Improving Durability TSCS – Measuring Asphalt Density, In Situ Test Method

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Bituminous mixtures — Test methods — Part XX: In situ density test

ICS:
Descriptors:

Contents

Page

Foreword

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1 Scope

This European Standard describes a test method for non-destructive asphalt density measurement. The asphalt density will depend on the properties of the material and the level of compaction it receives. The test is designed for use on all asphalt surfaces for the purpose of Quality Control.

This document is not intended to address any safety concerns associated with the device use.

2 Normative references

This European Standard incorporates provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

BS 594987:2015, Asphalt for roads and other paved areas – Specification for transport, laying, compaction and product-type testing protocols.

BS EN 12697-5:2009, Bituminous mixtures – Test methods for hot mixed asphalt Part 5: Determination of the maximum density

BS EN 12697-6:2012, Bituminous mixtures – Test methods for hot mixed asphalt Part 6: Determination of bulk density of bituminous specimens

BS EN 12697-8: 2003 Bituminous Mixtures – Test methods for hot mix asphalt Part 8: Determination of void characteristic of bituminous specimens, british standards institution

ASTM D7759/D7759M – 14: Standard Guide for Nuclear Surface Moisture and Density Gauge Calibration

ASTM D7113/D7113M − 10: Standard Test Method for Density of Bituminous Paving Mixtures in Place by the Electromagnetic Surface Contact Methods

ASTM D7013/D7013M – 15: Standard Guide for Calibration Facility Setup for Nuclear Surface Gauges

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1

NDG

Nuclear Density Gauge

3.2

Electromagnetic surface contact device

Electromagnetic surface contact devices, such as Pavement Quality Indicator (PQI) and Pavetracker, measure the changes in the electromagnetic field resulting from the compaction process, and therefore determine the in-situ density and relative compaction of bituminous mixture.

4 Principle

This test provides a rapid, non-destructive, indirect density measurement alternative method to intrusive core methods. The in-situ density of the compacted bituminous mixtures can be determined by indirect density gauges. The percentage air voids are calculated in accordance with BS EN 12697-8 by comparing the in-situ density to the maximum density of the mixture.

It is advisable to conduct laboratory testing on new equipment or equipment which is yet to be trialled in order to verify its accuracy.

5 Apparatus

5.1 Indirect Density Measurement Gauge

BS 594987 allows for the use of indirect density gauges such as nuclear density gauges and electromagnetic surface contact devices to be used as an alternative to coring or to augment the data between core locations.

The device shall allow calibration of the unit over the expected range of application conditions and materials. It shall also function at the temperature and moisture levels experienced during the placement of asphalt pavements.

The device shall include the internal circuitry suitable for displaying individual measurements to allow operators to record the results.

5.1.1 Nuclear Density Gauge (NDG)

The NDG emits a small gamma ray of photons from a radioactive source. The photos are transmitted through the pavement material and received and counted by the detector(s) on the other side of the NDG. The denser the pavement, the more energy consumed in penetrating the material and the less the count number. It comprises two primary testing modes – backscatter mode and direct transmission mode. The former is suitable for up to 50mm layer thicknesses and latter is suitable for layer thicknesses greater than 50mm. Thin lift gauges may be used for layer thicknesses up to 100mm.

5.1.2 Electromagnetic Surface Contact Device (EMSCD)

The Electromagnetic surface contact devices, such as PQI and PaveTracker, operate by assessing the change in an electric field to determine the dielectric constant of the tested material. The density can be calculated by comparing the dielectric constants with a material with a known density. The typical measuring thicknesses should be provided by the device manufacturer, the PQI and PaveTracker are 25-100mm and up to 51mm respectively.

5.2 Standard Blocks

A block of dense material usually made of magnesium or aluminium to establish a reference count rate.

5.3 Site Preparation Device

Straight edge / fine sand

5.4 Driver pin

A steel rod to prepare a pre-drilled hole for the extendable resource rod used in the NDG direct transmission mode

6 Calibration

The precision of the indirect density gauge readings is sensitive to the on-site calibration. It is recommended to take regular calibrations and to calibrate using a good spread of core densities. As suggested in BS 594987:

"Each gauge should be calibrated to produce a relationship between gauge readings and core density. Calibration should be carried out at or adjacent to the location of six cores to be taken for the determination of air void content (see 9.5.1.2). Gauge readings should be taken before the coring process.

This procedure should be carried out on at least two areas, one well inside the compaction compliance limit, and one close to or outside the compliance limit. A graph should be plotted to show the relationship between the density gauge readings and the corresponding core densities. If more than one gauge is to be used, each gauge should be individually calibrated, preferably using the same core positions.

NOTE 1 A suitable density range to produce results with the necessary spread of values has been found to be at least 4%.

NOTE 2 Careful selection of test positions is required to achieve a suitable density range. This can be achieved by locating some positions at the end of the test strip or close to joints. Small areas of the trial strip may be left under-compacted; however, these would not normally be retained as part of the permanent works."

In addition, at least six indirect densities and six core densities are used to establish a calibration factor. The above calibration procedure shall be repeated when a change is made in the paving mixture or where moisture and/or temperature change considerably.

Once the numeric difference between the averaged reading and the corresponding core density is obtained for each test location, record their mean. Adjust the offset value in the device according to the manufacturer's procedure if available. Otherwise, add or subtract the difference from the subsequent density measurements.

NDG calibration using standard blocks according to the manufacturer's instructions may be acceptable if the measurements are only used to monitor the compaction process by comparing the relative density readings.

7 Procedure

Turn on the devices before the test to allow for stabilisation.

Select a flat, smooth and dry surface on the asphalt mat. Brush off any sand or stones that prevent the full contact between the device and the test surface. Taking density measurements on wet surfaces shall be avoided.

Native fines and fine sands may be applied to the test surface to fill the surface texture and ensure a firm contact between the gauge and the surface of the paving material for each measurement.

The use of electromagnetic surface contact devices shall avoid any nearby known source of electromagnetic interferences, such as high voltage power lines or large metal objects.

In accordance with Annex I of BS 594987, an appropriate frequency for indirect density gauge measurements is at 20 m spacing with successive measurements in alternate wheel tracks.

The reading duration for NDG shall be at least 1 minute, although 4-minute readings provide better accuracy.

For the direct transmission mode, a pre-drilled hole shall be prepared at the test location to accommodate the steel resource rod to a depth of at least 25mm below the desired measurement depth.

Place the device on the test surface and draw the outline around the base plate. Rotate the device by 120° in order to obtain three readings per location, unless instructed differently by the manufacturer. Record the measurements and average readings in accordance with Section 9.

8 Calculation and expression of results

9 Test report

9.1 General

With reference to this European Standard, the test report shall include the following information:

a) Make, model, and serial number of the test apparatus;

b) Identification of site or scheme, core or in situ test locations, mixture type(s) and any anomalies in visual appearance;

c) Date of test;

d) Weather Conditions;

e) Thickness of layer tested and any adjustment bias;

f) Temperature of the bituminous mat at the time of the reading, to the nearest 0.5°C, if taken;

g) Moisture index on the test surface at the time of the reading, if available;

h) Individual density readings at each measured point within a test location to the nearest 0.001Mg/m^3, together with the calculated average density value for the location.

i) Dated signature by the test operator;

9.2 NDG

j) Date and source of calibration data;

k) Standard count for the day of the test;

l) Method of measurement (backscatter or direct transmission), depth, reading duration, count rate, calculated density of each measurement and any adjustment data and percentage of compaction, if required;

9.3 Electromagnetic Surface Contact Device (EMSCD)

m) Device calibration data

n) Corresponding density data (if taken) from alternative methods, such as from nuclear gauge or core sample methods, for each test location to the nearest 0.001Mg/m^3.

10 Precision

Third party references present precision results of two sample equipment:

- EMSCD - refer to ASTM D7113/D7113M
- NDG – refer to ASTM D7759/D7759M