Asphalt Keeps Aircraft Flying at Boeing Field

By John Duval, P.E.

On a warm summer afternoon in Seattle, with exhausted construction crews looking on, the pilots of a Boeing 737-800 eased the throttles forward and started moving down Runway 13R at the King County International Airport (KCIA), known locally as Boeing Field. The brand-new multimillion-dollar jet was bound for delivery to Alaska Airlines at the Seattle-Tacoma International Airport just a few miles to the south.

As the jet soared skyward, shouts and cheers could be heard from jubilant airport officials and construction personnel, who had just managed a miracle—reopening Runway 13R-31L on time after a 10-day closure to mill, overlay and reconstruct portions of the hot mix asphalt (HMA) surface.

Runway 13R-31L at Boeing Field is one of the primary arteries that pump economic vitality into Seattle, Washington, and the surrounding King County region. The airport's total annual economic impact to the region is estimated at $1.6 billion. More than 150 businesses call Boeing Field "home," including regional commercial airlines, air freight companies such as UPS and DHL, flight schools and charter operations.

Most notably, Boeing Field is home to the Boeing Company's Flight Test Programs and the 737 Commercial Delivery Center where newly minted 737 aircraft are certified and delivered to airline customers. The bottom line is that business at Boeing Field is tied directly to the availability of Runway 13R-31L, a 10,000-foot long by 200-foot wide stretch of asphalt located just four miles south of downtown Seattle.

Time is Money

Closing the runway meant that no flight testing and certification

would occur at Boeing Field, potentially delaying scheduled deliveries of new aircraft. To UPS, DHL and other express cargo carriers, the closure meant incurring costs to relocate operations to another airport, as well as downgrading service during the closure. Finally, a runway closure would impact many secondary businesses that depend on the airfield traffic, such as the jet fuel distributors and the restaurant in the airport terminal.

"When we added it all up, it came to $30,000 per hour," says KCIA Engineer Rick Renaud, referring to the total business impact of closing Runway 13R-31L.

A Plan Comes Together

Last overlaid in 1985, the HMA runway at Boeing Field had performed well for 20 years but had experienced significant settlement and cracking during the 2001 Nisqually Earthquake, a magnitude 6.8 event centered approximately 45 miles from the field. While emergency repairs were made in 2001, runway smoothness and drainage problems persisted.

Planning, design and scheduling of the complex project fell to Airport Engineer Renaud. "We needed to carefully identify the stakeholders and their interests in order to structure the project," recalls Renaud. From July to December 2005, Renaud met with airport tenants at three formal group meetings and several individual meetings, seeking their input, refining scheduling options, and gaining critical insight on the impact of the runway project on their businesses.

Understandably, many of the tenants pushed for nighttime-only work to rehabilitate the runway. Renaud estimated it would take 140 nights to complete the project, but the trick was finding 140 dry, warm nights in the cool, moist climate of Puget Sound. Nighttime-only construction would likely push the project into a second year and drive the cost of the project even higher.

Renaud understood the benefits to the project of a full runway closure. Rather than stringing the project along for months, or even years, a full runway closure of two or three weeks could allow the pavers to get in, get out, and stay out for a long time.

It was also clear to Renaud that a full runway closure would allow for higher quality paving. A full closure allowed for more consistent production, longer pulls, steady laydown and compaction operations, better overall quality and improved runway smoothness of the mat, something that Boeing requires for its flight testing and other airport tenants value as well.

Ultimately, nine separate construction scheduling alternatives were under consideration by the airport. Each alternative was evaluated based on its benefits and costs. Local contractors agreed that production levels of 500 and 750 tons per hour were reasonable.

The airport coordinated closely with the Federal Aviation Administration (FAA), the agency that provided $24 million in project funding through an Airport Improvement Program Grant. After months of exchanges to better understand each others' concerns, the airport and its tenants agreed on how to proceed. A breakdown of the selected alternative is shown in the table.

Construction Phasing for Selected Alternative

Phase	Construction Activity	Duration
1	Preconstruction activities	60 days
2	Install temporary threshold for Runway 31L – Runway closed	4 hours
3	Temporary threshold for Runway 31L – South 2500 LF of Runway closed	110 hours
4	Full closure – Runway closed	240 hours
5	Temporary threshold for Runway 13R – North 1620 LF of Runway closed	110 hours
6	Remove temporary threshold for Runway 13R – Runway closed	4 hours
7	Night closures for pavement grooving – Runway closed (2100 to 0400)	45 nights
8	Construction activities under escort – Runway operational	15 days
9	Final pavement markings – Runway 13R-31L closed	36 hours

The Intensity Builds

In April 2006, airport officials awarded the project to ICON Materials, a local asphalt paving and earthwork contractor with plants in Auburn and Seattle. ICON's Asphalt Division Manager, Dave Gent, was faced with figuring out how to place 106,000 tons of HMA in less than 20 days.

The project was going to be tough for three reasons. The obvious challenge was the sheer volume of material to be produced, hauled, placed and compacted. For weeks leading up to the start of paving, mountains of aggregates meeting the requirements of the FAA P-401 specification were mined, crushed, washed and stockpiled for the job at ICON's Auburn plant. Not far away, mammoth tanks of PG 64-22 asphalt binder were blended, tested and stored at the Tacoma refinery operated by US Oil & Refining. Moving these materials into place at the right time would be a challenge of its own.

The second challenge was the clock. In order to ensure that the runway was returned to operational condition at each stage in the project, contract terms called for liquidated damages as high as $15,000 per hour if stage construction deadlines were not met. "It's a big hammer that keeps everybody focused," explained Renaud.

It was the third major challenge of the project that kept Gent awake at night with a nagging question. What was waiting deep under the surface at seven taxiway/runway intersections that had been damaged in the 2001 Nisqually Earthquake? The plans called for removal of the existing asphalt and concrete in these locations in order to reconstruct a new pavement section from the bottom up. Earthquake-induced soil liquefaction had reduced the bearing capacity of the subgrade soils, causing the pavement to shift, settle and crack.

Everybody knew that the work had to be done. It was the quantity of over-excavation and replacement work that remained unknown until final determination could be made in the field based on the results of on-site evaluation and field tests. "Rebuilding taxiways from scratch over suspect soils within the time allowed was a daunting task," said Gent.

Back to School

Just prior to construction, URS Project Manager Shammi Ratti faced his own challenges. URS was hired by the airport to administer the construction activities. One of Ratti's primary tasks was to bring his fifteen construction inspectors "up to speed" on current asphalt technology.

Ratti's plan was to hold an HMA construction workshop that would provide a primer on principles of HMA construction to the URS engineers, architects and technicians serving as inspectors on the project. He also wanted to bring in the airport staff, laboratory technicians and the construction crews to be a part of the class. The workshop served a second, but equally important purpose—a partnering session that reduced some of the intensity on the project and eased communication among all parties.

URS made arrangements for the Asphalt Institute (AI) to conduct the training workshop for an audience of 35 people two weeks before the start of paving. The AI provided two field engineers to serve as instructors on the basic elements of HMA materials, mixes, laydown, compaction, quality control and acceptance testing.

The AI instructors adapted the course specifically to the project, using information pertinent to the exact aggregates, asphalt binder, and P-401 mixes to be used on the project. Together with ICON's Dave Gent, the AI team even used photos of ICON's Auburn plant to show how HMA would be produced for the project.

The workshop was a success. ICON's Gent praised the seminar for "…familiarizing the whole team with the basics of hot mix paving," and providing a forum so everyone involved could "…ask practical questions from experienced professionals about what they could expect in the field." URS's Shammi Ratti observed, "The seminar contributed to our overall success on the project. We plan to write into our specification that AI shall be contracted to conduct a pre-construction seminar on all future airport projects."

Showtime

The project clock started ticking at 10:00 a.m. on August 8, 2006, signaling the kick-off of paving operations. ICON had just 20 days, or 480 hours to be exact, to take up the old runway and replace it with new high quality HMA.

There were people and machines everywhere at every hour of the day or night. A group of three milling machines went ahead, removing the grooved surface of the existing mat and creating a smooth bed for a new lift of HMA. They were followed by the distributor trucks, spraying a tack coat of emulsified asphalt. Paving trains came next, working in echelon where possible to create a smooth seamless surface.

As many as 54 28-ton belly-dump trucks were on-site, in route, or at one of the two ICON plants used to feed the job. As they unloaded the 300°F mix in long, straight windrows, Roadtec Shuttlebuggy material transfer vehicles scooped up the material and fed it to the four Caterpillar AP 1055 pavers. The compaction train consisted of 13 high-frequency vibratory steel drum and pneumatic-tire rollers constantly moving back and forth to create a uniformly dense mat that would meet the demanding FAA P-401 specification.

At the taxiway connections, a guillotine breaker pounded the existing concrete and asphalt alongside trackhoes that loaded the rubble into dump trucks for a trip to the recycling yard. URS inspectors took load tickets at the pavers and monitored mixture temperature, ensuring that the mixture was hot. They selected random testing locations and cored the new mat to measure in-place density. Two field testing laboratories were on site to monitor material properties and determine whether the mix was acceptable by FAA standards. Lab technicians sampled fresh mix and ran tests for HMA mixture volumetric properties on a 24/7 basis.

Success

Looking back, the Boeing Field Runway Rehabilitation project was a success by every measure. "The end result was the runway was able to open 24 hours ahead of schedule, there were no construction or aircraft accidents, and the project will close out at or under the FAA grant amount," concluded FAA Project Manager Karen Miles.

It took careful planning, ongoing communication among team members, and flawless execution on the part of the construction crews. Gent attributes the success of the project to the cooperative spirit of the partners involved, who "allowed ICON to perform up to our full potential." In a similar vein, Ratti believes, "The overall success of the project is due to the early partnering between URS, ICON Materials, the FAA and King County airport staff."

Clearly, the selection of hot mix asphalt played a significant role in the success of this project. In fact, according to Ratti, "HMA was the only way the airport could meet its schedule commitments to its tenants." Airport Engineer Renaud agreed that "the shorter construction time was a compelling factor in choosing asphalt."

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