INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

DETERMING TARGET INTELLIGENT COMPACTION MEASUREMENT VALUE OF A SOIL
ITM No. 513-25

1.0 SCOPE

1.1 This method of test covers the procedure for determining the target Intelligent Compaction Measurement Value (IC-MV) of a soil. The number of IC-MV roller passes is also determined at the specified moisture range. DCP requirements for QC/QA Soils can be determined by the same procedure. This procedure includes methods for determining the number of blow counts for 95% compaction for modified Proctor or 100% compaction for standard Proctor.

1.2 The target IC-MV is required to be monitored to verify changes in the soil or the roller response as lifts of the soil progress or conditions change. New test sections may be required when these changes occur.

1.3 This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the ITM. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

T 99 Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
T 180 Moisture-Density Relations of Soils Using a 4.5-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
T 191 Density of Soils by In-Place

2.2 ITM Standards.

ITM 506 Field Determination of Moisture Content of Soils
ITM 509 Field Determination of Strength Using Dynamic Cone Penetrometer
ITM 512 Field Determination of Maximum Dry Density and Optimum Moisture Content of Soil
ITM 803 Contractor Quality Control Plans

3.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101 and as follows:

3.1 Construction Area. Subsections of the contract being compacted continuously by the Contractor that are used to evaluate the soil stiffness for acceptance.

3.2 Global Positioning System (GPS). A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. For this application, GPS is referred to all GPS-related signals including US GPS and other Global Navigation Satellite Systems (GNSS).

3.3 GPS Base Station. A single ground-based system that consists of a GPS receiver, GPS antenna, radio, and radio antenna to provide L1/L2 differential GPS correction signals to other GPS receivers within a range limited by radio, typically 3 miles in radius without repeaters.

3.4 GPS Rover. A hand-held GPS radio/receiver for in-situ point measurements.

3.5 Intelligent Compaction (IC). A process, using accelerometer or Machine Drive Power (MDP) technology, that is equipped with a compaction measurement and documentation system that automatically records various critical compaction parameters in real time during the compaction process. IC uses roller compaction measurements to assess the mechanistic soil properties and to ensure optimum compaction is achieved through continuous monitoring of the operations.

3.6 Intelligent Compaction Measurement Value (IC-MV). The output from the IC roller represents the stiffness of the soil based on the rolling resistance or vibration of the roller drums and the resulting response from the underlying materials.

3.7 Intelligent Compaction (IC) Roller. A self-propelled static or vibratory roller equipped with machine drive power and/or with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted soil to evaluate the applied compaction effort. IC rollers may be configured in various combinations to include smooth or pad foot drums, static or vibratory, and accelerometer or MPD.

3.8 Mapping. The process of rolling the Construction Area with the IC roller to determine the IC-MV.

3.9 QC/QA. Quality control/quality assurance of the embankment or subgrade.

4.0 **SIGNIFICANCE AND USE.** This ITM shall be used to determine the target IC-MV of a soil that corresponds with the target DCP measurement at the required moisture content range. The target IC-MV is determined by several roller passes. Soil compaction may be determined by monitoring the stiffness using the IC-MV.

This ITM shall be used to determine the number of roller passes for verification of DCP requirements for QC/QA Soils in accordance with ITM 803. This procedure shall exclude section 5.4, section 7.7, sections 8.6-8.9, section 9, and section 10.2.

This ITM shall be used to estimate the number of DCP blow counts when 95% compaction of the modified Proctor or 100% compaction of the standard Proctor is required. This procedure shall exclude section 5.4, section 7.7, sections 8.6-8.9, section 9, and section 10.2.

5.0 APPARATUS.

5.1 IC Roller, meeting the requirements of Section 3.7

5.2 DCP, meeting the requirements of ITM 509

5.3 Moisture content equipment, meeting the requirements of ITM 506

5.4 GPS equipment, which shall consist of a GPS Base Unit and a GPS Rover as defined in 3.3 and 3.4

6.0 GEOMETRICS OF A TEST SECTION. The test section shall be approximately 100 ft long and 24 ft wide. Smaller test section may be considered if approved by the Engineer and the Division of Materials and Tests. For IC accelerometer and IC MDP type rollers, the initial test section shall be mapped after approximately 12 in. for clayey soils and 18 in. for others of embankment has been placed. QC/QA Soils test section shall use the same geometrics for all types of compaction equipment.

7.0 TEST SECTION PREPARATION.

7.1 The ground surface shall be proofrolled in accordance with 203.26 prior to construction of the first lift of the test section. The moisture content shall be in accordance with 203.09.

7.2 The soil in the test section shall meet the requirements of 203.09 and 203.23.

7.3 The roller shall be checked to assure that the equipment complies with the specification requirements. The speed of the roller and the frequency of vibratory rollers shall be consistent throughout the test section. There shall be no stopping or turning within the established test section.

7.4 The boundaries of the test section shall be determined by the GPS rover and visually identified for the IC Roller Operator and Technicians.

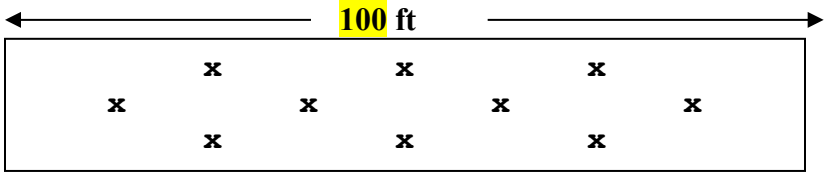
8.0 PROCEDURE – NUMBER OF ROLLER PASSES

8.1 Initially roll each lift of the test section with a minimum of five roller passes. Rutting greater than ½ in shall not be accepted prior to placement of the next lift. Test section shall have thickness of 12 in. for clayey soils and 18 in. for other soils.

Note 1: A roller application is defined as one pass of the roller over the entire test section.

Note 2: The roller that is used for normal production compaction shall be used for the test section. This may be the IC roller or a different roller as designated in the Quality Control Plan.

8.2 Following the initial applications with the compaction roller, obtain 10 DCP tests for 6 in. for clayey soils or 12 in. for other soils in accordance with 203.23 spaced uniformly throughout the test section at the following locations. Each location shall be marked with paint.



8.3 Average the 10 DCP test values for the top 6 in. for clayey soils and the top 12 in. for other soils. The average shall include no more than two out of ten tests short of the target DCP values specified in the 203.23. No individual DCP value shall be more than 2 below the minimum specified in 203.23. If these conditions are not met, the material shall be reworked or dried and the test area shall be retested.

8.4 When the average of the 10 DCP tests meet the DCP value requirements of 203.23, the number of roller passes that was used is reported and the test section is complete.

8.5 Additional rolling is required when the average DCP values do not meet the requirements of 203.23, or when the conditions of 8.3 are not met. After the additional roller passes are complete, perform the DCP tests at the same 10 locations 1 ft from each original test site and repeat section 8.3. For material requiring 100% compaction of standard Proctor, proceed to section 8.10. For material requiring 95% compaction of modified Proctor, proceed to section 8.11.

8.6 When the test section is complete, the test section for mapping with one or more passes of a smooth drum roller or grader to provide a smooth surface for the IC mapping. If pad footed rollers were used for the compaction of the test section and IC pad footed rollers are used for mapping, this additional preparation is not required.

8.7 Zero the roller data and printer and verify this equipment is ready to function

8.8 Map the test section and print the data from the IC roller

8.9 Report the initial target IC-MV value by recording the average IC-MV from the printout

8.10 Process for 100% compaction for standard Proctor

8.10.1 Determine the maximum dry density and optimum moisture content of the soil in accordance with ITM 512 or AASHTO T 99.

8.10.2 Additional rolling is required for 100% compaction.

8.10.3 After the additional rolling is completed, three sand cone tests shall be performed in accordance with AASHTO T 191. The test locations shall be spaced uniformly throughout the test section. Determine the average of the three density values obtained from the sand cone tests. All three results shall be within 5 pcf.

8.10.4 Compare the average of the three density tests determined by sand cone to the maximum dry density of the soil. When the average test density is greater than or equal to the maximum dry density, the compaction is 100% and the test section is complete. If the compaction is less than 100%, additional compaction is required.

8.10.5 Repeat sections 8.2 to 8.5 to achieve 100% compaction.

8.10.6 The average of the ten DCP values shall be a minimum of 2 DCP values greater than the DCP values specified in 203.23 for the given material for 95% compaction levels.

8.11 Process for 95% compaction for modified Proctor

8.11.1 Determine the maximum dry density and optimum moisture content of the soil in accordance with AASHTO T 180.

8.11.2 Additional rolling is required for 95% compaction.

8.11.3 After the additional rolling is completed, three sand cone tests shall be performed in accordance with AASHTO T 191. The test locations shall be spaced uniformly throughout the test section. Determine the average of the three density values obtained from the sand cone tests. All three results shall be within 5 pcf.

8.11.4 Compare the average of the three density tests determined by sand cone to the maximum dry density of the soil in accordance with AASHTO T 180. When the average test density is greater than or equal to 95% of the maximum dry density, the test section is complete. If the compaction is less than 95%, additional compaction is required.

8.11.5 Repeat sections 8.2 to 8.5 to achieve 95% compaction.

8.11.6 The average of the ten DCP values shall be a minimum of 2 DCP values greater than the DCP values specified in 203.23 for the given material for 95% compaction levels.

9.0 PROCEDURE – TARGET IC-MV

9.1 Set the initial target IC-MV in the IC roller.

9.2 Compact the construction area.

9.3 Verify that the DCP and moisture acceptance tests on each lift of the 12 in. or 18 in. layer construction area meet the specification requirements.

9.4 Prepare the construction area with one or more passes of a smooth drum roller or grader to provide a smooth surface for the IC mapping. If pad footed rollers were used for compaction and IC pad footed rollers were used for mapping, this additional preparation is not required.

9.5 Zero the roller data and printer and verify this equipment is ready to function.

9.6 Set the printer to identify at least three deficient areas.

9.7 Map the construction area with the IC roller.

9.8 Print the data from the roller and identify the deficient areas from the printout and operators screen.

9.9 Select three deficient areas with the lowest IC-MV for further investigation with the DCP.

9.10 Test each of the deficient areas with the DCP and locate one boundary for each of the three deficient areas. A boundary is a location where the DCP test results transition from failing to passing tests.

9.11 Identify each boundary with paint.

9.12 Correlate the boundary limits with the IC roller information screen and drive the roller to the boundary of the first deficient area.

9.13 Compare the red area on the IC roller screen to the location of the roller icon on the screen.

9.13.1 If the red boundary matches the location of the roller, the target IC-MV is tentatively correct.

9.13.2 If the red boundary does not match the location of the roller, adjust the target IC-MV on the IC roller screen until the boundary correlates with the roller location at the edge of the deficient area. Increasing the target IC-MV enlarges the red area and decreasing the target IC-MV reduces the red area.

9.13.3 Record the tentative target IC-MV for the first deficient area.

9.14 Drive the roller to the boundaries of the second and third deficient areas and repeat step 9.13. Additional deficient areas may be tested if there is an inconsistency in the test results from the three deficient areas. A minimum of three representative deficient areas are required to determine the final target IC-MV.

9.15 Average the target IC-MV numbers obtained from the three deficient areas to determine the final target IC-MV for that type of soil.

9.16 Set the target IC-MV in the roller software and print the report for the mapped area.

10 REPORT.

10.1 The information from the test section shall include the date, location, number of passes to achieve the target DCP, DCP test data for the initial passes and each additional pass of the roller, the type of roller used to compact the test section, and DCP blow count for 100% of the standard Proctor or 95% of the modified Proctor shall be reported.

10.2 The target IC-MV shall be reported.