lecture 10

(1) Calculate the critical wind speed $\bar{u}_{cr}$ and the design reference wind speed at the top of the structure $\bar{u}_H$

For the problem, slope radio $= \frac{(8.71-5.72)\times\frac{1}{2}}{90} = 0.0166 < 0.02$

Use the diameter at $\frac{2}{3}H$ to calculate the critical wind speed $\bar{u}_{cr}$

i. For the first period $\bar{u}_{cr_1} = \frac{D}{St\,T_1} = \frac{6.33}{0.2\times 2.102} = 15.06\,m/s$

ii. For the second period $\bar{u}_{cr_2} = \frac{D}{St\,T_2} = \frac{6.33}{0.2\times 0.508} = 62.303\,m/s$

where $Z_6 = 60m$. $D_6 = 6.46m$

$Z_7 = 70m$ $D_7 = 6.26m$

$\Rightarrow$ when $Z = \frac{2}{3}H = \frac{2}{3}\times 100 = 66.67\,m \Rightarrow D = 6.33_n$

The design reference wind speed at the top of the structure $\bar{u}_H$

For the $\bar{u}_H = \sqrt{\frac{2000\,u_H\,w_0}{\rho}} = \sqrt{\frac{2000\times 2.00\times 0.55}{1.25}} = 41.95\,m/s$

$\therefore \bar{u}_H = 41.95\,m/s < \bar{u}_{cr_2} = 62.303\,m/s$

$\therefore$ only checking for the first period.

(2) Cacalate Re

$\therefore Re = 69000\,\bar{u}D = 69000\,\bar{u}_{cr_1}D = 69000\times 15.06\times 6.33 = 6.58\times 10^6 > 3.5\times 10^6$

$\bar{u}_H\times 1.2 = 41.95\times 1.2 = 50.34\,m/s > \bar{u}_{cr_1} = 15.06\,m/s$

$\therefore$ Post critical, it need checking for vortex induced vibration.

(3) cdcintate the equivalent cross-wind resonance force $P_{d_1}(z_i)$ and base bedind moment $M_{di}(D)$

① Catulate the equivalent cross-wind resonance force $D_{d_1}(z_i)$

$P_{dj}(z_i) = P_{dji}(z_i)h_i = \frac{\lambda_j\cdot\phi_{ji}\,\bar{u}_a^2\,D_i h_i}{1280\,\xi_j}$, where λ_j is chosen in GB50009-2012

For the first period, $\lambda_j = \lambda_1 \cdot \frac{H_1}{H} = \left(\frac{\bar{u}_{0i}}{1.2\bar{u}_{1i}}\right)^{\frac{1}{\alpha}} = \left(\frac{15.06}{41.93 \times 1.2}\right)^{\frac{1}{0.15}} = 3.21 \times 10^{-4} \approx 0$

$\therefore \lambda_1 = 1.56$

$\therefore P_{d1}(Z_i) = 1.56 \times \frac{\phi_{1hi} \times 15.06^2 \times D_i}{12800 \times 0.05} = 0.0573 \phi_i h_i D_i$.

where $h_1 = 15m$, $h_{2\sim9} = 10\,m$, $h_{10} = 5m$

Point	1	2	3	4	5	6	7	8	9	10
$P_{di}(Z_i)$	0.578	1.565	3.507	6.169	9.392	13.361	17.759	22.352	26.954	15.816

(2) Caculate the base bending moment $M_{d1}(0)$

$M_{d1}(0) = \sum_{i=1}^{10} P_{d1}(Z_i) Z_i = 0.578 \times 10 + 1.565 \times 20 + \cdots + 15.816 \times 100 = 8702.6\,KN \cdot$