(1) Settling velocity, $V_s = \frac{gd^2}{18\nu}(G-1)$

$\Rightarrow V_s = \frac{9.81 \times (20\times10^{-6})^2}{18 \times 8\times10^{-7}}(2.65-1)$

$\Rightarrow \boxed{V_s = 4.496\times10^{-4}\ m/sec}$

Scouring velocity, $V_{sc} = 4\sqrt{gd(G-1)}$

$= 4\sqrt{9.81\times1.65\times20\times10^{-6}}$

$\boxed{V_{sc} = 0.072 m/sec}$

S.O.R $= V_s = 4.496\times10^{-4}\ m^3/m^2$ per sec

$Q = 25\ MLD = \frac{25\times10^3}{86400}\ m^3/sec$

$\Rightarrow \boxed{Q = 0.289 m^3/sec}$

S.O.R $= \frac{Q}{A}$

$\Rightarrow 4.496\times10^{-4} = \frac{0.289}{A}$

$\Rightarrow \boxed{A_{req} = 643.07 m^2}$

Let us provide $L = 60m$, $B = 12m$

Hydraulic retention time, $\theta = \frac{LBD}{Q}$

$\Rightarrow (3\times3600) = \frac{60\times12\times D}{0.289}$

$\Rightarrow \boxed{D = 4.33m}$

Horizontal velocity, $V_H = \frac{Q}{BH} = \frac{0.289}{12\times4.33}$

$\Rightarrow V_H = 0.0056 m/sec < V_{sc}$

hence, ok.

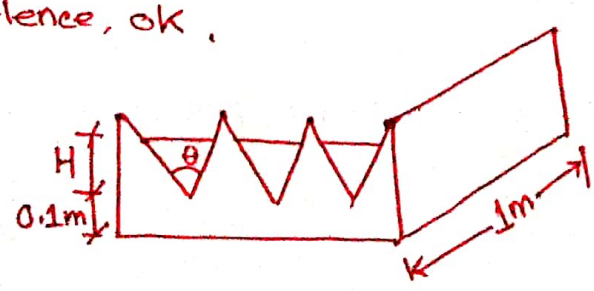
Effluent Launder:

$Q = C_e \tan\left(\frac{\theta}{2}\right)(H+K)^{5/2}$

$\theta = 90°$,

$C_e = 1.53$,

$K = 8.99\times10^{-4}$



Loading rate = $12 m^3/m$ per hour

Length required = $\frac{0.289 \times 3600}{12} = 86.7 m$

provide, 174 weirs of 0.5m width each

Flow/weir = $\frac{0.289}{174} = 1.66 \times 10^{-3} m^3$

$1.66 \times 10^{-3} = 1.53 \tan 45 \, (H + 8.99 \times 10^{-4})^{5/2}$

$\Rightarrow \boxed{H = 0.064 m}$

Retention time, $\theta = \frac{Vol}{Q}$

$\Rightarrow \theta = \frac{86.7 \times 1 \times (0.1 + 0.064)}{0.289}$

$\Rightarrow \boxed{\theta = 49.2 \text{ sec}}$

efficiency calculation

here is the corrected table

$V_s = \frac{g d^2 (G-1)}{18 \nu}$

$V_s = \frac{1.124 d^2}{10^3}$ mm/sec

↑ Mm

Size, Mm	30	20	15	10	5
Wt fraction less than	95	80	55	25	0
V_s (mm/sec)	1.012	0.449	0.253	0.112	0.028
Wt fraction (%)	5	15	25	30	25

} very important

80% particles have settling velocity less than S.O.R

$\therefore$ 20% particle will be completely removed and rest of them will be removed in the ratio of $\frac{V_s}{S.O.R}$

$\boxed{S.O.R = V_s = 0.449 \text{ mm/sec}}$

$\therefore$ Efficiency of removal

$= (100 - 80) + 25 \times \frac{0.253}{0.449} + 30 \times \frac{0.112}{0.449} + 25 \times \frac{0.028}{0.449}$

$= 20 + 14.08 + 7.48 + 1.56$

$= 43.12\%$

can also be solved graphically

② Avg imperviousness co-efficient = $0.5\times70 + 0.3\times80 + 0.2\times15$

$= 35+24+3 = 62$

1 year frequency → 26 storms in 26 years

duration of storm = inlet time = 12 minutes

From table:

For 10 min duration:

intensity, $I = 60 - \frac{60-50}{41-25}\times(26-25) = 59.375$ mm/hour

For 15 min duration

intensity, $I = 50 - \frac{50-45}{45-20}\times(26-20) = 48.8$ mm/hour

∴ for 12 min duration, $I = 48.8 + \frac{59.375-48.8}{15-10}\times(15-12)$

$I = 55.145$ mm/hour

Run-off co-efficient, C value from the table for a 12 min storm is:

$C = 0.365 + \frac{0.427-0.365}{20-10}\times(12-10)$

$= 0.3774$

Flow, $Q = CIA$ ← Area

$\Rightarrow Q = 0.3774 \times \frac{55.145}{10^3\times3600}\times(5\times10^4)$

$\boxed{Q = 0.289\ m^3/sec}$

half flow velocity, $v = 1$ m/sec

$Q = v.A$

$\Rightarrow 0.289 = 1\times\left(\frac{\pi D^2}{8}\right)$

$\Rightarrow D = 0.857$m

Provide, $\boxed{D = 0.86m}$

Check for slope:

$V = \frac{1}{n} R^{2/3} S^{1/2}$ 'R' value same for full & half flow

$\Rightarrow 1 = \frac{1}{0.013}\left(\frac{0.86}{4}\right)^{2/3} S^{1/2}$

$\Rightarrow S_{req} = 1.312$ m in 1000 m

< 6.05m in 1000m

hence ok