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BRAKE WEAR & DUST: COMPARISON OF TEST PROCEDURES

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TEST METHODS FOR WEAR TESTING: DYNO TESTING

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- Wear Dynamometer Tests usually run at temperatures 100^{o}C and higher
  - SAE J2707 General Wear Test 100-500^{o}C
  - SAE J2707 Block Wear Test 100-350^{o}C

- Pros:
  - Fast
  - Good for friction development purposes (comparison of materials)
- Cons:
  - Risk of “conditioning” of pad material at multiply identical brake applications
  - Does not reflect “normal driving pattern” regarding speed, deceleration, application sequence, brake temperature
  - Wear evaluation in the range above 100^{o}C only

TEST METHODS FOR WEAR TESTING: VEHICLE TESTING

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- Vehicle brake wear durability testing is combined with brake NVH testing.
- There are generally two methods (with their possible regional substitutions):
    - Mojacar (cross country + city traffic + highway)
    - LACT (LA suburban + city traffic)
- Basically developed as brake noise tests, need higher brake temperatures (above 200^{o}C max)
    - Mojacar average / max temperature: 125-175^{o}C / >250^{o}C
    - LACT average / max temperature: 100-150^{o}C / >200^{o}C
- Reaching above temperature levels require adequate driving pattern and vehicle payload.

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BRAKE TEMPERATURE DURING VEHICLE TESTING

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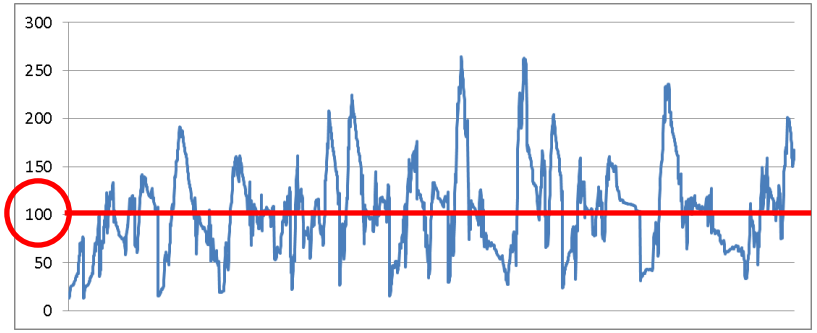
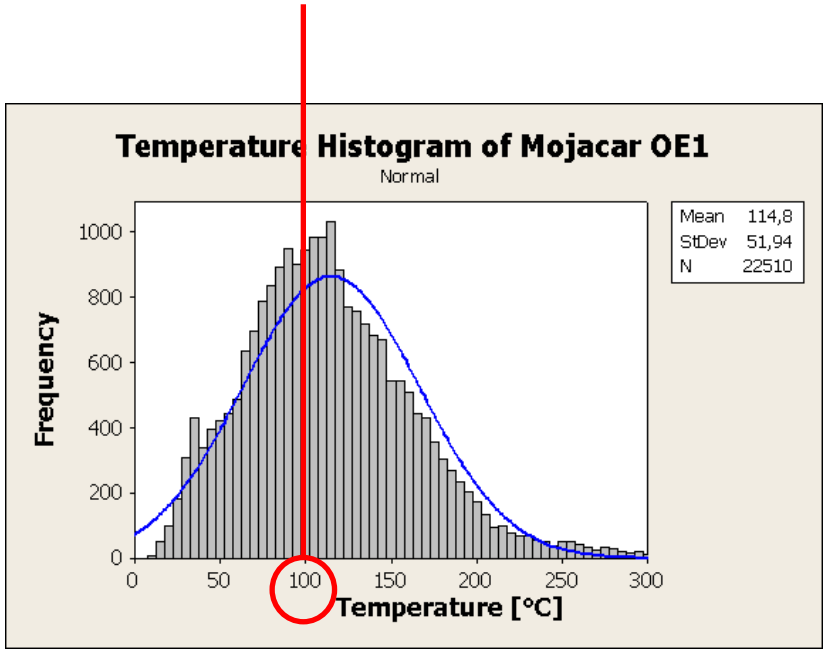


Temperature trace during Mojacar durability test (OE1)



Temperature histogram

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TEST METHODS FOR WEAR TESTING: VEHICLE TESTING

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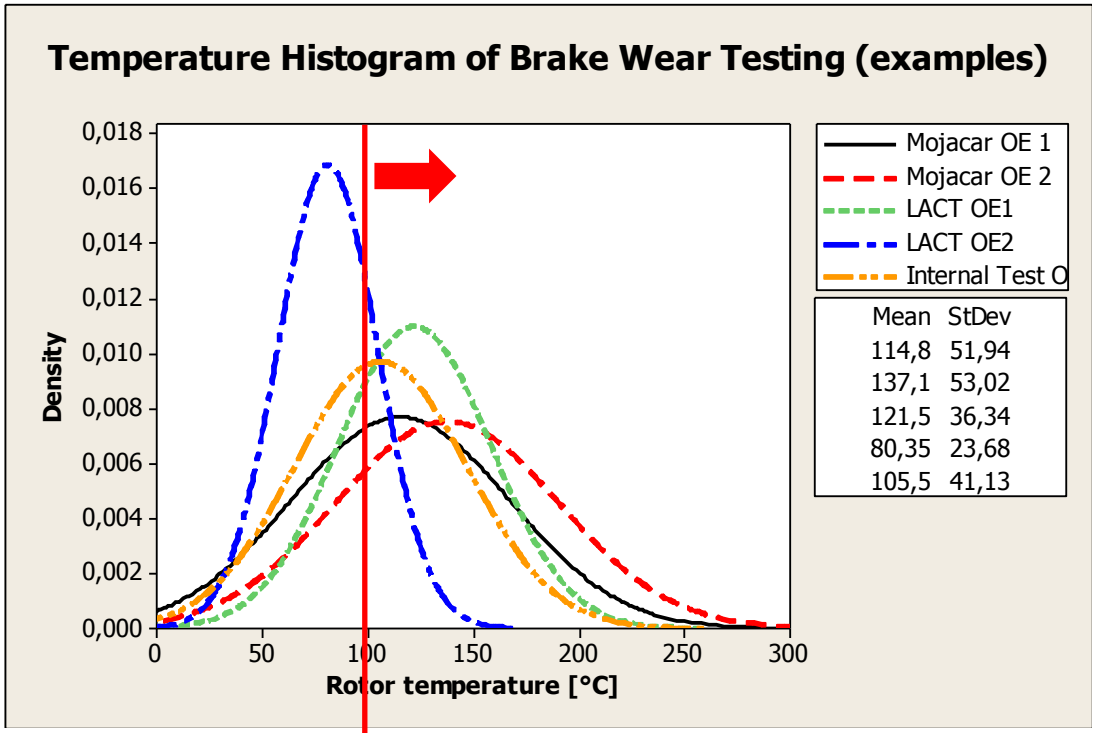

Test	% of brake applications above 100°C
Mojacar OE1	59
Mojacar OE2	73
Internal test OE2	68
LACT OE1	73
LACT OE2	19*

* Run DOW

Starting temperature of SAE J2707 dyno testing

European wear testing: More than 59% of all brake applications are above 100°C

But which temperatures does the brake see at a “normal” customer and what are the implications?

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CASE STUDY

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- Two brake specs with European performance pads
- Similar brake life evaluated in Mojacar procedure

- Different dust generation on the vehicle in daily usage

COLOGNE TRAFFIC TEST

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- Run on vehicle
- Vehicle equipped with data logger
  - Speed
  - Rotor temperature
  - Deceleration
  - Brake pressure
  - Distance
- Run in Cologne
- Mostly “driver only”*

* In Germany, the average pay load is 1,5 persons (Pkw- Besetzungsgrad bei der privaten Autonutzung)

Source:

DLR - Deutsches Zentrum für Luft- und Raumfahrt, Institut für Verkehrsforschung, infas Institut für angewandte Sozialwissenschaft, 2010

http://www.forschungsinformationssystem.de/servlet/is/79638/

INITIAL DISC AND SPEED TEMPERATURE ON COLOGNE CIRCUIT

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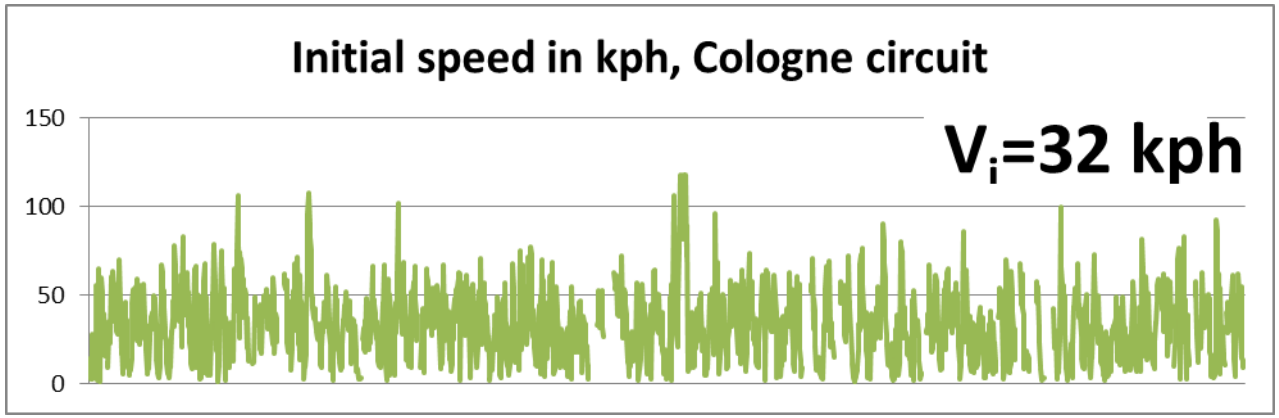

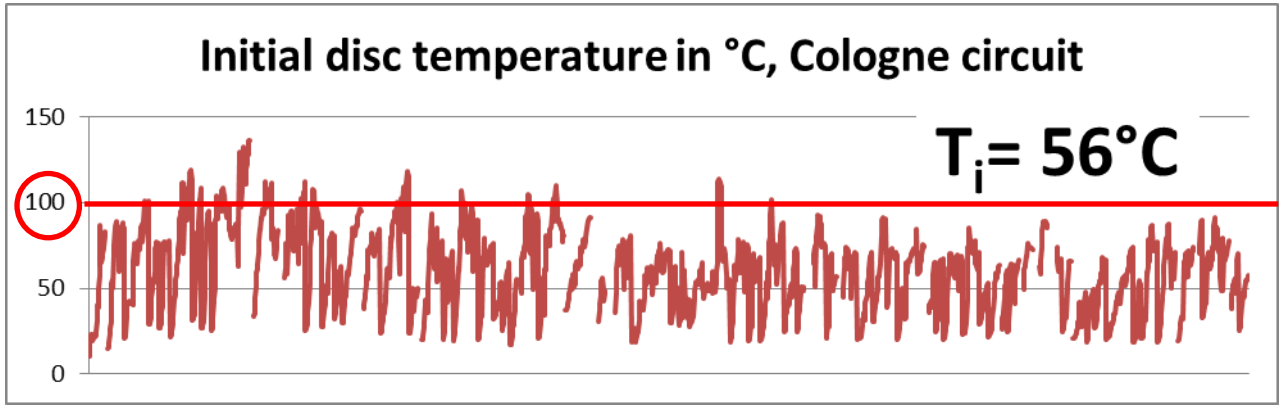

More than 90% of brake applications were made at brake temperatures below 100°C

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INITIAL SPEED AND DISC TEMPERATURE ON WIESBADEN CIRCUIT (INITIAL RUN); DATA: FEDERAL MOGUL

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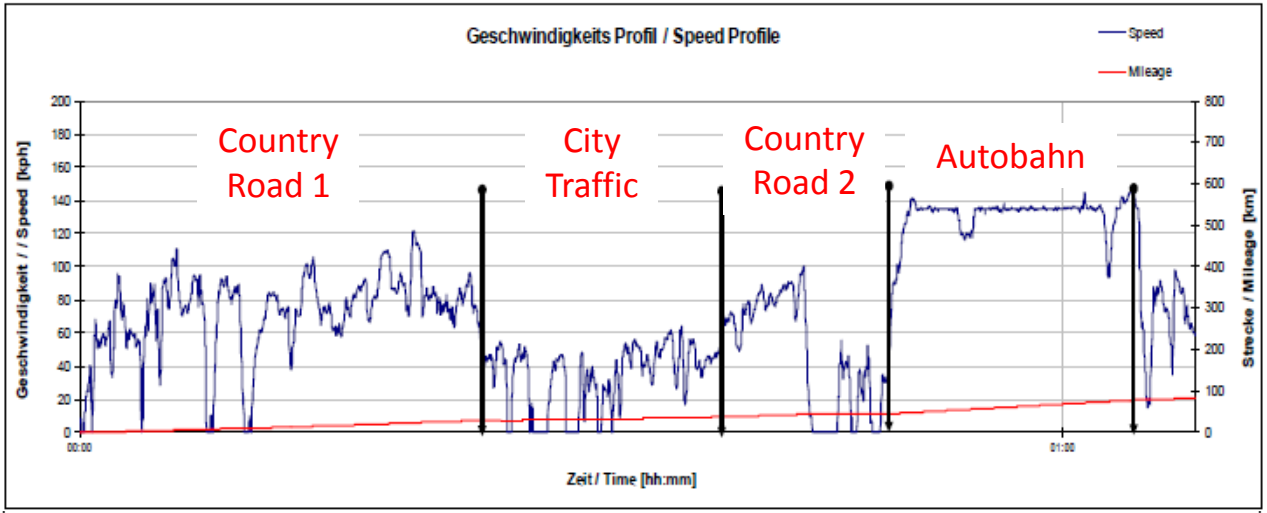

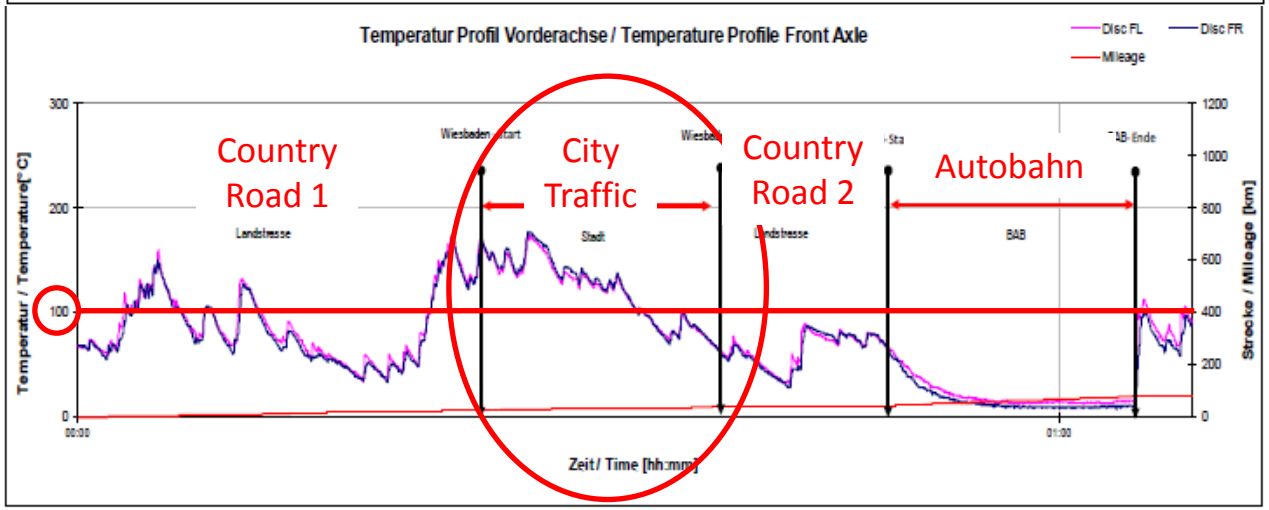

City Traffic section started with T>150ºC.

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INITIAL SPEED AND DISC TEMPERATURE ON WIESBADEN CIRCUIT (ADDED CITY TRAFFIC WITH T_{INI}=50ºC); DATA: FEDERAL MOGUL

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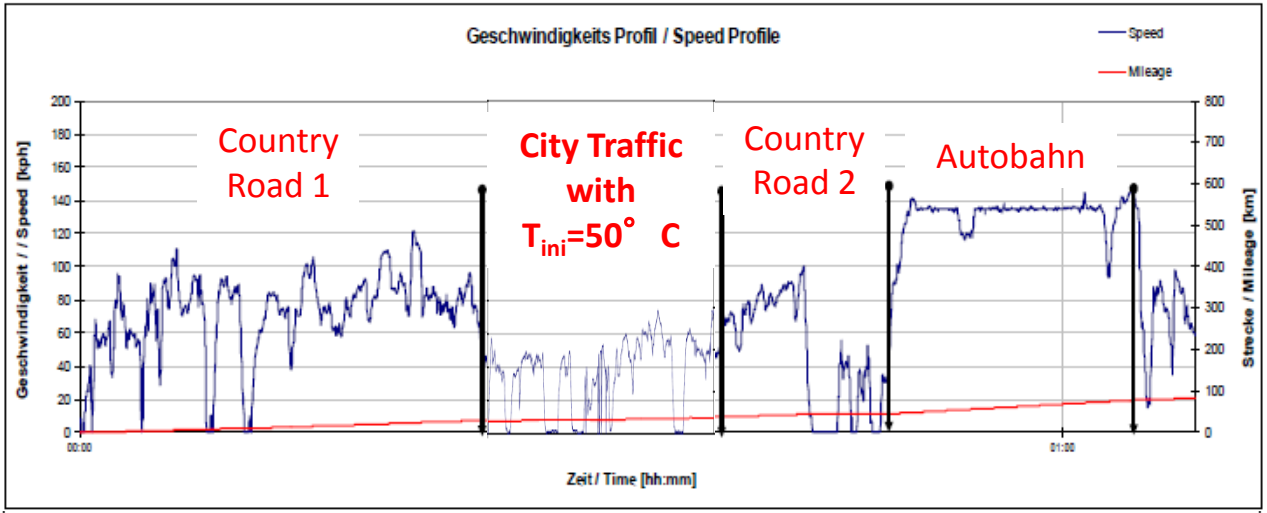

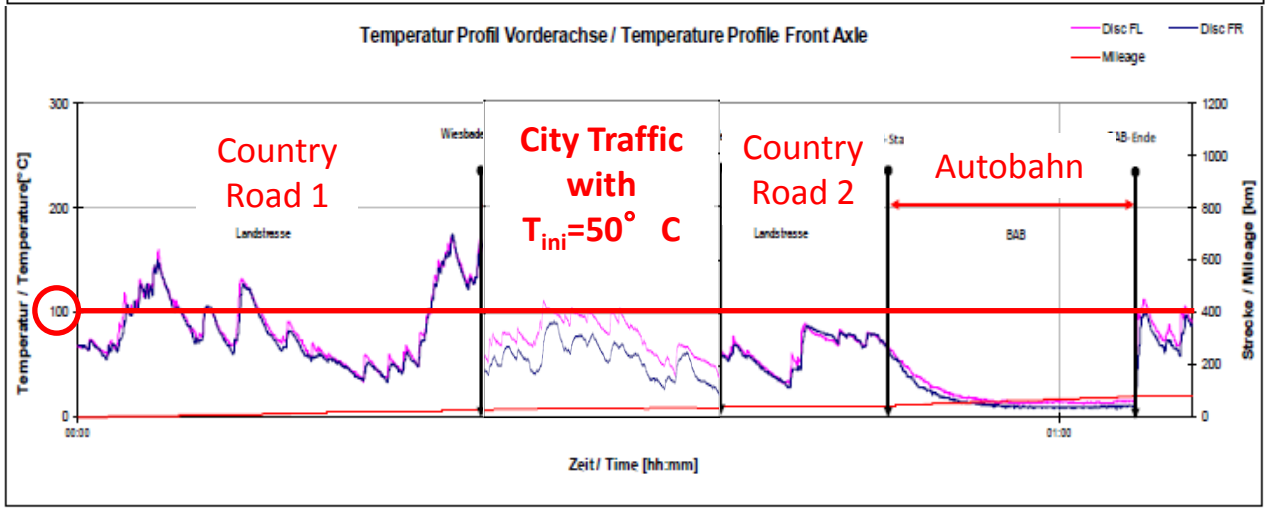

City Traffic section run with T_{ini}=50ºC.

In total: More than 73% of brake applications were made below 100ºC

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VEHICLE WEAR TESTING: BRAKE TEMPERATURE LEVEL

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Test	% of brake applications above 100°C
Mojacar OE1	59
Mojacar OE2	73
Internal test OE2	68
LACT OE1	73
LACT OE2	19
Cologne	**10**
Wiesbaden	**27**

- (It is known, that) Mojacar does not represent “normal” customer driving pattern - common assumption: approx. **double brake life** in the field compared with life in Mojacar.
- Real daily usage (Cologne) and daily usage simulation (Wiesbaden) show very high percentage of brake applications below 100^{o}C (73-90%).
- What are the implications of this finding on evaluated vehicle?

MODIFICATIONS OF TEST METHODS: DYNO TEST

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- Dyno testing
  - Modification of Wear vs. Temperature tests by adding low temperature sections with 60°C and 80°C temperature levels
  - Reduced deceleration level
  - Slight speed increase
  - Number of stops 300 per temperature level
  - Affected friction materials tested in the same brake

DISC WEAR IN GRAM IN A DYNO WEAR VS. TEMPERTAURE TEST

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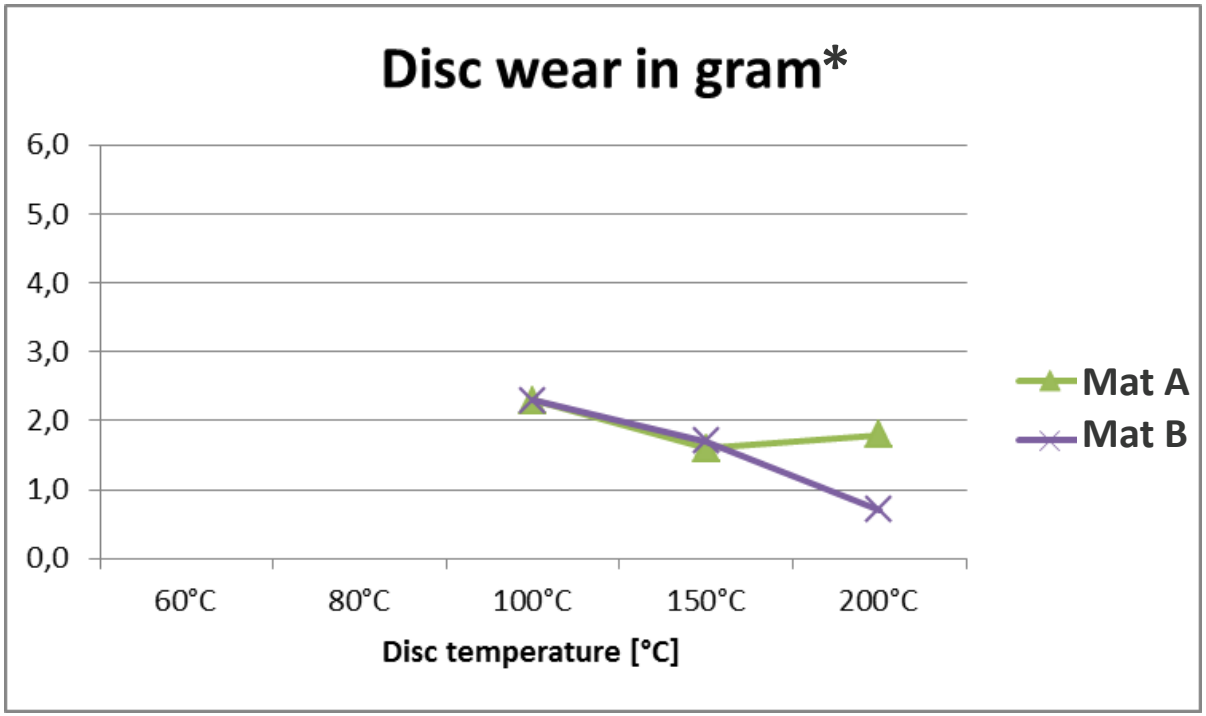

Both materials shows similar disc wear between 100 and 200ºC as in current J2707 procedure ……..

* Disc wear has high importance for brake dust generation

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DISC WEAR IN A EXTENDED DYNO WEAR VS. TEMP. TEST

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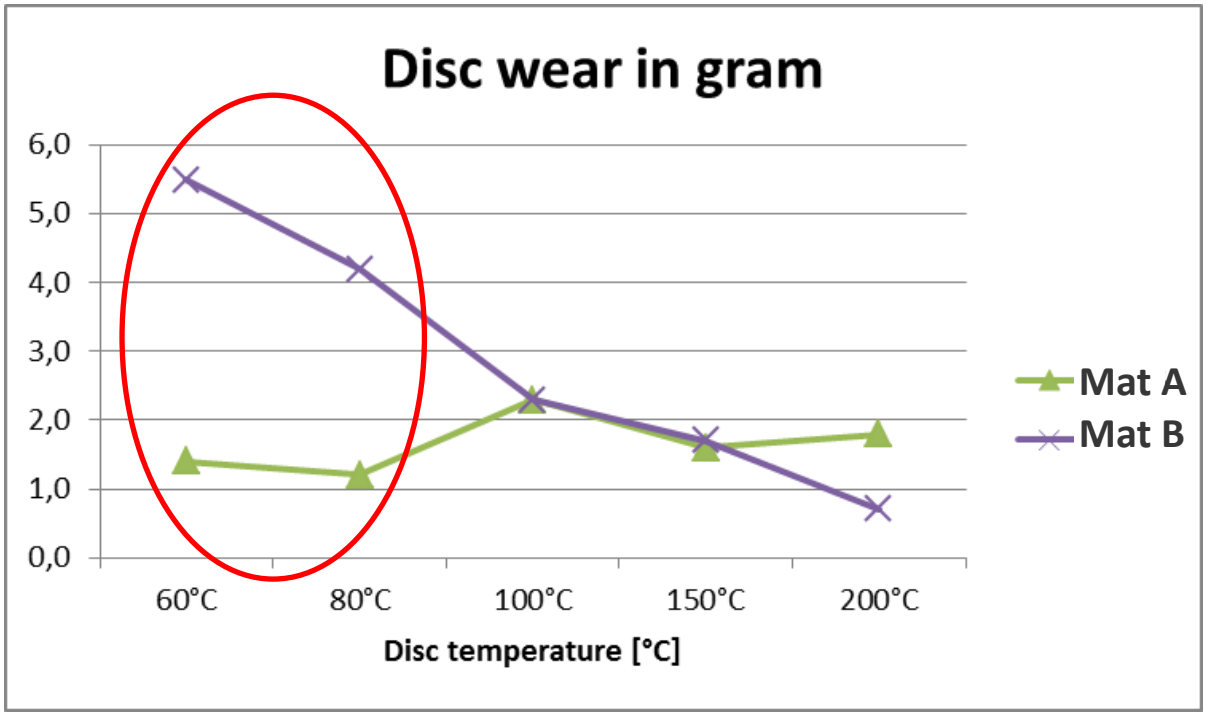

……. but different wear under 100°C!

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VEHICLE WEAR TESTING: BRAKE TEMPERATURE LEVEL

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- Vehicle testing
  - New procedure (distance and speed controlled) as combination of:
    - Deceleration levels
    - Speed levels
    - Distances between the stops
    - Approx. average initial brake temperature of 80^{o}C (brake/vehicle depended due to driving pattern)
  - Evaluation of
    - Mass loss for pad and rotors
    - Dust deposition on wheel

MODIFICATIONS OF TEST METHODS: NEW VEHICLE TEST

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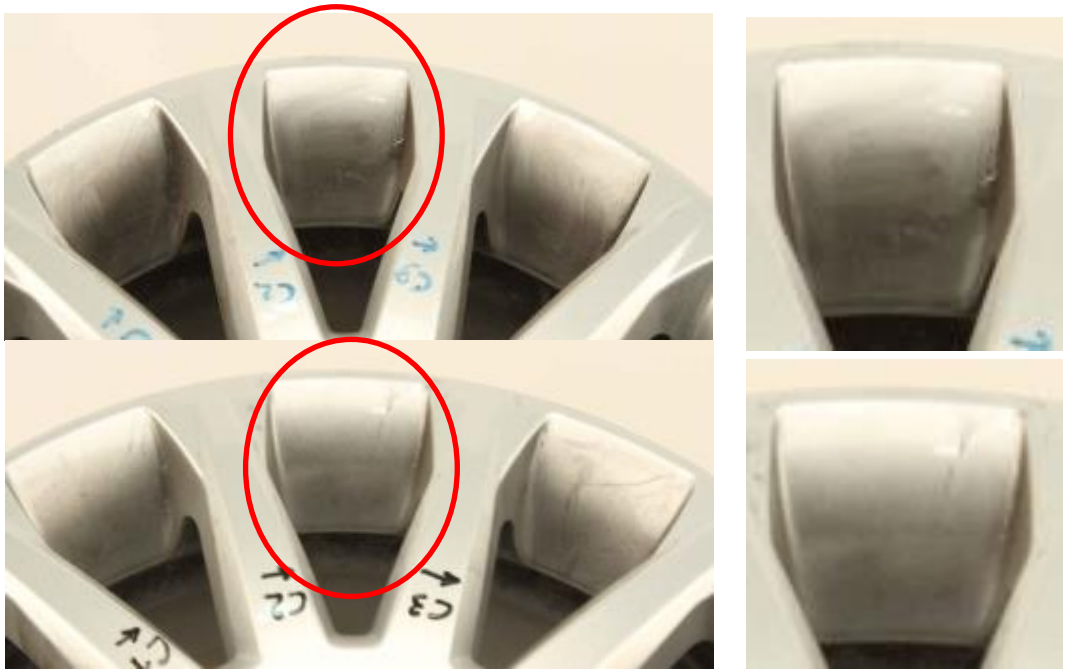
Material B (higher TGW), dust generated between stops 400 to 600

Material A (lower TGW), dust generated between stops 400 to 600



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CONCLUSIONS

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- Typical driving patterns, especially with low vehicle payload (driver only), are characterized by high percentage of brake applications with rotor temperature below 100^{o}C
- These thermal conditions are not sufficiently reflected in current well-established dynamometer and vehicle brake wear procedures
- Dyno SAE J2707 procedures can be easily updated to incorporate conditions critical for dust generation

  Remark: brake applications at identical parameters may lead to

  a negative effects like “friction conditioning” influencing wear ratios
- New vehicle procedures for dust generation (and/or their simulations on brake dynamometers) must be developed or an (significant) update of established procedures must be undertaken to better integrate and reflect “driver only” conditions.
- The simulated driving profile will be dependent on the fact which driving conditions should simulated: mostly city traffic only or a combination of different conditions.

Thank you

Q&A