MODELING STRAKES AND FOIL SECTIONS IN VIVA

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1 Effectiveness of Strakes and Modeling of Forces

Scrutton & Walshe (1957) and Woodgate & Maybree (1959) proposed and studied the effect of helical strakes as means for suppressing the wind-excited vibrations of stacks. They considered triple sharp-edged helical strakes with pitch P to diameter D ratio of P/D = 15 and various strake heights h. Starting with h/D = 0.029, they found that vibrations are reduced; further improvement was found as they increased the height to h/D = 0.029, h/D = 0.059, h/D = 0.088, and h/D = 0.118. They provided graphs showing the unstable regime over which vibrations occur, as function of the reduced velocity $U^* = \frac{U}{f_n D}$ and the mass-damping ratio ξ, where $\xi = \frac{2M\delta}{\rho D^2}$. The region of unstable response reduces as function of h/D and the reduced velocity of peak response moves to higher values:

- for a bare cylinder they find peak response at about U^* = 5.0;
- for h/D = 0.029 at U^* = 5.1;
- for h/D = 0.059 at U^* = 6.7,
- for h/D = 0.088 at U^* = 7.1,
- for h/D = 0.118 at U^* = 8.4.

The basic finding is that beyond h/D of 0.10, the response is reduced substantially, while the peak response occurs at U^* above 8.0.

Woodgate & Maybree (1959) found that the optimal pitch to diameter ratio is close to a value of P/D = 5, away from the originally proposed value of P/D = 15. However, the optimal reduction is rather weak, and the pitch to diameter ratio is not a strong parameter of the problem.

2 Modeling of Faired Sections

Foil sections have small oscillatory lift coefficient, and smaller drag coefficient than smooth circular cylinder sections. When there is a misalignment between the direction of the current and the orientation of the foil, there is a steady lift coefficient as well; this is not modeled herein.

The fairing drag coefficient depends on:

- the Reynolds number based on the chord length c
- the chord to thickness ratio c/t

The fairing drag coefficient c_D, based on the projected front area, is given as:

$$c_D = c_f (4 + 2\frac{c}{t} + 120(\frac{t}{c})^3) \tag{1}$$

For c_f we use either the laminar value, for Re < 10^6:

$$c_f = \frac{1.328}{\sqrt{\mathrm{Re}}} \tag{2}$$

or the turbulent value, for Re > 10^6:

$$\frac{1}{\sqrt{c_f}} = 3.46\log(\mathrm{Re}) - 5.6 \tag{3}$$

The drag per unit riser length, F_D is found as:

$$F_D = \frac{1}{2}\rho c_D t U^2 \tag{4}$$

3 Definition of Symbols

D = cylinder diameter (m)
c = chord length (m) for fairings
c_f = frictional coefficient (per wetted surface)
c_D = drag coefficient (per frontal area)
f_n = natural frequency of oscillation of a compliantly mounted cylinder (Hz)
F_D = Drag force on fairings (N)
h = height of the helix (m)
M = mass of the cylinder per unit length (kg/m)
P = Pitch of the helix (m)

Re = Reynolds number = $U\,D/\upsilon$
t = thickness (m) for fairings
U = Velocity of the steady stream (m/s)
δ = damping ratio
ν = kinematic viscosity of water (m s²)
ξ = mass-damping ratio
ρ = density of water (kg/m³)

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