Seismic Group

(136)

RAILWAY ENGINEERING

Assignment - I

1. Find out the radius of the track laid on 4 ° curve.

2. Find out the degree of the curve if the radius is 1500 ft.

3. Find out the degree of the curve if the radius is 500 m.

4. Find out the radius of track in ft laid on 3 degree of the curve.

5. If a 3 degree curve is located on a ruling gradient of 1 in 150. How much is the gradient on the curve

6. Find out the actual gradient of the track laid on 4 ° curve. The track is Broad gauge track and ruling gradient is 1 in 200.

7. Find out the actual gradient of the track laid on 5 ° curve. The track is Standard gauge track and ruling gradient is 1 in 150.

8. Calculate the expressions for BG, MG, Standard gauge and narrow gauge track when speed is in miles per hour and R is in ft and super elevation is in inches ,1 mile = 5280 ft, g= 32.2 ft/sec^2

9. Calculate the expressions for BG, MG, Standard gauge and narrow gauge track when speed is in km per hour and R is in m and super elevation is in cm.

10. Find SE of a 3° curve for a BG, MG, NG track. The permitted speed is 50 mph.

11. Find SE of a 4° curve for a BG, MG, NG track. The permitted speed is 60 km/hr.

12. A 6° curve branches off a 3° main curve in opposite direction in the layout of a BG track. If the speed on the branch track is restricted to 22 mph. Determine speed restriction on main line. Assume deficiency in super elevation is 3 inches.

13. On a railway track 15, 12, 8 and 5 trains move at a speed of 50, 45, 40 and 60 mph. Find the speed for which super elevation is provided. Also calculate equilibrium super elevation. The track is broad gauge having degree 3.

14. Calculate super elevation and maximum permissible speed for a 2 degree broad gauge transitioned curve track with maximum sanctioned speed of 110 km/hr. The speed for calculating super elevation as decided by the chief engineer is 80 km/hr and speed for goods train is 50 km/hr. (Hint; maximum permissible speed is minimum of; maximum sanctioned speed, maximum or safe speed over the curve based on theoretical consideration, presence or absence of transition curve)

15. Find the track material required for one mile length of track with sleeper density of n+4.

Q=1

Data: $R = ?$

$D = 4°$

Sol:

$$D = \frac{1750}{R}$$

$$R = \frac{1750}{4} = 437.5m$$

Q=2

Data:

$D = ?$

$R = 1500 ft$

Sol:

$$D = \frac{5730}{R}$$

$$= \frac{5730}{1500} = 3.82°$$

Q=3

Data:

$D = ?$

$R = 500 m$

Sol:

$$D = \frac{1750}{R}$$

$$= \frac{1750}{500}$$

$$D = 3.5°$$

Q=4

Data:

$R = ?$ (in ft)

$D = 3^\circ$

Sol:

$$R = \frac{5730}{D}$$

$$= \frac{5730}{3} = 1910 \text{ ft}$$

Q=5

$D = 3^\circ$

Rolling gradient = 1 in 150

$$= \frac{1}{150} \times 100 = 0.67\%$$

Gradient on curve = ?

Sol:

Let grade compensation for $1^\circ = 0.05\%$

" " " $3^\circ = 3 \times 0.05\% = 0.15\%$

Actual gradient on curve $= 0.67 - 0.15$

$= 0.52\%$

Q=6

Data:

Actual gradient = ?

D = 4°

BG track

Ruling gradient = 1 in 200

$= \frac{1}{200} \times 100 = 0.5\%$

Sol:

Let grade compensation for 1° = 0.05 %

" " " 4° = 4 × 0.05 = 0.2%

Actual gradient = 0.5 − 0.2

= 0.3 %

Q=7

Data:

Actual gradient = ?

D = 5°

S.G track

Ruling gradient = 1 in 150

$= \frac{1}{150} \times 100 = 0.667\%$

Sol:

Let grade compensation for 1° = 0.03%.

" " " 5° = 5 × 0.03 = 0.15%

Actual gradient = 0.667 − 0.15

= 0.517%

Prob 8

Calculate expressions

when V in mph

R in ft

e in inches

1 mile = 5280 ft

$g = 32.2\ ft/s^2$

BG = 5.5'

MG = 3.29'

SG = 4.71'

NG = 2.5'

Sol:

→ BG

$$e = \frac{GV^2}{gR} = \left(\frac{(5.5^*)\left(\frac{5280}{3600}\right)^2 V^2}{32.2R} \times 12 \right)$$

$$= 4.41 \frac{V^2}{R} \quad (in)$$

→ MG

$$e = \left(\frac{(3.29)\left(\frac{5280}{3600}\right)^2 V^2}{32.2R} \right) \times 12$$

$$= 2.64 \frac{V^2}{R} \quad (in)$$

→ SG

$$e = \frac{4.71\left(\frac{5280}{3600}\right)^2 V^2}{32.2R} \times 12$$

$$= 3.78 \frac{V^2}{R} \quad (in)$$

→ NG

$$e = \frac{2.5\left(\frac{5280}{3600}\right)^2 V^2}{32.2R} \times 12$$

$$= 2 \frac{V^2}{R} \quad (in)$$

Prob 9

V in km/h
R in m
e in cm

BG = 1.676 m
MG = 1 m
SG = 1.435 m
NG = 0.762 m

Sol:

⇒ BG

$$e = \frac{GV^2}{gR} = \frac{(1.676)\left(\frac{1000}{3600}\right)^2 V^2}{9.81 R} \times 100$$

$$= 1.32 \frac{V^2}{R} \quad (cm)$$

⇒ MG

$$e = 0.79 \frac{V^2}{R} \quad (cm)$$

⇒ SG

$$e = 1.13 \frac{V^2}{R} \quad (cm)$$

⇒ NG

$$e = 0.6 \frac{V^2}{R} \quad (cm)$$

Prob 10

Data:

S.E = ?

D = 3°

V = 50 mph

For

BG = 5.5'

MG = 3.29'

NG = 2.5'

Sol:

$$D = \frac{5730}{R}$$

$$R = \frac{5730}{3} = 1910 \text{ ft}$$

BG $\Rightarrow$ $e = \dfrac{GV^2}{gR}$

$$= \frac{5.5 \left(\frac{5280}{3600}\right)^2 (50)^2}{32.2 \times 1910} \times 12$$

$$= 5.77 \text{ in}$$

MG = 3.45 in

NG = 2.62 in

Prob 11

Data:

S.E = ?

D = 4°

V = 60 km/h

BG = 1.676 m

MG = 1 m

NG = 0.762 m

Sol:

$$e = \frac{GV^2}{gR}$$

$$D = \frac{1750}{R}$$

$$R = \frac{1750}{4^\circ} = 437.5 \text{ m}$$

$$e = \left(\frac{G \left(\frac{1000}{3600} \right)^2 V^2}{9.81 R} \right) \times 100$$

BG = 10.85 cm

MG = 6.47 cm

NG = 4.93 cm

Prob 12

Data:

$D_b = 6^\circ \Rightarrow V = 22 \text{ mph}$

$D_m = 3^\circ \Rightarrow V = ?$

BG track

Deficiency of e = 3in

For BG track

$G = 5.5'$

$R = \frac{5730}{D}$

$= \frac{5730}{6} = 955'$

For Branch

$$e = \frac{GV^2}{gR} = \left(\frac{5.5 \times (22)^2 \left(\frac{5280}{3600}\right)^2}{32.2 \times 955} \right) \times 12$$

$e = 2.23''$

Negative 'e' in Branch track = S.E def. + S.E

$= -3 + 2.33$

$= -0.77''$

Theoretical SE for main track = $3 + 0.77$

$= 3.77''$

Outer rail is higher than inner rail by $0.77''$

$$e = \frac{GV^2}{gR}$$

$$3.77 = \left(\frac{5.5 \; V^2 \left(\frac{5280}{3600}\right)^2}{32.2 \times 1910} \right) \times 12$$

$\therefore R = \frac{5730}{D}$

$= \frac{5730}{3}$

$R = 1910 ft$

$V = 40.5 mph$

Prob 13

Data:

Trains = 15, 12, 8, 5

V = 50, 45, 40, 60 mph

a) Speed = ? at for which 'e' is provided

b) equilibrium 'e' = ?

Track = BG

D = 3°

Sol:

For BG = G = 5.5'

$$R = \frac{5730}{D} = \frac{5730}{3} = 1910 \text{ ft}$$

a) $$V = \frac{n_1V_1 + n_2V_2 + n_3V_3 + n_4V_4}{n_1 + n_2 + n_3 + n_4}$$

$$= \frac{(15)(50) + (12)(45) + (8)(40) + (5)(60)}{15 + 12 + 8 + 5}$$

$$\boxed{V = 47.75 \text{ mph}}$$

b) $$e = \frac{GV^2}{gR}$$

$$= \left(\frac{5.5 \times (47.75)^2 \left(\frac{5280}{3600}\right)^2}{32.2 \times 1910} \right) \times 12$$

$$\boxed{e = 5.26''}$$

Prob 14

Data:

$e = ?$

$V = ?$

$D = 2°$

Track = BG $\Rightarrow$ $G = 1.676\,m$

Max sanctional speed = 110 km/h

Speed for calculating e = 80 km/h

" " goods trains = 50 km/h

Sol:

$$R = \frac{1750}{D} = \frac{1750}{2} = 875\,m$$

$\Rightarrow$ S.E for equilibrium speed $= e = \frac{GV^2}{gR}$

$$e = \frac{(1.676)\left(\frac{1000}{3600}\right)^2 (80)^2}{9.81 \times 875} \times 100$$

$$e = 9.64\,cm$$

$\Rightarrow$ S.E for max. sanctional speed.

$$e = \frac{(1.676)\left(\frac{1000}{3600}\right)^2 (110)^2}{9.81 \times 875} \times 100$$

$$e = 18.23\,cm$$

Cant deficiency = 18.23 − 9.64

= 8.59 cm < 10 cm, hence permissible

⇒ S.E for goods trains

$$e = \frac{GV^2}{gR}$$

$$= \frac{(1.676)\left(\frac{1000}{3600}\right)^2 (50)^2}{9.81 \times 875} \times 100$$

$$e = 3.77 \text{ cm}$$

Cant excess = 9.64 − 3.77 = 5.87 cm < 7.5 cm

hence permissible

⇒ Max. Permissible Speed : Safe speed of curve

High speed route

$$V = \sqrt{\frac{(C_a + C_d)R}{13.76}}$$

Put Ca and Cd in (mm)

$$= \sqrt{\frac{(96.4 + 85.9)\,875}{13.76}}$$

V = 108 km/h

Max. permissible speed is least of following

1) Max. sanctional speed = 110 km/h
2) Max. speed / Safe speed by theoretical = 108 km/h

Hence

Max. permissible speed over curve = 108 km/h

SE to be provided = 9.64 cm

Cant deficiency = 8.59 cm

Prob 15

Data:

Track material = no. of sleepers = ~~sleepers~~

Sleeper density = $n + 4$

length of track = 1 mile

n = 1760 yards

Sol:

Track material = sleeper density = no. of sleepers

$= n + 4$

$= 1760 + 4$

$= 1764$