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

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U.S. Department of Transportation
Federal Highway Administration

Presentation Outline

- 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

Importance of Compaction

We've known it for a long time…

"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 in 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

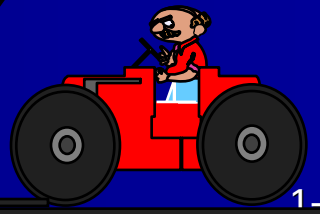
Compaction is the process of compressing hot mix asphalt into a smaller, denser volume.

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

Roadway Compaction

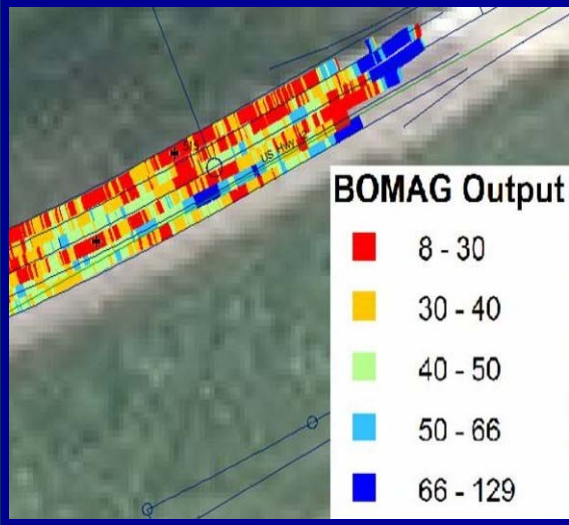
- Proper in-place density is vital for good performance
- Conventional compaction procedures have some limitations...

- Intelligent compaction technology appears to offer *"a better way"*



Benefits of IC for HMA

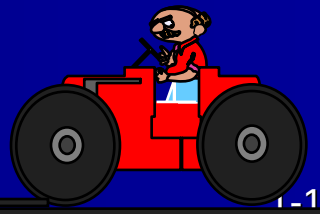
- Improve density....better performance
- Improve efficiency....cost savings
- Increase information...better QC/QA



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

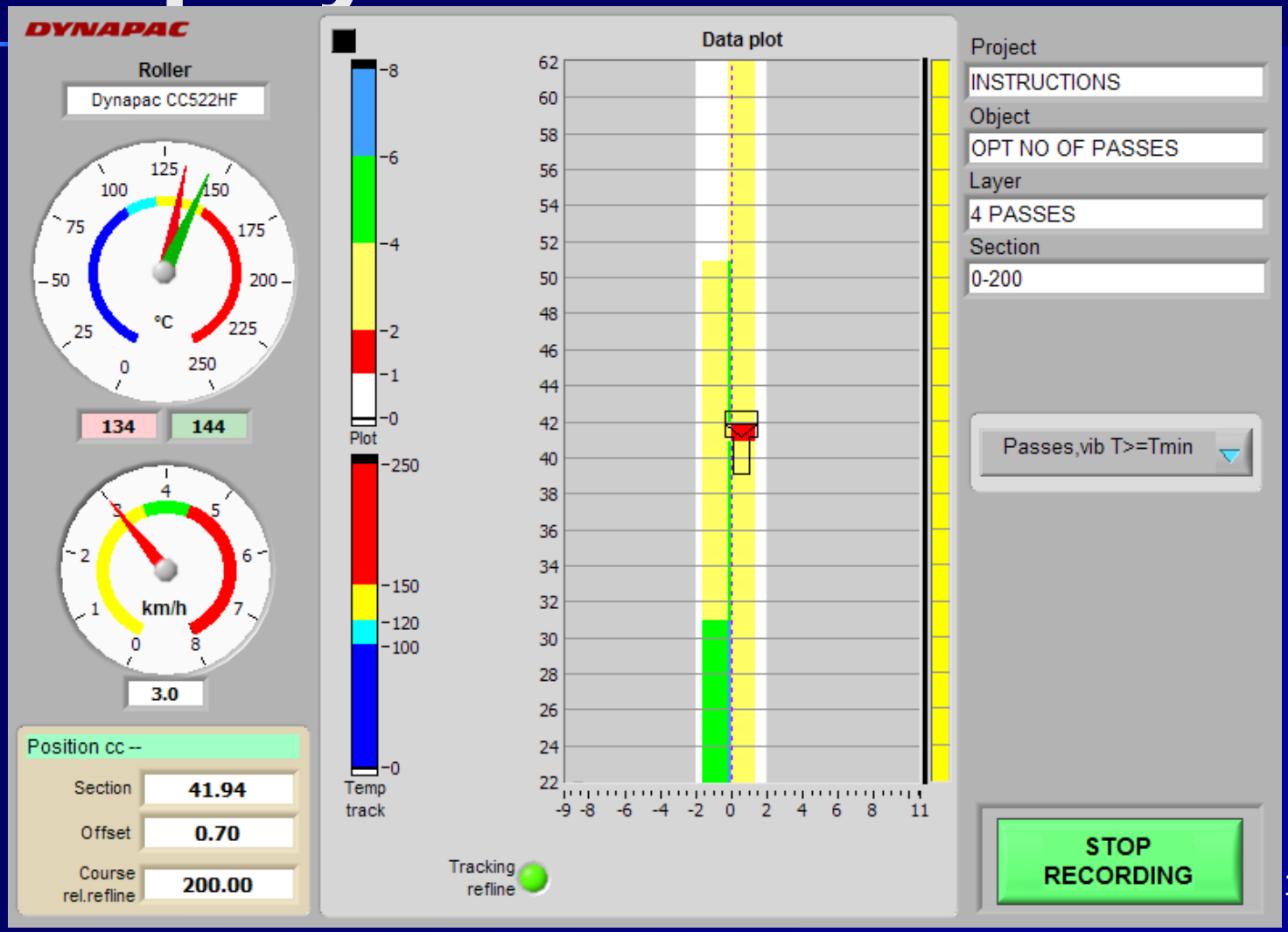
- How does an IC roller work? (cont.)
  - Feedback control system automatically adjusts parameters to optimize compaction
  - GPS tracks roller position and matches it with RMV, mat temperature, # roller passes
    - **Printout – hardcopy**
    - **Color-coded mapping capabilities**
    - **Electronic record**

IC for HMA


EVIB 298 PSI x100
0 100 200 300 400 500
0.9 in/100
188 °F
3.5 mph
3060 vpm
F1
F2
F3
F4
F5
F6
F7
F8
A
B
C
F9
F10
F11
F12
F13
F14
P1
P2
P3
?
ESC
Enter

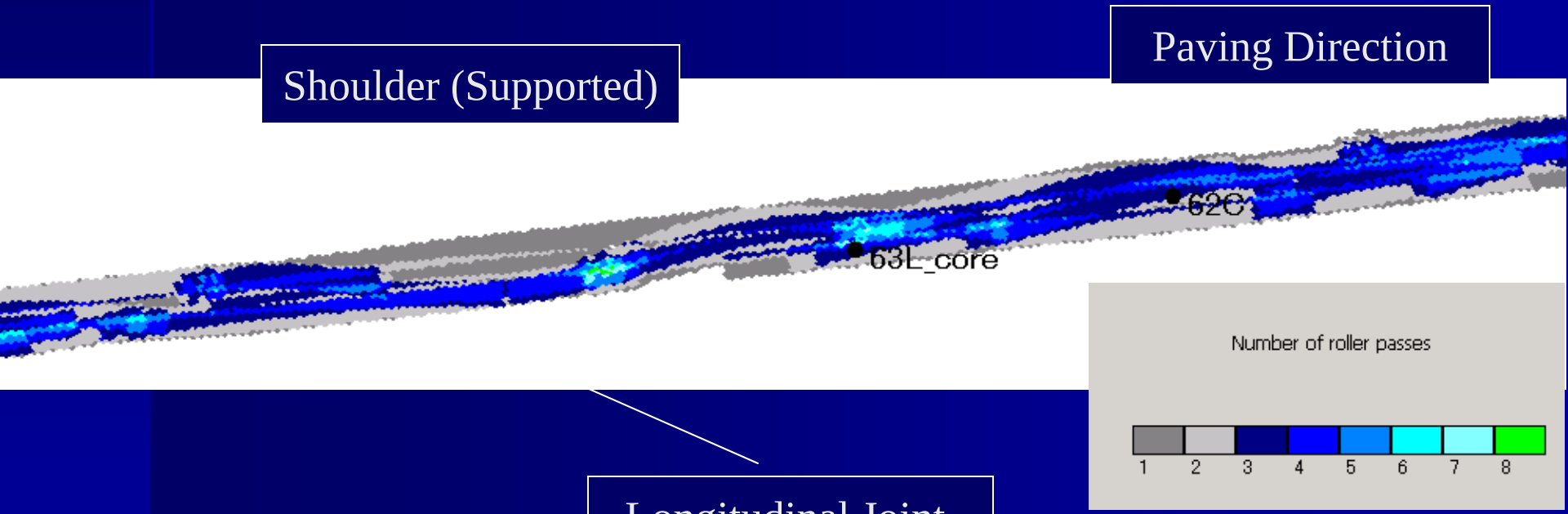
Caterpillar On-Board Display

Dynapac On-Board Display



Sakai IC Roller Project

- Roller Passes



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

MnROAD Research Center

MnROAD
Office of Minnesota Road Research

Building a Better Foundation for the Future

July 2006; MnROAD Research Center

NCHRP 21-09 Phase One Project

NCHRP 21-09 Phase One Project

Iowa State University
Geotechnical Mobile Lab

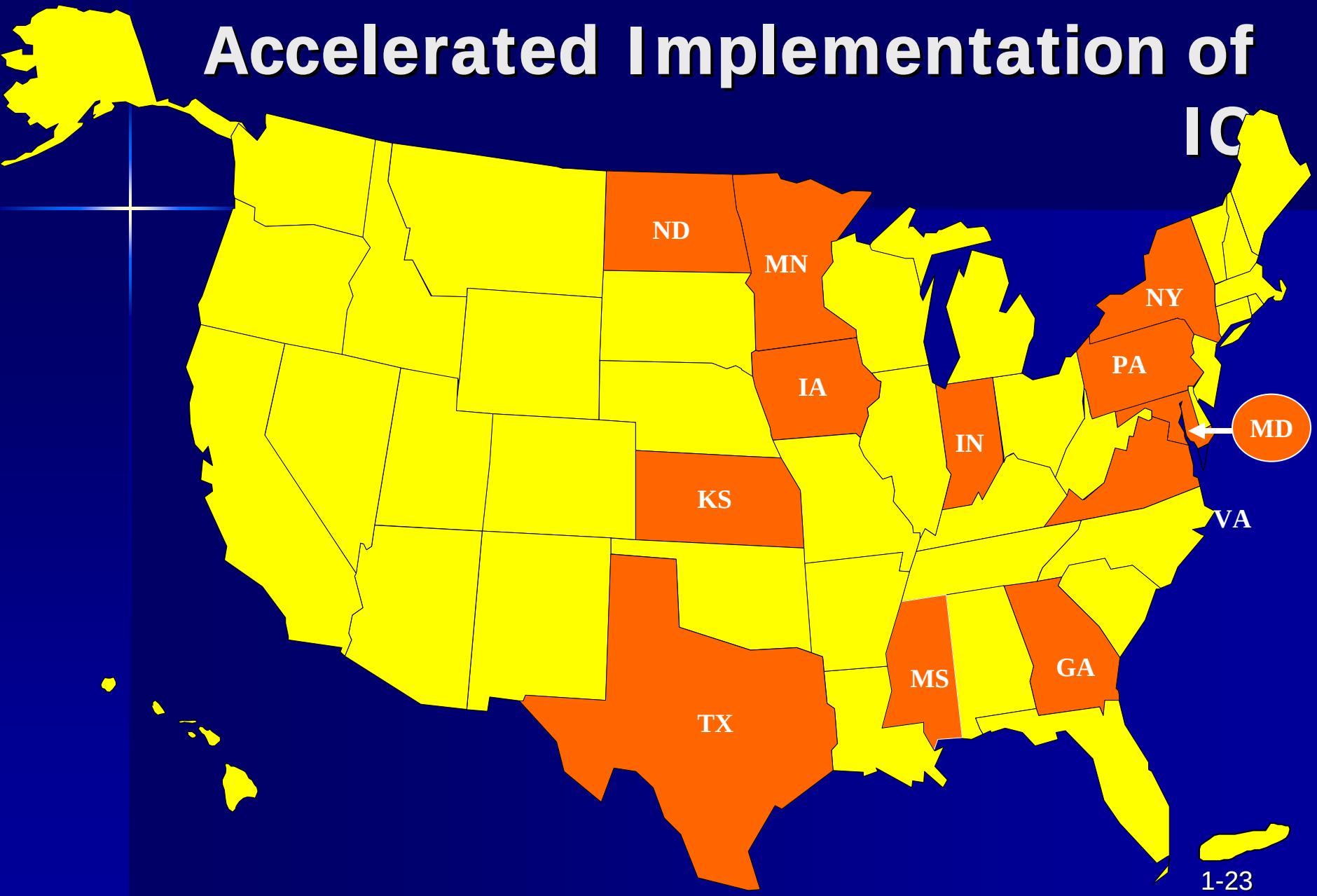
"Advancing Intelligent Construction"

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

Accelerated Implementation of IC



Pooled Fund, Objectives

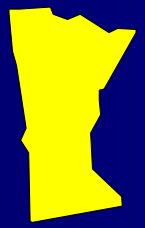
- **Objectives: Based on data obtained from field studies:**
  - Accelerated development of QC/QA specifications for granular and cohesive subgrade soils, aggregate base and Hot Mix Asphalt (HMA) pavement materials...

Pooled Fund, Objectives

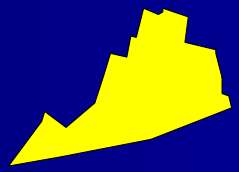
- Develop an experienced and knowledgeable IC expertise base within Pool Fund participating state DOT personnel
- Identify and prioritize needed improvements to and/or research of IC equipment and field QC/QA testing equipment (DCP, FWD, GeoGauge, etc)

Early Field Demo's by Industry and DOT's

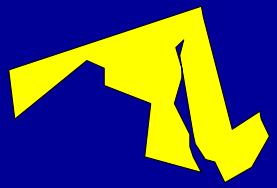
California



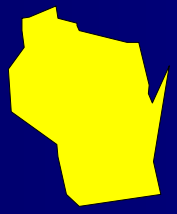
Minnesota



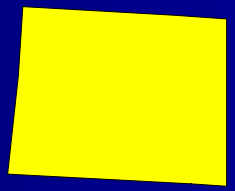
Virginia



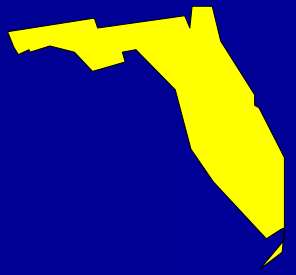
Maryland



Wisconsin



Colorado

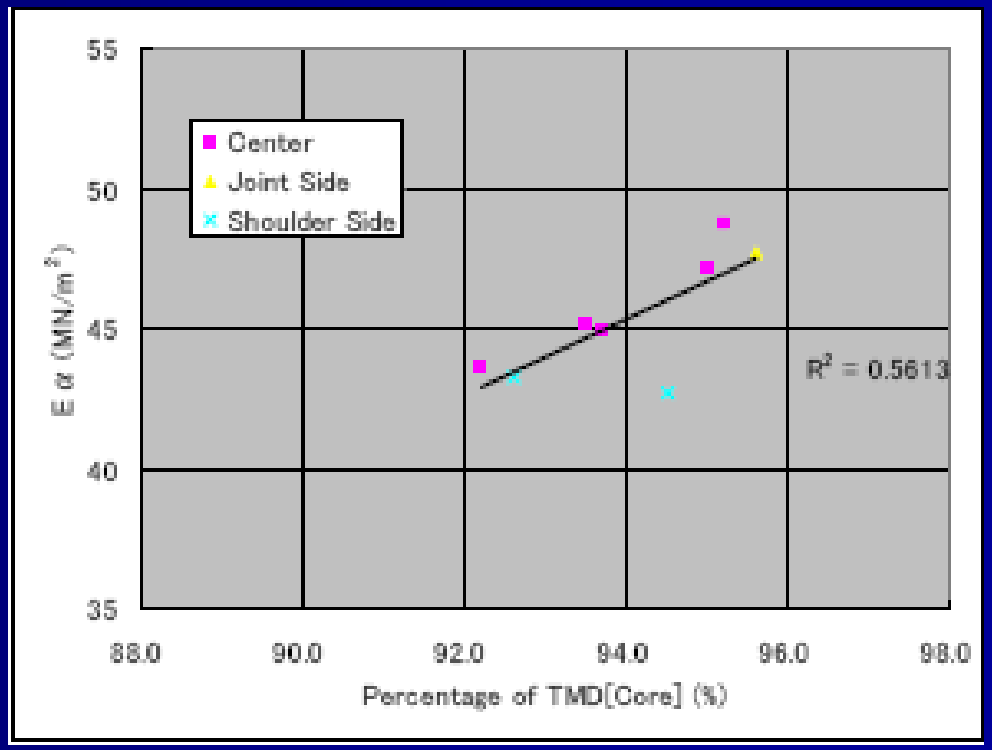


Florida

Sakai IC Roller Project

Stiffness vs. Density During Breakdown Rolling

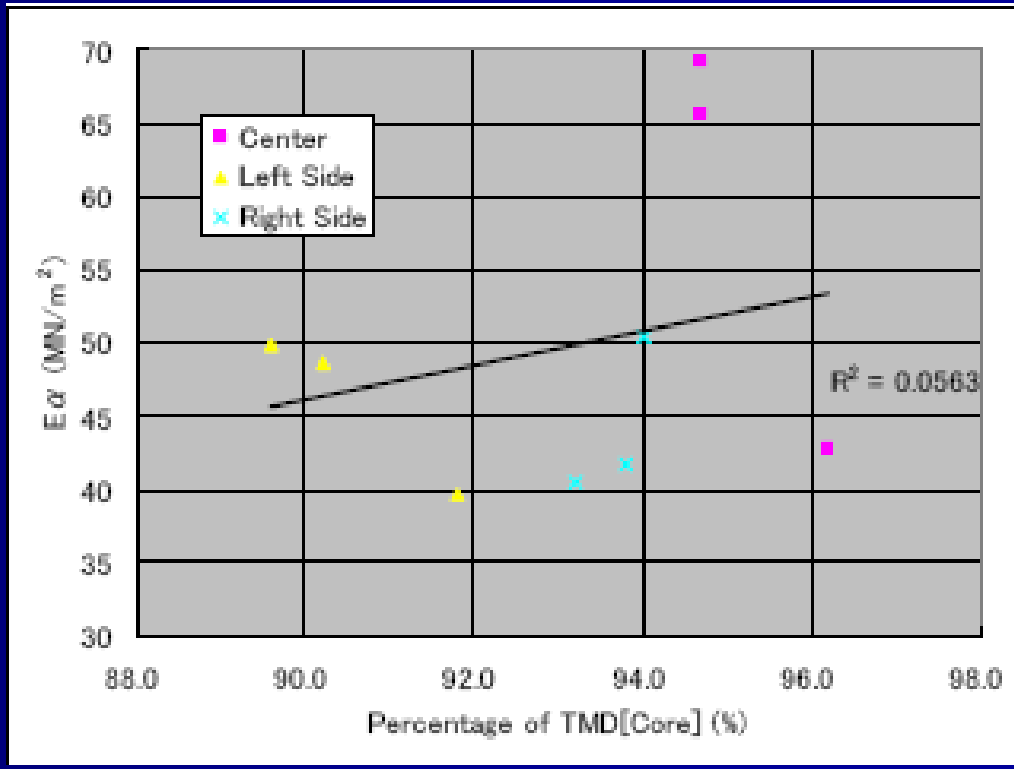
1. Fair correlation between stiffness of last breakdown roller pass and core density ($R^2 = 0.5613$)
2. All cores were cut after finishing rolling was done.
3. Coordinates of core locations were measured by GPS with accuracy of 5 ft.



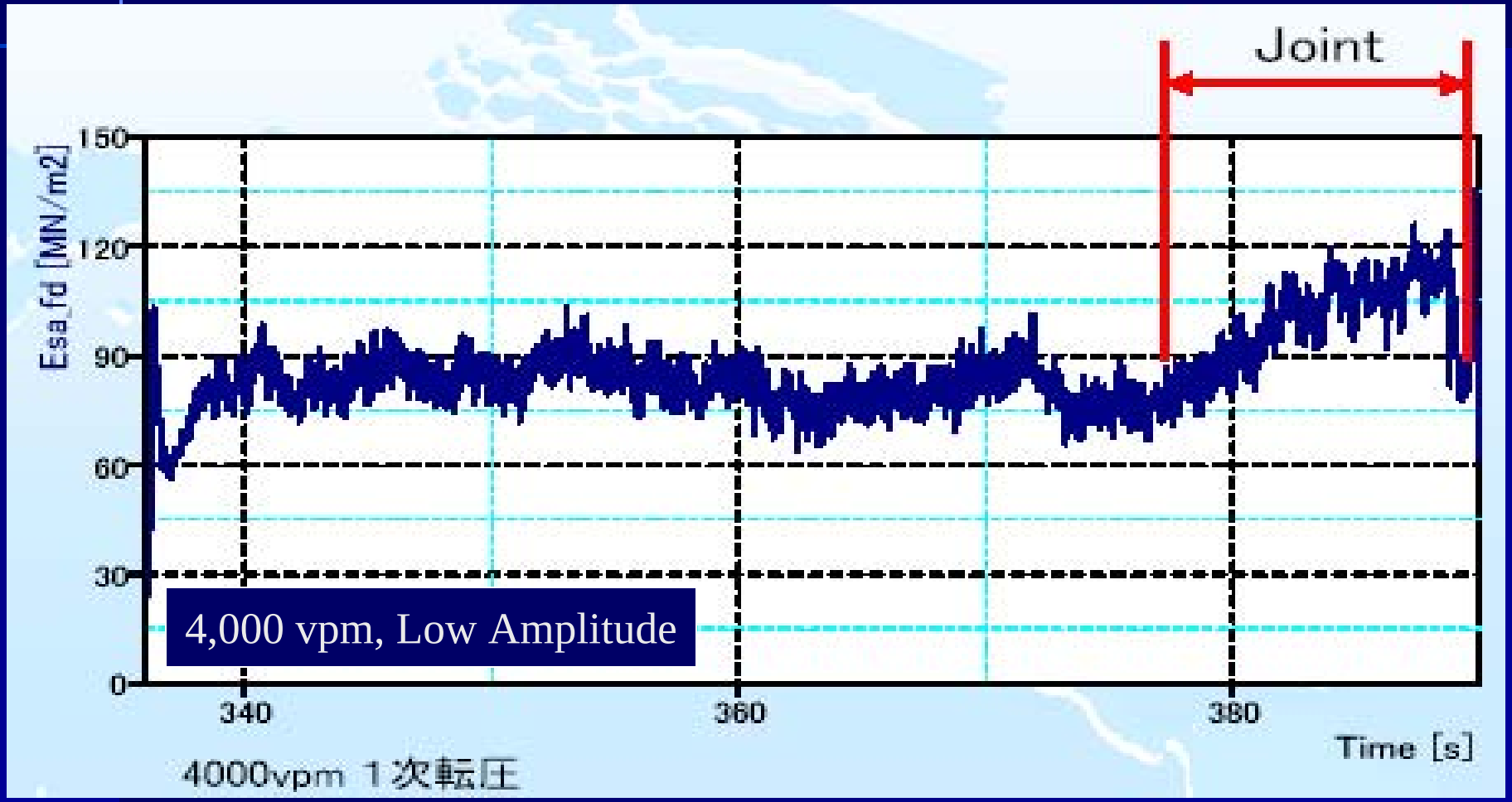
Sakai IC Roller Project

Stiffness vs. Density During Finish Rolling

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

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