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Development of Capacity and Delay Model

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Abstract - *Connectivity between towns, cities and different areas is an essential component in the development of a Nation. Roads and railways provide this connectivity. High speed road corridors have been one of the most vital infrastructures in the overall socio-economic development of the country.*

A highway pavement is a structure consisting of super imposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics and low noise pollution.

The goal of this project is to maintain the quality of materials that can be used in the construction of highways. For the maintaining of quality materials in the construction of highway systemto control the damaging of highway roads and the life highway road should also increases.

Finally to conclude we have studied the details of national quality control of highway construction materials and we can say that highway can be useful for the advancement of the community, economic prosperity and general development of the country.

1. INTRODUCTION

The major purpose of capacity modeling of U-turn median opening is to develop useful relationship between capacity and set of traffic and geometric characteristics. The developed model should be easy for practical applications and predictive under different traffic conditions. It should be mentioned that intersections are provided to facilitate traffic turning movements. As part of traffic management to improve intersection operation, some traffic movements are not permitted at some

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intersection locations, especially along divided arterial. In most cases, such minor movements are accommodated at separate U-turn median openings. Compared with turning movements at intersections, U-turn movement at median openings is highly complex and risky. Normally, the speed of conflicting traffic stream is relatively high and the turning vehicle must wait for accepted gap and then turn under low speed level. Therefore, the turning vehicle needs large gap in the conflicting stream before performing the U-turn. In fact, the little studies which contain procedures and models for estimating capacity and delay for different movements at unsignalized intersections do not provide specific guidelines for estimating capacity and delay of U-turn movement at median openings. For this reason, an effort was made to estimate capacity and delay at U-turn median openings.

However, the operation can be considered as an interaction of drivers on the minor or stop-controlled turn with drivers on the oncoming approach of the major street in two directions simultaneously. Although the U-turn movement is more complex than right-or left-turning movements at unsignalized intersections, the general concepts and procedures developed for analyzing capacity at priority unsignalized intersections are very crucial in this respect.

The purpose of capacity analysis is to insure that planned highway network could deal with the present and future traffic flows with satisfying quality; Since unsignalized intersections and Median openings are the most common type, their functionality has a great impact on the quality of traffic flows on the urban street network and especially on the suburban and rural highway network (at connections of state and county roads). In the following chapters of this paper, first the development of available capacity methodologies is presented followed by the summary results of conducted capacity modeling using regression analysis. The detailed procedure of field data collection as well as the results of capacity models testing has been presented in paper. Next, the development of the modern delay models based on the linear regression analysisispresented. At the end of the paper the results of delay models testing are presented. Also, the reliability of the model and the applicability of model parameter values for the prevailing roads and the

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traffic conditions in Hyderabad are discussed.

OBJECTIVES OF THE STUDY

The objectives of the present study are mentioned below

- To develop a model for estimating the capacity and Delay at U-turn median opening.
- To evaluate the effect of U-turning vehicles on the capacity of a stretch.
- To evaluate the relation between capacity and conflicting traffic flow.
- To evaluate the relation between delay and conflicting traffic flow

2. LITERATURE REVIEW

Very little studies were available for traffic operation at U-turn median openings. Using the empirical and gap acceptance approaches .Over the past few decades, many studies on gap acceptance concept have been conducted to analyze gaps and develop models correlating the previously mentioned factors with gap acceptance. However, a very small portion of those studies addressed U-turns.

2.1 Theoretical Background

Location of median openings

The growing number of multilane highways with raised or depressed medians and without access control has created the need to provide median openings, or crossovers, at various locations along such facilities to permit vehicles to reach abut- ting property or reverse their direction of travel. Median openings, however, may also become points of increased congestion and accident exposure. Turbulence in traffic flow created by vehicles turning on or off high-speed roadways causes undesirable acceleration and deceleration maneuvers. Therefore, if traffic safety on multilane highways is to be preserved, the location of median openings must be given careful consideration.

A committee of the Institute of Transportation Engineers developed a list of factors to consider in locating median openings. These included the potential number of left turnsbinto driveways, length of frontage along the street right- of-way line of the property proposed to be served, distance of proposed opening from adjacent intersections or other openings, length and width of the left-turn storage lane as functions of the estimated maximum number of vehicles to be in the lane during peak hours, and traffic control. The committee noted the need to consider circuitous routing and added intersection turns that may be caused by closing a median opening.

3. STUDY AREA AND METHODOLOGY

3.1 General

Today the city of Hyderabad, India cover an area of 650 square kilometers (250 sq mi), has a population of 6,809,970 making it the fourth most populous city in India.There are 3,500,802 male and 3,309,168 female citizens. The area under the municipality increased from 170 square kilometers (66 sq mi) to 650 square kilometers (250 sq mi) in 2007 when the Greater Hyderabad Municipal Corporation was created. As a consequence, the total population leaped from 3,637,483 in 2001 census to 6,809,970 in 2014 census, an increase of over 87%. Migrants from rest of India constitute 24% of the city population. Hyderabad city is governed by Greater Hyderabad Municipal Corporation that comes under the Hyderabad Urban Agglomeration, which has a population of 12 million the fourth most populous urban agglomeration in the country, with 3,985,240 males and 3,764,094 are females. A proposal to expand the area covered by the city to make it 721 square kilometers (278 sq mi) by merging the surrounding gram panchayats and around 30 villages is being considered, as of 2009.

The most commonly used forms of medium distance transport in Hyderabad include government owned services such as light railways and buses, as well as privately operated auto rickshaws, short distance transportation is provided by the ubiquitous cycle rickshaws. Bus services operate from the Mahatma Gandhi Bus Station in the city centreand carry over 130 million passengers daily across the entire network. Hyderabad's light rail transportation system, the Multi-Modal Transport System (MMTS), is a three line suburban rail service used by over 160,000 passengers daily. Complementing these government services are minibus routes operated by Setwin (Society for Employment Promotion & Training in Twin Cities).

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As of 2012, there are over 3.5 million vehicles operating in the city, of which 74% are two-wheelers, 15% cars and 3% three-wheelers. The remaining 8% include buses, goods vehicles and taxis. The large number of vehicles coupled with relatively low road coverage roads occupy only 9.5% of the total city area as led to widespread traffic congestionespecially since 80% of passengers and 60% of freight are transported by road. The Inner Ring Road, the Outer Ring Road, the Hyderabad Elevated Expressway, the longest flyover in India and various interchanges, overpasses and underpasses were built to ease the congestion. Maximum speed limits within the city are 50 km/h (31 mph) for two-wheelers and cars, 35 km/h (22 mph) for auto rickshaws and 40 km/h (25 mph) for light commercial vehicles and buses.

There are a lot of midblock U-turn facilities on urban arterials in the developing countries and cities. These midblock U-turn junctions interrupt the through traffic movement. After arriving the midblock median opening, the U-turn vehicles wait for the large enough gap and make U-turn maneuver.

3.2 Study Area

Hyderabad city is the sixth largest metropolitan city in India. The phenomenal increase in population coupled with growth of road vehicles has created considerable traffic problems. It is facing a peculiar problem of combined traffic conditions, where cars, scooters, autos, buses, trucks etc., are operating together. In addition to this the city is facing with the problems of narrow streets and chocked intersections. Compared with turning movements at intersections, U-turn movement at median openings is highly complex and risky. Normally, the speed of conflicting traffic stream is relatively high and the turning vehicle must wait for accepted gap and then turn under low speed level. Therefore, the turning vehicle needs large gap in the conflicting stream before performing the U-turn. So for the modeling of capacity and delay three median openings were chosen in the present study.

To accomplish the objective of this study, three median openings located in Hyderabad City were selected.

- Nagole
- Himayatnagar
- Barkatpura

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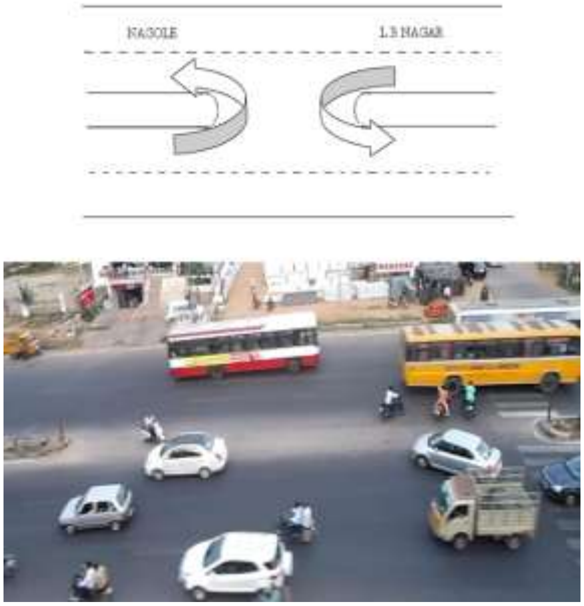

Fig 1: Median opening at Nagole stretch

Fig 2: Median opening at Himayathnagar stretch

4. DATA COLLECTION AND ANALYSIS

4.1 General

- For the present study all selected sites were at least 500 meters from the nearest signalized intersection, thus no spillback problems or abnormal bunched arrivals were observed during data collection.
- Three different locations in Hyderabad were selected i.e., Nagole stretch, Himayathnagar and Barkatpura stretch.
- At three locations models for Capacity and Delay are developed using Linear Regression analysis.
- For the purpose of this study, data set was collected to develop an empirical relationship for estimating capacity of U-turn at median openings. The data set included 60 observations on capacity of turning stream, conflicting traffic flow and average total delay.
- These data were observed at one-minute intervals. The observations were taken with stable queuing in the left turn lane (at capacity operation). It was decided to adopt recording technique using an automatic video camera to collect the field data.
- Video tapes are then played back in the laboratory to process the collected data, as required. The total delay for the

turning vehicles was measured directly from the videotape.

- Data of No. of vehicles taking U-turn (veh/min), Conflicting Traffic Flow(veh/min) and Delay (sec/veh) are taken from the video.
- The observed data i.e., No. of vehicles taking U-turn and Conflicting Traffic Flow is converted from veh/min to veh/hr.
- Mean and Standard Deviation of the observed data is calculated and Covariance of the variables is also calculated.
- By using the above data models for Capacity and Delay at the Median Openings are generated.

5. SUMMARY AND CONCLUSIONS

5.1 Summary

In this study, an attempt has been made to develop a Capacity and Delay model in order to estimate the delay caused to vehicles given the base data (which are easily measurable in field) at U-turn median openings under heterogeneous traffic conditions. The average delay caused to vehicles is an important and commonly used measure to evaluate the U-turn performance. The conflicting traffic flow is a vital factor influencing the extent of delay caused to vehicles. As field measurement of capacity and delay caused to vehicles is tedious and difficult, theoretical models are generally used to estimate the delay. These theoretical models have been derived based on the linear regression analysis for fairly heterogeneous traffic conditions. Under mixed traffic conditions, such as the one in India, there is no queue or lane discipline followed by traffic and the vehicles occupy the available road space on the approaches as densely as possible in a haphazard manner. Therefore, these models are used for calculating capacity and Delay at U-turn median openings.

5.2 Conclusion

Based on the results of this study, the following points were concluded:

- Capacity and average total delay models for U-turn movements at median openings were found to be significantly influenced by the conflicting traffic flow.
- For Nagole stretch, Capacity of the U-turning vehicles is inversely proportional to the Conflicting Traffic Flow.

- Capacity model at Nagole stretch has an R^2 value of 0.9239 i.e., it explains a high percentage of relation between Capacity of U-turning vehicles and conflicting traffic flow.
- The Delay model has linear relationship obtained between the average total delay and the conflicting traffic flow at U-turn median openings.
- Delay model has an R^2 value of 0.924 i.e., it explains a high percentage of relation between Delay and conflicting traffic flow.
- Capacity model at Himayathnagar stretch has an R^2 value of 0.911 i.e., the capacity is 91.1% correlated with conflicting traffic flow.
- Delay model has an R^2 value of 0.914 i.e., delay is 91.4% correlated with conflicting traffic flow.
- Capacity model at Barkatpura stretch has an R^2 value of 0.9014 i.e., the capacity is 90.14% correlated with conflicting traffic flow.
- Delay model has an R^2 value of 0.9066 i.e., delay is 90.66% correlated with conflicting traffic flow.

5.3 Scope for Future Work

For better understanding of the model, the data should be considered from morning to evening. The model developed in this study should be validated from a completely different set of observations to understand the field applicability of the model. Besides, linear regression methodology, other models should also be modified under the heterogeneous road traffic conditions to estimate the Capacity and Delay for Over saturated conditions.

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