INTELLIGENT COMPACTION

Directions to the Future

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What Is Intelligent Compaction (IC)?

- Vibratory rollers equipped with a stiffness measurement system that continuously measures and reports the material’s stiffness in real time during compaction.

- GPS-based recording and documentation system that continuously displays a color-coded map of stiffness and roller’s location in real time during compaction.
Technology

Caterpillar: CMV, MDP

Dynapac: CMV

Bomag: \( E_{\text{VIB}} \) (MN/m²)

Sakai: CCV

Case/Ammann: \( k_b \) (MN/m)

Hamm: HMV
TxDOT Retrofit Kit Installation

- Accelerometer
- Base Station Radio Receiver
- Display Panel
- Trimble IC Retrofit Kit (outside)

- Receiver
- Radio
- Base Station
- Trimble IC Retrofit Kit (inside)
Why Use IC?

- **Ordinary Compaction**
- **Density Control**
  - Compactive Energy
  - Moisture Content
  - Material Type
  - Compact Lift Thickness
  - Underlying Conditions
Why Use IC?

- Not used in pavement design
- A layer-specific spot test providing no info on the uniformity of compaction over the entire section
- Only measured after compaction is complete providing no feedback in real time

Can We Do A Better Job?
Why Use IC?

- Lose the track of rolling pass counts
- Compaction job becomes guesswork
- Inconsistent and non-uniform density
- Under/over compaction
- Premature pavement failure

Before

After
34 States Exploring IC

2012 – less than 20 projects
2013 – approximately 50 projects
2014 – projected 150 projects
TxDOT IC Projects

Fort Worth (8)
- FM156; DFW Connector;
- US287; FM1938; FM731;
- SH267; IH35W; and IH30

Paris (2)
- US75
- SH24

Atlanta (1)
- FM450

Houston (1)
- SH35

Amarillo (1)
- LP335

El Paso (1)
- FM1281
FM156 Project

- FM156, Fort Worth, TX
- FHWA/TPF IC Study
- SG, Lime Stabilized SG, and Flex Base

Ammann/Case padfoot drum IC roller
Ammann/Case smooth drum IC roller
Dynapac single smooth drum IC roller
FM156 Project – Identify Soft Spots

$K_S$ shows compaction progress and a soft spot

Screen shots of $k_{SIPD}$ maps for different passes on TB 1

Untreated cohesive soil

Case/Ammann single-drum padfoot IC roller
FM156 Project – Identify Underground Structures and Soft Area

Box Culvert

Case/Ammann single-drum padfoot IC roller
Spatial comparison of $k_{\text{SIPD}}$ and $k_{\text{SISD}}$ maps
(TB 1 – subgrade clay material)

Padfoot vs. Smooth Drum
IC data vs. Conventional Tests (NDG, LWD, DCP, FWD)

Box culvert at 8 in. depth

$k_{SISO}$ Map $\alpha = 0.8$ mm, $f = 30$ Hz, and $v = 3.2$ km/h

Lime Stabilized Subgrade

DCP

LWD

FWD

FWD
What We Learned

- IC for QC only
- Identify soft spots and know when to stop rolling
- Padfoot and smooth drum IC rollers produce results that are comparable and repeatable
- Test strips are hard to implement and may not be necessary if for QC only.
- MDP is not sensitive to pick up soft areas

Soft ground condition = hard to push

Firm ground condition = easy to push
Benefits

- Covers 100% of the area compacted
- Monitors pass count
- Identifies areas of poor compaction
- Intelligently picks areas to test for QC/QA
- Improves productivity and minimizes cost
- Improves safety in construction zones
Challenges

- Extensive training for DOT and contractors
- Data management difficulties
- More expensive than ordinary
- High variation of field moisture
- No strong correlation b/w stiffness and density
- Lack of IC industry standardization and specification
Future Plans

- Workshops/Webinars and pilot projects in districts
- Revise IC specification
  - Short Term: density based on IC proof mapping
  - Long Term: stiffness based on IC proof mapping
1. IC is a CCC process.
2. IC is for both QC and QA.
3. IC measures both stiffness and density.
4. IC measures both stiffness and moisture.
5. IC measures both stiffness and pass count.
6. IC measurements are sensitive to moisture.
7. IC improves safety in construction zones.
Thank You!

QUESTIONS?

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