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Destorted Model of Dam:-

Models are called distorted if we are not able to maintain full geometric similarity for economic, practical, or physical reasons. In distorted models two scale ratios are used. horizontal scale ratio L_r, and verticle scale ratio Z_r. All dimensions in the horizontal direction are reduced by L_r, while those in the verticle direction are reduced by Z_r. It is not possible to reduce the two dimensions in the horizontal extension (say, length and width) by two different rations. The verticle scale ratio Z_r, applies only to the verticle direction.

Distorted Models are used extensiely in rivers & harbors as flow depth are quite small as compared to other areal dimensional. In such problems for example Z_r, is taken as 1:100, while L is taken as 1:200 or even 1:500.

Complete hydraulic similarity may be difficult to achieve in many cases.

while,

$$Q_{r_v} = A_{r_h} \cdot V_r = L_r^2 Z_r^{1/2}$$

Dimensional Analysis & Similarity:-

Geometric Similarity:- The model must be the same shape as the prototype. Each dimension must be scaled by the same factor.

Kinematic Similarity:- Velocity as any point in the model must be proportional.

Dynamic Similarity:- All forces in the model flow the scale by the constant factor to corresponding forces in the prototype flow.

Complete Similarity:- is achieved only if all 3 conditions are met. This is not always possible e.g river hydraulics models.

Experimental Testing & Incomplete Similarity:-

Flows with free surfaces present unique challanges in achieving complete dynamic similarity.

- For hydraulics applications depth is very small in comparison to horizontal dimensions. If geometric similarity is used, the mode depth would be so small that other issues would arise.
  - Surface tensions effects (weber number) would become important.
  - Data collection becomes difficult.

Distorted models are therefore employed, which, requires empirical corrections/ corrections to extrapolate model data to full scale.

Q4) What are the effects of the following on Fall velocity ....?

Ans:- **Particle Diameter:-** The diameter of a sphere particle has some specific gravity & the terminal uniform setling velocity as the given particle in the some seedimeutation.

Particle Density:- Particle density effect the settling fall velocity. As Air density increases with decreaseing altitude at about 1% per 80 meter (260 ft) for every 160 meter of fall the terminal speed decrease 1%.

Particle Concentration:- When the suspended concentration of sediment increases, the setting velocity of each particles decreases due to the modification of the flow induced by previous particles.

Particle shape:- Non - spherical analogue particle fall up to 75% slower than equilant sphere Model show 100 µm - non spherical particles travel 44% further than sphere verticle structure of modelled volcanic ash cloud is sensitive of modelled valcanic ash ~~cloud~~ cloud is sensitive of Particle shape.

Viscosity of water:-

Fluid velocity through porous media is approximated as inversely proportional to the kinematic viscosity. A decrease in viscosity there fore increases the velocity of a compound through porous media.

Turbulance of water:-

Turbulance of water effect the Fall velocity of water in reservior because the non-linearity & zig-zag path effect the flow of water & cause the variatio in the flow.

Q3:- Using any hydraulic model & explain ......?

Ans :- Dimensional Analysis Similitude & Hydraulic Models:-

Objectives:-

1) Understand dimensions, Units & dimensional homogeneity.
2) Understand benefits of dimensional analysis.
3) Know how to use the the method of analysis.
4) Understand the concept of Similarity & how to apply it to experimental modeling.

Dimensions & Units:-

- Dimension :- Measure of a physical quantity, e.g length, time, mass.
- Units :- Assignment of a number to a dimension eg (m), (sec), (kg).
- 7 primary Dimensions:-

1) Mass	M	(kg)
2) Length	L	(m)
3) Time	t	(sec)
4) Temperature	T	(K)
5) Current	I	(A)
6) Amount of light	C	(cd)
7) Amount of matter	N	(mol)

7) Total width of base of dam:

$b = b' + a/16$

$= 48 + 11.6/16$

$= 48.7$

8) $\tan\theta = \frac{b'}{H}$

$\tan^{-1}(48/77)$

$= 32.31^\circ$

9) Depth of verticle portion on D/s (from WL on U/s side)

$\tan\theta = a/d' = \frac{11.6}{d'}$ $\Rightarrow \tan\theta = \frac{11.6}{d'}$

$\Rightarrow \frac{48}{77} d' = 11.6$

$d' = 893.2/48$

$d' = 18.6 m$

$a = 14\%$ of HD

$a = \frac{14}{100} \times 83.15$

$= 11.641m$

3) Base width 'b' (without off set)

For No Sliding Criteria

$b = \frac{Hw}{\mu G} = \frac{77}{0.7 \times 2.5} = 44m$

Maximum depth Hw

(ii) For No tension Criteria

$b' = \frac{Hw}{\sqrt{G}} = \frac{.77}{\sqrt{2.5}} = 48m$

4) Depth of verticle portion on u/s side

$h' = 2a\sqrt{G - C_v}$

$= 2 \times 11.6 \sqrt{2.5 - 0}$

$h' = 36m$

5) Up stream off set :-

$= a/16$

$= 11.6/16$

$= 0.725m$

6) ~~Total~~ Depth below water level to end of inclined portion in US $= 3.14\, a\sqrt{G}$

$= 3.14 \times 11.6\sqrt{2.5}$

$= 57.5m$

a) Dynamic Similarity requires that all non-dimensional groups be the same in model and prototype; i-e

$$\pi_1 = [\Delta p/\rho V^2]_p = [\Delta p/\rho V^2]_m$$

$$\pi_2 = [h/d]_p = [h/d]_m$$

$$\pi_3 = [\rho V d/\mu]_p = [\rho V d/\mu]_m$$

From the last, we have a velocity ratio.

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)_p}{(\mu/\rho)_m}\frac{d_m}{d_p} = \frac{0.002/800}{1.0\times10^{-6}} \times 1/5 = 0.5$$

Hence,

$$V_m = \frac{V_p}{0.5} = \frac{3.0}{0.5} = 0.6\,ms^{-1}$$

b) The ratio of the quantities of flow is

$$\frac{Q_p}{Q_m} = \frac{(\text{velocity} \times \text{area})_p}{(\text{velocity} \times \text{area})_m} = \frac{V_p}{V_m}\left[\frac{d_p}{d_m}\right]^2 = 0.5\times5^2 = 12.5$$

c) Finally, For the pressure drop

$$\pi_1 = [\Delta p/\rho V^2]_p = [\Delta p/\rho V^2] \Rightarrow \frac{(\Delta p)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left[\frac{V_p}{V_m}\right]^2 = \frac{800}{1000}\times0.5^2$$

$$= 0.2$$

Hence,

$$\Delta P_p = 0.2 \times \Delta P_m = 0.2\times60 = 12.0\,kPa$$

I·D #7797

Q1 A prototype & gate valve will control the flow in a pipe system conveying praffin is to be studied in a model. list the . . . .?

Solution:-

The pressure drop Δp is expected to depend upon the gate opening h, the over all depth d, the velocity V, density ρ and viscosity μ.

List the relevant variables:

$\Delta p, h, d, V, \rho, \mu$.

Dimensions.

Δp	$ML^{-1}T^{-2}$
h	L
d	L
V	LT^{-1}
ρ	ML^{-3}
μ	$ML^{-1}T^{-1}$

Number of variables : $n = 6$

Number of independent dimensions : $m = 3$ (M, L and T)

Number of non-dimensional groups : $n - m = 3$

Choose $m (= 3)$ scaling variables geometric (d) ; kinematic/time-dependent (V); dynamic/mass-dependent (ρ). From dimensionless groups by non-dimensionalising the remaining variables : Δp, h and μ.

$\pi_1 = \Delta p\, d^a V^b \rho^c$

$M^0 L^0 T^0 = (ML^{-1}T^{-2})(L)^a(LT^{-1})^b(ML^{-3})^c$

$= M^{1+c} \cdot L^{-1+a+b-3c}\, T^{-2-b}$

M: $0 = 1 + c \Rightarrow c = -1$

T: $0 = -2 - b \Rightarrow b = -2$

L: $0 = -1 + a + b - 3c \Rightarrow a = 1 + 3c - b = 0$

$\Rightarrow \pi_1 = \Delta p\, V^{-2} \rho^{-1} = \Delta p / \rho V^2$

$\pi_2 = h/d$ (by inspection, since h is a length)

$\pi_3 = \mu d^a V^b \rho^c$

~~$M^0 L^0 T^0 = (M^{1+c} L^{-1+a+b-3c}$~~

$M^0 L^0 T^0 = (ML^{-1}T^{-1})(L)^a(LT^{-1})^b(ML^{-3})^c$

$= M^{1+c} L^{-1+a+b-3c}\, T^{-1-b}$

M: $0 = 1 + c \Rightarrow c = -1$

T: $0 = -1 - b + 0 \Rightarrow b = -1$

L: $0 = -1 + a + b - 3c \Rightarrow a = 1 + 3c - b = -1$

$\Rightarrow \pi_3 = \mu d^{-1} V^{-1} \rho^{-1} = \mu / \rho V d$

Recognition of the Reynolds number suggests that we place π_3 by.

$\pi_3' = (\pi_3)^{-1} = \rho V d / \mu$

Hence dimensional analysis yields

$\pi_1 = f(\pi_2, \pi_3')$

i-e $\Delta p / \rho V^2 = f(h/d, \rho V d / \mu)$

Q2 Design a Practical Profile of gravity dam with the following data.

1) Maximum Depth of water in the ...... ?
2) Specific gravity of dam material .... ?
3) Allowable compressive strength for the dam ...... ?
4) Height of wave is Hw (Can be your own .....)?
5) G & Hw is of your own choice but .... ?

Solution:-

Maximum depth of water in Reservior = H = 77

Specific Gravity of dam material = G = 2.5

Allowable compressive stress for dam Mansory

$= 779\ T/m^3$

Height of wave = 4.1m

No uplift pressure = $C_u = 0$

1) H limiting:-

$$\frac{\sigma_{au}}{\gamma_w (G - C_u + 1)}$$

Put values

$$H_{limiting} = \frac{779 \times 1000}{1000(2.5 - 0 + 1)}$$

$= 222.57m \quad > H_w = 77m$

so it is low gravity dam.

2) Top width 'a':- Free board = $1.5 h_{wave} = 1.5 \times 4.1$

$= 6.15m$

Height of dam = $H_D = H_w + F.B$

$= 77 + 6.15$

$H_D = 83.15m$