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PERFORMANCE EVALUATION OF ROUNDABOUT INTERSECTIONS IN DHAKA METROPOLITAN CITY, BANGLADESH

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ABSTRACT

Operational performance of intersections conduces remarkably towards the efficacy of the entire road network system of a city. The population in Dhaka Metropolitan City in Bangladesh is growing rapidly and as a result, the number of vehicles on the streets are increasing at an alarming rate. Due to this, traffic congestion and accident rates are also on the rise. In addition, poor and cursory planning of road networks leads toward an overall tedious and unsafe journey for a commuter. Traffic congestion has a direct impact on social, economic and environmental costs. It is imperative to acquire a thorough idea about the existing conditions of the intersections for adopting appropriate corrective measures. In this regard, this study concentrates on analyzing the operational performance of the roundabout intersections in Dhaka Metropolitan City in Bangladesh. This paper presents an evaluation of the capacity of three roundabouts located in Dhaka Metropolitan City; namely, Doyel Chattar, SAARC Fountain and Zero Point. The capacity and consquently, level of service were assessed using two methods: the empirical gap-acceptance technique that is adopted by SIDRA software and the analytical method by using Akçelik's Base Capacity Equation. The required geometric data (Island Diameter, Entry Width, Circulatory Lane Width, Entry Angle etc.) for the analysis and traffic volume data traffic volume data along with vehicle characteristics were collected during evening peak hour (4.30 pm to 5.30 pm) on a typical busy, working day from the aforementioned roundabouts. For conducting capacity analysis by the analytical method, critical gap and follow-up headway values were required to be estimated. The critical gap values for each lane in each leg of the roundabouts were evaluated based on the widely used Raff's Method. As estimation of follow-up headway is less intricate, it was measured directly from the field data. Afterwards, from the analysis using SIDRA software for the three roundabouts, the degree of saturation (v/c ratio) was found greater than 0.85 which indicated heavy traffic congestion. In developed countries such as, USA, UK, Germany, the roundabouts are designed as so that the v/c ratio does not exceed the saturation limit of 85%. The level of service (LOS) was found 'F' for all the roundabouts in this study. SIDRA also rendered a comprehensive lane-by-lane analysis for each roundabout. The equation based analytical method exhibited roughly similar results which further corroborated the analysis results. Finally, the results, on the whole, suggest that the main causes of over-saturation are the inadequate number of circulatory and entry lanes, lack of important geometric elements and high traffic volumes.

Keywords: *Roundabouts, SIDRA, Critical gap, Level of service.*

1. INTRODUCTION

A roundabout fall under the category of intersection that is distinguished by yield-on-entry approaches and circulation of traffic flow around a central island (clockwise in Bangladesh). Circulating vehicles are given priority but approaching vehicles at entries are compelled to wait for a gap in the circulating stream. Roundabouts are popular alternatives to signalized intersections owing to the fact that they are much more efficient in dealing with lower volumes of vehicles. Roundabouts are the best substitutions for intersections having two entry lanes that deal with heavy through and/or left traffic turning volumes (Sisiopiku and Oh, 2001). A roundabout, in various cases, is a more convenient option as vehicles are required to slow down while making their way around the central island but the vehicles entering the roundabouts, unlike stop and signalized intersections, are not required to stop. Evaluation of roundabout performance and gap acceptance behaviour is essential as it is directly linked to overall delay, accidents, level of service and operational cost. The FHWA, in the year 2008 have released the Guidance Memorandum on Consideration and Implementation of Proven Safety Countermeasures, distinguishing roundabouts as one of nine safety countermeasures (Lindely, 2008). In Dhaka Metropolitan City, Bangladesh, there are several roundabouts and have been in service for a few decades. However, hardly any of them have been assessed for their design and capacity or level of service. Therefore, it has become necessary to acquire an approximate idea about their current level of service and capacity so that proper solutions can be sought to minimize traffic congestions, accidents and delays. Extreme traffic congestion and delay is prevalent during the peak hours on the streets of Dhaka Metropolitan City. Hence, the traffic police are required to intervene to manage the road traffic, especially at roundabout intersections as they rely more upon driver behaviour. The situation is deteriorating with increased population growth rate and number of vehicles. Inappropriate road planning and defective geometric conditions of roundabout intersections impose a significant effect on capacity and efficiency of roundabout and traffic congestion.

2. LITERATURE REVIEW

Regarding capacity and delay analysis of modern roundabouts, quite a good number of comprehensive and novel research work have been conducted in the recent years. McDonald and Noon (1978) published a study on the impact of geometric factors to delay. A new equation was also theorized to estimate delays. In Akcelik's (1997) paper, SIDRA was employed for evaluating capacity of roundabout and conducting delay analysis in addition to traditional gap acceptance and queuing theory. Sisiopiku and Oh (2001) evaluated performance of different types of intersections and discussed in which cases roundabouts function better than controlled intersections. SIDRA was adopted for roundabout analysis in this study. Polus et al. (2003) asserted that throughout Europe and Australia, the use of roundabouts is prevalent, and are extensively being used in North America in lieu of the traditional intersections. Arroju et al. (2015) calibrated a simulation model using VISSIM and estimated the capacity of a roundabout. Dahl and Lee (2012) revealed that exiting traffic have considerable impact on the entry lane capacity. Ren et al. (2016) analyzed capacity of roundabouts with single lane using five different analytical models including SIDRA. The study introduced a new roundabout capacity (NRC) model based on the gap acceptance theory. The NRC model assesses single-lane roundabout capacity with inclusion of the effect of exiting traffic. In our study, we have used SIDRA, the most commonly used roundabout analysis software for analyzing the capacity of the roundabout junctions in the prevailing traffic condition. We have also employed the analytical method based on gap-acceptance theory, suggested by Akcelik et al. (1999) for the further assessment of capacity evaluation. Evaluation of critical gap is crucial for developing a capacity model based on gap-acceptance theory. As critical gap value is not determinable directly from the field, there exists more than 20 models around the globe for the estimation of critical gap. In practice, the most commonly used models are that of Raff et al. (1950) and Troutbeck (1992). Ashworth (2001) has also suggested alternative models for gap-acceptance analysis.We had to estimate critical gap and follow-up headway for implementing Akcelik Base Capacity Equation method. Hence, we had chosen Raff's Method to evaluate critical gap values for its wide acceptability and ease of applicability.

3. ANALYTICAL APPROACH & METHODOLOGY

The site survey was conducted in three roundabout locations in Dhaka Metropolitan City, namely, Doyel Chattar, SAARC Fountain & Zero Point Roundabout. These three roundabouts were chosen considering the most common attributes of the existing roundabouts in terms of size and traffic condition. As a matter of fact, a notable number of these roundabouts were built decades ago when traffic circle was a more popular option but at the present time, the drivers are obliged to operate conforming to modern roundabout traffic rules, even though some geometric elements of modern roundabouts are lacking. All the roundabouts in Dhaka Metropolitan City are more or less similar to each other, so, these roundabouts can provide a preliminary idea of the current state of all the other roundabouts.

3.1 Employment of SIDRA Software

The software tool that was used for capacity analysis is SIDRA, Version 8.0. PLUS. SIDRA is a comprehensive software that can be used for design and assessment of different categories of intersections, such as, roundabouts, signalized intersections, yield-sign control intersections (Akcelik, 1996). This is the most widely used software tool in the USA for roundabout performance analysis. The geometric data required by SIDRA include: island diameter, inscribed island diameter, circulatory roadway width, average lane width at entry, number of circulatory and entry lanes, entry angle and entry radius. These geometric parameters were measured by using a measuring tape and applying concept of geometry. The measurements were taken as accurately as possible since road geometric design is a major factor that impacts overall capacity and safety during operation. Along with geometric data, traffic volume data were collected from these intersections during the peak hour (4.30 pm to 5.30 pm) on a sunny, working day under prevailing traffic and road condition as well as the direction of movements of the vehicles.The geometric data obtained are summarized in Table 1 and Table 2.

Table 1: Summary of Roundabout Geometry

SL No	Name of Roundabout	No. of Legs	No. of Circulatory Lanes	Island Diameter (m)	Circulatory Roadway Width (m)	Inscribed Circle Diameter (m)
1	Doyel Chattar	4	2	30	15	45
2	SAARC Fountain	5	2	26	23	49
3	Zero Point Roundabout	4	2	6	21	27

According to Roundabout Information Guide, FHWA (2000), Doyel Chattar and SAARC Fountain fall under the category of Urban Double Lane Roundabout and Zero Point Roundabout is a typical Urban Compact roundabout. Entry lane width and number of entry lanes are two geometric elements that have a direct effect on the capacity of a roadway. Another important parameter is entry angle. It is the angle measured between the entering and circulating traffic streams for each entry at a roundabout. Larger entry angles may cause vehicles crashing into the center-island and are also uncomfortable for drivers to negotiate, reducing capacity in the long term.

Table 2: Summary of Legs of Roundabouts

SL No.	Name of Roundabout	Name of Legs	No. of Entry Lanes	Average Entry Lane Width (m)	Entry Angle (Degree)	Entry Radius (m)
1	**Doyel Chattar**	Secretariat Road	2	5.0	35	39
		High Court Road	2	5.0	21	26
		University Street (from DMC)	2	4.5	33	17
		University Street	2	4.5	32	51
2	**SAARC Fountain**	Airport Road	2	6.5	39	9
		Panthapath Road	2	5.7	26	17
		Link Road	2	5.5	48	30
		Sonargaon Road	1	4.8	22	49
		Kazi Nazrul Islam Ave	2	5.9	25	15
3	**Zero Point Roundabout**	North South Road	2	5.7	30	11
		North South Road (from Paltan)	2	6.0	28	25
		Abdul Gani Road	2	5.3	39	18
		Bangabandhu Ave	2	6.4	21	7

On the streets of Dhaka city, different categories of vehicles can be observed. Heavy vehicles, for example, bus, truck, pulled rickshaw and cycle van and light vehicles, such as, car, CNG three-wheelers, motorcycles, pickup etc. traverse the same segment of road at the same time. In most cases, separate lanes for buses and bicycles are absent. Hence, it disrupts the normal traffic flow and forces drivers to violate traffic rules. In SIDRA, the standard passenger car equivalent factor used for heavy vehicles and light vehicles were 2.00 and 1.00 respectively. Rickshaws and cycle vans are slow moving vehicles and in general, have PCU value of 2.00 in Bangladesh according to MoC (2001). Therefore, they had been considered as heavy vehicles in the analysis. In this study, SIDRA has been calibrated as so that the simulated traffic resembles the actual traffic in the field. The vehicles counted are compiled as depicted in Table 3. The data were collected for one-hour duration during 4.30 pm to 5.30 pm.

Table 3: Traffic Volume at Peak Hour at the Roundabouts

Name of Roundabout	Heavy Vehicles				Light Vehicles				
	Bus	**Truck**	**Rickshaw & Cycle Van**	**Total**	**Car**	**CNG three-wheeler & Motorcycle**	**Pickup**	**Bicycle**	**Total**
Doyel Chattar	13	-	2172	2185	1293	1539	58	97	5172
SAARC Fountain	208	21	-	214	1982	3275	50	107	5857
Zero Point Roundabout	281	19	1968	2268	886	2064	12	36	5266

Finally, both geometric and traffic data were entered as inputs into SIDRA software and analysis was run.

3.2 Application of Akcelik's Base Capacity Equation

Analytical approach is a more suitable means. One of the advantages of this approach is that the gap acceptance technique provides a logical premise for the evaluation of capacity. In addition, gap-acceptance theoretically correlates traffic interactions at roundabouts with the availability of gap in the circulating traffic streams as stated by Taekratok (1998). The capacity equation requires determination of the circulating flow to calculate the capacity of each entry lane. This equation is largely based on the follow-up headway and critical gap values, inclusive of bunching parameters. The drawback of this analytical procedure is that it is only calibrated for roundabouts having two circulatory lanes.

$$Q_e = \left(\frac{3600}{\beta}\right) * \left(\left(1-\Delta_c * q_c\right) + \left(0.5 * \beta * \Phi_{c*q_c}\right)\right) * e^{-\lambda*(\alpha-\Delta_c)} \quad (1)$$

Where,
Q_e = Capacity of a single entry lane (pce/hour)
β = Follow-up Headway (seconds/vehicle)
α = Critical gap (seconds/vehicle)
Δ_c = Intrabunch headway (seconds/vehicle)
q_c = Circulating flow at entry (pce/hour)
Φ_c = Proportion of unbunched vehicles in the circulating stream
λ = Parameter in the exponential arrival headway

3.3 Determination of Critical Gap

In terms of a roundabout, the critical gap is the minimum gap a vehicle entering a roundabout accepts between two circulating vehicles. It cannot be directly measured in the field as any gap that is accepted by the driver is larger than the critical gap. Hence, one of the first and simplest technique for estimating critical gap - Raff's method (Raff et al., 1950) was used. After their definition, the value of critical gap can be estimated graphically by finding the point of intersection between percentage of rejected and accepted gap times. The example below demonstrates the method adopted for determining the critical for the left in the leg "University Street" of Doyel Chattar. Table 4 presents the percentage of vehicles that rejected or accepted each corresponding gap size. The graph plotted based on these data are shown in Figure 1. In the similar manner, critical gap was estimated for each lane for all three roundabouts. The data are tabulated in Table 5.

Table 4: Raff's Method Reduced Data for Left Lane (University Street)

Gap Size (sec)	Percent Rejected	Percent Accepted	Count Rejected	Count Accepted
≤ 2	85	15	103	18
3	55	45	43	35
4	47	55	42	47
5	36	64	32	58
6	22	78	8	30
7	14	86	2	12
≥ 8	8	92	2	15

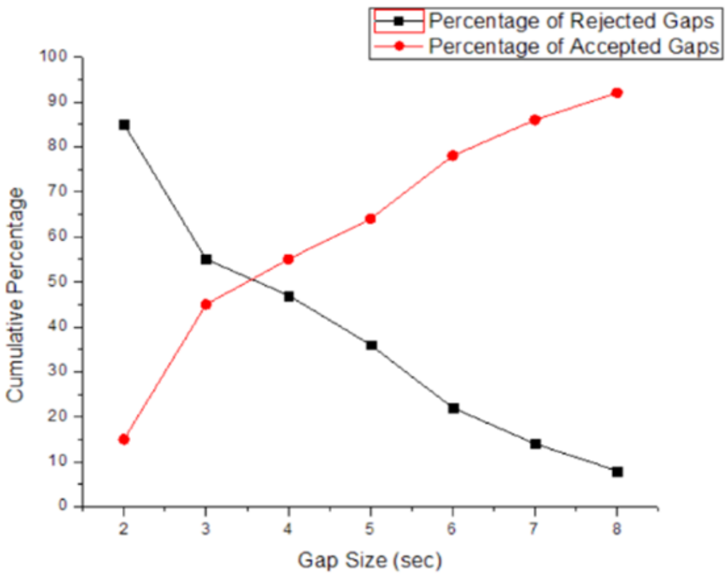

Figure 1: Determination of Critical Gap using Raff's Method for Left lane (University Street)

3.4 Determination of Follow-up Headway

Follow-up headway is another pivotal parameter that controls the entry capacity. In contrast to critical gap, it can be measured directly from the present traffic in the field (Ren et al., 2016). All follow-up headways were determined for each roundabout. The follow-up headway was calibrated by taking a mean value of all measured follow-up headway for each lane in a roundabout. A sample size of 20 vehicles for each lane in each leg of the roundabouts was chosen for this evaluation. The estimated values of critical gaps and follow-up headway are presented in Table 5.

Table 5: Critical Gap and Follow-up Headway values for each lane of the roundabouts

Name of Roundabout	**Name of Leg**		**Critical Gap, α (sec)**	**Follow-up Headway, β (sec)**
Doyel Chattar	Secretariat Road	Left lane	3.33	3.10
		Right lane	3.25	2.94
	University Street (from DMC)	Left lane	4.20	3.30
		Right lane	4.14	3.27
	University Street	Left lane	3.55	3.00
		Right lane	3.50	2.97
	High Court Road	Left lane	3.57	3.20
		Right lane	3.42	3.00
SAARC Fountain	Airport Road	Left lane	3.20	3.00
		Right lane	3.09	2.89
	Link Road	Left lane	3.00	2.80
		Right lane	2.82	2.53
	Panthapath Road	Left lane	3.46	3.20
		Right lane	3.00	2.64
	Kazi Nazrul Islam Ave	Left lane	2.85	2.60
		Right lane	2.71	2.51
	Sonargaon Road		2.48	2.87
Zero Point Roundabout	Abdul Gani Road	Left lane	3.64	3.35
		Right lane	3.60	3.29
	North South Road (from Paltan)	Left lane	3.92	3.60
		Right lane	3.85	3.50
	North South Road	Left lane	3.40	3.63
		Right lane	3.35	3.55
	Bangabandhu Avenue	Left lane	3.83	3.53
		Right lane	3.70	3.50

3.5 Step-by-Step Example of the Formulation

In order to find the capacity of each lanes of leg "University Street" (Northbound approach) of Doyel Chattar, first, it is required to determine the circulating flow at that approach.This traffic flow comprises the southbound lefts, and eastbound lefts and throughs, along with U-turns, with the exclusion of northbound. The equations fitted for the outside and inside lane are shown in the following example. Circulatory flow, $VOL'_c =$ 989 pce/hour

For right lane, $q_{cr} = \sum_d VOL'_c * P_c * \Psi$ (2)

$q_{cr} = 989*0.8*1.075 = 851$ pce/hour

And for left lane, $q_{cl} = \sum_d VOL'_c * \Psi$ (3)

$q_{cl} = 989*1.075 = 1063$ pce/hour

Now, the Equation (1) is used to obtain the capacity of each entry lane for the given approach.

$$Q_e = \left(\frac{3600}{\beta}\right) * \left(\left(1 - \frac{\Delta_c * q_c}{3600}\right) + \left(\frac{\beta * \Phi_c * q_c}{2*3600}\right)\right) * e^{-\frac{\lambda}{3600}*(\alpha - \Delta_c)}$$

$$Q_{er} = \left(\frac{3600}{2.97}\right) * \left(\left(1 - \frac{1.2*851}{3600}\right) + \left(\frac{2.97*0.55*851}{2*3600}\right)\right) * e^{-\frac{851}{3600}*(3.50-1.2)}$$

$$Q_{el} = \left(\frac{3600}{3.00}\right) * \left(\left(1 - \frac{1.2*1036}{3600}\right) + \left(\frac{3.00*0.55*1036}{2*3600}\right)\right) * e^{-\frac{1036}{3600}*(3.55-1.2)}$$

Thus, $Q_{er} = 640$ pce/hour and $Q_{el} = 544$ pce/hour

The values of the criteria varied for each entry lane. It is observed that follow-up headway and critical gap hold lower values for the right entry lane compared to the left since it takes a driver longer to get into the inside lane. The determined values for α and β are 3.50 and 2.97 for the right entry lane, and 3.55 and 3.00 for the left entry lane. These values are in seconds per vehicle. Φ_c is the proportion of unbunched vehicles in the circulating stream. It is a calculated variable in the above equation. In order to maintain simplicity for users, this was kept as a fixed parameter with the value of 0.55 for this formulation. Δ_c denotes intrabunch headway. Akcelik recommends a value of 1.2 seconds for circulatory roadways with two lanes assuming equal flows. Additional equations may be used for unequal flows. However, to keep it less intricate, value of 1.2 was used. λ is a parameter in the exponential arrival headway. According to Tanner (1962), its value can be considered as equal to the circulating flow. λ is to be converted to pce/sec, by dividing it by 3600.

4. RESULTS & DISCUSSIONS

4.1 SIDRA Analysis Results

A summary of the results from capacity analysis is shown in Table 6. The performance of the roundabouts was measured on the basis of Degree of Saturation (v/c ratio) and the level of service (LOS) had also been determined. From the analysis, it is noticed that all the roundabouts exhibit high degree of saturation. Higher traffic flow may have led to higher v/c ratio. All three roundabout intersections provide LOS "F". In reality, the capacity of the roundabouts depend on the performance of the approaches of legs. In Table 6, the maximum v/c ratio among the approaches has been represented.

Table 6: Summarized SIDRA Capacity Analysis Results

SL No.	Name of Roundabouts	Total Vehicle Flow (veh/h)	Effective Capacity (veh/h)	Degree of Saturation (v/c ratio)	Average Delay (sec)	LOS
1	**Doyel Chattar**	5172	3604	1.957	240.0	F
2	**SAARC Fountain**	5857	4503	2.482	256.3	F
3	**Zero Point**	5266	3296	3.039	401.1	F

In the following Table 7, summarized output results for each leg of the roundabouts have been shown.

Table 7: Summarized SIDRA Capacity Analysis Results on the Approaches or Legs

SL No.	Name of Roundabout	Name of Leg	No. of Entry Lanes	No. of Circulatory Lanes	Entry Traffic at Legs (veh/h)	Capacity at Legs (veh/h)	v/c
1	**Doyel Chattar**	High Court Road	2	2	1961	1002	1.957
		University Street	2		798	783	1.027
		University Street (from DMC)	2		1065	867	1.229
		Secretariat Road	2		1168	952	1.278
2	**SAARC Fountain**	Airport Road	2	2	1577	1073	1.469
		Link Road	2		1027	1122	0.916
		Panthapath Road	2		1778	899	2.482
		Kazi Nazrul Islam Ave	2		1401	1156	1.212
		Sonargaon Road	1		188	253	0.745
3	**Zero Point Roundabout**	Abdul Gani Road	2	2	1055	507	2.081
		Bangabandhu Ave	2		1340	526	3.039
		North South Road	2		1685	1115	1.511
		North South Road (from Paltan)	2		1668	1148	1.454

By examining the v/c ratio from the above Table 7, it is easy to identify which legs are in critical condition. From the table, it is conspicuous that the number of entry lanes at each leg are inadequate to carry such high amount of traffic during the peak hour. The value of 0.85 is recommended in many countries such as USA, Australia, United Kingdom and Germany where roundabouts are designed to operate at no more than 85 percent of their estimated capacity. When the demand exceeds the capacity (v/c ratio greater than 1.0), traffic flow becomes unstable and excessive delay and queuing is anticipated. Number of entry lanes and average entry lane width controls capacity at legs substantially.

4.2 Results from Analysis by Akcelik Base Capacity Formula

According to the analytical method of capacity analysis, gap-acceptance data were collected and as described earlier, capacity was analyzed for each lanes and legs. All the results from the calculation are shown in Table 8, Table 9 and Table 10.

Table 8: Capacity Evaluation of Doyel Chattar Roundabout

Name of Legs	Entry volume (pce/h)	Circulatory Volume (pce/h)	q_{cr}	q_{cl}	Capacity on right lane (pce/h)	Capacity on Left Lane (pce/h)	Capacity at leg (pce/h)	v/c ratio
High Court Road	2653	851	732	915	685	588	1273	2.084
University Street (from DMC)	1482	901	775	969	547	448	995	1.489
University Street	981	989	851	1063	640	544	1184	0.828
Secretariat Road	1424	1013	871	1089	675	546	1221	1.166

Table 9: Capacity Evaluation of Zero Point Roundabout

Name of Legs	Entry volume (pce/h)	Circulatory Volume, (pce/h)	q_{cr}	q_{cl}	Capacity on right lane (pce/h)	Capacity on Left Lane (pce/h)	Capacity at leg (pce/h)	v/c ratio
Abdul Gani Road	1364	1412	1214	1518	439	338	777	1.755
Bangabandhu Ave	1669	1390	1195	1495	442	310	752	2.219
North South Road	2158	655	563	704	678	620	1298	1.663
North South (from Paltan)	1861	702	604	755	658	540	1198	1.553

Table 10: Capacity Evaluation of SAARC Fountain Roundabout

Name of Legs	Entry volume (pce/h)	Circulatory Volume, (pce/h)	q_{cr}	q_{cl}	Capacity on right lane (pce/h)	Capacity on Left Lane (pce/h)	Capacity at leg (pce/h)	v/c ratio
Airport Road	1362	844	725	907	781	437	1218	1.118
Panthapath Road	1450	1290	1109	1387	669	413	1082	1.340
Link Road	1301	1005	864	1080	848	586	1434	0.907
Sonargaon Road	221	2229	-	-	-	-	423	0.522
Kazi Nazrul Islam Ave	1133	1167	1004	1255	808	647	1455	0.779

As the PCU values differ from the SIDRA standard PCU values and as the analytical method mainly depends on the gap-acceptance parameters, the results obtained from SIDRA and the equation based method vary to a certain extent. However, from the tables 8, 9 and 10, we can see that quite a few numbers of legs at those roundabouts tackle high traffic volume and end up in over-saturated condition (v/c ratio > 1.00).

5. CONCLUDING REMARKS

The capacity analysis results for the three selected roundabouts in Dhaka Metropolitan City indicate that most of the roundabouts are subjected to heavy congestion or are over-saturated (v/c ratio > 1.00). From the inspection in the actual field conditions, it was observed that traffic police generally were required to get involved with regulating the traffic, especially, during the peak hour. This is because heavy traffic at that time cause drivers to maneuver in a haphazard manner, violating traffic rules and causing unnecessary delay. Slower moving vehicles, for example, rickshaw and cycle vans noticeably affects delay and congestion in the roundabouts. However, during off-peak hour, a comparatively lighter traffic volume is observable at Doyel Chattar roundabout. The study revealed that the major problems are concerned with inadequate road width, small number of entry lanes and circulatory lanes, high traffic flow and unbalanced traffic on the approaches. These circumstances are not recommended for proper roundabout operation. The geometric elements of these roundabouts in Dhaka Metropolitan City should be altered and built accordingly as endorsed in design manuals of modern roundabouts since they prove to ensure reasonable capacity and traffic safety. Adequate number of entry and circulatory lanes and optimal entry angle based on size and purpose of roundabouts should be provided carefully. Kerbs and islands in the entries should be modified to allow greater entry flare. By gradually widening the approach (flaring) through the entry geometry, a greater capacity at the leg can be achieved. Besides, there are a number of important characteristic geometric elements of ideal roundabout, such as, deflection, splitter islands etc. that are not present in all of the roundabouts. Deflection is the most important geometric element which forces drivers to regulate their speed and to avoid collision between neighboring leg entry vehicles. The splitter islands on the roundabout approaches provide cues to the driver as to the entry angle and radius of the approach of the roundabout. In addition, dividers can prevent the drivers from frequently changing the lane which is one of the major causes of accident. Considering that the collected data for the analysis was limited to only three roundabouts, the proposition asserted in this research gives a substantial but preliminary insight on the geometric and operational defects of the roundabouts situated at Dhaka Metropolitan City, the most populous city of Bangladesh. However, this study also effectively helps to provide a detailed capacity estimation for planning new roundabouts or capacity improvements.

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