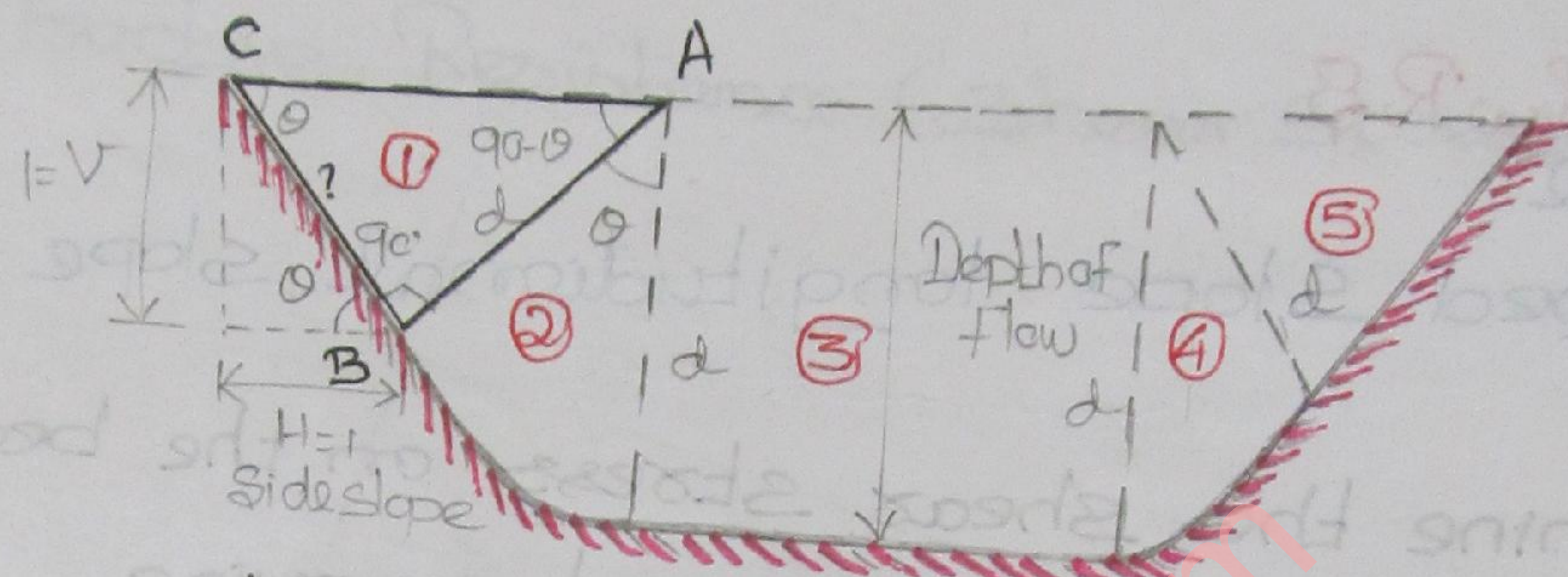
Tan bedslope = $0.75 \gamma_w R S$

$= 0.75 \times 9810 \times 1.49 \times \frac{1}{5887.5}$

$= 1.86\ Pa$

05/10/10

Design of Lined cannal:



$\tan\theta = \frac{V}{H}$

Trapezoidal Lined canal.

1) C/S $A = A_1 + A_2 + A_3 + A_4 + A_5$

$= 2A_1 + 2A_2 + A_3$

A_1 = Area of triangle

$= \frac{1}{2} \times d \times \cot\theta \times d$

$\cot\theta = \frac{BC}{AB}$

$BC = AB\cot\theta$

$= d\cot\theta$

A_2 = Area of Arc

$= \frac{\pi r^2}{360} \times \theta$

$= \frac{\pi d^2}{2\pi} \times \theta = \frac{d^2}{2} \times \theta$ [θ - Must be in radian]

A_3 = Area of rectangle

$= B \times d$

$A_{Trap} = \frac{1}{2} \times d \times d\cot\theta \times 2 + \frac{d^2}{2} \times \theta \times 2 + B \times d$

$= d[d\cot\theta + d\theta + B]$

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$A_{trap} = Bd + d^2[\theta + \cot\theta]$

For triangular channel $B = 0$

$A_{triangular} = d^2(\theta + \cot\theta)$

ii) perimeter

Arc length $= \frac{2\pi R}{360} \times \theta$

$= R \times \theta$

$P_2 = d\theta$

$P_1 = d\cot\theta$

$P_3 = B$

Final perimeter $= d\cot\theta \times 2 + (\theta \times d) \times 2 + B$

$= B + 2d(\theta + \cot\theta)$

$Peri_{Trape} = B + 2d(\theta + \cot\theta)$

For triangular channel, $B = 0$

$P_{triangular} = 0 + 2d(\theta + \cot\theta)$

$P_{tri} = 2d(\theta + \cot\theta)$

hydraulic Mean depth $= \frac{\text{Area}}{\text{Wetted perimeter}}$

$$R_{trap} = \frac{Bd + d^2(\theta + \cot\theta)}{B + 2d(\theta + \cot\theta)}$$

$$R_{tri} = \frac{d^2(\theta + \cot\theta)}{2d(\theta + \cot\theta)} = \frac{d}{2}$$

* hydraulic Mean depth is independent of side slope and is half of depth of flow

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Numericals

1) A triangular lined canal carries discharge of 30 cumec and the side slope is 1:1 Determine the depth of flow. Take n= 0.013 and bed slope 1in 4000

Manning's Formula

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

$$Q = AV$$

$$= A \times \frac{1}{N} R^{2/3} S^{1/2}$$

N - Manning's Constant
- Roughness Constant
- Rougosity Constant
- 0.013 (Concrete lining)

$$\tan\theta = \frac{V}{H} = 1/1$$

$$\theta = 45° \times \pi/180$$

$$= 0.785$$

$$Q = AV$$

$$= A \times \frac{1}{N} R^{2/3} S^{1/2}$$

$$= D^2(\theta + \cot\theta) \times \frac{1}{N} \times (A/P)^{2/3} S^{1/2}$$

$$Q = d^2(\theta + \cot\theta) \frac{1}{n} \times \left(\frac{d}{2}\right)^{2/3} S^{1/2}$$

Radian Mode

$$30 = d^2(0.785 + \cot 45°) \frac{1}{0.013} \times \left(\frac{d}{2}\right)^{2/3} \left(\frac{1}{4000}\right)^{1/2}$$

$$d = 3.18 m$$

2) A trapezoidal lined canal has base width 10m and depth of flow 2m, Side slope 1.25:1 (H:V). Determine the

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rate of flow. Take bed slope 1 in 5000

$\tan\theta = V/H = 1/1.25 = 38.66 \times \frac{\pi}{180} = 0.675$

$A = Bd + d^2(\theta + \cot\theta)$

$= 10\times2 + 2^2(0.675 + \cot 38.66)$

$= 27.69\ m^2$

$P = B + 2d(\theta + \cot\theta)$

$= 10 + 2\times2(0.675 + \cot 38.66)$

$= 17.69\ m^2$

$R = A/P = \frac{27.69}{17.69} = 1.565$

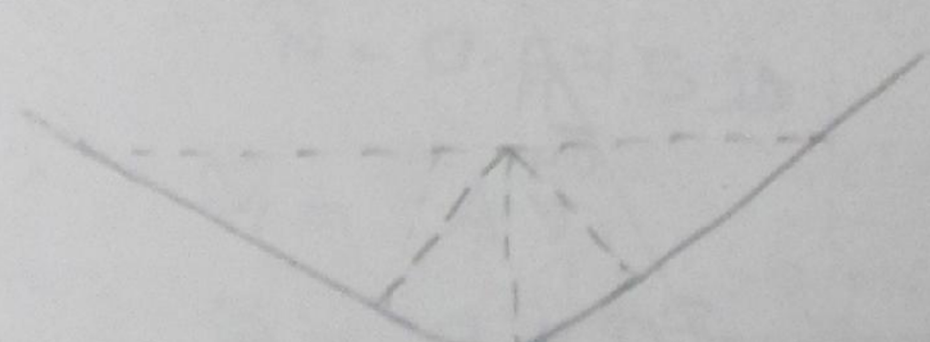
$Q = A\frac{1}{N}R^{2/3}S^{1/2}$

$= 27.69\frac{1}{0.013}\left(1.565\right)^{2/3}\left(1/4000\right)^{1/2}$

$= 45.402$ cumec

8/11/2010

3) Determine the hydraulic mean depth of a triangular lined canal having side slope 1.25H : 1V. Also determine rate of flow if bed slope is 1 in 4000. Take depth of flow 2m



$\tan\theta = \frac{1}{1.25} \Rightarrow \theta = 38.66$

$A = D^2(\theta + \cot\theta)$

$= 2^2(38.66\times\frac{\pi}{180} + \cot 38.66)$

$= 7.7\ m^2$

$P = 2D(\theta + \cot\theta) = 2\times2(38.66\times\frac{\pi}{180} + \cot 38.66)$

$= 7.7 m$

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hydraulic Mean depth $= \frac{A}{P} = \frac{7.7}{7.7} = 1m$

$Q = AV$

$= A \times \frac{1}{N} R^{2/3} S^{1/2}$

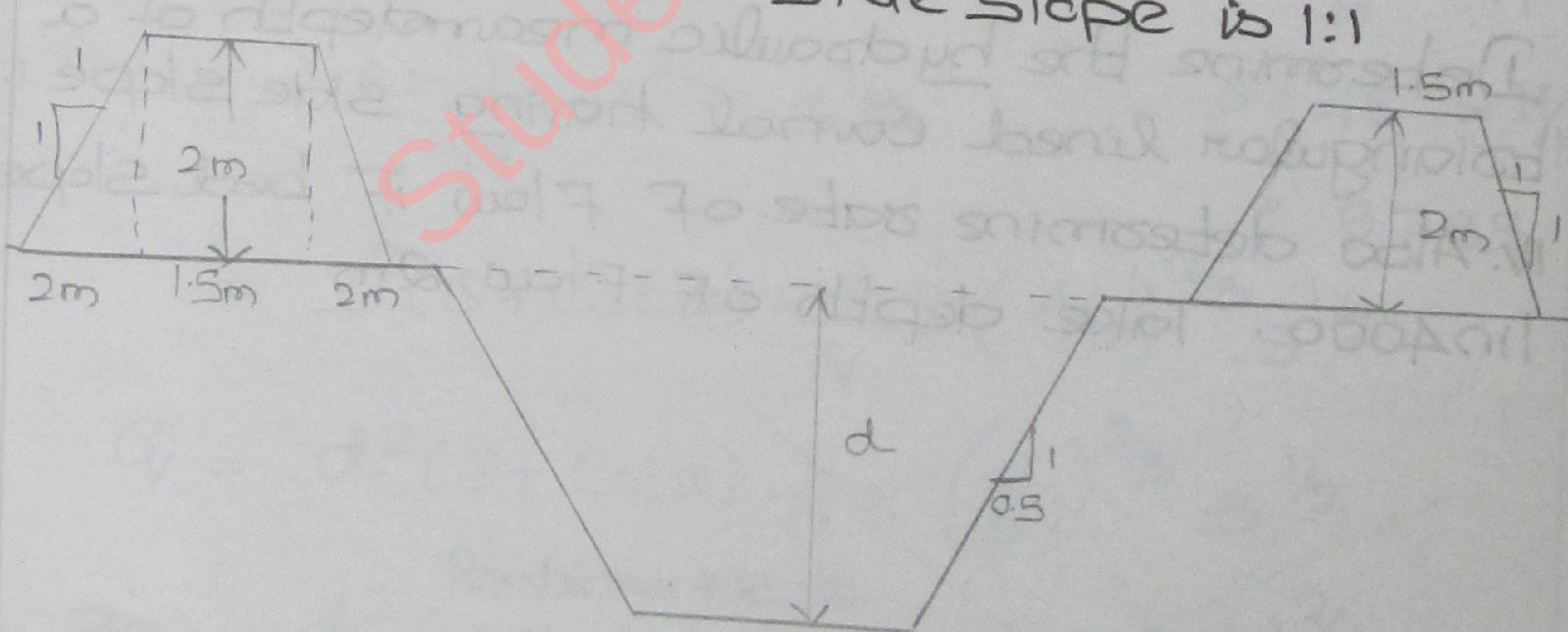
$= 7.7 \times \frac{1}{0.013} \times 1^{2/3} (1/4000)^{1/2}$

$= 9.365$ cumec.

Note:-

The balancing depth is the depth of Excavation of canal such that the volume of Excavated soil is equal to volume of filled Embankment ie) Area of Excavated soil is equal to Area of both Embankments.

4) Determine the balancing depth of a canal ~~such that the volume of~~ to provide depth of flow equal to 2m. and balancing width of 10m. The side slope of cutting is 0.5:1 Top width of each bank is 1.5m. and height of bank is 2m. The side slope is 1:1



Area of cutting $= (10 \times d) + 2 \times \frac{1}{2} \times d \times \frac{d}{2}$

$= 10d + 0.5d^2$ ---(1)

C/S Area of Filling $= 2\left[2 \times 1.5 \times 2 + \frac{1}{2} \times 2 \times 2 \times 2\right]$

$= 14$ ---(2)

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Equating ① & ②

$10d + 0.5d^2 = 14$

$d = 1.314 m$

5) An Eartheen canal is to be designed such that the ratio of breadth to depth is 3.1. The rate of flow in the canal is 5 cumec. Take CVR is equal to 0.9. Determine the dimension of canal.

Kennedy theory

$V_c = 0.55 m D^{0.64}$

$Q = Av$

$= A \times 0.55 m D^{0.64}$

$B/D = 3.1$

$A = BD + \frac{1}{2} \times 2 \times D \times 0.5D$

$= BD + 0.5D^2$

$= 3.1D^2 + 0.5D^2$

$= 3.6D^2$

$P = B + 2\sqrt{D^2 + 0.5D^2}$

$= 3.1D + 2 \times 1.118D$

$= 5.336D$

$R = A/P = \frac{3.6D^2}{5.336D}$

$R = 0.675D$

$Q = Av$

$5 = 3.6D^2 \times 0.55 \times 0.9 \times D^{0.64}$

$D = 1.478 m$

$B = 3.1 \times 1.478$

$= 4.582 m$

Kutter's Formula,

$v = C\sqrt{RS}$

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where

$$C = \frac{\frac{1}{N} + 23 + \frac{0.00155}{S}}{1 + \left(23 + \frac{0.00155}{S}\right)\frac{N}{\sqrt{R}}}$$

$$V_{kennedy} = V_{kutter}$$

$$0.55 m D^{0.64} = C\sqrt{RS}$$

$$0.55 \times 0.9 \times (1.478)^{0.64} = \frac{\frac{1}{0.025} + 23 + \frac{0.00155}{S}}{1 + \left(23 + \frac{0.00155}{S}\right)\frac{0.025}{\sqrt{0.675 \times 1.478}}} \times \sqrt{0.675 \times 1.478 \times S}$$

$$\frac{0.6356}{\sqrt{0.99765 \times S}} = \frac{\frac{1}{0.025} + 23 + \frac{0.00155}{S}}{1 + \left(23 + \frac{0.00155}{S}\right)\frac{0.0025}{\sqrt{0.675 \times 1.478}}}$$

$$S = 1/3947.296$$

6) A channel is to carry a discharge of 100 cumec. The ratio of breadth to depth is 3. The bed slope is 1 in 4000 and canal is unlined. Side slope is 1:1. Determine c/s Take N=0.0225

$$Q = AV$$

$$= A \times \frac{1}{N} R^{2/3} S^{1/2}$$

$$100 = \frac{\left(BD + \frac{1}{2} \times 2 \times D \times D\right)}{0.0225} \times \left(\frac{BD + \frac{1}{2} \times 2 \times D \times D}{B + 2\sqrt{D^2 + D^2}}\right)^{2/3} \times \left(\frac{1}{4000}\right)^{1/2}$$

$$= \frac{(BD + D^2)}{0.0225} \times \left(\frac{BD + D^2}{B + 2 \times 1.414 D}\right)^{2/3} \times \left(\frac{1}{4000}\right)^{1/2}$$

$$= \frac{(3D^2 + D^2)}{0.0225} \times \left(\frac{3D^2 + D^2}{3D + 2.828 D}\right)^{2/3} \times \left(\frac{1}{4000}\right)^{1/2}$$

$$= \frac{4D^2}{0.0225} \times \left(\frac{4D^2}{5.828 D}\right)^{2/3} \times \left(\frac{1}{4000}\right)^{1/2}$$

$$D = 4.194 \text{ m}$$

$$B = 3 \times 4.194 \simeq 12.58 \text{ m.}$$

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7) An Eartheon canal has base width 10m and depth 2m. The size of silt is .4mm Determine

i) Rate of Flow
ii) HMD
iii) Silt Factor
iv) Bed slope
v) Scour depth.

1) $P = 4.75\sqrt{Q}$

$$10 + 2\times 2\sqrt{1+0.5^2} = 4.75\sqrt{Q}$$

$$Q = 9.283 \text{ cumec}$$

2) HMD $R = \frac{A}{P}$

$$= \frac{BD + 2\times\frac{1}{2}\times D\times 0.5D}{B + 2\sqrt{D^2 + (0.5D)^2}}$$

$$= \frac{10\times 2 + 2\times\frac{1}{2}\times 2\times 0.5\times 2}{10 + 2\sqrt{2^2 + (0.5\times 2)^2}}$$

$$= 1.52 \text{ m.}$$

3) Silt factor $F = 1.76\sqrt{d}$

$$F = 1.76\times\sqrt{.4}$$

$$= 1.113$$

4) Bed slope

$$S = \frac{F^{5/3}}{3340\, Q^{1/6}}$$

$$= \frac{(1.113)^{5/3}}{3340\times(9.283)^{1/6}}$$

$$= 2.469\times 10^{-4}$$

$$= 1 \text{ in } 4050$$

5) $R_s = 0.47\left[\frac{Q}{F}\right]^{1/3}$

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$$= 0.47 \times \left[\frac{9.283}{1.113}\right]^{1/3}$$

$$= 0.953 m.$$

8) Determine Mannings constant for a regime canal

Regime canal, No silting, No scouring

$V = 10.8 R^{2/3} S^{1/3}$ Lacy

Manning

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

$$10.8 R^{2/3} S^{1/3} = \frac{1}{N} R^{2/3} S^{1/2}$$

$$N = \frac{S^{1/2 - 1/3}}{10.8}$$

$$= \frac{S^{1/6}}{10.8}$$

$$N = \frac{S^{1/6}}{10.8}$$

Importance Notes:-

1) Free board is the clearance between FSL of a canal and the top of lining which shall be as below

		Free board
a) Main canal	(Q > 10 cumec)	0.75 m
b) Branch canal	(Q ⇒ 5 to 10 cumec)	0.60 m
c) Distributary canal	(Q < 5 cumec)	0.50 m
d) Minor canal (Minor distributary)	(Q < 2 cumec)	0.30 m

2) If the size of silt is finer, then cross-section of the canal shall be narrow and deep. If the silt is coarser, then the cross section of canal shall be broad and shallow.

3) If the discharged is doubled, then the bed slope of the regime canal gets

Types of canal

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reduced $S = \frac{F^{5/3}}{3340 Q^{1/6}}$

4) If discharge is kept constant, then

$P = 4.75\sqrt{Q}$ - P- constant

$V = \left[\frac{QF^2}{140}\right]^{1/6}$ - $V \propto F^{1/3}$

$S = \frac{F^{5/3}}{3340 Q^{1/6}}$ $S \propto F^{5/3}$

$A = \frac{Q}{V} = \frac{Q}{\left[\frac{QF^2}{140}\right]^{1/6}}$ $A \propto \frac{1}{F^{1/3}}$

5) If the dia of the silt is 0.3mm, then Froude Number is,

Froude Number $= 0.204\sqrt{F}$

$= 0.204 \times \sqrt{1.76\sqrt{0.3}}$

$= 0.2.$

6) The quandity of silt in water should be less than 5000ppm ⇒ 5gm/litre (< 5gm/litre)

7) If the c/s of a canal is made and the bed slope is not properly made then such canal is called initial regime, where Lacy theory is not applicable.

8) If the canal cross section and bed slope of are made properly then such canal is called final regime where Lacy theory is applicable. It is also called True regime

9) If the canal is fully lined then it is called Permanent regime canal where Lacy theory is not applicable, only mannings formula applicable

10) For Alluvial canal, Mr. Lacy formulae are applicable

11) Mr. Lacy considered horizontal & vertical eddies to keep the silt in suspension and hence developed formula in terms

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Hydraulic Mean Depth.

12) The factor of safety considered for Scour depth is 2

13) The free board of unlined canal is the clearence between FSL and the top of the bank which is given as per IS 7112-1973

Discharge	Freeboard
1-5 cumec	0.6 m
5-10 cumec	0.6 m
10-30 cumec	0.75 m
>30 cumec	0.9 m

14) The best quality of linning material is cement concrete and the most inferior quality of linning material is bentonite.

15) The value of Manning's constant or Rogousity Coefficient or Roughness coefficient (N or n) is dependent of type of condition of canal.

Canal condition	Manning's Constant
a) Excellent	0.0225
b) Good	0.0250
c) Fair (indifferent)	0.0275
d) poor	0.0300

16) The channel bed formation is dependent on velocity of flow

a) If the velocity is gradually increased then sediment is just to move known as Threshold motion

b) If the velocity is increased, ripple of Sediment (in the form of Saw tooth)

c) If the velocity is increased further then dunes with ripple takes place

d) At higher velocity ripple disappear and only dunes are left.

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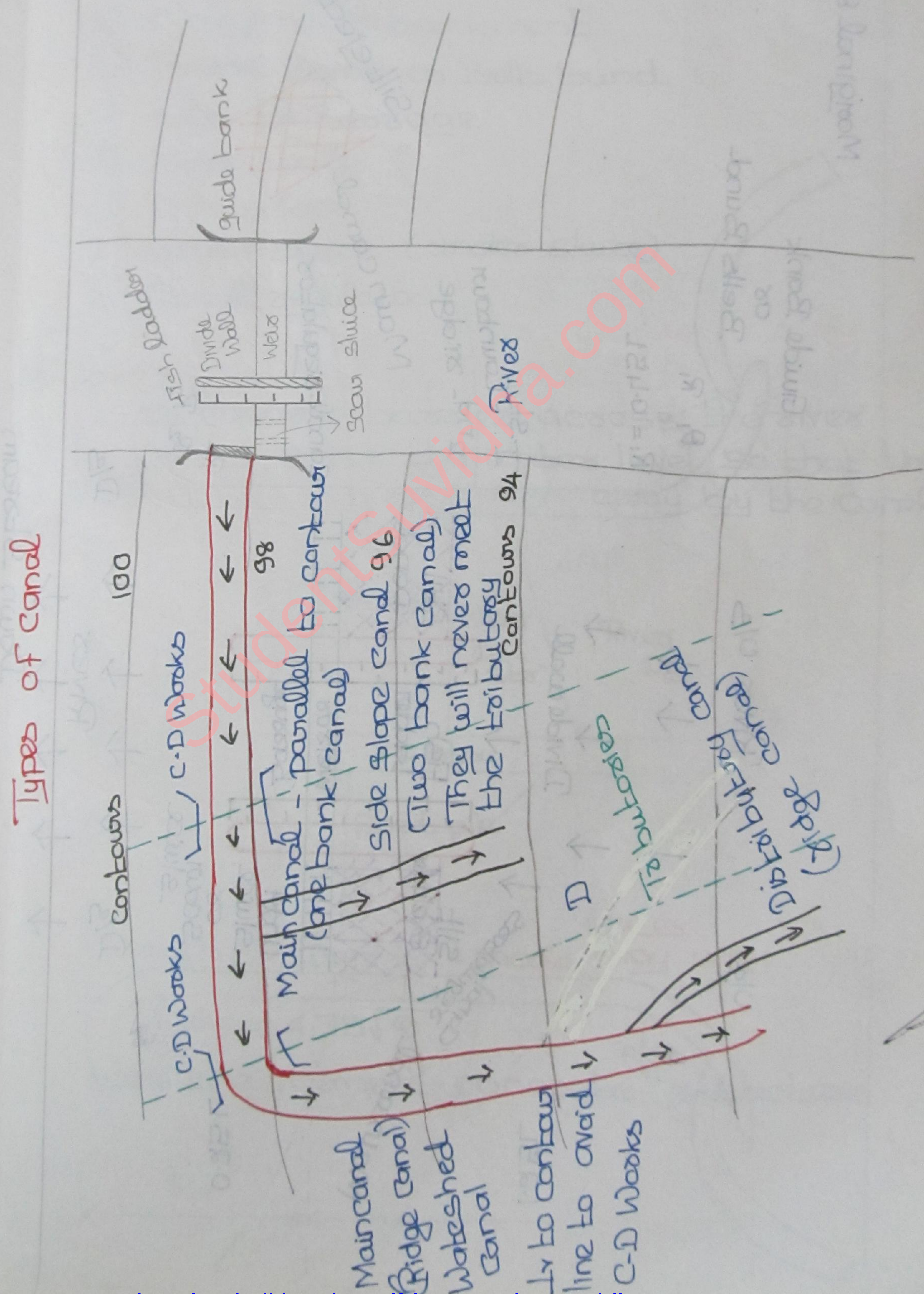
e) If the velocity is further increased the dunes disappear and flat surface is left

f) If the velocity is increased further then waves takes place

g) If the velocity is highest then antinode takes place.



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