

**PROJECT TITLE**  
RECOMMENDED FATIGUE  
TEST FOR OKLAHOMA  
DEPARTMENT OF  
TRANSPORTATION

FINAL REPORT ~  
[FHWA-OK-16-05](#)  
ODOT SP&R 2243

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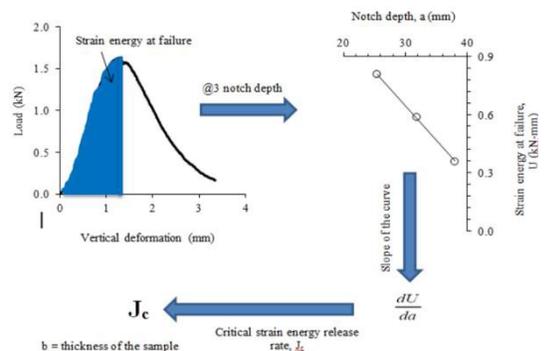
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## RECOMMENDED FATIGUE TEST FOR OKLAHOMA DEPARTMENT OF TRANSPORTATION

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**OVERVIEW** Fatigue cracking is a critical distress in asphalt pavements. This distress occurs due to repeated traffic load application, insufficient pavement structure, and most importantly due to use of fatigue prone asphalt mixes in the construction. A survey conducted under the scope of this study indicated that many asphalt pavements fail due to fatigue cracking. However, the current Superpave<sup>®</sup> volumetric-based mix design method does not account for the fatigue behavior of asphalt mixes. The fatigue resistance of an asphalt mix can be determined by conducting the following tests: (i) Semi-Circular Bend (SCB), (ii) Four-Point Beam Fatigue (BF), (iii) Indirect Tension (IDT), (iv) Cyclic Direct Tension (CDT), (v) Disc-shaped Compact Tension (DCT) and (vi) Overlay Tester (OT), etc. In most cases, one specialized equipment and trained personnel are required for performing fatigue tests on asphalt mixes. Unfortunately, even though several fatigue test methods are available, many state Departments of Transportation (DOTs) do not have guidelines and specifications for performing fatigue tests for their prevailing conditions. This is mainly due to the following reasons: (i) significant variability among different fatigue test methods, (ii) use of different test protocols by agencies, (iii) considerable amount of time needed for conducting fatigue tests, (iv) complexities involved in conducting the tests and high level of expertise needed for analyzing and interpreting the test results, (v) shortage of trained personnel, and (vi) more importantly, lack of consensus over the most suitable fatigue test method.

**RESULTS** The primary objective of this study was to evaluate different fatigue test methods and to recommend the most suitable one to Oklahoma Department of Transportation (ODOT). To achieve this objective, six commonly used asphalt mixes were tested using five different fatigue test methods: (i) Semi-Circular Bend (SCB, illustrated right and below), (ii) Four-Point Beam Fatigue (BF), (iii) Indirect Tension (IDT), (iv) Cyclic Direct Tension (CDT), and (v) Overlay Tester (OT). These fatigue test methods were evaluated with respect to the following criteria: (i) repeatability of test results; (ii) time spent for sample preparation and testing; (iii) training level needed for sample preparation and testing; and (iv) personnel expertise level and complexities involved in the data analysis. Based on aforementioned criteria, it was found that the SCB test method as per ASTM D 8044 is the most suitable



fatigue test method, and thereby, this particular test method was recommended to ODOT for screening asphalt mixes based on their fatigue resistance.

The study provided a comparison of different fatigue test methods, as shown in the following table. The coefficient of variation values (COVs) of the test results in SCB method were generally below 30%, except one particular result for Mix-4 (S5, PG 76-28 OK) when COV was found to be 37%. The COV values calculated for toughness indices (TI) in IDT method were lower than 30%. However, the variations in the TI values between the different mixes were quite low when the TI values were computed considering a same terminal strain for all the mixes. Therefore, a quantitative estimation of fatigue life may be difficult based on the TI values. The COVs of BF and OT tests were found to be higher than 30%. The initial analysis of the CDT test results also indicated a higher value for COV.

Fatigue Test	Repeatability (COV, %)	Sample preparation and testing time	Rigor in sample preparation and testing	Tediousness in the computational procedure	Required training level
SCB	< 30	Less time consuming	Relatively easy	Easy	Moderate
BF	< 60	Very much, takes weeks	Difficult	Moderate	Extensive
IDT	< 20*	Less time consuming	Easy	Moderate	Moderate
CDT	To be determined	Needs considerable time	Difficult	Moderate	Extensive
OT	< 40	Needs considerable time for sample preparation	Sample preparation is difficult, testing is easy	Easy	Moderate

\*Difference in the value of TI between different mixes is low.

Sample preparation for SCB, IDT and their associated tests are comparatively easier than those for the other tests. Computation of fatigue resistance parameters in SCB, BF and OT tests are relatively simple. The most tedious computational procedure is involved with the CDT test method. All the tests require training; however, extensive level of training is required for conducting BF and CDT tests. Based on aforementioned findings, it appears that the SCB test method may be the best overall test for screening asphalt mixes in terms of their fatigue resistance.

Based on all the factors considered in this study, which include many of those considered in NCHRP 9-57, it is recommended that ODOT fully adopt SCB (ASTM D 8044) as the standard mix design fatigue test to screen asphalt mixes for their fatigue resistance. However, the target limits of the critical strain energy release rate ( $J_c$ ) shall be established before implementing this test method. These limits can be a function of traffic volume, material types (e.g., virgin mix, mix with RAP/RAS, HMA mix, WMA mix) and class of roadways. Although all the tests in this project were conducted at 20°C (71.6 °F), the test temperature for the asphalt mix screening can be decided based on the asphalt binder grade.

**POTENTIAL BENEFITS** This work provided important information related to fatigue testing of asphalt pavements. It was found that the SCB test method as per ASTM D 8044 is the most suitable fatigue test method and was recommended to ODOT for screening asphalt mixes based on their fatigue resistance.