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RESIDUAL STRESSES DUE TO TRAVELING LOADS AND REFLECTION CRACKING

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Residual Stresses Due to Traveling Loads and Reflection Cracking

by

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The report summarized in these pages presents the results of a three dimensional stress-strain analysis called the mechano-lattice analogy. The technique is used here to simulate the stress-strain behavior of a single layered elasto-plastic pavement subjected to repeated rolling in one direction by a pneumatic tire. The mechano-lattice analysis is the only presently known way of analyzing such a problem realistically and quantitatively. It is able to simulate any non-linear, energy absorbing elastic or elasto-plastic behavior of a material using a rigorous technique that preserves equilibrium and has strain compatibility.

The calculated results show that when material properties remain constant, rutting and longitudinal material flow and build-up of residual stresses continue at an accelerating rate as wheel passes continue. The knowledge of this behavior is useful in explaining the mechanism of corrugation formation, the rate at which critical tensile regions in the pavement are reduced by accumulated residual stresses and the slow down of rutting rate due to the increasing strength of the materials. This increase of strength can be inferred from calculated residual mean stresses and from calculated increasing density of the material.

The analysis was also used for investigating the stress-strain behavior in an overlay over an opening and closing crack in an underlying old pavement. The analysis was able to predict some of the behavior of the overlay test which is reported in Research Report 207-5, "Methodology for Predicting the Reflection Cracking Life of Asphalt Concrete Overlays." The analysis predicted that the overlay material will continually move toward the crack and form a hump which would be further modified by traffic. The high tensile stresses caused by the crack opening would tend to be reduced by residual stresses built up in the overlay by passing traffic.

The mechano-lattice analysis will have many uses in pavement design, construction and maintenance.

1. When applied to multilayer pavements, it can be used for predicting shift factors between the number of repetitions to failure

in laboratory tests of fatigue cracking and rutting, and the actual number of repetitions observed in the field.

2. It can be used for calculating the number of roller passes to achieve a desired level of compaction.

3. It could be used in the investigation of maintenance problems such as rutting, corrugations, and roughness.

4. The technique can also be used for the investigation of the cause and remedy of reflection cracking.

Even with the best analysis tools that have been developed up to the present time, including linear elastic and viscoelastic theory, it has been impossible to predict the field behavior of pavements in fatigue, rutting, and reflection cracking directly from the properties of pavement materials as they are measured in the lab. The report documents the development of a new such tool that shows promise of being able to predict fatigue life, rutting behavior, and even reflection cracking directly from the laboratory-measured material properties. Many figures showing the calculated results are presented to give a good feel for the physical effects that occur in a pavement which accumulates stresses and strains under traveling wheel loads.

Results of calculations with this computer program will serve as a reference for decision making concerning the improvement of pavement design techniques, particularly for fatigue cracking, rutting, and reflection cracking.

The published version of the report may be obtained by addressing your request as follows:

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