TENNESSEE
DEPARTMENT OF TRANSPORTATION

ULTRA-THIN PORTLAND CEMENT CONCRETE OVERLAY OF A GENERAL AVIATION RUNWAY

FINAL REPORT

Project Number: TNSPR-RES1157

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16. Abstract

The principle objective of this research project was to evaluate the use of a thin concrete overlay to be used for asphalt pavement rehabilitation for an existing runway and if found practical, implement the concept into a construction project. Testing of the concrete/asphalt interface to study the paving responses under traffic loadings and evaluate the interface bonding strength between the two surfaces took place after construction. At the time of the project, there had not been an ultra-thin whitetopping (UTW) overlay of an asphalt runway at a general aviation runway in the United States.

The appendix portion of the report is available from the Tennessee Department of Transportation upon request.

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EXECUTIVE SUMMARY

This document is the final report for the project "Ultra-Thin Portland Cement Concrete Overlay of a General Aviation Runway" carried out by Barge, Waggoner, Sumner and Cannon, Inc. with assistance from the Tennessee Department of Transportation.

The objective of this project was to research and evaluate the use of a concrete overlay to be used for pavement rehabilitation for the runway. The research objectives of this project also include a comparison to a traditional asphalt overlay in terms of life cycle costs and down time to the airport due to construction.

The project consisted of several phases which are typical for a construction project:

- Preliminary Investigation/Pavement Analysis Phase
- Preliminary Design Phase
- Final Design Phase
- Construction Phase
- Instrumentation/Field Testing

Much research into the previous use of UTW in the U.S. was conducted during the preliminary phase of the project. The findings from that research served as a foundation from which to build upon, as this project was the first of its kind in the United States for a general aviation airport. Currently, the Federal Aviation Administration does not have design standards for the use of UTW, and the pavement specifications established for this project are being studied and considered by the FAA.

ACKNOWLEDGMENTS

Barge, Waggoner, Sumner and Cannon, Inc., headquartered in Nashville, Tennessee, performed the work on this project through a grant furnished by the Tennessee Department of Transportation. The sponsoring agency was the Tennessee Aeronautics Division. Assistance from that agency came from Mr. J. Tom Burgess, Chief Engineer, and Mr. Ron Fitzgerald, Project Manager. Their support and cooperation is greatly acknowledged.

Acknowledgments are hereby given to the following who assisted with the design and construction of this project:

- Louis Mishu: Geotech Engineering, Nashville, Tennessee -- conducted the geotechnical testing of the subgrade, core drilling and conducted quality control testing during construction.

- Dr. Athar Saeed: Applied Research Associates, Albuquerque, New Mexico -- conducted field evaluation of the existing pavement which included the use of falling weight deflectometer and dynamic core penetrometer, assisted with design recommendations and provided post-construction testing.

- Kurt Johnson: Kurt Johnson Surveyors, Winchester, Tennessee -- performed the topographic survey of the existing runway surface and shoulders

- Bob Bogert: Anderson and Bogert, Inc., Cedar Rapids, Iowa -- provided expertise regarding concrete overlays on asphalt pavement airfields

APAC-Georgia, Southern Rebuilders, Inc., provided construction services, and their professionalism and expertise is acknowledged. Construction of the 5,000 by 100-foot overlay was completed in twenty-two days, eighteen days ahead of schedule. Soon after completion, TDOT approved a change order for a UTW overlay of the apron and taxiway connectors as well. Even with this change order, all work was completed within the original schedule.

The design team from Barge, Waggoner, Sumner and Cannon, Inc. included the following:

- Tony Manci, Project Manager

- Bob Boyd, Structural Engineer

- Raymond Canady, Construction Representative

INTRODUCTION

The Tennessee Aeronautics Division (TAD) oversees numerous airport runway pavement rehabilitation projects yearly. The traditional method practiced for years has been the use of asphalt overlays to extend the pavement's life. This process requires maintenance of the pavement every few years to maintain integrity of the pavement. It has been considered in the past that an answer to maintenance rehabilitation has provided the best value for the money expended. Advances in recent years in the concrete with topping process allow a thinner concrete layer to be placed using conventional paving equipment and materials, therefore, making concrete more cost beneficial.

To date, ultra-thin PCC overlays on G.A. airfields have been limited to aprons and low-speed taxiways. The typical pavement distress pattern for G.A. airports is block cracking which is not normally related to load stresses. It is suspected that the narrow spacing of control joints in an ultra-thin PCC overlay will yield a runway with a longer maintenance-free life span and lower long-term costs.

1.1 RESEARCH OBJECTIVES OF THE STUDY

The TAD would like to research and evaluate the use of a concrete overlay to be used for pavement rehabilitation for the runway. The rehabilitation method is to be compared to a traditional asphalt overlay in terms of the life cycle cost benefits for each of the initial construction costs and loss of the use of the airport during construction. Within each method to be studied, further possible solutions are to be examined depending on the severity of problems that the runway is experiencing.

The pros and cons for each method studied will be compared. Also, the study is to include an annual review of the concrete overlay for a period of six years to inspect the integrity of what has been placed. This review will consist of updating a report on the findings of each annual review. This information is to be used as a comparison of maintenance costs to asphalt systems already in place.

Also, strain gauges are to be placed in the portland concrete cement (PCC) white-topping and at the PCC/Asphalt surface interface to record date that will be used to study white-topping paving responses under traffic landing and to evaluate the interface bonding strength between the concrete/asphalt surfaces.

Different concrete design parameters such as joint spacing and joint depths, are to be incorporated into construction and reviewed for performance.

1.2 PROJECT APPROACH

A. Preliminary Investigation/Pavement Analysis Phase:

This phase will involve nondestructive testing and analysis to determine existing pavement structural conditions with recommendations for rehabilitation and design recommendations for the reconstruction of the existing runway pavements with minimum impact on traffic operations, as described below:

1. **Assessment of Existing Runway Pavement Condition** – An easement of the existing surface conditions and types of distresses exhibited at the pavement surface will be made. This will be accomplished through observations made by walking the runway. This assessment will be beneficial in understanding problems that may be associated with the existing pavements, maps from usual observations, the major cracking areas of the runways and asphalt jointing.

2. **Conduct Field Evaluation** – The runway consists of different thicknesses flexible pavement. An evaluation of all the runway pavement will be made using Falling Weight Deflectometer (FWD) and Dynamic Cone Penetrometer (DCP) testing. The FWD test will be conducted in two lines, each offset from the centerline approximately 25 feet. Tests will be spaced 200 feet apart along each line to effectively provide a test every 100 feet along the runway. Based on results of the FWD and DCP tests, locations for soil borings to evaluate subsurface materials and obtain samples for laboratory tests will be made.

3. **Design Surveying** – Surveying of the existing runway surface and shoulders will be accomplished in order to determine compliance with FAA longitudinal and transverse grade standards and for use in the subsequent design. Elevations will be obtained every 50 feet for the entire runway length and for 100 feet outside each side of the runway pavement.

4. **Analysis of Evaluation Data** – The Engineer will analyze the FWD and DCP data to determine design strength parameters for the existing pavement conditions. The FWD deflection data will be used in WESDEF back calculation program to compete layer moduli. The DCP results will be processed to give CBR values, and these will be compared to the back calculated moduli. The Engineer will review results from field borings and laboratory

results to further refine design parameters and k-valves will also be determined.

5. **<u>Prepare Design Recommendations</u>** -- With consideration to design aircraft traffic and existing pavement structural conditions, the Engineer will recommend design approach for rehabilitation of the runway pavements which will consider such options as: (1) increase structural capacity and life expectancy with structural overlay, (2) removal and replacement of the existing pavement sections, (3) partial removal and replacement of the existing pavement sections, (4) recycling of existing asphalt concrete, and (5) concrete pavement overlay.

B. Preliminary Design Phase:

1. Prepare preliminary costs estimates for the various rehabilitation methods studied.

2. Revise the airport layout plans as necessary to show any changes necessary to reflect the details of the project.

3. Furnish five (5) copies for drawings, sketches, forms and reports as appropriate to the OWNER for submission to government agencies.

4. In consultation with the Airport and other government agencies through conferences, meetings or submission of preliminary reports as appropriate, determine the extent of the project and the design criteria to be used in final design.

5. Prepare an Engineer's Report in accordance with FAA criteria which shall include, but not necessarily be limited to:

    (a) An analysis of the different rehabilitation options and reasons for the design choices.

    (b) An analysis of the airport pavement design.

    (c) An analysis of the manner that the work will be accomplished.

    (d) A project cost estimate based upon the final design.

C. Final Design Phase:

1. Prepare final design detailed contract drawings, specifications and contract documents for the design.

2. Submit appropriate documents to local, state, and federal agencies for necessary approvals and permits.

3. Furnish five (5) copies of completed drawings, specifications, reports, estimates, and contract documents.

4. Assist in securing bids, tabulation, and analysis of bid results.

5. Prepare a construction management plan according to FAA requirements.

D. Construction Phase:

During the construction phase, the engineer shall provide the following services:

1. Assist in preparation of formal contract documents for the Award of Construction contracts.

2. Consult with and advise the Airport and act as his representative as provided in the approved construction specifications and contract documents.

3. Provide construction administration services.

4. Provide construction observation services. Full-time inspection.

5. Check shop drawings and other submissions of the contractor for compliance with the design concepts and specification requirements.

6. Review laboratory, shop and mill test reports, and prepare a tabulation or summary of laboratory test results to assist in monitoring the quality of construction.

7. Check and certify the accuracy of partial and final payment due to contractors based upon the completed work.

8. From information provided by the resident project representative and surveys made under special services or by others, compute final quantities of work completed by contractors on the project.

9. Make a final inspection with Airport and government representatives of the completed work.

E. Instrumentation:

1. <u>Background</u>:

Overlay pavements are designed to increase strength (load-carrying capacity) and serviceability, thereby extending the life of the pavement facility. Two types of pavement failure must be considered in design of rehabilitation using whitetopping: fatigue of the Portland cement concrete and fatigue of the asphalt concrete under joint loading. By selecting the thickness of the overlay consistent with anticipated traffic over the design life of the pavement and the structural support provided by the asphalt concrete base and supporting layers, a serviceable, low maintenance pavement will be designed.

Other primary considerations include temperature and moisture gradients through the depth of the overlay slab. The gradients can lead to significant curling of the overlay over the asphalt concrete base. As the slabs curl and warp, they may lose contact with the underlying support layer ultimately resulting in corner breaks. Another environmentally related source of distress in the overlay slab is the frictional restraint stress that develops as the overlay slab contracts relative to the asphalt concrete base with changes in temperature and moisture. The magnitude of the tensile restrain stress is dependent upon the length and thickness of the overlay panel and the characteristics of the friction force-displacement curves at the interface of the overlay panel and the asphalt concrete base. As is the case for conventional Portland cement concrete pavement construction, limiting the size of the slab panels mitigates environmentally related distresses. Selection of proper joint spacings and sawing depths will lead to controlled cracking of the overlay at regularly-spaced intervals selected to eliminate corner breaks and shrinkage cracking.

2. **Instrumentation Objectives and Required Data:**

The objectives of the instrumentation and field testing are:

(a) To study whitetopping pavement responses under traffic loading and environmental effects; and

(b) To evaluate interface bonding strength between the concrete and the asphalt layers.

To this end, the recommended instrumentation for the Savannah airport rehabilitation includes the following types of measurements:

(a) Strains in the PCC whitetopping and at the PCC/AC interface;

(b) ambient and pavement temperatures; and

(c) manual measurements of pavement elevations.

Each of these measurements is described on the following page.

3. **Embedment Strain Sensors:**

The measurement of strains at the top and bottom of the PCC and at the PCC/AC interface is most important research information expected from the instrumentation. The degree of bond between PCC whitetopping and existing asphalt pavement is perhaps the most important factor in the performance of whitetopping pavements. Bonding allows the concrete and asphalt layers to perform as a composite section, causing the layers to act monolithically and share the load. Monolithic action shifts the neutral axis from the middle of the concrete downward towards the bottom of the slab, thereby lowering the stresses at the bottom of concrete into a range the concrete can withstand without cracking.
The effects of the composite section are different at a slab corner. The corner behaves as a cantilever and experiences maximum stress at the top of the slab. Thus, the shifting down of the neutral axis increases the corner stresses. If the neutral axis shifts low enough in the concrete, the critical load location may move from the edge to the corner depending on the materials and layer characteristics. This explains why many whitetopping projects have developed corner cracking. Therefore, the designer must look

at both the edge and corner in order to determine the critical load location.

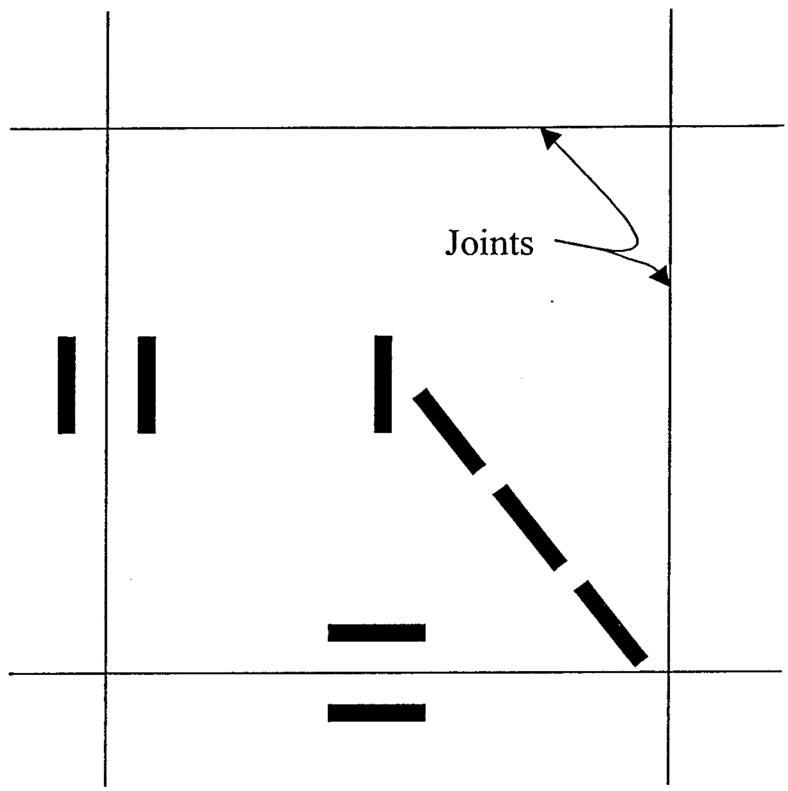
Reliable embedment strain gages are available from a number of commercial vendors. It is recommended that the gages be install in a pattern similar to that shown in Figure 1. Embedment strain gages should be located near joints, the center of the slab, and along a radial line from the cent of the slab to a corner. At each location, gages should be installed near the top of the PCC, near the bottom of the PCC, and at the PCC/AC interface. For a fully bonded composite pavement, at any point, strains at bottom of concrete slabs would be the same as those at top of the asphalt layer. For a completely unbonded system, however, strains at concrete slab top should be the same as those at concrete slab bottom. Strains measured at different depth can be used to whitetopping pavements are completely bonded, completely unbonded or partially bonded. We recommend that a minimum of two slabs be instrumented.

4. **Temperature Sensors:**

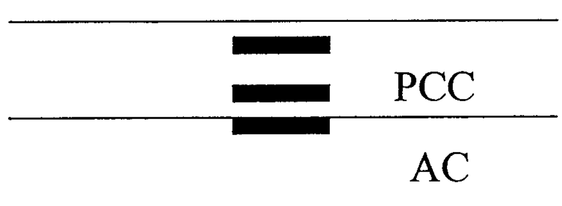
Temperature sensors (thermistors) should be installed to measure air temperature, pavement surface temperature and temperature gradients through the PCC surface. The thermistor is a temperature-sensitive resistor. A thermistor is more sensitive to temperature change than a thermocouple. It is composed of a semiconductor material encased in epoxy. The thermistor resistance decreases nonlinearly with increasing temperature. This sensor has a large temperature coefficient allowing the thermistor circuit to detect minute changes in temperature. Thermistors are wired as one leg of a Wheatstone bridge. They are not self-powered and require a current source for operation. 0

Thermistors should be installed at increments of depth to determine the temperature gradients through the HMA surface with depth. It is recommended each array of temperature sensors consist of four temperature sensors: one each at the top, middle, and bottom of concrete slabs, and one in the asphalt approximately ½ in. below the PCC/AC interface. It is recommended that, as a minimum, an array be placed at the center of a slab, and one near a corner.

At least two thermistors should be installed above ground to measure ambient air temperatures on a continuous basis.



A) Plan View of Typical Strain Gage Locations



B) Typical Vertical Strain Gage Layout

FIGURE 1. Strawman Strain Gage Layout

5. **Pavement Elevations:**

Curling and warping of the PCC slabs should be measured using manual rod and level surveying techniques. A permanent benchmark, unaffected by temperature and moisture changes should be established. Brass pins should be placed in selected concrete slabs near the center of the slab at each corner, and selected interior points to establish permanent measurement points. Manual measurements can be made to detect curling and warping under various weather conditions (summer, winter, etc.) and day and night conditions.

6. **Load Testing:**

Load testing should be conducted at different seasons and times of the day. Using slowly moving wheels loaded to approximately 10,000 to 12,000 lbs. An aircraft or a truck can provide these loads, provided that the wheel loading can be determined by weighing on a portable scale.

7. **Data Acquisition:**

The data acquisition system measures the analog response of the sensors, converts the measurements to engineering units, and stores the data for future processing and analysis. The data acquisition equipment includes signal processing equipment, analog to digital conversion, and a local site computer and recording equipment. Static temperature should be recorded on the data loggers at specified at specified sampling intervals. Dynamic strain data under moving wheel loads will be acquired on the site computer by manually triggering the data acquisition system during load testing events.

All data will be put into a spreadsheet database along with identifying information, time, and date. It is proposed that the data acquisition equipment be contained in a protective shelter (concrete vault) adjacent to the test site with the vault constructed partially below ground to reduce temperature of the equipment.

8. **Sensor Installation Considerations:**

Low sensor survivability is salient problem in the construction of instrumented pavements. Therefore, the installation of the sensors is the most critical aspect of the construction project. Sensor failure is largely due to harsh environmental conditions after placement.

However, handling of the sensors during the installation process is a factor in the gage durability and, and affects the validity of the data. Many sensors are delicate, and must be handled with extreme care. The installer should develop installation practices to ensure that the sensors are not damaged during the paving operations and to ensure that the data they collect are valid. Everyone involved in the process must recognize that no activity can be carried on or near a sensor that will cause excessive stress, vibration, or heat.

The sensor installer should performed by a qualified electronics technician with experience in sensor selection, calibration, and installation. Although the actual installation of the sensors should be performed jointly by the sensor installer and the paving contractor, the sensor installer is responsible for ensuring that the installation procedures minimize the risks associated with the sensor installation. Education of everyone involved as to the goals and objectives of the project will increase the probability of a successful outcome. Construction personnel, for example, are more apt to respect the needs of the researchers if they understand the delicacy and cost of the sensors and the intention of the research.

Sensor leads should be placed in Schedule 80 PVC conduits. The ends of all conduits should be sealed to prevent moisture ingress and to minimize any effects of the conduit on the sensor measurements. The recommended inside diameter of the conduits is approximately twice the diameter of the wires inside. Conduit trenches should be 12 to 15 in. deep outside the traveled lane and 4-in. deep under the traveled lane to reduce potential settlement problems. Backfilling over the conduits should be performed in 6-in. lifts.

Load response information output is extremely sensitive to load location. Accurate as-built sensor location data is a must. Appropriate surveying techniques are recommended for locating sensor placement and tying in the final as-built locations prior to paving.

1.3 PAVEMENT DESIGN

This concrete pavement project is a new realm for concrete usage at airports. There are no historical records for ultra-thin whitetopping runway paving of this nature because it has not been done before. Writing a specification for this project required research of airport apron projects and State highway projects where similar procedures were used. A soils investigation of the runway was performed which included some strength and slab thickness recommendations. The concrete strength specification needed to be tight enough to achieve the required flexural strength and yet provide for slump adjustments without sacrificing any of that strength. Control joints are spaced closely so that the uncracked section strengths of small slab sizes can be effective.

The research for background information included the Tennessee Department of Transportation and historical documentation of procedures and design mixes that were used. The paving, which seems to be performing well, are those which use a flexural strength of 700 psi or better and have a slab size limited to twelve times its thickness or less in either direction. Further, the recommendations from the field evaluation of a 4" thickness and a 4'-0" by 4'-2" maximum slab size to allow for the use of 20'-0" or 25'-0" wide vibrating slip-form paving machines.

In order to achieve a level playing field and keep the bidding competitive, several items not usually addressed in the writing of a concrete specification section were included. Usually, the strength of concrete is determined by compression test cylinders. But, the concrete for this concrete usage would normally involve making and testing of flexural test blocks. This is not as common or readily available a test procedure as compression test cylinders. Thus, the specification was expanded to allow compression testing for a mix design of 7000 psi strength at 28 days. A minimum of 700 pounds of cement and a maximum water/cement ratio of 0.35 were also specified. No additional water will be permitted. Further, vibrating slip-form installation procedures do not require a high slump concrete. Therefore, moderate amounts of mid-range or high-range water reducing agents may be added to achieve the desired workability. The usual air entrainment for exposed concrete was specified with the addition of 3 pounds of polypropelene fibers with lengths from 0.75 inches to 2 inches to be permitted.

Finishing tolerances were specified as well as the sawcut control joints. All joints must be cut immediately upon completion of the finish trowel work and curing method of choice will then be applied. The joints at longitudinal construction joints (or transverse if construction is halted before completion of one strip) will also receive a saw cut to help prevent concrete adhesion between first and second placements to weaken any bonding at the joint which could cause unwanted cracks near the construction joint.

1.4 CONSTRUCTION SUMMARY

A. Contract time allowed airport to be closed for 40 calendar days.

B. Contractor set up a batch plant at the north end of the airport which had easy road access for materials delivery. Two days were required for this set up. Hopper/Side dump trucks were used for delivery to runway.

C. Runway was divided into four 25' wide lanes for paving which were numbered 1, 2, 3 and 4 with Lane 4 being closest to the terminal building.

D. Paving was placed on Lane 4 first and then on 2, 1 and Lane 3 last. This afforded maximum time to trench work for runway edge drain installations to be done and not have crew conflicts for space. Lanes 4 and 2 were placed in four days with about half of each lane done in one day's time.

E. A typical day's paving work required the paving machine to start at the south end at first light and work until late afternoon. Sawcut crew chalk lined their cut lines and began cutting in early afternoon and finished after midnight.

F. When Lane 2 was finished, the crew had a three-day break. Concrete test beams were broken to determine when truck traffic could be placed on Lanes 2 and 4.

G. The quantity of concrete used required continual delivery of sand and crushed stone aggregates as well as frequent delivery of cement. The aggregates were stored directly on grade surrounding the batch plant. A front-end loader was used to deposit the aggregates into the conveyor system to the batch plant. Whether trucks left mud in aggregates or the front end loader went too deep at times is unknown, but some mud balls did get into the concrete.

H. A pre-bid issue was the water-cement ratio that was specified for the concrete mix design. The 0.35 ratio was claimed by several contractors as too low, even though superplasticizers (mid- or high-range) were permitted. When construction got underway, it was discovered that the 0.35 ratio yielded concrete with about 1" to 1½" slump which worked perfectly with the contractor's slab extruding equipment.

I. The saw cuts were made at 50" longitudinally and at 48" transversely. This resulted in a total of about 45 miles of saw cuts and over 30,000. Perhaps as much as half of the sawing was done after dark. The only lights used were those on the saws themselves (not known until after the fact). Future specifications will require movable, portable lighting since some blades seem to have been used beyond when they should have been replaced. Better lighting would probably have added decision- making for blade replacement. The ragged edge produced with overworn blades caused a significant amount of small concrete and aggregate chips that need brushed from the joints and removed from the runway.

J. During autumn follow-up inspection, mud balls were found in the concrete surface. They were not restricted to localized concentrated areas but were randomly spotted throughout the entire runway. These were chipped out and repaired with grout. The specifications for future batch plans will require paved aggregate storage sites and paved delivery roads to prevent on-site mud from getting mixed into the aggregates. Clean tires will be required for trucks delivering materials and those exiting the site onto public roads. A wheel cleaning and inspection station will be required of the 30,000 plus squares -- only three had cracks outside the cut control joints. Cores made in the runway show excellent adhesion of the overlay concrete to the underlying asphalt pavement.

FACT SHEET

Savannah-Hardin County Airport Ultra-Thin Whitetopping Project

Engineer's Estimate:	**$1,300,000**
Runway Cost:	$1,019,055
Contract Extension:	$ 247,775
Total Construction Cost:	**$1,266,830**
Amount Under Budget:	**$ 33,170**
Estimated Construction Time:	40 days
Actual Consideration Time:	8 days from the milling of the existing asphalt surface to the completion of the placement of the concrete on the runway; 30 days total including placement of concrete on apron and taxiway
Runway Dimensions:	5,000 feet long by 100 feet wide
New Surface Composition:	4 inches of high strength fiber reinforced Ultra-Thin Whitetopping concrete
Process:	Ultra-Thin Whitetopping is the overlay of an existing asphalt surface with a 2 to 4-inch layer of fiber reinforced concrete
New Surface Strength:	60,000 pounds dual wheel gear
Joint Pattern:	48 x 50-inch spacing requiring over 45 miles of sawcutting and over 30,000 individual concrete panels
Joint Size:	1-inch deep by 1/8-inch wide
Saws Used:	The contractor had 10 Soff Cut Saws sawing the required 28,125 feet of joints per day

1.5 SUMMER TESTING

Based upon analysis of the data collected during summer testing, the following conclusions are drawn:

A. Two cores extracted during the construction of the UTW showed good bond between the PCC and AC.

B. Analysis of dipstick data showed no difference between the morning and afternoon measurements indicating that the PCC slabs are bonded to the milled AC surface.

C. Analysis of strain data indicates that the PCC is bonded to AC at the middle of slabs and along the joints. At corners, the data suggest that some debonding may have occurred. However, interpretation of the data at these locations may be problematic due to the structural discontinuities present.

D. Comparison of strain data at identical locations shows slightly higher strains at slower speeds, as would be expected due to rate of loading effects.

E. Comparison of strain data at identical locations in morning and afternoon conditions suggests that, on the whole, the PCC and AC are bonded and acting as a composite structure.

F. Strain measured across loaded and non-loaded slabs suggests that there is a good load transfer across the longitudinal and transverse joints.

G. In general, the data confirm that the assumptions of the design are valid (except at the corners) and that the rehabilitation pavement should perform as designed.

1.6 WINTER TESTING

Based on analysis of the winter data and comparison of the summer and winter test results, the following conclusions are drawn:

A. Analysis of dipstick data showed no difference between the morning and afternoon measurements during winter and summer tests indicating that the PCC slabs are bonded to the milled AC surface.

B. Analysis of winter data indicated that PCC slabs are bonded to the milled AC surface at the middle of the slabs, along the longitudinal and transverse joints and at the corners.

C. Analysis of summer data indicated that some bonding may have occurred at the corners. Based on winter data analysis results, this discrepancy is attributed to incorrect positioning of the loaded truck wheels during summer tests; however, interpretation of corner strain data is problematic due to structural discontinuities present.

D. During both winter and summer tests, comparisons of strain data at identical locations shows generally slightly higher strains at slower speeds, as would be expected due to rate of loading effects.

E. Comparison of summer strain data at identical locations for the morning and afternoon runs indicated that, on the whole, PCC slabs and the milled AC surface are bonded and acting as a composite structure. Winter data did not show such a clear trend -- some difference in magnitudes was evident.

F. Strains measured across longitudinal and transverse joints between loaded and unloaded slabs suggest that there is a good load transfer across the joints.

G. In general, the analysis of winter data and comparison of winter and summer analysis results indicate that the PCC slabs and the milled AC surface are bonded together and that the rehabilitated pavement should perform as designed.

1.7 PROJECT RECOGNITION

This project has received much attention due to the potential of being a practical alternative to the usual approach to major reconstruction projects at general aviation airports. Currently, the Federal Aviation Administration (FAA) is reviewing the process, design approach, and construction results of this project to determine if UTW can be considered an approved approach for future projects. Representatives for the aviation divisions and highway departments of several states, several county and municipal governments, and a multitude of contractors have visited the project site. There have been inquiries from as far away as Barbados and England. This project will be the catalyst for other state agencies and municipal governments to utilize this construction technique to their benefit in regards to time, money and longevity.

Numerous magazine articles have been written regarding this project, and below is a list of some of those articles:

Civil Engineering (ASCE) - June 2001
Public Works - January 2001
Tennessee Concrete - Summer 2000
American Concrete Pavement Association - October/November 2000
AOPA Pilot - January 2001
Roads and Bridges - April 2001
The Courier (Savannah, Tennessee) - April 2000
The Southern Aviator - November 2000
Airport Business - January/February 2001; May 2001
Engineering News-Record - May 29, 2000
Heavy Equipment - May 2001
Memphis Business Journal - November 2000
AAAE - November 2000

The project has won several awards from different agencies and are listed below:

-- Rebuild Tennessee Infrastructure Excellence Award - 2000

-- National Association of State Aviation Officials (NASAO) - "Most Innovative State Award" - 2000

-- Tennessee Ready Mix Concrete Associate (TRMCA) - "Pioneer Award" - 2000