iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: V Month of publication: May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5088

Design of Tall Chimney for Thermal Power Plant

Karan Dhall
Delhi College of engineering, India

Abstract: This research paper presents the Study of along and across wind effects on150m high single flue RCC chimney for Nardana, Maharastra, India where the Basic Wind speed is taken from Figure 1 of IS 875 Part 3 which is 39m/s.
Index Terms: Reinforced concrete chimney, structural designing of tall chimney, wind analysis of tall chimney, earthquake analysis and design of tall structures.

I. INTRODUCTION

This article was primarily conceptualized to understand behavior of tall structures to wind, in our case it is a tall chimney, 150 meter in height which makes it susceptible to wind forces, along with wind, the research paper also calculates earthquake forces on the chimney.

Wind is essentially the large-scale movement of free air due to thermal currents. It plays an important role in design of tall structures because it exerts static and dynamic loads whose effects on a slender structure, such as a chimney are significant. The wind load exerted at any point on a chimney can be considered as the sum of quasi-static and a dynamic load component.

In case of calculating the forces Simplified method as per as per IS code 875 is used, in order to study the structure completely with random and small variations Random Response method is applied. Random response method also provides us detailed analysis which is much effective than Simplified Method for result evaluations.

II. THE BEHAVIOR OF TALL CHIMNEY IN WIND

A. Along-wind Effects and Across-wind Effects

In a tall freestanding structure like chimneys, wind is generally a governing force. The effect of wind on these tall structures can be separated into two components, known as

along-wind effect

across-wind effect

Along-wind loads are caused by ‘drag’ component of wind force on the chimney, whereas the across-wind loads are caused by the resultant ‘lift’ component. The former is accompanied by the ‘gust buffeting’ causing a dynamic response in the direction of the mean flow, whereas the second is associated with the phenomenon of ‘vortex shedding’ which causes the chimney to oscillate in the direction perpendicular to the direction of wind flow. Evaluation of wind effects therefore includes the estimation of these two types of loads.

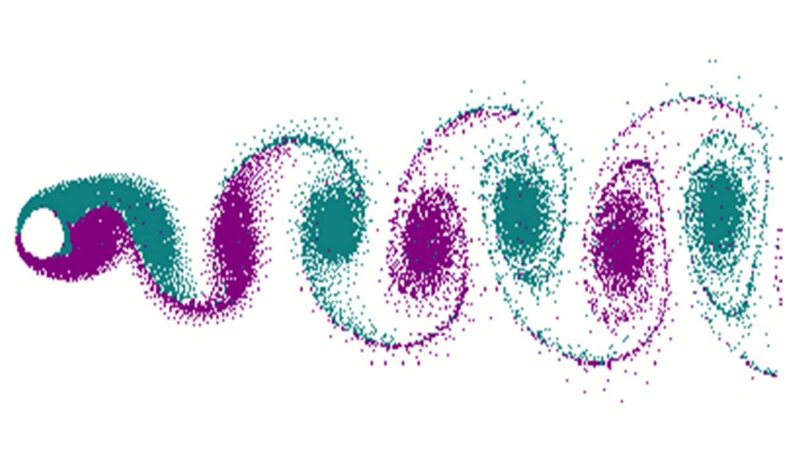
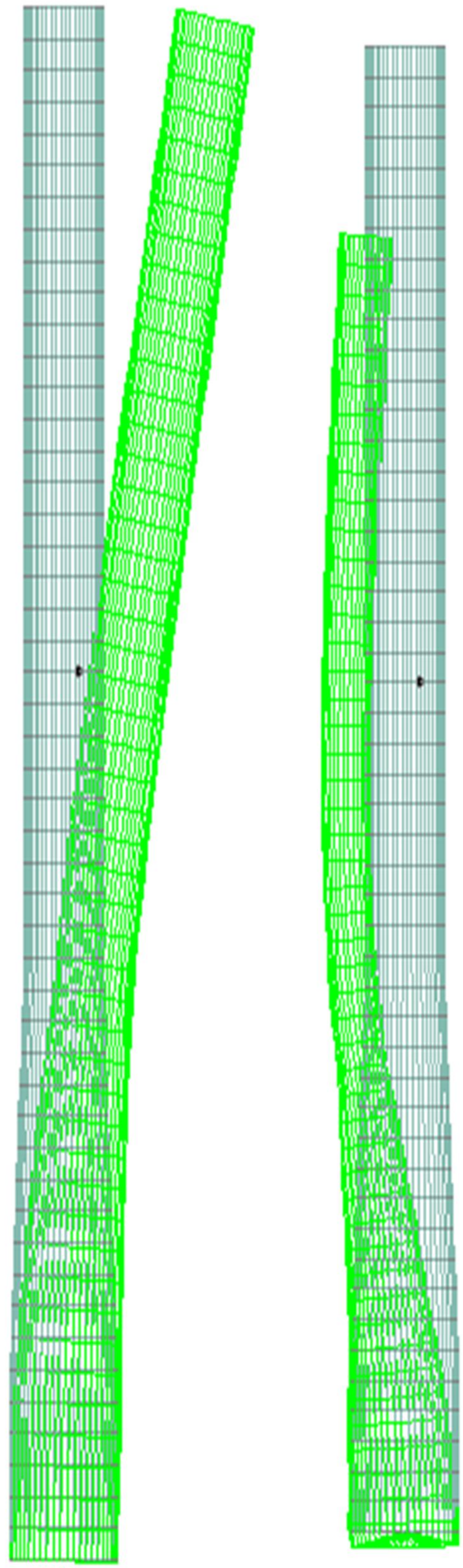


Figure 1 Vortex Shedding



Along wind bending of chimney (N.T.S.)   Across wind bending of chimney (N.T.S.)

Figure 2

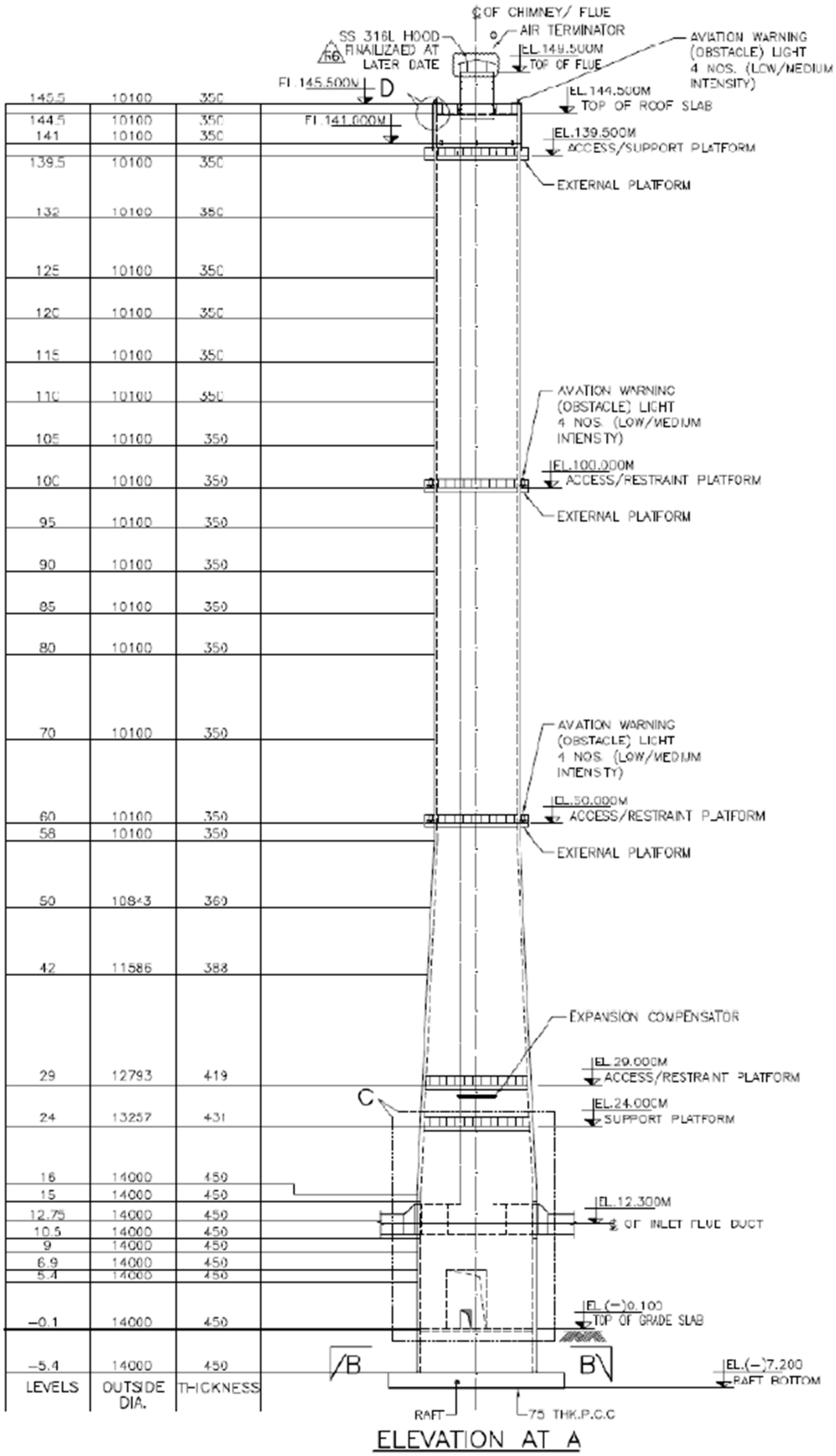


Figure 3 Chimney elevation

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

III. NUMERICAL PROBLEM

A. Design Wind Speed

The basic wind speed(Vb), from figure 1 of IS: 875 (Part 3) – 1987, is 39m/s for Shirpur TPS at Nardana. Basic wind speed is based on peak gust velocity which is averaged over a short time interval of 3 seconds and which corresponds to mean heights 10 m over ground level in an open ground for a 50 year return period. The basic wind speed is modified in order to include the subsequent effects to get design wind velocity at a height (Vz) for the chimney structure:

1) Risk level;
2) topography roughness, elevation and size of structure; and
3) Local geography

It can be mathematically expressed as follows:

$Vz= Vb\ k1k2\ k3$

Where,

Vb= basic wind speed

= 39 m/s

k1 = probability factor (risk coefficient)

= 1.06

k2 = terrain, height and structure size factor, it is calculated for different heights, as per IS 4998 Part 1 we need to consider

K3 = topography factor

= 1.0

Thus, the design wind velocity and related base shear and bending moment for along wind with simplified method.

Class C, Category 2

Height(M)	K1	K2	K3	Vb	Vz	pz(N/Sqm)
145.5	1.06	1.28	1	39	52.9152	1680.011
144.5	1.06	1.28	1	39	52.9152	1680.011
140	1.06	1.28	1	39	52.9152	1680.011
135	1.06	1.28	1	39	52.9152	1680.011
130	1.06	1.28	1	39	52.9152	1680.011
125	1.06	1.28	1	39	52.9152	1680.011
120	1.06	1.28	1	39	52.9152	1680.011
115	1.06	1.28	1	39	52.9152	1680.011
110	1.06	1.28	1	39	52.9152	1680.011
105	1.06	1.28	1	39	52.9152	1680.011
100	1.06	1.24	1	39	51.2616	1576.651
95	1.06	1.24	1	39	51.2616	1576.651
90	1.06	1.24	1	39	51.2616	1576.651
85	1.06	1.24	1	39	51.2616	1576.651
80	1.06	1.24	1	39	51.2616	1576.651
75	1.06	1.24	1	39	51.2616	1576.651
70	1.06	1.24	1	39	51.2616	1576.651
65	1.06	1.24	1	39	51.2616	1576.651
60	1.06	1.24	1	39	51.2616	1576.651
58	1.06	1.24	1	39	51.2616	1576.651
50	1.06	1.17	1	39	48.3678	1403.6664
42	1.06	1.17	1	39	48.3678	1403.6664
29	1.06	1.12	1	39	46.3008	1286.2584
24	1.06	1.12	1	39	46.3008	1286.2584
16	1.06	1.07	1	39	44.2338	1173.9774
15	1.06	1.05	1	39	43.407	1130.5006
12.75	1.06	1.05	1	39	43.407	1130.5006
10.5	1.06	1.05	1	39	43.407	1130.5006
9	1.06	1	1	39	41.34	1025.3974
6.9	1.06	1	1	39	41.34	1025.3974
5.4	1.06	1	1	39	41.34	1025.3974
0	1.06	1	1	39	41.34	1025.3974

B. Circumferential Wind Moments = 0.33 x pz x r^2 N-m/m(Ref. Clause 5.4 IS 4998 Part 1)

Where

Moe and Moi = internal and external ring moment

Pz = Design Wind Pressure at Z in N/sqm

rm = Mean Radius of the shell at the cross-section under consideration in M

Height	pz	r radius in m	Moe	Moi
145.5	1680	5.05	14139	14139
144.5	1680	5.05	14139	14139
140.0	1680	5.05	14139	14139
135.0	1680	5.05	14139	14139
130.0	1680	5.05	14139	14139
125.0	1680	5.05	14139	14139
120.0	1680	5.05	14139	14139
115.0	1680	5.05	14139	14139
110.0	1680	5.05	14139	14139
105.0	1680	5.05	14139	14139
100.0	1577	5.05	13269	13269
95.0	1577	5.05	13269	13269
90.0	1577	5.05	13269	13269
85.0	1577	5.05	13269	13269
80.0	1577	5.05	13269	13269
75.0	1577	5.05	13269	13269
70.0	1577	5.05	13269	13269
65.0	1577	5.05	13269	13269
60.0	1577	5.05	13269	13269
58.0	1577	5.05	13269	13269
50.0	1404	5.4215	13615	13615
42.0	1404	5.793	15545	15545
29.0	1286	6.3965	17367	17367
24.0	1286	6.6285	18650	18650
16.0	1174	7	18983	18983
15.0	1131	7	18280	18280
12.8	1131	7	18280	18280
10.5	1131	7	18280	18280
9.0	1025	7	16581	16581
6.9	1025	7	16581	16581
5.4	1025	7	16581	16581
0.0	1025	7	16581	16581

C. Calculation For Static Wind Load

Along wind load –Simplified method (Peak factor method):

$$F_z, = P_z C_D\, d\, z$$

Where

Pz= design wind pressure obtained in accordance IS 875 (part3):1987.

Z = height of section of the chimney in m measured from the top of foundation.

CD = drag coefficient of the chimney taken as 0.8&dz = external diameter of the chimney.

NOTE — Take the proper factor leading to the class of the structure as defined in the IS 875 (part3):1987.

Height	pz	CD	FZ	DIA	SHEAR	BASE SHEAR	Bending
m			N/sqm/M	dz	M-Ton	M-Ton	Mton-M
146	1680	0.8	13574	10.1	1.36	0.00	
145	1680	0.8	13574	10.1	6.11	1.36	0.678724
140	1680	0.8	13574	10.1	6.79	7.47	22.05854
135	1680	0.8	13574	10.1	6.79	14.25	76.3565
130	1680	0.8	13574	10.1	6.79	21.04	164.5907
125	1680	0.8	13574	10.1	6.79	27.83	286.7611
120	1680	0.8	13574	10.1	6.79	34.61	442.8677
115	1680	0.8	13574	10.1	6.79	41.40	632.9106
110	1680	0.8	13574	10.1	6.79	48.19	856.8896
105	1680	0.8	13574	10.1	6.58	54.98	1114.283
100	1577	0.8	12739	10.1	6.37	61.56	1405.091
95	1577	0.8	12739	10.1	6.37	67.92	1728.79
90	1577	0.8	12739	10.1	6.37	74.29	2084.339
85	1577	0.8	12739	10.1	6.37	80.66	2471.735
80	1577	0.8	12739	10.1	6.37	87.03	2890.98
75	1577	0.8	12739	10.1	6.37	93.40	3342.073
70	1577	0.8	12739	10.1	6.37	99.77	3825.015
65	1577	0.8	12739	10.1	6.37	106.14	4339.805
60	1577	0.8	12739	10.1	2.55	112.51	4876.889
58	1577	0.8	12739	10.1	9.97	115.06	5111.88
50	1404	0.8	12176	10.843	10.07	125.03	6072.661
42	1404	0.8	13010	11.586	17.01	135.10	7140.926
29	1286	0.8	13164	12.793	6.70	152.11	8940.798
24	1286	0.8	13642	13.257	10.72	158.82	9728.16
16	1174	0.8	13149	14	1.29	169.53	11003.85
15	1131	0.8	12662	14	2.85	170.82	11174.8
13	1131	0.8	12662	14	2.85	173.67	11562.36
11	1131	0.8	12662	14	1.81	176.52	11955.16
9	1025	0.8	11484	14	2.41	178.33	12221.75
7	1025	0.8	11484	14	1.72	180.74	12598.05
5	1025	0.8	11484	14	6.20	182.47	12873.81
0	1025	0.8	11484	14		188.67	13859.13

D. *Calculations Of Dynamic Wind Loads*

Across wind load –Simplified method:

$$\eta_{o1} = \left\{ \frac{\int_{0}^{H} d_z \, \phi_{z1} \, d_z}{\int_{0}^{H} \phi^2_{z1} d_z} \right\} \times \frac{C_L}{4 \pi S^2_n K_{s1}}$$

Where

η_{oi}= peak tip deflection due to the vortex shedding in the ith mode of the vibration in m

dz = external diameter of chimney.

CL= peak oscillatory lift coefficient to be taken as 0.16

H = height of the chimney in m.

Ksi = mass damping parameter for the ith mode of vibration

Sn= Strouhal number to be taken as 0.2

Øzi= mode shape function normalized with respect to the dynamic amplitude at top of the chimney in the ithmode of vibration

1) *Calculating Ø (mode shape):* This is calculated from STAAD software using Dynamic analysis using plates in space frame for details refer appendix: A

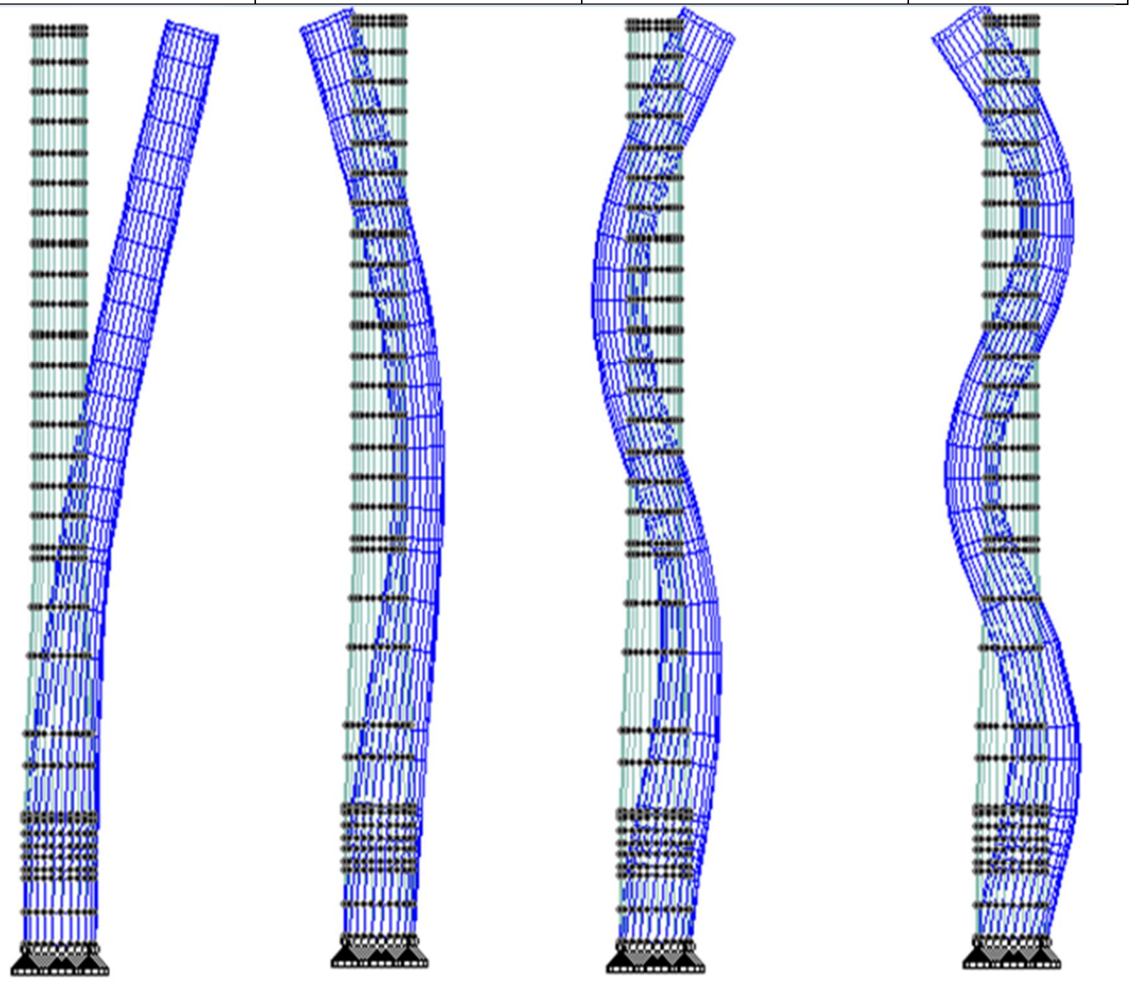
Consolidated data for different modes

Height	Outer Diameter	Thickness	Mass	Mode 1	Mode 2	Mode 3	Mode 4	
M	OD	M	Kg/m	Ø1	Ø2	Ø3	Ø4	
145.5	10.1	0.35	26788.13	1	-1	1	-1	
144.5	10.1	0.35	26788.13	0.989	-0.966	0.947	-0.927	
140	10.1	0.35	26788.13	0.942	-0.813	0.711	-0.61	
135	10.1	0.35	26788.13	0.89	-0.642	0.448	-0.254	
130	10.1	0.35	26788.13	0.837	-0.472	0.19	0.081	
125	10.1	0.35	26788.13	0.785	-0.305	-0.052	0.364	
120	10.1	0.35	26788.13	0.732	-0.142	-0.268	0.569	
115	10.1	0.35	26788.13	0.68	0.014	-0.447	0.675	
110	10.1	0.35	26788.13	0.629	0.16	-0.579	0.673	
105	10.1	0.35	26788.13	0.578	0.294	-0.659	0.567	
100	10.1	0.35	26788.13	0.528	0.414	-0.683	0.375	
95	10.1	0.35	26788.13	0.48	0.518	-0.651	0.126	
90	10.1	0.35	26788.13	0.432	0.604	-0.568	-0.146	
85	10.1	0.35	26788.13	0.386	0.67	-0.439	-0.401	
80	10.1	0.35	26788.13	0.342	0.716	-0.277	-0.605	
75	10.1	0.35	26788.13	0.3	0.742	-0.094	-0.729	
70	10.1	0.35	26788.13	0.261	0.747	-0.095	-0.756	
65	10.1	0.35	26788.13	0.224	0.734	0.277	-0.684	
60	10.1	0.35	26788.13	0.19	0.702	0.438	-0.527	
58	10.1	0.35	26788.13	0.178	0.686	0.493	-0.449	
50	10.843	0.36	29624.96	0.134	0.595	0.637	-0.052	
42	11.586	0.388	34106.87	0.097	0.487	0.679	0.318	
29	12.793	0.419	40699.94	0.052	0.305	0.568	0.637	
24	13.257	0.431	43394.85	0.039	0.24	0.486	0.641	
16	14	0.45	47865.38	0.022	0.148	0.335	0.536	
15	14	0.45	47865.38	0.02	0.137	0.316	0.518	
12.75	14	0.45	47865.38	0.016	0.114	0.271	0.466	
10.5	14	0.45	47865.38	0.013	0.093	0.228	0.41	
9	14	0.45	47865.38	0.011	0.079	0.2	0.371	
6.9	14	0.45	47865.38	0.008	0.063	0.164	0.315	
5.4	14	0.45	47865.38	0.007	0.052	0.138	0.274	
-0.1	14	0.45	47865.38	0.002	0.021	0.06	0.129	
-5.5	14	0.45	47865.38	0	0	0	0	
				2.68	0.55	0.222	0.124	period sec
				2.34	11.42	28.28	50.82	ώ

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Mode shapes

Mode 1	Mode 2	Mode 3	Mode 4



Shapes for different modes.

Figure 4 view showing different mode shapes

Knowing the values of Ø following equation can be calculated using graphical method as specified by GeoffryM.Pinfort, Nachshen, crofts and Leggatt in book "Reinforced concrete Chimneys and towers"

2) Finding Ksi = mass damping parameter for the ith mode of vibration

Given by

$$K_{si} = \frac{2m_{ei}\delta_s}{\sigma.d^2}$$ where

mei = equivalent mass per unit length in kg/m in the ith mode of vibration as defined,

δs = logarithmic decrement of the structural damping = 2πβ

β = structural damping as a fraction of critical damping to be taken 0.016,

σ = mass density of air to be taken 1.2 kg/m3,

d = effective diameter taken as average diameter above the top 1/3rd height of chimney in m.

= 10.1M

3) The equivalent mass per unit length in ith mode of vibration (mei):

Follwing eq is shown the ith mode of vibration

$$m_{ei} = \frac{\int_0^H m_z . \phi^2{}_{zi} . d_z}{\int_0^H \phi^2{}_{zi} . d_z}$$

4) Consolidated data and corresponding results of K_{s1}, m_{e1}, η_{o1} for first mode

Height	Outer	Thickness	Mass	Mode	mz ø1 dz	mz ø1 (z-z0)	mz	ø1^2 dz	Dz ø1 dz	ø1^2 dz
M	OD	M	Kg/m							
145.5	10.1	0.35	26788.125	1	26640.79	3876234.99	26494	0.98903	10.04445	0.98903025
144.5	10.1	0.35	26788.125	0.989	116387.7	16818023.53	112372	4.194856	43.881975	4.19485613
140	10.1	0.35	26788.125	0.942	122689.6	17176545.75	112384	4.19528	46.258	4.19528
135	10.1	0.35	26788.125	0.89	115657.7	15613793.51	99870	3.728161	43.60675	3.72816125
130	10.1	0.35	26788.125	0.837	108625.8	14121360.09	88096	3.288605	40.9555	3.288605
125	10.1	0.35	26788.125	0.785	101594	12699245.51	77059	2.876611	38.30425	2.87661125
120	10.1	0.35	26788.125	0.732	94562.08	11347449.75	66761	2.49218	35.653	2.49218
115	10.1	0.35	26788.125	0.68	87664.14	10081375.99	57376	2.141851	33.05225	2.14185125
110	10.1	0.35	26788.125	0.629	80833.17	8891648.391	48783	1.821061	30.47675	1.82106125
105	10.1	0.35	26788.125	0.578	74069.17	7777262.391	40960	1.529045	27.9265	1.529045
100	10.1	0.35	26788.125	0.528	67506.07	6750607.5	34023	1.27008	25.452	1.27008
95	10.1	0.35	26788.125	0.48	61076.92	5802307.875	27851	1.03968	23.028	1.03968
90	10.1	0.35	26788.125	0.432	54781.72	4930354.406	22406	0.836405	20.6545	0.836405
85	10.1	0.35	26788.125	0.386	48754.39	4144122.937	17747	0.66248	18.382	0.66248
80	10.1	0.35	26788.125	0.342	42994.94	3439595.25	13801	0.515205	16.2105	0.515205
75	10.1	0.35	26788.125	0.3	37570.35	2817775.898	10538	0.393401	14.16525	0.39340125
70	10.1	0.35	26788.125	0.261	32480.6	2273642.109	7877	0.294031	12.24625	0.29403125
65	10.1	0.35	26788.125	0.224	27725.71	1802171.109	5739	0.214245	10.4535	0.214245
60	10.1	0.35	26788.125	0.19	9858.03	591481.8	1814	0.067712	3.7168	0.067712
58	10.1	0.35	26788.125	0.178	35201.76	2041702.3	5215	0.194688	12.6048	0.194688
50	10.843	0.36	29624.958	0.134	29444.1	1472205.19	3162	0.106722	10.018932	0.106722
42	11.586	0.388	34106.868	0.097	36225.2	1521458.315	2461	0.072153	11.221041	0.07215325
29	12.793	0.419	40699.942	0.052	9565.782	277407.6859	421	0.010351	2.9104075	0.01035125
24	13.257	0.431	43394.847	0.039	11133.75	267209.9303	323	0.007442	3.234708	0.007442
16	14	0.45	47865.375	0.022	1005.173	16082.766	21	0.000441	0.294	0.000441
15	14	0.45	47865.375	0.02	1938.548	29078.21531	35	0.000729	0.567	0.000729
12.75	14	0.45	47865.375	0.016	1561.608	19910.50021	23	0.000473	0.45675	0.00047306
10.5	14	0.45	47865.375	0.013	861.5768	9046.555875	10	0.000216	0.252	0.000216
9	14	0.45	47865.375	0.011	954.9142	8594.228081	9	0.00019	0.2793	0.00018953
6.9	14	0.45	47865.375	0.008	538.4855	3715.549734	4	8.44E-05	0.1575	8.4375E-05
5.4	14	0.45	47865.375	0.007	1163.129	6280.894508	5	0.000109	0.3402	0.00010935
0	14	0.45	47865.375	0.002	263.2596	0	0	5.5E-06	0.077	0.0000055
-5.5	14	0.45	47865.375	0						
				∑	1441330	156627690.9	883641	32.94353	536.88186	32.9435252
							me1	26822.91	ηo1	0.02357315
							Ks1	44.03434		

5) Consolidated data and corresponding results of K_{s2}, m_{e2}, η_{o2} for second mode

Height	Outer	Thickness	Mode	mz ø2 dz	mz ø2 (z-z0)	mz ø2^2	ø2^2 dz	Dz ø2 dz	ø2^2 dz
M	OD	M							
145.5	10.1	0.35	-1	-26332.7	-3831411.8	25885.07	0.966289	-9.9283	0.966289
144.5	10.1	0.35	-0.966	-107226	-15494181	95377.68	3.560446	-40.4278	3.560446
140	10.1	0.35	-0.813	-97441.8	-13641853	70888.91	2.646281	-36.7388	2.646281
135	10.1	0.35	-0.642	-74604.9	-10071665	41554.94	1.551245	-28.1285	1.551245
130	10.1	0.35	-0.472	-52035.9	-6764671.3	20215.96	0.754661	-19.6193	0.754661
125	10.1	0.35	-0.305	-29935.7	-3741966.2	6690.636	0.249761	-11.2868	0.249761
120	10.1	0.35	-0.142	-8572.2	-1028664	548.6208	0.02048	-3.232	0.02048
115	10.1	0.35	0.014	11652.83	1340075.95	1013.797	0.037845	4.3935	0.037845
110	10.1	0.35	0.16	30404.52	3344497.41	6901.826	0.257645	11.4635	0.257645
105	10.1	0.35	0.294	47414.98	4978573.03	16784.9	0.62658	17.877	0.62658
100	10.1	0.35	0.414	62416.33	6241633.12	29086.01	1.08578	23.533	1.08578
95	10.1	0.35	0.518	75140.69	7138365.61	42153.93	1.573605	28.3305	1.573605
90	10.1	0.35	0.604	85320.18	7678816.03	54348.95	2.028845	32.1685	2.028845
85	10.1	0.35	0.67	92820.85	7889772.52	64324.85	2.401245	34.9965	2.401245
80	10.1	0.35	0.716	97642.72	7811417.25	71181.54	2.657205	36.8145	2.657205
75	10.1	0.35	0.742	99718.8	7478909.65	74240.64	2.771401	37.59725	2.771401
70	10.1	0.35	0.747	99183.03	6942812.3	73445.04	2.741701	37.39525	2.741701
65	10.1	0.35	0.734	96169.37	6251008.97	69049.61	2.57762	36.259	2.57762
60	10.1	0.35	0.702	37181.92	2230915.05	25804.25	0.963272	14.0188	0.963272
58	10.1	0.35	0.686	144530.3	8382758.48	92571.67	3.281922	51.7524	3.281922
50	10.84	0.36	0.595	137915.7	6895783.62	74612.38	2.341448	46.9285	2.341448
42	11.59	0.388	0.487	192552.7	8087214.67	76250.88	2.038608	59.64473	2.038608
29	12.79	0.419	0.305	57289.58	1661397.68	15611.41	0.371281	17.43046	0.371281
24	13.26	0.431	0.24	70817.93	1699630.38	13738.68	0.301088	20.57486	0.301088
16	14	0.45	0.148	6820.816	109133.055	971.9663	0.020306	1.995	0.020306
15	14	0.45	0.137	13515.99	202739.779	1696.256	0.035438	3.95325	0.035438
12.75	14	0.45	0.114	11146.65	142119.777	1153.678	0.024103	3.26025	0.024103
10.5	14	0.45	0.093	6174.633	64833.6504	531.0185	0.011094	1.806	0.011094
9	14	0.45	0.079	7136.727	64230.5467	506.7076	0.010586	2.0874	0.010586
6.9	14	0.45	0.063	4128.389	28485.8813	237.3823	0.004959	1.2075	0.004959
5.4	14	0.45	0.052	9434.265	50945.0332	344.3507	0.007194	2.7594	0.007194
0	14	0.45	0.021	2764.225	0	29.02437	0.000606	0.8085	0.000606
-5.5	14	0.45	0						
			∑	1103145	42141657.1	1067753	37.92054	379.6942	37.92054
						me2	28157.63	ηo2	0.013797
						Ks2	46.22551		

Calculated values for the first 2 modes we get

ηo1	ηo2
0.02357315	0.013797

Calculation of the sectional shear force (F_{zoi})&Sectional Bending Moment (M_{zoi})

$$F_{zoi} = 4\,\pi^2\, f_1{}^2\, \eta_{oi} \int_{z0}^{H} m_z \phi_{zi} d_z$$

$$M_{zoi} = 4\,\pi^2\, f_1{}^2\, \eta_{oi} \int_{z0}^{H} m_z \phi_{zi} (z - z_0) d_z .$$

where

f1 = natural frequency of the chimney in Hz in the ith mode of vibration

mz = mass per unit length of the chimney at section z in kg/m.

Result taken from STAAD Pro.

Mode	Frequency Hz
1	0.373
2	1.818

Critical wind speed

$$V_{cri} = \frac{f_1 d}{S_n}$$

d	avgdia of top 1/3	10.1
Sn	strouhal number	0.2
Vcr1	18.8365	
Vcr1	91.809	does not govern

Thus calculated values of the Shear force Kg&Bending Moment Kg-M at base is as follows:

Fzo1	Fzo2	Mzo1	Mzo2
186431	Doesn't govern	20259236	Doesn't govern

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

E. Along wind R.R.M. Analysis

The along wind load per unit height at any height z on a chimney shall be calculated from the equation: Fz = Fzm + Fzf

							Along	Wind	R.R.M				SHEAR	Bending
Height (M)	V_{10}	f_1	S	E	B	r	Vt	g_r	G	∫Fzm.Z.dz	F_{zf}	Fzf+ Fzm	M-Ton	Mton-M
145.5	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	137102	28	13602	0	
144.5	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	616961	123	13698	1	1
140	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	133	13707	8	22
135	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	128	13703	14	77
130	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	123	13698	21	166
125	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	119	13693	28	289
120	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	114	13688	35	447
115	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	109	13684	42	639
110	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	104	13679	49	864
105	49.92	0.37	0.3	0.09	0.63	0.24	1148.96	3.91	2.42	685512	100	13674	55	1123
100	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	88	12827	62	1415
95	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	83	12823	68	1739
90	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	79	12818	74	2096
85	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	75	12814	81	2484
80	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	70	12810	87	2904
75	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	66	12805	94	3357
70	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	62	12801	100	3841
65	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	643337	57	12796	106	4357
60	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	257335	21	12760	113	4896
58	48.36	0.37	0.3	0.09	0.63	0.24	1143.13	3.91	2.4	1029339	82	12821	115	5132
50	45.63	0.37	0.28	0.09	0.63	0.24	1131.88	3.9	2.37	1056192	70	12246	126	6097
42	45.63	0.37	0.28	0.09	0.63	0.24	1131.88	3.9	2.37	1959586	110	13120	136	7171
29	43.68	0.37	0.27	0.09	0.63	0.24	1122.92	3.9	2.34	842041	32	13196	154	8983
24	43.68	0.37	0.27	0.09	0.63	0.24	1122.92	3.9	2.34	1446767	45	13687	160	9776
16	41.73	0.37	0.27	0.08	0.63	0.24	1113.06	3.9	2.31	184080	4	13152	171	11063
15	40.95	0.37	0.26	0.08	0.63	0.24	1108.85	3.9	2.3	398841	8	12669	172	11235
12.75	40.95	0.37	0.26	0.08	0.63	0.24	1108.85	3.9	2.3	398841	6	12668	175	11625
10.5	40.95	0.37	0.26	0.08	0.63	0.24	1108.85	3.9	2.3	265894	4	12665	177	12019
9	39	0.37	0.25	0.08	0.63	0.24	1097.56	3.9	2.27	337643	4	11488	179	12287
6.9	39	0.37	0.25	0.08	0.63	0.24	1097.56	3.9	2.27	241173	2	11487	182	12665
5.4	39	0.37	0.25	0.08	0.63	0.24	1097.56	3.9	2.27	868224	6	11490	183	12940
0	39	0.37	0.25	0.08	0.63	0.24	1097.56	3.9	2.27	0	0	11484	186	13929
									=	20670804				

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Height	Mode 1	β	CL	L	Sn	σ	∩	me1	ka	ø1^2 dz	deflection
M	ø1					mass density of air				with respect to height	M
145.5	1	0.016	0.12	1	0.2	1.2	14.40594059	26822.90553	0.5	32.94352519	0.073196556
144.5	0.989	0.016	0.12	1	0.2	1.2	14.30693069	26822.90553	0.5	31.95449494	0.073250134
140	0.942	0.016	0.12	1	0.2	1.2	13.86138614	26822.90553	0.5	27.75963881	0.073680438
135	0.89	0.016	0.12	1	0.2	1.2	13.36633663	26822.90553	0.5	23.56435881	0.074194765
130	0.837	0.016	0.12	1	0.2	1.2	12.87128713	26822.90553	0.5	19.83619756	0.074629771
125	0.785	0.016	0.12	1	0.2	1.2	12.37623762	26822.90553	0.5	16.54759256	0.075145234
120	0.732	0.016	0.12	1	0.2	1.2	11.88118812	26822.90553	0.5	13.67098131	0.075534619
115	0.68	0.016	0.12	1	0.2	1.2	11.38613861	26822.90553	0.5	11.17880131	0.075963401
110	0.629	0.016	0.12	1	0.2	1.2	10.89108911	26822.90553	0.5	9.036950063	0.076432881
105	0.578	0.016	0.12	1	0.2	1.2	10.3960396	26822.90553	0.5	7.215888813	0.076793022
100	0.528	0.016	0.12	1	0.2	1.2	9.900990099	26822.90553	0.5	5.686843813	0.077115638
95	0.48	0.016	0.12	1	0.2	1.2	9.405940594	26822.90553	0.5	4.416763813	0.077534526
90	0.432	0.016	0.12	1	0.2	1.2	8.910891089	26822.90553	0.5	3.377083813	0.077674464
85	0.386	0.016	0.12	1	0.2	1.2	8.415841584	26822.90553	0.5	2.540678813	0.077761758
80	0.342	0.016	0.12	1	0.2	1.2	7.920792079	26822.90553	0.5	1.878198813	0.077739994
75	0.3	0.016	0.12	1	0.2	1.2	7.425742574	26822.90553	0.5	1.362993813	0.077508464
70	0.261	0.016	0.12	1	0.2	1.2	6.930693069	26822.90553	0.5	0.969592563	0.077239433
65	0.224	0.016	0.12	1	0.2	1.2	6.435643564	26822.90553	0.5	0.675561313	0.076527319
60	0.19	0.016	0.12	1	0.2	1.2	5.940594059	26822.90553	0.5	0.461316313	0.07546994
58	0.178	0.016	0.12	1	0.2	1.2	5.742574257	26822.90553	0.5	0.393604313	0.075257235
50	0.134	0.016	0.12	1	0.2	1.2	4.611269944	26822.90553	0.5	0.198916313	0.083858767
42	0.097	0.016	0.12	1	0.2	1.2	3.625064733	26822.90553	0.5	0.092194313	0.087830751
29	0.052	0.016	0.12	1	0.2	1.2	2.266864692	26822.90553	0.5	0.020041063	0.097161465
24	0.039	0.016	0.12	1	0.2	1.2	1.810364336	26822.90553	0.5	0.009689813	0.100612033
16	0.022	0.016	0.12	1	0.2	1.2	1.142857143	26822.90553	0.5	0.002247813	0.10471596
15	0.02	0.016	0.12	1	0.2	1.2	1.071428571	26822.90553	0.5	0.001806813	0.102808572
12.75	0.016	0.016	0.12	1	0.2	1.2	0.910714286	26822.90553	0.5	0.001077813	0.098177894
10.5	0.013	0.016	0.12	1	0.2	1.2	0.75	26822.90553	0.5	0.00060475	0.096640754
9	0.011	0.016	0.12	1	0.2	1.2	0.642857143	26822.90553	0.5	0.00038875	0.094425433
6.9	0.008	0.016	0.12	1	0.2	1.2	0.492857143	26822.90553	0.5	0.000199225	0.083994889
5.4	0.007	0.016	0.12	1	0.2	1.2	0.385714286	26822.90553	0.5	0.00011485	0.085632706
0	0.002	0.016	0.12	1	0.2	1.2	0	26822.90553	0.5	5.5E-06	
-5.5	0	0.016	0.12	1	0.2	1.2					
										∑	32.94352519
										ηo1 (max)	0.10471596

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

F. Across Wind R.R.M. Analysis

Thus values of the Shear force Kg&Bending Moment Kg-M at base is as follows:

Fzo1	Fzo2	Mzo1	Mzo2
53268.48743	DOES NOT GOVERN	43560.9311	DOES NOT GOVERN

G. Seismic Analysis

1) Horizontal Seismic Force The horizontal seismic coefficient Ah, shall be obtained using the period T, described as under.
2) When using site specific spectra, the seismic coefficient shall be calculated from the expression :

$$A_h = \frac{\left[S_a / g \right]}{(R/I)}$$

where / g = spectral acceleration coefficient calculated from the expression:

$$A_h = \frac{\left[Z / 2 \right] \left[S_a / g \right]}{(R/I)}$$

where
Z = Zone factor
Sa/g = Spectral acceleration coefficient
R = Response reduction factor

Table 1 Importance factor for various Industrial structures II

Sl No. (1)	Categories of Structures (*see* 7.1) (2)	Importance Factor (3)
i)	Structures in Category 1	2.00
ii)	Structures in Category 2	1.75
iii)	Structures in Category 3	1.50
iv)	Structures in Category 4	1.00

NOTE — Higher importance factor may be assigned to different structures at the discretion of the project authorities.

T lamental time period for stake-like structures, ‘T” is given by:

$$T = C_T \sqrt{\frac{W_t . h}{E_s . A . g}}$$

C_T = coefficient depending upon slenderness ratio.
W_T = Total weight of structure.
h = Height of structure above the base.

Table 2 Values of C_T and C_v

Sl No. (1)	$k = h/r_e$ (2)	Coefficient, C_T (3)	Coefficient, C_v (4)
i)	5	14.4	1.02
ii)	10	21.2	1.12
ii)	15	29.6	1.19
iv)	20	38.4	1.25
v)	25	47.2	1.30
vi)	30	56.0	1.35
vii)	35	65.0	1.39
viii)	40	73.8	1.43
ix)	45	82.8	1.47
x)	50 or more	1.8 k	1.50

NOTE — k = slenderness ratio, and
r_e = radius of gyration of the structural shell at the base section.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Calculation for Time period

Area	g	Es (M25)	wt	H/r	Ct	T
19.14615	9.81	32000000000	4651909	30.3	56	1.86

3) Seismic Calculations

Height	Outer Diameter	Thickness	Mass	Mass				time	medium soil	Ah1	HORIZO SEISMIC	BENDING
M	OD	M	Kg/m	kg	Z	I	R	period	Sa/g		LOAD	MOMENT
145.5	10.1	0.35	26788.13	13394.06	0.24	1.75	3	1.8613	0.731	0.0511	685.0619904	99676.51961
144.5	10.1	0.35	26788.13	73667.34	0.24	1.75	3	1.8613	0.731	0.0511	3767.840947	544453.0169
140	10.1	0.35	26788.13	127243.6	0.24	1.75	3	1.8613	0.731	0.0511	6508.088909	911132.4473
135	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	924833.6871
130	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	890580.5876
125	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	856327.488
120	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	822074.3885
115	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	787821.289
110	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	753568.1895
105	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	719315.09
100	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	685061.9904
95	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	650808.8909
90	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	616555.7914
85	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	582302.6919
80	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	548049.5923
75	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	513796.4928
70	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	479543.3933
65	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	445290.2938
60	10.1	0.35	26788.13	93758.44	0.24	1.75	3	1.8613	0.731	0.0511	4795.433933	287726.036
58	10.1	0.35	26788.13	133940.6	0.24	1.75	3	1.8613	0.731	0.0511	6850.619904	397335.9545
50	10.84	0.36	29624.96	236999.7	0.24	1.75	3	1.8613	0.731	0.0511	12121.74884	606087.4419
42	11.59	0.388	34106.87	358122.1	0.24	1.75	3	1.8613	0.731	0.0511	18316.76171	769303.9917
29	12.79	0.419	40699.94	366299.5	0.24	1.75	3	1.8613	0.731	0.0511	18735.00666	543315.1931
24	13.26	0.431	43394.85	282066.5	0.24	1.75	3	1.8613	0.731	0.0511	14426.76874	346242.4497
16	14	0.45	47865.38	215394.2	0.24	1.75	3	1.8613	0.731	0.0511	11016.70018	176267.203
15	14	0.45	47865.38	77781.23	0.24	1.75	3	1.8613	0.731	0.0511	3978.252844	59673.79267
12.75	14	0.45	47865.38	107697.1	0.24	1.75	3	1.8613	0.731	0.0511	5508.350092	70231.46368
10.5	14	0.45	47865.38	89747.58	0.24	1.75	3	1.8613	0.731	0.0511	4590.291744	48198.06331
9	14	0.45	47865.38	86157.68	0.24	1.75	3	1.8613	0.731	0.0511	4406.680074	39660.12066
6.9	14	0.45	47865.38	86157.68	0.24	1.75	3	1.8613	0.731	0.0511	4406.680074	30406.09251
5.4	14	0.45	47865.38	165135.5	0.24	1.75	3	1.8613	0.731	0.0511	8446.136808	45609.13876
0	14	0.45	47865.38	129236.5	0.24	1.75	3	1.8613	0.731	0.0511	6610.020111	0
				4651909							231319.722	15251248.78
				wt							KG	KG-M
											DOSENT GOVERN	

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

IV. RESULTS AND DISCUSSIONS

A. After Analysis of chimney with respect to IS 875, IS 4998, IS 1893, following table Shows Resultant Moment

Table 3Results of chimney

S.NO.	EFFECTS OF WIND	UNIT	W.R.T. (IS CODES), SIMPLIFIED METHOD	RESULTANT	W.R.T. (IS CODES), RANDOM RESPONSE	RESULTANT
1	Along wind maximum bending moment	KTON-M	13.86	24.55	13.93	13.93
2	ACROSS wind maximum bending moment	KTON-M	20.26		0.044	
3	Along wind maximum BASE SHEAR	KTON	0.188	0.26	0.186	0.19
4	ACROSS wind maximum BASE SHEAR	KTON	0.186		0.053	

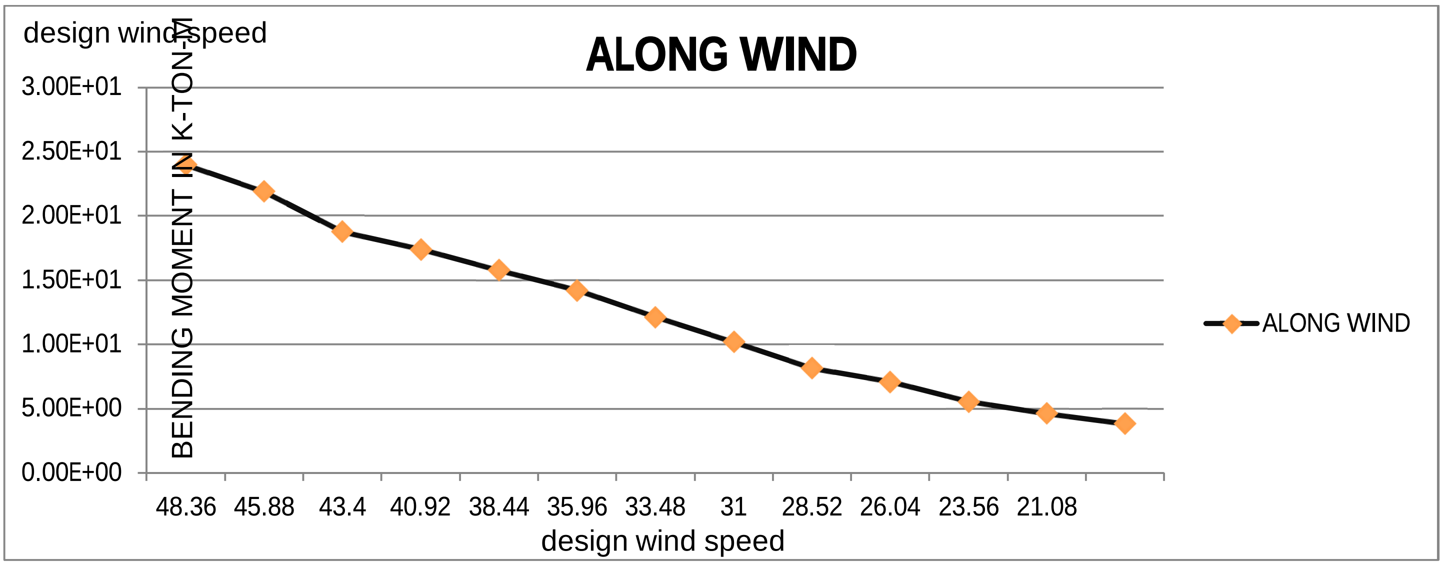


Figure 5 Bending Moment Vs Design wind speed (Along wind)

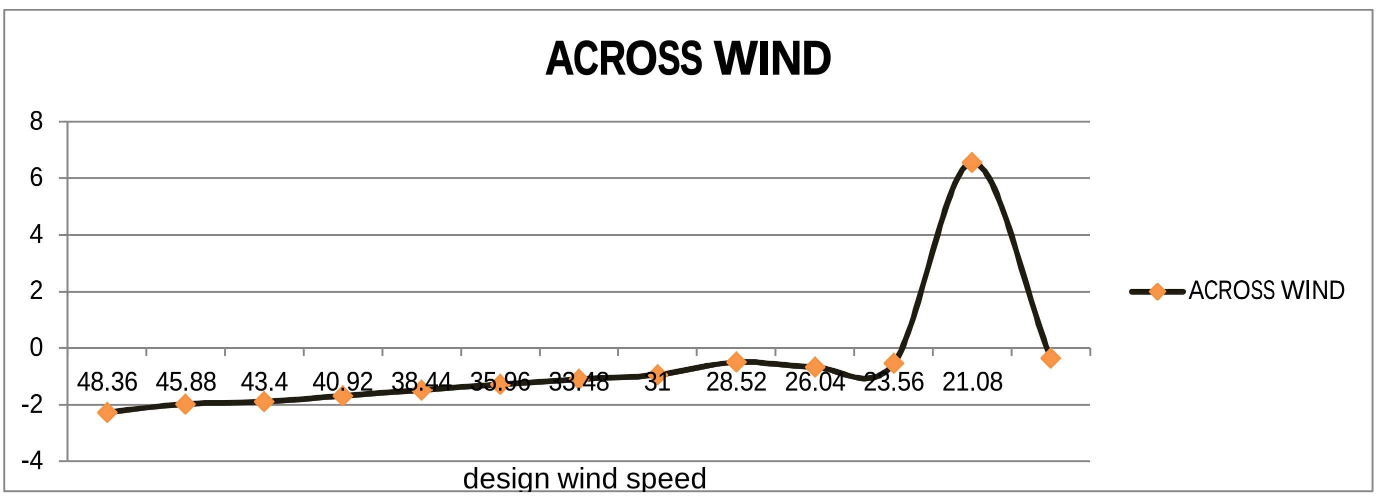
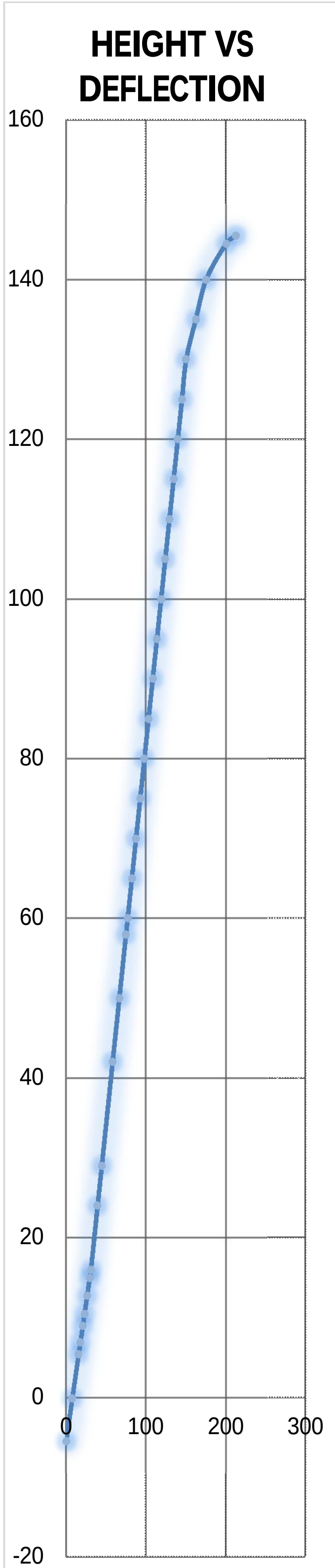
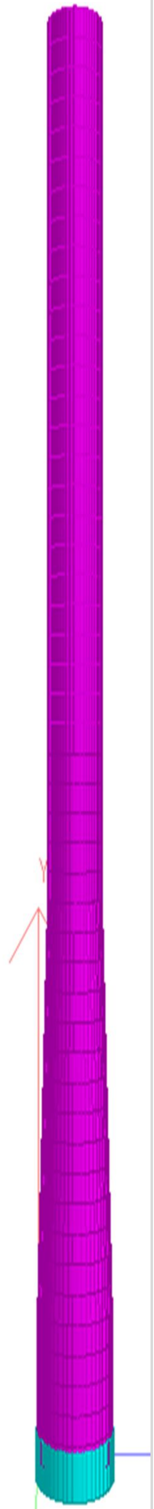


Figure 6 Moment Vs Design wind speed (Across wind)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Graph Showing Deflection In Mm Vs Height Of The Chimney For Random Response Calculation As Per Is 4998 Equations





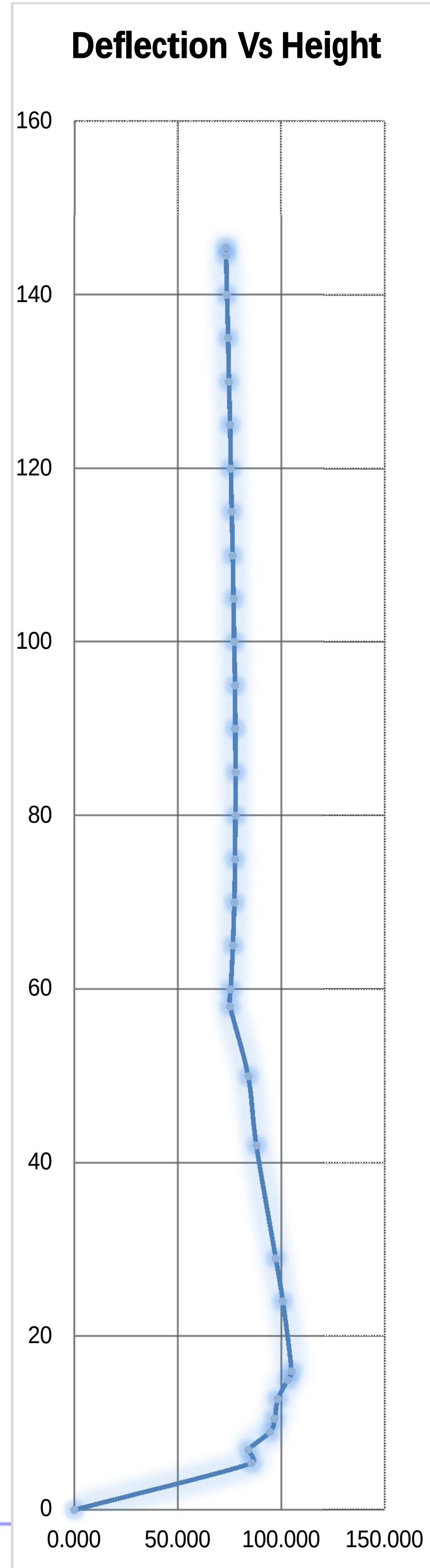


Figure 7 Deflection Vs Height (Along R.R.M.)

Figure 8 Deflection Vs Height (ACCROS R.R.M)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Design of CHIMNEY

	SHEAR	BASE SHEAR	Bending	DESIGN CALCULATIONS								
Height(M)	ton	Ton	ton-M	Weight(KN)	Eccentricity (e)mm	Min stress	Max stress	providereinf.	providedreinf.		Tension	CHECK
145.500	1.37	0.0	0.0			in concrete(N/Sq mm)		1% thus Ast	every 300mm	Compression capacity	capacity	
144.500	6.17	1.4	228.9	273	8	0	0	107153	1050	10	-2	HENCE SAFE
140.000	6.85	7.5	324.9	1502	2122	0	0	107153	1050	10	-2	HENCE SAFE
135.000	6.85	14.3	408.4	2867	1397	0	0	107153	1050	10	-2	HENCE SAFE
130.000	6.85	21.1	571.4	4233	1324	0	1	107153	1050	10	-2	HENCE SAFE
125.000	6.84	27.8	772.1	5598	1353	0	1	107153	1050	10	-2	HENCE SAFE
120.000	6.84	34.6	908.6	6963	1280	0	1	107153	1050	10	-2	HENCE SAFE
115.000	6.84	41.5	1784.2	8329	2102	0	1	107153	1050	10	-2	HENCE SAFE
110.000	6.63	48.3	2326.3	9694	2354	0	2	107153	1050	10	-2	HENCE SAFE
105.000	6.41	55.6	3842.9	11059	3409	0	2	107153	1050	10	-2	HENCE SAFE
100.000	6.41	62.8	4541.5	12425	3586	0	3	107153	1050	10	-2	HENCE SAFE
95.000	6.41	70.0	5150.4	13790	3664	-1	3	107153	1050	10	-2	HENCE SAFE
90.000	6.41	76.5	5390.9	15155	3489	0	3	107153	1050	10	-2	HENCE SAFE
85.000	6.40	83.5	5904.6	16521	3506	-1	4	107153	1050	10	-2	HENCE SAFE
80.000	6.40	90.8	6503.7	17886	3567	-1	4	107153	1050	10	-2	HENCE SAFE
75.000	6.40	98.3	7183.7	19251	3661	-1	4	107153	1050	10	-2	HENCE SAFE
70.000	6.39	104.4	7420.7	20617	3531	-1	5	107153	1050	10	-2	HENCE SAFE
65.000	6.40	112.2	8200.4	21982	3660	-1	5	107153	1050	10	-2	HENCE SAFE
60.000	2.51	120.3	9046.2	23347	3801	-1	5	107153	1050	10	-2	HENCE SAFE
58.000	10.15	125.3	9782.6	23894	4016	-1	6	107153	1050	10	-2	HENCE SAFE
50.000	10.53	137.6	10957.8	26078	4122	-1	5	118500	1080	10	-2	HENCE SAFE
42.000	17.47	150.5	12256.4	28494	4220	-1	5	136427	1164	10	-2	HENCE SAFE
29.000	6.71	170.0	14067.5	33014	4180	-1	5	162800	1257	10	-2	HENCE SAFE
24.000	10.33	180.8	15306.7	35088	4279	-1	5	173579	1293	10	-2	HENCE SAFE
16.000	1.27	195.7	16904.6	38627	4293	0	4	191462	1350	10	-2	HENCE SAFE
15.000	2.85	203.1	17839.5	39115	4474	0	5	191462	1350	10	-2	HENCE SAFE
12.750	2.72	212.8	18967.2	40213	4627	-1	5	191462	1350	10	-2	HENCE SAFE
10.500	1.72	223.5	20151.9	41311	4785	-1	5	191462	1350	10	-2	HENCE SAFE
9.000	2.41	234.4	21318.6	42043	4974	-1	5	191462	1350	10	-2	HENCE SAFE
6.900	1.72	246.7	22605.9	43067	5149	-1	5	191462	1350	10	-2	HENCE SAFE
5.400	114.95	258.4	23775.3	43799	5325	-1	6	191462	1350	10	-2	HENCE SAFE
0.000	0.00	265.2	24546.1	46434	5186	-1.1	6	191462	1350	10	-2	HENCE SAFE

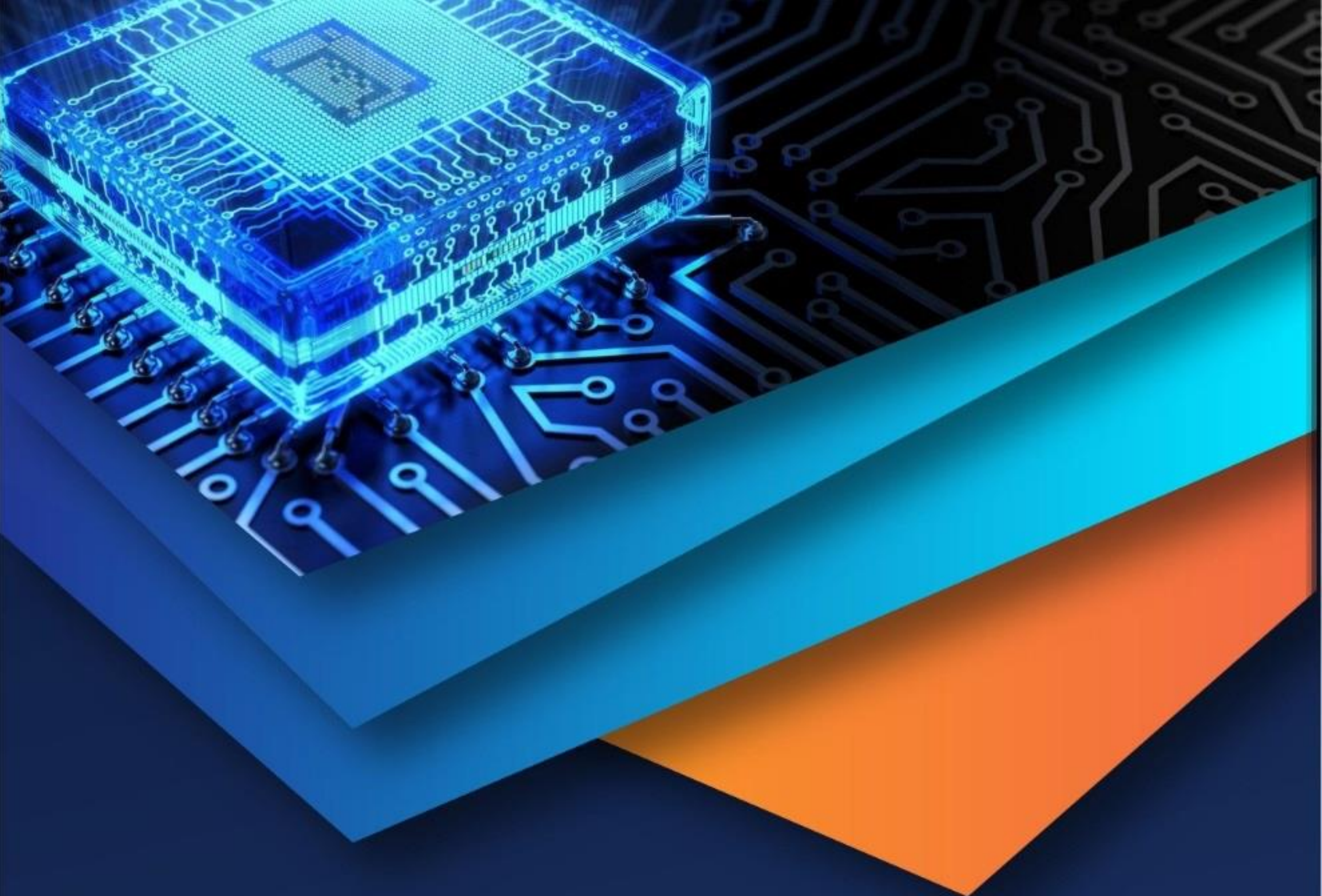
V. CONCLUSIONS, DISCUSSION, FUTURE SCOPE.

Our objective of study included Analysis of structure as per IS Codes and comparing the results with each other, after we obtained results we found that Bending moment and shear forces obtained from Simplified method and R.R.M method of analysis as per IS 4998 are higher than bending moment and shear force obtained due to earthquake analysis, also every structure is unique and with changes in geometry the governing forces and their values differs, after in depth study of codes in this paper I have worked out a case study of a chimney and using this solution chimney any other chimney problem can be solved quickly and with accuracy.

Future scope includes analysis of chimney of different height and material properties in similar fashion as explained in this case study to understand behavior of structures in a better manner, wind velocity may also be increased to study behavior of structure when excited in higher modes, one may also go for wind tunnel testing and CFD analysis to testify results obtained with Indian standard codes.

REFERENCES

[1] Batham, J.P., “Parameters required for the wind-tunnel simulation of the wind loads on large power station chimneys”, Wind Engineering and Industrial dynamics, Elsevier science publishers -Amsterdam, Vol.18, 1985.
[2] Milford R.V., “Structural reliability and cross wind response of tall chimneys”. Engineering structures, Butterworth & Co. (Publishers) Ltd, Vol.4, 1982,
[3] Reddy K.R.C, Jaiswal O.R and Godbole P.N, “Wind response control of tall RC chimneys”, Wind and Engineering, Vol. 8, 2011.
[4] Reddy K. R. C, Jaiswal O. R. and P. N. Godbole., “Wind and Earthquake Analysis of Tall RC Chimneys”, Earth sciences and Engineering, October 2011,
[5] Vickery B.J. and Basu.R. “Simplified approaches to the evaluation of the across wind Response of chimneys”, Wind Engineering and Industrial dynamics, Elsevier science Publishers -Amsterdam, 1983, pp. 153-166.
[6] Manohar, S.N., “Tall Chimneys”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1981.
[7] Code of practice for design loads for buildings and structures, IS: 875(Part-III):1987, published by Bureau of Indian standards.
[8] GeoffryM.Pinfort, Nachshen, crofts and Leggatt in their book “Reinforced concrete Chimneys and towers”
[9] Criteria for design of Reinforced concrete Chimneys, IS: 4998(Part-I):1992, published by Bureau of Indian standards.
[10] IS 1893(Part1) – 2002, Indian Standard Code of Practice for Criteria for Earthquake Resistant Design of Structures. Bureau of Indian Standard, (New Delhi)
[11] K. Suresh Kumar and G. N. V. Rao, Wind Loading over the Top Portions of Tall Stacks with and Without External Landing Platforms, Journal of Wind Engineering and Industrial Aerodynamics, Vol. 51, Page 319-338, July 1993
[12] Lawrence C Maugh and Wadi S. Rumman, Dynamic Design of Reinforced Concrete Chimneys,
[13] ACI Journal, Vol. 64, No. 47, Page 560-567, September 1967
[14] S. R. Joshi, N. S. Pendse, V. T. Patilkakad, Some Special Aspects of the Design and Analysis of Tall Chimneys, Irrigation and Power Journal, Vol. 42, No. 1, January 1985
[15] K. S. Babu Narayan, Subhash C. Yarogal, and Yukio Tamura, “Interaction Envelops For Limit State Design of Chimneys”, Fourth International Symposium on Computational Wind Engineering, Yokohama, 2006 [10] J. L. Wilson, Code Recommendation for the aseismic Design of Tall Reinforced Concrete Chimneys, CICIND’s Report Australia, Bibao, Vol. 16, No. 2, September 2000
[16] N. S. Pour, Indrajit Chowdhary, Dynamic Soil – Structure Interaction Analysis of Tall Multi flue Chimneys Under Aerodynamic and Seismic Force, Twelfth International Conference of IACMAG India, Goa, Page 1-6, October 2008
[17] Jaiswal, O.R., Srinivas, V., 2005, ‘Effect of tuned mass damper on across-wind response of tall RC Chimneys’, Journal of Wind & Engineering, India, vol.2, No.1, pp.9-21
[18] Shivaji, M., Raju, V.S.N., ‘Dynamic analysis of R.C.C. chimneys’
[19] H.Taibi Zinai, A. Plumier and D. Kerdal, “Computation of Buckling Strength of Reinforced Concrete Columns by the Transfer-Matrix Method”, International Journal of Civil Engineering & Technology (IJCIET), Volume 3, Issue 1, 2012, pp. 111 - 127, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
[20] B.C.Punmia, Ashok K Jain and Arun K Jain, “Reinforced concrete structures- Vol.II”, Laxmi Publication (P) Ltd. New Delhi-110002.
[21] Mohammed S. Al-Ansari, “Flexural Safety Cost of Optimized Reinforced Concrete Beams”, International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 2, 2013, pp. 15 - 35, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
[22] A Model code for concrete chimneys, Part-A-The shell (1984)-CICIND, 136 North street, Brighton, England.
[23] Shravya Donkonda and Dr.Devdas Menon, “Optimal design of reinforced concrete retaining walls”, The Indian Concrete Journal, Vol.86, No.04, pp. 9-18.
[24] A Flaga and T Lipecki (2010), “Code approaches to vortex shedding and own model”, Engineering Structures. 32, pp.1530-1536.
[25] A Kareem and J Hseih (1986), “Reliability analysis of concrete chimneys under wind loading”, Journal of Wind Engineering and Industrial Aerodynamics. 25, pp. 93-112.
[26] A Hlaga (1983), “A analysis of along-across and torsional wind effect on slender engineering structures in stochastic formulation”, Wydawnictwa politechniki, Monografia No 22, Krakow (in Polish).
[27] A. Castelani (1983), “Construzioni in zona sismica.Milano”, Masson Italia Editori.
[28] CICIND, “Model code for steel chimneys (Revision 1-December 1999)”, Amendment A, March 2002.
[29] D Menon and PS Rao (1997), “Uncertainties in codal recommendations for across-wind load analysis of R/C chimneys”, Journal of Wind Engineering and Industrial Aerodynamics.72, pp. 455-468.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY