TM no. M-75-53-4

TECHNICAL MEMORANDUM

title: "AIRFIELD PAVEMENT CONDITION SURVEY, USNAS WHIDBEY ISLAND AND USNOLF COUPEVILLE, WASHINGTON, by

author: R. B. BROWNIE,

date: DECEMBER 1975."

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 WHIDBEY ISLAND AND USNOLF COUPEVILLE, WASHINGTON

Technical Memorandum M-75-53-4

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, Whidbey Island, Washington 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. Also, a condition survey of the runway at the U.S. Naval Outlying Field, Coupeville is reported. The results of the condition surveys show that the pavement condition is almost unchanged since the last condition survey in 1970. Friction measurements show that the runways at NAS Whidbey Island have satisfactory frictional resistance.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
BACKGROUND	1
CONSTRUCTION HISTORY	2
CURRENT AIRCRAFT TRAFFIC	2
CLIMATOLOGICAL DATA	2
PAVEMENT CONDITION SURVEY	2
Condition Survey Procedure	2
Results of Condition Survey	3
RUNWAY FRICTION MEASUREMENTS	3
Test Locations	3
Test Equipment	3
Test Procedures	4
Runway Friction Test Results	4
DISCUSSION OF RESULTS	5
Runway Friction Measurements	6
RECOMMENDATIONS FOR FURTHER EVALUATION EFFORT	6
REFERENCES	6
Table 1. Aircraft Operation Data, USNAS Whidbey, Washington	7
Table 2. Types of Aircraft Using USNAS Whidbey, Washington	8
Table 3. Defect Severity Weights	9
Table 4. Runway Friction Measurements Summary	10
Table 5. Mu-Meter Aircraft Pavement Rating	11
Table 6. Runway Slope Measurements, USNAS Whidbey Island, Washington	12
Figure 1. Aerial View of USNAS Whidbey Island, Washington	13
Figure 2. Discrete Area Map	14
Figure 2A. Discrete Area Map	15
Figure 3. Friction Test Locations	16
Figures 4-7 Friction Coefficient Versus Distance	17-20
Figures 8-11 Average Friction Coefficient Versus Time After Wetting	21-24
Discrete Area Summaries	25
Facility Defect Summaries	33
Discrete Area Condition Analyses	37
Appendix A. Construction History	45
Appendix B. Climatological Data	55
Appendix C. Condition Survey Procedures	59
Appendix D. Mu-Meter Test Results	73

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 these condition surveys was to determine the suitability of the airfield pavement surfaces for aircraft operations, and to establish a uniform basis for maintenance and repair efforts. A pavement condition survey was conducted at the Naval Air Station, Whidbey Island and Naval Outlying Field, Coupeville, Washington by the Naval Civil Engineering Laboratory* in October 1970 and reported in reference (1). Commencing in FY-75, pavement condition surveys are being performed only on active runways, and increased emphasis is being placed on determining runway friction coefficients. During the month of May 1975, a second pavement condition survey was made at NAS Whidbey Island and NOLF Coupeville by CEL. 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 at NAS Whidbey Island using a Mu-Meter, a small friction-measuring trailer. Additional survey efforts included preparation of a construction histories of the airfields, compilation of current aircraft traffic data, summarization of climatological data, and delineation of requirements for future pavement evaluation efforts at the stations.

BACKGROUND

The U.S. Naval Air Station, Whidbey Island, is located in Island County, 57 miles north of Seattle, Washington, at an elevation of 47 feet. An aerial photograph of the station is shown in Figure 1. The airfield has two runways, Runway 13-31 and Runway 6-24, both of which are 8,000 feet long. The mission of NAS Whidbey Island is to provide squadron support for the operational and training squadrons of the Pacific Fleet, to serve as a base for Naval Air Reserve training, to support Marine Air Reserve training, and to provide air support for the Alaska Sea Frontier.

The U.S. Naval Outlying Field, Coupeville is located in Island County in the town of Coupeville, Washington at an elevation of 193 feet. There is only one runway 5,000 feet long with a taxiway at the outlying field. The facilities are used solely for carrier landing practice by aircraft from NAS Whidbey Island.

---

* On 1 January 1974, redesignated the Civil Engineering Laboratory (CEL) of the Naval Construction Battalion Center, Port Hueneme, California

CONSTRUCTION HISTORY

Original construction of the NAS Whidbey Island facilities now designated as Taxiways E and I was completed in 1942. These facilities served as the station runways at that time. One of the 8,000 foot runways, Runway 6-24 was constructed in 1951-52. The other 8,000 foot runway, Runway 13-31, was constructed in 1961-62. A complete history of construction and recorded maintenance of the facilities at NAS Whidbey Island is provided in Appendix A.

The portland cement concrete runway at NOLF Coupeville was constructed in 1942. The asphaltic concrete taxiway and a short section of steel matting were constructed in 1944. A complete history of construction of the NOLF Coupeville facilities also is given in Appendix A.

CURRENT AIRCRAFT TRAFFIC

A tabulation of the number of aircraft operations at NAS Whidbey Island 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 Whidbey Island is presented in Appendix B.

PAVEMENT CONDITION SURVEY

Condition Survey Procedure

The condition survey procedure used at NAS Whidbey Island and NOLF Coupeville 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 Whidbey and NOLF Coupeville, only the runways were surveyed and they were all PCC. Discrete areas were selected after a preliminary inspection of the runways. The locations of the discrete areas are shown in Figures 2 and 2A. Defect severity weights as used at NAS Whidbey Island and NOLF Coupeville 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 through of this report. Each Discrete Area Defect Summary includes a narrative description of the pavement defects encountered.

Total weighted defect densities for pavements at NAS Whidbey Island ranged from 0.19C (0.00C being no visible defects) for discrete area R6-2 to 1.79C for discrete area R13-1. The only discrete area at NOLF Coupeville has a defect density of 0.85C. An analysis of the change in pavement condition since the last condition survey is given in the Discrete Area Condition Analysis sheets, pages through .

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, artifically-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 3. 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. No friction tests were made at NOLF Coupeville as it is used only for touch-and-go operations.

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 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.

The water truck provided by the station was a runway foamer with a spray bar 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 Whidbey Island are those outlined in NAVFAC INSTRUCTION 11132.14B. The methods were:

(1) A preliminary reconnaissance of the pavement surfaces was made and representative test areas (each 1000 feet long) 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.

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 4 through 7.* 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 Whidbey Island the low-coefficient areas correspond to areas of heavy rubber deposits. Appendix D contains all test results for each Mu-Meter test section.

* Except Run 2 on Test Section D of Runway 13-31 is shown in Figure 7 because of a mechanical failure during Run 1.

Figures 8 through 11 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 demonstrate 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 8 through 11, 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 ocefficient can be considered a dry pavement condition. The curves in Figures 8 through 11 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 Results

A decrease in the amount of spalling was noted in most discrete areas since the 1970 condition survey (Reference 1). This is attributed to repairs accomplished by the Public Works Department of the station.

Runway Friction Measurements

The wet (3 minute) friction coefficients given in Table 4 show that all runways tested have an acceptable level of friction resistance. The only areas which demonstrated any potential hydroplaning hazard were the rubber-covered areas of Runway 6-24 (Test Sections A and D).

RECOMMENDATIONS FOR FURTHER EVALUATION EFFORT

Comprehensive evaluations of load-carrying capacity were performed at Whidbey Island and NOLF Coupeville by NCEL in 1966 (See Reference 2). No defects attributed to changes in load-carrying capacity were noted in this current (1975) condition survey. Therefore, no additional evaluation effort is recommended at this time.

REFERENCES

1. U.S. Naval Civil Engineering Laboratory. Technical Note N-1201, Airfield Pavement Condition Survey, USNAS Whidbey Island and USNOLF Coupeville, Washington, by D. J. Lambiotte and L. J. Woloszynski, Port Hueneme, California, November 1971.

2. U.S. Naval Civil Engineering Laboratory. Technical Note N-939, Airfield Pavement Evaluation, USNAS Whidbey Island and USNOLF Coupeville, Washington, by D. J. Lambiotte and W. H. Chamberlin, Port Hueneme, California, October 1967.

TABLE 1

AIRCRAFT OPERATION DATA
USNAS WHIDBEY ISLAND, WASHINGTON

Date	Number of Operations
May 1974	9,617
June	8,815
July	9,733
August	10,022
September	10,313
October	8,469
November	10,391
December	8,740
January 1975	9,022
February	11,016
March	6,547
April	10,353
Total Operations	113,038
Average monthly operations for the above one-year period	9,420

Runway Usage

Runway	Percent Used
6	2.8
24	45.5
13	43.7
31	8.0

TABLE 2

TYPES OF AIRCRAFT USING
USNAS WHIDBEY ISLAND, WASHINGTON

Aircraft based at the station:	A6, A3, P3, C54, C118, C119, H34, US2B
Transient aircraft using the station:	C130, C131, C141

TABLE 3

DEFECT SEVERITY WEIGHTS
USNAS WHIDBEY ISLAND, WASHINGTON
AND USNOLF COUPEVILLE, WASHINGTON

Portland Cement Concrete

Defect	Weight
Depression	9.0
Shattered Slab	9.0
Faulting	9.0
Spalling	7.5
Scaling	7.0
"D-Line" Cracking	6.5
Pumping	3.5
Poor Joint Seal	2.5
Corner Break	2.5
Intersecting Crack	1.0
Longitudinal or Transverse Crack	1.0

TABLE 4

RUNWAY FRICTION MEASUREMENT SUMMARY
USNAS WHIDBEY ISLAND, WASHINGTON

Test Location	Average Friction Coefficients		
	3 Min. (Mu)	15 Min. (Mu)	30 Min. (Mu)
Runway 6 - 24			
Test Section A	0.58	0.69	0.70
Test Section B	0.63	0.73	0.73
Test Section C	0.72	0.85	0.85
Test Section D	0.46	0.65	0.80
Runway 13 - 31			
Test Section A	0.67	0.83	0.83
Test Section B	0.68	0.85	0.85
Test Section C	0.60	0.74	0.74
Test Section D	0.75	0.82	0.82

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 SLOPE MEASUREMENTS, USNAS WHIDBEY ISLAND, WA

Location	Transverse Slopes Left Percent	Left Percent	℄ Right Percent	Right Percent	Longitudinal Slopes Percent
Runway 6 - 24					
0+00	-0.3	-0.3	+1.1	+0.8	-0.3
5+00	-0.5	-0.3	+0.2	+0.3	-0.6
10+00	+0.9	+1.6	+1.7	+1.0	+0.1
15+00	+1.2	+0.9	+1.0	+1.0	+0.6
20+00	+1.0	+0.9	+1.0	+0.6	+0.3
25+00	+1.2	+1.2	+0.7	+0.7	+0.4
30+00	+0.9	+0.9	+0.4	+0.7	+0.3
35+00	+1.2	+1.2	+1.2	+1.0	+0.1
40+00	-0.6	-0.4	+0.6	+0.5	+0.3
45+00	-0.4	-0.3	+0.9	+1.0	+0.1
50+00	+0.8	+1.0	+0.9	+0.9	0.0
55+00	+0.9	+1.1	+1.2	+1.0	-0.1
60+00	+0.8	+0.8	+1.2	+1.0	-0.1
65+00	+0.7	+0.6	+0.5	+0.7	-0.1
70+00	+0.8	+0.8	+0.9	+0.9	-0.1
75+00	+0.7	+0.8	+0.9	+0.8	0.0
80+00	+0.9	+0.8	+1.1	+0.6	-0.7
Runway 13 - 31					
0+00	+0.8	+0.9	+0.6	+0.7	-0.1
5+00	+1.2	+1.2	+1.2	+1.2	-0.3
10+00	+0.6	+0.6	+1.0	+0.8	-0.1
15+00	+0.7	+1.0	+1.0	+0.7	0.0
20+00	+0.8	+0.9	+0.9	+0.9	-0.3
25+00	+0.9	+1.0	+1.1	+0.8	-0.3
30+00	+1.0	+1.1	+1.2	+0.8	-0.3
35+00	+0.7	+0.8	+0.8	+0.8	-0.5
40+00	Intersection with R/W 6-24				
45+00	+0.9	+0.9	+1.2	+1.1	-0.7
50+00	+0.8	+0.8	+0.9	+0.8	0.0
55+00	+0.8	+1.1	+1.0	+0.9	+0.4
60+00	+0.8	+1.1	+1.0	+0.9	+0.3
65+00	+0.9	+1.3	+1.0	+1.0	+0.7
70+00	+0.8	+1.0	+0.9	+0.9	+1.2
75+00	+0.8	+1.1	+0.9	+0.9	+0.9
80+00	+0.6	+1.2	+1.2	+0.8	+0.9

Note: Positive transverse slopes indicate water drains to the runways edge without crossing the centerline while negative transverse slopes indicate drainage across the centerline. Positive longitudinal slopes indicate rising grades in the direction of increasing runway stationing, while falling grades are negative.

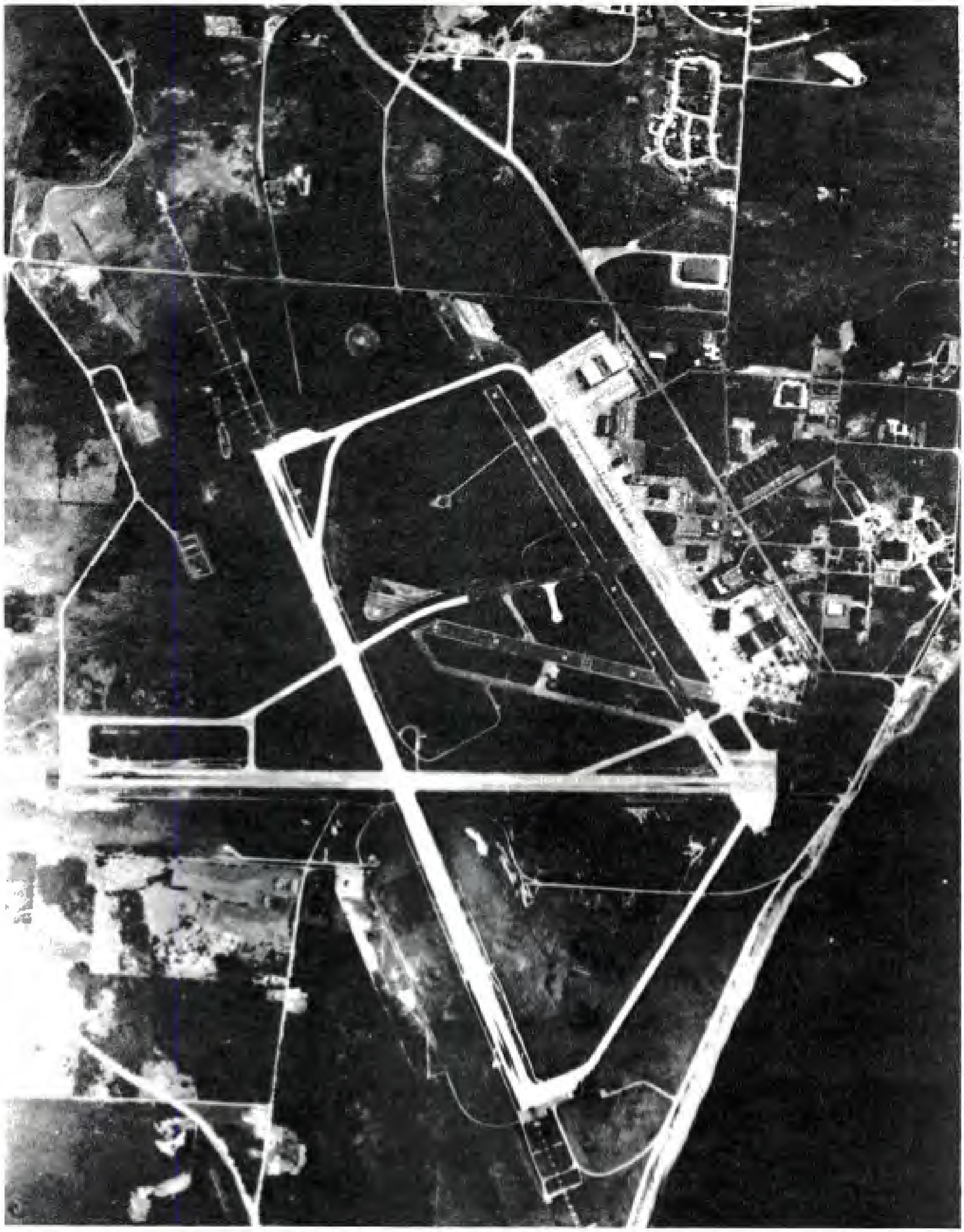
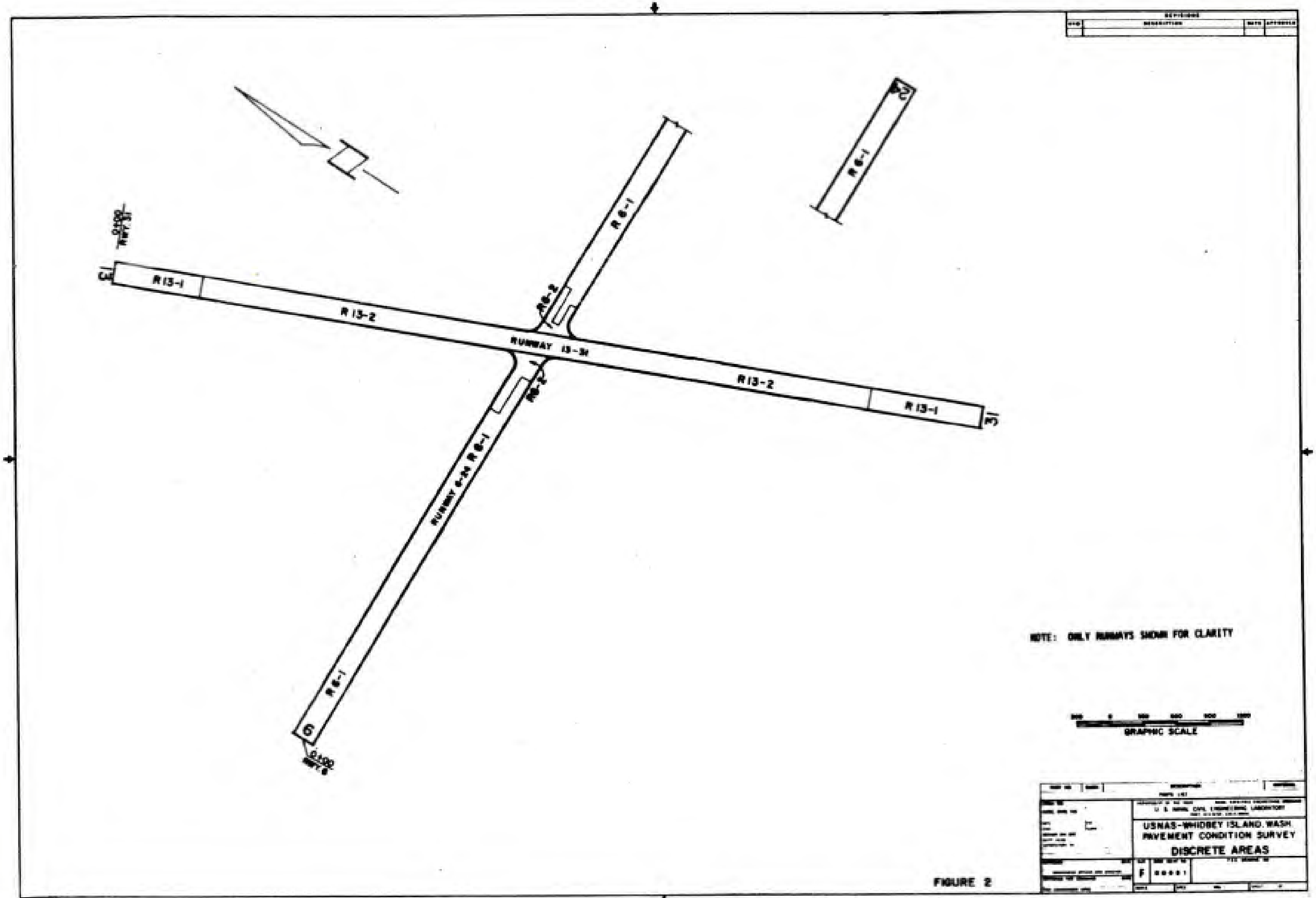


Figure 1. Aerial view of USNAS Whidbey Island, Washington.



R13-1
R13-2
RUNWAY 13-31
R6-1
R6-2
RUNWAY 6-24
13
31
6
24
NOTE: ONLY RUNWAYS SHOWN FOR CLARITY
GRAPHIC SCALE
USNAS-WHIDBEY ISLAND, WASH.
PAVEMENT CONDITION SURVEY
DISCRETE AREAS
U. S. NAVAL CIVIL ENGINEERING LABORATORY

FIGURE 2

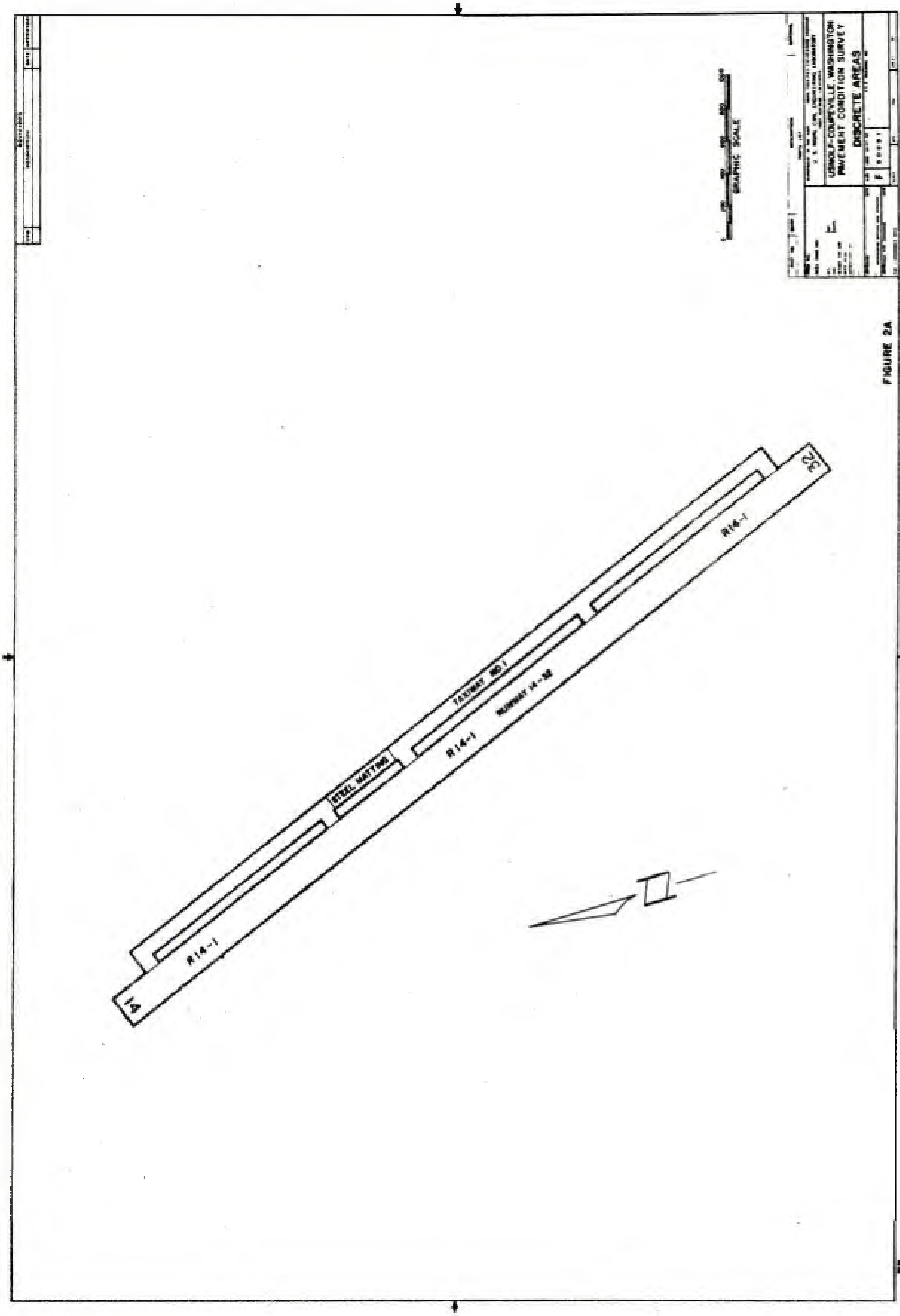
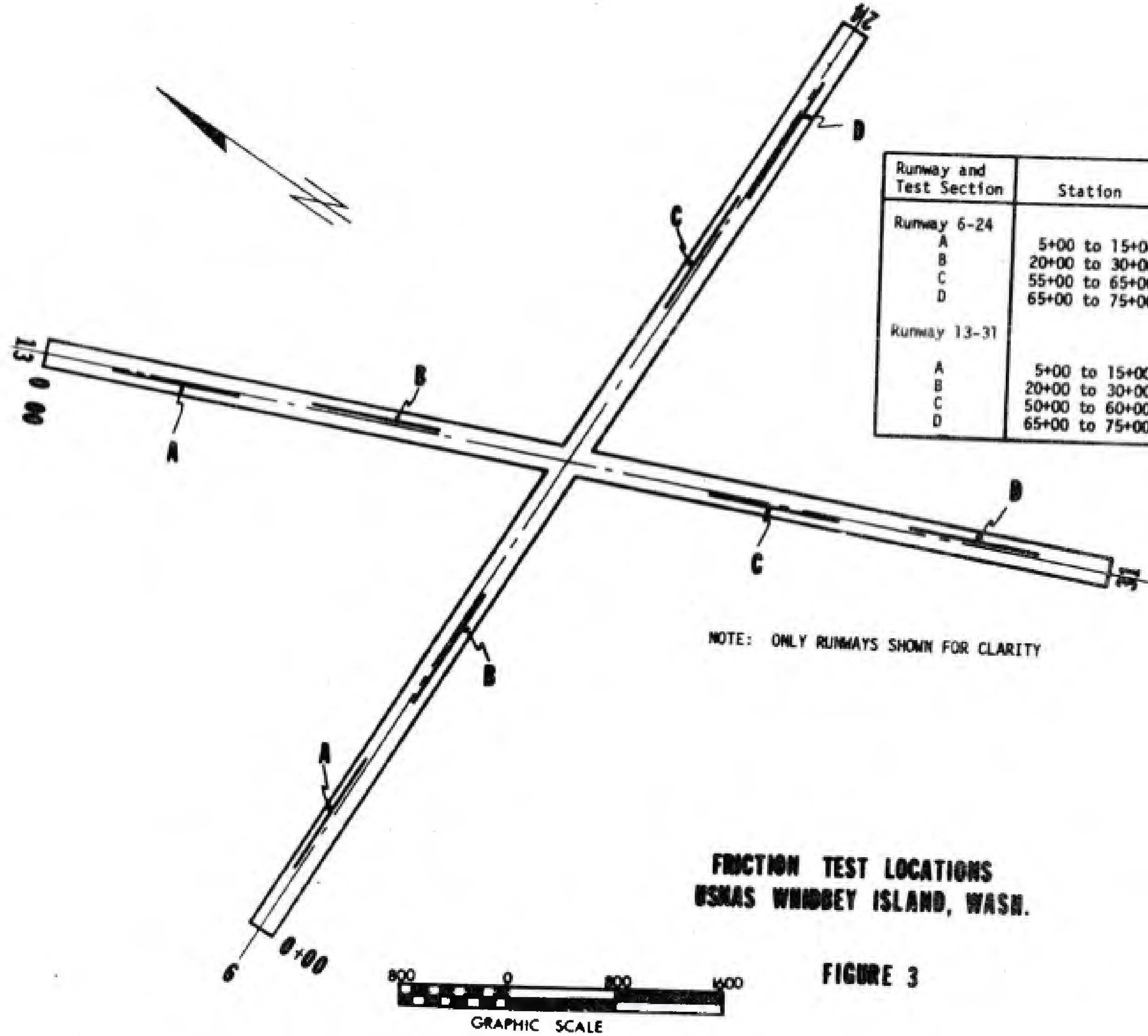

USNOLF-COUPEVILLE, WASHINGTON
PAVEMENT CONDITION SURVEY
DISCRETE AREAS
GRAPHIC SCALE
TAXIWAY NO. 1
STEEL MATTING
RUNWAY 14-32
R14-1
R14-1
R14-1
14
32

FIGURE 2A



Runway and Test Section	Station	Offset from Center Line
Runway 6-24		
A	5+00 to 15+00	10' left
B	20+00 to 30+00	10' right
C	55+00 to 65+00	10' left
D	65+00 to 75+00	10' right
Runway 13-31		
A	5+00 to 15+00	10' right
B	20+00 to 30+00	10' left
C	50+00 to 60+00	10' right
D	65+00 to 75+00	10' left

NOTE: ONLY RUNWAYS SHOWN FOR CLARITY

FRICTION TEST LOCATIONS
USNAS WHIDBEY ISLAND, WASH.

FIGURE 3

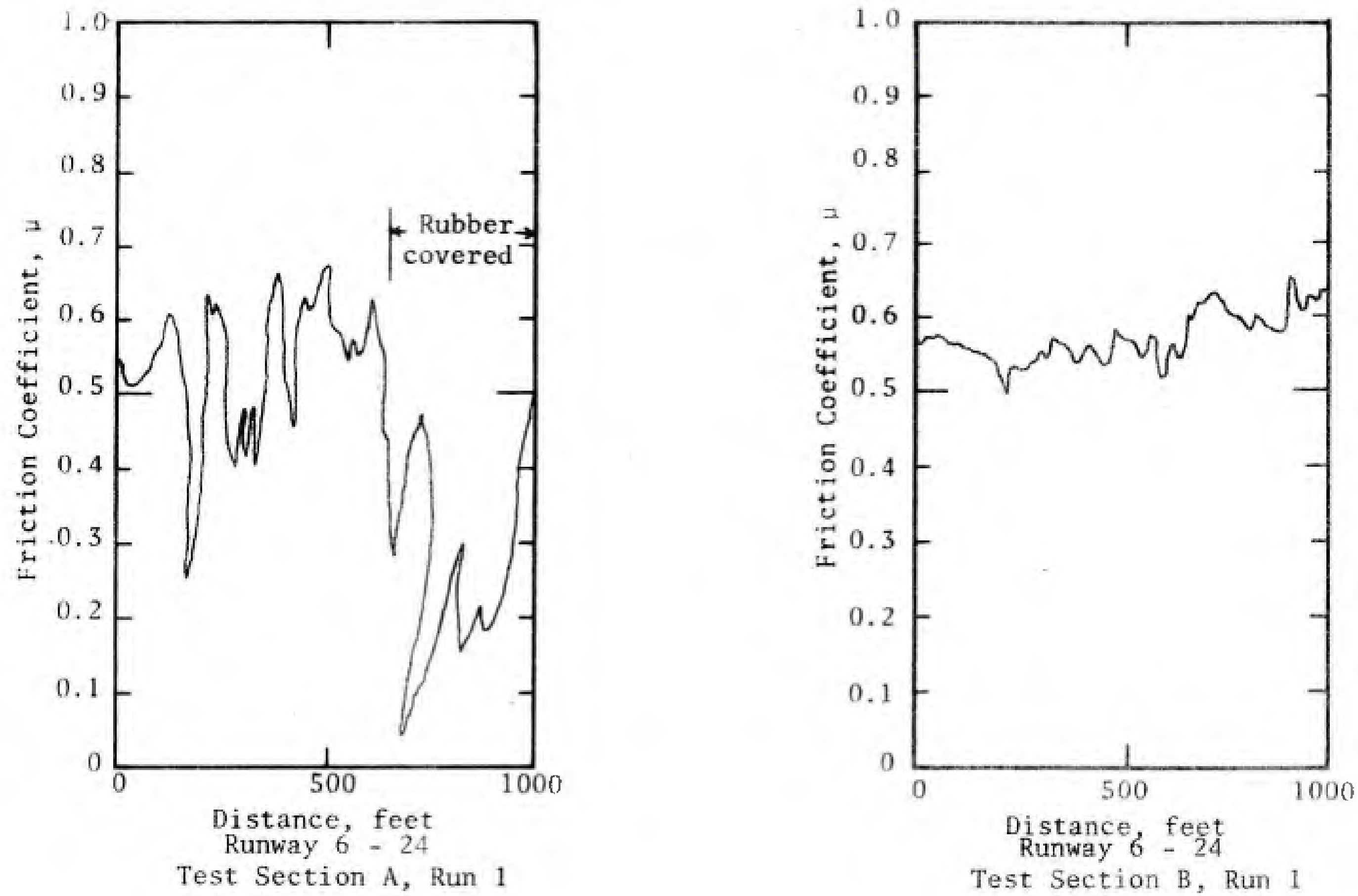


FIGURE 4. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS WHIDBEY ISLAND, WA

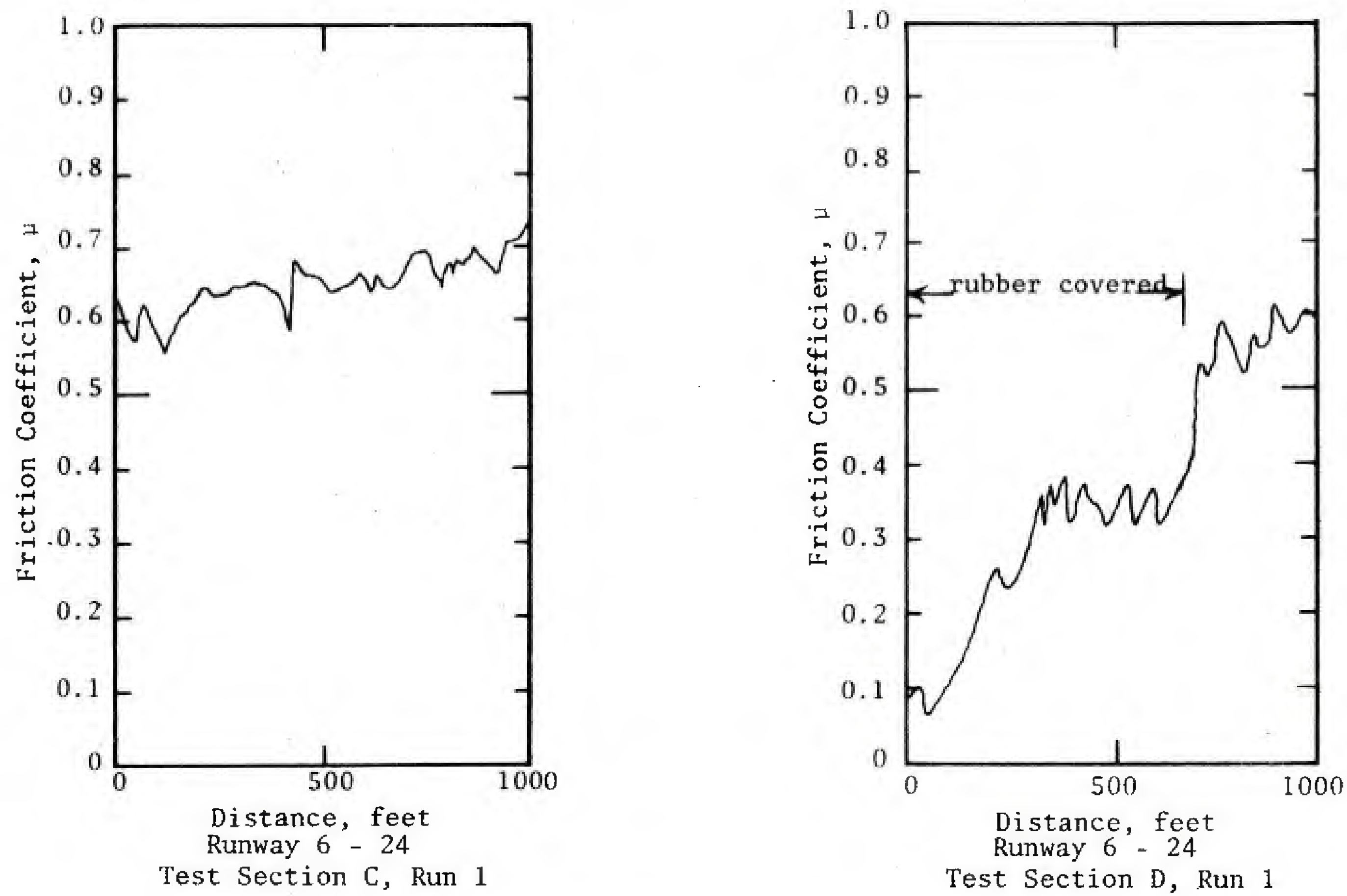
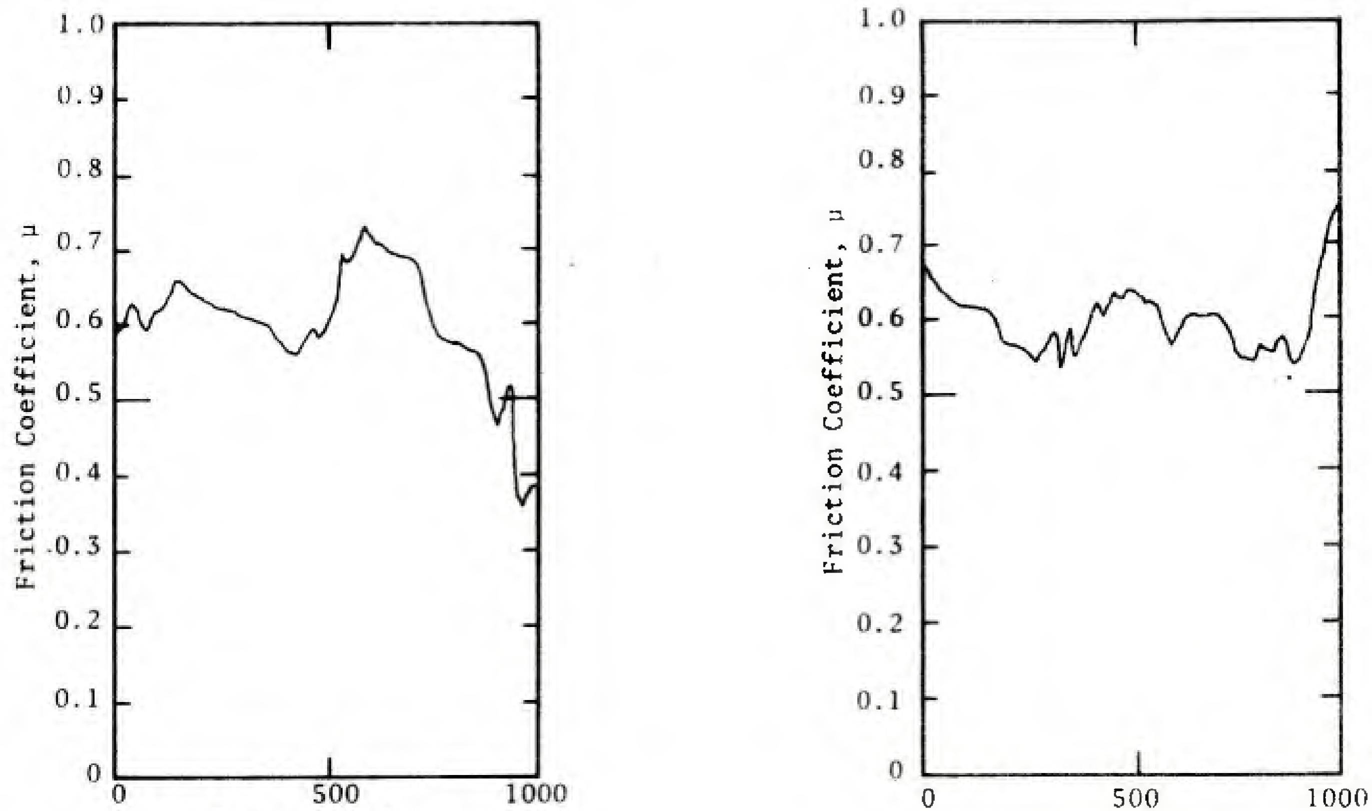


FIGURE 5. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS WHIDBEY ISLAND, WA



Runway 13-31
Test Section A, Run 1

Runway 13-31
Test Section B, Run 1

FIGURE 6. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS WHIDBEY ISALND, WA

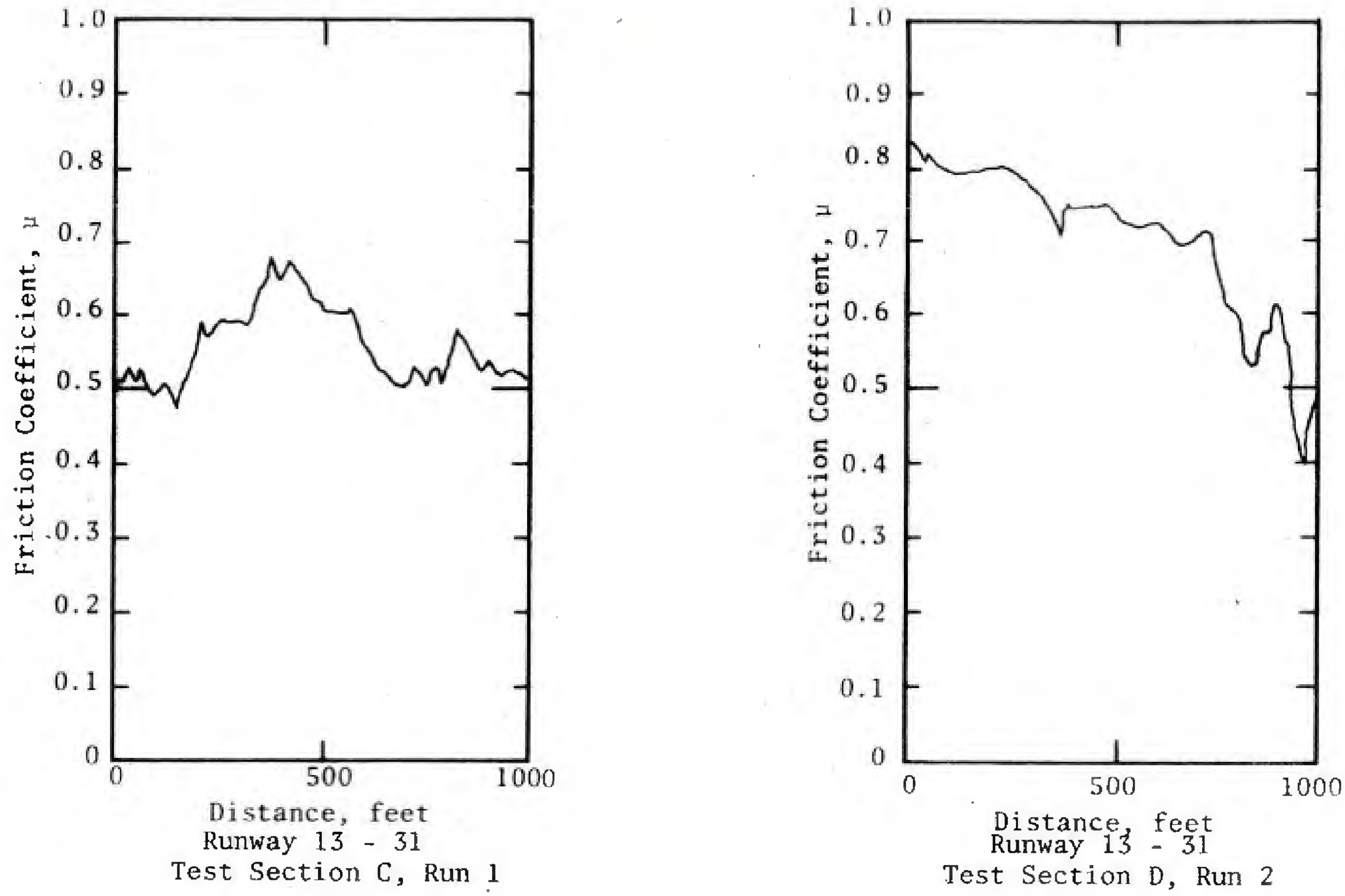
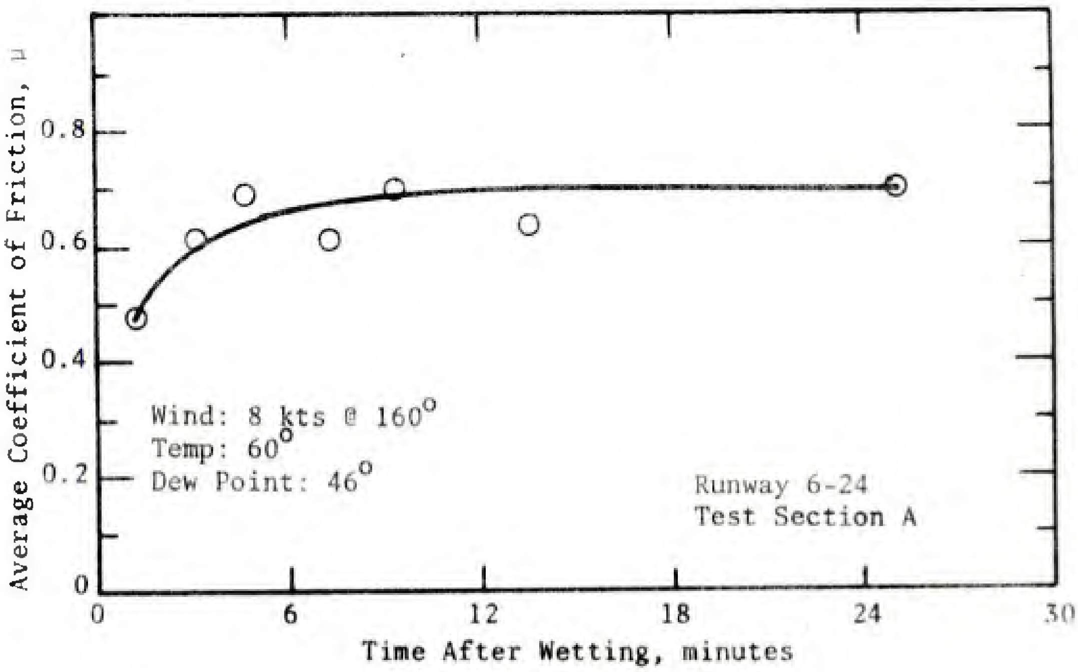


FIGURE 7. FRICTION COEFFICIENT VERSUS DISTANCE, USNAS WHIDBEY ISLAND, WA



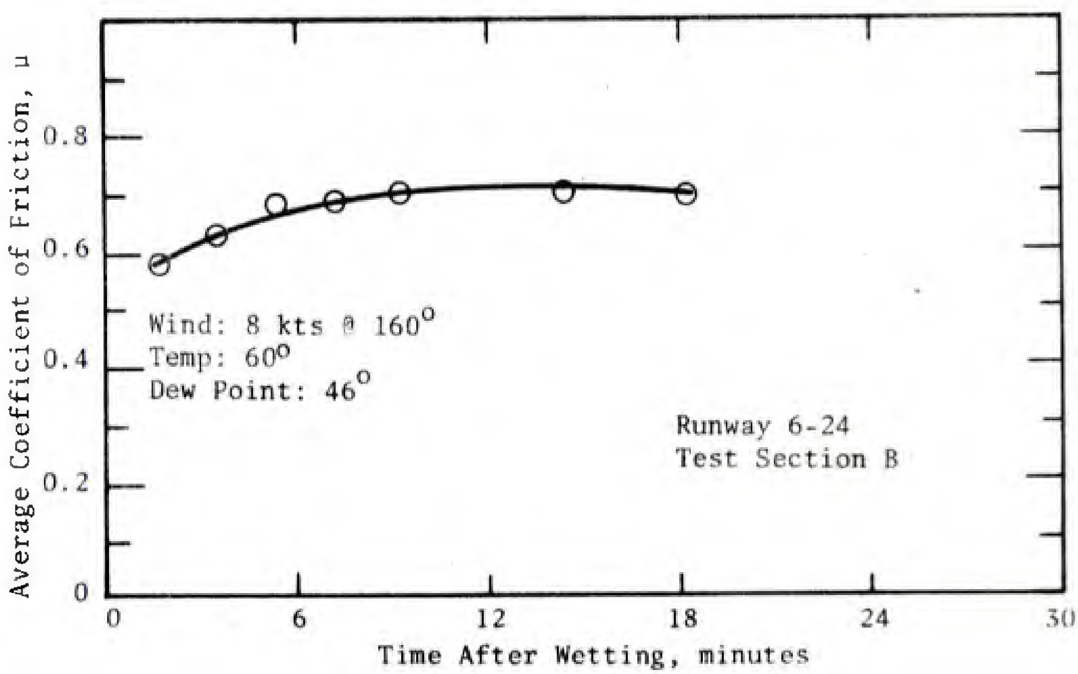
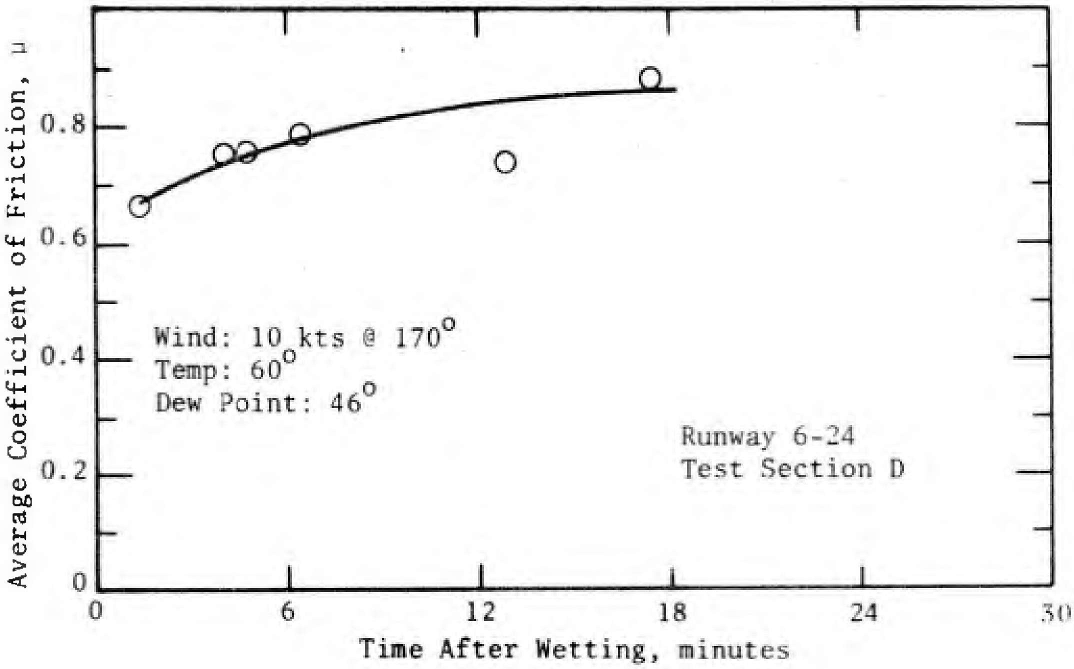


FIGURE 8. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS WHIDBEY ISLAND, WA



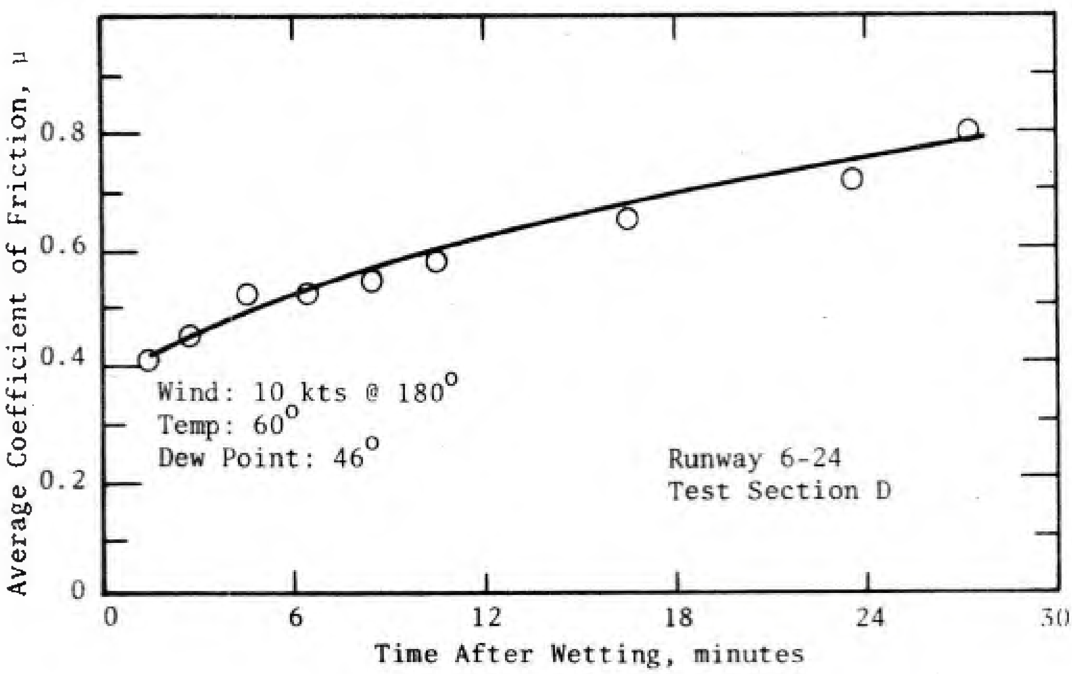
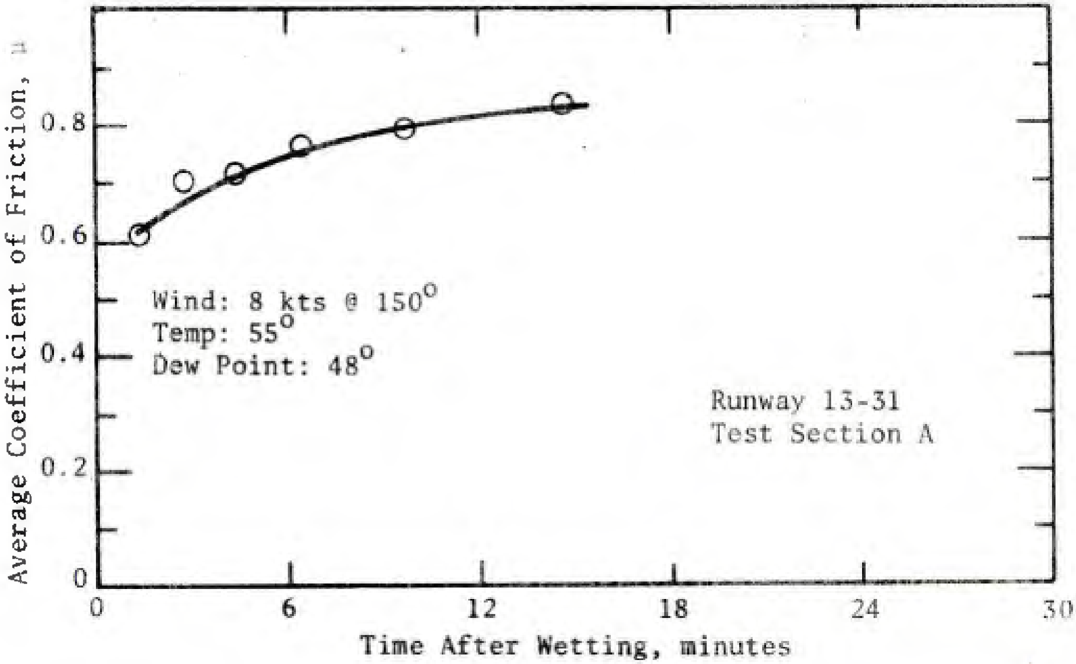


FIGURE 9. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS WHIDBEY ISLAND, WA



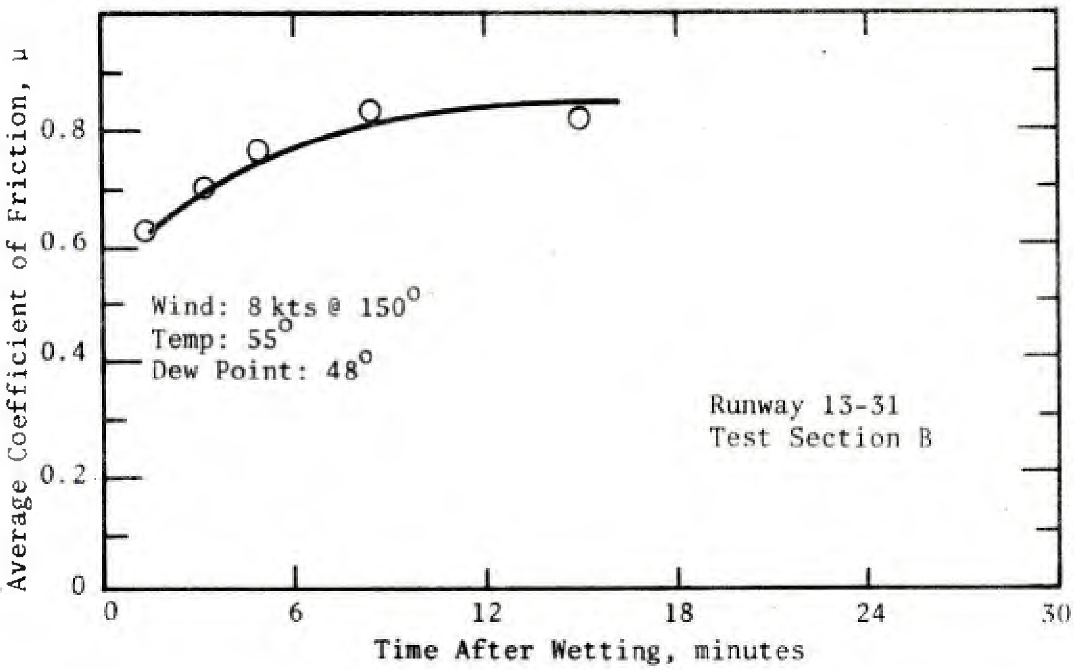
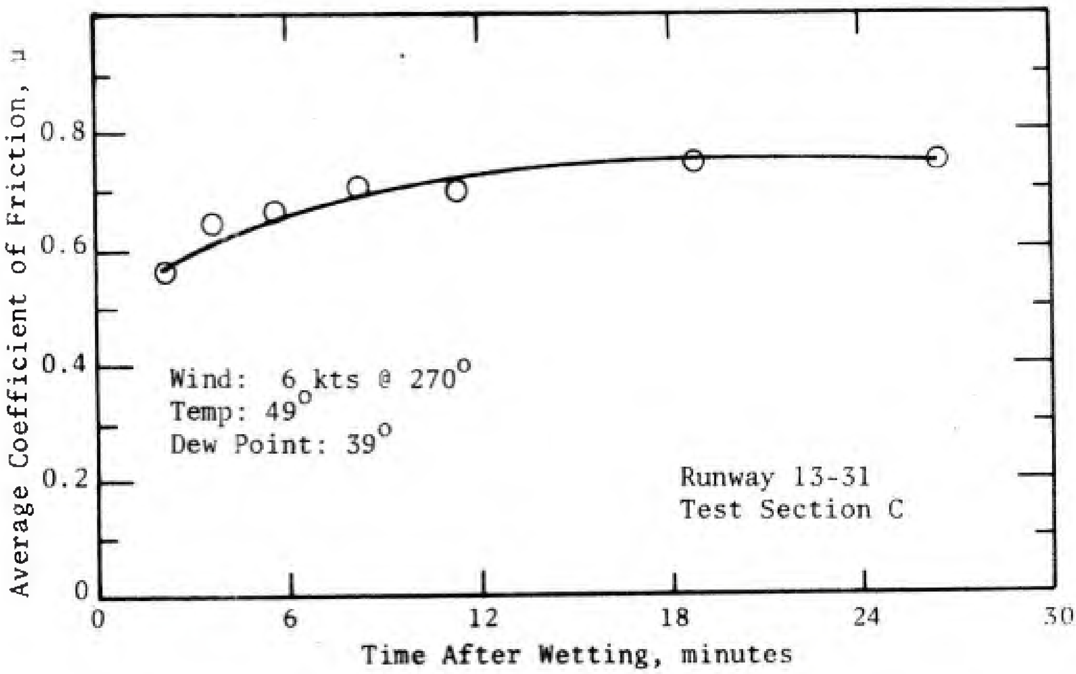


FIGURE 10. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS WHIDBEY ISLAND, WA



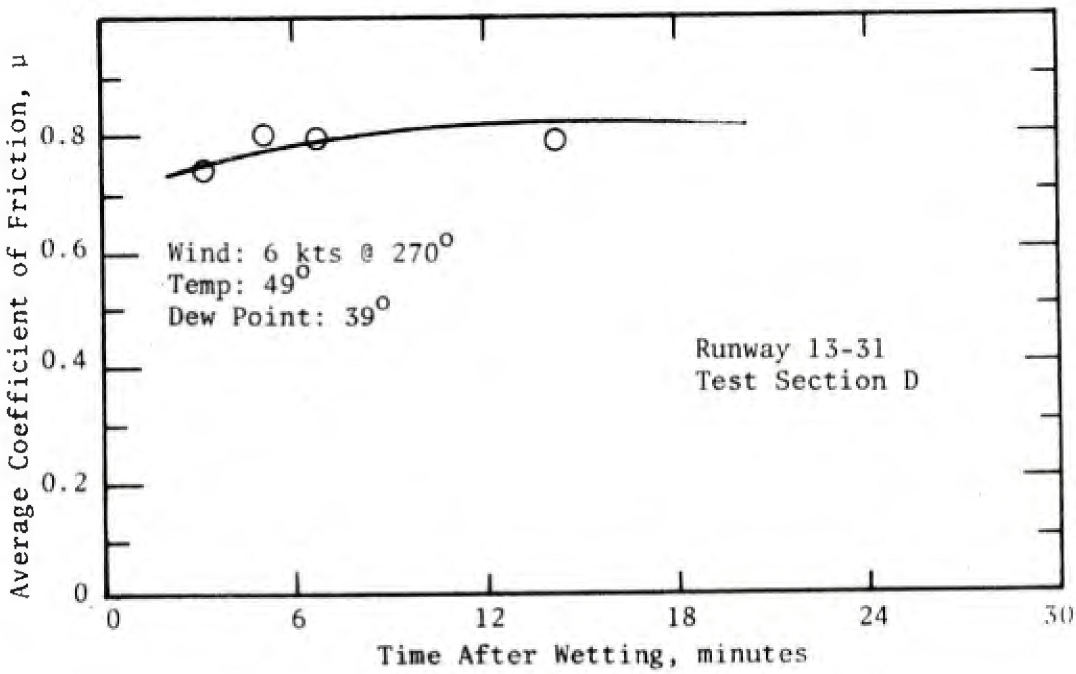


FIGURE 11. AVERAGE FRICTION COEFFICIENT VERSUS TIME AFTER WETTING, USNAS WHIDBEY ISLAND, WA

DISCRETE AREA DEFECT SUMMARIES

USNAS WHIDBEY ISLAND, WASHINGTON
AND
USNOLF COUPEVILLE, WASHINGTON

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield NAS Whidbey Island Facility Runway 6-24

Discrete Area R6-1 Total Slabs in Discrete Area (a) 3560

No. of Slabs Sampled (b) 187 Ratio a/b = 19.0

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	6	114	0.032	7.5	0.24
Scaling					
Shattered Slab					
Joint Seal	9	171	0.048	2.5	0.12
Pumping					
"D-line" cracking					
				Total	0.36C***

Remarks on Pavement Condition

Joint seal had some small pieces missing and showed a slight loss of bond. Spalls were small, generally less than 1" by 3".

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

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield NAS Whidbey Island Facility Runway 6-24

Discrete Area R6-2 Total Slabs in Discrete Area (a) 384

No. of Slabs Sampled (b) 96 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	2	8	0.02	7.5	0.16
Scaling					
Shattered Slab					
Joint Seal	1	4	0.01	2.5	0.03
Pumping					
"D-line" cracking					
				Total	0.19C***

Remarks on Pavement Condition

Spalls were small, less than 1" by 3".

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

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield NAS Whidbey Island Facility Runway 13-31

Discrete Area R13-1 Total Slabs in Discrete Area (a) 408

No. of Slabs Sampled (b) 102 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	1	4	0.01	2.5	0.03
L.C. or T.C.*	4	16	0.04	1.0	0.04
I.C.**					
Depression					
Spalling	15	60	0.15	7.5	1.13
Scaling					
Shattered Slab					
Joint Seal	24	96	0.24	2.5	0.59
Pumping					
"D-line" cracking					
				Total	1.79C***

Remarks on Pavement Condition

The spalls were small, averaging less than 1" by 3". The joint seal was slightly shriveled and small pieces were missing. The cracks tallied were transverse cracks which had been sawed and sealed. It is assumed that these cracks are uncontrolled contraction cracks and occurred shortly after construction.

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

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield NAS Whidbey Island Facility Runway 13-31

Discrete Area R13-2 Total Slabs in Discrete Area (a) 3180

No. of Slabs Sampled (b) 187 Ratio a/b = 17.0

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.*	1	17	0.005	1.0	0.005
I.C.**					
Depression					
Spalling	2	34	0.011	7.5	0.080
Scaling					
Shattered Slab					
Joint Seal	10	170	0.053	2.5	0.135
Pumping					
"D-line" cracking					
				Total	0.22C***

Remarks on Pavement Condition

Some vegetation was noted growing in a few joints. Spalls were very small and contained no loose material.

* Longitudinal crack or Transverse crack

** Intersecting crack

*** Letter suffix "C" represents PCC pavement

PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield NOLF Coupeville Facility Runway 14-32

Discrete Area R14-1 Total Slabs in Discrete Area (a) 2880

No. of Slabs Sampled (b) 180 Ratio a/b = 16.0

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	16	0.005	2.5	0.013
L.C. or T.C.*	5	80	0.028	1.0	0.028
I.C.**					
Depression					
Spalling	7	112	0.039	7.5	0.292
Scaling					
Shattered Slab					
Joint Seal	37	592	0.205	2.5	0.514
Pumping					
"D-line" cracking					
				Total	0.85C***

Remarks on Pavement Condition

Defective joint seal in most cases consisted of vegetation growing in the joints. Spalls were generally small and contained no loose material. The cracks tallied had been sealed.

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

FACILITY DEFECT SUMMARIES

USNAS WHIDBEY ISLAND, WASHINGTON

AND

USNOLF COUPEVILLE, WASHINGTON

PORTLAND CEMENT CONCRETE FACILITY DEFECT SUMMARY

Airfield USNAS Whidbey Island, WA

Date Surveyed May 1975

Facility (or portion)	Weighted Defect Density Total	Ratio: Discrete Area / Total Facility Area*	Average Weighted Defect Density (a) x (b)
	(a)**	(b)	(c)**
1975 Condition Survey			
Runway 6 - 24			
R6-1	0.36C	0.90	0.32
R6-2	0.19C	0.10	0.02
			0.34C(total)
Runway 13-31			
R13-1	1.79C	0.25	0.45
R13-2	0.22C	0.75	0.06
			0.51C(total)
1970 Condition Survey			
Runway 6-24			
R6-1	0.21C	0.90	0.19
R6-2	0.34C	0.10	0.03
			0.22C(total)
Runway 13-31			
R13-1	1.73C	0.25	0.43
R13-2	0.44C	0.75	0.33
			0.76C(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.

PORTLAND CEMENT CONCRETE FACILITY DEFECT SUMMARY

Airfield USNOLF Coupeville, Washington

Date Surveyed May 1975

Facility (or portion)	Weighted Defect Density Total	Ratio: Discrete Area / Total Facility Area*	Average Weighted Defect Density (a) x (b)
	(a)**	(b)	(c)**
1975 Condition Survey			
Runway 14-32			
R14-1	0.85C	1.00	0.85C
1970 Condition Survey			
Runway 14-32			
R14-1	1.81C	1.00	1.81C

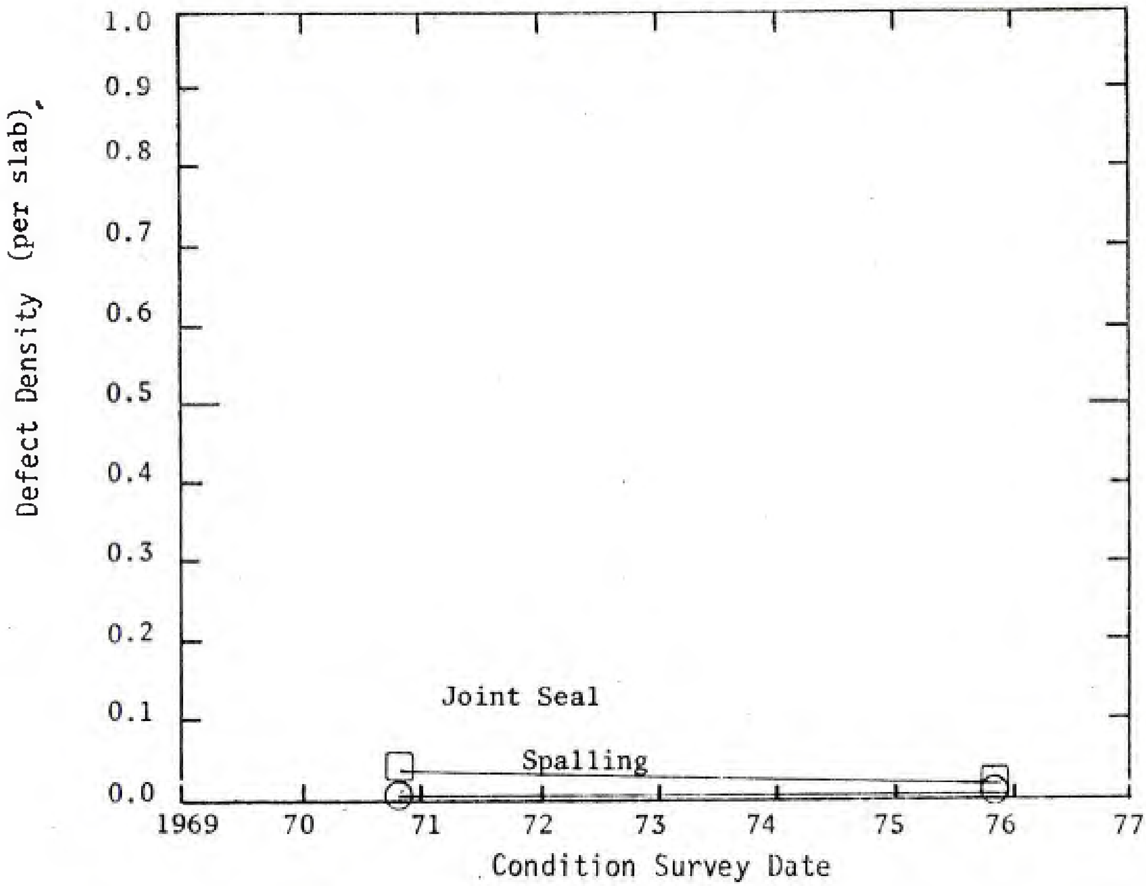
* If facility entirely constructed of PCC, indicates total facility area. If facility only partly constructed of PCC, indicates total area of PCC portion of facility.

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

DISCRETE AREA CONDITION ANALYSES

USNAS WHIDBEY ISLAND, WASHINGTON
AND
USNOLF COUPEVILLE, WASHINGTON

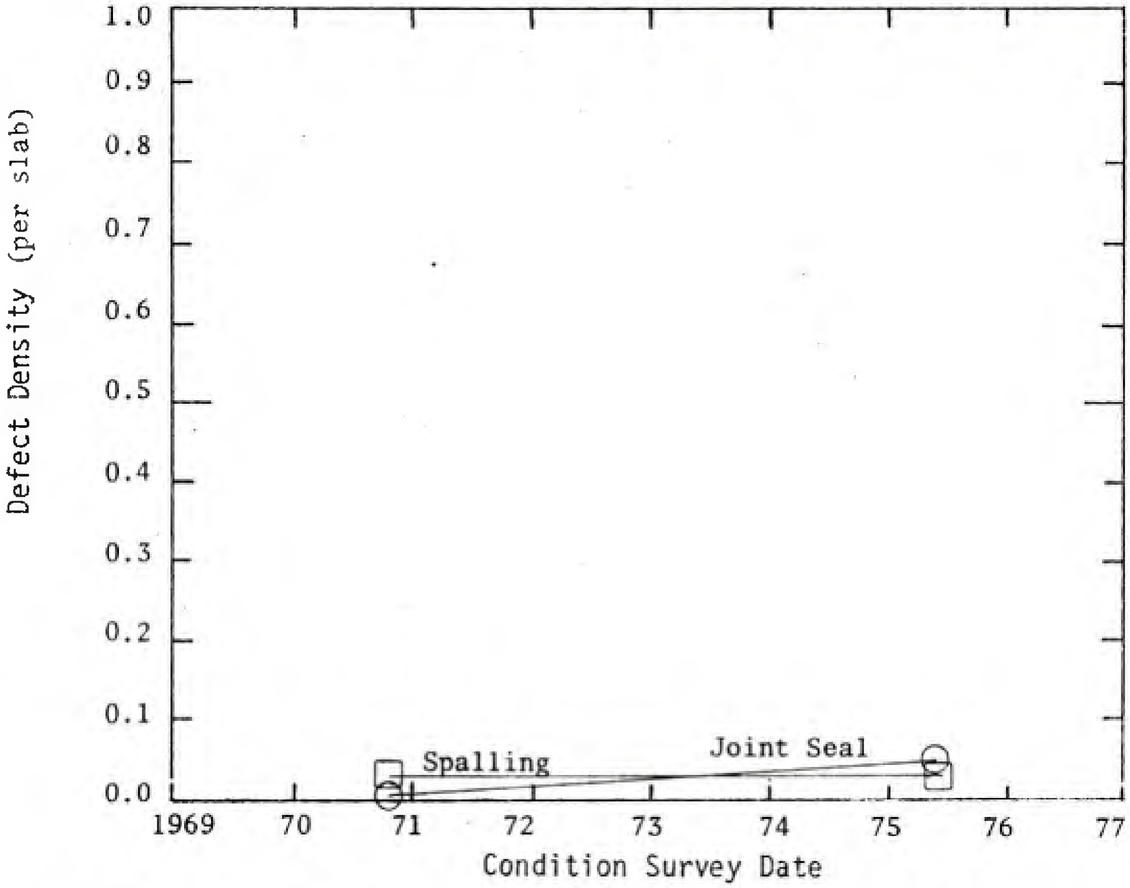
DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Whidbey Island Facility Runway 6-24
Discrete Area R6-2 Pavement Type PCC
Discussion

The pavement condition is essentially unchanged since the last condition survey.

DISCRETE AREA CONDITION ANALYSIS

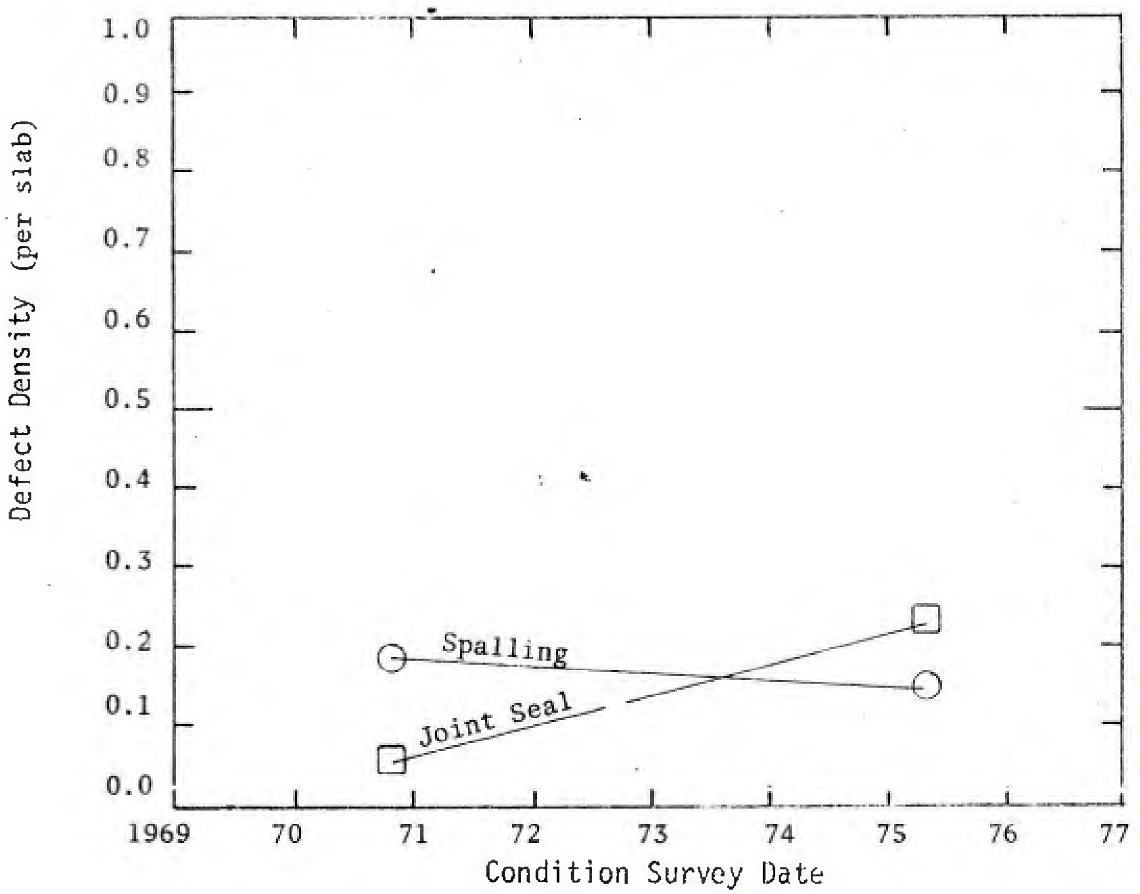


Airfield NAS Whidbey Island Facility Runway 6-24
Discrete Area R6-1 Pavement Type PCC

Discussion

An insignificant change in the amount of spalling and defective joint seal was noted.

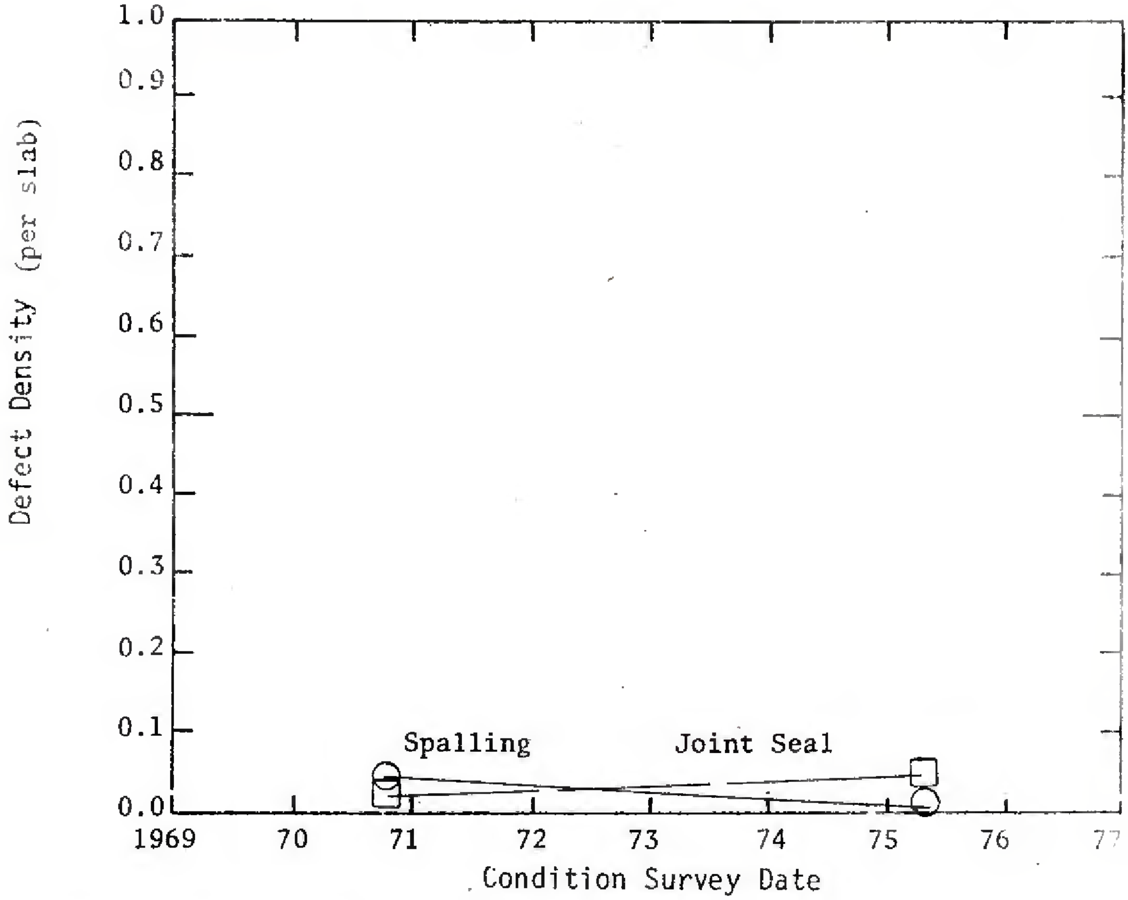
DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Whidbey Island Facility Runway 13-31
Discrete Area R13-1 Pavement Type PCC
Discussion

The increased amount of defective joint seal is probably due to aging. Spalling quantities are esentially unchanged. Other defects noted are considered insignificant.

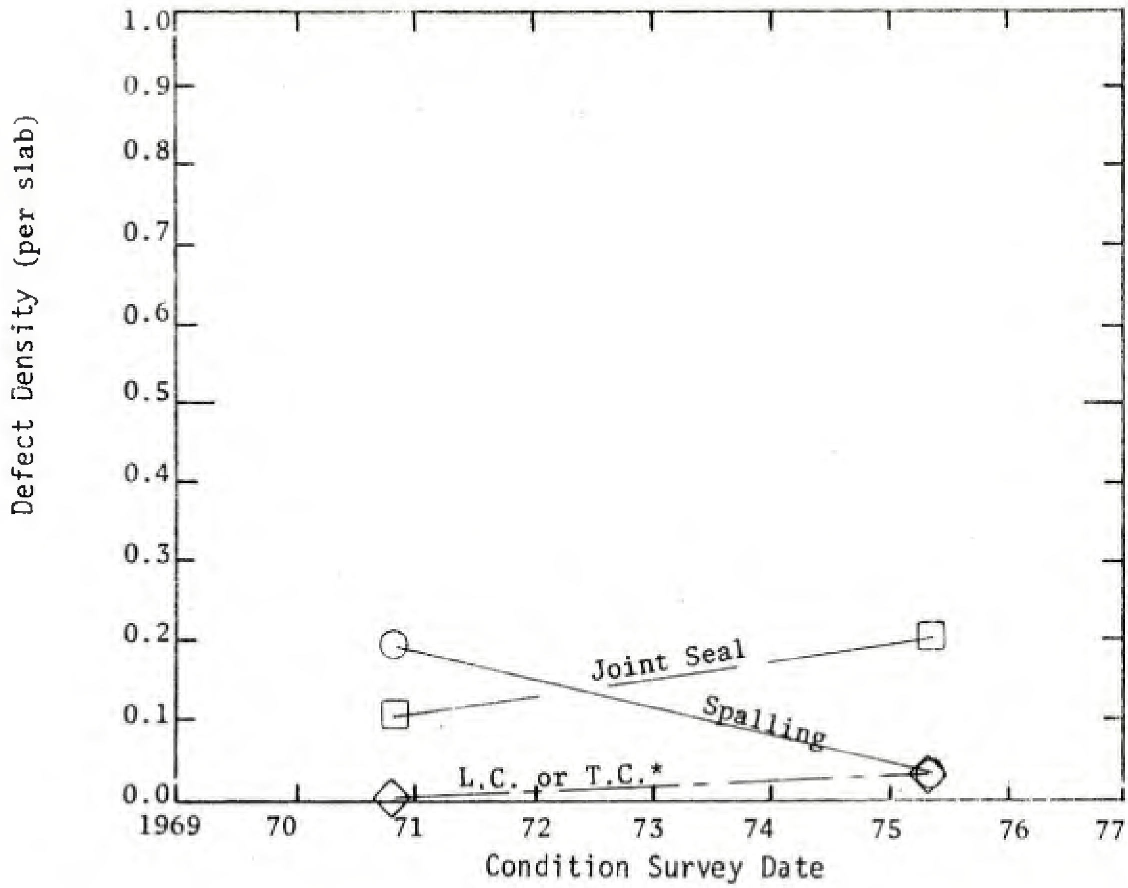
DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Whidbey Island Facility Runway 13-31
Discrete Area R13-2 Pavement Type PCC
Discussion

The slight increase in joint defects is attributed to aging.

DISCRETE AREA CONDITION ANALYSIS



Airfield	NOLF Coupeville	Facility	Runway 14-32
Discrete Area	R14-1	Pavement Type	PCC

Discussion

The decrease in spalling is assumed to be the result of repairs made since the 1970 condition survey. Increased defective joint seal is probably due to aging.

*Longitudinal crack transverse crack

APPENDIX A

CONSTRUCTION HISTORY

USNAS WHIDBEY ISLAND, WASHINGTON
AND
USNOLF COUPEVILLE, WASHINGTON

APPENDIX A

CONSTRUCTION HISTORY FOR USNAS WHIDBEY ISLAND, WA

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened or Sealed
1	Runway 13-31, portions of Taxiways L, N, P, and Runway 6-24		
	Minor Repairs on Runway 13-31		1972-1975
	11" Portland cement concrete	1961-1962	
	9" Granular base course	1961-1962	
2	Runway 13-31 ends and portions of Taxiways L and P		
	12" Reinforced portland cement concrete	1961-1962	
	9" Granular base course	1961-1962	
3	Runway 6-24, Taxiways D & F, portions of Taxiways C & B		
	Minor repairs on Runway 6-24		1972-1975
	Joints sealed - 1000' each		
	Runway end SS-S-00200C		1964
	Interior portion SS-S-164		1965
	Taxiways D, F, C, SS-S-0167B		1965
	10" Reinforced portland cement concrete	1951-1952	
	14" Subbase		
4	Runway 6-24 (West end and warmup apron) Taxiway C, A, portions of Taxiway I		
	Joints sealed SS-S-00200C		1964
	11" Reinforced portland cement concrete	1951-1952	
	13" Subbase	1951-1952	
5	Taxiway E (center 150'), portion of Taxiway I		
	Slurry seal		1957
	2" Asphaltic concrete overlay		1950
	6" Portland cement concrete	1942	
	Approximately 6" base course	1942	

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened or Sealed
5A	Portion of Taxiway I		
	2" Asphaltic concrete wearing course		1970
	Variable thickness asphaltic concrete binder course		1970
	2" Asphaltic concrete overlay		1950
	6" Portland cement concrete	1942	
	Approximately 6" base course	1942	
5B	Portion of Taxiway I		
	Asphaltic concrete overlay		1968
	Slurry seal		1957
	2" Asphaltic concrete overlay		1950
	6" Portland cement concrete	1942	
	Approximately 6" base course	1942	
6	Taxiway E and Taxiway I (20' widening each side		
	6" Portland cement concrete	1943	
7	Portion of Parking Apron 1 & 2		
	6" Portland cement concrete	1945	
8	Portion of Parking Apron 1		
	8" Portland cement concrete	1947	
	12" Pit run base	1947	
9	Portion of Parking Apron 1		
	8" Portland cement concrete	1949	
	12" Pit run base	1949	
10	Portion of Parking Apron 1		
	Joints sealed SS-S-00167B		1965
	10" Portland cement concrete	1950	
	10" Base course	1950	
11	Portion of Parking Apron 1		
	Joints sealed SS-S-00200C		1962
	11" Portland cement concrete	1956	
	12" Base course	1956	

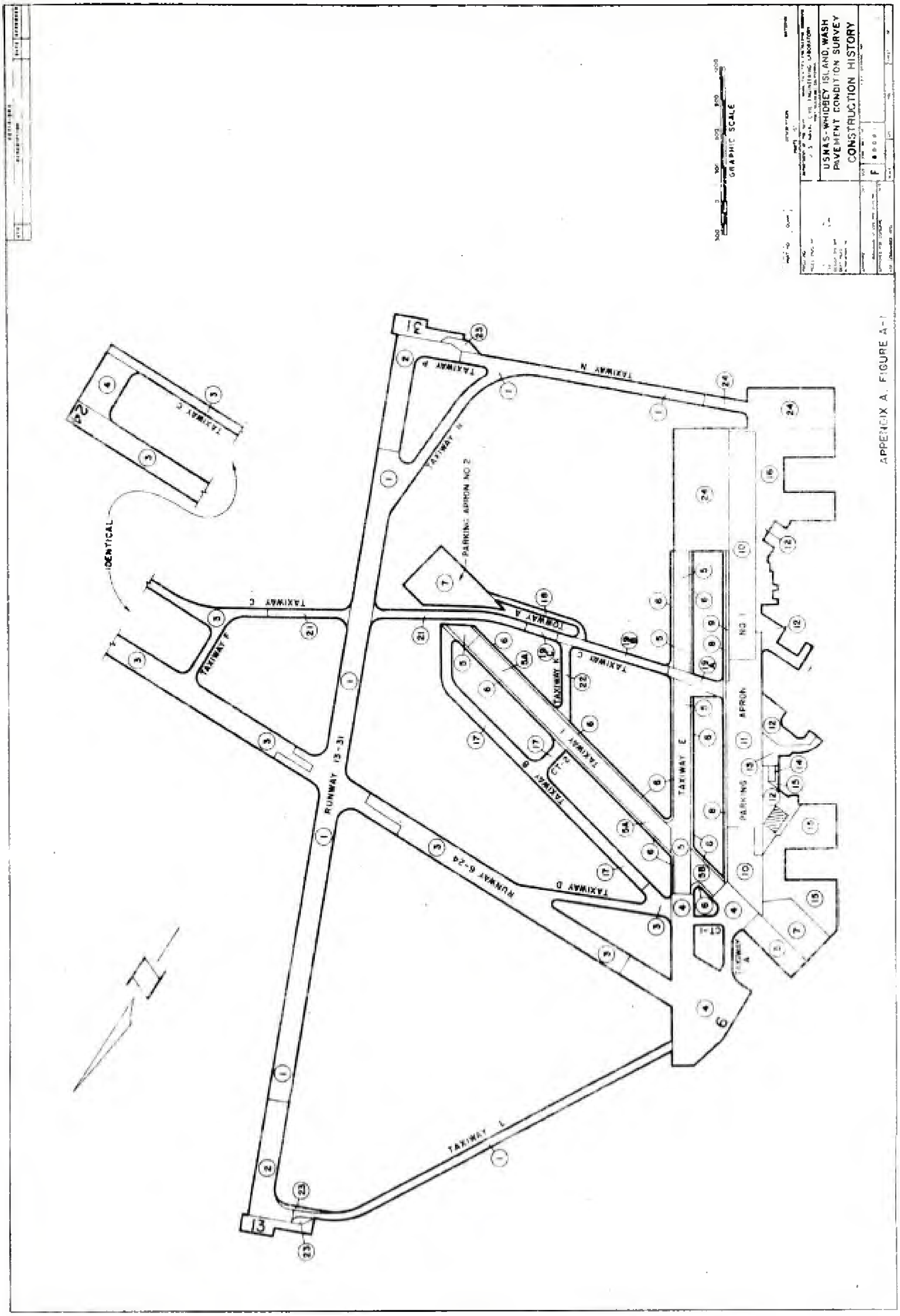
Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened or Sealed
12	Portion of Parking Apron 1		
	6" Portland cement concrete	1942	
	Approximately 6" base course	1942	
13	Portion of Parking Apron 1		
	6" Portland cement concrete	1945	
14	Portion of Parking Apron 1		
	4" Asphaltic concrete	1955	
	12" Base course	1955	
15	Portion of Parking Apron 1		
	11" Portland cement concrete	1952	
	12" Base course	1952	
16	Portion of Parking Apron 1		
	11" Portland cement concrete	1955	
	12" Base course	1955	
17	Taxiway B and Connecting Taxiway 2		
	6" Portland cement concrete	1942	
18	Towway A		
	3" Asphaltic concrete		1970
	2" Top course		1970
	6"-12" Base course		1970
	Tack coat		1970
	3" Asphaltic concrete	1961-1962	
	4" Crushed rock	1961-1962	
	8" Granular base	1961-1962	
19A	Portion of Taxiway C		
	1½" Asphaltic concrete wearing course	1970	
	2½" Asphaltic concrete binder course	1970	
	12" Asphalt treated base	1970	
	47" Compacted subbase	1970	

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened or Sealed
19B	Portion of Taxiway C		
	1½" Asphaltic concrete wearing course		1970
	2½" Asphaltic concrete binder course		1970
	12" Asphalt treated base		1970
	Variable depth subbase		1970
	Variable asphaltic concrete overlay		1951-1952
	6" Portland cement concrete	1943	
19C	Portion of Taxiway C		
	1½" Asphaltic concrete wearing course		1970
	2½" Asphaltic concrete binder course		1970
	Variable depth asphalt treated base		1970
	2" Asphaltic concrete wearing course		1961
	4" Asphaltic concrete binder course		1961
	11" Crushed rock base		1961
	10" Portland cement concrete	1951	
	14" Subbase	1951	
21	Portion of Taxiway C		
	11" Portland cement concrete		1961
	9" Granular base		1961
	Variable fill to bring to grade of Runway 13-31		1961
	10" Portland cement concrete	1951	
	14" Subbase	1951	
22	Taxiway K		
	2" Asphaltic concrete wearing course		1970
	Variable asphaltic concrete binder course		1970
	Tack coat		1970
	6" Portland cement concrete	1944	
23	Portions of Taxiways L & N		
	11" Portland cement concrete	1964	
	9" Granular base	1964	
24	Portions of Parking Apron 1 & Taxiway N		
	10" Portland cement concrete	1970	
	8" Base course	1970	

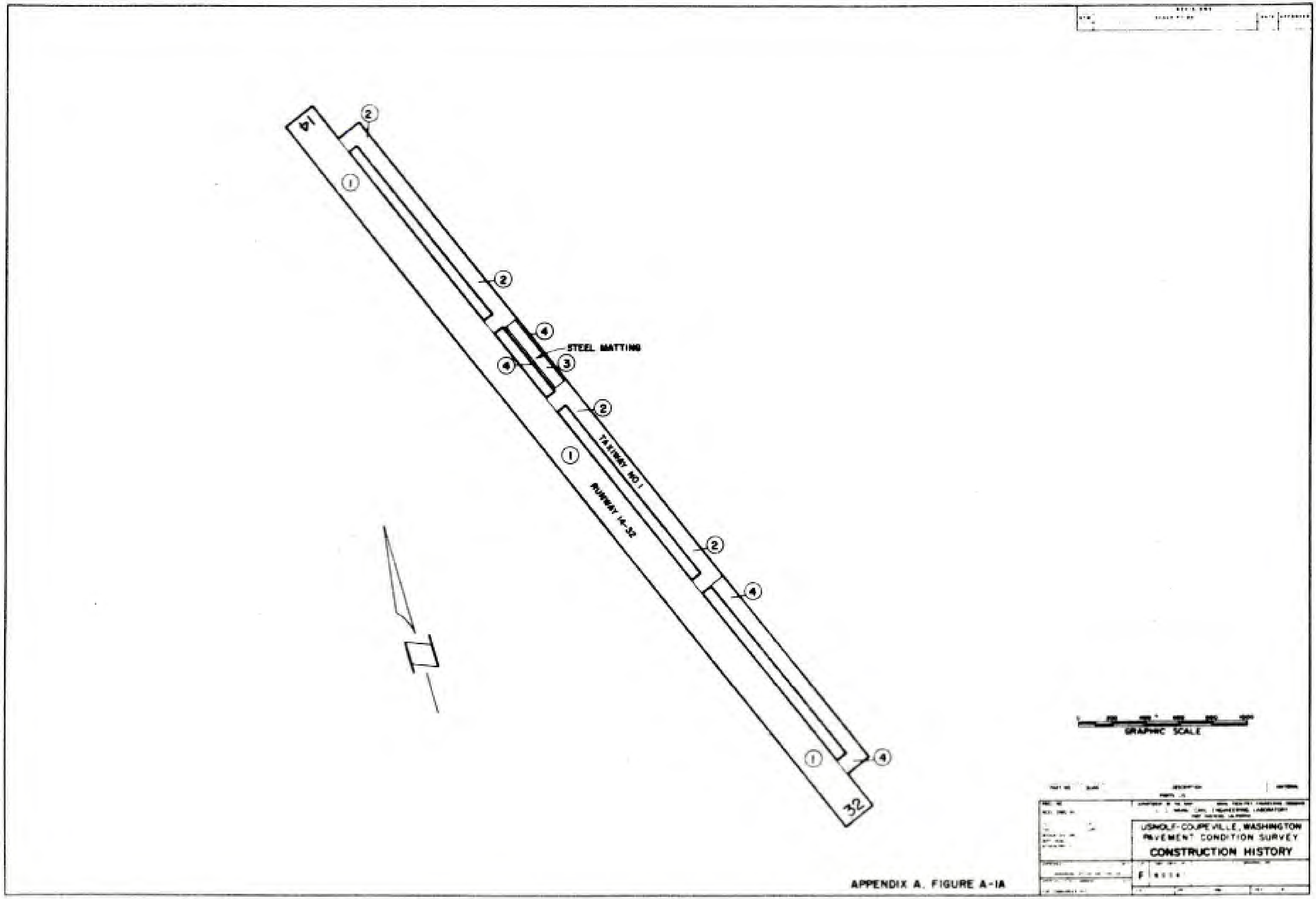
APPENDIX A

CONSTRUCTION HISTORY FOR USNOLF COUPEVILLE, WASHINGTON

Item No.	Section From Surface to Subgrade	Date Constructed	Date Strengthened or Sealed
1	Runway 14-32		
	Minor repairs		1973-1975
	6" Portland cement concrete	1943	
	12" Select granular base course	1943	
2	Portions of Taxiway No. 1		
	1" Asphaltic concrete overlay		1951
	2" Asphaltic concrete	1944	
	21" Select granular base course	1944	
3	Portion of Taxiway No. 1		
	Steel matting	1944	
4	Portions of Taxiway No. 1		
	2" Asphaltic concrete	1951	
	12" Granular base course	1951	



APPENDIX A. FIGURE A-1



APPENDIX A. FIGURE A-1A

APPENDIX B

CLIMATOLOGICAL DATA

USNAS WHIDBEY ISLAND, WASHINGTON

APPENDIX B

CLIMATOLOGICAL DATA FOR
USNAS WHIDBEY ISLAND, WASHINGTON

Temperature Data
(Degrees Fahreneit)

Month	Means		Extremes	
	Daily Maximum	Daily Minimum	Record Highest	Record Lowest
January	44.4	34.9	64	-1
February	47.6	36.4	64	6
March	49.4	37.0	70	16
April	54.2	41.2	72	29
May	58.8	46.0	82	32
June	62.7	49.9	85	37
July	65.4	51.7	86	42
August	65.9	52.1	88	42
September	63.6	48.8	87	34
October	57.1	44.2	75	26
November	50.2	39.3	64	9
December	46.3	37.0	62	3

Length of Record: 22 years, 1946 - 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	2.28	4.46	0.68	0.91
February	1.83	3.27	0.85	1.34
March	1.62	2.57	0.30	0.94
April	1.28	2.57	0.07	0.87
May	1.13	3.68	0.30	1.26
June	1.23	4.67	0.25	2.32
July	0.65	2.11	T	1.02
August	0.88	2.52	0.04	0.92
September	1.04	2.65	0.17	1.38
October	1.98	4.03	0.56	1.10
November	2.40	4.06	0.58	1.52
December	2.70	5.14	1.22	1.81

Annual Mean 19.02
T = Trace, an ammount too small to measure

Wind

Month	Mean Speed (kts)	Prevailing Direction	Peak Gust		
			Speed	Direction	Year
January	9.1	SE	60	SW	1951
February	8.5	SE	58	W	1959
March	8.4	SE	54	SW	1957
April	7.8	W	53	WSW	1959
May	7.0	W	47	SE	1948
June	6.3	SW	39	SE	1962
July	6.0	SW	44	SSE	1954
August	5.2	SW	44	SE	1958
September	5.1	W	51	W	1958
October	6.7	SE	58	SSE	1962
November	8.0	SE	56	SSE	1948
December	9.1	SE	58	NW	1958

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

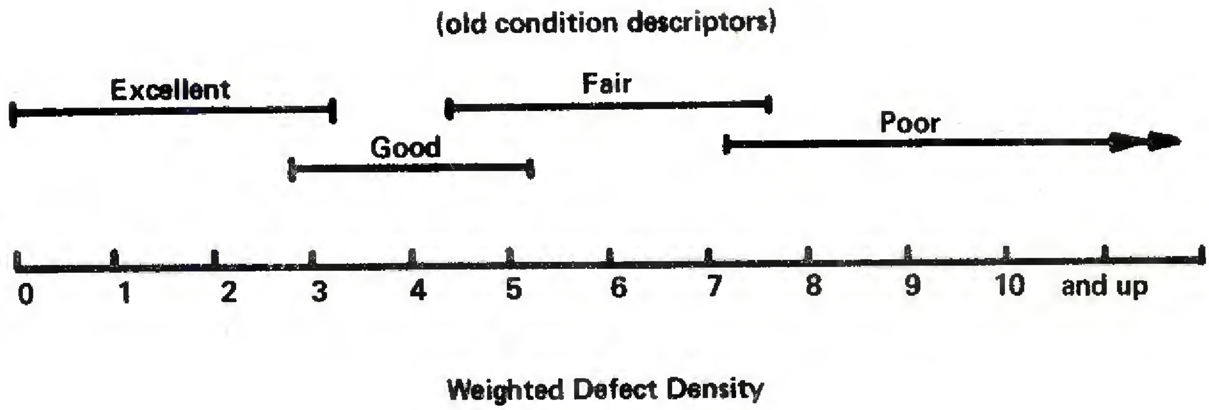
A final step in providing a numerical condition rating for each facility (runway, taxiway, etc.) is accomplished in the Facility Defect Summary sheets, Figures C-5 and C-6. Again note that separate sheets have been provided for AC and PCC pavements. In these sheets the individual weighted defect densities 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 not numerically compatible and must not be combined. (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 both AC and PCC pavements, but provides a separate average weighted defect density for the entire AC portion and a separate average weighted defect density for the combined PCC end pavements. It is not 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 many 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.

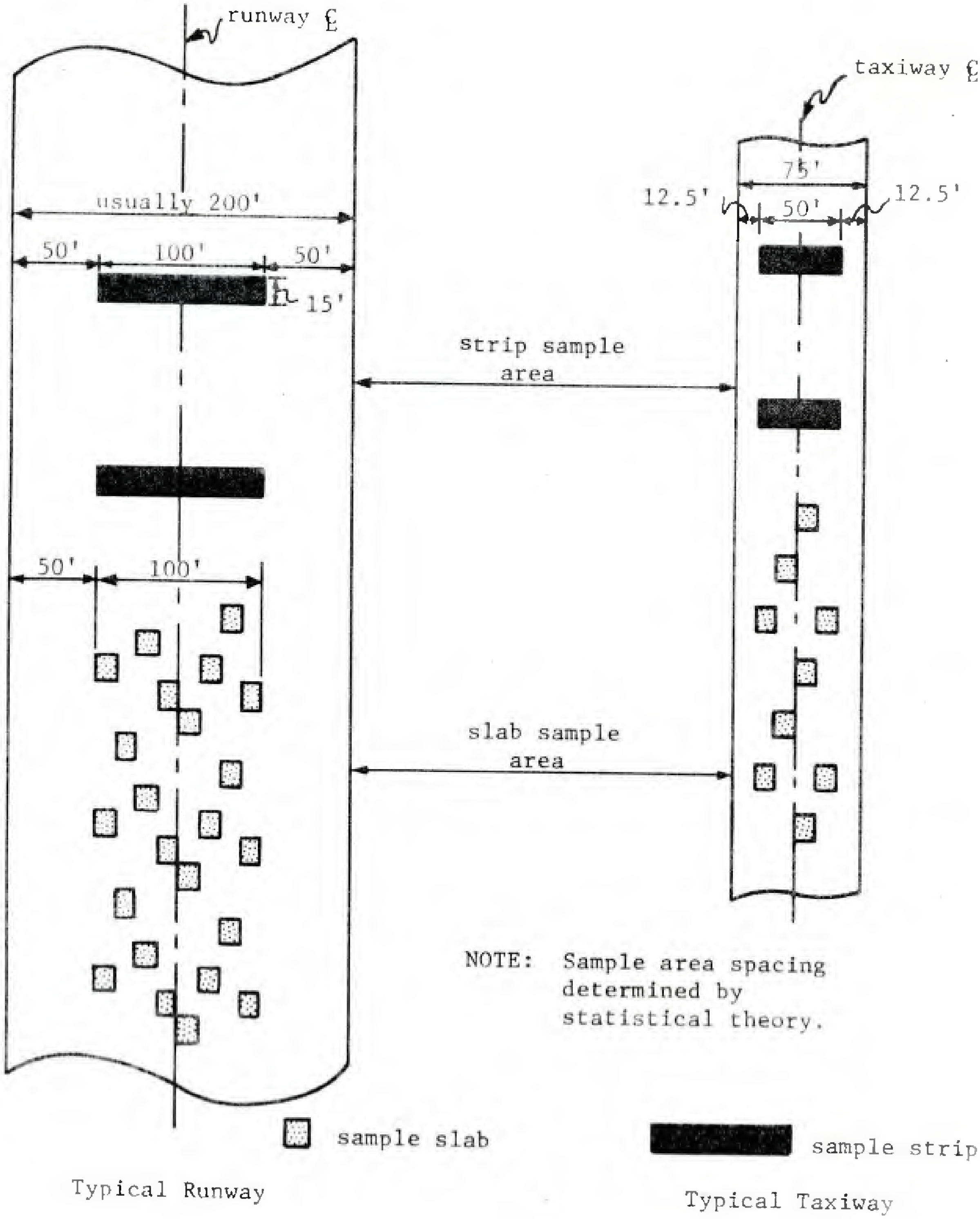


Figure C-1. Portland cement concrete sample areas.

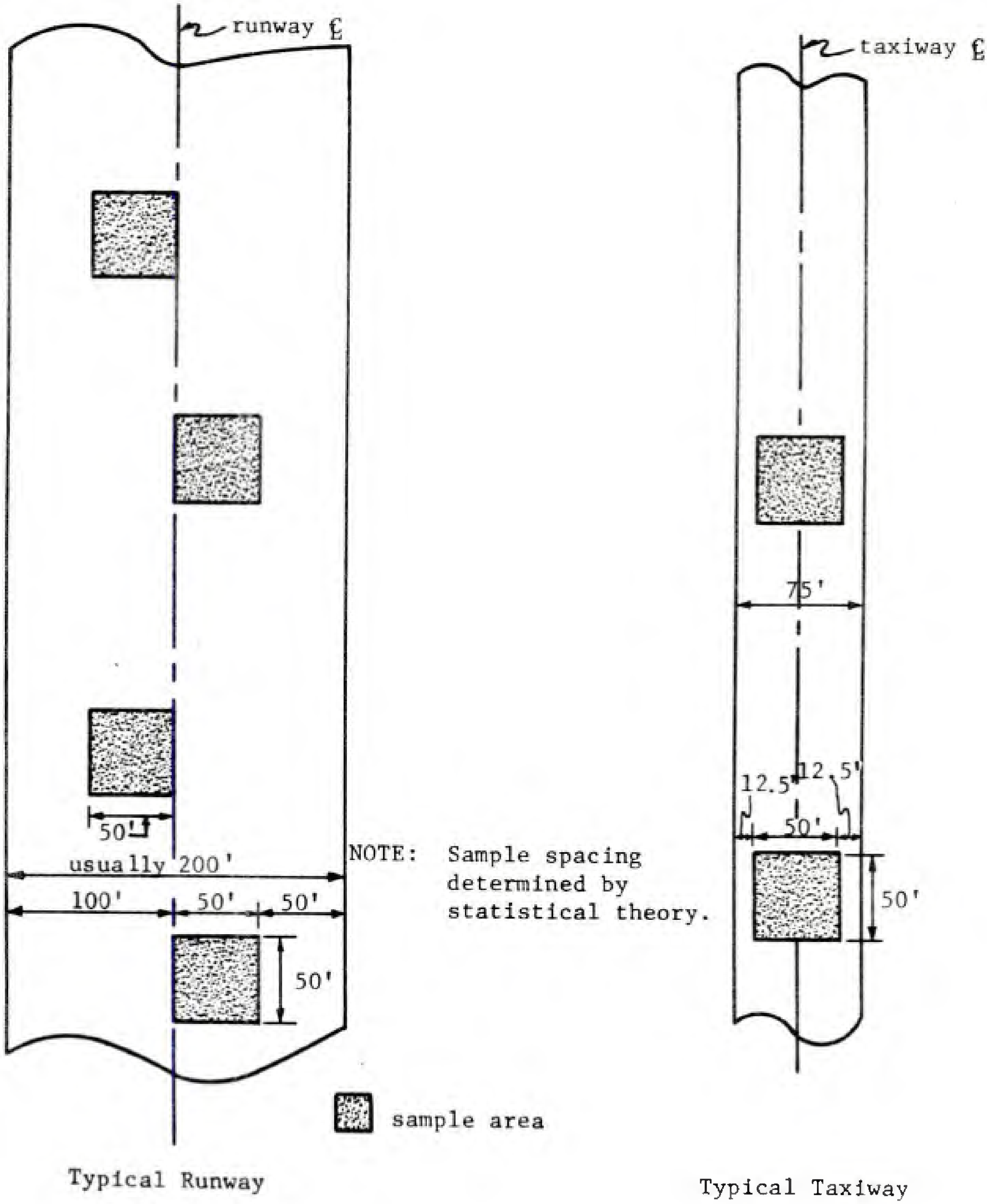


Figure C-2. Asphaltic concrete sample areas.

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 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/s	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

ASPHALTIC CONCRETE FACILITY DEFECT SUMMARY

Airfield EXAMPLE

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 PA7-2	4.97 A 23.18 A	0.79 0.21	3.93 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

PORTLAND CEMENT 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)**
Runway 11-29			
R11-1	0.80 C	0.25	0.02
R11-2	4.43 C	0.75	3.33
			3.35 C (Total)
Runway 18-36			
R18-1	1.25 C	0.68	0.85
R18-2	0.76 C	0.32	0.28
			1.13 C (Total)
Taxiway 1			
T1-1	2.82 C	0.12	0.34
T1-2	0.98 C	0.88	0.86
			1.20 C (Total)
Taxiway 2			
T2-2	2.57 C	1.00	2.57 C
Taxiway 3			
T3-1	1.82 C	1.00	1.82 C
Taxiway 4			
T4-1	3.02 C	1.00	3.02 C
Taxiway 5			
T5-1	0.98 C	1.00	0.98 C
Taxiway 6 and Taxiway 7			
T6-1 and T7-1	0.06 C	1.00	0.06 C

* 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.

Figure C-6. Typical Portland Cement Concrete Facility Defect Summary

APPENDIX D

MU-METER TEST RESULTS

APPENDIX D. MU-METER TEST RESULTS
USNAS WHIDBEY ISLAND, WA

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 6-24					
Test Section A					
1	24	1.31	0.47	0.66	0.05
2	6	3.06	0.61	0.76	0.16
3	24	4.83	0.68	0.79	0.21
4	6	7.32	0.62	0.79	0.20
5	24	9.38	0.68	0.78	0.10
6	6	13.63	0.63	0.73	0.20
7	24	25.04	0.69	0.74	0.55
	6				
Test Section B					
1	24	1.84	0.59	0.66	0.50
2	6	3.66	0.64	0.71	0.55
3	24	5.37	0.68	0.75	0.53
4	6	7.20	0.69	0.76	0.61
5	24	9.19	0.71	0.75	0.60
6	6	14.43	0.71	0.78	0.60
7	24	18.14	0.69	0.76	0.56
Test Section C					
1	24	1.38	0.67	0.73	0.55
2	6	4.16	0.76	0.79	0.65
3	24	4.71	0.76	0.80	0.67
4	6	6.38	0.78	0.81	0.72
5	24	12.93	0.74	0.77	0.66
6	6	17.69	0.87	0.90	0.69
Test Section D					
1	24	1.37	0.40	0.64	0.06
2	6	2.83	0.45	0.80	0.02
3	24	4.55	0.53	0.74	0.08
4	6	6.41	0.52	0.83	0.06
5	24	8.40	0.54	0.87	0.10
6	6	10.56	0.57	0.82	0.05
7	24	16.44	0.65	0.82	0.18
8	6	23.08	0.72	0.84	0.31
9	24	27.08	0.80	0.86	0.52

APPENDIX D. MU-METER TEST RESULTS
(Continued)

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 13-31					
Test Section A					
1	31	1.25	0.62	0.77	0.36
2	13	2.83	0.71	0.82	0.46
3	31	4.38	0.72	0.81	0.40
4	13	6.58	0.77	0.84	0.50
5	31	9.82	0.79	0.85	0.38
6	13	14.76	0.84	0.88	0.65
Test Section B					
1	31	1.35	0.63	0.75	0.53
2	13	3.07	0.71	0.76	0.53
3	31	4.82	0.77	0.82	0.64
4	13	6.56	0.77	0.83	0.61
5	31	8.49	0.83	0.86	0.76
6	13	15.07	0.82	0.85	0.74
Test Section C					
1	31	2.02	0.57	0.67	0.46
2	13	3.60	0.65	0.72	0.51
3	31	5.50	0.67	0.73	0.56
4	13	8.05	0.71	0.76	0.59
5	31	11.17	0.71	0.74	0.58
6	13	18.88	0.75	0.79	0.67
7	31	27.50	0.75	0.79	0.68
Test Section D					
1	N.G.	--	--	--	--
2	13	3.28	0.74	0.82	0.40
3	31	5.11	0.81	0.85	0.50
4	13	6.89	0.80	0.84	0.53
5	31	14.23	0.79	0.86	0.70