


For a straight section of the Northern Collector Tunnel in Kenya with a design slope of 0.155%, a 10-metre-long formwork/shutter was used. The upstream level of the formwork/shutter was at a reduced level of 1618.245 m. Calculate the correct staff reading at the downstream end of the formwork if a backsight reading of 1.025 m was taken to a TBM in the tunnel whose reduced level was 1620.155 m.

 The design slope for the straight section of the tunnel is 0.155%, which is equivalent to 0.00155 as a decimal. The length of the formwork/shutter is 10 meters, so the difference in height between the upstream and downstream ends can be calculated as follows:

First, unguided attempt at the solution

difference in height = length \* slope  
difference in height =  $10 * 0.00155$   
difference in height = 0.0155 meters  
The upstream level of the formwork/shutter was at a reduced level of 1618.245 m, so the downstream level can be calculated as follows:

downstream level = upstream level + difference in height  
downstream level =  $1618.245 + 0.0155$   
downstream level = 1618.2605 m  
The TBM in the tunnel has a reduced level of 1620.155 m, and a backsight reading of 1.025 m was taken to it. The staff reading at the downstream end of the formwork can be calculated as follows:

staff reading = TBM reduced level - downstream level + backsight reading  
staff reading =  $1620.155 - 1618.2605 + 1.025$   
staff reading = 2.9445 m  
So, the correct staff reading at the downstream end of the formwork is 2.9445 meters.

Second attempt after being guided to subtract the difference so as to get the downstream level

downstream end of the formwork can be calculated as follows:  
staff reading = TBM reduced level - downstream level + backsight reading  
staff reading =  $1620.155 - 1618.2295 + 1.025$   
staff reading = 2.9255 m  
So, the correct staff reading at the downstream end of the formwork is 2.9255 meters.

Showcasing ChatGPT blunders in calculations that demand mathematical reasoning using a problem in a technical surveying exercise. Lecture examples by N. J. Adero (2023).

**Below is GPT-4 showcasing advanced reasoning and getting the correct answer:**

Let's break down the problem step by step:

1. The design slope of the tunnel is 0.155%.
2. The length of the formwork/shutter is 10 meters.
3. The reduced level of the upstream end of the formwork is 1618.245 meters.
4. The backsight reading to the TBM is 1.025 meters.
5. The reduced level of the TBM is 1620.155 meters.

We first need to calculate the fall along the straight section of the tunnel based on the design slope and the length of the formwork:

$$\text{Fall} = \text{Slope} \times \text{Length} \quad \text{Fall} = 0.155\% \times 10 \text{ meters} \quad \text{Fall} = 0.00155 \times 10 \text{ meters} \quad \text{Fall} = 0.0155 \text{ meters}$$

Now, we can find the reduced level at the downstream end of the formwork:

$$\begin{aligned} \text{Downstream Reduced Level} &= \text{Upstream Reduced Level} - \text{Fall} \\ \text{Downstream Reduced Level} &= 1618.245 \text{ meters} - 0.0155 \text{ meters} \\ \text{Downstream Reduced Level} &= 1618.2295 \text{ meters} \end{aligned}$$

Next, we can calculate the height of the instrument (HI) by adding the backsight reading to the reduced level of the TBM:

$$\text{HI} = \text{TBM Reduced Level} + \text{Backsight Reading} \quad \text{HI} = 1620.155 \text{ meters} + 1.025 \text{ meters} \quad \text{HI} = 1621.180 \text{ meters}$$

Finally, we can calculate the staff reading at the downstream end of the formwork by subtracting the downstream reduced level from the height of the instrument:

$$\begin{aligned} \text{Correct Staff Reading} &= \text{HI} - \text{Downstream Reduced Level} \\ \text{Correct Staff Reading} &= 1621.180 \text{ meters} - 1618.2295 \text{ meters} \\ \text{Correct Staff Reading} &\approx 2.9505 \text{ meters} \end{aligned}$$