Development of Saturation Flow Model for Mixed Traffic on Urban Arterial Roads, Intersection

Subhas Kumar C Singh[1] N.G.Raval[2]
[1]student,M.E. Civil (Transportation) – 4th Sem [2]associate Professor, Civil Department (Transportation)
[1,2]l.D.College of Engineering, Gujarat Technological University, Navrangpura, Ahmedabad,

Abstract—past research has indicated that the effectiveness and efficiency of traffic control of signalized intersections strongly depend on the accurate calculation of saturation flow rate, particularly when demand approaches capacity. Minimal work has been done in the past on calibration of the parameters for saturation flow rate used in traffic control of signalized intersections. This paper discusses a saturation flow study conducted in Ahmedabad city, the commercial city of Gujarat, which lies in the west of India. Using linear regression analysis, of saturation flow rate for four signalized intersections has been studied. Base saturation flow rate have been calculated. The results confirm that the methodology for saturation flow rates, put forward by highway capacity manual (HCM) can also be used in India. However, parameters should be systematically calibrated, based upon widespread study, before they can be used effectively in the practice of traffic control in India.

Keywords:- Saturation flow model

I. Introduction

Road traffic conditions in India are getting worse day by day. The average number of vehicles in India is growing at the rate 10.16 percent annually, since last five years. Spending hours in traffic jam has become part and parcel of metropolitan life style, leading to health and environmental hazards. The vehicle penetration in metropolitan cities like Ahmedabad is suffering from about 590 vehicles per Km of road stretch and Bangalore with around 5 million of vehicle ply over a network that extends barely up to 3000kms. Our aim is to detect traffic condition using speed as traffic feature. This thesis-work is the part of the project 'Horn-Ok-Please'. The project has got its name from the famous tag-line painted at the back of the trucks in India, which are known for their notorious horns.

II. Problem Definition

There are no proper guidelines available to estimate saturation flow for non-lane based traffic conditions. Department of Transportation uses an ideal saturation flow rate of 1800 pcphgpl (passenger car per hour group per lane) which is less than the default value of 1900 pcphgpl (passenger car per hour group per lane) provided by HCM. This is to account for the less aggressive characteristics.

III. Objectives

- To develop saturation flow model considering only width criteria by regression method .
- To develop saturation flow model considering width, vehicle composition and Gradient criteria for non-lane based traffic condition.
- To validate the developed model.

IV. Study Area

Study area is selected in the Ahmedabad city in which there are 4 intersections:

- Income Tax Intersection
- Shyamal Intersection
- 3 Shastri Nagar Intersection
- Jodhpur Intersection

V. Data Collection For Measurement Of Saturation Flow

Table1: shows the data of field measurement of saturation flow and vehicle composition

Approach	Width (m)	TW (%)	Auto (%)	Car (%)	Bus (%)	Bicycle (%)	Lcv (%)	Hcv (%)	Others (%)	PCU/ hour	Grade (%)
Income Tax Intersection											
South	9.5	55	21	16	3	2	2	1	0	10581	4.72
West	9.5	59	17	15	4	2	2	1	0	9993	5.36
North	9.5	69	15	18	5	2	2	2	0	9674	4.01
East	10.5	68	2	17	6	3	2	1.5	0.5	10919	3.94
Shyamal Intersection											
South	9.5	44	15	27	1	6	5	1	1	7762	2.52
North	9.5	58	10	23	2	3	2	1	1	6395	2.44
East	9.5	48	11	26	3	5	3	1	1	8344	1.78
West	9.5	56	11	23	1	3	4	1	1	8052	2.68
Jodhpur Intersection											
North	6.0	58	10	23	2	3	2	1	1	6322	8.58
South	6.0	46	20	25	1	3	3	1	1	4745	7.12
East	7.0	41	11	40	1	2	3	2	1	10423	7.45
West	7.0	42	12	37	2	3	2	1	1	8906	2.40
Shastri Nagar Intersection											
West	7.5	47	10	29	2	5	5	1	1	6189	3.00
East	6.0	54	12	24	1	3	4	1	1	7504	5.34
South	9.0	43	11	38	2	1	3	1	1	6705	4.51
North	7.0	55	11	23	1	3	4	2	1	7221	8.58

Four intersections were selected for knowing how many vehicles pass through the intersection.Videography was done on all four intersections to know the traffic composition.After doing videography all vehicles were counted manually from the video and then saturation flow is obtained.

VI. DEVELOPMENT OF MODEL

Model 1 :

Saturation flow=448W+5944W+5179AU+3579C -10B-4320LCV+31772HCV-89G

Model 2 :

SATURATION FLOW S = 986.57W

Where,

S = Saturation flow

W = Width of road in meter

Tw = Proportion of two wheeler in percentage

Au = Proportion of auto rickshaw in percentage

C = Proportion of car in percentage

B = Proportion of buses in percentage

LCV= Proportion of light commercial vehicle in percentage

HCV=Proportion of heavy commercial vehicle in percentage

G = Gradient of intersection on its stretch in percentage

S = Saturation flow in PCU / hour.

Table2:Comparison of saturation flow by various models considering only width

Sr. No.	Width of Road	Webster Method	IRC Method	Sama & Mehlotra	Bhattacharya & Bhatta	Developed Model no 2 Pcu/hour
1	3	1575	1850	1398	1110	2960
2	4	2100	1950	1830	1600	3946
3	5	2625	2550	2262	2090	4933
4	6	3150	3150	2694	2580	5919
5	7	3675	3675	3125	3070	6906
6	8	4200	4200	3557	3560	7892
7	9	4725	4725	3989	4050	8879

VII. VALIDATION OF MODEL

T-test is done to validate the model following values are found in validating model

– Model No 1

Model Validation :

R_2=0.990

F=4795.97

Df =455

– Model 2

Model Validation

R_2=0.980

F=19022.41

D_f =462

VIII. CONCLUSION

HCM 2000 suggests measurement of saturation flow should start after 10 second of green initiation which is considered as startup lost time. From the present study, it was found that auto rickshaws and motor cycle find way in between heavy vehicles and try to come near stop line. Most of the times these vehicles cross stop line before green starts. During red period large number of vehicles accumulates near stop line. This causes to discharge large amount of traffic during initial 10 seconds. and hence it is suggested that count for measurement of saturation flow should start after 3 seconds of green initiation for non-lane based traffic condition. Regression model developed to estimate saturation flow shows good correlation with field values. This model can used to estimate saturation flow at any intersections knowing signal timing approach width. The developed model no 2 of Saturation flow is modified based on the width of the road criterion. The developed model no. 2 of saturation flow gives the value in PCU/hr considering width and vehicle composition of intersection. It gives the satisfactory results nearer to field observations. The developed model of saturation flow gives the value in PCU/hr considering width and vehicle composition of intersection. It gives the satisfactory results nearer to field observations. Besides delay, the number of vehicle stops on intersection approach must be considered in the performance evaluation of signalized intersection. This measure not only relates to the level of service that is provided to the drivers, but also to the level of fuel consumption and air pollution that is generated by the vehicles traversing the signalized intersection.

REFFERENCES

[1] Modification of Webster's delay formula using modified saturation flow model for non-lane based heterogeneous traffic condition N.G. Raval & P.J. Gundaliya, 2010

[2] Department of Civil Engineering, University of Stellenbosch, Private Bag X1, MATIELAND 7602,1989

[3] Yanming Guo1; Quan Yu2; Yunlong Zhang3; and Jian Rong4, 1999

[4] Chang-qiao Shao and Xiao-ming Liu, 1989

[5] Key Lab of Transportation Engineering, Beijing University of Technology, Beijing 100124, China, 1992

[6] Correspondence should be addressed to Chang-qiao Shao, shaocq@bjut.edu.cn Received 26 August 2012; Revised 11 October 2012; Accepted 27 October 2Dr. Lloyd James French, III, Ph.D., P.E. (Chair), Dr. Ronald W. Eck, Ph.D., P.E.Dr. David R. Martinelli, Ph.D., Department of Civil Engineering Morgantown, West Virginia 2005 Keywords: Ideal Saturation Flow Rate, Highway Capacity Manual Copyright 2005 Bruce M. Dunlap Xinkai Wua,1, Henry X. Liu a,*, Douglas Gettman b,2 a Department of Civil Engineering, 500 Pillsbury Drive S.E., Minneapolis, MN 55455,

[7] United States b Kimley-Horn & Associates, 7878 N. 16th St., Suite 300,

[8] 85020, United States Phoenix, AZ

[9] By Feng-Bor Lin,1 Member, ASCE(Reviewed by the Highway Division)6th International Symposium on Highway Capacity and Quality of Service Stockholm, Sweden June 28 – July 1, 2011.

