NCEL
TM-
53-76-1
c.2

TM no. M-76-53-1

TECHNICAL MEMORANDUM

title: AIRFIELD PAVEMENT CONDITION SURVEY, USNAS LOS ALAMITOS, CA

author: R. B. BROWNIE

date: APRIL 1976

sponsor: NAVAL FACILITIES ENGINEERING COMMAND

program nos: 53-024

CIVIL ENGINEERING LABORATORY
NAVAL CONSTRUCTION BATTALION CENTER
Port Hueneme, California 93043

AIRFIELD PAVEMENT CONDITION SURVEY, USNAS LOS ALAMITOS, CALIFORNIA

Technical Memorandum 76-53-1

53-024

by

R. B. Brownie

ABSTRACT

The results of a condition survey and friction measurements on the runways at the U.S. Naval Air Station, Los Alamitos, California are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of the individual pavement facilities. The runway friction measurements showed the aircraft hydroplaning/skidding potential of the field. Friction measurements show that the runways at NAS Los Alamitos have satisfactory frictional resistance.

TABLE OF CONTENTS

INTRODUCTION

In October 1969, the Naval Facilities Engineering Command authorized a series of periodic pavement condition surveys to be conducted at Naval and Marine Corps air stations. The purpose of this condition survey task is to determine the suitability of the airfield pavement surfaces for aircraft operational requirements and to establish a uniform basis for maintenance and repair efforts. During the month of March 1976, a pavement condition survey and runway friction measurements were conducted at the Naval Air Station, Los Alamitos, California. For this survey, only the active runways were evaluated. The survey consisted of a sophisticated, statistically-based procedure of pavement defect measurement which permitted the establishment of condition numbers (weighted defect densities) which are direct indicators of the condition of airfield pavement facilities. Runway friction measurements were made using a Mu-Meter, a small friction-measuring trailer. Additional survey efforts included photographic coverage of pavement defect types, preparation of a construction history of the airfield, compilation of current aircraft traffic data, summarization of climatological data, and delineation of requirements for future pavement evaluations efforts at the station.

BACKGROUND

The U.S. Naval Air Station, Los Alamitos, California, is located within the city of Los Alamitos at an elevation of 35 feet. The airfield has one main, one auxiliary, and one abandoned runway. The main runway, 4R-22L, is 8,000 feet long. Runway 4L-22R is 6,000 feet long. Runway 16-34 is now abandoned. An aerial photograph of the air station is shown in Figure 1.

CONSTRUCTION HISTORY

The original construction of the airfield was started in 1941 with the construction of Runway 16-34. Runway 4L-22R was constructed in 1942 and Runway 4R-22L was extended to its present length in 1951. A complete history of construction for the air station is presented in Appendix A. In addition, design pavement cross-sections are provided for major pavement areas.

CURRENT AIRCRAFT TRAFFIC

A tabulation of the number of aircraft operations for a 12-month period is shown in Table 1. Table 2 lists the aircraft normally based at the station and transient aircraft observed using the station.

CLIMATOLOGICAL DATA

A summary of climatological data for NAS Los Alamitos is presented in Appendix B.

PAVEMENT CONDITION SURVEY

Condition Survey Procedure

The condition survey procedure used at NAS Los Alamitos was developed by CEL in 1968. This procedure permits the establishment of condition numbers (weighted defect densities) which are direct indicators of the pavement surface condition. A complete description of the pavement condition survey procedure is presented in Appendix C. It should be noted that Appendix C describes procedures for both asphaltic concrete (AC) and portland cement concrete (PCC) pavements, and includes other pavement facilities in addition to runways. At NAS Los Alamitos only the runways were surveyed. Discrete areas were selected after a preliminary inspection of the runways. The locations of the discrete areas are shown in Figure 2. Defect severity weights as used at NAS Los Alamitos are given in Table 3.

Results of Condition Survey

The results of the survey of each discrete area are shown in the Discrete Area Defect Summary sheets, pages 29 through 36 of this report. Each Discrete Areas Defect Summary includes a narrative description of the pavement defects encountered. In addition, photographs of typical pavement conditions noted during the survey can be seen in Figures 3 through 6. Facility Defect Summaries are shown on pages 39 and 40.

Total weighted defect densities for asphaltic concrete pavements range from 1.72A (0.00A being no visible defects) for discrete area R4R-3, to 22.33A for discrete area R4L-1. For portland cement concrete areas, total weighted defect densities ranged from 0.00C for discrete area R4R-4, to 0.94C for discrete area R4R-1.

RUNWAY FRICTION MEASUREMENTS

The skid resistance/hydroplaning characteristics of the runway surfaces were evaluated with a Mu-Meter friction measuring device. The test program consisted of field measurements of skid resistance/hydroplaning potential under standardized, artificially-wet conditions. In addition, both transverse and longitudinal pavement slopes were measured at intervals along each runway centerline to evaluate surface drainage characteristics.

Test Locations

Test sections on each runway were selected to provide a representative sample of the skid resistance properties of each runway. The test section layout is shown in Figure 7. The test sections were selected to provide pavement friction data in: (a) the aircraft touchdown areas, and (b) the runway interior where maximum braking is normally developed.

Test Equipment

The principal items of test equipment used were the Mu-Meter, a tank truck for water application, and a device for measuring pavement slopes.

The Mu-Meter is a small trailer, designed and manufactured by M. L. Aviation of Maidenhead, England. It measures the side-force friction coefficient generated between the pavement surface and the pneumatic tires on the two wheels which are set at a fixed toe-out (yaw angle) to the line of drag. The Mu-Meter is a continuous recording device that graphically records the coefficient of friction, mu*, versus the distance traveled along the pavement.

The water truck was provided by the station and had spray nozzle and pumping system calibrated to place 0.1 inch of water on the skid test strip with each pass.

The slope measuring device consisted of a rectangular aluminum section (10 feet long, 1 inch thick, and 4 inches high) with machinists levels attached to define slope from 0 to 2.5 percent.

Test Procedures

The field test procedures utilized at NAS Los Alamitos are those outlined in NAVFAC INSTRUCTION 1132.14B. The methods were:

(1) A preliminary reconnaissance of the pavement surfaces was made and representative test areas were selected for skid testing.

(2) Transverse and longitudinal slope measurements were made at 500 foot intervals along the runway centerline. Transverse measurements were made at two places on each side of the centerline covering a distance of approximately 20 feet. Longitudinal measurements were made on the centerline at the same stations where the transverse measurements were made.

(3) The water truck, which had been calibrated to apply 0.1 inch of water each time it passed over a test strip, made two passes over the test strip.

(4) Mu-Meter runs at 40 miles per hour, 1.2 times the theoretical hydroplaning speed for this vehicle, were initiated immediately after completion of the second water truck pass. Mu-Meter runs were made in alternate directions at convenient time intervals until a dry pavement condition was reached or 30 minutes had elapsed.

(5) All water truck and Mu-Meter operations were measured to the nearest second using a stop watch.

---

* The symbol mu or μ designates the coefficient of friction which is a constant used to represent the ratio of frictional force to force normal to the pavement surface.

Runway Friction Test Results

The pavement skid resistance results are reported in terms of mu, coefficient of friction, as measured by the Mu-Meter. The actual friction coefficient versus distance traces as recorded by the Mu-Meter during the first run after wetting for each test section are shown in Figures 8 through 12. The traces show the variation of friction coefficient within each test section. Sharp dips in the curves indicate areas of lower friction values. At NAS Los Alamitos the low-coefficient areas correspond to areas of localized ponded water. Appendix D contains all test results for each Mu-Meter test section.

Figures 13 through 17 show changes in surface friction coefficient versus time after wetting for each pavement section tested. (Note that the time intervals after wetting at which skid tests were made often differed from one test to another, due to small variations in water truck speed and Mu-Meter adjustments). These graphs démonstrate the natural drainage characteristics of the runway surface and the time required to return to an essentially dry condition or a consistently high friction coefficient.

A summary of test data and an associated Mu-Meter aircraft pavement rating guide are presented in Tables 4 and 5. The rating guide was developed from the results of an Air Force Weapons Laboratory research program and a joint NASA/AF/FAA test program using actual aircraft correlated with Mu-Meter skid coefficient results. While the current state-of-the-art does not allow a more precise delineation of exact aircraft responses, the rating guide provides a good rule-of-thumb for interpretation of test data.

Table 4 presents the average skid resistance values for each skid test section. From the curves presented in Figures 11 through 14, values of mu were determined for time periods of 3, 15, and 30 minutes after water was applied. The coefficient determined at 3 minutes after water application corresponds to a wet runway condition and the coefficient determined at 15 minutes after water application corresponds to a damp runway condition. At 30 minutes after wetting the friction coefficient can be considered a dry pavement condition. The curves in Figures 11 through 14 were extrapolated, if necessary, to obtain friction coefficients at those time intervals. These data indicate the rate the pavement skid resistance properties were recovered after the test sections were wetted. By comparing the actual values of mu shown in Table 4 with the expected aircraft response in the associated rating guide, Table 5, it is possible to evaluate aircraft hydroplaning potential.

Measured pavement slopes are shown in Table 6. Positive transverse slopes indicate that water drains to the runway edge without crossing the centerline, while negative transverse slopes indicate that water crosses the runway centerline before draining to the edge. Positive longitudinal slopes indicate rising pavement grades in the direction of increasing runway stations while negative longitudinal slopes indicate falling grades in the direction of increasing stations.

DISCUSSION OF RESULTS

Condition Survey

The condition of the asphaltic concrete portion of the runways at NAS Los Alamitos generally reflects a lack of maintenance and the effects of aging. The AC surfaces of both runways are now 25-26 years old and the only maintenance in evidence is some crack sealing and minor patching. Results of tests on recovered asphalt in Reference 1 indicated that the surface course binder for Runway 4R-22L was extremely brittle with penetrations of 4 to 7.

The condition of the portland cement concrete is also typical of aging and lack of maintenance. The joint seal was hardened and occasionally had vegetation growing in it.

Runway Friction Measurements

The wet (3 minute) friction coefficients given in Table 4 show that both runways have acceptable average frictional resistance according to the guidelines given in Table 5. All test sections on Runway 4L-22 and Test Section 4 on Runway 4R-22L exhibited large variations in frictional resistance within the test sections. This variation is attributed to ponding of water and poor transverse drainage.

RECOMMENDATIONS FOR FURTHER EVALUATION EFFORT

A comprehensive pavement evaluation was performed at NAS Los Alamitos in 1966 (Reference 1). Since then, limited load tests were made at the request of NAS Los Alamitos during December 1974 and were reported in Reference 2. No further evaluation effort is recommended at this time.

REFERENCES

1. U.S. Naval Civil Engineering Laboratory. Technical Note N-902, Airfield Pavement Evaluation, USNAS Los Alamitos, California, by R. J. Lowe, D. J. Lambiotte, and W. H. Chamberlin, Port Hueneme, California, July 1967.

2. Civil Engineering Laboratory, Naval Construction Battalion Center. Enclosure to CEL letter L53/CRW/dn, Serial 91 of 16 January 1975, Results of Plate Bearing Tests at NAS Los Alamitos, California, by L. J. Woloszynski, Port Hueneme, California, December 1974.

TABLE 1 AIRCRAFT OPERATIONS DATA
USNAS LOS ALAMITOS, CA

Date	Total Landings and Take Offs
Jan 1975	1048
Feb	1127
Mar	1490
Apr	1751
May	1429
Jun	1593
Jul	1411
Aug	1195
Sep	1395
Oct	1530
Nov	881
Dec	1069

Total operations for above 1 year period	15919
Average Monthly Operations	1327

Estimated Percentage of fixed wing aircraft at 30000 lb total load or higher was 10%

TABLE 2 TYPES OF AIRCRAFT USING USNAS LOS ALAMITOS, CA

Primary Aircraft Using USNAS Los Alamitos:	UH-1
Other Aircraft Using USNAS Los Alamitos:	Cessna, occasional C-141, P3, C-9 C118, Convair, C-130, most military aircraft

TABLE 3. DEFECT SEVERITY WEIGHTS, LOS ALAMITOS, CALIFORNIA

Asphaltic Concrete: Defect	Weight	Portland Cement Concrete: Defect	Weight
Depression	9.0	Depression	9.0
Rutting	9.0	Shattered Slab	9.0
Broken-up Area	9.0	Faulting	8.5
Faulting	8.5	Spalling	7.5
Raveling	7.0	Scaling	7.0
Erosion-Jet Blast	7.5	"D-Line" Cracking	6.5
Longitudinal, Transverse, or Longitudinal Construction Joint Crack	3.0	Pumping	4.0
Pattern Cracking	3.0	Poor Joint Seal	3.0
Patching	3.5	Corner Break	3.0
Reflection Crack	1.5	Intersecting Crack	3.0
Oil Spillage	1.5	Longitudinal or Transverse Crack	1.5

TABLE 4. RUNWAY FRICTION MEASUREMENT SUMMARY
USNAS LOS ALAMITOS, CALIFORNIA

Test Location	Average Friction Coefficients		
	3 Min. (Mu)	15 Min. (Mu)	30 Min. (Mu)
Runway 4R-22L			
Test Section 1			
AC Portion	0.64	0.75	0.76
PCC Portion	0.63	0.77	0.80
Test Section 2	0.70	0.74	0.74
Test Section 3	0.58	0.69	0.75
Test Section 4			
AC Portion	0.50	0.67	0.75
PCC Portion	0.51	0.72	0.83
Runway 4L-22R			
Test Section 1	0.54	0.68	0.72
Test Section 2	0.50	0.68	0.72
Test Section 3	0.52	0.69	0.77

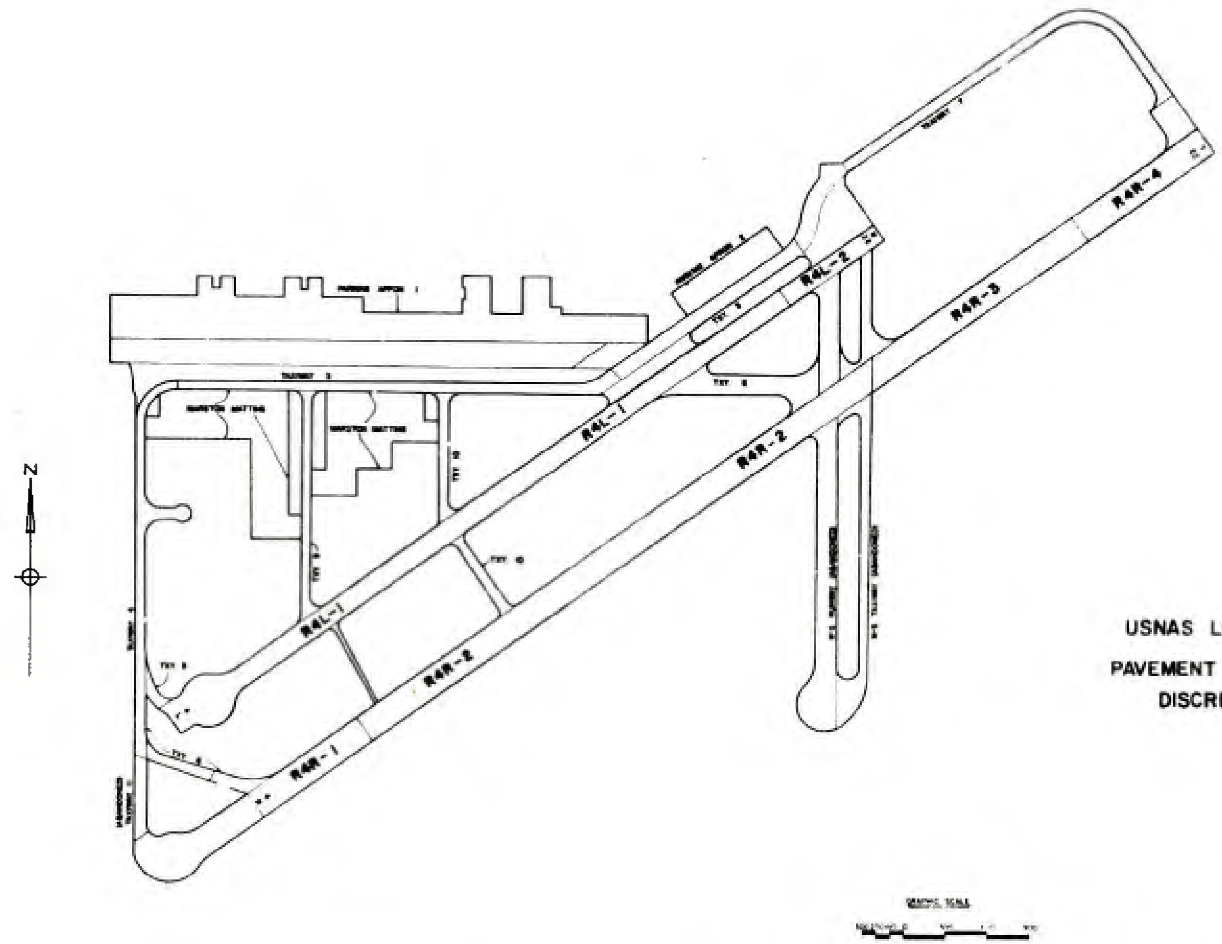
TABLE 5. MU-METER AIRCRAFT PAVEMENT RATING

Mu	Expected Aircraft Braking Response	Hydroplaning Potential
Greater than 0.50	Good	No hydroplaning problems are expected
0.42-0.50	Fair	Transitional
0.25-0.41	Marginal	Potential for hydroplaning for some aircraft exists under certain wet conditions
Less than 0.25	Unacceptable	Very high probability for most aircraft to hydroplane

TABLE 6. RUNWAY PAVEMENT SLOPES
USNAS LOS ALAMITOS, CA

	Transverse Slopes				Longitudinal
	Left		℄	Right	Slopes
Location	Percent	Percent	Percent	Percent	Percent
Runway 4R-22L					
0+00	+0.7	+0.6	+0.9	+0.9	+0.1
5+00	+1.2	+1.1	+0.9	+0.9	0.0
10+00	+0.6	+0.6	+0.8	+0.8	+0.1
15+00	+0.8	+0.8	+0.8	+0.8	+0.3
20+00	+1.2	+0.8	+0.7	+1.2	+0.2
25+00	+0.7	+1.1	+0.7	+1.4	+0.1
30+00	+1.0	+1.4	+0.9	+1.2	+0.4
35+00	+0.8	+1.0	+0.8	+0.7	0.0
40+00	+0.9	+0.8	+0.9	+1.2	+0.2
45+00	+0.4	+1.0	+0.3	-0.3	+0.2
50+00	0.0	0.0	+0.4	-0.2	+0.0
55+00	+0.4	+0.6	-0.5	+0.9	+0.3
60+00	+0.3	+0.7	+0.4	+0.0	+0.1
65+00	+0.4	+0.4	+0.4	+0.4	+0.3
70+00	+1.0	+0.8	+1.3	+0.9	+0.7
75+00	+1.3	+1.1	+1.0	+1.1	+0.0
80+00	+0.9	+0.6	+1.0	+1.0	+0.4
Runway 4L-22R					
0+00	-0.6	-0.4	+0.4	+0.2	+0.9
5+00	-0.3	+0.3	0.0	+0.5	-0.1
10+00	+0.2	+0.6	+0.1	0.0	+0.2
15+00	+0.4	+0.3	+0.2	+0.3	+0.4
20+00	+0.1	0.0	+0.2	+0.3	+0.1
25+00	+0.3	+0.2	+0.3	+0.3	0.0
30+00	+0.1	0.0	-0.5	0.0	+0.2
35+00	+0.2	+0.5	-0.1	+0.3	0.0
40+00	+0.2	0.0	-0.2	+0.2	+0.2
45+00	+0.4	+0.3	0.0	+0.3	+0.4
50+00	+0.4	0.0	-0.3	+0.1	+0.3
55+00	+0.5	+0.2	0.0	+0.8	+0.3
60+00	+0.6	+0.2	+0.4	+0.5	-0.3

Figure 1. Aerial view of U.S. Naval Air Station, Los Alamitos, California.



USNAS LOS ALAMITOS, CA
PAVEMENT CONDITION SURVEY
DISCRETE AREAS

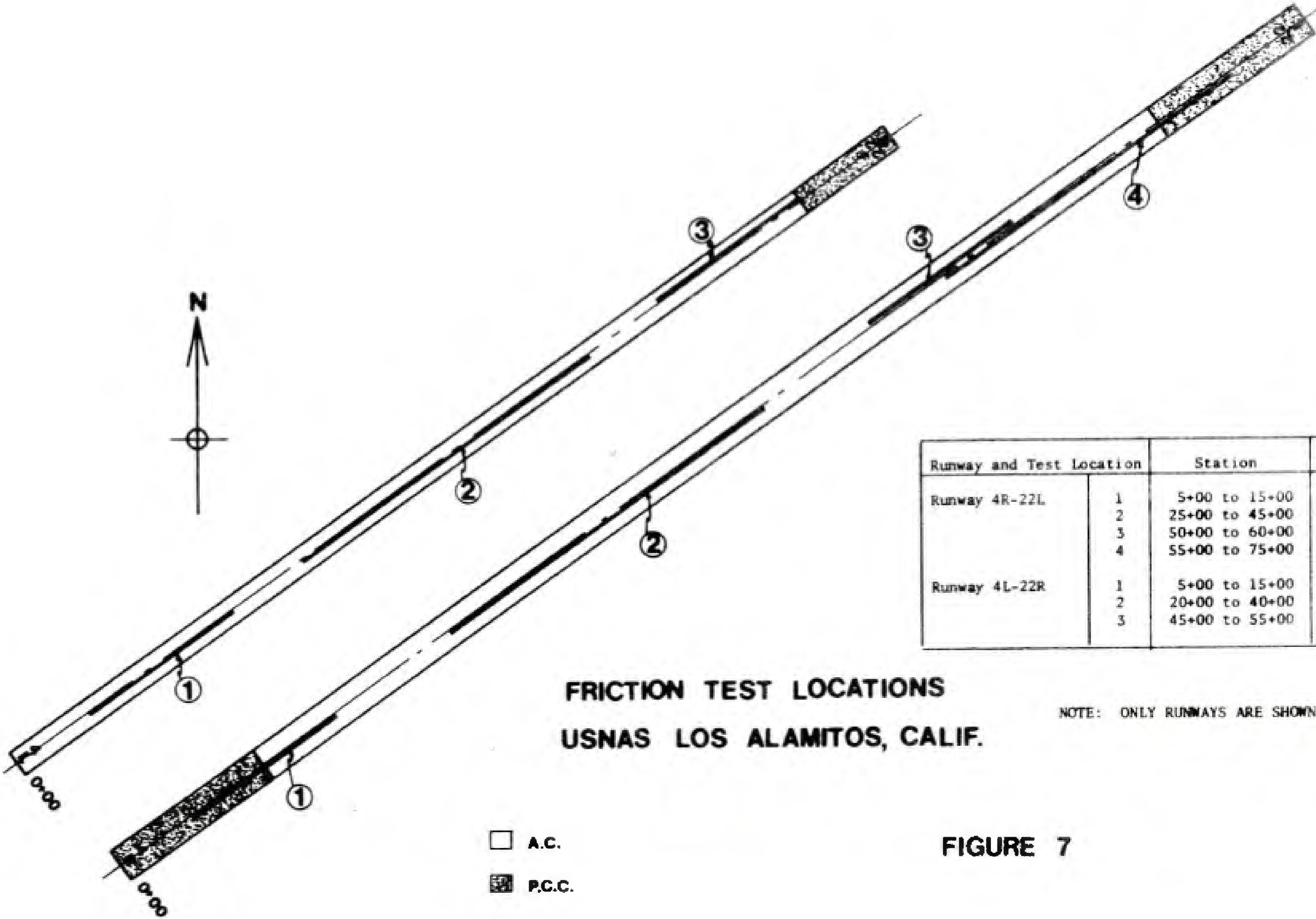
FIGURE 2

Figure 3. Typical partially sealed pattern cracking, Discrete Area R4R-2.

Figure 4. Pattern cracking, Discrete Area R4R-3.

Figure 5. Longitudinal construction joint cracks, Discrete Area R4L-1.

Figure 6. Vegetation in joints, Discrete Area R4R-1.



FRICTION TEST LOCATIONS

USNAS LOS ALAMITOS, CALIF.

Runway and Test Location		Station	Offset From Center Line
Runway 4R-22L	1	5+00 to 15+00	10' right
	2	25+00 to 45+00	10' right
	3	50+00 to 60+00	10' left
	4	55+00 to 75+00	10' right
Runway 4L-22R	1	5+00 to 15+00	10' right
	2	20+00 to 40+00	10' right
	3	45+00 to 55+00	10' left

NOTE: ONLY RUNWAYS ARE SHOWN FOR CLARITY

FIGURE 7

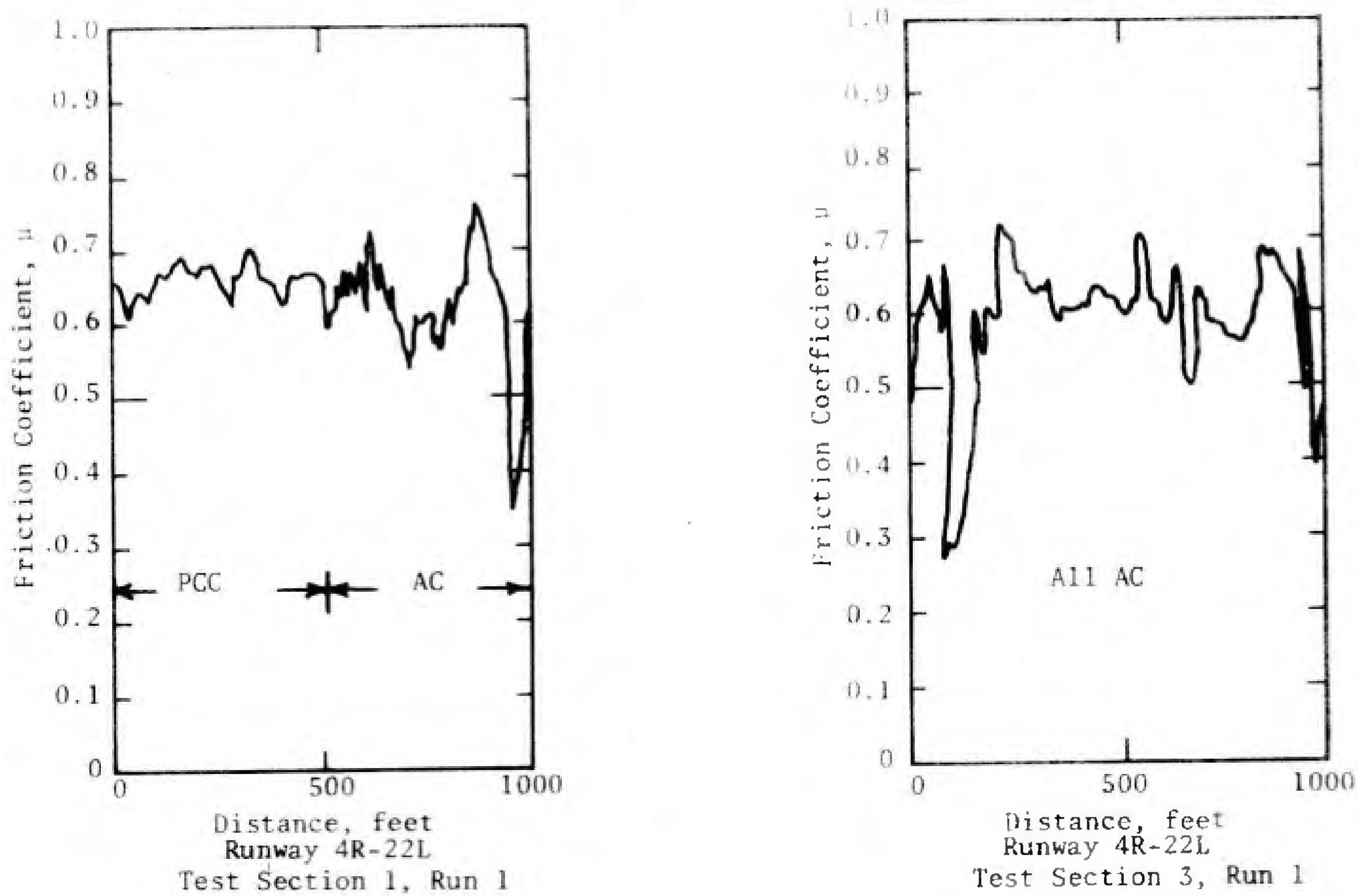


FIGURE 8. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS LOS ALAMITOS, CALIFORNIA

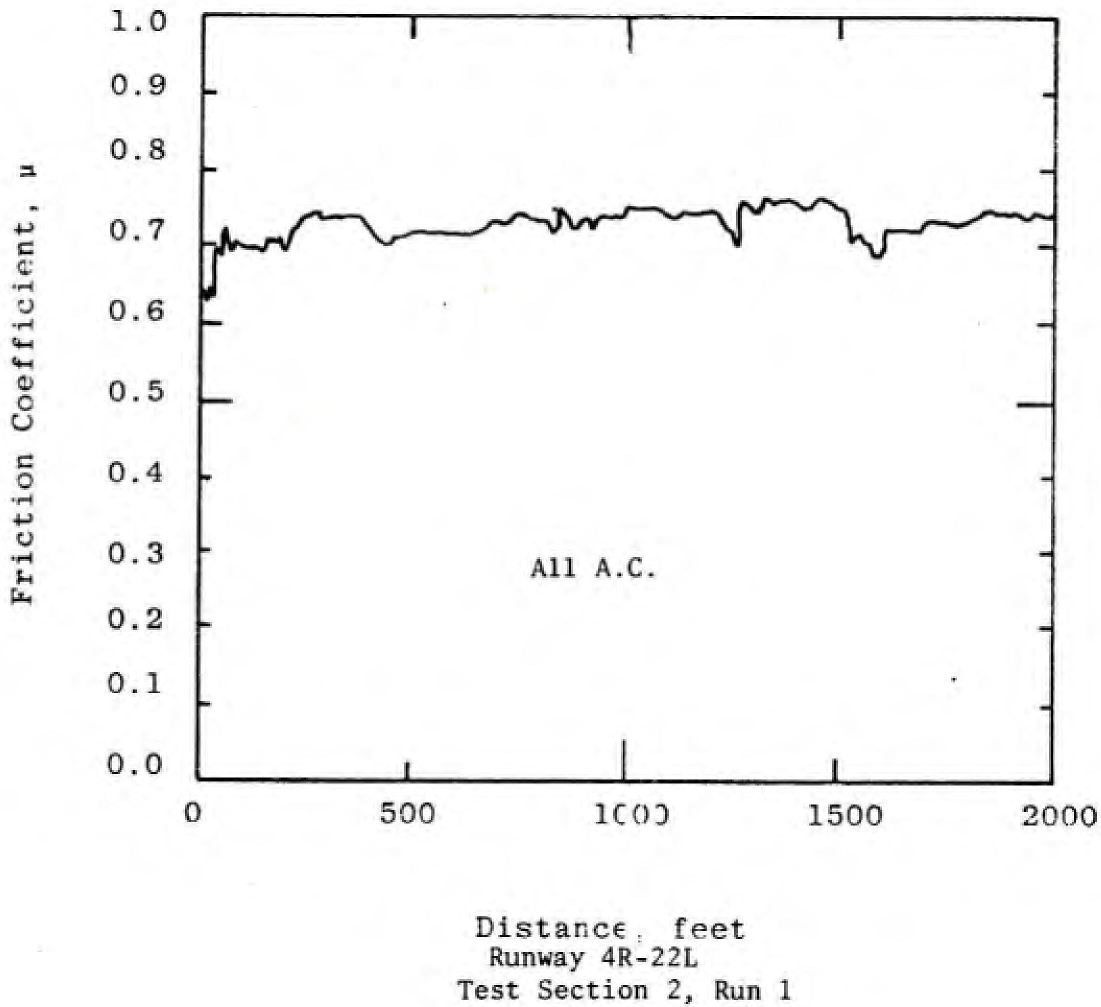
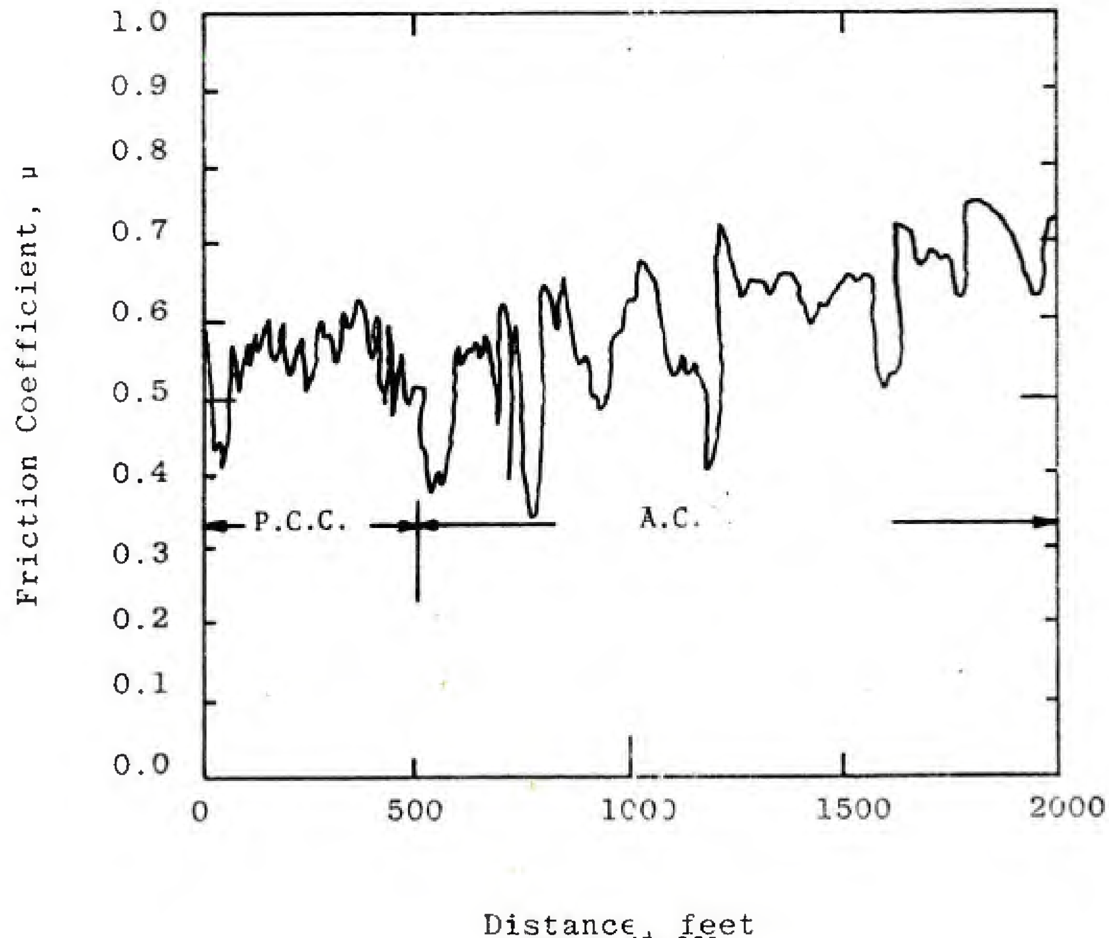
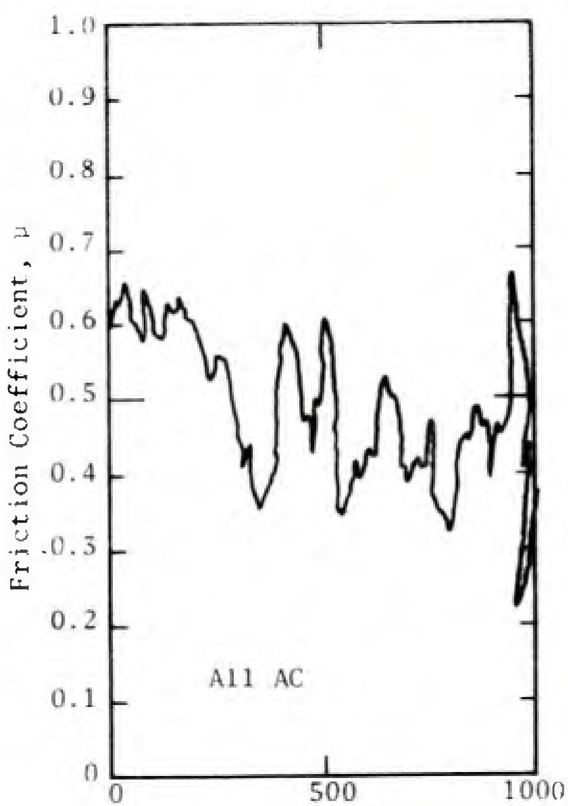


FIGURE 9. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS LOS ALAMITOS, CALIFORNIA

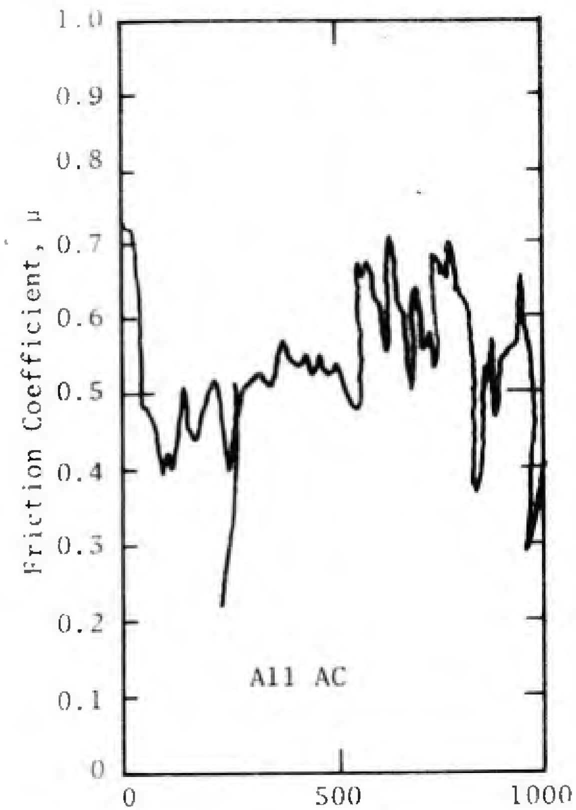


Runway 4R-22L
Test Section 4, Run 1

FIGURE 10. FRICTION COEFFICIENT VERSUS DISTANCE USNAS LOS ALAMITOS, CALIFORNIA



Distance, feet
Runway 4L-22R
Test Section 1, Run 1



Distance, feet
Runway 4L-22R
Test Section 3, Run 1

FIGURE 11. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS LOS ALAMITOS, CALIFORNIA

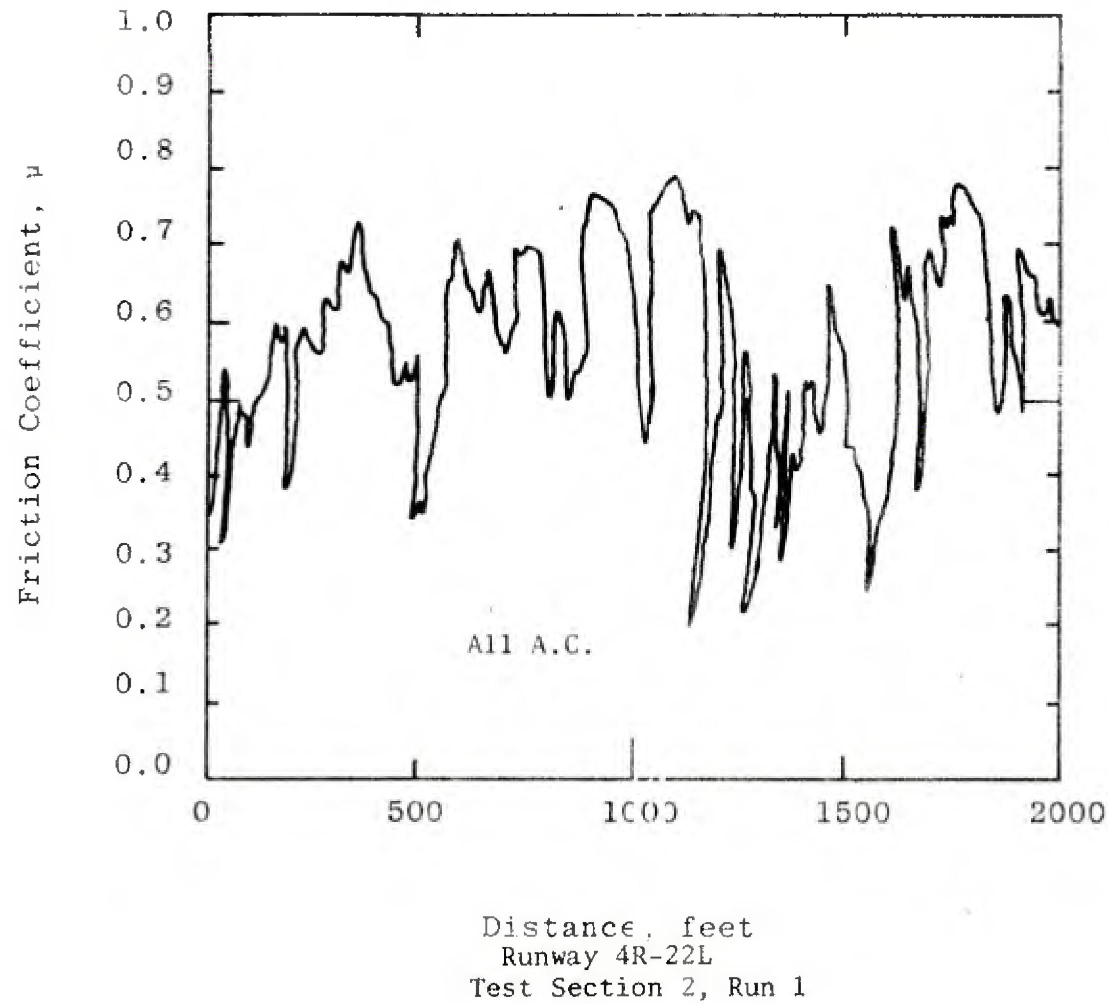
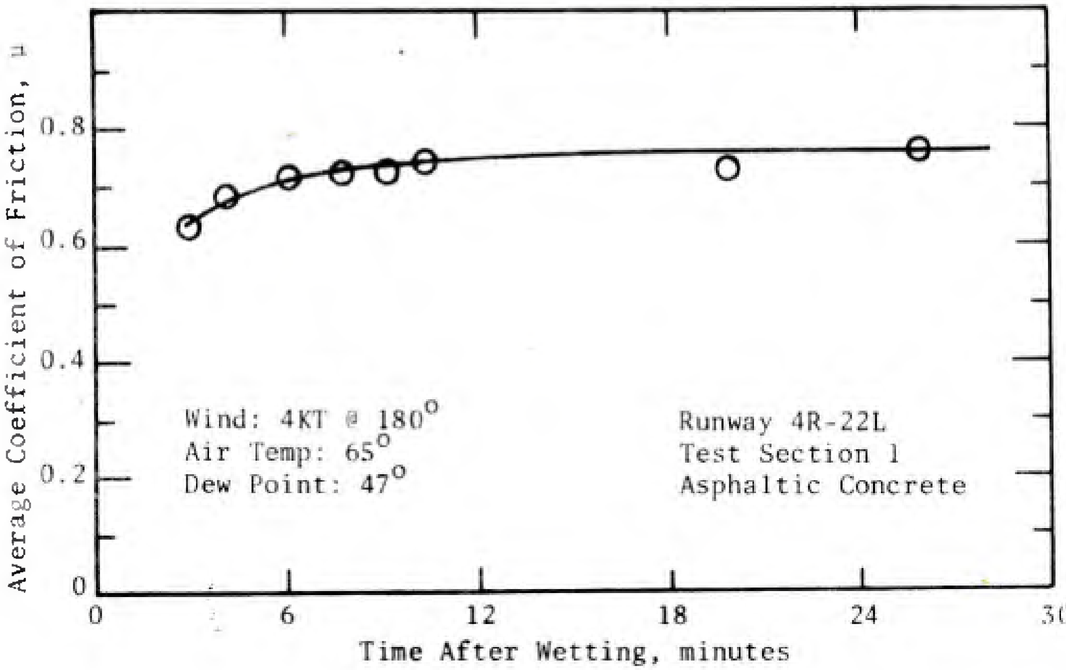


FIGURE 12. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS LOS ALAMITOS, CALIFORNIA



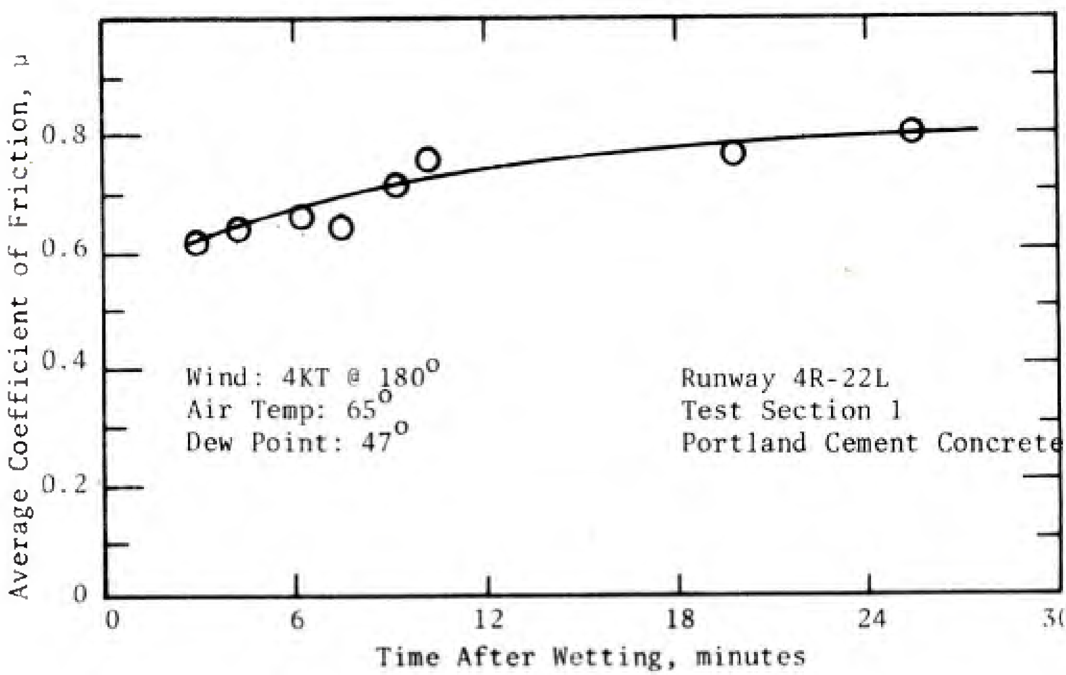
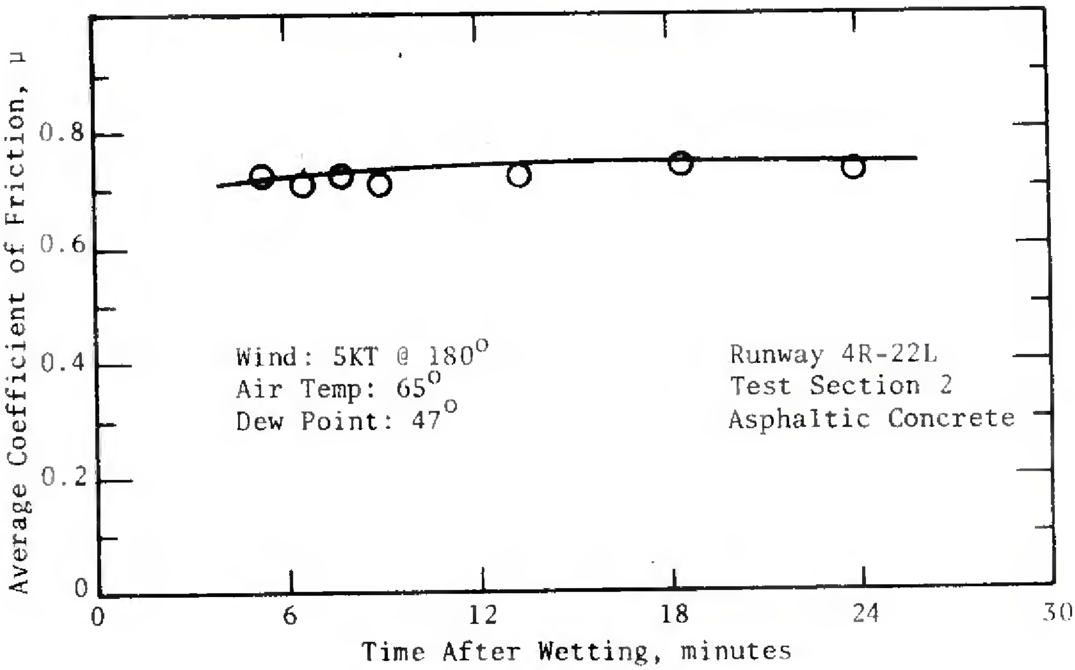


FIGURE 13. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS LOS ALAMITOS, CALIFORNIA



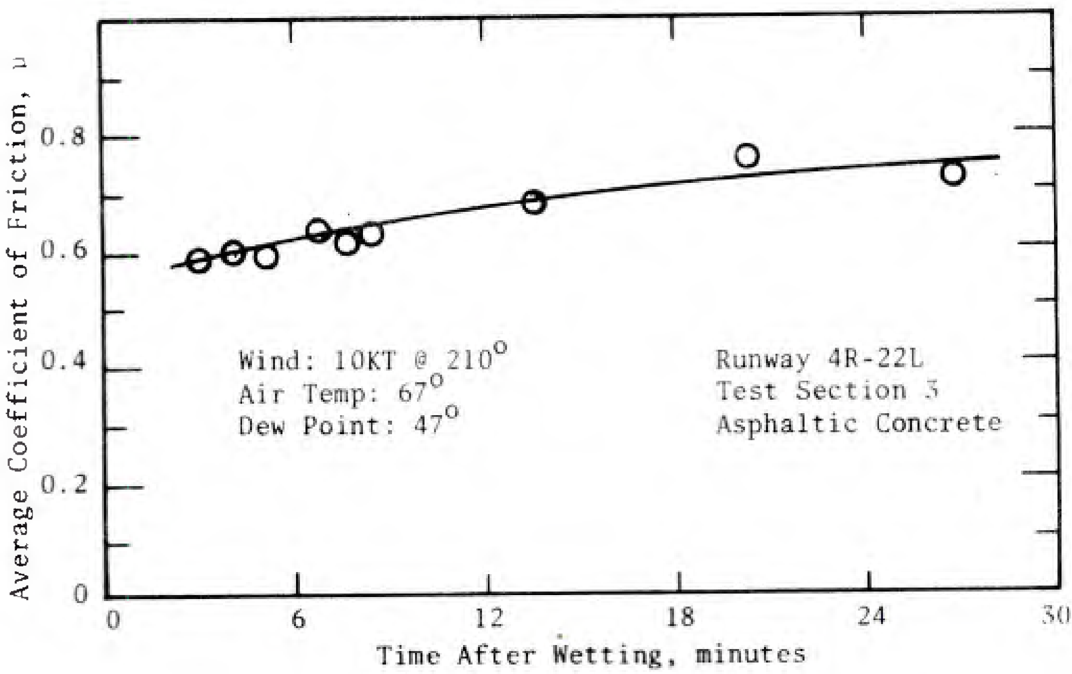
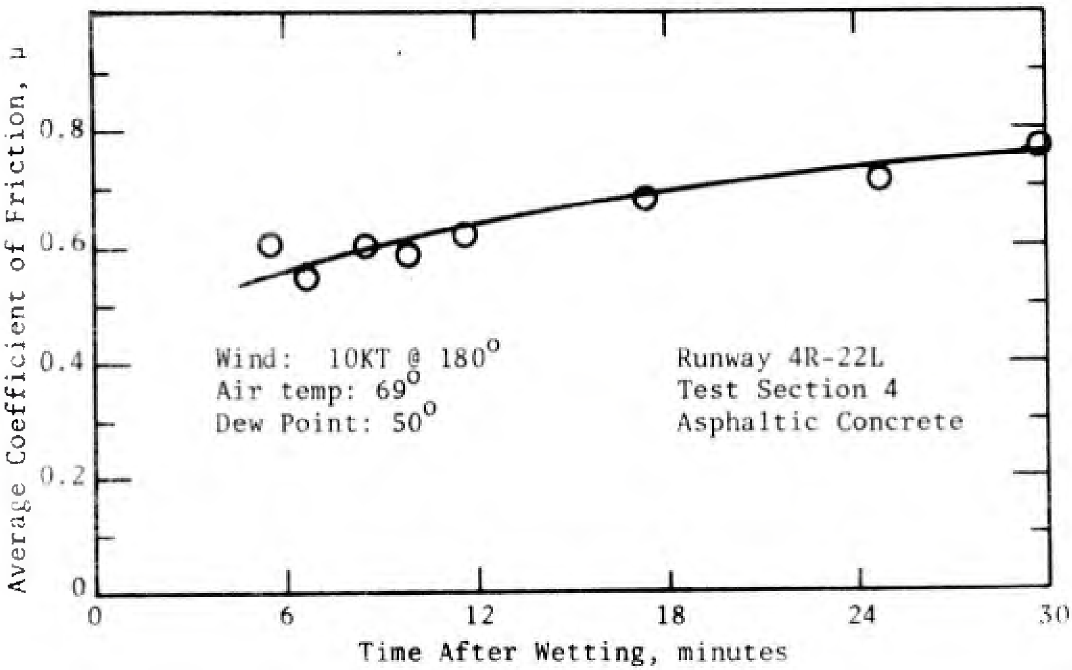


FIGURE 14. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS LOS ALAMITOS, CALIFORNIA



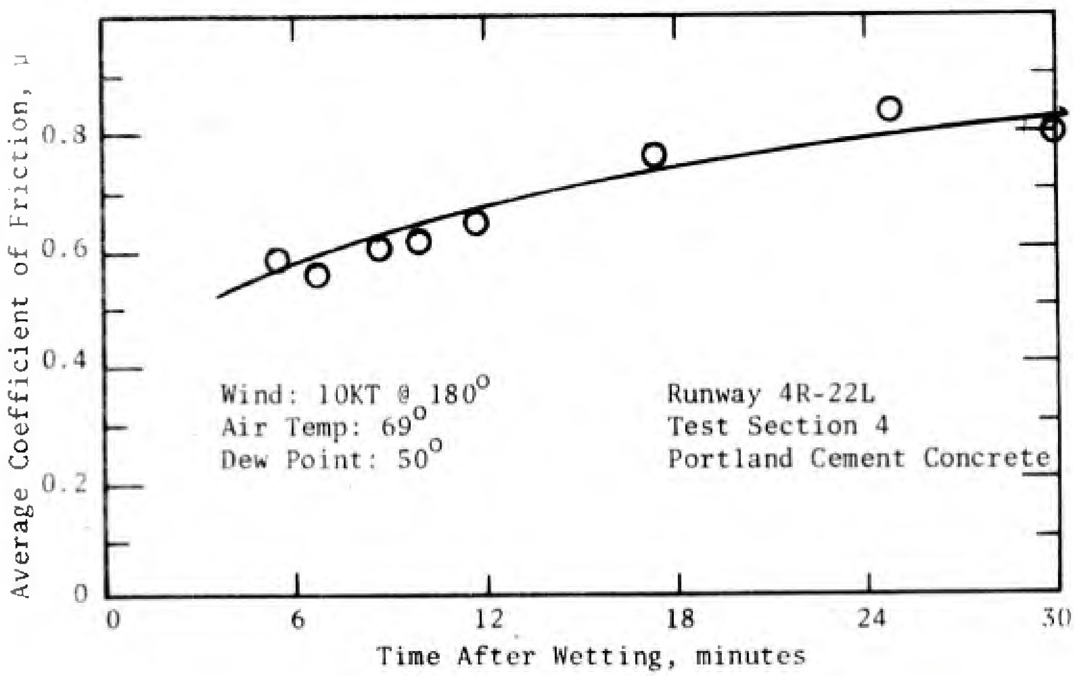
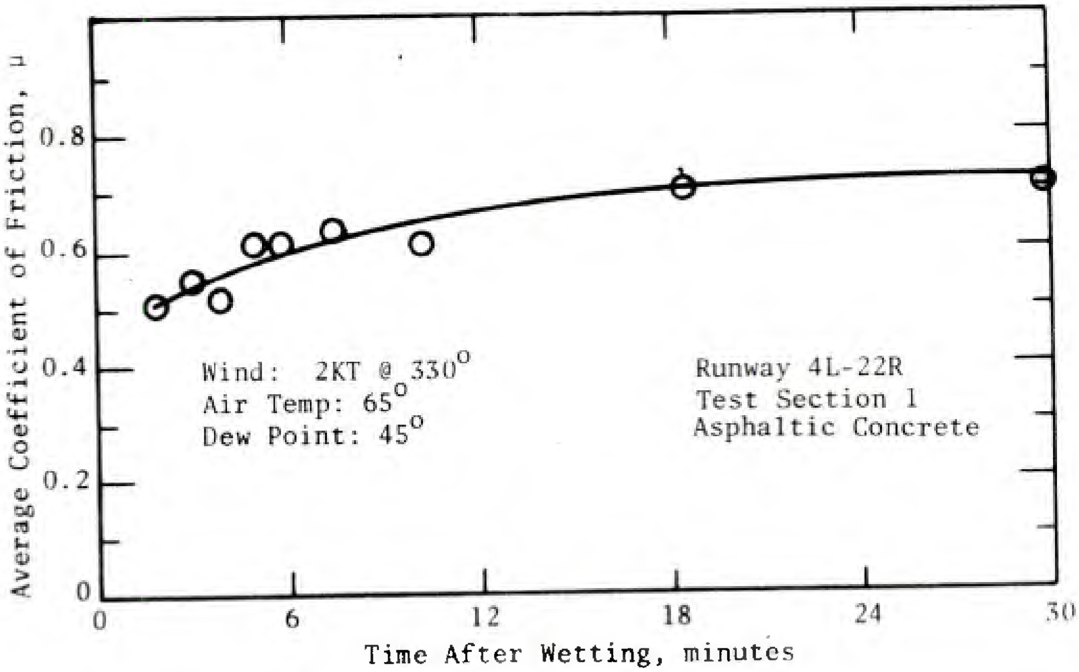


FIGURE 15. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS LOS ALAMITOS, CALIFORNIA



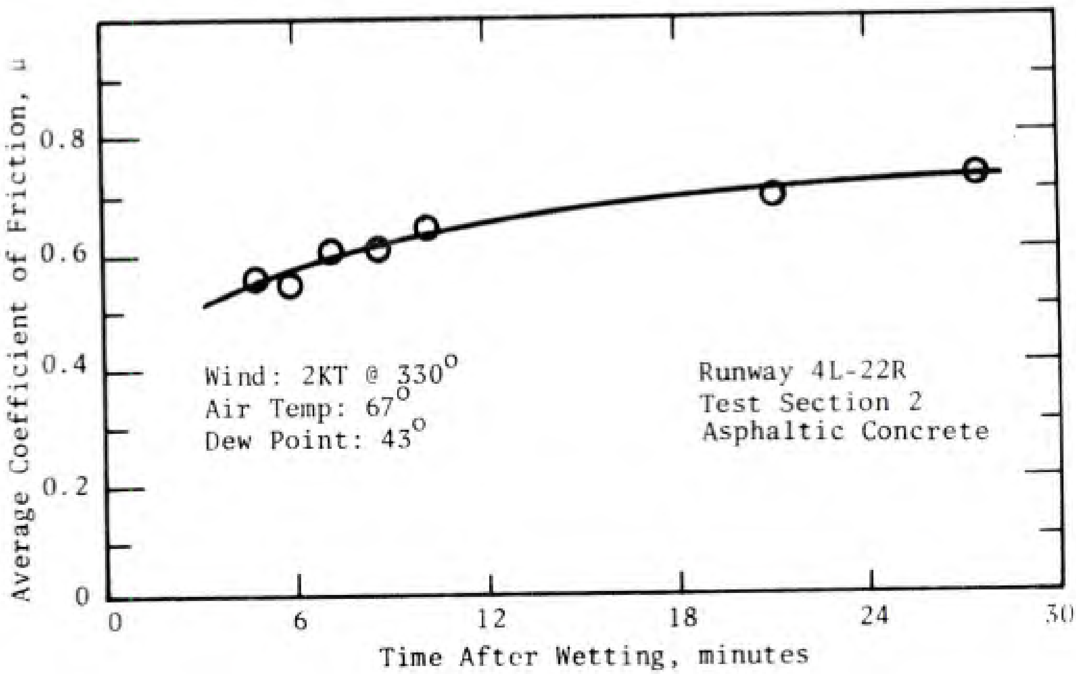


FIGURE 16. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS LOS ALAMITOS, CALIFORNIA

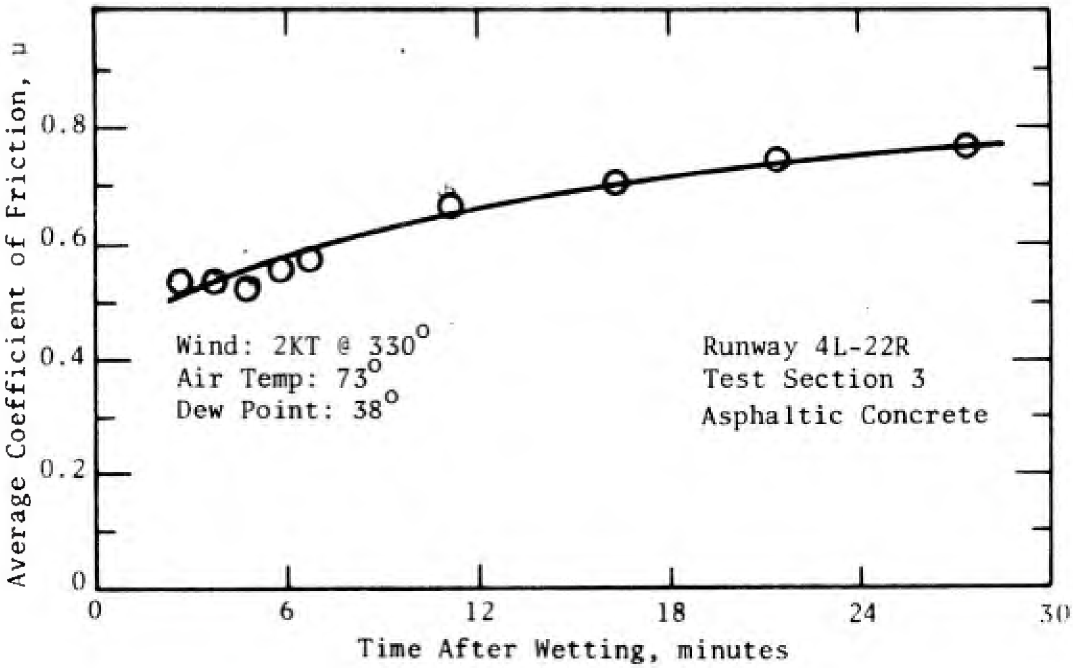


FIGURE 17. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS LOS ALAMITOS, CALIFORNIA

DISCRETE AREA DEFECT SUMMARIES

USNAS LOS ALAMITOS, CA

ASPHALTIC CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos Facility Runway 4R-22L

Discrete Area R4R-2 Area of Discrete Area (a) 414,000 ft^2

No. of Sample Areas (b) 15 Ratio: (a/2500b) 11.04

Defect Type	Length or Area of Sampled Defects	Total Length or Area of All Defects: (c) x Ratio	Defect Density (per 10 sq. ft.) 10 d/a	Defect Severity Weight	Weighted Defect Density: (e) x (f)
	(c)	(d)	(e)	(f)	(g)
T.C., L.C. or LCJ*	3400 ft	37536 sq ft	0.907	3.0	2.720
Reflection Crack					
Faulting					
Patching					
Settlement or Depression					
Pattern Cracking	7550 sq ft	83352 sq ft	2.013	3.0	6.040
Rutting					
Raveling	208 sq ft	2296 sq ft	0.055	7.0	0.388
Erosion—Jet Blast					
Oil Spillage					
Broken-up Area					
				Total	9.15A**

Remarks on Pavement Condition

Surface is completely devoid of bitumen. Surface texture is rough, caused by loss of fines. See Figure 3.

* Transverse crack, longitudinal crack or longitudinal construction joint crack.
** Letter suffix "A" indicates asphaltic pavement.

ASPHALTIC CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos Facility Runway 4R-22L

Discrete Area R4R-3 Area of Discrete Area (a) 184600 ft^2

No. of Sample Areas (b) 15 Ratio: (a/2500b) 4.92

Defect Type	Length or Area of Sampled Defects	Total Length or Area of All Defects (c) x Ratio	Defect Density (per 10 sq. ft.) 10 d/a	Defect Severity Weight	Weighted Defect Density: (e) x (f)
	(c)	(d)	(e)	(f)	(g)
T.C., L.C. or LCJ*	845 ft	4157 ft	0.225	3.0	0.676
Reflection Crack					
Faulting					
Patching	300 sq ft	1476 sq ft	0.080	3.5	0.280
Settlement or Depression					
Pattern Cracking	950 sq ft	4764 sq ft	0.253	3.0	0.759
Rutting					
Raveling	2 sq ft	10 sw ft	0.0005	7.0	0.004
Erosion—Jet Blast					
Oil Spillage					
Broken-up Area					
				Total	1.72A**

Remarks on Pavement Condition

Surface is completely devoid of bitumen. Surface texture is rough, caused by loss of fines. See Figure 4.

* Transverse crack, longitudinal crack or longitudinal construction joint crack.

** Letter suffix "A" indicates asphaltic pavement.

ASPHALTIC CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos Facility Runway 4L-22R

Discrete Area R4L-1 Area of Discrete Area (a) 525,800 ft^2

No. of Sample Areas (b) 15 Ratio: (a/2500b) 14.02

Defect Type	Length or Area of Sampled Defects	Total Length or Area of All Defects: (c) x Ratio	Defect Density (per 10 sq. ft.) 10 d/a	Defect Severity Weight	Weighted Defect Density: (e) x (f)
	(c)	(d)	(e)	(f)	(g)
T.C., L.C. or LCJ*	1430 ft	20048 ft	.3813	3.0	1.144
Reflection Crack					
Faulting					
Patching					
Settlement or Depression					
Pattern Cracking	26480 sq ft	371250 sq ft	7.061	3.0	21.182
Rutting	3 sq ft	42 sq ft	.0008	7.0	0.006
Raveling					
Erosion—Jet Blast					
Oil Spillage					
Broken-up Area					
				Total	22.33A**

Remarks on Pavement Condition

Surface aggregate lacks bitumen coating. Fines have been eroded from pavement surface. See Figure 5.

* Transverse crack, longitudinal crack or longitudinal construction joint crack.

** Letter suffix "A" indicates asphaltic pavement.

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos   Facility Runway 4R-22L

Discrete Area R4R-1   Total Slabs in Discrete Area (a) 536

No. of Slabs Sampled (b) 134   Ratio a/b = 4

Defect Type	No. of Sample Slabs w/Defect	Total Slabs w/Defect: c x a/b	Defect Density (per slab) d/a	Defect Severity Weight	Weighted Defect Density e x f
	(c)	(d)	(e)	(f)	(g)
Faulting					
Corner Break					
L.C. or T.C.*					
I.C.**					
Depression					
Spalling					
Scaling					
Shattered Slab					
Joint Seal	42	168	0.3134	3.0	0.94
Pumping					
"D-line" cracking					
				Total	0.94C***

Remarks on Pavement Condition

Joint seal defects consisted of small amounts of vegetation growing through joints. See Figure 6.

* Longitudinal crack or Transverse crack
** Intersecting crack
*** Letter suffix "C" represents PCC pavement

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos Facility Runway 4R-22L

Discrete Area R4R-4 Total Slabs in Discrete Area (a) 536

No. of Slabs Sampled (b) 134 Ratio a/b = 4 0

Defect Type	No. of Sample Slabs w/Defect	Total Slabs w/Defect: c x a/b	Defect Density (per slab) d/a	Defect Severity Weight	Weighted Defect Density e x f
	(c)	(d)	(e)	(f)	(g)
Faulting					
Corner Break					
L.C. or T.C.*					
I.C.**					
Depression					
Spalling					
Scaling					
Shattered Slab					
Joint Seal					
Pumping					
"D-line" cracking					
				Total	0.00C***

Remarks on Pavement Condition

No defects were observed.

* Longitudinal crack or Transverse crack
** Intersecting crack
*** Letter suffix "C" represents PCC pavement

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Los Alamitos Facility Runway 4L-22R

Discrete Area R4L-2 Total Slabs in Discrete Area (a) 340

No. of Slabs Sampled (b) 85 Ratio a/b = 4

Defect Type	No. of Sample Slabs w/Defect	Total Slabs w/Defect: c x a/b	Defect Density (per slab) d/a	Defect Severity Weight	Weighted Defect Density e x f
	(c)	(d)	(e)	(f)	(g)
Faulting					
Corner Break					
L.C. or T.C.*					
I.C.**					
Depression					
Spalling	8	32	.0941	7.5	0.71
Scaling					
Shattered Slab					
Joint Seal	4	16	.0470	3.0	0.14
Pumping					
"D-line" cracking					
				Total	0.85C***

Remarks on Pavement Condition

Spalls noted were generally small, 1" by 2" to 6" average size. Joint seal defects called were of sections of missing seal. Most seal had embedded gravel particles which were not called defects in this survey.

* Longitudinal crack or Transverse crack
** Intersecting crack
*** Letter suffix "C" represents PCC pavement

FACILITY DEFECT SUMMARIES

USNAS LOS ALAMITOS, CA

ASPHALTIC CONCRETE FACILITY DEFECT SUMMARY

Airfield USNAS Los Alamitos

Date Surveyed March 1976

Facility (or portion)	Weighted Defect Density Total	Ratio: Discrete Area / Total Facility Area*	Average Weighted Defect Density (a) x (b)
	(a)**	(b)	(c)**
Runway 4L-22R			
R4L-1	22.33A	1.00	22.33A Total
Runway 4R-22L			
R4R-2	9.15A	0.69	6.31
R4R-3	1.72A	0.31	0.53
			6.84A Total

* If facility entirely constructed of AC, indicates total facility area. If facility only partly constructed of AC, indicates total area of AC portion of facility.

** Letter suffix "A" on weighted defect densities indicates asphaltic concrete pavements.

PORTLAND CEMENT CONCRETE FACILITY DEFECT SUMMARY

Airfield USNAS Los Alamitos

Date Surveyed March 1976

Facility (or portion)	Weighted Defect Density Total	Ratio: Discrete Area / Total Facility Area*	Average Weighted Defect Density (a) x (b)
	(a)**	(b)	(c)**
Runway 4L-22R			
R4L-2	0.85C	1.00	0.85C Total
Runway 4R-22L			
R4R-1	0.94C	0.50	0.47C
R4R-4	0.00	0.50	0.00
			0.47C Total

* If facility entirely constructed of PCC, indicates total facility area. If facility only partly constructed of PCC, indicates total area of PCC portion of facility.

** Letter suffix "C" on weighted defect densities indicates Portland cement concrete pavements.

APPENDIX A

CONSTRUCTION HISTORY FOR USNAS LOS ALAMITOS, CA

APPENDIX A

CONSTRUCTION HISTORY FOR USNAS LOS ALAMITOS, CA

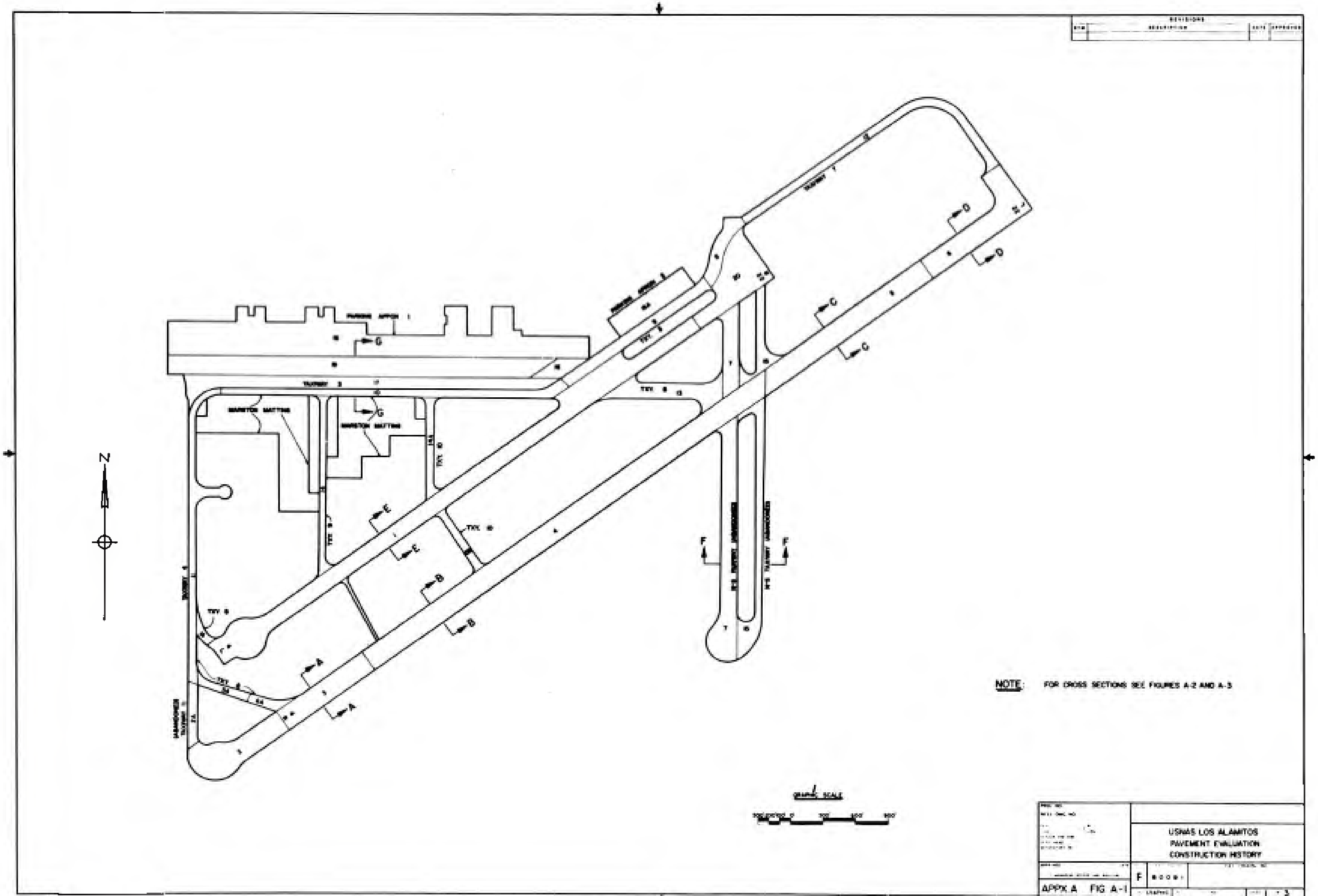
Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened
1	Runway 4L-22R		
	3½" Asphaltic concrete overlay		1950
	Seal coat		1947
	2½" Asphaltic concrete	1942	
	10" Base	1942	
2	Runway 4R-22L		
	2½" Asphaltic concrete	1944	
	8" Base	1944	
3	Runway 4R-22L		
	8" Portland cement concrete		1951
	2½" Asphaltic concrete	1944	
	4" Base	1944	
	12" Subbase	1944	
4	Runway 4R-22L		
	3" Asphaltic concrete		1951
	5" Bituminous black base		1951
	2½" Asphaltic concrete	1944	
	4" Base	1944	
	12" Subbase	1944	
	Shoulders (75')		
	Seal coat	1955	
	2" Asphaltic concrete	1955	
	Prime coat	1955	
	Penetration treatment		1951
	8" Subbase		1951
	Compacted native	1944	
5	Runway 4R-22L		
	3" Asphaltic concrete	1951	
	9" Crusher run base	1951	
	15" Subbase	1951	
	Shoulders (50')		
	Seal coat		1955
	2" Asphaltic concrete		1955
	Prime coat		1955
	Penetration treatment	1951	
	8" Subbase	1951	

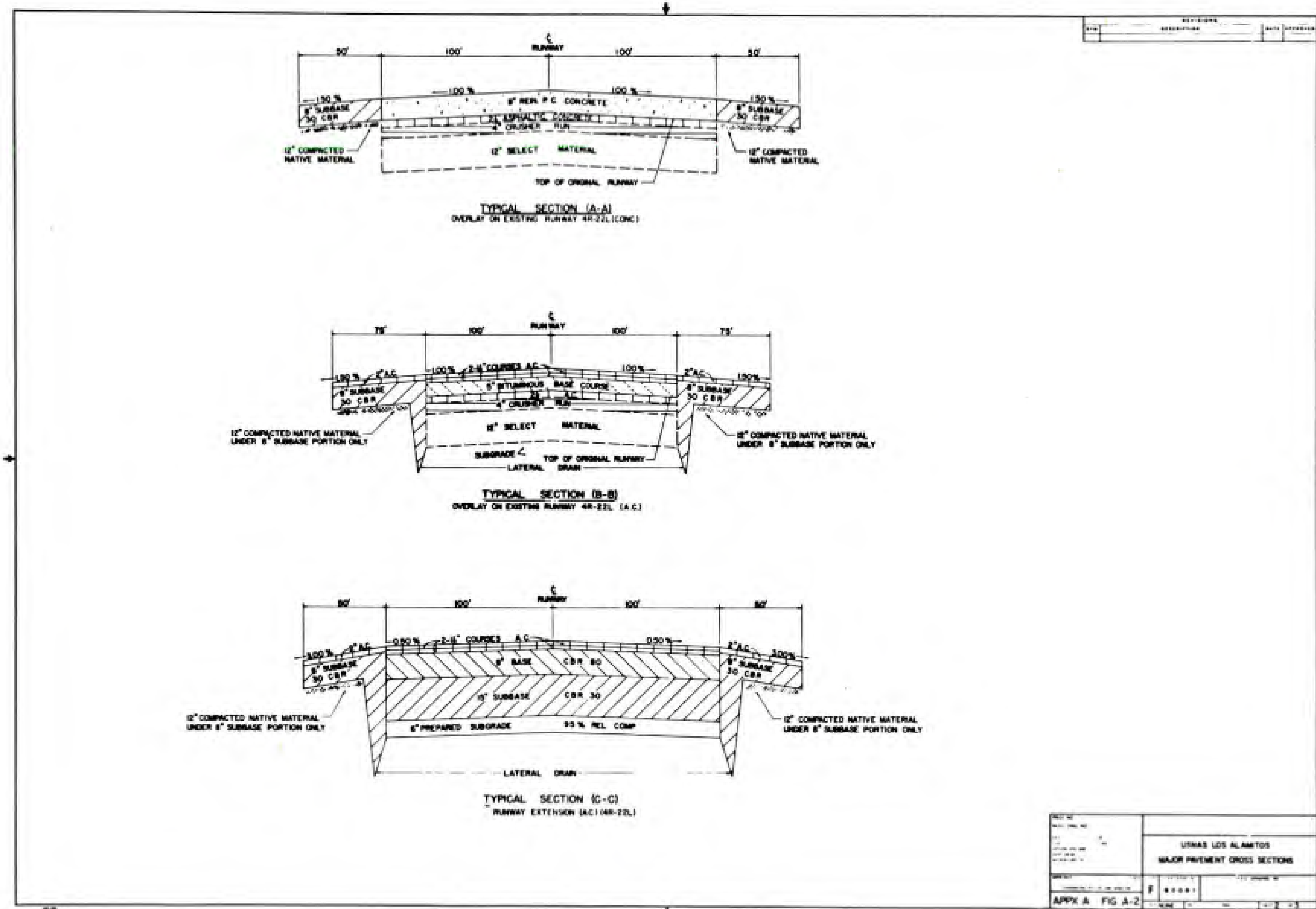
Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened
6	Runway 4R-22L		
	10" Portland cement concrete	1951	
	12" Subbase	1951	
	6" Compacted subgrade	1951	
	Shoulders (50')		
	Seal coat		1955
	2" Asphaltic concrete		1955
	Prime coat		1955
	Penetration treatment	1951	
	8" Subbase	1951	
7	Runway 16-34 (abandoned)		
	Seal coat		1947
	2½" Asphaltic concrete	1941	
	7" Base	1941	
	9" Compacted subbase	1941	
	Shoulder		
	2" Road mix	1941	
8	Taxiway 3		
	3" Asphaltic concrete	1958	
	5" Base	1958	
9	Taxiway 3		
	4" Asphaltic concrete	1964	
	8" Granular base	1964	
	18" Subbase	1964	
	18" Subgrade	1964	
10	Taxiway 3		
	10" Portland cement concrete	1957	
	12" Subbase	1957	
	6" Native material compacted to 90 percent	1957	
11a	Taxiway 3		
	Seal coat		1955
	3" Asphaltic concrete		1955
	9" Base		1955
	2½" Asphaltic concrete	1942	
	8" Base	1942	

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened
11a	Shoulders (10')		
(Con't)	Penetration treatment	1955	
	6" Base	1955	
11	Taxiway 4		
	Seal coat		1955
	3" Asphaltic concrete		1955
	9" Base		1955
	2½" Asphaltic concrete	1942	
	8" Base	1942	
	Shoulders (10')		
	Penetration treatment	1955	
	6" Base	1955	
1a	Taxiway 5 (145')		
	Seal coat		1955
	3" Asphaltic concrete		1955
	9" Base		1955
	2½" Asphaltic concrete	1942	
	8" Base	1942	
	Taxiway 5 (148')		
	3½" Asphaltic concrete overlay		1950
	Seal coat		1947
	2½" Asphaltic concrete	1942	
	10" Base	1942	
5a	Taxiway 6		
	3" Asphaltic concrete	1951	
	9" Crusher run base	1951	
	15" Subbase	1951	
6a	Taxiway 6		
	10" Portland cement concrete	1951	
	12" Subbase	1951	
	6" Compacted subgrade	1951	
12	Taxiway 7		
	3" Asphaltic concrete	1951	
	9" Crusher run base	1951	
	15" Subbase	1951	

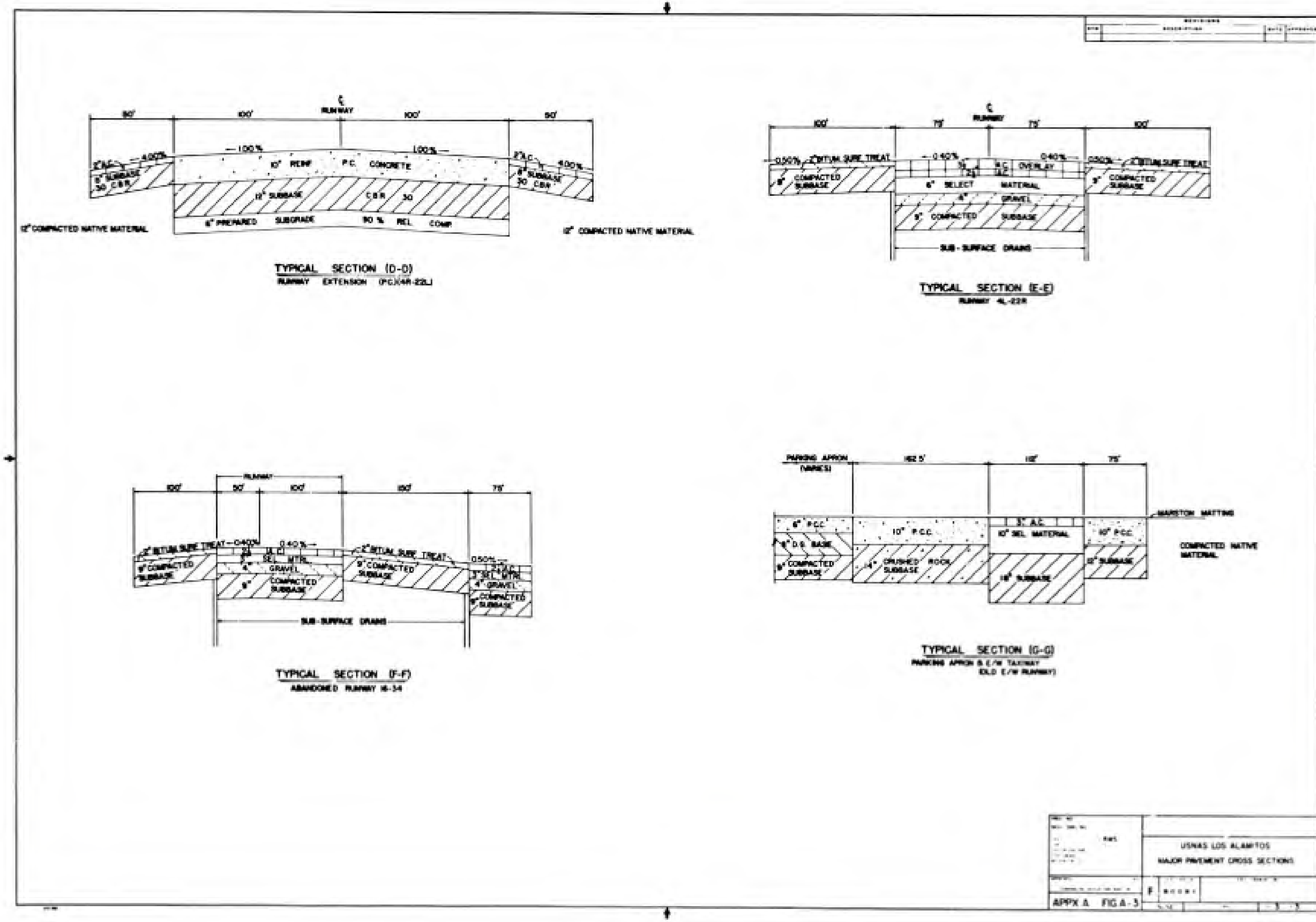
Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened
12 (Con't)	Shoulders (20')		
	4" Road mix	1951	
	4" Subbase	1951	
13	Taxiway 8		
	Seal coat		1947
	2½" Asphaltic concrete	1941	
	3" Base	1941	
	4" Crushed rock	1941	
	Shoulder		
	2" Road mix	1941	
14	Taxiway 9		
	Seal coat		1947
	2½" Asphaltic concrete	1944	
	4" Base	1944	
	12" Subbase	1944	
	Shoulders (25')		
	Compacted native	1944	
14a	Taxiway 10 (south of runway)		
	Seal coat		1947
	2½" Asphaltic concrete	1944	
	4" Base	1944	
	12" Subbase	1944	
	Shoulders (25')		
	Compacted native	1944	
5b	Taxiway 10 (north of runway)		
	3" Asphaltic concrete	1951	
	9" Crusher run base	1951	
	15" Subbase	1951	
2a	Taxiway 11 (abandoned taxiway west end of Runway 4R-22L)		
	2½" Asphaltic concrete	1944	
	8" Base	1944	

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened
15	North-South Taxiway (abandoned)		
	Seal coat		1947
	2½" Asphaltic concrete	1942	
	7" Base	1942	
	9" Compacted subbase	1942	
	Shoulder (inboard)		
	2" Road mix	1942	
16	Parking Apron 1		
	Joints resealed		1948
	6" Portland cement concrete	1944	
	6" Crusher run base	1944	
17	Parking Apron 1		
	2½" Asphaltic concrete	1942	
	4" Crusher run base	1942	
	6" Select material	1942	
18	Parking Apron 1		
	2½" Asphaltic concrete	1942	
	26" Crusher run base	1942	
19	Parking Apron 1		
	10" Portland cement concrete	1959	
	14" Subbase	1959	
16a	Parking Apron 2		
	Joints resealed		1948
	6" Portland cement concrete	1944	
	6" Crusher run base	1944	
20	Warm-Up Pad A		
	10" Portland cement concrete	1957	
	12" Subbase	1957	
	6" Native material compacted to 90 percent	1957	


NOTE: FOR CROSS SECTIONS SEE FIGURES A-2 AND A-3
GRAPHIC SCALE
USNAS LOS ALAMITOS
PAVEMENT EVALUATION
CONSTRUCTION HISTORY
APPX A FIG A-1
PARKING APRON 1
TAXIWAY 3
MARSTON MATTING
TXY 10
TXY 9
TAXIWAY 4
TAXIWAY 7
PARKING APRON 2
HARMONIZED TAXIWAY



TYPICAL SECTION (A-A)
OVERLAY ON EXISTING RUNWAY 4R-22L (CONC)
RUNWAY
50'
100'
100'
50'
100 %
150 %
8" REIN. P.C. CONCRETE
2" ASPHALTIC CONCRETE
4" CRUSHER RUN
8" SUBBASE 30 CBR
12" SELECT MATERIAL
12" COMPACTED NATIVE MATERIAL
TOP OF ORIGINAL RUNWAY
TYPICAL SECTION (B-B)
OVERLAY ON EXISTING RUNWAY 4R-22L (A.C.)
75'
100'
100'
75'
100 %
150 %
2" A.C.
2-1/2" COURSES A.C.
5" BITUMINOUS BASE COURSE
4" CRUSHER RUN
8" SUBBASE 30 CBR
12" SELECT MATERIAL
SUBGRADE ℄
TOP OF ORIGINAL RUNWAY
LATERAL DRAIN
12" COMPACTED NATIVE MATERIAL UNDER 8" SUBBASE PORTION ONLY
TYPICAL SECTION (C-C)
RUNWAY EXTENSION (AC) (4R-22L)
50'
100'
100'
50'
0.50 %
3.00 %
2" A.C.
2-1/2" COURSES A.C.
8" BASE CBR 80
13" SUBBASE CBR 30
6" PREPARED SUBGRADE 95 % REL. COMP.
8" SUBBASE 30 CBR
LATERAL DRAIN
12" COMPACTED NATIVE MATERIAL UNDER 8" SUBBASE PORTION ONLY
USNAS LOS ALAMITOS
MAJOR PAVEMENT CROSS SECTIONS
APPX A FIG A-2


TYPICAL SECTION (D-D)
RUNWAY EXTENSION (PCC)(4R-22L)
12" COMPACTED NATIVE MATERIAL
10" REINF P.C. CONCRETE
12" SUBBASE C.B.R. 30
6" PREPARED SUBGRADE 90 % REL COMP
TYPICAL SECTION (E-E)
RUNWAY 4L-22R
SUB - SURFACE DRAINS
TYPICAL SECTION (F-F)
ABANDONED RUNWAY 16-34
SUB - SURFACE DRAINS
TYPICAL SECTION (G-G)
PARKING APRON & E/W TAXIWAY
(OLD E/W RUNWAY)
PARKING APRON
(VARIES)
MARSTON MATTING
COMPACTED NATIVE
MATERIAL
USNAS LOS ALAMITOS
MAJOR PAVEMENT CROSS SECTIONS
APPX A FIG A-3

APPENDIX B

CLIMATOLOGICAL DATA FOR USNAS LOS ALAMITOS, CA

APPENDIX B

CLIMATOLOGICAL DATA FOR
USNAS LOS ALAMITOS, CA

TEMPERATURE DATA
(DEGREES FAHRENHEIT)

Month	Means		Extremes	
	Daily Maximum	Daily Minimum	Record Highest	Record Lowest
January	64.1	41.7	89	26
February	65.0	44.5	93	31
March	65.6	46.2	90	34
April	67.9	49.6	99	36
May	69.8	52.9	99	42
June	72.6	56.7	101	45
July	78.3	60.4	100	48
August	79.7	41.1	102	51
September	79.2	58.7	110	48
October	76.9	54.0	107	40
November	71.5	47.9	100	30
December	66.9	42.9	93	30

Length of Record: 19 years, 1949-1967

Data From: Naval Weather Service Command
Job No. 72002
Local Climatological Data for Selected U.S. Navy and Marine Corps Stations, Asheville, NC June 1968

PRECIPITATION
(Inches)

Month	Mean	Maximum Monthly	Minimum Monthly	Maximum In 24 Hours
January	1.98	5.24	0.16	1.70
February	1.75	7.89	T	2.29
March	1.35	4.74	T	1.83
April	1.12	3.42	T	1.22
May	0.18	1.49	T	1.25
June	0.04	0.33	T	0.31
July	0.01	0.16	0.00	9.16
August	0.03	0.13	0.00	0.12
September	0.14	1.31	0.00	0.79
October	0.14	1.14	0.00	0.37
November	1.32	4.98	0.00	1.70
December	1.27	3.76	T	1.52

Annual Mean = 9.30
T = Trace, An amount too small to measure

WIND

Month	Mean Speed (kts)	Prevailing Direction	Peak Gust		
			Speed	Direction	Year
January	5.2	NE	54	W	1951
February	5.3	SW	42	NE	1964
March	5.6	SW	54	WSW	1952
April	5.4	SW	47	WNW	1951
May	5.6	SW	35	W	1953
June	5.2	SW	32	ENE	1957
July	4.7	SW	25	W	1954
August	4.4	SW	24	SW	1954
September	4.0	SW	26	SW	1966
October	4.1	SW	39	NW	1953
November	4.5	NE	53	ENE	1957
December	4.9	NE	54	ENE	1953

APPENDIX C

CONDITION SURVEY PROCEDURES

Appendix C

CONDITION SURVEY PROCEDURES

Step 1. Preliminary Survey

In the preliminary survey the evaluators make a general and personal inspection of all airfield pavement areas, during which they note the type and distribution of defects in each facility (runway, taxiway, etc.). In addition, a previously-prepared construction history is consulted and areas of different construction and different pavement type (AC or PCC) within a facility are noted. As a result of these efforts, each pavement facility is then divided into "discrete areas" of reasonably similar failure modes for performance of the subsequent sampling and tally or measurement of defects. Thus, if the type and/or number of defects found in one portion of a facility are distinctly different from those found in another portion of that facility, discrete areas are selected on this basis. If, however, the pavement facility contains few defects or if the defects found are similar in type and distribution throughout the facility, each facility is individually divided for survey according to the construction history. Under either criterion, a discrete area may vary, for example, from a 500 foot length of runway or taxiway to the entire length of the facility. All discrete areas are numbered with a system that relates the discrete area to the runway, taxiway, etc., of which it is a part. For example, discrete areas comprising Runway 11-29 are designated R 11-1 and R 11-2, etc.; discrete areas for Taxiway 2 are T 2-1 and T 2-2, etc.

A special survey of singular occurrences of serious defects is made during the preliminary survey. This is necessary because the statistical sampling techniques utilized in the subsequent survey are effective in spotting defects only when such defects are numerous and/or relatively well distributed. This abbreviated special survey provides information on those infrequent defects, if any, which may present a problem to safe aircraft operation.

Step 2. Statistical Sampling and Defect Survey

After discrete areas are selected, a number of small "sample areas" are chosen within each discrete area. The total number of sample areas is determined by statistical theory as a function of the relative size of the discrete area. Actual locations of the sample areas are selected at random from the discrete area.

Sample areas in PCC pavements basically consist of individual slabs, usually 12½ x 15 feet in size. For the convenience of the evaluators, either a single slab or a number of adjacent slabs can be considered as a sample area. Both types of sampling area are shown schematically in Figure C-1. Note from Figure C-1 that individual sample slabs and/or sample strips are selected within the center 100 feet (laterally) of runways and within the center 50 feet (laterally) of taxiways by a random selection process. For parking aprons, mats, etc., similar sample areas are selected at random over the entire pavement area.

For AC pavements, sample areas are fifty-foot-square areas located as shown in Figure C-2. For parking aprons, mats, etc.(not shown in Figure C-2) sample areas are fifty-feet square, as for other traffic areas, and randomly located over the entire pavement area.

All defects or defected slabs in each of the selected sample areas are noted on appropriate data sheets. For PCC pavement slabs or sample strips, either single or multiple occurrences of a given defect type within the slab qualify the slab as a defected slab. For example, one or more spalls qualifies a slab as a spalled slab. A crack in the same slab requires that it be counted again, this time as a cracked slab. No measurement of length, area, etc. is recorded for PCC pavement defects. When a sample slab strip is chosen for test, the above mentioned tally method (slab by slab) is still utilized.

The defects found in AC sample areas are measured and tallied, rather than merely tallied as are those for PCC pavements. Depending on the type of defect, the total length in feet (for cracks, etc.) or total area in square feet (for pattern cracking, raveling, etc.) is recorded.

The above survey of defects found in sample areas (in each discrete area) are shown in column (c) of the Discrete Area Defect Summary sheets, Figures C-3 and C-4. Separate summary sheets are provided for portland cement concrete (PCC) and asphaltic concrete (AC) pavements. Total defect counts for the entire discrete area are calculated by a linear extrapolation of the defect data in column (c), and are shown in column (d) of the Discrete Area Defect Summary sheets. To remove the influence of the size of the discrete area on the total defect count (i.e., the count is divided by either the number of slabs in the discrete area (for PCC pavements) or by the area (in 10-square-foot increments) of the discrete area (for AC pavements). This gives a defect density (per slab or per 10 square feet) which is listed in column (e).

Step 3. Defect Severity Weighting System

A weighting system, providing a numerical weight for each type defect in proportion to the relative severity of that defect, is applied in the following manner to each of the defect counts in the discrete area;

$$\text{given defect density} \times \frac{\text{weight for that}}{\text{type defect}} = \frac{\text{weighted defect}}{\text{density}}$$

This is accomplished in columns (f) and (g) of the Discrete Area Defect Summary sheets. Next, a total weighted defect density is obtained for each discrete area by summing column (g) of these sheets. Note that a letter suffix is added to each total weighted defect density for the purpose of further distinguishing between asphaltic concrete defect densities (suffix "A") and portland cement concrete defect densities (suffix "C").

The defect weighting guide developed by NCEL assigns greater weights to defects that (1) presently affect the safe operation of aircraft or the cost of aircraft operation; (2) will lead to increased airfield pavement maintenance costs; or (3) will result in significant deterioration of load-carrying capacity of the pavements. The resultant numerical weights are further modified to reflect variations in pavement environment from station to station. For example, higher (more severe) weights are assigned to defects which are affected by factors such as freezing weather, heavy rainfall, or blow sand for surveys of airfields located in areas where these undesirable environmental effects occur. Thus, it can be seen that the higher the numerical weighted defect density, the poorer the condition of the surveyed pavement.

Remarks concerning the general pavement condition and the defects identified are given in narrative form on each Discrete Area Summary sheet. In addition, photographs of typical pavement conditions noted during the survey are used to further illustrate typical pavement defects.

Step 4. Facility Summary-- Weighted Defect Densities

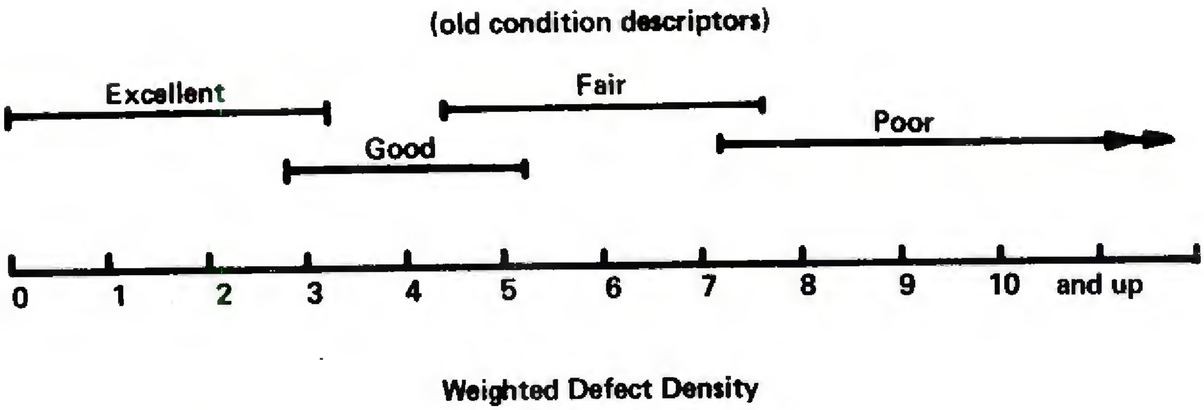
A final step in providing a numerical condition rating for each facility (runway, taxiway, etc.) is accomplished in the Facility Defect Summary sheets, Figures C-5 and C-6. Again note that separate sheets have been provided for AC and PCC pavements. In these sheets the individual weighted defect densities for all discrete areas comprising the entire AC or PCC portion of a facility (runway, taxiway, etc.) are summarized in column (a). When an AC or PCC facility (or portion) has been divided into more than one discrete area for the condition survey, the proportional contribution of each discrete area to the entire AC or PCC facility area is determined in column (b). In column (c) these proportions are applied to the individual discrete area weighted defect densities listed in column (a) and added to obtain an overall average weighted defect density for the entire AC or PCC portion of the facility (marked "total" in column (c)). When an entire AC or PCC facility (or portion) has been designated a single discrete area (as often occurs), the proportionality factor in column (b) is obviously 1.00 and the discrete area weighted defect density from column (a) becomes the average weighted defect density for the entire facility (or portion) in column (c).

GENERAL COMMENTS ON CONDITION SURVEY PROGRAM

The weighted defect densities, listed in column (a) of the Facility Defect Summary for individual discrete pavement areas and in column (c) as averaged weighted defect densities for entire AC or PCC runways, taxiways, etc. (or portions thereof) represent, numerically, the surface condition of the airfield pavements at the station. As previously stated, the larger defect density numbers indicated basically a greater number and/or severity of defects per unit area of pavement, i.e., a poorer pavement. Thus, they represent the final product of the pavement condition survey. It should be noted specifically, however, that AC and PCC pavement defect densities, although often numerically similar, are obtained by two different condition survey techniques and, as such, are <u>not numerically compatible</u> and <u>must not be combined</u>. (It is largely because of this fact that the letter suffixes "A" and "C" have been affixed to defect densities for AC and PCC pavements respectively.) As an example, consider the common case of an AC runway with PCC ends. The condition survey system presented herein provides indivdual discrete are weighted defect densities for discrete areas selected on <u>both</u> AC and PCC pavements, but provides a <u>separate</u> average weighted defect density for the entire AC portion and a <u>separate</u> average weighted defect density for the combined PCC end pavements. It is <u>not</u> possible to combine these defect densities to obtain an average AC/PCC defect density for the entire runway. Thus the defect densities for AC and PCC are reported separately, given different letter suffixes, and should incldue the letter suffix when reference is made to them.

Individual numerical defect densities, however accurately they indicate pavement condition, may mean little to the reader of an individual airfield condition survey report, for he has no basis upon which to judge the relative severity of pavement condition associated with the numbers obtained for his pavements. The primary value of a numerical condition survey program will be the accumulation of uniformly-obtained, comparative condition data for <u>many</u> airfields which can best be correlated, studied, and used in the decision-making processes at headquarters levels.

For the benefit of the individual reader, however, an effort was made during the first year of pavement condition surveys (FY-70) to relate the numerical condition (defect densities) to the basic subjective condition descriptors (excellent, good, fair, poor, etc.) used in all previous Navy pavement evaluation procedures. Although the subjective condition-descriptor approach is poorly regarded as a means of comparing pavement condition from one airfield to another, the following diagram may serve temporarily as a rudimentary bridge between the old subjective system and the new (numerical) condition approach:



The system of numerical defect densities was developed to aid in determining the suitability of airfield pavement surfaces for satisfying aircraft operational requirements and to establish an unbiased, uniform basis for initiating maintenance and repair efforts. As such, defect densities are simply visually-determined indicators of the condition of the pavement and do not represent true "condition ratings" in that they do not include factors relating to pavement strength, traffic usage, etc. It is possible that additional measurements or modifications may be considered necessary or desirable in future condition survey programs.

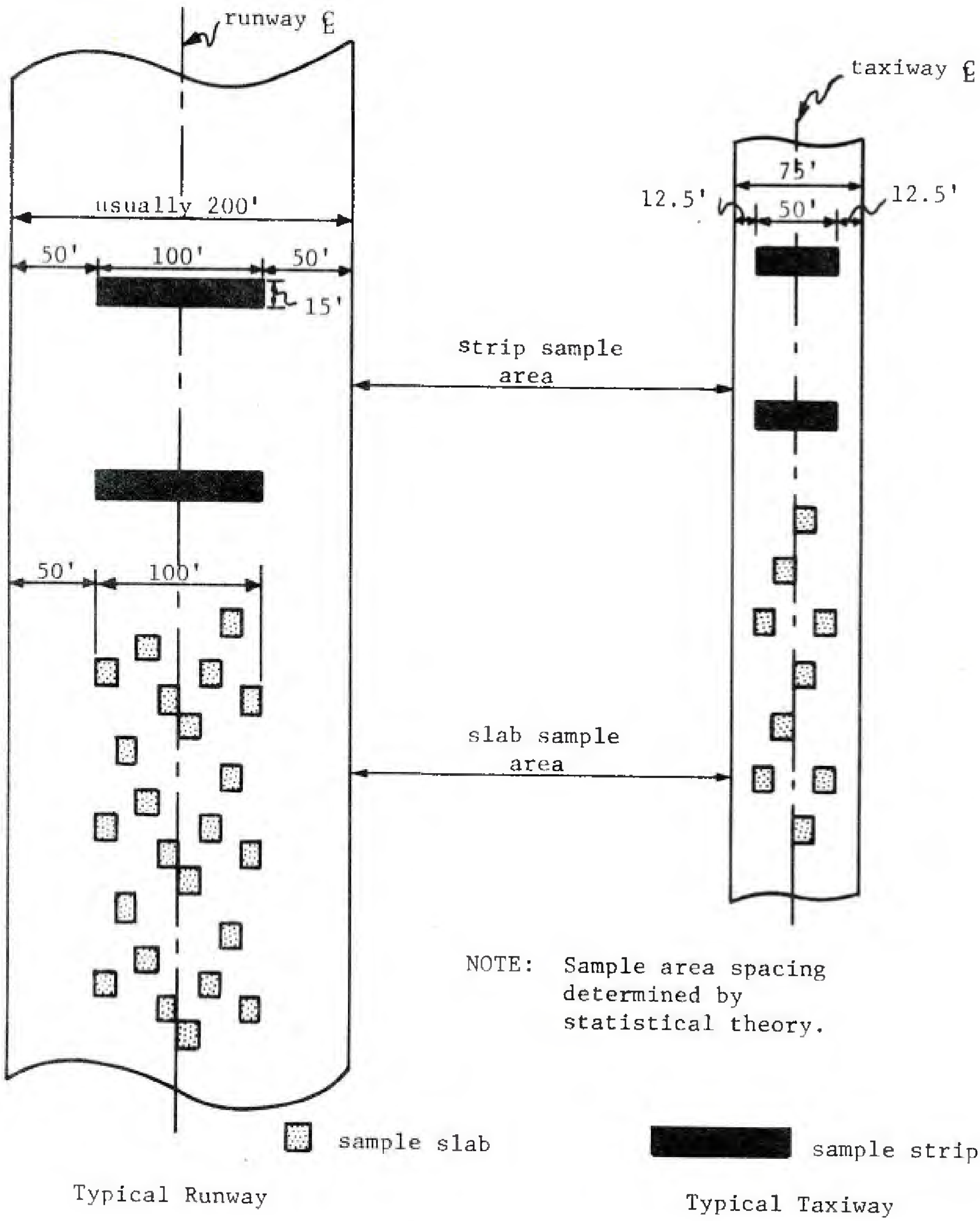


Figure C-1. Portland cement concrete sample areas.

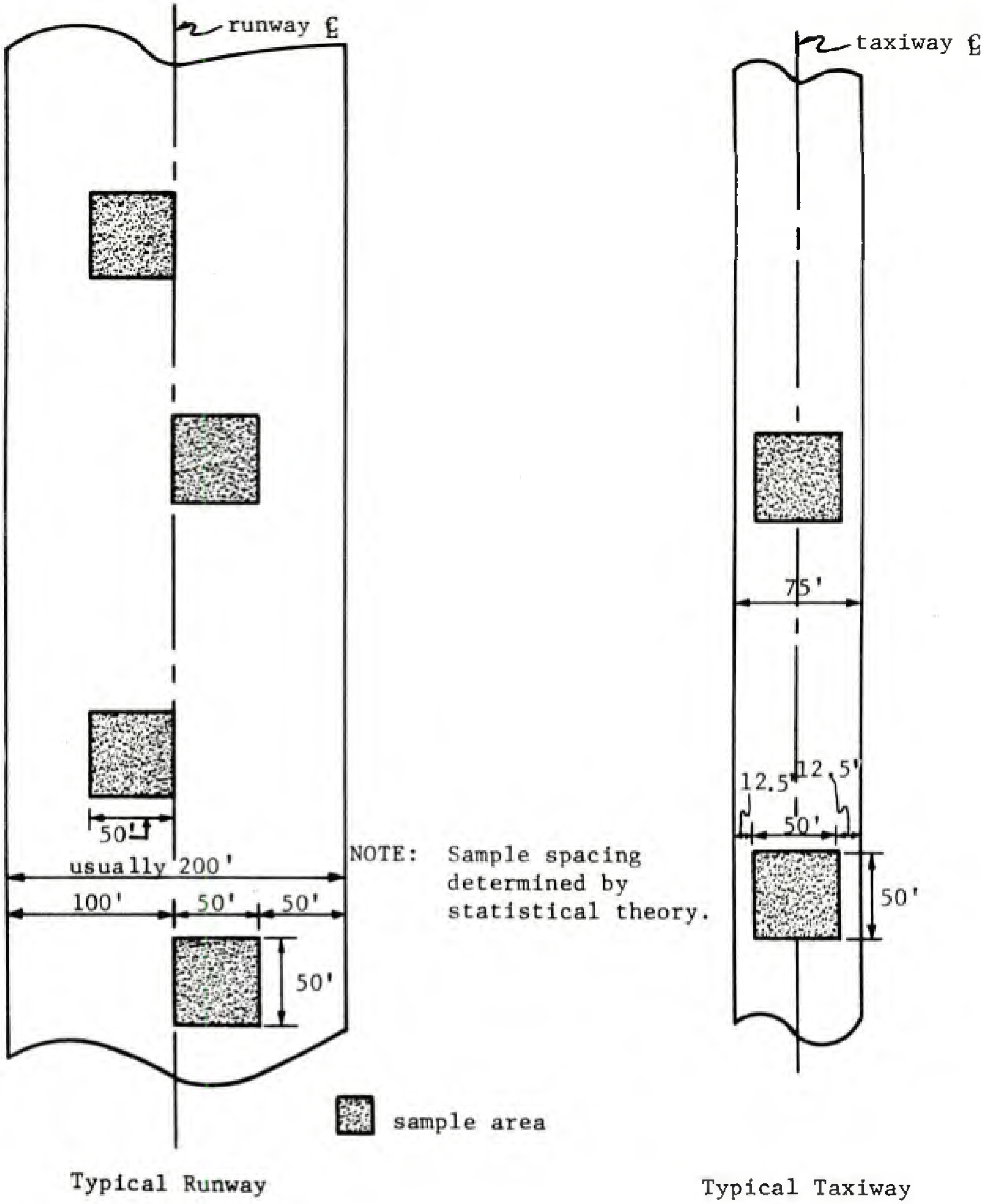


Figure C-2. Asphaltic concrete sample areas.

ASPHALTIC CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield E X A M P L E Facility Taxiway 2

Discrete Area T2-1 Area of Discrete Area (a) 97,700 ft^2

No. of Sample Areas (b) 10 Ratio: (a/2500b) 3.9

Defect Type	Length or Area of Sampled Defects	Total Length or Area of All Defects: (c) x Ratio	Defect Density (per 10 sq. ft.) 10 d/a	Defect Severity Weight	Weighted Defect Density: (e) x (f)
	(c)	(d)	(e)	(f)	(g)
T.C., L.C. or LCJ*	80 ft	312 ft	0.0319	2.5	0.0798
Reflection Crack					
Faulting					
Patching					
Settlement or Depression	530 ft^2	2,067 ft^2	0.2116	9.0	1.9041
Pattern Cracking	126 ft^2	491.4 ft^2	0.0503	2.5	0.1257
Rutting					
Raveling					
Erosion—Jet Blast					
Oil Spillage					
Broken-up Area					
				Total	2.11 A**

Remarks on Pavement Condition

The depressions were generally 1/2" deep. Pattern cracking formed 6" to 12" polygons and was associated with the depressions. Longitudinal cracks were unsealed and 1/8" wide. (See Figure 5.)

* Transverse crack, longitudinal crack, and longitudinal construction joint

** Letter suffix "A" indicates asphaltic concrete pavement

Figure C-3. Typical Asphaltic Concrete Discrete Area Defect Summary

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield E X A M P L E Facility Taxiway 2

Discrete Area T2-2 Total Slabs in Discrete Area (a) 1,542

No. of Slabs Sampled (b) 193 Ratio a/b = 8.0

Defect Type	No. of Sample Slabs w/Defect	Total Slabs w/Defect: c x a/b	Defect Density (per slab) d/a	Defect Severity Weight	Weighted Defect Density e x f
	(c)	(d)	(e)	(f)	(g)
Faulting					
Corner Break	1	8	0.0052	2.5	0.013
L.C. or T.C. *	19	152	0.0985	1.0	0.098
I.C. **	1	8	0.0052	2.5	0.013
Depression		2***	0.0013	9.0	0.012
Spalling	59	472	0.3060	7.5	2.295
Scaling					
Disintegrated Slab					
Joint Seal	10	80	0.0518	2.5	0.130
Pumping					
				Total	2.57 C****

Remarks on Pavement Condition

Spalls were generally 1" wide by 3" long with some spalls up to 4" wide and 12" long. The longitudinal cracks found were mostly sealed. The depressions noted as singular defects consisted of two depressed and cracked slabs. The depression was approximately 1/2" deep. An attempt had been made to repair these slabs with portland cement concrete. Joint seal was missing in strips 4" to 12" long. (See Figures 25 and 26.)

* Longitudinal crack or transverse crack

** Intersecting crack

*** Counted as singular defects during the preliminary survey

**** Letter suffix "C" indicates portland cement concrete pavement

Figure C-4. Typical Portland Cement Concrete Discrete Area Defect Summary

ASPHALTIC CONCRETE FACILITY DEFECT SUMMARY

Airfield E X A M P L E

Date Surveyed ______

Facility (or portion)	Weighted Defect Density Total	Ratio: Discrete Area / Total Facility Area*	Average Weighted Defect Density (a) x (b)
	(a)**	(b)	(c)**
Taxiway 2			
T2-1	2.11 A	1.00	2.11 A
Taxiway 10			
T10-2	0.004 A	1.00	0.004 A
Towway 1			
TOW-1	3.77 A	1.00	3.77 A
Parking Apron 2			
PA2-1	7.29 A	1.00	7.29 A
Parking Apron 6			
PA6-1	7.44 A	1.00	7.44 A
Parking Apron 7			
PA7-1	4.97 A	0.79	3.93
PA7-2	23.18 A	0.21	4.87
			8.80 A (Total)
Parking Apron 8			
PA8-1	2.76 A	1.00	2.76 A
Central Mat			
CM-1	2.89 A	1.00	2.89 A

* If facility entirely constructed of AC, indicates total facility area. If facility only partly constructed of AC, indicates total area of AC portion of facility.

** Letter suffix "A" on weighted defect densities indicates asphaltic concrete pavements.

Figure C-5. Typical Asphaltic Concrete Facility Defect Summary

APPENDIX D

MU-METER TEST RESULTS

USNAS LOS ALAMITOS, CA

APPENDIX D MU-METER TEST RESULTS
USNAS LOS ALAMITOS, CA

Test Location Run #	Runway Heading	Average Time After Wetting Min.	Average Coefficient of Friction (Mu)	Maximum Coefficient of Friction (Mu)	Minimum Coefficient of Friction (Mu)
Runway 4R-22L					
Test Section 1					
Asphaltic Concrete					
1	4	2.92	0.63	0.70	0.60
2	22	4.15	0.68	0.78	0.60
3	4	6.19	0.72	0.75	0.63
4	22	7.51	0.73	0.78	0.59
5	4	9.19	0.73	0.76	0.70
6	22	10.29	0.74	0.77	0.72
7	4	19.85	0.73	0.78	0.70
8	22	25.51	0.76	0.78	0.74
Portland Cement Concrete					
1	4	2.92	0.62	0.76	0.32
2	22	4.15	0.64	0.76	0.28
3	4	6.19	0.66	0.77	0.35
4	22	7.51	0.64	0.81	0.42
5	4	9.19	0.72	0.80	0.36
6	22	10.29	0.76	0.85	0.36
7	4	19.85	0.76	0.84	0.42
8	22	25.51	0.80	0.86	0.42
Test Section 2					
1	4	5.29	0.73	0.76	0.56
2	22	6.48	0.71	0.76	0.46
3	4	7.72	0.72	0.75	0.57
4	22	9.00	0.71	0.76	0.53
5	4	13.58	0.72	0.76	0.58
6	22	18.62	0.74	0.76	0.65
7	4	23.92	0.73	0.76	0.69
Test Section 3					
1	22	3.09	0.59	0.71	0.28
2	4	4.07	0.60	0.72	0.26
3	22	5.07	0.59	0.75	0.29
4	4	6.70	0.64	0.74	0.40
5	22	7.72	0.61	0.75	0.39
6	4	8.56	0.63	0.75	0.34
7	22	13.72	0.68	0.77	0.40
8	4	20.42	0.75	0.78	0.48
9	22	26.96	0.71	0.76	0.49

Test Location Run #	Runway Heading	Average Time After Wetting Min.	Average Coefficient of Friction (Mu)	Maximum Coefficient of Friction (Mu)	Minimum Coefficient of Friction (Mu)
Runway 4R-22L					
Test Section 4					
Asphaltic Concrete					
1	4	5.53	0.61	0.75	0.34
2	22	6.73	0.55	0.76	0.36
3	4	8.68	0.61	0.77	0.35
4	22	9.98	0.59	0.76	0.35
5	4	11.85	0.62	0.77	0.30
6	22	17.46	0.68	0.78	0.45
7	4	24.93	0.72	0.78	0.48
8	22	29.96	0.77	0.87	0.42
Portland Cement Concrete					
1	4	5.53	0.58	0.63	0.40
2	22	6.73	0.56	0.71	0.30
3	4	8.68	0.60	0.72	0.48
4	22	9.98	0.61	0.76	0.30
5	4	11.85	0.64	0.81	0.31
6	22	17.46	0.76	0.83	0.30
7	4	24.93	0.83	0.90	0.56
8	22	29.96	0.80	0.86	0.69
Runway 4L-22R					
Test Section 1					
1	4	1.89	0.50	0.76	0.22
2	22	2.95	0.55	0.65	0.37
3	4	3.80	0.51	0.76	0.22
4	22	4.68	0.61	0.73	0.44
5	4	5.63	0.62	0.80	0.41
6	22	7.32	0.64	0.76	0.43
7	4	10.08	0.61	0.78	0.36
8	22	18.52	0.70	0.82	0.41
9	4	29.63	0.70	0.83	0.45
Test Section 2					
1	4	4.79	0.56	0.80	0.20
2	22	5.91	0.54	0.80	0.28
3	4	7.08	0.60	0.81	0.28
4	22	8.32	0.60	0.83	0.27
5	4	10.11	0.64	0.82	0.31
6	22	21.09	0.68	0.83	0.30
7	4	27.47	0.72	0.83	0.36
Test Section 3					
1	22	2.88	0.53	0.76	0.21
2	4	3.74	0.53	0.76	0.23
3	22	4.71	0.51	0.82	0.28
4	4	5.79	0.55	0.77	0.29
5	22	6.82	0.56	0.81	0.31
6	4	11.14	0.66	0.78	0.36
7	22	16.29	0.70	0.80	0.36
8	4	21.58	0.74	0.85	0.40
9	22	27.36	0.76	0.88	0.43