Assignment/Quiz:

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SUBJECT: HIGHWAY AND TRANSPORTATION

Q: N(1)

a. Write a note on sight distance and its types. Also, write equations for each of the types.
b. If the Annual average daily traffic (AADT) is 4000 vpd and the 30th highest hourly volume for the year is 420 vph, what is the K-factor for that facility?

Answer: (A)

Sight Distance:

- The visibility of the road ahead of the driver will help in the safe and efficient operation of the vehicles. This will hence demand the geometric design to be highly efficient so that the length of the road is highly visible to the driver even from a distance ahead. This distance is hence termed as the sight distance.

OR

- The actual distance that is observed along the road surface which is visible for a driver from a specified height above the carriage way is called as the sight distance at a point. This distance will let the driver see all the stationary and the moving objects in front of the vehicle

Types of sight distance:

- SSD – Stopping Sight Distance or Absolute Minimum Sight Distance
- ISD – Intermediate Sight Distance: This is twice the value of SSD
- OSD – Overtaking Sight Distance

Stopping Sight Distance or Absolute Minimum Sight Distance(SSD):

- This is defined as the sight distance that is available for the moving the vehicle in the highway that will enable the driver to stop the vehicle safely without collision with any other obstacle.
- This demand the sight distance used in the geometric design to be equal to the safe stopping distance. The Stopping distance can be defined as the sum of Lagging distance and the Brake distance.
- The lagging distance is the distance that is moved by the vehicle (during reaction) in a time period ‘t’ at a velocity of ‘v’ in m/s.

  Hence, Lag distance = v t
- Let ‘F’ be the maximum frictional force that is developed and ‘l’ be the braking distance. Hence, the work that is done against friction is given by

  Fl = fWl

  Here W = the weight of the vehicle.
- The Kinetic energy attained at the design speed of the vehicle

$$\frac{1}{2}mv^2 = \frac{1}{2}\frac{Wv^2}{g}$$

$$fWl = \frac{Wv^2}{2g}$$

$$l = \frac{v^2}{2gf}$$

Hence,

- The Stopping Sight Distance (SSD) = Lag Distance + Braking Distance

$$SSD = vt + \frac{v^2}{2gf}$$

The Table-1 Below shows the coefficient of friction for different design speeds:

Table 1: Coefficient of longitudinal friction

Speed, kmph	<30	40	50	60	>80
f	0.40	0.38	0.37	0.36	0.35

- If the road possesses an ascending gradient in an amount equal to + n%, to the braking action the component factor of gravity will be added. This will decrease the braking distance.
- We can also derive the braking distance for a descending gradient which is performed similarly, and we get:

$$SSD = vt + \frac{v^2}{2g(f \pm 0.01n)}$$

Intermediate sight distance:

- A distance equivalent to twice the stopping sight distance is termed as intermediate sight distance.
- Here, overtaking could be attempted with reasonable safety

Intermediate sight distance = 2 X Stopping sight distance

Overtaking Sight Distance (OSD):

- The minimum distance available for the driver to safely overtake the slow vehicle in front of him by considering the traffic in the opposite direction

is called as the overtaking sight distance. This distance will make us see whether the road is clear to undergo an overtaking movement.

- The overtaking sight distance is also called as the passing sight distance that will be measured along the center line of the road. This is the line level over which the driver keeping an eye level of 1.2 m above the road level can easily see the top of the object 1.2 m above the road surface.

PART(B)

ANSWER (B):

K-Factor = $\frac{DHA}{AADT} \times 100$

K-Factor = $\frac{420}{4000} \times 100$ = **10.5**

QUESTION: (2):

Briefly describe any five types of interchanges in your own words?

ANSWER:

TYPES OF INTERCHANGE:

➢ Diamond Interchange:

A diamond interchange involves four ramps, exiting and entering the highway. These designs are very economical because, compared to other options, they require less land and materials. Some of the first diamond interchanges were developed along the Pasadena Freeway in Los Angeles in 1941.

➢ Tight Diamond Interchange:

A tight diamond has the same general form as the conventional diamond. But, as the name suggests, the spacing of the design is tighter. The spacing between the two at-grade intersections (intersections directing travelers either onto or off of the arterial) is usually between 250 and 400 feet**,**

- **Cloverleaf Interchange:**

The cloverleaf design eliminates the need for traffic signals and keeps motorists moving. However, weaving is a problem that may lead to a breakdown in traffic operation and more accidents. The cloverleaf was the first interchange design constructed in the United States. It was built in Woodbridge, New Jersey in 1928.

- **Directional Interchange:**

The directional interchange design often requires less right of way than a cloverleaf design. The primary disadvantage is increased cost because of the need for multiple-level structures. Directional interchanges are often warranted in certain urban areas where traffic volumes are very high and high-speed maneuvering is desired.

- **Fully Directional (Stack) Interchange:**

The stack interchange design eliminates the need for looping and weaving, making for easier transitions. However, they tend to be costly and take up a lot of land to implement. The first four-level stack interchange was built in Los Angeles, around 1952**.**

QUESTION NO:(3)

a. Derive an equation for mechanical widening on a horizontal curve. Illustrate with a suitable diagram.
b. A count for road is 200 vehicles per hour consisting of 100 cars, 50 trucks and 50 buses, the traffic flow on this road in Passenger Car Unit (PCU) per hour will be?

ANSWER: (A)

Horizontal curve:

- A horizontal highway curve is a curve in plan to provide change in direction to the central line of a road.
- When a vehicle traverses a horizontal curve, the centrifugal force acts horizontally outwards through the centre of gravity of the vehicle.
- The centrifugal force is given by the equation:

$$P = Wv^2/Gr$$

Where,

P=centrifugal force in kg

W=Weight of the vehicle in kg

R=radius of the circular curve in m

v=speed of the vehicle in m/s

g=acceleration due to gravity=9.8 m/s2

- P/W is known as the centrifugal ratio or the impact factor. The centrifugal ratio is thus equal to v^2/gR.
- The centrifugal force acting on a vehicle negotiating a horizontal curve has two effects:

i. Tendency to overturn the vehicle outwards about the outer wheels

Tendency to skid the vehicle laterally, outward

Mechanical widening/Off tracking (Wm):

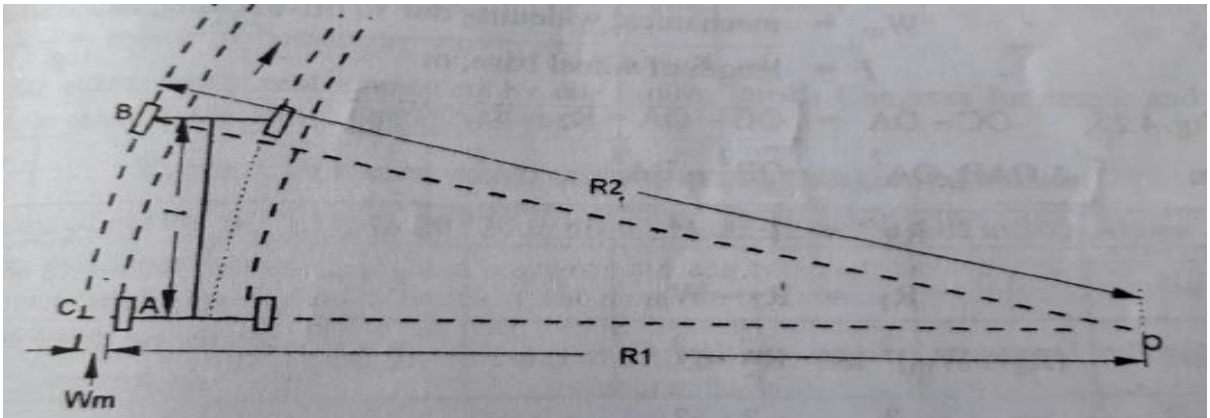

Fig. 4.25 Off-tracking and mechanical widening on horizontal curve

Consider

OA=R1=radius of the path traversed by the outer rear wheel,m

OB=R2=radius of the path traversed by the outer front wheel,m

Wm=mechanical widening due to off-tracking, m

l=length of wheel base,m

R=mean radius of the horizontal curve, m

OB-OA= R2 - R1 =Wm

PART;(B)

ANSWER: (B)

PCU for CAR = 1.0

PCU for truck= 3.0

PCU for bus= 3.0

Solution: Type equation here.

PCU for 100 cars = 1.0 × 100 = 100

PCU for 50 trucks= 3.0 × 50 = 150

PCU for bus = 3.0 × 50 = 150

PCU for 100 cars, 50 trucks, and 50 bases

=100+50=150

PCU = 400

QUWSTION: NO(4)

a. Write down the equation for finding the length of a summit curve when L>SSD.
b. Write down the values of Ruling, Limiting and Exceptional gradients when the terrain is plain and rolling.
c. What should be the width of carriageway for a single lane road and for two lanes with raised kerbs?
d. What is the maximum limit of super-elevation on hill roads not bounded by snow and on urban roads with intersections?
a. Write down the equation for finding the length of a summit curve when L<OSD.

ANSWER:

A)

a. When L > SSD

The general equation for length of curve is given by:

$$L = \frac{NS2}{[\sqrt{2H} + \sqrt{2h}]2}$$

- Substituting the value of H=1.2m and h=0.15m,

$$L = \frac{NS2}{4.4}$$

B)

Ruling gradient for plain is 1/30 is 33%

Limiting gradient for plain is 1/20 is 5%

Exceptional gradient for plain is 1/15 is 6.7%

C)

The desirable side clearance for single lane traffic is 0.68m. This require minimum of lane width of 3.75m for a single lane road.

For raised kerbs it is 7.5meters;

D)

On hill roads not bound by snow a maximum super elevation up to 10% has been recommended.

E)

b. When L < OSD

The general equation for length of curve is given by:

$$L = 2S - \frac{8H}{N}$$

- Substituting the value of H=1.2m,

$$L = 2S - \frac{9.6}{N}$$