# Pavement response due to different tyre configuration
## - a full scale HVS study

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FINDING A BETTER WAY

# Background


# 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

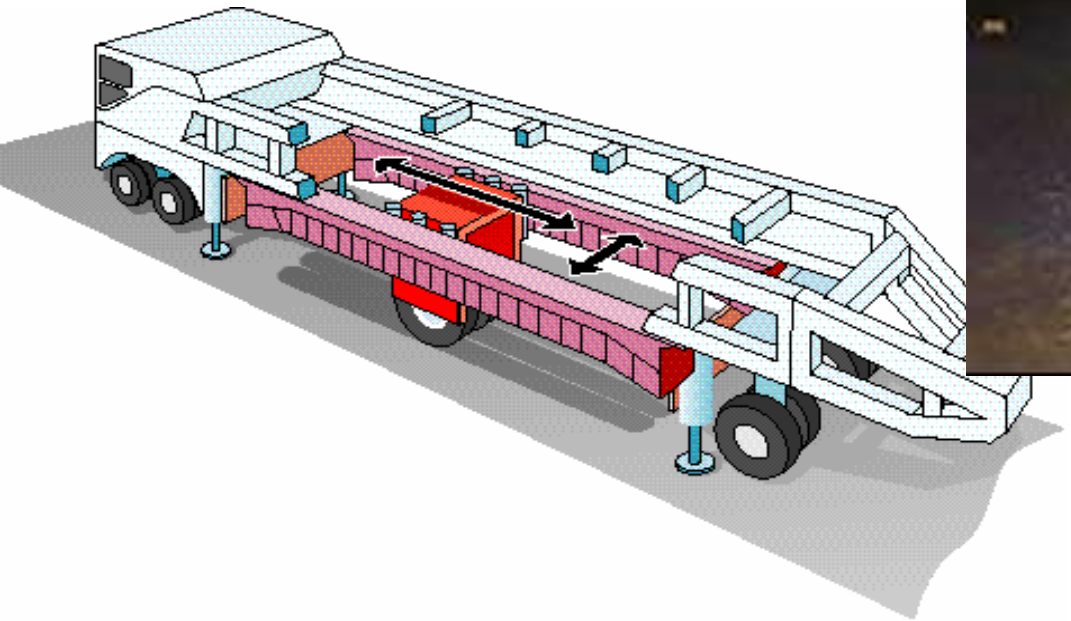
To get direct measurements of the response of typical pavement structure from different tyres and their configuration.

## Results

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

# The HVS Nordic

The HVS Nordic is a mobile APT test facility.



# Construction of a test object #1

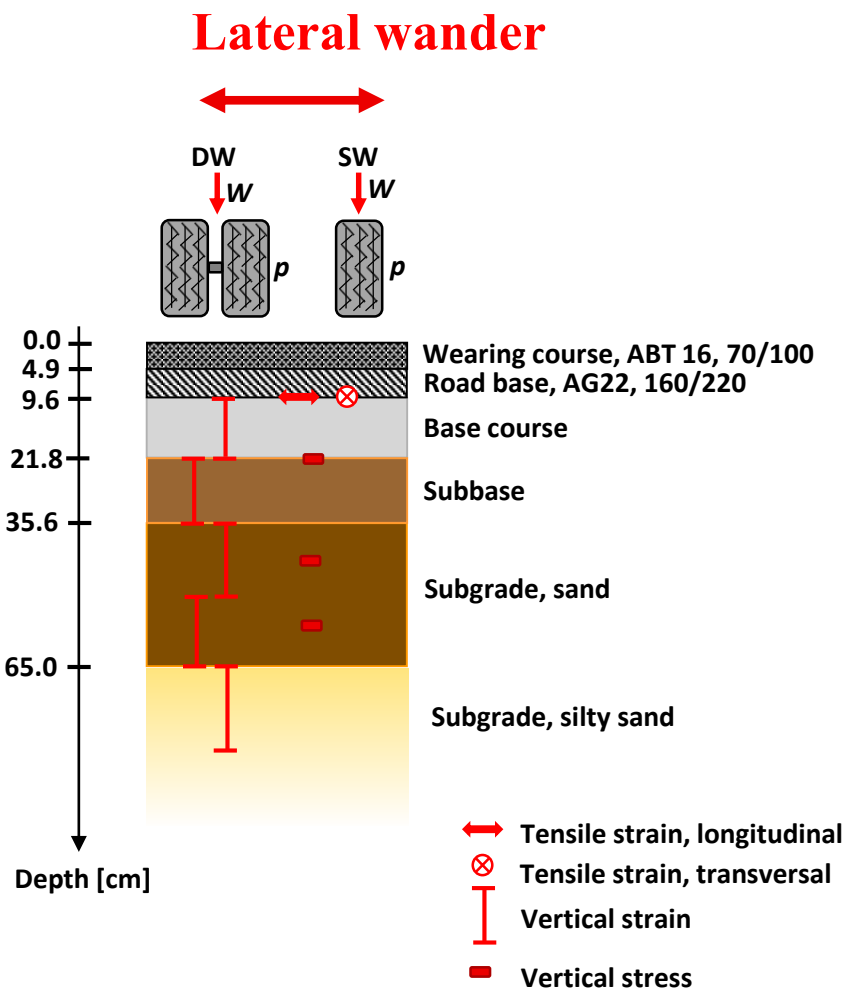
# Construction of a test object #2

# Construction of a test object #3

# Construction of a test object #4

# Construction of a test object #5

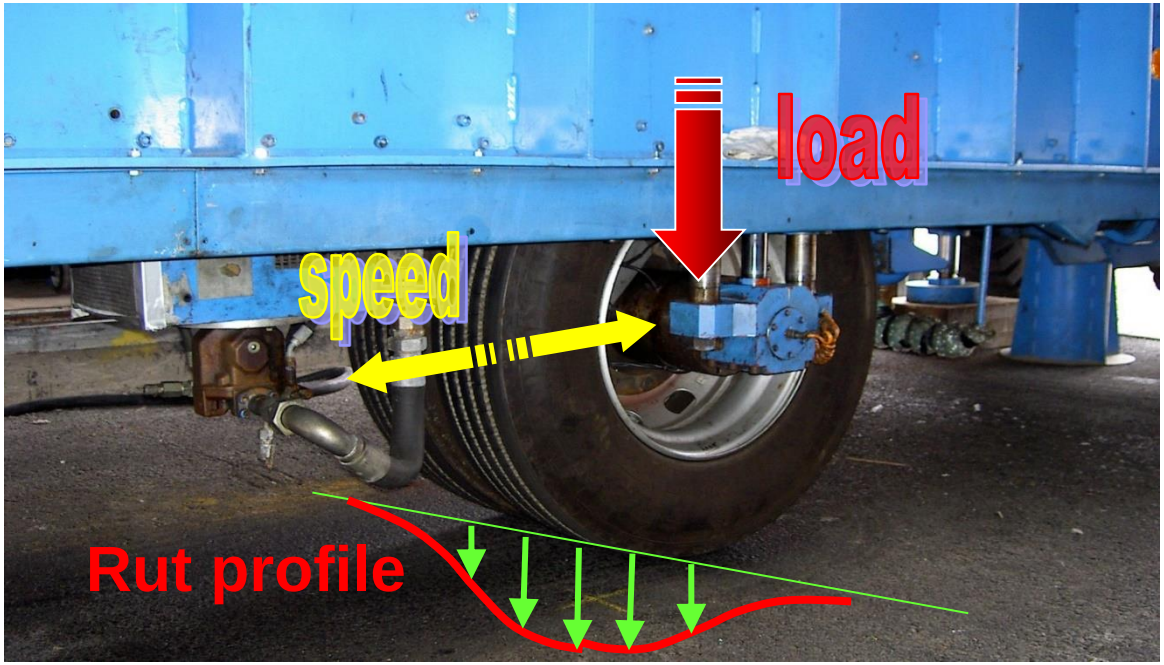
# Tyre configuration




| 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

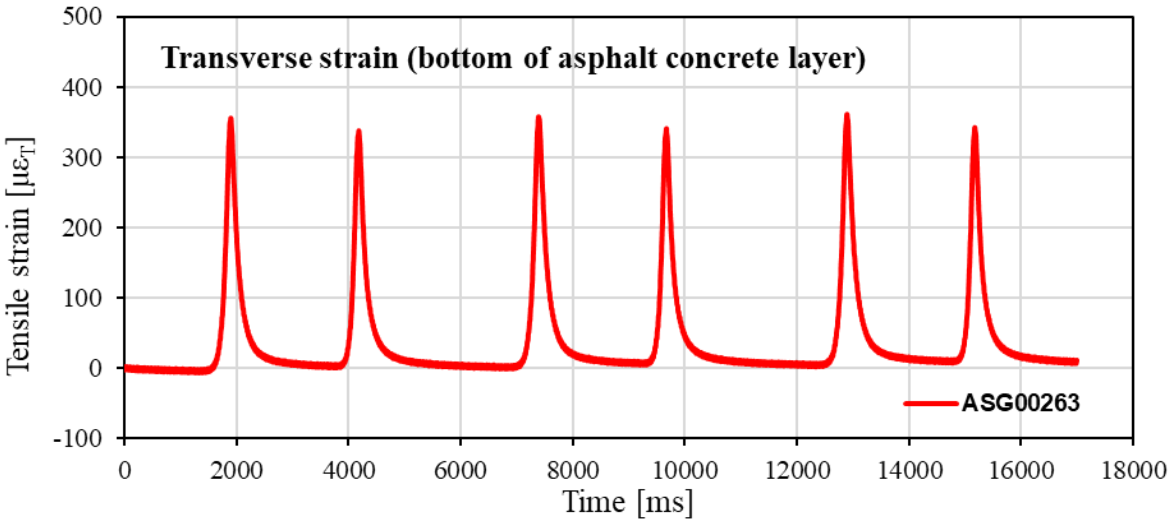
# The response scheme

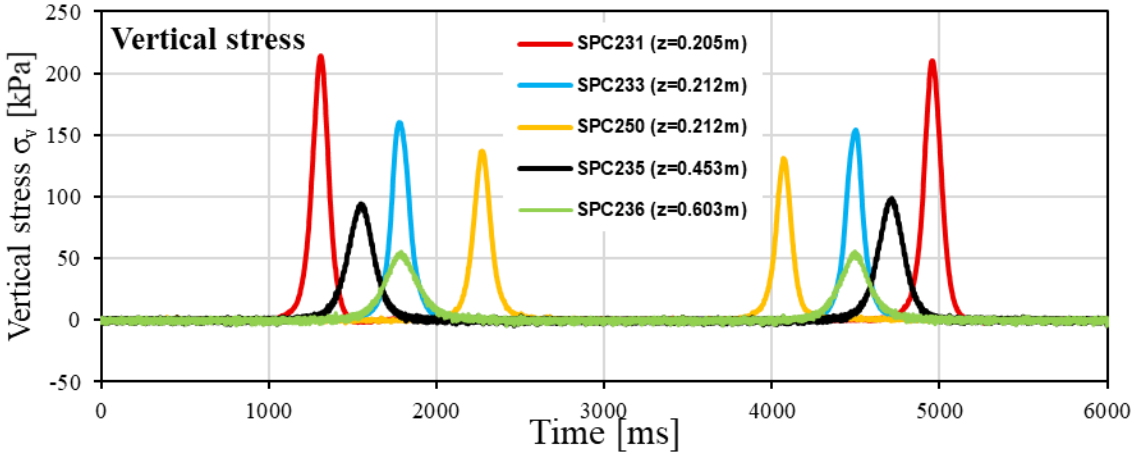


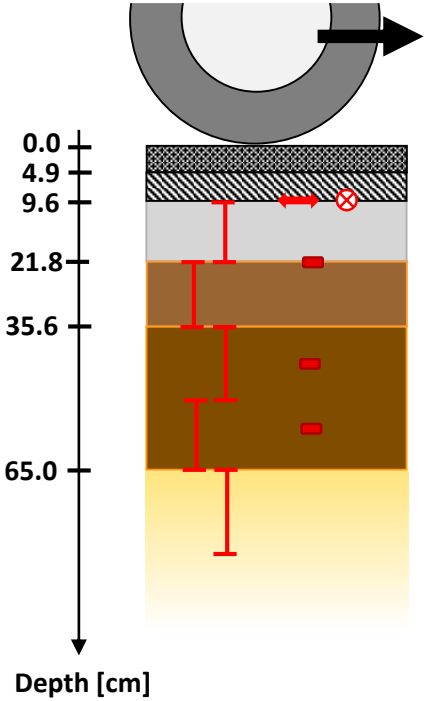

**Temp.: $T$ = 10°C**
**Speed: $v$ = 12 km/h**

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

# Typical response



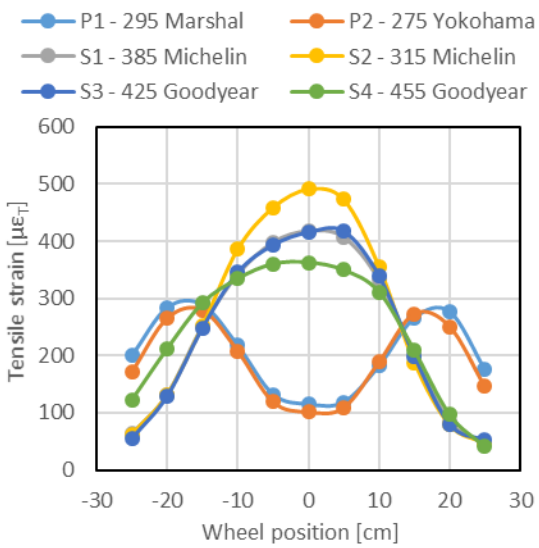



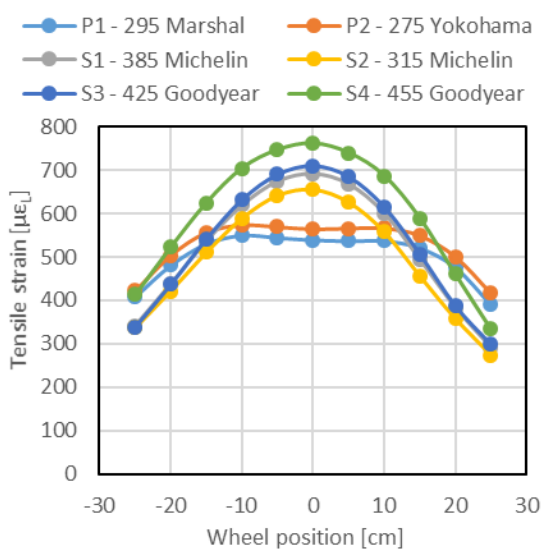



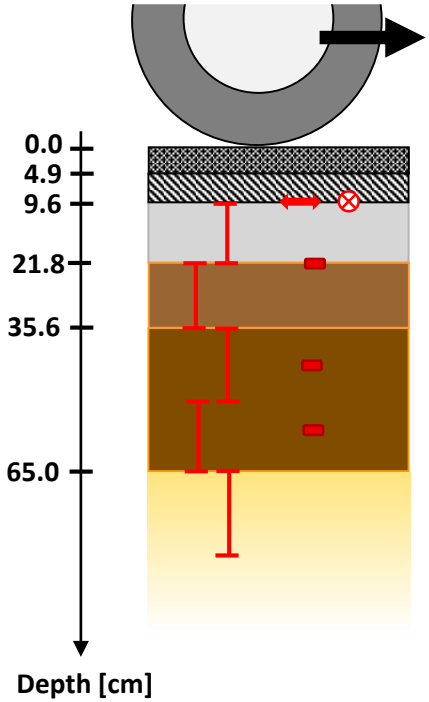
# Response

## Tyre configuration $L_A$= 100 kN & $p$ = 800 kPa

## Tensile strain

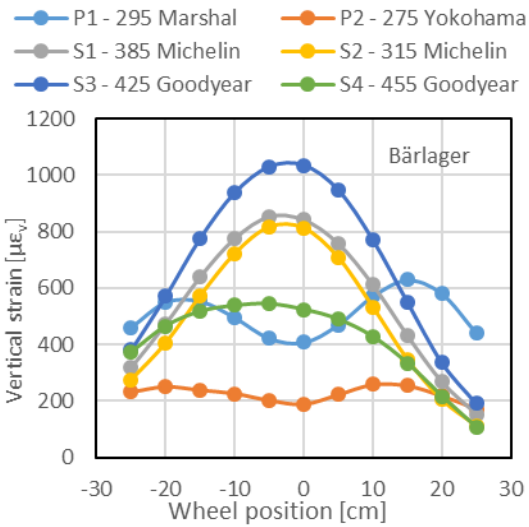


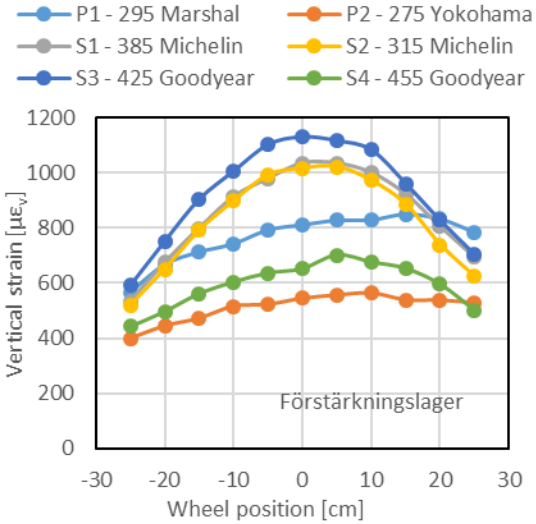



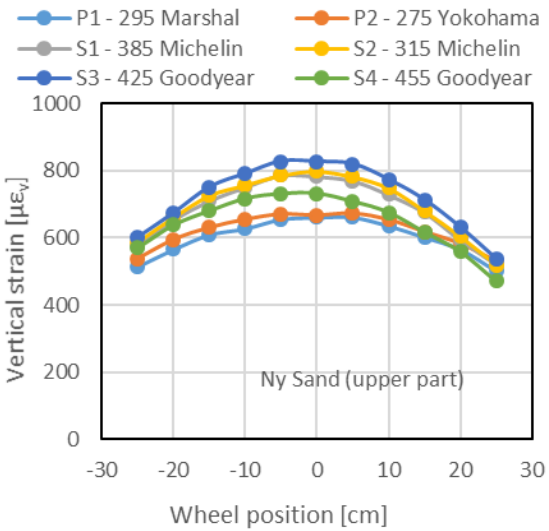



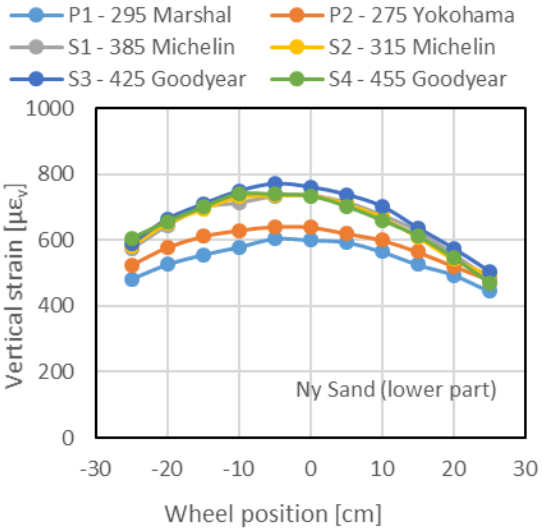
# Response Vertical strain

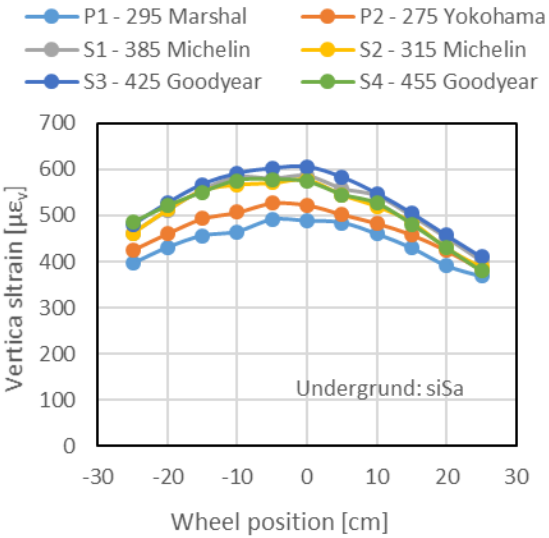
## Tyre configuration $L_A$= 100 kN & $p$ = 800 kPa

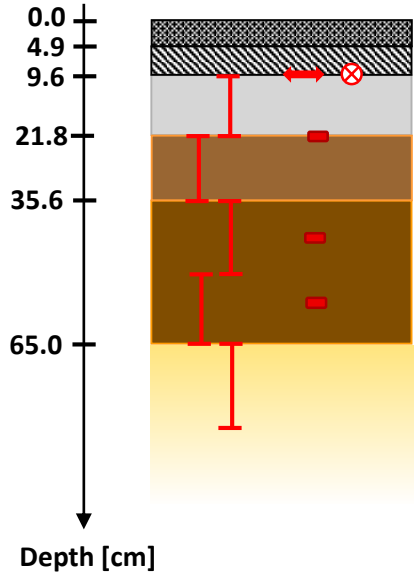


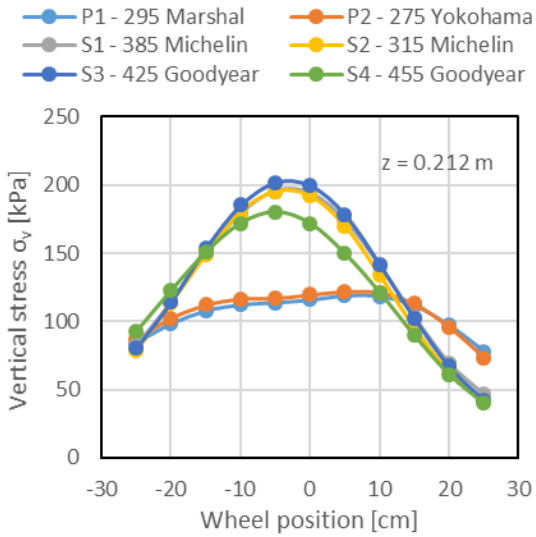



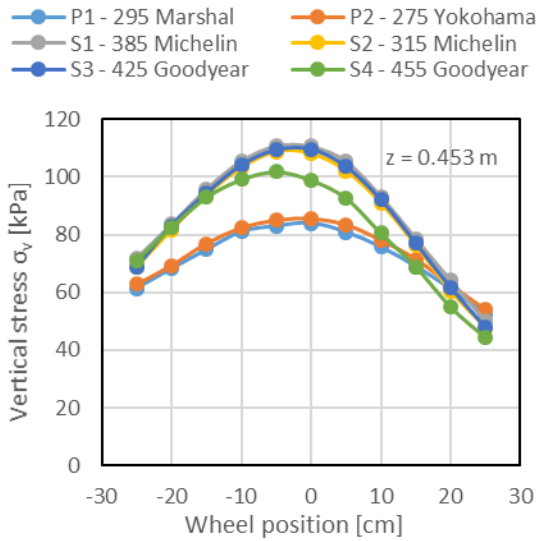



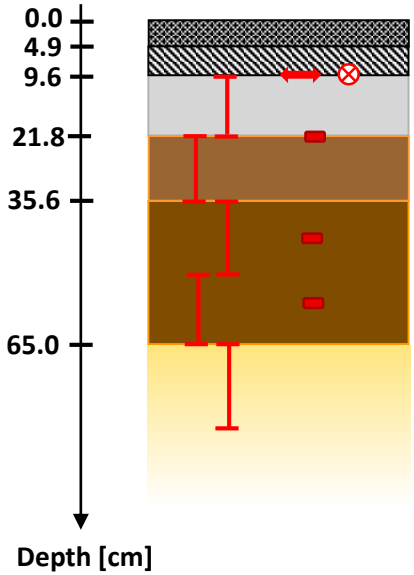
# Response Vertical stress

## Tyre configuration $L_A$= 100 kN & $p$ = 800 kPa

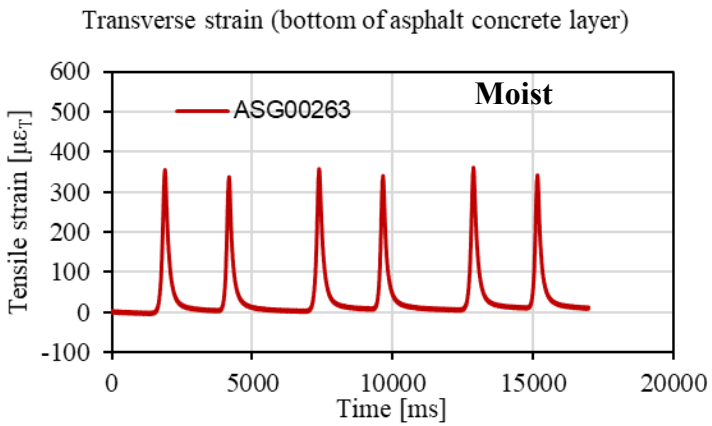


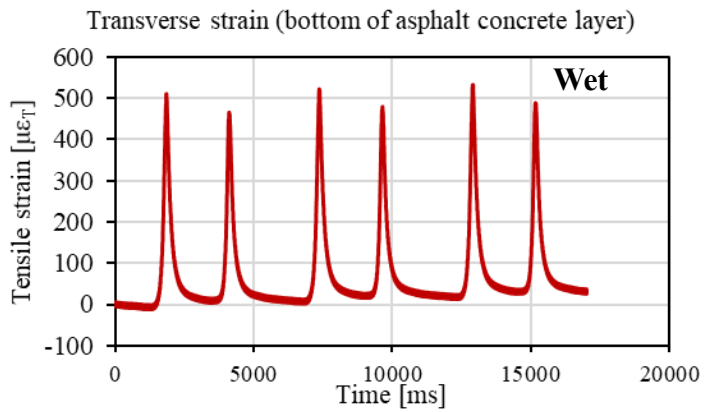



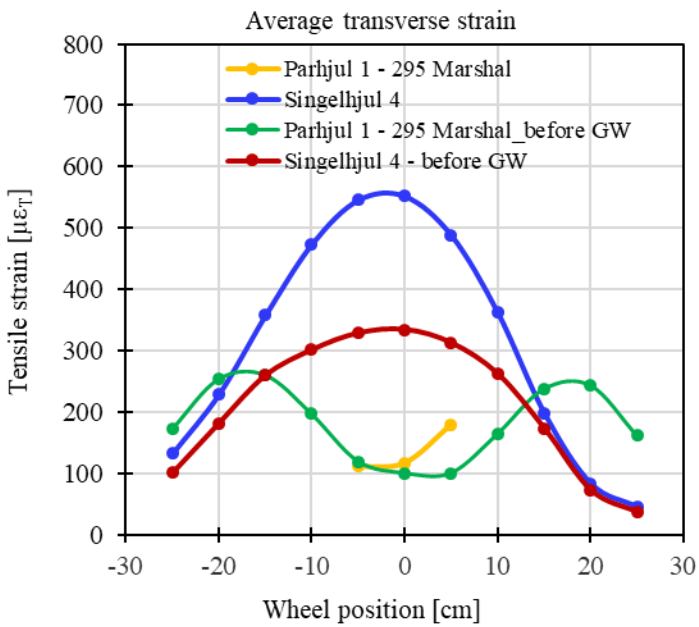


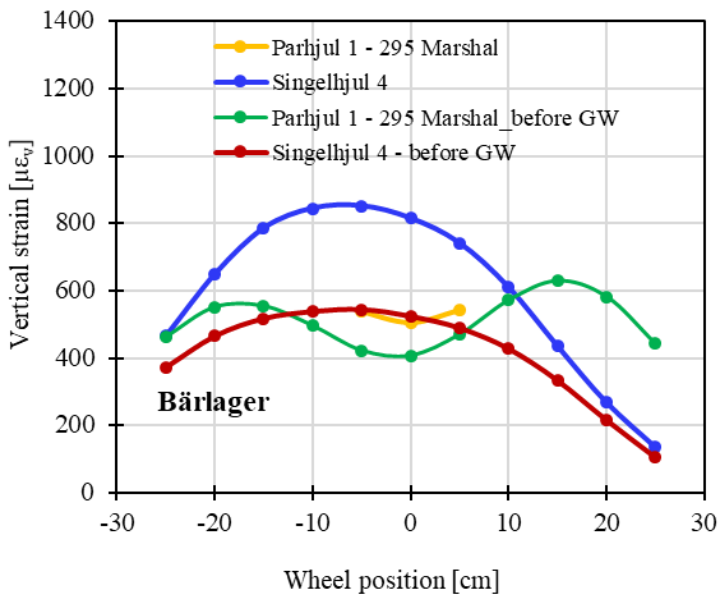


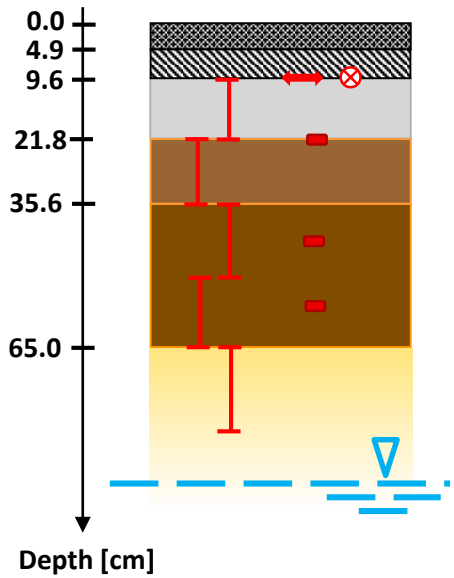
# Moist vs. wet


Transverse strain (bottom of asphalt concrete layer)
Moist
ASG00263
Tensile strain [με_T]
Time [ms]


Transverse strain (bottom of asphalt concrete layer)
Wet
Tensile strain [με_T]
Time [ms]


Average transverse strain
Parhjul 1 - 295 Marshal
Singelhjul 4
Parhjul 1 - 295 Marshal_before GW
Singelhjul 4 - before GW
Tensile strain [με_T]
Wheel position [cm]

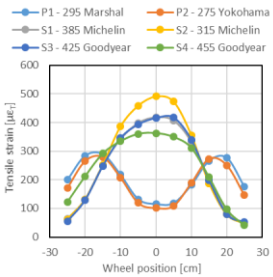

Parhjul 1 - 295 Marshal
Singelhjul 4
Parhjul 1 - 295 Marshal_before GW
Singelhjul 4 - before GW
Bärlager
Vertical strain [με_v]
Wheel position [cm]

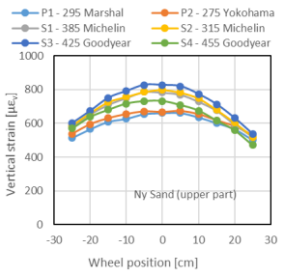

0.0
4.9
9.6
21.8
35.6
65.0
Depth [cm]

# Distress development

**Design criteria according to MPS Objekt:**

| Tensile strain | Permanent deformation |
|---|---|
| $N_f = k_1 \cdot \varepsilon_t^{-4}$ | $N_f = k_2 \cdot \varepsilon_v^{-4}$ |

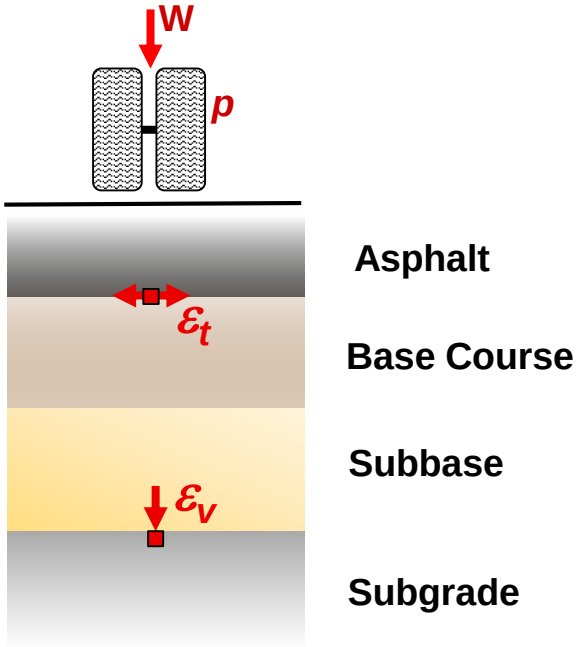



**For the standard axle loading case:**

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

| | Tensile strain $\varepsilon_t$ [με] | Vertical strain $\varepsilon_v$ [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

**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 $\varepsilon_t$, vertical strain $\varepsilon_v$ & vertical stress $\sigma_v$. The difference decreases with depth.**
- **As the tyre width increases the response generally decreases.**
- **The response increase ($\varepsilon_t$, $\varepsilon_v$ & $\sigma_v$) as the water table is raised.**

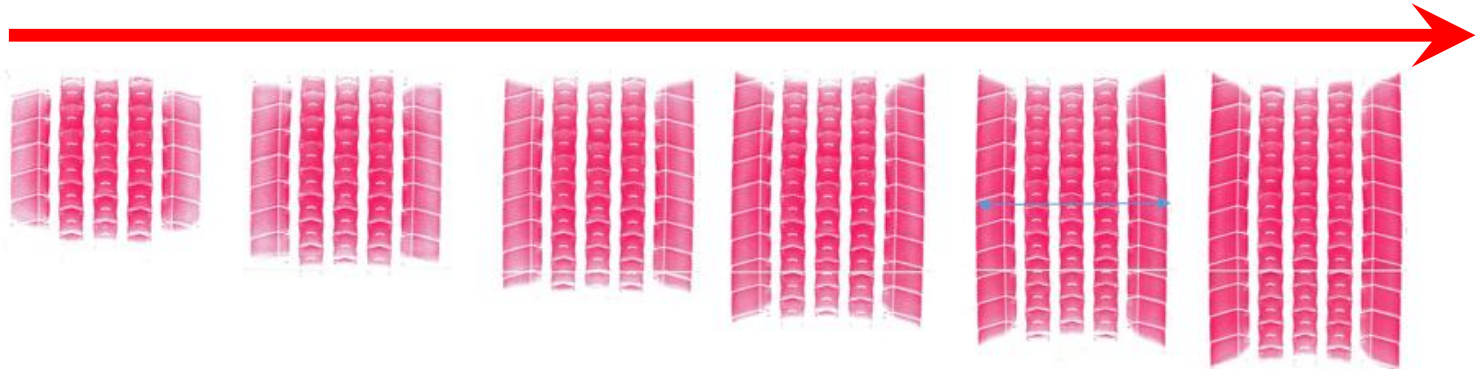
**Note that this is only based on one thin pavement structure that has been tested.**

# Thanks
# &
# Questions?

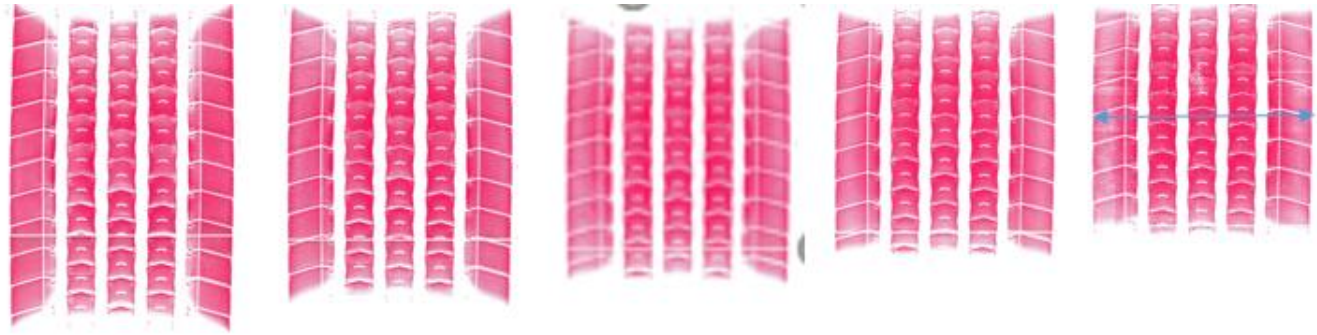
# Tyre footprint measurements

- 315/80R22.5

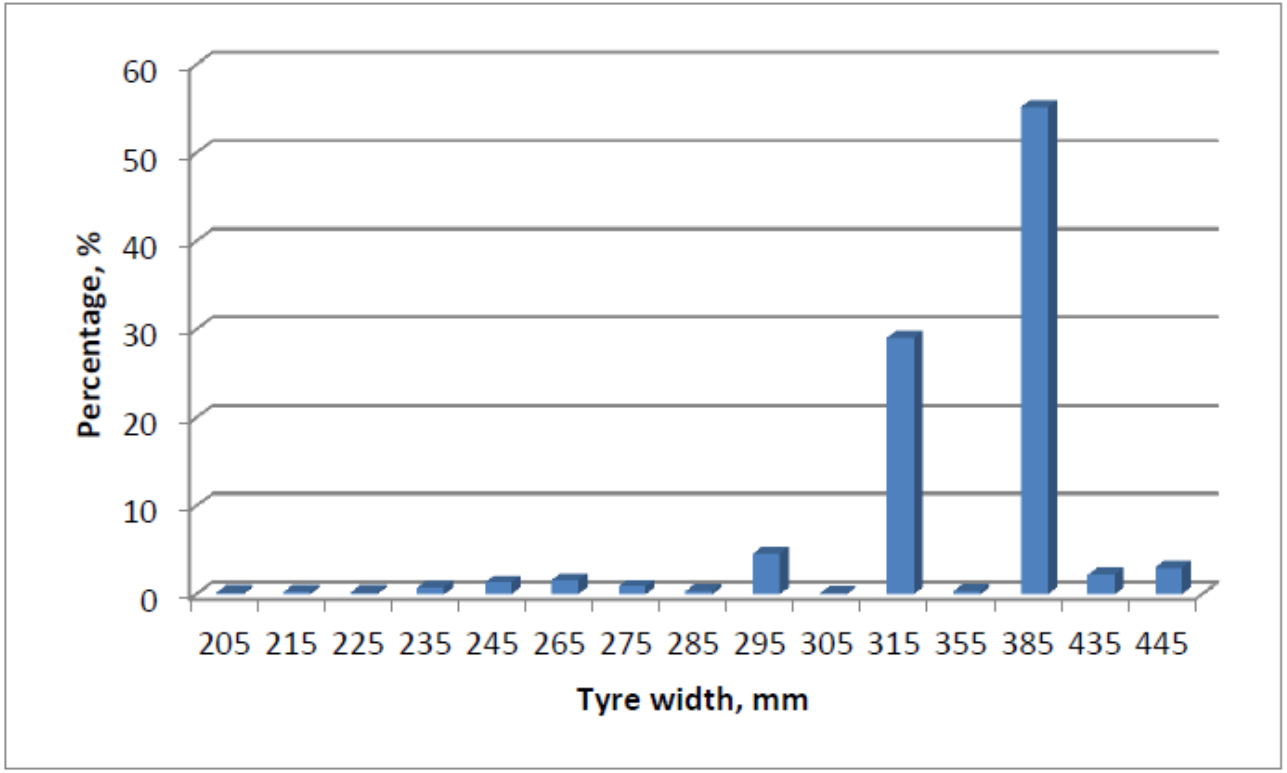
**Wheel load increased from 50 kN to 80 kN @ 800kPa**



**Tire pressure increased from 500 kPa to 950 kPa @ 80kN**



# Selection of tyre types




*Distribution of tyre widths – Nordic survey*

**Blokland & Berge, 2014, Tire Selection for NordTyre Part3, SINTEF**