INTELLIGENT COMPACTION

More Science than Art

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Why use IC?

- Good pavement requires a uniform foundation to build on
- Current compaction methods do not meet the needs

Fatigue life increases 70% on average with uniform support
What is it?

- A vibratory roller with a stiffness measurement system that records the material’s stiffness in real time
- A GPS system that tracks the roller’s position and pass counts in real time
- An in-cab display panel showing a color-coded map of stiffness, roller’s position, and pass counts in real time
What is it? - IC Rollers and Measurements

**Caterpillar:** CMV, MDP

**Dynapac:** CMV

**Bomag:** $E_{\text{VIB}} \ (\text{MN/m}^2)$

**Sakai:** CCV

**Case/Ammann:** $k_b \ (\text{MN/m})$

**Hamm:** HMV
What is it? - TxDOT IC Retrofit Kit

- Display Panel
- Accelerometer
- Receiver
- IC Retrofit Kit
What information does IC provide?

✔ Stiffness
✔ Pass Counts

![Stiffness](image)

![Pass Counts](image)
IC provides stiffness and pass counts in two separate data files:

- **All Passes Data**: IC data (stiffness and pass counts) for all passes for a given area
- **Final Coverage Data**: IC data (stiffness and pass counts) only for last pass for a given area
How to use the IC information?

- **ICMV (IC Measurement Values)**
  - A whole set of IC data collected in a given area
  - ICMV is assumed in normal distribution

- **ICTV (IC Target Value)**
  - The average of ICMV
  - Color codes are based on ICTV
How to use the IC information?

In-situ point tests such as NDG and DCP are performed based on the color-coded maps.
TxDOT IC Projects

Fort Worth (12)
- FM156; DFW Connector; US287; FM1938
- FM730; SH267; IH35W; and IH30; FM2264; FM1189; FM19838 (extension); US281

Amarillo (1)
- LP335

Waco (2)
- SH95
- FM2311

El Paso (1)
- FM1281

Brownwood (3)
- FM2214
- SH6
- SH206

Austin (1)
- FM1460

Paris (2)
- SH24
- US75

Atlanta (1)
- FM450

Beaumont (1)
- US90

Houston (1)
- SH35
TXDOT Fort Worth District IC Projects

- **FM156 (FHWA Demonstration Project)**
  - FHWA/Pooled-fund study IC demonstration
- **FM1938 (Highway for Life Project)**
  - TxDOT retrofit kit implementation
- **DFW Connector Design-Build Project**
- **US 287 in Mansfield**
- **FM 731 at Lake Weatherford**
- **US 67 Bypass north of Cleburne**
- **IH 35W in North Fort Worth**
- **SH 267 Bypass around Dublin**
Intelligent Compaction

- FM 156 (North Fort Worth at Alliance Airport)
- FHWA/TPF IC Study
- Cohesive subgrade, Lime treated subgrade, and Aggregate Base (Flex Base)

**padfoot drum IC roller**

**smooth drum IC roller**

Dynapac Single Smooth drum IC roller
Intelligent Compaction

$K_s$ shows compaction progress and a soft area

Case/Ammann
Single-drum padfoot IC roller
Detect Underground Structures

**Box Culvert**

Point 1:
- $w = 20.8\%$
- $\gamma_d = 16.0 \text{ kN/m}^3$
- $E_{LWD-Z2} = 61.1 \text{ MPa}$

Point 13:
- $w = 29.5\%$
- $\gamma_d = 13.8 \text{ kN/m}^3$
- $E_{LWD-Z2} = 11.6 \text{ MPa}$

Point 12:
- $w = 20.8\%$
- $\gamma_d = 16.0 \text{ kN/m}^3$
- $E_{LWD-Z2} = 61.1 \text{ MPa}$

Point 5:
- $w = 29.5\%$
- $\gamma_d = 13.8 \text{ kN/m}^3$
- $E_{LWD-Z2} = 61.1 \text{ MPa}$

Point 13:
- $E_{LWD-Z2} = 47.5 \text{ MPa}$
- $E_{V1} = 42.1 \text{ MPa}$
- $E_{V2} = 121.1 \text{ MPa}$
- $E_{FWD-D3} = 57 \text{ MPa}$
- $E_{D-SPA} = 44 \text{ MPa}$

Point 12:
- $E_{LWD-Z2} = 58.4 \text{ MPa}$
- $E_{V1} = 96.9 \text{ MPa}$
- $E_{V2} = 381.1 \text{ MPa}$
- $E_{FWD-D3} = 145 \text{ MPa}$
- $E_{D-SPA} = 88 \text{ MPa}$

Point 5:
- $w = 29.5\%$
- $\gamma_d = 13.8 \text{ kN/m}^3$
- $E_{LWD-Z2} = 11.6 \text{ MPa}$

Point 12 DCP refusal (Box Culvert):
- $E_{LWD-Z2} = 58.4 \text{ MPa}$
- $E_{V1} = 96.9 \text{ MPa}$
- $E_{V2} = 381.1 \text{ MPa}$
- $E_{FWD-D3} = 145 \text{ MPa}$
- $E_{D-SPA} = 88 \text{ MPa}$

Differentiate Different Materials

CMV Map $a = 1.2$ mm, $f = 30$ Hz, $v = 3.5$ km/h

CMV Map $a = 1.9$ mm, $f = 30$ Hz, $v = 3.5$ km/h

Flex Base

Lime Treated Subgrade

Flex Base

Dynapac
Single
Smooth drum
IC roller

Lime Stabilized Subgrade

Flex Base

Flex Base
Intelligent Compaction

- Project Length: 2.205 Miles
  Estimated Cost: $16.5M
  Estimated Duration: 367 Working Days

- Provides a more complete picture of the area being worked
- Less labor required
- Less time required due to testing
DFW Connector Design-Build Project

- $1.1 billion CDA Design-Build project
- Groundbreaking Feb. 17, 2010
- Expected completion 2014; complete 2013
- Approximately half the construction time needed for traditional contracts
Dallas/Fort Worth Connector

Courtesy Dr. David White Iowa State University

Courtesy Mark Morrow NorthGate Constructors

July 2010
Intelligent Compaction

DFW Connector Project

Compaction Target Value (CTV) = 42

<table>
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<tr>
<th>% Target</th>
<th>CCV</th>
<th>IC Data</th>
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<tr>
<td>&gt;130%</td>
<td>55</td>
<td>26%</td>
</tr>
<tr>
<td>90-130%</td>
<td>38 - 55</td>
<td>68%</td>
</tr>
<tr>
<td>80-90%</td>
<td>34 - 38</td>
<td>4%</td>
</tr>
<tr>
<td>70-80%</td>
<td>29 - 34</td>
<td>1%</td>
</tr>
<tr>
<td>&lt;70%</td>
<td>&lt; 20</td>
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Current TxDOT QA Criteria:

>90% of IC Data should be equal to or greater than the CTV
- US 287 (Mansfield TX)
- New frontage roads and bridges
- Lime treated subgrade
- Testing of 4 separate locations with DCP, DSPA, IC, and NDG
- FM 730 (over Lake Weatherford headwaters)
- New bridge on roadway realignment
- Wet to inundated natural ground, 5’ rockfill embankment, low PI soil embankment, lime treated subgrade, and flex base
- US 67 (widen to 4 lane divided section) –
- SH 267 (construction of a new 4 lane divided bypass)
- IH 35W (Reconstruction of a freeway section)
- Natural field crushed rock, lime treated subgrade, and flex base
IC benefits

- Provides uniformity information
  - Covers 100% of the compacted area
  - Tracks roller’s position and pass counts
- Identifies areas of poor compaction
- Selects areas to test for QC/QA
- Eliminates guesswork and reduces risk of rework
- Optimizes efficiency, maximizes productivity and minimizes costs
- Improves safety in construction zones
IC Challenges

- Executive leadership and champions
- Extensive training for both DOT’s staff and contractors
- GPS system setup
- Data management including data collection, conversion, and analysis
IC resources – www.intelligentcompaction.com

INTELLIGENT COMPACTION

One-stop shop for IC

LEARN IC  VEDA  EQUIPMENT  PROJECTS  SUPPORT

AN AMMANN/CASE IC ROLLER AND A CATERPILLAR IC ROLLER IN MISSISSIPPI

IC Support
View helpful info and contact us for support at our IC Technical Support Service Center.

Veda Upgrade
Download the latest version of Veda, the IC data management and analysis software.

Learn IC in a Day
Attend an IC workshop and learn how to use IC to ensure longer pavement lives.

Specifications
View and download asphalt and soils IC specifications.

Intelligent Compaction News
Questions?

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