Derivation

i) Consider a small section of an open channel. The forces acting on the free body of water ABCD in the direction of flow are as follow —

i) Force of hydrostatic water pressure F_1 and F_2 acting on the two end of the free body

$$F_1 = F_2 \quad (\because \text{depth of water at section 1 \& 2 are same})$$

(ii) Component of weight of water in the direction of flow $wAL \sin\theta$

w = Specific weight of water

A = Wetted perimeter of the channel

θ = Angle of inclination of channel bottom with horizontal

(iii) The resistance of flow exerted by wetted surface of channel

P = Wetted perimeter of the channel

τ_0 = Average shear stresses at the channel boundary

Total resistance to flow = $PL\tau_0$

2) According Newton's second law of motion.

$$WAL\sin\theta - PL\tau_0 = 0$$

$$\tau_0 = w\left(\frac{A}{P}\right)\sin\theta = wRS_0 \quad \text{— (1)}$$

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

$S_0 = \sin\theta$ = Slope of channel bottom

3) $$\tau_0 = \frac{f}{8}\rho v^2 \quad \text{— (2)}$$

4) Eq (1) & (2)

$$wRS_0 = \frac{f}{8}\rho v^2 =$$

$$v = \sqrt{\frac{8w}{f}}\sqrt{RS_0}$$

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$$\sqrt{\frac{8g}{f}} \quad \sqrt{RS_o}$$

$$g = w/\rho$$

$$v = c\sqrt{RS_o}$$

5) Discharge, $Q = Av = AC\sqrt{RS_o}$

$$C = \sqrt{\frac{8g}{f}}$$