MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**INTELLIGENT COMPACTION MAPPING OF SUBBASE AND AGGREGATE BASE**

DAV:TLB 1 of 5 APPR:DMG:RWS:09-01-21

**a. Description.** This work consists of utilizing intelligent compaction (IC) technology to map the uniformity and relative stiffness of the constructed subbase layer and the aggregate base layer at the locations where trunkline pavement construction will occur. IC is a process that uses vibratory rollers equipped with a measurement and documentation system that automatically records compaction parameters in real time and roller location by GPS. IC data will be considered when selecting density test locations for QA.

Provide a sufficient number of IC rollers and associated equipment to complete the compaction requirements for the subbase and aggregate base layers. IC rollers may be used during all production work and will be required for evaluation of the compaction operation. IC documentation of proof rolling measurement passes is required for the specified work.

**b. Materials.** Furnish materials for subbase and aggregate base in accordance with the plans and standard specifications.

**c. Equipment.** Furnish the Engineer with the proprietary IC software and access to personal computer based or web-based data storage until 6 months after the final grading work is accepted. Ensure this software allows the capability to export roller files and optionally transfer to web-based storage as detailed in subsection f. of this special provision. Furnish instrumented rollers meeting the following:

1. Self-propelled single smooth drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials.

2. The output from the roller is designated as the Intelligent Compaction Measurement Value (ICMV). The ICMV correlates to the stiffness of the material.

3. Includes an integrated on-board documentation system that is capable of displaying real-time color-coded maps of ICMVs, roller location, number of roller passes, machine settings, roller speed, frequency and amplitude of roller drums. Ensure the display unit is capable of transferring data by means of a universal serial bus (USB) port and/or cloud-based storage.

4. Mount real time kinematic GPS (RTK-GPS) radio and receiver units or equivalent on each IC roller. Use the Michigan State Plane Coordinate system as the horizontal datum referenced in the RTK-GPS. Use the State Plane Coordinate Zone for this project as indicated on the plans. Use the North American Vertical Datum of 1988 (NAVD 88) as the vertical datum referenced in the RTK-GPS, unless a local vertical datum has been specified by the Engineer.

5. Base Stations. Furnish ground mounted or virtual GPS base units that record values in northing, easting and the elevation data in feet using the State Plane Coordinate System along with the longitude/latitude of the ICMV. Ensure the GPS base station broadcasts updated correction data to the GPS receivers on the IC rollers and the hand-held rovers during operation with a survey tolerance of not greater than 1.6 inches in both horizontal (x and y) directions.

6. Rover. Furnish a portable hand-held GPS radio/receiver for locating in-place density measurements.

7. Furnish RTK-GPS and IC rollers that operate within the tolerances in Table 1.

**Table 1: Intelligent Compaction Tolerance Requirements**

|  |  |
| --- | --- |
| Parameter | Tolerance (±) |
| Roller Position  (northing, easting and elevation) | 1.6 inch |
| Roller Speed (forward) | 0.3 mph |
| Frequency | 2 Hz |
| Amplitude | 0.008 inch |

**d. Data Analysis Software.** Use the latest version of the standardized data analysis software, Veta. It is available for download at [www.intelligentconstruction.com](http://www.intelligentconstruction.com). Veta will utilize the ICMV data from the IC roller for analysis of coverage, uniformity, and stiffness values during production and proof rolling of subbase and aggregate base lifts. Ensure at a minimum, the following information is exportable to either American Standard Code for Information Interchange (ASCII) or Text Format or directly importable to the Veta software for processing:

1. File name.

2. Date and time stamps.

3. Machine manufacturer, model, and type.

4. Drum width and diameter.

5. Roller and drum weight.

6. Roller RTK-GPS positions with northing, easting, and elevation.

7. Roller speed, pass count and travel direction (forward or backward).

8. Drum frequency and amplitude.

9. ICMV, reporting resolution for independent ICMVs in the roller moving direction and 90 degrees to the roller moving direction.

10. Number of IC data points.

**e. IC Training.** The IC vendor and Contractor must provide training on the use of the Veta software and hands on field usage of the IC equipment as needed for the appropriate Department and Contractor staff. Ensure the Veta software training is provided by The Transtec Group or Engineer approved equivalent. Ensure the field training for familiarity with the IC equipment and implementation of this special provision is provided within the limits of the project by the IC vender and Contractor prior to implementing IC operations. At a minimum, the staff to receive the IC training is as follows:

1. Department staff:

A. Inspectors.

B. Construction Engineer and assistants.

C. Density Control Specialists.

D. IC Initiative Team.

2. Contractor staff:

A. Operators of the instrumented rollers.

B. QC field representative.

C. Field grading superintendent.

D. Other Contractor specified personnel.

The training conducted by the IC vendor must cover at a minimum the following topics:

3. General background information on IC and GPS.

4. Hands on operation of the IC system including on-board documentation system, proprietary software use and setup.

5. Verification of IC GPS accuracy.

6. Details on the system relevant to both the Contractor and Department. At a minimum:

A. data transfer.

B. data backup.

C. recommended operator settings.

D. data storage capacity of on-board documentation system.

E. base station and GPS use.

F. Veta analysis.

**f. Construction.**

1.Develop and implement a project specific QC plan for subbase and aggregate base layer material construction that is based on roller compaction parameters, moisture, density, and other QC practices that will provide ongoing IC data to the Engineer. Ensure the materials are placed and compacted in accordance with the standard specifications to meet density requirements detailed in the *Density Testing and Inspection Manual* (Manual).

2. Verify the proper setup each day prior to the start of the IC work. In the presence of the Engineer, the Contractor, GPS representative or IC roller manufacturer must verify the proper setup and accuracy of the GPS, IC roller(s) and the rover(s) using the same datum as follows:

A. Move the IC roller around until the GPS header computation is initialized.

B. Move the IC roller and park at a selected location.

C. Record the GPS measurements from the IC roller ensuring the distance offsets are applied so that the GPS coordinate is at the center or at left/right edges of the front drum.

D. Mark two locations on the ground adjacent to the right and left edges of the front drum contact patch.

E. Move the IC roller from the marked locations.

F. Use a hand-held rover to measure the marked locations.

G. Average the rover GPS measurements if the roller GPS measurement is at the center of the front drum.

H. Ensure the differences between the roller GPS and rover measurements are within ±12 inches for northing and easting.

Do not begin work until proper verification has been obtained.

3. Construct test strip utilizing IC technology. At a location agreed upon by the Engineer and Contractor, construct at least one test strip to establish a rolling pattern for each lift of subbase and aggregate base material. Ensure the subbase and aggregate base layers are constructed in lifts in accordance with the standard specifications.

Construct additional test strips when a change has been made to the source, gradation, material, moisture, and lift thickness or as directed by the Engineer. Each test strip may be left in place and included as part of the project. Construct the test strips approximately 100 feet long and 20 feet wide within the project limits unless otherwise directed by the Engineer.

Initiate the test strip with two passes with the IC roller. After two passes, mark and take three density and moisture content measurements at randomly selected locations at least 2 feet from the edge of the material course. Take additional density and moisture content measurements at the three original locations after every 2 subsequent passes of the roller. Continue to compact the test strip until the target maximum density as required in the Manual is achieved.

After the test strip has been constructed, place and compact successive lifts of subbase and aggregate base layers in a similar manner to meet required density specification.

Determine the moisture content of the subbase and aggregate base material at the beginning of and during compaction in accordance with the Manual. Maintain the moisture content of the specified material during compaction within the acceptable range as specified in the Manual.

4. Proof roll the finished subbase and aggregate base layers over the full width of the layer using the same IC rollers throughout the project. Provide the locations for the proof rolling measurement passes to the Engineer at least 24 hours in advance. Ensure all required information detailed in subsection d. of this special provision is recorded during compaction efforts. Conduct proof rolling with IC rollers moving in the forward direction only at a speed of 3 mph and using the vendor recommended drum weight, constant frequency, and amplitude. Provide to the Engineer immediate viewing of the measurement pass data as requested. After completion of the measurement pass, provide to the Engineer electronic or printed copies of the compaction data files before placing successive layers.

5. Final compaction acceptance of the subbase and aggregate base layers will be based on Department-performed field density and moisture content measurements in accordance with the Manual. Supply GPS measurements for all density test locations, obtained utilizing the rover. Rework and compact material that fails to meet the applicable density requirements before the next lift is placed. Perform this work at no additional cost to the contract.

**g. Measurement and Payment.** All costs associated with utilizing IC technology as specified herein are included in the applicable unit prices for the subbase and aggregate base items. No additional payment will be permitted.