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Northern Periphery Programme 2007–2013
Innovatively investing in Europe's Northern Periphery for a sustainable and prosperous future

European Union
European Regional Development Fund

ROADEX Route Risk Assesment Methods

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Roadscanners, Finland

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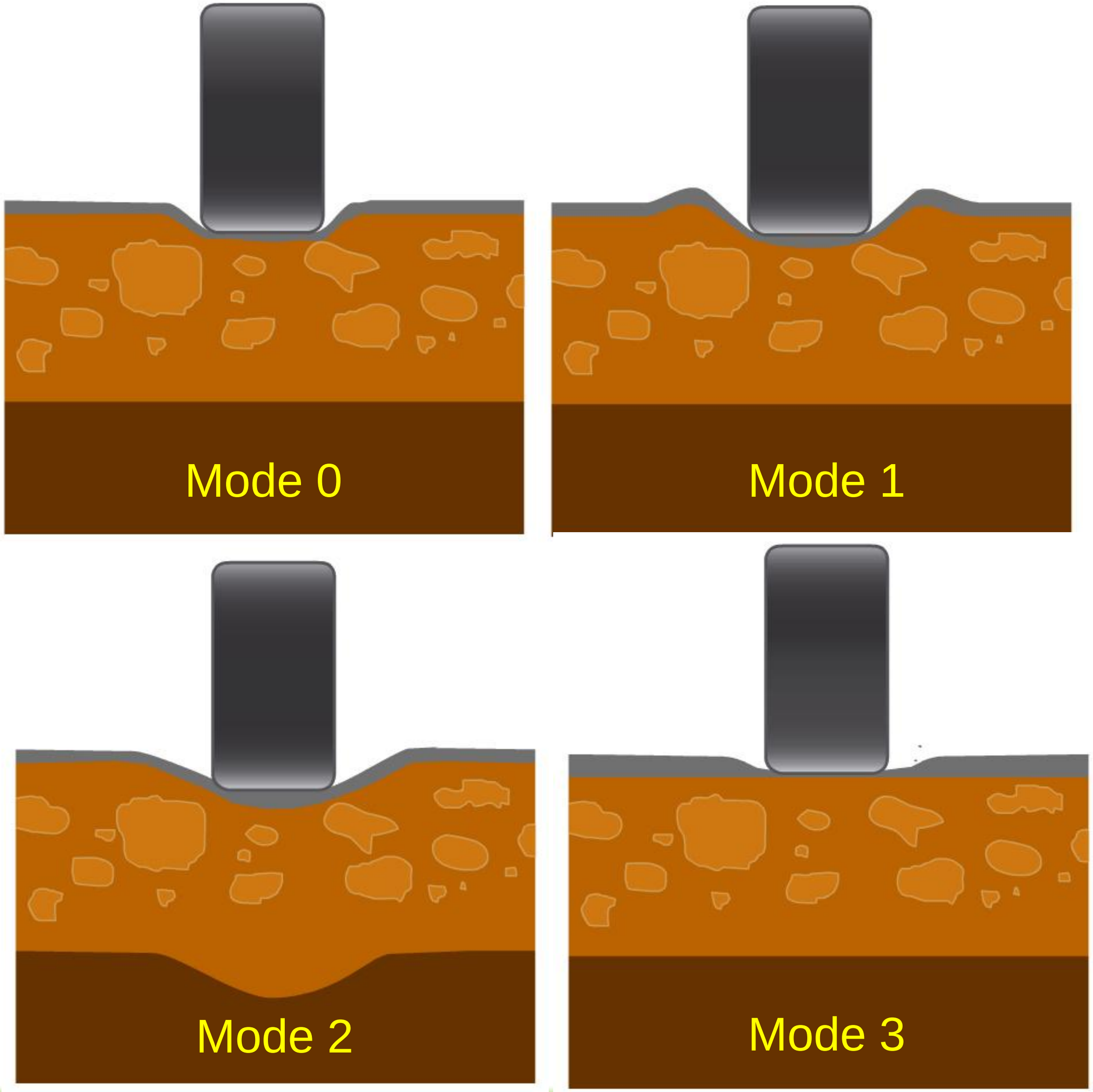
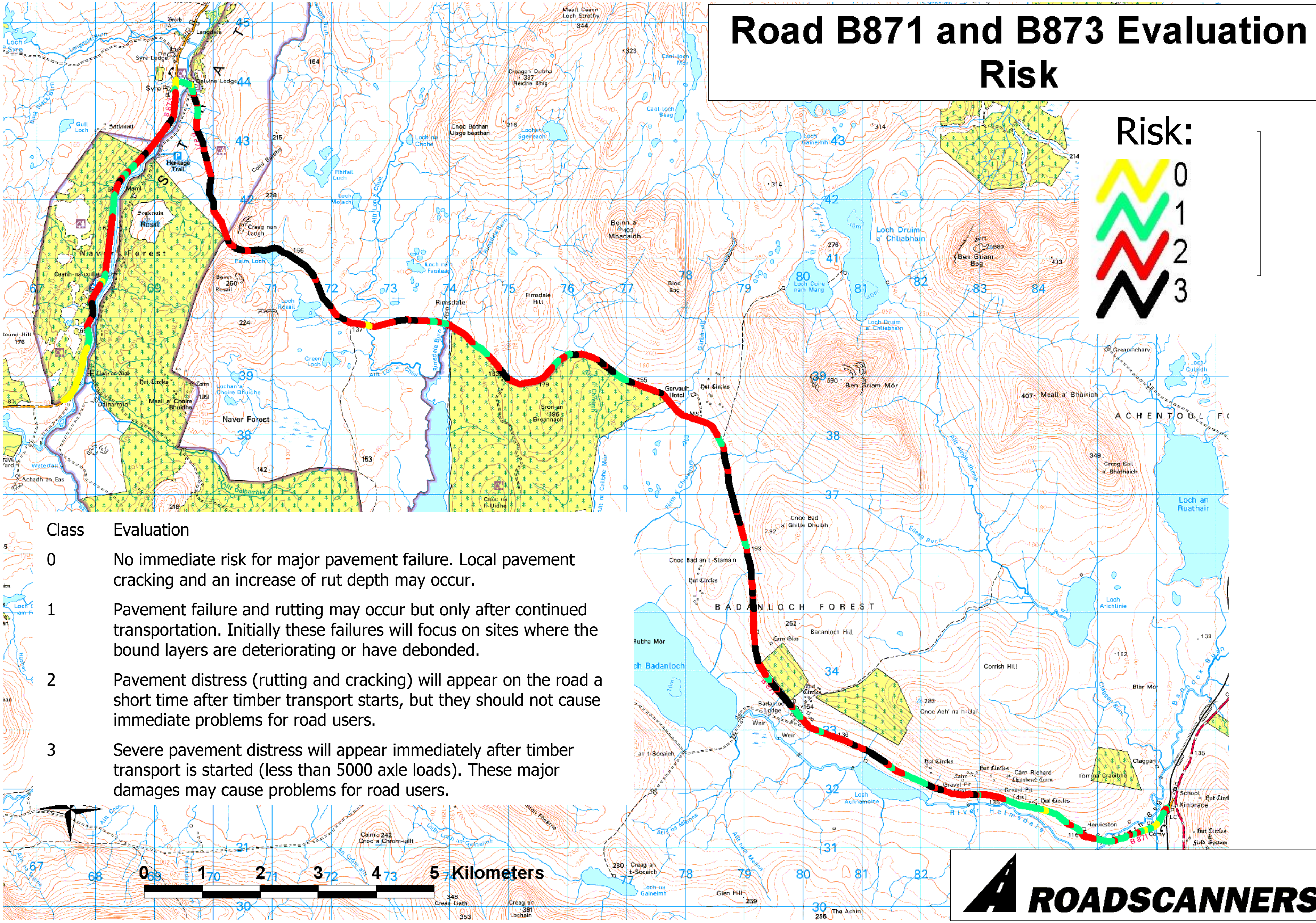
Basic Diagnostig of Low Volume Roads - Different Rutting Modes Accoroding to ROADEX Project



In addition the following matters should be noticed:

- frost heave problems
- geotechnical problems
- drainage problems
- mistakes in building process

Road B871 and B873 Evaluation Risk



Class	Evaluation
0	No immediate risk for major pavement failure. Local pavement cracking and an increase of rut depth may occur.
1	Pavement failure and rutting may occur but only after continued transportation. Initially these failures will focus on sites where the bound layers are deteriorating or have debonded.
2	Pavement distress (rutting and cracking) will appear on the road a short time after timber transport starts, but they should not cause immediate problems for road users.
3	Severe pavement distress will appear immediately after timber transport is started (less than 5000 axle loads). These major damages may cause problems for road users.

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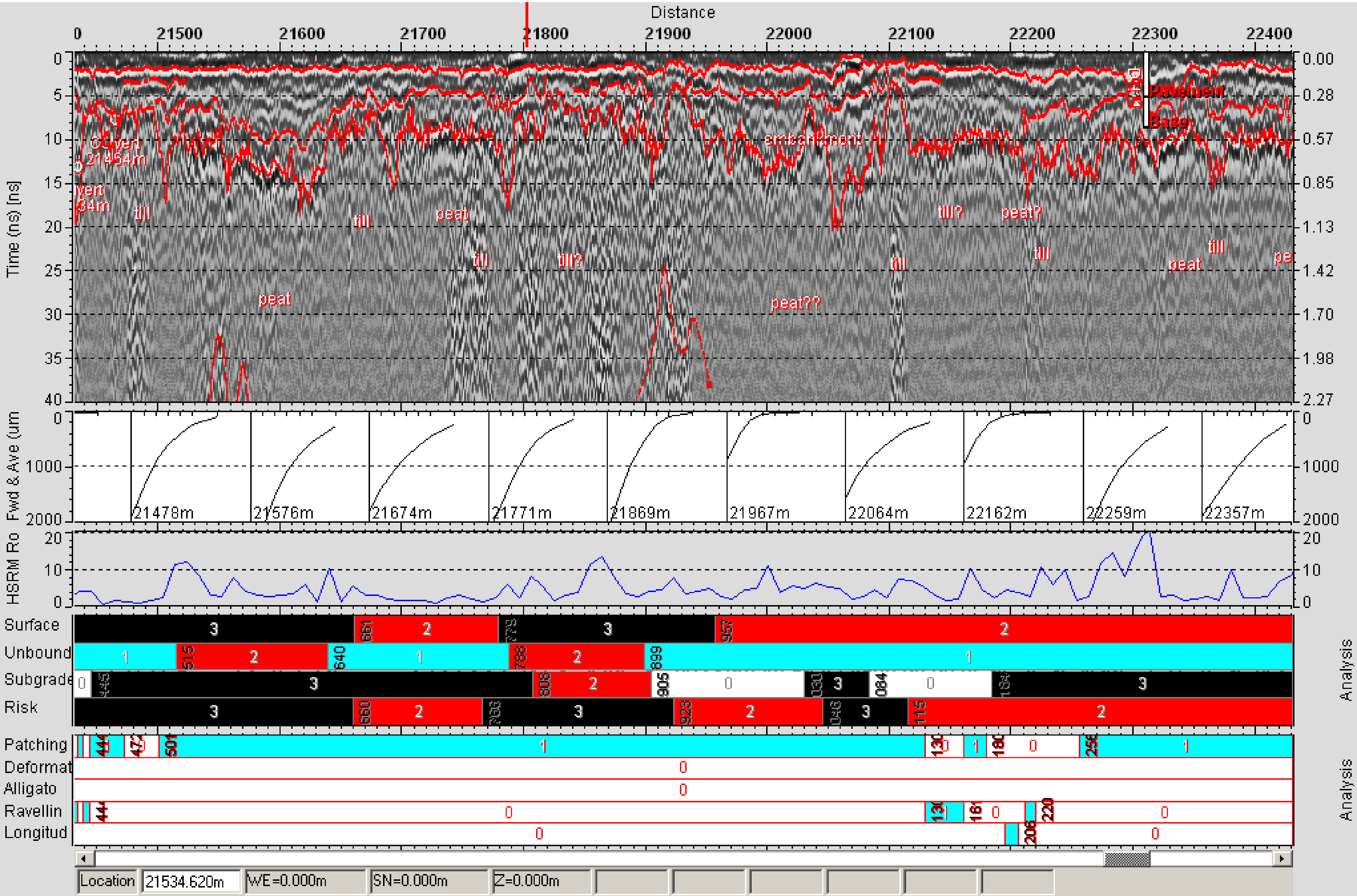
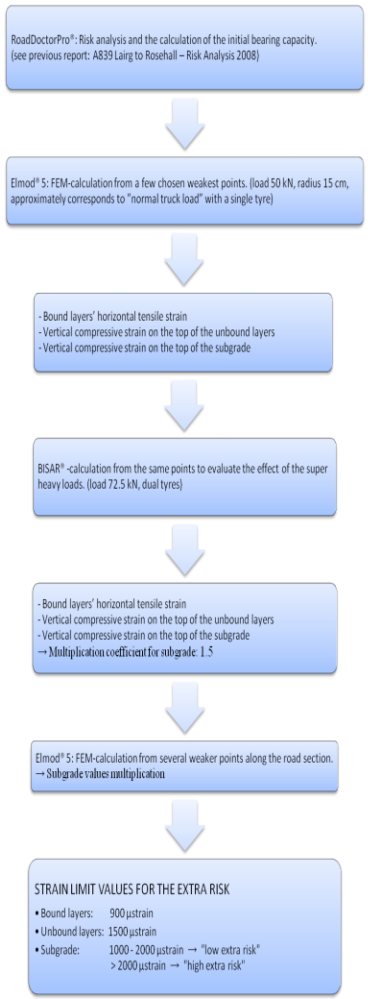
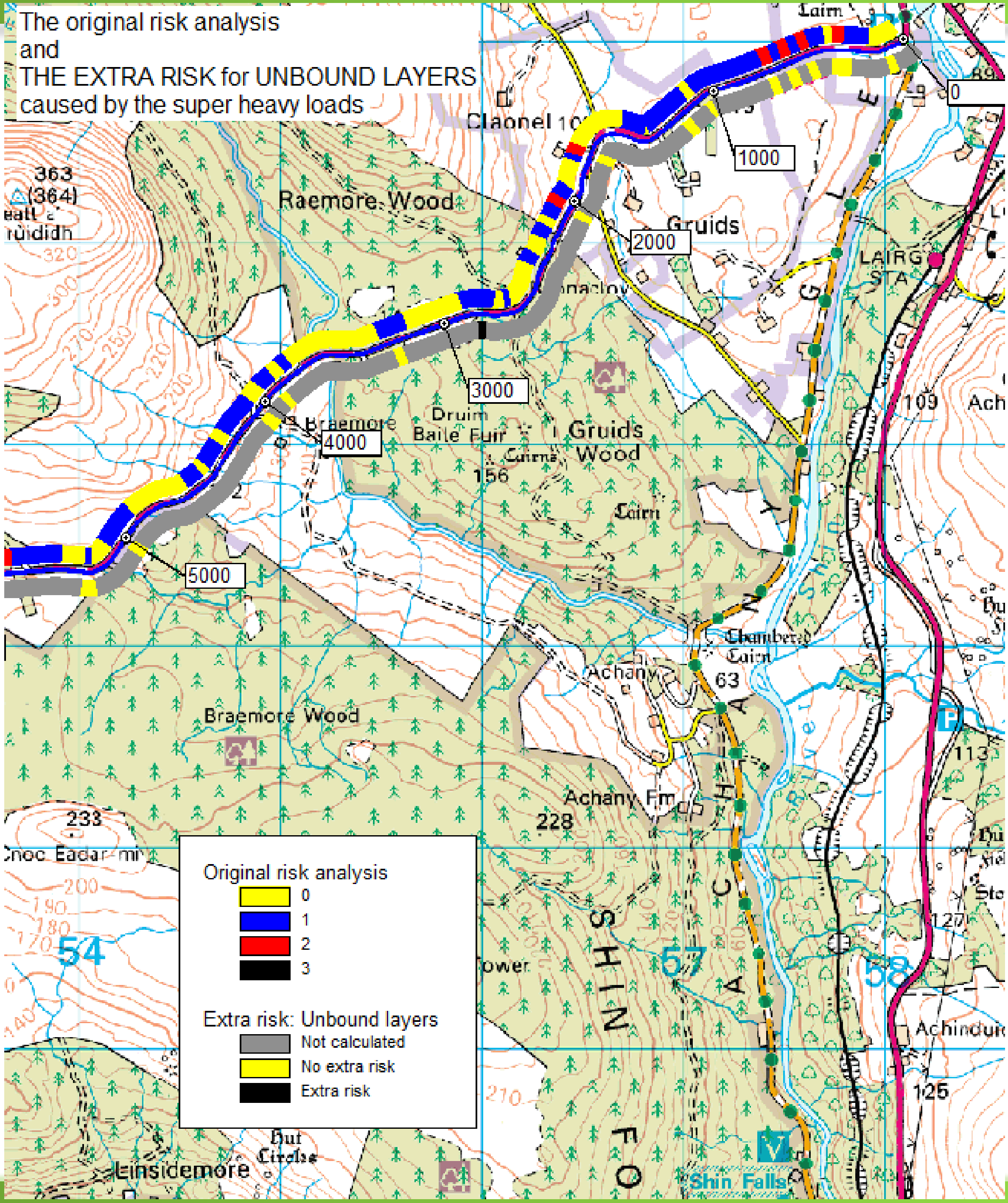

Distance
0
21500
21600
21700
21800
21900
22000
22100
22200
22300
22400
Time (ns) [ns]
0
5
10
15
20
25
30
35
40
0.00
0.28
0.57
0.85
1.13
1.42
1.70
1.98
2.27
Culvert 21454m
Pavement
Base
embankment
till
peat
till?
peat?
peat??
Fwd & Ave (um
1000
2000
21478m
21576m
21674m
21771m
21869m
21967m
22064m
22162m
22259m
22357m
HSRM Ro
Surface
Unbound
Subgrade
Risk
Patching
Deformat
Alligato
Ravellin
Longitud
Analysis
Location
21534.620m
WE=0.000m
SN=0.000m
Z=0.000m

Extra Risks for Sper Heavy Loads





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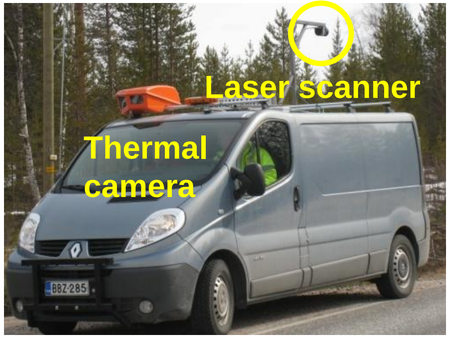
ROAD CONDITION DATA METHODS AND TECHNIQUES

Objektive Measurements & Analysis

Visual evaluation

Latest techniques



ROAD STRUCTURE MEASUREMENTS USING GPR TECHNIQUE

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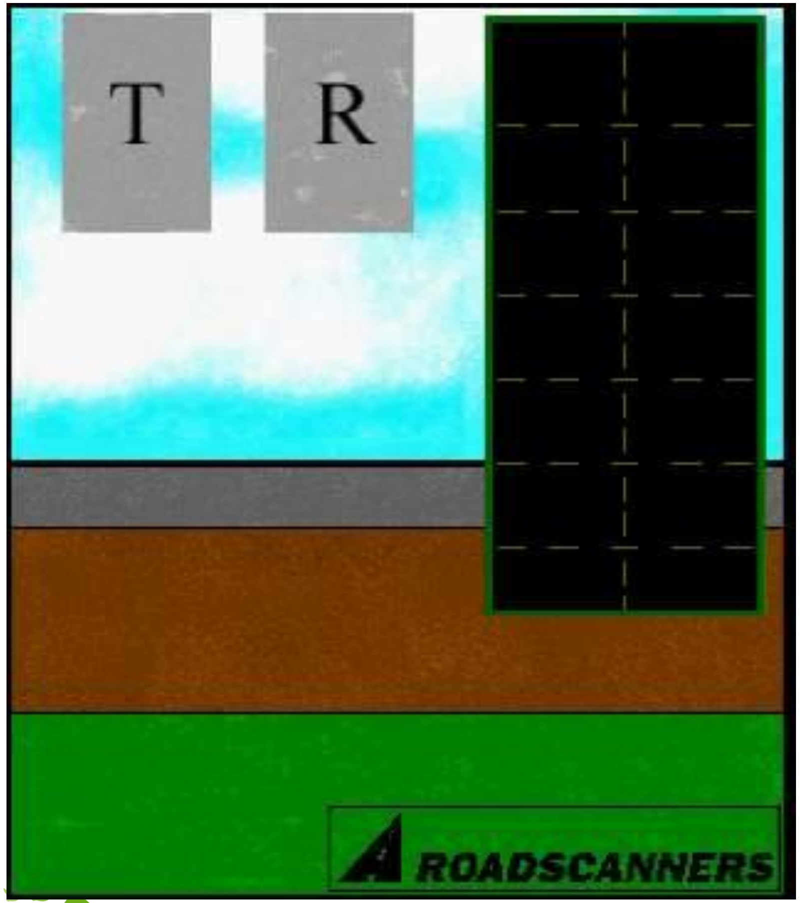
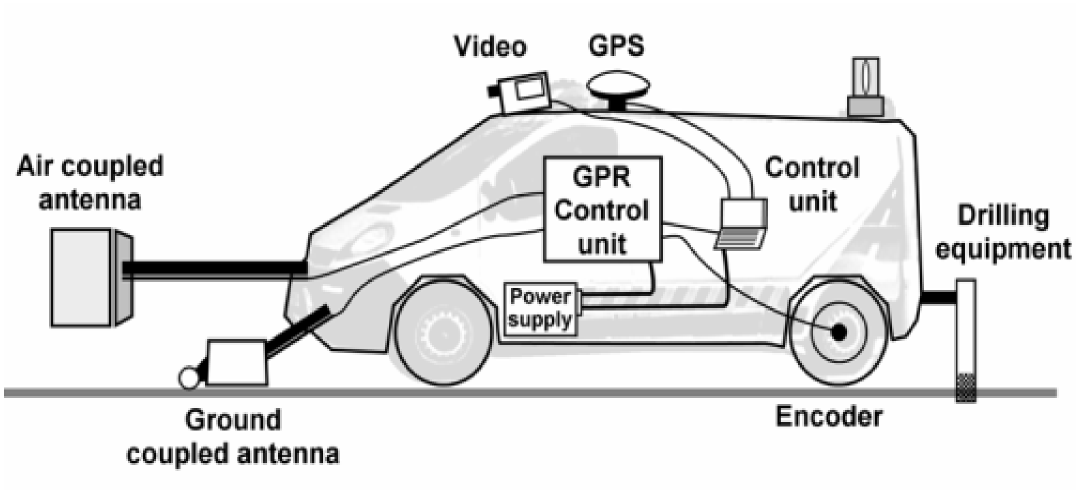
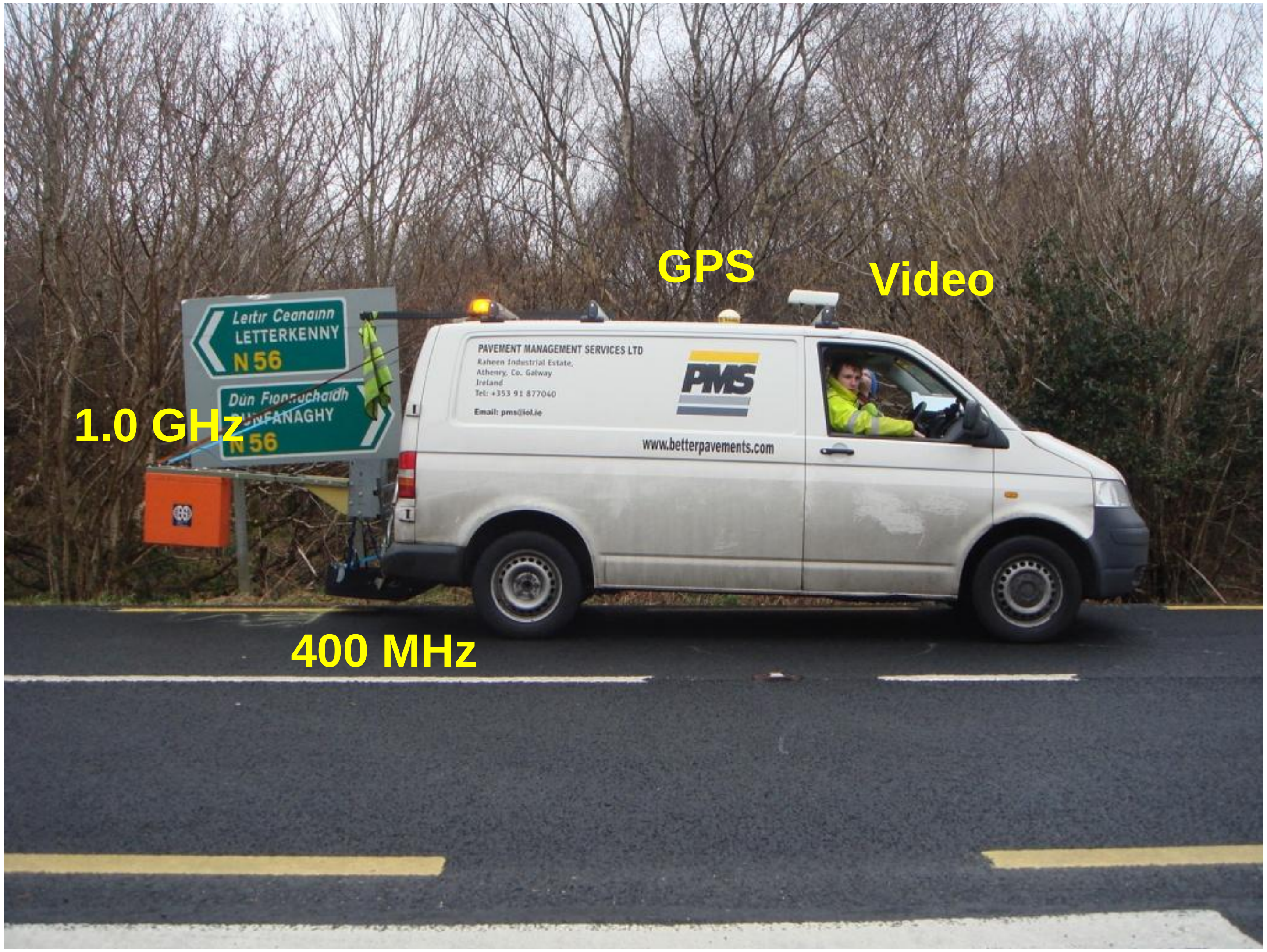
Principles of GPR

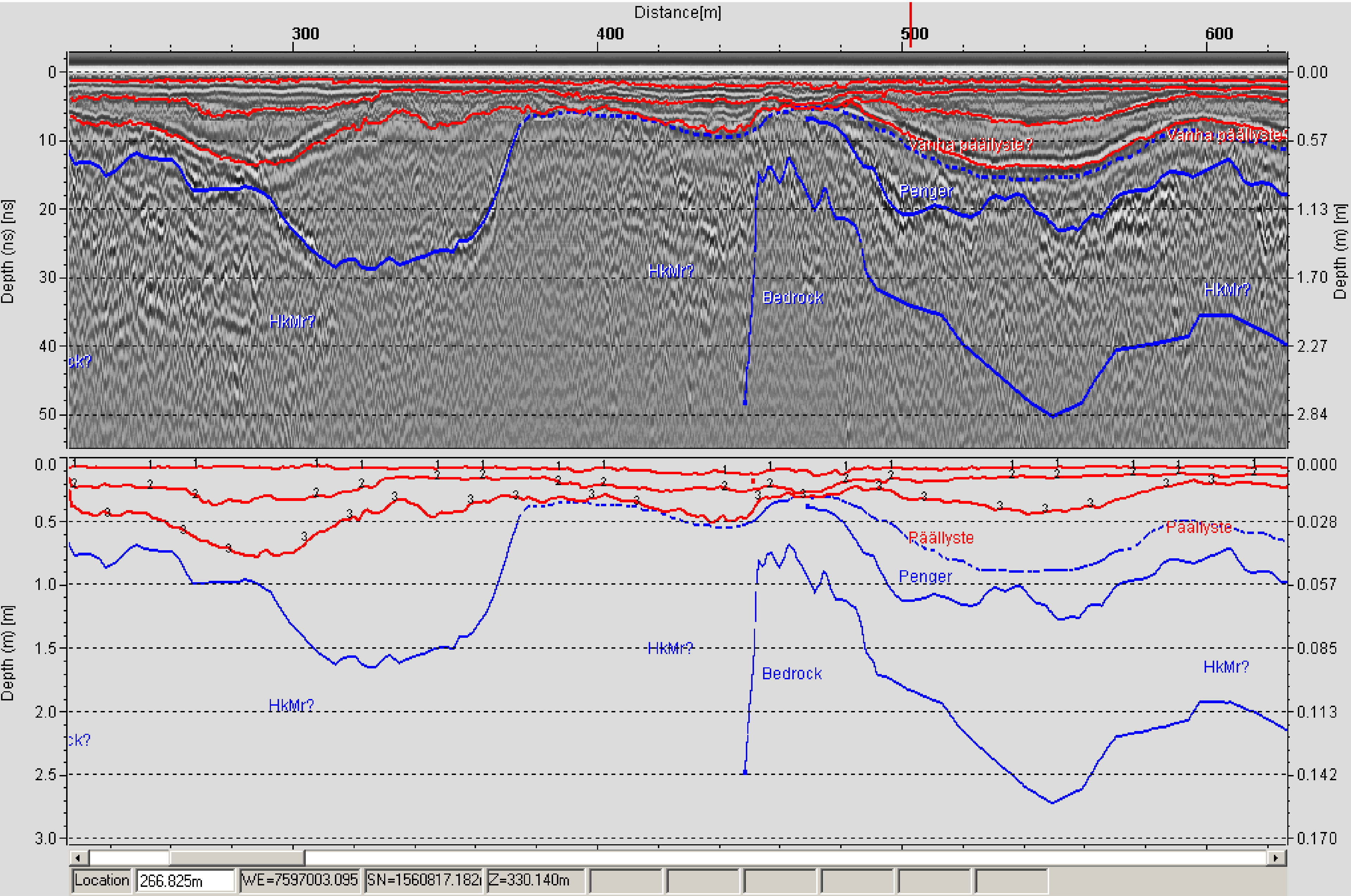




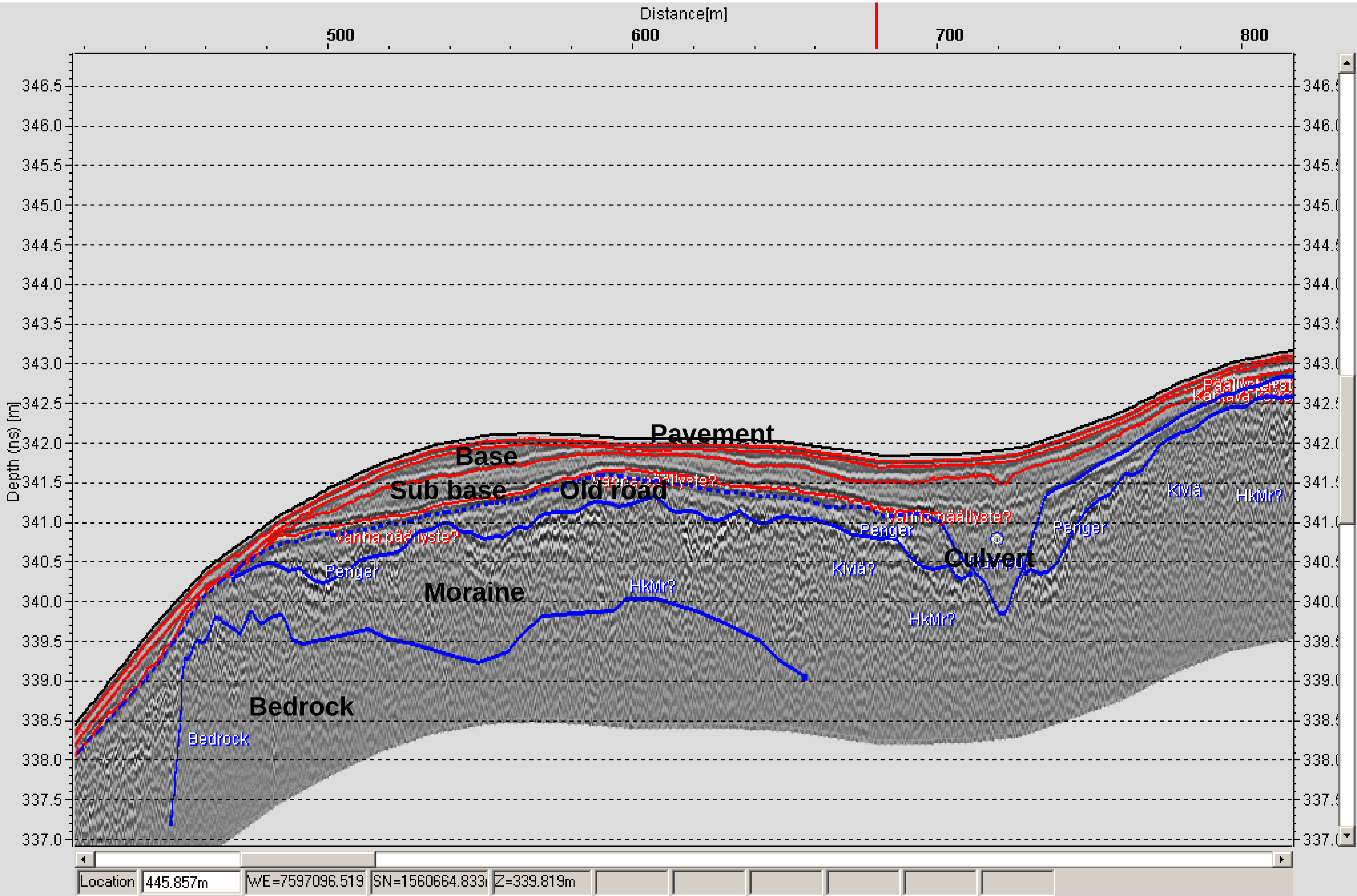
N56 & N59 GPR Surveys



GPR Data Interpretation



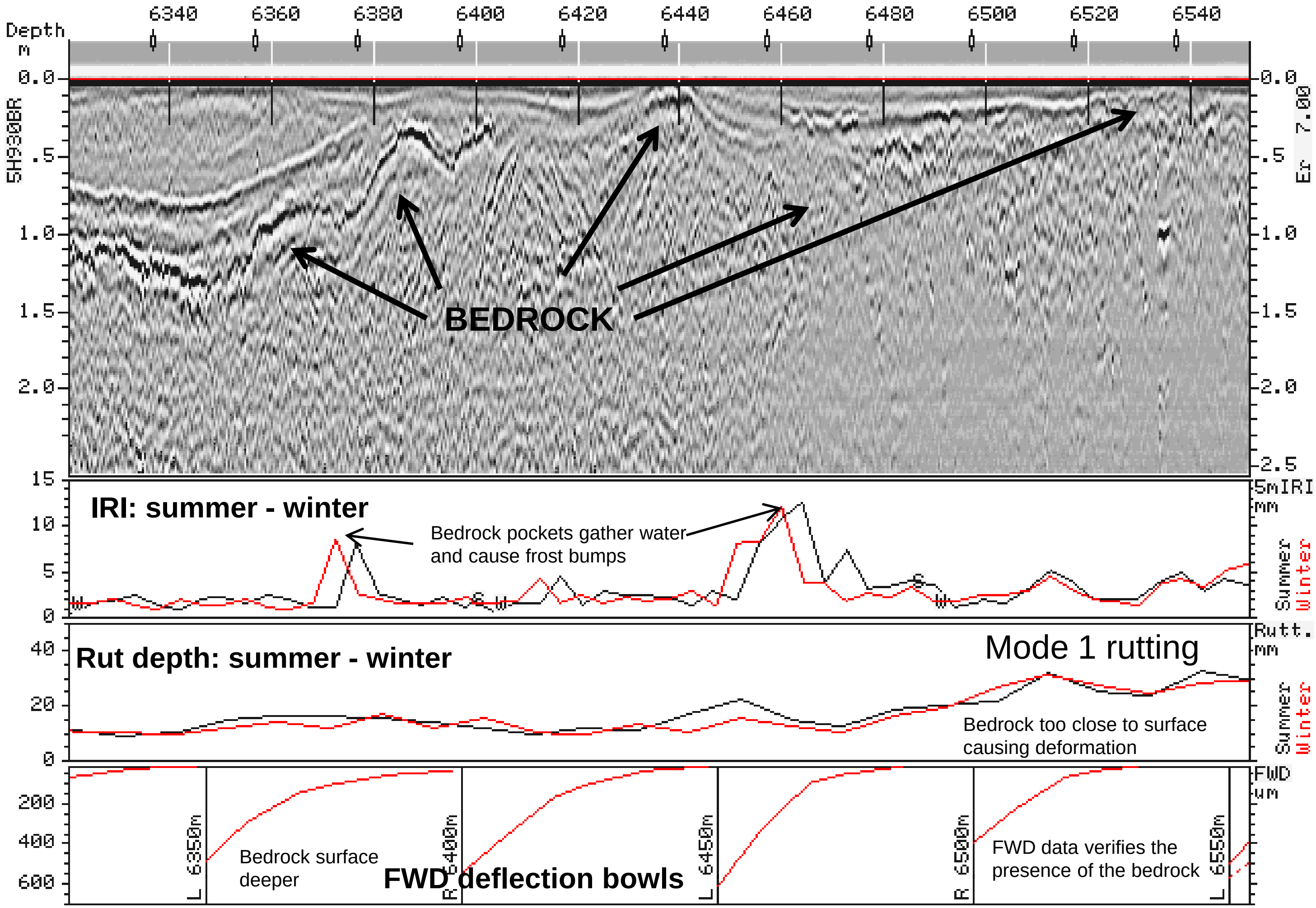
Integration of GPR and GPS Data Sets



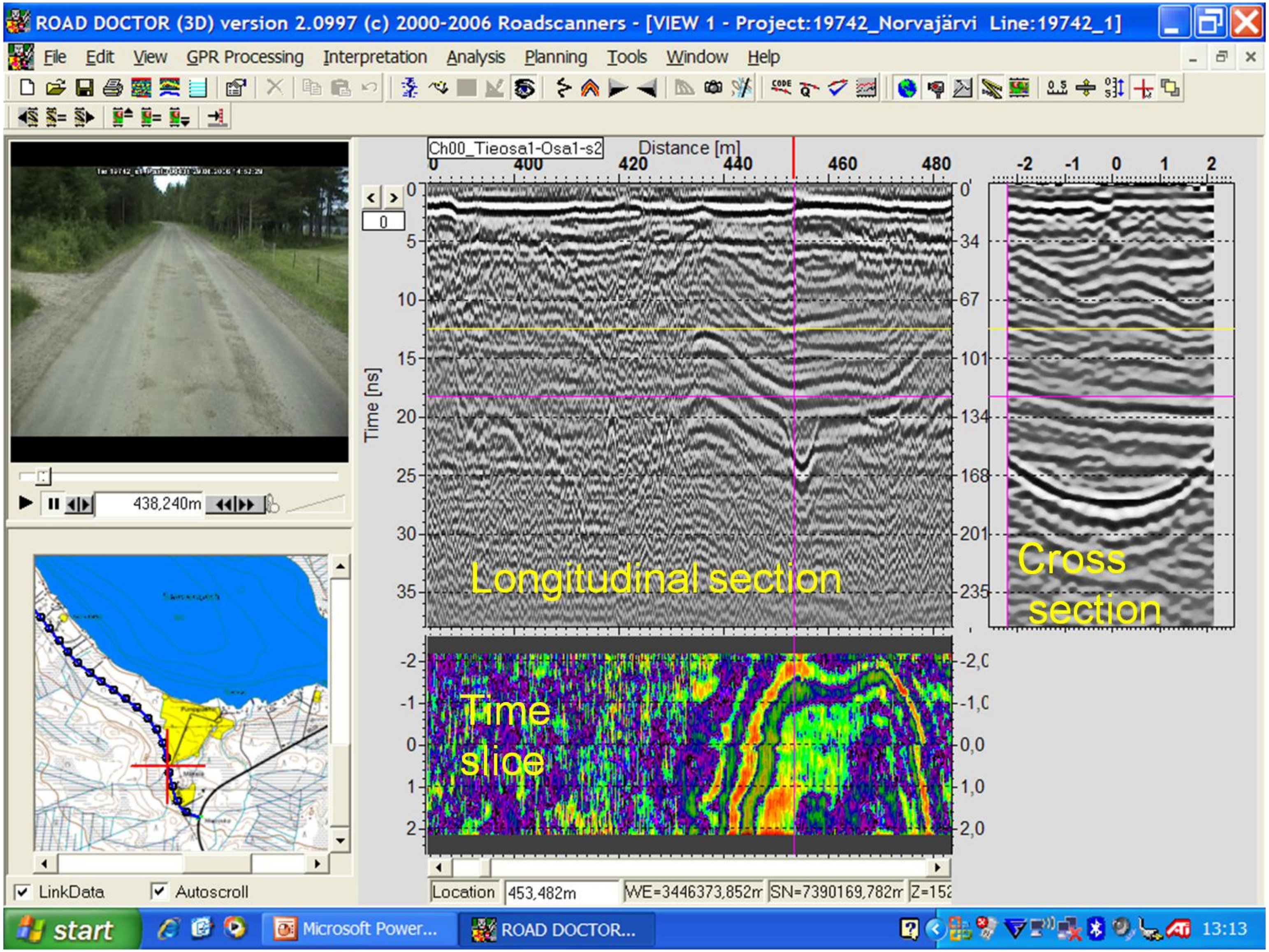
GPR APPLICATIONS ON ROADS

1. NETWORK LEVEL SURVEYS
- Thickness, structural sections, special structures
2. PROJECT LEVEL SURVEYS
- Site investigations, structure thickness, dimensioning parameters, reasons for damages
3. QUALITY CONTROL & QUALITY ASSURANCE
- Thickness & location, air voids content, special structres
4. FORENSIC SURVEYS
- Thickness, moisture susceptibility, transition structures, etc
5. ROAD CONDITION MONITORING
- Pavement distress, moisture, etc.

REHABILITATION CASES: WHAT DOES GPR DATA TELL YOU?

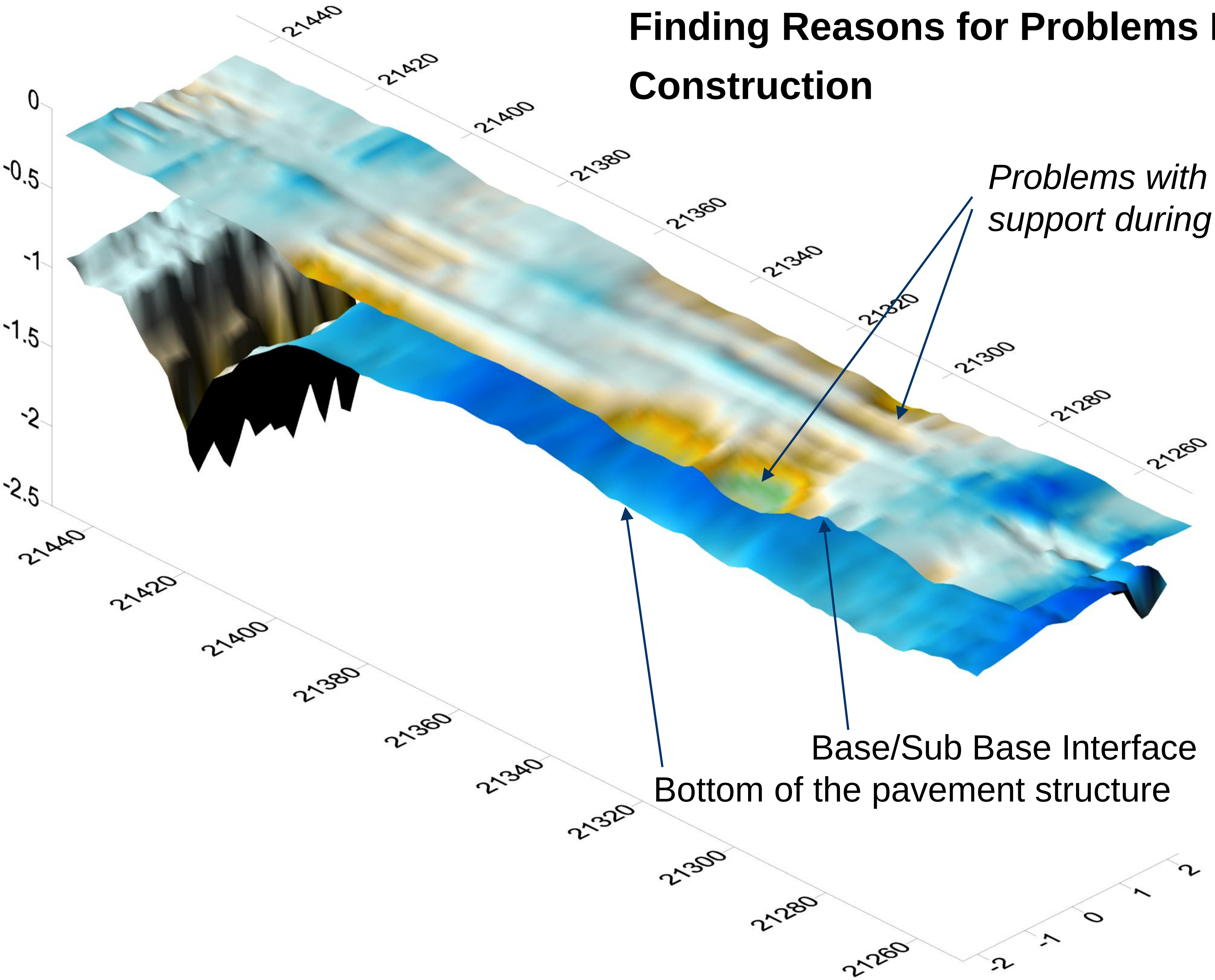


3D GPR in Rut Mode Analysis

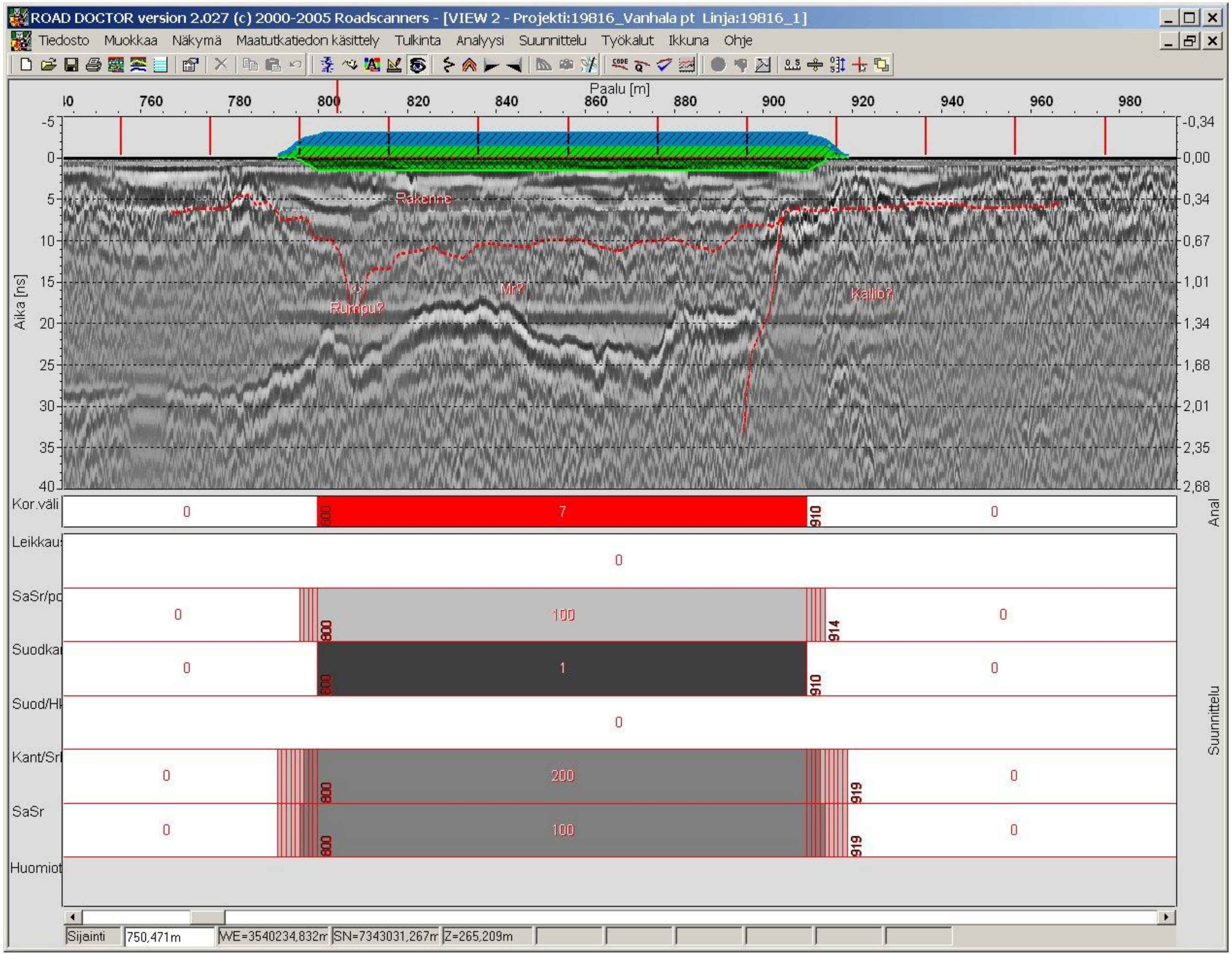


3D GPR TOMOGRAPHY

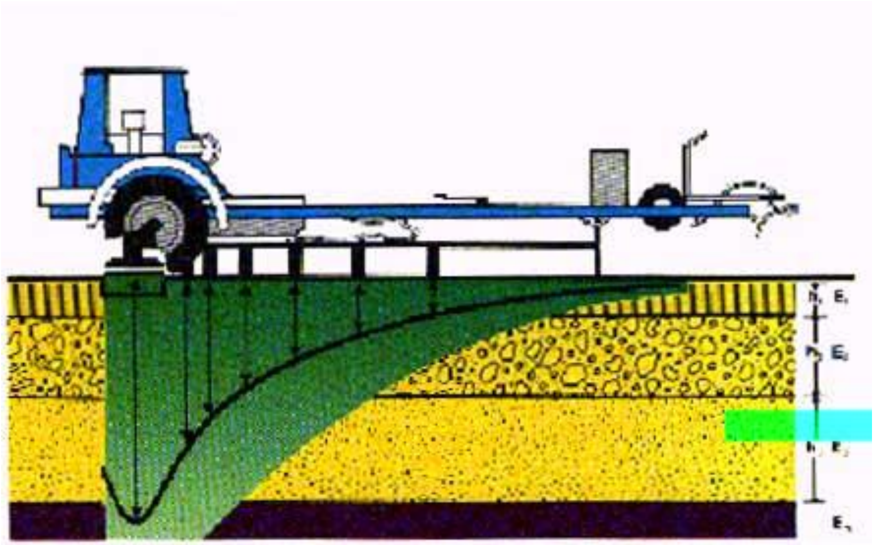
Finding Reasons for Problems During the Construction



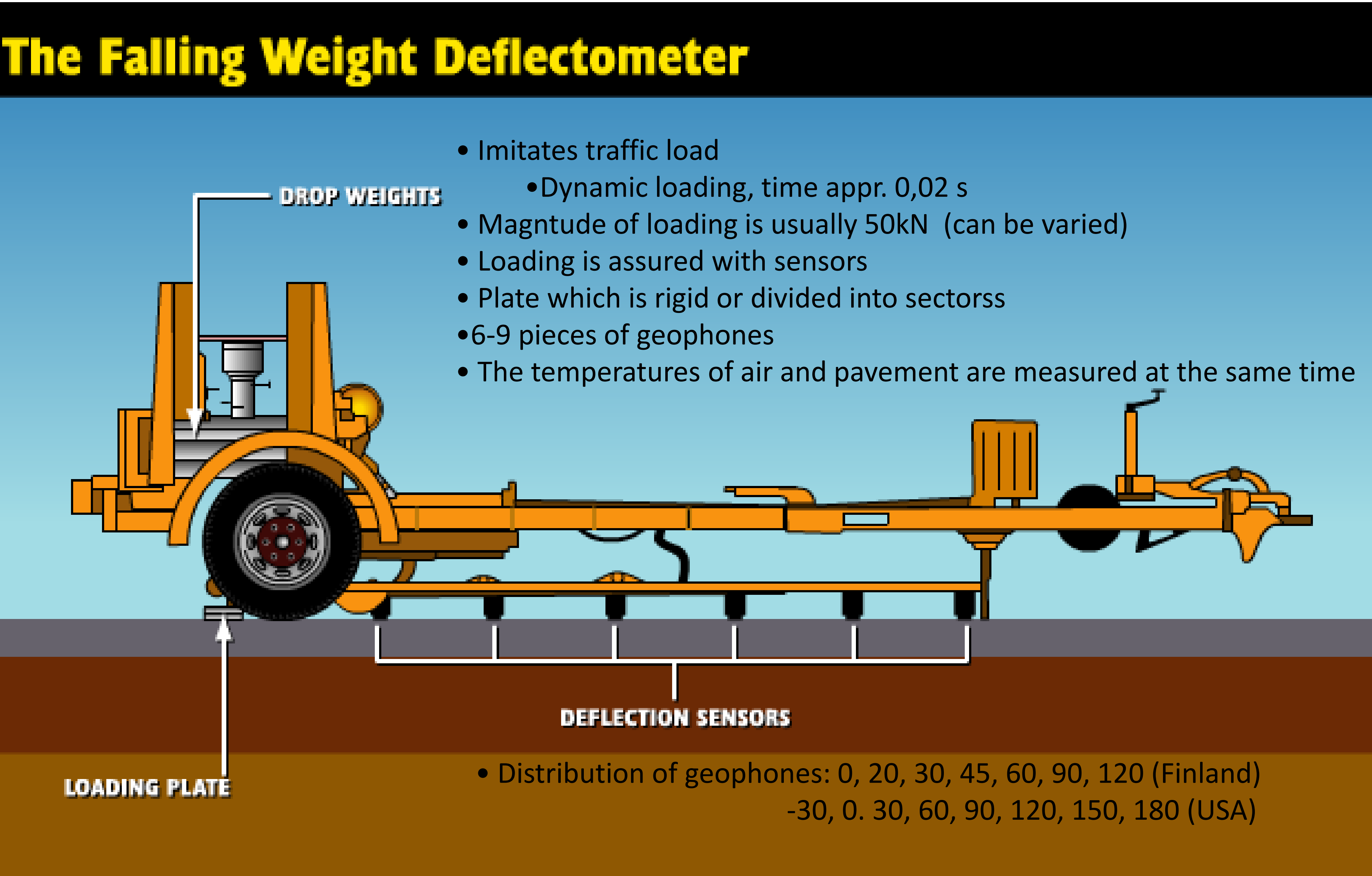
Presenting Design Results



FWD BEARING CAPACITY MEASUREMENTS



Falling Weight Deflectometer



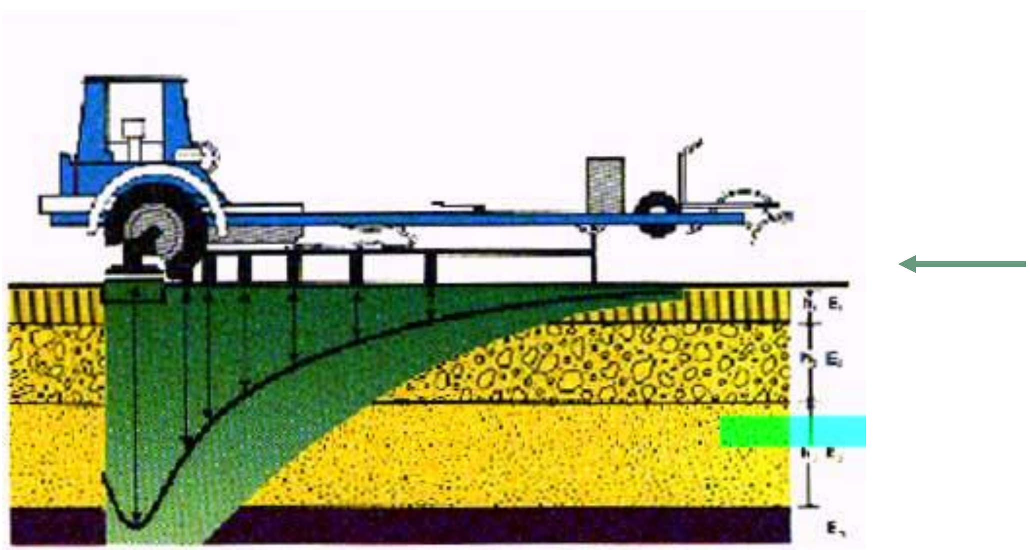
- Imitates traffic load
    - Dynamic loading, time appr. 0,02 s
- Magntude of loading is usually 50kN (can be varied)
- Loading is assured with sensors
- Plate which is rigid or divided into sectorss
- 6-9 pieces of geophones
- The temperatures of air and pavement are measured at the same time

- Distribution of geophones: 0, 20, 30, 45, 60, 90, 120 (Finland)
  -30, 0. 30, 60, 90, 120, 150, 180 (USA)

Evaluation of Subgrade Soil Type According to FWD Results (D1200mm Deflection)

Thickness of road structure : 0,6 – 1,2 m

	D_{1200} deflection (um)
Bedrock is near	< 10
Clay, soft	200 – 400
Peat	300 – 700 (thin peat 200 – 300)
Silt	100 – 200
Sand, gravel	10 - 100



Indexes Determined with FWD-results

SCI = Surface Curvature Index: $D_o - D_{200}$, $D_o - D_{300}$, $D_o - D_{305}$

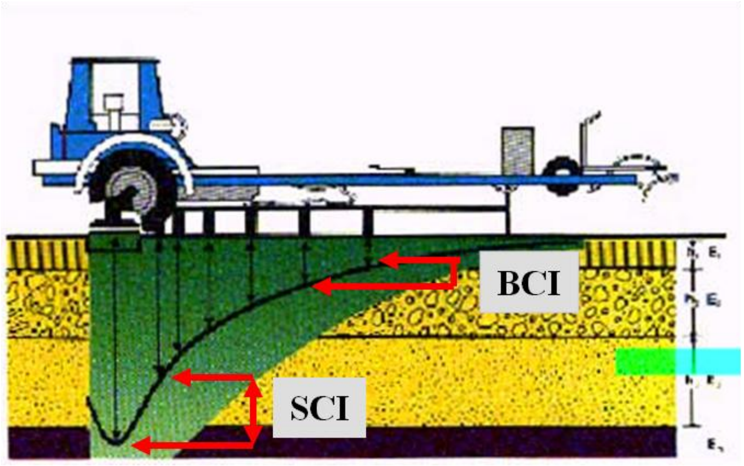
"Stiffness of the top part of the pavement structure"

BDI = Base Damage Index: $D_{300} - D_{600}$, $D_{305} - D_{610}$

"Stiffness of sub base and filter course" (seldom used)

BCI = Base Curvature Index: $D_{900} - D_{1200}$, $D_{610} - D_{914}$

How well road spreads the load over a weakasubgrade soil



SCI Classification (forest and gravel roads) (SCI 200):

< 200 Good
>400 Poor
>600 Extremely poor

(paved roads)

< 200 Good
> 250 Poor
> 400 Extremely poor

BCI Classification (BCI 1200)

< 20 Good
>40 Problems will occur
>60 Poor
>100 Extremely poor

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Indexes Determined with FWD-results

Swedish Bearing Capacity Indexes:

Strain in the bottom of pavement:

E_a strain in the bottom of pavement without temperature correction

$$\varepsilon_a = 37{,}4 + 0{,}988 * D_0 - 0{,}553 * D_{300} - 0{,}502 * D_{600}$$

D_0 , D_{300} , D_{600} deflections at respective distances

E_a10 E_a value corrected for a temperature of +10 grades Celsius, using formula: T = measurement temperature, h = pavement thickness in mm

$$\varepsilon_{a,10} = \frac{\varepsilon_{a,T}}{\left(\frac{T}{10}\right)^{3{,}08*10^{-8}*h^2*D_0}}$$

Subgrade Module (Mpa):

E_u Subgrade moduli

$$\varepsilon_u = \frac{52000}{D_{900}^{1{,}5}}$$

Analysis of FWD-Results:

Moduli calculations:

1. E2 – module (calculated immediately after measurements)

   E2 = average module of structure (Mn/m^2)

   (simulates the results of plate bearing test)

   Problems:

   - Bedrock increases the E2-values regardless of structure
   - Temperature correction of pavement is not noticed
   - Can be manipulated with Poissons ratio

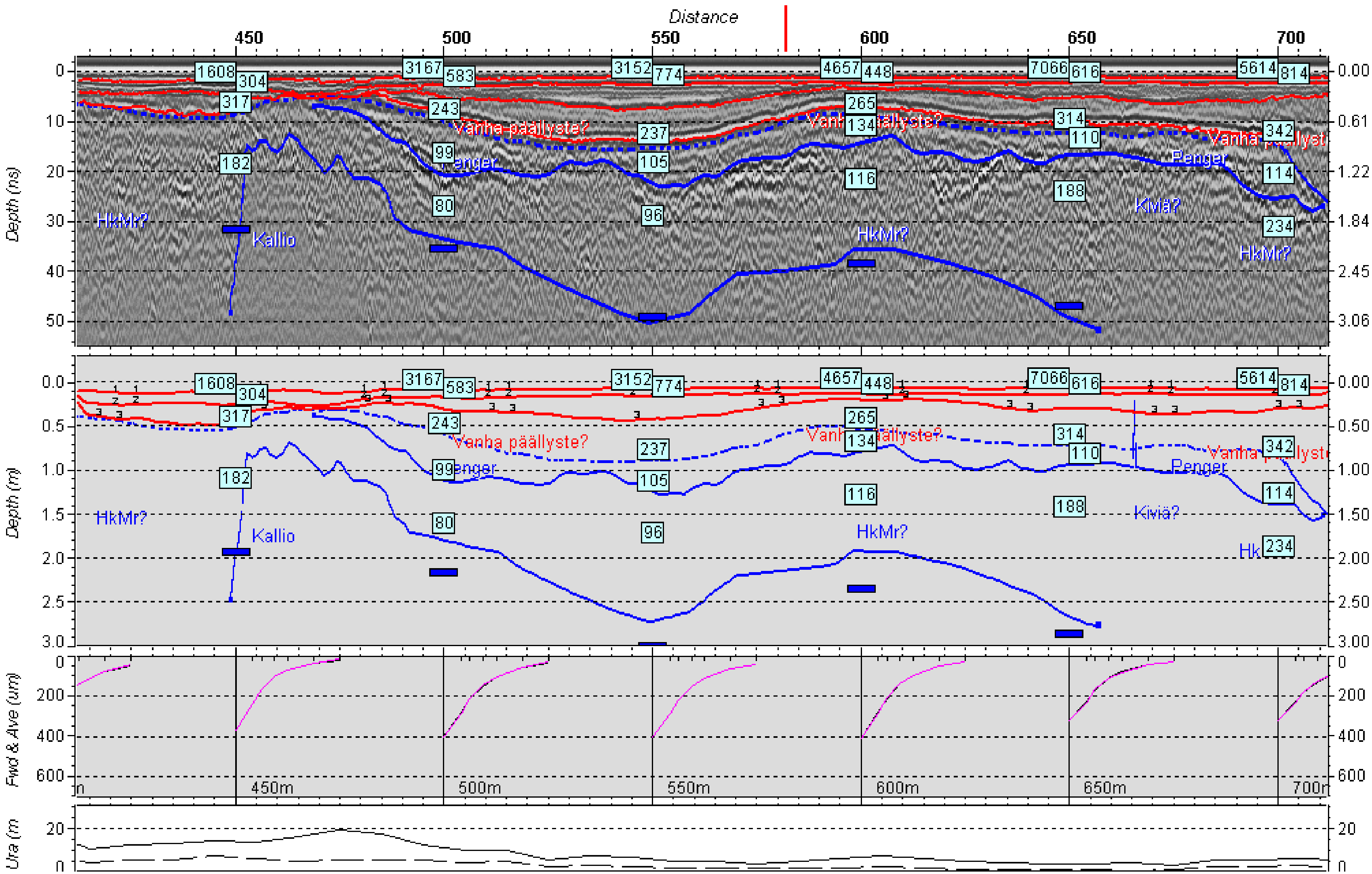
2. Back calculation of modules of structure courses:

   - Modules of different structures (MPa) and subgrade modules
     - Usually linear elastic theory (Odemark, FEM)
   - Depth of bedrock

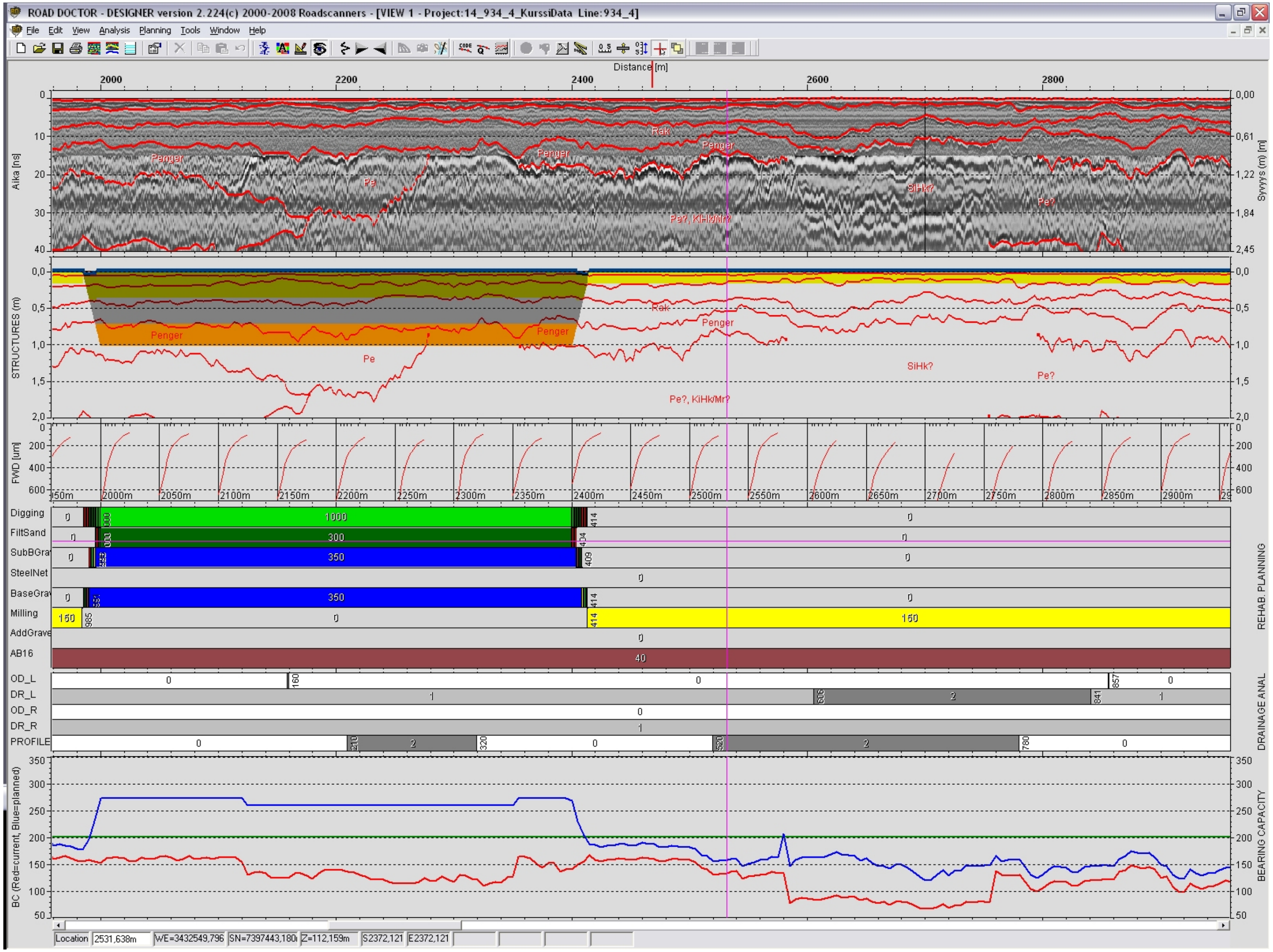
   Problems:

   - The information of structure thicknesses is also needed (GPR)
   - The separate software is needed
   - If the road is paved, the temperature correction have to be done
   - Nonlinearity of subgrade modules

Back Calculation of Layer and Subgrade Moduli Values

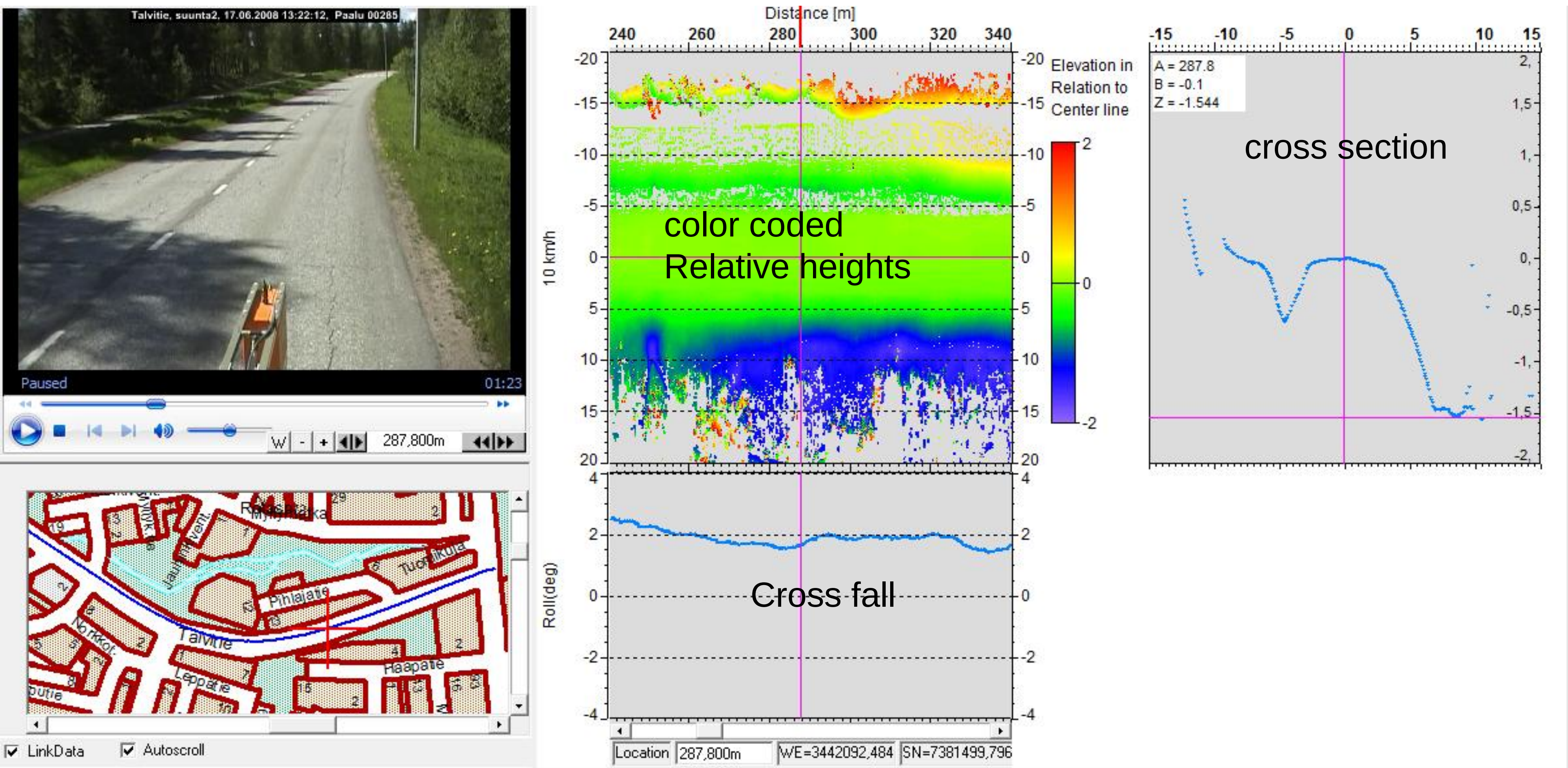


Rehabilitation Design and Dimensioning of a Road Structure



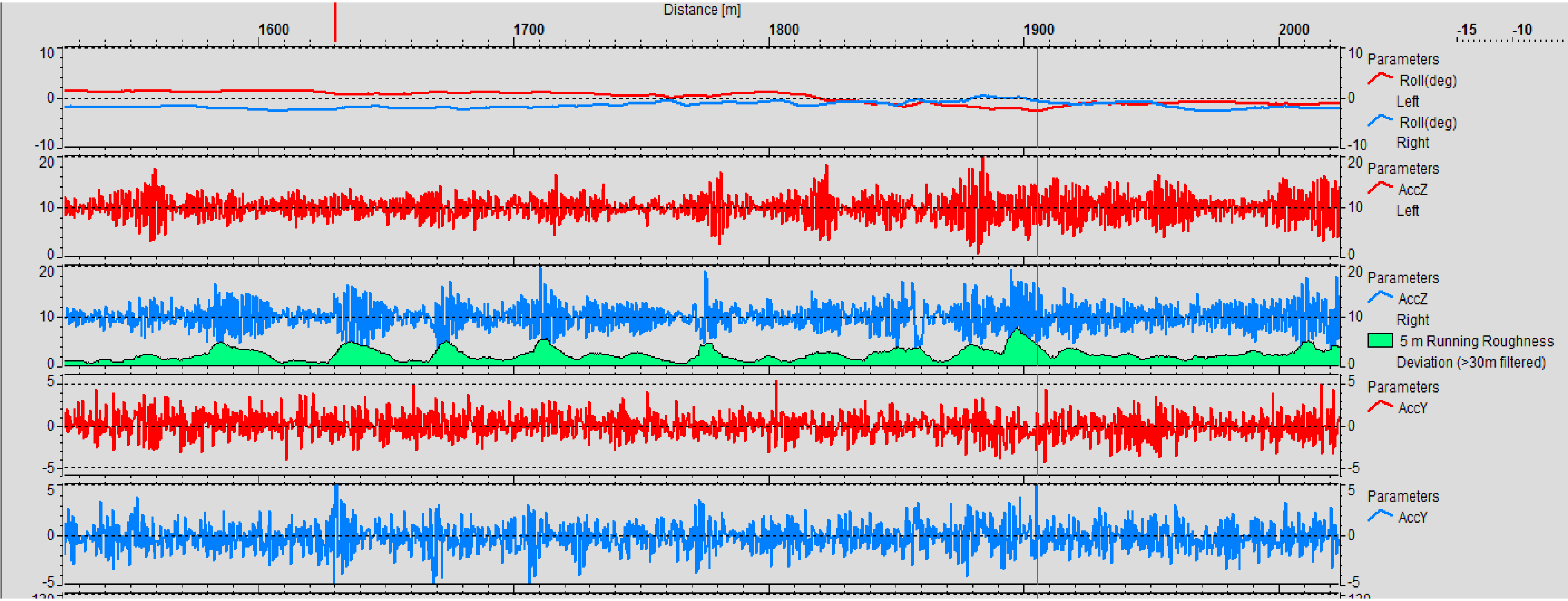
Laser Scanner Technique

Laser Scanners Data with 3D Accelometer Correction

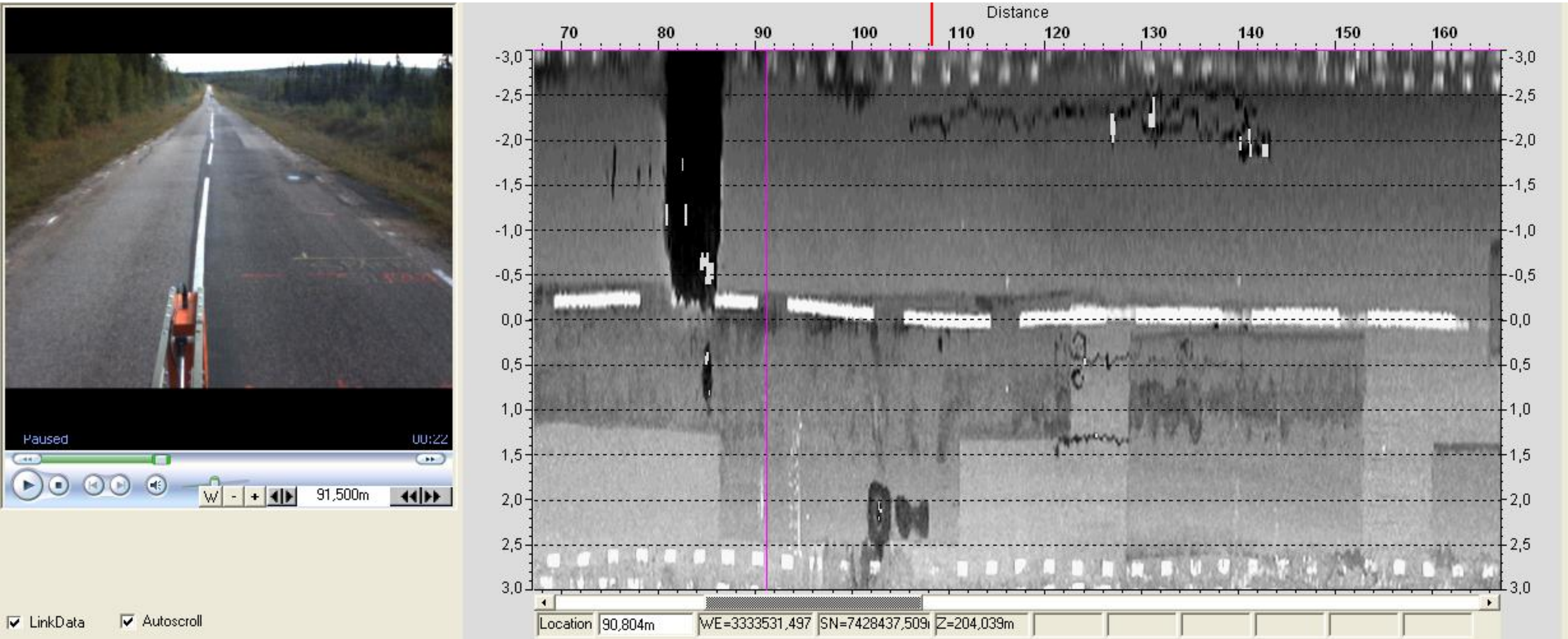


Example of 3D Accelometer Data:

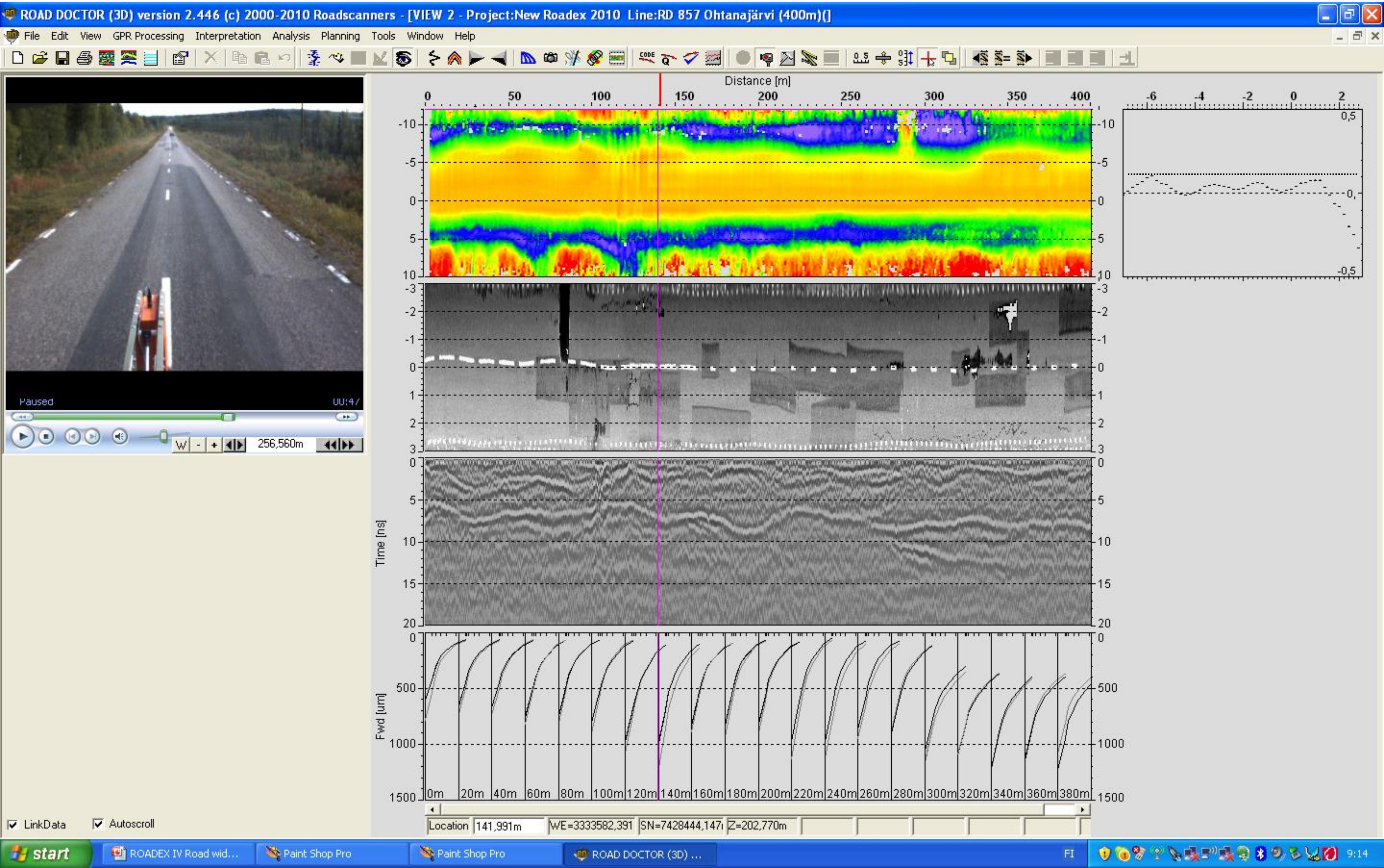
- Cross fall,
- Vertical acceleration
- Transverse acceleration



Pavement Condition Inventory



Laser Scanner, GPR AND FWD diagnostics



GPS

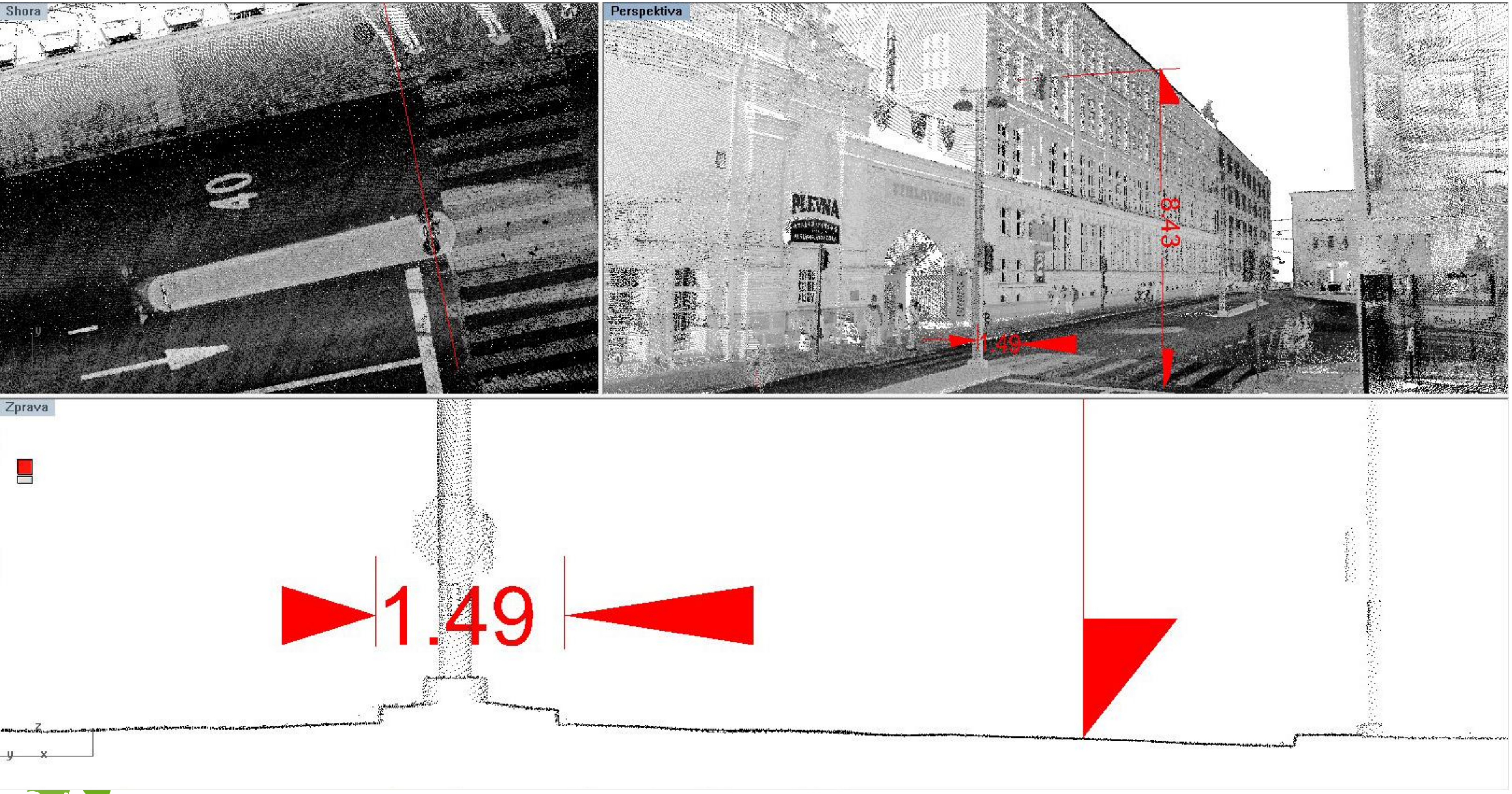
IMS

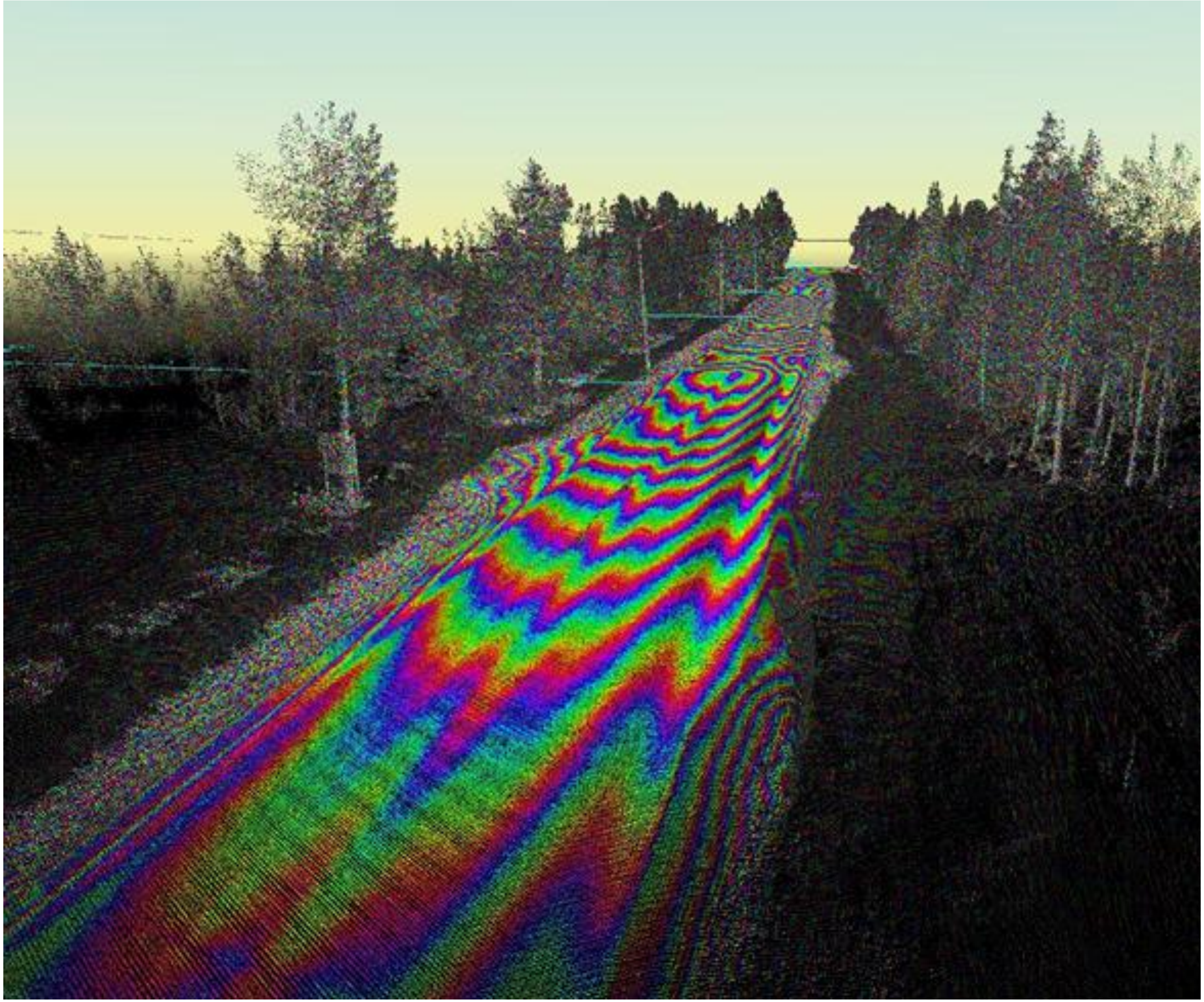
2 video cameras

2 laser scanners

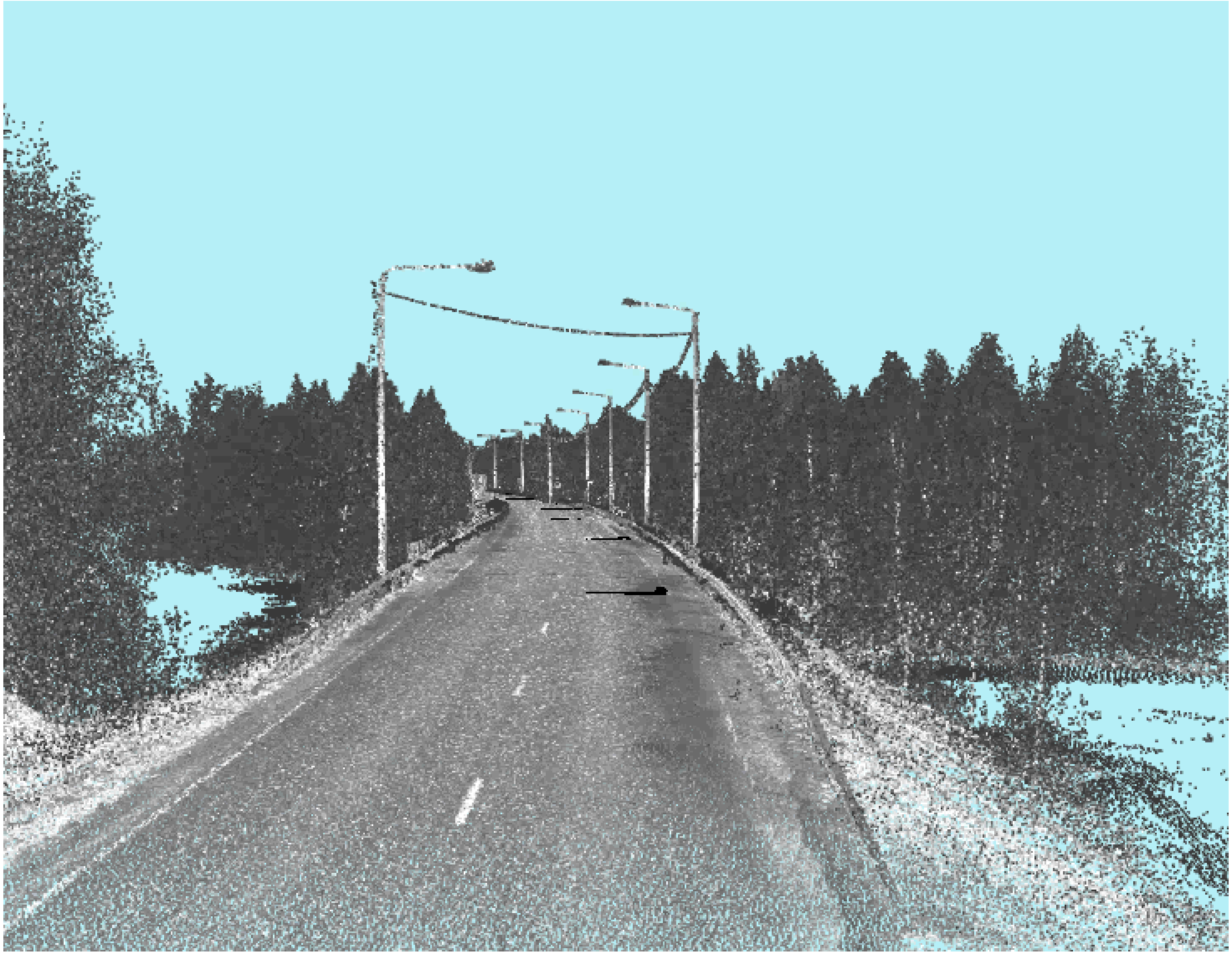
Street View Example

Modelling Laser Scanner data on city streets





Thank You



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