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Comparision of IS-875(Part 3)1987 and IS-875(Part 3)2015 for Tall Junction Tower

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Abstract:- **Intention of the present work to compare the behavior of junction tower build for the material handling purposes in thermal power plant when applied with wind load based on IS-875(part 3)1987 and IS-875(PART 3)2015. The loads are applied based on IS-875 (part 3) 1987 and IS-875(part 3)2015 was applied separately. The design in both the cases was performed using the codal provisions and standards of IS 800-1984(working stress method). The results (design, sway) in both the cases were compared.**

I. INTRODUCTION

The junction towers are the supporting structures which are constructed to provide a support for the belt conveyors to convey the material to the power generation point in thermal power plant. It is built mainly for the intension to turn the material conveyor belt on particular degree in the industry. The change of direction is achieved by way of dropping the material from upper level to lower level of conveyor running in different direction. The junction towers also facilitates in transferring one belt conveyor to other belt conveyor going in two or more direction. The junction tower also accommodates horizontal and vertical gravity take up in order to maintain the belt tension as per the design requirements. It also houses Dust Extraction System, screw conveyor Inline Magnetic Separators, Cranes / Monorails etc.

2. OBJECTIVES

1. To perform the analysis and design of junction tower based on IS-875(part 3)1987 and IS-875(part 3)2015 for both coastal and non coastal zones and compare the quality of steel required in each condition.
2. To find the percentage of members that do not satisfy the codal provisions of IS-875(part 3)2015 but satisfy 1987.
3. To find what type of members that does not satisfy the codal requirements of 2015 version that satisfied in 1987 version.
4. To find the additional quantity of steel required to satisfy the codal provision of IS-875(part 3)2015.
5. To compare the maximum sway in both orthogonal directions as per IS-875(part 3)1987 and IS-875(part 3)2015.
6. To determine the additional quantity of steel required to satisfy the sway requirements of junction tower analyzed and designed as per IS-875(part 3)2015.

3. BUILDING DETAILS

Junction tower is composed of structural steel members braced in both framing directions. It is provided wherever conveyor gallery changes its direction. The tower dimension is 14m×14m with 75m height. The maximum allowable sway according to codal provisions of design is h/1000(i.e 75m). The support provided was hinged support. It is assumed that the structure is cladded on all sided.

TABLE NO: 1 BUILDING DETAILS

MODEL	
Structure	Steel Structure
Building Dimension	14mx14m
Height	75m
Number Of Floors	6
Floor finish	R.C floor
Roof Finish	R.C roof
Cladding	C G I
Number of conveyors	2
Location of conveyor	EL @54 , EL@ 66

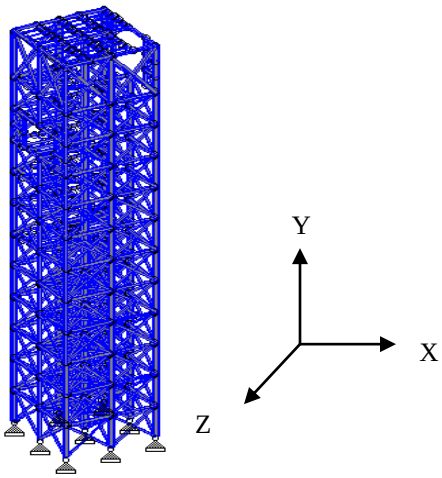

FIG 1 3D VIEW IN STAAD.pro

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4. LOADS CONSIDERED

Load Cases

1. Dead Load
2. Live Load
3. Wind load at +Z direction
4. Wind load at - Z direction
5. Wind load at +X direction
6. Wind load at - X direction
7. Wind load at internal pressure WLIP
8. Wind load at internal pressure WLIS

Dead load and live load have been taken as per **IS 875 (part 1)1987** and **IS 875(part 2)1987** respectively. The following are the loads considered for design.

- Self weight of the structural members
- Cladding
- Conveyor
- Staircase

Wind load: IS-875(PART 3)

The basic wind speed (V_b) of 50m/sec at a different height above the ground level is considered.

Design wind velocity $V_Z = V_b \times k_1 \times K_2 \times k_3$

V_z = design wind speed at any height z in m/s;

V_b = 33 m/sec(non-coastal zone)

V_b = 50 m/sec(coastal zone)

K_1= 1.05(non-coastal zone), 1.08(coastal zone)

K_2 =

TABLE NO:2 Height Factor for IS-875(1987) and IS-875(2015)

Height(m)	K_2	
	1987	2015
0-6	0.99	1.05
6-18	1.03	1.09
18-24	1.06	1.12
24-30	1.09	1.15
30-54	1.14	1.20
54-75	1.20	1.26

K_3= 1

P_Z according to IS-875(PART 3) 1987

The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

$P_Z = 0.6 \times V_Z^2$

Where

P_Z = design wind pressure in N/ms at height z, and

V_Z = design wind velocity in m/s at height

TABLE NO:3 P_Z and V_Z values for IS-875(1987)

Height (m)	Non coastal zone		Coastal zone	
	v_z(m/s)	P_z(kN/m^2)	v_z(m/s)	P_z(kN/m^2)
0-6	34.30	0.71	73.71	1.70
6-18	35.68	0.76	76.518	1.86
18-24	36.73	0.81	78.62	1.96
24-30	37.77	0.86	80.73	2.07
30-54	39.50	0.94	84.24	2.27
54-75	41.58	1.04	88.45	2.52

P_Z according to IS-875(PART 3) 2015

The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

$P_Z = 0.6 \times V_Z^2$

Where

P_Z = design wind pressure in N/ms at height z, and

V_Z = design wind velocity in m/s at height

The design wind pressure P_d can be obtained as

$P_d = K_d \times K_a \times K_c \times P_z$

K_d = wind directionality factor,

K_a = area averaging factor, and

K_c = combination factor

K_d = 0.9(non coastal), 1.0(coastal)

K_a =1.0

K_c = 0.9

TABLE NO:4 P_Z and V_Z values for IS-875(2015)

Height (m)	Non coastal zone		Coastal zone	
	v_z(m/s)	P_z(kN/m^2)	v_z(m/s)	P_z(kN/m^2)
0-6	45.05	1.22	73.71	3.26
6-18	46.76	1.31	76.52	3.51
18-24	48.05	1.39	78.62	3.71
24-30	49.34	1.46	80.73	3.91
30-54	51.48	1.59	84.24	4.26
54-75	54.05	1.75	88.45	4.69

5. RESULTS AND DISCUSSIONS

The junction tower is designed as per the codal standards. The percentage changes in sway in different wind load for both versions of codes are tabulated. The percentage change in the increase of quantity of steel according to new version of code and number of failed members are tabulated below.

5.1 SWAY

TABLE NO: 5 SWAY FOR NON-COASTAL ZONE

LOADS	SWAY (mm)					
	1987		2015(loads as per 1987)		2015	
	X	Z	X	Z	X	Z
DL+LL	6.24	2.05	6.24	2.05	7.85	1.05
DL+LL+(WL+X)+WLIP	40.95	3.19	40.33	3.23	40.97	1.61
DL+LL+(WL+X)+WLIS	29.00	2.95	42.11	3.25	42.66	1.62
DL+LL+(WL-X)+WLIP	22.52	1.14	34.50	0.66	31.67	0.29
DL+LL+(WL-X)+WLIS	28.54	0.90	32.72	0.68	29.98	0.44
DL+LL+(WL+Z)+WLIP	2.67	36.66	4.21	45.42	1.54	43.92
DL+LL+(WL+Z)+WLIS	2.28	36.90	2.43	45.40	0.15	43.91
DL+LL+(WL-Z)+WLIP	10.34	41.01	1.51	48.97	1.27	45.73
DL+LL+(WL-Z)+WLIS	4.32	40.76	0.27	48.99	1.37	45.74
DL+(WL+X)+WLIP	36.96	3.71	36.33	3.75	36.53	2.45
DL+(WL+X)+WLIS	30.93	3.47	38.11	3.77	38.22	2.46
DL+(WL-X)+WLIP	26.51	1.66	38.49	1.18	36.11	1.22
DL+(WL-X)+WLIS	32.53	1.42	36.71	1.20	34.42	1.23
DL+(WL+Z)+WLIP	4.31	36.14	8.20	44.90	5.98	43.08
DL+(WL+Z)+WLIS	1.72	36.38	6.42	44.88	4.29	43.07
DL+(WL-Z)+WLIP	6.35	41.53	5.50	49.48	4.76	46.57
DL+(WL-Z)+WLIS	0.32	41.28	3.73	49.51	3.07	46.58
0.9DL+(WL+X)+WLIP	36.65	3.46	36.03	3.50	36.16	2.26
0.9DL+(WL+X)+WLIS	30.63	3.22	37.81	3.52	37.84	2.27
0.9DL+(WL-X)+WLIP	26.82	1.41	38.79	0.93	36.48	1.03
0.9DL+(WL-X)+WLIS	32.84	1.17	37.01	0.95	34.79	1.04
0.9DL+(WL+Z)+WLIP	4.00	36.39	8.50	45.16	6.36	43.27
0.9DL+(WL+Z)+WLIS	2.02	36.64	6.73	45.13	4.67	43.26
0.9DL+(WL-Z)+WLIP	6.04	41.27	5.81	49.23	5.13	46.38
0.9DL+(WL-Z)+WLIS	0.02	41.03	4.03	49.26	3.44	46.39

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TABLE NO: 6 SWAY FOR COASTAL ZONE

LOADS	SWAY (mm)					
	1987		2015(loads as per 1987)		2015	
	X	Z	X	Z	X	Z
DL+LL	2.77	2.03	2.77	2.03	4.34	4.54
DL+LL+(WL+X)+WLIP	58.42	2.57	95.35	2.91	57.27	5.04
DL+LL+(WL+X)+WLIS	53.56	2.47	90.50	2.81	55.19	4.97
DL+LL+(WL-X)+WLIP	45.27	1.73	79.30	2.17	43.48	4.28
DL+LL+(WL-X)+WLIS	50.13	1.58	84.16	1.85	45.56	4.21
DL+LL+(WL+Z)+WLIP	2.63	59.54	6.86	98.32	0.94	50.77
DL+LL+(WL+Z)+WLIS	7.10	59.64	11.72	98.42	1.73	50.83
DL+LL+(WL-Z)+WLIP	3.39	63.57	6.51	102.29	0.78	59.81
DL+LL+(WL-Z)+WLIS	6.23	63.46	11.36	102.18	1.31	59.75
DL+(WL+X)+WLIP	56.17	3.02	93.10	3.36	55.20	4.02
DL+(WL+X)+WLIS	51.31	2.92	88.24	3.26	53.11	3.96
DL+(WL-X)+WLIP	47.53	2.14	81.55	1.86	45.56	3.26
DL+(WL-X)+WLIS	52.39	2.03	86.41	1.76	47.64	3.20
DL+(WL+Z)+WLIP	4.50	59.08	9.12	97.86	1.72	51.79
DL+(WL+Z)+WLIS	9.35	59.19	13.97	97.97	3.80	51.85
DL+(WL-Z)+WLIP	3.62	64.02	8.76	102.74	1.30	58.80
DL+(WL-Z)+WLIS	8.48	63.92	13.62	102.64	3.38	58.73
0.9DL+(WL+X)+WLIP	56.08	2.82	93.01	3.16	54.98	3.71
0.9DL+(WL+X)+WLIS	51.22	2.72	88.16	3.06	52.89	3.65
0.9DL+(WL-X)+WLIP	47.61	1.93	81.64	1.66	45.78	2.95
0.9DL+(WL-X)+WLIS	52.47	1.83	86.50	1.55	47.86	2.89
0.9DL+(WL+Z)+WLIP	4.58	59.28	9.20	98.07	1.94	52.10
0.9DL+(WL+Z)+WLIS	9.44	59.39	14.06	98.17	4.02	52.16
0.9DL+(WL-Z)+WLIP	3.71	63.82	8.85	102.54	1.52	58.49
0.9DL+(WL-Z)+WLIS	8.57	63.72	13.70	102.44	3.60	58.43

5.2 PERCENTAGE CHANGE IN FAILED MEMBERS

TABLE NO: 7 PERCENT CHANGE IN FAILED MEMBERS

Zones	No of failed members			% change
	Total	Passed	Fail	
Non-coastal	1813	1755	58	3.2
Costal	1813	1550	263	14.5

5.3 QUANTITY OF STEEL

TABLE NO: 8 PERCENT INCREASE IN QUANTITY

zones	QUANTITY(KN)		% INCREASE
	OLD	NEW	
Non-coastal	5037	5150	2.2
Costal	5919	7874	24.8

6. CONCLUSION

1) The junction tower for a coal handling system was analyzed and designed according to the IS codes designed.

2) 3.2% of members for non-coastal zone and 14.5% of members for coastal zone were not satisfying the codal requirement if IS-875(PART 3) 2015.

3) The maximum horizontal sway in X-direction and Z-direction for IS-875(PART 3) 1987 and 2015 are as follows.

TABLE NO: 9 MAXIMUM HORIZONTAL SWAY

zones	**X-direction**			**Z-direction**		
	1987	**2015 (loads as per 1987)**	**2015**	**1987**	**2015 (loads as per 1987)**	**2015**
Non-coastal	40.95	42.11	42.66	41.53	49.51	46.58
Costal	58.42	95.35	57.27	64.02	102.74	59.81

4) The increase in the percentage of quantity of steel for non-coastal zone is 2.2% and coastal zone is 24.8%.

5) There is considerable change in the increase in quantity of steel only in coastal zone. It is better and efficient if we design according to old version.

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