1,25

هيدروليكا ثالثة معاني

Hydraulics 3rd Year Civil

G.V.F.

Hydraulic jump cases

No. 18

OPEN CHANNEL

HYDRAULICS

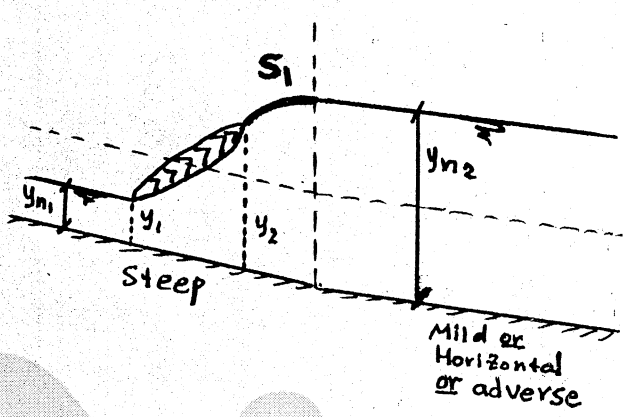
HJ

• الحالة الأولى :-

عند تغير الميل من Steep إلى Mild أو Horizontal أو Adverse

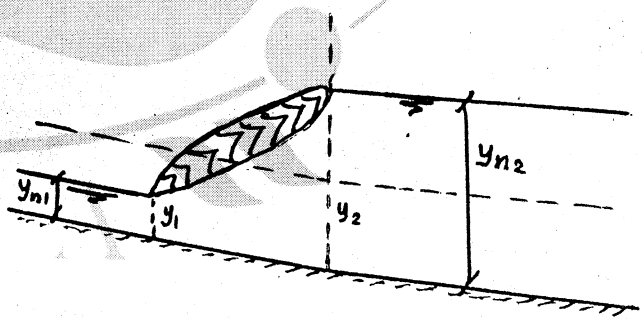
(1) HJ in Steep zone :.

- $y_1 = y_{n1}$
- $y_2 < y_{n2}$
- S_1 Curve is formed



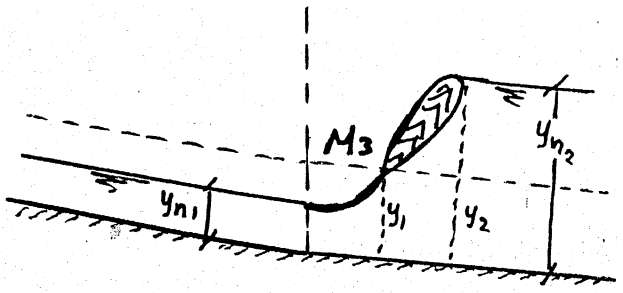
(2) Perfect Jump :.

- $y_1 = y_{n1}$
- $y_2 = y_{n2}$
- NO Curves



(3) HJ in Mild or Horizontal zone :.

- $y_1 > y_{n1}$
- $y_2 = y_{n2}$
- M_3 Curve is formed



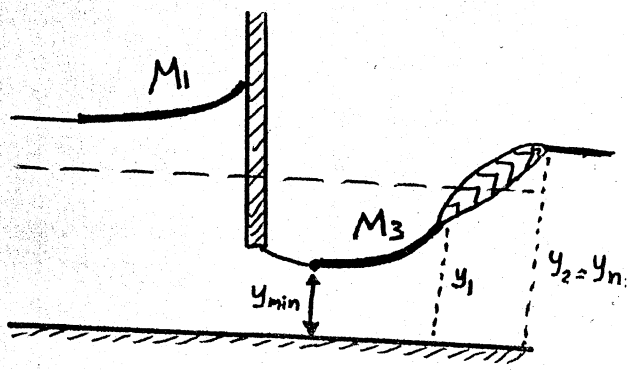
HJ

• الحالة الثانية :-

Adverse or Horizon. or Mild في حالة وجود بوابة على ميل

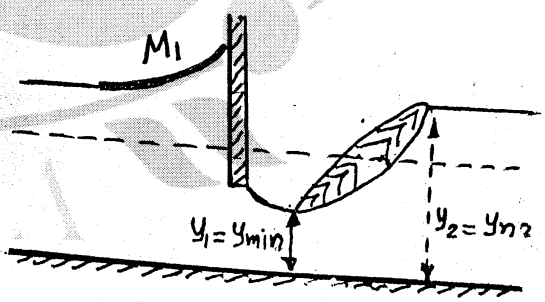
(1) $y_1 > y_{min}$

- $y_2 = y_{n2}$
- $y_1 > y_{min}$
- ∴ M_3 Curve is formed

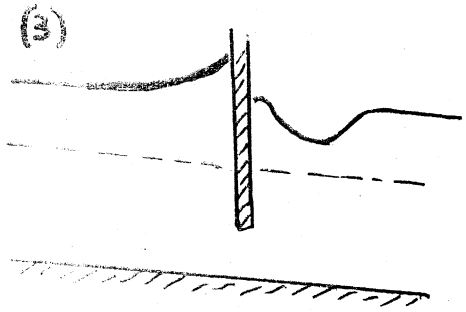


(2) $y_1 = y_{min}$

- $y_2 = y_{n2}$
- $y_1 = y_{min}$
- No Curves



(3)



* سنعلم فقط هناك حالة غير مقدرة علميا تحدث عندما يكون $y_2 < y_{n_2}$ وتسمى Submerged Jump

عشان تحل أي مسألة G.V.F لابد من :-

① حساب التصرف "Q"

1- manning من طريقه اهدى . معلوم Sn & n لنفس الميل

2- critical عندما معلوم "y_c"

3- HJ اذا الكام معلوم $y_1 < y_2$ لل HJ يكون صاحب الكبرى هو المعادله العامه لل HJ

② تحديد نوع الميل في كل منطقة

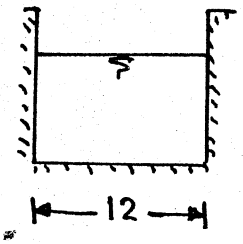
يتم تحديد نوع الميل في كل منطقه بطريقه صاحب y_n و y_c ومقارنتهما

- لو قال حمل منحنى "S_2" ← يبقى Steep
- لو قال الارض عندك طول uniform ← والميل الارض يكون adverse او Horizontal
- لو معطى $S = 10, 15 * 10^{-5}$ يبقى الميل Mild
- لو معطى $S = 0.04, S = 0.3$ يبقى الميل Steep

"M_1" ← يبقى Mild

Problem (8) Sh# 5

- **Given:**



  - $b = 12\ m$
  - $S_o = 15 * 10^{-5}$
  - $Q = 34\ m^3/s$
  - $\frac{1}{n} = 70 \qquad n = 0.0143$
  - $y_{min} = 0.2\ m$

- **Req.:**

  1- IS a HJ formed ?

  2- Distance from gate to Jump.

- **SOL:**

- **Get "y_n"**

maning

$$34 = 70 * \frac{(12\,y_n)^{5/3}}{(12+2y_n)^{2/3}} * \sqrt{15*10^{-5}}$$

by trial:. $\boxed{y_n = 2.34\ m}$

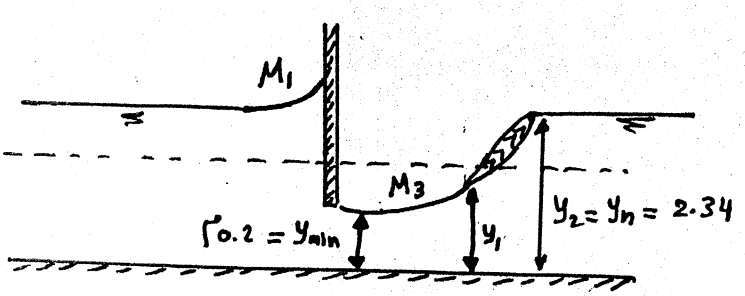
- **Get "y_c"**

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(34/12)^2}{g}}$$

$$\boxed{y_c = 0.935\ m}$$

- Now
  - $y_n > y_c$
  - ∴ Mild Slope
  - ∴ Yes a HJ will formed DS the gate.

(5)



• To get "y_1"

$$y_2 = y_n = 2.34 \text{ m}$$

$$Fr_2^2 = \frac{Q^2 T}{A^3 g} = \frac{34 * (12)^2}{g * (12 * 2.34)^3} = 0.064$$

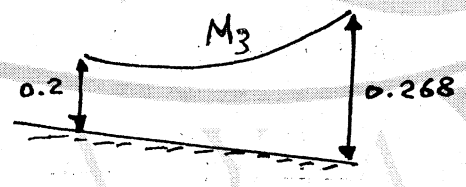
$$y_1 = \frac{y_2}{2}\left[\sqrt{1 + 8\,Fr_2^2} - 1\right]$$

$$= \frac{2.34}{2} * \left[\sqrt{1 + 8 * 0.064} - 1\right]$$

$$\boxed{y_1 = 0.268 \text{ m}} \quad > y_{min} \quad \text{ok}$$

∴ M_3 Curve is formed

Distance from gate to Jump = length of M_3 curve

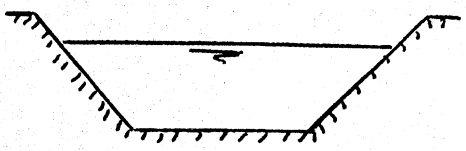


y	A	P	R	V	E	ΔE	Se	Se_{av}	ΔS	ΔX	Σ ΔX
0.268	3.22	12.536	0.257	10.572	5.965		0.1402				
						0.832		0.1582	0.1580	5.265	5.265
0.25	3.00	12.500	0.24	11.333	6.797		0.1761				
						1.511		0.2125	0.2123	7.11	12.379
0.23	2.70	12.450	0.22	12.593	8.307		0.2489				
						2.122		0.3077	0.3076	6.899	19.278
0.20	2.40	12.400	0.19	14.167	10.429		0.3666				

Distance from gate to jump = 19.278 m

Problem (9) Sh#5

* Given:



$b = 12\ m$

$z = 1.5$

$n = 0.014$

Reach ①	Reach ②	Reach ③
$y_{n_1} = 1,413$	$S_2 = 10 * 10^{-5}$	$y_{n_3} = 0.624 m$
	Flow is uniform for 1 km	$S_3 = 0.004$

* Req:-

1- water surface profile, find y_n, S for each reach

2- Length of Non-uniform flow in 2nd reach

[3 Sections only]

* SOL:-

- Get "Q"

Reach (3) maning

$$Q = \frac{1}{0.014} * \frac{[0.624(12+1.5*0.624)]^{5/3}}{[12+2*0.624\sqrt{1+1.5^2}]^{2/3}} * \sqrt{0.004}$$

$$\boxed{Q = 24,965\ m^3/s}$$

- Get "y_{n_2}"

Reach (2) maning

$$24,965 = \frac{1}{0.014} * \frac{[y_2(12+1.5*y_2)]^{5/3}}{[12+2y_2\sqrt{1+1.5^2}]^{2/3}} * \sqrt{10*10^{-5}}$$

by trial $\boxed{y_2 = 1.820\ m}$

- Get "S_1"

Reach(1) maning

$$24,965 = \frac{1}{0.014} * \frac{[1.413(12+1.5*1.413)]^{5/3}}{[12+2*1.413\sqrt{1+1.5^2}]^{2/3}} * \sqrt{S_1}$$

$$\boxed{S_1 = 22*10^{-5}}$$

- Get "y_c"

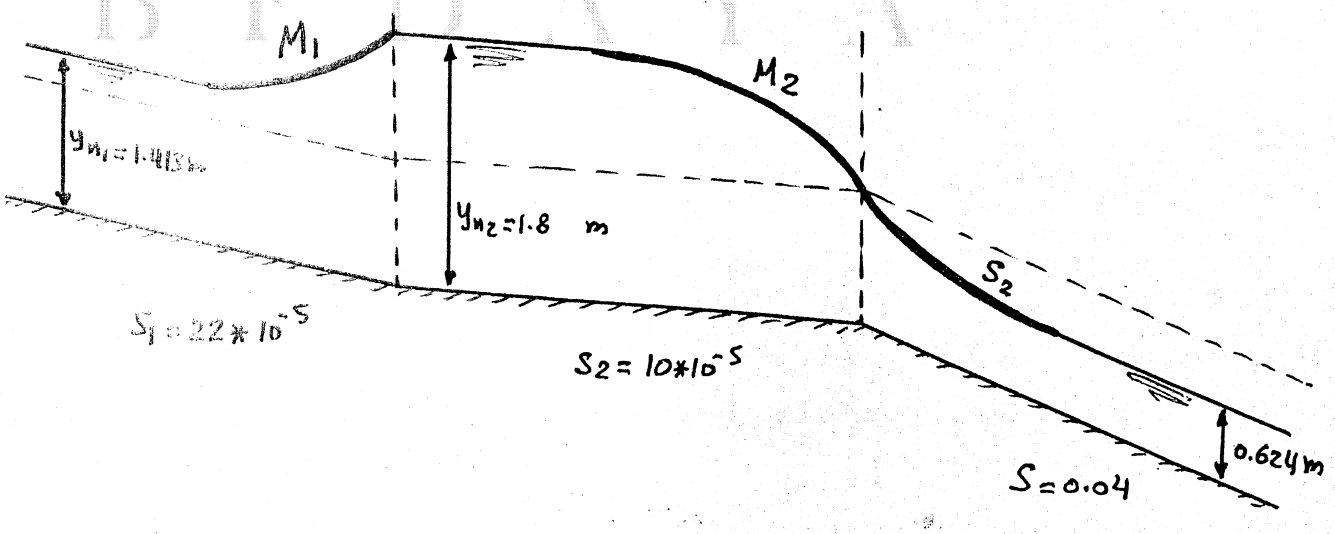
$$\frac{Q^2 T}{A^3 g} = 1$$

$$\frac{(24,965)^2 * (12+2*1.5*y_c)}{[y_c(12+1.5*y_c)]^3 * g} = 1$$

By trial :. $\boxed{y_c = 0.737 \text{ m}}$

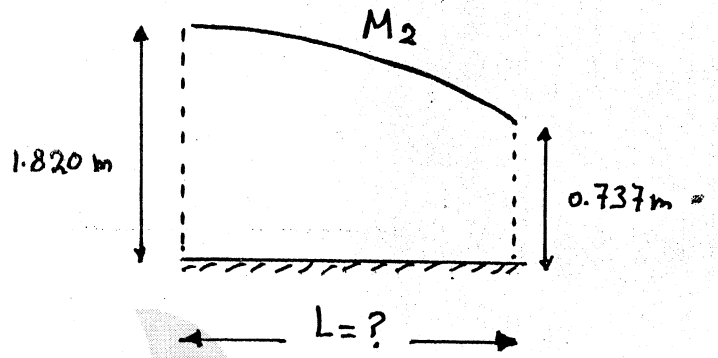
- NOW

- Reach ① ⟶ $y_{n_1} > y_c$ ⟶ Mild
- Reach ② ⟶ $y_{n_2} > y_c$ ⟶ Milder
- Reach ③ ⟶ $y_{n_3} < y_c$ ⟶ Steep



[B]

Length of Non-uniform in Reach ② = Length of M_2



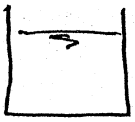
y	A	P	R	V	E	Δy	Se. $*10^{-5}$	Sea $*10^{-5}$	ΔS $*10^{-5}$	ΔX	X
1.82	26.84	18.569	1.44	0.93	1.866		10,37				
						0.691		45,86	35,86	1928,45	1928,84
1.00	13.5	15.61	0.865	1.85	1,17		81,34				
						0.096		154,37	144,37	67,00	1995,85
0.737	9.67	14.66	0.659	2.58	1.077		227,39				

Length of M_2 = 1995,85m

= 1,995 Km

Problem (16) .. Sh≠5

Given:



b = 8 m

n = 0.025

Reach ①	Reach ②	Reach ③
S = 0.04	$S = 33*10^{-5}$	$y_n = 0.8$ m
	$y_n = 3.0$ m	
	uniform for 1Km	

Req:

1- water surface Profile (y_n, HJ)

2- hieght of HJ

3- Non-uniform length in Reach ①

SOL:

- Get "Q"

maning Reach ②

$$Q = \frac{1}{0.025} * \frac{(8*3)^{5/3}}{(8+2*3)^{2/3}} * (33*10^{-5})^{1/2}$$

$$\boxed{Q = 25 \ m^3/s}$$

*تصنيف الميل :.

- Get "y_{n_1}"

maning $$25 = \frac{1}{0.025} * \frac{(8y_{n_1})^{5/3}}{(8+2y_{n_1})^{2/3}} * (0.04)^{1/2}$$

by trial $$\boxed{y_{n_1} = 0.6 m}$$

- Get " y_c "

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(25/8)^2}{g}}$$

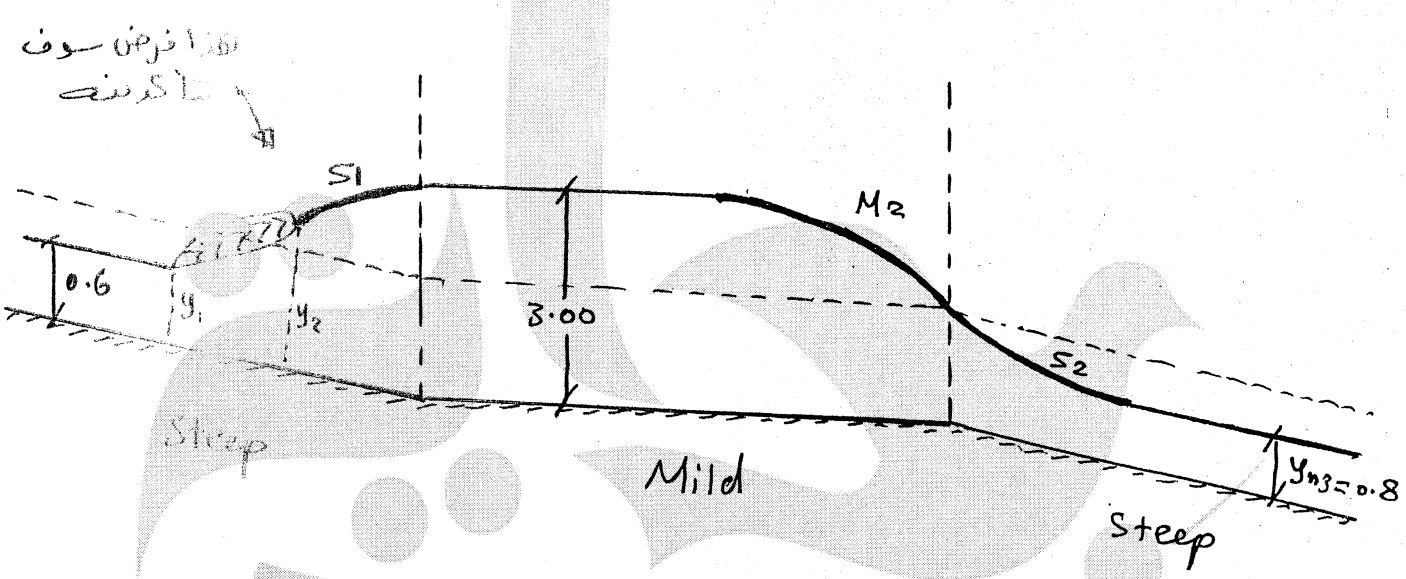
$$y_c = 1.00\ m$$

- NOW ..

Reach ① ⟶ $y_{n_1} = 0.6 < y_c$ ⟶ ∴ Steep

Reach ② ⟶ $y_{n_2} = 3 > y_c$ ⟶ ∴ Mild

Reach ③ ⟶ $y_{n_3} = 0.8 < y_c$ ⟶ ∴ Steep



تم فرض أن ال Jump حدث فى الميل ال Steep

$$\therefore y_{n_1} = y_1 = 0.6\ m$$

$$\cdot Fr_1 = \frac{V}{\sqrt{gy}} = \frac{25/0.6*8}{\sqrt{g*0.6}} = 2.1467$$

$$y_2 = \frac{y_1}{2} * \left[\sqrt{1+8Fr_1^2} - 1\right] = \frac{0.6}{2}\left[\sqrt{1+8*2.1467^2} - 1\right]$$

$$y_2 = 1.55\ m < y_{n_2}$$

∴ الفرض صحيح

NOTE تذكر لو كان ال Jump حدث فى منطقة ال mild كان $y_2 > y_{n_2}$

$y_1 > y_{n_1}$

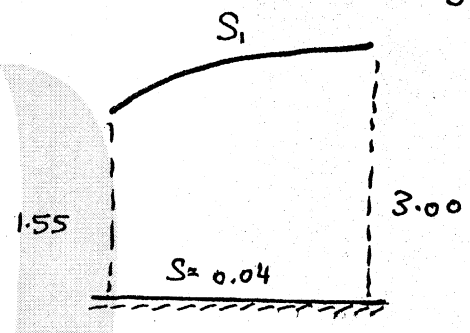
[2]

$$H_J = y_2 - y_1$$
$$= 1.55 - 0.6 = 0.95\ m$$

[3]

Non uniform length = Jump طول + S_1 طول

↓ L_j ↓ من الجدول



y	A	P	R	V	E	ΔE	Se *10^{-5}	Se$_{av}$*10^{-5}	ΔS*10^{-5}	ΔX	Σ ΔX
1.55	12.40	11.10	1.117	2.016	1.757	0.115	219.172	193.045	3806.95	3.02	3.02
1.70	13.60	11.40	1.193	1.838	1.872	0.123	166.918	148.638	3851.36	3.20	6.22
1.85	14.80	11.70	1.265	1.689	1.995	1.060	130.357	81.706	3918.29	27.05	33.27
3.00	24.00	14.00	1.714	1.042	3.055		33.054				

$$L(S_1) = 33,3\ m$$

$$L_J = 5(y_2 - y_1) = 5(1.55 - 0.6) = 4,75\ m$$

∴ Non-Uniform length = 33,3 + 4,75

= 38,05 m

TRIAL EXAM

QUESTION [1] DEC. 2000 A discharge of 20 m^3/sec is flowing in a rectangular channel. At section (1), the bed width equals 12.0 m and the water depth = 3.0 m . The channel bed width is gradually contracted to reach a bed width of 9.0 m at section (2). Within the contracted zone, the bed level is gradually raised by a vertical distance Z. The water depth at section (2) is 1.95 m. Determine:

A. The value of Z
B. The minimum rise in bed so that you have y_c at the downstream.
C. The water depth at section (2) if the rise in bed equals 2.0 m
D. Sketch the specific energy and discharge curves for case A & B

QUESTION [2] FINAL. 2008 For a constant specific energy of 2.0 m, what is the maximum flow may occur in a rectangular channel 3.0 m wide?

QUESTION [3] FINAL 2008 Determine the regime of flow (sub or super or critical) in the following cases:

A. The regime of flow upstream the hump if the flow depth over a hump is less than the water depth upstream the hump.
B. The regime of flow upstream the rising bed level and expanding bed width in the same location if the depth of flow over a raised bed level and expanded bed width is less than the water depth just upstream the variation.
C. The regime of flow over the hump if the flow depth upstream the hump is greater than the normal water depth.
D. The regime of flow just downstream the hydraulic jump.

QUESTION [5] Trapezoidal channel of bed width 6.0 m and side slope 2:1 and longitudinal slope 8 cm/km and roughness coefficient 0.013 if the froude number Was 0.15, find:

A. The alternate depths.
B. The Froude number in the super critical flow case.
C. Compare the values of the average boundary shear stress in cases of sub and super flow considering the channel section is wide.

QUESTION [6] FINAL 2009 Sketch the water surface profile when the channel bed slope is changed according to the following:-

A. (-Sc) to (0.8 Sc) to (S=0) B. Adverse to Horizontal to steep

Alexandria University
Faculty of Engineering
Irrigation & Hydraulics Dept.
Hydraulics (II) Exam

Third Year Civil Engineering
2nd Mid Exam 2012/2013
Sunday, Dec. 16th, 2012
Time allowed: 75 min

Question (1):

A. Discuss the effect of changing the value of the design velocity on the obtained values of the bed width and water depth of an open channel.

B. Give neat sketches showing:
- For an open channel, the relationship between the water depth and:
  - Water area (A).
  - Discharge (Q).
- For a circular pipe, the relationship between the water depth and:
  - Mean velocity (V).
  - Discharge (Q).

Question (2):

A trapezoidal channel of bed width 10.0 m, side slope 3:2, longitudinal bed slope 10 cm/km, mean velocity 0.594 m/sec, and Manning coefficient 0.025. Determine:

A. The average boundary shear stress acting on the channel wetted perimeter.
B. Estimate the passing discharge.
C. The maximum boundary shear stress on the bed and side.
D. If the mean diameter of the material forming the channel bed and sides is 0.4 mm and the angle of repose is 35°, what is the maximum discharge that can pass in this channel without causing scour?
$(\tau_b)_{cr} = 0.0491 d_s^{0.8371}$, $(\tau_s)_{max} = 0.77\gamma y S$ and $(\tau_b)_{max} = 0.98\gamma y S$.

Question (3):

Two identical pumps are connected in parallel, each pump is connected to a delivery pipeline of length 400 meters and diameter 30 cm. The sum of minor losses coefficient for each pipe is 2. At the end of these two pipelines, they are connected together to form a single pipeline of diameter 50 cm and length 600 meter. The sum of minor losses coefficient for this third pipeline is also 2. The static head is 10 meters, The pump characteristic for each of the two pumps is given in the following table:

Q in m^3/hour	0	100	200	300	400	500	800	700
H in meters	29.06	27.91	26.74	25.13	22.66	18.91	13.46	5.89

After several years of operation it was required to increase the rate of flow in the 50 cm diameter pipeline. The same two pumps in parallel are to be used and the two first pipelines of diameter 30 cm and length 400 meters are to be replaced by a new single pipeline of length 400 meters and diameter 80 cm. Determine the percentage increase in the rate of flow. Consider the friction factor f is constant for all pipes = 0.018. Neglect hydraulic losses in the suction pipe.

Good Luck and Best Wishes,
Dr. Haytham Mamdouh Awad

A storm water channel is constructed in a mountain area to convey storm water to a river. The channel is of rectangular section of bed width 20.0 meters, and consists of two reaches of different longitudinal bed slopes. The slope of the first reach is 0.10, while the slope of the second reach is 325 cm/km. In the second reach the normal water depth is 3.0 meters and the flow is uniform for a distance of 2 kilometers. At the end of the second reach water is spilled to the river, and the water depth at the brink is 2.80 meters. Considering Manning roughness coefficient to be 0.03, you are requested to carry out the following:

A. Sketch the water surface profile along the two reaches giving values of water depths at the beginning and end of each water surface profile.
B. Determine the length of the G.V.F profile ending at the brink. Consider only three sections.

H.W.

A storm water channel is constructed in a mountain area to convey storm water. The channel is **rectangular** of constant bed width of 10.0 meters and consists of three reaches of different longitudinal bed slopes. The second reach is horizontal, while the bed slope of the third reach is two times the critical slope.

In the first reach a hydraulic jump is formed with an initial water depth of 0.50 meter.

The water depth at the beginning of the horizontal reach is 2.50 meters, while the water depth at the end of the horizontal reach is 1.08 meter.

Considering n = 0.03 for all reaches. Determine:

A. The conjugate depths of the hydraulic jump.
B. The normal water depth in the third reach.
C. Sketch the water surface profile along the three reaches showing names of profiles, values of : normal water depths (y_{n1} , y_{n3}) , water depths at the beginning and end of each reach, and conjugate depths.

A storm water channel is constructed in a mountain area to covey storm water. The channel is rectangular of constant bed width of 8.0 meters and consists of three reaches of different longitudinal bed slopes. The following data are available:

A. For the first reach: The bed slope is 0.040.
B. For the second reach: The bed slope is 33 cm/km, the normal water depth is 3.0 meters and the flow is uniform for a distance of 1.50 kilometer.
C. For the third reach: The normal water depth is 0.80 meter.

You are requested to carry out the following:

1. Sketch the water surface profile along the three reaches showing values of normal water depths and water depths at the beginning and end of each reach and hydraulic jump.
2. The height of the hydraulic jump.
3. Determine the length in which the flow is non-uniform in the first reach. Arrange your answer in a table.

Take Manning's coefficient n = 0.025 for the three reaches.