Designation: F2803 – 09 (Reapproved 2015)

Standard Test Method for Evaluating Rim Slip Performance of Tires and Wheels[1]

This standard is issued under the fixed designation F2803; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is performed to determine the amount of rotational slip occurring at the tire/wheel interface while under heavy longitudinal load conditions.

1.2 This test method is suitable for research and development purposes where tires are compared during a single series of tests. They may not be suitable for regulatory statutes or specification acceptance because the values obtained may not necessarily agree or correlate either in rank order or absolute performance level with those obtained under other environmental conditions on other surfaces or the same surface after additional use.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F538 Terminology Relating to the Characteristics and Performance of Tires

2.2 *SAE Standards:*[3]

SAE J2013 Military Tire Glossary

SAE J670e Vehicle Dynamics Terminology

3. Terminology

3.1 *Definitions:*

3.1.1 *bead, n—of a tire*, the part of a tire that comes in contact with the rim and is shaped to secure the tire to the rim. **F538**

3.1.2 *candidate tire, n*—test tire that is part of a test program. **F538**

3.1.3 *control tire, n*—reference tire used in a specified manner throughout a test program. **F538**

3.1.4 *deflection, n*—difference between the unloaded and loaded section heights. **SAE J2013**

3.1.5 *drawbar, n*—device for coupling a hauling vehicle to a load.

3.1.6 *dynamometer, n*—machine used to measure torque and rotational speed (rpm) from which power produced by an engine, motor or other rotating prime mover can be calculated.

3.1.6.1 *Discussion*—For the purpose of this test method, a dynamometer can be any vehicle or trailer that can be towed and produce longitudinal resistance.

3.1.7 *longitudinal force, n—of a tire*, the component of the tire force vector in the X direction. **F538**

3.1.8 *longitudinal slip velocity [L/T], n*—effective rolling radius multiplied by the difference between the spin velocity (in rad/unit time) of a driven or braked tire and that of a free rolling tire when each is traveling in a straight line. **F538**

3.1.9 *maximum load rating [M], n—of a passenger tire*, the load rating at the maximum permissible cold inflation pressure for that tire. **F538**

3.1.10 *paved road, n*—two or more lanes, all weather, maintained, hard surface roads with good driving visibility used for heavy and high-density traffic, in accordance with the U.S. Federal Highway Administration. **F538**

3.1.11 *rim, n*—specially shaped circular periphery to which a tire may be mounted with appropriate bead fitment. **F538**

3.1.12 *rim slip, n*—circumferential distance along the rim flange between the corresponding marks.

3.1.13 *section height, n*—radial height of a tire section, expressed as one half the difference between the outside diameter of the unloaded tire and the nominal rim diameter; the outside diameter is measured on a tire-wheel assembly with the tire inflated to rated inflation pressure. **F538**

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[1] This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.20 on Vehicular Testing.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

3.1.14 *sidewall, n—of a tire*, that portion of a tire between the tread and the bead. **F538**

3.1.15 *test, n*—technical procedure performed on an object (or set of objects) using specified equipment, that produces data, which are used to evaluate or model selected properties or characteristics of the object (or set of objects). **F538**

3.1.16 *test tire, n*—tire used in a test. **F538**

3.1.17 *torque [FL], n—of a wheel*, the external torque applied to a tire from a vehicle about the wheel spin axis. **F538**

3.1.18 *tractive effort, n*—total force output of the traction device acting parallel to the surface of the ground and in the direction of travel of a driving wheel.

3.1.18.1 *Discussion*—Tractive effort is expressed as a ratio of load to vehicle weight. **SAE J2013**

4. Summary of Test Method

4.1 This test method is used to quantify the amount a driven tire rotates relative to a rim under severe conditions. This method is designed to produce the greatest amount of rim slip in the shortest amount of time using a test vehicle that is capable of 60 % tractive effort. The 60 % tractive effort is a target from military requirements but can be adjusted to fit a commercial application. This test method can be modified to accommodate different objectives including longer distances or various drawbar loads. Test tire results are compared to a control tire to evaluate the relative change in performance and to negate affects from environmental conditions.

5. Significance and Use

5.1 This test method establishes a standard procedure of comparative testing, for driven wheel rim slip, between candidate tire group(s) and a control tire group. This test method is suitable for research and development purposes where tire and rim specimens are compared during a brief testing time period. They may not be suitable for regulatory or specification acceptance purposes because the values obtained may not necessarily agree or correlate, either in rank order or absolute value, with those obtained under other conditions (for example, different locations or different seasonal time periods on the same test course).

6. Interferences

6.1 The absolute values of the parameters obtained with this test method are dependent upon the characteristics of the vehicle, the selected test pavement(s), and the environmental conditions at the test course. A change in any of these factors may change the absolute values and may also change the relative rating of the tires and wheels so tested. It is recommended that all testing occur at similar conditions and in as short a time frame as possible to reduce this variability.

6.2 Wheel condition, lubrication, and the elapsed time from tire mounting may affect the results of testing. It is recommended tires are mounted consistently, without lube if possible, between tire and wheel specimens.

7. Apparatus

7.1 The testing apparatus shall consist of a wheeled vehicle capable of providing consistent torque to the test wheel locations, a dynamometer, load cell, calibrated speedometer, and tire/wheel specimens. The test course shall be a smooth, less than 2 % grade, dry pavement surface. The surface and ambient temperature must be above 0°C (32°F).

8. Reagents and Materials

8.1 This test method requires a paint pen or equivalent device capable of marking tires and rim surfaces.

9. Hazards

9.1 The towing vehicle shall be secured with a load cell and a cable/drawbar that is suitable to provide safety for testing personnel.

10. Sampling, Test Specimens, and Test Units

10.1 The speed and drawbar load data shall be acquired at a minimum of 10 Hz. The speed data shall be accurate to ±1 km/h (0.6 mph). The drawbar load cell shall be accurate to within 2 % for the maximum reading.

10.2 Prior to testing, the tires and wheels shall be marked on the side facing away from the test vehicle. Two lines shall be made at the valve stem with a paint pen or suitable marker, across the tire bead and rim a minimum of 6 cm (2.5 in.) on each surface. A similar single mark shall be made 180 radial degrees on the same face of the tire. Refer to Fig. 1 for example tire and rim markings.

10.3 All units in this test method are listed in SI units; the results of testing may be presented in the units chosen by test personnel.

11. Preparation of Apparatus

11.1 The test vehicle shall be loaded so that each wheel position shall be within 5 % of the maximum load rating for each test tire at a minimum of two wheel positions.

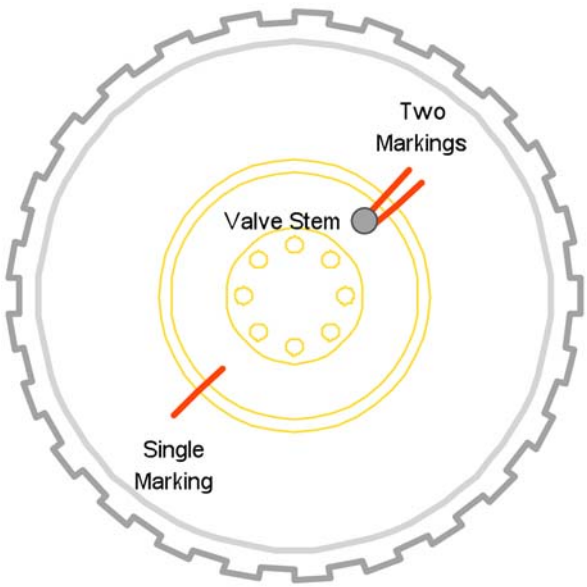

FIG. 1 Example Tire and Rim Markings Prior to Testing

11.2 The test vehicle shall be driven at an operating speed less than 40 km/h (25 mph) for a minimum of 5 min to warm up the drive train components.

11.3 After warm up, the test vehicle shall be attached to the dynamometer to begin test.

11.4 Preparation of tire and wheel specimens shall be consistent to minimize any variables such as lubrication or improper bead seating.

12. Calibration and Standardization

12.1 Test speed shall be measured using a calibrated device such as a GPS or a fifth wheel. Drawbar load shall be measured using a calibrated load cell or equivalent device. Rim slip shall be measured using a calibrated flexible ruler or tape that will not be affected by bending.

13. Conditioning

13.1 A minimum of 160 km (100 miles) of break in are required for each test tire. It is recommended that all tires groups have a similar amount of break in.

14. Procedure

14.1 At no time is a tire longitudinal slip velocity greater than 8 km/h (5 mph) acceptable and will cause a void of the test results.

14.2 The tires shall be inflated to their recommended cold operating pressures, or other value as specified by the end user. Additional testing is recommended at an off road tire pressure, typical at 25 to 30 % tire deflection.

14.3 The vehicle shall be driven with a towed drawbar load that is equal to 40 % tractive effort initially, and a second test at 60 % tractive effort. If the test vehicle is not capable of producing the required load, the vehicle shall be driven at ⅔ of the maximum tractive effort at a test speed of 8 km/h (5 mph) and at a second load that is equal to the maximum tractive effort.

14.4 Test duration is 15 min.

14.5 At the conclusion of test each test wheel location shall be photographed to include the entire rim and tire assembly. A minimum of one additional photo per wheel is required to include the marks made at the valve stem as well as the two markings made on the tire. The final inflation pressure shall be measured and recorded.

14.6 The rim slip shall be measured using a flexible measuring tape that is capable of flexing around the tire rim. Refer to Fig. 2 and Fig. 3 for measurements examples. The rim slip is the measured circumferential distance along the rim flange between the corresponding marks. Measurements are to be made on the corresponding leading edge of each line to exclude the thickness of the line.

15. Calculation or Interpretation of Results

15.1 The average test speed, average drawbar load, and measured rim slip for each wheel position are tabulated as a means of comparison between the candidate and control tire groups. Comparisons shall be made at equivalent wheel positions. This standard assumes a single run for each tire group, an average of multiple tests may be done at the discretion of the test operators.

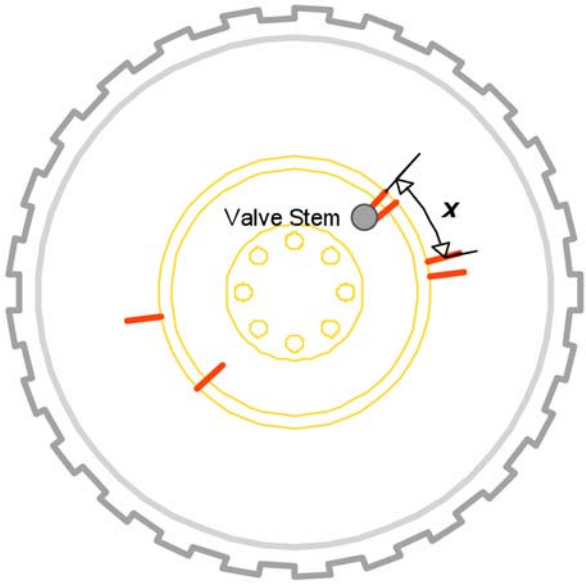

FIG. 2 Example Tire and Rim Markings Post Test

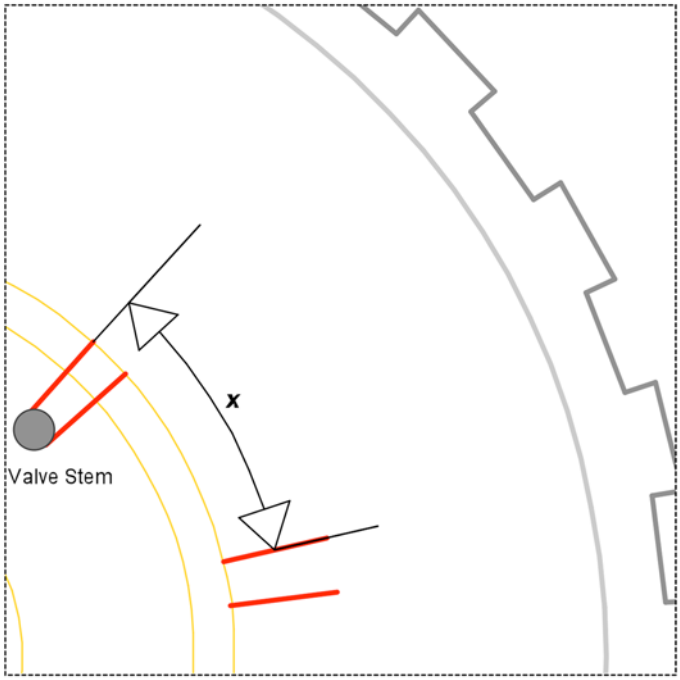

FIG. 3 Example Measurement Points

16. Report

16.1 Report the following information:
16.1.1 Test vehicle used, gross vehicle load (mass),
16.1.2 Method used: ASTM XXXX Rim Slip Test,
16.1.3 Procedure used, and
16.1.4 Instrumentation used.

16.2 For each test event report the following:
16.2.1 Test date,

16.2.2 Pavement condition,
16.2.3 Tire size, name, and manufacturer,
16.2.4 Rim size, contour, and manufacturer,
16.2.5 Ambient temperature, °C (°F),
16.2.6 Average test speeds, km/h (mph),
16.2.7 Average drawbar load, N (lb),
16.2.8 Initial tire inflation pressure, kPa (psi),
16.2.9 Final tire inflation pressure, kPa (psi),
16.2.10 Tire break in, km (miles),
16.2.11 Rim slip for each wheel position, cm (in.), and
16.2.12 A statement that tires did not slip relative to the pavement during test.

17. Precision and Bias

17.1 *Precision*—Data are not yet available, therefore no statement on the repeatability or reproducibility of the test method can be made.

17.2 *Bias*—There are no standards or reference values with which the results of this test method can be compared; therefore, bias cannot be evaluated.

18. Keywords

18.1 bead slip; rim slip

ANNEX

(Mandatory Information)

A1. RIM SLIP REPORT

A1.1 *Example Report Form*—See Table A1.1.

APPENDIX

TABLE A1.1 Example Report Form

Test Vehicle:	Make Model				
		Left Front	Right Front	Left Rear	Right Rear
	Recommended Inflation Pressure:				
	GVWR:				
	Measured Vehicle Weight:				
	Total Vehicle Weight:				
	Target Drawbar Load:				
Instrumentation:		Cal Date	Cal Due Date	Accuracy	Maximum Reading
	Load Cell:				
	Speed:				
Test Results:	Test Date				
	Ambient Temperature:				
	Pavement Condition:				
	Tire Size, Name, and Manufacturer:				
	Rim Size, Contour, and Manufacturer:				
	Average Test Speed:				
	Target Drawbar Load:				
	Average Drawbar Load:				
		Left Front	Right Front	Left Rear	Right Rear
	Initial Inflation Pressure:				
	Final Inflation Pressure:				
	Rim Slip:				
	Did the Tire Slip Relative to Pavement?: (y/n)				

(Nonmandatory Information)

X1. TEST METHOD OPTIONS

X1.1 This test method measures the rim slip in units of length along the circumference of the flange edge of the rim. For control and candidate tires of different rim diameters, it may be required to calculate the rim slip in angular units.

X1.2 If rim slip is found or expected to be greater than or near an entire rotation of the tire relative to the rim, the measurement method may require additional testing equipment. The following options can be used to accommodate this result:

X1.2.1 Reduction of drawbar load.

X1.2.2 Reduction of test duration.

X1.2.3 If quantification of the rim slip at this condition is required, a string can be attached to the hub and fixed to the tire sidewall using a suitable adhesive. The string shall be attached near the hub in a way that it will wind around a shaft as the tire rotates relative to the wheel. An example of this alternate test setup is shown in Fig. X1.1. If the number of winds is greater than one, the rim slip shall be added to the number of winds that the string has made around the shaft multiplied by the circumference of the outer flange of the rim.

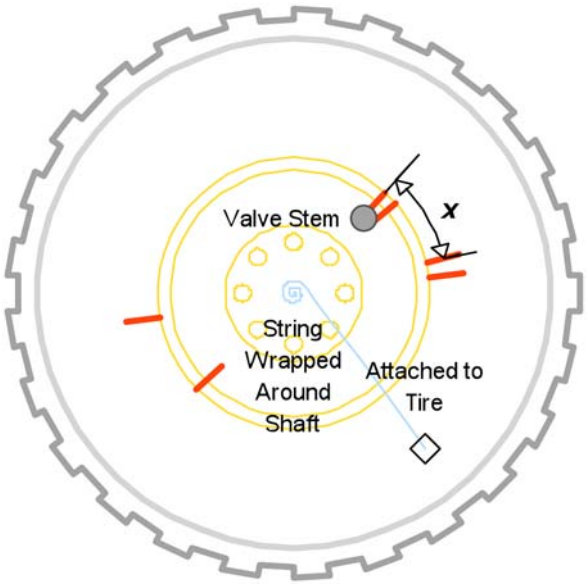

FIG. X1.1 Method for Quantifying Rim Slip of Greater than or Equal to One Rotation of the Tire Relative to the Rim