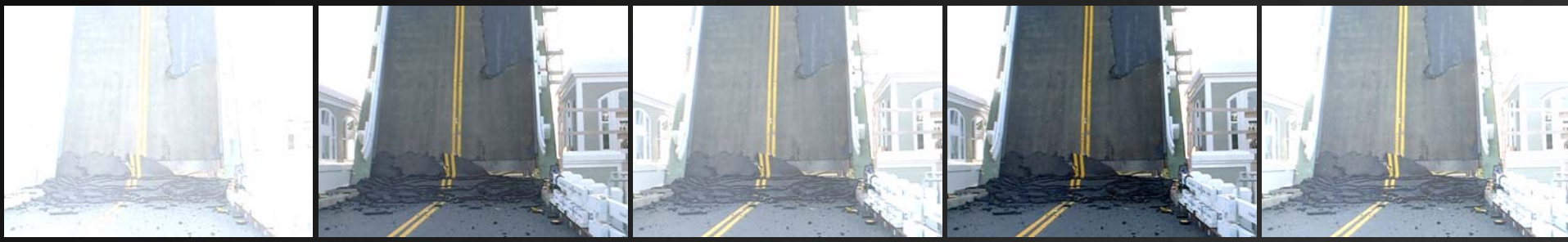
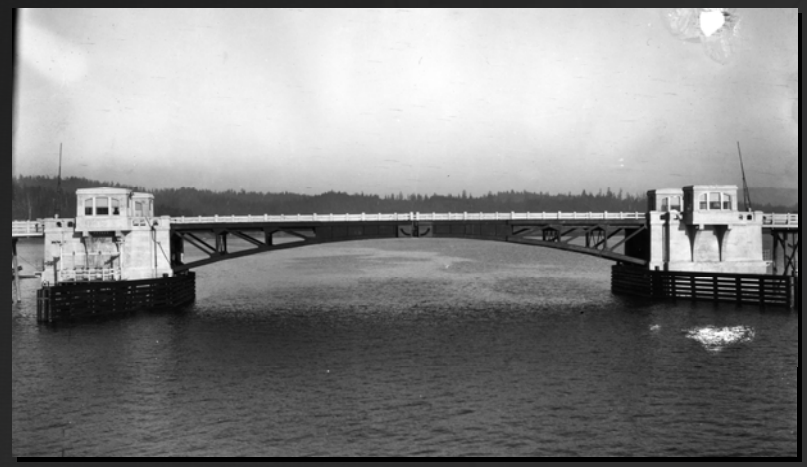


Oregon DOT's FRP Bridge Decks

By Steven Lovejoy

Oregon Department of Transportation

ODOT has 3 Bascule Bridges with FRP Decks



Chronology

- **Lewis and Clark River Bridge was the first structure to have a FPR deck installed in 2002**

Chronology

- **Old Young's Bay Bridge was the second structure to have a FRP deck installed in 2002**

Chronology

- **Siuslaw River Bridge was the last bridge to have a FRP deck installed in 2005**

Purpose of Presentation

- Briefly summarize the installation of the FRP decks
- Discuss connection details
- Discuss wear surface selection
- Summarize service performance
- Present recommendations

Lewis and Clark River Bridge

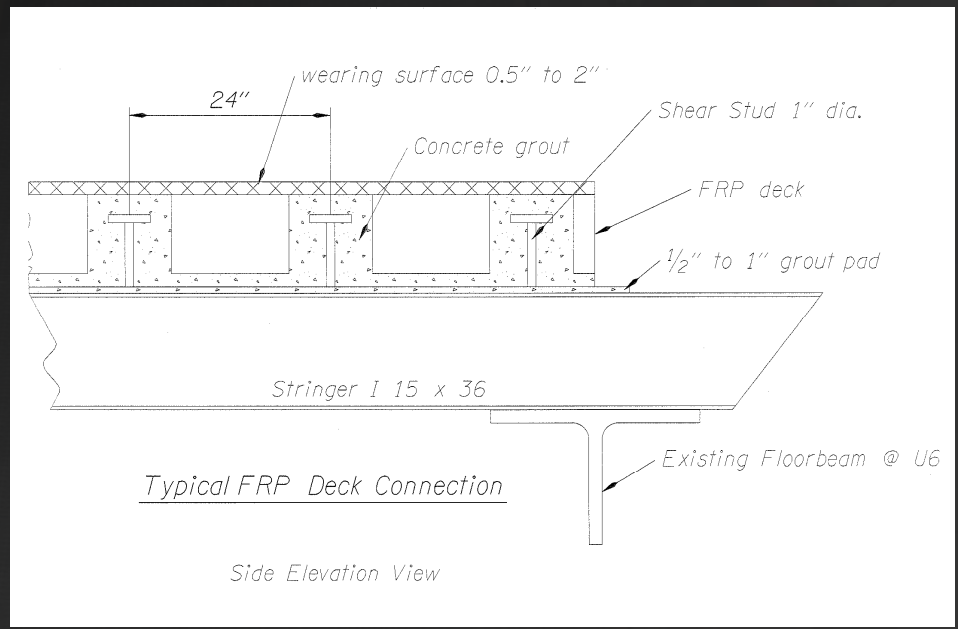
- Built in 1924 with timber/asphalt deck
- Carries US101 Business Route near Astoria, OR
- Deck replacement project was combined with Old Young's Bay Bridge

Troubles Began in Design Phase

- FRP decks were selected for trial and partially subsidized by FHWA to try new materials
- Very little engineering went into the plans and specifications concerning the deck
- Connection details were left to the deck manufacturer
- Wear surface was unspecified other then commercial mix asphalt with 2” thickness

Martin Marietta was the deck Supplier

- The approved detail used shear studs welded to the stringers which were then encased in concrete grout
- Stringers spaced at 2’-9”

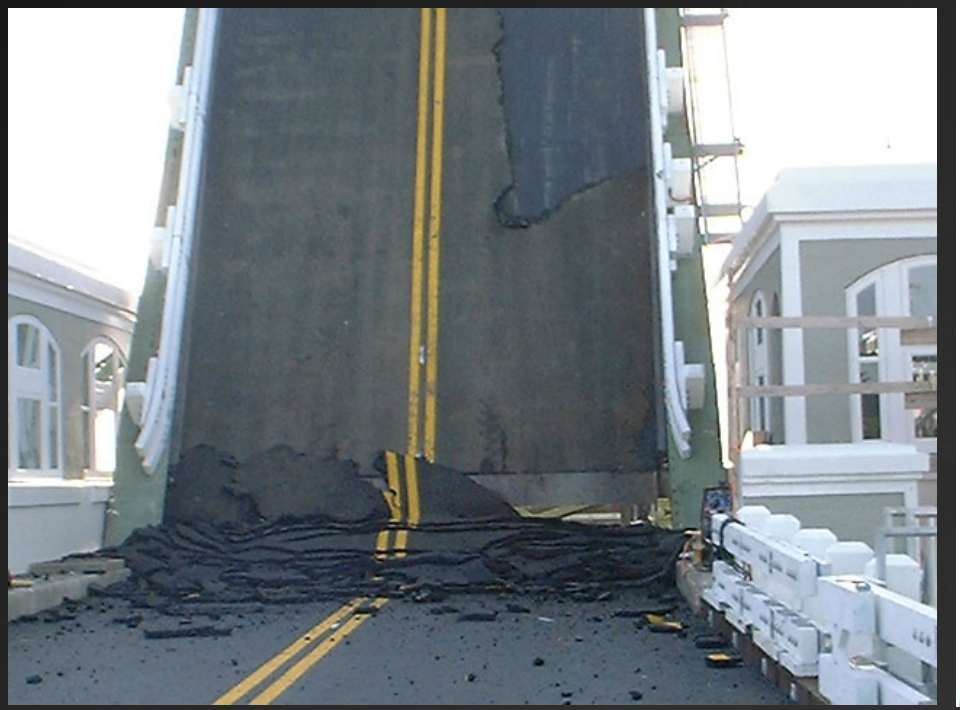


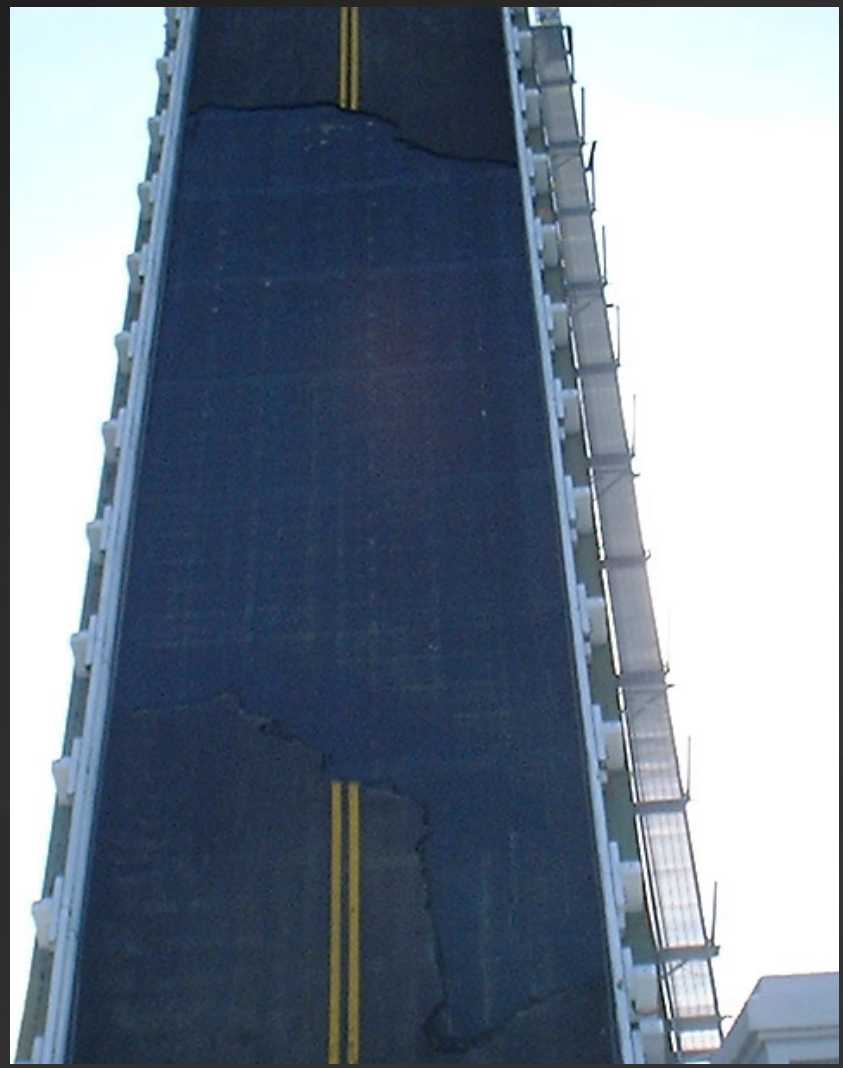
Deck to Flooring System Connection

Wearing Surface

- A “commercial” mix of asphalt concrete was specified
- A emulsified tack coat was first applied
- 2 inches of asphalt was then applied and rolled but not compacted

Result Were Spectacular!





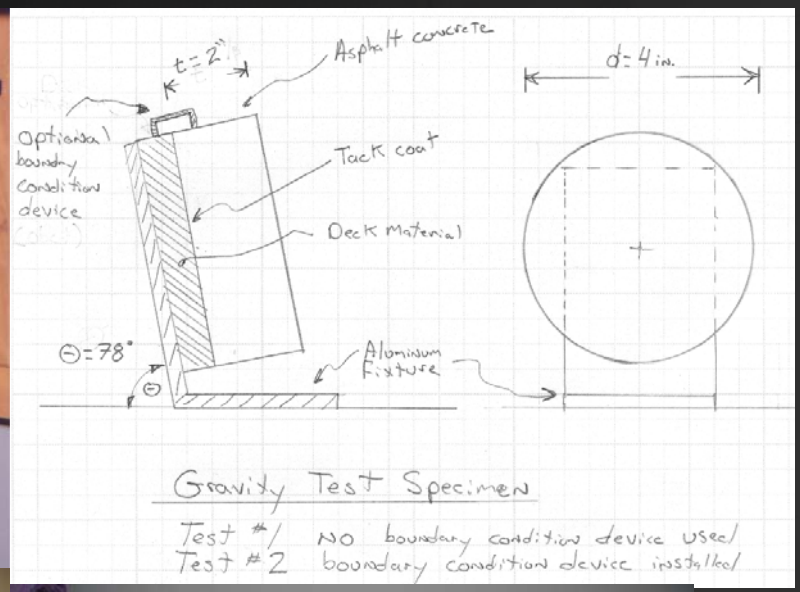
What happened?

- Upper layer of asphalt was semi-compacted with voids in the lower layers
- Water filled the voids with the span in the horizontal position under heavy rains
- Sun came out and warmed the deck greatly reducing the creep strength of the tack coat
- Raising the span caused the water in the voids to follow gravity

What happened?

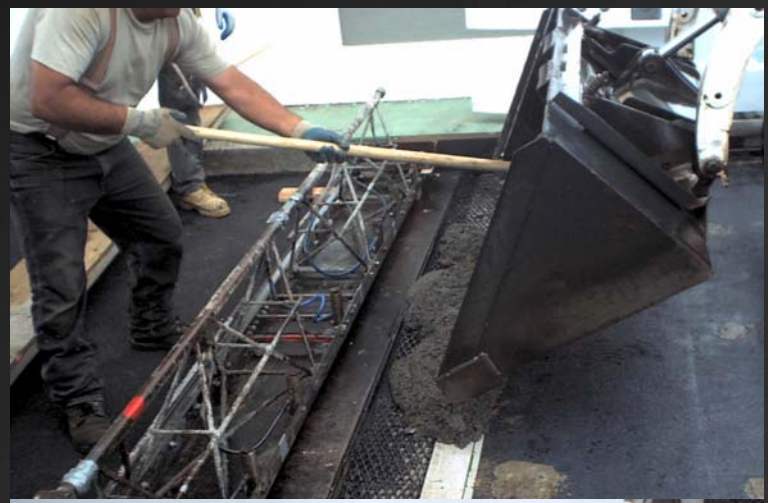
- Water could not easily escape the asphalt and pore pressure raised putting the tack coat in tension
- Author witnessed water jetting out of the lower sections of the deck as the asphalt debonded

Rush Test Program for Redesign



Epoxy concrete was selected

- An epoxy concrete was selected as the lowest risk system given the limited testing program
- A 2 inch thick wear surface was then installed
- 77,000 lbs of counter weight had to be added



Old Young's Bay Bridge

- **Built in 1921**
- **Carries US101 Business Route**
- **5'-4" stringer spacing**

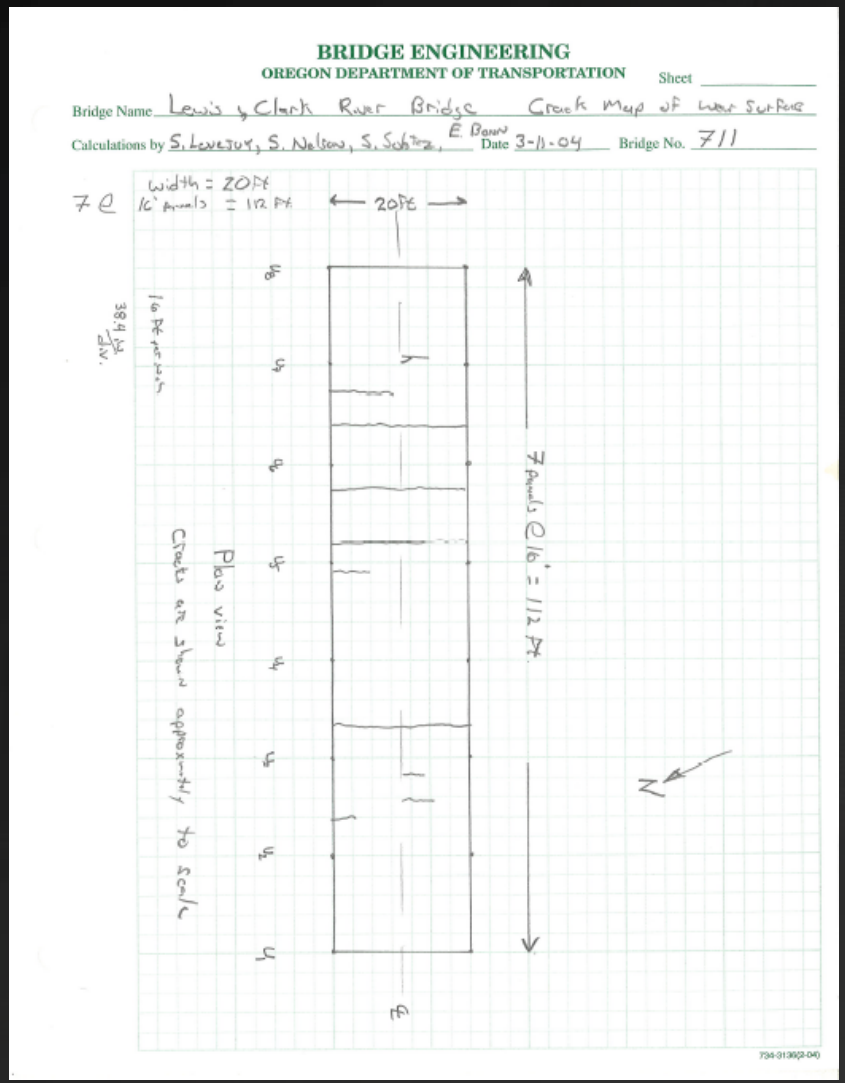
Old Young's Bay Bridge

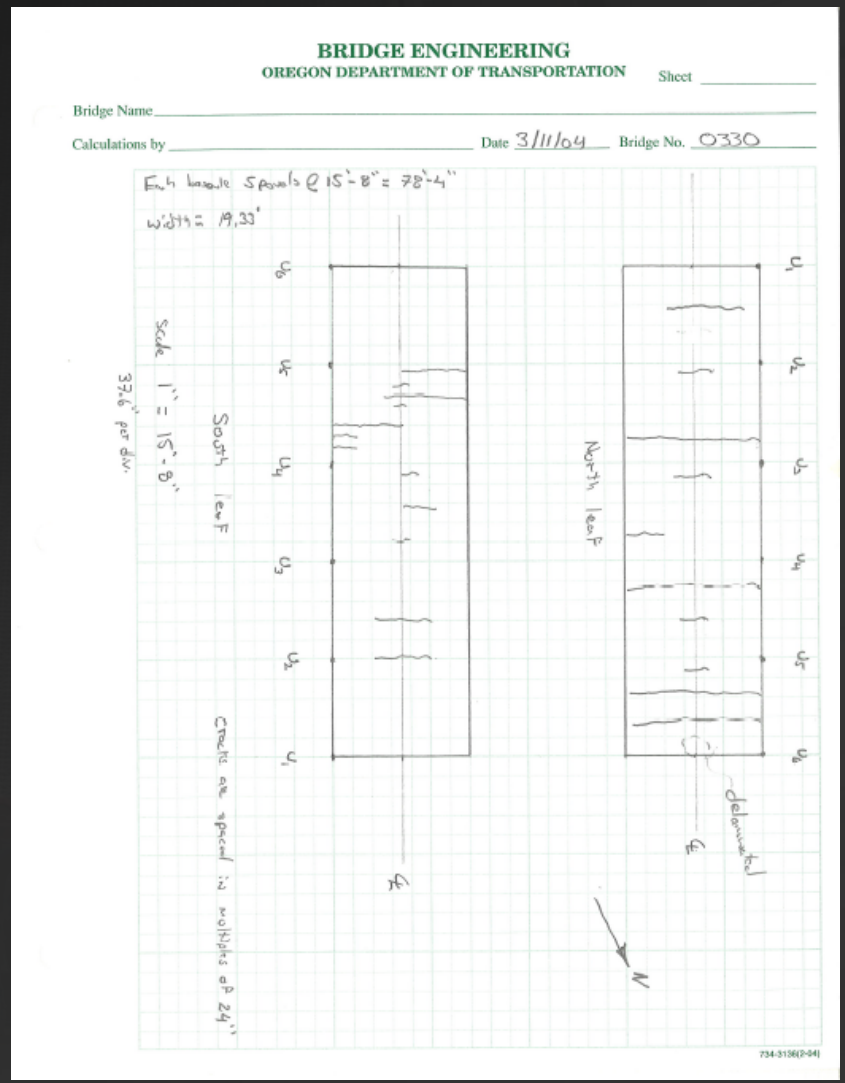
- Same deck to flooring system connection was used
- Geometry only required a ½" thick wearing surface
- 30,000 lbs of ballast was required for each counterweight

First signs of trouble

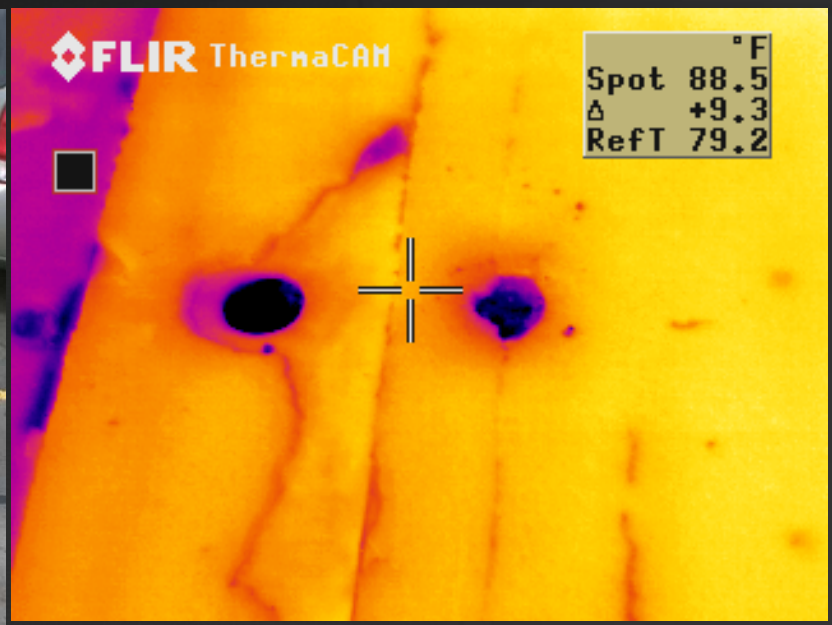
- **Both decks developed lateral cracking in the wear surface within a year of service**
- **Old Young's Bay bridge was the worst of the two**

Crack maps after 2 years of service





FLIR used to examine deck failure



Lewis and Clark

- Wear surface continues to crack
- A few locations of delamination
- No obvious signs of distress in FRP
- WJE Inc. hired to assess remaining life in 2011

Old Young's Bay Bridge

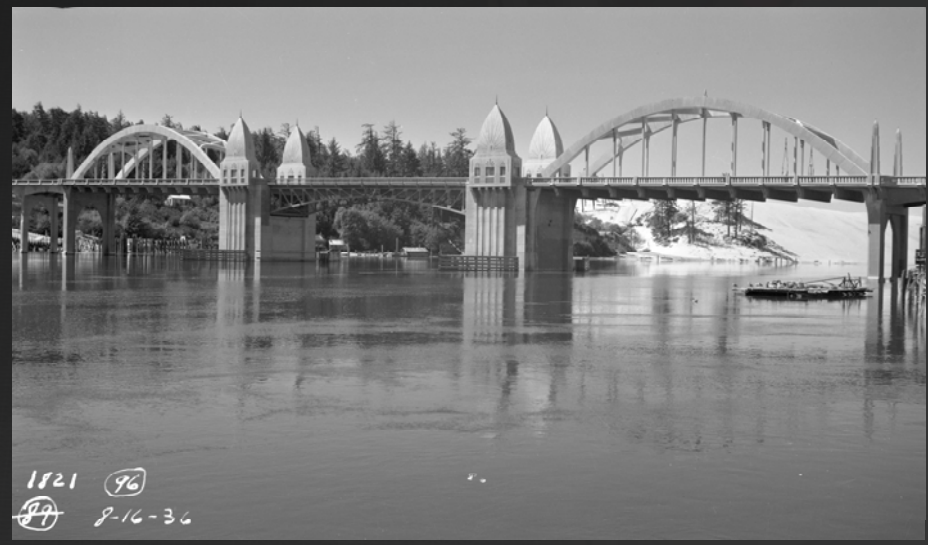
- By 2007 the deck has suffered punch through in a few location
- The deck to stringer connections are breaking apart
- A replacement project is in design

Siuslaw River Bridge

- This is working so well why not apply it on a major highway with a 172 mile detour?
- Siuslaw River Bridge is selected to receive and FRP deck!

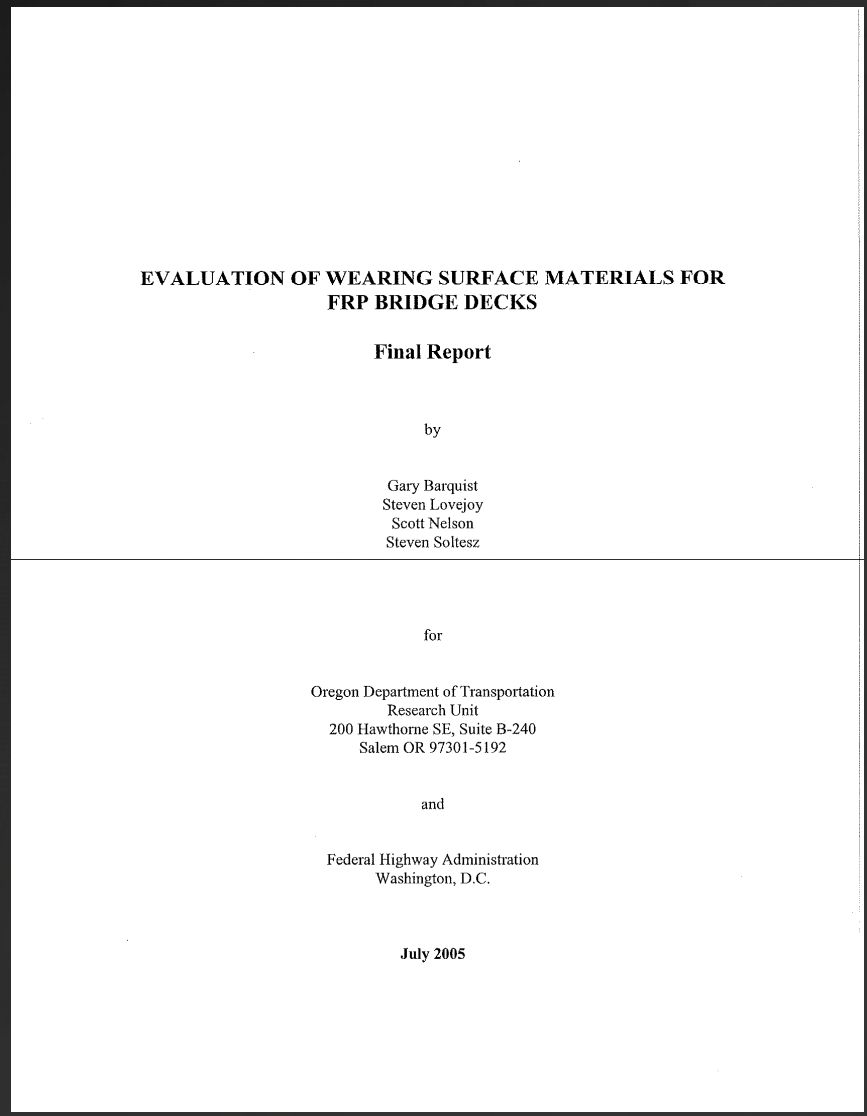
Siuslaw River Bridge

- Deck replacement project slated for 2005
- After loosing the battle to stop the project author initiates a more rigorous research project concerning wearing surfaces



ODOT Wearing Surface Research

- Study includes 4 binder products that use aggregate
- Strain rate, temperature, aggregate content are primary variables
- Tensile strength, strain, bond strength and wear rate are evaluated



EVALUATION OF WEARING SURFACE MATERIALS FOR FRP BRIDGE DECKS

Final Report

by

Gary Barquist
Steven Lovejoy
Scott Nelson
Steven Soltesz

for

Oregon Department of Transportation
Research Unit
200 Hawthorne SE, Suite B-240
Salem OR 97301-5192

and

Federal Highway Administration
Washington, D.C.

July 2005

Urethane Binder Proves Superior

Urefast PF60 has best combination of properties

1= Best

	Flexolith	Degadeck Bridge Overlay System	Urefast PF60	Ceva Deck 110
Failure Strain at 15° F	4	3	2	1
Tensile Strength at 140° F	1	2	2	2
Abrasion Resistance	4	2	1	2
Bond Strength	3	1	2	Not tested

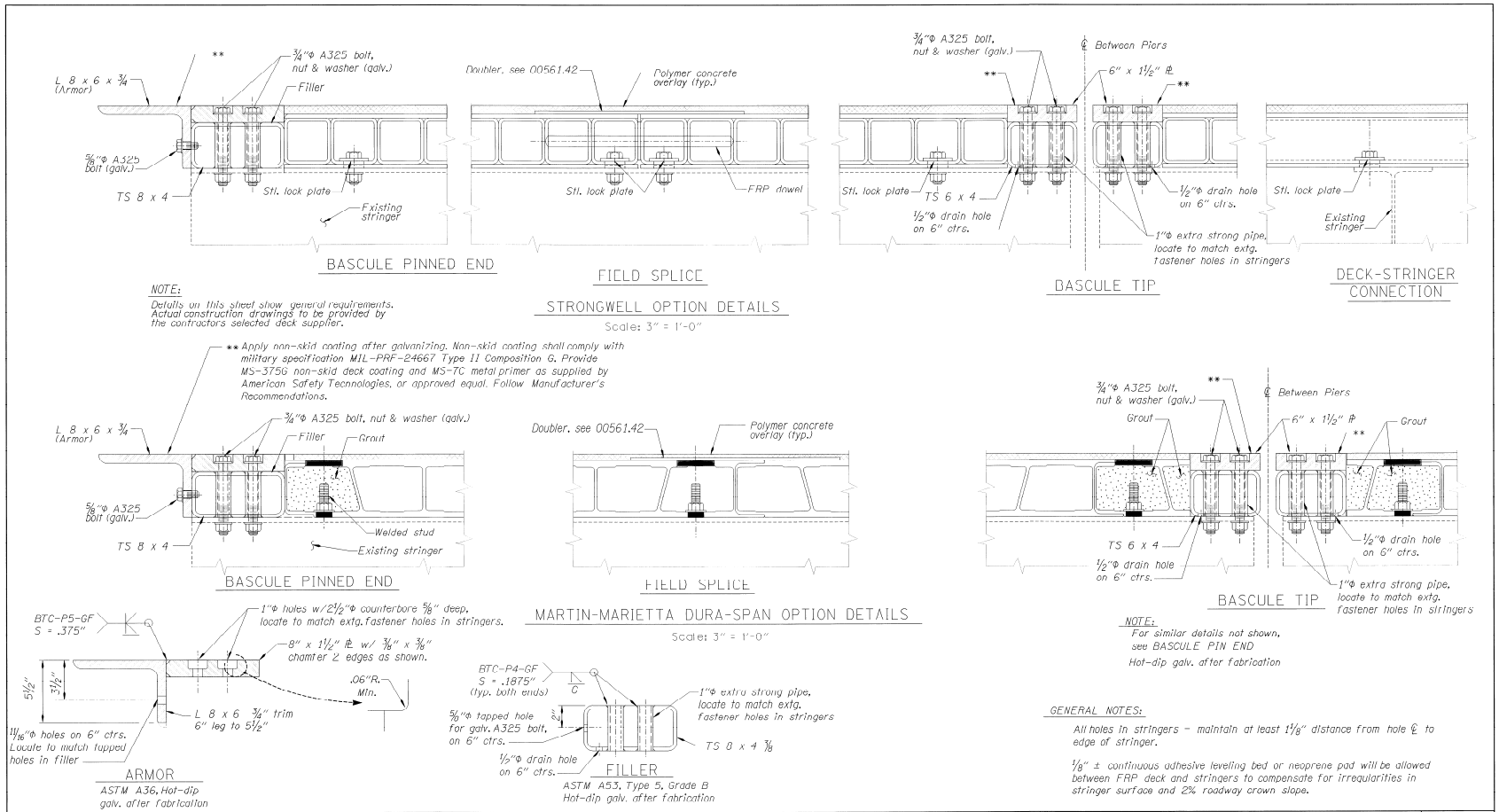
Siuslaw River Bridge

- Built in 1936
- Carries US101 over the Siuslaw River in Florence, OR
- High ADT and ADTT
- 172 mile detour
- Existing deck is open steel grid

The Right Person for a Tough Job

- Raymond Bottenberg is a senior engineer at ODOT
- Formerly an engineer at Boeing
- Paid close attention to the details of connections, wear surfaces and corrosion

Connection to Flooring System



	DATE	REVISION	BY
2	12-3-04	Redrawn, new designer	RDB

DRAFTED: Tom Ohren
CHECKED:
REVIEWED: Frank J. Nelson
DESIGNER
REGISTERED PROFESSIONAL ENGINEER — OREGON — FRANK JOSEPH NELSON
EXPIRES: 12-31-05

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE ENGINEERING SECTION

BRIDGE NO. 01821E
DATE 4-12-2004
CALC. BOOK 5231

SIUSLAW RIVER (FLORENCE) BRIDGE
LIFT SPANS DECK REPLACEMENT

FRP BRIDGE DECK REPLACEMENT DETAILS

SHEET 4 OF 7
DRAWING NO. 65198

\\sc-salemnev-1\hwye93d\ODOT_DATA\projects\ER\PROJECT_j01821.dgn 12/6/2004 7:35:03 AM hwye93d

1:4 - [FRP BRIDGE DECK]

Connection details

Corrosion Protection Details

Wear Surface Installation

Completed FRP Deck

Performance of L&C Bridge

- FRP installed 2002
- Epoxy concrete shows cracking within 1 year
- Wear surface is in very poor condition after 9 years
- FRP deck and connections appear sound after 9 years

Performance of Old Bay Bridge

- Epoxy concrete deck shows cracking before 1 year of service
- Severe cracking after 4 years
- Deck and connection failures after 5 years
- Replaced with steel grid after 8 years

Performance of Siuslaw Bridge

- Installed in 2005
- Wear surface is in good condition with minor to moderate wear after 6 years
- Connection details show minor and localized degradation
- Very heavy traffic

Lessons Learned

Connection details

- Grouted studs could work if a flexible grout is used
- Stringer spacing is important
- Blind fasteners work well if enough are used

Wearing surface

- Urethane/aggregate shows best performance and is easy to repair
- Thin to win

Lessons Learned General

- Pay attention to the details; connections, installation QA, wear surface, corrosion
- Do not rely on manufacturers to provide such details
- Whether replacing timber/asphalt or steel grid plan on adding significant ballast to counterweights on bascule and lift span movable bridges

Pro's and Con's

Pro's

- Excellent corrosion resistance of deck (*be careful of flooring system*)
- Smooth and quiet ride
- Possible composite action for increased strength of flooring system

Con's

- Both suppliers and installers are new to bridge industry
- Initial cost is higher than common options
- Maintenance is more difficult to perform

Will ODOT use more FRP decks?

- That will likely depend on which engineer is assigned the next movable bridge deck replacement project
- Mr. Bottenberg would likely choose FRP and make it a success
- The author’s last two deck replacements used open steel grid and a third would be the same

Mr. Bottenberg's telling of the same story

Oregon's Experiences with FRP Decks on Movable Bridges

Polymer Composites Conference IV

Composite Applications and Fundamentals

Morgantown, West Virginia

March 21, 2007

Ray Bottenberg, P.E.

Corrosion Engineer

Oregon Department of Transportation


1821 (83) 4-15-36


(31) 4/19/35


(30) 4/19/35


1821 (95)
8-16-36

Questions?