

التمرين الثاني

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F$$

F

F

-:

(F)

$$F = \frac{1}{m+1} + \frac{1}{2N} + \frac{\sqrt{m-1}}{6N^2}$$

-:

= m

= N

$$H_L = H_e + 1.1 H_f \pm \Delta H_z$$

$$H_L = H_{sp} + 0.75 H_f \pm 0.5 \Delta H_z + H_f$$

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$$h_L \leq \frac{20}{100} H_{SP} = 1.1 H_f \pm \Delta H_z$$

. F

$$H_{main} = H_L + 1.1(H_f)_{main} \pm (\Delta H_z)_{main}$$

H_f

$$H_f = 1.22 \times 10^0 \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F$$

$$h_L \leq \frac{20}{100} H_{SP} = 1.1 H_f \pm \Delta H_z$$

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$$\frac{\pi}{4} d^2 = \frac{Q}{V}$$

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$$\begin{aligned} L &= 200 \text{ m} & S &= 1\% \downarrow & P_{sp} &= 280 \text{ kPa} \\ \therefore h_L &\leq \frac{20}{100} H_{sp} \\ \therefore h_L &= \frac{20}{100} \times \frac{280}{9.81} = 0.20 \times 28.54 = 5.71 \text{ m} \\ \therefore h_L &= 1.1 H_f \pm \Delta H_z \\ 5.71 &= 1.1 H_f - \frac{1}{100} \times 200 \\ \therefore H_f &= \frac{5.71 + 2.0}{1.1} = 7 \text{ m} \end{aligned}$$

$$H_L = H_e + H_f + H_s \pm \Delta H_z$$

$$\Delta H_z = +25 \text{ cm}/100 \text{ m}$$

$$\begin{aligned} H_e &= H_L - H_f - H_s - \Delta H_z \\ &= 3 \times 10 - 1.10 \times \left(\frac{0.3 \times 10}{100} \times 190 \right) - \frac{0.25}{100} \times 190 \\ &= 30 - 6.27 - 0.475 = 23.255 \text{ m} \\ P_e &= 2.3255 \text{ kg}/\text{cm}^2 \end{aligned}$$

$$\begin{aligned} d &= 100 \text{ mm} & N_{sp} &= 13 & S_s &= 12 \text{ m} & S_1 &= 6 \text{ m} & Q_{sp} &= 3.7 \text{ m}^3/\text{hr} \\ P_{sp} &= 2.7 \text{ kg}/\text{cm}^2 & CHW &= 140 & F &= 0.36 & HL - H_e &= ? & HL &= ? \\ S &= 1.5\% = 0.015 \uparrow \end{aligned}$$

$$\begin{aligned} Q_{sp} &= 3.7 \text{ m}^3/\text{hr} = \frac{3.7 \times 1000}{3600} = 1.0278 \text{ L}/\text{sec} \\ L &= S_1 + S_s (N_{sp} - 1) = 6 + 12(13 - 1) = 150 \text{ m} \\ Q_L &= N_{sp} \times Q_{sp} = 13 \times 1.0278 = 13.36 \text{ L}/\text{sec} \end{aligned}$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F$$

$$H_f = 1.22 \times 10^{10} \times 150 \times \left(\frac{13.36}{140} \right)^{1.852} \times 100^{-4.87} \times 0.36 = 1.54 \text{ m}$$

$$H_L - H_e = 1.1 H_f \pm \Delta H_z$$

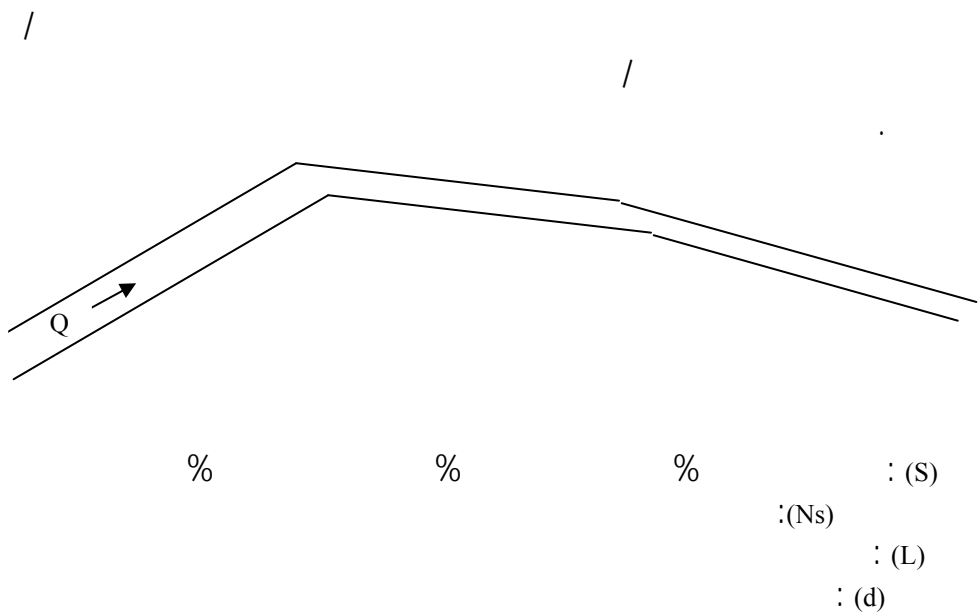
$$H_L - H_e = 1.1 \times 1.54 + 0.015 \times 150 = 1.694 + 2.25 = 3.944 \text{ m}$$

$$H_L = H_{sp} + 0.75 H_f + H_r + 0.5 \Delta H_z$$

$$\text{ : (Hr = 1.5 m) ,$$

$$H_L = 2.7 \times 10 + 0.75 \times 1.54 + 1.5 + 0.50 \times 0.015 \times 150$$

$$= 27 + 1.16 + 1.5 + 1.123 = 30.78 \text{ m}$$



$$Q_{s_3} = N_s \times Q_{sp} = 6 \times \frac{10}{60} = 1 \text{ Lit/sec}$$

$$Q_{s_2} = N_s \times Q_{sp} = 11 \times \frac{10}{60} = 1.833 \text{ Lit/sec}$$

$$Q_{s_1} = N_s \times Q_{sp} = 19 \times \frac{10}{60} = 3.17 \text{ Lit/sec}$$

$$F_3 = \frac{1}{m+1} + \frac{1}{2N_3} + \frac{\sqrt{m-1}}{6N_3^2} = \frac{1}{1.852+1} + \frac{1}{2 \times 6} + \frac{\sqrt{1.852-1}}{6 \times 6^2} = 0.438$$

$$F_2 = \frac{1}{m+1} + \frac{1}{2N_2} + \frac{\sqrt{m-1}}{6N_2^2} = \frac{1}{1.852+1} + \frac{1}{2 \times 5} + \frac{\sqrt{1.852-1}}{6 \times 5^2} = 0.457$$

$$F_1 = \frac{1}{m+1} + \frac{1}{2N_1} + \frac{\sqrt{m-1}}{6N_1^2} = \frac{1}{1.852+1} + \frac{1}{2 \times 8} + \frac{\sqrt{1.852-1}}{6 \times 8^2} = 0.4155$$

$$H_{f3} = 1.22 \times 10^{10} \times L_3 \times \left(\frac{Q_{s3}}{C_{HW}} \right)^{1.852} \times d_3^{-4.87} \times F_3$$

$$H_{f3} = 1.22 \times 10^{10} \times 72 \times \left(\frac{1}{145} \right)^{1.852} \times 25^{-4.87} \times 0.438 = 5.95\text{m}$$

$$H_{f2} = 1.22 \times 10^{10} \times L_2 \times \left(\frac{Q_{s2}}{C_{HW}} \right)^{1.852} \times d_2^{-4.87} \times F_2$$

$$H_{f2} = 1.22 \times 10^{10} \times 60 \times \left(\frac{1.833}{145} \right)^{1.852} \times 37^{-4.87} \times 0.457 = 2.354\text{m}$$

$$H_{f1} = 1.22 \times 10^{10} \times L_1 \times \left(\frac{Q_{s1}}{C_{HW}} \right)^{1.852} \times d_1^{-4.87} \times F_1$$

$$H_{f1} = 1.22 \times 10^{10} \times 96 \times \left(\frac{3.17}{145} \right)^{1.852} \times 50^{-4.87} \times 0.4155 = 2.174\text{m}$$

$$H_{f_{\text{total}}} = H_{f1} + H_{f2} + H_{f3}$$

$$H_{f_{\text{total}}} = 2.174 + 2.354 + 5.95 = 10.48\text{m}$$

$$(H)_{LS1} = 0.10 H_{f_{\text{total}}} = 0.10 \times 10.48 = 1.048\text{m}$$

$$HL = H_{f_{\text{total}}} + H_{Ls} \pm \sum \Delta H_z + H_e$$

$$HL = 10.48 + 1.048 + \frac{4}{100} \times 96 - \frac{1}{100} \times 60 - \frac{2}{100} \times 72 + (3 \times 10) = 43.33\text{m}$$

$$PL = 4.333 \text{ kg/cm}^2$$

(C_{HW}=150)

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$$L = 330 \text{ m} \quad C_{HW} = 150 \quad N_L = 2 \quad \Delta H_Z = 0 \quad Q_L = 16 \text{ m}^3/\text{hr}$$

$$P_L = 2.3 \text{ bar} \quad P_{\text{main}} = ?$$

$$Q_{\text{main}} = 1 \times Q_L = 1 \times 16 = 16 \text{ m}^3/\text{hr} = 0.00444 \text{ m}^3/\text{sec} = 4.44 \text{ Lit}/\text{sec}$$

$$H_L = \frac{P_L}{\gamma} = \frac{2.3 \times 100}{9.81} = 23.44 \text{ m}$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{\text{HW}}} \right)^{1.852} \times d^{-4.87}$$

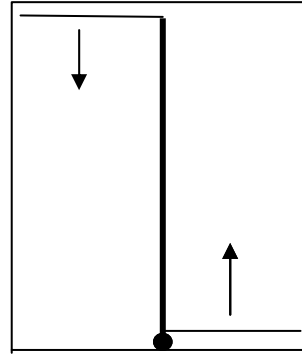
$$H_f = 1.22 \times 10^{10} \times 330 \times \left(\frac{4.44}{150} \right)^{1.852} \times 75^{-4.87} = 4.39 \text{ m}$$

$$\therefore H_L = H_{\text{main}} - 1.1 H_f \pm \Delta H_z$$

$$\therefore H_{\text{main}} = H_L + 1.1 H_f \pm 0$$

$$\therefore H_{\text{main}} = 23.44 + (1.1 \times 4.39) = 28.27 \text{ m}$$

$$P_{\text{main}} = H_{\text{main}} \times \gamma = 28.27 \times 9.81 = 277 \text{ kPa} = 2.77 \text{ bar}$$



$$H_{f1} = 1.22 \times 10^{10} \times 165 \times \left(\frac{4.44}{150} \right)^{1.852} \times 75^{-4.87} = 2.195 \text{ m}$$

$$H_{f2} = 1.22 \times 10^{10} \times 165 \times \left(\frac{4.44}{150} \right)^{1.852} \times 50^{-4.87} = 15.8 \text{ m}$$

$$H_f = H_{f1} + H_{f2} = 2.195 + 15.8 = 18 \text{ m}$$

$$\therefore H_{\text{main}} = H_L + 1.1 H_f$$

$$\therefore H_{\text{main}} = 23.44 + (1.1 \times 18) = 43.24 \text{ m}$$

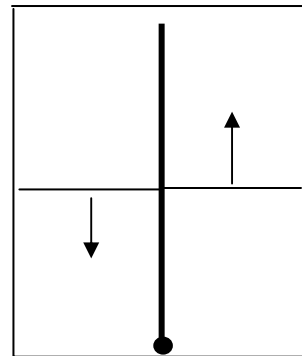
$$P_{\text{main}} = H_{\text{main}} \times \gamma = 43.24 \times 9.81 = 424.18 \text{ kPa} = 4.24 \text{ bar}$$

$$Q_{\text{main}} = 2 \times Q_L = 2 \times 16 = 32 \text{ m}^3/\text{hr} = 0.00888 \text{ m}^3/\text{sec} = 8.88 \text{ Lit}/\text{sec}$$

$$H_f = 1.22 \times 10^{10} \times 175 \times \left(\frac{8.88}{150} \right)^{1.852} \times 75^{-4.87} = 7.92 \text{ m}$$

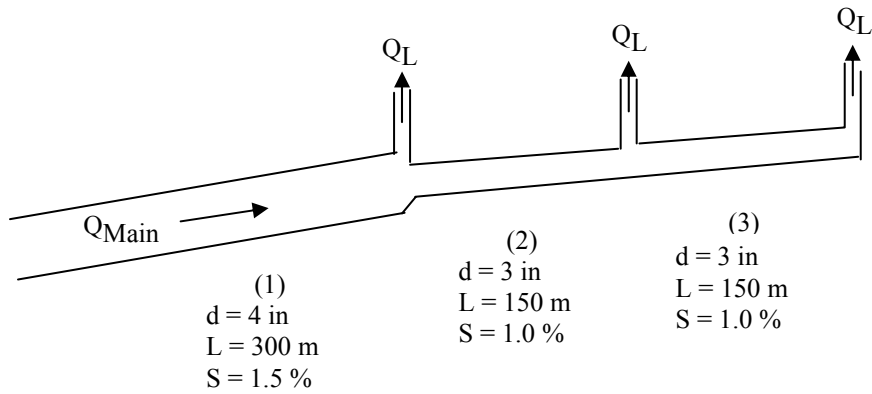
$$\therefore H_{\text{main}} = 23.44 + (1.1 \times 7.92) = 32.15 \text{ m}$$

$$P_{\text{main}} = H_{\text{main}} \times \gamma = 32.15 \times 9.81 = 315.4 \text{ kPa} = 3.15 \text{ bar}$$



$$P_{\text{main}} = 3.15 \text{ bar}$$

(CHW=150) PVC
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$$C_{HW} = 150 \quad N_L = 3 \quad Q_L = 4 \text{ L/sec} \quad P_L = 345 \text{ kPa} \quad P_{\text{main}} = ?$$

$$Q_3 = 1 \times Q_L = 1 \times 4 = 4 \text{ Lit/sec}$$

$$Q_2 = 2 \times Q_L = 2 \times 4 = 8 \text{ Lit/sec}$$

$$Q_1 = 3 \times Q_L = 3 \times 4 = 12 \text{ Lit/sec}$$

$$H_{f3} = 1.22 \times 10^{10} \times 150 \times \left(\frac{4}{150}\right)^{1.852} \times (3 \times 25.4)^{-4.87} = 1.61 \text{ m}$$

$$H_{f2} = 1.22 \times 10^{10} \times 150 \times \left(\frac{8}{150}\right)^{1.852} \times (3 \times 25.4)^{-4.87} = 5.81 \text{ m}$$

$$H_{f1} = 1.22 \times 10^{10} \times 300 \times \left(\frac{12}{150}\right)^{1.852} \times (4 \times 25.4)^{-4.87} = 5.73 \text{ m}$$

$$\therefore H_{\text{main}} = H_L + 1.1 H_f \pm \Delta H_z$$

$$\therefore H_{\text{main}} = \frac{345}{9.81} + 1.1 \times (1.61 + 5.81 + 5.73) + \left(\frac{1.5}{100} \times 300\right) + \left(\frac{1.0}{100} \times 150\right) + \left(\frac{1.0}{100} \times 150\right)$$

$$\therefore H_{\text{main}} = 35.17 + 1.1 \times (13.15) + 4.5 + 1.5 + 1.5$$

$$\therefore H_{\text{main}} = 57.135 \text{ m}$$

$$\therefore P_{\text{main}} = H_{\text{main}} \times \gamma = 57.135 \times 9.81 = 560.5 \text{ kPa}$$

$$\left(\frac{C_{HW}}{145} \right) \left(\frac{Q_L}{Q_{SP}} \right)^{1.852} \times d^{-4.87} \times F F$$

$$C_{HW} = 140 \quad N_{SP} = 20 \quad S_s = 9 \text{ m} \quad S_1 = 4.5 \text{ m} \quad Q_{SP} = 20 \text{ L/min}$$

$$P_{sp} = 2.0 \text{ bar} \quad d = ?$$

$$L = S_1 + S_s(N_{SP} - 1) = 4.5 + 9(20 - 1) = 175.5 \text{ m}$$

$$Q_L = N_{SP} \times Q_{SP} = 20 \times \frac{20}{60} = 6.666 \text{ L/sec}$$

$$\therefore h_L \leq \frac{20}{100} H_{SP}$$

$$\therefore h_L = \frac{20}{100} \times (2 \times 1.02 \times 10) = 4.1 \text{ m}$$

$$F F = 0.365$$

$$\mathbf{A:} \quad S = 0 \quad \text{or} \quad \Delta H_z = 0$$

$$\therefore h_L = 1.1 H_f \pm \Delta H_z$$

$$4.1 = 1.1 H_f$$

$$\therefore H_f = \frac{4.1}{1.1} = 3.73 \text{ m}$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F F$$

$$3.73 = 1.22 \times 10^{10} \times 175.5 \times \left(\frac{6.666}{140} \right)^{1.852} \times d^{-4.87} \times 0.365$$

$$d = 66 \text{ mm} = 2.6 \text{ in}$$

$$d_{act} = 3 \text{ in}$$

$$\mathbf{B:} \quad S = 2\% \downarrow$$

$$\therefore h_L = 1.1 H_f \pm \Delta H_z$$

$$4.1 = 1.1 H_f - \frac{2}{100} \times 175.5$$

$$\therefore H_f = \frac{4.1 + 3.51}{1.1} = 6.92 \text{ m}$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F$$

$$6.92 = 1.22 \times 10^{10} \times 175.5 \times \left(\frac{6.66}{140} \right)^{1.852} \times d^{-4.87} \times 0.365$$

$$d = 59 \text{ mm} = 2.3 \text{ in}$$

$$d_{\text{act}} = 2.5 \text{ in}$$

C: $S = 2\% \uparrow$

$$\therefore h_L = 1.1 H_f \pm \Delta H_z$$

$$4.1 = 1.1 H_f + \frac{2}{100} \times 175.5$$

$$\therefore H_f = \frac{4.1 - 3.1}{1.1} = 0.91 \text{ m}$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87} \times F$$

$$0.91 = 1.22 \times 10^{10} \times 175.5 \times \left(\frac{6.66}{140} \right)^{1.852} \times d^{-4.87} \times 0.365$$

$$d = 89 \text{ mm} = 3.49 \text{ in}$$

$$d_{\text{act}} = 3.5 \text{ in}$$

$$\mathbf{D:} \quad \therefore \Delta H_z \geq \frac{20}{100} H_{\text{SP}}$$

$$\therefore \Delta H_z = \frac{20}{100} \times (2 \times 1.02 \times 10) = 4.1 \text{ m}$$

$$\therefore h_L = 1.1 H_f \pm \Delta H_z$$

$$4.1 = 1.1 H_f + 4.1$$

$$\therefore H_f = 0 \quad \text{or} \quad -$$

$$V = 2 \text{ m/sec}$$

$$A = \frac{Q}{V} = \frac{0.0066}{2} = 0.0033 \text{ m}^2$$

$$d = 0.065 \text{ m} = 65 \text{ mm}$$

$$(C_{HW}=150)$$

$$L_{\text{main}} = 240 \text{ m} \quad C_{HW} = 150 \quad N_L = 4 \quad \Delta H_Z = 0 \quad Q_{\text{SP}} = 1.5 \text{ m}^3/\text{hr}$$

$$H_L = 25 \text{ m} \quad D_{\text{main}} = ? \quad P_{\text{main}} = ?$$

$$Q_{\text{main}} = 2 \times Q_L = 2 \times (N_{\text{SP}} \times Q_{\text{SP}}) = 2 \times (10 \times 1.5) = 30 \text{ m}^3/\text{hr} = 0.00833 \text{ m}^3/\text{sec}$$

$$A = \frac{Q}{V} = \frac{0.00833}{2} = 0.004166 \text{ m}^2 \quad \therefore \frac{\pi}{4} d^2 = 0.004166$$

$$\therefore d = 0.073 \text{ m} = 73 \text{ mm} = 2.87 \text{ in}$$

$$\therefore d_{\text{act}} = 3 \text{ in} = 76.2 \text{ mm}$$

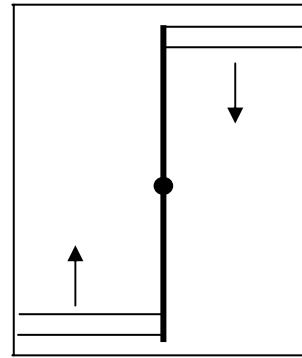
$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{HW}} \right)^{1.852} \times d^{-4.87}$$

$$H_f = 1.22 \times 10^{10} \times 120 \times \left(\frac{8.33}{150} \right)^{1.852} \times 76.2^{-4.87} = 4.73 \text{ m}$$

$$\therefore H_{\text{main}} = H_L + 1.1 H_f \pm \Delta H_Z$$

$$\therefore H_{\text{main}} = 25 + (1.1 \times 4.73) + 0 = 30.2 \text{ m}$$

$$P_{\text{main}} = H_{\text{main}} \times \gamma = 30.2 \times 9.81 = 296.26 \text{ kPa}$$



$$Q_{\text{main}} = 4 \times Q_L = 4 \times 15 = 60 \text{ m}^3/\text{hr} = 0.01666 \text{ m}^3/\text{sec}$$

$$Q_{\text{main}} = 2 \times Q_L = 2 \times 15 = 30 \text{ m}^3/\text{hr} = 0.00833 \text{ m}^3/\text{sec}$$

$$A = \frac{Q}{V} = \frac{0.01666}{2} = 0.00833 \text{ m}^2$$

$$\therefore d = 0.103 \text{ m} = 103 \text{ mm} = 4.067 \text{ in}$$

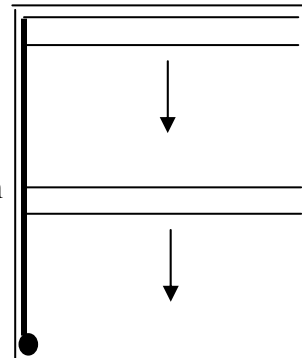
$$\therefore d_{\text{act}} = 4 \text{ in} = 101.6 \text{ mm}$$

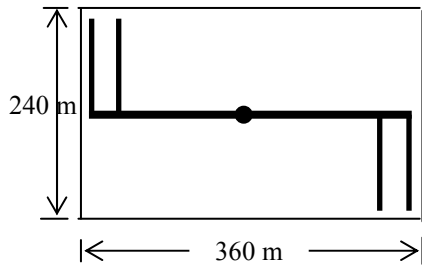
$$H_{f1} = 1.22 \times 10^{10} \times 120 \times \left(\frac{16.66}{150} \right)^{1.852} \times 101.6^{-4.87} = 4.21 \text{ m}$$

$$H_{f2} = 1.22 \times 10^{10} \times 120 \times \left(\frac{8.33}{150} \right)^{1.852} \times 101.6^{-4.87} = 1.17 \text{ m}$$

$$\therefore H_{\text{main}} = 25 + 1.1(4.21 + 1.17) + 0 = 30.92 \text{ m}$$

$$P_{\text{main}} = H_{\text{main}} \times \gamma = 30.92 \times 9.81 = 303.32 \text{ kPa}$$





$$\begin{array}{llll}
 N_{SP} = 10 & Q_{SP} = 20 \text{ L/min} & S_S = 12 \text{ m} & S_L = 15 \text{ m} \\
 \text{Slop Laiteral} = 1\% \downarrow & \text{Slope Main} = 0 & CHW = 150 & P_{SP} = 2.3 \text{ kg/cm}^2 \\
 d_L = ? & d_M = ? & &
 \end{array}$$

$$L = S_1 + S_S(N_{SP} - 1) = 6 + 12(10 - 1) = 114 \text{ m}$$

$$Q_L = N_{SP} \times Q_{SP} = 10 \times \frac{14}{60} = 2.33 \text{ L/sec}$$

$$\therefore h_L \leq \frac{20}{100} H_{SP}$$

$$\therefore h_L = \frac{20}{100} \times (2.3 \times 10) = 4.6 \text{ m}$$

$$\therefore h_L = 1.1 H_f \pm \Delta H_z$$

$$4.6 = 1.1 H_f - \frac{1}{100} \times 114$$

$$\therefore H_f = \frac{4.6 + 1.14}{1.1} = 5.22 \text{ m}$$

$$F = 0.371$$

$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{CHW} \right)^{1.852} \times d^{-4.87} \times F$$

$$5.22 = 1.22 \times 10^{10} \times 114 \times \left(\frac{2.33}{150} \right)^{1.852} \times d^{-4.87} \times 0.371$$

$$d = 37.3 \text{ mm} = 1.47 \text{ in}$$

$$d_{act} = 1.5 \text{ in} = 38.1 \text{ mm}$$

$$(H_f)_{act} = 1.22 \times 10^{10} \times 114 \times \left(\frac{2.33}{150} \right)^{1.852} \times 38.1^{-4.87} \times 0.371 = 4.61 \text{ m}$$

$$: (H_r = 1 \text{ m})$$

$$\therefore H_L = H_{sp} + 0.75 H_f + H_r \pm 0.5 \Delta H_z$$

$$H_L = 2.3 \times 10 + 0.75 \times 4.61 + 1.0 - 0.5 \times \frac{1}{100} \times 114 = 26.9 \text{ m}$$

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$$Q_{\text{main}} = 2 \times Q_L = 2 \times 0.00233 = 0.00466 \text{ m}^3/\text{sec}$$

$$A = \frac{Q}{V} = \frac{0.00466}{2} = 0.00233 \text{ m}^2 \quad \therefore \frac{\pi}{4} d^2 = 0.00233$$

$$\therefore d = 0.054 \text{ m} = 54 \text{ mm} = 2.12 \text{ in}$$

$$\therefore d_{\text{act}} = 2.5 \text{ in} = 63.5 \text{ mm}$$

$$L_{\text{main}} = \frac{360}{2} - \frac{15}{2} = 180 - 7.5 = 172.5 \text{ m}$$

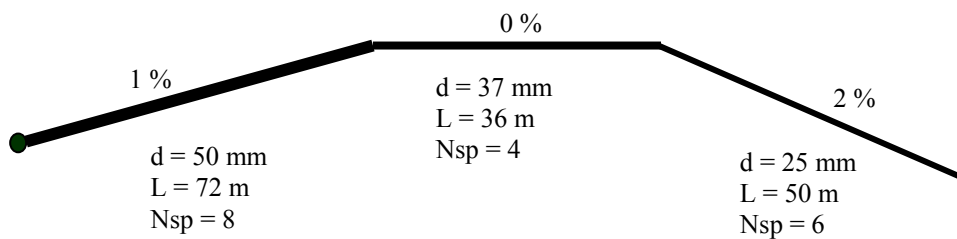
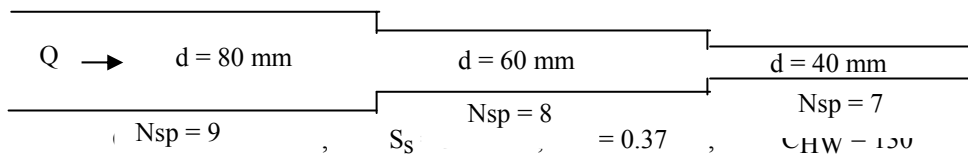
$$H_f = 1.22 \times 10^{10} \times L \times \left(\frac{Q}{C_{\text{HW}}} \right)^{1.852} \times d^{-4.87}$$

$$H_f = 1.22 \times 10^{10} \times 172.5 \times \left(\frac{4.66}{150} \right)^{1.852} \times 63.5^{-4.87} = 5.64 \text{ m}$$

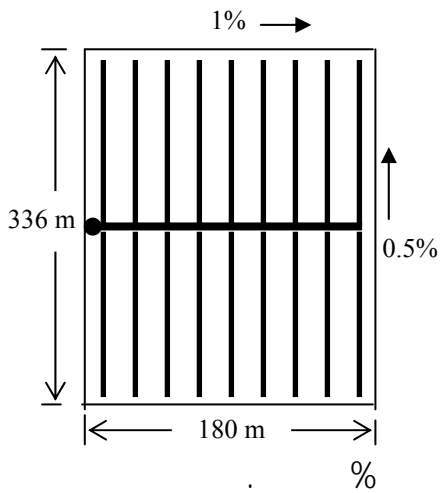
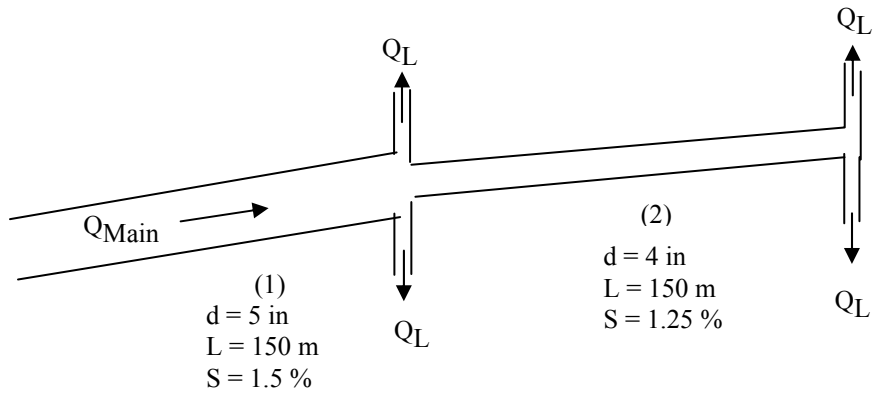
$$\therefore H_{\text{main}} = H_L + 1.1 H_f \pm (\Delta H_z)_{\text{main}}$$

$$\therefore H_{\text{main}} = 26.9 + (1.1 \times 5.64) + 0 = 33.1 \text{ m}$$

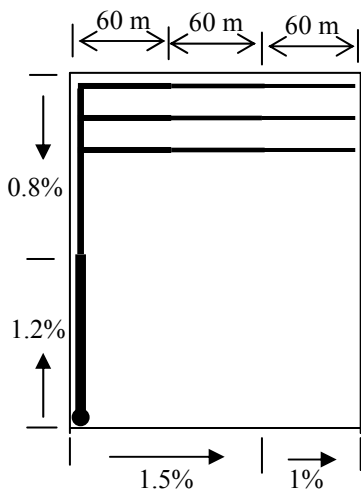
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($C_{HW}=150$) PVC
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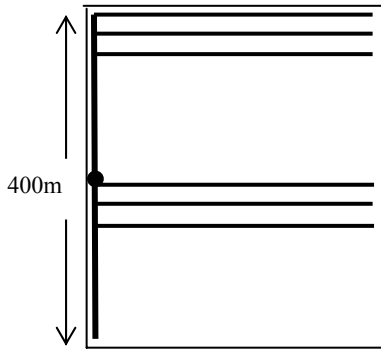
($C_{HW}=150$)



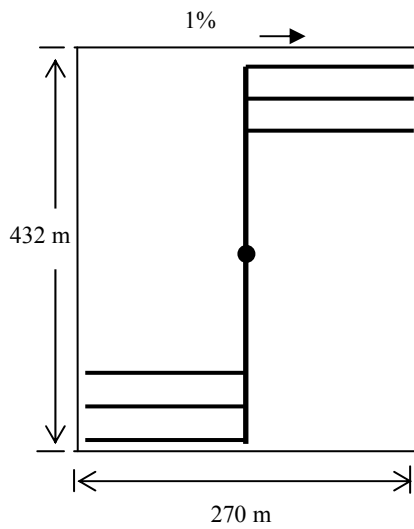
(% (C_{HW}=140))

% , (C_{HW}=150)

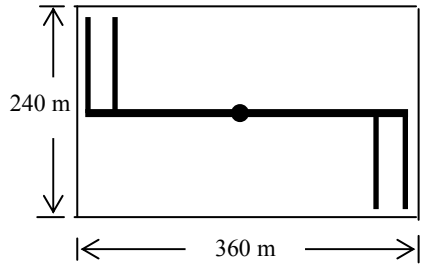
(C_{HW}=150) %



(C_{HW}=140) %



(C_{HW} =150)

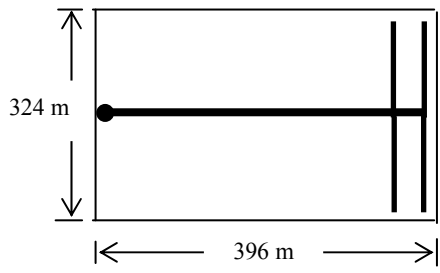


×
%

/

· (CHW = 150)

: _____



×

/

%

: _____ · (CHW = 150)