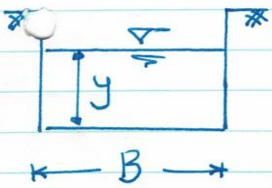
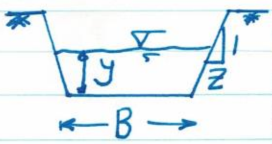
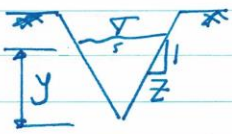
# 4 Area of Prismatic channel :

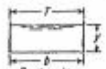
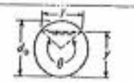
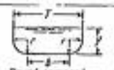
توجد عده اشكال من القنوات المفتوحه ذات المقطع الثابت من حيث المساحه ولكن المتغير هو الارتفاع كالاتي :

| Section | Area A | المحيط المبتل P Wetted Perimeter | نصف القطر الهيدروليكي hydraulic radius $R_h$ |
|---|---|---|---|
|  Rectangular Section | $B \cdot y$ | $2y + B$ | $\frac{B \cdot y}{2y + B}$ |
|  TrapeZoidal Section | $By + Zy^2$ | $B + 2y\sqrt{1+Z^2}$ | $\frac{By + Zy^2}{B + 2y\sqrt{1+Z^2}}$ |
|  Traingle Section | $Zy^2$ | $2y\sqrt{1+Z^2}$ | $\frac{Zy^2}{2y\sqrt{1+Z^2}}$ |

ويمكن حساب معامل يسمى معامل المقطع للجريان الحرج $Z_1$ من خلال المعادله الاتيه :

$$Z_1 = A\sqrt{\frac{A}{T}}$$

TABLE 2-1. GEOMETRIC ELEMENTS OF CHANNEL SECTIONS

| Section | Area $A$ | Wetted perimeter $P$ | Hydraulic radius $R$ | Top width $T$ | Hydraulic depth $D$ | Section factor $Z$ |
|---|---|---|---|---|---|---|
|  Rectangle | $by$ | $b + 2y$ | $\frac{by}{b+2y}$ | $b$ | $y$ | $by^{1.5}$ |
|  Trapezoid | $(b + zy)y$ | $b + 2y\sqrt{1+z^2}$ | $\frac{(b+zy)y}{b+2y\sqrt{1+z^2}}$ | $b + 2zy$ | $\frac{(b+zy)y}{b+2zy}$ | $\frac{[(b+zy)y]^{1.5}}{\sqrt{b+2zy}}$ |
|  Triangle | $zy^2$ | $2y\sqrt{1+z^2}$ | $\frac{zy}{2\sqrt{1+z^2}}$ | $2zy$ | $\frac{1}{2}y$ | $\frac{\sqrt{2}}{2}zy^{2.5}$ |
|  Circle | $\frac{1}{8}(\theta - \sin\theta)d_0^2$ | $\frac{1}{2}\theta d_0$ | $\frac{1}{4}\left(1-\frac{\sin\theta}{\theta}\right)d_0$ | $(\sin\frac{1}{2}\theta)d_0$ or $2\sqrt{y(d_0-y)}$ | $\frac{1}{8}\left(\frac{\theta-\sin\theta}{\sin\frac{1}{2}\theta}\right)d_0$ | $\frac{\sqrt{2}}{32}\frac{(\theta-\sin\theta)^{1.5}}{(\sin\frac{1}{2}\theta)^{0.5}}d_0^{2.5}$ |
|  Parabola | $\frac{2}{3}Ty$ | $T + \frac{8}{3}\frac{y^2}{T}$ * | $\frac{2T^2y}{3T^2+8y^2}$ * | $\frac{3}{2}\frac{A}{y}$ | $\frac{2}{3}y$ | $\frac{2}{9}\sqrt{6}\,Ty^{1.5}$ |
|  Round-cornered rectangle ($y>r$) | $\left(\frac{\pi}{2}-2\right)r^2+(b+2r)y$ | $(\pi-2)r+b+2y$ | $\frac{(\pi/2-2)r^2+(b+2r)y}{(\pi-2)r+b+2y}$ | $b+2r$ | $\frac{(\pi/2-2)r^2}{b+2r}+y$ | $\frac{[(\pi/2-2)r^2+(b+2r)y]^{1.5}}{\sqrt{b+2r}}$ |
|  Round-bottomed triangle | $\frac{T^2}{4z}-\frac{r^2}{z}(1-z\cot^{-1}z)$ | $\frac{T}{z}\sqrt{1+z^2}-\frac{2r}{z}(1-z\cot^{-1}z)$ | $\frac{A}{P}$ | $2[z(y-r)+r\sqrt{1+z^2}]$ | $\frac{A}{T}$ | $A\sqrt{\frac{A}{T}}$ |

* Satisfactory approximation for the interval $0 < x \leq 1$, where $x = 4y/T$. When $x > 1$, use the exact expression $P = (T/2)[\sqrt{1+x^2} + 1/x \ln(x + \sqrt{1+x^2})]$.

# 5 uniform flow ( Basic Equation)

Discharge estimation in open Prismatic channel

هناك عده معادلات لحساب التصريف المار خلال القنوات المفتوحه ذات المقطع المنتظم وكالاتي :

## A CHEZY's Eq. For Discharge :-

This eq. Published in 1775 is known as chezy's eq. and the constant C is known chezy's coefficient and noted that chezy coefficient is not dimensionless

$$Q = C A \sqrt{R_h S'} \quad --- (1)$$

where :-

$S'$ = bed slope

The dimension of C is $\left(\frac{L^{1/2}}{T}\right)$.

and, can be writted eq. above as:

$$V = C \sqrt{R_h S'} \quad --- (2)$$

ان المعامل (C) اشبه بعامل خسائر الاحتكاك (f) ويمكن كتابه المعادله الاتيه :-

$$C = \sqrt{\frac{8g}{f}} \quad --- (3)$$

**Ex1** Determine the flow rate of water through a rectangular channel (3m wide) with a flow depth of (1m). The bed slope is (1 in 2500) and f = 0.038 ?

**Soln**

$$C = \sqrt{\frac{8g}{f}} = \sqrt{\frac{8\times 9.81}{0.038}} = 45.46 \ \frac{m^{1/2}}{sec}$$

$$P = B + 2y = 3 + (2\times 1) = 5m$$

$$A = By = 3\times 1 = 3m^2$$

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

$$\therefore Q = CA\sqrt{R_h S} = 45.46\times 3\sqrt{0.6\times \frac{1}{2500}}$$

$$Q = 2.112 \ m^3/sec \quad \text{ANS}$$

**Ex2** A rectangular open channel has (5m) width and (1.5m) depth. The bed slope is 1:1000, C = 50, determine the flow rate ?

**Soln.**

$$A = B\times y = 5\times 1.5 = 7.5m^2$$

$$P = B + 2\times y = 5 + 2(1.5) = 8m$$

$$R_h = \frac{A}{P} = \frac{7.5}{8} = 0.938m$$

$\therefore Q = C A \sqrt{R_h \, S}$

$Q = 50 \times 7.5 \sqrt{0.938 \times \frac{1}{1000}} = 11.48 \ m^3/sec$

ANS

**H.W** A triangular open channel with (0.25m) depth and 60° angle conveys water. if the bed slope is (1: 137) and chezy constant C = 52, determine the flow rate? (ANS (40 litters / sec)

# • Determination of chezy's constant

## 1 Bazin's Eq. for chezy's constant..

The Bazin eq. is

$$C = \frac{86.9}{1 + \frac{K}{\sqrt{R_h}}}$$

where K is Bazin constant. The value varies from 0.11 for smooth surface to 3.17 for earthen channel in rough condition, for Brick lined channel is 0.5.

**Ex1** caculate the value of chezy's constant using Bazin equation in the case of rectangular channel (3m wide) and (1m deep), bed sloope of (1:2500), Find the value of flow rate ?

**Soln.** $A = By = 3 \times 1 = 3 m^2$ $\quad P = B + 2y = 3 + 2(1) = 5_m$

$$\therefore R_h = \frac{A}{P} = \frac{3}{5} = 0.6_m$$

$$\text{Bazin eq.} \Rightarrow C = \frac{86.9}{1 + \frac{K}{\sqrt{R_h}}} = \frac{86.9}{1 + \frac{K}{\sqrt{0.6}}}$$

and, chezy eq. discharge $\Rightarrow Q = CA\sqrt{R_h S'}$

حسب معادلة بازن يتغير قيمة C كلما تغيرت قيمة K ولأن السؤال
لم يحدد قيمة K سنأخذ جميع الحالات وكالآتي :

| Case No. | Nature of surface | Bazin constant | C | Q $m^3/sec$ |
|---|---|---|---|---|
| 1 | Smooth cement lining | 0.06 | 80.65 | 3.75 |
| 2 | Smooth brick | 0.16 | 72.02 | 3.35 |
| 3 | Rubble masonary | 0.46 | 54.52 | 2.53 |
| 4 | Earthen channel (in ordinary condition | 1.303 | 32.4 | 1.51 |
| 5 | Earthen channel (in rough condition | 1.75 | 26.66 | 1.24 |

## 2 Kutter's Eq. for chezy's constant C

The Kutter's Eq. is

$$C = \frac{23 + \left(\frac{0.00155}{S}\right) + \left(\frac{1}{N}\right)}{1 + \left[23 + \left(\frac{0.00155}{S}\right)\right]\left(N \div R_h^{0.5}\right)}$$

Where N is Kutter constant.

**EX4** Determine the flow rate for rectangular channel (3m wide) and (1m deep) with slope (1 : 2500), using Kutter constant ?

**Soln.** $A = By = 3 \times 1 = 3m^2$  $P = B + 2y = 3 + 1(2) = 5m$

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

Kutter eq. $\Rightarrow$ $$C = \frac{23 + \left(\frac{0.00155}{S}\right) + \left(\frac{1}{N}\right)}{1 + \left[23 + \left(\frac{0.00155}{S}\right)\right]\left(N + R_h^{0.5}\right)}$$

and, Chezy eq. $\Rightarrow Q = CA\sqrt{R_h S}$

حسب معادله كاتر تتغير قيمة C كلما تغيرت قيمة N ولأن السؤال
لم يحدد قيمة N سنأخذ جميع الحالات وكالاتي :

| Case No. | Type of surface | Kuttur constant N | C | Q m³/sec |
|---|---|---|---|---|
| 1 | Smoot cement lining | 0.11 | 85.25 | 3.96 |
| 2 | Smooth concerete | 0.013 | 71.53 | 3.32 |
| 3 | Rough brick | 0.015 | 61.52 | 2.86 |
| 4 | clean earthen channel | 0.018 | 50.74 | 2.36 |
| 5 | Rubble masonary | 0.017 | 53.9 | 2.51 |