



# ROADEx

Implementing Accessibility

## ROADEx eLearning Package: Permanent Deformation



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**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

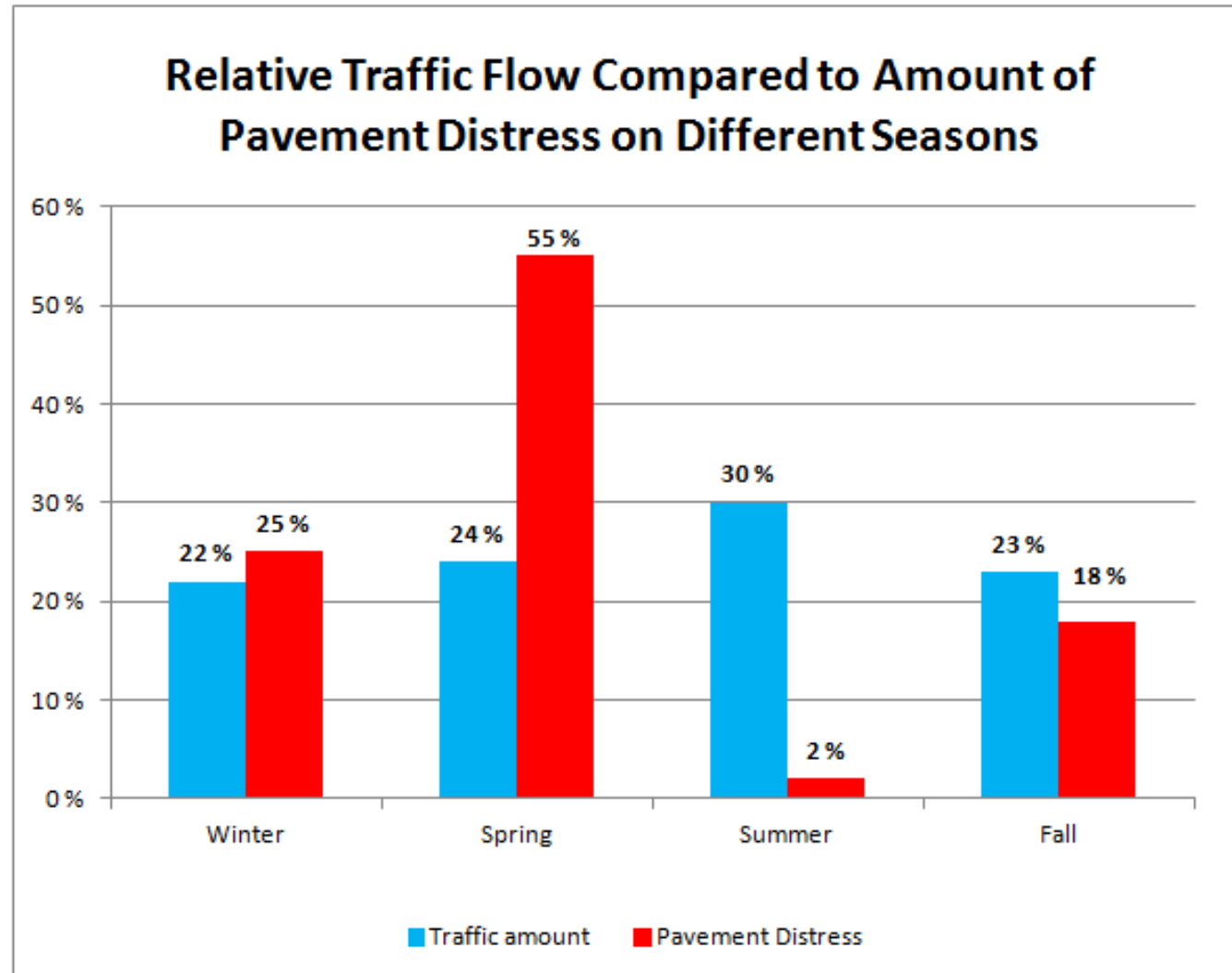


Elastic response

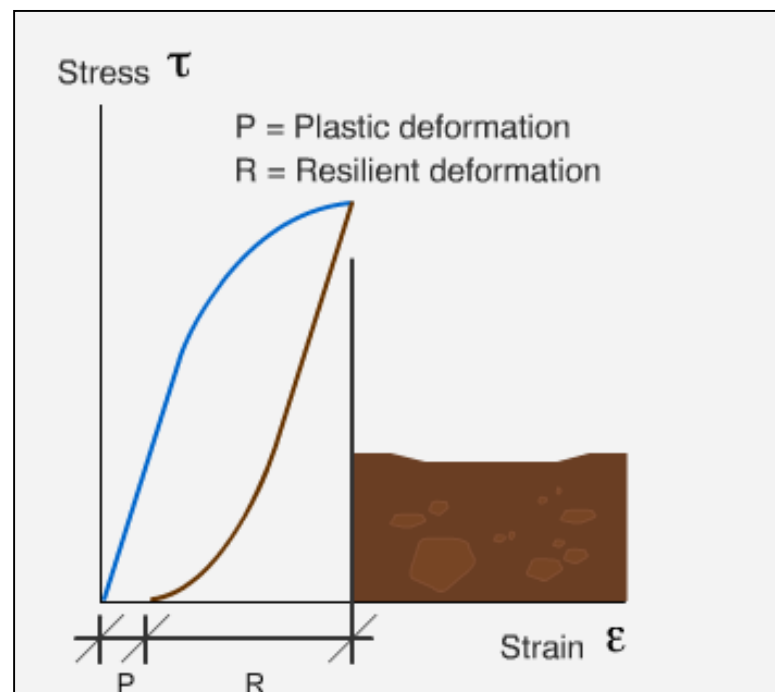
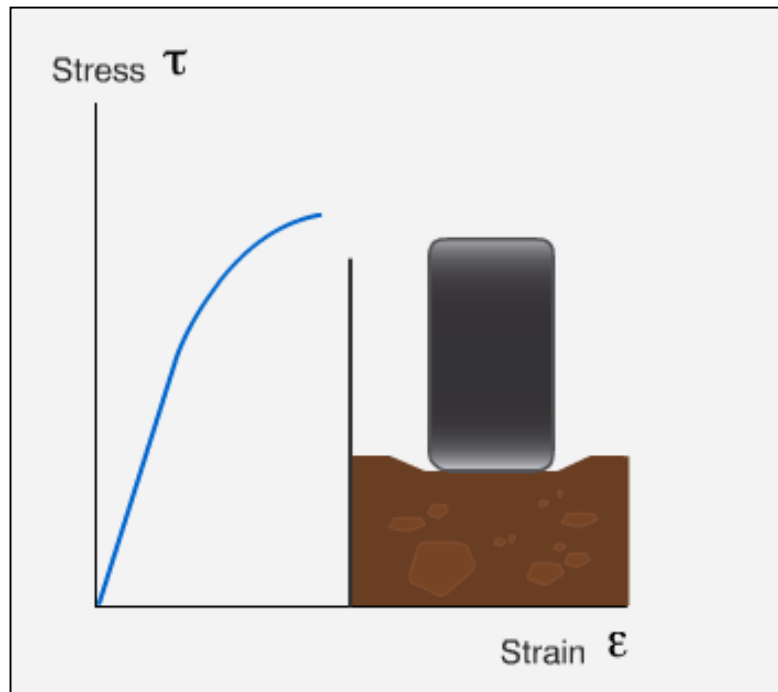
Permanent deformation



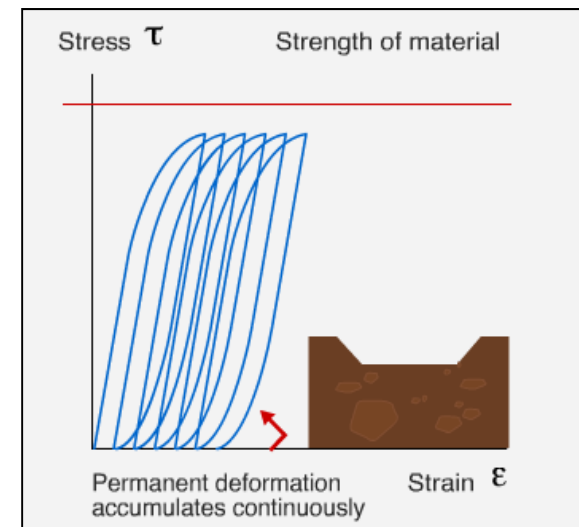
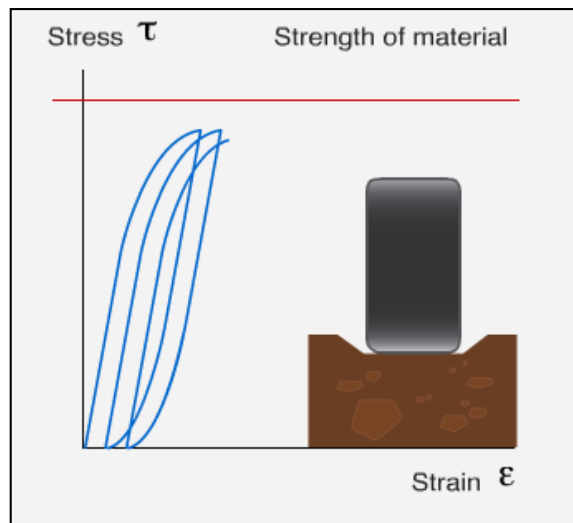
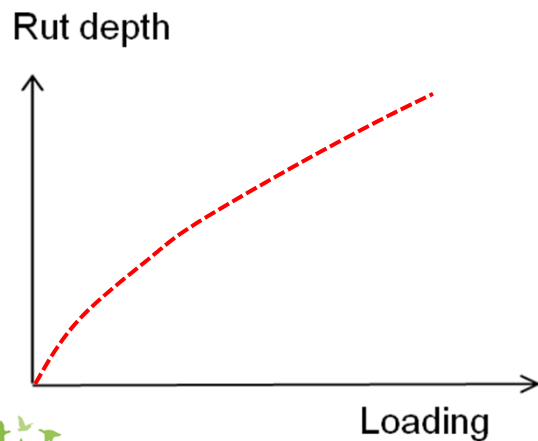
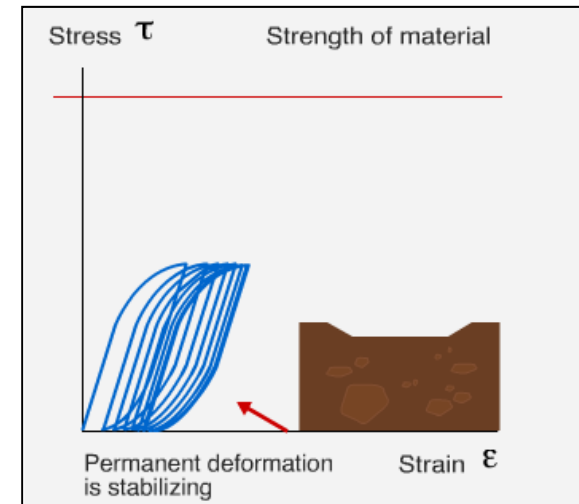
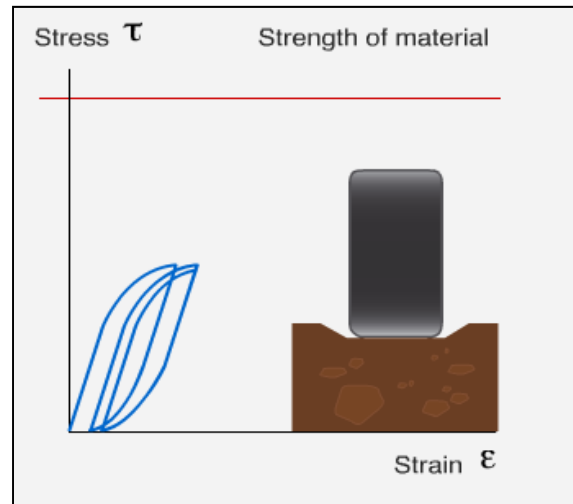
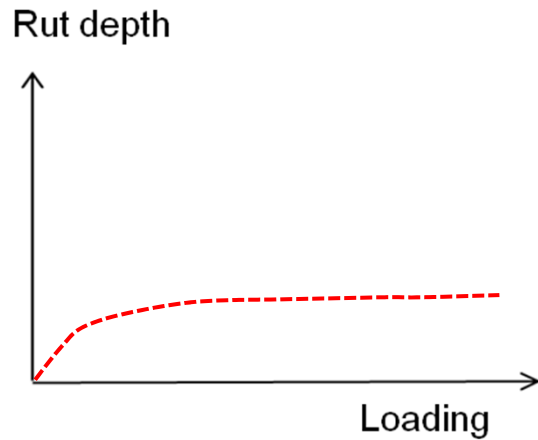
## Challenge: Understanding and Managing Seasonal Changes and Permanent Deformation in Road Deterioration



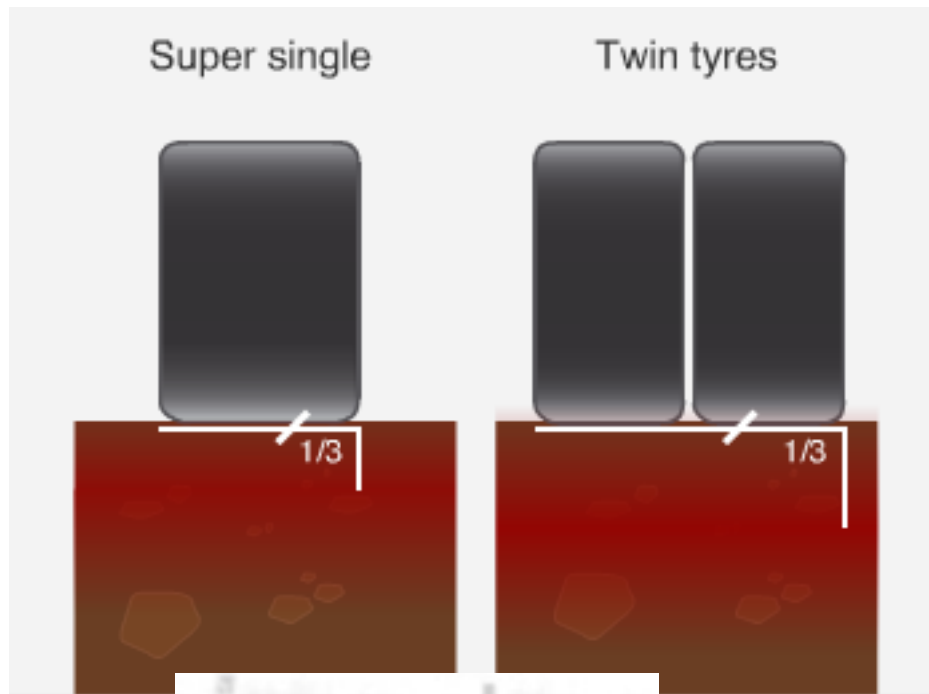
# What is Permanent Deformation



# Permanent Deformation and Repeated Loading



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



Dual



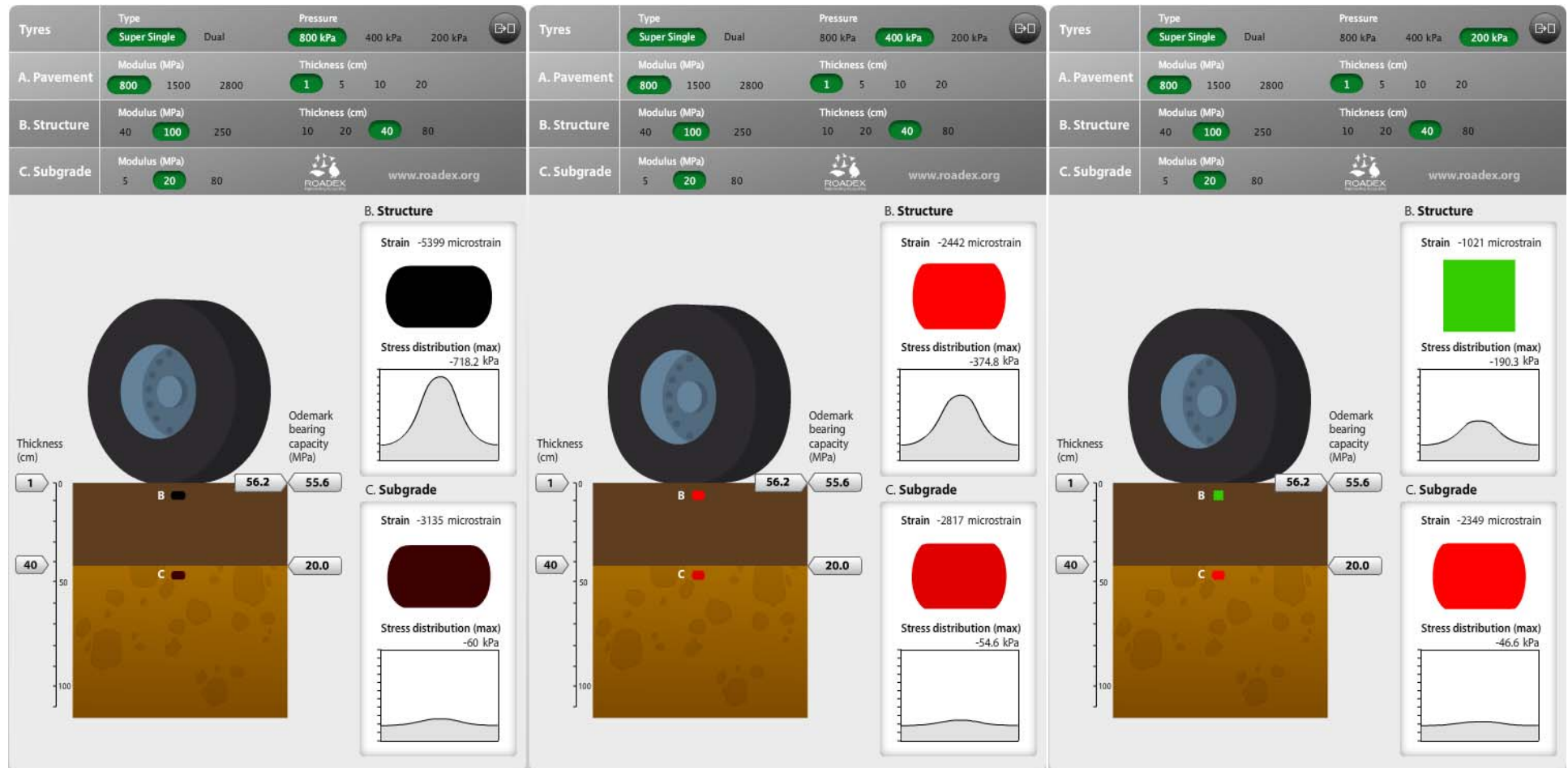
Maxi



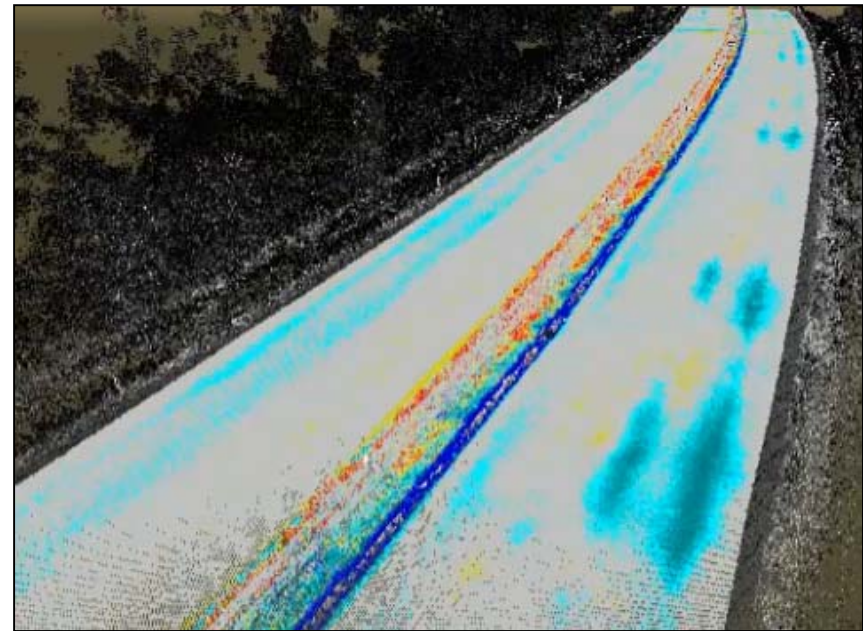
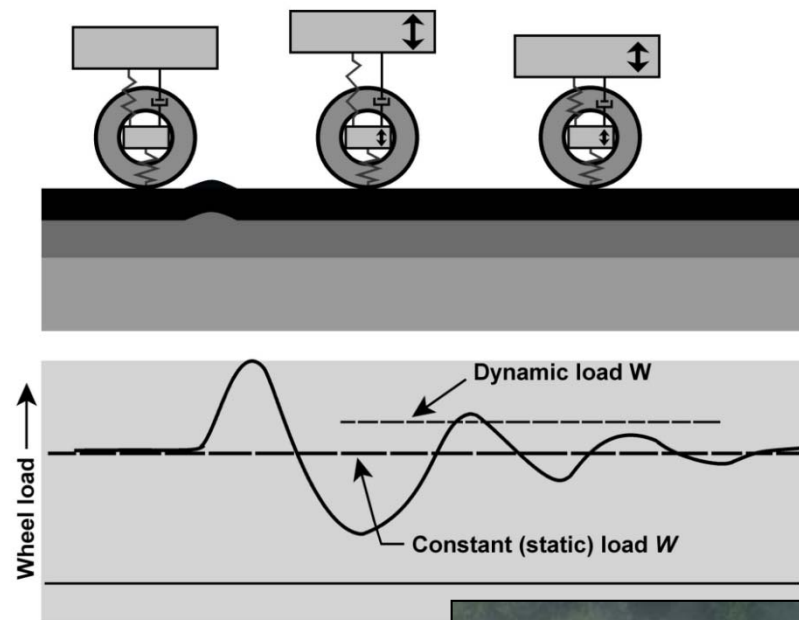
Super Single



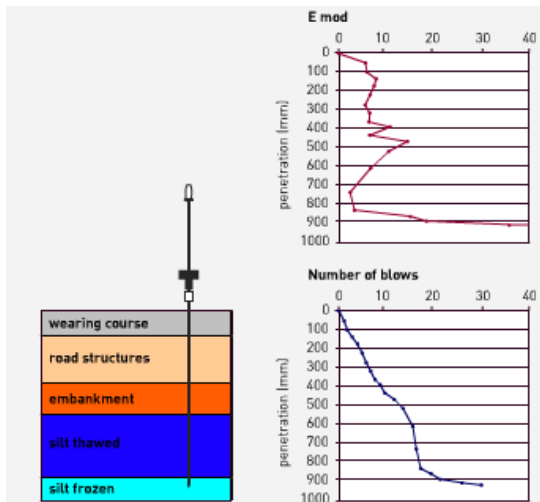
# The Effect of Tyre Pressure Control System (TPCS / CTI) to Stresses and Strains



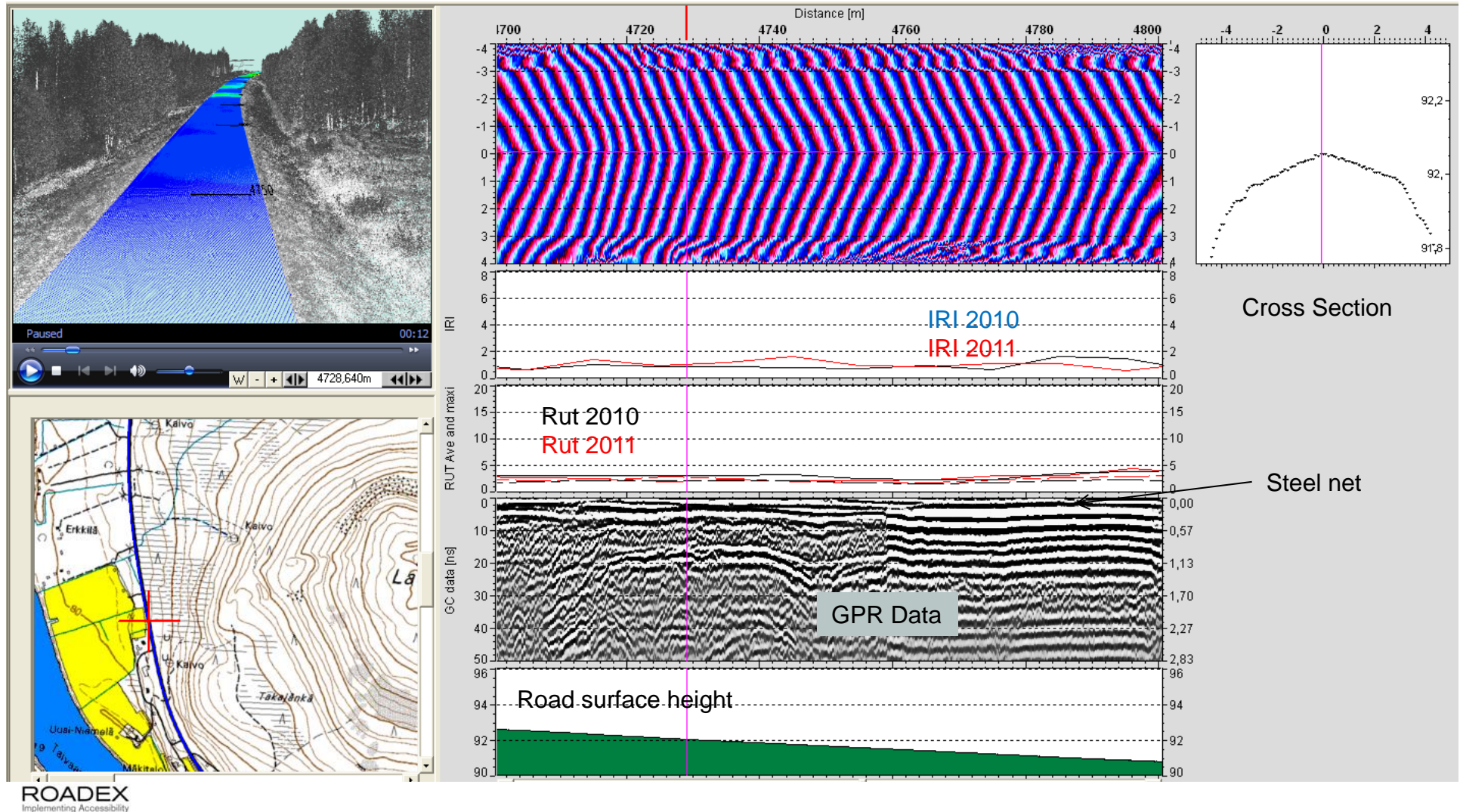
# Dynamic Loading and Permanent Deformations



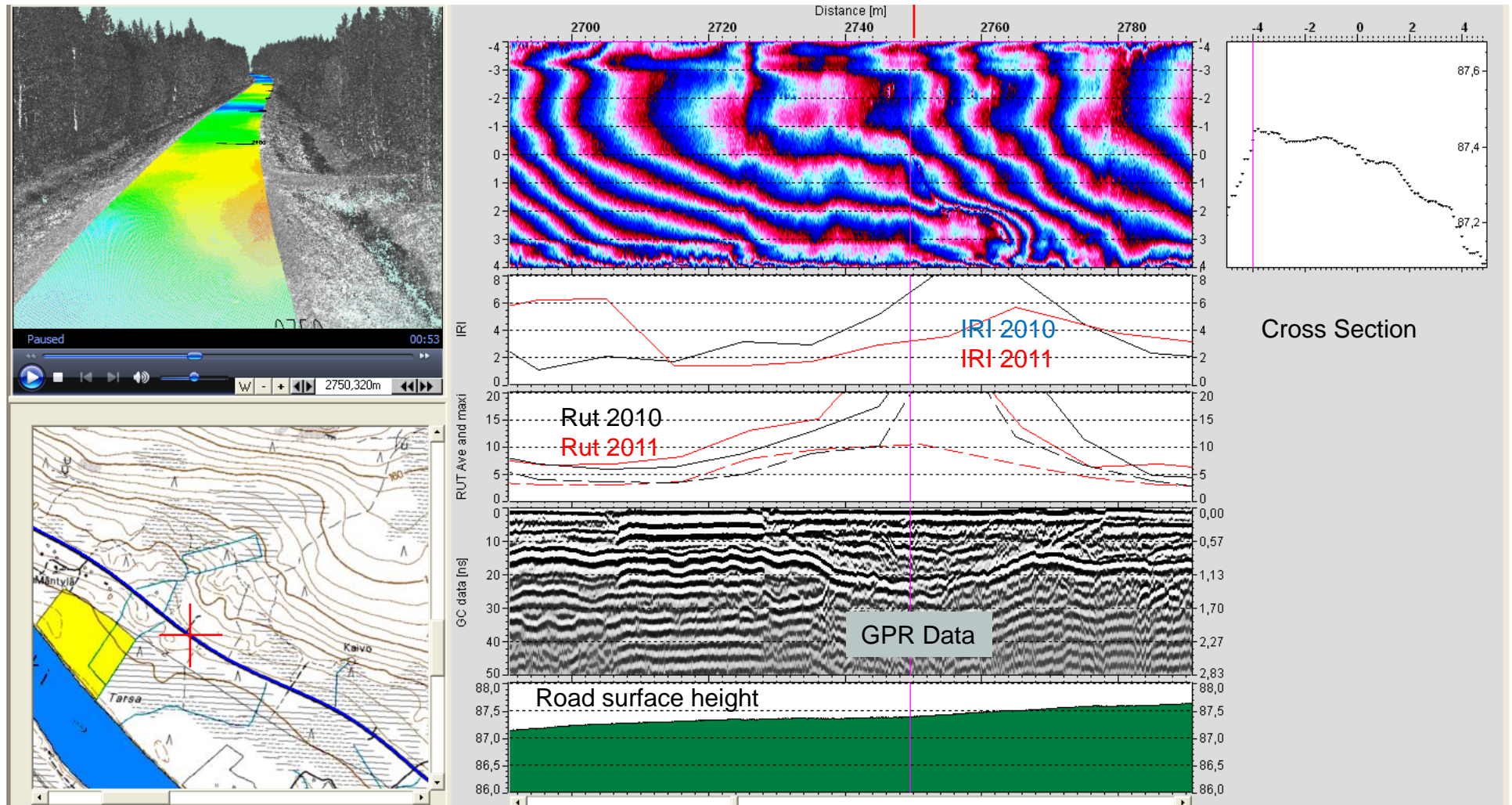
# New Techniques in Road Diagnostics: 2D/3D GPR, Digital Videos, 3D Videos, High Precision Thermal Cameras, Laser Scanners, Lidars



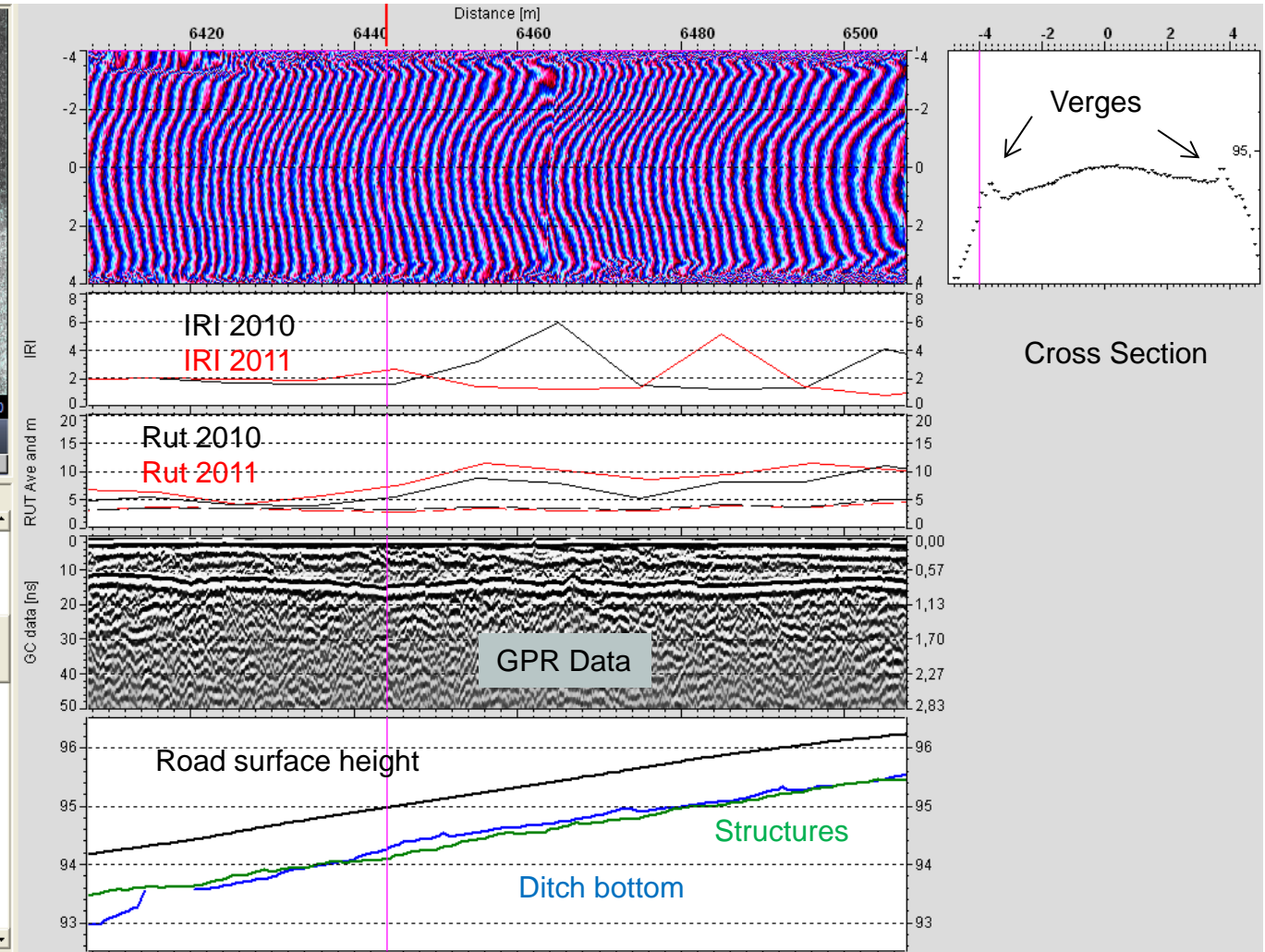
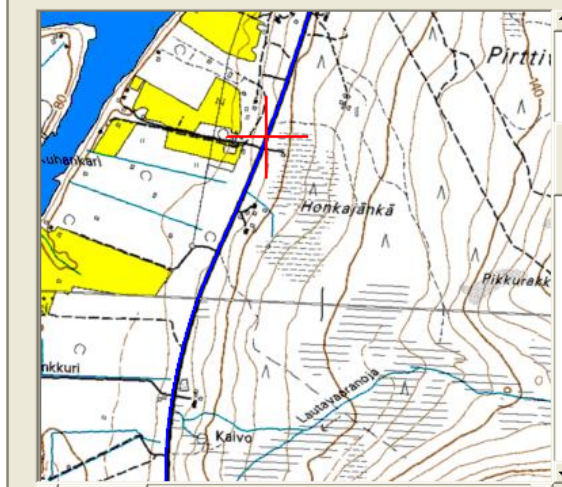
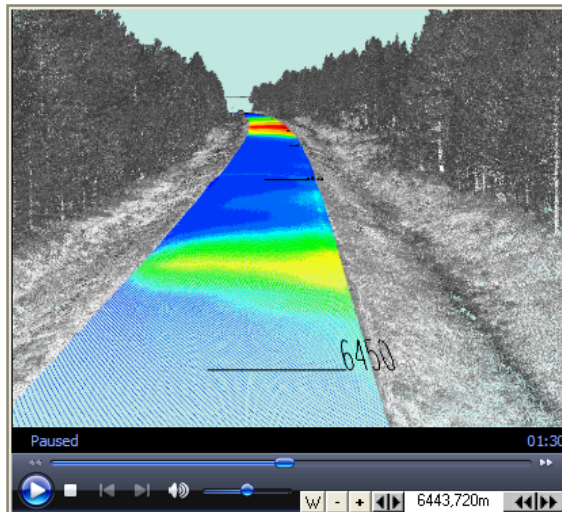
# Integrated Road Data Analysis and Diagnostics



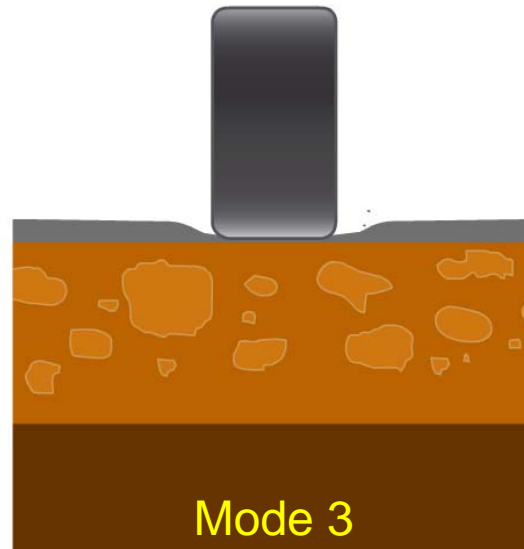
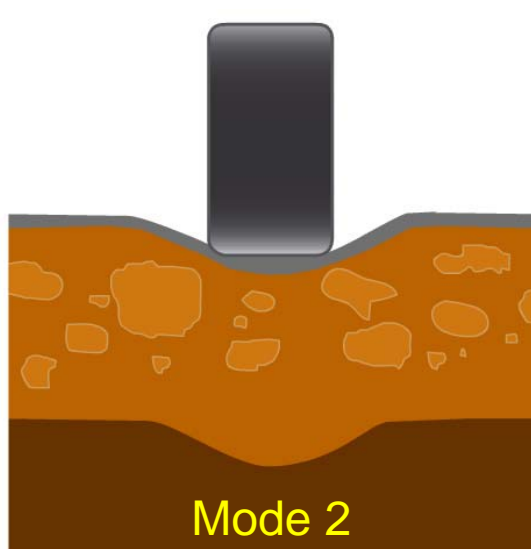
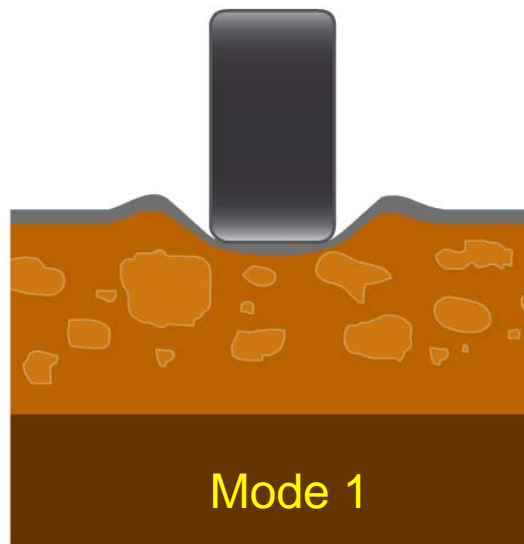
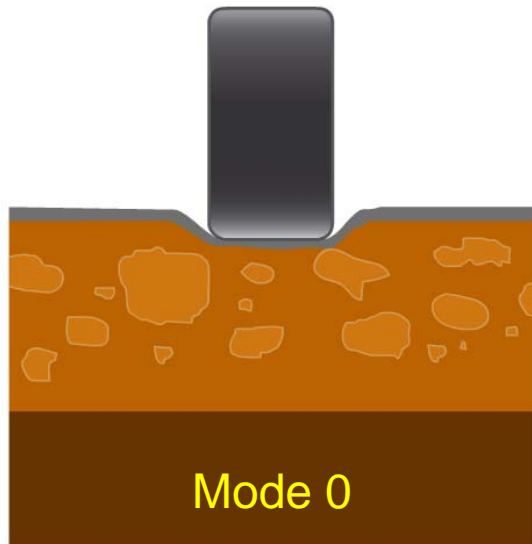
# Integrated Road Data Analysis and Diagnostics



# Integrated Road Data Analysis and Diagnostics



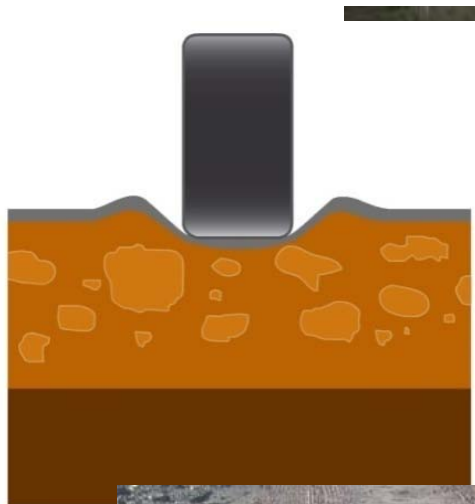
# RUTTING MODES PROPOSED BY ROADDEX



In addition diagnosis should cover:

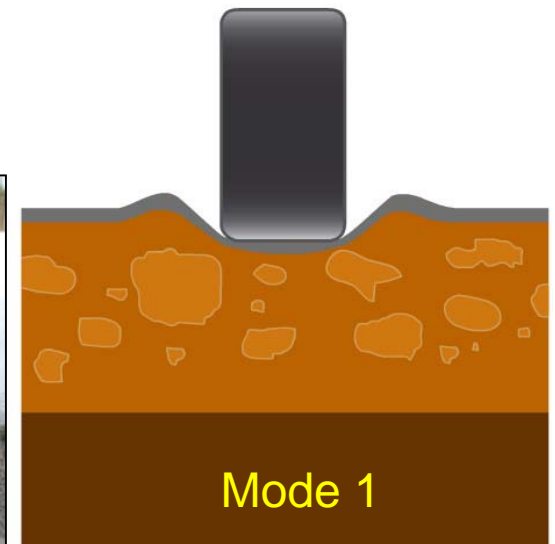
- frost damages
- geotechnical problems
- drainage related problems
- construction faults

# Mode 1 Rutting Problems

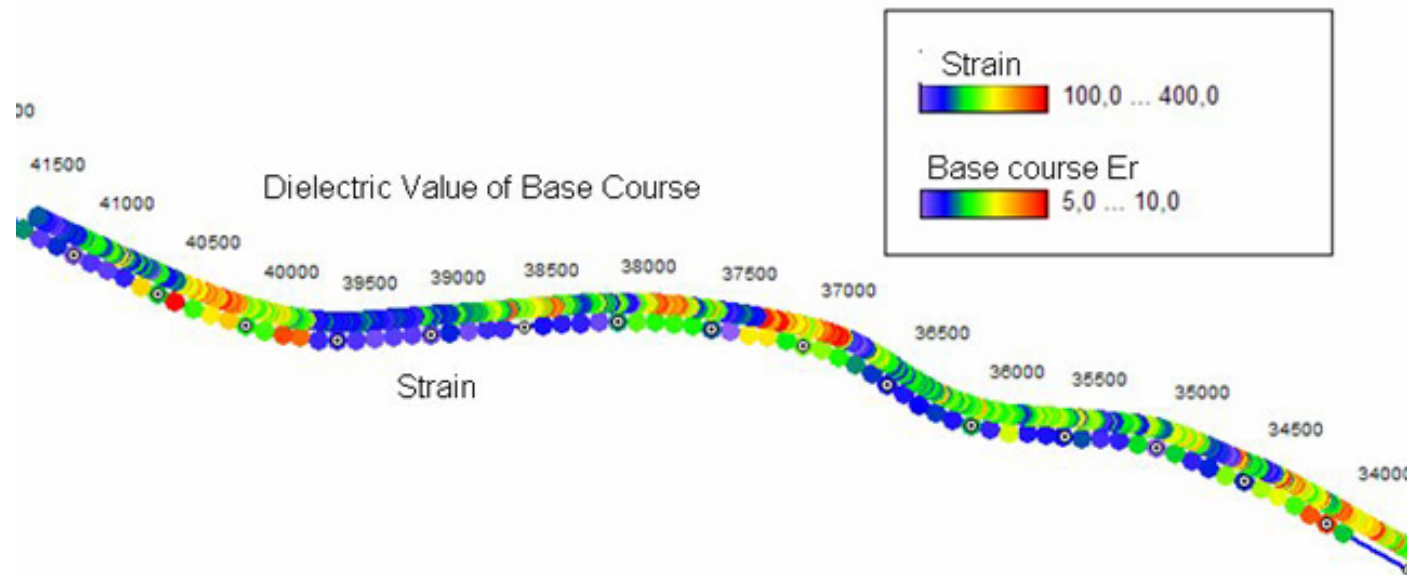
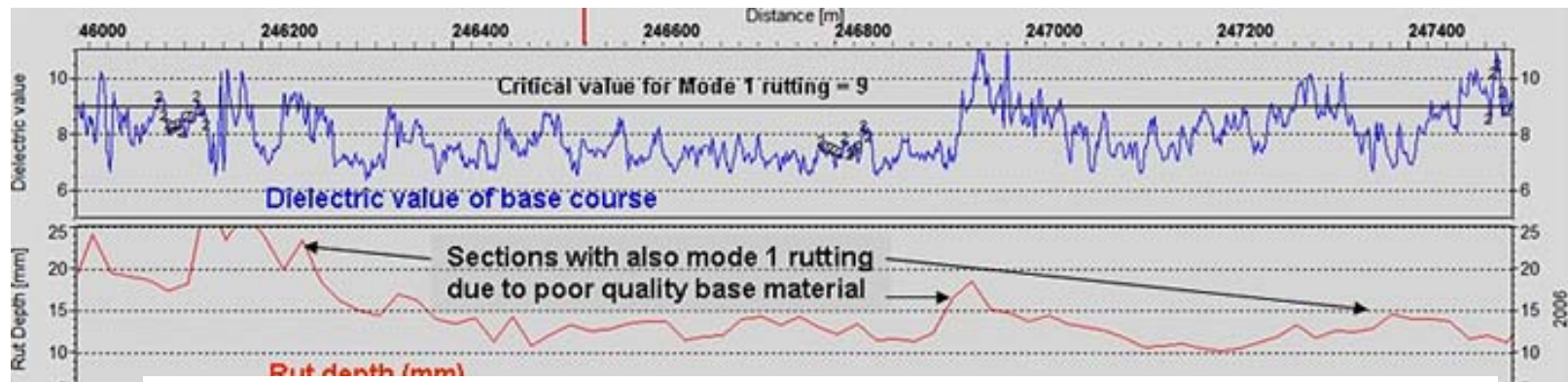


# DETECTING MODE 1 RUTTING ON PAVED ROADS

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

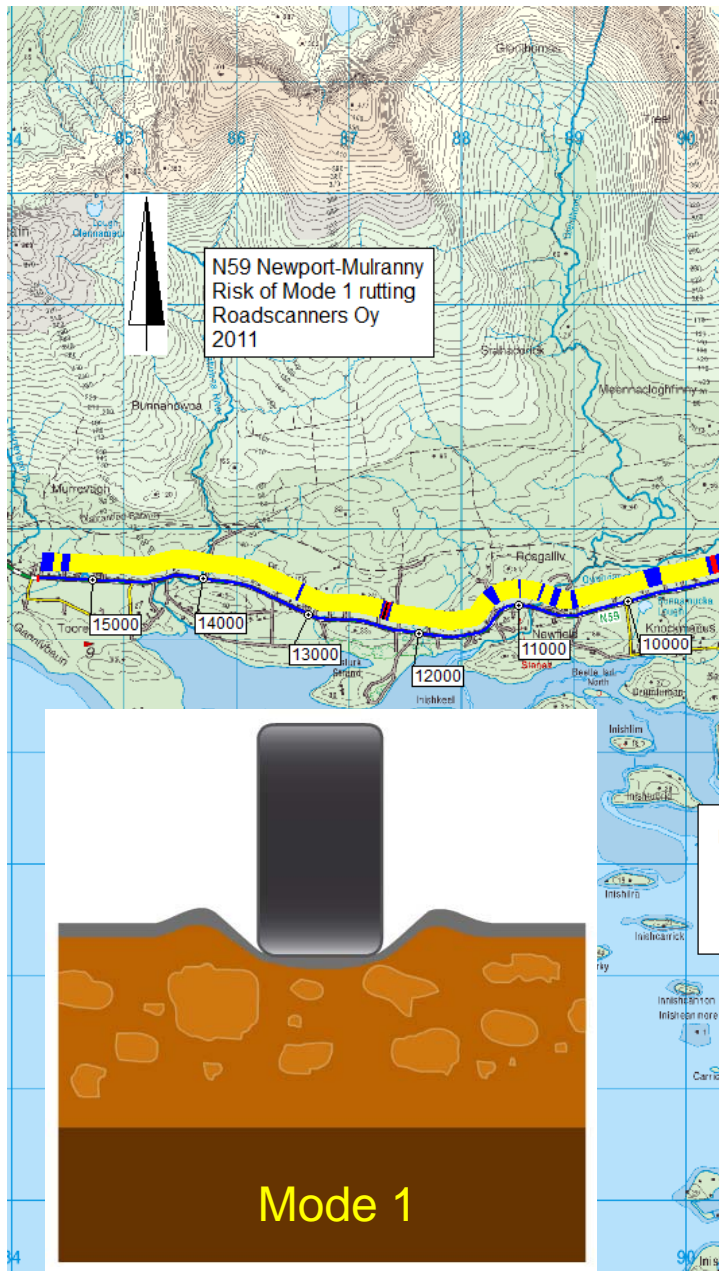


# Indications of Mode 1 Rutting Problems

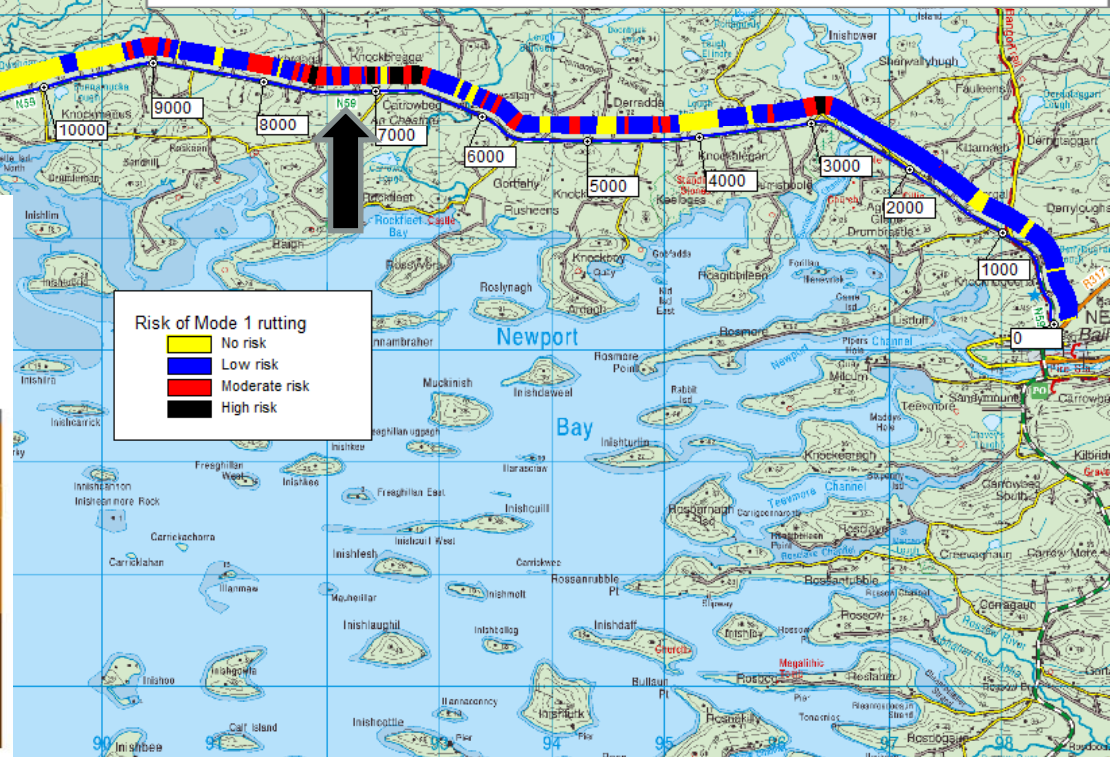
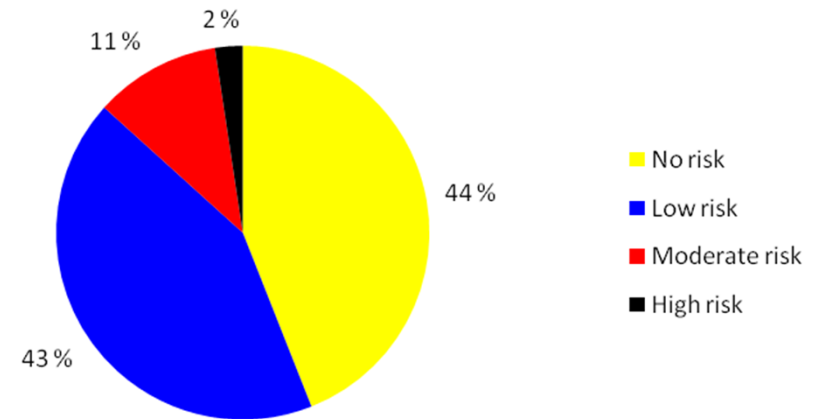


N59

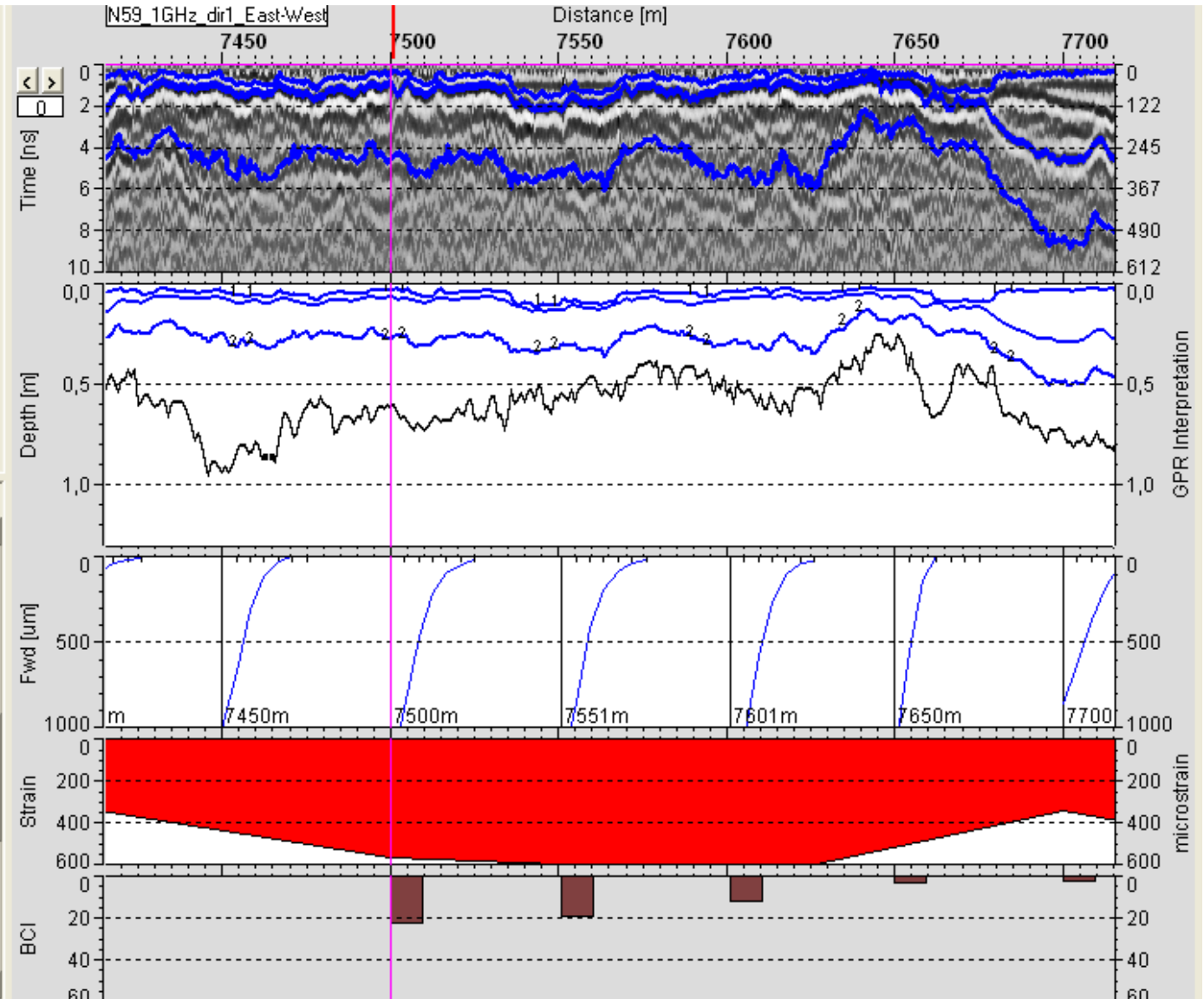
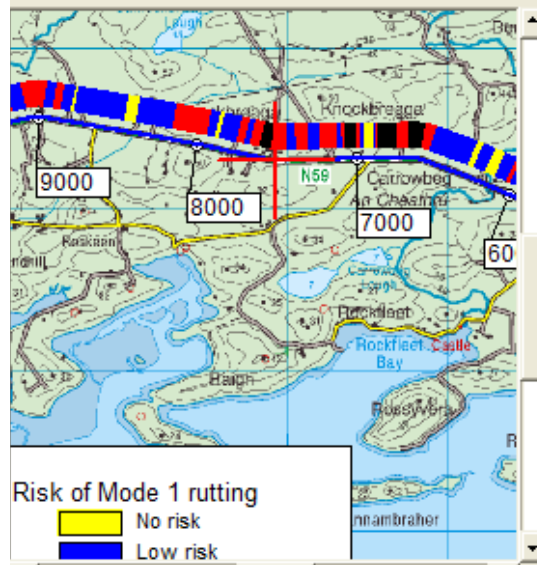
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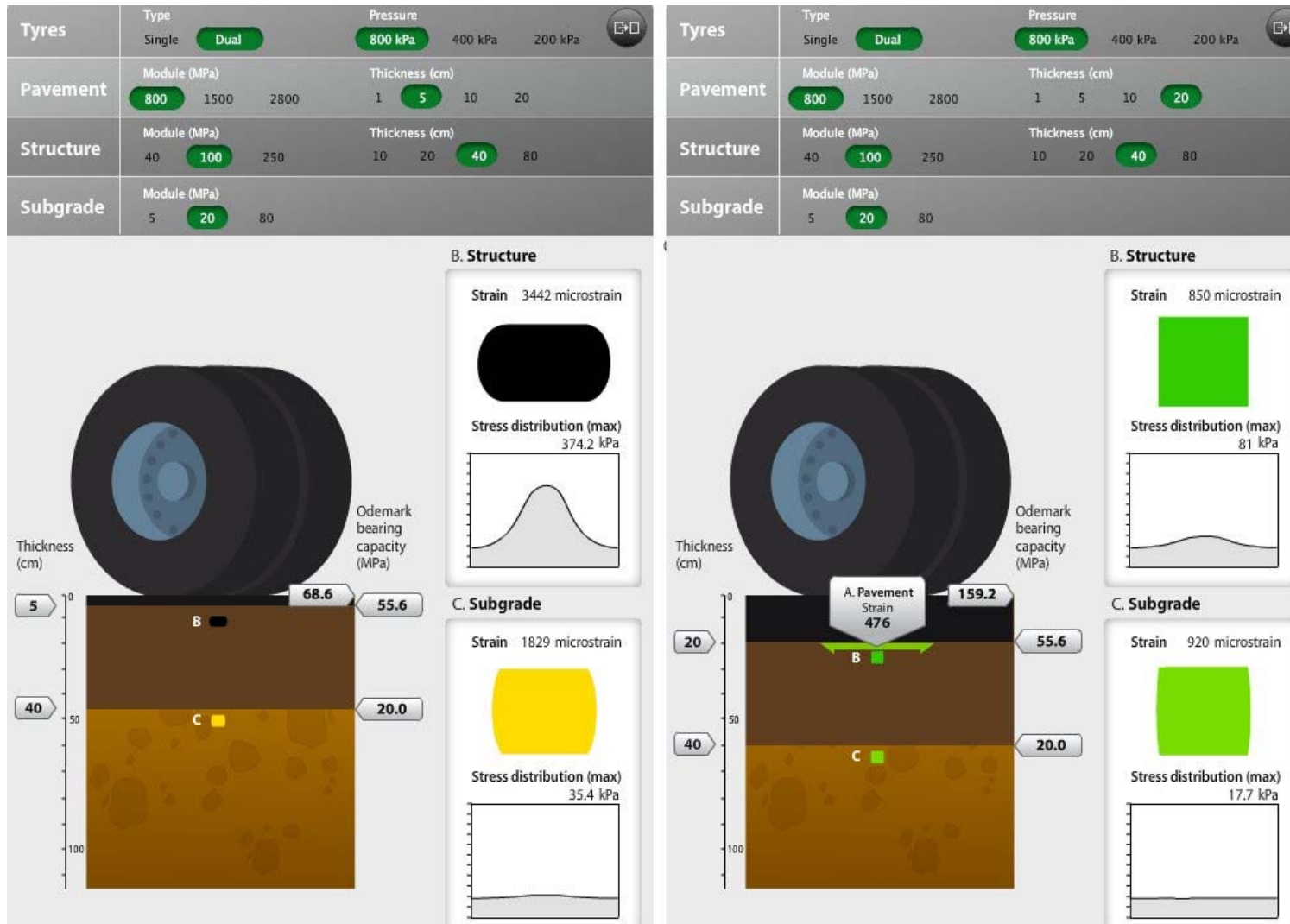
## Risk of Mode 1 rutting



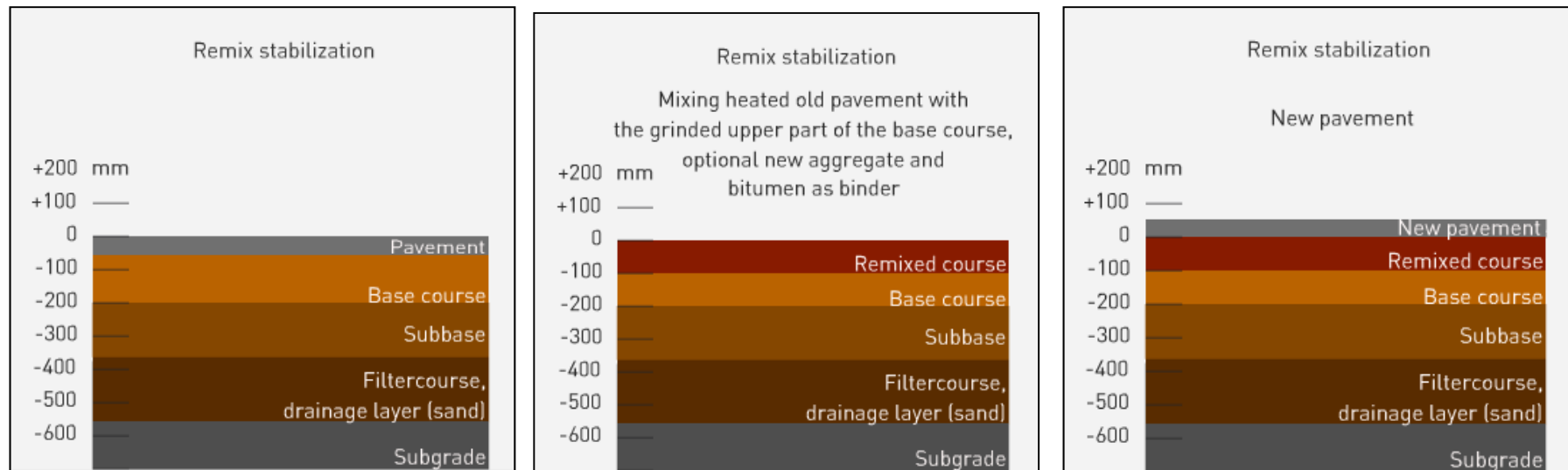
# N59: 7500 m



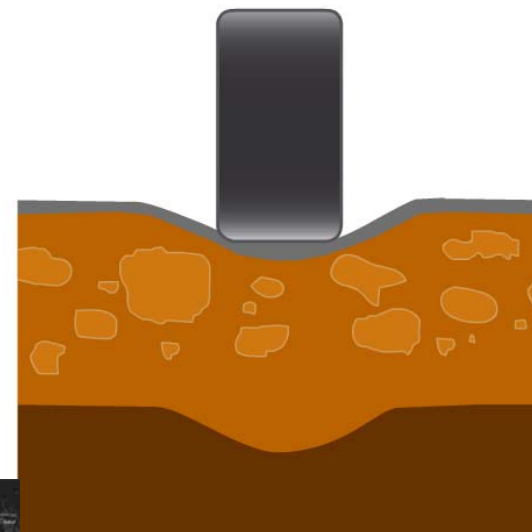
# Pavement Thickness and Mode 1 Rutting Risk



# Solution for Mode 1 Rutting Problems

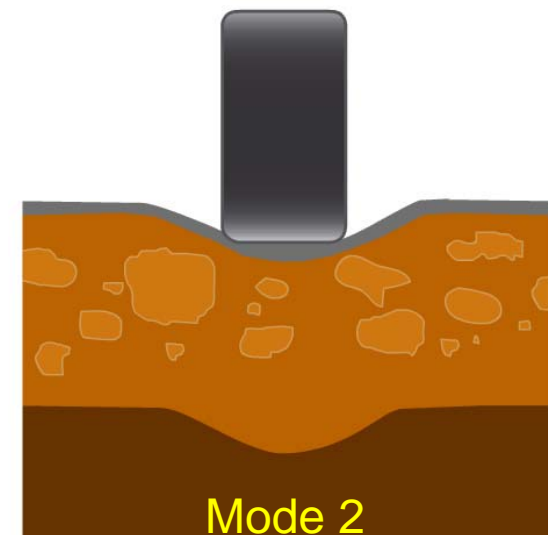
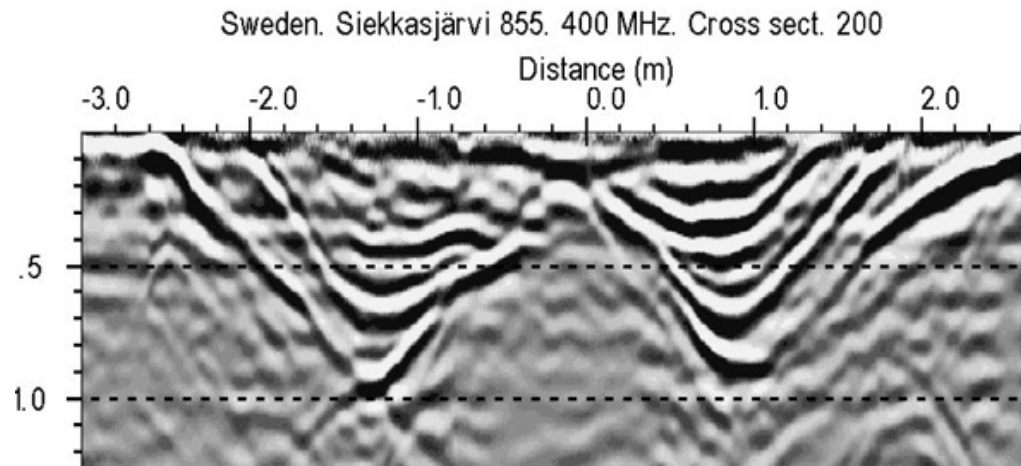


# Mode 2 Rutting Problems

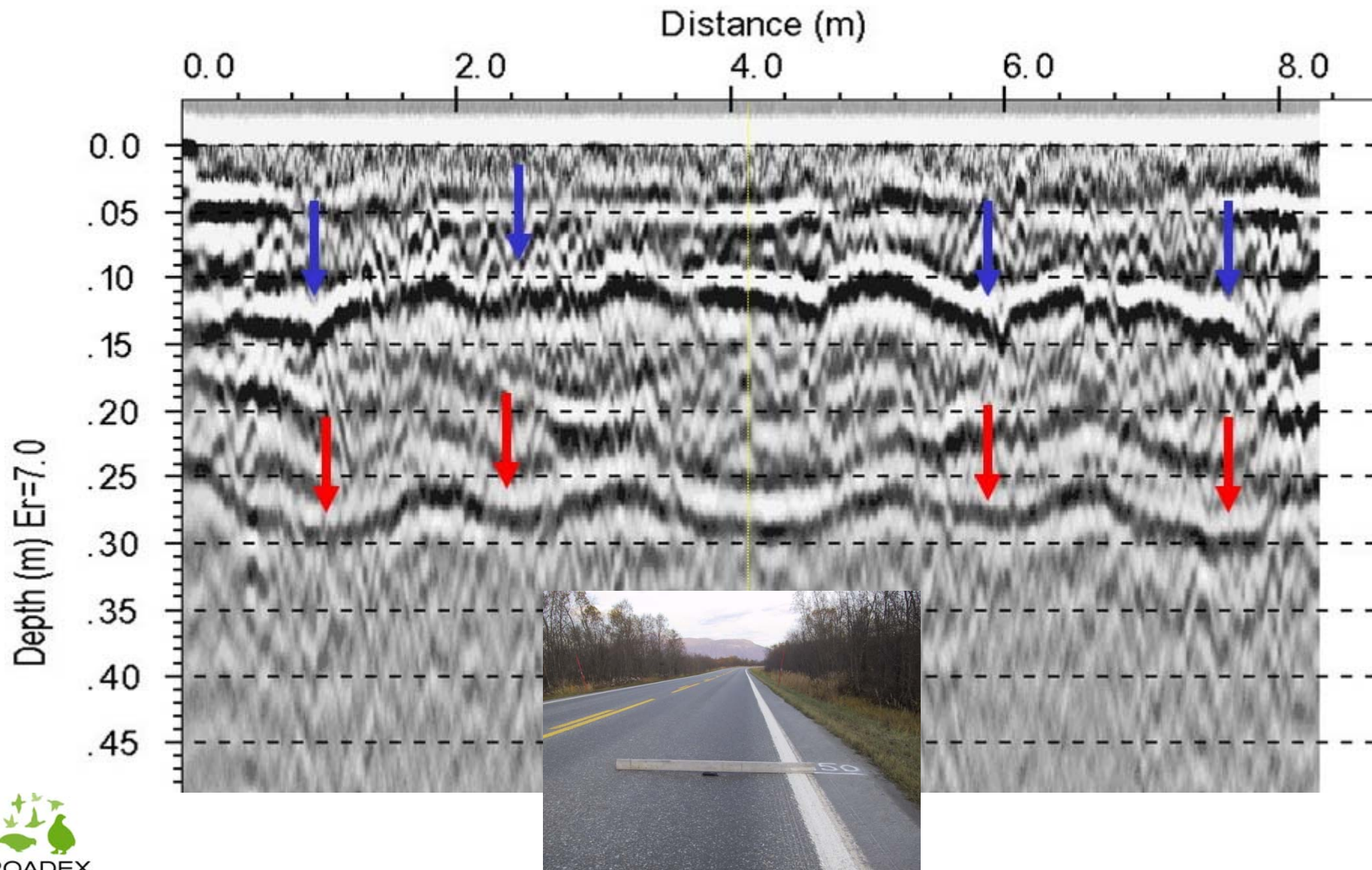


# DETECTING MODE 2 RUTTING ON PAVED ROADS

1. GPR CROSS SECTIONS
2. BCI AND SUBGRADE MODULI

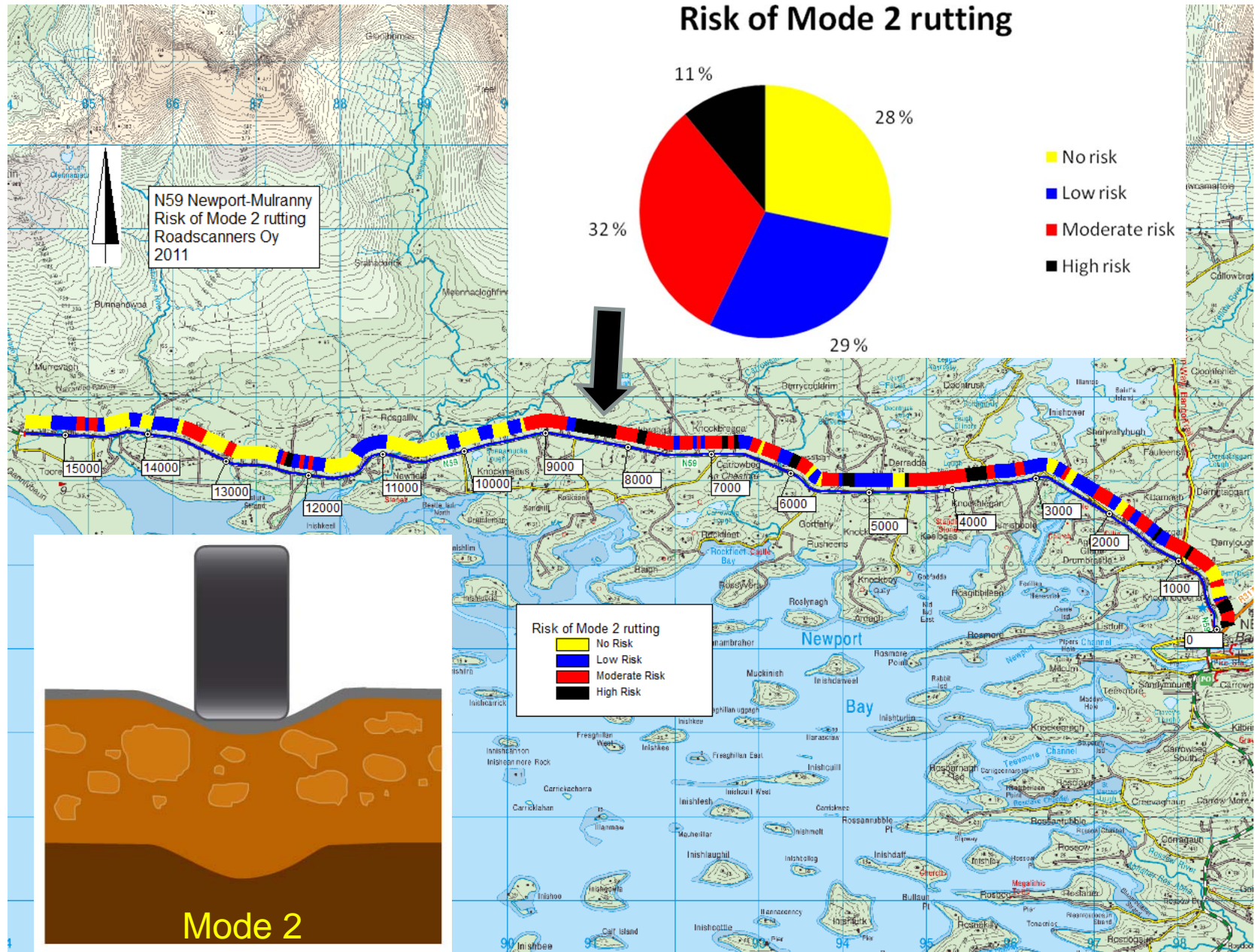


# DETECTING MODE 2 RUTTING ON PAVED ROADS

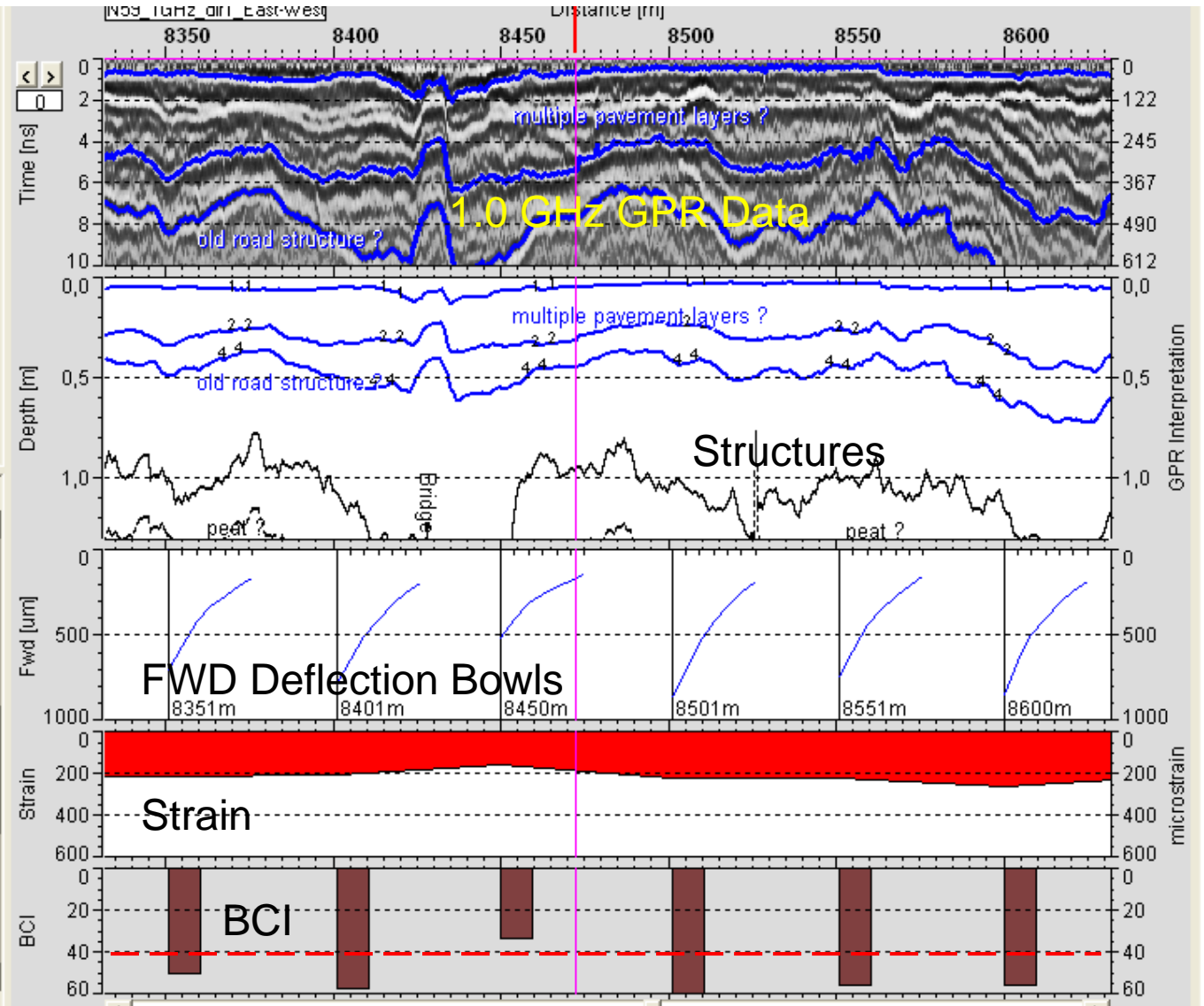
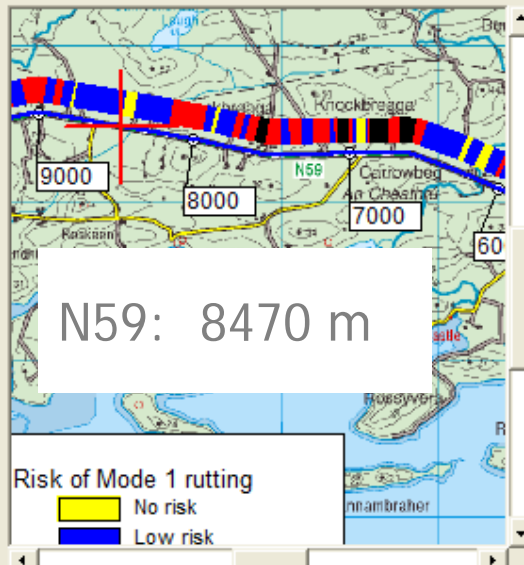


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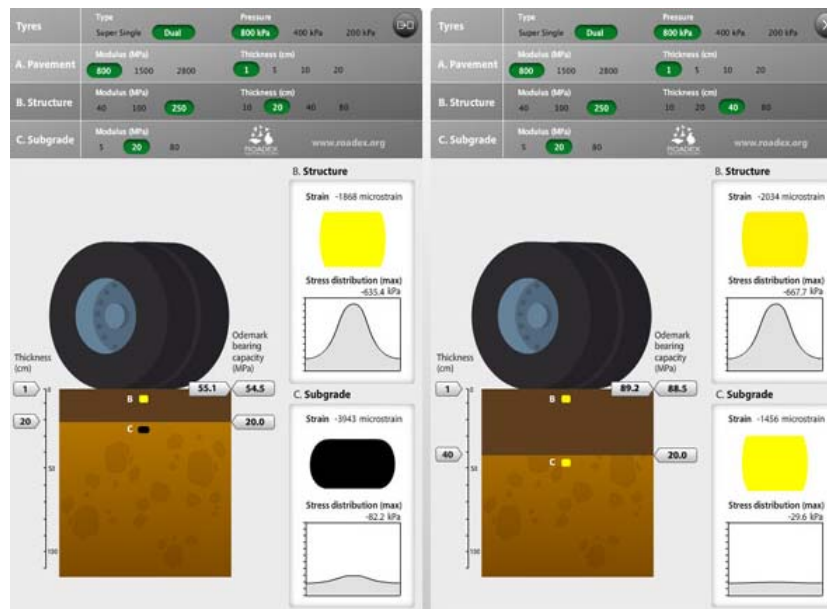
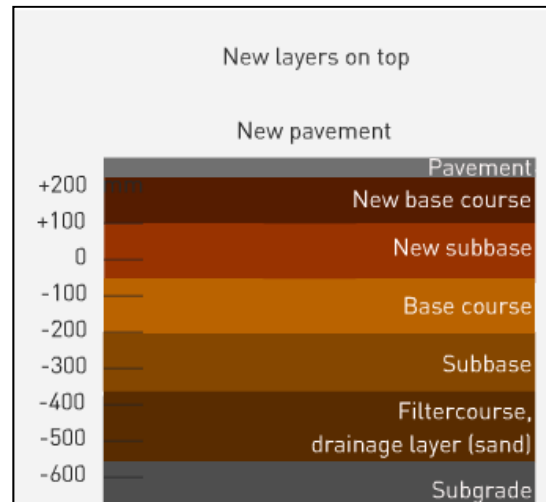
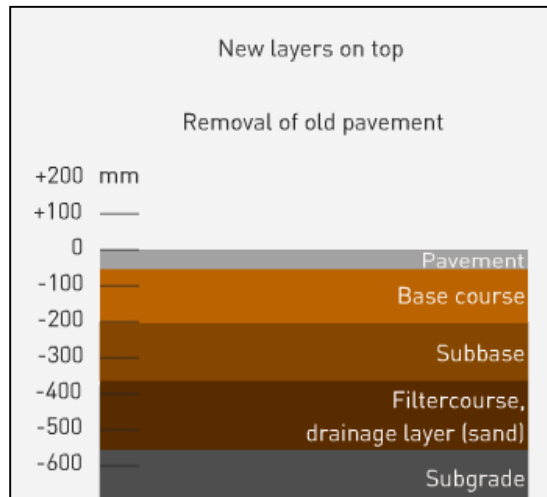
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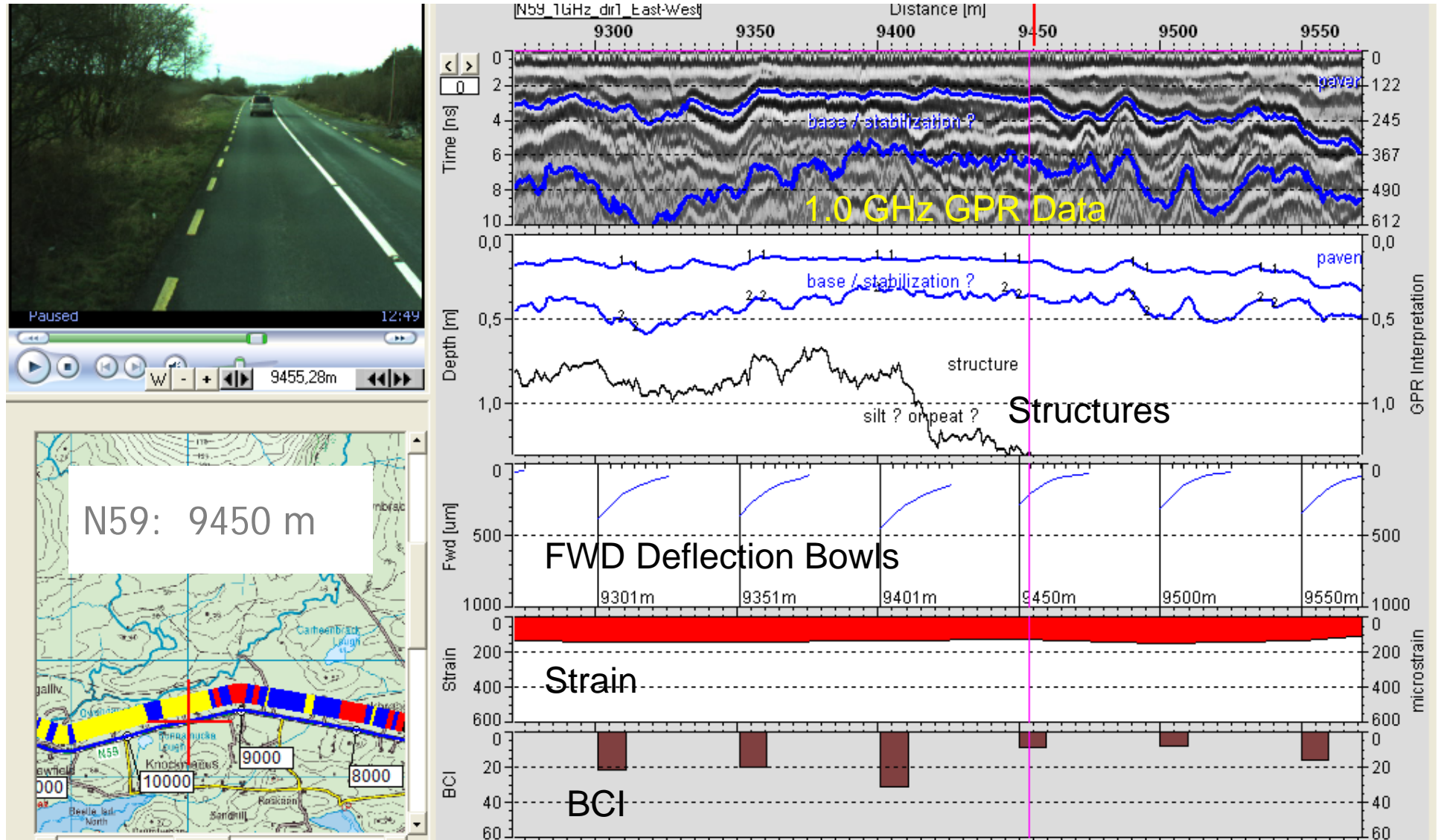
# High Risk for Mode 2 Rutting



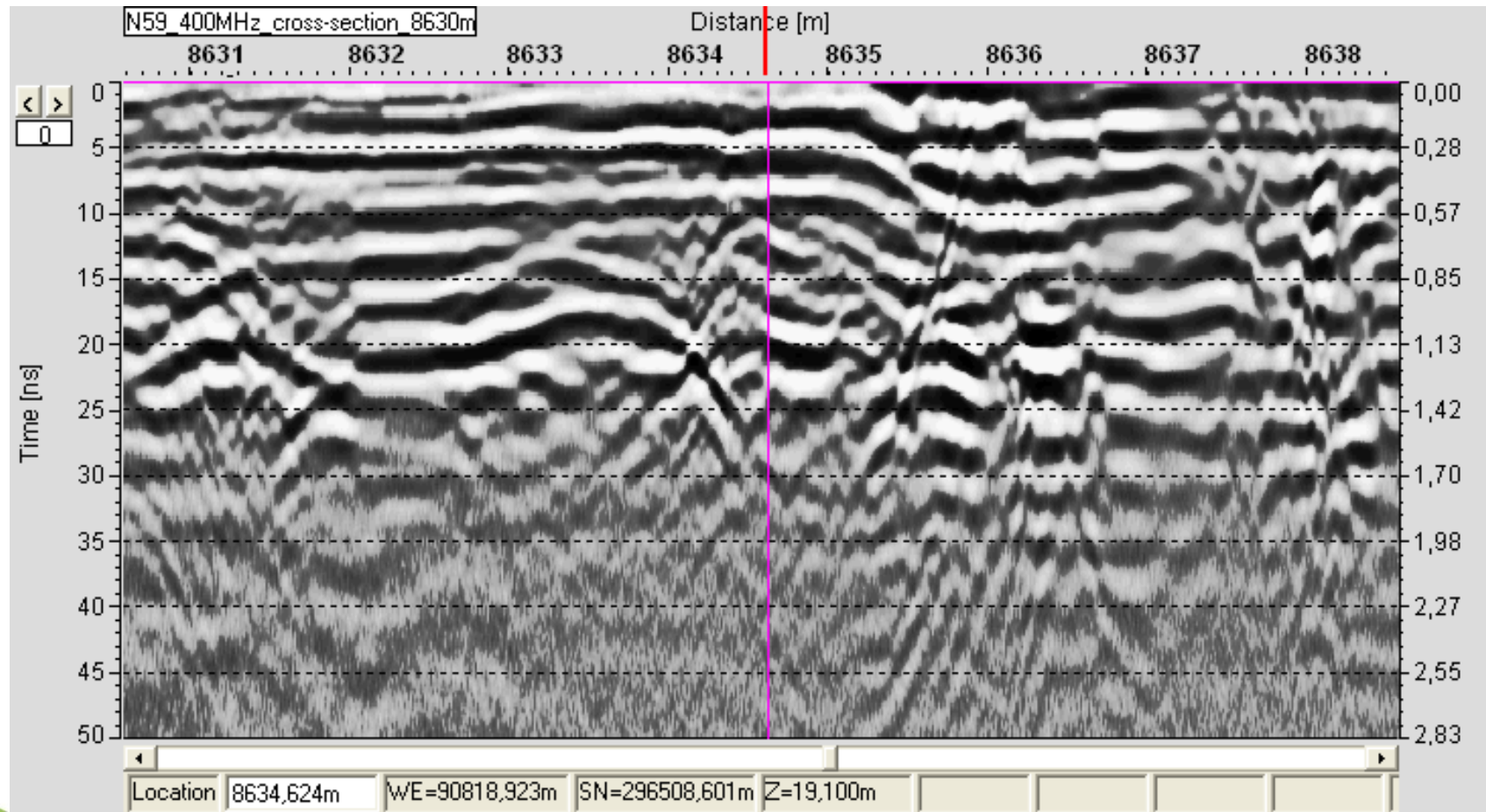
# Solution for Modes 2 Rutting Problems



# No Risk for Mode 1 and Mode 2 Rutting

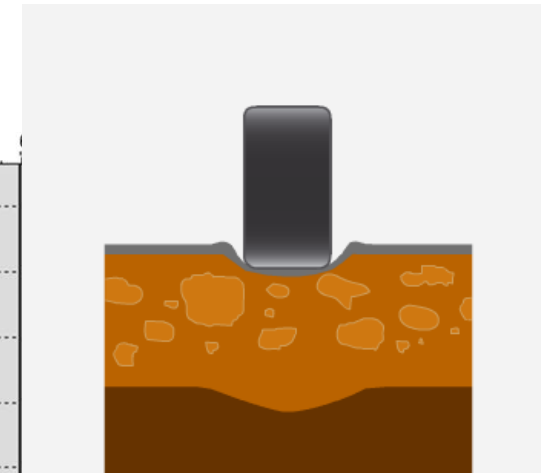
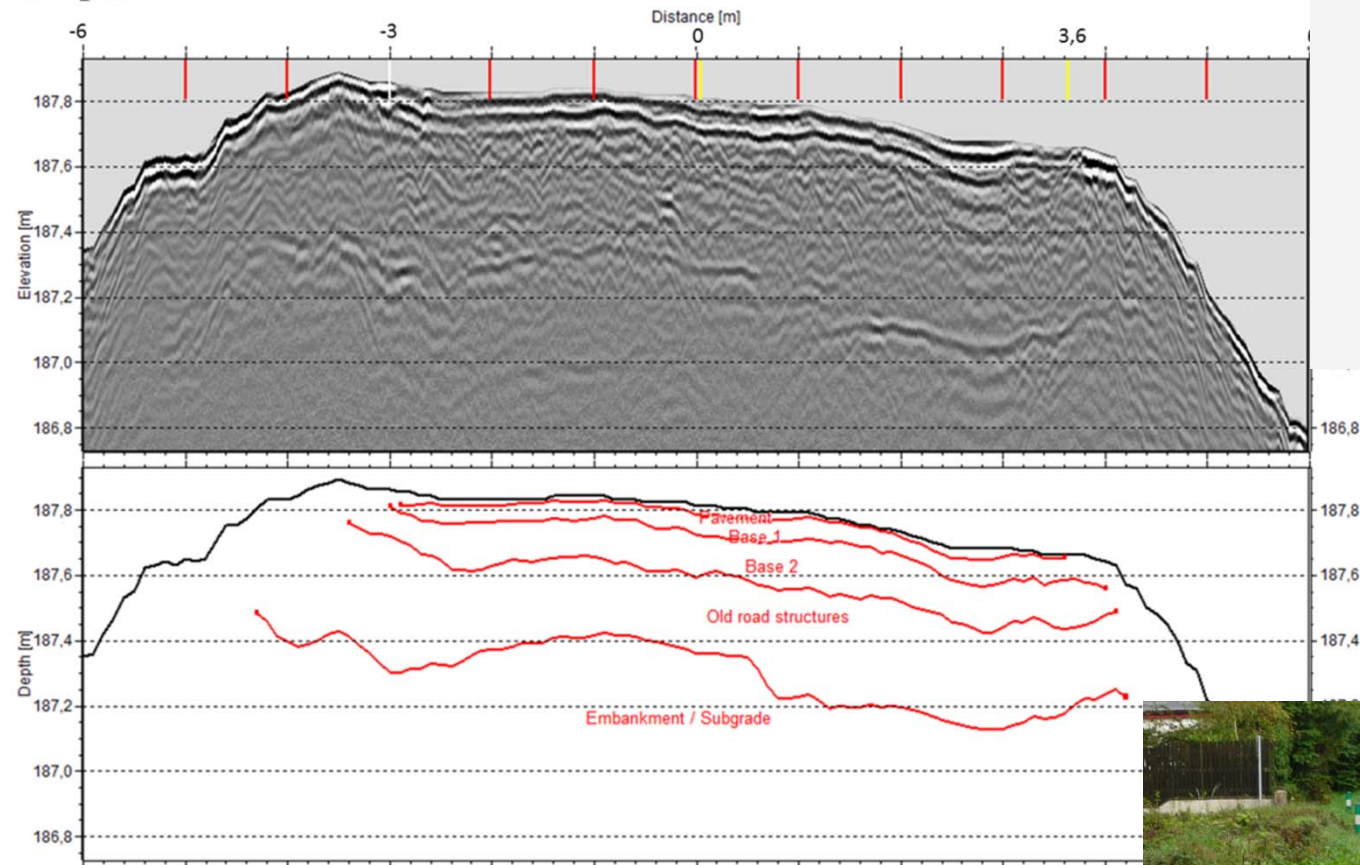


# Road Cross Section and Deformation Risk



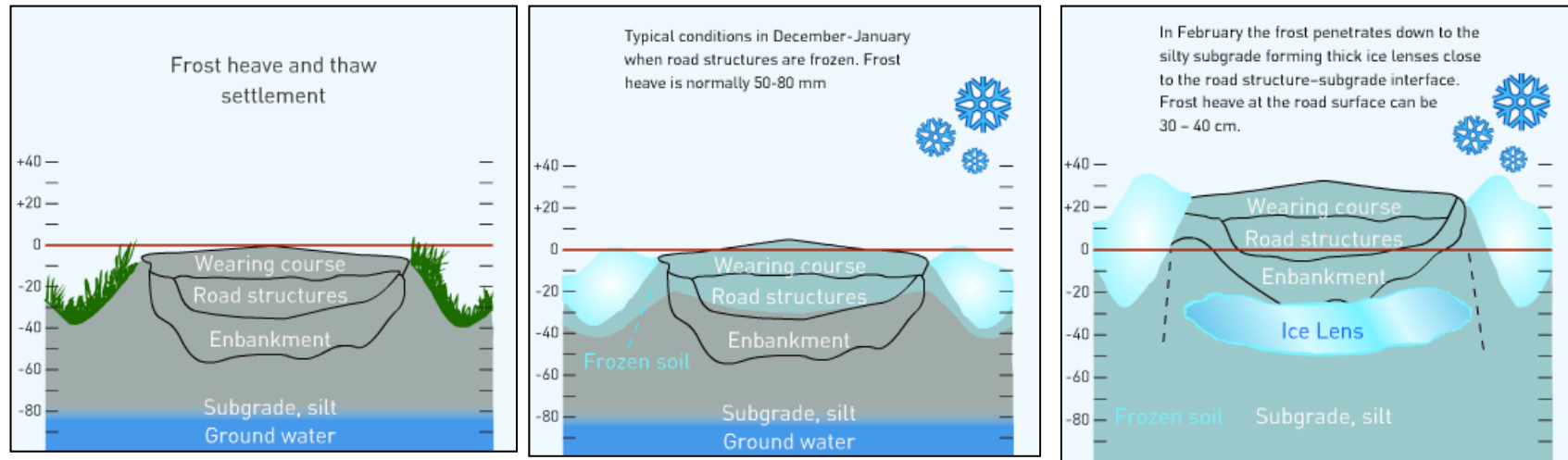
# COMBINED RUTTING MODES

Section 3\_58229

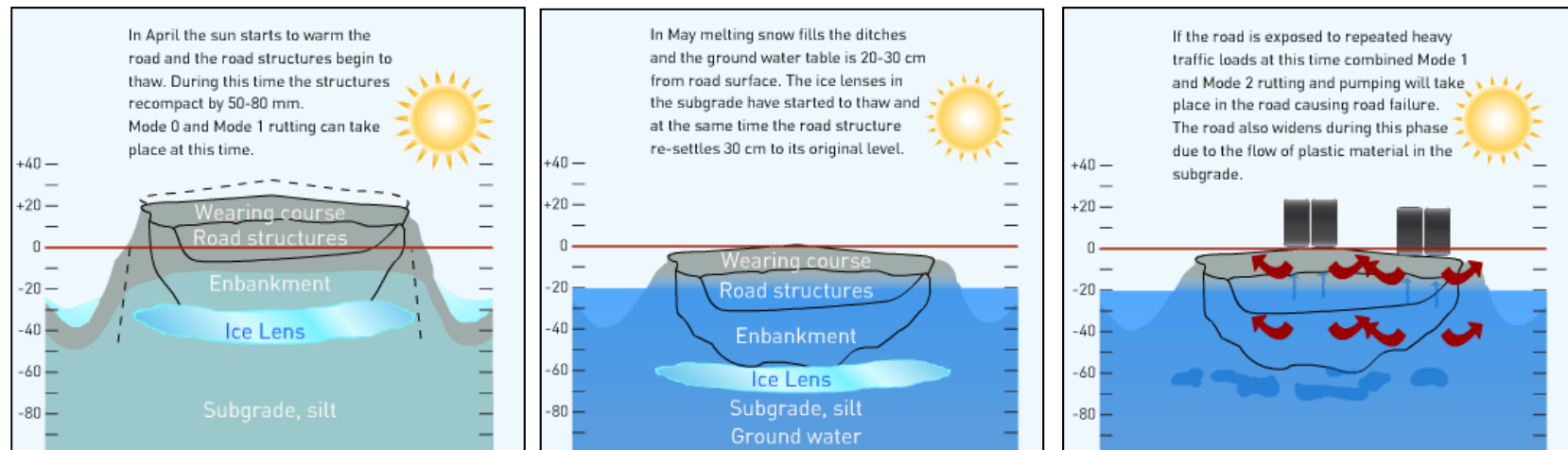


# FROST ACTION AND PERMANENT DEFORMATION

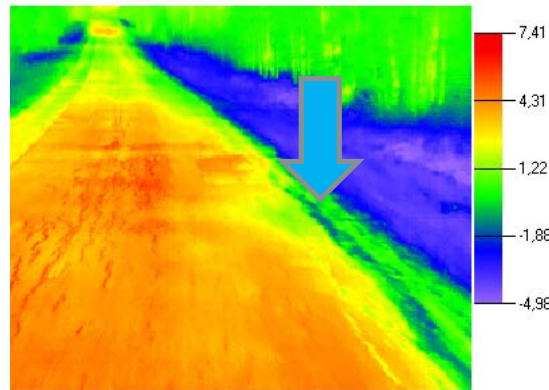
## FREEZING



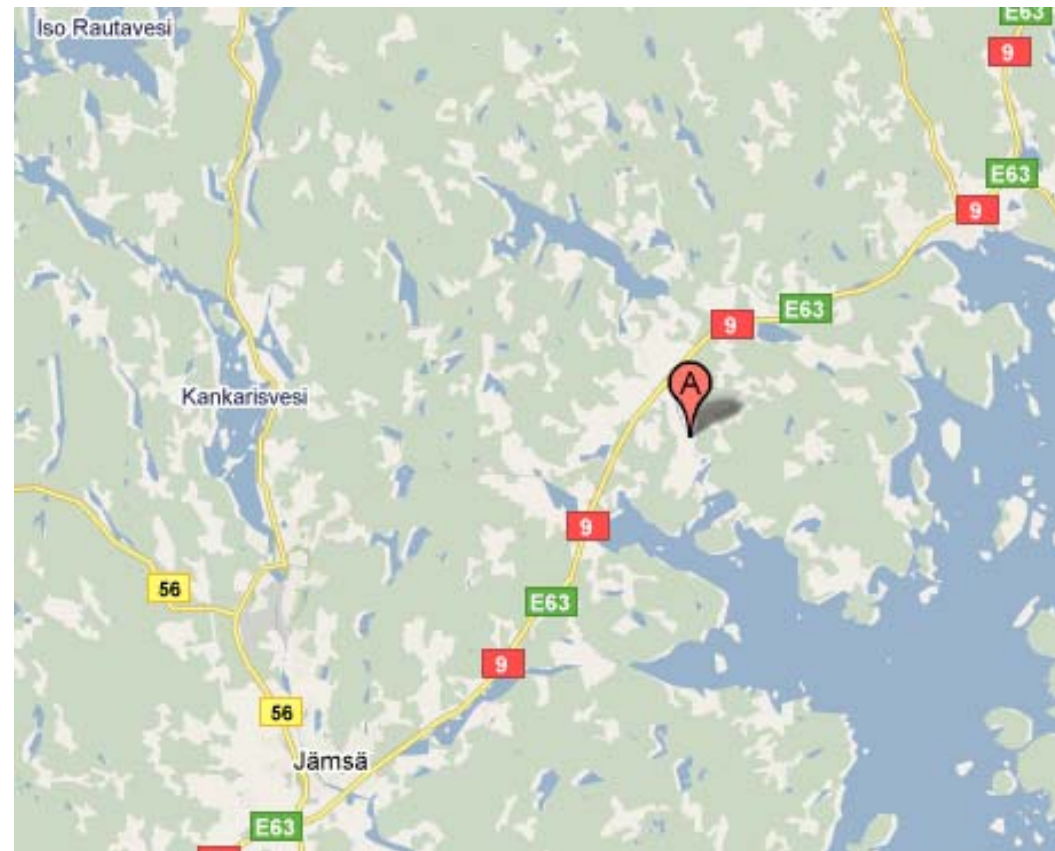
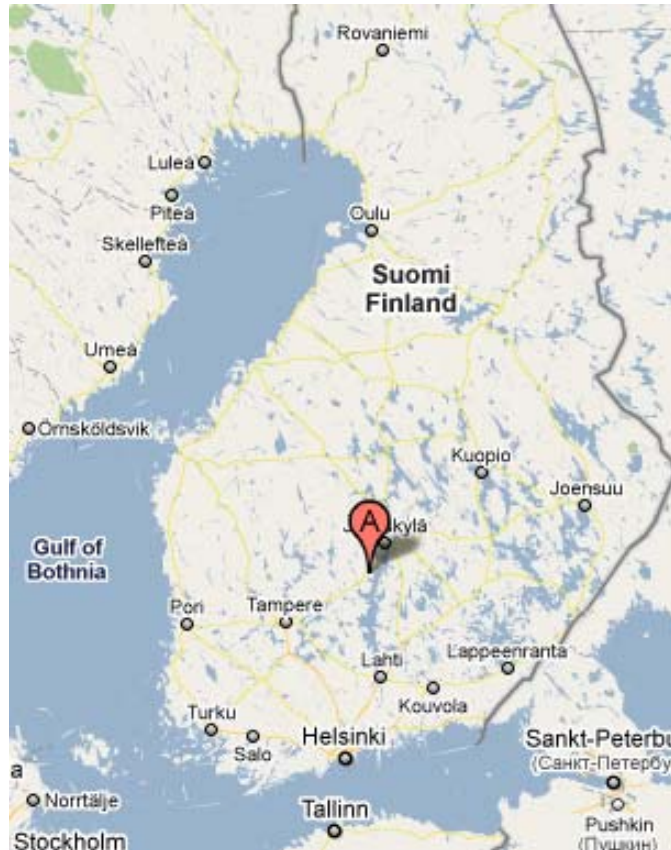
## THAWING



# ROAD WIDENING, FROST AND MODE 2 RUTTING



# Saalahti, reinforcement of a Mode II rutting site on a silty subgrade



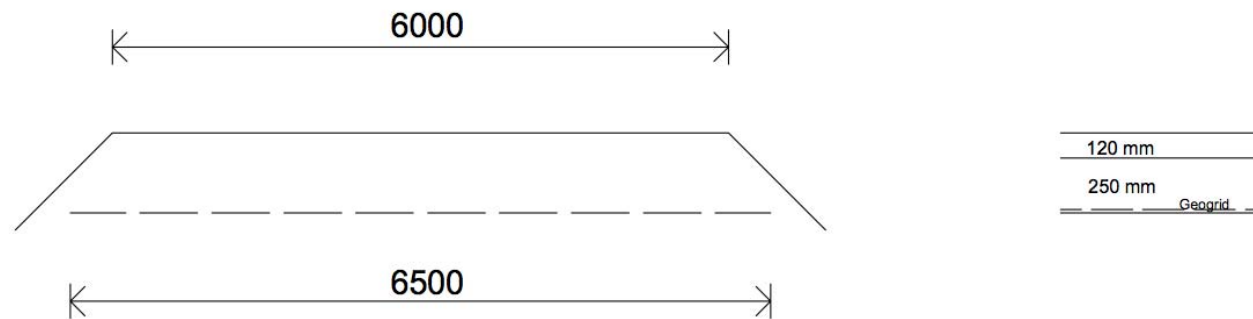
# Saalahti, reinforcement of a Mode II rutting site on a silty subgrade



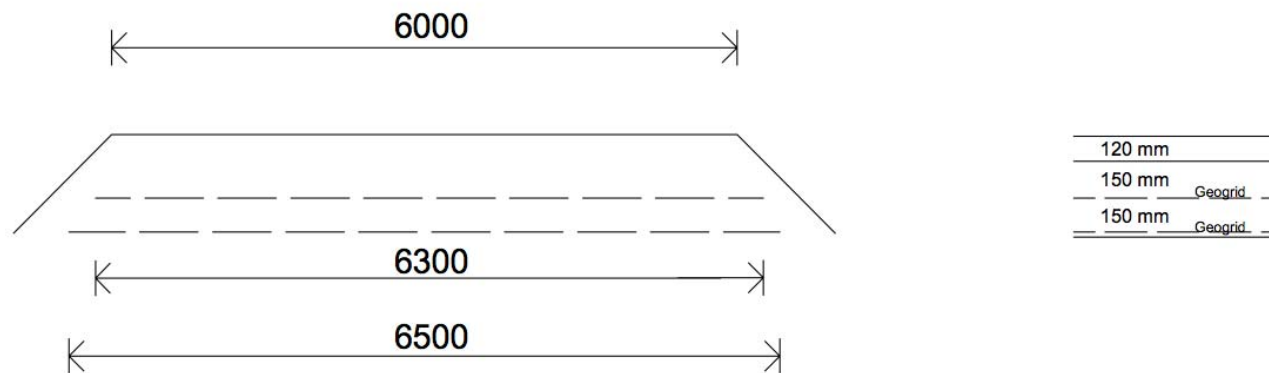
Mode II rutting and related extensive widening of the road cross section on a silty subgrade area - side ditches have practically disappeared.

# Saalahti, reinforcement of a Mode II rutting site on a silty subgrade

1B



1C



# Saalahti, reinforcement of a Mode II rutting site on a silty subgrade



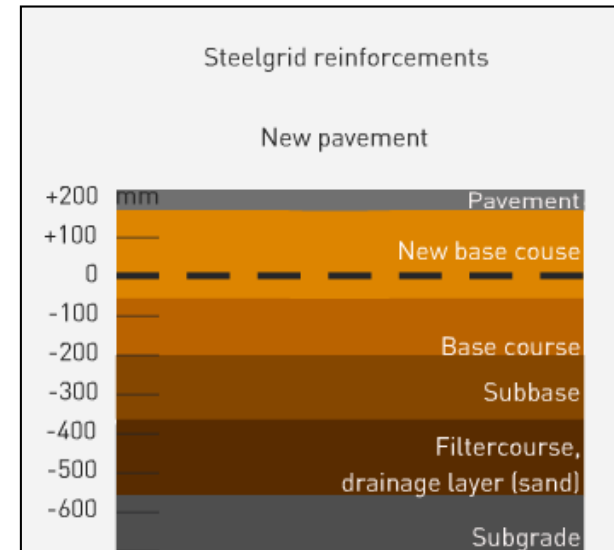
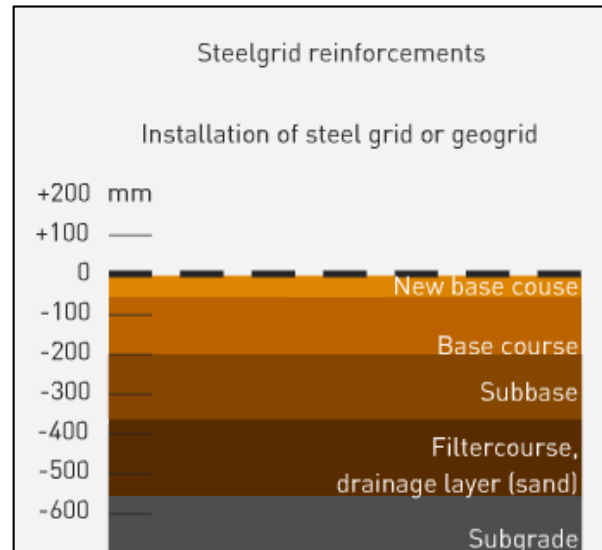
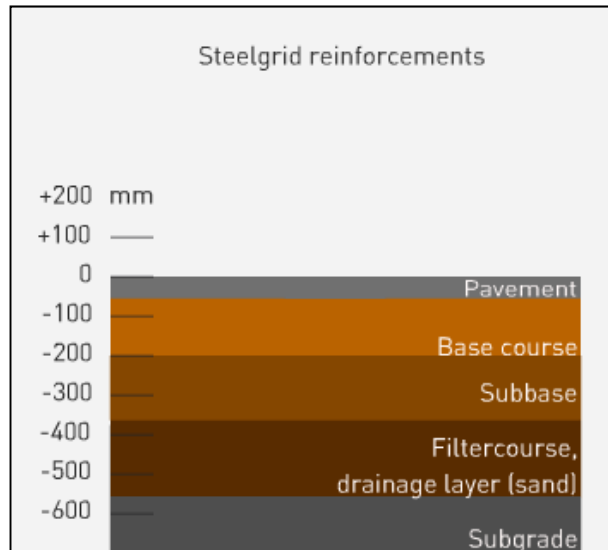
# Saalahti, reinforcement of a Mode II rutting site after the first winter



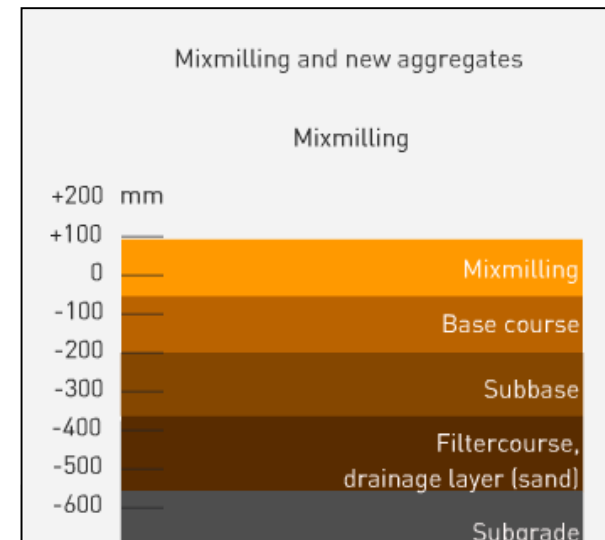
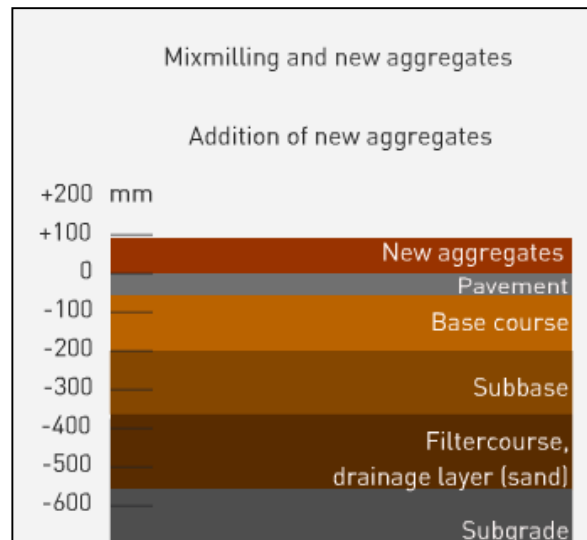
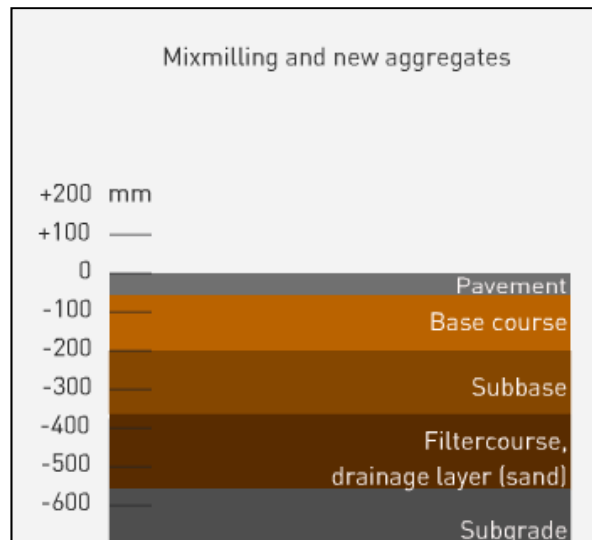
# Saalahti, typical drainage problems of the area one year after ditch cleaning



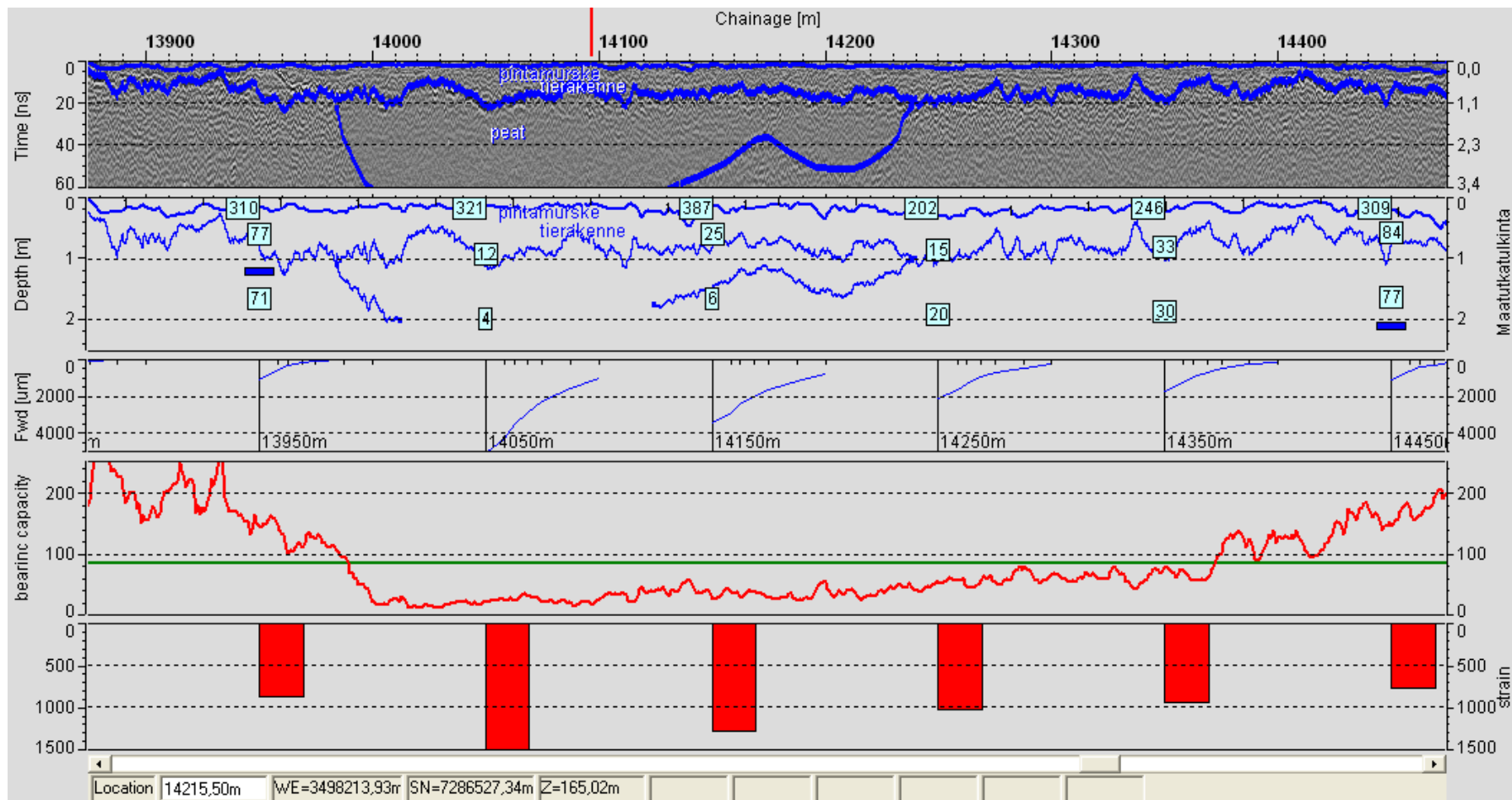
# Solution for Road with Frost Cracking and Mode 2 Rutting Problems



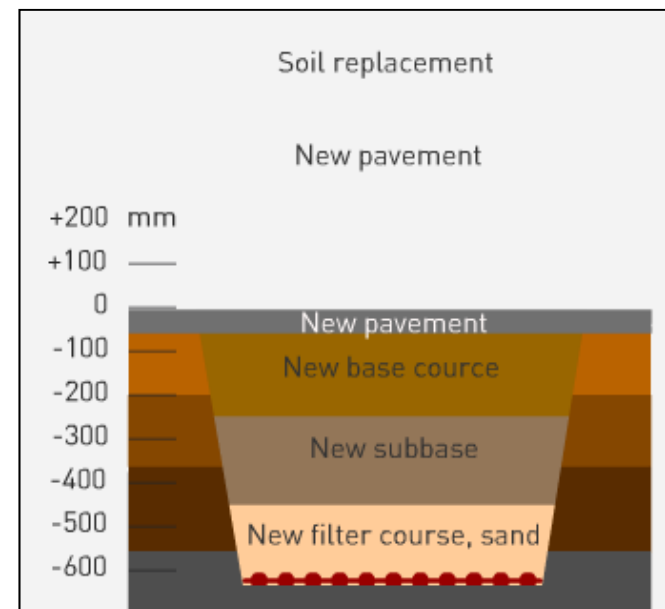
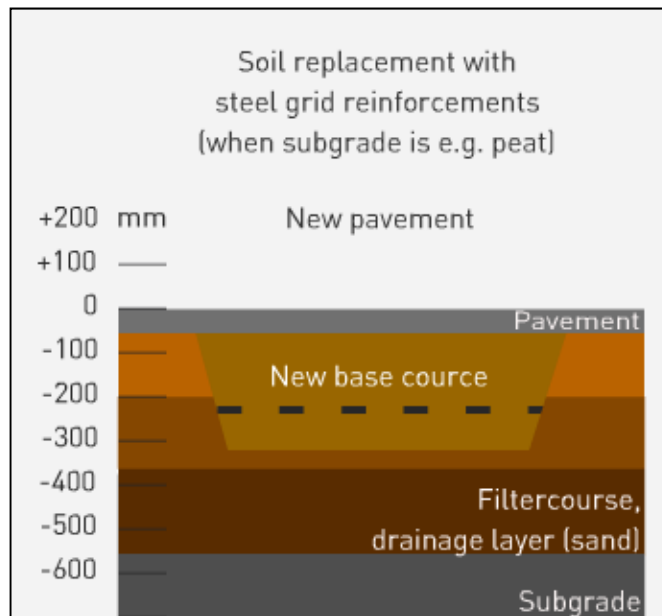
# Solution for Combined Rutting Modes (1 and 2)



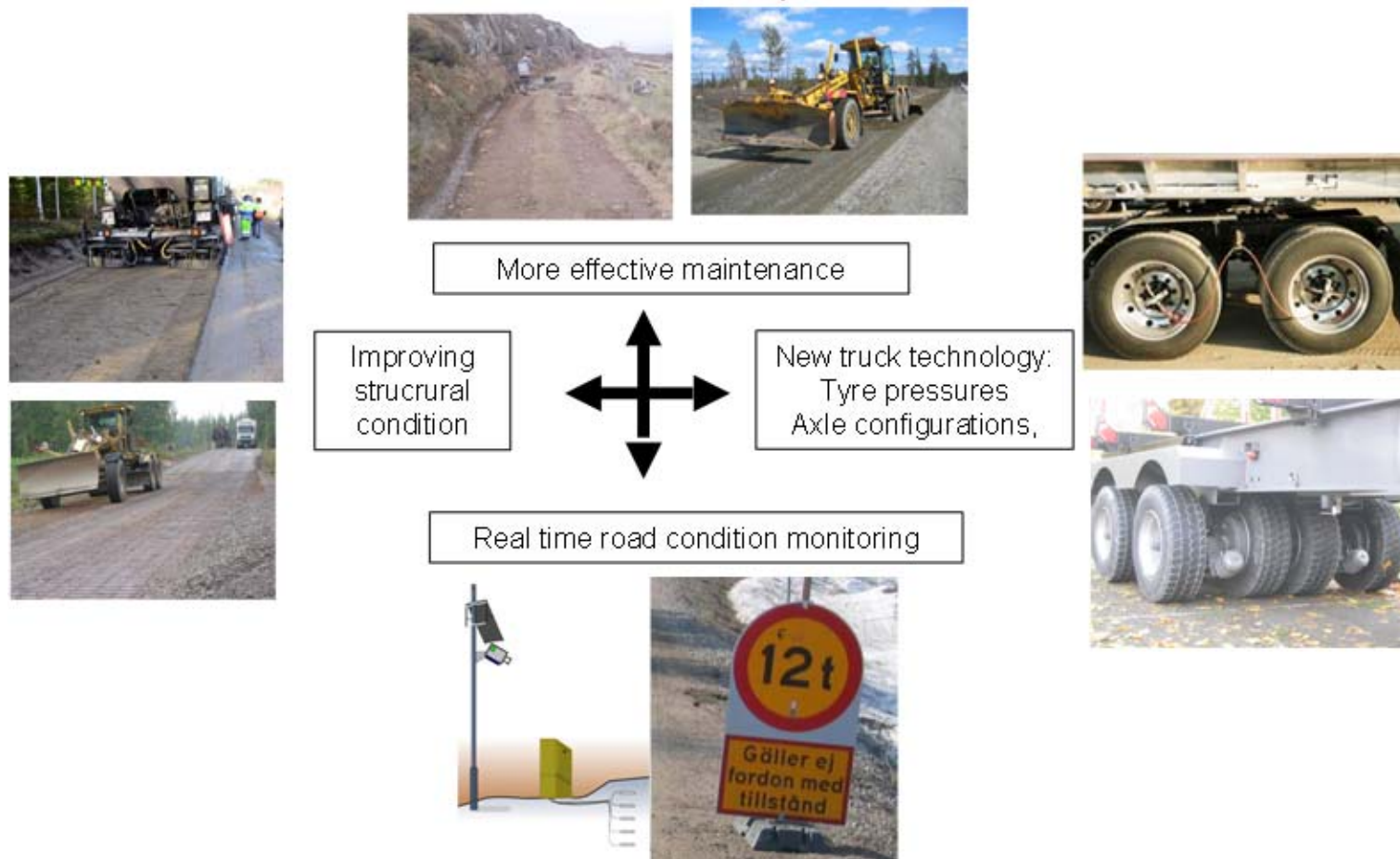
# Mode 2 Rutting Special Case – Peat Subgrade



# Special Structures: Peat Subgrade and Frost Problems

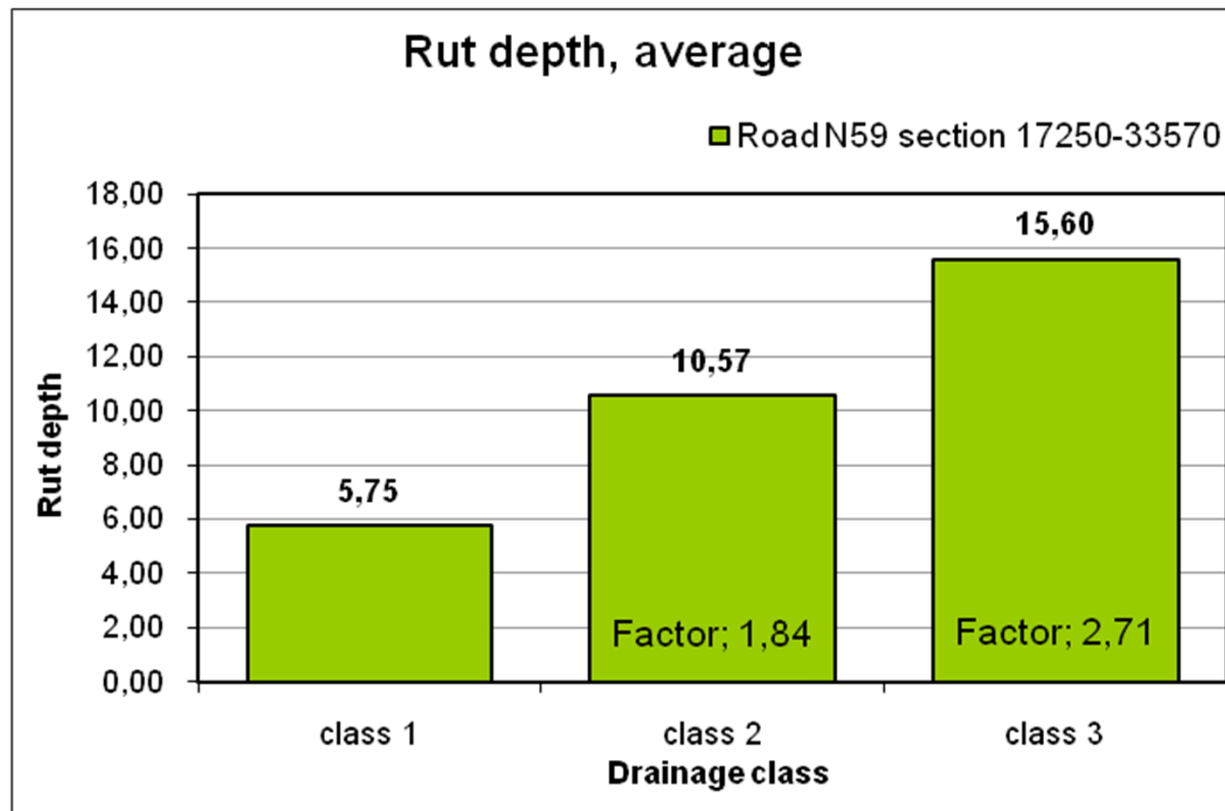


# ROADEX TOOLBOX FOR EFFECTIVE AND SUSTAINABLE ROAD CONDITION MANAGEMENT

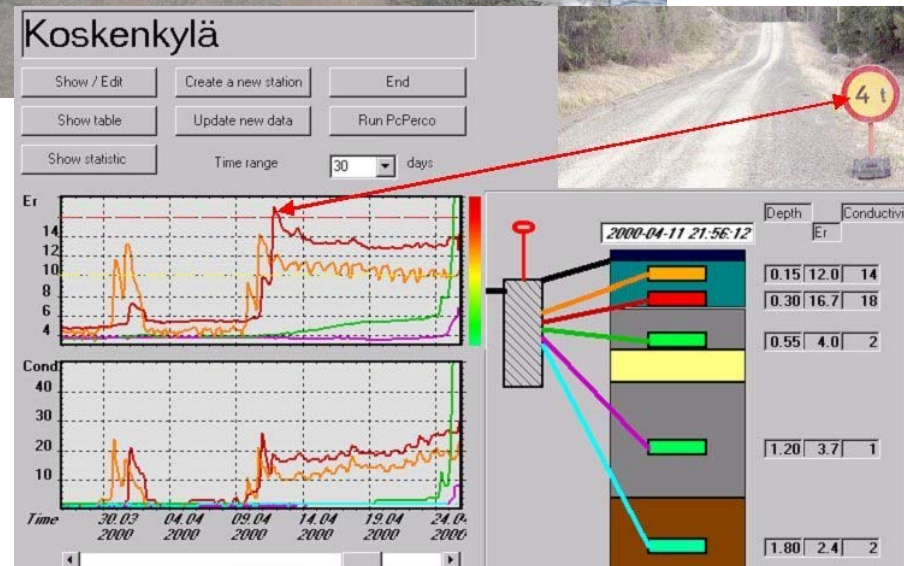
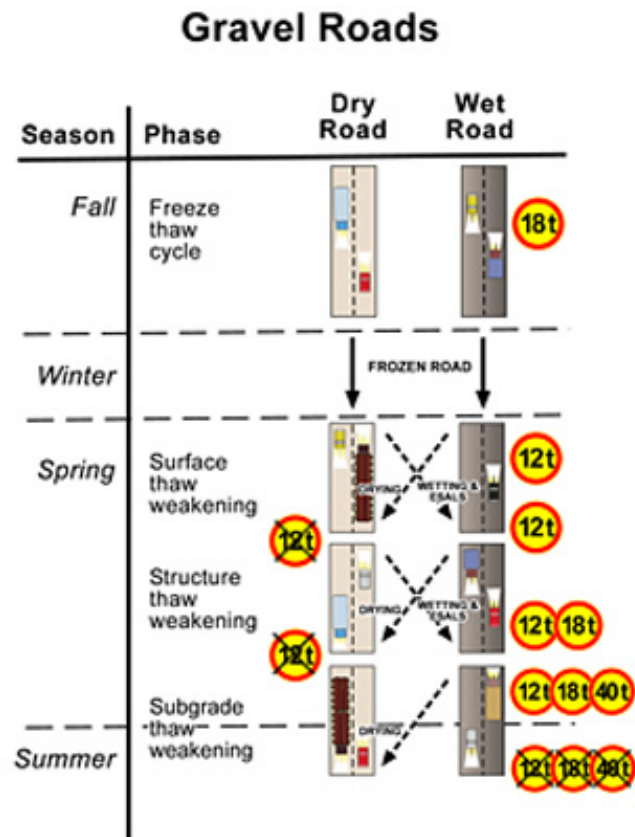


# The Role of Drainage in Permanent Deformation in Ireland

## Drainage Class and Average Rut Depth



# Road Monitoring and Load Restrictions Policy



# Road Monitoring and Load Restrictions Policy

