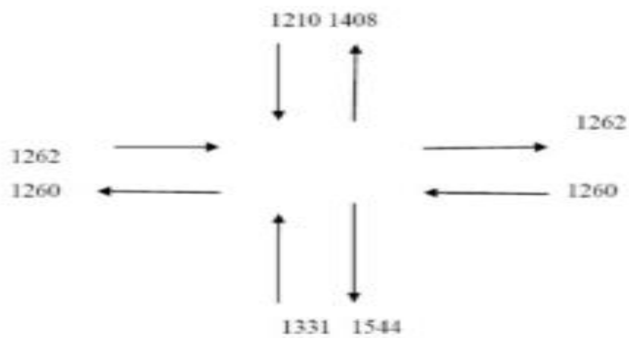
CMR
INSTITUTE OF
TECHNOLOGY

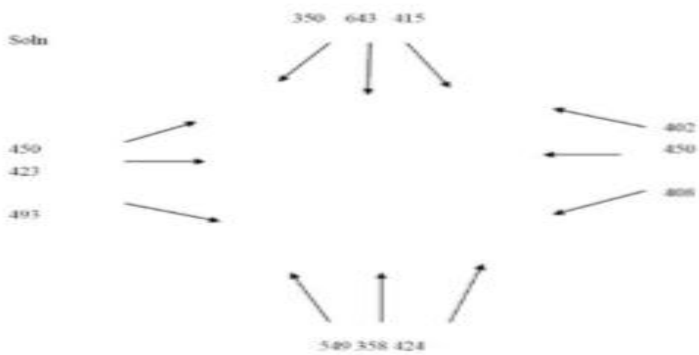
Internal Assessment Test 2 – November 2017

Solution

Sub:	HIGHWAY GEOMETRIC DESIGN					**Code:**	10 CV755
Date:	08/ 11 / 2017	Duration: 90 mins	Max Marks: 50	**Sem:**	7	**Branch:**	CIVIL

Q1. Rotary design :





W = (e1 + e2) / 2 +3.5 = 13.5

L =4W = 54

Calculation of P :

$$p = \frac{b+c}{a+b+c+d}$$

= 0.72

$$Q_w = \frac{280w[1+\frac{e}{w}][1-\frac{p}{3}]}{1+\frac{w}{l}}$$

= 288*13.5*1.74*0.76/12.45 = 4000PCU/hr

This is higher than the traffic flow 2746PCU/hr

The final sketch of the rotary designed is as follows.

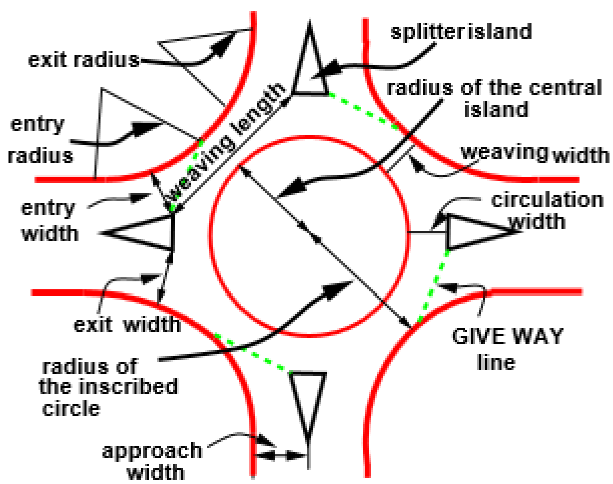


Figure 40:2: Design of a rotary

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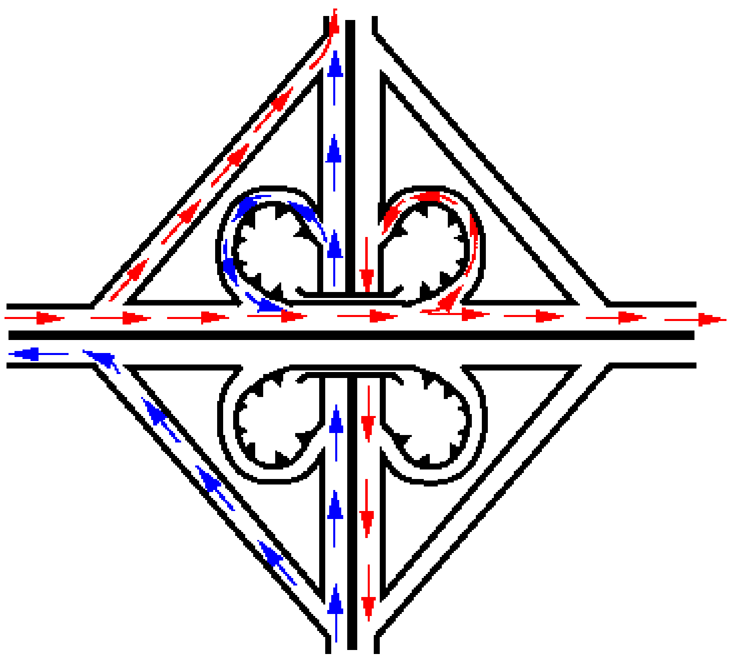
Q2. A) Principles of intersection design:

1. The number of intersections should be kept to a minimum. If necessary, some minor roads may be connected with each other before joining a major road.
2. The geometric layout should be so selected that hazardous movements by drivers are eliminated. This can be achieved by various techniques such as channelizing and staggering.

3. The design should permit the driver to discern quickly either from the layout or form traffic signs the path he should follow and the actions of merging and diverging. This can be achieved by a good layout, traffic islands, signs and carriageway markings. Good visibility improves safety.
4. The layout should follow the natural vehicle paths. Smoothness, in contrast to abrupt and sharp corners, should guide minor streams of traffic into stopping or slowing down positions.
5. The number of conflict points should be minimized by separating some of the many cutting, merging and diverging movements.
6. Vehicles that are forced to wait in order to cross the traffic stream should be provided with adequate space at the junction.

b) **Clover leaf interchange**: It is also a four leg interchange and is used when two highways of high volume and speed intersect each other with considerable turning movements. The main advantage of cloverleaf intersection is that it provides complete separation of traffic. In addition, high speed at intersections can be achieved. However, the disadvantage is that large area of land is required. Therefore, cloverleaf interchanges are provided mainly in rural areas.



Some of its advantages are

1. Through traffic on both roads is unimpeded.
2. Only one structure is required
3. Left turning traffic has a direct path
4. It is very simple to use and does not confuse the drivers.

Some of the disadvantages are:

1. Relatively large area is needed.
2. The carriageway area required is also higher than a rotary interchange
3. Weaving maneuvers are involved, some of them on the roadway of the structure and some underneath
4. The weaving capacity is limited to 1200 pcus/hr, but may be increased by providing an auxiliary lane
5. The U-turns are long and operationally difficult
6. Loop design speeds have to be low and speeds above 50 kmph are likely to increase the cost.
7. Right turning traffic has to travel extra distance
8. The capacity of the loop is also restricted. A capacity of 800-1200 veh per hour is the limit.

3. a) An ascending gradient of 1 in 100 and a descending gradient of 1 in 120 meet at a point. Design a summit curve for a speed of 80 kmph so as to have an OSD of 420 m.

Ans:

OSD = S =420m

N1= +1/100 n2= -1/120

N = N1 –N2 = (1/100) – (-1/120) = 11/600

N= 0.018

Assume , L > OSD, L = $NS^2/9.6$ = 336.9 m. which is not greater than the given OSD.

Hence the assumption is wrong.

Hence assume ,L<OSD.

L= 2S- 9.6/N = 317m < OSD

b) Advantages and disadvantages of rotary

The key advantages of a rotary intersection are listed below:

1. Traffic flow is regulated to only one direction of movement, thus eliminating severe conflicts between crossing movements.

2. All the vehicles entering the rotary are gently forced to reduce the speed and continue to move at slower speed. Thus, none of the vehicles need to be stopped, unlike in a signalized intersection.

3. Because of lower speed of negotiation and elimination of severe conflicts, accidents and their severity are much less in rotaries.

4. Rotaries are self governing and do not need practically any control by police or traffic signals.

5. They are ideally suited for moderate traffic, especially with irregular geometry, or intersections with more than three or four approaches.

Although rotaries offer some distinct advantages, there are few specific limitations for rotaries which are listed below.

1. All the vehicles are forced to slow down and negotiate the intersection. Therefore, the cumulative delay will be much higher than channelized intersection.

2. Even when there is relatively low traffic, the vehicles are forced to reduce their speed.

3. Rotaries require large area of relatively flat land making them costly at urban areas.

4. The vehicles do not usually stop at a rotary. They accelerate and exit the rotary at relatively high speed. Therefore, they are not suitable when there is high pedestrian movements.

4 a) **Overtaking sight distance**

The overtaking sight distance is the minimum distance open to the vision of the driver of a vehicle intending to overtake the slow vehicle ahead safely against the traffic in the opposite direction. The overtaking sight distance or passing sight distance is measured along the center line of the road over which a driver with his eye level 1.2 m above the road surface can see the top of an object 1.2 m above the road surface.
The factors that affect the OSD are:
_ Velocities of the overtaking vehicle, overtaken vehicle and of the vehicle coming in the opposite direction.
_ Spacing between vehicles, which in-turn depends on the speed
_ Skill and reaction time of the driver
_ Rate of acceleration of overtaking vehicle
_ Gradient of the road

The
overtaking sight distance consists of three parts.
_ d1 the distance traveled by overtaking vehicle A during the reaction time t
_ d2 the distance traveled by the vehicle during the actual overtaking operation T
_ d3 is the distance traveled by on-coming vehicle C during the overtaking operation (T).
Therefore:
OSD = d1 + d2 + d3

It is assumed that the vehicle A is forced to reduce its speed to vb, the speed of the slow moving vehicle B and travels behind it during the reaction time t of the driver.

So d1 is given by:
d1 = vbt

Then the vehicle A starts to accelerate, shifts the lane, overtake and shift back to the original lane. The vehicle
A maintains the spacing s before and after overtaking. The spacing s in m is given by:
s = 0.7vb + 6

Let T be the duration of actual overtaking. The distance traveled by B during the overtaking operation is
2s+vbT. Also, during this time, vehicle A accelerated from initial velocity vb and overtaking is completed while reaching _nal velocity v. Hence the distance traveled is given by:
$d2 = vbT + ½ aT^2$
$2s + vbT = vbT + ½ aT^2$
$2s = 1 /2 aT^2$
$T = \sqrt{4S / a}$

D2 = b +2s

The distance traveled by the vehicle C moving at design speed v m=sec during overtaking operation is given by:
d3 = vT

The the overtaking sight distance is

OSD = d1 +d2 +d3

4. b) GIVEN:

Speed of overtaking vehicle = $V_A = V_C$ = 80 kmph

Speed of overtaken vehicle = V_B = 65 kmph

Average rate of acceleration A = 3.6 kmph/sec.

It is a single lane road.

Assume t = 2 seconds.

Hence, OSD = $d_1 + d_2 + d_3$ (for two way traffic)

OSD = $d_1 + d_2$ (for one way traffic)

Calculation of d_1:

$d_1 = 0.28 \times V_b \times t = 0.28 \times 65 \times 2 = 36.4$ m

$d_1 = 36.4$ m

Calculation of d_2:

$d_2 = b + 2S$

where $b = 0.28 V_b \times T$, $S = 0.2 V_b + 6$, $T = \sqrt{\frac{14.4 S}{A}}$

$S = 0.2 V_b + 6 = 0.2 \times 65 + 6 = 19$ m

$T = \sqrt{\frac{14.4 S}{A}} = \sqrt{\frac{14.4 \times 19}{3.6}} = 8.71$ seconds

$b = 0.28 \times V_b \times T = 0.28 \times 65 \times 8.71 = 158.52$ m

$d_2 = b + 2S = 158.52 + 2 \times 19 = 196.52$ m

$d_2 = 196.52$ m

Calculation of d_3:

$d_3 = 0.28 V \times T = 0.28 \times 80 \times 8.71 = 195.10$ m

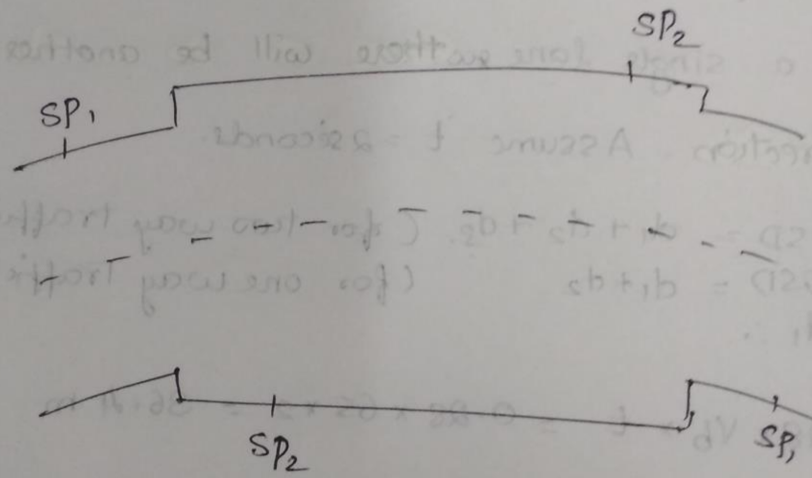
OSD = $d_1 + d_2 + d_3 = 36.4 + 196.52 + 195.10$ m = 428 m (two way)

OSD = $d_1 + d_2 = 36.4 + 196.52$ m = 232.92 m (one way)

Overtaking Zone: (for two way traffic)

Minimum Length = $3 \times OSD = 3 \times 428\ m = 1284\ m$

Desirable Length = $5 \times OSD = 5 \times 428\ m = 2140\ m$.



Overtaking Zone