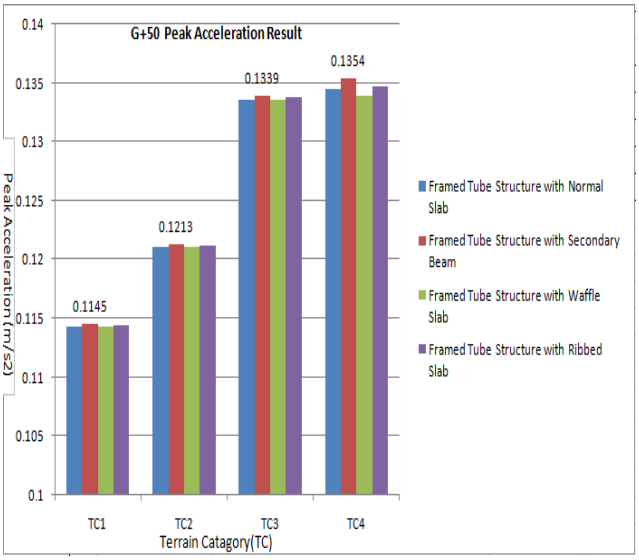

Fig 8: G+ 50 Peak Acceleration result

Discussion:

1) In G+50 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Peak acceleration is obtained at framed tube with Secondary beam are maximum and minimum acceleration is obtained at framed tube with Waffle Slab.

2) Framed Tube Structure with Secondary Beam has peak acceleration in all terrain categories.

3) Terrain Category 1 (TC1) obtained the minimum acceleration and Terrain Category 4 (TC4) obtained the maximum acceleration from the TC1, TC2, TC3 & TC4.

4) Peak acceleration increases with increase the terrain category from 1 to 4.

4) As per above result the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.110 to 0.140 m/s2.

B.1 G+40 Story:-

Table- IX: Peak Acceleration Results

Peak Acceleration Results (m/s^2)					
G+40 Story					
S. No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure With Normal Slab	0.0846	0.0859	0.0864	0.0919
2	Framed Tube Structure With Secondary Beam	0.0848	0.0862	0.0867	0.0922
3	Framed Tube Structure With Waffle Slab	0.0846	0.086	0.0865	0.092
4	Framed Tube Structure With Ribbed Slab	0.0846	0.0859	0.0864	0.0919

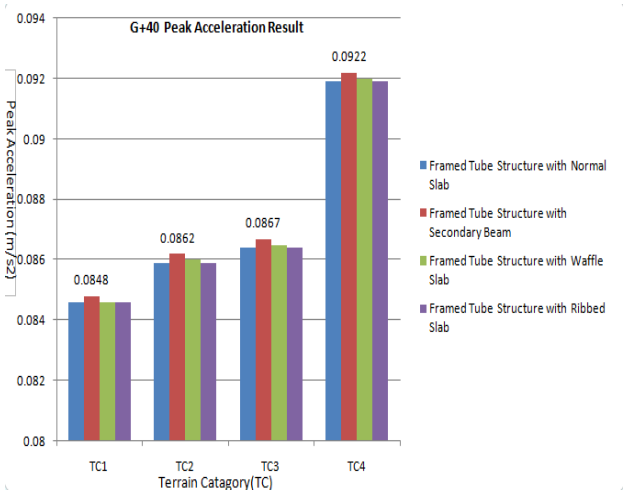

Fig 9: G+ 40 Peak Acceleration results

Discussion: -

1) In G+40 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Peak acceleration is obtained at framed tube with Secondary beam are maximum and minimum acceleration is obtained at framed tube with Waffle Slab& Ribbed Slab.

2) Framed Tube Structure with Secondary Beam has maximum peak acceleration in all terrain categories.

3) Terrain Category 1 (TC1) obtained the minimum acceleration and Terrain Category 4 (TC4) obtained the maximum acceleration from the TC1, TC2, TC3 & TC4.

4) Peak acceleration increases with increase the terrain category from 1 to 4.

5) As per above result the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.08 to 0.10 m/s2

B.3 G+30 Story:-

Table- X: Peak Acceleration Results

Peak Acceleration Results (m/s^2)					
G+30 Story					
S. No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure With Normal Slab	0.07201	0.0748	0.07412	0.07392
2	Framed Tube Structure With Secondary Beam	0.0727	0.07507	0.0743	0.07514
3	Framed Tube Structure With Waffle Slab	0.0722	0.07518	0.0745	0.07445
4	Framed Tube Structure With Ribbed Slab	0.0727	0.07507	0.0743	0.07514

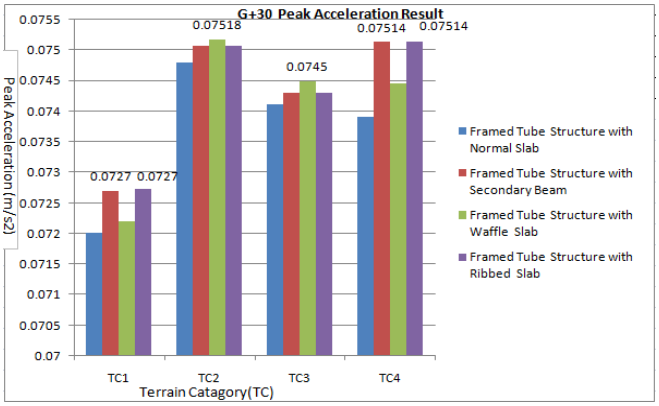

Fig 10: G+ 30 Peak Acceleration result

Discussion: -

1) In G+30 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Peak acceleration is obtained at framed tube with Secondary beam are maximum in TC1 & with Waffle Slab in TC2,TC3 & TC4 and minimum acceleration is obtained at framed tube with normal Slab.

2) Terrain Category 1 (TC1) obtained the minimum acceleration and Terrain Category 2 (TC2) obtained the maximum acceleration from the TC1, TC2, TC3 & TC4.

3) As per above result the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.072 to 0.076 m/s2.

B.4 G+20 Story:-

Table- XI: Peak Acceleration Results

Peak Acceleration Results (m/s^2)					
G+20 Story					
S. No.	Structure Type	TC1	TC2	TC3	TC4
1	Framed Tube Structure With Normal Slab	0.042	0.0416	0.0394	0.035
2	Framed Tube Structure With Secondary Beam	0.0424	0.0419	0.0399	0..0355
3	Framed Tube Structure With Waffle Slab	0.0426	0.0421	0.0401	0.0357
4	Framed Tube Structure With Ribbed Slab	0.0424	0.042	0.04	0.0356

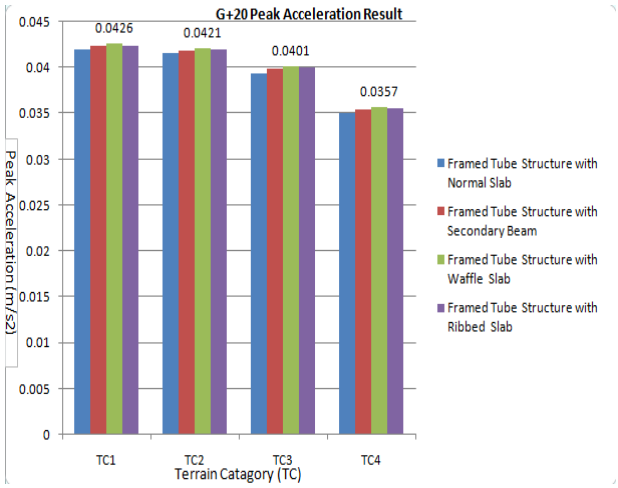

Fig 11: G+ 40 Peak Acceleration result

Discussion: -

1) In G+20 Framed Tube Structure with Normal Slab, Secondary Beam, Waffle Slab and Ribbed Slab, the Peak acceleration is obtained at framed tube with Waffle Slab are maximum and minimum acceleration is obtained at framed tube with Normal Slab.

2) Framed Tube Structure with Waffle Slab has peak acceleration in all terrain categories.

3) Terrain Category 4 (TC4) obtained the minimum acceleration and Terrain Category 1 (TC1) obtained the maximum acceleration from the TC1, TC2, TC3 & TC4.

4) Peak acceleration decrease with increase the terrain category from 1 to 4.

4) As per above result the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.03 to 0.05 m/s2.

C. MODEL RESULTS:- story maximum displacement and peak acceleration result of Mode 1 to Mode 12

C.1 G+50 Story:-

Table- XII: Peak Acceleration Results

Modes Peak Acceleration results							
G+50 With							
Mode No.	Mode Frequency	Maximum Displacement	Mode Time Period	Peak Acceleration	Peak Acceleration	Peak Acceleration	Peak Acceleration
	(Hz)	(mm)	(second)	TC 1	TC 2	TC 3	TC 4
Mode 1	0.383	0.00312	2.612	0.000005	0.000006	0.000007	0.000008
Mode 2	0.384	0.003064	2.602	0.000005	0.000006	0.000007	0.000008
Mode 3	0.639	0.00423	1.565	0.000020	0.000023	0.000028	0.000031
Mode 4	1.185	0.003344	0.844	0.000055	0.000061	0.000076	0.000084
Mode 5	1.194	0.003406	0.837	0.000057	0.000063	0.000078	0.000087
Mode 6	1.765	0.004875	0.566	0.000178	0.000198	0.000245	0.000271
Mode 7	2.34	0.002695	0.427	0.000173	0.000193	0.000238	0.000263
Mode 8	2.385	0.002797	0.419	0.000187	0.000208	0.000256	0.000284
Mode 9	3.181	0.003932	0.314	0.000466	0.000520	0.000641	0.000710
Mode 10	3.579	0.003135	0.279	0.000471	0.000525	0.000647	0.000716
Mode 11	3.681	0.003232	0.272	0.000513	0.000572	0.000705	0.000781
Mode 12	4.629	0.003051	0.216	0.000766	0.000854	0.001053	0.001166

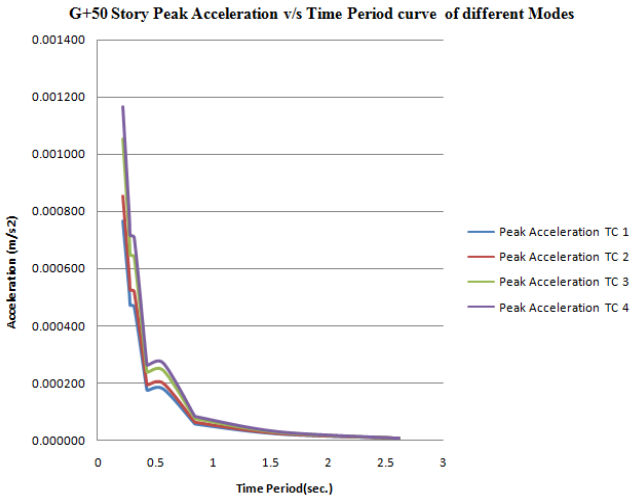

Fig 12: G+ 50Peak Acceleration v/s Time Period Curve

C.2 G+40 Story:-

Table- XIII: Peak Acceleration Results

Modes Peak Acceleration results							
G+40 With							
Mode No.	Mode Frequency (cycle/sec.)	Maximum Displacement mm	Mode Time Period (second)	Peak Acceleration TC 1 (m/sq. Sec)	Peak Acceleration TC 2 (m/sq. Sec)	Peak Acceleration TC 3 (m/sq. Sec)	Peak Acceleration TC 4 (m/sq. Sec)
Mode 1	0.494	0.002663	2.026	0.000007	0.000008	0.000009	0.000010
Mode 2	0.495	0.002636	2.02	0.000007	0.000008	0.000009	0.000010
Mode 3	0.779	0.004385	1.283	0.000030	0.000032	0.000036	0.000042
Mode 4	1.64	0.003701	0.61	0.000110	0.000119	0.000134	0.000158
Mode 5	1.659	0.003796	0.603	0.000116	0.000125	0.000141	0.000166
Mode 6	2.354	0.00536	0.425	0.000329	0.000354	0.000401	0.000471
Mode 7	3	0.003858	0.333	0.000385	0.000414	0.000469	0.000550
Mode 8	3.069	0.003945	0.326	0.000412	0.000443	0.000502	0.000589
Mode 9	3.985	0.005482	0.251	0.000965	0.001038	0.001175	0.001380
Mode 10	4.366	0.0031	0.229	0.000655	0.000704	0.000798	0.000937
Mode 11	4.524	0.003218	0.221	0.000730	0.000785	0.000889	0.001044
Mode 12	5.687	0.004419	0.176	0.001585	0.001704	0.001930	0.002265

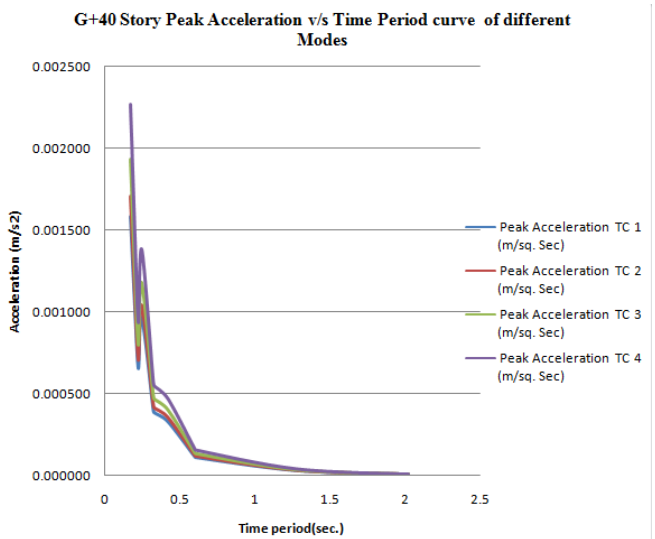

Fig 13: G+40 Peak Acceleration v/s Time Period Curve

C.3 G+30 Story:-

Table- XIV: Peak Acceleration Results

Modes Peak Acceleration results							
G+30							
Mode No.	Mode Frequency (cycle/sec.)	Maximum Displacement mm	Mode Time Period (second)	Peak Acceleration TC 1 (m/sq. Sec)	Peak Acceleration TC 2 (m/sq. Sec)	Peak Acceleration TC 3 (m/sq. Sec)	Peak Acceleration TC 4 (m/sq. Sec)
Mode 1	0.628	0.00446	1.593	0.000017	0.000019	0.000021	0.000023
Mode 2	0.637	0.004432	1.57	0.000017	0.000019	0.000021	0.000024
Mode 3	0.83	0.00635	1.205	0.000042	0.000046	0.000052	0.000058
Mode 4	2.155	0.004166	0.464	0.000187	0.000205	0.000230	0.000257
Mode 5	2.203	0.004147	0.454	0.000195	0.000214	0.000239	0.000267
Mode 6	2.646	0.00622	0.378	0.000421	0.000462	0.000517	0.000578
Mode 7	4.133	0.004168	0.242	0.000688	0.000756	0.000846	0.000944
Mode 8	4.263	0.00408	0.235	0.000717	0.000787	0.000881	0.000983
Mode 9	4.768	0.006168	0.21	0.001356	0.001489	0.001666	0.001860
Mode 10	6.009	0.004055	0.166	0.001416	0.001555	0.001739	0.001942
Mode 11	6.271	0.004	0.159	0.001521	0.001670	0.001869	0.002086
Mode 12	6.847	0.006053	0.146	0.002744	0.003013	0.003371	0.003764

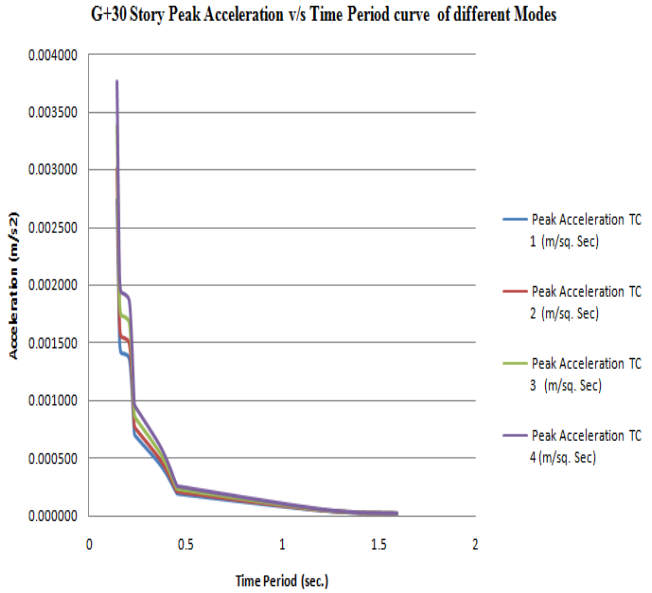

Fig 14: G+ 30Peak Acceleration v/s Time Period Curve

C.4 G+20 Story:-

Table- XV: Peak Acceleration Results

Modes Peak Acceleration results							
G+20							
Mode No.	Mode Frequency (cycle/sec.)	Maximum Displacement mm	Mode Time Period (second)	Peak Acceleration TC 1 (m/sq. Sec)	Peak Acceleration TC 2 (m/sq. Sec)	Peak Acceleration TC 3 (m/sq. Sec)	Peak Acceleration TC 4 (m/sq. Sec)
Mode 1	1.1	0.005485	0.909	0.00005	0.00006	0.00006	0.00006
Mode 2	1.117	0.005424	0.895	0.00006	0.00006	0.00006	0.00007
Mode 3	1.337	0.007892	0.748	0.00012	0.00012	0.00013	0.00014
Mode 4	3.531	0.005219	0.283	0.00053	0.00056	0.00061	0.00063
Mode 5	3.644	0.005197	0.274	0.00056	0.00060	0.00065	0.00067
Mode 6	4.116	0.007638	0.243	0.00106	0.00112	0.00122	0.00126
Mode 7	6.526	0.005159	0.153	0.00180	0.00191	0.00206	0.00214
Mode 8	6.827	0.005043	0.146	0.00192	0.00204	0.00221	0.00229
Mode 9	7.332	0.007536	0.136	0.00331	0.00352	0.00381	0.00395
Mode 10	9.409	0.00507	0.106	0.00367	0.00390	0.00422	0.00438
Mode 11	9.978	0.005009	0.1	0.00407	0.00433	0.00469	0.00486
Mode 12	10.43	0.007279	0.096	0.00647	0.00687	0.00744	0.00772

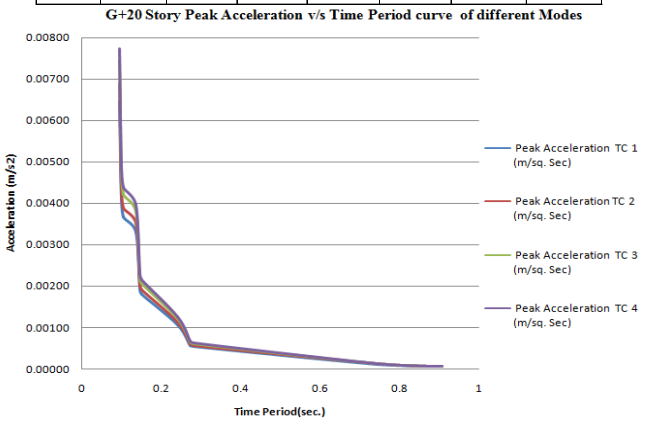

Fig 15: G+ 20Peak Acceleration v/s Time Period Curve

C.5 Assessment of Range:-

On the behalf above mode result of mode 1 to mode 12 of different time period the acceleration range are comes under are as follow:-

Table- XVI: Model Peak Acceleration Results

Modes result of Peak Acceleration				
Story	Minimum acceleration (m/s2)	Maximum acceleration (m/s2)	Reference Perception range	Effect
G+50	0.000005	0.0016	< 0.005	Humans cannot Perceive Motion.
G+40	0.000006	0.0022	< 0.005	Humans cannot Perceive Motion.
G+30	0.000016	0.0037	< 0.005	Humans cannot Perceive Motion.
G+20	0.000005	0.0077	0.005-0.010	Sensitive people can perceive motion. Hanging objects may move slightly

V. CONCLUSION

1) In G+50 story result obtained from the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.110 to 0.140 m/s^2. The range comes under the human perception range 3 i.e. (0.1-0.25) when it compares it with reference data of human perception level which implies that majority of people will perceive motion, level of motion may affect desk work, long term exposure may produce motion sickness.

2) In G+40 the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.08 to 0.10 m/s^2. The range comes under the human perception range 2 i.e. (0.05-0.10 m/s^2) when it compares it with reference data of human perception level which implies that sensitive people can perceive the motion, hanging object may move slightly.

3) In G+30 the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.072 to 0.076 m/s^2. The range comes under the human perception range 2 i.e. (0.05-0.10) when it compares it with reference data of human perception level which implies that sensitive people can perceive motion, hanging object may move slightly.

4) In G+20 the different models of Framed Tube Structure are generated the peak acceleration value under the range 0.03 to 0.05 m/s^2. The range comes under the human perception range 1 i.e. (less than 0.05 m/s^2) when it compares it with reference data of human perception level which implies that human cannot perceive motion.

5) As per the human Perception level G+ 20 stories are completely safe in human comfort in which human cannot perceive the motion. G+30 and G+40 are also comes under the Acceptable limit of human comfort in which hanging object may perceive motion but in G+50 Story are not comes under comfort zone in which majority of people will perceive the motion so in G+50 Story some other vibration control devices adopted for human comfort.

6)In G+50, G+40, G+30 Story Peak acceleration is obtained at framed tube structure with Secondary beam is maximum and minimum acceleration is obtained at framed tube structure with Waffle Slab so framed tube structure with waffle slab is safer side and best structure.

7) In G+50, G+40, G+30 and G+20 Terrain Category 1 (TC1) obtained the maximum Displacement and Terrain Category 4 (TC4) obtained the minimum Displacement due to buffeting effect of building.

8) In G+20 peak acceleration is obtained at framed tube with Waffle Slab are maximum in all terrain categories and minimumacceleration is obtained at framed tube with Normal Slab. So normal slab structure is safer in G+20 Story.

9) In G+50, G+40, G+30 and G+20 Terrain Category 1 (TC1) obtained the minimum Acceleration and Terrain Category 4 (TC4) obtained the maximum acceleration.

10) Under the different modes of structure G+50,G+40,G+30 Story Humans cannot Perceive Motion and G+20 Story Sensitive people can perceive motion. Hanging objects may Move slightly.

11) Under model analysis it observed that with increase in section sizes result of peak acceleration and story displacement are reduces.

REFERENCES

1. Md Ahesan, Md Hameed, Salman Shaikh P "Effects of Wind Load On Rc Buildings By Using Gust Factor Approach" Journal of Emerging technologies and Innovative Research(JETIR) Volume 6, Issue 5nd ISSN-2349-5162 May 2019.
2. Nishant Raj Kapoor, Dr. J.P. Tegar "Human Comfort Indicators Pertaining To Indoor Environmental Quality Parameters Of Residential Buildings In Bhopal" International Research Journal of Engineering and Technology (IRJET) Volume:05 Issue:07 e-ISSN:2395-0056p-ISSN:2395-0072 07 July 2018.
3. Channappagoudar, VineethaPalankar, R. ShanthiVengadeshwari, RakeshHiremath" Parametric Comparison Study On The Performance Of Building Under Lateral Loads As Per Is 875(Part3):1987 And Revised Code Of Is 875(Part 3):2015" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 05e-ISSN: 2395-0056p-ISSN:2395-0072 07 May 2018.
4. Er. Mayank Sharma, Er. Bhupinder Singh & Er.RituGoyal"Gust Factor Method For Wind Loads On Buildings And Indian CodalProvisions " International Journal Of Engineering Sciences & Research Technology(IJESRT) Code: Ijess7: 2277-9655 March, 2018.
5 .Neethi B. Elsa Joby "Aerodynamic Modifications against Wind Excitation on Tall Buildings-Shape Optimization" International Journal of Engineering Research & Technology (IJERT) Vol. 7 Issue ISSN: 2278-0181, May- 2018.
6. Aiswaria G. R and DrJisha S. V " Along and Across Wind Loads Acting on Tall Buildings" 92 Second International Conference on Architecture Materials and Construction Engineering – AMCE 2018.
7. AthulyaUllas, Nimisha P "Response of Buildings of Different Plan Shapes Subjected To WindVibrations" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 05, e-ISSN: 2395 -0056 p-ISSN: 2395-0072 May 2017.
8. Rabi Akhtar, Shree Prakash, MirzaAamirBaig " Study Of Comparison Between Static And Dynamic Analysis Subjected To Wind And Earthquake Load " International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 07, e-ISSN: 2395-0056, p-ISSN: 2395- 0072 July -2017.
9. F .Ubertini ,F. Comodini,A. Fulco, and M. Mezzi "A Simplified Parametric Study on Occupant Comfort Conditions in Base Isolated Buildings under Wind Loading" Hindawi Advances in Civil Engineering Volume2017, Article ID3524975, 3524975- 2017.
10. TharakaGunawardena, Shiromal Fernando, PriyanMendis, BhathiyaWaduge, DilinaHettiarachchi "Wind Analysis And Design Of Tall Buildings, The State Of The Art" 8th International Conference on Structural Engineering and Construction Management, Conference Paper ICSECM2017-463, December 2017.
11. RohanKulkarni, Dr .K. Muthumani "Shape Effects on Wind Induced Response of Tall Buildings Using CFD" International Journal of Innovative Research in Science, Engineering and Technology(IJIRSET) Vol. 5, Issue 3, ISSN(Online): 2319-8753, ISSN (Print): 2347-6710, March 2016.
12. V. M. Passosa L. A. Feitosaa E. C. Alvesa M. S. Azevedoa " Analysis of instability of tall buildings with prestressed and waffle slabs " Revista IBRACON de Estruturas e Materiais On-line version ISSN 1983-4195 Rev. IBRACON Estrut. Mater. vol.9 no.2 São PauloMar./Apr. 2016.
13. M. D. Burton1,K. C. S. Kwok,A. Abdelrazaq "Wind Induced Motion of Tall Building Desining for Human Comfort" International Journal of High Rise Building, Vol. 4, No. 1, 1 -6 ,March 2015.
14. Mohamed I. Farouk "Check the comfort of occupants in high rise building using CFD" in Shams Engineering Journal , Received 18 February 2015; revised 3 May 2015; accepted 30 June 2015.
15. Xin Zhao, Xiang Jiang " Optimization of wind-induced acceleration of super tall buildings by modal shape updating" 11th World Congress on Structural and Multidisciplinary Optimisation, Sydney Australia, 07th - 12th, June 2015.
16. S.H. El- Sherif, M.M. Hassan, H. M. Ahmed, and S.A. Mourad" Human Comfort Study Of Medium Rise Reinforced Concrete Buildings Under Wind Excitations"International Conference on Structural and Geotechnical Engineering, Ain Shams University ICSGE 14:publication 286392308, Conference Paper · December2015
17. Jumana Al Balushi and A. D. John "Effect of Wind and Structural Parameters on Wind-Induced Acceleration of RC Building" Proceedings of International Conference on Architecture and Civil Engineering (ICAACE'14), ISBN 978-93-84468-11 -8, pp. 135-149, Dubai, December 25-26, 2014.

18. Srikanth1 and B Vamsi Krishna “Study On The Effect Of Gust Loads On Tall Buildings" International Journal of structural and civil engineering research(IJSCER) ,ISSN
2319 – 6009, Vol. 3, No. 3, August 2014.
19. Samet Tozan, KadirGüler, BarışErkuş “Study Wind Comfort Assessment of a Tall Building According toVarious Structural Codes" Second Conference on Smart Monitoring Assessment and Rehabilitation of Civil Strucutres(SMAR) 2013.
20. M.F. Huang, C.M. Chan and Kenny, C.S. Kwok “Occupant comfort evaluation and wind-induced serviceability design optimization of tall buildings" Wind and Structures, Vol. 14, No. 6, 559-582, Received July 8, 2010, Revised February 14, 2011, Accepted April 7, 2011.
21. Dae-Kun Kwon, Ahsan Kareem “Gust-Front Factor: A New Framework for Wind Load Effects on Structures" Journal of Structural Engineering. Posted ahead of print February 25, 2009. doi:10.1061/(ASCE)ST.1943-541X.0000010 , December 9, 2008.
22.P. Mendis, T. Ngo, N. Haritos, A. Hira“Wind Loading on Tall Buildings" EJSE International, Special Issue: Loading on Structures 2007.
23.Daryl Boggs “Acceleration Indexes for Human comfort in tall building, acceleration or RMS”Submitted for publication CTBUH Monograph Chpt. 13: Motion Perception Tolerance and Mitigation, July 1995.
24. R Narasimha, Ushrinivasa “Specification of design wind loads in India” Centre for Atmospheric Sciences,Indian Institute of Science, , India Sttdhan & Vol. 7, Part 3,pp.259-274,November1984.

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