Major Test – CVL381: Design of Hydraulic Structures

25 Marks

Q. 1. Estimate the following loads for the gravity dam section shown in Figure

(a) Forces due to Uplift Pressure at the section CC' **(2 Marks)**

(b) Forces at the section AA' and moments wrt **A'** due to Earthquake acceleration in horizontal upstream direction **(8 Marks)**

Q. 2. Determine the following for a gravity dam section shown in Figure with indicative forces and moments as listed in the table **(2 Marks each)**

(a) FS against sliding at BB' for the load combination B,

(b) Principal stress at **B** for the load combination D,

(c) Shear stress at **B** for the load combination B, and

(d) Normal stress at **B'** for the load combination E

Table for Q.2: Forces (in kN) and Moments (in MN.m)

Force Description	Force at **BB'**	Moment about **B'**
Dead load (Self Weight)	62434	2515.3
Reservoir water+silt force (Horizontal)	32720	858
Vertical component of Res. Water+silt force	2772.5	170
Uplift force	13720	577.3
Hydrodynamic force (Horizontal)	5243.9	125.4
Vertical component of hydrodynamic force	350	21.4
Tail water force (Horizontal)	125	0.2
Vertical component of Tail water force	87.5	0.1
Inertia force due to horizontal Earthquake acceleration	5151	188.6
Inertia force due to vertical Earthquake acceleration	2575.5	153.4
Wave force	50	4.3

Data for Q.1 and Q.2

Dam is located in zone IV ($\alpha_0 = 0.05$, $F_0 = 0.25$)

Unit Weights – 10 kN/m^3; 13.6 kN/m^3; 19.25 kN/m^3; 24 kN/m^3

$\sigma_{c\,per} = 3.25$ N/mm^2; $\tau_{c\,per} = 1.45$ N/mm^2; $\mu = 0.7$

F_ϕ = 1.5 & F_c = 3.6 for Load combination A, B, & C and

F_ϕ = 1.2 & F_c = 1.4 for Load combination D, & E

$$C_v = \frac{0.735}{2}\left(1-\frac{\theta}{90}\right)\left\{\frac{y}{h}\left(2-\frac{y}{h}\right)+\sqrt{\frac{y}{h}\left(2-\frac{y}{h}\right)}\right\}$$

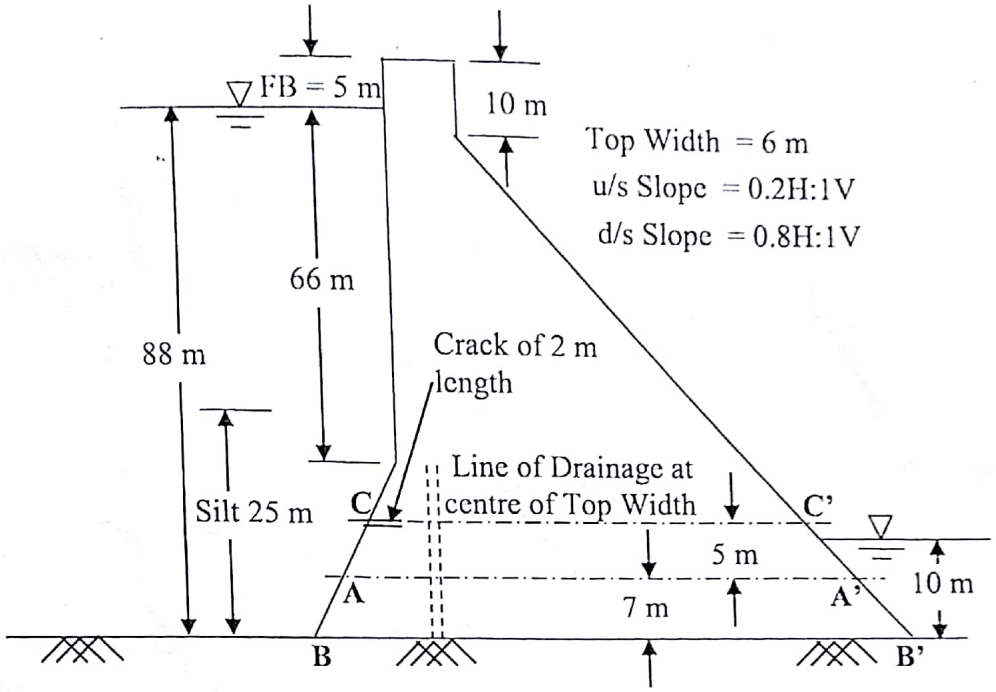


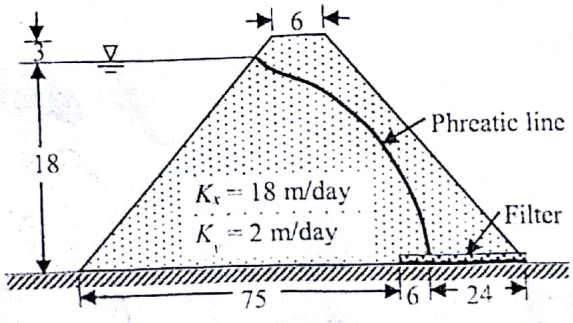
Figure for Q.1 and Q.2

Q.3 Answer the following **(1.5+1.5+4 Marks)**

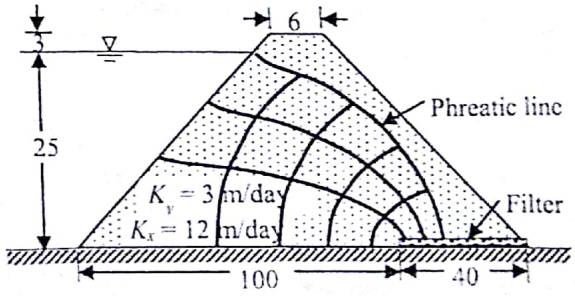
a) Show that length of the tension crack in a gravity dam is $l_c = \frac{b}{2}\left(1-\frac{b}{6e}\right)$

b) M15 concrete (σ_{cc} = 4.0 N/mm^2, S_c = 2.4) was used in a 105 m high gravity dam. Assuming intermediate uplift (C = 0.5), compute the limiting height and then identify the type of the dam.

c) Compute the quantity of seepage through per unit length of the embankment dam sections shown below



(i)



(ii)