FHWA/TPF
Intelligent Compaction Study

By
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Transportation Pooled Fund #954

“Accelerated implementation of intelligent compaction for embankment subgrade soil, aggregate base, and asphalt pavement material”

3-year IC study for all the above materials

12 participating States

12+ field demonstration
Objectives

- Accelerated development of QC/QA specifications for subgrade soils, aggregate base and asphalt pavement materials
- Develop an experienced and knowledgeable IC expertise base within Pool Fund participating State DOTs
- Identify and prioritize needed improvements to and/or research of IC equipment and field QC/QA testing equipment
Prioritization of IC Improvements

- Simplifying IC usage
- Achieving greater IC value, cost benefit, etc.
- Improved accuracy
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IC Roller Requirements

- Continuous roller-integrated measurement system
- Real-Time Kinematic (RTK) Global Position System (GPS) based mapping
- Real-time onboard display and integrated software reporting system
- (Optional) Feedback control
Participating Soil/SB Rollers

- Ammann/Case
- Caterpillar
- Bomag America
- Dynapac
- Sakai America
Participating Asphalt Rollers

- Ammann/Case
- Bomag America
- Caterpillar
- Dynapac
- Sakai America
Application of Material Types

- Type I: Non-cohesive subgrade soil
- Type II: Cohesive subgrade soils
- Type III: Aggregate base material
- Type IV: Asphalt pavement material
- Type V: Stabilized base material
**Correlation Tests**

*Correlation test strip* with 20 in-situ spot test measurement. Can be done after selected roller passes (e.g. 1, 2, 4, 8 passes) to build compaction curve. Also used to establish IC target value.

- **Low temperature area**
- Systematic and random testing for QC

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**IC Compaction**

- Traditional Compaction

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**Asphalt**

- Correlation test strip
- In-Situ Spot tests
- Current Spec
- Target IC MV

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3-4 roller widths
Correlation Tests

**Correlation test strip** (~300 ft) with 5 to 10 in-situ spot test measurement
Can be done after selected roller passes (e.g. 1, 2, 4, 8 passes) to build **compaction curve**. Also used to establish IC target value.

- **IC Compaction**
- **Traditional Compaction**

**Random testing**

- Identified by IC machine QC that are below target value, i.e. less QA testing!
- Only spot test areas
- Correlation test strip (~300 ft) with 5 to 10 in-situ spot test measurement
- Can be done after selected roller passes (e.g. 1, 2, 4, 8 passes) to build compaction curve. Also used to establish IC target value.

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**In-Situ Spot tests**

- Current Spec
- Target IC MV

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**Soil/SB**
In-Situ Testing Methods

Which tests can be used as companion tests to RMV?

- Impact Force From Rollers
- LWD/FWD
- LWD
- Nuclear Density Gauge
- Dynamic Cone Penetrometer

Influence depths are assumed ~ 1 x B (width)

Distance = Roller travel in 0.5 sec.

Area over which the roller MV's are averaged

Courtesy of Dr. David White
In-Situ Test Methods for HMA

NG

LWD-a

NNG

PSPA

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In Situ Test Methods for Soils/SB/STB
Key Findings

- Values of mapping existing support before construction or overlay
- Significant improvements of rolling patterns, thus, consistent products
- Improvement of roller operators’ accountability
Key Findings (cont’d)

- Construction process-control greatly improved
- IC-MVs correlate to various in-situ point measurements
- Measurement influence depth varies depending on technology and site conditions
- Machine operation parameters influence MVs
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Premature Failure

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)

HMA Map

Subbase Map
Mapping STB

Mapping w/ Sakai double-drum IC roller

TB 2C-2  TB 2C-1

TB 2A-1
TB 2A-2
TB 2A-3

TB 2B-1  TB 2C-1
TB 2B-2  TB 2C-2

Graph: CCVs

TB02A (5-day cure)  TB02B (6-day cure)  TB02C (7-day cure)
Mapping
Milled ACP

Sakai CCV

North

Lane 1

Shoulder

Semi-variogram for CCV

Bridge

Kridging Map

Exponential Model
Nugget = 300
Sill = 350
Range = 65
Accessing Uniformity

TB 03B SMA overlay (distance 0 to 684 m)

Semi-variogram - exponential model

Column: CCV  
Direction: 0.0  
Tolerance: 90.0

Nugget=16.5  
Sill=28.5  
Range=40

Surface Temperature

SAKAI CCV
Improved Rolling Pattern

Before

After

Sakai Double-drum IC roller

TB04

TB05
IC Clearing House

www.IntelligentCompaction.com