Solutions to Water Supply and Sewerage System Design Problems

1. **Problem 1:** A city has a population of 500,000 people. If the average daily water consumption per person is 150 liters, determine the total daily water demand.

   Solution: The total daily water demand Q is calculated as:

   $$Q = Population \times Percapitaconsumption = 500{,}000 \times 150 = 75{,}000{,}000 liters/day = 75{,}000 cubicmeters/d$$

   Video Solution: `https://www.youtube.com/watch?v=f2faanH0_Ww`

2. **Problem 2:** A sewer pipe with a diameter of 0.6 m carries a flow of 0.4 m^3/s. Compute the flow velocity.

   Solution: The flow velocity v is determined using the formula:

   $$v = \frac{Q}{A}$$

   where Q is the discharge and A is the cross-sectional area of the pipe. The area A for a circular pipe is:

   $$A = \pi \left(\frac{d}{2}\right)^2 = \pi \left(\frac{0.6}{2}\right)^2 = 0.2827\, m^2$$

   Thus, the velocity v is:

   $$v = \frac{0.4\, m^3/s}{0.2827\, m^2} \approx 1.415\, m/s$$

   Video Solution: `https://www.youtube.com/watch?v=_1CRUHPE5lI`

3. **Problem 3:** A fire flow demand of 30 L/s is required for a residential area. If the fire event is expected to last 3 hours, determine the total fire flow volume.

   Solution: The total fire flow volume V is calculated by:

   $$V = Flowrate \times Time = 30\, L/s \times (3 \times 3600\, s) = 324{,}000\, liters = 324\, cubicmeters$$

   Video Solution: `https://www.youtube.com/watch?v=MvZ5Oe18TK0`

4. **Problem 4:** A gravity sewer line has a slope of 0.002 and a Manning's roughness coefficient of 0.013. If the sewer pipe has a diameter of 0.8 m, determine the velocity of flow using Manning's equation.

Solution: Manning's equation is:

$$v = \frac{1}{n} R^{2/3} S^{1/2}$$

where:

- n = Manning's roughness coefficient = 0.013
- R = Hydraulic radius = $\frac{D}{4} = \frac{0.8}{4} = 0.2$ m
- S = Slope = 0.002

Substituting these values:

$$v = \frac{1}{0.013} \times (0.2)^{2/3} \times (0.002)^{1/2} \approx 1.03\, m/s$$

Video Solution: `https://www.youtube.com/watch?v=1QtwF6uabAs`

5. **Problem 5:** A wastewater treatment plant is designed to handle 50,000 m^3/day. If the influent wastewater contains 250 mg/L of BOD, determine the total daily BOD load in kg/day.

   Solution: The total BOD load L is calculated by:

$$L = Q \times C$$

where:

- Q = Flow rate = 50,000 m^3/day
- C = BOD concentration = 250 mg/L = 0.25 g/L

Since 1 m^3 = 1,000 L:

$$L = 50{,}000\, m^3/day \times 0.25\, g/L = 12{,}500{,}000\, g/day = 12{,}500\, kg/day$$

Video Solution: `https://www.youtube.com/watch?v=_1CRUHPE5lI`