International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 5 Issue 6, June-2016

Traffic Performance Evaluation of NH-1

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ABSTRACT

The country has witnessed tremendous increase in the Traffic Performance Evaluation of NH-1. The type of deterioration present in the pavement should be considered for determining whether it has a functional or structural deficiency, so that appropriate overlay type and design can be developed. Structural failure arises from the conditions that adversely affect the load carrying capability of the pavement structure. Inadequate thickness, cracking, distortion and disintegration cause structural deficiency. Functional deficiency arises when the pavement does not provide a smooth riding surface and comfort to the user. This can be due to poor surface friction and texture, hydro planning and splash from wheel path, rutting and excess surface distortion such as potholes, corrugation, faulting, blow up, settlement, heaves etc. Functional condition determines the level of service provided by the facility to its users at a particular time and also the Vehicle Operating Costs (VOC), thus influencing the national economy. Prediction of the pavement deterioration is helpful to assess the remaining effective service life (RSL) of the pavement structure on the basis of reduction in performance levels, and apply various alternative designs and rehabilitation strategies with a long range funding requirement for pavement preservation. In addition, they can predict the impact of treatment on the condition of the sections. The infrastructure prediction models can thus be classified into four groups, namely primary response models, structural performance models, functional performance models and damage models.

1. INTRODUCTION

Efficient transportation is very important for the rapid economic growth of a country and road transport is the only mode that is complete itself. Since independence. Vehicle population in the country has increased from 3 lacs to 750 lacs (250 times) whereas length of roads has hardly risen from 4 lacs to 33 lacs (8 times). Number of vehicles has been growing at an average rate of about 10.2% per annum over the last five years. Roads in the country carry about 65% of the freight and 80% of passenger traffic. As the road development has not matched the transport demand, the country is faced with the problem of severe traffic congestion resulting into large number of accidents, delays and frustrations on the roads. About 90,000 persons are killed and 4.5 lacs are injured every year in the country in road accidents.

The road network of India is one of the largest in the world. It consists of about 200 km of Expressways, 66,590 km of National Highways, 1,31,899 km of State Highways, 4,67,763 km of Major District Roads and 26,50,000 km of Rural & Other Roads. The National Highways constitute about 2% of total road length whereas they carry as high as 40% of the total road traffic. About 32% of NHs have single / intermediate lane 56% of the NHs have double lane and only 12% have four or more lanes. This shows that the NHs which are the most important carrier of traffic in the country, are in urgent need of improvement and up gradation along with their expansion to meet the traffic demand of these roads. The present study is taken up with a view to know the traffic demand of these roads. The present study is taken up with a view to know the traffic performance on the premier National Highway in the country, i.e.,NH-1.

Dissertation Problem and Its Sighificance

The study entitled ‘Traffic Performance Evaluation of NH – 1’ aims at collecting and analyzing the speed – flow data of NH -1 the road connecting Delhi – Kurukshetra – Ambala – Amritsar, with a view to evaluate performance of traffic on the road. The study envisages finding the daily and hourly variation of traffic, composition of traffic, composite PCU value, growth rate of traffic and capacity and level of service of the identified 4 – lane and 6 – lane sections of the road.

Daily and hourly variation of traffic helps in deciding the road facilities and regulations needed during peak traffic period. Composition of traffic is useful in structural design of pavement, in geometric design and in computing roadway capacity. Composite PCU value helps in converting traffic volume in vehicles to PCUs in a simplified manner. The growth rate and

trend chart showing volume trends over a period of years are useful for planning future expansion, design and regulations. The significance of Capacity and Level of Service is that they help in describing the operational conditions within a traffic stream and enable for planning road improvements including future road widening decisions.

Speed – flow analysis of traffic helps in evaluating traffic performance of a road. The traffic flow plying on a road network and its analysis is important for understanding the efficiency at which the system works. The evaluation of Capacity and Level of Service of a road helps to know the extent of congestion on the road. Knowing the traffic – flow characteristics and the Level of Service, one can easily determine whether a particular section of the road is handling traffic much above or below its design capacity. Traffic – flow analysis and Level of Service evaluation is, therefore, an indicator of the need to improve the transport facilities and is an invaluable tool in the hands of transport planners.

From the traffic flow data of the past number of year, the rate at which traffic flow has increased in the past can be easily determined. Extrapolating the past trend into the future, a reasonable indication of the future traffic is made possible.

The practice of expressing capacity of rural highways in terms of daily traffic (PCU/day) by IRC does not give a true picture of the state of congestion prevailing on the road on various hours of the day. This is possible that the daily traffic volume might very well exceed the daily design service volume of the road while the peak hour traffic on the road be still less than the hourly design service volume of the road. Therefore, hourly traffic volume should be given due consideration while evaluating level of service of the road.

The increasing traffic intensity, high tire pressure, increasing axle loads etc are causing early signs of distress to bituminous pavements throughout the world. The deterioration of the paved roads in tropical and subtropical countries differ from those in the more temperate regions of the world. This can be due to the harsh climatic conditions and sometimes due to the lack of good pavement materials and construction practices. Pavement performance can be defined as the ability of the road to meet the demands of traffic and environment during its design life. The reduction in the performance level of the pavement with time is termed as deterioration. Flexible pavements deteriorate due to many factors, predominantly traffic, climate, material, construction quality and time.

These multiple parameters make the process very complex. The condition of the road at any time can be predicted approximately using performance models. For managing the transport infrastructure system, prediction and modelling of their performance are the main inputs as well as major challenges. The predicted deterioration play major roles at both network level and project level. The overall facilities can be planned for justifying the budget and resources with help of deterioration models. The planning and scheduling of the maintenance work for individual project is dependent on the time at which the section becomes deficient in service. This can be predicted through accurate deterioration models. Development of appropriate transportation policy and evaluation of the economic impacts also depend on the performance and interplay between the infrastructure facility and its user (traffic). One such example is the imposition of axle load limits, which is responsible for the damage of the pavement at exponential rates.

SCOPE OF THE STUDY

Under the study, the speed – flow data are collected for NH – 1 on selected 4 – lane and 6 – lane sections between Delhi and Ambala. The data thus collected are analysed to know the capacity of the road sections, and their present and future level of service. The selected 4 – lane and 6 – lane sections of the road represent straight and leveled mid – block sections of a non – urban road located in a plain terrain with good pavement and shoulder conditions. The present study though has been analysed for the selected sections of the road, the results may be generalized and used for other such roads having similar roadway and traffic conditions.

METHODOLOGY

The objective of the present research is to evaluate the traffic performance of NH -1. With this objective in view, the speed – flow data were collected on identified 4 – lane and 6 – lane sections of NH – 1. A flow chart of methodology of the study draw up to achieve the objective is presented in Fig. 1.

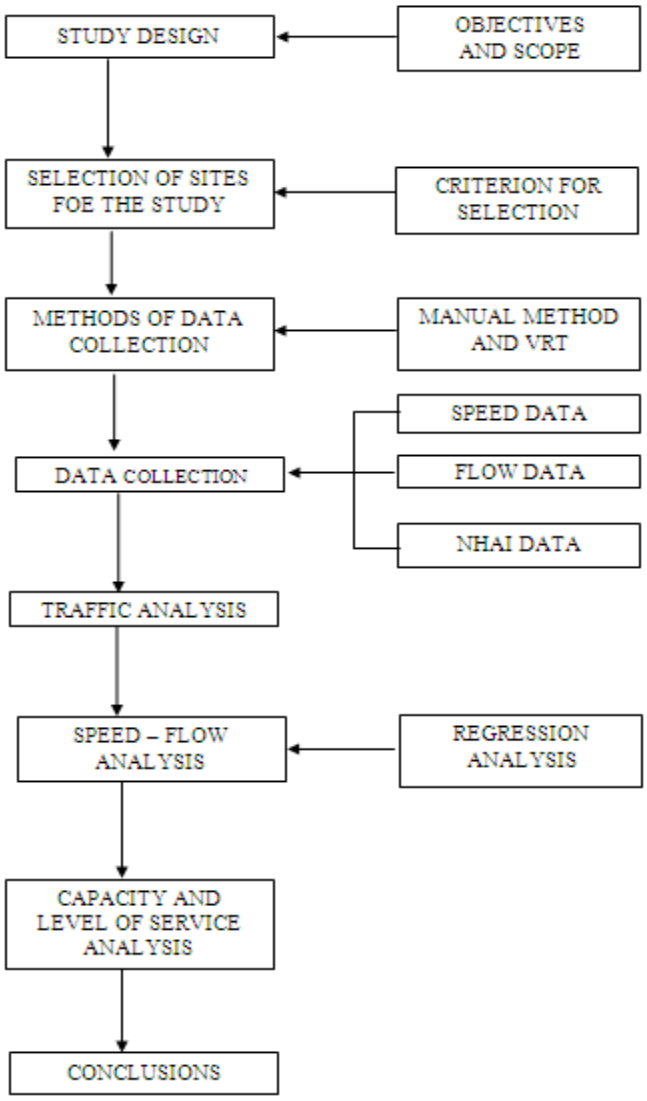

Fig. 1: Methodology of the Study

SITE SELECTION CRITERIA

The speed – flow data for the present study were collected on two identified sections of NH – 1, one consisting of 4 – lane and the other 6 – lanes. The study sites were selected to meet the requirements of the objectives of the study. The following criteria were following while selecting the sites for the study.

- The sections of road selected for the study constituted four – lane and six lanes.
- The site for the study should be straight, leveled stretch of the road within the mid - block sections, away from the influence of road intersections and the city traffic.
- The road pavement was in good condition.
- The site was not having any hindrance to the sight distance.
- The study site presented uniform features in respect of pavement condition, shoulder condition and road alignment for sufficient distance on its both sides along length of the road.
- The site of study provided proper working space for the positioning of the study teams and for proper placement of the video camera.
- The study site was so selected that the placement of the equipment / team should not attract undue attention of the drivers to affect their speeds.
- Due consideration was given to the convenience of the road users and safely of the study team and equipment while selecting the site for the study.

Collection of Speed – Flow Data

Volume is the actual number of vehicles observed or predicted to be passing a point during a given time interval. The rate of flow represents the number of vehicles passing a point during a time interval less than 1 hour, but expressed as an equivalent hourly rate. Time intervals ranging from about 2 minute up to one hour are used to measure capacities of facilities and to determine daily peaking patterns (James, 1998). For the purpose of highway capacity analysis, time interval is taken to be around 5 minute (Papacostas, 1990). In Road User Cost Study (CRRI,1982), a 5 – minute traffic count was used to derive speed – flow relationships. Kadiyali et al (1991) also used a 5 – minute count to evolve speed – flow relationships and determine capacity of roads. Time intervals in this range are used because they reduce random variation without unduly obscuring repetitive peaking patterns.

In the present study, a tow – minute time interval was taken to determine the equivalent hourly traffic flow rate. Accordingly, the speed – volume data were collected in terms of 2 – minute interval. In manual data collection, the number and type of vehicles with their direction of movement and their respective speeds were noted down in each 2 – minute interval during the total duration of the study. In the VRT, the data extraction was done in such a manner so as to get the speed and volume data in each two – minute interval for the total duration of the study. Two – minute traffic count is converted to the equivalent hourly flow rate by multiplying the number of vehicles with 30. The data extracted from the VRT study is used in the project. The manual method data has been used only for verification of the VRT data.

TRAFFIC ANALYSIS

Traffic analysis in terms of its daily and hourly variation and its composition helps the designer to adopt the appropriate values of traffic for the design of geometrics and pavement for the road. It also aids in planning various facilities for different type of vehicles on the road. Regulatory measures for controlling traffic are based upon peak hour traffic conditions on the road. Composite PCU value is used for converting total traffic into passenger car units in a simplified manner without using equivalence factors for individual vehicles. Growth rate of traffic in needed to project the present traffic to the design year. Peak hour factor relates the daily traffic to the maximum hourly traffic. All these parameters of traffic have been analysed in the following paragraphs.

Hourly and Daily Variation of Traffic

To view the variation of traffic according to days of the week, a plot is obtained showing the daily variation of traffic. The 7 – day 24 – hour traffic – volume data for the period May 2004 to Nov. 2006 has been obtained from NHAI, Ambala. The 7 – day 24 – hour count for the traffic in Nov. 2005 has been given in. The data as extracted from these tables for plotting the daily and hourly variation of traffic is given in Fig. 2. The hourly variation of traffic has been plotted both for the day of the maximum traffic in terms of vehicles (Thursday) and for the average hourly traffic for whole of the week.

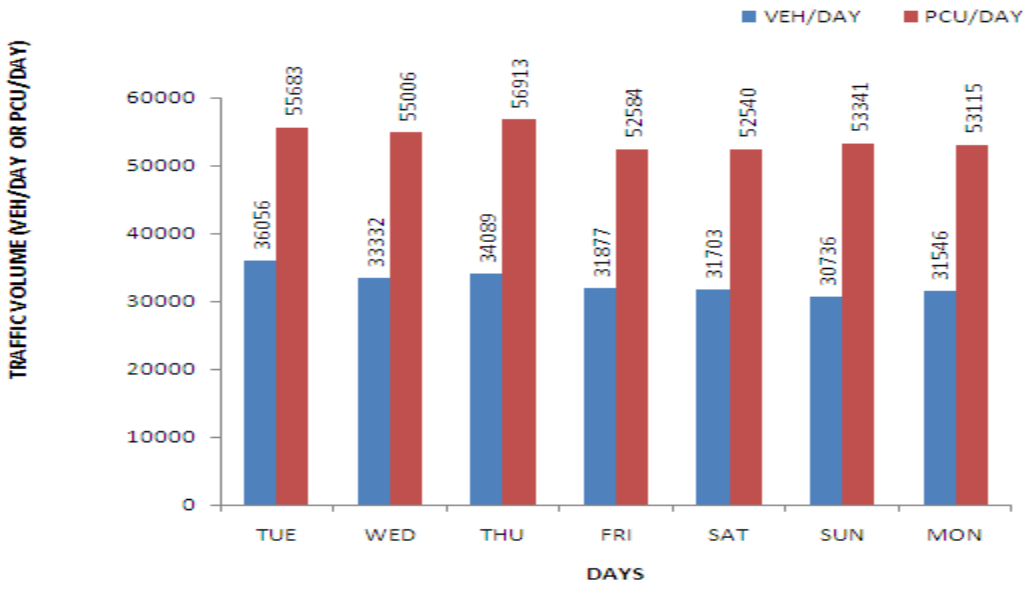

Fig.2: Daily Variation of Traffic Volume on NH 1(Nov.2015)

From the daily variation plot it is observed that in the year 2005 the maximum traffic 36056 vehicles passed on Tuesday, the 29th Nov., while in terms of PCUs, the maximum traffic of 56913 PCU passed on Thursday, the 24th November. The minimum traffic of 30736 vehicles occurred on Sunday (27.11.05) and 52540 PCUs on Saturday (26.11.05).

From the daily variation plot in Fig. 3, it is also observed that the traffic is almost evenly distributed on all days of the week except that it is relatively less on Saturday and Sunday. It is also observed from the daily variation plot that the daily variation tends to follow almost the same pattern in both the cases when the traffic is expressed in vehicle per day or PCU per day.

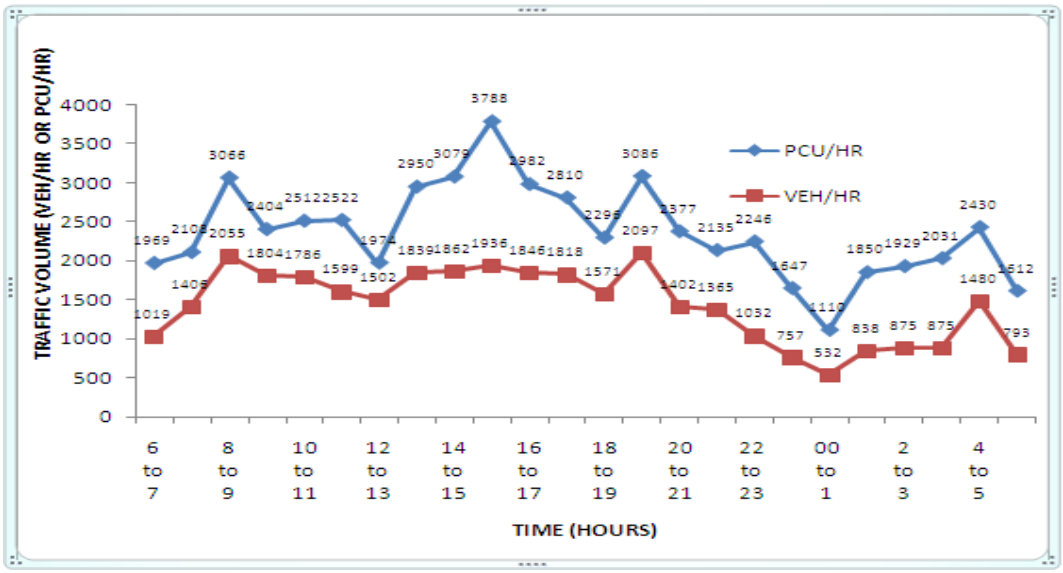

Fig.3: Hourly variation of traffic volume on NH-1(Nov. 24, 2015)

Composition of Traffic

The traffic using a road is composed of a variety of vehicles ranging from the simple cycle to the motor car and the heavy commercial vehicles, each type having an influence on the performance of the road in its own way. A simple volume count, without classifying the vehicle into distinct types, is of limited use. It is, therefore, the normal practice to classify the vehicle into distinct types.

The vehicles are mainly classified into two types:

- Fast Moving Vehicles
- Slow Moving Vehicles

Fast Moving Vehicles: In this category power driven vehicles are considered such as cars, jeeps bused, trucks, motorcycles, scooters, light commercial vehicles and tractor – trailers etc. They generally move on the road with speed more than 20 kmph.

Slow Moving Vehicles: In this category manually drawn or animal drawn vehicles are considered such as cycles, cycles rickshaws, horse drawn vehicles and bullock carts. They generally move on the road with speed less than 20 kmph.

CAPACITY AND LEVEL – OF – SERVICE EVALUATION

Capacity is the maximum traffic volume that a road can accommodate, or it is the maximum number of vehicles that can pass a section of the road per unit time under given roadway and traffic conditions. Knowing the traffic volume and the capacity of a road, the extent of congestion on the road can be determined. Level – of – Service (LOS) is the qualitative

measure describing operational conditions within a traffic stream, and their perception by drivers/ passengers. Capacity and LOS of 4 – lane and 6 – lane sections of NH – 1 have been evaluated in the following paragraphs.

Capacity Estimation

The speed – flow relationships are the basis for determining capacity of a road. The theoretical speed – flow curve (Fig. 2.), which is a parabola with capacity occurring at half the free speed, is superimposed over the straight – line speed – flow relationship for a road. The intercept of the straight – line equation on the y – axis given the free speed. The value of traffic flow corresponding to half of free speed given the capacity of the road. The same technique is used by Kadiyali et at (1991) and Indian Roads Congress (IRC: 64 – 1990) for evaluation of capacity of roads. The speed – flow relationships for cars developed in the previous chapter have been used to determine the capacity of 4 – lane and 6 – lane section of NH – 1. The capacity for 4 – lane and 6 – lane sections of the road has been determined for good pavement condition with 1.5 m surfaced shoulders and minimum 1.0 m good pavement condition with 1.5 m surfaced shoulders and minimum 1.0 m good earthen shoulders.

Capacity of 4 – Lane Section of NH – 1

The speed – flow relationships developed in Section 5.3.1 were used to determine capacity of the road as per the procedure given in Section 6.2. The speed – flow relationship for cars is shown in Fig. 6.1. The theoretical speed – flow curve is superimposed over this straight – line relationship. The intercept of the straight – line relationship on the y – axis given the free speed. The traffic flow corresponding to half the free speed is taken as capacity of the roads. The capacity thus obtained is 3300 PCU/hr. As the above equation is developed only for one direction of the dual carriageway, the total capacity of the four – lane road becomes 6600 PCU/hr.

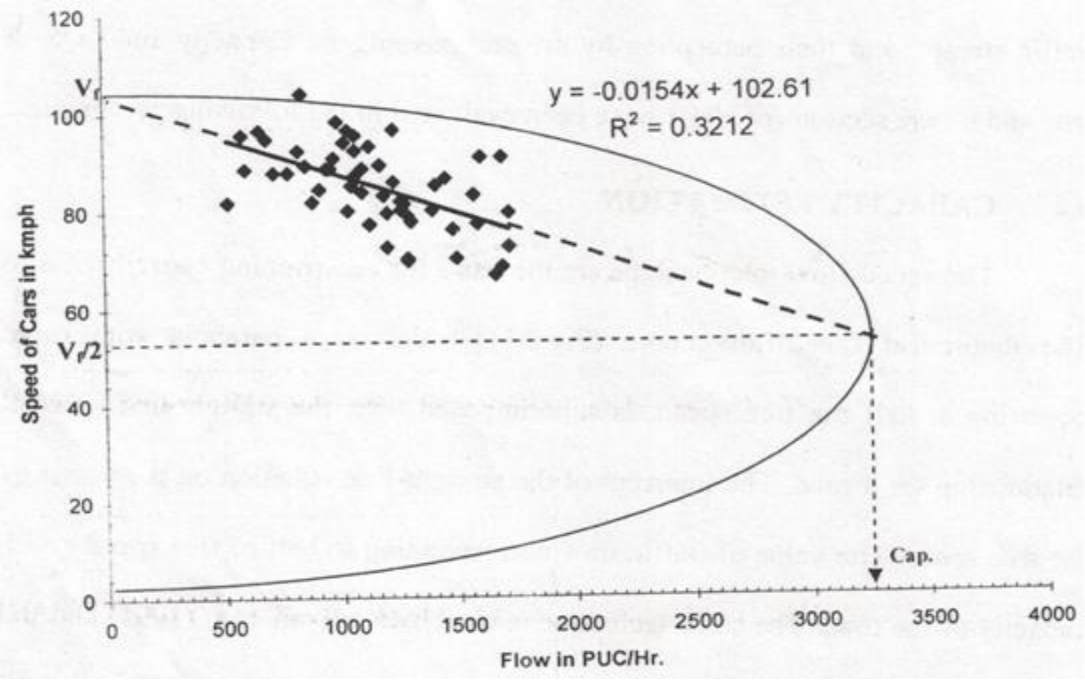

Fig.4: Capacity of 4 lane Section of NH-1

Capacity of 6 – Lane Section of NH – 1

The speed – flow relationships developed in Section 5.3.2 were used to determine capacity of the road as per the procedure given in Section 6.2. The speed – flow relationship for cars is shown in Fig. 6.2. The theoretical speed – flow curve is superimposed over this straight – line relationship. The intercept of the straight – line relationship on the y – axis given the free speed. The traffic flow corresponding to half the free speed is taken as capacity of the road. The capacity thus obtained

is 6375 PCU/hr. As the above equation is developed only for one direction of the dual carriageway, the total capacity of the six – lane road becomes 12750 PCU/hr.

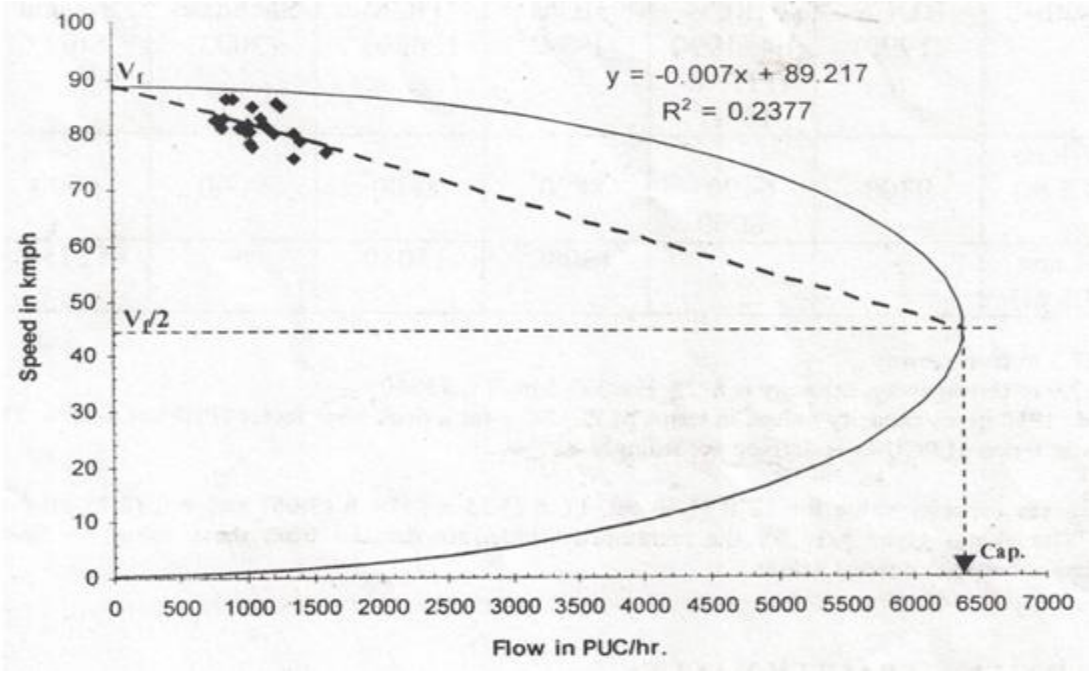

Fig.5: Capacity of 6 – Lane Section of NH – 1

CONCLUSIONS

The study presented in the dissertation is conducted to evaluate the traffic performance of NH–1. The following main conclusions are drawn from this work:

1. The daily variation of traffic on the road indicated a maximum of 36056 vehicles on Tuesday and a minimum of 30736 vehicles on Sunday. In terms of PCUs, the maximum traffic of 56913 PCUs is found on Thursday while the minimum traffic of 52540 PCUs occurred on Saturday.
2. The traffic is almost evenly distributed on all days of the week except that it is relatively less on Saturday and Sunday. The daily variation of traffic tends to follow almost the same pattern in both the cases when the traffic is expressed in vehicle per day or PCU per day.
3. On the day of maximum daily traffic, the maximum hourly traffic of 2097 vehicles passed between 1900 – 2000 hours, and in terms of PCU the maximum traffic of 3788 PCUs occurred between 1500 – 1600 hours. The minimum traffic both in terms of vehicles and PCUs (532 Vehicle and 1110 PCU) passed between 0000 – 0100 hours.
4. In terms of average daily traffic, the maximum traffic of 1843 vehicles passed between 0900 – 1000 hours, and in terms of PCU the maximum traffic of 2900 PCUs occurred between 1100 – 1200 hours. The minimum traffic both in terms of vehicles and PCUs (550 Vehicle and 972 PCU) passed between 0000 – 0100 hours.
5. The pattern of hourly variation both for vehicles and PCU's tends to be almost the same.
6. The traffic in terms of vehicles consists of 42% car/jeep/vans, 38% commercial vehicles (2 – axle trucks 12%, multi – axle trucks 6.0%, LCVs 10%, buses 8.0% and agricultural tractor trailer 2.0%), 2 – wheelers 13.0%, 3 – wheelers are 4.0% and about 3.0% cycles / cycle rickshaws. Animal drawn vehicles are negligible in the traffic stream on the road. Nearly 80% of the traffic in vehicles is composed of cars and commercial vehicles.

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