Time Line of Airport Use of Continuously Reinforced Concrete Pavement

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Abstract

This paper is a timeline of significant uses of continuously reinforced concrete pavement (CRCP) at airports projects in the United States and abroad. Information has been gathered from detailed records kept at the Concrete Reinforcing Steel Institute during the 1960s and 1970s and from various industry sources from around the world. The paper gives a short overview of the successful applications and performance of CRCP at airport facilities — runways, taxiways, aprons, at both commercial and military airfields. CRCP was first looked at in 1921 by the Bureau of Public Roads, and followed by the Stilesville, Indiana, roadway project in 1938; Vandalia, Illinois, roadway project in 1947; Fairfield, California, roadway project 1949; and many experimental miles in Maryland, Pennsylvania, Texas and other states in the early 1950s. The first use of CRCP at airports began in the 1960s and is still used today, although in a more limited capacity. CRCP served Chicago O'Hare with no major rehabilitation for over 35 years of heavy use. The paper will also briefly cover the design aspects of CRCP for airports, including available design methods.

Introduction

The information in this report on continuously reinforced concrete pavement projects at airports in the United States and abroad and U.S. agency requirements has been gathered from detailed records kept at the Concrete Reinforcing Steel Institute (CRSI) during the 1960s and 1970s and from various industry sources from around the world.(CRSI, 1967-1993) The report is not comprehensive, but gives a short overview of the successful applications and performance of CRCP at airport facilities — runways, taxiways, aprons, etc.

> CRCP was first looked at in 1921 by the Bureau of Public Roads, and followed by the Stilesville, Indiana, roadway project in 1938; Vandalia, Illinois, roadway project in 1947; Fairfield, California, roadway project 1949; and many experimental miles in Maryland, Pennsylvania, Texas and other states in the early 1950s. During the years additional applications of CRCP have been proposed, engineered, tested, constructed and evaluated, and have performed well. These applications include airfield pavements, as well as industrial, port and intermodal pavements; warehouse floors; tunnel pavements; water channel liners — anywhere a long-lasting, heavy duty, joint-less concrete surface would be a benefit.
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> In CRCP the longitudinal steel reinforcing bars are there to transfer the concrete's tensile stress after a transverse crack forms to the steel and then carry that stress until at some distance from the crack where the stress in the

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bars is transferred back to the concrete. Most transverse cracks form at very early ages, before pavement is open to traffic: where the tensile stress in the concrete exceeds the concrete's developing tensile strength due to volume changes — first due to shrinkage and then due to temperature changes. At a much later date some cracks may form due to external forces from expansion and contraction due to seasonal temperature changes. Most cracks occur from the top down, but some can occur from the bottom up. Forensic work by Texas researchers has found that many transverse cracks on the slab surface do not penetrate through to the bottom. The steel bars keep those cracks tight. Rarely do traffic loads cause common transverse cracks in a properly sized CRCP slab.

It is worth noting that CRCP is not the same as a structurally reinforced concrete slab. While the longitudinal steel mat stiffens the concrete slab somewhat (in-field deflection measurements indicate the mat adds stiffness to counteract bending/ deflection from wheel loads), the location of the longitudinal bars — mid-slab or higher — does not help to take tension stresses from bending of the slab due to traffic loading. For that, the bars would need to be near the bottom, as in a flexural beam.

The following statement from a May 1974 report for the Federal Aviation Administration is also worth noting because it applies today as much as when it was written: "Up to the present time no truly definitive design procedures have existed for continuously reinforced airfield pavements, either new or overlays. Most designs have been made on an extrapolation of highway design experience. Perhaps the most rational design to date is for the overlays placed at Palmdale, California ... However, the lack of rational design methods has restricted its use to date."(Treybig, 1974) Unfortunately, the design/analysis process described in that report — using elastic layer theory as in asphalt pavement design — has not yet been adopted for CRCP design.

CRCP Airport Timeline

The first use of CRCP for an airfield pavement may have been built outside the U.S. Sources indicate that at the Arlanda Airport, 45 km north of Stockholm, pavements built with CRCP were designed by Prof. A. Losberg using yield line theory, and constructed in the late 1950s. The CRCP Main Runway replaced the little-used Halmsjön Runway, nicknamed "the hump runway" because of its corkscrew-like shape, which was constructed in the early 1950s. On June 23, 1960, a Scandinavian Airlines System (SAS) Douglas DC-8 takes off on the first scheduled flight to New York. They were replaced with asphalt after 35 years due to cracking from traffic loads. Today, Stockholm Arlanda Airport is Sweden's largest airport and operates with 3 take-off and landing runways. The present-day field garage served as the terminal back then.

Back in the U.S., in 1962 Midway Airport was Chicago's primary commercial airfield, and one of the busiest airports in the nation. That all changed when nearly all of Midway's scheduled operations moved to O'Hare International. O'Hare had been constructed in 1942–43 as a manufacturing plant for Douglas C-54s during World War II at Orchard Place, a small nearby farming community. The Douglas Company's contract ended in 1945 and the company ultimately chose to concentrate production on the west coast. With the departure of Douglas, O'Hare took the name of Orchard Field Airport (the source of the code **ORD)**. In preparation for the tremendous traffic volumes and loads, O'Hare needed new runways and taxiways that would be low-maintenance and long-lasting, to minimize pavement closures and operations delays. To meet this extreme challenge, airport officials started using CRCP. Their selection was based on considerable experience with CRCP on the expressways of Chicago, having built over 880,000 m^2 by this time. Designers wanted the increased effective thickness which CRCP provides as a hedge against heavier planes in the future.

CRCP Use at O'Hare International Airport, Chicago, Illinois

For decades, CRCP at O'Hare experienced continuous heavy commercial aircraft operations, with virtually no signs of rehabilitation. In 1994, the CRCP runways were overlaid with hot-mix asphalt. In 2001, Stephen Shelus, Chief Airport Engineer for the Chicago O'Hare International Airport was quoted as saying, "CRCP served Chicago O'Hare very well with no major rehabilitation for over 35 years of heavy use." However, with the modernization project to add more takeoff and landing capacity, many of the CRCP sections have been removed from service in order to build parallel runways which allow for greater capacity. New runways, taxiways and aprons are jointed plain concrete pavement (JPCP) as much as 66 cm thick.

CRCP Construction at O'Hare International Airport

Year	Designation	Dimensions	Pavement	Notes
1970	Runway 4R/22L and taxiway	2461 m by 45.6 m runway, 3658 m by 22.9 m taxiway	35.6 cm & 40,6 cm CRCP, with 0.60% longitudinal steel using #8 (25mm) bars, placed on 20.3 cm cement-treated base over crushed stone; 1994, overlaid with asphalt	4th runway, open 1971; first use of "slip-form," older projects were fixed-form; 332,284 m^2
	Runway 9L/27R	2428 m	Asphalt/Concrete	
1967	Runway 9R/27L, taxiway and hold apron	3092 m	30.5 cm CRCP on 20.3 cm crushed limestone base for runway and taxiway, 25.4 cm CRCP for hold apron; 1994, overlaid with asphalt	210,459 m^2, at US$7.70/$m^2$ for 25.4 cm & US$9.66/$m^2$ for 30.5 cm. 1972, approx. 1219 m at 27L end covered with 9 cm asphalt overlay. **Also, 1980, 244 m by 46 m prestressed overlay at 27L end.**
1966	Runway 14L/32R (decommissioned), taxiway & hold apron	6858 m by 45.7 m runway extension.	25.4 & 30.5 cm CRCP, on granular base; 1994, overlaid with asphalt	148,190 m^2, at US$8.58/$m^2$ for 25.4 cm & US$10.56/$m^2$ for 30.5 cm; 11,685 m^2 for second taxiway.
1968	Runway 14R/32L (decommissioned) & taxiway	3962 m by 30.5 m keel section	30.5 cm CRCP on granular base; 1994, overlaid with asphalt	JPCP keel section had failed; 89,468 m^2 for runway & 44,377 m^2 for taxiway.

A 1974 study report (Treybig, 1974) included the following table, Figure 1., which analyzed the stresses in the 40.6 cm CRCP of Runway 4R/22L:

SUMMARY OF COMPUTED TENSILE STRESSES IN CRCP

RUNWAY 4R-22L - O'HARE

AIRCRAFT	TENSILE STRESS (psi) *
B-727	43
B-727-200	46
B-737	31
B-747	60
B-707	52
B-720	41
DC-9	30
DC-8	47
DC-8 super	54
DC-10	62
C-880	42
C-580	19
L-1011	61
F-27	16

*Maximum tensile stress in bottom of CRC pavement slab

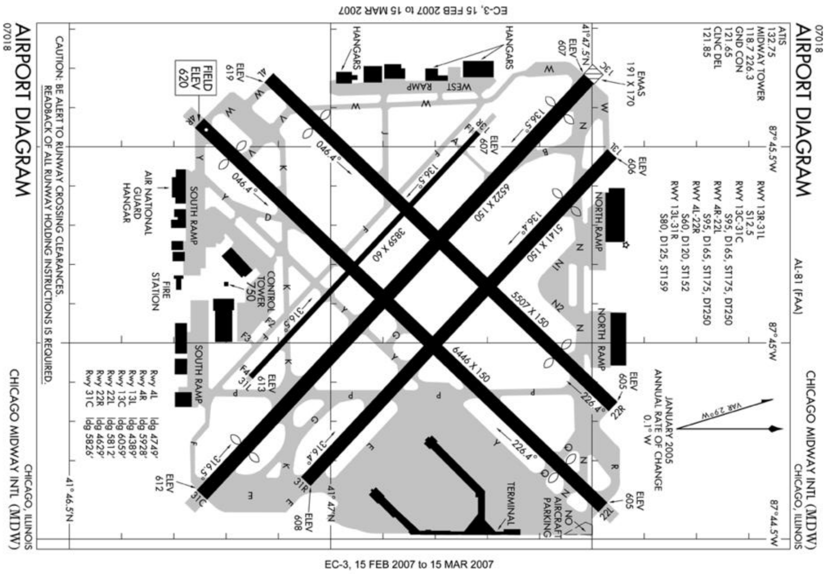
1 psi = 6.9 kPa.

Figure 1. Tensile Stresses in CRCP Runway

1967. By the middle 1960s, Midway Airport in Chicago need to rebuilt its infrastructure in order to be reactivated to give O'Hare competition, as well as relief. The airport engineers chose to overlay the existing asphalt runways with CRCP. It was the first time this design was used at an airfield.

CRCP Use at Midway Airport, Chicago, Illinois

Year	Designation	Dimensions	Pavement	Notes
1967	Runway 4R/22L	1965 m by 30.5 m keel section	20.3 cm CRC overlay on existing asphalt, with 0.60% longitudinal steel; asphalt overlay placed at some point	**First reported use of CRC overlay;** 116,225 m^2
1967	Runway 13C/31C	1988 m by 30.5 m keel section	20.3 cm CRC overlay on existing asphalt, with 0.60% longitudinal steel	1974, surface problems noted. (Treybig, 1974)



At reactivated Midway Airport, CRC overlays were placed on the asphalt runways, forming the cross, in order to serve medium range jets.

Figure 2. Midway Airport Runway and Taxiway Configuration

1968. Patuxent River Naval Air Station, Maryland – NAS Patuxent River began using CRCP in various applications to repair and strengthen existing facilities, becoming the first military airfield to adopt the technology. The first project was a 15.2 cm CRC overlay, with #4 (13mm) bars @ 18 cm (0.48%) longitudinal steel, placed directly on a 23 cm jointed concrete apron with a deteriorated surface (12,542 m^2). Throughout the 1970s Patuxent added several more projects: 15.2 cm CRC overlay on existing jointed concrete apron (14,215 m^2); 15.2 cm CRC overlay with 3.8 cm leveling course on existing jointed concrete apron at Hanger 305-306 (140,473 m^2); and full-depth 25.4 to 43.2 cm CRCP on granular base for apron at Hanger 305-206 (30,101 m^2).

In 2002-03, a forensic survey was undertaken to evaluate the condition of the facilities at NAS Patuxent River. (Department of the Navy, 2003) Excerpts from the report covering CRCP are included in the following table.

NAS Patuxent River CRCP Inventory (Department of the Navy, 2003)

Designation	Performance	Repair or Maintenance
Air Operations Apron AOA-1	CRCP in very good condition, except 15% of joints in fair condition.	Routine maintenance required next 8 years.
Hangar 101 & 109	CRCP in very good condition.	Major project to reseal

Aprons H101A-1, H101A-4, H109A-1	Transverse cracks in lanes slightly greater than 1997 survey. Tight cracks, no spalls.	joints planned for 2005.
Hangar 115 Apron H115A-2	CRCP portion south of hangar little change since 1997 survey, portion north of hangar with many cracks & joints with spall repairs in relatively good condition; portion east of hangar in very good condition.	Increased monitoring & routine maintenance performed to control FOD. Portion north programmed for replacement 2008.
Hangar 201 Apron H201A-4	12.7 cm CRCP. Transverse cracks throughout majority of lanes occur every 2.4 to 3.0 m.	Cracks exceeding 0.6 cm should be sealed as developed. Routine required next 8 years.
Hangar 305-306 Aprons H305A-1 & H306A-1	CRCPs in excellent condition. Transverse cracks in lanes only slightly greater than 1997 survey. Tight cracks, no spalls.	Sealing of cracks at interface of ACP. Routine maintenance required next 8 years.
Test Pilot School Aprons TPSA-1A, TPSA-1B, TPSA-2A, & TPSA-2B	TPSA-1A & TPSA-1B is 15.2 cm CRCP over 20.3 cm JPCP, in good to very good condition. Areas of blast damaged pavement exist, but no noticeable effect on CRCP. TPSA-2A CRCP in very good condition. Isolated areas of surface abrasion of no consequence, some medium severity joint damage. TPSA-2B CRCP in very good condition.	Routine maintenance required next 8 years.

1969. United States Air Force Plant 42, Palmdale, California – When Air Force Plant 42 was asked to handle 1,000,000 lb aircraft (such as the then-proposed SST) by 1970, the U.S. Air Force asked for a stronger and more durable pavement to withstand the larger aircraft loads. The existing concrete placed in 1955-1956 had shown distress under B-70, 707 and DC-8 type aircraft, far exceeding its design criteria. CRCP of 20.3 to 35.6 cm variable thickness, with 0.52% longitudinal steel, was used to overlay Runway 7-25. A stress-relief layer of 2.5 to 7.6 cm asphalt was used where a CRC overlay was placed over existing concrete. The outer 15.2 m on either edge was leveled with asphalt. Taxiways were given full-width CRC overlays over the stress-relief layer. Additional CRCP was constructed in the 1970s.

CRCP Use at Air Force Plant 42, Palmdale, California

Designation	Dimensions	Pavement
Runway 7-25	3658 m by middle 30.5 m (outer 15.2 m each side asphalt)	549 m with 20.3 cm CRCP (Sec E); 1402 m with 25,4 cm (Sec D); 305 m with 33.0 cm (Sec C); 1402 m with 35.6 cm (Sec B). 111,208 m^2
Taxiway B(ravo)	4268 m by 22.9 m	2134 m with 27.9 cm CRCP; 2134 m with 34.3 cm
Taxiway L(ima)	2438 m by 22.9 m	1219 m with 24.1 cm CRCP; 1219 m with 27.9 cm
Taxiway 3	1219 m by22.9 m	457 m with 30.5 cm CRCP, 762 m with 40.6 cm

A study (Treybig, 1974) showed that by comparing the transverse crack pattern with the joint pattern, it was found that as many as 50 to 65% of the joints might actually be reflected in the regular crack pattern of the CRC overlay, with the higher percentages being on the thinner overlays. However, there was no significant difference in crack widths between the cracks associated with joints and those randomly located. This was confirmed by the measurement of crack widths throughout the entire length of Taxiway Alpha. Overall, the Palmdale runway and taxiways have provided excellent service to the Air Force for over 30 years.

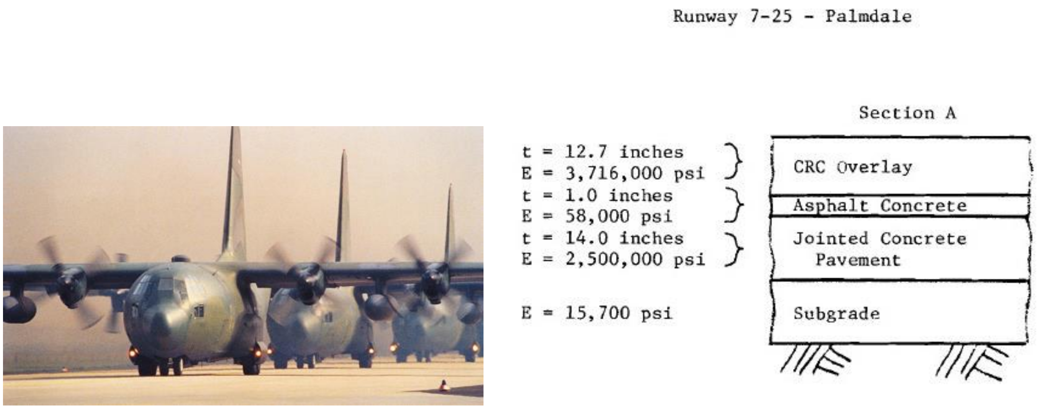


Figure 3: CRCP Runway Cross-Section at Air Force Plant 42, Palmdale, California

Commercial Aviation 1969-79.

Year	Airport	Designation	Pavement	Notes
1969	Minneapolis-St. Paul Intl. Airport/Wold-Chamberlain Field, MN	Runway 11L/29R (now 12L/30R) 610 m extension & taxiway	30.5 cm CRCP with 0.70% longitudinal steel (#6 (19mm) bars @ 13 cm) & transverse steel, on granular base	51,841 m^2
1969	J.F. Kennedy Intl. Airport, New York, NY	488 m by 22.9 m keel section of existing runway	20.3 to 30.5 cm CRC overlay, with #6 (19mm) bars @ 15.2 cm longitudinal steel	11,184 m^2; modified design using 2.5 cm expansion joints @ 36.6 m
1970	Richmond Byrd Field (now Richmond Intl. Airport), VA	Runway 02/20 122 m extension at each end, Taxiway D (now U) & Taxiway S4 (now H)	Taxiway S4: 30.5 cm CRC overlay on WWII vintage 15.2 cm concrete, 30.5 cm CRCP on cement-treated subbase in widened sections	Rebuilt to accommodate heavier jets & increased air traffic.
1971	Jackson Municipal Airport (now Jackson-Medgar Wiley Evers Intl. Airport), MS	73 m by 243 m cargo apron	30.5 cm CRCP, with 0.60% longitudinal steel, on 3 layers of subbase over YAZOO clay	Additional bars used to strengthen bottom edge, see Figure 4 below.
1972	Jackson Municipal Airport, MS	Concrete runway extension & taxiway	30.5 cm CRCP on asphalt base.	40,546 m^2
1973	Jackson Municipal	Runway extension &	30.5 cm CRCP on asphalt base.	50,503 m^2

	Airport, MS	taxiway		
1978	Narita Intl. Airport, Tokyo, Japan	Runway A, taxiway, aprons	CRCP	See table below.

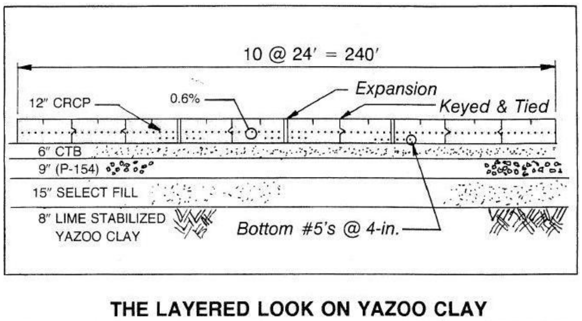


Figure 4. Jackson Municipal Airport CRCP Section

Military Aviation 1970-99.

Year	Airport	Designation	Pavement	Notes
1972	Glenview Naval Air Station, IL	Apron area	15.2 cm CRC overlay	13,378 m^2; base decommissioned.
1974	Moody Air Force Base, Valdosta, GA	735 m by 22.9 m Taxiway No. 10 (with 45.7 m JPCP at ends).	15.2 cm CRC overlay, with longitudinal #5 (16mm) bars @ 19 cm & transverse #5 (16mm) bars @ 91 cm, on existing asphalt	15,765 m^2 at US$17.34/$m^2$; designed for T-38 & T-37 aircraft, since 1975 used by F-4.
197?	NALF Fentress, Chesapeake County,VA	R5-1A & R5-3A 152 m by 15.2 m sections at ends of runway, Simulated Carrier Deck	30.5 cm CRCP	Used for touch-and-go exercises to simulate landings on aircraft carrier flight decks; 2013, new CRCP simulated decks constructed.
1999	NAS Point Mugu, Ventura County, CA	230 m by 24 m at ends of runway, Simulated Carrier Deck	35.6 cm CRCP	Concrete mix included 30% Class F fly ash, w-cm ratio 0.40.

Naval Auxiliary Landing Field (NALF) Fentress is used by squadrons stationed at NAS Oceana or NS Norfolk Chambers Field for Field Carrier Landing Practice operations, intended to familiarize pilots with carrier landings under both daytime and nighttime conditions. NALF Fentress was established in 1940 as a part of NAS Oceana during World War II. Pilots perform approximately 140,000 operations annually, about two-thirds during the daytime. F-14 fighter loads are 24,040 kg per landing.

Figure 5. CRCP Use for Simulated Carrier Decks at NALF Fentress, Virginia

Commercial Aviation 1980s-1990s.

Year	Airport	Designation	Pavement	Notes
1980s	El Paso Intl. Airport, TX	ADAD-9 Ramp	35.6 cm CRCP	6,540 m^2
1980s	Huntsville-Madison Co. Airport (now Huntsville Intl. Airport), AL	Apron	35.6 cm CRCP	27,130 m^2; airport service road constructed of 20.3 cm CRCP.
1989	William P. Hobby Airport, Houston, TX	Runway 4-22	38.1 cm CRCP on 5.1 cm HMA over 20.3 cm cement-stabilized base	Unconsolidated concrete reported in bottom 10.2 cm at northern and southern ends due to poor vibration during construction; repaired.
1997	Zagreb Airport, Croatia	Upgrading of taxiway for wide-body aircraft	PMA overlay on CRCP.	Operational since July 1997. Source MINCAD systems.

CRCP Use at Narita International Airport, Tokyo, Japan

Designation	Dimensions	Pavement	Notes
Runway A (16R/34L)	150 m by 60 m sections each end, built as 8 lanes	35.6 cm CRCP, with 0.60% longitudinal steel & 0.08% transverse steel	Thickness calculated using standard concrete slab thickness design procedure by Portland Cement Association. 860,396 m^2; 2011-12, 10.2 cm asphalt layer added in central trafficked portion, distress developed due to water infiltration, remedied in 2014.
Taxiway for Runway A	30 m sections each end, built	CRCP	High impact areas where aircraft are mostly taxing and/or braking.

	as 4 lanes		
Loading Aprons for Runway A	4 sections each 7 m wide, parallel to runway	CRCP; 15.2 cm CRC overlay on existing CRCP	Aprons designed for 453,592 kg (B747 type aircraft) load; 1993, surface repair/strengthening. using CRC overlay, with strength between new/existing layers over 85% of new concrete.(Motohiro, 2000)
Maintenance Apron		CRCP	629,619 m^2; apron built around airport's circular maintenance hanger.

2004. Full-Scale CRCP Testing

Ten full-scale CRCP test sections were built and five sections loaded under accelerated traffic conditions at the Advanced Transportation Research and Engineering Laboratory (ATREL) at the University of Illinois, Champaign-Urbana, starting in 2002. The Illinois Department of Transportation instituted the study to verify the 40-year-design-life of the proposed CRCP structure for the rebuilding of the Dan Ryan Expressway in Chicago. The sections were tested continuously from December 2002 to August 2004. The CRCP thickness was 25.4 cm or 35.6 cm (with 0.55%, 0.80% & 1.09% longitudinal steel), on 10.2 cm asphalt base over 15.2 cm granular subbase. (Kohler, 2006)

Figure 6.1: CRCP Test at ATREL, Rantoul, Illinois

While not directly intended to be airfield pavement research, the Accelerated Transportation Loading System (ATLAS) machine did employ a single aircraft tire with an inflation pressure of 1450 kPa. ATLAS loads ranged from 226824,948 kg; most testing was done at a wheel speed between 10 and 13 kph, mostly in bidirectional mode, and with fixed lateral position; and the wheel load was applied at 2.5 to 5.1 cm from slab edge (to produce the maximum feasible deflection and stresses in concrete, and therefore accelerating pavement failure). The sections were instrumented to capture pavement vertical and horizontal deformations, as well as pavement temperature.

The experimental research consisted of characterizing crack width magnitude and applying accelerated (damaging) loading to fail the pavement sections in a short period of time. All transverse cracks developed naturally.

The results (some shown diagrammatically below) can be directly correlated to airfield CRCP response. Figure 6.5 shows loads vs. applications history. Section 1 consists of 25.4 cm CRCP with 0.55% steel, Section 2 consists of 25.4 cm CRCP with 0.80% steel, Section 3 consists of 25.4 cm CRCP with 1.09% steel, and Section 4 consists of 35.6 cm. CRCP with 0.80% steel (Dan Ryan Expressway). Figure 6.14 show the load transfer efficiency (LTE) over time, a measure of crack performance. Table 6.4 summarizes the CRCP test sections performance.

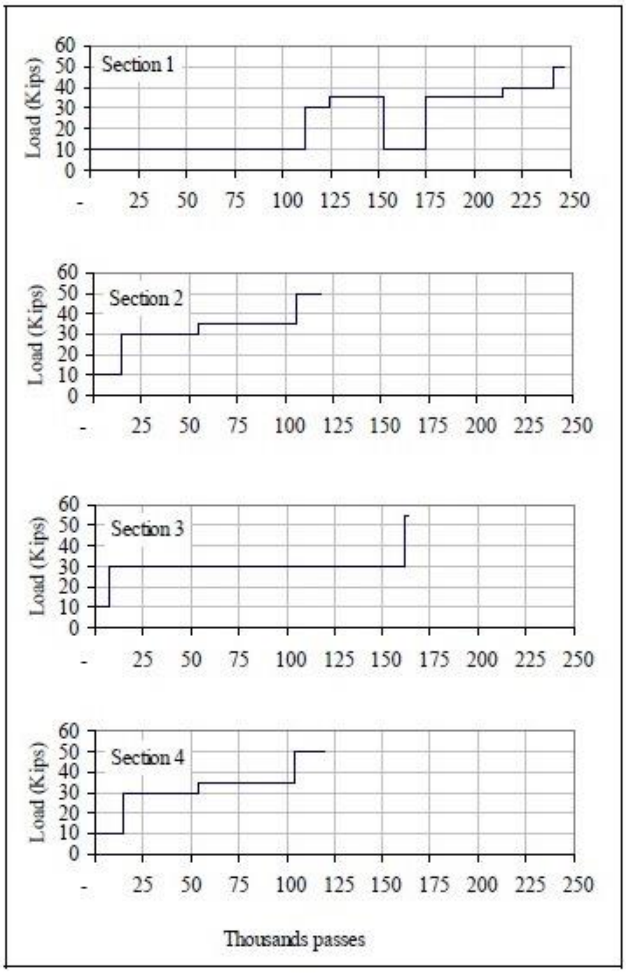


Figure 6.5. ATLAS Load history in each section

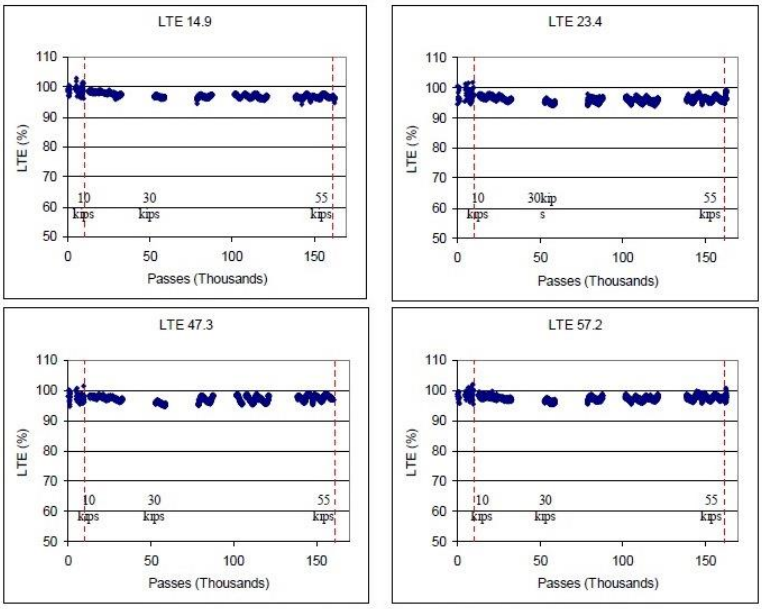


Figure 6.14. Load transfer efficiency at four cracks in section 3

Table 6.4. Summary of tested sections

	Section one	Section two	Section three	Section four	Section five
Duration of testing[1]	12 months (6/16/02-6/23/03)	11 weeks (6/30/03-9/13/03)	10 weeks (5/26/04-8/4/04)	9 weeks (1/3/04-3/6/04)	2 weeks (4/6/04-4/15/04)
Total load repetitions	246,800	118,600	163,400	64,300	1,800
Total ESALs	911 M	778 M	627 M	764 M	12.5 M
Approx ESALs at first failure	511 M	230 M	548 M	NA	NA
Maximum load applied	50 Kips	50 Kips	55 Kips	55 Kips	35 Kips[3]
Pavement temperature range	34-80 °F [2]	75-95°F	64-80°F	25-50°F	40-65°F
Failure description	Extended punchouts	Extended punchouts	Extended punchouts	Section did not fail	Response loading only

[1] Includes time when no load was being applied.
[2] Most of the effective test was done during June 2003, when temperature was 60-80 °F
[3] Loads up to 55 kips were used, but less than 10 passes were applied at each load level higher than 35 kips

Government Standards and Industry for CRCP Airfields

Year	Agency	Document/ Edition	Design Procedure	Notes
1974	Federal Aviation Administration (FAA) and Department of Defense	*Design Manual for Continuously Reinforced Concrete Pavements,* FAA-RD-74-33, III	CRCP design method developed by researchers based on elastic layer method, which had been developed previously for asphalt analysis.	Document not available on internet.
1978	FAA	AC 150/5320-6C, July 7, 1978	348. Continuously Reinforced Concrete Pavement: "The main advantage of CRCP is the elimination of transverse joints … often a source of maintenance problems. CRCPs usually provide a very smooth riding surface. **Thickness Design: The thickness requirements for CRCP are the same as plain concrete ...** Longitudinal Steel Design: "The design	FAA policy for use of CRCP was set down in AC 150. While the document has been updated throughout the years, there has been little change to the CRCP section. Longitudinal steel design follows the methodology developed in *Design and Construction, Continuously Reinforced Concrete Pavement,* Continuously Reinforced Pavement Group, sponsored by Concrete Reinforcing Steel Institute and Committee of Steel Bar Producers of the

			of longitudinal steel reinforcement must satisfy three conditions. The maximum steel percentage determined by any of the three ...”	American Iron & Steel Institute, 1968; this methodology has been incorporated in all airfield pavement standards since.
2001	Department of Defense	United Facilities Criteria *Pavement Design for Airfields*, UFC 3-260-02, June 30, 2001	Chapter 15. CRCP Design. “Its use will require approval of the Commander, U.S. Army Corps of Engrs., the appropriate Air Force Major Command, or the Naval Facilities Eng. Command.” 4. Thickness Design. “The required thickness of a CRCP … will be the same thickness as plain concrete pavement.”	Chapter 1. Introduction: 7. Use of Rigid Pavements. “The following pavements will be rigid pavement: … CRCP will be used in liquid oxygen storage and handling areas ... The type of pavement to be used on all other paved areas will be selected on the basis of life cycle costs.”
2009	Department of Defense	F-35B or C Supplement to UFC 4-211-01N “Aircraft Maintenance Hangars …” & UFC 2-000-05N	Sect. 3-16.6.2 “Pavements for F 35B”: VTOL (vertical take-off or landing) pads shall be designed with CRC.	The pads shall have a minimum 29 m by 29 m (or 30 m by 30 m) CRC center, with continuous reinforcement in both directions.
2009	FAA	AC 150/5320-6E September 30, 2009 (cancels AC 150/5320-6D)	Sect. 343 “Continuously Reinforced Concrete Pavement;” no change.	Sect. 344 “CRCP Jointing,” Sect. 345 “CRCP Terminal Treatment,” Sect. 346 “CRCP Design Example.”

Conclusions

Performance history and recent full-scale testing has shown that CRCPs are suitable and viable for airfield pavement construction. The lack of recent projects appears to largely be due to the lack of a true CRCP design-analysis procedure developed or adopted by either the Federal Aviation Administration or the Department of Defense. Performance, testing, research and analysis have shown that stresses in CRCP are lower than in comparable JPCP. A true procedure for airfield pavements would take into account the performance and load-carrying capabilities of the reinforced section. Such a procedure may show that CRCP would be a competitive choice, either in initial cost through the use of a thinner slab or by using a life-cycle analysis by considering the long, maintenance-free performance it could provide. A procedure used in the past, layered elastic method, commonly used for asphalt pavement design would allow the stresses in CRCP to be evaluated directly.

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