different

Name Sajid Saleem

ID # 7793

Section A

Subject Hydraulic Engineering

Submitted to Sir Fawad

Date 25-6-202

1

$P = 1$ ID# 7793

Solution

The Pressure drop ΔP is expected to depends upon the gate opening h, the overall depth, d, the Velocity V, density ρ, & Viscouscity μ

List the releavet Variables

$\Delta P, h, d, V, \rho, \mu$

Their 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 & T)

Number of non-dimensional group $n - m = 3$

Choose m(=3) Scaling Variables

geometric(d): Kinematic/Time-depended (V): dynamic mass dependt

From dimensionless groups by non-dimensionlisting the remaining Variables ΔP, h & μ

$$\pi = \Delta P d^{a} V^{b} \rho^{c}$$

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

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

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

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

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

$$\pi_1 = \Delta P V^{-2} \rho^{-1} = \frac{\Delta P}{\rho V^2}$$

$\pi_2 = \frac{h}{d}$ (by inspection since h is a length)

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

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

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

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

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

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

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

Recognition of the Rynold number suggests that we replace π_3 by $\pi_3' = (\pi_3)^{-1} = \frac{\rho V d}{\mu}$

Hence dimensional analysis yields

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

ie.

$$\frac{\Delta P}{\rho V^2} = f\left(\frac{h}{d}, \frac{\rho V d}{\mu}\right)$$

(a) Dynamic Similarly requires that non-dimensional groups be the same in model & ~~P~~ prototype ie.

$$\pi_1 = \left(\frac{\Delta P}{\rho V^2}\right) = \left(\frac{\Delta P}{\rho V^2}\right)$$

$$\pi_2 = \left(\frac{h}{d}\right)_p = \left(\frac{h}{d}\right)_m \quad \text{Geometric Similarity}$$

$$\pi_3' = \left(\frac{\rho V d}{\mu}\right)_p = \left(\frac{\rho V d}{\mu}\right)_m$$

From the last we have a velocity ratio

$$p = u$$

ID# 7793

$$\frac{V_p}{V_m} = \frac{(u/\rho)_p \, d_m}{(u/\rho)_m \, d_p} = \frac{0.002/800}{1.0 \times 10^{-6}} \times \frac{1}{5} = 0.5$$

Hence

$$V_m = \frac{V_p}{0.5} = \frac{3.0}{0.5} = 6.0 \ m s^{-1}$$

(b) The ratio of the quantities of flow is

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

$$= 0.5 \times 5^2 = 12.5$$

(c) Finally, for the pressure drop

$$\pi_1 = \left(\frac{\Delta P}{\rho V^2}\right)_p = \left(\frac{\Delta P}{\rho V^2}\right)_m \Rightarrow \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p}{\rho_m}\left(\frac{V_p}{V_m}\right)^2$$

$$= \frac{800}{1000} \times 0.5^2 = 0.2$$

Hence

$$\Delta P_p = 0.2 \times \Delta P_m = 0.2 \times 60 = 12.0 \ KPa$$

Ans (2)

Given Data

Maximum Depth of water in Reservoir = H_w = 77 m

Specific Gravity of Dam material = G = 2.5

Allowable Compressive Stress for the Dam masonary σ_{all} = 779 T/m^2

Height of wave = H_{wave} = 1.3

$\mu = 0.7$

$C_u = 0$ (No uplift pressure)

Solution

1) $H_{limiting} = \frac{\sigma_{all}}{\gamma_w (G - C_u + 1)} = \frac{779 \times 1000}{1000(2.5 - 0 + 1)}$

$H_{limiting} = 222.57\ m > H_w = 77\ m$

So It is low gravity Dam

2) Top Width :-

Free board $= 1.5 \cdot h_{wave} = 1.5 \times 1.3 = 1.95$

$F.B = 1.95\ m$

P=6 ID#7793

height of Dam $= H_D = H_w + F.B = 77 + 1.95 = 78.95$

$H_D = 78.95m$

Now

$a = 14\%$ of H_D

$= \frac{14}{100} \times 78.59$

$a = 11.05m$

3) Base Width b" (without offset)

i) For No sliding Criteria

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

$b' = 44m$

ii). For No tension Criteria

$b' = \frac{H_w}{\sqrt{G}} = \frac{77}{\sqrt{2.5}} = \frac{77}{1.58}$

$b' = 48.73m$

we will use $b' = 48.73m$

Scanned with CamScanner

P = 7 ID# 7793

4) Depth of verticle Portion on U/S Side

$h' = 2a\sqrt{C_1 - C_u}$

$h' = 2 \times 11.05 \sqrt{2.5 - 0}$

$h' = 22.1 \times \sqrt{2.5}$

$h' = 34.94\ m$

$h' = 35\ m$

5) upstream off set $= \frac{a}{16}$

$= \frac{11.05}{16} = 0.70\ m$

$= 0.70\ m$

6) Depth below the water level to the end of Inclined portion in U/S $= 3.14a\sqrt{C_1}$

$= 3.14 \times 11.05 \times \sqrt{2.5}$

$= 54.86\ m$

7) Total width of the base of dam

$b = b' + \frac{a}{16} = 48.73 + \frac{11.05}{16}$

$b = 48.73 + 0.70$

b = 49.42m

8) $\tan \phi = \dfrac{b'}{H}$

$\tan \phi = \dfrac{48.73}{77}$

$\tan \phi = 0.63$

$\phi = \tan^{-1} 0.63$

$\phi = 32.2^\circ$

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

$\tan \phi = \dfrac{a}{d'} = \dfrac{11.05}{d'}$

$\Rightarrow \tan \phi = \dfrac{11.05}{d'}$

$d' = \dfrac{11.05}{\tan \phi} = \dfrac{11.05}{\tan 32.2^\circ}$

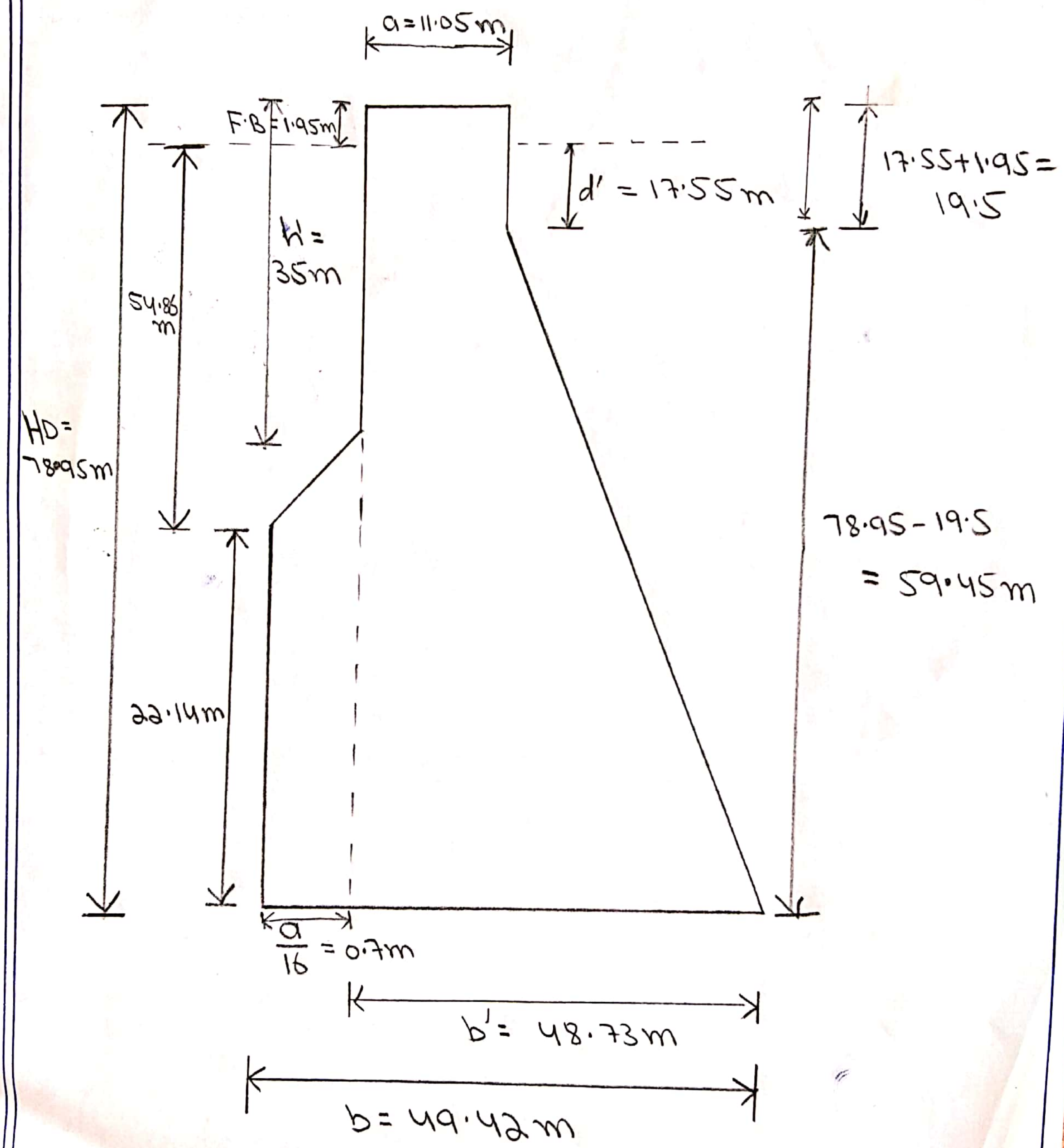
$d' = 17.55m$

depth of verticle Portion

$d = d' + F.B = 17.55 + 1.95$

$d = 19.5m$

P = 9 ID#7793


a=11.05m
F.B=1.95m
d' = 17.55m
17.55+1.95=
19.5
H=
35m
54.86
m
HD=
78.95m
78.95-19.5
= 59.45m
22.14m
a/16 = 0.7m
b'= 48.73m
b= 49.42m

Ans (3)

Similitude & Model Analysis:-

⇒ Similitude is a Concept used in testing of engineering model.

⇒ Experimental Investigation are often Performed on small Scale model Called model Analysis

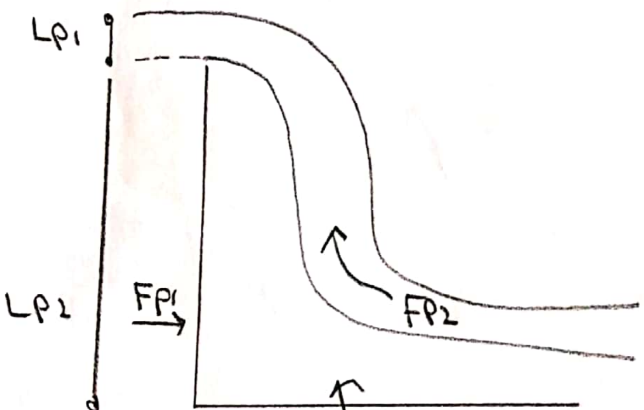
⇒ A few example where model may be used are Ships, airplane, spillsways of dam. Centifugal pumps, hydraulic turbines, river channel etc.

Model Analysis:-

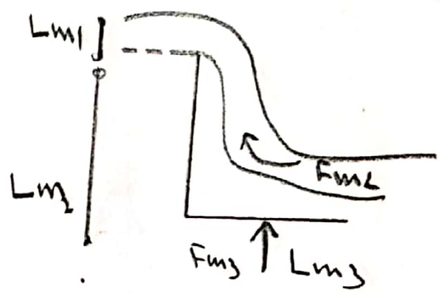
Model is a small Scale replica of the actual model while prototype is the actual structure or machine.

It is not necessory that models should be smaller then that of prototype, they may larger then prototype

- Model Analysis is actually an experimental method of finding solution of complex flow problem.



Prototype



Model

Model Analysis:

It is actually an experimental method of finding solution of complex flow problems

Advantages of Model Analysis

Using Dimensional Analysis, a relationship b/w the Variables Influences a flow problem is obtained which held in Conducting tests.

- The Performance of the hydraulic structure Can be predicted in advance form it model.
- The merits of Alternative design Can be predicated with the help of model Analysis to adopt most economical & Safe design.

☆ Similitude:-

It is defined as Similarity b/w the model & Prototype in every respect which mean model & Phototype have Similar properties or model & Prototype are Completly Similar

Types of Similitude

1) Geometric Similarity:-

It is the Similarity of shape. It is Said to exist b/w model & Prototype ratio of all the Corresponding linear dimension in the model & prototype are equal.

$$\frac{L_p}{L_m} = \frac{B_p}{B_m} = \frac{D_p}{D_m} = L_r$$

2) Kinematic Similarity:-

It is the Similarity of motion. It is Said to exist b/w model & Prototype. It is the ratio of velocities & accelaration at the Corresponding points in the middle &

Prototype are equal

$$\frac{V_{p1}}{V_{m1}} = \frac{V_{p2}}{V_{m2}} = V_r \; : \; \frac{a_{p1}}{a_{m1}} = \frac{a_{p2}}{a_{m2}} = a_r$$

3) Dynamic Similarity:-

It is the Similarity of forces

It is said to exist b/w models & Prototype if the ratio of forces at the corresponding points in model & prototype are equal

$$\frac{(F_i)_p}{(F_i)_m} = \frac{(F_v)_p}{(F_v)_m} = \frac{(F_g)_p}{(F_g)_m} = F_r$$

Dimensional Analysis and Similarity

In most experiments to Save time & money, test are performed on geometically Scaled model rether then on the full Scale prototype. In Such Cases Care must be taken, to properly Scaled the result. We Introduce there a powerful technique Called dimensional Analysis

Purposes of Dimensional Analysis

1) To generate non dimentional parameters that help in the design of experiments & in the reporting of experimental result.

2) To obtaining Scaling laws so that prototype Performance Can predicated from model performance.

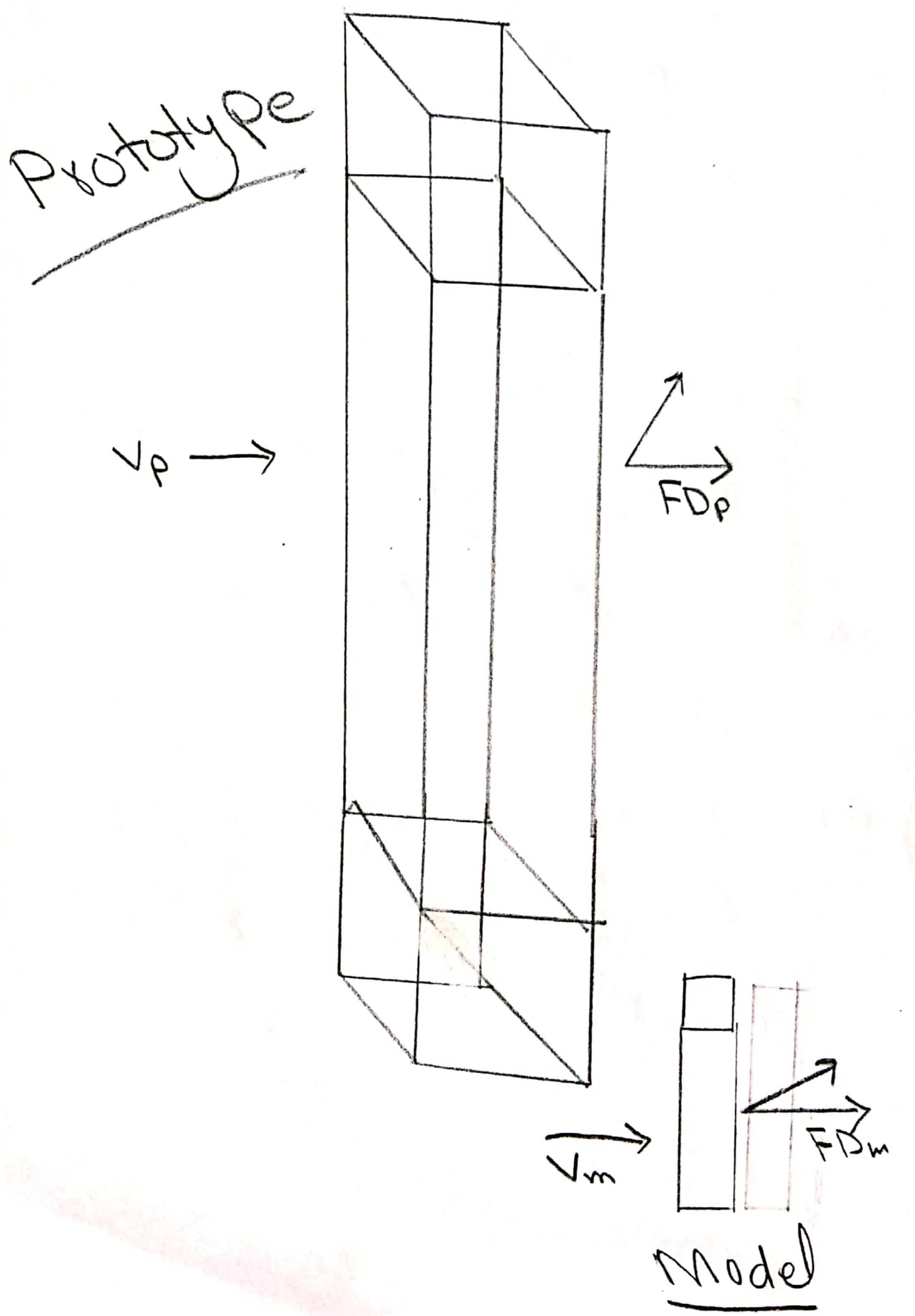
3) To predicated trends in the relationship b/w parameters.

There are three necessary conditions for complete similary b/w model & prototype.

i) Geometric Similarity.
ii) Kinematic Similarity
iii) Dynamic Similarity.

⇒ The first condition is geometric similarity the model must be same shape as the phototype - but may be scaled by some constant scale factor.

⇒ The second condition is kinematic similarity which mean that the velocity at any point in the model flow must be proportional to the velocity at the corresponding point in the prototype flow.



The third & most restrictive Similarity is that of dynamic Similarity

It is achived when all the forces in the model flow Scale by Const factor to the Correspondig forces in the prototype flow (force Scale equivalence)

Thus
⇒ All three Similarity Conditions must exist for Complete Similarity to be ensured

For Dimensional Analysis

$$\pi_1 = f(\pi_2, \pi_3 \dots \pi_K)$$

where K is total no of pi's

Mathematically we write a Conditional statement for Similarity as

$\pi_{2m} = \pi_{2p}$ & $\pi_{3m} = \pi_{3p}$ and $\pi_{K_m} = \pi_{K_p}$

then $\pi_{1m} = \pi_{1p}$

a

P=19 ID# 7793

Ans 4

Fall Velocity:-

When a grain falls down in still water it obtain a constant velocity when the upward fluid drag force on the grain is equal to the downward submerged weight of the grain, This constant velocity is defined as the fall velocity of the grain.

This is also known as Setting Velocity.

Factors Depends:

1) Particle Diameter:-

As fall velocity of Sediment is given by

$$w_s = \sqrt{\frac{4gd}{3C_D}\left(\frac{\rho_s - \rho}{\rho}\right)} \quad \text{--- (1)}$$

As $w_s \propto d$

From above equation, Fall Velocity of the Sediment is directly Proportion to the diameter of the Particle.

ii) Particle Density:-

From equation (1)

$W_s \propto \rho_s$ where W_s = Fall Velocity & ρ_s = Density of Sediment

So, Fall Velocity of the Sediment is directly proportional to density of sediment

iii) Particle Concentration

Velocity of fall is directly proportional to Particle Concentration. So by Increasing the Concentration of Particles, the fall velocity also Increases.

iv) Shape of Particle:-

Smooth (Round shapes) Particles will sit quackly, so the Fall velocity for such Particles will be more. And for Angular Shape Particles the fall velocity will be less because such Particles will sit slowly.

P=21 ID# 7793

v) Viscosity of water

Viscosity has inverse relation with the fall velocity of Particle.
So, by increasing the viscosity of water the flow resistance for the Particle increases & hence the fall velocity of Particle increases.

c) Turbulence

Turbulence has direct effect on the fall velocity of Sediments.

Turbulence act Perpendicular on Particles thus increasing the turbulence the fall velocity also increases.