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ROAD SURFACE FRICTION IMPACT TO VEHICLE DYNAMICS TESTING

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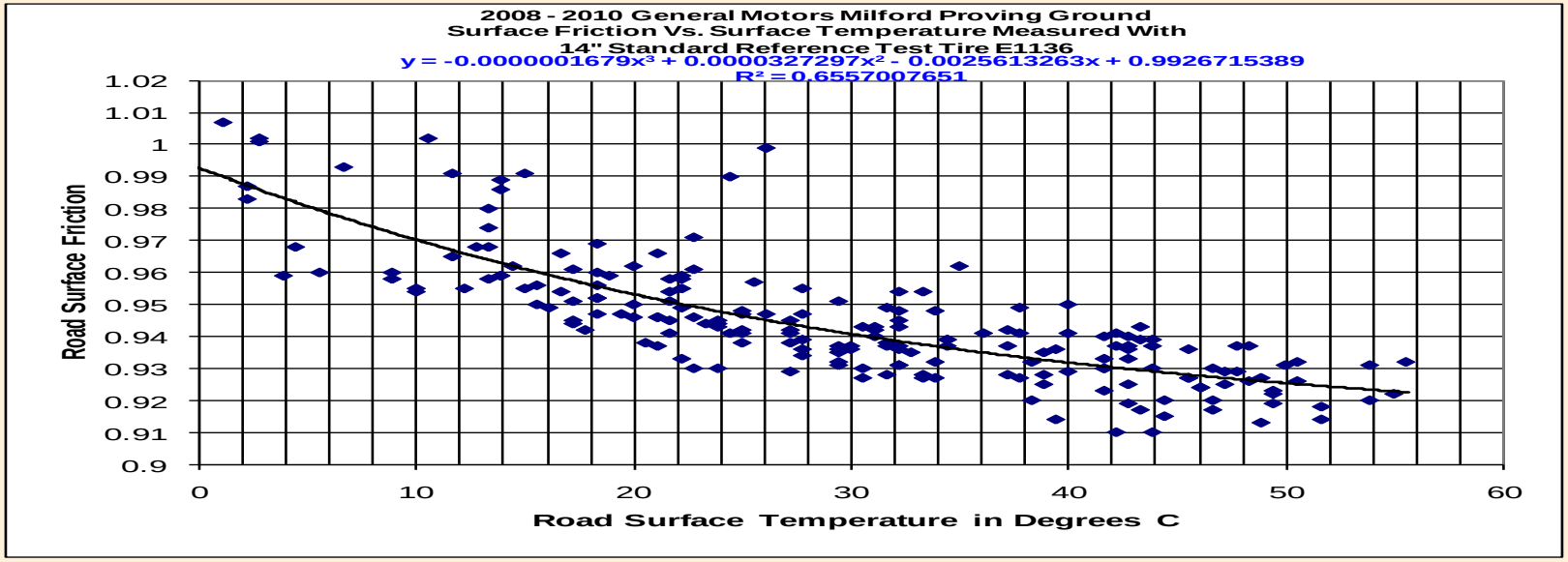
Introduction

- Vehicle stopping distance testing, FMVSS126 ESC testing, and NHTSA NCAP Fishhook testing results will vary based on state of tire burnish and road surface friction.
- FMVSS126 road surface requirements are to have grade less than 1% and to have road surface friction of 0.9.
- Surface friction measured using ASTM E1337-90 Standard Test Method for Determining Longitudinal Peak Braking Coefficient of Paved Surface Using Standard Reference Test Tire (E1136-93 Standard Specification for a Radial Standard Reference Test Tire).
- Increased road surface friction will shorten stopping distances and decrease stability margin ((side pull force/vehicle weight) – maximum lateral acceleration).
- Stability margin has impact on potential for vehicle tip up.

Road Surface Friction - Measurement

- Road surface temperature has an effect on road surface friction
- For most passenger vehicle tires, road surface friction is increased with lower road surface temperature (note that performance tires may show opposite relationship depending on compound)
- E1136 standard reference test tire used to measure road surface friction



2008 - 2010 Milford Proving Ground Road Surface Friction as a Function of Road Surface Temperature

Road Surface Friction – Stopping Distance

- Road surface friction is a significant factor when measuring stopping distance and can lead to significant test variation without the application of test procedure controls.
- Road surface measurements made on a test track over time may demonstrate significant change (> 5%) in road surface friction due to the change in ambient and road surface temperatures.
- Stopping distance measurements are corrected to a target surface friction for the purpose of accounting for changes in surface friction on test surface due to surface temperature variation.
- Traction trailer is used at time of test to determine surface friction or is used to establish a regression which can be used to estimate the surface friction by measuring the road surface temperature.
- Measuring stopping distance of 40.3 meters on a 0.99 surface yields a stopping distance of 42.8 meters on a 0.93 surface.

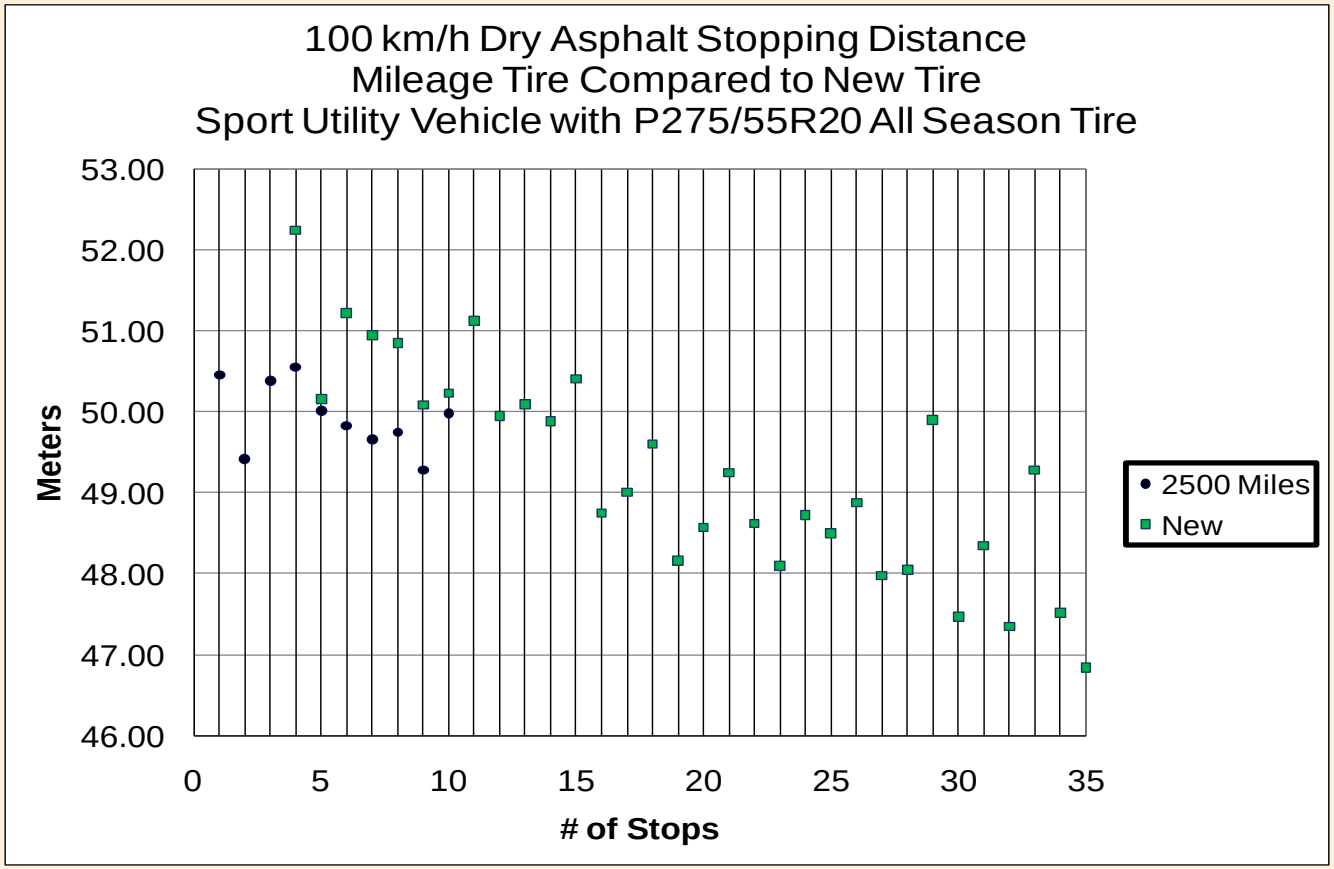
Road Surface Friction – FMVSS126 & Fishhook

- Road surface friction is a significant factor when assessing vehicle lane change performance, ESC FMVSS126 performance, and fishhook performance and can lead to test variation without the application of test procedure controls.
- GM test surfaces exceed 0.9 FMVSS126 requirement throughout road surface temperature range, meaning that the test surface is biased towards decreased stability margin. GM also tests to higher speeds to provide additional margin to industry standards.
- Less rigor required to monitor road surface friction for handling performance metrics compared to stopping distance due to higher test speeds and higher surface friction.

Tire Burnish

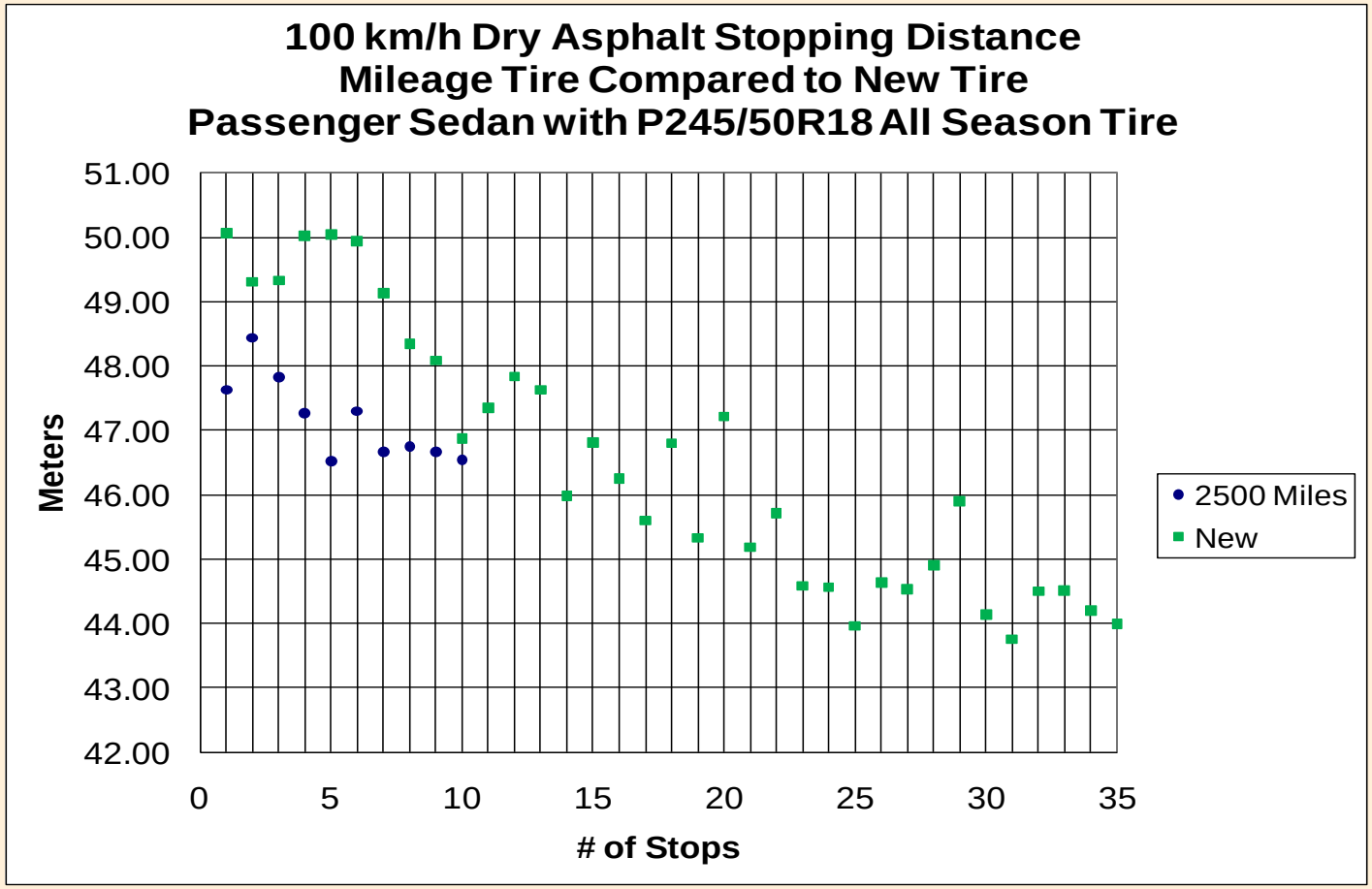
- The state of tire burnish is a significant factor when assessing stopping distance or vehicle handling and can lead to significant test variation without the application of test procedure controls.
- Stopping distance measured for first stop on a new tire can be more than 5 meters greater than the measurement made after completing 35 ABS stops from 100 km/h.
- Tire burnish has same effect on maximum lateral acceleration (stability margin) capability of a vehicle. NHTSA test procedures use new tires with prescribed burnish (FMVSS126 requires 3 laps around a 100 foot diameter circle in each direction at a lateral acceleration of 0.5 to 0.6 g).
- Tire burnish effect is affected by tire design. Summer only tires typically demonstrate a lower sensitivity to tire burnish.

Tire Burnish



100 KM/H DRY ASPHALT STOPPING DISTANCE
Mileage Tire Compared to New Tire - SUV

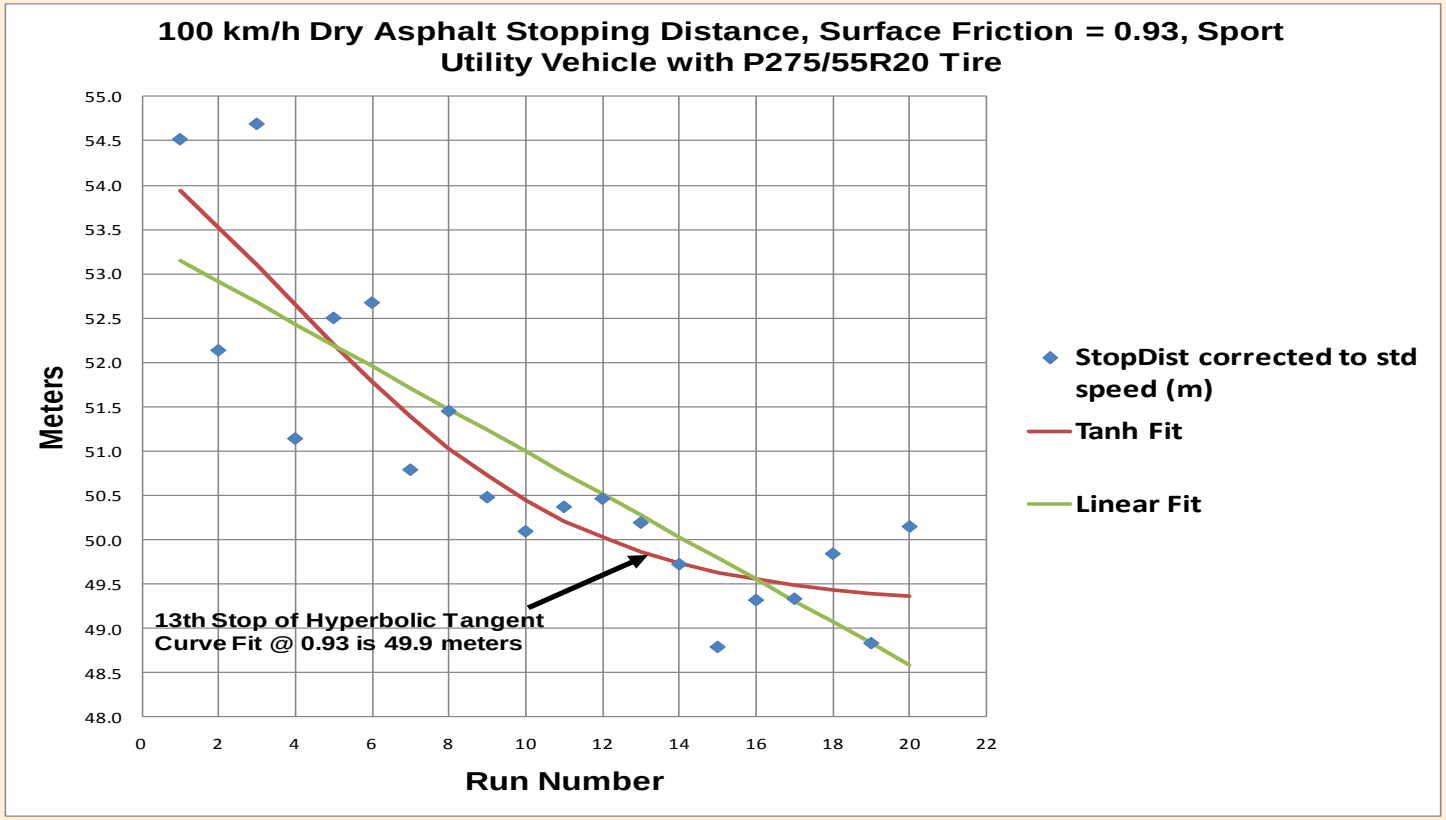
Tire Burnish



100 KM/H DRY ASPHALT STOPPING DISTANCE MILEAGE TIRE COMPARED TO NEW TIRE – SEDAN

Tire Burnish

SAE J2909 – stopping distance contains protocol for tire burnish



EXAMPLE - 20 STOP TIRE BURNISH USING SAE J2909 TANH CURVE FIT

Tire Burnish

- Tire burnish is difficult to simulate within hardware in the loop simulations. Typically handled by increasing the surface friction within the simulation.
- Current tire measurement process for hardware in the loop simulation does not account for tire burnish due to tire being consumed during testing.
- For simulation, a target road surface friction is used which exceeds 0.9 NHTSA requirement.
- Hardware in the loop simulations is an effective method to analyze other vehicle factors by removing tire burnish effects that would occur during physical vehicle testing.