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REVIEW PAPER ON ROAD ROUNDABOUT WITH TRAFFIC SIGNALS IN URBAN AREA

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ABSTRACT: Modern roundabout, first installed in England in the early 1960s, are becoming popular substitute for signalized intersections in India. These facilities were originally introduced in order to solve the problems of the existing traffic circles. This thesis presents a formulation for evaluate the capacity, delay, and level of service of multilane signalized roundabout. Besides circulating and exiting flows, number of lanes and lateral position of the vehicles, as they approach and cross the roundabout, showed significant influence on roundabout entry capacity.
Keywords: Capacity, control delay, signal, roundabout and density.

I. INTRODUCTION

Roundabout is the intersections of two or more roads that are made up of one-way circulating roadway that give priority over the approaching traffic. The approaching traffic is controlled by traffic signs, and can only make a left turn onto the circulating headway. The only decision that the motorist needs to make while reaching the yield line is whether or not the gap in circulating traffic is large enough for them to enter. The vehicles then easily exit the circulating roadway by making a left turn towards their destination. The necessity of the roundabout is that the traffic is required to slow down for negotiating the curve around the central island. In most cases, modern roundabout have been found to be much safer than other intersections. The reductions of points of conflict from 32 to 8 lessen the chances for crashes, and when combined with reducing speed, crash probability is further reduced. There are three main characteristics of roundabout that identify them when compared to traffic circles:

Yield-at-entry or offside priority – Roundabout provide vehicles in the circulatory roadway with the right of way. This is quite different than other uncontrolled, yield controlled or multi-way-stop controlled intersections that give priority to the vehicles already in the facility, these roundabout control the entering vehicles not with a stop signs or traffic signals but with a yield sign.

Approach flare – Roundabout, mostly, approach flare out at the entries and allow the entrance of more vehicles to the circulatory roadway at more obtuse angles. This increases capacity, and allows the vehicles to enter at reduced and similar speeds as the circulating vehicles. The angle and size of the flare is controlled generally by a raised splitter island that separates all the entering and exiting traffic at the approach.

Deflection – this characteristic is related to the geometry of the roundabout that requires vehicles to slow down while manoeuvring through the roundabout. The diameter of the central island and the angle of entry determine the potential speeds and deflection of circulating and entering vehicles.

Introduction of roundabouts at intersection had many advantages other than eliminating the conflict points which lead to perpendicular crashes. It reduces driver confusion associated with perpendicular junctions and also reduces the queuing caused due to signalization. It simplifies the pedestrian visual environment as the traffic is unidirectional. They allow U-turns within the normal flow of traffic, which often are not possible at other forms of junction. Moreover, roundabout prove to be eco-friendly as it causes less pollution, since vehicles on average spend less time idling at roundabout than at signalized intersections. Along with it, the emission produced by engine is also less as vehicle don't come to stop at junction, they need to give way. These are the parameters which make it essential to design these roundabout efficient enough to handle the traffic conditions.

II. LITERATURE REVIEW

Since the introduction of the modern roundabout in many different types of models have been developed for determining the roundabout capacity and level of service. This chapter addresses several different approaches used to determine roundabout performance. The literature review will go through the different theories upon which these models are based, and the various equations that use a series of variables and parameters for estimating capacity and delay. These models have been developed in many countries, but primarily from Australia and Western Europe.

Stuwe (1991) developed a formula for calculating the capacity of roundabout. These formulae were developed by use of an empirical procedure and regression techniques. Therefore, traffic flow at several roundabouts was observed and recorded by video equipment.

Wallwork (1997) describes traffic circles as the one having square entries, and use stop control of the entry. State three main characteristics of roundabouts as: yield at entry, flared entries and deflection.

Ray and Rodegerdts (2001) also identified other elements that distinguish modern roundabouts from other circulatory roadway facilities. These elements include parking availability, pedestrian access and crossing location and the circulation direction on the roadway.

Hagring and Rouphail (2003) investigated two-lane roundabout in Copenhagen, Denmark and the collected data enabled the estimation of follow-up headway, critical gap, and delay and entry capacity.

Chodur, J. (2005) did a detailed study on the Poland

roundabouts and analyzed the parameters with respect to polish conditions. Studies were conducted in several Polish cities and towns to analyze capacity of the movements at stop-controlled two way intersections, at roundabouts and two-way yield-controlled intersections.
Akcelik (2011) studied the control of the roundabouts using materials signals and describe the basic concepts of the analytical model of the operation of roundabouts with these metering signals.

III. OBJECTIVES AND SCOPE

On the basis of above problem statement, the objectives of the study are:

- To estimate the capacity and corresponding degree of saturation using several calibrated method to check the operational efficiency of the signalized roundabouts.
- To compare the output of different models using the field data.
- To access the performance by finding out the average control delay, queue length and level of service for each approach leg of rotary.

IV. METHODOLOGY

Estimation of Critical Gap & Follow up Headway
Critical Gap/Headway
The minimum time interval which is required in circulating flow when an entering vehicle can safely enter the roundabout is called critical gap. In this study, the gap accepted by a driver is greater than or equal to the critical gap. The critical gap is estimated on the bases of quantified rejected and accepted gap and the points where accepted and rejected gaps equally possible.
Follow up Headway
The minimum headway between two entering vehicles, when two vehicles accepting the main stream headway under a queued condition is called follow up headway. It is the inter vehicle headway on an approach at capacity.
Method Used for Estimating Critical Gap
INAFOGA Method
Satish et al in the year of March 2011 presented another idea for measuring critical gap making utilization of clearing conduct of vehicles in conjunction with gap acceptance information. An area named as the Influence Area for Gap Acceptance (INAFOGA) which have a dimension of L×W, where L= 3.5 m (lane width) & W= 1.5 times width of crossing /merging vehicle. The method considers the clearing behaviour of a vehicle (clearing time is the time taken by the minor street/U-turn vehicle to clear the influence area) & gap acceptance behaviour.

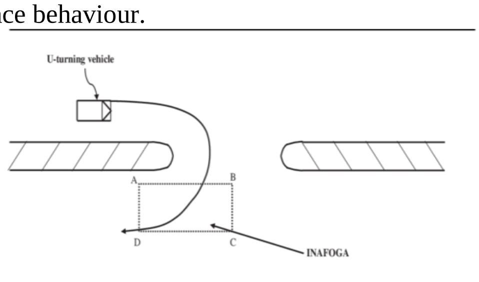

Fig 1 INAFOGA method diagram.

where,
t1 = front bumper of first vehicle in circulating flow
t2 = front bumper of first through vehicle in the approach leg
t = time instant for back bumper touches the boundary

Characteristics of the "INAFOGA":

I. Vehicle taking the right turn from the minor street INAFOGA & is said to clear the crossing point when it last part crosses the stop line in the major street.
II. Distinction between landings of continuous major road vehicles at the upstream end of the INAFOGA is considered as 'Gap'.

In this method, a typical cumulative frequency distribution curve for clearing time of a minor street vehicle against its corresponding Lag & Gap Acceptance curve is plotted obligating a common point of intersection. sufficient for the vehicle to enter the INAFOGA keeping in mind the safety aspect. The critical gap and the follow up headway for each of the approach leg is as shown in the table 1.

Table 1 Critical gap and follow-up headway of each approach leg.

Roundabout	N		S		E		W	
	Critical gap (sec)	Follow up time(sec)	Critical gap (sec)	Follow up time(sec)	Critical gap (sec)	Follow up time(sec)	Critical gap (sec)	Follow up time(sec)
Tribune Chowk, Chandigarh	3.28	2.43	3.53	2.49	3.17	2.33	3.69	2.47

Performance Analysis
As we found earlier that the roundabout is Under Saturated from every considered model, some more performance analysis has been done. The queue for each of the approach leg was found out to be within limits and the corresponding average control delay for the roundabout was well below 10 which suggests that the level of service for each of the leg of the roundabout was satisfactory and can be graded A.
Comparison Between Different Akcelik Models Fig.2 Represent opposing flow rate for each of the four legs for the comparison of the Akcelik models (M3D, M3T, M1 & M2) of N, S, E & W zones. For comparison, linear regression was performed between Akcelik models and the results have been shown in the graphs.

Table 2 Queue, Delay & LOS for each leg

Approach leg	Queue (veh)	Control Delay (sec/veh)	Level of Service (LOS)
N	2.42	4.164	A
S	5.852	4.8826	A
E	0.5614	2.44	A
W	5.0244	6.1177	A

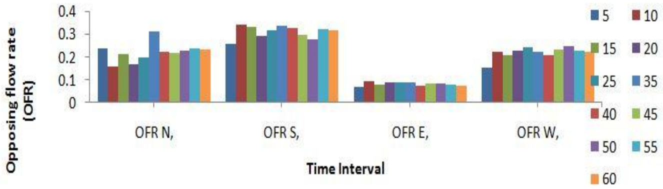

Fig. 1 Opposing flow rate of vehicles per second

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