NZTA M32 NOTES: 2021

NOTES TO THE SPECIFICATION FOR HIGH MODULUS ASPHALT

New Zealand Government

1 GENERAL

High modulus asphalt, commonly termed EME Class 2, or EME 2, from the French Enrobé à Module Élevée, is a structural asphalt paving material developed in France during the 1970s. It is a high modulus, fatigue-resistant material suitable for heavy duty pavements where traffic volumes and loads are high, and there is an increased need for deformation resistance.

EME 2 has a very good resistance to permanent deformation combined with a very high stiffness especially at elevated temperatures. EME 2 mixes also perform well in fatigue due to the relatively high binder content of the mix.

EME 2 is used as a base or intermediate structural layer in a pavement. It is not suitable as a wearing course as it will not provide adequate texture and wet skid resistance for trafficking.

2 MATERIALS

2.1 Aggregates

Aggregates suitable for asphalt production and as specified by M10 and M27 may be used for EME 2 except that natural or uncrushed aggregate components, including natural sands, are specifically excluded. Some additional criteria, wet/dry strength variation and ethylene glycol weathering have also been included to ensure high quality, durable aggregate are used for EME 2.

NZTA T20, the Ethylene Glycol Accelerated Weathering Test is useful for detecting the presence of deleterious smectite clays in aggregates. However “false positives” can occur with some materials, or the volume of smectites can be low, so where the aggregate exceeds the maximum level in Table 2.1 of the specification, further advice and/or testing is recommended to determine if the non-compliance is material. The Waka Kotahi Lead Advisor Pavements, or Principal Surfacings Engineer should be contacted for advice and direction in these instances.

Note: The Wet/Dry strength variation maximum vale of 35% for the coarse aggregate has been based on values published by other jurisdictions. It may be subject to amendment depending on results obtained for New Zealand aggregates and their performance in EME 2.

The aggregate blend and resultant particle size distribution are chosen by the contractor. The only criterion is that combined aggregates and added filler (if used) must all pass through a 19.0mm test sieve.

2.2 Binder

EME 2 derives its unique properties from its very stiff binder. The binder is specified empirically, using traditional criteria such as Penetration (ASTM D5), Softening Point (ASTM D36) and Viscosity (ASTM D2171). This empirical approach is consistent with the original French approach for specifying EME 2 binder.

The specified criteria mean that the binder will be an air-blown material, or possibly a heavily polymer-modified binder. There are two grades specified: a “10/20 Grade”, being the harder, and a “15/25 Grade” being less hard. The grade numbers are the range in which the Penetration must fall – so while the binders are non-traditional road binders, they are Penetration-graded.

Table 2.3 of the specification sets out the limits for the binder properties. Some criteria for the 10/20 grade are designated “report only” as limits have not yet been established. The limits are derived from Austroads research, AP-T249-13, located at https://austroads.com.au/publications/pavement/ap-t249-13.

In addition, Table 2.3 requires reporting of the Multiple Stress Creep Recovery (MSCR) of the binder following aging in the Rolling Thin-Film Oven. This was added into the specification to allow performance-based characterisation of the EME 2 binder consistent with the approach of NZTA M01-A specification. The MSCR is related to the deformation resistant properties of the binder hence it is considered to be a useful parameter to measure and report.

Because EME 2 is an empirical “recipe-based” material binders should comply with both the philosophy and the specified properties of Table 2.3. Therefore, it is preferred that an air-blown (i.e. heavily oxidised) binder is used rather than alternatives such as polymer-modified binders (PMBs). This is not to exclude PMBs – but if such a binder is proposed, good evidence including additional testing should be provided to give assurance that the PMB will perform in the EME 2 as required. The advice of the Waka Kotahi Principal Surfacings Engineer should be sought in these instances.

3 MIX DESIGN

EME 2 mixes are designed in the laboratory in a similar way to conventional asphalt mixes. The final mix composition is based on volumetric criteria and confirmed by performance-related testing.

Test specimens are blended and compacted in a gyratory compactor. The compaction conditions differ from those normally used: the vertical loading stress, the compaction angle and rate of compaction are based on those used in France. In future it may be that the compaction conditions of AASHTO T 312 (or ASTM D6925) can be used but this has not yet been demonstrated to give similar specimen densities, so the French parameters should be used until this work has been done.

The minimum binder content is set by a calculated richness modulus. The richness modulus is related to the thickness of the binder film on the total aggregate surface area and serves to ensure that the EME 2 mixes are relatively binder-rich and consequently have good fatigue lives.

Design air voids for the EME 2 mix is 3.0 – 4.0%, measured by water displacement. Note that some other specifications from other jurisdictions specify air voids by mensuration, and their design air voids level is correspondingly higher. This offset is due to the inclusion of surface voids when using mensuration and is an artefact of testing rather than any substantive difference in the EME 2 design process.

This design air voids range has been chosen to place a limit on the upper characteristic core air voids content of 7.0% maximum and limit the lower characteristic core air voids level to 1.0% minimum. While this design air voids range is conservative, it will control layer permeability while allowing some void volume for binder expansion.

Specification table 3.1 requires performance-related properties to be determined for all EME 2 mix designs. Deformation resistance is quantified by the Wheel Tracking test, as used for conventional asphalt materials, but with amended requirements. These are:

(a) A lower maximum rut depth at the normal tracking parameters, and;

(b) An additional criterion for increased tracking cycles.

Flexural stiffness and fatigue testing at AGPT-T274 (located here) is required. Some jurisdictions set a minimum flexural modulus (50με, 15°C, 10Hz,) of 14000 MPa. Some anecdotal evidence suggests that use of the stiffer 10/20 binder is needed to achieve this stiffness.

Table also requires resilient modulus tested using the method of AS 2891.13.1 to be reported. This is to provide a benchmark value during the mix design process so that plant produced EME 2 can be tested and shown to have moduli similar to the benchmark value for quality control purposes.

A production trial is required to confirm that the asphalt plant will produce the EME 2 with volumetrics within specified limits of the design air voids.

4 PLACEMENT

4.1 Treatment Selection

EME 2 asphalt mixes require the support of, and must be placed over low deflection, relatively stiff sub-base layers. The sub-base layer must have a tack coat or a chip seal for good bonding and to prevent slippage of the EME 2 layer.

A wearing course asphalt layer is also required. This is to provide texture as the EME 2 asphalt may not have sufficient texture for compliance with NZTA T10.

4.2 Construction

Manufacture, storage, transport and placement are generally the same for normal asphalt mixes except production and placement temperatures can be higher due to the binder characteristics. However, the use of high viscosity (low Penetration) binders in EME 2 mixes mean that care must be taken to maintain mix temperature prior to placement and to complete compaction before the mix cools and becomes unworkable.

The appearance of the finished mat should be uniform and without visible areas of segregation. The surface may appear glossy and binder-rich.

4.3 Testing of Cores

The determination of asphalt thickness and compaction is by measurement of core specimen thicknesses and air voids respectively. The compliance of thickness and air voids is determined by a statistical process based on a proportion defective of 10% (consumer's risk) and a probability of acceptance of 90% (producer's risk).

Core air voids are calculated from the core Bulk Specific Gravity (relative density) and the Maximum Theoretical Specific Gravity (relative density) using ASTM D3203.

There are four test methods generally used to measure core specific gravity, but they return different bulk specific gravities, and consequently air voids, depending on core surface texture and amount of interconnected voids, if any. These methods are ASTM D2726 (water displacement), ASTM D6752 (vacuum sealing), ASTM D1188 (coated specimens) and ASTM D3549 (mensuration).

The default method for determining core density is ASTM D2726. However, this test method requires the use of alternative methods for determining specimen volume if core water absorption exceeds the maximum specified level. These alternative methods can return different values for specimen volumes depending on the specimen surface texture. Consequently, the air voids results may include some or all of the specimen surface texture and return higher values than would have been obtained using ASTM D2726 (water displacement).

It is required that testing laboratories report the voids derived from water displacement even if water absorption exceeds the maximum level. This requirement is due to the air voids acceptance criteria being based around voids derived from water displacement. The use of other methods introduces bias into the voids results and could cause compliant asphalt to be inappropriately rejected.

Air voids results from cores that exceed the maximum water absorption should be suitably annotated. All the core specimens in a set of cores (i.e. including those with water absorptions greater than 2%) must be used when calculating the lot characteristic values and compliance.

Air voids results for core specimens with high absorptions will be biased down as the water can access internal voids within the specimen. Thus, if the Upper Characteristic Value for a set of core air voids results exceeds the maximum allowable value then there is good evidence that the lot is non-compliant and appropriate remedial actions should be taken.

Maximum specific gravity values used to calculate specimen air voids should be derived from the testing of mix from the production lot rather than using values obtained during the mix design process. If there are several tests over the production lot, then the average maximum specific gravity should be calculated and used.

Engineers must carefully review and understand the basis of core specimen air voids and if necessary, seek advice from qualified and experienced asphalt technologists so that asphalt pavements are not inappropriately accepted or rejected due to test method effects.

It is recommended that core specimens are individually photographed beside a scale rule.