# Evaluation of Thin Polymer Overlays for Bridge Decks

Paul D. Krauss, P.E. and Kathleen A. Hawkins – Wiss, Janney, Elstner Associates, Inc.

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

MONTANA Department of Transportation

## Problem Statement

The Montana Department of Transportation (MDT) installed high-friction surface treatments (HFSTs) on four bridge decks in 2014 and 2015 in order to improve their skid resistance. Initial skid numbers were approximately 80 after HFST installation but after only 3 or 4 years, two of the HFSTs had average skid numbers between 50 and 55 while the other two HFSTs had average skid numbers of 36 and 17. A skid number of 30 to 35 is typically considered to be the minimum acceptable skid number for highway structures. The objective of this research was to assess the factors that influence the long-term performance of polymer-based HFST systems in Montana, specifically with respect to friction resistance and durability, and to provide guidance and recommendations to MDT regarding the use of HFSTs across Montana's varying geographic regions.

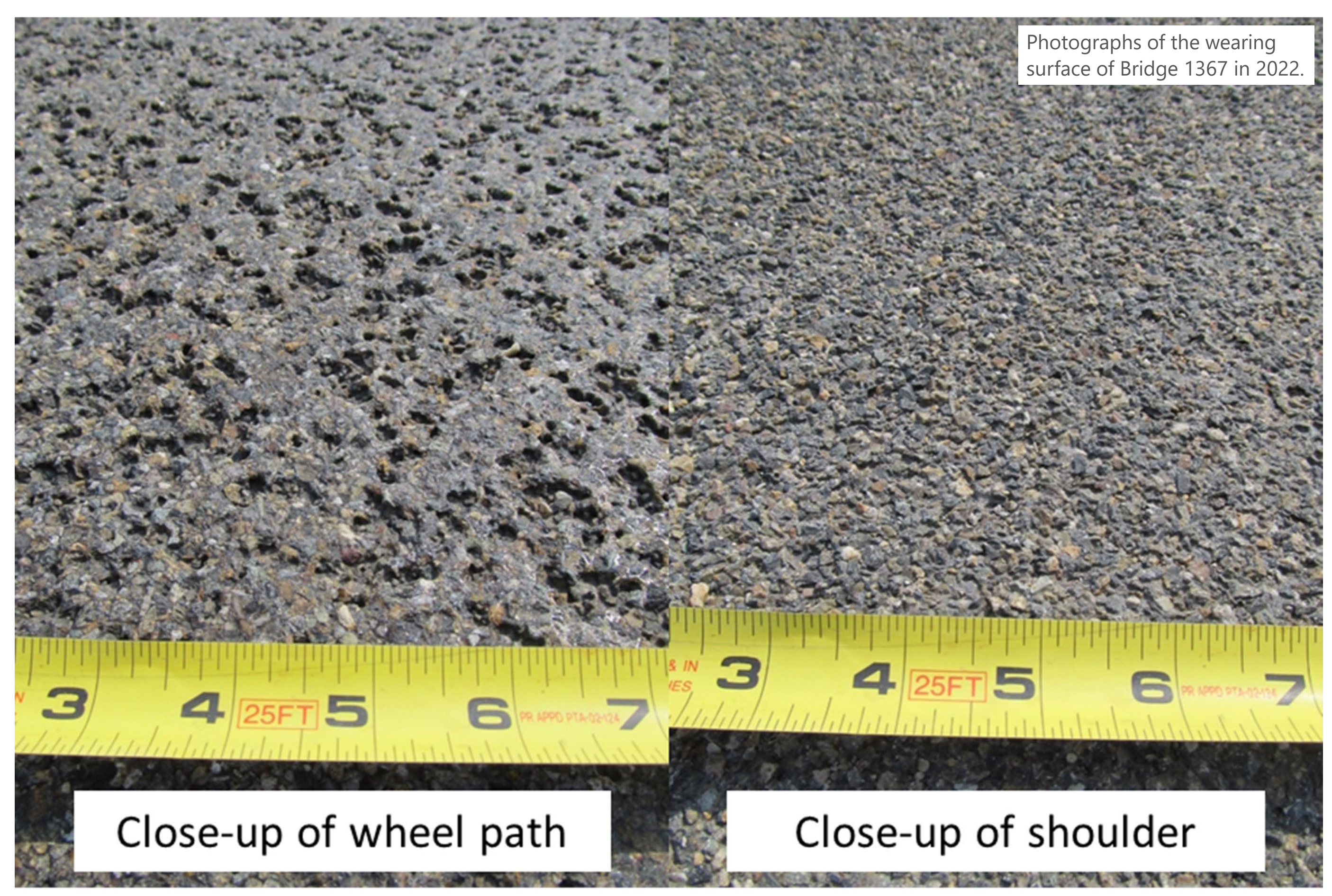
## Methodology

1. Literature Review and Survey
   a. Compiled research literature, construction challenges, potential performance issues, and best practices
   b. Survey of practices across 12 states and provinces
2. Field Investigation
   a. Visual inspection and sounding surveys of 16 HFSTs
   b. Detailed investigation of four HFSTs with cores sampled in 2020 and 2022
   c. Skid testing data collected (ASTM E274) from 2014 to 2023
3. Laboratory Testing
   a. Petrographic examination (ASTM C856)
   b. Rapid chloride penetration (ASTM C1202) and rapid chloride migration (AASHTO T 357)
   c. Bond strength (ASTM C1583)
   d. Chemical composition (Fourier Transform Infrared spectroscopy)
   e. Polymer degradation (Differential Scanning Calorimetry and Thermogravimetric Analysis)
   f. Pavement macrotexture depth (modified ASTM E965)

Core 1670-5 before ASTM E965 (left) and after the surface was filled with sand (right) using the modified procedure.

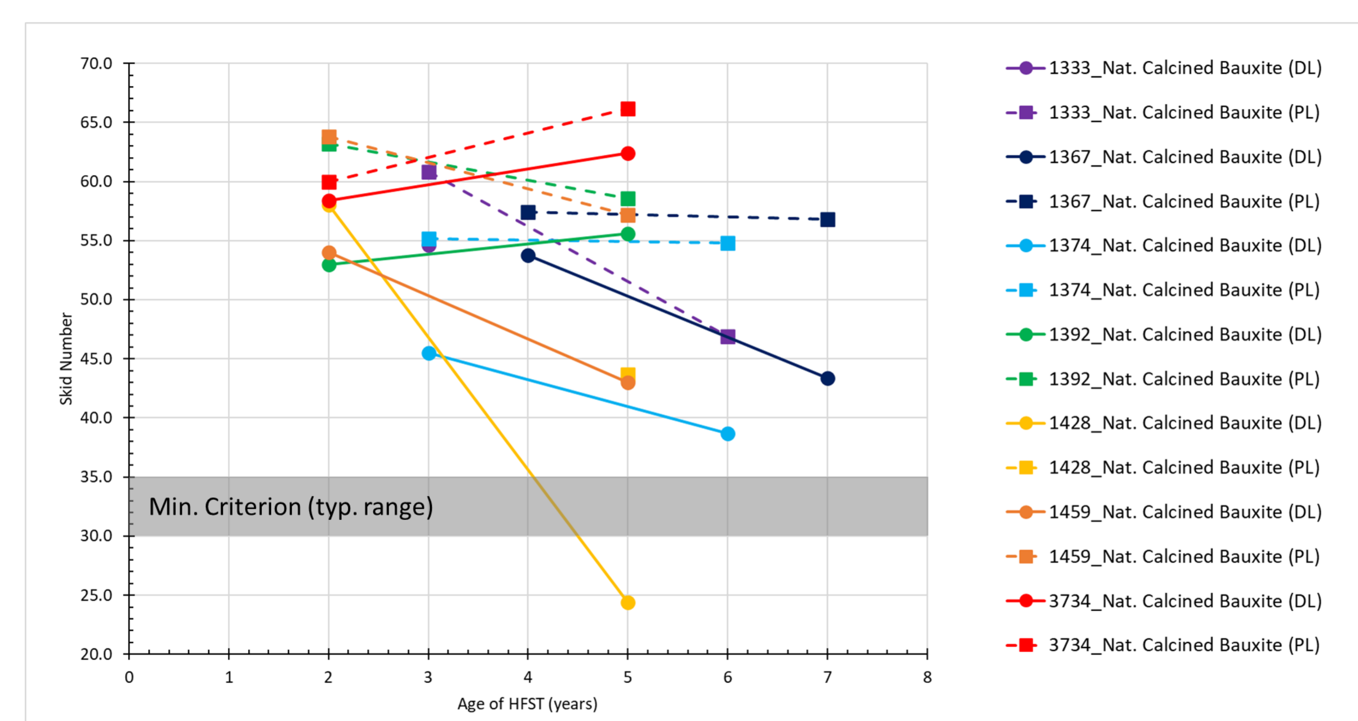
Cross-section of the HFST on Core 1459-1 (collected 2020) with primer filling a crack in the deck substrate.

Map identifying the original four HFSTs that initiated the study (red markers with yellow descriptions) and HFSTs included in the field investigation, identified by the state ID number or mile marker of the bridge. Purple markers indicate the bridge was located in the Billings District and blue markers indicate the Missoula District.



Photographs of the wearing surface of Bridge 1367 in 2022.

| Bridge ID | Route Carried | Year of HFST Installation | Type of Aggregate | ADT (vehicles per day) | ADTT (% of ADT) |
|---|---|---|---|---|---|
| 1670 | I-90 WB | 2015 | Armorstone | 9522 | 19 |
| 1682 | I-90 WB | 2015 | Armorstone | 9522 | 19 |
| 1459 | I-90 EB | 2018 | Nat. Calc. Bauxite | 8044 | 22 |
| 1367 | I-90 EB | 2016 | Nat. Calc. Bauxite | 6415 | 29 |
| 14 | Russell St NB | 2020 | Nat. Calc. Bauxite | 15747 | 0 |
| 25 | Russell St SB | 2020 | Nat. Calc. Bauxite | | |
| 1333 | I-90 EB Ramp | 2017 | Nat. Calc. Bauxite | 768 | 3 |
| 1336 | I-90 WB | 2017 | Nat. Calc. Bauxite | 6553 | 27 |
| 1338 | I-90 WB | 2021 | Nat. Calc. Bauxite | 6553 | 27 |
| 1374 | I-90 EB | 2017 | Nat. Calc. Bauxite | 6415 | 29 |
| 1392 | I-90 EB | 2018 | Nat. Calc. Bauxite | 9138 | 20 |
| 1428 | I-90 EB | 2018 | Nat. Calc. Bauxite | 16309 | 11 |
| 3734 | Rock Creek Rd | 2018 | Nat. Calc. Bauxite | 100 | 3 |
| 49.39 (mile marker) | I-90 EB | not recorded | Nat. Calc. Bauxite | 6415 | 29 |




## Findings

- Overlays were well-bonded, generally intact, and performing well with the following conditions observed in the field:
  - Areas of surface polishing
  - Aggregate pop-out and small gouges (on the order of one or two inches in diameter)
  - Reflective cracking and spalling around pre-existing partial-depth repairs
  - Deck delaminations due to ongoing reinforcement corrosion
- Progression of deterioration observed in field:
  - Initial surface wear is rapid but slows with age and appeared to stabilize after ~ 2 years of age
  - Transverse cracks sometimes reflect in HFSTs and increased between inspections for some HFSTs. Some transverse deck cracks did not reflect through the HFSTs.
- Results of laboratory testing:
  - High bond strength (failure in deck substrate) at ages of 2 to 5 years
  - Good chloride penetrability resistance (0 Coulombs passed) at ages of 2 to 5 years
  - Installations of good quality, although some voiding and incomplete consolidation observed
- Skid resistance and HFST wear:
  - Driving lane of one HFST had skid number < 35 after 5 years of service, but skid numbers > 35 observed for all other lanes tested after 5 to 8 years of service
  - Loss of skid resistance appeared to govern service life of HFSTs in driving lanes
  - Wear characterized by fracture of aggregates at level of resin, loss of aggregates, and loss of aggregate agglomerations exposing voids in HFSTs
  - Difference in wear between driving lanes, passing lanes, and shoulders measurable by skid testing and pavement macrotexture depth
  - No definitive correlation between ADT or ADTT and skid resistance
  - No geographical restrictions for the use of HFSTs


Small "popout" spall observed on Bridge 1367 in 2022 exposing deck substrate.


Transverse cracking in the driving lane of Bridge 1367 in 2022.

## Recommendations

Based on the findings, the researchers concluded that the HFST systems studied are appropriate for use on Montana bridge decks, particularly for decks with no active corrosion or minimal repair needs due to ongoing corrosion, and that current practices are adequate for the system studied. Continued monitoring of performance to better characterize the actual service life of the HFSTs and how the performance of different HFST systems and aggregates compares was recommended. Each polymer system should be evaluated separately and new resin formulations that better address loss of skid resistance were identified as an area for future research.