

Estimation of Stone-loss on network condition surveys by use of multiple texture lasers

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OUTLINE

- •5 years of experience in Finland
- Ravelling project in Netherlands
- Homogeneity



Indication of Ravelling Finland

...detected by point lasers



Basic information of collected data

The Laser works at a frequency of 32 000 pulses per second

Speed km/h	Interval between values
30	0.3 mm
50	0.4 mm
70	0.6 mm
90	0.8 mm
Spotsize	0.5 mm
Vertical	
resolution	0.1 mm



What will the collected values look like?



Indication of Ravelling - Model





Indication of Ravelling. Change in Surface type

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осе	age			ev	osis	ness	e	5%	95%																	
Dista	Avera	Mode	Мах	Std d	Kurto	Skew	Rang	PERC	PERC	0.4	0.5	9.6	7 .0	8.0	6.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
3820	0.8	0.8	1.2	0.1	0.6	0.9	0.6	1	1.05						26%	32%	20%	10%	10%		2%					
3825	0.8	0.8	1.3	0.2	2.6	1.3	0.8	1	1.06				20/	10%	28%	24%	20%	12%	100/	2%	4%					
3830	0.9	0.9	1.3	0.2	##	11	0.9	1	1.21				2%	8% 4%	10%	12%	28%	18%	10%	6%	2%	2%	2%	2%		
3840	0.9	0.9	1.4	0.2	##	0.5	0.8	1	1.22					8%	10%	16%	24%	18%	8%	8%	4%	4%	2,0	270		
3845	0.9	0.6	1.3	0.2	##	0.3	0.9	1	1.31				4%	2%	18%	12%	18%	22%	2%	14%	2%	6%				
3850	0.8	0.9	1.2	0.1	1.9	0.7	0.7	1	0.95					8%	12%	36%	32%	8%	00/	2%	2%					
3860	0.8	0.7	1.2	0.2	##	0.2	0.8	1	1.17				2%	2 %	24%	20%	20%	12%	16%	6%	270	2%				
3865	0.9	0.9	1.5	0.2	0.9	0.7	0.9	1	1.14					8%	18%	12%	24%	18%	10%	8%			2%			
3870	0.9	0.9	1.5	0.2	2.0	0.6	1	1	1.17				2%	2%	6%	18%	26%	26%	8%	8%	2%		2%			
3875	0.8	0.7	1.3	0.2	0.4	0.5	0.8	1	1.15				4%	4%	20%	26%	22%	8%	8%	4%	4%					
3880	0.8	0.9	1.3	0.2	0.2 ##	0.4	0.8	1	1.11					6% 2%	18%	34%	32%	24%	12%	4%	2%					
3890	0.8	0.8	1.2	0.2	##	0.1	0.7	1	1.09				2%	16%	6%	22%	24%	16%	10%	4%	270					
3895	0.9	0.8	1.4	0.2	0.1	0.4	1	1	1.28				2%		12%	14%	26%	18%	10%	8%	8%	2%				
3900	0.9	0.8	1.4	0.2	0.5	0.3	0.9	1	1.12					10%	10%	14%	22%	18%	20%	4%			2%			
3905	0.9	1.0	1.2	0.1	##	##	0.6	0.7	1.1					4%	8%	18%	22%	26%	20%	2%	2%					
3915	0.9	0.8	1.2	0.1	##	0.2	0.7	0.6	1.2				2%	4 /8 8%	16%	12%	24%	24%	4%	4%	6%					
3920	0.8	0.7	1.3	0.2	0.3	0.5	0.8	0.6	1.2					4%	22%	10%	32%	20%	4%	4%	4%					
3925	1.0	0.9	1.5	0.2	##	0.1	1.0	0.6	1.3					6%	8%	10%	14%	24%	10%	14%	6%	6%	2%			
3930	1.0	1.0	1.4	0.2	##	0.0	0.8	0.7	1.3					2%	8%	14%	8%	26%	24%	6%	8%	4%		2%		
3935	1.0	0.8	1.4	0.2	##	0.3	0.9	0.7	1.3					2%	2%	10%	12%	22%	14%	14%	14 %	4 %	6%	270		
3945	1.0	1.0	1.6	0.2	0.5	0.7	1.0	0.8	1.3						2%	10%	24%	20%	16%	12%	10%	4%		2%		
3950	1.0	1.1	1.5	0.2	##	0.2	1.0	0.6	1.4					4%	14%	12%	14%	6%	24%	6%	6%	10%	2%	2%		
3955	0.9	0.9	1.2	0.1	##	0.1	0.6	0.7	1.2		1 20/	220/	109/		2%	20%	14%	30%	20%	8%	6%	4.0/	20/		CHANC	
3965	0.7	0.9	0.6	0.4	27	1.3	0.4	0.3	0.5	2%	42%	46%	6%	4%	270	270	4 70	20%	070	1076	4 70	076	270		CHANG	E IN SU
3970	0.3	0.3	0.5	0.1	2.5	0.3	0.4	0.2	0.4	4%	36%	54%	4%	2%												
3975	0.3	0.3	0.4	0.0	##	0.2	0.2	0.2	0.4		52%	46%	2%													
3980	0.3	0.2	0.5	0.1	0.6	0.7	0.3	0.2	0.4		60%	36%	4%													
3985	0.3	0.4	0.5	0.1	##	0.0	0.3	0.2	0.4	2%	32%	54%	12%	0%	194	2%										
3995	0.4	0.4	0.6	0.1	0.5	0.6	0.4	0.2	0.5	2%	28%	50%	16%	4%	4 /0	270										
4000	0.3	0.3	0.5	0.1	##	0.0	0.3	0.3	0.4	2%	28%	56%	14%													
4005	0.3	0.3	0.6	0.1	6.2	1.7	0.4	0.2	0.4		50%	44%	4%	2%												
4010	0.3	0.3	0.4	0.0	0.2	0.0	0.2	0.2	0.4	4%	58%	38%	1.2%													
4015	0.3	0.4	0.5	0.1	##	0.2	0.3	0.3	0.4		34%	44%	22%													
4025	0.3	0.4	0.5	0.1	##	##	0.2	0.2	0.4		30%	54%	16%													
4030	0.3	0.4	0.5	0.1	1.3	0.9	0.3	0.2	0.4		40%	54%	4%	2%												
4035	0.3	0.3	0.6	0.1	3.2	1.4	0.4	0.3	0.5		42%	40%	16%	20/	2%											
4040	0.3	0.3	0.5	0.1	0.1	0.7	0.3	0.2	0.5		42%	46%	10%	2%												
4050	0.3	0.3	0.5	0.1	0.8	0.7	0.3	0.2	0.4		44%	50%	6%	270												
4055	0.3	0.3	0.4	0.0	##	0.0	0.2	0.2	0.4		60%	40%														
4060	0.3	0.3	0.5	0.1	0.5	0.6	0.3	0.2	0.4		44%	48%	6%	2%												
4065	0.3	0.3	0.5	0.1	##	0.2	0.2	0.2	0.4		46%	44% 54%	10%	2%												
4075	0.4	0.3	0.7	0.1	3.3	1.2	0.4	0.3	0.4		22%	46%	30%	2 /0	2%											
4080	0.4	0.3	0.7	0.1	0.9	1.2	0.5	0.3	0.6		20%	42%	22%	6%	8%	2%										
4085	0.4	0.4	0.7	0.1	3.3	1.3	0.5	0.3	0.5		14%	56%	22%	6%		2%										
4090	0.4	0.4	0.7	0.1	2.7	1.2	0.5	0.3	0.5		20%	44%	30%	4%		2%										

Porous Asphalt

Dense Asphalt

Indication of Ravelling. Make Statistics within same Surface Type



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Indication of Ravelling. Pre-test Road 1102



RMS 10m väg 1102, sektion 1 (uu505b)

RAMBOLL



Ravelling - Netherlands

Based on experience from 30 000 km survey over 6 years on the secondary road network in Netherlands

Purpose: Establish a methodology that can identify surfaces to be renewed within 2 years due to raveling.





- Information from road A348 over the years 2007, 2008, 2009, 2010 and 2011
- Measurement system: RST29, 32 kHz point lasers (3).
- Texture measured in the middle (1) and the right wheel position (2). In the years 2010 and 2011 the texture was also measured in the left wheel track.



Methodology – frame work

- The 95-percentile RMS texture value from year 1 (new asphalt) is <u>reference.</u>
- The <u>change in texture is yearly monitored through survey</u>.
- When the 95-percentile value has <u>increased</u> to "X" times compared to reference, the surface will be indicated as <u>open</u>.
- When the 95-percentile value has increased to "Y" times to the reference, the surface will be indicated as <u>raveled</u> and recommended for resurfacing.



Average RMS texture



Average value of RMS texture.

The distribution is narrow which can be explained by the surface type with the dominating stone sizes of 5 mm.



Laser 1 in between wheel paths

Laser 2 in the right wheel path

95-percentile RMS texture



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Change in distribution over time

The change over time is visible.





Increase in RMS texture 2007-2011

Laser 1: + 37.1% Laser 2: + 35.8%





Figure: % of 5m sections with RMS texture over the 2007 year's 95-percentile

Conclusions

- It seems possible to detect changes over time with RMS texture by using statistical distributions.
- It is possible to quantify this change and therefore possible to use it for indication of raveling.
- For detection of raveling the number of measurement point would benefit from increasing from 2-3 to 5.
- Driving pattern of the survey vehicle is essential (driver education).





Homogeneity as quality control



Examples



Poor texture/homogeneity



Proper texture/homogeneity



Purpose with a control of homogeneity

The quality will rise by using demands on surface structure and homogeneity

Proper structure/texture

- Better friction
- Influence on fuel consumption, tire wear and noise

Proper homogeneity

- Increase possibility for achieving the desired service life
- Reduced risk for future stone loss and separations
- Reduced risk for plastic deformations



Present control methods. Non-destructive

DOR (Density On Run)

- + Good parameter (density)
- + Cover areas not lines
- Low speed (0.9 km/h)
- Less good repeatability on short sections



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Thermal camera (FLIR)

Shows the asphalt temperature directly after paving Sections with too low temperature are classified as risk sections



Texture

Makrotexture (wave lenght 0.5 – 50.0 mm)

Parameters: MPD (Mean Profile Depth), RMS



Point lasers in three lines



Poor quality - example

Separation due to high binder content on the right hand side.





Correlation RMS Texture/density (DOR)





Model

- Collect data over 100 mm
- Calculate distribution for each 5 m
- Determine deviation from normal distribution





Conclusions - homogeneity

- Surface texture can be a proper indicator of open and dense surfaces (quality) using distributions
- Acceptable correlation between DOR and laser texture survey
- Knowledge of expected values for different surface types is needed





Further work

- Determine "master curve" for various asphalt types
- Define how deviations (grey area) shall be determined
- How large deviations can be accepted?





Conclusions

- Point lasers can be used for indication of raveling/stone loss and homogeneity (MPD under implementation in Sweden).
- The method can be based on macro texture and statistical distributions
- Changes over time are essential to track (stone loss)
- Reference data for new asphalt nice to have "mastercurves"
- Preferably 5 texture lasers should be used.
- Method also applicable for scanning lasers (more laser lines...)
- Driving pattern of the survey vehicle is essential (driver education).





