University of Al-Maarif
College of Engineering
Department of Civil Engineering

TRAFFIC ENGINEERING

NINTH LECTURE

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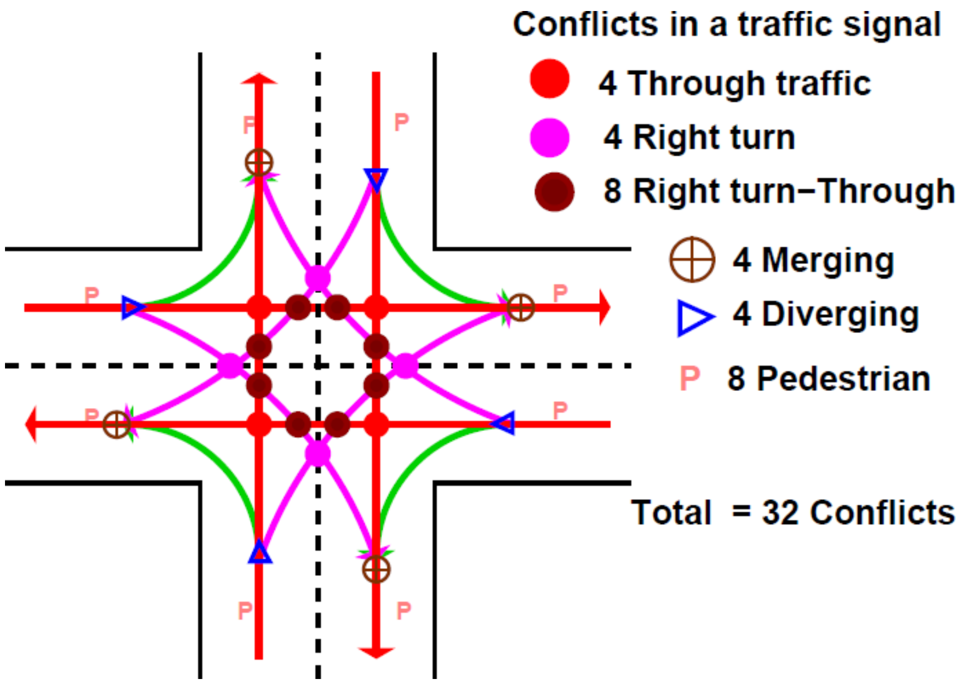
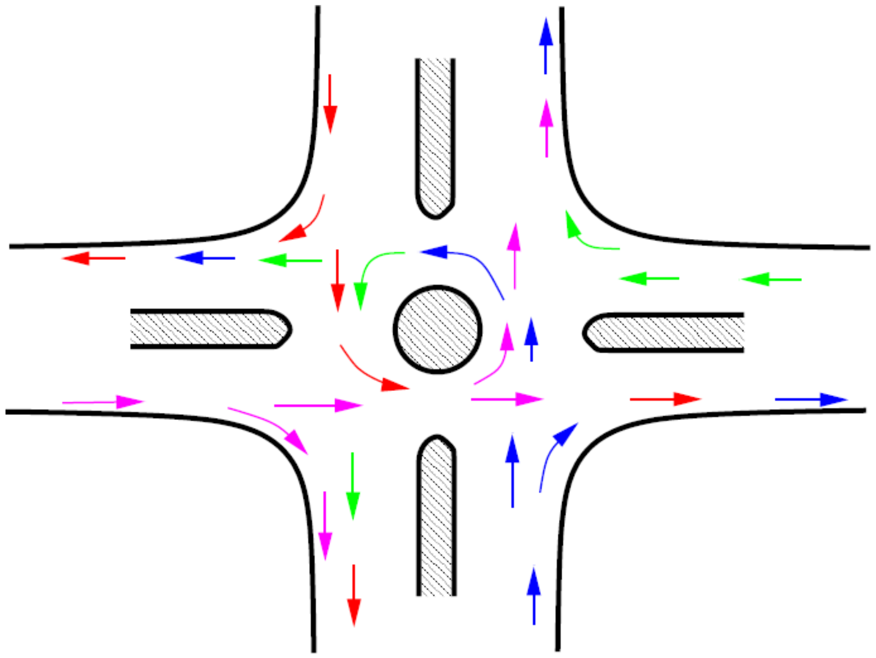
CONFLICTS AT AN INTERSECTION

Conflicts at an intersection are different for different types of intersection. Consider a typical four-legged intersection as shown in figure. The number of conflicts for competing through movements are 4, while competing right turn and through movements are 8. The conflicts between right turn traffics are 4, and between left turn and merging traffic is 4. The conflicts created by pedestrians will be 8 taking into account all the four approaches. Diverging traffic also produces about 4 conflicts. Therefore, a typical four-legged intersection has about 32 different types of conflicts.



TRAFFIC ROTARIES

Rotary intersections or roundabouts are special form of at-grade intersections laid out for the movement of traffic in one direction around a central traffic island. Essentially all the major conflicts at an intersection namely the collision between through and right-turn movements are converted into milder conflicts namely merging and diverging. The vehicles entering the rotary are gently forced to move in a counter-clockwise direction in orderly fashion. They then weave out of the rotary to the desired direction.



ADVANTAGES AND DISADVANTAGES OF ROUNDABOUT

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.

ADVANTAGES AND DISADVANTAGES OF ROUNDABOUT

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.

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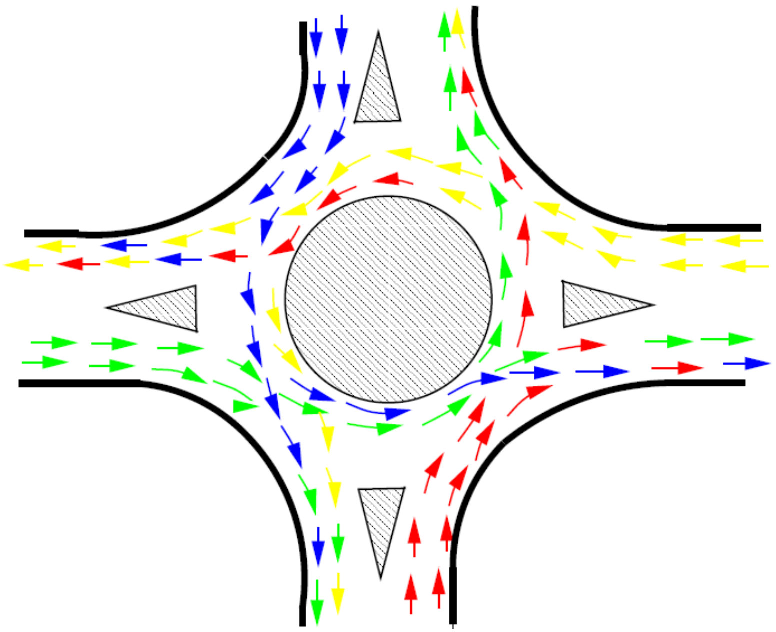
TRAFFIC OPERATIONS IN A ROTARY

the traffic operations at a rotary are three; diverging, merging and weaving. All the other conflicts are converted into these three less severe conflicts.

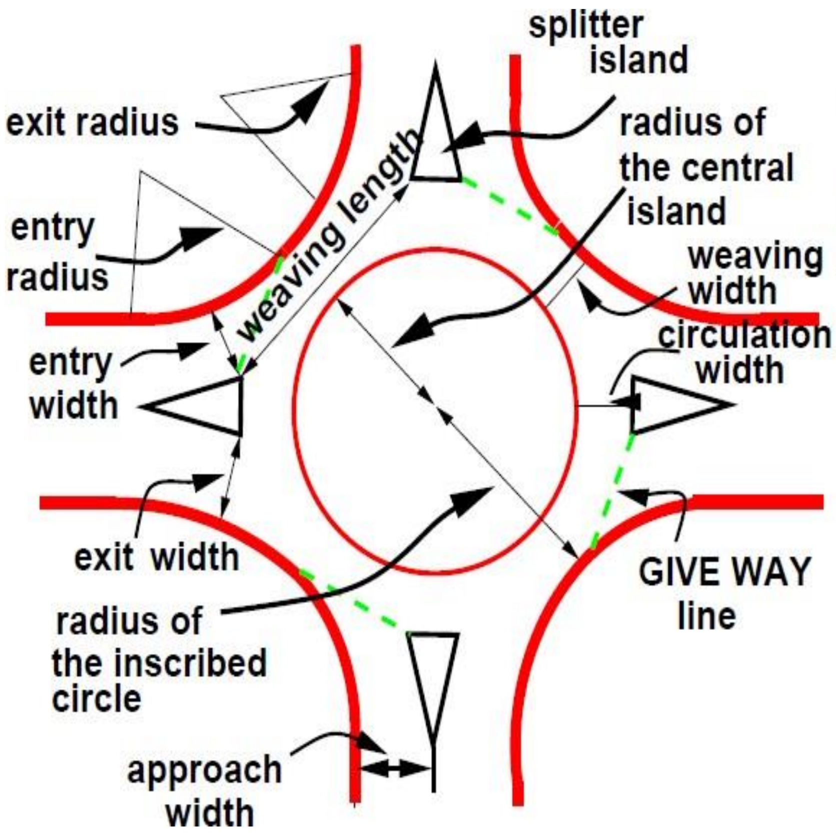
1. Diverging: It is a traffic operation when the vehicles moving in one direction is separated into different streams according to their destinations.
2. Merging: Merging is the opposite of diverging. Merging is referred to as the process of joining the traffic coming from different approaches and going to a common destination into a single stream.
3. Weaving: Weaving is the combined movement of both merging and diverging movements in the same direction.



DESIGN ELEMENTS AND SPEED IN ROUNDABOUT

The design elements include design speed, radius at entry, exit and the central island, weaving length and width, entry and exit widths. In addition, the capacity of the rotary can also be determined by using some empirical formula. A typical rotary and the important design elements are shown in figure below.

All the vehicles are required to reduce their speed at a rotary. Therefore, the design speed of a rotary will be much lower than the roads leading to it. Although it is possible to design roundabout without much speed reduction, the geometry may lead to very large size incurring huge cost of construction. The normal practice is to keep the design speed as 30 and 40 kmph for urban and rural areas respectively.



$$speed = 30 - 40 kmph$$

$$R_{entry} = 20 - 25m$$

$$R_{exit} = R_{entry} \times 1.5to2$$

$$R_{CentralIsland} = R_{entry} \times 1.3$$

ENTRY, EXIT AND ISLAND RADIUS

Entry, exit and island radius The radius at the entry depends on various factors like design speed, super-elevation, and coefficient of friction. The entry to the rotary is not straight, but a small curvature is introduced. This will force the driver to reduce the speed. The entry radius of about 20 and 25 meters is ideal for an urban and rural design respectively. The exit radius should be higher than the entry radius and the radius of the rotary island so that the vehicles will discharge from the rotary at a higher rate. A general practice is to keep the exit radius as 1.5 to 2 times the entry radius. However, if pedestrian movement is higher at the exit approach, then the exit radius could be set as same as that of the entry radius. The radius of the central island is governed by the design speed, and the radius of the entry curve. The radius of the central island, in practice, is given a slightly higher radius so that the movement of the traffic already in the rotary will have priority. The radius of the central island which is about 1.3 times that of the entry curve is adequate for all practical purposes.

WIDTH OF THE ROTARY

The entry width and exit width of the rotary is governed by the traffic entering and leaving the intersection and the width of the approaching road. The width of the carriageway at entry and exit will be lower than the width of the carriageway at the approaches to enable reduction of speed. IRC suggests that a two-lane road of 7 m width should be kept as 7 m for urban roads and 6.5 m for rural roads. Further, a three-lane road of 10.5 m is to be reduced to 7 m and 7.5 m respectively for urban and rural roads.

$$w_{weaving} = \left(\frac{e_1 + e_2}{2}\right) + 3.5m$$

where e_1 is the width of the carriageway at the entry and e_2 is the carriageway width at exit.

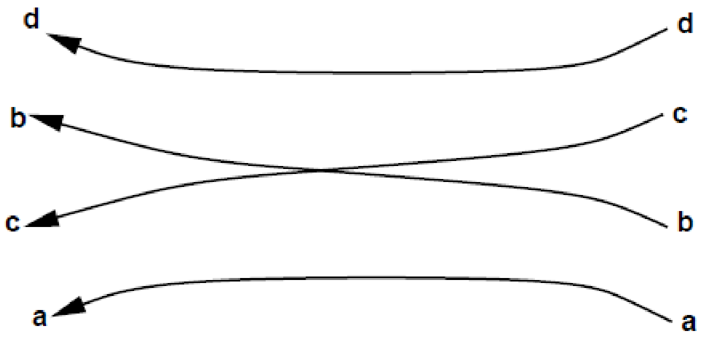
CAPACITY

The capacity of rotary is determined by the capacity of each weaving section. Transportation road research lab (TRL) proposed the following empirical formula to find the capacity of the weaving section.

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

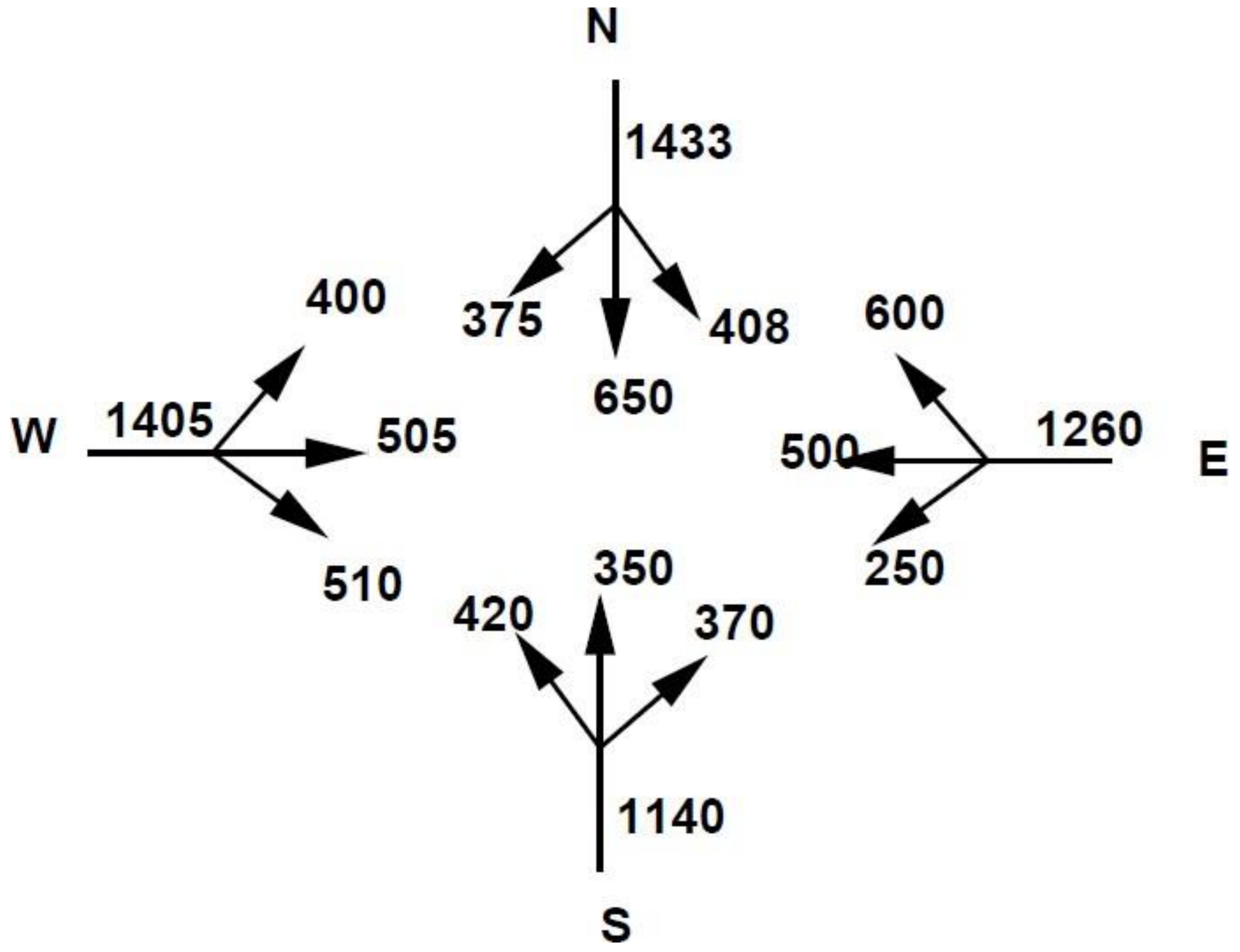
where e is the average entry and exit width, i.e, (e1+e2)/2 , w is the weaving width, l is the length of weaving, and p is the proportion of weaving traffic to the non-weaving traffic. Figure below shows four types of movements at a weaving section, a and d are the non-weaving traffic and b and c are the weaving traffic. Therefore,

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



NUMERICAL EXAMPLE

The width of a carriage way approaching an intersection is given as 15 m. The entry and exit width at the rotary is 10 m. The traffic approaching the intersection from the four sides is shown in the figure below. Find the capacity of the rotary using the given data.



NUMERICAL EXAMPLE

Solution:

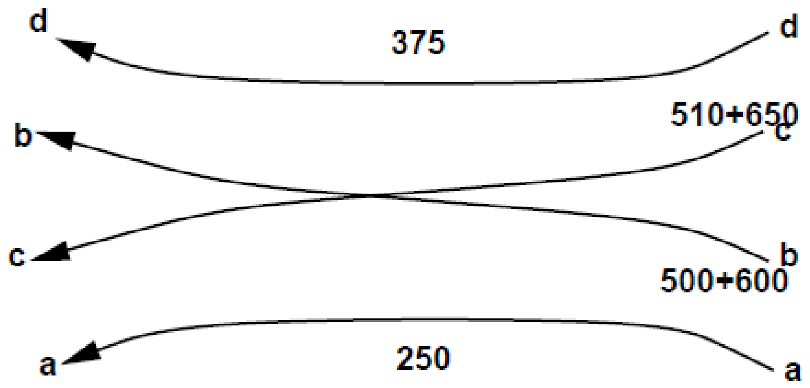
- Weaving width is calculated as, w = $\frac{e_1+e_2}{2}$ + 3.5 = $\frac{10+10}{2}$ + 3.5 = 13.5 m
- Weaving length, l is calculated as = 4×w = 4 X 13.5 = 54 m
- The weaving traffic movements in the East-South direction is shown in figure below. Then using equation,

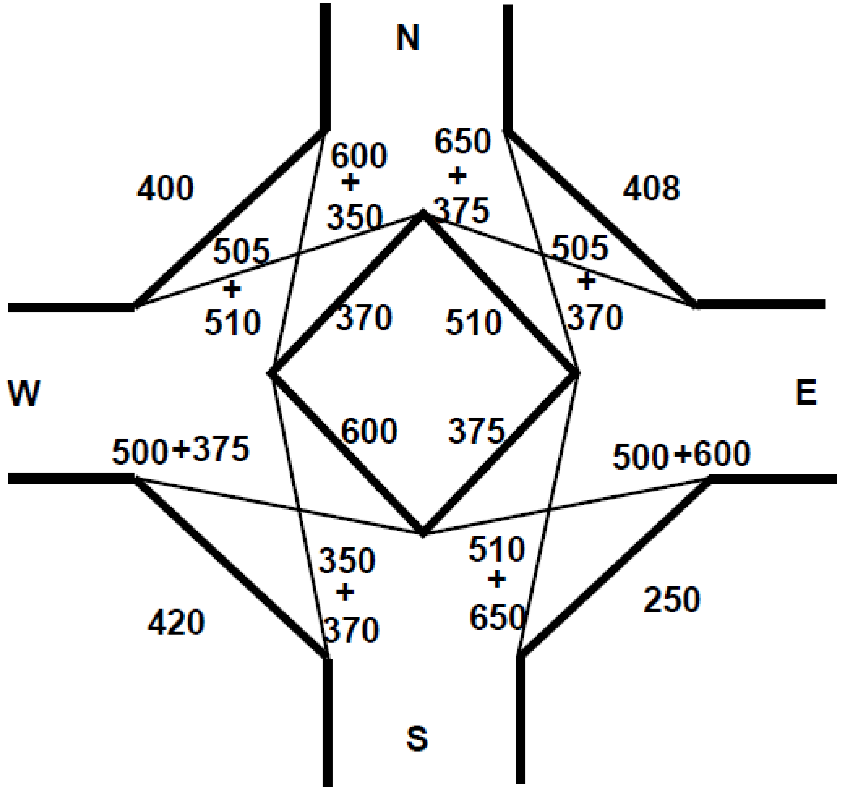
$$p_{ES} = \frac{510+650+500+600}{510+650+500+600+250+375} = \frac{2260}{2885} = 0.783$$

$$p_{WN} = \frac{505+510+350+600}{505+510+350+600+400+370} = \frac{1965}{2735} = 0.718$$

$$p_{NE} = \frac{650+375+505+370}{650+375+505+370+510+408} = \frac{1900}{2818} = 0.674$$

$$p_{SW} = \frac{350+370+500+375}{350+370+500+375+420+600} = \frac{1595}{2615} = 0.6099$$





NUMERICAL EXAMPLE

Solution:

Therefore, the capacity of the rotary will be capacity of this weaving section. From equation,

$$Q_{ES} = \frac{280 \times 13.5[1 + \frac{10}{13.5}][1 - \frac{0.783}{3}]}{1 + \frac{13.5}{54}} = 2161.164 veh/hr.$$

THANK YOU FOR LISTENING