BEST PRACTICES FOR FLEXIBLE PAVEMENT STRUCTURE WIDENING: WORKSHOPS

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TxDOT Project 6-6748: Best Practice for Flexible Pavement Structure Widening Projects

JULY 2013

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Introduction

This document presents a summary of the two half-day workshops/webinars that took place at CTR July 2, 2013. The workshops constitute Product 2 (P2) of the research project and correspond to Task 3. The purpose of the workshops was to obtain expert opinions from TxDOT personnel, contractors, and construction equipment and materials manufacturers with experience in pavement widening projects. For logistical and practical reasons both workshops were conducted on the same day.

The workshop was conducted to facilitate face-to-face participation for those who could travel to Austin; the webinar component was added to increase the participation of those who could not attend due to limited travel budgets or time restrictions. The morning workshop focused on contractors and suppliers presenting their experience while the afternoon workshop focused on TxDOT experience. The details of the workshops and the workshop materials follow:

Workshop Webinar 1: Contractors and Suppliers Experience

The participants in the morning workshop included contractors, construction equipment and materials manufacturers and suppliers, and construction industry representatives. This workshop focused on construction methods and considerations, practical problems encountered during construction of narrow widening projects, modified or specialized equipment that has been successfully implemented, and suggested improvements to construction plan details, specifications, and standards. Discussion topics and points included the following:

a. It would be beneficial in terms of project costs and construction duration for TxDOT to standardize widening project designs to fit the sizes and widths of existing equipment and materials (geotextiles, geogrid, etc.). Improve preliminary project testing to ensure that information such as pavement thicknesses and material types are up to date.

b. Milling machines provide an excellent joint cut face that is clean and uniform; remove the scarified material from the cut trench and place the material into a dump truck using a conveyor system; and allow for adjustment of the cut width and depth depending on the machine type and size. In addition, milling machines can cut the trench along the entire length of the project as required by some districts or can stop the milling operation at drives or intersections, climb out of the trench, and cross to the road to begin the trench on the opposite side. Districts currently use both of these widening methods depending on circumstances.

c. TxDOT currently sets the maximum construction distance at 1 mile for widening projects. Some contractors might be able to successfully construct more than 1 mile per day. It is recommended that TxDOT consider allowing the contractor to demonstrate their equipment and capabilities to maximize construction efficiency.
d. TxDOT does not let a steady number of widening projects for statewide letting. For this reason, some contractors might be reluctant to invest in specialized equipment for constructing road widening projects, although the equipment could improve construction quality and efficiency.

e. TxDOT has successfully used geotextiles, fabrics, and grids to reinforce subgrade and base courses. However, placement of these materials varies from district to district. TxDOT may want to consider further studies to evaluate the best placement of these reinforcing materials within the pavement structure.

f. No guidance is provided regarding placement of geogrid or fabrics with regard to the vertical cut face of the widening section or overlap into the adjacent existing lane. It is suggested that further study address the benefits of wrapping the grid or fabric over the joint face and providing overlap within the lane to strengthen the joint and reduce the potential for reflective cracking.

g. When constructing the widened section using a Weiler or Midland road widener, it is unclear whether the contractor should set the widener screed at an elevation that places an additional thickness of material to allow for compaction and densification of the base layer. Further guidance is needed in this regard.

h. Manufacturers make narrow width steel wheel or pneumatic tired rollers that can fit in a narrow widening section to properly compact the subgrade and each subsequent pavement lift. Further study is needed to identify the appropriate type and weight of these smaller rollers, considering that the contractor will want to make use of this equipment for other applications.

i. Widening the pavement with asphalt-stabilized base (ASB) is preferred by many districts and contractors since this material is easy to place and compact and can be opened to traffic at the end of each day’s construction. However, TxDOT design guidance warns that ASB should not be placed full-depth against a flexible base layer due to blockage of sub-surface drainage. A test site has been constructed on SH 21 in the Austin District to investigate the use of drainage layer fabric placed under a 3-in. stone base layer to accommodate drainage under the ASB base layer. Further study and monitoring of this and similar sites is recommended to determine the value of this installation.

j. The contractors and equipment suppliers requested additional information regarding the average widening amount on TxDOT projects, including the distribution of widening sections. This information would be helpful in determining equipment sizes during purchase.

k. Additional guidance is needed regarding the optimum moisture content of various base types for use in geogrid applications.

Workshop Webinar 2: TxDOT Experience

The participants in the afternoon workshop included personnel from TxDOT and other transportation agency and industry representatives. The afternoon workshop focused on
design considerations, design details, standards and specifications, construction problem areas and solutions. Discussion topics included the following:

a. Some districts have found that the cost of constructing a full-depth reclamation of the entire roadbed is from 15 to 22% higher than constructing a narrow widening section on each side of the roadway. Though slightly more expensive, full-depth reclamation results in total rehabilitation of the roadway and eliminates the widening joint lines and potential variability in material stiffness and moisture contents, which improves construction quality and pavement performance.

b. TxDOT funding guidelines for Category (CAT) 8 Highway Safety Improvement Program (HSIP) funding may restrict best practices for widening projects. There is some confusion and disagreement whether rehabilitation of the existing lanes can be performed using CAT 8 funding during a widening project. For this reason, deteriorated roadways might be selected as widening project candidates, although deteriorated roadways are better candidates for full-depth reclamation or rehabilitation (including lane widening). Further study is needed to clarify the selection criteria for HSIP criteria and funding.

c. Variations among districts regarding materials, climatic conditions, truck loading, and average daily traffic suggests that a more detailed study of recommended, standardized designs is needed to address these variations while providing consistency.

d. Variations from district to district occur regarding whether projects are constructed through statewide letting by contractors, through routine maintenance contracts or by state maintenance forces. Due to variations in available equipment, materials, personnel, and other factors, the resulting variability in construction quality and performance of widening projects may occur. Further study is needed to determine how resources can be made available to all districts to ensure the best quality and performance of widening projects.

e. Approximately 40,000 center line miles of FM roads exist on the state system. A large percentage of these roadways have narrow 9-, 10-, and 11-foot lanes and often do not have a paved shoulder. Districts in which oil and gas exploration is occurring are experiencing increased problems with pavement failures, rutting, edge-drop offs, cracking, and related distresses, raising concerns about safety and pavement structural capacity.

f. Pavement widening projects funded with CAT 8 money do not qualify for structure widening. This limits the ability of the district to provide the safest possible road cross section and clear zone widths in some cases. Further consideration should be given to the criteria and conditions established for HSIP funding for widening projects.

g. Some districts have purchased milling machines to construct narrow widening projects and to perform other functions in the district. Further consideration
should be given to the value of purchasing self-propelled pavement widening equipment for maintenance sections to further expand in-house capabilities.

h. Further consideration should be given to the use of a water truck to control dust during construction. Often water trucks will spray the base material after placement in the trench, which might result in higher-than-optimum moisture content just prior to surface or prime placement. Higher-than-optimum moisture contents might result in later settlement, rutting, or dry land shrinkage cracking as the base dries out and/or moisture is drawn from the widened section into the existing pavement and subgrade layers.

i. Further study is needed to evaluate the use of dust palliatives during full-depth reclamation and narrow widening projects to hold down dust and enhance safety. Contractors use motorized brooms on certain projects to remove dust after base placement, causing dust clouds that obscure the roadway and may cause safety concerns for traffic and construction workers within the work zone.

j. Further work is needed to evaluate the specific mechanisms that cause cracking of the joint line within a narrow widening project. Failure of the joint line can occur due to poor joint construction, traffic loads, dry land shrinkage cracking, or a combination of these factors. Quite often extensive and continued maintenance activities are required to address joint failure problems.

k. The most common joint design is a vertical cut joint face at the pavement widening line. Further study is needed to determine if other designs that involve tapers or a stepped construction might improve joint density and reduce the potential for reflective cracking. However, the joint design should also address contractor equipment capabilities and construction efficiency.

Workshop Presentations and Materials

Six presentations were made in the morning workshop and another six presentations were given in the afternoon workshop. In addition, a recap discussion took place at the end of the afternoon workshop. To start the workshop, the first presentation was given to introduce the topic of narrow widening and explain the purpose of the workshop. Morning presentations included perspectives from RoadTec (equipment manufacturer), APAC (contractor), Allen Keller (contractor), and Tencate and Tensar (geosynthetic materials manufacturers). Presentations during the second workshop included perspectives from TxDOT’s Austin, Waco, San Angelo, Bryan, and Atlanta Districts and an overview of pavement widening equipment. The final portions of the workshops were reserved to recap and further discuss important issues identified during the presentations. Appendix A contains the agenda on the full day and Appendix B lists the individuals who attended both workshops, both in person and online. On the accompanying CD, Appendix C provides the industry presentations from Workshop 1 while Appendix D presents the TxDOT presentations from Workshop 2.
Summary and Conclusions

The workshops were organized to obtain opinions and additional knowledge about narrow widening projects from experienced professionals involved in the construction, equipment, materials, and design aspects of these projects. Presenters came from different areas of Texas; some suppliers came from out of state.

During the workshops, knowledge was shared on the types of equipment available for narrow widening projects and the advantages and disadvantages of different equipment pieces. The size of the equipment used should match the work being done, and there are different options for the different types of work. For example, to cut the joint of the existing pavement, a milling machine or a road saw (attached to a skid steer or front end loader) could be used. To spread the base material, a road widener (self-propelled or non-self-propelled) or a belly dump could be used.

Geosynthetic manufacturers discussed the products they offer that could be used for narrow widening projects. In particular, they emphasized how geosynthetics could help provide reinforcement for the road and retard movement of cracks rising to the surface. Geosynthetics could also help with drainage issues. Participants noted the lack of standards for the use of pavement inter-layers, and indicated a study is needed.

Contractors and TxDOT representatives from District offices shared their current practices that work well, as well as lessons learned from experiences that did not provide acceptable results. Flex base was compared to ASB in multiple presentations: flex base is cheaper and allows to better drainage, but ASB is faster (allowing the traffic to return to the road sooner) and reducing dust. A pilot car is usually needed for narrow widening projects, as the narrow width presents a safety issue. Some solutions for narrow widening issues depend on the source of funding (safety versus rehabilitation funds).

In summary, the workshop/webinar met the project objectives. Based on the sign-in sheet and number of webinar logins, 17 individuals attended the workshop in person and an estimated 70–90 TxDOT personnel attended all or a part of the webinar through the TxDOT Webex system.

The researchers plan to follow up on the issues and questions raised during the workshops and will document new information in the final project report.
Appendix A – Workshop Agenda
Webinar-Workshop Agenda

Project 0-6748 ‘Narrow Pavement Widening’

University of Texas – at Austin Center for Transportation Research
Large Conference Room
1616 Guadalupe, Suite 4.202
Austin, Texas 78701

Tuesday July 2, 2013  9:00 – 4:30 PM

The Texas Department of Transportation has initiated project 0-6748 to develop a compendium of best practices for narrow pavement widening. The project addresses design, construction, equipment, materials and related issues associated with projects involving widening of narrow pavements by from 1’ – 6’.

The research team has conducted interviews of Districts, Construction Equipment manufacturers and sellers, Contractors and Material Suppliers to obtain first-hand information about the challenges and best practices associated with narrow pavement widening. The purpose of this Webinar-Workshop is to allow Districts, Contractors, Equipment and material suppliers to discuss their methodologies and products as applied to narrow pavement widening projects to facilitate discussion and share information about best practices and ‘lessons learned’.

Webinar – Workshop Arrangements

Location
The Webinar – Workshop will be conducted from the University of Texas at Austin – Center for Transportation – Large Conference Room. Map attached to Email, park on the 10th floor of the parking garage – parking validated.
Webinar-Workshop Agenda
Project 0-6748 ‘Narrow Pavement Widening Webinar-Workshop’

PART I: 9:00 AM – 12:00 PM

1. Introductions and Purpose of the Workshop
   Mike Murphy 15 m

2. RoadTec
   a. Discussion
   David Zuehlke 25 m
dzuehlke@roadtec.com
   b. Lessons learned and ‘take-aways’
   (512) 638-2429

3. APAC Trotti and Thompson
   a. Discussion
   Maria Burton CTR 25 m
   Manuel Trevino CTR
   maria_christina.86@hotmail.com
   Manuel.trevino@mail.utexas.edu
   b. Lessons learned and ‘take-aways’

4. Allen Keller
   a. Discussion
   Kory Keller 25 m
   kkeller@allenkellerco.com
   (830) 997-2118
   b. Lessons learned and ‘take-aways’

5. Tencate Geosynthetics
   a. Discussion
   Mike Samueloff 25 m
   Katie Strain
   m.samueloff@tencate.com
   (248) 302-8806
   k.strain@tencate.com
   b. Lessons learned and ‘take-aways’

6. Tensar
   a. Discussion
   Stephen Archer 25 m
   sarcher@tensarsorp.com
   b. Lessons learned and ‘take-aways’

Lunch Break 12:00 – 1:00 pm
PART 2: 1:00 – 4:30 PM

7. **Austin District**
   a. Discussion
   b. Lessons learned and ‘take-aways’
   Mike Arellano 25 m
   miquel.arellano@txdot.gov
   (512) 832-7093

8. **Waco District**
   a. Discussion
   b. Lessons learned and ‘take-aways’
   John Jasek 25 m
   john.jasek@txdot.gov
   (254) 867-2770
   Don Miller
   Don.miller@txdot.gov
   (254) 867-2730

9. **San Angelo District**
   a. Discussion
   b. Lessons learned and ‘take-aways’
   Lewis Nowlin 25 m
   lewis.nowlin@txdot.gov
   (325) 446-9603

10. **Bryan District**
    a. Discussion
    b. Lessons learned and ‘take-aways’
    Darlene Goehl 25 m
    Darlene.goehl@txdot.gov
    (979) 778-9650

11. **Atlanta District (Survey Summary)**
    Andre Smit 10 m
    Asmit@mail.utexas.edu
    (512) 906-5495

12. **Pavement Widening Equipment** (overview)
    Mike Murphy 20 m
    Maria Burton

13. **Recap of presentations Questions & Answers**
    Jorge Prozzi 45 m
    Prozzi@mail.utexas.edu
    (512) 905-2435
Appendix B – List of Attendees
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</thead>
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Present: Jorge Zornberg, zornberg@mail.utexas.edu, UT
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<td>Gregor Granato</td>
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**Notes:**
- Wendy Simmons
- Robert Moya III
- Scott
- Tony Moran
- Felix Lerma
- Richard Izzo
- Guy
- Tyler District
- Maintenance Engineer
- Laredo - Construction
- San Antonio (Contract)
- CST - Soils Ass
Appendix C – Contractor and Supplier Presentations
0-6748: Best Practice for Flexible Pavement Structure Widening Projects

Introduction
Project Purpose

• **Objective**: identify best practices for improving pavement performance on projects involving widening of narrow pavement structures
Reasons for Widening

• **Reasons:**
  – Improve safety
    • Edge failures & vehicle control
    • Greater traffic separation
  – Enhance pavement performance
    • Edges deteriorating from softening due to poor drainage
    • Reduce rutting due to tire loads at edges

Other Reasons?

• Narrow widening: adding 1 - 6 ft. width to shoulder
Construction Challenges

• Narrow work areas
• Variable subgrade support
• Surface and subsurface drainage
• Potential need for acquisition of additional ROW
• Keeping time short per task to maintain traffic flow
• Narrow widening equipment not worth purchase
• Project choices can depend on funding source
  – CAT1, CAT8, RMC, In House
Failures

• Difference between old and new structure
  – Differences in thickness, material properties, and compaction

  – Can result in:
    • Rutting in existing or new pav’t
    • Uneven settlements
    • Cracking
    • Different load bearing capacities for both structures

(Varin & Saarenketo, 2012)
Failures

• Joint construction and location
  – Should not be placed under/near wheel path
  – Traffic loading can cause reflection cracking
Failures

• Settlement
  – Sufficient compaction of new structure else, differential settlement could occur

(Varin & Saarenketo, 2012)
Failures

• Moisture penetration

  – Should:
    • Maintain lateral drainage within pavement structure
    • Proper Selection of base materials key
    • Good Construction Inspection

  – Else, can cause:
    • Moisture penetration - base, subgrade softening
    • Swelling and heave of heavy clays

(Varin & Saarenketo, 2012)
Failures

• Drainage
  – Maintain sufficient pavement surface drainage
  – Can result in:
    • decreased bearing capacity
    • Edge deformation
    • Ponding of water (accelerates deformation - safety)

(Varin & Saarenketo, 2012)
Failures

• **Slope stability**
  – Should ensure stability of side slopes (inner & outer)
  – Problems if ROW space is limited

  – **If steep inner slope:**
    • Could result in poor compaction of widened section
      – cause shear failure & edge deformation
      – Structure widening a challenge
Workshop Webinar

• **Webinar Purpose:**
  – Obtain expert opinions
  – Experience in pavement widening projects
    • TxDOT personnel & transportation agencies
    • Industry representatives
    • Contractors
    • Construction equipment manufacturers
Workshop Webinar

- Contractors, construction equipment manufacturers & suppliers, & construction industry representatives
  - Identify construction projects performed well/not well
  - Good practices
  - Guidelines, specifications, standards
  - Equipment

- TxDOT Districts
  - Discuss projects that performed well/not well
  - Good practices
  - Guidelines, specifications, standards
Equipment for TXDOT Shoulder Widening

David Zuehlke, Roadtec Inc.
AGENDA

Introduction

Historical Equipment

Current Equipment

Challenges
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<td><strong>Aggregate and Mining Group</strong></td>
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<td>TELSMITH</td>
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</table>

**ASTEC INDUSTRIES, INC.**
CHATANOOGA, TN

Manufacturers Road
- 216,500 sq. ft. –
Company HQ
New equipment manufacturing

Riverside Drive Location
- 54,009 sq. ft. –
Parts, Rebuild, and Used Equipment

• 359 Employees Total
ROADTEC PRODUCT LINES
Historical – Custom Equipment
SIDE-CUTTER ATTACHMENT

- Old Option – none in Texas
- RX-60C now RX-900
- Soft Shoulders / Deeper Cuts
- Economic Feasibility
- Lane Closure
SHUTTLE BUGGY WIDENER

- Limited number
- Buggy Utilization 2000 vs. Now
MILLING CONCEPT
CUTTER OPTIONS

1. 12” Max Depth
2. Standard 4’ Fixed Width
3. Variable Cutter System – VCS
VCS

1 Housing – 3 Widths

24” Cutter

36” Cutter

48” Cutter
AUTOMATED GRADE & SLOPE
One Person Operation

Exceptional visibility and controls allow the machine to be operated by one person.
RX-400e

- Right Hand Flush Cut
- Rear Flush Cut
- No legs in cut
- Minimal lane intrusion
RX-400e
12” Deep Cut - 24” Wide
RX-400 District Usage

Atlanta
Beaumont
Bryan
Houston
Lufkin
Paris
Waco
RX-600e

- 6’ 7” or 7’ 2” Cutter
- VCS Capable with
  24” Cutter
  36” Cutter
  48” Cutter
Real County – FM 336
Real County – FM 336

Grade depth set on the left side
Slope set on the right

Slope matched to existing grade
Real County – FM 336
SHOULDER MILLING ADVANTAGES

- Clean Joints & Sub-Grade Surface
- Accurate sub-grade depth and slope
- Full Recovery and Recycle RAP & Aggregates
- More productive – faster construction cycle
- One machine operation allows for tighter job footprint
SHOULDER WIDENING CHALLENGES / ISSUES
SHOULDER WIDENING CHALLENGES / ISSUES

• Contractor Work Volume & Timing
• In-consistent widths among Districts
  - Example 2’ 6” vs. 2’, 3’, or 4’
  - Max Depth 12”
• Most common size mill cut width is 6’ 7” followed by 7’ 2”
• Under/Over cut vs. specialty size cuts
THANK - YOU

QUESTIONS
0-6748: Best Practice for Flexible Pavement Structure Widening Projects

APAC Site Visit & Commentary
(Beaumont District – FM 1414)

Maria Burton
Manuel Trevino
Project Description

- APAC – Ashland Paving and Construction
  - Regional Office in Beaumont, TX

**Highway Routine Maintenance Contract:**
- Beaumont District – Newton County
- FM 1414

- **Type/Work:**
  - Pavement Widening (4 ft), Structure Extension, Seal Coat and Restripe

- **Project Length:** 5.260 miles
• **Limits of Work:**
  - From 10.439 miles South of SH 63 in Burkeville, South to SH 87
Reasons for Widening

- **This Project: widening for Safety**
  - Roads tight on traffic, 10.5’ – 11’ wide
  - Collisions
  - Logging trucks – too long for turning on road
    - put slope on it to help

- **Common narrow widening projects:**
  - FM roads
  - Widening for safer access to mailboxes for mail carriers

(East Texas logging trucks)

(FM 1414)
Challenges with Narrow Widening

- Tighter area to work in
  - Use smaller equipment
    - smaller mill with variable drum
    - smaller roller to proof roll
    - smaller dozer

(photos from this project)
Challenges widening with **traffic**; it is already narrow as-is

- Curves & line of sight issues: use pilot car (this project)
- **If flat:** use flagger station

(photos & drawing plan from this project)
- Sometimes dust problem
  - Have to spray with water
  - Asphalt stabilizer base better than flex base – get compaction & don’t have to worry about dust control

(photo from this project)
Narrow Widening – Past Experiences

- **Previous projects:**
  - *Lesson Learned:* should seal joint so don’t have base failures
  - Roots discovered in original material after milling – caused base failures

- **Information desired in plan set:**
  - Need existing road condition (sometimes information unknown)
    - e.g. Challenge making slope on something already there
      - Condition of existing road based on surveys done years in advance
      - Road changed since surveys (wheel ruts, etc.)

(drawing from this project plans)
Narrow Widening – Practices

• Work on a mile at a time, one side at a time

• **For Good Results:**
  • Use quality materials
  • Use modern machines
  • Check grades as go
  • Check compaction (TxDOT does it as well)

• **Safety & Training:**
  • Safety meeting every morning
  • All signs put up etc. before machines come out
  • Training class for machines

(photograph from this project)
• Will make sure residents have access to their driveways – will tell them ahead of time
• **Drainage:**
  - Box Culverts: TxDOT Standards, Standard Width
  - Match existing slopes of roads
    - make drain naturally
    - some cross-structures need to be extended

• **Subgrade** prior to base placement – typically proof-roll it

• **Compaction process:** smaller roller to compact subgrade
  - calculate to get one pass
Narrow Widening - Materials

- All material shipped in (Brownwood for this project)
- All material tested and TXDOT-approved

- Don’t have option of choosing **base material**; just bid what’s specified in plans
  - Sometimes use **flex base** (this project)
  - Sometimes use **black base** from hot mix plant
    - Quicker
    - Better ride
    - Get public back on sooner

(photo from this project)
Narrow Widening - Equipment

- **Sawing existing pavement**: milling machine – cuts smooth edge
- **Excavating or cutting trench**: milling machine
- **Treating subgrade**: don’t do it
- **Compacting subgrade**: double drum asphalt roller, 4’
- **Cleaning trench prior to base placement**: maintainer with custom-made piece on mouldboard
- **Placing new base material**: road widener/shoulder machine, self-propelled, levels & spreads at same time
- **Treating base with stabilizer**: don’t do it
- **Compacting base**: 12-ton roller
- **Placing hot mix**: asphalt paving machine
- **Compacting hot mix**: asphalt roller
- **Other**: backhoe, broom, water truck, dozer for edges
Photos from this project (Narrow Widening Construction Process)

**Equipment for first process:**
- Milling Machine
- Maintainer
- 4’ Asphalt Roller
Photos from this project
(Narrow Widening Construction Process)

- Smooth edges cut
- Widened section subgrade compacted
Photos from this project
(Narrow Widening Construction Process)

Next process, following in order:
• Dump truck
• Road Widener
• Front Loader Backhoe
• Water Truck
• Broom
• 12-ton Roller
• Dozer
Photos from this project
(Narrow Widening Construction Process)

- Dump truck applying base material
- Road Widener spreading material
- Backhoe replacing dropped material
Photos from this project (Narrow Widening Construction Process)

- Road widener continuing to spread new base, as backhoe follows behind
Photos from this project
(Narrow Widening Construction Process)

- Water truck follows behind backhoe
- Water is sprayed on new base
Photos from this project (Narrow Widening Construction Process)

- Broom is following close to Water truck
- Broom sweeping excess material
• 12-ton roller follow behind water truck
• Roller making multiple passes to compact base
Photos from this project
(Narrow Widening Construction Process)

- Dozer following last for edges
Photos from this project (Narrow Widening Construction Process)

- Erosion control
  - culvert
Acknowledgement

Thanks to:
• APAC
• Scott Blanchard,
• Ace Mathews
• Mike Weible
Thank You!

Questions?
Narrow widening projects

Kory Keller
Allen Keller Company
• Ranch Road, and Farm to Market experience.

• Parameters
  • Constructability
  • Efficiency
  • Construction Safety
Topics

• Safety Slopes
• Flex Base vs. HMAC
• Aggregate Prime
• Widening vs. Rehabilitation
Safety slopes – the enemy

- Work that is not gainful to the progress of the project.
- Quality Control issues
- Permeates Runoff
While safety slopes are an obvious and necessary hazard abatement, the elimination of the hazard is even better.
How can we avoid the safety slope hazard?

- Avoid the use of multiple layers in pavement design

- Multilayer Example: 6 in flex base, prime, and 2’’hmac
How can we avoid the safety slope hazard (cont)?

• Consider using a single layer, or “monolithic” approach.

• Monolithic example, 6 or 8” of flex base over subgrade, or 4-8” of hmac that fills to final surface.

• The need for the safety slope is eliminated.
Flex base vs. hot mix

- Flex base is considerably cheaper, especially as we move farther away from the HMAC plants.

- HMAC is seasonal

- Unsuitable subgrade risk
Benefits of aggregate prime

• Quick and reliable protective cover

• Finished base under Traffic

• Adheres very well to base course

• Low maintenance under traffic in comparison

• Protects ride quality on finished base
Benefits of aggregate prime (cont)

- Traffic uses the widened road immediately
- Cheap base slope protection
- All season application
Aggregate prime recommendations

- RC-250 with Grade 5 aggregate
  - 0.2-0.23 g/sy
  - Grade 5-Grade 6
    - dry screened
    - Non-coated
Widening vs. Rehabilitation

- Benefit/Cost Ratio
  - Labor
  - Equipment
  - Project Duration

is comparable between widening and Rehabilitation
Widening vs. Rehabilitation

- Major components of increase
  - Cement
  - Extra base
  - Second full width chip seal
CAUTION
NEXT 10 MILES
SINCE JAN 2006
6 KILLED
IN MOTORCYCLE RELATED CRASHES
STAY ALERT
SAVE A LIFE
Completed Project RM 783 Gillespie
Widening RM 336 – Post Agg. Prime
Widening RM 336 – Post Agg. Prime
Widening RM 335 –Before Agg. Prime
Typical Milling Machine
Finishing Base RM335 Real
Katie Strain
TenCate Mirafi – Roadway Reinforcement
Enhancing the Performance and Design Life of Roadways

Michael Samueloff
TenCate Mirafi - Pavement Solutions
Narrow Pavement Widening Using Interlayers
Geosynthetics In Construction

Tencate
materials that make a difference
Geosynthetic Functions

- Separation
- Filtration
- Drainage
- Confinement
- Reinforcement
Separation

Geotextile placed between dissimilar materials so that the integrity of both can remain intact or be improved.
## Product Comparisons

<table>
<thead>
<tr>
<th></th>
<th>RS580i</th>
<th>RS380i</th>
<th>HP570</th>
<th>HP270</th>
<th>600X</th>
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<tbody>
<tr>
<td>AOS</td>
<td>40</td>
<td>40</td>
<td>30</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Flow Rate</td>
<td>75</td>
<td>75</td>
<td>30</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>Permittivity</td>
<td>1.0</td>
<td>0.9</td>
<td>0.4</td>
<td>0.7</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Confinement

Depends on the fill, but usually is a function of interlock for geogrids and friction for geotextiles.
## Product Comparisons

<table>
<thead>
<tr>
<th></th>
<th>RS580i</th>
<th>RS380i</th>
<th>HP570</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci</td>
<td>.90</td>
<td>.89</td>
<td>.85</td>
</tr>
</tbody>
</table>
Mirafi RS580i
Reinforcement

Improvement of the system strength created by the introduction of a geosynthetic into a soil/aggregate system
# Product Comparisons

<table>
<thead>
<tr>
<th></th>
<th>RS580i</th>
<th>HP570</th>
<th>RS380i</th>
<th>HP370</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% XD (#/ft)</td>
<td>1800</td>
<td>1320</td>
<td>1020</td>
<td>540</td>
</tr>
<tr>
<td>5% XD (#/ft)</td>
<td>4380</td>
<td>2700</td>
<td>2255</td>
<td>1560</td>
</tr>
</tbody>
</table>
Stabilization Testing - Permanent Deformation

Actual Number of Cycles and Loads

- Control
- BXG11
- BXG12
- HP570
- RS580i

Rut Depth (mm)

Load Cycles
Mirafi® RS580i, RS380i & RS280i

Integration of 5 Key Properties for Base Reinforcement and Subgrade Stabilization

- High Modulus especially in CMD
- High Water Flow/Permittivity
- Separation (US sieve #40)
- High Interaction Coefficient (Confinement)
- Product Identification
Geosynthetics Pavement Interlayers

Base Preservation – Crack Mitigation
Geosynthetic Pavement Interlayers

- Deterioration Causes & Delay
- Interlayer Types & Functionality
- Cost/Benefit
Pavement Deterioration

From day ONE these forces are at work

- Deficiencies in design, construction and maintenance
- Weather / Environmental Action
- Aging
- Traffic Loading

Crack Growth 1" / Yr Avg

Thermal movement

Moisture intrusion

HMA Overlay

HMA Layer

Base

Subbase/Native
Pavement Deterioration

Forces Interlayers Address

- Water intrusion
- Thermal Movement
- Traffic Loading
- Reflective Crack Forces

Base
Protect base from moisture saturation

Pavement Interlayer Functionality

Interlayer Functions that Delay Deterioration

- Mitigates Weather / Environmental Effects
- Stops water intrusion
- Point Load Distribution
- Stress Absorbing/Dispersing Paving Interlayer
- Mitigate Impact of Thermal Movement
- Delay Crack Return and Severity

Top HMA Layers

Bottom HMA Layers

Base
“One major factor that degrades a roadbed’s ability to function is the infiltration of water into the base material.”

Caltrans Pavement Evaluation Manual
Pavement Condition Survey
John Poppe
Deteriorating Impact of Moisture Intrusion

Useful Life, Compared With Perfectly Drained Pavements-%

% Of Time Structural Section Is Filled With Water

S = SEVERITY FACTOR

S = 5
S = 10
S = 20

From Drainage Of Highway And Airfield Pavements
By Harry R. Cedergren
<table>
<thead>
<tr>
<th>Drainage Quality</th>
<th>Time</th>
<th>Drainage Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>2 hours</td>
<td>1.2</td>
</tr>
<tr>
<td>Good</td>
<td>1 day</td>
<td>1.0</td>
</tr>
<tr>
<td>Fair</td>
<td>1 week</td>
<td>0.8</td>
</tr>
<tr>
<td>Poor</td>
<td>1 month</td>
<td>0.6</td>
</tr>
<tr>
<td>Very Poor</td>
<td>Doesn’t drain</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Pavement Interlayer Value

HOW?

...Extend Life:
✓ Preserve base structural value
✓ Delay crack return & severity
✓ Add flexural strength to HMA

...Greater Value:
✓ Reduce impact of asphalt cost
  i.e. In Dec. 07, $175/ton, today...$650+
✓ Greater benefit at less cost
NEW?...Interlayer evolution to higher levels of performance
✓ to multifunctional, Moisture barrier *Plus* reinforcement
✓ to multi-axial reinforcement
✓ to focus on in-place functionality
**Pavement Interlayer Functionality**

**How Interlayers Work**

<table>
<thead>
<tr>
<th>STRAIN ABSORBING</th>
<th>STRESS DISSIPATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass to soak up (Sponge)</td>
<td>Tensile strength and efficiency to disperse low strain crack energy (Rebar) Multi-Axial strong all directions</td>
</tr>
<tr>
<td>Tighter bond, thicker/more mass = greater ability to absorb = better reflective crack retardation</td>
<td>Tighter bond, higher, more efficient tensile strength, more homogeneous the structure = greater ability to dissipate crack energy = better reflective crack retardation</td>
</tr>
</tbody>
</table>

**Interlayers Types**

<table>
<thead>
<tr>
<th>FABRICS</th>
<th>MAT Multi-Axial</th>
<th>GRIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous Strand Fiberglass</td>
<td>Bi-Axial</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>Multi-Axial</td>
</tr>
</tbody>
</table>
Pavement Interlayer Functionality

**Description**

- **With Asphalt forms Moisture Barrier**
- **With Asphalt absorbs and/or disperses crack forces**
- **Multi-Axial, multi-directional reinforcing**
- **Bi-Axial, 2 way reinforcing, weak at bias angle**
- **With Asphalt tack forms a strong bond between layers**
- **Mills completely and can be added back into new mix**
## Interlayer Functionality Summary

<table>
<thead>
<tr>
<th>TenCate Products</th>
<th>FUNCTIONALITY</th>
<th>Constructibility</th>
<th>Ease of Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moisture Barrier Membrane</td>
<td>Mills + Recycles into new mix</td>
<td>Wide Vs Narrow Rolls</td>
</tr>
<tr>
<td></td>
<td>Crack Stress Relief and Delay</td>
<td>Monolithic bond</td>
<td>Uncoated, Flexible Rolls</td>
</tr>
<tr>
<td></td>
<td>Stress Absorbing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tensile to Reinforce</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bi-Axial</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multi-Axial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Stress Absorbing Geosynthetic Interlayer

<table>
<thead>
<tr>
<th>MPV Polypropylene Fabric</th>
<th>YES</th>
<th>YES</th>
<th>NO</th>
<th>NO</th>
<th>YES</th>
<th>Can Be</th>
<th>YES</th>
<th>YES</th>
</tr>
</thead>
</table>

### Fiberglass Tensile Reinforcing Geosynthetic Interlayers

<table>
<thead>
<tr>
<th>TruPave Multi-Axial Mat</th>
<th>YES</th>
<th>YES</th>
<th>YES</th>
<th>Up to 80N</th>
<th>YES</th>
<th>YES</th>
<th>YES</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGM G4 Multi-Axial Mat</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>Up to 100kN</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>PGM G2 Composite</td>
<td>YES</td>
<td>YES</td>
<td>Up to 100kN</td>
<td>NO</td>
<td>YES</td>
<td>Can Be</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>FG1 Bi-Axial PreCoated self Stick/Scrim</td>
<td>NO</td>
<td>NO</td>
<td>Up to 100kN</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>FGC2 PreCoated Composite</td>
<td>YES</td>
<td>YES</td>
<td>Up to 100kN</td>
<td>NO</td>
<td>YES</td>
<td>Can Be</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

¹ Replaced by G4, ² Replaced by G2
Interlayer Selection by Functionality

- Slight Cracks: FABRIC (PP)
- Moderate Cracks: MAT Glass+ Multi-Axial
- Severe Cracks: GRID Glass + Moisture Barrier

…..increasing ADT & ESALS Traffic Loads

Over Stable Base
Pavement Interlayer Installation

NEW EXTENDED LIFE ASPHALT SURFACE
Figure 5: Asphalt Pavement Analyzer – Wheel Track
Interlayer Functionality Capability

Interlayer Effectiveness and Total Life Averages

- Cycles to 100% failure
- IEF # of cycles with interlayer/#of cycles to 100% crack on the control

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Fabric</th>
<th>Mat</th>
<th>Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to 100% crack-through</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interlayer effectiveness factor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Selection by Type/Functional Impact

Interlayer Impact on Pavement Deterioration Curve

**REHAB - OVERLAY PAVEMENT**

Delay Deterioration - Extend Life (Yr Y – Yr X):

- Original Pavement
- HMA Overlay w/ Interlayers

Pavement Condition:
- Excellent
- Good
- Fair
- Poor

- Time For New Overlay Possibly Recycle
- HMA Overlay Only
- No Interlayer
- Grid at 5.5 times longer
- Mat 2.75 times longer
- Fabric 1.6 times longer
- Failed Pavement

Crack Delay using an interlayer

Pavement Age (Time In Years)
## Interlayer Cost/Benefit Calculation

### Crack Mitigation

## Cost of Hot Mix Asphalt

<table>
<thead>
<tr>
<th></th>
<th>HMA Cost</th>
<th>HMA Density</th>
<th>Lbs/Inch</th>
<th>Tons</th>
<th>Inch/ SY</th>
<th>$5.25</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Mix Asphalt</td>
<td>$75.00</td>
<td>140</td>
<td></td>
<td>0.07</td>
<td></td>
<td>$5.25</td>
<td></td>
</tr>
</tbody>
</table>

### Added Value of Crack Mitigation

<table>
<thead>
<tr>
<th>Interlayer Type</th>
<th>AVG</th>
<th>Total</th>
<th>Added value based on performance Vs cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPV500 4.1 Oz PP Fabric</td>
<td>$2.10</td>
<td>$12.60</td>
<td>20% 1.6 3.2 60% 3.94</td>
</tr>
<tr>
<td>TruPave Multi-Axial Fiberglass Mat</td>
<td>$2.50</td>
<td>$13.00</td>
<td>24% 2.75 5.5 175% 2.36</td>
</tr>
<tr>
<td>PGM G4 Multi-Axial Fiberglass Grid</td>
<td>$6.00</td>
<td>$16.50</td>
<td>57% 5.5 11 450% 1.50</td>
</tr>
</tbody>
</table>

© 2013 TenCate Geosynthetics Americas
### Interlayer Cost/Benefit Calculation

#### Crack Mitigation PLUS Base Saturation Protection

Pavement interlayers that provide crack delay AND added preservation of base structure by creating a moisture barrier to prevent base saturation can add over 50% life over one with base saturation as little as 10% of the time, per the Cedergren study. There is also less maintenance cost for crack filling and less road closure.

#### Cost of Hot Mix Asphalt

<table>
<thead>
<tr>
<th>HMA Cost: $75.00</th>
<th>Ton</th>
<th>HMA Density</th>
<th>140 Lbs/Inch</th>
<th>Tons</th>
<th>0.07</th>
<th>Inch/SY</th>
<th>$5.25</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10.50</td>
<td></td>
<td>2.0 Inch Thickness:</td>
<td>$10.50</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Added Value of Crack Mitigation PLUS Base Protection

<table>
<thead>
<tr>
<th>Interlayer Type</th>
<th>AVG</th>
<th>Total</th>
<th>Added value based on performance Vs cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPV500 4.1 Oz PP Fabric</td>
<td>$2.10</td>
<td>$12.60</td>
<td>20% 1.6 2.4 4.8 140% $2.63</td>
</tr>
<tr>
<td>TruPave Multi-Axial Fiberglass Mat</td>
<td>$2.50</td>
<td>$13.00</td>
<td>24% 2.8 4.1 8.25 313% $1.58</td>
</tr>
<tr>
<td>PGM G4 Multi-Axial Fiberglass Grid</td>
<td>$6.00</td>
<td>$16.50</td>
<td>57% 5.5 8.3 16.5 725% $1.00</td>
</tr>
</tbody>
</table>

50% Added life of keeping base structure dry and protection load bearing capacity 150%
Interlayer Performance Compromised

Expectation Not Met

1. Incomplete Interlayer System:
   Includes Interlayer WITH asphalt

2. Installation quality
   a. Asphalt tack
   b. Overlay too thin
   c. Lack of base prep
   d. Uncut wrinkles

3. Site selected exceeds functionality
   a. Unstable base
   b. Unstable underlying surface
   c. Wide cracks with excessive thermal movement
Performance Compromised: Site Selection

Extreme Pavement and Base Failures

Mix Rutting
Base Failures

Slab Fracture/Uneven

Extreme fatigue cracking/unstable base

Caution! Not all conditions interlayer appropriate!
NC Old Rt. 52
Expansion crack “reflected” through…..after 14 mo.
Arkansas Route 67-Hope, AR

Original Pavement Concrete on 10’centers…widened to 12’-0”
Arkansas Route 67-Hope, AR
Arkansas Route 67-Hope, AR

Level-up w/ 100kN bi-axial grid
Arkansas Route 67-Hope, AR
Interlayer Use Summary

CHEAPEST INSURANCE TO:

- Extend pavement life
- Maximize base performance
- Delay crack return & severity
- Reduce impact of asphalt cost
- Reduce maintenance & road closure

Tencate
materials that make a difference
Mirafi® MTK Crack Solution

- Seals crack – Keeps water out
- Flexes to keep cracks sealed
- Delays reflective cracking
- Slows pavement deterioration
- Fast, easy to install
- Adheres to cleaned surface
- Used in wide temperature range
- Reduces traffic disruption

Mirafi® MTK Roll Dimensions
- 0.30 m x 15.2 m (12 in x 50 ft)
- 0.46 m x 15.2 m (18 in x 50 ft)
- 0.60 m x 15.2 m (24 in x 50 ft)
- 0.91 m x 15.2 m (36 in x 50 ft)
Mirafi® MTK Crack Solution

Asphalt Overlay

Existing Pavement

Mirafi® MTK

Subgrade

Control Joint or Crack in Existing Pavement
Thank You

QUESTIONS?
TenCate Mirafi

Katie Strain
Roadway Engineer
Cell: (512) 534-9028
k.strain@tencate.com

Michael D. Samueloff
Pavement Engineer
Cell: (248) 302-8806
m.samueloff@tencate.com

www.tencate.com
Geosynthetic Reinforcement for Shoulder Widening & Rehabilitation
Project 0-6748 Best Practices

Texas Department of Transportation
Austin, TX

July 2, 2013

Tensar International Corporation
Stephen Archer, P.E. – Frisco, TX
Agenda

- Product Description/Historical Usage
- Geogrid Mechanisms
- Application Definition
- TxDOT Specifications for Geogrids in Roadways
- TxDOT Narrow Widening Examples – Typical Sections
- Pavement Interlayers for Narrow Widening
Rib Profile - Typical Biaxial Geogrid
Tensile Stiffness in Two Directions

-30°  0° (MD)  +30°

+60°  +90° (TD)
Lateral Restraint - TEXAS Aggregate Sources

- Subgrade CBR = 6.0

Uvalde, TX - LS at 6.5% moisture (OMC)

Laredo, TX - Caliche at 7.5% moisture (OMC)
<table>
<thead>
<tr>
<th>Property</th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture Size, mm (in)</td>
<td>25 - 51 (1.0 - 2.0)</td>
<td>25 - 51 (1.0 - 2.0)</td>
</tr>
<tr>
<td>Percent Open Area, %</td>
<td>70 minimum</td>
<td>70 minimum</td>
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<tr>
<td>Thickness, mm (in)</td>
<td>0.77 (0.03) minimum</td>
<td>1.27 (0.05) minimum</td>
</tr>
<tr>
<td>MD ribs</td>
<td>0.64 (0.025) minimum</td>
<td>1.15 (0.045) minimum</td>
</tr>
<tr>
<td>CMD ribs</td>
<td>1.50 (0.06) minimum</td>
<td>2.54 (0.10) minimum</td>
</tr>
<tr>
<td>Junctions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Modulus @ 2% elongation *, N/m (lb/ft)</td>
<td>204,260 minimum (14,000) minimum</td>
<td>291,100 minimum (20,000) minimum</td>
</tr>
<tr>
<td>MD &amp; CMD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Efficiency, % of rib ultimate tensile strength MD &amp; CMD</td>
<td>90 minimum</td>
<td>90 minimum</td>
</tr>
</tbody>
</table>

* Determined as a secant modulus without offset allowances.
<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirements</th>
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<tbody>
<tr>
<td><strong>Ultimate Tensile Strength (lb/ft)</strong></td>
<td>Tex-621-J</td>
<td>850 minimum</td>
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<tr>
<td>MD² and CMD²</td>
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<td></td>
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<tr>
<td><strong>Tensile Strength at 2% strain (lb/ft)</strong></td>
<td>Tex-621-J</td>
<td>270 minimum</td>
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<tr>
<td>MD and CMD</td>
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<tr>
<td><strong>Junction Strength (lb/junction)</strong></td>
<td>Tex-621-J</td>
<td>20 minimum</td>
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<tr>
<td>MD and CMD</td>
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<td></td>
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<tr>
<td><strong>Aperture Size (in.)</strong></td>
<td>Tex-621-J</td>
<td>0.5–2.0</td>
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<tr>
<td>Range in either MD or CMD</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent Open Area</strong></td>
<td>Tex-621-J</td>
<td>60% minimum</td>
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<tr>
<td><strong>Resistance to Installation Damage</strong></td>
<td>Tex-629-J</td>
<td>≤ 2 ruptured</td>
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<tr>
<td>a. Ribs</td>
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<td>≤ 2 displaced or ruptured</td>
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<tr>
<td>b. Junctions</td>
<td></td>
<td>75%</td>
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<tr>
<td>c. Retained tensile strength ratio</td>
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Mechanisms – Improved Bearing Capacity

Source: USACOE ETL 1110-1-189
Texas does not have a formal guideline for the use of geogrid. We have had a significant usage of geogrid in three primary applications: reduce environmental cracking from subgrade desiccation, construction platforms in subgrade soils with high sulfate content, and construction expediency over soft soils.

Geogrid has been used to mitigate the effects of cracking due to soil movement. One rule of thumb that has been applied is to place grid where the PI of the subgrade has exceeded 35. This has reduced desiccation cracking often observed on shoulders or in the roadway if shoulders are not present or are narrow. Grid has also been placed between stabilized base (recycled roadway materials) and new granular base to reduce cracking from both soil movement and shrinkage cracking often observed in stabilized bases.

Until we have more experience and better control of techniques to incorporate calcium based stabilizers into subgrade soils with high levels of sulfates, some regional offices have chosen to use geogrid as a substitute to provide a working platform if not a support layer substitute. There are also the projects of the more typical construction expediency application, establishment of a construction platform.

Texas has taken a cautious approach to geogrid application to ensure there is a measurable benefit to installation. No structural credit is offered in pavement design at this time and is not anticipated until there is more research and quantification of its structural benefits.
Mechanisms Differ for Application Types

Subgrade Stabilization
- Bearing Capacity

Environmental Cracking
- Lateral Restraint

Pavement Optimization
- Lateral Restraint
- Bearing Capacity
- PI > 35: Consider geogrid at Base-Subgrade interface
Environmental Cracking
Environmental Cracking

Unreinforced Road on high PI Clay
Practical Application in Narrow Widening

Geogrid-Reinforced DBST Road on high PI Clay
Materials Cost Snapshot
(Source: TxDOT Average Low Bid Unit Price – Jul 2012 through Jun 2013)

- HMA (Asphalt): $3.98 / SY-in
- Flexible Base: $1.12 / SY-in
- Lime Treatment: $0.54 / SY-in
- Cement Treatment: $0.39 / SY-in
- Geogrid: $1.58 / SY
Pavement sub-layers cost:

\[(10" \times $1.12/\text{SY-in}) + (6" \times $0.54/\text{SY-in}) + ($1.58 / \text{SY}) = \]

\$16.02/\text{SY (w/ geogrid)}

\$14.44/\text{SY (w/o geogrid)}

Life-Cycle Cost Analysis:

Design Life: 15 years
Discount Rate: 4%

Maintenance Cost: $85,000
Rehabilitation Cost: $170,000

\textbf{PWOC (Life-Cycle Cost Savings): $196,000}

(Calculations based upon 1993 AASHTO Empirical Pavement Design Method)
Pavement Profiles

Recent installations of Geogrid for Narrow Widening Applications
US 183 – Caldwell Co.
**Detail 2**

Passing Lane 10

Planing must follow existing travel lane cross slope which varies. Refer to cross sections sheet(s) for more information.
1" THIN OVERLAY MIX

3" HOT MIX ASPHALT
TYPE B

PRIME COAT
(AE-P OR MC-30)

11" FLEX BASE#

GEORGRID

8" LIME TREATED SUBGRADE

SAWCUT

*1' NOTCH CUT AT 3" DEPTH

GEORGRID OVER 8" LIME TREATED SUBGRADE
Pavement Interlayers for Narrow Widening

Geosynthetic Interlayers for Pavement Rehabilitation Applications
Geosynthetic Interlayers for Pavements

Conventional Overlay

Overlay w/ Geosynthetic
US 277 – Maverick Co.

DETAIL- 2
PASSING LANE 10

EXIST ACP
EXIST FLEX BASE

EXIST 8' SHLDR TO BE PLANED (2"-0")
EDGE OF PAVEMENT

PROP. WIDENING

PROP. ONE CRSE SURF TRT
PROP. 2" ACP (TY C)
PROP. 4" ACP (TY B)
PROP. PRIME COAT
PROP. 12" FLEX BASE (DONE IN 2 LIFTS)
PROP. GEOGRID

PLANING MUST FOLLOW EXISTING TRAVEL LANE CROSS SLOPE WHICH VARIES REFER TO CROSS SECTIONS SHEET(S) FOR MORE INFORMATION
Texas Case Studies – Shoulder Repair

Van Hut Road - Harris, County, TX
GlasGrid installation 03/13/2006

Van Hut Road - Harris, County, TX
3 years after installation 08/14/2009
Agenda

- Product Description/Historical Usage
- Geogrid Mechanisms
- Application Definition
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Geosynthetic Reinforcement for Shoulder Widening & Rehabilitation
Project 0-6748 Best Practices

Texas Department of Transportation
Austin, TX

July 2, 2013

Tensar International Corporation
Stephen Archer, P.E. – Frisco, TX
Appendix D – TxDOT Presentations
Austin District Pavement Widening

Project 0-6748, “Narrow Pavement Widening Webinar-Workshop”
July 2, 2013
Mike Arellano, P.E.
Historical Practices

- “Narrow Widening”: 3 to 6 foot safety widening
  - Flexible Pavement
    - Match adjacent section with HMA and flexible base
    - Compaction issues – equipment wider than the section
    - Differential consolidation of pavement between existing and widened section
    - Differential consolidation or movement of subgrade
    - Start to use geogrids for reinforcement and improve compaction
Historical Practices

- Full Depth HMA or Cement Treated Base (Plant)
  - No lateral drainage
  - With stiffer shoulder ~ load transfer issues with less stiff existing pavements
  - Impermeable barrier, especially in super elevation sections
  - Water infiltration at construction joint
    - Use underseals, but water always finds a way
  - Accelerated damage to existing section
  - Long-term issues = Full rehabilitation
  - Still use deep HMA, but not full depth,
    - Insure drainage at depth with good subgrade conditions
    - In urban areas (super-street or turn-lanes) with thick pavement structures
Current Practices

- No narrow widening...if possible
  - Benefit/Cost ratio better to rehab or widen wider than widen narrow and incur long-term maintenance costs
- Widen wider!
  - Uniformity
  - Better Construction = High Probability of Success
  - Salvage Existing Material
  - Address other issues like edge failures from drought damage
Conventional Widening
SH 21 – Lee County
STA 220+97.70

TX 5
Control – No grid
BX 1100

TX 130
Control – No grid
BX 4100

4500'
4500'
~700'
4500'
Alternative Widening

- Accelerated Construction Section
  - Urban areas
  - Alternate to Full Depth HMA
  - Flexible Pavement with inverted prime coats (RC-250 w/ Grade 5)
  - Use of geosynthetic (separation/reinforcement layer)
- 3” Aggregate (Similar to TY D Backfill)
  - Maintain lateral drainage
  - Easy compaction with little to no secondary consolidation, especially in a 3-4 foot trench
  - Widen section move similar to the adjacent existing section
3" Rock Drainage Layer with Geosynthetic Separation

First Geogrid Layer

Salvage Material

Cement Treated Salvage

2nd Geogrid Layer
SH 21 – Bastrop County

- TenCate Mirafi® woven geosynthetic
- Wicking Capability
- Special hydrophilic and hygroscopic yarn that provides wicking action through the plane of the geosynthetic.
SH 21 – Bastrop County

- CTR is monitoring the moisture levels and migration in this test section using moisture probes.
- Goal is to see if there is any benefit to this new woven geosynthetic product.
- If the moisture can be controlled, this may diminish the soil movement at the edge of pavement.
- May allow denser material adjacent to the existing pavement.
Questions
Waco District Experience

Project 0-6748:
Narrow Pavement Widening

Don Miller, P.E. – Waco Design
John Jasek, P.E. – Director Construction
Waco District
‘Mixed Climate’

30 – 35 inches rain
(when not in drought)
Hot in summer
Cold in winter

Some sulfate soils
Heavy clays
Heavy trucks
FM 56  Bosque County
STATE OF TEXAS
DEPARTMENT OF TRANSPORTATION

PLANS OF PROPOSED
STATE HIGHWAY IMPROVEMENT
FEDERAL AID PROJECT

BOSQUE COUNTY
FM 56

LENGTH OF PROJECT: 45,840,000 FT. = 13.742 MI.

LIMITS: FROM FM 1713 TO SH 22, ETC.

CONSISTING OF PROPOSED ADDITIONAL PAVED SURFACE WIDTH.

RECEIVED
JUL 22 2010

HILLSBORO AO

FINAL PLANS
RECEIVED
JUL 22 2010

HILLSBORO AO

STATEMENT OF EVALUATION

RECOMMENDED FOR

APPROVED FOR LETTING

SPECIFIC TRAFFIC OPERATIONS DIVISION

APPROVED FOR LETTING

SPECIFIC DESIGN DIVISION

RECOMMENDED FOR

APPROVED FOR LETTING

SPECIAL TRANSPORTATION PLANNING

APPROVED FOR LETTING

SPECIAL DESIGN DIVISION

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FM 56 Before Widening
FM 56 Before Widening
FM 56 Before Widening
FM 56 During Construction
FM 56 During Construction
FM 56 During Construction
FM 56 During Construction
FM 56 During Construction
After level-up
After Seal Coat
Have Experienced Problems with pavement failures
STATE OF TEXAS
DEPARTMENT OF TRANSPORTATION

PLANS OF PROPOSED
STATE HIGHWAY IMPROVEMENT
PROJECT NO: STP 2001 (HIL) 5B

HILL COUNTY
FM 309, ETC.
LIMITS: SH 22 TO CM 1361, ETC.

PROJECT NO:

INDEX OF SHEETS

 SHEET NO. | DESCRIPTION
-----------|-------------
 1         | TITLE SHEET
 2         | INDEX SHEET

INDEX OF SHEETS

FM 309

FM 1947

HILLSBORO

SCALE: 1" = 2 MI.

FOR THE CONSTRUCTION OF SAFETY ELIMINATION AND SAFETY
CONSISTING OF PROVIDE ADDITIONAL FITED SURFACE WIDTH.
FM 309 Finished Product
FM 309 Experiencing joint cracking due to drought
FM 309 Experiencing joint cracking due to drought
Questions ???
San Angelo District
Experience

Project 0-6748:
Narrow Pavement Widening
Overview

• Maintenance Experience

• Construction Projects
San Angelo District
Energy Sector
Energy Sector
Edge Drop Offs
Edge Drop Offs
Traditional Method
Scope of Work

W = 2 – 3 ft

D = 6 – 8 in

TY A LRA (Black Base)
Bonnell Road Widener

Cost = $2000
Road Widener
In-House Device
Road Widener
Road Widener
In-House Device
In-House Device
Belly Dump
Side Discharge Conveyor
Side Discharge Conveyor
Side Discharge Conveyor
Side Discharge Conveyor
Level Material
Compaction
Compaction
Compaction
Compaction
Finished Product
Finished Product
Maintenance Experience

• Material Cost: $20,000 / Lane Mile

• Production: ½ Lane Mile / Day
Construction Project

FOR THE CONSTRUCTION OF HAZARD ELIMINATION AND SAFETY CONSISTING OF WIDEN ROADWAYS

BEGIN PROJECT
STA. 00+00.00
BEGIN C-S-J 0830-01-017
TRM 454+0.050
DFO 0.000
MILE POINT 0.000
LATITUDE 30.07757541
LONGITUDE -100.04649281°

END PROJECT
STA. 240+35
END C-S-J 0830-01-017
TRM 458+0.500
DFO 4.552
MILE POINT 4.552
LATITUDE 30.02445105°
LONGITUDE -100.06819725°

BEGIN PROJECT
STA. 501+71
BEGIN C-S-J 0554-01-031
TRM 464+1.600
DFO 9.502
MILE POINT 9.502
LATITUDE 28.93595099°
LONGITUDE -99.79965448°

END PROJECT
STA. 903+20
END C-S-J 0554-01-031
TRM 472+1.300
DFO 17.106
MILE POINT 17.106
LATITUDE 29.84991722°
LONGITUDE -99.78269755°

© 2011 Texas Department of Transportation
Project STP 2012(456) HRR, ETC.

CSJ: 0554-01-031, ETC.

Highway: RM 336, ETC.

County: Real

Length: 24.673 mi

Cost: $3,573,173.63

Area Engineer: R. Lewis Nowlin, P.E.

Contractor: Allen Keller Company
Limited Work Area
Limited Work Area
Existing: 18 ft to 20 ft Wide
Scope of Work: Add 3’ w/ 6:1 Base Taper
ROADTEC RX-600e
Step 1: Mark Cut Line
Step 2: Mark Cross Slope
Step 3: Blade Existing Grass Off
Step 4: Remove Existing Material 6” Deep and 6.5’ Wide
ROADTEC Miller in Operation
Provides Clean Cut
Mills Through Existing Rock
Mills Through Existing Rock
Step 5: Haul Off Excavated Material
Step 6: Compact Existing Subgrade
Step 7: Dump Pre-Wet Flexbase
Step 8: Process Flexbase
Step 9: Prime with RC-250 Asphalt and Gr 5 Aggregate

Overlap joint 6 in

Prime front slope
Remaining Work: Place Final Seal Coat
Remaining Work: Place Final Seal Coat
Project STP 2012(456) HRR, ETC.

Project Cost: $145,000 / Mile
BRYAN DISTRICT - PAVEMENT WIDENING

Project 0-6748, “Narrow Pavement Widening Webinar-Workshop”
July 2, 2013
Darlene Goehl, P.E.
Outline

- Widening Projects
  - 3’ Shoulders for safety projects
- Initial Design philosophy
- Problems during construction
- Cost Analysis and Design Change
- Current design Philosophy
Initial Design Philosophy

- Select Roadways with good existing pavement condition
- Widen to each side with thick flexible base
  - Widening with denser material than existing causes “bathtub” effect, which increases the deterioration rate of the existing pavement.
  - Future rehabilitation projects would recycle the new base into the old pavement
  - Minimize subgrade and front slope work
Typical Section – FM 244

PROPOSED TYPICAL SECTION

STA 0+00 TO STA 125+00
Construction Problems
Construction Problems
Problems

- Compacting narrow widening
- Early Maintenance of deteriorated construction Joint
- Can we design a cost effective widening that is competitive with the other projects in the State based on the benefit-cost ratio?
## Cost Effective Solution

- **Pavement Design**
  - Uniform Pavement Structure
  - Eliminate the narrow area compaction problems
  - Cost competitive design

<table>
<thead>
<tr>
<th>County</th>
<th>Highway</th>
<th>csj</th>
<th>LOW BID</th>
<th>SY</th>
<th>cost/sy</th>
<th>miles</th>
<th>Typ Sec</th>
<th>comments</th>
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<tbody>
<tr>
<td>Milam</td>
<td>FM1712</td>
<td>0210-03-021</td>
<td>$1,046,654.75</td>
<td>56047.79</td>
<td>$18.67</td>
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<td>Milam</td>
<td>FM487</td>
<td>0210-03-022</td>
<td>$276,144.74</td>
<td>17313.71</td>
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<td>Narrow</td>
<td>Additional Maintenance</td>
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<td>FM1600</td>
<td>1519-01-030</td>
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<td>58528.21</td>
<td>$18.19</td>
<td>3.563</td>
<td>Uniform</td>
<td></td>
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</tbody>
</table>

| Avg Uniform | $18.43 |
| Narrow      | $15.95 |

| Difference | $2.48 |

~$40,750 per mile more for Uniform pavement structure
Typical Section

- **SUBGRADE WIDENING**
- **Existing Pavement Limits of Pay SCARIFY & RESHAPE**
- **SCARIFY AND RESHAPE BASE**
  - Existing pavement over widened subgrade
- **HALF SECTION SUBGRADE WIDENING**
- **HALF SECTION SCARIFY & RESHAPE BASE**

- **Proposed Subgrade Width**
- **Limits of Pay Flexible Base**
  - Proposed Surface Width

- **HALF SECTION CEMENT TREAT SUBBASE**
  - COMPACTED SUBBASE (EXIST MATL)
- **HALF SECTION FLEXIBLE BASE**

- **PROPOSED TYPICAL SECTION**
Uniform Pavement Structure
Uniform Pavement Structure
Questions
0-6748: Best Practice for Flexible Pavement Structure Widening Projects

Atlanta District Experience

André de Fortier Smit
Miles Garrison
Widening Construction

• Fast moving:
  – Subgrade + Flexbase = 0.5 mile/day/side
  – Flexbase + Prime = 1 mile/week

• No pavement drop-off at the end of the day

• Equipment (contractor):
  – Modify grader for subgrade widening
  – Use smaller milling machine
  – Don’t disturb existing side slope
Widening Construction

• Longitudinal construction joint:
  – Compaction issues
  – Flexbase settlement
  – Patch prior to OCST
  – If severe, overlay problem areas with HMA using drag box

• Not always possible to extend or widen existing drainage structure with road widening due to timing of funding
District Interview

• Most of the widening of roads in Atlanta district is completed, 95% - 98%, so very few projects are planned or ongoing

• Atlanta is particularly wet (compared to other districts) with very few HMA plants, hence their widening projects differ significantly from their neighbor, Tyler, which uses a lot of HMA for widening.
Pavement Widening Design

Surface Treatments

- 1 - 2" Bituminous*
  - 6" Flexbase
  - Subgrade

- 10" Flexbase
  - Subgrade

* Seal coats, blade on LRA and ACP
Widening

• Widening typically involves 10 inches of unstabilized flexbase, a level-up and seal coat covering the entire roadway - decision could be dictated by age of last seal and when scheduled for next District Wide seal.

• 6” to 8” of cement stabilized subgrade when widening 4 feet or more. Helpful when widening out over old ditch line. When used minimum width of cement treatment is 7 feet.
Widening

- If the road is under the district wide seal coat program then the widening will receive a second surface treatment as well. Lots of attention to ensure adequate drainage – Atlanta is a wet district!
## Design per Funding

<table>
<thead>
<tr>
<th>Safety Bond (78 projects)</th>
<th>ESALS (1,000s)</th>
<th>ATHWLD (lbf)</th>
<th>% Tandems</th>
<th>Texas Triaxial, in</th>
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<tbody>
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<td>AVG</td>
<td>384</td>
<td>9,682</td>
<td>53</td>
<td>15</td>
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<tr>
<td>MIN</td>
<td>41</td>
<td>7,600</td>
<td>10</td>
<td>10</td>
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<tr>
<td>MAX</td>
<td>1,519</td>
<td>10,500</td>
<td>80</td>
<td>28</td>
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<th>ESALS (1,000s)</th>
<th>ATHWLD (lbf)</th>
<th>% Tandems</th>
<th>Texas Triaxial, in</th>
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</thead>
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<tr>
<td>AVG</td>
<td>469</td>
<td>9,941</td>
<td>58</td>
<td>16</td>
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<tr>
<td>MIN</td>
<td>41</td>
<td>7,600</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>MAX</td>
<td>1,335</td>
<td>11,500</td>
<td>90</td>
<td>25</td>
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</tbody>
</table>
Safety Bond: Design ESALS

![Bar graph showing standard axle loads](image)
Safety Bond: ATHWLD

Average of the Ten Heaviest Wheel Loads (ATHWLD)

Frequency

ATHWLD, lbf
Safety Bond: Percent tandems

[Bar chart showing frequency distribution of percent tandems]
Safety Bond: Texas Triaxial

- Texas Triaxial Depth

- Frequency vs. Texas Triaxial Depth, in

- Bar chart showing frequency distribution of Texas Triaxial depth.
HES: ESALs

**Standard Axle Loads**

- **Frequency**
  - 14
  - 12
  - 10
  - 8
  - 6
  - 4
  - 2
  - 0

- **ESALs, Thousands**
  - 300
  - 600
  - 900
  - 1200
HES: ATHWLD

Average of the Ten Heaviest Wheel Loads (ATHWLD)

Frequency

ATHWLD, lbf

THE UNIVERSITY OF TEXAS AT AUSTIN
WHAT STARTS HERE CHANGES THE WORLD
HES: Percent tandems
HES: Texas Triaxial

Texas Triaxial Depth

Frequency

Texas Triaxial Depth, in

0  5  10  15  20  25  30

12  16  20  24
0-6748: Best Practice for Flexible Pavement Structure Widening Projects

Pavement Widening Equipment

Mike Murphy
Maria Burton
**Equipment types:**
- Milling machines
- Attachments for skid steer and front end loaders
- Road wideners
  - Non self-propelled & self-propelled
- Full depth reclamation equipment
- Small compactors and other devices to ensure good quality projects
Milling Machines

Roadtec
RX-400e Cold Planer

Roadtec
RX-700 Cold Planer

Roadtec
RX-600e Half-Lane Cold Planer

Roadtec
RX-900 Cold Planer

Caterpillar
PM-201 Cold Planer

Wirtgen
Cold Milling Machine W 150/W 150i
Attachments
(for Skid-Steer Loaders)

Skid steer with **Road Hog** Self Power Cold Planer attached

- Hydraulic tilt, depth, and sideshift controls
- Options for narrower drums
- Models 18” - 40” cutting width
Skid steer with a **Road Widener** attached

- Easy to maneuver around obstructions (e.g. guardrails, sign posts)
- Shoulder widths 1 – 3.5’
- Trench repairs
- Bicycle trails and paths
Attachments (for Skid-Steer Loaders)

RoadHog
Road Saws

PowerAttachments – Zanetis
Cold Planers (Spain)
Attachments
(for Front-End Loaders)

Front-end loader with Road Hog Self Powered Cold Planer attached

- Models 30” - 72” cutting width
- Shoulder milling, pothole milling
- Cuts for utility pipe installation
- In-place pavement recycling
- Full depth reclamation
Attachments
(for Front-End Loaders)

Front-end loader with Asphalt Zipper attached
Attachments
(for Road Graders)

- Some districts / contractors use:
  - motor graders to cut the trench
  - a plow mounted to the front of the grader to clear the trench
  - a belly dump to place the base material
Attachments
(for Road Graders)

Road grader with a **Bonnell** Road Widener attachment

Road grader with a **Bonnell** Flow Gate attachment
Road grader with a Maddock rotary cutter attachment

CAT Motor Grader Scarifier
Non Self-Propelled Road Wideners

Midland Machinery Widener Attachment

- Spread width: 1’ – 8’
- Spread depth: 12’ above to 12’ below grade
- Heavy duty caster wheels – don’t deflect under load as pneumatic tires do
Lessons Learned:

- Non self propelled & skid steer/front end loader equipment:
  - Used successfully for short projects, edge repairs & patching
  - Not of sufficient strength to handle a full size (longer) construction project
  - Front end loader devices are mounted too far away from the operator
    - Hard to feel cutting depth
    - Hard to control line of cut
Self-Propelled Road Wideners

- **Lessons learned:**
  - Important to match the size of the self propelled road widener to the project
    - light weight machines might not provide adequate quality or may break down due to overload
Midland Machinery Co. Self Propelled Road Wideners

• spread width: 1 to 12’ max, 10’ max., 8’ max.
• 12” above to 12” below grade
• Trench fill option, broom option

• Converts left or right side spreading
Self-Propelled Road Wideners

Weiler Road Wideners

• 1’ – 8’ widening
• optional weight kits – can widen up to 10’
• working depth: 12” above to 12” below grade

• optional rear steering for maneuverability
Mid-State Equipment Company – Wilspread road widening machine

- Build road shoulders 1’ – 5’ width
- Operator controls flow of materials and spread speed
Self-Propelled Road Wideners

Blaw Knox
RW-100B Road Widener

Franex
Self-Propelled Road Widener EL1000 (France)
**Lessons Learned:**
- Recommended: cutting the joint further into the pavement
- Gain more good base material and to stabilize the pavement with emulsion
- Overall added width remains same
  - Amount used in widening will be greater
  - End product of higher quality
Full Depth Reclamation (FDR)

Example:

**Narrow widening project:**

- Reclaimer linked to Emulsion Tank Truck
- Included larger portion of existing pavement
  - ensured base material available for widening
- Additional material added, scarified with Wirtgen with Emulsion
- Worked with a grader, rolled with a sheep's foot, then flat wheel and pneumatic tired roller
- Overall added width remained same
  - but allowed use of full size equipment & got better quality
Full Depth Reclamation (FDR)

- Some Districts own a BOMAG or CAT tiller which can be used to perform Full Depth Reclamation on narrow widening projects.
Other Equipment - Rollers

Mauldin Paving Products
4700 Pneumatic Roller

Broons
Square Impact Rollers

Broons
BH-1300 Impact Roller

Hamm
CompactLine HD 8 – HD 14, The flexible all-rounder

Sakai SW/TW300-1 Series
Vibratory Asphalt Rollers

Sakai R2H-2 Series
Three-Wheel Static Roller

(Australia)
More Equipment (from around the world)

(Germany)

Midland Europe (SPR 6 shown)

(Sweden)

Dynapac - Equipment (Compact Planer – PL350T shown)

(Australia)

Flocon Road Base Grader Attachment

(Australia)

Sharpe Brothers Sidewinder

(U.K.)

UK Sidewinder Widening Machine