BEST PRACTICES FOR EDGE CRACKING

DARLENE C. GOEHL, P.E.
TXDOT – BRYAN DISTRICT – MAY 31, 2013
OUTLINE

• Problems – Flexible and Rigid Pavement
  • Edge Cracking
  • Environmental Cracking
  • Contributing Factors

• Testing and Design
  • Flexible Pavement
    • Design Techniques
  • Rigid Pavement
    • JCP with reinforced repair

• Maintenance
FLEXIBLE PAVEMENT
LONGITUDINAL CRACKING PROBLEMS
FLEXIBLE PAVEMENT
LONGITUDINAL CRACKING PROBLEMS
FLEXIBLE PAVEMENT LONGITUDINAL CRACKING PROBLEMS
CRACKING IN JOINTED CONCRETE PAVEMENT

• Random Longitudinal Cracks
WEATHER - DROUGHT

U.S. Drought Monitor

July 12, 2011
Valid 8 a.m. EDT

Annual Precipitation

Precipitation: Annual Climatology (1971-2000)

U.S. Drought Monitor

May 14, 2013
Valid 7 a.m. EDT

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

http://droughtmonitor.unl.edu/

2011

2013
ENERGY SECTOR ISSUES
SUPERHEAVY LOADS
PROJECT SPECIFIC ISSUES

- Edge Support
- Steep Front Slopes
- Soils
  - Typically PI>35
- Vegetation
  - Oak Trees
SOME CAUSES OF LONGITUDINAL CRACKING

- Subgrade Shrinkage associated with:
  - PI > 35
  - Trees near edge
  - Summer droughts
  - Stiff bases
IDENTIFY THE CAUSE OF CRACKING

• Assemble Background Information
• Nondestructive testing (NDT) Evaluation and Section Breakdown
  – Ground Penetrating Radar (GPR)
  – Falling Weight Deflectometer (FWD)
• Verifying Pavement Structure and Sampling
  – Auger samples of pavement
  – Verification of problem location
  – Dynamic Cone Penetrometer (DCP) on shoulder/front slope for widening
  – Subgrade properties
ONLINE SOIL DATA

SH OSR – (FM39 to 4 miles West)
PI ranges 5 to 55 over length of project and within the same boring.
• GPR - thickness variability; identify major problem areas; sampling locations
• DCP - in-site strengths of lower layers
• FWD - Strength variability; subgrade stiffness entire project
DCP

- Determine underlying pavement support
- Determine depth of failure shear plane for edge failures
PAVEMENT EVALUATION TOOLS

Soil and Pavement sampling
Site 5

Cumulative Number of Blows

No Base

9.8 ksi

6.3 ksi

DCP - Outer Wheel Path
# PAVEMENT TESTING VS. PROJECT COST

Testing is typically less than 1.5% of project cost.

<table>
<thead>
<tr>
<th>Scope of Work</th>
<th>Project (28’ rdwy)</th>
<th>GPR</th>
<th>FWD</th>
<th>Pave Cores</th>
<th>Soil Cores</th>
<th>Total Testing</th>
<th>Test % of total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay w/ underseal</td>
<td>$15.22</td>
<td>$250,000</td>
<td>$155</td>
<td>$100</td>
<td>$110</td>
<td>$365</td>
<td>0.15%</td>
</tr>
<tr>
<td>Rework + 6” FB + 2cst</td>
<td>$16.44</td>
<td>$270,000</td>
<td>$155</td>
<td>$100</td>
<td>$110</td>
<td>$3,500</td>
<td>1.43%</td>
</tr>
<tr>
<td>Cement Treat exist + FB+2cst</td>
<td>$18.26</td>
<td>$330,000</td>
<td>$155</td>
<td>$100</td>
<td>$110</td>
<td>$3,500</td>
<td>1.17%</td>
</tr>
<tr>
<td>Spot Repair (est 15% repairs 8” thick)+SC</td>
<td>$7.00</td>
<td>$115,000</td>
<td>$155</td>
<td>$100</td>
<td>$110</td>
<td>$365</td>
<td>0.32%</td>
</tr>
<tr>
<td>Spot Repair (est 25% repairs 8” thick)+SC</td>
<td>$10.00</td>
<td>$165,000</td>
<td>$155</td>
<td>$100</td>
<td>$110</td>
<td>$365</td>
<td>0.22%</td>
</tr>
</tbody>
</table>

Note: Pavement is approximately 70% of the total project cost. Preliminary Engineering, including testing, is approximately 4% of the total project cost.
FLEXIBLE PAVEMENT DESIGN APPROACH

DESIGN TECHNIQUES
TYPICAL LOW VOLUME ROADWAY - PAVEMENT REPAIR

Goal –
Uniform Pavement Structure
Widen to improve edge support.
VARIABLE PAVEMENT STRUCTURE

Variable depths HMA up to 9 inches,
3 inches of base, PI 60 soils
Lots of maintenance;
No shoulders
Traffic handling issues
FM - HMA THICKNESS
### Uniform Pavement Structure

Change design strategy throughout the limits of the project

<table>
<thead>
<tr>
<th>From - To (feet)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 700</td>
<td>2 inch overlay only (new construction)</td>
</tr>
<tr>
<td>700 - 1800</td>
<td>Mill 4 inches of HMA the FDR 8 ins + base overlay</td>
</tr>
<tr>
<td>1800 - 3000</td>
<td>Mill 6” HMA add 4” new base; FDR 8” + Geogrid + base overlay</td>
</tr>
<tr>
<td>3000 - 6000</td>
<td>FDR 8” + base overlay</td>
</tr>
<tr>
<td>6300 - 7200</td>
<td>Mill 4 inches of HMA the FDR 8 ins + base overlay</td>
</tr>
<tr>
<td>7200 - 8900</td>
<td>Mill 6” HMA add 4” new base; FDR 8” + Geogrid + base overlay</td>
</tr>
<tr>
<td>8900 - 14000</td>
<td>Mill 4 inches of HMA the FDR 8 ins + base overlay</td>
</tr>
<tr>
<td>14000 - 15600</td>
<td>Mill 6” HMA add 4” new base; FDR 8” + Geogrid + base overlay</td>
</tr>
<tr>
<td>15600 - 16700</td>
<td>Mill 4 inches of HMA the FDR 8 ins + base overlay</td>
</tr>
<tr>
<td>16700 - end</td>
<td>2 inch HMA overlay only (intersection new construction)</td>
</tr>
</tbody>
</table>
FWD DATA - EXAMPLE
FWD 9000 LB MAXIMUM DEFLECTION

Predicted from design
Average before
Use Geogrid Reinforcement to control reflective cracking from the subgrade.
All sections have 10” lime treated subbase (5% lime) and a seal coat surface.
## TEST SECTION SUMMARY

<table>
<thead>
<tr>
<th>Section 1</th>
<th>Control Section</th>
<th>Section 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geogrid and 8” Flexible base</td>
<td>No Geogrid 8” Flexible Base</td>
<td>Geogrid and 5” Flexible base</td>
</tr>
<tr>
<td>0.65 miles west of Little River Relief Bridge</td>
<td>1.6 miles west of Little River Relief Bridge</td>
<td>2.5 miles west of Little River Relief Bridge</td>
</tr>
</tbody>
</table>
| Subgrade 6” to 6’  
PI = 37 Black clay  
Subgrade 6’ to 8’,  
PI = 36 gray clay | Subgrade 0’ to 1’  
PI = 26 Brown clay  
Subgrade 1’ to 2’,  
PI = 19 Tan silty clay  
Subgrade 2’ to 6’,  
PI = 37 Black clay  
Subgrade 6’ to 8’,  
PI = 31 Gray clay | Subgrade 0’ to 8’  
PI = 49 Black clay |
| No Cracking at yr 5 | Cracking at yr 5 | No Cracking at yr 5 |
FM1915 – 5 & 16 YEARS AFTER RECONSTRUCTION
DISTANCES MEASURED FROM LITTLE RIVER RELIEF BRIDGE

GEOGRID SECTION 1
0.65 MILES

2001

2013

GEOGRID SECTION 2,
2.2 miles

2001

2013
FM1915 – 5 & 16 YEARS AFTER RECONSTRUCTION
DISTANCES MEASURED FROM LITTLE RIVER RELIEF BRIDGE

CONTROL SECTION, 1.3 miles

CONTROL SECTION, 0.83 MILES
DESIGN APPROACH

• Utilize the U.S. Department of Agriculture Soil Conservation Service maps to identify possible problem soils. Define testing locations based on this information.
  • This is in addition to the District’s standard one mile testing frequency.
• Perform soils tests to a depth of seven feet below the pavement.
  • This depth is based on the moisture fluctuation within the district.
• Define the limits of potential problem areas based on the soil testing.
• Analyze the FWD data, looking for areas of weak subgrade.
• Drive the project and look for existing problems and areas maintenance has already repaired.
• Combine all the information to define the limits of Geogrid reinforcement.
### GEOGRID COST INFORMATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Geogrid Cost</th>
<th>FY 01 &amp; FY 02 Maintenance Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH OSR 0475-03-048</td>
<td>n/a</td>
<td>$38,900</td>
</tr>
<tr>
<td>SH OSR 0475-03-053</td>
<td>$55,734</td>
<td>n/a</td>
</tr>
</tbody>
</table>

- FY 00 average Geogrid Cost = $1.89/sy
- FY 01 average Geogrid Cost = $1.60/sy

- These projects are adjacent between the Navasota River and FM39 in Madison County.
- The benefit is in extending the service life of pavements under environmental loads, and consequently, reducing the maintenance costs associated with these roads.
- Note: Reference TxDOT research project 5-4829 for additional information.
NEW APPROACHES TO SHOULDER WIDENING
SH 21 EAST OF US 290
CONTROL TRANSVERSE CRACKS IN STABILIZED BASE
MICRO-CRACK CEMENT TREATED BASE

Not Microcracked

Microcracked
MICRO-CRACKING

• Determine optimum stabilizer content based on unconfined compressive strength and moisture susceptibility.
• 12 ton vibratory roller
• 1 – 2 days after placement
• 2-3 mph, High amplitude
• 2 – 4 passes
• Test after 2 passes

• TxDOT research project 4502
RIGID PAVEMENT CASE STUDY

FM 2347
FROM FM 2154 TO FM 2818, BRAZOS COUNTY TEXAS
JOINTED CONCRETE PAVEMENT

• Random Longitudinal Cracks

9” CPCD
4” HMA
10” Lime Treated Subgrade
Subgrade PI ranges from 14 to 49
REPAIR DETAIL - REINFORCED PATCH OF JOINTED CONCRETE PAVEMENT

GENERAL NOTES

1. REFER TO CPCD-11-03 SHEET FOR THE STEEL AND JOINTS DETAILS. USE 48 IN AT 18" SPACING FOR TRANSVERSE STEEL.

2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE REFER TO THE GENERAL SPECIFICATIONS FOR "CONCRETE PAVEMENT," AND "FULL DEPTH REPAIR OF CONCRETE PAVEMENT.

3. DETAILS FOR PAVEMENT THICKNESS, PAVEMENT MATERIALS, AND CROWN CROSS SLIPS SHALL BE SHOWN ELSEWHERE IN THE PLAN.

4. TRANSVERSE SAW CUT CREP TO MATCH THE TRANSVERSE JOINTS ON AQUIRING CPCD LANE. THE SAW CUT DEPTH IS 1/2" WHEN POSSIBLE, MATCH CORB-BLED JOINTS ON TRANSVERSE JOINTS.

5. PAYMENT WORKING IS MORE THAN 5 FT. SMALL HOLE A LONGITUDINAL CONSTRUCTION JOINT. REFER TO CPCD-11-03.

6. WHEN CPCD SLAB IS LESS THAN 15 FT IN LENGTH, INSTALL TIE BARS AT LOCATIONS AS DIRECTED BY THE ENGINEER.

7. TO STARTING REPAIR AREA, SAW Cuts AT THE TRANSVERSE JOINT CUTTING THROUGH THE GROWTH. ORIENT AND PLACE TIE BARS IN THE EXISTING PAVEMENT. REFER TO A-A DETAILS FOR CONSTRUCTION JOINT.

8. WHEN DETERMINED BY THE ENGINEER THAT THE EXISTING GROWTH CANNOT BE REMOVED, LEAVE THE GROWTH IN PLACE. REFER TO A-A DETAILS FOR TRANSVERSE TIE JOINT TO TIE THE NEW GROWTH TO THE EXISTING PAVEMENT.

TYPICAL LAYOUT

DRILL HOLE IN EXIST. CONC. PAV. OR FULL-DEPTH SAW CUT
(SEE J-2-09, METHOD B)

REPAIR CPCD WITH CRCP

NOT TO SCALE

(STATE OF TEXAS)

LICENSED PROFESSIONAL ENGINEER

HUACHEN

TEXAS DEPARTMENT OF TRANSPORTATION

CONSTRUCTION DIVISION (DIAGRAM PREPARED)
FM 2347 CONCRETE REPAIR

2006 – Before Repairs

2013 – 7 years after repairs
FM 2347 CONCRETE REPAIR

Reinforced Patch

Crack is Controlled
MAINTENANCE

- Widen Edge for Support
- Herbicide
- Blade back soil buildup
- Fix dropoffs
CONCLUSION

• Determine the cause of the cracking
  • Research History
  • Perform Field Testing

• Design a cost effective solution
  • Improve edge support
  • Consider Geogrid Reinforcement
  • Microcrack stabilized bases
  • Reinforce patches in Jointed Concrete

• Perform Routine Maintenance
  • Herbicide
  • Blade edges
QUESTIONS

Heather Goehl
Fightin’ Texas Aggie
Class of 2013