Early Performance of Concrete Pavement Overlays in Minnesota

15th Annual TERRA Pavement Conference
February 10, 2011

Tom Burnham, P.E.
Minnesota Department of Transportation

Office of Materials and Road Research

PCC OVERLAYS

- Becoming more popular in Minnesota

  - q Why????
    - $ More competitive on first cost basis
    - $ Federal stimulus money
    - $ Mn/DOT Innovation funding

  - q Good performance

    Standard (thick) unbonded concrete overlays have performed very well

  - q What's new

    How thin can we go?

PCC OVERLAYS

- Unbonded
  - § Used over distressed PCC pavements requiring additional structural capacity
  - § Thickness
    - – “Standard” or most common > 7.5”
    - – “Thin” < 7”
  - § Interlayer
    - – To prevent reflective cracking and provide “cushioning” between rigid layers
      - > PASSRC (Permeable Asphalt Stabilized Stress Relief Course)
      - > Dense graded HMA (new)
      - > Milled HMA (existing composite pavement)
      - > Fabric (new to Minnesota)

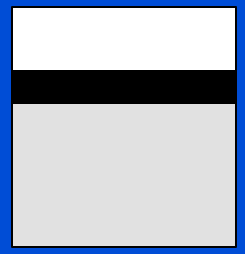
PCC OVERLAYS

- Bonded
  - § Used over distressed HMA pavements (aka whitetopping)
  - § Thickness
    - – "Standard" = 6" or more (bond not critical)
    - – "Thin" = 4" to 6" (temporary bond *beneficial*)
    - – "Ultra-thin" = 4" or less *(bond is critical)*
  - § HMA prep
    - – Milling (inlays)
    - – Pre-overlay repairs for true "overlays"

Early PCC Overlay Performance in Minnesota

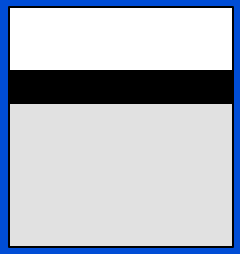
- Unbonded Overlays
  - MnROAD Cells 105-405
  - TH53 Twig
  - TH 212 Renville to Danube

MnROAD Cells 105-405, Thin UBOL



- Design Details:
  - Thickness = 4” and 5”
  - Panel size = 15’L x 14’/13’ (driving/passing)
  - PASSRC interlayer
  - Unsealed joints
  - I-94 traffic
  - 14 year joints vs broken joints

MnROAD Cells 105-205, Thin UBOL



- Early Performance = poor
  - More than 80% of 4” thick panels cracked within 2 years
  - Cause: Excessive curling of thin slabs
  - Distress from impact loads
  - To be replaced in 2011 with 5”, 6’L x 6’/7.5’W panels over fabric interlayer

MnROAD Cells 305-405, Thin UBOL

- Early Performance = fair
  - 40% of 5” thick panels cracked within 2 years
  - Less cracked panels over non-broken joints

TH 53 Twig, Thin UBOL

- Design Details:
  - Southbound lanes constructed 2008, N.B. 2009
  - Thickness = 5”
  - Panel size = 12’L x 12W’ (also section with 6’x6’)
  - Dense graded HMA interlayer
  - Unsealed joints
  - Some panels reinforced
  - Heavy truck traffic
  - 36 year existing “joints”

TH 53 Twig Southbound, Thin UBOL

- Early Performance = fair
  - Numerous transverse cracks within 6 months
  - Corner and longitudinal cracks now progressing

TH 53 Twig Southbound, Thin UBOL

TH 53 Twig Southbound, Thin UBOL

Crack in 6’ x 6’ panel

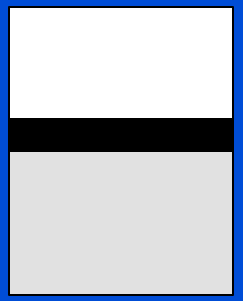
TH 53 Twig Southbound, Thin UBOL

Wide joints – Would hot-pour sealant be effective?

TH 53 Twig Northbound, Thin UBOL

- Early Performance = good
  - Some transverse cracks

TH 212 Renville to Danube, UBOL



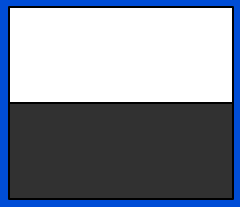
- Design Details:
  - Constructed 2009
  - Thickness = 8” (Standard)
  - Panel size = 15’L
  - Milled existing HMA interlayer
  - 11 dowels/joint

- Early Performance = Very good

Early PCC Overlay Performance in Minnesota

- Bonded Overlays (whitetopping)
  - MnROAD Cells 114-914
  - I-35 North Branch
  - CSAH 9 Harris
  - CSAH 7 Hutchinson
  - TH 23 Marshall
  - CSAH 46 Albert Lea
  - TH56 West Concord

MnROAD Cells 114-514, Thin Whitetopping



- Design Details:
  - Thickness = 6”
  - 6’L x 6’W panels
  - Remaining HMA (5-6.5”)
  - Doweled (2’ c. to c. spacing) vs undoweled
  - Unsealed joints
  - I-94 traffic

Study Objective:
Effect of remaining HMA thickness

MnROAD Cells 114-514, Thin Whitetopping

- Early Performance = Good
  - A few panels cracked, Cells 114 and 314
  - Insufficient remaining HMA thickness (5”) or bad material?

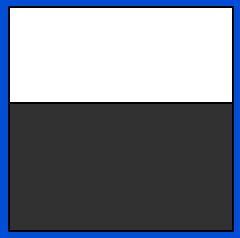
MnROAD Cell 614, Thin Whitetopping

- Design Details:
  - Thickness = 6”
  - 12’L x 6’W panels
  - Remaining HMA thickness = 7”
  - Flat dowels (1’ c. to c. spacing)
  - Unsealed joints
  - I-94 traffic

MnROAD Cell 614, Thin Whitetopping

- Early Performance = Good
  - One longitudinal crack
  - Cause: Refill of core hole?

MnROAD Cells 714-914, Thin Whitetopping



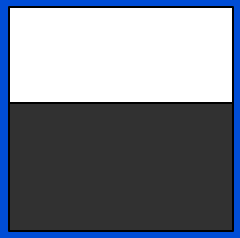
- Design Details:
  - Thickness = 6”
  - 6’L x 6’W panels
  - Remaining HMA thickness = 8”
  - Doweled (2’ c. to c. spacing) vs undoweled
  - Unsealed joints
  - I-94 traffic

Study Objective:
Effect of remaining HMA thickness

MnROAD Cells 714-914, Thin Whitetopping

- Early Performance = Very Good
  - No distresses (other than popouts)
  - Sufficient remaining HMA thickness = 8”?

I-35 North Branch, Thin Whitetopping



- Design Details:
  - Constructed 2009
  - 7.1 miles
  - Thickness = 6”
  - Milled HMA (4” inlay)
  - Remaining HMA = 8”
  - 6’L x 6’W panels
  - Undoweled
  - Ties between panels and lanes
  - Sealed joints
  - I-35 traffic

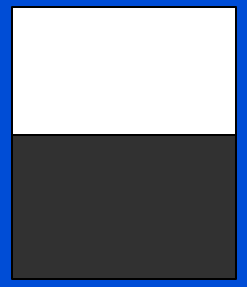
I-35 North Branch, Thin Whitetopping

- Early Performance: Good
  - Multiple transverse cracks with first 6 months
  - Cause: Reflective cracking from underlying bonded HMA
  - Feb 2011: Little change in distresses

I-35 North Branch, Thin Whitetopping

Cracks in shoulder do not always reflect

CSAH 9 Harris, Whitetopping

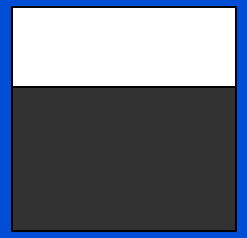


- Design Details:
  - Constructed 2010
  - 1.1 mile
  - Thickness = 7”
  - Milled HMA (7” inlay)
  - 15’L x 12/14’W panels
  - 3 dowels in OWP only
  - Sealed joints
  - Heavy local truck traffic

CSAH 9 Harris, Whitetopping

- Early Performance = Very good
  - No visible cracks

CSAH 7 Hutchinson, Thin Whitetopping



- Design Details:
  - Constructed 2009
  - 2.5 miles
  - Thickness = 5”
  - Average milling depth = 3.6”
  - Remaining HMA = 8” (var.)
  - 6’L x 6’W panels
  - Undoweled
  - Unsealed joints
  - Local traffic (ADT=2200)

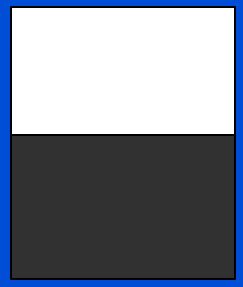
CSAH 7 Hutchinson, Thin Whitetopping

- Early Performance: Good
  - One reflective crack near driveway

Reflective cracking into PCC from HMA driveway entrance?

No reflective cracking into inlay

TH23 Marshall, Whitetopping



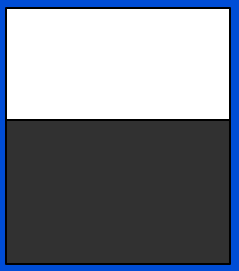
- Design Details:
  - Constructed 2009/2010
  - 8.3 miles
  - Thickness = 7.5”/8.5”
  - Average milling depth = 3”
  - 15’L x 13/14’W panels
  - 11 dowels across joints
  - Sealed joints
  - Heavy truck traffic

- Early Performance = Very good?

(Could not safely evaluate due to weather conditions)

TH23 Marshall, Whitetopping

CSAH 46 Alden to Albert Lea, Thin Whitetopping



- Design Details:
  - Constructed 2009
  - Thickness = 6”
  - Milled HMA (2”)
  - 15’L x 13.5’W panels
  - 3 dowels in OWP only
  - Unsealed joints(?)
  - Traffic?

CSAH 46 Albert Lea, Thin Whitetopping

- Early Performance: Very Good
  - No visible distresses

TH 56 West Concord, Thin Whitetopping

- Design Details:
  - Constructed 2010
  - 6.2 miles
  - Thickness = 6”
  - Milled HMA (2”)
  - Remaining HMA = 8.5” (very poor condition)
  - 15’L x 13.5’W panels
  - 11 Dowels
  - Sealed joints
  - Heavy truck traffic

TH 56 West Concord, Thin Whitetopping

- Early Performance: Very Good
  - Some construction issues at joints

Summary

- UBOLs
  - § Good performance on standard “thick” UBOLs
  - § More frequent occurrence of distresses in thin UBOLs
  - § Definite limits on acceptable panel size
- Whitetoppings
  - § Mixed application of large and small panel sizes
  - § Overall good performance for thin sections
  - § Demonstrating susceptibility to reflective cracking
  - § Evidence of lower limit on remaining HMA thickness after milling

Questions?