

Development of tyre abrasion test methods by Indoor Drum Method

Task Force on Tyre Abrasion

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JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER

Background

- Microplastic - Tyre and Road Wear Particles (TRWP) is considered one of major source.
- Regulatory actions on TRWP mitigation becoming global.
 - ✓ Tyre Abrasion had been raised on priority items of GRBP and Task Force on Tyre Abrasion was created.
 - ✓ EU's tyre labeling regulation, Regulation 2020/740, stipulate that abrasion performance shall be introduced once the reliable test method will be available.
 - ✓ USEPA/CARB intends to work on tyre abrasion issues.

Vision

- To develop a global abrasion test method, which is reliable, universal regardless of regions, and fair.

- Vehicle Method vs Indoor Drum Method 
 - Vehicle Method has many variance factors, which are not possible or difficult to control.
 - Indoor Drum Method can control those variances. Thus, it has smaller variance.
- Japan Conclusions
 - As an abrasion test method, Indoor Drum is superior in repeatability. 
 - In view of future standardization as ISO, Indoor Drum is more fair and transparent vs Vehicle Method that needs to designate the specific test course at specific location.
- Moving Forward
 - Japan is working on development of Indoor Drum (external drum) tyre abrasion test method, which is:
 - ✓ **Fair, reliable and affordable.**
 - ✓ **Reflecting real world's condition of each region.**

Requirement:

- Represents the driving conditions of the world

How to represent the driving conditions of the world?

- Drum running mode based on WLTC
 - ✓ Because “representativeness” of real-world endorsed by many countries
 - ✓ However, WLTC does not give enough lateral force on the tyre
- “Curve and Slope” running mode will be added
 - ✓ As lateral force is a necessary element for tyre wear

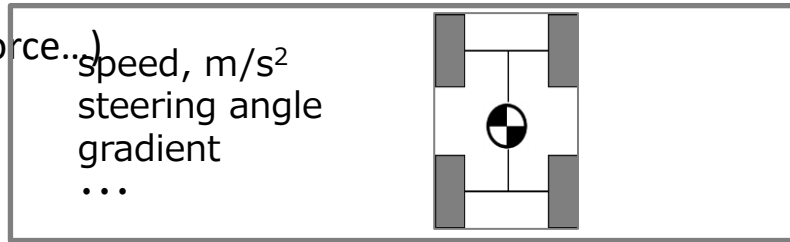
Development of Indoor Drum Method

Converting the vehicle driving conditions representing Japan / the world into the test conditions of indoor drums.

Based on vehicle running conditions (traction/brake, lateral force...)

“Representative” measurement data (vehicle)

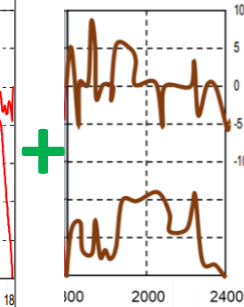
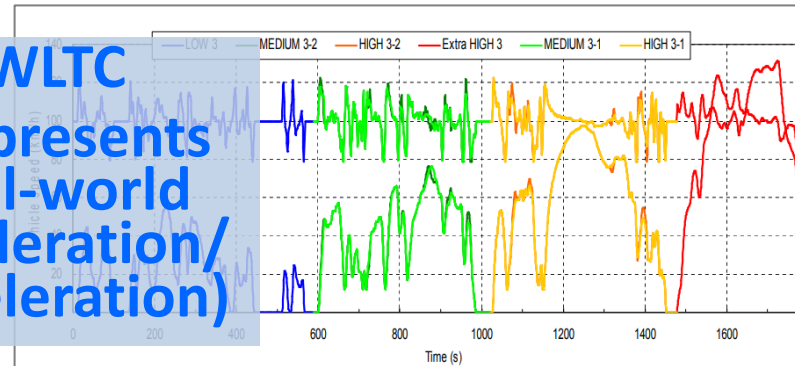
Reproduce the real-world driving conditions



Convert to tyre input using the vehicle models

Acceleration, speed, lateral force...

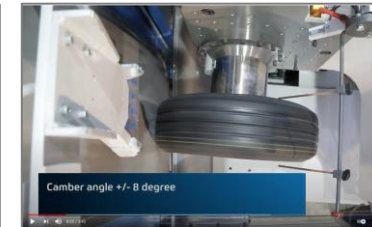
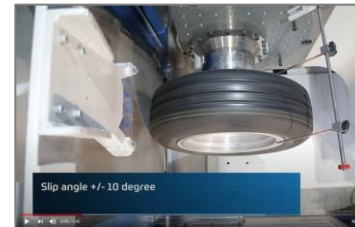
WLTC
(Represents real-world acceleration/deceleration)



Curve and Slope
(Added factors for tyre wear)



Convert to drum testing conditions



Drum running mode developed by JATMA based on the contract research to JARI, a core member of developing WLTP (GTR-15/UN R154)

JARI: Japan Automobile Research Institute

Japan believes that good Indoor Drum Method will benefit all stakeholders

- Contracting Parties, tyre industries, end users and society
- All regions, not only Japan

Thus, Japan proposes Indoor Method which represents driving conditions of the world

- Japan is developing Indoor Method based on WLTC plus Curve and Slope test cycle

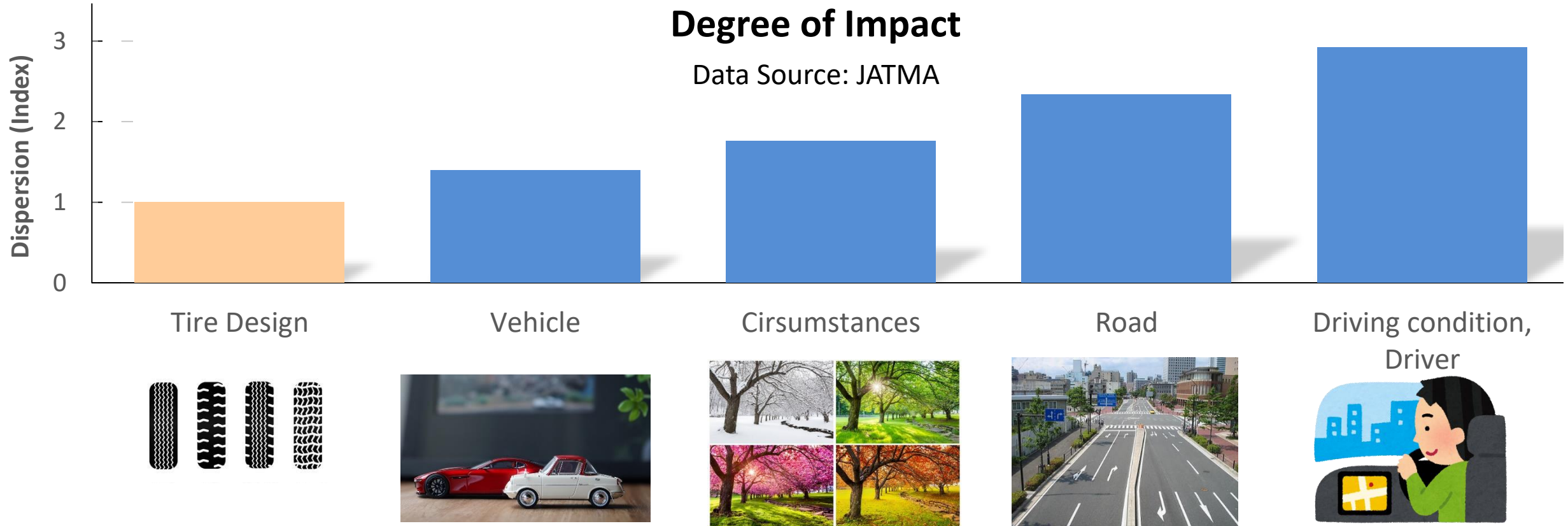
Once tentative testing condition will be fixed, validation tests will be conducted

Japan requests that the indoor drum test method be an item for consideration in this Task Force.

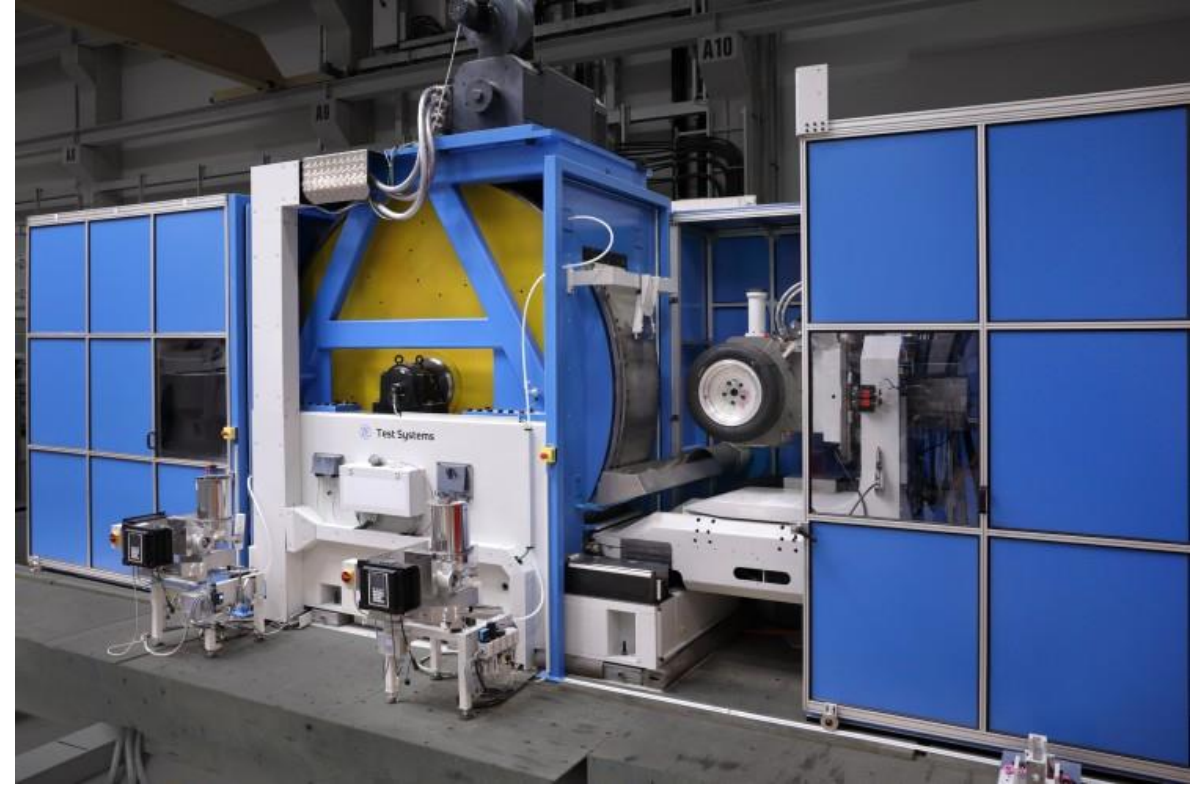
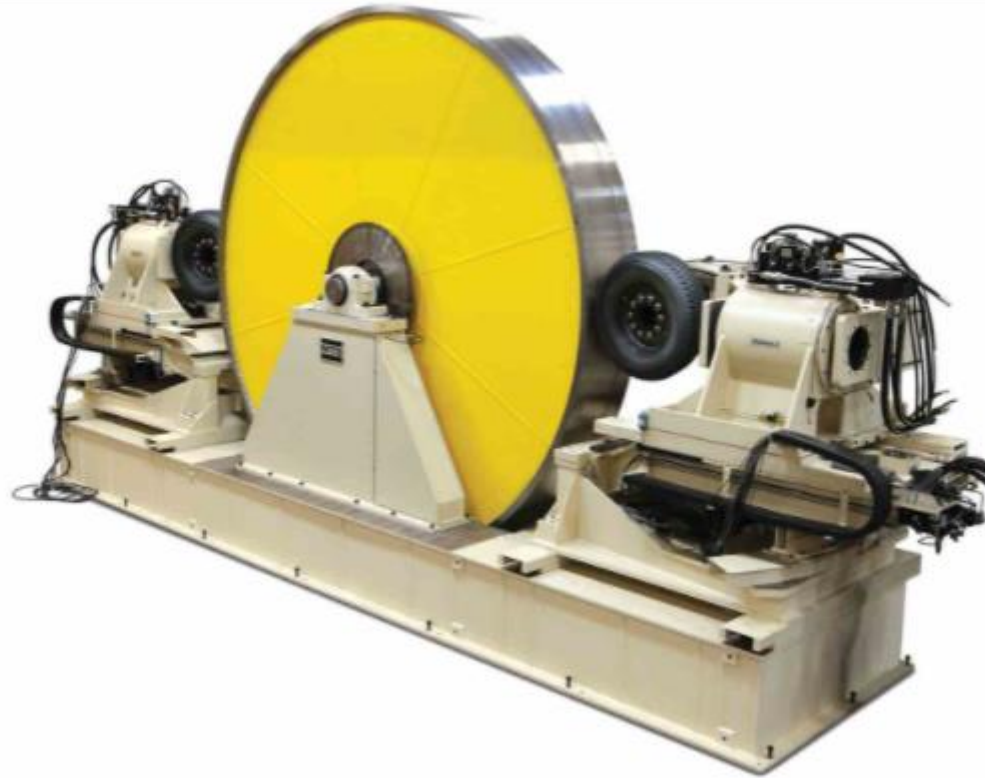
Thank you for your attention

Factors affecting tyre wear

Vehicle, Circumstance (weather, climate...) , Road and Driving conditions and Driver are known as factors affecting tyre wear



- These 4 factors affect tyre wear greater than tyre design
- Test methods need to control these 4 factors



<https://www.mts.com/en/products/automotive/tyre-test-systems/tyre-treadwear>

<https://www.youtube.com/watch?v=Ve8Kwv6UB9s>

Japan develops an abrasion test method by indoor external drums
Japan does not develop a tester itself



Factors that cannot be controlled are underlined

Factor	Vehicle Method	Indoor Drum Method
Test Vehicle	<ol style="list-style-type: none"> 1) <u>Alignment, especially dynamic alignment cannot be adjusted.</u> 2) A wide variety of test vehicles needed to cover all tyre sizes, resulting in variance by vehicles. 	<ol style="list-style-type: none"> 1) Alignment controlled 2) One test machine covers all tyre sizes
Circum-stance	<ol style="list-style-type: none"> 1) <u>Climate out of control - rain, wind and temp.</u> 2) <u>Inflation pressure changes during operation by temperature changes and direct sunlight.</u> 	<ol style="list-style-type: none"> 1) Climate controlled 2) Internal pressure controlled
Road	<ol style="list-style-type: none"> 1) Difficulty in setting up multiple courses (cannot match road surface, curve and slope). 2) <u>Surface management of public roads is not possible</u> (Aging degradation and repair frequency). 	<ol style="list-style-type: none"> 1) Can simulate real road conditions, by defining standards 2) Surface controlled (once procedures established)
Driving Condition/ Driver	<ol style="list-style-type: none"> 1) Different drivers have different driving styles. 2) <u>Driving mode varies due to traffic conditions</u> (Traffic jams, construction works, etc.). 3) Large test load tolerance required. 	<ol style="list-style-type: none"> 1) Driving controlled 2) Driving controlled 3) Test load controlled



Vehicle Method does not control tyre abrasion factors, while Indoor Drum method does

WLTP: Worldwide Harmonized Light Vehicle Test Procedure

WLTC: Worldwide Harmonized Light Vehicle Test Cycle

- WLTP is a global harmonized standard for emissions and fuel consumption
- Adopted by UNECE as GTR-15/UN R154
- WLTC is based on real-driving data submitted by:
 - ✓ EU, India, Japan, South Korea and USA
- WLTC is used as an emission or a fuel consumption standard by:
 - ✓ China, EU, India (plan), Japan and South Korea (plan)
- Brake-dusts test method which is under development, is also based on WLTC

WLTC is endorsed by various countries

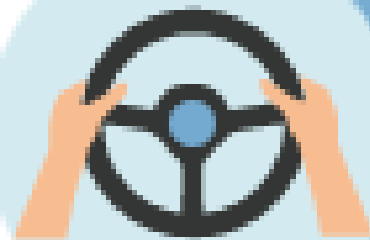


- Supplementary materials

WHAT ARE THE BENEFITS OF WLTP?

WLTP WILL INTRODUCE MUCH **MORE REALISTIC TESTING CONDITIONS**. THESE INCLUDE:

Optional equipment: CO2



More realistic driving
behaviour



representative accelerations
and decelerations



Shorter stops

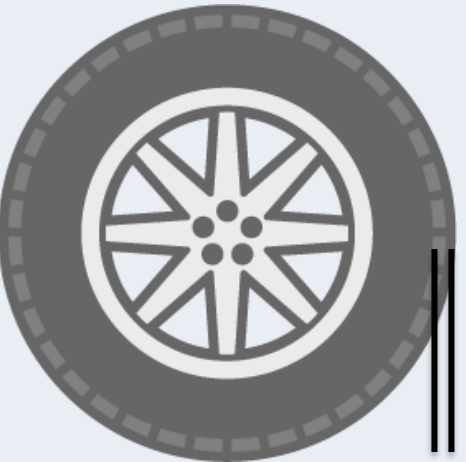
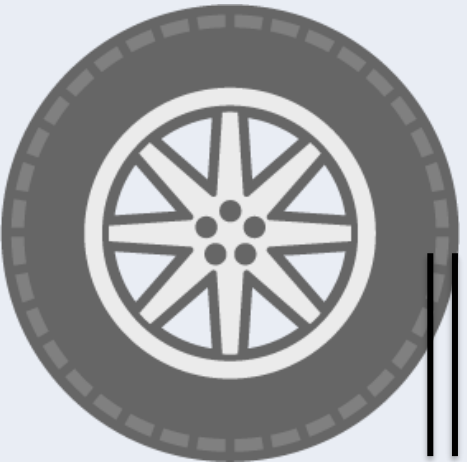
Source: <https://www.wltpfacts.eu/wltp-benefits/>

Because of all these improvements, WLTP will provide a much more accurate basis for calculating a car's fuel consumption and emissions. This will ensure that lab measurements **better reflect the on-road performance of a car**.

Representativeness of real-driving conditions endorsed by EU Industry

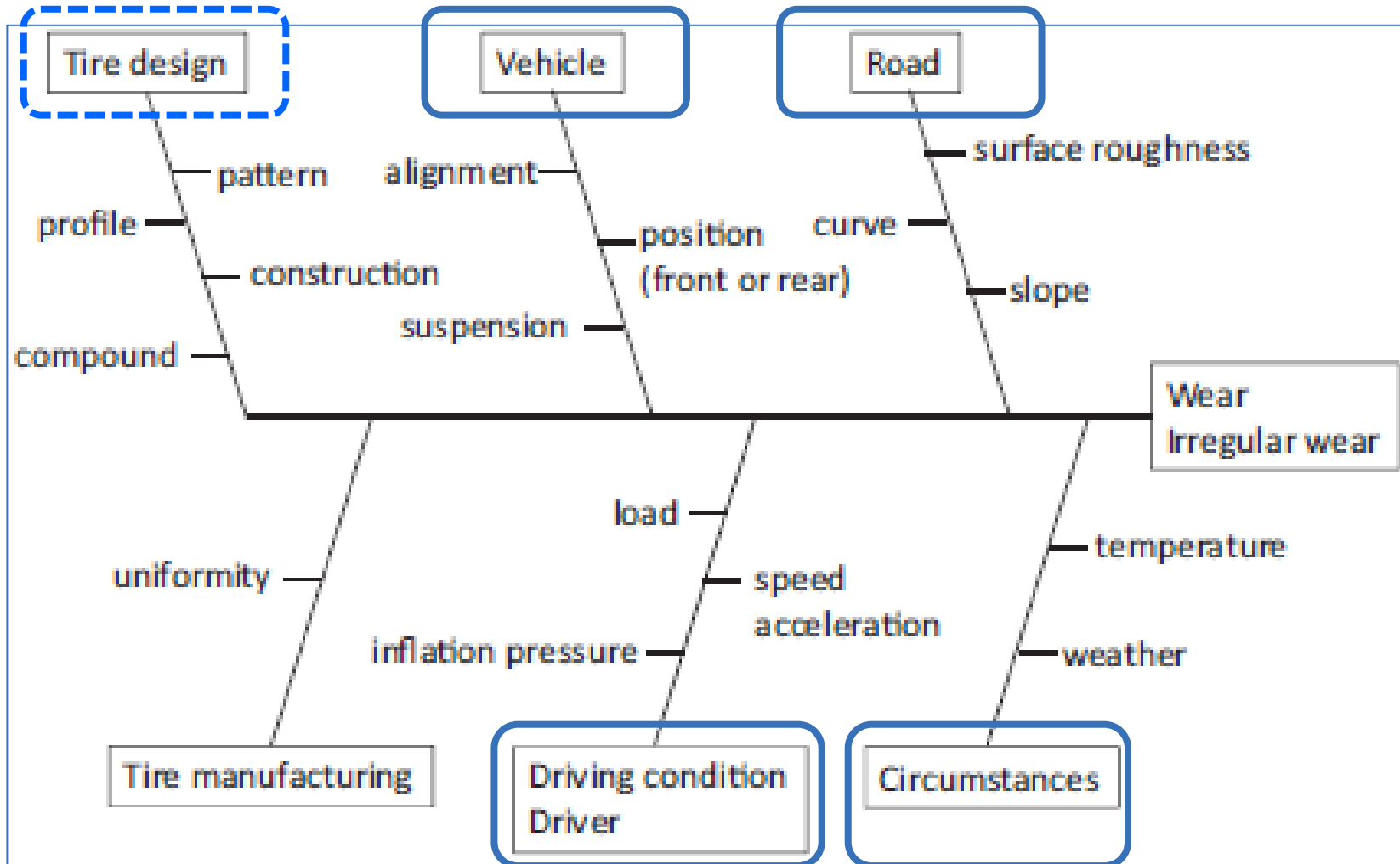
tyre abrasion rate [mg/km], NOT tyre mileage, is the relevant indicator to quantify tyre wear particle

Example

		 <p>6 mm Tread Depth</p>	 <p>9 mm Tread depth</p>
Tread depth (at new)		6 mm	9 mm
Tread weight (at new)	(a)	1.0 kg	1.8 kg
tyre life (mileage)	(b)	50,000 km	60,000 km
Abrasion rate / km	(a)/(b)	20 mg/km	30 mg/km

Test methods for abrasion rate are necessary to measure tyre emitted particles

Factors affecting tyre wear



Factors affecting tyre wear

Other than tyre itself, there are four (4) factors affecting tyre wear

- Vehicle
- Road
- Driving condition/ Driver
- Circumstances

Source: "Current Studies on Wear Mechanics of tyre", JOURNAL OF THE SOCIETY OF RUBBER SCIENCE AND TECHNOLOGY, JAPAN Vol. 88, No. 2 (2015)