

## ASPHALT COMMITTEE

### Technical Note: Penetration and Viscosity Grading of Bitumen

GM Bosma, R Patience: December 2005

#### 1 Introduction

Bitumen manufactured as a binder for bituminous mixes (hotmix asphalts and cold mixes, as well as chip sealing) is specified in various ways internationally. New Zealand uses the Penetration test (ASTM D5) to define the grades of bitumen specified by TNZ M/1, whereas Australian Standard AS 2008 uses the Viscosity test to define bitumen grades used in Australia. These different means of specifying bitumen grades have given rise to differences between the bitumens manufactured in New Zealand with those in Australia.

This technical Note is intended to briefly outline these differences, and suggest some approximate parallels between the grades manufactured.

#### 2 New Zealand Bitumen

Bitumen manufactured in, or imported into New Zealand, for use as a binder for pavement construction is required to comply with TNZ M/1 specification. M/1:1995 uses the Penetration test (ASTM D5) to define four grades of bitumen:

Grade	General Application	Physical Characteristic
180/200	Chip sealing	Soft ↓ Hard
130/150	Chip sealing	
80/100	Hotmix asphalt binder, chip sealing	
60/70	Hotmix asphalt binder	

The Penetration test dates from 1888 and is simply a means for grading bitumens at ambient temperature. The test is carried out under laboratory conditions at 25° C, and determines the depth that a weighted needle sinks into a bitumen specimen over 5-seconds. Softer bitumens allow the needle to penetrate to a greater depth than do hard bitumens, thus the higher the Penetration grade in M/1, the softer the bitumen.

Penetration is measured in tenths of a millimetre. Thus 180/200-grade bitumen is required to have a needle penetration between 18 and 20 millimetres; similarly the harder 60/70-grade has a depth of penetration between 6 and 7 millimetres.

While this Penetration test is old-fashioned and crude, there are some distinct advantages in persisting with it as a means of grading bitumens:

- The test is carried out at 25° C, which is close to the average pavement surface temperature in New Zealand. It therefore gives some measure of control of the bitumen properties at average pavement temperature.
- Temperature susceptibility (change in bitumen consistency with temperature) of the bitumen can be controlled by comparing Penetration test results at 25° C with higher-temperature tests such as Softening Point and Viscosity.

The Penetration test is still widely used internationally to specify grades of bitumen.

### 3 Australian Bitumen Grades

Bitumen is refined in Australia to comply with Australian Standard AS 2008. In contrast to TNZ M/1, AS 2008 uses the Viscosity test at 60° C to define four grades of bitumen used for pavement construction. Viscosity is a measure of consistency, so the higher the viscosity number, the harder the bitumen is.

Grade	Viscosity at 60° (Pa.s)	General Application	Physical Characteristic
Class 50	40 - 60	Rarely used	Soft ↓ Hard
Class 170	140 - 200	Chip sealing	
Class 320	260 - 380	Hotmix asphalt binder, chip sealing	
Class 600	500 - 700	Hotmix asphalt binder	

Four grades, or "Classes" are defined. The Class "number" is the mid-point of the viscosity limits at 60° C; i.e. for Class 170 bitumen, the viscosity is specified to fall between 140 and 200 Pa.s, with the mid-point between these limits being 170 Pa.s.

There are advantages in taking the viscosity-grading approach to specifying bitumen, as compared with Penetration grading:

- Viscosity is a fundamental property, whereas Penetration is an empirical test. Thus, viscosity testing is independent of the test system and the sample size.
- The viscosity is tested at 60° C, which is generally regarded as the maximum pavement temperature in summer (although this may be exceeded in the northern States of Australia).
- Temperature susceptibility (change in bitumen consistency with temperature) of the bitumen can be controlled by comparing viscosity test results at different temperatures (60° and 135° C for AS 2008) and also by the use of the Penetration test.

AS 2008 continues to use the Penetration test to control bitumen consistency at 25°, but unlike TNZ M/1, does not specify upper and lower limits.

### 4 Grade Equivalence

Because TNZ M/1 specifies bitumen grades at 25° by Penetration, and AS 2008 specifies grades at 60° C using Viscosity, the bitumens available in New Zealand are not exactly equivalent.

In addition, Australia has several crude oil refineries using different refining techniques to produce AS 2008 bitumens whereas New Zealand has only one refinery. Thus it is difficult to exactly compare

bitumen grades between the two nations, and TNZ M/1 compliant bitumen will not necessarily comply with AS 2008 (and vice versa).

Nonetheless, approximate equivalencies can be drawn as tabulated below. Note that it is not suggested that M/1 bitumen will meet AS 2008, nor will AS 2008 grades necessarily meet M/1.

Approximate Bitumen Equivalencies	
TNZ M/1 Grade	AS 2008 Grade
180/200	Class 50
130/150	No equivalent
80/100	Class 170
60/70	Class 320
40/50	Class 600

Note that TNZ M/1:1995 does not specify a 40/50-grade of bitumen but it is manufactured in New Zealand for blending with 180/200-grade to make harder bitumens.

## 5 Conclusions

There are technical differences in the way bitumen grades are specified between New Zealand and Australia. There are advantages and disadvantages with either way and neither way is clearly better than the other. International specification (for example ASTM D946 and ASTM D3381) use either method.

These technical differences have given rise to actual differences in the bitumens produced in Australia and New Zealand. There are historical reasons for these differences but this Note does not seek to discuss the historical background nor comment on the quality of bitumens in New Zealand and Australia.

While bitumen quality is important in respect of pavement surfacing performance, there is still no substitute for appropriate treatment selection, design and excellent construction.