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Technical Data
Asphalt production consistence

Importance to pavements

The ability of MacRebur products to simultaneously improve deformation resistance (eg. wheel track rutting), the structural contribution (eg. stiffness modulus) and asphalt fracture resistance (eg. fatigue life) is well established. However, these benefits are only valuable if the MacRebur products are uniformly distributed through the asphalt mixtures so that all of the asphalt produced receives the same level of improvement.

Asphalt variability

Variability in asphalt is complex and stems from many factors. Even nominally identical asphalt produced at the same plant with the same raw ingredients will show variability due to slight differences in the incoming aggregate gradings and variations in the production temperature and mixing efficiency.

Importantly, different asphalt tests will be more or less sensitive to these changes, meaning that one test may have low variability in results while another test may produce highly variable results. For example asphalt fatigue life testing is highly variable compared to asphalt modulus.

Method of evaluation

The production consistence associated with MacRebur products is evaluated by comparing the variability of various asphalt properties, measured multiple times on nominally identical asphalt with MacRebur products. The results are compared to the variability of results for otherwise identical asphalt without MacRebur products. The primary indicator of variability is known as the 'coefficient of variation' which is the standard deviation divided by the average of any number of replicate test results. The greater than number of replicate results, the more reliable the analysis.

MacRebur production consistence

In Australia, eight replicate samples of a dense graded 14 mm sized asphalt were produced in a drum mixer asphalt plant, from the same aggregate and to the same mixture design, but with the following bituminous binders:

- C320. Unmodified bitumen, similar to 50-70 penetration bitumen.
- M1000. Acid modified 'multigrade' bitumen.
- C320 with 6% MR 6 bitumen replacement.
- C320 with 6% MR 10 bitumen replacement.

The results indicate that MacRebur modified products had comparable variability to the other materials, indicating no significant difference in the production consistence.

Test	Coefficient of Variation			
	C320	M1000	MR6	MR10
Marshall Stability (kN)	7.9%	11.1%	9.4%	6.2%
Marshall Flow (mm)	12.3%	15.3%	15.4%	11.9%
Resilient Modulus (MPa)	6.0%	4.1%	5.9%	4.2%

Similar work in the UK tested four replicate samples of a 10 mm sized stone mastic asphalt produced with:

- 40-60 penetration bitumen.
- C320 with 6% MR 6 bitumen replacement.
- C320 with 8% MR 6 bitumen replacement.
- C320 with 10% MR 6 bitumen replacement.

The testing included indirect tensile stiffness modulus and asphalt fracture toughness. The coefficients of variability for the MacRebur products are again comparable to those associated with 40-60 bitumen, as shown below, indicating uniform distribution of the products.

Test	Coefficient of Variation			
	40-60	MR6	MR8	MR10
Fracture toughness ($N/mm^{3/2}$)	4.2%	6.1%	6.5%	5.1%
Stiffness modulus (MPa)	6.4%	7.2%	5.6%	6.7%