

AFD40(2) Monthly Web Meeting – MLS Session

**Accelerated Pavement Testing Program with the
Mobile Load Simulator MLS10
– Temperature Analysis**

Bastian Wacker

Design and structure of pavements

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Bundesanstalt für Straßenwesen

Introduction

- **Name:** Bastian Wacker
- **Education:** civil engineer
(Dipl.-Ing, master of engineer)
- at BASt since 02/2013
- **Section:**
Design and structure of Pavements
- **Research activities:**
accelerated pavement testing,
structure analysis and external
research

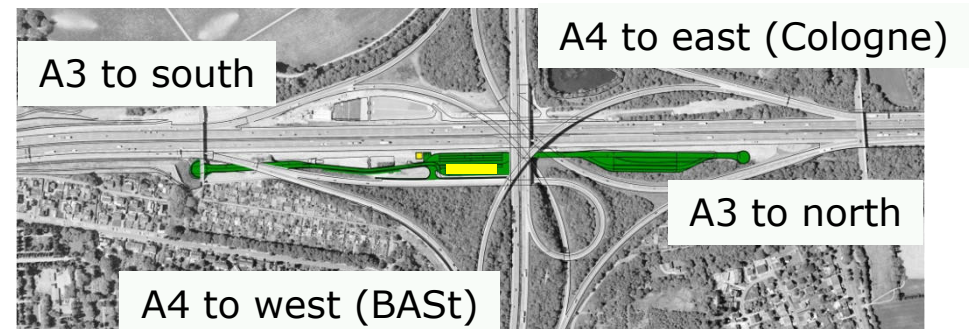


Introduction

- Testing facilities at BAST
 - Indoor asphalt pavement test track
 - Indoor concrete pavement test track
 - Test hall for different research studies



- duraBAST → from 2016



Introduction

duraBAST – outdoor test area

demonstration, investigation (**U**ntersuchung), reverence **a**rea



Investigation area for
MLS10 and non-destructive test methods

Introduction

- Studies carried out until October 2015

Test name	Local number	Main focus	Test period (weeks)	Test section	Wheel load [kN]	Number of loading
2012_MLS_001	F1100.3413000	Structural analysis	4 + 1	Asphalt	50	600.000
2012_MLS_002	MW1100.3712002	innovative concrete material	32	Concrete	50	1.500.000 1.500.000
2012_MLS_003	F1100.3414110	Temperature analysis	(5)	Asphalt	50	365.000
2012_MLS_004	F1100.3414002 (a)	Structural analysis	28	Asphalt	50	3.000.000
2012_MLS_005	F1100.3414002 (b)	Structural analysis	1,5	Asphalt	50	300.000
2012_MLS_006	F1100.3415111 (a)	Innovative material	2		50	400.000
2012_MLS_007	F1100.3414002 (c)	Structural analysis	??	Asphalt	50	Intended 1.200.000

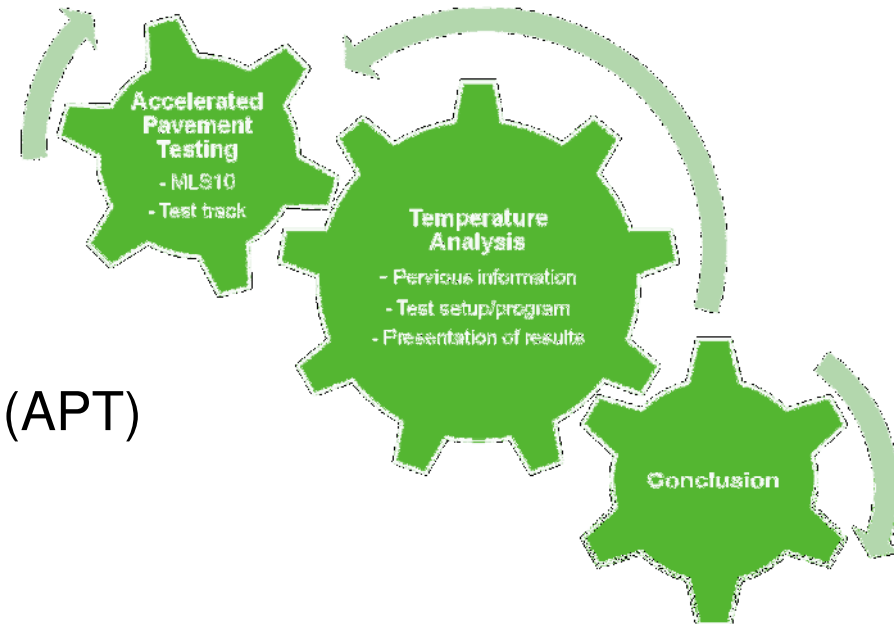
Introduction

- Studies carried out until October 2015

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2012_MLS_003	F1100.3414110	Temperature analysis	(5)	Asphalt	50	365.000
2012_MLS_004	F1100.3414002 (a)	Structural analysis	28	Asphalt	50	3.000.000
2012_MLS_005	F1100.3414002 (b)	Structural analysis	1,5	Asphalt	50	300.000
2012_MLS_006	F1100.3415111 (a)	Innovative material	2	Asphalt	50	400.000
2012_MLS_007	F1100.3414002 (c)	Structural analysis	??	Asphalt	50	Intended 1.200.000

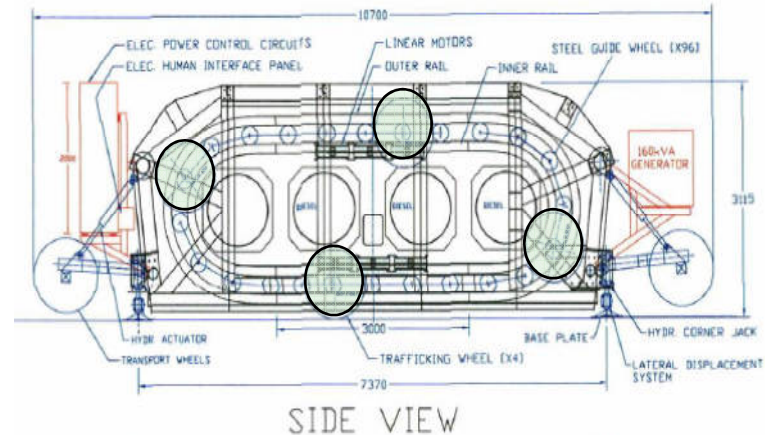
Main topic for this presentation

Accelerated Pavement Testing (APT)



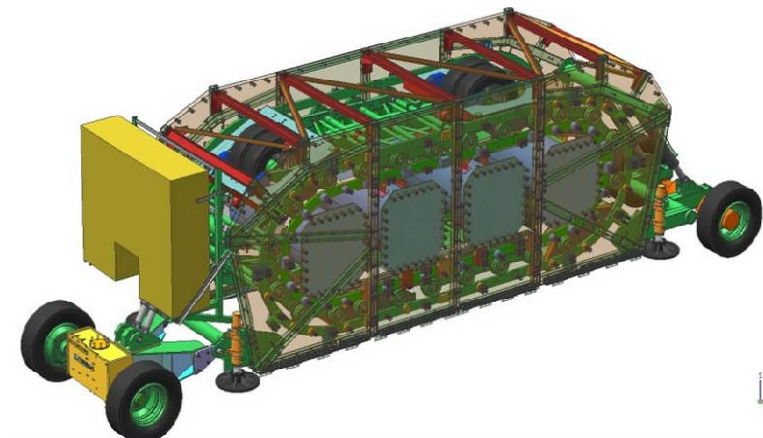
Accelerated Pavement Testing

- Full Scale APT MLS10
Full Scale accelerated pavement testing with MLS10
 - **Mobile Load Simulator**
 - Design and development at University Stellenbosch, South Afrika
 - 5 machines worldwide (2x MLS10 und 3x MLS66)
 - new owner since 2014: PaveTesting (GB)
new Name: **Pave@MLS30**
- final certification and start test operation April 2013
 - Since Construction: over 9,5 Mio. passes



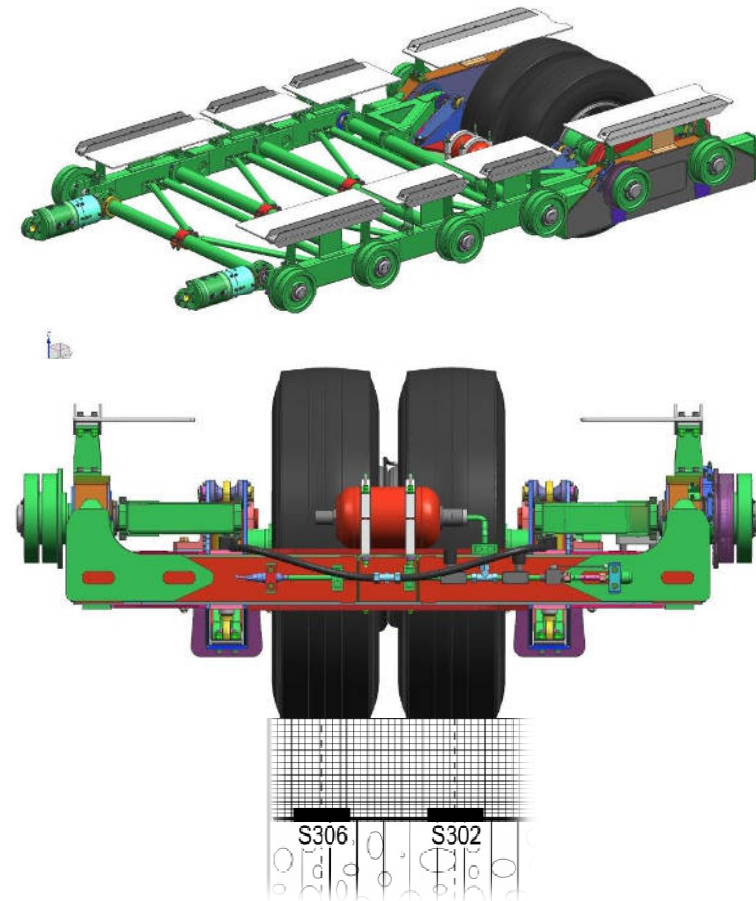
Accelerated Pavement Testing

- Loading with Bogie - including loading wheels
 - Wheel load 40 to 75 kN
 - chosen standard operation with 50 kN (equivalent 10 to-Axle)
- Completion of loading wheels
 - dual or single
- Testing length
 - 3,50 m
- Speed
 - up to 22 km/h
= **6000 passes/h**



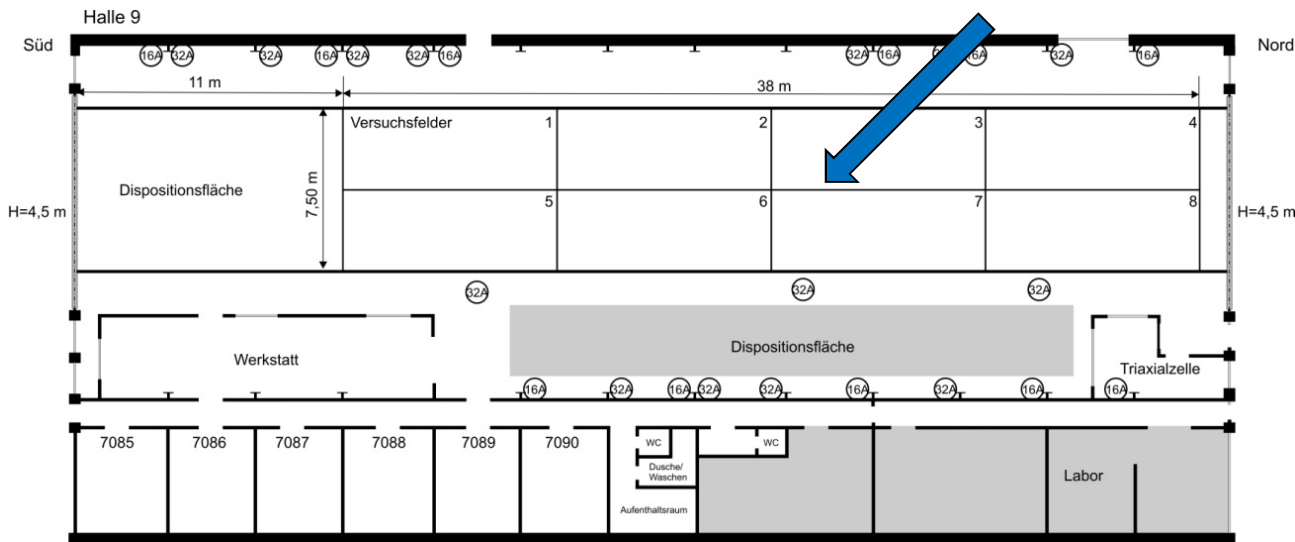
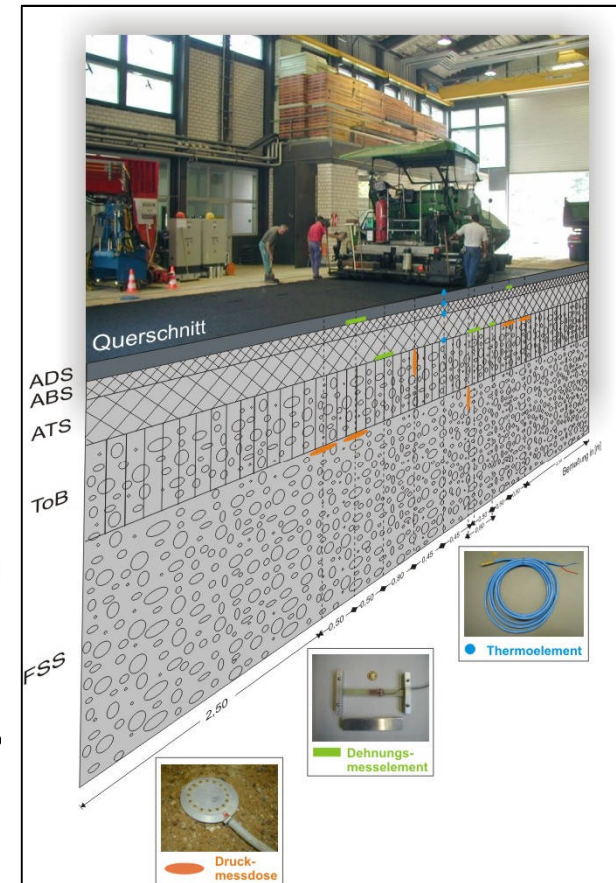
Accelerated Pavement Testing

- **Bogie** (four present in the MLS10)
 - 6 axes (guide wheels)
 - 1 construction with loading wheel
 - reaction plate for linear motor
 - connection to next bogie (closed chain)
- Drive-by 24 linear motors
 - high voltage current and diesel generator
- Adjust the support pressure
 - changing the load for the wheels

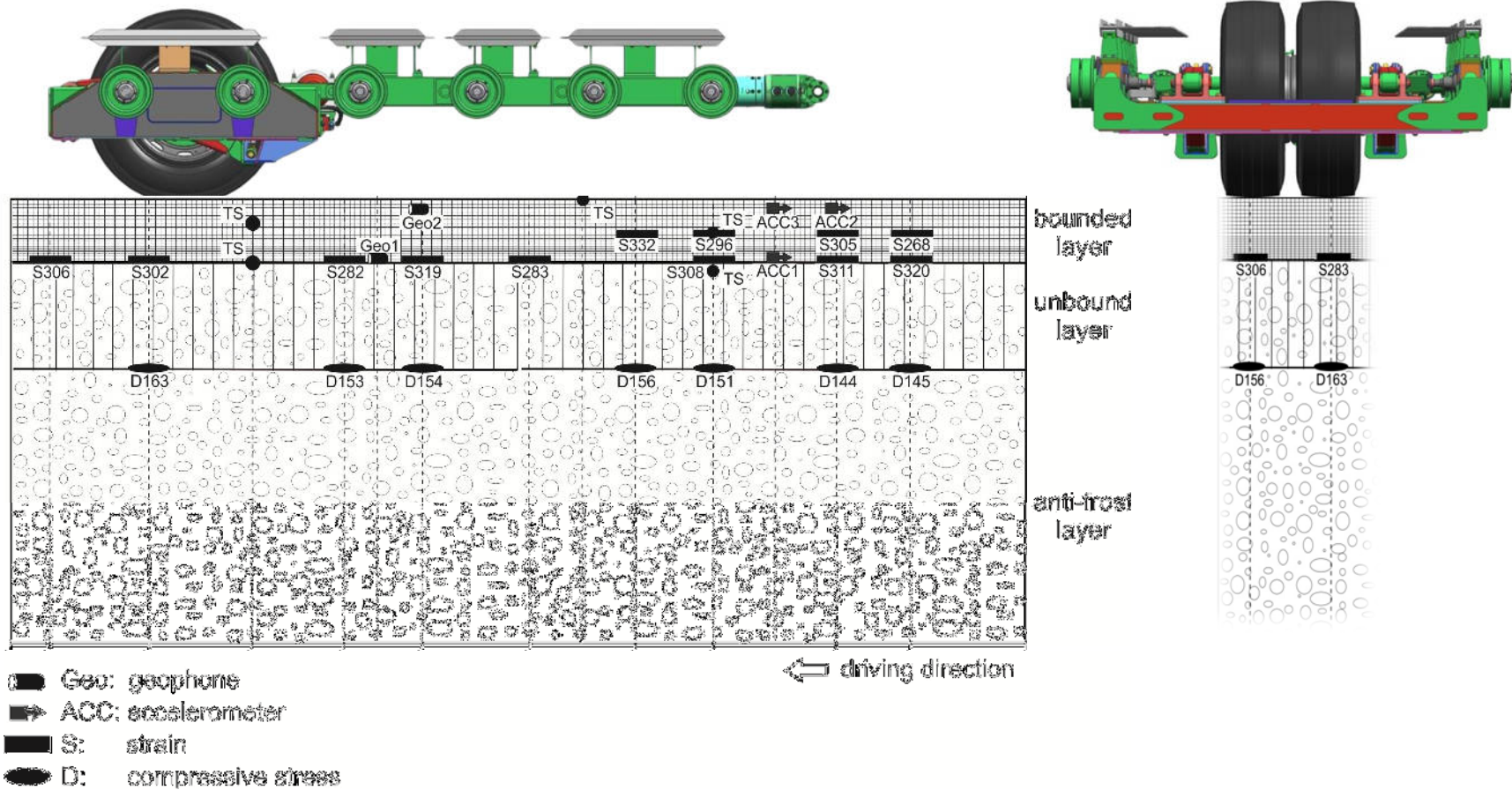


Accelerated Pavement Testing

- Indoor asphalt pavement test track (details)
 - Pit: 38,00m long; 7,50m wide; 3,00m deep
 - defined boundary conditions
 - Multi-layered structure
 - Measuring instruments (strain and compressive stress sensors, temperature sensors)
 - Non-destructive test methods (e.g. FWD)

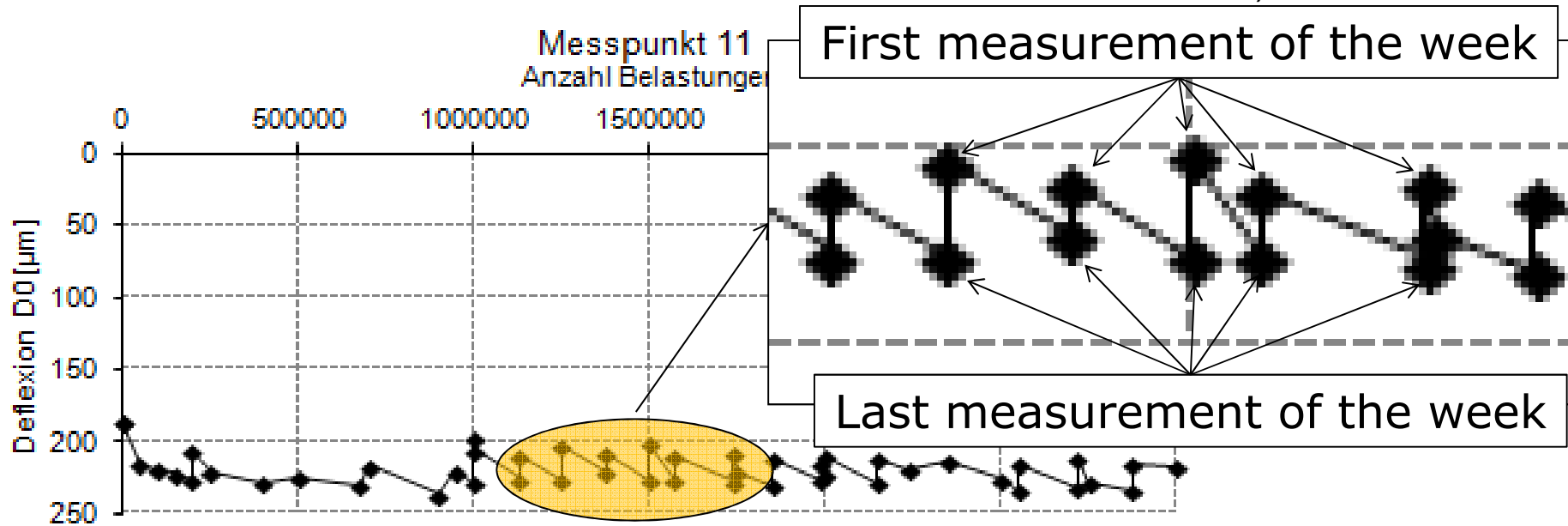


Accelerated Pavement Testing



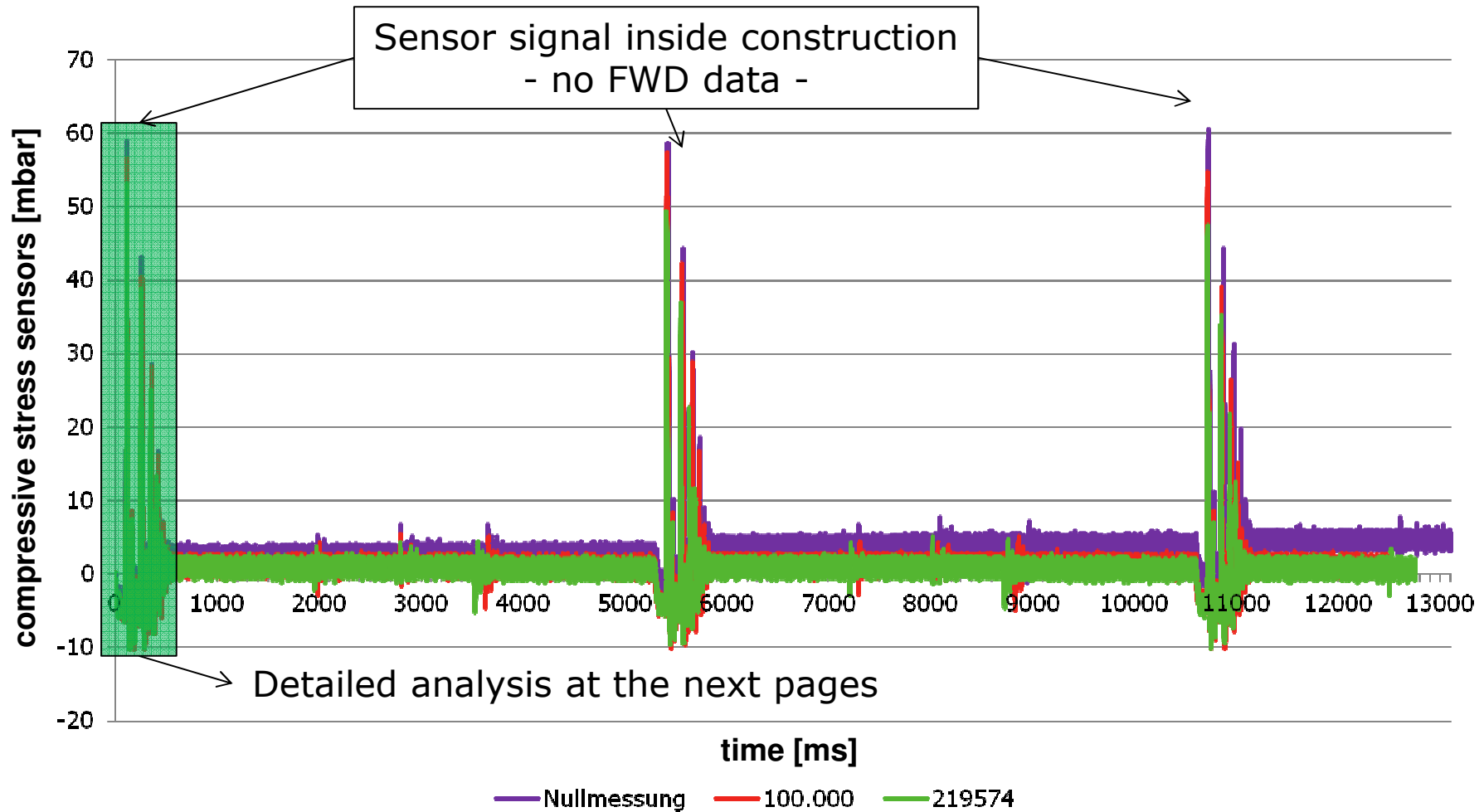
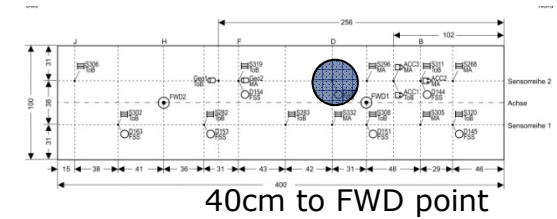
Accelerated Pavement Testing

- FWD-measuring (previous test program)
 - Regeneration during the weekend = D0 get smaller
 - because of the construction temperature – were this construction temperature is coming from?
 - and other factors (not included into this presentation)



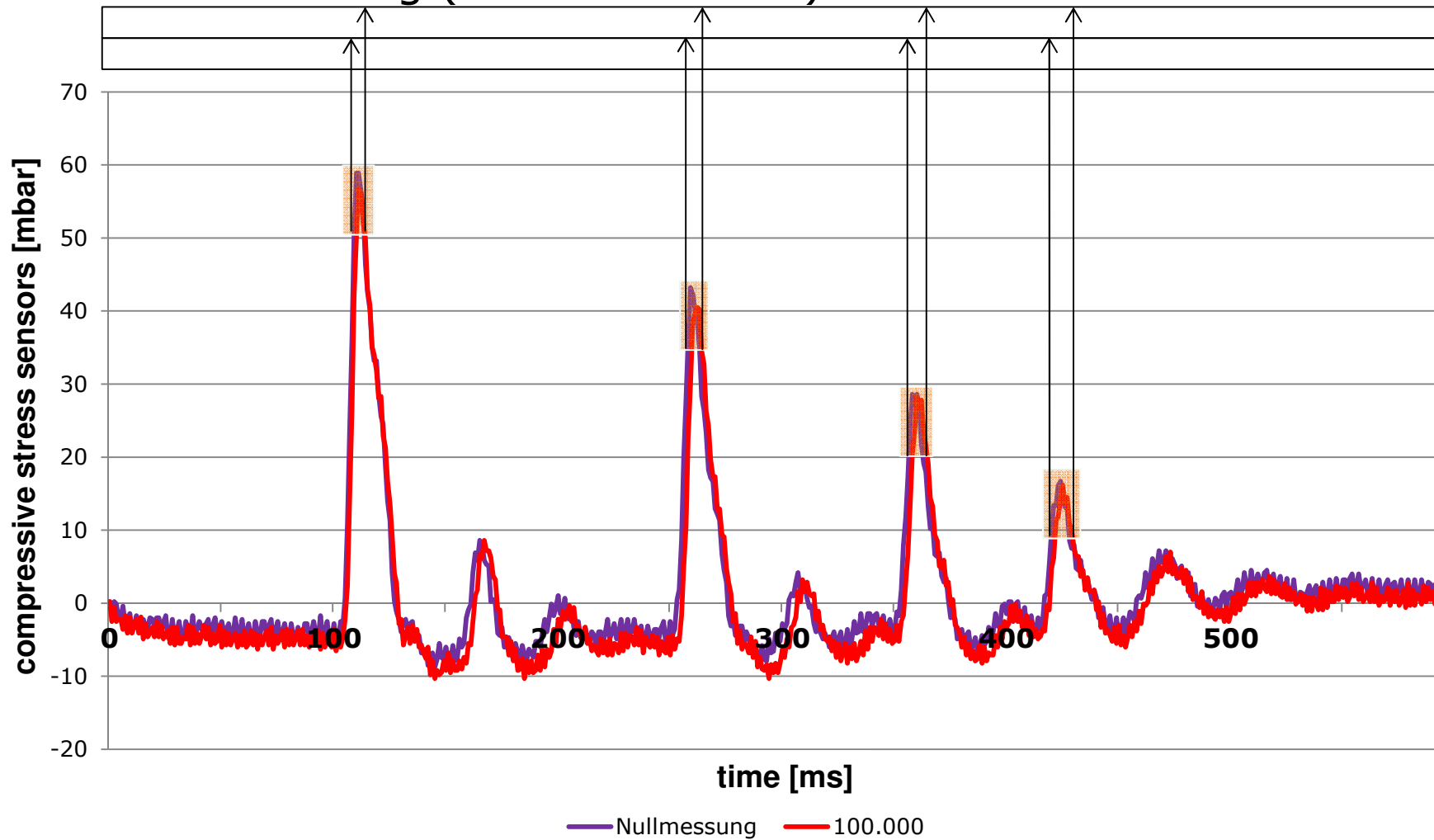
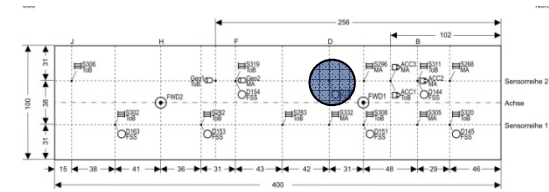
Accelerated Pavement Testing

- FWD-measuring (previous test program)



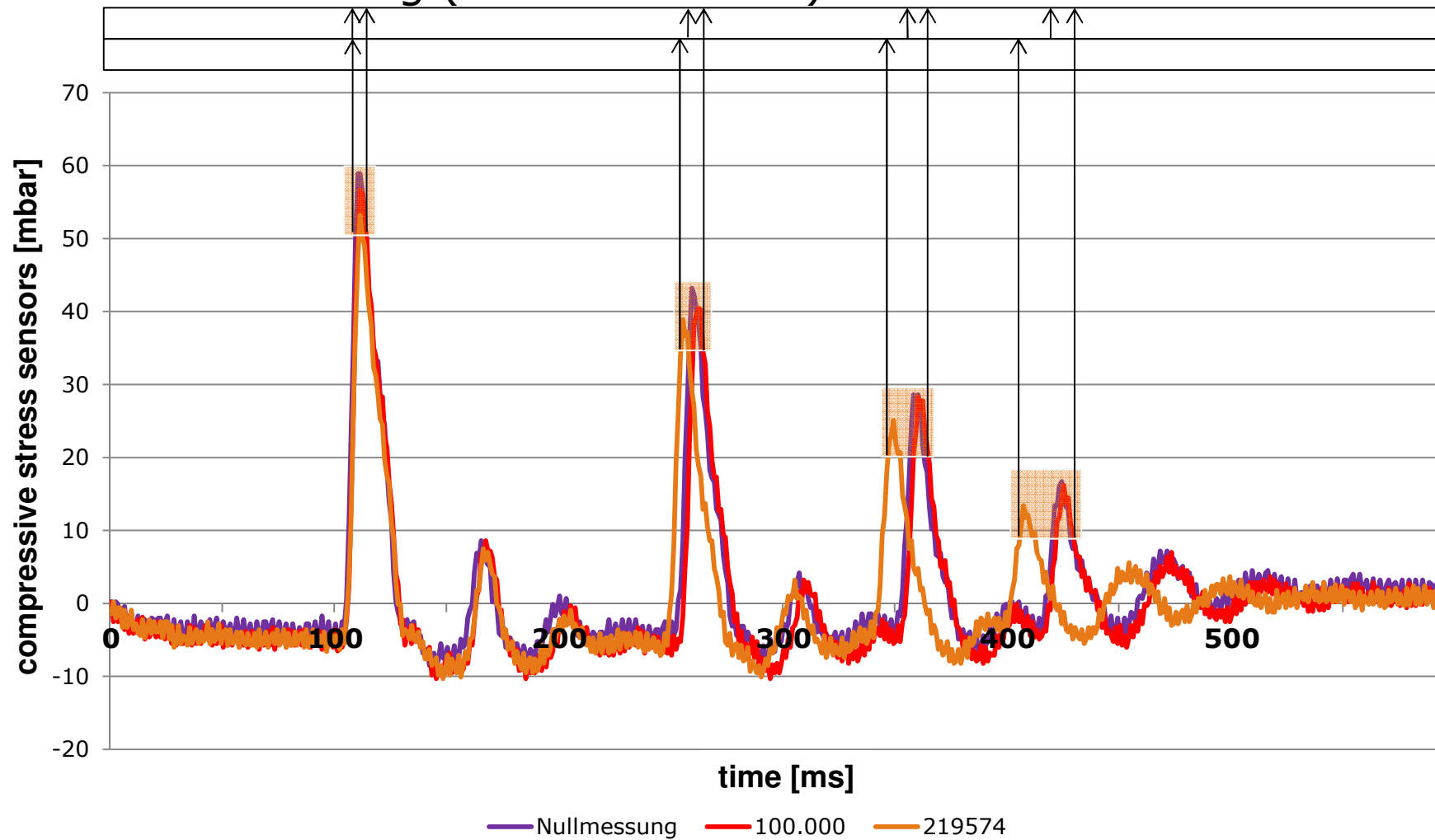
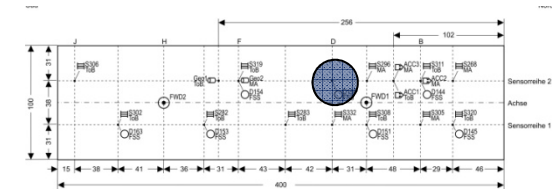
Accelerated Pavement Testing

- FWD-measuring (at Sensor D156)



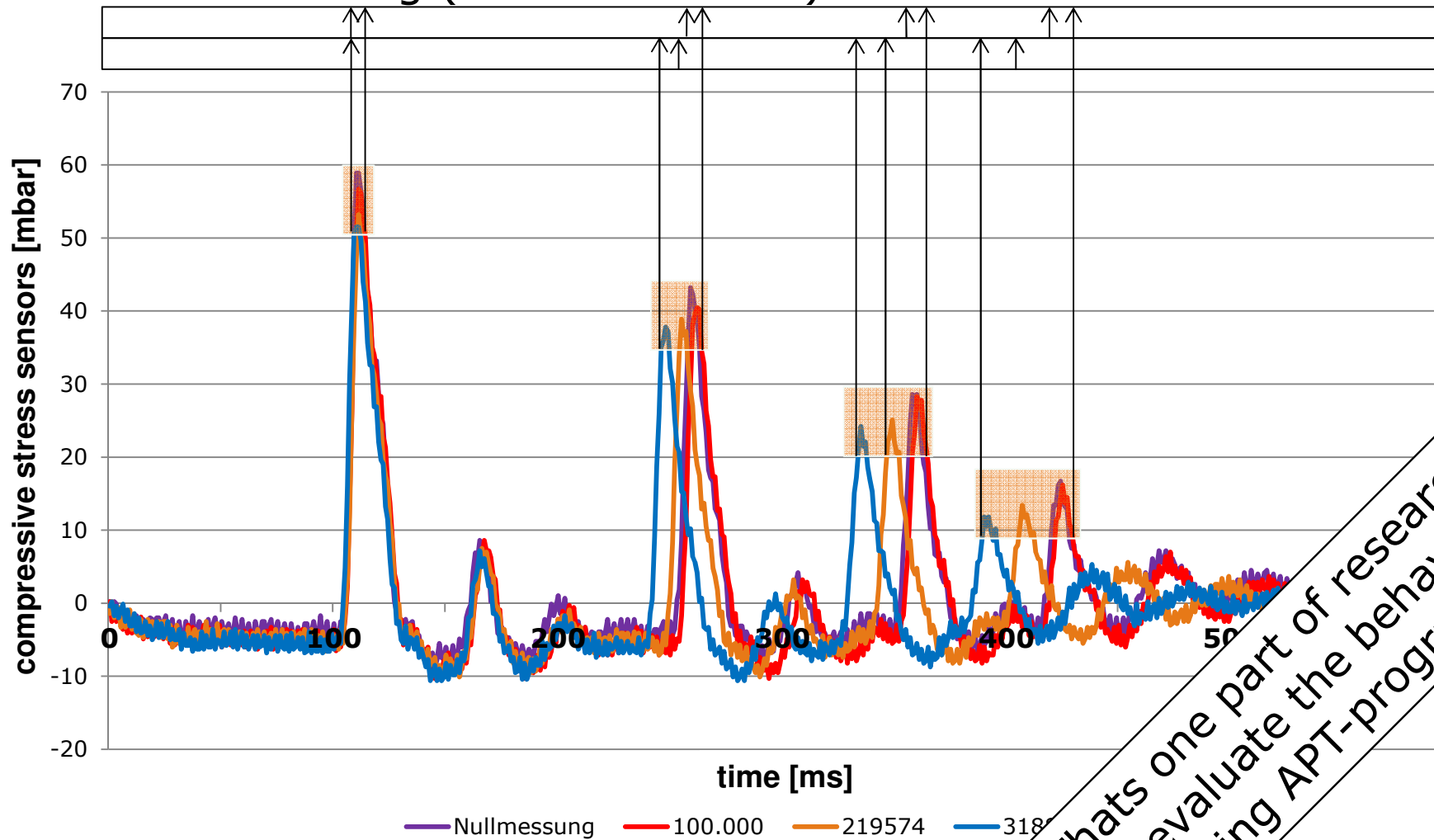
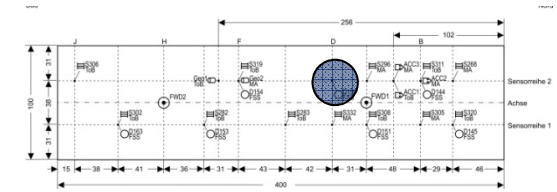
Accelerated Pavement Testing

- FWD-measuring (at Sensor D156)



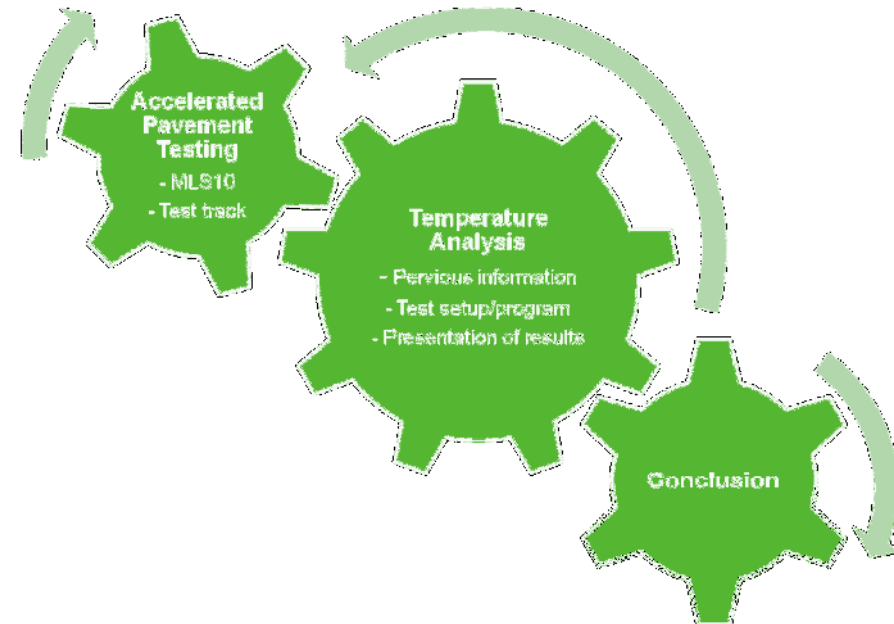
Accelerated Pavement Testing

- FWD-measuring (at Sensor D156)



Thats one part of research to evaluate the behavior during APT-programs.

Temperature Analysis



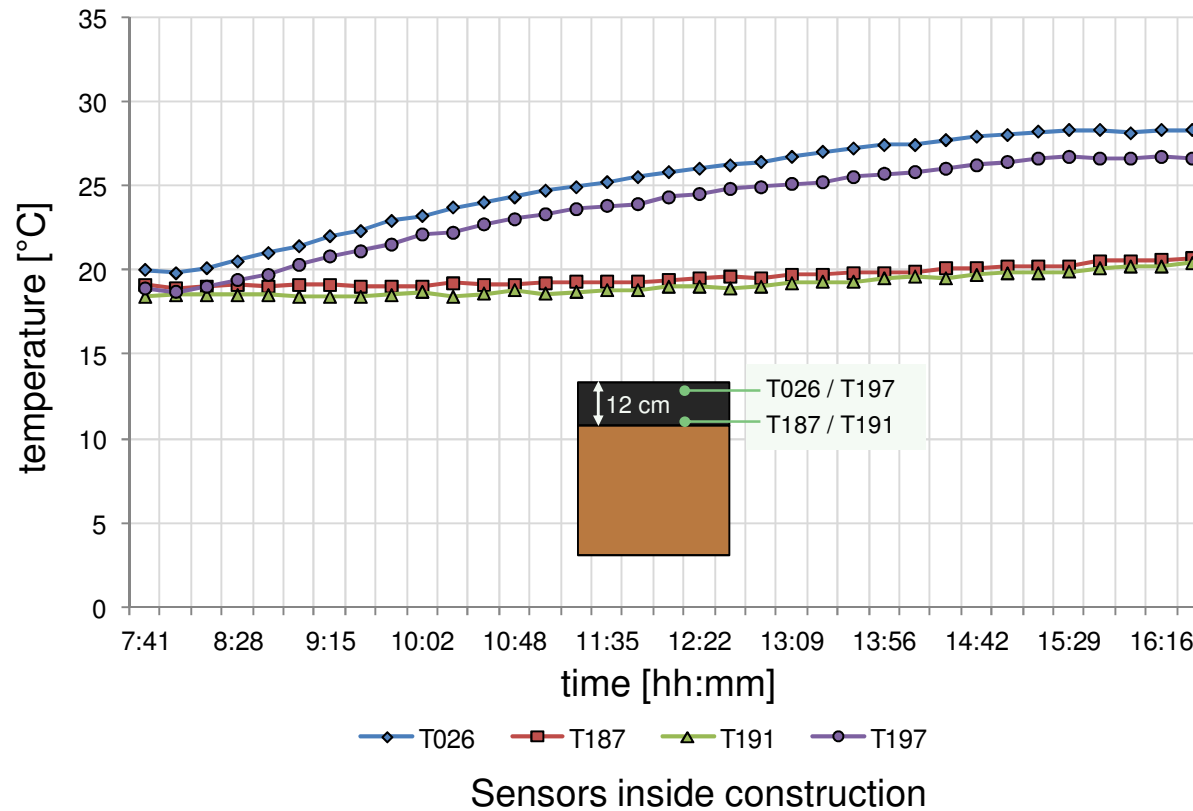
Parts of this presentation presented on this conference
10th- 12th June 2015
<http://iconfbmp.civil.auth.gr/>

Temperature Analysis

- Previous research results

Reference: Wacker et al, Straße und Autobahn 1/2014 (Germany)

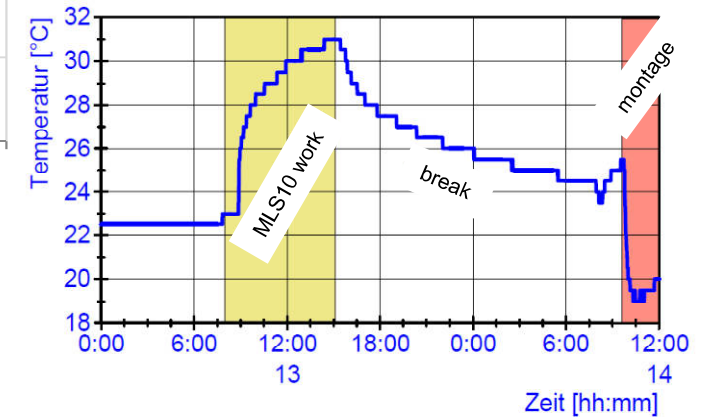
temperature profile – test section 4 – April 2014



higher sensors – 6,5 cm under surface

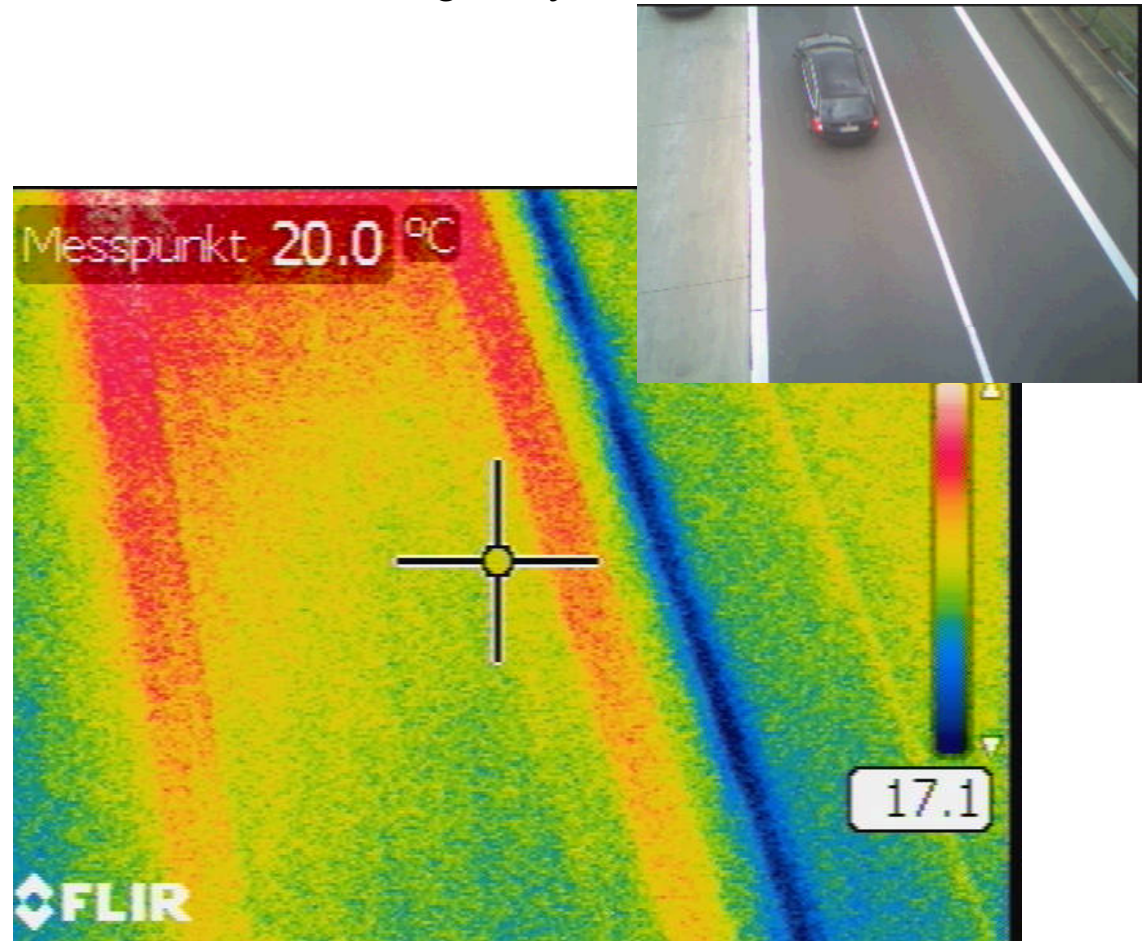
deeper sensors – 12,0 cm under surface

External Datalogger at surface



Temperature Analysis

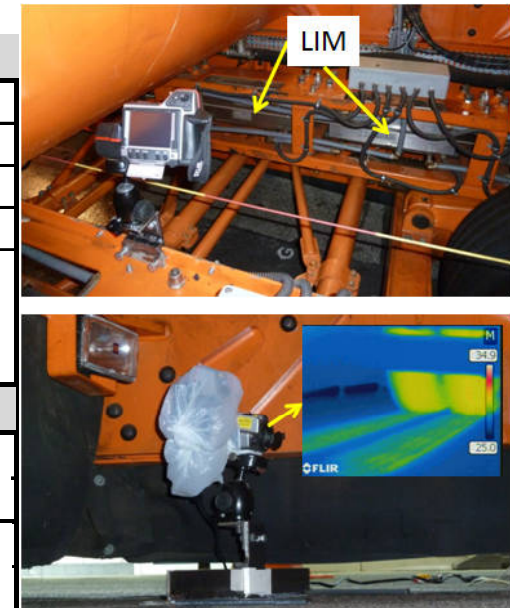
- Cross check with reality
 - First impression of situation on German highway surface
- Outside condition
 - Highway A3 near cologne - truck lane
 - Time: 10am
 - Weather: approx. 14[°C] and dry but cloudy



Temperature Analysis

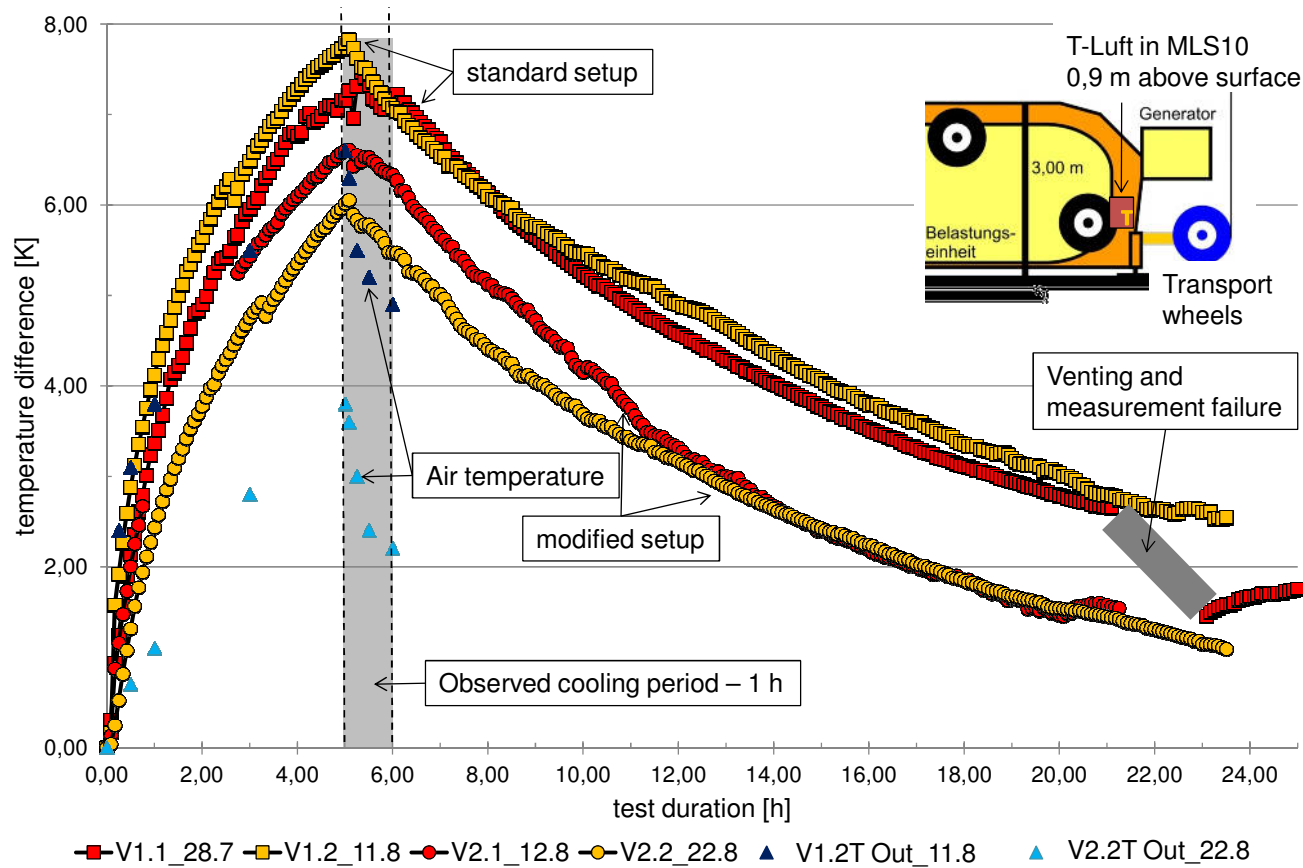
- Test setup/program

General Information	
test location	Instrumented, inside test track at BAST
test duration	respectively 5 [h] = 30.000 wheel loads
loading	every time 50 kN
equipment	infrared camera, temperature sensor (PT1000), thermometer
camera position	(a) view to the linear motors (b) view to the loading wheels from the front and the back (c) view to the asphalt surface from the front and the back
Detailed Information	
Setup	
Mode	



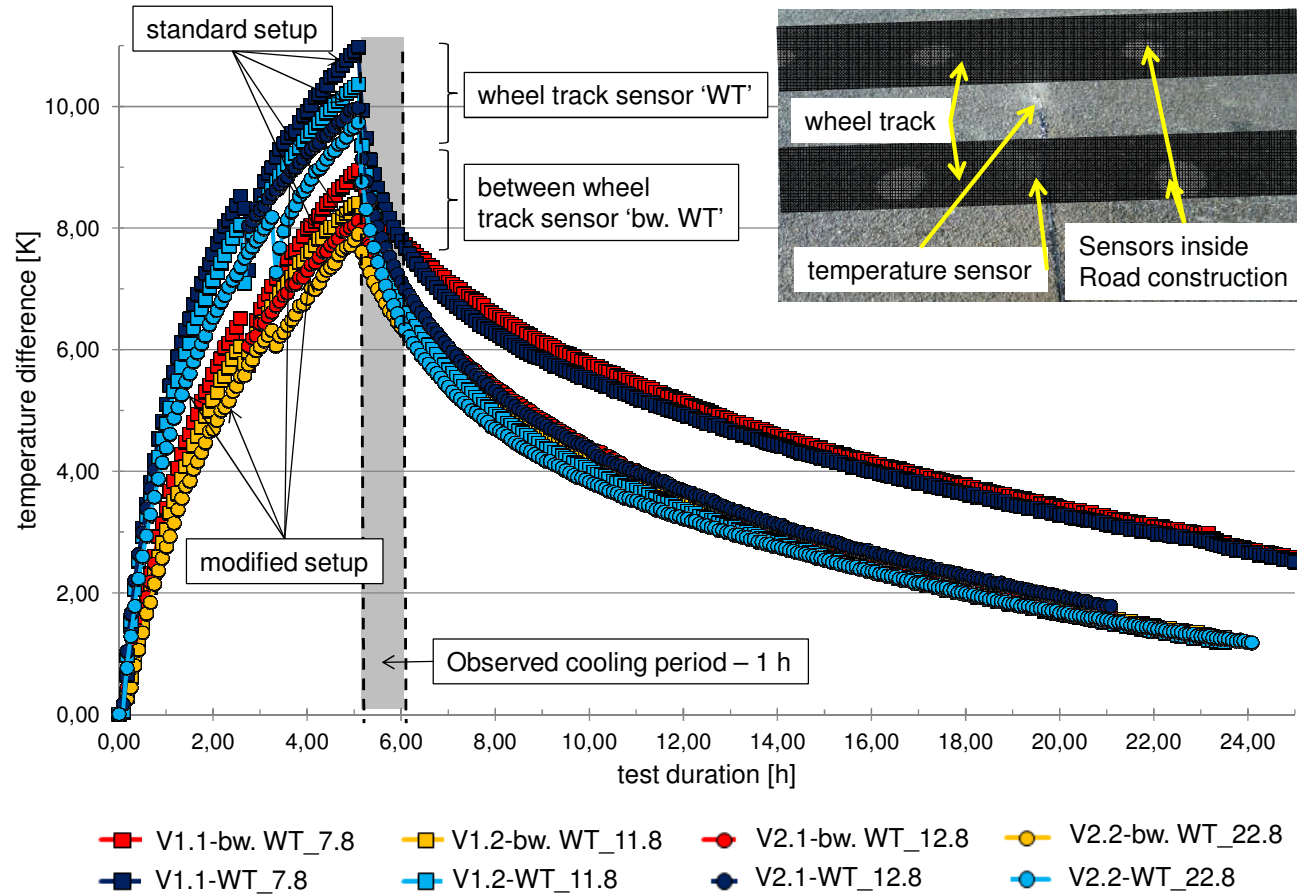
Temperature Analysis

- Results of the test program - Sensors
 - Air temperature (inside und outside MLS10)



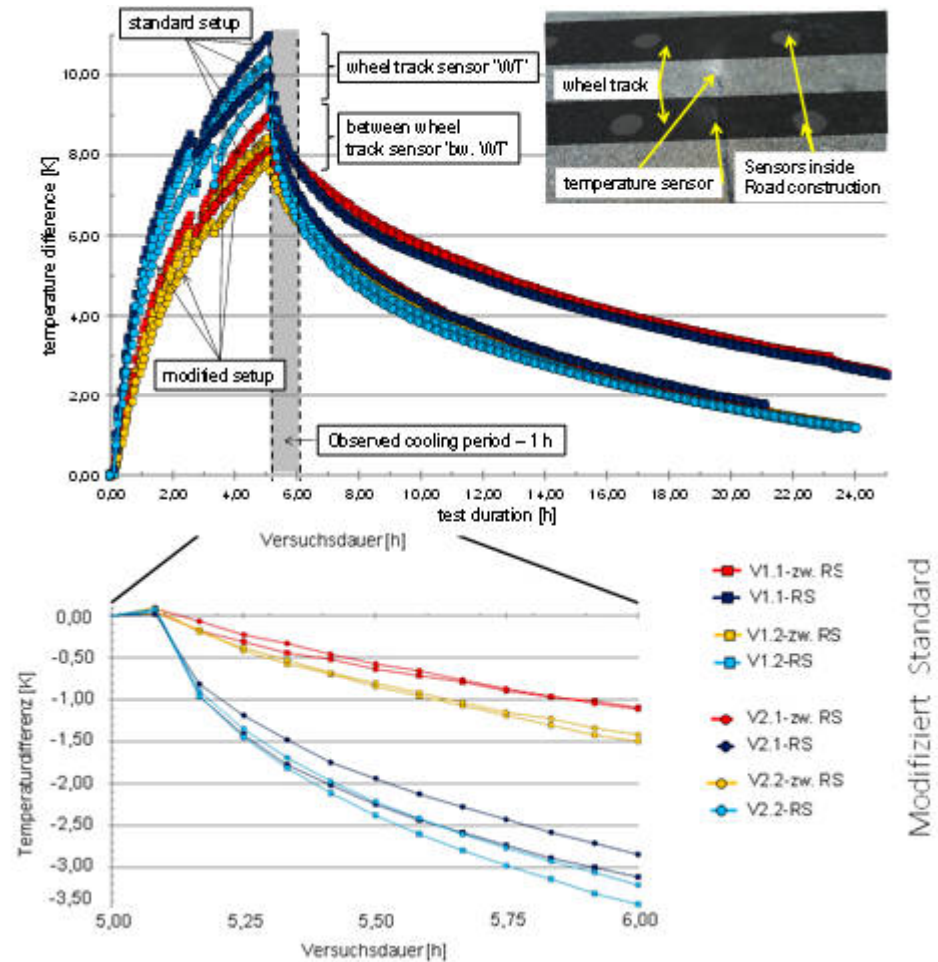
Temperature Analysis

- Results of the test program - Sensors
 - Asphalt surface temperature



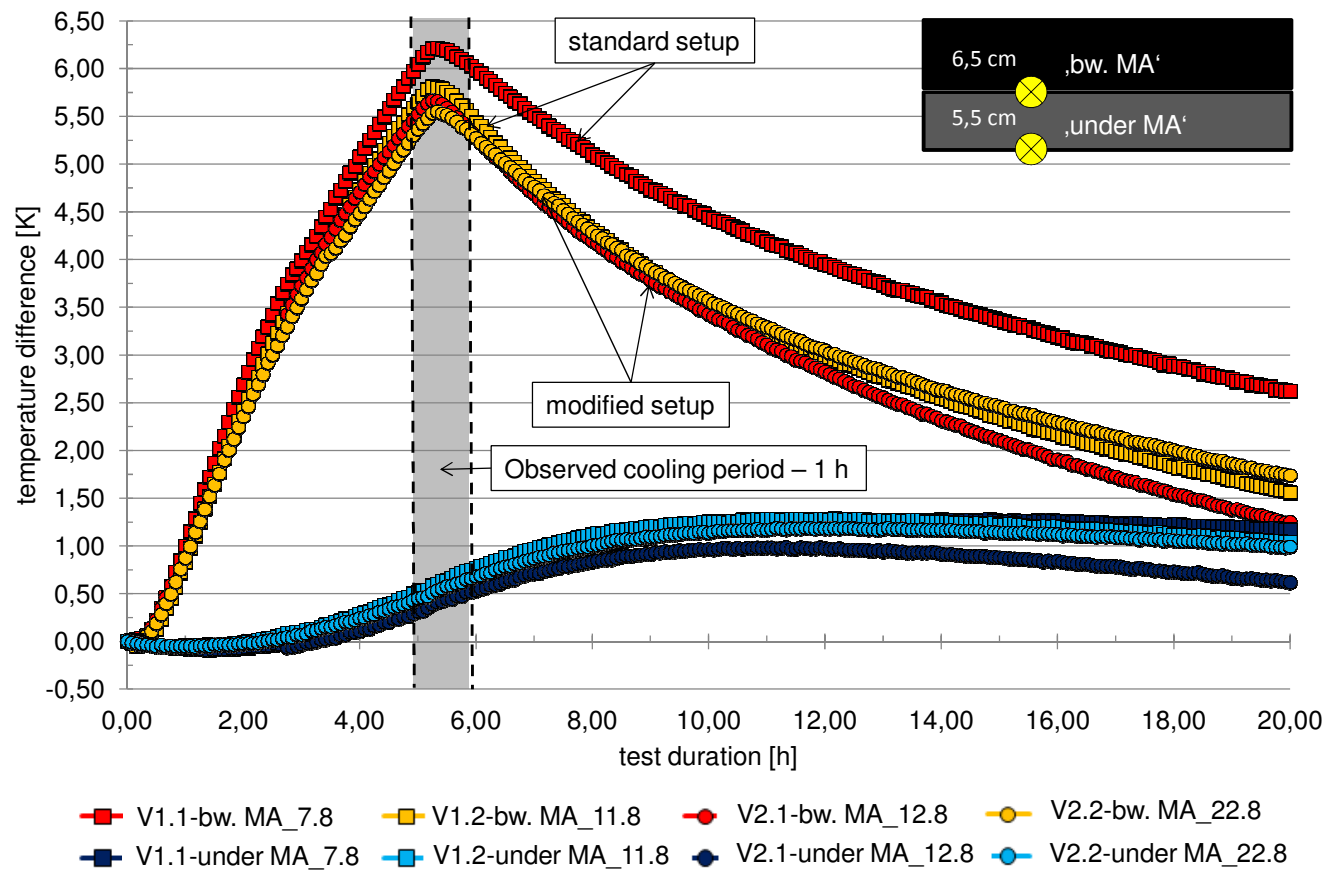
Temperature Analysis

- Results of the test program - Sensors
 - Asphalt surface temperature



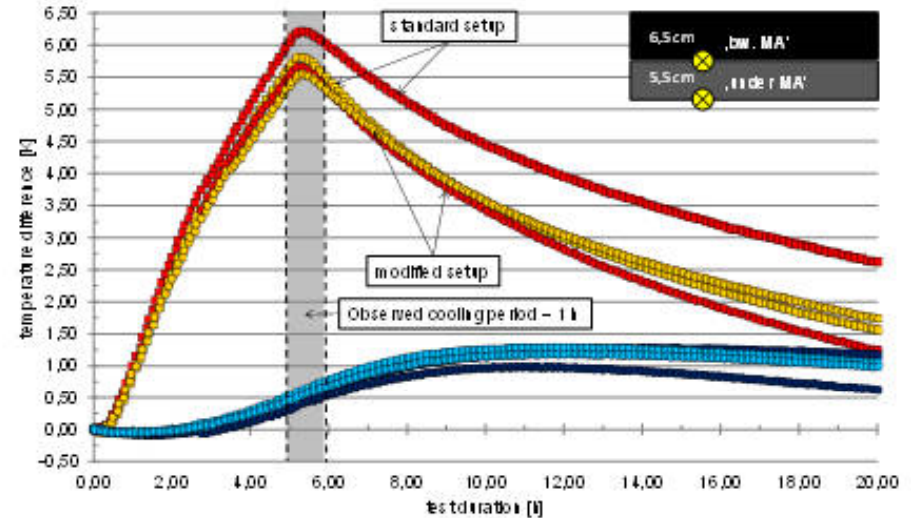
Temperature Analysis

- Results of the test program - Sensors
 - Asphalt structure temperature

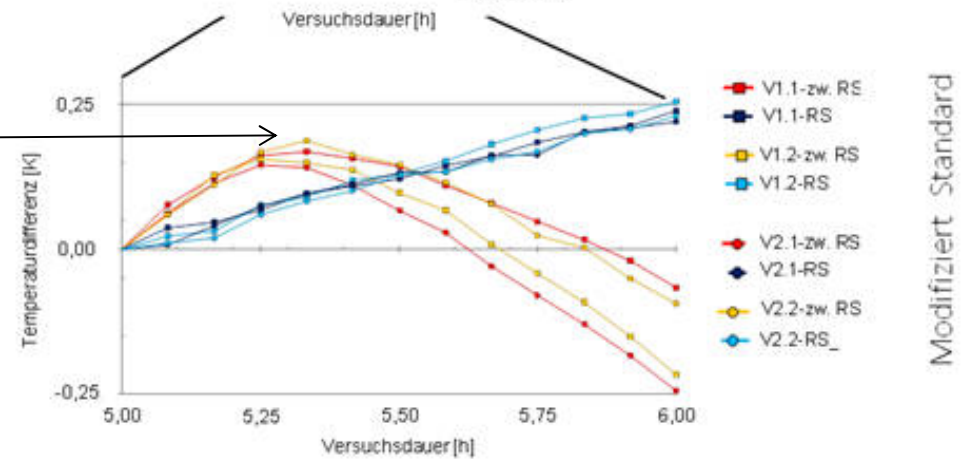


Temperature Analysis

- Results of the test program - Sensors
 - Asphalt structure temperature

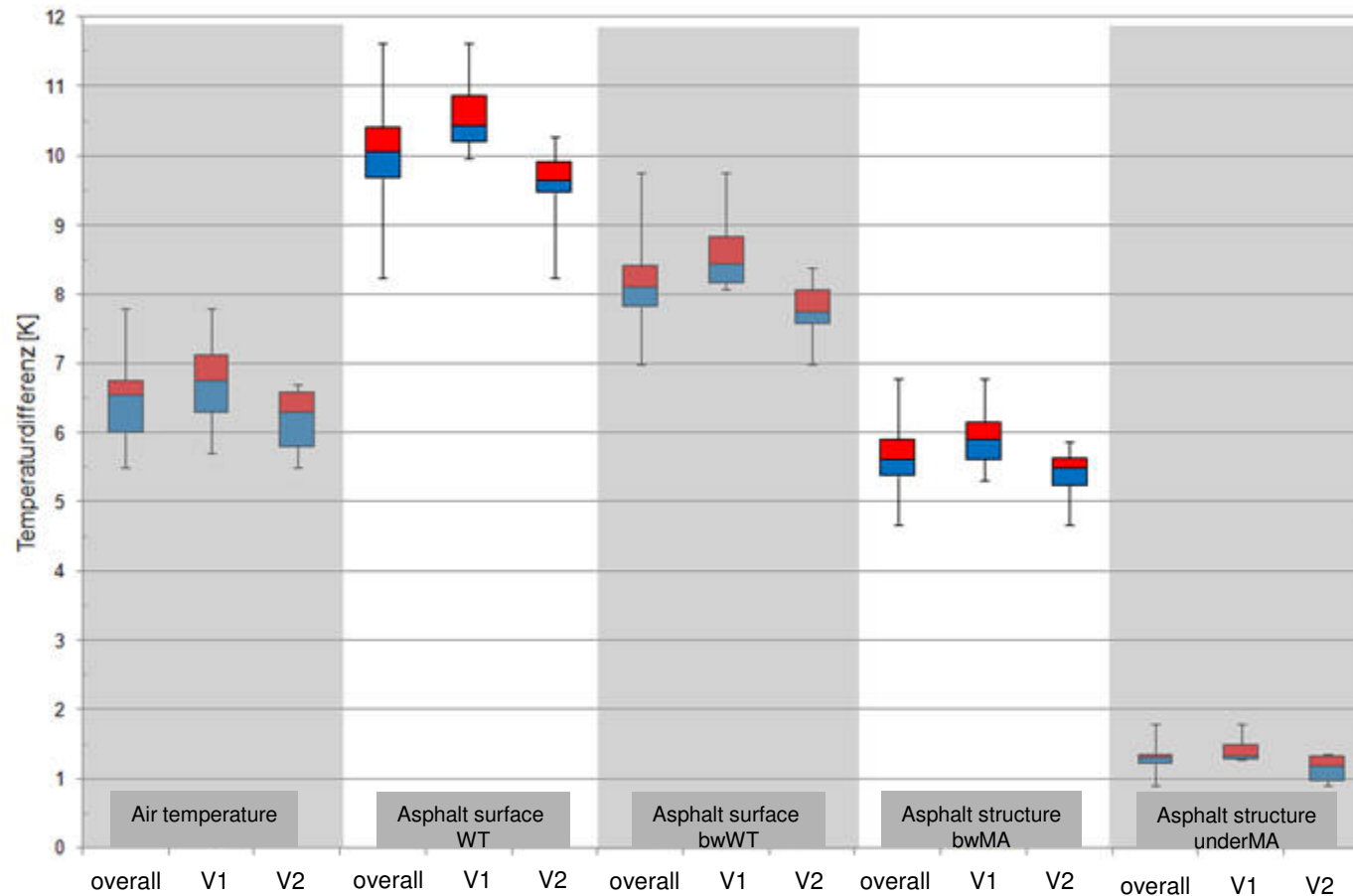


Measurement time?



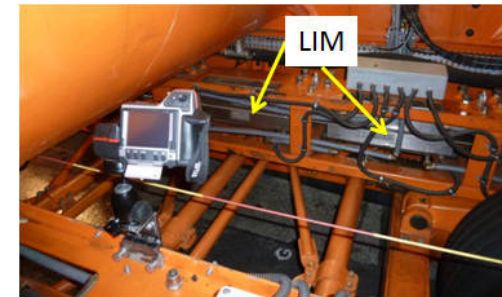
Temperature Analysis

- Results of the test program - Sensors
 - Average values of each sensor position

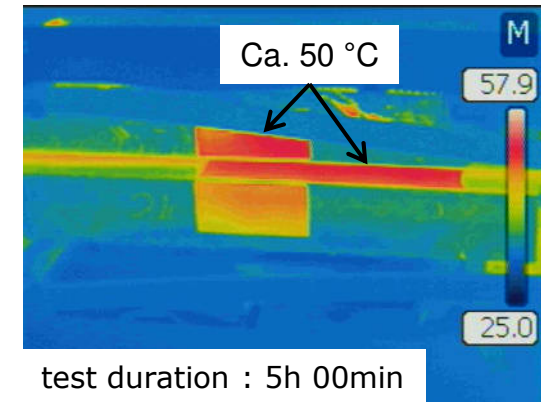
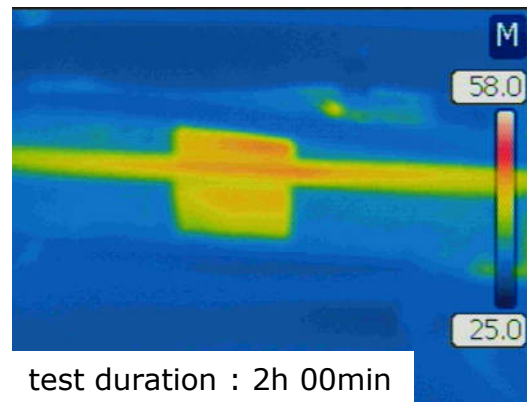
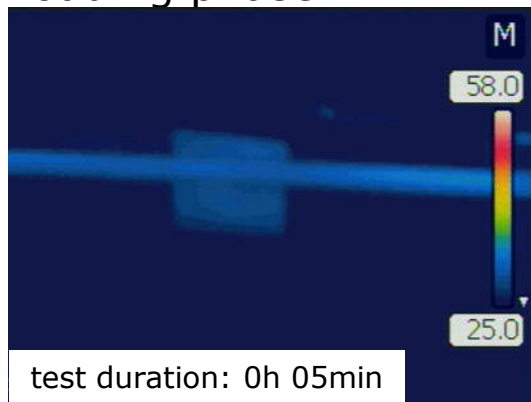


Temperature Analysis

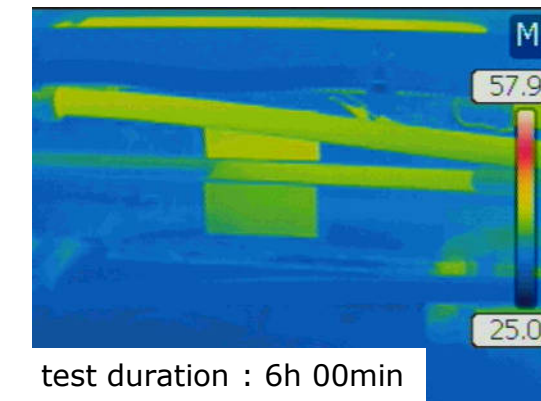
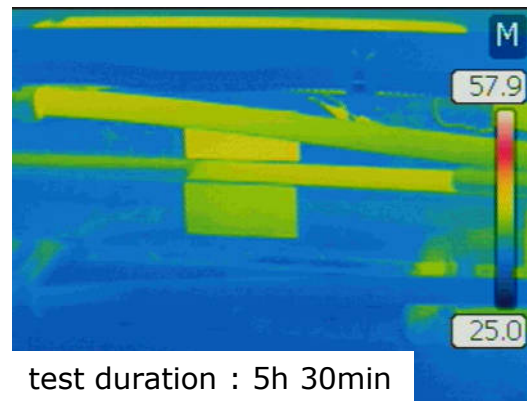
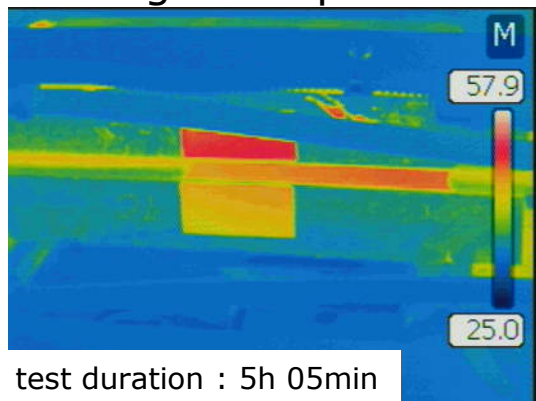
- Results of the test program – Infrared pictures
 - View to the linear motors



Loading phase



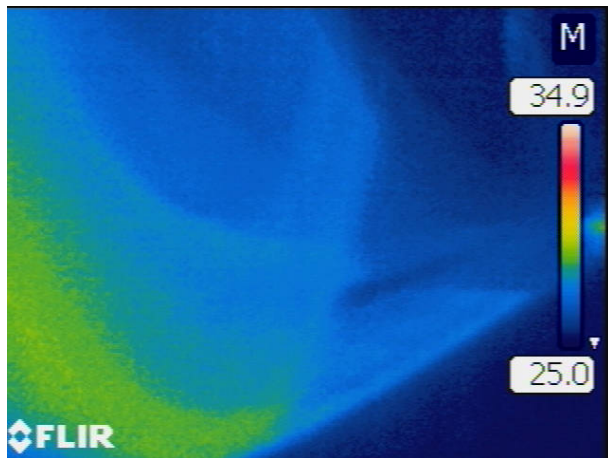
Cooling down phase



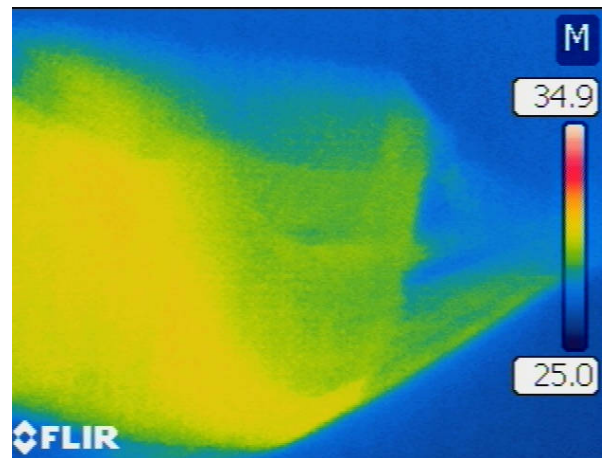
Temperature Analysis

- Results of the test program – Infrared pictures
 - View to the loading wheels from the front

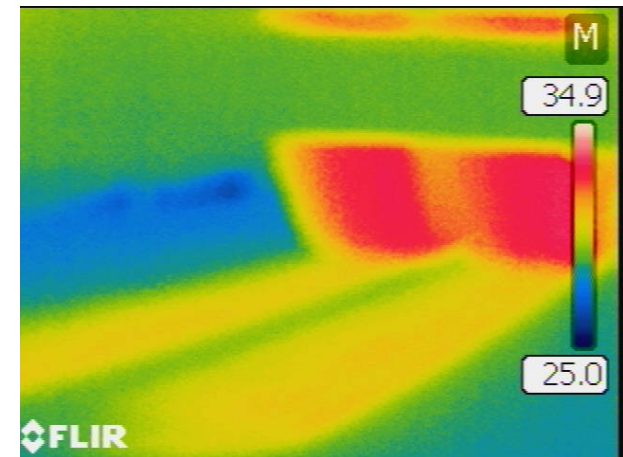
test duration: 1h 00min



test duration : 2h 00min

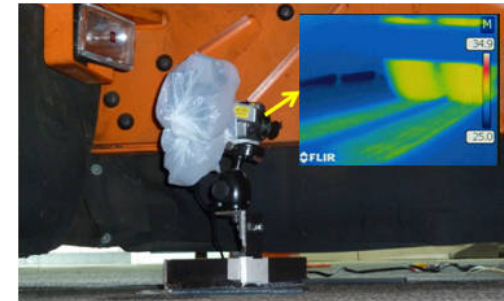


test duration : 5h 00min

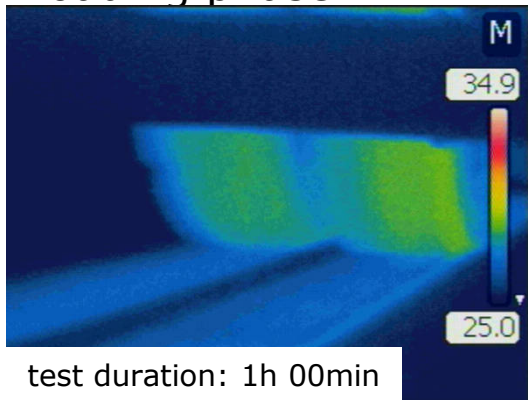


Temperature Analysis

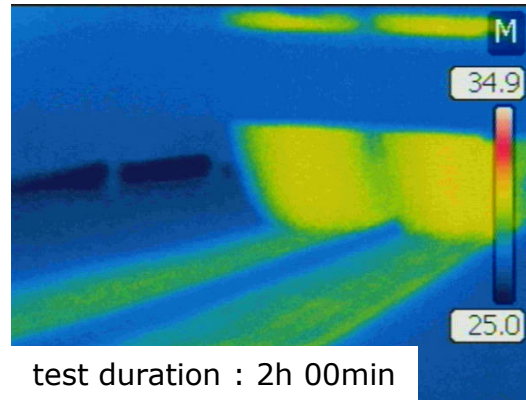
- Results of the test program – Infrared pictures
 - View to the loading wheels from the front



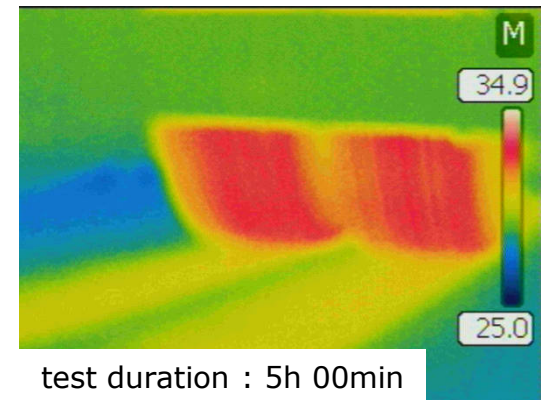
Loading phase



test duration: 1h 00min

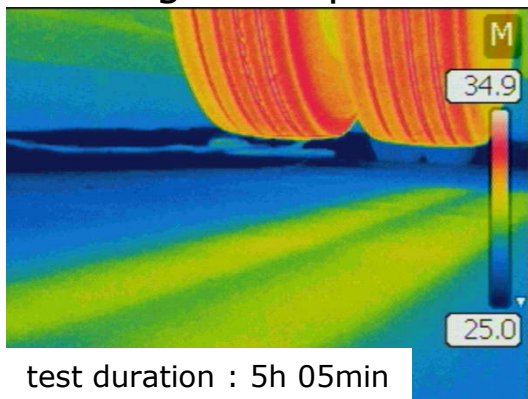


test duration : 2h 00min

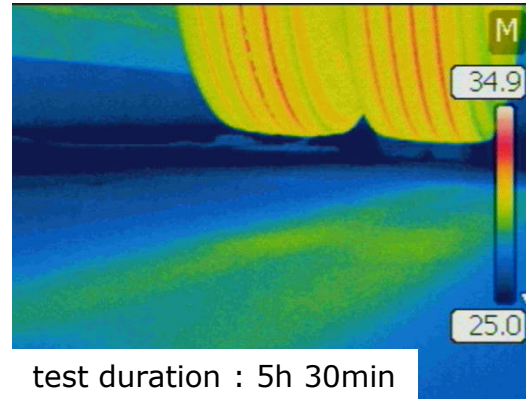


test duration : 5h 00min

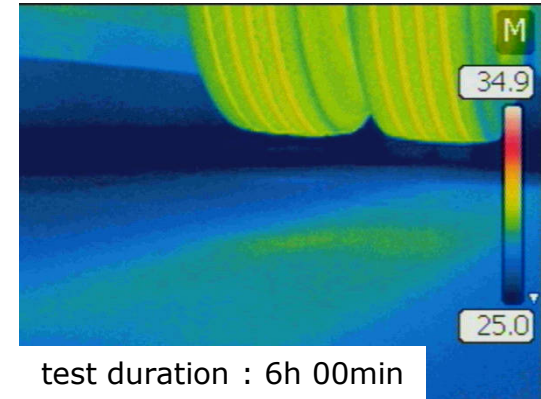
Cooling down phase



test duration : 5h 05min

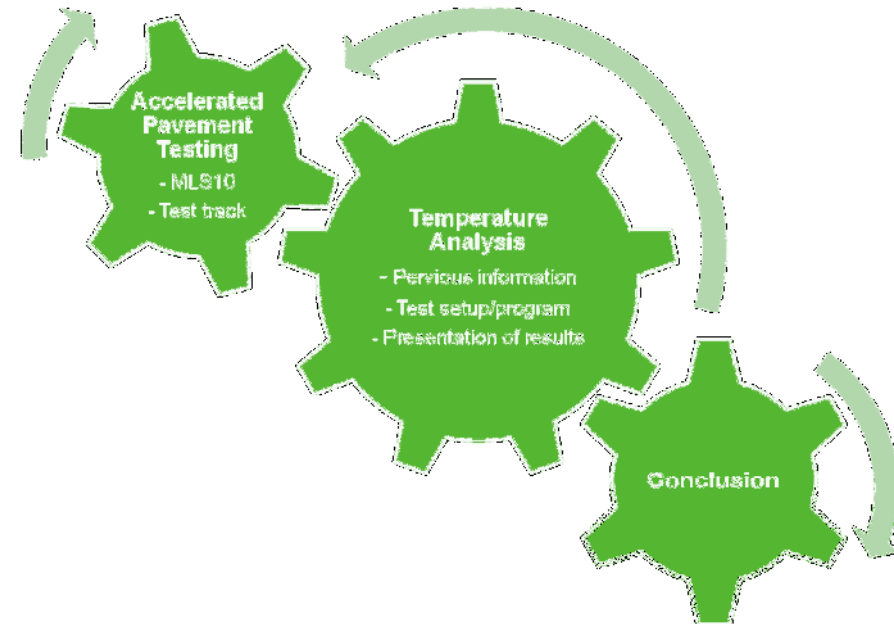


test duration : 5h 30min



test duration : 6h 00min

Conclusion



Conclusion

- Localization of temperature increase
 - different machine parts (linear motors and loading wheels) *and*
 - different location inside and outside of the test track
- Important information for prospective APT programs
 - to develop the next programs *and*
 - to analyze the programs
- Temperature changes inside the asphalt are coming
 - from the constantly passing of loading wheels
 - not only from the air temperature

Thank you for your attention!



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