WIND LOAD ASSESSMENT FOR STEEL LATTICE TOWER WITH DIFFERENT CODES

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ABSTRACT

The paper describes a comparison of wind load calculation on lattice tower with different wind load standards in Asia pacific region. Steel lattice tower of height 80 m assume to locate at rural area with open terrain. The design wind speed and other wind properties as per different standards were calculated. The comparison of different coefficients and loads were prescribed and comments on the difference are given.

KEY WORDS: Design wind speed, Indian standard codes IS 802 (part1/sec1):1995,British standard institution CP3:Chapter V :part 2:1972 , ASCE-7-05chapter 6 wind load , wind hazard , disaster.

1. INTRODUCTION

A practical outcome of this paper is a comparison of wind load on lattice tower from different code of practice. Wind loading codes and standards of three different countries American standard ASCE-7-05 , British standard BSI:CP3:chapter V:part2 and Indian standard IS 875 and IS 802(part1/sec1):1995 were used in comparison of wind load on lattice tower with similar condition of topography , return period, basic wind speed on same lattice tower. In the comparison reported in this paper design wind speed, chosen terrain, gust averaged over a short time interval of about 3 seconds, and return period were all specified.

1.1 General consideration of steel lattice tower:

The lattice tower was 80 meter height with base dimension 10.790 x10.790 m and top dimension 2.0 x2.0 m located in open terrain (figure 1) .The tower has 23 panels, 75.0 m inclined and 5.0 m straight. The along wind base moment and shearing force were required to be calculated for wind direction normal and diagonal.

Basic wind speed of 47 m/sec with open terrain with well scattered obstructions having height generally 1.5 m to 10 m (this category includes normal country lines with very few obstacles) and return period of design loads of 50 years was considered. The basic wind speed is applicable at 10 m height above mean ground level and based on peak gust averaged over a short time interval of about 3 seconds corresponding to mean height above ground level in an open terrain.

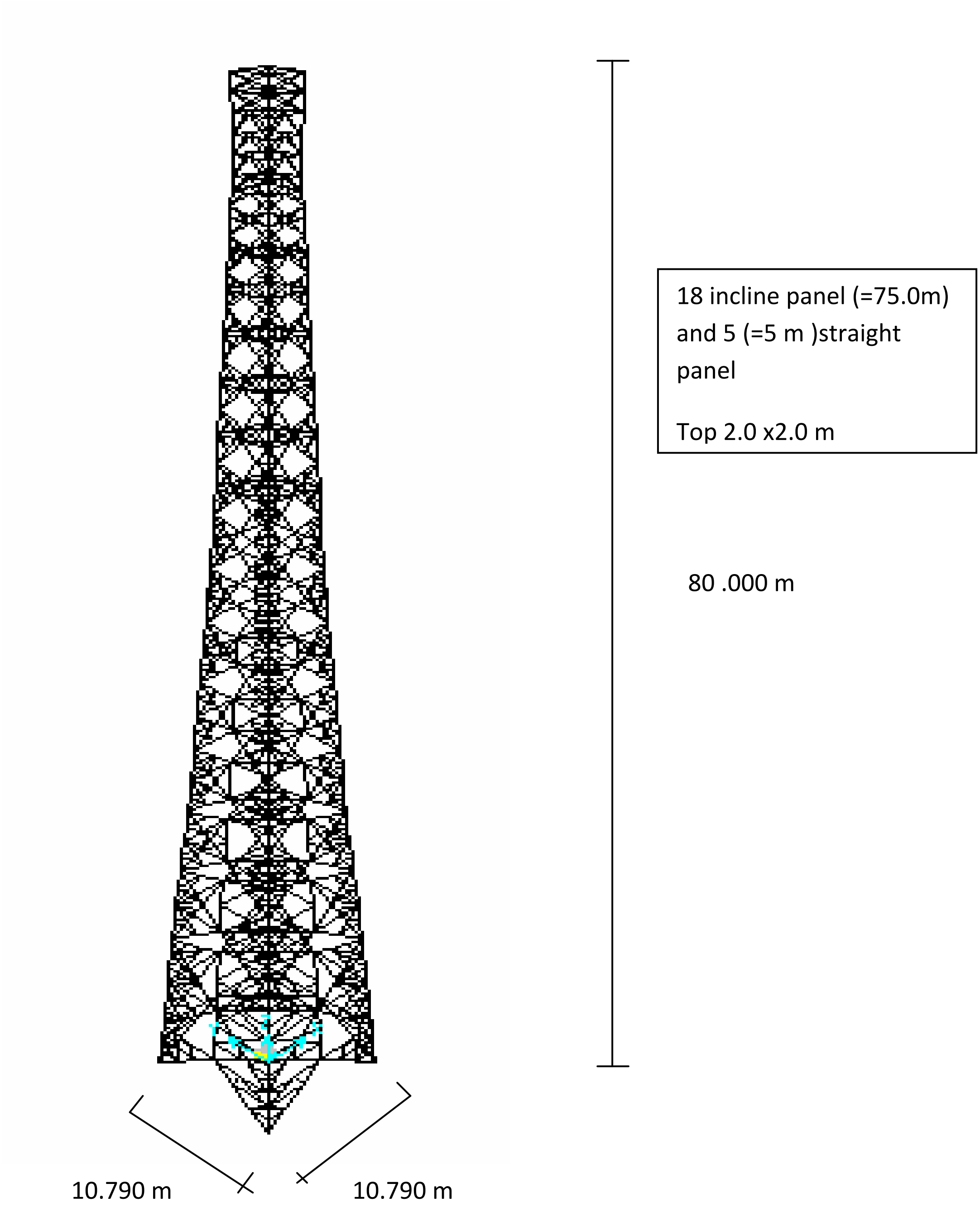

Figure 1: model of 80 m height lattice tower

1.2 Wind pressure on lattice tower

Table 1 gives the comparison of coefficients for design wind speed from various codes for 80 m height lattice tower.

Table 1

S.N.		Indian standard IS 875-1987 and IS 802(part1/sec1):1995	British standard Institution CP3:Chapter V:part 2:1972	ASCE-7-05
1	Basic wind speed	47 m/sec	47 m/sec	47 m/sec
2	Metrological	$V_r = Vo \ / \ K_o$		

	wind speed	(K_o is the factor to3 sec peak gust speed into average speed of wind during 10 minutes period and equal to 1.375)		
3	Design wind speed	K_1=risk coefficient for wind zone 4 and return period 50 years =1 K_2=Terrain roughness coefficient for open terrain category 2=1 $V_d = V_r \times k_1 \times k_2$ =34.342 m sec	S1=topographic factor =1(Except very exposed hill and valley shaped to produce a funneling of wind) S2=ground roughness factor for class C and value change as S2(z)= if Z > 10m $S2=(V_{et}/V_{e3})(V_{e3}/V_{10,3})((H-Y)/10)^a$ S3=Statistic factor =1 for 50 years return period	K_{zt} = topographic factor $K_{zt} = (1+K_1*K_2*K_3)^2$ K_1=0.26 ,K_2=0.67 K_3=0.67 K_{zt} = 1.247

Table 2 compares maximum design pressure as per three codes and here gives variation of coefficients

Table 2

S.N.		Indian standard IS 875-1987 and IS 802(part1/sec1):1995	British standard Institution CP3:Chapter V:part 2:1972	ASCE-7-05
1	Design wind pressure	$P_d=0.6\ (V_d)^2$ =707.616 N/mm^2	Dynamic pressure $q=0.613(V_d)^2$	Velocity pressure $q_z=0.613K_z*Kzt*K_d*I*V^2$ K_z=Velocity pressure expose coefficient depends on height. K_d = wind directional factor =0.85 I= Importance factor =1 V = basic wind speed
2	Design wind load	$F = P_d * C_{dt}*A_e*G_t$ C_{dt} = drag coefficient for panel depends on solidity ratio A_e = effective area of the object normal to wind G_t = gust response factor depends on ground roughness and height above ground.	$F = C_f *q*A_e$ C_f = force coefficient depends on solidarity ratio A_e = effective area of the object normal to wind	$F = q_z*G*C_f*A_f$ G = gust effect factor C_f = force coefficient factor A_f = projected area normal to wind

1.3 Wind load on lattice tower

Table 3 compares maximum loads on 80 m height tower under different panel at different height with respect to various standards. Wind load is calculated with respect to Indian standard, British standard and ASCE standard.

The wind load on tower at different panel height varies 3 percent to 23 percent between the Indian and British standard. Similarly, 25 percent to 65 percent varies between Indian and ASCE standard. Likewise, 71 percent to 86 percent varies between British and ASCE standard for wind load.

Table 3

S.N.	Height of tower above ground level (m)	Effective area Transferred (sq. m)	Wind load as per IS 802(part1/sec1):1995 (KN)	Wind load as per British standard Institution CP3:Chapter V:part 2:1972 (KN)	Wind load as per ASCE-7-05 (KN)
1	5.00	8.346	35.772	19.684	45.860
2	10.98	9.846	41.602	33.776	63.111
3	20.00	7.017	35.173	30.677	52.692
4	23.90	5.048	26.274	23.252	40.371
5	30.00	5.840	29.986	27.251	46.832
6	36.00	5.073	26.853	24.653	42.483
7	42.00	4.258	23.074	21.444	36.972
8	47.00	3.424	18.519	17.458	29.801
9	51.00	2.895	15.231	14.561	24.724
10	55.00	2.360	12.663	12.146	20.701
11	58.50	1.999	11.060	10.619	18.082
12	62.00	1.831	10.058	9.687	16.487
13	65.00	1.637	8.853	8.534	14.554
14	68.00	1.386	7.499	7.239	12.356
15	70.00	1.116	5.693	5.465	9.389
16	72.00	0.893	4.693	4.520	7.752
17	73.50	0.730	3.806	3.666	6.287
18	75.00	0.544	2.854	2.749	4.726

19	76.00	0.391	2.154	2.076	3.569
20	77.00	0.391	2.158	2.081	3.578
21	78.00	0.441	2.437	2.351	4.042
22	79.00	0.490	2.531	2.443	4.197
23	80.00	0.245	1.268	1.224	2.104

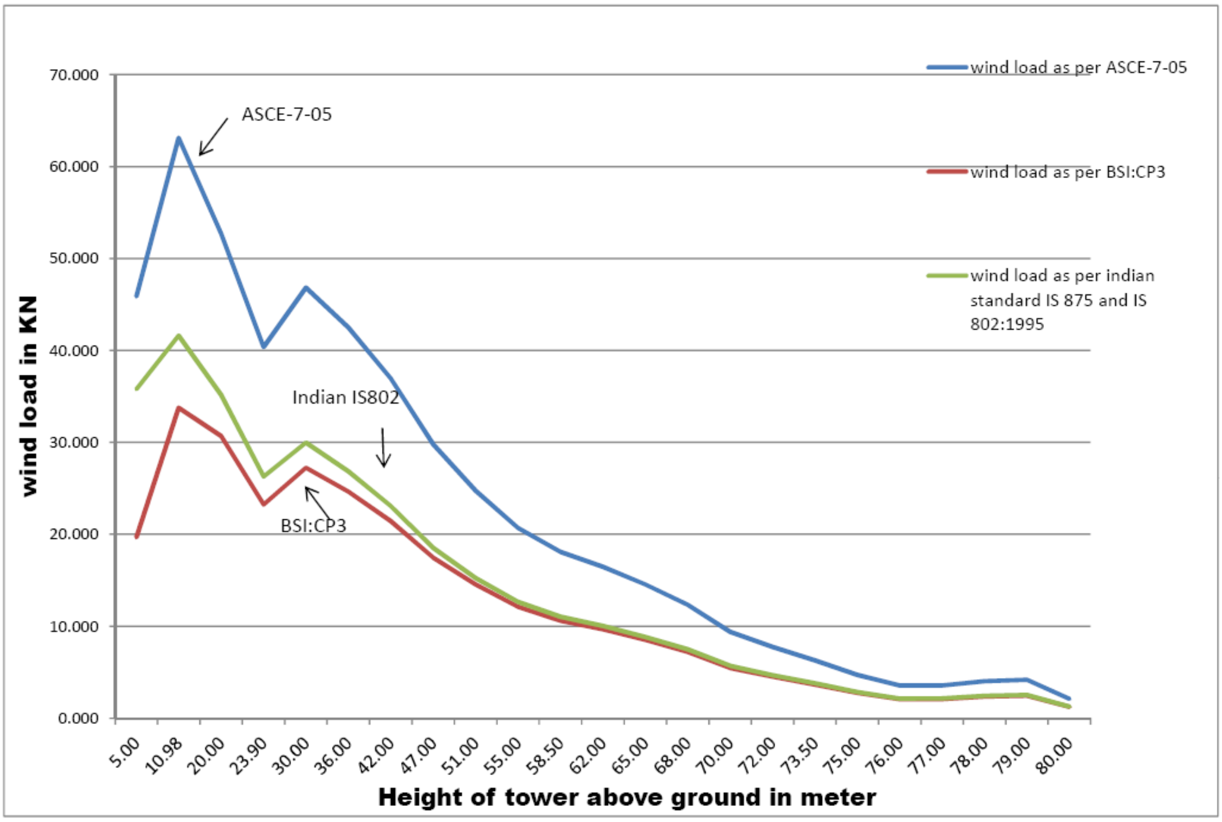

Figure 2: plot between wind load and height of tower

Figure 2 shows that Wind load calculated for the tower with ASCE standard is higher than other calculated with Indian and British standard. Wind Load curve calculated from British and indian were nearly the same value whereas Calculated from ASCE is higher.

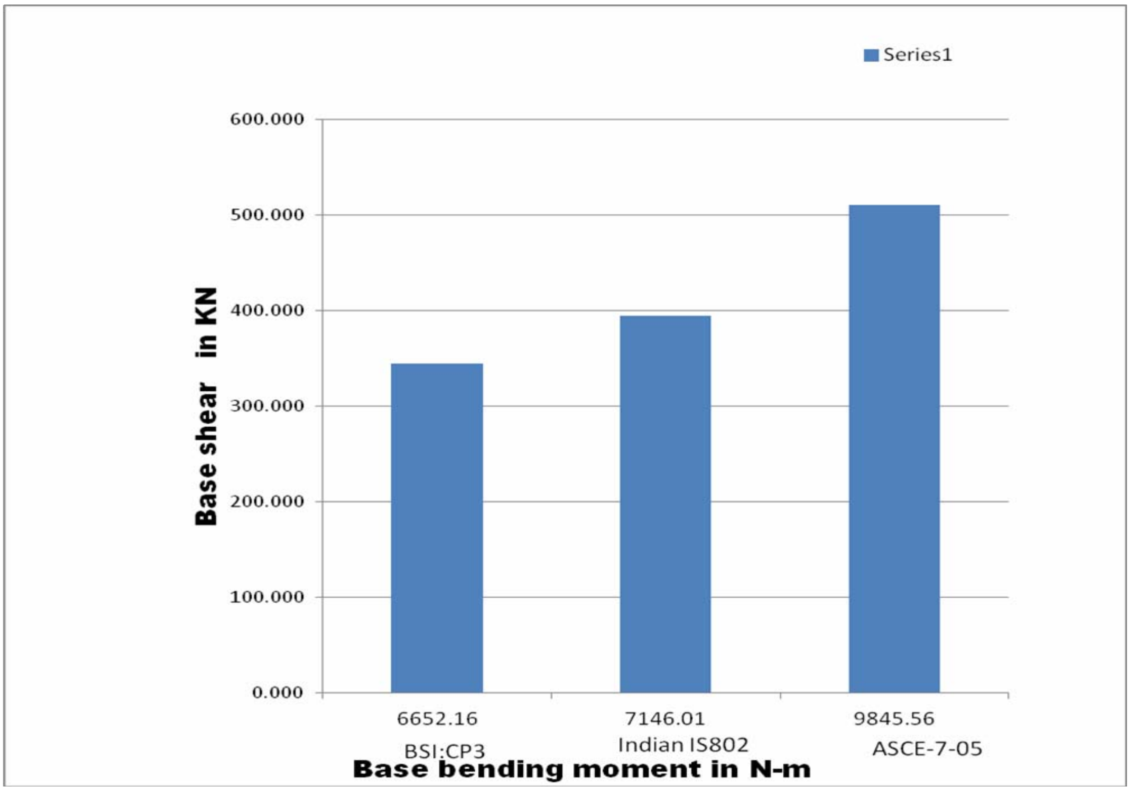

Figure 3 : plot between base shear and base bending moment for lattice tower 80 m height

Table 4 show base shear and bending moment at base of 80 m height tower.

Table 4

S.N	Type of load	Country/region	Code /standard	Base shear (KN)	Bending moment at base (N-m)	Deflection (mm)
1	Wind (at diagonal)	United Kingdom	BSI:CP3:chapter V	345.01	6652.16	324.2
2	Wind (at diagonal)	India	IS 802:1995 and IS 875:1987	394.48	7146.01	340.18
3	Wind (at any direction)	United states	ASCE-7-05	510.62	9845.56	462.8
	Average			416.70	7881.24	

Table 4 compares the base shear and base bending moment at base of 80 m height tower during the wind load case. The BSI: CP3: chapter V and Indian standard IS 802:1995 stated that for square lattice towers maximum load occurs when the wind blows under corner (at 45^0 winds) and taken as 1.2 times the load for the face on wind. ASCE-7-05 stated same value in any direction. The base shear calculated as per ASCE-7-05 is 48 percent higher than British code and 29 percent higher than Indian code. Bending moment calculated as per ASCE standard at base is 48 percent and 37 percent higher than British and Indian standards respectively. Similarly for tower with same material properties and same sections used during design the deflection calculated by ASCE wind loading is 42 percent and 32 percent higher than British and Indian standard for wind load, whereas base shear, base bending moment and deflection calculated by both British and Indian standards are within the limit of 5 percent to 14 percent.

CONCLUSIONS

It is noted that variation is more significant. The variation ranges from 29 percent to 48 percent for base shear and base moment calculation for wind loading cases. Because of various factors consideration in different standard, wide variation in wind load, base shear and base moment are found and well harmonization is required.

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