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Comparison between Steel Chimney and R.C.C. Chimney

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Abstract - Chimneys are tall and slender structures which are used to discharge waste/flue gases at higher elevation with sufficient exit velocity such that the gases and suspended solids(ash) are dispersed in to the atmosphere over a defined spread such that their concentration , on reaching the ground is within acceptable limits specified by pollution control regulatory authorities. Fast and economical construction of chimney is the need of the industries. This project is about comparison between steel chimney and R.C.C. chimney.

Keywords:– *Interaction Curve, stack height, flue gases.*

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I. INTRODUCTION

As large scale industrial developments are taking place all around, a large number of tall chimneys would be required to be constructed every year. The primary function of chimney is to discharge pollutants into atmosphere at such heights and velocities that the concentration of pollutants deemed harmful to the environment are kept within acceptable limits at ground level. Due to increasing demand for air pollution, height of chimney has been increasing since the last few decades, and these are valid reasons to believe that this trend towards construction of taller chimneys will continue. However, chimneys being tall slender structures, they have different associated structural problems and must therefore be treated separately from other forms of tower structure. Construction of such tall chimneys needs the better understanding of loads acting on them and of the structural behavior, so that with the help of modern construction equipment and technique such as slip form, reinforced concrete, the most favored material for chimney construction, could be used efficiently. The proper design and construction of such chimneys will create self-standing structures to resist wind load and other forces acting on them. It is a common practice to consider the effects of wind and earthquake separately in the design. The present paper discusses analysis of reinforced concrete tall chimney. The main focus is to compare the wind analysis result with that due to seismic one. Wind analysis is done for along wind and across wind (shell completed case) and the results so obtained are compared with seismic analysis for deciding the design criteria.[1]

II. METHODOLOGY

The loads on the chimney are calculated by I.S. 875 [5]. The design of steel chimney is done by I.S. 6533- Part (1), Part (2) and for R.C.C. chimney by 4998 Part (1), Part (2).The following are the design steps:

A. Design aspect of R.C.C. chimney

1.) *Working Stress Method:*Chimney is designed according to IS: 4998 (Part I) and following steps are followed:

i. Determine eccentricity (e) = M/W
ii. Determine (eccentricity/radius) at section
iii. Assume the *p* (percentage of steel at section) at the section under consideration
iv. Select the value of m (modular ratio)for concrete grade to be used
v. Determine α (position of neutral axis)
vi. Determine compressive stresses for different values of α and β (β = constant depends on openings in chimneys) in concrete and steel
vii. Calculate temperature stresses in steel and concrete
viii. Calculate stresses in steel and concrete due to wind induced moment. And check combined stresses.

2.*) Limit State Method for Collapse:* Following steps are followed*:*

i. Calculate the W/fck D2 and M / fck D3.
ii. Calculate ratio d/D and D’/D
iii. Where, d=inner diameter of concrete shell
iv. D=outer diameter of concrete shell
v. D’=D - concrete cover
vi. Refer the suitable Pu-Mu Interaction curves
vii. From selected interaction curve take appropriate value of *p*/fck
viii. Calculate *p* percentage of steel required at section for the value of fckused[2].

3.) *Generation of pu – mu interaction curves:*
The greatness of Pu decides the unbiased pivot. On area of the impartial pivot the strain appropriation is known. This can then be utilized to settle for the estimation of Pu and a definitive minute Mu. It is in this manner evident that the answer for the above arrangement of comparisons can be found as a shut structure arrangement. This is on the grounds that the area of the nonpartisan hub is required for the figuring of the ordinary power Pu, while the estimation of Pu is itself required for the area of the neural axis. For the motivation behind building up the association bends the area the impartial pivot is accepted and the estimations of the typical power and the minute are computed. The unbiased hub is then changed to compute another arrangement of Pu and Mu. This is rehashed to get the connection bends of PuVs Mu.The figure no. 1 shows the interaction curve for d/Dfrom were area of steel is determine. Following steps are followed:

i. Select various outer diameter D inner diameter d and cover c to generate various cases of Pu- Mu interaction curves for d/D and D'/D ratios for chimney. Total 27 cases are generated.

ii. Assume the location of neutral axis in the cross section for various cases from 0.1d to 1d.

iii. Various percentages of steel (*P*%) from 0.25% to 55.5% of steel is taken to generate interaction curves of various cases of *p*/fck, Total 1100 cases are taken for designing of chimneys.

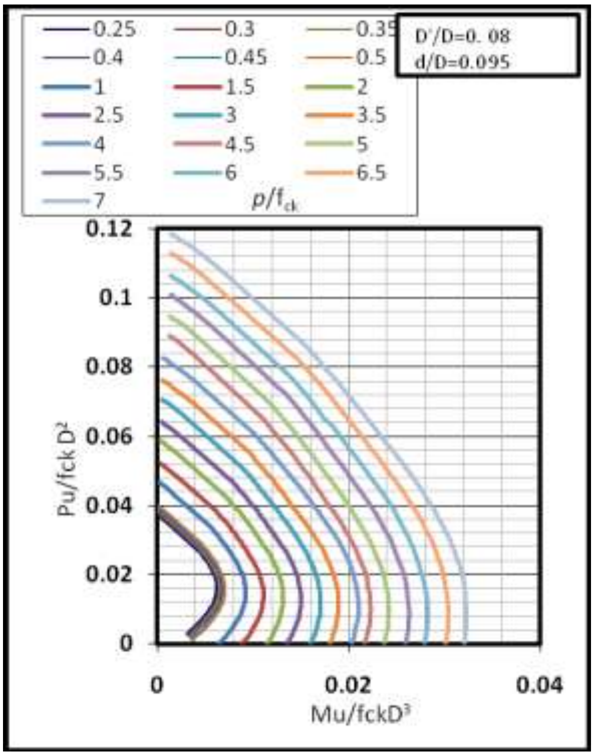

Fig.1 Pu-Mu Interaction curve for d/D = 0.95, D'/D =0.008

iv. Find strain in concrete (**ec**).

v. Find stress in concrete according to the strain (**fc**).

vi. Find load carrying capacity of concrete (**Pc**).

vii. Find moment carrying capacity of concrete (**Mc**).

viii. Find strain in steel (**es**).

ix. Find stress in steel (**fs**).

x. Find load carrying capacity of steel (**Ps**).

xi. Find moment carrying capacity of steel (**Ms**).

xii. Total load carrying capacity **Pu**= **Pc+ Ps.**

xiii. Total moment carrying capacity **Mu** = **Mc+ Ms.**

xiv. Find Pu/fckD2.

xv. Find Mu/fckD3.

xvi. Plot the graphs for different percent of steel.[3]

B. Design aspects of steel chimney

Mechanical aspects

This part covers plan, development upkeep and investigation of steel stacks. This likewise incorporates lining materials, draft computations, thought for scattering of toxins into air and fiery remains transfer. The estimating of stack relies on numerous variables, extensively it can be said that a stack is measured such that it can be fumes a given amount of vent gasses at a reasonable rise and with such a speed, to the point that the ground level concentration (GLC) of toxins, after environmental scattering, is inside the breaking points endorsed in contamination administrative gauges, while the stack holds basic respectability. Thus, while handling a given quantity of flue gases, the major factors which influence a stack dimensions are:

i. Draft requirements 20

ii. Environmental regulations

iii. Structural considerations

iv. Compositions of flue gas are specific weight, quantity of dust data above the aggressiveness of gases.

In order to minimize loss of heat from a stack and to maintain the temperature of the steel shell above the acid due point level external insulations may be fitted. The amount of insulation required to maintain the temperature of flue gases above he acid dew point depends upon

i. Effective of insulation

ii. The velocity of the gases

iii. The inlet temperature of the flue gases

According to Indian standard code IS: 14164-2008, industrial application and finishing's of thermal insulation materials at temperatures above -800 C and up to 7500 C, code of practice deals with the material selection for selection for insulation and method of application. Structural aspects; It covers loadings, load combinations, materials of construction, inspection, maintenance and painting of both self-supporting and guyed steel stacks (with or without lining) and there supporting structures.[4]

III. COMPARISION

***A.* Steel chimney**

i. The quality of steel construction components are always under control. They are produced in factory conditions according to the standards in proper sizes and proportions. As it is a homogeneous and isotropic material it reacts as expect.

ii. In static calculations the margin of errors are very low.The use of small sections of steel profiles avoids big columns. By this way this system increases the building areas and provides large spaces. Very lightweight structures can be built. Any type of design can be realized at low costs

iii. .This system can be built fast under any kind of weather conditions lowering labor costs. Skilled work required. This minimizes the implementation defaults. The system also provides significant advantage against the major earthquake loads .For any reason whatsoever damaged structural steel elements by can easily be replaced. This process is fast, easy and with low cost.

iv. This system allows for dismantling and reinstalling. When the construction is completed, the steel construction components carry full loaded capacity. The products can be controlled at every stage.

B. Concrete chimney

The quality of the concrete shows deterioration when there are implementation defaults. Since concrete is not as homogeneous and isotropic as steel, the static calculations depends on acceptances. The margin of error is a lot more and this causes additional high costs.

i. Big sections are required even in minimum conditions, so there occurs a lot of lost space.Since skilled work is not required, the implementation defaults occur.It is rough and expensive to control the concrete after pouring it. To strengthen any construction component damaged by any reason is a hard and expensive operation, and this operation causes architecture problems.

ii. In wide open areas the size of the sections are bigger and this has a higher cost. Also the big sections limit different types of design possibilities. Because of their high burdens the base costs are high and constructions periods are long

iv. Due to the establishment ground cooperation, cement is impeded for the seismic tremors .The development periods are long. Cement does not permit to work at any sort of climate condition. Hence the outcome is all the more exorbitant and opportune. In solid structures fortifying is hard. It is difficult to disassemble a solid building.

IV. CONCLUSION

We have looked at the smokestack on basic viewpoint. Thus, we infer that steel fireplace is ideal than R.C.C. fireplace. This smokestack is positive for the release of vent gasses likeCOxSO2, NOX.As the cost examination is concern it absolutely relies on upon the stack tallness on the grounds that as stature builds region of steel increments in R.C.C. furthermore, henceforth, both stacks are prudent.

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