Innovative HMA Compaction Technologies

Presented by: Todd Mansell, Sakai America, Inc.

Four innovative technologies

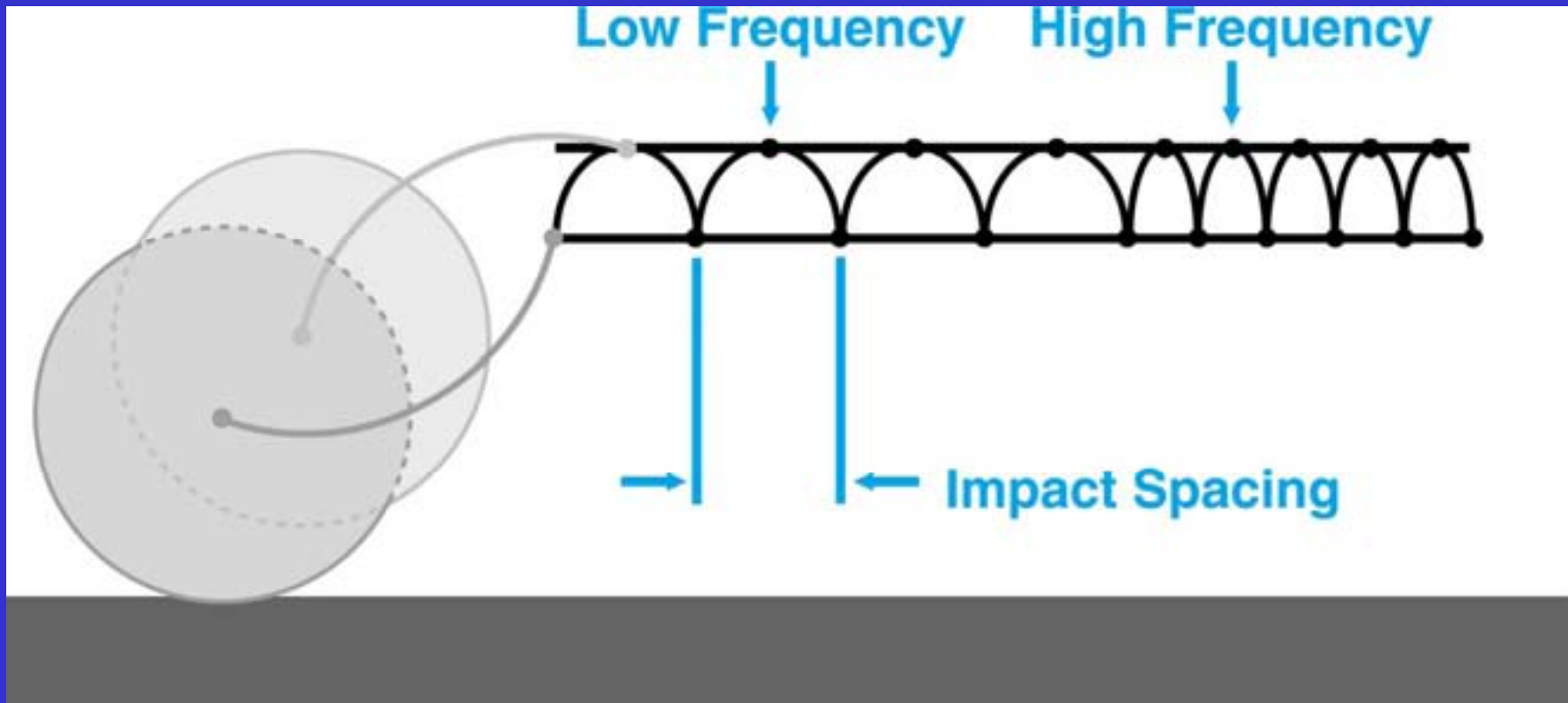
- *Impact spacing meters*
- *Oscillatory rollers*
- *Vibratory pneumatic tire rollers*
- *Intelligent compaction*
  - *Sakai's experience*

Impact spacing meters

- *One of the best quality control tools available on asphalt rollers*
- *Industry standard of 10 to 12 ipf gives both density and ride quality*

Steel Drum Vibratory Roller settings

- **Frequency** *controls the number of impacts per foot between the steel drum and the mat*



How fast can my roller go?

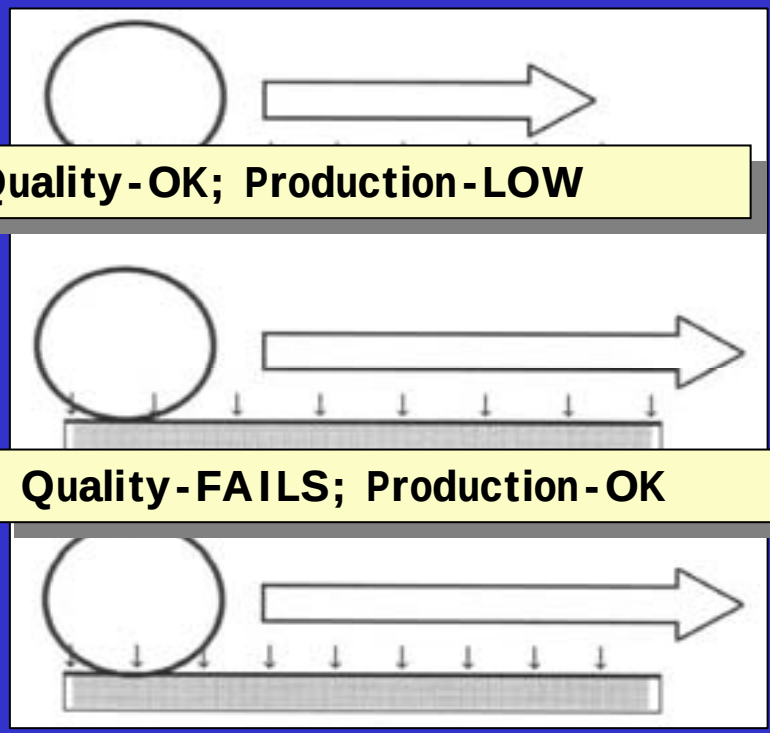
$$\frac{4{,}000 \ \frac{\cancel{\text{vibrations}}}{\text{minute}}}{10 \ \frac{\cancel{\text{impacts}}}{\text{foot}}} = 400 \ \frac{\text{feet}}{\text{minute}}$$

$$\frac{400}{88} = 4.5 \text{ mph}$$

Speed up the roller! But…

- 2520vpm, @2.4 mph
  - 12 ipf (impact per foot)
- 2520vpm, @3.8 mph
  - 7.6 ipf (impact per foot)
- 4000vpm, @3.8 mph
  - 12 ipf (impact per foot)

Quality of HMA; Density and smoothness



Quality-OK; Production-LOW

Quality-FAILS; Production-OK

Quality and Production-OK

Washboard – frequency too low or rolling speed too fast…

Controlling impacts per foot

Cruise control

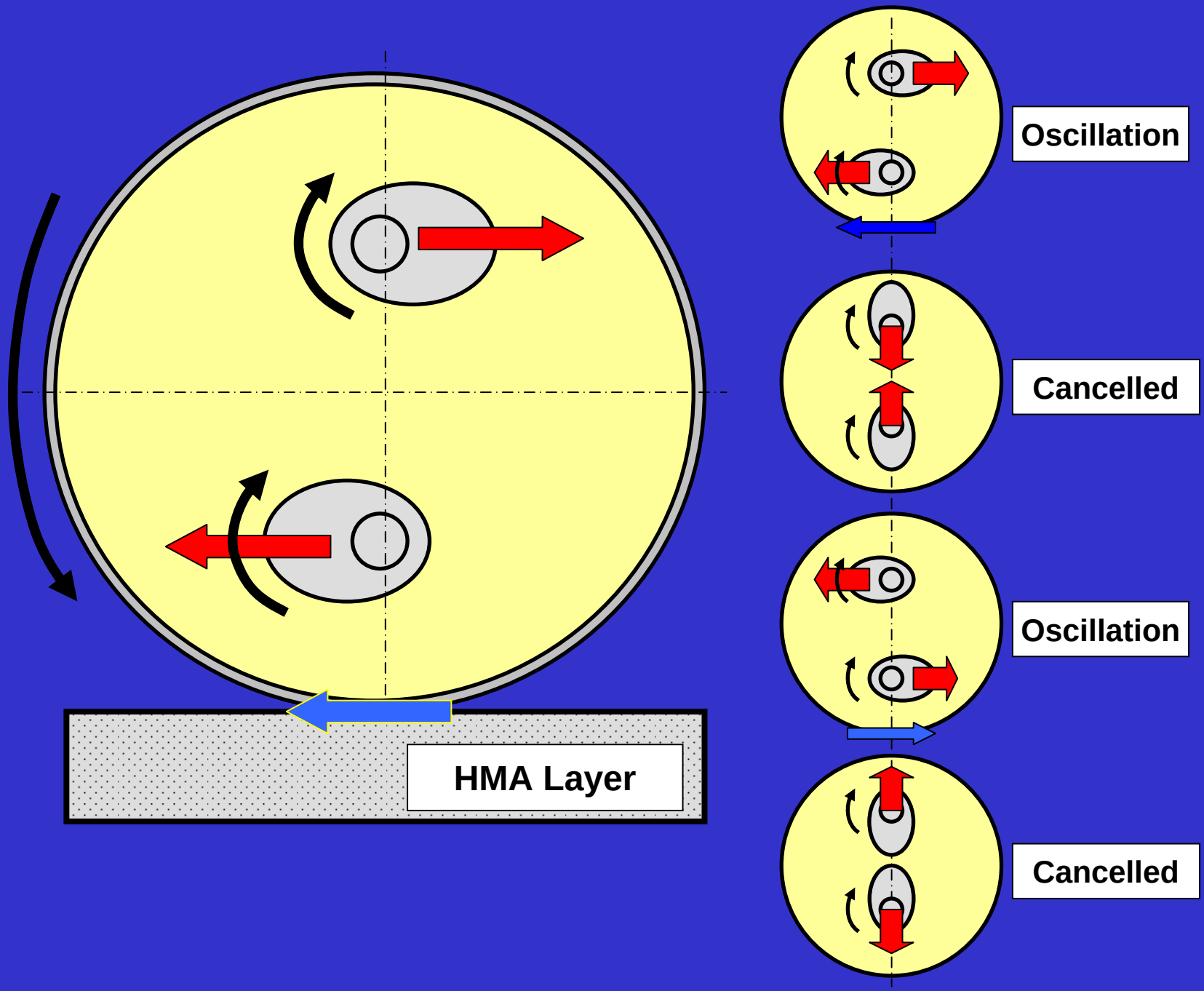
10 to 12 impacts per foot

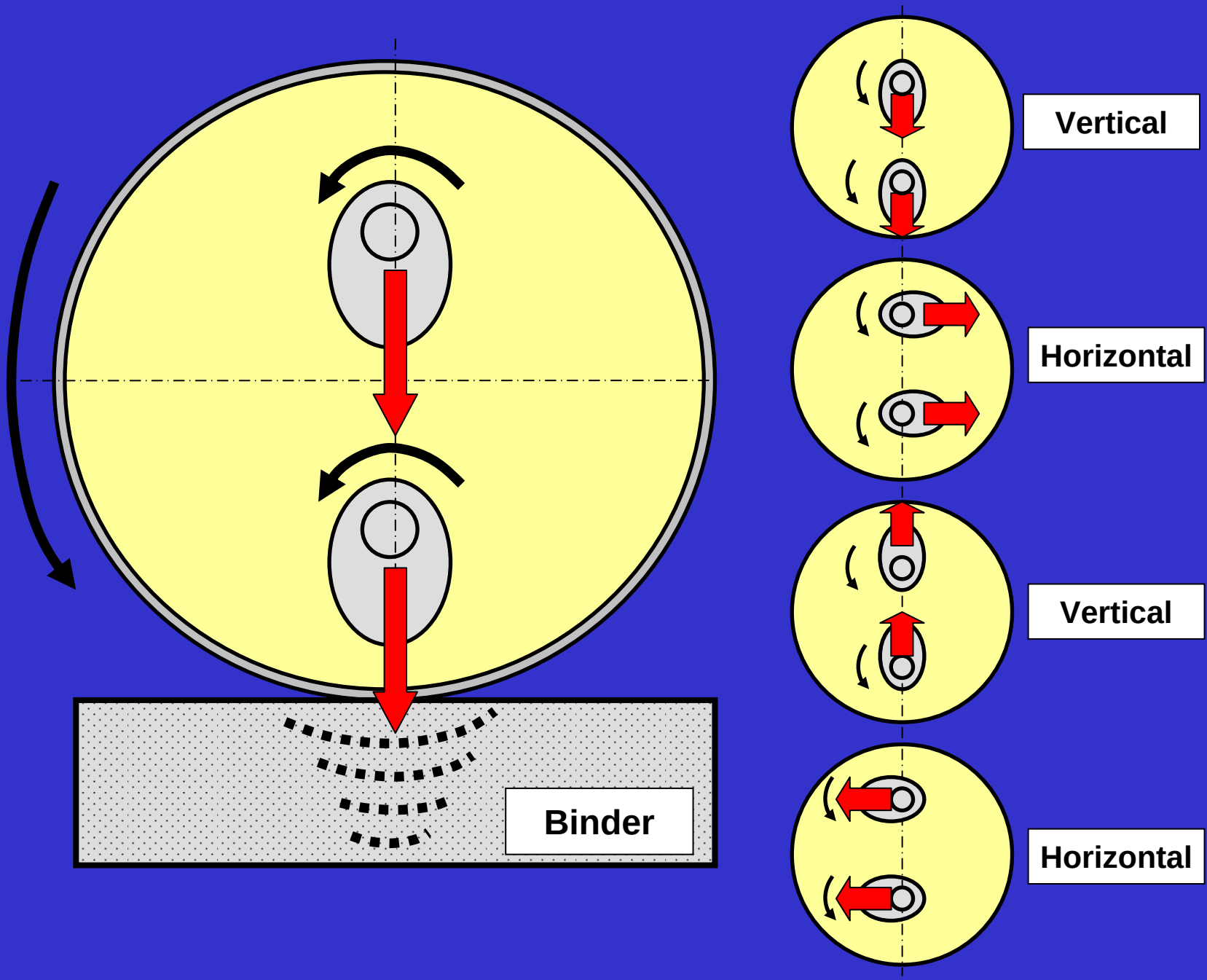
Good walking speed

It's not my job!

Oscillation rollers

- *Have a horizontal vibrating action*
- *Difficult to damage the mat*
- *Leave a smooth finish*
- *Most efficient results on thin lifts*


Oscillation
Cancelled
Oscillation
Cancelled
HMA Layer


Binder
Vertical
Horizontal
Vertical
Horizontal

Thin lifts

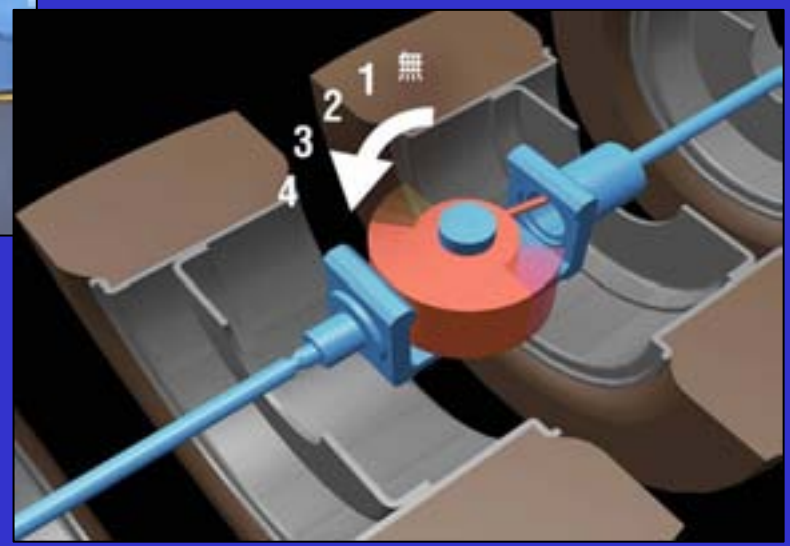
Bridge decks

Do they work?

- *Okay on thin lifts, less than 1 ½ "*
- *Leave a nice, smooth surface*
- *Difficult for inexperienced operators to damage the mat*
- *Limited application roller*
- *Be careful how density is measured*

Vibratory Pneumatic Tire Roller

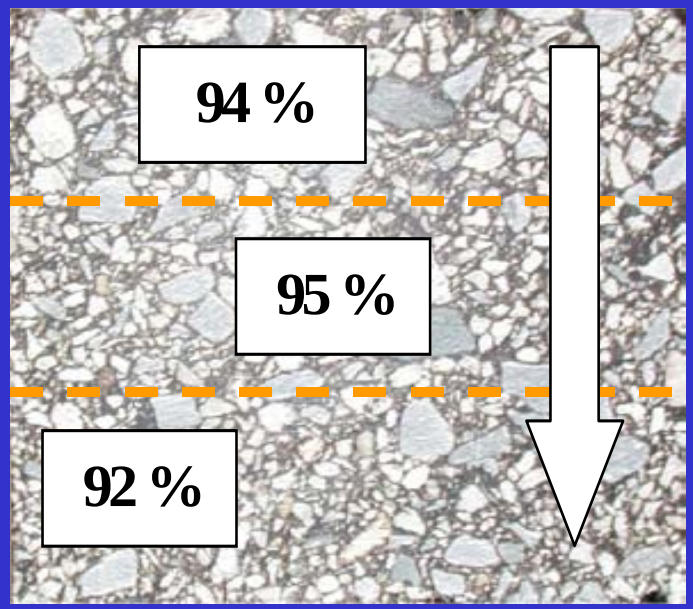
4 Amplitude Settings



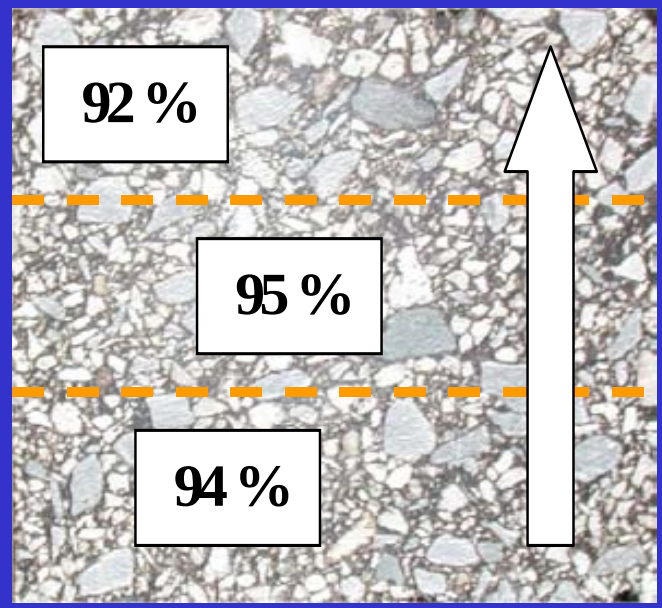
Benefits of a Vibratory Pneumatic Tire Roller

- *More uniform density through the depth of pavement layer*
- *Use in breakdown position for stiff mixes*
- *Improves bonding between lifts (milled surfaces)*
- *Good for improving longitudinal joints density without fracturing aggregate*
- *Dynamic kneading seals the surface and decreases mix permeability*
- *Take out bumps from steel drum rollers*

Density distribution with depth using conventional rollers

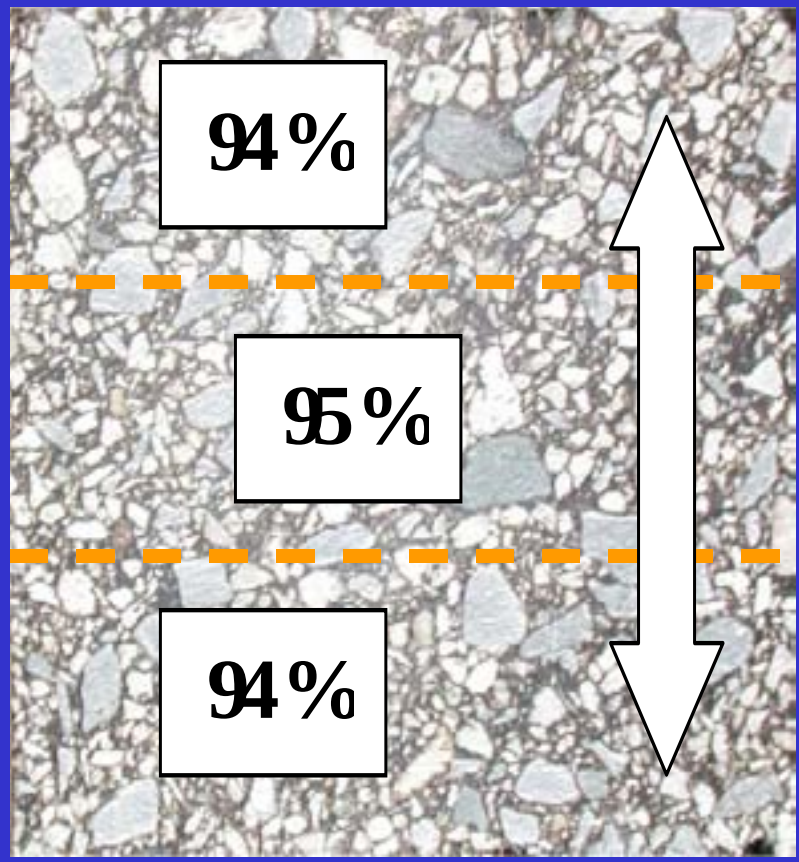


Top down using a double drum vibratory roller



Bottom up using a pneumatic tire roller

Density distribution with a vibratory pneumatic tire roller

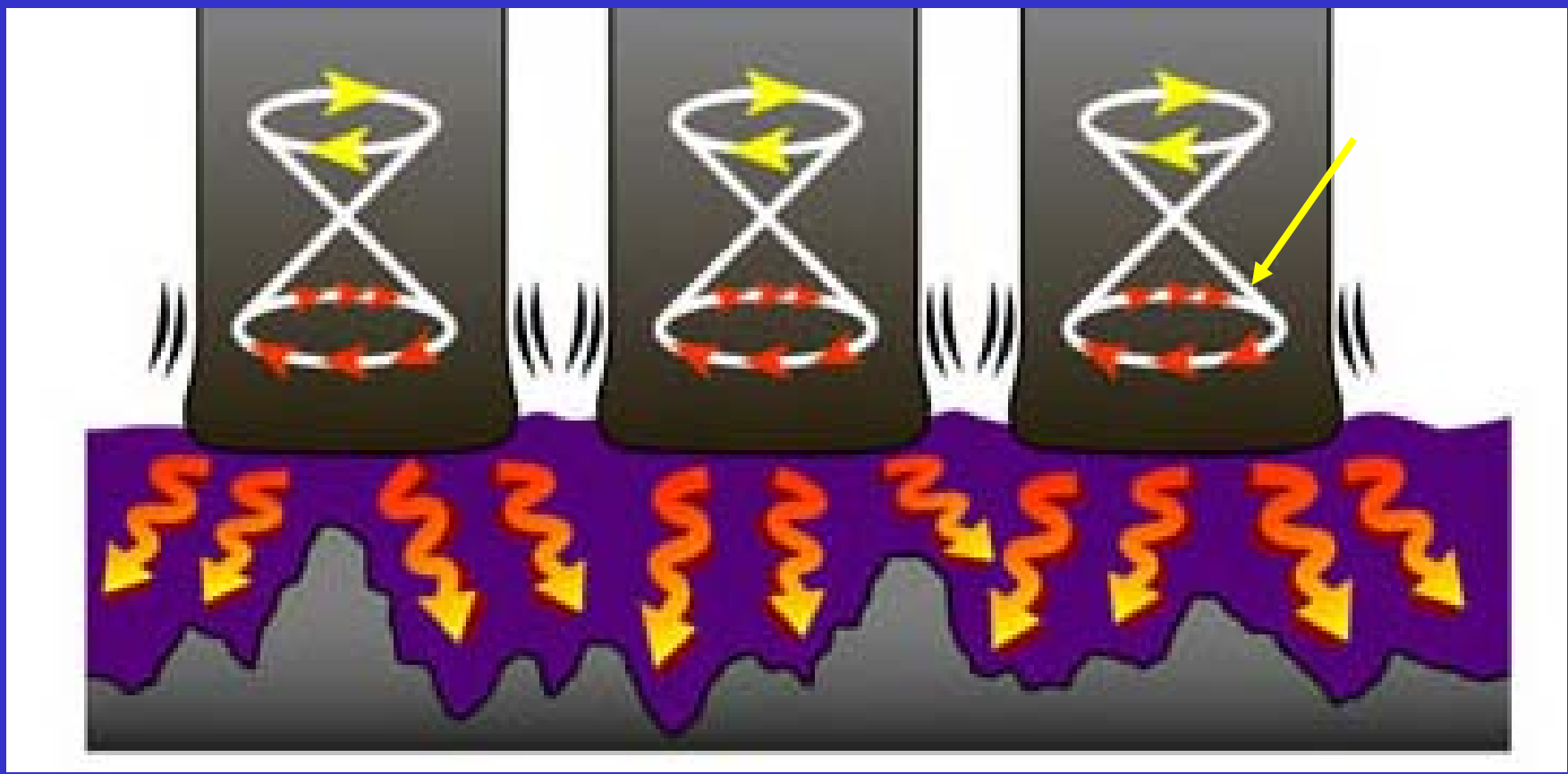


Density distribution research


Breakdown roller

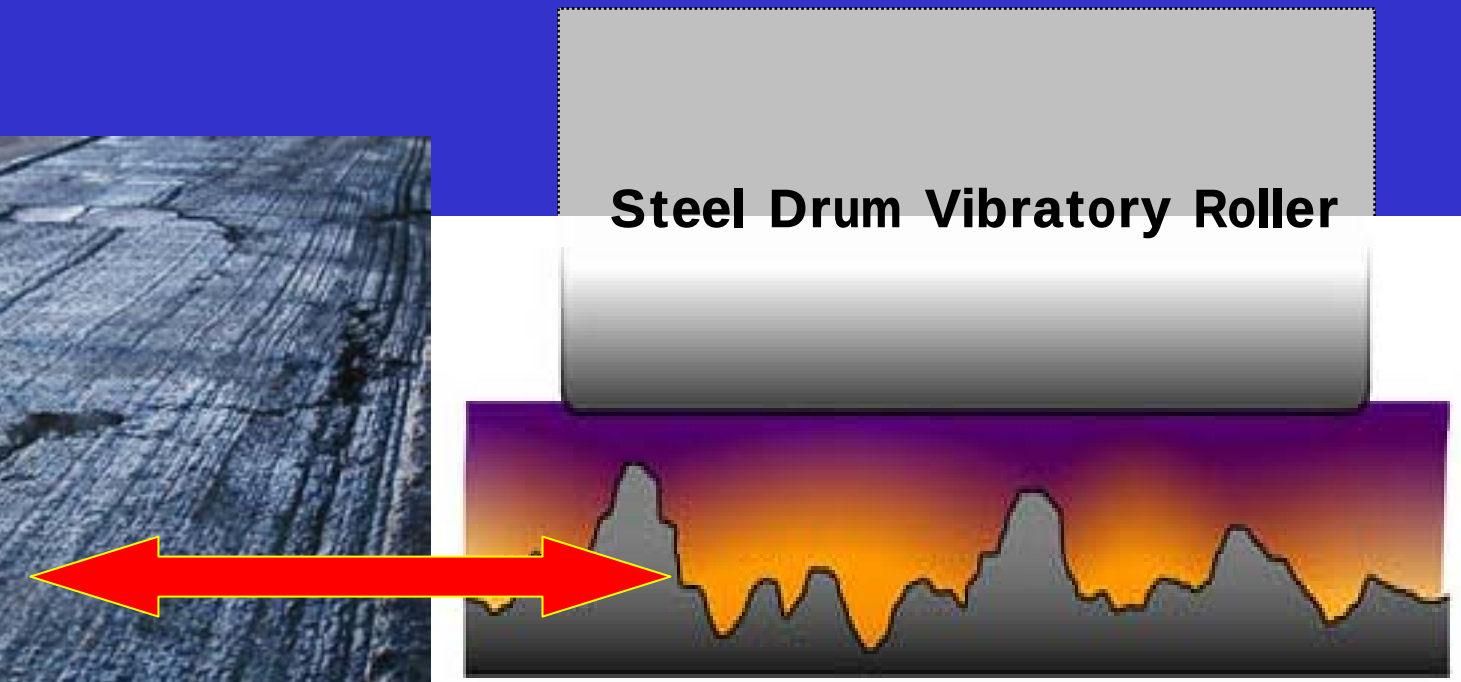
Dynamic Kneading Action

- *Kneading action of tires combined with the dynamic action of a vibratory drum roller*



Eliminate the Bridging Effect

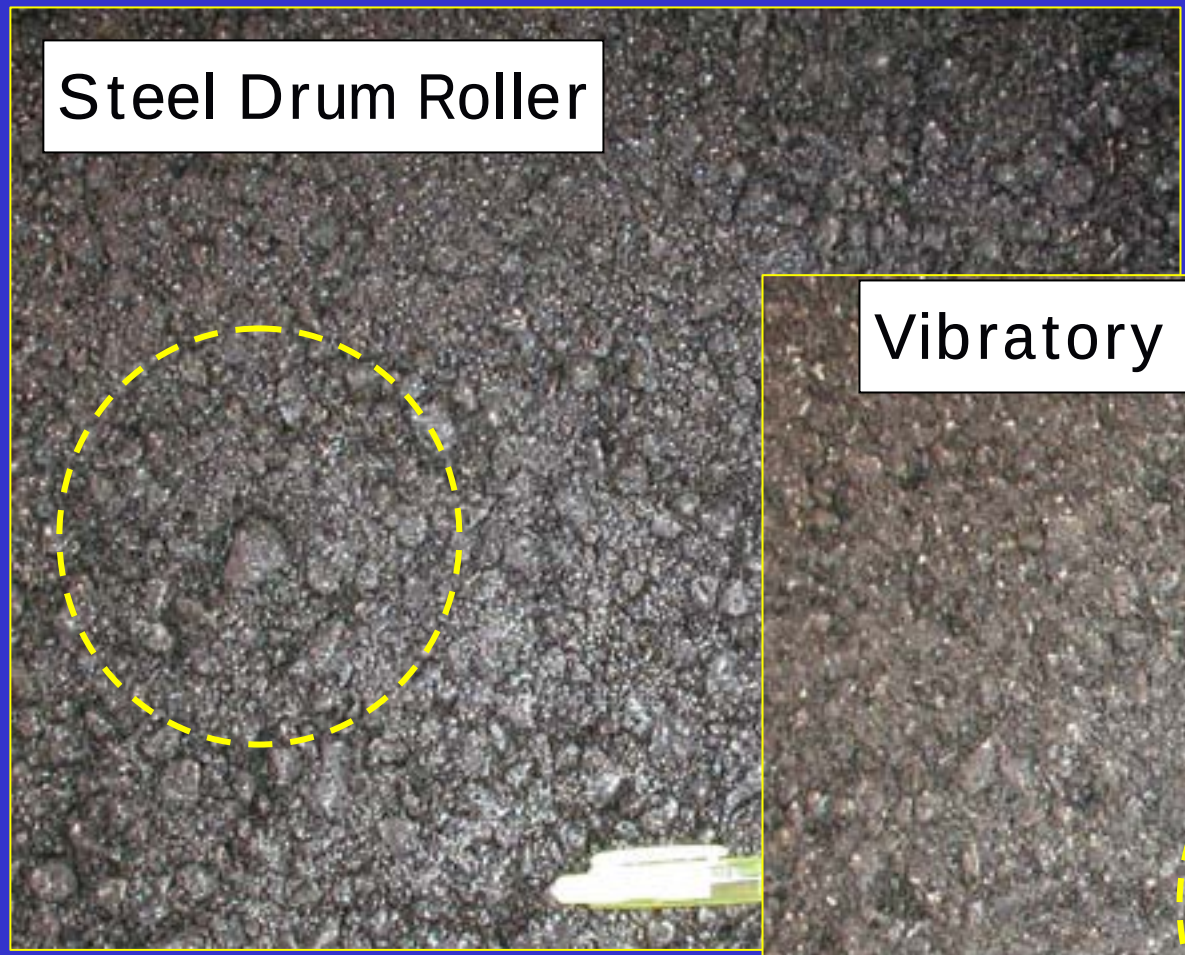
- Dynamic kneading will significantly improve bonding of mixes placed over a milled surface



Tight & Dense Longitudinal Joints

Fracturing aggregate with a steel drum vibratory roller

GW750 lowers mix permeability

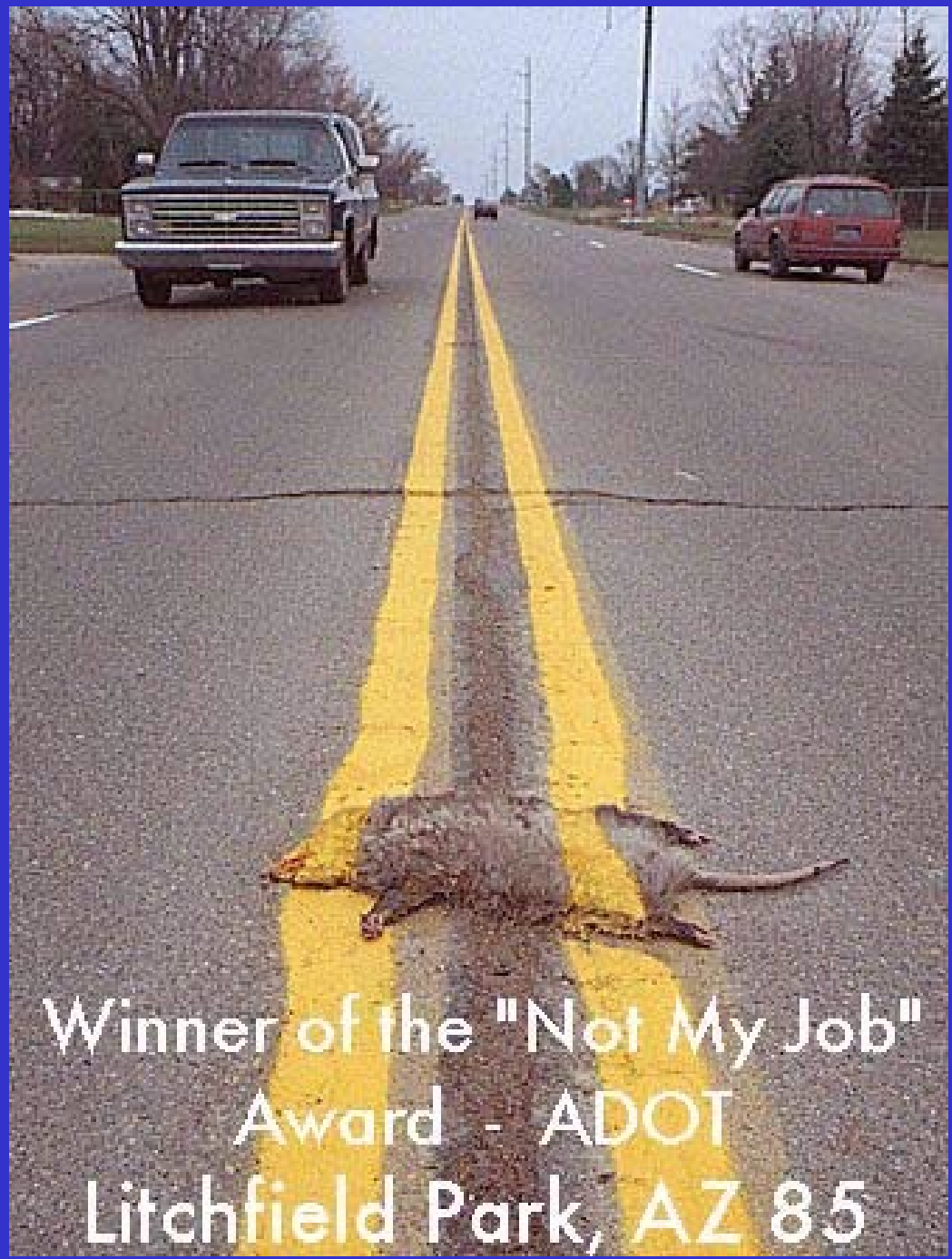


Helps with roller checking


Before


AKAI
N750
After

Take out bumps


Winner of the "Not My Job"
Award - ADOT
Litchfield Park, AZ 85

*Intelligent Compaction – The Vision**

- *IC is an emerging technology that allows greater control of the compaction process*

- *New tool under development for in-situ measurement, next step to implement mechanistic design modulus-based construction*

**FHWA 2005*

Sakai CIS

- *Sakai's Intelligent Compaction system is named CIS (Compaction Information System).*

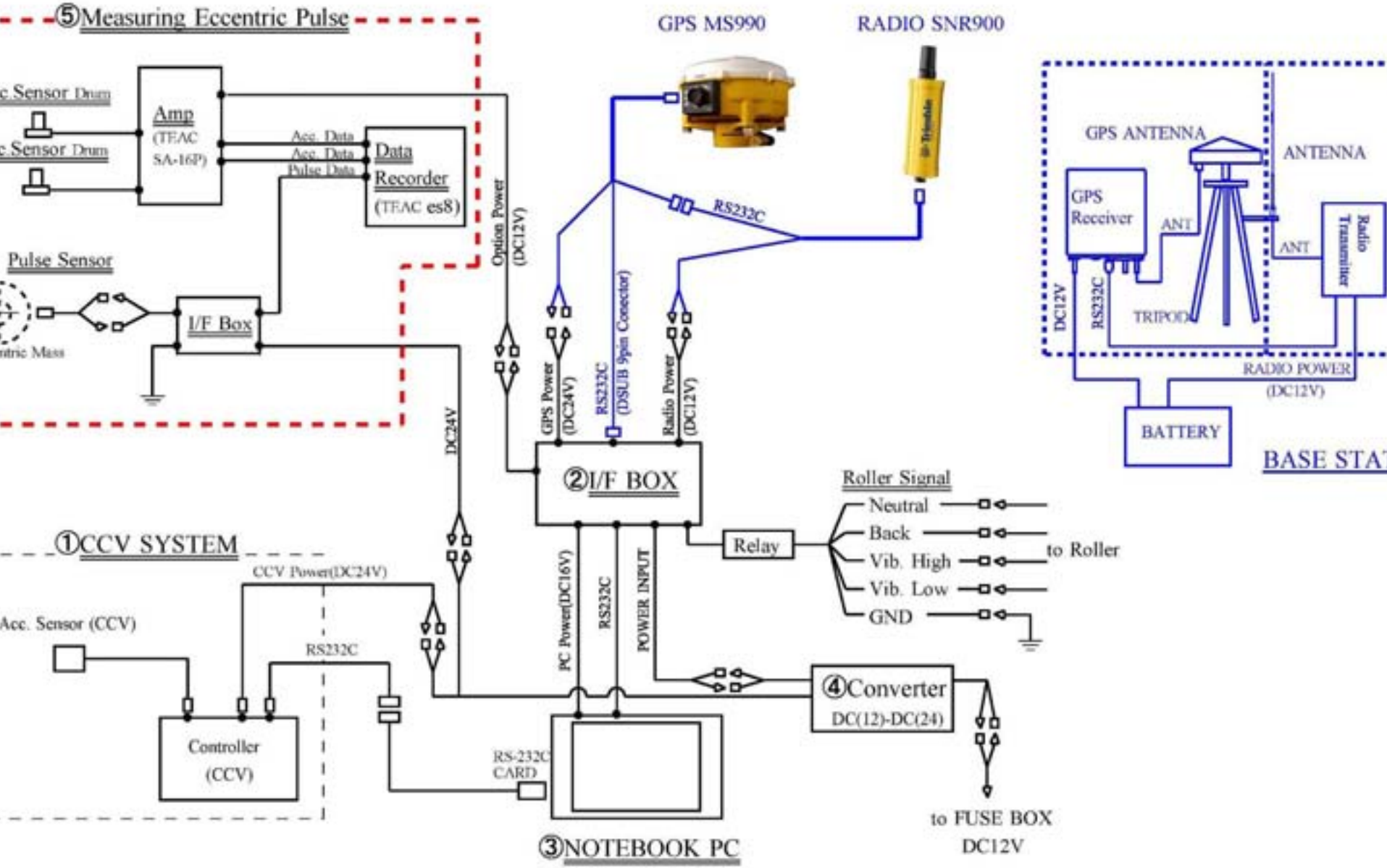
- *Comprehensive data collection of*
  - *Number and GPS location of roller passes*
  - *Material stiffness values (correlated to density)*
  - *HMA surface temperature data*

Sakai CIS

- *Hardware mounted on an asphalt roller*
  - *Accelerometer*
  - *Infrared temperature sensor*
  - *GPS*
  - *Onboard computer*
  - *Touch screen interface for operator*

CIS – Compaction Information System

Measuring System for SV (GPS+CCV)



Inputs before the job

- *Plan file of the project from AutoCAD© or other*

  or

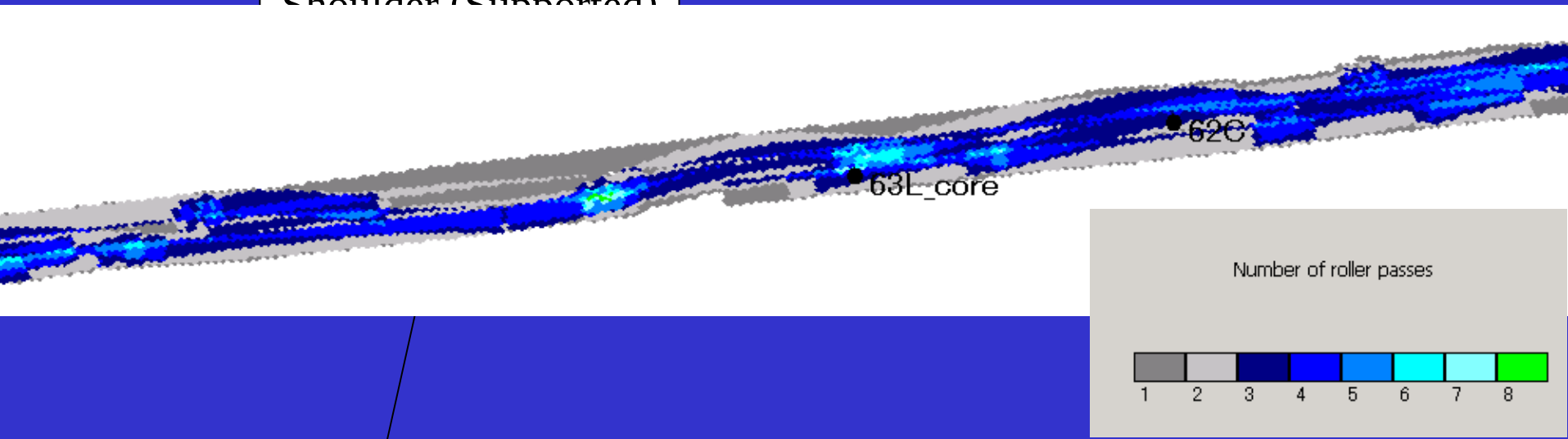
- *Direct from GPS coordinate data (csv format)*

Real time info for operator

SR-68, West to Monterey, CA

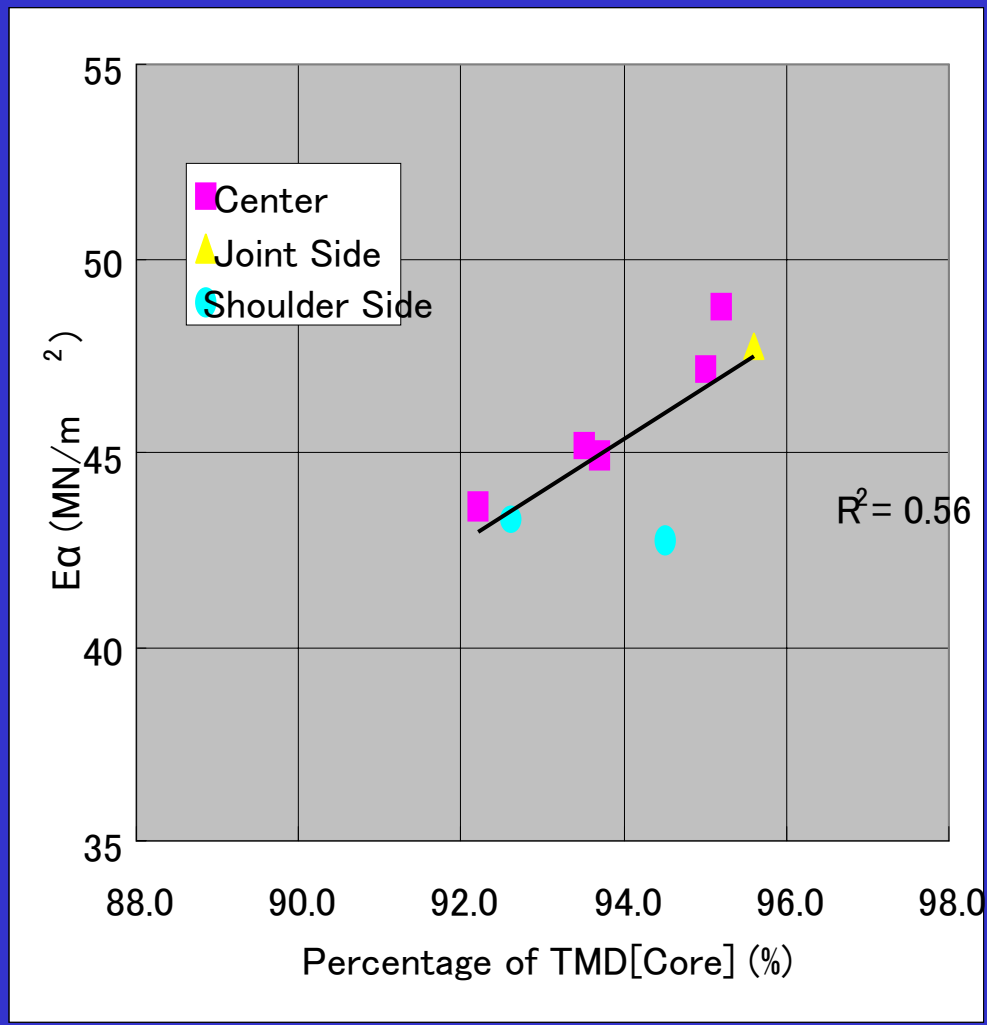
Uncontrolled breakdown rolling

Paving Direction



Longitudinal Joint

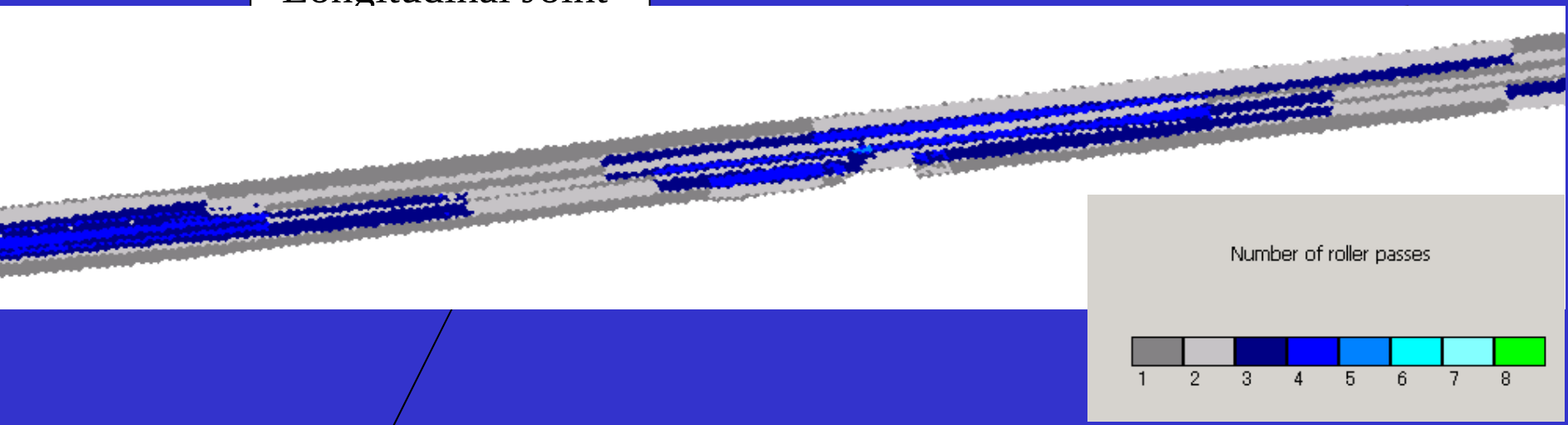
Roller Modulus vs. Density during Breakdown Rolling



Uncontrolled finish rolling

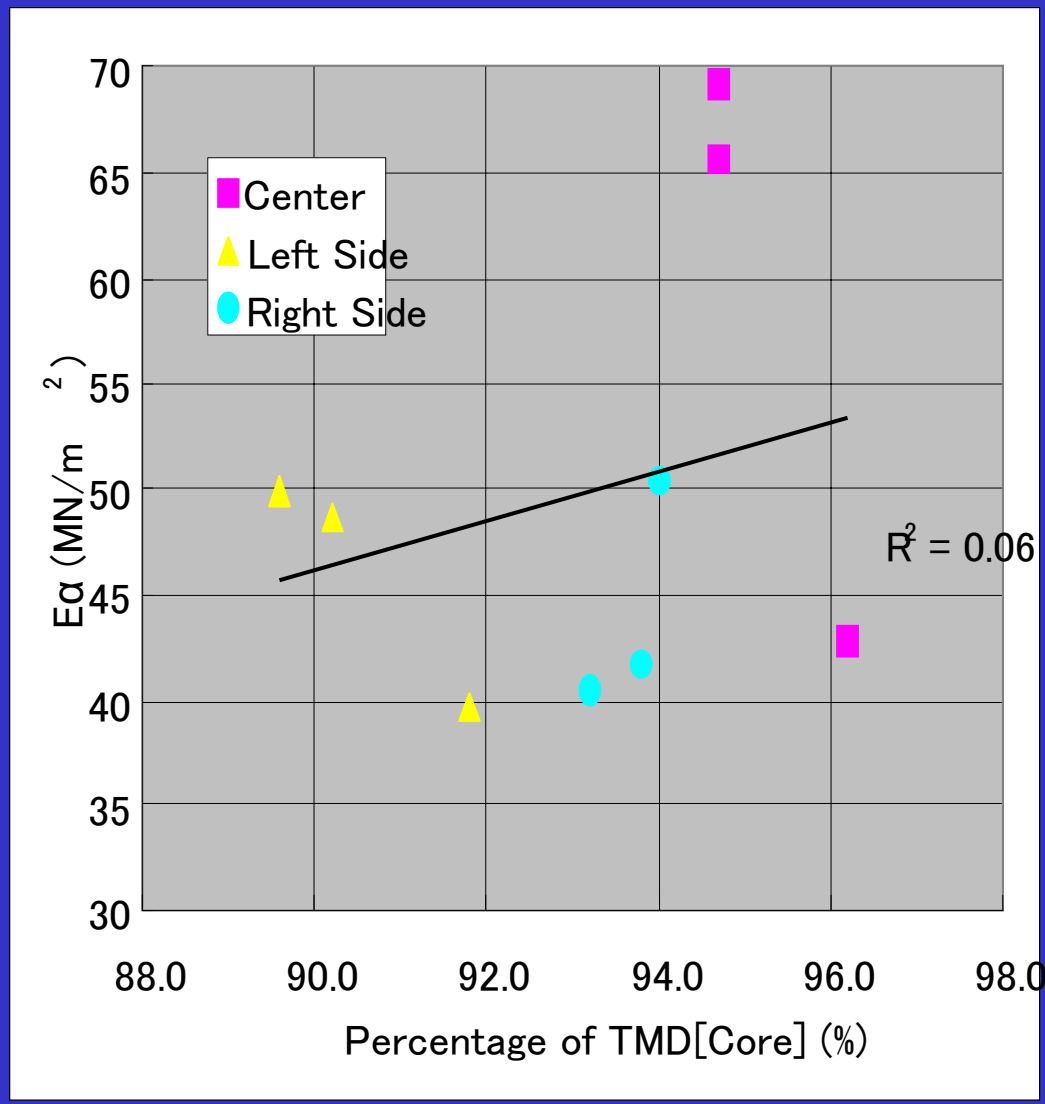
Paving Direction

Longitudinal Joint

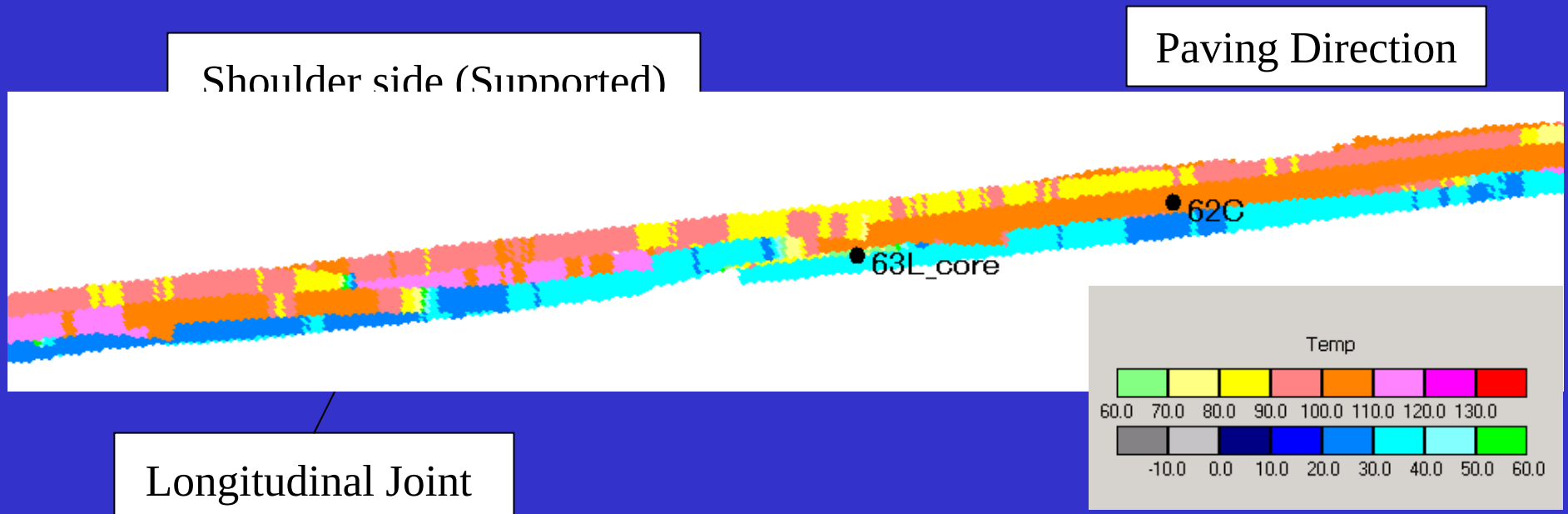


Shoulder (Median) side

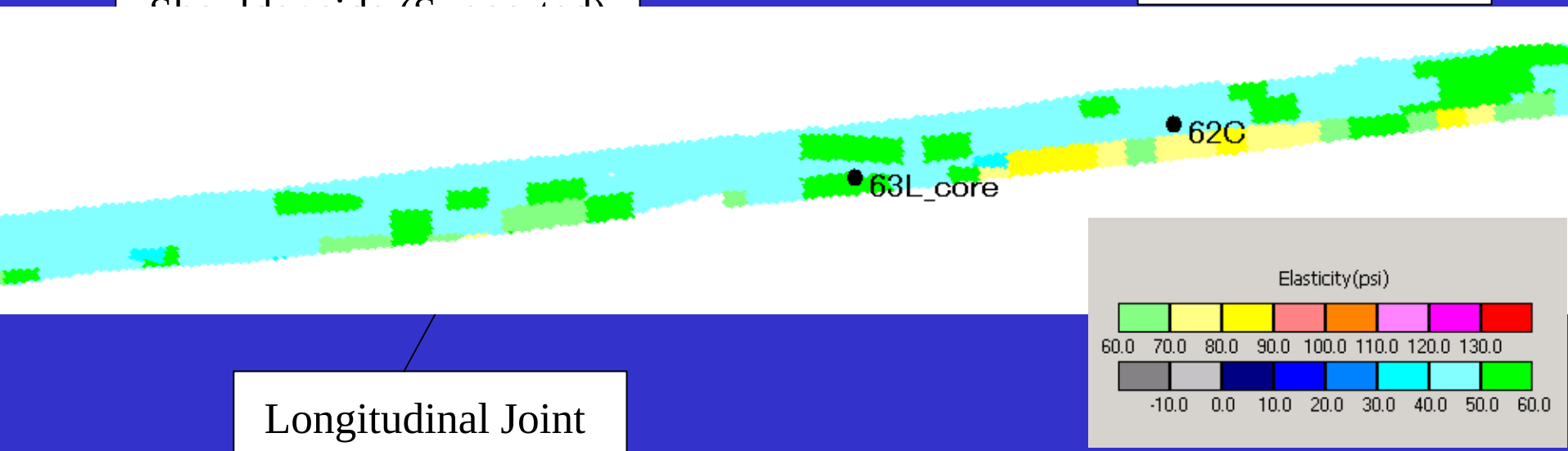
During Finish Rolling
No Correlation



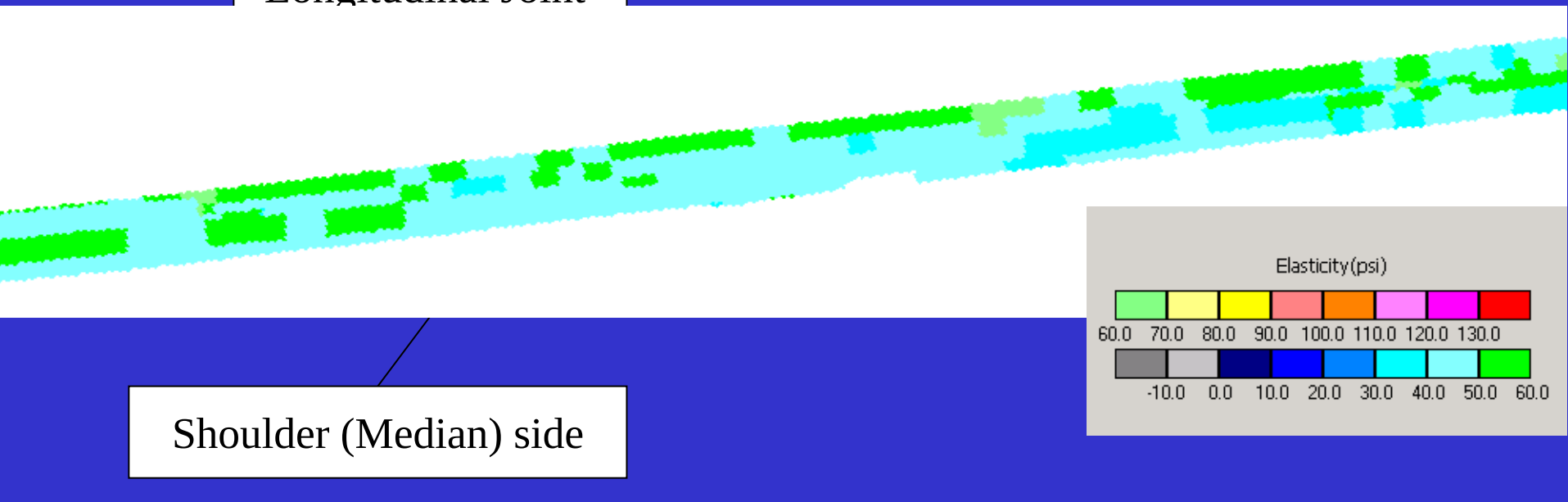
Surface temperature of pavement during breakdown rolling



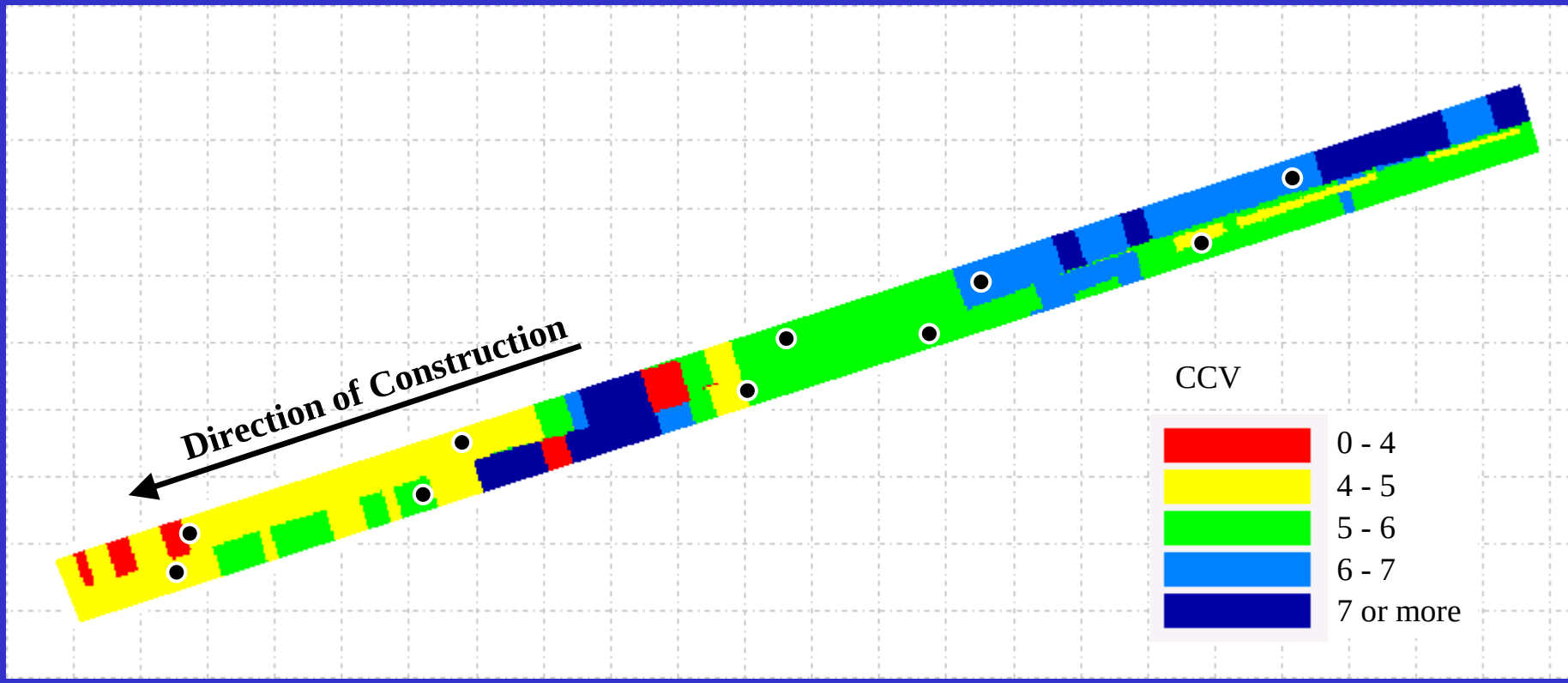
Pavement stiffness during breakdown rolling



Pavement stiffness during finish rolling



Test Strip - Florida

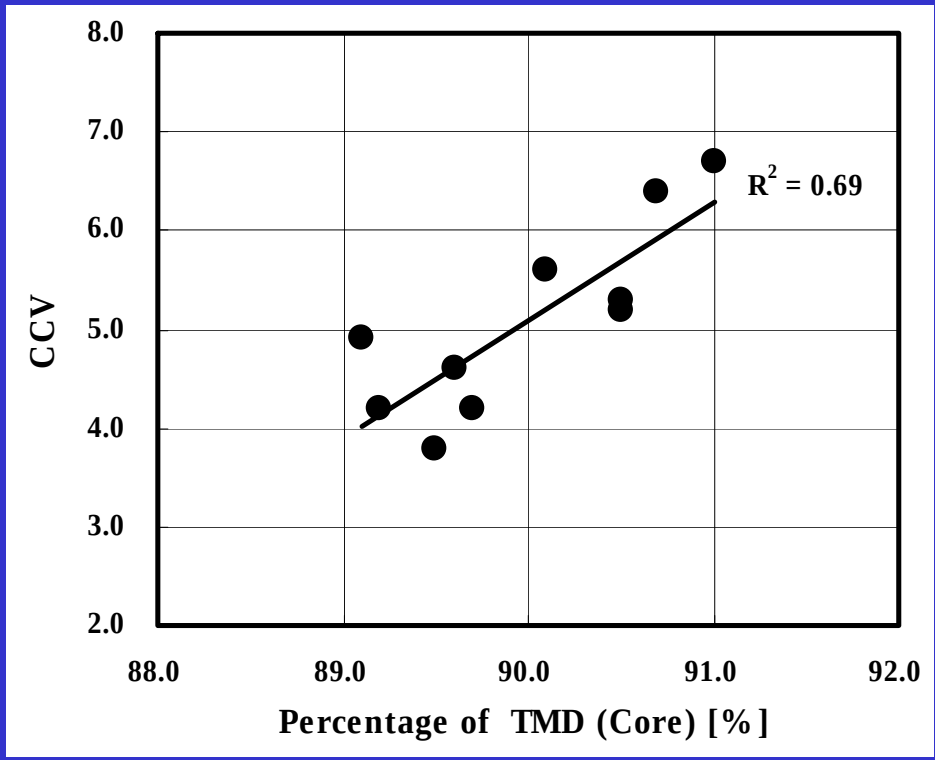


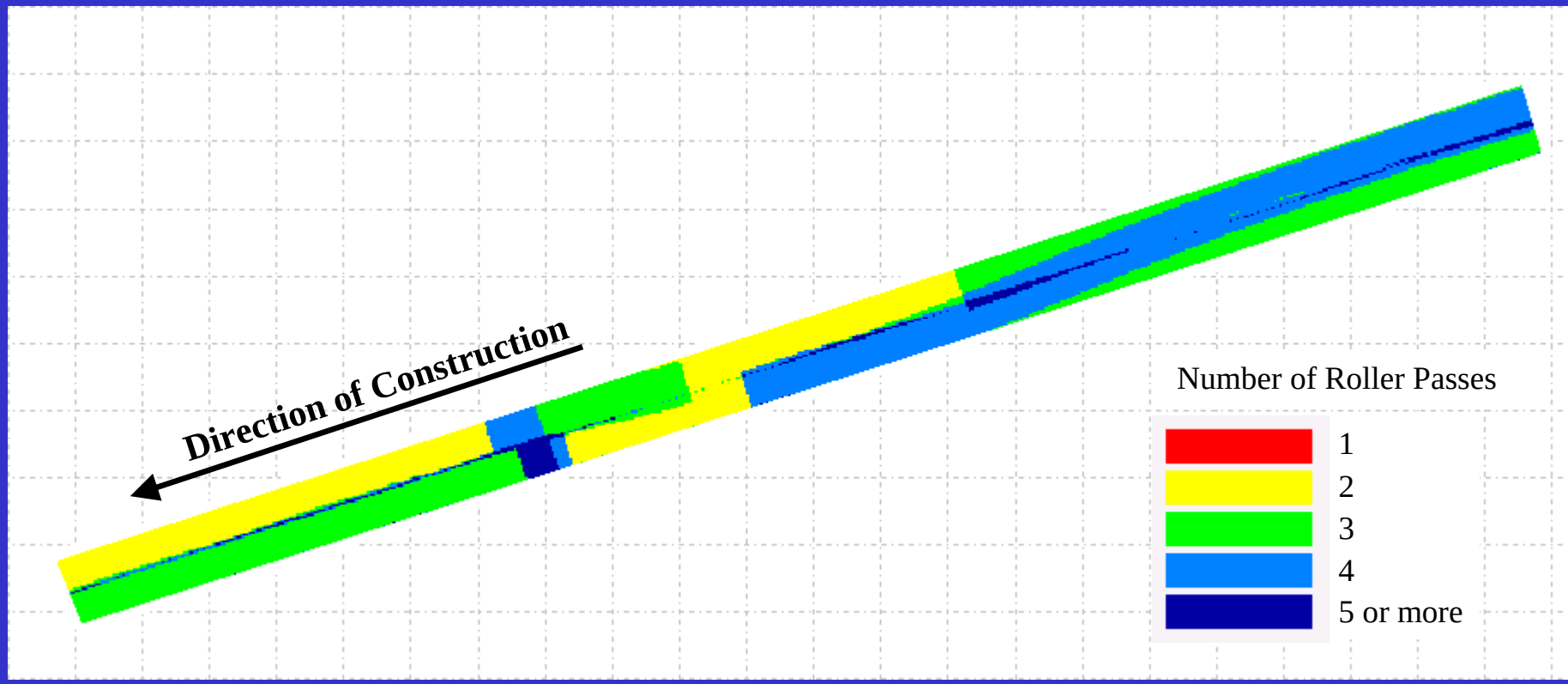
Florida test section June 2007

Colors indicate the roller measured compaction value (CCV)

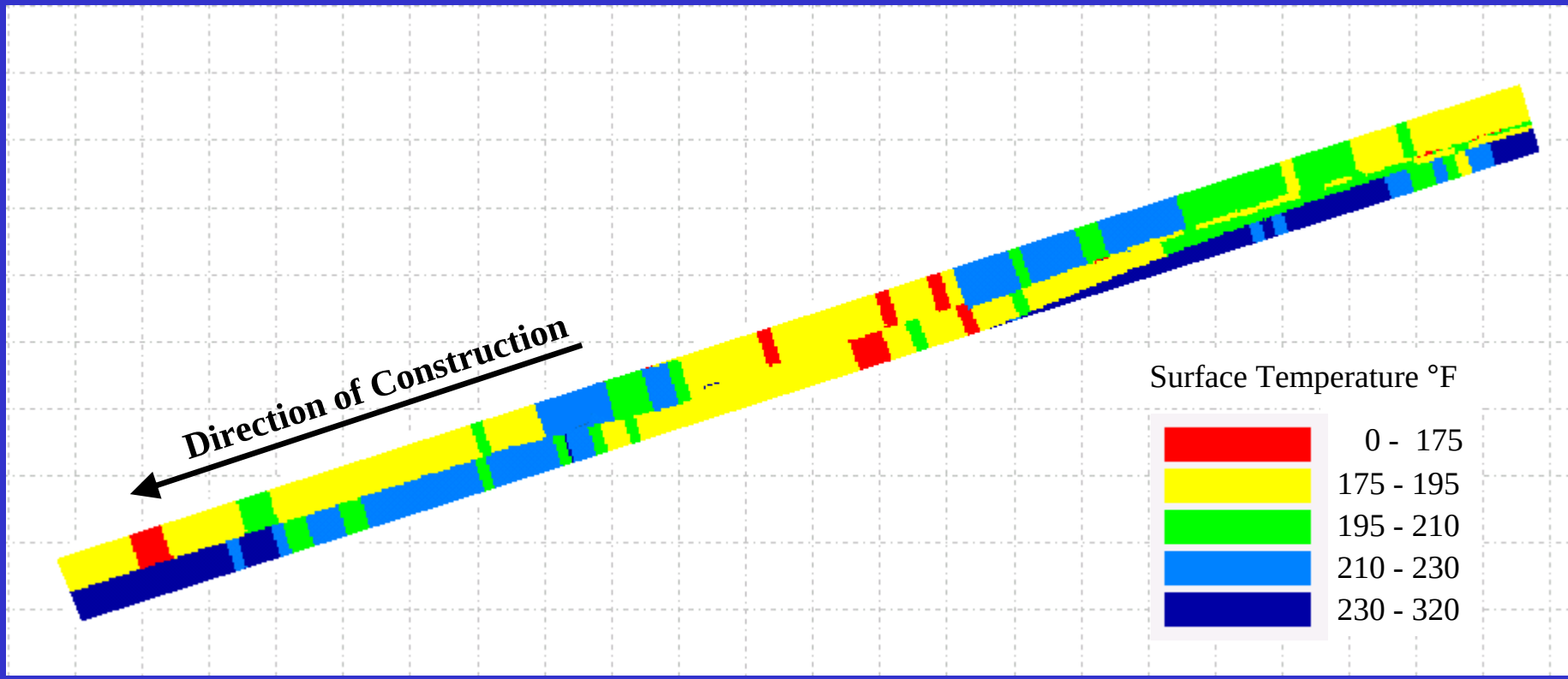
Black Dots indicate location of cores drilled from the pavement

Correlation between roller-measured stiffness and core densities





Number of roller passes recorded during the test section



Surface temperature °F at compaction

Kandiyohi Route 4

Acrobat Document

Output data

- *Approximately 10 readings per second*

1. *GPS location (# roller passes)*
2. *CCV value (stiffness)*
3. *Surface temperature*
4. *Time*

Output data file example

Roller Factors affecting Drum Acceleration

- *Roller Travel Speed*
- *Amplitude*
- *Vibration frequency*
- *Drum weight*

Hot Mix Asphalt Factors

- *Temperature affects stiffness, not a linear relationship.*
- *Uniformity of mat placed by paver*

  --Material segregation , temperature variations

  --Consistent paver speed and lift thickness
- *Subbase condition*
- *Longitudinal joint (overhanging drum edge)*

Benefits

- *Collecting compaction bonuses*
- *Operator training & self-training*
  - *improved rolling patterns*
- *Warranty paving*
- *Documentation*
- *QC personnel allocation*
- *Reputation for quality*

Warranty work benefits

- *Documentation for issues that may arise later. Owner and contractor.*
- *"Insurance policy" for the contractor.*
- *Use the information to estimate life-cycle pavement costs.*
- *Use information in preparing bids.*

Documentation

Information can be used by management for:

- *Training*
- *Bidding – estimating production*
- *Equipment selection*

Quality Control benefits

- *Allows QC personnel to devote more time to other issues besides compaction – typically, the majority of a QC person's field time is spent taking density readings.*

Reputation for Quality

- *Intelligent compaction gives a density map of the entire project whereas random sampling still misses "bad areas" that may fail later.*

- *Real-time feedback allows the contractor to act immediately – saves 'going back' after which is much more costly.*

- *Quality product every square inch of the job*

Other benefits…

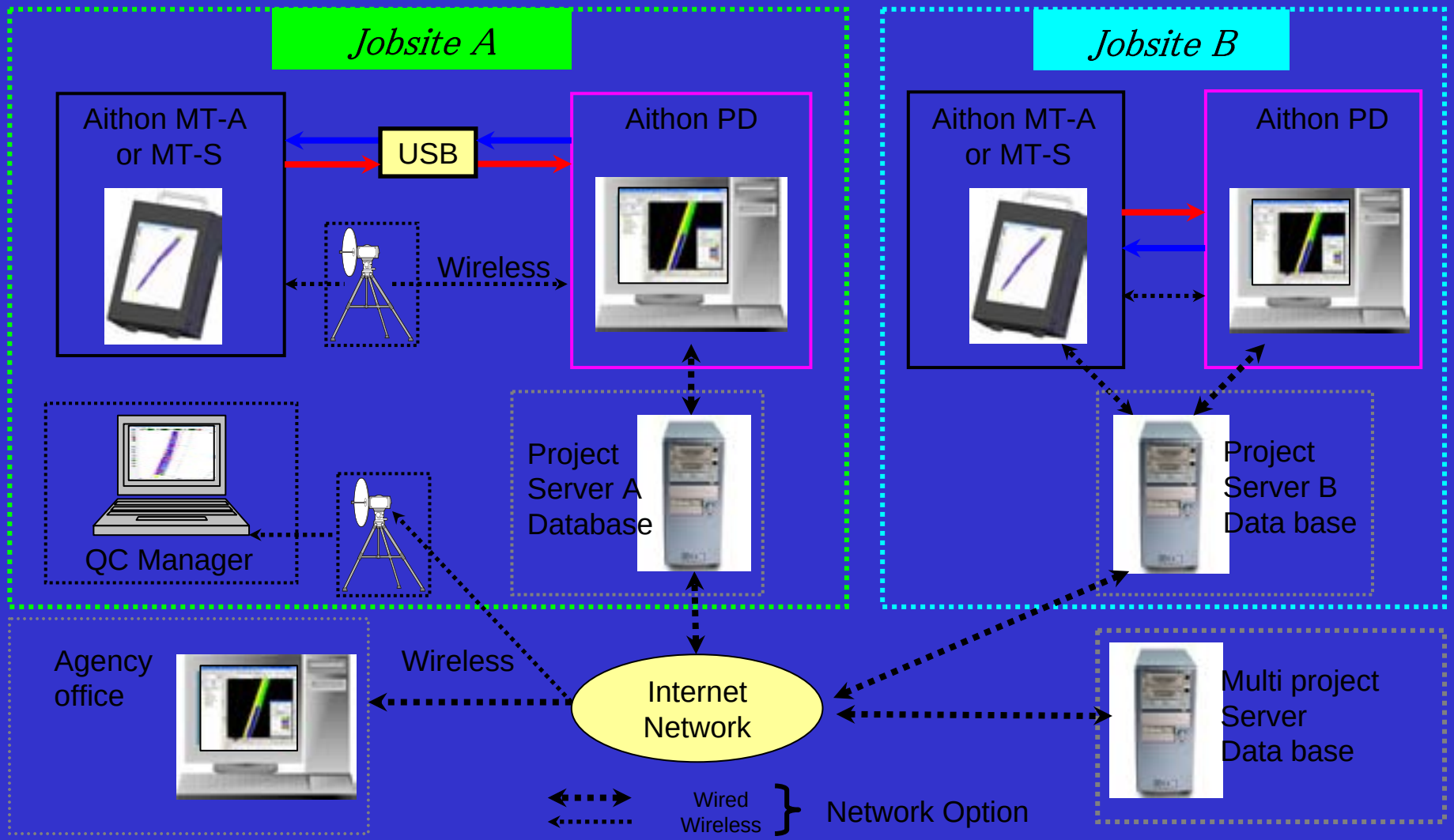
- *Operator "self-training".*
- *Placement crew training based on temperature feedback.*
- *Record of temperatures to share with trucking company and hot plants.*
- *Record of rolling pattern to share with operators and supervisors.*

Where are we, then?

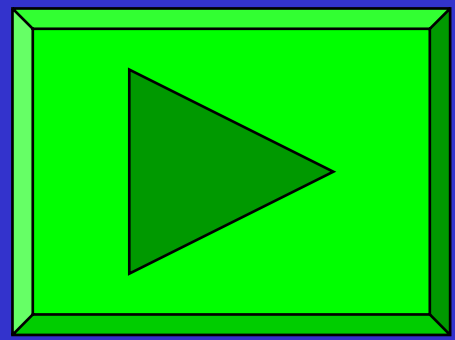
- *Systems that measure relative stiffness of the HMA mat that can be correlated to density*
- *GPS maps number roller passes to millimeter accuracy*
- *Maps surface temperature at time of rolling*

Future of IC development

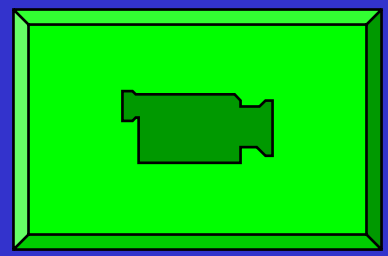
- *Machine control?*
- *Integration with job management software*
  - *Tracking costs for compaction work*
  - *Final grade control data – airports, other*


Jobsite A
Aithon MT-A
or MT-S
USB
Aithon PD
Wireless
QC Manager
Project
Server A
Database
Jobsite B
Aithon MT-A
or MT-S
Aithon PD
Project
Server B
Data base
Agency
office
Wireless
Internet
Network
Multi project
Server
Data base
Wired
Wireless
Network Option

Demo of Intelligent Compaction
Kandiyohi County Road 4



Thank you!



QUESTIONS ?