DeWayne Wilson
Bridge Asset Management Engineer

Deck Replacement vs Rehabilitation Experience

2019 WBPP

DeWayne Wilson
Bridge Asset Management Engineer
• WSDOT’s Bridge Network
  • Bridge Deck Inspection
  • Concrete Deck Replacements
  • Concrete Deck Rehabilitation
  • Develop Criteria (Repl vs Rehab)
  • Current Bridge Deck Conditions
  • 10 year Bridge Deck Needs
  • Questions
WSDOT’s Bridge Network

- Concrete: 35%
- Prestress Conc: 41%
- Steel: 23%
- Timber: 1%

% based on bridge deck area

3,322 bridges (54.4 M SF)
Repl value $58 Billion

3,039 Bridges with Concrete Decks
45.8 million SF deck area
11 Border Bridges
5 – ODOT
5 – WSDOT
1 - IDOT

US101 Astoria (ODOT)  
Yr Blt – 1966

SR433 Lewis and Clark (WSDOT)  
Yr Blt – 1929

US 97 Biggs Rapids (WSDOT)  
Yr Blt – 1962

I-5 Interstate Brgs (ODOT)  
Yr Blt – 1917/1958

I-205 Glen Jackson (ODOT)  
Yr Blt – 1982

US-12 Clarkston (WSDOT)  
Yr Blt – 1939

US 197 Dallas (ODOT)  
Yr Blt – 1953

I-82 Umatilla (WSDOT)  
Yr Blt – 1955/1988

SR-41 RR OC (IDOT)  
Yr Blt – 1966
WSDOT’s Bridge Network

- 3,322 NBI Structures (54.4 M SF)
  - Repl value $58 Billion
- Ave Age - 49
- Oldest - 1910

[3,132 Bridges / 3,039 Conc Decks]

- Number of Bridges
  - 0-19 years old: 2,800
  - 20-39 years old: 1,600
  - 40-59 years old: 3,322
  - 60-79 years old: 1,200
  - 80+ years old: 800
- Billions
  - $28
  - $24
  - $20
  - $16
  - $12
  - $8
  - $4
  - $0

-$2.7B  
266 Brgs  
2.0M SF
WSDOT’s Bridge Network

Non-Integral Concrete Bridge Decks (Non-Composite)
Washington State DOT’s Bridge Network

Integral Concrete Bridge Decks (composite)

- Precast Prestress Slab
- Conc Box
- Conc T-Beam
- Floating Bridge
- Segmental Post-Tension Box
- Prestress Bulb-T
WSDOT’s Bridge Network

- **Bare Concrete (Bare Conc)**: 2,000,000 SF
- **Concrete-ECR (Bare Conc-ECR)**: 4,000,000 SF
- **Concrete Overlays (Conc Overlays)**: 6,000,000 SF
- **Asphalt Polyester Polymer**: 8,000,000 SF
- **Polyester**: 10,000,000 SF
- **Polymer**: 12,000,000 SF

**Concrete Overlays**
- 589 overlays: 51.8%
- 792 overlays: 48.2%

**Total Bridges with Concrete Decks**: 3,039
**Deck Area**: 45.8 million SF

[589 Concrete Overlays]
Agenda

• WSDOT Bridge Network
• **Bridge Deck Inspection**
  • Concrete Deck Replacements
  • Concrete Deck Rehabilitation
  • Develop Criteria (Repl vs Rehab)
• Current Bridge Deck Conditions
• 10 year Bridge Deck Needs
• Questions
Bridge Deck Inspection
Bridge Deck Inspection

Concrete Overlay Element # 803

Concrete Deck Element # 12

Deck Soffit Element # 35
**Bridge Deck Inspection**

**Condition State 1**
The deck surface has no spalls/delaminations or previous repairs. May have cracking or rutting.

**Condition State 2**
The deck surface has previous repairs.

**Condition State 3**
The deck surface has spalling.

**Condition State 4**
Delamination Test Results.

---

**Elem** | **Description** | **Total** | **Unit** | **State1** | **State2** | **State3** | **State4**
---|---|---|---|---|---|---|---
12 | Conc. Deck | 3,990 | SF | 2,774 | 1,053 | 0 | 163
35 | Soffit | 3,990 | SF | 3,990 | 0 | 0 | 0
376 | Delam Testing | 3,990 | SF | 3,827 | 0 | 0 | 163

90/316N Paha Rd OC - milepost 215.24

Year Built – 1972 (40 yrs in 2012)
Deck Thickness – 7”

(26%)
Bridge Deck Deterioration

- **Good Deck @ 0% Deterioration**
- **Monitor FAIR Deck @ 1%**
- **Good Deck @ 0% Overlay @ 0%**
- **FAIR Threshold @ 2%**
- **Prioritize Overlay @ 2%**
- **Overlay Lower Threshold @ 5%**
- **Overlay between 2% and 5%**

Deck Condition vs. Time - Years

Deck Deterioration Curve
Agenda

- WSDOT Bridge Network
- Bridge Deck Inspection
- **Concrete Deck Replacements**
- Concrete Deck Rehabilitation
- Develop Criteria (Repl vs Rehab)
- Current Bridge Deck Conditions
- 10 year Bridge Deck Needs
- Questions
Concrete Deck Replacements

17 bridges (588,536 sq ft)
[1.5% of total Statewide Deck Area]

<table>
<thead>
<tr>
<th>Br Num</th>
<th>Yr</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>395/40</td>
<td>1986</td>
<td>2,451</td>
</tr>
<tr>
<td>12/512N</td>
<td>1987</td>
<td>1,270</td>
</tr>
<tr>
<td>82/280S</td>
<td>1988</td>
<td>1,471</td>
</tr>
<tr>
<td>395/16</td>
<td>1988</td>
<td>72</td>
</tr>
<tr>
<td>240/32W</td>
<td>1989</td>
<td>244</td>
</tr>
<tr>
<td>281/1</td>
<td>1990</td>
<td>196</td>
</tr>
<tr>
<td>9/130</td>
<td>1991</td>
<td>344</td>
</tr>
<tr>
<td>529/10E</td>
<td>1994</td>
<td>1,544</td>
</tr>
<tr>
<td>397/10</td>
<td>1995</td>
<td>261</td>
</tr>
<tr>
<td>509/101</td>
<td>1995</td>
<td>562</td>
</tr>
<tr>
<td>509/103</td>
<td>1995</td>
<td>264</td>
</tr>
<tr>
<td>433/1</td>
<td>2004</td>
<td>5,478</td>
</tr>
<tr>
<td>97/1</td>
<td>2009</td>
<td>2,567</td>
</tr>
<tr>
<td>10/143</td>
<td>2012</td>
<td>430</td>
</tr>
<tr>
<td>5/670W</td>
<td>2014</td>
<td>859</td>
</tr>
<tr>
<td>26/119</td>
<td>2018</td>
<td>154</td>
</tr>
<tr>
<td>82/280S</td>
<td>2019</td>
<td>1,920</td>
</tr>
</tbody>
</table>
Concrete Deck Replacements

Common Details
- Non-Integral (17)
- Thin decks 5-3/4” (6)
- Lightweight Concrete (3)
- EA Wa (12) / Western Wa (5)
- Average Age 49 years
- Age Range (26 – 81 years)
Concrete Deck Replacements – Non Integral

Steel Girder Bridges (5)

SR509
1929 / 1996

SR10
1937 / 2012

SR509
1962 / 2009

US97
Concrete Deck Replacements – Non Integral

Steel Truss Bridges (6)

- I-5
  - 1933 / 2014
    - 02/10/2014 08:41
  - 1929 / 2003
- US395
  - 1954 / 1986
- SR433
  - 1950 / 1988
- US12
Concrete Deck Replacements – Non Integral

Prestress Girder Bridges (6)

SR9
1961 / 1991

US12
1964 / 1997

SR240
1960 / 1989

SR26
1959 / 2018

SR397
1965 / 1995

SR281
1964 / 1990

Deck Thickness 5 3/4”
Common Details
• Non-Integral (17)
• Thin decks 5-3/4” (6)
• Lightweight Concrete (3)

91 PCG Bridges Statewide
5 ¾” Deck
4 in Poor Condition
Concrete Deck Replacements – Lightweight Conc

7 Bridges Statewide With Lightweight Conc 2 in Poor Condition

Common Details
- Non-Integral (17)
- Thin decks 5-3/4” (6)
- Lightweight Concrete (3)

SR 433 Lewis and Clark 1929 / 2003 (74ys)

US97 Biggs Rapids 1962 / 2009 (47 yrs)

I-82 Umatilla 1955 / 2019 (64 yrs)
I-82 Col R Umatilla
Located near Umatilla Or

Bridge Built – 1955
Approaches Rebuilt- 1990
Bridge Length – 3,403 feet
Truss spans – 1,920 feet
ADT – 8,947

Deck on Main Truss Rehabilitated in 1990 with modified concrete overlay

Patches and Spalls 3,884 SF (7.4%)
Concrete Deck Replacements – Lightweight Conc

I-82 Col R Umatilla
Located near Umatilla Or

Deck Replacement Contract
Awarded to Max J Kuney in 2018 ($9.5 M)
Agenda

• WSDOT Bridge Network
• Bridge Deck Inspection
• Concrete Deck Replacements
• Concrete Deck Rehabilitation
• Develop Criteria (Repl vs Rehab)
• Current Bridge Deck Conditions
• 10 year Bridge Deck Needs
• Questions
Concrete Deck Rehabilitation

3,039 Bridges with Concrete Decks
45.8 million SF deck area

Bare Conc (19.3%) Bare Conc-ECR (28.9%) Conc Overlays (30.8%) Asphalt (18.6%) Polyester (1.6%) Polymer (0.8%)

- 589 Conc Overlays
- 792 SF
- 13.2M SF
- 563 SF
- 14M SF
- 1025 SF
- 8.5M SF
- 28
- 21
Concrete Deck Rehabilitation

Total # Brgs = 584
Deck area = 14.1 mil SF

Hydromilling (Began in 1993 2005 Standard practice)

64 bridges (1.8M SF)

Low Slump

Latex

Microsilica

Fly-Ash

Concrete Deck Rehabilitation

1st Mod Conc Overlay
Low Slump Discontinued
1st Microsilica Conc Overlay
1st Fly-Ash Conc Overlay
Rapid Set Discontinued
1st Perf Mix Design Conc Overlay
Concrete Deck Rehabilitation

- 357 Bridges (6.5M SF, 46%)
- 183 Bridges (7.0M SF, 49.6%)
- 44 Bridges (0.6M SF, 4.4%)

- 187 Bridges (4.9M SF, >30 yrs)
- 584 Bridges (14.1M SF, Avg Age: 27 yrs, Oldest: 40 yrs)

- Concrete Deck Rehabilitation
Concrete Deck Rehabilitation

- 64 Bridges
- 1.9M SF
- "Good"

1 Bridge
- "Fair"

- Hydromill Scarification
- 64 Bridges
- 1.9M SF
- Ave Age – 8yrs
- Oldest – 26yrs
Concrete Deck Rehabilitation

Cantilever Steel Truss
Standard rebar in Deck
Year Built – 1941 (78yrs)
LMC Overlay – 2012 (8yrs)
Deck – 6.5”

ADT = 4,269 (2012)
Trucks = 683 (16%)

Length – 1,267 feet
Width – 24 feet
Max Span 600 ft
Repl Value - $40M

US395 Columbia R Kettle Falls in 2012 (1st Gen)
Concrete Deck Rehabilitation

US395 Columbia R Kettle Falls in 2012 (1st Gen)
Concrete Deck Rehabilitation

24ft Roadway

6.5” Deck
Concrete Deck Rehabilitation

INSPECTION YEAR

DETERIORATION - PERCENT OF DECK AREA

0.0%  1.0%  2.0%  3.0%  4.0%  5.0%  6.0%  7.0%


Monitor Deck @ 1%

Prioritize Project @ 2%

Overlay @ 5%

Deck Element Data

Poly. (Deck Element Data)

\[ y = -2E-07 x^5 + 0.0019 x^4 - 7.7415 x^3 + 15497 x^2 - 2E+07 x + 6E+09 \]
Concrete Deck Rehabilitation

- Two truss panels: 60 SF patching = 0.194%
- Not on the Radar
- Built 1941  Length = 1267 ft. Area = 30,408 SF
Concrete Deck Rehabilitation

- Same two truss panels: (2002 @ 60 SF)
- 2007: Five Panels & other patching, 536 SF = 1.8%
Concrete Deck Rehabilitation

- 2010 Chain Drag Results = 5.4% Deterioration
  - Patch = 1159 SF, Spall = 156 SF, Delam = 324 SF
- New deteriorated truss panels
- Raised the priority in 2010
Concrete Deck Rehabilitation

- Deck Replacement or Overlay?
  - $8M
  - $1.8M
Concrete Deck Rehabilitation

2018

Bridge Deck in Good Condition
($1.8M investment deferred $8M deck replacement)
• WSDOT Bridge Network
• Bridge Deck Inspection
• Concrete Deck Replacements
• Concrete Deck Rehabilitation
• **Develop Criteria (Repl vs Rehab)**
• Current Bridge Deck Conditions
• 10 year Bridge Deck Needs
• Questions
Develop Criteria (Deck Repl vs Rehab)

- Thin Deck < 5% Patching / 1st Gen / Good Soffit
- Normal Deck / Good Soffit
- Integral Deck

- Thin Deck > 5% Patching / 1st Gen
- Thin Deck > 2% Patching / 2nd Gen
- Normal Deck > 5% Patching / Bad Soffit
- Lightweight Deck > 2% Patching
Agenda

- WSDOT Bridge Network
- Bridge Deck Inspection
- Concrete Deck Replacements
- Concrete Deck Rehabilitation
- Develop Criteria (Repl vs Rehab)
- **Current Bridge Deck Conditions**
- 10 year Bridge Deck Needs
- Questions
NBI Deck Code Summary

3,038 WSDOT Bridges with Conc Deck

- Good: 2,124 brgs, 26.3M SF (57.7%)
- Fair: 807 brgs, 17.5M SF (38.4%)
- Poor: 107 brgs, 1.8M SF (3.9%)
Current Bridge Deck Conditions

Poor
107 brgs
1.8M SF
Agenda

• WSDOT Bridge Network
• Bridge Deck Inspection
• Concrete Deck Replacements
• Concrete Deck Rehabilitation
• Develop Criteria (Repl vs Rehab)
• Current Bridge Deck Conditions
• **10 year Bridge Deck Needs**
• Questions
10 year Bridge Deck Needs

- ECR - $1/SF
- ACP w/membr - $20/SF
- Rehab/Conc Overlay - $80/SF
- Replace Deck - $300/SF
- Replace Bridge - $800/SF
10 year Bridge Deck Needs

In next decade, 616 WSDOT bridges will need repairs to concrete decks  
As of June 2018; Dollars in millions

<table>
<thead>
<tr>
<th>Bridge deck status</th>
<th>Number of bridges</th>
<th>Square footage</th>
<th>Cost to repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract work in progress</td>
<td>18</td>
<td>323,500</td>
<td>$31.6</td>
</tr>
<tr>
<td>Past due for repair²</td>
<td>20</td>
<td>141,800</td>
<td>$13.1</td>
</tr>
<tr>
<td>Due for repair³</td>
<td>50</td>
<td>1,565,100</td>
<td>$99.4</td>
</tr>
<tr>
<td>To be due in next 10 years</td>
<td>528</td>
<td>11,974,000</td>
<td>$902.4</td>
</tr>
<tr>
<td><strong>Total 10-year needs</strong></td>
<td><strong>616</strong></td>
<td><strong>14,004,400</strong></td>
<td><strong>$1,046.5</strong></td>
</tr>
</tbody>
</table>

Data source: WSDOT Bridge and Structures Office.

Notes: ¹ Square footage is rounded to the nearest hundred. ² Bridges with more than 5% of deck area patched or spalled are classified as "past due." ³ Bridges with 2% to 5% of deck area patched or spalled are classified as "due."

Needed funding – $100M per year  
10 year budget – $15M per year  
Gap – $85M per year
10 year Bridge Deck Needs

Reinforced Conc Box Girder Bridges

421 CBOX Brgs Statewide
10.2 million SF

140 on the 10 year needs list
$340M Deck Rehab
2019 Deck Rehab Funded Projects
10 bridges

WSDOT Concrete Deck Rehab – 2019

- I-90 Cle Elum R 90/134N & S – C9214
  4,000D – 17,582SF
- I-90 Holder Cr 18/31N – C9345
  4,000D – 12,251SF
- I-5 Toutle R 5/140W – Apr 2019
  Polyester – 14,832SF
- I-90 Yakima R 90/140N & S – C9214
  4,000D – 23,400SF
- I-90 2nd Ave OC 290/2W-W – C9264
  4,000D – 6,346SF
- I-90 Yakima R 90/140N & S – C9214
  4,000D – 23,400SF
- I-90 Yakima R 90/154N & S – C9214
  4,000D – 19,684 SF
- I-90 3rd Ave OC 290/1W-W – C9264
  4,000D – 19,684 SF
2020 Deck Rehab Funded Projects
1 bridge

I-90 Hamilton St Ramp
90/562E-E – Mar 2020
4,000D – 33,402 SF
Questions?