Pavement response due to different tyre configuration

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FINDING A BETTER WAY

Background, Objectives & Results

Background

Type of tyres and their configurations has changed throughout the years as new tyres have been launched. Different tyres and their configuration affects the degradation of the road network. In this project the VTI:s HVS machine is used to get direct measurements of pavement response to quantify their impact.

Objectives

To get direct measurements of the response of typical pavement structure from different tyres and their configuration.

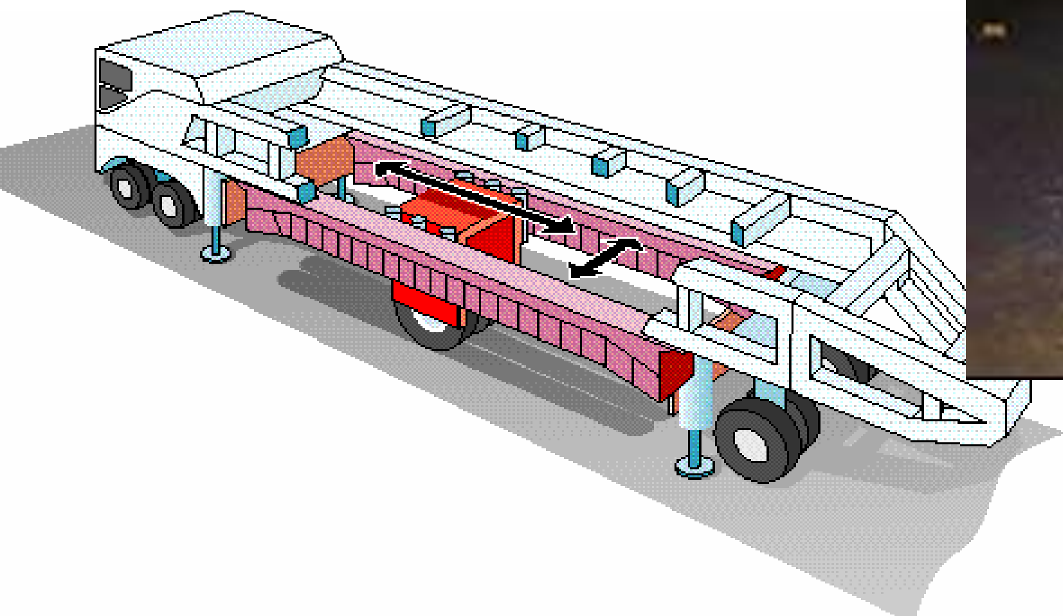
Results

Direct measurements of pavement response that can be used with transfer functions to predict their degradation rate.

Background, Objectives & Results - cont.

The HVS Nordic

The HVS Nordic is a mobile APT test facility.



Construction of a test object 1

Construction of a test object 2

Construction of a test object 3

Construction of a test object 4

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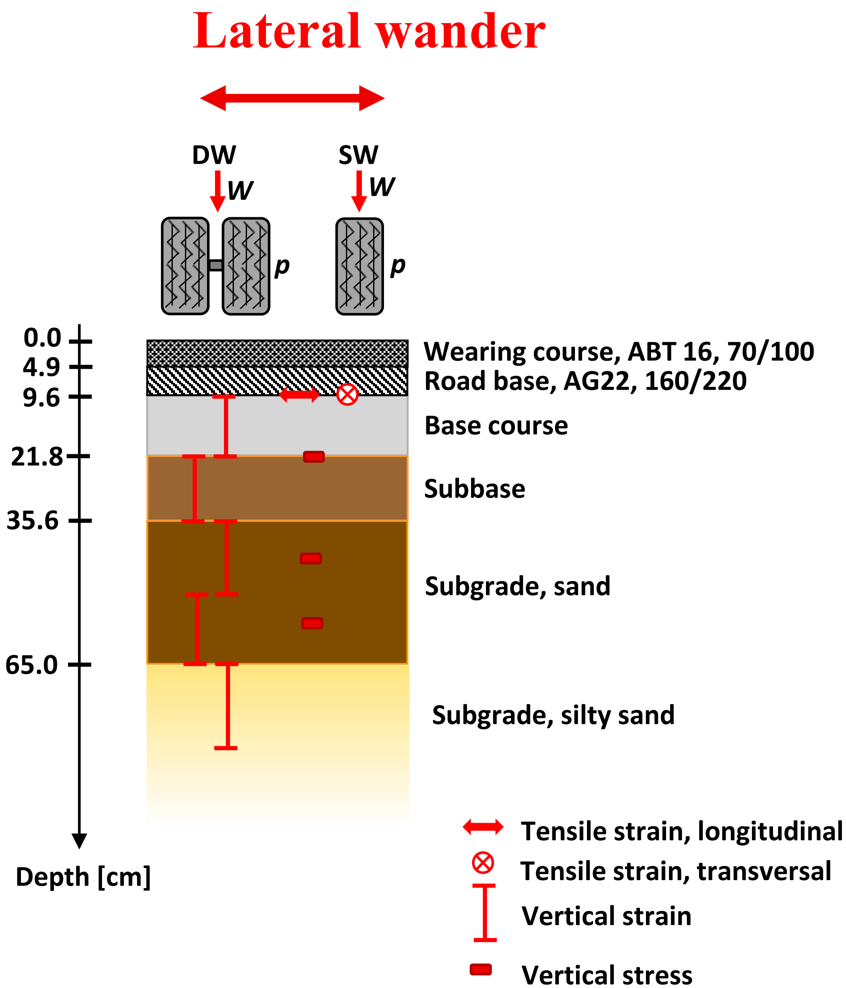
Construction of a test object 5

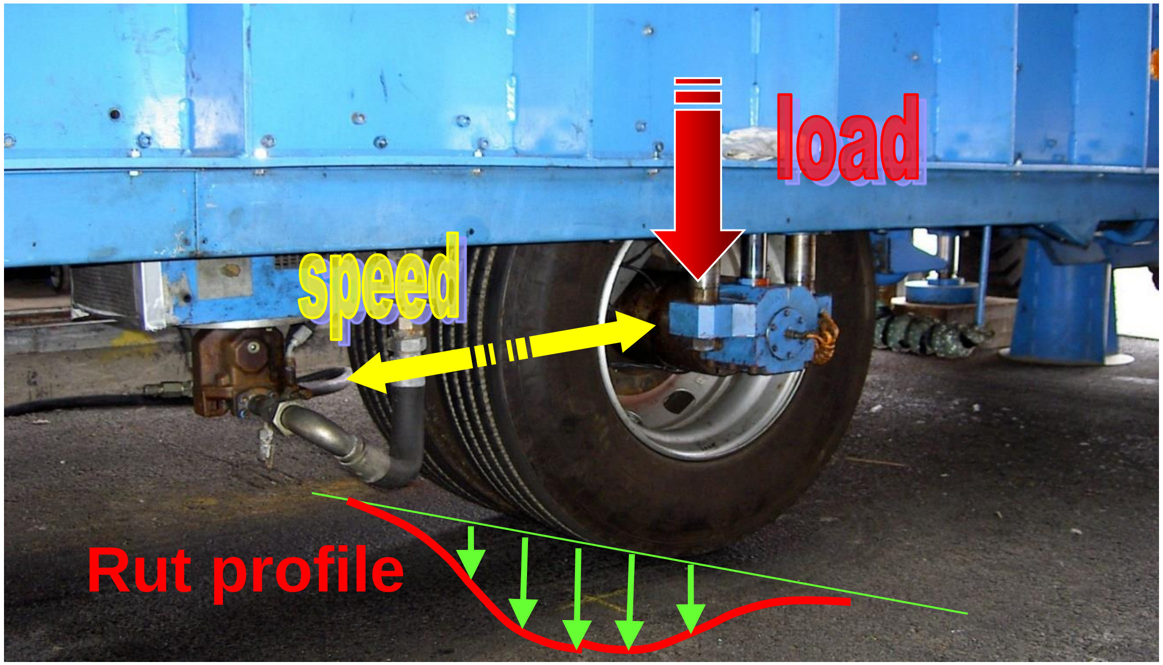
Tyre configuration



Dimensions	Configuration	Brand
275/80 R 22,5	Twin / Dual	YOKOHAMA Supersteel RY103
295/80 R 22,5	Twin / Dual	Marshal KRS 15
315/80 R 22,5	Single	Michelin X Multiway 3D
385/65 R 22,5	Single	Michelin X Multi
425/65 R 22,5	Single	Goodyear G165
455/40 R 22,5	Single	Goodyear Marathon LHT+

Tyre configuration

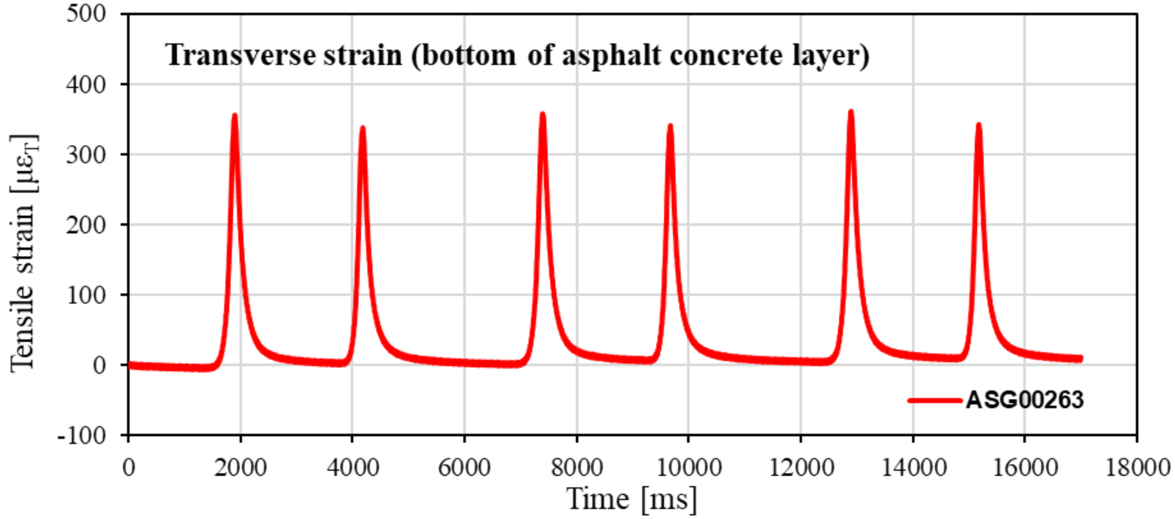
The response scheme

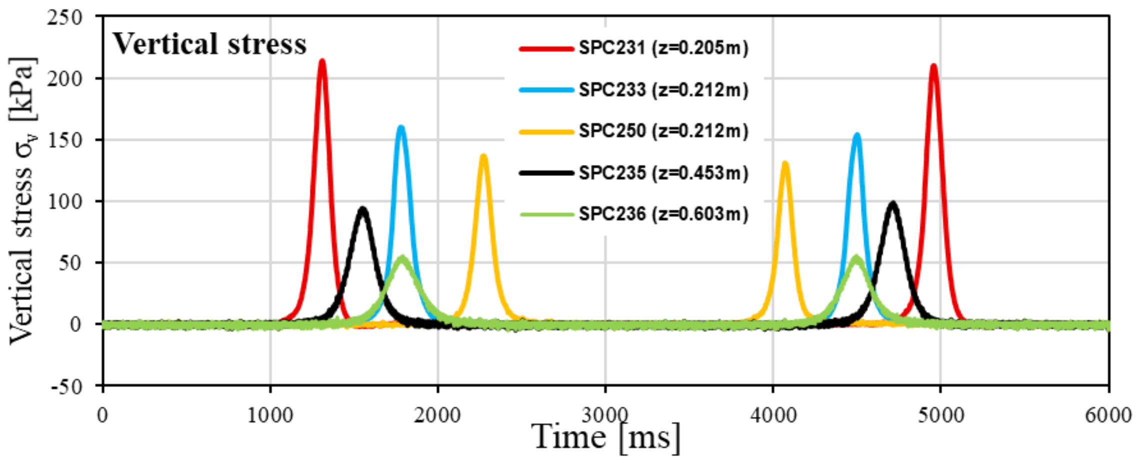


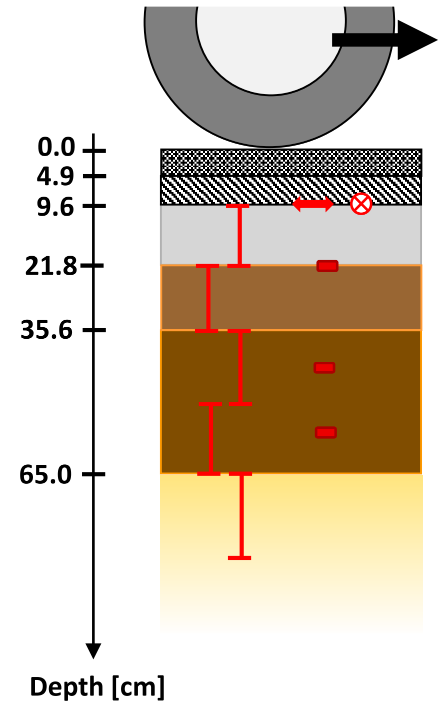
Temp.: $T = 10°C$ **Speed:** $v = 12$ km/h

Loading: $W = 40$; 50; 60 & 80 kN
Tyre pressure: $p = 700$; 800; 900 & 950 kPa
Loading configuration: Single & Dual

Typical response



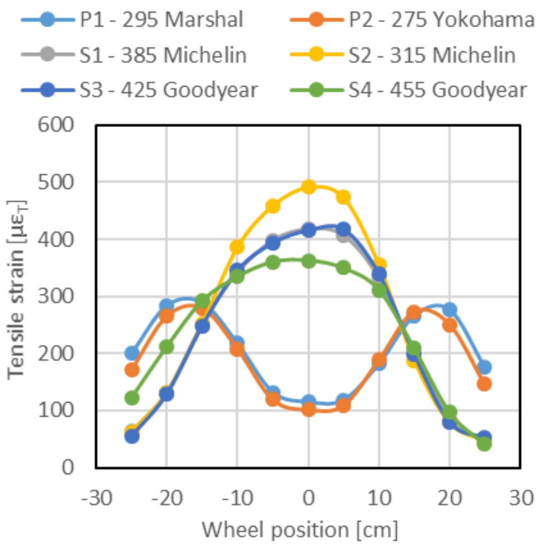


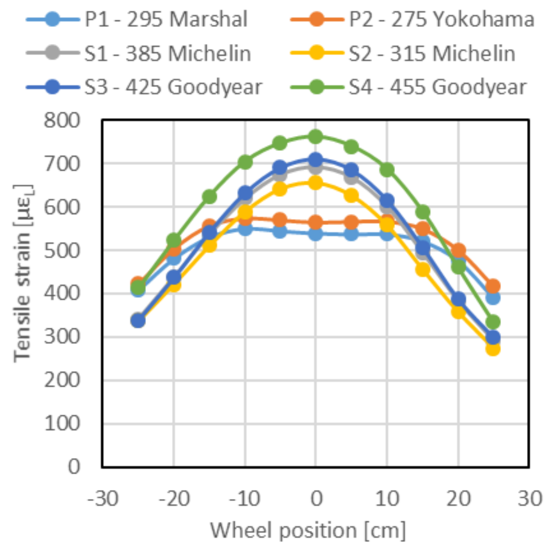


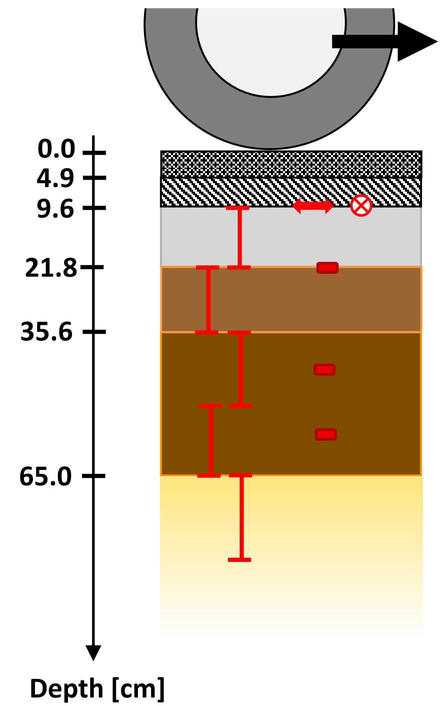
Response

Tyre configuration L_A= 100 kN & p = 800 kPa

Tensile strain



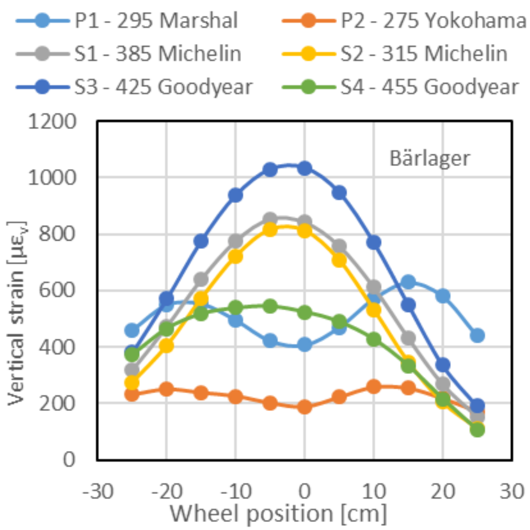


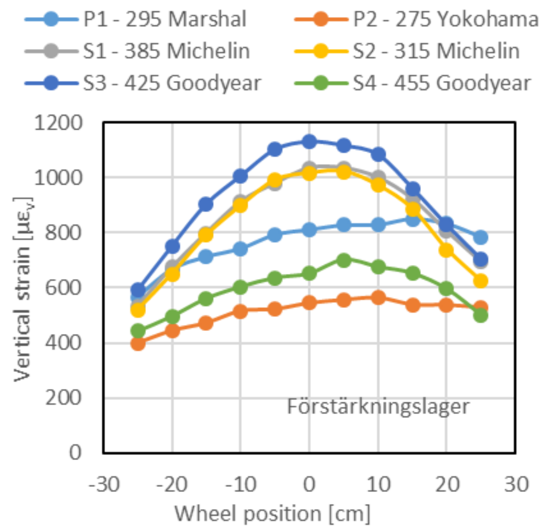


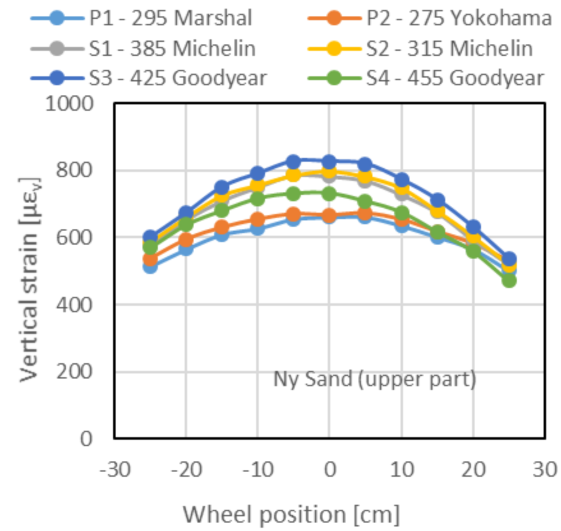
Response

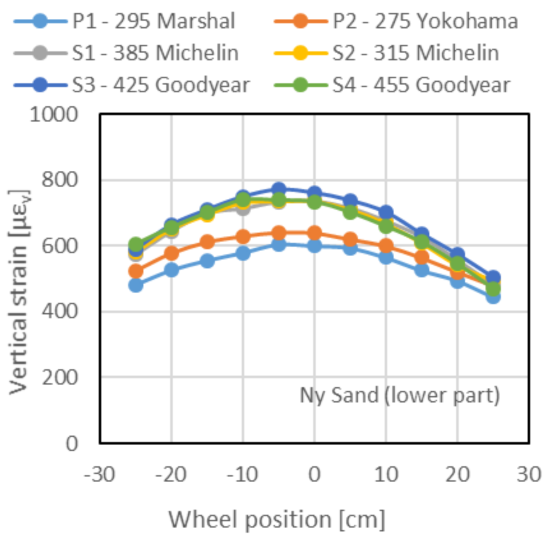
Vertical strain

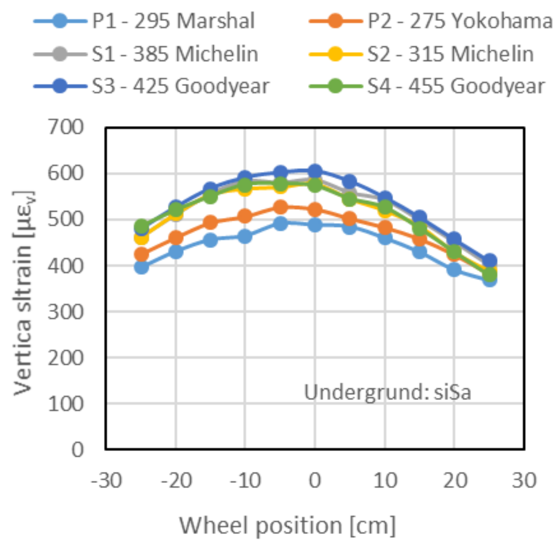
Tyre configuration L_A= 100 kN & p = 800 kPa

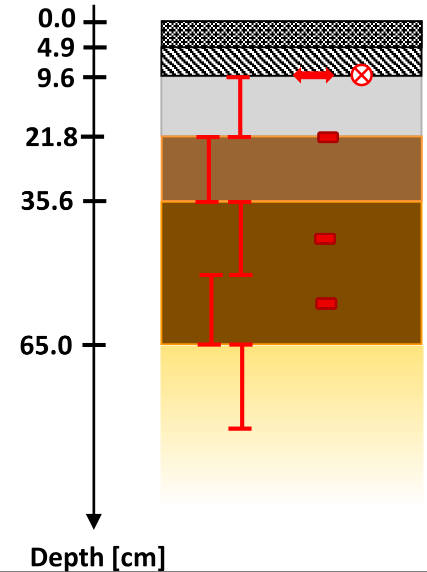








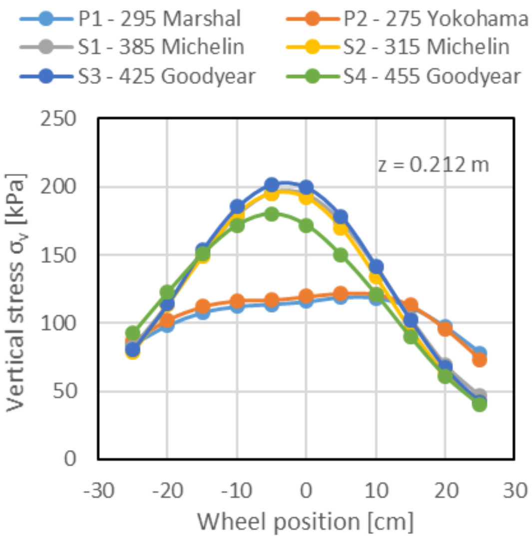


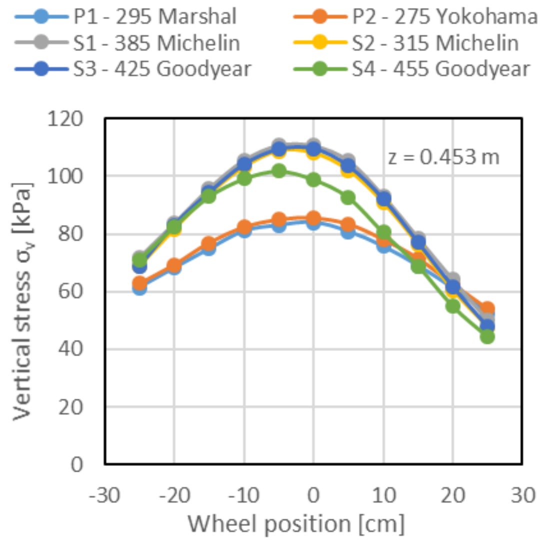


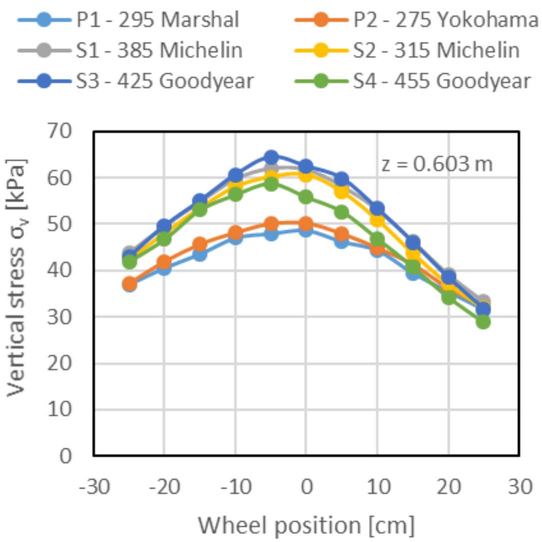
Response

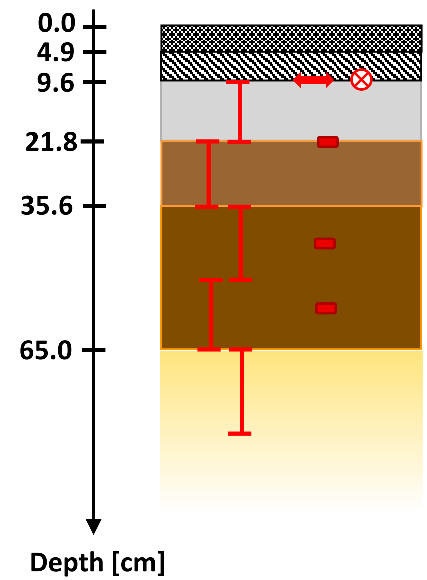
Vertical stress

Tyre configuration L_A= 100 kN & p = 800 kPa

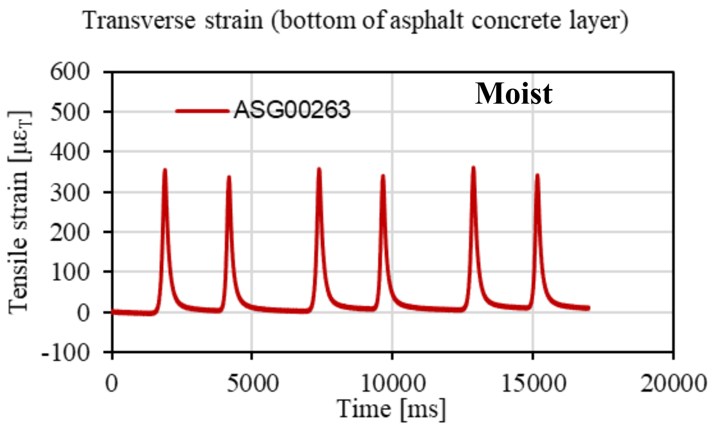




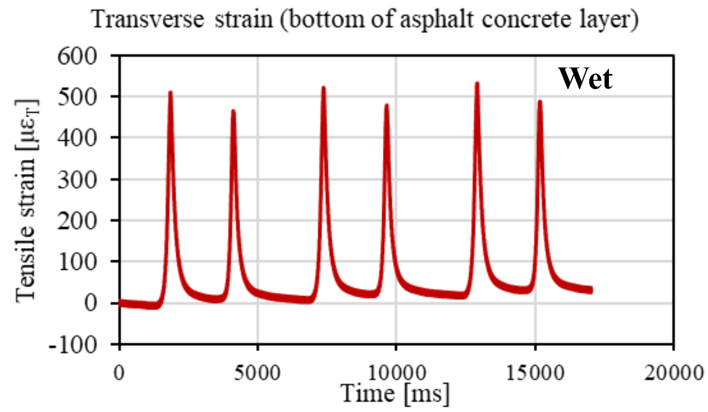




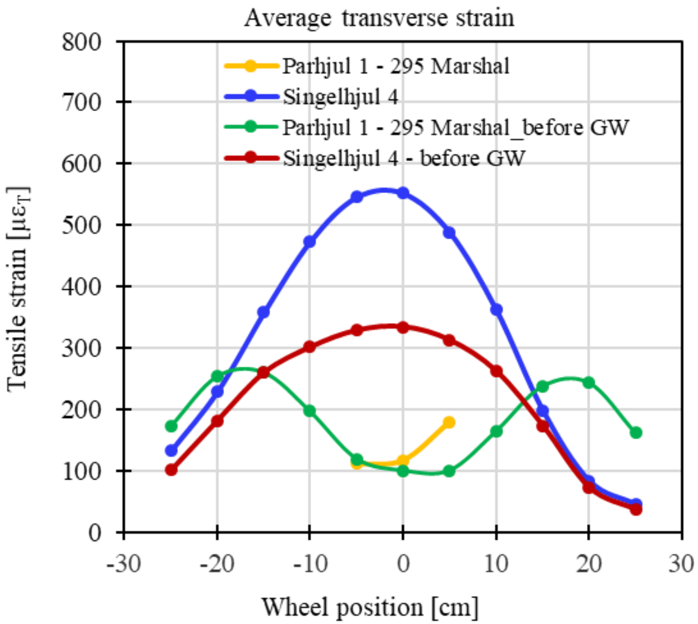
Moist vs. wet



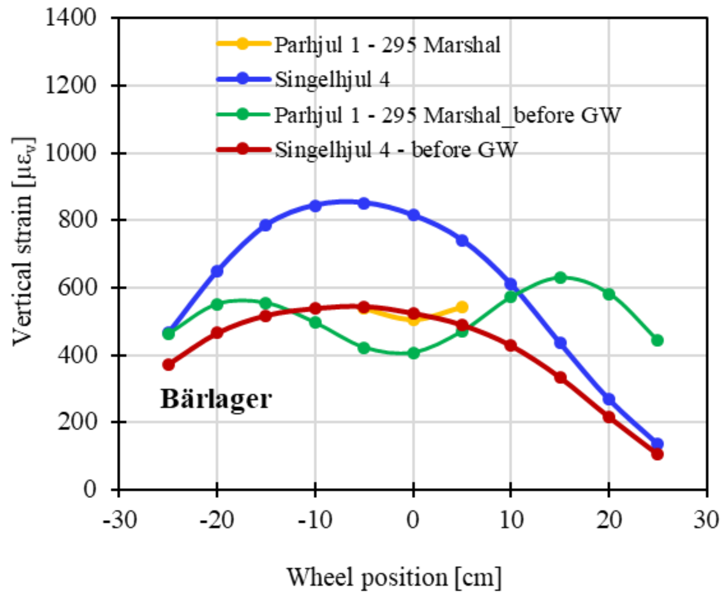
Transverse strain (bottom of asphalt concrete layer)
Moist
ASG00263
Tensile strain [$\mu\varepsilon_T$]
600
500
400
300
200
100
0
-100
0
5000
10000
15000
20000
Time [ms]



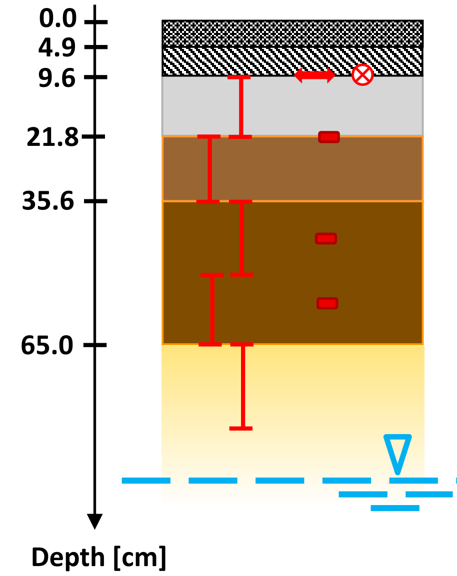
Transverse strain (bottom of asphalt concrete layer)
Wet
Tensile strain [$\mu\varepsilon_T$]
600
500
400
300
200
100
0
-100
0
5000
10000
15000
20000
Time [ms]



Average transverse strain
Parhjul 1 - 295 Marshal
Singelhjul 4
Parhjul 1 - 295 Marshal_before GW
Singelhjul 4 - before GW
Tensile strain [$\mu\varepsilon_T$]
800
700
600
500
400
300
200
100
0
-30
-20
-10
0
10
20
30
Wheel position [cm]

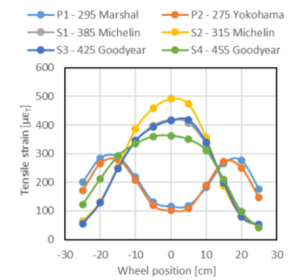


Parhjul 1 - 295 Marshal
Singelhjul 4
Parhjul 1 - 295 Marshal_before GW
Singelhjul 4 - before GW
Bärlager
Vertical strain [$\mu\varepsilon_v$]
1400
1200
1000
800
600
400
200
0
-30
-20
-10
0
10
20
30
Wheel position [cm]



0.0
4.9
9.6
21.8
35.6
65.0
Depth [cm]

Distress development



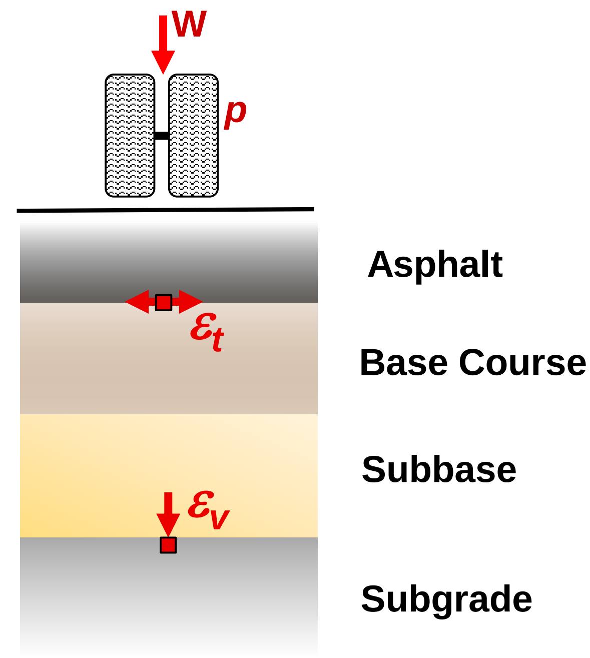
Design criteria according to PMS Objekt:

Tensile strain $N_f = k_1 \cdot \varepsilon_t^{-4}$

Permanent deformation $N_f = k_2 \cdot \varepsilon_v^{-4}$

For the standard axle loading case:

$L_A = 100$ kPa & $p = 800$ kPa:



	Tensile strain ε_t [με]	Vertical strain ε_v [με]
Dual wheel (average)	285	663
Single wheel (average)	422	785
S/D	1.48	1.18
Reduction in live (D/S)^4	4.79	1.94

Conclusion

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Pavement response from different tyres has been measured in a full scale testing from four single tyres and two dual tyres configurations.

» **Great difference between dual tyre configuration vs. single tyres is observed in the upper part of the structure. This is true for tensile strain ε_t, vertical strain ε_v & vertical stress σ_v.**

» **The difference between single and dual tyres decreases with depth.**

» **As the tyre width increases the response generally decreases.**

» **The response increase (ε_t, ε_v & σ_v) as the water table is raised.**

Note: This is only based on one thin pavement structure that has been tested.

Thanks

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Questions?