Intelligent Compaction (IC) for Hot Mix Asphalt (HMA)

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Federal Highway Administration
What is Intelligent Compaction
Who’s doing what with IC
Field Evaluation Studies
Does IC work
What is Intelligent Compaction Technology

An Innovation in Compaction Control and Testing

Office of Pavement Technology
Federal Highway Administration
www.fhwa.dot.gov/pavement/
Intelligent Compaction

--- Definition ---

What is “Intelligence?”

- Oxford Dictionary: “…able to vary behavior in response to varying situations and requirements”

- Ability to:
  - Collect information
  - Analyze information
  - Make an appropriate decision
  - Execute the decision

3000-4000 TIMES A MINUTE
THE IMPORTANCE OF COMPACTION in highway construction has long been recognized. Recent laboratory and field investigation have repeatedly emphasized the value of thorough consolidation in both the base and surfacing courses. Thorough compaction is known to produce the following desirable results:

1. It increases interlocking of the aggregate particles, which is the primary factor in developing a high degree of stability. 2. It retards the entrance of moisture, thus preventing excessive loss of stability under adverse service conditions. 3. It reduces the flow of air and water through bituminous mixtures and is therefore an effective means of lessening damage from weathering and film stripping.

Reference -- "Public Roads, May 1939, authors J.T. Pauls and J.F. Goode"
Conventional Density Testing Shortcomings

- Density Acceptance…

Limited Number of Locations

After Compaction is Complete
Basics of HMA Compaction

Compaction is the process of compressing hot mix asphalt into a smaller, denser volume.

Asphalt coated aggregate particles are reoriented and consolidated which increases the pavement density.
Roadway Compaction

- Proper in-place density is vital for good performance
- Conventional compaction procedures have some limitations...
- Intelligent compaction technology appears to offer "a better way"
Benefits of IC for HMA

- Improve density... better performance
- Improve efficiency... cost savings
- Increase information... better QC/QA
IC for HMA

What are main components of IC
1. Vibratory rollers with a measurement system
2. Automatic feedback control system
3. GPS-based documentation system
IC for HMA

How does an IC roller work?

- Vibratory rollers
- Accelerometers on drum measure materials response to vibratory impulses
- On-board computer calculates roller measurement value (RMV) – Manufacture Dependant
- RMV is displayed to the roller operator continuously during compaction process
IC for HMA

- How does an IC roller work? (cont.)
  - Feedback control system automatically adjusts parameters to optimize compaction
  - GPS tracks roller position and matches it with RMV, mat temperature, # roller passes

- **Printout** - hardcopy
- **Color-coded mapping capabilities**
- **Electronic record**
IC for HMA
Caterpillar On-Board Display
Dynapac On-Board Display

- Roller: Dynapac CC522HF
- Temperature: 134°C
- Speed: 3.0 km/h
- Position CC: 41.94
- Offset: 0.70
- Course: 200.00

Data plot:
- Project: INSTRUCTIONS
- Object: OPT NO OF PASSSES
- Layer: 4 PASSSES
- Section: 0-200

Stop recording button
Sakai IC Roller Project

- Roller Passes

Shoulder (Supported)

Longitudinal Joint

Paving Direction

Number of roller passes:
1 2 3 4 5 6 7 8

Courtesy Sakai America
IC National Efforts

- **NCHRP 21-09** “Examining the Benefits and Adoptability of Intelligent Soil Compaction”

- **Transportation Pooled Fund #954** –
  “Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base and Asphalt Pavement Material”
NCHRP 21-09 Phase One Project

July 2006; MnROAD Research Center
NCHRP 21-09 Phase One Project

- Bomag
- Caterpillar
- Ammann
NCHRP 21-09
Phase One Project
FHWA Pooled Funds Study (Soils / HMA)

- 3 year study of IC for Subgrade, aggregate bases, and HMA materials
- Work has started October 1st, 2007
- 12 participating states
- Estimate 1+ project / State / year ~ 15-20?
- Close coordination with NCHRP project
- To work closely with roller suppliers to increase the number of IC rollers and manufacturers
Objectives: Based on data obtained from field studies:

- Accelerated development of QC/QA specifications for granular and cohesive subgrade soils, aggregate base and Hot Mix Asphalt (HMA) pavement materials...
Pooled Fund, Objectives

- Develop an experienced and knowledgeable IC expertise base within Pool Fund participating state DOT personnel

- Identify and prioritize needed improvements to and/or research of IC equipment and field QC/QA testing equipment (DCP, FWD, GeoGauge, etc)
Early Field Demo’s by Industry and DOT’s

- California
- Minnesota
- Virginia
- Maryland
- Colorado
- Florida
1. Fair correlation between stiffness of last breakdown roller pass and core density ($R^2 = 0.5613$)
2. All cores were cut after finishing rolling was done.
3. Coordinates of core locations were measured by GPS with accuracy of 5 ft.
1. No correlation between stiffness and core density measured during finish rolling.
2. All cores were cut after finishing rolling was done.
3. Coordinates of core locations were measured by GPS with accuracy of 5 ft.
Sakai IC Roller Project

Distribution of roller-generated stiffness on final pass of breakdown rolling

4,000 vpm, Low Amplitude
Special Issues for HMA IC

- Thin lift construction
- Mixture type and size
- Allowable temperature ranges
- Surface vs. internal temperature measurement during placement
- Non-destructive, in-situ stiffness
- Response parameters
Question: Does IC work?

- Soils and Aggregate materials have had good experiences to date.
- For HMA - the jury is still out, but stay tuned for future updates.
What have we learned so far?

- IC technology appears to have great potential to improve the compaction process.
- Improved and more uniform density should increase pavement service life.
- There is a great deal of interest among industry as well as federal and state DOTs to learn more about it.
What have we learned so far?

- Roller manufacturers are responding to this interest by performing R&D, providing rollers and by coordinate efforts with state and national research efforts.

- Preliminary findings for HMA from studies in US are not glowing but are encouraging.
Thank you