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Analytical Review of 300m High RCC chimney by Different Codes

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Abstract: In early 1960, a 122-meter-high chimney was considered to be very tall and nowadays many chimneys in the range of 220 M height have been built in our country. In the USA, several chimneys in the range of 380 m already exist, and this trend toward constructing taller chimneys will continue. Construction of such tall Chimneys has been possible with the better understanding of loads acting on them and of the structural behaviour above all with the utilization of modern construction plant equipment and techniques such as slip form. Reinforced concrete has been the most favoured material for Chimney construction since it has the advantage to resist wind load and other forces acting on them as a self-standing structure.
Key Words: *Tall RCC Chimney, Modal mass participation, Self-weight of Structure ASCE7-16, IS1893-2016, SAP2000.*

I. INTRODUCTION

Chimneys are the structures which are built to greater heights as tall slender structures. In period of time, as household vents and over the years; they're popularly referred to as chimneys. Chimneys or stacks are used as a medium to transfer highly contaminated polluted gases to atmosphere at greater heights. Over the years because of development of large-scale industries, an oversized number of tall slender chimneys are required to be designed per annum. The most function of chimneys is to require highly poisonous gases which aren't acceptable at ground level were taken to greater heights with sufficient velocities. Chimneys are more susceptible to wind and earthquake loads which can cause severe problem in power plants and major industries. However, if they located in higher seismic zone with lower wind speeds, then, seismic forces may become analogous, if no more, than the wind loads, it's designed for both, along wind and across wind loads.

Chimneys are relatively tall structures to a few kinds of stresses (i) Stresses because of self- weight, (ii) Stresses because of wind moment and (iii) Stresses because of temperature variation between the within and out of doors of the chimney.

II. TALL RC CHIMNEY

Chimneys are a logo of commercial growth in any country. In recent years there has been an increased demand for tall chimneys because of fixing several large thermal power stations within the country. In early 1960, a 1222-meter-high chimney was considered to be very tall and nowadays many chimneys within the range of 220m height are in-built our country. In the USA, several chimneys within the range of 380m exist already, and this trend toward constructing taller chimneys will continue. Construction of such tall chimneys has been possible with the higher understanding of loads performing on them and of the structural behaviour particularly with the employment and techniques like slip form. The heights of the chimneys are increased to reduce the atmospheric pollution. The changes within the dimensions may have the influence on the dynamic properties of chimneys.

The height of the many industrial chimneys in India is quite 200m. The tallest chimney in India is Dahanu Thermal Power Station's chimney (1985) at Mumbai with the height of 275.3m and GRES-2 station (1987) at Kazakhstan is that the tallest chimney within the world with a height of 419.7m. The necessity of skyrocketing the peak of chimney is incredibly essential because it is directly associated with social and economic aspects of any country.

III. MODELLING OF RC CHIMNEY

i) Details of Chimney

Sr. no.	Parameters	Values
1	Material used	Concrete-M40
		Reinforcement Fe500
2	Plan Dimension	The external Dia. At bottom and top, 18m and 3.6 m respectively
3	Height of each level	10m
4	Density of concrete	$25 KN/m^3$

5	Poisson Ratio	0.2-concrete and 0.15-steel
6	Code of Practice adopted	IS456:2000, IS1893:2016, ASCE 7-16
7	Seismic zone for IS1893:2016	III
8	Importance Factor	1
9	Response Reduction Factor	5
10	Foundation soil	Medium
11	Wall thickness	800mm
12	Floor Finish	1KN/m^2
13	Live load	2.5KN/m^2
14	Earthquake load	As per IS 1893-2016
15	Model to be analysed	300m ht. of chimneys.
16	Ductility class	IS1893:2016 SMRF

Fig. 1 Rendering View of RC Chimney

ii) Material Property

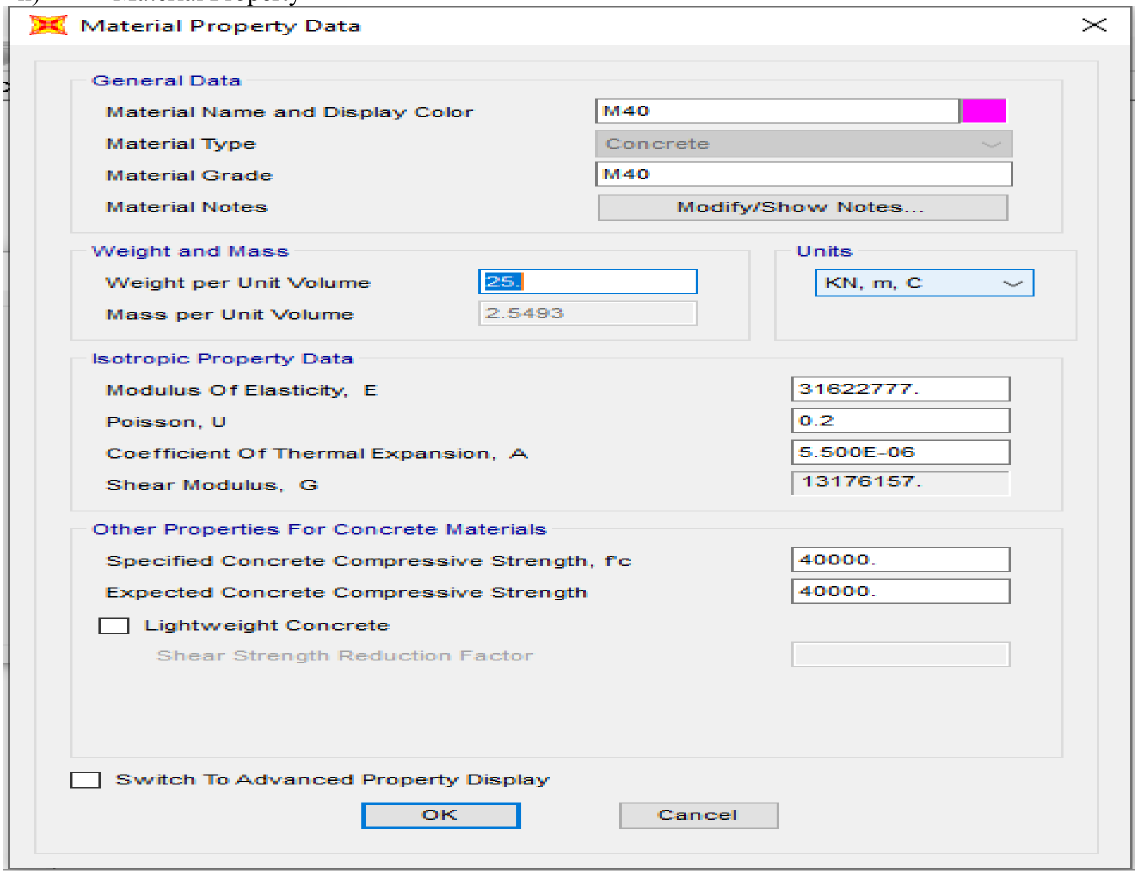


Fig. 2 Material Defines

iii) Define load patterns

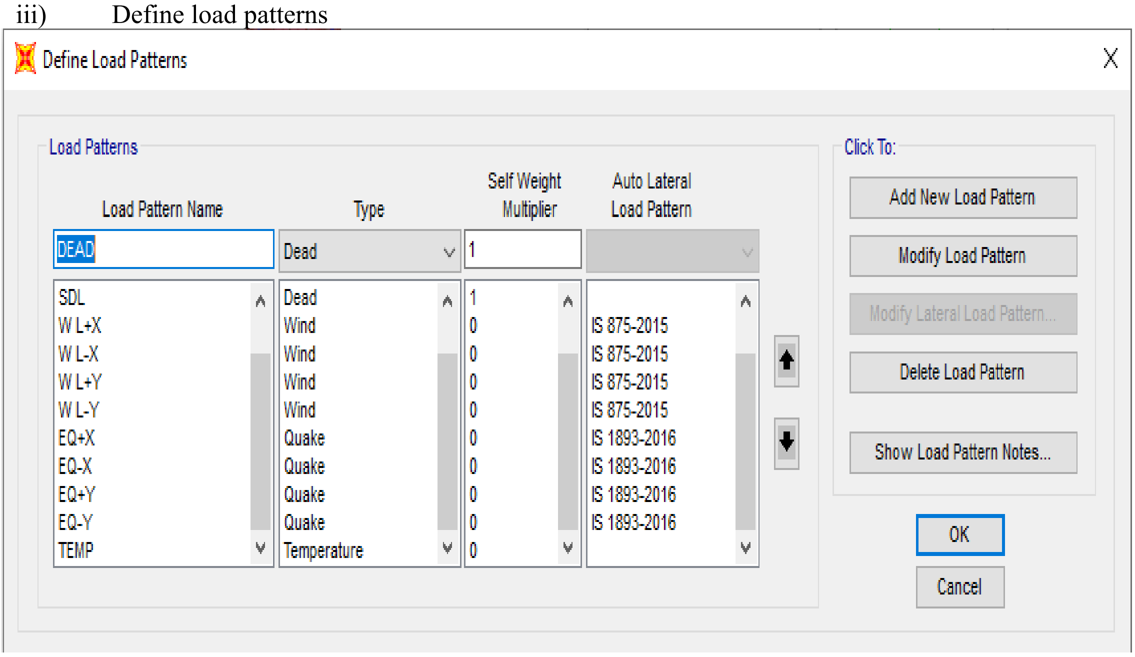


Fig. 3 Load Patterns Define

iv) Response Spectrum Function Define

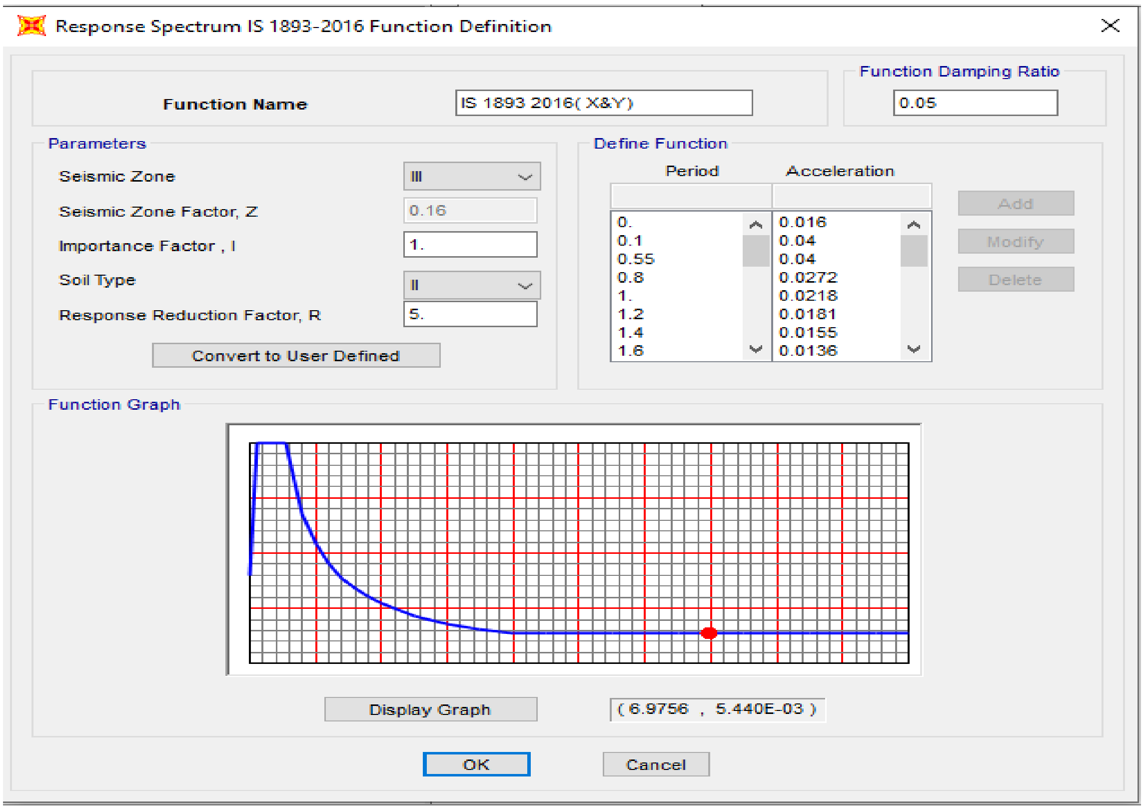


Fig. 4 Response Spectrum Function Define

v) Earthquake load Define

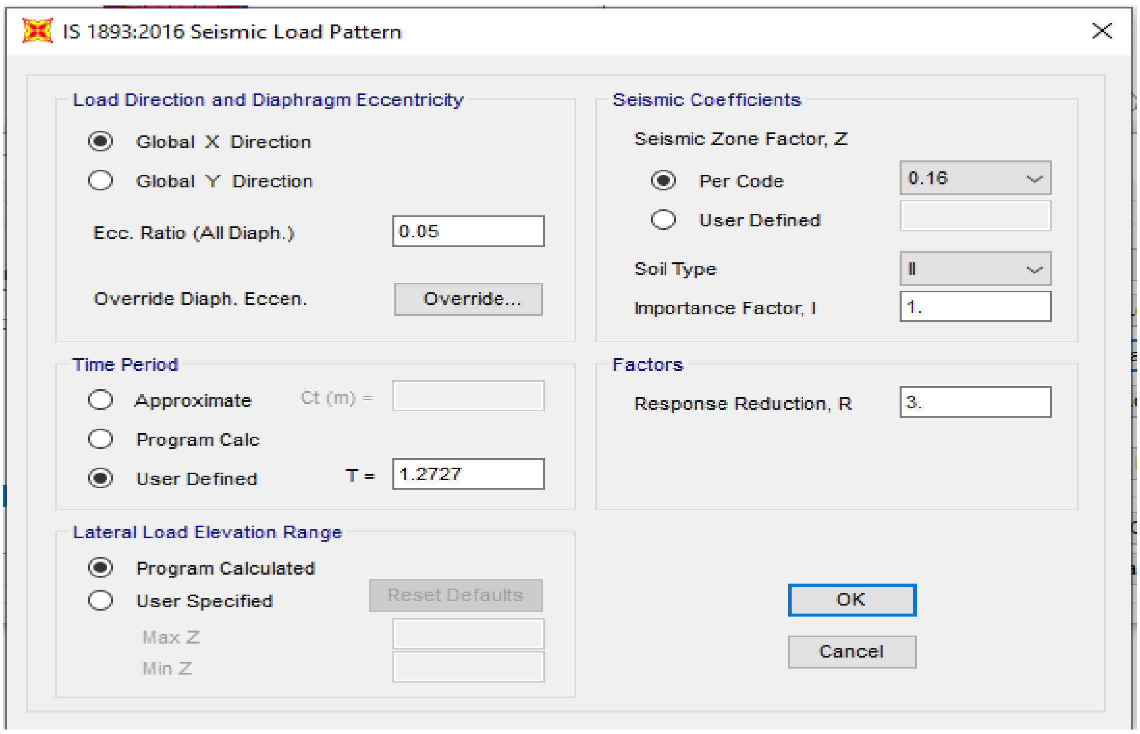


Fig.5 Earthquake Load Define

IV. RESULTS AND DISCUSSIONS

- For Modal Mass Participations

Table 1. Modal Mass Participations Results Indian Code

Step Num	Period	UX	UY	RX	RY	RZ
Unit less	Sec	Unit less	Unit less	Unit less	Unit less	Unit less
1	3.027007	0.17317	0.2622	0.33416	0.22057	2.076E-11
2	3.025912	0.26219	0.17315	0.22056	0.33415	1.148E-10
3	0.86777	0.10681	0.11573	0.01511	0.01395	9.281E-09
4	0.86753	0.11572	0.1068	0.01398	0.01513	2.279E-10
5	0.450913	4.374E-08	3.689E-08	1.97E-08	2.236E-08	2.689E-07
6	0.450718	5.924E-08	7.199E-08	0.000000105	8.39E-08	2.692E-12
7	0.396171	0.00361	0.11919	0.08092	0.00244	2.637E-08
8	0.396159	0.11917	0.0036	0.00244	0.08091	4.916E-08
9	0.304742	2.113E-09	3.969E-09	2.367E-10	4.445E-11	2.377E-10
10	0.304729	4.664E-09	2.917E-09	1.982E-09	3.252E-09	2.179E-07
11	0.281451	2.859E-08	2.889E-08	3.076E-08	3.145E-08	0.5763
12	0.260148	4.511E-08	0.000000066	7.096E-08	4.856E-08	0.00003173

Table 2. Modal Mass Participations Results ASCE 7-16 Code

Step Num	Period	UX	UY	RX	RY	RZ
Unit less	Sec	Unit less	Unit less	Unit less	Unit less	Unit less
1	3.15306	0.18022	0.25308	0.32502	0.23132	3.449E-11
2	3.151874	0.25305	0.18019	0.23131	0.32501	8.692E-09
3	0.903681	0.1271	0.0959	0.01218	0.01615	9.048E-09
4	0.903227	0.0959	0.1271	0.0162	0.01221	1.986E-11
5	0.470077	1.136E-07	9.097E-08	5.745E-08	7.095E-08	4.201E-07
6	0.469829	1.785E-07	2.312E-07	0.00000027	2.068E-07	7.647E-14
7	0.412905	0.07337	0.05025	0.0338	0.04939	4.103E-08
8	0.412837	0.05025	0.07337	0.04938	0.03379	1.072E-09
9	0.317069	3.947E-10	6.88E-10	5.973E-10	5.267E-10	3.594E-14
10	0.317057	3.725E-09	1.881E-09	1.001E-09	2.365E-09	2.967E-07
11	0.293041	3.261E-09	7.312E-09	9.499E-09	5.347E-09	0.57543
12	0.270697	3.218E-08	4.248E-08	4.389E-08	3.341E-08	0.00003206

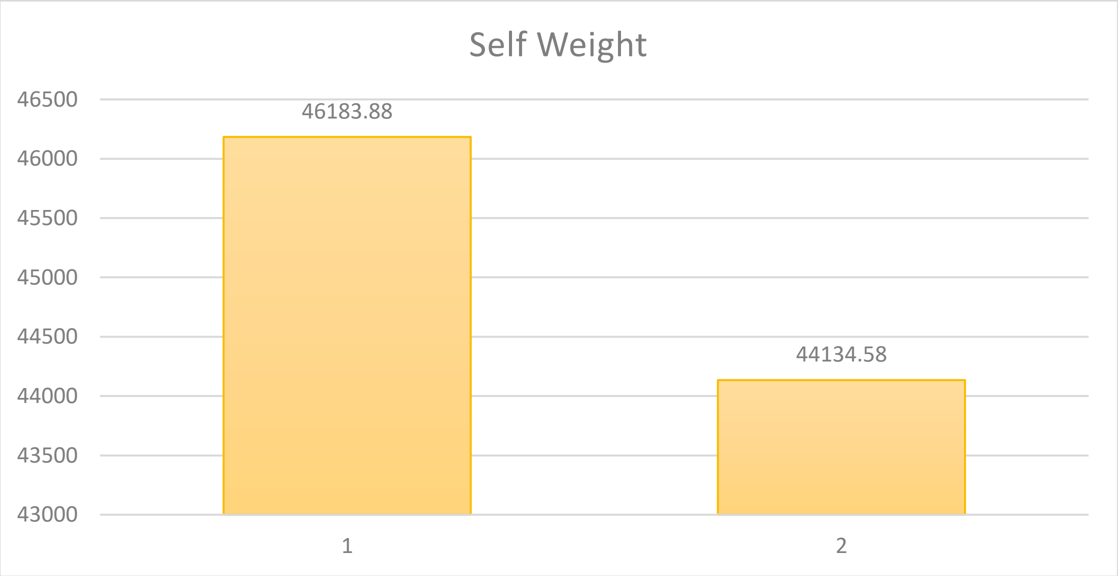
- For Self-weight of Chimney

Table 3. Self-Weight of Chimney Structure by Indian Codes

TABLE: Groups 3 - Masses and Weights					
Group Name	**Self-Mass**	**Self-Weight**	**Total Mass-X**	**Total Mass-Y**	**Total Mass-Z**
Text	KN-s2/m	KN	KN-s2/m	KN-s2/m	KN-s2/m
ALL	46183.88	452909.127	46183.88	46183.88	46183.88

Table 4. Self-Weight of Structure by ASCE

TABLE: Groups 3 - Masses and Weights					
Group Name	**Self-Mass**	**Self-Weight**	**Total Mass-X**	**Total Mass-Y**	**Total Mass-Z**
Text	KN-S2/M	KN	KN-S2/M	KN-S2/M	KN-S2/M
ALL	44134.58	432812.416	44134.58	44134.58	44134.58



Graph 1. Self-Weight Indian vs. ASCE 7-16 Code

V. CONCLUSIONS

In the present study, comparative analysis of RCC chimney structure with earthquake Indian code IS 1893 2016 and an US Earthquake code ASEC 7-16, The chimney structure is analyses for Indian Earthquake zone III and spectral accelerations 0.89 ASCE 7-16 code,

1. Chimney Structure Analysis for earthquake code as per ASCE 7-16 or IS 1893 2016 Indian code Modal mass participations in both code is almost same for translational or Rotations.
2. The natural time period of chimney is closely spaced, while IS 1893 2016 Indian code time period increased 1.0123 times as compare to ASCE 7-16 Code models.
3. Chimney with code ASCE 7-16 self-weight of structure is increased 1.0054 times as compare to IS 1893 2016 Indian Earthquake code.

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