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REDUCTION IN DYNAMIC LOAD IN RC CHIMNEY BY STRAKES PROVISIONS

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Abstract: The Industrial growth of the any developing country like India is fast but the development of Research Centers are not supporting the development specially in a special structures like RC chimney, The effect of Aerodynamic Interference in chimney specially provided in cluster with their distance is within the 20 times 2/3 of top diameter . Also when the Height of RC chimney is increasing to fulfill the norms of Pollution control Board. This increase in height of RC chimney will increase the dynamic wind load pressure which also requires to reduce these loading as in case of cluster of chimney. To reduce this dynamic loading we can reduce the effective design moments at the base of chimney by strakes provisions at top 1/3 height to 1/2 height of chimney to ensure stability and safety. The idea about both tall identical chimney and cluster of chimney is shown in the paper to help the designer about safety and economy and thus helping to maintain the standard of PCB.

Key words: - Identical, Cluster, Vortex shedding, Aerodynamic Interference, PCB, Strakes.

I. INTRODUCTION

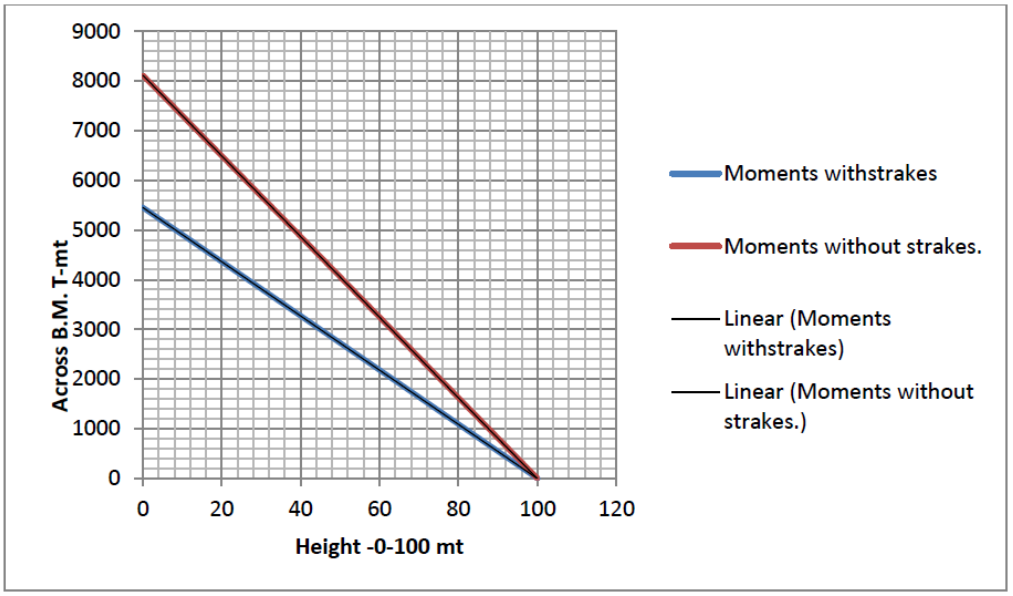
The RCC Chimney is a slender structure and affected more by dynamic wind loading specially vortex shedding as interacted by nearby structures and especially by Aerodynamic interference of other tall chimney at top 2/3 portion by distance within 20 times the diameter. This vortex shedding effect is also increasing as the height of chimney increasing with considering sides-lopes and thickness. The concluding paper is an outcome form the work carried out by analyzing and comparing the static and dynamic load analysis of RC chimney. As we know the wind loading in case of RC chimney is more effective than dynamic loading. The wind study and aerodynamic research work in India is initiated and developed up to international standard by Shri G N V Rao. The Indian code for analysis work for RC chimney is IS:-4998 (Part-I) which well co-ordinate with ACI-307 and other relevant international Codes is well guided by Shri Rao. Depending upon the various wind tunnel Research Centers all over in India at various Indian Institutes of Technologies and Science Study centers at Bangalore. As suggested by all this study it is very important to establish more wind tunnel study and Research Centers as prediction of perfect wind load at a particular place is very complicated work. But for the guidelines in accordance with the work done so-far in developing country like India this study paper will be useful for designer to ensure safety and security at their sites. Also the study will give idea about the % of design moment reduction due to provision of strakes in chimney and thus give idea of % of cost reduction in the project specially when the industry and area is to fast growing and likely to increase height of chimney or inter affected by any other chimney nearby.

For this work two RC chimney of Height = 100.0 m with Stand-Alone condition and with interference chimney effect is selected for analysis work of strakes provisions and the results are obtained with more critical sited condition of wind angle and surrounding effects of other

buildings and structures has been considered. The strakes are in discrete form providing with minimum redial 0.1d to 0.125 d and at a vertical distance of 1 to 1.5 times the redial depth. Where d is top diameter of the chimney. It is found from the work that the design moments are reduced by 30-35 % with strakes provision which a big relief for such type of typical chimney structures where readymade charts or other related data in the codes are not available.
The obtained results are as under for strakes and without strakes provisions in Case of Identical Single placed Chimney & Chimney in Cluster. H= 100.0 m top diameter 13.61 m thickness 0.3 and bottom diameter 16.1 m and thickness 0.4.& taper less than 1 in 50.

Position of Chimney	Along wind Moments In kN-m	Across wind Moments In kN-m	% Reduction in Stress due to Strakes
Identical Chimney			
Without strakes	39120.00	42500.00	-
With strakes	37100.00	38980.00	7.5%
Cluster of Chimney			
Without strakes	53100.00	81175.00	-
With strakes	54140.00	55100.00	30%

Table-1: Table showing % reduction of B.M. Due to strakes provision in100.0m chimney.

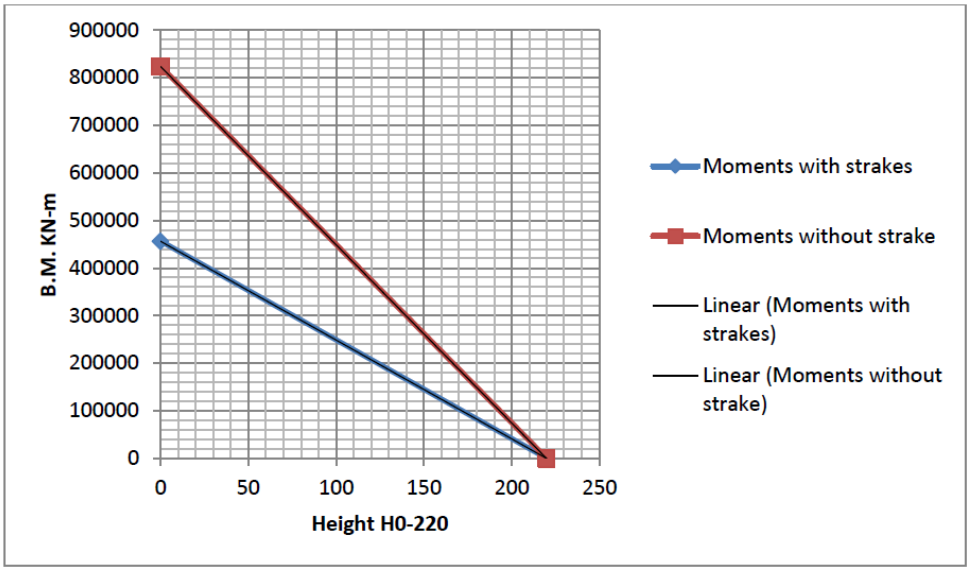


The data also considered and selected for 220.0 height RC chimneys are 24.0 base diameter and thickness 0.80 m and top diameter 14.0 with thickness of 0.27 m is selected to perform the analysis work. The chimney is identical one but the surrounding effect of building is likely to affect the design wind loading and the terrain and category and importance of the chimney is selected accordingly. The analysis work is carried out considering the Magnification Factor for chimney as 1.25 & 1.55as prescribed in the IS Code : 4998 (Part-I) and discrete strakes of 1.3m redial depth and 1.8 m vertical spacing are provided on top 33m height of the Identical chimney and 1.75m redial depth and 1.9 m vertical spacing are provided in case of cluster of chimney.
Same way the stresses in 220.0 m tall RC chimney with wind speed of 44 m/sec has been studied as per dimensions stated earlier. Considering all parameters about the critical conditions are to be checked as per code to avoid critical vortex shedding and designing the chimney to

satisfy the field requirement. The discrete of 1.6 radial depth and 2.25 m vertical distance has been provided to reduce vortex shedding. E= 3.2 x 1010 N/mm2 for M-25.

Position of Chimney	Along wind Moments In kN-m	Across wind Moments In kN-m	% Reduction in Stress due to Strakes
Identical Chimney.			
Without strakes.	421386.00	824000.00	-
With strakes.	440917.0	456770.00	43.0%

Table-2: Table showing % reduction of B.M. due to strakes provision in220.0m chimney.



The case of cluster chimney is not common as we go for tall chimney above 200 m high as this comparison study will found more useful in as a field data in RC chimney. Although there is somewhat increase in along wind loading due to strakes but overall design criteria i.e. dynamic loading is coming well within the control as there is quite reduction in top dynamic deflection of chimney and reduction of vortex shedding of the chimney due to strakes provision in chimney.

II. CONCLUSION

1) There is 30 % reduction in Base design bending moments for cluster of chimney in case of moderated tall chimney, and @ 7-8% reduction in identical chimney.

2) There is 43 % reduction in Base design bending moments for Identical tall RC chimney whose height is about 200 or more than 200 m.

3) For H/d Ratio = 7.34 (H = 100) the reduction is 8% while for H/d Ratio = 15.7 for (H=220.0 Stand alone) the reduction is 43% due to strakes provisions.

4) The study will help designer in plan the angle of wind, H/d ratio, and interfacing distance as well as proper height and give a useful data for designer.

5) Project-cost reduction due to strakes provisions and less maintenance.

6) There is more safety insurance at chimney site where there is fast development in surrounding areas and likely increase in across wind stresses.

7) More height can be planned to meet the PCB norms as level of Pollution is increasing day-by day and norms are also tightened.

8) The earth quake moments are below the maximum design moments due to wind.

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