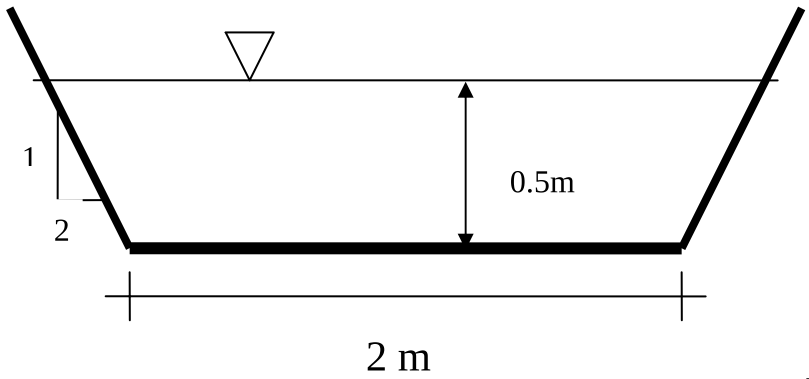
ASSIGMENTS

Problem 1

Given : Trapezoidal earth channel B = 2m, sideslope = 1V:2H, **n=0.02,** S = 0.003m/m, normal depth y = 0.5m .



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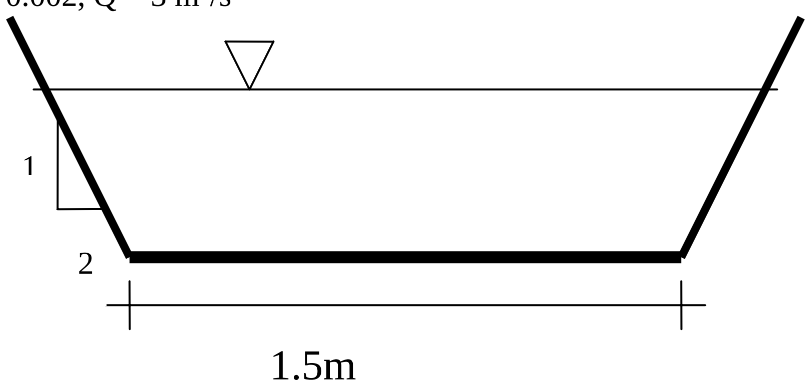
Find : Velocity V and discharge Q

Problem 2

Given : A concrete trapezoidal channel B = 1.5m, sideslope = 1V:2H, n=0.013, slope = 0.002, Q = 3 m^3/s



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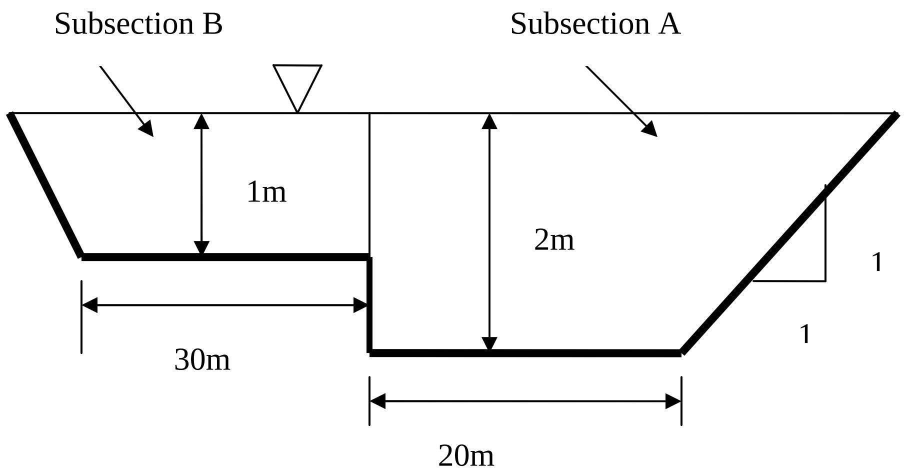
Find : Depth y and velocity v

Problem 3

Given: A compound channel as illustrated, with an n value of 0.03 and a longitudinal slope of 0.002m/m



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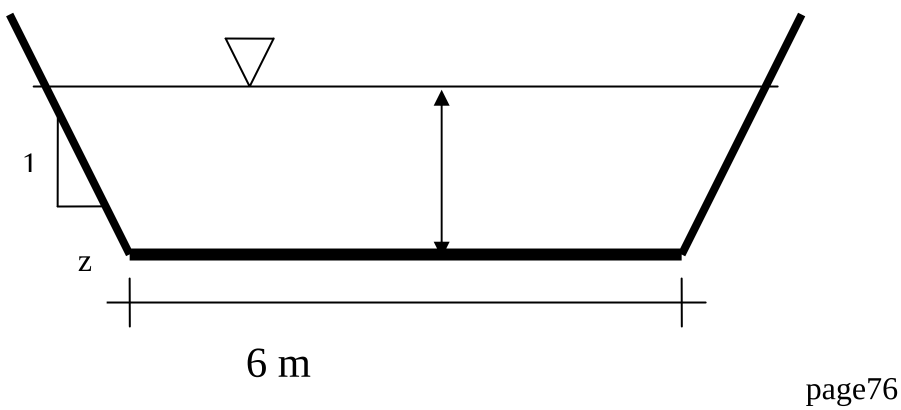
Find: Discharge Q

Problem 4

Given : Determine the critical depth in a trapezoidal shaped swale with z = 1, given a discharge of 9.2m^3/s and bottom Width = 6m. Also, determine the critical velocity.



Find : Critical depth and Velocity at critical depth

WATER HAMMER

Water hammer is the term used to express the resulting shock caused by the sudden decrease in the motion (velocity) of a fluid.

Simply put if the velocity of a liquid in a pipeline is abruptly decreased by a valve movement the phenomenon encountered is called WATER HAMMER.

- It is a very important problem in the case of hydroelectric plants where the flow of water must be rapidly varied in proportion to the load changes on turbine.
- Water hammer occurs in liquid flow pressure systems whenever a valve is closed.
- ***Note: The terminology water hammer may be misleading since the phenomenon can occur in any liquid.***

- In a pipeline the time of travel of the pressure wave up and back (round trip) is given by: $T_r = \frac{2L}{C_p}$
- $T_r =$ time of roundtrip in seconds
- L=Length of pipe in meter
- $C_p =$ Celerity of pressure wave in (m/s)
- **FOR RIGID PIPES (Non-Elastic):** The velocity of pressure wave (sound wave) is commonly referred to as ACOUSTIC VELOCITY.
- $C = \sqrt{\frac{gE_v}{\gamma}} = \sqrt{\frac{E_v}{\rho}} kN/m^2$
- $E_v =$ Volume modulus of the medium. For water a typical value is $2.o7x10^6 kN/m^2$, thus the velocity of pressure wave in water is C=1440m/s.
- **ELASTIC PIPES:** But for water in an elastic pipe this value is modified by the stretching of the pipe walls. E_v is replaced by K such that
- $K = \frac{E_v}{1+\left(\frac{D}{t}\right)\left(\frac{E_v}{E}\right)}$
- D= diameter of the pipe
- t=thickness of the pipe
- E=the modulus of elasticity of the pipe material.

Therefore the velocity of a pressure wave in an **elastic pipe** is;

$$C_p = \sqrt{\frac{gK}{\gamma}} = C\sqrt{\frac{1}{1+\frac{DE_v}{tE}}}$$

For normal pipe dimensions the velocity of a pressure wave in a water pipe usually ranges between <u>600 and 1200m/s</u> but it will always be less than <u>1440m/s.</u>

- The increase in pressure caused by the **sudden closing of a valve** is calculated by;

  $d_p = \rho C_p dV$

- Change in pressure = density x celerity x change in velocity.

INSTANTANEOUS CLOSURE:

In case of instantaneous and complete closure of a valve, the velocity is reduced from V to zero, i.e. $\Delta V = V$, Δp then represents the increase in pressure due to valve closure,

- The water hammer pressure $P_h = \rho C_p V$