INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Development of Speed Based Consistency Evaluation of Four-Lane Highway Geometry Using Naturalistic Driving Data

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SHORT ABSTRACT

India has experienced rapid growth in its infrastructure, including the expansion of two-lane to four-lane highways and the construction of new four-lane highways in mountainous terrains. However, the safety of these highways has not kept up with their development. In 2019 alone, there were over 1,80,000 fatalities due to accidents on Indian highways mainly over curves. To address this issue, a study was conducted on a 65km four-lane highway in mountainous terrain to understand driving behavior and improve safety. Data was collected from GPS equipped passenger cars driven by various drivers, revealing that the highway covered 285 horizontal curves with varying design speeds, curve lengths, vertical gradients, and superelevation. The data showed that most drivers were traveling above the design speed, and operating speeds varied across curve from point of curvature (PC) to point of tangent (PT), indicating the need for separate four-lane consistency criteria. To evaluate the safety of mountainous terrain four-lane horizontal curves, two safety criteria were developed: Speed Synchronization (SS) and Speed Harmony (SH), which consider the variation in speed across the curve. The SS criterion evaluates safety based on speed variation between successive locations within the curve, while the SH criterion evaluates safety due to variation in operating speed from the curve design speed. These criteria were used to develop a new speed-based geometric design for four-lane highways, which, along with vehicle dynamics, can be used to evaluate the safety of existing four-lane curves. Geometric parameters influencing drivers speed over four-lane horizontal curves were also identified, including tangent length, gradient, curve length, and deflection angle. A continuous percentile speed distribution model was developed to accurately predict any percentile speed across the four-lane highway alignment using ANN machine learning models. In addition to improving highway safety through design and warning systems, the study also developed a three-level over-speed warning system using operating speed (V85) and design speed (V95) to assist drivers in identifying upcoming hazards. The studies outcomes have several benefits, including the ability to predict percentile speed values using the developed speed models to evaluate highway safety and design, overcoming the limitation of uniform speed assumptions across

curves, improving four-lane highway geometric design on mountainous terrains, and enhancing driver safety through the over-speed warning system.