Center for Transportation Research and Education

IOWA STATE UNIVERSITY

ME Design Approach for HMA Overlaid PCC Pavements

tech transfer summary

RESEARCH PROJECT TITLE
Rehabilitation of Concrete Pavements Utilizing Rubblization and Crack and Seat Methods

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Objectives

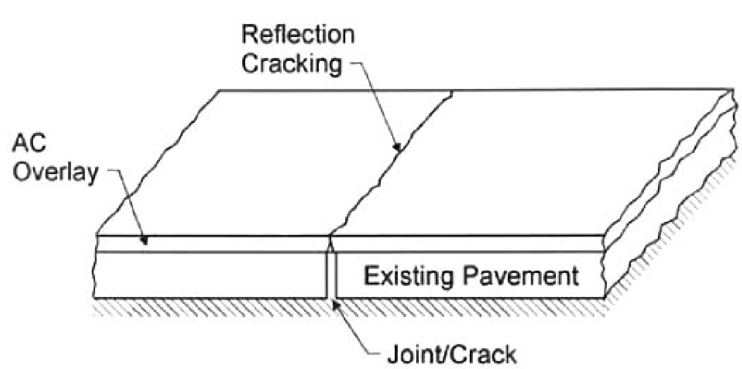
Develop a mechanistic-empirical (ME) design approach for the Hot Mix Asphalt (HMA) overlay thickness design for fractured PCC pavements.

Problem Statement

Highway pavements of portland cement concrete (PCC) type usually deteriorate due to distresses caused by a combination of traffic loads and weather conditions. The need for repair or rehabilitation depends on the type and level of distress. Repair and rehabilitation activities are carried out to extend the service life of the existing pavements. As total reconstruction is very expensive and time-consuming, rehabilitation is frequently considered to be a better alternative.

Options for rigid pavement rehabilitation include bonded and unbonded overlays, full-depth repair, crack and seat asphalt overlay, joint and crack repairs, asphalt overlay, and rubblization with asphalt surface overlay. The selection of alternatives primarily depends upon the pavement type and its existing condition.

Construction of HMA overlays over existing concrete pavement is considered to be the most common type of rigid pavement rehabilitation. However, the performance of HMA overlaid PCC pavements is hindered due to the occurrence of reflective cracking, resulting in significant reduction of pavement serviceability. Reflective cracking is minimized by reducing the slab action using various fractured slab techniques, including rubblization, crack and seat, and break and seat. Currently, there is no viable design methodology for designing HMA overlay thickness for fractured PCC pavements.



Reflection cracking

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The American Association of State Highway and Transportation Officials (AASHTO) Pavement Design Guide empirical procedures method for the design of HMA overlay thickness is not a viable approach. The AASHTO method is empirically based on the AASHTO Road Test, which did not employ any fractured slab technique. Also, since the time of AASHTO Road Test (1958–1961), material specifications, traffic volumes and weights, and tire types and pressures have changed significantly. In alignment with the new ME Design Guide, a new ME design procedure should be developed to combine the soundness of mechanistic models with the experience from field data.

Description of Design Approach

ME design methods are based on the mechanics of materials that relate an input, such as wheel load, to an output of pavement response, such as stress or strain.

In the ME Design Guide procedure, the pavement is regarded as a multi-layered elastic system. The materials in each of these layers are characterized by modulus of elasticity (E) and Poisson's ratio (μ). Material characterization of the pavement is performed using the Falling Weight Deflectometer (FWD) data.

Mechanistic-empirical design of overlays is similar to that of design of new pavements. This method requires the determination of critical stress, strain, or deflection in the pavement by some mechanistic method and the prediction of resulting damages by some empirical failure criteria. Prior to the thickness design, remaining life of the existing pavement must be evaluated, based on which the thickness of the overlay will be determined.

HMA overlaid rubblized concrete pavements typically comprise of three layers: (a) HMA overlay, (b) rubblized PCC, and (c) subgrade. In the ME design process, this three-layer structure is analyzed mechanistically to estimate the critical strains developed within the structure. These strain values are used to estimate the structural capacity in terms of repeated traffic loading by using the empirically derived transfer functions. The results are compared with the results obtained from a field test section to validate the mechanistic component.

Implementation Benefits

A mechanistic-based pavement design procedure, like the one developed in this study, has the following advantages over the existing AASHTO empirical procedures:

- It provides more reliable and realistic design.
- It has an ability to predict the type of distress.
- It can be used for both existing pavement rehabilitation and new pavement construction.
- It accommodates changing load types, environmental, and aging conditions.
- It uses material properties which relate better to actual pavement response.
- It can better characterize materials, allowing for the following:
  - o Accommodation of new materials and utilization of available materials
  - o Improved definition of existing layer properties

Implementation Readiness

Prediction of capacity is beyond the scope of this project to validate since one would have to monitor pavements for their complete design life to make a confident statement as to the validity of the method. However, the mechanistic component of the developed overlay design procedure was validated using field data from an instrumented trial project in Iowa.