CE 353

PRINCIPLES OF TRANSPORTATION AND TRAFFIC ENGINEERING

PROBLEM SET-1

1) On a topographic map with scale of 1/10000 and contour intervals of 2 m., the zero line of a certain highway section is to be drawn with minimum gradient due to drainage requirements. What should be the divider opening?

2) What should be the speed of the vehicle to stop before hitting the object 70 m ahead on its roadway?

Given **:** road adhesion (μ) = 0.66, break efficiency (η_b) = 0.57, grade (G) = -3.0%, t_r= 2.5s)
Note **:** use practical brake distance

3) A driver traveling at a speed of 50 km/h sees an object 60m ahead on the roadway. The vehicle hits the object and moves to the shoulder and stops after a while. Assuming the impact of hitting is negligible calculate the distance traveled on the shoulder?

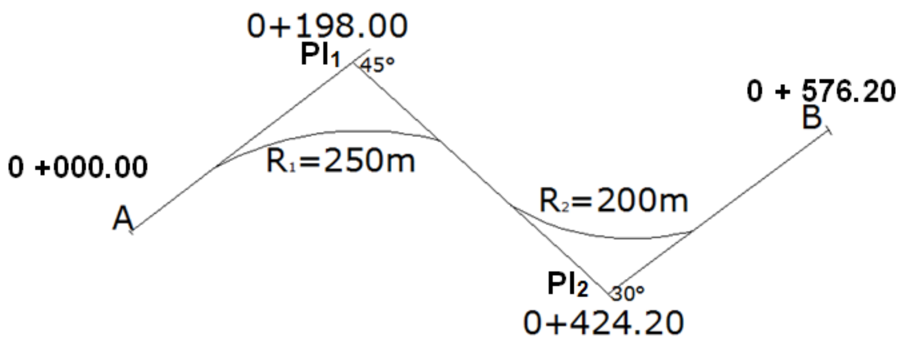
Given: road adhesion-pavement (μ) = 0.60, road adhesion-shoulder (μ) = 0.84, break efficiency (η_b) = 0.50, grade (G) = -2.0 %, t_r= 2.5 s)
Note **:** use practical brake distance.

4) A car having a braking efficiency of 80% is traveling at 130 km/h. The brakes are applied to miss an object that is 50 m from the point of break application. If the coefficient of road adhesion is 0.80, assuming theoretical minimum braking distance calculate the speed of the car when it strikes the object if (a) the surface is level (b) the surface is on a 5% downgrade.

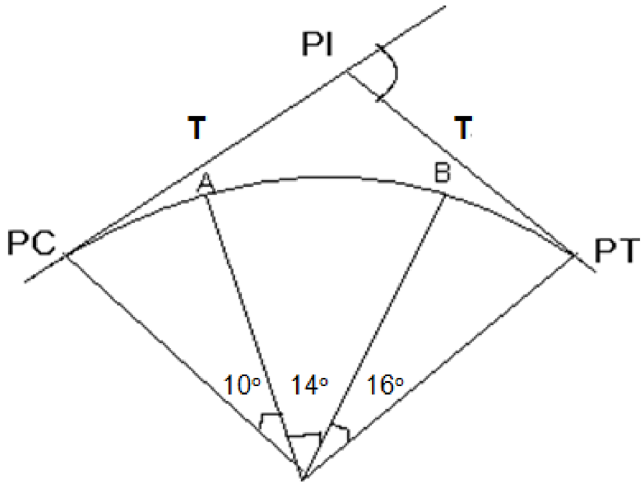
Note : take mass factor = 1.04

5) In a horizontal curve, the tangent and long chord lengths are given as 80.41 m and 139.27 m respectively. Find the length of the curve.

6) For the given polygonal station kilometers and intersection angles, calculate the true station kilometers of PC1, PT1, PC2, PT2 and B.



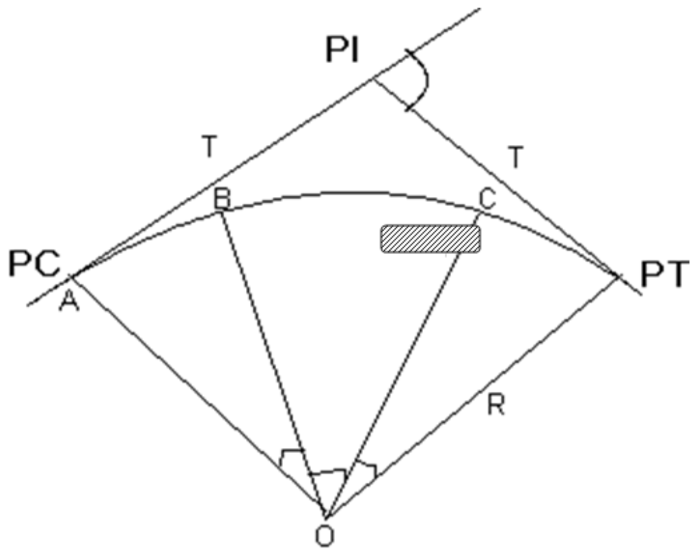
7) How much additional length would you take if you traveled along the horizontal curve compared with traveling along straight portions PC-A-B-PT for the curve given below?



Given: T = 109.20 m

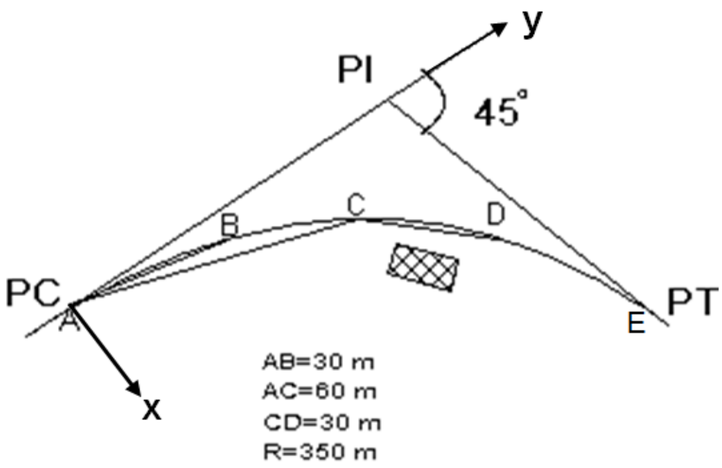
8) For the horizontal curve shown below the following data is given:

- chord length between A and B = 34.86 m
- cord length between B and C = 60 m.
- deflection angle of point B = 5^o,
- external distance (E) = 26.0 m
- station km of PI is 4+135.40.



Find: a) The radius of the curve (R)
b) Intersection angle (Δ)
c) Station km's of PC and PT
d) The chord length of C-PT

9)



It is desired to locate the above a circular horizontal curve by using deflection angles method. As can be seen from the figure, by placing the theodolite on PC, it is impossible to sight point D due to the obstruction between points C and D. Thus, to locate point D and the last point E (PT), the theodolite has to be moved to point C and further staking should be proceeded there on.

a) Find the deflection angles to locate point B and C.
b) Explain the procedure for staking out the points D and E by indicating directions, deflection angles and distances.
c) Find the chord length DE.
d) If point C is tried to be located by the use of coordinate method, what would be X and Y distances?

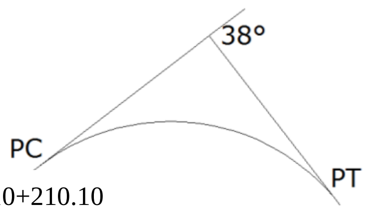
10) For a simple horizontal curve, the following data was given:

Design speed = 60 km/hr
Grade at horizontal curve = -4% (downgrade)
Tangent length (T) = 120 m
Long Chord L_c = 217.5 m
Lane width= 3.5 m

What should be the minimum distance between center of the inner lane and the edge of a lateral obstruction (lateral clearance to obstruction (M_s) ?

Note: use practical brake distance (road adhesion (μ) = 0.66, break efficiency (η_b)=0.50)

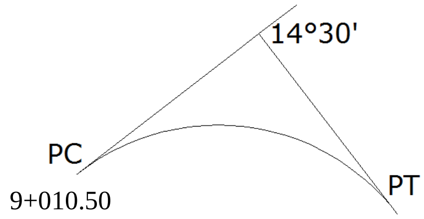
11)



10+210.10

Prepare data table for staking out the horizontal curve using deflection angle method.

12)

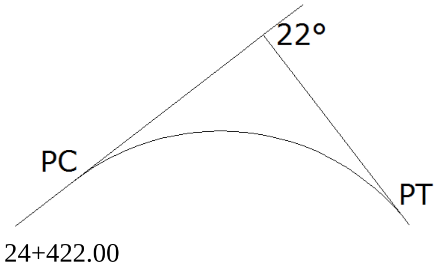


450m

: 20m

Prepare data table for staking out the horizontal curve using deflection angle method.

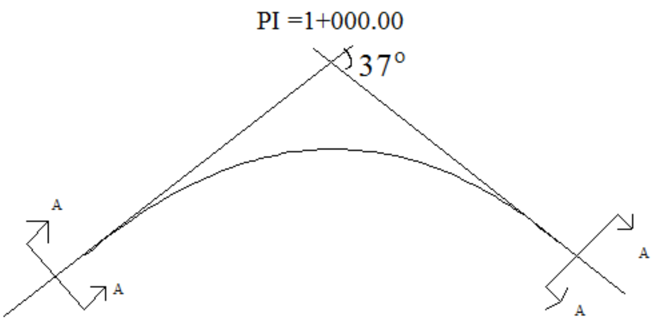
13)



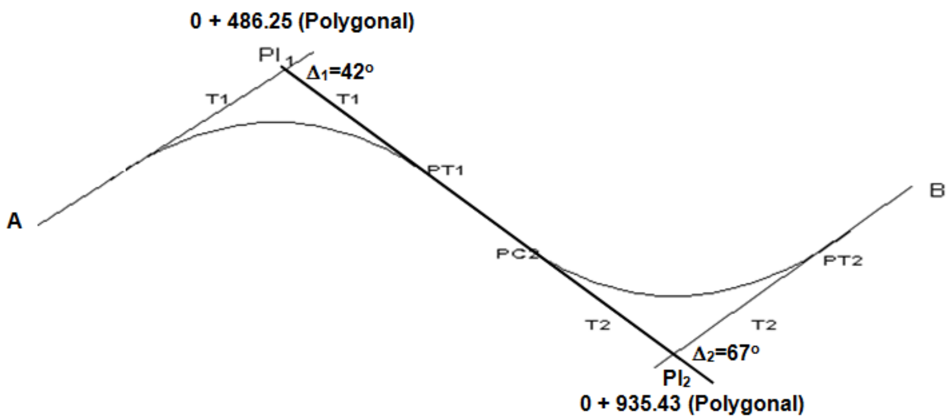
R = 200 m

Prepare data table for staking out the horizontal curve using coordinate method.

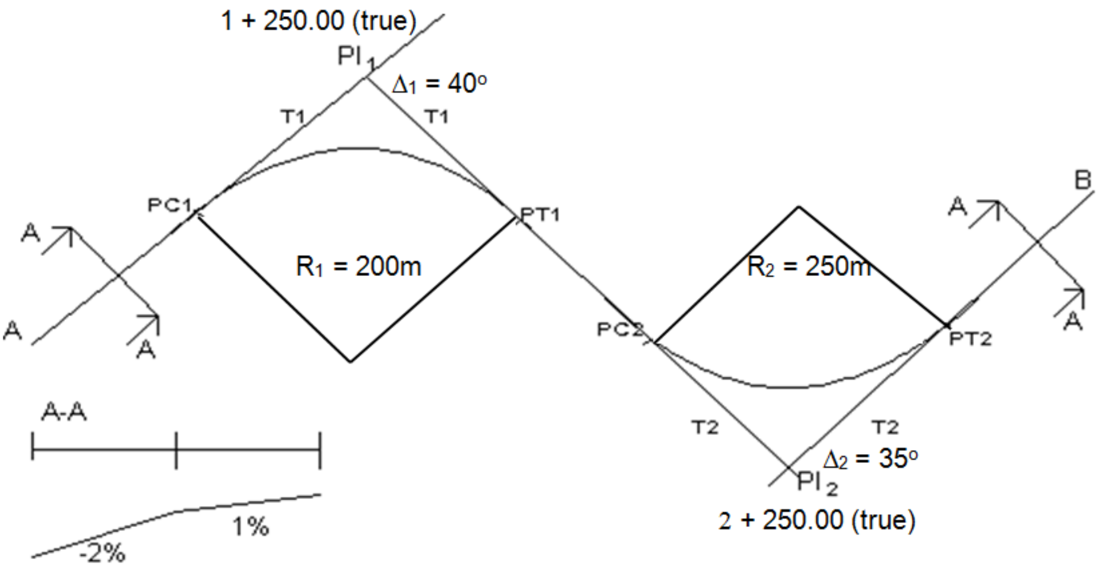
14) For the below horizontal curve the design speed is 90 km/hr and the radius of curve is 600 m. Find the superelavation at St. Km. 1+187.00. (**Note:** Apply Turkish practice)



15) Design of horizontal alignment given below is to be completed for 75 km/h design speed according to Turkish Standards. If maximum superelevation (e_{max}) of second curve is 7.0%, determine the curve lengths and tangent lengths for both horizontal curves.



16)



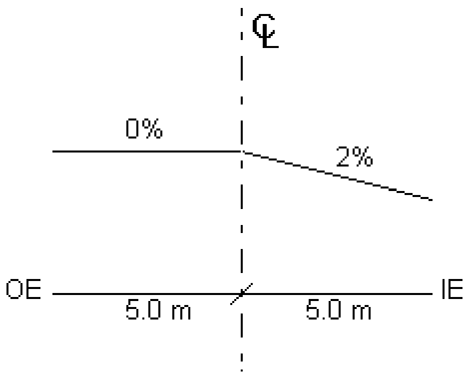
For the above given horizontal alignment and the cross section (A-A) on alignment;

a) Find the true station kilometers of PC_1, PT_1, PC_2 and PT_2.

b) For the given reverse curves and the original cross section, carry out superelevation calculations for a design speed of 80 km/h by applying rotation around centerline.

Notes : max e = 8%, use modified (reduced) speed in L_s calculations whenever required.

17) Normal cross-section of a two lane highway is shown below.



For a right turning curve of 275 m radius, superelevation is to be applied by rotating around center line for design speed (V_d) of 70 km/h).

a. Find maximum superelevation e_{max} and L_s distance

b. Draw the superelevation diagram by rotating around center line and tabulate superelevation data by using 10 meter station intervals.

c. Draw the cross-section at PC point.

Note: Apply Turkish practice. (use rounded figures for design)

18) The horizontal curve shown below was designed for 90 km/h design speed (V_d). The maximum superelevation (e_{max}) was calculated as 8%.

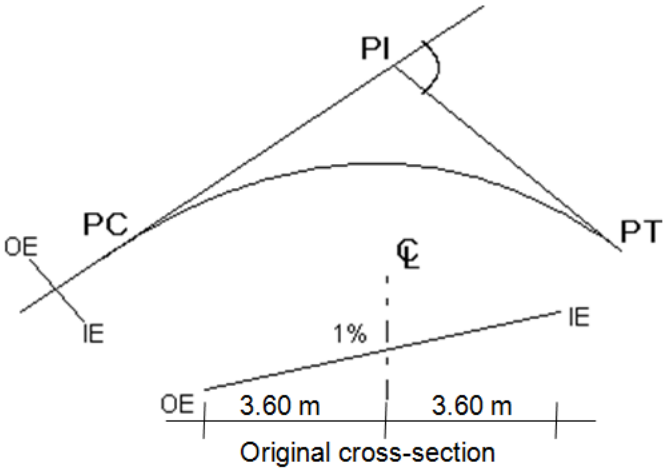
Find: a) Find transition length (L_s) by applying slope ratio of 1/200. (Use rounded Ls values, i.e. if Ls is calculated as 47.00 m then take Ls = 50 m)

b) If the coefficient of lateral friction is 0.13, determine minimum safe curve radius.

c) Draw superelevation diagram by rotating around center line (Apply Turkish Standards).

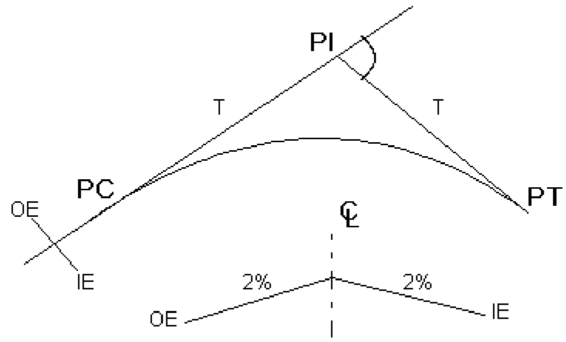
d) Prepare superelevation table by using 10 meter station intervals.

e) Draw cross sections at every 10 m.



19) For the horizontal curve and the original cross-section of a two lane highway shown below, the following data is given:

- Radius (R) = 150 m
- Intersection angle (Δ) = 35^o
- Design Speed (V_d) = 60 km/h
- Stopping Sight Distance (S_s) = 72.26 m



Find; a) T, L, E, M lengths of the curve

b) Minimum lateral clearance distance (M_s)

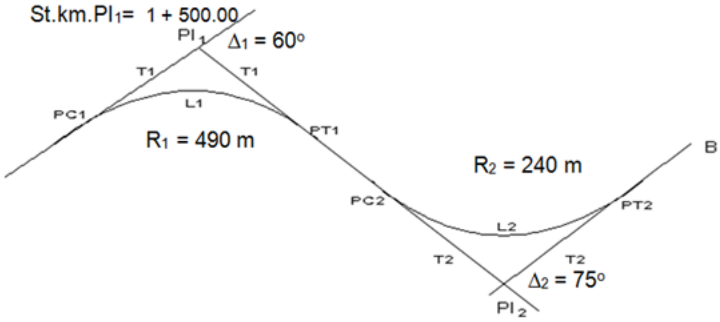
c) Determine the maximum superelevation (e_{max}) and transition length (L_s) for rotation around centerline. (Hint: use modified speed in L_s calculations)

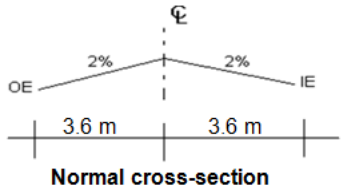
d) Tabulate superelevation data by using 10 m station intervals starting from the start L_s point.

e) Draw superelevation diagram by **r**otating the roadway around the center line and inner edge (lane width = 3.5 m and shoulder width = 1.5 m)

Note: Apply Turkish practice.

20)





If the design speed is 90 km/h;

a) What should be the minimum value of PT_1-PC_2 distance so that superelevation application for both curves will be provided by applying 1/200 Slope Ratio

b) Determine the true station kilometers of PC_1, PT_1, PC_2 and PT_2 for the condition in part (a).

21) Solve problem 21 by changing the radius second curve (R_2) as 350 m.

22) For a given horizontal curve, in rotation around center line, the equation for outer edge elevation difference is given as y= -0.08+0.008x, where y is the elevation difference with respect to CL & x is the distance along L_s with origin being at the beginning of L_s. If the design speed is 80km/hr and original crown slopes are -2%;

a) Sketch the profile of this rotation

b) Find platform width

c) Find maximum superelevation

d) Find transition distance

ANSWER SHEET

1. 4cm
2. V_1= 51.26km/hr
3. 6.89m
4. a.) 26.16m/s b) 27.04m/s
5. 145.56m
6. St km PC_1= 0+094.45 , St km PT_1= 0+290.80 , st km PC_2= 0+359.86, st km PT_2=0+464.58 , st km B= 0+562.99
7. 0.53m
8. a) R=200m, b) 55.51^o , c) st km PC= 4+030.15 st km PT= 4+223.92
   d) 97.65m
9. a) 2.46^o
   b) → Look PI from PC
   → Rotate theodolite 2.46^o
   → Find point C by measuring 60m along line of sight
   →Set the instrument on point C
   → Look point PC
   → Rotate the theodolite 2.46^o backward
   → Flip theodolite
   → Rotate theodolite 2.46^o
   → Measure 30m in the line of sight and mark point D.
   c) 182.71m , d) X=59.75m, Y=5.14m
10. Ms=3.99m
14. 3.99%
15. T_1=162m, T_2=235.63m , L_1=309m , L_2=416.27m
16. a) PC_1= 1+177.21 , PT_1= 1+316.84 , PC_2=2+162.18 , PT_2=2+314.90
17. e_{max}= 7.89% , Ls= 44.15m
18. a) Ls= 57.6m ≈60m b) Rmin= 303.71m
19. a) T= 47.29m , L= 91.63m , M= 6.94m , E=7.28m
    b) Ms=4.38m
    c) e_{max}= 8% Ls=29.5m
20. a) 73.44m
    b) st km PC1= 1+217.10 , st km PT_1= 1+730.10 , st km PC_2= 1+803.54 , st km PT_2= 2+117.54

21. a) 73.44m

b) st km PC_1=1+217.10 , st km PT_1=1+730.10 , st km PC_2= 1+803.54,

st km PT_2=2+261.69

22. b) 8m c.) emax=7.18% d.) Ls=45.9m