HBRC Journal (2014) **10**, 298–307

Housing and Building National Research Center

HBRC Journal

http://ees.elsevier.com/hbrcj

The use of light weight deflectometer for in situ evaluation of sand degree of compaction

Amr F. Elhakim *, Khaled Elbaz, Mohamed I. Amer

Public Works Department, Faculty of Engineering, Cairo University, Egypt

Received 4 December 2013; revised 23 December 2013; accepted 24 December 2013

KEYWORDS

Light weight deflectometer;
LWD;
Compaction quality control;
Unit weight;
Field density;
Sand density

Abstract The light weight deflectometer (LWD), also known as the light falling weight deflectometer, light drop weight tester, and dynamic plate load test, is a hand portable device that was developed in Germany to measure the soil in situ LWD dynamic modulus. Typically, this modulus is used to evaluate the subsoil degree of compaction. Thus it is suitable for compaction quality control of soil-surfaced roads, embankments and replacement fill. As a dynamic test, the device is suited, in particular, for coarse and mixed grained soils with a maximum grain size of 63 mm. The response of poorly graded calcareous and siliceous sands is the focus of this research. First, the index soil properties of the tested soils including grain size distribution; maximum and minimum void ratios and specific gravity were obtained. Petrographic analyses of the tested sands were also performed to determine their mineralogical composition. A 1-m^3 chamber was built for performing the LWD testing in the laboratory. The study was performed for relative densities of 20%, 40%, 60% and 80% to represent the behavior of very loose, loose, medium dense and dense sands. The effect of the existence of a rigid boundary beneath the tested soil on test results was also investigated to determine the zone of influence of the light weight deflectometer.

1. Introduction

The light weight deflectometer (LWD) is a hand portable falling weight device that first appeared in 1981 at Magdeburg, Germany and developed as in situ testing device by the Federal Highway Research Institute, and HMP Company in Germany [1]. The LWD has gained acceptance and popularity in several countries such as the United States, as there is a growing interest in the use of LWD as in situ spot-testing device for quality control and quality assurance of earthwork compaction [2]. The device was first introduced to Egypt in 2008 for testing both natural subgrade and compacted fill commercially in field work.

The light weight deflectometer is also known by other names including; light falling weight deflectometer, light drop weight tester, and dynamic plate load test. Different types of LWD are commonly available around the world, but are very similar in principle. This research is performed using the LWD No. (1.06.01) produced by HMP Company, which is provided in the German specification [2] to check the suitability of this

* Corresponding author. Tel.: +20 1111921320.
E-mail address: aelhakim@hotmail.com (A.F. Elhakim).
Peer review under responsibility of Housing and Building National Research Center.

ELSEVIER Production and hosting by Elsevier

1687-4048 © 2014 Production and hosting by Elsevier B.V. on behalf of Housing and Building National Research Center.
http://dx.doi.org/10.1016/j.hbrcj.2013.12.003

device for predicting the degree of compaction of the two specified sands.

2. Description of light weight deflectometer

The LWD device consists of the following elements which are illustrated in Fig. 1.

1. A top fix and release mechanism which holds the falling weight at a constant height. This mechanism is released to allow the falling weight to freely drop and transmit the load pulse through the plate resting on the material to be tested.
2. A guide rod that allows the falling weight to drop freely at a set distance of about 720 mm. The guide rod and falling weight together weigh approximately 15 kg.
3. A falling weight grip which provides a grip for the operator to raise the falling weight to the top fix and release mechanism.
4. A falling weight which typically varies between 10 and 20 kg. This weight is capable of being raised to the bottom of the grip predetermined height. The weight is guided by a low resistance rod when dropped to impart a controlled force on the loading plate.
5. A lock pin which has two positions (locked and unlocked) to release the falling weight for use.
6. A damping system which provides a controlled transient pulse length to the impact force, typically in the range of 16 to 30 ms. The spring element is typically a series of rubber cones/buffers, or cylindrical pad system.
7. An anti-tipping fixture that prevents the guide rod and falling weight from tipping when these parts are placed and standing freely on the load center ball/loading plate. A load center ball serves as a connector between the anti-tipping fixture and the loading plate. It also allows for disassembly which reduces the size of the instrument for transport.
8. A cup with sensor that connects to an electronic device and is installed in the middle of the plate. It records the movements of the plate even while the test is being carried out.
9. Carry grips to assist the operator with carrying the loading plate.

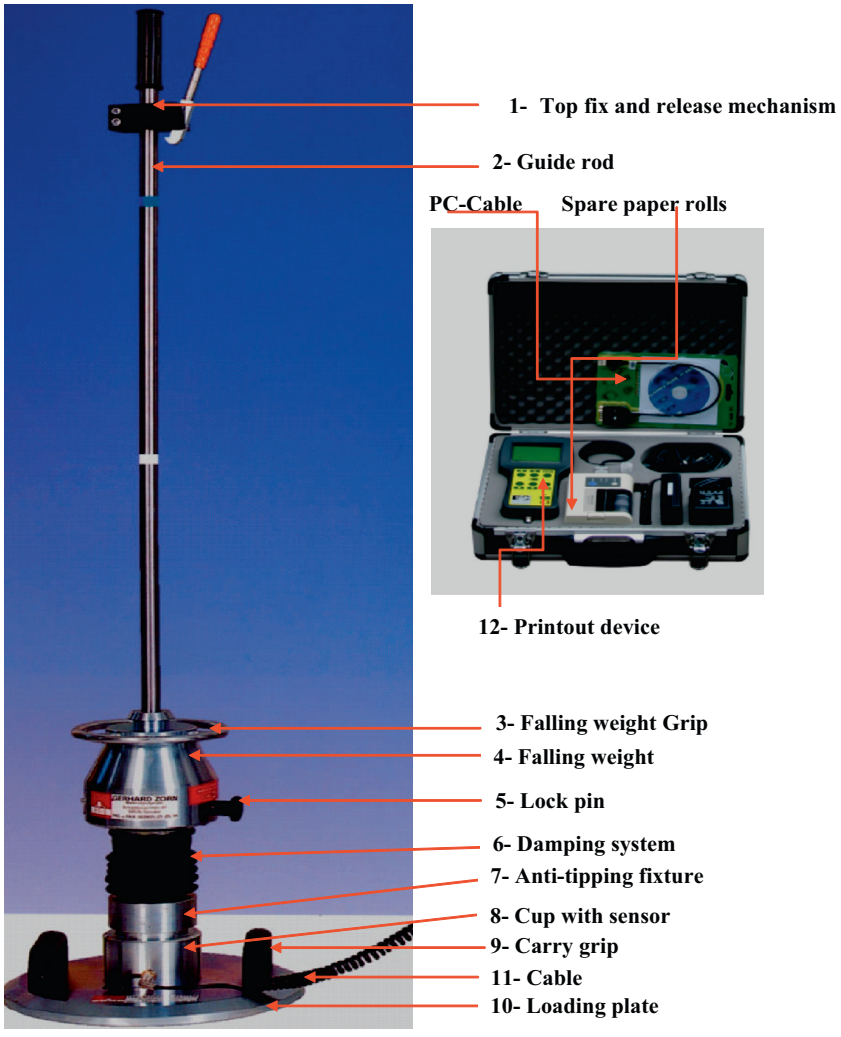

Fig. 1 Components of light weight deflectometer [3].