

Machine Road Condition Survey Specification for Regional and Local Roads

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1 Introduction

General

The Road Management Office, as part of a Local Authority shared service, assists and supports local authorities procure machine surveys to collect pavement condition, skidding resistance data, and digital imagery on selected sections of the non-national roads network under a revised pavement survey regime. Surveys to collect pavement condition data in Ireland have been carried out using an ARAN (Automatic Road Analyser) since 1995 and Road Survey Profiler (RSP) since 2007. Skid resistance surveys have been carried out using the SCRIM (Sideways Coefficient Routine Investigating Machine). Future contracts are open to any vehicle system which can collect the required data in accordance with the specifications while travelling at the prevailing traffic speeds. It will be a requirement that IRI, Texture, and any other pavement condition data as required under a Contract and derived from any new measuring system is satisfactorily correlated and compatible with the existing data and imagery to ensure continuity of condition criteria and performance monitoring of the roads network.

These parameters properly analysed are used to determine the required maintenance, overlay, and rehabilitation needs for the pavement including expected time of such interventions and the effect such interventions have on pavement performance life.

Scope

This specification shall be used for the collection of road pavement data using machine equipment. It applies to regional and local roads in Ireland. It is provided to Local Authorities procuring contracts for machine surveys as it details the requirements for Contractors responsible for collecting road condition data using machine techniques. Due to the variable nature of roadway characteristics of rural single lane roads it is generally accepted that surveys do not have to be conducted on local secondary and local tertiary roads less than 4.0m in width.

Implementation

This specification shall be used forthwith on all machine road condition surveys conducted on regional and local roads in Ireland in accordance with data collection protocols detailed in the DTTAS Pavement Survey Standard for Regional and Local Roads.

2 Pavement Survey Specification

2.1. General Requirements

Machine surveys are generally conducted on Regional & local Roads in accordance with the '*Pavement Survey Standard for Regional and Local Roads*'. The contracting authority specifies the road network over which surveys are required. The contractor carries out the surveys in accordance with this specification. The contracting Authority own the results of the surveys, the survey data and results of any data processing carried out by the contractor. The Contracting Authority requires the survey data to be uploaded to the MapRoad Pavement Management System.

2.2. Surveys

The Contracting Authority provides the contractor with a list of sections of the road network to be surveyed. The contracting authority provides the following information for each section;

- Road number and/ or name
- The Segment code
- A description of the start and end points
- National grid co-ordinates for the start and end points (ITM)
- Section or route length
- TAB file or Shapefile of the road network
- Any additional information the contractor may require for the surveys

The surveys may only be carried out using survey equipment which has passed a correlation test and has a currently valid accreditation certificate.

The Contractor shall be aware that the non-national road network consists of single and dual carriageway roads. Single carriageway roads make up most of the road network. There are a wide variety of single carriageway widths ranging from 2.5m (rural tertiary) to 15m (wide single carriageway). Machine surveys are generally not required for roads less than 4.0m wide. For a single carriageway road, one lane in the preferred direction is surveyed. Where the carriageways are physically separated i.e. for Dual Carriageways, the lane subjected to the heaviest loading, generally the left or slow lane is surveyed. The surveys shall be carried out in the direction of normal traffic flow.

The surveys shall be carried out in the same direction as previous surveys, the Contractor shall contact the contracting authority to seek clarification if required. It is a requirement of the Contract that measurements shall normally be taken over the maximum legal width of the vehicle. Vehicle operators shall ensure that the lateral position of the vehicle is such that the longitudinal measurements are centred in the middle of the wheel path.

Surveys are normally carried out over the complete length of a route. However, where works surveys are required, survey lengths may be shorter but shall be a minimum of 1km. However, the start or end locations of SCRIM surveys in urban areas will be determined where the correct operating

speed can be achieved. Changes to the current testing practice may be advised over the period of the contract. It is a requirement of the Contract that the SCRIM measurement shall be taken in the Left-Hand side wheel path in the direction of travel, however the Contracting Authority may on occasion require measurements in both wheel paths. SCRIM surveys shall be conducted on regional roads only, in addition, SCRIM surveys shall not be carried out on sections of road where a treatment of surface dressing has been applied within the previous 6 months.

2.3. Location Referencing

The Contractor shall reference all data collected to the MapRoad PMS Network Referencing System, to be provided by the Contracting Authority in electronic shape file format in advance of the commencement of any full or part network or works survey.

The referencing shall be in accordance with IPAG Pavement Asset Management Guidance Section 2 Network Referencing v1.0 Dec. '14.

The Contractor shall reference all data collected during the survey uniquely in relation to distance travelled within Section and Lane. The Contractor shall ensure the accuracy of the Location Referencing shall be unaffected by operating speed or by road geometry.

All survey vehicles shall be equipped with an accurate distance-measuring instrument (DMI) which is calibrated and maintained throughout the contract so that all measured data is referenced to a longitudinal position on the road to an accuracy of 0.1% or better from the start location of that survey. This accuracy shall be independent of vehicle speed and road geometry.

If a section start point requires identification manually, the Contractor shall locate the section start point accurate to within $\pm 5.0\text{m}$.

If a Section start point is reported using Longitude/Latitude Co-ordinates provided by the Contracting Authority (and the Contracting Authority and the Contractor have agreed that these are to be used for location referencing), the Contractor shall locate the Section start points accurate to within $\pm 5.0\text{m}$.

For elapsed distances within a Section of up to 1,000m from the recorded start of a Section, the Contractor shall reference the longitudinal position of all data measured within the Section accurate to within $\pm 1.0\text{m}$ from the recorded start of the Section.

For elapsed distances within a Section greater than 1,000m from the recorded start of a Section, the Contractor shall reference the longitudinal position of all data measured within the Section accurate to within $\pm 0.1\%$ from the recorded start of the Section.

2.4. GPS Co-ordinates

Survey vehicles shall be equipped with GPS technology so that all recorded data is referenced to 3-dimensional spatial co-ordinates. The GPS data shall be differentially corrected in order to improve accuracy. The GPS equipment shall be integrated with an inertial measurement system to allow for

Longitude/Latitude co-ordinates to be derived from the GPS data irrespective of the quality of the satellite coverage. The minimum requirements for GPS data is:

- Longitude/Latitude co-ordinates derived from the GPS are provided over no less than 950 meters in any 1 km length.
- Longitude/Latitude co-ordinates to be provided to a coverage requirement of at least 99% of the total length surveyed.
- 95% of the measured positions in any 1 km length shall be within a horizontal error of 1 metre or better from the true position.
- 95% of the measured positions in any 1 km length shall be within a vertical error of 2 metres or better from the true position.
- The horizontal error between the measured and the true position shall never to exceed 10metres.
- The vertical (altitude) error between the measured and true position shall never to exceed 20 metres.

The Contractor shall measure the 3-Dimensional Spatial Co-ordinates of the position of the equipment during the survey at points separated by no more than 5.0 m of distance travelled.

The Contractor shall report the 3-Dimensional Spatial Co-ordinates as ITM (Irish Transverse Mercator) Co-ordinates and Altitude, where the Altitude measurement describes the Altitude of the surface of the road being surveyed.

The Contractor shall report the availability of the signal from which the 3-Dimensional Spatial Co-ordinates have been derived with each reported ITM Coordinate.

Where the equipment is unable to meet the accuracy requirements the Contractor shall label the 3-Dimensional Spatial Co-ordinate data as invalid.

The Contractor shall monitor the coverage of Longitude/Latitude Co-ordinates achieved in the surveys, including altitude. Invalid measurements of Longitude/Latitude Co-ordinates will result in reduced survey coverage where coverage is defined as the total length within any predetermined length over which valid measurements of longitudinal profile variance are provided. The contractor reports any survey lengths greater than 1km over which 95% by length of valid co-ordinate measurements could not be delivered.

2.5. Pavement Data Collection

The following pavement parameters are included in this specification;

- Skid Resistance
 - SCRM
 - Texture Depth/Macro Texture
- Transverse Profile
 - Rut Depth
- Ride Quality - Longitudinal Profile
 - International Roughness Index (IRI)

- Enhanced Longitudinal Profile Variance
 - LPV3
 - LPV10
- Digital Video
- Geometry
 - Crossfall, Gradient & Radius of Curvature
 - Rise and Fall (absolute value per km)
 - Road Width
- Cracking
- Visual condition rating - Pavement Surface Condition Index (PSCI)
- Falling Weight Deflectometer (FWD)
- Surface Material Type

2.6. SCRIM

Purpose

Skid resistance shall be measured using a Sideway Force Coefficient Routine Investigation Machine (SCRIM). SCRIM measures the frictional resistance generated between the road surface and a tyre under wet conditions. The micro-texture on the surface of the aggregate particles and also provided by the fines in the mixture is the main contributor to skid resistance at low speeds and the main property measured in SCRIM tests. In combination with the specification of surfacing materials the skid resistance of roads is monitored to identify areas where micro texture is lost and treatment might, therefore, be needed to improve skid resistance.

Measurement

The testing speed for SCRIM surveys shall be 50kph. The Sideways Force Coefficient (SFC) shall be measured. SFC is a ratio of the sideways-force to the vertical load on the test wheel i.e. the frictional resistance generated between the road surface and a tyre under wet conditions. Data is typically collected every 25mm to 125mm and averaged over 1m intervals.

Recording & Averaging of Data

SFC shall be used to calculate the characteristic SCRIM coefficient (CSC). CSC is the measured SFC factored by the Index of SCRIM and corrected for speed and seasonal effects where applicable. As SCRIM is a coefficient, there is no unit of measurement.

The testing speed on single carriageways where the radius of curvature is 150m or less shall be measured at a testing speed of 30km/hr. The locations on the network that this applies to are to be identified by the Contractor.

The equipment shall provide the following Survey Data for each sub-section length:

- SCRIM Reading
- Average speed (km/h)
- Elapsed distance (m)
- Dimensional Spatial Co-ordinates

- The sub-section length shall be 10m
- Forward view High Definition Video

After collection, survey data shall be validated and subject to processing. SCRIM Survey data shall be processed and imported as CSC for all sections on the Road Network.

Survey results shall be processed at 10m intervals and geo-referenced to national grid co-ordinates in accordance with 2.4 above. These results shall be provided to the Contracting Authority in excel (.xls) format. Furthermore, results at 10m intervals shall be averaged for longer lengths, typically 100m subsections and uploaded to MapRoad PMS.

For standardised tests, measurements shall be made during the testing season, defined as the summer period 1 May – 30 September.

The SCRIM machine shall conform to the general characteristics of the SCRIM designed by the Transport Research Laboratory. The test equipment, calibration, operation and testing procedures shall be as outlined in TII AM-PAV-06045 “Management of Skid Resistance”.

The SCRIM machine shall also be capable of measuring the SFC in both wheel paths simultaneously, as measurements in both wheels paths may be requested by the Contracting Authority.

Quality Assurance

In advance of SCRIM surveys commencing, the Contractor shall provide a certificate from the U.K. - Highways Agency confirming that the SCRIM machine(s) to be used in the surveys has performed within the set limits of the SCRIM Correlation Trial for that year. The SCRIM machine(s) identified in the certificate shall be used for all surveys in that year.

Prior to the start of the any survey, test tyres conforming to the specification in BS 7941-1 shall be tested on the control sites and only tyres which fall within an agreed range are to be used in the surveys. The results of this test shall be forwarded to the Contracting Authority for approval prior to starting any survey.

Control sites covering a range of SFC values shall be identified in consultation with the Contracting Authority. The purpose of these sites is to ensure consistency of results over the testing period. The selected sites shall conform to the general requirements in BS 7941-1. The control sites shall be surveyed immediately following the SCRIM correlation trials to establish baseline data and to evaluate the repeatability of the equipment. These sites shall be at least twice weekly in the case of a continuous survey programme. The control site data shall be checked to ensure that the machine is measuring SFC accurately and that the DMI and GPS are performing within specifications. The control site data and a report summarising the results shall be forwarded to the Contracting Authority within 7 days and prior to commencement of any survey. The Contractor is responsible for ensuring that control site data verifies that SCRIM systems are operating within specifications. Reports where the control site data covering that cycle is missing or suspect shall not be accepted by the Contracting Authority .

Other requirements

The Contractor shall make arrangements for obtaining water for all surveying machines and shall pay all charges associated herewith.

2.7. Surface Texture Depth (Macro Texture)

Purpose

Texture Depth or macro-texture is a measure of the coarse surface texture. Macro-texture provides the majority of friction at higher speeds. In addition to providing friction benefits, good macro-texture provides drainage channels for water expulsion between the tyre and the pavement to reduce splash and spray as well as headlight glare.

Measurement

The macro texture shall be measured continuously in both right and left wheel path using a laser system to the specification necessary to enable the Mean Profile Depth (MPD) to be calculated at 1.0mm intervals in accordance with IS EN ISO 13473-1:2004.

Recording & Averaging of Data

The texture profile shall be used to calculate MPD values over 10m lengths and geo-referenced to national grid co-ordinates in accordance with 2.3 & 2.4 above. These results shall be provided to the Contracting Authority in excel (.xls) format. Furthermore, results at 10m intervals shall be averaged for longer lengths, typically 100m subsections and uploaded to MapRoad PMS. Units are expressed in 1/100mm.

The accuracy of the measured texture profile shall be unaffected by the texture or profile of the pavement over the full range of profiles and textures that can reasonably be expected to be encountered on the road network.

The Contractor shall label any texture depth data that fail to meet the specified requirements as invalid. The Contractor shall check the Survey Data for any conditions that may result in invalid measurements of texture profile. These conditions may include but would not be limited to drop-outs (missing data points), and failures in any of the measurement devices. The Contractor shall monitor the coverage achieved in the surveys of texture profile. Invalid measurements of texture profile (and hence MPD) will result in reduced survey coverage, where coverage is defined as the total length within any predetermined length over which valid measurements of texture profile (and/or MPD) are provided.

Quality Assurance

The surveys may only be carried out using survey equipment which has a valid accreditation certificate. Upon request by a Contracting Authority the Contractor shall provide said certificate(s). The Contractor shall monitor the coverage achieved in the surveys of texture profile. Invalid measurements of texture will result in reduced survey coverage, where coverage is defined as the total length within any predetermined length over which valid measurements of texture are provided.

The Contractor shall report any survey lengths greater than 1.0 km over which less than 95% by length of valid MPD measurements can be delivered to the Contracting Authority. The Contractor shall carry out repeat surveys of these lengths and shall be carried out until a valid length of MPD measurements is delivered.

The Contractor shall provide the Contracting Authority with a summary report of the coverage achieved in the measurement of texture profile. This report shall be provided in excel (.xls) format and shall include:

- The total length surveyed within each Section of the road network,
- The total length within each Section for which the Contractor is unable to provide valid MPD data.
- The locations within each Section of the network over which the Contractor is unable to provide valid texture profile data.

The Contractor shall collate all confirmed data from permitted sources to ensure a complete set of network results are available at the end of each survey in accordance with section 2.1.

2.8. Transverse Profile (Rut Depth)

Purpose

Rutting is formed along pavement wheelpaths under repeated traffic loading. Rut depth is a measure of this deformation in the transverse pavement profile. Rutting can be a safety hazard because it can cause steering instability of vehicles, furthermore, they collect water during wet weather, which can lead to skidding or hydroplaning.

Measurement

Transverse profile shall be measured in both left and right wheel path using non-contact sensors. The equipment shall be capable of measuring and storing transverse profile data at a maximum longitudinal spacing of 100mm.

Recording and Averaging of Data

Rut depths in both wheel paths shall be calculated from the measured transverse profile over longitudinal lengths of 1m. Units are expressed in 1/100mm. These ruts shall be used to calculate the rut depth values at 10m intervals in both wheel paths.

These results shall be provided to the Contracting Authority in excel (.xls) format. Furthermore, results at 10m intervals shall be averaged for longer lengths, typically 100m subsections and uploaded to MapRoad PMS.

The accuracy of the rut depth measurements shall be such that the difference between the measured rut depth and the true rut depth is less than 3 mm for 95% of readings.

The Contractor shall label any rut depth data that fail to meet the specified requirements as invalid.

The Contractor shall monitor the coverage achieved in the surveys of rut depth. Invalid measurements of rut depth will result in reduced survey coverage, where coverage is defined as the total length within any predetermined length over which valid measurements of rut depth are provided.

The Contractor shall collate all confirmed data from permitted sources to ensure a complete set of network results are available at the end of each survey in accordance with section 2.1.

The Contractor shall provide the Contracting Authority with a summary report of the coverage achieved in the measurement of transverse profile and rut depth. This report is provided as a comma delimited text file including:

- The total length surveyed within each Section of the road network,
- The total length within each Section for which the Contractor is unable to provide valid rut depth and/or transverse profile data (as applicable).
- The locations within each Section of the Network over which the Contractor is unable to provide valid rut depth and/or transverse profile data (as applicable).

The Contractor shall monitor the measurement of transverse profile and reports in the Survey Data, where possible, individual measurements of transverse profile subject to error as values outside the permitted range.

The accuracy of the measured transverse profile shall be unaffected by the profile of the pavement over the full range of profiles that can reasonably be expected to be encountered on the road network.

The Contractor shall monitor the coverage achieved in the surveys of transverse profile. Invalid measurements of transverse profile will result in reduced survey coverage, where coverage is defined as the total length within any predetermined length over which valid measurements of transverse profile are provided.

2.9. Longitudinal Profile (IRI & LPV)

2.9.1. International Roughness Index (IRI)

Purpose

IRI (International Roughness Index) is a measurement of pavement roughness of the longitudinal profile. Roughness evaluation is extremely important as it provides a direct measurement influencing the public's perception of the quality of service provided by the pavement i.e. ride quality.

Measurement

Longitudinal profile measurements are required in both wheel paths. The profiling system shall meet ASTM E 950-98(2004) Class 1 requirements for the measurement of Longitudinal Profile. The profile measurements shall be independent of vehicle speed and vehicle acceleration over the normal range of traffic speeds. Measurements shall be accurate and repeatable down to speeds of 10 km/h due to nature of urban environment and the particular characteristics of lower volume routes in Ireland. Units are expressed as m/km.

Recording and Averaging of Data

The International Roughness Index (IRI), calculated for consecutive 10 m lengths, is one parameter currently used by Contracting Authorities to categorise the condition of the network. It will be

necessary for the Contractor to establish a satisfactory correlation between the IRI values derived from their equipment and IRI values derived from ARAN/RSP.

The profiling software shall calculate IRI values at 10m intervals in accordance with World Bank Specifications. The raw profile data shall be saved and delivered in csv file format as per data specification sheets and shall be uploaded into MapRoad PMS system at intervals of 100m or as requested by the Contracting Authority.

2.9.2. Longitudinal Profile Variance (LPV)

Purpose

Longitudinal Profile Variance (LPV) is a measurement of the shape (ride quality). TRL studies have shown that enhanced LPV better correlates with road users' perception of ride quality.

Measurement

The Contractor may use HRM or GM method to measure LPV. The Contractor shall measure the longitudinal profile during the survey in the nearside and offside wheel path at points separated by no more than 0.01m of longitudinal distance travelled. The profile measurements shall be independent of vehicle speed and vehicle acceleration over the normal range of traffic speeds. Measurements shall be accurate and repeatable down to speeds of 10 km/h due to nature of urban environment and the particular characteristics of lower volume routes in Ireland. Units are expressed as mm^2 .

Recording and Averaging data

The Contractor shall calculate 3m and 10m variance parameters at 10m intervals. This Enhanced (LPV) requires the collection of the short and medium wavelength features (3m and 10m variance). The contractor filters the measured longitudinal profile from each wheel path to attenuate wavelengths in excess of 100m using a filter that attenuates the amplitude of wavelengths greater than 150m by at least 50% without distorting the phase of any profile features with wavelengths shorter than 100m.

The Contractor averages the measured profile points over 0.1m and expresses the value in units of $1/10\text{mm}^2$ for each wheel path.

The Contractor shall monitor the coverage achieved in the surveys of longitudinal profile. Invalid measurements of longitudinal profile will result in reduced survey coverage, where coverage is defined as the total length within any predetermined length over which valid measurements of longitudinal profile variance are provided.

The Contractor shall provide the Contracting Authority with a summary report of the coverage achieved in the measurement of longitudinal profile (and hence longitudinal profile variance). This report shall be provided as a comma delimited text file including:

- The total length surveyed within each Section of the road Network.
- The total length within each Section for which the Contractor is unable to provide valid longitudinal profile and or variance data (as applicable).
- The locations within each Section of the Network over which the Contractor is unable to provide valid longitudinal profile and or variance data (as applicable).

The Contractor shall collate all confirmed data from permitted sources to ensure a complete set of network results are available at the end of each survey in accordance with section 2.1.

2.10. Digital Video

Each survey vehicle shall be fitted with two digital cameras. One camera is to provide a forward view of the pavement surface and one camera with a rear view of the pavement surface to enable a PSCI visual survey to be subsequently carried out using the video images. Video resolution on this camera system to be a minimum of 1280 x 720 High Definition. The camera software system shall be capable of adding a header with relevant information e.g. Survey Date, Route Surveyed, Chainage along route, GPS co-ordinates etc. while collecting the video information. The header shall not obscure any portion of the video image. The Contractor shall be able to add/remove/alter the header post-survey when required by the Contracting Authority. All video files to be stored in .jpeg format. All associated telemetry data for each video frame to be stored in Access .mdb files.

Video files at 5m intervals to be stored in .jpeg format. All associated telemetry data for each video frame to be stored in Access.mdb files.

Video quality from the digital camera system is extremely important. Shall the ambient survey visibility be reduced for example by adverse weather conditions, shade/shadow, sun-glare, so as to detract from the image quality of the video survey, then the survey shall be abandoned until such time as conditions improve.

If the quality of the video image is not clear, then the sub-standard video survey for the section in question shall be rejected and the Contractor shall re-survey the roads at no extra cost to the Contracting Authority.

Forward view video imagery to be uploaded to MapRoad PMS at 50m intervals, see section 3.2.

2.11. Geometry - Crossfall, gradient and radius of curvature

Measurements of crossfall, gradient and radius of curvature data are required at longitudinal intervals not exceeding 0.5 meters. Calculated values shall be averaged over 5m intervals and geo-referenced to national grid co-ordinates in accordance with section 2.3 and 2.4.

The measured crossfall is required to be within ± 1.5 or $\pm 10\%$ of the true crossfall, whichever is greater for 95% of the readings.

The measured gradient is required to be within ± 1.5 or $\pm 10\%$ of the true gradient, whichever is greater for 95% of the readings.

The measured radius of curvature is required to be within ± 50 metres or $\pm 25\%$ of the true radius of curvature, whichever is greater for 95% of the readings.

2.12. Rise and Fall

The rise and fall is defined as the sum of the absolute values of total vertical rise and total vertical fall of the original ground, in metres, along the road section divided by the total section length, in km. Units are measured in m/km. All calculated parameters shall be reported at 10 metre intervals. All calculated parameters shall be delivered to the Contracting Authority in Microsoft Excel data files.

2.13. Road Width

The Contractor shall record the road pavement width at longitudinal intervals not exceeding 100 metres. Measurements of width are required for the portion of a road which is provided primarily for the use of vehicles. However, at some locations this may include cycle lanes. Road width shall be imported at 100m intervals, see section 3.1. Units are expressed as 1/10m.

2.14. Surface Material Inventory

The Contractor shall record the road surface material continuously using the MapRoad Mobile App or alternatively it may be recorded as a desktop exercise provided a Contracting Authority permits a contractor to access their MapRoad PMS system. Surface material is required for the portion of a road which is provided primarily for the use of vehicles. Road surface materials displayed on MapRoad PMS are as follows;

- Surface Dressing
- Microsurfacing – Slurry seal
- High Friction Surfacing
- HRA (Hot Rolled Asphalt)
- SMA (Stone Mastic Asphalt) – Clause 942
- Surface Course Asphalt Concrete
- Cobbles
- Concrete
- Modular Paving
- Other

2.15. Cracking

The Contracting Authority may require an automated survey of cracking. The equipment shall be capable of gathering the required data at normal traffic speeds or as otherwise agreed with the Contracting Authority.

The automated system required shall be composed of two high performance 3D laser profilers that are capable of measuring complete transverse road profiles with 1mm resolution at normal traffic speeds. The high-resolution 3D data acquired by the automated system shall be processed using algorithms developed to automatically extract crack data including;

- **Crack Type**
 - linear - discrete transverse and longitudinal,
 - Interconnected – widely spaced block cracking and closely spaced fatigue cracking,
 - Irregular or Meandering cracking,
- **Severity** and
- **Intensity**

The automated system shall meet the following specification unless otherwise agreed with Contracting Authority;

Number of Laser Profiles	2
Sampling Rate (max)	11,200 profiles
Vehicle Speed	100Km/hr (maximum)
Profile spacing	Adjustable
3D Points per Profile	4096
Transverse field of view	4m
Depth range of operation	250mm
Z axis Range of accuracy	0.5mm
X Axis Resolution	1mm

The reported subsection length shall be 100m. Network cracking shall be quantified in terms of the dominant crack type, severity and extent for each segment over the sample lengths and widths, or as otherwise agreed with the Contracting Authority.

It is a requirement that cracking data will be reported as a summary for a network or a portion of a network, and in detail for each subsection. Guidelines for data reporting are summarised below.

Crack type: The dominant crack type shall be used for reporting. See table 2 below.

Cracking severity: Average crack width in mm. See table 2 below. Severity rating may be influenced by pavement type and environment.

Cracking extent: The area affected by cracking as a percentage of lane area (lane width by length). See table 2 below.

Crack Type	Severity			Intensity
	Name	Width Range	Category	
Longitudinal	Fine	1mm	1	< 1%
Transverse	Medium	1mm - 3 mm	2	1% - 5%
Block	Wide	>3mm	3	>5% - 10%
Fatigue	Spalled	>3mm & Spalled	4	>10% - 25%
Irregular				>25%

Table 1 – Cracking data reporting format

Cracking reports shall show the dominant crack type, severity (average crack width) and extent (percentage of area affected) using Table 2. Or as otherwise agreed with the Contracting Authority.

The Contractor shall indicate if cracking is load or non-load-related cracking.

Control sites covering a range of cracking types and levels shall be identified in consultation with the Contracting Authority. The purpose of these sites is to ensure consistency of results over the testing period. The length and type of these sites shall be agreed in advance with the Contracting Authority.

Verification testing is based on fresh surveys of a length of road with known cracking characteristics. The aim is to confirm that the measuring system has not changed. However, it is noted that due to temperature and other effects it cannot be expected that a reference section can be maintained where cracking will be constant over time. It is therefore necessary to concentrate on repeatability and to keep some record of observed cracking, also with recording of environmental conditions, particularly temperature.

Suitable verification sections shall be located where crack types and cracking levels (severity and extent) are known.

Detailed verification testing is necessary to assess a new system before it is commissioned for use in cracking surveys. After initial calibration and verification has been undertaken the following additional verification is required;

- After changes to hardware and software.
- At the beginning of a Network Survey.
- At intervals not exceeding six months.
- At intervals not exceeding 2750km of survey, whichever of these comes first.
- At the end of a Network Survey.

Verification of distance measurement; The accuracy of distance outputs from the crack measuring device shall be verified:

- Before each cracking survey commences.
- At intervals not exceeding one month during each survey.
- After the completion of each survey.
- Immediately after any change is made to the distance measuring features of the measuring device or its host vehicle during a survey.

Repeatability and bias are important factors in ensuring that changes in cracking can be identified over relatively short time spans. Repeatability is the variation between repeated measurements of the same distress using the same survey personnel with the same data collection procedure. Bias error indicates whether a device is systematically measuring high or low when compared to a reference set of measures. Reproducibility is the variation between measurements of the same pavement distress parameter using different survey personnel with the same data collection procedure.

Data shall be properly referenced in order to be meaningful for use in decision making processes.

Accordingly, cracking data shall be reported using the IPAG Network Referencing System.

It shall be the responsibility of the Contractor to establish appropriate health and safety practices and determine the applicability of any regulatory limitations related to and prior to its use.

2.16. Pavement Surface Condition Index (PSCI)

PSCI is the national standard for recording the visual condition rating on the regional and local road network and is a requirement of the Pavement Survey Standard for Regional and Local Roads released by DTTaS. PSCI is a visual assessment of road conditions using a 1 to 10 rating system in accordance with the DTTaS pavement condition manuals for pavement surface evaluation and rating on Irish Roads. There are three manuals in the series, namely;

- Rural Flexible Roads Manual (Volume 1 of 3)
- Urban Flexible Roads Manual (Volume 2 of 3)
- Urban Concrete Roads Manual (Volume 3 of 3).

The manuals are available from; <http://www.rmo.ie/library.html>

The PSCI scale ranges from 10 for a pavement in excellent condition to 1 for a pavement in failed condition. The road pavement is rated using the 1 to 10 scale based on visible pavement defects to visually rate pavement surface condition in accordance with the appropriate manual. The 1 to 10 system is colour-coded with ratings 1 to 4 coloured Red, rating 5 and 6 coloured Amber, rating 7 and 8 coloured Blue, and rating 9 and 10 coloured Green.

The rating manual for each road type provides details of distress descriptions, how to link them to the 1 to 10 visual rating scale, with high resolution colour photographs of distress types and road pavements in each of the 1 to 10 rating categories. There is typically four major categories of

common road surface defects on Irish roads outlined in each manual comprising Surface Defects, Pavement Deformation, Cracks and Surface Openings. The significance of surface-related, structural-related and other-related pavement defects in the 1 to 10 rating system shall be identified and used to evaluate and rate pavement surface condition.

The PSCI 1 to 10 rating is directly linked to maintenance treatment categories specified for use on roads by the DTTAS. The typical maintenance treatment categories are Routine Maintenance, Restoration of Skid Resistance, Surface Restoration, Structural Overlay/Inlay and Road Reconstruction.

The visual rating for rural flexible, urban flexible or urban concrete roads shall only be carried out by trained personnel who have completed the Road Pavement Condition Rating Surveyor training for each manual. Training is available through the Local Authority Services National Training Group (LASNTG), www.lasntg.ie.

The PSCI 1 to 10 rating is a continuous driven visual condition survey consisting of a two-person team, a driver and an assessor. A rating is applied to a road segment based on its overall condition and the defects present on the road. The rating is assigned on the MapRoad Mobile App using a tablet with an Android operating system. The 1 to 10 rating and associated GPS data is recorded in real-time using the road schedule. The PSCI data can be subsequently uploaded to the Local Government Management Agency (LGMA) MapRoad PMS system.

Alternatively, the 1 to 10 visual rating can also be assigned to the pavement from geo-referenced digital imagery recorded in the field. The PSCI visual rating data from video can be subsequently be post-processed and uploaded to the MapRoad PMS system.

2.17. Falling Weight Deflectometer

Purpose

Falling Weight Deflectometers are used to evaluate the in-situ performance and strength of pavements and their foundations. FWD testing is typically deployed at a project level and can be used to assist with treatment selection i.e. to determine what structural capacity exists within a pavement and therefore identify what strengthening may be required. Generally, it is not appropriate for local roads.

FWD testing shall be conducted in accordance with TII Publication '*Guidelines for the use of the Falling Weight Deflectometer in Ireland*' publication number CC-GSW-04008. This publication is available at <http://www.tiipublications.ie/library/CC-GSW-04008-01.pdf>

3 Data Collection and Processing

3.1. Data Collection and Processing

After collection, survey data shall be validated to verify calculation software and is subject processing. Good practice dictates that all data shall be sense/logic checked for any anomalies as part of standard data processing.

Data cleaning may be required for any conditions that may result in invalid measurements or any readings that may be deemed illogical. These conditions may include but are not limited to drop-outs (missing data points), and failures in any of the measurement devices. In these circumstances, the Contractor labels the data as invalid. The invalid data caused by such drop-outs does not contribute to the coverage requirements and if necessary, rejected and replaced with relevant updated data.

The Contractor is responsible for the quality and accuracy of the data supplied and shall ensure data supplied is accurate.

Data collected and subsequently processed shall be uploaded to the MapRoad Pavement Management System by the Contractor. Currently MapRoad PMS can facilitate the upload of the following data;

- SCRIM - CSC
- Texture Depth – MPD left, MPD right and MPD average
- IRI
- Rut Depth
- LPV
- Video Imagery
- Road Width
- Surface Material
- PSCI
- FWD

The Road Management Office (RMO) together with the LGMA facilitate the importation of the road condition data and subsequently manage the data imported to MapRoad PMS on behalf of local authorities. A copy of the upload format is available from the RMO/LGMA. The latest version of this will be supplied to the Contractor prior to commencement of surveys. Note that this format may be updated periodically, and it is the responsibility of the Contractor to ensure that they have the latest version available when uploading the data

3.2. Quality Assurance

The Contractor shall ensure that all personnel are properly trained and experienced in the operation of the equipment and understand the requirements of the contracting authority. The drivers of the vehicles shall ensure that the lateral position of the vehicle is such that the longitudinal measurements are centred in the middle of the wheel path.

In addition to the regular monitoring and checking of the control site data as outlined the Contractor shall ensure that the daily calibrations and equipment checks recommended by the equipment manufacturer are carried out and the calibration data is forwarded to the Contracting Authority together with the survey data for that period.

The Contractor shall have calibration procedures and system checks in place to ensure the integrity of network surveys. The Contractor shall check that the IRI, Rut Depth, Texture Depth, and Cracking readings are within the expected range daily and that valid data for the total route is recorded. The procedures shall also ensure that GPS coverage is in accordance with section 2.4.

The Contractors shall be capable of monitoring data collection in real time in the data collection vehicle. In addition, vehicle operators shall spot check real time data to ensure that equipment is operating properly.

The Contracting Authority will require the Contractor to resurvey at their own expense any significant lengths with invalid or missing data.

The Contractor shall ensure that good quality video images are provided in accordance with section 2.10.

Processed data shall be uploaded to MapRoad PMS system as requested by the Contracting Authority. This shall be completed within 7 days from the end of the week in which the survey was carried out unless otherwise agreed with the Contracting Authority. Prior to submitting data, all processed files shall be edited to remove data which is not part of that survey route including calibration files.

3.3. Control Sites

One or more suitable control sites covering a range of IRI, rut depth, surface texture, LPV3 and LPV10, SCRIM and Cracking values shall be selected by the Contractor and approved by the Contracting Authority. Such sites shall demonstrate the repeatability and satisfactory operation of the survey equipment over the contract period.

Weekly control site checks;

- The contractor selects a suitable site (ideally greater than 1km in length) and conducts a survey with an accredited survey vehicle within 7 days.
- This data is then used as a benchmark dataset to compare future surveys against.
- At intervals not exceeding 7 days, each accredited device conducts a repeat survey.
- This data is compared to the benchmark survey by the Contractor to ensure the survey equipment is operating correctly.

Daily control site checks;

- The Contractor selects a suitable site (a minimum of 400m in length) and conducts a survey with an accredited survey vehicle before and after each day's work.
- These two data sets are compared by the Contractor to ensure the survey equipment is operating correctly.

The control site data shall be checked to ensure that the machine is measuring all parameters accurately and that the DMI and GPS systems are performing within specifications. It is the responsibility of the Contractor to ensure that the control site data verifies that all measuring systems are operating within specifications before undertaking a main survey.

The data and a report summarising the results shall be sent to the Contracting Authority upon completion of the contract or monthly whichever comes first. The Contracting Authority will not accept survey data if the control site data covering that survey cycle is missing or suspect.

3.4. Documentation

The Contractor shall provide and operate an effective and documented Quality Assurance regime, including, but not limited to:

- Equipment calibration, testing/certification and correlation trials.
- Vehicle operation and maintenance.
- Vehicle operator and operative training and instruction.
- Survey operation and record keeping.
- Data recording, processing, and analysis.
- Delivery of survey results.

The Contractor shall deliver all Quality Assurance tests and data required by the specification within the overall price agreed with the Contracting Authority for surveys on the road Network.

The Contractor shall deliver any reports required by the Specification to the Contracting Authority promptly in accordance with the timescales defined in the contract or, if the contract defines no timescales, defined by this Specification.

The Contractor shall report any repairs or alterations carried out on the equipment within 7 days to the Contracting Authority. The successful tenderer shall be INAB accredited by the Irish National Accreditation Board for the Measurement of Skid Resistance or similarly approved.

3.5. Survey Procedures

The surveys shall generally be carried out between April and October, to a schedule agreed with the Contracting Authority. However, SCRIM surveys shall only be carried out between 1st May and 30th Sept in accordance with best practice.

Surveys shall not be carried out in any weather conditions that could adversely affect the accuracy of the data or the quality of the video images. In particular surveys shall not be carried out in the direction of a low sun which may render video footage unusable.

The road network has a range of route lengths. The Contractor may survey a route continuously which is the preferred option particularly for the shorter routes. If a route is surveyed in sections, the surveys shall be overlapped and the operator shall record all relevant information to enable the data from the overlaps to be edited efficiently.

The driver of the vehicle shall ensure that the lateral position of the vehicle is such that longitudinal measurements are centred in the middle of the wheel path.

The surveys shall be carried out in the same direction as previous surveys on the same road section. Directional data can be clarified by the Contracting Authority upon request prior to commencement of surveys.

The surveys shall be carried out in the left-most traffic lane, unless otherwise agreed with the Contracting Authority.

Where there are a significant number of parked cars the survey shall follow the left most path taken by normal traffic flow.

The Contracting Authority may require surveys in urban areas to be carried out during off peak times to ensure the collection of sufficient valid data. Where daytime surveys are not feasible on urban roads, the Contractor shall;

1. Draft proposals for alternative survey arrangements for approval of the Contracting Authority.
2. Liaise with the Contracting Authority and An Garda Siochana to agree the alternative survey arrangements.

The operator shall record the following information and report in an agreed electronic format:

- Operator Name.
- Route and Survey direction.
- Survey Date.
- Survey start and end locations.
- Weather conditions detailing changes to survey progress.
- Problems encountered with plate markers, e.g. plate missing/incorrect location.
- Description of Detours encountered, and incorrect routes taken.
- Location of any unusual surface conditions encountered such as the surface contaminated by materials, which could invalidate the measured data.
- Start and end chainages and description of any road works encountered, and action taken that could influence measured data.

3.6. Survey Progress Reporting

The Contractor shall provide a schedule for the surveys and deliver a progress report at monthly intervals unless otherwise agreed following the start of the surveys. The report shall be delivered by electronic mail and shall provide the following information;

- A list of the routes and lengths surveyed since the previous report.
- Reports of any accidents, incidents, failures or breakdowns.
- Progress against the schedule and the proposed future schedule.

The Contractor shall provide details of the location of the equipment at any time, if requested by the Contracting Authority.

The Contractor shall report all deviations from the survey route. Survey data collected during deviations from the survey route may be considered invalid in terms of the specified coverage requirements. Deviations as a result of parked vehicles shall not deem data invalid.

The Contractor shall provide road survey equipment with the ability to identify and record lengths containing features placed in or on the road surface for the purposes of traffic control (e.g. speed humps and traffic "chicanes"). Where these features are present the Contractor shall record their presence in the survey data and the Contractor shall label any of the parameters of survey data that is affected by these features (for example longitudinal profile) as invalid and will not be used to evaluate data compliance.

3.7. Traffic Management and Health and Safety Requirements

The Contractor shall plan the surveys in such a manner that the safety of the operators and public is not compromised.

The Contractor is solely responsible for all requisite traffic management and shall comply with all statutory health and safety requirements. The Contracting Authority requires all survey work to be carried out in compliance with the Safety, Health and Welfare at Work Act 2005; Safety, Health and Welfare at Work (General Application) Regulations 2007, the Safety, Health and Welfare at Work (Construction) Regulations 2013 and all other current applicable Regulations, Codes of Practice and Guidance.

The Contracting Authority or its representative may carry out safety audits to monitor and check the performance of the Contractor working on contracts. The Contracting Authority will work closely with Contractors to ensure health and safety requirements are being adhered to during the duration of the contracts.