MEASURING ASPHALT TEMPERATURE VARIATION USING THERMAL IMAGING

1. INTRODUCTION

This Technical Note provides advice on the causes and detection of temperature segregation in asphalt mixes as an aid to improvement of asphalt quality by reduction of variation in temperature. Severe temperature segregation can be an indicator of particle segregation as well as a potential source of variation in asphalt density with a potential for reduced service life and increased surface roughness.

Particular reference is made to two studies undertaken in the USA that used thermal imaging of asphalt to reveal temperature variations in asphalt as it was being handled and spread.

The outcomes of first study were published as Technical Paper T-134 by Brock and Jakob of Astec Industries\(^1\).

The second study has been recently completed by the National Centre for Asphalt Technology (NCAT)\(^2\).

2. CAUSES OF SEGREGATION

Two forms of segregation in asphalt mixes are particle segregation and temperature segregation. Particle segregation tends to occur:

- In large size asphalt mixes.
- As a result of poor operation of surge storage and truck loading systems.
- At the start and end of truck loads.
- As a result of paver operation through uneven flow of material.
- As a result of poor handwork.

Temperature segregation which tends to occur in a cyclic manner with each truckload is the result of:

- Loss of heat from the sides, top and bottom of the load during transport.
- Transfer of that cool material to the sides of the paver hopper.
- Uneven feeding of the cool material from the sides of the hopper, mainly when emptying the hopper after each load.

3. TEMPERATURE SEGREGATION STUDIES

Equipment

Thermal imaging equipment used in the studies incorporates an infrared scanner to record surface temperature as a camera type image. Images can be viewed in real time and stored for later analysis. Use of a suitable colour gradation and temperature range provides a vivid picture of temperature variation. Spot temperatures can also be shown on the image.

Findings

In the Brock and Jakob study, the camera was used to give a graphic picture of temperature differential at the following stages of the construction process:

- During truck loading.
- In the truck on arrival at site and discharging to the paver.
- In the paver hopper.
- In the asphalt mat behind the paver.

The temperature images were recorded for a variety of paving operations, including conventional paving, windrowing and use of a materials transfer device.

The images in the truck arriving on site illustrated the existence of cooler material in zones adjacent to the truck sides and, to a lesser degree, across the surface of the load (see Figure 1). Within the paver hopper, cooler zones developed within the wings of the hopper and around its edges (see Figure 2). The temperature of material from these zones was tracked through the paver onto the freshly placed mat where it showed as cooler zones in the mat (see Figure 3).

Samples taken from areas identified as cooler were tested for particle segregation, and cool spots in the mat were marked and tested for density. Areas of significantly lower temperature were shown to correlate with lower density and demonstrated the importance of managing the mix supply and paving operations to minimise the development of significant variation in temperature of the mix.

A particular interest of the Brock and Jakob study was the effect of using a materials transfer device - a self-propelled device that travels in front of the paver and into which the trucks discharge the mix. Provision is made for re-mixing of asphalt in the transfer hopper, thereby reducing segregation.
and temperature differential levels that may have occurred during truck loading and transport. It also allows a steady flow of asphalt from the transfer device through the paver to the paver screed that is independent of delivery trucks.

Thermal imaging of the mat was able to show that the use of a materials transfer device resulted in a significant improvement in uniformity of temperature in the freshly spread asphalt behind the paver.

In the NCAT study it was found that, although thermal imaging could not distinguish between grading and temperature segregation types, it could be used to indicate areas where further testing might be required as a result of large temperature differentials, or to indicate likely characteristics associated with segregation for various temperature differentials as follows:

- **10 to 16°C** low (minimal increase in air voids or decrease in mix stiffness)
- **17 to 21°C** medium (moderate increase in air voids and decreased mix stiffness)
- **> 21°C** high (increase in air voids of more than 4% and substantial decrease in mix stiffness)

4. **MINIMISING TEMPERATURE DIFFERENTIALS**

Some of the means of minimising damage from the effects of temperature differential include:

- Good work practices, in general.
- Minimising the use of handwork.
- Careful operation of pavers to maintain consistent materials flow, to control segregation and to avoid accumulation of dead pockets of cooler asphalt.
- Reducing cooling of materials in trucks and pavers by avoiding excessive transport and site delays.
- Effective insulation of loads transported for longer distances.
- Using a materials transfer device.

5. **CONCLUSION**

The thermal imaging camera has been be used to good effect to illustrate the level of temperature variation at various stages through the asphalt paving operation and to provide an indicator of those aspects of the operation that need to be closely and carefully managed to minimise that variation.

6. **REFERENCES**


7. **CONTACT**

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