pavement work tips

Nuclear Density Testing of Asphalt Pavements

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INTRODUCTION

Compacted density is an important measure of the potential performance of asphalt. Nuclear gauges provide rapid non-destructive testing for monitoring construction processes or assurance of quality of completed asphalt work.

This pavement work tip provides some practical guidelines for the use of nuclear gauges and should be read in conjunction with relevant Australian Standard Test methods, Specifications requirements and gauge manufacturers' manuals.

BENEFITS OF NUCLEAR DENSITY TESTING

Compared to coring, nuclear gauges (Figure 1) offer the following advantages for field density testing of asphalt:

- Speed of results – testing can take place immediately behind asphalt placing operations thus enabling monitoring of compaction procedures or timely corrective action.
- Subsequent asphalt layers can be placed without delays due to waiting on density test results for underlying layers.
- Testing on same day as placing can avoid additional traffic control.
- There is no damage to the pavement. Costs for core hole reinstatement are eliminated.

Used properly, the accuracy of nuclear density measurement is comparable with coring. Gauges must, however, be properly calibrated, maintained and operated by qualified personnel.

AUSTRALIAN STANDARDS

Australian Standard AS 2891.14 provides for three different forms of nuclear gauge measurement.

AS 2891.14.1.1 *Direct transmission mode*. This mode provides an accurate measure of density of layers greater than 75 mm in thickness. It requires the gauge probe to be inserted in a hole drilled to a depth of 25 mm greater than the required test depth. Direct transmission operation does not require the use of density offsets.

AS 2891.14.1.2 *Backscatter mode*. This mode is suitable for asphalt layer thicknesses greater than 40 mm and up to 100 mm.

AS 2891.14.2 *Thin-layer density gauge*. This is a form of backscatter gauge that uses a dual detector set that enables the operator to select the effective depth of backscatter measurement within a range of 25 mm to 100 mm. This provides greater versatility and hence greater popularity in use.

Key Summary

This issue of 'pavement work tips' provides a guide to the use of nuclear gauges for determination of density of asphalt pavements

Both forms of backscatter measurement require the use of density offsets.

Figure 1: Nuclear Density Testing

CALIBRATION AND DENSITY OFFSETS

A range of procedures are used to check the efficiency and accuracy of density measurements. The following general procedures apply:

Gauge calibration is undertaken at least every two years or after any major repair or component replacement. It must be done in a suitably qualified laboratory.

Operational checks are a combination of:

- a monthly check of gauge function and density consistency using a secondary reference block
- a standard count check undertaken on each day of use, at the laboratory, and in the same location
- a field standard density count undertaken on site using the manufacturer's reference block placed on the material to be tested.

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Density Offsets for backscatter measurement must be established for each individual asphalt mix to be tested. Density offsets are determined from the bulk density of cores taken from directly under the nuclear gauge measurement at a minimum of six sites. Offsets are used to adjust subsequent field density readings. Density offsets should be checked regularly as required by the Standard or otherwise specified.

PROCEDURES

Site Safety

The test site shall be protected from traffic in accordance with the relevant code of practice. Where necessary, additional warning shall be provided for construction traffic and machinery within protected worksites.

Operators shall wear appropriate personal protective equipment. Warning signs and personal radiation monitors shall be used in accordance with approved procedures. Other personnel should not approach within 3 m of the gauge when in operation.

All equipment shall be handled and operated in accordance with relevant manuals and safe working procedures.

Reference density and density ratio

The reference density and density ratio shall be determined in accordance with AS 2891.14.5 and any specified requirements.

AS 2891.14.5 provides for four alternative measures of reference density:

- Bulk density of laboratory designed mix
- Bulk density of samples of production mix
- Maximum density of laboratory designed mix
- Maximum density of production mix.

Maximum density of production mix is preferred.

Surface preparation

The location of sites to be tested should be selected in accordance with a defined sampling plan or specification.

Testing should be undertaken with the longitudinal axis of the gauge placed in the direction of asphalt placement/compaction, i.e. in the direction of roller travel.

Any loose material on the surface shall be swept or cleared from the surface.

The surface must be essentially flat and free from cracks.

For direct transmission measurement a hole is drilled or driven to a depth of 25 mm greater than the required test depth.

Fine sand (0.425 mm maximum) is spread over the test site (Figure 2), using a steel straight edge, to fill surface voids while the tops of the surface aggregate remain exposed. The sand must not form an added layer on the surface. Sand is not used when testing open graded asphalt as surface voids are included in bulk density measurement.

The gauge is placed on the surface and checked to ensure that it is firmly seated, without rocking.

Gauge readings and recording

The gauge must be operated in accordance with the manufacturer's recommendations. Counting period is set by the application standard.

Relevant gauge checks, density offsets, all counts and density readings must be recorded as well as the application of density offsets and site information such as mix type, location (chainage and offset) and reference density.

Figure 2: Site preparation

REFERENCES

AS 2891.14.1.1: *Field density tests – Determination of field density of compacted asphalt using a nuclear surface moisture density gauge – Direct transmission mode.*

AS 2891.14.1.2: *Field density tests – Determination of field density of compacted asphalt using a nuclear surface moisture density gauge – Backscatter mode.*

AS 2891.14.2 *Field density tests – Determination of field density of compacted asphalt using a nuclear thin-layer density gauge.*

AS 2891.14.3 *Field density tests – Calibration of a nuclear thin-layer density gauge using standard blocks.*

AS 2891.14.4 *Field density tests – Calibration of a nuclear surface moisture-density gauge – Backscatter mode.*

AS 2891.14.5 *Field density tests – Density ratio of compacted asphalt*

For more information on any of the construction practices discussed in "pavement work tips", please contact either your local Austroads representative or AAPA — tel (03) 9853 3595; fax (03) 9853 3484; e-mail: info@aapa.asn.au

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