Study on Congestion of National Highways due to Traffic Volume

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Abstract — *Traffic congestion continues to remain a major problem in most cities around the world, especially in development regions resulting in massive delays, increased fuel wastage and monetary losses. Due to the poorly planned road networks a common outcome in many developing regions in the presence of small critical areas which are common hot-spots for congestion. Poor traffic management around these hot-spots potentially results in traffic congestions which ultimately causes elongated traffic jams. Traffic congestion creates negative impact on society and it becomes a necessity to control it. In the recent past, traffic congestion has emerged as one of the main challenge for engineers, planners and policy makers in urban areas. The present study carried out to evaluate traffic congestion on NH-444A from Ambala Cantt and Saha which is a stretch of 15.00 km. Ambala Cantt and Saha have very important because of large industrial areas. Saha has a National Food Park in which lot of companies situated in this industrial area. Factories, markets, shopping malls, hospitals and residential areas are existing on this stretch. The traffic volume on this stretch is high. The stretch remains quite busy due to continuous traffic movement leading to traffic congestion. The main aim of this study is to evaluate traffic congestion on NH-444A.*

Keywords — *Traffic congestion, National Highway, Food park.*

I. INTRODUCTION

Cities and traffic have developed hand-in-hand since the earliest large human settlements. Rapid industrialization and the consequent urbanization is taking place since last few decades in all over the world, India is no exception. Transport demand in most Indian cities has increased substantially due to increase in population as a result of both natural and migration from rural areas and small towns. Availability of motorized transport has also increased. But the demand and the construction of new highway capacity to accommodate this growth has not kept pace leading to congestion. There is no single, broadly accepted definition of traffic congestion. One of the principal reasons for this lack of consensus is that congestion is both:

i. A physical phenomenon relating to the manner in which vehicles impede each other's progression as demand for limited road space approaches full capacity.
ii. A relative phenomenon relating to user expectations *vis-à-vis* road system performance.

Both operational and user perspectives are important in understanding congestion and its impacts. Traffic congestion is a condition on transport networks that occurs as use increases and is characterized by slower speeds, longer trip times and increased vehicular queuing. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream this results in some congestion. Congestion is a possibility for any mode of transportation. As demand approaches the capacity of a road or of the intersection along the road, extreme traffic congestion sets in. When vehicles are fully stopped for periods of time, this is colloquially known as traffic jam or traffic snarl-up.

Most of us at some point in our lives have had the misfortune of experiencing the effect of a congested roadway. For a majority of commuters, traffic congestion has become something that they endure on a regular basis during their morning and evening commutes. However, aside from the frustration and aggravation of creeping through slow moving traffic, congested roadways exert both private costs in wasted time and fuel and social costs in the from increased travel times for all commuters as well as the release of pollutants and greenhouse gas emissions into the air.

Traffic in developing countries like India, is however very different in its form and characteristics. Two-wheeler motorbikes, three-wheeler auto-rickshaws, four-wheeler cars and heavy vehicles likes buses and trucks ply together on the same road intermingled with each other without any lane discipline. Such non-lane based disorderly traffic with high heterogeneity of vehicles cause traffic congestion.

Traffic congestion may be of two types:

1. Recurrent Congestion: This congestion generally occurs at the same place, at the same time every weekday or weekend day. This is generally the consequence of factors that act regularly or periodically on the transportation system such as daily commuting or weekend trips. Recurrent congestion is predictable and typically occurs during peak hours. It displays a large degree of randomness in terms of duration and severity.
2. Non-Recurrent Congestion: This congestion is the effect of unexpected, unplanned large

events like road works, accidents, special events and so on that effect transportation system more or less randomly. This type of congestion cannot be predicted easily.

Traffic Congestion Causes:

i. Too many cars for roadway due to inadequate mass transport system.
ii. Obstacles in the road causing a blockage like double parking, road work, an accident etc.
iii. Malfunctioned traffic signals.
iv. Too many pedestrian crossings not permitting cars to turn.
v. Overdevelopment in areas where the mass transport system is already overcrowded.
vi. Inadequate road system.

Traffic Congestion Effects:

i. Loss of valuable time due to unexpected traffic.
ii. Increase in travel time.
iii. More consumption of fuel thereby causing fuel loss.
iv. One of the most harmful effects of traffic congestion is its impact on environment.
v. Drivers who become impatient may be more likely to drive aggressively and dangerously causing accidents.
vi. Negative impact on people's psychological state, which may affect productivity at work and personal relationships.
vii. Increase in vehicle maintenance cost due to wear and tear on mechanical components of vehicle.
viii. Decrease in road surface lifetime.

II. LITERATURE REVIEW

Knowing congestion is a necessary step in order to deliver better congestion outcomes. The purpose of this literature review is to understand what researchers know about traffic congestion and some of the researches done in this aspect are given below:

Lighthill and Whitham (1955) introduced the continuum model LWR model based on fluid dynamics, which builds the continuous function between traffic density and speed to capture the characteristics such as traffic congestion formation.

Dewees (1978) used a simulation program to estimate the external time costs that an additional vehicle using a congested city street imposes on other motorists on that street. This study demonstrated the usefulness of a traffic simulation program for estimating congestion costs.

Meyer and Gomez-Ibanez (1981) stated that the travel demand for public transport is highly concentrated on morning and evening peak hours.

Lindley (1987) developed the congestion severity index (CSI) originally to measure freeway congestion in terms of total delay (vehicle-hours) per million vehicle miles of travel (VMT).

Amedeo R. Odoni., (1987) a system of flow management is one of the most promising short-term approaches to alleviating the severe network-wide congestion problems that air traffic in the United States and in Europe is currently experiencing. To design such a system one must address the flow management problem (FMP), a description and discussion of which is the subject of this paper. Even simplified versions of the FMP, such as the "generic FMP" which is based on a "macroscopic" model, are very challenging.

Deakin, and Elizabeth., (1994) had studied a brief review of the literature on transportation and urban form, focusing primarily on the effects of changes in accessibility on land use and location. The many options available to travelers for responding to congestion prices are discussed next, some of which may considerably dampen or offset the potential for congestion prices to reshape urban form. Finally, the results are presented of interviews with a small sample of businesses and local government officials in which likely responses to congestion pricing were explored.

R. H. M Emmarink, P. Nijkamp, and P. Riet Veld., (1995) arguments used in the literature pro and contra congestion pricing are analysed. Although it is a first-best instrument in theory, it is argued that the assumptions needed to arrive at this conclusion oversimplify reality. In practice, congestion pricing is a second-best instrument with some advantages over other second-best instruments, but it will also give rise to numerous problems, as discussed in the paper. These problems will be illustrated with the Dutch attempts to implement an electronic road-pricing system.

Lindsey, C. Robin Verhoef, and Erik T., (1999) discussed the principles of static and dynamic equilibrium on a road network in a deterministic environment, and then identifies equilibrium concepts that account for stochastic city in demand and capacity. Finally, conceptual and practical issues regarding congestion pricing and investment on a network will be addressed.

Cervero R. (2001) explained that the relative ineffectiveness of reducing traffic congestion through roadway expansion is a consequence of induced demand. According to Cervero, expanding roadway capacity in a congested corridor decreases travel times and increases travel speeds along that roadway during peak periods. However, these travel time and speed improvements attract more drivers to the corridor as the cost to the driver for entering the expanded roadway during peak periods declines.

STUDY AREA

The road stretch of 15.00 km between Ambala Cantt to Saha located on NH-444a has been selected for evaluating traffic congestion and its remedial measures. This national highway is very important due to its connectivity to national highway 344 which is connected way for Uttar Pradesh. Factories, markets, shopping malls, hospitals, educational institutes, schools and residential areas exists on this stretch. The traffic volume on this stretch is high. Due to the high volume of traffic this stretch remains quite busy leading to congestion. It becomes necessary to evaluate traffic congestion on this stretch. Based on the evaluation of traffic congestion necessary remedial measures shall be implemented in order to remove or reduce the traffic congestion.

METHODOLOGY

The data is collected by video graphy method. In this method a mobile phone with high resolution camera Mi Note5 Pro is used. This mobile has a dual camera setup having 12-megapixel (f/2.2, 1.25-micron) + 5-megapixel (f/2.0, 1.12-micron) resolution and it is capable to record full HD 1080p video on 30 frames per second. The mobile phone is placed on a tripod stand in order to keep it in stable position while recording video.

With the help of high resolution camera, data is collected for at least 30 minutes interval at each station during peak hour. A section of 10 meters length is selected by placing markers on both sides of the road for each location. Then the camera is placed at the centre of the section so that the entire station was covered. Since it is a 4 lane divided highway, the data is collected separately for upstream and downstream vehicular moments for each selected locations. The data collected by video camera was then decoded in the computer by playing the video with the help of video player.

STATION WISE DATA ANALYSIS

Data is collected from three stations S1, S2 and S3 which are mentioned in previous chapter in details. Station wise data analysis is discussed below:

STATION 1

On the basis of traffic data collected at location A1 and A2 of Station 1 Traffic Flow (q), Traffic Density (k) and Speed (u) is calculated and represented in tabular form below:

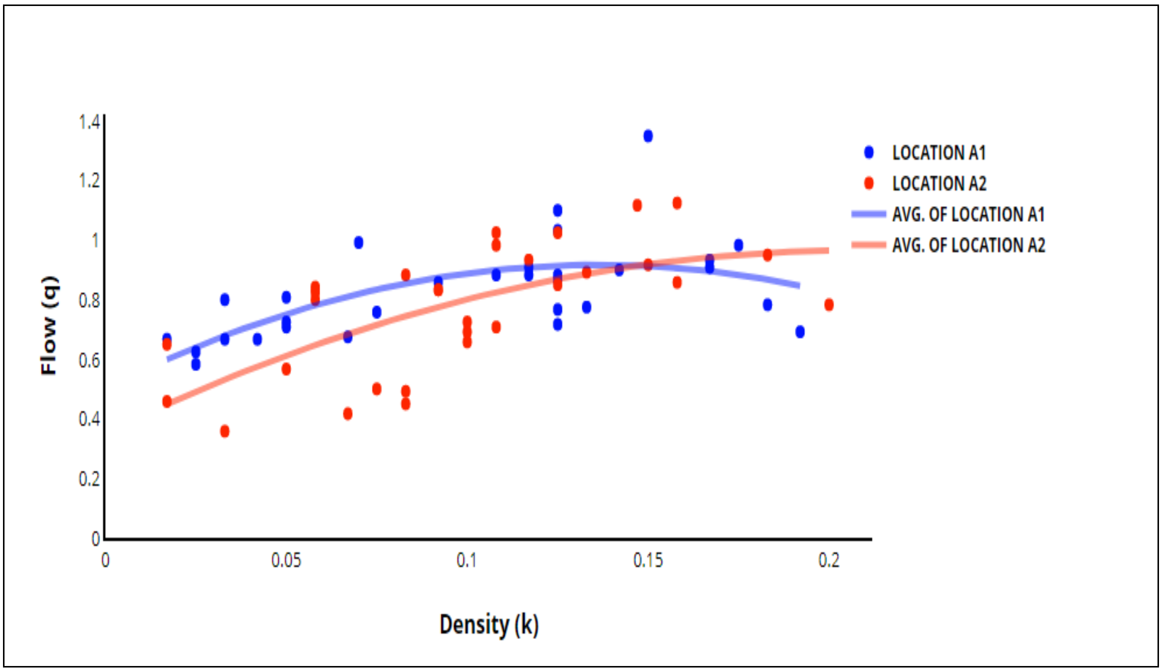

Fig. 1 Flow (q) vs. density (k) curve

Here Fig. 4.1 is showing flow versus density graph for the data collected at location A1 and location A2 of Station 1. In this graph the curvature shape of the curve in each case reflects that initially the flow increases with increase in density up to a certain limit and there after the flow decreases with further increase in density.

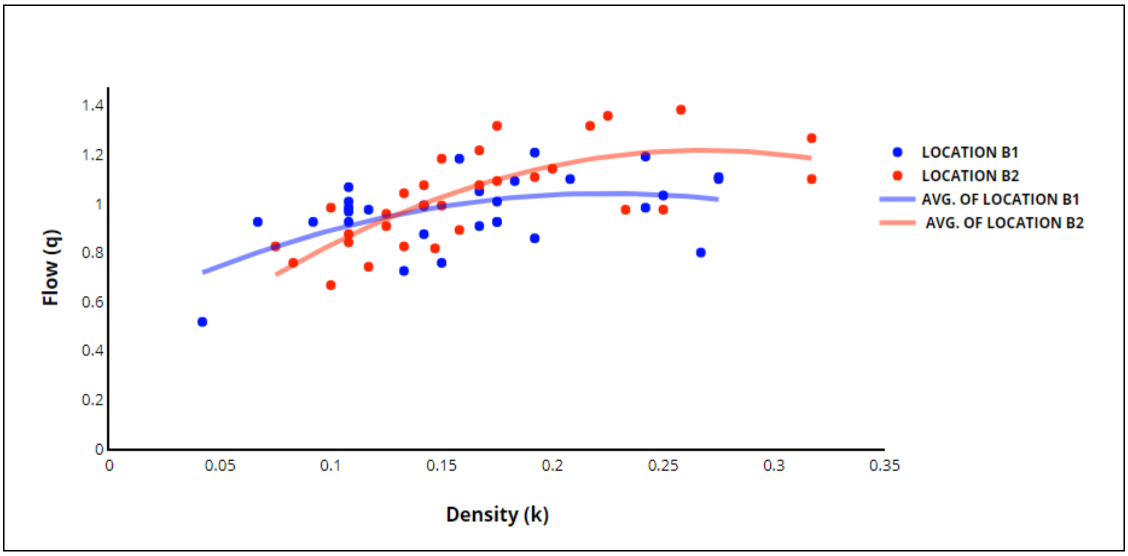

Fig. 2 Flow (q) vs. density (k) curve

Fig showing flow versus density graph for the data collected at location B1 and location B2 of Station 2. In this graph the curvature shape of the curve in each case reflects that initially the flow increases with increase in density up to a certain limit and there after the flow decreases with further increase in density.

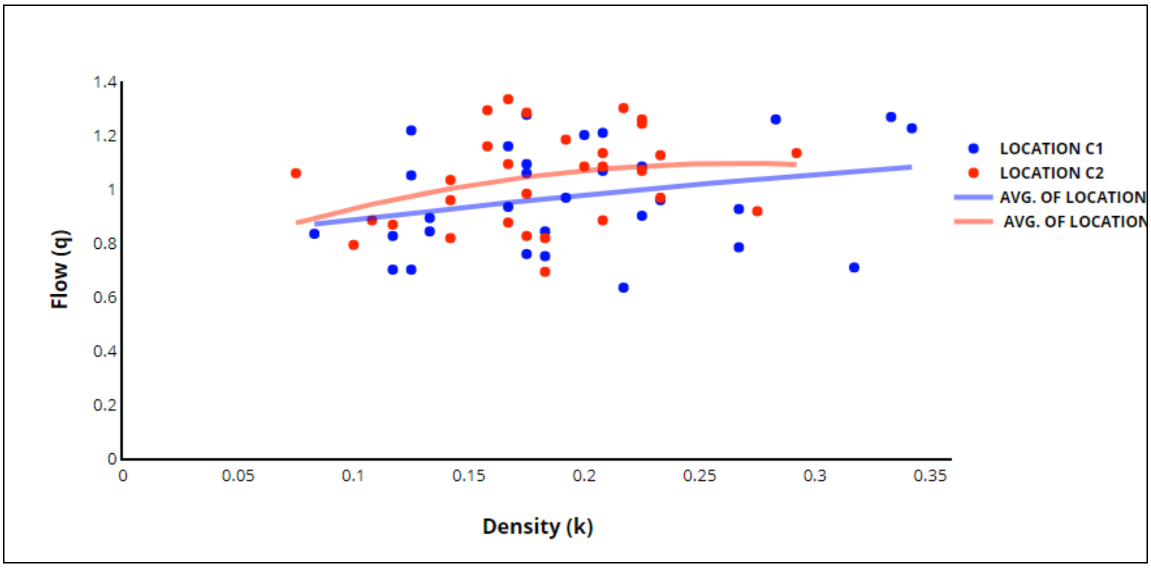

Fig. 3 Flow (q) vs. density (k) curve

Here Fig. is showing flow versus density graph for the data collected at location C1 and location C2 of Station 3. In this graph the curvature shape of the location C1 curve is linear i.e. flow increases with increase in density and the curvature shape of location C2 curve reflects that initially the flow increases with increase in density up to a certain limit and there after the flow decreases with further increase in density.

CAPACITY OF ROAD SECTION

From the above collected data, capacity of the road section is given below:

i. Capacity for location A1 and A2 at Station1 is 1.350 PCU/ second and 1.125 PCU/ second respectively.

ii. Capacity for location B1 and B2 at Station 2 is 1.208 PCU/ second and 1.383 PCU/ second respectively.

iii. Capacity for location C1 and C2 at Station 3 is 1.275 PCU/ second and 1.333 PCU/ second respectively.

Table 1 Total traffic volume data of Station 1

	No. of Cars	No. of Buses and Trucks	No. of Two Wheelers	No. of Auto Rickshaws	No. of NMVs	Total PCU /30 minutes	Total PCU / minute
A1	735	163	358	73	9	1494	54.55
A2	659	167	312	55	9	1389	50.58
Total	1394	330	670	128	18	2883	105.13

Table 2 Total traffic volume data of Station 2

	No. of Cars	No. of Buses and Trucks	No. of Two Wheelers	No. of Auto Rickshaws	No. of NMVs	Total PCU /30 minutes	Total PCU / minute
B1	919	151	471	83	22	1734.5	57.82
B2	995	161	438	118	13	1841	61.37
Total	1914	312	909	201	35	3575.5	119.19

Table 3 Total traffic volume data of Station 3

	No. of Cars	No. of Buses and Trucks	No. of Two Wheelers	No. of Auto Rickshaws	No. of NMVs	Total PCU /30 minutes	Total PCU / minute
C1	899	146	497	117	22	1746.5	58.22
C2	991	140	497	150	19	1847.5	61.58
Total	1890	286	994	267	41	3954	119.8

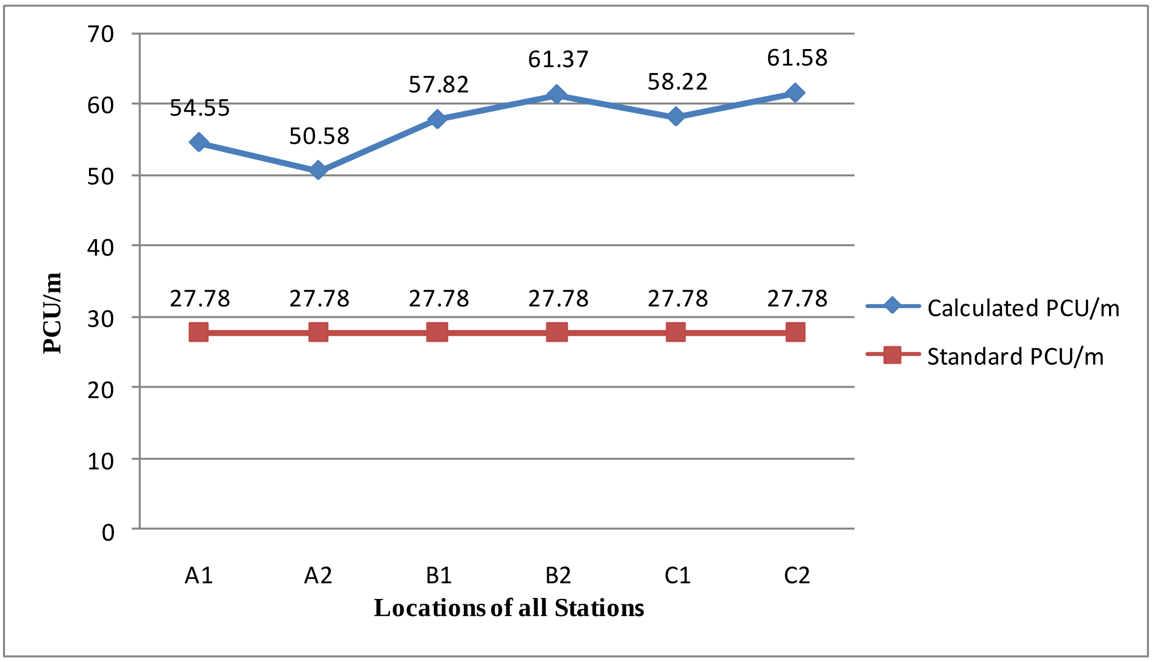

Fig. 4 Comparison of total traffic volume data collected of all stations with standard traffic volume

Fig.4.4 represents that the existing traffic volume on selected stretch of 4-lane divided highway is quite high when compared with the traffic volume for 4-lane divided highway as per IRC standards. So this stretch is causing traffic congestion and it needs immediate action in order to reduce it.

CONCLUSIONS

The following conclusions are made in this study:

- From the graphical representations it is clear that the traffic volume at all stations is exceeding the Indian Road Congress standard traffic volume for four lane undivided National Highways as per Indian Road Congress.
- The usable/specified road width is reduced due to parking of vehicles inside the both edges of roads.
- Traffic congestions can be reduced by providing separate lanes for vehicles such as trucks/buses, two wheelers/cars etc as per their. With sizes different speeds. Also at all necessary locations on Highways sufficient sign boards and traffic sign signals be provided for the traffic flow.

FUTURE SCOPE

Following is the future scope of this work:

- For study on traffic congestions, geometric design of the highways may also be taken up.
- Traffic volume data collection can be worked out by some other methods such as manual, aerial or GPS oriented methods.

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