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ESTIMATION OF FACTORS AFFECTING BASE SATURATION FLOW RATE AT SIGNALIZED INTERSECTION

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Abstract -With growing population and urbanization to provide the safe and efficient traffic is a challenging task to the transportation engineering. To estimate the traffic at signalized / un-signalized intersection the base saturation flow rate play vital role. The base saturation flow rate was measured and analyzed to provide the smooth traffic flow rate at Hyderabad, for four intersection approaches. The objective of the study is to estimate and develop the affecting parameter of base saturation flow rate for various approaches in the Hyderabad city. Form the obtained base saturation flow rate, the capacity of the signalized intersection was determined. The study result was concluded that the maximum base saturation flow rate found at L. B nagar and also the minimum base saturation flow rate at tarnaka. It's also indicated that the parameter affects the base saturation flow rate at various approaches and its factors values were described.

Keywords: saturation flow rate, adjustment factors, traffic, signalized intersection.

1. INTRODUCTION

In developing countries, the rapid growth of urbanization affects the faster moment of vehicles at signalized and un-signalized intersection. The moment of vehicles depends on the road network and capacity of the traffic signals. Form the road network, intersection (signalized and un-signalized) is a key role to control the traffic for smooth flow of vehicles. As a result, many of the researchers are involve estimating the capacity of the intersection. The capacity of the intersection is measured in terms of base saturation flow rate and it's affecting parameters. The base saturation flow rate was measured or estimated in terms of field studies with including capacity-influence factors empirically and the second approaches to measure the base saturation flow rate is maximum theoretical values. The obtained base saturation flow rate further used to determine the capacity of the traffic at signalized and un-signalized intersection. In addition to that its further help in the design of the intersection with consideration of various parameters affects the capacity of the traffic. In this study, four approaches are chosen in the Hyderabad city, evaluated its affecting parameter and determine the use of the standard equation as per the 2013 data. The data were collected manually at four intersections and observed the affecting parameter.

2. LITERATURE

The study was conducted to evaluate the effects of heavy vehicles on traffic flow at two intersection using the empirical data and microscopic traffic simulation. The study was revealed that the traffic operation at free flow condition, the effect of heavy vehicles increases with the increased, the effect of grade length was smaller effects on the traffic flow and the location of bottleneck is at the top of upgrade is higher than the bottom of the upgrade [1]. 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 [2]. An attempt is made to estimate the base saturation at various intersections, and the factors affecting the saturation flow at intersection. The study were adopted at three different intersections, the maximum saturation is noted as 2323 vh/h/la. The author concluded that the obtained traffic flow is slightly higher than the HCM manual for the city of Doha, Qatar [3]. 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 [4]. The capacity of signalized intersection was estimated under two categories, the obtained saturation flow was compared with the actual saturation flow rate equation (highway capacity manual 2000). 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 [5]. 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 [6]. The study is attempted to estimate the saturation flow rate of three cities with the help of t-test. The measured saturation headway of the city was compared with the HCM. 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 [7].

3. STUDY ARE AND ITS CHARACTERIZATION

In the present study, the data were collected to estimate the base saturation flow rate at four intersection approaches. 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
- Minimize extraneous factors that may influence saturation flow rate but which are beyond the scope of this research (e.g., pedestrian effects)
- Intersection (L.B NAGAR)
- Intersection (NAGOLE)
- Intersection (UPPAL)
- Intersection (TARNAKA)

3.1 Factors Affecting the Base Saturation Flow Rate

- Right-turn radius; lane width, Posted speed limit;
- Driveway location, if present;
- Bus stop location, if present;
- Left-turn length; Right-turn length;
- Adjacent land use characterization (i.e., business, shopping, residential); and
- Any other factors that may influence saturation flow.

In addition to the above features, the lane assignments for all approach and departure legs are shown on the diagram. The data needed for this diagram were collected before or after the field study of saturation flow rate.

3.2 Field Data and Summary

The base saturation flow rate and its influence parameter were evaluated at four intersection approaches in the present 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 consists 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. Geometric information of the filed data such as lane width and curb radius. Initially, the intersection approach study sites are identified and described. Then, the saturation flow rates measured at each site are summarized to provide. Study site traffic characteristics and geometry are summarized in Table 3.1.

Table-3.1 Saturation Flow Rate and Details of the Geometry

Inter-section	S. No.	Site	Travel Dir.	App. Config.	Aadt Veh/D	Flow Rate,2 Veh/H	Heavy Veh In %	Lane Width, Ft	Turn Radius, Ft	Cycle Length, S
1	1	Sarror Nagar,Ntr Nagar	N	6	58,000	1485	2.2	11	55	130 a.m. 0 p.m.
	2		S	6		1707	2.3	11	45	
	3	Sarror Nagar,Ntr Nagar	N	6	------	1234	5.6	12	100	130 off 140 p.m.
	4		S	6		1297	7.8	12	90	
	5	Maha Laxmi Theater,Rajiv Gruha Kalpa	E	3	53,000	1470	5.2	11	105	150 a.m. 160 p.m.
	6		w	5		1603	4.0	11	140	
	7	Maha Laxmi Theater,Rajiv Gruha Kalpa	E	2	------	892	9.1	11	45	125 a.m. 135 p.m.
	8		W	5		749	5.8	12	50	
	9		E	6	53,000	1380	2.7	12	120	130-150
	10		W	6		1730	2.6	12	145	
	11	Polytechnic Coll, Mahakaxmi Theater.	N	5	32000	1150	4.7	11.5	30	95-105
	12		S	2		1176	3.7	12	20	

2	13	Polytechnic Coll, Mahakaxmi Theater.	N	2	20000	736	1.6	12	32	120-140
	14		S	4		702	2.9	12	60	
	15		N	3		1735	6.3	11	35	125-150
	16		S	3		1969	2.9	11	35	
	17	Mohan Nagar To Indu	E	1	15000	630	12.0	12	50	120-130
	18		W	1		692	14.1	12	50	
	19	Mohan Nagar To Indu Arranya	E	2	30000	859	1.7	10	20	100-120
	20		W	2		835	2.5	11	30	
3	21		N	2	31000	1173	8.9	12.5	30	115-125
	22		S	2		1117	7.8	12.5	75	
	23	Nagole To Uppal Ring Road	N	5	50000	1469	8.0	13	50	140-160
	24		S	5		1341	9.5	13	50	
	25	Gis Toward Uppal Ring Road	E	2	21000	726	2.2	11	40	120-140
	26		W	2		915	1.4	11	40	
	27	Amberpet To Uppal Ring Road	E	4		396	12.5	13	75	105 a.m. 115 p.m.
	28		W	4		420	13.2	12	115	

This narrow range was intentional and intended to limit the effect of influences that are outside the scope of this project. In contrast, there is an intentionally wide range in the right-turn radius and cycle lengths among the sites. This range was intended to facilitate the analysis of these factors and their effect on saturation flow rate. Approach grades and pedestrian volumes were negligible at all study sites. None of the sites had shared through plus left-turn lanes.

4. RESULTS AND CONCLUSION

To reduce the delay at the signalized intersection significantly improves the total travel time, the ability of a traffic signal to serve a given volume of traffic at the signalized intersection is defined the capacity of the intersection. The analysis of the traffic signal relationship considered a wide range of factors. The traffic factors related to the geometry of the intersection, environment and also the traffic characteristics. In the present study, the following major factors were considered to estimate the traffic at the selected intersection. The specific factors considered including; right-turn percentage, number of through lanes, area population, traffic pressure, heavy-vehicle percentage, speed limit, lane width, and curb radius. Those factors that were found to be visibly correlated saturation flow rate are discussed in this section. The effect of right-turn percentage on saturation flow rate the four site with shared through plus right-turn lanes is shown in Fig. 4.1. Form the analysis of the traffic flow data, it was found that the lower the saturation was observed at lower the population and which is led to the effect of right-turn vehicle presence on saturation flow rate.

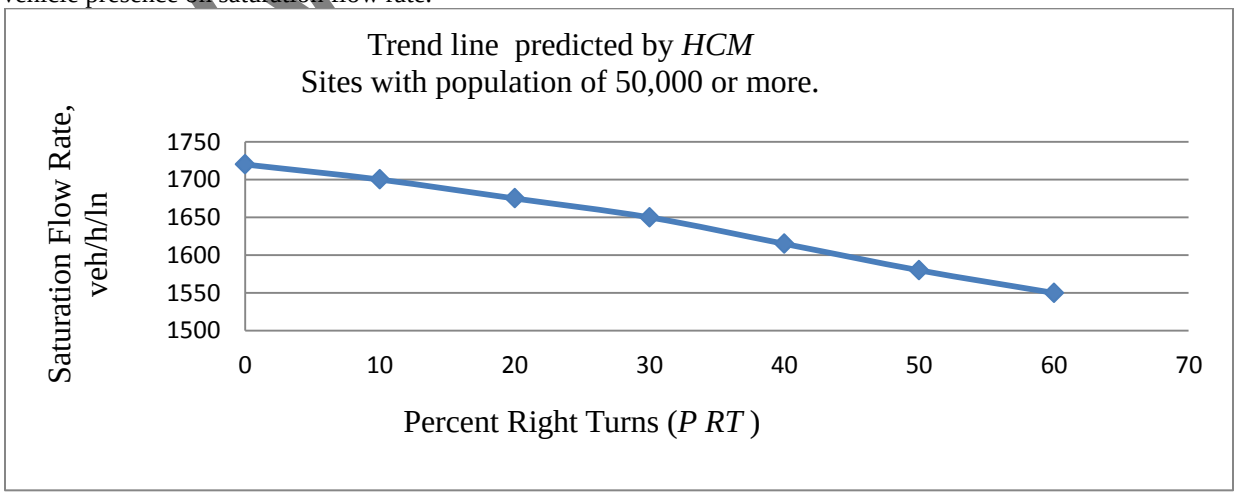

Fig. 4.1 Effect of Right-Turn Percentage on Saturation Flow Rate

To determine the base saturation flow rate at the signalized intersection, the influence of the right-turn over the saturation flow rate using the right-turn adjustment factors (fRT). The obtained right-turn adjustment factors (f_RT) using a base saturation flow rate of 1715 veh/h/ln as per the highway capacity manual at four intersections as per the 2013 data analysis in Hyderabad city. This effect is illustrated using a trend line. Form the data it was concluded that the saturation flow rate data revealed a density for a lower saturation flow rate has occurred at the shared-lane approaches. Further examination of this trend indicated that it also existed on intersection approaches with only through lanes. The effects of the lane over the saturation flow rate was shown in Fig. 4.2.

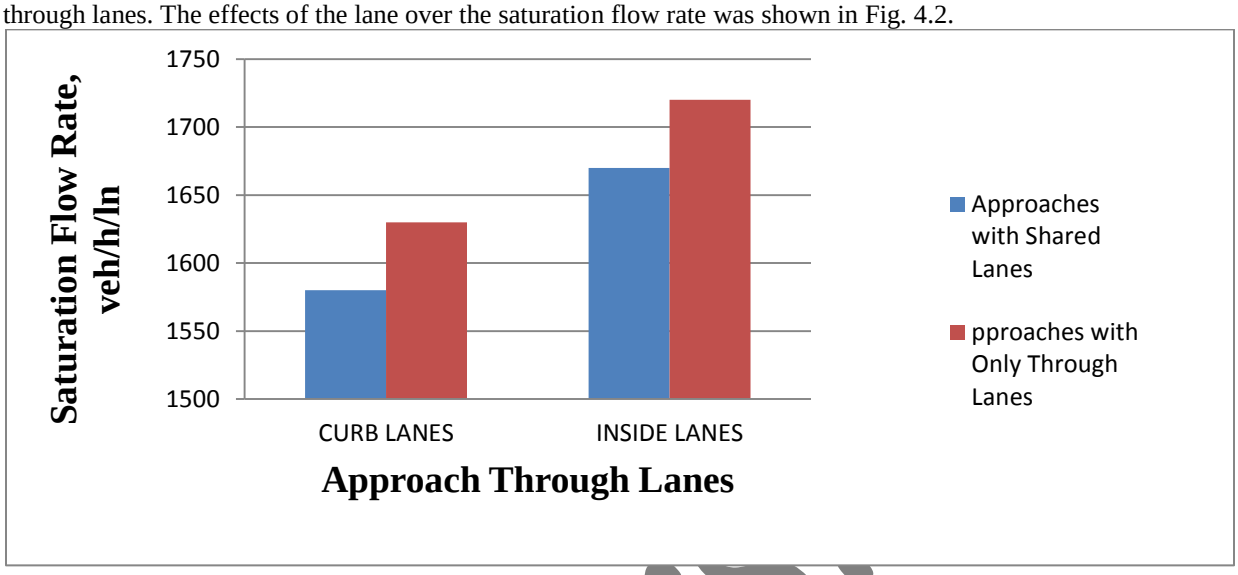

Fig. 4.2 Effect of Lane Location on Saturation Flow Rate

In this case the saturation flow rate is corrected with area population at each intersection. The traffic capacity (base saturation flow rate) is determine with population and area type. The estimated saturation flow ate at higher traffic capacity with higher area population. The shape of the curve is consistent with the trends reported of increasing the base saturation flow arte with increasing the population. The more population area were subjected with higher traffic parameter were concluded. The relationship between saturation flow rate and population is shown in Fig. 4.3.

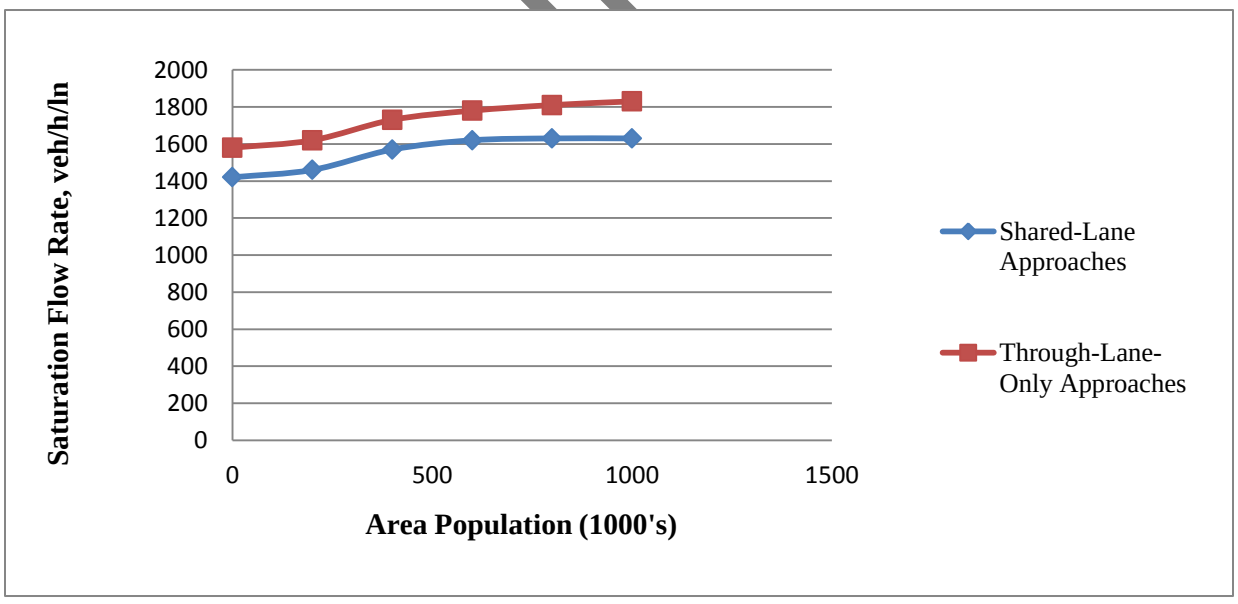

Fig. 3 Relationship between Population and Saturation Flow Rate

The relation between the average saturation flow arte and the number of lanes were developed to estimate the base saturation flow rate. The obtained relation between them is indicate that the saturation flow rate of an approach increases with the number of through lanes on the approach. The saturation flow arte and the number of traffic lane is shown in the Fig. 4.4. The trend lines are consistent among the two lane uses and show saturation flow rate increasing with an increase in traffic pressure.

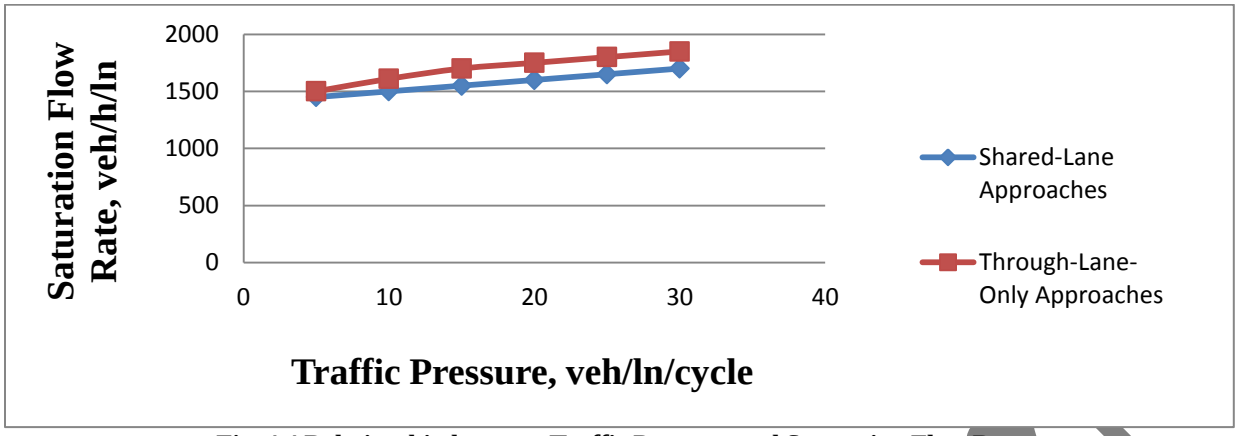

Fig. 4.4 Relationship between Traffic Pressure and Saturation Flow Rate

In case of percentages of heavy vehicles, the obtained saturation flow rate effected and the base saturation flow rate was reduced by increasing the heavy vehicles percentages. The percentages of heavy vehicles and the base saturation flow rate are shown in fig. 4.5. The factors were developed heavy vehicles percentages based on the highway capacity manual and it's suggested as denoted as (f_HV) heavy-vehicle adjustment factor.

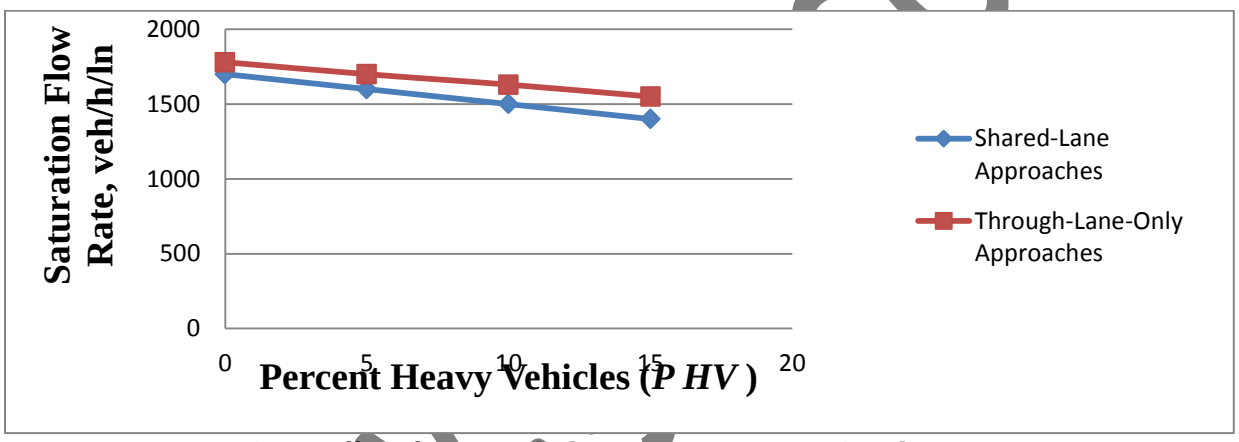

Fig. 4.5 Effect of Heavy-Vehicle Percentage on Saturation Flow Rate

Form the analysis of the data, the relationship between the speed limit and saturation flow rate were concluded. The relation between the saturation flow rate and the speed limit is shown Fig. 4.6. The trend line indicates that saturation flow rate increases with an increase in speed limit. The speed of the different vehicles has the adverse effect on the saturation flow rate.

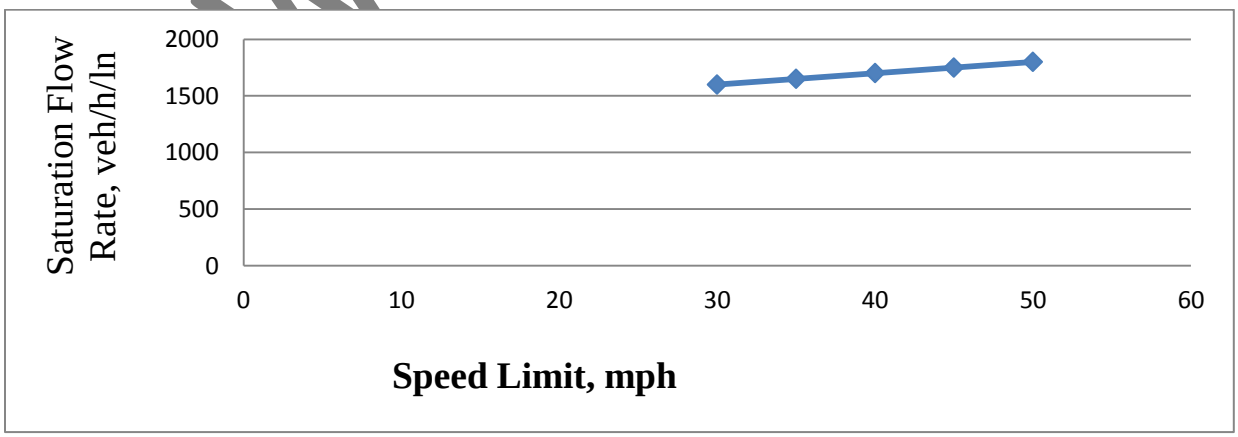

Fig. 4.6 Relationship between Speed Limit and Saturation Flow Rate

Theoretical models of the queue discharge process indicate that saturation flow rate increase with speed. However, the relationship between speed limit and saturation flow rate may also be a reflection of roadside development, pedestrian activity, signal spacing, high-density roadside driveway, high-density roadside development, frequent

pedestrian activity, and short segment lengths. The above mention parameter has the adverse effects on the base saturation flow rate. The averaged saturation flow rate can be reduced with the appropriate design of the geometry of each intersection and the queen of the average speed of the vehicles.

CONCLUSION

- The traffic capacity or density were found maximum at intersection approach (L.B Nagar) which is found as 58000 veh/day with the higher turning radius, sufficient width of the roads and appropriate installation of the traffic signals.
- The minimum base saturation flow rate was found at tarnaka intersection approaches due to the lower turning radius and also the number of vehicles (heavy traffic).
- The average base saturation flow rate at all intersection significantly reduced while providing the suitable geometry, speed, shared lane, and heavy vehicles and lanes distribution of the vehicles. The suitable width of right turn radius and the shared lanes are needed to improve the efficient traffic control.

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