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# **Standard Method of Test for Measuring Asphalt Binder Yield Energy and Elastic Recovery Using the Dynamic Shear Rheometer**

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**AASHTO Designation: TP 123-16 (2022)<sup>1</sup>**

**First Published: 2016**

**Reviewed but Not Updated: 2022**

**Editorially Revised: 2021**

**Technical Subcommittee: 2b, Liquid Asphalt**



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# Measuring Asphalt Binder Yield Energy and Elastic Recovery Using the Dynamic Shear Rheometer

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## 1. SCOPE

- 1.1. This test method covers the Binder Yield Energy Test (BYET) for evaluation of asphalt binders' resistance to yield-type failure under monotonic constant shear-rate loading using the Dynamic Shear Rheometer (DSR). This test procedure can also be adapted for performing surrogate test procedure using the DSR in place of the conventional ductility test ([T 51](#)), and the Elastic Recovery test ([ASTM D6084/D6084M](#)). The test method can be used with unaged material and material aged using [T 240](#) (RTFOT) and/or [R 28](#) (PAV) to simulate the estimated aging for in-service asphalt pavements.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to 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.*

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## 2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
  - [M 320](#), Performance-Graded Asphalt Binder
  - [R 18](#), Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
  - [R 28](#), Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
  - [T 51](#), Ductility of Asphalt Materials
  - [T 240](#), Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
  - [T 300](#), Force Ductility Test of Asphalt Materials

- [T 315](#), Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

2.2. *ASTM Standards:*

- [D8](#), Standard Terminology Relating to Materials for Roads and Pavements
- [D6084/D6084M](#), Standard Test Method for Elastic Recovery of Bituminous Materials by Ductilometer

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### 3. TERMINOLOGY

3.1. *Definitions:*

- 3.1.1. Definitions of terms used in this practice may be found in Terminology [D8](#), determined from common English usage, or combinations of both.

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### 4. SUMMARY OF TEST METHOD

- 4.1. The binder is prepared either at an unaged condition or using [T 240](#) (RTFOT) to represent short-term aging of asphalt pavements, or further conditioned using [R 28](#) (PAV) to simulate long-term aging of asphalt pavements. The sample is prepared consistent with [T 315](#) (DSR) using the 8-mm parallel plate geometry with a 2-mm gap setting.
- 4.2. For the binder yield energy procedure, the sample is tested in monotonic shear using a constant strain rate. The sample is continuously loaded until peak shear strength is achieved and the sample has yielded. The results can also be used to estimate ductility or forced ductility using the strain and stress at the peak of the yield curve.
- 4.3. For measuring the binder Elastic Recovery, after 2 min of monotonic shear using a constant strain rate, the sample is allowed to recover for 30 min before calculating the percent strain recovery.

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### 5. SIGNIFICANCE AND USE

- 5.1. This method is intended to evaluate the performance of binders at intermediate temperatures in terms of resistance to yielding and in terms of elastic recovery. The “yield energy” of the sample can be used to identify the relative performance of different materials in terms of resistance to fatigue or extreme loading damage.
- 5.2. This method also provides a simple and more repeatable alternative to conducting the ductility test ([T 51](#)) and elastic recovery test ([ASTM D6084/D6084M](#)), using a standard Dynamic Shear Rheometer and a small sample size. The stress–strain response curve from the yield test, as well as the strain recovery from the elastic recovery test, can be useful in identifying the presence of modifiers in binders and their potential benefits in improving ductile behavior of binders.
- Note 1**— It is to be noted that the relationship between ductility and elastic recovery to pavement performance is not known and there is no clear evidence that having higher ductility or higher elastic recovery improves pavement performance. The significance of this test is to replace the use of a ductilometer used for ductility, forced ductility, and elastic recovery with simpler and more repeatable tests in the DSR.