AI Webinar Series – October 15 2014

Intelligent Compaction

A Quality Control Tool for Constructing Asphalt Pavements

This webinar is offered by AI in cooperation with FHWA

Topics for Today

- Importance of Compaction and Obtaining Optimum Density
- What is Intelligent Compaction (IC)?
- What are the Benefits of IC?
- What were the Major Findings of IC Research?
- How can IC be used to improve Quality Control (QC)?
- Where can you find IC Resources?

The Importance of Compaction

Importance of Compaction

- Compaction is the final step in construction of a quality pavement
- Good compaction is critical to obtain expected service life
- The success of compaction is currently defined by measuring in-place density
- There is a direct relationship between in-place density and pavement performance

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Goals of Compaction

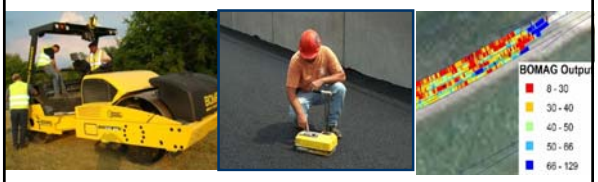
- Obtain target air voids which:
  - Prevents further consolidation
  - Provides shear strength/resistance to rutting
  - Improves resistance to thermal and fatigue cracking
  - Provides a waterproof (impermeable) pavement that prevents damage from moisture and aging
  - A major factor in obtaining a smooth, quiet pavement

Importance of Compaction

What is Intelligent Compaction (IC)?

What is Intelligent Compaction?

An Innovation in Compaction Control and Quality Control



What is Intelligent Compaction?

- IC consists of a vibratory roller that is equipped with various hardware/software tools and Global Positioning Systems (GPS) that work together to:
  - improve the pavement material compaction process through consistency and uniformity
  - provide data that can be processed, viewed and analyzed by contractors/owners for enhanced evaluation of compaction related parameters

What is Intelligent Compaction?

Current IC technology is accelerometer-based.

Vibratory Single Drum Soil Roller

Vibratory Tandem Drum Asphalt Roller

Accelerometer – front drum only

Accelerometer data is stored and processed on the on-board computer to calculate materials stiffness continuously during compaction.

IC Measurement Value (ICMV)

- IC suppliers have various "stiffness" (or measurement) values
  - Bomag – E_{vib} (MN/m²)
  - Caterpillar/Trimble – CMV
  - Hamm/Wirtgen – HMV
  - Sakai - CCV
- ICMV is a generic term used to describe all suppliers' measurement value

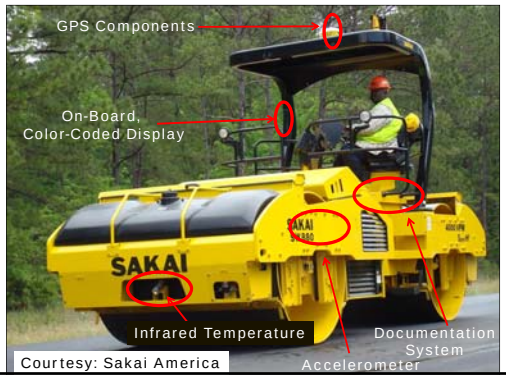
FHWA Definition of IC

- Tandem drum vibratory rollers that are equipped with:
  - Accelerometer-based IC Measurement Value (ICMV)
  - GPS-Based documentation system
  - On-Board, Color-Coded display
  - Surface temperature measurement system
  - Data produced is compatible with Veda software

Tandem Drum IC Rollers

Retrofit Tandem Drum IC Roller

Components of IC Roller



Hamm IC Onboard Display

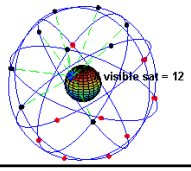
Sakai/TopCon Onboard Display

Positioning Systems for IC

- Global Positioning System (GPS)
- Laser-based positioning systems
- Other Wireless positioning technology

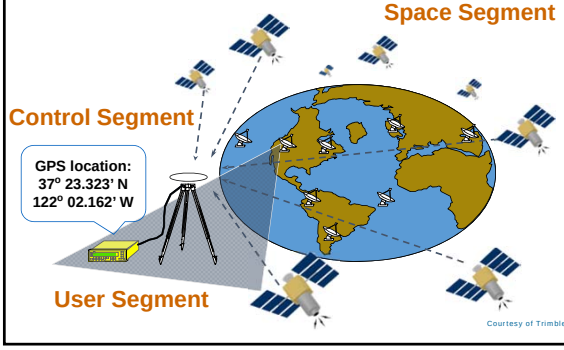
Global Positioning System

- Space-based global navigation satellite system (GNSS)
- Satellite timing and ranging system
- Controlled by US Department of Defense
- Augment with GLONASS



Courtesy: Trimble

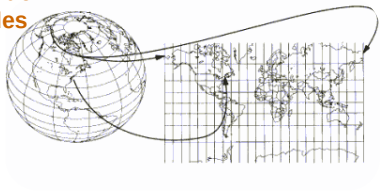
GPS Measurements



GPS Plane Projection

- From Curved Earth Surface to Flat Maps

Longitude
Latitudes



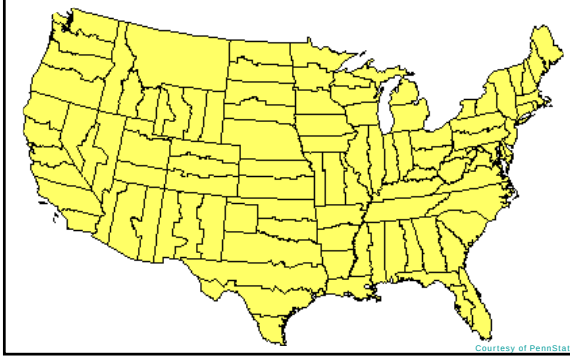
Easting
Northing
Elevation

Courtesy of Franson/CoordTrans

Coordinate Systems

- Universal Transverse Mercator Coordinate (UTM)
- State Plane Coordinate System (SPC)
- County Coordinates
- Local Coordinates

State Plane Coordinate System



Courtesy of PennState U

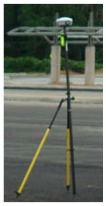
Cat Coordinate Screen

Global Positioning System (GPS)

GPS Base Station

GPS Radio & Receiver

GPS Rover



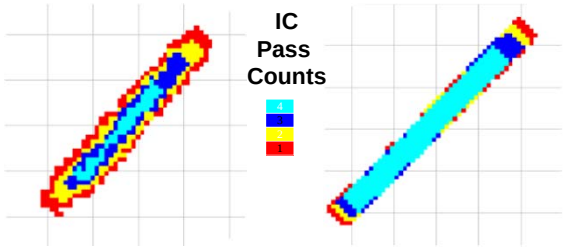
Real Time Kinematic (RTK) GPS Precision

OmniStar HP on IC Roller

2-4 inch precision?

OmniStar is being evaluated against land-based GPS systems on FHWA research projects at this time.

GPS Accuracy for IC



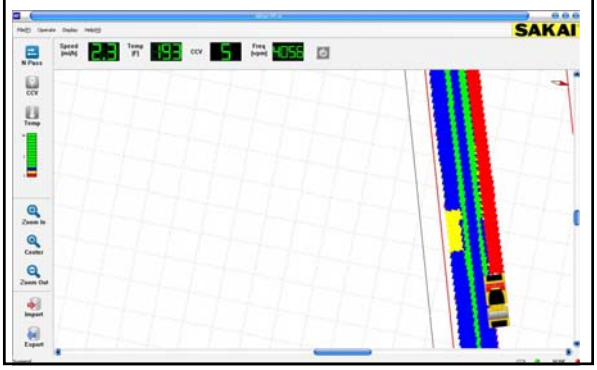
Unspecified Source

How does IC Work?

- IC related data is collected and stored continuously during the compaction operation
- ICMV, mat surface temperature and pass counts are displayed to the roller operator in “real time”
- The collected data can then be transferred to a computer for viewing, editing and evaluation using vendor and Veda software

Sakai IC Onboard Display Unit

Color-Coded Onboard Display



Map view of pass count

What are the Benefits of IC?

What are the benefits of IC?

- Increased operator awareness
  - Real-time compaction, temperature, pass count data providing the operator the ability to make changes in real-time while asphalt is hot
- Improved, more uniform density/air voids
  - Improved uniformity of compaction
- Night-time paving operation
  - ability to "see" roller passes in the dark
- Lower operating costs
  - Optimized pass coverage, better efficiency
- Documentation
  - Quality control and post-process data analysis
  - View opportunities for improvement
- 100% coverage of the entire area being constructed
  - Provides a comprehensive view with color-coded mapping of roller passes, mat temperature and ICMV
  - Opportunity to identify potential problem areas

IC Provides 100% Coverage

- Traditional methods only obtain data on a single spot that represents a large area
  - is test result representative?
- IC provides data for the entire area being compacted
  - ICMV, temperature, pass count
- Color coded mapping of 100% of area provides permanent records

Overall Benefits of IC

- Improve density….better performance
- Improve efficiency….cost savings
- Increase information…better QC/QA

- Overall Benefit:
  Improved Pavement Performance!

Polling Question #1

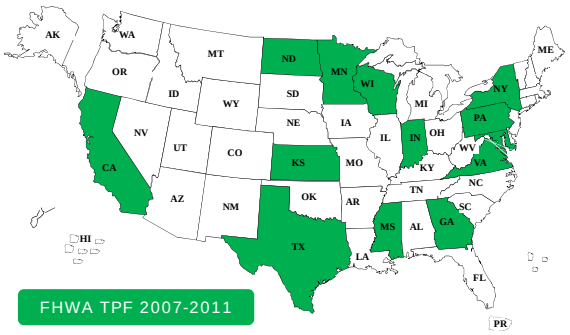
- What is the generic term used for the materials "stiffness" measured by IC rollers during the compaction process?
  a. CCV
  b. ICMV
  c. CMV
  d. None of the above

What Were the Major Research Findings?

IC Research Projects - US

- There have been three major research efforts in the United States
  - Two have been completed / final report avail.
    - NCHRP 21-09 “Intelligent Soils Compaction Systems” (2007-2008)
    - TPF 5 (128) “Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base, and Asphalt Pavement Materials” (2008 – 2010); IC Pooled Fund (ICPF)
  - One is ongoing
    - FHWA “HMA IC and Density Projects” (2012-2014)

IC Pooled Fund Project



FHWA TPF 2007-2011

IC Pooled Fund Project

- ICPF was a three year research project to study IC technology from various suppliers on actual pavement projects
- 12 states participated in the ICPF
- Research included various types of pavement materials, including
  - Asphalt materials
  - Soils
  - Sub base (including aggregate base)

ICPF Preliminary Findings

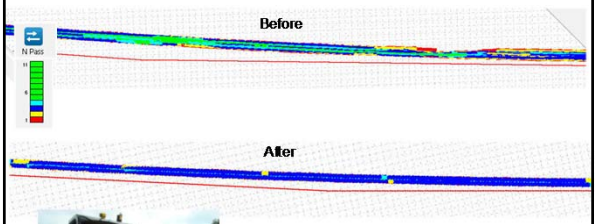
- Successful use of both single drum and tandem drum IC technology for QC
- Use and acceptance by roller operators
- Onboard display was very effective in dramatically improving the compaction process
- Improved roller patterns / passes
- Use of IC rollers for pre-mapping of underlying materials (evaluate support)
- Improved compaction-related information with 100% coverage

Use and Acceptance by Roller Operators

Roller Operator Training

Improved Roller Passes

Improved Rolling Patterns



Sakai IC roller

Indiana ICPF Project

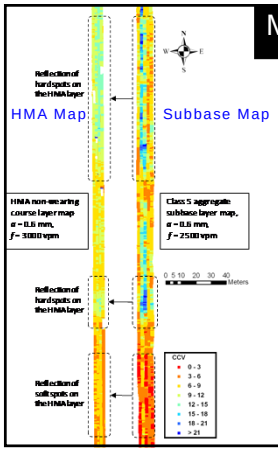
IC Pre-Mapping Prior to Paving

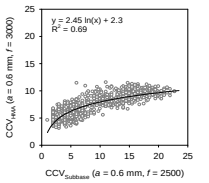
Pre-Mapping of Underling Layers

Minnesota ICPF Project

Mapping of the subgrade / agg. base layer

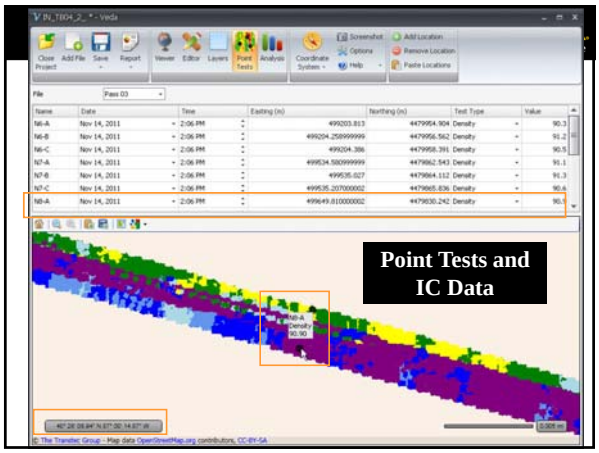
Mapping Aggr. Base





MN ICPF Project

100% Coverage of Compacted Materials



IC Website and Veda Software Developed through ICPF Research Project

Intelligent Compaction Website

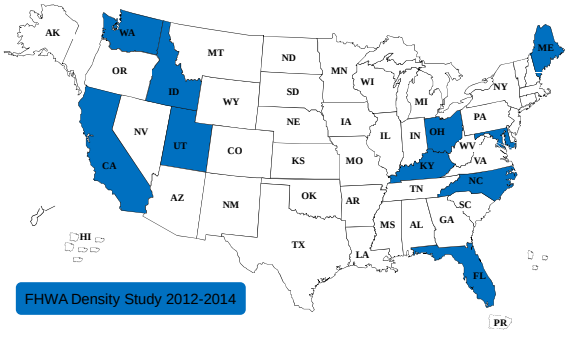
www.intelligentcompaction.com

Veda Software

ICPF – Unresolved Issues?

- Improve correlation of ICMV and density
  - Research projects now underway
- Data Management and Analysis
  - Improve data collection and management
  - Improve Veda software and offer training
- IC Specifications
  - Best ways to use IC on pavement construction projects?
- Continue to work toward development and implementation of IC technology
  - Best ways to encourage and support implementation by agencies?

IC Asphalt Density Study



FHWA Density Study 2012-2014

Research Findings – ICMV

- Overall findings
  - At this time, IC is **not** ready for use as a Quality Assurance (acceptance) tool
    - Consistently reliable correlation between ICMV and in-place density readings have not been established
    - On many projects, there has been a "relationship" between ICMV and density
  - IC can be used as a Quality Control tool
    - Contractors can use IC capabilities to improve their compaction process

Polling Question #2

- Should IC output be used for acceptance purposes?
  a. Yes
  b. In some cases
  c. No, only for Quality Control
  d. Not sure

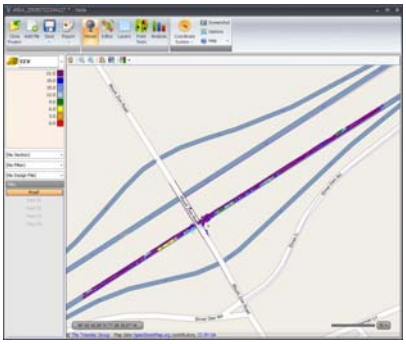
How can IC be used to improve QC?

How can IC Improve QC?

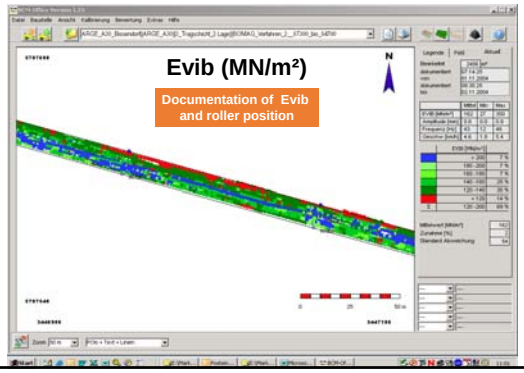
- During compaction, operator can use the onboard display to:
  - Make sure that the optimum number of passes is applied consistently
  - Monitor the mat temperature
  - Use a target ICMV value which can relate to density
- Data can be post processed to:
  - view, edit and statistically analyze the data
  - evaluate the critical components of the compaction process to learn how to improve future work

Caterpillar IC Onboard Display

ICMV Plot - Veda Software



Verification-100% Coverage

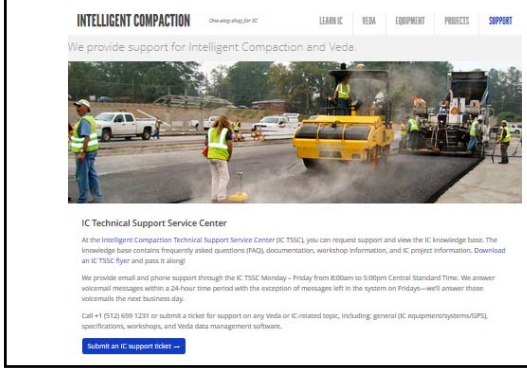


Where can you find IC Resources?

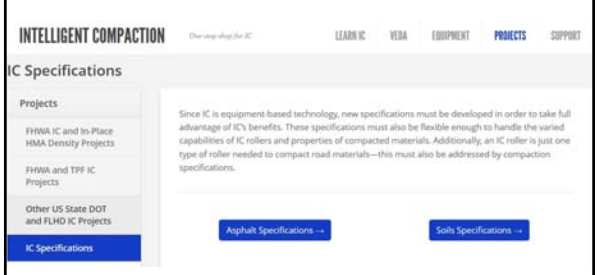
What Resources are Available?

- IC Website
  - www.intelligentcompaction.com
    - Guide specifications
    - Available Training
    - Veda Software and Support
    - Library of IC related documents
    - Research project reports
- IC Technical Support Service Center
  - http://www.fhwa.dot.gov/construction/ictssc/

IC Technical Support Service Center



IC Specification Database



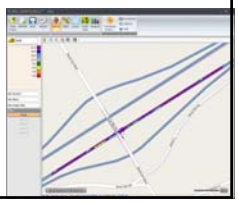
Guide IC Specs

FHWA Soils/Asphalt IC

AASHTO PP81-14

Veda (Veh-da)

- Geospatial Analysis Software for Intelligent Compaction
- Import data from various IC suppliers
- Perform viewing, editing/layering, point tests, and analysis.



Training

- States and contractors increasingly ready to start using IC for all material types on non-research projects
- To ensure successful use of IC, a significant national training effort is needed
- FHWA has developed two different IC workshops that are free to agencies that request them

Requesting IC Workshops

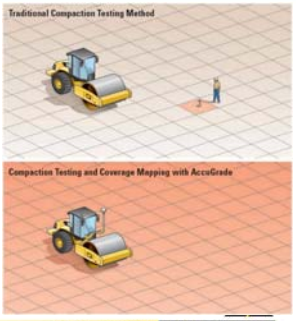
- Agencies can request a free IC Workshop through their FHWA Division Office

FHWA IC Workshops

- Two different IC Workshops are now available free to agencies
  - IC Overview Workshop
    - Typically 4-5 hours
    - For agencies that want to learn more about IC
  - IC Data Management (ICDM) Workshop
    - One day workshop
    - For agencies that have upcoming IC projects
    - Hands on training with Veda software
    - Optional half-day equipment demo

In Conclusion……

- Need for IC Technology
  - Improved consistency with compaction and density
  - 100% coverage for monitoring roller speed, roller passes, surface temperature, and indexed compaction values
  - Identification of soft spots (base & subgrade layers)
  - Improved efficiency – no over-rolling or under-rolling
  - Operator accountability
  - **To be used only for QC, not for acceptance**



Courtesy of Trimble/Caterpillar

Let's Wrap it up…

- IC is an exciting innovation that offers many benefits to both contractors and agencies in the construction of asphalt pavements
- IC and GPS technologies are readily available through multiple vendors
- IC is ready to implement now as a Quality Control tool.
- IC resources such as specifications, training/support and software are available through FHWA and at www.asphaltinstitute.org.

Sitka Airport Project 2013