Florida Department of Transportation Research

Quantification of the Physical Properties Required of Raised Pavement Markers and Accelerated Laboratory Testing
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Retroreflective raised pavement markers (RRPMs) can provide lane and directional information at night, particularly during wet weather conditions. However, in recent years, the service life of RRPMs in Florida has been generally shorter than expected. In addition to the maintenance and expense that this implies, it has brought into question the accuracy of current RRPM laboratory testing methods and procedures.

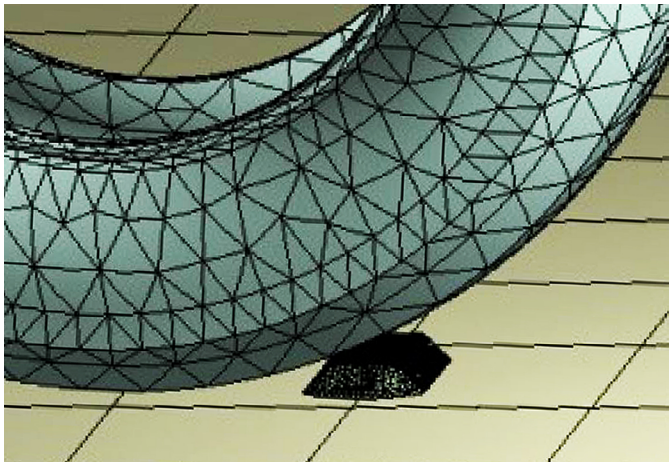
In this project, University of South Florida researchers worked to improve current RRPM designs and to develop new laboratory tests that better predict marker performance in the field.

A literature review of current RRPM use on U.S. highways among all the states showed that the main RRPM brands approved on U.S. highways include 3M, Rayolite, Ennis, and Apex. A map of RRPM use in the U.S. showed that most RRPMs are installed in southern regions. In northern tiers, some states have replaced RRPM models that cannot be snowplowed with ones that can be.

To collect information on RRPM usage, performance, and efforts to increase RRPM durability, the researchers conducted a nationwide survey of state departments of transportation. A field condition survey, repeated after one year, was conducted on Florida highways to document major failure modes of RRPMs. Typical failure modes included lens cracking and loss, body cracking and breakage, detachment, sinking, and contamination.

Finite element modeling (FEM) was used in a series of studies of RRPMs. The researchers used the ANSYS software to model the impact of a vehicle tire with the body of an RRPM. The data produced was analyzed for critical stresses induced in RRPMs from major suppliers under various loading and impact conditions on both rigid and flexible pavements.

Alteration of RRPM designs was also analyzed with FEM. Design elements examined included RRPM height, adhesive pad, bottom shape, side slopes, and solid vs. hollow construction. A variety of testing protocols were used to evaluate their relationship to findings from FEM studies. FEM analysis suggested two new laboratory tests to be further evaluated: revised reversed latitude flexural test and offset latitude flexural test. These two new laboratory tests can better simulate the real tire-marker condition in terms of critical stress distribution match.



One of several finite element models of the tire-marker-pavement system that was used to model dynamic stresses on raised pavement markers.

Based on the effects of geometric and material factors on stress magnitudes, researchers analyzed and identified potential areas of improvement to extend the service life of RRPMs. A new RRPM was suggested, based on modifications to a commercial product. With the proposed design improvements, the new RRPM can reduce stresses incurred up to 40% and potentially increase service life by 66%.

This project showed the practical application of increasingly sophisticated computer modeling of physical processes. In this case, the results offer significant savings, considering the millions of RRPMs utilized to improve safety on Florida highways.

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