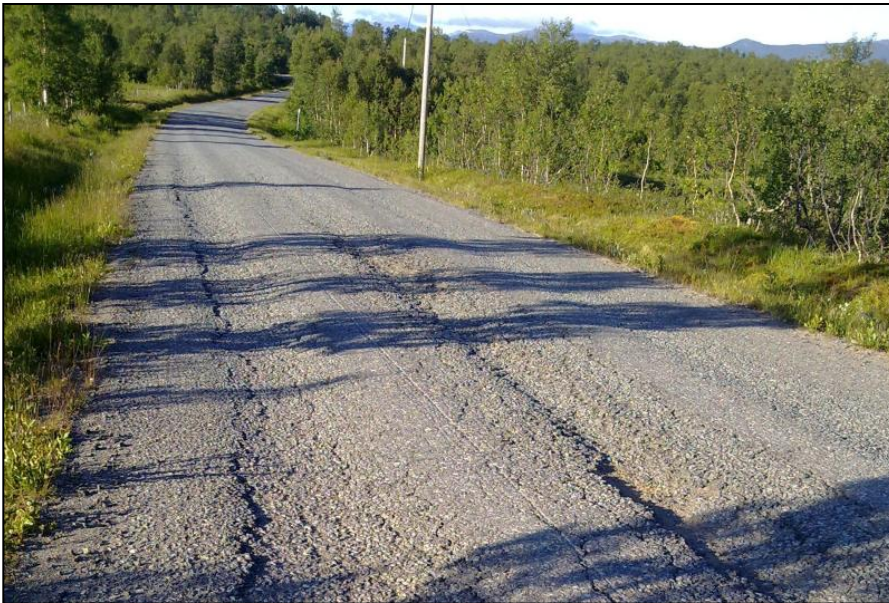


# ROADEx

Implementing Accessibility

## ROADEx eLearning Package: Permanent Deformation



**Timo Saarenketo, PhD**  
**Roadscanners Oy**

# Contents:

1. What is Permanent Deformation
2. Stresses and Strains in and under the Road Structure
3. Rutting Classification
4. Survey Techniques
5. Analysis and Diagnostics
6. Design Against Permanent Deformation
7. Managing Permanent Deformation
8. Cases





# The Problem: Current Design and Dimensioning Methods are Made for High Traffic Volume Roads

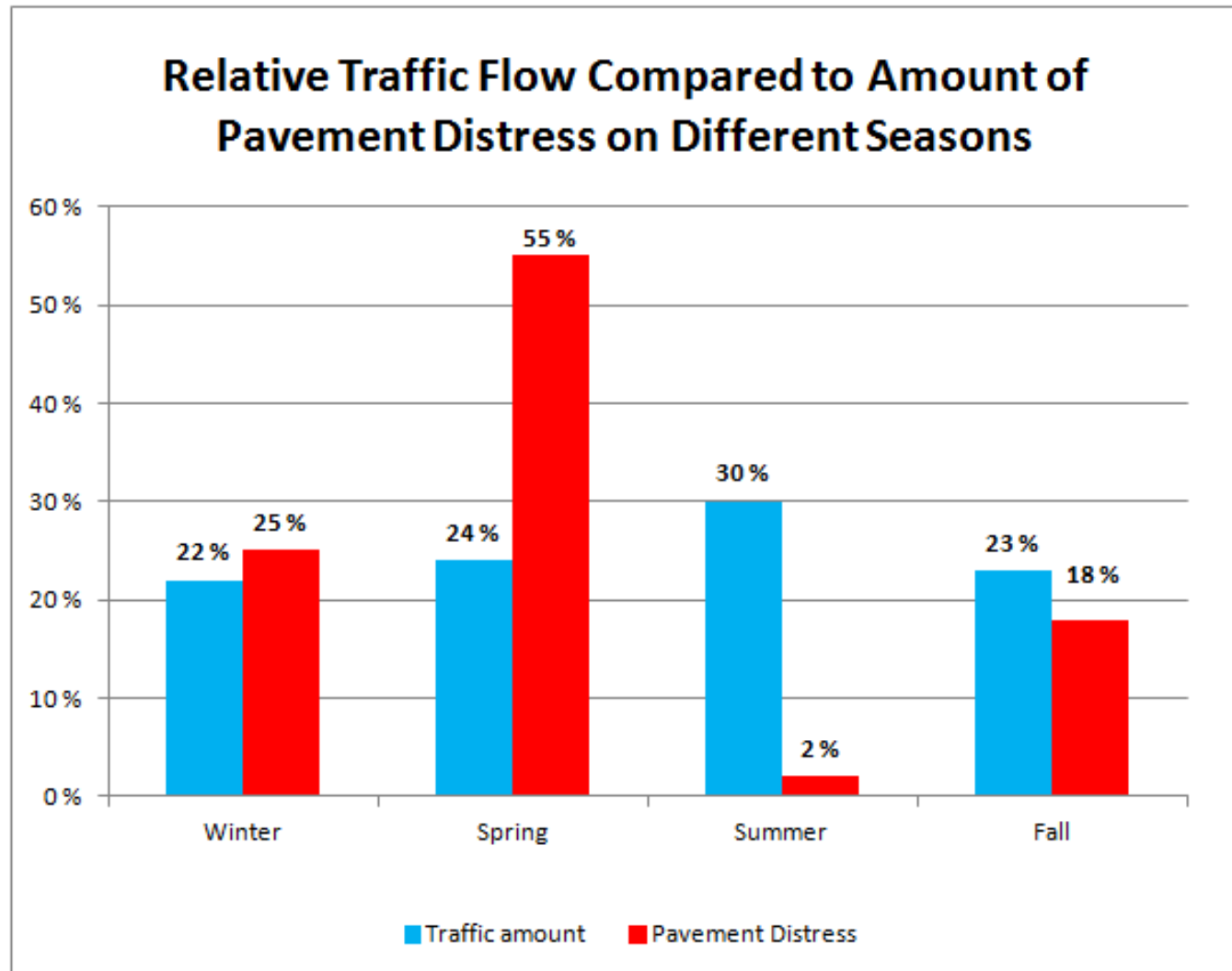


Permanent deformation

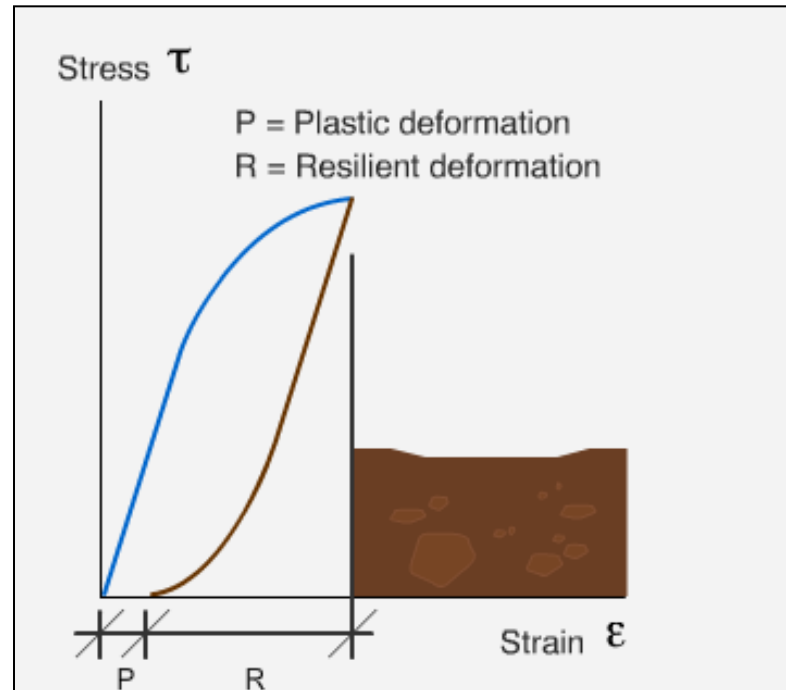
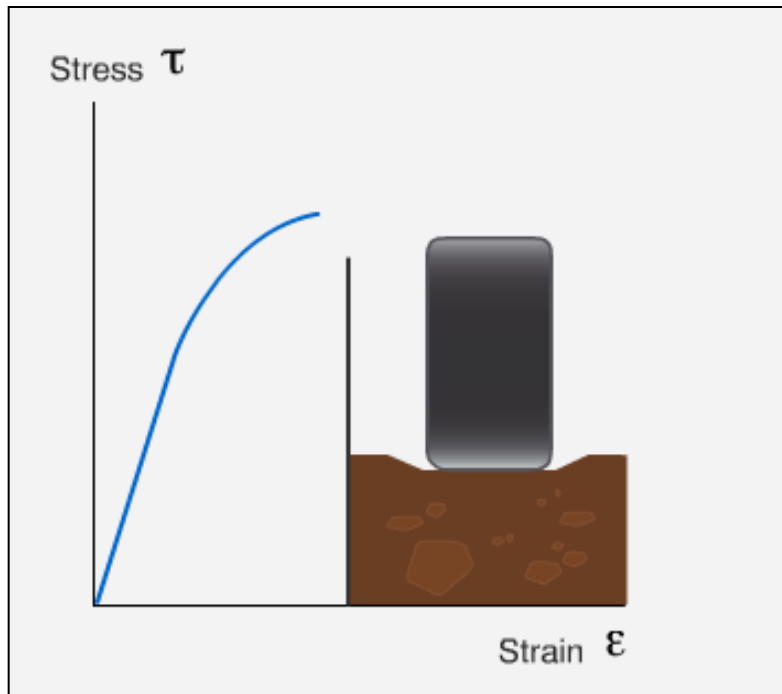


Elastic response

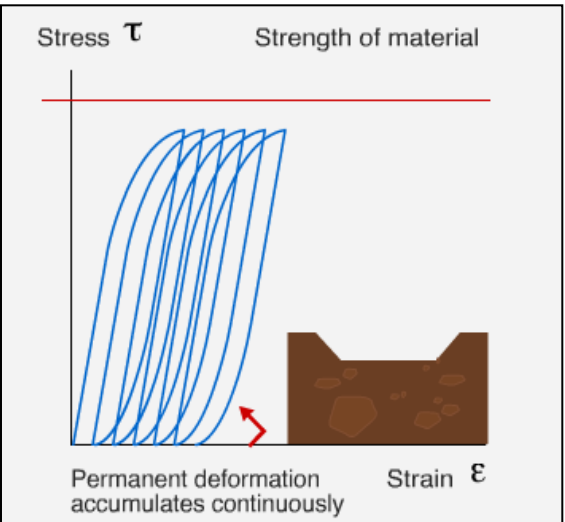
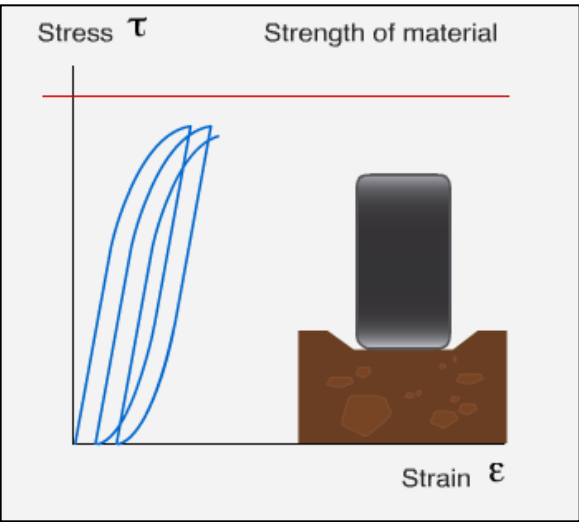
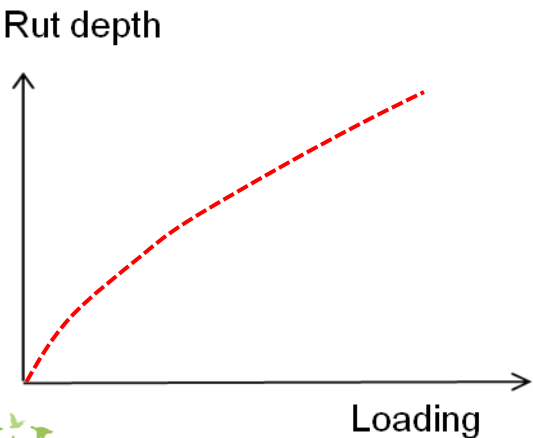
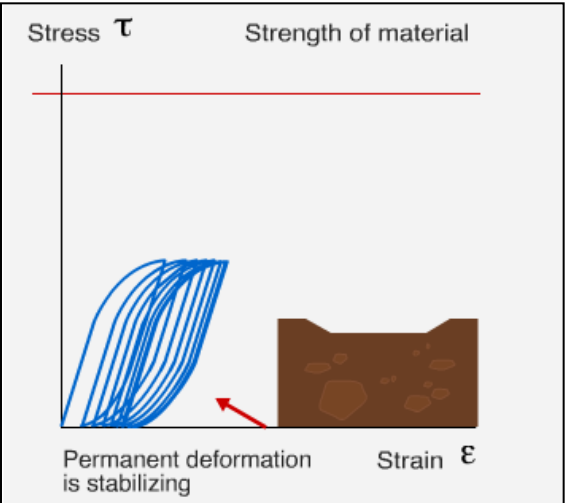
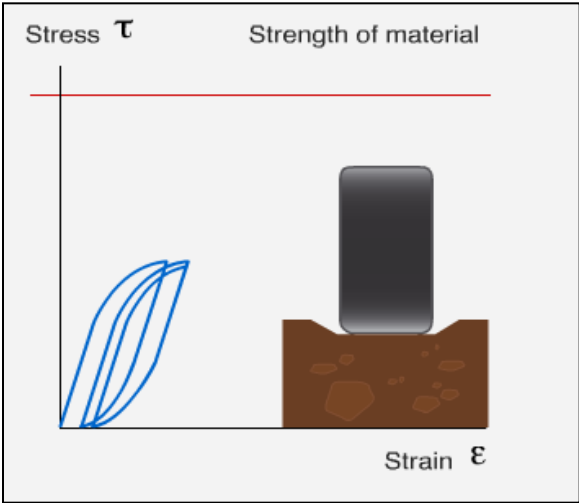
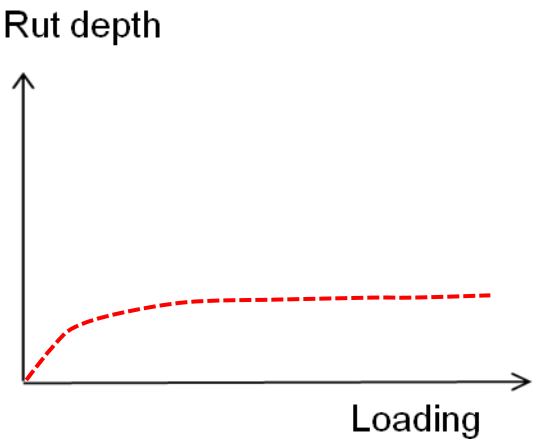
## Challenge: Understanding and Managing Seasonal Changes and Permanent Deformation in Road Deterioration



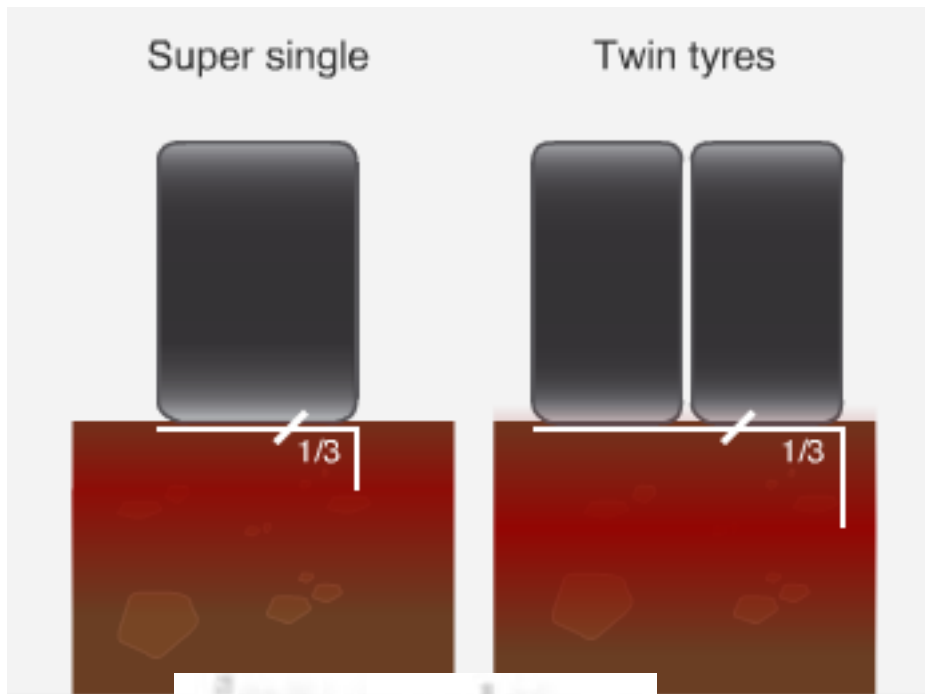
# What is Permanent Deformation



# Permanent Deformation and Repeated Loading



# Effect of Tyre Types to Stresses and Strains in Pavement Structure



Dual



Maxi



Super Single



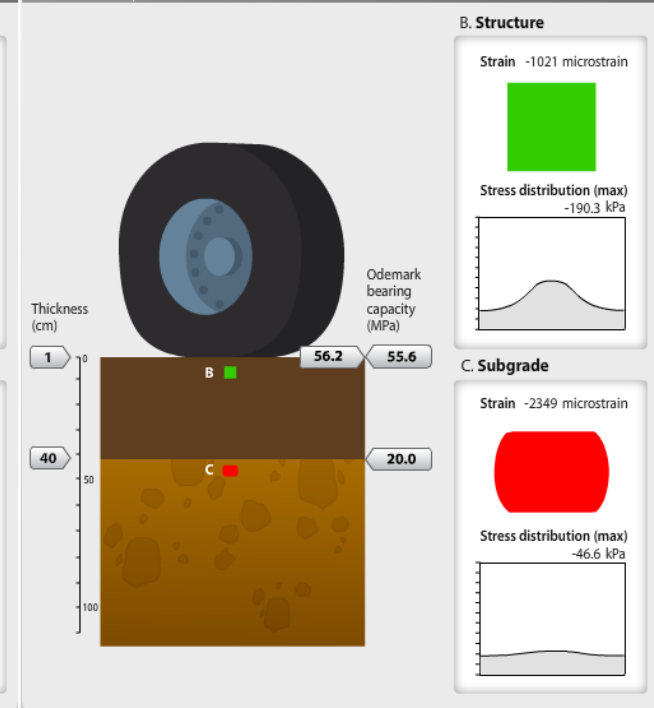
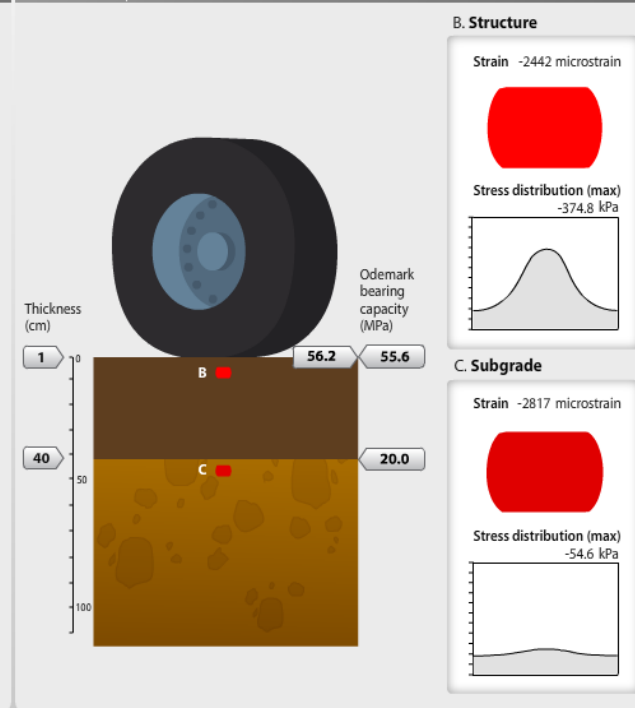
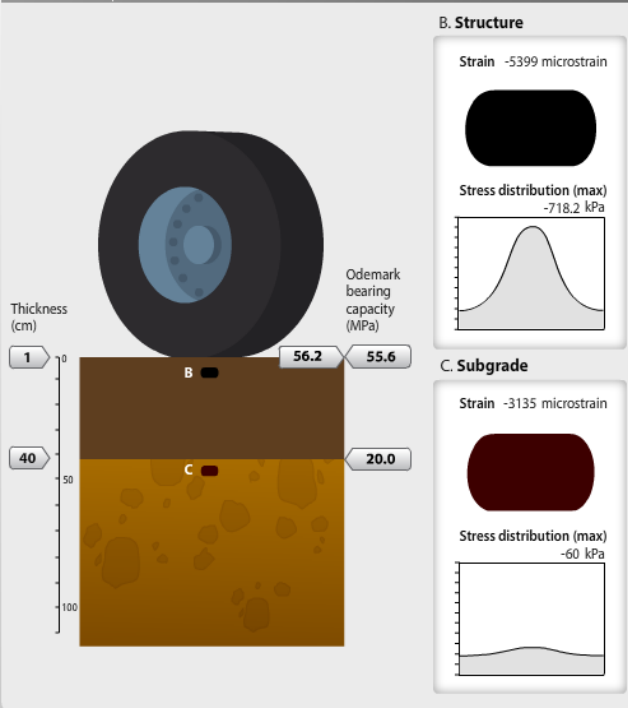


# The Effect of Tyre Pressure Control System (TPCS / CTI) to Stresses and Strains

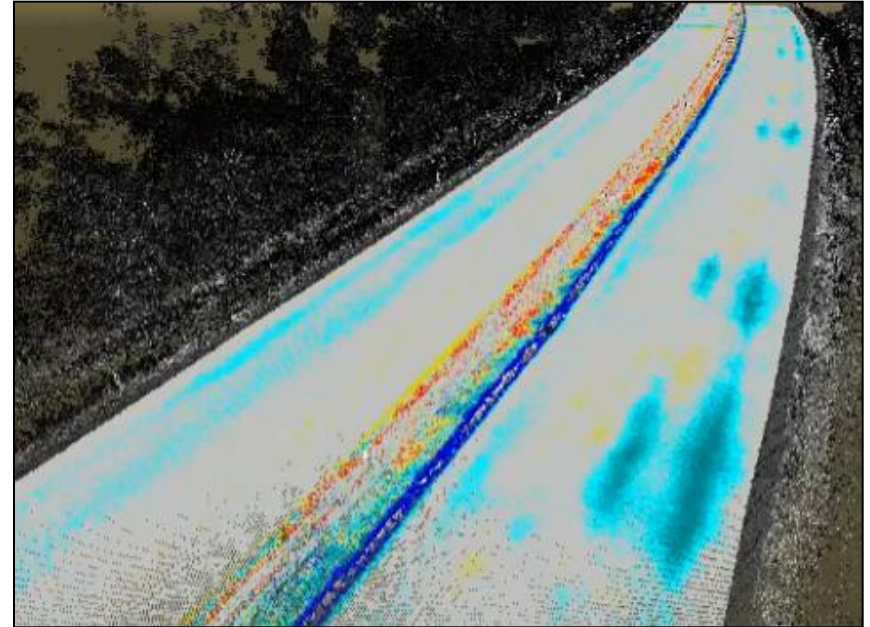
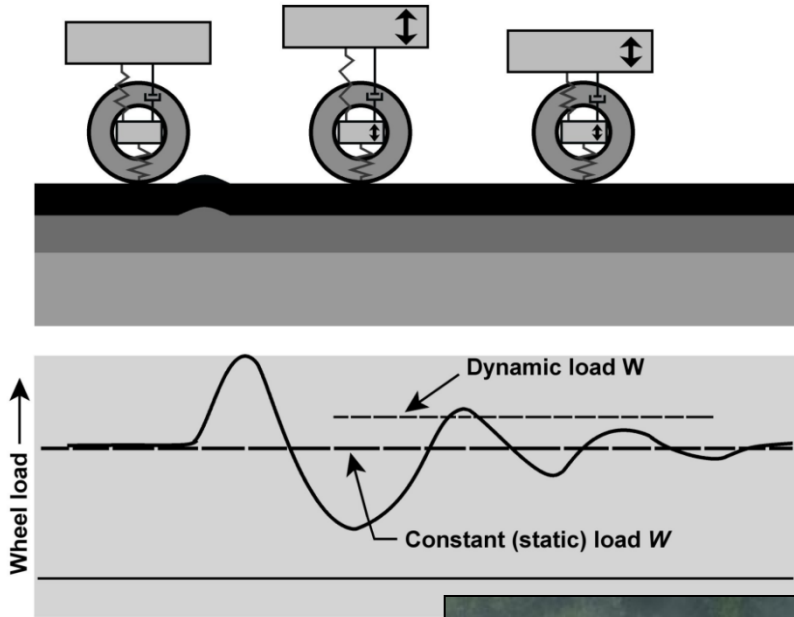
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A. Pavement	Super Single						
	Modulus (MPa)	800	1500	2800			
B. Structure	Modulus (MPa)	40	100	250			
C. Subgrade	Modulus (MPa)	5	20	80			

Tyres	Type	Dual	Pressure	800 kPa	400 kPa	200 kPa	
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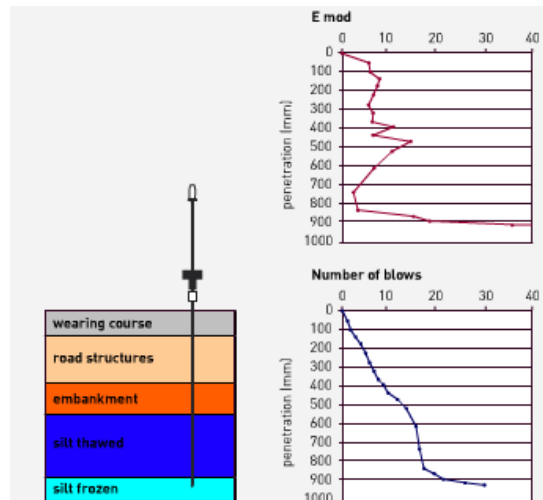
Tyres	Type	Dual	Pressure	800 kPa	400 kPa	200 kPa	
A. Pavement	Super Single						
	Modulus (MPa)	800	1500	2800			
B. Structure	Modulus (MPa)	40	100	250			
C. Subgrade	Modulus (MPa)	5	20	80			



# Dynamic Loading and Permanent Deformations

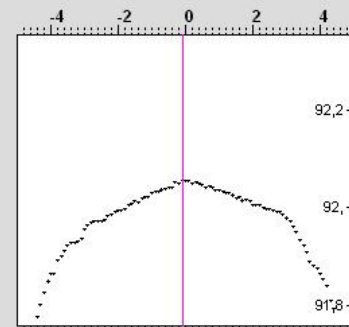
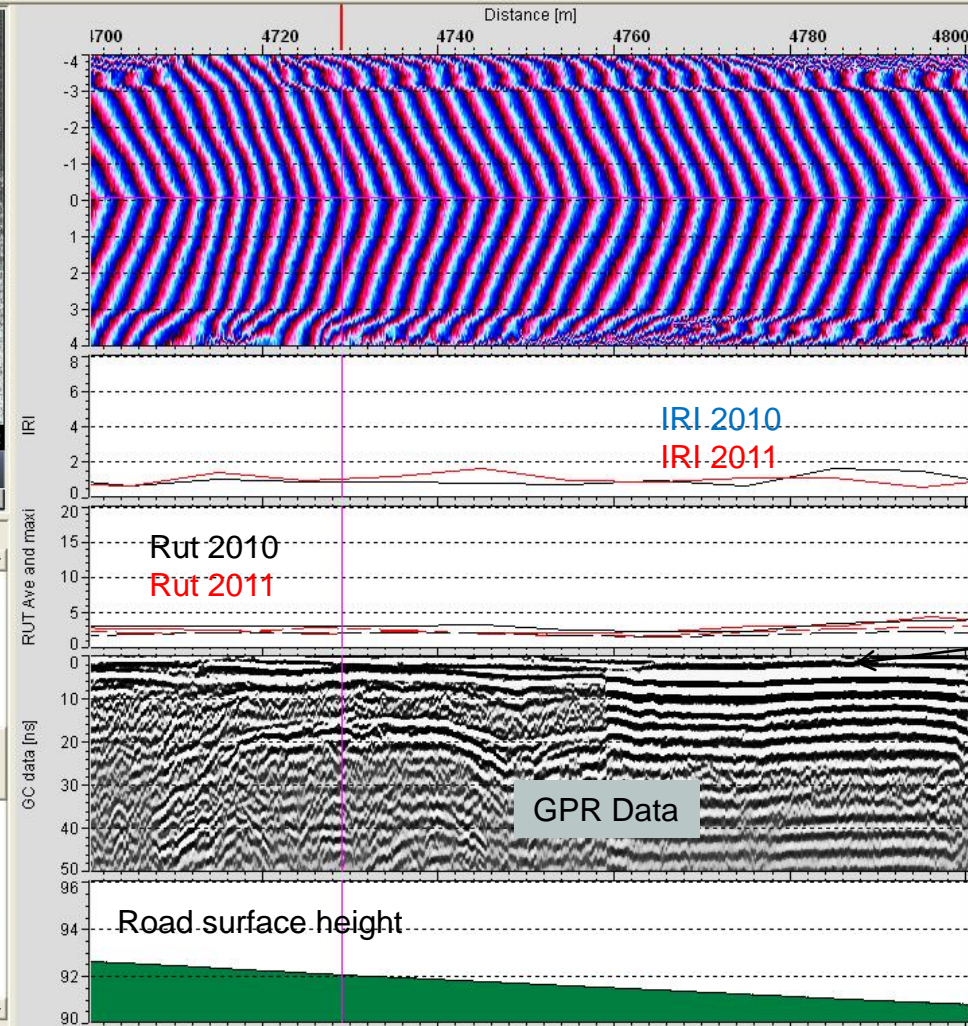
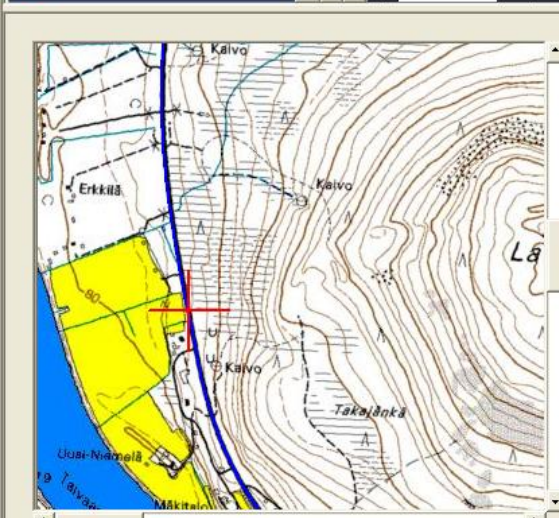
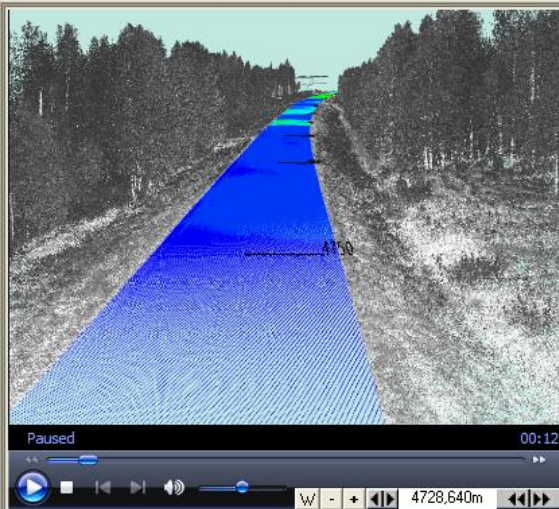


# New Techniques in Road Diagnostics: 2D/3D GPR, Digital Videos, 3D Videos, High Precision Thermal Cameras, Laser Scanners, Lidars





# Integrated Road Data Analysis and Diagnostics

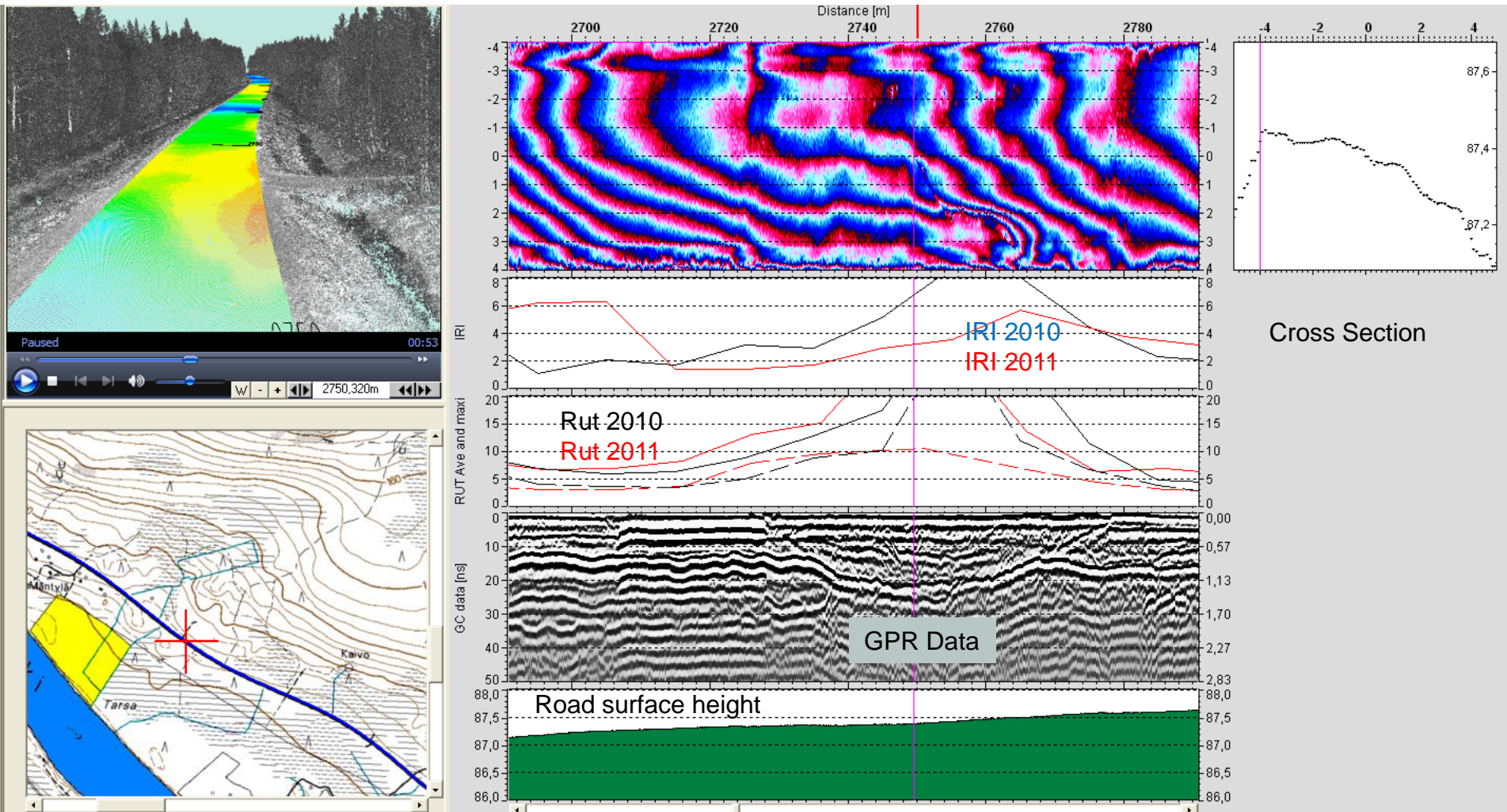


Cross Section

Steel net



# Integrated Road Data Analysis and Diagnostics



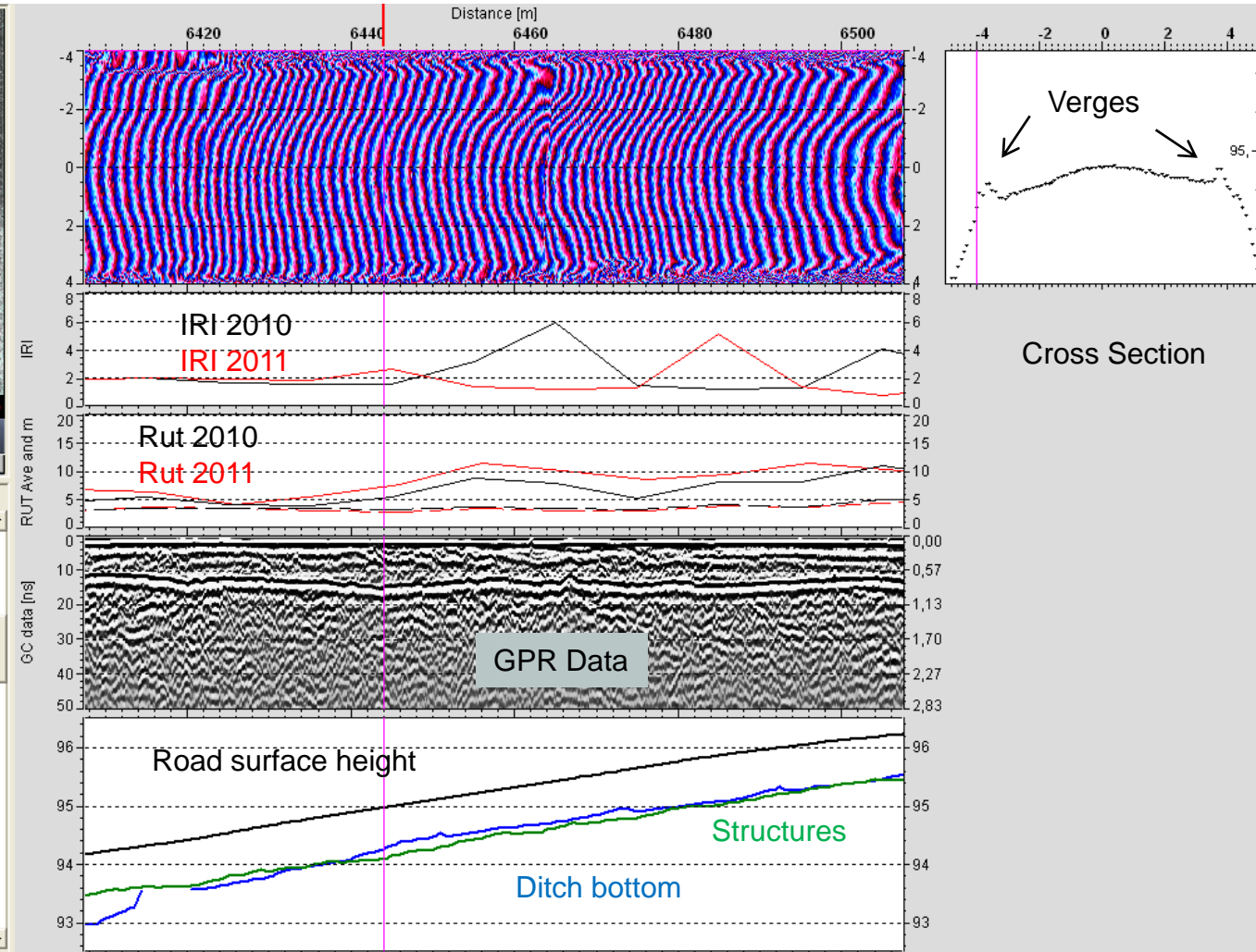
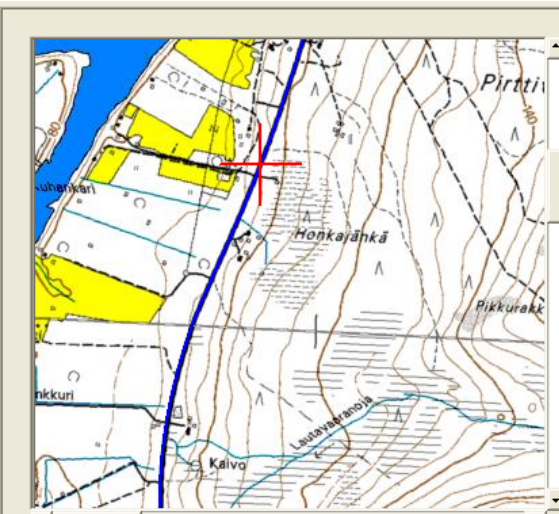
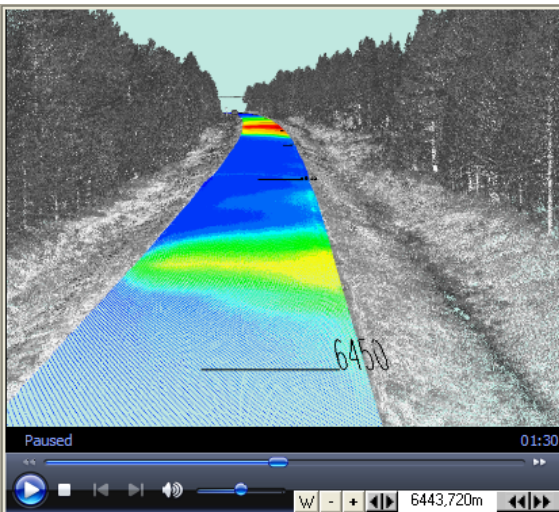
Cross Section

GPR Data

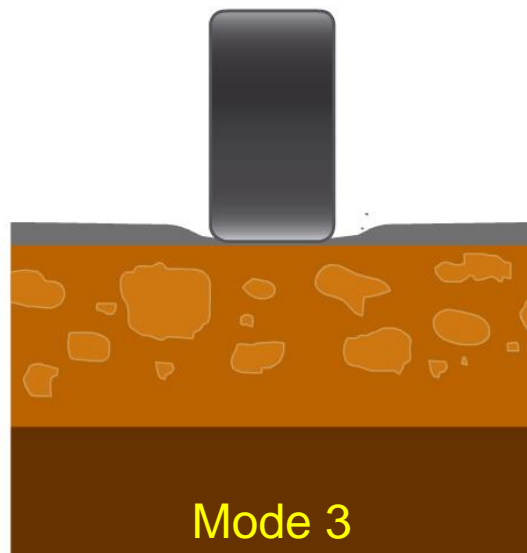
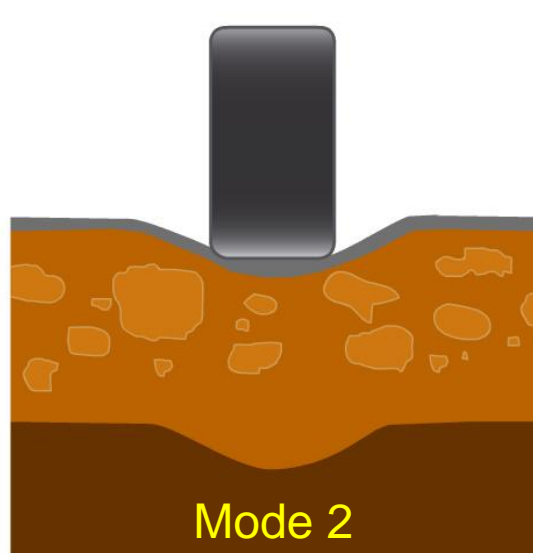
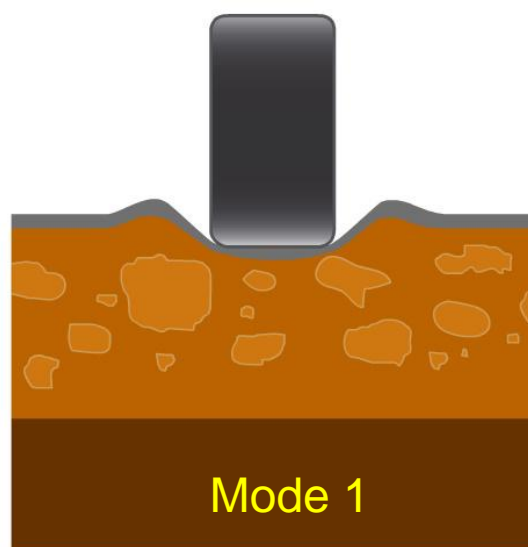
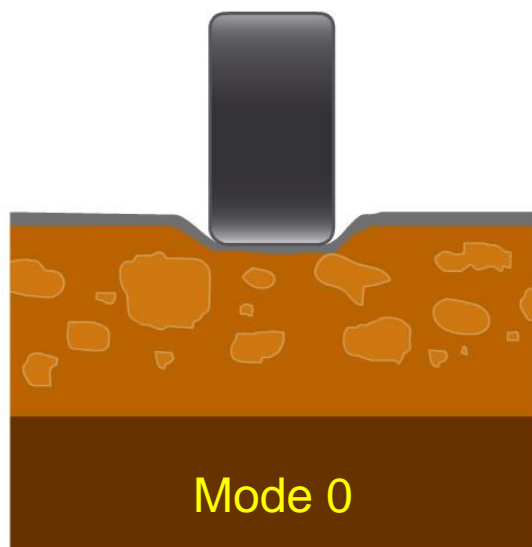
Road surface height



# Integrated Road Data Analysis and Diagnostics



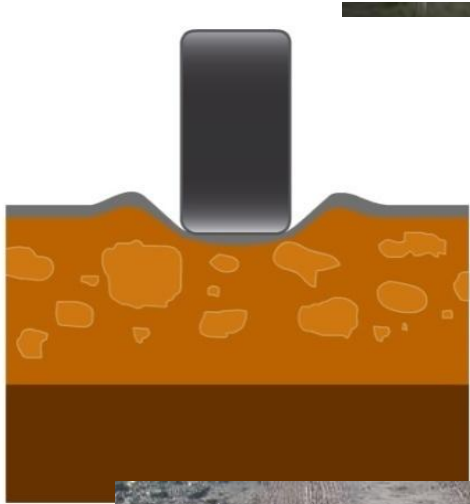
# RUTTING MODES PROPOSED BY ROADDEX



In addition diagnosis should cover:

- frost damages
- geotechnical problems
- drainage related problems
- construction faults

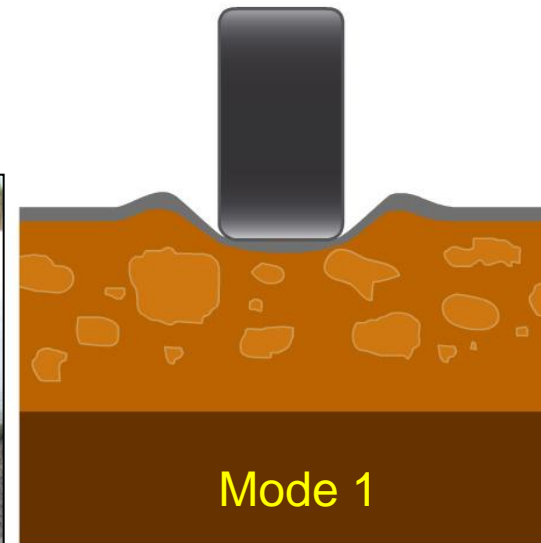
# Mode 1 Rutting Problems



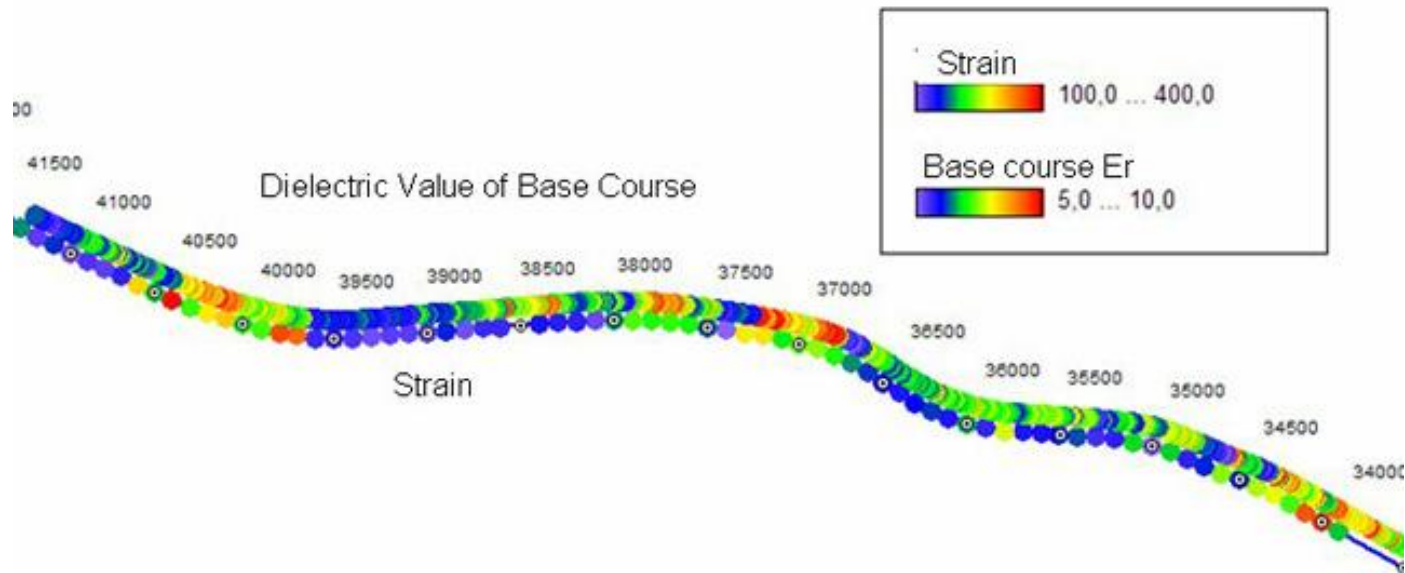
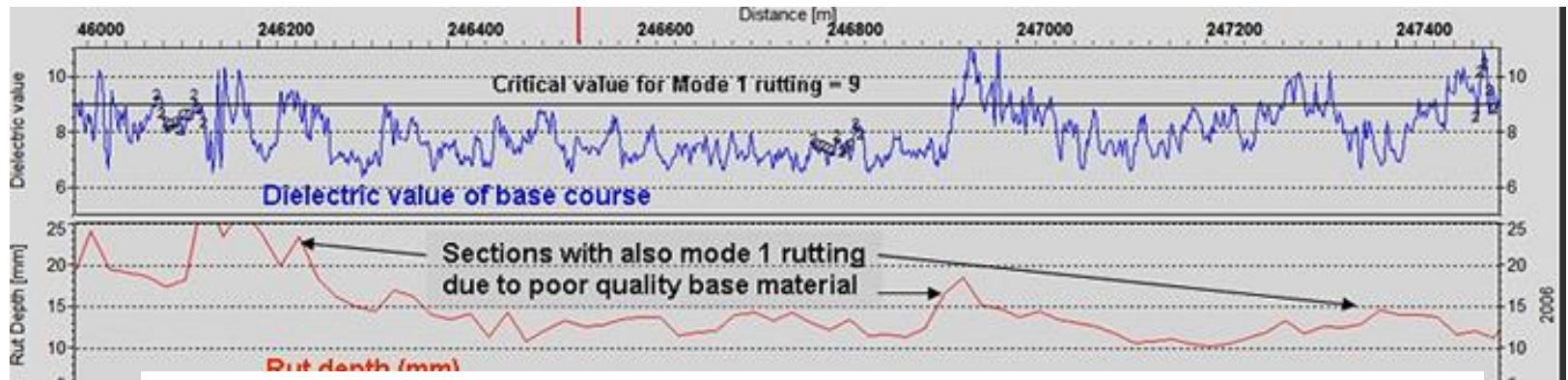


# DETECTING MODE 1 RUTTING ON PAVED ROADS

1. DIELECTRIC VALUE OF BASE COURSE
2. PAVEMENT STRAIN
3. SCI VALUE
4. LABORATORY ANALYSIS (FINES + TS-TEST)



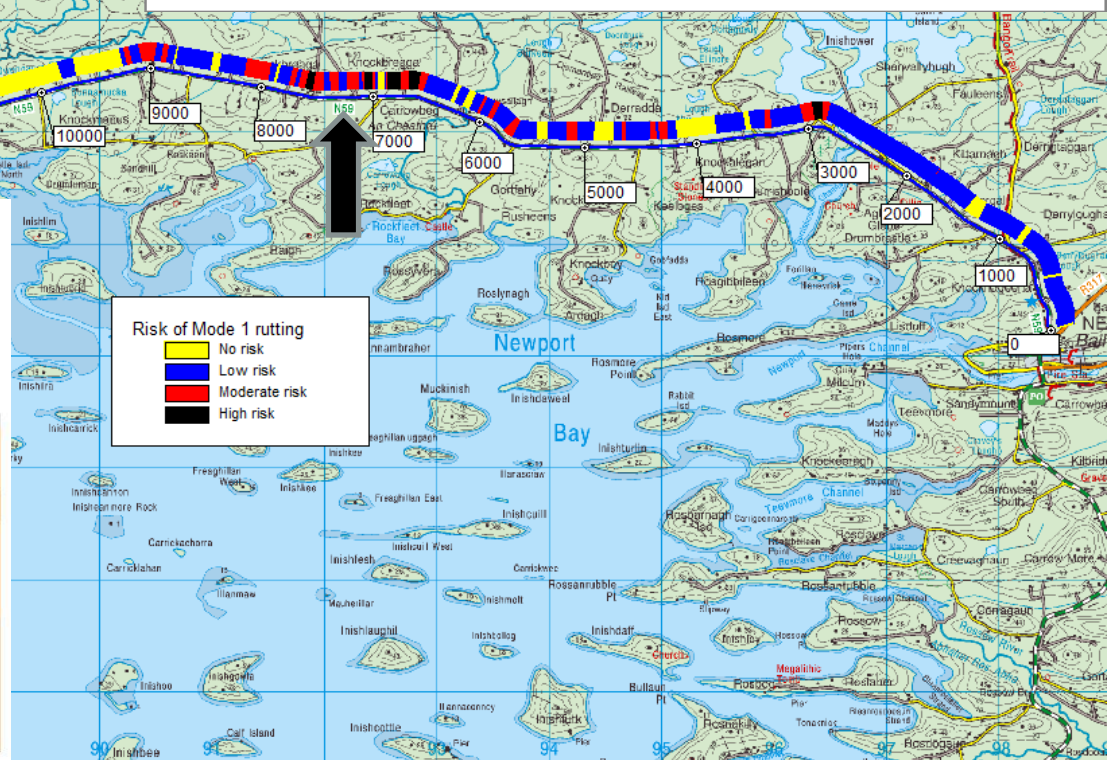
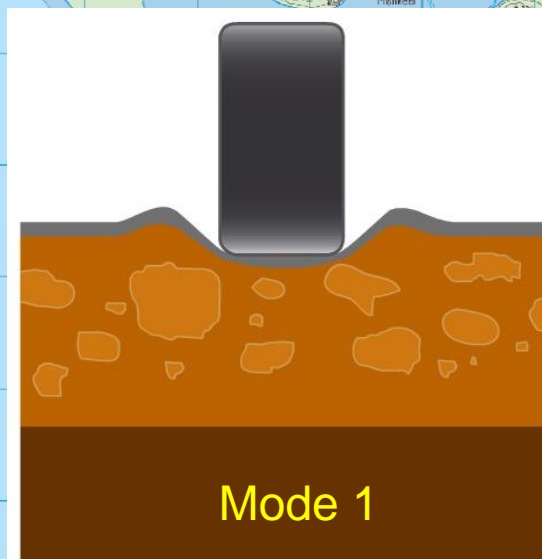
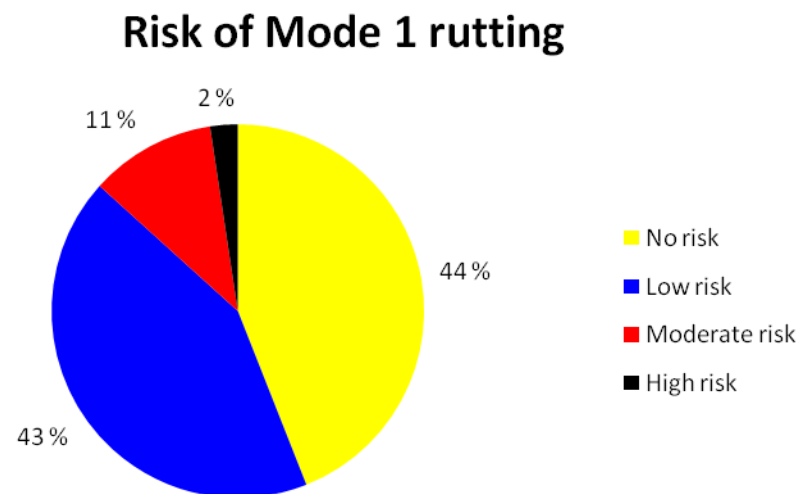
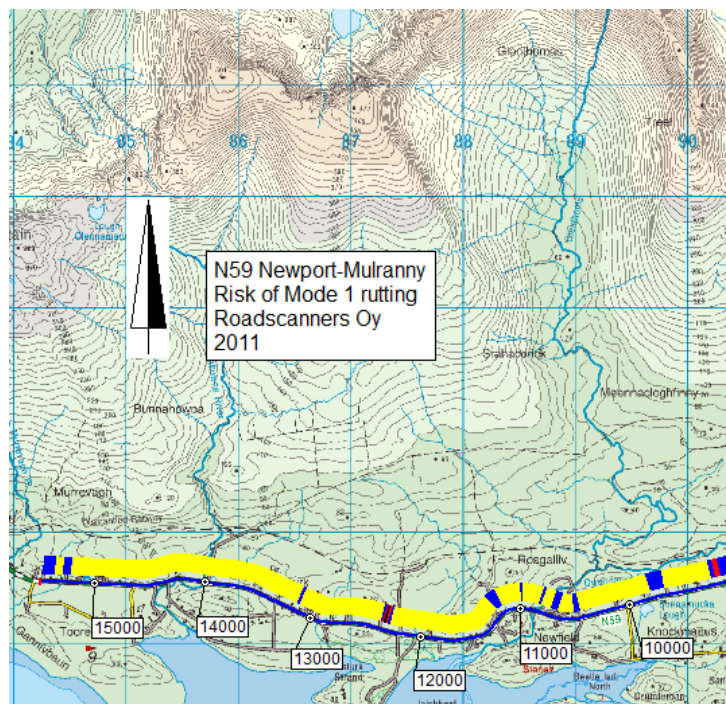
# Indications of Mode 1 Rutting Problems



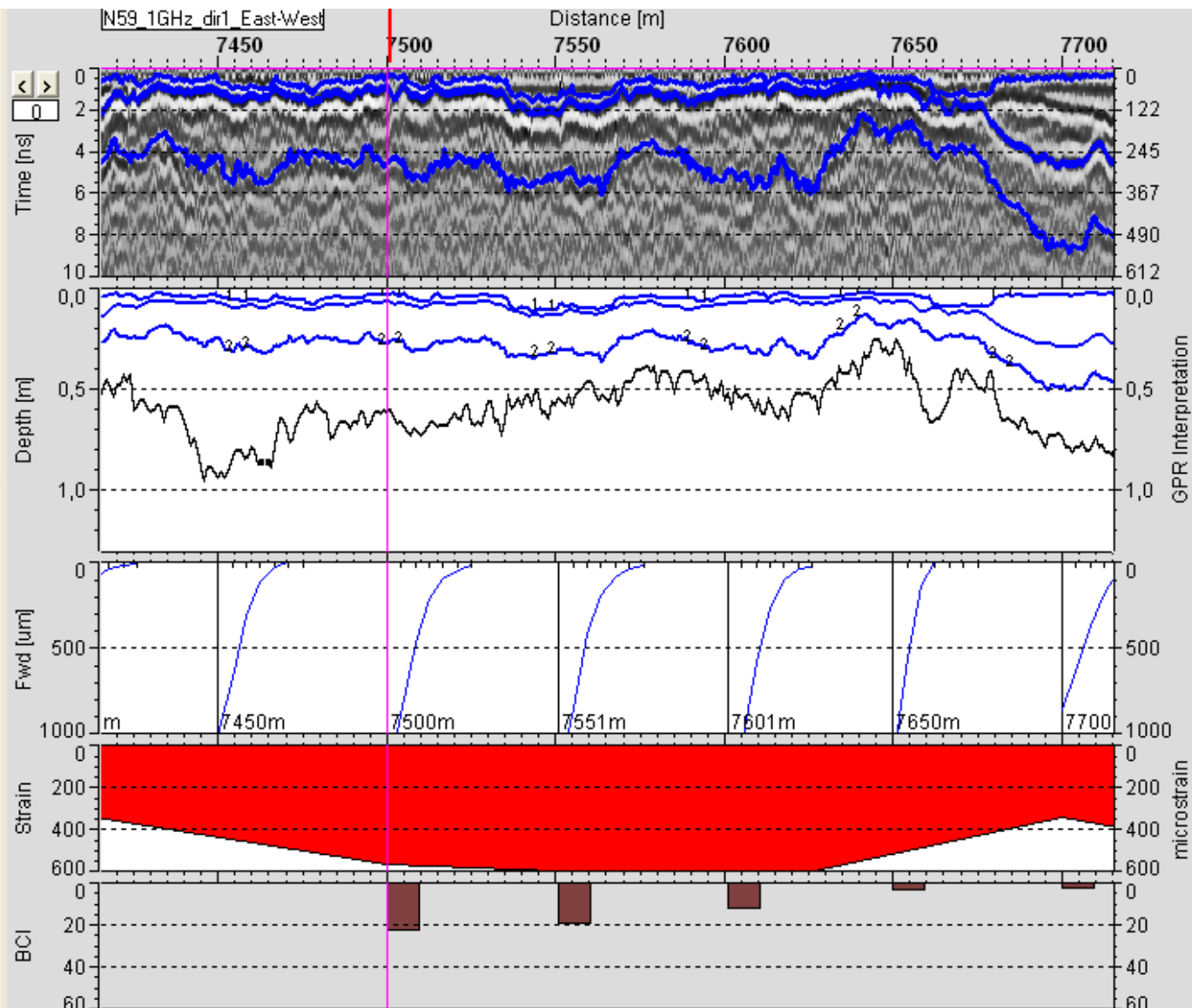
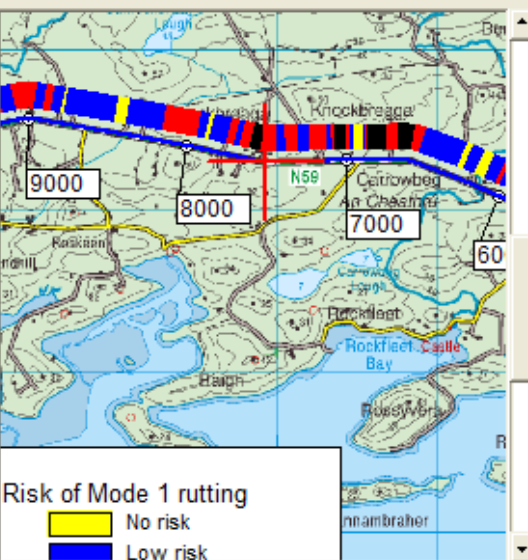


N59

I  
R  
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L  
A  
N  
D

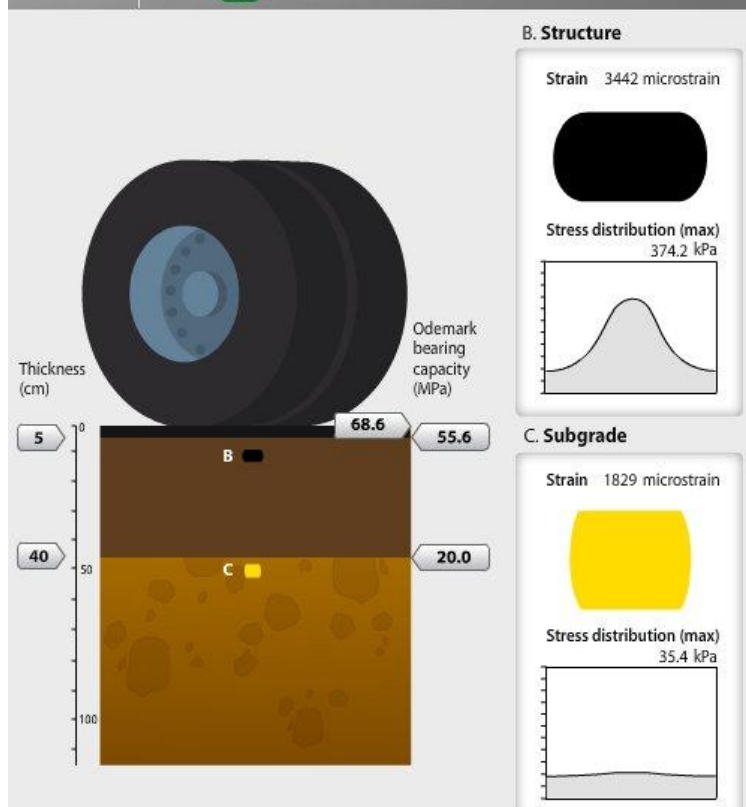


# N59: 7500 m

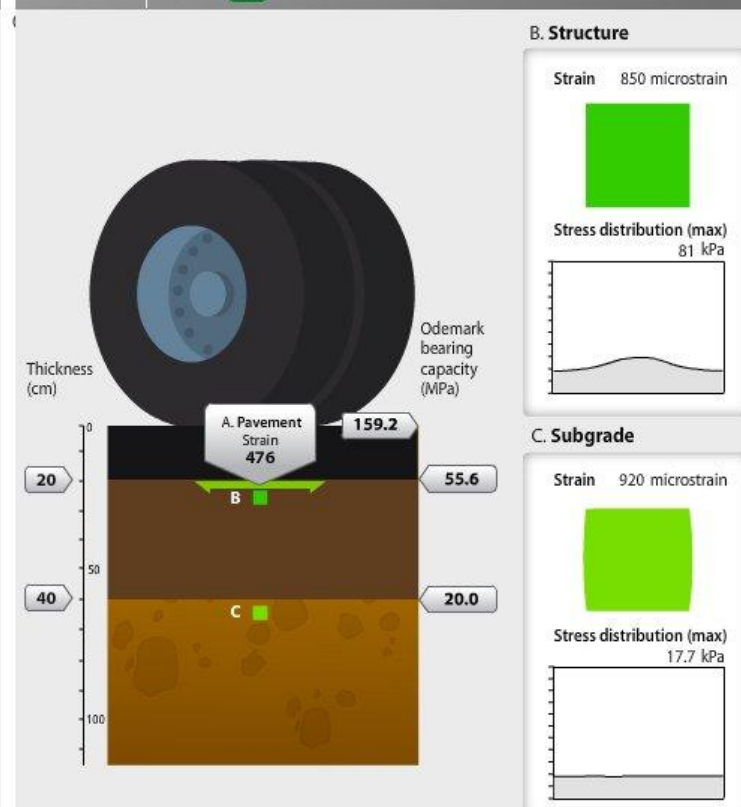


# Pavement Thickness and Mode 1 Rutting Risk

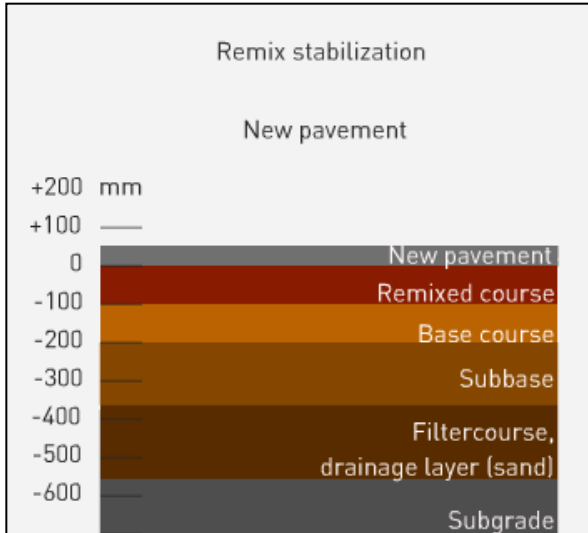
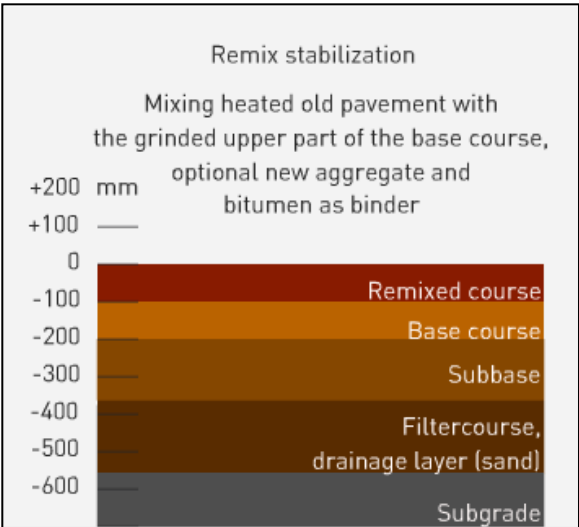
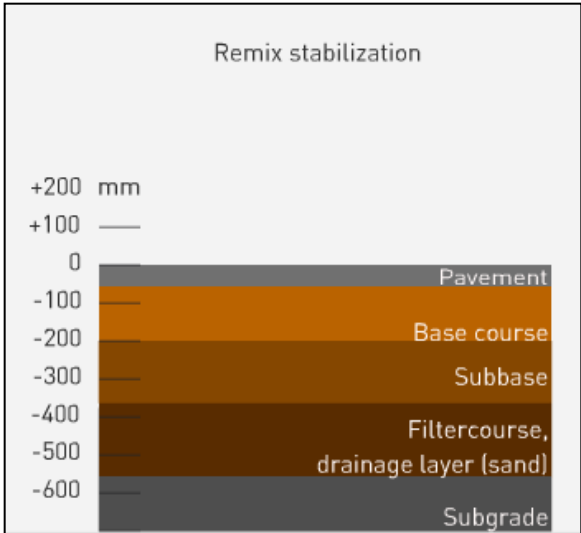
Tyres	Type Single Dual	Pressure 800 kPa 400 kPa 200 kPa			
Pavement	Module (MPa) 800 1500 2800	Thickness (cm) 1 5 10 20			
Structure	Module (MPa) 40 100 250	Thickness (cm) 10 20 40 80			
Subgrade	Module (MPa) 5 20 80				



Tyres	Type Single <b>Dual</b>	Pressure <b>800 kPa</b> 400 kPa 200 kPa	
Pavement	Module (MPa) <b>800</b> 1500 2800	Thickness (cm) 1 5 10 <b>20</b>	
Structure	Module (MPa) 40 <b>100</b> 250	Thickness (cm) 10 20 <b>40</b> 80	
Subgrade	Module (MPa) 5 <b>20</b> 80		

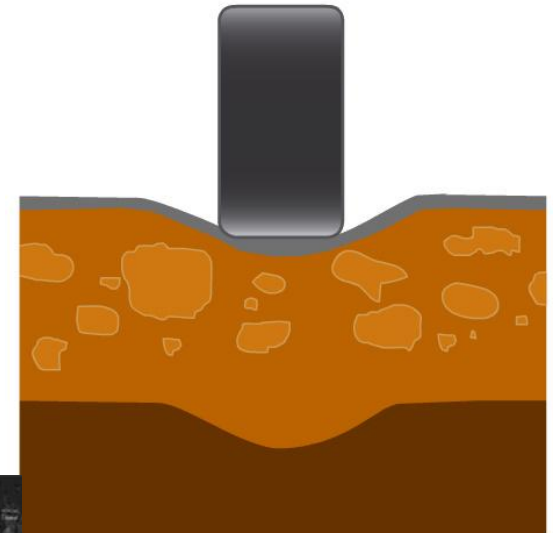


# Solution for Mode 1 Rutting Problems





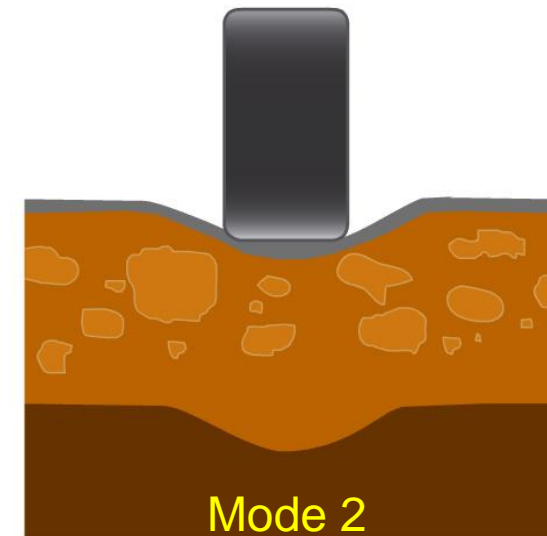
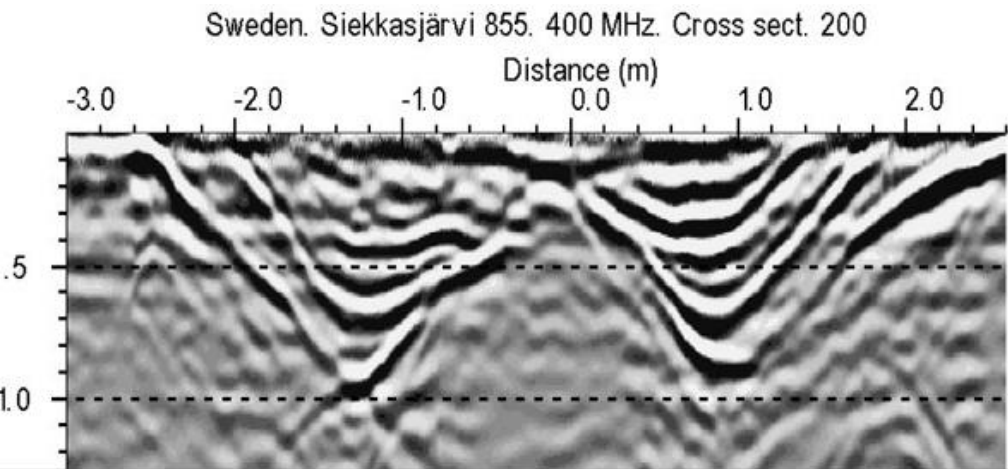
# Mode 2 Rutting Problems



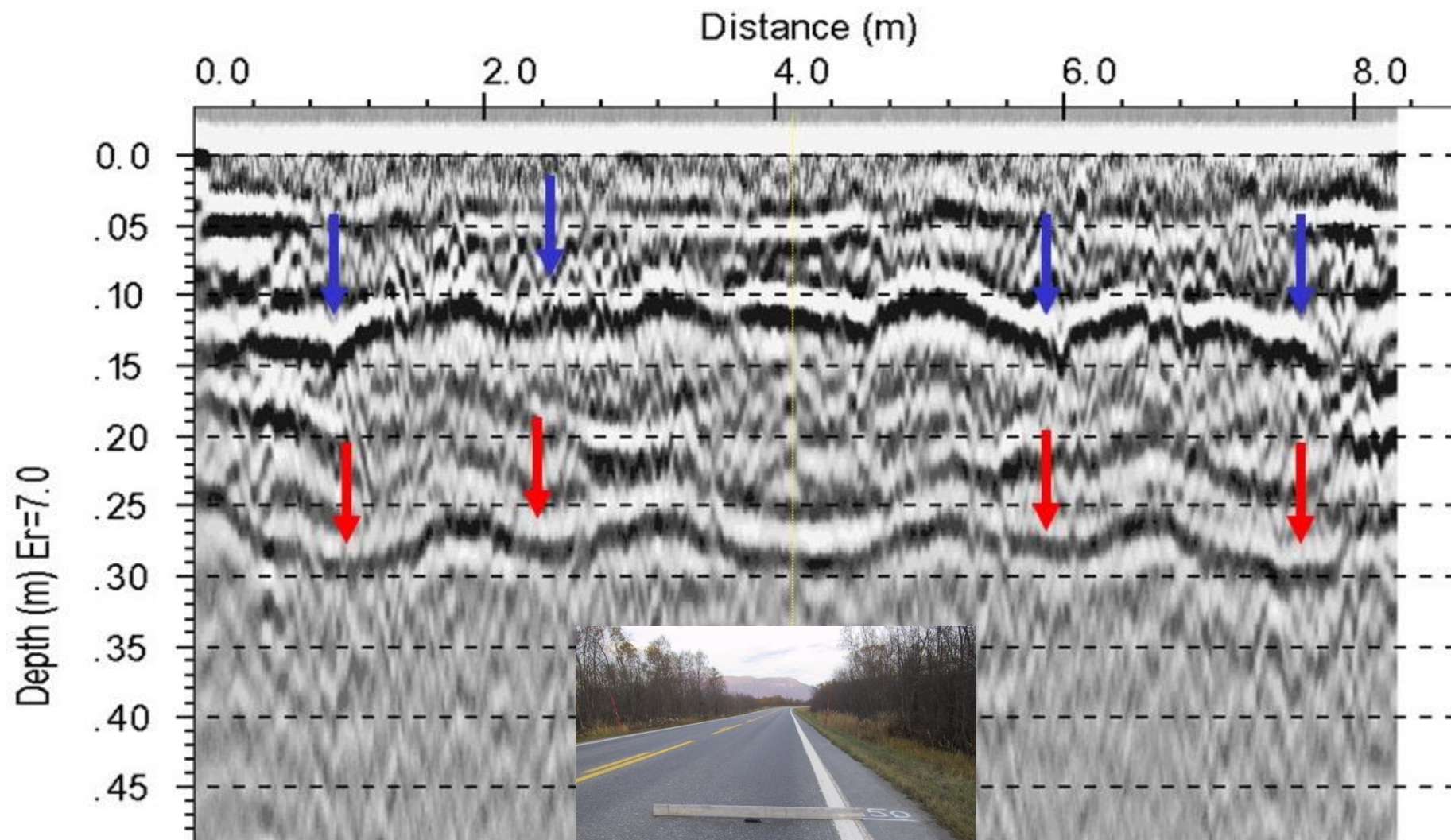


# DETECTING MODE 2 RUTTING ON PAVED ROADS

1. GPR CROSS SECTIONS
2. BCI AND SUBGRADE MODULI



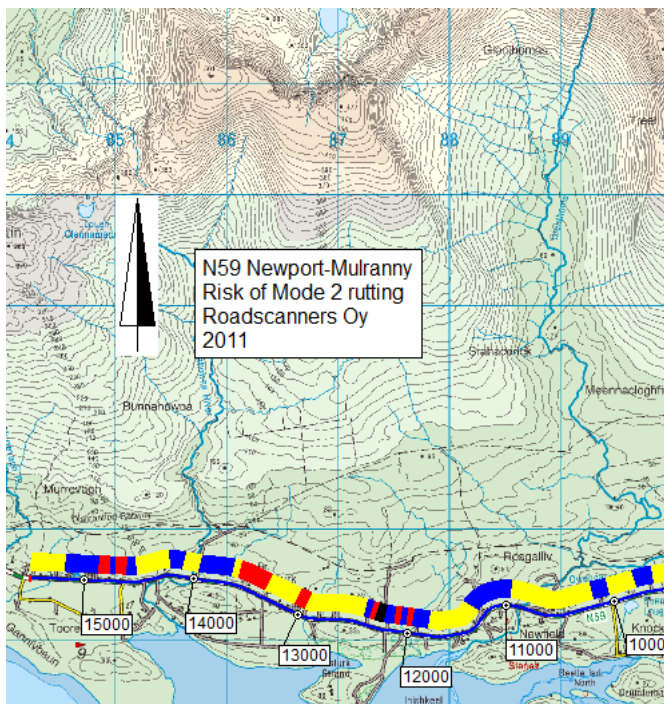
# DETECTING MODE 2 RUTTING ON PAVED ROADS



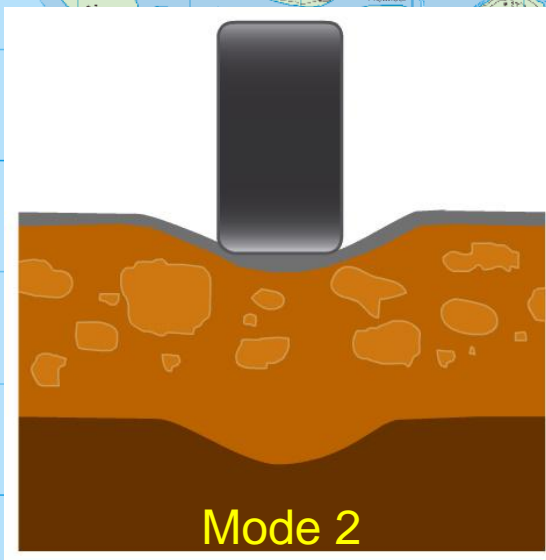
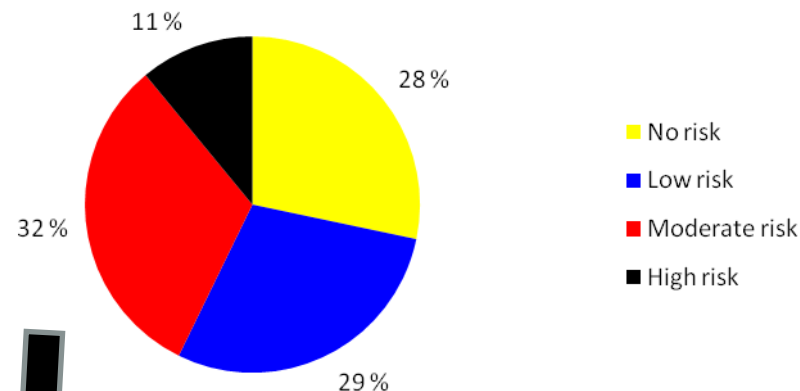


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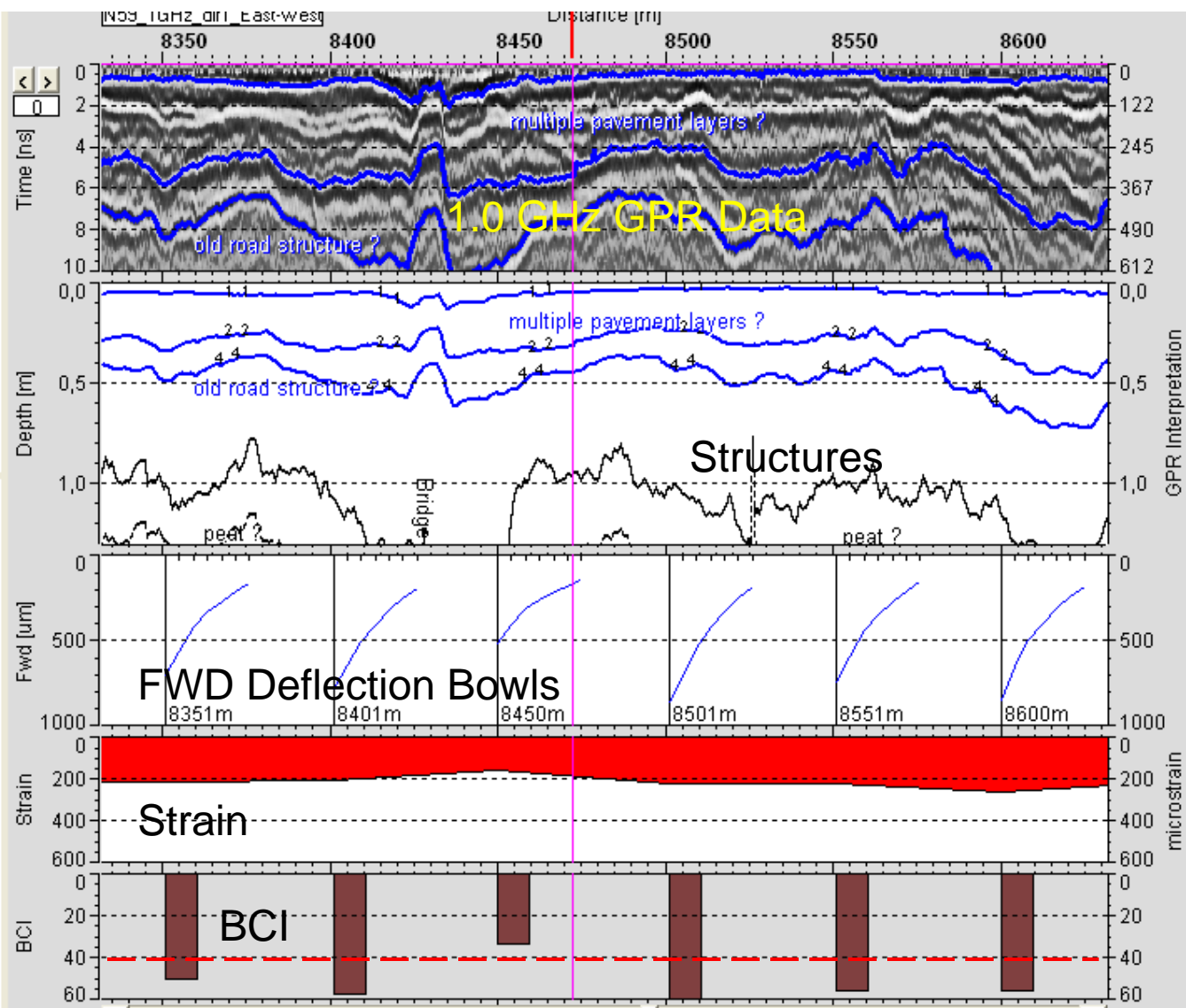
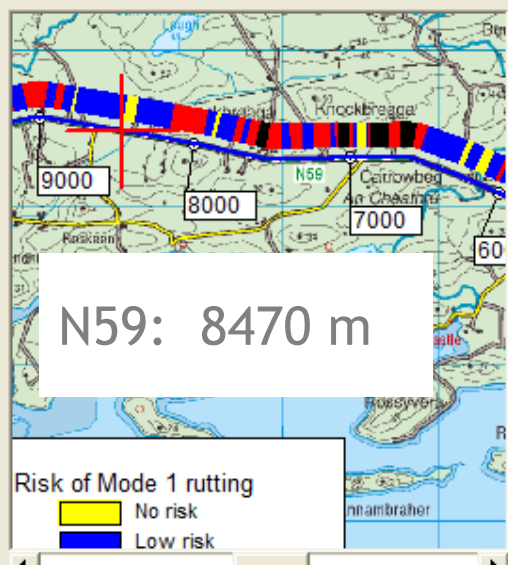
# I R E L A N D



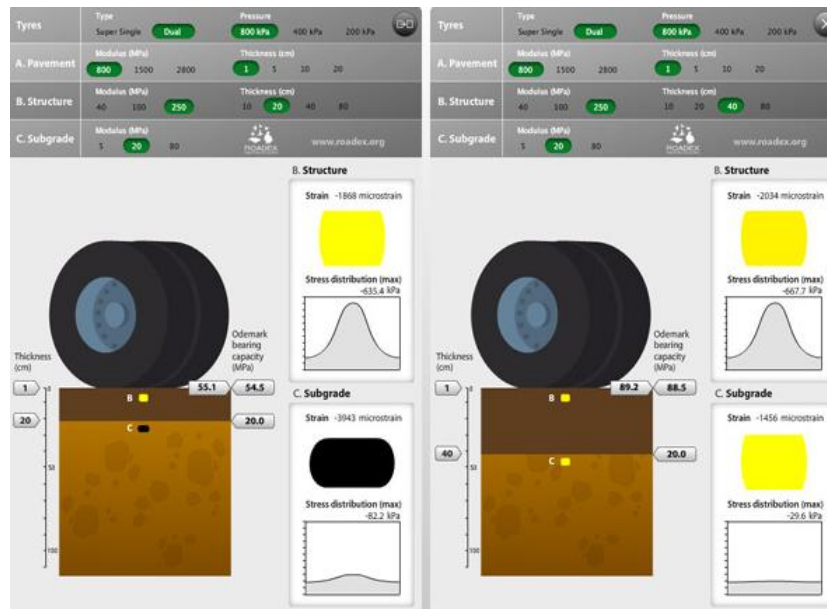
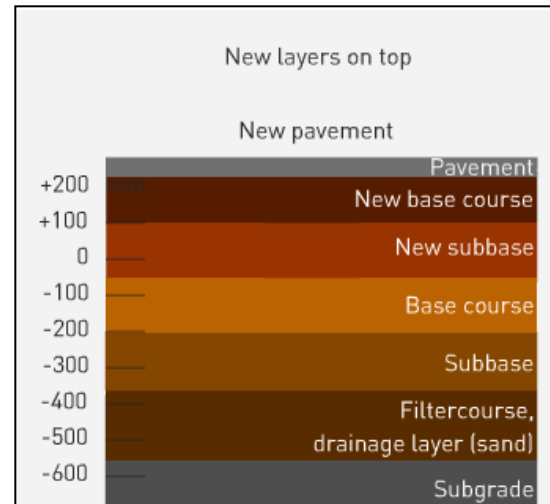
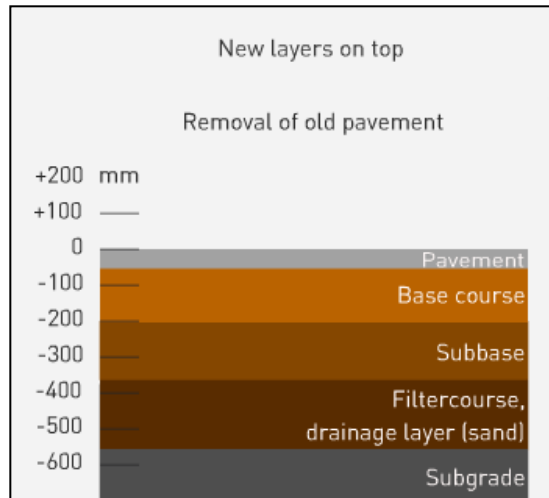
## Risk of Mode 2 rutting



# High Risk for Mode 2 Rutting

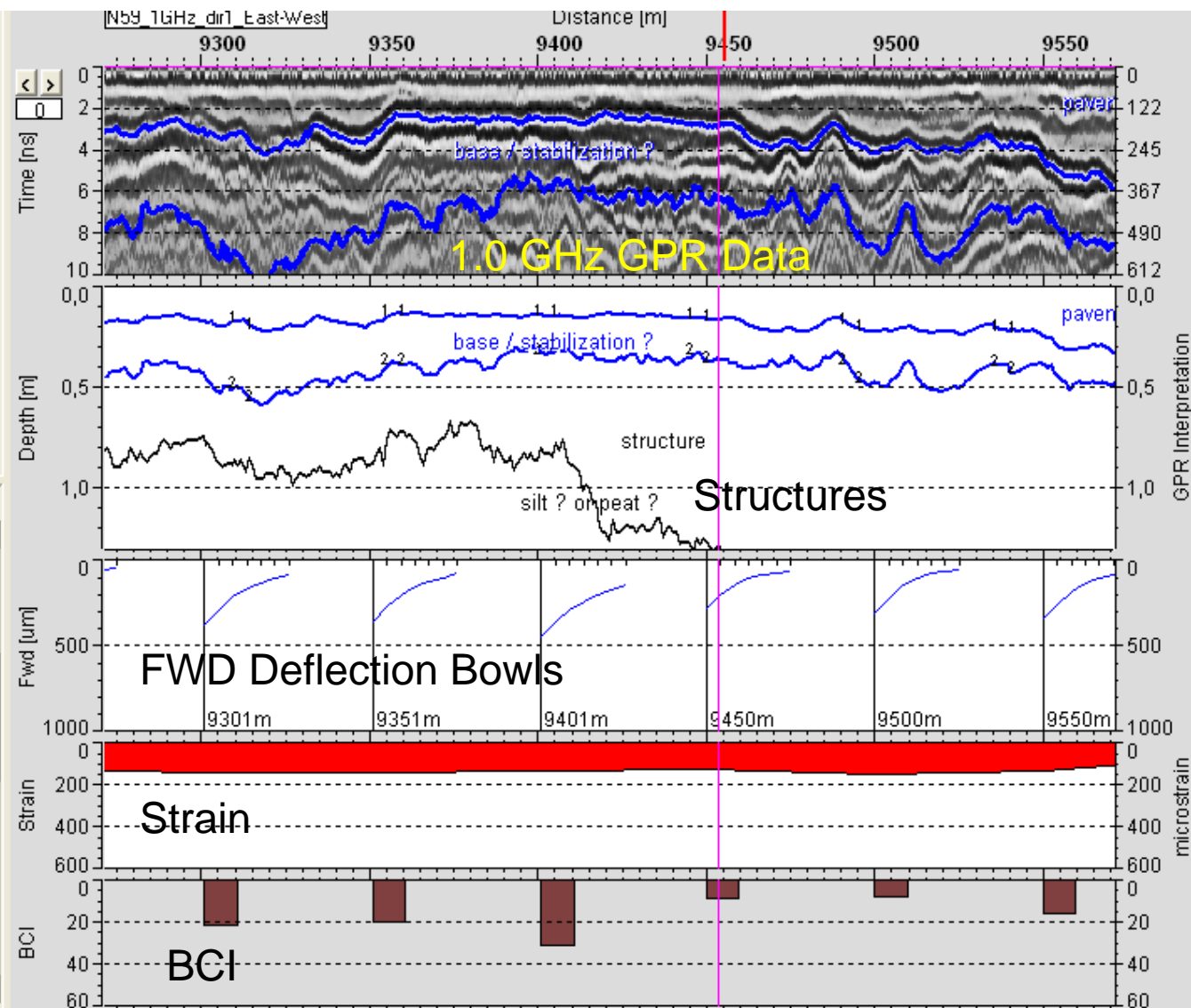
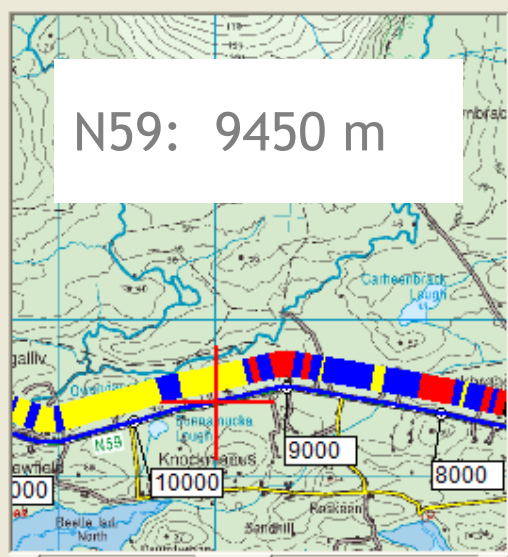


# Solution for Modes 2 Rutting Problems

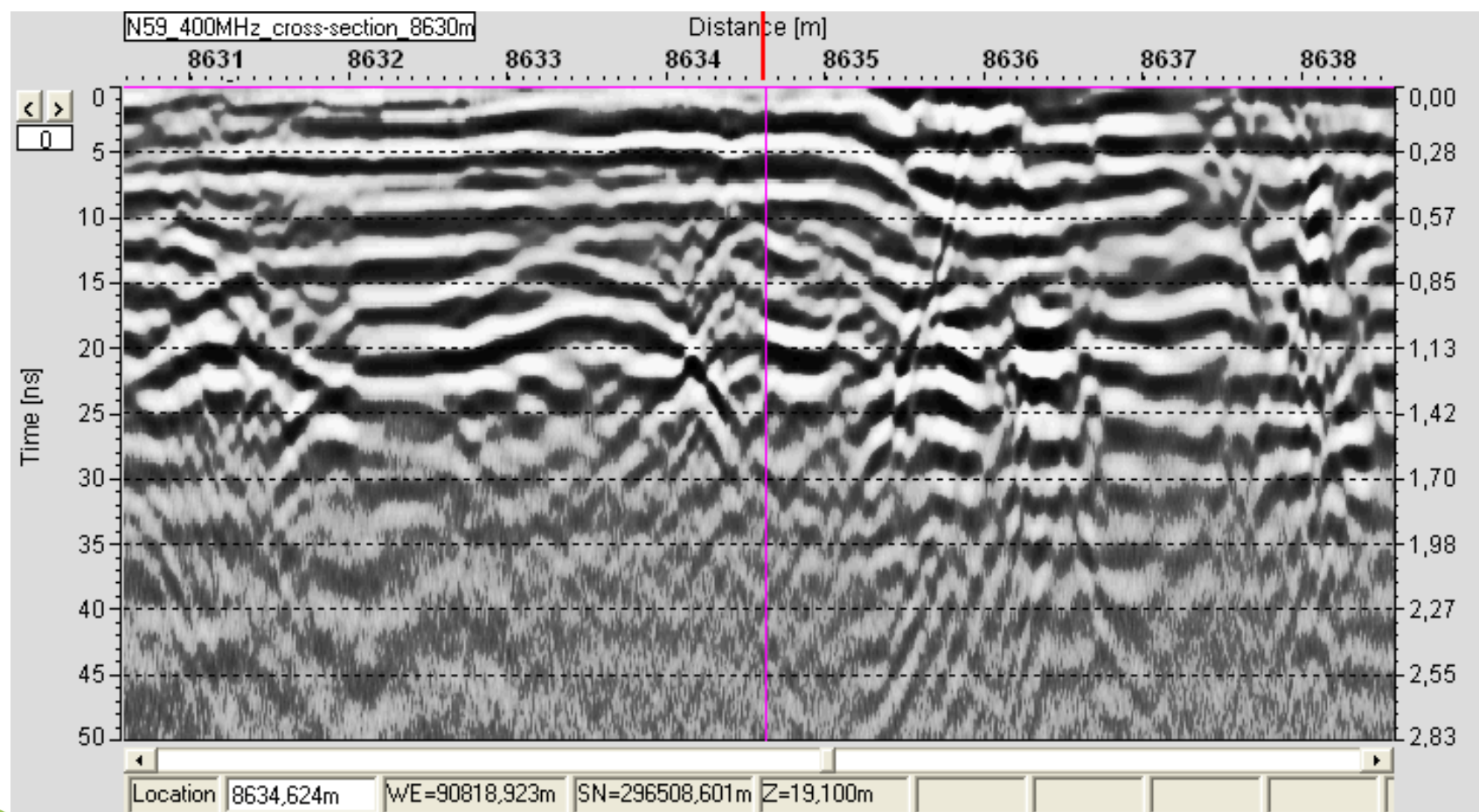




# No Risk for Mode 1 and Mode 2 Rutting

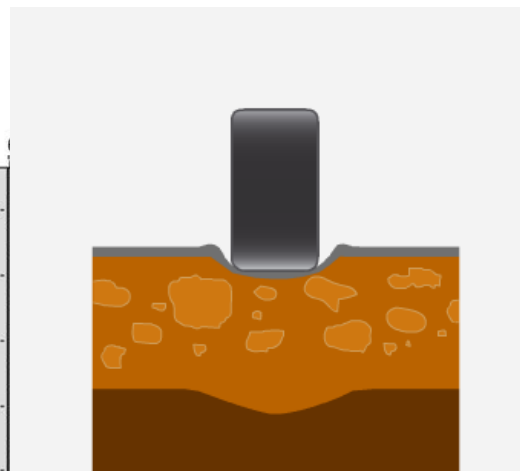
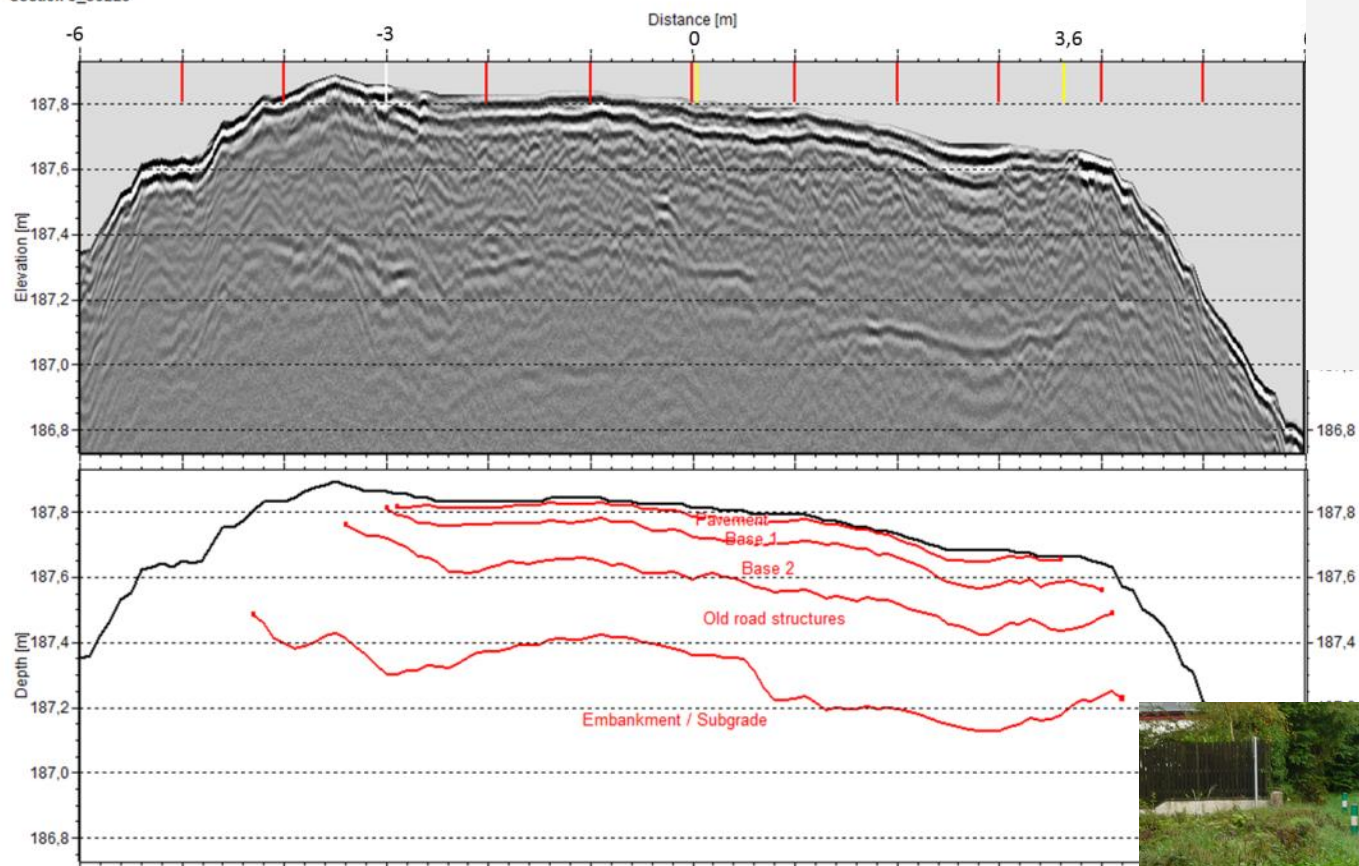


# Road Cross Section and Deformation Risk



# COMBINED RUTTING MODES

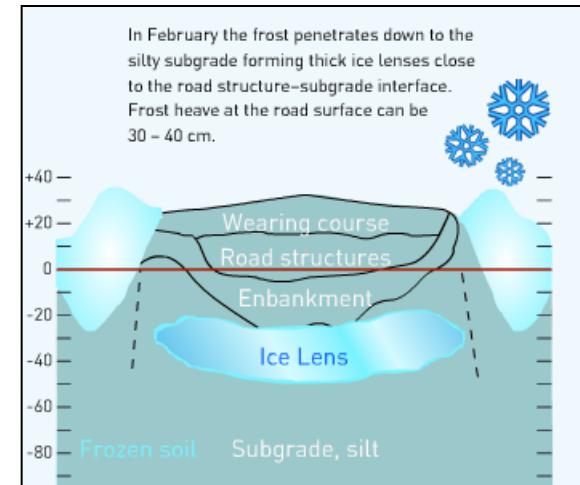
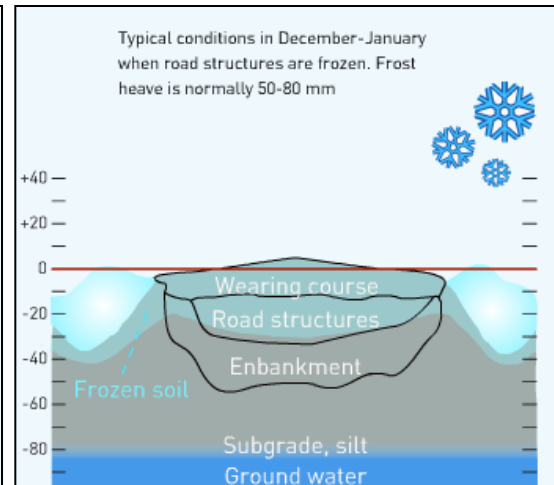
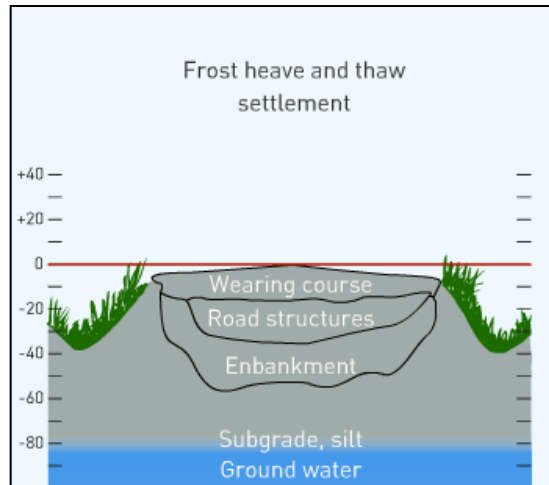
Section 3\_58229



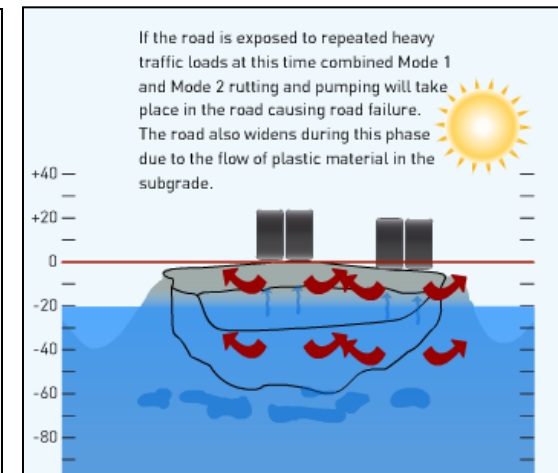
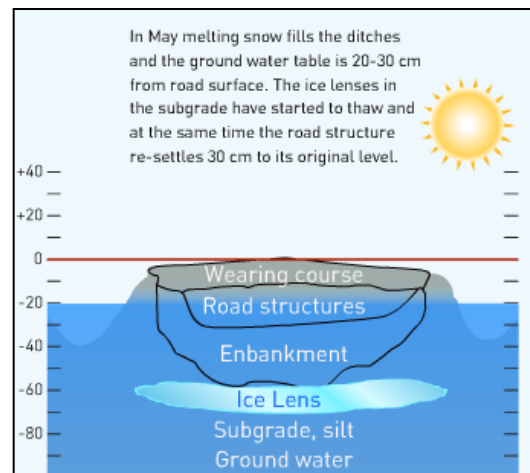
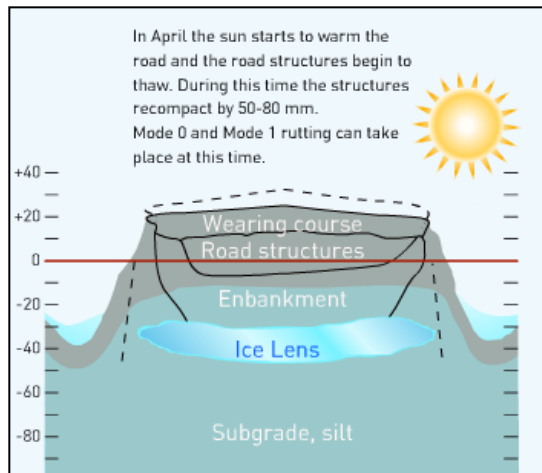


# FROST ACTION AND PERMANENT DEFORMATION

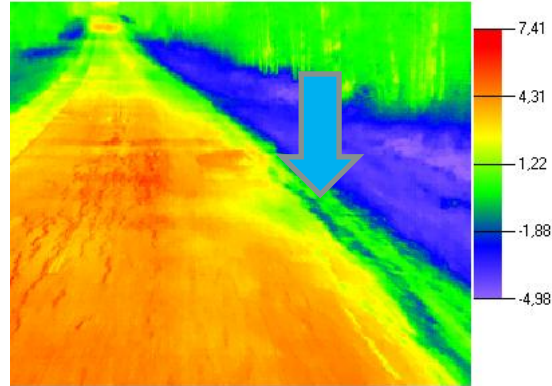
## FREEZING



## THAWING

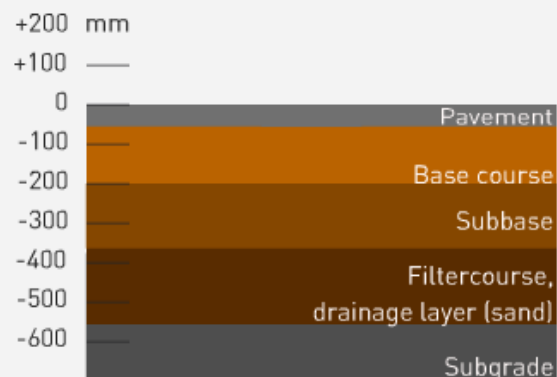


# ROAD WIDENING, FROST AND MODE 2 RUTTING



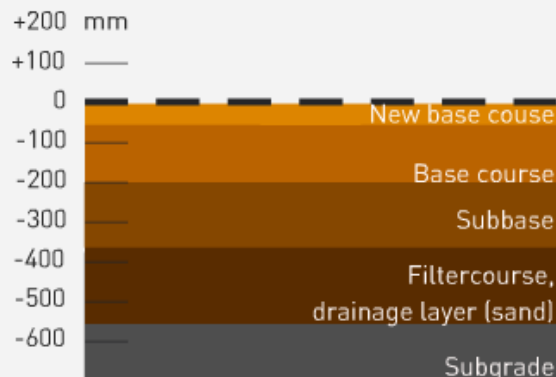
# Solution for Road with Frost Cracking and Mode 2 Rutting Problems

Steelgrid reinforcements



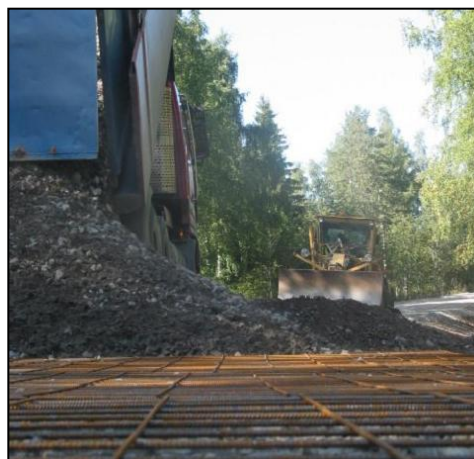
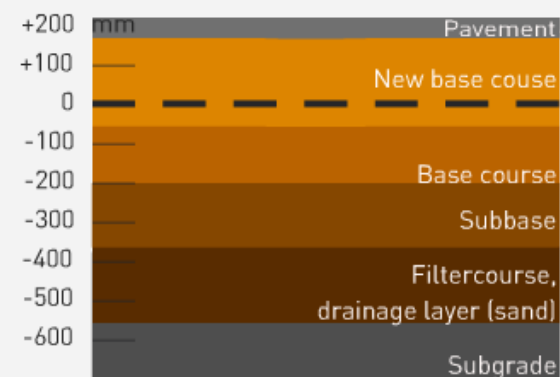
Steelgrid reinforcements

Installation of steel grid or geogrid



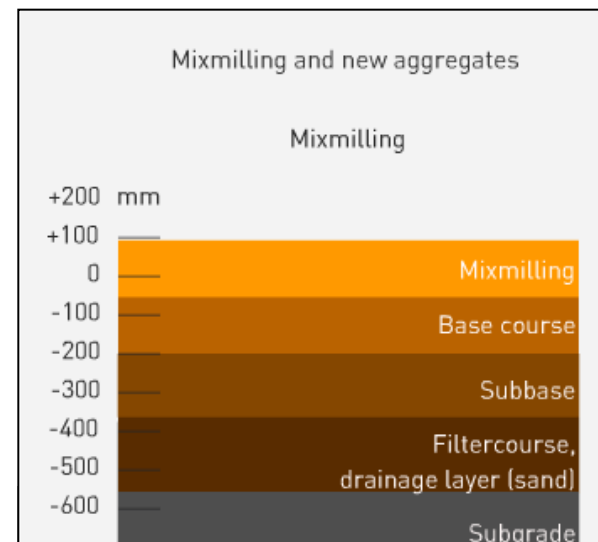
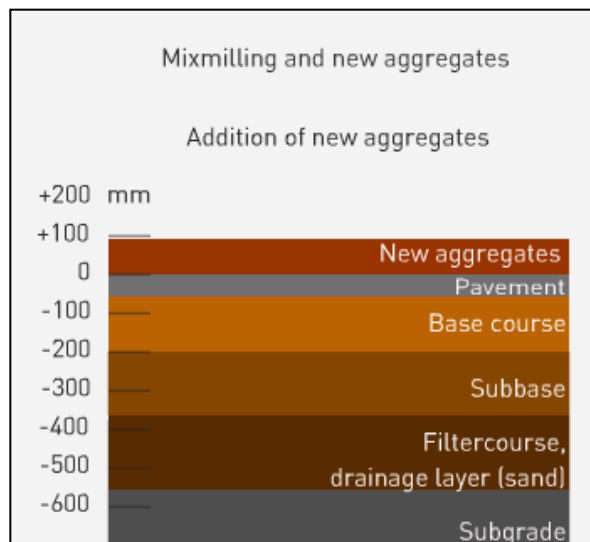
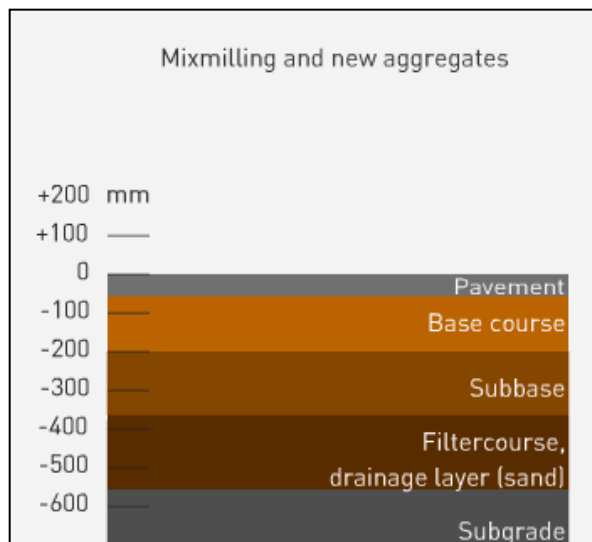
Steelgrid reinforcements

New pavement

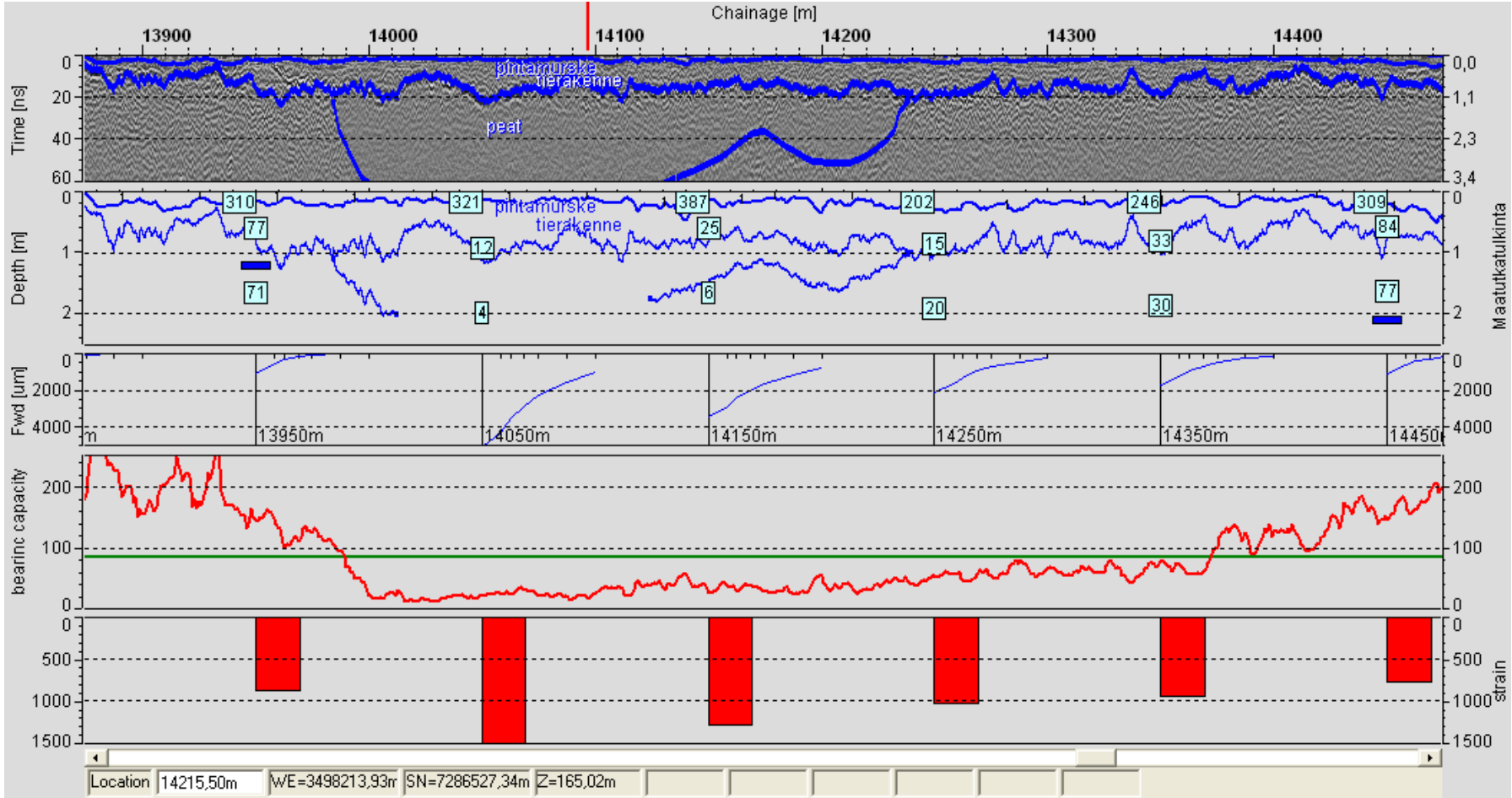




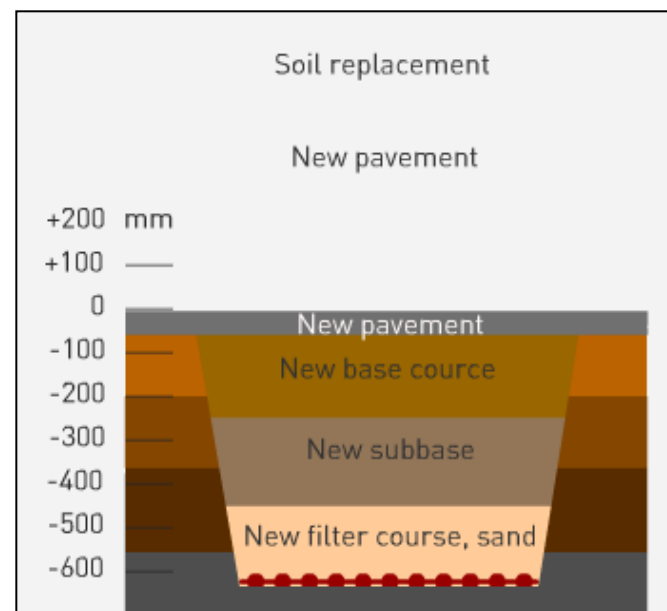
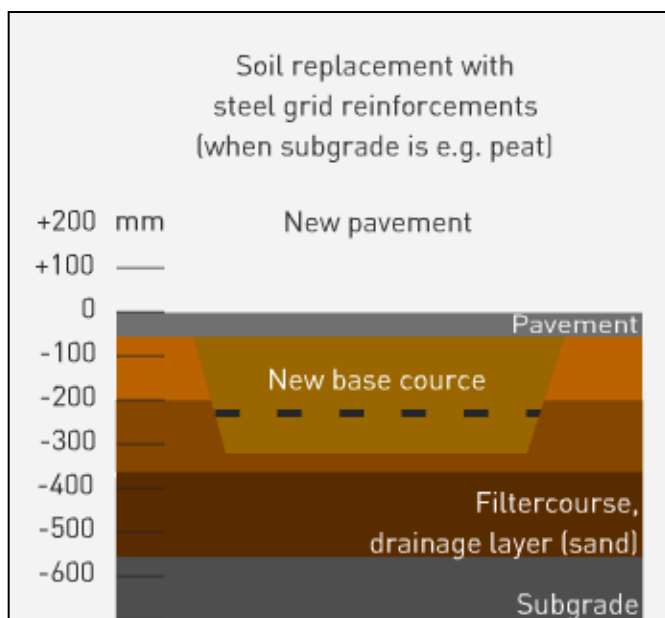
# Solution for Combined Rutting Modes (1 and 2)



# Mode 2 Rutting Special Case – Peat Subgrade

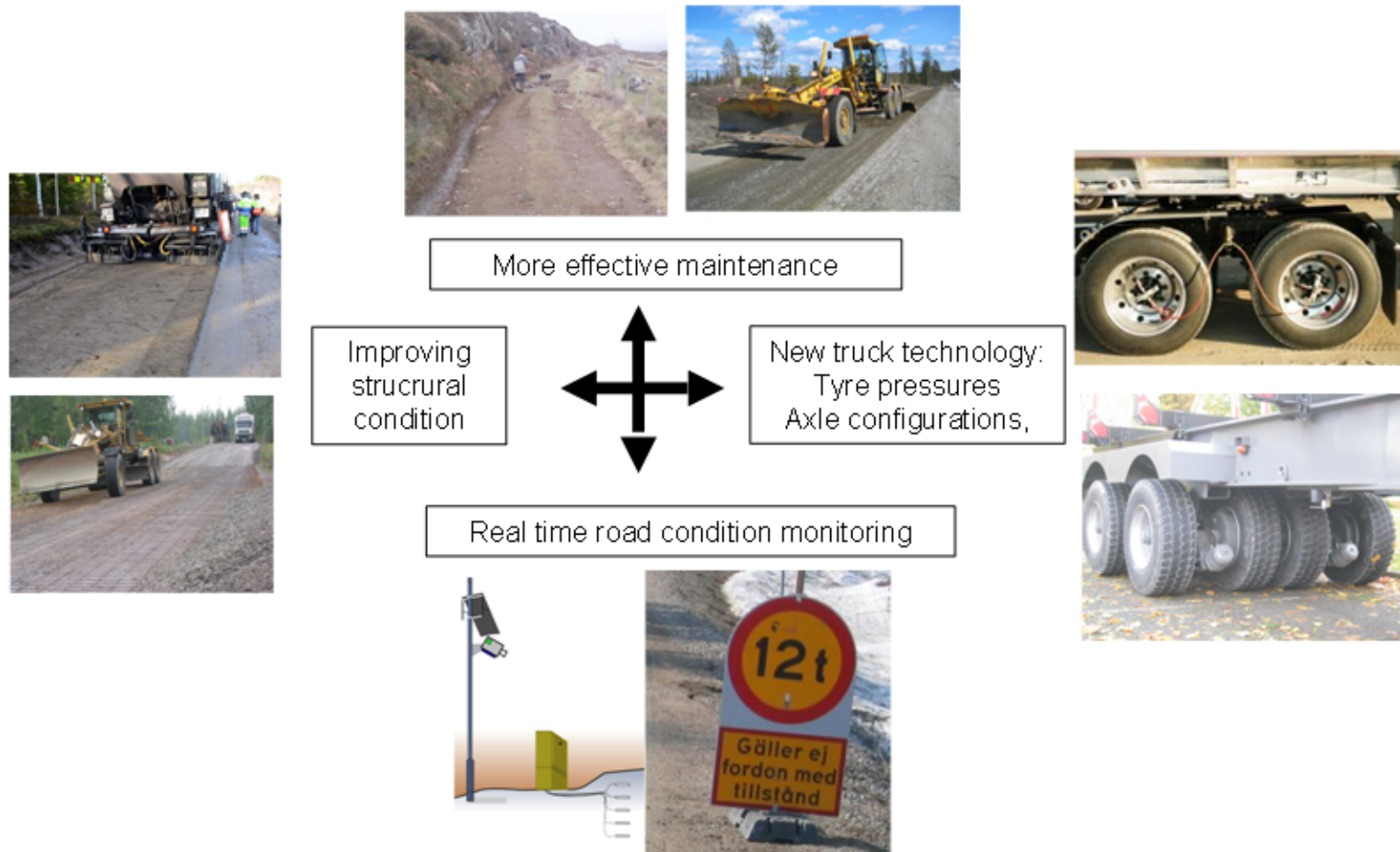


# Special Structures: Peat Subgrade and Frost Problems



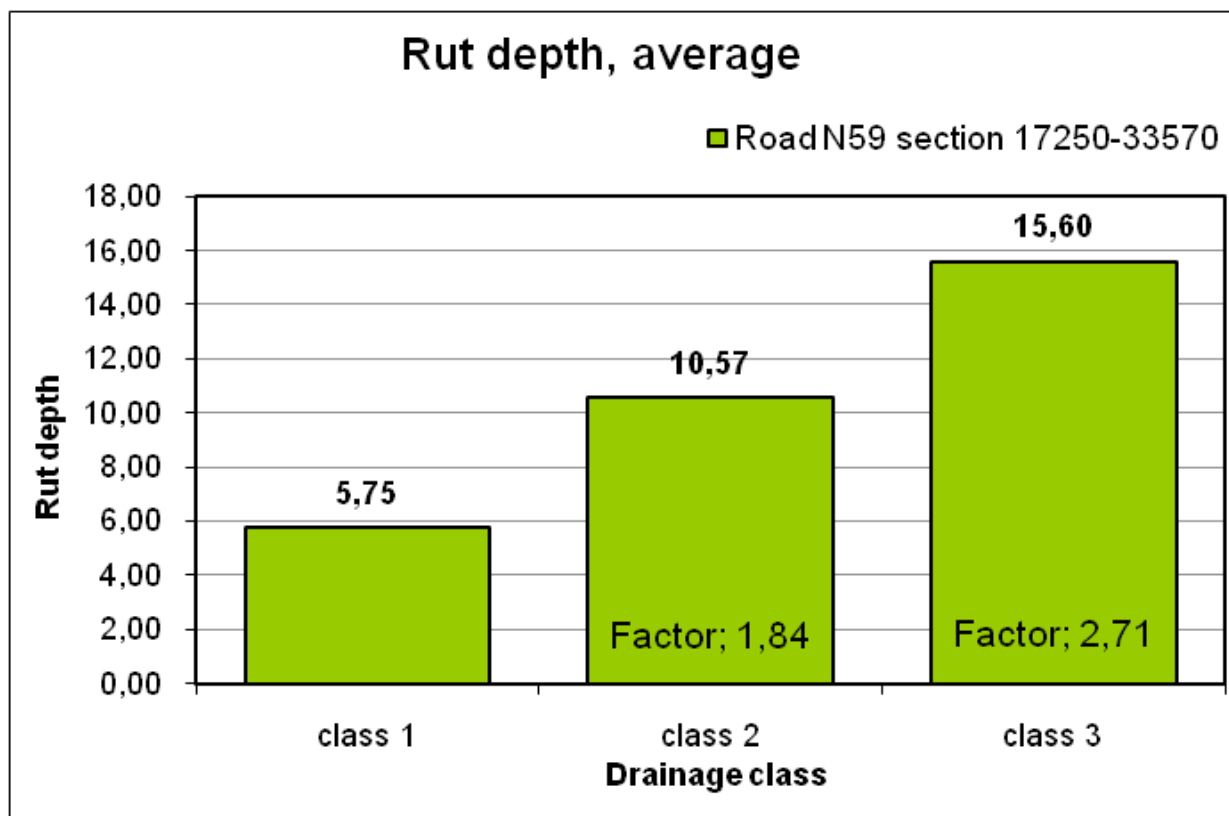


# ROADEx TOOLBOX FOR EFFECTIVE AND SUSTAINABLE ROAD CONDITION MANAGEMENT



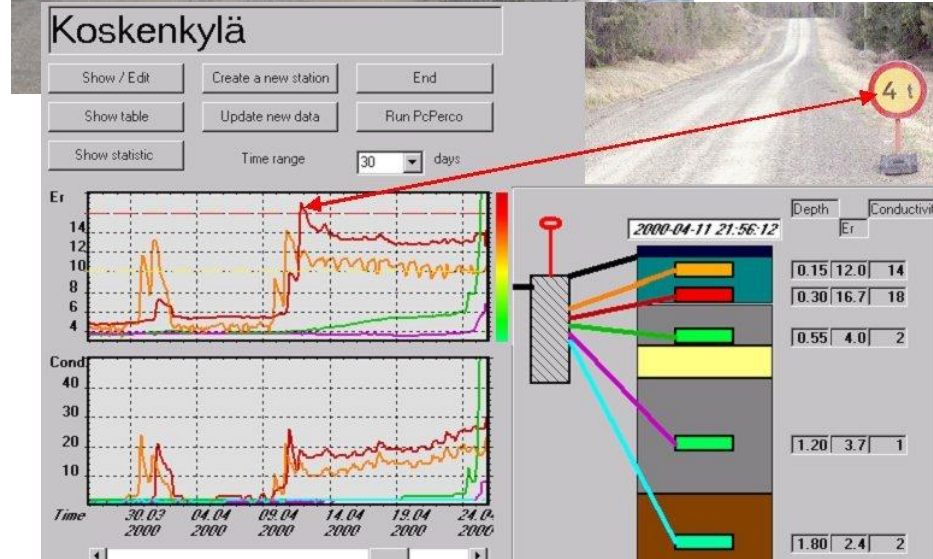
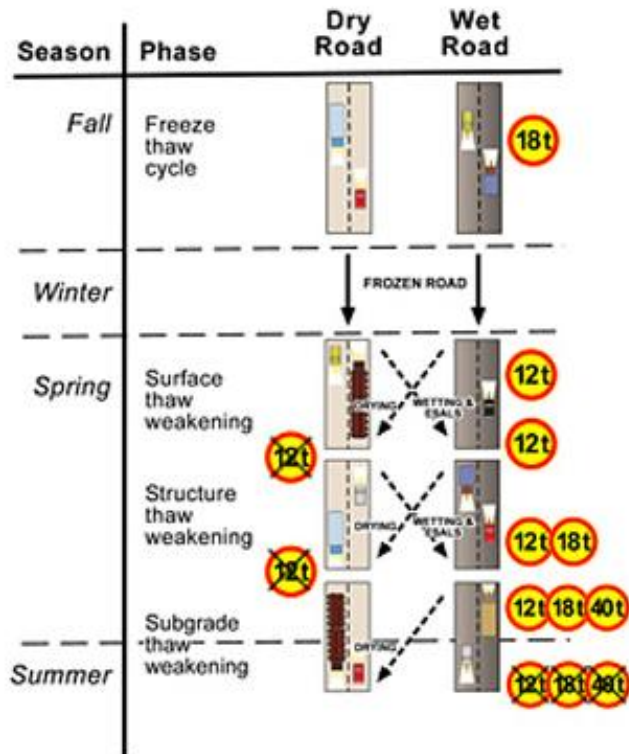
# The Role of Drainage in Permanent Deformation in Ireland

## Drainage Class and Average Rut Depth



# Road Monitoring and Load Restrictions Policy

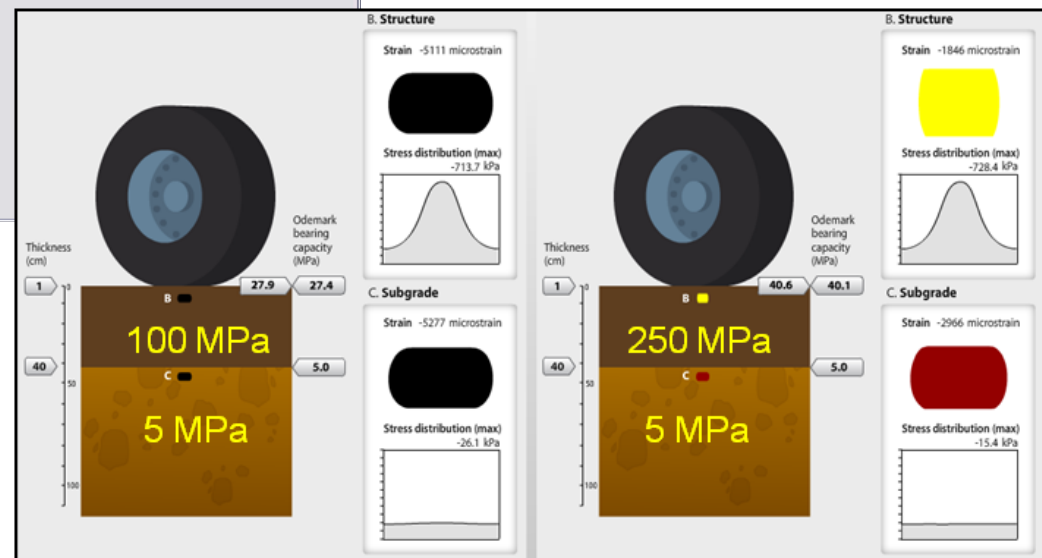
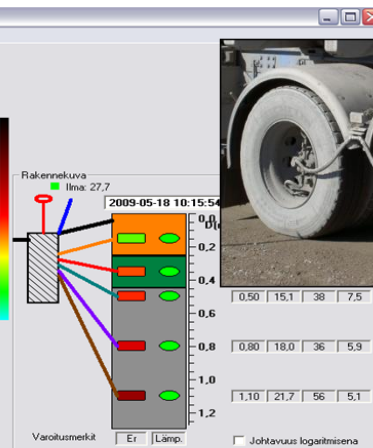
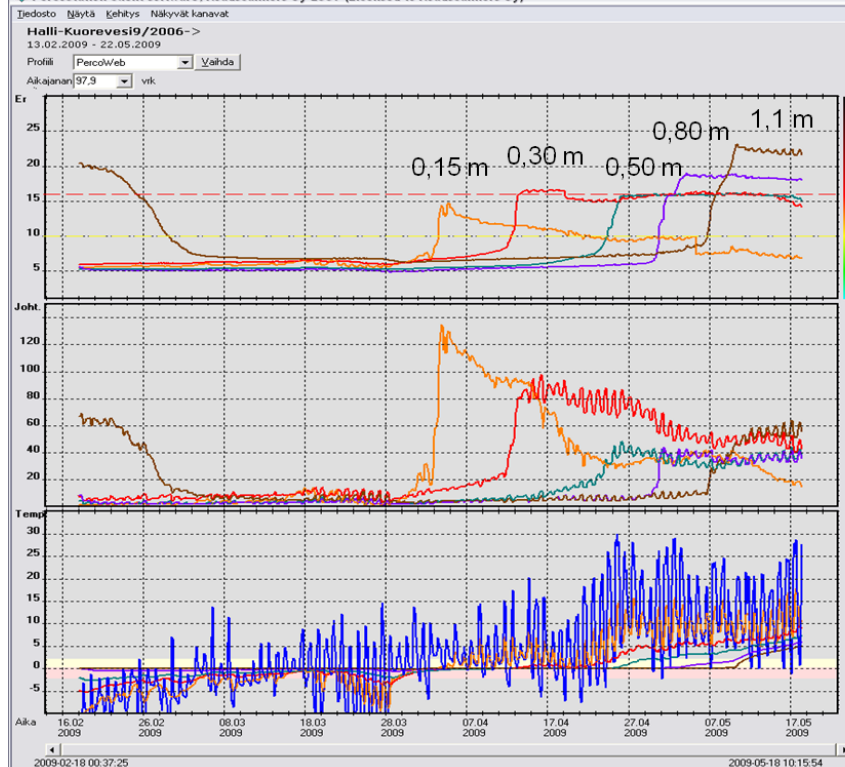
## Gravel Roads





# Road Monitoring and Load Restrictions Policy

PerceStation client software, Roadscanners Oy 2007 (Licensed to Roadscanners Oy)



# Thank You

