GUJARAT TECHNOLOGICAL UNIVERSITY

3rd Semester Civil Engineering – PDDC

Subject Code & Name : X30604 - Advanced Fluid Mechanics

Assignment - 3 (Open Channel Flow - Part-1)

Theory : **Date : 08-08-2014**

1. Classify various types of channels.
2. Explain various types of flow in open Channel.
3. Derive on expression for most economical Section for
   i. Rectangular Section
   ii. Trapezoidal Section
4. Discuss the specific energy Curve with a neat Sketch.
5. Explain Critical, Sub-Critical & Super Critical flow in on open.
6. Explain application of specific energy diagram.

Examples :

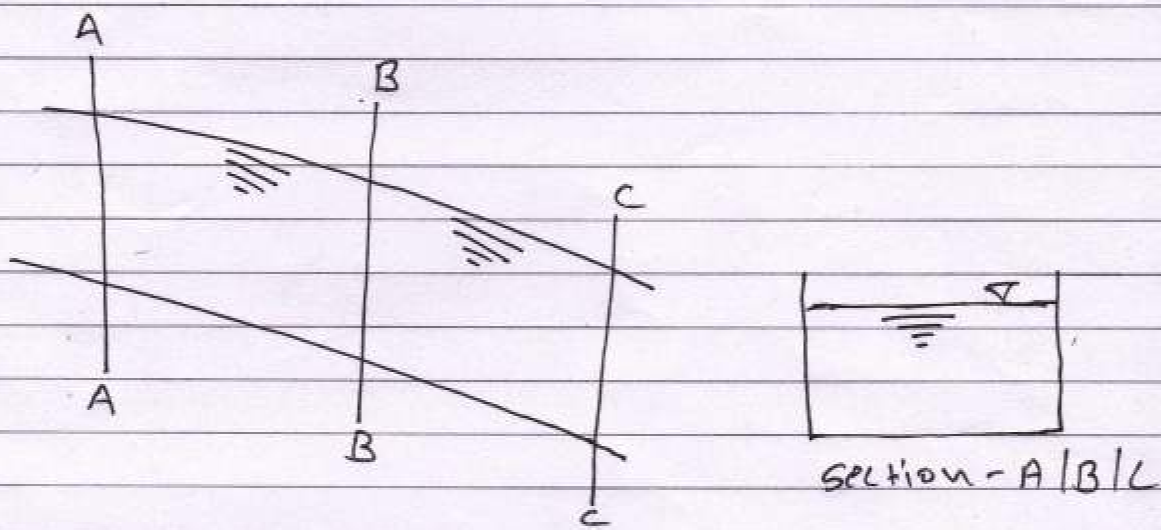
1. A rectangular channel conveys a discharge of 12 m3 / S at a bottom width 3.0 m. Find the bed slope require to carry above discharge if depth of flow is 1.0 .m. Take Chezy`s C = 50.
2. A circular channel having diameter 0.5 carries water at rate of 0.14 m3/s. Find the bed slope of channel for maximum velocity. Take C=55.
3. A 10m wide trapezoidal channel has a side slope of 1.5:1(H: V). The channel is carrying a uniform flow of 100 cumec at the bed slope of 0.0003. Compute the normal depth of flow if Manning's n = 0.012.Also compute mean velocity of flow.
4. A trapezoidal channel is having a bottom width of 2.5 and side slope 1.5:1(H: V). It is carrying a discharge of 18m3/s at a depth of 1.5m. Calculate the specific energy and critical depth.
5. The discharge of water through a rectangular channel with 6m width and 2m depth of flow is 17cumecs. Calculate (1) specific energy of flowing water (2) critical depth (3) critical velocity (4) minimum specific energy.
6. A rectangular channel 4.0m wide was laid at a slope of 0.0004.The incoming uniform flow depth is 2.5. Find the maximum Height of hump can be provided in channel section without causing afflux. Take manning's n=0.014.
7. In order to find discharge in a rectangular channel its width is reduced gradually from 2m to 1m and the floor is raised by 0.2m at the reduced section. The approaching flow depth is 1.2m. Calculate the rate of flow in channel if there is a drop of 0.2m in water surface elevation at contracted section.

Q-1 Classify various types of Channels.

Ans→ Types of Channels are describes as under.

1) Prismatic Channels

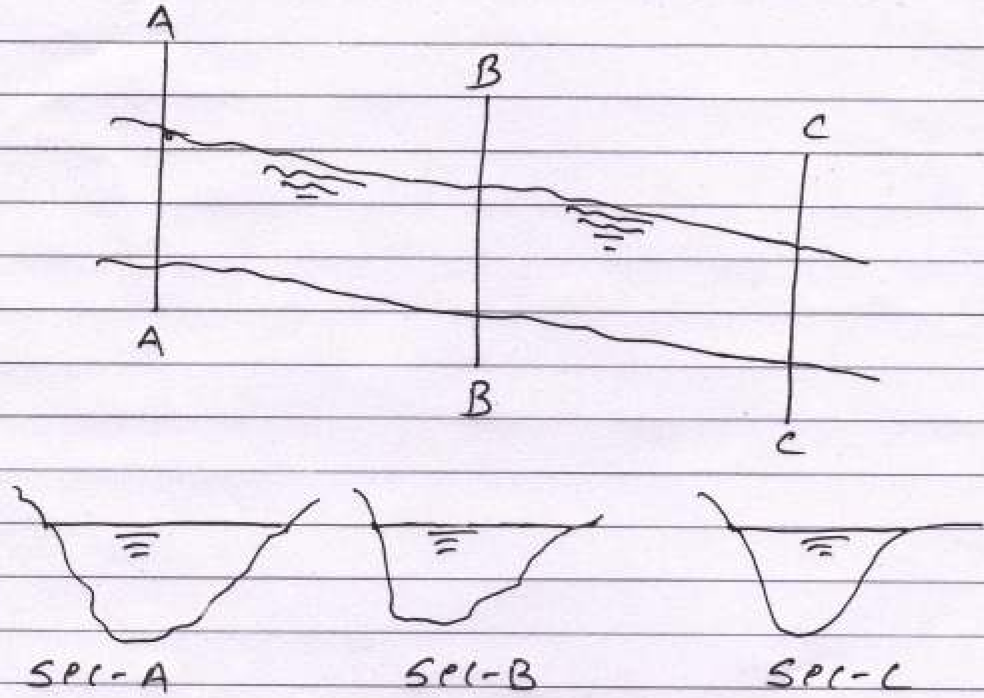
A channel is defined as Prismatic if it's in the form of Prism i.e the cross-section and bottom slope remain constant along the channel length. Most of the man made Channels i.e laboratory flumes are Prismatic channels.



Prismatic Channels

2) Non-Prismatic Channels

If the Cross Section and or bottom slope ~~of~~ of Channel Changes along the channel length, it is said to be non-Prismatic Channel. All the natural channels, rivers are non-Prismatic channel. Figure shows back side of the Paper.



Non-Prismatic Channels

→ On the basis of the nature of the boundary, open channel can also be classfied as.

3) Rigid boundary Channel:

If the materials on the bed and sides of channel is not movable the channel is said to be rigid boundary channel. lined canals, Sewers are the examples of this type of channel.

4) Mobile boundary Channel:-

The channel which consists of erodible bed and sides is known as mobile boundary channel. The shape of this type of channel undergoes deformation due to continous erosion and deposition due to the flow. Unlined canals, natural streams are the examples of this type of channel.

Q-2 Explain various types of Flow in open Channel.

→ The Flow through an open Channel may be classified as under:

1) Steady Flow and unsteady Flow
2) Uniform Flow and Non-uniform flow
3) Laminar Flow and turbulent Flow
4) Subcritical flow, critical flow, supercritical Flow.

1) Steady flow and unsteady Flow.

Steady flow:- Flow in open channel is said to be steady if the flow characteristics such as depth ~~&~~ of flow, velocity of flow and the flow rate at any cross-section, do not change with time.

$$\therefore \frac{\partial y}{\partial t} = 0, \quad \frac{\partial V}{\partial t} = 0, \quad \frac{\partial Q}{\partial t} = 0$$

where,

y = depth of flow
V = velocity of Flow
Q = rate of flow

Unsteady flow:- Flow in open channel is said to be unsteady if the flow characteristics such as depth of flow, velocity of flow and the flow rate at any cross section change ~~to~~ with time.

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$$\frac{\partial y}{\partial t} \neq 0, \frac{\partial v}{\partial t} \neq 0, \frac{\partial \omega}{\partial t} \neq 0$$

2) Uniform flow and non-uniform flow

→ Uniform flow:-

Flow in open channel is said to be uniform if the flow characteristics such as depth of flow, velocity of flow, slope of channel and cross-section do not change along the length of the channel.

$$\therefore \frac{\partial v}{\partial l} = 0, \quad \frac{\partial y}{\partial l} = 0$$

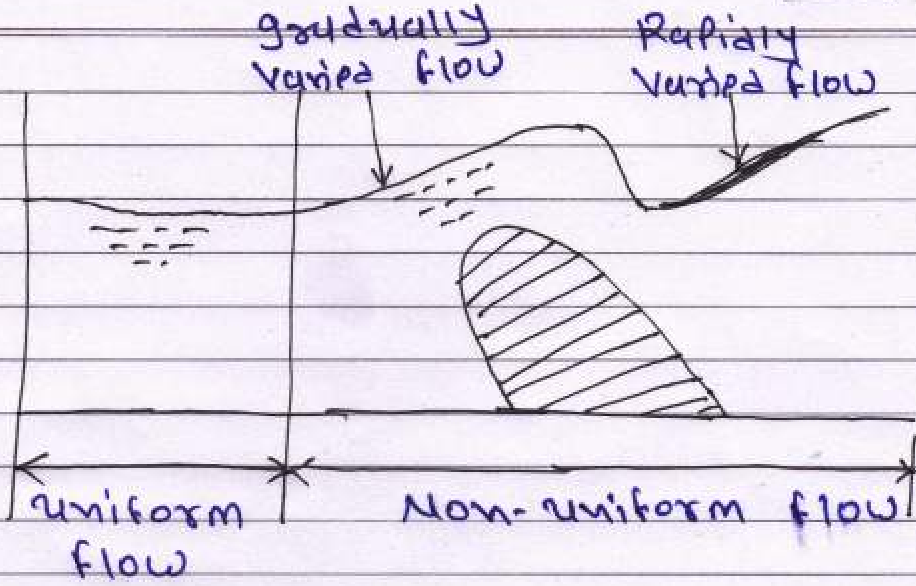
→ Non-uniform flow (varied flow):-

Flow in open channel is said to be non-uniform, if the flow characteristics such as depth of flow, velocity of flow etc. changes along the length of the channel.

$$\frac{\partial y}{\partial l} \neq 0, \quad \frac{\partial v}{\partial l} \neq 0$$

Varied flow

Rapidly varied flow (R.V.F)	Gradually varied flow (G.V.F)
depth of flow changes abruptly over short distance. e.g.	depth of flow changes gradually over a long distance.
- hydraulic jump	
- hydraulic flow	



Uniform & Non-Uniform flow

3) Laminar flow & turbulent flow

The flow in open channel is said to be laminar if the Reynold number (R_N) is less than 500

$$\text{Renold Number } (R_N) = \frac{\rho V R}{\mu}$$

Where,

ρ = mass density of water
V = velocity of water
μ = dynamic velocity of water
R = Hydraulic radius (hydraulic mean depth)

$$= \frac{\text{wetted area of flow}}{\text{wetted Perimeter}} = \frac{A}{P}$$

$R_N < 500$ ---- Laminar flow
$R_N = 500$ to 2000 ---- Transition flow
$R_N > 2000$ ---- turbulent flow

4) Subcritical Flow, Critical flow, Super critical Flow

→ froude Number (Fr):

The open channel flow is greatly influenced by the effects of gravity and viscocity. The froude number of Flow is an index which takes in to account the importance of gravity forces and interia forces.

$$\text{froude Number (Fr)} = \frac{\text{Interia forces}}{\text{gravity forces}}$$

$$Fr = \frac{V}{\sqrt{gD}}$$

Where,

V = mean velocity

D = hydraulic depth

$$= \frac{\text{wetted area}}{\text{top width at free surface}}$$

$$= \frac{A}{T}$$

- Based on froude number (Fr) the flow in open Channel is classified as:

(i) $Fr < 1.0$ ..... Subcritical flow or tranquil flow or streaming Flow

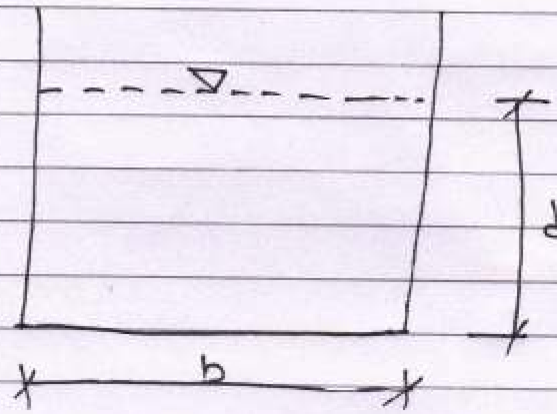
(ii) $Fr = 1.0$ ..... Critical flow

(iii) $Fr > 1.0$ ..... Super critical flow or Shooting flow or rapid flow or torrential flow

Q-3 Derive an Expression for most economical Section for (i) Rectangular section (ii) Trapezoidal Section

→ A Channel which give maximum discharge for given cross-section area and bed slope is called a channel ~~for~~ of most economical section. Expression for most economical Section are as under.

(1) Rectangular Section



Consider a channel of rectangular section as shown in above figure.

Let, b = width of channel

d = depth of water in channel

$\therefore A = b \times d$

Discharge, $Q = A \times V$

$= A \times C\sqrt{RS}$ | $V = C\sqrt{RS}$

$= A \times C\sqrt{\frac{A}{P} \times S}$ | $R = \frac{A}{P}$

Keeping A, C and S constant in the above equation, the discharge will be maximum when $\frac{A}{P}$ is maximum or the perimeter P is minimum, or in other words.

$$\frac{dP}{dd} = 0$$

We know that perimeter or rectangular section

$$P = b + 2d$$
$$= \frac{A}{d} + 2d$$

$$\therefore A = b \times d$$
$$b = \frac{A}{d}$$

Differentiating the above equation with respect to d, and equating to zero,

$$\frac{dP}{dd} = -Ad^{-2} + 2$$

$$= -\frac{A}{d^2} + 2 = 0$$

$$\therefore \frac{A}{d^2} = 2 \qquad \therefore A = 2d^2$$

$$\therefore bd = 2d^2$$

$$\therefore \boxed{b = 2d} \quad ----(1)$$

i.e width equal to twice the depth

Now, hydraulic mean depth

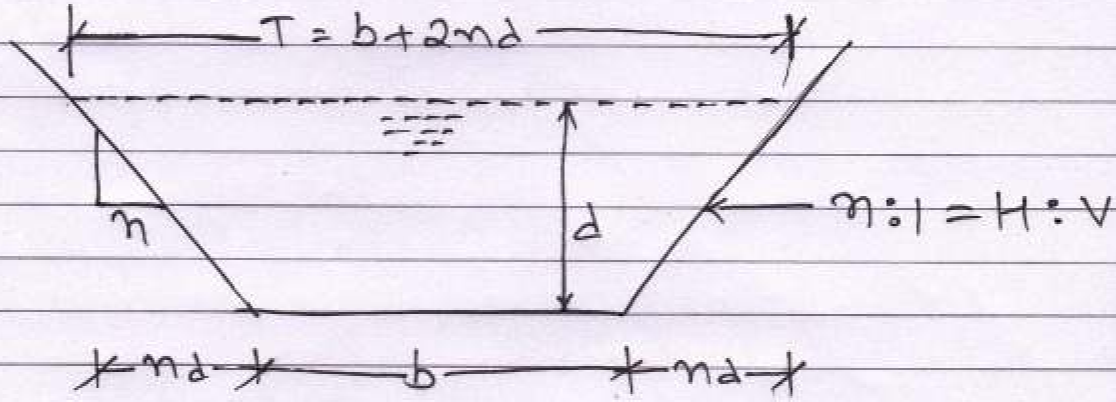
$$R = \frac{A}{P} = \frac{bd}{b+2d} = \frac{2d \times d}{2d+2d} = \frac{2d^2}{4d} = \frac{d}{2}$$

$$\therefore \boxed{R = \frac{d}{2}} \quad \text{----} \quad (2)$$

∴ For Rectangular Section, Conditions for most economical section are

(1) $b = 2d$ (2) $R = \frac{d}{2}$

(2) Trapezoidal Section :-



Consider a Channel of Trapezoidal section as shown in above figure.

Where, b = width of channel at bottom
d = depth of water in channel
$n:1$ = side slope
= n Horizontal to 1 vertical

$$A = bd + nd^2 = d(b+nd)$$

$$\therefore \frac{A}{d} = b + nd$$

$$\therefore b = \frac{A}{d} - nd \quad \text{---(i)}$$

Discharge, $Q = A \times V = A \times C\sqrt{\frac{A}{P} \times S}$

Keeping A, C and S constant in the above equation, the discharge will be maximum when $\frac{A}{P}$ is maximum or the perimeter P is minimum, or in other words

$$\frac{dP}{dd} = 0$$

We know that perimeter of a Trapezoidal section

$$P = b + 2d\sqrt{n^2+1}$$

Substituting the value of b from equation (i)

$$P = \frac{A}{d} - nd + 2d\sqrt{n^2+1}$$

Differentiating the above equation with respect to d and equating to zero,

$$\therefore \frac{dP}{dd} = \frac{-A}{d^2} - n + 2\sqrt{n^2+1} = 0$$

$$\therefore \frac{A}{d^2} + n = 2\sqrt{n^2+1} \quad \Big| \because A = d(b+nd)$$

$$\therefore \frac{d(b+nd)}{d^2} + n = 2\sqrt{n^2+1}$$

$$\therefore \frac{(b+nd)}{d} + n = 2\sqrt{n^2+1}$$

$$\frac{b+nd+nd}{d} = 2\sqrt{n^2+1}$$

$$\frac{b+2nd}{d} = 2\sqrt{n^2+1}$$

$$\frac{b+2nd}{d} = d\sqrt{n^2+1}$$ --- i.e sloping side is equal to half of the top width

$$\therefore \boxed{b+2nd = 2d\sqrt{n^2+1}} \quad ----(1)$$

Hydraulic mean depth,

$$R = \frac{A}{P} = \frac{d(b+nd)}{b+2d\sqrt{n^2+1}} = \frac{d(b+nd]}{b+(b+2nd)}$$

$$= \frac{d(b+nd)}{2b+2nd} = \frac{d(b+nd)}{2(b+nd)} = \frac{d}{2}$$

$$\therefore R = \frac{d}{2}$$

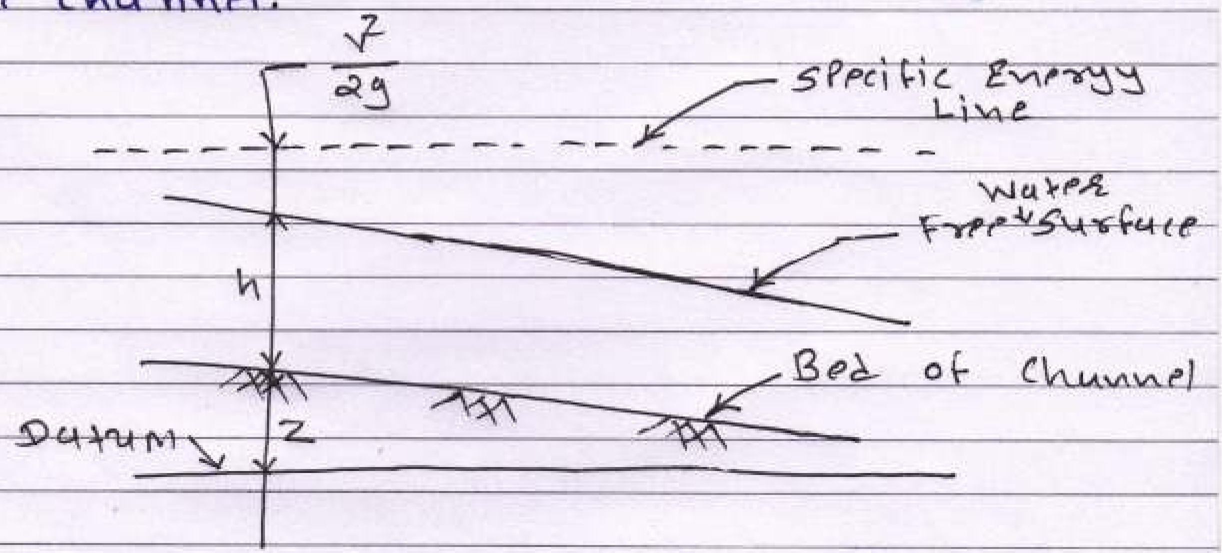
$\therefore$ For trapezoidal section, conditions for the most-economical section are.

(1) $b+2nd = 2d\sqrt{n^2+1}$

(2) $R = \frac{d}{2}$

Q-4 Discuss the specific energy curve with neat sketch.

→ The specific energy of a flowing liquid may be defined as the energy per unit weight (say per kg) with respect to the datum, passing through the bottom of the channel.



$$\text{Specific energy, } E = h + \frac{V^2}{2g}$$

$$\text{Total energy } E = Z + h + \frac{V^2}{2g}$$

Where

d = depth of flow

V = Velocity of flow

Specific energy diagram :-

We know that specific energy,

$$E = h + \frac{V^2}{2g}$$

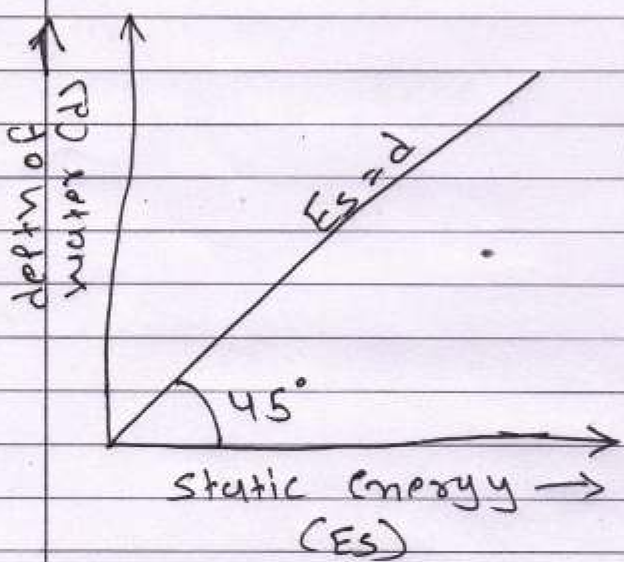
$$= E_s + E_k$$

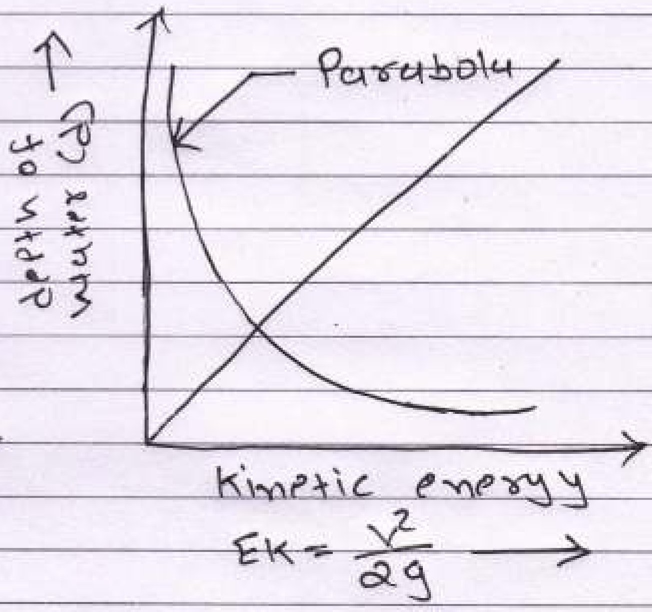
Where, $E_s = h$ = Static energy (Potential energy)

$$E_k = \frac{v^2}{2g} = \text{kinetic energy}$$

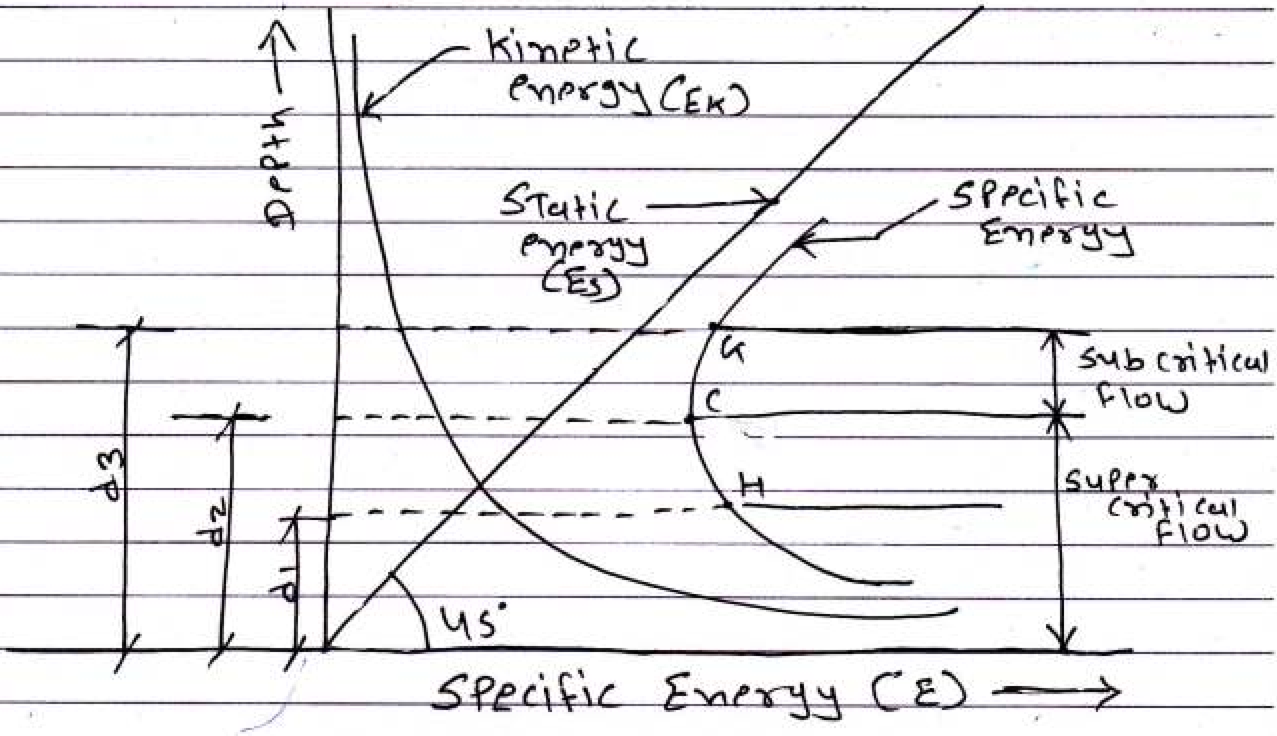
When depth of water is plotted against static energy, The curve so obtained is called static energy curve.

When depth of water is plotted against kinetic energy, the curve so obtained is called kinetic energy curve.





Now, the Co-ordinates of static energy Curve and energy curve are added to obtain specific energy curve.



From the static energy curve :-

If $d = d_c$ --- Critical flow
If $d_1 < d_c$ ---- Super critical flow
If $d_2 > d_c$ ---- Sub critical flow

Where (d_c) : Critical depth

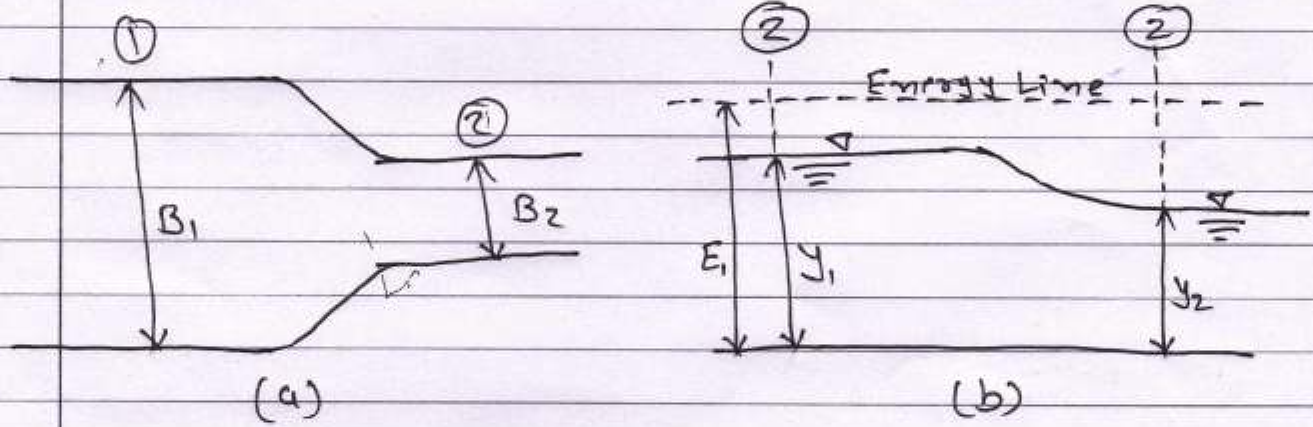
$$d_c = \left[\frac{q^2}{g}\right]^{\frac{1}{3}}$$

q = discharge per unit width (m^3/s) = Q/b
$g = 9.81\ m/s^2$

Q-6 Explain application of specific energy diagram.

→ In a channel which's width to be change.

1) Subcritical flow



Consider a frictionless horizontal channel of width B_1 carrying a discharge Q at a depth y_1 as shown in fig (a). Channel has been given a smooth transition and it's width reduced to B_2 at section 2. Since bed elevations are same at section ① and ②. The specific energy at sec-1 is equal to specific energy at section-2.

Hence, $E_1 = E_2$

$$\text{or} \quad y_1 + \frac{Q^2}{2gA_1^2} = y_2 + \frac{Q^2}{2gA_2^2}$$

$$\text{or} \quad y_1 + \frac{Q^2}{2gB_1^2 y_1^2} = y_2 + \frac{Q^2}{2gB_2^2 y_2^2} \qquad \because A_1 = B_1 y_1, \; A_2 = B_2 y_2$$

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It is easy to analyse the flow in terms of the discharge intensity $q = Q/B$. At sec-1, $q_2 = \frac{Q}{B_1}$ and

at Sec-2, $q_2 = \frac{Q}{B_2}$, since $B_1 > B_2$ hence $q_1 < q_2$.
As per discharge diagram, if discharge intencity increse in subcritical region the depth of flow goes on reducing. Therefore at section 2 the water surface will go down corresponding to that of at section 1.

2) Super Critical flow :-

If the incoming flow depth y_1 is in super critical flow regime, the flow depth y_2 will be more than y_1 while $q_2 > q_1$. This can be understood again from discharge diagram, that in super critical region as discharge increase the depth of flow goes on increasing. Therefore water surface will be ~~st~~ rise at section 2 corresponding to that of at section 1.

→ In a channel which's bed elevation (hump) to be change.

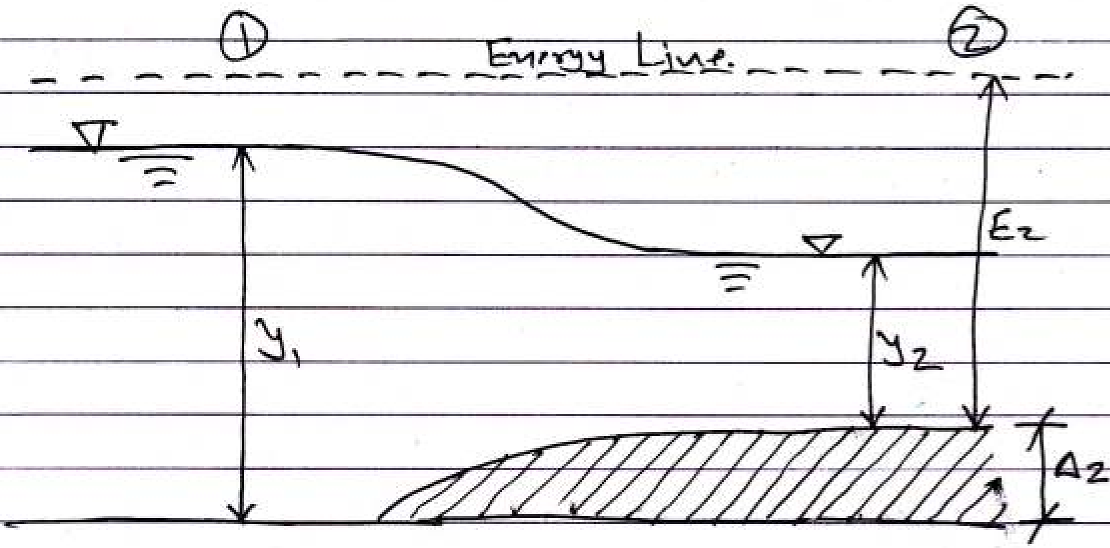
1) Sub critical flow

Consider a horizontal rectangular channel of width B ~~o~~ carrying discharge Q at a depth y_1. let the incoming flow is subcritical.

At Section 2, a smooth hump of height Δz is provided on the floor specific energy at Sec-1 is equal to

$$E_1 = y_1 + \frac{Q^2}{2gA_1^2}$$

At Sec-2, since there is a hump of height Δz, the specific energy at this section will be less than from section 1 by the amount Δz

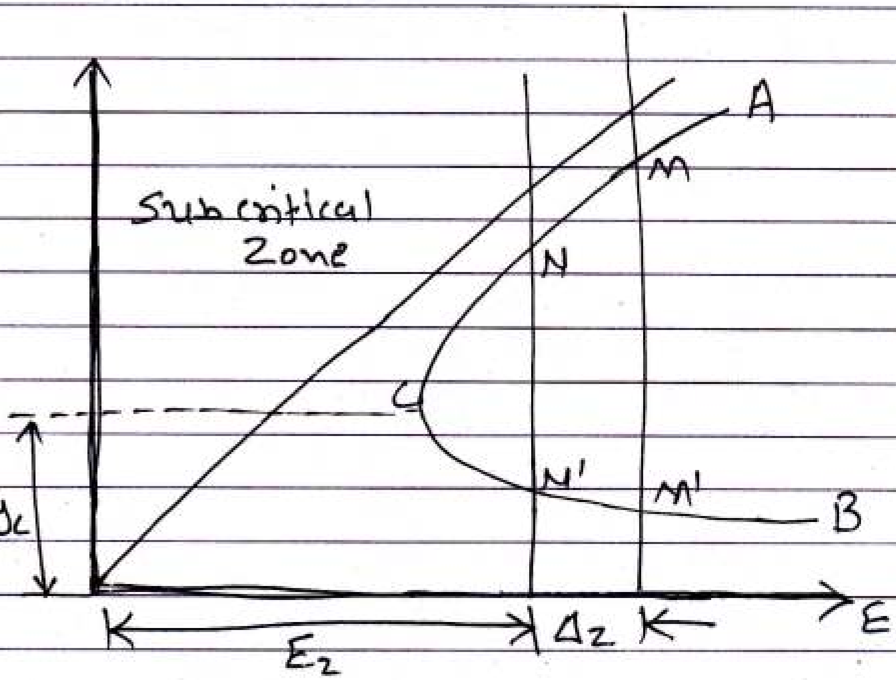


(a) Channel transition with a hump.

hence, $E_2 = E_1 - \Delta_2$

or $E_1 = E_2 + \Delta_2$

$$\text{or } y_1 + \frac{Q^2}{2gA_1^2} = y_2 + \frac{Q^2}{2gA_2^2} + \Delta_2$$



(b) Specific energy diagram

Fig (b) shows a typical specific energy diagram for a given discharge. From this diagram it is clear that in subcritical flow. if specific energy reduce the depth of flow will also reduce.

2) Super critical flow

When the incoming flow is in super critical regime shows that depth of flow increse with decrease in specific energy. Therefore water surface will rise at section 2. The water surface was at M' at section 1 will go up to Poin N' at section 2.

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Ex 1 A rectangular channel conveys a discharge of 12 m^3/s at a bottom width 3.0 m. Find the bed slope require to carry above discharge if depth of flow is 1.0 m. Tack Chezy's C = 50.

→ We have :-

$Q = 12\ m^3/s$ $\quad S = ?$

$C = 50$

$b = 3.0\ m$

$d = 1.0\ m$

$A = b \times d$

$= 3 \times 1$

$= 3\ m^2$

Parimeter $P = b + 2d$

$= 3 + (2 \times 1)$

$= 5\ m$

$R = \frac{A}{P} = \frac{3}{5} = 0.6\ m$

We know that

$$Q = AC\sqrt{RS}$$

$$12 = 3 \times 50 \times \sqrt{0.6 \times S}$$

$$0.08 = \sqrt{0.6} \cdot \sqrt{S}$$

Slope "S" = 0.0106

also say $\boxed{S = \frac{1}{93.75}}$

Ex-2 A circular channel having diameter 0.5 carries water at rate of 0.14 m^3/s. Find the bed slope of channel for maximum velocity. Take C = 55.

→

Discharge $Q = 0.14\ m^2/s$
Dia of channel $D = 0.5\ m$
Chezy's constant $C = 55$

For maximum velocity condition in a circular channel depth of flow $y = 0.81D$

$\therefore\ y = 0.81\ D$
$= 0.81 \times 0.5$
$= 0.405\ m$

Hydraulic Radius $R = 0.3D$
$= 0.3 \times 0.5$
$= 0.15\ m$

Perimeter $P = 2R\theta$

$= 2 \times 0.25 \times 128^\circ 45' \times \frac{\pi}{180}$
$P = 1.12\ m$

$R = \frac{A}{P} \quad \therefore\ A = R \times P = 0.15 \times 1.12 = 0.168\ m^2$

Now $Q = A \times V$
$Q = A \times C\sqrt{RS}$
$0.14 = 0.168 \times 55\sqrt{0.15 \times S}$

$\therefore\ \boxed{S = 0.0015 \text{ or } \frac{1}{653.4}}$

Ex - 3 A 10m wide Trapezoidal channel has a side slope of 1.5:1 (H:V). The channel is carrying a uniform flow 100 cumsec at the bed slope of 0.0003. Compute the normal depth of flow if manning's $n = 0.012$, Also compute mean velocity of flow

→ We have:-

Bed width $B = 10m$

Side slope $= 1.5:1$ (H:V) ∴ $m = 1.5$

Bed slope $S = 0.0003$

Discharge $Q = 100$ cumsec $= 100\ m^3/s$

manning's $n = 0.012$

Find depth of flow $= y = ?$

Velocity of flow $= V = ?$

Area of flow $A = By + my^2$

$= 10y + 1.5y^2$

Wetted Perimeter $P = B + 2y\sqrt{m^2+1}$

$= 10 + 2y\sqrt{1.5^2+1}$

$P = 10 + 3.6y$

$$R = \frac{A}{P} = \frac{10y + 1.5y^2}{10 + 3.6y}$$

We know that

$$Q = A \times V = \frac{1}{n} \times A \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

$$\therefore 100 = \frac{1}{0.012} \times (10y + 1.5y^2) \times \left[\frac{10y + 1.5y^2}{10 + 3.6y}\right]^{\frac{2}{3}} \times (0.0003)^{\frac{1}{2}}$$

$$\therefore 100 = 83.33 \times (10y + 1.5y^2) \times \left[\frac{10y + 1.5y^2}{10 + 3.6y}\right]^{\frac{2}{3}} \times 9 \times 10^{-8}$$

$$\therefore \boxed{y = 2.957 \text{ m}}$$

Now, $Q = A \times V$

$100 = 42.69 \times V$

$\therefore \boxed{V = 2.34 \text{ m/s}}$

$A = 10y + 1.5y^2$

$= (10 \times 2.957) + (1.5 \times 2.957^2)$

$= 42.69 \text{ m}^2$

$\therefore$ depth of flow $= y = 2.957$ m

Velocity of flow $V = 2.34$ m/s

Ex-4 A Trapezodial channel is having a bottom width of 2.5 and side slope 1.5:1 (H:V). It is carrying a discharge of 18 m^3/sec at a depth of 1.5 m. Calculate the specific energy and critical depth.

→ Data given

Bed width of channel $B = 2.5\,m$

side slope $1.5:1\ (H:V) = m = 1.5$

Depth of flow $y = 1.5\,m$

Discharge $Q = 18\ m^3/sec$

$$Area = By + my^2$$
$$= 2.5 \times 1.5 + 1.5 \times 1.5^2$$
$$= 7.12\ m^2$$

Specific energy is given as

$$E = y + \frac{Q^2}{2gA^2}$$

$$= 1.5 + \frac{18^2}{2 \times 9.81 \times (7.12)^2}$$

$$E = 1.83\ m$$

for critical state of flow

$$\frac{Q^2}{g} = \frac{A^3}{T}$$

where

$Q = 18\ m^3/sec$

$A = (By_c + my_c^2)$

$g = 9.81$

$T = B + 2my_c$

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upon substitution

$$\frac{18^2}{9.81} = \frac{(By_c + my_c^2)^3}{B+2my_c}$$

$$33.03 = \frac{(2.5y_c + 1.5y_c^2)^3}{2.5 + 2\times 1.5y_c}$$

$$\therefore \boxed{y_c = 1.33 \text{ m}}$$

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Ex:5 The discharge of water through a rectangular Channel with 6m width and 2m depth of flow in 17 cumecs. (1) Specific energy of flowing water (2) critical depth (3) critical velocity (4) Minimum specific energy.

→ Data given :

Width of channel $B = 6m$
Depth of flow $y = 2m$
Discharge $Q = 17$ cumsecs $= 17 m^3/s$

Area of flow $= B \times y$
$= 6 \times 2$
$= 12 \ m^2$

Specific energy $E = y + \frac{V^2}{2g}$

$$= y + \frac{Q^2}{2g(A)^2}$$

$$= 2 + \frac{17^2}{2 \times 9.81 \times 12^2}$$

$$\boxed{E = 2.10 \ m}$$

Discharge per meter width "q"

$$q = \frac{Q}{B} = \frac{17}{6} = 2.83 \ m^3/sec/m$$

Critical depth of rectangular channel is given by

$$y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}} = \left(\frac{2.83^2}{9.81}\right)^{\frac{1}{3}}$$

$$\boxed{y_c = 0.94\,m}$$

Critical velocity V_c =

$$V_c = \frac{Q}{By_c} = \frac{17}{6 \times 0.94} \boxed{= 3.01\ m/s}$$

minimum specific energy E_{min} =

$$E_{min} = \frac{3}{2} y_c$$

$$= \frac{3}{2} \times 0.94$$

$$\boxed{E_{min} = 1.41\,m}$$

Ex :- 6 A rectangular channel 4.0 m wide was laid at a slope of 0.0004. The incoming uniform flow depth is 2.5. Find the maximum height of hump can be provided in channel section without causing afflux. Take manning's $n = 0.014$

→ Given Data

Depth of flow $y = 2.5\,m$
Width of channel $B = 4.0\,m$
Bed slope $S = 0.0004$
Manning's $n = 0.014$

Area of flow $A = By$
$= 4 \times 2.5$
$A = 10\,m^2$

Wetted Perimeter $P = B + 2y$
$= 4 + 2 \times 2.5$
$= 9\,m$

Thus Hydraulic radius $R = \frac{A}{P}$

$R = \frac{10}{9} = 1.11\,m$

using manning's formula velocity of flow is given as

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$= \frac{1}{0.014} \times (1.11)^{\frac{2}{3}} \times (0.0004)^{\frac{1}{2}}$$

$$= 1.53\ m/s$$

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Discharge $Q = A \times V$
$= 10 \times 1.53$
$= 15.3 \ m^3/sec$

Specific energy at upstream section

$$E_1 = y_1 + \frac{Q^2}{2gA_1^2}$$

$$= 2.5 + \frac{15.3^2}{2 \times 9.81 \times 10^2}$$

$$= 2.62 \ m$$

For rectangular channel the critical depth =

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

$$= \left(\frac{(3.82)^2}{9.81}\right)^{\frac{1}{3}}$$

$\therefore y_c = 1.14 \ m$

$$q = \frac{Q}{Y} = \frac{15.3}{4}$$

$$= 3.82 \ m$$

Specific energy under critical condition =

$$E_c = \frac{3}{2} y_c$$

$$= \frac{3}{2} \times 1.14$$

$$= 1.71 \ m$$

Designed by Keyur Padashala

maximum height of hump can be determined using equation

$$E_1 = E_c + \Delta z_{max}$$

$$\therefore 2.62 = 1.71 = \Delta z_{max}$$

$$\therefore \boxed{\Delta z_{max} = 0.91 m}$$

$\therefore$ maximum height of hump can be provide in channel section is 0.91 m

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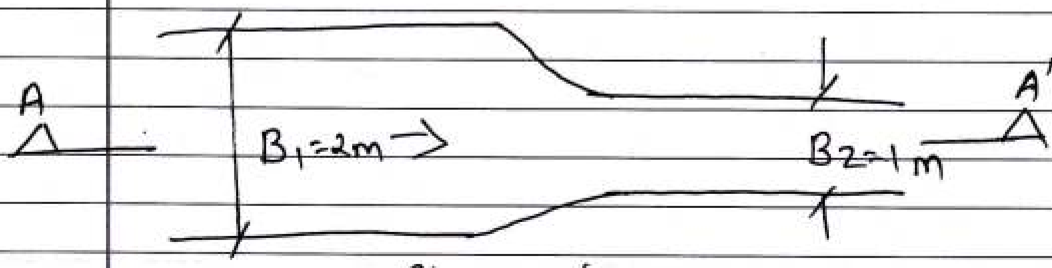
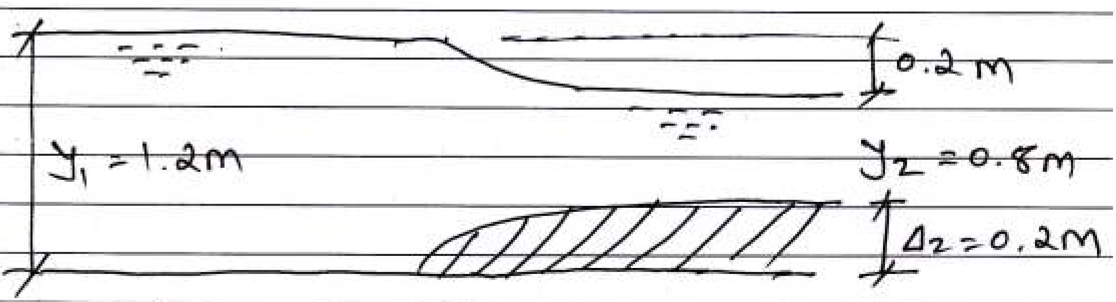
Ex-7 In order to find discharge in a rectangular Channel it's width is reduced gradually from 2m to 1m and the floor is rised by 0.2 m at the reduced section. The approaching flow depth is 1.2m. Calculate the rate of flow in channel if there is a drop of 0.2m in water surface elevation at contracted section

→ We have :-

Width of Section 1 = B_1 = 2m
Width of Section 2 = B_2 = 1m
Depth of flow at Section 1 = y_1 = 1.2m
Depth of flow at Section 2 = y_2 = 1.2 − Δ_2 − Drop
= 1.2 − 0.2 − 0.2
y_2 = 0.8m



Plan of channel



Section AA'

let Q is the discharge flowing through the channel, then specific energy at section I

$$E_1 = y_1 + \frac{Q^2}{2g A_1^2}$$

$$E_1 = 1.2 + \frac{Q^2}{2 \times 9.81 \times (2 \times 1.2)^2}$$

$$\therefore E_1 = 1.2 + \frac{Q^2}{113.01}$$

Similarly for section 2

$$E_2 = y_2 + \frac{Q^2}{2g A_2^2}$$

$$= 0.8 + \frac{Q^2}{2 \times 9.81 \times (1 \times 0.8)^2}$$

$$E_2 = 0.8 + \frac{Q^2}{12.56}$$

→ Assuming no losses of energy between both section, we get

$$E_1 = E_2$$

$$1.2 + \frac{Q^2}{113.01} = 0.8 + \frac{Q^2}{12.56}$$

$$\therefore \boxed{Q = 2.38 \ m^3/s}$$