

CEE 7111

PD# 17: Gradually Varied Flow (G.V.F.) Profiles

~ To develop description of G.V.F. flow profiles:

Define Total energy in a wide, rectangular channel:

$$H = z + y + \frac{q^2}{2gy^2} \quad \text{recall } q = vy$$

Take derivative in direction of flow:

For a wide rectangle: $R = y$

$$\text{Manning Eq } S_f = \quad \quad \quad (a)$$

$$S_0 = \quad \quad \quad (b)$$

$$\text{recall } y_c = \quad \quad \quad (c)$$

Rearrange energy derivative:

$$\frac{dy}{dx} = S_0(1 - S_f/S_0)/(1 - q^2/gy^3)$$

Substitute a,b,&c to get:

$$\frac{dy}{dx} = S_0[1 - (y_c/y)^{10/3}]/[1 - (y_c/y)^3]$$

which is the G.V.F. equation:

Limits of the W.S. slope are:

Actual depth, y	0	y_c	y_n	∞
dy/dx	∞	∞	0	S_0

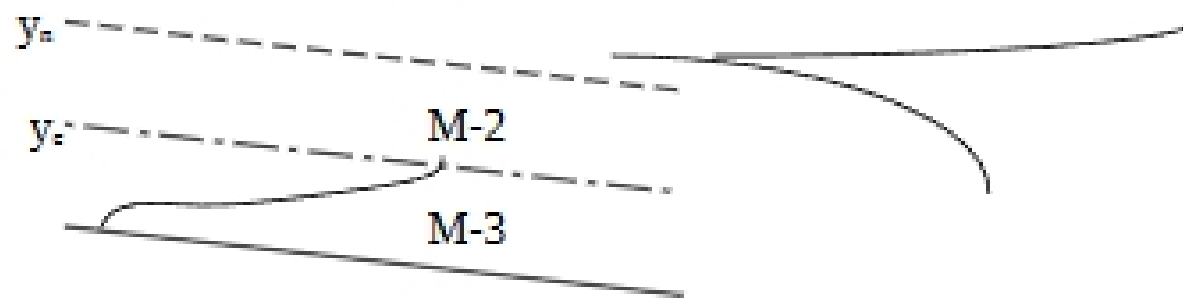
General Types of Profiles:

Mild: $y_n > y_c$

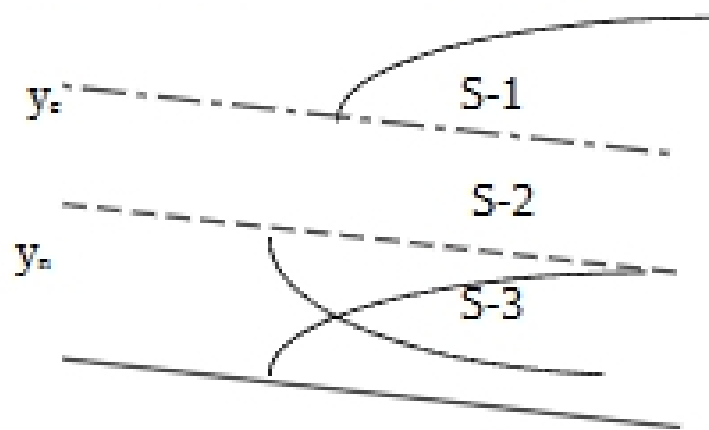
Steep: $y_c > y_n$

Description of Profiles on Mild Slope:

M-1

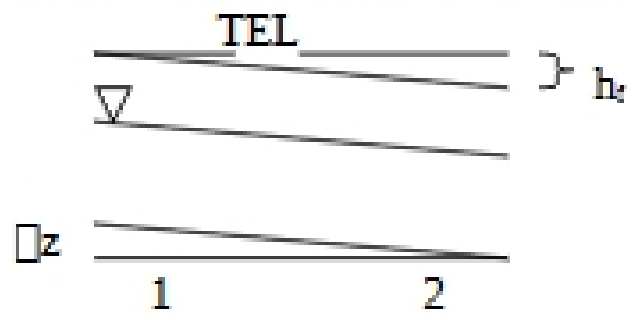


Description of profiles on Steep Slope:



Non-Uniform Flow

I. Start with uniform flow curve:



Total Energy:

$$H_1 = z + y_1 + v_1^2/2g$$

$$H_2 = y_2 + v_2^2/2g$$

* Energy Balance: $H_1 = H_2 + h_f$

How to calculate h_f ? Based on Manning's eq.

$$S_f = [nQ/(1.49A R^{2/3})]^2$$

S_f is constant for this case

Also $h_f = z$

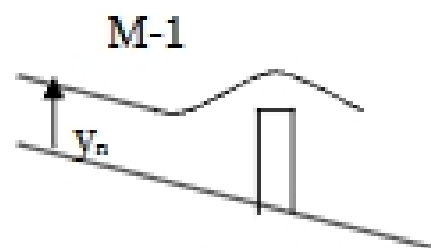
So, $S_o = S_f$

$$\Delta h_f = S_f + \Delta L$$

II Non-Uniform Flow:

~caused by some control which pulls depth away from normal depth.

~There will be a transition between the different controls- a 'water surface profile.'



So, at this point, we consider the gradually varied flow profiles- you cannot tell by eye that the W.S. profile occurs.

III. General Notes on G.V.F. Profiles

1. Need a starting depth (elevation/rating curve)
2. Must have a way to calculate head loss.