Development of Speed Flow Density Relationship- A Review Paper

Kartik Vermani
M.Tech Civil Engineering Student
PEC University of Technology,
Chandigarh, India

Tripta Goyal
Professor, Civil Engineering Department
PEC University of Technology,
Chandigarh, India

ABSTRACT
Different roads have different speed flow density relationships. Development of speed flow density model is the basis of finding different types of traffic characteristics for a traffic road. By finding these relationships, capacity and LOS of the road can be determined. These relationships are used for planning out the future infrastructure of the road. In this paper, different methods are used to find out these relationships that is by linear regression method and by simulation methods like VISSIM, HETEROSIM etc and different models like Greenshield, Greenberg etc are being compared for a particular road.

Keywords
LOS, simulation model, HETEROSIM, VISSIM

INTRODUCTION
The traffic characteristics form the basis of planning any city for a traffic engineer. There are valuable tools to understand the problem and evolve the suitable measures to overcome it. Traffic is just like flow of water, which have several parameters associate with it. These can be macroscopic which characterizes the traffic as whole or microscopic which deals with the behaviour of individual vehicles in the stream with respect to each other. Macroscopic characteristics are speed (v), flow or volume (q) and density or concentration (k) and microscopic characteristics are time headway, space headway and time travel. Traffic flow theory is mainly concerned with three macroscopic characteristics of road traffic which is defined as :

Speed (v) is the rate of movement of traffic and is expressed in mph or km/hr.

There are mainly 2 mean speeds :

Time mean speed is the average of all vehicles passing a point over a duration of time. It is the simple average of spot speed. Time mean speed is the arithmetic mean of all spot speeds.
Space mean speed is defined as the harmonic mean of speeds passing a point during a period of time. It also equals the average speeds over a length of roadway

Traffic Density (k) is the number of vehicles present in a stated length of road at an instant of time. It is expressed as vehicles per kilometer length per lane.

Traffic Volume (q) is the number of vehicles passing a specified point during a particular period of time. It is expressed in vehicles per hour.
BASIC FORM OF SPEED FLOW DENSITY RELATIONSHIP

Knowledge of speed flow density relations is very crucial in traffic studies. It is used to find capacity and Level of Service (LOS) of the road.

**Speed Density Relationship**
With increase in density the speed decreases. When there is no vehicle (density = 0), the speed is maximum. This speed is called “Free speed”. At very high density, the vehicles approach zero speed. This density is called “Jam density”.

**Speed Flow Relationship**
At very low speeds the volume would also be low. With increasing speed, traffic volume also increases up to a certain limit, as headway initially decreases. But as the speed further increases the spacing between the vehicles increases and becomes so large that volume decreases. There is an optimum speed at which the flow is maximum.

**Flow Density Relationships**
As the density increases from zero, volume increases up to the point of critical density . the density corresponding to maximum flow. It is called “Optimum density”. There after volume decreases as density continues to increases to a maximum value known as “Jam density” when all vehicles are stopped. As density increases the speed of vehicle is reduced, reducing the flow, till it reaches jam density when there is no movement or flow.

![Graph](image)

**LITERATURE REVIEW**
Greenshield Model is the basic form of speed flow density relationship which paves the way for other researchers to find different types of speed flow density relationships for different types of roads.

**Greenberg** also applied law of continuity and applied fluid dynamic principles to derive relation between speed, density and volume and developed logarithmic relation b/w speed and density. This model is unsuitable for low density roads as density tends to zero, speed tends to infinity.
K. M. Lum et al (1998) presented in his paper “SPEED-FLOW MODELING OF ARTERIAL ROADS IN SINGAPORE” modelled speed flow density relationship for radial and ring arterial roads in Singapore by taking minimum delay per intersection and no. of intersections per km as modal parameters.

Jomy Thomas et al (2011) in his paper “VEHICLE CLASS WISE SPEED-VOLUME MODELS FOR HETEROGENOUS TRAFFIC” studied vehicle class-wise speed volume models for heterogenous traffic of six lane divided roads in Chennai city at the mid-block section by using micro-simulation model HETEROSIM which was calibrated according to the observed traffic conditions.

Balaji Ponnu et al (2013) in his paper “Vehicle Class-wise Speed Volume model for Three-lane Undivided Urban Roads” found that multi-class speed flow equations are more relevant to these types of facilities rather than single class flow speed models. It aims to study the traffic flow in a three-lane two-way undivided road in the city of Chennai through developing multi-class speed-flow relationships using both linear and Bureau of Public Roads (BPR) models.

Ashish Dhamaniya et al (2013) in his paper “Speed Prediction Models for Urban Arterials under Mixed Traffic Conditions” developed speed density relations for different vehicle type on urban arterial roads under mix traffic conditions in Chandigarh, Jaipur and Delhi using a set of simultaneous equations and established speed prediction models and also compares the manoeuvrability of a vehicle type.

Hiren V Patel et al (2013) in his paper “Capacity Determination of an Arterial Road” determined capacity of Modasa town in Gujarat by developing speed flow density relationships which can be helpful for working out improvement plans of the town and finding out the LOS of the road.

XU Cheng et al (2014) in his paper “Analysis of Traffic Speed-Density Relation Model Characteristics” compared 10 typical speed density relation models and analysed by parameter calibrations and fitting errors on Beijing Expressway and found out that out of all, Newell and Logistic models showed good stability.
METHODOLOGY

The following are the steps for this research work:

CONCLUSION

Speed flow density relationship is very important for finding the existing condition of roads and for planning out the future infrastructure of the road. It is used to find out the capacity of the road by finding these relationships at peak hours and LOS of the road can also be found out. Speed limit for a particular road can also be estimated. It is the basic step to note down the traffic flow pattern of the road and serviceability of the road.
REFERENCES


