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.
Causes of Distress

- Moisture Damage
- Segregation
- Non-uniformity in Materials
  - Good compaction and uniformity in mat density can help mitigate these problem.
Coarse at Opt. AC Content

Air Void Content

% Fatigue Cracking

Low | Med | High

No Cracking | 2.8 Million | 3.4 Million

2.8 Million
Coarse at Opt. AC Content

Rutting (mm)

Air Void Content

Low

3.4 Million

2.8 Million

2.8 Million

High
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

GPS antenna

GPS reference station (Trimble)

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

Contact conditions:

\[ F_S = \begin{cases} 
0: & x_d > x_s \\
= k_s x_s + c_s x_s': & 0 < x_d < x_s \\
= m_f x_d'' + F_Z \cos(\Omega t) + (m_f + m_d)g & x_d = x_s = 0 \\
< 2(m_f + m_d)g: & \text{permanent contact} \\
> 2(m_f + m_d)g: & \text{periodic loss of contact} \\
> 2(m_f + m_d)g: & \text{double amplitude, Jumping} 
\]

Period 2T (Period Doubling)
Recompaction of soft formation area with VARIOCONTROL automatic mode, presetting (target value) $E_{\text{VIB}} = 80 \text{ MN/m}^2$
BW 174 AM equipped with BCM05 and GPS
Osnabrück A30, Germany,
GPS / positioning with reference station
Maps of the stiffness of the total pavement.

Documentation of Evib and roller position
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 processes 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 download 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