

INTELLIGENT COMPACTION

Nova Scotia Asphalt User

Producer

Seminar

April 10, 2014



NSUPA



NOVA SCOTIA ASPHALT USER PRODUCER ASSOCIATION

Intelligent Compaction!!!

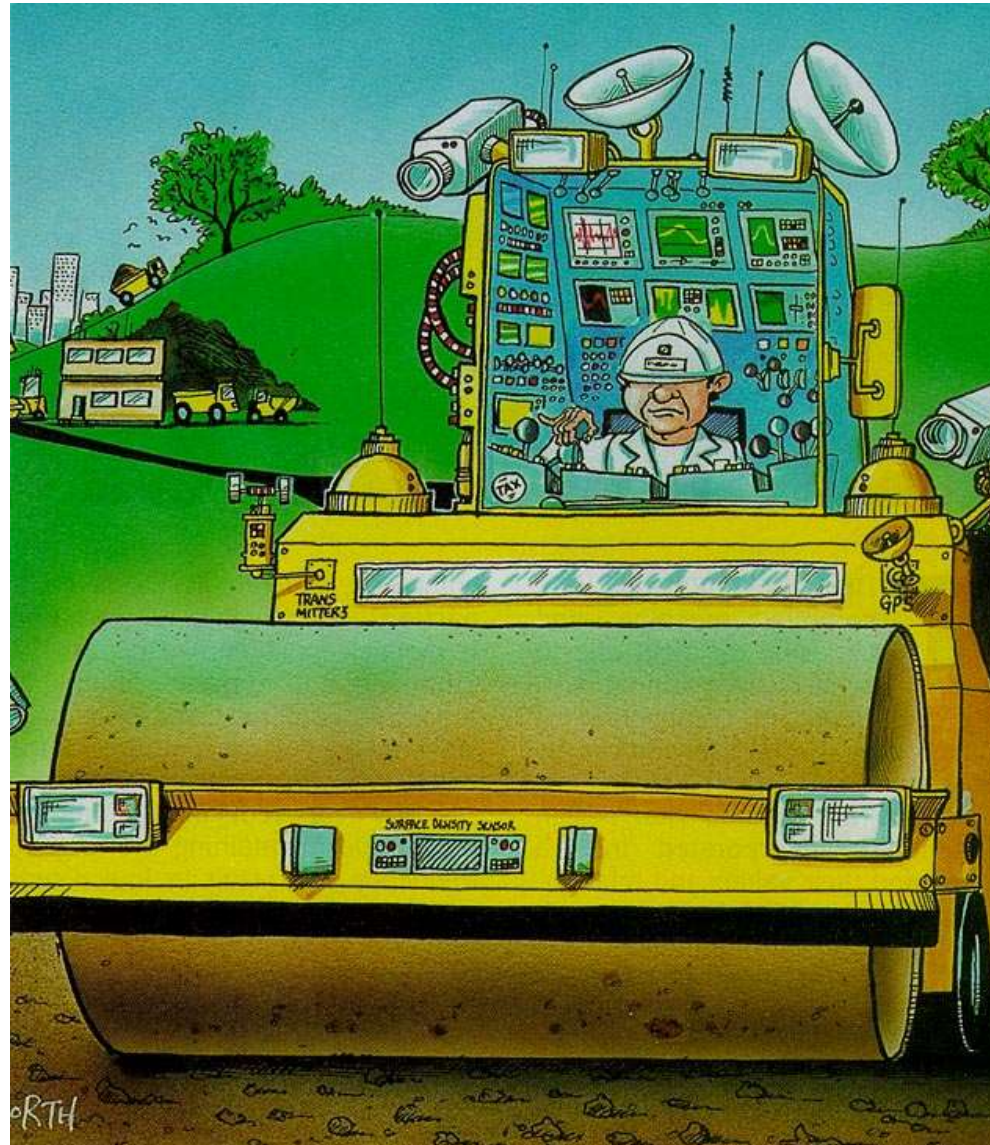
Soil

Asphalt

Intelligent compaction

- Maximise compaction efficiency
- Reduce compaction variability
- Optimise labour force and construction time
- Identify non-compactable areas (Soil)
- Identify weak spots (Soil)
- Achieve uniform compaction with 100% coverage

INTELLIGENT COMPACTION



Why is compaction important ?



Why is compaction important?

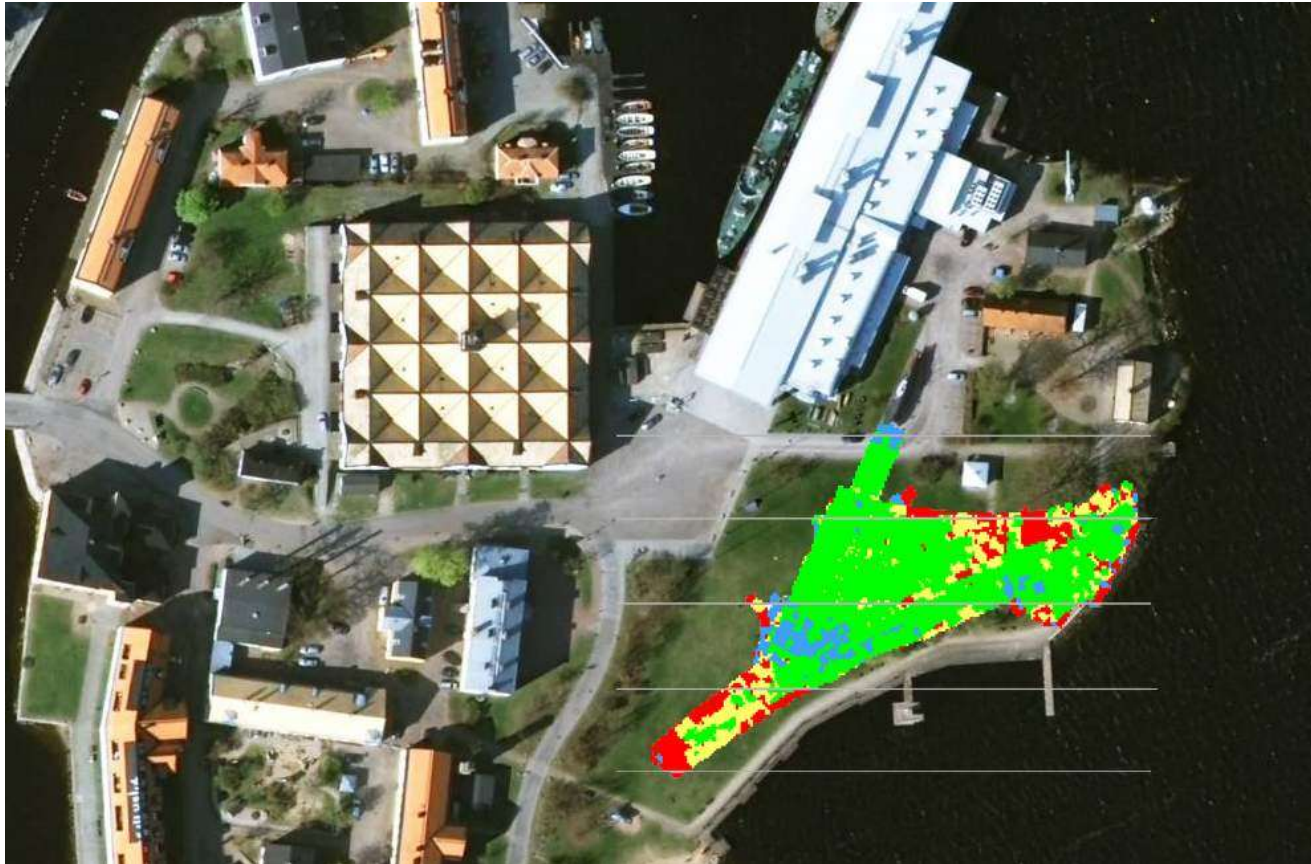


PROJECT OUTLINE



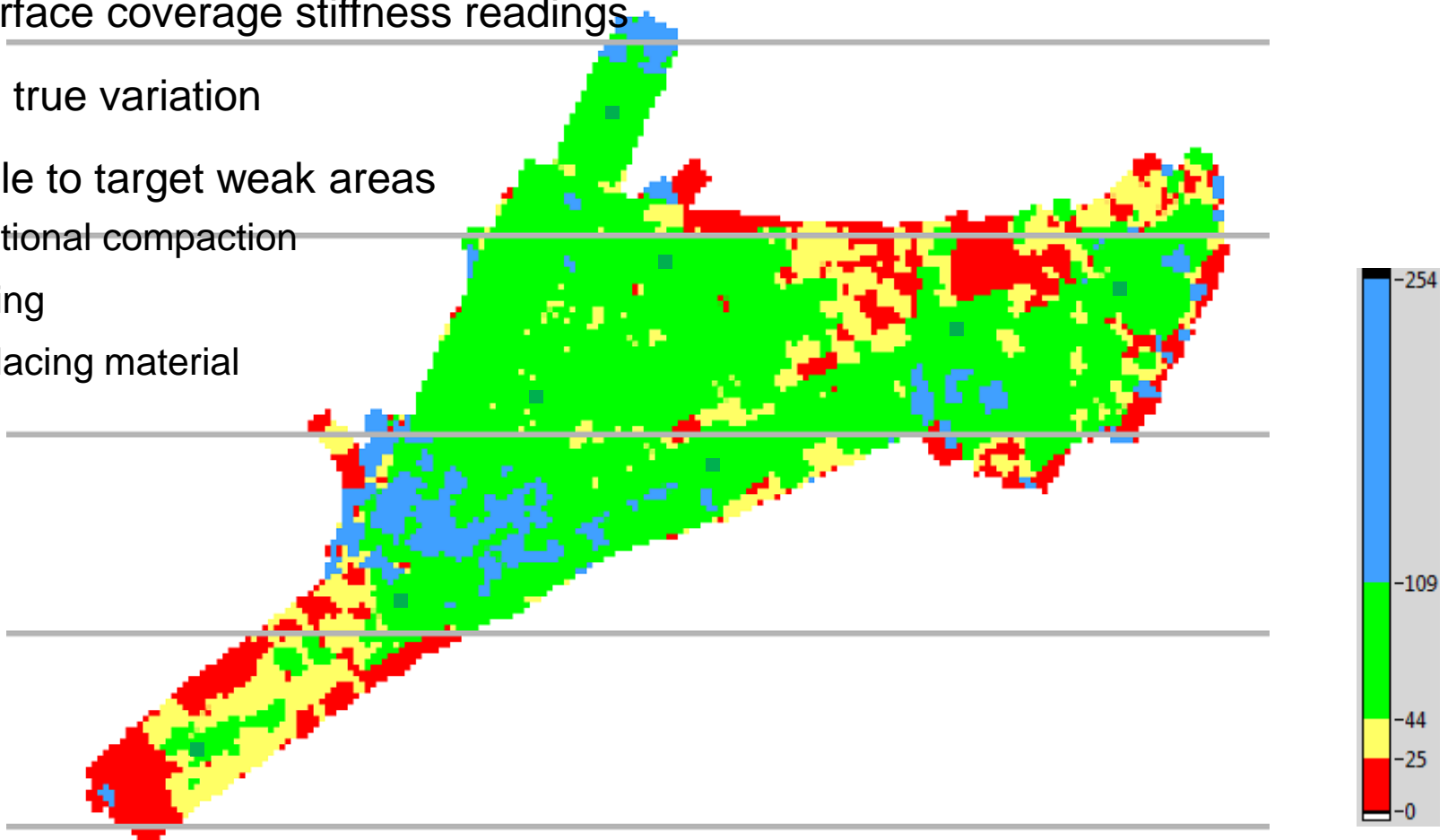
- Temporary ramp to carry the transport of a 49,5m long, 5,5m wide, 980 ton submarine (Neptun) on trailer
- Crushed gravel reinforced with geo-grids on top of existing lawn
- Compaction requirement: 6 vibratory passes with CA 5000
- Additional testing with static plate load test

AERIAL PHOTO WITH CMV MAP



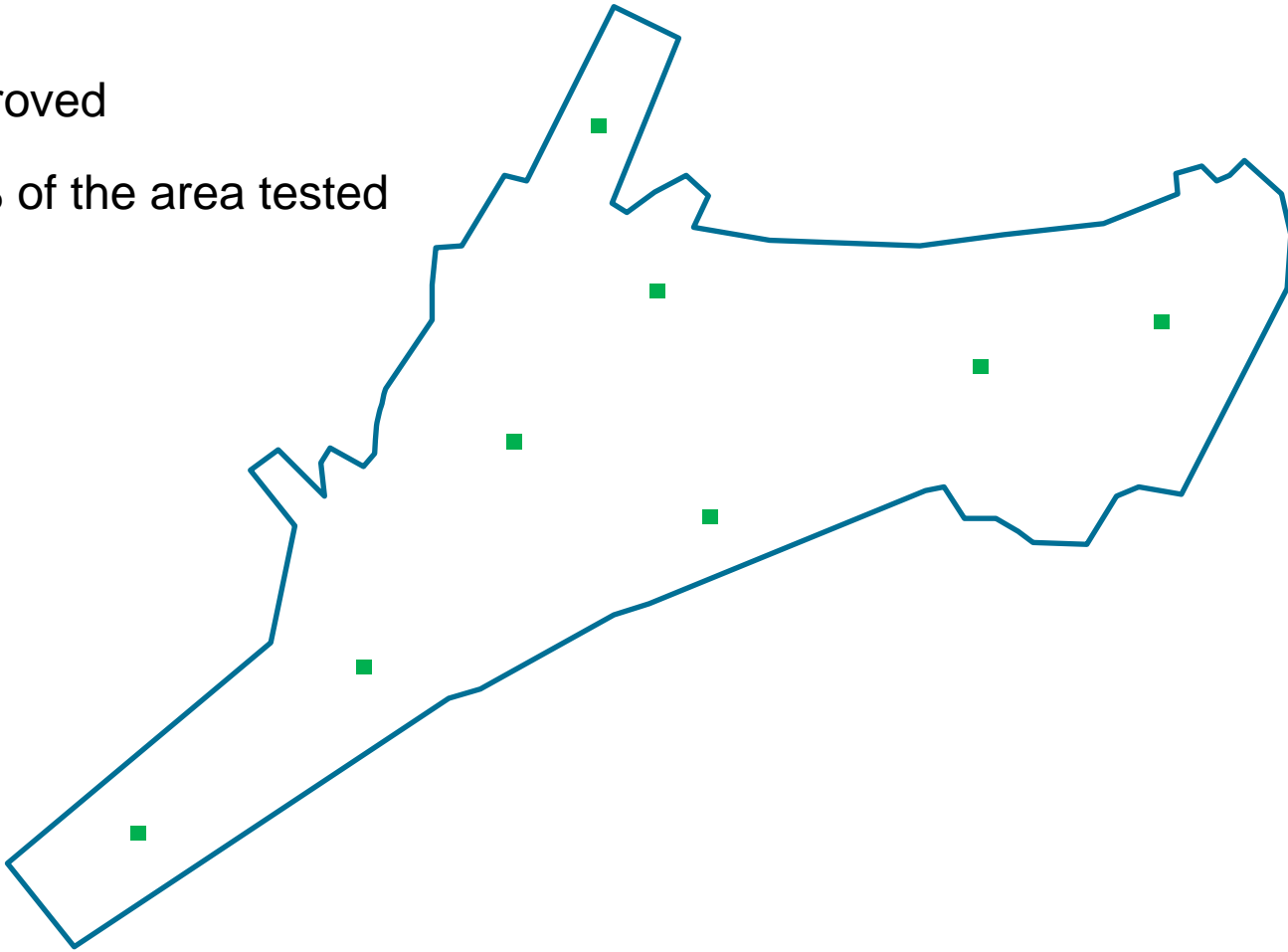
ACTUAL RESULTS USING DCA DISPLAYS A MORE COMPLETE PICTURE

- Full surface coverage stiffness readings
- Shows true variation
- Possible to target weak areas
 - Additional compaction
 - Testing
 - Replacing material

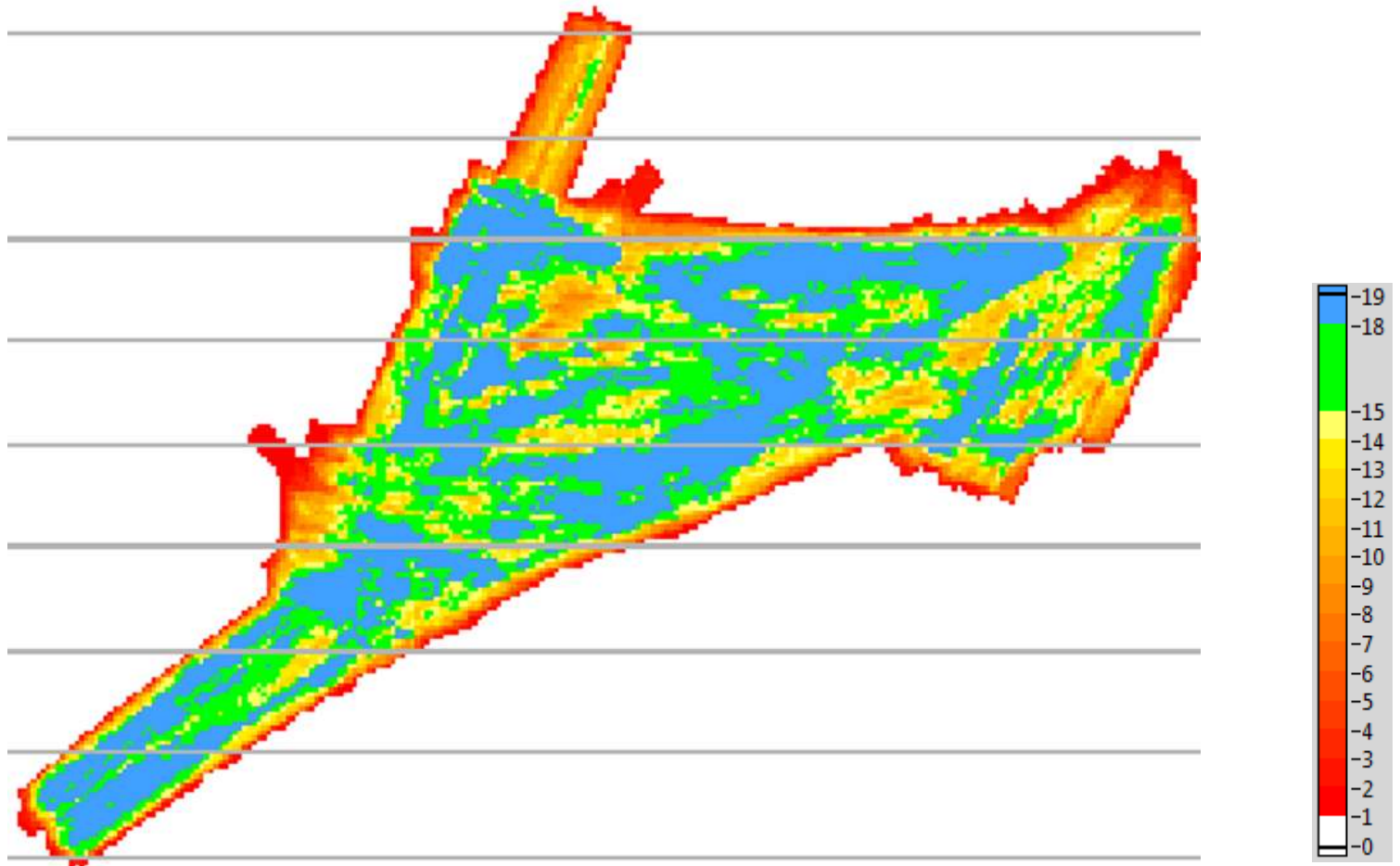


2988 M² COMPACTED AREA

- Random sampling
- 8 spots
- All approved
- 0,019% of the area tested



PASS COUNT MAP (TARGET: MIN 6 VIBRATORY PASSES)



FINAL RESULT



Test method

Plate test

Nuclear test unit



Rollers measurement values



Ammann (Kb)



Cat (CMV/MDP)



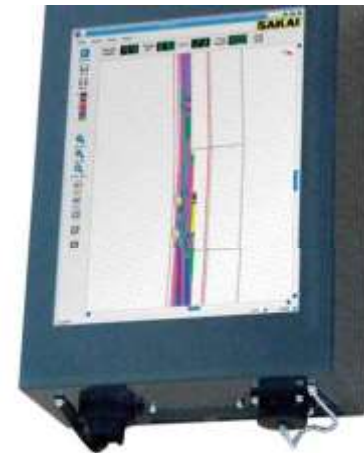
Hamm HMV



Bomag (Evib)



Dynapac (CMV)

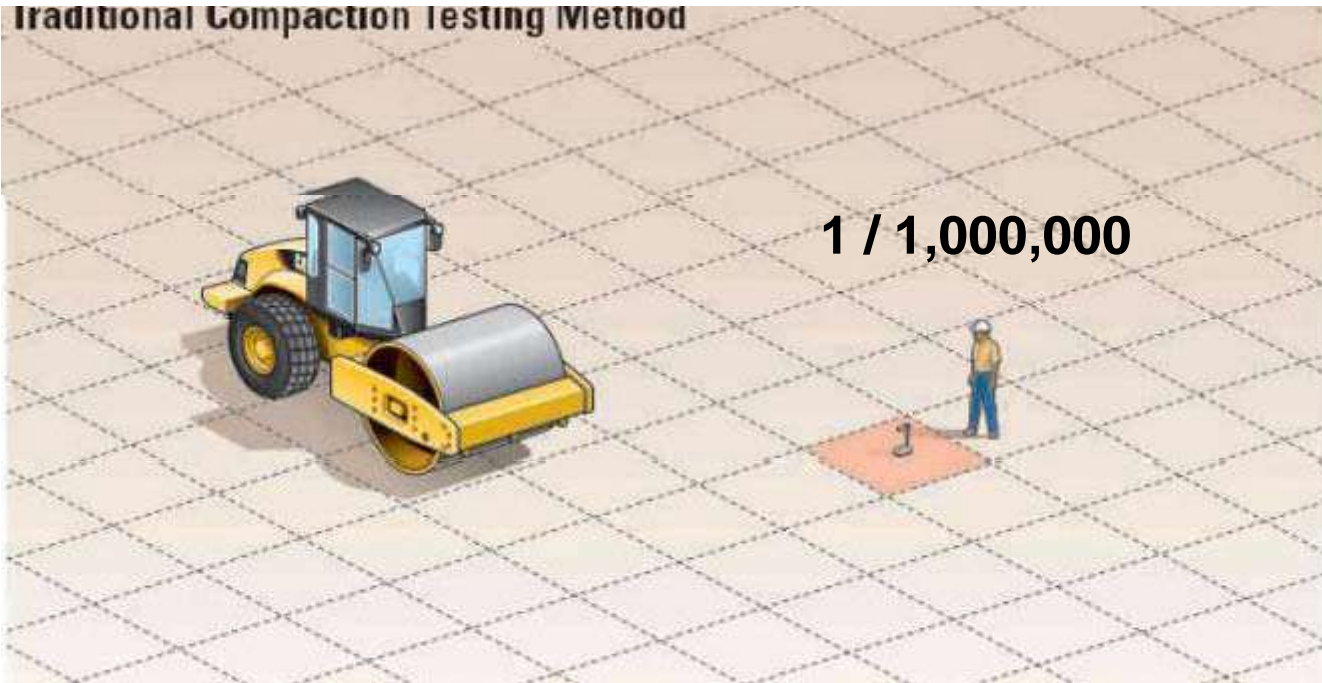


Sakai (CCV)



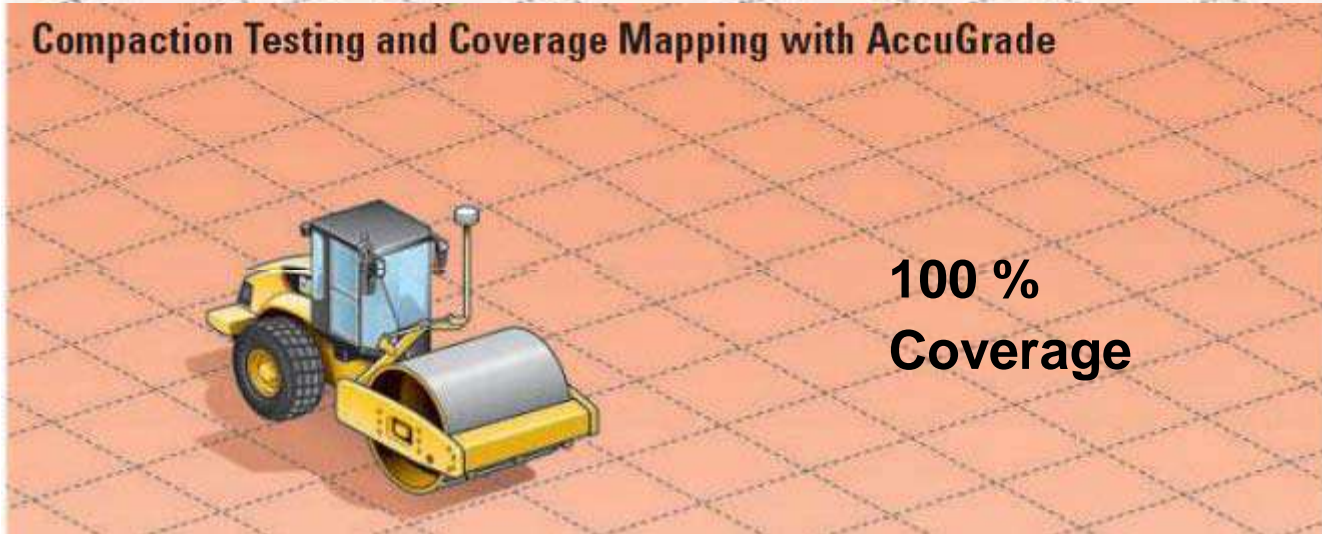
C
a
t

Traditional Compaction Testing Method



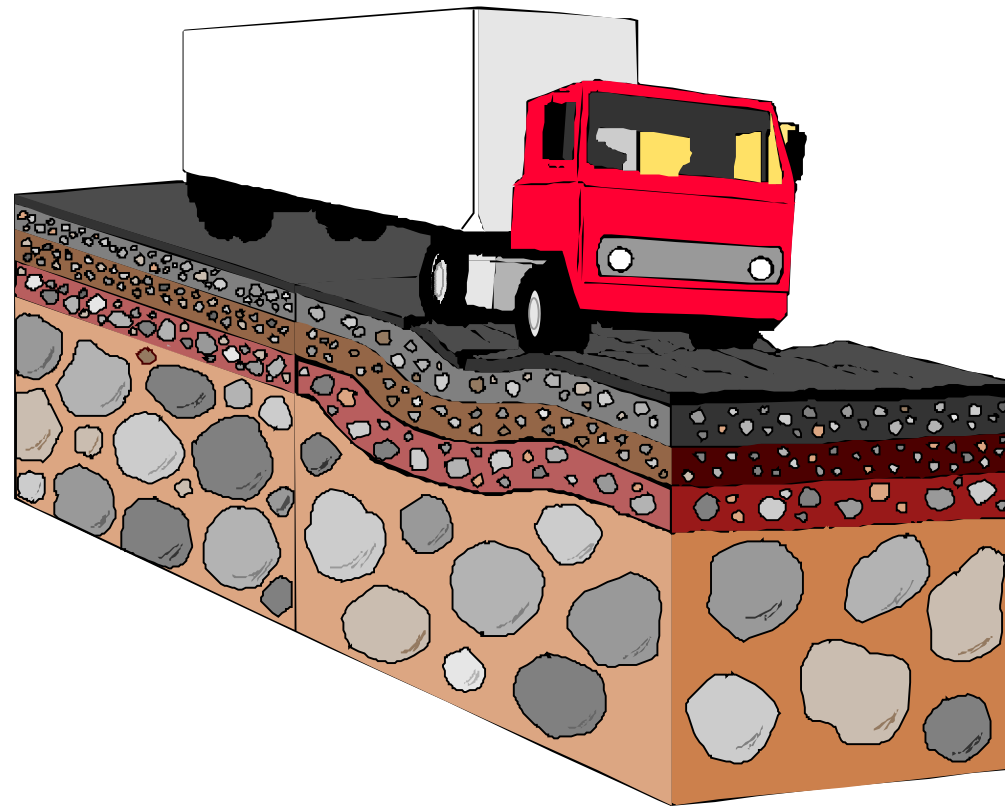
1 / 1,000,000

Compaction Testing and Coverage Mapping with AccuGrade



100 %
Coverage

Is the road base gradation & compaction important???



PRODUCTIVITY, IMPROVED COMPACTION CAPACITY

Material	Required passes	Performed passes	Time reduction (%)
Soil	14	19,8	29
Soil	8	14,6	45
Soil	6	11,9	50
Asphalt	4	5,7	30
Asphalt	4	6,4	38
Soil			30-50
Asphalt			30-40

Figures from above is evaluated from the field on different job sites.
Operator has not focused on the DCA display.

TWO STAGE APPROACH FOR QUALITY IMPROVEMENTS

- Stage I. Guided Production
- Stage II Post-production follow-up and feed-back



Intelligent Compaction (IC)

provides benefits over traditional testing methods:

- Increase Operator Awareness
- Optimized passes count & coverage
- Improve Rolling Pattern (asphalt)
- Improve Density & Smoothness (asphalt)
- Lower Operating Costs
- Documentation (statistically significant)

IC includes:

- A. Compactor integrated data measurement
- B. Positioning tied to collected data (GPS)
- C. Ability to analyze & document data
 - 1. IC on Soils is more a direct measure of compaction
 - 2. IC on Asphalt is more process control at this point

Process Control –

Awareness Real-time

Compaction,
Temperature (asphalt),

Pass count data

Easier night-time operation

Early detection of problem areas,
etc.

Productivity & Efficiency

Maximized machine utilization with
better efficiency

Identify poorly compacted
Longitudinal joints





HAMM Compaction Control

STAGE II: POST PROCESSING, ANALYSIS AND THINGS TO IMPROVE

- Correlate compaction acceptance testing to initial temperature and number of passes.
- Use the information to optimize the process and to find the current operation procedures
- Highlight good results and find the reasons for poor results

Comparing the results and procedures to the preparations will generate a continuously improving process for paving and compaction

What is available?

- ✓ Mapping
- ✓ Stiffness reading
- ✓ Mapping & stiffness reading


The BOMAG logo consists of the word "BOMAG" in a bold, black, sans-serif font.

Asphalt Manager
Stiffness reading

The AMMANN logo features the word "AMMANN" in a bold, black, sans-serif font, with a red triangle pointing upwards between the two 'M's.

ACE- Ammann Compaction Expert
Stiffness reading



HCQ Hamm Compaction Quality
Stiffness reading



Cat Intelligent Compaction
Stiffness reading

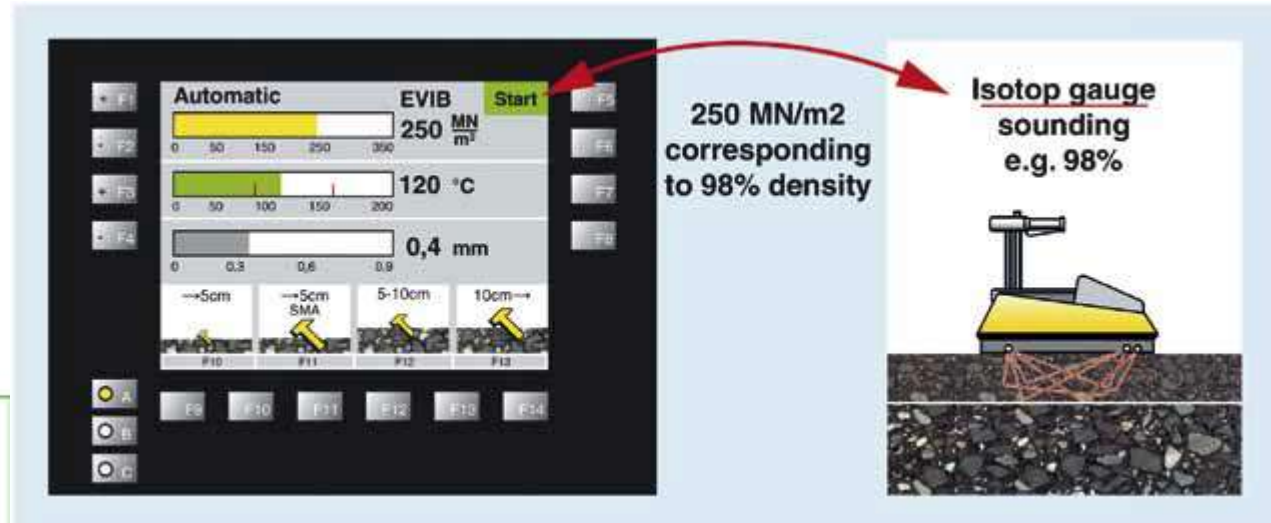
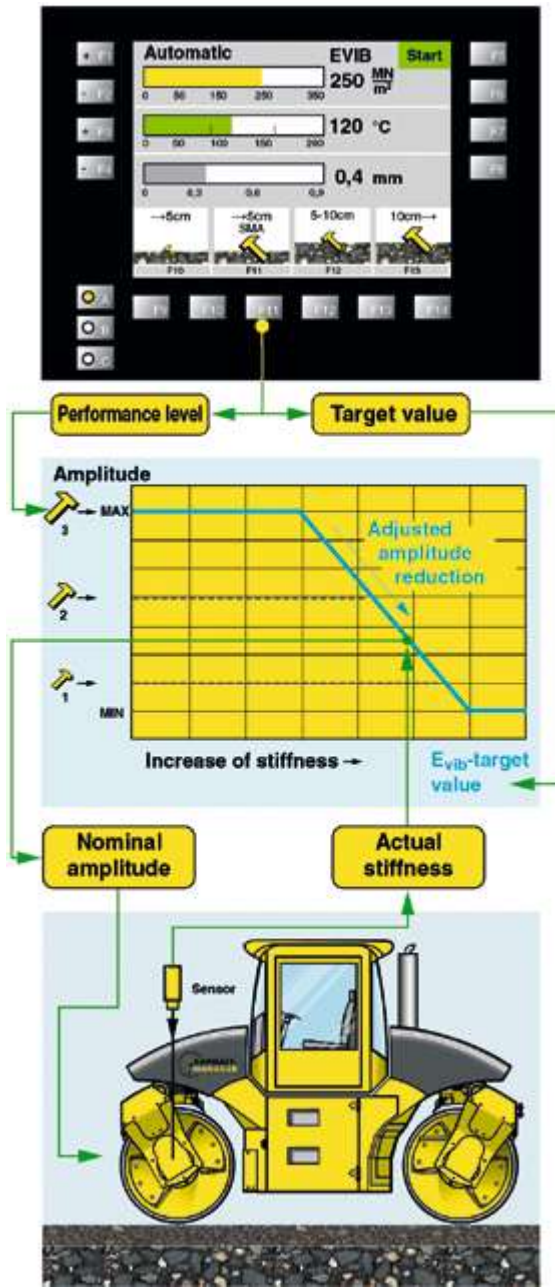
One dimension systems which measure only the stiffness
of the asphalt

DOCUMENTATION AND OPTIMIZATION – IT'S ALL IN THE DETAILS

- Quality assurance
- Optimize productivity
- Right number of passes
- Longer lasting roads



Bomab Evib II



OPERATIONAL PANEL

EVIB - Indication

Effective Amplitude

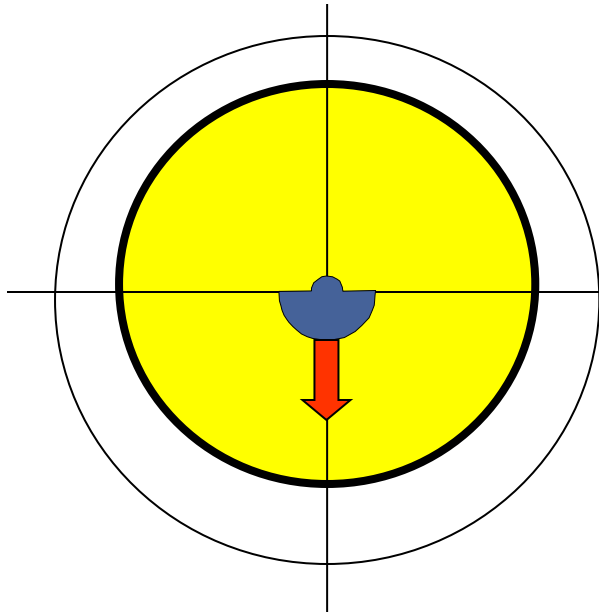
Roller speed



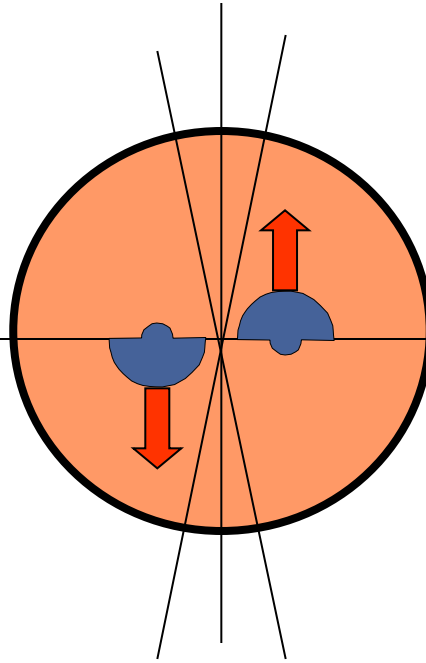
Asphalt-
Temperature

Frequency

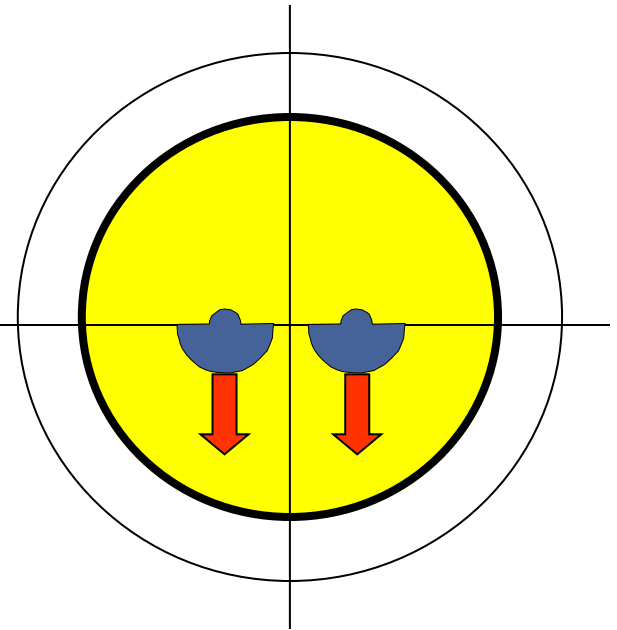
Rotary exciter



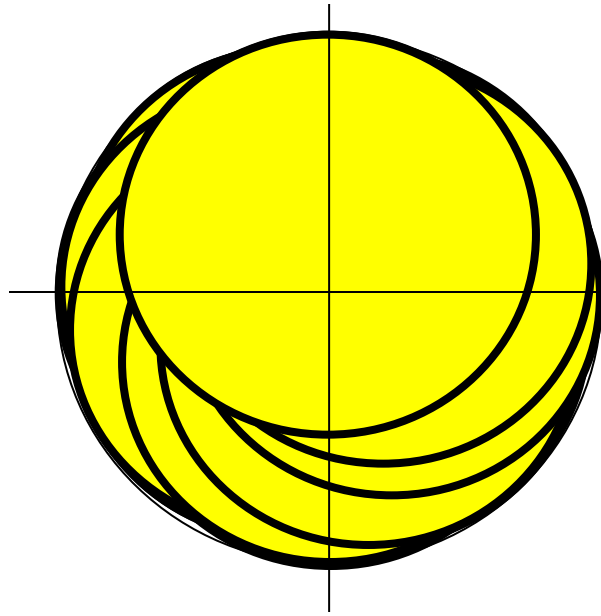
Oscillation



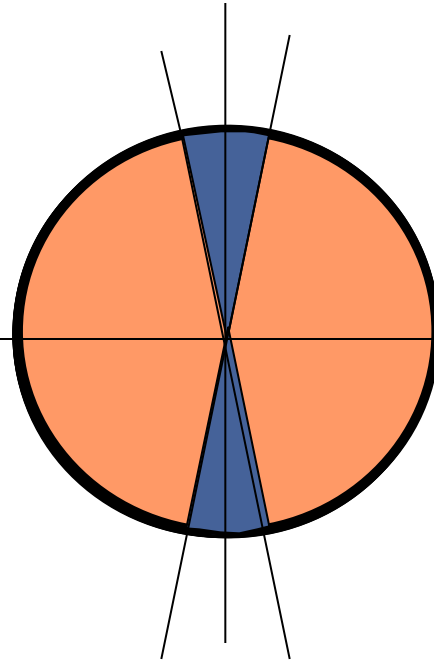
directed



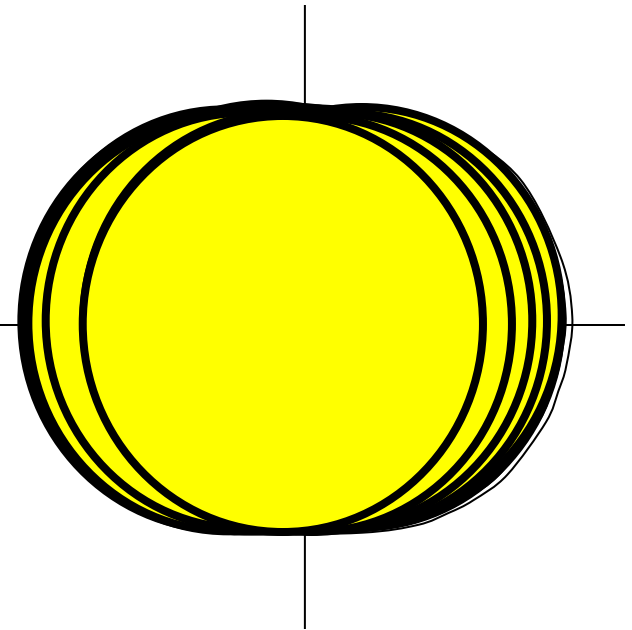
Rotary Exciter



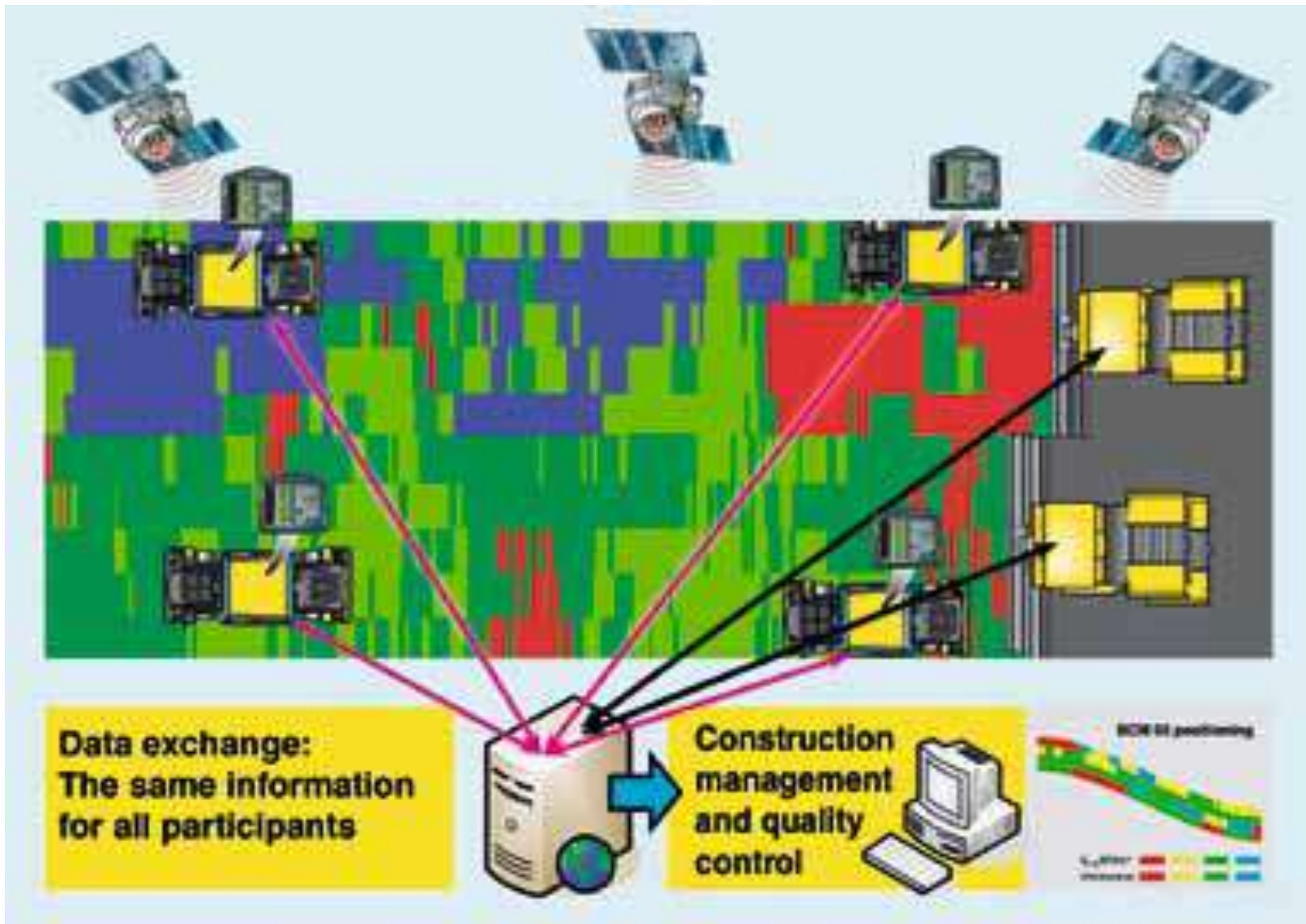
Oscillation

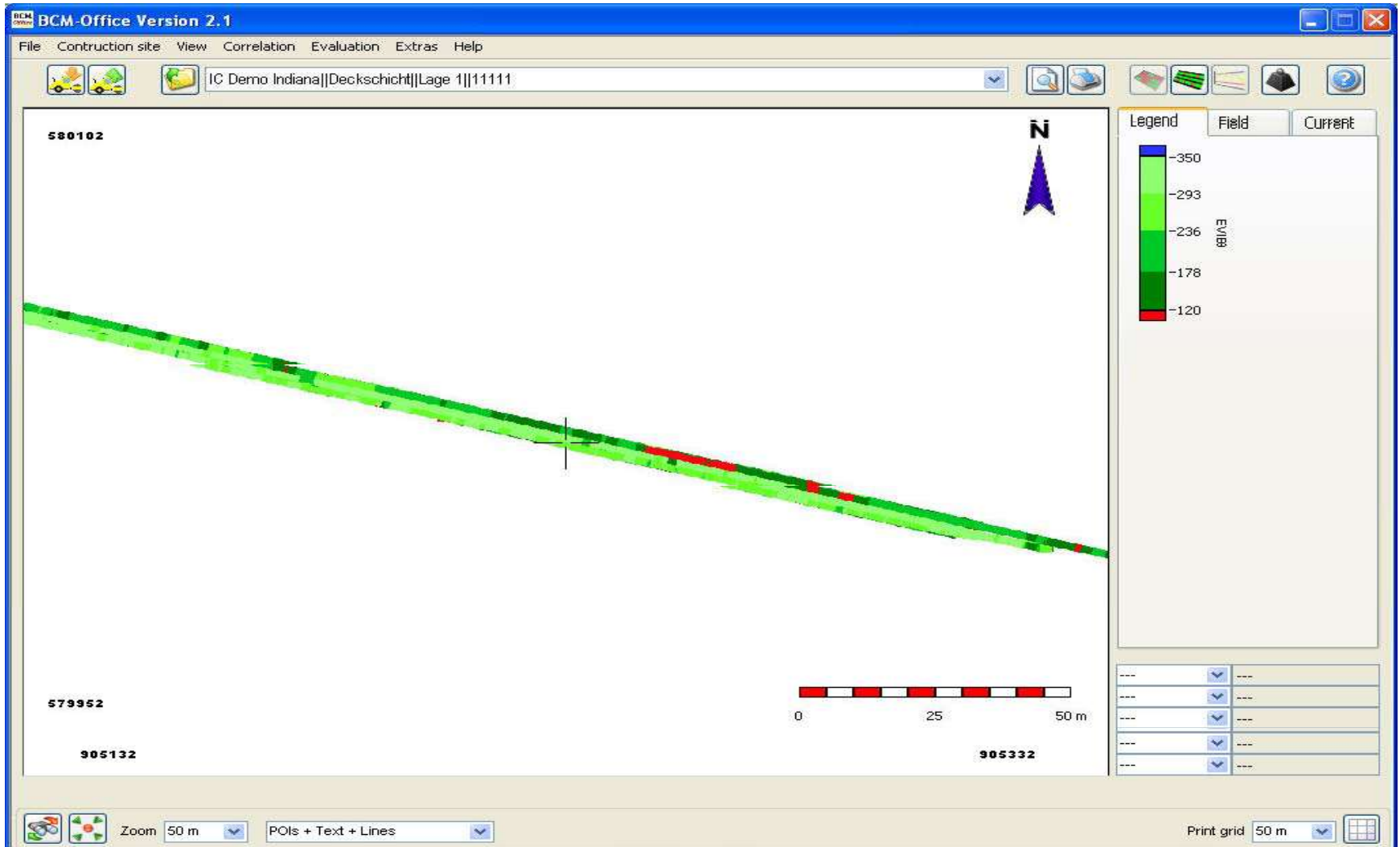


**Directed
horizontal**



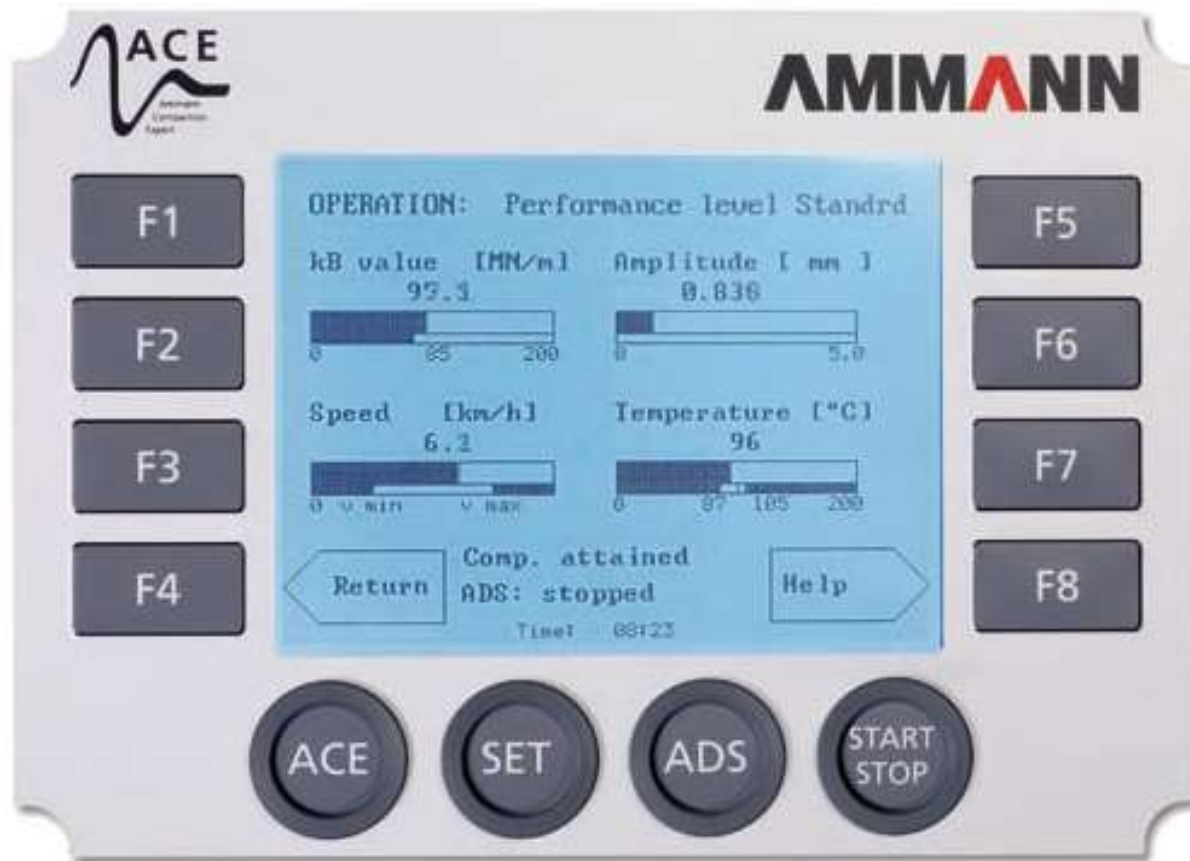
Information sharing !!!





Bomag BCM Office

Ammann Compaction Expert



- Bearing capacity (kB)
- Amplitude
- Frequency
- Speed of roller
- Temperature of asphalt (only on Asphalt roller)

Unit: Stiffness [MN/m]

Display Workstep: DefaultWorkstep

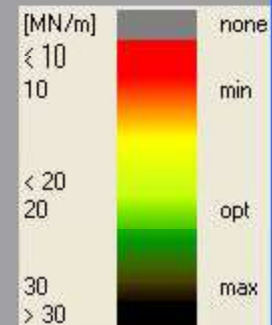
Assign to Workstep: DefaultWorkstep

Machine: Default Machine

Project: TB1 TX CLAY
Scale: 1:250
2008-07-22
Meas. time: T17:58:48
-06:00
Gps quality: Satellites: 9
Qlty: RTK fix

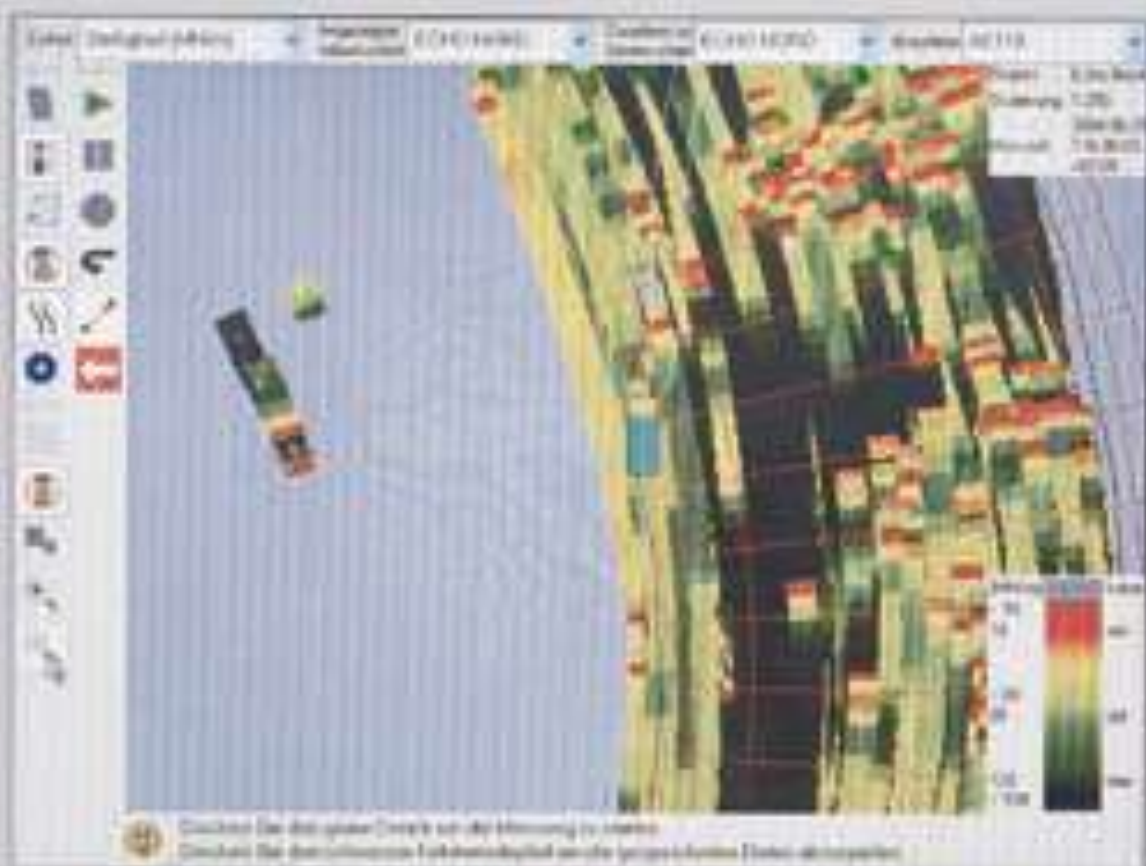


Ammann
ACEplus System



System is not able to perform measurements. You did not select the program mode allowing you to start measurements.
Press U-turn black arrow to playback recorded measurements.

AMMANN



ACE
plus

DYNAPAC COMPACTION ANALYZER-ASPHALT DCA-A

The pass-count and asphalt temperature are presented in real-time on the operator screen providing vital information for a successful compaction job

The GPS-receiver provides accurate positioning of the roller

Rear temperature sensor.

Front temperature sensors constantly monitor the asphalt temperature





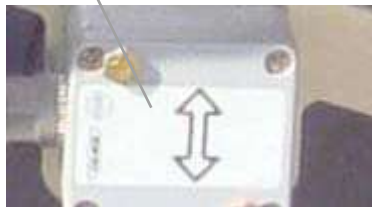
**HCQ GPS
Navigator**



**GPS
Receiver**



**Temperature
sensor**



Accelerometer

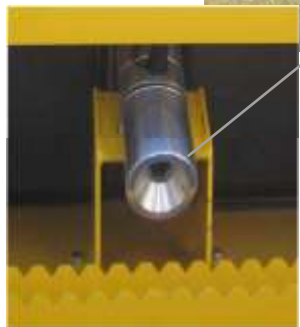


Control Panel

Compaction Information System



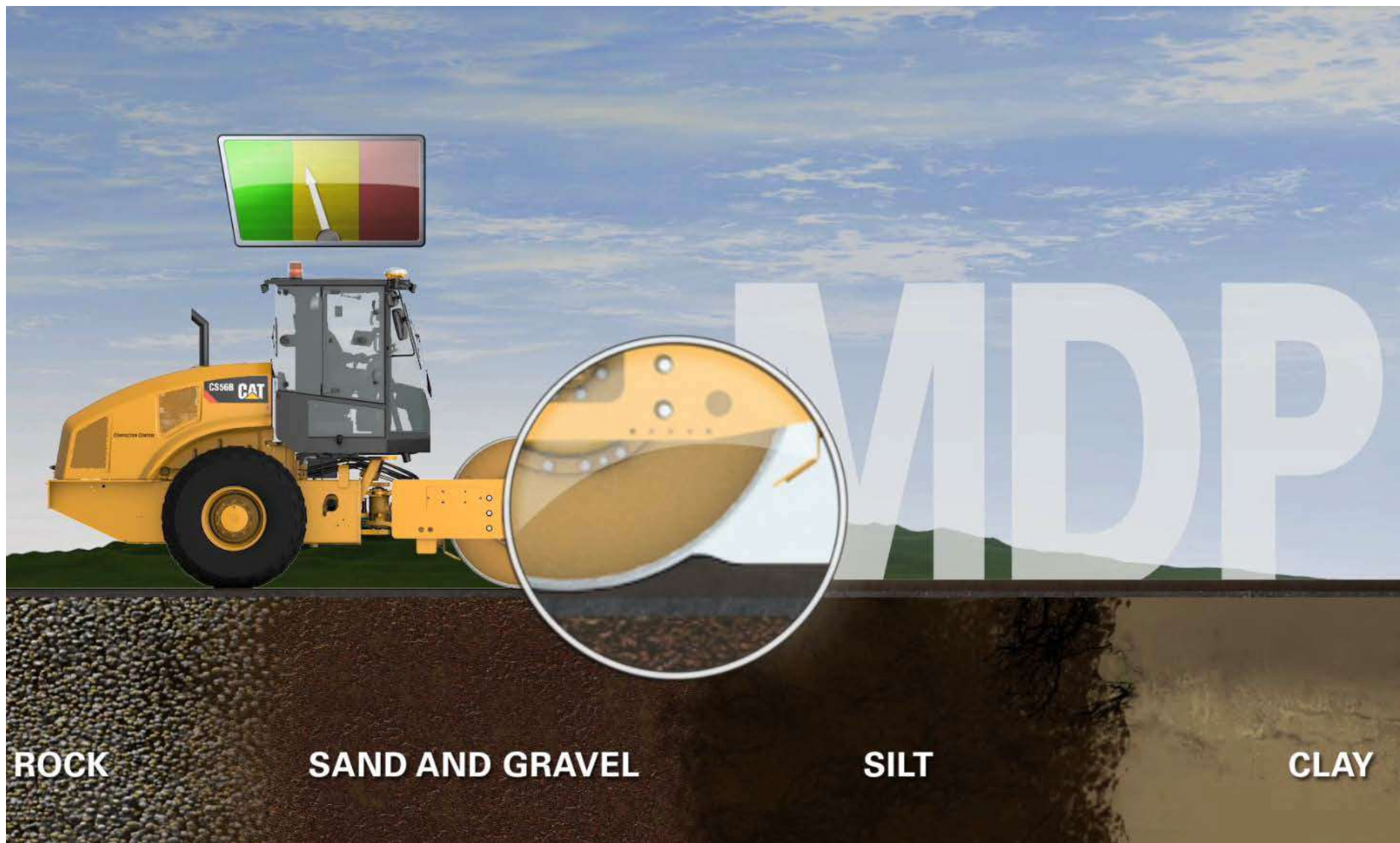
Display



Temp
sensor



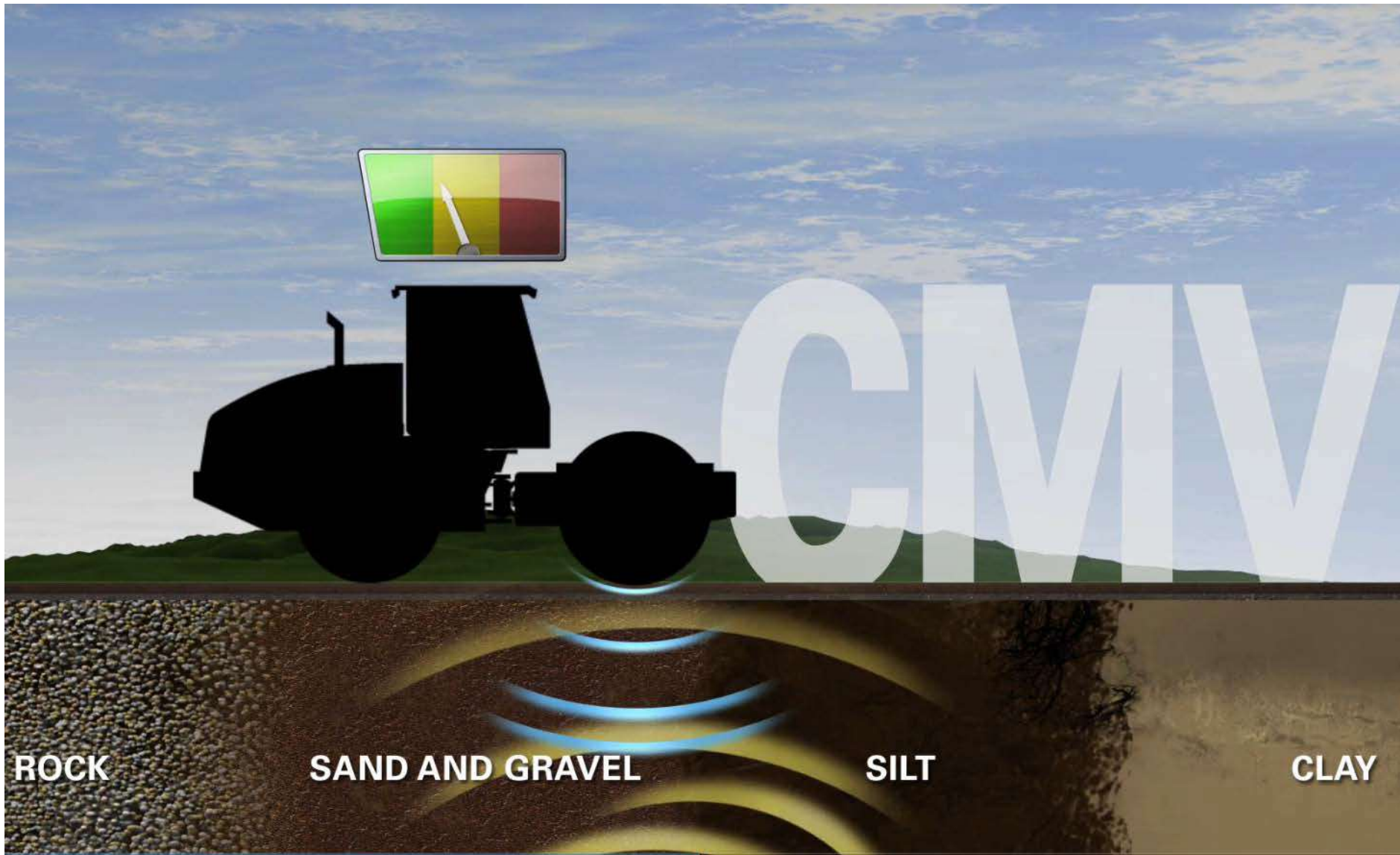
Accelerometer



COMPARISON: Cat (Soils)

	MDP Machine Drive Power	VS.	CMV Compaction Meter Value
Measurement basis	Rolling resistance / Energy		Accelerometer
Vib system for measurement	Active or inactive		Active only
Soil types	Granular or Cohesive		Granular only
Machine configuration	Smooth drum, Padfoot, Shell kit		Smooth drum only
Measurement depth*	30 – 60 cm (1-2 feet)		1- 2 meters (3 - 6 ft)
Can add GNSS mapping	Yes		Yes
Availability	CAT Dealers only		Several manufacturers

* Depends on machine weight, soil type and conditions



Equipment Required -

GPS

Rollers –

Soils – GPS, Compaction Measurement, Data Collection, Display

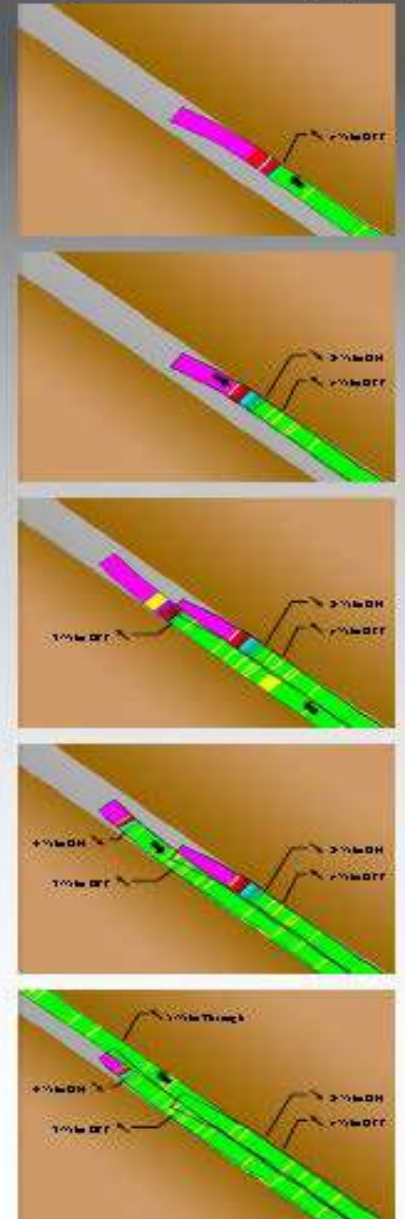
Asphalt – GPS, Compaction Measurement, Temperature, Data Collection, Display



CAT COMPACTION CONTROL

- **Infrared temperature sensors (front and rear)**
Keeps operator informed of when optimal temperatures exist for compaction
- **Temperature Mapping**
Record temperatures for data analysis
- **Pass-Count Mapping**
Keeps operator informed of where mat coverage has taken place and the number of passes made.
- **Accelerometers**
Provides feedback of vibration energy for a measurement value

Temperature/Pass Count Mapping



Temperature sensors

Not a direct measure of compaction, rather, a data for **process control** on asphalt

Dual infra-red sensors mounted on the front and rear of machine deliver real-time readings

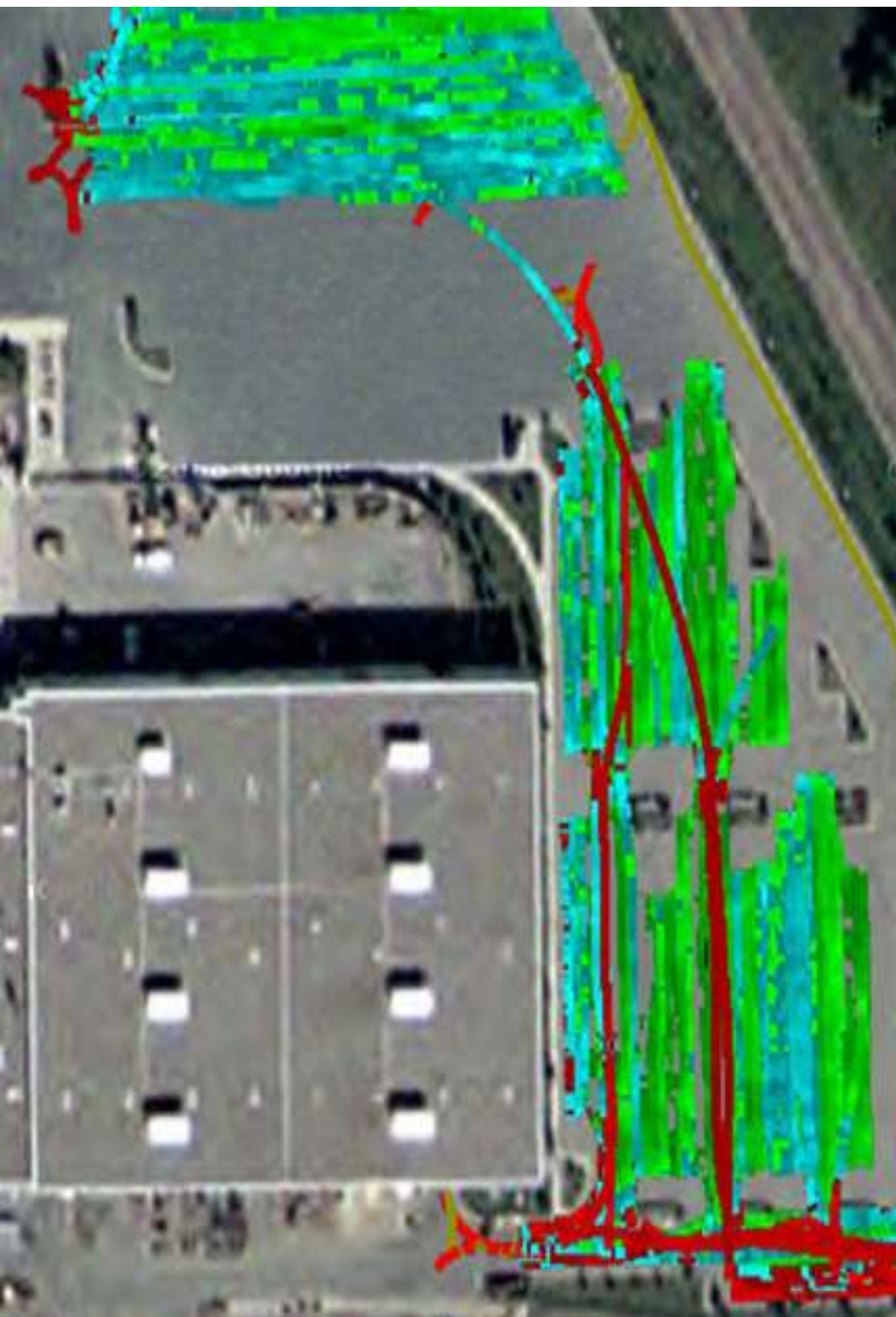
Keep operator informed of when to begin rolling and when to stop
Help avoid tender-zones that often occur in the 115° to 90° C
(240° to 195° F) temperature range

Eliminates hand-held devices

Breakdown compaction operation should be between 135 and 140 C
(275 and 300 F)

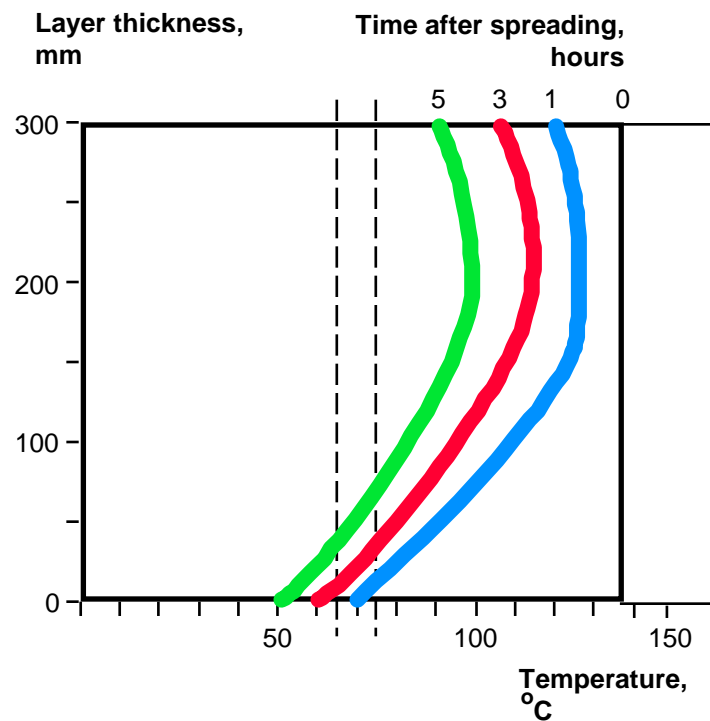
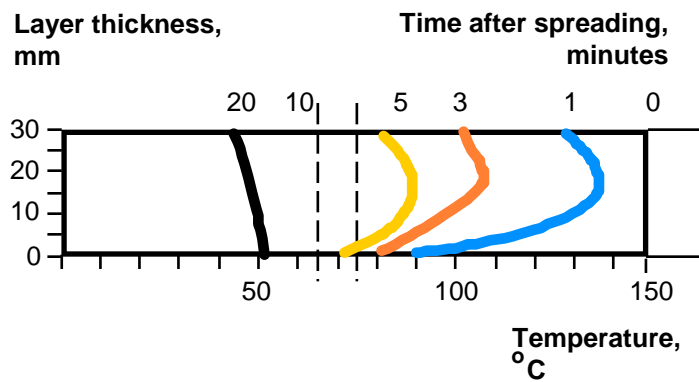
Upper limit of compaction is usually 149 C (300 F)

Lower limit of compaction is usually 85 C (185 F)



Mapping Temperature

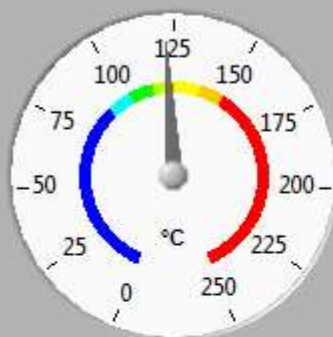
- This illustration provides asphalt temperatures as the roller passed over the fresh mat.
- The color pattern signifies the different temperature ranges that were present.
- Green – optimum temperature met
- Blue – Target temperature met, lower range than green
- Red – Temperature below target



DYNAPAC

Roller

Dynapac CC234HF



122



0,0

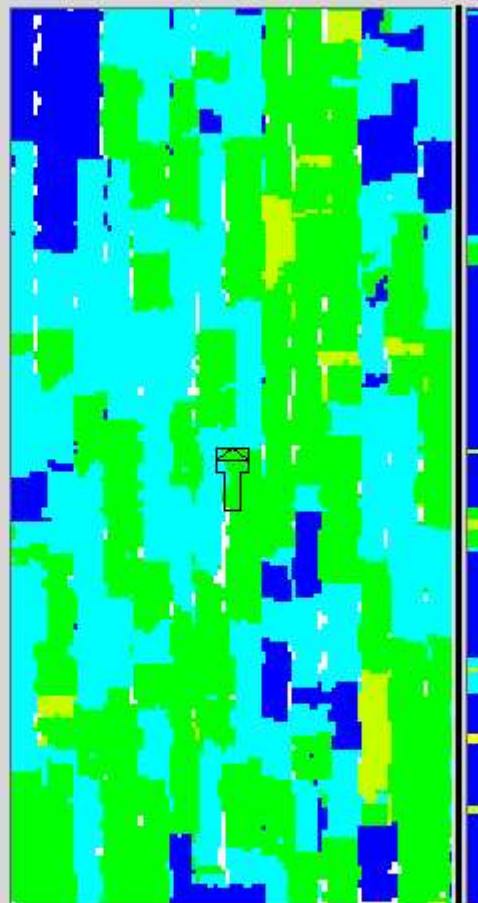
Position cc --

North 6226774,66

East 139237,36



Data plot



Project

STILLERYDSHAMNEN

Object

KOMBITERM1

Layer

TOPP

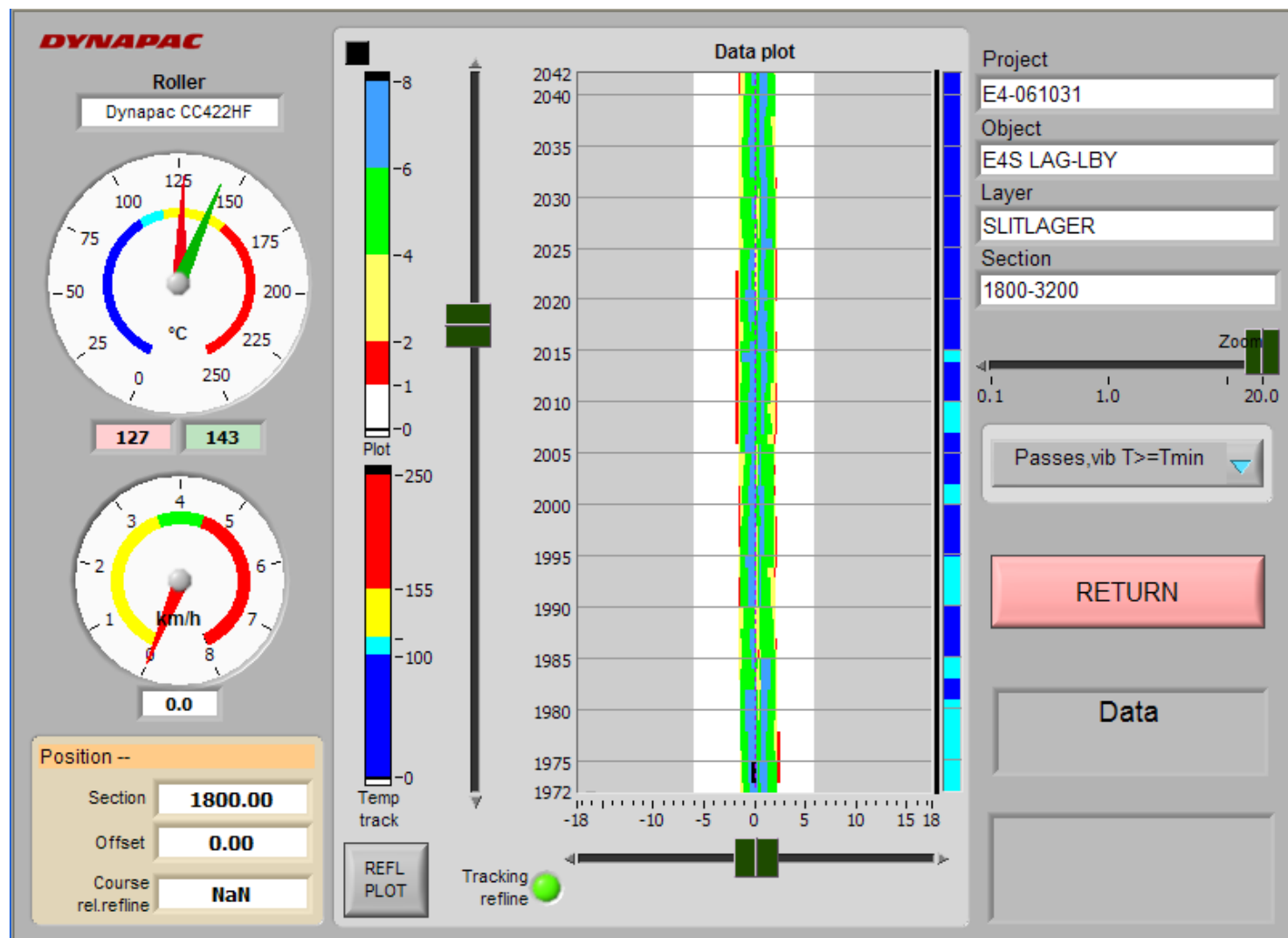
Section

TOPP

Temp. first pass

**STOP
RECORDING**

DYNAPAC DCA-A TEMP

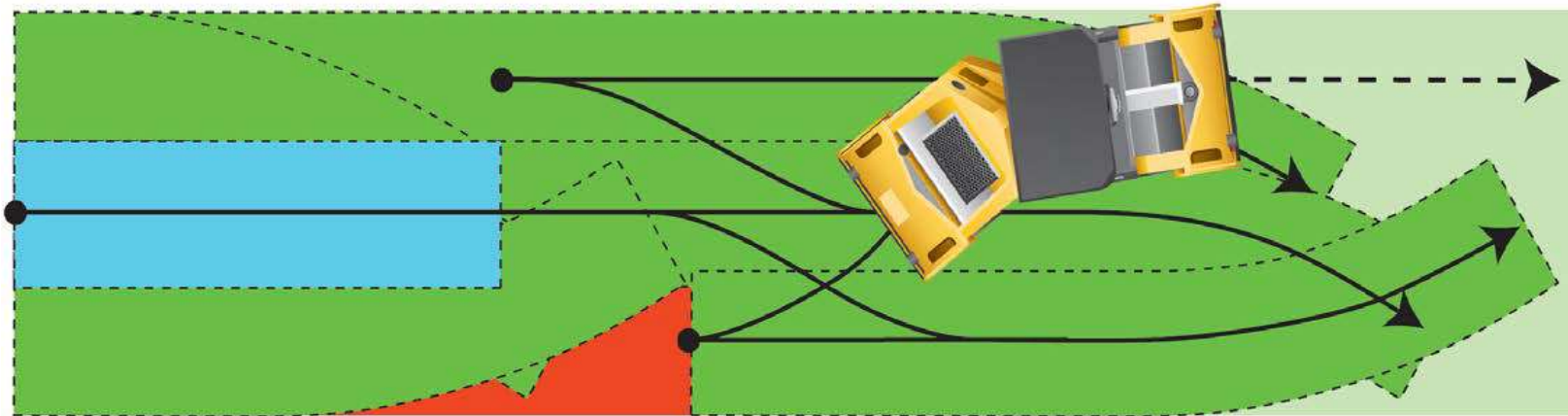


ROLLING PATTERNS/QUALITY



- What does today's rolling patterns look like?
- Is there an even number of passes made?
- At which temperature were the passes made?
- How fast was the roller going?
- What is the cost of insufficient compaction?
- What does excessive passes cost?



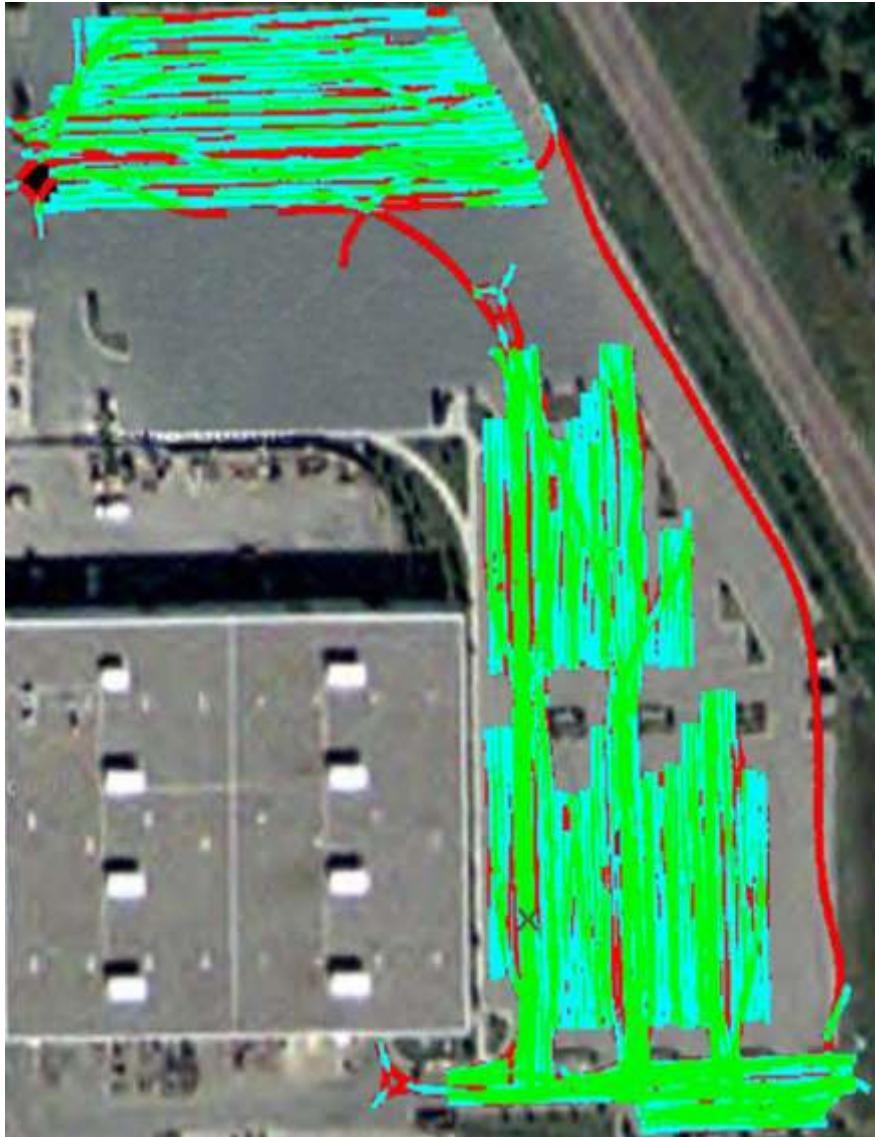
Rolling pattern Challenges



Maximize Efficiency – Monitor Starts and Stops

	Completed pass
	Overlap
	Fresh mat
	Incomplete pass

- Blue color indicates the compactor traveling too far onto the previous pass – inefficient
- Red color indicates the compactor stopped short of the complete pass – improper pattern

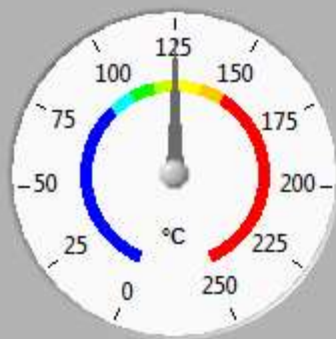


- Why is Pass-Count mapping important?
- Pass-count mapping helps achieve target density and increases roller efficiency.
- With proper pre-project planning including machine selection, vibratory selection and speed, the operator can execute the rolling pattern in the most efficient manner possible.
- Eliminate excessive overlap
- Prevent incomplete passes, stopping short or missed
- Maximize coverage
- Easier night-time operation

DYNAPAC

Roller

Dynapac CC234HF



125



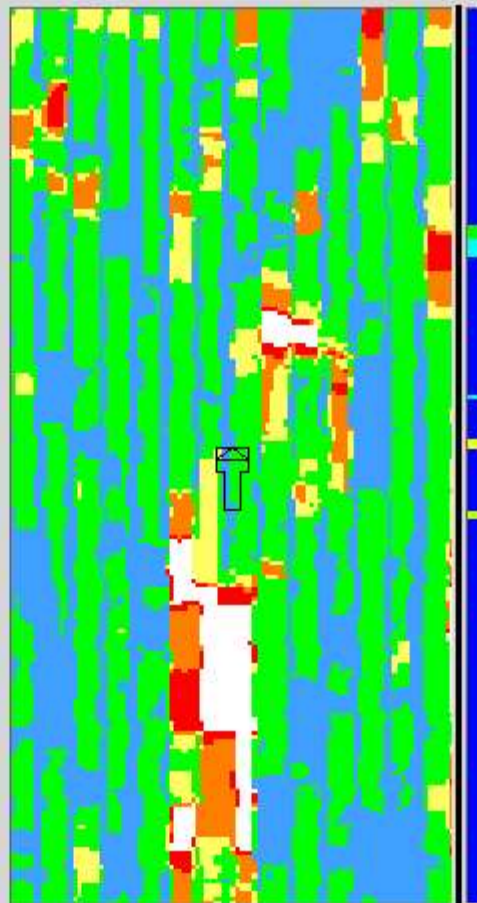
0,0

Position cc --

North 6226775,49

East 139224,00

Data plot

Plot
-250
-138
-114
-90
-0
Temp. track

Project

STILLERYDSHAMNEN

Object

KOMBITERM1

Layer

TOPP

Section

TOPP

Passes.stat T>=Tmin

**STOP
RECORDING**

THE ENEMY

Tender Mixes

Many reasons!!!

- ✓ **Moisture**
- ✓ **Excessive asphalt content in mix**
- ✓ **Rounded aggregates**
- ✓ **Aggregates gradation**
- ✓ **Poor bounding to the under laying layer**
- ✓ **Excessive mix temperature**
- ✓ **Rolling equipment and technique**
- ✓ **Stiffness of binder**
- ✓ **Contamination**

HOW TO OPTIMIZE THE COMPACTION PROCESS

- The correct number of passes with the right machine on the maximum/required layer thickness for the material in question.
- Verify the compaction method
- Pay attention to changing conditions
- Provide real time feed-back to a well trained operator

Why IC again?

- Offers advantages over conventional compaction equipment
- Offers valuable new tools to Contractors / Operators to improve Quality Control
- Offers valuable new tools to the Authorities to improve pavement service life
- Improved density **Better Performance**
- Improve Efficiency **Cost Saving**
- Increase Information **Better QC / QA**
- Overall Benefit **Improved Pavement Performance**

Intelligent Compaction Summary

A good road base compaction is needed

Intelligent compaction is a working tool

Intelligent compaction is a guide for the operators

Intelligent compaction will save \$ when used properly

Intelligent compaction provides backup data

The Authorities Always have the last word in compaction results!!

Conventional measurement - asphalt

- Density Gauges
- Cores



Thank You

To all my colleagues in the industry!!!

***COMMITTED TO
SUSTAINABLE PRODUCTIVITY.***



Atlas Copco

