KUAB Konsult & Utveckling AB

Calibration Certificate

The Falling Weight Deflectometer (FWD) with serial number FV127, Owned by Seoul City, S.Korea manufactured by KUAB Konsult & Utveckling AB in Sweden, was in 2018-06-01 calibrated by KUAB's personnel.

After the calibration the FWD FV127 measures with the same accuracy as a new KUAB FWD, and meets all relevant standards, including but not limited to ASTM standard D4694.

Seoul- South Korea 2018-06-01
KUAB Konsult & Utveckling AB

Afshin Lotfi

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Report from Calibration of FV127 Year 2018

Calibration

The measuring systems that are calibrated are the systems for distance measurement, temperature measurement, deflection measurement and load measurement.

The calibration includes everything that is required by SNRA's method description 112:2012. After the calibration the FWD meets the requirements in SNRA's method description 112:2012 and relevant parts of ASTM D 4694 and CROW requirements.

Distance measurement

The principle of the distance meter is that transducers are counting pulses when the trailer wheel is rotating.
A long section of a straight road, 300m, was established by Seoul City.
This section was driven with the FWD and the distance was divided with the number of pulses, giving a calibration factor expressed as meters / pulse. The distance is driven as least twice.
Notice that distance measurement depends on the temperature of the tire, and must be repeated by the FWD user at a temperature close to the measurement temperature.

Air temperature

The principle of the air thermometer is that a transistor allows a current proportional to temperature pass through.

A traceable thermometer is placed close to the FWD thermometer. After about 15 minutes, when the temperature is stable, the current is measured and the ambient temperature is entered in the computer, which calculates the calibration factor, in principle expressed as degrees Kelvin per ampere. This procedure neglects a zero error which may be about 1 degree Kelvin, i.e. Less than 0.1 degrees within the normal temperature range 0 to 40 degrees C.

Surface temperature

The pavement surface temperature is measured by an IR-thermometer.

Tests within the SHRP project in USA (made with Dynatest FWDs) showed that use of the initial factory-made calibration was better than annual calibration. The IR thermometer is therefore not calibrated. It is merely checked that the values are reasonable.

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Load

The principle of the load measurement is that the load is transferred to the pavement surface via hydraulic plungers, and the oil pressure is measured with strain a gauge bridge mounted on a membrance. Before each drop a resistor is connected in parallel with one of the bridge arms, giving a referens voltage, so called shunt calibration. For every drop the output from the bridge is measured, and the ratio between tis voltage and the referens voltage is measured. The load is calculated with the formula.

F=A* Rato ^ 2b * Ratio + e

At the calibration the FWD is placed on a traceable referens load measurement device, consisting of there load cells mounted between two aluminum plates.

The load at drops from all heights are measured with the FWD and with the referens device, and the parameters a, b and c are calculated such that RMS of the relative difference between the FWD measurement and the referens measurement is minimized, and within the tolerance of the different regulations.

After calibration the following numbers are guaranteed:

Systematic error : >+-2% of measured value,
Random error : < 1% of measured value.

Deflection

The deflection measurement is made with an LVDT, mounted such that the transformer follows the pavement surface, while the core is suspended in a mass-spring system with low resonant frequency and low damping, such that the core is moving only a small fraction of the total deflection. The output from the LVDT is measured before and during the impact, and the deflection is calculated as the difference between these, multiplied with a calibration factor.

The calibration is made in three steps. In the first step the relation between static output and static core position, with the position recorded by a traceable micrometer screw.

In the second step the seismometers are placed one by one on a vibrator, where they are subjected to pulse shaped movements with different amplitude and rise time. The deviation between the actual deflection measured by the excitation apparatus and the deflection calculated by multiplying the seismometer output with the calibration factor is calculated. Step two is not always done, but correction factors for the difference between static and dynamic measurement are based on statistics.

In the third step all deflection sensors are place on a stand which is placed on the pavement surface close to the load plate of the FWD. When the load is applied all sensors are subject to the same deflection. Of there is too large difference between the deflection outputs from the different sensors a correction factor is introduced and the test is repeated until the difference is small enough.

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After calibration the following numbers are guaranteed: Systematic error: <2% of measured value +1 micrometer
Random error: Standard deviation < 1% of measured value +1 micrometer

Precision verification

12 drops are made in the same point, which must be a point that is not changed by the dropping. The standard deviation shall be less than 1.25% of measured value +1.5 micropmeter.

Files

The raw data files from the calibration, and the configuration file FVO.INI with the result of the calibration, are saved on the laptop of the FWD.

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