MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 23-496 (project 540) | March 2023

Automating the Implementation of the Updated Grade Severity Rating System (GSRS) for Wyoming Mountain Passes

the ISSUE

Truck crashes caused by brake failures resulting from overheated brakes generated by excessive braking on steep downgrades is an ongoing concern for the Wyoming Department of Transportation. A previous mathematical model once used to set weight-specific speed limits needed to be upgraded to account for current truck characteristics and to incorporate horizontal curves into the model.

the RESEARCH

Researchers validated the Grade Severity Rating System (GSRS) model for trucks that have only drum brakes installed, incorporated horizontal curves into the formulation of weight-specific speed (WSS) signs, and developed a program that automates the GSRS implementation. The GSRS validation was achieved by conducting field tests, specifically, the hill descent and validation tests with a fully loaded truck fitted with only drum brakes. In this study, the GSRS model was updated, and the updated mathematical model was automated through an interactive, intuitive, aesthetically appealing, and user-friendly objected-oriented Visual Basic.net software. Additional research on the GSRS model was accomplished to account for large truck vehicle stability, specifically, rollovers and skidding/side slip during grade descent. These scenarios become relevant in the presence of horizontal curves. To factor in the influence of horizontal curves on the maximum safe speed of truck descent with respect to vehicle stability—rollover and skidding to be specific—simulations were run on TruckSim® 2020 for a variety of rollover margins, superelevations, truck weights, deflection angles of the horizontal curves, longitudinal grades, speeds, and radii of curvature of the horizontal curve.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

Lead Investigator(s)

Khaled Ksaibati
khaled@uwyo.edu

Co-Investigator(s)

Muhammad Tahmidul Haq
mhaq@uwyo.edu

Research Assistant(s)

Vincent-Michael K. Ampadu

Project Title

Updating and Implementing the Grade Severity Rating System (GSRS) for Wyoming Mountain Passes

Sponsors | Partners

Wyoming DOT

USDOT, Research and Innovative Technology Administration

the FINDINGS

The main objective of the field tests was to derive an equation for the heat coefficient, K2, and then compare it to the K2 obtained from the field tests conducted in 2016. The K2 value derived from the tests was minimally different from that computed for the scenario of the test truck equipped with both disc and drum brakes. This was established by examining the maximum safe descent speeds generated by the previous updated model and the model developed in this study. They were found to be essentially the same.

the IMPACT

The project has produced a better understanding of the relationship between truck weight and the maximum descent speeds necessary to prevent road crashes on Wyoming's mountainous downgrades. Prior to this phase of the project, the maximum speeds were only designed to prevent brake fade. Now maximum speeds are also set to prevent rollover and skidding/side slip in addition to brake fade. A model has also been created to account for trucks equipped with only drum brakes, which includes most trucks in the United States.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1121

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.