# Quality Assurance Where does the Future Lead US

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# QA of the Past

- Material Testing
  - Aggregate Gradations – stock pile or cold feeds
  - Binder Content – volume measurement from tank
    - Time consuming and doesn't represent final product.
- Production Evaluation
  - Compaction – roller passes
  - Ride not even measured
    - Doesn't represent the final product.

# QA today

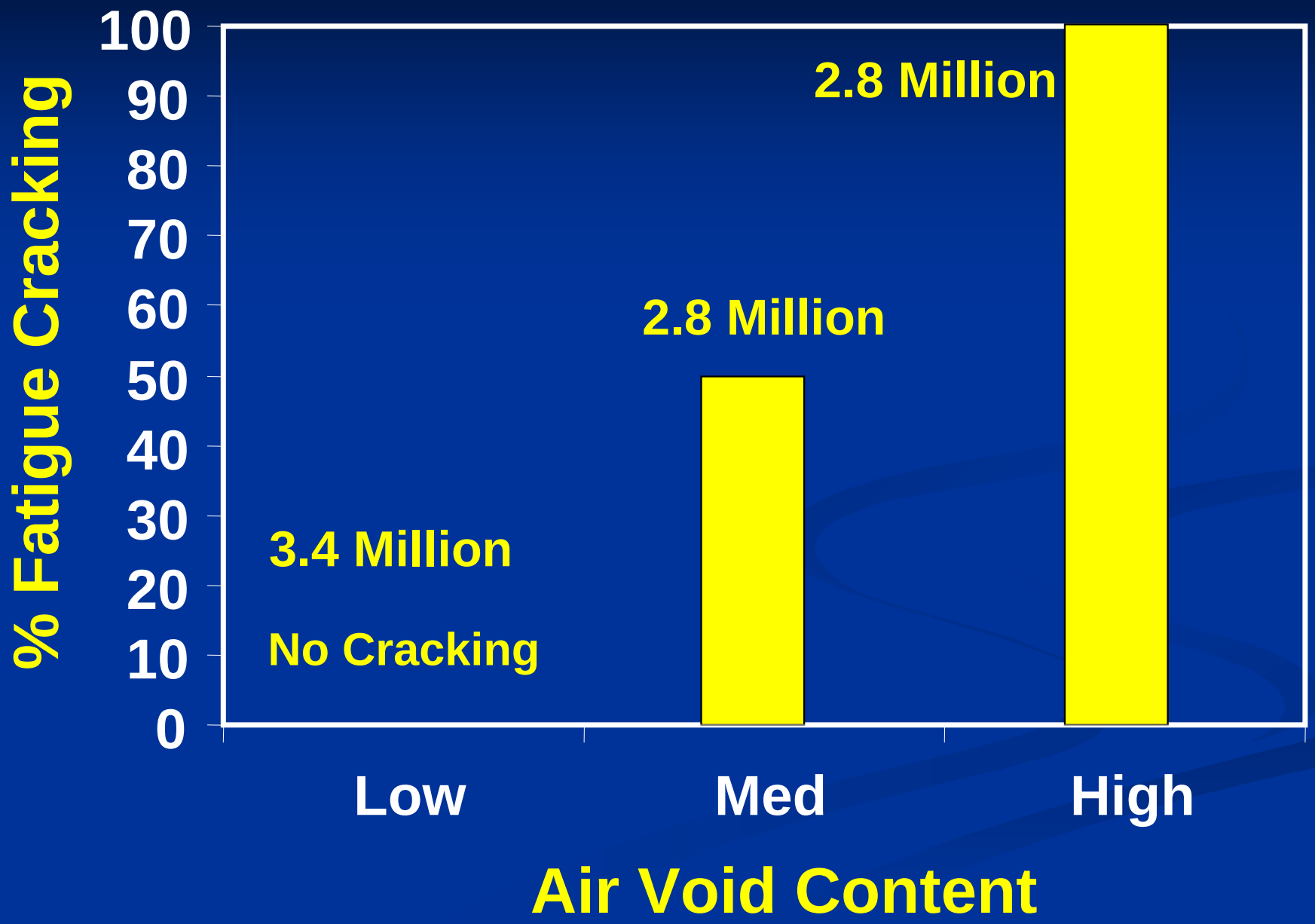
- Material Testing
  - Aggregate Gradations, Binder Content – Ignition Oven
  - Volumetrics – Field gyratory
    - Time consuming.
- Production Evaluation
  - Compaction – Nuclear Gauge, cores
  - Ride  profilometers
    - Small sample of product.


DUAL CONTROL
Wirtgen

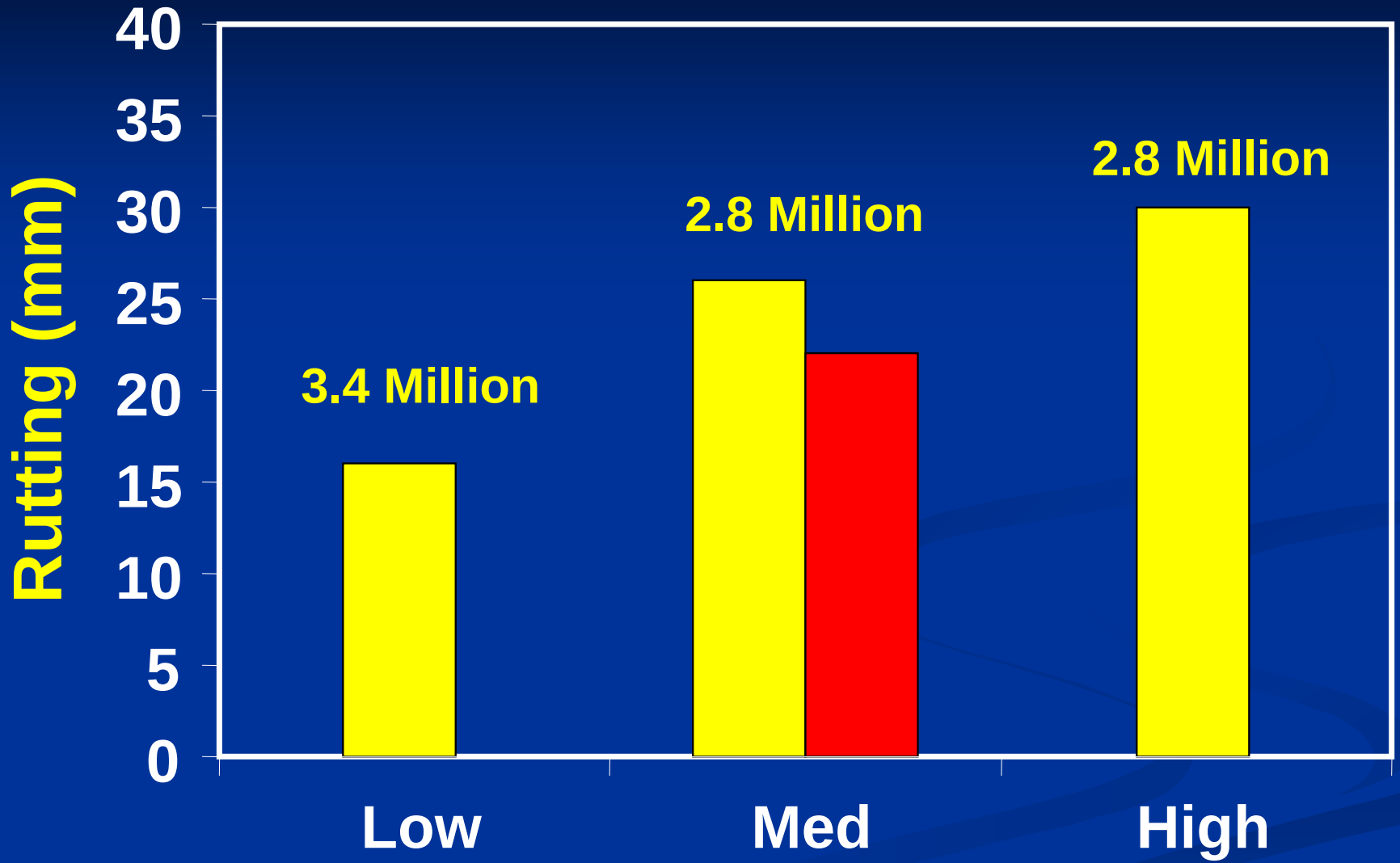
# Causes of Distress

- Moisture Damage
- Segregation
- Non-uniformity in Materials
  - Good compaction and uniformity in mat density can help mitigate these propblem.

# Coarse at Opt. AC Content



# Coarse at Opt. AC Content

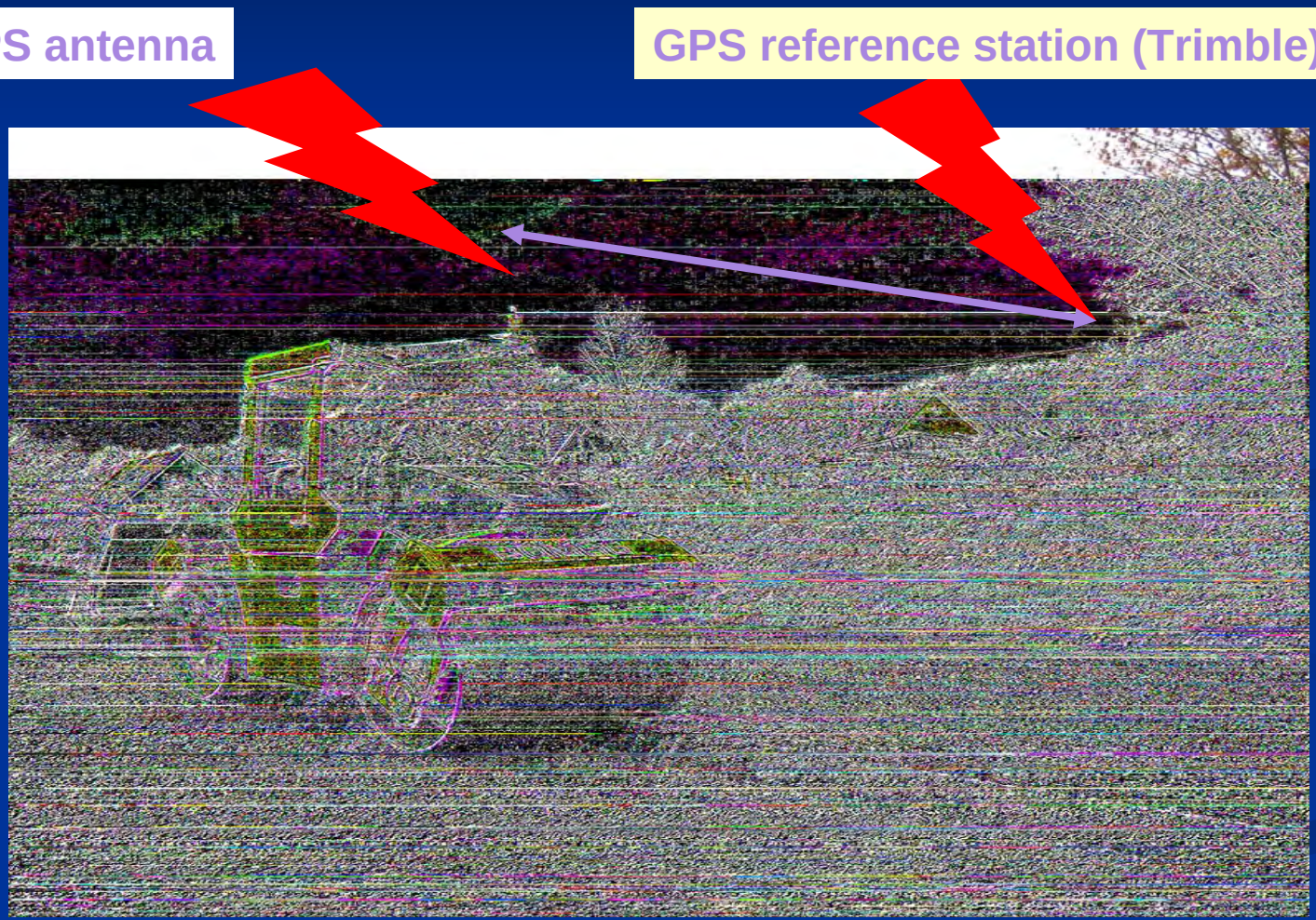


# Can we continue to put people on the roadway doing the same old tests.

# Does this one test represent the entire roadway.

# How can we assure the operators do their job properly

# One approach is Intelligent Compaction




BW 174 Asphalt Manager equipped with BCM05 and GPS

# What is intelligent compaction?

- Automatic adjustable compaction equipment
- Usage of Continuous Compaction Control, CCC
- Selection of the most suitable equipment

## Intelligent Compaction with Vibratory Rollers: Goals

**1. Optimized/Maximized Productivity**

**- Feedback Control System: Automatic Adjustment of**

**- Amplitude**

**- Frequency**

**- Roller Speed (Impact Spacing)**

**=> Easy to operate the roller**

**2. Sustainable Compaction**

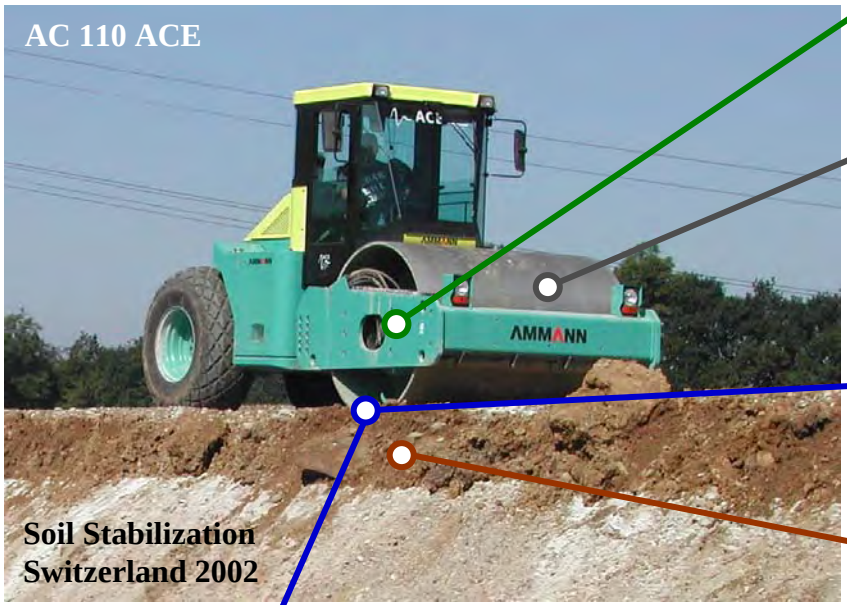
**- Homogeneous, optimal Compaction Results**

**- Process-Integrated Measurement of Soil Stiffness**

**- Continuous Compaction Control: Printer-System and GPS-Based System**

=> ***Visualization of the Compaction Process***

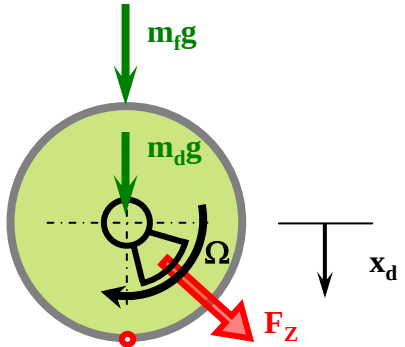
# Analytical Model of a Vibratory Roller




Frame

Drum

Soil




$F_S = -m_d x_d'' + F_Z \cos(\Omega t) + (m_f + m_d) g$

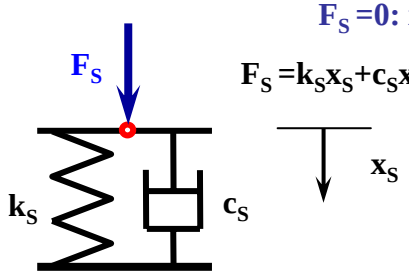
$F_Z = m_e r_e \Omega^2$ ; $\Omega = 2\pi f$ ; $x_d'' = d^2 x_d / dt^2$

$F_S$

**Contact conditions:**

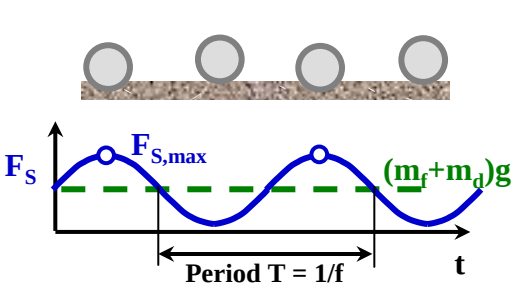
$F_S > 0$: $x_d = x_S = x$

$F_S = 0$: $x_d > x_S$

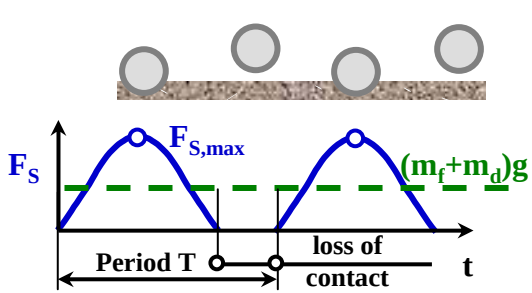



$F_S = k_S x_S + c_S x_S'$

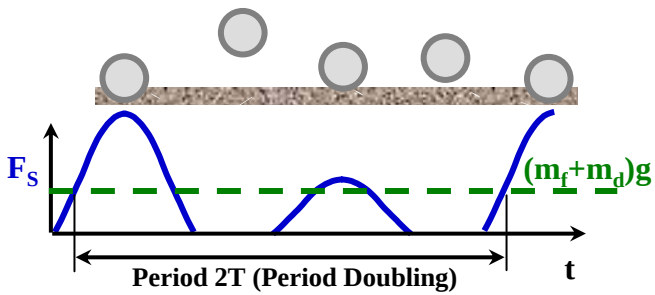
**Dynamic Behaviour: Force-Driven Nonlinearity**




$F_{S,max} < 2(m_f+m_d)g$ : permanent contact

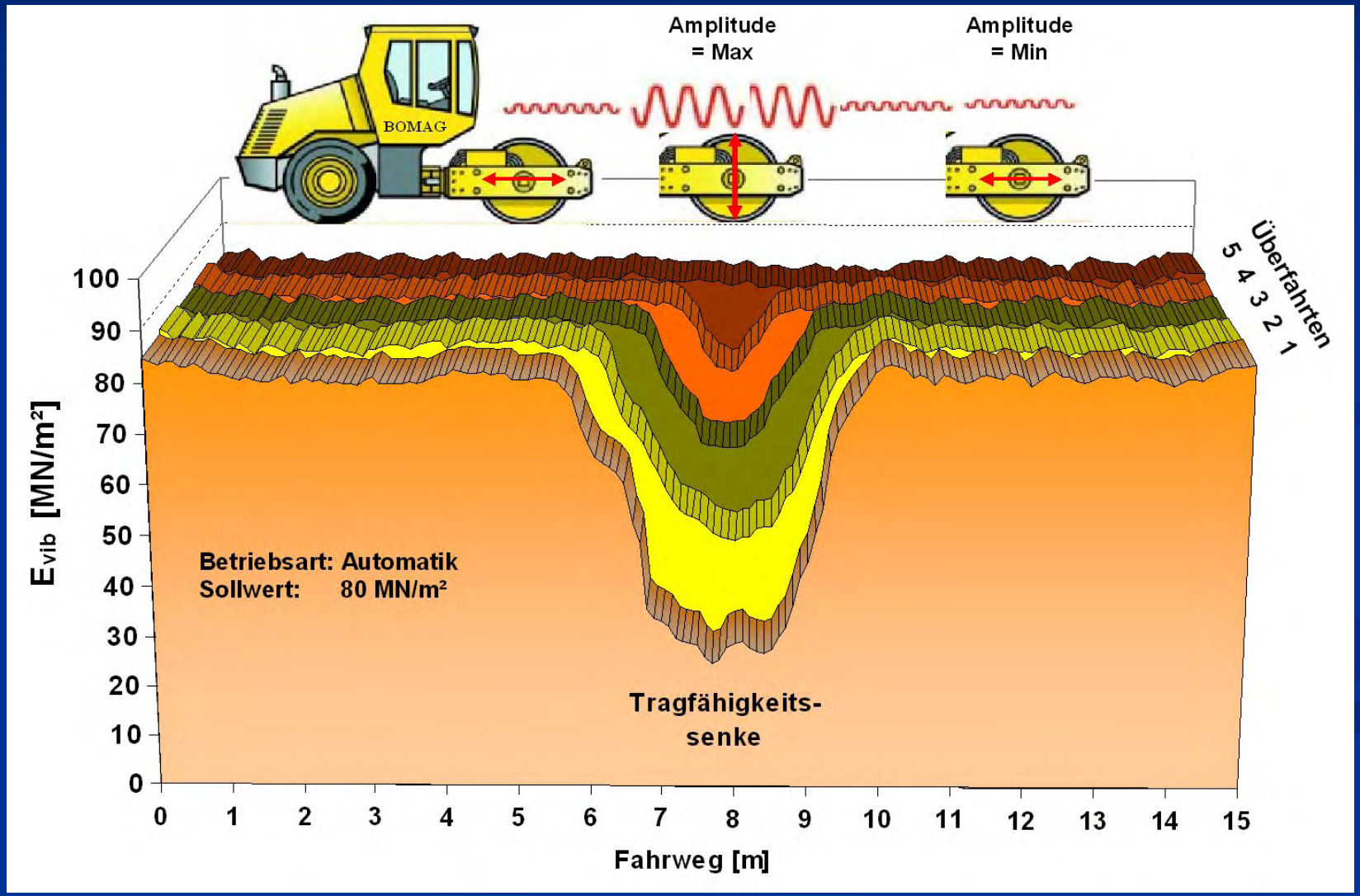



$F_{S,max} > 2(m_f+m_d)g$ : periodic loss of contact



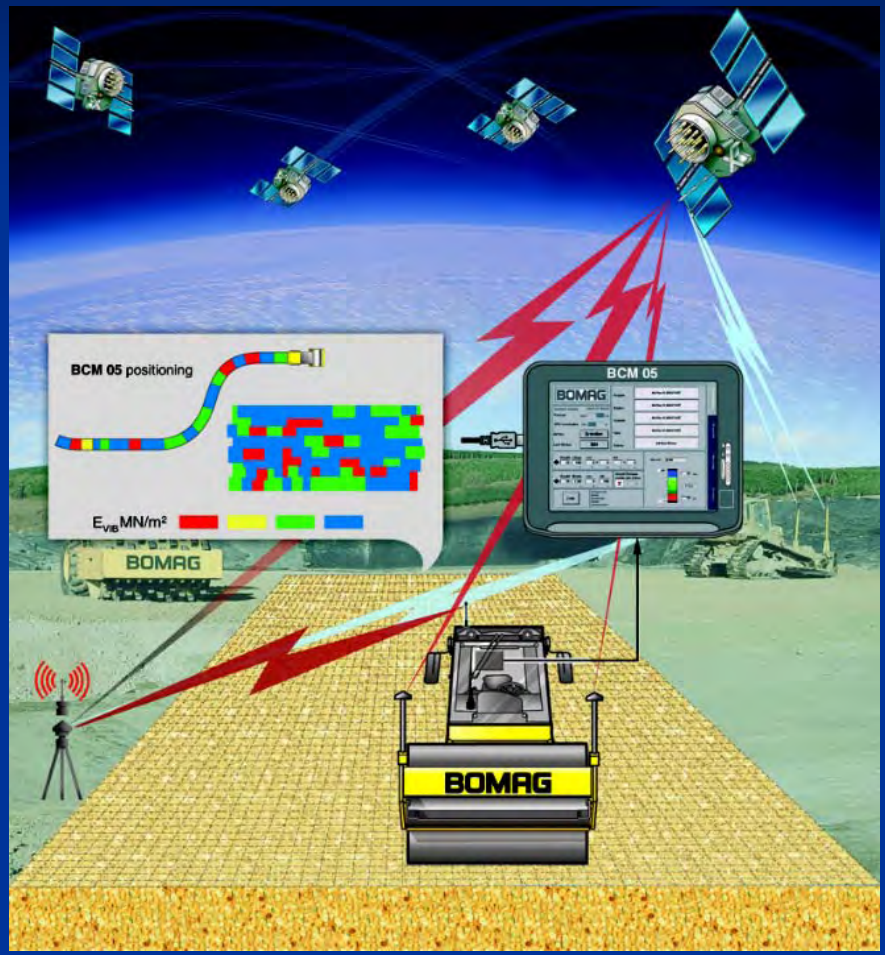

$F_{S,max} > 2(m_f+m_d)g$ : double amplitude, Jumping

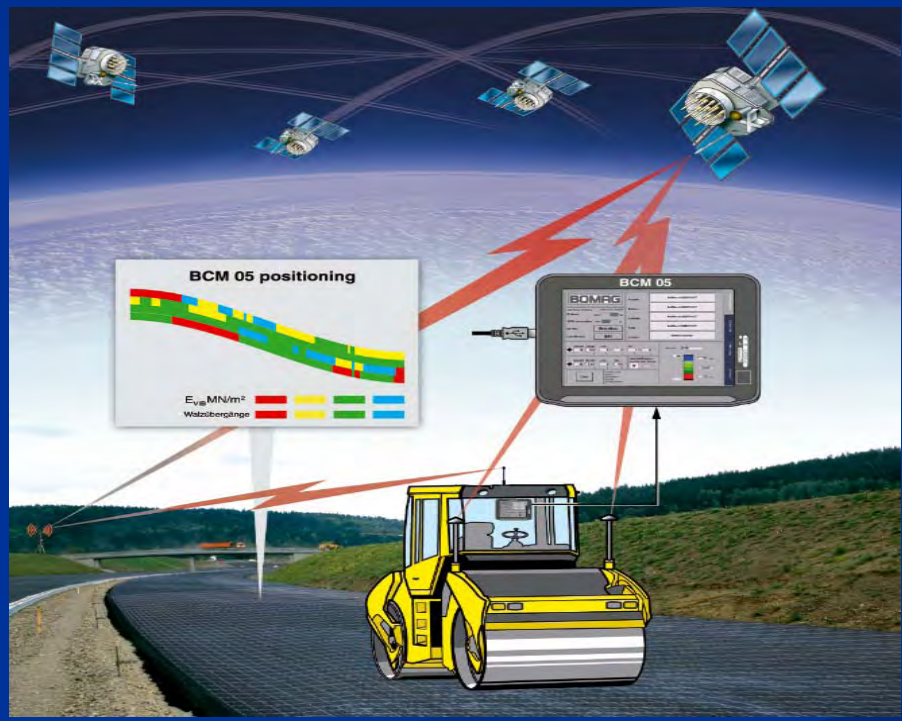
# Recompaction of soft formation area with VARIOCONTROL automatic mode, presetting ( target value ) $E_{VIB}$ = 80 MN/m²



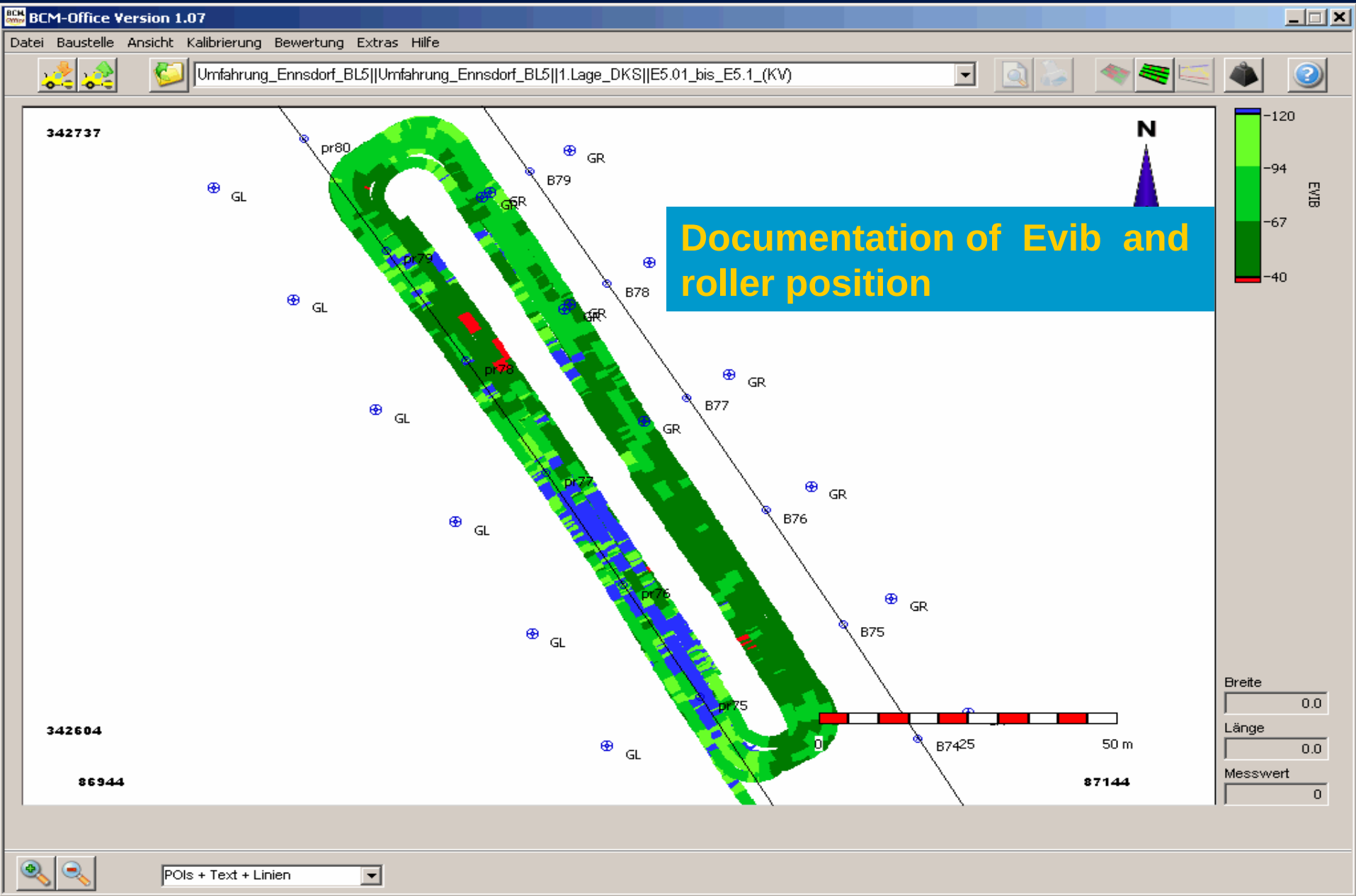
# BW 174 AM equipped with BCM05 and GPS Osnabrück A30, Germany,

# GPS / positioning with reference station

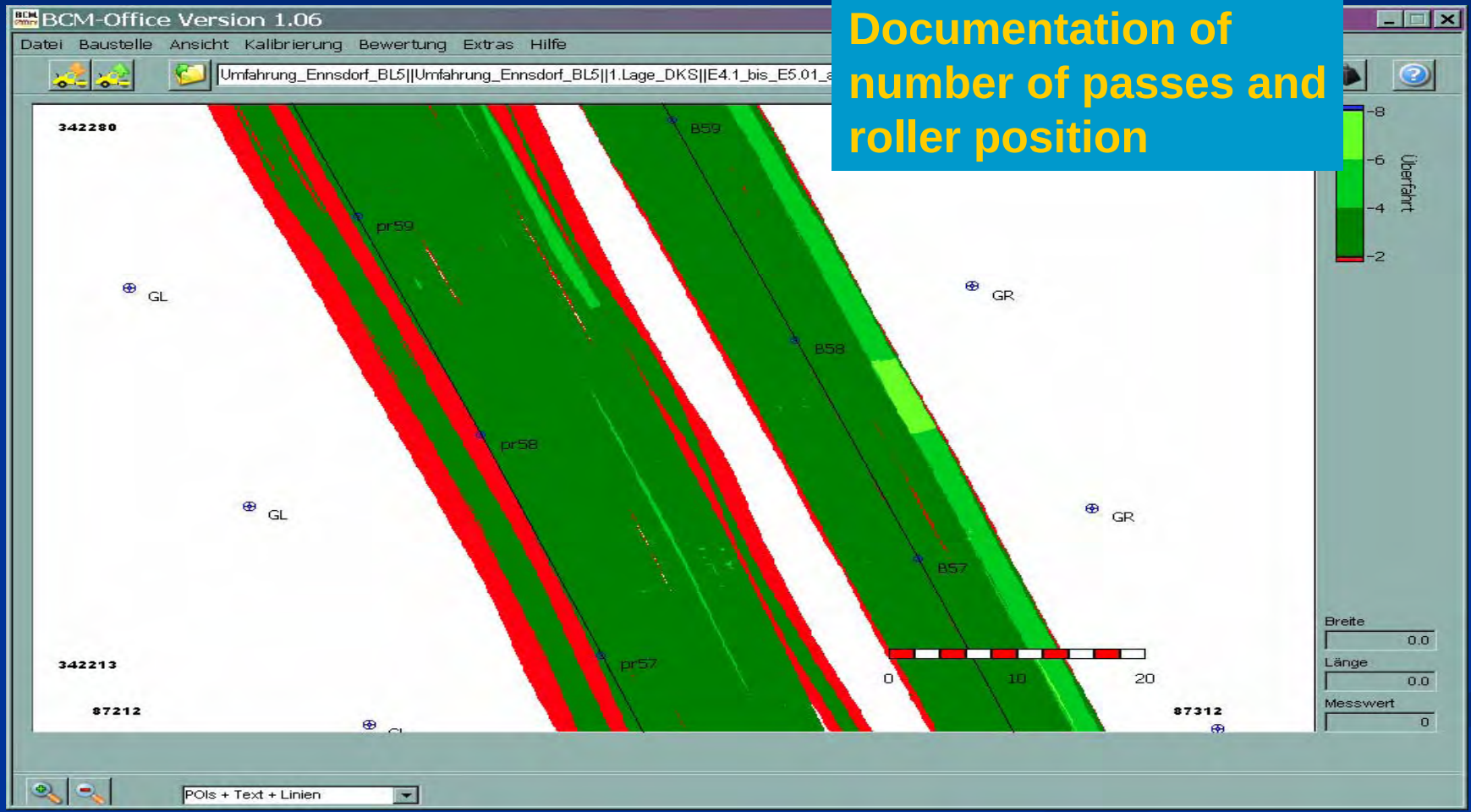


# Maps of the stiffness of the total pavement.

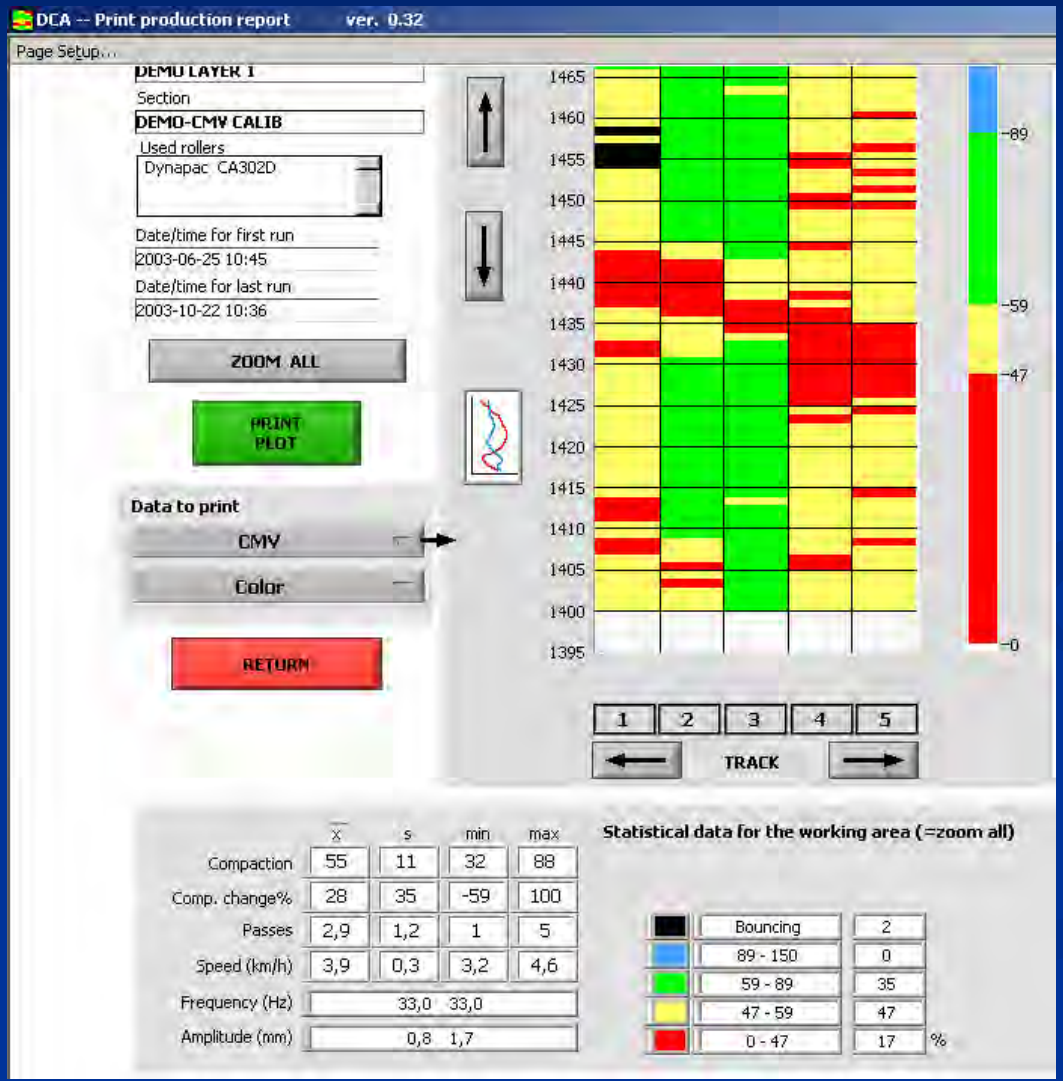


# Number of passes




**Documentation of number of passes and roller position**

# Improved data can reduce cores




Analysis
- Statistical data
- Surface plot
- Curve diagram

- Make printouts (simulator files is marked).
- Save to PDF file (except simulator files).

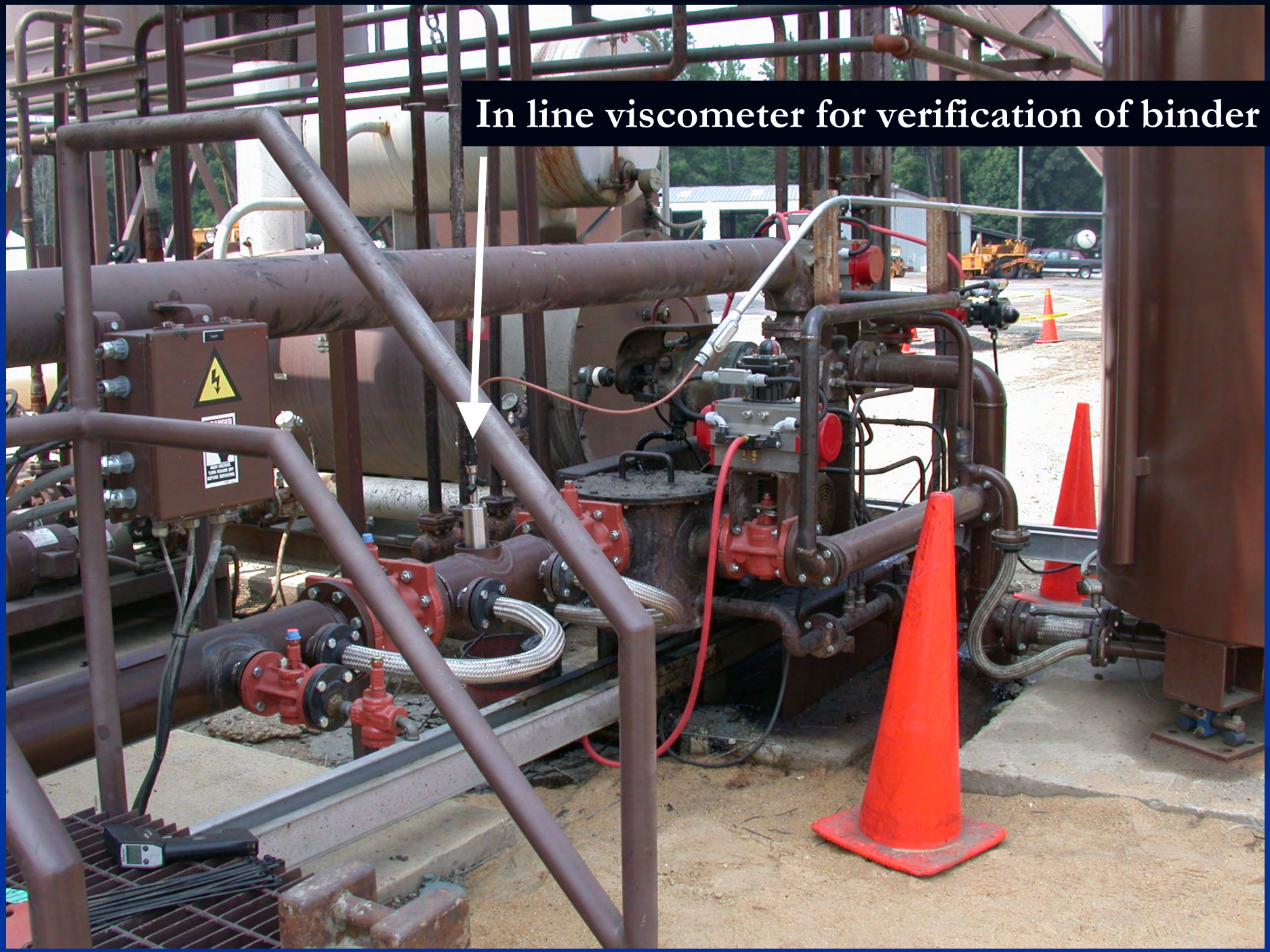
# Current Status

- FY 06 NCHRP project on soils.
- FHWA Pooled Fund project for HMA and soils.
- Field Trials in US

# At the mix plant are there other process that can be part of a QA program?

- Plant automation is available to automatically measure and record what is going on.
  - Automatic belt sampler and sieve analysis.

- Continuous recordation of all the plant operations going to computer records.


In line viscometer for verification of binder

# Computer recordation

# At the mix plant are there other process that can be part of a QA program?

- Plant Automation is process control PC.
- However, with improved PC, quality control and acceptance testing can be reduced.

# QA of the Future

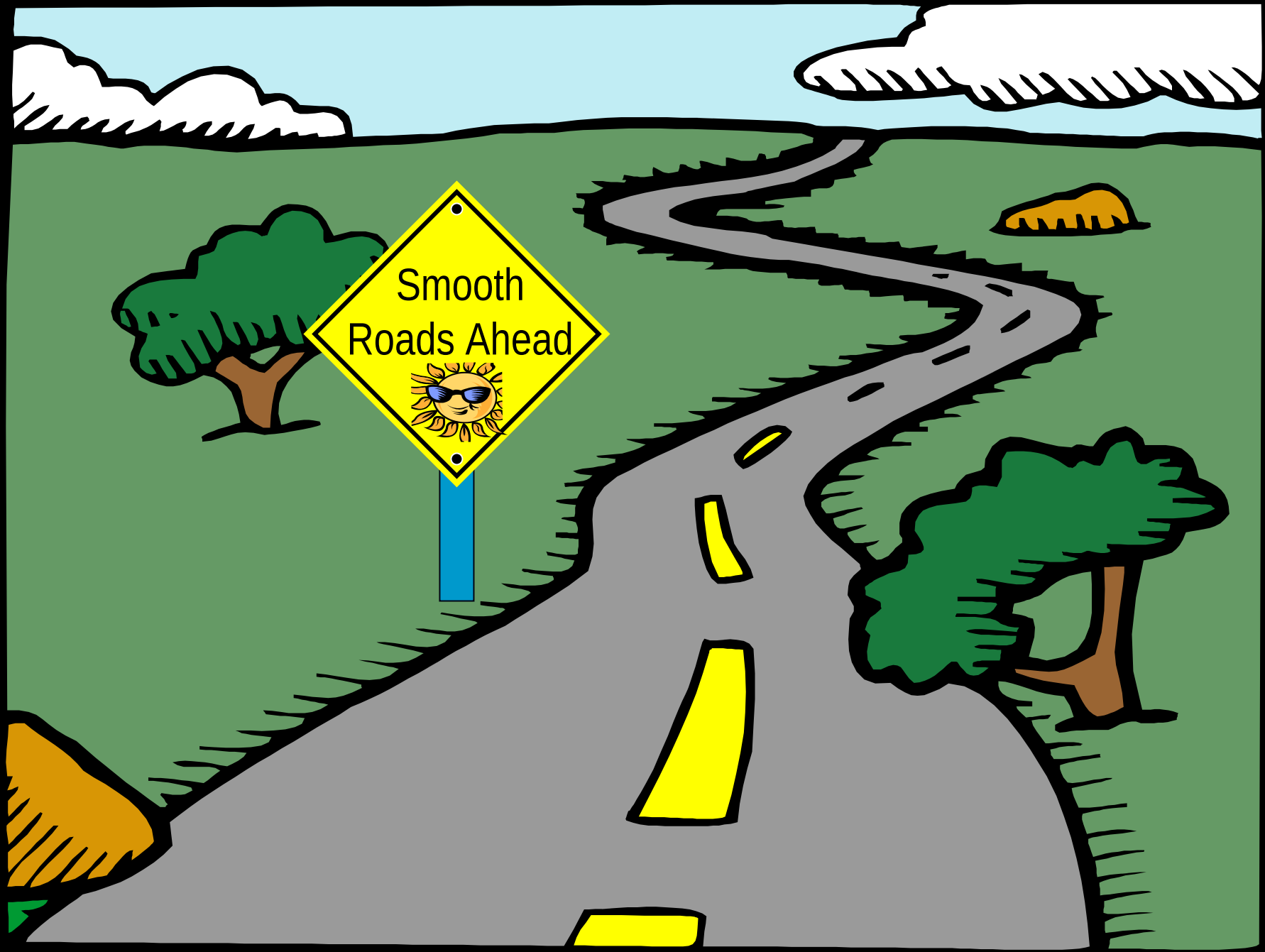
- The QA will all be tied to Internet.
  - Direct down load of info to the owner.
  - Posting of data immediately to all parties.
  - Faster review and resolution of discrepancies.

# Warranties the final QA

- Warranty
  - Performance-based contract
  - Guarantees product integrity
  - Contractor responsible for replacement of defects
- Warranty Period
  - Pre-specified for repair defects

**The future is bright and full of exciting new ideas! Be open to change.**

Thanks


Smooth
Roads Ahead