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Developing a Road Condition Indicator for Fretting

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Executive Summary

Fretting of road surfaces is becoming a defect of increasing concern for road authorities throughout Scotland. However, current analysis of condition survey data does not include indicators to identify locations that are affected by fretting, making scheme identification and programming challenging.

It has been observed that fretting can be associated with higher levels of texture reported in the SCANNER survey. Therefore an investigation into the use of texture data to provide an indicator of fretting has been carried out.

Assessment of the relationship between the existing SCANNER parameters and the results of VCS surveys led to the conclusion that there is little agreement between the current SCANNER texture parameters (SMTD, MPD, RMST) and fretting reported in the VCS. Thus these parameters cannot be used to identify fretting reliably on Scottish trunk roads.

Raw Condition Data (RCD) provided by the SCANNER survey has also been used to investigate the application of an algorithm developed in the Highways England TRACS survey specifically for the measurement of fretting. This parameter has shown more potential, but the results are complex. An initial assessment shows a reasonably low level of true positive, but several false positive reports of fretting. However, analysis shows that there are valid reasons for the false positives, many of which are associated with the reporting of features that are not fretting, but are defects. The algorithm is also constrained by the low level of resolution available in the texture data in comparison with the levels upon which the algorithm was developed. The work has therefore concluded that there is a need for the work to continue, to obtain a more complete understanding of the potential capability of this approach in assessing fretting on Scottish trunk roads.

1 Introduction and Background

Fretting of road surfaces is becoming a defect of increasing concern for road authorities throughout Scotland. However, current analysis of condition survey data does not include indicators to identify locations that are affected by fretting, making scheme identification and programming challenging.

Transport Scotland already carry out network level surveys of the surface condition of the network using survey devices that are accredited against the requirements of the SCANNER survey specification. The survey delivers information on the level of cracking, rutting and roughness and on the texture depth of the road surface. The texture depth has the potential to provide an indication of the extent of fretting due to the effect that the loss of surface aggregate has on the measured texture profile.

Transport Scotland have observed that fretting on a pavement can be associated with higher levels of texture and have therefore carried out a small, but thorough, investigation into the use of the SCANNER texture data, using the parameter called RMST. RMST is reported in 3 lines (nearside, middle and offside) every 10m. Transport Scotland observed that fretting could be associated with higher levels of texture, but not all locations of high texture were associated with fretting. Therefore a simple application of RMST data would not provide a robust measure of fretting. However, the results suggest that it might be possible to develop a way to identify fretting by improving the processing methodology.

This report presents the results of an investigation into the use of texture data to determine whether this could be used to provide an indicator of fretting - to support network level assessment and the identification of locations that should be considered for further investigation/schemes.

2 Data used

2.1 Visual Condition Data

Transport Scotland provided visual condition data collected on the A75, A76, A77 and A78, where maintenance schemes had been identified. The data covered almost 54 lane km from both dual carriageway roads and single carriageways and, along with construction joints, the following deterioration was reported:

- Fretting
- Cracking
- Alligator cracking
- Patching
- Fatting up
- Potholes
- Crazing
- Open Texture.

The VCS data was provided as road map images, with the location of defects marked, as shown in Figure 1. SCANNER data is reported as summary 10m condition parameters in the SCANNER HMDIF (see section 2.2). To enable comparison of the VCS with the SCANNER data it was necessary to convert the visual information from the road map images into quantitative values. This was undertaken by manually analysing the road map images, using TRL's bespoke software, ChartCrack. ChartCrack is usually used for the manual analysis of images of road surfaces collected by traffic speed imaging systems. Users are able to manually analyse the images of the road surface by drawing the cracks that can be seen in the images. The users draw these defects on a virtual road presented on the screen. Each defect is inserted into a "grid" that is overlaid on the virtual road. Therefore each defect is transformed from a line feature (e.g. crack, edge of patch) on the image to an area in the computer. The spatial location of each defect is maintained via the virtual road.

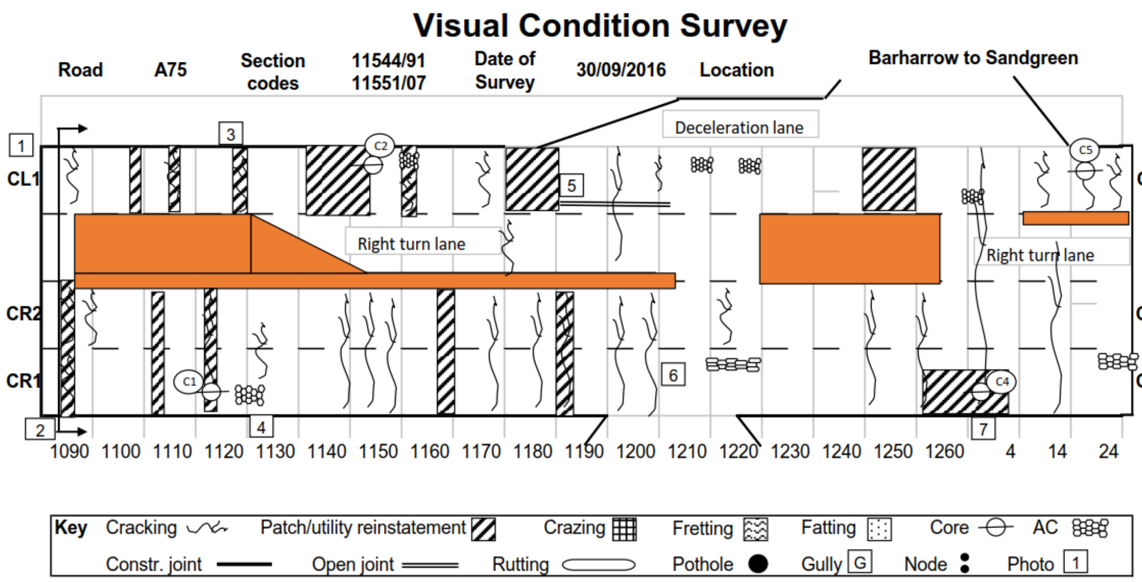

Figure 1: Example of VCS data provided

For this research we applied the same approach but the inspector "drew" the features that were shown in the road map images. This process allowed us to record the location of the defects against section and chainage, and convert each defect into an area, which could be output to an Excel spreadsheet. We could then calculate the percentage of the lane affected by each of the defects for each 10m length.

2.2 SCANNER Parameters

Transport Scotland commission annual SCANNER surveys of their network, which collect condition data from Lane 1 of the network. WDM are the current survey contractor. The contractor collects images and laser profile data and converts this raw data into condition parameters (such as SMTD, mean RMST), which are routinely delivered to Transport Scotland in HMDIF files. There are 36 SCANNER parameters delivered:

- Road Geometry: Gradient, Crossfall, and Radius of Curvature;
- Transverse shape: Rutting, Cleaned Rutting, Transverse Unevenness, and Transverse Variance;
- Ride Quality: 3m and 10m LPV (in the nearside wheelpath), 3m and 10m eLPV in the nearside and offside wheelpaths), and Bump Measure (in both wheelpaths);
- Texture: SMTD and MPD (measured in the nearside wheelpath), RMST (in the nearside, middle and offside of the lane), RMST variance (in the nearside, middle and offside of the lane, and across the whole lane), 5th and 95th percentile values of the RMST.
- Whole carriageway cracking (WCMD), Wheeltrack cracking (in the nearside and offside wheelpaths), Transverse cracking, and Surface Deterioration;
- Edge roughness, Edge coverage and Edge stepping

As part of their role as SCANNER auditor, TRL also receive HMDIF files from all SCANNER contractors, including the Scottish survey, to populate a national audit database of SCANNER data. This database was used to obtain the SCANNER parameters for each length covered by the VCS.

2.3 SCANNER RMST

The SCANNER survey measures texture in two ways:

- The texture profile is measured in a single line in the nearside wheelpath and recorded at 1mm spacing in the SCANNER raw data file (called RCD – Raw Condition Data). This data is used to calculate the standard texture parameters, SMTD (Sensor Measured Texture Depth) and MPD (Mean Profile Depth) reported in the delivered parameters file (called HMDIF) every 10m.
- Texture is also measured in the middle of the lane and offside wheelpath. The three texture values (i.e. including the above nearside measure) are used to calculate an RMST (root mean square texture) value for each 100mm travelled, which is reported

in the RCD. Several parameters are then calculated using this RMST data (mean, variance etc.) and reported in the delivered HMDIF.

RCD is not routinely delivered by the contractor to Transport Scotland, but WDM kindly provided this to TRL from surveys of the A75, A76, A77 and A78.

2.4 Increased Resolution Data

Experience on strategic roads in England (in the TRACS survey) has shown that having a low number of texture measurement lines can result in some drawbacks due to the lower level of detail available. This reduces the performance of the algorithms that aim to detect defects such as fretting. Technology advances mean that newer systems should be able to provide texture data at higher resolutions that should greatly increase the potential to measure fretting. This improvement in data delivery has been implemented in the 2017 TRACS contract in England, with an expectation that texture data over more than 30 lines will now be delivered. The current survey contractor employed by Transport Scotland (WDM) is the new TRACS contractor for Highways England, and WDM has been determining how to deliver this texture profile from their systems.

It was hoped that WDM would be able to provide this enhanced data to support further assessment of its potential to measure fretting on Scottish roads. Unfortunately, the increased resolution data was not delivered in time to be able to carry out this work within the timeframe of the project.

However, to briefly demonstrate the potential for this increased resolution data to improve the measurement of fretting, this work has obtained existing data collected using a higher number of measurement lines on English trunk roads.

3 Fretting from parameters reported in the HMDIF

In this section we analyse the behaviour of the SCANNER parameters reported in the HMDIF. This has been undertaken by comparing the SCANNER parameters with the reference dataset of fretting from visual condition surveys (VCS), and investigating whether it would be possible to use (either alone or combined) the current parameters to obtain a reliable indicator of fretting.

3.1 Texture parameters - SMTD and MPD

When SMTD and MPD values from SCANNER are compared to areas of fretting from the VCS, it can be seen that, in general, where there is fretting, there are high levels of texture (Figure 2 - Note that the gaps in data for CR1 lengths are where there is no CR1 data available (dual carriageways)).

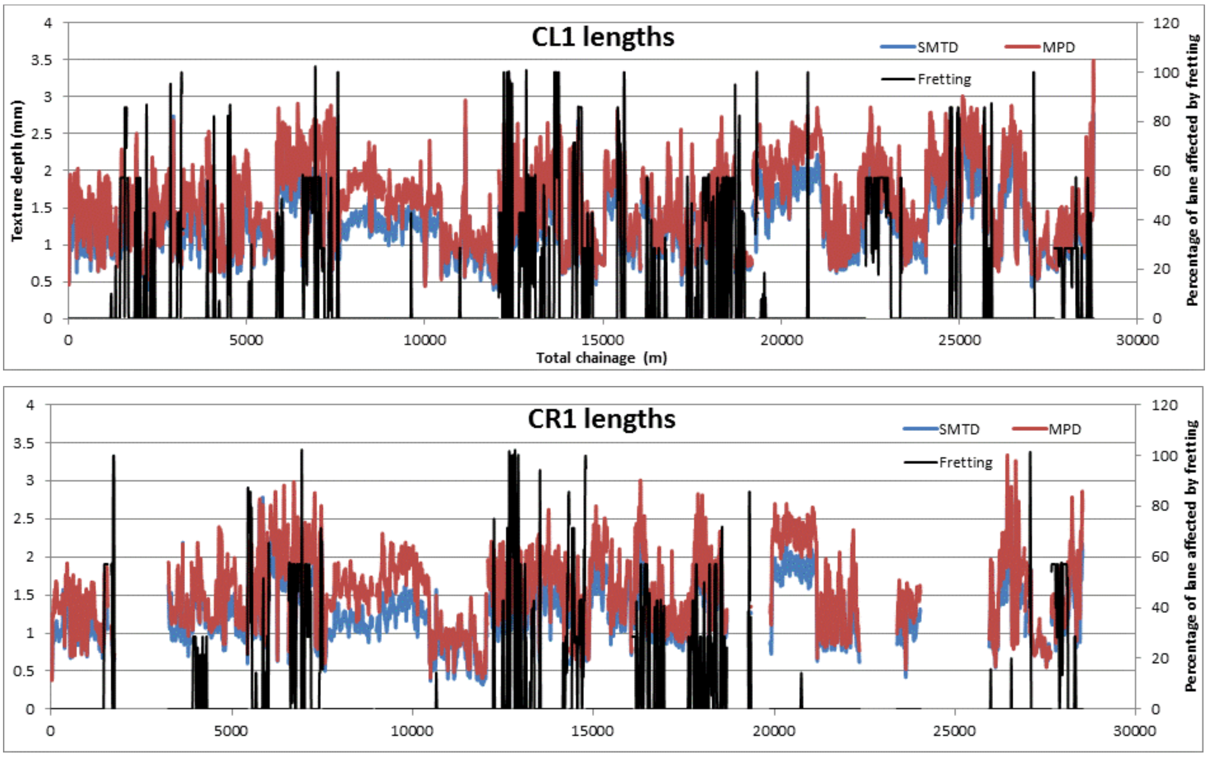

Figure 2: SMTD (blue), MPD (red) and levels of fretting (black) on CL1 lengths (top) and CR1 lengths (bottom)

However, the same cannot be said in reverse – there are many of lengths where the SMTD or MPD are high but no fretting has been reported - e.g. just before 25,000m on the CL1 graph in Figure 2.

However, fretting is not the only defect that may raise the texture depths. For example, section 11650/90, which occurs just before 25,000m in Figure 2, has high levels of crazing and some cracking. The SMTD is generally high, but fretting was only reported towards the end of the section (Figure 3).

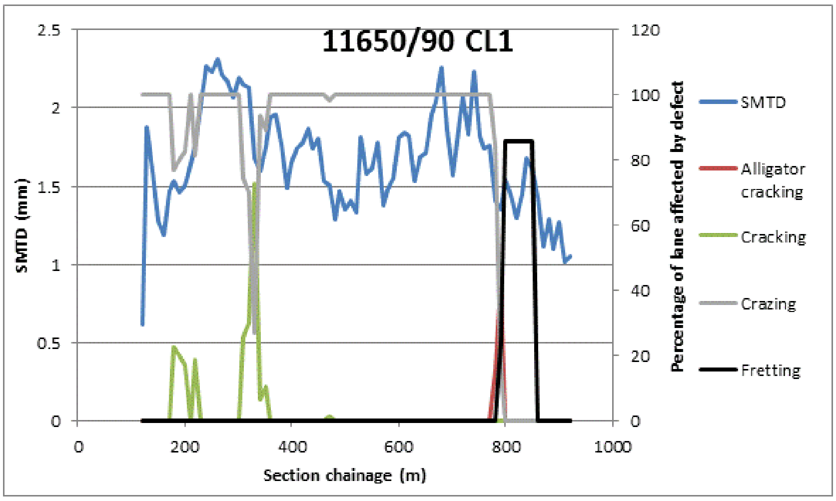

Figure 3: Defects that could affect texture on 11650/90

Similarly, there are examples of lengths where there are no defects reported in the VCS, and yet the texture is high e.g. chainage 1220m to 1830m of section 11506/55, compared with 1830m onwards (Figure 4).

Thus, the presence of high levels of SMTD or MPD does not appear to be a reliable indicator of the presence of fretting. This agrees with the findings of Transport Scotland, who have previously looked at the application of these parameters to detect fretting.

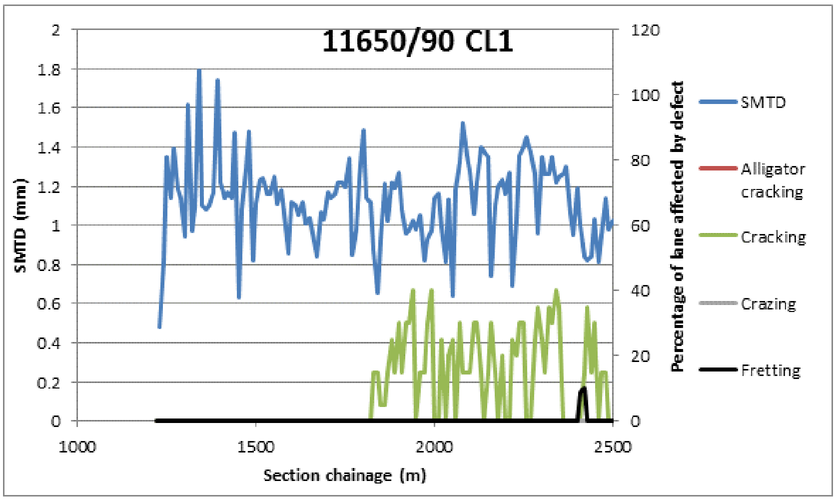

Figure 4: Texture and defects on section 11506/55

3.2 Texture parameters - RMST in three lines

RMST is measured in three longitudinal lines and is used to calculate several parameters that are reported in the HMDIF:

- Nearside RMST, middle RMST and offside RMST;
- Nearside RMST variance, middle RMST variance and offside RMST variance;
- Whole lane RMST variance;
- 5^{th} percentile value of RMST;
- 95^{th} percentile value of RMST.

As can be seen from Figure 5, Figure 6 and Figure 7, the RMST values are often high where fretting is present. However, as with SMTD and MPD, a high value of RMST does not imply that fretting is present. When considered as simple means, variances or percentiles, these parameters also appear to be poor indicators of the presence of fretting.

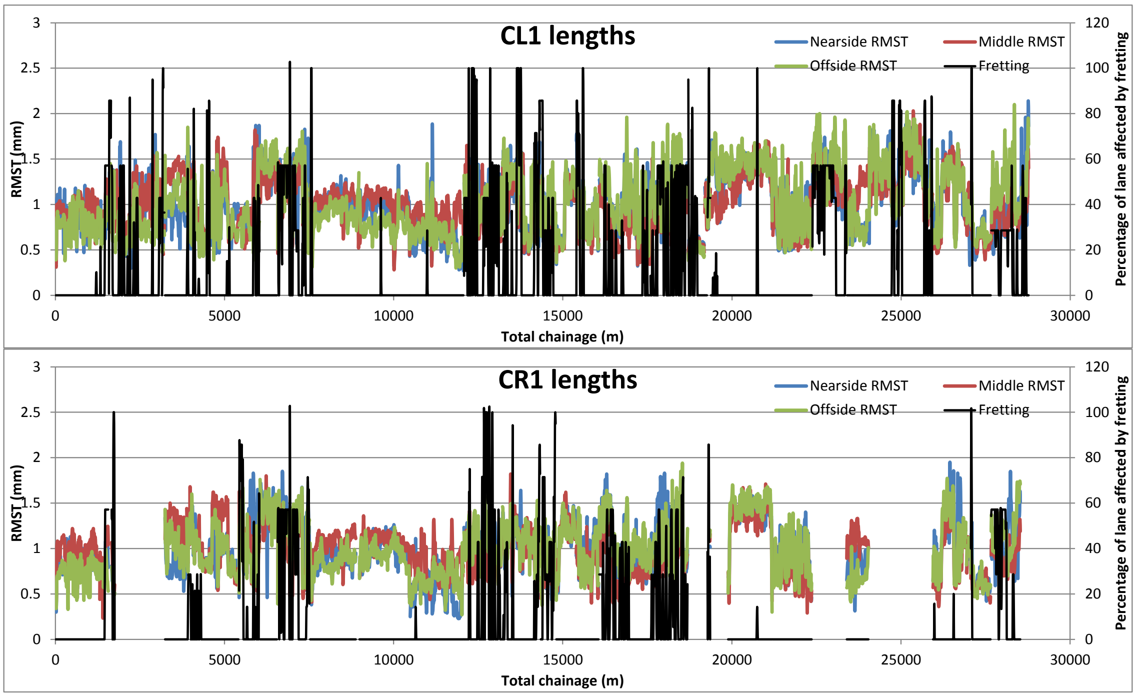

Figure 5: RMST in three lines (blue, red, and green lines) and levels of fretting (black) on CL1 lengths (top) and CR1 lengths (bottom)

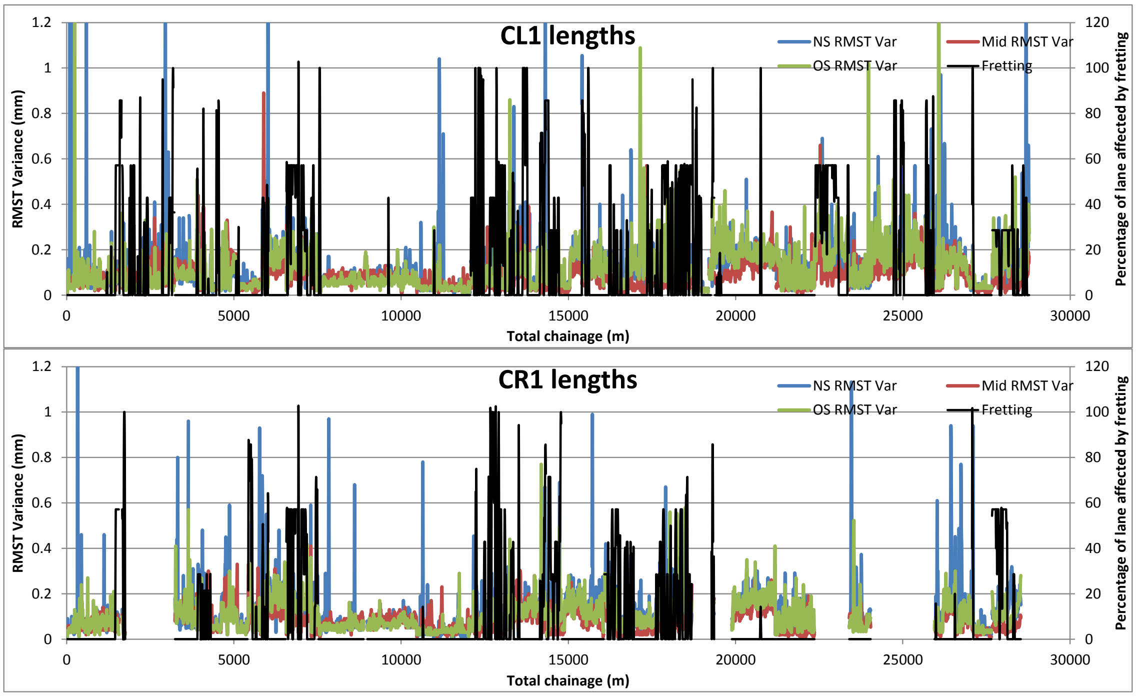

Figure 6: RMST Variance in three lines (blue, red, and green lines) and levels of fretting (black) on CL1 lengths (top) and CR1 lengths (bottom)

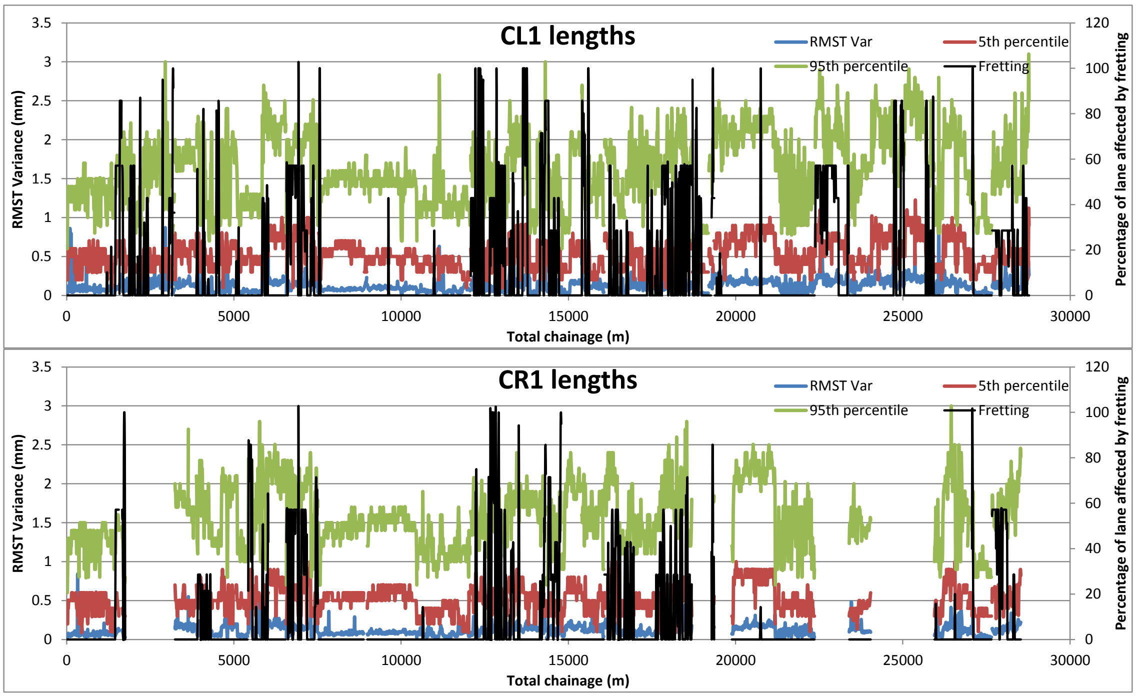

Figure 7: Full width RMST variance, and 5th and 95th percentile of RMST (blue, red, and green lines) and levels of fretting (black) on CL1 lengths (top) and CR1 lengths (bottom)

3.3 Other parameters

We have also performed an analysis of other SCANNER parameters reported in the HMDIF. There was no visual agreement between the VCS data and any of these parameters, except for the Surface Deterioration parameter (Figure 8).

Surface Deterioration was developed in work for DfT on cracking (Furness et al., 2007). It had been observed that automated crack detection systems tended to report higher levels of cracking where the road was actually fretted. The cracking tended to be reported as short segmented cracks. The focus of the DfT study was to try and identify lengths where these types of cracks were reported, and output a further parameter called Surface Deterioration that could be used by LAs to help understand their cracking data (when considered alongside the crack reports). However, the measure was focussed on HRA surfacings, and is not expected to work well on thin surfacing or other surfacing types.

It can be seen in Figure 8 that, when the Surface Deterioration parameter is greater than $0.3m^2$, this often coincides with areas of fretting. However, this is not always the case. Similarly to the above parameters, there is inconsistency in the reporting. It is possible that some of this is linked to the type of surface. However, the VCS reports provided did not give sufficient detail on surfacing type for an analysis of whether the parameter has identified fretting better on HRA surfaces than other surfaces. Thus no firm conclusions about the performance of the Surface Deterioration parameter can be drawn.

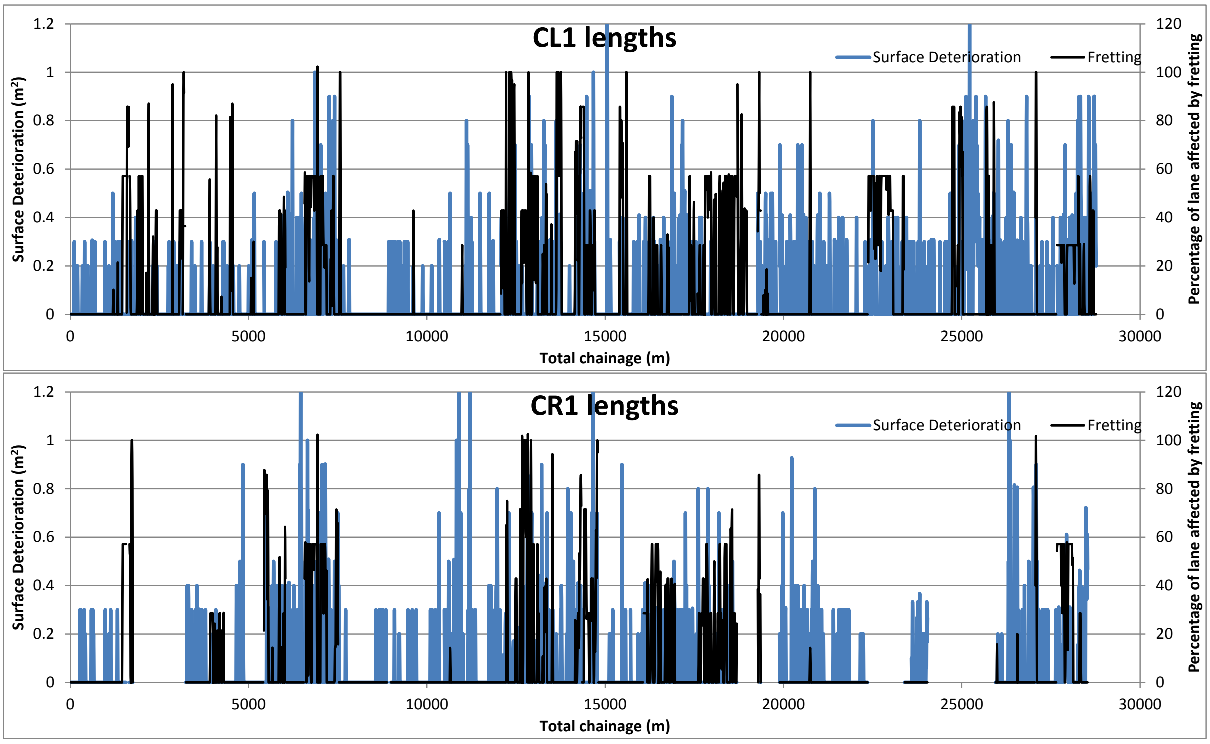

Figure 8: Surface deterioration parameter (blue line) and levels of fretting (black) on CL1 lengths (top) and CR1 lengths (bottom)

3.4 Summary

It is clear that there is little consistent agreement between the SCANNER texture parameters (SMTD, MPD, RMST) and fretting reported in the VCS. These parameters cannot be used to identify fretting reliably on Scottish trunk roads. The Surface Deterioration parameter, developed to help distinguish between fretting and cracking on HRA surfaces, also has inconsistent performance and is not likely to provide a reliable indicator of fretting.

4 Fretting from Raw Condition Data

As part of undertaking similar identification of fretting work for Highways England, TRL have developed new algorithms that utilise RMST data to identify fretting. These algorithms are not included in SCANNER. We have therefore investigated the potential for the application of these algorithms on Scottish roads.

4.1 TRACS fretting algorithm

Experience in previous research showed that the detection of fretting is challenging because the appearance of the defect is very different for different surface types. Therefore there is a need to either have detailed information about the surfacing used for each length, or an algorithm that enables estimates of fretting to be obtained without prior knowledge of the surface type. This has been the focus of the TRACS fretting algorithm.

The TRACS fretting algorithm essentially assumes that a road in generally good condition has an even distribution of texture. Fretting will usually be localised and will give uneven texture. The TRACS fretting algorithm therefore compares the texture in a short length of road (10m) with a longer length (100m) surrounding this short length. If the texture on the short length is distributed differently than that of the longer length surrounding it, then the algorithm reports a higher value. The distribution of texture depths can be confounded by patches and surface type changes and therefore the algorithm identifies and isolates patches and surface changes prior to comparison of the distributions. Since the TRACS fretting algorithm compares the texture of the short length with the longer length, if the whole length contains fretting then the comparison will show that the two lengths are similar and the result may be that no fretting or only very low levels of fretting are reported. Hence totally fretted roads will not be well measured. On trunk roads it has been assumed that this would be a rare occurrence.

4.2 Applying the TRACS fretting algorithm to SCANNER RMST data

We have obtained RCD data from the VCS sites and applied the TRACS fretting algorithm. It should be noted that TRACS fretting algorithm usually requires a minimum of 7 lines of RMST, and recently this has been expanded to >30 lines for the 2017- TRACS contract. We have only 3 lines of RMST in the SCANNER RCD and therefore this work is inevitably limited by the low resolution of the RMST data. However, it should give a pointer to the potential of the method.

The TRACS fretting algorithm has been applied to the SCANNER RMST data, fretting values for each 10m length obtained, and compared to VCS data as illustrated by the example in Figure 9. This analysis has been performed for each section for which both SCANNER RCD and VCS data were available.

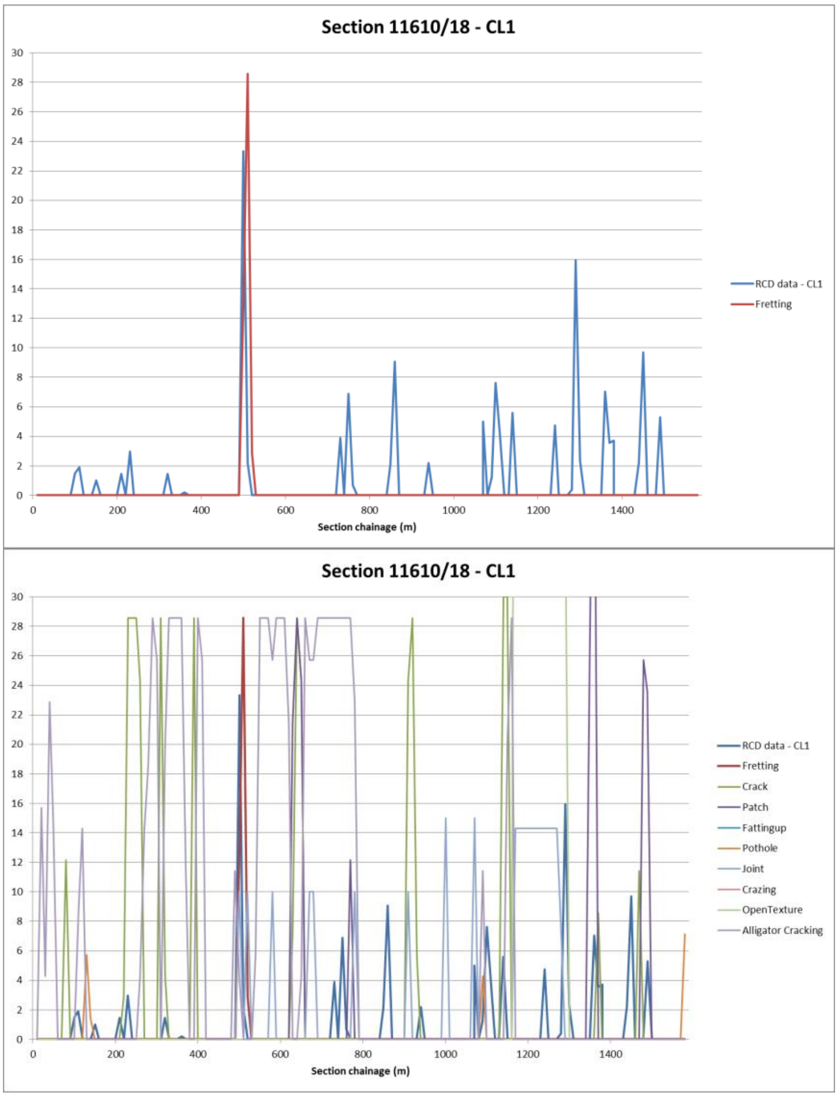

Figure 9: TRACS fretting data (calculated from RCD, blue line) compared to VCS fretting data (red line) for section 11610/18 – CL1 (left) and compared to all defects for same section (right)

The comparison allows assessment of the number of:

- “true positives” (where the algorithm and VCS both report that fretting is present)
- “false positives” (where the algorithm reports fretting whilst the VCS does not)
- “true negatives” (where the algorithm and VCS report that fretting is not present)
- “false negatives” (where the VCS reports fretting whilst the algorithm does not).

The number of instances of each occurrence is displayed below in Table 1. As can be seen, the algorithm reports fretting for very few of the lengths where fretting has been recorded in the VCS (only 8.4% of the 793 lengths). This may be because the extent of measurement, using only 3 lines, is not sufficient to measure all areas of fretting, or because of the approach taken by the algorithm to identify fretting. This is discussed further below.

Table 1: Assessment of TRACS fretting algorithm using SCANNER RMST

Available lengths:					3522		-	
Number of lengths with fretting according to VCS (VCS > 0) (% of total length of data):					793		22.5%	
Number of lengths with fretting but no fretting detected by algorithm (VCS > 0 & algorithm = 0) (% of lengths with VCS fretting):					555		70.0%	
Number of lengths with fretting but algorithm not able to calculate a valid value (% of lengths with VCS fretting):					171		21.6%	
Algorithm filter value	>0		>2		>4		>6	
Total number of algorithm positives (% of sites considered)	**797**	**23%**	**566**	**16%**	**367**	**10%**	**234**	**6%**
True positives (as a % of algorithm positives)	238	30%	198	35%	138	38%	95	41%
False positives (as a % of algorithm positives)	559	70%	368	65%	229	62%	139	59%
Total number of algorithm negatives	**2725**	**77%**	**2956**	**84%**	**3155**	**90%**	**3288**	**93%**
True negatives (as a % of algorithm negatives)	2170	80%	2361	80%	2500	79%	2589	79%
False negatives (as a % of algorithm negatives)	555	20%	595	20%	655	21%	699	21%

In Table 1 we have assessed the performance of the algorithm using four thresholds (0, 2, 4, 6), where we consider a value greater than the threshold to be a report of “fretting” in that 10m length (i.e. if the threshold is 2 and the TRACS fretting algorithm reported 2.4, then that 10m length is considered to be fretted).

Clearly the number of fretted lengths increases with decreasing threshold value. However, from Table 1, it is also clear that changing the threshold does little to improve the reliability of negative results (i.e. where the algorithm has not reported fretting), and has only a limited impact on the reporting of false positives. The majority of fretting was not detected by the algorithm at all – a maximum of 30% of the fretting reported by the VCS was reported by the algorithm. This is most likely due to the volume of damage present for the roads assessed – as noted above the fretting algorithm only detects local changes in texture and thus will not pick up long lengths of fretting. As these roads were deemed worthy of visual inspection, they are likely to have considerably more defects present than typical roads and the algorithm was designed to work on roads that have localised areas of fretting.

4.2.1 False negatives

The lengths containing false negatives i.e. the lengths where there is fretting reported in the VCS but not by the algorithm, have been further investigated. The key reasons for false negatives (i.e. the algorithm failing to detect fretting) are listed in Table 2. It can be seen that the presence of invalid data, and joints and patches, led to the TRACS fretting algorithm failing to report any value on many of the lengths (171) where fretting was reported in the

VCS. This is a practical limitation of the algorithm, not a technical failure in its ability to detect fretting.

For the remaining 555 lengths (where the algorithm was able to calculate a value) most of these were lengths containing long lengths of fretting. As noted above, it is known that the algorithm will perform poorly on such lengths. On such lengths the algorithm typically gives a high value at the start and end of the length (Figure 10). This is because the start and end will have larger differences between the local and long length texture distributions.

There are also some locations that have long lengths of cracking and crazing, both of which may have a similar effect on the road texture to fretting. Hence there are only 11 of the 555 lengths where the algorithm reports a false negative that cannot be explained, or which would not be expected (Table 2).

Table 2: TRACS fretting false negatives

Reason		Number of instances	
Algorithm not able to calculate a value	Invalid data in section	116	68%
	Multiple joints in section	44	26%
	Multiple patches in section	11	6%
Algorithm delivers a value	Long section of fretting	533	96%
	Offset in chainage	6	1%
	Crazing over much of section	3	1%
	Cracking over much of section	2	0%
	Unknown	11	2%

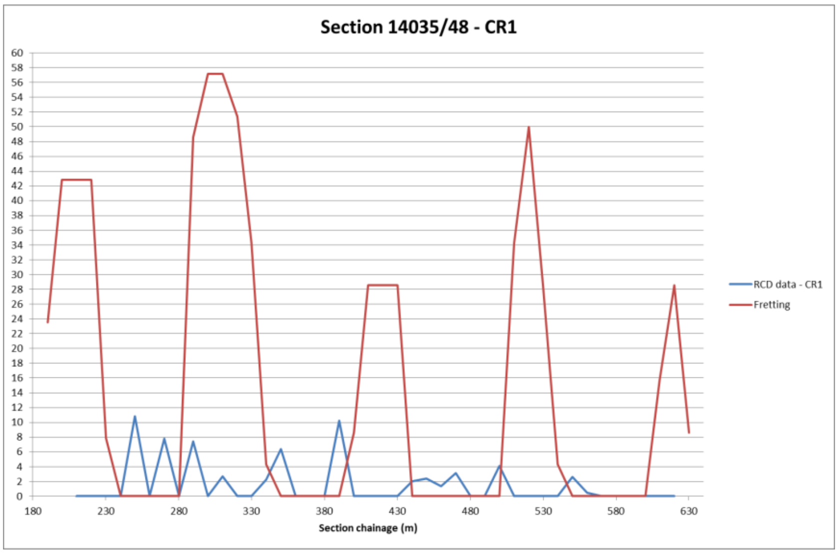

Figure 10: Example of algorithm fretting data (blue line) appearing mainly at the beginning and end of lengths of VCS fretting data (red line). Within the long length of fretting the algorithm reports low values.

4.2.2 *False Positives*

As noted above, the TRACS fretting algorithm has not been designed to detect fretting directly. It looks for locations where the distribution of surface texture is different to that of its surroundings, and it is assumed that this has arisen from the presence of fretting. This means that the algorithm is likely to be affected by any road defect that will affect the distribution of texture depths. The VCS identified cracking, patches, fretting, fatting up, potholes, joints, crazing, open texture and alligator cracking. These will all affect the distribution of texture depths, but to different extents. Each of these defects was compared to lengths where the algorithm had reported a false positive (a value >0), to identify potential causes of false positives. The results of this comparison can be seen in Table 3.

Table 3: Comparison of TRACS fretting false positives to VCS defects other than fretting

Defect	Number of instances	
Cracking	167	30%
Crazing	66	12%
Alligator Cracking	59	10%
Pothole	7	1%
Open Texture	1	0%
Fatting up	0	0%
Damage, causing an increase in texture	**300**	**53%**
Unknown	166	30%
Patch	78	14%
Joint	15	3%
No damage or unknown	**255**	**47%**

Despite a large number of false positives having no discernible reason (166), the majority are caused by road damage that would affect road the surface texture distribution. It is noted that 78 lengths included patches. As noted above, the algorithm attempts to remove these before estimating the fretting. However, if the algorithm fails to identify these patches it is likely that the algorithm will report that fretting is present. Similarly if the algorithm does not recognise a joint between two different surfacing types, then it may report fretting. When this fact is combined with the lengths where the algorithm matched the VCS fretting, the algorithm detected 23% of road damage for the sections evaluated, with an accuracy of 63%. The algorithm also detected 77% of no road damage with 42% accuracy (Table 4).

Table 4: Final assessment of fretting algorithm on general road damage

VCS				RCD			
Damage		Not damaged		Damage		Not damaged	
2093	59%	1429	41%	797	23%	2725	77%
			True values	503	63%	1135	42%
			False values	294	37%	1590	58%

4.3 Applying the TRACS fretting algorithm to higher resolution RCD RMST data

As noted above, SCANNER delivers RMST data in three measurement lines. However the TRACS fretting algorithm was developed for a minimum of 7 lines of data, and more recently is being used with >30 lines in the TRACS survey. Such data was not available to assess the performance in Scotland.

To demonstrate the potential improvement associated with this additional data we have sourced RMST data collected over 40 lines using the Highways England reference device (HARRIS3). The RMST data was then re-sampled to obtain 20 lines (using every other line) and then 10 lines of RMST data. The TRACS fretting algorithm was applied to these datasets and analysis undertaken on repeatability of the measurements – i.e. how many of the 10m lengths were reported to be in the same category in the two repeat runs. Three fretting categories were defined:

- Red: TRACS Fretting value ≥ 6
- Amber: 4 ≤ TRACS Fretting value < 6
- Green: 2 ≤ TRACS Fretting value < 4.

Figure 11 shows the percentage of 10m fretting values that fall in the same category (Red, Amber, Green) when applying differing numbers of measurement lines. The results show that there is a significant reduction in the repeatability with decreasing numbers of measurement lines. Although this is not an indication of absolute performance, it suggests that there is variation in the RMST transversely across the pavement and this has a significant effect on the values reported. To obtain a stable fretting value requires full transverse coverage of the lane being surveyed. Where this coverage is not available there is likely to be instability in the measure, which will inevitably affect its ability to report the true level of localised fretting.

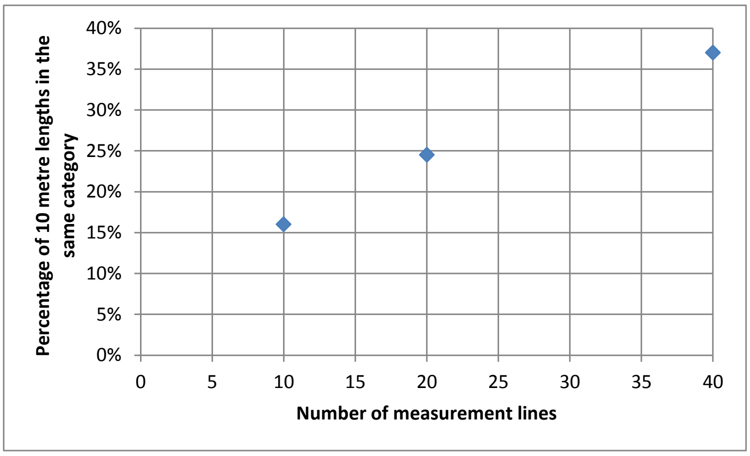

Figure 11: Percentage of 10m lengths lying in the same fretting category (Red, Amber, Green) for repeat surveys when using 10, 20 and 40 lines of RMST

4.4 Summary

As can be seen from Table 5, the TRACS fretting algorithm agrees with the VCS (true positives and true negatives) for 68% of the lengths considered. For a further 11% of lengths the algorithm reported fretting but the VCS did not. However, on these lengths other defects or features were present that would be expected to affect the distribution of texture in the same way as fretting. Also, for another 13%, where the VCS has reported fretting but the algorithm has not, many of the lengths either had long stretches of fretting (where we would not expect the algorithm to work) or many patches and surface changes (preventing the algorithm from calculating a valid value for fretting).

It can therefore be concluded that the algorithm did not work as expected <8% of the lengths considered. For these lengths, it may be that the low resolution of data has resulted in the machine data missing the areas of fretting, or some other characteristic of the pavement surface in these lengths that has caused the algorithm to fail.

Table 5: Summary of algorithm performance

	Number	% of lengths considered
True positives (where both VCS>0 and algorithm >0)	238	6.75%
True negatives (where both VCS=0 and algorithm =0)	2170	61.61%
False positives (where VCS=0 and algorithm >0)	559	15.87%
Where there is not a valid reason	**166**	**4.71%**
False negatives (where VCS>0 and algorithm <0)	555	15.76%
Where there is not a valid reason	**11**	**3.12%**

Thus it is apparent that the TRACS algorithm, even using three lines of RMST data, has potential to be used to detect isolated patches of fretting, or patches of other defects that cause a localised increase in texture. However, the capability of the algorithm may not be sufficient to detect all areas affected by fretting and there is also a known issue with repeatability when using such low resolution data.

5 Conclusions and Recommendations

This project has undertaken an investigation into the use of SCANNER parameters to detect fretting on Scottish trunk roads. This has been undertaken in the light of observations that fretting can be associated with higher levels of texture reported in the SCANNER survey.

We have assessed the relationship between the existing SCANNER parameters and the results of VCS surveys carried out on a number of sites. The work can conclude, as has been suggested in initial investigations carried out previously, that there is little agreement between the current SCANNER texture parameters (SMTD, MPD, RMST) and fretting reported in the VCS. These parameters cannot be used to identify fretting reliably on Scottish trunk roads. This is, perhaps, unsurprising as these parameters were not developed for the specific purpose of reporting fretting.

Using the Raw Condition Data (RCD) provided by the SCANNER survey we have also investigated the application of an algorithm developed in the Highways England TRACS survey specifically for the measurement of fretting. This parameter has shown more potential, but the results are complex. An initial assessment shows a reasonably low level of true positive, but several false positive reports of fretting (i.e. the algorithm misses quite a lot of the fretting and falsely reports fretting that is not there). However, analysis shows that there are valid reasons for the false positives, many of which are associated with the reporting of features that are not fretting, but are defects. The algorithm is also constrained by the low level of resolution available in the texture data in comparison with the levels upon which the algorithm was developed. A more complete measure of the surface texture would improve the performance (i.e. more lines of RMST). We understand that this could be provided using the equipment already in use in Scotland, and it is unfortunate that data could not be obtained within the scope of this project. We therefore recommend that the work continue, to obtain a more complete understanding of the potential capability of this approach in assessing localised fretting on Scottish trunk roads.

References

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Developing a Road Condition Indicator for Fretting

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