DURABILITY OF ASPHALT PAVEMENTS FOR CALIFORNIA GA-AIRPORTS, PHASE ONE (INSPECTION REPORT)

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Alaska University Transportation Center

for

State of California
Department of Transportation
Sacramento, California 95814

December 2006

Final Report
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California Dept. of Transportation
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16. Abstract:

Hot asphalt pavement is used as a surface course in many General Aviation (GA) airport pavements in California. The durability of the hot mix asphalt (HMA) to adverse climatic conditions (extreme hot and/or cold temperature, excessive moisture) is an important consideration for asphalt wearing course performance. In hot weather, asphalt binder loses its viscosity and stiffness and becomes "softer", causing pavement displacement (rutting, dimpling, and tearing). On the other hand, in cold weather, low temperature cracking can develop due to thermal stress in the pavement surface. These adverse climate effects can be accentuated by applied traffic operations. Hot mix asphalt durability is essential to improving serviceability, reducing maintenance costs, and promoting safe operations.

Original research objectives included evaluating the durability of asphalt pavements in GA airports in California under different climatic and traffic conditions. Phase I included a review of design, construction and maintenance methods currently used and field evaluation for eleven GA airports to determine and assess severity of durability-related damages.

CALTRANS' recent adoption of the Performance Grading (PG) system for asphalt cement accomplishes a primary objective of this research project. The PG binder grading system not only addresses the stiffness of the asphalt at the appropriate summer temperatures (to avoid shoving and/or rutting); it also addresses the asphalt binder elasticity at cold temperatures (which prevents low thermal cracking). The former binder grading system - Aged Residue (AR) - only addresses the stiffness of the asphalt cement at hot temperatures and ignores the elastic properties of the asphalt cement at cold temperatures.

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DISCLAIMER

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INTRODUCTION

Hot asphalt pavement is used as a surface course in many General Aviation (GA) airport pavements in California. The hot mix asphalt (HMA) surface is generally designed to distribute gear loads to the underlying pavement, aggregate base and subgrade layers, thereby providing adequate serviceability to resist rutting, abrasion, and environmental exposure of the pavement structure over the design life.

Durability of the hot mix asphalt to adverse climatic conditions (extreme hot and/or cold temperatures, excessive moisture) is crucial to the performance of the asphalt wearing course. In hot weather, the asphalt binder loses its viscosity and stiffness and becomes "softer", causing pavement displacement (rutting, dimpling, and tearing). On the other hand, in cold weather, low temperature cracking can develop due to thermal stresses in the pavement surface. Also, excess moisture can cause stripping of the asphalt cement from the aggregates in the hot mix asphalt surface, leading to raveling and potholes. Adverse climate effects can be accentuated by applied traffic operations.

As a result, the pavement surface could exhibit a number of distress modes such as alligator cracking, rutting, transverse and longitudinal cracking, raveling and potholes. Durability of the hot mix asphalt is essential to the improved serviceability, reduced maintenance costs and safe operations.

This research aimed to evaluate the durability of asphalt pavements in GA airports in California under different climatic and traffic conditions. Specific objectives included:

1) Determine the prevailing type and severity of distress in asphalt pavements of GA California airports at different locations and climatic zones.

2) Evaluate how current asphalt mix and maintenance procedures used in GA California airports influence pavement surface durability and serviceability.

3) Develop recommendations for improving mix design and surface treatment procedures to alleviate the problems associated with durability of asphalt pavements in GA California airports.

Phase I of this project included a review of the design, construction and maintenance methods currently used and a field evaluation of selected GA airports to determine and assess the severity of durability-related damages.

Phase II of this project originally included a sampling and testing program to determine the influence on aging and climatic conditions on pavement performance. The proposed testing program included:

1) Thermal Stress Restrained Specimen Test (TSRST) to evaluate the effects of cold temperature on pavement performance,

2) Georgia Wheel Load Tester (GWLT) to determine rutting resistance.

3) Flexure Beam Fatigue Testing to evaluate pavement performance to repeated load applications

4) Performance Grading tests to assess serviceability temperatures (winter and summer temperatures) that the asphalt cement could resist.

5) Moisture susceptibility tests to determine resistance to stripping and loss of stiffness and strength of the asphalt mix under extreme climatic conditions.

This report summarizes the results of Phase I and includes recommendations for revising the scope of Phase 2.

SUMMARY OF FIELD REVIEWS

Field reviews were conducted at eleven General Aviation (GA) airports. These airports were selected, with CALTRANS' assistance, to represent a variety of climatic conditions – specifically airports with cold winter temperatures and hot summer temperatures. Figure 1 shows the location of the GA airports reviewed, and Table 1 summarizes the key information for each airport.

Field surveys consisted of meeting with Airport Managers or other appropriate staff, review of available construction records, and onsite inspection of each airport to determine types and severity of pavement distress.

Two High Desert airports – California Pines and Herlong - are in extremely poor condition with significant block cracking and, in the case of California Pines, significant alligator cracking. Both airports were apparently constructed over 40 years ago and have had minimal maintenance since original construction.

Two airports – Scott Valley (High Mountain) and Sierraville (High Desert) – were recently constructed. Both airports were reconstructed by grinding up the existing pavement, mixing with the existing crushed aggregate base course, and paving with hot asphalt.

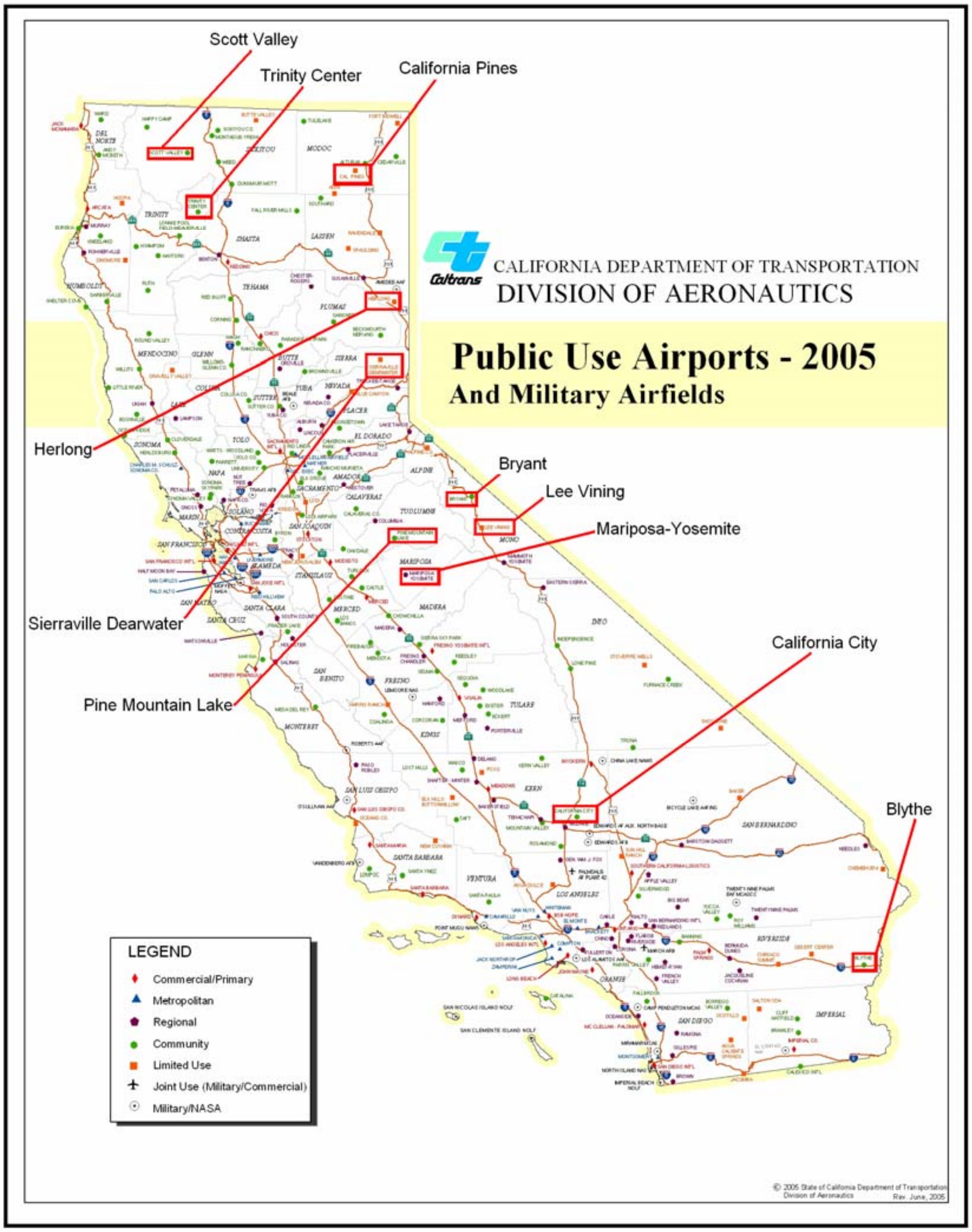

Figure 1. List of California General Aviation Airports Reviewed

Table 1. Detail Information for the California GA Airports

Airport	FAA ID	Climate Region	Runway Length (ft)	Runway Width (ft)	Operations per Month	Load Capacity	Runway Elev. (ft)	Avg. Summer Temp (F)	Avg. Winter Temp (F).
Scott Valley	A30	High Mountain	3,700	60	660	12,000	2,728	83.66	27.44
Trinity Center	O86	High Mountain	3,215	60	1,410	10,000	2,390	87.6	36.6
California Pines	A24	High Desert	4,398	60	33	12,000	4,398	76.45	24.27
Herlong	H37	High Desert	3,260	40	58	4,000	4,055	79.42	24.88
Sierraville	O79	High Desert	3,260	50	83	12,000	4,984	76.99	21.69
Lee Vining	KO24	High Desert	4,040	50	165	30,000	6,802	76.01	15.00
Bryant Field	KO57	High Desert	4,239	60	264	30,000	6,468	76.01	15.00
Pine Mountain Lake	E45	High Mountain	3,625	50	2,700	12,000	2,930	85.17	35.65
Mariposa	MPI	Low Mountain	3,306	60	2,460	12,000	2,254	74.13	28.72
California City	L71	Desert	6,027	60	3,060	26,000	2,454	88.91	42.19
Blythe R/W 8/26	BLH	Desert	6,562	150	2,070	80,000	397	99.18	42.08
Blythe R/W 17/35	BLH	Desert	5,820	100		520,000	397	99.18	42.08

The remaining seven airports (High Mountain, High Desert and Desert) – Trinity Center, Lee Vining, Bryant Field, Pine Mountain, Mariposa, California City and Blythe – have undergone a series of construction projects since they were originally constructed. The scope of these projects included adding taxiways, expanding parking aprons, and overlaying the runways. Six of the seven runways have been overlaid since 1995. Six of the seven projects had developed longitudinal cracks along the construction joints. The field survey for the seventh (Pine Mountain airport) was not conducted due to conflicts with air traffic. Transverse cracks were present only at Bryant Field, Lee Vining and California City runways.

REVIEW OF DESIGN, CONSTRUCTION AND MAINTENANCE METHODS

Key design and construction information pertinent to this task included hot mix asphalt type, pavement thickness, asphalt binder grade (AR, PBA or PG grading systems); aggregate gradation and asphalt mix design procedure (Hveem, Marshall or SUPERPAVE).

No original design and construction records were available for any of the eleven airports investigated. Some construction records were available for some of the more recent construction projects (see Table 2).

There are no design and construction records available for two airports, California Pines and Herlong. These airports were constructed at least 40 years ago, and no significant runway paving construction projects have occurred since.

Two airports, Scott Valley and Sierraville, were reconstructed in the last two years. While some construction records are available for Scott Valley, none were received from Sierraville.

The remaining seven airports have undergone a series of construction projects since they were original constructed. Project scopes included adding taxiways, expanding parking aprons, and overlaying runways.

Of the approximately 14 construction projects at these eleven airports since 1995, only partial records from 7 of the projects are available.

Five of the six projects used the Hveem mix design method, and one project used the Marshall Mix design method; for the other seven projects, the mix design method remains unknown.

Table 2. Design Data for the Eleven GA California Airports investigated in the study

Airport	Load Capacity	Initial Pavement Const.	Last Pavement Const	Specs.	Binder Type	Mix Design
Blythe 8/26	80,000	1940s	2004	FAA	PG 76-10	Marshall
Blythe 17/35	520,000	1940s	2002	?	?	?
Bryant Field	30,000	1920 & 1960 (paved)	2006 - Apron	?	Pba-6b	Hveem
California City	26,000	1960s	1997 - T/W	?	?	?
			2004 - Apron	?	?	?
California Pines	12,000	1947	1995 apron	?	?	?
Herlong	4,000	1978	none	n/a	n/a	n/a
Lee Vining	30,000	1962 & 1966	2001	?	AR 4000	?
Mariposa	12,000	1971 r/w 1983 t/w	1998 - Apron	?	?	?
			2000 -Apron	?	?	?
			2002 - Apron & R/W Overlay	?	AR-4000	Hveem
Pine Mountain Lake	12,000	?	2000 - R/W, T/W & Apron	?	?	?
Scott Valley	12,000	1971	2005	CALTRANS	PBA-6a	Hveem
Sierraville	12,000	1958??	2005	CALTRANS	AR 4000	Hveem
Trinity Center	10,000	1960	1997 - T/W & R/W overlay	CALTRANS	AR 4000	Hveem

Four projects used the AR binder classification system, two used the PBA, and one used the PG system. The binder classification system used on the other seven projects is unknown.

Three projects used CALTRANS specifications, and one project used FAA specifications. Specifications used for the other 10 projects are unknown.

COMMENTS

Based on a review of the limited number of construction records available and field reviews for the eleven airports, the following comments are offered:

1. Most recent projects used the AR 4000, PBA 6a or PBA 6 asphalt binder. Only the apron reconstruction project at Blythe Airport (constructed in 2005) used the PG grading system for asphalt binder. Despite CALTRANS' adoption of the PG grading system for asphalt binders on 1 January 2006, few airport managers were aware of the change or understood the benefits of the PG grading system.

2. Both the Hveem and Marshall Mix design procedures were used for asphalt mix design. California is the only state still using the Hveem mix design system for highway pavements. All other states – including the 12 other states that formerly used the Hveem mix design procedure – either are using the Marshall Mix design method (required by FAA) or SUPERPAVE for their highway pavements. SUPERPAVE, developed as part of a $150 million research program funded by the Federal Highway Administration (FHWA) to improve durability and performance of highway pavements, has been used on some airport pavements in the United States. The Airfield Asphalt Pavement Technology Program (AAPTP) is currently conducting research on evaluating SUPERPAVE mix design for airfield pavements; this research is scheduled to be completed in November 2007.

3. Field review showed several construction-related problems, primarily segregation and checking (minor surface cracks), on some of the recently paved projects. These construction problems may have a detrimental impact on the long term performance of these pavements. However, the relatively light traffic and dry climate may minimize these impacts.

4. Longitudinal cracking at the construction joints were present on all seven of the pavements that were overlaid within the last 10 years. The Airfield Asphalt Pavement Technology Program (AAPTP) is currently conducting research on improving longitudinal joints on airfield pavements. The research project is scheduled to be completed in August 2007.

5. There are a minimal number of transverse thermal cracks on the runways paved in the last ten years. A number of these transverse cracks appear to be reflective cracks developed over cracks from the underlying pavement.

6. In an effort to prevent reflective cracking, a pavement fabric was used at Trinity Center and Lee Vining airports. However, longitudinal cracks (probably reflective cracking) are present on both runways.

7. To minimize transverse thermal cracking, the pavement at Bryant Field was cut on a 17’ to 25’ by 25’ pattern approximately 21 years after it was paved. However, some transverse cracks did develop between the transverse saw cuts. There was also significant alligator cracking adjacent to the saw cuts – especially at the corners.

8. The only significant alligator cracking on a recently overlaid runway is at Bryant Field and appears to be associated with the pavement saw cuts.

9. The two recently reconstructed airports (Scott Valley and Sierraville) did not show any longitudinal or transverse cracking, or other forms of pavement distress. This is probably due to the properties of the asphalt binder or asphalt mix.

RECOMMENDATIONS

1. CALTRANS’ recent adoption of the Performance Grading (PG) system for asphalt cement accomplishes one of the original objectives set for this research project. The PG grading system not only addresses asphalt stiffness at the appropriate summer temperatures (to avoid shoving and/or rutting); it also addresses asphalt binder elasticity at cold temperatures (to prevent low thermal cracking). The former system – Aged Residue (AR), which applies to asphalt cement – only addresses the stiffness of the asphalt cement at high temperatures and ignores elastic properties at cold temperatures.

2. Additional testing and evaluation of additional laboratory tests for a “PG+” is appropriate. However, others are already conducting this research. With CALTRANS’ adoption of the Performance Grading (PG) system for asphalt binders, there is no need to perform the laboratory testing and analysis tasks originally designed for Phase II of this research project.

3. It is recommended that Phase II of this research project be modified as shown in Appendix B. Key changes include replacing the sampling and testing program with the following two tasks:

- Provide assistance in implementing appropriate portions of the CALTRANS standard pavement specifications in place of FAA pavement specifications.
- Develop “Guide for Design, Construction and Maintenance of Asphalt Pavements for General Aviation Airports”.

4. Training airport managers and airport design consultants about the benefits of adopting the PG grading system would facilitate its implementation.

5. Training appropriate personnel in asphalt pavement construction would improve pavement performance.

APPENDIX A

FIELD REVIEWS OF GA AIRPORTS

A field review was conducted at eleven airports. The following reports include field reviewers' observations and a short summary of the construction history of each airport. In addition, the latest Pavement Condition Survey showing the Pavement Condition Index (PCI) of the runway, taxiway and parking apron was included for each airport (except for the Scott Valley and Sierraville Airports, which had been reconstructed since the last Pavement Condition Survey was conducted.

BLYTHE AIRPORT

Blythe airport is located 6 miles west of Blythe, California at an elevation of 397 feet above sea level; it is in a low desert climate region. The average high summer temperature is 99.2°F and the average low winter temperature is 42.1°F. It does not snow in the winter.

Runway 8/26 is 6,562 feet long by 150 feet wide, and runway 17/35 is 5,820 feet long by 100 feet wide. Airport facilities consist of a parking apron, hangars, and a refueling station. Runway 8/26 has a single wheel weight bearing capacity of 80,000 pounds (lbs), double wheel weight bearing capacity of 160,000 lbs, and a double tandem weight bearing capacity of 300,000 lbs. Runway 17/35 has a single wheel weight bearing capacity of 52,000 lbs, a double wheel weight bearing capacity of 76,000 lbs and a double tandem weight bearing capacity of 135,000 lbs. The airport averages 69 operations a day and has 11 aircraft based on the field, including 9 single-engine and 2 multi-engine airplanes.

Construction History

Blythe airport was originally built during WWII as a bomber training base. The original pavement design is unknown at this time. Riverside County took ownership of the airport in the 1950s. Ownership was transferred to the city of Blythe in 1999. R/W 17/35 was reconstructed in 2002, and R/W 8/26 was reconstructed in 2004. The 2004 project used the FAA specifications, including the Marshall Asphalt mix design method. The asphalt binder used was PG 76 -10. See figures 2 and 3 for review details.

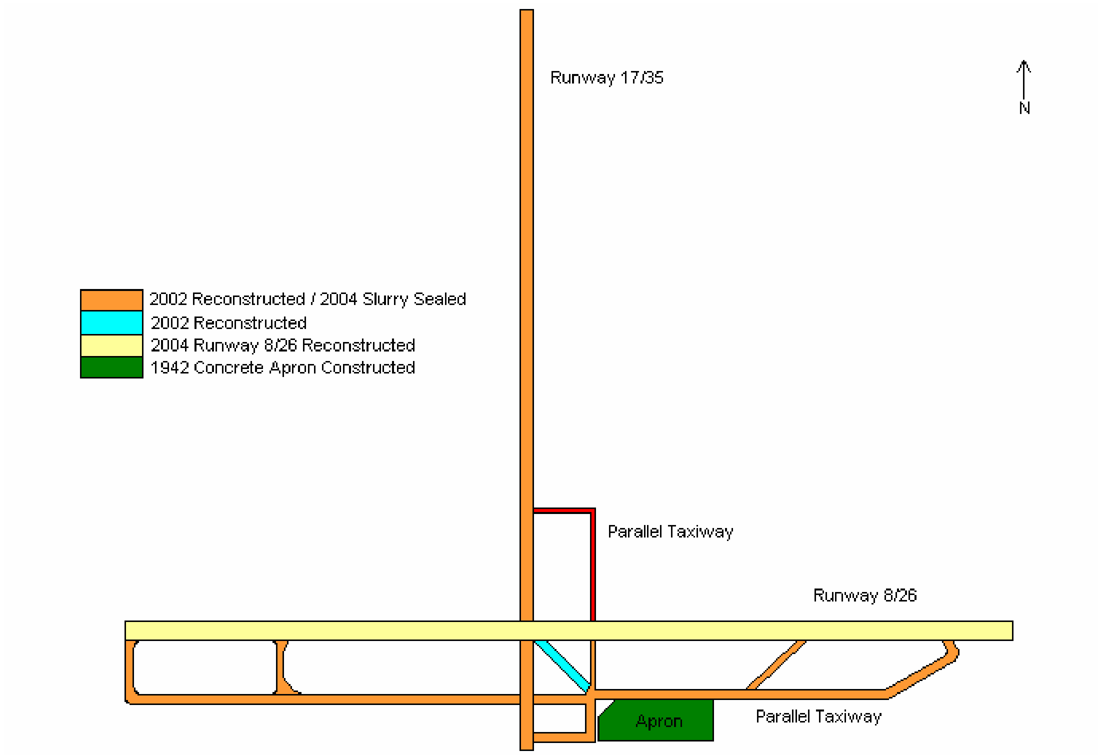

Figure 2. Blythe Airport Construction History

Field Survey (summer of 2006)

Parallel taxiway for runway 8/26 (T5): The taxiway showed signs of block cracking with transverse cracking spaced every 25 feet and longitudinal cracking every 12.5 feet. The longitudinal cracks corresponded with the construction joints.

Runway 8/26 (R2A, R2B, R2C) (Reconstructed post APMS study): Minor longitudinal cracks and transverse cracks were present. The runway was constructed in panels 15 feet wide, and longitudinal cracks were present at the joints of the pavement panels. Transverse cracks were present only on the east end of the runway; the rest of the runaway appeared free of them.

Parallel taxiway for runway 17/35 (T4) (PCI=41): The majority of pavement distress evident was mainly transverse cracks spaced between 25 and 35 feet apart; very few longitudinal cracks were present.

Runway 17/35 (R1A, R1B) (PCI=89, 94): The only distress present was longitudinal cracking along the construction joints. The beginning stages of transverse cracking were present, with some minor hairline cracks.

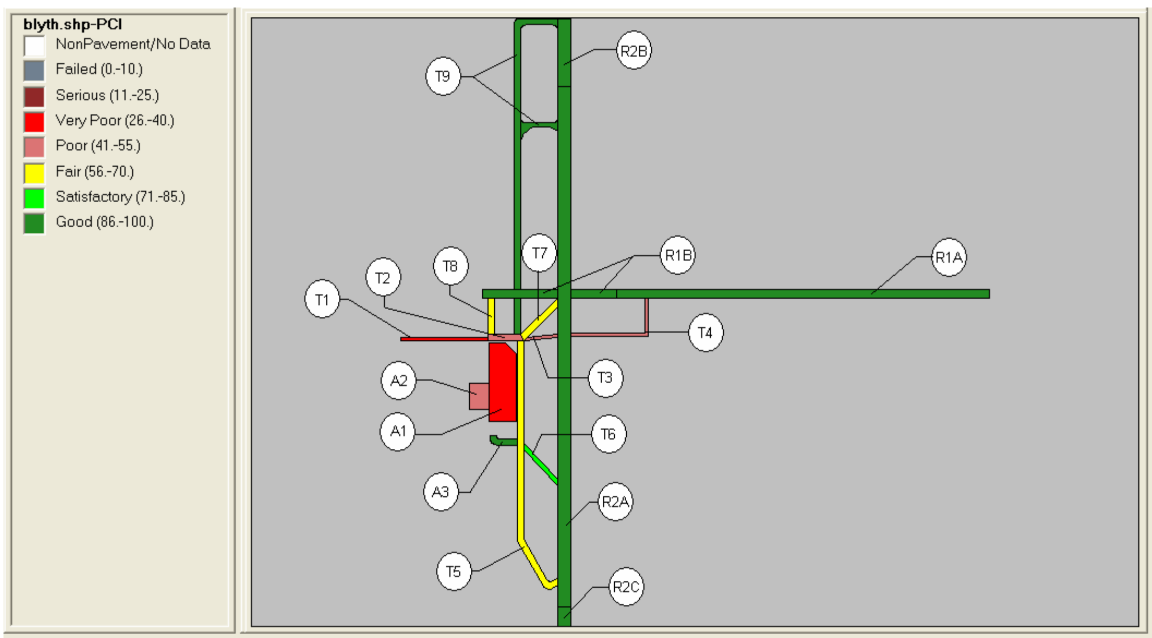

Figure 3. Blythe Airport Inspection Results

BRYANT FIELD

Bryant Field is located in Bridgeport, California at an elevation of 6,468 feet, in a high desert climate region. The average summer high temperature is 76.0°F and the average winter low temperature is 15.0°F. Snow can accumulate up to 2 feet in a heavy snow year.

The runway is 4,239 feet long by 60 feet wide and has a single wheel bearing capacity of 30,000 lbs. Bryant Field averages 61 operations a week. Two aircraft are stationed at Bryant permanently; one is a single-engine airplane and one the other is a helicopter.

Construction History

The runway was first paved in the 1960s, but has been in use since the early 1920s. In the 1960s, the apron was constructed and later expanded. It was overlaid in 1982. The entire apron was reconstructed and resurfaced in the 1980s and again in 2006.

In 1982, the parallel taxiway was constructed and the runway overlaid. In an attempt to minimize thermal cracking, in 2003 the runway was saw-cut in a pattern of 18’ to 25’ by 25’ pattern.

In 2006, the apron was reconstructed. The new apron has a 3 inch pavement that was constructed in two lifts. The lower 1.5” thick lift is a ¾ inch minus mix. The top 1.5” thick is a ½ inch minus mix. Both lifts had a PBA-6b asphalt binder. The Hveem mix design was used for the asphalt mix. The designer was Eastern Sierra Engineering from Gardenville, Nevada. See figures 4 and 5 for layout and details.

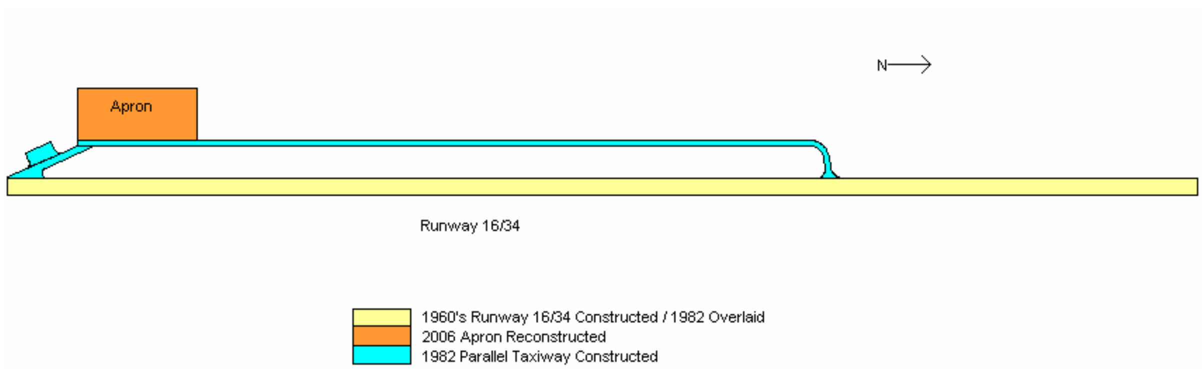

Figure 4. Bryant Airport Construction History

Field Survey (summer of 2006)

Runway 16/34 (R1) (PCI=69): Saw cuts were on a 25’ by 25’ pattern at the runway centerline, and on a 18’ to 25’ by 25’ pattern along the pavement edge. At the runway’s south end, there was extensive alligator cracking adjacent to the saw cuts, especially at the cut intersections. Longitudinal cracks existed at the construction joint at the runway centerline and other locations between transverse saw cuts. These longitudinal cracks were present for the majority of the runway, as were some transverse cracks between saw cuts. The runway exhibited signs of edge cracking on roughly 80% to 85% of its length.

Parallel Taxiway (T2) (PCI=69): The only signs of pavement distress were minor transverse cracks, spaced approximately 25 to 30 feet apart.

Apron (A1) (PCI=9 & 29 – before 2005 repaving): The apron was paved just prior to the field review.

Cross Taxiways (T1A & T1B) (PCI=24 & 69): Neither cross taxiway showed signs of distress, except at the construction joint where the taxiways met the runway.

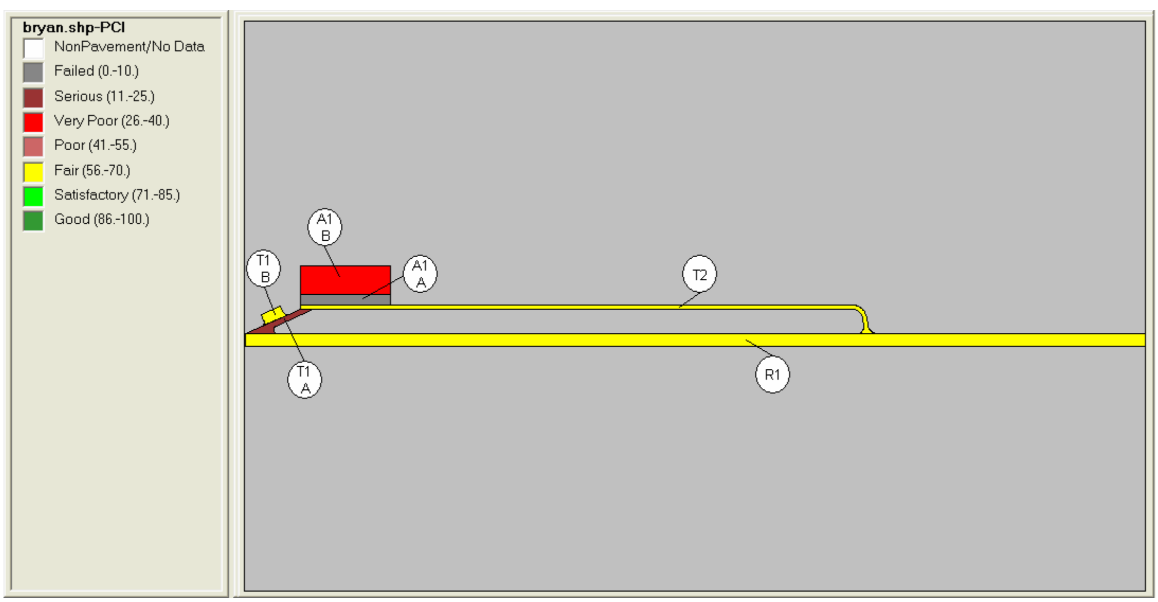

Figure 5. Bryant Airport Inspection Results

CALIFORNIA CITY AIRPORT

California City airport is located 2 miles northwest of California City, at an elevation of 2,454 feet, in a low desert climate region. The average summer high temperature is 88.9°F. The average winter low is 42.2°F. The runway, 6,027 feet long by 60 feet wide, has a single wheel weight bearing capacity of 26,000 lbs. The airport is a base for 91 aircraft, including 26 single-engine airplanes, 4 multi-engine airplanes, 5 jet airplanes, 53 gliders, and 3 ultra-lights. The airport averages 102 operations a day. This municipal airport was recently transferred from the county to California City.

Construction History

The runway was constructed in the 1960s and repaved in 1994. Two slurry seals were placed in 1998 and 2002. A major portion of the parallel taxiway (T/W) and the three eastern cross T/Ws were constructed in 1979. The western portion of the parallel T/W and the westernmost cross T/W were constructed in 1997. The parking apron was repaved in 2004. See figures 6 and 7 for layout and details.

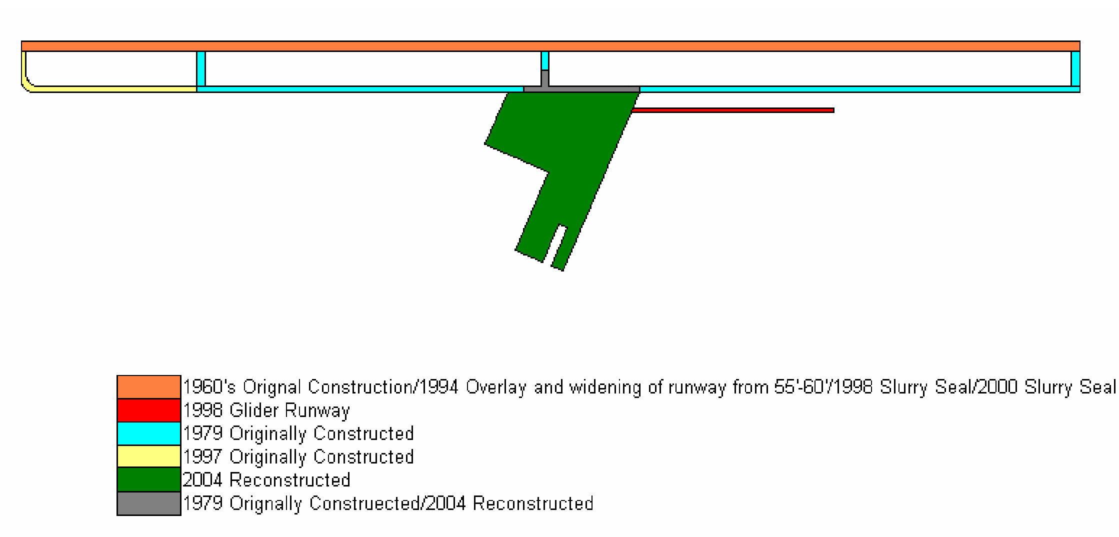

Figure 6. California City Airport Construction History

Field Survey (summer of 2006)

Runway 6/24 (R1Am R1B) (PCI=94, 93): Longitudinal cracks were present throughout the entire length of the runway. These narrow (<¼" wide) cracks were located at the construction joints. In a few instances, the slurry seal had started to fail at the joints. Thirteen transverse cracks were present, but their spacing was inconsistent.

Parallel Taxiway (T1A, T1B) (PCI=74, 94): Starting on the west end and working east, the first section between cross T1B and T5, the second oldest pavement, showed signs of severe thermal cracking. The average crack spacing was 83.9 feet. The spacing of the thermal cracks on this section of the parallel taxiway was more consistent than the spacing of the thermal cracks on the runway. Cracks were previously sealed with a cold mix sealant, which created bumps. The oldest of the three pavements is on the east side between crosswinds T5 and T3 and after crosswind 3. This older pavement had severe block cracking. While some of this cracking was in a fairly tight grid pattern, other areas of block cracking appeared random and nonrectangular.

Cross Taxiways (T1B, T3, T4, and T5) (PCI=94, 22, 68, and 34): Cross T1B was paved with the same material as the taxiway and had experienced the same thermal cracking. These thermal cracks were also sealed with a cold mix as well and created similar bumps. T5 had signs of minor block cracking. T3 was repaved at the same time that the apron was reconstructed. The condition of cross taxiway T4 was the worst of the cross taxiways, showing both block and edge cracking; it was also the oldest mix.

Apron (TD1): The apron, which was repaved in 2005, showed no signs of pavement distress.

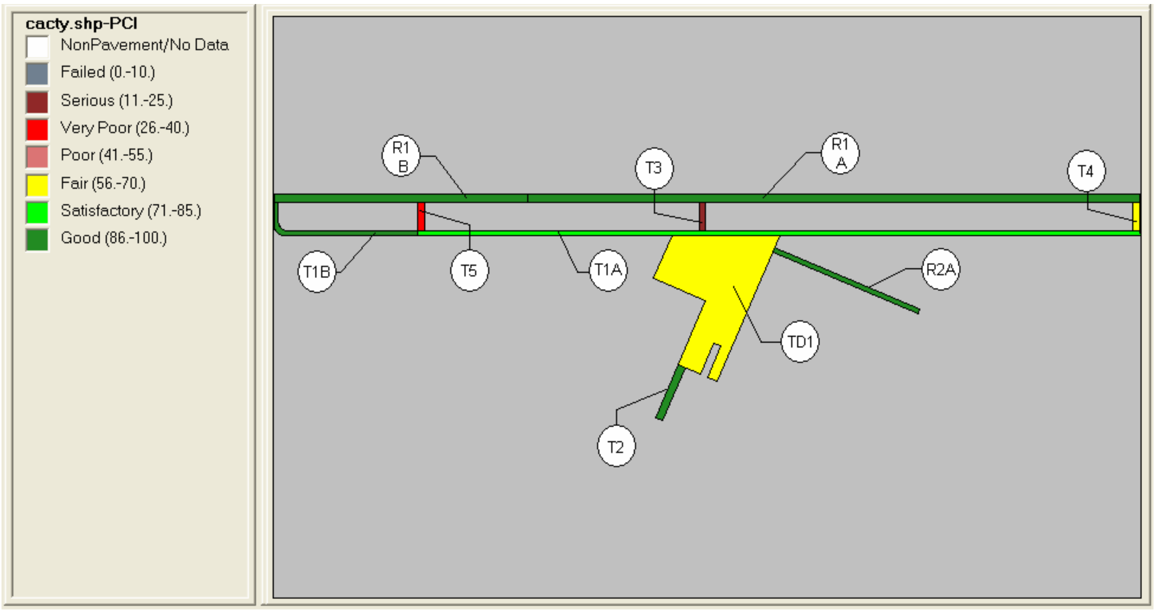

Figure 7. California City Airport Inspection Results

CALIFORNIA PINES AIRPORT

California Pines Airport is located 8 miles southwest of Alturas, California, at an elevation 4,398 feet above sea level; it is considered to be in a high desert climate. The average summer high temperature is 74.7°F; the average winter low is 24.3°F.

The runway is 4,250 feet by 60 feet and has a single wheel weight bearing capacity of 12,000 lbs. There is a small (about 50' radius) circular parking apron and a cross taxiway linking the apron to the runway. Although a few airplanes are based at this airport, it averages only one operation per day. See figures 8 and 9 for layout and details.

Construction History

The runway was originally constructed in 1947 by a private developer. The apron was overlayed in 1995. Ownership of the airport has since been transferred to Alturas

County. Although no construction records are available, the airport manager provided a construction history.

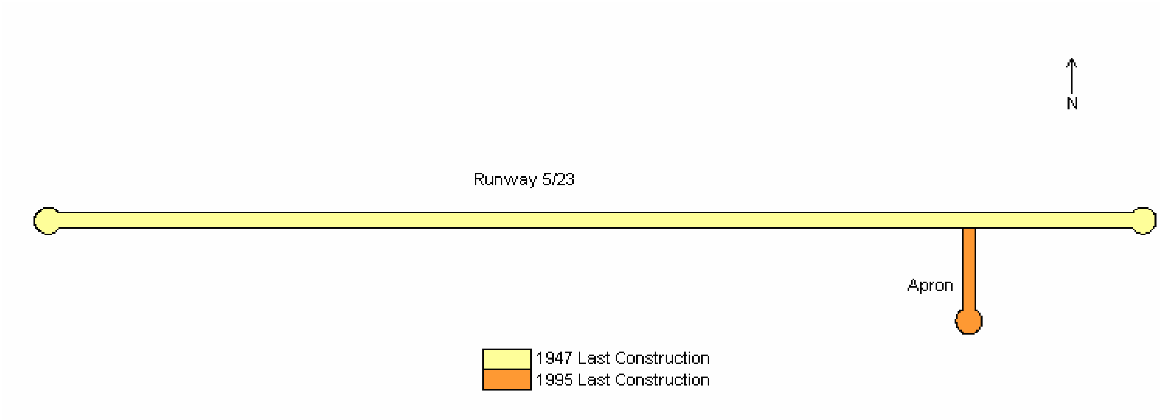

Figure 8. California Pines Airport Construction History

Field Survey (summer of 2006)

Runway 5/23 (R1) (PCI=18): The runway is severely cracked with block cracking over its entire length. Extensive alligator cracking is propagating from the longitudinal and transverse cracks; these cracks are up to 1 inch wide. Some of the cracks have been sealed.

Since there are no construction records, it is not possible to determine what, if anything has been done since the original runway construction in 1947.

Apron (TD1) (PCI=81): The apron was in better condition than the runway since it was recently overlaid in 1995. The taxiway had some wide (2.5" to 3") transverse cracks. The cracks were sealed, but they have since expanded beyond the sealant's capacity to maintain a seal. It does not appear that a backing rod was used prior to placing the crack sealant.

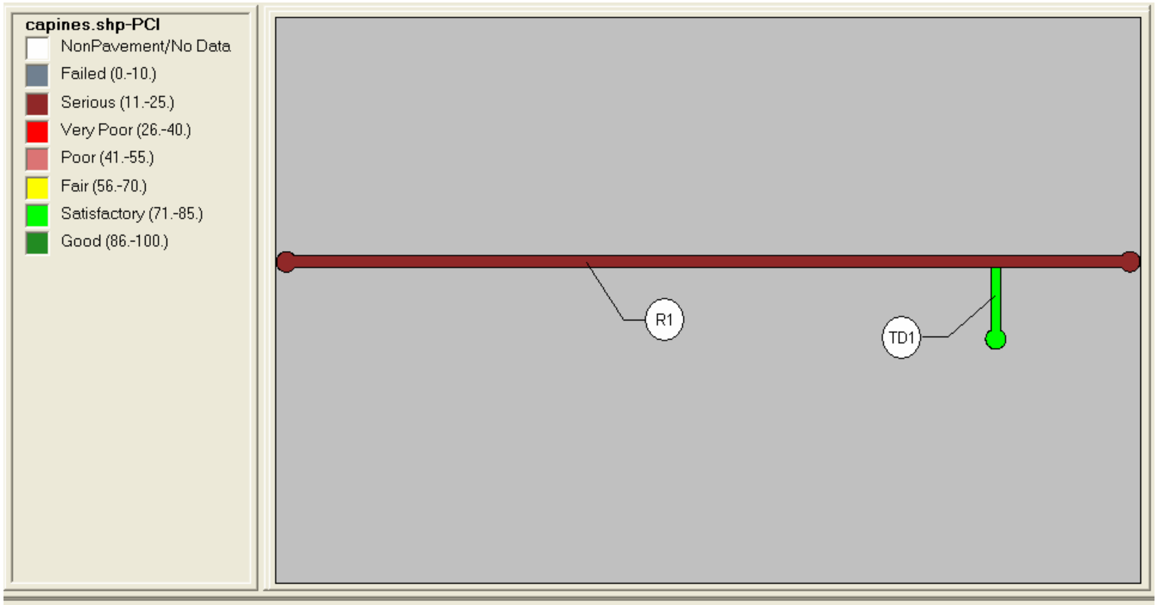

Figure 9. California Pines Airport Inspection Results

HERLONG AIRPORT

The runway is located 2 miles west of Herlong at an elevation of 4,055 feet in what is considered a high desert area. The average summer high temperature is 79.4°F; the average low is 24.9°F. During an average winter, there are snowstorms of 2 to 6 inches, but these usually melt within a couple of days. The runway is plowed occasionally.

The runway is 3,260 feet long and 40 feet wide. There is a small parking apron and a cross taxiway. Although there appear to be no planes currently based at this airport, the Herlong airport has an average of 58 operations a month.

Construction History

According to a CALTRANS airport pavement management study, the runway was last paved in 1978; the apron, in 1972. There are no construction records available. See figures 10 and 11 for layout and details.

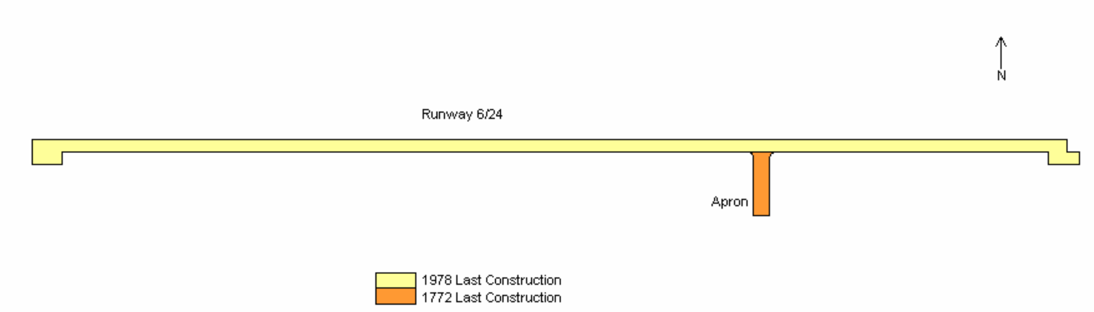

Figure 10. Herlong Airport Construction history

Field Survey (summer of 2006)

Runway 6/24 (R1) (PCI=54): The runway has extensive block cracking. It appeared that the runway underwent a sand slurry seal at some point in the past. At the time of this inspection, the sand slurry seal had shrinkage cracks and was not bonded to the pavement in numerous areas throughout the runway.

Apron (A1) (PCI=9): The apron has longitudinal and transverse cracking, but the majority of the pavement distress is due to alligator cracking, which was present on about 95% of the entire apron area.

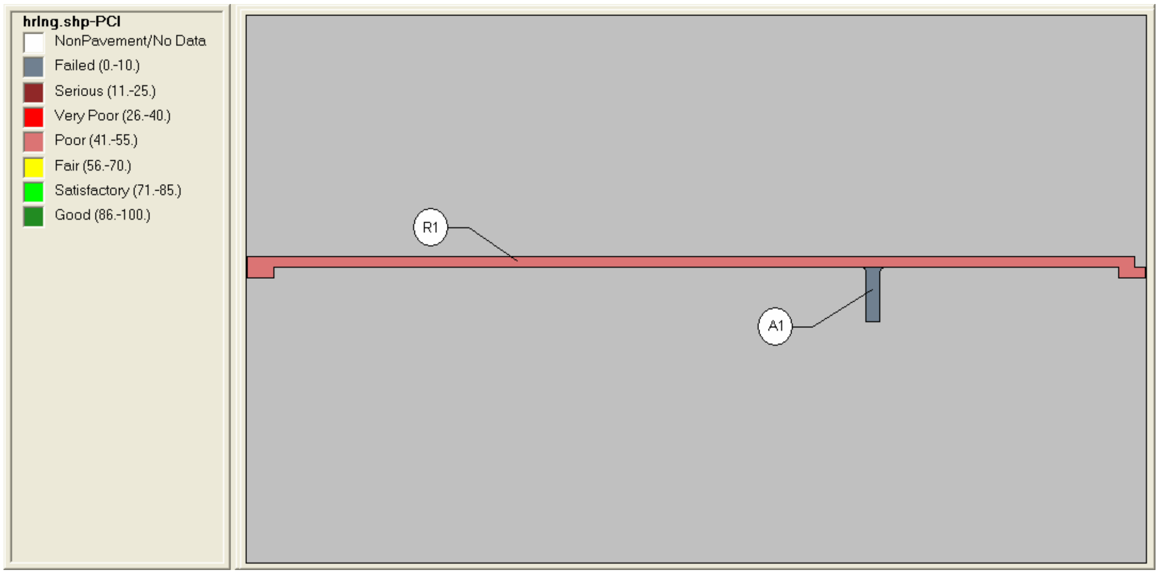

Figure 11. Herlong Airport Inspection Results

LEE VINING AIRPORT

Lee Vining airport is located 1 mile east of Lee Vining, California, at an elevation of 6,802 feet above sea level. It is considered to be in a high desert climate. The average summer high temperature is 76.0°F and the average winter low temperature is 15.0°F. Winter snowstorms at this airport accumulate 1 to 6 inches, and it is plowed when needed.

The runway is 4,090 feet long by 50 feet wide and has a single wheel weight bearing capacity of 30,000 lbs. The airport has a parking apron and a single taxiway connecting the apron to the south end of the runway. The airport has an average of 38 operations a week. The authors do not know if there are any resident planes.

Construction History

In 1962, a 1,260 foot by 35 foot paved runway was constructed. In 1966, the runway was widened and extended to the current size of 50 feet wide and 4,040 feet long.

In July 2001, the entire runway, taxiway and apron were covered with a reinforcing fabric, and then overlaid with three inches of hot asphalt pavement using an AR 4000 asphalt binder. The contractor was Jackson Baker from Redding California. See figures 12 and 13 for layout and further detail.

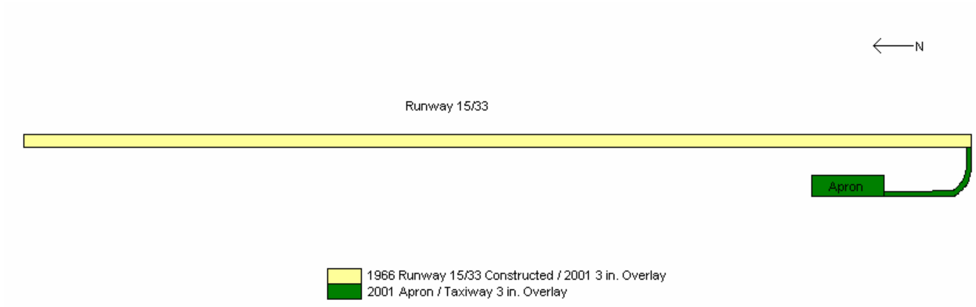

Figure 12. Lee Vining Airport Construction History

Field Survey (summer of 2006)

Runway 14/32 (R1) (PCI=100): The runway has some straight longitudinal cracking at the construction joints; the cracks were clean and less than half an inch wide. There was no sign of raveling or any other form of secondary distress associated with the longitudinal cracks. The runway also had some edge cracking, mainly present on the east side, for about 55% of its length. Transverse cracking was present in the south quarter of the runway; cracks varied in size from ½ to 1½ inches wide and 1 to 4½ inches deep. At some locations, the mat was segregated along a width of 12 inches along the construction joint.

Taxiway (T1, T2, and T3) (PCI=95, 100, and 100): There were isolated areas of segregation at the joints. In addition, there were areas with two linear bands of segregation running parallel to the paving panel; these bands were approximately 12 to 18 inches wide and they were separated by about 3 feet of non-segregated material. The taxiway also had some edge cracking on its inner radius, as the taxiway turned east, toward the runway.

Apron (TD1) (PCI=100): The apron also showed some segregation and signs of thermal cracking.

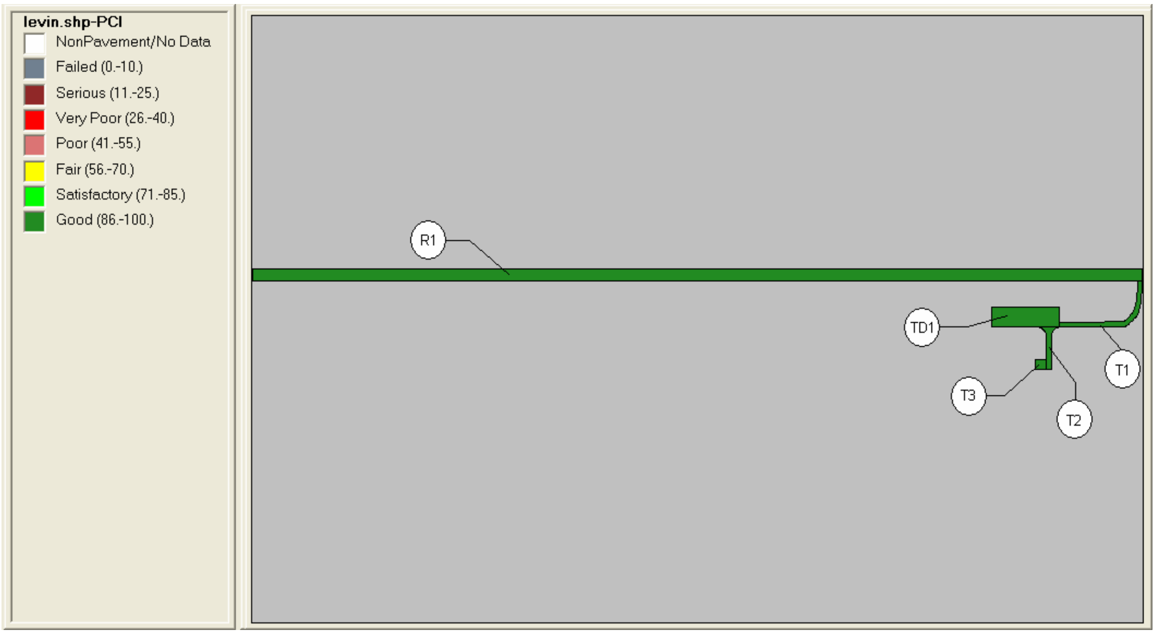

Figure 13. Lee Vining Airport Inspection Results

MARIPOSA-YOSEMITE AIRPORT

Mariposa-Yosemite airport is located 4 miles west of Mariposa, California at an elevation of 2,254 feet, in a low mountain climate region. The average summer high temperature is 74.1°F; the average winter low, 28.7°F. The airport does get occasional snow, but it melts quickly. The runway is 3,306 feet long and 60 feet wide with a single wheel weight bearing capacity of 12,000 lbs. The airport is the base for 52 aircraft, including 50 single-engine airplanes, 1 multi-engine airplane and 1 starlight. The airport averages 88 operations a day.

Construction History

The runway was originally constructed in 1971-1972. The taxiway was constructed in 1983. In 1997, the runway was crack-sealed and then slurry seal coated. The seal coat included a very sharp angular aggregate that ended up cutting airplane tires. To combat this problem, a roller was used to compact the slurry seal during very hot weather, to reduce the seal's abrasive texture.

In 2002, the runway was overlaid with 2 inches of asphalt pavement and widened from 50 feet to 60 feet. CALTRANS specifications, including the Hveem asphalt mix design method, were used for the 2002 construction work. AR 4000 asphalt cement was used during this work. For layout and more details, see figures 14 and 15.

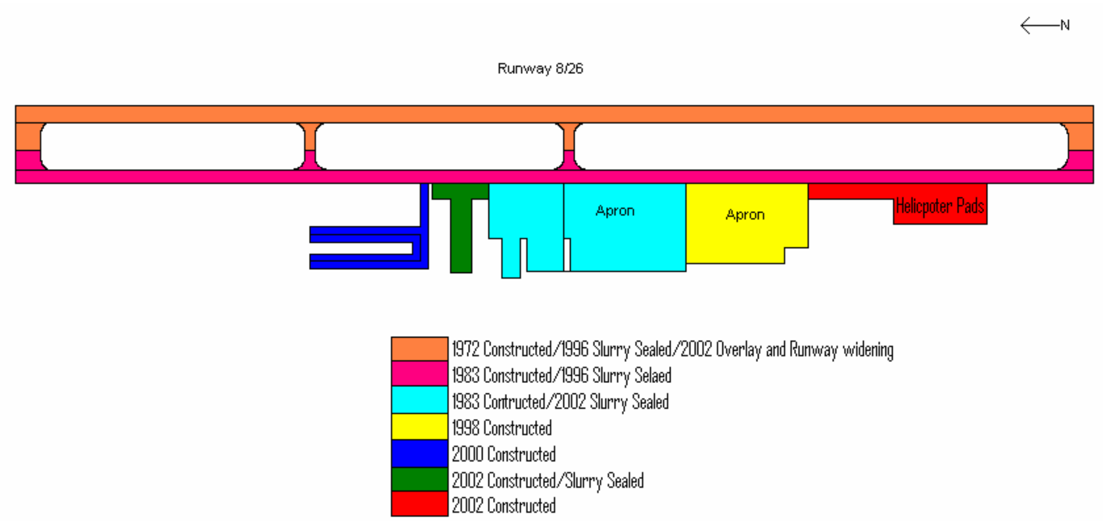

Figure 14. Mariposa-Yosemite Airport Construction History

Field Survey (summer of 2006)

<u>Runway 8/26 (R1) (PCI=100):</u> The runway has a longitudinal crack that runs along 80% to 85% of the construction joint at the runway centerline. The crack is narrow (< ¼") wide. An additional longitudinal crack runs to the left of the centerline joint; this could be a

reflective crack from the original pavement, when the runway was only 50 feet wide. A large amount of checking was evident, along with a few minor patches of apparent segregation along the edge of the paving panel.

Parallel Taxiway (T2) (PCI=79): Block cracking was present on the south end of the parallel taxiway (T/W). The north end showed transverse cracks which were randomly spaced; occasionally a longitudinal crack existed at the centerline construction joint.

Cross Taxiways (T1 A, T1 B, T3 A, T3 B, T4 A, T4 B, T5 A, and T5 B) (PCI= 100, 73, 69, 90, 96, 20, 100, and 72): All cross T/Ws showed block cracking; the T/Ws were crack-sealed and covered with a slurry seal in 1997. There was also a transverse crack at the construction joints between the new and old pavement. Edge cracking was also present at some of the edges of the cross T/Ws.

Parking Apron (A1 A, A1 B, and A3) (PCI= 89, 98, and 100): The south end of the parking apron had been coated with coal tar to protect the pavement surface from fuel spills.

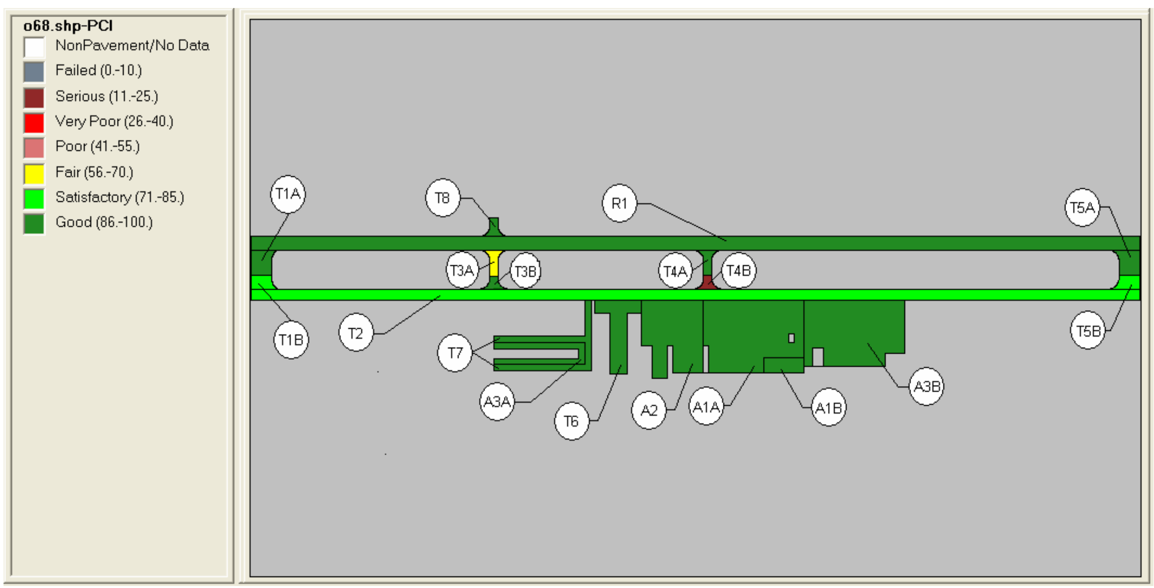

Figure 15. Mariposa-Yosemite Airport Inspection Results

PINE MOUNTAIN LAKE AIRPORT

Pine Mountain Lake airport is located 3 miles northeast of Groveland, California at an elevation of 2,930 feet above sea level. The airport is located in a high mountain climate region. The average high summer temperature is 85.2°F; the average winter low, 35.7°F. The runway is 3,625 feet long by 50 feet wide and has a single wheel bearing capacity of 12,000 lbs. The airport is the base for 113 aircraft – 105 single-engine airplanes, 5 multi-engine airplanes, and 3 helicopters. The airport averages 90 operations a day. Figures 16 and 17 show layout and further details.

Construction History

According to CALTRANS, the runway was privately constructed by the Pine Lake community at some unknown date and was recently transferred to the county. There are no construction records available.

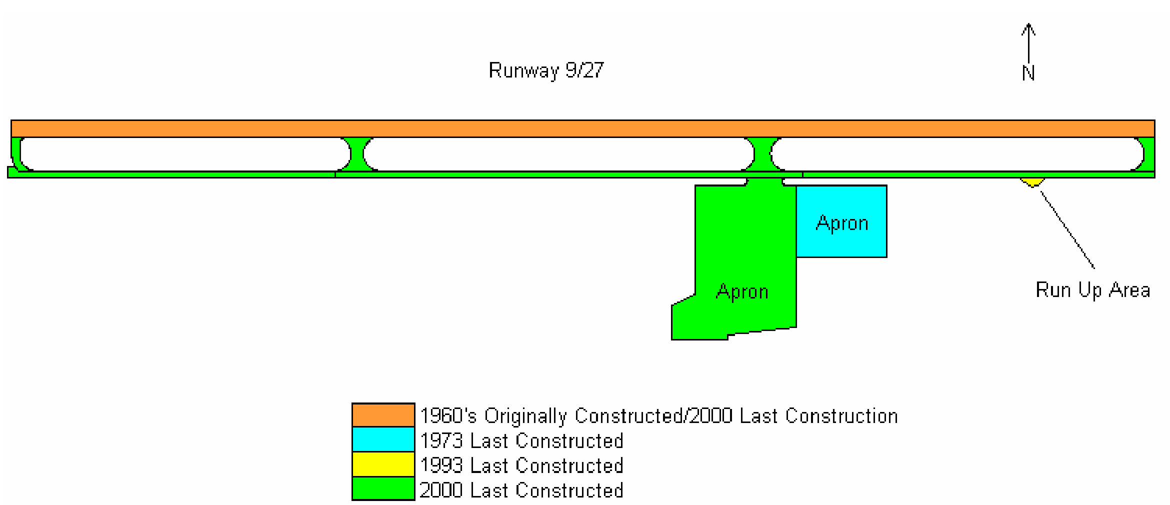

Figure 16. Pine Mountain Lake Airport Construction History

Field Survey (summer of 2006)

Runway 9/27 (R1) (PCI=99): A field survey was not conducted on this runway due to heavy air traffic.

Parallel Taxiway (T1- A, B, C) (PCI=94, 100, and 100): There was some minor longitudinal cracking at the joint between the taxiway and the preflight apron on the east end. There was extensive transverse cracking in a 1,200 foot long section in T1-A. Average spacing between transverse cracks was 42 feet.

Apron (TD1 – A &B) (87,100): No cracks were evident in the pavement in the west section (TD1 B). The east section (TD1 A) has some block cracking and thermal cracking at the tie down areas. The tie down areas also appeared to be sealed with coal tar to protect the pavement from fuel spills.

Cross Taxiways (T2, T3, T4, and T5) (PCI=100, 95, and 90,100): The cross taxiways were in good condition, with only a few random cracks and one crack forming above a culvert.

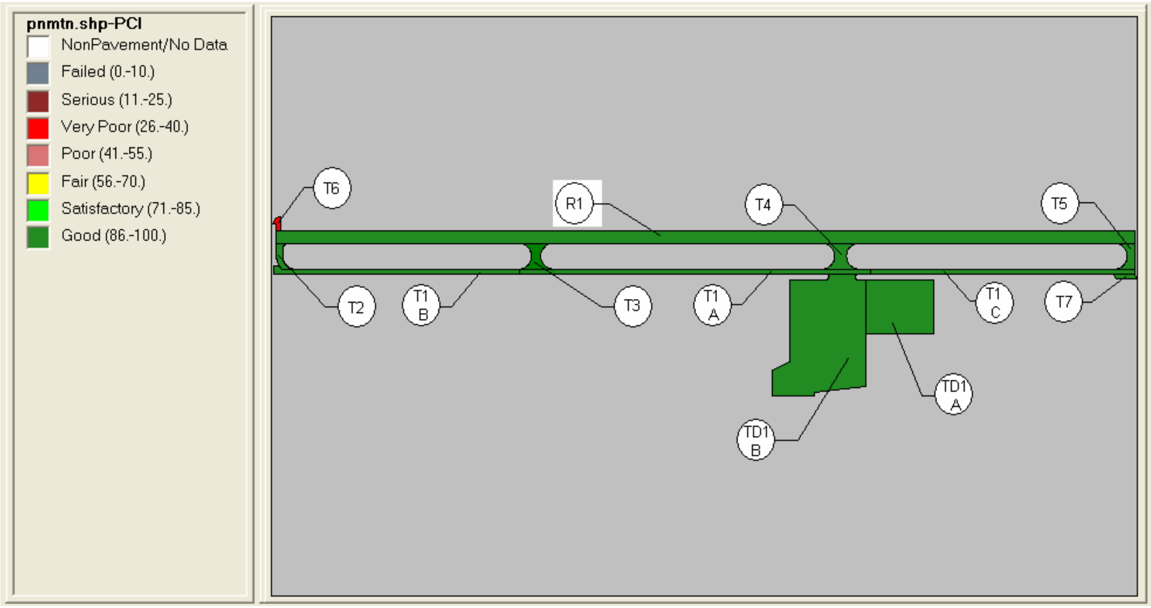

Figure 17. Pine Mountain Lake Airport Inspection Results

SCOTT VALLEY AIRPORT

The Scott Valley airport is located 3 miles south of Fort Jones, California at an elevation of 2,728 feet above sea level, in a high mountain climate region. The average summer high temperature is 83.9°F and the average low temperature is 27.4°F. There is no snow data for this airport.

The runway is 3,700 feet long by 60 feet wide. There is a parking apron and a single cross taxiway. The runway surface is less than two feet above the valley floor. The subgrade appears to be a silt/clay. The runway was designed for a single wheel weight bearing capacity of 12,000 lbs. Services consist of an aviation fueling station and a tie down parking apron. The facility is currently a base for 18 single-engine airplanes, 1 helicopter and 1 ultra-light. There is an average of 22 operations per day on this runway. See Figure 18 for layout.

Construction History

The runway embankment was constructed in 1950 and paved in 1964; the parking apron was constructed in 1974. In 2005, the runway was reconstructed and widened from 50 to 60 feet. The existing asphalt pavement was reconditioned and compacted as base course. An additional 4 inches of crushed asphalt base course was placed on top of the reconditioned (crushed) material. The newly constructed pavement surface consists of 2 inches of hot asphalt mix (¾ inch minus), with PBA-6a as the asphalt binder. The designer, Scott Waite at the Siskiyou County Department of Public Works, used the Hveem asphalt mix design method (in accordance with CALTRANS specifications). The construction contract price was approximately $750,000.

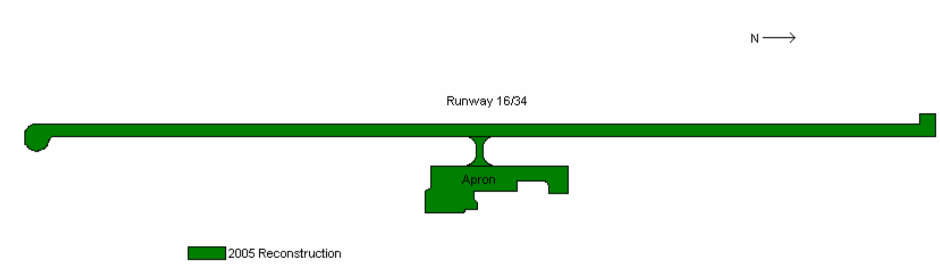

Figure 18. Scott Valley Airport Construction History

Field Survey (summer of 2006)

There were no longitudinal or transverse cracking, or other signs of pavement distress after the first winter. There were some signs of segregation of the asphalt surface. Each pavement panel had approximately 12 to 18 inch wide bands of segregation centered at the quarter points of each of the 15 foot wide pavement panels.   This may have been caused, at time of construction, by the pickup machine not transferring all the asphalt mix for the windrow into the paver. There were also signs of segregation along the joints in the parking apron.

SIERRAVILLE - DEARWATER AIRPORT

Sierraville - Dearwater airport is located 1 mile southeast of the city of Sierraville, California at an elevation of 4,984 feet above sea level, in a high mountain region. The average high summer temperature is 77.0°F; the average winter low is 21.7°F. The runway is 3,260 feet long by 50 feet wide. The pavement is designed for a single wheel weight bearing capacity of 12,000 lbs. The airport has a parking apron and two cross taxiways. There is no refueling station or hangars. The runway averages 83 operations a month.

Construction History

The runway, two cross taxiways and short parallel taxiways adjacent to the parking apron were reconstructed in 2004. No construction records are available.

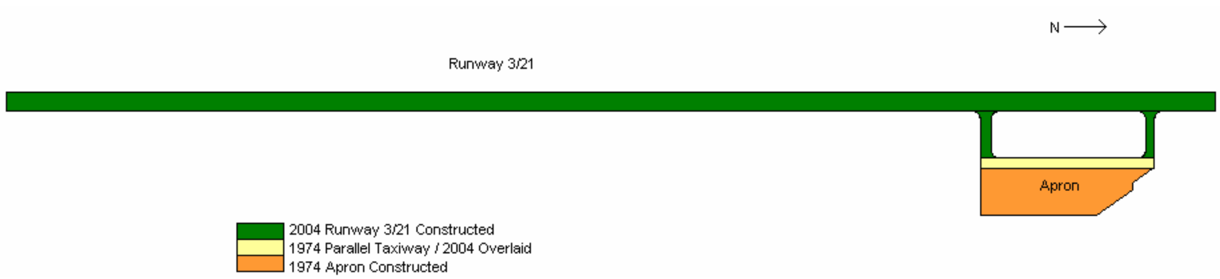

Figure 19. Sierraville - Dearwater Airport Construction History

Field Survey (summer of 2006)

Parking Apron TD1 (PCI 0): The pavement in the parking apron area has completely failed. The parking apron exhibited both severe block cracking and fatigue cracking. The parking apron had been slurry-sealed and crack-sealed at some time in the past.

Parallel Taxiway (Reconstructed post-AMPS study): Transverse and fatigue cracks were reflected through the new (2004) pavement. Both cases of reflective cracking were minor and overall the taxiway pavement is in good condition.

Cross taxiways, T1 & T2 (Reconstructed post AMPS study): On the eastern side of cross taxiway T1, the only form of distress observed was a minor transverse crack. On cross T2, along the northern end, the edge of the base course had eroded away adjacent to a culvert, causing some edge cracking.

Runway 3/21 (Reconstructed post AMPS study): No cracks were observed in the runway. At a few locations, there were some early stages of raveling at some of the construction joints. There were also some areas where it appeared that the subbase/subgrade could not support the construction equipment and failed during construction. These areas had a rough surface but appeared to be sealed with a fog seal or slurry seal. In one area, the pavement was segregated in two 18-inch wide bands at the quarter points of the paving panel.

TRINITY CENTER AIRPORT

The Trinity Center airport is located next to the community of Trinity Center, adjacent to Trinity Lake. The airport is at an elevation of 2,390 ft. The average summer high temperature is 87.6°F and the average winter low temperature is 36.6°F. There is occasional snowfall during the winter, and the runway is occasionally plowed.

The runway is 3,215 feet long; the south end and the second cross taxiway (heading north) are 50 feet wide. The remaining portion of the runway is 60 feet wide. A 2,476 foot long parallel taxiway extends from the second cross taxiway to the northern end of the runway. Four cross taxiways connect the parallel taxiway with the runway.

A parking apron, 540 feet by 140 feet, is located adjacent to the runway’s southern end. An additional, larger parking apron (561’ by 185’), is located slightly to the west. Trinity Center runway was designed for a 10,000 lb single wheel weight bearing capacity. The airport is the base for 30 single-engine airplanes and 2 multi-engine airplanes. The airport has an average of 47 operations a day. See figures 20 and 21 for layout and further detail.

Construction History

The Bureau of Reclamation originally constructed the Trinity Center airport in 1960; it was 2,315 feet long by 60 feet wide. In 1983, the runway was extended 200 feet on the north end and 700 feet on the south end, for a total present day length of 3,215 feet. The parking apron, the two southern cross taxiways, and the taxi lanes constructed to access the new hangar development, were also constructed in 1983. In 1997, the parallel taxiway, the two northern cross taxiways that connected the runway was constructed and the runway was overlaid. In 1997, one of the original taxi lanes running within the hangar development was reconstructed, and in 1998 two new taxi lanes leading to the new hangars were added within the hangar development area. The last improvement to the runway took place in 2004 with a slurry seal of the parking apron and those taxi lanes leading to the hangar development.

In 1983, a Type "A" (¾ inch minus) hot asphalt mix was used to pave the parking apron. Before the runway was overlaid in 1997, a nonwoven polypropylene geotextile produced by Synthetic Industries was placed on the existing paved surface. AR 4000 was applied to bind the geotextile to the paved surface. The asphalt overlay was 0.2 feet 2.4 inches) thick. A hot asphalt mix (½ inch minus) was used, along with the Hveem mix design method. The 2004 construction consisted of sealing the cracks in the apron with Crafco crack sealer and applying a slurry seal.

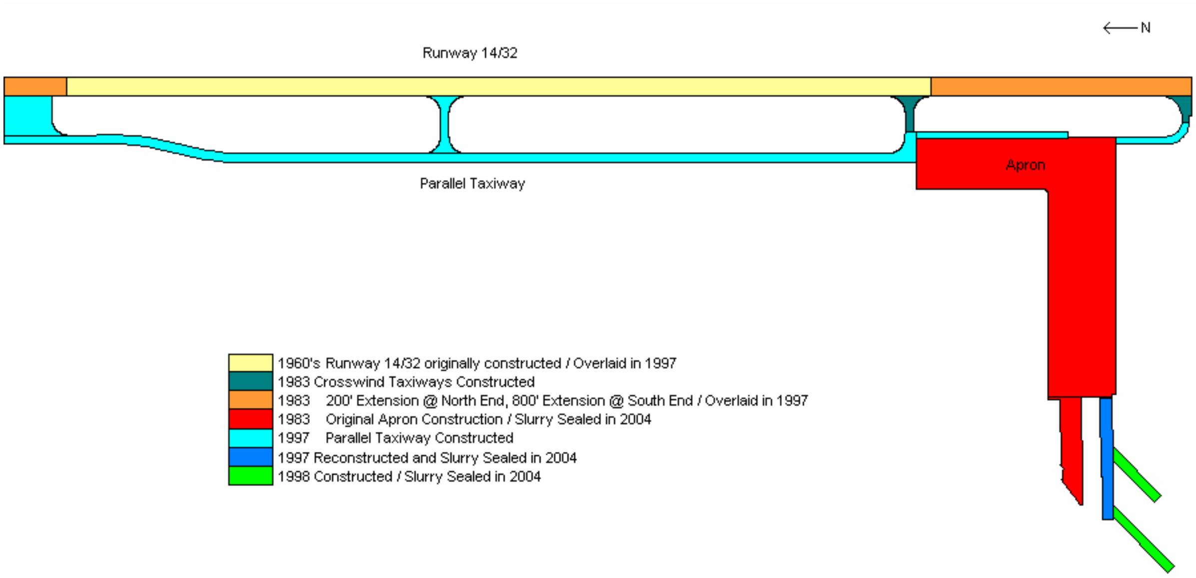

Figure 20. Trinity Center Airport Construction History

Field Survey (summer of 2006)

Parking Apron TD1 (PCI 49): The parking apron had extensive transverse and longitudinal cracking. The majority of the longitudinal cracking was located at the construction joints. Alligator cracking was also present in some low spots where water will accumulate. This parking apron was slurry-sealed in 2004, but the underlying cracks reflected through the seal.

Parallel Taxiway T2B (PCI 96): The parallel taxiway area was in good condition; the only sign of distress was a longitudinal crack down the middle of the taxiway at the construction joint. The crack was discontinuous along the length of the taxiway, but did extend roughly 40% to 50% of the length. The crack was clean with no raveling or deterioration.

Cross Taxiways T1, T3, T4, T2C (PCI = 91, 96, 94, and 96): There are four cross taxiways (T/Ws) at Trinity Center Airport. The cross TW located on the south end of the runways is denoted as cross T1; the one located at the northern end is cross T2C, with cross

T/Ws T3 and T4 in between. Cross T1 had experienced some transverse cracking and fatigue cracking at the edges. Cross T3 and T4 both had transverse cracking located at the center of each, at the low point for drainage. These two cross taxiways both showed cracking along the construction joints. At the northern cross (T2C), early stages of block cracking were present.

Runway R1 (PCI 87): The runway has longitudinal cracks along a majority of the construction joints. The cracks were narrow (< ½" wide), clean, and showed no sign of additional pavement distress.

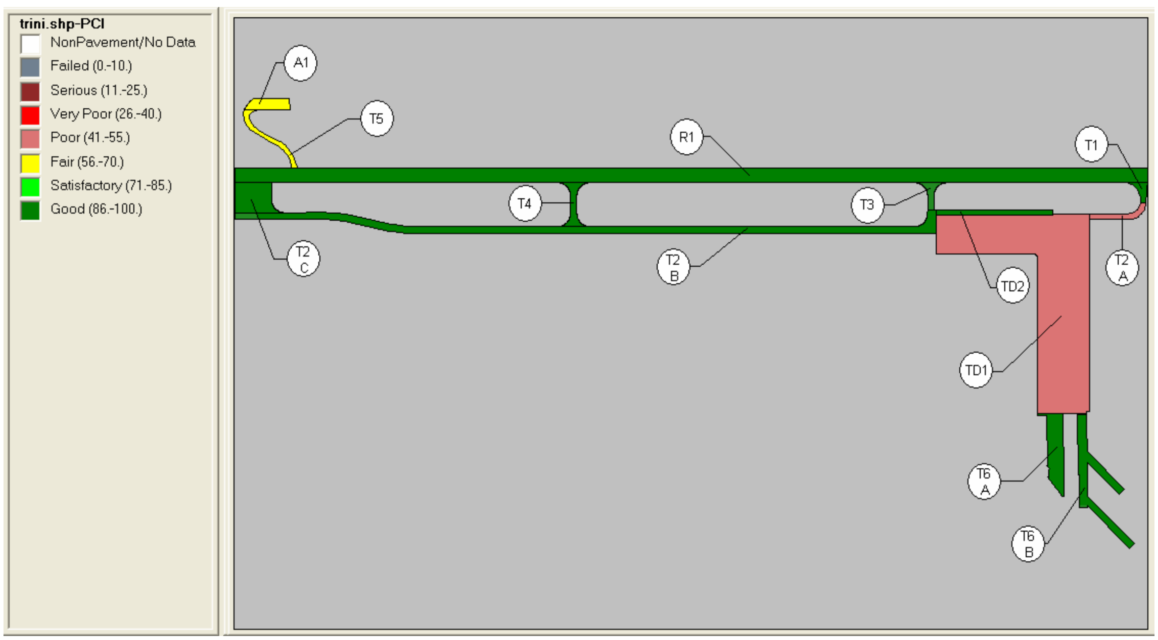

Figure 21. Trinity Center Airport Inspection Results

APPENDIX B

RESEARCH PLAN FOR PHASE II

PHASE I

Task 3 – Develop New Research Plan
Develop research plan for Phase II of this project.

Task 4 – Final "*Durability of Asphalt Pavements of California GA-Airports, Airport Inspection Report*"

This report summarizes the findings for Phase I of this project. This report consists of 1) a summary of comments of the field reviews conducted at eleven GA airports *(modeled after the power point presented to CALTRANS on 7/19);* 2) a new research plan for Phase II, and 3) a summary of field reviews, included as an appendix.

PHASE II

Task 5 –Prepare "*Comparison FAA and CALTRANS Pavement Specifications*" Report
Identify the differences between:

1. FAA (Section 401 & 403) pavement specifications and CALTRANS specifications (Sections 39 & 92).
2. FAA (Section 620) striping specifications and CALTRANS specifications (Section 84).
3. FAA (Section 626) slurry seal specifications and CALTRANS specifications (Section 37).

Evaluate benefits of adopting appropriate sections of the CALTRANS pavement specifications. Assist CALTRANS in seeking approval from FAA to implement adoption of these specifications. This report will include recommendations of appropriate sections of the CALTRANS pavement specifications that should be adopted for GA airport projects.

Task 6 – Prepare "*Guide for Design, Construction and Maintenance of Asphalt Pavement for General Aviation Airports*".

This guide, describing the basics of pavement design, construction and maintenance, will be written for General Aviation Airport Managers with limited experience in asphalt pavements. Key topics will include 1) pavement design, 2) asphalt mix design, 3) asphalt binder, 4) aggregate gradation, 5) aggregate quality, 6) pavement construction, 7) pavement distress conditions, and 8) maintenance strategies. This guide is not intended to be a comprehensive report describing all aspects of asphalt pavements, but a brief summary of the key topics necessary to understanding asphalt pavements, with reference to other sources for more in-depth information.

Deliverables will include: 1) written report, 2) an electronic copy suitable for posting on the CALTRANS website, and 3) a power point presentation.

Task 7 – Presentation

Presentation of *"Guide for Design, Construction and Maintenance of Asphalt Pavement for General Aviation Airports"* to Airport Managers and other appropriate personnel at the annual Airport Manager's meeting. (*This task is beyond the project budget but can be added at the request of CALTRANS).*

Task 8 – Final Report

A final report will be prepared that includes a brief summary of the project. The three deliverables from Tasks 4, 5 & 6 **–** "*Durability of Asphalt Pavements of California GA-Airports*, *Airport Inspection Report", "Comparison of FAA and CALTRANS Specifications"* and **"***Guide for Design, Construction and Maintenance of Asphalt Pavement for General Aviation Airports*" will be included**.**