From Rubble to

The arrival of a lone KC-135 at Grand Forks AFB, N.D. on Oct. 30, 2005 marked the unofficial opening of Air Mobility Command's newest state-of-the art runway and the end of a long summer of construction at the base.

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Originally built in 1956, the 47-year-old runway's history includes serving both B-52 Stratofortresses and B-1 Lancers under Strategic Air Command. In 1958, when the runway was widened from 100 to 300 feet to handle the larger strategic bombers, extra pavement was added to only one side, producing a crown that was actually 50´ east of the runway centerline. Grand Forks is now home to KC-135 Stratotankers, whose operational requirements call for a runway width of only 150´. A May 2003 infrastructure assessment revealed an urgent need to repair or replace the runway. That, combined with the runway's off-center crown and the rising costs of maintaining the extra pavement, convinced AMC that it was time to bring the runway up to current standards.

The $27.5M O&M project was the Air Force's largest in FY04. Grand Forks AFB's 319th Civil Engineer Squadron, AMC's Infrastructure Branch, and the Army Corps of Engineers' Transportation Systems Center collaborated with several contract firms to take an innovative approach to the project that incorporated state-of-the-art technology with revolutionary construction methods. With construction costs at an all-time high, cost containment was an important consideration.

Runway

The design process began in August 2003 and lasted almost 12 months. Several runway repair options were presented by the design team, ranging in scope from all new concrete to various combinations of concrete and performance grade asphalt placed on top of the existing concrete runway after rubblization. The latter was chosen based on life cycle cost analysis. Rubblization, which has been used on very few military airfields, involves breaking existing pavement, rolling it, and leaving it in place to serve as a base course for the new pavement (see article on rubblization, p. 11).

Construction began in earnest on March 22, 2005, with a climate-driven deadline of November 1—paving operations had to be complete before low temperatures hit or be delayed until the following spring. Construction started with concrete removal and crushing operations, followed by trenching and underdrain installation. Then the entire airfield was closed so the contractor could start rubblizing the concrete pavement.

The Army Corps of Engineers' Engineering Research and Development Center closely monitored the entire design and construction process. They performed tests both before and after construction in order to evaluate structural properties for rubblized concrete base courses.

The specifications called for rubblization using both resonant and gravity breakers. The project was started using a resonant breaker to send very fast shock waves into the concrete, literally vibrating it apart. The method worked, but was too slow, and the machine was plagued by breakdowns, so only a small percentage of the pavement was broken in this way. The remainder of the surface was done using a common guillotine breaker to crack the pavement into 12″–15″ pieces and then a multiple-hammer breaker—with up to 16 separate, 1,000 to 1,500-pound breaking hammers—broke the top half of the concrete slabs into 6″ pieces. These machines were followed by special rollers with "Z-grid" drums to seat the concrete pieces and vibrate them into a very stable permeable base. Because the new runway is paved atop the existing pavement, its elevation is 1.8´ higher than its predecessor.

The runway design called for 1000´ of 16″ thick concrete pavement at the north end; 1,080´ of concrete at the south end; 10,270´ of 9″ thick asphalt in the center; and 3″ thick asphalt overruns of approximately 1,000´, for a total length of 14,370´.

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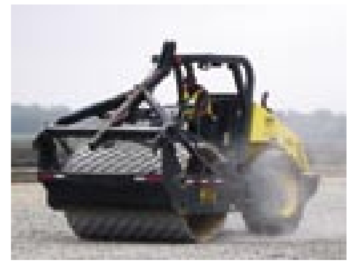
The asphalt proved to be a sticking point in the construction process. Performance grade 64-40 asphalt binder was specified for this project because it could handle temperature extremes (especially lows) without cracking. But PG 64-40 had never been used on an Air Force project, so the contractor had no experience with it and despite numerous attempts could not produce a test strip that met density requirements without check-cracking during rolling. Based on recommendations by a team of pavement engineers from private industry and the Department of Defense, design specifications were modified to allow the successful substitution of PG 64-34, a binder more commonly used in North Dakota, with a proven history in the harsh northern climate.

The contract specifications were also modified to include a sliding pay scale, which was originally included in draft specifications but was omitted in the final edition. This allowed the contractor to be paid at a reduced rate for deficiencies that didn't fully meet specifications but wouldn't significantly affect the strength or quality of the final product. Without a sliding pay scale, the contractor would have had to remove pavement if it missed a parameter by only a fraction of a percent, significantly increasing the contractor's costs and greatly affecting the tight schedule and climate-driven deadline.

Paving was completed on September 19 and pavement marking and electrical work (see box) kicked into high gear. Much of concrete. This gave a very clean result that didn't require patching around the lights.

Grooving in the concrete portions of the runway was completed concurrently with the asphalt paving. However, transverse grooving of the asphalt portion won't be complete until early spring of 2006, because



Left: The guillotine breaker cracked the pavement into 12″–15″ pieces. Center: The multiple-hammer breaker—with up to 16 separate, 1,000–1,500 lb. breaking hammers—broke the chunks from the guillotine breaker into 6″ pieces. Right: The Z-Grid roller seated the rubblized concrete and vibrated the pieces into a stable base. (photos courtesy Applied Research Associates)

the electrical work had been completed concurrently with paving, but the lights couldn't be installed until after paving. To prevent potential "birdbaths" created by paving around edge lights and to maintain a better transition between runway and shoulder pavement, the contractor used GPS to pre-position the light cans. After shoulder paving was completed, workers cut a circle above each light can location using an 18″ diameter core drill. The light cans were then installed in PVC liners and encased in

of the 30-day cure specified for the asphalt as well as lengthy delays caused by wetter than normal weather.

The Grand Forks runway officially opened with a ribbon-cutting on Nov. 7, 2005, giving the base a state-of-the-art runway that will carry Air Force aircraft for many years to come.

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Runway lighting at a glance

In addition to the pavement work, a large amount of electrical equipment was installed during the runway project:

- Installed new High Intensity Runway Edge Lighting System on the primary runway.
- Modified two existing ALSF-I approach lighting systems.
- Relocated two Precision Approach Path Indicator Systems.
- Re-installed runway distance markers.
- Installed new taxiway edge lighting and signage system.
- Installed new electrical duct bank system and updated computerized controls.

Electricians installed over 126,100 linear feet of cable, over 102,100 linear feet of conduit, 391 light fixtures mounted to base cans, and over 500 L-823 connector kits with heat shrinks. Runway 17/35 at Grand Forks AFB now has a lighting system that meets all current Air Force criteria.

Mr. Don Marlen, HQ AMC/A7O, Command Electrical Engineer

The Rubblization Procedure

Mr. Guy Ivie
Staff writer

Rubblization isn't exactly a new idea. Over the past 20 years, the procedure has gained in popularity as an option for rigid pavement rehabilitation. It's been used successfully on highways and airport runways around the United States. With this procedure, the existing concrete material, rather than being removed from the site, becomes a structural layer overlaid with new concrete or asphalt. One of the biggest advantages is monetary: rubblization costs 66% less than removing the old concrete and starting fresh. Other benefits can be time savings, reduced environmental impact and a smoother ride.

Rubblization fractures the existing slab and breaks it into particles ranging from sand-sized to 3″ at the surface and from 12″–15″ at the bottom of the rubblized layer. The end result is a material comparable to a high-quality aggregate base course. There is no need to align joints when the new concrete overlay is applied. The rubblized layer also eliminates thermal expansion/contraction, thus helping to prevent reflective cracking in the concrete overlay.

Two types of breakers are used for rubblization: resonant and gravity. Resonant breakers use vibrating hammers to send high-frequency, low-amplitude shock waves into the concrete layer while maintaining the base integrity of the pavement. Gravity breakers work in pairs. The first, a guillotine breaker, employs a wide drop-hammer to make the initial fracture. Then a multi-head breaker—with up to 16 individual drop-hammers weighing 1,000–1,500 pounds—breaks up the fractured slab into smaller particles. After the breakers comes a vibratory drum roller that seats the fractured concrete and breaks up larger particles on the surface.

Although rubblization is becoming more popular, there is still no single standard design procedure or methodology for characterizing the rubblized layer. Without standards, there is a risk of premature failure. The U.S. Army Engineer Research and Development Center in Vicksburg, Miss., conducted a study of airfield concrete pavement rehabilitation using rubblization. The goal is to help set the standards to be followed in future projects.

The first phase of the study evaluated existing equipment and techniques for use on thick airfield pavements. The second phase involved validation and calibration of the rubblization procedure through field demonstration projects. Researchers conducted visual pavement condition surveys and then performed structural evaluations using a heavy-weight deflectometer. Hunter Army Airfield in Savannah, Ga., and Selfridge ANGB in Selfridge, Mich., were selected for the study because they've both undergone rubblization projects in the past three years.

Although this study was completed before the Grand Forks AFB project (see page 8) got fully under way, the USACE ERDC monitored the work done there. Those observations will be used in the determination of rubblization construction specifications.

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Intermediate results of rubblizing at Selfridge ANGB, Mich. (U.S. Air Force photo)