

# Temperature Characteristics of Binders in Asphalt

pavement work tips - No 13

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## INTRODUCTION

The viscosity (or flow) characteristics of bituminous binders have a significant influence on the handling properties of asphalt mixes, including:

- mixing
- cohesion
- binder drain-down during storage and transport
- compaction.

Binder viscosity varies with temperature and different binders require different temperatures to achieve the same handling properties. Polymer modified binders, in particular, increase in viscosity at a much faster rate on cooling than normal paving grade bitumens.

Flow characteristics of binders can also be altered using 'warm mix' technologies such as foaming of binder during mixing or flow modifying additives. This 'pavement work tip', however, refers only to conventional asphalt manufacture and placing.

Figure 1 shows typical relationships between viscosity and temperature for three different binders and the ranges of viscosity for mixing and effective compaction.

Table 1 provides a ready reference of the temperature, and associated viscosity, for various binders to enable effective mixing and placement of asphalt.

## MIXING

The binder is heated to enable it to flow so as to achieve proper coating and "wetting" of aggregates. It must not be so fluid as to cause binder drain-down or lead to segregation or inadequate cohesion of the mix. Overheating or extended mixing times can also cause hardening of the binder due to oxidation or breakdown of polymers.

Good mixing can generally be achieved within a binder viscosity range of 0.08 to 0.2 Pa.s with a target value of 0.1 Pa.s preferred.

Binder drain-down is not generally an issue with dense graded asphalt but may need to be considered with the higher binder contents associated with open graded and stone mastic asphalt mixes.

In open graded asphalt it is common practice to limit the maximum temperature of the mix to prevent drainage by providing a minimum binder viscosity of about 0.12 Pa.s. Increased resistance to binder drain-down can be obtained with fibres and polymer modified binders.

Stone mastic asphalt is often handled at slightly higher temperatures than open graded asphalt in order to achieve workability, in which case fibres are nearly always used to reduce binder drain-down.

## ASPHALT COMPACTION

Compaction of asphalt while it remains workable is a vital requirement for placement of all hot mix asphalt.

Compaction should not commence unless the mix has sufficient cohesion to support rollers and avoid excessive displacement. Generally this relates to a minimum binder viscosity of about 0.25 Pa.s.

Steel-wheeled rolling has greatest effectiveness in the range 0.25 to 10 Pa.s, while multi-tyre rolling can continue up to about 100 Pa.s. Multi-tyred rolling cannot generally commence until viscosity has increased to about 2 Pa.s to avoid excessive pick-up. The minimum compaction temperature in Table 1 is based on a viscosity of 10 Pa.s, beyond which the effectiveness of compaction falls rapidly.

## POLYMER MODIFIED BINDERS (PMBs)

It is important to appreciate that the stiffness of PMBs can increase more rapidly than unmodified bitumen on cooling and, consequently, influence the required compactive effort and time available for compaction. In some instances, they may also be handled at marginally higher viscosities than unmodified bitumen and the temperatures in Table 1 have been adjusted to reflect that practical experience.

### Key Summary

*This issue of "pavement work tips" outlines the influence of temperature and binder viscosity on handling properties of asphalt using various binders.*



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FIGURE 1: BINDER VISCOSITY/TEMPERATURE RELATIONSHIP

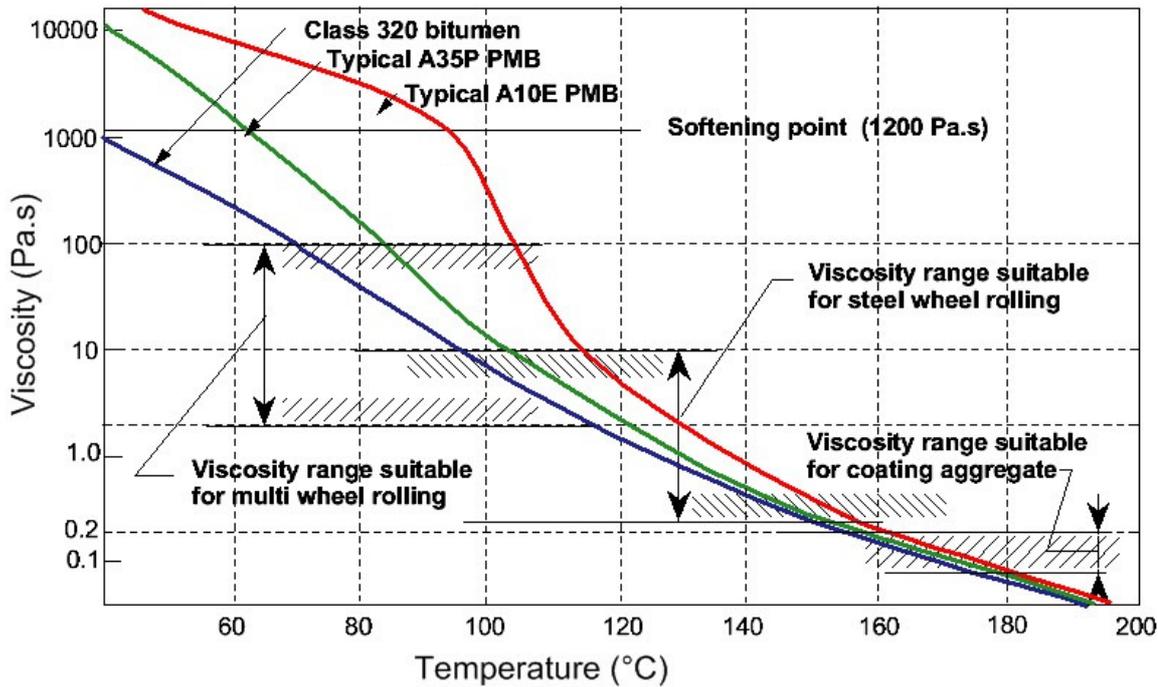


TABLE 1: TYPICAL BINDER TEMPERATURE/VISCOSITY RELATIONSHIPS

Binder Class		Temperature (°C) <sup>1</sup>					
		Softening Point (1200 Pa.s)	Minimum for final rolling (100 Pa.s)	Minimum for effective compaction <sup>2</sup> (10 Pa.s)	Maximum for Compaction (Cohesion) (0.25 Pa.s)	Maximum to prevent drainage in OGA <sup>4</sup> (0.12 Pa.s)	Optimum Mixing <sup>2</sup> (0.1 Pa.s)
Bitumen	170	45	65	90	140	150	160
	320	48	70	95	150	160	165
	600	52	75	100	160	n.a.	170
Multigrade	M500/170	55	75	100	165	165	170
	M1000/320	60	75	100	165	170	170
PMBs	A35P	62	85	105	150	155	170
	A25E	58	80	105	150	150	155
	A20E	77	95	115	155	155	160
	A15E	94	110	120	160	160	165 <sup>3</sup>
	A10E	97	115	125	160	160	165 <sup>3</sup>

- Notes:
1. Temperatures are typical of relevant binder classes in about middle of classification range.
  2. Refer comments on polymer modified binders in text.
  3. A maximum temperature of 165°C is generally recommended in the AAPA Guide to safe use of SBS binders to avoid fuming, unless otherwise recommended by the binder supplier (refer AAP Advisory Note 7).
  4. Fibres can inhibit drainage at higher temperatures.

## REFERENCES

- AAPA (1998) HS&E Guide No 5 – *Guide to safe use of SBS*.  
 AAPA Advisory Note 7 – *Guide to the Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt*.

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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