



## Tech Brief

### LABORATORY PERFORMANCE EVALUATION OF CIR-EMULSION AND COMPARISON AGAINST CIR-FOAM RESULTS FROM PHASE II

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#### RESEARCH PROJECT TITLE:

Laboratory Performance Evaluation of CIR-emulsion and Comparison against CIR-foam Test Results from Phase II

#### SPONSOR:

Iowa Highway Research Board (TR-578 Phase III)

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## Objectives

The main objective of the study is to determine if the CIR-foam mix design process can be applied to CIR-emulsion with some minor adjustments.

## Problem Statement

During the previous study, the mix design procedure was developed and validated for cold in-place recycling using foamed asphalt (CIR-foam). The CIR using engineered emulsion (CIR-EE) mix design procedure is complex and requires special equipment that is not commonly available. Currently, no standard mix design procedure is available for CIR using emulsified asphalt (CIR-emulsion) in Iowa. The current flat application rate for standard emulsion should be reviewed to determine if changes would improve the performance of the CIR. It is critically needed to determine if the CIR-foam mix design process can be applied to CIR-emulsion with some minor adjustments

## Research

To apply CIR-foam mix design process to the CIR-emulsion mixtures, RAP materials were collected from the field for preparing the test specimens using CSS-1h and HFMS-2p. The CIR-foam mix design process was then applied to CIR-emulsion mixtures with varying emulsion contents. Dynamic modulus test, dynamic creep test, static creep test and raveling test were conducted to evaluate both short- and long-term performance of CIR-emulsion mixtures at various testing temperatures and loading conditions.

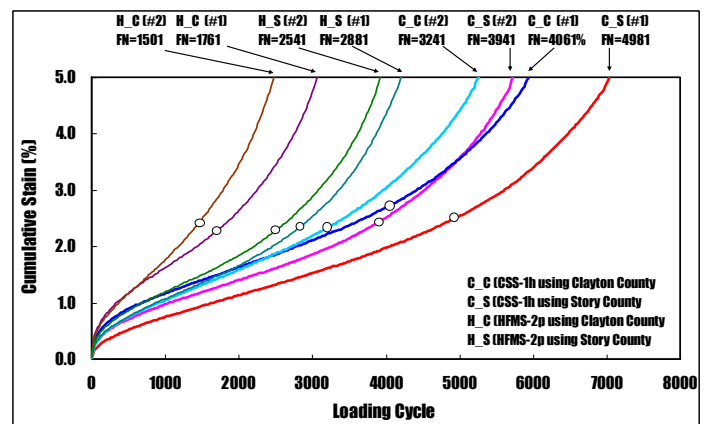
## Benefits

This research examined the existing CIR-foam mix design process with commonly available equipment that may give similar results for the CIR-emulsion mixtures. The performance of the CIR-emulsion mixtures was compared against CIR-foam based on laboratory performance test results. One of the most significant benefits is to provide pavement engineers with a rational mix design procedure that helps them select the most appropriate CIR technology, types and amount of the stabilization material for the existing pavement conditions.

## Key Findings

Based on the limited laboratory experiment, the following conclusions are derived:

1. The mix design procedure developed for CIR-foam is applicable to CIR-emulsion.
2. Based on the wet indirect tensile strength of gyratory compacted CIR-emulsion specimens, residual asphalt content of emulsion was found at around 1.0%.
3. Dynamic modulus, flow number and flow time of CIR-emulsion mixtures using CSS-1h were higher than those of HFMS-2p.
4. Dynamic Modulus of CIR-emulsion using RAP materials from Clayton County was higher than that of Story County.
5. Flow number and flow time of CIR-emulsion using RAP materials from Story County was higher than those of Clayton County.
6. Flow number and flow time of CIR-emulsion was higher with lesser emulsified asphalt.
7. Raveling loss of CIR-emulsion was less with more emulsified asphalt.
8. Given the same curing condition, test results of CIR-foam mixtures are generally better than those of CIR-emulsion mixtures



## Recommended Refinements through Additional Research

In the future, the optimum target range of designing specific amount of stabilizing agent for CIR based on the test results from permanent deformation and raveling loss should be studied. Given the limited RAP sources used in this study, the CIR-emulsion mix design procedure should be validated against several RAP sources and emulsion types. The mix design procedure should be adopted for CIR along with flow number and raveling tests to predict the field performance of CIR.



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