ASSIGNMENT

MID TERM ONLINE EXAM

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ID:- 7669

SUBJECT:- HYDRAULIC ENGINEERING (CE-322)

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SEMESTER:- SENIOR.

SECTION:- "B"

ASSIGNMENT.

Hydraulic Engineering.

QNo:1):- a):- Let Suppose a Rectangular Channel, discharges R liter/sec of water into a 8m wide apron with zero slope. mean velocity is R-220 ft/sec.

Required = ?

1): Height of Hydraulic Jump (In Unit of Meters)

2): Power absorbed due to hydraulic Jump (In Unit of kW).

Given :- $R = 7669$

Discharge (Q) = 7669 liter/sec

or.

$$(Q) = \frac{7669}{1000} = 7.6 m^3/sec = Q$$

wide (b) = 8m.

Mean velocity (V) = R-220 ft/sec

(V) = 7669-220

(V) = 7449 ft/sec or

$$v = \frac{7449}{3.28}$$

$$\boxed{v = 2271 m/sec.}$$

2/:. Height of Hydraulic Jump :-

We Know that,

q is discharge per unit width.

$$q = \frac{Q}{b}$$

$$q = \frac{7.6}{8}$$

$$\boxed{q = 0.95 m^2/sec}$$

Critical Depth:. (yc):.

We Know that,

$$y_c = \left(\frac{q^2}{g}\right)^{1/3}.$$

$$y_c = \left(\frac{(0.95)}{9.81}\right)^{1/3}.$$

$$\boxed{y_c = 0.451 m}$$

Critical velocity:- (Vcr).

$q = vy$ or $v = q/y$ or $V_c = \frac{q}{y_c}$

$V_{cr} = \frac{0.95}{0.451}$

$\boxed{V_{cr} = 2.10 m/sec}$

Depth of water on Upstream of Hydraulic Jump:- (y_1).

$Q = AV$ $A = b \times y$

or

$Q = (b \times y) v$

or

$y = \frac{Q}{V \cdot b}$ or $y_1 = \frac{Q}{V_1 b}$

$y_1 = \frac{7.6}{2271 \times 8}$ $y_1 = 0.000418$

or

$\boxed{y_1 = 4.18 \times 10^{-4}}$

Depth of water on Downstream Side of Hydraulic Jump:-

We know that,

$$y_2 = -\frac{y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2 y_1 v_1^2}{g}}$$

Putting values,

$$y_2 = \frac{-0.000418}{2} + \sqrt{\frac{0.000418}{4} + \frac{2(0.000418)(2271)^2}{9.81}}$$

$$\boxed{y_2 = 20.95 m}$$

Difference in Depths:

$\Delta y = y_2 - y_1$

$\Delta y = 20.95 - 0.000418$

$$\boxed{\Delta y = 20.95 m}$$

From Discharge formula:-

$Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$\cancel{b_1} y_1 v_1 = \cancel{b_2} y_2 v_2$

$y_1 v_1 = y_2 v_2$

OR

$$v_2 = \frac{y_1 v_1}{y_2} = \frac{(0.000418)(2271)}{20.95}$$

$$\boxed{v_2 = 0.045 m/sec}$$

$\Delta E = E_1 - E_2$

$E_1 - E_2 = \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$

Putting values.

$E_1 - E_2 = \left(0.000418 + \frac{(2271)^2}{2(9.81)}\right) - \left(20.95 + \frac{(0.045)^2}{2(9.81)}\right)$

$\boxed{E_1 - E_2 = 262845m}$

Power Dissipation in Hydraulic Jump:.

we know that,

$\Delta P = \rho g Q [E_1 - E_2]$

$\Delta P = (1000)(9.81)(7.6)(262845)$

$\Delta P = 1.959667182 \times 10^{10}$

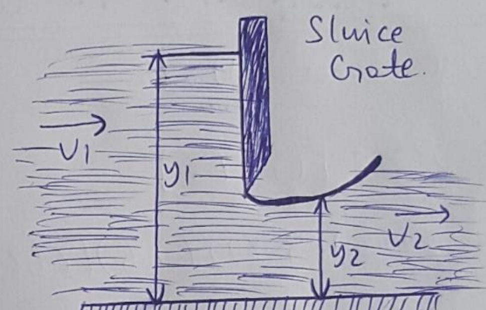
OR

$\Delta P = 1959667182 \, W$

$\Delta P = 1959667.182 \, KW$

$\boxed{\Delta P = 1.95 \times 10^6 \, KW}$

Q2) B):- A Sluice gate controls the flow in a channel of width 4m. If the discharge is R/ft³/sec and the upstream and downstream water depth is 2.9m and 1.1m respectively, Calculate the downstream velocity. Also state the type of flow at upstream and downstream side any equation.



Given Data:-

$Q = 7669 \, ft^3/sec$

Solution:

Channel width (b) = 4m.

Discharge (Q) = 7669 ft³/sec

or.

$Q = 217.32 \, m^3/sec$

Depth of Upstream side = 2.9m.

Depth of Downstream side = 1.1m

Downstream Velocity:-

We know that,

$E_1 = E_2$. (Energy remain same in both streams).

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} \rightarrow \text{equ (A)}$$

we know that,

$Q = AV$

$A_1V_1 = A_2V_2$ $\qquad A = b \times y$

$b_1 \times y_1 \times v_1 = b_2 \times y_2 \times v_2$

$y_1 v_1 = y_2 v_2$

$v_2 = \frac{y_1 v_1}{y_2}$

$v_2 = \frac{2.9\, v_1}{1.1}$

$\boxed{v_2 = 2.63 v_1} \rightarrow$ equ (B)

Put the values of v_2 in equ (A)

$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g}$

$2.9 + \frac{v_1^2}{2\times(9.81)} = 1.1 + \frac{(2.63\, v_1)^2}{2(9.81)}$

$\frac{v_1^2}{2(9.81)} - \frac{6.91 v_1^2}{2\times 9.81} = 1.1 - 2.9$

$\frac{v_1^2 - 6.91 v_1^2}{2\times 9.81} = -1.8$

$+5.91 v_1^2 = +(1.8)(19.62)$

$\sqrt{v_1^2} = \sqrt{\frac{(1.8)(19.62)}{5.91}}$

$\boxed{v_1 = 2.44 \text{ m/sec}}$

$V_2 = 2.63 (V_1) \rightarrow$ eqn (B)

Put the values of V_1 in eqn (B).

$V_2 = 2.63 (2.44)$

$V_2 = 6.41 \, m/sec$

→ Type of Flow on Upstream Side:.

Using Floud Number:.

we know that,

$$F_{r1} = \frac{V_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} \quad F_{r1} = 0.45$$

$0.45 < 1$

The Flow is sub-critical flow.

→ Type of flow on Downstream flow:-

using Floud Number.

we know that,

$$F_{r2} = \frac{V_2}{\sqrt{g y_2}} = \frac{6.41}{\sqrt{9.81 (1.1)}} = 1.95$$

$1.95 > 1$.

The flow is Super-Critical flow.

QNo:2) A)::What is the minimum height (In Unit of meter) of broad crested weir if it is to function critical depth on the crest.
If water flows along a rectangular channel at a depth of 1.8m with a discharge of R ft³/sec.
the channel width is 66ft.

Given Data::

Discharge $(Q) = 7669\ ft^3/sec$ or $\frac{7669}{(3.28)^3}$ $= 227.32\ m^3/sec$

Channel depth $(d) = 1.8m$

width of channel $(b) = 66ft = \frac{66}{3.28} = 20.1m.$

→ Required:=?

weir Height =? (P)

We know that

$Q = AV.$

$V_1 = Q/A = \frac{Q}{b \times y}$ $A = b \times y$

$V_1 = \frac{217.32}{20.1 \times 1.8}$ $V_1 = 6\ m/sec$

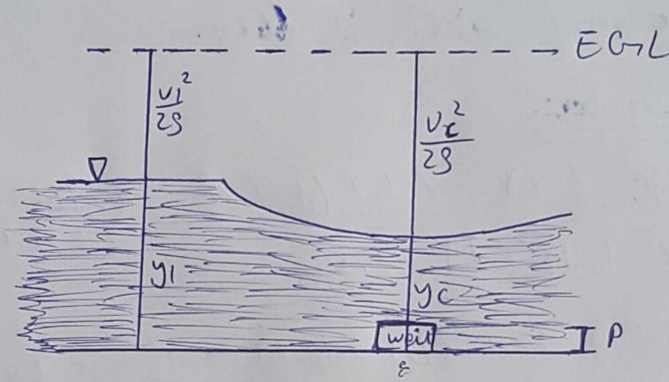
Critical Depth :: (yc).

$y_c = \left(\frac{q^2}{g}\right)^{1/3}$ $q = Q/b = \frac{217.32}{20.1}$, $q = 10.81\ m^2/sec$

$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(10.81)^2}{9.81}\right)^{1/3}$, $y_a = 2.28m$

$v = \sqrt{gy}$ or $v_a = \sqrt{g y_a}$.

$v_a = \sqrt{9.81 \times 2.28}$ $v_a = 4.73 m/sec$



According to the figure

$$y_1 + \frac{v_1^2}{2g} = P + y_a + \frac{v_a^2}{2g}.$$

$$(1.8) + \frac{(6)^2}{2(9.81)} = P + 2.28 + \frac{(4.73)^2}{2(9.81)}$$

$$1.8 + 1.83 = P + 2.28 + 1.14$$

$$P = 3.63 - 3.42$$

$P = 0.21m$ (Height of weir should be 0.21m from channel bed)

QNo:2) B):. An orifice in one side of large tank is rectangular in shape. 2·8m broad and 1·5m deep. The water level on one side of the orifice is 5meters above its top edge. The water level on the other side of the orifice is 0·6m below its top edge. Calculate the discharge through the orifice if coefficient of discharge Cd = 0.R.

R = 7669

Given Data:

Breadth (b) = 2·8m.

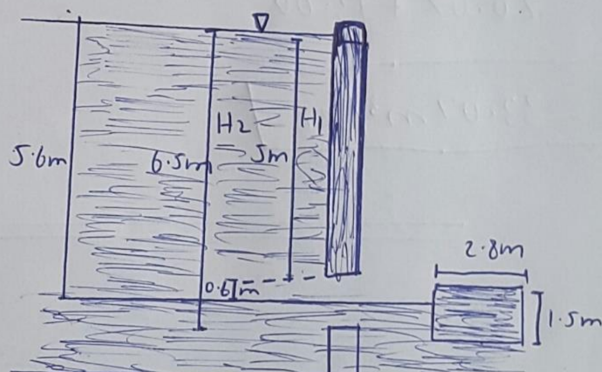
Depth (d) = 1·5m

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.76$



Solution:.

Discharge through Submerged Portion:.

We know that,

$Q_1 = Cd \times b \times (H_2 - H_1) \times \sqrt{2gH}$

$Q_1 = 0.76 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$Q_1 = 20.07 m^3/sec$

Discharge Through free Portion:.

we know that,

$$Q_2 = \frac{2}{3} C_d \times b\sqrt{2g} \times [H^{3/2} - H_1^{3/2}]$$

$$Q_2 = \frac{2}{3}(0.76) \times 2.8\sqrt{2\times9.81} \times [(5.6)^{3/2} - (5)^{3/2}]$$

$$\boxed{Q_2 = 13.00 m^3/sec}$$

Total Discharge = $Q_1 + Q_2$.

$Q = 20.07 + 13.00$

$$\boxed{Q = 33.07 m^3/sec}$$

Q.No: 3) A):. The Diameter of a water pipe is suddenly enlarged from R - 200mm to R + 3000mm. The Rate of flow through is 0.95 m³/sec. and the pressure in the large pipe is R + 800 N/m² Calculate:.

1):. The Loss of Head due to sudden Enlargement.

2):. The Power loss due to sudden Enlargement

3):. The Pressure in the smaller pipe (if the pipe is horizontal).

Given Data:.

R = 7669

Solution:-

Discharge $(Q) = 0.95 \, m^3/sec.$

Pressure in large Pipe $= R + 800$

" $= 7669 + 800$

Pressure in large Pipe $= 8469 \, N/m^2$.

$d_1 = R - 200$, $d_1 = 7669 - 200$, $d_1 = 7469 mm$

$d_2 = R + 3000$, $d_2 = 7669 + 3000$, $d_2 = 10669 mm$

2). Head loss due to sudden Enlargement:-

$d_1 = 7469mm$ or $7.4m$

$A_1 = \frac{\pi}{4} d^2$, $A = \frac{3.14}{4}(7.4)^2$, $\boxed{A_1 = 43 m^2}$

$d_2 = 10669mm$ or $10.6m$.

$A_2 = \frac{\pi}{4} d^2$, $A_2 = \frac{3.14}{4}(10.6)^2$, $\boxed{A_2 = 89.35 m^2}$

we know that,

$Q = AV$, $V = Q/A$, $V_1 = \frac{Q}{A_1}$, $V_1 = \frac{0.95}{43}$

$\boxed{V_1 = 0.022 m/sec}$

Now,

$Q = AV$, $V = Q/A$, $V_2 = \frac{Q}{A_2}$, $V_2 = \frac{0.95}{89.35}$

$\boxed{V_2 = 0.0106 m/sec}$

→ **For Sudden Enlargement:-**

$$he = \left(1 - \frac{A_1}{A_2}\right)^2 \times \left(\frac{(V_1 - V_2)^2}{2g}\right)$$

$$he = \left(1 - \frac{43}{89.35}\right)^2 \times \left(\frac{(0.022 - 0.0106)^2}{2 \times 9.81}\right)$$

$$\boxed{he = 1.78 \times 10^{-6} m}$$

2):- Power Loss due to Sudden Enlargement:-

using formula,

$$P = \rho g Q h_e$$

Putting values

$$P = (1000)(9.81)(0.95)(1.78 \times 10^{-6})$$

$$\boxed{P = 0.0165\ W}$$

3):- Pressure in Smaller Pipe:-

Using Bernoulli's Equation.

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + h_e$$

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.022)^2}{2(9.81)} = \frac{8469}{(1000)(9.81)} + \frac{(0.0106)^2}{2(9.81)} + 1.78 \times 10^{-6}$$

$$\frac{P_1}{9810} + 0.0000246 = 0.8633 + 0.00000000114 + 0.00000178$$

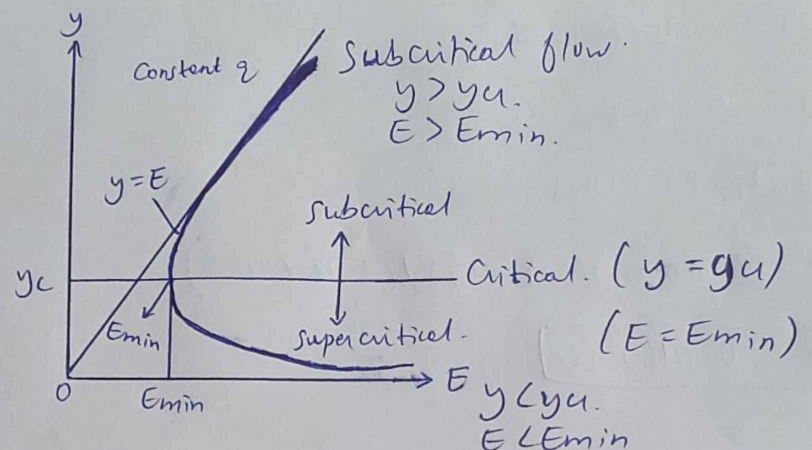
$$\frac{P_1}{9810} = 0.8633 - 0.0000246$$

$$\frac{P_1}{9810} = 0.8632 , \quad P_1 = 0.8632(9810)$$

$$\boxed{P_1 = 8468.74\ N/m^2}$$

QNo: 3) B.

y = depth of water, E = Specific Energy



What does this blue curve indicates, How it is obtained. Explain the above figure from each and every point of view.

* **Blue Curve:-**

From the Given figure the blue Curve is the 3-degree or 3° polynomial curve or figure which show the flow is critical, Super Critical or Subcritical flow. The Middle point show that the depth of water is equal to the critical depth corresponding to the minimum energy so, the flow is critical flow.

$y = y_c, \; E = E_{min}$

→ The Top point show that depth of water is greater then critical depth so the flow is sub-critical flow.

$y > y_{cr}, E > E_{min}$

→ The bottom point show that the water depth is less then the critical depth. so flow is super-critical flow.

$y < y_{cr}.$
$E < E_{min}$

• **Specific Energy :-**

Specific Energy is the parameter that can be used to classify the meaning of sub-critical, super-critical and Critical flow in an open channel.

→ The Given graph indicates the relation between depth of water (y) and Critical depth (y_{cr}).

• **Critical Depth :-**

It is the depth of water at which minimum specific energy is obtained. That depth is called Critical Depth.

→ The Given graph consist of two Axis.

i) X - Axis (Specific Energy).

ii) Y - Axis (Depth of water)

From the given graph, the centerline where $E = y$ show that the specific energy is directly proportional to ~~Specific Energy~~ Depth of water.

$$E \propto y.$$

E = Specific Energy.

y = Depth of water.

Equation of Specific Energy:-

From the derivation of Specific Energy equation, we have obtained three degree polynomial equation.

$$(E - y)y^2 = \frac{q^2}{2g} \rightarrow \text{equ (A)}$$

→ we can plot a curve of Specific Energy.

* From the above equ (A),

→ E = Specific Energy

→ y = Depth of water

→ q = Discharge per Unit width ($q = m^2/sec$)