

IMPROVED ASPHALT COMPACTION QUALITY CONTROL & INTELLIGENT COMPACTION

Antonio Nieves Torres
FHWA-HQ - Office of Infrastructure

57th Annual New Jersey Asphalt Paving Conference, March 24-26, 2014

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Scope of Presentation

1 What is IC? \ What do you Need for IC? \ Why Use IC?

2 Emergence of Intelligent Compact (IC) in FHWA

3 Intelligent Compaction Implementation

4 Current State Trends on implementation

5 Benefits of using IC

Improved Asphalt Compaction Quality Control & Intelligent Compaction

What is IC?

This archived news story is available only for your personal, non-commercial use. Information in the story may be outdated or superseded by additional information. Reading or replaying the story in its archived form does not constitute a re-publication of the story.



Improved Asphalt Compaction Quality Control & Intelligent Compaction

What is IC?

Intelligent Compaction is the compaction of road materials:

- ✓ Soils,
- ✓ Aggregate bases,
- ✓ Asphalt pavement materials (HMA/WMA, Etc.),

Using a modern vibratory roller equipped with the appropriate equipment to monitor the compaction effort.

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Shortcomings in Conventional Compaction



**Limited
On-The-Fly
Feedback**



**Over-
Compaction**



**Under-
Compaction
Leads to
Distresses**

Improved Asphalt Compaction Quality Control & Intelligent Compaction

What do you need for IC? (FHWA Definition)

- ✓ Vibratory Roller (Single or Double)
- ✓ Accelerometer-based roller measurement system
- ✓ High Precision Positioning System (HPPS)
- ✓ Infrared Temperature Sensors for real time pavement surface temperature data acquisition (Asphalt Pavements)
- ✓ Integrated Onboard Reporting System. (optional)

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Must have all Elements to be called IC roller

If you don't then you have a roller

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Photos courtesy of each company

Ammann-Case



Caterpillar



HAMM-Wirtgen



Bomag



Dynapac



Sakai



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Photos courtesy of each company

Bomag



HAMM-Wirtgen



Caterpillar



Sakai



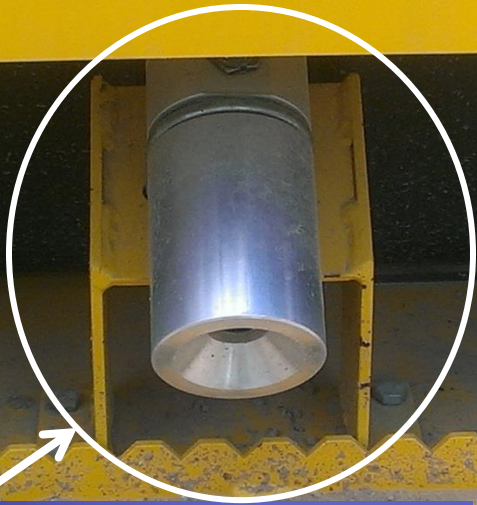
Improved Asphalt Compaction Quality Control & Intelligent Compaction



Courtesy of Sakai and Bomag

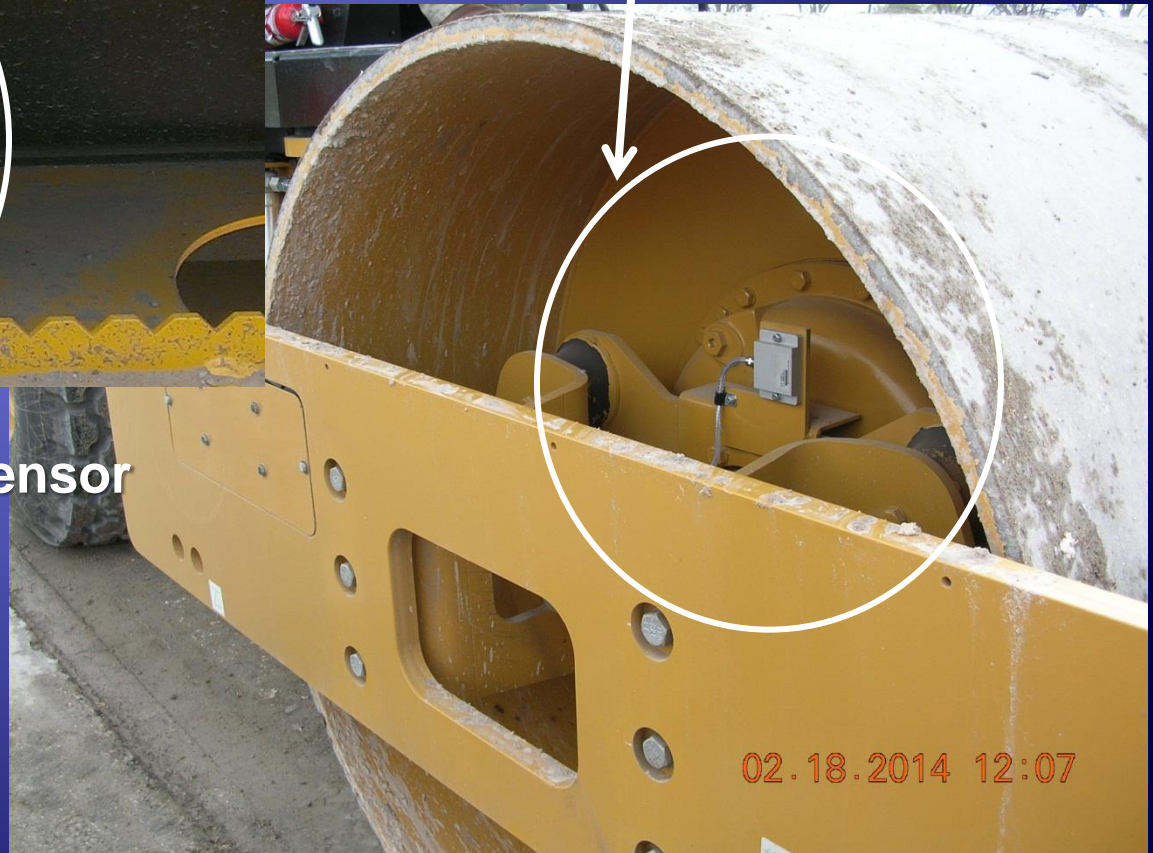
Display Monitors

Improved Asphalt Compaction Quality Control & Intelligent Compaction



Infrared Temperature Sensor

Accelerometer



02.18.2014 12:07

Improved Asphalt Compaction Quality Control & Intelligent Compaction



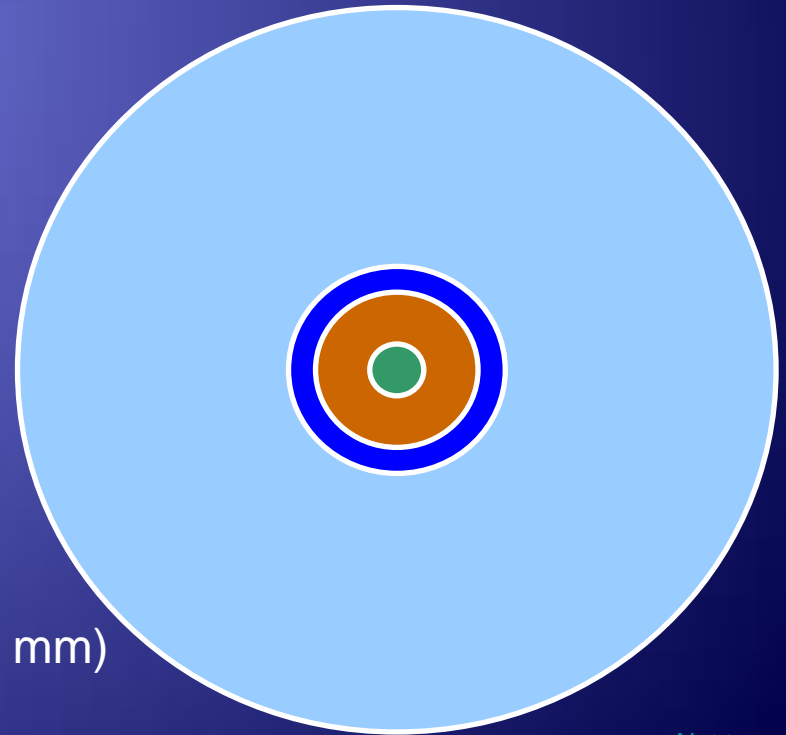
Positioning System Receiver and Transmitter

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Why do we need
High Precision Positioning System (HPPS) ?

- Autonomous: 10 - 15m
- DGPS: 0.5 - 5m
- Float : 1 m
- Fixed : 1-3 cm

FHWA recommended precision ± 6 in. (± 150 mm)
in both the horizontal (northing and easting)



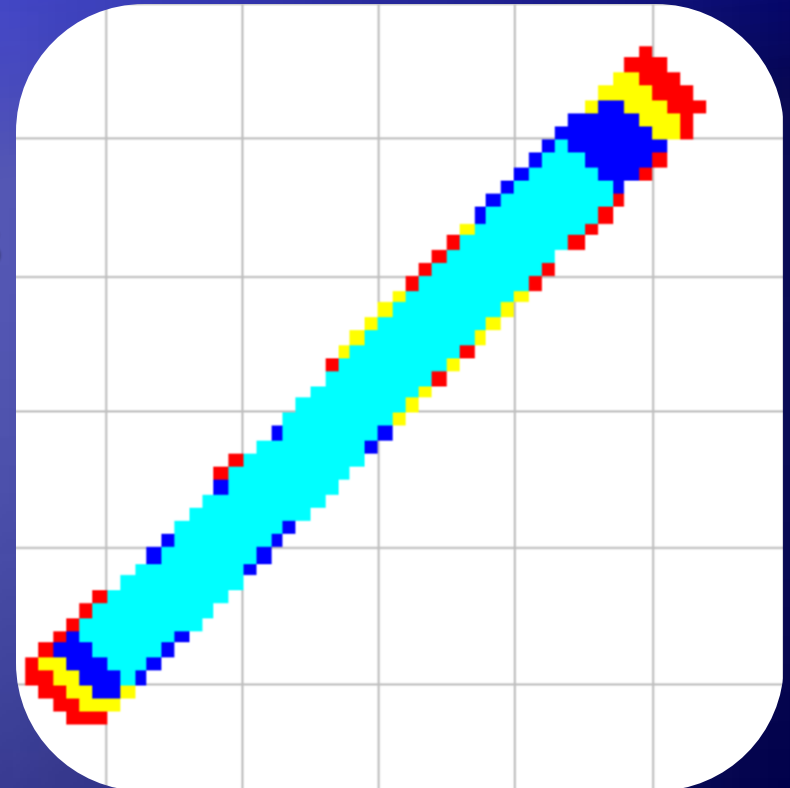
Not to scale

Improved Asphalt Compaction Quality Control & Intelligent Compaction



Poor HPPS

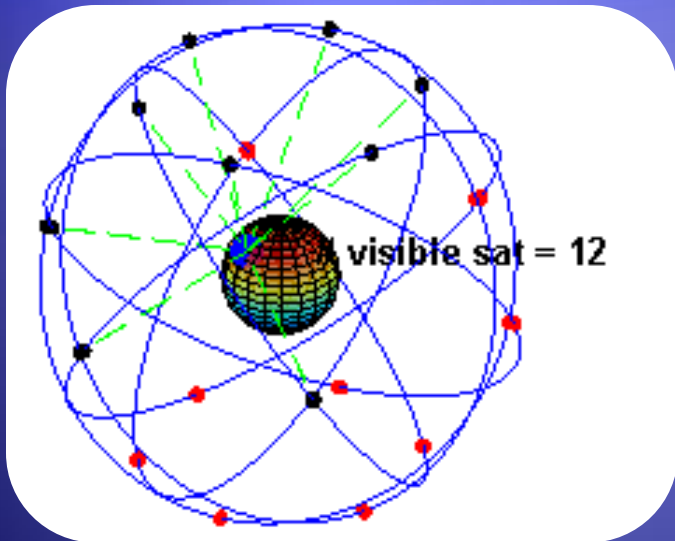
IC
Pass
Counts



Good HPPS

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Precision can be obtained in several ways!



GPS

38 orbiting satellites
Department of Defense & Glonass - Russian



Animation courtesy of Trimble

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Base Stations



Photos Courtesy of Trimble

Rover



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Other Systems

- ✓ Wireless
- ✓ Real Time Kinematic
- ✓ Land Based Systems
- ✓ Subscription Based

Improved Asphalt Compaction Quality Control & Intelligent Compaction

WHY USE IC?

Improved Asphalt Compaction Quality Control & Intelligent Compaction Shortcomings in Conventional Acceptance



**Limited Number
of Locations**



**After Compaction
is Complete**

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Shortcomings in Conventional Compaction



**Limited
On-The-Fly
Feedback**



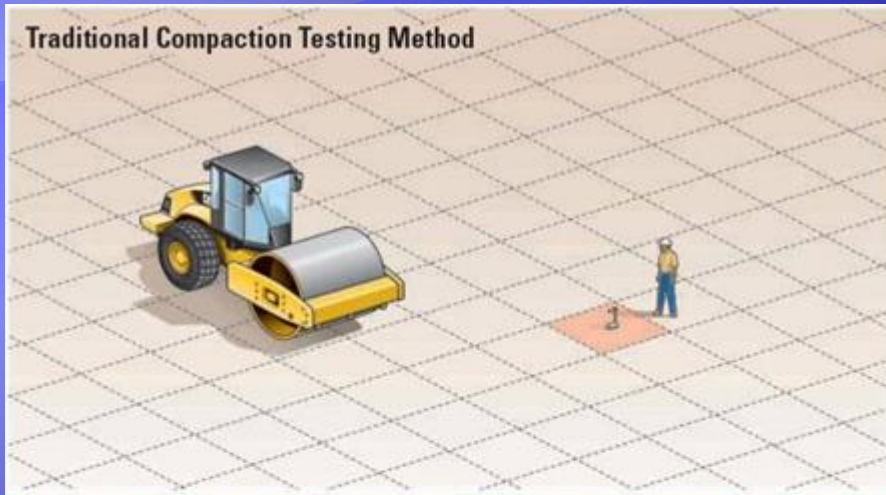
**Over-
Compaction**



**Under-
Compaction
Leads to
Distresses**

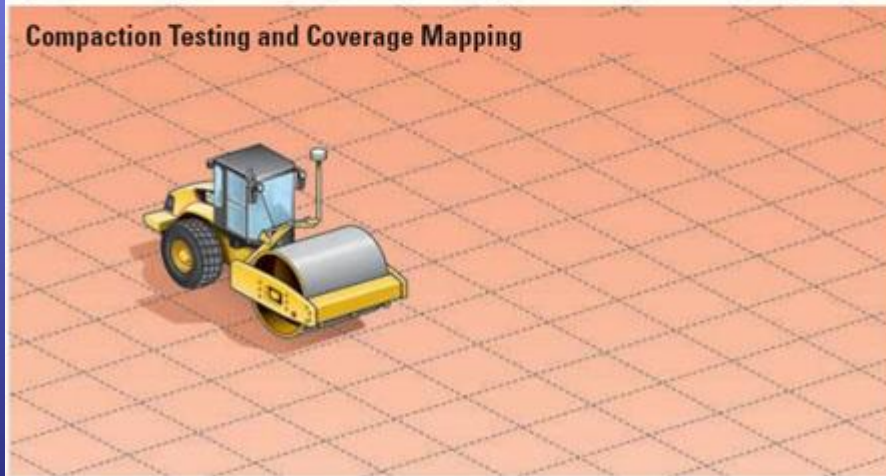
Improved Asphalt Compaction Quality Control & Intelligent Compaction

What if we
go from
this!



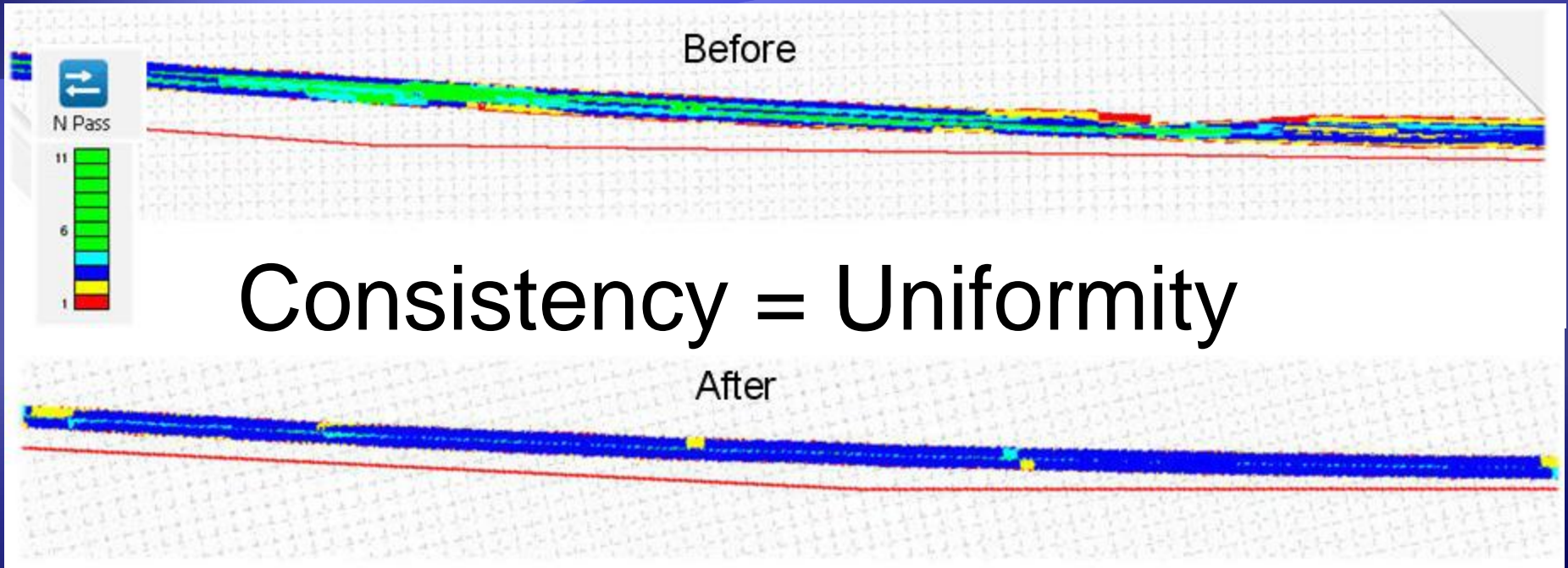
1 / 1,000,000

To this!

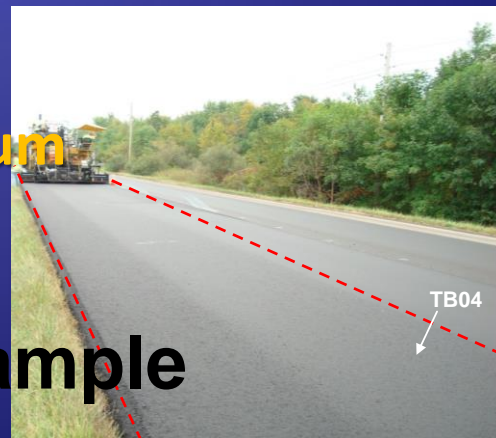


100 % Coverage

Improved Asphalt Compaction Quality Control & Intelligent Compaction



Sakai
Double-drum
IC roller



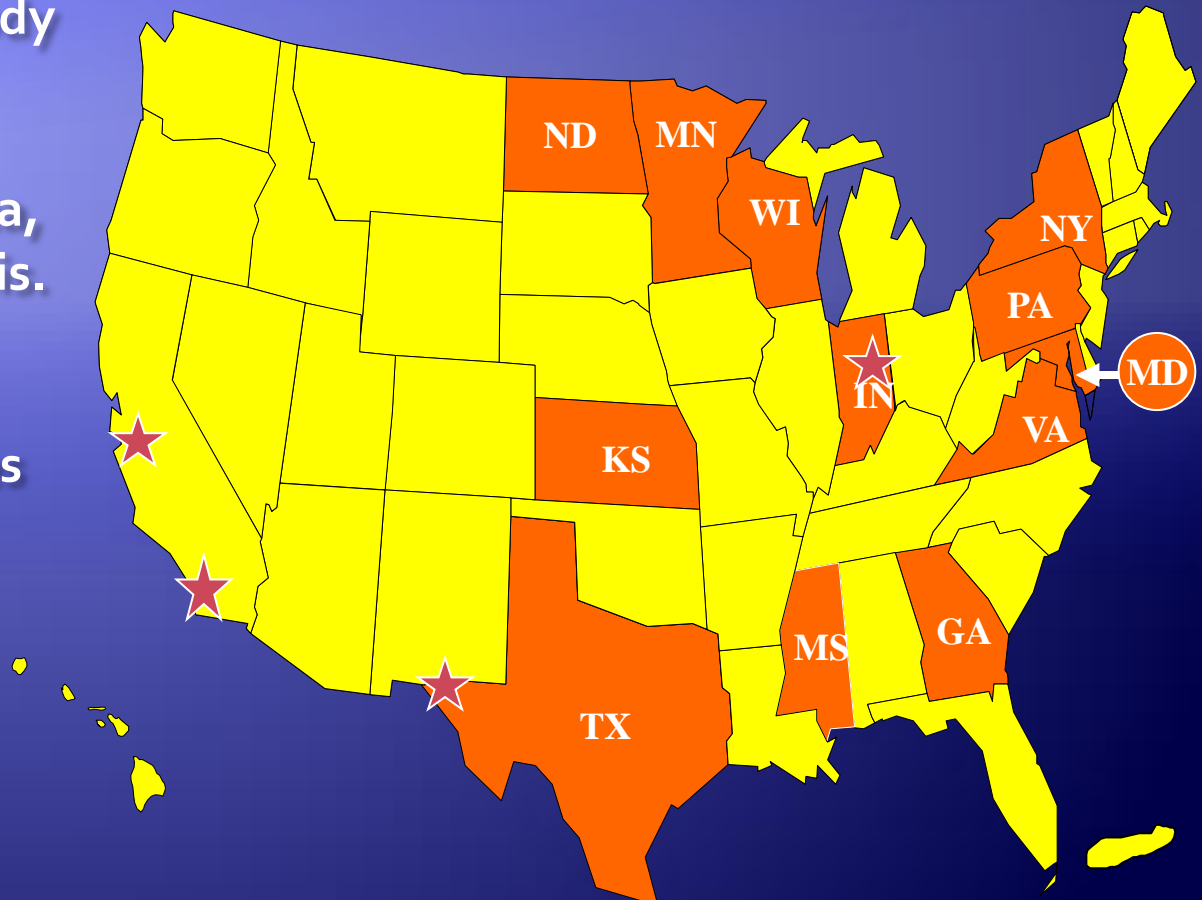
TB 04

Indiana Example

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Emergence of IC in FHWA

- 12 State Pooled Fund Study
- Field Trials in 12 States
- Started in 2008-2011
- IC Pilot Workshops Atlanta, Salt Lake City, Minneapolis.
- EDC-2 in 2013-2014
- Development of the IC Technical Support Services Center (TSSC).



Improved Asphalt Compaction Quality Control & Intelligent Compaction

IC Implementation

- ✓ Specifications
- ✓ Field Implementation

Improved Asphalt Compaction Quality Control & Intelligent Compaction

- ✓ Approval of IC Equipment
- ✓ IC Data Requirements
- ✓ Quality Control Plan
- ✓ GPS/Datum Requirements
- ✓ Test Sections and Target Values
- ✓ QC/QA for Production Areas
- ✓ IC Data Submittal
- ✓ Payment and Measurements

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Generic - IC Specifications for Aggregate Bases
DOT to modify as applicable to meet State Specifications

June 2011

Intelligent Compaction Technology for Aggregate Base Applications

DESCRIPTION

This work shall consist of the construction of the aggregate base materials utilizing Intelligent Compaction (IC) rollers within the limits of the work as described in the plans. IC is defined as a process that uses vibratory rollers equipped with a measurement/documentation system that automatically records various critical compaction parameters correlated to agency standard testing protocols in real time during the compaction process. IC uses roller vibration measurements to assess the mechanistic properties and to ensure optimum compaction is achieved through continuous monitoring of the operations. Additional information on the IC technology may be found on the website www.intelligentcompaction.com and from the Transportation Research Board - NCHRP Report 676 on Intelligent Soil Compaction Systems.

The Contractor shall supply sufficient numbers of rollers and other associated equipment necessary to complete the spreading and compaction requirements for the aggregate materials. The Contractor will determine the number of IC rollers to use depending on the scope of the project. The IC roller(s) may be utilized during production with other standard compaction equipment and shall be used for the evaluation of the compaction operations.

EQUIPMENT

The IC rollers shall meet the following specific requirements:

1. IC rollers shall be self propelled single-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compaction effort. Rollers shall have smooth drums.
2. The output from the roller is designated as the Intelligent Compaction Measurement Value (IC-MV) which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials.
3. The IC rollers shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of IC measurement values including the stiffness response values, location of the roller, number of roller passes, machine settings, together with the speed, frequency and amplitude of roller drums. The display unit shall be capable of transferring the data by means of a USB port.
4. Roller mounted GPS radio and receiver units shall be mounted on each IC roller. RTK-GPS radio and receivers are required to monitor the location and track the number of passes of the rollers.

1

Generic - IC Specifications for Soils
DOT to modify as applicable to meet State Specifications

June 2011

Intelligent Compaction Technology for Soils Applications

DESCRIPTION

This work shall consist of the construction of the roadway fill embankment utilizing Intelligent Compaction (IC) rollers within the limits of the work as described in the plans. IC is defined as a process that uses vibratory rollers equipped with a measurement/documentation system that automatically records various critical compaction parameters correlated to agency standard testing protocols in real time during the compaction process. IC uses roller vibration measurements to assess the mechanistic soils properties and to ensure optimum compaction is achieved through continuous monitoring of the operations. Additional information on the IC technology may be found on the website www.intelligentcompaction.com and from the Transportation Research Board - NCHRP Report 676 on Intelligent Soil Compaction Systems.

The Contractor shall supply sufficient numbers of rollers and other associated equipment necessary to complete the compaction requirements for the specific materials. The Contractor will determine the number of IC rollers to use depending on the scope of the project. The IC roller(s) may be utilized during production with other standard compaction equipment and shall be used for the evaluation of the compaction operations.

EQUIPMENT

The IC rollers shall meet the following specific requirements:

1. IC rollers shall be self propelled single-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compaction effort. Rollers may be smooth or pad footed drums.
2. The output from the roller is designated as the Intelligent Compaction Measurement Value (IC-MV) which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials.
3. The IC rollers shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of IC measurement values including the stiffness response values, location of the roller, number of roller passes, machine settings, together with the speed, frequency and amplitude of roller drums. The display unit shall be capable of transferring the data by means of a USB port.
4. Roller mounted GPS radio and receiver units shall be mounted on each IC roller. RTK-GPS radio and receivers are required to monitor the location and track the number of passes of the rollers.

1

Aggregate Base

Asphalt

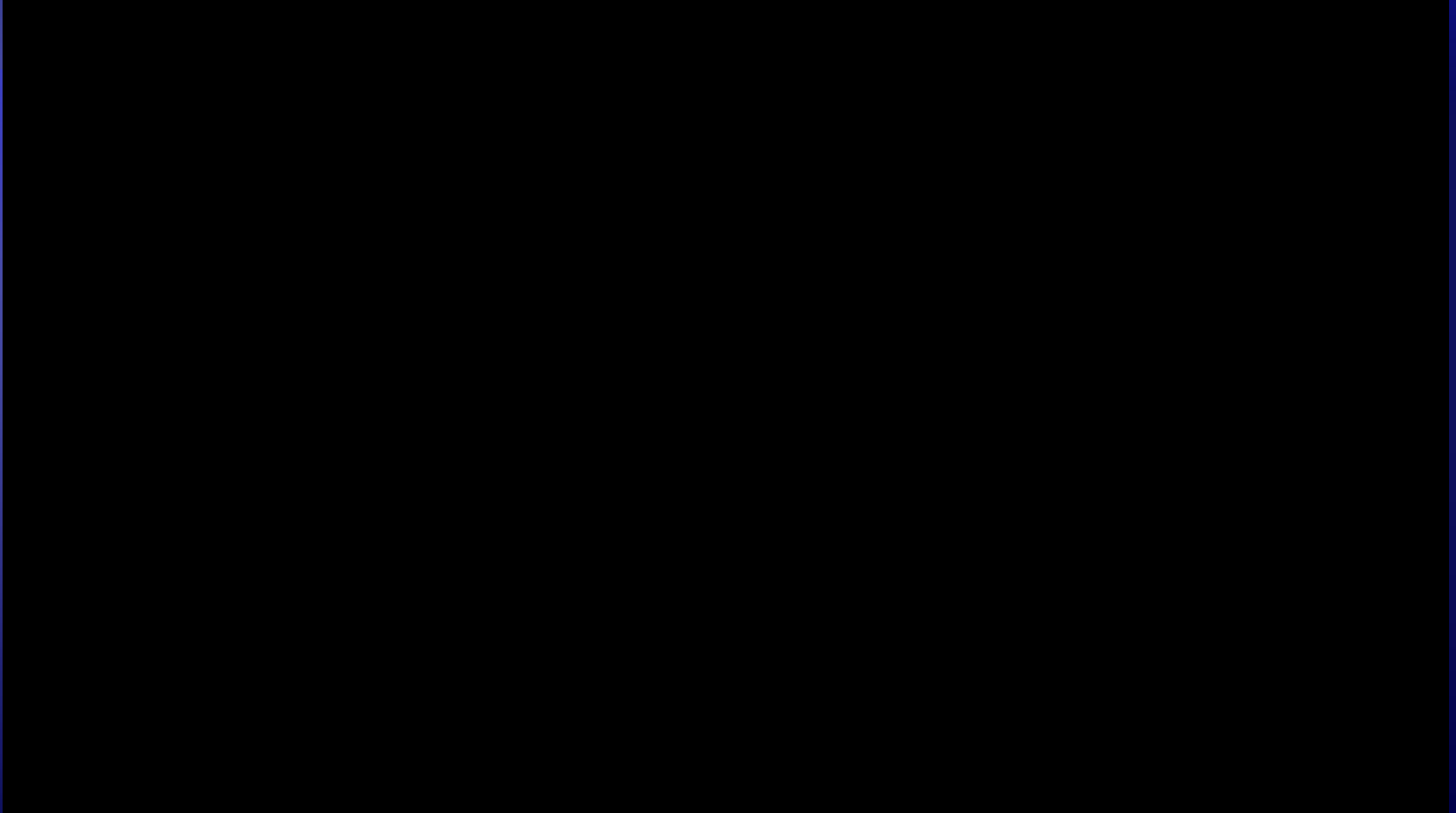
Soils

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Available at:

- ◆ www.intelligentcompaction.com
- ◆ <http://www.fhwa.dot.gov/construction/ictssc/>

Improved Asphalt Compaction Quality Control & Intelligent Compaction



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Before you start using IC on a project

FHWA recommends

- ◆ Have a test strip done
- ◆ Extract cores from test strip
- ◆ Conduct other tests
- ◆ Build a “Compaction Curve” using the IC data and core density data from the test strip
- ◆ Determine optimal number of roller passes for the mix design and location.

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Photos courtesy of each company



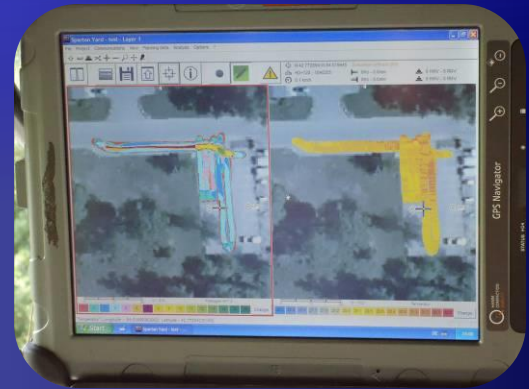
Ammann

k_b



Caterpillar

CMV, MDP



HAMM/Wirtgen

HMV



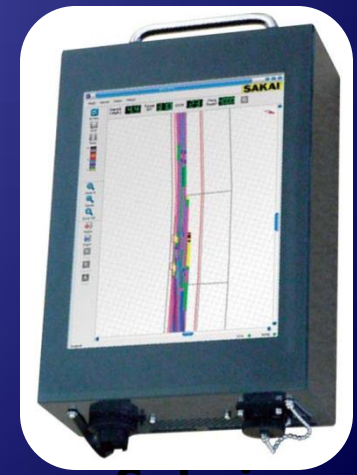
Bomag

E_{VIB}



Dynapac

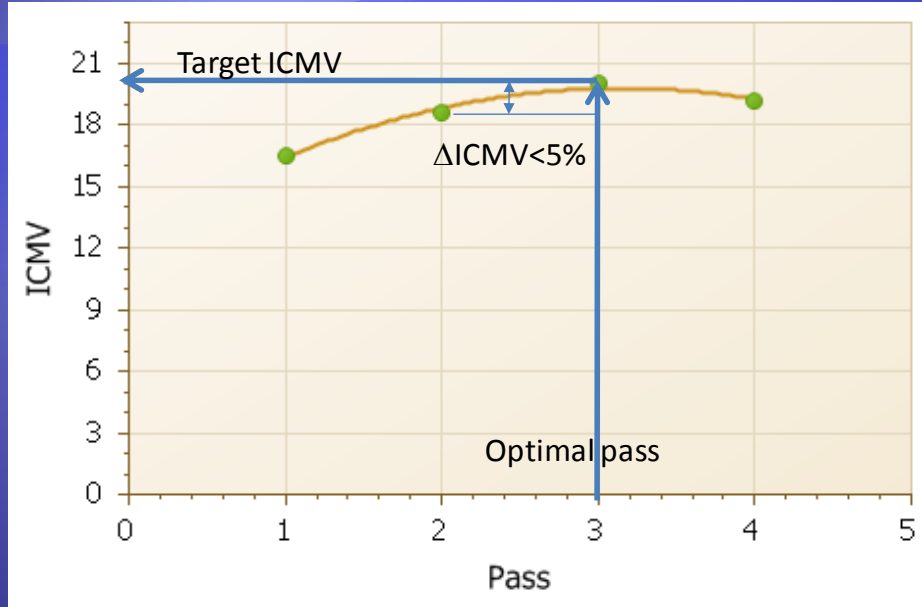
CMV



Sakai

CCV

Improved Asphalt Compaction Quality Control & Intelligent Compaction



Example:

Target ICMV
= 19 @ 3 passes

Test Strip

- Based on the specific test strip data
- Obtain the optimal number of passes

Equipment Setup

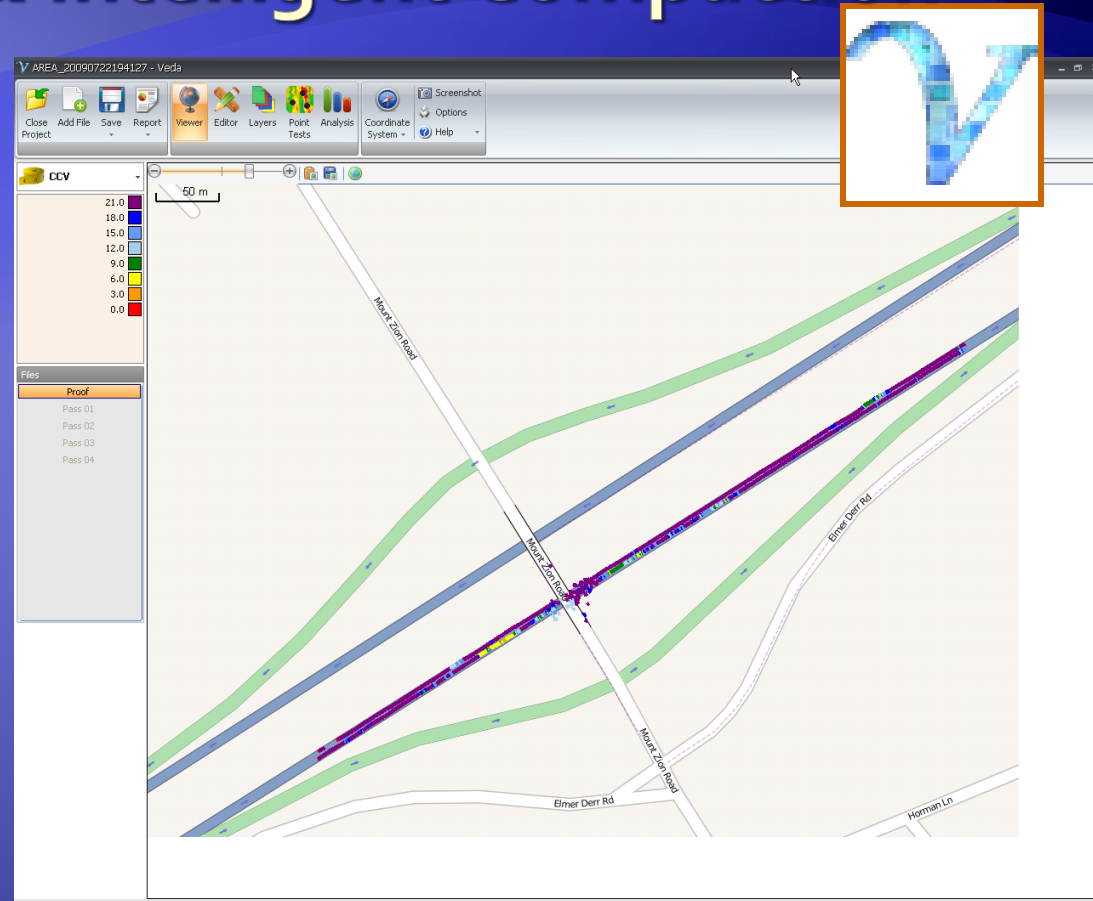
- Speed
- Amplitude
- Frequency

Improved Asphalt Compaction Quality Control & Intelligent Compaction

IC Analysis with Veda

- Veda can import data from various intelligent compaction (IC) machines
- Perform viewing, editing, layering, point test, and analysis.
- Available at

www.intelligentcompaction.com



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Volvo with Trimble Retrofit



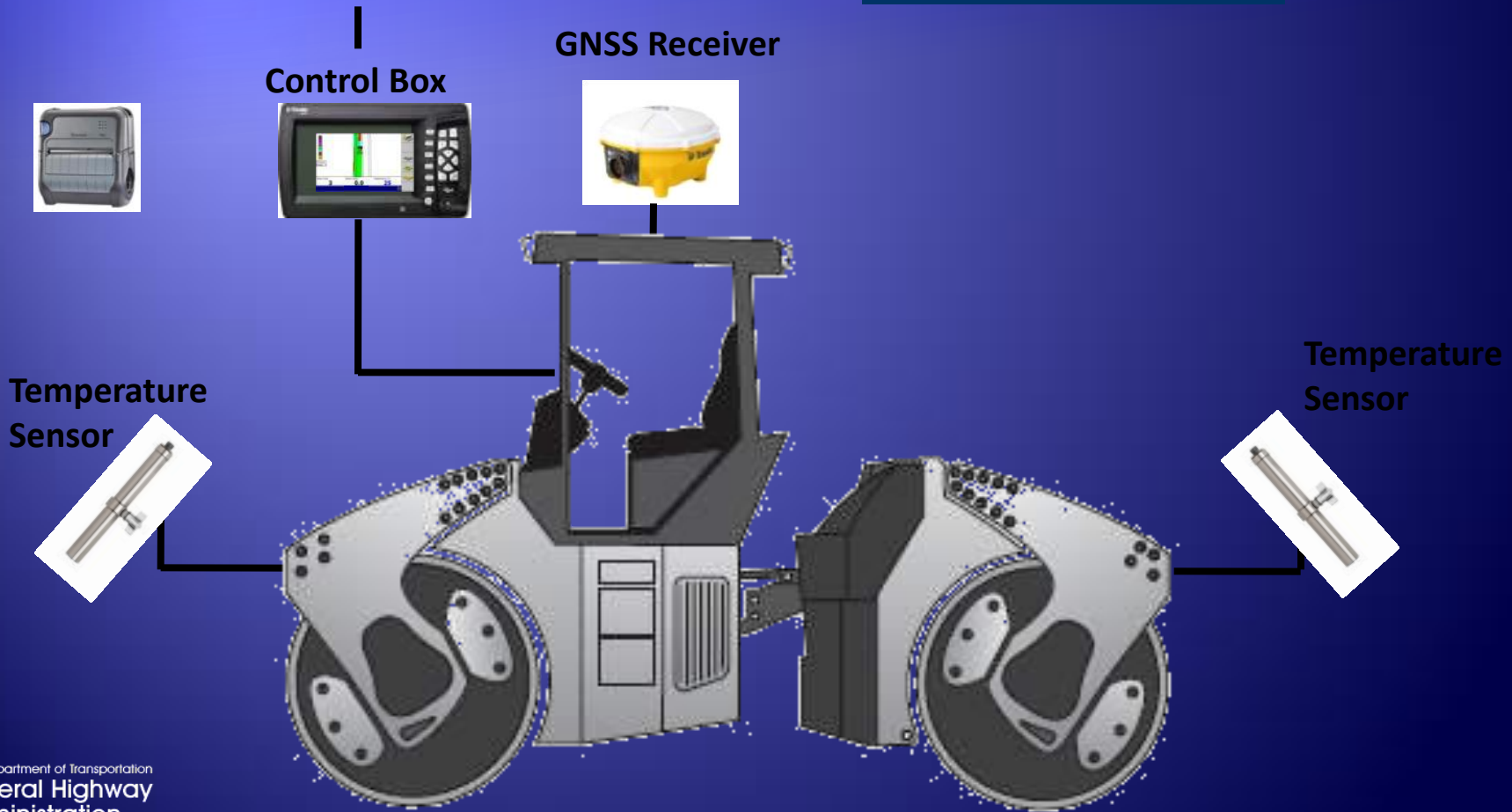
Retrofit Single Drum IC Roller

Photos courtesy of each company

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Printer
Retrofit Double Drum IC Roller

Conventional Roller
with Trimble Retrofit



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Benefits of using IC

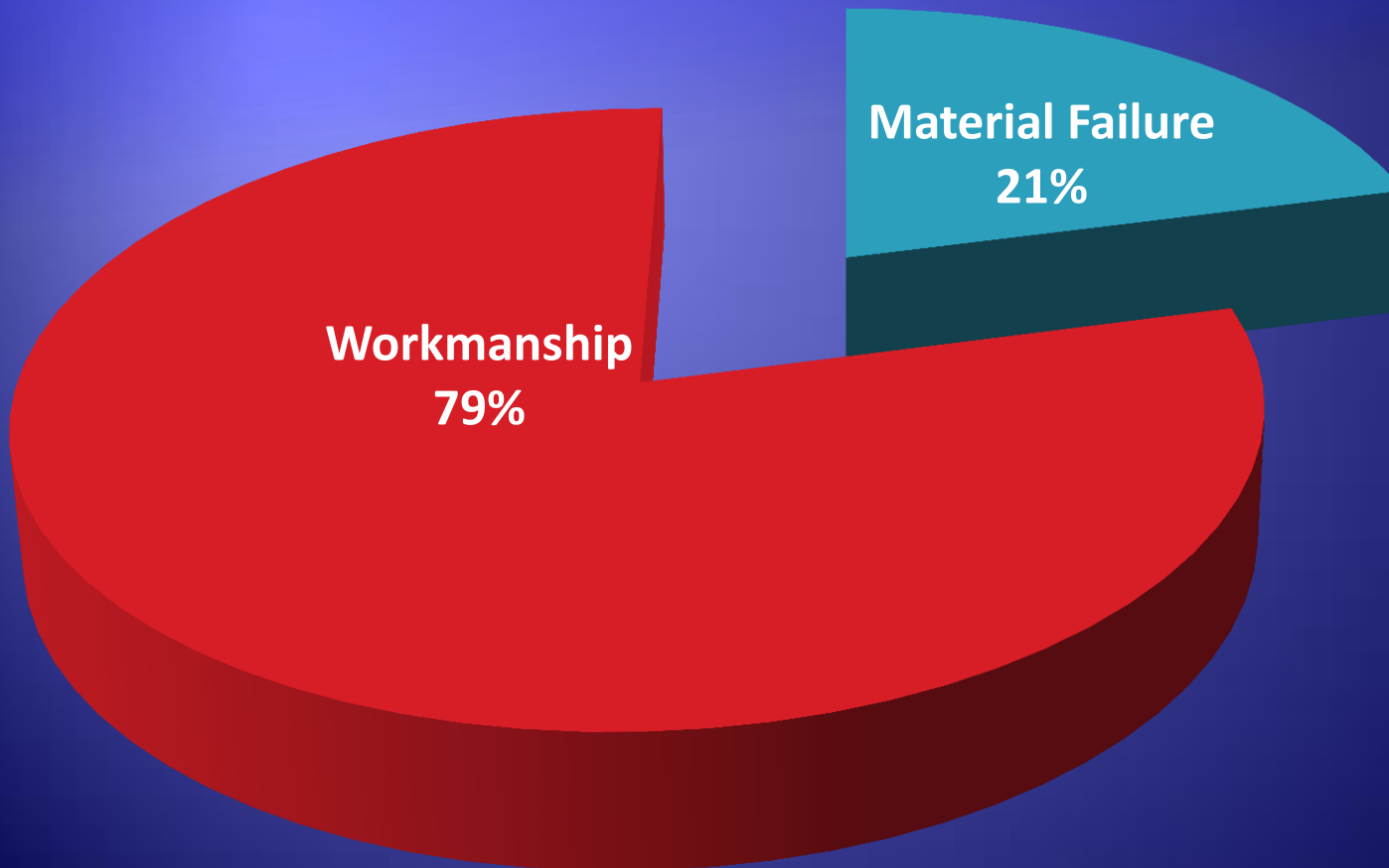
- ✓ Identify non-uniform compacted areas
- ✓ Improve roller operators' accountability
- ✓ Improve rolling patterns and consistent pavements
- ✓ Improve QC with 100% coverage
- ✓ Maximize compaction productivity(no over rolling/under rolling)
- ✓ Works very well for night paving operations

Improved Asphalt Compaction Quality Control & Intelligent Compaction

- ✓ Increased productivity (cost savings)
- ✓ Quality improved reduction in highway repair costs
- ✓ Improved depth of compaction
- ✓ Continuous record of material stiffness values

Improved Asphalt Compaction Quality Control & Intelligent Compaction

VT Paving Construction Causes of Failure



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Do we want to continue to do things the same way?

Why use Intelligent Compaction ?

Why Not!

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Intelligent Compaction

[Home](#)

Specifications

As IC is largely an equipment based technology, new specifications must be developed to take advantage of the benefits of IC. These specifications must also be flexible enough to handle the differences in the capabilities of IC rollers and properties of the materials undergoing compaction. In addition, IC rollers are just one type of roller needed to compact road materials, which must be addressed in any compaction specification.



Compaction of Soils and Subbase



Compaction of Asphalt Pavement Materials

[Printer-friendly version](#)

Copyright © 2008-2011 by The Transtec Group, Inc.
[Disclaimer](#) | [Privacy Policy](#)

Contents

- ▷ Introduction
- ▷ Equipment
- Projects
- Workshops
- ▽ Specifications
 - Soils and Subbase
 - Asphalt
- ▷ Veda Software
- ▷ Library
- Contact Us
- Links

Shared Folders

- Core Team

anieves

- ▷ Create content
- My account
- Log out

www.IntelligentCompaction.com

<http://www.fhwa.dot.gov/construction/ictssc/>

Improved Asphalt Compaction Quality Control & Intelligent Compaction

IC TSSC - Technologies and Innovations - Construction - Federal Highway Administration - Mozilla Firefox

File Edit View History Bookmarks Tools Help

IC TSSC - Technologies and Innovations ...

www.fhwa.dot.gov/construction/ictssc/

Personal Sports Emails FHWA Sites Sports TSP Funds Comedy Central Estaciones de Radio Send | YouSendIt Hulu - Watch your fav... Fox On Demand - Hou... Spanish to English Dict...

U.S. Department of Transportation
Federal Highway Administration

About Programs Resources Briefing Room Contact Search FHWA

Construction

FHWA / Programs / Construction / Technologies and Innovations / IC TSSC

3D Engineered Models Accelerated Construction **Intelligent Compaction** Slide-in Bridge Construction SHRP2

Knowledge Base Workshops Projects Support Specifications

Intelligent Compaction

Intelligent Compaction (IC) refers to the compaction of road materials, such as soils, aggregate bases, or asphalt paving materials, using modern vibratory rollers equipped with an integrated measurement system, Global Positioning System (GPS) based mapping, onboard computer reporting system, and (optionally) a feedback control. By integrating measurement, documentation, and control systems, the use of IC rollers allow for real-time monitoring and just-in-time corrections in the compaction process. IC rollers also maintain a continuous record of color-coded plots that include number of roller passes, material stiffness measurement values, and precise location of the roller.

This technology has been selected under the Administrator's "Every Day Counts" initiative 2 (EDC-2) and was showcased at the 8 National Regional summits held in the fall of 2012. Since then our state partners have been requesting training and other support on this technology which will help them implement the technology locally.

IC Technical Support Service Center (TSSC)

The mission of the IC Technical Support Service Center customer service center is to supply knowledge base support for the implementation of Intelligent

Every Day Counts

- This is among the Every Day Counts (EDC) initiatives. [Learn more about EDC](#)

Events

- [FHWA ICDM Workshop and Equipment Demo](#)



1:37 AM
3/19/2014

Improved Asphalt Compaction Quality Control & Intelligent Compaction

Keys to Success

- ◆ Passion
 - ◆ IC Champions within Agencies
- ◆ Patience
 - ◆ It Takes Time!
- ◆ Communications
 - ◆ Among Agency, Suppliers, Contractors, and Consultants



Improved Asphalt Compaction Quality Control & Intelligent Compaction

Thank You

Antonio Nieves Torres

anieves@dot.gov

202-366-4597

www.intelligentcompaction.com

<http://www.fhwa.dot.gov/construction/ictssc/>