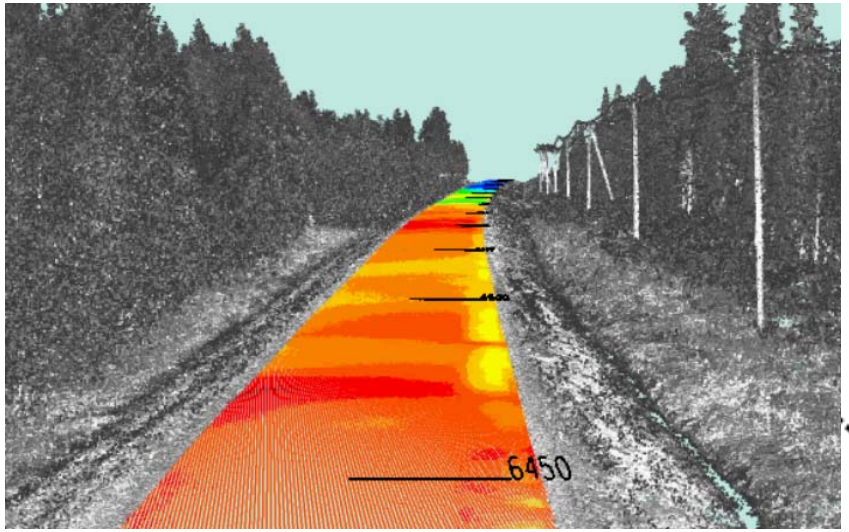
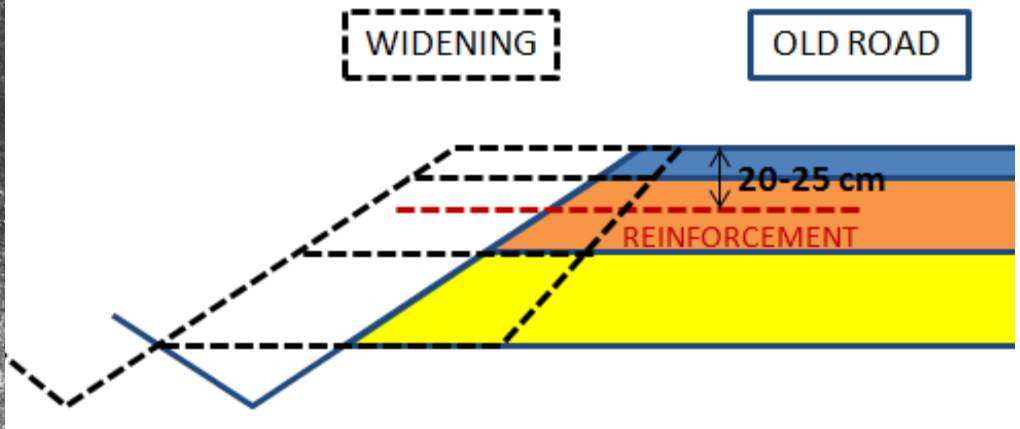
ROADEX RESEARCH PROJECT:
Road Widening





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Roadscanners Oy

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Research Project: Widening of Roads

Background:

- The cost effective widening of roads is a major issue facing the ROADEX Partners.
- **State-of-the-art survey**: Some of the partner countries have national road widening guidelines and some have not. The main difference in existing guidelines is in the scope of information provided.
  - Finland: Extensive guidance for road widening in different circumstances. One dedicated chapter in a design guideline.
  - Iceland: Good general guideline for road widening.
  - Scotland (UK): Extensive road design manual, but road widening guidance is slight.
  - Norway: Guidance is given in a range of handbooks. No one dedicated guideline.
  - Greenland, Ireland and Sweden: No nationally agreed guidelines.

  → New guidelines specifically tailored to the Northern Periphery are required.

Research Project: Widening of Roads

Goals:

1. Information about the reasons why road widening fails
2. Information about the critical parameters road engineer needs to know when designing road widening
3. Information how to fix widened roads with problems

Project Phases:

1. State-of-the-art survey
   - Interviews and literature reviews about current practises and guidelines for widening (NP area, North America)
2. Field surveys on selected test sites
   - A range of widened roads
   - Technology: GPR, Video, Laser Scanners, Thermal analysis, FWD
   - Some of the sites same as in ROADEX I
3. Final Report & New Guidelines for Road Widening
   - Final report
     - Summarizes research results
   - Guidelines
     - A ”pocket book” what to keep in mind in road widening projects and when repairing widened roads with problems

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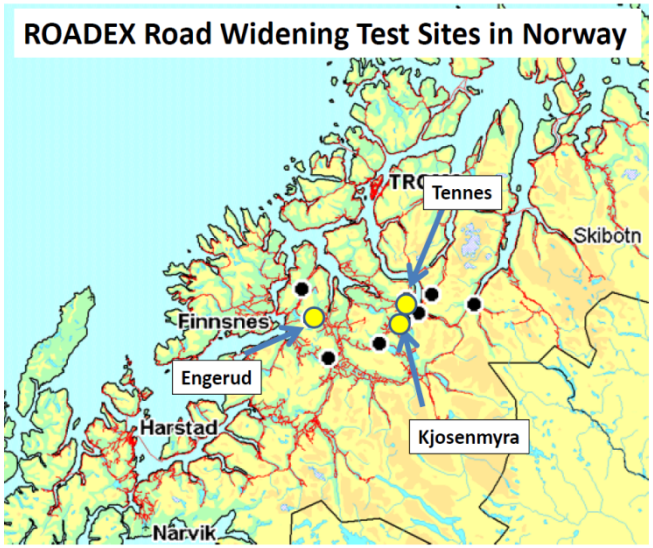
Research Project: Widening of Roads

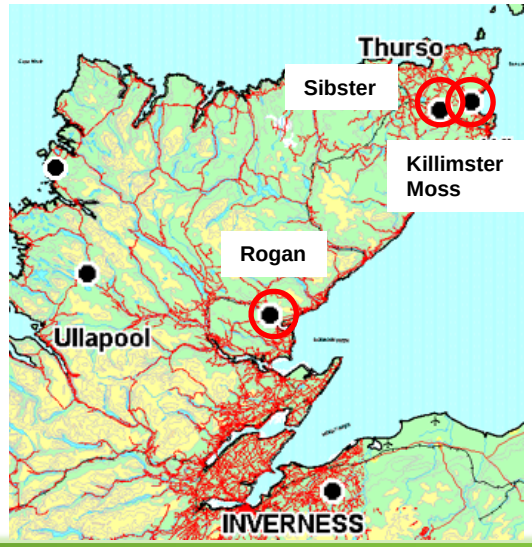
Common problems:

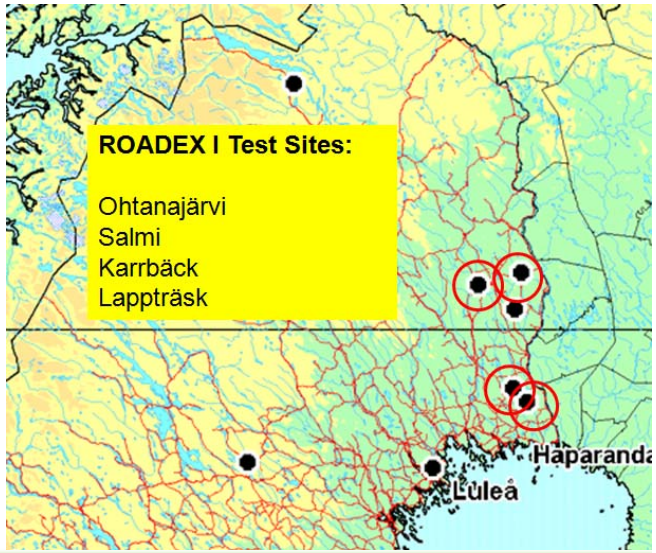
- Differences between old and new structure in structural thickness, material properties and/or degree of compaction
- Problems with joint construction and location
- Settlement (compressive soils, especially peat)
- Frost action and spring thaw weakening
- Drainage problems
- Slope stability problems
- Crossfall problems

Field surveys

- A range of widened roads, examples of different kinds of problems
- Technology: GPR, Video, Laser Scanners, Thermal analysis, FWD
- Some of the sites same as in ROADEX I







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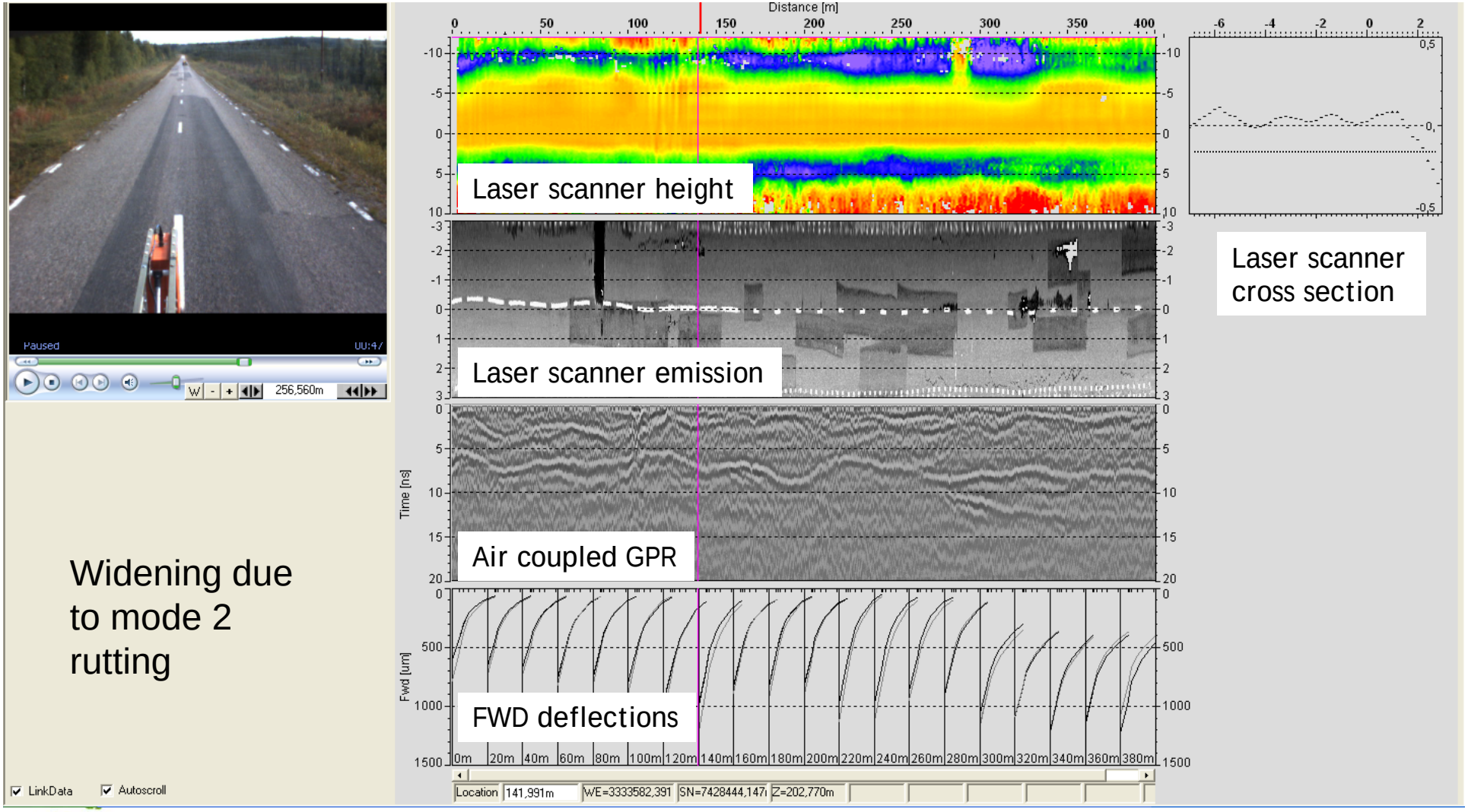
Field survey example: Old gravel road

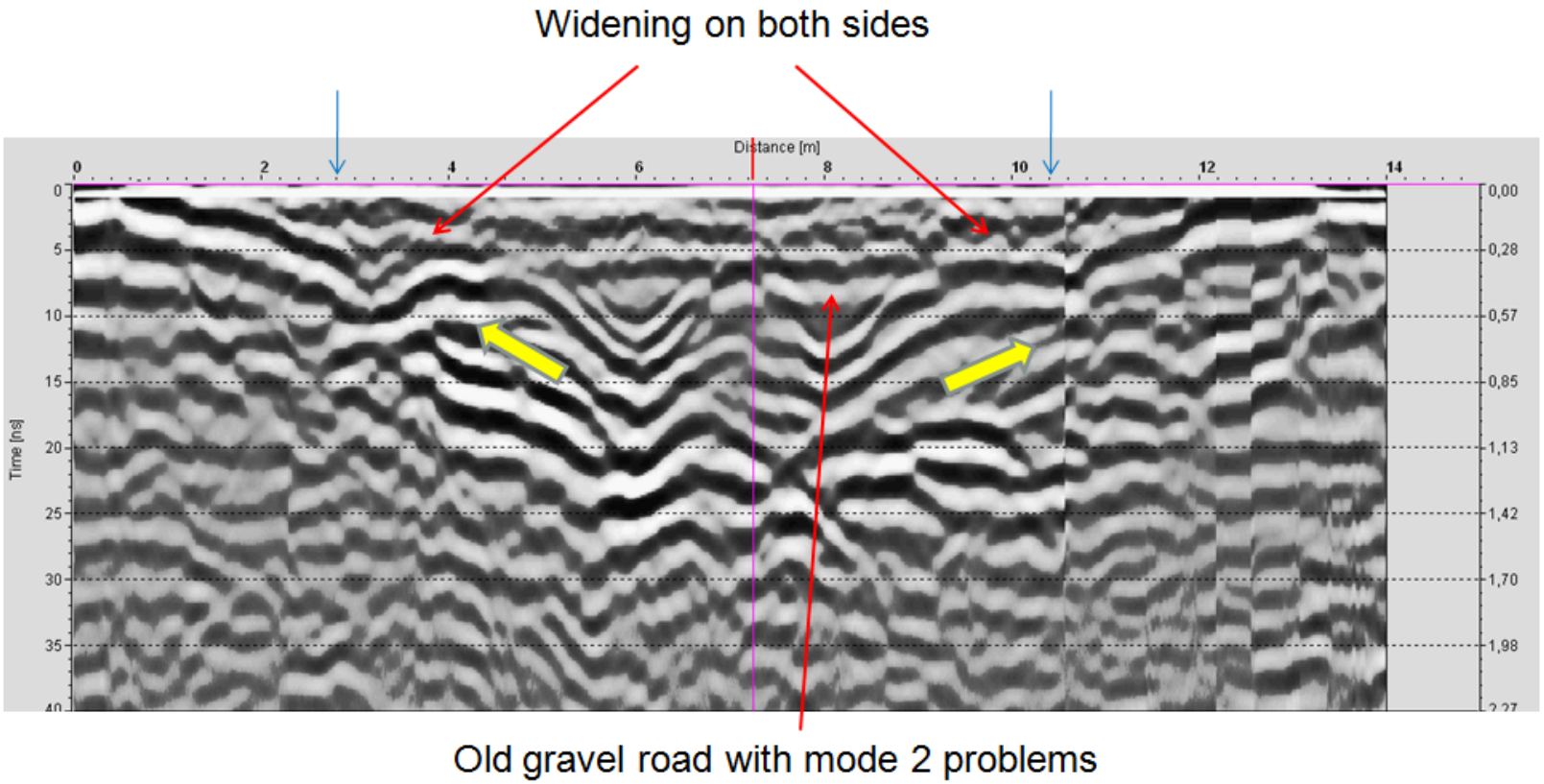
Rd 857, Ohtanajärvi, Sweden



Field survey example: Old gravel road

Rd 857, Ohtanajärvi, Sweden

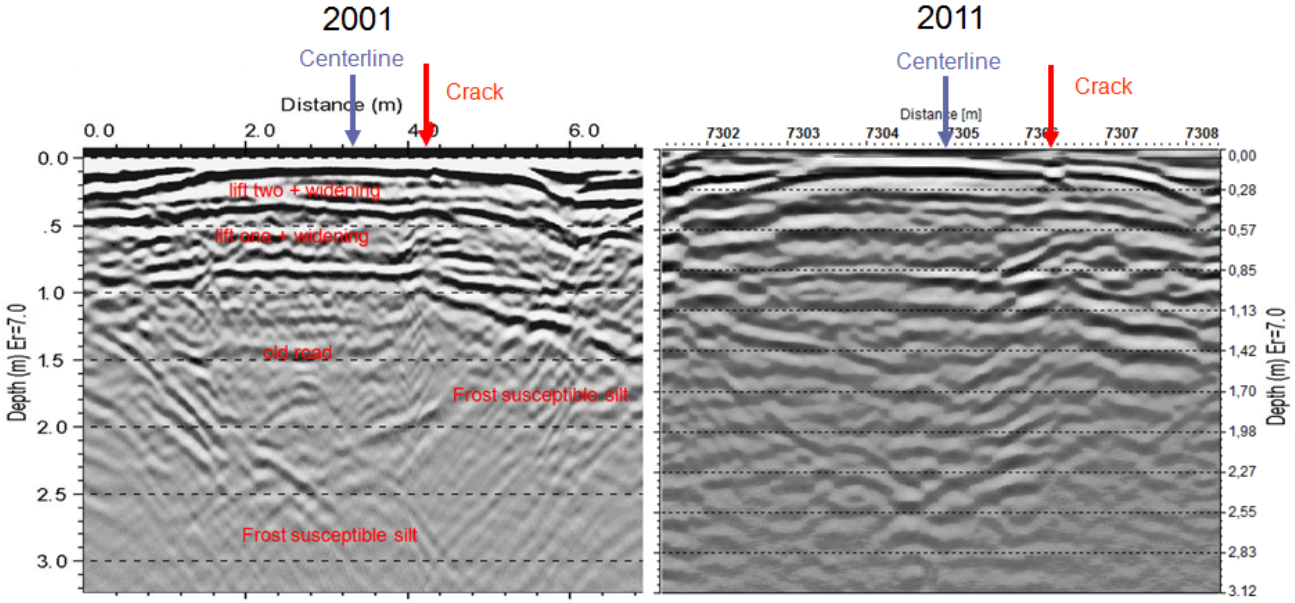
- The road has been widened but is also widening by itself
- Spring thaw weakening and Mode 2 rutting → unwanted widening
- This phenomenon should be kept in mind → shoulder of the existing road may already be thinner and weaker



Field survey example: Reflection crack

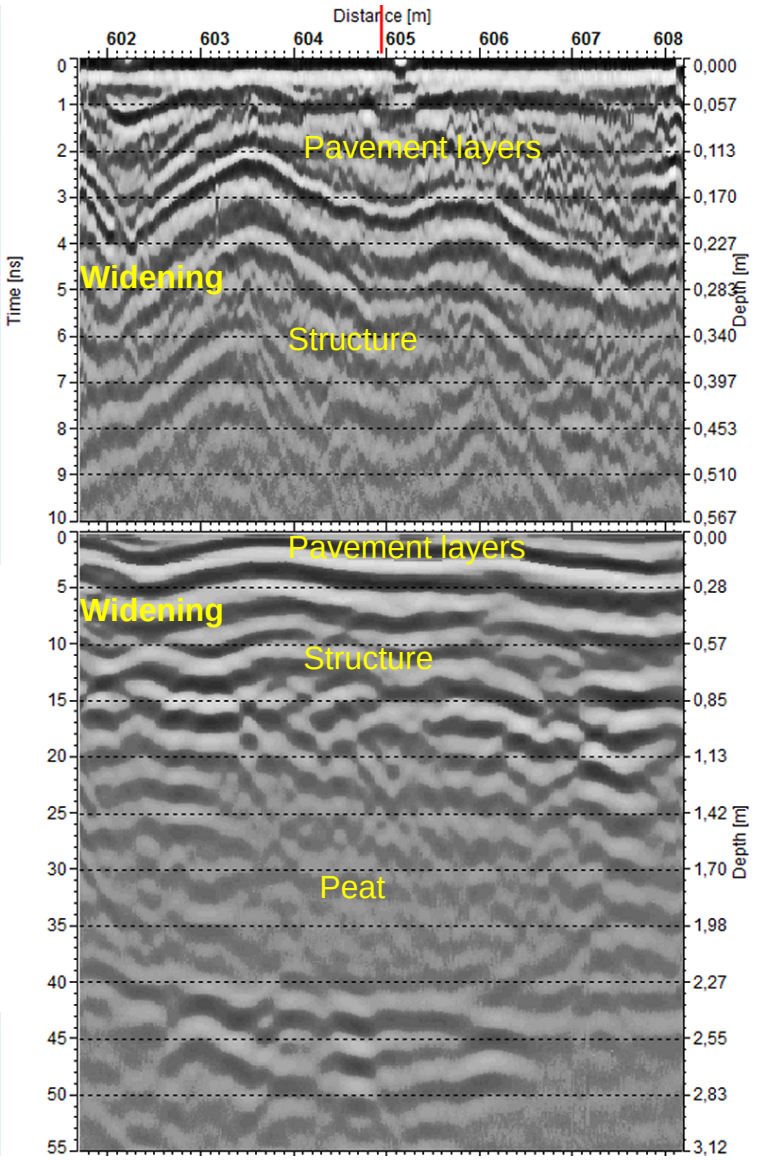
Rv-855, Engerud, Norway

- Longitudinal cracking
- Composite glassfiber fabric was used, but the structure failed
- Road structure:
  - wearing course – soft asphalt (40 mm)
  - **composite glassfiber fabric**
  - top of the old pavement layers stabilized (40-60 mm)
  - subbase - gravel
- Reflection crack on the joint
- Structure thickness on the widening side is thinner than on the old road side



Field survey example: Road on peat

Rv-858, Kjosenmyra, Norway



- Road has been widened to left, later bicycle path was built to the right
- Settlements in widened area: 15 – 30 cm
- Due to settlement road that has been paved several times over peat
- Severe peat settlement problems
- However, no major roughness problems

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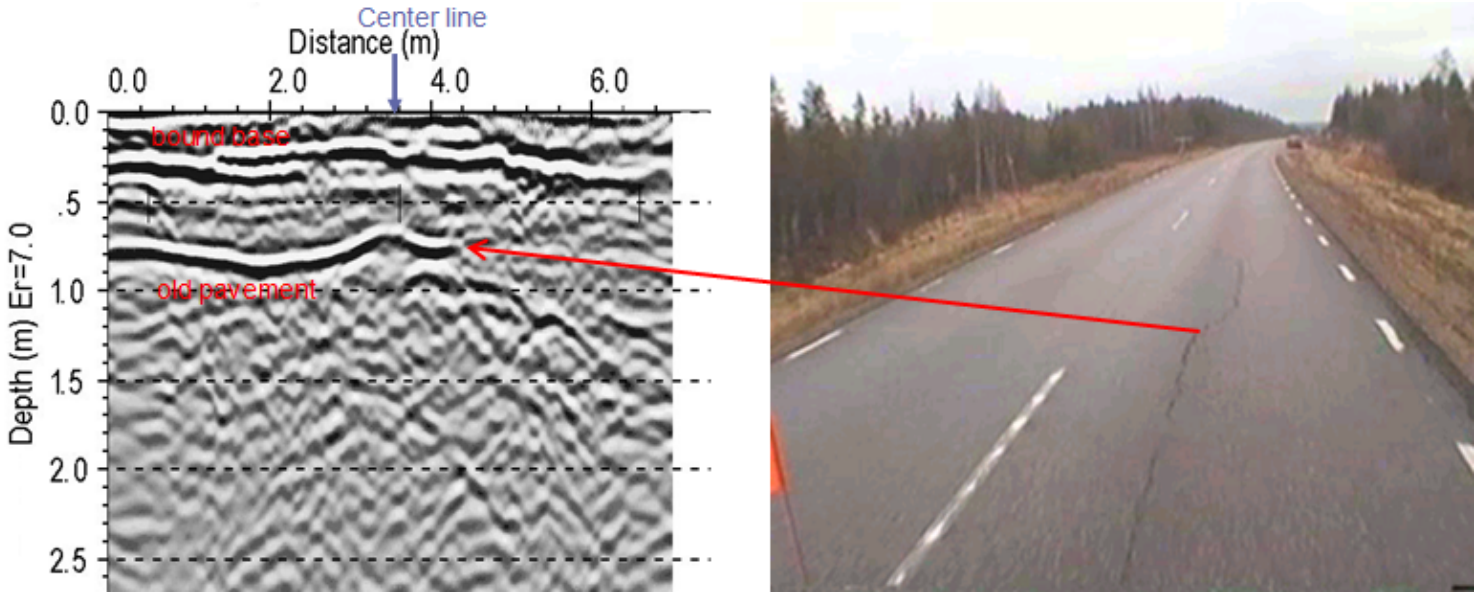
Field survey example: Old structure inside

Rd 392, Salmi, Sweden

- Old pavement layer inside the structure → reflection crack
- Sandwich structure is a clear construction error → must be avoided in all rehabilitation design
- Old bituminous pavement layers must be removed or crushed and homogenized before widening construction



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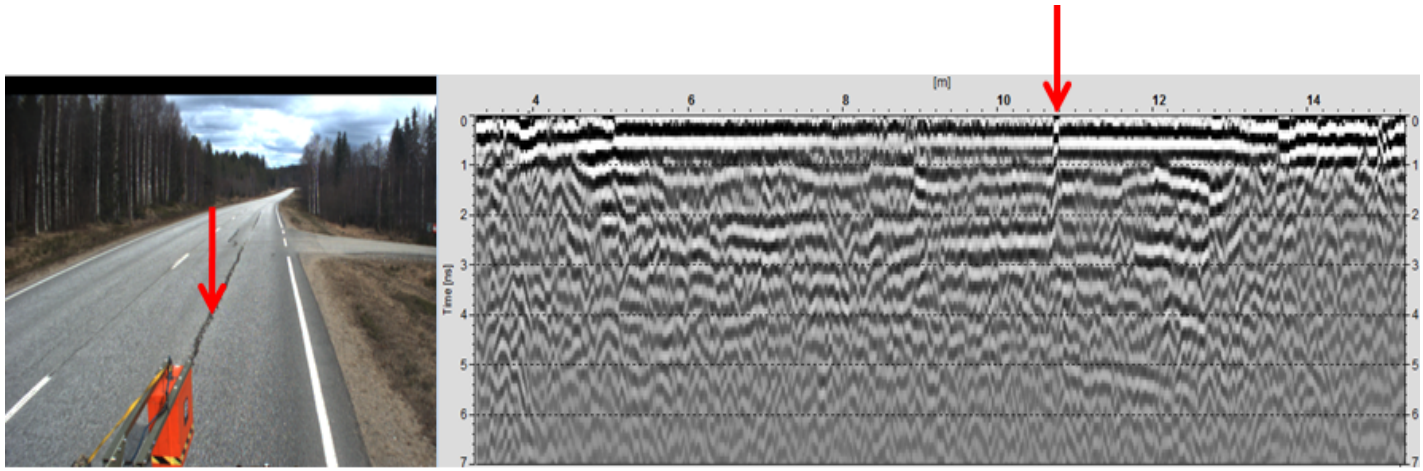
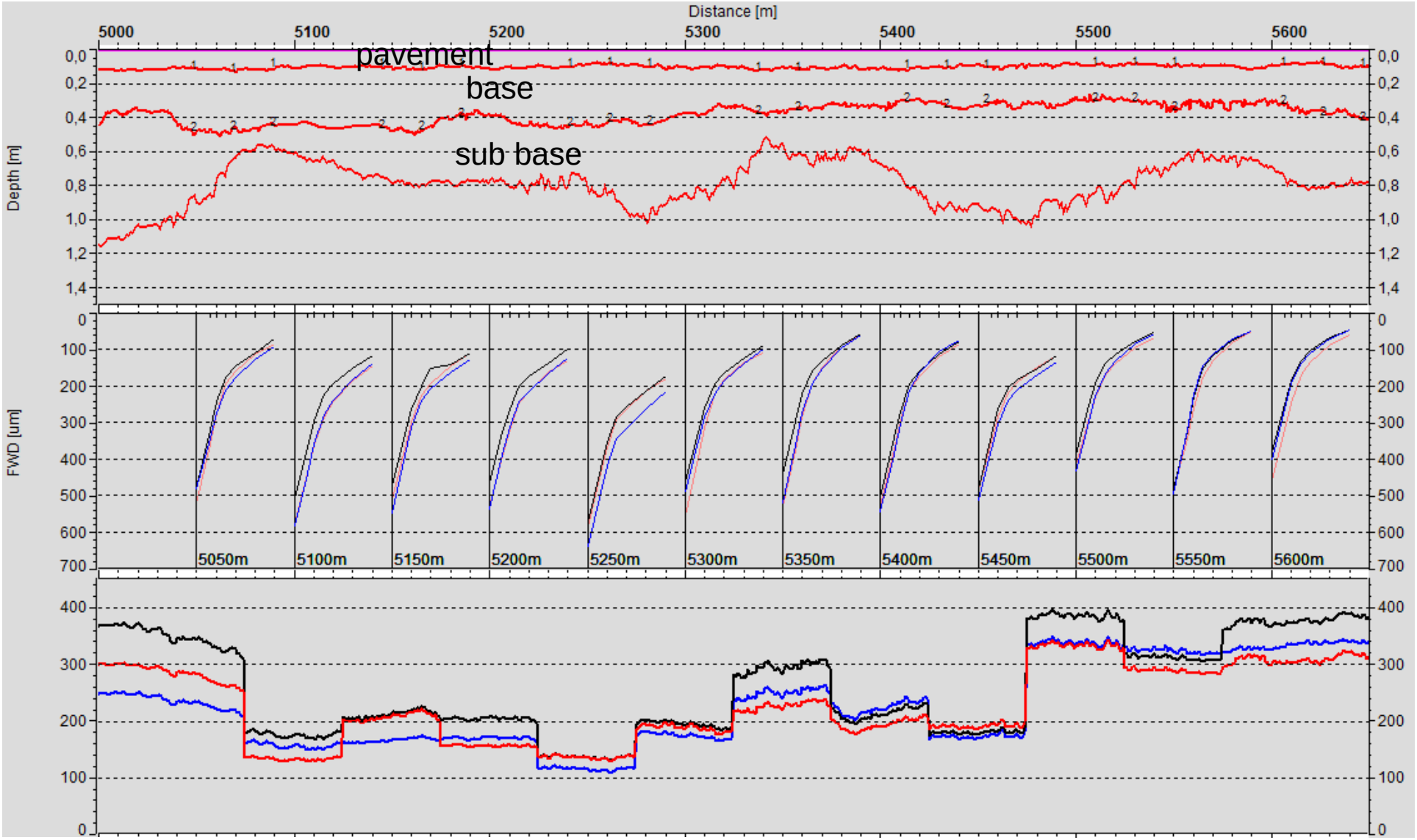
Field survey example: Rd 75, Nurmes, Finland

- Digital videos and GPS coordinates
- Laser scanner
- Thermal camera
- GPR profiles and cross sections
- FWD



Field survey example: Rd 75, Nurmes, Finland

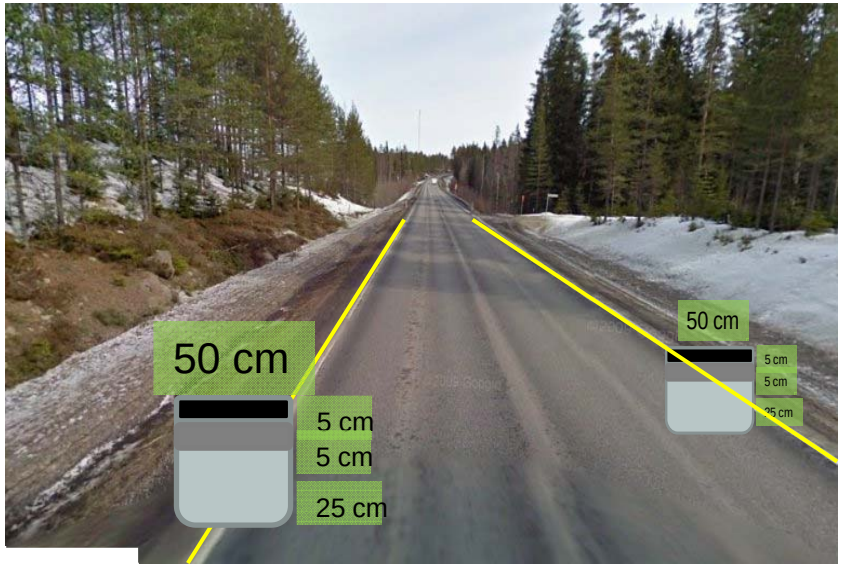


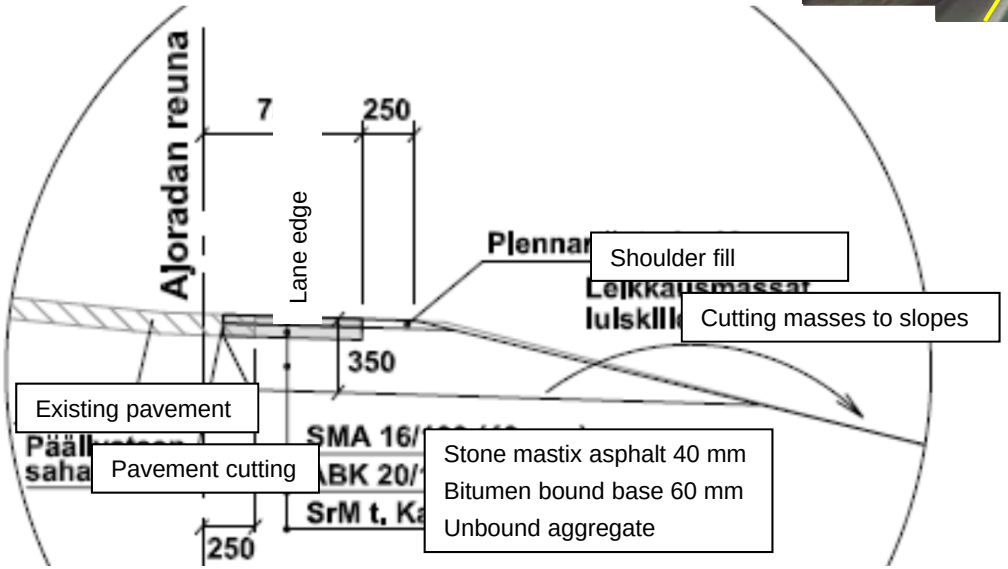
black = center, red = left, blue = right

Field survey example: Widening to both sides

Hw 9, Suonenjoki, Finland

- "Light widening"
- After widening the traffic load is still on the old lanes and the widening is for the shoulder and safety area only

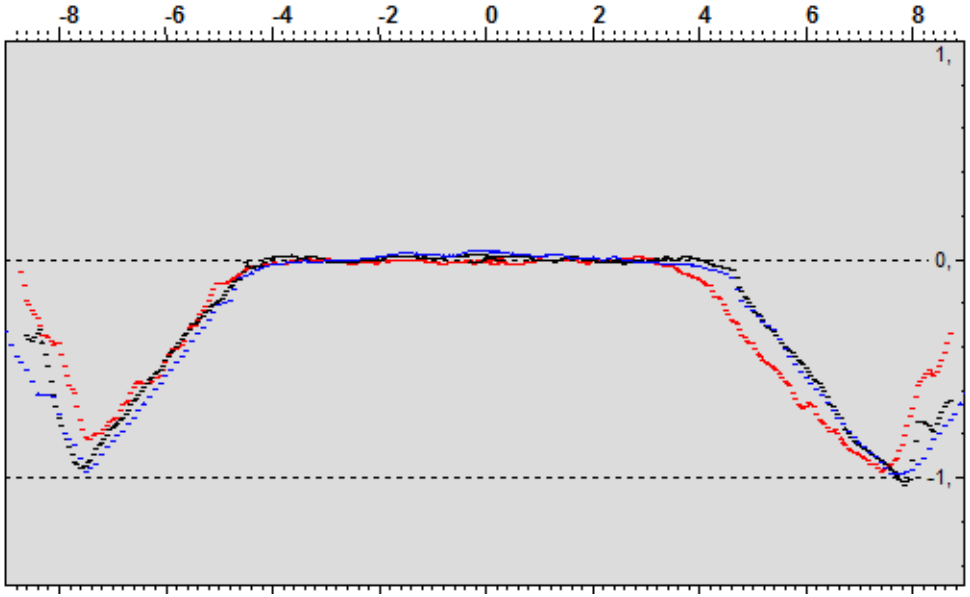


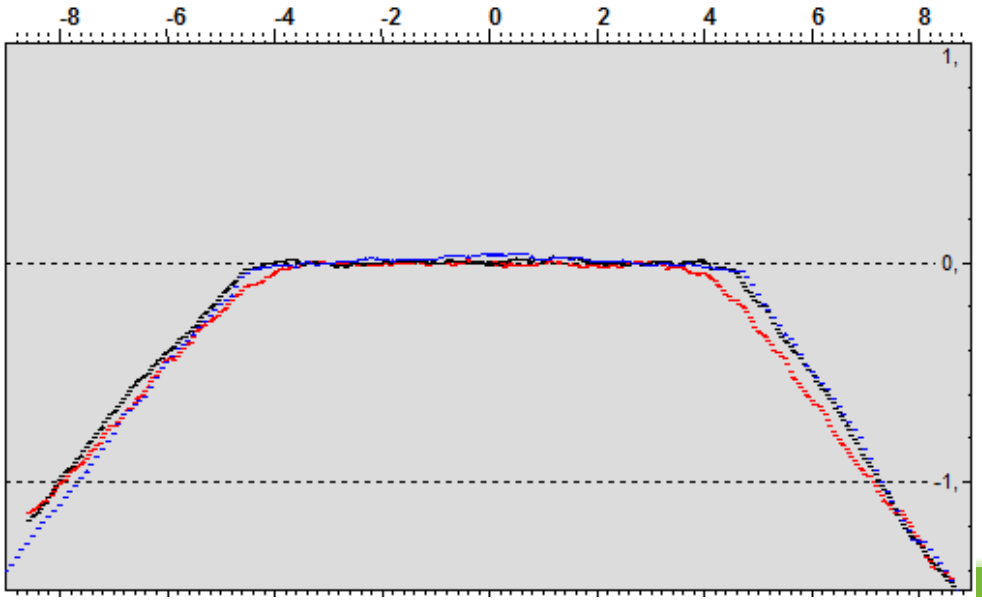


Hw 9: Examples of laser scanner cross sections

May 2010 (Red, before construction) vs. October 2010 (Black) vs. May 2011 (Blue)

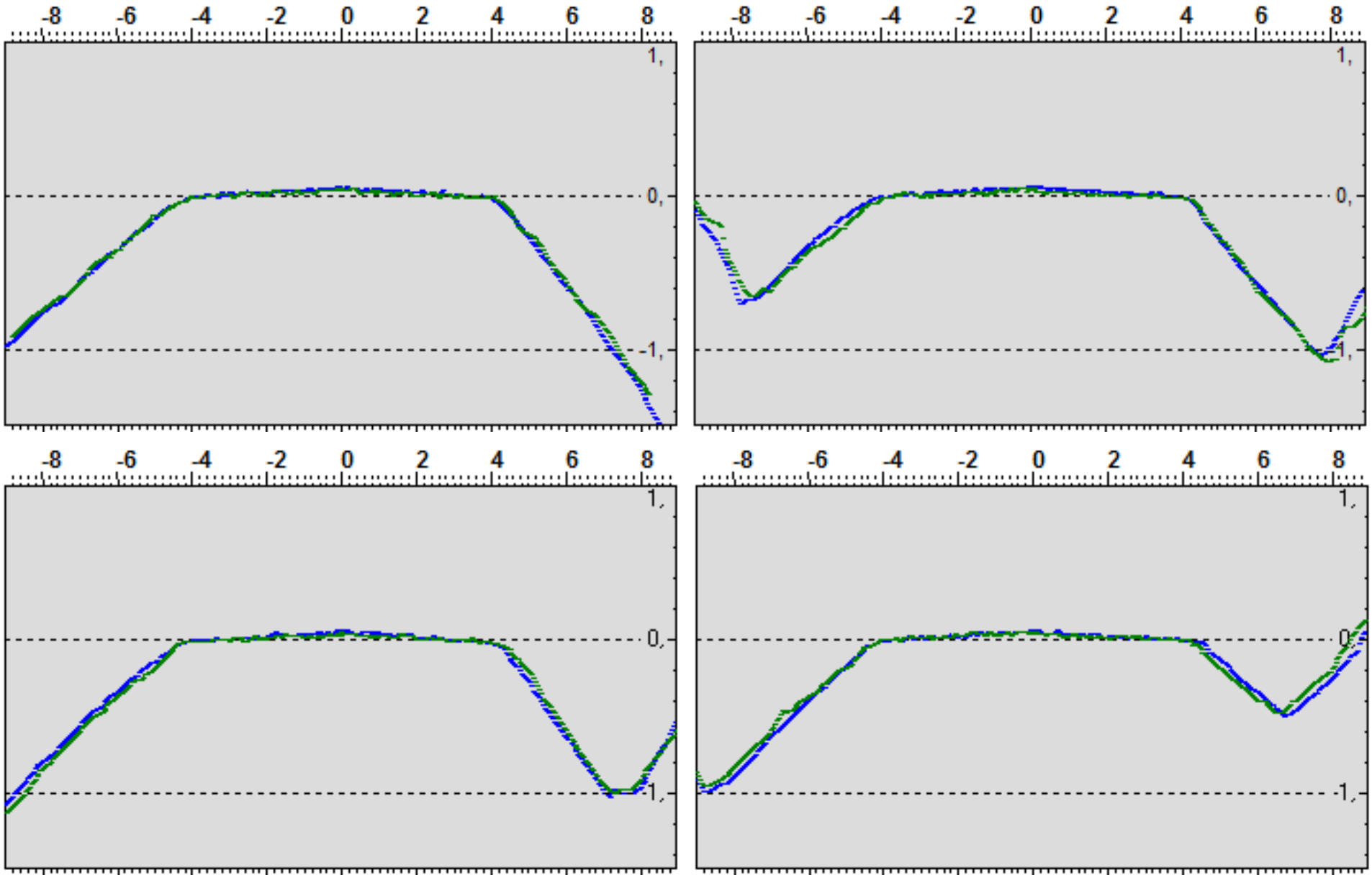
- Road has maintained its shape well
- No major changes in the cross section profile when comparing the autumn 2010 and spring 2011 measurements





Hw 9: Condition in spring 2012

Examples of laser scanner cross sections in May 2011 (Blue) vs. May 2012 (Green)



Hw 9: Condition in spring 2012

- Follow up measurements with video and laser scanner were made in May 2012.
- No changes when compared to May 2011 measurements. The widening is still in good condition.

2011

2012

2011

2012

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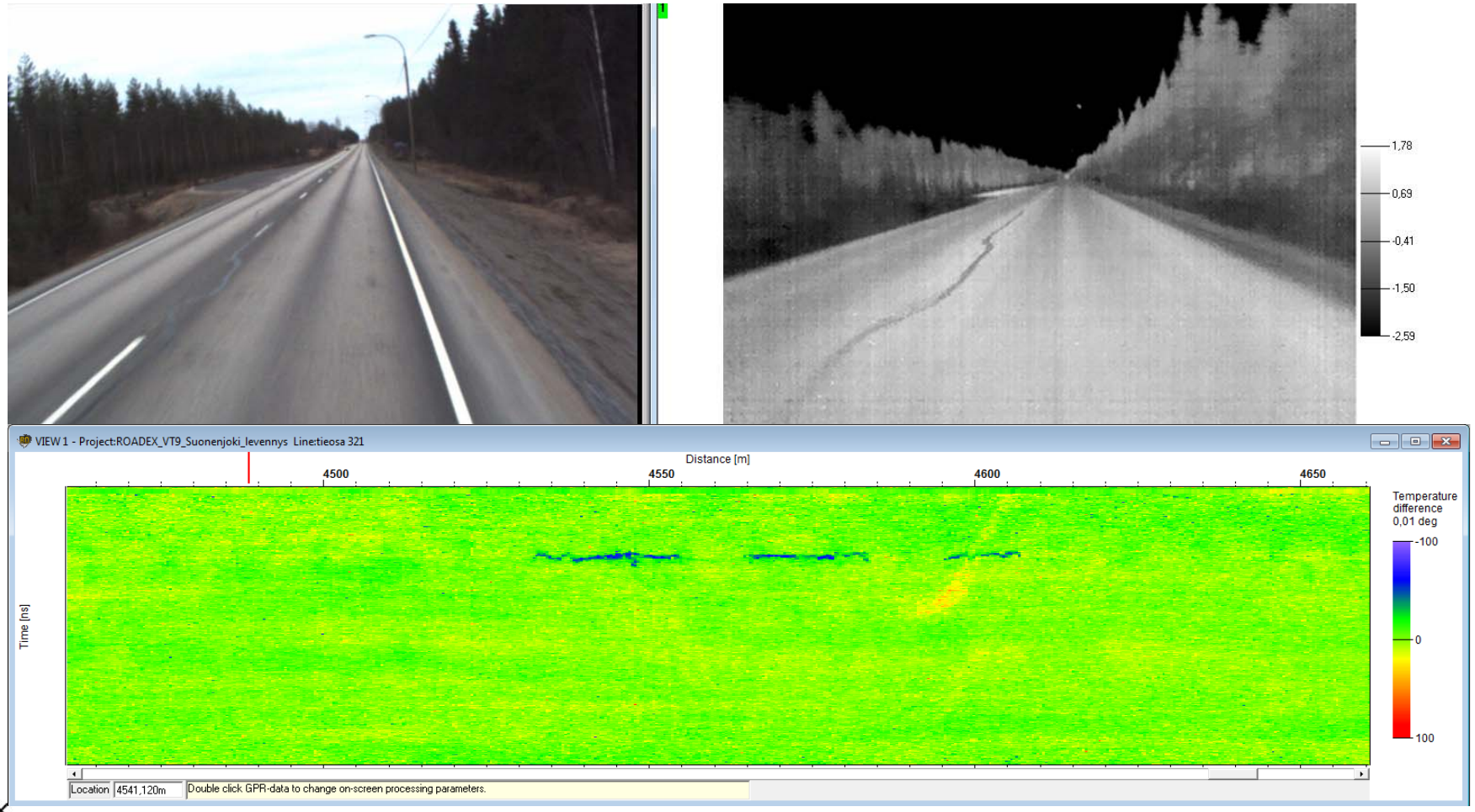
Hw 9: Thermal camera measurements

- Thermal camera measurements: general temperature distribution of the road is uniform
- No significant temperature difference between the widened shoulder and the old road structure
- The repaired cracks on the road can be seen cooler than their surroundings



Road widening case Killimster Moss, Highland

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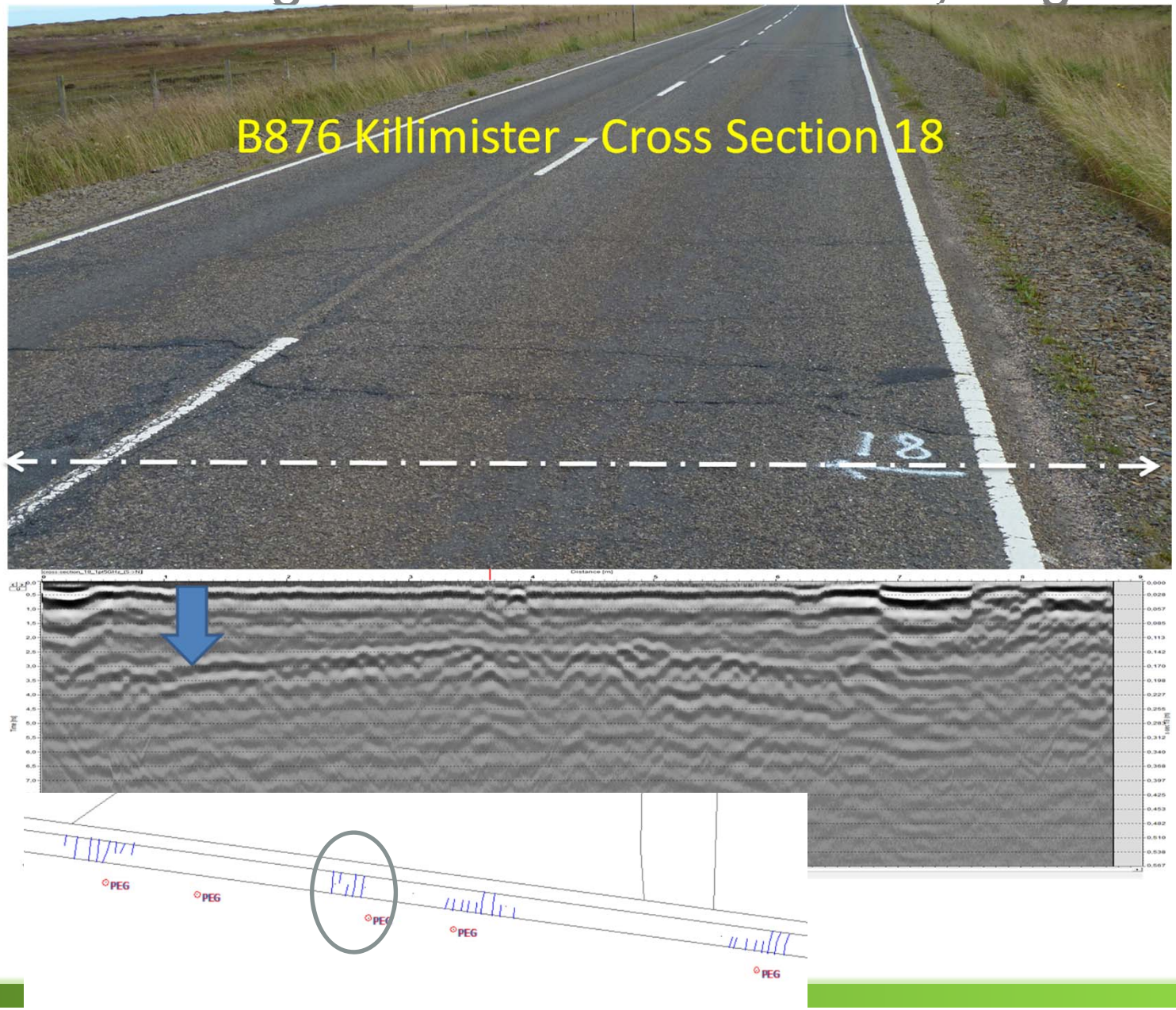
Road widening case Killimster Moss, Highland



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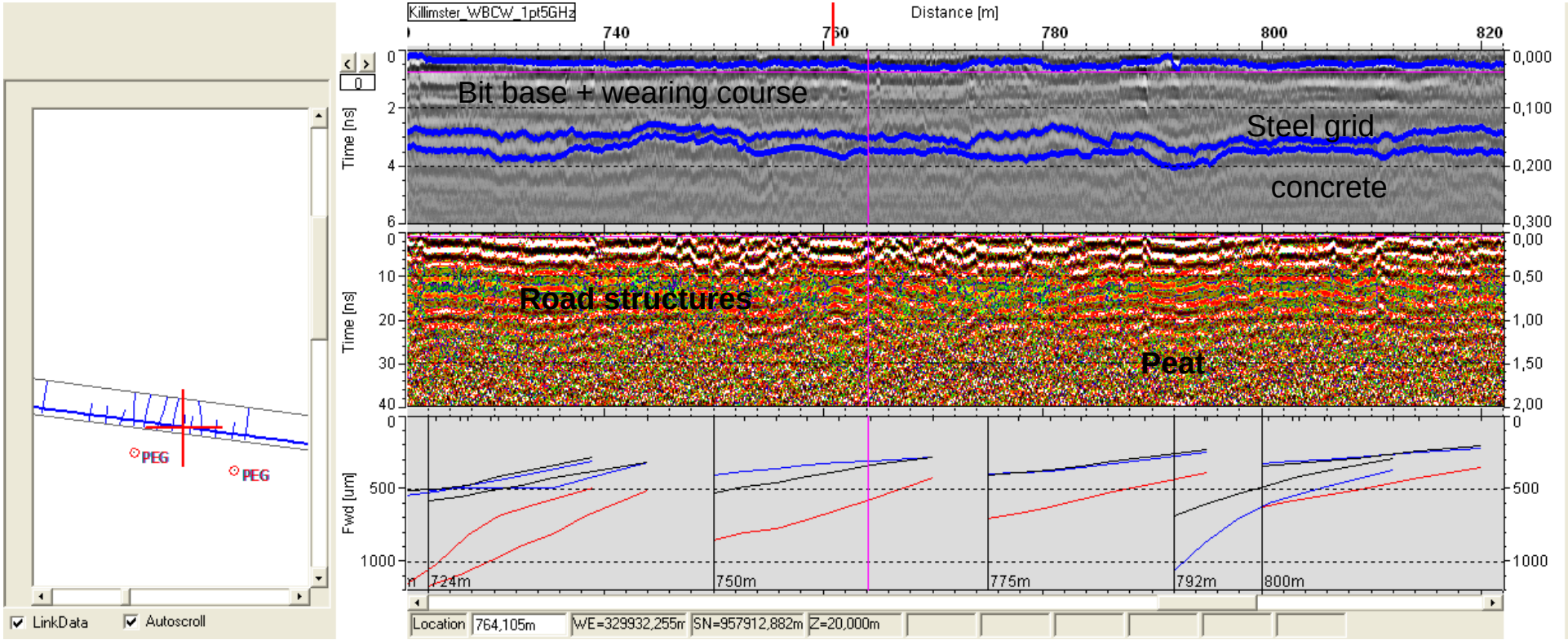
Road Widening Case Killimster Moss, Highland



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Conclusion: widening with steel grid has been performing extremel well

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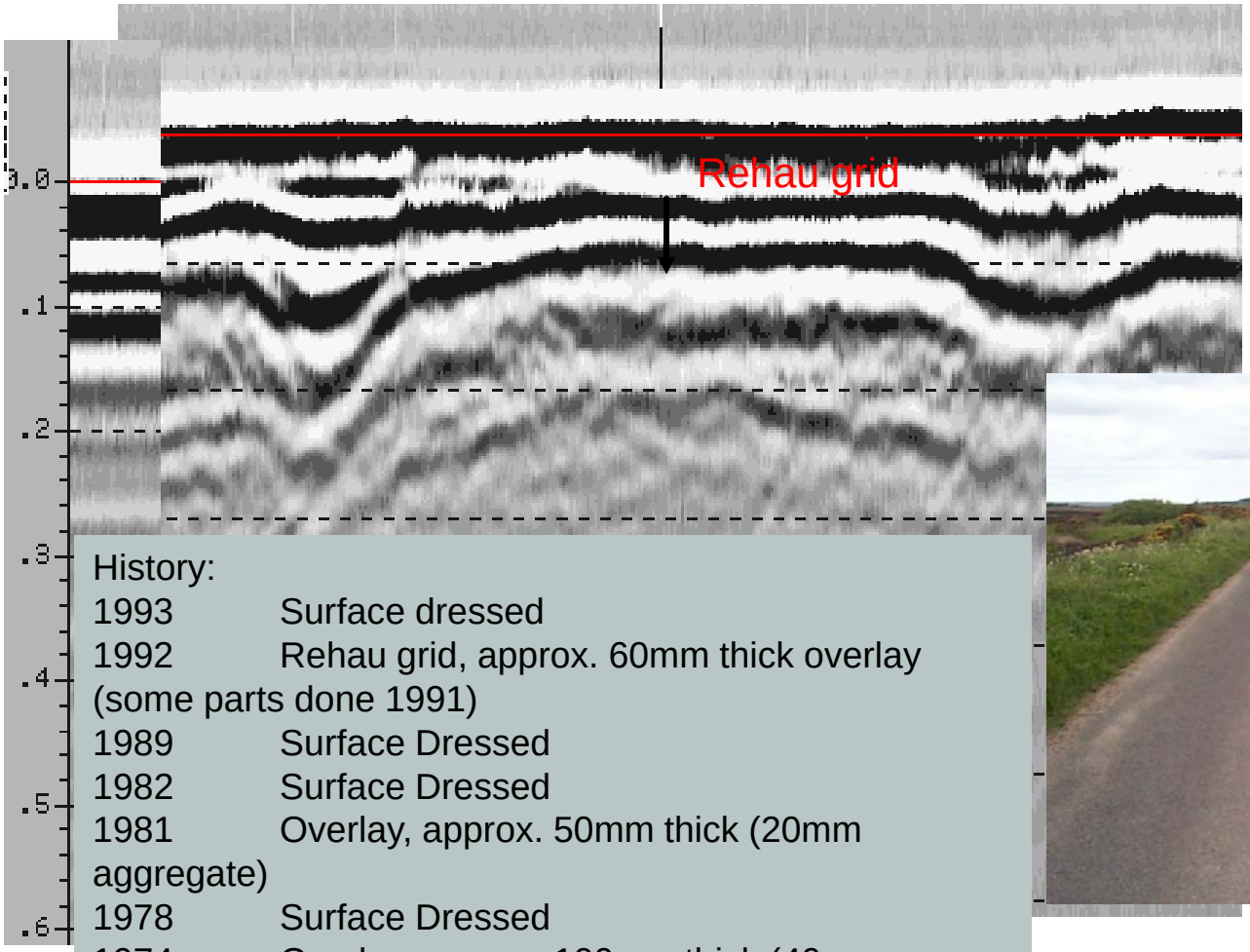
Rd 854 Sibster, Scotland, 2000, Cross section 80 m



History:

1993	Surface dressed
1992	Rehau grid, approx. 60mm thick overlay (some parts done 1991)
1989	Surface Dressed
1982	Surface Dressed
1981	Overlay, approx. 50mm thick (20mm aggregate)
1978	Surface Dressed
1974	Overlay, approx. 100mm thick (40mm aggregate, topped with bitumen 'grit')
1972	Surface Dressed
1971	Overlay??

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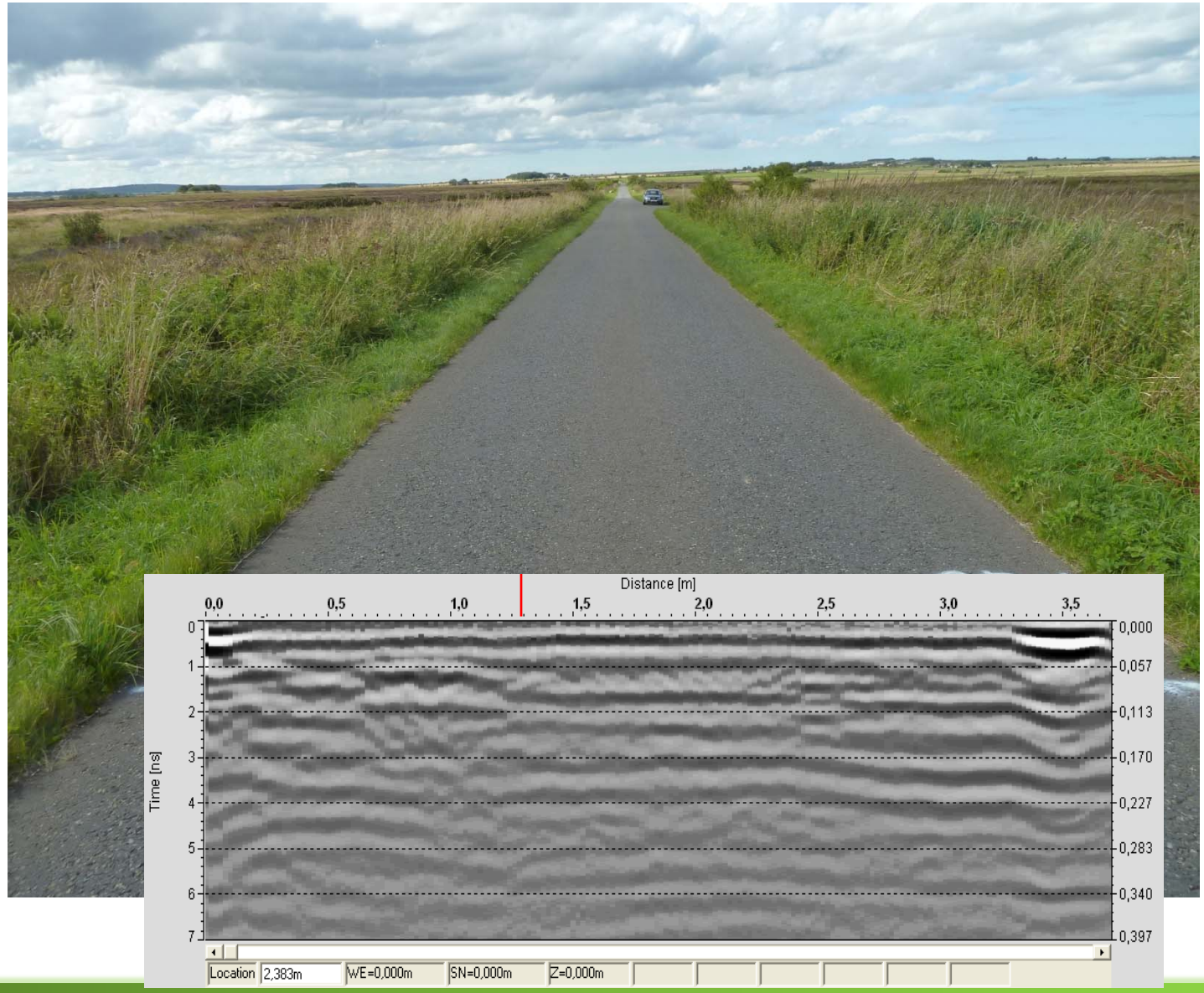
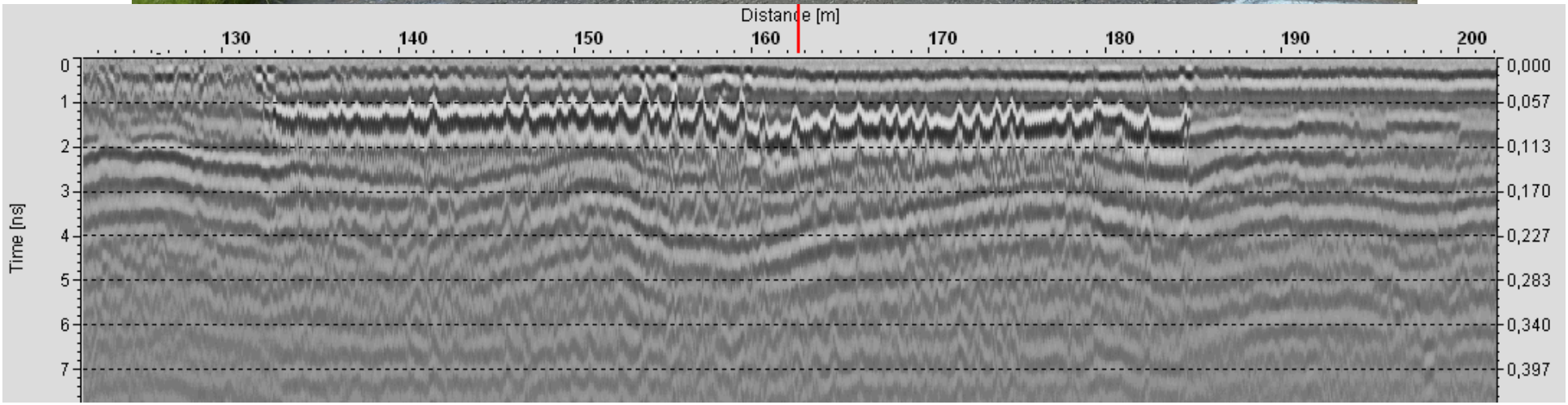
Sibster 2011




Sibster 2011
RD X
RD X

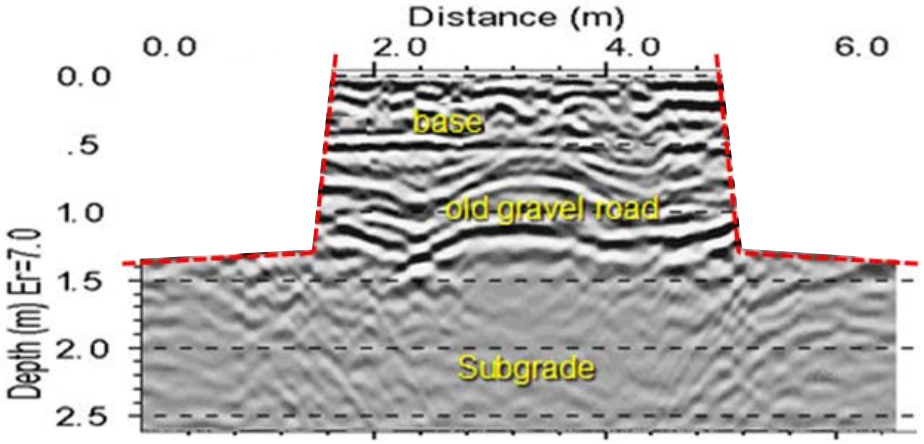

Distance [m]
130
140
150
160
170
180
190
200
Time [ns]
0
1
2
3
4
5
6
7
0,000
0,057
0,113
0,170
0,227
0,283
0,340
0,397

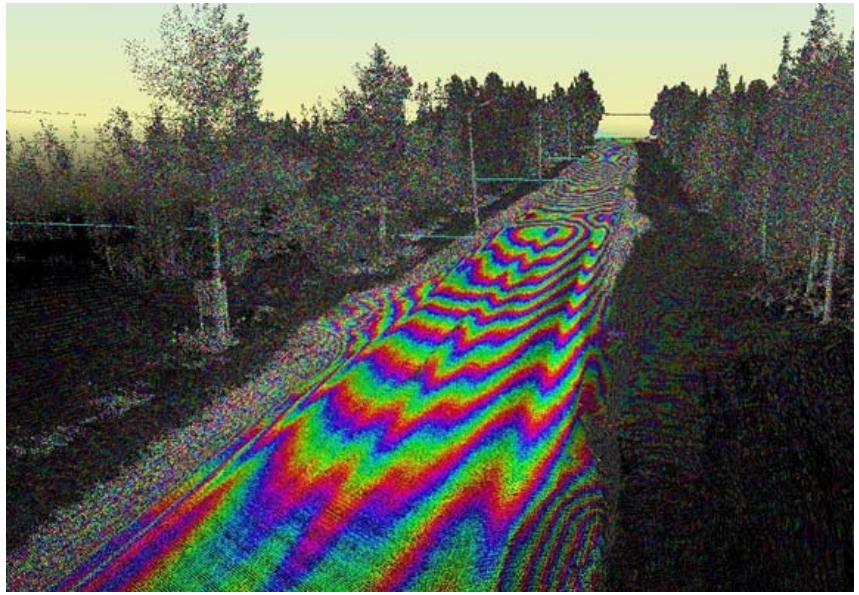
Road widening guidelines: Pre-Design Surveys

- Things that need to be surveyed:
  - thickness and quality of the existing road structural layers
  - subgrade quality
  - road shape and its surroundings
  - problem areas and damages
  - drainage condition
- Recommended methods:
  - Ground Penetrating Radar surveys
  - Drilling, sampling and laboratory analysis
  - Falling Weight Deflectometer surveys
  - Digital videos and pavement distress analysis
  - Laser scanning
  - Drainage analysis
  - Profilometer data analysis

Road widening guidelines: Design

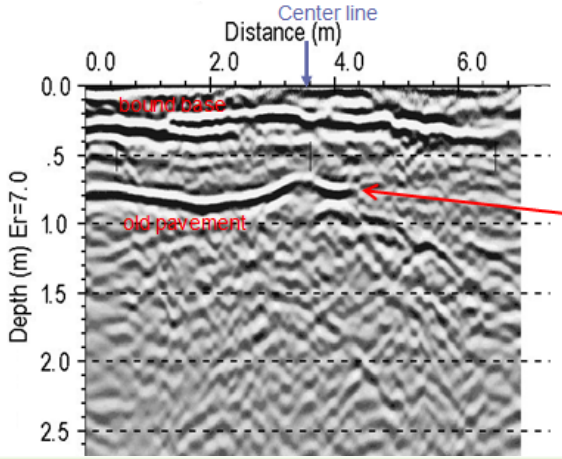
Old road structures





- Old structures below or inside the existing road structure → discontinuity → potential problem causing sections

- Old structures may include e.g.:
  - old gravel road below the existing layers
  - old reinforcement
  - old pavement layers inside the structure



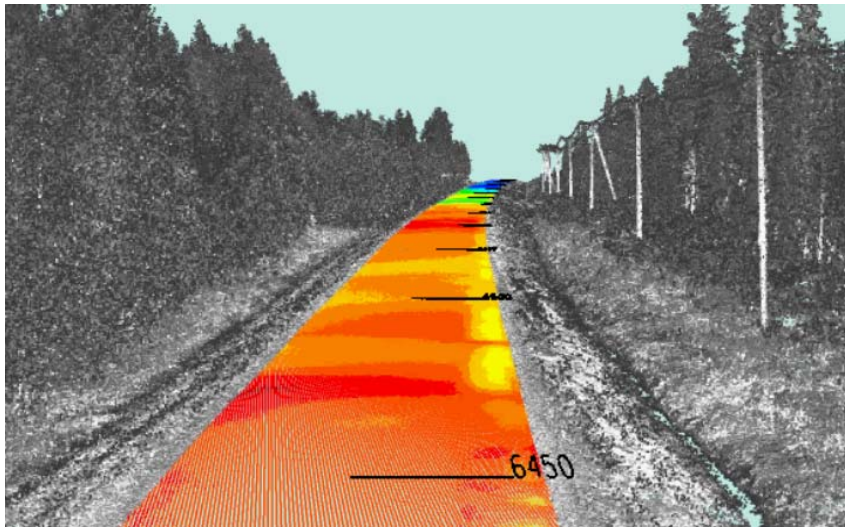
Road widening guidelines: Design

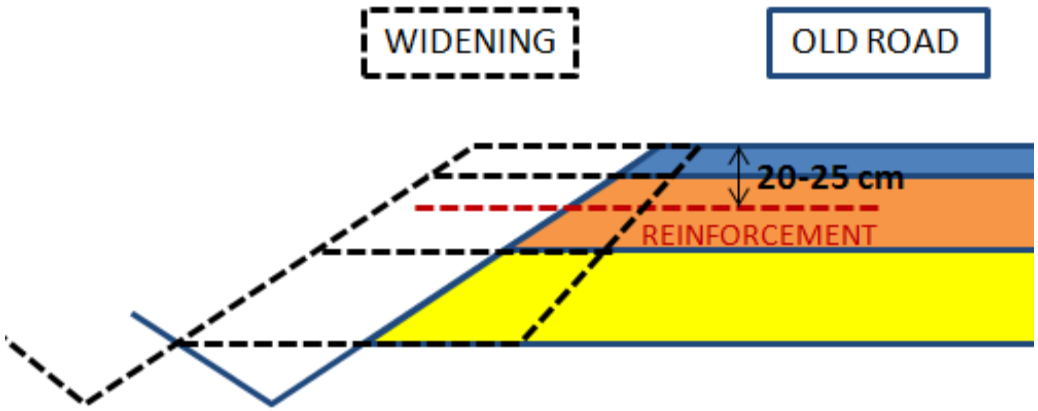
Frost action

Recommended methods to minimise frost action:
- Similar thickness of structures
- Reinforcement
- Good consistent drainage

"Rule of thumb" recommended by ROADEX:
A: Maximum frost heave on the old road less than 10 cm → equal widening structures are enough
B: Maximum frost heave on the old road 10 cm or more → old part should also be improved

Installing reinforcement **deep enough** (20-25 cm)

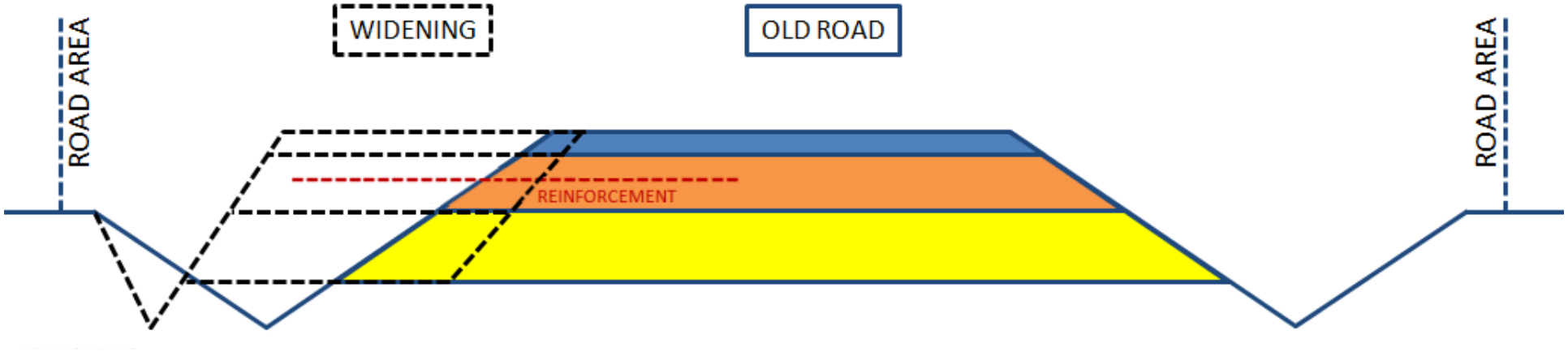




Road widening guidelines: Design

Topography, geometry and crossfall 1/3

- Limited space → steeper slopes
- Reinforcement and/or retaining walls can be used
- If road area is not problem → create more space



Road widening guidelines: Design

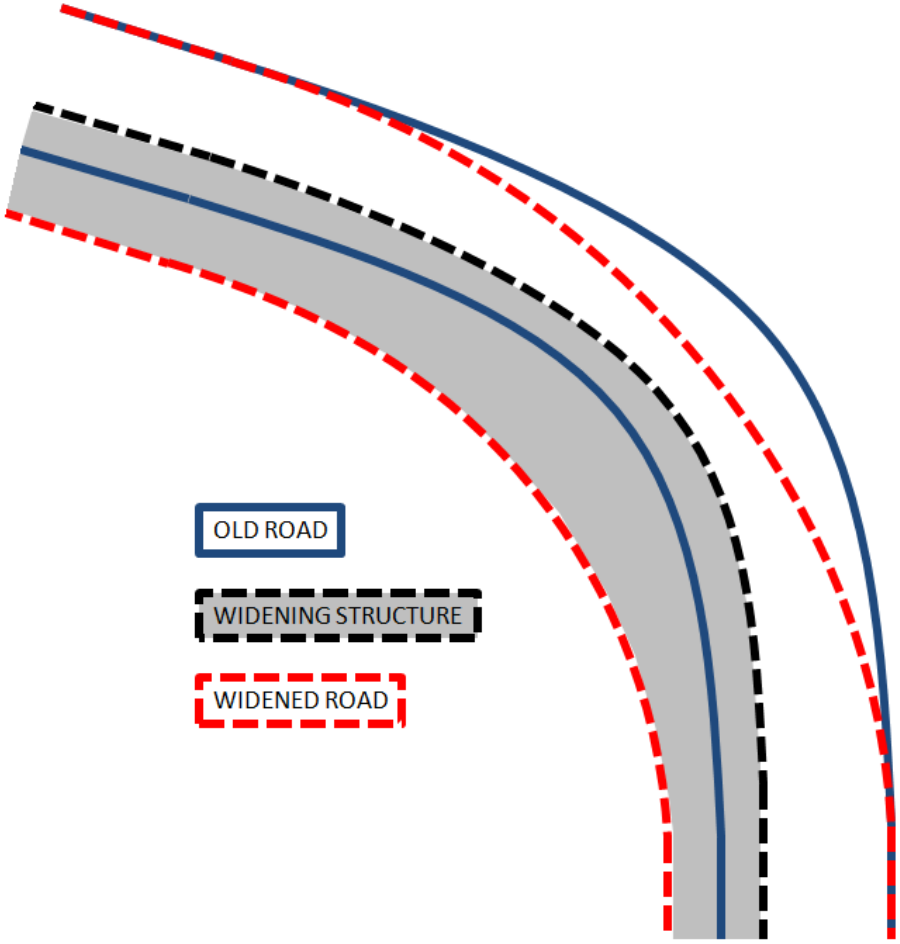
Slope stability

- The steepening of side slopes can lead to slope stability problems
- Methods to improve slope stability:
  - geotextiles
  - geogrids
  - steel reinforcement
  - heavy rip-rap
  - retaining walls or stepped batters
  - vegetation on the slopes
  - good drainage

Road widening guidelines: Design

Topography, geometry and crossfall 2/3

- Often beneficial to upgrade the horizontal geometry of the existing road during widening
- Improvement of sharp curves may lead to diagonal construction joints → special attention to joint construction
- Improvement of the existing road at the same time decreases the impact of traffic loading and frost action



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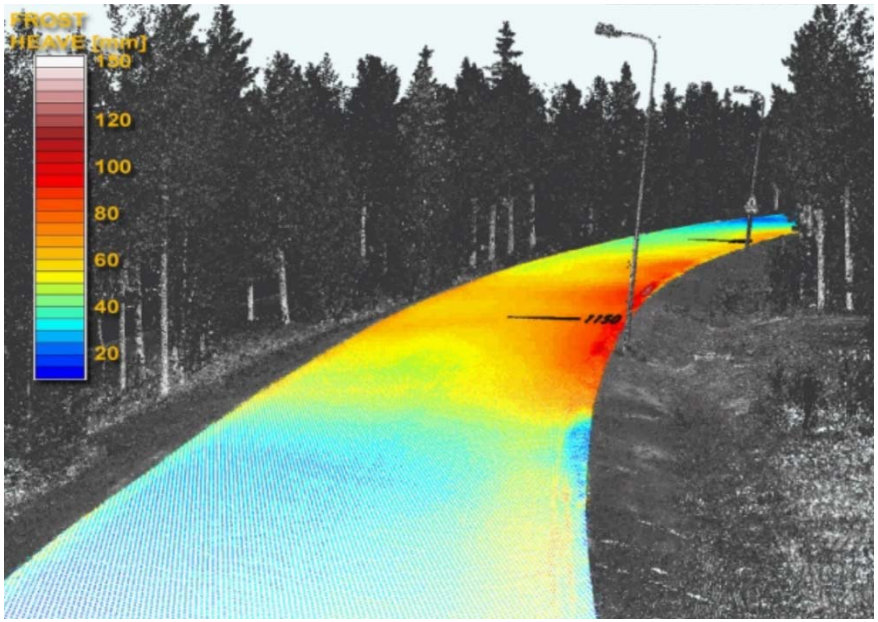
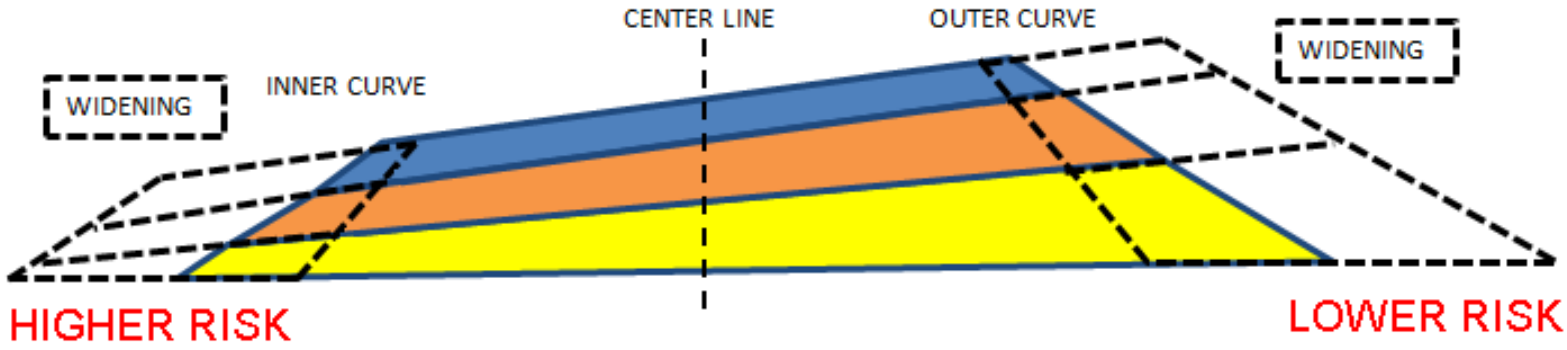
Road widening guidelines: Design

Topography, geometry and crossfall 3/3

- General practice is to dimension the structures according to the center line → structure in inner curve often thinner
- Widening to the inner curve side includes a higher risk for failures than widening to the outer curve side
- However widening to the inner curve side is recommendable → geometry can be improved

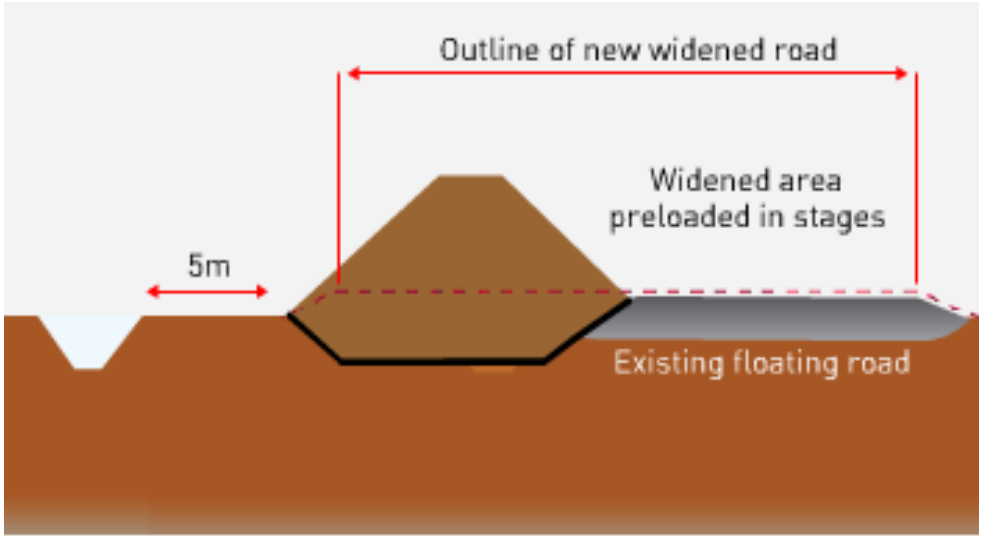


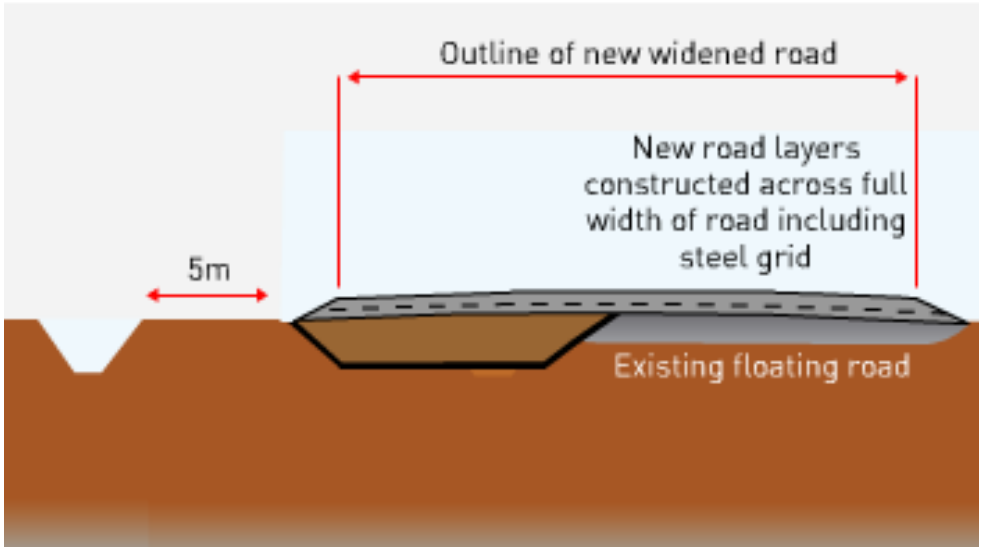


Road widening guidelines: Design

Settlement and compressive soils

- Compressive soil → uniform settlement is essential
- Construct similar structures, but before that preloading is usually required
- Methods for widening on compressive soils:
    - overload embankments
    - reinforcement
    - soil replacement
    - piles
    - stabilization
    - lightweight structures

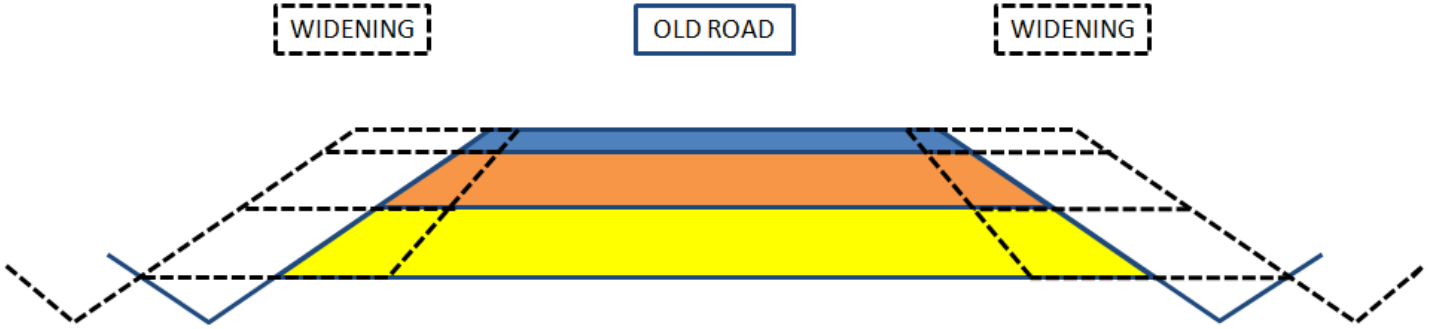




Road widening guidelines: Design

Cross section design

- Often beneficial to widen only to one side → reduces costs
- Advantages of widening to both sides: Joint cracking and non-uniform settlement normally develops in the shoulders, especially if the traffic load will still be on the old road and the widening is for the shoulder and safety area only.
- The need for reinforcement or additional land can be lessened and deformation can be expected to be smaller.



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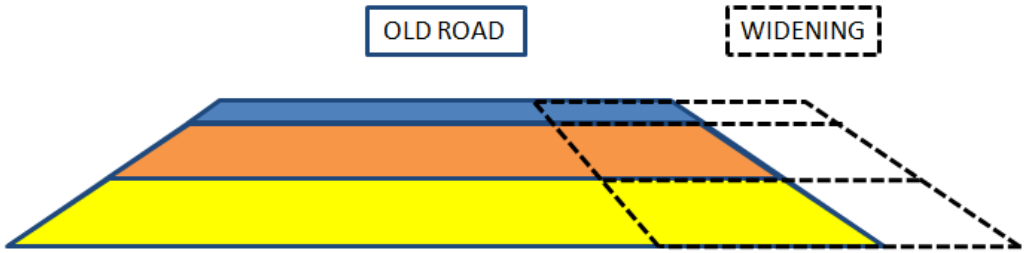
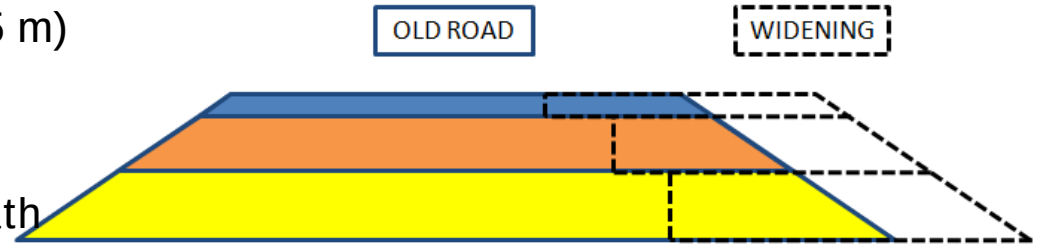
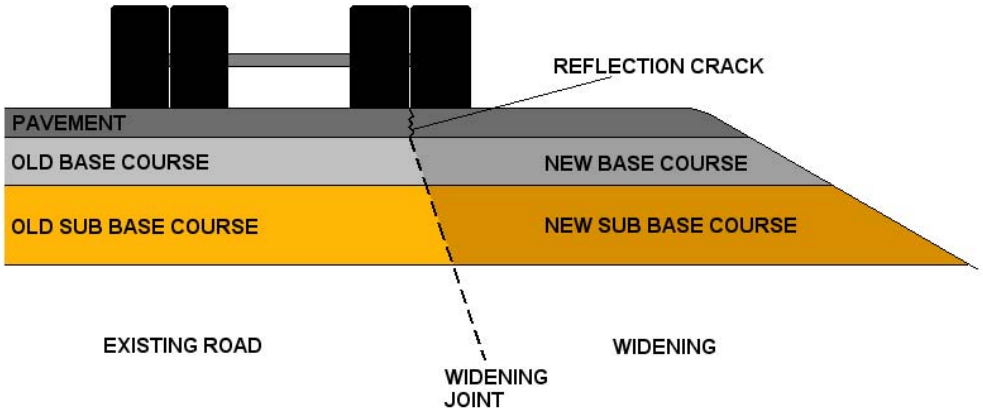
Road widening guidelines: Design

Widening techniques and structures 1/2

- Recommended method: homogenous structures
- Stepped and angled joint are both recommended options
- Vertical joint only if necessary
- Joint of bituminous bound layers always away from the joint of other layers (0,3-0,5 m)
- Also stepped joint between different bituminous bound layers
- No construction joints under the wheel path → reflection cracking
- Reinforcement recommended inside pavement or base course
- Wrapping of unbound materials in geotextile
- Reinforcement must be firmly tied into the old embankment







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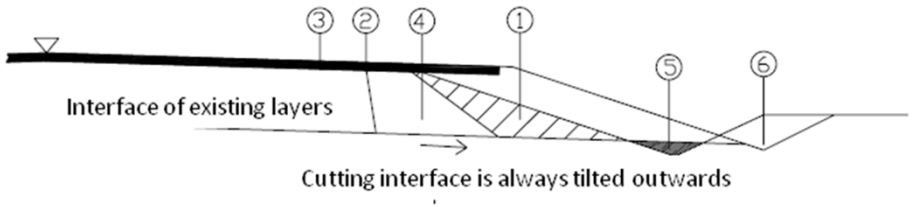
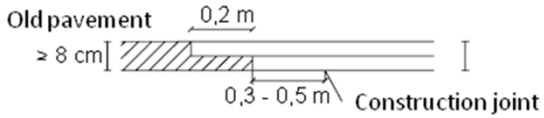
Road widening guidelines: Design

Widening techniques and structures 2/2



③ Detail of benching of the pavement



① Excavate the frost-susceptible fill in inner side slope

② Excavate the embankment construction (4:1...2:1) in the edge of existing pavement or more centered if shoulder deformation exists

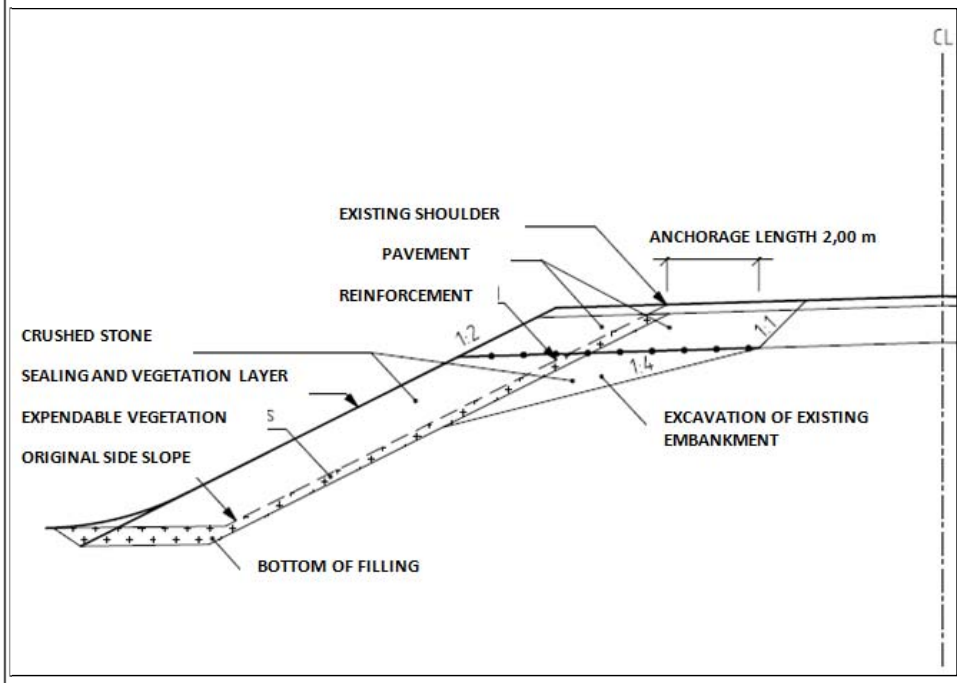
③ Cut the bituminous pavement 0.3-0.5 m towards road centre from the excavation area. Pavement cutting is made last before paving.

④ Construct new layers in new part. Fill material must be similar type than existing pavement structure.

⑤ Ditch is filled with compactable, dry material such as subgrade (percent fines ±5 % compared to subgrade)

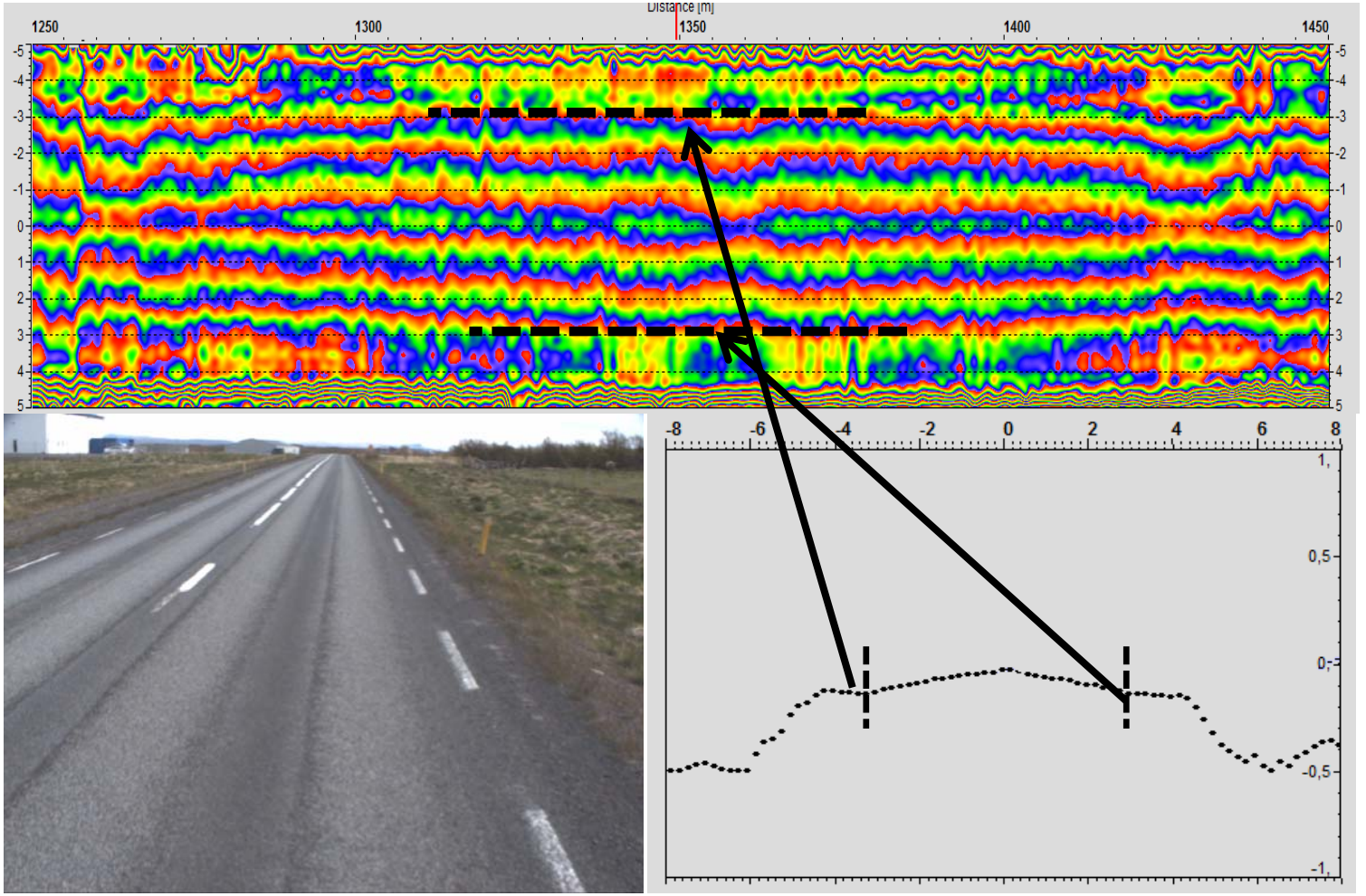
⑥ New ditch is dig to the level required by drainage. Minimum is the existing level

[Modified from Finnish Road Administration 2005]



[Modified from Norwegian Public Road Administration 2007]

Widening structure should not be also too strong: Example from Iceland



Road widening guidelines: Design

Road furniture and utilities

- Careful mapping of road signs, guardrails, cables and pipelines before widening works
- Essential especially in urban areas
- It is possible that e.g. pipelines or underground cables must be moved
- Also a possibility that e.g. sections with guardrails must be increased as a consequence of steepening of side slopes

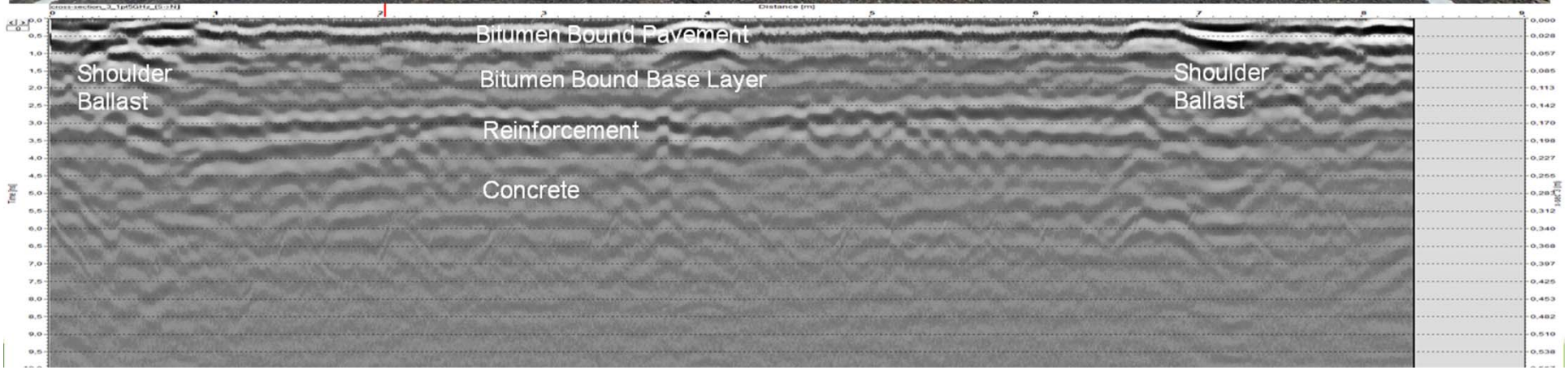
Road widening guidelines: Design

Construction practise and traffic arrangements

- The scope of needed traffic arrangements depends mainly on traffic volume
- Bypass roads and temporary widening recommended alternatives
- Careful work planning and adequate resources → shorter working period
- Correct timing of works to avoid rush hours
- Well carried out pre-design surveys → smaller probability of unexpected surprises

Summary: The most important things to keep in mind, when desigining road widening

- Careful pre-design surveys
- Homogenous structures
- Joint construction and location
- Old structures
- Frost
- Drainage
- Settlement
- Reinforcement



Thank You!

ROADEX
Implementing Accessibility