

LIGHT WEIGHT DEFLECTOMETER TESTING

The Light Weight Deflectometer (LWD) apparatus is used to provide in-situ measurement of the foundation surface modulus (E) of the subgrade for use in pavement design. It is also useful in compaction control for bound and unbound base layers and sub-bases.

The foundation surface modulus is a measurement of the stiffness of the layer upon which the test is undertaken in terms of transient deflection caused by the application of a dynamic stress through a circular plate. The test method is set out in BS 1924-2:2018, 9.2 “Hydraulically bound and stabilised materials for civil engineering purposes, Part 2, Sample preparation and testing of materials during and after treatment” but is also referenced in ASTM Standard E2583-07: 2011 “Standard test method for measuring deflections with a light weight deflectometer (LWD).”

The standard test equipment comprises a 300mm diameter plate which is dynamically loaded through a buffer system to produce a load pulse of 15 ms to 30 ms duration using a 10kg weight falling from a variable height (generally less than 1m) to impart a target stress in the order of 100kN/m² (100 +/- 5 kN/m²). The actual stress imparted is measured by a load cell within the equipment and the resulting deflection is measured by a geophone in the centre of the plate to a precision of +/- 2µm.



LWD apparatus

Load and deflection data are recorded and transferred via bluetooth to a smartphone device that stores the data and allows calculation of the foundation surface modulus. Data can be uploaded in the field from the smartphone via the internet.

Testing should be undertaken on a level ground surface but a small amount of kiln dried sand can be added to infill any surface irregularities. The drop weight is raised to a fixed level and generally three seating drops are carried out to bed the plate into the surface. The drop height is adjusted where necessary to ensure that the target peak stress in the region of 100kN/m² is generated.

Three further drops are then carried out to provide the data from which the test results are calculated.

The resultant surface modulus values are generally deemed to be representative of the material beneath the plate to a depth of between 1 and 1.5 times the plate diameter. Where test results need to be reflective of a specific thinner layer, smaller plate diameters of 100mm or 150mm can be utilised.



LWD site set-up

The output values of surface modulus can be used as estimated values of subgrade surface modulus for pavement design purposes in accordance with the Design Manual for Roads and Bridges (DMRB), but BS 1924-2 suggests that the results from LWD devices should only be used where the equipment has been calibrated against a calibrated falling weight deflectometer (FWD) device, which is not always practicable.

The results from the LWD can also be converted to estimated CBR values in accordance with equation 2.4 given in DMRB document CD225 “Design for new pavement foundations”.

$$\text{Equation 2.4: } E = 17.6 (\text{CBR})^{0.64}$$

Comparison of measured CBR values with estimated CBR values from LWD testing gives highly comparable values, especially within the stated validity range of 2 to 12%.

Where the maximum particle size of the subgrade exceeds 20mm, traditional CBR tests are not valid and historically plate loading tests are used from which estimated CBR values can be obtained. However, these tests are time consuming and can be costly, depending upon kentledge requirements. The LWD therefore provides a reliable and quick alternative method of obtaining estimated CBR values in addition to allowing the direct measurement of surface modulus for use in pavement design.