10-Year Performance Review of Fiber-Reinforced, Porous Friction Course at Jackson Hole Airport

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Introduction

In 2009, Runway 1-19 at the Jackson Hole Airport in Jackson, Wyoming was milled and resurfaced with one inch of FAA P-402 porous friction course (PFC) modified with FORTA-FI fibers (blend of polyolefin and aramid) over 1.5 inches of FAA P-401 asphalt concrete. Inclusion of fibers was the selected strategy in attempt to minimize premature failure of the PFC and extend overall service life as the airport historically received highly variable PFC performance. PFCs were placed in 1982 and 1987 (5-year service life) and again in 2000 (13-year service life). The PFC placed in 2000 failed prematurely due to severe raveling that began five years after construction but was not replaced until 2009 due to funding. Raveling required extensive sweeping to remove aggregate from the runway surface and the effective service life was considered between six and seven years.

Stempihar, Souliman, and Kaloush (2012) carried out a study on the sustainable aspects of the 2009 fiber-reinforced porous friction course (FR-PFC) and documented mixture properties. This follow-up study presents the 10-year FR-PFC condition on Runway 1-19. The FR-PFC performed very well and required fewer maintenance treatments than typically applied to previous PFC's on the runway. The 2009 FR-PFC is not scheduled for replacement until 2021 which equates to a 12-year service life. In comparison, the service life of the previous three PFC's on Runway 1-19 averaged just over eight years (range of five to 13 years). Based on the 2019 visual condition, the runway surface needs a preservation treatment to maintain the integrity of the FR-PFC.

Background

Jackson Hole Airport (JAC) is a commercial service airport located entirely within the Grand Teton National Park near the town of Jackson, Wyoming (Figure 1). The airport is important to the local economy as it provides a vital link to the National Parks, ski areas and other major tourist destinations. The main runway (1-19) is 6,300 feet long by 150 feet wide and has a pavement section consisting of one-inch of FAA P-402, fiber-reinforced asphalt concrete porous friction course, on 10 to 16 inches of existing asphalt concrete. The P-402 PFC provides friction for aircraft operating on the runway and must be able to withstand snow removal operations, extreme temperature changes, and heavy aircraft loads. Introducing fiber reinforcement into P-402 was done to evaluate any potential performance benefit over conventional P-402 material. Typical aircraft operating at JAC include the Boeing 737 and 757 along with the Airbus A319.

During peak tourist seasons, the single-runway airport sees nine daily takeoffs and landings. Closing the runway has a major impact to the airport and thus, attaining intended service life (or longer) from the airfield pavement is necessary. In addition, maintaining acceptable runway friction over the pavement service life is of utmost importance to the airport because:

- Chemical deicers are not used on pavement surfaces because the airport is located entirely within the Grand Teton National Park. The airport relies entirely on steel-blade snowplows and steel-bristle brooms to clear the runway pavement surface (Figure 2). The pavement surface must provide adequate wear resistance to abrasive forces from snow removal equipment.

- The runway length is considered short (by comparable standards) for the type of commercial aircraft using the airfield and their required takeoff and landings distances at the airfield elevation of 6,445 feet on hot summer days. Thus, aircraft braking and high-speed turning becomes a concern, especially during precipitation events.

Figure 1. Jackson Hole Airport location (Source: Google Maps)

Figure 2. Example steel-bristled brooms and steel-blade snow removal equipment.

In 2009, Runway 1-19 at the Jackson Hole Airport in Jackson, Wyoming was milled and resurfaced with one inch of FAA P-402 porous friction course (PFC) modified with FORTA-FI fibers (blend of polyolefin and aramid) over 1.5 inches of FAA P-401 asphalt concrete. Inclusion of fibers was the selected strategy in attempt to minimize premature failure of the PFC and extend overall service life. A control section without fibers was not constructed at the site for comparison. The previous PFC failed prematurely after five years in service due to severe raveling.

The 2009 PFC mixture properties and aggregate gradation are summarized in Table 1 and Table 2. During the fiber-reinforced asphalt concrete production at the drum plant, fibers were added to the mix prior to the silo conveyor and blended through a material transfer device and asphalt concrete paver. Figure 3 presents an image of FR-PFC paving along with a close-up image of aramid fibers in the mixture.

Table 1. Runway 1-19 P-402 Mix Design Properties

Mix Design Properties	
Gradation	Open graded
Binder	PG 64-34
Asphalt content	5.70%
Laboratory target air voids	13%, 15%[a]
G_{mm}	2.416
Hydrated lime	0.75%
Fiber reinforcement	1 lb/ton
Mixing-compaction temperature	325 – 300 °F

[a]Air voids for cylinder and beam samples, respectively (CoreLok method).

Table 2. P-402 Mix Gradation

Sieve Size, U.S.	% Passing
1 in.	-
¾ in.	100
½ in.	82
3/8 in.	57
No. 4	22
No.8	12
No. 30	6
No. 200	2

Figure 3. FR-PFC paving (left image) and close-up of blended aramid fibers (right image).

10-Year FR-PFC Condition

On May 6, 2019, NCE visited Jackson Hole Airport and performed a visual assessment of the 10-year-old P-402 FR-PFC on Runway 1-19. The weather was sunny and clear, enabling good visual delineation of the pavement surface. Photographs were taken to document the overall FR-PFC condition and a video log of the pavement surface was captured for future reference. No physical testing was conducted during the site visit.

After 10 years of service the FR-PFC visually appeared in good condition with a few minor distresses identified. Around 10 low-severity transverse cracks were noted along the entire length of runway, in an uneven spacing pattern. This is an indication that the asphalt concrete structure, including FR-PFC continues to provide excellent resistance to cracking in an environment with extreme temperature changes that generally facilitates thermal cracking. Figure 4 provides an example of the observed transverse cracks. Longitudinal cracks were observed in some paving lane joints.

Around 12 small areas (1-2 ft^2 each) of severe FR-PFC surface material loss were observed near the runway thresholds and near intersections with taxiways (Figure 5). When the parallel taxiway is closed for maintenance or construction, aircraft are required to back-taxi along the runway and perform a locked-wheel turn at the thresholds. This distress predominantly occurs when these turning maneuvers take place on very hot summer days but only when the taxiway is closed for rehabilitation.

Figure 4. Low severity transverse cracking.

Figure 5. FR-PFC material loss from locked-wheel aircraft turning maneuvers.

Rubber build-up was observed along the runway centerline and airport personnel indicated that no rubber removal was performed over the 10-year period. Figure 6 provides examples of the runway FR-PFC surface with and without rubber build-up. The entire FR-PFC, except for areas with rubber build-up, had an exposed aggregate surface shown in Figure 7. The original asphalt cement films were worn away, leaving bare aggregate. In general, the FR-PFC exhibited good coarse aggregate retention in the middle-third of the runway width and moderate coarse aggregate retention along the outer thirds of the runway width (see Figure 8). Moderate aggregate polishing was evident in the middle-third of the runway width. Longitudinal paving joints had signs of deterioration with loss of coarse aggregate and intermittent cracking (see Figure 9).

Figure 6. Example of centerline surface with rubber build-up (top-left image) edge surface (top-right image) and associated close-up of surfaces (bottom images).

Figure 7. Close-up of typical exposed aggregate (½-inch) surface observed on the runway.

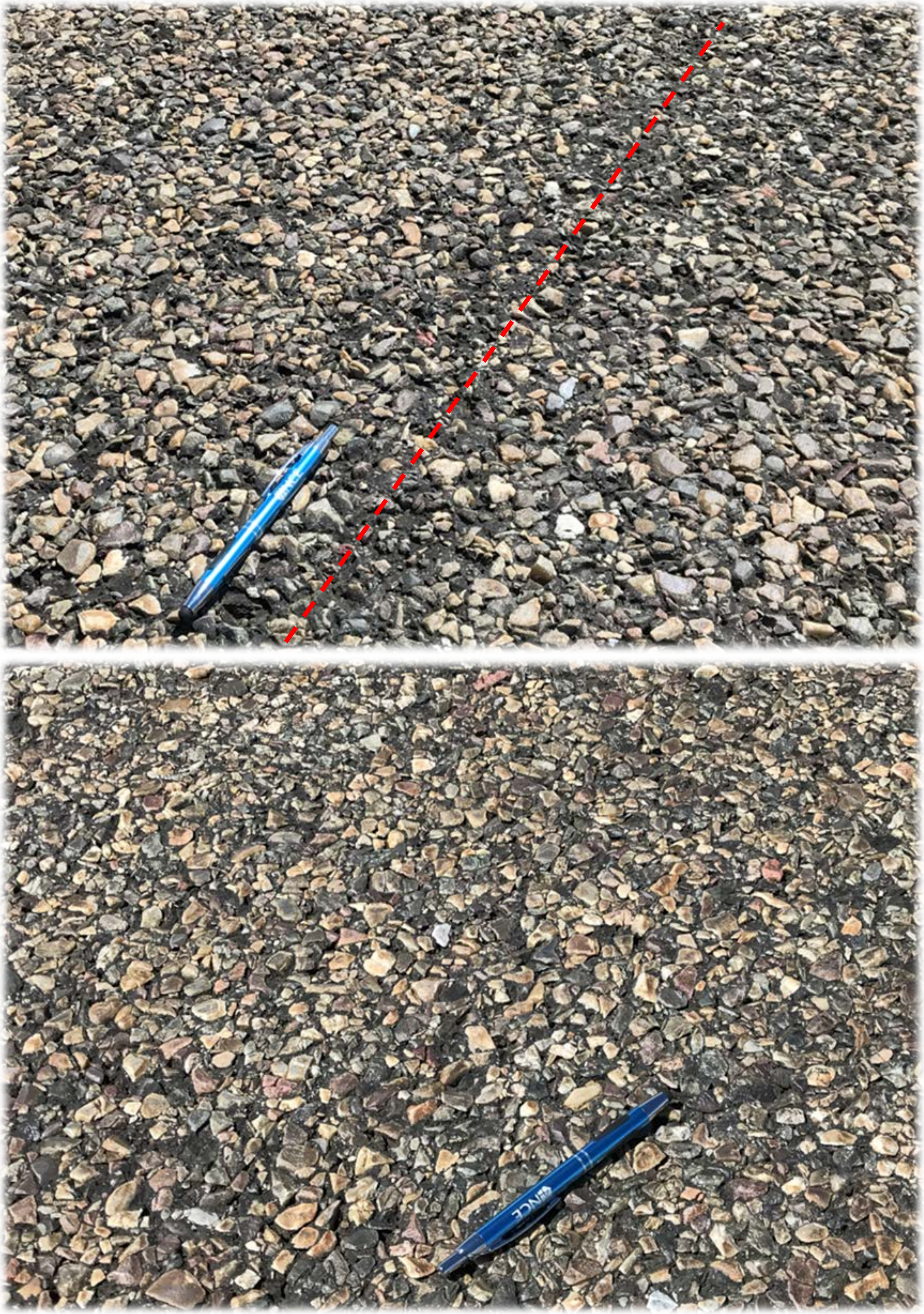

Figure 8. Top image: moderate coarse aggregate retention on outer thirds of the runway width and a deteriorating longitudinal paving joint (red dashed line). Bottom image: good coarse aggregate retention in the middle-third of the runway width.

Figure 9. Example of deterioration at longitudinal paving joints.

Preservation & Maintenance

Over the 10-year service life, only one treatment of a Gilsonite-modified asphalt emulsion was applied (5th year) to the 2009 FR-PFC. Other maintenance activities include an annual runway sweeping in the spring and repairs to damaged FR-PFC from locked-wheel aircraft turns. Historically, surface seal preservation treatments were necessarily applied to Runway 1-19 PFC's on a two- to three-year cycle. The excellent performance of the FR-PFC has resulted in fewer needed maintenance activities that translated to a cost savings to the airport and reduced impacts to airlines. Based on the 2019 visual condition, the runway surface needs a preservation treatment to maintain the integrity of the FR-PFC.

Summary

The FAA P-402 porous friction course, with FORTA-FI fiber reinforcement performed well for the 10 years following construction. The following represent findings of this 10-year follow-up site visit.

- Overall, the runway surface exhibited exposed FR-PFC aggregates except for areas with tire-rubber build-up. Coarse aggregate retention was better in the middle-third of the runway width (compared to outer thirds), likely due to kneading action from aircraft wheels. Distresses included 10 low-severity transverse cracks, surface material loss from shear forces during locked-wheel turns, paving joint deterioration, and some raveling toward the edges of the runway.

- The runway was originally scheduled to be resurfaced in 2019 but the timeline has been extended to 2021 as the FR-PFC is performing well. The service life of the previous three PFC's on Runway 1-19 averaged just over eight years (range of five to 13 years) and the current FR-PFC is scheduled to be in service for at least 12 years. Stempihar, Souliman, and Kaloush (2012) reported the inclusion of FORTA-FI fibers added approximately 6.5 percent to the per ton price of standard P-402 PFC, an amount that could be recouped by the owner in as little as a one-year extension in service life.

- Based on the 2019 visual condition, the runway surface needs a preservation treatment to maintain the integrity of the FR-PFC.
- The excellent performance of the FR-PFC has resulted in fewer needed maintenance activities than previous P-402 PFC's, reduced cost to the airport, and fewer impacts to airlines.

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Reference

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