# Florida Department of Transportation Research

Hydroplaning on Multi Lane Facilities

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As lanes are added to widen existing roadways on the state highway system, the Florida Department of Transportation (FDOT) needs a procedure to evaluate hydroplaning potential. The FDOT Plans Preparation Manual specifies a cross-slope in one direction across a maximum of three lanes. Widening beyond three lanes requires the inside lane to be sloped toward the median, at great cost in time and expense.

In this project, University of South Florida researchers developed methods for evaluating the potential for hydroplaning which could reduce costs associated with widening. In a series of tasks, researchers explored factors that lead to hydroplaning, in order to build a comprehensive model. The model was verified through tests on a course equipped to produce a regulated, adjustable water film.

*A truck towing the locked wheel skid tester prepares for a run through a water film on a prepared course.*

Accounting for the many factors that influence drivers' response to wet conditions — rainfall level, water depth, visibility, and others — is difficult. The researchers used Monte Carlo simulations to explore and vary as many factors as they wished, comparing the results with various models and field observations of drivers to rank the factors. They concluded that speed reduction depended strongly on rainfall intensity and traffic density.

Pavement permeability and macrotexture influence both water film thickness and the interaction of tires with the water film. Researchers compared available permeability models with tests performed on local roads.

The several models that relate water film thickness to the speed at which hydroplaning can occur provided researchers with the opportunity for experimental verification. Researchers examined each model, developing them as needed for comparison to experimental trials.

As another means of ranking hydroplaning factors, researchers examined conditions of actual hydroplaning crashes, identifying incidents of interest in FDOT databases, primarily the Crash Analysis Reporting System (CARS). Incidents were analyzed for pavement condition, composition, and profile at the crash location, traffic volume and distribution across lanes, and rainfall intensity. Correlations were extensively explored and compared with predictions of the National Cooperative Highway Research Program (NCHRP) PAVDRN software.

Hydroplaning causes vehicle tires to transition from static friction, in which tires effectively contact pavement, to sliding friction, in which tires, often locked due to braking, slide over the pavement surface. Understanding the dynamics of sliding tires is complex, again due to the many factors, such as sliding speed, tire inflation, pavement macrotexture, vehicle weight, and water film thickness. The researchers built models of locked tires sliding on pavement with MATLAB, based on three aspects: hydrodynamics of thin film fluids; tire deformation; and uplift condition. Model predictions were compared with experimental results conducted on the test course at several speeds using a locked wheel skid tester.

Research into hydroplaning can result in better roadway design that advances highway safety and significantly reduces construction costs.

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For more information, visit http://www.dot.state.fl.us/research-center