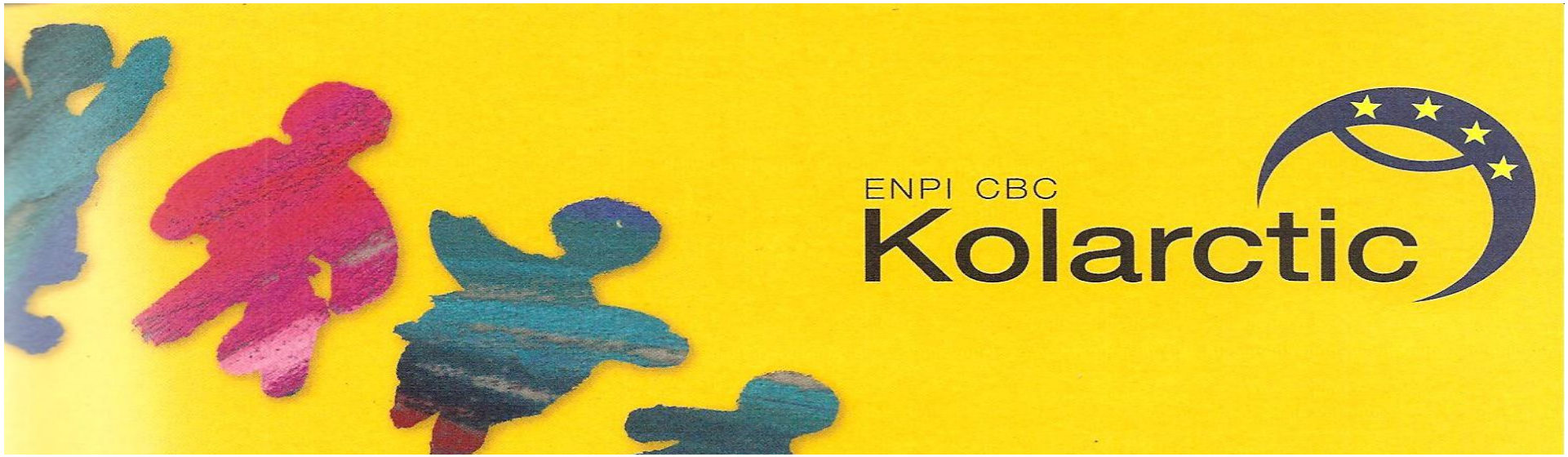

Barents Case HW4 Finland

Timo Saarenketo, PhD
Managing director
Roadscanners Oy,
Finland

ROADEX
Implementing Accessibility

ROADSCANNERS

BACKGROUND

1. Timber transports is moving towards 90 tn/30 m truck & trailers, cost saving 25 %
2. Economical pressure towards higher loads for ore transportation from new mines
3. New windmills are built in rural areas, heaviest parts weigh 160 tons
4. Modern logistic do not allow spring load restrictions

Problem of the road owner:

How to react if exemptions for load restrictions are applied?

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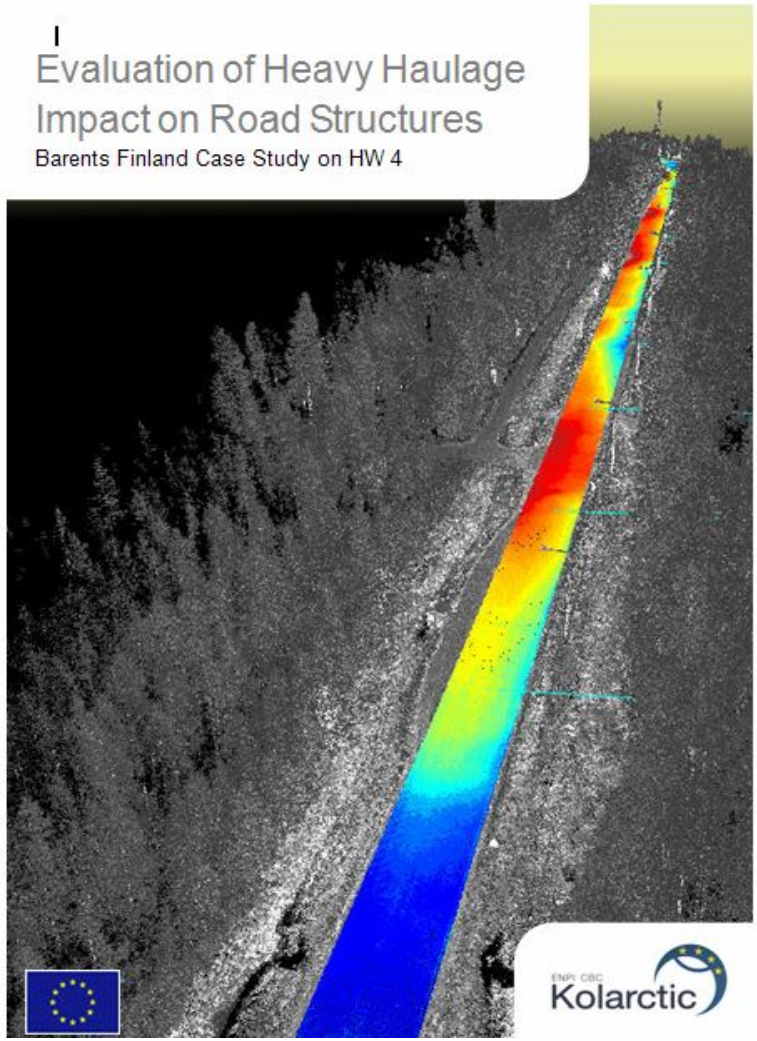
GOAL:

Making a model and action plan how to evaluate consequences if total loads will be lifted in the low volume road network in Lapland.

Output:

- Pilot Survey using ROADEX risk analysis technique in HW4
- Method description



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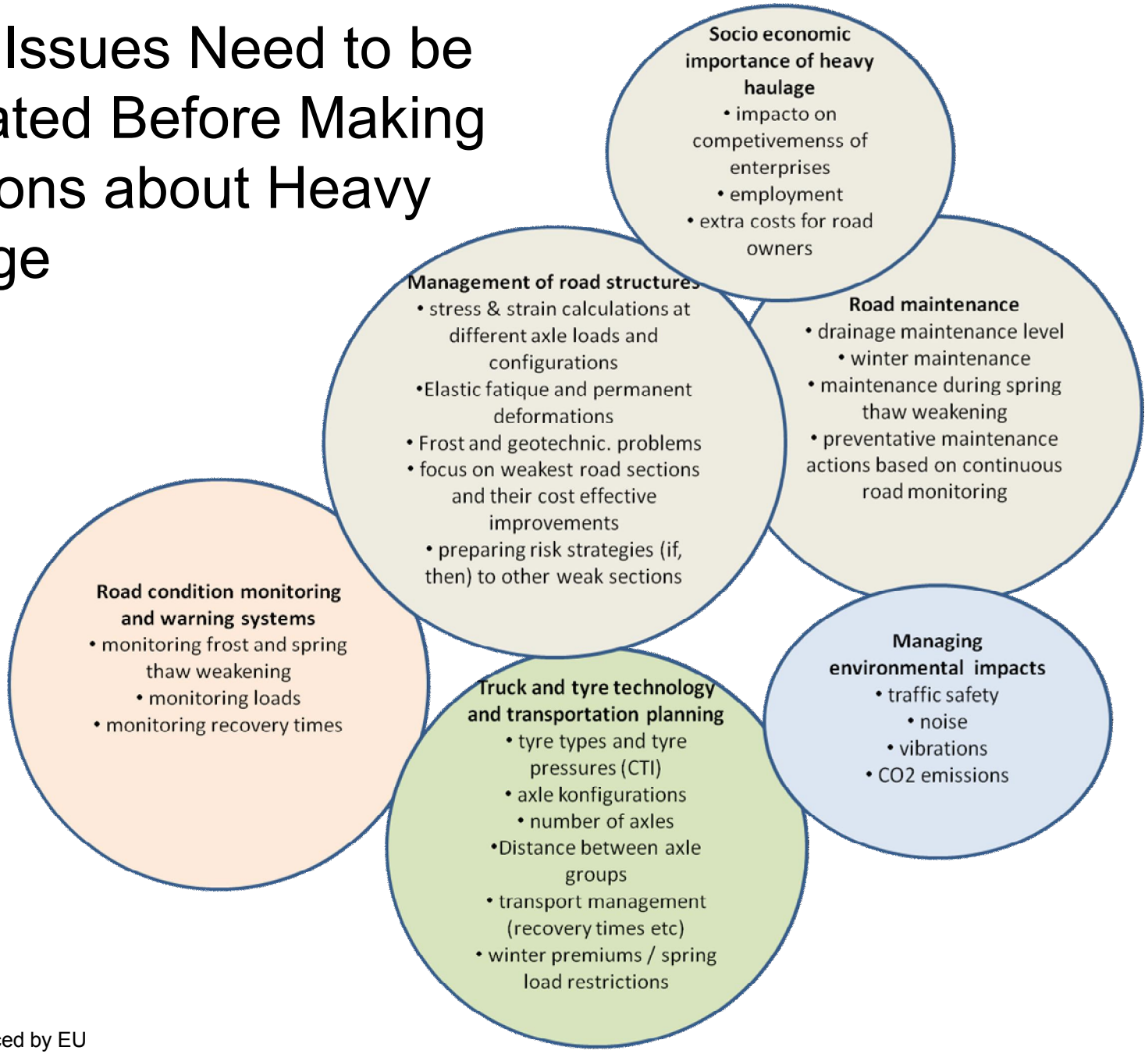
Areas Issues Need to be Evaluated Before Making Decisions about Heavy Haulage



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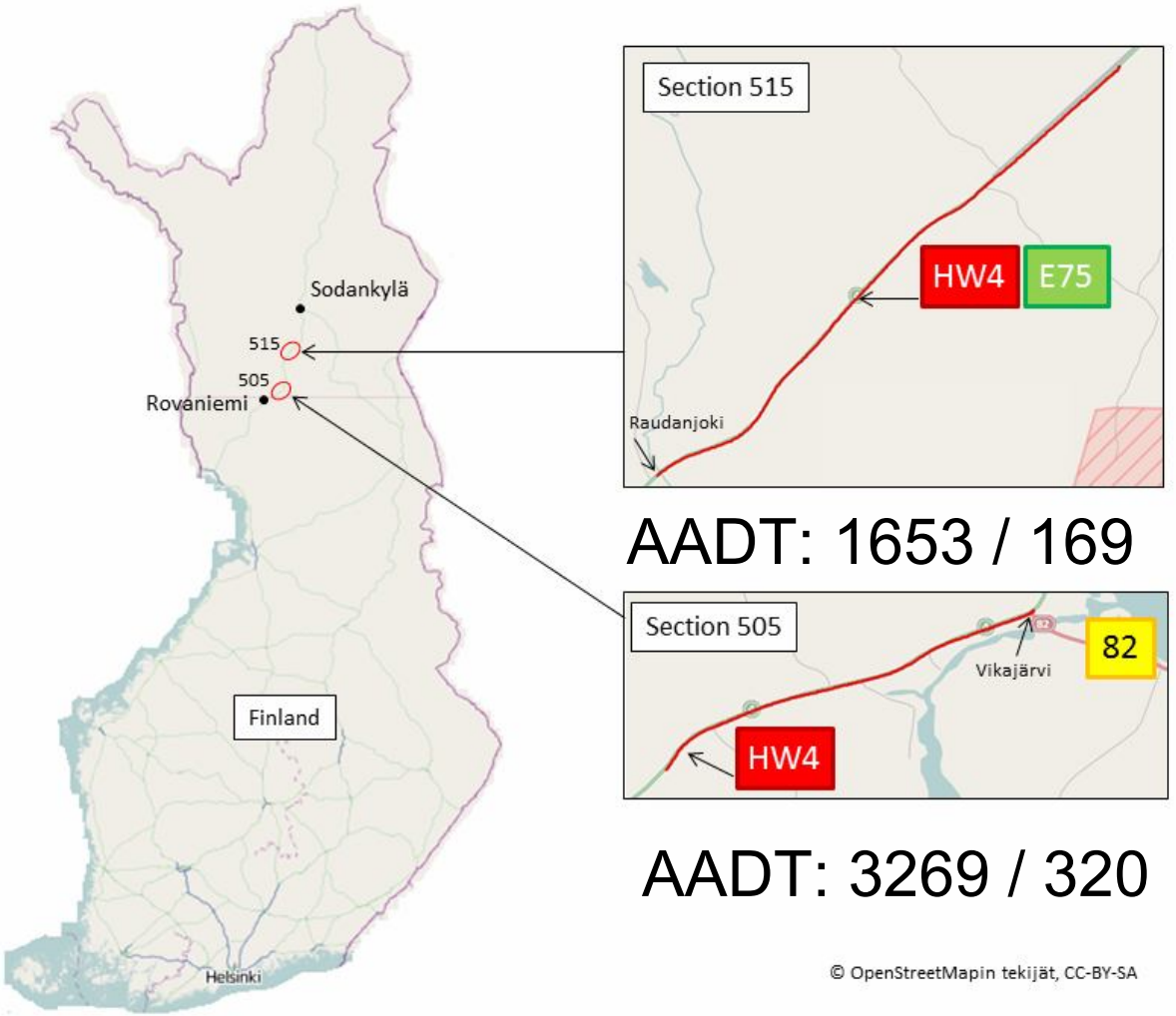
Location of HW 4 Test Section :



AADT: 1653 / 169

AADT: 3269 / 320

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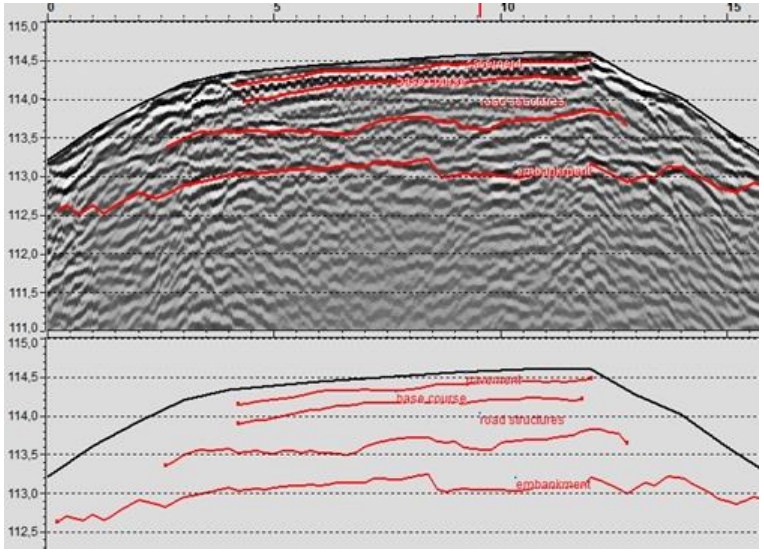
Survey Techniques :

- GPR
  - Structures in 2d / 3d
  - Moisture
  - Problem diagnostics
- Laser Scanning
  - Accurate model of road and its surroundings
  - Frost
  - Drainage
- FWD
  - Stiffness analysis
- Profilimeter data analysis
  - Rutting and roughness history
- Pavement distress analysis
- Drainage analysis



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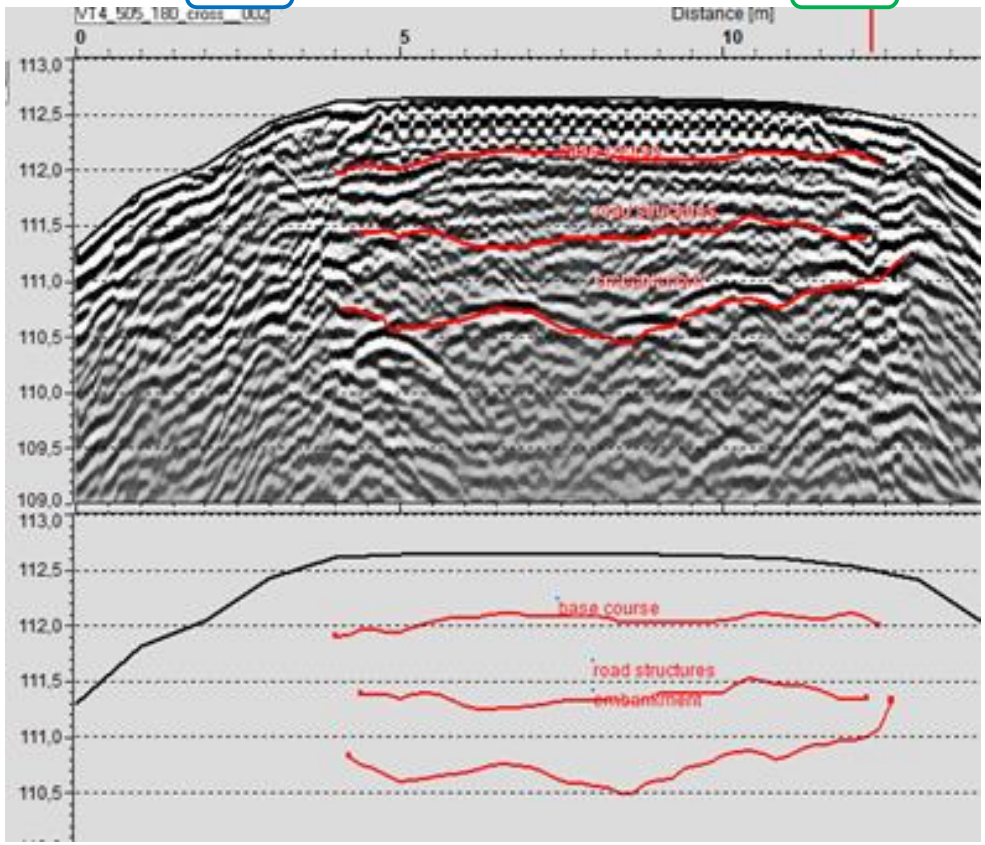
Road Structure Statistics in Sections 505 and 515

	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
	Bound	Unbound	Other unbound	
average	Bound 165	Unbound 319	Other unbound 847	1331



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Section 505 and 515 Pavement Distress

Section	Deformation (%)	Longitudinal cracking (%)	Transverse cracking (%)	Alligator cracking (%)	Edge breaks, right (%)	Edge breaks, left (%)	Patches (%)
505	0,4	4,2	2,1	0,5	1,7	0	0
515	0,4	12,1	4,1	28,4	4,4	9,3	0,06

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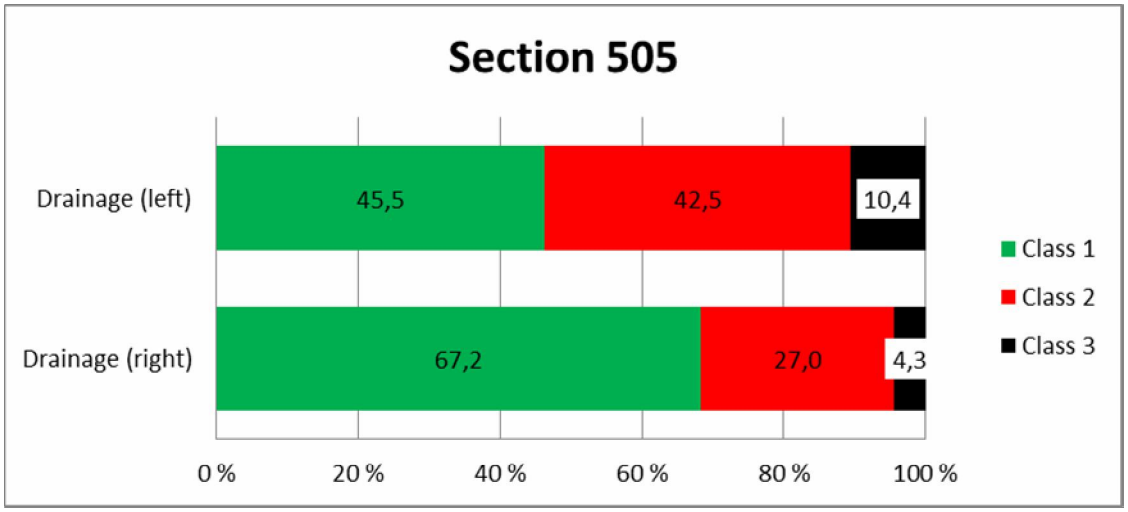
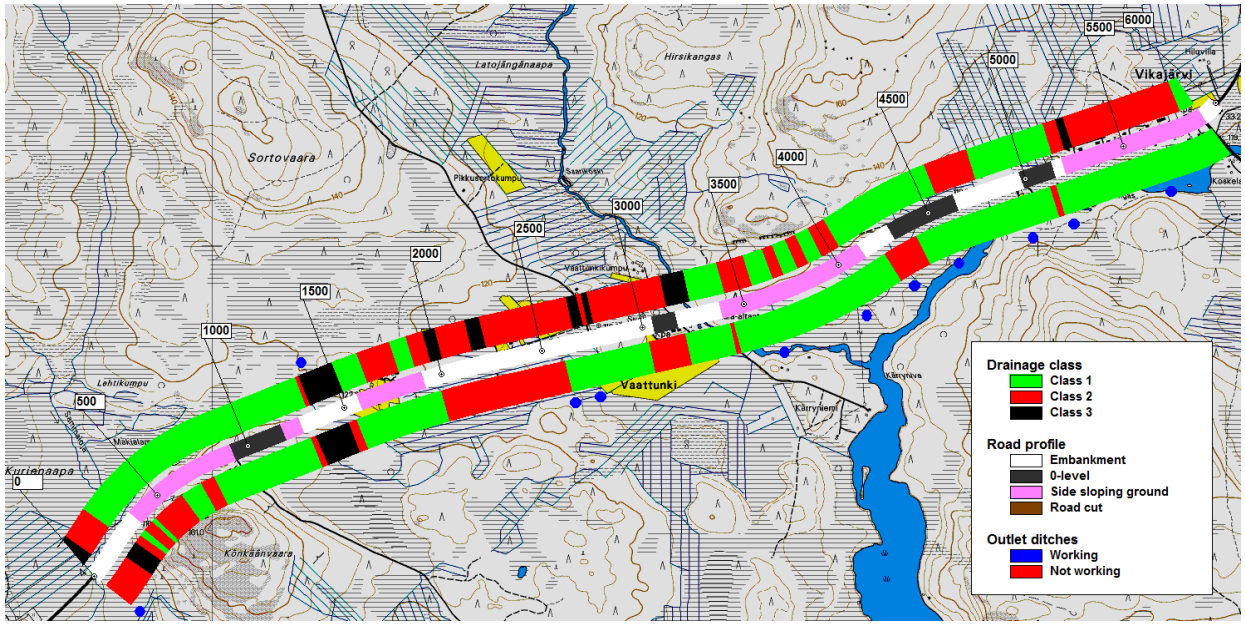
Drainage Analysis





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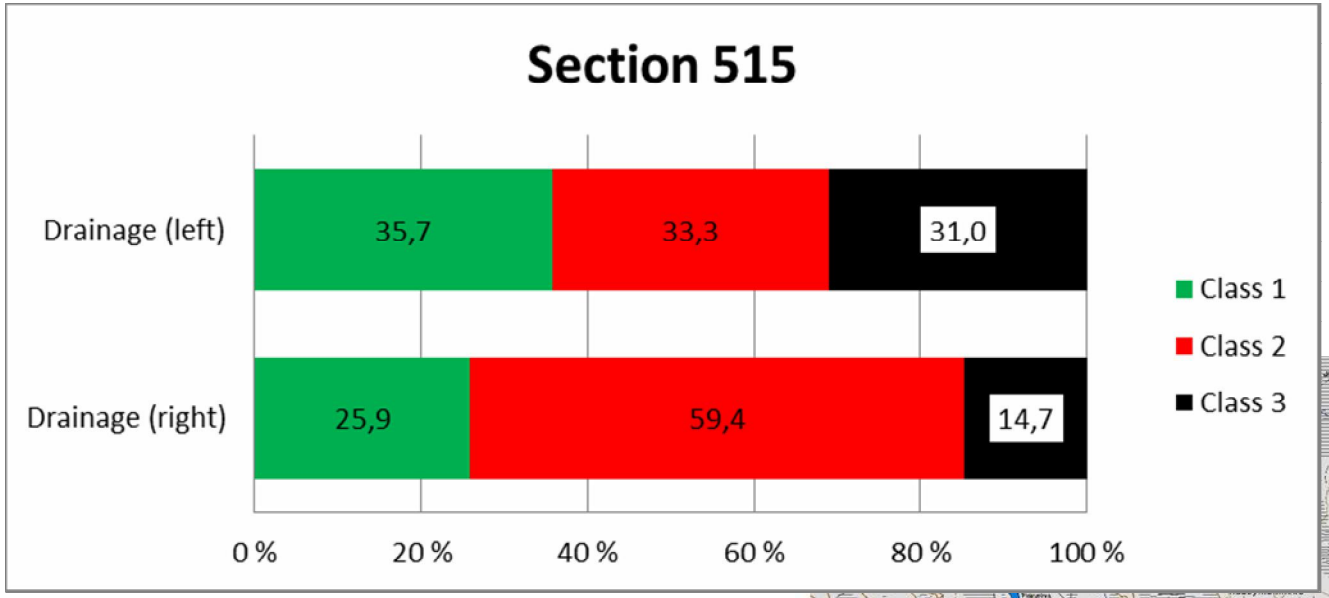
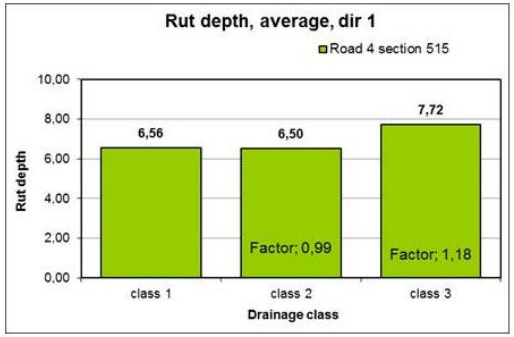
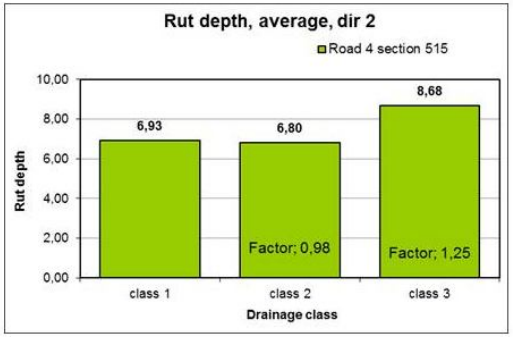
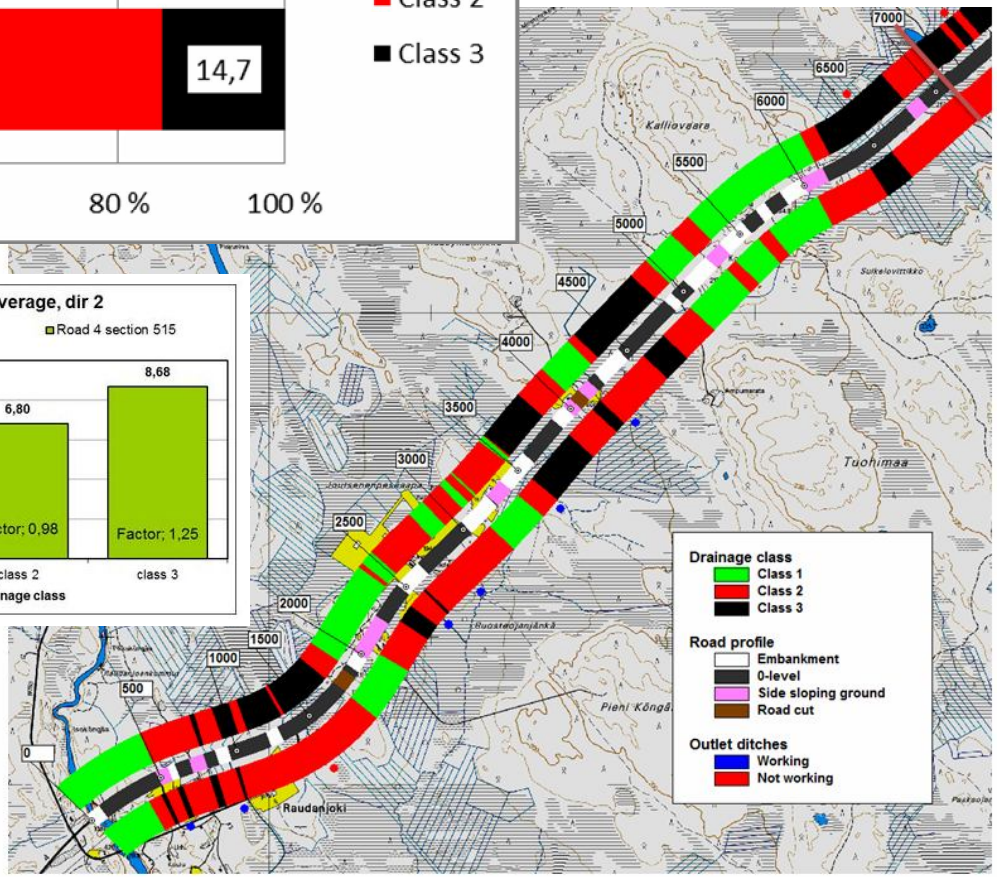
Drainage Analysis









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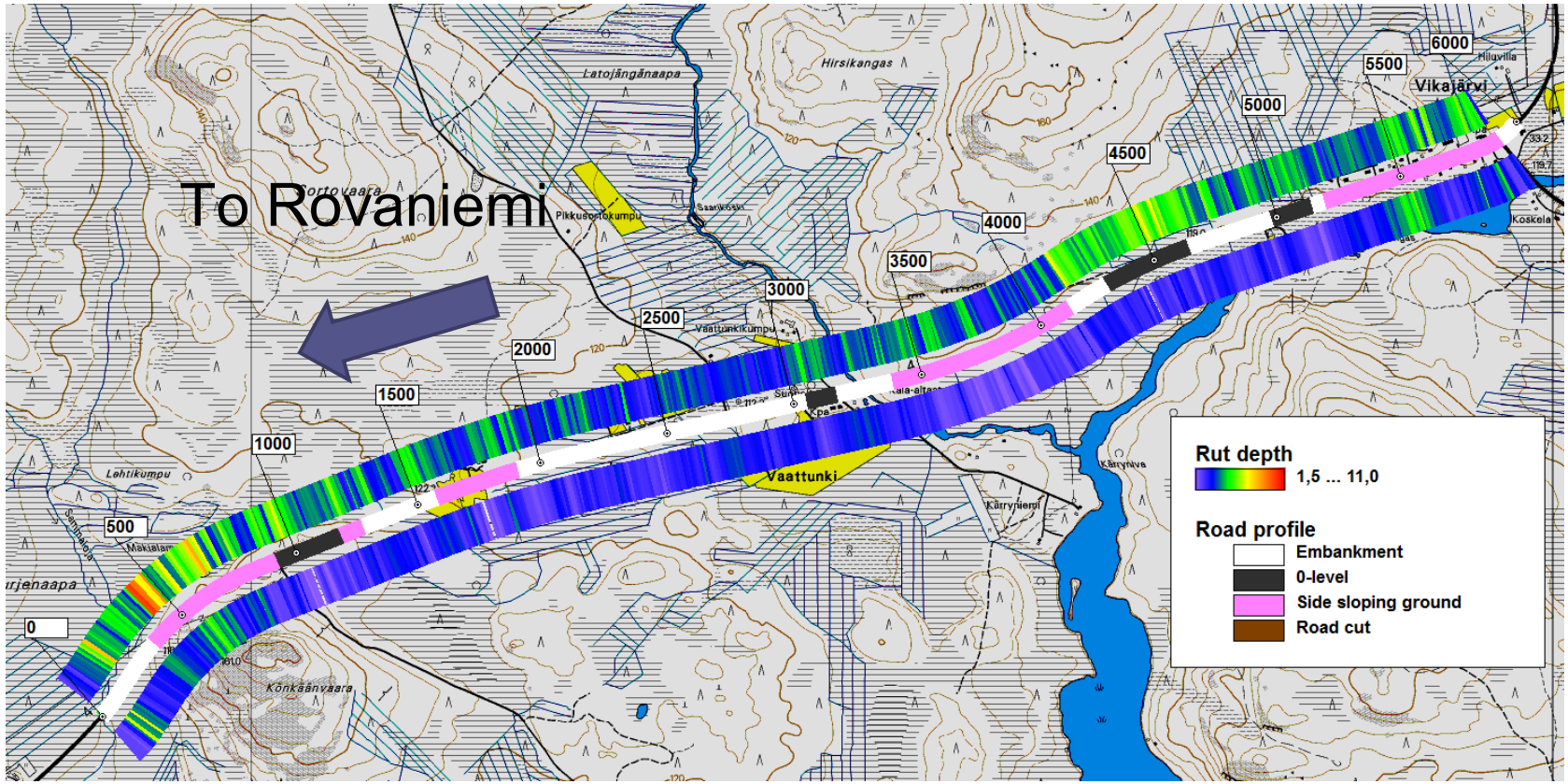
Profilometer Data Analysis

Road Section 515 Rut Depths 2011 – Last paving in 2010



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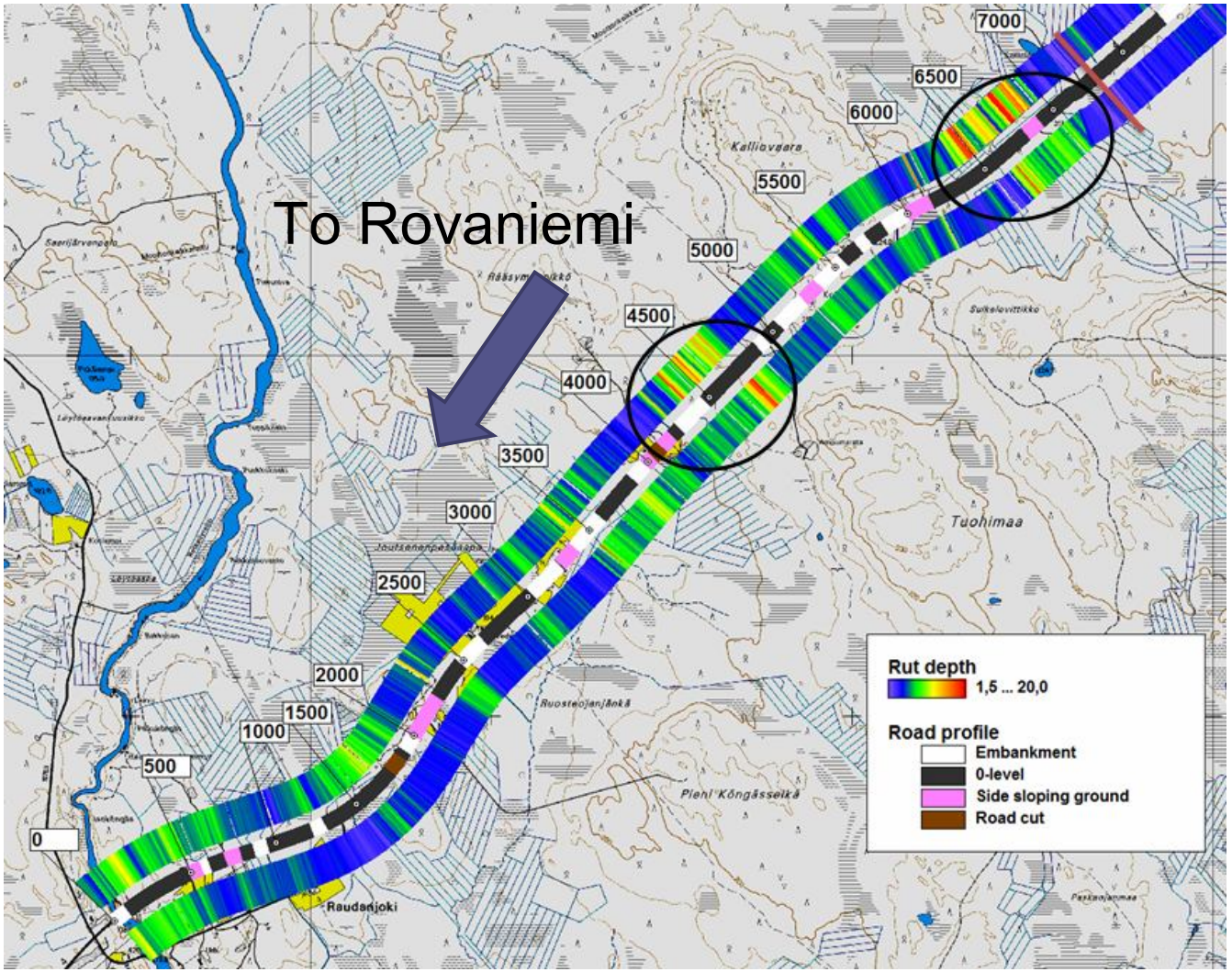
Profilometer Data Analysis

Road Section 515 Rut Depths 2011 – Last paving in 1997



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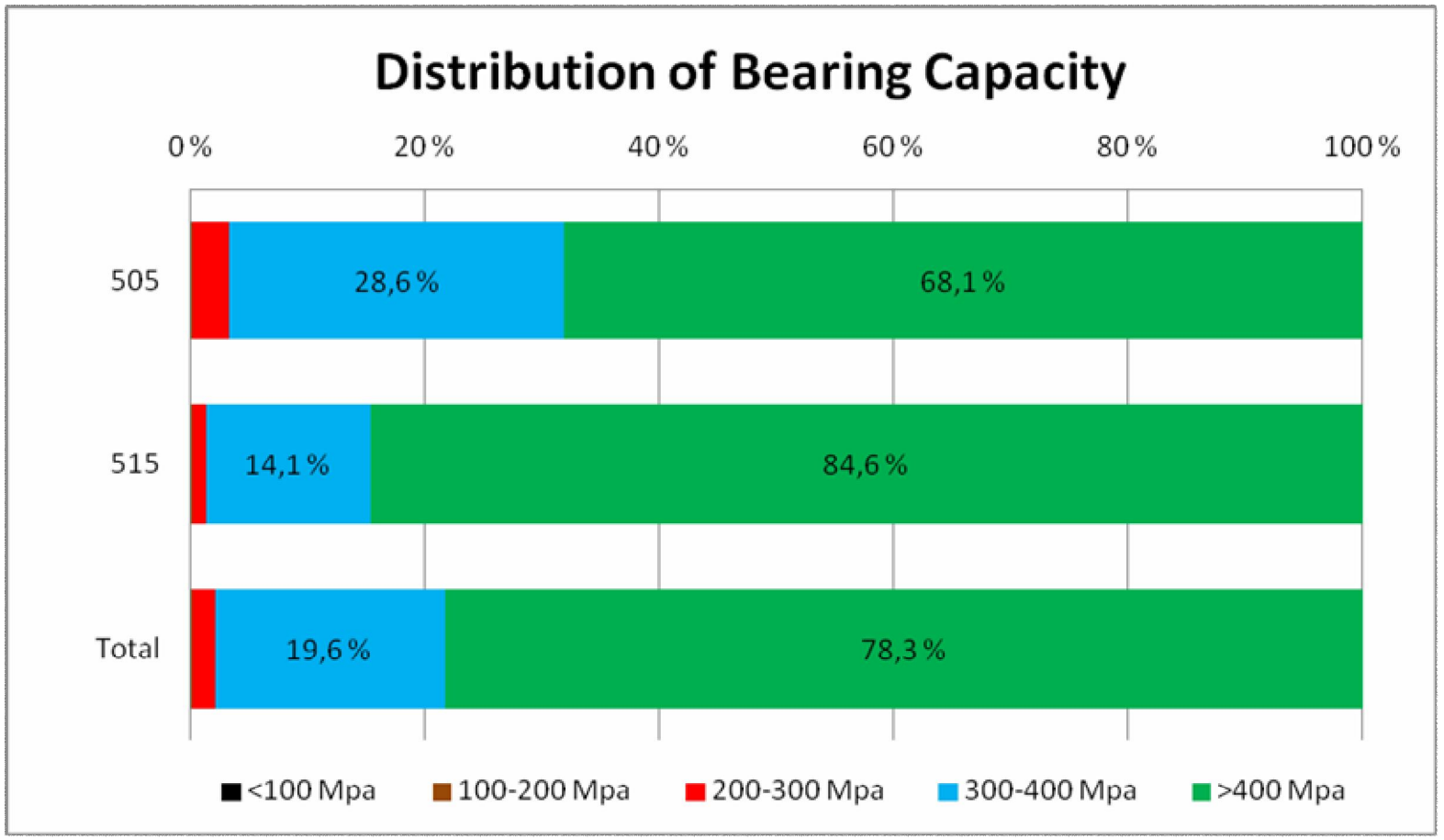
Bearing Capacity Analysis:



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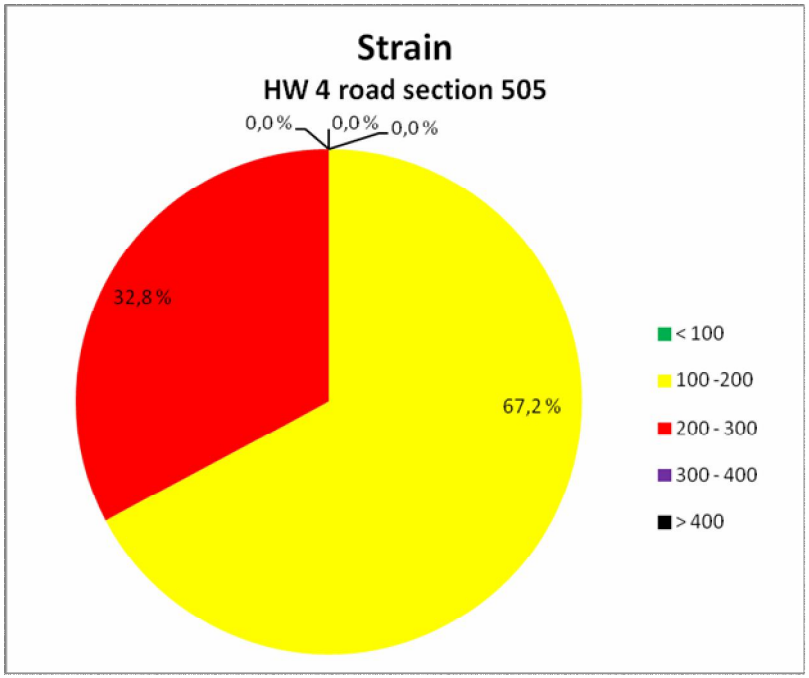
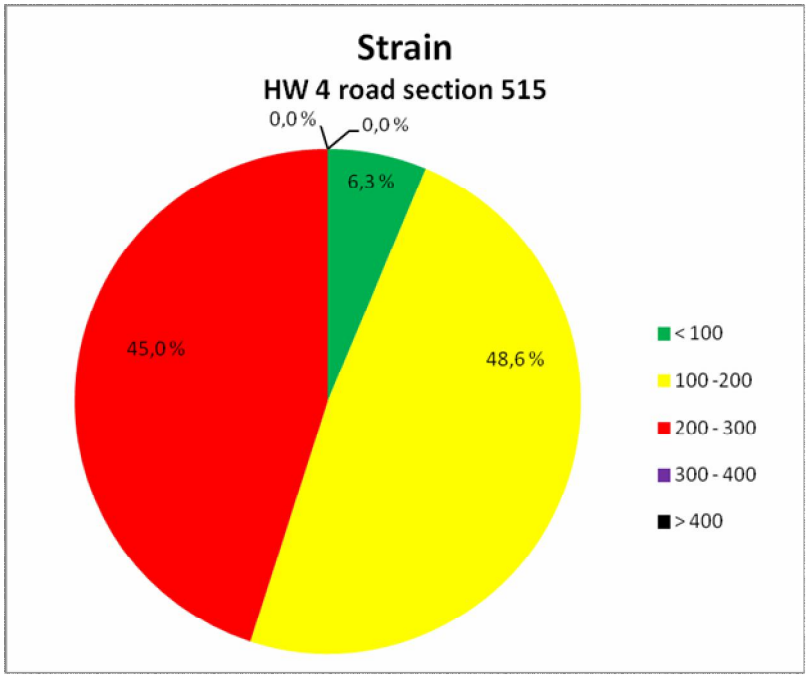
Bearing Capacity Analysis:

Pavement Strain





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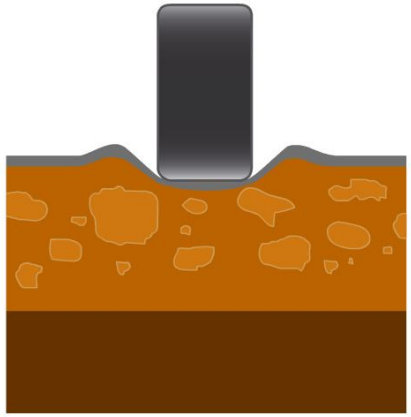
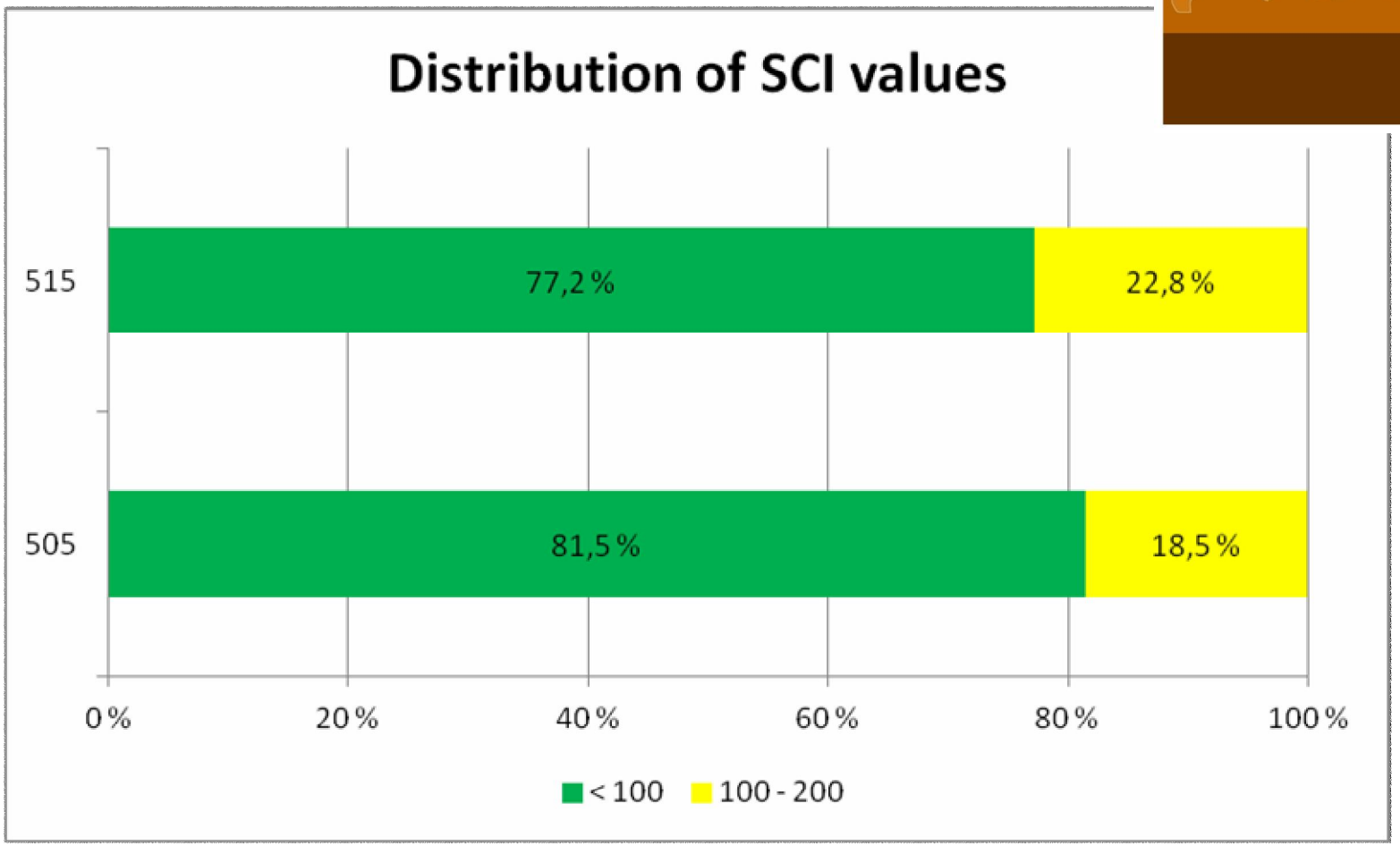
Risk for Mode 1 Rutting





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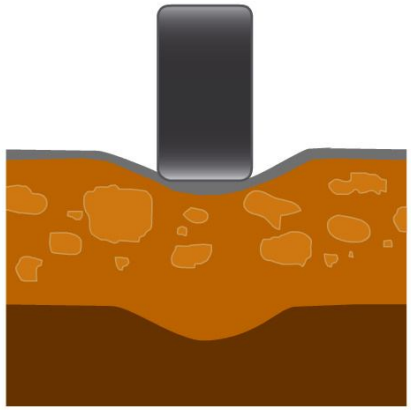
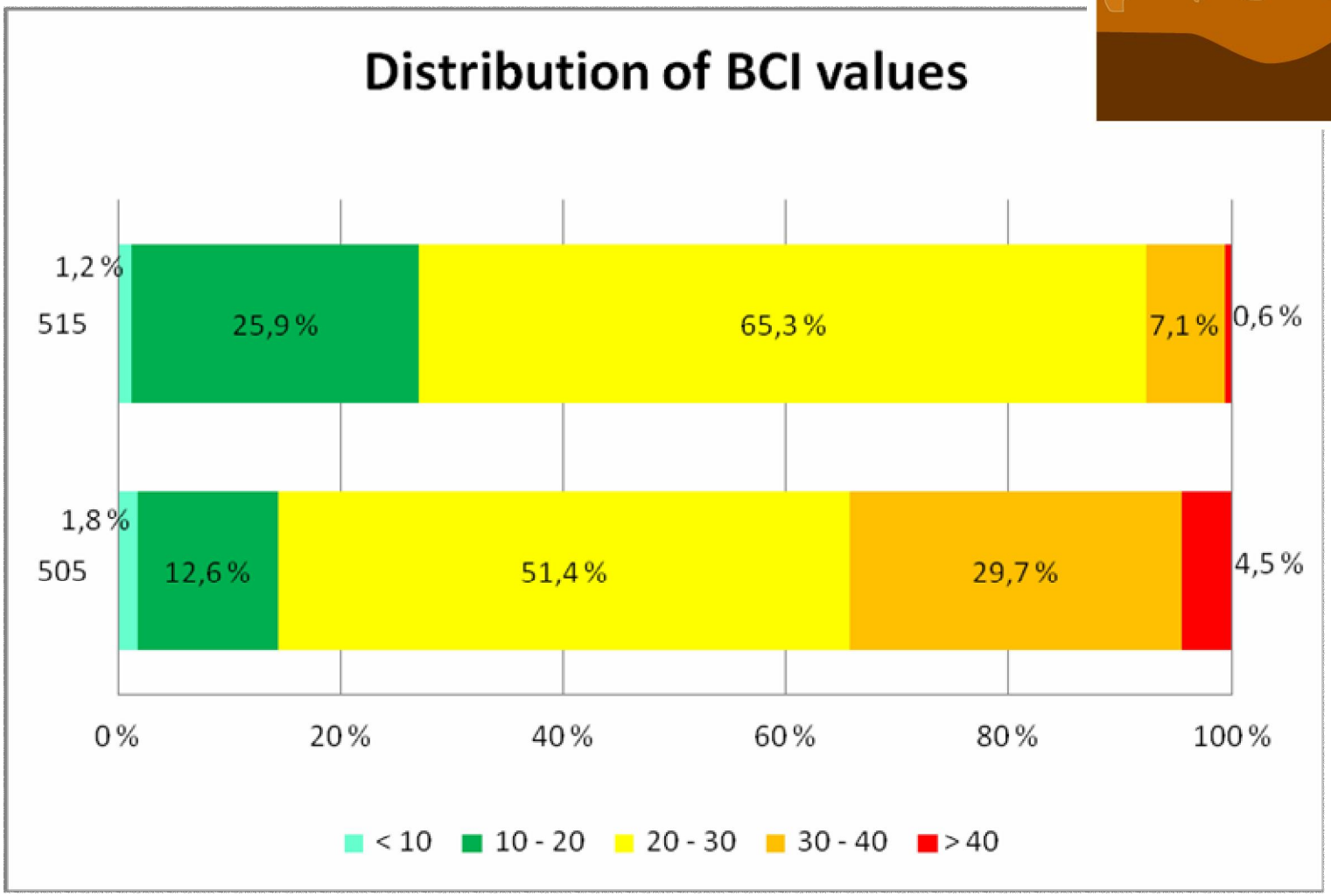
Risk for Mode 2 Rutting





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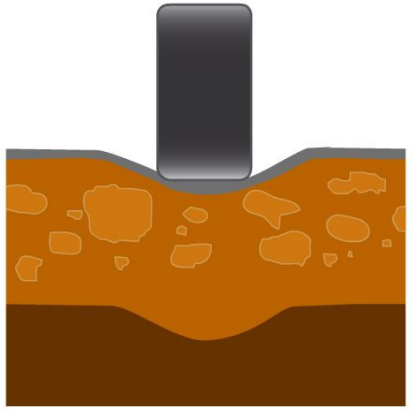
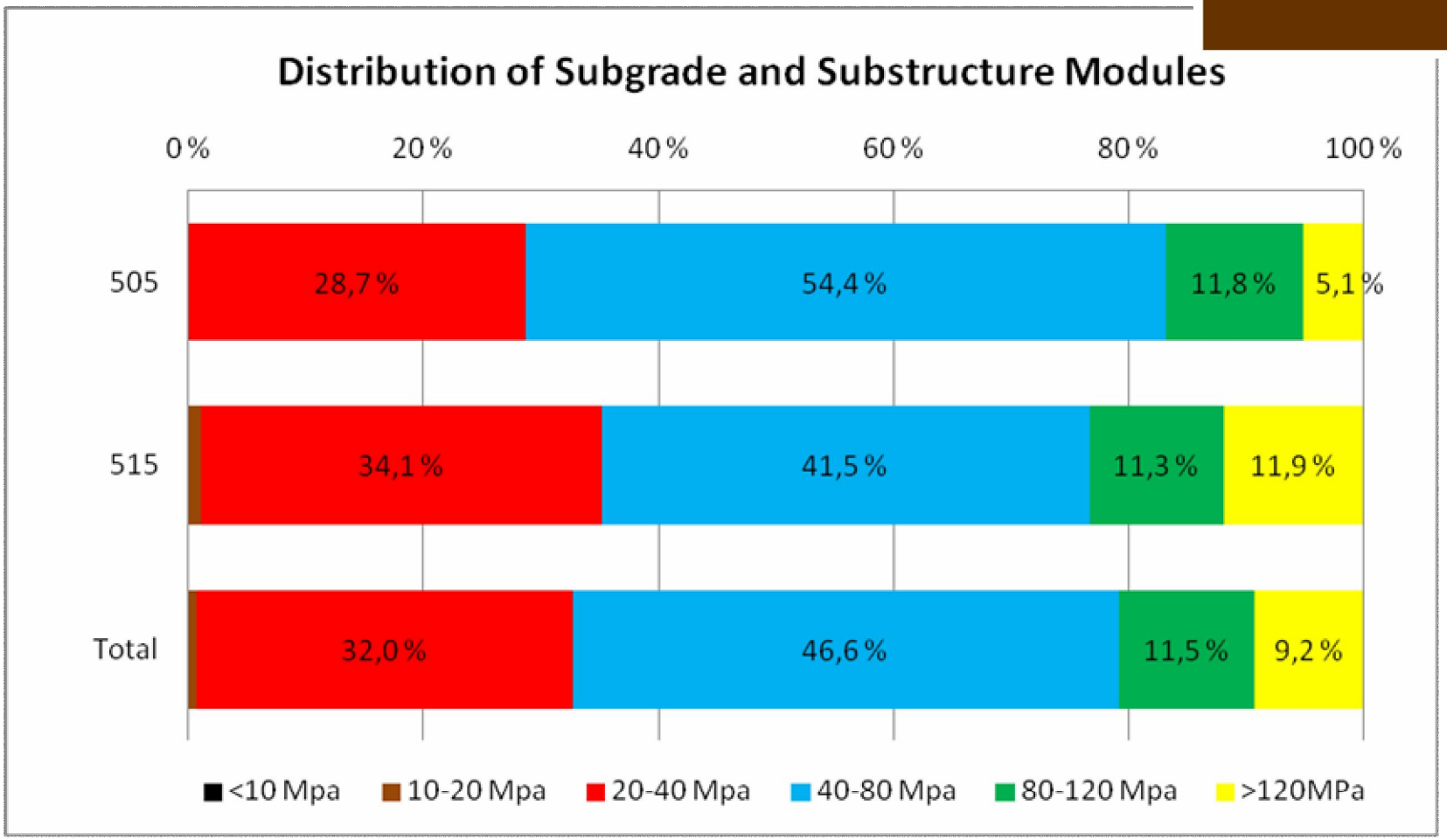
Bearing Capacity Analysis:





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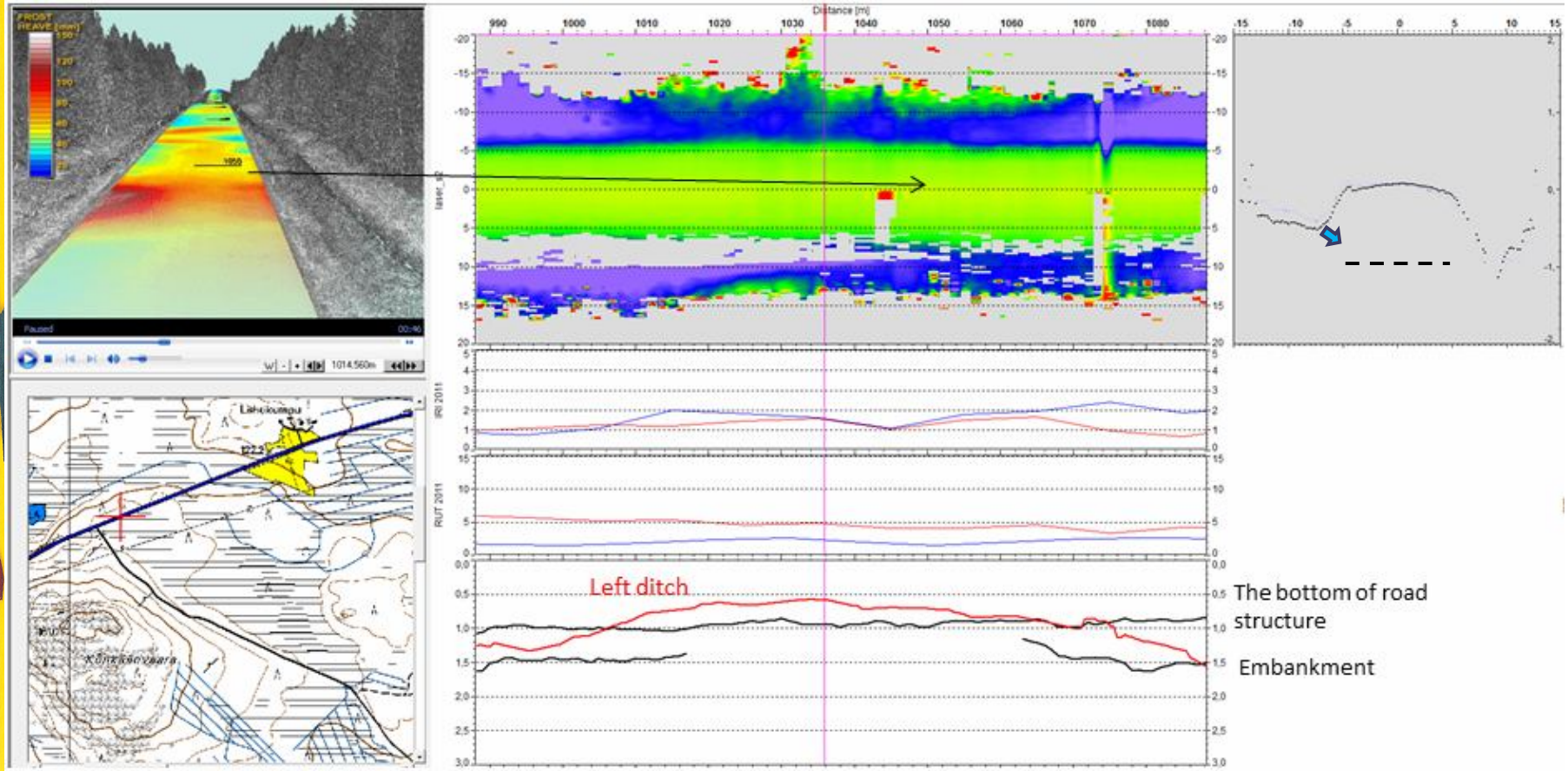
Frost and Drainage Analysis:



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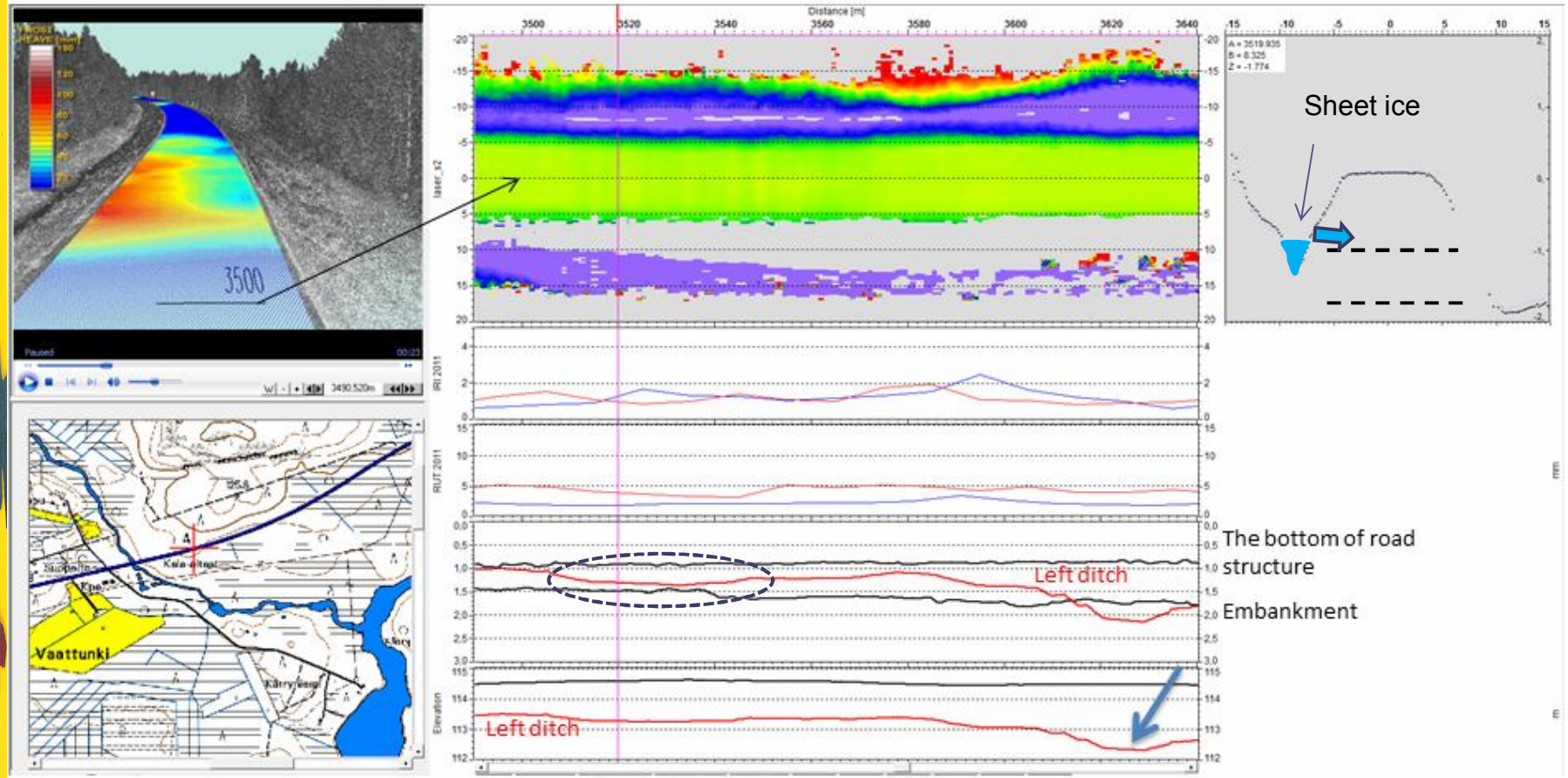
Frost and Drainage Analysis:



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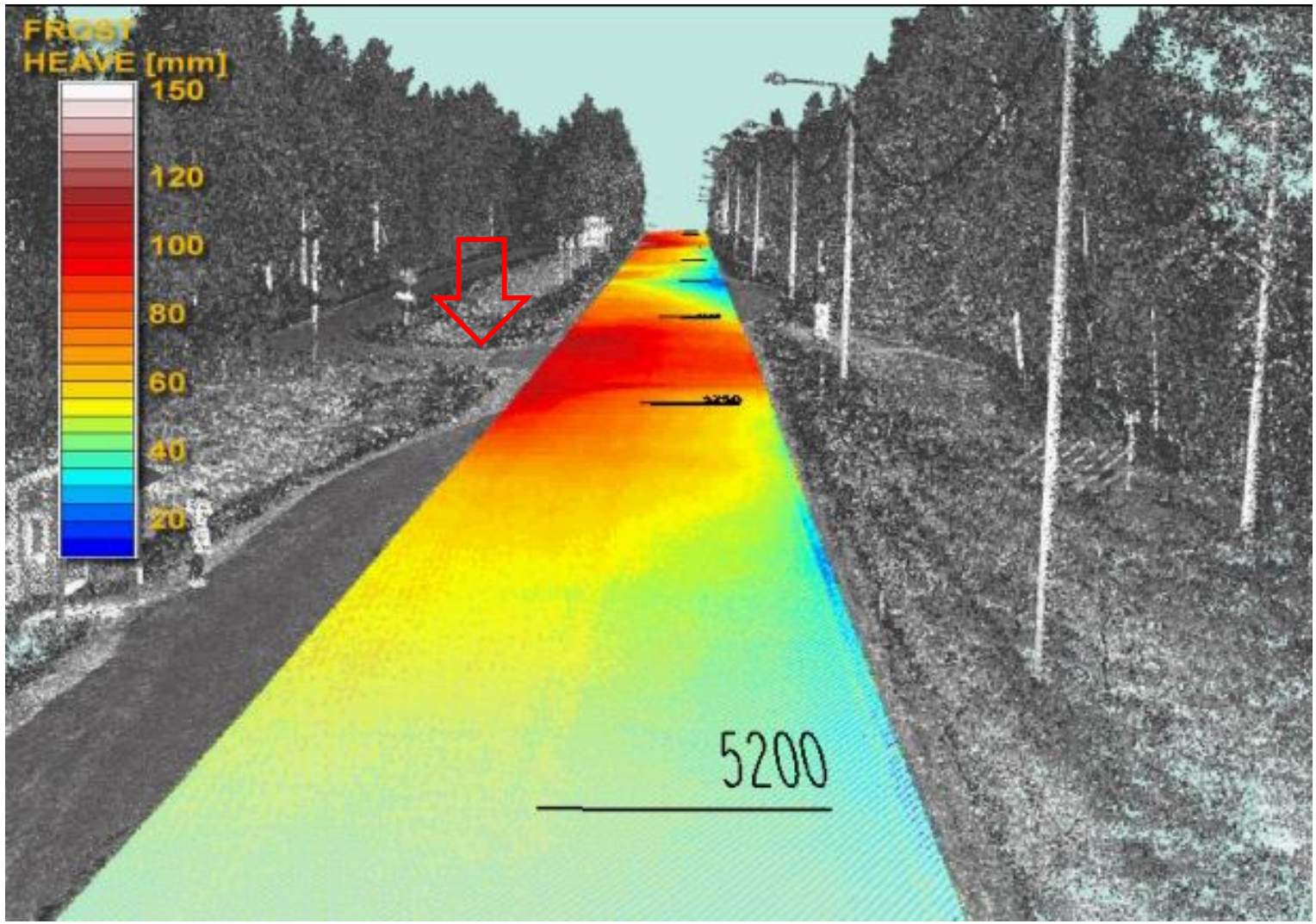
Frost and Drainage Analysis:



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Risk Classification:

•Risk class 1: Strong road section, no major risk for immediate failures. Pavement fatigue will follow normal road lifetime prediction models.
•Risk class 2: Relatively strong road. Road damage will appear quickly only in extreme loading conditions or due to poor drainage maintenance etc. Strengthening is still recommended for this class.
•Risk class 3: Adequate road section. The risk will mainly develop during particularly bad spring thaw weakening periods. Strengthening is still also recommended for this class.
•Risk class 4: Weak road section. High risk for road failures especially during the spring thaw weakening period. Strengthening strongly recommended.
•Risk class 5: Extremely weak road section. Severe damages can be predicted immediately after heavy haulage starts – should be strengthened immediately.

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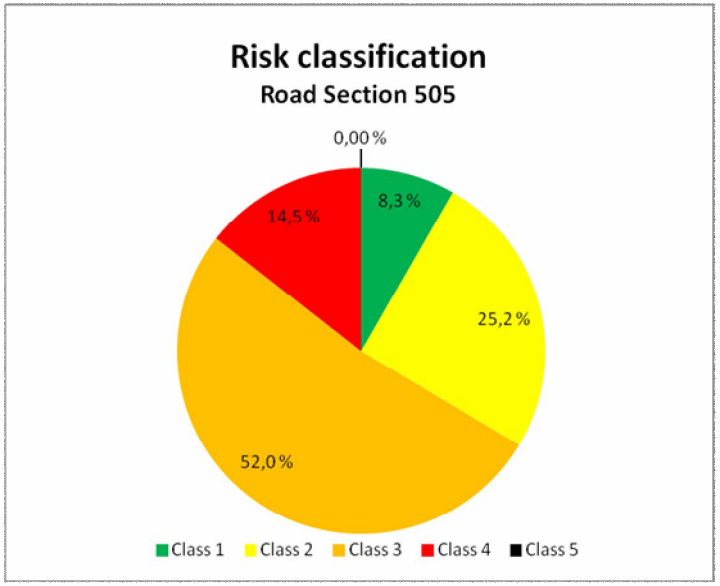
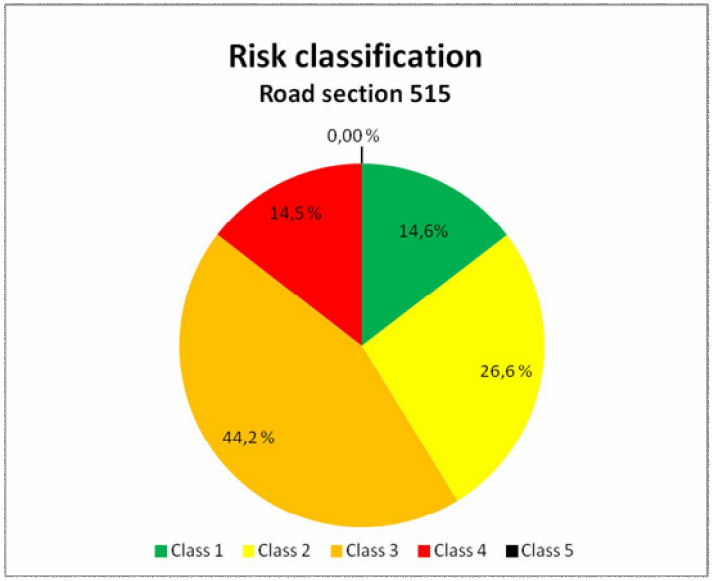
Risk Classification:





Remaining Lifetime – Initial Traffic (PMS – Objekt)

505	Initial traffic		515	Initial traffic	
505	Initial traffic		515	Initial traffic	
505	Initial traffic		515	Initial traffic	
505	Initial traffic		515	Initial traffic	
4	7	7	4	9	13

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Impact of Increased Heavy Traffic:

	Initial		Heavy traffic +50 %		Heavy traffic +100 %		Heavy traffic +200 %	
	Initial		Heavy traffic +50 %		Heavy traffic +100 %		Heavy traffic +200 %	
515	Initial 1653	169	Heavy traffic +50 % 1738	254	Heavy traffic +100 % 1822	338	Heavy traffic +200 % 1991	507

505	Heavy traffic +50%		505	Heavy traffic +100%		505	Heavy traffic +200%	
Risk class	Bound	Foundation level	Risk class	Bound	Foundation level	Risk class	Bound	Foundation level
1	17	>20	**1**	13	>20	**1**	8	>20
2	12	>20	**2**	9	>20	**2**	5	>20
3	14	>20	**3**	10	>20	**3**	7	>20
4	5	5	**4**	4	4	**4**	3	2

515	Heavy traffic +50%		515	Heavy traffic +100%		515	Heavy traffic +200%	
Risk class	Bound	Foundation level	Risk class	Bound	Foundation level	Risk class	Bound	Foundation level
1	3	>20	**1**	2	>20	**1**	2	>20
2	3	>20	**2**	2	>20	**2**	1	>20
3	9	>20	**3**	7	>20	**3**	5	>20
4	6	9	**4**	5	7	**4**	3	4

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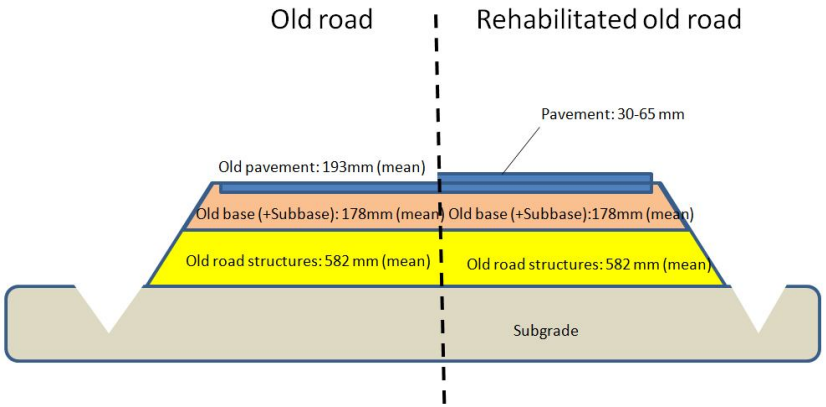
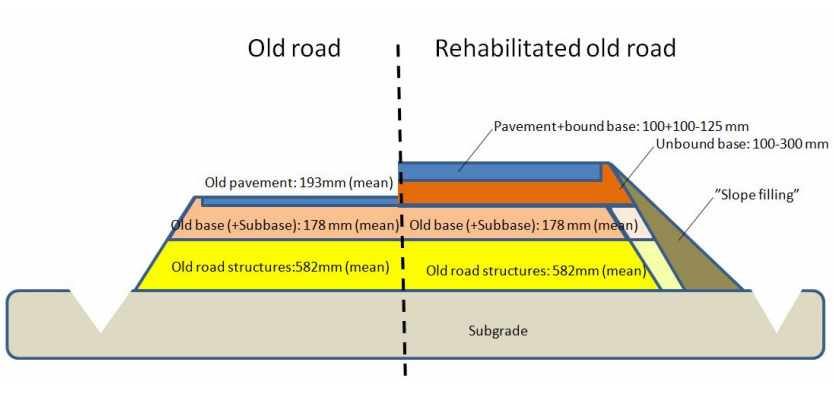
Strengthening Need for 20 Year Pavement Life Time



505: Risk class 1-3
515: Risk class 1-4



505: Risk class 4

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Strengthening Need for 20 Year Pavement Life Time

505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
4	100mm	100mm	100mm	100mm	100mm	100mm	

505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
505	Initial traffic			Heavy traffic +50%			
4	100mm	125mm	100mm	100mm	125mm	300mm	

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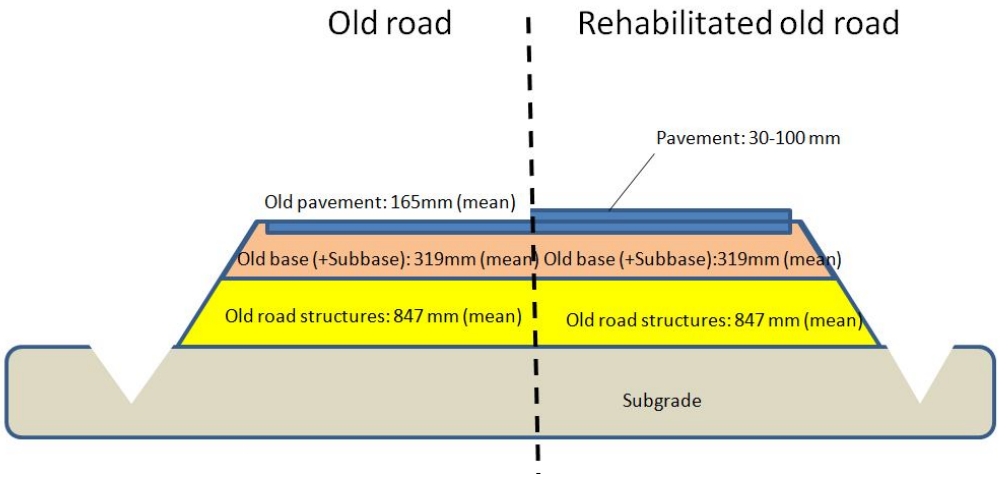
Strengthening Need for 20 Year Pavement Life Time - Section 515



515	Initial traffic	Heavy traffic +50%	Heavy traffic +100%	Heavy traffic +200%
515	Initial traffic	Heavy traffic +50%	Heavy traffic +100%	Heavy traffic +200%
515	Initial traffic	Heavy traffic +50%	Heavy traffic +100%	Heavy traffic +200%
515	Initial traffic	Heavy traffic +50%	Heavy traffic +100%	Heavy traffic +200%
4	40mm	50mm	65mm	80mm

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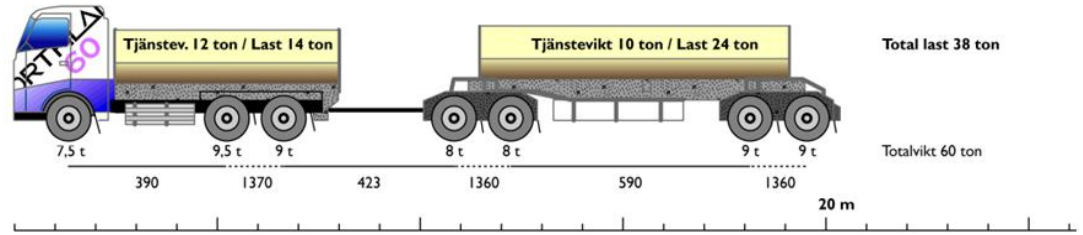
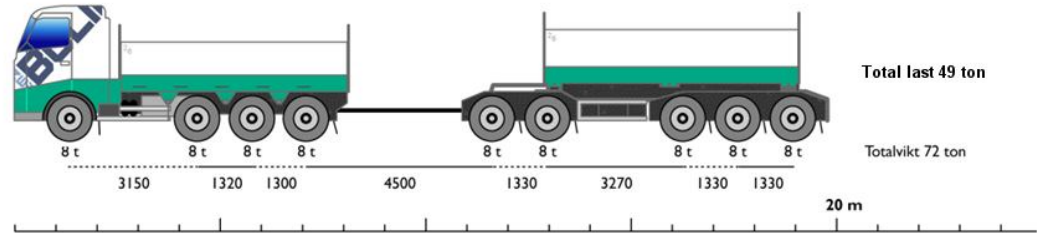
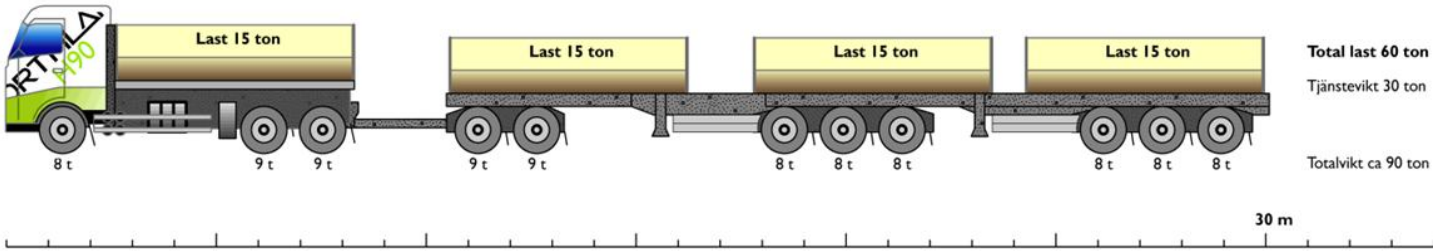
Impact Analysis of Different Heavy Haulage Options



standard



”Boliden”



”En trave till”

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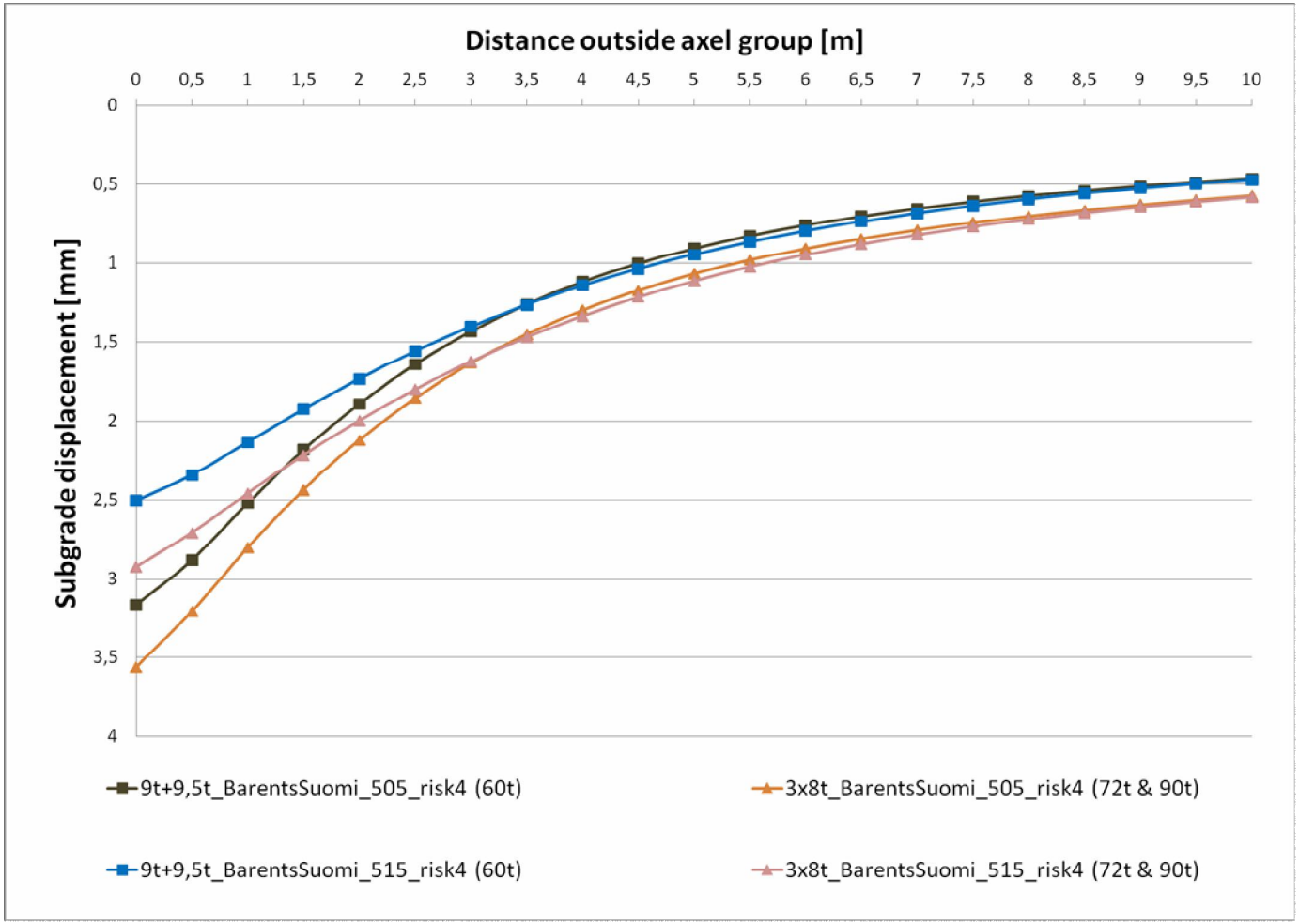
SUBGRADE DISPLACEMENT UNDER HEAVIEST AXLE GROUP, SUBGRADE MODLUS 10 MPa



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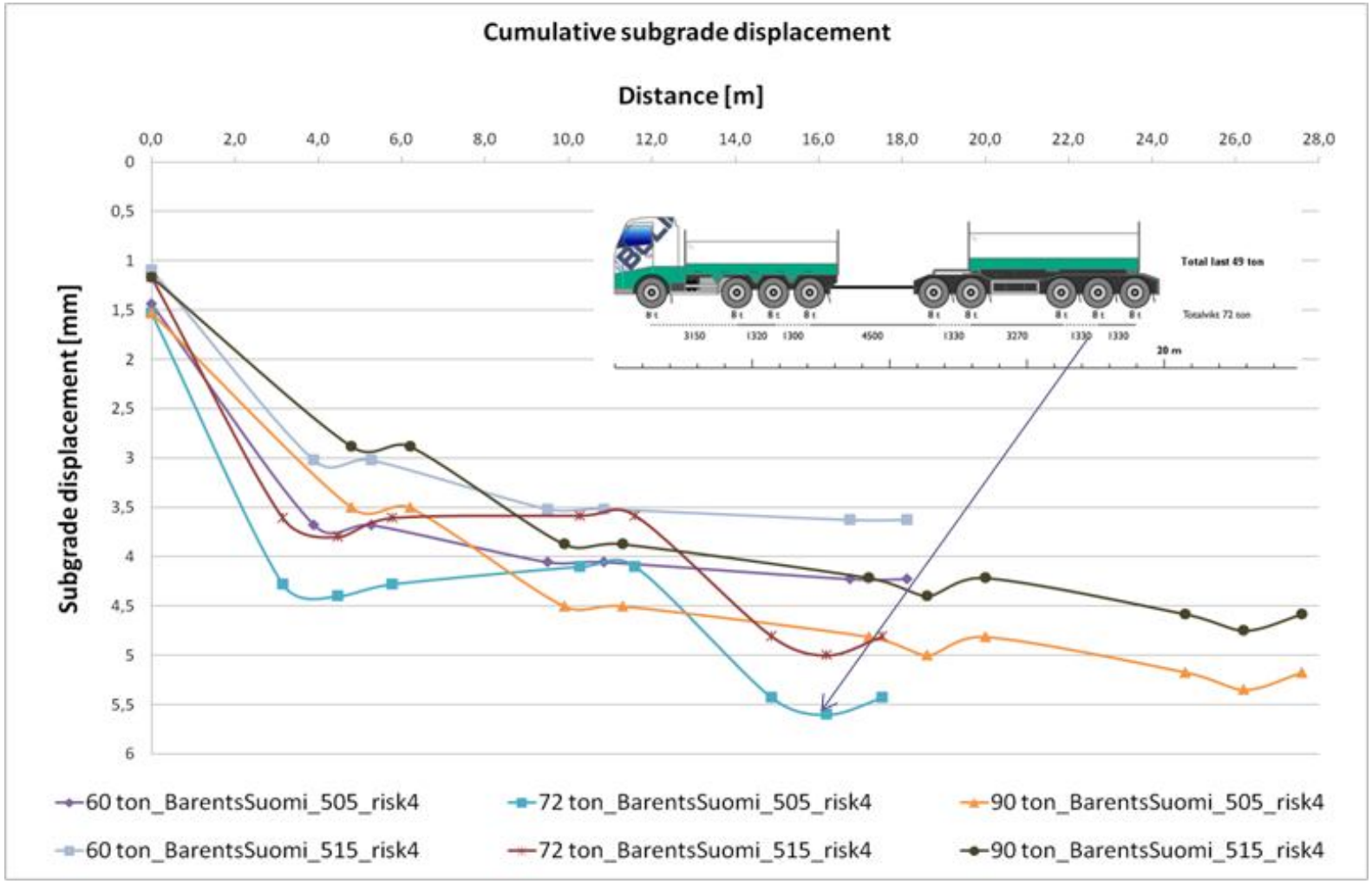
CUMULATIVE SUBGRADE DISPLACEMENT SUBGRADE MODULUS 10 MPa



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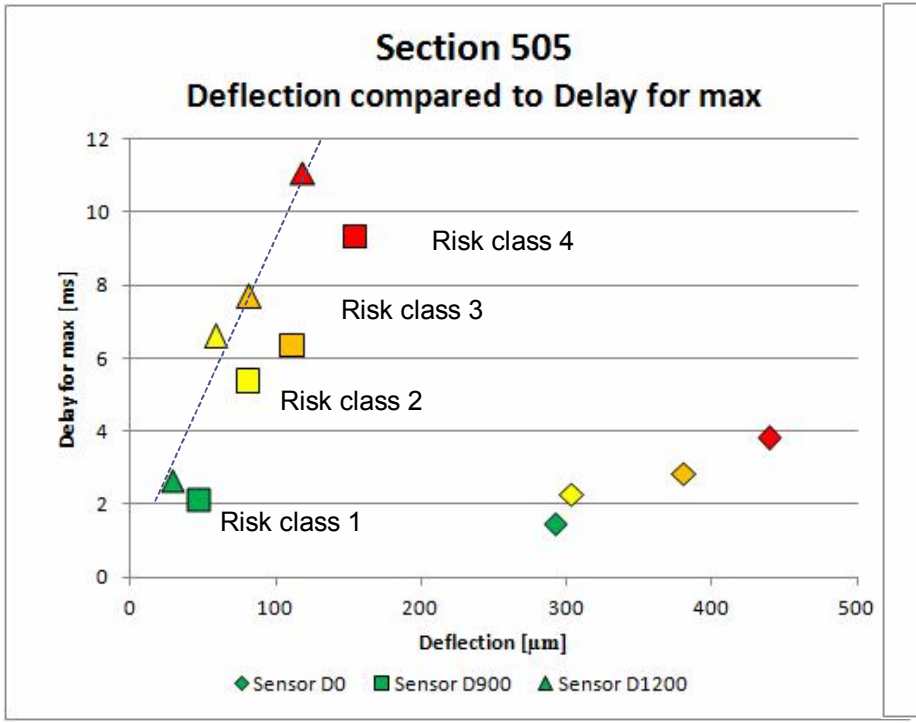
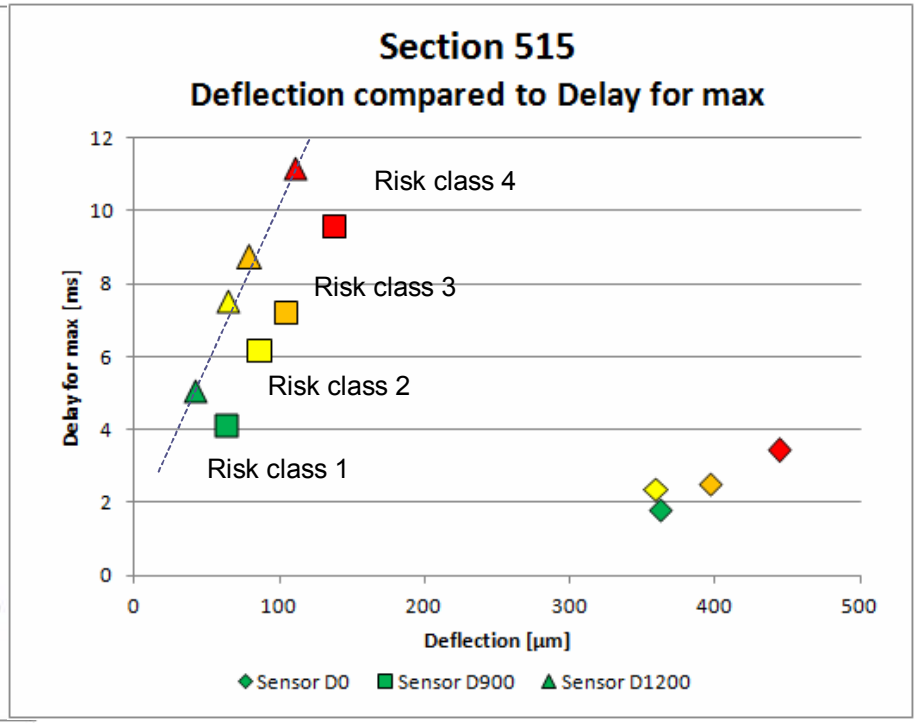
Recovery Time Analysis





No major risks with recovery times !

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Impact of Heavy Haulage Truck Combinations on the Pavement Performance

Dual Tyres, tyre pressure 800 KPa

	Max. horizontal pavement strain		Max. vertical strain on top of unbound structure	
Worst sections:	**60 ton**	**72 & 90 ton**	**60 ton**	**72 & 90 ton**
Section 505, risk class 4	229,8	193,3	-501,2	-435,3
Section 515, risk class 4	249,4	219,1	-697,1	-611,0

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DIFFERENT TRUCK OPTION IMPACT TO PAVEMENT DAMAGE – FOURTH POWER RULE CALCULATIONS

Fourth power rule:
-Underestimates rutting
- Overestimates distress

Truck option & total weight	Axel loads					Truck EKV	Net weight	Truck loads	Load effect	Comparison to 60 ton
	7,5 ton	8 ton	8,5 ton	9 ton	9,5 ton		[ton]			
Standard 60 ton	1	2	0	3	1	3,918	38	116800	457671	1
"Boliden" 72 ton	0	9	0	0	0	3,686	49	90580	333913	0,730
"En trave till" 90 ton	0	7	0	4	0	5,492	60	73973	406232	0,888
Annual transportation (ton) = 365 days * 320 heavy vehicles (60 ton trucks)/day * 38 tons/vehicle =										4438400
Stress exponent used in calculations =			4							

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Strenthening Costs for Different Heavy Haulage Options – Calculations for 20 year life time

	Initial traffic		Heavy traffic +50%	
	Initial traffic		Heavy traffic +50%	
	Initial traffic		Heavy traffic +50%	
515	72802	101103	109204	121378

	Heavy traffic +100%		Heavy traffic +200%	
Section	Total price [€]	Average price/km [€]	Total price [€]	Average price/km [€]
505	99757	16877	148305	25090
515	100399	14127	131167	18456

Total strengthening costs between Rovaniemi and Sodankylä:
Current traffic volume: **1.3 – 1.8 m€**
Current traffic + 200 %: **2.4 – 3.2 m€**

But this does not cover costs for bridges!

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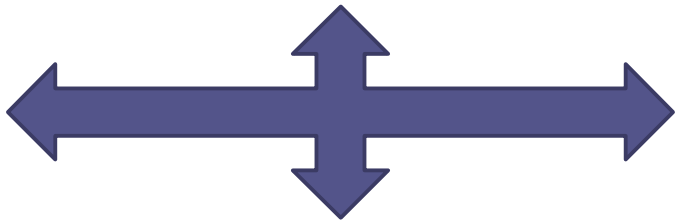
Next Step:
Heavy Load Management Tools

Road Maintenance Standards

- drainage maintenance
- winter maintenance
- spring thaw maintenance
- preventative maintenace based on monitoring results

Improving Structural Performance

- Stress & strain calculations
- focusing on weakest sections and strenthening them to a level resources allow
- making an if/then emergency strategy to other weak sections



Truck and Tyre Technology and transport planning

- tyre types and pressure (CTI)
- axle configurations
- number of axles
- transportation management (recovery times)
- avoiding loading on weak days

Road Condtion Monitoring and Warning Systems

- monitoring and warning system for spring thaw weakening (can road be closed for a few days?)
- monitoring road performance and reacting even to weak changes in the road

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ROADEX
Implementing Accessibility

Conclusions

- Road structures in HW4 mainly thick enough and in good shape – displacements in even worst sections relatively low
- More critical is poor drainage and frost damages and permanent deformations it causes = more focus on drainage management.
- Heavier than 60 tn truck options cause slightly higher displacement on weak subgrade soils but are more ”friendly” for the pavement (assuming dual tyres) =>

No Major Risks with Heavier Truck Options

- CTI trucks do not provide extra benefits due to strong structures in HW4 – on other roads their benefits are clear!
- In addition impact analysis should be made for:
  - **bridges, noise, vibrations**

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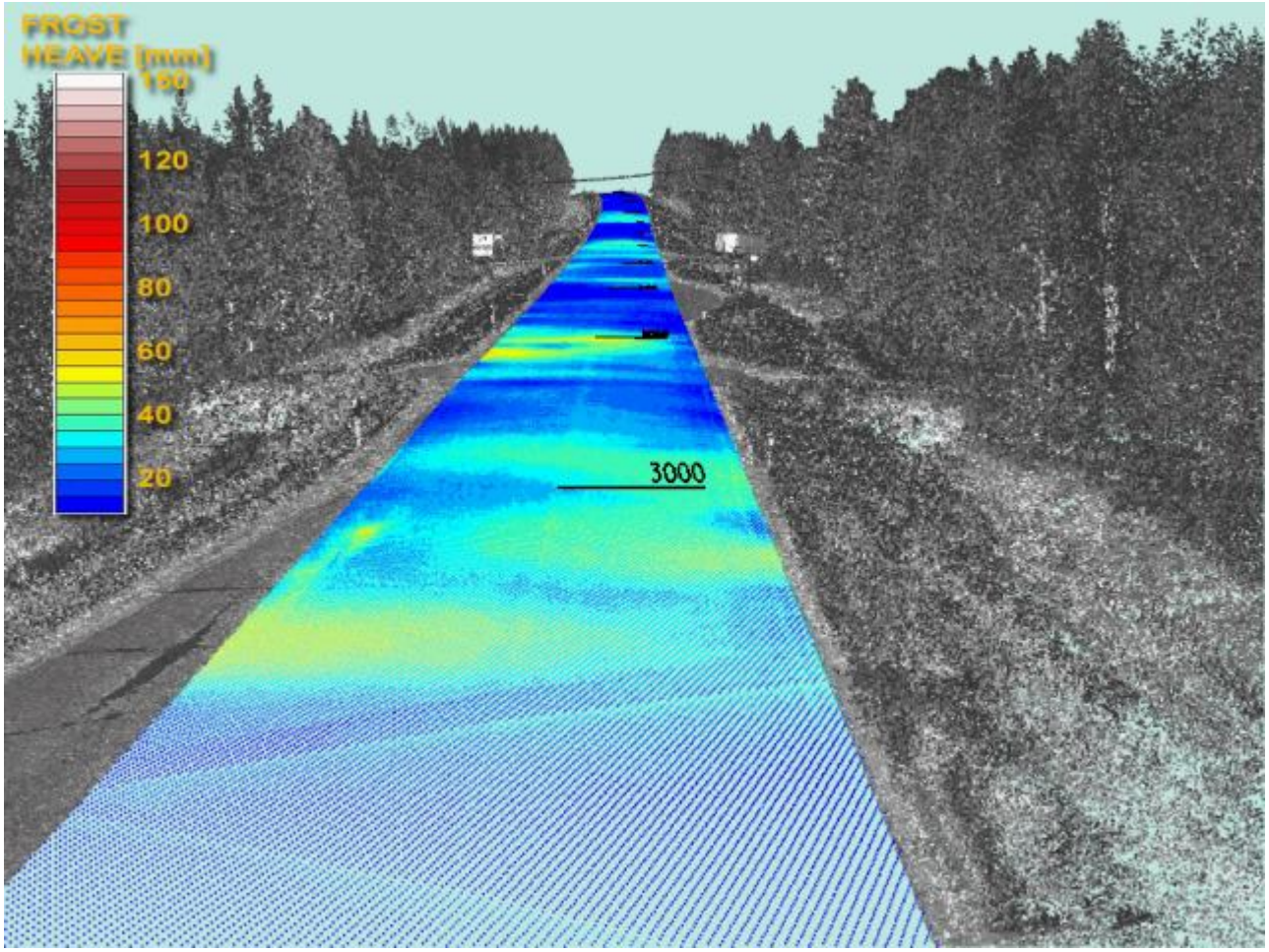
Thank You!



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