Ex→1→ A rectangular channel with a bottom with of 4m and a bottom slope of 0.0008 has a discharge of 1.50 m^3/s. In a gradually varied flow in this channel, the depth at a certain location is found to be 0.30 m. Assuming n = 0.016, determine the type of GVF profile.

solution →

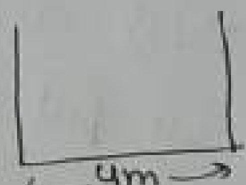
$S_0 = 0.0008$

$Q = 1.50\ m^3/s$

$y = 0.30\ m$

$n = 0.016$

Type of GVF profile = ?



For determination of GVF profile value of y_0, y_c is required.

Calculation of y_0 →

anning's $Q = \frac{A}{n} R^{2/3} S_0^{1/2}$

$$A = B \cdot y_0 = 4y_0$$

$$P = y_0 + 4 + y_0 = 4 + 2y_0$$

$$R = \frac{A}{P} = \frac{4y_0}{4+2y_0} = \frac{2y_0}{2+y_0}$$

$$1.5 = \frac{4y_0}{0.016}\left(\frac{2y_0}{2+y_0}\right)^{2/3}(0.0008)^{1/2}$$

$$6\times10^{-3} = \frac{y_0 \times y_0^{2/3}}{(2+y_0)^{2/3}} \times 0.044898$$

$$0.1336348\,(2+y_0)^{2/3} = y_0^{5/3}$$

$$2.386\times10^{-3}\,(2+y_0)^2 = y_0^5$$

$$2.386\times10^{-3}\,(4+y_0^2+4y_0) = y_0^5$$

$$y_0^5 - 2.386\times10^{-3}\,y_0^2 - 9.5459\times10^{-3}\,y_0 - 9.5459\times10^{-3} =$$

By trial and error method

if we put $y_0 = 0.4\,m$

-0.0035 which is nearly $\simeq 0$

so $\boxed{y_0 = 0.4\,m}$

Calculation of y_c

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

$$\frac{(1.5)^2}{9.81} = \frac{(4\times y_c)^3}{4} = 16\,y_c^3$$

$$\frac{0.22936}{16} = y_c^3$$

$$\boxed{y_c = 0.243\,m}$$

as we can see $y_0 > y_c$

$0.4 > 0.243$

$\because y_0 > y_c \rightarrow$ Mild Slope

$y = 0.30\,m$

$0.4 > 0.30 > 0.243$

$y_0 > y > y_c \longrightarrow$ M2 curve

$\boxed{\text{M2 Profile}}$ Ans

Example of Brake in Grade →

Ex → A rectangular channel of 4.0 m width has a Manning's coefficient of 0.025. For a discharge of 6.0 m³/s in this channel, identify the possible GVF profiles produced in the following break in grades.

(a) $S_{01} = 0.0004$ to $S_{02} = 0.015$

(b) $S_{01} = 0.005$ to $S_{02} = 0.0004$

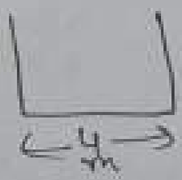
Solution →

(a)

$S_{01} = 0.0004$

$n = 0.025$

$Q = 6\ m^3/s$



y_c →

$$\frac{Q^2}{g} = \frac{A_c^3}{T_c}$$

$$\frac{(6)^2}{9.81} = \frac{(4y_c)^3}{4} = 16y_c^3$$

$$\frac{3.6697}{16} = y_c^3$$

$$\boxed{y_c = 0.6121\ m}$$

y_{01} →

$$Q = \frac{A}{n} R^{2/3} S_0^{1/2}$$

$A = 4y_0$

$P = y_0 + 4 + y_0 = 4 + 2y_0$

$$R = \frac{A}{P} = \frac{4y_0}{4+2y_0} = \frac{2y_0}{2+y_0}$$

$$6 = \frac{4y_0}{0.025}\left(\frac{2y_0}{2+y_0}\right)^{2/3}(0.0004)^{1/2}$$

$$1.18117598 = \frac{y_0 \cdot y_0^{2/3}}{(2+y_0)^{2/3}}$$

$(2+y_0)^2 \; 1.6479 = y_0^5$

$y_0^5 - 1.6479(2+y_0)^2 = 0$

By trial and error method

$y_0 = 1.9\,m$

$-0.3035 \simeq 0$

$\boxed{y_{o1} = 1.9m}$

$\underline{y_{o2}} \rightarrow$

$$Q = \frac{A}{n} R^{2/3} S_o^{1/2}$$

$$6 = \frac{4y_0}{0.025}\left(\frac{2y_0}{2+y_0}\right)^{2/3}(0.015)^{1/2}$$

$$0.1928(2+y_0)^{2/3} = y_0 \cdot y_0^{2/3}$$

$$7.176\times10^{-3}(2+y_0)^2 = y_0^5$$

$$y_0^5 - 7.176\times10^{-3}(2+y_0)^2 = 0$$

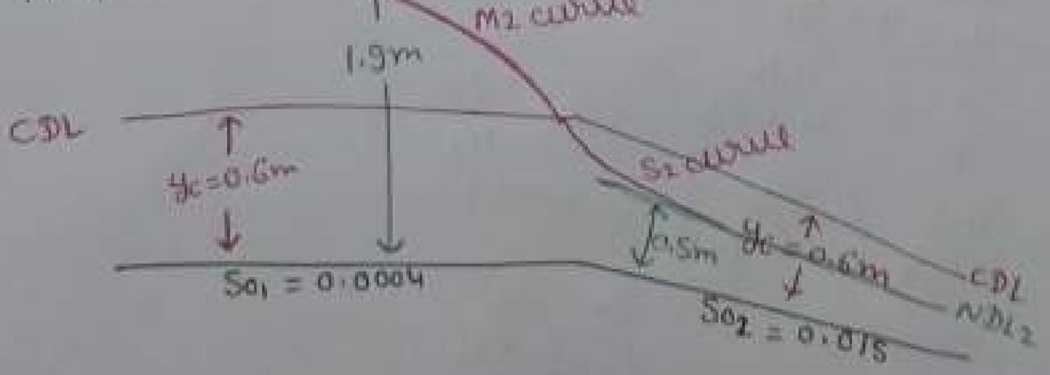
By trial and error method

$y_0 = 0.5m$

$-0.0136 \simeq 0$

$\boxed{y_{o2} = 0.5m}$

NDL > CDL → Mild Slope



CDL > NDL
Steep Slope

(b) $\underline{y_{01}} \rightarrow$

$$Q = \frac{A}{n} R^{2/3} S_0^{1/2}$$

$$6 = \frac{4y_0}{0.025}\left(\frac{2y_0}{2+y_0}\right)^{2/3}(0.005)^{1/2}$$

$$0.334\,(2+y_0)^{2/3} = y_0\,(y_0)^{2/3}$$

$$0.0373\,(2+y_0)^2 - y_0^5 = 0$$

By trial and error method

$y_{01} = 0.7\,m$

$0.1038 \simeq 0$

$$\boxed{y_{01} = 0.7m}$$

$\underline{y_{02}} \rightarrow$

$$Q = \frac{A}{n} R^{2/3} S_0^{1/2}$$

$$6 = \frac{4y_0}{0.025}\left(\frac{2y_0}{2+y_0}\right)^{2/3} \times (0.0004)^{1/2}$$

$$(2+y_0)^{2/3}\,1.181 = y_0 \cdot y_0^{2/3}$$

$$1.648\,(2+y_0)^2 = y_0^5$$

$$y_0^5 - 1.648\,(2+y_0)^2 = 0$$

By trail and error method

$y_{02} = 1.9m$

$-0.305 \simeq 0$

$$\boxed{y_{02} = 1.9\,m}$$