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Factors Affecting Base Saturation Flow Rate at Multi-Lane Intersections approaches - A Case Study of Hyderabad city

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Abstract - *In developing cities the movement of vehicles depends on the traffic capacity of the intersection, speed, and design geometry of the intersection and saturation flow rate at signalized/un-signalized the estimation of average traffic capacity and density rate at intersection, involves the base saturation flow rate and its effective parameter such as adjustment factors were described. In this paper, the factors affecting base saturation flow rate (traffic capacity of the signalized intersection) such as right-turn vehicles adjustment factors, lane distribution adjustment factors, etc were analyzed and estimated at four intersection approach in Hyderabad city. The study results of the paper are indicated that the average base saturation flow rate widely varies based on the adjustment factors, in addition to this, the adjustment factors are estimated at for intersection based on the standard equation. It was also noticed that the traffic capacity at four intersection approach at Hyderabad city as per the 2013 filed data analysis.*

***Key Words*: saturation flow rate, adjustment factors, traffic, signalized intersection.**

1. INTRODUCTION

To control the traffic and provide the accessibility to the vehicles, intersection plays a key role in rapidly developing cities. The intersection (signalized/un-signalized) is a focal point of conflicts in the road network. The design and estimation of traffic capacity at intersection signalized/un-signalized has been subjected more research from the last few decades. The estimation of signalized traffic capacity of the intersection based on the base saturation flow rate and its influence parameter are important to design and provide the safe moment of the vehicles. The traffic capacity influence factors were used to adjust the saturation flow rate at the proposed intersection. In this paper, the maximum capacity at four intersection approach and its influence parameter were described briefly. The data were used to estimate used as per the 2013 filed data collection. In addition to this, the paper was suggested the adjustment factors equation and their values at the four intersections. The saturation flow rate is defined as the number of vehicles crossing the roads during the green signal time. The practically not possible to measure the saturation flow rate remained the green time because the signal does not usually green more than one minutes. The many of the intersection are design to poor signals (traffic allow), insufficient green time, un-satisfied the drivers' behavior, the estimated of poor saturation flow rate, traffic design parameter are influence.

2. LITERATURE

The study was conducted to determine the parameter effects on base saturation flow arte at intersection. The authors concluded the factors and estimated the base saturation flow rate to prevent the traffic at the intersection [1]. The study is conducted to determine the saturation flow rate under heterogeneous traffic condition. The saturation flow rate estimated at ground scenario under the mixed traffic condition, the concluded flow rate compared with the HCM 2010 and IRC:SP:41-1994 [2]. The capacity of signalized intersection was estimated under two categories, the obtained saturation flow was compared with the actual saturation flow rate equation. The this study conclude that the field saturation flow rate of two signalized intersection are 1579 and 1470 vphgpl and the operational traffic flow in between 1470 to 1774 vphgpl [3]. The study is conducted to analyze the saturation flow rate at mixed traffic condition with traffic volume and speed data. The study was revealed that the certain urban intersection are handling the over saturation flow rate [4]. The study is attempted to estimate the saturation flow rate of three city with the help of t-test. The saturation headway of the city was analyzed with an empirical-based exponential model with limiting input parameters to estimate the actual saturation flow rate [5]. The field study is performed to know the base saturation flow ate at signalized intersection, the base saturation flow rate is suggested the 1800 per hour per lane. The study concluded that the lane width, turning radius and effective left-turn effect on the saturation and suggested the correction factors [6].

III. STUDY AREA AND DATA COLLECTION

These intersections approaches were found were selected because they offered a higher range of population densities and traffic density. The selection of site based on the suitable criteria. The following criteria were used to select the site to collect the filed data such as approach configuration, area population, and the number of study sites, traffic volume, and intersection geometry. The field study is conducted to estimate the saturation flow rate at three intersections in the summer season of the 2013 year. They are intended to: Ensure that the database contains intersection approaches that are typical to Hyderabad conditions and

1) Intersection (L.B NAGAR)

2) Intersection (NAGOLE)

3) Intersection (UPPAL)

4) Intersection (TARNAKA)

The base saturation flow rate and its influence parameter were evaluated at four intersection approaches in the presented study were presented in the study. In addition to this, the filed data elements consist of general information about the site and also the specific information about its traffic characteristics and geometry. The site information consist the intersecting street names, travel direction, approach lane configuration, area population, and speed limit. Traffic characteristics include approach volume, heavy-vehicle percentage, and daily traffic volume, and also the Geometric information of the filed data such as lane width and curb radius. Initially, the intersection approach study sites are identified and described.

3.0 RESULTS AND DISCUSSION

Theoretic models of the queue discharge process indicate that saturation flow rate increase with speed. However, the speed-limit adjustment factors may also be reflecting the effect of driveway density, roadside development, pedestrian activity, signal spacing, etc. in the vicinity of the intersection.

Table -1: Calibrated Model Statistical Description.

CALIBRATED COEFFICIENT VALUES				
VARIABLE	DEFINITION	VALUE	STD. DEV.	T-STATISTIC
b1	BASE SATURATION HEADWAY(=1905)	1.89	0.014	138.3
b2	EFFECT OF CURB LANE	1.03	0.006	164.4
b3	EFFECT OF RIGHT TURNS	1.07	0.015	72.8
b4	EFFECT OF HEAVY VEHICLES	1.74	0.023	77.0
b5	EFFECT OF AREA POPULATION	-0.01	0.0017	-10.7
b6	EFFECT OF TRAFFIC PRESSURE	-0.00	0.00040	-8.0
b7	EFFECT OF SPEED LIMIT	-0.00	0.00078	-8.4

The values associated with each of the calibrated coefficients are shown in the bottom half of Table 1. The statistics shown indicate that all of these values are statistically significant with a 99 percent level of confidence.

3.1 VALIDATION BASED ON COLLECTED DATA

In the present study, for each observation all four of the calibrated adjustment factors were analyzed and multiplied together to observation headway was also computed for each site and then converted into an estimate of the overall average saturation flow rate.

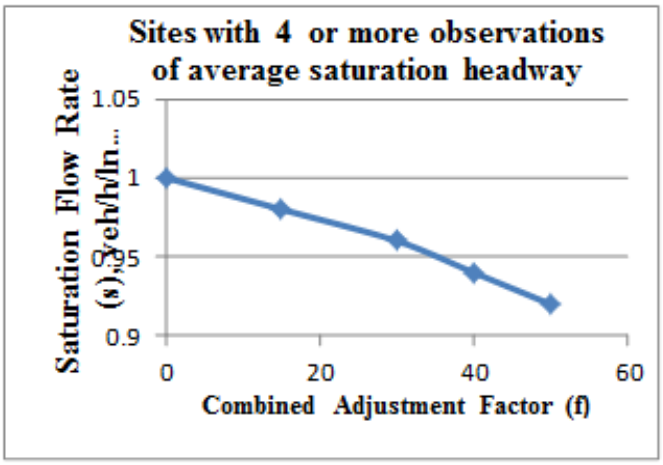

Chart -1: Adjustment factor validation based on collected data.

As shown in chart-1 the combined adjustment factors, suggests that the adjustment factors are able to explain 60 percent of the variability in saturation flow rate among the 3 sites. The saturation flow rate at one site did not follow the trend in the other 3 sites and was excluded from the analysis.

3.2 ADJUSTMENT FACTOR FOR RIGHT TURNS

The relationship between right-turn percentage and the calibrated adjustment factor value is shown in chart-2. Also shown is the relationship obtained from the right-turn adjustment factor described. Both relationships indicate a reduced saturation flow rate with increasing turn percentage. The relationships suggest that the effect of right turn is more significant than was measured at the intersection.

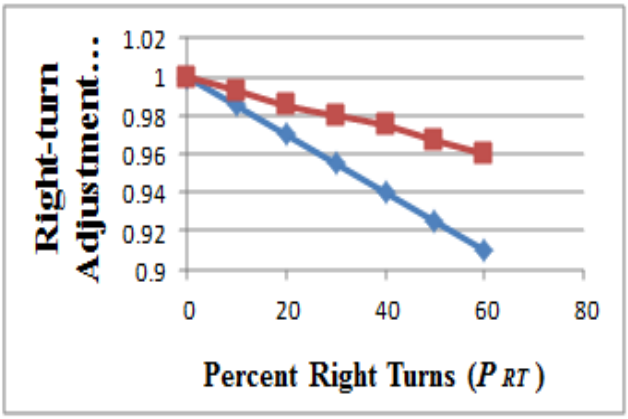

Chart -2: Right-Turn Adjustment Factor

The number-of-lanes adjustment factor and the right-turn adjustment factor should be used together to estimate the effect of a shared, through plus right-turn lane on lane group saturation flow rate. The right-turn adjustment factor is 0.992

3.3 ADJUSTMENT FACTOR FOR NUMBER OF LANES

The relationship between number of lanes in the lane group N and the calibrated adjustment factor value is shown in chart-3. The combined adjustment factor is 0.954. A comparison of this factor with that for the two-lane lane group indicates that the multilane approach has a saturation flow rate that is 2.4 percent (=0.977/0.954) larger than the single-lane approach, given the same traffic volume in the shared lane.

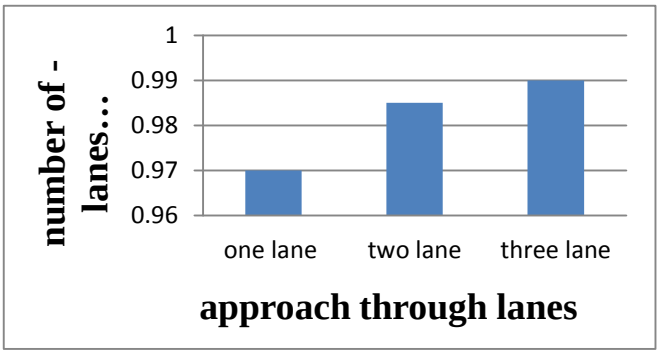

Chart -3: Number-Of-Lanes Factor

Now consider the same approach but with the inside through lane removed. The lane group now has one through-plus-right-turn lane. The right-turn adjustment factor is 0.983; the number-of-lanes factor for a one-lane lane group is 0.971.

3.4 ADJUSTMENT FACTOR FOR AREA POPULATION

In general, there is good agreement between the two curves. The best-fit curve obtained from the Hyderabad data suggests that area population has less effect on saturation flow rate. The relationship between area population and the calibrated adjustment factor value is shown in chart-4.

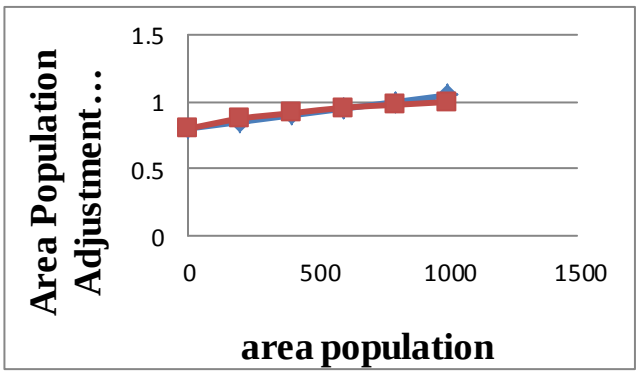

Chart -4: Area-Population Factor

3.5 ADJUSTMENT FACTOR FOR TRAFFIC PRESSURE

The relationship between traffic pressure and the calibrated adjustment factor value is shown in chart-5. The two trend lines shown that the saturation flow rate increases when the volume of vehicles served each cycle increases.

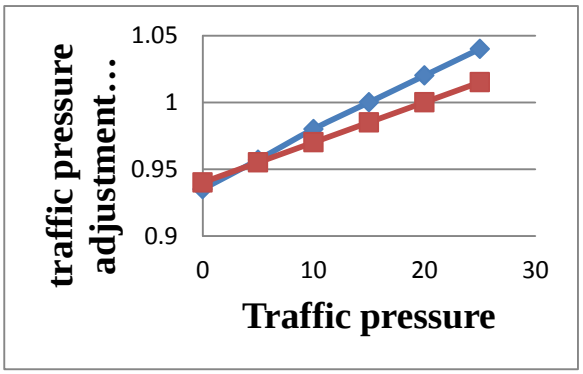

Chart -5: Traffic-Pressure Factor

Because of its empirical nature, it is important to the factor is applied to intersections with a flow rate in excess of 35 veh/ln/cycle, the adjustment factor associated with a flow rate of 35 veh/ln/cycle should be used.

3.6 ADJUSTMENT FACTOR FOR SPEED LIMIT

The relationship between speed limit and the calibrated adjustment factor value is shown in chart-6. Also shown is the relationship obtained from the local adjustment factors found in Table.

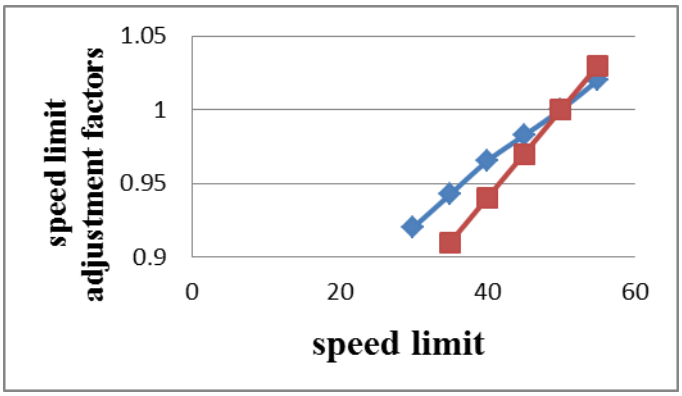

Chart -6: Speed-limit adjustment factor

This adjustment factor can be used to indirectly evaluate the effect of the street or highway environment on performance. Specifically, a lower limit on speed of 30 mph is appropriate for this factor. Similarly, an upper limit on speed of 55 mph is appropriate. If the factor is applied to intersection approaches with a speed limit in excess of 55 mph, the adjustment factor associated with a speed of 55 mph should be used.

BASE SATURATION FLOW RATE ESTIMATE:

This section describes the method used to estimate the base saturation flow rate using the databases describes in the two previous sections. Specially, the base saturation flow estimate was obtained by using a weighted average of the saturation headway estimates form the two studies. The value used to weigh the two estimates is the standard

deviation obtained from their respective regression analyses. The analysis is illustrated in Table 3 (values shown are rounded).

DATA BASE	SATURATION HEADWAY(H) S/VEH	STANDARD DEVIATION(S) S/VEH	WEIGHT (W)	H × W
Table 1	1.87	0.014	5102	9519
McMahon	1.83	0.015	4258	7785
TOTAL:			9360	17,304
AVERAGE:	1.85	BASE SATURATION FLOW RATE, PC/H/LN:		1950

As indicated in the last row of Table 3, the weighted average saturation headway is 1.85 s/veh. The corresponding base saturation flow rate is 1950 pc/h/ln. This value is recommended for use with the calibrated adjustment factors at intersections in Hyderabad. It reflects the saturation flow rate that would be measured when using the measured discharge times of queue positions four and ten. Slightly different values will be obtained if different queue positions are used as a basis for the estimate of base saturation flow rate.

4. CONCLUSIONS

1. The factors affecting base saturation flow rate such as right-turn vehicles adjustment factors, lane distribution adjustment factors, etc were analyzed and estimated at four intersections. Along with that the base saturation flow rate of the intersection were concluded at the intersection.

2. The adjustments factors play a vital role in determine the average base saturation flow of the intersection. Maximum flow rate were found at the uppal X road.

3. The obtained factors are compared with McMahan data analysis, noticed that the adjustment factors of speed limit, area population and traffic pressure are shown the similar values at the four intersection.

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