

Intelligent Compaction

Improving Quality Control of HMA Paving using IC Technology



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**NW Pavement Management Association
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Benefits of IC for HMA

- Improve density....better performance
- Improve efficiency....cost savings
- Increase information...better QC/QA
- Overall Benefit:
Improved Pavement Performance!

IC Demo Riverside CA



IC Demo Riverside CA



How Important is Compaction?

- Proper in-place density is essential for good performance of asphalt pavements
- Density is directly related to the air void content in the compacted asphalt pavement.
- Numerous research and field studies have verified that obtaining optimum air voids through good compaction practices is essential to achieve expected service life

Importance of Compaction?



Effect of In-Place Voids on Life

Washington State DOT Study



93%

92%

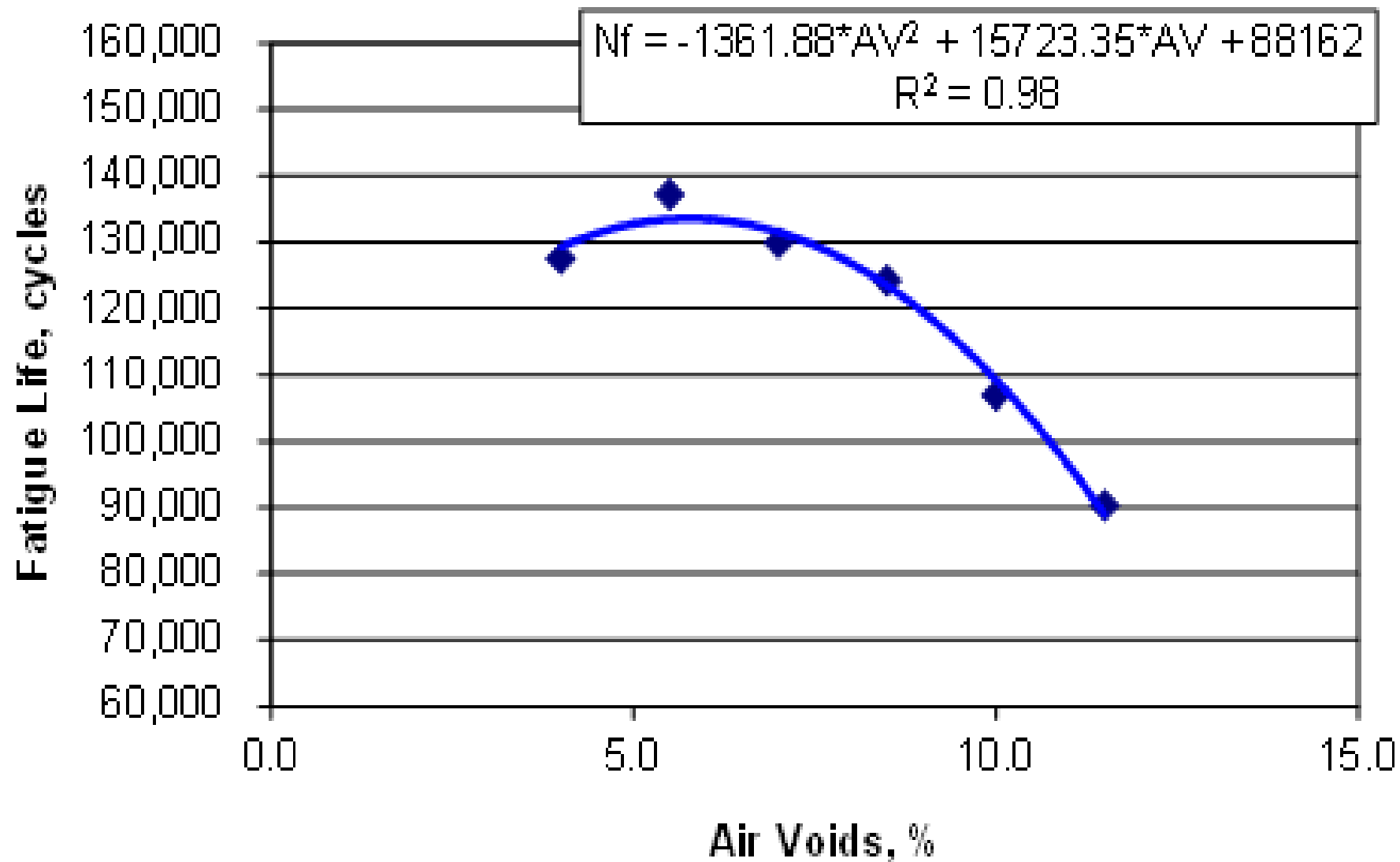
91%

90%

89%

Compaction Level

Effect of Percentage of Air Voids on Fatigue Life 20C, 500 microstrain

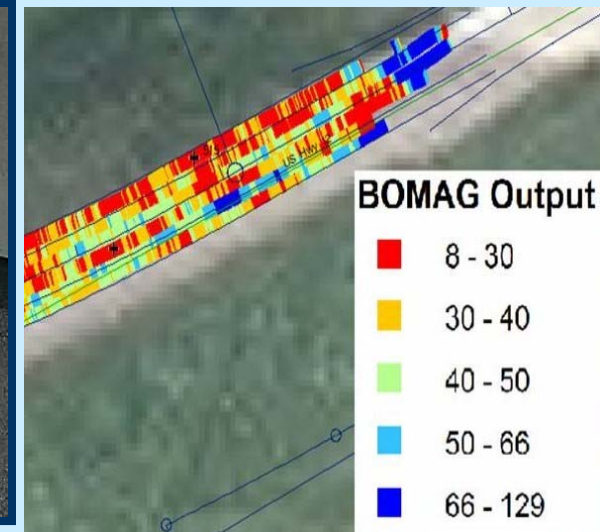


Discussion Items

- What is Intelligent Compaction (IC)?
- What are advantages of IC compared to conventional compaction?
- IC Pooled Fund – HMA Projects
- Practical Uses of IC to improve QC
 - IC mapping
 - Improving roller pass consistency
 - 100 % coverage and color-coded maps that provide permanent records of process

What is Intelligent Compaction?

An Innovation in Compaction Control and Acceptance



What is Intelligent Compaction?



Vibratory Single Drum
Soil Roller



Vibratory Tandem Drum
Asphalt Roller

Definition of Intelligent Compaction

- 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

Tandem Drum IC Rollers

Bomag



HAMM-Wirtgen



Caterpillar



Sakai



Components of IC Roller



GPS Components

On-Board,
Color-Coded Display

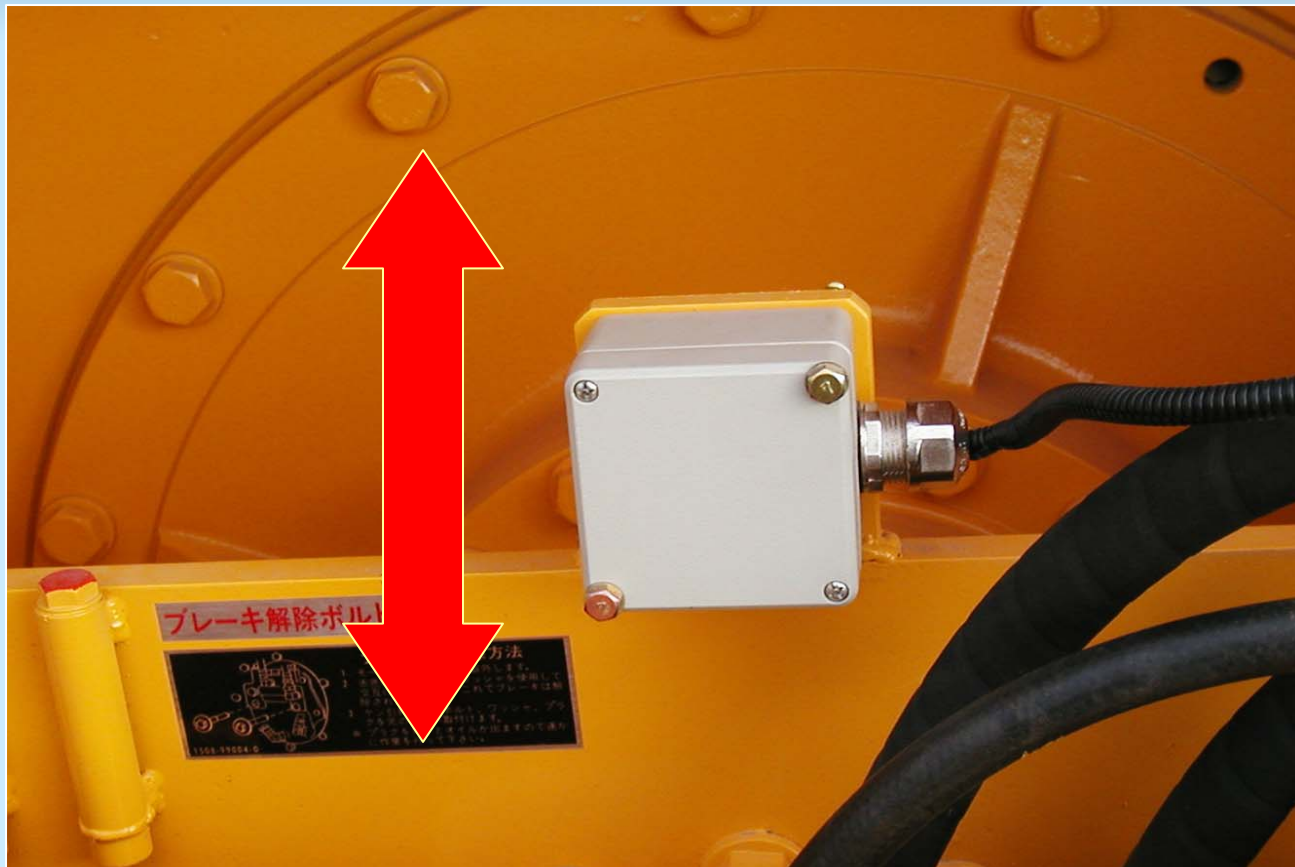
Infrared Temperature

Accelerometer

Documentation
System

Courtesy: Sakai America

Accelerometer – front drum





Global Positioning System (GPS)

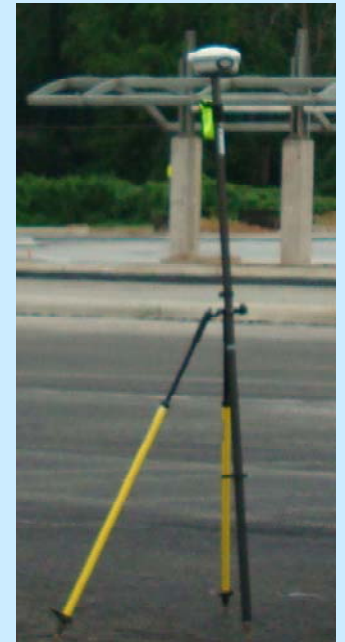
GPS Base Station



GPS Radio & Receiver



GPS Rover

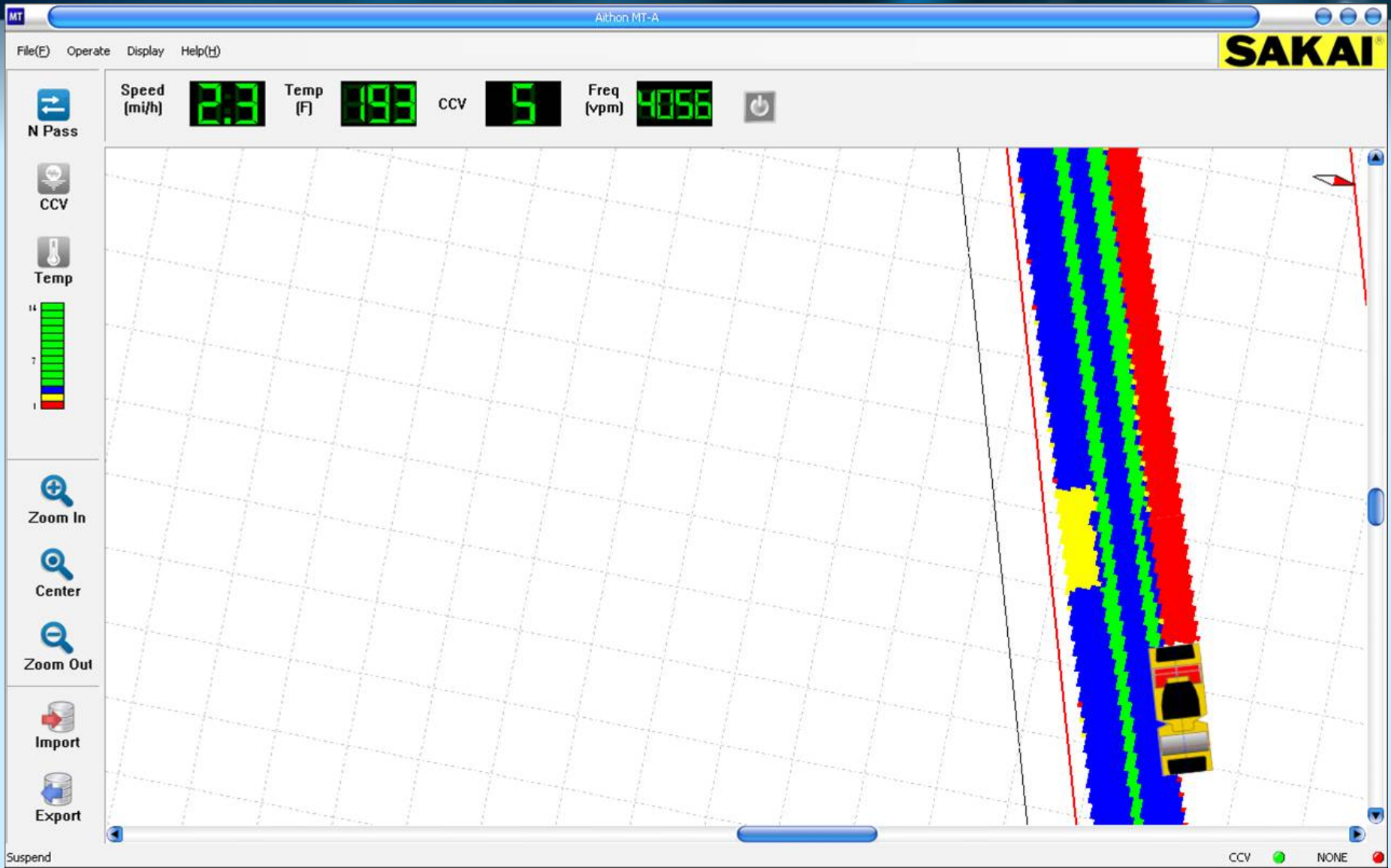


Real Time Kinematic (RTK) GPS Precision

Sakai IC Onboard Display Unit



Color-Coded On Board Display



IC Measurement Values (ICMV)

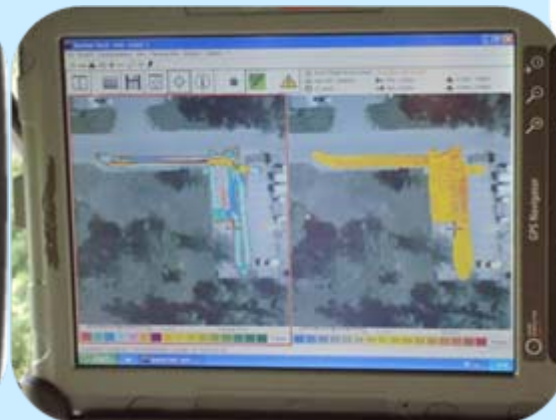


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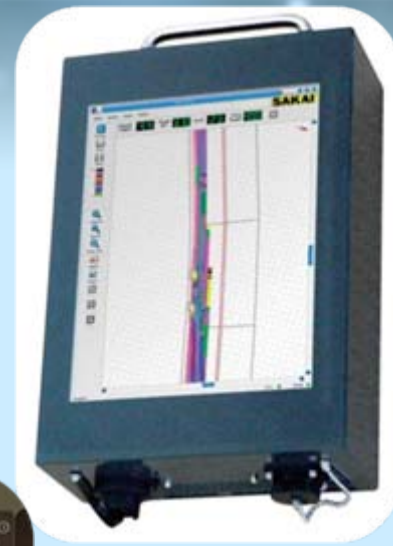
E_{VIB}



Caterpillar/Trimble
CMV



HAMM/Wirtgen
HMV



Sakai

CCV

What is Intelligent Compaction?



Mat Surface Temperature Measurement

Why Adopt IC?

- Conventional compaction equipment and processes have been used for years and can be used successfully...however....
- They have shortcomings.
- Intelligent Compaction can help address these shortcomings in both equipment and processes
- And offer a “better way” to help ensure optimum compaction effort

Why Intelligent Compaction?

- Shortcomings in the Compaction Process...



Limited "On The Fly" Feedback

Over or Under-Compaction
Can Occur

Why Intelligent Compaction?

- Shortcomings in Density Acceptance Process...



Limited Number of Locations

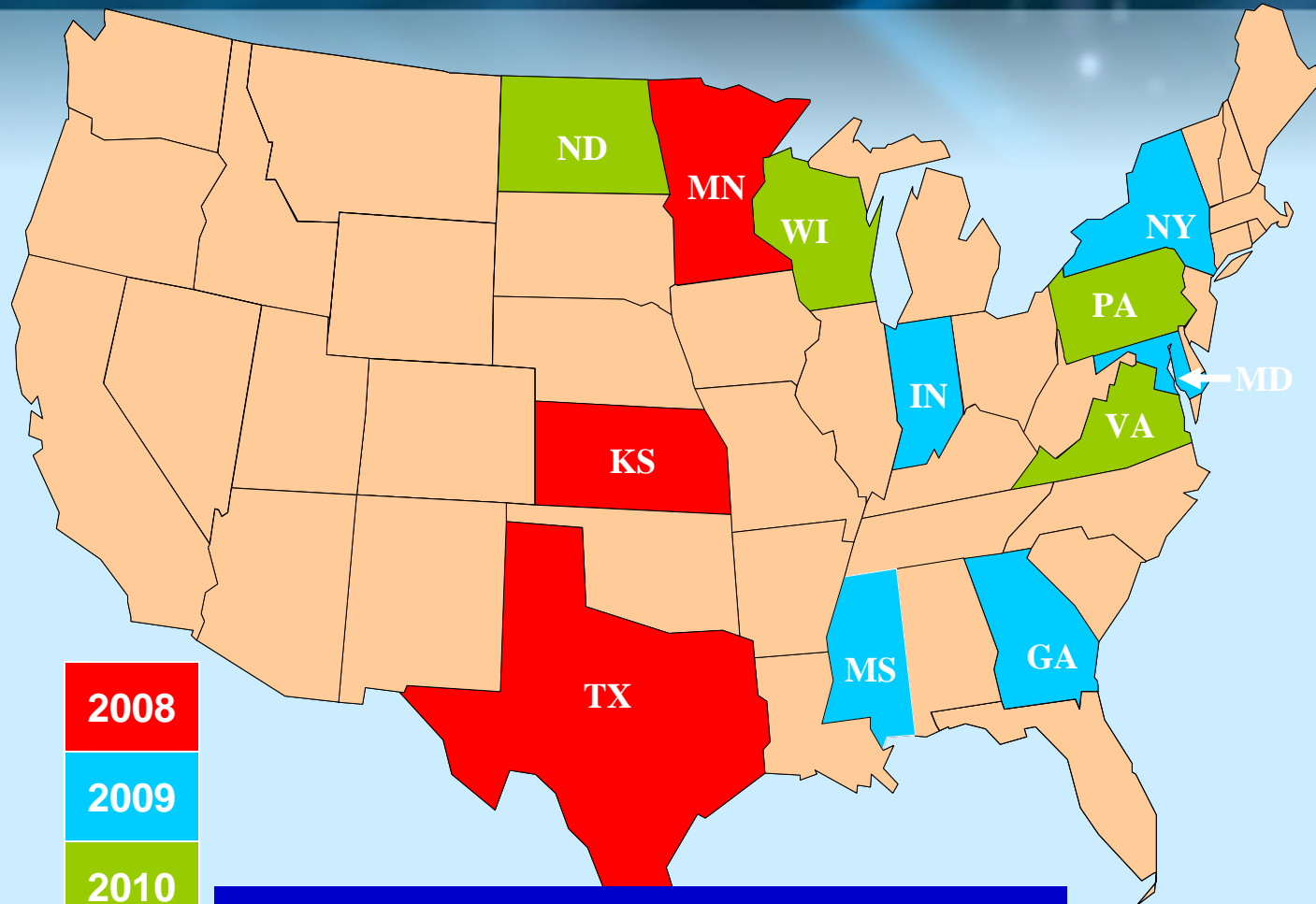


After Compaction is Complete

Intelligent Compaction Pooled Fund

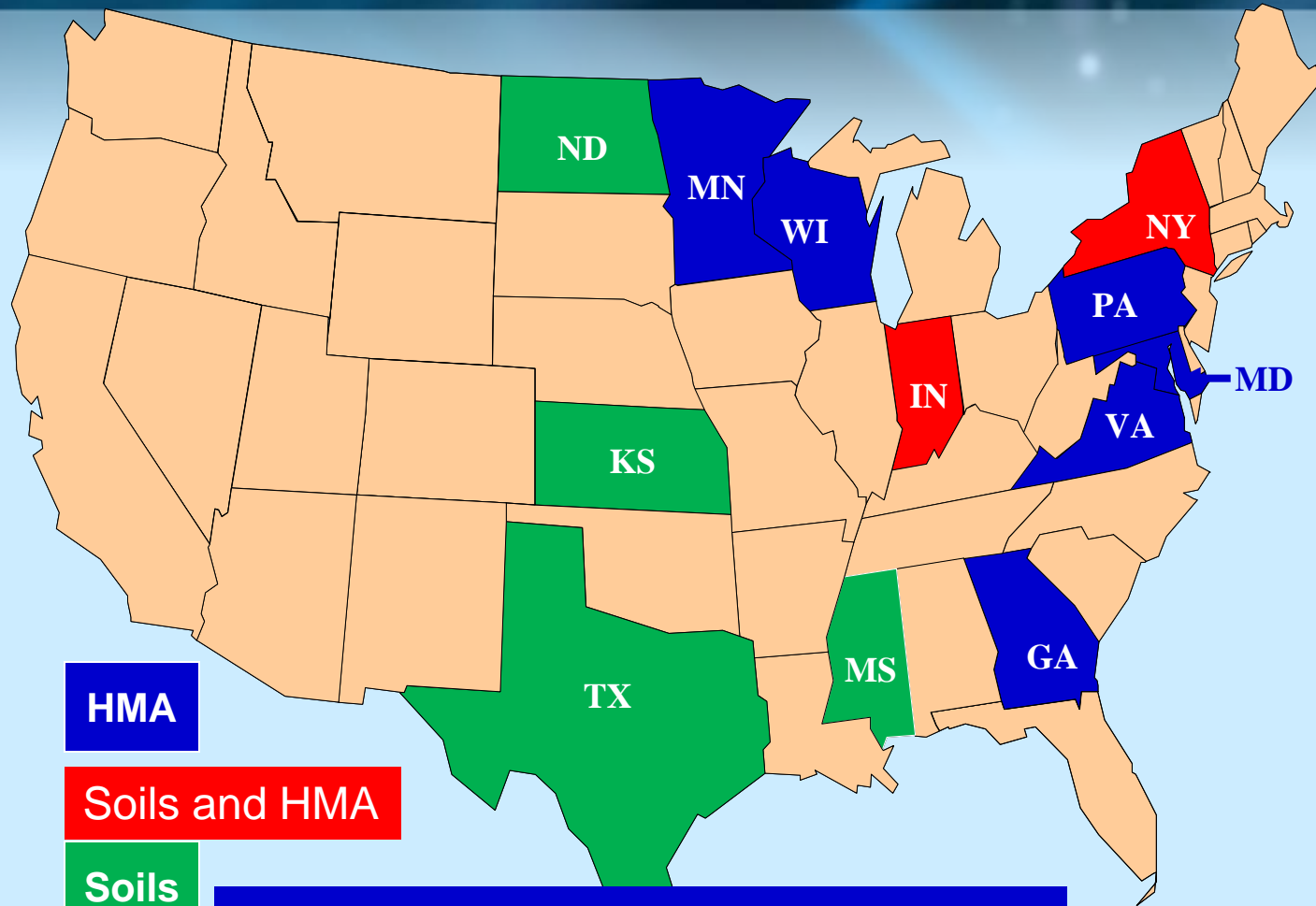
- ICPF was a three year research project to study IC technology on actual pavement projects
- Research included various types of pavement materials, including
 - Asphalt materials
 - Soils
- 12 states participated in the ICPF
- Total of 8 projects involving asphalt mat'ls.

IC Pooled Fund (ICPF)



ICPF States / Year

IC Pooled Fund (ICPF)



HMA

Soils and HMA

Soils

ICPF Materials Type

ICPF Preliminary Findings

- Use and acceptance by roller operators
- Improved roller patterns / passes
- Use of IC rollers for measuring support of underlying materials (Soils, GAB, Existing Asphalt Pavements)
- Underlying support affects compactability of subsequent layer
- More research is recommended in certain areas and on new technologies



USE AND ACCEPTANCE BY ROLLER OPERATORS

Roller Operator Training

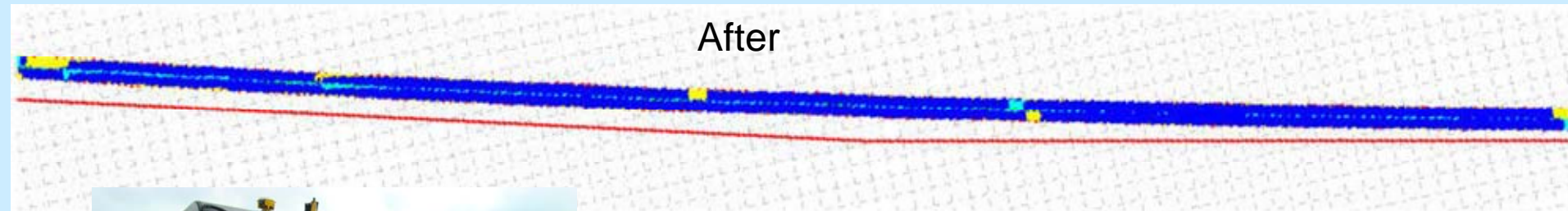
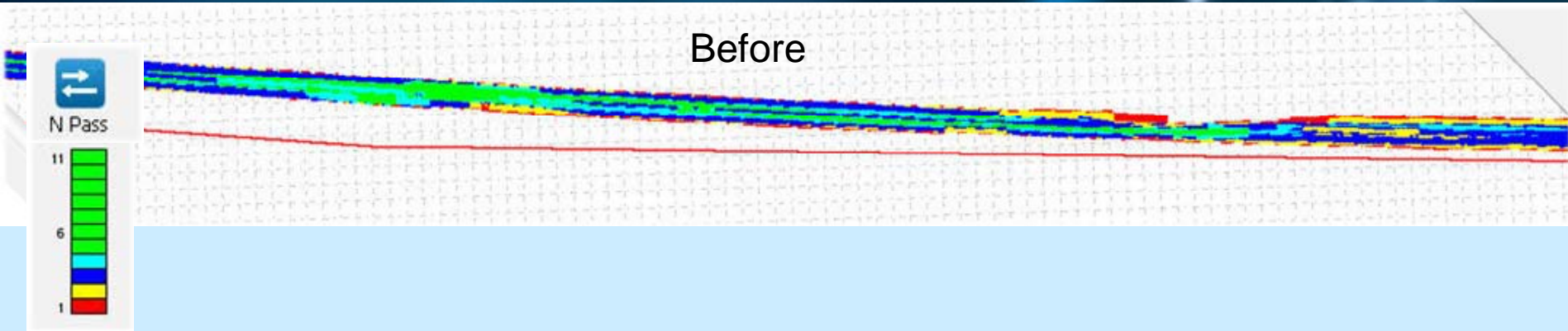


Georgia HMA Demo



IMPROVED ROLLER PASSES

Improved Rolling Patterns



Sakai IC roller

Indiana ICPF Project

IC Mapping

- IC mapping is accomplished by simply measuring ICMV on underlying material prior to paving
- Vibratory roller amp. and frequency must be adjusted to prevent double jump
- GPS location and ICMV data is processed to create a color-coded map of roadway
- Map shows 100% coverage of color coded “soft” and “hard” spots

IC Mapping of underling layers

Minnesota ICPF Project



Mapping of the subgrade / agg. base layer

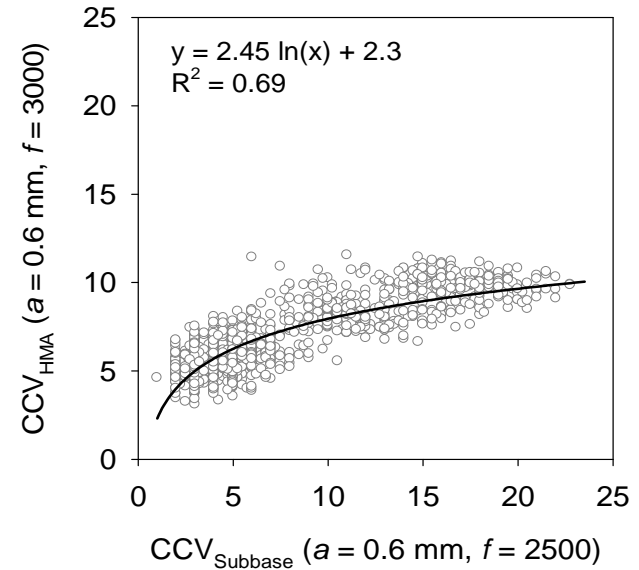
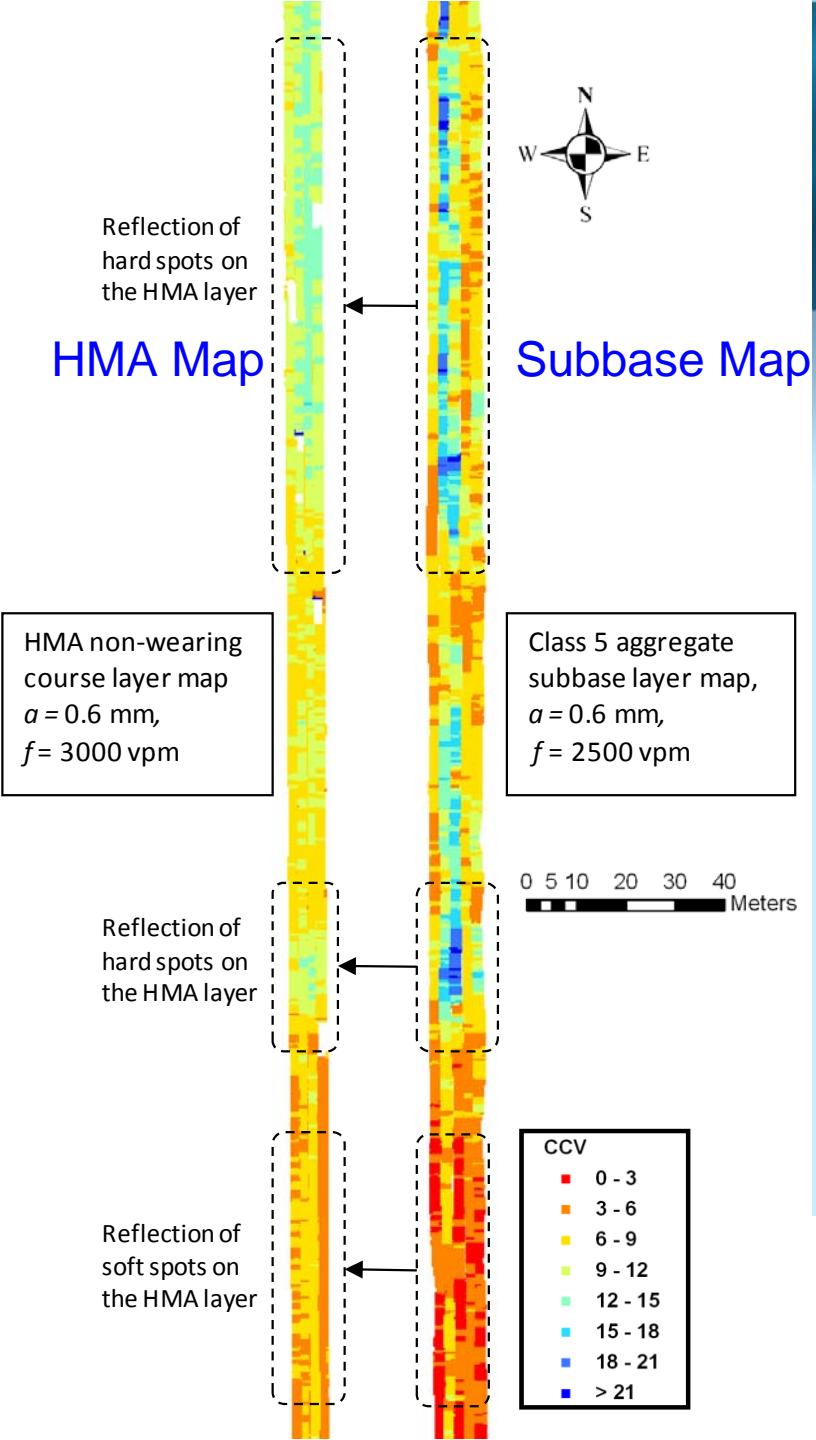
Mapping of HMA layers

Minnesota ICPF Project



Compaction/mapping of HMA base course layer

Mapping Aggr. Base



MN ICPF Project

Bomag Sakai

Mapping Milled HMA

Bomag Evib

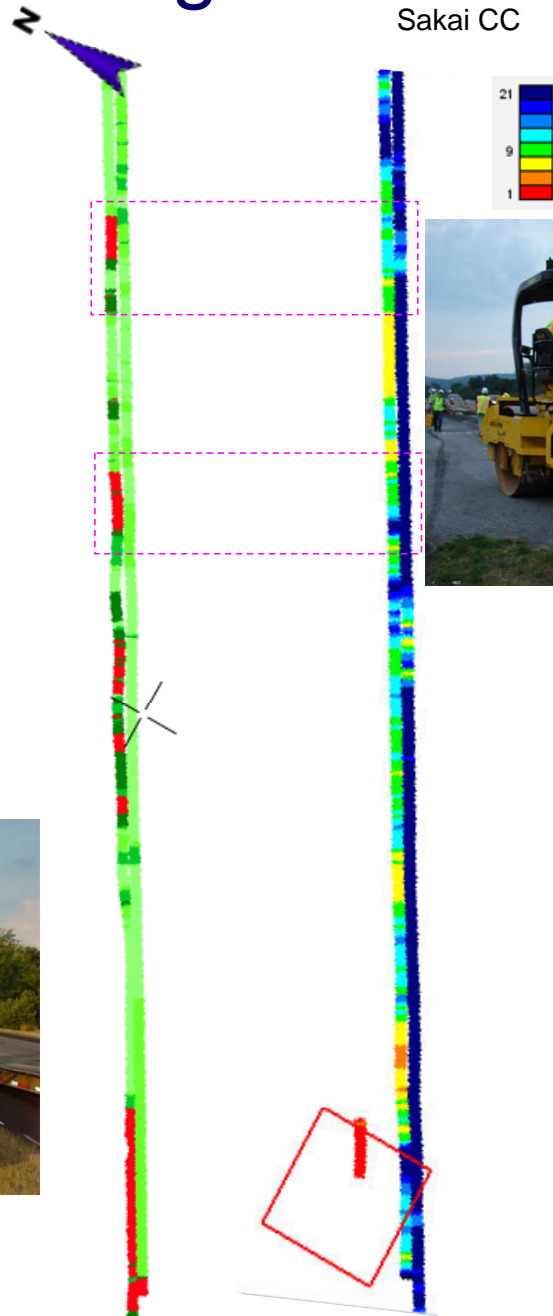
Sakai CC

Done	650 m ²
Start date	12:35:17 PM 7/21/2009
End date	12:41:51 PM 7/21/2009

	AVG	Min	Max
EVIB [MN/m ²]	286	101	350
Amplitude [mm]	0.3	0.2	0.6
Frequency [Hz]	50	16	67
Speed [km/h]	5.5	1.0	6.6

EVIB [MN/m ²]		
	> 350	19 %
	313 -350	29 %
	276 -313	21 %
	238 -276	7 %
	200 -238	8 %
	< 200	16 %
Σ	200 -350	65 %

AVG-value [MN/m ²]	286
Increase	8
Standard deviation	66



MD ICPF Project

Summary – IC Mapping

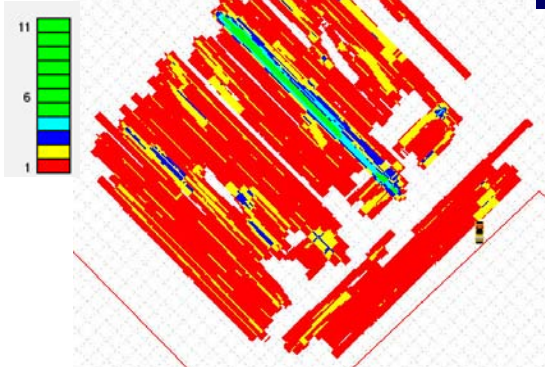
- All mapping was done with tandem drum IC roller
- Typical settings were low amplitude and 2500 vpm frequency
- No damage to roller or material was noted
- IC mapping seemed to be effective in identifying soft spots in all underlying materials except possibly rubblized PCC



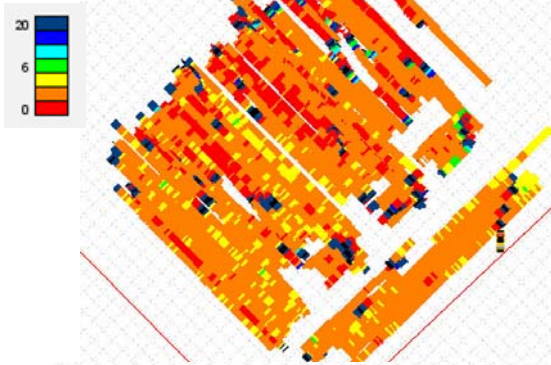
Permanent Records of Compaction Data

Permanent Records

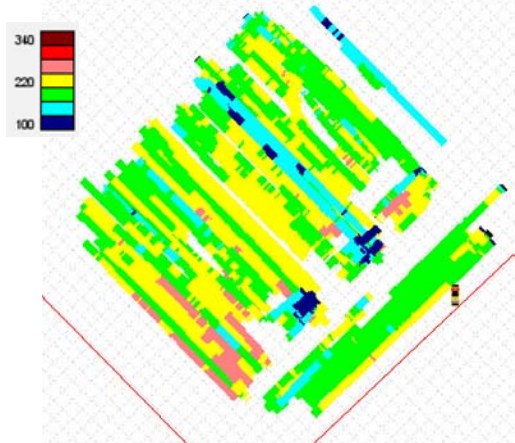
Roller pass



Sakai CCV



Surface temperature (°C)



Georgia ICPF Project

What are Current Issues?

- Data Management and Analysis
 - Best ways to utilize massive amounts of data produced on a typical job?
- IC Specifications
 - Best ways to use IC on HMA projects?
- Continue to work toward implementation of IC technology
 - IC recently added to list of “Every Day Counts 2012” initiatives

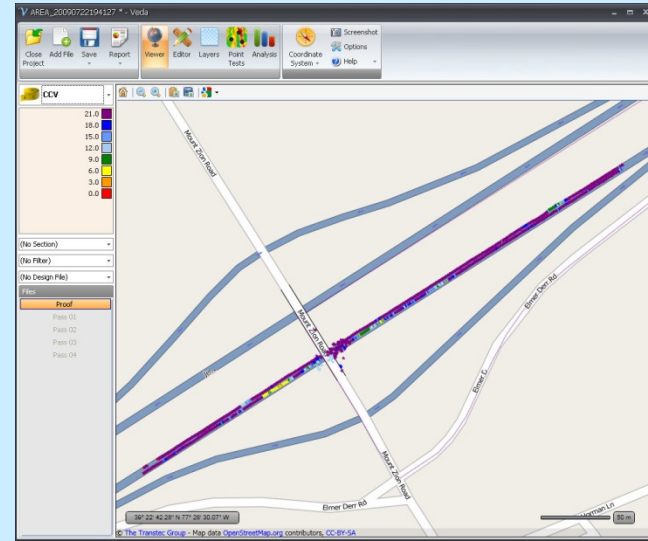
Issues with IC Data Management

- Data format
- Data collection
- Data storage
- Data processing
- Develop independent software tool
 - Efficient
 - Accurate
 - Fast



Veda (Veh-da)

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



Close Add File Save Report Viewer Editor Layers Point Tests Analysis Coordinate System Screenshot Options Help

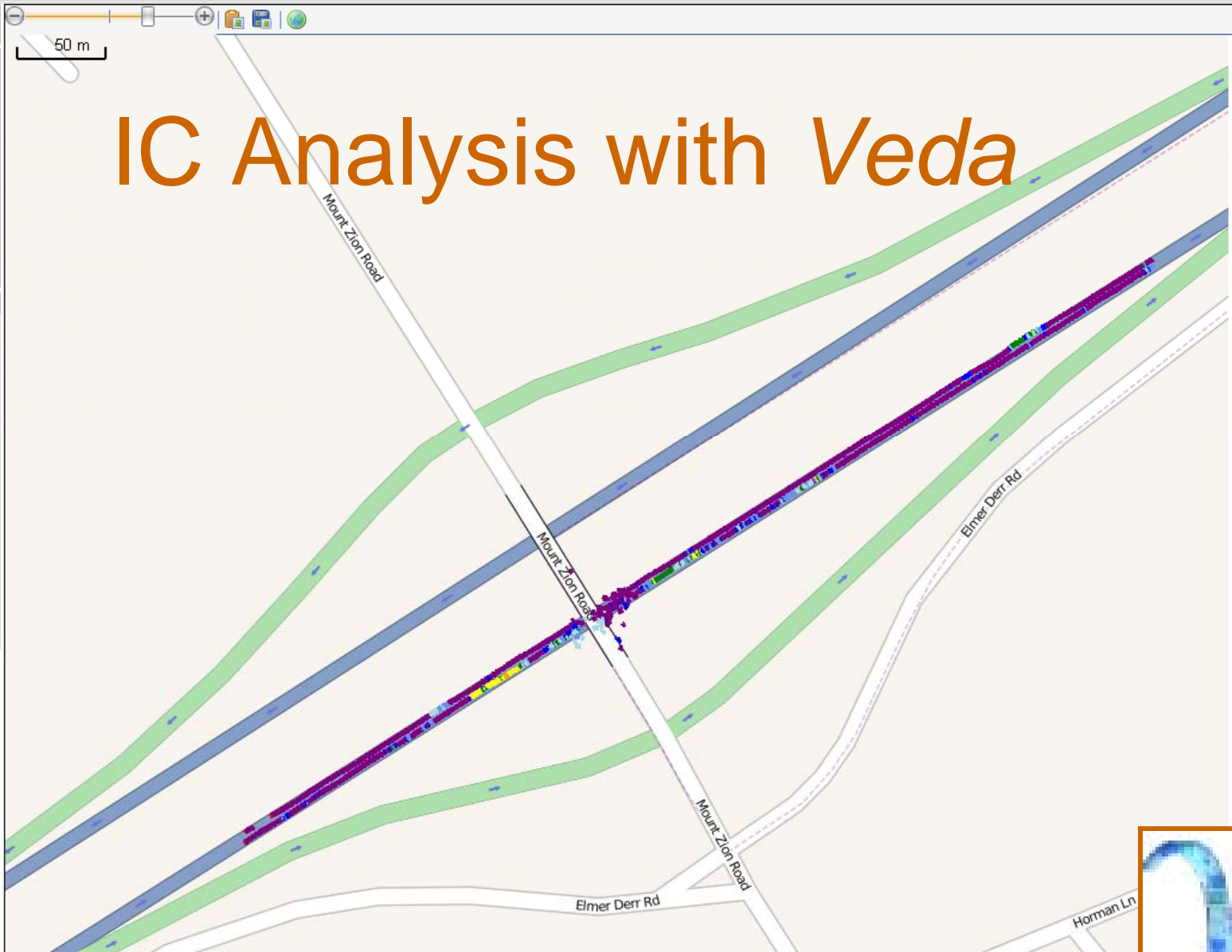
CCV

21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0

Files

Proof

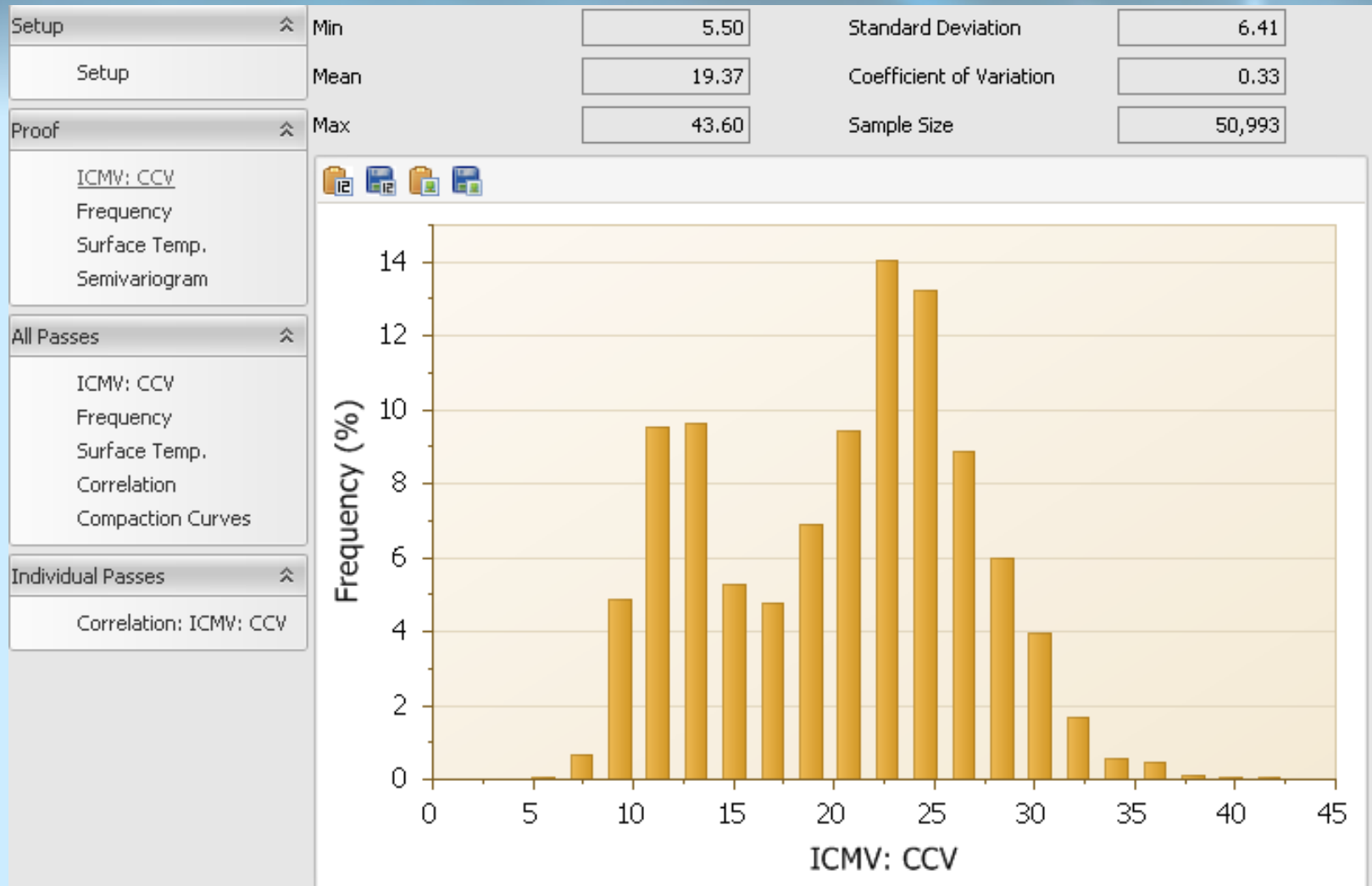
- Pass 01
- Pass 02
- Pass 03
- Pass 04



IC Analysis with Veda



Statistics of IC-MV



Generic IC Specifications

- Generic IC specifications are now available for agencies that want to try it on a project
- IC should be used for Quality Control (QC) purposes only at this time
- Specs are available at:
www.intelligentcompaction.com; click on **specifications** tab

IC and EDC 2012

- Intelligent Compaction is one of the initiatives on FHWA “Every Day Counts 2012” program
- EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways and protecting the environment

Conclusions

- Intelligent Compaction (IC) is a major innovation in compaction technology
- IC is valuable tool to improve the compaction process of paving operations
- All major roller suppliers have and are continuing to develop IC technology
- FHWA has identified IC as an important innovation that should be implemented quickly

Benefits of IC for HMA

- Improve density....better performance
- Improve efficiency....cost savings
- Increase information...better QC/QA
- Overall Benefit:
Improved Pavement Performance!

Questions?

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We've Come a Long Ways!

Yesterday



Buffalo Springfield Steam Roller

INTELLIGENT COMPACTION EQUIPMENT

Yesterday



1924 Buffalo Springfield Steam Roller

IC –The Future of Compaction Technology

Today

