

CAPACITY ESTIMATION OF TWO LANE HIGHWAYS BASED ON LINEAR REGRESSION MODEL USING SPSS

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Abstract: Capacity analysis is the fundamental concept in design of roadway like need of widening and other future improvements in road geometry. But very limited studies are undertaken in capacity estimation for mixed traffic at different road geometry on undivided highways. In this study, an attempt has been made to determine the effect of varying lane width, horizontal curve radius and gradients on capacity of two lane undivided highway using speed-volume relationship. Also an attempt has been made to develop the linear regression equations using SPSS software to evaluate the capacity of highway. Data collected for Seven days at different sections of two lane National Highways (NH-206, NH-209 and NH-207) using manual and videographic method. The result shows an attempt has been made to find the capacity by developing a linear regression equations using SPSS under varying lane width, radius of curvature as well as gradient and the result shows with the increase in lane width and horizontal curve radius, there will be proportionate increase in capacity of roadway and with the increase in amount of gradient, capacity of highway is reduced.

Keywords— Traffic composition, Highway capacity, Regression equation, SPSS

1. INTRODUCTION

Capacity is key concept in design, analysis, and operation of highway facilities. Estimation of roadway capacity in an important issue for determining the traffic demand for roadways when these facilities are designed. When estimating capacity, each vehicle type in the traffic stream is considerably different because of occupying different space on the roads and moving at variable speeds with different acceleration and deceleration capabilities. In most capacity analysis, prevailing conditions are not ideal and computation

of capacity should include predictive adjustment to reflect this absence of ideal conditions. Traffic composition, proportion of different class of vehicles, road geometrics, pavement surface characteristics, driver's behaviour and other environmental factors affects the capacity of highway. In this lane width, horizontal radius and gradients across different national highways were considered for the study.

2. OBJECTIVE OF THE STUDY

Study was taken up with the following objectives

1. Study the effect of influencing variables such as lane width, horizontal radius and gradient on capacity of two lane undivided national highway.
2. Developing the linear regression equation for an individual variable using SPSS and validate.

3. LITERATURE REVIEW

Nitish goyal et.al (2001) done detailed studies and analysis carried out on Delhi-Haridwar Road (NH 58). The effect of gradient on PCU of different categories of vehicles and also capacity of two lane road is also analysed and speed volume relationship of all road has been studied. It is observed that every one percent of upgrade decreases capacity by 2.61% and every one percent of downgrade increases the capacity by 3.09%. Upendra kumar et.al (2003) in this study, data were collected on various part of Indian 2 lane undivided NH roads. It was found that PCU of vehicle increases with increasing in carriageway width. This provides a greater freedom for movement of vehicle on wider road and also there will be difference in speed between car and other vehicles. The capacity will also get increases with increase in width of carriage way. Deepika Chukka et.al (2015) in this study various road geometrics such as cycle track, service road, carriage way, median, unpaved shoulder and

parking lane are considered. It has concluded that capacity of road is affected by cycle traffic which enters into the service lanes. It has been analysed that service lane connecting towards arterial roads at junction points also affect the capacity of road. Parking lanes, medians, carriage ways will also affect the capacity of road at larger extent. The capacity values are different from base capacity values and nearly equal to theoretical capacity which has been calculated by using other factors. Prathik U. Mankar et. al (2016) in this research work various software such as VISSIM, HETEROSIM is used for comparison along with that manual calculation of capacity by using Chandra's method is also being carried out. In this study they have found that by using HETROSIM software provides exact copy of field condition of mixed flow and useful for moulding heterogeneous traffic condition and by sing VISSIM software capacity estimation of roads under heterogeneous traffic condition can be carried out easily and also it is useful for simulating larger networks.

4. SITE SELECTION

Field experimentation was designed so as to collect the data which would give required information. Following factors are considered while selecting the gradient for this study

- Selected site should be free from intersections and curves
- Width of the road should be same at all selected sections
- Selected sections should be free from villages, bus stop, and public buildings.

In this study, the various parameters related to capacity effects, have been evaluated on two different National highways (NH206 and NH209) at different sections of Roads. **NH-206** starts from **Tumkur** (Tumkur – Honnavara bypass) to **Honnavara** of distance 363km, NH 207 connected the towns of Doddaballapur and Hosur, Via: Devanahalli, Sarjapur, Bagalur, and it was 143km long and **NH-209** starts from **Bengaluru** (Kanakpura exit main road) to **Tamil Nadu** border (Dindigul bypass) of distance 486km.



Figure 1: collection of data required for the research work

In this study field data was collected by manual method also by using videographic method.

5. ANALYSIS OF DATA AND DISCUSSION

5.1 Traffic composition:

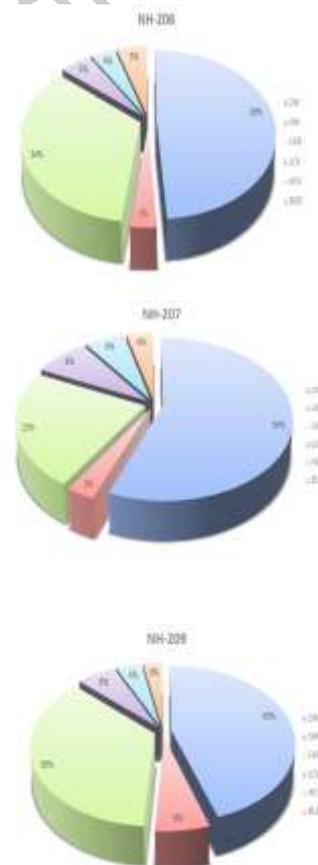


Figure 2: Composition of traffic on NH-206, NH-207 and NH-209

Pie charts give percentage volume of different vehicles passing on different sections where 2 wheeler and car occupies major portion of road in all sections as compared to 3 wheeler, bus, LCV and truck.

5.2 Estimation of Capacity: Capacity estimation is one of the major objective of this study but knowing the capacity one can easily determine particular section of road is capable of carrying capacity or not. The traffic using the road consists of various types of vehicle such as cycles, motorbikes, car, bus, LCV, truck etc. Each type of vehicle have influence on road Therefore by classifying the vehicle into different type during volume count one can get clear picture of maximum flowing vehicle type ,minimum flowing vehicle type and average flowing vehicle type in that particular section.

5.2.1 Speed-volume relationship: The relationship between stream speed and flow is developed for the selected study stretches. The relationship between these were used to determine the observed capacity. Traffic volume and speed are determined at the mid-block of all sections.

5.2.2 Regression Model 1 (Capacity-Lane width): Figure 3 shows a plot between capacity and lane width. It follows a second degree curve relationship of the form given in equation (1).

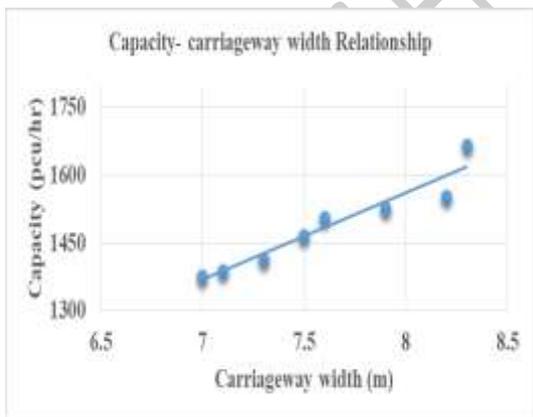


Fig. 3: Capacity as related to lane width

$$C = 192.84x + 18.482, R^2 = 0.9202 \quad (1)$$

Where, C = Capacity of road (pcu/hr)
x = Total width of the lane (m)

From the figure (3) it can be observed that there is a substantial increase in capacity of highway corresponding to increase in lane width. Linear regression equation pertaining to capacity with

mixed traffic and traffic volume based on lane width has been established and specified in equation 1. The R^2 (regression co-efficient) obtained is very high, hence equation derived is highly validated.

5.2.3 Regression Model 2 (Capacity- Horizontal curve radius): Figure 4 shows a plot between capacity and horizontal curve radius. It follows a second degree curve relationship of the form given in equation (2).

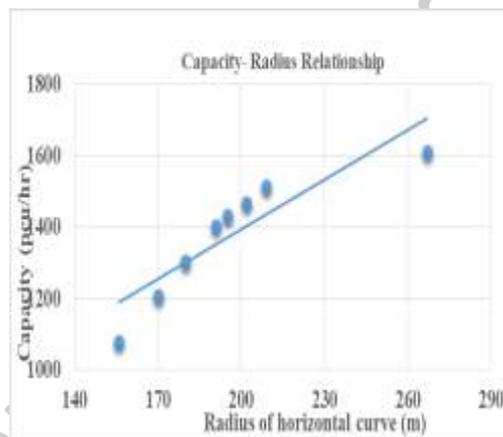


Fig. 4: Capacity as related to radius of horizontal curve

$$C = 4.6402x + 464.86, R^2 = 0.805 \quad (2)$$

Where, C = Capacity of road (pcu/hr)
x = Radius of curve (m)

From the figure (4) it can be observed that there is a substantial increase in capacity of highway corresponding to increase in radius. Linear regression equation pertaining to capacity with mixed traffic and traffic volume based on radius of curve has been established and specified in equation 2. The R^2 (regression co-efficient) obtained is high, hence equation derived is validated.

5.2.4 Regression Model 3 (Capacity- Gradient): Figure 5 shows a plot between capacity and gradient. It follows a second degree curve relationship of the form given in equation (3).

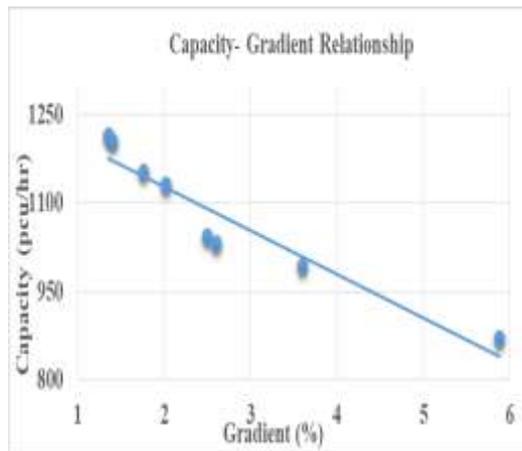


Fig. 5: Capacity as related to gradient

$$C = -74.123x + 1276.5, R^2 = 0.9121 \quad (3)$$

Where, C = Capacity of road (pcu/hr)
x = Gradient (%)

From the figure (5) it can be observed that there is a substantial decrease in capacity of highway corresponding to increase in gradient. Linear regression equation pertaining to capacity with mixed traffic and traffic volume based on change in gradient has been established and specified in equation 3. The R^2 (regression co-efficient) obtained is very high, hence equation derived is highly validated.

6. CONCLUSION

The specific conclusions that can be drawn from the field study and analysis are listed below

- After seven days of volume count on different National Highways at various sections it was found that Two wheelers occupies (50%) major portion of the road followed by Car (31%) in mixed traffic condition.
- Attempts have been made to develop linear regression equation using SPSS to estimate the capacity of two lane highway based on lane width, radius of horizontal curve and gradient. The equation obtained is as follows.

$$C = 192.84 * \text{lane width} + 18.482$$

$$C = 4.6402 * \text{radius of curve} + 464.86$$

$$C = -74.123 * \text{gradient} + 1276.5$$
- The result shows, with the increase in lane width and horizontal curve radius, there will be proportionate increase in capacity of roadway and with the increase in amount of gradient, capacity of highway is reduced.

ACKNOWLEDGEMENT

This research was supported by Visvesvaraya Technological University, Jnana Sangama, Belagavi-590018 for grant of financial assistance.

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