STRATEGIES FOR IMPROVED DURABILITY

- **Specifying a higher minimum AC content** – Studies have shown that mixes with higher AC content outperforms those with lower AC content. Higher AC content is largely driven by increasing the minimum requirements for Voids in the Mineral Aggregate (VMA) during design and/or production. Since the VMA available is controlled by the aggregate properties, blend gradation, mixture viscosity and the compactive effort, a key to achieving the correct increase in AC content is to ensure the correct aggregate bulk specific gravity (G_{sb}) is used in the mix design and during production.
- **Lowering the Laboratory Compaction Effort (number of gyrations)** – Reducing the N_{design} requirement by 20 to 25 per cent **depending on the mix type and design traffic** is a proven strategy to obtain more AC in the mix, and has resulted in increased density in the field. However, research into mixes designed at different gyrations for some Superpave mixes, suggests that reducing *N_{design} does not necessarily impact on asphalt content*, but N_{design} does impact rutting resistance.
- **Lowering the air void content of the mix to allow more asphalt** – In this case, the design aggregate structure is selected based on 4 per cent air voids, but the final design AC content for that structure is selected at 3 per cent air voids by using the air void regression technique. This option is being evaluated in Ontario with recent modifications to BITU0025 (SP 103F03M) and BITU0026 (SP 111F06M).
- **Introducing cracking testing on the asphalt mixes prior to finalizing a mix design** – This consists of designing the mix for an intended application and service requirements then running performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate and location within the pavement structure. Some states such as Texas, Louisiana, California, new Jersey and Illinois have incorporated cracking and rutting tests into their specifications. Efforts are being made in Ontario towards better understanding of this option.
- **Superpave 5 Volumetric Mix Design Method** – This method requires that mixtures are designed to have the same density in the lab and in the field. Optimum binder content is chosen at 5 per cent air voids rather than the currently specified 4.0%, thus decreasing the in-place air voids target from 7 to 8 per cent down to 5 per cent. To maintain the same volume of effective asphalt content, the minimum VMA requirement is increased by 1.0%, and the design compactive effort is decreased to 50 gyrations. Ontario's experience with this method is limited.

In summary, increasing the AC content in asphalt concrete mixtures should be a high priority for improving pavement performance in Ontario. This can be encouraged by increasing the minimum VMA requirement, lowering the Ndesign requirements to increase in-place pavement density, exploring the air void regression mix design method, implementing mixture performance tests for "Balanced Mix Design" and quality assurance, or by advancing the Superpave 5 mix design system. Regardless of the method adopted, differences between the desired properties of the Job-Mix Formula (JMF) and the properties of the plant-produced asphalt mix **MUST** be checked and verified for compliance, and necessary adjustments should be made to minimize any variations and mitigate against consequent negative effects on the in-service pavement performance.

ONTARIO ASPHALT PAVEMENT COUNCIL

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The OAPC developed the TOP 10 List, from results of the Quality of Asphalt Review, which commenced in September 2018. The Quality of Asphalt Review was commissioned in the fall of 2017 and was managed by KPMG and consisted of analysis conducted by Texas A&M Transportation Institute (TTI).

ONTARIO ASPHALT PAVEMENT COUNCIL

top 10 list

WAYS TO GET MORE DURABLE HMA PAVEMENTS

#2 ENCOURAGE MIXES THAT HAVE HIGHER ASPHALT CEMENT (AC) CONTENT

The durability of an asphalt pavement is seen through its ability to resist factors such as aging of the asphalt, disintegration of the aggregate and stripping of the asphalt film from the aggregates. Asphalt pavements perform well when they are designed, produced and constructed to provide desired properties such as durability, impermeability, strength, stability, stiffness, flexibility, fatigue resistance, and workability.

The following checklist highlights provides best practices and recommendations for increasing the Asphalt Cement (AC) content, including strategies to address the issues with designing asphalt mixtures for improved durability.

AC CONTENT IMPACTS ON MIXES

- Low AC content results in fatigue cracking, dryness or ravelling and a brown dull pavement appearance, while excess AC content leads to bleeding, fat spots and low skid resistance. For virgin mixes, low AC contents are typically caused by one of the following:
  - asphalt absorption problems
  - increase in dust content, thus decreasing VMA
  - the loss of VMA during production and thus decreasing the AC content to meet the air voids requirement
  - production automation problems: pumps, weigh bridge, asphalt meter, aggregate moisture, etc.

In recycled mixes, low AC contents can be caused by above-mentioned problems, but can also be related to:

- increased total dust percentages due to RAP fines, thus decreasing VMA
- improper RAP proportions due to inaccurate RAP moisture content
- high moisture contents in RAP, hampering the softening of the RAP binder required to blend with virgin binder, thus coating "black rocks" and reducing the total binder content for the recycled mix

ENHANCING MIX DURABILITY

- The objective of any asphalt mix design process is to select materials in the right proportion and within economic parameters to obtain desired qualities and properties depending on purpose and other project requirements. To enhance durability vis-à-vis performance, general practice recommends:
  - designing the mix using a dense gradation of sound, tough, moisture-resistant aggregates;
    This enhances impermeability due to closer contact among aggregate particles. Sound, tough aggregates provide resistance to disintegration under traffic loading.
  - maximizing the asphalt film thickness on the aggregate; and
    Thick asphalt films do not age and harden as rapidly as thin films. Also, increased film thickness effectively seals off a greater percentage of interconnected air voids in the pavement, making it difficult for water and air to penetrate.
  - compacting the mixture to be impervious.
    As low as 5 per cent in-place voids, depending on Nominal Maximum Aggregate Size (NMAS) and gradation.

INDUSTRY'S SHORTCOMINGS

- Figure(s) 1 and 2 illustrate design shortcomings in practices with gradation selection of specific Superpave mixtures revealed from the "Quality of Asphalt Review (QAR)". The gradation of the aggregate, shown in green, follows the line of maximum packing and there is little room left for the AC. This practice also allowed mix designers to sometimes bend the gradation to go below the line of maximum packing, effectively limiting room for the asphalt binder in the mixture, and leading to mixes that were more susceptible to pre-mature cracking. All the mixtures examined in the "Quality of Asphalt Review (QAR)" had asphalt content values ranging between 4.5 and 5.0%. For a cold climate like Ontario, the report expects to see asphalt contents of 0.5 to 1.0% higher at least.

Graphs are retrieved and redrawn from ORBA's 2018 Quality of Asphalt Review Report.

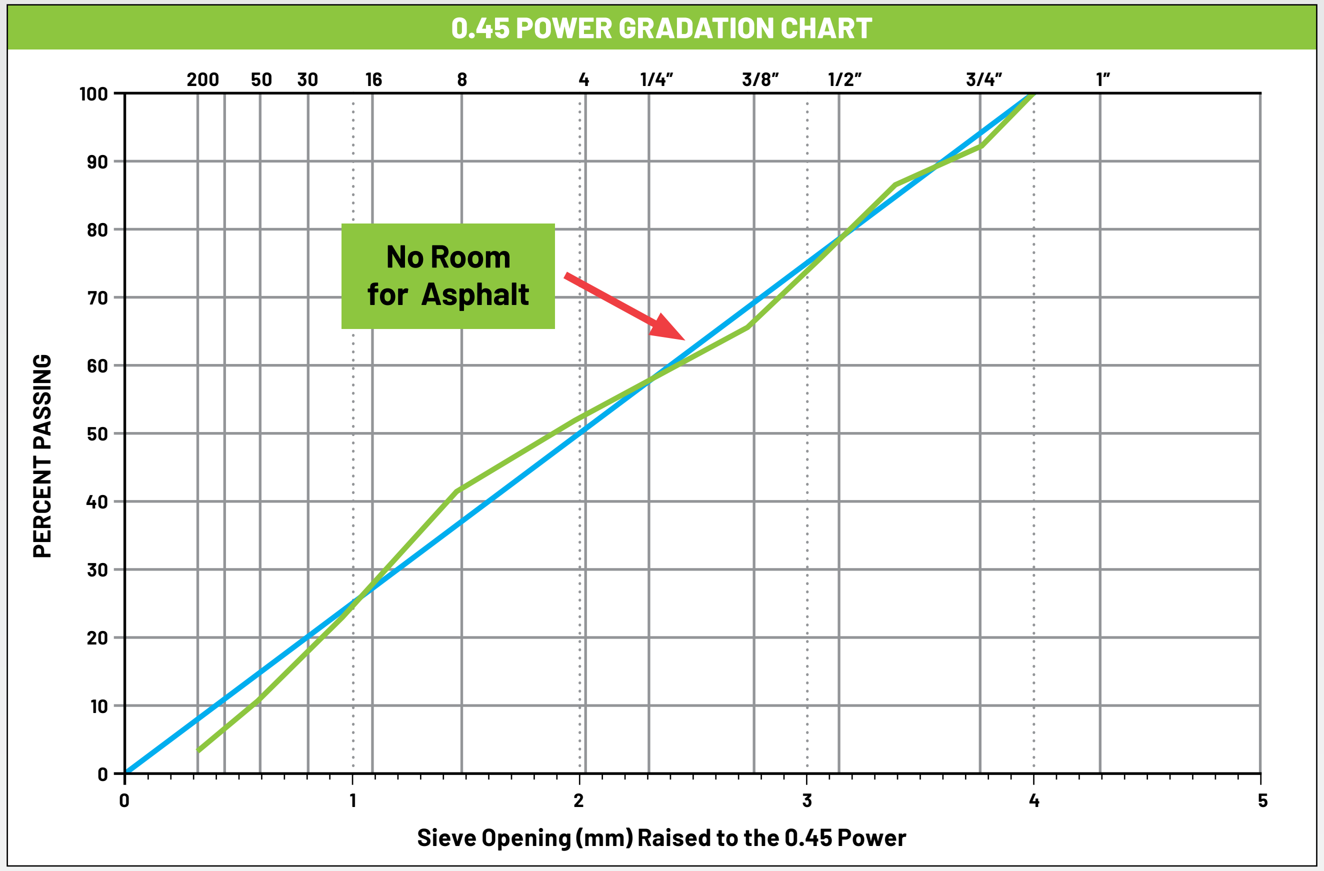

***Figure 1** Example of Dense-Packed Gradation*

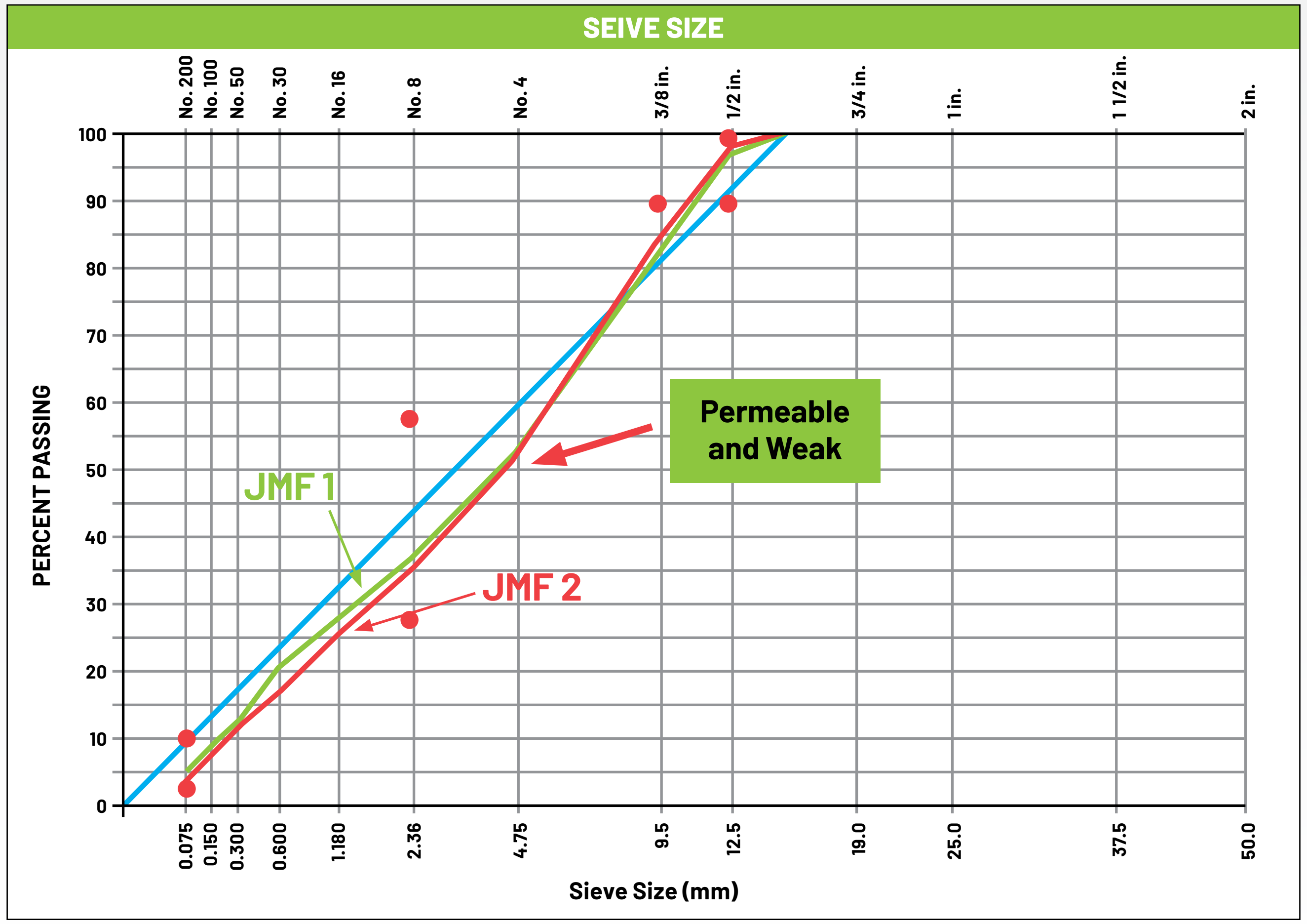

***Figure 2** Example of Coarse Gradation*