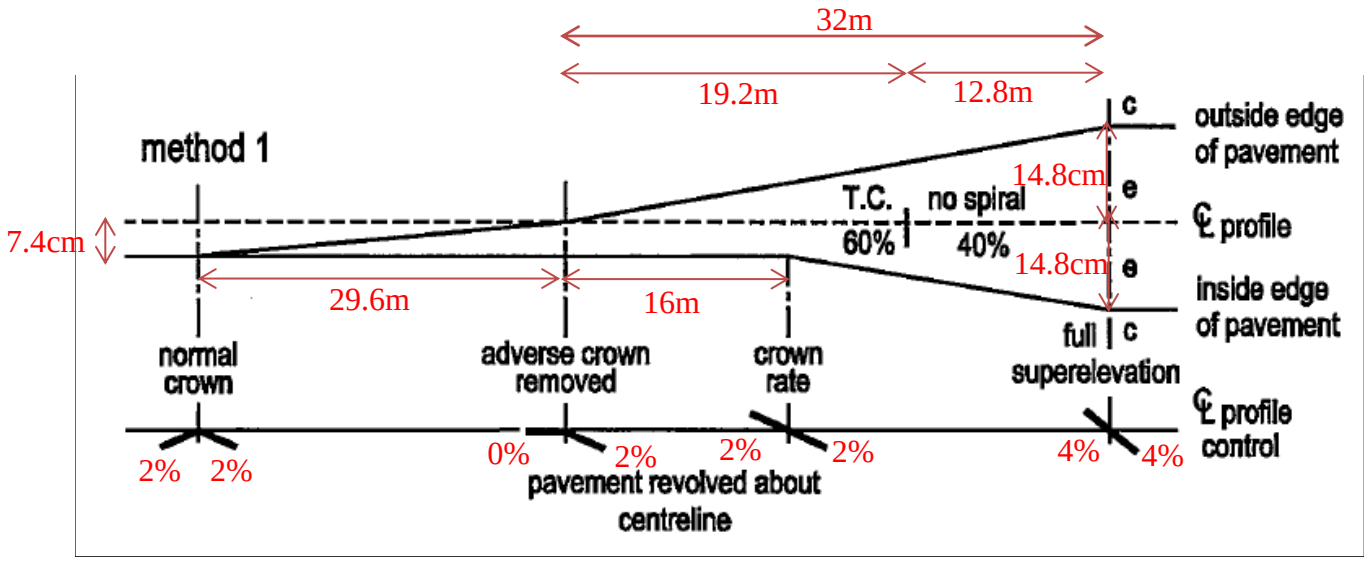
Question 1



$2\% \times 3.7m = 7.4cm$

$4\% \times 3.7m = 14.8cm$

Length of superlevation runoff = 32.0m

Length of tangent run out = $400m \times 0.074 = 29.6m$

Question 2

(a)

$v_0 = 110\ \frac{km}{hr} = 30.55\ \frac{m}{s}$

$e_{max} = 0.06$ and $f_{(max)} = 0.1$

$$R_{min} = \frac{v^2}{g(e_{max} + f_{(max)})} = \frac{30.55^2}{9.81(0.06 + 0.1)} = 594.61\ m$$

$$R_{design} = 1.25R_{min} = 1.25 \times 594.61 = 743.26m$$

$$e_{des} = \frac{v^2}{gR} - f_{(max)} = \frac{30.55^2}{9.81 \times 746.26} - 0.1 = 0.208 - 0.1 = 0.028$$

(b)

$$D = \left(\frac{5729.58}{R(ft)}\right)^o = \left(\frac{1746.4}{R(m)}\right)^o = \left(\frac{1746.4}{743.26}\right)^o = 2.35^o$$

$$E = R\left(\frac{1}{cos\frac{50}{2}} - 1\right) = 743.26 \times \left(\frac{1}{cos\frac{50}{2}} - 1\right) = 76.83\ m$$

$$M = R\left(1 - cos\frac{\Delta}{2}\right) = 743.26 \times \left(1 - cos\frac{50}{2}\right) = 70\ m$$

$$T = Rtan\frac{\Delta}{2} = 743.26 \times tan\frac{50}{2} = 347\ m$$

$$L = 100(ft)\frac{\Delta}{D} = 30.48(m)\frac{50}{2.35} = 648.5m$$

$$LC = 2Rsin\frac{\Delta}{2} = 2 \times 743.26 \times sin\frac{50}{2} = 628.2\ m$$

Question 3

$z = (75 + 40) - (75 + 00) = 40\text{m}$

Tangent elevation = $50.9 + (40 \times -1.2\%) = 50.42m$

Roadway elevation = $51.1 + 0.8 = 51.90m$

$y = 51.90 - 50.42 = 1.48m$

$$E = \frac{AL}{800} = \frac{(0.8 - (-1.2)) \times L}{800} = \frac{L}{400}$$

$$y = 4E\left(\frac{x}{L}\right)^2 = 4\left(\frac{L}{400}\right) \times \left(\frac{\frac{L}{2}+40}{L}\right)^2 = 1.48 \quad \Longrightarrow \quad L = 416.7m$$