ASPHALT COMPACTION

1 INTRODUCTION
These notes are based substantially on the text of the Austroads Asphalt Guide. For more detailed information, users are referred to the Asphalt Guide and other referenced publications.

During the asphalt paving operation, compaction is a two-stage process, as follows:
1. Primary compaction by the paver screed
2. Secondary compaction by rollers.

This section deals with secondary compaction by rollers and supplementary devices for areas inaccessible to rollers.

Adequate compaction of asphalt is essential to ensure the design performance of the mix and expected service life is achieved. The compaction should be uniform and achieve a high density. Mix properties that are directly related to the achievement of adequate density include:
- strength, both compressive and shear
- stability
- permeability
- resistance to oxidation and ravelling
- resistance to rutting
- surface texture and appearance
- pavement life.

The main factors influencing the successful compaction of asphalt are:
- rolling procedures and techniques
- temperature of the mix
- mix properties
- soundness and stiffness of the underlying base
- type and numbers of rollers or other compaction equipment.

The underlying base must be sufficiently sound and rigid to uniformly distribute the stresses from the compaction equipment without distortion. In the event that the underlying base is inadequate for the type of mix and compaction equipment being used, the resultant surface may be uneven and cracked, and the asphalt thickness and density non-uniform.

2 Compaction Equipment
The compaction equipment for asphalt work includes:
- non-vibratory (“static”) steel-wheeled rollers
- vibratory steel-wheeled rollers (Figure 1)
- pneumatic-tyred rollers (Figure 2)
- impact compactors such as vibratory plates (Figure 3), hand tampers, etc. (minor works only).

The condition of rollers used for asphalt work can have a significant effect on the finished surface. To be suitable for asphalt work, the compacting surfaces of the equipment must be true and free from marks.

It is important that rollers are properly maintained. With pneumatic-tyred rollers, the tyre pressures should be even and wheel bearings in good condition to avoid uneven tyre load and resulting differential compaction of the mix. Adequate ballast should also be used.
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Rollers should have good brakes and smooth transmission systems to prevent shoving damage to the mix when starting, stopping and changing direction. The steering should also be in proper adjustment.

To prevent pick-up of the mix, rollers should be fitted with watering systems and fibre mats or scrapers. Care should be taken not to use excessive amounts of water, which may cool the asphalt. Once the tyres of pneumatic-tyred rollers have heated up, the water may not be required.

Figure 1 Vibratory steel-wheeled roller

Figure 2 Pneumatic-tyred rollers
Figure 3 Vibratory plate

Mechanical tampers, vibratory plates, hand guided rollers and hand tampers are used mainly on small jobs, or in areas where it is difficult to obtain access for larger rollers, e.g. median nosings. Light applications of diesel oil on this compaction equipment may also be used to prevent pick-up. The use of excessive diesel should be avoided, as it will soften the asphalt.

3 Mix Temperatures for Placing

Asphalt must be compacted while it is in a workable state. The major factors in workability or compactability are:

- internal friction, determined by maximum aggregate particle size, particle size distribution and aggregate shape
- viscosity of the binder, which affects internal cohesion and the shear resistance.

Generally, mixes with coarse gradings, fully crushed aggregates and larger aggregate sizes are more stable and require greater compactive effort.

Viscosity of the binder is a function of temperature and binder type. Temperature is by far the most important factor and a key element in the compactability of the asphalt mix.

The mix should not, however, be so hot as to result in a low viscosity of binder and insufficient cohesion in the mix to adequately support rollers without excessive displacement.

Temperature of asphalt during placing will depend on the initial spreading temperature and rate of cooling.

The rate of cooling is a function of:

- layer thickness
- road surface temperature
- ambient conditions – air temperature, wind, and moisture.

Thicker layers retain the heat longer, resulting in more time for compaction and/or a reduced number of passes. Retention of heat in thick layers may also lead to a need to delay placing of subsequent layers until the lower layer has cooled sufficiently to provide a solid working platform.

Asphalt will cool more rapidly at low base temperatures. Wind and rain will further increase the rate of cooling.

Asphalt mixes containing modified bitumen binders generally require compaction to be completed at temperatures that are typically 5°C to 10°C higher than mixes with conventional binder, as the binder stiffens more quickly. Most manufacturers of PMBs provide guidelines for their particular products.

All these factors are inter-related and influence:

- conditions under which asphalt work should proceed
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- minimum temperature for delivery and spreading of asphalt
- time available for compaction and hence choice of rolling equipment and compaction techniques.

Table 1 provides a guide to minimum temperatures for spreading dense graded asphalt mixes based on road surface temperature and layer thickness, using conventional bitumen binders and conventional compaction techniques.

Table 1  Asphalt spreading temperatures

<table>
<thead>
<tr>
<th>Road surface temperature(^\text{1}) (°C)</th>
<th>Minimum mix temperature(^\text{2}) (°C)</th>
<th>Range of mix temperature(^\text{3}) (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness of layer, mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td>See note 4</td>
<td>135 - 150</td>
</tr>
<tr>
<td>10 – 15</td>
<td>150</td>
<td>140</td>
</tr>
<tr>
<td>15 – 25</td>
<td>150</td>
<td>135</td>
</tr>
<tr>
<td>&gt; 25</td>
<td>150</td>
<td>125 – 140</td>
</tr>
</tbody>
</table>

Notes:

1. Surface temperature should be generally that applicable to the coolest area of the pavements, e.g. shade areas, if applicable
2. Mix temperatures apply to dense graded mixes with Class 170 and 320 bitumen binder. Use of Class 600, Multigrade, or PMBs may require minimum temperatures 5°C to 10°C higher than those shown. The need to avoid binder drain-off in open graded mixes may result in temperatures of up to 15°C less than dense graded mixes.
3. The upper limit of temperature of thick layers is applied to avoid excessive displacement under rolling.
4. Placing asphalt in thin layers under cool conditions may adversely affect the result due to the increased difficulty in achieving proper compaction, effective joints and good surface finish. Additional attention should be paid to issues of mix workability, asphalt temperature, compaction techniques and any influence from additional cooling due to wind or moisture.

Table 2 provides a guide to typical asphalt mix temperatures related to critical binder viscosities for different stages of compaction (Section 6).

The table is based on the following nominal viscosity levels:

- **Mixing** – a viscosity of around 0.1 Pa.s provides a binder of a suitable consistency for mixing with aggregates, and also tends to be around the maximum temperature for production and delivery.
- **Binder drainage in OGA** – Binder drainage will be influenced by binder content, filler content and use of fibres (Section 4.13). Without fibres, the risk of drainage is increased if the binder viscosity is less than about 0.12 Pa.s.
- **Maximum compaction temperature** – The asphalt mix must have sufficient cohesion to support rolling equipment without excessive displacement. This is typically a binder viscosity of around 0.12 Pa.s.
- **Minimum compaction temperature** – this is the minimum temperature at which initial rolling by steel rollers remains effective and typically occurs at around 10 Pa.s, although some PMBs may continue to be compacted at slightly higher binder viscosities.
- **Minimum for final rolling** – Minimum temperature at which intermediate and final rolling is effective. This typically occurs at around 100 Pa.s.
- **Softening point** – Typical values are provided for reference and generally represent a viscosity of around 1200 Pa.s.
Table 2 Typical temperatures for placing and compacting of asphalt containing various binders

<table>
<thead>
<tr>
<th>Binder Class</th>
<th>Temperature (°C)¹</th>
<th>Softening Point (1200 Pa.s)</th>
<th>Minimum for final rolling (100 Pa.s)</th>
<th>Minimum for effective compaction (10 Pa.s)</th>
<th>Maximum for Compaction (Cohesion) (0.25 Pa.s)</th>
<th>Maximum to avoid drainage in OGA (0.12 Pa.s)</th>
<th>Optimum Mixing² (0.1 Pa.s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td></td>
<td>170</td>
<td>45</td>
<td>65</td>
<td>90</td>
<td>140</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>320</td>
<td>48</td>
<td>70</td>
<td>95</td>
<td>150</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>52</td>
<td>75</td>
<td>100</td>
<td>160</td>
<td>n.a.</td>
</tr>
<tr>
<td>Multigrade</td>
<td></td>
<td>52</td>
<td>75</td>
<td>100</td>
<td>165</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>PMBs</td>
<td></td>
<td>A20E</td>
<td>65</td>
<td>85</td>
<td>105</td>
<td>150</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A10E</td>
<td>85</td>
<td>100</td>
<td>110</td>
<td>155</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A35P</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>150</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A30P</td>
<td>65</td>
<td>85</td>
<td>105</td>
<td>150</td>
<td>160</td>
</tr>
</tbody>
</table>

Notes:
1. Temperatures are typical of relevant binder classes in about middle of classification range.
2. Polymer modified binders may be mixed and compacted at temperatures that represent a slightly higher viscosity than non modified binders.
3. Industry Code of Practice for SBS binders permits a maximum of 165°C to avoid fuming.
4. Fibres can inhibit drainage at higher temperatures.

4 Determination and Use of Temperature Profiles

In some cases it may be desirable to establish the cooling rate of asphalt as an aid to effective operation of rollers. This may be used to determine the time available for initial rolling and the maximum distance behind the paver that rollers should operate for each compaction phase.

A suitable procedure is application of the temperature limits from Table 2 to an Asphalt Temperature Profile curve determined from direct measurement of temperature of the asphalt mat.

A thermometer is placed in the centre of the uncompacted layer immediately behind the paver, at the start of the paving operations. Temperature readings are taken as the distance between the paver and the thermometer increases, for 10 m intervals (up to 200 m depending on rate of cooling). The readings are plotted on the Asphalt Temperature Profile Sheet, as shown in Figure 6.28, so that the resulting profile curve intersects the lower temperature limits for the three rolling phases. The intersection points define the maximum distance behind the paver within which each phase of the rolling should be completed.

Figure 4 is an example only. Although minimum temperatures for completion of rolling phases are specified, temperature profile curves are situation specific and must be drawn up on site as required.

For a particular set of conditions, the Asphalt Temperature Profile only needs to be determined once, unless the asphalt mix temperature, layer thickness or ambient conditions change.
5 Roller Numbers and Speed

The minimum number of rollers required to achieve adequate compaction will depend on:

- depth and width of layer
- laydown temperature and rate of cooling of mix
- rate of spreading (output)
- mix type and binder type
- compactability of mix.

Table 3 provides a guide to the minimum number of rollers required based on rate of spreading, or output. Actual types and numbers of rollers should be determined for each project.

Sufficient rollers should be available on the work site to match the desired output of the paver(s). Otherwise, the output of the paver(s) may be restricted.

On major projects, stand-by rollers should be available to cover the possibility of plant breakdown.

Rollers should travel at uniform speed, which is sufficiently slow to prevent displacement of the mix. Acceleration and braking should be carried out as smoothly as possible.

Roller speeds should be in the following ranges:

- steel wheeled rollers – not exceeding 5 km/h
- vibratory rollers – 8 to 10 km/h
- pneumatic-tyred rollers – 6 to 10 km/h.

If the mix is being adversely affected by rolling, the speeds should be reduced to prevent excessive displacement.

If transverse cracks appear in the surface, the roller should be removed until the mix is sufficiently stable to support the roller.

Table 3 Number of rollers
### Range of Output

<table>
<thead>
<tr>
<th>Tonnes per hour</th>
<th>Tonnes per day</th>
<th>Steel static (see Note 3)</th>
<th>Steel vibrating (see Note 4)</th>
<th>Pneumatic tyred (see Note 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20</td>
<td>Up to 160</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>20 to 45</td>
<td>160 to 360</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>45 to 85</td>
<td>360 to 680</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>85 to 120</td>
<td>680 to 960</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### NOTES:

1. For thin layers in cold weather, additional rollers will be required.
2. Thicknesses assumed for the purpose of this table are up to 60 mm. For greater thicknesses, the numbers of rollers may be reduced, e.g. for rate 45 t/h to 85 t/h and depth of 100 mm, only one steel vibrating or static roller and one pneumatic-tyred roller would be required.
3. The steel static rollers are assumed to be self-propelled of 6t to 12t mass.
4. The steel vibrating rollers are assumed to be self-propelled tandems of a minimum of 6t mass.
5. The pneumatic-tyred rollers are assumed to be of 10t to 20t ballasted mass. Multi tyred rollers are not used on open graded asphalt, ultra thin open graded asphalt, stone mastic asphalt and many minor works.
6. For open graded asphalt, steel rollers should only be operated in static mode.

### 6 Rolling Procedures

Rolling should be carried out as soon as possible after placing the mix but should not commence before deficiencies in spreading of the mix are corrected.

The rolling of a freshly laid asphalt mix should be carried out in the following order:

- transverse joints
- longitudinal joints (when adjoining a previous run)
- outside edge
- remainder of the mat.

The sequence of rolling the remainder of the mat is:

- initial rolling
- intermediate rolling
- final rolling.

Initial rolling compacts the asphalt to obtain most of the final density. Intermediate rolling densifies and seals the surface. Final rolling removes roller marks and other blemishes left by previous rolling.

A typical rolling sequence is shown in Table 4.

Vibration is not normally used for thin lifts, open graded asphalt and stone mastic asphalt.

To ensure the required results, the whole rolling procedure must be carefully observed by both operators and supervisors, so that any necessary adjustments to the rolling technique to adapt to conditions can be made immediately.

Heavy equipment, including rollers, should never stand on the recently compacted surface before it has cooled sufficiently to resist deformation under the static load.
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Table 4 Typical rolling sequence

<table>
<thead>
<tr>
<th>ROLLING PHASE</th>
<th>ROLLER TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial rolling</td>
<td>Non-vibratory steel roller or vibratory roller in static mode</td>
</tr>
<tr>
<td>Intermediate rolling</td>
<td>Vibratory steel roller in vibratory mode plus pneumatic-tyred roller</td>
</tr>
<tr>
<td>Final rolling</td>
<td>Steel roller</td>
</tr>
</tbody>
</table>

7 Rolling of Transverse Joints

The joint should be rolled transverse to the line of paving with a steel wheel roller initially overlapping about 150 mm onto the fresh mix. This should continue for several passes, projecting about 200 mm further onto the mat each pass before commencing normal longitudinal rolling.

The joint should be checked with a 3 m straight edge immediately following rolling of each lane, to facilitate correction of excessive deviations.

Boards should be used to enable the roller to travel beyond the edge of the layer without causing damage or rounding of the edge of the mat.

The rolling of a transverse joint is shown in Figure 5 (a).

Figure 5 (a) Rolling of transverse joint

8 Rolling of Longitudinal Joints

The breakdown roller compresses this material against the edge of the previously placed run. The longitudinal joints should be rolled before the rest of the mat to ensure a smooth matched surface is obtained. Rolling should commence with the steel roller, operating in static mode, travelling on the cold mat with about 150 mm overlap onto the hot mat (see Figure 5 (b)).
9 Initial Rolling

Most of the increase in density of the asphalt occurs during initial (sometimes called "breakdown") rolling. It is therefore an important phase of the rolling operation.

Initial rolling is normally begun at the lower side of the run, with the roller moving and reversing on the same longitudinal track. The rollers should work with the driving wheels closest to the paver, except on very steep grades where the driving wheels are placed down-hill.

Rolling should then proceed in parallel passes from the lower to the higher edge of the newly laid mat. Two passes should be completed on each track, with each track overlapping the preceding track by about 200 mm and finishing beyond the end of the preceding track by at least one metre.

Initial compaction is obtained using a steel-wheeled roller, making 2 to 4 passes over the material. Each pass of the roller consists of a movement in either direction over the length of uncompacted mix.

When rolling unsupported (free) edges, except those which are to be hot joints, the roller should overhang the edge by no more than about 100 mm.

When the layer thickness is 100 mm or more, the following procedure should be applied:
• complete rolling to within 200 mm of edge to minimise displacement of the mix before proceeding to roll the edge
• the first roller pass of this 200 mm strip should cover about half of the unrolled strip
• the second roller pass should cover the remainder of the strip, but not overhang the edge by more than 100 mm.

10 Intermediate Rolling
Intermediate rolling usually completes the compaction process to achieve the specified density. It also seals the surface. This phase ensures minimum distortion when the pavement is opened to traffic.

Intermediate rolling is achieved with steel rollers followed by pneumatic tyred roller.

The number of passes will depend on the type of roller used, and is generally between 2 and 7. Vibratory rollers will generally achieve the required density with fewer passes than static rollers.

11 **Final Rolling**

Final rolling is only necessary where roller marks, generally from the intermediate rolling, need to be removed. The marks are removed by making the minimum number of passes necessary, with a steel-wheeled roller.

12 **Special Techniques**

On occasions roller stop depressions may occur that need to be removed by cross rolling in conjunction with intermediate or final rolling.

13 **Rolling Pattern**

Best results are obtained only when the rolling is performed in a definite pattern that provides a uniform coverage of the run. A rolling pattern should be developed to suit the particular location, and operators should be required to follow it.

The traditional recommended rolling pattern for initial rolling of thin layers with a steel-wheeled roller is shown in Figure 6.

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**Figure 6 Typical rolling pattern**

Rolling patterns should be arranged so that joints are rolled first.

The length of a rolling lane should normally be about 30 to 50 metres, depending on ambient conditions.

Sharp turns should be avoided and any change from forward to reverse should be made smoothly. Vibratory rollers should not be stopped or reversed while in vibratory mode. Lateral changes in the direction of rolling should be made on previously compacted mix.

The rolling pattern and number of passes should be selected carefully when using vibratory rollers. Over use of vibration or number of passes can lead to de-compaction and delamination of the mix. This results in a rapid lowering of density, which is extremely difficult to correct with the falling temperature.
An alternative technique allows for a sweeping turn at the end of each pass equivalent to the width of an adjacent pass, during the initial rolling. This method results in a diagonal roller stop depression (and ridge of uncompacted material) rather than it being ‘square’. When the roller passes over this diagonal stop the progressive (rather than sudden) transition from the compacted mat to the uncompacted material results in a better distribution of the material and a reduced depression. Therefore, this technique aims at a better surface finish with less noticeable roller stop depressions.

14 **Hand Compaction**

Hand compaction is normally restricted to small areas where rollers cannot operate. The mix should be placed in layers of sufficient thickness to allow compaction to adequate density, and should be finished with a texture similar to that of the surrounding surface.

15 **Compaction of Open Graded Asphalt**

The rolling procedure for open-graded mixes differs from the above in the following respects:

- compaction is by steel wheeled roller in the static (non-vibratory) mode
- fewer passes are generally required to achieve the specified density
- pneumatic-tyred rollers should not be used on open graded wearing courses because of kneading and closing effect on the mix.

16 **Compaction of Deep Lift Asphalt**

Deeper lifts retain heat longer, have a longer time available for compaction and are generally easier to compact. The larger size aggregate used in deeper lifts tends to make the mix more workable, facilitating compaction.

The retained heat also enables a greater coverage with the same rolling equipment before the mix temperature falls below that for optimum compaction.

Special care is needed to ensure that good longitudinal and transverse profiles are maintained. Rolling must not be left too long, otherwise the surface may cool off and form a crust, which then causes excessive cracking during rolling.

17 **Compaction of Stone Mastic Asphalt**

SMA mix is compacted at similar temperatures to dense graded asphalt.

Generally, a heavy static roller (minimum 10 t) is preferred. Vibratory rollers can fracture the aggregate particles due to the stone-on-stone contact of this type of mix. Vibratory compaction can also lead to flushing by bringing binder to the surface of the mix. The use of vibration should therefore be kept to a minimum – no more than one or two passes.

Pneumatic multi-tyred rollers should not be used because of the tendency to cause flushing. Similarly, opening to traffic before the surface temperature falls to about 40°C can also draw binder to the surface, with flushing and loss of surface texture.

18 **Placing and Compaction of Ultra Thin Open Graded Asphalt Surfacing**

The procedure for placing open graded asphalt as ultra thin surfacing generally involves a heavy tack coat of polymer modified bituminous emulsion immediately ahead of spreading of asphalt.

This is most effectively achieved in a purpose-built paving unit that combines spraying of tack coat and spreading of asphalt in a single machine.

The application rate of tack coat is normally 0.9 L/m² but may need to be varied in some circumstances, such as use in combination with a SAMI treatment, in which case the tack coat application rate may be substantially reduced. The emulsion is usually applied at a temperature of 60 to 80°C. The process relies on the heat of the OGA mix to break the emulsion.
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The wearing course may be laid in layers from 12 mm to 25 mm thick for a 10 mm nominal size. Handwork should avoided as much as practicable.

Compaction is similar to conventional open graded asphalt. Rolling normally uses a minimum of 3 passes of a double drum steel wheeled roller, with a minimum mass of 6 tonnes, before the material temperature has fallen below about 80°C. Due to rapid cooling of the mix, and rate of spreading, two steel-wheeled rollers are usually necessary. Special care should be taken to ensure that joints are properly formed and uniform.

The new surface may be opened to traffic immediately upon completion of compaction and when the mix has cooled sufficiently to ensure no damage by traffic.

### 19 Compacted Density

#### 19.1 General

Testing of density is usually undertaken on a lot-by-lot basis. Lot sizes are generally one shift production of the same mix and layer. Lots must be essentially homogeneous sections of completed pavement. Defective areas of pavement showing cracking, bony or fatty material should be rectified before being tested separately.

Density testing is usually not undertaken on lots of less than about 50 t, layers with a nominal thickness less than 30 mm, or layers with a nominal thickness less than 2.5 times the nominal mix size.

Density testing should be carried out as soon as practicable after completion of work, using either core samples or nuclear gauge testing of in situ materials. Location of test sites should be determined by a suitable method of random sampling.

Relative compaction is the percentage ratio of the in situ density of the compacted asphalt to the reference density of the asphalt of a particular lot. Characteristic values of relative compaction are calculated using statistical procedures. Typically the characteristic value should represent the lower limit that is exceeded by approximately 80% of the material in the lot.

Two methods for determination of reference density are in common use. They are:

- Maximum density
- Laboratory compacted bulk density.

Use of maximum density as the reference density allows results to be directly converted to in situ air voids (i.e. 100 – percentage relative compaction). The required value will vary according to mix type and application. Typical minimum characteristic values for air voids for dense graded asphalt work are shown in Table 5.

Typical values of relative compaction based on laboratory bulk density are shown in Table 6.

<table>
<thead>
<tr>
<th>Layer Thickness/ Application</th>
<th>Maximum Characteristic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heavy traffic</td>
</tr>
<tr>
<td>30 to 50 mm</td>
<td>8</td>
</tr>
<tr>
<td>&gt; 50 mm</td>
<td>7</td>
</tr>
<tr>
<td>High fatigue base</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 5 Typical in situ air voids**
(dense graded asphalt)
### Table 6  Typical relative compaction (bulk density)

<table>
<thead>
<tr>
<th>Layer Thickness</th>
<th>Minimum Characteristic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 to 50 mm</td>
<td>95%</td>
</tr>
<tr>
<td>&gt; 50 mm</td>
<td>96%</td>
</tr>
</tbody>
</table>

#### 19.2 Testing of Density Using Nuclear Density Gauge

Nuclear density testing is quick and non-destructive. The variability of density test results measured with a nuclear density gauge is generally considered greater than tests on core samples, but the nuclear gauge has the advantage that many more samples can be obtained in a given amount of time.

Care is required to ensure accurate seating of the meter in order to achieve accurate results.

Two forms of nuclear gauge used on asphalt work are the standard backscatter gauge and “thin lift” gauge. The thin lift gauge uses a dual detector set that enables the operator to select the measurement depth over a range of 25 to 100 mm, whereas the standard gauge is not suitable for layers less than 50 mm in thickness.

Gauges are calibrated using blocks of materials of known density. It is also recommended that field density offsets be established by comparison with core samples.

Nuclear density gauges may be used in the development of rolling patterns (particularly the number of passes) and for quick determination of approximate asphalt.
REFERENCES

AUSTROADS (2002) Framework for specifying Asphalt, AP−T18/02
AUSTROADS AGPT04B/07 : Guide to Pavement Technology - Part 4B: Asphalt

AAPA/APRG Pavement Work Tips

No. 4  Asphalt joints
No. 12 Compaction of asphalt
No. 13 Temperature characteristics of binder in asphalt
No. 31 Asphalt paver speed

Australian Standards

AS 2891  Methods of sampling and testing asphalt
  AS2891.14  Field density tests
  AS2891.14.1.1 Determination of field density of compacted asphalt using a nuclear surface
              moisture-density gauge – Direct transmission mode
  AS2891.14.1.2 Backscatter mode
  AS2891.14.2 Determination of field density of compacted asphalt using a nuclear thin-
              layer density gauge
  AS2891.14.3 Calibration of nuclear thin-layer density gauge using standard blocks
  AS2891.14.4 Calibration of nuclear surface moisture-density gauge – Backscatter mode
  AS2891.14.5 Density ratio of compacted asphalt