Intelligent Compaction

Improving Quality Control of HMA Paving using IC Technology

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Our Visit Today

• Answer the Questions:
  • What is Intelligent Compaction (IC)?
  • What are the benefits of IC?
  • Can IC technology be used in a practical way to improve the Quality Control (QC) process for Hot Mix Asphalt (HMA) paving projects?
What is Intelligent Compaction?

An Innovation in Compaction Control and Testing
Tandem Drum IC Rollers

- Bomag
- HAMM-Wirtgen
- Caterpillar
- Sakai
Definition of Intelligent Compaction

• 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
Roller Measurement Values (RMVs)

Bomag $E_{VIB}$

Caterpillar/Trimble CMV

Hamm/Wirtgen HMV

Sakai CCV
IC Pooled Fund (ICPF)

ICPF States / Year

2008
2009
2010
Findings of Research

• IC can be a valuable tool to improve QC of asphalt paving compaction operations
• IC addresses many of the shortcomings of conventional equipment and processes
• Software has been developed to provide a practical tool to simplify and speed up IC data management and analysis
• It is recommended that agencies consider trial projects using IC for QC purposes
Benefits of IC

- Identification of soft spots in underlying materials prior to paving using IC “mapping”
- More consistent roller coverage during HMA compaction which should result in decreased density variability
- IC data analysis which provides an independent QC tool that can augment conventional QC spot testing
IC Mapping of Underlying Layers
IC Mapping of Underlying Layers

• Ability to effectively compact HMA layers is best interpreted with knowledge of the underlying layer’s support conditions
• For compaction to be effective, underlying layers must provide a consistently solid platform for rollers
• Level of underlying support for compaction operations and limits of “soft spots” has been difficult to accurately quantify using conventional methods
IC Mapping of Underlying Layers

Minnesota ICPF Project

Mapping of the subgrade / aggregate base layer
HMA non-wearing course layer map, $a = 0.6 \text{ mm}$, $f = 3000 \text{ vpm}$

Class 5 aggregate subbase layer map, $a = 0.6 \text{ mm}$, $f = 2500 \text{ vpm}$

Reflection of hard spots on the HMA layer

Reflection of hard spots on the HMA layer

Reflection of soft spots on the HMA layer

$y = 2.45 \ln(x) + 2.3$

$R^2 = 0.69$

MN ICPF Project
Summary – IC Mapping

• All mapping was done w/ tandem drum IC roller using low amplitude and vibration
• On ICPF projects, area of lower support were found on virtually every type of pvmt.
• IC mapping seemed to be effective in identifying “soft spots” in most underlying materials
• Soft spots in underlying layers “reflect” up through the new HMA overlay
Improving the Compaction Process
Sakai IC Onboard Display Unit
Color-Coded On-Board Display
Improved Rolling Patterns

Before

After

Indiana ICPF Project

Sakai IC roller
Summary – Improving Compaction

- On-board, color-coded display provided roller operators with a valuable tool to improve consistency of desired number of roller passes
- More consistent roller passes will likely result in better and more consistent asphalt pavement density
Conducting statistical and geospatial analysis of IC data
Analysis of IC Data

• IC creates a massive amount of data during compaction process which has to be collected, processed in a timely basis
• IC data is supplier-specific, in different formats and new to users
• Therefore, ICPF developed a third party data management and analysis software tool called Veda (Veh-da) for standardized analysis and reporting
Veda (Veh-da)

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

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![Histogram of IC-MV](chart.png)
Summary-Data Analysis

• Data collection, management and analysis is a major challenge in implementing the use of IC technology
• Veda software is a good first step in providing contractors/agencies with a practical, fast and user friendly tool
• Veda software and related IC data guidelines are available to the public at www.intelligentcompaction.com.
Guide Specifications

• Guide specifications have been developed and are available on www.intelligentcompaction.com

• Use of IC technology for Contractor’s Quality Control (process control) not QA (acceptance)

• Spec. includes lump sum pay item that covers all costs related to use of IC technology
What’s Next?

• Further research efforts
• Agency trial projects
• Refinement and improvement in IC data software
• More innovations related to IC and GPS
• Long term: Implementation of routine use of IC technology in equipment and project compaction
Conclusions

• Intelligent Compaction (IC) is a major innovation in compaction technology
• IC is a valuable tool to improve the compaction process during paving operations
• All major roller suppliers have and are continuing to develop IC technology
• IC technology is now available and ready to be specified for QC purposes for trial projects
• www.intelligentcompaction.com
• Under “Veda Software”
  • Download software
• Under “Specifications”:
  • Generic HMA IC Specification
Intelligent Compaction

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Why Intelligent Compaction?

• Shortcomings in the Compaction Process…

Limited “On The Fly” Feedback

Over or Under-Compaction Can Occur
Why Intelligent Compaction?

- Shortcomings- Density Measurement Process...

  Limited Number of Locations

  After Compaction is Complete
Importance of Compaction?