Performance Evaluation of Asphalt Pavement Preservation and Repair Activities in Nevada (TRB10-2268)

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Identification of Preservation Activities

- **Chip seal:** asphalt binder overlaid by a layer of embedded aggregate
  - Emulsion: SS-1, SS-1h, CSS-1 or CSS-1h, LMCRS-2 or LMCRS-2h.

- **Sand seal:** emulsion followed by a sand layer.
  - RS-1, CRS-1, MS-1 or HFMS-1.

- **Scrub seal:** polymer-modified emulsion, sweeping or squeegee followed by a sand layer.
  - Poly-methyl-phenyl-silane (PMPS) emulsions
Identification of Preservation Activities

- **Fog seal**: application of SS emulsion diluted with water
  - Emulsions: SS-1, SS-1h, CSS-1 or CSS-1h.

- **Crack filling**: cleaning of cracks and filling them with rubberized asphalt, rejuvenating agent, emulsion, or liquid asphalt (cutback).
  - Hot-applied CRAFCO PolyFlex crack filler sealants Type 1, Type 2 and Type 3 were used depending on the climatic zone.
Identification of Repair Activities

• **Maintenance overlay cold mix (MO-CM):**
  – Small paver
  – small roller compactor.
  – CMS-2S (AC-10 base asphalt)

• **Machine patching paver laid plantmix (MP-PLP):**
  – Dense graded HMA
  – Small paver
  – small roller compactor.
  – PG64-28 (northern NV), PG76-22 (southern NV).
Identification of Preservation Activities

• **Machine patching blade laid cold mix (MP-BLC):**
  - restore surface lost to raveling → vertical difference > 1” in 10 ft.
    - Max 2” thick
    - < 300 yd³ or 550 tons in 10 mile section
    - CMS-2S (AC-10 base asphalt)

• **Machine patching blade laid plantmix (MP-BLP):**
  - Dense graded HMA laid down from the truck
  - Motor-grader
  - PG64-28 (northern NV), PG76-22 (southern NV).
Assessing Performance

• Review of NDOT maintenance records
  – 15 years
  – 17,000 preservation activities
  – Construction date, location, costs (labor, equipment and materials)...

• Treatment selection
  – Road classification (SR, US or IR)
  – Location (District 1, 2 and 3) – Counties
  – Length: greater than 1 mile
  – 847 sections evaluated
Assessing Performance

- Analysis of NDOT Pavement Management System (PMS)
  - Distress data
    - Rutting, fatigue cracking, thermal cracking and smoothness.
  - Present Serviceability Index (PSI)
  - Integrate MMS and PMS
Assessing Performance

From the PMS database:

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<tr>
<th>County</th>
<th>Route</th>
<th>Initial MP</th>
<th>Final MP</th>
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(Nevada DOT logo)
Assessing Performance

From the maintenance database:

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</table>

[NDOT-Maintenance Project v4.0 : Database (Access 2007) - Microsoft Access image]

Nevada DOT logo
Assessing Performance

Years:
- 11/29/2006
- 5/28/2005
- 11/25/2003
- 5/24/2002
- 11/20/2000
- 5/20/1999
- 11/16/1997
- 5/15/1996
- 11/12/1994
- 5/11/1993
- 11/8/1991
- 5/7/1990
- 11/3/1988

PSI:
- 0.0
- 1.0
- 2.0
- 3.0
- 4.0
- 5.0

Graph categories:
- Maintenance overlay cold mix
- Chip seal
- Average PSI

Legend:
- ES-SR265-16-15.5
Analysis Approach
Example: State Route

![Graph](image)

- **Pre-trt PSI: 1 yr**
- **Improve/Extnd: 3 yr**
- **Performance: 4.0 – 6.2 yr**
- **Hold: 3.2 yr**

### Analysis Approach

- **Example: State Route Performance:** 4.0 – 6.2 yr
- **Failure Criteria:**
  - Hold: 3.2 yr

### Graph Details:
- **Y-axis:** PSI
- **X-axis:** Years
- **Events:**
  - Chip seal
  - Improve/Extend
  - Hold

### Data Points:

### Legend:
- **Red:** Chip seal
- **Blue:** Average PSI
Assessing Performance

- **Analysis Approach**
  - **Project level analysis: Benefit**
    - Area under the performance curve under the analysis period.
Assessing Performance

• Benefit-cost
  ▪ Cost per lane-mile
  ▪ Cost includes:
    ▶ Labor
    ▶ Materials
    ▶ Equipment

\[
B/C = 100 \times \frac{PSI \times \text{years}}{1000 \$/\text{lane-mile}}
\]
Performance Periods for Chip Seal

![Graphs showing performance periods for Nevada District with hold/maintain and improve/extend categories.]

**District**

**Hold/Maintain**

**Improve/Extend**

- Period 1:
  - Nevada District 1: 3.4
  - Nevada District 2: 2.6
  - Nevada District 3: 2.5

- Period 2:
  - Nevada District 1: 2.0
  - Nevada District 2: 1.7
  - Nevada District 3: 2.5

- Period 3:
  - Nevada District 1: 5.6
  - Nevada District 2: 5.0
  - Nevada District 3: 4.8
Performance Periods for Chip Seal

### HOLD/MAINTAIN

- SR: 3.3 ± 0.9
- US: 3.2 ± 0.9
- IR: 1.8 ± 0.9

### IMPROVE/EXTEND

- SR: 6.9 ± 1.4
- US: 4.5 ± 2.7
- IR: 3.1 ± 1.4
B/C for Chip Seal

HOLD/MANTAIN

IMPROVE/EXTEND
B/C for Chip Seal

ROUTE

HOLD/MANTAIN

IMPROVE/EXTEND

Road Classification
Overall Performance

• Chip seals were effective on
  – SR regardless of pre-treatment PSI
  – on US/IR routes with a pre-treatment PSI > 2.8.
  – Higher benefit on SR roads

• Sand seals:
  – more effective on SR with a pre-treatment PSI > 2.5.
  – effectiveness on SR with a pre-treatment PSI < 2.5 was similar to its
effectiveness on US with a pre-treatment PSI < 2.8.
  – Sand seals were not applied on IR.
Overall Performance

- Scrub seals:
  - Effectiveness on SR with a pre-treatment PSI > 2.5 was similar to its effectiveness on US with a pre-treatment PSI > 2.8.
  - A low benefit was found for the scrub seal when applied to SR and US roads with a pre-treatment PSI < 2.5 and 2.8, respectively.
  - Scrub seals were not applied on IR.
Overall Performance

• Fog seals
  – Low benefit on SR and US/IR.
  – Most benefit of fog seals when pre-treatment PSI > 2.5 and 2.8 for SR and US/IR roads.

• Crack fillings
  – More effective when applied to SR when compared to US/IR roads specifically when the pre-treatment PSI > 2.5.
Overall Performance

- **Maintenance overlay cold mix (MO-CM):**
  - Effective on SR and US roads.
  - Highest benefit on SR with a PSI > 2.5.

- **Machine patching paver laid plantmix (MP-PLP):**
  - Highly effective on SR and US roads.
Overall Performance

• Machine patching blade laid cold mix (MP-BLC)
  – Low benefit on SR and US roads.
  – Highest benefit when applied to PSI > 2.5 and 2.8 for SR and US.

• Machine patching blade laid plantmix (MP-BLP) were
  – More effective on SR when compared to US/IR roads.
  – Effectiveness on SR was similar to its effectiveness on US/IR roads with a pre-treatment PSI > 2.8.
Overall Recommendations

US/IR Routes

- PSI ≤ 2.8 or IRI ≥ 145 in/mile
  - Rut Depth ≥ 0.15"
    - Fatigue Cracking Type B: (> 0.25", ≥ 400 ft²)
    - Transverse Cracking: (> 0.25", ≥ 400 ft²)
    - Block Cracking Type C: (> 0.25", ≥ 200 ft²)

- 2.8 < PSI ≤ 4.0 or IRI < 145 in/mile
  - Rut Depth < 0.15"
    - Fatigue Cracking Type B: (≤ 0.2", ≤ 650 ft²)
    - Transverse Cracking: (≤ 0.25", ≤ 50 ft²)
    - Block Cracking Type C: (≤ 0.25", ≤ 300 ft²)

Pre-treatment PSI or IRI

- Pre-treatment Distress (The existence of at least one of the following conditions)
  - Machine Patching Paver Laid Plantmix®
  - Scrub Seal

Pre-treatment Activity

- Maintenance
  - Machine Patching Paver Laid Plantmix®
  - Scrub Seal
  - Chip Seal
  - Machine Patching Blade Laid Plantmix®

Treatment Performance

- Improve/Extend (PSI > 2.8):
  - 57% chance
  - 60% chance
  - 94% chance

- Hold/Maintain (PSI ≥ 2.8):
  - 57% chance
  - 61% chance
  - 83% chance

Performance Periods (50% Reliability)

- 3.5 to 7.0 years
- 2.5 to 3.5 years
- 2.0 to 3.5 years
- 4.0 to 7.5 years
- 3.0 to 6.0 years
- 2.5 to 4.5 years
- 2.5 to 5.0 years

Benefit-Cost Ratio, B/C

- 100 x [PSI x yrs] / [$10^5/lane-mile]
- 50% Reliability

- B/C = 73
- B/C = 49
- B/C = 47
- B/C = 103
- B/C = 92
- B/C = 44
- B/C = 28
QUESTIONS?