A Review on Impact of Heavy Vehicles on Highway Traffic

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***Abstract*— The operational ability and acceleration capability of heavy vehicle are different as that of other smaller size vehicles and passenger car. An increasing number of heavy vehicles in urban traffic may result in relatively different traffic flow characteristics. The purpose of this paper is to examine the study done by Chang-Gyun Roh *etal.* (2011) [1], who investigated the effects of Heavy Vehicles on traffic flow using real-time AVC data and to analyse the relationship between average speed, HV ratio, flow rate, and the number of lanes. The work examines the impact of heavy vehicle movement on measured highway traffic characteristics in detail. In order to analyse the impact of heavy vehicles (HV) on highway traffic flow and density, real-time Automatic Vehicle Classification (AVC) data was collected for different major highways (four-lane and six-lane and eight-lane respectively) in Seoul Metropolitan area, South Korea, for a period of 2 months. The observations showed that the average speed decreased with the flow rate increase of flow rate and HV ratio for the highways.**

Keywords-Heavy vehicles (HVs), Highway, Traffic flow parameters.

I. INTRODUCTION

With advancements and innovations in society, the need for heavy vehicles, used for purposes like transportation of goods and personnel, have risen. Heavy vehicles (HV) such as buses, trucks, recreational vehicles (RV) etc. affect the traffic flow more than other vehicles. Although heavy vehicles comprise a small proportion of traffic stream, they have an important effect in traffic flow and produce a disproportionate effect particularly during heavy traffic conditions [2].The presence of heavy vehicles in traffic strongly influences various traffic parameters, depending on its percentage. These vehicles are bigger in size, generally have a lower rate of acceleration, resulting in slow speed of these vehicles and hence affecting smaller vehicles. Drivers of small vehicles are forced to either comply by decreasing their speed and following the large vehicles, or resort to change lanes to drive around them. Highway Capacity Manuals (HCM) have integrated a way to solve the problem of mixed traffic by using passenger car equivalents (PCEs)[3]. These units can be used to convert a mixed highway traffic flow into an equivalent standard passenger car traffic flow. This method can trigger speed variations and change the features of traffic flow on highways [4].

II. LITERATURE REVIEW

For conducting this study, Chang-Gyun Roh *etal.* (2011) collected a large amount of traffic data over a 2-month duration from August to September 2011 on three major highways in Seoul, South Korea. The unique factor was the difference in number of lanes in the selected highways, four, six and eight lanes respectively [5]. Hence various environmental and traffic conditions were provided to study the traffic dynamics between HVs and other passenger cars [6], [7]. The main objectives were:

1. To analyse the impact of heavy vehicle ratio in reduction of overall traffic speed.
2. To study the effect of flow, speed, volume and number of lane-changing movements of the highway on the impact of heavy vehicles.
3. To examine the HV traffic flow pattern based on number of highway lanes

III. METHODOLOGY

The works begins with site selection for data collection. Piezo-electric sensors are used in the roads, for the movement of traffic and to identify the different categories of vehicles passing through. The AVC systems are installed on the roads and as the vehicles passing through the road, the system would detect the number of axles on the vehicle, vehicle speed and traffic volume. Before being used for further analysis, the data gathered is screened for errors. When an error is detected, all 5-minute data before and after that point in the data is deleted. Time is not included in the research data sets. Any data collected during heavy rain or bad weather was excluded due to high probability of inaccuracies.

A. Data Collection

According to Roh *et al* (2011), the impact of large vehicles on traffic was examined using collected data included high traffic volume and various ratios of heavy vehicles on the highways. The piezoelectric sensor with AVC system collecting the traffic information distinguished the various types of vehicles in the traffic flow. The axle weight of vehicles which pass through the sensor generate electric charges that measures the number of axles, thus recognising the vehicle category. These sensors are also able to measure the speed of the vehicles.

B. Determination of Study Area

Data was collected from various suitable sites. The sites should be straight sections with level terrain and without having any influence of access points, intersections or traffic control devices up to 500 meters in either direction. The finalised sites were (1) four-lane highway (Seoul-Chuncheon Expressway) (2) six-lane highway (the Pyeongtaek-Jecheon Expressway) (3) eight-lane highway (Gyeongbu Expressway).

- *Four-lane Highway*

The Seoul-Chuncheon Expressway is a four-lane highway with a total length of 61.4km, having nine major intersections. In this research, the AVC detectors are installed in each direction of the expressway. The traffic data was collected over a two-month period from August-September 2011. AVC detectors were installed along the expressway to examine the effect of heavy vehicles on the traffic.

- *Six-lane Highway*

The Pyeongtak-Jecheon expressway in the Seoul metropolitan area has a total length of 57.1 km that began operations in 2008. This place has the most freight traffic into and out of a major industrial complex. Compared to other sections the HVs are stable in highway sections. In this research, the AVC detectors are installed along the six –lane highways. the traffic data was analysed using 15-min intervals of data during the month of October 2011.

- *Eight-lane Highway*

The Gyeongbu Expressway has a total length of 416km, the flow data was gathered in the area between the Anseong and Cheonan intersections. In this research detectors were used to collect the data for15 min-time intervals during the month October 2011. The system used here is similar to the AVC used in the six-lane expressway.

C. Data Extraction and analysis

The data to be extracted included the speed of the vehicles, volume, number of vehicles. Speed difference of two successive vehicles was also determined. Before further analysis, the collected data was subjected to a screening test for errors. Figure 1 shows the data correlation and validation.

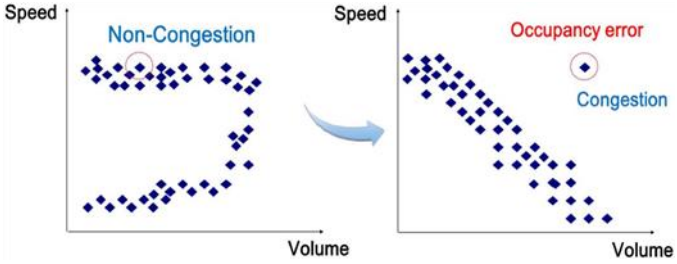

Fig. 1 Data correlation and validation

IV RESULTS AND ANALYSIS

The collected data was analysed from a variety of perspectives related to the impact of HVs on the traffic. The data with each highway type was as follows-

- *Four-lane Highway*

Figure 2 shows the average speed reduction that occurs when the proportion of HVs varies as analysed, compared to the case in which all the vehicles are passenger cars. It was observed that the percentage of heavy vehicle increases with increase in speed reduction. The graph given below illustrates the relationship between the speed reduction as shown in theY-axis and percentage of heavy vehicles in X-axis which results in large number of HVs affecting the traffic. When the HV ratio surpasses 35%, the curve fluctuates and falls over time.

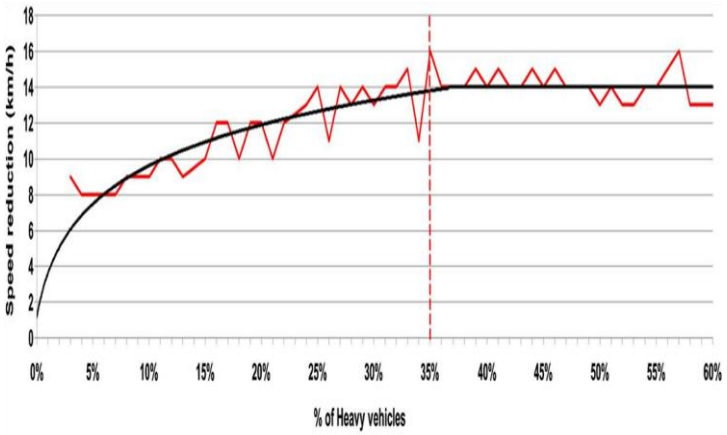

Fig. 2 Average Speed Reduction vs Heavy Vehicle %

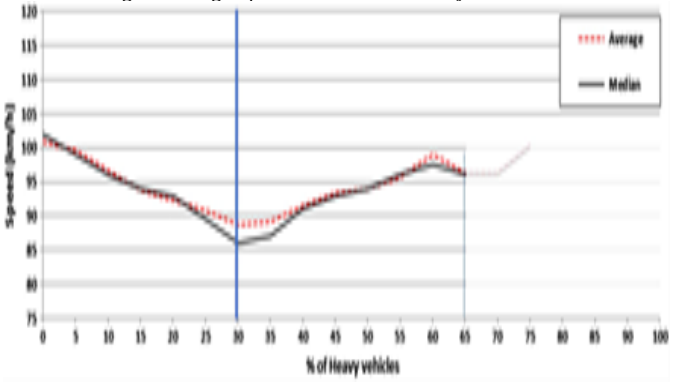

Fig. 3 Traffic speed vs Heavy Vehicle %

- *Six-lane Highway*

n the six lane highways, the given graph (Fig 3) depicts the percentage of HVs on X-axis and vehicle speed on Y-axis. Percentage of HVs increases with decrease in vehicle speed across all traffic flows. In higher traffic conditions, the speed reduction did not occur. Owing to the possibility of being trapped by slower vehicles ahead, the increased number of lanes seemed to provide more opportunities for the vehicles to change lanes,

- *Eight-lane Highways*

The given graph (Fig 4) illustrates the dynamics between the

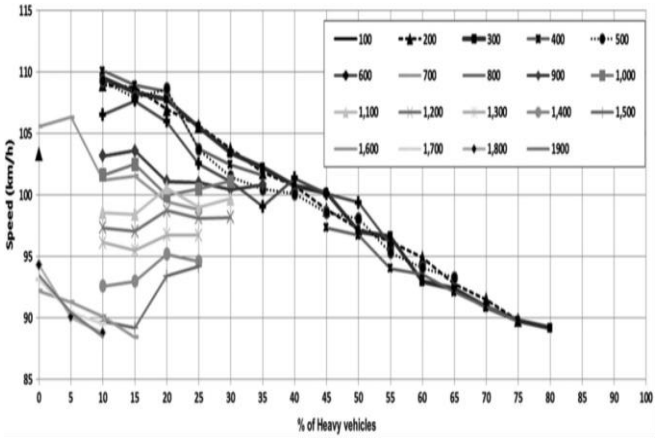

Fig. 4 Relationship between HV ratio and speed (Eight-Lane Highway)

HV's ratio and vehicle speed. Higher percentage of HVs resulted in decreased speed value. When the flow rate was higher than 500 veh/h/ln, speed reduction was not available for the give data set. In the case of six lane and eight lane

highways, the average traffic speed declined as the HVs ratio increased. It is presumed that the commuter cars travelling in this highway determine the characteristics of the traffic flow, even if the number if heavy vehicles is high. A commuter car may use approaches like lane shifting to avoid being obstructed by large vehicles in front of them. As a result, speed reduction variations may differ on eight-lane highways.

V. CONCLUSION AND DISCUSSION

Heavy vehicles have more influence on surrounding traffic compared with passenger cars. They impose physical effects on surrounding traffic because of their physical and operational characteristics. Despite the increasing number of heavy vehicles on highways and freeways, the influence of heavy vehicles on their surrounding traffic has received little attention. Using vehicle detection systems, the key goal of this study by Roh *etal.* (2011) was to examine the characteristics of actual traffic flows on which the impact of heavy vehicles differed with traffic flow rate and percentage of HVs. The highlights of their work were the availability of sophisticated technology and the opportunity to investigate in various environments. Using AVC system, data was collected on four lane, six lane and eight lane highways. The average speed of traffic flows and percentage of heavy vehicles were increased on six lane and eight lane highways. In four lane highways, decreased proportion to the higher percentage of HV to the point where the average speed moved in a gradient of average speed shifts or stayed at a characteristic speed. One should note that other than traffic density, speed and vehicle ratio, other parameters could also be considered for further understanding. Suggested parameters are vehicle load (passenger weight or goods weight), rate of acceleration for various vehicles and torque. The research done here by Chang-Gyun Roh *etal.* (2011) is based on traffic conditions, heavy vehicle proportions and road environments in Seoul, South Korea. While certain findings and results may be assumed to be same in India, A similar study in local environments is recommended for further investigation. Suggested sites would be National Highways connecting the states of Kerala, Tamil Nadu and Karnataka where 6-lane and 8-lane highways operate and where large movement of goods trucks and transportation buses maybe be observed. It should be noted that these regions also face strong bouts of weather throughout the year, hence it acts as an important factor in the influence of traffic conditions in India. Furthermore, the systems and technology required to perform these tests may not be available or feasible in developing countries, so manual measures or other possible alternatives is highly suggested.

VI. REFERENCES

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