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MEASUREMENT OF TRAFFIC CONGESTION FOR INDORE

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ABSTRACT

Traffic congestion is caused due to an imbalance of transportation demand and supply. Traffic congestion is not only responsible for harming our health but also for not gaining full potential in our economic sector. Traffic congestion is an obstacle to the development of any country as it creates a huge amount of economic costs, discomfort cost, and alike. In the current scenario Indore city also prevails such a condition, some intersections of the city are badly affected by traffic congestion which causes potential hazard and delays so traffic congestion study is much needed at some potential road intersections. Several parameters like segmental delay, delay ratio, and relative delay ratio have been used to effectively measure traffic congestion at some potential sections taken for 6 locations. A model developed for segmental delay (Vehicle-second), segmental delay (person-second), delay rate, and relative delay Rate.

KEYWORDS

Segmental delay, Delay rate, Relative Ddelay rate, Traffic congestion

INTRODUCTION

Transportation contributes to the social, economic, industrial, and cultural development of any country. Every product whether it is food, medicine, clothes, industrial items, or other essential commodities needs transport facility at all stages to get supply thoroughly throughout the country, which in term helps the country to uplift its economy and development hand to hand.

But in recent years, the usage of transportation facilities has been increased drastically. Many of the cities experiencing a huge number of traffic flow which leads to a system break down in some cases, in talking about India, considerable numbers of cities facing a huge transportation management problem, as a result, the movement of vehicle, speed characteristics have been observed not up to the mark.

Due to incessant increase in population, increase in household incomes and its resultant increase in the level of car usage coupled with poor land-use planning, poor transport design and planning. In urban areas, the problem of traffic is observed in road intersections for most of the cases [5]. Road intersections consist of too many actual and potential conflict points [4]. This is because at intersections, vehicular flows from several directions approaches making either left-turn, through and right-turn movements seek to occupy the same physical space at the same time. In addition to these vehicular flows, pedestrians also seek to use this space to cross the street and thereby worsening the already bad traffic situation.

Traffic congestion is the result of the gap between transportation demand and supply [2]. It may be said that traffic jam is killing our time only but that will be wrong. Traffic congestion can be held responsible not only for harming our health but also for not gaining full potential in our economic sector [1]. The transportation system has now become the spider that is sitting in the

centre of a development web in which every web string controls almost every development process of a country. Traffic congestion is an obstacle to development of any country as it creates a huge amount of economic costs, discomfort costs, and so on [3]. Because of traffic congestion, companies that are related with the public transport system cannot achieve their targeted profit.

In the current scenario Indore city also prevails such a condition, some intersections of the city are poorly affected by traffic congestion which causes potential hazard and delays so traffic congestion study is much needed at some potential road intersections. The aim of the study is measure effective congestion at potential sections by using segmental delay, delay ratio, relative delay ratio techniques.

STUDY AREA

The National Highway-3 also known as Agra Bombay Road is one of the prime and important road networks which pass through Indore, connecting Agra and Mumbai. The study area concerns some potential sections of this road in between the city named

a. Section 1(Palasia Square to Industry House)
b. Section 2 (Industry House to LIG Square)
c. Section 3 (LIG Square to Rasoma Chouraha)
d. Section 4 (Rasoma Chouraha to MR9 Chouraha)
e. Section 5 (MR9 Chouraha to Vijayanagar Square)
f. Section 6 (Vijaynagar Square to Satya Sai)

The AB road consists of two way with 6 meters of road width at Palasia square and Industry House sections. LIG square, Rasoma Chouraha, and MR9 sections have a lane width of 7 meters. Vijaynagar section consists of 7.5 meters of lane width. The city transport authority also established a BRTS system in between the road section at the central position as public transport facilitation. The studied section has a capacity of approx. 4000 PCU/hr.

The study area consists of total 3.5 km stretch starting from Palasia square to Vijaynagar square.

DATA COLLECTION

Traffic Flow

The method of obtaining traffic flow data in this study was using standard video recording procedure. This is however essentially a manual method. Traffic flow was analyzed from a video recording of the studied sites themselves. This includes the entire count of the vehicle over the recorded time at peak hours. The classification of vehicles, their quantity and direction were also observed from the recordings at laboratory.

Speed

Speed could be recorded in three distinct ways
a. Space mean speed
b. Time means speed
c. Spot speed

The short base speed that is the speed at a particular section (spot speed) can be used but the proper instrument has to be used. While taking the speed of the vehicle every time it was ensured that it should be free from the influence of traffic signalling or any other factors such as

inclined terrain, junction effect, etc. In this study time mean speed or the average speed has been taken into consideration as it can be obtained by two observers, one in starting position and another at the end position of the stretch, besides this can also be cross-checked in the laboratory from the video recordings. Over all this method of obtaining the speed of any vehicles is easy to apply, economical and collected data can be subjected to statistical procedures.

Travel Time

Travel time data is very crucial to calculate traffic congestion, time taken to travel a particularly known length of section is measured for every types of vehicle. The data includes travel time during free-flow condition and peak hour flow at congestion like situations. This is totally a manual and field observation method but video recordings also can be useful in some cases.

Geometric Characteristics

Geometric measurements were obtained in the field by the means of simple tape measurement. The degree of accuracy was nearest to 10 cm. The data were recorded in the rough notebook.

DATA REDUCTION PROCESS

Video recording was carried out continuously over the predefined period of the time at peak hours at every section. To produce the variables much needed for the analysis, in the next step the raw data have been retrieved. Raw data that were collected and recorded in the field included traffic flow, vehicle types, passage time of the vehicles, and occupancy per vehicle over the measurement lines. The video recorded data were retrieved in the laboratory and transcribed in the computer files. There after further processing of the data has been carried out using a standard spread sheet, statistical software packages and some computer macros. The first and foremost task was to convert the passage time into travel time and eventually measure the speed of each category of the vehicle, the time data included normal passage time and passage time during congestion like situation. Obviously, the speed that came up from the data should include free-flow speed and congested speed of the different categories of the vehicles, using the particular studied section. Thereafter, the speed data were inspected for each site if there were any outliers or other unusual values.

When retrieving data from the video clips, few incidences that were suspected to be true value have been noticed and neglected. The vehicles that were moving slowly due to some influence were treated as valid for sampling and some fast-moving vehicles that stopped due to some personal reason or unnecessarily has been taken as invalid, besides these few incidences like slowing down of vehicle due to running out of fuel or some mechanical problem encountered, also taken as an invalid and neglected simultaneously.

Generally, results required from the data reduction process for the studied sites were as follows:

a. 16 hrs. data to obtain the peak periods of traffic flow and identify the congestion timing.
b. Traffic flow and composition for a period of 15 minutes, for each site and each direction.
c. Space mean speed, over 5 minutes' period for each and every class of vehicles at each site and each direction.
d. Free-flow speed and congested speed based upon time calculation over a known length of stretch of 20 meters.

RESULTS AND DISCUSSION

The process to estimate the traffic congestion, measurement of traffic flow in the section should be carried out accurately. The travel time analysis also plays a crucial role in this case. The proper analysis of traffic and design of the road should thoroughly study to make an effective conclusion which may further used for future design and implementation. Before proceeding to the analysis part there need to be discussed some conceptual definitions and theory related topics.

Flow Measurement

Traffic composition of different vehicles has been determined and their proportion has been calculated as mentioned earlier. As per IRC:106-1990[6], PCU conversion is done by using proper factors to get an equivalent flow estimation. A proper example of PCU conversion is shown in Table 1 for an individual section.

Tab. 1- Traffic Flow for all Sections at Peak Hour

Locations	Flow (PCU/hr.) towards Dewasnaka	Flow (PCU/hr.) towards Bhawarkuan
Section 1	3472	3225
Section 2	2837	2747
Section 3	4142	3605
Section 4	3035	3207
Section 5	3248	3305
Section 6	3738	4004

Segmental Delay

Segmental delay is the measurement of overall time consumption due to the bad condition of traffic flow. Congestion increases the time consumption of traveling for a particular distance than the usual traffic condition which causes delay. In the delay analysis the excess time lost per vehicle and per person has been quantified at each section in terms of Vehicles-second and person-second. A relative comparison has been made to identify which section is most affected by congestion and which one has less effect of congestion. Speed comparison at various sections is shown in Figure 1 and Figure 2.

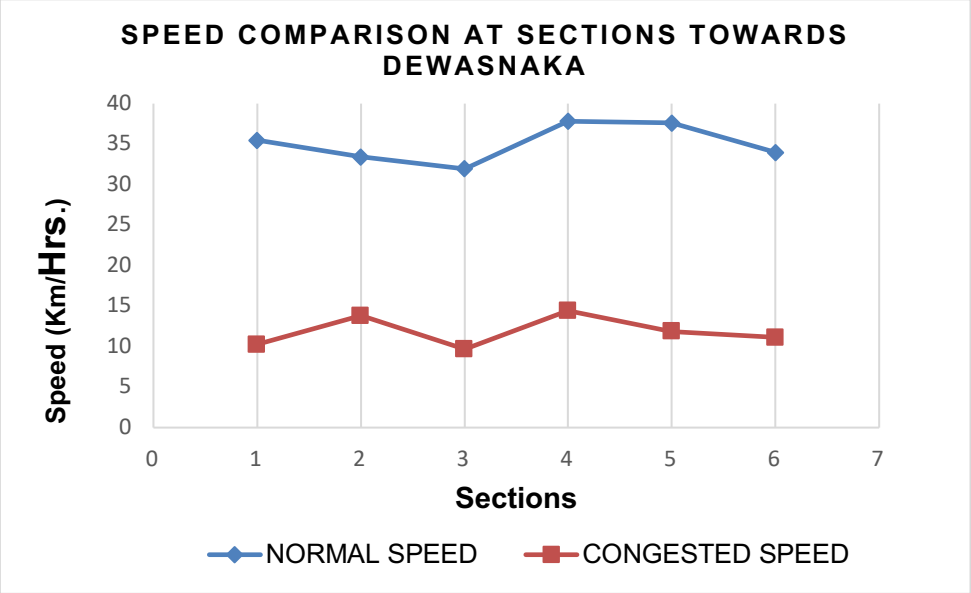

Fig. 1- Speed comparison at sections towards Dewasnaka

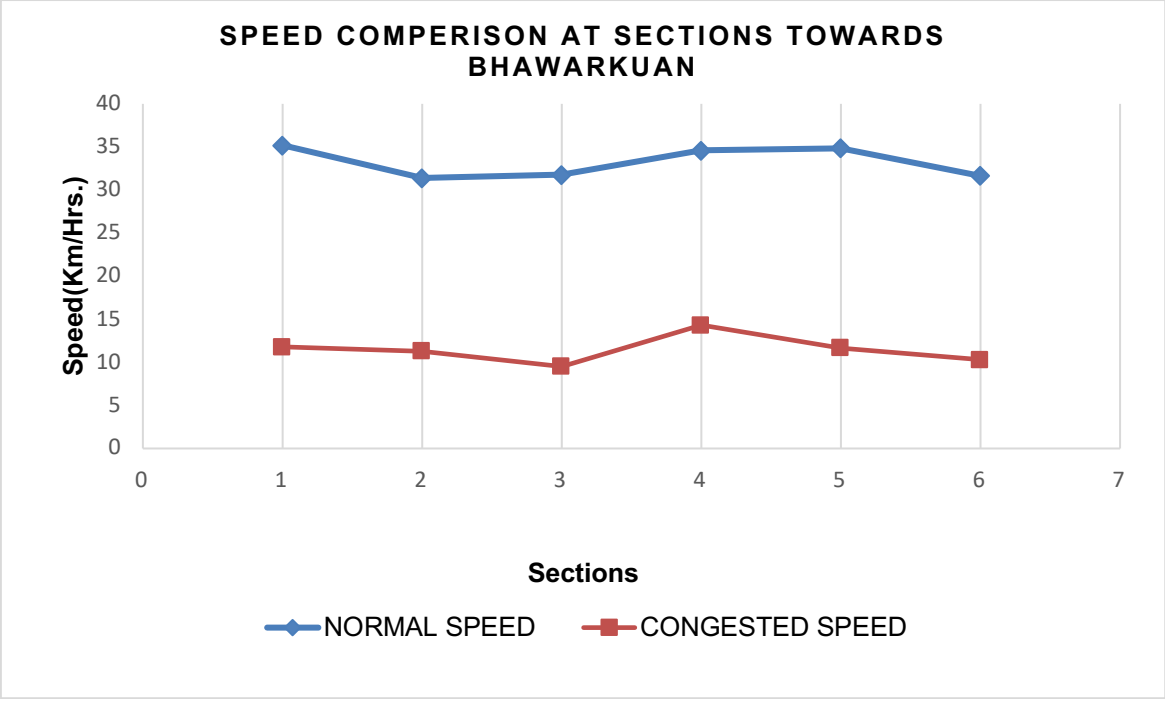

Fig. 2- Speed comparison at sections towards Bhawarkuan

Multiple regression analysis has been carried out for Segmental delay (Vehicle-second) and Segmental delay (person-second), as shown in Table 2.

Tab. 2- Model for Segmental delay (Vehicle-second) and Segmental delay (person-second)

S.N.	Model	R^2	RMSE
1.	$D = -19176.4 + 3738.815 * T_C - 2922.22 * T_a + 4.699241 * V_P$	99%	1.1027E-11
2.	$D' = -69855 + 7414.247 * T_C - 6022.11 * T_A + 9.31578 * V_P + 16330.11 * V_{OC}$	99%	2.31043E-11

Where,
$\boldsymbol{D}$ = Segmental delay (Vehicle-second), $\boldsymbol{D'}$ = Segmental delay (person-second),

$\boldsymbol{T_a}$ =Acceptable travel time over a defined section (second), $\boldsymbol{T_C}$ = Congested travel time over a defined section (second), $\boldsymbol{V_P}$ = Vehicle volume in peak period (PCU/hr.), $\boldsymbol{V_{OC}}$ = Vehicle occupancy (persons/ vehicle), **R^2**= Coefficient of correlation, **RMSE**=Root Mean Square Error

Delay Rate

Delay rate is the difference between the rate of travel of congestion situation and normal situation. The rate of travel can be measured as the time required to travel a particular segment length. It is the inverse of the velocity at any section, measured as Sec per meter. Relative delay rate can be explained as the ratio of delay rate to acceptable (normal) travel rate. A regression model has been developed for delay rate and relative delay rate, as shown in Table 3.

Tab. 3- Model for delay rate and relative delay rate

S.N.	Model	R^2	RMSE
1.	$D_R = -0.02631 + 0.948524 * T_{R_c} - 0.63062 * T_{R_a}$	99%	2.80432E-16
2.	$R_{D_R} = -0.03035 + 1.029935 * (\frac{D_R}{T_{R_a}})$	98%	5.1279E-16

Where,

$\boldsymbol{D_R}$= Delay rate, $\boldsymbol{R_{D_R}}$= Relative Delay Rate, $\boldsymbol{T_{R_c}}$= Travel Rate at congestion (sec / meter), $\boldsymbol{T_{R_a}}$= Acceptable Travel Rate (sec / meter), **R^2**= Coefficient of correlation, **RMSE**=Root Mean Square Error

CONCLUSIONS

I. Section 3 and Section 6 accommodates the highest number of traffic flow among all the sections. However, in section 3(LIG square) lowest speed has been observed during congestion.

II. Section 1 has less a flow of traffic than section 6 but stillsection1 has a higher segmental delay. This variation was observed due to the high value of merging traffic to straight moving traffic ratio, due to the rotary effect at Vijayanagar streaming of traffic is quite good.

III. Segmental delay is maximum at section 3, traffic flowing towards Dewasnaka and for traffic towards Bhawarkuan, the segmental delay is maximum at section 6. But the relative delay rate is maximum in section 1, traffic flowing towards Dewasnaka.

IV. Section 3 experience worst traffic congestion at the Level of Service of E and V/C ratio tends to unity. However, Section 1 and section 4 also have a bad flow condition and LOS obtained there is E. Section 6, section 2 and section 5 has favourable flow condition.

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