

“Development of Traffic Congestion Index for Urban Road Links in Rajkot City”

Mr. Jasmin B. Sojitra¹ Dr. Yogesh U. Shah²

¹Student ²Associate Professor

^{1,2}Department of Civil Engineering

^{1,2}Marwadi Education Foundation Group of Institution, Rajkot, Gujarat, India

Abstract— One of the most important problem which the world faces today is the problem of traffic congestion. It is necessary to define congestion and to quantify it in terms of various factors that cause congestion. The literature review has revealed that travel time is an important measure of congestion. An attempt has been made in this work to quantify congestion in terms of congestion index which is the ratio of delay experienced during the existing condition to the free flow travel time. Detailed information regarding all parameters that affect congestion such as traffic volume, number of pedestrian crossing etc. are collected. Effect of by roads is also quantified and incorporated in terms of the number of vehicle merging with traffic stream and number of vehicles crossing the traffic stream to merge with opposite stream of vehicles. The required data has been collected using both moving car observer method as well as video recording. Multiple nonlinear regression equation connecting congestion index. The developed congestion Index once developed would be useful in calculating and comparing the level of congestion of different road stretches. This would help in proper planning of traffic movement, by keeping a balance between the congestion index of different roads.

Key words: Urban Road Links, Traffic Congestion Index

I. INTRODUCTION

1) Definition of Traffic Congestion:

“The traffic congestion occurs when the volume of vehicular traffic is greater than the available road capacity.”

2) Definition of Congestion Index:

“Congestion index, which is the ratio between delay and travel time during free flow condition is a very good indicator of traffic congestion.”

$$C.I. = \frac{T - T_0}{T_0}$$

Where, T = The Actual Travel Time

To = The Free Flow Travel Time

Traffic congestion is a condition on networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased queuing. When traffic demand increases the interaction between vehicles also increases and reduces the speed of the traffic stream thus increasing the travel time. Peak-hour traffic congestion is one of the major problems of all growing metropolitan regions around the world, which is that too many people want to move at the same time each day. In fact, it is almost certain to get worse during at least the next few decades mainly because of rising population and wealth.

B. Problem Statement

Traffic congestion has become a serious problem in many cities, especially in large cities. In order to improve traffic congestions, and improve the levels of service and efficiencies of urban transportation system, advanced traffic

control and management methods have become effective and common approaches. Evaluating traffic congestion levels of road networks is important for traffic management and control, since it could allow the corresponding agencies an accurately and clearly grasping of network traffic operation status including the information of location and time for congested roads. Therefore, it is necessary to evaluate traffic congestion situations for urban road traffic networks using applicable evaluation measures.

C. Objective and Scope

The main objective of this study is to determine the congestion index and to determine the variation of congestion with traffic volume and others parameters. To identify the parameters affecting traffic congestion. To investigate the geometric elements of selected urban road sections. To determine the traffic flow characteristics. To evaluate the Traffic Congestion Index.

D. Study Area

Kalawad Road (BAPS Temple To A.G.Chowk) – 2.9 Km

II. DATA COLLECTION

Following are the factors affecting to Traffic Congestion as Identified for the Study:

- Traffic Volume Count
- Surveying of Road Geometry
- Crossing movements of Pedestrians
- Turning manoeuvres of vehicles

III. DATA ANALYSIS

Traffic Volume	
Name of Road :- Kalawad Road	
Classification of Road :- Urban Arterial Road	
Kilometrage/Mileage :- 2.9 Km	
Name of City :- Rajkot Gujarat	
Date :- 15/10/2015	
Day of the Week :- 4th	
Direction of Traffic :-BAPS To A.G. Chowk	
Location at :- Punjab Honda Show Room	
Time	Volume in PCU
07:00 To 08:00	1952
08:00 To 09:00	1986.5
09:00 To 10:00	1742
10:00 To 11:00	1566
11:00 To 12:00	1640.5
12:00 To 01:00	1977.5
01:00 To 02:00	1737
02:00 To 03:00	1859.5
03:00 To 04:00	1477
04:00 To 05:00	1566.5
05:00 To 06:00	1652

06:00 To 07:00	1906.5
07:00 To 08:00	1738.5
Total	22801.5

Table 1: Traffic Volume Count

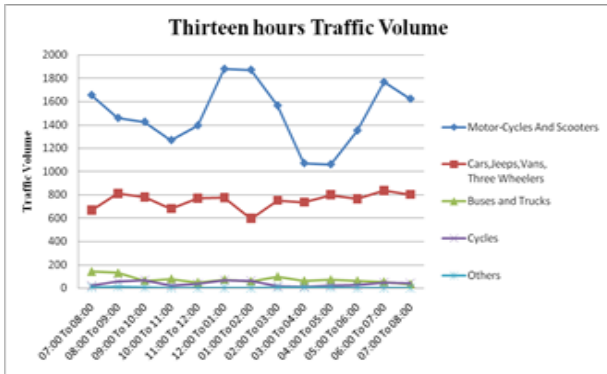


Fig. 1: Traffic Volume

Name of Road =	Kalawad Road
Length of Road (Km) =	2.9
No. of Lane =	4
Right of Way (m) =	28.33
Carriage Way (m) =	8
Width of Median (m) =	0.88
Width of Shoulder (m) =	2
Types of Shoulder =	Paved
Width of Footpath (m) =	1.6
Width of Kerb (m) =	0.15
Category of Road =	Arterial
Road Surface =	Flexible
Side Drainage =	No

Table 2: Surveying of Road Geometry

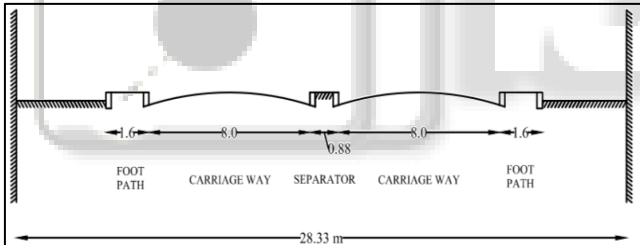


Fig. 2: Cross sectional diagram

A. Crossing Movements of Pedestrians:

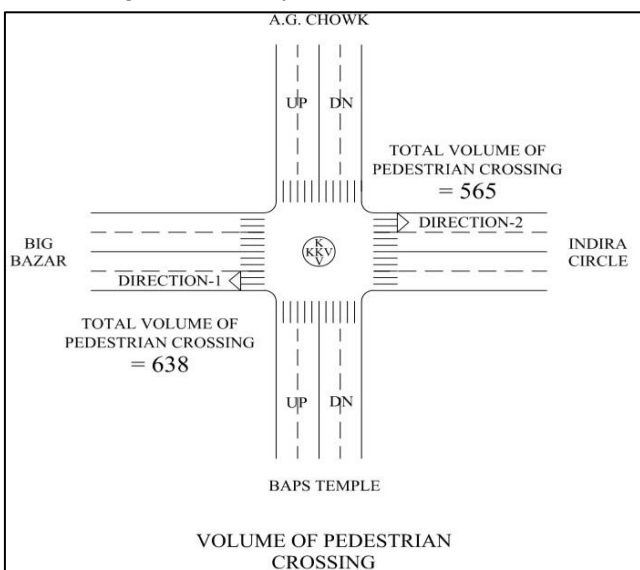


Fig. 3: Volume Pedestrian crossing

- Total Volume of pedestrian Crossing on Direction-01 = 638 Person
- Total Volume of pedestrian Crossing on Direction-02 = 565 Person

B. Turning Manoeuvres of Vehicles:

- Total Volume of Merging Traffic (Up side) = 5067 PCU
- Total Volume of Merging Traffic (Down side) = 4826 PCU

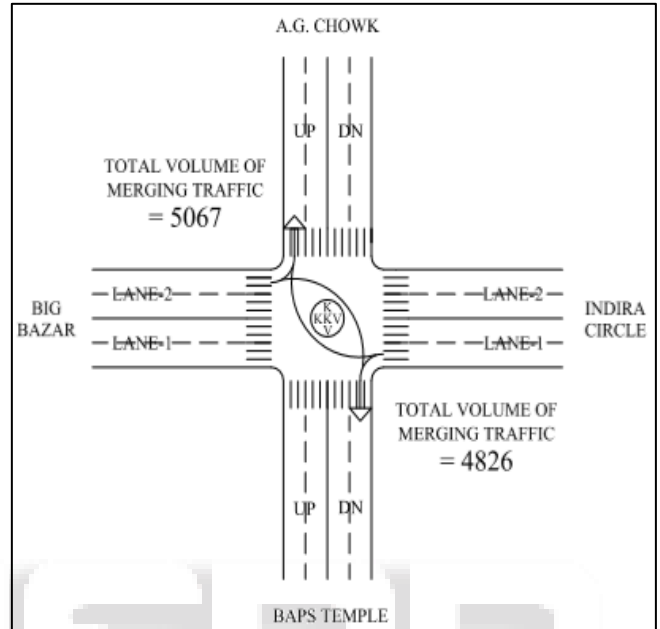


Fig. 4: Turning Manoeuvres of Vehicles

- Total Volume of Left side Diverging Traffic (Up side) = 1889 PCU
- Total Volume of Left side Diverging Traffic (Up side) = 1767 PCU

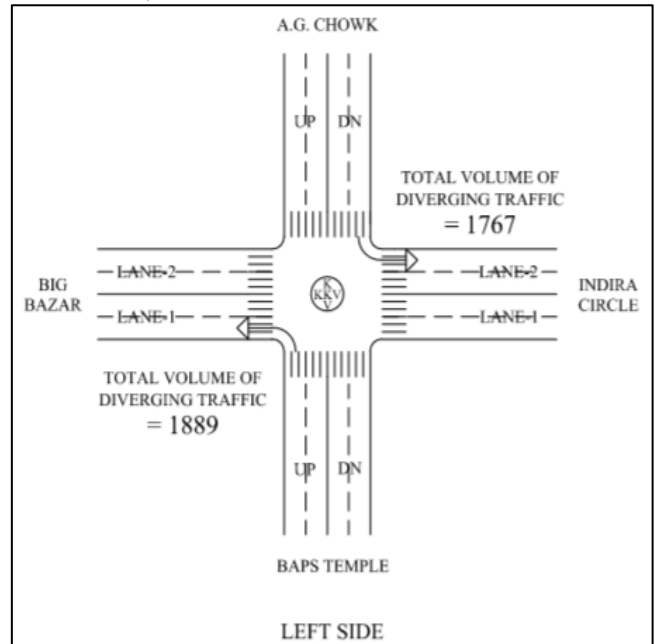


Fig. 5: Turning Manoeuvres of Vehicles

- Total Volume of Right side Diverging Traffic (Up side) = 1889 PCU
- Total Volume of Right side Diverging Traffic (Up side) = 1889 PCU

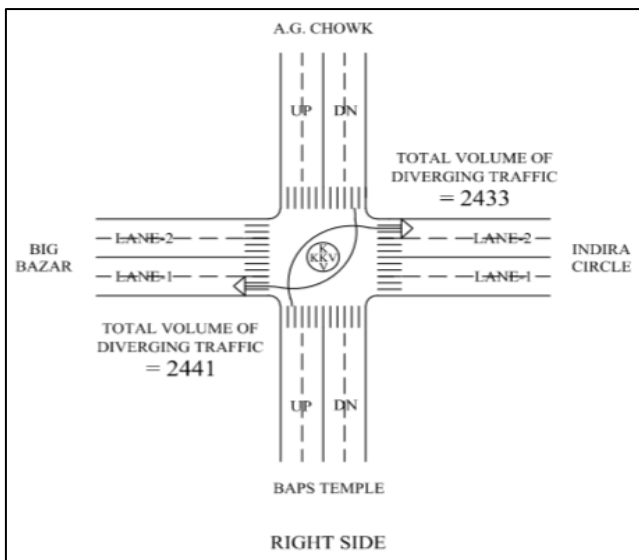


Fig. 6: Turning Manoeuvres of Vehicles

- Total Volume Crossing Traffic (Lane-01) = 3920 PCU
- Total Volume Crossing Traffic (Lane-02) = 3827 PCU

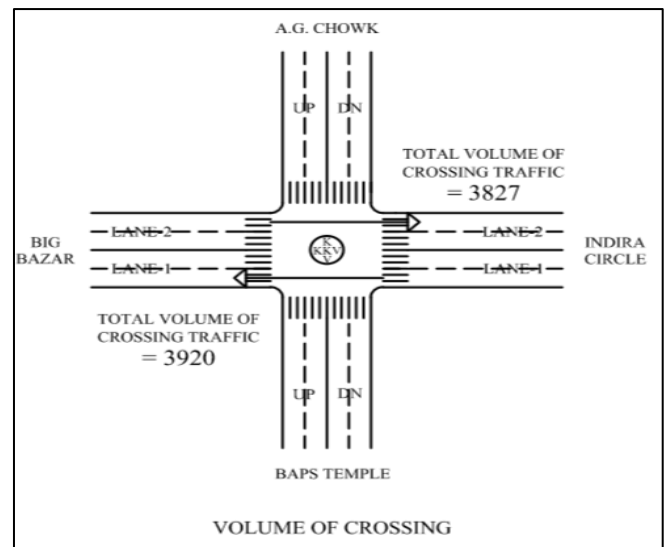


Fig. 7: Turning Manoeuvres of Vehicles

Name of Road :- Kalawad Road								Date :- 22/12/2015							
Classification of Road :- Urban Arterial Road								Day of the Week :- 4th							
Kilometrage/Mileage :- 2.9 Km								Direction of Traffic :- BAPS Temple To A.G. Chowk							
Name of City :- Rajkot Gujarat								Route Number :- 01							
Location :- KKV Hall Chowk															
Sr. No.	Actual Travel Time (Sec)	Free Flow Travel Time (Sec)	C.I.	V		V ^M		V ^L		V ^R		V ^C		V ^{PC}	
				UP	DN	UP	DN	UP	DN	UP	DN	Lane-1	Lane-2	Direction-1	Direction-2
1	424.54	228.03	0.86	978	747	414	241	96	72	117	110	181	168	15	9
2	422.65	228.03	0.85	967	814	419	244	99	64	118	114	186	175	19	11
3	418.89	228.03	0.84	869	802	326	289	102	84	138	133	277	270	38	28
4	417.56	228.03	0.83	860	641	228	302	106	81	142	140	270	272	31	27
5	434.67	228.03	0.91	781	724	301	277	131	111	131	131	218	216	24	19
6	458.12	228.03	1.01	777	722	309	278	130	115	138	135	222	228	20	19
7	444.59	228.03	0.95	817	801	330	299	143	127	162	169	229	216	19	22
8	449.57	228.03	0.97	818	811	333	309	145	134	167	175	235	222	28	25
9	404.85	228.03	0.78	768	792	315	319	106	101	164	166	229	236	33	32
10	409.18	228.03	0.79	777	786	341	333	109	103	163	162	240	233	39	33
11	441.18	228.03	0.93	821	828	293	335	108	105	174	171	298	282	42	36
12	443.75	228.03	0.95	837	861	332	348	111	118	178	168	303	288	38	35
13	483.49	228.03	1.12	952	912	299	331	119	122	162	155	244	230	81	75
14	479.57	228.03	1.10	959	941	304	332	121	134	170	182	240	239	78	73
15	471.88	228.03	1.07	868	888	252	289	130	149	157	161	277	275	66	59
16	470.55	228.03	1.06	868	911	271	300	133	147	160	161	271	277	67	62
Total Volume In PCU =				13717	12981	5067	4826	1889	1767	2441	2433	3920	3827	638	565
Unit of Traffic Volume = PCU/30 min								V ^L = Volume of Left Diverging Traffic							
C.I. = Congestion Index								V ^R = Volume of Right Diverging Traffic							
V = Volume of Traffic								V ^C = Volume of Crossing Traffic							
V ^M = Volume of Merging Traffic								V ^{PC} = Volume of Pedestrians crossing Traffic							

Table 3: Summary of Collected Data

Name of Road :- Kalawad Road								Date :- 22/12/2015							
Classification of Road :- Urban Arterial Road								Day of the Week :- 4th							

Kilometrage/Mileage :- 2.9 Km								Direction of Traffic :- BAPS Temple To S.G. Chowk							
Name of City :- Rajkot Gujarat								Route Number :- 01							
Location :- Kotecha Chowk															
Sr. No.	Actual Travel Time (Sec)	Free Flow Travel Time (Sec)	C.I.	V		V ^M		V ^L		V ^R		V ^C		V ^{PC}	
				UP	DN	UP	DN	UP	DN	UP	DN	Lane-1	Lane-2	Dire Ction-1	Dire Ction-2
1	424.54	228.03	0.86	978	747	112	101	183	173	266	251	98	115	11	15
2	422.65	228.03	0.85	967	814	115	105	174	158	268	255	105	118	14	18
3	418.89	228.03	0.84	869	802	158	147	237	219	346	349	114	133	17	18
4	417.56	228.03	0.83	860	641	167	145	233	224	348	355	119	139	15	19
5	434.67	228.03	0.91	781	724	151	159	220	222	289	295	150	165	14	19
6	458.12	228.03	1.01	777	722	157	142	228	224	274	277	146	168	17	22
7	444.59	228.03	0.95	817	801	191	195	241	219	418	419	144	164	18	20
8	449.57	228.03	0.97	818	811	199	192	249	244	425	428	149	169	17	21
9	404.85	228.03	0.78	768	792	151	152	166	168	507	508	157	160	15	16
10	409.18	228.03	0.79	777	786	157	168	179	189	515	524	145	167	18	18
11	441.18	228.03	0.93	821	828	148	157	258	257	637	639	174	189	15	17
12	443.75	228.03	0.95	837	861	149	160	268	284	639	665	182	199	14	19
13	483.49	228.03	1.12	952	912	199	200	261	278	812	822	200	234	20	22
14	479.57	228.03	1.10	959	941	209	207	268	277	819	827	217	239	22	24
15	471.88	228.03	1.07	868	888	147	149	251	269	690	699	132	153	18	20
16	470.55	228.03	1.06	868	911	155	167	259	268	703	711	144	168	17	21
Total Volume In PCU =				13717	12981	2565	2546	3675	3673	7956	8024	2376	2680	262	309
Unit of Traffic Volume = PCU/30 min								V ^L = Volume of Left Diverging Traffic							
C.I. = Congestion Index								V ^R = Volume of Right Diverging Traffic							
V = Volume of Traffic								V ^C = Volume of Crossing Traffic							
V ^M = Volume of Merging Traffic								V ^{PC} = Volume of Pedestrians crossing Traffic							

Table 4: Summary of Collected Data

The R² value obtained for the model was 0.765.

Other statistical parameters are presented in Table_ below:

	Coefficients	Standard Error	t Stat
Intercept	0.10995852	0.2481289	0.443151
V	0.00053268	0.0001989	2.678242
V ^L	0.00330012	0.0006263	5.269076
V ^R	-0.00049491	0.0007805	-0.63407
V ^{PC}	0.0018855	0.0007768	2.427235

Table 6: Statistical Analysis Results

IV. MODEL DEVELOPMENT

After determination of CI value a Regression model was developed between CI and other measured values. The result in Table shows the correlation between different variables and effect on Congestion Index.

	C.I.	V	V ^M	V ^L	V ^R	V ^C	V ^{PC}
C.I.	1.00						
V	0.32	1.00					
V ^M	-0.13	0.08	1.00				
V ^L	0.67	-0.27	0.08	1.00			
V ^R	0.37	-0.32	0.10	0.58	1.00		
V ^C	0.21	-0.29	-0.13	0.29	0.59	1.00	
V ^{PC}	0.71	0.30	-0.07	0.46	0.56	0.48	1.00

Table 5: Correlation Matrix

It can be observed that Merging vehicles have Negative effect on CI. Considering the correlation matrix it was found that only 4 parameters are affecting the CI more prominently.

A multiple linear regression model was developed considering CI as dependent variable and all other as independent variable. The developed equation is shown below:

$$CI = 0.1099 + 0.00053V + 0.00033 V^L - 0.0004 V^R + 0.0018 V^{PC}$$

V. CONCLUSIONS

- The congestion index was determined for the selected road section of Rajkot city. The average value is 0.94.
- The results obtained from the statistical analysis indicate that traffic volume, pedestrian crossing and volume diverting to left and right directions and pedestrian crossings are the most significant variables that affect congestion.

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