**Design Criteria For Vortex Shedding from Reinforced Concrete Chimneys**

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The design of reinforced concrete chimneys is based primarily of the ultimate strength of a given cross-section (1,2), the loads derived from those associated with a 50 yr. or 100yr. event, and the use of a suitable load factor. The load factors presently in use vary considerably from a value of 1.3 (1), up to 2.2 for chimneys in hurricane regions (2). While the ultimate strength approach is logical for drag loads, it is not at all clear that it is accepatble for loads due to vortex shedding. In the latter case, the loads reach a peak in the vicinity of the critical speed, and then generally reduce with increasing speed, falling below those induced by drag. If, as is common with height/diameter ratios above 11, the critical speed falls below the design speed the chimney may be subject to many load cycles in excess of 70% of the design ultimate strength. The question that then arises is whether the fatigue capacity of the cross-section is sufficient to ensure satisfactory performance.

The present paper addresses the question of fatigue, and examines the possibility of ensuring satisfactory performance by placing suitable limits on the concrete and steel stresses induced at the critical speed. The number of cycles with stress of the order of those induced at critical speed increases with decreasing critical speed and, for a given form of the parent distribution of wind speed, will be a function of the ratio Vc/Vd where:

$V_c$ = critical speed
$V_d$ = 50 yr. speed.

The paper sets out to define the relationship between the allowable stresses and Vc/Vd, and its' sensitivity to:
(a) the form of the parent distribution
(b) the non-linear nature of the stress/moment relationship
(c) the chosen model for fatigue damage, and
(d) the breadth of the vortex shedding bandwidth.

For the purposes of computing the fatigue damage, some simplifying assumptions are made. The true, cross-section specific non-linear stress/moment relationship is replaced with a linear function by matching the two curves at $\alpha$ standard deviations of moment. The climate is modelled as a Weibull form with the probability of exceeding the 50 yr. hourly wind speed equal to 1/200,000. The shape factor is taken as 2.0 but the sensitivity to damage predictions if examined. The linearized results are compared to exact solutions for particular cross-section, and an optimum value of n is derived. The end result of the approach is a set of curves which define the lower stress limit to acheive a specific fatigue life.

References:

1. "Standard Practice for the Design and Construction of Reinforced Concrete Chimneys (ACI 307-95) and Commentary (ACI 307R-95)", American Concrete Institute, Detroit, Michigan, 1995.

2. "Model Code for Concrete Chimneys. Part A: The Shell", Int. Ctt. for the Dsign of Industrial Chimneys, 1984.