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Falling Weight Deflectometer Setup and Quality Assurance for Works Performance Assessment of Unbound Granular Mixtures

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This document has been authorised by the Director of Professional Services, Transport Infrastructure Ireland. For any further guidance on the TII Publications system, please contact the following:

Contact: Standards and Research Section, Transport Infrastructure Ireland
 Postal Address: Parkgate Business Centre, Parkgate Street, Dublin 8, D08 DK10
 Telephone: +353 1 646 3600
 Email: infoPUBS@tii.ie

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1. Introduction

This publication sets out interim guidance for Falling Weight Deflectometer (FWD) surveys as part of the Works Performance requirements of Unbound Granular Mixtures (UGM) as detailed in CC-SPW-00800 Road Pavements – Unbound and Hydraulically Bound Mixtures. This publication also provides interim guidance on Quality Assurance procedures to ensure FWD Equipment operates reliably and accurately when measuring a pavement structure’s response to loading.

The definitions of capitalised terms referred to in this publication are provided in the “*Accreditation and Quality Assurance of Dynamic Plate Test Survey Devices*” specification prepared by the Transport Research Laboratory (TRL).

2. Works Performance Assessment of Unbound Granular Mixtures using the Falling Weight Deflectometer

2.1 Design Performance

The design performance requirements for a UGM are specified through the selection of a works performance category within the Irish Analytic Pavement Design Method (IAPDM). Guidance on the IAPDM is provided in DN-PAV-03021 (Analytic Pavement and Foundation Design).

The stiffness of the constructed UGM layer is represented by the in-situ surface modulus. The method of determining in-situ surface modulus for a pavement foundation or part thereof, shall be by the application of a FWD. The performance categories for UGM layers are detailed in Table 2.9 of CC-SPW-0800 Road Pavements – Unbound and Hydraulically Bound Mixtures.

2.2 FWD Testing Setup

The FWD Equipment for testing on UGM layers shall be setup as per Table 2.1, and in accordance with the requirements set out in CC-GSW-04008 (Guidelines for the Use of the Falling Weight Deflectometer in Ireland) and AM-PAV-06050 (Pavement Assessment, Repair and Renewal Principles).

Table 2.1 FWD Test Setup for Performance Verification

Load Plate Radius (mm)	Peak Stress under Load Plate (kPa)	Testing Spacing
225	150	Seating drop + 3 drops at 25m station spacing in the left wheel path of each lane.

2.2.1 Calculation of the Surface Modulus

The deflection and the peak stress measured at the centre of the load plate are used to calculate the Surface Modulus at each location. The surface modulus is calculated using the following equation.

$$Surface\ Modulus\ (MPa) = 2(1 - \nu^2)r \frac{\sigma_0}{d_{avg}} \quad (Equation\ 1)$$

r = is the radius of the load plate (mm)

σ_0 = is the contact pressure under the load plate (kPa)

d_{avg} = Average of 3 normalised maximum central deflections (microns) under the load plate. Measured maximum deflections are to be normalised to an equivalent peak stress of 150 kPa. Normalisation is the pro-rata adjustment of FWD deflection measurements based on the ratio of the measured load plate stress and target peak stress (150kPa).

3. Falling Weight Deflectometer Quality Assurance

3.1 FWD Quality Assurance Overview

It is mandatory that FWD Equipment is accredited to undertake surveys and the organisation carrying out FWD surveys (the Contractor) shall follow an on-going Quality Assurance regime to ensure that the data provided by the Equipment always remains valid. The Accreditation and Quality Assurance processes to be followed shall be in accordance with the requirements in the latest version of “*Accreditation and Quality Assurance of Dynamic Plate Test Survey Devices*” specification prepared by the Transport Research Laboratory (TRL). The Accreditation and Quality Assurance of Dynamic Plate Test Survey Devices (Accreditation and QA of DPT Devices) specification describes the Accreditation and Quality Assurance programme and processes to be followed by the Contractor.

The central principles of the Accreditation and Quality Assurance programme are:

- to undertake tests of the Equipment leading to the award of an Accreditation Certificate showing suitable performance levels prior to undertaking FWD Surveys.
- to undertake Re-accreditation at appropriate intervals.
- to apply an on-going Quality Assurance programme for all FWD Surveys.
- to confirm that the Accreditation and Quality Assurance programme is implemented, via independent audit.

In addition to the specific processes detailed in the Accreditation and QA of DPT Devices specification, the Contractor’s effective and documented Quality Assurance regime shall cover all aspects of the surveys including, but not limited to:

- Equipment operation and maintenance
- Calibration of the Equipment
- Driver and operator training and instruction – the Equipment shall only be driven and operated by competent personnel
- Survey operation and record keeping
- Data recording, processing and analysis
- Delivery of Survey Data

The main elements of the Accreditation and Quality Assurance programme that shall be followed are summarised in the following sections.

3.2 FWD Equipment Calibration

It is mandatory that any day to day or longer term calibration required to ensure the ongoing performance of the Equipment has been carried out by the Contractor, Equipment Developer or System Developer as appropriate. The Accreditation and Quality Assurance processes to be applied to test and monitor the performance of the FWD Equipment assume that such calibrations have been carried out and recorded. Particular systems or components of the FWD Equipment which are known to require calibration include:

- Load cell calibration – reference calibration may only be performed by the Equipment Developer, System Developer or by a recognised calibration laboratory.

- Deflection sensor calibration – reference calibration may only be performed by the Equipment Developer, System Developer or by a recognised calibration laboratory.
- Odometer calibration – reference calibration may only be performed by the Contractor.
- Temperature probe – reference calibration may only be performed by probe manufacturer or by a recognised calibration laboratory.

3.3 FWD Accreditation

The main requirements of the FWD Accreditation and Quality Assurance programme include:

- FWD Owners shall obtain Accreditation via an Accreditation/Re-accreditation trial (annual FWD Correlation Trial).
- Calibration Checks and Quality Assurance tests shall be undertaken on an ongoing basis between Accreditation/Re-Accreditation trials in accordance with the Accreditation and QA of DPT Devices specification (summarised in section 1.3.5 below).
- Contractor's Calibration Checks and Quality Assurance Tests shall be reported to the Auditor, for assessment and approval of continued accreditation.

3.4 FWD Contractor's Calibration Site and Primary Check Site(s)

The Accreditation and QA of DPT Devices specification describes in detail the purpose and requirements of the Contractor's calibration and primary check sites. In summary:

- The Contractor shall establish a number of fixed test sites to achieve the Quality Assurance test programme. This shall include a Contractor's calibration site.
- The Contractor's calibration site provides a reference site for monitoring the performance of the Equipment since the last successful Accreditation or Re-accreditation of the Equipment.
- The selection of sites shall follow the parameters described in the Accreditation and QA of DPT Devices specification. To obtain deflection reference data for sites, a reference survey shall be carried out on the site with the FWD Equipment within 7 days of successfully carrying out an Accreditation/Re-accreditation Trial. The Contractor should build up a "historical data set" which can include data collected in the current and previous years whilst conducting Accredited Surveys. If the condition of a test site is affected by maintenance or other external factors at any time, the Contractor shall re-establish the changed characteristics of the site by repeated testing, or establish another calibration site.
- A summary of the requirements for the sites required for FWD Quality Assurance is given in Appendix E of the Accreditation and QA of DPT Devices specification.

3.5 Summary of the FWD Contractor's Quality Assurance Processes


The following Quality Assurance Tests shall be undertaken as per the Accreditation and QA of DPT Devices specification:

- Stack/tower Consistency Check (or Developer equivalent procedure) every six months.

- Contractor's Calibration Check within the defined time frame of the Accreditation/Re-accreditation Trial
- Contractor's Calibration Check at the end of a Lay Off Period prior to conducting surveys
- Contractor's Calibration Check no more than 40 days apart whilst not in a Lay Off Period
- Two Weekly Check (no more than 20 days apart) whilst not in a Lay Off Period
- Contractor's Calibration Check before entering a Lay Off Period
- Daily Check every day that testing is carried out
- The Contractor should also check that any other systems/components are working satisfactorily between annual calibrations, e.g. temperature measurement systems, geospatial systems, imagery systems.

All reports for each Check or Test shall be supplied to the Auditor within the specified time periods described in the Accreditation and QA of DPT Devices specification. The Survey Data for the Contractor's Calibration Checks shall be retained by the Contractor and Owner (if different) for examination by the Auditor as required.



 Ionad Ghnó Gheata na Páirce,
Stráid Gheata na Páirce,
Baile Átha Cliath 8, D08 DK10, Éire

 Parkgate Business Centre,
Parkgate Street,
Dublin 8, D08 DK10, Ireland

 www.tii.ie

 info@tii.ie

 +353 (01) 646 3600

 +353 (01) 646 3601