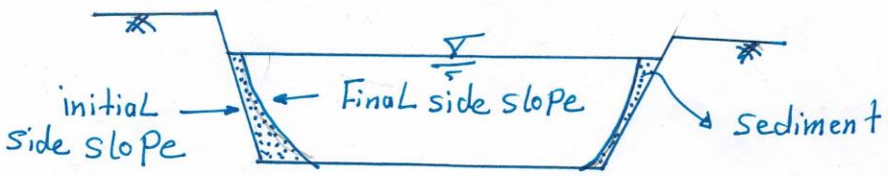
Alluvial Channels القنوات الرسوبية

- An alluvial channel was defined as transporting water as well as sediment.
- The shape, Longitudinal slope and cross-sectional dimensions of such a stable channel depend on discharge, size of sediment and sediment load.
- The two methods commonly for design of alluvial channels are:

ⓐ Kennedy's Equation ⓑ Lacey's Equation.



ⓐ Kennedy's Equation

Kennedy analysed data from stable canals of the upper Bari Doab system and found that non-scouring and, non-silting velocity (V_o) (initial velocity) is:

السرعة قبل بدء تكون الترسبات

$$V_o = 0.55\, y^{0.64} \quad \text{--- (1)}$$

Kennedy also found that critical velocity ratio (m) as:

$$V = 0.55\, m\, y^{0.64} \quad \text{---- (2)}$$

OR, m = critical velocity ratio $= \dfrac{V}{V_o}$

$m > 1$ for sands coarser.

$m < 1$ for finer sands.

يستفاد من تحديد قيمة m لمعرفة نوع الترسبات

and, V = Velocity of flow of alluvial channal can be combined with flow equation of manning equation:

$$V = 0.55\, m\, y^{0.64} = \frac{1}{n} R^{2/3} S^{1/2} \quad \text{--- (3)}$$

سرعة الجريان الطبيعي بعد تكون الترسبات

- The commonly ranges for n (0.02 – 0.025) and m (0.9 – 1.1).

- The cross-section to assume trapezoidal with side slope ($Z = 0.5$).

in which $P = B/y$ --- (4)

and, $S' = \dfrac{Q^2 n^2 (P + 2.236)^{4/3}}{y^{16/3} (P + 0.5)^{10/3}}$ --- (5)

$$y = \left[\frac{1.818\,Q}{(P+0.5)\,m}\right]^{0.378} \quad ---\ (6)$$

and, can Eliminate P from following Eq. :

$$\frac{S\,Q^{0.0202}}{n^2\,m^{2.02}} = 0.299\,\frac{(P+2.236)^{1.33}}{(P+0.5)^{1.313}} \quad ----\ (7)$$

$\boxed{\text{Hint}}$ but not all of these channels will be stable, the resulting solution is compared with the following recommended value of (B/y), if the two values differ significantly, suitable modification in the slope would be necessary.

Q	5	10	15	50	100	200	300
B/y	4.5	5	6.5	9	12	15	18

EX21 Design astable canal to carry adischarge of ($10\ m^3/sec$) at slope of (2×10^{-4}), $n = 0.023$, $m = 1$?

SoL^n. المطلوب من التصميم حساب قيمة B و y على فرض
ان المقطع شبه منحرف بميل جانبي قيمته ($Z = 0.5$)

$$\frac{S\, Q^{0.02}}{n^2\, m^2} = 0.299\,\frac{(P+2.236)^{1.33}}{(P+0.5)^{1.3}}$$

$$\frac{(2\times10^{-4})(10)^{0.02}}{(0.023)^2(1)^2} = 0.299\,\frac{(P+2.236)^{1.33}}{(P+0.5)^{1.3}} \Rightarrow P = 7.5$$

$$P = 7.5 = \frac{B}{y}$$

$$y = \left[\frac{1.818\,Q}{(P+0.5)\,m}\right]^{0.378} = \left[\frac{1.818\,(10)}{(7.5+0.5)(1)}\right]^{0.378} = 1.364_m$$

$$\therefore B = P \cdot y = 7.5\,(1.364) = 10.2_m$$

ملاحظة/ ان قيمة P المحسوبة هنا ($P=7.5$) يجب ان تقارن مع القيمة التصميمية الموجودة في الجدول المرفق مع هذا الموضوع.

وبالعودة الى الجدول السابق نلاحظ ما يلي :

when $Q = 10 \xrightarrow[\text{table}]{\text{From}} \frac{B}{y} = 5$

$\therefore P_{cal.}(7.5) > 5 \Rightarrow$ 7.5 عليه يمكن اعتماد القيمة

في الحل وعليه يكون قيمة

$$B = 10.2_m \quad \text{and,} \quad y = 1.364_m$$

Alluvial channels
(Stable channel)

↓

Kennedy's Eq. المعادلات الاساسية

$m, n \rightarrow$ Eq. (7) $\rightarrow$ Eq. (6) $\rightarrow$ Eq. (4)

Eq. (7) $\rightarrow P_{cal.}$

Eq. (6) $\rightarrow y$

Eq. (4) $\rightarrow B$

$P_{cal.}$ ↓ مقارنه مع الجدول

if $P_{cal.} \geq P_{table} \longrightarrow$ يتم اعتماد قيم B و y المحسوبة سابقاً وينتهي الحل

↓

if $P_{caL} < P_{table} \longrightarrow$ هناك اسلوبين للحل

الاسلوب الاول في حالة $P_{cal} < P_{table}$

تغير قيمة S وبالطريقة الاتية :

اولاً : تطبيق المعادلة رقم (7) لحساب قيمة S جديدة

$$\frac{S'_{New}\,Q^{0.02}}{n^2\,m^2} = 0.299\,\frac{(P_t + 2.236)^{1.33}}{(P_t + 0.5)^{1.313}} \quad \text{——— (7)}$$

ثانياً : تم تعويض قيمة S'_{New} في المعادلة رقم (5) لايجاد قيمة y

$$S'_{New} = \frac{Q^2\,n^2\,(P_t + 2.236)^{4/3}}{y^{16/3}\,(P_t + 0.5)^{10/3}} \quad \text{——— (5)}$$

ثالثاً : نطبق المعادلة رقم (4) لايجاد B

$$P_{table} = \frac{B}{y} \quad \text{——— (4)}$$

الاسلوب الثاني في حالة $P_{cal.} < P_{table}$

هو تطبيق Lacey's Eq.

b) Lacey's Equation

The main limitation of Kennedy's equation is that it does not specify a stable width, that any $(B/y)_{table}$ is satisfactory long as $(B/y)_{cal.}$.

i.e if $P_{cal.} < (B/y)_{table}$ then,

Lacey Proposed the following equations for channel design:

$$P = 4.75\sqrt{Q} \quad \text{——} (1)$$

$$R = 0.47\sqrt[3]{Q/f_s} \quad \text{——} (2)$$

$$S = 3\times10^{-4}\, f_s^{5/3}\, Q^{-1/6} \quad \text{——} (3)$$

$$f_s = \text{silt factor} = 1.76\, d^{1/2} \quad \text{——} (4)$$

d = sediment size (mm)

and, lacey flow equation is:

$$V = 10.8\, R^{2/3}\, S^{1/3} \quad \text{——} (5)$$

Equation (5) has been found to be applicable to alluvial rivers in floods at their full supply discharge .

Ex22 Design a Lacey channel to carry ($5\ m^3/sec$) through ($0.5\ mm$) sand ?

Soln. $f_s = 1.76\ d^{1/2} = 1.76\sqrt{0.5} = 1.24$

$$S' = \frac{3\times10^{-4}\ f_s^{5/3}}{Q^{1/6}} = \frac{3\times10^{-4}\times(1.24)^{5/3}}{(5)^{1/6}} = 3.27\times10^{-4}$$

$$R = 0.47\sqrt[3]{Q/f_s} = 0.47\sqrt[3]{\frac{5}{1.24}} = 0.746\ m$$

$$P = 4.75\sqrt{Q} = 4.75\sqrt{5} = 10.6\ m$$

assume $Z = 0.5$

$$\therefore P = B + 2\sqrt{1+Z^2}\ y = B + 2.24y = 10.6 \quad \text{———} (1)$$

$$A = PR = 10.6\times0.746 = 7.9\ m^2$$

$$A = By + Zy^2 = By + 0.5y^2 = 7.9 \quad \text{———} (2)$$

Solving eq (1) and eq (2) for y :

$y = 0.877\ m \qquad B = 8.63\ m$

H.W (1) use Kennedy equation to design canal for following:
$S' = 2.5\times10^{-4} \quad n = 0.0225 \quad m = 0.9 \quad Q = 30\ m^3/sec$

(2) using Lacey's equation design channel given :
$f_s = 1 \qquad Q = 4.5\ m^3/sec$