

OPERATING MANUAL FOR THE
MICHIGAN NUCLEAR SOIL DENSITY-MOISTURE GAGE

Prepared Under a Research Project Conducted in Cooperation
with the Bureau of Public Roads, U.S. Department of Commerce

Research Laboratory Division
Office of Testing and Research
Research Project 61 E-22
Research Report No. R-500

LAST COPY
DO NOT REMOVE FROM LIBRARY

Michigan State Highway Department
Lansing, March 1965

OPERATING MANUAL FOR THE MICHIGAN NUCLEAR SOIL DENSITY-MOISTURE GAGE

This manual has been prepared to provide nuclear gage operators with basic information to ensure reliable and uniform use of the equipment. It is also intended as a reference for all Department personnel involved in use of nuclear gages for soil testing.

General Instructions and Precautions

Although the nuclear gage is a fairly rugged instrument there are several electronic components that could be damaged or jarred out of adjustment by severe shocks. It is recommended that the instrument system be given the same care in handling and transporting as a transit or engineer's level.

The instrument should not remain inoperative for prolonged periods of time. Experience has shown that gages not operated regularly are more liable to malfunction than gages in regular use. When no field testing is required, the instrument should be operated for at least 1 hr each week, preferably a few minutes each day, and the battery checked for water and recharged each week. Both regular operation and weekly battery maintenance should be performed without fail to minimize battery failure and down time for repairs.

Description of Equipment

Principal items of equipment required for determining in-place soil density and moisture by the nuclear method include the following:

1. Gage. The unit containing the radioactive source and radiation detector tubes. It is placed directly on the soil to be tested. The term "gage" is also frequently used in referring to the entire instrument system; the intended meaning of the term is usually clear from the context in which it is used.

2. Scaler. An electronic counter that presents the gage reading.
3. Standard. A block of material having constant density and moisture content. The gage is placed on the standard and checked for proper performance.
4. Calibration Curves. Charts provided with each instrument for converting gage readings to density and moisture values. These charts are to be used only with the particular instrument for which they are issued.

Operating Instructions

Initial preparation for field testing:

1. Connect the gage and scaler. Turn the power on and allow the instrument to warm up about 5 min. When tests are to be performed frequently throughout the day, leave the equipment connected and turned on all day. Be sure the scaler power is turned off when connecting or disconnecting the cable, to avoid electric shock and to prevent damage to electronic components.
2. Place the gage on the standard and obtain a density reading and a moisture reading. Enter these readings in Columns 3 and 4, respectively, on the nuclear density inspection form. A sample copy of this form is included in this manual.
3. Prepare the surface of the soil to be tested by removing all loose dry material. Level the surface and remove voids with a straight edge so the gage will sit flat without rocking.

Determination of in-place density and moisture:

1. Place the gage on the prepared surface and obtain density and moisture readings. Enter these readings in Columns 5 and 7, respectively, on the form.
2. Using these readings (Columns 5 and 7), determine the wet density and percent moisture from the appropriate calibration curve. Enter these values in Columns 6 and 8 on the form.

3. Compute the dry density from the following formula (in which m = percent moisture, dry basis), and enter in Column 9 on the form:

$$\left(\text{dry density} = \frac{\text{wet density}}{1 + \frac{m}{100}} \right) \text{ or } \left(\text{Column 9} = \frac{\text{Column 6}}{1 + \frac{\text{Column 8}}{100}} \right)$$

This procedure uses the nuclear method to determine in-place soil conditions. Tests for determining maximum unit weight are conducted in the conventional manner and the results entered working up from the bottom of the form.

Routine Maintenance

1. The battery must be charged daily when the instrument is in use. Plug the charging cord into any ordinary electrical outlet (110-v ac, 60-cycle). Recharge overnight with scaler set on "automatic."

2. Check the water level in the battery before charging. Refill only with distilled water, which can be obtained from either a drug store or the Research Laboratory.

3. When the instrument is not used for prolonged periods, it should be operated at least 1 hr each week by obtaining several moisture and density readings on the standard. The battery should also be checked for water level and charged at this time. If checked and maintained in this manner, the equipment should be in condition for use at all times.

4. Other maintenance and repairs should be performed by Research Laboratory personnel.

Personnel Safety

A 5-millicurie source of Radium-Beryllium, contained in the gage, constantly emits ionizing radiation which could cause damage to human tissue, if the gage is handled improperly. However, the gage is designed with adequate protective shielding, provided persons do not remain near the gage for too a long period of time.

1. Operators should wear film badges at all times while working with the gage. These badges measure the exposure received by the wearer, and are processed and read every two weeks. When not in use, badges should be stored well away from gages to avoid indicating exposure that the operator does not actually experience.

2. Personnel not wearing a film badge should remain at least 5 ft from the gage. Operators can handle the gages safely and work nearer than 5 ft during the time needed to perform tests, because any buildup in absorbed radiation would be indicated on the film badge and corrective measures taken. No person, however, should remain near the gage longer than necessary.

3. The gage should be stored in a locked container when not in use. The gage can be locked either in the density kit on the truck or in a box inside the project office. The kit or box should be clearly marked with a yellow-and-magenta sign "Caution--Radioactive Material."

Accident Procedure

In case of an accident causing damage to the gage there is danger that the source may be ruptured, allowing the radioactive material (which is a powder) to spread over a wide area. This would create a definite radioactive hazard to persons exposed.

In event of any accident, take the following immediate steps:

1. Keep persons away from any fumes, smoke, etc. Stay upwind of the source.
2. Seal off at least a 50-ft radius around the source to prevent possible tracking of radioactive material.
3. Call the nearest State Police post (Area Code 517, 332-2521, for the Lansing area).
4. Call the State Health Department (Area Code 517, 373-1410).
5. Call the MSHD Safety Section (Area Code 517, 373-2288).

