Book review

PPR535 – Assessment of Asphalt Durability Tests: Part 1, Widening the Applicability of the SATS Test

J. R. A. Grenfell, G. D. Airey, A. C. Collop, R. C. Elliott and J. C. Nicholls. TRL Ltd, Wokingham, UK, ISBN 978-1-84608-957-2, £35.00 (printed document), £25.00 (PDF format), 64 pp.

This report was prepared for the Highways Agency and Defence Estates and was published by TRL Ltd on 12 May 2011.

This report, together with PPR536 and PPR537 which look at correlation between different methods of testing the deformation of asphalts and the applicability of the SATS test on bases respectively, forms part of a trilogy of reports looking at the durability of asphalt mixtures in the laboratory.

The saturation ageing tensile stiffness (SATS) test was developed for the Highways Agency from 2000 and published in 2004 (it was slightly revised in 2008) in clause 953 of the Specification for Highway Works (SHW), as a means to evaluate low binder content mixtures with very stiff (low penetration) bitumen binders, for example, HMB 15, following poor in-service performance. This was apparently due to ageing and excessive embrittlement of the bitumen and loss of cohesion/adhesion under load in the presence of air and water.

The development of the SATS test showed that by placing vacuum-saturated specimens in a pressure vessel in a moist atmosphere at elevated temperature for a period of time, the test could simulate this deterioration by measuring the stiffness modulus before and after testing. In addition, it could discriminate between aggregates that performed adequately and poorly. It was this lack of validation in other tests worldwide that made the test so interesting.

With the demise of HMB 15 and the introduction from France of 2 EME2 (*Enrobé à Module Élevé*) and ongoing usage of dense bitumen macadam (DBM 50), it was necessary to confirm that the SATS test protocol could still be used with these mixtures which have higher binder content and/or softer bitumen.

This report describes work carried out by TRL Ltd (TRL) and Scott Wilson, with testing subcontracted to a laboratory at the University of Nottingham, to evaluate changes to the SATS test protocol using a DBM 50 mix, with various test pressures, temperatures and timescales. The first two changes were because preliminary work showed the original protocol was too harsh; some specimens disintegrated or had very low retained stiffness after SATS, the third change was to reduce test time and hence test cost.

Two aggregates with known acceptable performance and one with known poor performance were evaluated together with a limited amount of work on different binder contents, to produce a series of 32 charts in total and a large appendix of numerical data. The test apparatus contains five specimens, four of which were tested in pressurised saturated air and one under water. The charts contained data for all specimens making a hard copy or colour print essential for the reader, especially for someone wishing to compare the charts.

The results, which are listed below, produced some encouraging conclusions which could lead to a suitable revised SATS protocol.

- The results confirmed that the original SATS conditions of 2.1 MPa pressure, 85°C temperature and 65 h test time that are used with 10/20 grade bitumen were indeed too harsh for 40/60 grade bitumen.
- Discrimination between adequate/poor aggregate sources and realistic values for retained stiffness after test were still obtained with a pressure of just 0.5 MPa. The report noted that this is the pressure experienced in-service by a heavy vehicle tracking over a saturated binder course or base.
- A reduction in temperature even down to 30°C was evaluated and stiffness loss occurred. However, at this low temperature and pressure unsurprisingly no accelerated ageing took place and the test regime did not discriminate between aggregates.

The retained stiffness of 70 to 80% of the dry value, even though the samples were only 20 to 40% saturated, demonstrated clearly the loss of stiffness that must be occurring in-service in a wet road and, hence, the need to ensure bound pavements stay as dry as possible. Although not reported here, it is known that as the material returns to the dry state after the test the stiffness also recovers provided the sample has not been degraded while weak at the high temperature.

The duration of the test was found to be unimportant, so reducing the test time to 24 h from 65 h was possible. Indeed it was found that even 24 h of testing at low pressure at a temperature of 30°C was sufficient to reduce the stiffness by up to 20%. It can be observed that it was not necessarily the case that the samples completely submerged were degraded more than those in saturated air. These observations have interesting ramifications for designers in the wetter parts of the UK.

On balance the recommended protocol for the SATS test for a 40/60 grade bitumen binder in a DBM mix was 85°C temperature, 0.5 MPa pressure and 24 h duration.

The work only fully evaluated three aggregate sources; one basic, one acidic with adequate performance and one of known poor performance. More data may be required on validation using a wider range of materials. It does not evaluate EME2.

This Report was commissioned primarily to help the Highways Agency develop improvements to the *Specification for Highway Works*. It could also be used by asphalt specialists or highway engineers who may be presented with test results and seek background on their significance. It may also give some support to highway design engineers seeking to improve the drainage and pavement details to help keep the pavement layers dry. It also provides some data in support of the best practice in asphalt installation published by TRL as Road Note 42.

There is no current guidance from the Highways Agency or Defence Estates on the use of SATS for DBM. The current Association of Directors of Environment, Economy, Planning and Transport (ADEPT) guidance is that SATS testing is only required if a new source of aggregate, for which there is no experience, is used.

Ian Walsh