INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Assessment of speed variability on the horizontal curves using vehicle trajectories for geometric design consistency and safety evaluation of a two-lane rural highway passing through mountainous terrain

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SHORT ABSTRACT

Horizontal curves play a crucial role in providing a smooth and safe transition from one tangent to the successive tangent. But, the crash data corresponding to Indian highways shows that the crashes on curves went up by 46.05% on average between 2016 to 2021. In this scenario, evaluating the consistency of horizontal curves is important to improve safety. There are various consistency measures that are classified based on parameters such as operating speed, driver workload, alignment indices, side friction, and driving dynamics for assessing geometric design consistency. Among these measures, Lamm's criteria developed based on operating speed, is widely accepted across the world and used for consistency evaluation. However, in evaluating the consistency using the Lamm's criteria, past studies estimated operating speed (V_{85}) using spot speed data collected at the center of the curve. Recent studies with driving simulators and GPS instrumented vehicles found that speed is varying on the curve, and collected minimum operating speed on the curve for modeling operating speed reduction models. Majority of the operating speed reduction models that were developed are meant for rural highways in plain terrain and these models are not applicable to the highways passing through mountainous terrain. Besides, none of the studies have attempted to study the design and operating speed consistency for the horizontal curves of two-lane highways passing through mountainous terrain.

The objective of this thesis is to assess the role of minimum and maximum speed on the curve in evaluating the design and operating speed consistency and safety aspects of two-lane undivided rural highways passing through mountainous terrain. To achieve the objective, four tasks were performed. First, a multiple homography approach was proposed that enables the researches to collect vehicle trajectories on the horizontal curves accurately. The proposed approach was evaluated using the speed data collected from an instrumented vehicle. In the second task, operating speed profile models, statistical test for speed variables (V_{Max}, V_{Min}, V_{CC}) and their locations, and the analysis of acceleration and deceleration length were performed to understand the speed variability on the curve. Considering the speed variation on the curve, $Max\Delta_{85}V$ was modeled, and important determinants were found. In the third task, with reference to the speed at center of the curve, two operating speed correction models were developed. One model is for estimating the correction factor for minimum speed, and another is for maximum speed on the curve. Finally, the role of minimum operating speed and maximum operating speed in the safety and consistency evaluation of horizontal curves were assessed through the endangerment level proposed by Lamm and crash frequency modeling. The contributions of the thesis have potential applications in improving the safety of rural highways. The proposed multiple homography approach enables researchers and practitioners to collect naturalistic vehicle trajectories from the horizontal curves located in a non-planar region. This study emphasized the role and importance of speed variables (V_{Min} and V_{Max}) for the safety and consistency evaluation of the geometric elements (horizontal curves) in mountainous terrain.