NEW METHODS FOR NETWORK LEVEL AUTOMATED ASSESSMENT OF SURFACE CONDITION IN THE UK

A WRIGHT, N DHILLON & S MCROBBIE
Infrastructure Division, TRL, UK
mwright@trl.co.uk, ndhillon@trl.co.uk, smcrobbie@trl.co.uk

C. CHRISTIE
Highways Agency, UK
colin.christie@highways.gsi.gov.uk

ABSTRACT

Automated traffic-speed surveys have been applied on the English Strategic Road Network since 2000, under the Traffic-speed Condition Surveys (TRACS) specification, which employ image and laser-based equipment to measure surface condition at traffic-speed. The original requirements for TRACS surveys were based on research carried out by TRL for the Highways Agency. However, there have been significant advances in the technologies for the measurement of surface condition since 2000. The introduction of a new contract in 2012 has provided the opportunity enhance the requirements. This paper focuses on the developments undertaken in two areas – rutting and surface disintegration. Rutting is a key indicator of condition, but the laser-based transverse profile systems used to quantify rutting can be adversely affected by features such as road markings. An approach has been developed to use high resolution transverse profile in combination with surface intensity measurements to remove the influence of such features. Surface disintegration is becoming a major source of deterioration on the SRN. This has required the development of an improved assessment method, which utilises multiple laser texture measurements to identify disintegration over the full survey width. The research has lead to the publication of a revised survey specification for TRACS.

1. INTRODUCTION

Traffic-speed surveys of the condition of the English Strategic Road Network (SRN) are carried out annually for the Highways Agency under the TRAffic-speed Condition Surveys (TRACS) contract. These surveys use traffic-speed image collection and laser profile measurements to automatically assess cracking, rutting, texture, geometry and ride quality on the network. The data is loaded into the Highway Agency Pavement Management System (HAPMS) and can be accessed by engineers in each of the Highways Agency's Areas to assess the condition of lengths of the network. The data is used for the identification of projects/schemes and to support bids for maintenance funding. The data is therefore essential for reporting condition at the "local" level and also at the national level, where the TRACS data is used in the calculation of one of the Agency's Key Performance Measures (KPM).

Surveys have been carried out under the TRACS contract since 2000 (TRACS1 between 2000 and 2005 and TRACS2 between 2006 and 2011). The original requirements for TRACS surveys were based on the results of research carried out by TRL for the Highways Agency into the measurement of surface condition at traffic-speed [1,2], including the development of the HARRIS1 and HARRIS2 (Highways Agency Road Research Information System) survey vehicles as reference devices. This research lead to

the definition of the types of raw data required (e.g. transverse profile, longitudinal profile etc.), the derived parameters that would be calculated (e.g. rutting), and their accuracy (e.g. 95% of rut measurements on a test length must lie within 3mm of a reference). Since the introduction of TRACS surveys there have been significant advances in the technologies employed for the measurement of road surface condition. The introduction of a new survey contract in 2012 has therefore provided the opportunity to introduce enhancements to the survey requirements, drawing on the results of the research or developments that have been carried out during the period of the TRACS2 survey. Such enhancements could encompass the raw data, the derived parameters or the accuracy requirements.

Research has therefore been undertaken to investigate how the requirements for TRACS could be brought up to date in order to meet the current key needs of the Highways Agency. Although the research has reviewed all of the measurements provided by TRACS, in this paper we focus on the measurement of rutting and surface disintegration.

2. THE MEASUREMENT OF RUTTING

2.1. The problem

Traditionally, measurements of rutting in the UK have been collected using the "straight edge and wedge" technique, where a 2m straight edge is laid on the pavement and a wedge is used to determine the maximum distance between the straight edge and the road surface. To simulate this, TRACS surveys use fixed point lasers (20 lasers) to measure the transverse profile of the pavement across a 3.2m width of the traffic lane. Rut depths are calculated by applying an algorithm to simulate the 2m straight edge. The algorithm identifies three points within the transverse profile (i.e. where the left and right sides of the virtual straight edge touch the surface and where the perpendicular distance with the straight edge is at its maximum) to calculate the rutting. Although data from each laser can be extremely accurate, the relatively small number of transverse profile measurement points has been found to be insufficient to fully describe the profile of the pavement. Additionally, problems have been identified resulting from the presence of road markings and from poor driving line, which are exacerbated by the limited survey width of TRACS (3.2m). Figure 1 shows an example of the effect of a thermoplastic road marking (which can be up to 6mm high) on the TRACS 20 point transverse profile measurement. The high point on the left hand side arises from the road marking. Due to the limited information provided in the transverse profile the simulated straight edge cannot consistently remove such points, and is placed in the wrong location (a proposed 'correct' placement of the nearside straight edge is shown with the dashed line). This problem can significantly influence the magnitude of the reported rut depths (e.g. increasing the reported rut depth by at least 2.5mm in the example of Figure 1), and hence both the reproducibility and repeatability of the data.
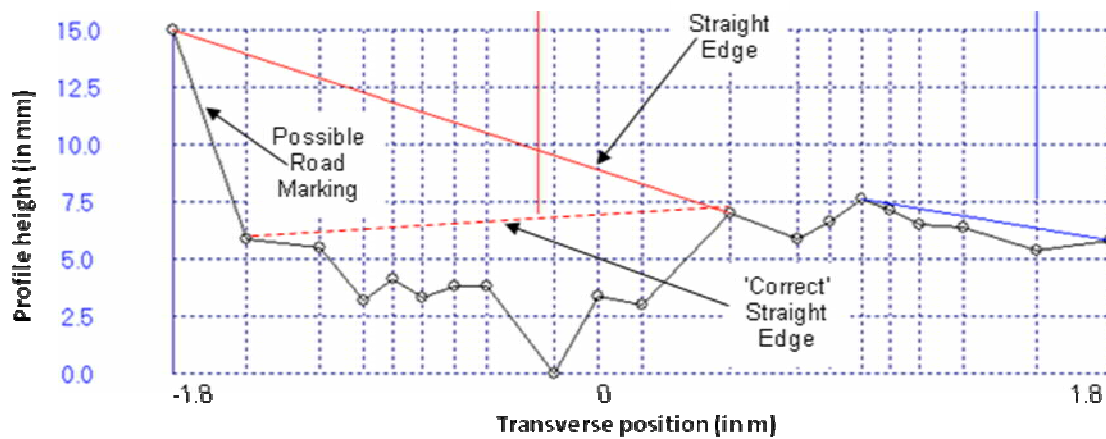
Figure 1 - Transverse profile from TRACS with the simulated straight edge measuring an incorrect (high) level of rutting.

Because the errors (in particular the repeatability) can be larger than changes in the rut depths from year to year caused by genuine deterioration [3], it is difficult to accurately trend TRACS rutting data. We know that the reliable computation of the rut depth for each transverse profile relies on the ability to correctly position the highest and lowest points, and, as a result, the straight edge [4]. Hence there is scope to increase the accuracy and repeatability of the rut measurement via better identification of such points.

2.2. Developing the measurement

The HARRIS2 survey vehicle is equipped with a Phoenix Scientific Pavement-Profile System (PPS) high resolution transverse profile laser capable of collecting over 1000 transverse points across an approximately 4.2m survey width. The system uses a spinning polygon to scan a laser point across 4.2m of the road surface, measuring up to 1000 transverse profiles per second, and hence delivering high resolution transverse profiles at a longitudinal spacing of 22mm and a transverse spacing of 4mm when travelling at 80km/h. The system also provides information about the amplitude of the signal returned from the pavement surface. As road markings give larger 'amplitude' responses than pavement surfaces, these amplitude values offer the potential to reduce the influence of road markings on the rut measurement. We therefore investigated the use of such measurements in the improvement of the measurement of rutting.

Although the PPS system provides much more detailed information than fixed laser systems we found that spikes (both positive and negative) can occur intermittently in the high resolution transverse profiles. Such spikes have been observed for other systems [5] and are thought to be due to very high amplitude responses or sudden amplitude changes across the pavement surface. If not removed, the spikes will have an adverse effect on the measurement of rutting. A simple algorithm was developed to remove individual spikes from each high resolution transverse profile using a "sample and hold" method, where the value of the transverse profile adjacent to the spike was used to replace the spike data. Due to the magnitude of the spikes in relation to the general texture, this was generally successful (Figure 2). The method was unable to remove invalid values seen at the extreme edges of the profiles and therefore we removed the outer values by truncating the edges of the transverse profile.
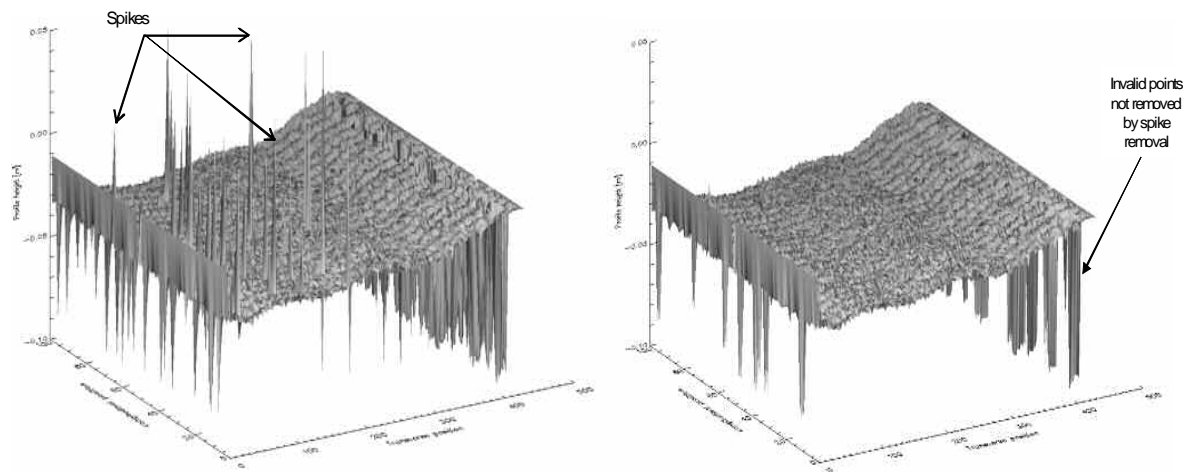
Figure 2 - A 3D representation of successive individual transverse profiles from the high resolution transverse profile system, without (left) and with (right) cleaning.

Figure 3 shows a single HARRIS2 (PPS) transverse amplitude profile collected over a road marking. The high values of amplitude generated by the marking (present in the left hand side of the lane) can be seen, as well as the variability in the amplitude values across the road marking (note the higher response at the right hand edge of the marking). The PPS measurement system deploys an Automatic Gain Control (AGC) to attenuate the amplitude response across each transverse profile to try to prevent the signal from saturating as it scans from right to left. The time required for the AGC to respond will affect the reported amplitude at a discontinuity such as observed at the edge of the marking.
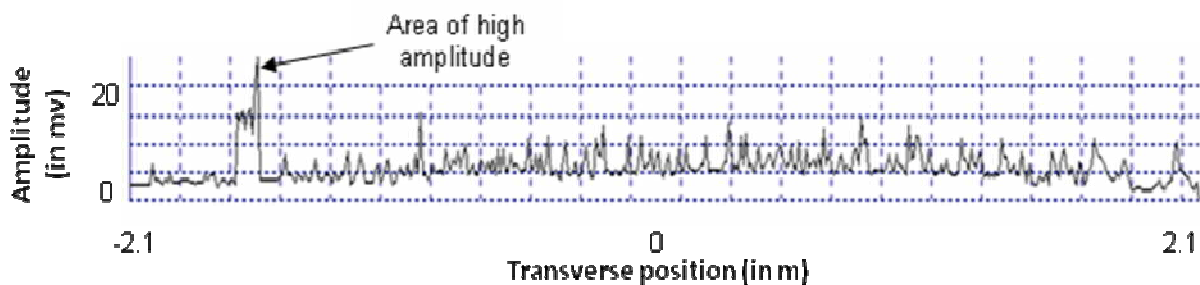

Figure 3 - Amplitude profile collected over a road marking

The behaviour of the amplitude data suggested that it should be possible to use such measurements to identify data points in the high resolution transverse profile data collected over road markings and then remove these from the rut calculation. Such a methodology was developed based on the following approach.

A high-pass filter is applied to both the high resolution transverse profile and amplitude data to remove the underlying shape of the profile data. Thresholds are then applied to both the profile and amplitude data to obtain a binary dataset of points defined as likely to be collected over a marking, and points unlikely to be collected over a marking. A cleaning (median) filter is then applied to remove spurious values from the thresholded amplitude data and this is then analysed longitudinally to join together continuous longitudinal features that are considered wide enough to be road markings. The result is a binary dataset of values showing the presence (=1) or not (=0) of road markings. However, further assessment of this data found that areas marked as not containing road markings which lay to the left of road markings on the left hand side of the road, or to the right of road markings on the right hand side of the road, had a detrimental effect on the rut

calculation. Therefore it was decided that the marking removal algorithm should also remove points from the high resolution transverse profile between the edge of the pavement and the road marking. The results are shown in Figure 4, with the road markings reported in red. Note that in this example we have shown a length that includes a directional arrow. This results in a significant part of the transverse profile being removed, resulting in a low amount of data for the application of the rut algorithm. We have therefore applied a rule in our rut calculation such that at least 2.5m width of transverse profile must remain for application of the rut algorithm. If not, no rut depth is calculated for that transverse profile.
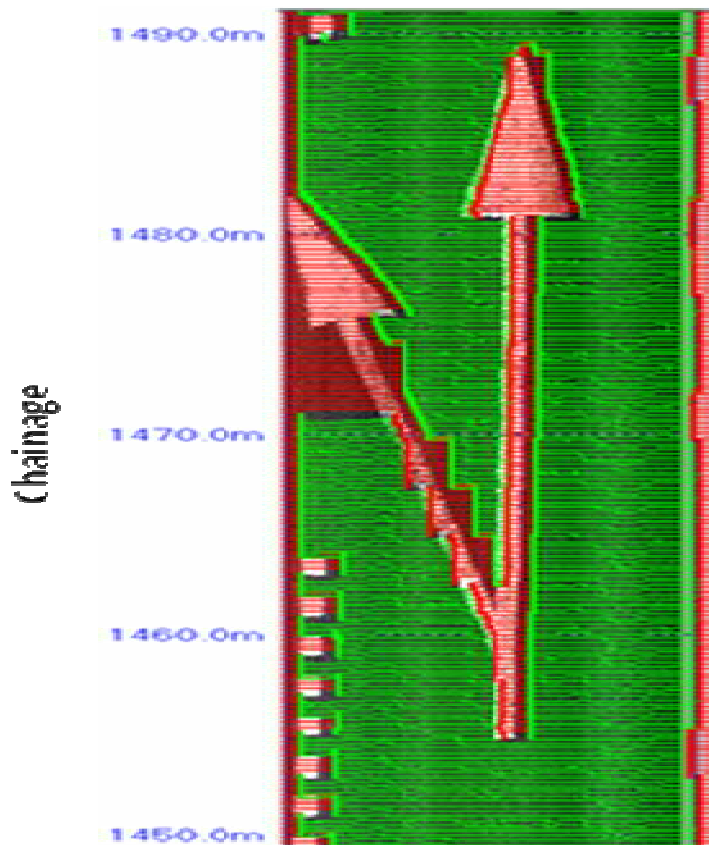

Figure 4 - Successive transverse profiles with road markings removed.

In initial testing of the application of the high resolution transverse profile and amplitude data for the removal of road markings we found that the rut measurements obtained from the resulting cleaned profiles were much higher than those collected with traditional point laser transverse profile measurement systems. We found that the rutting algorithm was affected by the 'noise' present in the high resolution transverse profile data, which we assume to have arisen from the pavement macro-texture (see section 4 below). This required that the high resolution transverse profiles be smoothed. Initially we considered the application of a low-pass filter applied transversely to individual transverse profiles, to remove short wavelengths. However, the filters could distort the profile, and also resulted in "lost" points at the edges of the transverse profile. Therefore we have taken the alternative approach to filter each transverse point longitudinally over successive transverse profiles. This method assumes that the survey vehicle is travelling in a straight line and that the road's longitudinal profile does not change significantly over short longitudinal lengths. We felt this would be valid for short lengths (less than 1m).

2.3. Network tests

Tests were carried out on lengths of the English SRN to compare the results obtained with the new approach with those obtained using the current TRACS survey. Figure 5 shows the results of two high-resolution rutting (HARRIS2) runs carried out on 6km of a Motorway (displayed using the right hand y-axis) with the TRACS data from 2005 to-2008 (year 5 to 8 of the TRACS survey) displayed on the left hand y-axis. Although each run of the TRACS survey was collected in consecutive years, it is clear that the differences between each run do not arise from gradually increasing rut depths, but due to erroneous measurements, most likely taken over road markings or the full width of the rut not being measured both due to poor driving line. No two runs from the TRACS data matched consistently on this 6km dataset.
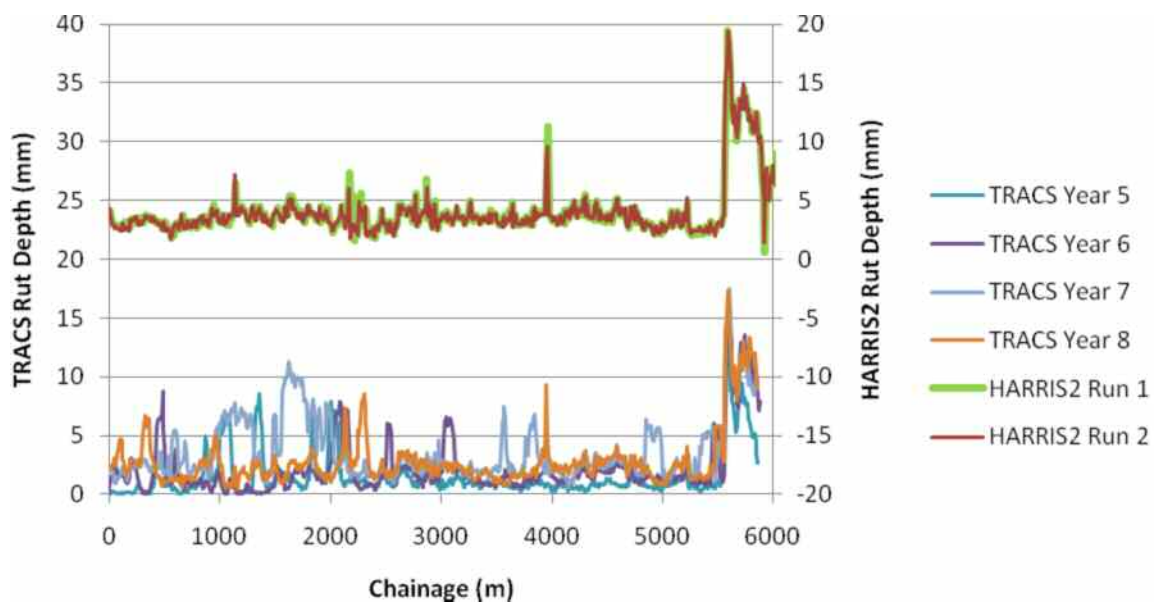

Figure 5 - Left hand rut depths from TRACS (2005-2008), and HARRIS2 on the M3

The current specification for TRACS surveys requires that rutting be reported with repeatability such that 95% of measurements are reported within 3mm of the first survey run. Figure 6 assesses the capability of the HARRIS2 and TRACS measurements of rutting in the nearside (i.e. left hand side) and offside (i.e. right hand side) of the traffic lane, with respect to this requirement. We can see that the HARRIS2 data is far more repeatable than the TRACS data. It can also be seen that the TRACS nearside measurement of rutting is less repeatable than the TRACS offside measurement of rutting. This reflects the greater influence of road markings on the nearside rutting. Typically on UK motorways the nearside of the lane has a thick continuous ribbed thermoplastic marking to assist in alerting drivers when they inadvertently drift of the road (e.g. if falling asleep). This thick marking clearly has a notable effect on the TRACS measurement of rutting.
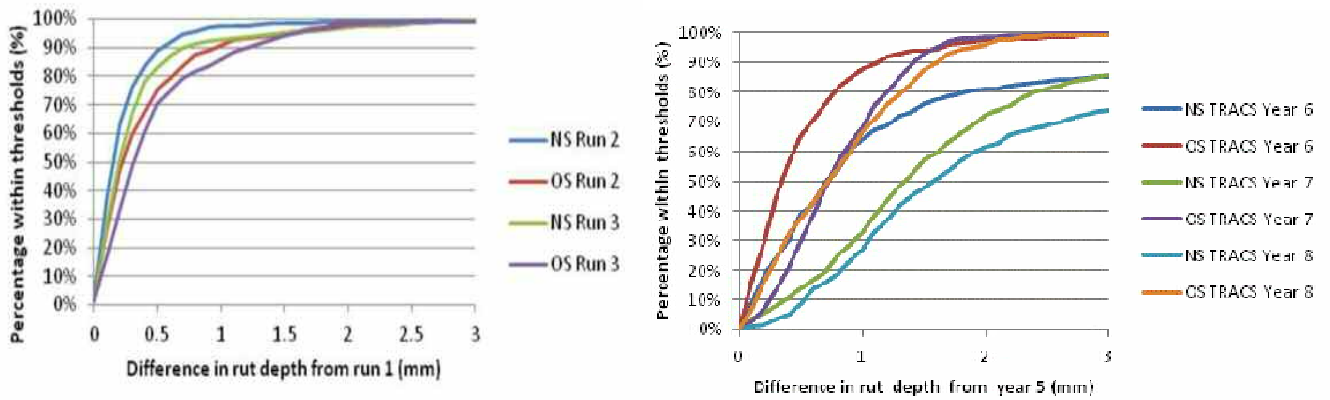
Figure 6 - Repeatability of rut depths for HARRIS2 with the new rut calculation (left) and TRACS (right)

3. THE MEASUREMENT OF SURFACE DISINTEGRATION

3.1. The problem

Surface disintegration (also called fretting and ravelling) is a major problem for those responsible for maintaining the English SRN [6]. Factors such as age, traffic and weather cause the binder to harden, leading to loss of surface aggregate (Figure 7), which leads to costly and disruptive maintenance. If untreated the defect can easily develop into localised total loss of the surface course, and can eventually lead to potholes.

Figure 7 - Example of surface disintegration on hot rolled asphalt.

A method to automatically identify surface disintegration was introduced in the first TRACS contract, based on a single line texture measurement in the wheel-path. The method was derived fromd the "Stoneway" algorithm [7], tuned for use on Hot Rolled Asphalt (HRA), where much larger stones are used than on the porous asphalt surfaces for which the Stoneway method was originally developed. The algorithm uses the texture profile data, provided every 1mm (longitudinally), to identify short "holes" in the profile, which are summed up and reported as surface disintegration. One of the limitations of the approach is that it relies on the hard coding of parameters for each surface type in order to trigger a report of surface disintegration on that surface. These parameters relate to the size of a typical piece of aggregate, and so must be adapted to the type of the pavement being surveyed. With a wide range of surfacings now being used on the network in addition to HRA, it is difficult to automate the identification of the surface type (although methods have been proposed [8]), and not feasible to either collate the appropriate parameter sets or to

develop an approach which automatically selects the correct set. In addition, the existing method uses a single laser located in the nearside wheelpath, but the occurrence of surface disintegration is not restricted to the nearside wheelpath. Therefore the TRACS surface disintegration parameter does not always provide reliable information. As a result engineers currently primarily rely on manual visual condition surveys. Unfortunately these are impractical, are not always performed in a controlled or consistent way, complicating the comparison of results from subsequent surveys.

3.2. Developing the measurement

Work has been undertaken to develop a new, network-level, surface-type-independent method for detecting surface disintegration. The development of the method has been proposed elsewhere [9], and is summarised herein.

The Highways Agency Road Research Information System 1 (HARRIS1) survey vehicle is equipped with a Greenwood Engineering transverse profile measurement system employing 25 point lasers distributed over a 3.6m measurement width. A "traditional point measurement transverse profile" is provided by the 25 point lasers, which reports the measurements as averages over 100mm lengths. In developing the methodology for the measurement of surface disintegration we have drawn on ability of the data collection system to provide raw measurements of profile in multiple longitudinal measurement lines. Hence the system was enhanced such that it also reports the raw profiles collected by the point lasers, at a longitudinal spacing of down to 3mm at 80km/h. We call this the pseudo texture profile (Figure 8).
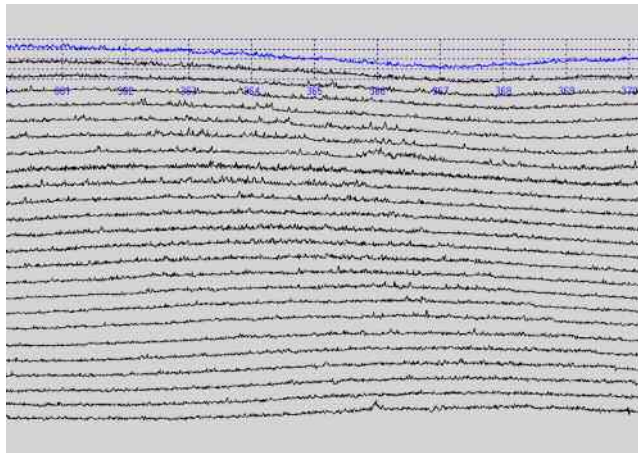

Figure 8 - Pseudo texture profiles provided by HARRIS1 over 25 longitudinal measurement lines

The pseudo-texture measurements are made across the full width of the carriageway. The laser measurements in each longitudinal line are filtered and processed to find the Root Mean Square Texture (RMST) value reported every 100mm in each longitudinal line. The pavement surface can then be considered as an array of RMST cell elements with dimensions 100mm longitudinally and 150mm transversely. Figure 9 shows these RMST measurements as a colour coded grid (moving from left to right across the figure) with each grid square having a transverse width of 150m and a longitudinal length of 100mm. The colour coding is from blue (low RMST) to red (high RMST). Note that the grid has 21 transverse grid squares. We found that the outer measurements could be affected by road edge features such as road markings (which have low texture) and therefore removed the outer 2 lines on each side of the survey width.
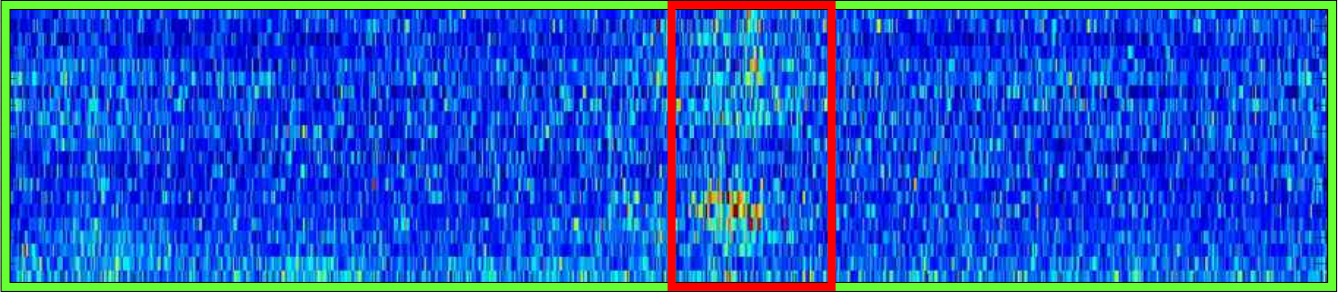
Figure 9 - Display of RMST values showing local and global areas (lighter colours indicate greater texture depths).

The underlying concept used in the new surface disintegration algorithms is the comparison of the distribution of RMST values in a small area (e.g. within the red box in Figure 9), with those from a much larger surrounding area (e.g. within the green box in Figure 9). Figure 10 shows typical histograms obtained from a short length of HRA containing surface disintegration (blue), located in a longer length that is generally sound (green). This approach will identify areas where the local texture (e.g. from a 10m length of pavement) is different from the surrounding global texture (e.g. from a 100m length, centred on the 10m length of the local area). By further investigating the data and characterising the ways in which the local and global RMST distributions differ, it is possible to determine whether the local length is showing signs of surface disintegration, or whether, for example, it is a patch, or a surface change. For example we may expect that a length of HRA containing surface disintegration to exhibit a larger number of high RMST values than a length not affected by surface disintegration.
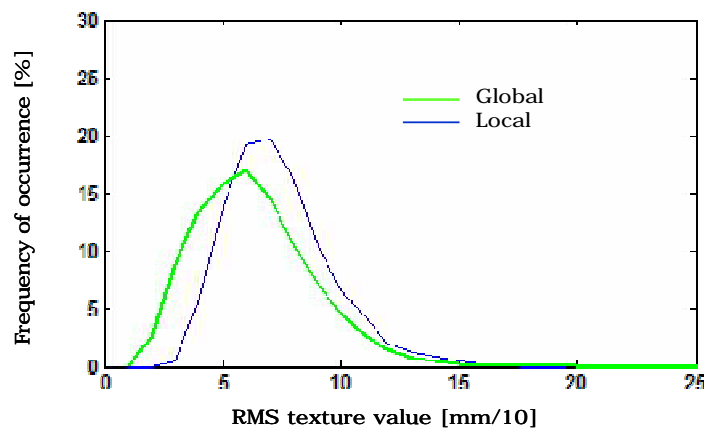

Figure 10 - Histograms corresponding to a local length (blue) containing surface disintegration, and a sound global length (green) of HRA.

The key to identifying the surface disintegration from the RMST data is to develop reliable parameters that can be used to indicate where there is a local change in texture, and where this is an indicator of surface disintegration. Unfortunately, because of the nature of pavements it is likely that false positive reports will occur as a result of "intentional" differences (e.g. patches), the influence of which must be minimised. We researched potential parameters for highlighting the presence of surface disintegration in a specific length of RMST data, and have shortlisted five types.

Local Global Correlation (LGCorr). LGCorr represents the correlation between the distribution of filtered RMST values within the current 10m subsection and the distribution of RMST values for the current 100m length (surrounding the 10m subsection). If the distribution of texture from the local 10m dataset is different from the distribution within the global 100m dataset then the two distributions are uncorrelated and a spike is seen in LGCorr . This is a primary indicator.

Local Global Difference (LGDiff). LGDiff is the value of the 90th percentile of the local distribution minus the 90th percentile value of the global distribution. This parameter can be used to identify locations where *LGCorr* has identified that there is a difference in the RMST distributions, but the local texture is actually smoother than the global texture. White lines or surface patches can often produce such behaviour.

Nearside/Middle/Offside Correlations (NMCorr, OMCorr, NOCorr). These assess transverse differences in the distribution of texture values which can indicate the presence of surface disintegration (as for LGCorr) by comparing local RMST distributions for the nearside, middle and offside of the survey width. Each distribution is compared against the other two to identify transverse differences in the distribution of texture values, which can indicate the presence of surface disintegration. *NMCorr* is nearside vs middle; *OMCorr* is offside vs middle; *NOCorr* is nearside vs offside. These three parameters are considered together. By interpreting which parameter is different to the others it is possible to infer which part of the carriageway may be deteriorated.

Surface Consistency (SCons). SCons shows the consistency of the surface texture values within the whole global 100m length. This is calculated by correlating the distribution of the texture values in the first 50m and the second 50m of the dataset. If this value is low then there is a possible surface change present. *SCons* can therefore be used to remove false positives.

3.3. Testing

The development of the surface disintegration measure is not yet complete, but we have carried out an initial validation, using a number of HARRIS1 surveys carried out on a total of 270km of the SRN, spread over several sites in the north of England. These are being used to identify the potential of the approach and any improvements required. Visual inspections were carried out on the sites to provide reference data, against which the automated data could be assessed. The sites were selected following advice from the local engineers, who suggested a set of sites known to exhibit surface disintegration. Reference data was collected on the sites by visual inspectors working from either the hard shoulder or an adjacent verge or footway. The inspectors recorded the pavement condition with respect to surface disintegration. Each 5m length was assessed as "0 – no deterioration", "1 – some visible signs of deterioration", "2 – definite surface disintegration present" and "3 – serious surface disintegration present". Due to access and survey time constraints the length over which the manual reference data could be obtained was limited to about 13km, or about 5% of the total length surveyed with HARRIS1.

Figure 11 shows the variation of *LGCorr* along a length of a site where manual reference data was available. There is good general agreement with the reference, although a length of moderate disintegration is missed at about 5300m. The LGCorr parameter shows several spikes in the region between 6500m and 7000m, agreeing with the part of the site in which the reference data indicated the most severe surface disintegration. Assessment of the *SCons* parameter showed that some of these spikes arise from the presence of surface changes. There is therefore potential to "filter" such areas through appropriate use of *SCons*. Figure 12 shows *NMCorr, OMCorr* and *NOCorr*. The behaviour of these

parameters again indicates that the majority of the surface disintegration on this site lies between 6300 and 7000m. Interestingly the spike in the reference at 6700m is not reflected by these parameters, which suggests an even distribution of disintegration across the pavement. However, there are also large spikes in *NMCorr* and *OMCorr* just before 7500m where these is no corresponding spike in *NOCorr*. This suggests that that the surface texture is different in the wheelpaths to that in the middle of the carriageway.
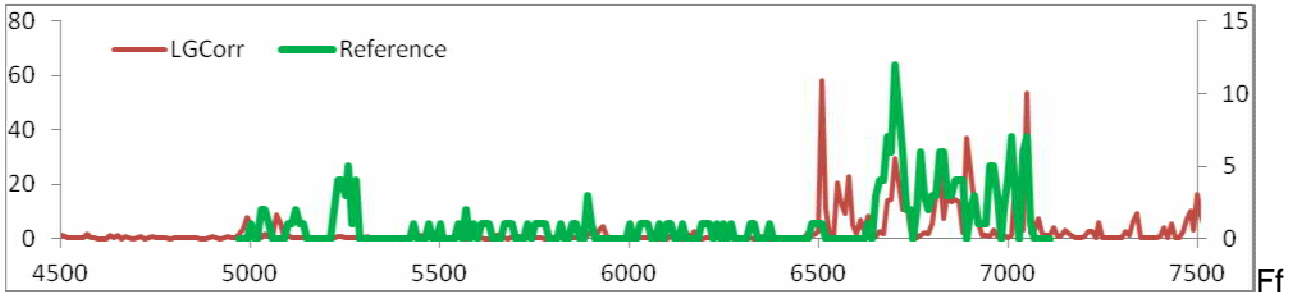

Figure 11 - Data from Site 6 NB, showing LGCorr (left hand axis), and reference data (right hand axis).
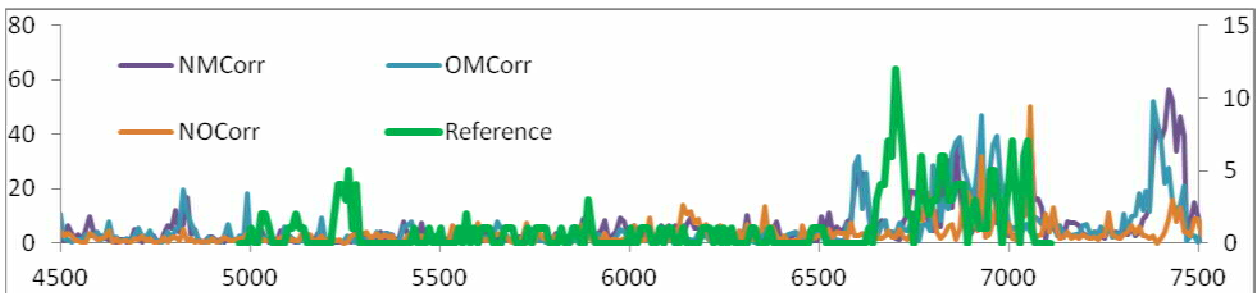

Figure 12 - Data from Site 6 NB, showing NMCorr, OMCorr and NOCorr (left hand axis), and reference data (right hand axis).

The current results suggest that the assessment of the behaviour of the RMST values along a length can be used to identify surface disintegration, and that the proposed parameters should be useful indicators of the levels of pavement surface disintegration. However, the test dataset has been quite limited and the interpretation of the parameters currently requires user input. Therefore work continues on the development of a combined measure and further network tests.

4. IMPLICATIONS FOR TRACS SURVEYS

This paper has presented the results of work carried out in England to develop the requirements for the traffic-speed condition survey of the strategic road network, called the TRACS survey. TRACS surveys include many parameters such as ride quality, geometry, surface texture and surface cracking. Although work has also been undertaken to develop requirements for all those parameters, herein we have focussed on the measurement of rutting and surface disintegration.

4.1. TRACS Rutting

The work on the measurement of rutting has shown very promising results for improving the repeatability of rut measurements. The methodology we have developed used high resolution transverse profiles and a measurement of the amplitude of the road surface to identify road markings, so that their influence can be removed from the measurement of rutting. In this work we have used the Phoenix PPS to collect the high resolution profile. The system has the advantage that the amplitude of the profile is reported at exactly the

same time, from the same measurement device. This presents the benefit that the transverse profile and amplitude data is closely linked and hence there are no alignment issues. However, alternative methods could be applied, for example using image collection and processing to obtain the road marking information, provided that the system is able to identify the road markings and relate these to the measured transverse profile.

The results of the rutting research have stimulated a change in the requirements for TRACS surveys. TRACS3 will specify the provision of a minimum of 100 transverse profile points within the transverse profile over a width of 3.8m; A road marking profile (reported as "1" or "0" – present / not present), will also be required, closely coupled to the reported transverse profile data. To ensure that the data is delivered to an acceptable standard, the TRACS contract includes accreditation testing of all raw data delivered and of the derived parameters. TRACS accreditation will include an assessment of the accuracy of the measurement of transverse profile using a set of reference profiles, and tests on the accuracy of identifying road markings, via comparison with manual analysis of downward images. As a result of the higher level of repeatability we have seen in the research in the network tests, the required repeatability for rutting will improve, to 95% of differences in reported rut depths falling within 2.5mm.

4.2. TRACS Surface disintegration

The research into the measurement of surface disintegration continues, with the development of a methodology to combine the surface disintegration parameters to obtain a single indicator of surface disintegration. However, the work to date has shown that the use of multiple line pseudo-texture data may be a powerful technique for the measurement of surface disintegration. Therefore the delivery of multiple line pseudo-texture will become part of the TRACS survey, in readiness for the delivery of a surface disintegration parameter.
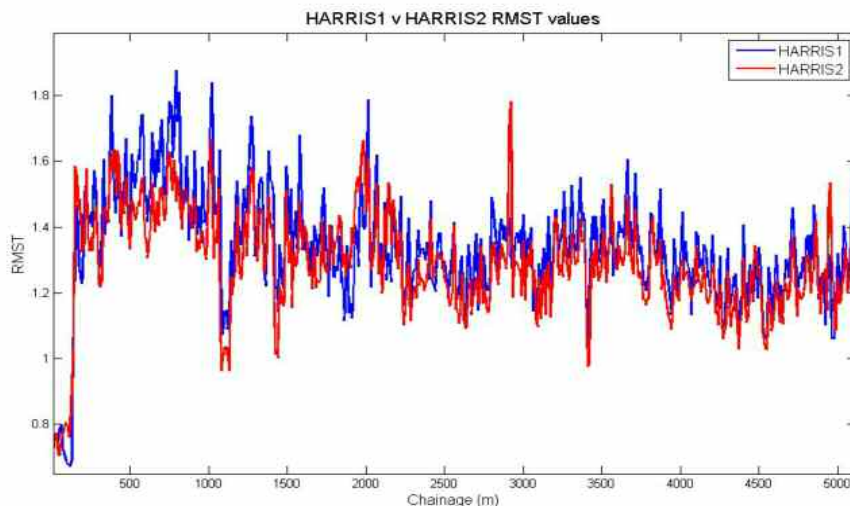

Figure 13- HARRIS1 and HARRIS 2 surveys of the same location, comparing 10m average RMST values obtained longitudinally and transversely

In the research we have used the traditional 25 point laser transverse profile system installed on HARRIS1 to develop the measure of surface disintegration. Although this has led to the use of 25 measurement lines it does not necessarily mean that this many measurement lines are required for defect detection. Therefore we have investigated the effect of reducing the number of lines on the outputs from the surface disintegration measure. By comparing data with different numbers of measurement lines we found that a

minimum of 7 lines is required. This will become the requirement in the TRACS contract. However, we have also noted that, for a TRACS contractor to provide high resolution transverse profile for the improvement of rutting, *and* multiple line pseudo texture for the measurement of surface disintegration, the contractor would have to install both a high resolution (e.g. scanning or projected line) transverse profile measurement system and at least 7 traditional point lasers. We investigated whether this practical constraint could be alleviated by making better use of the high resolution transverse profile measurements.

In section 2.2 above we noted that the transverse profile measurement provided by the PPS are subject to noise as a result of the macro-texture present in the pavement. We therefore investigated whether the content of this "noise" does represent the texture present on the surface of the pavement. This was achieved by undertaking HARRIS1 surveys on lengths of the network and obtaining RMST values every 100mm along the site for each of the point lasers. We also obtained HARRIS2 data on these sites, measuring 4.2m wide high-resolution transverse profiles every 100mm. We applied the RMST algorithm transversely to the high resolution transverse profile data to obtain RMST values transversely every 100mm across the 4.2m width. We then selected the RMST values within this data from the nearside wheelpath and averaged them over 10m lengths. These are compared with the nearside wheelpath RMST values provided by HARRIS1 in Figure 13. It can be seen that they are very closely related. On this site 65% of the differences fell within 0.09mm. Therefore there is potential for the surface disintegration data to be provided by the same equipment as used for the collection of high resolution transverse profile. This would significantly improve survey practicality. As a result of this observation the TRACS contract will specify a minimum of 7 measurement lines of RMST, but will allow this to be obtained using either transverse or longitudinal methods. Tests will be included in the acceptance tests to check that the frequency response of the offered system is suitable.

5. CONCLUSIONS

The research described in this paper has been carried out to support the development of a new specification for traffic-speed surveys of the condition of the English Strategic Road Network (SRN) – the TRACS survey. TRACS surveys use traffic-speed image collection and laser profile measurements to automatically assess cracking, rutting, texture, geometry and ride quality on the network. Although our research has reviewed all of the measurements provided by TRACS, in this paper we have focussed on the measurement of rutting and surface disintegration.

We have found that the measurement of rutting can be affected by the presence of features on the road surface such as road markings. These cause the simulated straight edge to be placed incorrectly by the rutting algorithms. We have found that the rutting measurement could be improved by increasing the resolution of the transverse profile data and by providing additional intensity information to assist in the identification of surface features. By using such data from HARRIS2, and by developing the required processing algorithms, we have shown that this does significantly improve the repeatability of the rutting measurement. As a result the specification for the new TRACS survey will require the delivery of high resolution transverse profile and intensity information.

Surface disintegration is becoming a major problem on the English SRN. However, it is not currently reported to a sufficient level of accuracy in TRACS surveys. We have found that the defect can be identified through examination of the surface texture across the full width of the pavement, and have therefore developed a method that examines the local texture

in the context of the surrounding texture data to identify locations where the defect may be present. We propose to include a requirement for the delivery of such data in the TRACS specification. We have found that it should be possible to obtain this using either traditional point lasers or high resolution scanning lasers. Work is ongoing to finalise the definition of a parameter that will report the overall intensity of the defect.

It is expected that these measurements will become routinely available on the English SRN under the new TRACS contract from the autumn of 2012.

ACKNOWLEDGEMENTS

REFERENCES

1. Ferne B W, M A Wright and J Pynn (2003). The development of HARRIS - a system for road surface condition monitoring at traffic speed. TRL Annual Research Review 2002, Crowthorne, TRL 2003.
2. Pynn J, M A Wright and R Lodge (1999). Automatic identification of cracks in road surfaces. Proceedings of 7th IEE international conference on image processing and its applications, University of Manchester
3. Mallela R. and Wang H. (2006). Harmonising automated rut depth measurements - Stage 2. Land Transport New Zealand Research Report 277.
4. Chen H. and Li Z. (2008). Comparisons of five computational methods for transverse profiles. Journal of Testing and Evaluation. Volume 36, Issue 5.
5. Walker R. and Underwood S. (2003). Development of a Real-Time Transverse Pavement Profile Measurement System. Research Report 0-1782-1.
6. Scott, P, K Radband, M Zohrabi, P Sanders, S McRobbie, and A Wright (2008). Measuring surface disintegration (ravelling or fretting) using traffic speed condition surveys. 7th International Conference on Managing Pavement Assets. Calgary.
7. van Ooijen, W, M van den Bol, and F Bouman (2004). High-speed measurement of ravelling on porous asphalt." 5th Symposium on Pavement Surface Characteristics, Roads and Airports. Toronto.
8. Wright M A, H Viner and C Christie (2004). Automatic real-time identification of road surface type from the texture profile. . 5th International Symposium on Pavement Surface Characteristics of Roads and Airfields, Toronto, Canada
9. McRobbie, S, A Wright, J Iaquinta, P Scott, C Christie, and D James (2010). Developing new methods for the automatic measurement of ravelling at traffic speed. 11th International conference on Asphalt Pavements. Nagoya, 2010.