
Standard Method of Test for Stress Sweep Rutting (SSR) Test Using Asphalt Mixture Performance Tester (AMPT)

AASHTO Designation: TP 134-22 (2023)¹

Technically Revised: 2022

Reviewed but Not Updated: 2023

Editorially Revised: 2023

**Technical Subcommittee: 2d, Proportioning of
Asphalt–Aggregate Mixtures**



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This standard describes a test method to characterize the resistance of asphalt mixtures to rutting using the shift model. The stress sweep rutting (SSR) tests are conducted using the Asphalt Mixture Performance Tester (AMPT).
- 1.2. This standard is applicable to laboratory-prepared specimens of asphalt mixtures with a nominal maximum aggregate size that is less than or equal to 37.5 mm (1.5 in.).
- 1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.*
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED STANDARDS

- 2.1. *AASHTO Standards:*
 - < R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - < R 83, Preparation of Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC)
 - < T 378, Determining the Dynamic Modulus and Flow Number for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)
- 2.2. *Federal Highway Administration:*
 - < FHWA. *TechBrief: Rutting Strain Index (RSI) Parameter for Asphalt Balanced Mixture Design*. FHWA-HRT-21-044. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, April 2021. Available from <https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/21044/21044.pdf>

- < Kim, Y. R., et al. *Development of Asphalt Mixture Performance Related Specifications*, Final Report. FHWA Project No. DTFH61-08-H-00005. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, 2018.

2.3. *Other Documents:*

- < Choi, Y. and Y. R. Kim. Implementation and Verification of a Mechanistic Permanent Deformation Model (Shift Model) to Predict Rut Depths of Asphalt Pavement. *Road Materials and Pavement Design*, Vol. 15, 2014. Taylor and Francis Group, London, SW1P 1WG, pp. 195–218.
- < Ghanbari, A., B. S. Underwood, and Y. R. Kim. 2020. Development of a Rutting Index Parameter based on the Stress Sweep Rutting Test and Permanent Deformation Shift Model. *International Journal of Pavement Engineering*, Vol. 23, Issue 2. Taylor and Francis Group, London, SW1P 1WG, 2020, pp.1–13.
- < Kim, D. and Y. R. Kim. Development of Stress Sweep Rutting (SSR) Test for Permanent Deformation Characterization of Asphalt Mixture. *Construction and Building Materials*, Vol. 154. Elsevier Inc. (Corporate Office), Suite 800, 230 Park Avenue, New York, NY, 2017, pp. 373–383.

3. **TERMINOLOGY**

- 3.1. *confining pressure*—stress applied to all surfaces in a confined test.
- 3.2. *deviatoric stress*—difference between the vertical stress and the confining pressure.
- 3.3. *loading block*—200 repetitions of loading cycles.
- 3.4. *permanent strain*—non-recovered strain in a repeated load test.
- 3.5. *repeated load cycle*—loading of 0.4 s followed by a 3.6-s rest period at the high test temperature (T_H) and loading of 0.4 s followed by a 1.6-s rest period at the low test temperature (T_L).
- 3.6. *rutting strain index (RSI)*—the rutting index parameter that can be determined from the SSR test.
- 3.7. *shift model*—permanent strain model that can predict permanent strain under various load times, deviatoric stress levels, and temperatures.
- 3.8. *vertical stress*—total vertical stress, including applied stress and confining pressure.

4. **SUMMARY OF THE TEST METHOD**

- 4.1. The SSR test is conducted at two test temperatures, referred to as T_H (the high temperature) and T_L (the low temperature), and under constant confining pressure of 69 kPa (10 psi), with three 200-cycle loading blocks of three deviatoric stress levels.
- 4.2. The load pulse is 0.4 s for each cycle. The rest period is dependent on the test temperature. The permanent axial deformation that occurs at each load cycle is measured using actuator displacement.

5. **SIGNIFICANCE AND USE**

- 5.1. The SSR test measures permanent deformation characteristics of asphalt mixtures as a function of deviatoric stress, loading time, and temperature. The results from two SSR tests at each of the high

and low temperatures can be used to develop the shift model. The shift model has been incorporated into the pavement performance prediction program, FlexPAVE™, to predict the permanent deformation of asphalt layers under various deviatoric stress levels, loading times, and temperatures as a function of pavement depth and time. The SSR test results are used to calculate the RSI and can be employed as part of a performance-engineered mix design for asphalt mixtures.

- 5.2. The shift model is based on the permanent deformation behavior of an asphalt mixture in the primary and secondary regions. If tertiary flow occurs during the SSR test, the applicability of the shift model to the test results depends on when the tertiary flow occurs. If the tertiary flow occurs during the first or second loading blocks, the test results should not be used to develop the shift model. If the tertiary flow occurs toward the end of the third loading block, the test results can be used to develop the shift model.

6. APPARATUS

- 6.1. *Specimen Fabrication Equipment*—Equipment used to fabricate SSR test specimens as described in R 83.
- 6.2. *Asphalt Mixture Performance Tester (AMPT)*—Dynamic testing apparatus that meets the requirements of Equipment Specification for the Simple Performance Test System, Version 3.0.
- 6.3. *Conditioning Chamber*—Environmental chamber that is used to condition the test specimens to the desired test temperature. The environmental chamber shall be able to control the temperature of the specimen over a temperature range from 4 to 70°C (39 to 158°F) to an accuracy of ±0.5°C (±0.9°F). The chamber shall be large enough to accommodate at least two specimens to be tested, plus a dummy specimen with a temperature sensor mounted in the center for temperature verification.
- Note 1**—The temperature range required for the conditioning chamber is a function of the anticipated test temperature. The temperature control range provided in this section is intended to be inclusive of all areas of the U.S. In many climatic regions, it may not be necessary to have equipment capable of controlling the temperature up to 70°C (158°F).
- 6.4. *Latex Membranes*—100-mm (4-in.) diameter by 0.3-mm (0.012-in.) thick latex membranes to be used to encase the specimen and greased double-latex friction reducers to be used between the specimen and the loading platens in SSR tests.
- 6.5. *Silicone Grease*—Dow Corning high vacuum grease or equivalent to be used to fabricate the greased double-latex friction reducers.
- 6.6. *Balance*—Scale device that is capable of determining mass to the nearest 0.01 g. The balance is used to determine the mass of the silicone grease for the fabrication of greased double-latex friction reducers.

7. HAZARDS

- 7.1. This practice and associated standards involve the handling of hot asphalt binder, aggregate, and asphalt mixtures. It also includes the use of sawing and coring machinery and servohydraulic testing equipment. Use standard safety precautions, equipment, and clothing when handling hot materials and operating machinery.

8. TESTING AND EQUIPMENT CALIBRATION

- 8.1. The guidelines provided in T 378 shall be followed to ensure that all test equipment is calibrated properly.
- 8.2. If any of the verifications yield data that does not comply with the accuracy specified, the problem shall be corrected prior to further testing.

9. PROCEDURE

9.1. *Test Specimen Preparation:*

- 9.1.1. Tests shall be performed using 100-mm (4-in.) diameter by 150-mm (6-in.) tall test specimens fabricated in accordance with R 83.
- 9.1.2. *Replicates*—At least two replicate specimens shall be tested for each temperature.
Note 2—It has been found that, when the difference in the strain at the end of the test between two replicates exceeds 25 percent, a third replicate should be tested.
- 9.1.3. Prepare four test specimens at the target air void content ± 0.5 percent and with the aging condition in accordance with R 83.
Note 3—A target air void content of 7.0 percent with tolerance of ± 0.5 percent is reasonable for a typical in-place density.

9.2. *Test Temperatures:*

- 9.2.1. The SSR test requires two temperatures: high (T_H) and low (T_L).
- 9.2.2. An appropriate high temperature (T_H) can be selected based on LTPPBind Online at the location of interest. The T_H is calculated from the degree-days parameter for the construction site using LTPPBind Online.
- 9.2.3. Enter relevant project information into LTPPBind Online. Use the MERRA weather station selected from the LTPPBind Online map function and obtain the Yearly Degree-Days $> 10^\circ\text{C}$.
- 9.2.4. Calculate the high temperature (T_H) using Equation 1:

$$T_H = 0.87 \left(\frac{58 + 7 \left(\frac{DD}{1000} - 15 \right) \log(H + 45)}{8} \right) \quad (1)$$

where:

T_H = high test temperature, $^\circ\text{C}$,

DD = degree-days $> 10^\circ\text{C}$ obtained from LTPPBind Online, and

H = 0 for the surface layer and design depth to top of layer for intermediate and base layers, mm.

Note 4—If the design structure is unknown at the time of testing, use 75 mm and 150 mm as the depths to top of layer for the intermediate and base layers, respectively.

- 9.2.5. Calculate the low temperature (T_L) using Equation 2.

$$T_L = T_H - 25 \text{ for } T_H > 45$$

$$T_L = 20 \text{ for } T_H \leq 45 \quad (2)$$