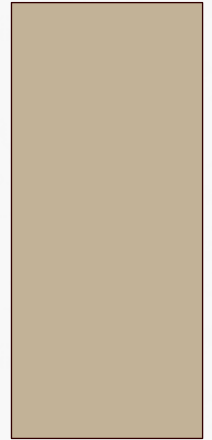


BEST PRACTICES FOR EDGE CRACKING

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

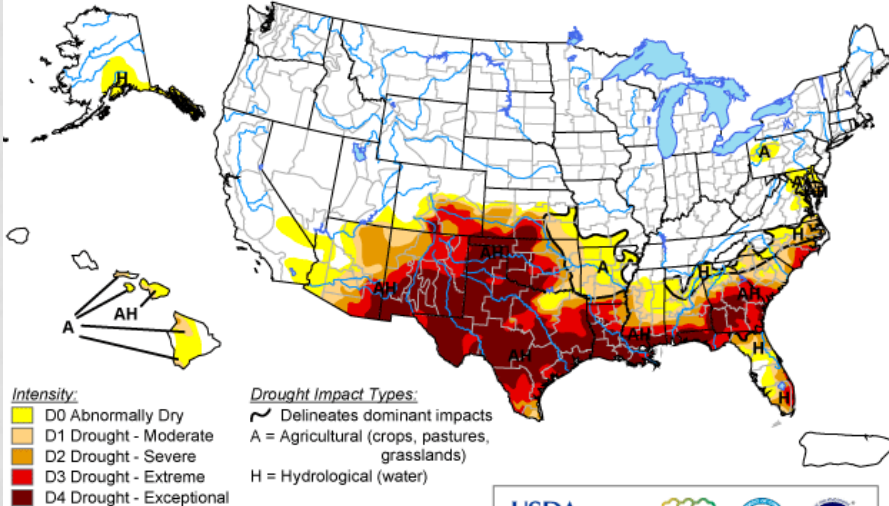
- Random Longitudinal Cracks



WEATHER - DROUGHT

U.S. Drought Monitor

July 12, 2011
Valid 8 a.m. EDT



Intensity:
 D0 Abnormally Dry
 D1 Drought - Moderate
 D2 Drought - Severe
 D3 Drought - Extreme
 D4 Drought - Exceptional

Drought Impact Types:
 ~ Delineates dominant impacts
 A = Agricultural (crops, pastures, grasslands)
 H = Hydrological (water)

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

<http://drought.unl.edu/dm>

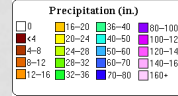
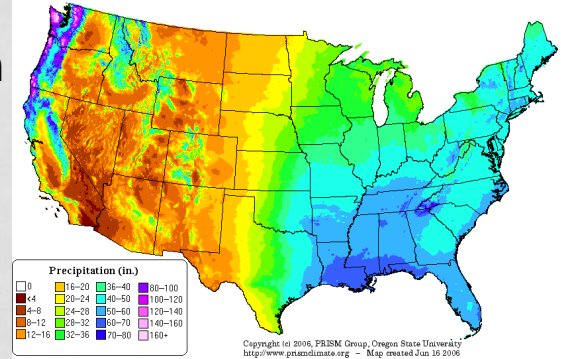


Released Thursday, July 14, 2011
Author: David Miskus, NOAA/NWS/NCEP/CPC

2011

Annual Precipitation

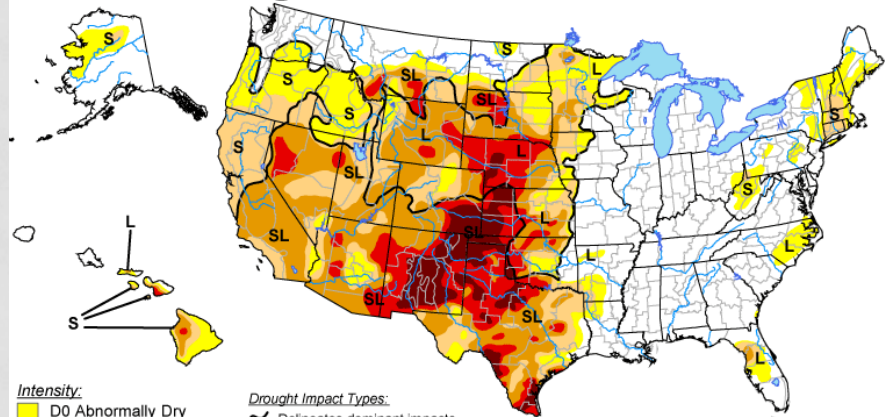
Precipitation: Annual Climatology (1971-2000)



Copyright (c) 2006, PRISM Group, Oregon State University
<http://www.prismclimate.org> - Map created Jun 18 2006

U.S. Drought Monitor

May 14, 2013
Valid 7 a.m. EDT



Intensity:
 D0 Abnormally Dry
 D1 Drought - Moderate
 D2 Drought - Severe
 D3 Drought - Extreme
 D4 Drought - Exceptional

Drought Impact Types:
 ~ Delineates dominant impacts
 S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
 L = Long-Term, typically >6 months (e.g. hydrology, ecology)

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

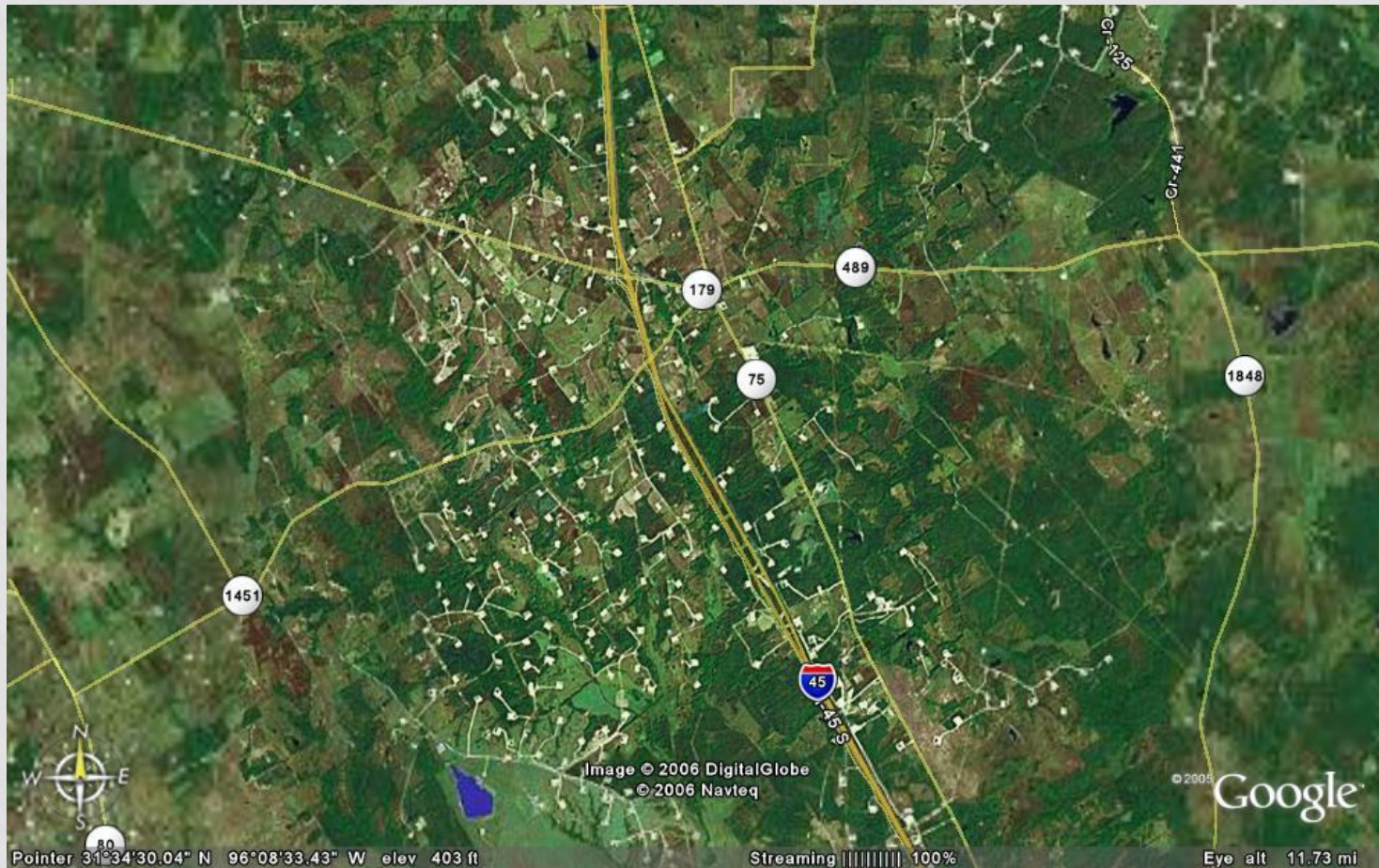
<http://droughtmonitor.unl.edu>



Released Thursday, May 16, 2013
Author: Rich Tinker, NOAA/NWS/NCEP/CPC

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

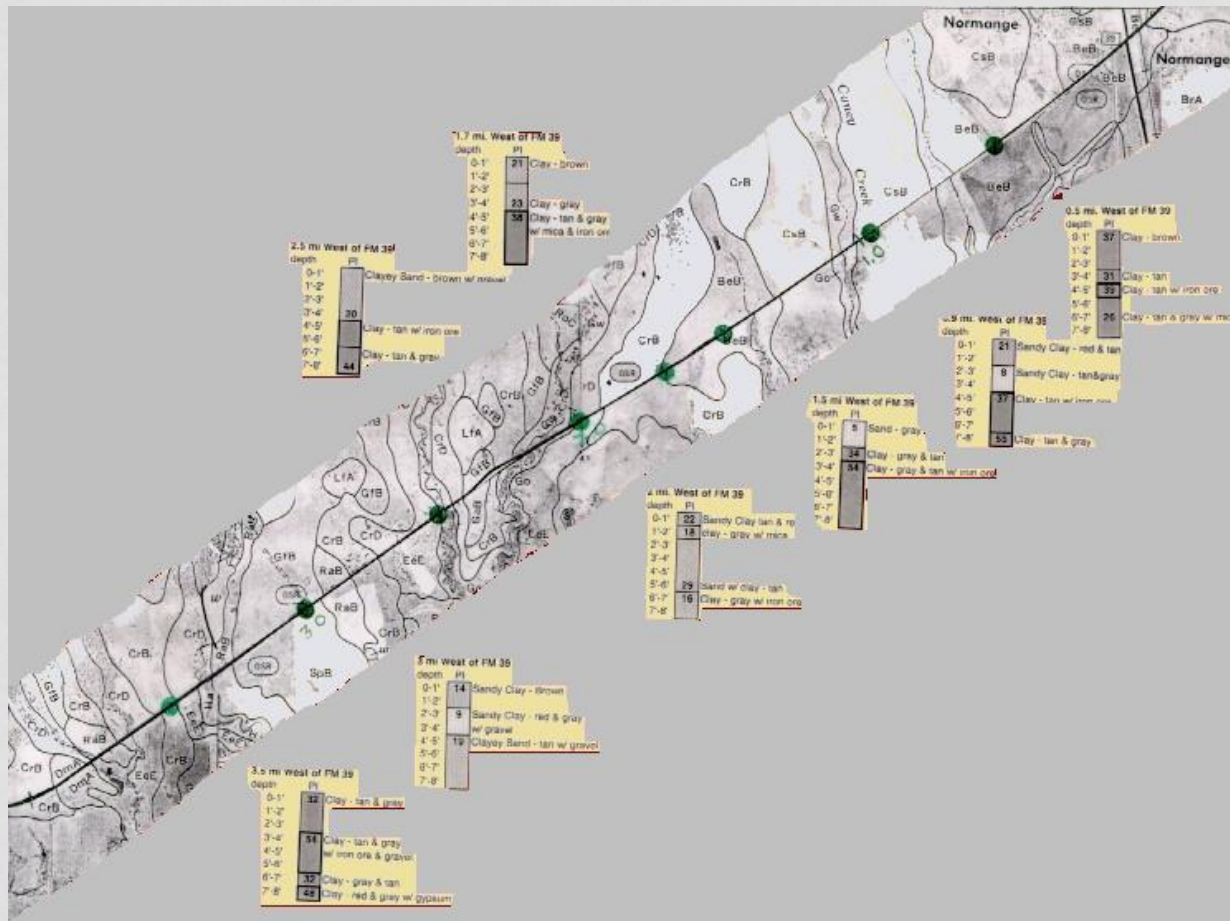
- Assemble Background Information
- Nondestructive testing (NDT) Evaluation and Section Breakdown
 - Ground Penetrating Radar (GPR)
 - Falling Weight Deflectometer (FWD)
- Verifying Pavement Structure and Sampling
 - Auger samples of pavement
 - Verification of problem location
 - Dynamic Cone Penetrometer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

ONLINE SOIL DATA

- <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>

The screenshot displays the Web Soil Survey application within a Windows Internet Explorer browser. The address bar shows the URL <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>. The page features a navigation menu with options like 'Area of Interest (AOI)', 'Soil Map', 'Soil Data Explorer', and 'Shopping Cart (Free)'. A search and navigation sidebar on the left includes sections for 'Search', 'Area of Interest', 'Quick Navigation', and a list of agencies such as the Bureau of Land Management and Forest Service. The main content area is titled 'Area of Interest Interactive Map' and shows a map of the contiguous United States with state boundaries and major highways. A scale bar at the bottom of the map indicates 0 to 208 miles. The footer contains links for FOIA, Accessibility Statement, Privacy Policy, Non-Discrimination Statement, Information Quality, USA.gov, and White House. The browser status bar at the bottom shows 'Done' and 'Internet | Protected Mode: Off'.

TYPICAL SOIL MAP FOR BRYAN DISTRICT



SH OSR – (FM39 to 4 miles West)

PI ranges 5 to 55 over length of project and within the same boring.

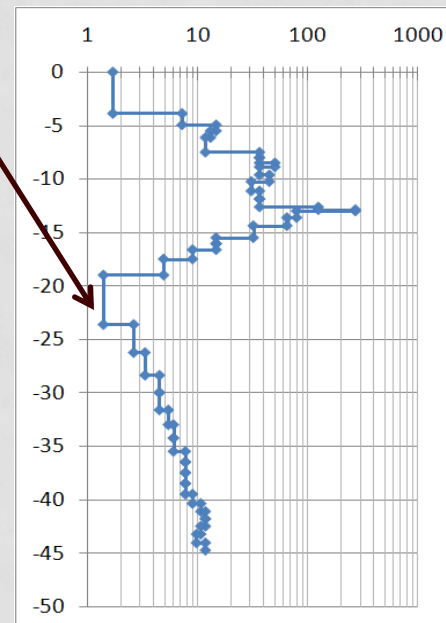
PAVEMENT EVALUATION TOOLS

- GPR - thickness variability; identify major problem areas; sampling locations
- DCP - in-site strengths of lower layers
- FWD - Strength variability; subgrade stiffness entire project



DCP

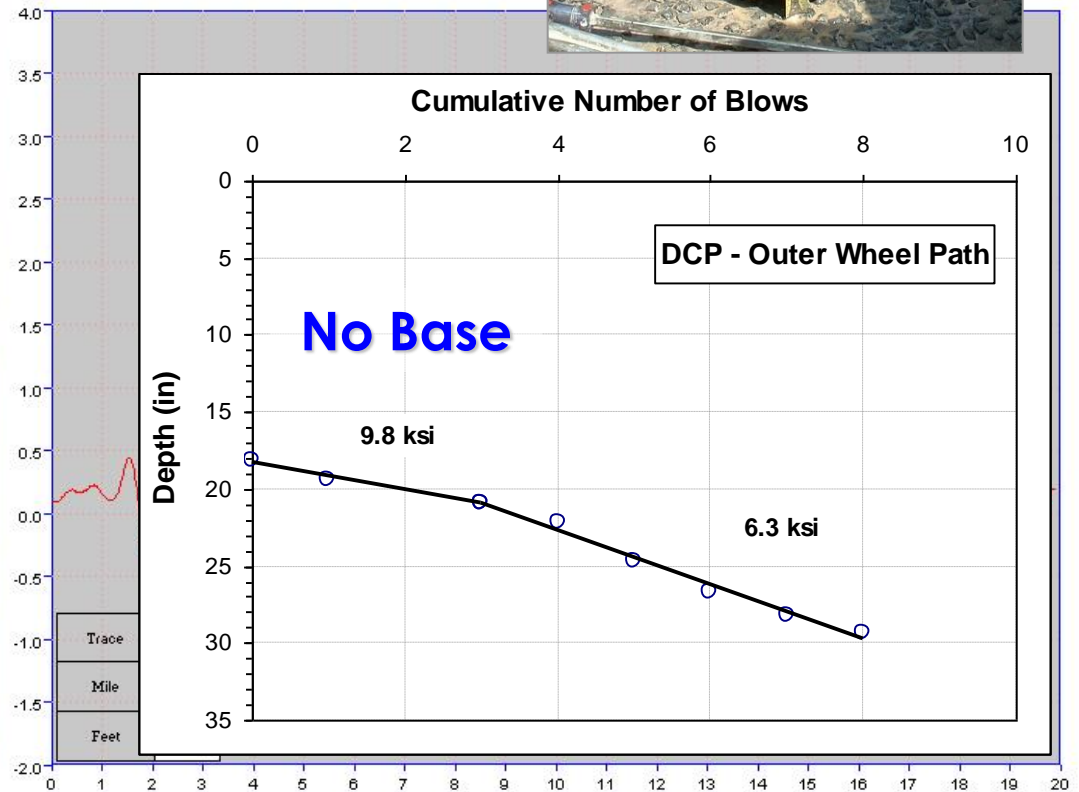
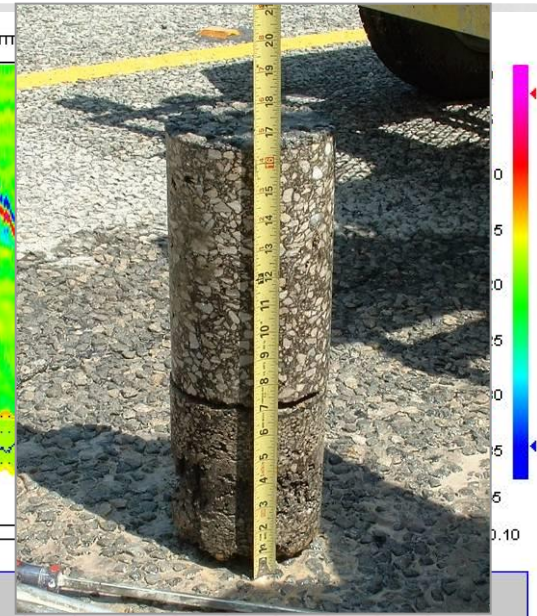
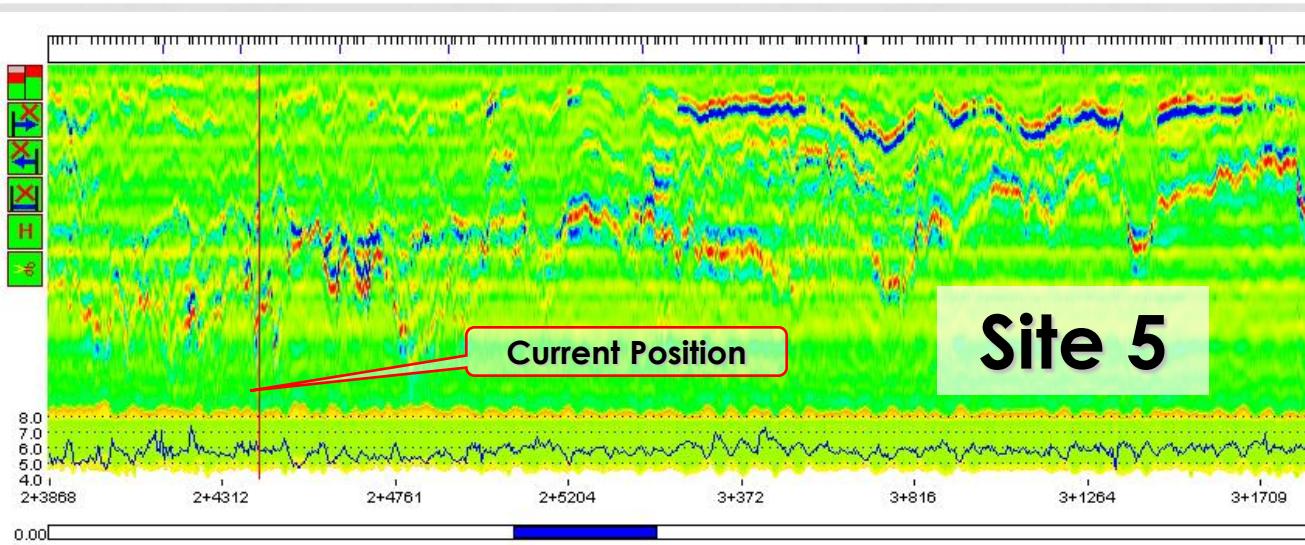
- Determine underlying pavement support
- Determine depth of failure shear plane for edge failures



PAVEMENT EVALUATION TOOLS

Soil and Pavement sampling





PAVEMENT TESTING VS. PROJECT COST

Testing is typically less than 1.5% of project cost.

| Scope of Work | Project | Project | GPR | FWD | Pave | Soil | Total | Test % of total |
|---|---------|-----------------------|---------|---------|---------|---------|---------|-------------------------|
| | \$/sy | (28' rdwy) \$/mile | \$/mile | \$/mile | \$/mile | \$/mile | \$/mile | Project Cost \$/mile |
| Overlay w/ underseal | \$15.22 | \$250,000 | \$155 | \$100 | \$110 | | \$365 | 0.15% |
| Rework + 6" FB + 2cst | \$16.44 | \$270,000 | \$155 | \$100 | \$110 | \$3,500 | \$3,865 | 1.43% |
| Cement Treat exist + FB+2cst | \$18.26 | \$330,000 | \$155 | \$100 | \$110 | \$3,500 | \$3,865 | 1.17% |
| Spot Repair (est 15% repairs 8" thick)+SC | \$7.00 | \$115,000 | \$155 | \$100 | \$110 | | \$365 | 0.32% |
| Spot Repair (est 25% repairs 8" thick)+SC | \$10.00 | \$165,000 | \$155 | \$100 | \$110 | | \$365 | 0.22% |

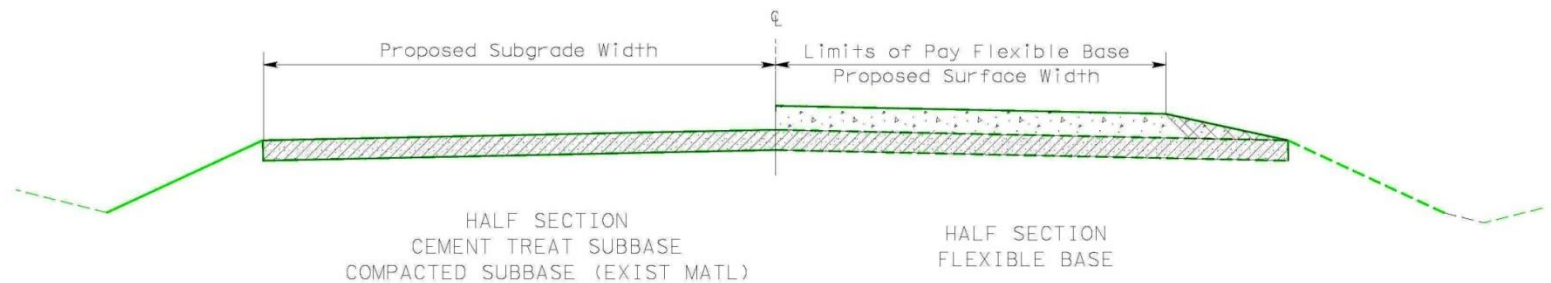
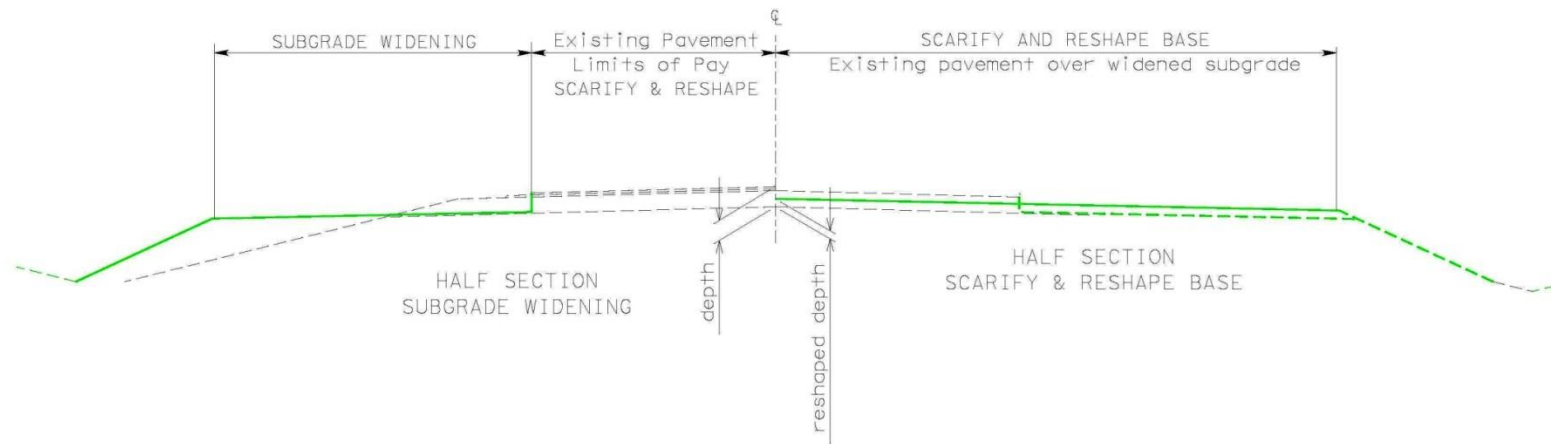
Note: Pavement is approximately 70% of the total project cost. Preliminary Engineering, including testing, is approximately 4% of the total project cost.

FLEXIBLE PAVEMENT DESIGN APPROACH

DESIGN TECHNIQUES

TYPICAL LOW VOLUME ROADWAY - PAVEMENT REPAIR

Goal –
Uniform Pavement Structure
Widen to improve edge support.



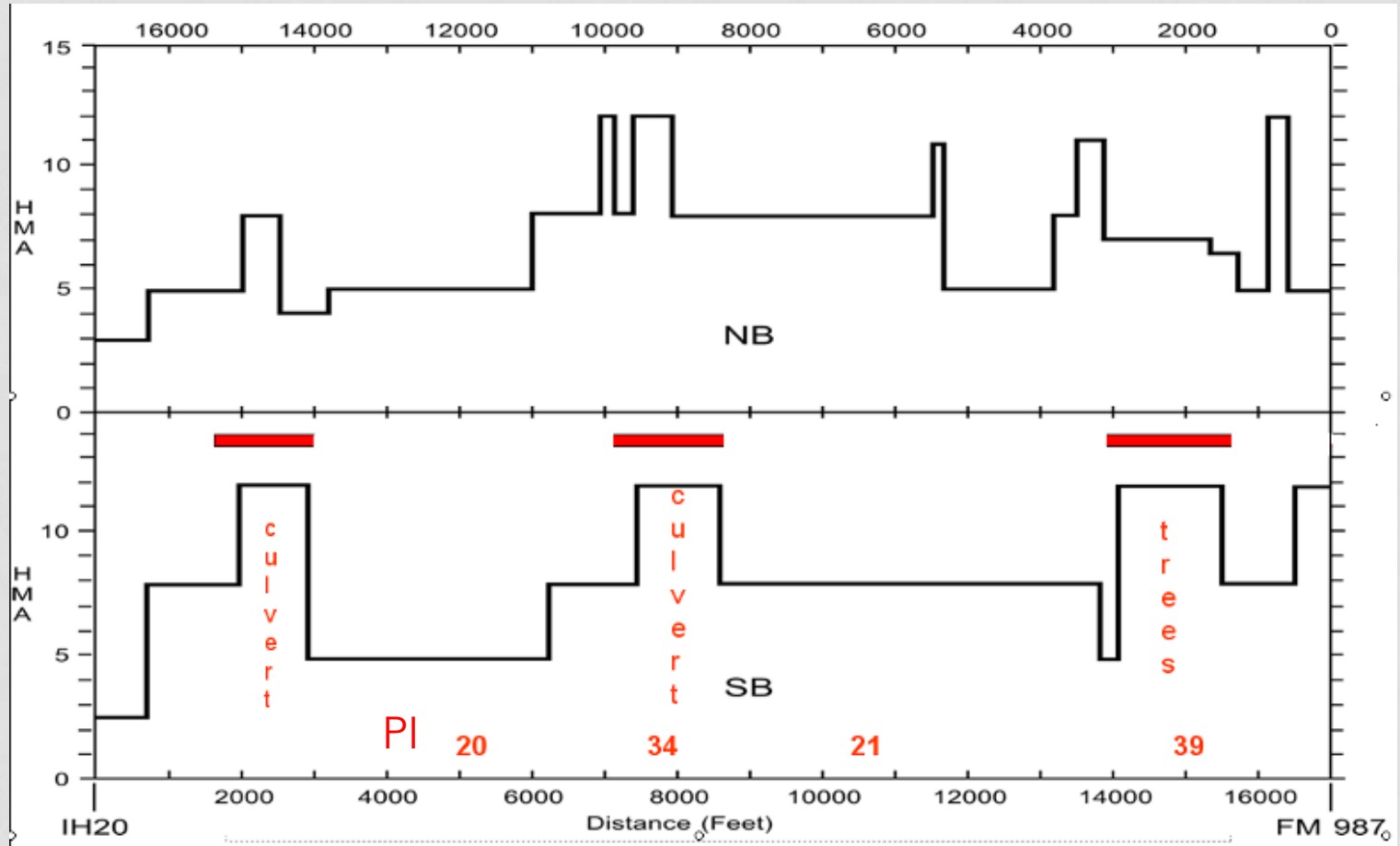
PROPOSED TYPICAL SECTION

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



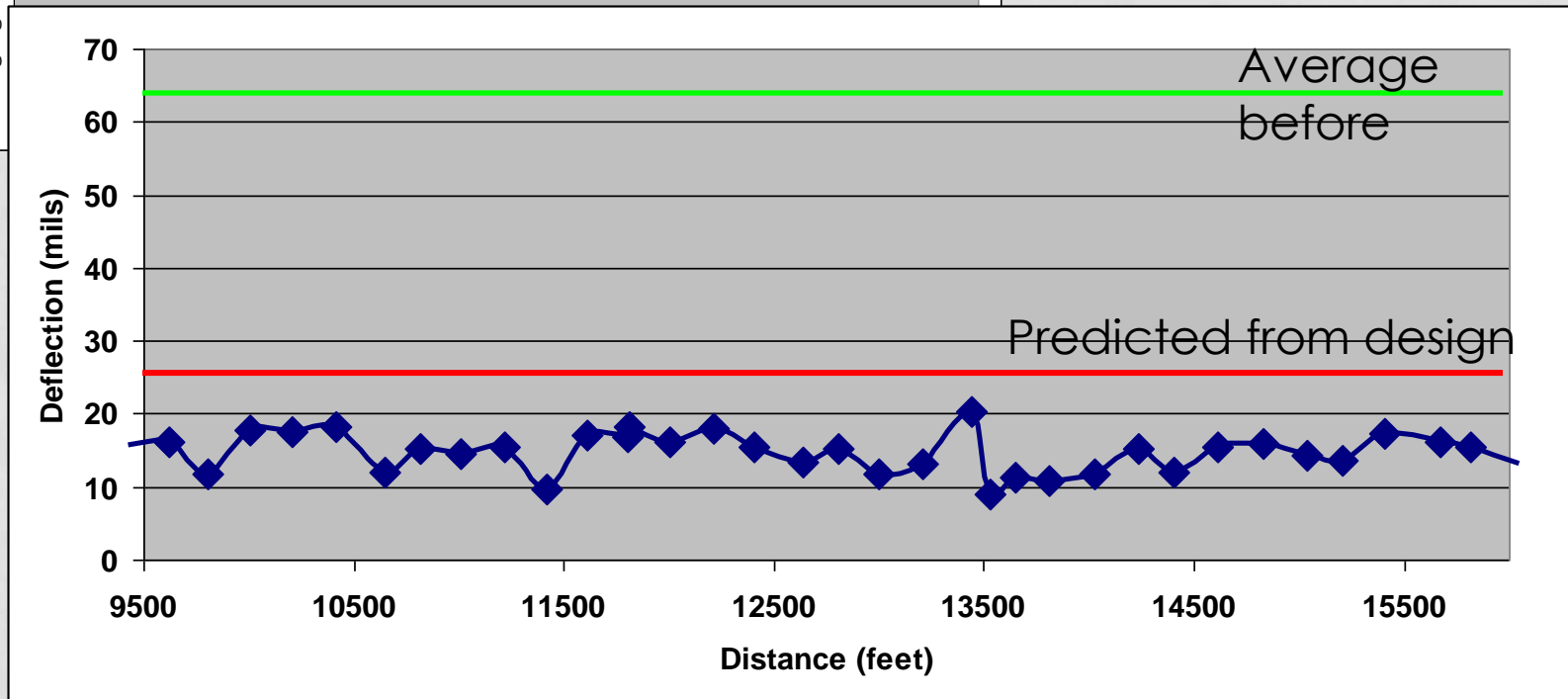
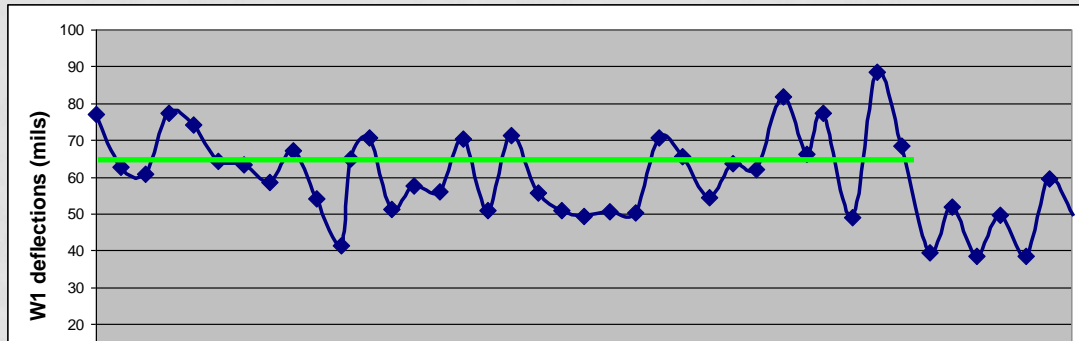
UNIFORM PAVEMENT STRUCTURE

CHANGE DESIGN STRATEGY THROUGHOUT THE LIMITS OF THE PROJECT

| From - To (feet) | Treatment |
|---------------------|--|
| 0 - 700 | 2 inch overlay only (new construction) |
| 700 - 1800 | Mill 4 inches of HMA the FDR 8 ins + base overlay |
| 1800 - 3000 | Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay |
| 3000 - 6000 | FDR 8" + base overlay |
| 6300 - 7200 | Mill 4 inches of HMA the FDR 8 ins + base overlay |
| 7200 - 8900 | Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay |
| 8900 - 14000 | Mill 4 inches of HMA the FDR 8 ins + base overlay |
| 14000 - 15600 | Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay |
| 15600 - 16700 | Mill 4 inches of HMA the FDR 8 ins + base overlay |
| 16700 - end | 2 inch HMA over only (intersection new construction) |

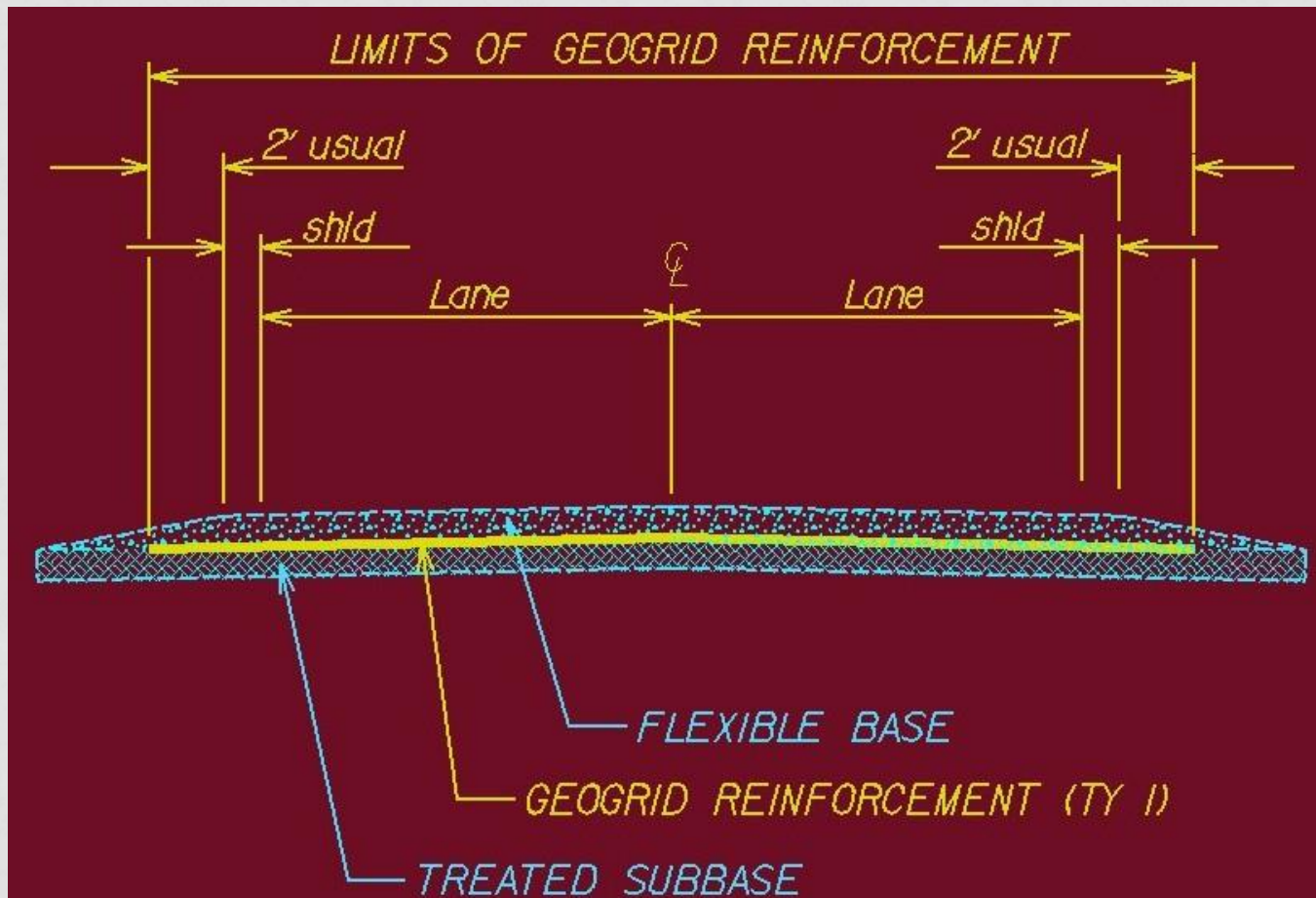
FWD DATA - EXAMPLE

FWD 9000 LB MAXIMUM DEFLECTION



PAVEMENT REPAIR OVER HIGH PI SOILS

Use Geogrid Reinforcement to control reflective cracking from the subgrade.



FM 1915 - RECONSTRUCTED IN 1997
US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION
SERVICE SOIL SURVEY



All sections have 10" lime treated subbase (5% lime) and a seal coat surface.

TEST SECTION SUMMARY

| Section 1 | Control Section | Section 2 |
|--|--|--|
| Geogrid and 8" Flexible base | No Geogrid 8" Flexible Base | Geogrid and 5" Flexible base |
| 0.65 miles west of Little River Relief Bridge | 1.6 miles west of Little River Relief Bridge | 2.5 miles west of Little River Relief Bridge |
| 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



GEOGRID SECTION 2,
2.2 miles

2001



2013



2013



FM1915 – 5 & 16 YEARS AFTER RECONSTRUCTION

DISTANCES MEASURED FROM LITTLE RIVER RELIEF BRIDGE

CONTROL SECTION,
1.3 miles

2001



2001

CONTROL SECTION,
0.83 MILES



2013



2013



DESIGN APPROACH

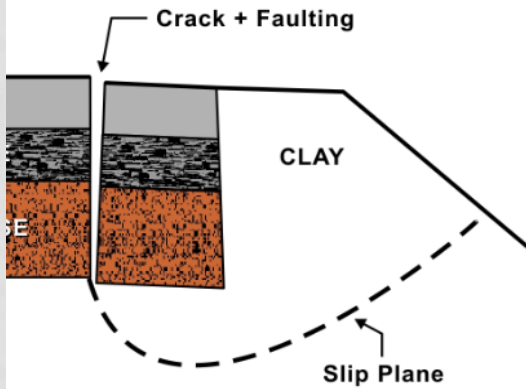
- Utilize the U.S. Department of Agriculture Soil Conservation Service maps to identify possible problem soils. Define testing locations based on this information.
 - This is in addition to the Districts standard one mile testing frequency.
- Perform soils tests to a depth of seven feet below the pavement.
 - 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

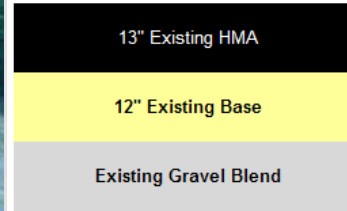
| Description | Geogrid Cost | FY 01 & FY 02 Maintenance Cost |
|--|--------------|--------------------------------|
| SH OSR 0475-03-048 | n/a | \$38,900 |
| SH OSR 0475-03-053 | \$55,734 | n/a |
| FY 00 average Geogrid Cost = \$1.89/sy FY 01 average Geogrid Cost = \$1.60/sy | | |

- 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.

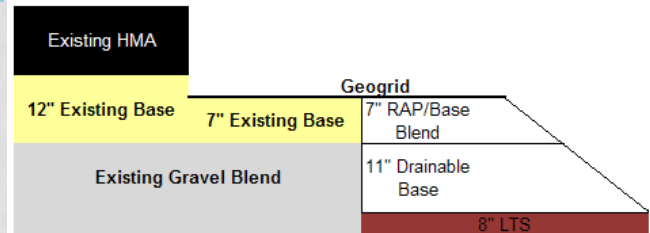
NEW APPROACHES TO SHOULDER WIDENING



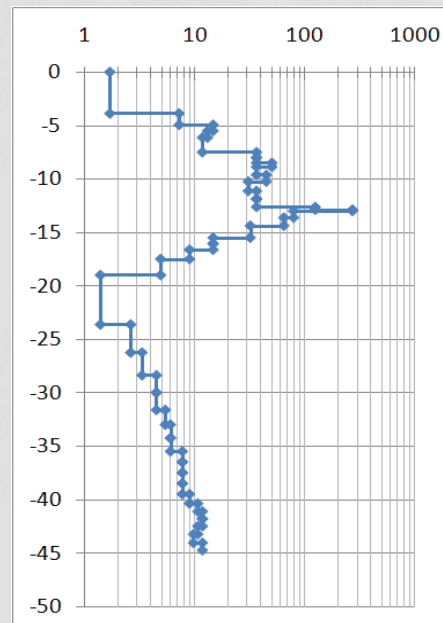
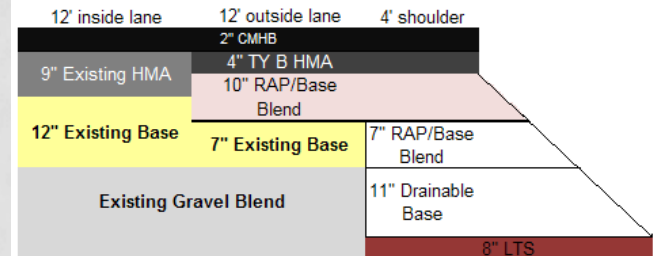
Existing Typical Section.
12 ft inside lane 12 ft outside lane



Mill 8" in outside lane.
FDR 10" and remove offsite for pugmill mixing.
Construct shoulder and place geogrid.



Place 10" RAP/Base Blend.
Place 6" new HMA.
Mill 4" in inside lane and place 2" CMHB.



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

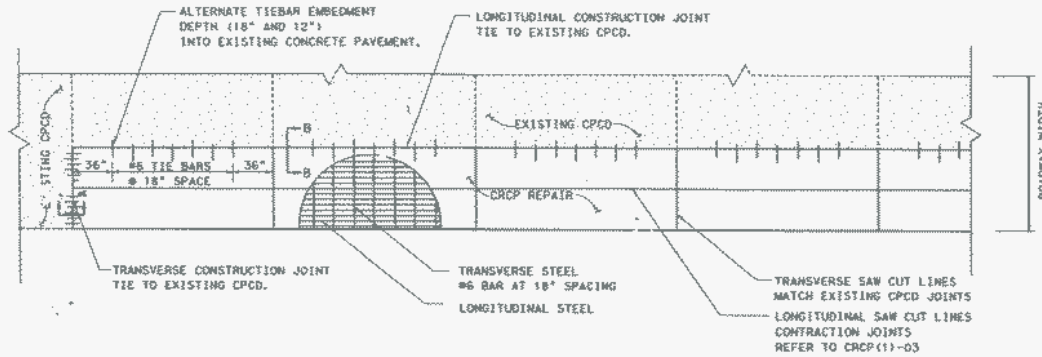
4" HMA

10" Lime Treated Subgrade

Subgrade PI ranges from 14 to 49

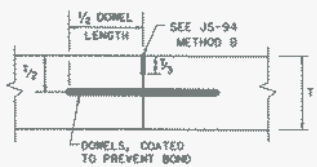


REPAIR DETAIL - REINFORCED PATCH OF JOINTED CONCRETE PAVEMENT

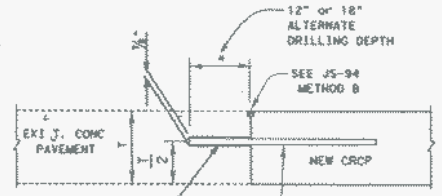


TYPICAL LAYOUT

- GENERAL NOTES
1. REFER TO CRCP(11)-03 SHEET FOR THE STEEL AND JOINTS DETAILS. USE #6 BAR AT 18" SPACING FOR TRANSVERSE STEEL.
 2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE REFER TO THE GOVERNING SPECIFICATIONS FOR "CONCRETE PAVEMENT," AND "FULL DEPTH REPAIR OF CONCRETE PAVEMENT."
 3. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS, AND CROWN CROSS SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLAN.
 4. TRANSVERSE SAW CUT CRCP TO MATCH THE TRANSVERSE JOINTS ON ADJOINING CPD LANE. THE SAW CUT DEPTH IS MIN. 1/3 WHEN POSSIBLE, MATCH CURB-GUTTER JOINTS TO TRANSVERSE JOINTS.
 5. PAVEMENT WIDTHS OF MORE THAN 15 FT. SHALL HAVE A LONGITUDINAL CONTRACTION/CONSTRUCTION JOINT. REFER TO CRCP(11)-03.
 6. WHEN CPD SLAB IS LESS THAN 15 FT IN LENGTH, INSTALL TIE BARS AT LOCATIONS AS DIRECTED BY THE ENGINEER.
 7. TO START/END REPAIR AREA, SAW CUT AT THE TRANSVERSE JOINT, CUTTING THROUGH THE DOWEL BASKET.
 - A. REMOVE AND REPLACE DOWELS IN THE EXISTING PAVEMENT. REFER TO A-A DETAILS FOR CONTRACTION JOINT.
 - B. WHEN DETERMINED BY THE ENGINEER THAT THE EXISTING DOWEL CANNOT BE REMOVED, LEAVE THE DOWEL IN PLACE. REFER TO A-A DETAILS FOR TRANSVERSE TIE JOINT TO TIE THE NEW CRCP TO THE EXISTING PAVEMENT.

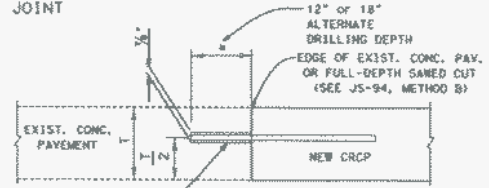


| T, IN. | DOWELS (SMOOTH BARS) | |
|--------|----------------------|--------------------------|
| | SIZE AND LENGTH | AVERAGE SPACING (INCHES) |
| 8 | 1" X 18" | 12 |
| 9 | 1 1/4" X 18" | 12 |
| 10 | 1 1/2" X 18" | 12 |
| 11 | 1 3/4" X 18" | 12 |
| 12 | 1 7/8" X 18" | 12 |
| 13 | 2" X 18" | 12 |
| 14 | 2 1/4" X 18" | 12 |
| 15 | 2 1/2" X 18" | 12 |

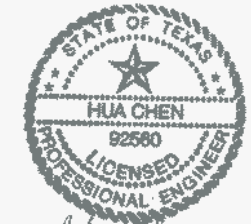


DRILL HOLE AND SECURE TIEBAR WITH TY III CLASS C EPOXY. METHODS OF CLEANING AND APPLICATION SHALL BE APPROVED BY THE ENGINEER PRIOR TO PLACEMENT.

TIEBARS # 18" SPACING OMIT TIE BARS WITHIN 36" OF TRANSVERSE JOINTS OR AS DIRECTED BY THE ENGINEER.



DRILL HOLE AND SECURE TIEBAR WITH TY III CLASS C EPOXY. METHODS OF CLEANING AND APPLICATION SHALL BE APPROVED BY THE ENGINEER PRIOR TO PLACEMENT. OMIT TIE BARS WITHIN 12" OF LONGITUDINAL JOINTS, SPACE MIDWAY BETWEEN DOWELS LEFT IN PLACE OR AT 12" SPACING WHEN JOINT IS NOT AT AN EXISTING TRANSVERSE CONSTRUCTION JOINT.



Hua Chen
01/18/2008

(NOT TO SCALE)

Texas Department of Transportation
Construction Division (Highway Personnel)

REPAIR CPD WITH CRCP

| | | | |
|------------|----------|---------|------|
| DATE | BY | CHECKED | DATE |
| 01/18/2008 | HUA CHEN | | |

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

