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Troxler Electronic Laboratories, Inc. - Troxler International, Ltd.
3008 Cornwallis Road, P.O. Box 12057, Research Triangle Park, NC 27709 - USA
Telephone: 1.919.549.8661 Telefax: 1.919.549.0761 Web: troxlerlabs.com

Application Brief

TROXLER MODEL 4640B

Thin Layer
Nuclear Density Gauge

September 2007

Introduction

The Troxler Thin Layer Density Gauge, Model 4640, features patented technology to measure the density of thin asphalt and concrete layers from 2.5 to 10 cm (1 to 4 inches) without influence from underlying material. This model is the only nuclear gauge on the market capable of this method of density testing. This application brief will describe the operation, application and features of the Model 4640 Thin Layer Density Gauge.

Background

Prior to the advent of the Model 4640, a “standard surface moisture/density gauge”, used with a nomograph, provided the only viable means of quickly measuring the density of thin asphalt overlays. Using a nomograph, a backscatter measurement is taken and the top layer density is calculated, provided the top layer thickness and bottom layer density are known. Although a nomograph will, in theory, provide a reasonable estimation of the top layer density, the results are highly dependent on the actual bottom layer density. Since the bottom layer is covered by the overlay, density is usually estimated and results can be erroneous.

Measurement Technology

The thin layer surface nuclear gauge obtains density measurements using backscattered gamma radiation (photons). The system uses two sets of Geiger- Mueller tubes to detect the number of photons scattered towards the detectors. As the density increases the number of photons measured by the detectors decreases.

The only radioactive source needed in this type of nuclear gauge is an 8 mCi Cesium-137 source located in the source rod. This source never leaves the base of the gauge and the source rod never extends outside of the gauge. The source rod of the Model 4640 has two positions, “safe” and “measure”; therefore, this gauge only utilizes the backscatter mode. When the source rod is in the measure position, the source and detectors are in the same horizontal plane. In this mode the photons that enter the measurement medium must be scattered at least once before reaching the detectors. Photons reaching the GM detectors in the 4640 are counted for selected intervals of time. The gauge program uses the counts to determine the density of the material being tested. The number of photons counted is directly related to the density of the material. The lower the density the higher the count rate (fewer

photons will be absorbed or scattered) and the higher the density the lower the count rate (more photons will be absorbed or scattered).

Gauge Operation

The thin layer density gauge allows the operator to determine automatically the true density of thin layer asphalt overlays using Troxler patented technology. After programming the target Marshall and/or Voidless density into the gauge memory, the user need only enter the top layer thickness, place the source rod in the measure position and press the START/ENTER key. The gauge displays the density of the material tested, percent Marshall and percent Voids upon completion of the count time.

Several functions are offered as options on this gauge to make the operation more efficient as well as to improve the accuracy of the testing. The *Average* function provides a method of averaging from 2 to 12 readings. This is especially helpful when testing around a core or core site for correlation purposes. The *Special Calibration* function allows the user temporarily to offset the gauge calibration for use on materials that fall outside of the normal density range of 1762 to 2723 kg/m^3 (110 to 170 PCF). The *Surface Voids* mode may be used to obtain a more accurate reading on material that contains large aggregate. A *Target Precision* count may be used to increase the count time to reach a higher than normal precision (up to 60 minutes). A *Calculator* mode is also offered to assist the operator. The keys located on the two left rows of the keypad are the function keys when the calculator function is enabled. Many more features are available on the Model 4640, as with all of the Troxler gauges.

The Model 4640 keypad is designed so that the operator can easily access any of the gauges many options. The keypad consists of 22 keys with the numeric keys representing a second function, which is accessed by pressing the SHIFT key. The result is a keypad with 32 direct options available. This provides full access to gauge functions while limiting the menu screens to be viewed or the keys to be pressed. A “beep” verifies keystrokes have been received by the gauge. Above the keypad is a 4 line by 16 character alphanumeric Liquid Crystal Display allowing for descriptive menus.

Data Storage

In order to aid the operator the Model 4640 gauge has the capability to store up to 750 gauge measurements by location and project number, print project data and to erase old projects from memory. The Project function allows projects to be created, retrieved, viewed and/or erased. When a project is active, all readings taken will be stored in memory under the project number for retrieval at a later time. The operator may elect to enter a station number and the distance from centerline into memory. Additional information such as grid coordinates, mix type, or any other numeric information (up to 12 characters per line) may be stored. When printing the saved data, either all projects or a single project can be printed. Data may be printed (uploaded) to a computer file or to a printer. The computer control unit or the printer can be connected to the serial port, located on the front of the gauge.

Batteries and Power Consumption

The Model 4640 gauge runs on a rechargeable Ni–Cad battery. Under normal conditions a fully charged battery will remain operational for approximately 8 weeks. When the “BATTERY LOW” warning appears, there are a few hours remaining before the battery must be recharged. A full charge (16 hours) is recommended at that time, but a 30 minute recharge will provide several hours of use if necessary. Two adapters are included as standard accessories with this gauge: either a 120 VAC / 60 Hz for domestic use or a 120 / 230 VAC (50 / 60 Hz) for international use and a 12 VDC charger. Alkaline batteries (D size) can be used temporarily in the event that recharging is not an option. A separate battery case is supplied for this purpose.

Additional Features

Correct gauge operation is ensured by a number of features. To compensate for source decay and natural background factors, such as hydrogen and naturally occurring radiation, a daily reference standard count is performed. The new standard count generated each day is compared to the average of the last four standard counts (Multi-Standard Mode) or to the decay corrected calibration standard count (Single-Standard Mode). The new counts must be within a set limit of the count(s) to which it is compared. This procedure, when performed daily, promotes the highest accuracy and precision possible with the gauge. In the case of readings that seem to fluctuate, a statistical stability, or Stat test may be performed to validate the normal operation of the gauge. An additional test, called a Drift test, can be performed to check the long term drift of the gauge.

Summary

The Model 4640 Thin Layer Density Gauge is a pioneer in true thin lift asphalt testing. This technology to measure the density of thin asphalt and concrete layers is patented and only available from Troxler. The alternative thin layer testing method, known as nomograph, relies on the operator to determine the bottom layer density and the thickness of the top layer. The bottom layer density is often estimated, causing the nomograph readings to be erroneous.

The Model 4640 meets or exceeds all the requirements of “ASTM D – 2950 – 91, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods”. This gauge is specified by many State DOTs, government agencies, and contractors as the best test method for determining the density of bituminous overlays.

In as little as one minute, the 4640 measures and displays densities of thin overlays. The gauge operator enters the thickness of the overlay into the gauge memory and then accurately measures the overlay density (compaction) without influence from the underlying material. Results may be displayed in lb/ft^3, kg/m^3, or g/cm^3, and as percent Marshall, percent voids or percent of theoretical maximum density (voidless). The operator will enjoy the ease of operating this density gauge; it is menu driven and prompts the user through the test procedure.

Comparison of Measurement Precision

Model 4640 Thin Layer Density Gauge

TIME (min.)	THICKNESS	kg/m^3	PCF
0.5	2.5 cm (1”)	+/-23	+/-1.4
	5.0 (2”)	+/-14	+/-0.85
	6.3 (2.5”)	+/-11	+/-0.71
	10.0 (4”)	+/-11	+/-0.68
1.0	2.5 cm (1”)	+/-16	+/-1.0
	5.0 (2”)	+/-10	+/-0.60
	6.3 (2.5”)	+/-8	+/-0.50
	10.0 (4”)	+/-8	+/-0.48
2.0	2.5 cm (1”)	+/-11	+/-0.71
	5.0 (2”)	+/-7	+/-0.52
	6.3 (2.5”)	+/-6	+/-0.35
	10.0 (4”)	+/-6	+/-0.34
4.0	2.5 cm (1”)	+/-8	+/-0.50
	5.0 (2”)	+/-5	+/-0.30
	6.3 (2.5”)	+/-4	+/-0.25
	10.0 (4”)	+/-4	+/-0.24

Precision is defined as +/- one standard deviation in density readings. This number is calculated by the ratio of the standard deviation in the counting rate and slope of the calibration curve at a given density.