10.1 Bitumen Penetration Test

10.1.1 General requirements

10.1.1.1 Scope. This is a basic test for determining the grades of bitumen. In effect, the test is an indirect determination of high temperature viscosity and low temperature stiffness. The scope of this is to provide a method for determining the consistency of semi-solid and solid bituminous materials in which the sole or major constituent is either bitumen or tar pitch.

10.1.1.2 Definition. The penetration of bituminous material is its consistency expressed as the distance in tenths of a millimeter that a standard needle penetrates vertically into a specimen of the material under specified conditions of temperature, load and duration of loading.

Grades of straight-run bitumen are designated by two penetration values, for example, 40/50, 60/80, 80/100 etc.; the penetration of an actual sample of the bitumen in any grade should fall between the lower and upper value given.

10.1.1.3 Apparatus

a) The test apparatus consists of a right frame which holds the needle spindle in a vertical position and allows it to slide freely without friction. A dial gauge calibrated in millimeters measures the penetration. The total weight of the needle and spindle must be 50 ± 0.05 grams and facilities for adding additional weights of 50 ± 0.05 grams and 100 ± 0.05 grams must be provided. The surface on which the sample container rests must be flat and at right angles to the needle.

b) A penetration needle made of fully hardened and tempered stainless steel of 1.00mm in diameter and 50mm in length, with one end ground to a truncated cone as shown in Figure 10.1.1. The needle is held by brass or stainless steel ferrule. The test is shown diagrammatically in Figure 10.1.1.

c) The sample is placed in a metal or glass flat bottom container of the following dimensions:

For penetrations below 200 mm:
Diameter 55 mm
Internal depth 35 mm

For penetrations between 200 and 350 mm
Diameter 70 mm
Internal depth 45 mm

The sample and dish are brought to the required temperature in a water bath which is maintained at a temperature within ±0.1°C of the test temperature. The sample container must be placed on a perforated shelf which is between 50 and 100 mm below the surface of the water.
Penetration Test

DIAL GAUGE READS PENETRATION (in mm)

START

AFTER 5 SECS

Penetration Needle

Figure 10.1.1 Penetration needle
10.1.2 Sample preparation

a) A sample of bitumen is first heated carefully in an oven or on a hotplate until it has become sufficiently fluid to pour. When using a hotplate, the bitumen should be stirred as soon as possible to prevent local overheating. In no case should the temperature be raised more than 90°C above the softening point, and samples must not be heated for more then 30 minutes.
b) When sufficiently fluid a portion of the sample is poured into the sample container to a depth of at least 10mm greater than the depth to which the needle is expected to penetrate.
c) The sample is then covered loosely to protect against dust, and allowed to cool in the atmosphere between 15 and 30°C for 1 to 1½ hours for the small container and 1½ to 2 hours for the large container.
d) After cooling in air, the sample containers together with the transfer dishes should be placed in the water bath at the required temperature, for a period of 1 to 1½ hours for the small container and 1½ to 2 hours for the large container.

10.1.3 Conditions of test

The test is normally carried out at a temperature of 25°C with the total weight of the needle, spindle and added weights being 100 grams, the needle is released for a period of 5 seconds. If it is not possible to obtain these conditions or if there are special circumstances, one of the following alternative conditions may be used:-

<table>
<thead>
<tr>
<th>Temperature, °C (°F)</th>
<th>Total sliding weights, grams</th>
<th>Time, seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (32)</td>
<td>200</td>
<td>60</td>
</tr>
<tr>
<td>4 (39.2)</td>
<td>200</td>
<td>60</td>
</tr>
<tr>
<td>46.1 (115)</td>
<td>50</td>
<td>5</td>
</tr>
</tbody>
</table>

It will be noted that, to obtain the standard temperature of 25°C in Bangladesh, cooling of the water bath is normally required, it may, therefore, be more convenient in many cases to use a temperature of 46.1°C.

10.1.4 Test procedure

a) The needle should be examined for damage or surface roughness; it should be dry and clean. To ensure the needle is perfectly cleaned, it should be wiped with a cloth soaked in toluene or another suitable bitumen solvent and then dried with a clean cloth.
b) The clean needle should be inserted into the penetrometer apparatus and the total sliding weight made up to the required value, if necessary by adding additional weights. For example, if 100 grams is required, and the needle and spindle weigh 50 grams, an additional weight of 50 grams must be added.
c) The sample container is then placed in the transfer dish complete with water at the required temperature from the constant temperature bath, the sample being completely covered with water at all times. The transfer dish is then placed on the stand of the apparatus.
d) The penetrometer needle is then slowly lowered until it just touches the surface of the sample. This point is best judged by using a strong source of light and determining the point where the tip of the needle just meets its image reflected by the surface of the sample. The initial dial gauge reading is taken.

e) The needle is then released for the specified time and re-locked immediately at the end of the period. Care should be taken not to disturb or jolt the apparatus when releasing the needle, if this occurs or the sample moves, the test must be repeated. The final dial gauge reading is taken.

f) The transfer dish should then be returned to the water bath and a clean needle fitted to the machine. The test is then repeated on the same sample. This procedure is repeated so that at least 3 determinations are made on each sample, taking care that each point is at least 10mm from the side of the sample container and at least 10mm from the other determinations. If the penetration exceeds 200mm, the needles should be left in the sample until all three determinations have been completed.

10.1.5 Calculation

The penetration is given by:

\[
\text{Penetration} = (\text{Initial dial gauge reading (mm)} - \text{Final dial gauge reading (mm)}) \times 10
\]

A typical worksheet is shown as Form 10.1.1.

The three penetration values obtained on the sample must agree to within the following limits:-

<table>
<thead>
<tr>
<th>Penetration</th>
<th>0 to 49</th>
<th>50 to 149</th>
<th>150 to 249</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum difference between highest and lowest determination</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

If the differences exceed the above values, the results are ignored and the test must be repeated on the second sample. If the differences are again exceeded by the second sample, the results must be ignored and the test completely repeated.

If the determinations are within the above tolerances, the penetration is quoted as the average of the individual results.

10.1.6 Test report

The report shall contain at least the following information:

a) Identification of the material tested
b) A reference to the test method used.

c) A statement of any deviation from the method stated for 25°C/100g/5 seconds.
d) The test result
e) Date of test.
# WORKSHEET

## PENETRATION TEST

<table>
<thead>
<tr>
<th>Contract Name</th>
<th>Dhaka-Feni Highway CH. 22+000 - 28+500 construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing agency</td>
<td>BRRL, Paikpara, Mirpur, Dhaka.</td>
</tr>
<tr>
<td>Material Identification</td>
<td>60 - 70 pen bitumen no. BRRL-0001 60/70 pen bit.</td>
</tr>
<tr>
<td>Material delivered by</td>
<td>M/S. Ali Bros Constracing</td>
</tr>
<tr>
<td>Material collected by</td>
<td>N/A</td>
</tr>
<tr>
<td>Manufacturer / Supplier</td>
<td>Bangladesh Refinery Ltd. / The Engineers Co. Ltd.</td>
</tr>
<tr>
<td>Date sampled</td>
<td>22/5/2000</td>
</tr>
<tr>
<td>Date tested</td>
<td>27/5/2000</td>
</tr>
<tr>
<td>Name and designation of tester</td>
<td>Mangal Chandra Roy, ARO</td>
</tr>
<tr>
<td>Signature of tester</td>
<td></td>
</tr>
</tbody>
</table>

### Any deviations:
- None

<table>
<thead>
<tr>
<th>Penetration mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>64</td>
</tr>
</tbody>
</table>

### Any other remarks:
- Average penetration 64 mm acceptable.
- Sample No. BRRL-0001 60/70 Pen Bit. OK.