MnDOT’s Use of Incentives for Paving

Maria Masten, PE
MnDOT Concrete Engineer
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We all have a stake in A→B
A Little About Quality

- Several definitions of quality
- Varies depending on business
- Many traits agreed upon
- One general definition
  “Quality is the systematic pursuit of excellence.”
How do we approach quality?

- Agencies Represent the Taxpayers
  - Agencies should expect the best product possible for a fair price while balancing risk and cost.

- Contractors Are Businesses
  - There are several common traits of successful businesses.
  - The most common is profit
What Makes This Work Best?

- Owner needs to realize and understand that the contractors need to make money.
- Contractor needs to provide a product that meets or exceeds the owner’s expectations.
Quick Review – Incentives

- **Who**
  - MnDOT, Local Agencies and Contractors

- **What**
  - Offering Incentives to Contractors

- **When**
  - Ongoing Effort – must continue to evaluate and change as needed

- **Where**
  - Major concrete projects > 3500 cubic yards (plant incentives apply)

- **Why**
  - **Durable, Smooth and Long Life Concrete**
Minnesota’s Concrete Paving Spec

- 3 Principal factors that guide the current spec:
  - Mix durability
  - Curing Practices
  - Incentives/disincentives

- W/C Ratio (Max $3.00/cy)
- Well-Graded Aggregate (Max $2.00/cy)
- Coarse Aggregate Quality (Max $2.00/cy)
- Smoothness (Max $890/0.1 mile segment)
What did low w/c ratio specifications and incentives do for MnDOT?
All low w/c concrete pavements are High Performance Concrete

Max of 2500 coulombs at 28 days for HPC
Investigation of Benefits of the MnDOT w/cm Specification

- Petrography – Joints and Mid panels
- Rapid Chloride Permeability – Mid panels
- Chloride Ion Penetration – Mid panels

- Acknowledge Gerard Moulzolf, PG
- American Engineering Testing, Inc.
Pre-1996 (19 projects)

1996 & After (15 projects)

Ongoing Investigation of Benefits of the MnDOT w/c Specification
Silicone sealant completely de-bonded. Severe joint distress.
Sealant bonded both sides, pristine joint crack

Purposefully Unsealed Joint, Developing tunneling
Silicone sealant well bonded both sides. LATE, pristine crack.
Silicone sealant fully de-bonded one side. Vertical scaling in paste along joint crack (8mm)
SP. 7380-199 TH 1-94
# 7009 STA. 116.000
OFFSET 6'
DRLN EB
CONC. 9.75 "

(1-94, D3 – Central MN)
Silicone sealant mostly debonded from one side of joint. Developing tunneling.

D3 I-94 (Central MN) 7380-199
(1-94, D3 – Central MN)
Silicone sealant well bonded both sides. LATE, pristine crack

D3 I-94 (Central MN) 7380-199
Well bonded
Silicone sealant well bonded both sides. LATE, pristine crack

D4  I-94 (Northwest MN) 1480-131
Silicone sealant de-bonded from one side of joint. Developing tunneling.
Neoprene sealant missing. Developed tunneling and vertical spalling full depth.
Degenerated Hot Pour Sealant developing tunneling and vertical spalling full depth.
Lower Permeability
- Concrete holds less water
- Fights the ingress of deicers
- Lower critical saturation level
- Can’t transport as much water
The key is keeping the chemicals out.
Preliminary Conclusions

- All cores exhibited freeze–thaw resistant air void systems
- All concrete was devoid of obvious batching and placement deficiencies.
- Apart from 1992 US52 Dolostone, all aggregates were hard, sound, and durable.
Preliminary Conclusions

- Intact Joint Sealant = No distress ~ joint sealant preparation is critical
- Post w/cm cores exhibit less distress and thinner zones of ettringite–filled entrained–sized air voids ~ benefit of reduced permeability
Preliminary Conclusions

- A 1996, 1997, and 2000 concrete exhibited “later” joint activation (<shrinkage) ~ sawcut depth is critical

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Required Sawcut Depth</th>
<th>Cores</th>
<th>% Minimum sawcut depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regrade</td>
<td>t/4</td>
<td>12 of 13</td>
<td>92%</td>
</tr>
<tr>
<td>Concrete Overlays**</td>
<td>t/3</td>
<td>4 of 20</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Crown is generally corrected with concrete
What have ride incentives done for MnDOT?
Evolution of Smoothness


How did we get here?

- PI Spec at 0.2 blanking band
- MnDOT never used zero blanking band – concerns with effect of texture on IRI value
- Initial goal was to not change incentive $
- Contractor response...
  - We do not understand IRI
  - 50 inches/mile – we will never get it
  - Why change
2007 Contractor IRI vs. PI

At 71.7 IRI changes from Incentive to Disincentive

< 50 Maximum Incentive for IRI

Incentive Disincentive

> 90 Corrective Action

Incentive Disincentive
<table>
<thead>
<tr>
<th>Project Type</th>
<th>Project Length</th>
<th>Total Incentive at maximum bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban project with 4 lanes and center turn lane</td>
<td>1 mile (5 lanes)</td>
<td>$44,500</td>
</tr>
<tr>
<td>2 lane undivided road</td>
<td>5 miles (2 lanes)</td>
<td>$89,000</td>
</tr>
<tr>
<td>4 lane divided road</td>
<td>10 miles (4 lanes)</td>
<td>$356,000</td>
</tr>
<tr>
<td>CPR – 2 lane undivided road</td>
<td>5 miles (2 lanes)</td>
<td>$45,000</td>
</tr>
</tbody>
</table>
2399 Ride Specification (Combined Bituminous/Concrete)
Needed Certifications

Operator
Online Certification
Every 3 years

Equipment
Certified Yearly at MnROAD

2014 Inertial Profiler Certificate
Date: ____________________________
Serial #: _________________________
VIN:  ___________________________ 
Manufacturer: _____________________
Software: _________________________ 
Signature: _________________________

Minnesota Dept. of Transportation
What Part of the Specification Applies?

- 30 mph
- 50 mph

10 ft Straightedge
ALR
Smoothness

Change in $ → -$
$ → -$
$ → +/-$
Smoothness Evaluation

- Both right and left wheel paths must be profiled at the same time with a certified Inertial Profiler.

- An IRI value will be computed for each wheel path, for each 0.1 mile segment, and then averaged. This average (MRI) will be used to calculate the segment pay adjustment.
Day of Profiling: Submittal

Profile Summary

Raw Data File

(*.ERD File)
Within 5 Days of Completion of Paving: Smoothness Assurance Report
Data analyzed through Proval

![Graph showing MRL (inches/mile) vs Distance (ft) with horizontal lines at 250, 175, and 125]
# Areas Excluded from Smoothness Evaluation

## For All Pavements

- Paving in areas with a posted vehicle speed less than or equal to 45 mph
- Ramps and loops
- Acceleration and deceleration lanes less than or equal to 1,000 ft. in length
- Projects less than 1,000 ft. in length
- Bridge decks and approach panels – the occurrence of bridges shall not interrupt the continuity determination

## For Concrete Pavements

- Intersections constructed under traffic – begin and end exclusion 100 ft. from the intersection radius
Areas of Localized Roughness (ALR)

- Measured using a 25 foot moving straightedge
  - Bumps
  - Dips
  - Joints
## Areas Excluded from Smoothness and ALR Evaluation

**For All Pavements**
- Paving in areas with a posted vehicle speed less than 30 mph
- Turn lanes, crossovers
- 10 ft. on either side of obstructions in lane that obstruction is located
- Side streets, side connections
- 150 ft. before intersections that end at a stop sign or a yield sign at a roundabout

**For Concrete Pavements**
- Undoweled shoulders less than or equal to 10 ft. in width
- Headers adjacent to colored concrete
Corrective Work

- Before Corrective Work:
  - Submit a written corrective work plan to the Engineer (Smoothness Assurance analysis)
  - Do not begin corrective work before the Engineer approves the plan

- After profiling, submit:
  - Paper ProVAL summary report indicating the results of the ‘Smoothness Assurance: Short Continuous Histogram.
  - Final spreadsheet summary in tabular form, with each 0.1 mi. segment occupying a row
Do we need urban IRI requirements
Until combine concrete/bit spec – speed limit of 42 mph and greater had smoothness specs
Asphalt pavements didn’t require smoothness for 45 mph or less
Pavement Smoothness – where are we now?

- It has been 6 years since we went fully into IRI
- Ride Incentive/Disincentives payout
  - Average (1997–2013): 2.6% of concrete cost
  - Average (1997–2013): 0.50% of Contract cost
- We are currently evaluating the ride data and looking at revising incentive equations
Have our Contractor's Improved?

<table>
<thead>
<tr>
<th>Contractor</th>
<th>2007 Average IRI</th>
<th>2009-2013 Average IRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>72.9</td>
<td>66.02</td>
</tr>
<tr>
<td>B</td>
<td>60.2</td>
<td>42.16</td>
</tr>
<tr>
<td>C</td>
<td>67.3</td>
<td>50.62</td>
</tr>
</tbody>
</table>
Where are we going?

IRI Dollars - Current vs. Proposed

\[ y(50+) = -41x + 2940 \]
\[ y(50+ \text{ rev}) = -48.75x + 3150 \]
\[ y(45-) = -15.765x + 1678.2 \]
Some Questions Regarding Incentives

- How much do incentives cost?
- How much of the risk is bid in by the contractor?
- How much additional life is gained by increasing the quality attributes (life cycle costs)?
Intent Of Specification Is To Allow Contractor To Optimize Costs And Materials To Maximize Benefits And Reduce Risks.

- Incentives will be bid in as contractors become accustomed.
- All but impossible to measure how much incentives are bid into project.
How Do We Get Contractor Buy In To These Ideas?

- Reward excellence
- Reward innovation
- Encourage new ideas
- Allow for mistakes and failure
How Did The Transition Go?

- Water reducers
- Cement
- Fly ash
- Sand
- Aggregate gradation
- Recycled aggregates
- Finishing
- Ride

It’s a “system”
How Did We Work Through The Changes And Get Contractor Buy In?

- Communication!!!
  - Contractors need to know what the objectives are
  - Contractors need to know what has worked and what hasn’t
  - Contractors need to be given leeway/opportunity to learn

- Shared risk

- More carrot than stick
Incentives Typically Earned

- Average w/c = 0.37 which achieves $3.00/cy
- Aggregate Quality incentive averages $2.00/cy (100% of available incentive)
- Typically meet well graded incentive ($2.00/cy) but intermediate aggregates often used to reduce segregation of mix and increase workability
- Ride incentive on highways (high production projects) – typically earn 50% or better of incentive
Incentives as Total Cost of Concrete and Total Cost of Contract

Average: 6.92%
Standard Deviation: 1.71%

Average: 1.44%
Standard Deviation: 0.97%

Percent of Total

Construction Year

Where Are We Now?

- Contractors believe in and buy into the incentive system.
  - Contractors Will Reduce Their Bids Partially To Account For Some Of The Expected Incentive To Assure Being The Low Bidder

- Quality has increased
  - Ride
  - Durability/permeability
  - Aggregate options

- Most within the Agencies do not believe incentives are just an add on
How Are We Doing?

› After 17+ years little signs of deterioration
› All noticeable defects appear to be construction related
› Smoothness has improved
› Durability has improved
What Is Our Future?

- We are evaluating our pavements to see if the specifications are giving us the results we are looking for.
- We have been reviewing our specifications to see if we are heading in the right direction.
- We will continue to review/evaluate/update.
Thank You
Questions?

“Happiness” is riding on a SMOOTH road!

We all have a stake in A - B