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QUALITY OF ASPHALT PAVEMENT TASK FORCE

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Re: SPECIAL BULLETIN 2-A | Asphalt Cement Quality and Specifications

This follow up bulletin is an Executive Summary of a White Paper that takes a critical look at the topic of asphalt cement quality and specifications as they relate to pavement cracking performance. The White Paper is an integral part of the bulletin and readers are encouraged to consult both documents. The intent is to synthesize and link the key outcomes from several important studies investigating the relationship between binder properties and pavement cracking in Ontario. The bulletin also discusses factors which should be considered in establishing appropriate specifications.

While it is acknowledged that many factors affect pavement cracking performance (asphalt cement quality, asphalt cement content in mix, responsible use of recycled materials, pavement design, drainage etc.) it is agreed that a thorough review of asphalt cement quality and the related specifications needs to be part of the solution.

The following properties are desirable in a quality Asphalt Cement:

- Flexibility at low temperatures to reduce the risk of thermal cracking;
- Resistance to fatigue cracking at intermediate temperatures; and
- Resistance to premature aging (i.e. oxidation).

Various procedures that are being used in Ontario to address asphalt Cement quality are outlined below.

Test Methods and Specifications That Can Be Used to Address Premature Pavement Cracking:

1. Low Temperature Performance Grade (PG) and Bending Beam Rheometer (BBR) Testing

When the PG system was implemented in Ontario to grade asphalt cement binders in the mid to late 1990's Ontario was divided into zones. Locations south of a line drawn from Honey Harbour, south-easterly through Longford, Taylor Corners, Caven, Campbellford and Mallorytown specified PG XX-28 binders and locations north of this line required PG XX-34 binders. The Ontario map showing the PG zones is presented in the figure below.

Establishing zones in the manner above has resulted in certain areas in Ontario which specify binders at less than 98% reliability. It has become apparent that these zones should be reviewed and binders may have to be specified using a low temperature with higher design reliability as part of the strategy to improve low temperature pavement cracking performance.

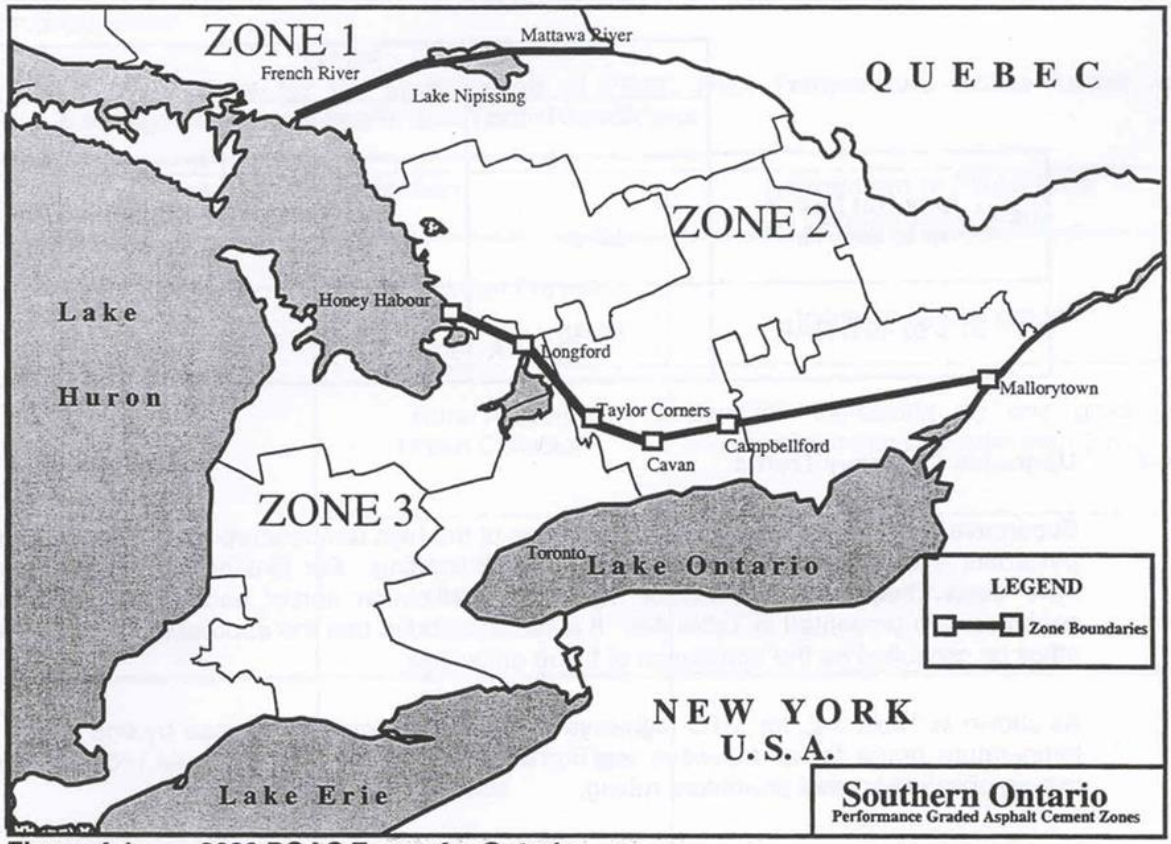

Figure 4-1: 2000 PGAC Zones for Ontario

2. Extended Bending Beam Rheometer (BBR) Testing

Physical hardening properties are measured using the LS-308 Extended BBR test to determine low temperature PG properties after the beam has been conditioned at low temperatures for 72 hours (3 days). The outputs from the Extended BBR test are called the Low Temperature Limiting Grade (LTLG) and the Grade Loss.

3. Intermediate Temperature Fatigue Cracking and the Double Edged Notched Tension Test (DENT)

The Double Edged Notched Tension Test (DENT) has been developed as a supplementary (PG+) test to better reflect fatigue cracking properties at intermediate temperatures. The PAV residue is poured into rectangular moulds that are notched on two sides. The samples are pulled (in a similar manner to how ductility samples are tested) after conditioning at an intermediate temperature. This test is based on fracture mechanics principles and the output is called the Crack Tip Opening Displacement (CTOD).

4. Multiple Stress Creep Recovery Test and AASHTO M332 vs. AASHTO M320

The J_{nr} portion of the Multiple Stress Creep Recovery (MSCR) test was developed as a high temperature rutting test to better reflect the improvements to permanent deformation resistance. The % Recovery portion was added to better control polymer distribution in asphalt cement. The Average Percent Recovery is one of the outputs from the MSCR test. In simple terms this test measures the ability of the binder to recover after subjected to multiple stress cycles in the DSR (think of how an elastic band rebounds back after it is stretched). The purpose of this test is to identify both the presence of elastomeric (rubber like) polymer modifiers in asphalt cements as well as the effectiveness with which they have been incorporated into the asphalt cement with respect to providing improved elasticity properties. Specifying MSCR Average Percent Recovery criteria promotes the use of elastomeric polymers (e.g. Styrene-Butadiene-Styrene also called SBS) to modify asphalt cement. Elastomeric polymers can impart improved strain tolerance properties to the asphalt cement binder. Strain tolerant asphalt cements have improved cracking endurance.

5. Ash Content Test

The Ash Content test method is intended to control the presence of inorganic materials which will not burn off (and hence leave an ash content) in asphalt cement binders. Currently the Ash Content Test is being used to control the dosage of Vacuum Tower Asphalt Extender (VTAE) also known as Re-refined Engine Oil Bottoms (REOB). Understanding the effects of VTAE on pavement performance is currently the topic of considerable research and debate. Current MTO specifications limit LS-227 Ash Content to 0.8% for all grades with the exception of PG XX-40 where the limit is 1.0%. Some municipalities limit ash content to 0.8% in -40 grades as well.

6. Recipe Specifications

Recipe specifications that specify how to modify binders (e.g. what type and how much polymers) may be considered by some as problematic. Opinions about using recipe specifications are divided. Some think that these types of specifications are in direct contrast to the performance-based specifications. It is also important to note that the implementation of PG specifications in Ontario from the inception was 'blind' to modification. This essentially means that binders are accepted based on specific criteria and not on the formulation. Others think recipe specifications, particularly with restrictions on the use of REOB, can be used until the research on the asphalt cement modifiers is completed, giving us a clear view of what the impact is and how to test the asphalt cement.

Asphalt cements are modified in order to meet specifications which cannot always be met by straight run asphalt cements. The type and method of modification used to modify asphalt cement binders can influence pavement cracking performance in ways that may not fully be captured by current physical property specifications. Complicating the issue is that implementation of increasingly complex specifications drives the

need for advances in the types of modifiers required, which then raises questions about the influence of these modifiers on pavement cracking performance.

It is understood that recipe specifications are a short-term or mid-term solution. Ideally, when performance specifications are finalized and a consensus is reached, these recipe specifications should be redundant.

A proliferation of rapidly changing and growing recipe specifications has emerged in a number of municipal specifications. The intended objective is to provide better quality and performance; however the nature and frequency of the changes to permitted modifiers and specified dosages suggests that the specifications are being developed without adequately understanding the impact on pavement performance, as well as the impacts on production and lay-down characteristics. Challenges with recipe specifications include a lack of standardized and validated methods to test for compliance to limits on types and dosages of modifiers in recipe specifications. Chemical analyses are subject to interpretation and valid limits have not been established. Testing variation and sources of contamination are also not well understood. In some cases materials which are not permitted as modifiers in a recipe specification are found in the very crude oils that are refined to produce asphalt cement.

Test Method Variability

Variability in testing between laboratories is inherent to all test methods. This variability is quantified by determining the Precision of the test method which establishes criteria for judging the acceptability of test results. Some test methods are prone to higher variability between labs than others.

While MTO uses their approved QA and referee laboratories to conduct acceptance testing, municipalities are not necessarily bound to do so. The subject of testing limits needs to be discussed. Municipalities may ask their lab to provide their correlation ranking or contact MTO for a list of laboratories currently used for referee testing. Test method variability should be considered when establishing meaningful asphalt cement specifications.

MTO Ontario Field Trials and Pavement Studies to Investigate Improved Asphalt Cement Specifications

Since 2003 many different trials/initiatives have been undertaken by MTO in order to assess field performance of pavements built using different asphalt cements:

1. Highway 655 Phase 1 Field Trial;
2. Highway 655 Phase 2 Field Trial;
3. Highway 417 Field Trial;
4. Study of Performance of Twenty Pavements in Eastern and Northeastern Ontario; and
5. Pilot projects using different specifications.

There is considerable debate by the industry regarding the conclusions that can be drawn from these projects. As we move forward with updating asphalt cement (binder) specifications, it is important that the test procedures being recommended and implemented continue to be properly validated through rigorous procedures. Data continues to be analyzed, but at this time there is considerable debate as to whether there are clear relationships between performance and the physical properties of the asphalt cements used, particularly with regard to Ash Content, MSCR, DENT and Extended BBR. While significant analysis has been completed, a meaningful assessment of specified binder properties as they relate to pavement cracking performance may yield more clarity.

An in depth and critical assessment of the issues, background information, and investigation outcomes relating to premature pavement cracking in Ontario is presented in Bulletin 2-A. This is a very complex issue and views on the selection and implementation of effective specifications vary.

It is the industry's opinion that specifying asphalt cement binders at a 98% low temperature reliability level has been shown to relate to good pavement cracking performance in Ontario field trials and pavement studies. This initiative may be one of the aspects worthy of consideration to improve pavement cracking performance.

MTO concludes that premature cracking failures, as they relate to asphalt cement, have been caused by some modifications which are not ruled out by current specifications. The MTO supports the implementation of the Extended BBR test as a compliment to the MSCR Percent Recovery, DENT, and Ash Content tests which currently form part of the provincial specification.

Municipalities are of the view that premature cracking failures as they relate to asphalt cement have been caused by low cost modifiers which are permitted by current specifications. Some municipalities support the banning of modifiers such as VTAE (REOB) in order to reduce the risk of potentially negative or unknown effects on pavement quality.

Industry believes that asphalt cement specifications should ultimately move towards tests which have been properly validated and relate to field performance in order to address premature cracking failures as they relate to asphalt cement. Industry contends that a critical assessment of Ontario field trials and pavement studies shows that tests such as the DENT and Extended BBR have not been properly validated and correlation to cracking performance is inadequate to move forward with implementation of the procedures. Industry views that the implementation of the full MSCR test (AASHTO M-332) and Ash Content, along with other improvements i.e. increasing asphalt cement content, implementation of the binder replacement ratio etc. will greatly improve the performance of HMA.

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There are different opinions about the use of DENT and Extended BBR tests and, if they are used, what the specified limits should be. This is one of the most urgent targets to be discussed and clarified. There are a number of municipalities and consultants that believe that it is critical to implement these tests. MTO is of the same opinion. At the same time there are many technically minded people who oppose the use of these two tests.

The Quality of Asphalt Pavement Task Force

In response to the concerns about the quality of asphalt pavement in Ontario, OHMPA formed the Quality of Asphalt Pavement Task Force. The purpose of this group comprised of industry experts, consultants and academics and representatives' municipalities and MTO is to assess these concerns and propose workable solutions that are scientifically sound and also practical. In response to this challenge, the task force has road owners' concerns in mind and has drawn on the expert options of the members of the group.

These and other findings and recommendations of the Quality of Asphalt Pavement Task Force will be published on OHMPA's website (www.ohmpa.org). For more information, please contact the OHMPA office at 905-507-3707 or by email at info@ohmpa.org.