Case Study 2

The City Planning Commission is overseeing the construction of a new eco-friendly residential complex. To ensure structural integrity and sustainability, the engineers use a specific concrete mix. The mix consists of cement, sand, and gravel in a strict ratio of $2 : 3 : 5$ by weight. The project manager, Ms. Ananya, monitors the supplies closely to avoid wastage. She observes that the consumption of water for curing the concrete is in direct proportion to the amount of cement used; specifically, 10 liters of water are needed for every 4 kilograms of cement.

Furthermore, the timeline of the project depends on the labor force. Ms. Ananya notes that the time taken to complete the foundation is inversely proportional to the number of workers employed. Currently, a team of 30 workers can complete the foundation in 20 days. However, due to an upcoming monsoon forecast, the commission wants to finish the foundation much faster. The engineers must use their knowledge of ratios and proportions to adjust the material orders and the workforce size without compromising the quality of the construction or the budget of the city.

Multiple Choice Questions

1. If a total of 1200 kg of concrete mix is prepared for the first floor, what is the weight of the sand required?

   (a) 240 kg

   (b) 360 kg

   (c) 600 kg

   (d) 400 kg

   Answer: (b) 360 kg
   Solution: The ratio of Cement : Sand : Gravel is $2 : 3 : 5$. Sum of the ratio parts $= 2 + 3 + 5 = 10$. Total weight $= 1200$ kg. Weight of sand $= (3/10) \times 1200 = 3 \times 120 = 360$ kg.

2. A supplier delivers 500 kg of gravel. To maintain the standard $2 : 3 : 5$ ratio, how much cement should be mixed with this entire quantity of gravel?

   (a) 200 kg

   (b) 300 kg

   (c) 100 kg

   (d) 250 kg

   Answer: (a) 200 kg
   Solution: The ratio of cement to gravel is $2 : 5$. Let the required cement be x. So, $x/500 = 2/5$. Solving for x: $x = (2 \times 500)/5 = 1000/5 = 200$ kg.

3. If the project uses 160 kg of cement, how many liters of water will be required for curing, based on the direct proportion mentioned in the passage?

   (a) 320 liters

   (b) 400 liters

   (c) 40 liters

   (d) 800 liters

Answer: (b) 400 liters
Solution: The ratio of water to cement is 10 liters : 4 kg. Let the water required be w. So, $w/160 = 10/4$. $w = (10 \times 160)/4 = 1600/4 = 400$ liters.

4. To complete the foundation in just 12 days instead of 20 days, how many workers should be employed in total?

   (a) 40 workers
   (b) 45 workers
   (c) 50 workers
   (d) 60 workers

   Answer: (c) 50 workers
   Solution: This is inverse proportion. $W_1 \times D_1 = W_2 \times D_2$. Here, $30 \times 20 = W_2 \times 12$. $600 = 12 \times W_2$. $W_2 = 600/12 = 50$ workers.

5. What is the ratio of the weight of cement to the total weight of the concrete mix in its simplest form?

   (a) 1 : 5
   (b) 2 : 5
   (c) 1 : 10
   (d) 2 : 3

   Answer: (a) 1 : 5
   Solution: The ratio of Cement : Sand : Gravel is 2 : 3 : 5. The total weight corresponds to $2 + 3 + 5 = 10$ parts. The ratio of cement to total weight is 2 : 10. Simplifying by dividing both sides by 2, we get 1 : 5.