

## Research Article

# Permanent Deformation Assessment of Cold Recycled Asphalt Mixtures

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The objective of this study was to evaluate the behavior in terms of the permanent deformation of four cold recycled asphalt mixtures stabilized with asphalt emulsion and foamed asphalt. The analysis was conducted considering three flow number test procedures adapted for cold recycled mixtures: (i) ABNT NBR 16505 (method A); (ii) adaptation of the FN test for CRAM according to Kim and Lee's method (method B); (iii) 3D-Move analysis software simulation of pavement structures to address the stress magnitude for the FN test (method C). The influence of the curing process on the performance of the materials was also verified. The study used an extensive database of computed pavement responses from the four different asphalt pavement structures of the experimental section subjected to axial loading of a tandem axle using the 3D-Move pavement response analysis program. The FN results using the 3D-Move data (method C) demonstrated the good mechanical behaviour with respect to permanent deformation of the cold recycled mixtures subject to axial stress and temperature. The method proposed by Kim and Lee (method B) showed little efficacy for the analysis of the CRAMs tested in this work. The ABNT NBR 16505 method (method A), conventionally used for HMA, highlighted the influence of temperature (60°C) on the CRAM mixtures. For all FN test conditions, the curing was a preponderant factor for the performance of cold recycled asphalt mixtures and should be carefully evaluated to simulate the early stage of the mixtures in the field. It is also important to verify the influence of humidity and temperature on the permanent deformation mechanism of cold recycled asphalt mixtures.

## 1. Introduction

Cold recycling is an increasing trend in rehabilitation, maintenance, and intervention of distressed asphalt pavements. The main advantages of this technique are the economic and environmental benefits allowing faster interventions and shorter traffic disruption [1, 2]. In the recycling process, reclaimed asphalt pavement (RAP), usually generated from pavement milling [3], is incorporated to a new mixture through asphalt binder addition (stabilization). Virgin aggregates can also be incorporated to adjust the mixture's aggregate gradation [4–6].

Cold recycled asphalt mixture (CRAM) is usually stabilized with foamed asphalt or asphalt emulsion. Active fillers may also be added (portland cement, hydrated lime, and others) to improve some mechanical properties, such as

moisture resistance, and to increase early age resistance [5–8]. CRAM's mechanical behaviour is dependent on various factors, such as the curing process, reclaimed asphalt pavement (RAP) source and gradation, moisture content, type and content of asphalt stabilization agent (foams or emulsion), presence of active fillers, and volumetric properties [2, 9, 10].

Considering the complex mechanical behaviour of CRAM, additional discussions are necessary on CRAM's mechanical behaviour in the laboratory. An appropriate laboratory characterization of the CRAM may increase projects' reliability, durability, and may reduce costs. Therefore, this work aims to assess the permanent deformation of four different CRAMs (these mixtures have been used as the base course in an experimental test section), stabilized with asphalt emulsion and foamed asphalt,

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*Mainline Flexible Pavement Sections* Claribel Alvarez,1998 This study utilized Illinois DOT IDOT mechanistic empirical M E technology and Mn ROAD mainline pavement section data and information to verify refine modify IDOT M E analysis and design concepts and procedures for full depth asphalt concrete FDAC and conventional flexible pavements CFP The Mn ROAD mainline flexible pavements include eleven CFP and three FDAC pavement sections Four different granular materials were used in the conventional flexible pavements A fine grained soil subgrade R value of about 12 is present throughout the mainline Laboratory material testing results field distress measurements and FWD test data were used to study pavement deflection response and performance rutting and asphalt concrete fatigue The study demonstrated that the IDOT M E analysis and design procedures for FDAC and CFP sections are adequate The ILLI PA VE structural model adequately predicts the pavement responses The use of bi linear arithmetic subgrade model and the theta granular material model ILLI PA VE inputs closely replicate CFP field FWD deflection responses The effect of granular material quality on CFP deflection response is very limited The ILLI PAVE FWD backcalculation algorithms are adequate for estimating the moduli of asphalt concrete and sub grade soils

*Development of a Simplified Test Method to Predict Rutting Characteristics of Asphalt Mixes* James S. Lai,1987 *Highway Research Abstracts* ,1994

**Modelling Permanent Strain Behaviour of Unbound Base Course Materials** J. R. Barrett,1977 *Pavement Distress, Evaluation, and Performance* National Research Council (U.S.). Transportation Research Board,1979

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