Intelligent Compaction
(Video)
MnDOT Intelligent Compaction Projects

- **2004**
  - District 3, Mn/ROAD, Demo
- **2005**
  - District 1, US 53, Duluth, Granular (Taconite)
  - District 7, US 14, Janesville, Non-Granular, Granular
  - District 8, US 12, Atwater, Base
- **2006**
  - District 2, TH 64, Bemidji, Granular
  - District 3, Mn/ROAD, Misc — Non-Granular
  - Metro District, I-494 Valley Creek Road, Granular Shoulders
- **2007**
  - District 3, US 10, Staples, Granular
  - District 4, US 10, Detroit Lakes, Non-Granular, Granular
  - District 7, TH 60, Worthington, Non-Granular, Granular
  - Metro District, TH 36, St. Paul, Non-Granular, Granular
- **2008**
  - Olmsted County, CSAH 2, Non-Granular, Base
  - Kandiyohi County, CSAH 4, Base, HMA (Breakdown)

- **2008 (cont)**
  - Kandiyohi County, CSAH 40, HMA (Breakdown)
  - District 3, Mn/ROAD, Non-Granular, Granular, Base, Base, FDR, SFDR
  - District 7, TH 60, Worthington, Non-Granular, Granular
  - District 8, TH 71, Wilmar, HMA (Breakdown)

- **2010**
  - District 3, TH169, Garrison, HMA (Breakdown)
  - District 7, TH 13, Albert Lea, HMA (Breakdown)
  - District 6, TH16, Hokah, SFDR
  - Metro District, TH 610, Granular
  - Olmsted County, CSAH 10, Granular (Compactor Rejected)

- **2011**
  - Metro District, TH35, HMA (Pneumatic, Vibratory)
  - District 7, TH 30, Amboy, FDR, SFDR (Padfoot)
  - District 7, TH 83, Waldorf, FDR (Padfoot)
  - District 8, TH 212, FDR (Padfoot)
  - District 8, TH 23, Granular (Compactor Rejected)

Total IC Projects = 25
Mn/DOT Priorities

- **Uniform Compaction** - All rollers in a train having a display showing # of passes (GPS)

- **Uniform Temperature** - Surface Temperature behind Screed (Pave-IR)
1989 – “Effect of Compaction on Asphalt Concrete Performance”

Each 1% increase in air voids (over 7 percent) tends to produce ~10 percent loss in pavement life (~1 year less life)
IC Roller Components

- GPS Tracking
- Roller Settings
- Surface Temperature
- Accelerometer

Dedicated IC Roller

Retrofit IC Rollers

Operator Display
Roller – Number of Passes
SP1380-63 (TH35)

IR3511

Filtered: 11 impacts/foot

SP1380-63 (TH35)

IR3511

Filtered: 9 impacts/foot
What is Involved

- Training
- Computer Equipment
- Compactor Placement
- Data Transfer
- Base Station / Repeaters Preparation
Example of Large Data Volume from our 2011 Asphalt IC Project

15.42 Miles
3 Compactors
11,207 Export Files
17,271,460 Rows (Raw Data)
7,750,844 Rows (Valid Data)

Not including Temperature Bar Data

Massive Amounts
File Characteristics

**Daily Data Submittal**
- Contractor
  - Raw Data File
  - dBase Data File

**Agency**
- Non-Proprietary Viewing Software
  - Veda
  - ArcGIS
- Proprietary Software

**Storage**
- Database
  - Oracle
  - Microsoft Access (Not Recommended)
Challenges/Solutions

Incorrect Coordinates

Use VRS System for coordinates.

Eliminate base stations.
Challenges/Solutions
Not Turning Off the GPS System

Implement Better QC Requirements
Compaction Measurement Value (CMV) differences (same time/location)

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<th>CC722</th>
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- No standardization or calibration of compactive energy
- Influences: direction, temperature, weight, speed, etc.
Benefits of Intelligent Compaction - Contractor

- Real-time feedback to operators
- Coverage
  - Prevent Gaps between passes
- Compaction Curves
  - ↓ Number of Passes
- Identify Weak Areas
- View Temperature
- Operator accountability

- GPS System Transferrable
Benefits of Intelligent Compaction – Agency

- Improved uniformity – better performance/longevity
- Increase information – better QC/QA
- Decreased maintenance
- Decreased sampling/testing (taking cores)
- Shortcomings of density acceptance process
  - Limited number of locations
  - After compaction is complete
Pave-IR Purpose

- Promote more uniform, higher quality pavements
- WADOT, NCAT, And TTI found thermal uniformity useful for detecting segregation.
- A segregated mat increases the contractor’s chances of QC/QA core being in a poor/low density area.
- A segregated mat increases agency’s risk of early distress
What will this technology do for you?

• Identify in real time if you have temperature segregation related issues due to:
  – End of truck
  – Streaks – paver/plant adjustments
  – Random – small clumps
  – Production temperature
12 sensors spaced 1 foot apart, reading interval = every 6 inches
12 individual sensors (rows)
6 inch reading interval
Paver Speed
Duration
4 hr 30 min

Paver Stops Total
1 hr 25 min

Avg. Paver Speed
36 ft./min

Surface Temp
Production Temperature Change

235°F WMA

275°F WMA

Time Diagram

Paver Stops
Cyclic End of Truckload Thermal Segregation

1000 feet

Paver Speed

Speed Diagram

Paver Speed

Distance in [ft]
Paver Stop

Temperature Differential

Time Diagram

Paver delay to last sample point

Temperature Differential
May – June (Produced at Plant A)
  – Max. as high as 380°F
  – Mean 313°F

August – September (Produced at Plant B)
  – Min. 200°F
  – Mean 268°F
Comparison to Texas Thermal Spec Summary

• # of 150 foot profiles = 3448

• May – June
  – 1491 profiles
    • 70% Moderate (25-50°F)
    • 27% Severe (> 50°F)

• August – September
  – 1957 profiles
    • 52% Moderate (25-50°F)
    • 18% Severe (> 50°F)
Pave-IR Benefits

- Real-time feedback to the contractor so needed changes can be made
- Tracks placement characteristics (paver speed, stops, temperature)
- Collects where low/high temperature regions are located
- Improves pavement quality and performance
Putting it Together
Screed Temp – Pass Count - Density

Behind Screed Temperature = 272°F

Density = 95.3%

9/8/2011
10:20 PM – 4 passes CC722
10:42 PM – 4 passes 3105
X=523200.03 y=158977.08
Conclusion

IC and Pave-IR together can provide:

• Feedback and control of the paving process
• Increase uniformity of mix placement and compaction
• Increase the performance of our pavements
• Ability to decrease the amount of QC/QA testing needed
• Proof of quality placement and compaction
• Increased accountability
TH 18 (169) Elk River, 1920’s

Thank You