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TALLINNA TEHNIKAÜLIKOOL  
TALLINN UNIVERSITY OF TECHNOLOGY

***An investigation on remould  
passenger car tyre handling  
and traction properties  
based on road tests***

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# Presentation content:

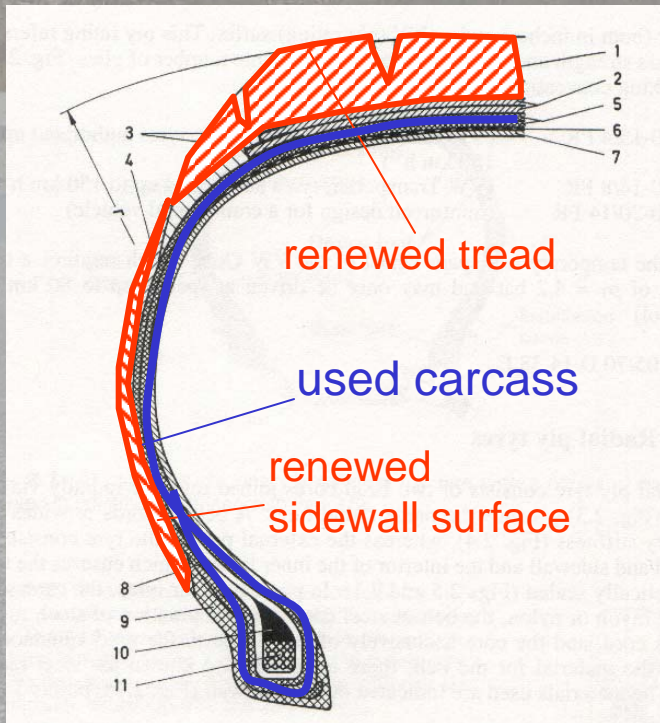
- **The product development problems of the remould tyre production**
- **An overview of the traction test results**
- **The method of determination of the tyre handling properties during road tests**
- **Measuring equipment**
- **Future studies**



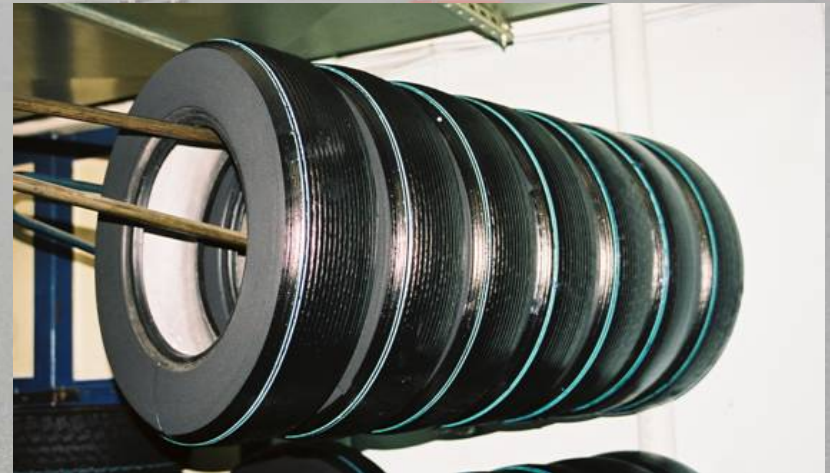
# Remould tyre in general

Tyre remoulding (retreading) means the generic term for reconditioning a used tyre by replacing the worn tread with new material. For passenger car tyre it also includes renovation of the outermost sidewall surface (“bead to bead” process).

[ECE Regulation No. 108]



Tyre construction



Tyres before reconditioning

# *The product development problems on remould tyre production*

- ***Determination the traction characteristics between tyre and road on different road conditions and comparison with new and used tyres***
- ***Tyre noise level and rolling resistance evaluation and comparison with new and used tyre construction models***
- ***The choise of effective method to evaluate tyre handling properties for safety reasoned selection of tyre carcasses for the remould tyre production***

***The comparison tests of tyres on different local road conditions are the initial solutions***

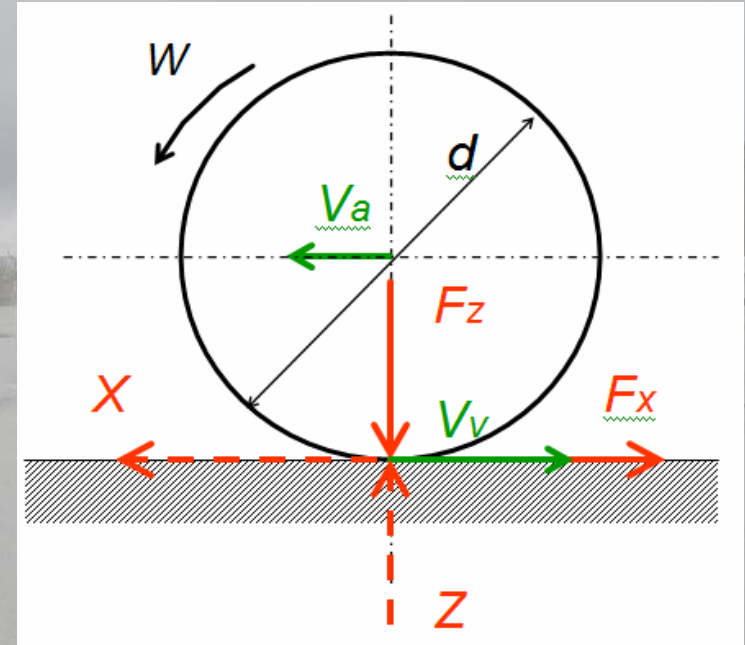
# Overview of the longitudinal traction test results

The longitudinal traction between the rolling tyre and road surface is described by the coefficient of longitudinal traction  $\varphi_x$

$$\varphi_x = \frac{F_x}{F_z}$$

*The maximum value of  $\varphi_x$  depends on:*

- road properties (adhesion, boundary layer deformation, abrasive interaction)
- longitudinal slip rate of the tyre
- tyre construction properties (rubber hardness and visco-elastic properties, tread design, vertical stiffness of the carcass)



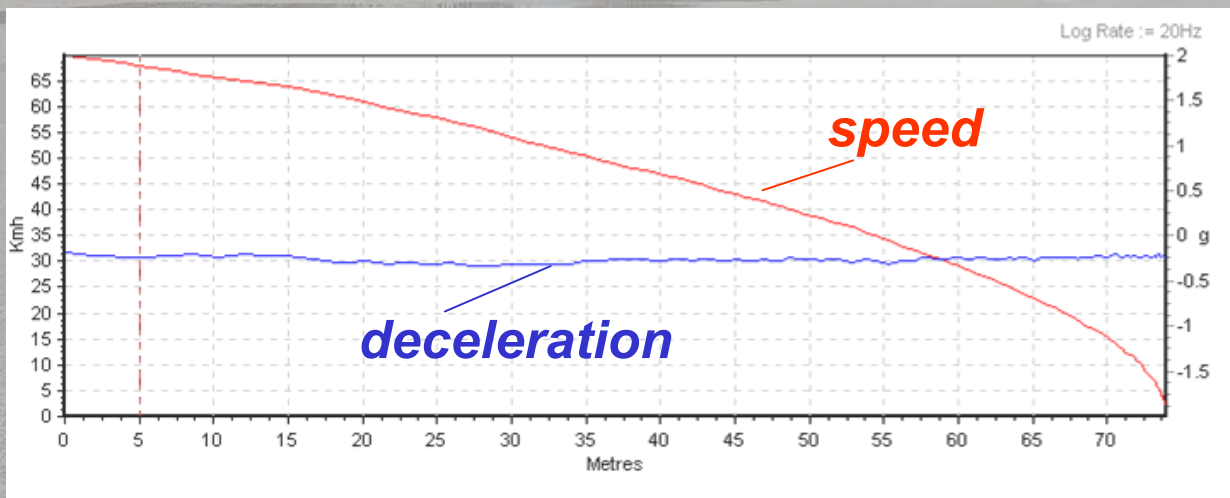
Loads on tyre and road contact surface

$$\varphi_x = f(P_{road1} \dots P_{roadN}, S_x, P_{tyre1}, \dots, P_{tyreN})$$

# Overview of the longitudinal traction test results

$$\varphi_x = \frac{F_x}{F_z} = \frac{j_x}{g}$$

The longitudinal coefficient of traction is determined also by deceleration  $j_x$  during the braking test.



$$S_p = \frac{V_a^2}{2 \cdot 3,6^2 \cdot g \cdot \varphi_x}$$

Braking distance  $S_p$  (m)

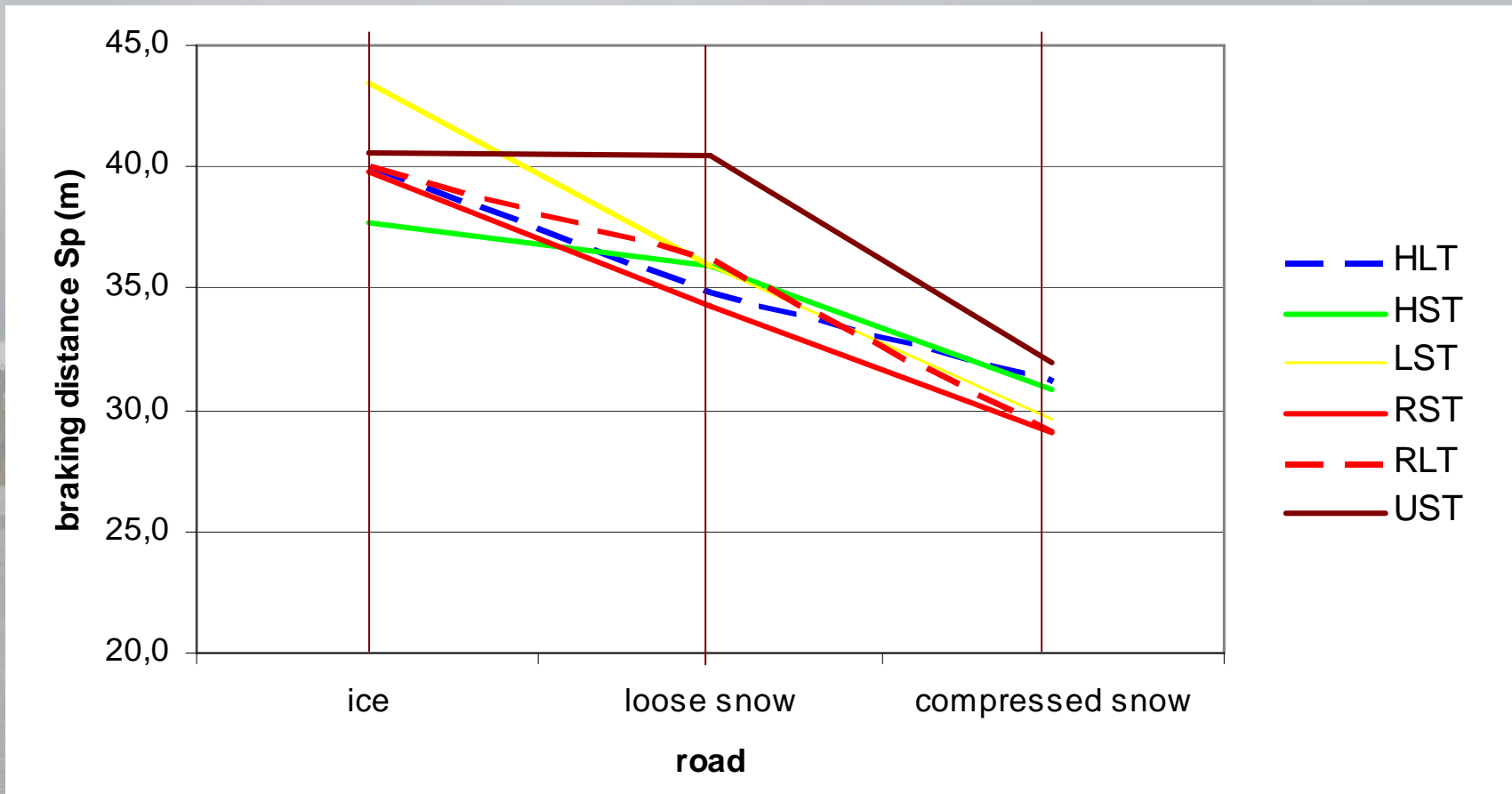
$V_a$  vehicle speed (km/h)

$g$  constant of gravity

The dependence of speed and deceleration on braking distance.

Note: An applying time of brakes and growing time of deceleration are not observed because these depend on the test vehicle braking system

# Overview of the longitudinal traction test results



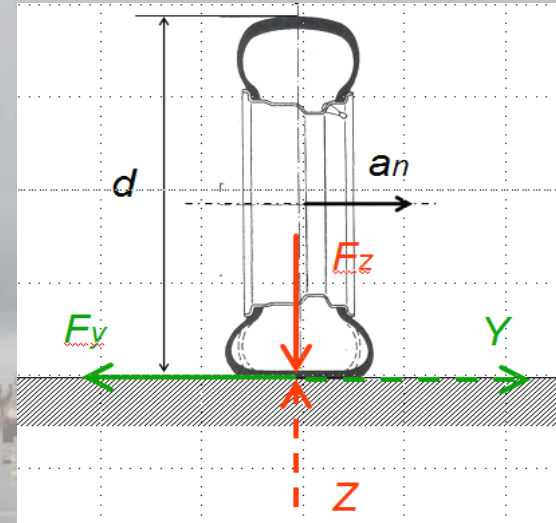
Braking distances  $S_p$  (m) of sets of six different winter tyres with the size 195/65 R15. HLT-studdless tyre, HST-studded tyre 1, LST-studded tyre 2, **RST – remould studded tyre**, **RLT- remould studdless tyre**, UST- used studded tyre

The remould wintertyres, especially studded tyres, have comparable longitudinal traction characteristics with new wintertyres.

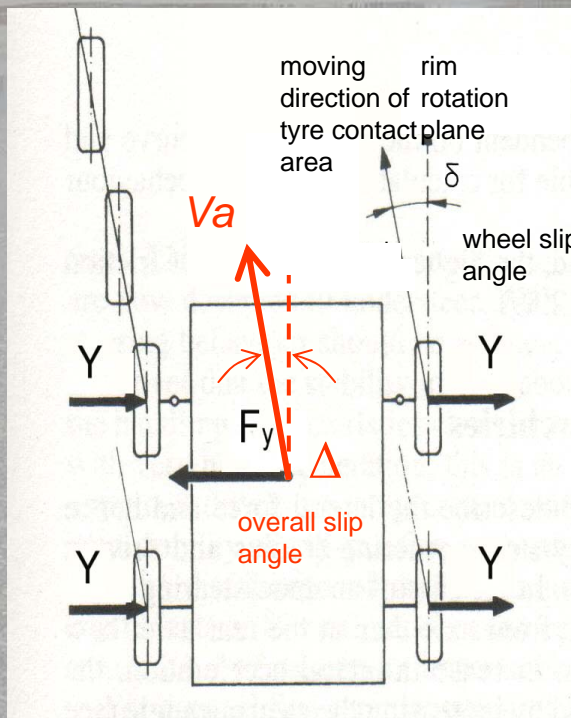
# Overview of the lateral traction test results

The lateral traction between the rolling tyre and road surface is described by the coefficient of lateral traction  $\varphi_y$

$$\varphi_y = \frac{F_y}{F_z}$$



Loads on tyre and road contact surface



Slip angle generation principle

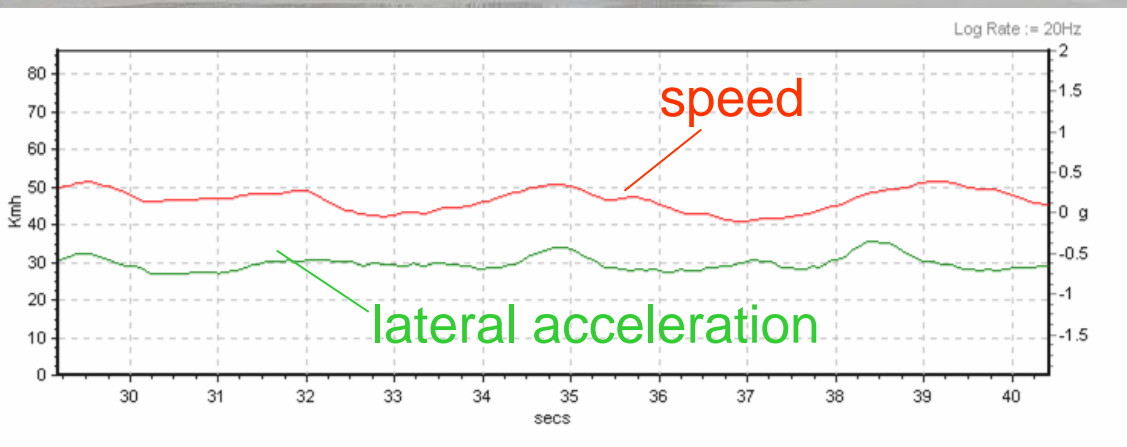
*The maximum value of  $\varphi_y$  depends on:*

- road properties
- tyre construction properties
- slip angle

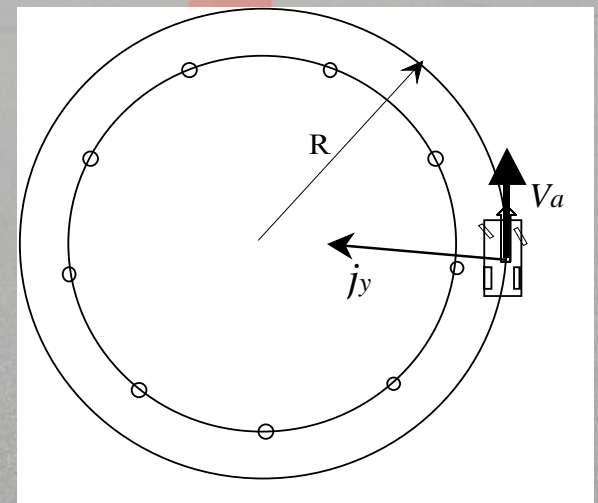
# Overview of the lateral traction test results

$$\phi_y = \frac{F_y}{F_z} = \frac{j_y}{g} = \frac{V_a^2}{R \cdot g}$$

The longitudinal coefficient of traction is determined also by lateral acceleration  $j_y$  during the skidpad test.

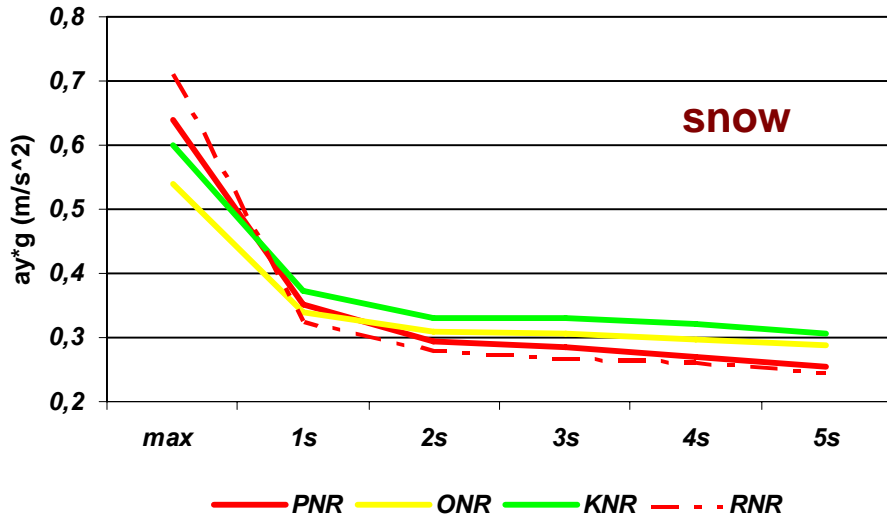


The dependance of speed on lateral acceleration on time.

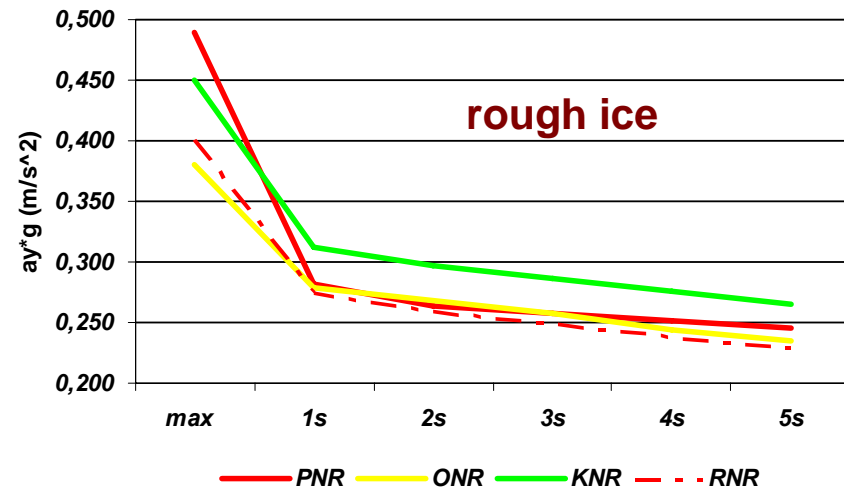
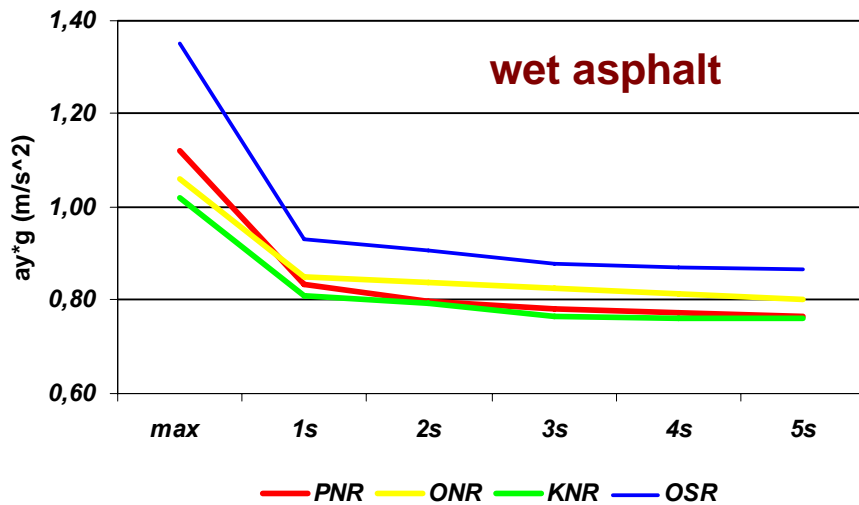


During the skidpad test vehicle is driven around circle in the limits of lateral traction

# Overview of the lateral traction test results

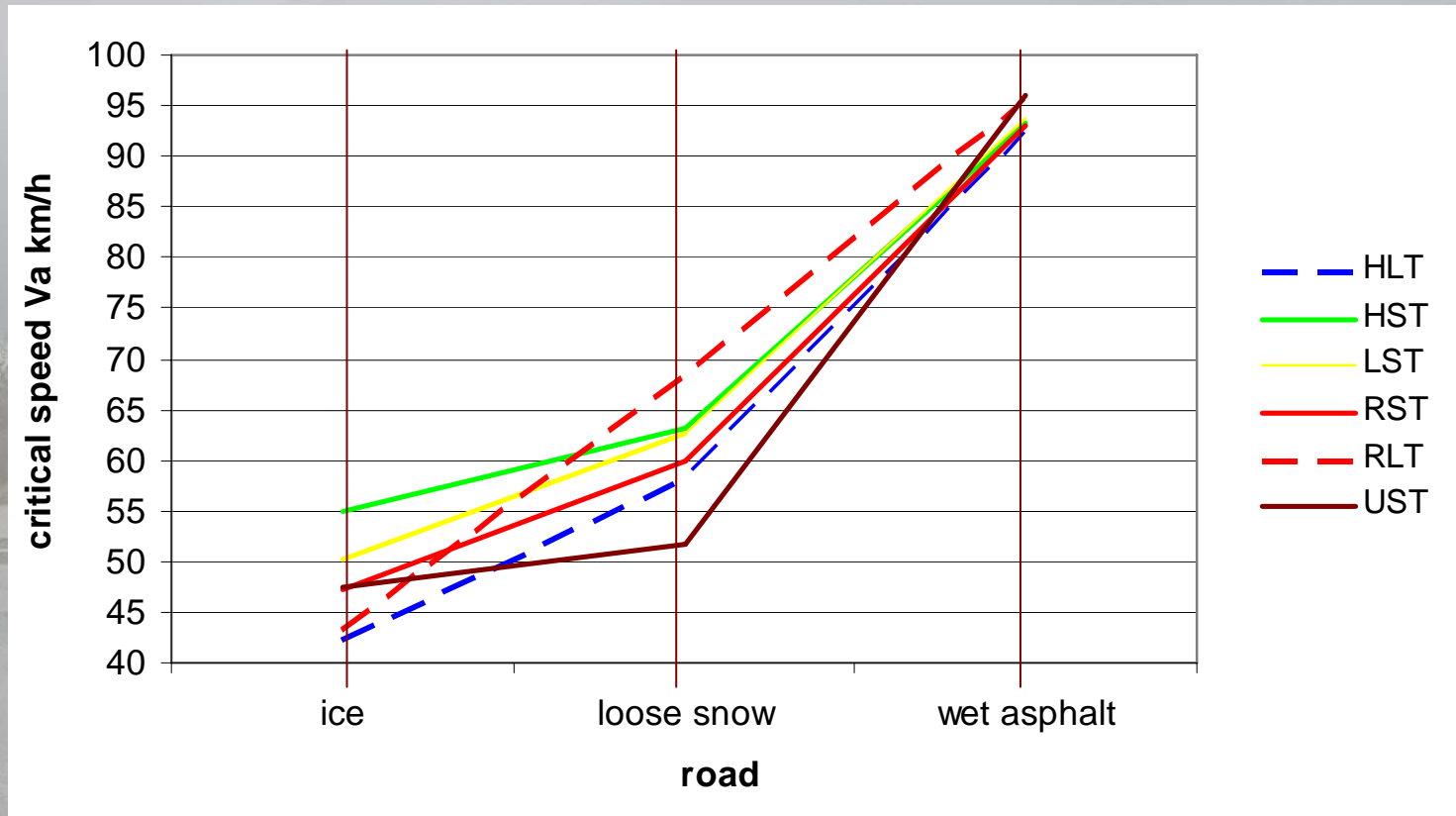


Lateral acceleration  $j_y$  values during skidpad test using different winter tyre sets with the size 205/55 R16. ONR-studded tyre 1, KNR-studded tyre 2, PNR – remould studded tyre, OSR- summertyre



Remould wintertyres especially studded tyres have comparable maximum lateral traction characteristics. The real driving characteristics of these tyres are moderate

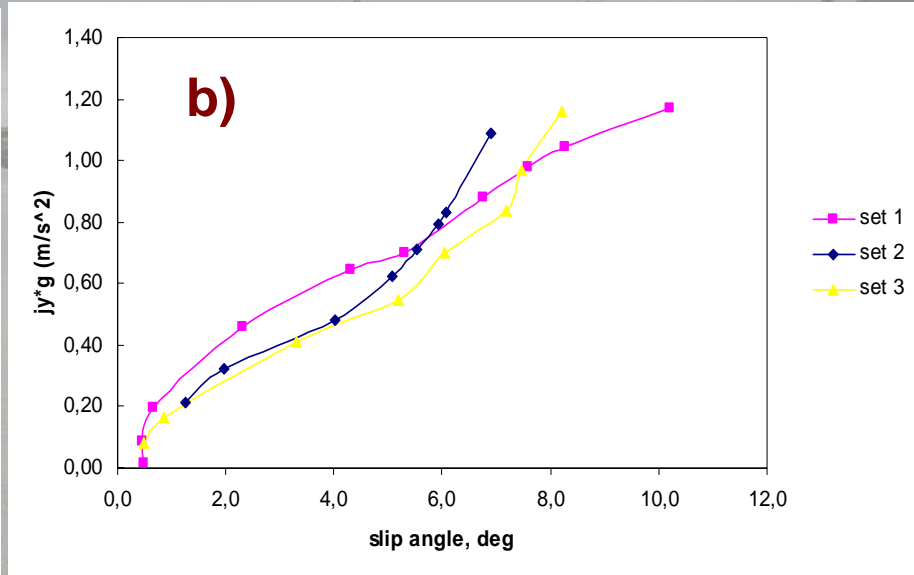
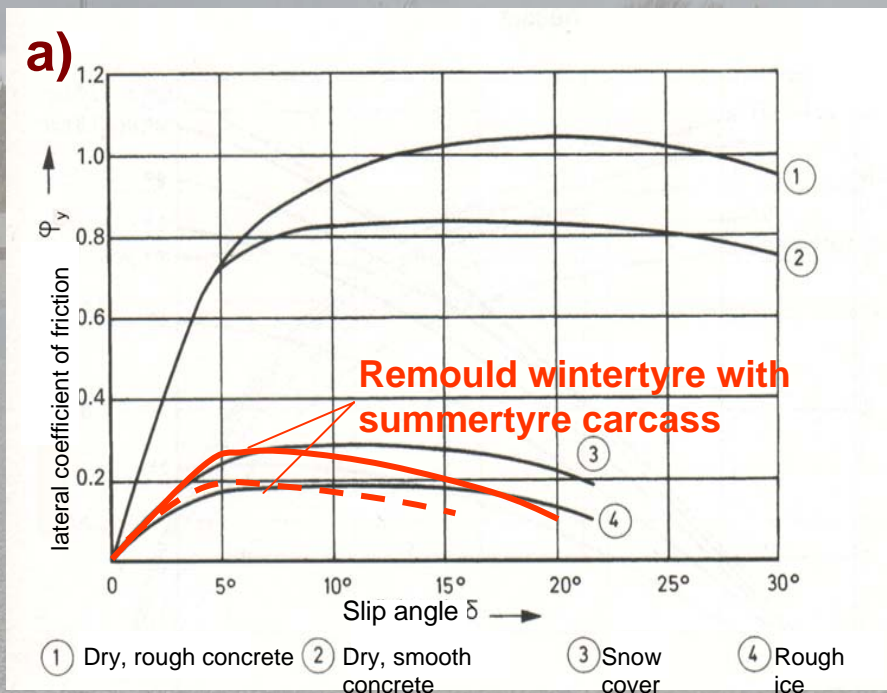
# Overview of the lateral traction test results



Critical speed  $V_a$  km/h on constant 100m radius turn using six different winter tyre sets with the size 195/65 R15. HLT-studdless tyre, HST-studded tyre 1, LST-studded tyre 2, **RST – remould studded tyre**, **RLT-remould studdless tyre**, UST- used studded tyre

# Determination of the tyre handling properties during road tests

The relation between lateral coefficient of friction and slip angle (cornering stiffness) measured with rolling road test rig a) and road test b)



Cornering stiffnesses of three sets of different summertyres (195/65 R15) on wet asphalt road

The use of summertyre carcass for the remould wintertire production restricts the lateral traction potential of these tyres due to inconvenient car handling properties

# Measuring equipment

For measuring the instantaneous speed, distance and longitudinal and lateral acceleration and yaw rate the non-contact GPS-based device Racelogic VBOX is used.



Units	Resolution	Accuracy
velocity	0.01 kmh	0.1 kmh*
distance	1 cm	0.05%
Long. Accel.	0.01 g	0.5%
Lateral accel.	0.01 g	0.5%
time	0.001 s	0,01 s

## *Future studies*

- The correlation analyses of the road test data and the data from the tyre test rig.
- The evaluation of relationship between steering angle and the heading response during the skidpad and line-change tests
- Modelling and evaluation of the standard handling test data (CarMaker, Lotus Vehicle Simulation software)
- The evaluation of relationship between the self-aligning torque of steering wheel and lateral force of different tyre carcasses.

The main aim of the optimization of the carcass selection for remould tyres is the safety aspect of unification of the handling properties of certain model of remould tyre.



*Thank You for Your attention!*

