Book review

PPR537 – Assessment of Asphalt Durability Tests: Part 3, Review of SATS Test to Evaluate Existing Base Layers

J. C. Nicholls, J. P. Harper, K. L. Green and R. C. Elliott. TRL Ltd, Wokingham, UK, ISBN 978-1-84608-959-6, £35.00 (printed document), £25.00 (PDF format), 60 pp.

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

This work, with PPR535 and PPR536 which look at widening the usage of the saturation ageing tensile stiffness (SATS) test and correlation between different methods of testing the deformation of asphalts, respectively, forms part of a trilogy of reports looking at the durability of asphalt mixtures in the laboratory.

The 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.

In this part of the research project the team investigated the use of the SATS test on cores of 20 and 28 mm Marshall asphalt, with nominally 50 pen bitumen taken from RAF airfields so that real-life variations could be assessed, rather than simply test specimens prepared in a laboratory. This could also help assess the remaining service life of existing asphalt layers.

These site cores will not have the air voids within the range $(8 \pm 2)\%$ as required by the clause 953 of the SHW but it was felt preferable to use these rather than reconstitute samples from cores at the correct air voids.

Evaluation was carried out on 30 150 mm dia. cores, cut to form 60 mm high specimens, from two airfields on one of which was material that was deemed suspect in terms of durability as it had 8% air voids but had suffered from extensive secondary compaction in-service.

The standard SATS protocol proved to be too harsh, with most of the specimens having less than 40% retained stiffness after testing which confirms the work in PPR535 (*Assessment of Asphalt Durability Tests: Part 1, Widening the Applicability of the SATS Test*).

Whereas the air void content did affect the degree of retained saturation, as would be expected from the permeability, there was no apparent relationship between air voids and retained stiffness (correlation coefficient $R^2 = 0.04$ – R^2 can be between 0 and 1, the higher the value the better

the degree of correlation) even down to very low air void values, so other factors were playing a larger role or masking the effect.

In order to reduce the harshness of the test, the protocol was adjusted to a reduced testing time of 24 h in lieu of 65 h. The 2.1 MPa pressure and the 85°C temperature were retained.

This interim revised test protocol was also found to be too harsh, with retained stiffness in the range 0.2 to 0.5, and it did not discriminate between known good and suspect material. The test results also exhibited the same lack of correlation with air voids found with the standard test time. It was found that the protocol produced little and variable additional ageing to the bitumen in these already in-service aged samples; the mean value was about 28 pen.

In order to reduce the harshness of the test further, the test protocol was adjusted to that reported in PPR535, namely a reduced pressure of 0.5 MPa compared with 2.1 MPa and 24 h test duration in lieu of 65 h; the 85°C temperature was retained.

This revised protocol produced values that were more realistic, with retained stiffness around 0.6 and although it did discriminate between the good and suspect materials the difference was very small. The amount of ageing of the binder in this modified protocol was a very modest 4 pen. Although it is clear that saturation plays the major role in loss of stiffness there was no correlation between it and the degree of saturation, very little moisture (e.g. 10% saturation at the end of the test) was quite sufficient to make a significant difference.

The report suggested that a revised test protocol with reduced pressure of 0.5 MPa and test time of 24 h, but retaining the test temperature of 85°C, could produce sensible results on cores taken from an existing surface.

However, the report demonstrates that the difference between good and suspect material was so small using this protocol that further work on material from existing surfaces is necessary.

The report stated that consideration of other properties such as air voids and stiffness modulus may be a useful alternative. Either that or additional methods could be used to identify the deficiencies encountered in a particular suspect material. It makes a very pertinent comment that 'the complex nature of the various aspects of durability, their interrelation and their time dependence mean that a range of different techniques may all usefully form part of a combined assessment procedure'. There is no indication whether the SATS test would provide one of these techniques. Indeed, with this new procedure, the SATS test becomes something of a misnomer as the samples under test are neither saturated nor aged. However, currently stiffness modulus testing on cores taken from pavement surfaces takes no account of the moisture condition of the cores; perhaps it should.

This report is an interesting background document for any asphalt specialist thinking of using the SATS test as part of their evaluation process for highway or flexible airfield pavements as it shows that the results obtained would not provide additional data.

Ian Walsh