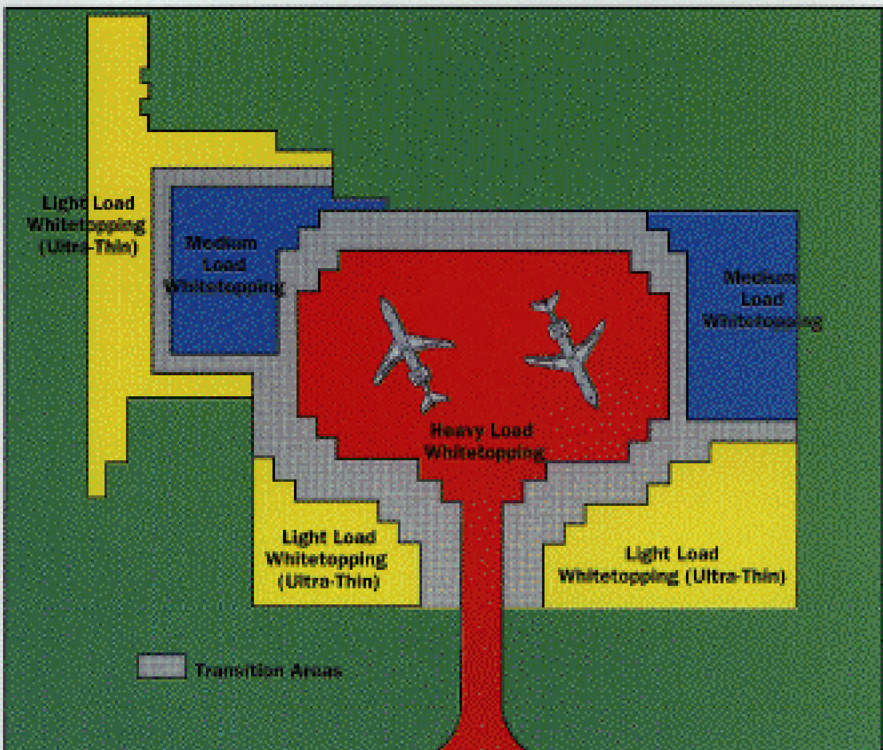
Whitetopping Restores Air Traffic at Spirit of St. Louis

Innovative whitetopping project marks the first use of an ultra-thin concrete overlay by a U.S. airport

By Susan Mowris

One of the largest general-aviation airports in the Midwest, Spirit of St. Louis Airport accommodates 1,000 takeoffs and landings daily. The airport opened in 1964 to relieve air traffic at Lambert Airport, the major airport in the St. Louis area. As overflow from Lambert increased, Spirit of St. Louis' six-acre asphalt apron—originally designed for only light aircraft—frequently became the parking area for medium-sized jet planes and heavy DC-9s and B-727s. Over the years, the heavy plane traffic caused severe deterioration of the asphalt. In some sections, exposure to jet fuel turned the asphalt to mush. A devastating flood in 1993 that submerged the ramp under 9 feet of water aggravated the damage, making the apron unusable.

Last February, however, the Spirit of St. Louis apron reopened to air traffic—after being restored in just three months by the use of a concrete overlay. The Federal Aviation Administration provided funds for the project through a pilot program with the Missouri Highway Transportation Department (MHTD). What makes this project noteworthy is the versatility of the overlay in accommodating aircraft of significantly different weights. It also marks the first use of ultra-thin whitetopping at a U.S. general-aviation airport. Whitetopping of airport runways and aprons has been performed in the past, but only at thicknesses of 5 inches or greater. Ultra-thin overlays are generally less than 4 inches thick.



All photos and drawings courtesy of CRD Campbell Inc.

Figure 1. **The mixed use of the apron area presented design challenges. A variety of whitetopping designs, including ultra-thin sections, was used to handle the different aircraft.**

Feasibility Studies Favored Whitetopping

The alternatives for rehabilitating the Spirit of St. Louis apron were either complete reconstruction or overlaying with concrete or asphalt. The new pavement surface had to be capable of supporting heavy aircraft.

Feasibility studies conducted by CRD Campbell Inc., an engineering, architectural, planning, and research firm in St. Louis, concluded that a concrete overlay would be more cost-effective than an asphalt overlay or apron replacement. The study was based on a 20-year life-cycle cost projection that considered apron maintenance, installation, and durability.

Design Challenges

The mixed use of the apron for light to heavy aircraft presented a design challenge. The 45,000-

square-yard area had to be divided into grid sections based on pavement loading (Figure 1). The heavy-load area (for the up to 120,000-pound DC-9s and B-727s) covers almost 15,000 square yards and required a 10-inch-thick concrete overlay. Medium-load aircraft (weighing up to 70,000 pounds) required an area of 7,200 square yards with an overlay thickness of 8 inches. Both the medium- and heavy-load areas are segmented into 12½-square-foot slabs with steel dowels across the joints for load transfer.

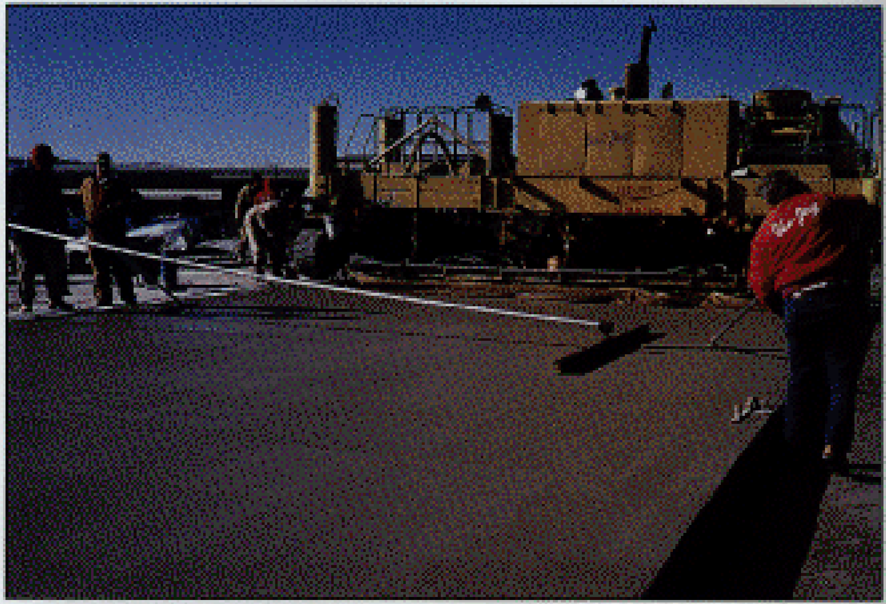
An ultra-thin (3½-inch-thick) concrete overlay was designed to cover almost 14,000 square yards of light-load areas, which support aircraft weighing up to 12,500 pounds. The idea for using an ultra-thin whitetopping for the light-load areas came from CRD Campbell president Carl Rapp. Through his membership on the Transportation Research Board Committee on Portland Cement Concrete Construction, Rapp was introduced to the results of a Louisville, Ky., experimental project that used 2- and 3½-inch-thick concrete whitetopping on a landfill entrance road traveled by more than 600 trucks per day. CRD Campbell also had experienced positive results designing a 6- to 7-inch concrete overlay project at St. Louis' Lambert International Airport.

Based on calculations from the American Concrete Pavement Association and CRD Campbell's own laboratory findings, Rapp was able to convince the MHTD that ultra-thin whitetopping would work as a bonded overlay for the apron sections designated for light aircraft. Using the existing 3½ inches of asphalt and 6- to 7-inch subbase as the base for the overlay would also cut down on costs and minimize downtime for the busy airport.

Minimum flexural strength for the ultra-thin overlay concrete was specified at 675 psi to address predicted stresses in the overlay ranging from 62 to 440 psi. The mix design used to achieve the high flexural strength specification also helped the concrete achieve the required strength quicker in cold weather (the overlay was placed in the winter).

Another design feature of the ultra-thin overlay was the 4-foot, 2-inch joint spacing. The smaller slabs minimized random cracking in the overlay and will be easier to remove and replace should concrete cracking occur. The mix design called for 3 pounds per cubic yard of polypropylene fibers. In previous ultra-thin projects, fibers were added to further minimize shrinkage cracking and aid in aggregate-interlock load transfer by holding joints tightly together.

The remaining 8,800 square yards of the apron consisted of transition areas between the different concrete overlay thicknesses. Because of the configuration of the apron area, transitions had to be made from the 10-inch-thick whitetopping down to the 3½-inch-thick ultra-thin overlay. Similar transitions had to be made between the medium-load concrete overlay and the ultra-thin light-load sections. Figure 2 shows the design CRD Campbell used to make the transitions of thickness and joint spacing.



Feasibility studies showed that overlaying the deteriorated asphalt apron at the Spirit of St. Louis Airport with concrete was the most cost-effective solution.

Overlay Placement

Before overlay placement began, the subgrade for the existing asphalt ramp was tested to ensure that it was an adequate base for the new apron. The asphalt surface was then rotomilled and air blasted to improve bond with the concrete overlay (Figure 3). Vee-Jay Cement Contractors Inc., St. Louis, placed the overlay using a slipform paver that could adapt to the varying overlay thicknesses using stringline gauges. Joe Vitale, co-owner of Vee-Jay, says, "Preplanning was a critical part of the slipform process to make sure the elevations worked out and the thickness of the concrete was correct. It took a considerable amount of coordinating on the part of the superintendent and the machine operator."

Paving work began on December 22, 1994. Fortunately the weather was temperate enough to allow placement of the concrete, but cold-weather precautions were still followed. "Depending on the weather, the subgrade would be covered with blankets and removed first thing in the morning. This allowed longer working days," says Mike Novak of C. Rallo Contracting Co., St. Louis, general contractor for the project. On a couple of days, when the weather cooperated, 1,300 cubic yards of concrete were placed.

Joints with spacings ranging from 4 feet, 2 inches to 25 feet were often sawcut at night to keep the project on schedule and prevent random cracking. The joints were sealed with silicone to prevent jet fuel from eroding the asphalt underneath the overlay.

Because of the ultra-thin overlay's high ratio of concrete surface area to volume, workers applied twice the normal amount of curing compound, using a minimum of 1 gallon per 100 square feet. The fiber-reinforced concrete was tested over a seven-day period for flexural strength. Results showed a 7% increase in flexural strength compared to a similar mix without fibers. The small slab-section size and use of polypropylene fibers yielded a durable surface.

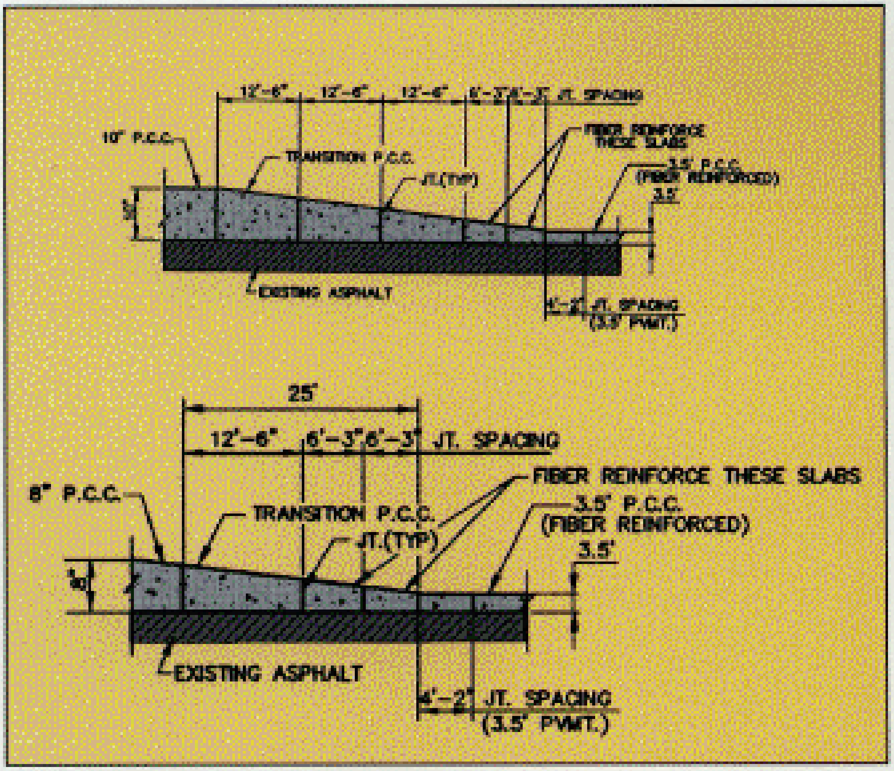


Figure 2. **Design and construction of the transition areas from the conventional-thickness whitetopping sections to the ultra-thin sections proved to be one of the more challenging aspects of the apron project.**

Opportunities for the Concrete Industry

Dick Hrabco, director of aviation for the Spirit of St. Louis Airport, says, "The whitetopping has tripled the life of the ramp pavement." He also notes that to achieve the grades required to improve the apron's drainage and accommodate heavy aircraft, a greater volume of asphalt would have been required. "Because we did not need to tear out the old pavement, the concrete was economical from the beginning," claims Hrabco.

ACPA is monitoring the concrete overlay for bond strength and stresses in the concrete and underlying asphalt (see next page). Steve Tritsch, executive director for the Missouri-Kansas Chapter of ACPA, says, "We want to see if the overlay adheres to the asphalt according to predicted calculations." Under the sponsorship of the Portland Cement Association, Construction Technology Laboratories, Skokie, Ill., has placed test equipment on-site to monitor the bond. ACPA will also monitor how the joints hold up after repeated exposure to jet fuel and freeze-thaw cycles. "Demonstrating that the ultra-thin concrete overlay is a viable, cost-effective solution at Spirit of St. Louis Airport will have good potential for the industry," says Tritsch.

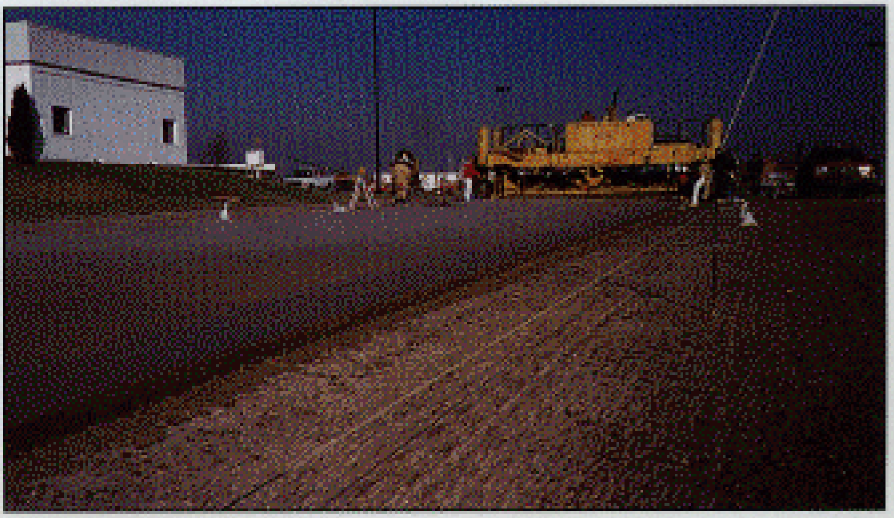


Figure 3. **Before placing the overlay, the contractor rotomilled and air blasted the asphalt surface to improve bond with the concrete overlay.**

Susan Mowris is a free-lance writer in St. Louis.

Ultra-thin Research Advances Whitetopping Technology

By Larry Cole

While whitetopping is a proven method of pavement rehabilitation, ultra-thin whitetopping is a more recent technology. Three characteristics distinguish ultra-thin whitetopping from the more conventional, well-established whitetopping used on many projects throughout the United States.

With ultra-thin whitetopping:

- The concrete overlay is less than 4 inches thick.
- The bond between the concrete overlay and the existing asphalt creates a composite pavement.
- The joint spacing is shorter.

Current whitetopping design procedures do not consider the benefits of bond between the concrete overlay and the underlying asphalt. But field experience and limited research show that the concrete overlay adheres to the existing asphalt. Since the two layers act together, the composite pavement significantly reduces the stresses in the concrete caused by traffic loads, reducing the required concrete thickness. The resulting thinner layer of concrete does require shorter joint spacings to prevent random cracking.

Since the 1991 experiment in Louisville, Ky., verified the viability of ultra-thin whitetopping, ultra-thin overlays have been constructed in Colorado, Georgia, Iowa, Kansas, Kentucky, Missouri, New Jersey, North Carolina, Pennsylvania, and Tennessee. Constructed under a variety of traffic and environmental conditions, the overlays verify the beneficial effect of short joint spacing and bond on ultra-thin whitetopping performance.

American Concrete Pavement Association

A key to the success of ultra-thin whitetopping is the bond formed with the existing asphalt, as shown in this core from the first ultra-thin experiment in Louisville, Ky. Researchers continue to investigate the durability of the bonded interface and its effect on overlay performance.

Two projects in particular involve comprehensive research efforts. At the Spirit of St. Louis apron project, instruments were installed in the concrete to monitor stresses at various depths and locations in the 3½-inch-thick concrete overlay. Researchers from Construction Technology Laboratories will compare the field data with analytical models to verify the composite action of the ultra-thin whitetopping. A main goal of the research, which is sponsored by the Portland Cement Association, is to develop a new engineering procedure for ultra-thin whitetopping.

CRD Campbell Inc.

Researchers placed strain gauges to measure stresses in the concrete in the ultra-thin sections of the Spirit of St. Louis apron. Note the short joint spacing used in the ultra-thin design.

The Iowa Department of Transportation is also conducting a major whitetopping experiment with the goal of developing new design procedures. The 7.2-mile project on Iowa Route 21 contains 64 experimental whitetopping sections, which vary in thickness (including ultra-thin 2-inch-thick sections), joint spacing, and asphalt surface preparation. Researchers from Iowa State University will monitor the overlay for five years and are particularly interested in changes to the bonded interface during the evaluation period.

Since its conception in 1991, ultra-thin whitetopping technology has continued to move forward. With several overlays now in service, firsthand field experience is being gained. Such in-service pavements are the best indicators of ultra-thin whitetopping performance. Detailed research information from the Spirit of St. Louis apron, Iowa Route 21, and future projects will add to our knowledge. Advances in experience and knowledge from these projects will lead to new design methods, promising a bright future for ultra-thin whitetopping.

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