

1. 4-2 已知水管中的水壓 340 kPa，水頭損失 138 kPa，求一建物高 9m 之剩餘壓力為何：

$$Z_1 + P_1/9.8 + v^2/2g = Z_1 + P_2/9.8 + v^2/2g + h_L$$

$$0 + 340/9.8 = 9 + P_2/9.8 + (138*0.102)$$

$$\underline{P_2 = 113.8 \text{ kPa}}$$

2. 4-9 已知鑄鐵管直徑 200 mm，流量 30 L/s，管長 300 m，求水頭損失。

$$Q = A * V = D^2/4 * V$$

$$\rightarrow V = 0.955 \text{ m/s}$$

由表 4-5，得  $f = 0.021$

利用 Darcy Weisbach equation:

$$\underline{h_L = f * (L/D) * (V^2/2g) = 0.021 * (300/0.2) * (0.955^2/2*9.8) = 1.47 \text{ m}}$$

3. 4-11 利用圖 4-6 決定管徑 150 mm 流量 22 L/s  $C=100$  之水管的流速與水頭損失。

$$Q = A * V = D^2/4 * V$$

$$\rightarrow V = 1.245 \text{ m/s}$$

$$\begin{aligned} S &= 10.666 * C^{-1.85} * D^{-4.87} * Q^{1.85} \\ &= 10.666 * 100^{-1.85} * 0.15^{-4.87} * 0.022^{1.85} \\ &= 0.0188 \text{ m/m} \\ &= \underline{18.8 \text{ m/1000m}} \end{aligned}$$

4. 4-43 840 mm 雨水道 ( $n = 0.013$ )，坡度 0.4 m/100 m，求 (a) 流速達 0.6 m/s 所需之水深；(b) 水深 450 mm 時之流量。

(a) 由表 4-21 得滿流時之  $V = 1.7 \text{ m/s}$ ；流量  $Q = 0.94 \text{ m}^3/\text{s}$

$v/V = 0.6/1.7 = 0.353$ ，由水利特性曲線 (表 4-22) 知  $d/D = 0.09$

$$\rightarrow d = 0.09 * 840 = 75.6 \text{ mm}$$

(b)  $d/D = 450/840 = 0.54$ ，由水利特性曲線 (表 4-22) 知  $q/Q = 0.58$

$$\rightarrow q = 0.58 * 0.94 = 0.55 \text{ m}^3/\text{s}$$

4-51

- 1) 本參考之題目與解答與課本題目完全一致，僅公制與英制之差別。
- 2) 管徑之答案為 730 mm，流量  $0.48 \text{ m}^3/\text{s}$
- 3) 試誤法亦可先假設流速，再確認流量是否正確（如上課講解之方法），蔡佳蓉同學之解法正確，可向她請教。

4.  $3 \text{ acres} \quad C=0.15$   
 $6 \text{ acres} \quad C=0.45$   
 $3 \text{ acres} \quad C=0.45$

$I = \frac{1.49}{1.49} \quad V = \frac{1.49}{1.49} R^{2/3} S^{1/2}$  已知流速時間管長 10 min 人孔間距離管 600 ft.  
 坡降 0.002, 求  $D = ?$

sol:  $Q = CIA = AV$  < 試誤法 >

○ 設  $D = 3 \text{ ft}$

$V = \frac{1.49}{0.015} \cdot \left(\frac{3}{4}\right)^{2/3} \cdot (0.002)^{1/2} = 4.22 \text{ ft/s}$

人孔 3+2:  $\frac{600 \text{ ft}}{4.22 \text{ ft/s}} = 142 \text{ sec} = 2.37 \text{ min}$

2+1:  $\frac{600 \text{ ft}}{4.22 \text{ ft/s}} = 142 \text{ sec} = 2.37 \text{ min}$

3+1 所需時間:  $10 \text{ min} + 2.37 \text{ min} + 2.37 \text{ min} = 14.74 \text{ min}$

$\therefore I = \frac{1.49}{14.74 + 19} = 2.883$

$\therefore Q = (0.15 \times 2.883 \times 3) + (0.45 \times 2.883 \times (3+6)) = 11.4135 \text{ ft}^3/\text{s}$

$AV = \frac{\pi \times D^2}{4} \times \frac{1.49}{0.015} \cdot \left(\frac{D}{4}\right)^{2/3} \cdot (0.002)^{1/2} = 5 \text{ ft}^3/\text{s}$

$\therefore CIA \neq AV \quad \therefore D = 3 \text{ ft} \text{ (不合)}$

○ 設  $D = 2.5 \text{ ft}$

$V = \frac{1.49}{0.015} \cdot \left(\frac{2.5}{4}\right)^{2/3} \cdot (0.002)^{1/2} = 2.74 \text{ ft/s}$

人孔 3+2:  $\frac{600 \text{ ft}}{2.74 \text{ ft/s}} = 219 \text{ sec} = 3.65 \text{ min}$

2+1:  $\frac{600 \text{ ft}}{2.74 \text{ ft/s}} = 219 \text{ sec} = 3.65 \text{ min}$

3+1 所需時間:  $10.34 \text{ min}$

$\therefore I = \frac{1.49}{10.34 + 19} = 2.815$

$\therefore Q = (0.15 \times 2.815 \times 3) + (0.45 \times 2.815 \times (3+6)) = 11.1615 \text{ ft}^3/\text{s}$

$AV = \frac{\pi \times D^2}{4} \times \frac{1.49}{0.015} \cdot \left(\frac{2.5}{4}\right)^{2/3} \cdot (0.002)^{1/2} = 18.3581 \text{ ft}^3/\text{s}$

$\therefore CIA \neq AV \quad \therefore D = 2.5 \text{ ft} \text{ (不合)}$

BY C.CHING

設  $D = 2 \text{ tL}$

$$V = \frac{1.482}{0.015} \cdot \left(\frac{2}{4}\right)^3 \cdot (0.002)^{1/2} = 2.22 \text{ t\%}$$

$$\text{LTL } 3 \rightarrow 2 : \frac{2.22 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.11 \text{ min}$$

$$3 \rightarrow 1 : \frac{2.22 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.11 \text{ min}$$

3 → 1 所需時間 = 16.22 min

$$I = \frac{19}{16.22 + 19} = 3.72$$

$$Q = (0.15 \times 3.72 \times 3) + (0.45 \times 3.72 \times (3+6)) = 16.74 \text{ t\%}$$

$$A \cdot V = \frac{1.482}{4} \times 2.22 \text{ t\%} = 10.12 \text{ t\%}$$

∵ CIA > A·V ∴  $D = 2 \text{ tL}$  (x)

設  $D = 2.4 \text{ tL}$

$$V = \frac{1.482}{0.015} \cdot \left(\frac{2.4}{4}\right)^3 \cdot (0.002)^{1/2} = 2.627 \text{ t\%}$$

$$\text{LTL } 3 \rightarrow 2 : \frac{2.627 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.627 \text{ min}$$

$$3 \rightarrow 1 : \frac{2.627 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.627 \text{ min}$$

3 → 1 所需時間 = 15.5 min

$$I = \frac{19}{15.5 + 19} = 3.777$$

$$Q = (0.15 \times 3.777 \times 3) + (0.45 \times 3.777 \times (3+6)) = 19.0865 \text{ t\%}$$

$$A \cdot V = \frac{1.482}{4} \times 2.627 \text{ t\%} = 16.4534 \text{ t\%}$$

設  $D = 2.44 \text{ tL}$

$$V = \frac{1.482}{0.015} \cdot \left(\frac{2.44}{4}\right)^3 \cdot (0.002)^{1/2} = 2.677 \text{ t\%}$$

$$\text{LTL } 3 \rightarrow 2 : \frac{2.677 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.677 \text{ min}$$

$$3 \rightarrow 1 : \frac{2.677 \text{ t\%} \cdot 60 \text{ km}}{600 \text{ tL}} = 2.677 \text{ min}$$

3 → 1 所需時間 = 15.44 min

$$I = \frac{19}{15.44 + 19} = 3.8037$$

$$Q = (0.15 \times 3.8037 \times 3) + (0.45 \times 3.8037 \times (3+6)) = 19.12 \text{ t\%}$$

$$A \cdot V = \frac{1.482}{4} \times 2.677 = 19.19 \text{ t\%}$$

∵ CIA > A·V ∴  $\begin{cases} D = 2.44 \text{ tL} \\ Q = 19.12 \text{ t\%} \end{cases}$

Excellent!