Asphalt Compaction

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INTRODUCTION

Proper compaction is essential for the performance of hot mix asphalt. Dense graded mixtures in particular, rely on high standards of compacted density for structural strength, fatigue life, resistance to deformation and durability.

Compaction of asphalt mixes is a complex interaction between the workability of an asphalt mix and compactive effort.

The most important factor in workability is the temperature of the asphalt mix during the compaction process. Asphalt temperature is influenced by placement temperature and rate of cooling. Factors affecting cooling are discussed below. Workability of an asphalt mix is also influenced by the mix characteristics and type of binder.

Compactive effort relies on the selection of compaction equipment and compaction procedures.

Other factors that can also have an effect on achieving satisfactory density include variations in temperature and asphalt uniformity through segregation, handwork, and formation of paving joins.

A detailed description of all the above factors is beyond the scope of this 'pavement work tip' which provides an outline of the key factors and some selected references to further sources of information.

ASPHALT COOLING RATE

Cooling of asphalt is a combination of loss of heat into the pavement base and into the atmosphere. Major factors affecting the time for a layer of asphalt to cool to the minimum temperature at which compaction remains effective include:

- **Laydown temperature:** The hotter the asphalt leaves a paver, the longer it will take to fall below the minimum effective compaction temperature. However, too high a temperature can cause binder hardening, mix tenderness and binder fuming.
- **Pavement temperature**: The colder the pavement, the quicker heat will be drawn out of the asphalt. Heat loss can be particularly high on wet or moist pavements or on concrete and steel surfaces.

Key Summary

This issue of "pavement work tips" provides an outline of some of the more important factors in achieving effective asphalt compaction.

- **Layer thickness**: Thicker layers cool more slowly. Thin layers of asphalt cool quickly.
- **Wind speed:** The rate of transfer of heat to the atmosphere is increased by higher wind speeds. Cooling rate is further increased by the presence of surface moisture.

A guide to the rate of cooling taking into account the above factors is provided in Pavement Work Tip No. 46.

INFLUENCE OF BINDER TYPE AND MIX TYPE

Binder type will influence the workability of an asphalt mix and hence the amount of compactive effort required and the temperature of the asphalt mix at which compaction remains effective. Work Tip No. 13 provides a guide to the influence of binder type on the temperature required for mixing, spreading and compaction of asphalt mixes.

Workability can also vary with mix type. Larger nominal sizes and coarse gradings generally require greater compactive effort than smaller nominal sizes and finer mixes. Texture and shape of crushed aggregates are also relevant as well as the use of natural sands which may be used to improve workability where high resistance to deformation is not a critical requirement.

SEGREGATION

High standards of compacted density require uniform asphalt materials in terms of both temperature and mix composition. Factors influencing smooth and uniform paving and reduction in temperature variation are described in Pavement Work Tip No 3.

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Segregation can also arise through poor practices involved in mixing, transport and placing of asphalt mixes. Generally this is seen in areas of coarse texture lacking in fines but can also occur in areas of fine, binder-rich materials. Coarse textured segregated materials result in reduced density, increased air voids and poor surface appearance.

A guide to identifying the causes of segregation in asphalt mixes and minimising its occurrence is provided in AAPA Advisory Note 18.

HANDWORK

Hand spreading of asphalt increases the risk of asphalt segregation. Reduced compacted density can also be the outcome of delays in rolling while waiting for hand spreading and finishing is to be completed. A guide to good practice in undertaking handwork is provided in Pavement Work Tip No 26.

PAVING JOINTS

Construction of longitudinal and transverse joints is a critical asphalt paving issue. Joints are a potential source of weakness and must be properly formed and compacted to ensure adequate density and possible increased permeability. Transverse joints are also a potential source of increased segregation, particularly if handwork is excessive. Pavement Work Tip No 4 provides an outline of the requirements for good practice in construction of asphalt joints.

COMPACTION EQUIPMENT AND PROCEDURES

The basic roller most commonly used for the compaction of asphalt mixes is the tandem, steel-wheeled vibratory roller.

Compacted density is achieved through a combination of contact pressure and amplitude and frequency of vibration. Roller manufacturers provide guidelines for selection of forward speed, vibration frequency and amplitude for different asphalt mix types, layer thickness and placing conditions.

Matching speed of rolling to frequency of vibration is an important factor in compaction effectiveness. Good practice requires the establishment of roller patterns and number of passes based on monitoring of density outcomes for the types of asphalt mix being placed.

Roller capacity must also be matched to the rate of delivery of asphalt and asphalt paver speed. A guide to calculation of asphalt paver forward speed and roller capacity based on asphalt rate of delivery is provided in Pavement Work Tip No 31.

Multi-tyred rollers are used to further increase the density of asphalt mixes compacted with steel-wheeled rollers. Care is required to avoid pick-up on rubber tyres. Preferably, tyres should be warmed on previously placed warm surfaces before rolling fresh hot materials.

Tandem, steel-wheeled vibratory roller.

Multi-tyred roller.

Use of tyre coating agents and cleaning of tyre surfaces, are also important practices.

Steel-wheeled rollers in non-vibratory mode may be used to finish rolling and remove surface marks, etc.

Vibrating plate compactors are used to supplement rolling in areas inaccessible to the larger machines.

TESTING AND MONITORING OF ASPHALT DENSITY

Techniques for testing the density of compacted asphalt mixes are described in Pavement Work Tip Nos. 41 and 42.

Nuclear density measurements are particularly useful in providing timely information on the effectiveness of the compactive effort being applied.

REFERENCES

Pavement work tip No. 3 *Asphalt Riding Quality.*

Pavement work tip No. 4 *Asphalt Joints.*

Pavement work tip No. 13 *Temperature Characteristics of Binders in Asphalt.*

Pavement work tip No. 26 *Asphalt Handwork.*

Pavement work tip No. 31 *Asphalt Paving Speed.*

Pavement work tip No. 41 *Coring of Asphalt Pavements.*

Pavement work tip No. 42 *Nuclear Density Testing of Asphalt Pavements*

Pavement work tip No. 46 *Asphalt Cooling Rates*

AAPA Advisory Note 18 – *Asphalt Segregation.*

*For more information on any of the construction practices discussed in "**pavement work tips**", please contact either your local AUSTROADS representative or AAPA:*
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