International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

Speed flow characteristics and capacity of multilane highway

[1]D.Ashok & [2]Ch.Sagar

1. ASSISTANCE PROFESSOR,,Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA - 507318

2. M.Tech,Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA – 507318

Abstract

This paper presents speed and acceleration characteristics of different types of vehicles on four-lane and six-lane divided highways under mixed traffic conditions. These characteristics are very intrinsic to the particular vehicle category plying on a roadway. Speed and acceleration data were collected on six sections of four-lane divided inter-urban highways and two sections of six-lane divided highways in India. Mean speeds of standard cars and big utility cars are compared using two tailed t-test and are found to be different on four-lane highway with earthen shoulders and paved shoulders. Average mean speeds of standard car are also compared on two classes of highway. F-test indicates that the mean speed of standard cars on six-lane divided highway is significantly higher than that on four-lane highway. Acceleration data were collected using GPS based V-Box device, and speed-acceleration profiles are established for each type of vehicle. Average acceleration of a vehicle is related with speed through an exponential relationship. Average acceleration rate of standard car on six-lane highway is found significantly different from that on four-lane divided highway. Acceleration of heavy vehicle is examined in three different loading conditions and relations are established for calculating average and maximum acceleration of a vehicle type at the given operational speed.

Keywords*:* Speed; Acceleration; Highway; Heavy vehicles; Distribution

INTRUDUDCTION

Speed of vehicles on a highway indicates the quality of service experienced by motorists. The speed is discriminated into different elements such as average mean speed, design speed, free-speed, operating speed, and upper and lower posted speeds. On a highway, design speed is the main criterion for setting the speed limits and posted speed is usually lower than the design speed because it is the driver's desired speed. Speed of vehicles on a highway is affected by various factors, but the most prominent are traffic volume and traffic composition. In a mixed traffic situation of the type prevailing in India, speed is considerably influenced by composition of traffic stream. Both free-flow and operating speeds play important part in assessment of highway capacity and level-of-service. The higher the speed variation, greater will be the interactions among vehicles, resulting bias in determining speed limits for design of highway facility. Along with speed, acceleration characteristics of vehicles are also important considerations for various highway design and construction aspects.

Measurement Along a Length of Road

Measurements along a length of road come either from aerial photography, or from cameras mounted on tall buildings or poles. It is suggested that at least 0.5 kilometers (km) of road be observed. On the basis of a single frame from such sources, only density can be measured. The single frame gives no sense of time, so neither volumes nor speed can be measured. Once

several frames are available, as from a video-camera or from time-lapse photography over short time intervals, speeds can also be measured, often over a distance approximating the entire section length over which densities have been calculated. Note however the shift in the basis of measurement. Even though both density and speed can be taken over the full length of the section, density must be measured at a single point in time, whereas measurement of speed requires variation over time, as well as distance. In general, flow refers to vehicles crossing a point or line on the roadway, for example one end of the section in question. Hence, flow and density refer to different measurement frameworks: flow over time at a point in space; density over space at a point in time.

Moving Observer Method

There are two approaches to the moving observer method. The first is a simple floating car procedure in which speeds and travel times are recorded as a function of time and location along the road. While the intention in this method is that the floating car behaves as an average vehicle within the traffic stream, the method cannot give precise average speed data. It is, however, effective for obtaining qualitative information about freeway operations without the need for elaborate equipment or procedures. One form of this approach uses a second person in the car to record speeds and travel times. A second form uses a modified recording speedometer of the type regularly used in long-distance trucks or buses. One drawback of this approach is that it means there are usually significantly fewer speed observations than volume observations. An example of this kind of problem appears in Morton and Jackson (1992).

Speed and acceleration characteristics are very intrinsic to the vehicle class and prevailing traffic conditions. Some empirical relationships are explained based on the experimental studies on free-speed and operating speed on highways.

Dixon et al. (1999) applied Highway Capacity Manual (HCM) methodology to estimate posted speed limit on rural multilane highway in Georgia. Authors opined that the posted speed limits directly influence the free-flow speeds and operating speeds on highway. Further, speed limits for 89 and 105 km/h confirmed to the normal distribution and observed free flow speed in daylight was greater by 1% than in night.

Fitzpatrick et al. (2002) found strong relationship between deign speed, operating speed and posted speed.

Hunt et al. (2004) studied the effect on driver speeds after increasing the posted speed limit from 100 km/h to 110 km/h on rural four-lane highway in Saskatchewan.

Tseng and Lin (2005) developed speed models to estimate harmonic mean and time-mean free-flow speed. They found a high correlation between time-mean speed and harmonic mean speed. Speed characteristics and equivalency unit for motorcycle traffic have been investigated by Minh et al. (2005) also to resolve the problem in speed and flow measurements due to high proportions of two-wheelers in traffic stream. Speed characteristics were found to be influenced by the presence of non-motorized vehicles under mixed traffic conditions.

Velmurugan et al. (2011) determined the free-speed for assessment of road users cost on high-speed multilane carriageways in India. They observed that free-speed of heavy vehicles and

autos were significantly higher on six-lane roads when compared with four-lane roads. However, the average speed on eight-lane roads was not different from that on six-lane roads. Shukla and Chandra (2011) analyzed the speed data collected on four-lane divided highways and estimated the speed parameters used to define variation in speed data on multilane highways.

Most of the studies on acceleration characteristics have been performed in developed countries. John and Kobett (1978) found the acceleration rates as linearly decreasing function of speed. The maximum and standstill acceleration was 3.36 m/s 2 and 5.19 m/s2 for passenger car and heavy vehicle respectively. The rate of change of acceleration with respect to speed was higher for heavy vehicle than car. Wang et al. (2004) collected field data to analyze acceleration rates of different vehicles using Global Positioning System (GPS) and developed a quadratic relationship between acceleration and speed for straight and turning maneuvers.

Kumar and Rao (1996) found a good relation between acceleration rates and overtaking time on two-lane roads. Long (2000) measured acceleration characteristics of starting vehicles in Florida and design accelerations were found to deviate substantially from observed accelerations. At start of the motion, observed accelerations were about 15% higher for passenger cars and 45% higher for trucks than design accelerations.

Bham and Benekohal (2002) proposed a dual regime constant acceleration model which provides higher value of acceleration rate at lower speed and lower acceleration rate at higher speed.

Dey et al. (2008) studied acceleration characteristics of vehicles on two-lane roads in India. Acceleration of vehicle starting from rest and during overtaking was estimated and relationships were developed between the rate of acceleration and overtaking time for different category of overtaking vehicles. Maximum, average and minimum acceleration rates were determined by fitting a third degree polynomial to the distance-time profile using least square technique.

Bokare and Maurya (2011) presented the acceleration behavior through manual gear transmission (MGT) of a vehicle and fitted the data from first to fourth gear as polynomial. For fourth to fifth gear transmission, linear variation was found.

CONCLUSION

The present paper demonstrates the speed and acceleration characteristics of vehicles on multilane highways in India. Speed and acceleration data were collected on four-lane and six-lane highways and are analyzed separately for each type of vehicle. Average speeds of standard car (CS) are found marginally lower than those of big cars on four lane highways. t-test was conducted to compare the mean speeds of these two vehicles on four-lane divided highway with paved and earthen shoulders. The results show that the mean speeds of standard car and big car on four-lane divided highways with earthen shoulders are significantly different from those on highway with paved shoulders at 95 % confidence level. Similarly, comparative test of variance resulted in a significant change in speed of standard car on six-lane highway and on four-lane highway at 95 % confidence level.

REFERENCES

[1] Bham, G. H. and Benekohal, R. F. (2002) "Development, Evaluation, and

Comparison of Acceleration Models", CD ROM of 81st Annual Meeting of the Transportation Research Board, Washington, DC.

[2] Bokare, P.S. and Maurya, A.K. (2011) "Acceleration Modeling of Vehicle in Developing Countries", 2 nd International Conference on Models and Technologies for Intelligent Transportation Systems, 22-24 June, Belgium.

[3] 3.Brooks, R.M. (2012) "Acceleration of Vehicles in Rural Pennsylvania", International Journal of Research and Reviews in Applied Sciences, 12 (3), pp. 449-453. Dey, P.P., Chandra, S. and Gangopadhyay, S. ( ) "Acceleration Characteristics of Vehicles on Indian Roads", Highway Research Board, Indian Roads Congress, 1(1), pp 43-48.

[4] 4.Dey, P. P., Chandra, S. and Gangopadhyay, S. (2006) "Speed Distribution Curves under Mixed Traffic Condit ions', Journal of Transportation Engineering, ASCE, 132 (6), pp 475-481.

[5] 5.Dixon, K. K., Wu, C. H., Sarasua, W., and Daniels, J. (1999) "Posted and Free-flow Speeds for Rural Multilane Highways in Georgia", Journal of Transportation Engineering, ASCE, 125 (6), pp. 487-494.

[6] 6.Fitzpatrick, K., Carlson, P. Brewer, M. and Wooldridge, M.D. (2002) "Design Speed, Operating Speed, and Posted Speed Limit Practices, Transportation Research Board,National Research Council, Washington, D.C. 82 nd Annual Meeting, Washington DC.

[7] 7.Hunt, P., Larocque, B. and Gienow, W. (2004) "Analysis of 110 km/h Speed Limit: Implementation on Sabkatchewan Divided Rural Highway, Proceeding ofTransportation Association of Canada (TAC) Annual Conference, Sept (19-22), Quebec City, Quebec.