REVIEW OF PAVEMENT THERMAL CRACKING OBSERVATIONS AND THEIR
RELATION TO BINDER PROPERTIES

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ABSTRACT
This paper reviews the influence of various pavement and construction materials on the thermal cracking of asphalt pavements which have confirmed the dominant role of the binder and the total dependence of thermal crack initiation on bitumen properties. Detailed observations of the Canadian low temperature study test roads have also provided considerable insight into the mechanism of thermal cracking. Finally the correlation of observed test road cracking with AASHTO MP1 binder low temperature criteria have confirmed that the MP1 specification is reasonable for minimizing pavement damage from thermal cracking for conventional and oxidized bitumens.

ESTABLISHMENT OF TESTING PROCEDURE FOR
THE DETERMINATION OF LOW-TEMPERATURE PROPERTIES OF ASPHALT BINDERS

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ABSTRACT
A sample preparation method for direct tension tests (DTT) giving test results with good repeatability (± 10%) was developed.

Asphalt can be viewed as a mixture of many types of more or less polar molecules with different molecular weights in a relatively neutral oily media. Molecules in liquid asphalt can move rather freely. However, once asphalt is solidified, the movement of molecules becomes restricted. If asphalt inside a DT mold is allowed sufficient time to stay in liquid state, the polar molecules will travel to form a more stable structure with aligned dipole moments.

Asphalt samples with a developed network of aligned molecules will have higher failure stress in DTT than those with a random structure. In this testing method, the asphalt binders, after being poured into DT molds, maintain their fluidity for a short period of time to allow the polar molecules to find a more stable position with aligned dipole moments, before cooling to a solid state with more restricted molecular movement. This sample preparation method actually simulates the condition of asphalt after it is paved on the road. (Development of the method was reported previously.)

In this paper, the theory and the step-by-step sample preparation procedure are presented with photographs. In testing an asphalt sample of PG58-28 grade, the average results of each run with six specimens and the average of the best four out of six, obtained by three new operators, all agreed within ± 10% of the result obtained by an experienced operator. Experience in training new DT operators and trouble-shooting in carrying out DT tests are also discussed. Direct tension results of eight AASHTO Materials Reference Library (AMRL) samples (AAA-1, AAA-2, AAB-1, ABC, AAH, AAN, AAP and AAM-1) together with their Superpave results and TSAR plus predicted critical cracking temperature ($T_{critical}$) are presented and discussed in this paper.

LARGE AMPLITUDE OSCILLATIONS IN ASPHALT

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ABSTRACT
It is common practice to test asphalt (conventional, and polymer modified - PMA) in small amplitude oscillations, i.e. in linear viscoelastic region. If asphalt, as a part of paving mixture, is exposed to large deformations, the need for understanding its properties in nonlinear region is eminent. Large amplitude oscillations (LAOS) represent a relatively simple mode of nonlinear testing of materials, thus they should also be useful for the testing of asphalts. One base asphalt (conventional) and its blends with a styrene-butadiene-styrene copolymer (SBS) and with a copolymer of vinyl-acetate (EVA) are studied in LAOS, at intermediate temperatures. The basic properties of LAOS are also discussed in this contribution.
A CASE STUDY ON LOW TEMPERATURE PERFORMANCE OF THE C-SHRP C-LTPP TEST SECTIONS

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ABSTRACT
The performance of an asphalt pavement is strongly affected by the response of the asphalt cement in the mix to the in-service conditions. In Canada, one of the major obstacles to achieving long term pavement performance is low temperature cracking.

The overall purpose of the paper is to identify those variables which can be used to predict low temperature cracking especially when the Superpave test properties are not available. This is particularly useful as there are a number of valuable databases, including those in the Canadian Long Term Pavement Performance (C-LTPP) study, which have long-term performance information, which were developed prior to the SHRP testing. Accordingly, a major objective of the paper is to examine low temperature cracking on the 65 sections located throughout Canada in the C-LTPP study. Three C-SHRP test roads were also included.

The first part of the paper examines the validity of using empirical measures to predict low temperature cracking. Because the PG test parameters were not available for the C-LTPP test sections, the validity of the Penetration Viscosity Number (PVN) is tested statistically. The PVN values are then combined with pavement thickness, design temperature, stiffness modulus, age and subgrade to predict low temperature cracking using the Canadian Airport Model and Hajek model. The predicted cracking is shown to be statistically the same as the observed cracking on the C-LTPP and C-SHRP test sites. The measured thermal contraction coefficient as one of the variables in the Airport Model is shown to be a very good indicator of low temperature cracking based on observed cracking.

DEVELOPMENT OF STANDARD TECHNIQUES FOR THE CALCULATION OF MASTER CURVES FOR LINEAR-VISCO ELASTIC MATERIALS

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ABSTRACT
The adoption of the new proposed low temperature binder specification in the US has led to the development of the first method of standardized master curve production for use with an asphalt binder. The low temperature specification makes use of data collected from the bending beam rheometer that is combined using non-linear fitting techniques to produce the desired result. The resulting master curve will achieve an error with a root mean square fit of <1.0%. This type of analysis is being applied to the production of master curves from a much wider range of temperatures in order that researchers and engineers will have available a set of procedures and techniques for developing the material behavior properties to support other research work.