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Contents

1. Preamble

This chapter is intended to provide a brief overview of the High Speed Road Monitor (HRM) and is aimed at those who require an appreciation of the principles behind the test method and the factors involved in the analysis and processing of results for utilisation within UKPMS. It also directs the reader, where appropriate, to other references for more detailed information.

2. Introduction

The HRM consists of a van and a trailer fitted with measuring devices that simultaneously assess the following parameters:

- Longitudinal profile
- Rut depth
- Texture depth
- Gradient
- Crossfall
- Radius of curvature

Surveys are undertaken at speeds up to 95 km/h and are intended to provide a rapid overview of the condition of the road surface. The results are analysed to identify lengths of road in a sub-standard condition that can then be more effectively targeted for more detailed investigation. By undertaking surveys on a routine basis, changes in the condition of the network over time can also be revealed.

The Department for Transport have recently decided to use SCANNER (see Chapter 7 of Volume 3 of the UKPMS User Manual) for measuring surface condition and statutory reporting purposes. (SCANNER was previously known as TTS.) This development could limit the use of HRM on the local road network although it remains valid for use within UKPMS.

3. Background

For background information on the HRM, reference should be made to TRL Report RR11 "*The TRRL High Speed Road Monitor: assessing serviceability of roads, bridges and airfields*" (1985).

4. Test Principles

For a full description of the test method, reference should be made to HD 29/94 "*Structural Assessment Methods*" (DMRB. Volume 7. Section 3. Part 2. Chapter 2).

The HRM offers relatively cheap network level assessments that can be undertaken within the normal traffic flow without causing delays. Surveys are continuous along the left hand lane of a chosen route and consist of a series of runs up to 100km in length. Maximum survey capacities of between 200 and 400 lane kilometres per day, depending on road type, are quoted by HRM contractors.

The HRM trailer is 4.5m long and contains systems that measure the functional requirements of the road surface[1]. These are considered individually in the following sections.

4.1 Longitudinal Profile

Laser sensors mounted above the nearside wheelpath are used to measure longitudinal profile. The variation in longitudinal profile is used for the assessment of riding quality.

Whilst an uneven road is not necessarily weak, the HRM is able to provide an indication of structural deterioration by assessing the change in profile over time. The Proportional Change in Variance (PCV) with time is the indicator used to reflect structural condition.

HD 29/94 of the DMRB provides threshold values for PCV and riding quality. The following reports provide background information on the development of these threshold values:

- "*Measurement and assessment of unevenness of major roads*", TRL Report LR1125, 1984
- "*Road Profile Deterioration as an Indicator of Structural Condition*" TRL Report RR183, 1989.

4.2 Rut Depth

A sensor mounted at the centre point of the trailer is used, in conjunction with the trailer wheels to measure rut depth. The HRM records the average rut depth of the nearside and offside wheelpath. It assumes that the trailer wheels are able to maintain a line of travel along the bottom of the rutted wheelpaths. In practice this is not always achievable. As such HRM rut depths should not be regarded as absolute measurements and they cannot be compared with "straight-edge and wedge" rut depths from visual condition surveys. HRM results are however a useful indicator of where the worst areas of rutting may be occurring on a network.

[1] Alternative equipment is available to provide HRM-equivalent surveys. For example, the Multifunction Road Monitor (MRM) is a self-contained trailer-less version of the HRM.

HD 29/94 of the DMRB provides threshold values for both rut depth and rate of change of rut depth. These are based upon the research findings published within TRL Report SR550 "*Proposed warning levels for the structural maintenance of flexible roads*" (1980).

4.3 Texture Depth

The macrotexture of the road surface contributes to high speed skid resistance (see Chapter 6 of Volume 3 of the UKPMS User Manual). Texture depth is a measure of macrotexture and provides an indication of the overall roughness of the surface - which assists vehicle braking and the dispersal of water from the contact areas between the road and vehicle tyres. The HRM measures macrotexture via laser sensors above the nearside wheelpath.

Reference should be made to BS 598 Part 105: 2000 ("*Sampling and examination of bituminous mixtures for roads and other paved areas. Method of test for the determination of texture depth*") for further details on texture depth measurements via laser[2].

HRM macrotexture measurements are recorded as Sensor Measured Texture Depth (SMTD). It should be noted that a device called the Mini Texture Meter[3] also records macrotexture measurements in units of SMTD. However, SMTD results obtained from the two devices are not the same. Mini Texture Meter SMTD data is not valid for use within UKPMS.

HD 29/94 of the DMRB provides threshold values for both texture depth and rate of change of texture depth. These too are based upon the research findings published within TRL Report SR550 (see Section 4.2).

4.4 Alignment Parameters

The gradient, crossfall and radius of curvature are the alignment parameters used to provide an indication of road geometry. An understanding of the road geometry is required when deciding upon appropriate maintenance actions.

HRM road geometry data can also be used when assigning site categories and investigatory levels for SCRIM testing (see Chapter 6 of Volume 3 of the UKPMS User Manual).

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[2] BS 598 Part 105: 2000 has been superseded by BS EN 13036 Part 1: 2002 "*Road and airfield surface characteristics. Test methods. Measurement of pavement surface macrotexture depth using a volumetric patch technique*".
[3] Ref. "*Measurement of the macro-texture of roads Part 2. A study of the TRRL mini texture meter*" TRL Report RR120, 1987.

Inclinometers mounted along and perpendicular to the trailer axle provide the data for the calculation of crossfall and gradient. Encoders on the nearside and offside wheels are used to calculate the radius of curvature. An accuracy of ± 10% is reported for road geometry calculated in this way.

4.5 Video

Video records can be produced at the time of the HRM survey, using cameras mounted on the towing vehicle. These videos can provide visual condition information of the road surface. They can be useful to assess surface distress (from a single survey) or to identify rapid deterioration (when comparisons are made against a repeat survey).

4.6 Location Referencing

As with all machine surveys, it is essential that data collected by the HRM can be referenced to a highway network. There are two complimentary location referencing systems available for HRM surveys:

- Thermoplastic node markers cored into the road surface - that are detected by HRM mounted cameras.
- Bar code plates located in the nearside verge (either on dedicated posts or existing street furniture) - that can be read by HRM mounted lasers.

The above systems will enable survey data to be referenced to a particular section of the highway network. Within each section of the highway network a shaft encoder fitted to the nearside wheel of the HRM provides the running chainage to which all survey measurements are referenced.

Recent developments in Global Positioning Systems (GPS) now provide additional capabilities for location referencing.

5. Test Considerations

5.1 Weather

HRM surveys may be carried out at any time of the year. Whilst there are no seasonal or temperature constraints on surveys, it is imperative that the road surface is dry (and free from snow and ice). The presence of water in surface voids and pores is known to affect the accuracy of HRM measurements.

5.2 Survey Interval

The HRM is useful in providing an overview of the state of road surface condition. When repeat surveys are undertaken at regular intervals it is possible to develop a trend history and to identify deteriorating areas for further investigation. HRM surveys conducted on a two year cycle (± three months) are used to calculate the PCV indicator of structural condition (Section 4.1).

6. HRM HMDIF

Table 1 provides an example of the file structure and content of a HRM HMDIF file that would be produced by a Contractor. This particular file relates to rutting only.

```
HMSTART ukPMS 001 " " ; , \
TSTART;
SURVEY\OWNER,TYPE,VERSION,NUMBER,COMPARE1,COMPARE2,SUBSECT,MACHINE,PREPROC,XSPUSED;
SECTION\NETWORK,LABEL,SNODE,LENGTH,SDATE,EDATE,STIME,ETIME;
OBSERV\DEFECT,VERSION,XSECT,SCHAIN,ECHAIN;
OBVAL\PARM,OPTION,VALUE,PERCENT;
TEND\6;
DSTART;
SURVEY\LA,HRM,1,11,,,10M,HRM01,HRM,F;
SECTION\UKPMS,UKPMSA244/1206,020296N,60,040993,040993,,;
OBSERV\LRUT,1,CR1,0,10;
OBVAL\13,,9.77,V;
OBSERV\LRUT,1,CL1,0,10;
OBVAL\13,,3.17,V;
OBSERV\LRUT,1,CR1,10,20;
OBVAL\13,,5.76,V;
OBSERV\LRUT,1,CL1,10,20;
OBVAL\13,,4.12,V;
OBSERV\LRUT,1,CR1,20,30;
OBVAL\13,,7.75,V;
OBSERV\LRUT,1,CL1,20,30;
OBVAL\13,,8.18,V;
OBSERV\LRUT,1,CR1,30,40;
OBVAL\13,,3.73,V;
OBSERV\LRUT,1,CL1,30,40;
OBVAL\13,,9.18,V;
OBSERV\LRUT,1,CR1,40,50;
OBVAL\13,,4.74,V;
OBSERV\LRUT,1,CL1,40,50;
OBVAL\13,,3.87,V;
DEND\24;
HMEND\32;
```

Table 1 Example HRM HMDIF