TIRE ROLLING RESISTANCE FOR LIGHT VEHICLES I: SELECTION OF TIRES AND TESTS FOR RATING SYSTEM DEVELOPMENT

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Tire Rolling Resistance for Light Vehicles, I: Selection of Tires and Tests for Rating System Development

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Tire Rolling Resistance Test Program

- Testing conducted at two laboratories to evaluate lab-to-lab variability:
  - Smithers Scientific Services, Inc. (SSS)
  - Akron Rubber Development Labs (ARDL)
    - Subcontracted to Standards Testing Labs (STL)

- Five rolling resistance test methods evaluated
  - Three SAE & Two ISO methods

- Twenty five tire models included in study
  - Included Standard Reference Test Tire (SRTT), Tire Type “M14” - ASTM F2493-06, 225/60R16 Tire
Laboratory Rolling Resistance Testing

Smithers Scientific Services, Inc.

- Standards Testing Labs
  - 1 x machine
  - 1 y machine
  - 1 z machine
  - 1 q machine
Five Test Methods Evaluated

- SAE (USA) Rolling Resistance Tests
  - J2452 Coastdown
    - Auto manufacturers use for vehicle fuel economy calculations over a range of speeds
  - J1269 Multi-Point
    - Uses four or six sets of test conditions and allows calculation of rolling resistance at a “Standard Reference Condition (SRC)”
  - J1269 Single Point
    - Runs a single test at the SRC

- ISO (Global) Rolling Resistance Tests
  - 18164 Multi-Point
    - Four or five rolling resistance values based on four or five test conditions
  - 28580 Single Point (Draft International Standard) in ballot
    - Runs a single test
## Selecting a Test Method

<table>
<thead>
<tr>
<th>Category</th>
<th>SAE J2452 Coastdown</th>
<th>SAE J1269 Multi-Point</th>
<th>SAE J1269 Single Point</th>
<th>ISO 18164 Multi-Point</th>
<th>ISO 28580 Single Point</th>
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## Overview of 25 Test Tire Models

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<th>Load Index</th>
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<td>P225/60R16</td>
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<td>Michelin</td>
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<td>H</td>
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<td>Goodyear</td>
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<td>S</td>
<td>Integrity</td>
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<td>B</td>
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<td>S</td>
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<td>N</td>
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<td>R</td>
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<td>R</td>
<td>Michelin X RADIAL LT</td>
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ASTM Standard Reference Test Tire (SRTT)

- **ASTM International (American Society for Testing and Materials)**
  - Industry and Government consensus standards organization
  - www.astm.org
- **ASTM Definition: Standard Reference Test Tire**
  - SRTT, n. A tire that is used as a control tire or surface monitoring tire.
- **Usage**
  - Test Sequence = SRTT, candidate 1, candidate 2, candidate 3, candidate 4,… SRTT
  - Ensures consistency in testing
  - Allows rating based on % of SRTT test value
**ASTM Standard Reference Test Tires**

**E 1136**
- P195/75R14
- Established 1986
- Currently used for F 1805 Single Wheel Driving Traction (Winter Test for Snowflake Tire) and UTQG
- FMVSS 139 specifies F 1805 test to determine “winter tire” test criteria

\[196 \text{ mm}\]

**F 2493-06 (M14 in this study)**
- P225/60R16 97S
- Established 2006
- Designed for use in braking, snow, wear and other performance tests
- In 28580 tests
  - Coefficient of Variation (C.V.) = 0.9
    - STD = 0.11 lbs. Mean = 11.8 lbs.

\[231 \text{ mm}\]
Overview of Passenger Tires – Axis #1

- One Manufacturer - Goodyear
- One Model - Integrity
  - Four Sizes
- One Run Flat Model

G9  P205/75R14 S
G10 P205/75R15 S
G8  225/60R16 S
G11 P225/60R17 S
U3 P225/60R17 T

Dunlop Sport 4000 DSST (Run Flat)
Overview of Passenger Tires

- One Manufacturer – Bridgestone
- One Size - P225/60R16
- Six Models
- Q-W Speed Rating

B15 Winterforce S
B14 Potenza RE-92A H
B14 Turanza LS-V
B12 Potenza RE750 W
B10 Blizzak REVO 1 Q
B13 Turanza LS-T
Overview of Passenger Tires – Axis #3

- Four Manufacturers
- One Size - P225/60R16
- One Speed Rating - H

- P5 Pep Boys Touring HR
- R4 Pirelli P6 Four Seasons H
- D10 Cooper Lifeliner Touring SLE H
- M13 Michelin Pilot MXM4 H
Overview of 16 Passenger Tire Models

1 Mfg. - Goodyear
4 Sizes
1 Model - Integrity
+ 1 Runflat

- G9 P205/75R14 S
- G10 P205/75R15 S
- G8 225/60R16 S
- G11 P225/60R17 S
- U3 P225/60R17 T

Axis #1
- M14 Reference Tire ASTM SRTT S
  - D10 Cooper Lifeliner Touring SLE H
  - R4 Pirelli P6 Four Seasons H
  - P5 Pep Boys Touring HR
  - M13 Michelin Pilot MXM4 H

Axis #2
- 1 Mfg. - Bridgestone
  - 1 Size - P225/60R16
  - 6 Tire Models
    - B15 Winterforce S
    - B10 Blizzak REVO 1 Q
    - B12 Potenza RE750 W
    - B14 Turanza LS-V
    - B11 Potenza RE-92A H
    - B13 Turanza LS-T

Axis #3
- 4 Mfg.
  - 1 Size - P225/60R16
  - 1 Speed Rating - H
  - 225/60R16 S
  - G11 P225/60R17 S
  - U3 P225/60R17 T
  - 1 Mfg. - Goodyear
    - 4 Sizes
    - 1 Model - Integrity
      + 1 Runflat
  - 4 Mfg.
    - 1 Size - P225/60R16
      - 1 Speed Rating - H
Overview of 9 Light Truck Tire Models

1 Mfg. - Cooper
3 Sizes
1 Model - Discoverer ST-C

Axis #5

LT235/85R16
LT245/75R16
LT265/75R16

Axis #6

1 Mfg. - Michelin
1 Size - LT245/75R16
3 Models

Michelin LTX A/S
Michelin LTX M/S
Michelin Radial LT
General Ameri*Trac TR
Kumho Road Venture HT
PEP Boys Scrambler A/P

Axis #7

3 Mfg.
1 Size - LT245/75R16
**Data Range - Pounds Force & RR Coefficient (10^-3)**

- **Light Truck**
  - Lbs. = 22.0 – 28.4
  - RRC = 8.5 – 11.0 (x10^-3)

- **Passenger**
  - Lbs. = 9.7 – 15.3
  - RRC = 7.3 – 11.6 (x10^-3)
**Axis #1 - Data range from 85.61 to 102.39% of SRTT**
- One Manufacturer - Goodyear
- One Model - Integrity
  - Four Sizes
- +One Run Flat Model

**Axis #2 - Data range from 83.97 to 124.65% of SRTT**
- One Manufacturer – Bridgestone
- One Size - P225/60R16
- Six Models
  - Q-W Speed Rating

**Axis #3 - Data range from 100.08 to 122.63% of SRTT**
- Four Manufacturers
- One Size - P225/60R16
- One Speed Rating - H
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<td>Model</td>
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<td>Size</td>
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<tr>
<td>Models</td>
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Comparison of Single Point Rolling Resistance Tests

**ISO 28580 (Draft)**
- 1.708m or greater Test Machine
  - Not corrected to 2m in this study
- Force/Torque/Power/Deceleration methods
- Bare or Textured Surface
- 25°C Reference Temperature
- 80 km/h (50 mph)
- 80 Passenger / 80 LT % sidewall load
- 210 kPa Pass / 100% LT pressure
- Capped pressure
- NO break-in
- Lab Alignment Procedure

**SAE J1269 Single (SRC)**
- 1.708m Test Machine
- Force/Torque/Power methods
- 80 Grit Surface
- 24°C Reference Temperature
- 80 km/h (50 mph)
- 70% sidewall load
- @ +20 kPa (3 psi) Regulated
- 60 minute break-in

Not corrected to 2m in this study
Disadvantages

ISO 28580 (Draft)
- Bare surface less accurate at high light truck tire loads
- Not a large database to date

J 1269 Single (SRC)
- Regulated pressure is different from highway usage
- Coefficient of Variation was 2.3

Advantages

- Harmonization - Being developed by ISO and Tire Industry as “World Standard”
- Least difference in labs studied
- Coefficient of Variation was 1.2

- Tire Industry has large data base of results from this test
- Database from J1269 Multi-Point can be used to calculate SRC result
ISO 28580 (DIS) Lab Alignment

- Includes 2 “Alignment Tires” for passenger being developed / defined by ETRTO

- Includes 2 “Alignment Tires” for light truck (C tire) being developed / defined by ETRTO

- Results corrected to 2 meter drum diameter

- Uses control tires to handle day-to-day, month-to-month variation, or out of calibration
Test Program Summary

- Two laboratories were included in testing
- Five Test Methods Evaluated
- Twenty five tire models included in study
- Passenger tire rolling resistance range:
  - Force = 9.7 – 15.3 lbs
  - RRC = 7.3 – 11.6 (x10⁻³)
  - %SRTT = 83.97 – 124.65%
- Light truck tire rolling resistance range:
  - Force = 22.0 – 28.4 lbs
  - RRC = 8.5 – 11.0 (x10⁻³)
  - %SRTT = 183.31 – 233.54%