SEISMIC GROUP UET LHR

we have done in class by four methods.

Rotation about inside edge

PROBLEM SHEET NO 1

1- A two lane highway goes from normal crown of 2.5% to 10 % SE by means of a spiral curve. Determine minimum length of spiral if difference in grade between center line edges of the road is limited to 1/200. Draw SE diagram taking Stn. of TS as 160+00. Width of one lane is 3.5 m.

2- Same as problem -1 except that SE is 8% and Stn of TS is 80+00. Rotation about outside edge

3- A 2 lane highway with design speed of 100 km/h has a 400 m radius. Horizontal curve connects tangents with bearings of N 75 E and S 78 E, determine SE rate and length of Spiral, if difference in grade between center line and edge of the road is limited to 1/200 also sketch SE diagram take Stn. of TS as 100+00.

4- For a SE of 0.08 compute minimum possible radii of curves for a road of 30, 40, 50, 60, 70 km/h.

5- Vehicle performance is being tested on a large flat paved area. For this situation,
- What coefficient of side friction must be developed to hold a car going 60 miles/h on a 1000 ft radius curve.
- What minimum radius of curve is required for a vehicle traveling at 60 miles/h if co-efficient of side friction is 0.40?

6- An existing horizontal curve on a highway has a radius of 268 ft which restricts the maximum speed on this section of the road to only 60% of the design speed of highway. If curve is to be improved so that its maximum speed will be the design speed of highway determine radius of the new curve. Assume $f = 0.15$ for the existing curve and $e = 0.08$ for both the existing and new curve to be designed.

7- Determine min. radius required at a curved Section of highway if design speed is 70 miles/h and SE = 0.08

8- Curve is to be designed for highway having design speed 60 miles/h. If physical conditions restrict the radius of curve to be 500 ft, what SE is required for this curve? Will this be a good design?

9- Radius of horizontal curve on an existing highway is 750 m. If SE = 0.08 and max. speed limit is 105 km/h, is this a hazardous location on highway? If so what action would you recommend to correct the situation?

10- Radius of horizontal curve on an existing highway is 750 ft. If SE = 0.08 and max. speed limit is 100 km/h, is this a hazardous location on highway? If so what action would you recommend to correct the situation?

10- A section of highway has e = 0.05 and curve with a radius of 300 ft what speed limit would you recommend at this section of highway, take f = 0.15.

11- A new highway is being built with a design speed 120 km/h for one of the horizontal curves radius of horizontal curve is being planned as 300 m. What "e" is required for this curve?

12- Determine proper SE rate for a gravel road with a design speed of 50 miles/h, and $D = 8°$.

13- Find max degree "D" of a horizontal curve for a roadway. Given: V = 65 m.p.h. f and e, are in the range of 0.1 to 0.15 and 0.08 to 0.1.

14- A l two lane highway has 6° horizontal curve what should be e to develop maximum permissible side friction on this section at V = 65 m.p.h.. Schematically show the method of attaining SE by revolving pavement about outside edge, take $f = 0.11$.

Q=1

Data:

Normal crown = 2.5%

SE = e = 10%

Min. length of spiral = L = ?

$\Delta g \leq \frac{1}{200}$

Sta of TS = 160 + 00

Width of one lane = 3.5m

Sol:

Super elevation runoff = L = 200De

= 200 (3.5)(0.1)

= 70m

= 80 m (multiple of 20)

Tangent Runoff = 20m

Elevation difference b/w C/L and edge at T.S = 0

" " " " " " " SC = De

= 3.5 × 0.1

= 0.35m

= 350 mm

PROBLEM 1

Ref:

Rotation about C.L

Super elevation transition

L = 80m

Super elevation rate 6%

TS

SC

Outer edge

350m

262.5

175

87.5

0

C.L

Inner edge

10%

7.5%

5%

2.5%

0%

-2.5%

-5%

-7.5%

-10%

159+80

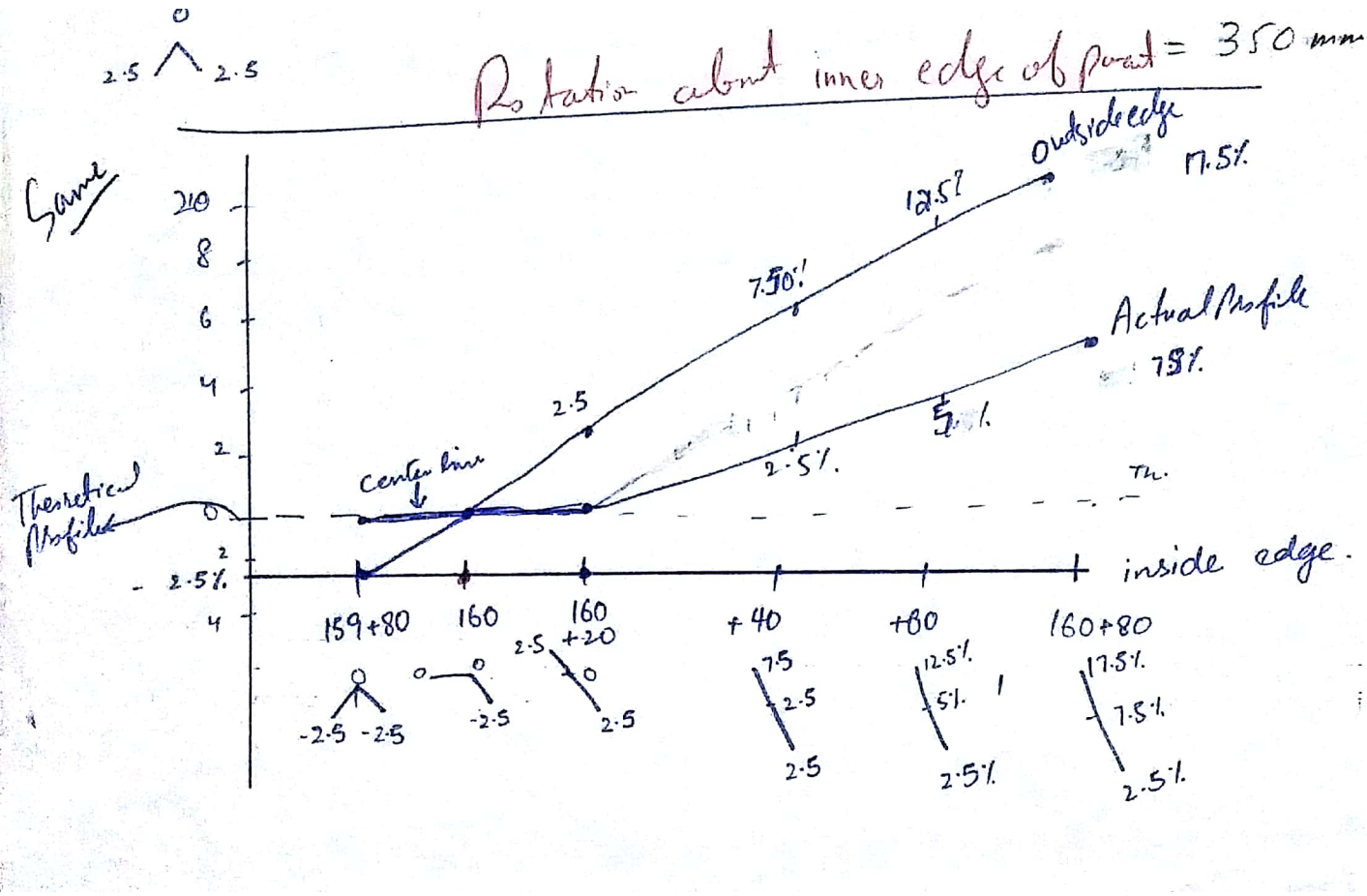
160+0

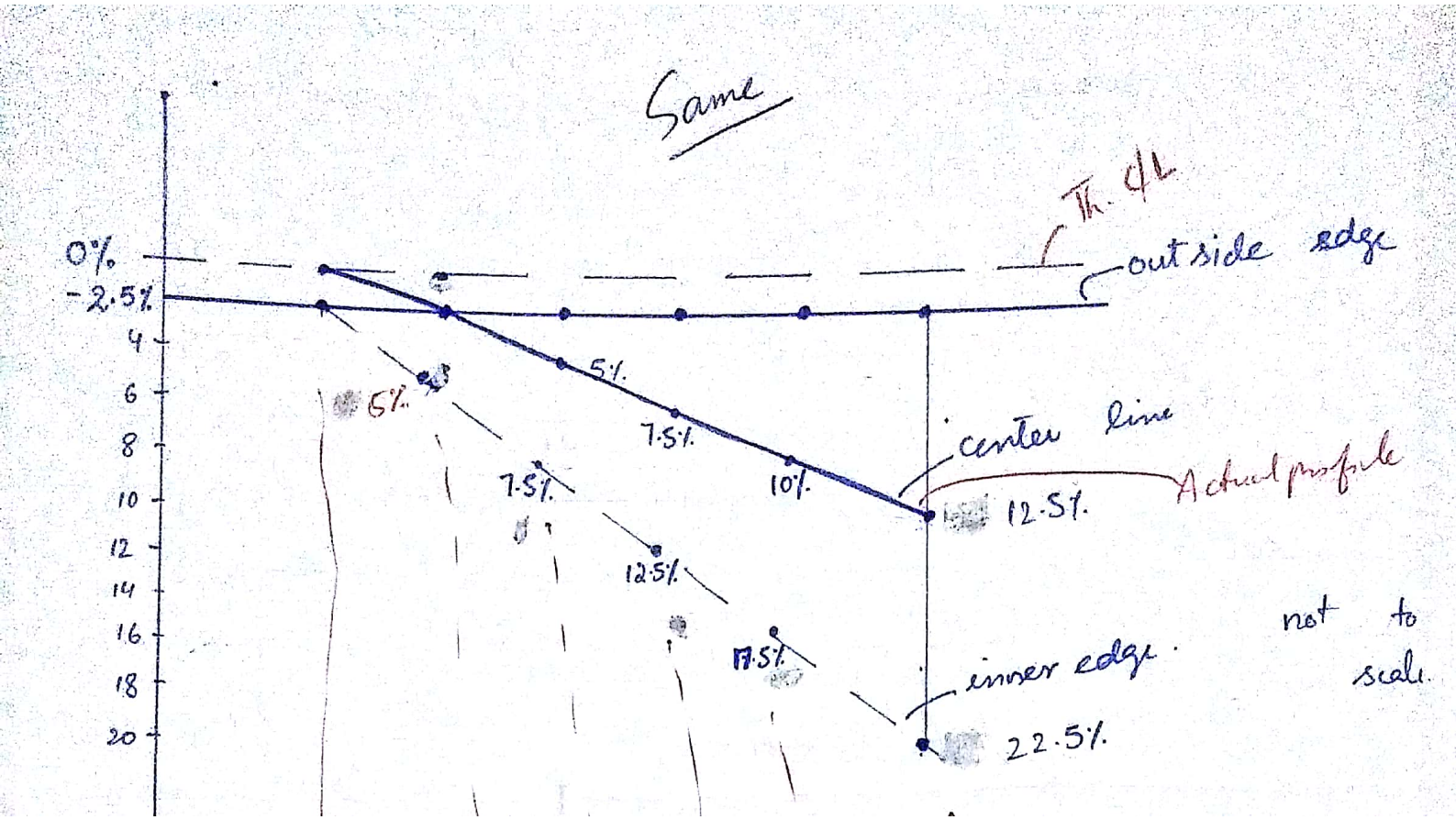
160+20

160+40

160+60

160+80





Q=3

Data:

Two lane highway

$V_{design} = 100$ km/h

$R = 400$ m

$e = ?$

Length of spiral = ?

$\Delta g = \frac{De}{L} \leq \frac{1}{200}$

Station of T.S = 100 + 00

Assuming width of one lane = 3.5 m

Assuming crown to be 2 %

Sol:

$$R = \frac{V^2}{127(e+f)}$$

$$400 = \frac{100^2}{127(e+0.12)}$$

$e = 0.077$

$\boxed{e = 8\%}$ (Let us say)

Length of supa elevation transition and spiral

$$L_s = 200De$$

$$= 200(3.5)(0.08) = 56\text{m}$$

$$= 60\text{m} \text{ (multiple of 20)}$$

Elevation difference b/w C/L and edge at TS = 0

" " " " " " " SC = De

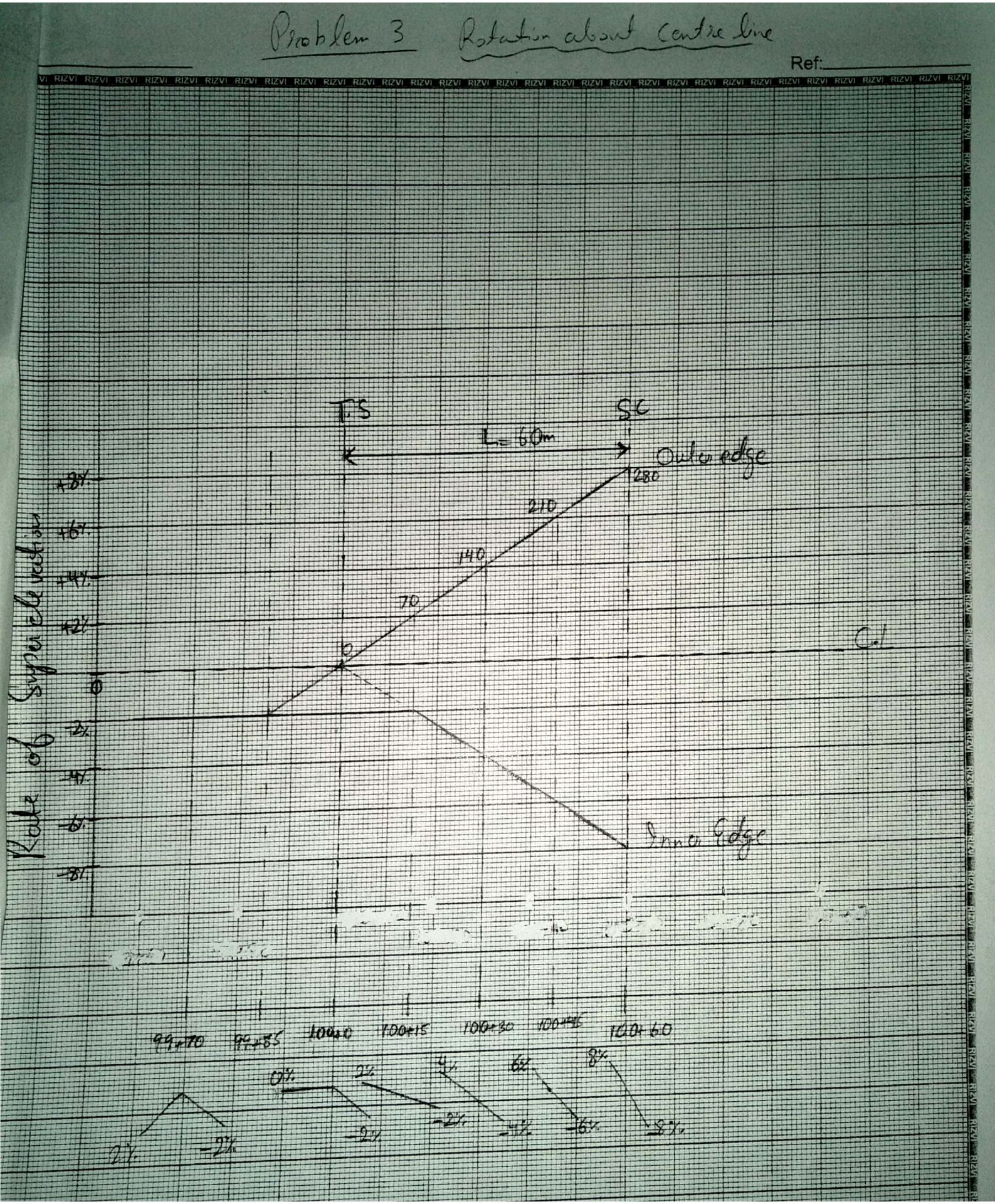
$= 3.5 \times 0.08$

$= 0.28$ m

$= 280$ mm

Problem 3 Rotation about centre line

Ref:



Q=4

Data:

$e = 0.08 = 8\%$

$R_{min} = ?$

Velocities (km/h)	f	$R_{min} = \frac{V^2}{127(e+f)}$ (m)
30	0.17	28.34
40	0.17	50.39
50	0.16	82.02
60	0.15	123.25
70	0.14	175.38

Q=5

Data:

a) $f = ?$

$V = 60 mph$

$R = 1000 ft$

b) $R_{min} = ?$

$V = 60 mph$

$f = 0.4$

Sol: For flat pavement $e = 0$

a) $R = \frac{V^2}{15(e+f)}$

$1000 = \frac{(60)^2}{15(0+f)}$

$\boxed{f = 0.24}$

b) $R_{min} = \frac{V^2}{15(e+f)}$

$R_{min} = \frac{(60)^2}{15(0+0.4)}$

$\boxed{R_{min} = 600 ft}$

Q=6

Data:

$R = 268$ ft

$V_{max} = 60\%\ V_{design}$

R of new curve = ?

$f = 0.15$ (for existing curve)

$e = 0.08$ (for both existing and new curve)

Sol:

$$R = \frac{V^2}{15(e+f)}$$

$$268 = \frac{(0.6V)^2}{15(0.08+0.15)}$$

$V_d = 50.68$ mph

$V = 81.09$ Km/h

OR

$$R = \frac{V^2}{15(e+f)}$$

$$268 = \frac{V^2}{15(0.08+0.15)}$$

$V = 30.4$ mph

As $V_{max} = 60\%\ V_{des}$

$$V_d = \frac{30.4}{0.6}$$

$V_d = 50.67$ mp

for $V = 81.09$ km/h, take $f = 0.14$

Now the new radius of curve will be

$$R = \frac{V^2}{127(e+f)}$$

$$= \frac{(81.09)^2}{127(0.08+0.14)}$$

$R = 235$ m

$R = 772$ ft

$$R = \frac{50.67^2}{15(0.08+0.}$$

$R_{min} = 778$ ft

Q=7

Data:

$R_{min} = ?$

$V_d = 70 \text{ mph} = 112.63 \text{ km/h} \Rightarrow f = 0.11$

$SE = e = 0.08$

Sol:

$$R = \frac{V^2}{15(e+f)}$$

$$= \frac{(70)^2}{15(0.08+0.11)}$$

$$\boxed{R = 1720 \text{ ft}}$$

Q=8

Data:

$V = 60 \text{ mph} = 96 \text{ km/h} \Rightarrow f = 0.12$

$R = 500 \text{ ft}$

$SE = ?$

Sol:

$$R = \frac{V^2}{15(e+f)}$$

$$500 = \frac{(60)^2}{15(e+0.12)}$$

$$e = 0.36$$

$$e = 36\%$$

This value of SE is very high, hence it is not a good design

The max $e = 12\%$

Either increase the radius

or decrease the design velocity.

Q-9 Data:

$R = 750m$

$SE = 0.08$

$V_{max} = 105 km/hr$

Is this hazardous location on highway?

Sol:

$$R = \frac{V^2}{127(e+f)}$$

$$750 = \frac{(105)^2}{127(0.08+f)}$$

$$f = 0.036$$

$$R_{min} = \frac{V^2}{127(e+f)}$$

$$= \frac{105^2}{127(0.08+0.$$

$$= 445.18m$$

At 105 km/hr the max f ≃ 0.115

Yes, Side friction factor is very less

Either provide very less superelevation

or provide lesser Radius of curvature.

10) a Data:

$R = 750 ft \Rightarrow 229..m$

$SE = 0.08$

$V = 105 km/h$

Is this hazardous location on highway?

Sol:

$$R = \frac{V^2}{127(e+f)}$$

$$229 = \frac{105^2}{127(0.08+f)}$$

$$\boxed{f = 0.3}$$

$$\boxed{R_{min} = 445.18m}$$

⇒ Yes, f is very high and cannot be adopted for such high speed

⇒ Either Increase Radius of curvature or increase superelevation.

⇒ or Increase Radius

10) b) Data:

$e = 0.05$

$R = 300\ ft \Rightarrow 92\ m$

$V = ?$

$f = 0.15$

Sol:

$$R = \frac{V^2}{15(e+f)}$$

$$300 = \frac{V^2}{15(0.05+0.15)}$$

$V = 30\ mph = 48\ km/h$

For $R = 100\ m$, $V = 50\ km/h$ can be recommended.

11) Data:

$V = 120\ km/h \Rightarrow f = 0.09$

$R = 300\ m$

$e = ?$

Sol:

$$R = \frac{V^2}{127(e+f)}$$

$$300 = \frac{120^2}{127(e+0.09)}$$

$e = 28\%$

Q=12 Data:

$e = ?$

$V = 50 mph = 80 km/h \Rightarrow f = 0.14$

$D = 8°$

Sol:

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

$$R = \frac{5730}{8°} = 716.25 ft$$

$$R = \frac{V^2}{15(e+f)}$$

$$716.25 = \frac{50^2}{15(e+0.14)}$$

$$\boxed{e = 9\%}$$

Q=13 Data:

$D_{max} = ?$

$V = 65 mph = 104 km/h$

$f = 0.1 \rightarrow 0.15$ For D_{max}, choose f_{max} and e_{max}.

$e = 0.03 \rightarrow 0.1$

Sol:

$$R = \frac{V^2}{15(e+f)}$$

$$= \frac{65^2}{15(0.1+0.15)} = 1126.67 ft$$

$$D_{max} = \frac{5730}{R_{min}} = \frac{5730}{1126.67} = 5.085°$$

Q=14

Data:

Two lane highway

$D = 6°$

$e = ?$ to develop f_{max}.

$V = 65$ mph

Draw sketch of attaining SE by revolving pavement about outside edge.

$f = 0.11$

Sol:

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

$$= \frac{5730}{6} = 955 \text{ ft}$$

$$R = \frac{V^2}{15(f+e)}$$

$$955 = \frac{65^2}{15(0.11+e)}$$

$$e = 0.185$$

$$\boxed{e = 18.5\%}$$