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## Hi-SPEQ – developing the technical and quality requirements for high-speed condition surveys of road networks

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### Abstract

High speed surveys have become a key source of information to support condition assessment and management of pavement assets. These surveys can be applied network wide to obtain data on the surface condition and structural robustness of the pavement. The success of high speed surveys is demonstrated by the growth in the survey industry and the wide range of measurement equipment that has become available. However, these advances bring challenges to road administrations in determining the most appropriate survey to specify for their networks, in selecting the equipment, and in ensuring that the condition parameters delivered will be suitable to support asset management decisions. Although standards have been developed for some of the measurements provided by high speed systems, the focus tends to be highly technical, often not considering the wide ranging needs of routine network level implementation. The HiSPEQ project has the objective of developing guidance and advice to help road administrations to understand high speed road survey equipment, and to help them in specifying the survey requirements, quality regimes and processing procedures. The project has considered high speed survey data that can be used to assess pavement structural robustness. It has investigated the measurement of pavement shape, visual condition, deflection and structure. Via review of current specifications both within and outside the EU, and direct consultation with practitioners and

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administrations, the project has proposed a set of core requirements for high-speed surveys of pavement surface and structural condition. These requirements have been used to propose survey specification templates that road administrations could use when developing survey requirements for their own networks. Guidance has been developed to accompany the specifications, to assist road administrations understand the requirements and the implications of different levels of resolution and accuracy on the use of the data. The project has also proposed a set of quality assurance processes to consider when specifying condition surveys.

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## 1. Introduction

Road administrations rely on high quality condition data to understand the condition of the asset and plan and undertake maintenance programmes on their networks. High speed surveys have become a key source of this information, providing data on the shape and condition of the road surface and, in recent years, the structural robustness and the structure of the pavement itself. These high speed systems bring the advantage of network wide data collection without interfering with the traffic flow. They can provide coverage of the network which would be impractical for traditional surveys to achieve. They have lower survey costs per km than slow speed surveys and bring data that does not suffer from the subjectivity or inaccuracy of manual surveys.

High speed surveys therefore bring significant practical advantages to condition assessment, to support robust asset management. However, research (Benbow and Wright, 2012) has found a wide range of policies across countries to define the requirements for the survey equipment, the survey frequencies and the data delivered. Each country appears to adopt its own requirements, each subtly different from one another. This is perhaps unexpected, given that the equipment used to collect this data within different countries is likely to be quite similar. A factor that contributes to this situation is the lack of standardisation for many of the measurements. Where standardisation does exist (e.g. for profile) it is limited in its practicality and may be too complex for road administrations to understand.

In May 2014 the HiSPEQ project was commissioned under the CEDR 2013 Ageing Infrastructure Management programme with the objective of developing the guidance and advice required to assist road administrations to understand high speed road survey equipment, and to help them in specifying the survey requirements, quality regimes and processing procedures. The project has concentrated on the aspects of high-speed survey data collection that contribute to the assessment of pavement structural robustness, in particular pavement shape, visual condition, structure and deflection. The approach taken in HiSPEQ has been to draw on technical expertise from the project consortium, reviews of previous research and existing survey specifications, and a reference group containing stakeholders (equipment manufacturers, road administrations, researchers etc.) to propose the core requirements that should be considered by a road administration when developing a specification for high-speed condition surveys of their network. The focus of this paper is to provide a summary of the work undertaken to develop these survey specifications. To complement the survey specification templates HiSPEQ also proposed that there would be significant benefit in the development of templates that could be used to describe survey equipment. Therefore the project has also developed these templates, which can be put to equipment manufacturers for population.

## 2. The requirements and challenges of high-speed surveys

Several research projects have investigated the application of high-speed routine monitoring of road surface condition in Europe. COST 354 (La Torre et al., 2007) found that surface condition parameters (which are measured) and other parameters like the age of the pavement, and the thickness of the layers, etc. are often used in asset management systems to obtain combined indicators of condition. The HeRoad project (Benbow and Wright, 2011, 2012) found that, to assess serviceability, road operators desire an assessment of the level of comfort (covering transverse and longitudinal evenness), the level of splash and spray and the length affected by potholes or significant local defects. For durability, the assessment of the structural strength of the pavement, visual deterioration (e.g. fretting and cracking) and transverse road surface shape (structural rutting) was also considered essential (Benbow et al., 2012). The measures of condition are all obtainable at the network level from the measurement of shape, visual and structural condition provided by high speed surveys. However, the question remains over how the core requirements for the measurements provided by these surveys should be defined.

To investigate these core requirements HiSPEQ collated and reviewed the current specifications for high-speed routine monitoring across fifteen countries to identify the current measurement practice in the collection of surface condition. The specifications covered the measurement of longitudinal evenness, transverse evenness and surface defects and a total of over 0.5 million lane km of surveys are currently being undertaken against these specifications. It was considered that these examples would together provide a robust and broad background to assist the establishment of improved common survey requirements. To support this review additional information was also sourced from previous research into pavement condition assessment (Benbow & Wright, 2012; Sjögren, Benbow et al., 2012; Žnidarič, 2012; Casse & van Geem, 2012; Haider & Gasparoni, 2012, Sjögren et al., 2012). Subsequent to the review a set of core requirements were proposed and collated into documents for consultation and review by the HiSPEQ reference group. Within the following sections we present some of the observations of the consultation and review, which have been taken into account in the development of survey specification templates.

### *2.1. Core requirements – contract and common data needs*

Before developing the technical requirements for their network survey a road administration must decide on their strategy for the delivery of the survey data. Two main approaches can be distinguished for specifying high-speed condition surveys. The first is to specify the equipment that is to be used for the survey (referred to as an “equipment specification”). The second is to specify the delivered data, i.e. the output of the measurements (referred to as a “data specification”). Regardless of the approach, the road administration will need to determine the data required for the asset management process, the accuracy needed, what type of measurement is required, etc. Implicitly this suggests that the first stage of defining a specification should be to decide what data is needed, which fundamentally defines a data specification. An administration may then consider the types of equipment that might be able to meet this specification, in order to determine whether their requirements can be delivered by the industry. However, this does not suggest that the administration should then define that equipment as the required system, as this restricts the ability of an administration to achieve competition. Hence an administration should be cautious when defining particular types of equipment within a survey specification.

Because a key aim of the HiSPEQ project has been to define the core requirements for the data collected by high-speed condition surveys HiSPEQ has recommended that road administrations base their specifications on a data requirement. The type of measurement equipment used is then left completely to the contractor. However, when developing a data specification it is desirable that the requirements can be met by more than one manufacturer as it enables competition and allows for innovation. An understanding of the equipment market is therefore desirable when developing a data specification.

In addition to the technical requirements for survey data, all specifications must consider the additional information that is required from, or must be provided to, contractors in order for the survey to be delivered. HiSPEQ found a degree of inconsistency in the level of detail and extent to which this is defined in current contracts and in particular areas such as survey strategy were not well covered in current specifications. As a result of the review and a critical assessment of the findings, HiSPEQ has proposed a summary list of core common requirements for inclusion in all survey specifications. These are summarised in section 3.

### *2.2. Measurement of surface shape and visual condition*

The measurement of transverse and longitudinal evenness and surface deterioration have been reported as key data requirements from high-speed surveys (Benbow et al., 2012). HiSPEQ found that these measurements are reported in many current surveys (Table 1). However, there are large variations in the requirements for the hardware required to carry out transverse evenness measurements. The covered width, the number of points per profile and the distribution of points across the profile vary significantly, with the hardware not always meeting the specification for a class II device in the CEN standard for transverse profile (CEN 13036-6). There is hence significant variation in the current requirements across the specifications:

- The number of points per profile showed a large variety from 11 up to 200 points per profile.
- For the distribution of the points, usually an even spacing is required. Taking the number of points, covered width and spacing into account, the distance between points across the profile varies from 0.025 to 0.3 m.
- In the longitudinal direction, the most common spacing between profiles is 0.1 m, sometimes defined as the maximum spacing and sometimes as a fixed value. The largest spacing found was 1.22 m (4 ft).
- There is a wide variation in the requirements for the sensors to be used for the measurements. Specifications range from “nothing specified at all” to a certain vertical measurement accuracy up to a detailed requirements of sensors regarding frequency, resolution and accuracy.

Table 1. Overview of measurements and parameters delivered by high-speed surface condition surveys.

Specification	Transverse Profile	Rutting	Longitudinal Profile	Ride Quality	Images	Surface defects
Australia		✓		✓		
Austria		✓		✓	✓	✓
British Columbia, Canada		✓		✓		x
France		✓		✓	✓	
Germany	✓		✓		✓	✓
Ireland	✓	✓	✓	✓	✓	✓
Morocco		✓	✓		✓	x
Netherlands, national roads	✓	✓	✓	✓		
Netherlands, regional roads		✓		✓		✓
New Zealand	✓	✓		✓		
Slovenia		x		✓		x
Sweden	✓	✓	✓	✓	✓	
UK		✓		✓		✓
UK 2	✓		✓		✓	✓
USA: California		✓		✓	✓	✓
USA: Louisiana		✓		✓	✓	✓

x: Not automatic or high speed measurement

Inconsistencies in the requirements for transverse profile measurements will lead to significant inconsistencies between the levels of rutting reporting across the network or across different road administrations. If a transverse profile does not contain enough points, it will poorly cover the highest and lowest point of the profile, and a subsequent calculation of rut depth will yield distorted results (fig. 1a). HiSPEQ has also noted that inclusion of transverse profile measurements made over road markings can increase the rut depths reported on a road network (Dhillon, 2009). However, only one specification in Europe explicitly requires that road marking effects are demonstrably removed from the results.

Greater consistency has been identified between current approaches to the measurement of longitudinal evenness. Only two major system types are in use: the HRM beam and the inertial (GM type) profilometer. Whilst some countries insist on a certain method (Austria and Germany on the HRM beam, US states an inertial profiler), others specify only the output. Both methods are able to produce accurate longitudinal profiles, but both have limitations: The HRM when measuring in sharp bends (as the re-sampling of identical points on the surface cannot be guaranteed) and the inertial profiler at low speeds (due to drift of its accelerometer). However, these are not often taken into account within the specifications (e.g. as defined geometric or speed constraints). Although the longitudinal evenness is usually determined in the wheelpath, current specifications range from only one wheelpath, to both and even three wheelpaths (a third for heavy vehicles). The position of the wheelpath in the lateral direction is usually not defined and the operator has to try following the actual wheelpath on their own. There are many different definitions regarding the distance between left and right wheelpath (fig. 1b). If the transverse position of the wheel paths is not clearly specified, then a different part of the pavement may be measured, leading to different values for the profile and any reported derived parameter.

HiSPEQ has found that the evaluation of surface deterioration is commonly achieved by collecting images of the surface using a downward facing camera. The images are either evaluated by a machine vision algorithm that identifies deterioration in each image (often cracking) or, a human operator assesses each image (manual evaluation). For manual evaluation, usually a catalogue of surface defects exists against which the manual assessor compares the images to identify and classify defects. The requirements for the assessment of surface deterioration are among the least well defined in current the specifications. The reason for this may be the short history of this parameter in comparison to the other parameters. There was also quite a range of measuring system requirements defined, covering a range of survey widths, image resolutions etc.

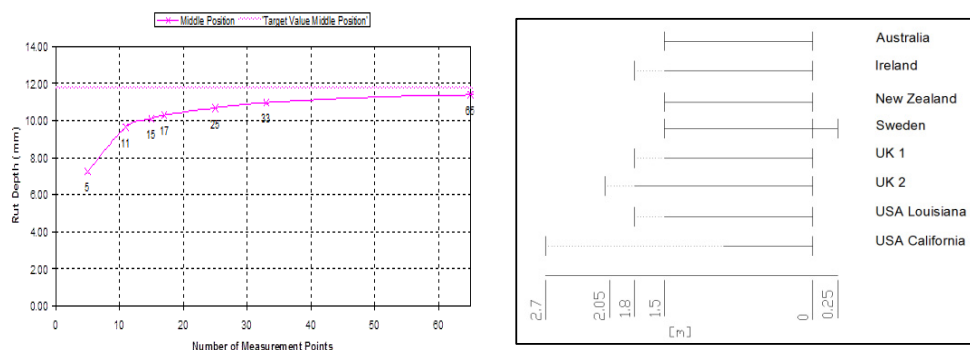


Fig. 1. (a) The influence of measurement points on rut depth (Sjogren and Lundberg, 2005) (b) variation in specified wheelpath separations.

Current requirements typically assume that a digital camera system will be employed for collection of road surface images. However, with the emergence of 3D imaging systems some administrations are beginning to consider specifying these systems. Currently there are few of these devices available, so where this requirement is being specified there is risk that it will be linked with particular commercial equipment. HiSPEQ has found variability in the requirements for image resolution, with some defining the minimum resolution per image pixel on the ground and some defining a minimum crack width to be determined from the images. The former requirement is unambiguous and easily checked. The latter effectively requires that manufacturers make claims about the likely capability of their equipment and is difficult to objectively assess. Administrations using automated crack detection have experienced many performance problems that can be associated with the quality of the images, which requires careful control on the focus and the level of illumination if consistency is to be achieved. HiSPEQ has used the outcome of the review to suggest how these should be managed within a survey specification for the measurement of visual condition.

### 2.3. Measurement of pavement structure and stiffness (deflection)

European road administrations and other stakeholders have been asked several times over the last 20 years about their needs for information on pavement structural condition. In 1997, COST Action 325 New Road Monitoring Equipment and Methods (European Commission, 1997) investigated needs and capabilities for new equipment and methods for description of pavement condition. FORMAT (European Commission, 2005) also looked at new methods for monitoring of pavement condition, and HeRoad (Benbow and Wright, 2012) examined measurement practices in Europe and interviewed stakeholders about their expectations and ideal measurements. COST 325 found that most countries use the Falling Weight Deflectometer or Lacroix deflectograph for bearing capacity measurements, which operate statically or at low speed to measure the amount that a pavement flexes under load, but the inquiry identified a strong desire for high-speed devices. HeRoad concluded that European countries see pavement durability as important and would desire a traffic-speed measurement device. FORMAT described two devices dedicated to traffic-speed testing of structural pavement condition: the Swedish Road Deflection Tester (RDT) and the Danish High Speed Deflectograph (HSD) (now renamed the Traffic Speed Deflectometer – TSD). Since then the TSD has been implemented in several countries in Europe and elsewhere.

To reliably assess the deflection data provided by the above devices requires information on the structure of the pavement, consisting of material type and material thickness as an under or over estimation of the thickness of the bound pavement layers can have a gross effect on the calculation of stiffness. Hence, to draw good value from the data, an administration undertaking network level structural condition survey would also have robust knowledge of the pavement structure. Physical in-situ tests, such as coring, are reliable ways of investigating the pavement structure. However, this is impractical for network level evaluation. As an alternative Ground Penetrating Radar (GPR) can survey at traffic speed to provide layer thickness information. HeRoad (2012) showed that 12 European agencies use GPR, but only Finland was carrying out GPR surveys at Network Level. This suggests that GPR is

regarded as a niche or specialist test. However, studies such as Mara Nord (2010) and TRIMM (2014) have demonstrated that the technique is capable of resolving different types of pavement structures and there is a range of commercially available equipment available which produce broadly similar results

Together, TSD and GPR provide the potential for delivering routine network level structural condition assessments. HiSPEQ has focused on these to consider the core requirements for specifying network level surveys.



Fig. 2. (a) The TSD (b) schematic of laser layout (South African TSD).

The TSD (Figure 2) is developed, manufactured and sold by Greenwood Engineering A/S in Denmark. It measures the vertical velocity of the deflected pavement surface based on advanced Doppler laser technique using 3 to 10 laser vibrometers. The measuring equipment is placed in a tractor-semi trailer combination, with the measurement instrumentation in the trailer and the operator in the driver's cabin. Loading is provided by the rear axle of the trailer. While the FWD simulates a moving wheel load, the TSD actually applies a moving wheel load to the pavement. Measurements are conducted continuously at driving speeds between 40 and 80 km/h. Six TSDs have been delivered in the system's "second generation" format to Italy, Poland, South Africa, China, USA and Australia, in addition to the two first generation devices delivered to Denmark and the UK. The development of the TSD from first to second generation has aimed to remove many of the limitations observed with the first generation devices. Improved hardware and software is less susceptible to environmental and load related influences and hence the second generation system has improved stability and reliability. The layout of the measuring system also allows for a much improved calibration procedure. However, attention must be paid to the requirements when specifying a TSD survey, as the equipment and how it is used will affect the detail and accuracy of the data. For example, using the second generation device's 7+ sensor measuring system (vs. four for the first generation) allows more flexibility in the data analysis, including analysis that can be compared to the FWD technique. Consequently administrations intending to implement a TSD should conduct these surveys with a device with at least 7 Doppler sensors as this would allow determination of a deflection basin and hence ease the determination of pavement parameters like layer stiffness (elastic layer moduli). Experience with especially the 1st generation devices has also shown that the system can be affected by the calibration, survey speed, pavement temperature, road condition (wet/dry), test load, sample rate etc. Therefore HiSPEQ has used the outcome of the review to suggest how these should be managed within a well-defined survey specification for measurement of pavement deflection (section 3).

GPR works by emitting low powered electromagnetic (EM) waves into the pavement which are reflected at material boundaries within the pavement. The ratio of how much EM energy is reflected from a material boundary and how much continues to propagate into deeper layers of the pavement is a function of the contrast of the electrical properties of the two materials present at the boundary; materials of similar electrical properties such as an asphalt wearing course to an asphalt base course produce weak reflections, whereas asphalt to concrete produces a stronger reflection. GPR data are generally displayed as 'radargrams' showing the time taken for the EM wave to travel down to a material boundary and then back to the road surface. In processing the two way travel time is converted into depth. GPR systems comprise of two main components: control system and antenna. The control system typically generates the EM pulse which is radiated by the antenna. The operator determines the time range (depth of investigation) and the density of scans per unit length of the pavement (trace increment). GPR antennae emit a broad spectrum of low power EM energy. Generally, low frequency antennae have good depth penetration and relatively poor lateral/vertical resolution whereas higher frequency antennae have relatively poor depth penetration and good lateral/vertical resolution (Table 2).



Table 2. Typical GPR Antenna frequencies.

Frequency	Depth penetration	Example application
<b>200–300 MHz</b>	1.5–3 m	Investigation of the formation materials
<b>300–600 MHz</b>	1–1.5 m	Investigation of sub-base material
<b>600–1000 MHz</b>	0.5–1 m	Investigation of the base course
<b>1000–2000 MHz</b>	0–0.5 m	Investigation of the wearing course
<b>2000 MHz plus</b>	0–0.3 m	Investigation of the surface course

The capability and selection of the GPR system components is therefore fundamental to the delivery of acceptable construction (layer thickness) information. The road administration also needs to be aware that, despite the best efforts of the survey contractor and selection of the most appropriate antenna, it is highly likely that it will not always be possible to resolve pavement layers to the full specified depth and it may also not be possible to resolve all layers within the pavement. This is because not all ground conditions are amenable to the transmission of EM waves. Ground containing relatively high moisture contents and/or clay tend to absorb EM energy meaning that there is no EM energy to be reflected back to the GPR antenna and therefore no resultant reflection in the radargram. Similarly pavement layers with high concentrations of metallic minerals (ash, slag, heavily metamorphosed roadstones) tend to reflect much of the EM energy meaning it is not possible to resolve the layers below. HiSPEQ has used the outcome of its review of GPR systems and survey methodologies to suggest how the risks to the delivery of robust layer thickness data should be managed within a well-defined survey specification for the measurement of pavement structure (section 3).

#### 2.4. Ensuring survey quality

Because of the complexity of collecting and delivering the survey data there can be problems obtaining accurate, high quality and consistent measurements across different survey devices and different networks. Many road administrations are now beginning to understand the importance of ensuring the quality of their data through the application of challenging accreditation regimes, including those implemented in the UK, Australia, Sweden, Austria, Germany (for surface condition measurements), and in the UK (for TSD surveys of structural condition). These regimes check that the equipment is fully compliant with the expectations of the survey commissioner, usually in terms of the data that is to be delivered. However, although all of the specifications containing accreditation testing required the data to be reported with locational referencing information (such as GPS), only ¾ of the specifications actually test the location data. As high quality measurement data has little value if it cannot be referenced back to the position on the road network on which it was measured there is a need for any accreditation test regime to include tests of the location data in addition to the measured data or parameters.

HiSPEQ identified similar inconsistencies in the assessment of the measured shape (longitudinal and transverse profile) data, with less than half testing all the types of raw data delivered. For the five specifications that required delivery of images (for surface deterioration analysis), only UK surveys tested the quality of the images. Given the strong influence of image quality on the results of these surveys (Figure 3), this is surprising. It may be because such tests are difficult to devise, carry out and assess. However, the majority of specifications requiring delivery of a surface deterioration parameter included accreditation tests for this. Further subtle differences were seen in the detail of the testing. For example the speed of the vehicle can affect the measurements obtained, particularly for longitudinal profile and first generation TSD data (Figure 3). Less than half of current longitudinal profile surveys are explicitly tested for the accuracy of data collected at different speeds.

In terms of how these systems are tested, HiSPEQ has found that it is common practice to compare the measurements with reference data. However, it is less common to check repeatability (we found 60% of transverse profile tests, 70% of rutting tests, 75% of ride quality tests and 40% of surface deterioration tests assessed repeatability). The assessment of consistency, i.e. how consistent all devices (carrying out the survey contract) are with each other, was limited to Sweden only. Clearly if all survey devices are subject to accuracy testing within accreditation tests they are likely to be consistent. By testing fleet consistency, more stringent requirements can be

applied to the consistency of the data delivered by a fleet. However, fleet consistency tests may only be practical where there are a large number of devices available (e.g. for very large surveys).

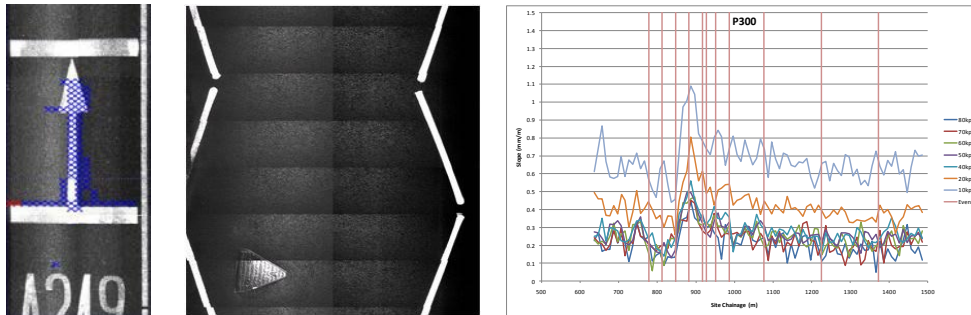


Fig. 3. (a) Issues with quality and interpretation of images collected at high speed (b) Effect of survey speed on TSD slope measurements.

Once surveys have commenced an administration must consider the need for ongoing QA tests. For large and long lasting contracts regular reaccreditation and QA testing is important to ensure data quality throughout the duration of the contract. However, only two thirds of the specifications described a significant QA regime, and these were not consistent. Only a third check the ongoing location referencing information, less than half employ a robust check on the road shape data. Interestingly, two thirds of those requesting the delivery of surface defect (e.g. cracking) data from images require QA tests on this data, perhaps reflecting existing experience on the challenges of obtaining consistency in this measurement. HiSPEQ also found that current specifications are not clear on how the QA tests should be carried out (i.e. on a test track, or on the road network), or what lengths should be surveyed. Therefore, the expertise of the project group and colleagues has been required to develop a suitable approach to suggest to road administrations how they might specify QA regimes.

### 3. HiSPEQ Specification templates

The above sections have discussed the observations and experience of HiSPEQ in gathering knowledge and identifying good practice in survey regimes both within and outside Europe, although within the limitations of this paper we have not been able to present this in any detail. The project has built on this information, and the peer review of the findings to develop a set of templates defining each area of collection of pavement condition data. The project has adopted a “volume” based approach in which we have identified the common core items that a road administration should always include within any survey specification, which HiSPEQ proposes should be included in the first “volume” of the survey specification. We have called this the *HiSPEQ1: Specification for Pavement Condition Measurement*, and recommend that it contains:

- The definition of the network and the survey strategy, to include: The location and length of each road section to be surveyed, the direction of survey, number of lanes to be surveyed, time frame and frequency of the survey etc.
- The location referencing method. We recommend geographic coordinates where a geographically defined network is available as this can result in improved locational accuracy. To achieve high locational accuracy it is necessary to stipulate accuracy requirements to the level of a few metres or better. This is achievable in practice.
- The environmental conditions for conducting the survey, covering road condition (dry road surface for laser devices, clean road surface), survey speed (e.g. minimum speed for measuring longitudinal profile with inertial profilers), pavement temperature (for TSD data) etc.
- The data formats. HiSPEQ found that although defined data formats are already in use for (national) road administrations, there is no internationally recognized format.
- Coverage requirements. This is the percentage of the surveyed network for which valid data will be delivered. It allows the specification to recognise that no survey equipment can measure and deliver valid data all the time and some survey equipment can deliver more valid data than others



When specifying a survey an administration would always include the areas recommended in the first volume. The remaining volumes may then be included if the administration requires the inclusion of that data within the survey (e.g. ride quality). A set of survey data specification templates have been developed for each data type, each containing sections the administration should include to ensure all core requirements are covered. These include:

- The core decision on how the data is to be delivered (processed/raw data). Requiring the delivery of raw data provides the benefit that derived values (rutting, ride quality) can be calculated consistently over all contractors. However, it does require the administration to develop and implement the processing tools.
- The raw data to be delivered, including the technical requirements (resolution, accuracy, frequency etc)
- The parameters that will be delivered, for example rutting, IRI, TSD deflection slope
- Accreditation requirements, including suggested tests, reference devices or methods to provide reference data, the frequency with which the test will need to be repeated, suggestions for who will be responsible for checking the data and requirements for the accuracy of any parameters delivered or calculated from delivered data.
- Quality assurance requirements to be employed by the survey contractor on the data, including a description of the tests (calibration, surveys of road network sites, number of repeat surveys required, whether accuracy and fleet consistency will be tested, in addition to system consistency), a description of the road network sites (i.e. length, characteristics etc.) to be surveyed and the frequency with which they should be surveyed, suggestions for who would be responsible for assessing and checking the data, how the data would be assessed etc.

The HiSPEQ survey data specification templates have been labelled as follows:

- HiSPEQ2: *Specification for Referencing Data to the Network*
- HiSPEQ3: *Specification for Pavement Transverse Evenness Measurement*
- HiSPEQ4: *Specification for Pavement Longitudinal Evenness Measurement*
- HiSPEQ5: *Specification for Pavement Surface Deterioration Measurement*
- HiSPEQ6: *Specification for Pavement Structure Measurement*
- HiSPEQ7: *Specification for Pavement Traffic Speed Deflection Surveys*

HiSPEQ has developed both the specification templates and a guidance document for road administrations to help them understand the requirements ([www.hispeq.com](http://www.hispeq.com)). It is intended that each section in the guidance can be used by road administrations to assist them in completing the requirements in the corresponding specification document. The guidance includes suggested specific requirements that a road administration may wish to use within their specifications (figure 4). These have been obtained from examples of common and good practice observed in Europe and elsewhere. The suggestions have also been derived from knowledge of existing equipment availability and capability, to assist administrations in ensuring that the requirements they define are achievable in practice. However, administrations will inevitably have their own requirements as a result of specific concerns on their networks, and therefore the ultimate selection of a certain requirement remains the decision of the administration.

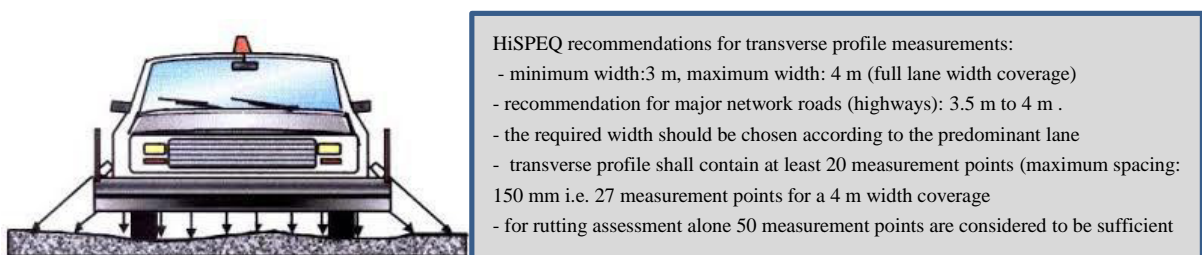


Fig. 4. Example HiSPEQ recommendations for specifying transverse profile measurement.

#### 4. Other deliverables of HiSPEQ: equipment descriptions

Whilst the focus of this paper has been to provide a summary of HiSPEQ's development of templates and guidance to assist in specifying network condition surveys, the project has also considered how the current approach to describing commercial survey equipment could be improved to assist administrations in their understanding of equipment. A further set of templates has thus been developed to describe equipment ([www.hispeq.com](http://www.hispeq.com)).. Road

administrations could use the equipment templates as an efficient tool for commissioning to obtain information about the proposed equipment that directly relates the equipment's capabilities to the specific survey requirements.

## 5. Conclusions

HiSPEQ has proposed a set of core requirements for high-speed surveys of pavement surface and structural condition, covering the data to be collected and the condition parameters derived from the collected data to evaluate pavement structural condition. These requirements have been used to develop survey specification templates for road administrations developing survey requirements for their own networks. Guidance has been developed to accompany the templates, to assist road administrations understand the technical requirements and the implications of different levels of resolution and accuracy on the use of the data. The project has also proposed a set of quality assurance processes to consider when specifying condition surveys.

There is a wide range of policies across countries to define the requirements for the survey equipment, the survey frequencies and the data delivered. The HiSPEQ guidance and template specifications could reduce this information asymmetry between road administrations, authorities and companies. It will contribute to improving the value of these surveys and the efficiency of the commissioning process, whilst also assisting in the delivery of higher quality survey data that will support more robust decision making.

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