Future of Construction: Intelligent Compaction

By

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Outlines

• Intelligent Compaction (IC)
• Veta for Data Management
• US National Implementation
• Benefits of Using IC
• Future Development and Further Information
Intelligent Compaction
OEM IC Systems
Example IC Retrofit System

MCi-3 and Satel Radio

GPS Antenna

Accelerometer

GX-60

Infrared Temperature Sensor

Courtesy of Topcon/RDO
Intelligent Compaction Measurement Values (ICMV)

Roller Drum

Compacted Materials

Accelerometer

Compaction & reaction force

Control System

ICMV

correlation with materials modulus & density
Various ICMVs

CMV Level 1
CCV Level 1
HMV Level 1
CMV, $E_{\text{VIB}}$ Level 1
$E_{\text{VIB}}$ Level 3
$K_b$ Level 3
CPMS-VCV Level 3
UIC—$F_r, E_{\text{est}}$ Level 4
Asphalt Density vs ICMV (Stiffness)
GPS Validation

AASHTO PP81  Diff < 6 in.
Temperature sensor validation

AASHTO PP81  Diff < 5 °F
Example IC Color-Coded Displays

Roller Passes

Asphalt Temperature

ICMV
Spot Tests and GPS Data
Daily Production Boundary
Alignment File – KMZ, LandXML
Veta for Data Management
Standard ICDM Software - Veta
IC/PMTP data

Automatic Wireless Transmission

Manually “Push”

Vendor’s cloud Server

Project and Machines IDs setup

Ungridded or gridded data files

Storage time

User log-in for access

THE TRANSTEC GROUP
Veta IC Analysis
IC Data Analysis
Veta Analysis – Coverage of Target Passes

Filter Group: 20160121-HMA-EB-L1
Overall Results

- 3+ Passes: 71.6%
- 2 Passes: 26.0%
- 1 Pass: 2.4%
Target ICMV from Trial Section Data

Passing

\[ R > 0.7 \]

Or

\[ R^2 > 0.5 \]
**Target ICMV for QC**

- **Target ICMV**: Blue line
- **ΔICMV<5%**: Blue dashed line between 1.5 and 2 on the y-axis
- **Optimal pass**: Red arrow from pass 2 to pass 3
Veta Analysis – Coverage of Target ICMV

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
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<tr>
<td>Mean</td>
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<td>Standard Deviation</td>
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<td>CoV (%)</td>
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<td>Max</td>
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<tr>
<td>Acceptance</td>
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National Implementation
A BRIEF HISTORY OF IC IN US

FHWA IC Road Map

2004

HfL IC Study

NCHRP 21-09 Study

2006

FHWA IC Spec

2008

AASHTO IC Spec

2010

NOVA Award

2012

IC Retrofit Study

2014

NCHRP 24-45 Study

2016

TPF-5(128) study

2018

EDC IC Support

2020

IC Retrofit Study

IC & Asphalt Density Study

TPF-5(334) study

????
US National IC Guide Specs

FHWA Soils/Asphalt IC

AASHTO PP 81-17 & Data Spec.

Standard Specification for Intelligent Compaction Technology for Embankment and Asphalt Pavement Applications

**AASHTO Designation:** PP 81-17

**Tech Section:** 5c, Quality Assurance and Environmental

**Release:** Group 1 (April 2017)

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**DESCRIPTION**

This standard covers the construction of the Smart IC embankment using Intelligent Compaction (IC) rollers within the limits of the work as described in the plans. IC is achieved in a process that uses static rollers equipped with automatic compaction technology. IC rollers are equipped with sensors that record the actions taken by the rollers while they are in use. These sensors provide real-time data that is used to evaluate the compaction process and ensure that the finished product meets the specified requirements.

**EQUIPMENT**

The IC rollers shall meet the following requirements:

1. IC rollers shall be well-profiled single drum rollers equipped with sensors to measure the performance of the roller and ensure they meet the specified requirements. The sensors shall be capable of measuring the vertical force applied by the roller and the movement of the roller while in use.

2. The roller shall be designed and built to perform the Intelligent Compaction Movement Value (ICMV), which represents the roller's ability to achieve the specified movement value for the given compaction application. IC rollers shall be equipped with sensors to monitor the movement of the roller while in use.

3. The roller shall be designed to achieve the Intelligent Compaction Measurement Value (ICMV), which represents the roller's ability to achieve the specified movement value for the given compaction application. IC rollers shall be equipped with sensors to monitor the movement of the roller while in use.

4. Roller-reversed GPS roller and recovery units shall be positioned to ensure proper alignment of the roller and to ensure the accuracy of the movement values recorded by the sensors. The sensors shall be capable of measuring the movement of the roller while in use.

**Standard Specification for File Format of Intelligent Construction Data**

**AASHTO Designation:** MP NN-16

**Tech Section:** 5d, Data Requirements and Specifications

**Release:** Group 1 (April 2017)

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**Release:** Group 1 (April 2017)
MnDOT IC Implementation plan

% of MnDOT Projects meeting project selection requirements.

- 2014: 10%
- 2015: 10-15%
- 2016: 40-50%
- 2017: 50-75%
- 2018: 100%
Benefits of Using IC
Pre-Mapping Subbase

Asphalt Compaction
Premature Failure

HMA Map

Subbase Map

Approximate location of subgrade section failed during test rolling (~ Sta. 134+00 to 144+00)

Approximate location of HA+MA non-wearing course layer failure due to construction traffic (~ Sta. 140+12 to 142+61)
Identify Underlying Joints

PCC Joints

Centerline

HMA Overlay
Lift 1

CMV

15 ft
Joint spacing

Courtesy of MNDOT
Improved Rolling Pattern

Before

After the Blind Test

After
Improved Roller Coverage

First Time Use of IC

Lift 1 without IC
< 3 Passes: 31 %
≥ 3 Passes: 69 %
COV: 71%

Lift 2 with IC
< 3 Passes: 10 %
≥ 3 Passes: 90 %
COV: 55%

Improved Consistency

Courtesy of MNDOT
Identify Causes of Failed Density

**Passed**
Consistent Vib Thru Out

**Failed**
Turn off Vib Too Early

 Courtesy of MnDOT
Future Development & Further Information
Advancements of ICMV

ICMV Road Map

Level 1
Level 2
Level 3
Level 4
Level 5
True Intelligent IC

Advanced Intelligent Compaction Technology
TPF-5(334) ICDM-Veta Pooled Fund Study

Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation

General Information

Study Number: TPF-5(334)  Status: Cleared by FHWA
Lead Agency: Minnesota Department of Transportation  Contract/Other Number:
Contract Start Date:  Last Updated: Jul 26, 2017
Est. Completion Date:  Contract End Date:
Solicitation Number: 1381
Partners: x, AK, AL, CA, CT, GA, ME, MN, MO, MS, NY, OR, PA

Contact Information:

Lead Agency Contact(s):
- Debra Fick
deb.fick@state.mn.us
- Phone: 651-366-3759

FHWA Technical Liaison(s):
- Richard Duval
Richard.Duval@dot.gov
Connected Sites

1. **FEASIBILITY PLANNING**
   - **Quanm**
   - **Quadri Connected Community Connect**

2. **DETAILED PLANNING**
   - Novapoint
   - Tilos

3. **DETAILED DESIGN**
   - Novapoint
   - Tilos

4. **ESTIMATING & BIDDING**
   - Business Center - HCE

5. **PLANNING & SCHEDULING**
   - Tilos

6. **EXECUTE CONSTRUCTION**
   - Business Center - HCE
   - Machine Control Systems
   - Site Positioning System
   - VisionLink

7. **AS-BUILT / SIGN OFF**
   - Business Center - HCE

8. **OPERATION & MAINTENANCE**
   - Novapoint

Courtesy of Trimble
International Intelligent Construction Technologies Group
Thank You!

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IntelligentCompaction.Com
IntelligentConstruction.Com
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