Assignment of Lecture 10

1. A reinforced concrete chimney is build in terrain B, the parameter are as $H = 100m$, $\zeta_1 = 0.05$, $T_1 = 2.102\text{s}, T_2 = 0.508s$, $u_{10} = 29.66\text{m/s}$, $w_0 = 0.55\text{kN/m}^2$. Calculate the equivalent cross-wind resonance force and base bending moment.

point	1	2	3	4	5	6	7	8	9	10
z_i (m)	10	20	30	40	50	60	70	80	90	100
$G(z_i)$ (kN)	3000	2100	1700	1510	1340	1200	1110	1070	990	490
$D(z_i)$ (m)	8.71	7.86	7.46	7.06	6.66	6.46	6.26	6.06	5.86	5.72
$\phi(z_i)$	0.008	0.036	0.085	0.158	0.255	0.374	0.513	0.667	0.833	1.000

Calculate the equivalent cross-wind resonance force and base bending moment using the method in China code (GB-50009-2012)

Solution:

the slope ratio $= \frac{8.71 - 5.72}{2 \cdot 100} = 0.015 < 0.02$

So $D = 6.33$

In China code (GB-50009-2012):

$u_H = 40\sqrt{\mu_H w_0} = 40\sqrt{2 \times 0.55} = 41.95\text{m/s}$

For the First period:

$$\bar{U}_{cr1} = \frac{D}{St\,T_1} = \frac{0.33}{0.2 \times 2.12} = 15.86\ m/s$$

For the Second period:

$$\bar{U}_{cr2} = \frac{D}{St\,T_2} = \frac{0.33}{0.2 \times 0.508} = 62.303\ m/s$$

So, only check the first period.

then $Re = 69000\,\bar{U}_{cr1}\,D > 3.5 \times 10^5$

So, it need check.

The start height:

$$H_1 = H\left(\frac{\bar{u}_{cr1}}{1.2 u_H}\right)^{\frac{1}{\alpha}}$$

$$= 100 \cdot \left(\frac{15.06}{1.2 \times 41.95}\right)^{\frac{1}{0.15}} = 0.052\ m$$

So the resonance height: $0.052 \sim 100\ m$

as $\frac{H_1}{H} = \frac{0.052}{100}$, $\lambda_1 = 1.56$

The cross-wind force

$$P_{d1}(z_i) = P_{d1i}(z_i) h_i$$

$$= \lambda_1 \frac{\phi_1(z_i) \bar{u}_{cr1}^2 D_o h_i}{12800\ \zeta_j}$$

$$P_{dz1(zi)} = 1.5b \times \frac{\phi_{1(zi)} \times 15.06^2 \times 6.33 \times h_i}{12800 \times 0.05}$$

$$= 3.499\, \phi_{1(zi)}\, h_i$$

The result are shown in this figure:

point	1	2	3	4	5	6	7	8	9	10
zi (m)	10	20	30	40	50	60	70	80	90	100
G(zi) (kN)	3000	2100	1700	1510	1340	1200	1110	1070	990	490
D(zi) (m)	8.710	7.860	7.460	7.060	6.660	6.46	6.260	6.060	5.860	5.720
ϕ(zi)(m)	0.008	0.036	0.085	0.158	0.255	0.374	0.513	0.667	0.833	1.000
P_{dz1}(kN)	0.816	1.224	2.890	5.372	8.670	12.716	17.442	22.678	28.322	17.000
M_{dz1}(KN·m)	8.160	24.480	86.700	214.880	433.500	762.960	1220.940	1814.240	2548.980	1700.000

The base bending moment:

$$M_{d1(0)} = 8814.84\ KN \cdot m$$