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# Lateral Placement of Vehicles on Horizontal Curves

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**Abstract**

The deterioration of pavement is a significant factor which adds to its life cycle cost. This is mainly due to wear and tear of the pavement caused due to wheels of vehicle and environmental factors. This deterioration is mainly observed at maximum wheel path on the pavement. The maximum wheel path is identified by conducting placement survey of vehicles. A review of literature indicates that lot of studies related to placement of vehicle in straight stretch is available whereas on curves it is very less. This has motivated the authors to conduct a placement study on horizontal curves. About 8 locations (paved and unpaved) in Bangalore city was identified for the present study. The data was analyzed for general placement and placement with respect to the type of vehicles for varying width and radius. It was found that as the curve radius increases the percentage shift was found to decrease. The vehicles were generally observed to shift towards center with increase in road width on curves. The placement of commercial vehicles was modeled by a probability distribution function and this was modeled as Johnson SB distribution
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## 1. Background of the study

As deterioration of pavement leads to a drastic increase in the life cycle cost there is a need to identify and rectify the most distressed locations on the road. Generally the wheel path tends to create more distress on the pavement.

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Therefore it is necessary to find the maximum wheel path for which lateral shifts of vehicles are to be investigated. Road vehicles along with the longitudinal movement performs lateral shift during moving condition. This lateral shift is named as "Placement of Vehicles". This is defined as the distance of its left front wheel from the edge of the pavement. The placement of vehicles on a highway depends on their size and speed of vehicles, condition of shoulders and also road geometry. The placement of mixed traffic on a highway also plays an important role in estimating the capacity and extra widening of the pavement.

Ideally the effect of lateral distribution of vehicles with in a lane should be uniform along the road so that every part of pavement wears at the same time. But in real world, a non-uniform lateral distribution of properties develops. Studies in England, Belgium and Germany revealed that vehicles in a lane are laterally positioned similar to a normal distribution in straight section of roads. Similar studies have shown that wheel position is normally distributed with a standard deviation ranging from 200 - 400 mm (Timm D. H and Priest A.L, 2005). However this distribution and consequent load concentration pattern doesn't always take the form of a bell shaped curve and standards do not address the situation. Further, studies have revealed that vehicles distribute themselves laterally within a lane according to a normal distribution in western countries and more irregular distribution in developing countries.

On Indian highways no dedicated lane is provided for a particular type of vehicle and hence, lane usage is generally of mixed type. The mixed traffic during moving condition interacts with each other and generates complex phenomenon affecting the stream speed, capacity and level of service of traffic facility along with the safe movement of traffic.

Horizontal curves are one of the important transition elements in geometric design for highways. A horizontal curve provides a transition between two tangent strips of roadway, allowing a vehicle to negotiate a turn at a gradual rate rather than a sharp cut. Review of literature indicates that a few studies have been conducted on lateral placement on straight stretches of road but with regard to the horizontal curves, it is almost very less in India which highlights the relevance of the study. The current study deals with placement of vehicles on horizontal curves at 8 locations in Bangalore city. The data was analyzed for general placement, placement with respect to type of vehicle for different curve radius. The $50^{th}$ percentile of placement was estimated from cumulative distribution curve and the placement of commercial vehicles was modeled as a probability distribution function.

## 2. Literature review

A study conducted by Taragin (1943), concluded that trucks travel closer to the pavement edge than passenger cars and do not change lateral positions as severely when meeting oncoming traffic. Case et al (1953) stated that drivers veer around objects near their path located on the road side, and react to curbing height, shoulder width, center line, variation and changes in the pavement surface. Jorol (1962) found passenger vehicles travelled closer to center line of the road in comparison to commercial vehicles. On multi-lane highway during relatively congested conditions, the common tendency of drivers is to move to the fast moving lane from the slow moving one. These switches are defined by Gazis et al. (1962) as 'density oscillation between lanes'. Oliver and Lamb (1965) proposed a nonlinear model, in which traffic was assumed to behave as a compressible fluid, obeying the equation of continuity. Nedas et al.(1982) completed a study of vehicle lane position and wider edge lines in New Jersey. The objective of this study was to compare the lateral placement of vehicles when no edge line pavement marking was present and also when 4-, 6-, and 8-inch edge lines were used. The curve data showed that increasing the edge line width caused drivers to move closer to the centerline, but did not increase centerline encroachments. In addition, the lateral placement of the vehicles was also less variable and more centrally located. Cottrell (1986) also studied the lateral placement and speed impacts of 8- versus 4-inch edge lines. Cottrell concluded, based on an analysis of the data, that there was no significant difference in lateral placement after the edge lines were widened. However, the drivers did position themselves closer to the center of the lane when the 8-inch edge lines were in place. A number of studies have also shown that drivers also do not drive a circular horizontal curve along an arc directly in the center of the travel lane (Zador[ 1987], Felipe and Navin [1998]). A large traffic engineering study observed drivers at 46 sites in Georgia and New Mexico and measured speed and lane placement (Zador[ 1987]). On left-hand curves, the researchers found that vehicles were closer to the centerline of the road at the midpoint of the curve and on right-hand curves they were closer to the edge line. Weise, et al (1997) focused on an in-depth examination of

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