

Module 20 Numerical solutions to Self Assessment

Question 20.8

The maximum flow in a sewer main is the peak wet weather flow (PWWF), which is made up of the peak dry flow (PDWF) for the equivalent population and the infiltration/inflow (I/I).

The first step to the problem is to solve for each of the two components as follows:

The ADWF for the population is $250 \times 1500 = 375 \text{ kL/d}$ (or m^3/d)

From figure 20.2 (p. 20.14) the peaking factor is 4.75

Hence, PDWF = $4.75 \times 375 = 1781.25 \text{ m}^3/\text{d}$

There are a total of 5.5 km of sewer pipes and house-drains in the system.

I/I = $28 \text{ m}^3/\text{d.km} \times 5.5 \text{ km} = 154 \text{ m}^3/\text{d}$.

$$\begin{aligned} \text{PWWF} &= \text{PDWF} + \text{I/I} = 1781.25 + 154 \\ &= \mathbf{1935.25 \text{ kL/d}} \text{ or } 0.0224 \text{ m}^3/\text{s} \end{aligned}$$

A suitable pipe size has to be determined by trial and error using the Manning's equation and the given slope and pipe roughness.

Select a trial pipe of 225 mm diameter and check the flow to be equal or about the PWWF. For full pipe flow $R = D/4$

Velocity and discharge for full pipe flow are calculated as follows:

$$\begin{aligned} V &= R^{2/3} \times S^{1/2} / n \\ &= (0.225/4)^{2/3} \times 0.005^{1/2} / 0.015 = 0.692 \text{ m/s} \end{aligned}$$

$$Q = V \times A = 0.692 \times \pi D^2/4 = 0.0275 \text{ m}^3/\text{s} > 0.0224$$

Therefore, the **225 mm** pipe can safely convey the maximum flow. However, under the Queensland's guidelines we need to ensure that maximum flow does not exceed $\frac{3}{4}$ of the pipe and flow velocity is self-cleansing.

The ratio $q/Q = 0.0224/0.0275 = 0.81$

From figure 20.4 (p. 20.20), the ratios $d/D = 0.68$; and $v/V = 1.11$

The depth of flow for $0.0224 \text{ m}^3/\text{s}$ is **0.153 m** and less than $\frac{3}{4}$ depth.

The corresponding velocity is **0.768 m/s** $> 0.65 \text{ m/s}$