

NCEL  
TM-  
53-75-2

c.2

TM no. M-75-53-2



# TECHNICAL MEMORANDUM

**title:** "AIRFIELD PAVEMENT CONDITION SURVEY, USNAS MIRAMAR, CALIFORNIA, 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

NCEL  
TM-  
53-75-2  
c.2

# AIRFIELD PAVEMENT CONDITION SURVEY, USNAS MIRAMAR, CALIFORNIA

Technical Memorandum M-75-53-2

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, Miramar, 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. The results of the condition survey show an increasing amount of joint seal defects. Continuing repairs have effected a decrease in the number of spalls. Runway friction measurements show that all runways have satisfactory frictional resistance.



# CONTENTS

|                                                                                      | Page  |
|--------------------------------------------------------------------------------------|-------|
| INTRODUCTION . . . . .                                                               | 1     |
| BACKGROUND . . . . .                                                                 | 1     |
| CONSTRUCTION HISTORY . . . . .                                                       | 1     |
| CURRENT AIRCRAFT TRAFFIC . . . . .                                                   | 2     |
| CLIMATOLOGICAL DATA . . . . .                                                        | 2     |
| PAVEMENT CONDITION SURVEY. . . . .                                                   | 2     |
| Condition Survey Procedure . . . . .                                                 | 2     |
| Results of Condition Survey. . . . .                                                 | 2     |
| RUNWAY FRICTION MEASUREMENTS . . . . .                                               | 3     |
| Test Locations . . . . .                                                             | 3     |
| Test Equipment . . . . .                                                             | 3     |
| Test Procedures. . . . .                                                             | 4     |
| Runway Friction Test Results . . . . .                                               | 4     |
| DISCUSSION OF RESULTS. . . . .                                                       | 5     |
| Condition Survey Results . . . . .                                                   | 5     |
| Runway Friction Measurements . . . . .                                               | 5     |
| RECOMMENDATIONS FOR FURTHER EVALUATION EFFORT. . . . .                               | 6     |
| REFERENCES . . . . .                                                                 | 6     |
| Table 1. Aircraft Operations Data . . . . .                                          | 7     |
| Table 2. Types of Aircraft Using USNAS Miramar, CA. . . . .                          | 8     |
| Table 3. Defect Severity Weights. . . . .                                            | 9     |
| Table 4. Runway Friction Measurement Summary. . . . .                                | 10    |
| Table 5. Mu-Muter Aircraft Pavement Rating. . . . .                                  | 11    |
| Table 6. Runway Slope Measurements. . . . .                                          | 12    |
| Figure 1. Aerial View of USNAS Miramar, CA . . . . .                                 | 14    |
| Figure 2. Discrete Area Map . . . . .                                                | 15    |
| Figures 3 to 13. Photographs of Pavements at USNAS Miramar, CA. . . . .              | 16-26 |
| Figure 14. Friction Test Locations. . . . .                                          | 27    |
| Figures 15 to 20. Friction Coefficient versus Distance . . . . .                     | 28-33 |
| Figures 21 to 24. Average Friction Coefficient versus Time<br>After Wetting. . . . . | 34-37 |
| DISCRETE AREA DEFECT SUMMARIES . . . . .                                             | 38-45 |
| FACILITY DEFECT SUMMARIES. . . . .                                                   | 46-47 |
| DISCRETE AREA CONDITION ANALYSIS . . . . .                                           | 48-55 |
| Appendix A. Construction History. . . . .                                            | 57    |
| Figure A-1. Construction History Drawing. . . . .                                    | 65    |
| Appendix B. Climatological Data . . . . .                                            | 67    |
| Appendix C. Condition Survey Procedures . . . . .                                    | 71    |
| Figure C-1. Portland Cement Concrete Sample Areas . . . . .                          | 77    |
| Figure C-2. Asphaltic Concrete Sample Areas . . . . .                                | 78    |
| Figure C-3. Typical Asphaltic Concrete Discrete Area Defect<br>Summary. . . . .      | 79    |

|            |                                                          |    |
|------------|----------------------------------------------------------|----|
| Figure C-4 | Typical Portland Cement Concrete Discrete Area Defect    |    |
| Summary    | .....                                                    | 80 |
| Figure C-5 | Typical Asphaltic Concrete Facility Defect Summary       | 81 |
| Figure C-6 | Typical Portland Cement Concrete Facility Defect Summary | 82 |
| Appendix D | Mu-Meter Test Results. ....                              | 83 |

## 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 conditions 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, Miramar, California by the Naval Civil Engineering Laboratory\* in January 1970 and reported in reference (1). Commencing in FY-75, pavement condition surveys will be performed only on active runways, and increased emphasis will be placed on determining runway friction coefficients. During the month of November 1974, a second pavement condition survey was made at NAS Miramar 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. In June 1975, 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 evaluation efforts at the station.

## BACKGROUND

The U.S. Naval Air Station, Miramar, is located in San Diego County, in the city of San Diego, California, at an elevation of 477 feet. An aerial photograph of the station is shown in Figure 1. The airfield has two major runways and one auxiliary runway. The two major runways, 6R-24L and 6L-24R, are 8,000 feet and 12,000 feet long, respectively, and lie parallel in a generally east-west direction. The auxiliary runway, 10-28, is 6,000 feet long and lies in a northwest-southeast direction.

## CONSTRUCTION HISTORY

Original construction of Runways 6L-24R and 10-28 was completed in 1943-44. Runway 6R-24L was completed in 1951. During the ensuing years since original construction, extension and strengthening of the runways and taxiways has been accomplished, along with additions of taxiways and parking aprons. A complete history of construction and recorded maintenance is provided in Appendix A.

---

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

## 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 Miramar is presented in Appendix B.

## PAVEMENT CONDITION SURVEY

### Condition Survey Procedure

The condition survey procedure used at NAS Miramar 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 Miramar, 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 Miramar 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 38 through 45 of this report. Each Discrete Area 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 13. Facility Defect Summaries are shown on pages 46 and 47.

Total weighted defect densities for portland cement concrete discrete areas range from 1.30C (0.00C being no visible defects) for discrete area R28-1 to 4.17C for discrete area R24R-2. The only asphaltic concrete discrete area, R24L-3 had a defect density of 0.00A. An analysis of the change in pavement condition since the last condition survey is given in the Discrete Area Condition Analysis sheets, pages 48 through 55.

## 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 14. 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 on Runway 10-28 as it is used only for arrested landings.

### 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 provided by the station was a runway foamer with a 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.

---

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

## Test Procedures

The field test procedures utilized at NAS Miramar 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 or 2000 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 15 through 20. 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 Miramar the low-coefficient areas correspond to areas of heavy rubber deposits. Appendix D contains all test results for each Mu-Meter test section.

Figures 21 through 24 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 21 through 24, 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 21 through 24 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 water drains to the runway edge without crossing the centerline, while negative transverse slopes indicate drainage 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 all discrete areas since the 1970 condition survey (Reference 1). An increase in the amount of defective joint seal was found in most areas as shown in the Discrete Area Condition Analysis sheets, pages 48 through 55. No defects were visible in the one asphaltic concrete discrete area due to the seal placed one month before the condition survey.

### 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 area which demonstrated any potential hydroplaning hazard was the rubber-

covered area of Runway 6L-24R as shown in Figure 18. It is also assumed that the FCLP (field carrier landing practice) area on Runway 6R-24L would have similar properties. The FCLP area was not included in the friction test sections as it is located on the side of the runway out of normal aircraft braking areas.

#### RECOMMENDATIONS FOR FURTHER EVALUATION EFFORT

A comprehensive evaluation was performed at NAS Miramar by NCEL in 1964 (see Reference 2). No defects attributed to changes in load carrying capacity were noted in this current (1974) condition survey. Therefore, no additional evaluation effort is recommended at this time.

#### REFERENCES

1. U.S. Naval Civil Engineering Laboratory. Technical Note N-1122, Airfield Pavement Condition Survey - USNAS Miramar, California, by D. J. Lambiotte and R. B. Brownie, Port Hueneme, California, August 1970.
2. U.S. Naval Civil Engineering Laboratory, Technical Note N-718: Airfield Pavement Evaluation - USNAS Miramar, California, by R. J. Lowe and W. H. Chamberlin, May 1965.

Table 1. Aircraft Operations Data.  
USNAS Miramar, California

| <u>Date</u>                                     | <u>Takeoffs and Landings</u> | <u>Touch and Go or Field Mirror Landing Practice</u> |
|-------------------------------------------------|------------------------------|------------------------------------------------------|
| October 1973                                    | 8594                         | 2,021                                                |
| November                                        | 5836                         | 3,072                                                |
| December                                        | 4305                         | 3,472                                                |
| January 1974                                    | 5286                         | 6,464                                                |
| February                                        | 5520                         | 6,694                                                |
| March                                           | 6954                         | 6,734                                                |
| April                                           | 7709                         | 10,407                                               |
| May                                             | 6222                         | 7,478                                                |
| June                                            | 5688                         | 6,003                                                |
| July                                            | 6257                         | 7,964                                                |
| August                                          | 6962                         | 5,371                                                |
| September                                       | <u>5493</u>                  | <u>5,226</u>                                         |
| Average per month for the above one year period | 6235                         | 5,909                                                |

Table 2. Aircraft Using USNAS  
Miramar, California

Aircraft based at  
NAS Miramar:

A4, F4, F8, F14, F5, T38, T28, C1

Aircraft using NAS  
Miramar on a transient  
basis:

A3, A5, A6, A7, P3, E1, E2, S2, S3,  
C2, C5, C9, C117, C118, C130, C141,  
F100, F101, F102, F105, F106, T33,  
T37, T39, OV10; and 707, 727, 737,  
DC8, DC9, and numerous other civilian  
aircraft.

Table 3. Defect Severity Weights

Airfield: USNAS Miramar, California

| Asphaltic Concrete                                                                |               | Portland Cement Concrete                     |               |
|-----------------------------------------------------------------------------------|---------------|----------------------------------------------|---------------|
| <u>Defect</u>                                                                     | <u>Weight</u> | <u>Defect</u>                                | <u>Weight</u> |
| 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,<br>or Longitudinal Construction<br>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<br>Crack. . . . . | 1.5           |

Table 4. Runway Friction Measurement Summary,  
USNAS Miramar, California

| Test Locations | Average Friction Coefficients |                 |                 |
|----------------|-------------------------------|-----------------|-----------------|
|                | 3 Min.<br>(Mu)                | 15 Min.<br>(Mu) | 30 Min.<br>(Mu) |
| Runway 6R-24L  |                               |                 |                 |
| Test Section A | 0.78                          | 0.78            | 0.78            |
| Test Section B | 0.69                          | 0.66            | 0.64            |
| Test Section C |                               |                 |                 |
| AC portion     | 0.67                          | 0.67            | 0.63            |
| PCC portion    | 0.56                          | 0.73            | 0.75            |
| Runway 6L-24R  |                               |                 |                 |
| Test Section A | 0.47                          | 0.68            | 0.73            |
| Test Section B | 0.65                          | 0.80            | 0.80            |
| Test Section C | 0.57                          | 0.73            | 0.73            |
| Test Section D | 0.69                          | 0.78            | 0.78            |

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 Miramar, California

| Location      | Transverse Slopes |         |         |         | Longitudinal<br>Slopes<br>Percent |
|---------------|-------------------|---------|---------|---------|-----------------------------------|
|               | Left              |         | Right   |         |                                   |
|               | Percent           | Percent | Percent | Percent |                                   |
| Runway 6R-24L |                   |         |         |         |                                   |
| 0+00          | +0.2              | +0.1    | +0.3    | +0.2    | -0.4                              |
| 5+00          | +0.4              | +0.3    | -0.2    | -0.3    | -0.8                              |
| 10+00         | +0.5              | +0.4    | +0.7    | +1.3    | -0.7                              |
| 15+00         | +0.7              | +0.4    | +0.5    | +0.7    | -0.7                              |
| 20+00         | +0.5              | +0.5    | +0.4    | +0.5    | -0.3                              |
| 25+00         | +0.7              | +0.5    | +0.7    | +0.5    | -0.4                              |
| 30+00         | +0.1              | -0.1    | +0.3    | +0.2    | -0.5                              |
| 35+00         | +0.3              | +0.3    | +0.1    | +0.2    | -0.8                              |
| 40+00         | +0.5              | +0.3    | +0.7    | +0.2    | -0.3                              |
| 45+00         | +0.6              | +0.4    | +0.3    | +0.3    | -0.3                              |
| 50+00         | +0.3              | +0.4    | +0.3    | +0.3    | -0.6                              |
| 55+00         | +0.3              | +0.3    | +0.5    | +0.2    | -0.5                              |
| 60+00         | +0.7              | +0.2    | +0.6    | +0.1    | -0.5                              |
| 65+00         | +0.2              | +0.7    | +0.6    | +0.4    | -0.3                              |
| 70+00         | +0.8              | +0.7    | +0.4    | +0.3    | -0.4                              |
| 75+00         | +0.3              | +0.3    | +0.2    | +0.3    | -0.3                              |
| 80+00         | +0.3              | +0.5    | 0.0     | +0.2    | 0.0                               |
| Runway 6L-24R |                   |         |         |         |                                   |
| 0+00          | -0.4              | -0.4    | +0.4    | +0.3    | -0.6                              |
| 5+00          | -0.2              | -0.5    | +0.3    | +0.1    | -0.6                              |
| 10+00         | 0.0               | -0.4    | +0.3    | +0.3    | -0.4                              |
| 15+00         | -0.2              | -0.2    | 0.0     | -0.2    | -0.5                              |
| 20+00         | 0.0               | +0.2    | -0.1    | 0.0     | -0.6                              |
| 25+00         | +0.4              | +0.6    | +0.2    | +0.1    | -0.7                              |
| 30+00         | +0.3              | +0.7    | +0.2    | +0.5    | -0.4                              |
| 35+00         | -0.1              | -0.3    | 0.0     | +0.4    | -0.7                              |
| 40+00         | -0.1              | 0.0     | +0.3    | 0.0     | -0.3                              |
| 45+00         | -0.3              | -0.8    | +0.3    | +0.4    | -0.2                              |
| 50+00         | +0.3              | +0.6    | +0.3    | +0.1    | -0.4                              |
| 55+00         | +0.3              | +0.7    | +0.3    | +0.2    | -0.5                              |
| 60+00         | +0.3              | +0.2    | +0.5    | +0.5    | -0.7                              |
| 65+00         | +0.7              | +0.4    | +0.5    | +0.3    | -0.3                              |
| 70+00         | +0.6              | +0.6    | +0.4    | +0.6    | -0.1                              |
| 75+00         | +0.4              | -0.1    | +0.3    | +0.3    | -0.4                              |
| 80+00         | +0.7              | +0.3    | +0.4    | +0.4    | -0.5                              |
| 85+00         | +0.7              | +0.6    | +0.7    | +0.8    | -0.1                              |
| 90+00         | +0.9              | +0.8    | +1.1    | +0.8    | -0.1                              |
| 95+00         | +1.1              | +0.7    | +0.9    | +1.0    | -0.3                              |
| 100+00        | +1.0              | +1.1    | +0.8    | +0.9    | -0.4                              |
| 105+00        | +0.7              | +0.6    | +0.8    | +1.2    | 0.0                               |
| 110+00        | +1.1              | +1.0    | +0.8    | +1.0    | -0.3                              |
| 115+00        | +0.8              | +0.7    | 0.9     | +0.8    | -0.2                              |
| 120+00        | +0.7              | +0.7    | -1.1    | +0.7    | 0.0                               |

Table 6. (Con't)

| Location     | Transverse Slopes |         |         |         | Longitudinal<br>Slopes<br>Percent |
|--------------|-------------------|---------|---------|---------|-----------------------------------|
|              | Left              |         | Right   |         |                                   |
|              | Percent           | Percent | Percent | Percent |                                   |
| Runway 10-28 |                   |         |         |         |                                   |
| 0+00         | +0.7              | +0.5    | -0.4    | -0.2    | +0.3                              |
| 5+00         | +0.4              | +0.3    | -0.2    | -0.4    | +0.7                              |
| 10+00        | +0.5              | +0.5    | -0.6    | -0.5    | +0.6                              |
| 15+00        | +0.5              | +0.5    | -0.4    | -0.6    | +0.3                              |
| 20+00        | +0.7              | +0.4    | -0.5    | -0.6    | +0.2                              |
| 25+00        | +0.5              | +0.6    | -0.0    | -0.3    | +0.3                              |
| 30+00        | +0.7              | +0.6    | -0.5    | -0.6    | +0.2                              |
| 35+00        | +0.3              | +0.3    | -0.7    | -0.8    | +0.2                              |
| 40+00        | +0.6              | +0.5    | -0.5    | -0.4    | +0.1                              |
| 45+00        | +0.4              | +0.3    | -0.8    | -0.3    | +0.1                              |
| 50+00        | +0.2              | +0.1    | -0.6    | -0.5    | 0.1                               |
| 55+00        | 0.0               | +0.2    | -0.6    | -0.7    | +0.5                              |
| 60+00        | 0.0               | +0.7    | -0.6    | -0.1    | +0.5                              |

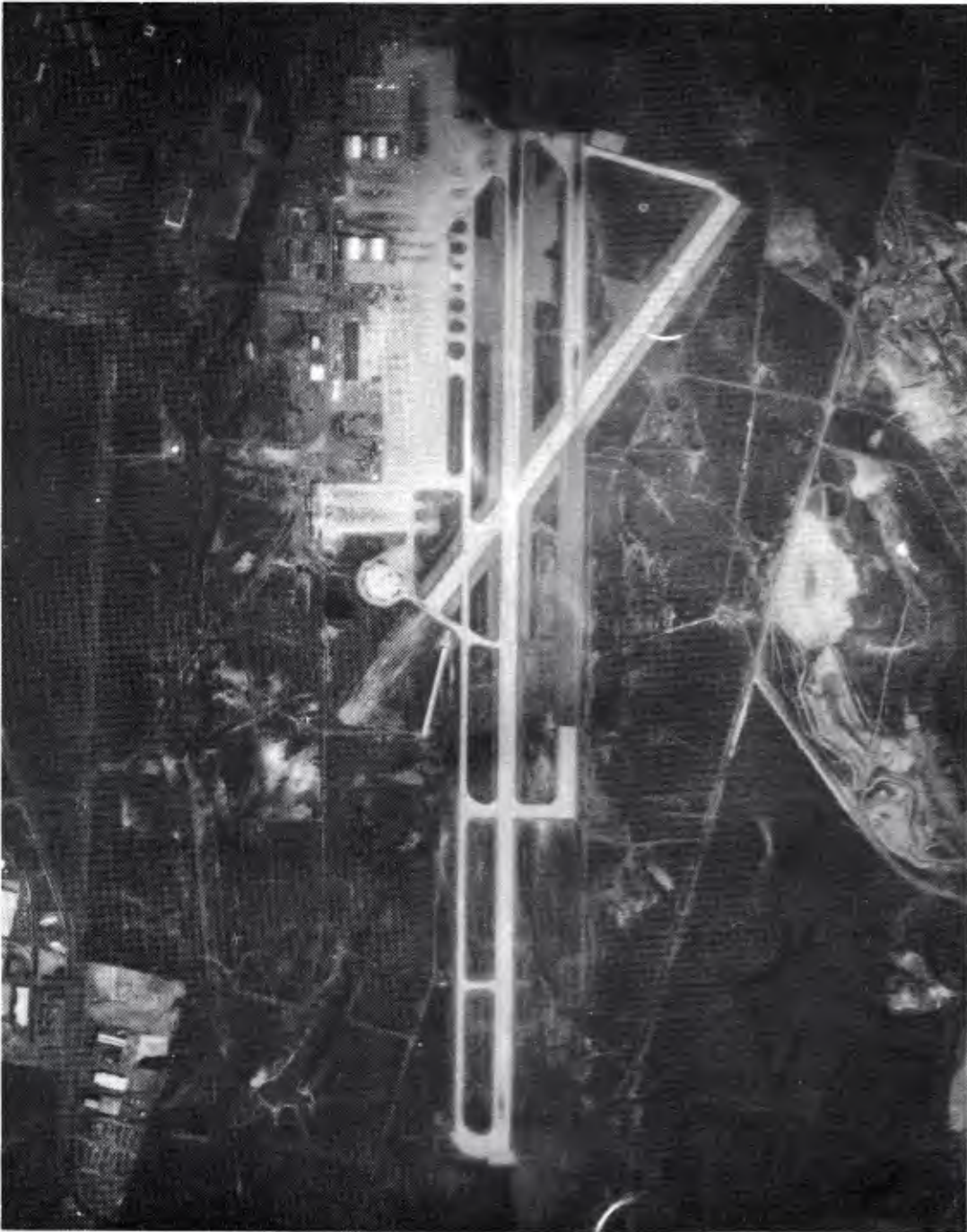
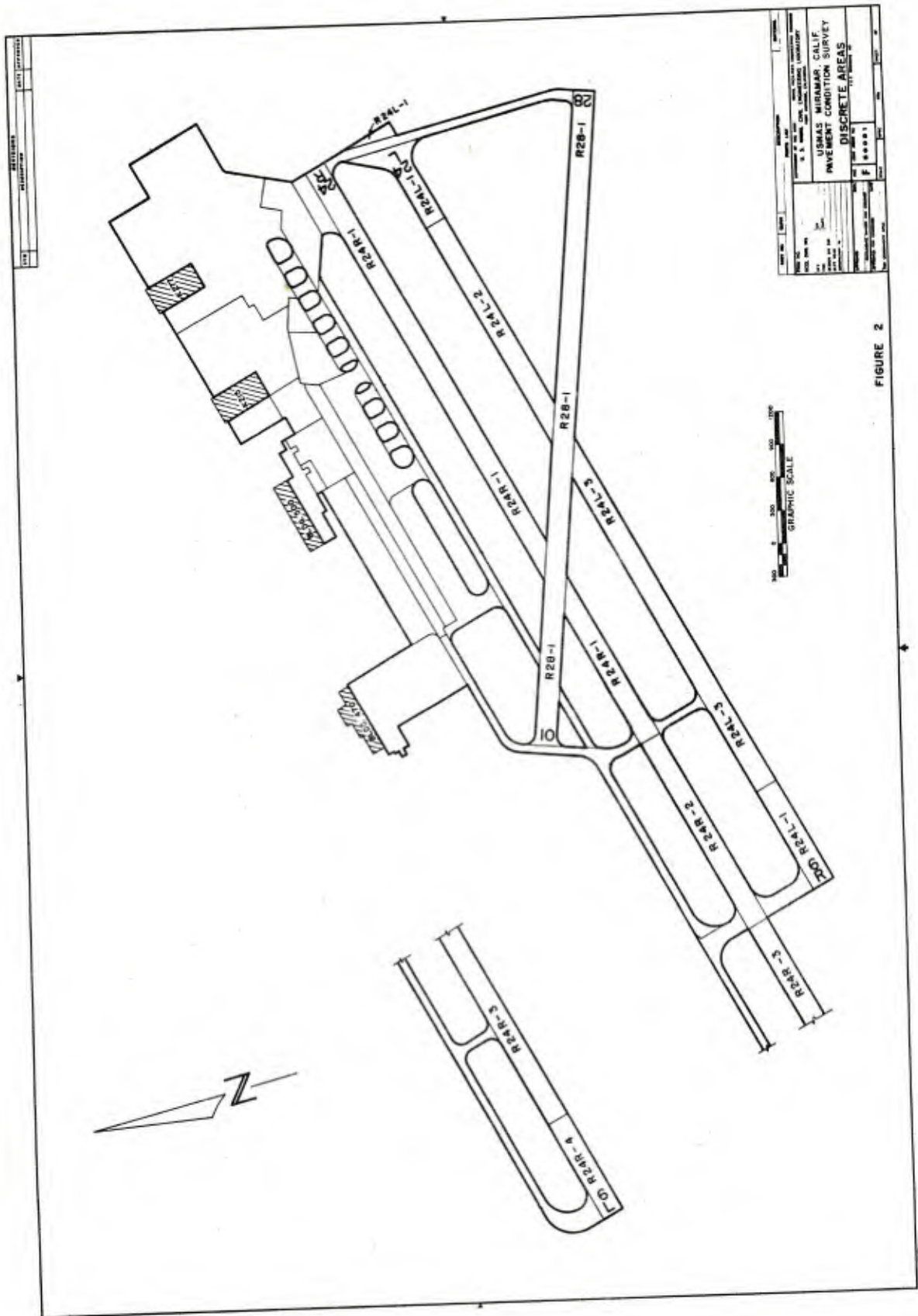


Figure 1. Aerial view of U.S. Naval Air Station, Miramar, California.



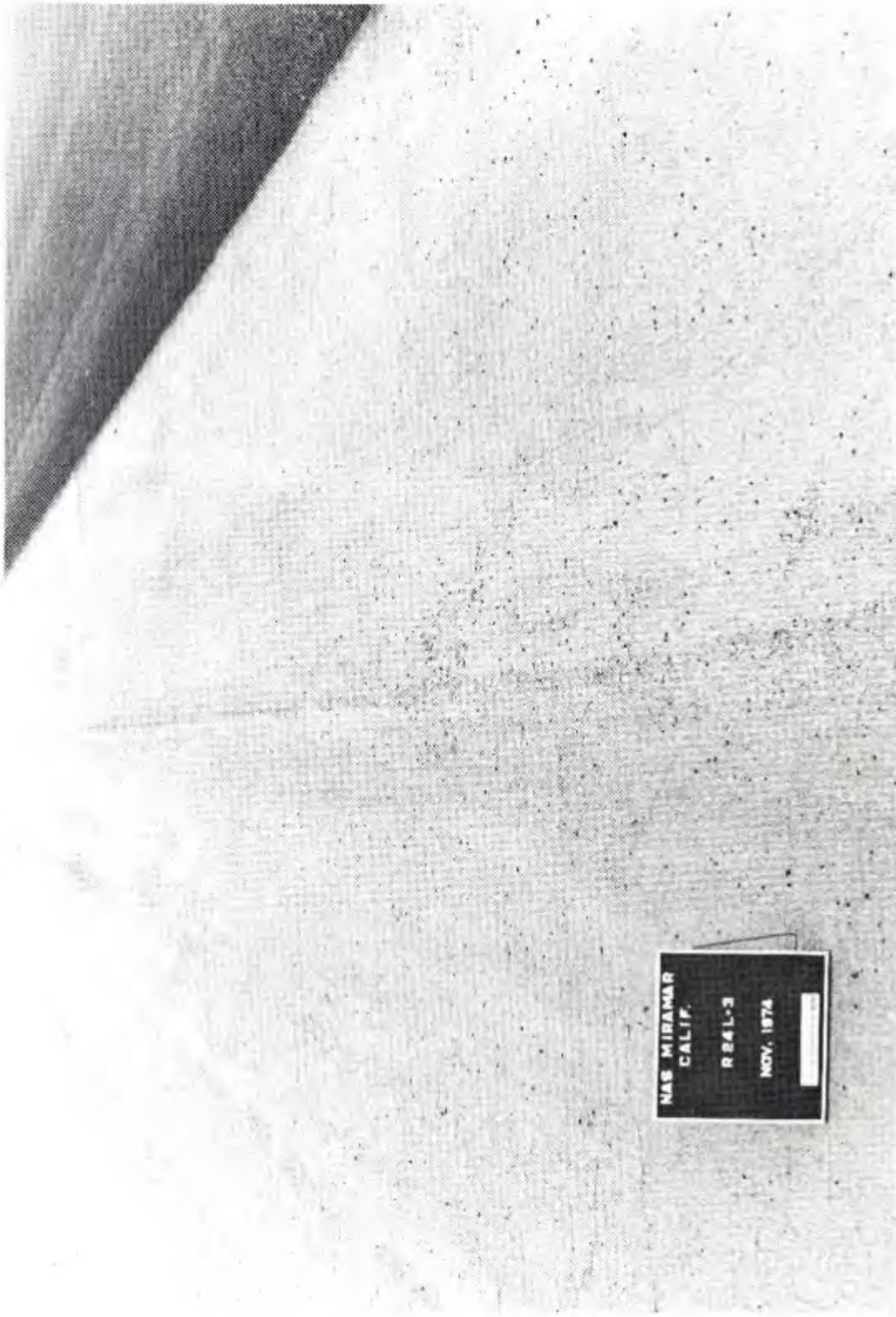


Figure 3. Loose aggregate blown onto runway shoulder from rubber-asphalt seal, Discrete Area R24L-3.



Figure 4. Washboard effect caused by poor chip distribution, Discrete Area R24L-3.



Figure 5. Shriveled and hardened joint seal, Discrete Area R24L-1.



Figure 6. Spall repair with portland cement concrete; note the lack of contraction joint in the repair, Discrete Area R24L-1.

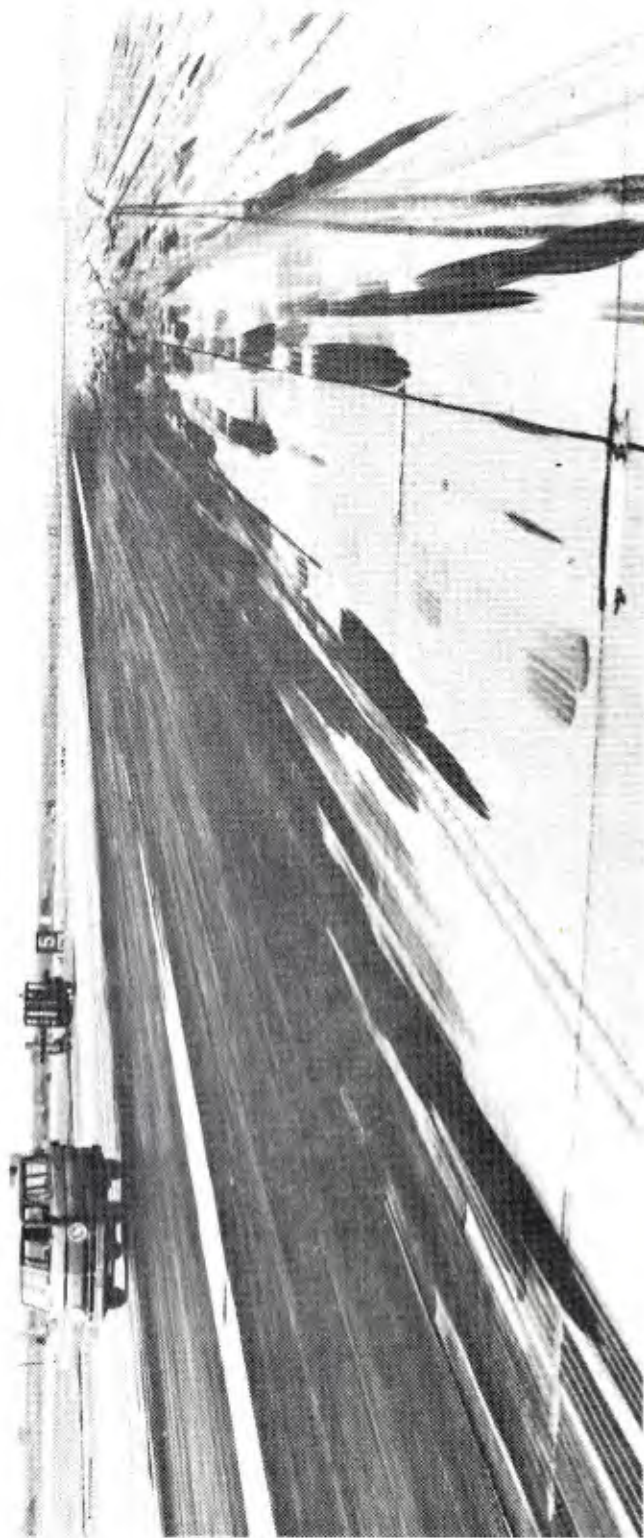


Figure 7. Heavy rubber deposits in the field carrier landing practice area, Discrete Area R24L-2.



Figure 8. Typical spall, Discrete Area R24R-1.



Figure 9. Burned and blown joint seal, Discrete Area R24R-1.



Figure 10. Hardened and shriveled joint seal, Discrete Area R24R-2.



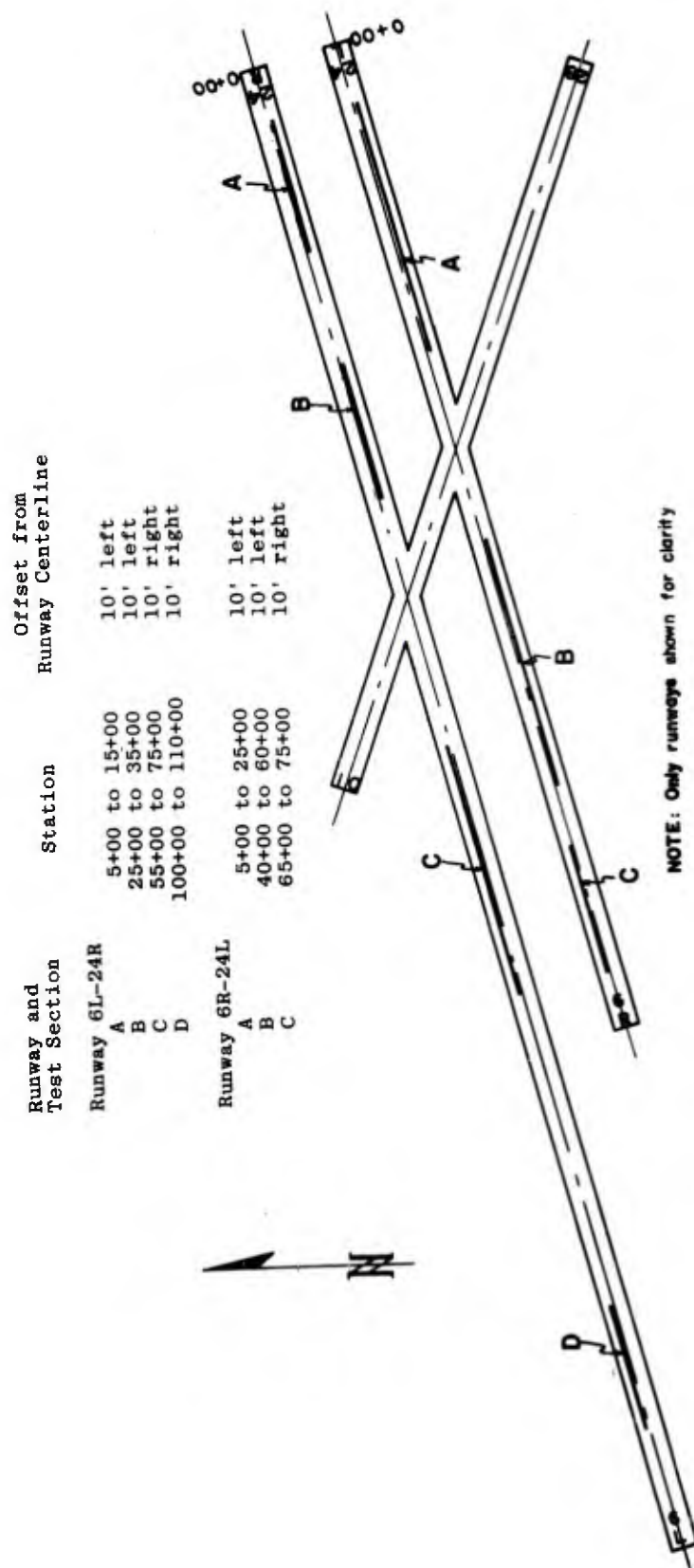
Figure 11. Typical corner spall, Discrete Area R24R-3.



Figure 12. Hardened and shriveled joint seal, Discrete Area R24R-4.

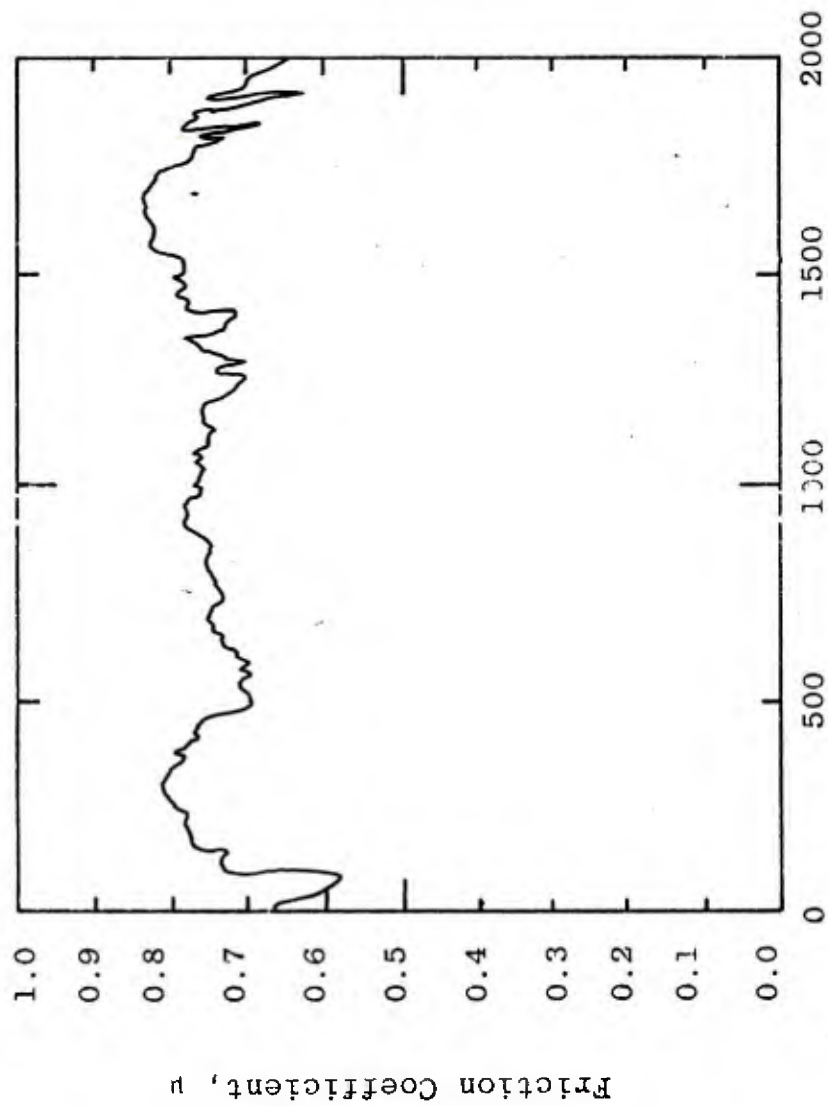


Figure 13. Vegetation growing in joint, Discrete Area R28-1.



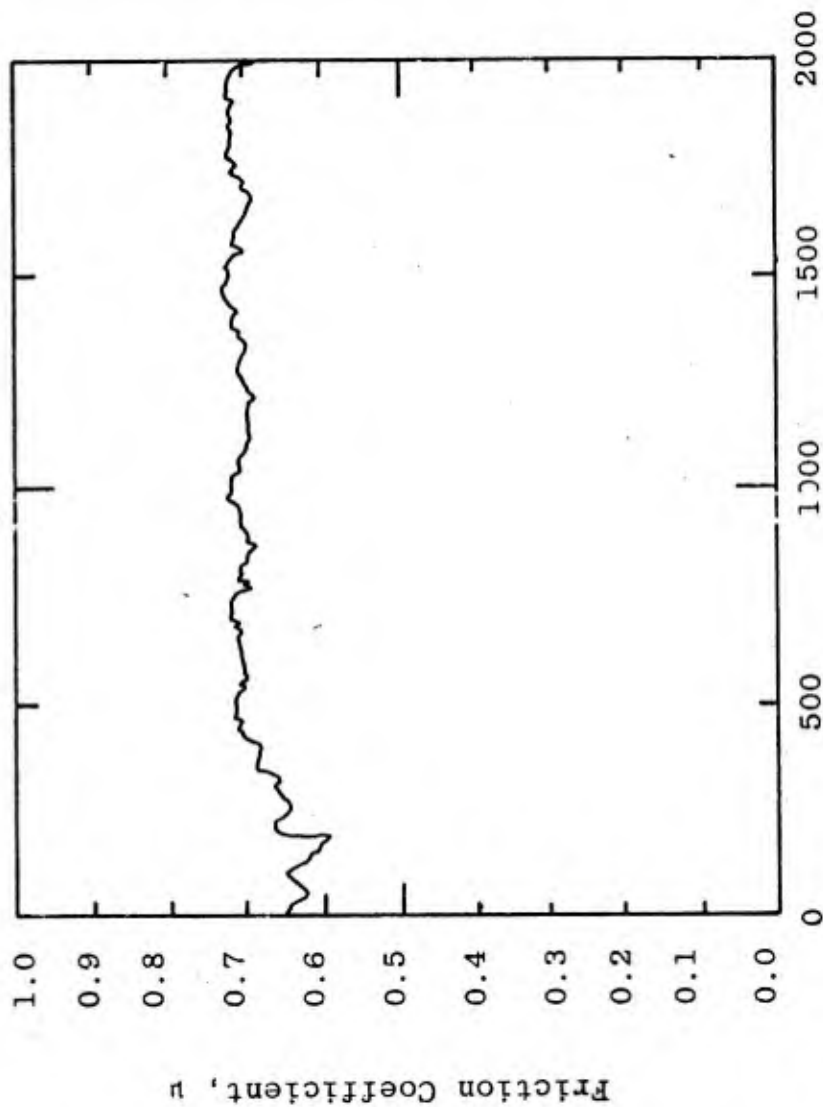
FRICITION TEST LOCATIONS  
USNAS MIRAMAR, CALIF.

FIGURE 14



Distance, feet  
Runway 6R-24L  
Test Section A, Run 1  
USNAS Miramar, California

Figure 15. Friction Coefficient versus Distance,  
USNAS Miramar, California



Distance, feet  
Runway 6R-24L  
Test Section B, Run 1

Figure 16. Friction Coefficient versus Distance,  
USNAS Miramar, California

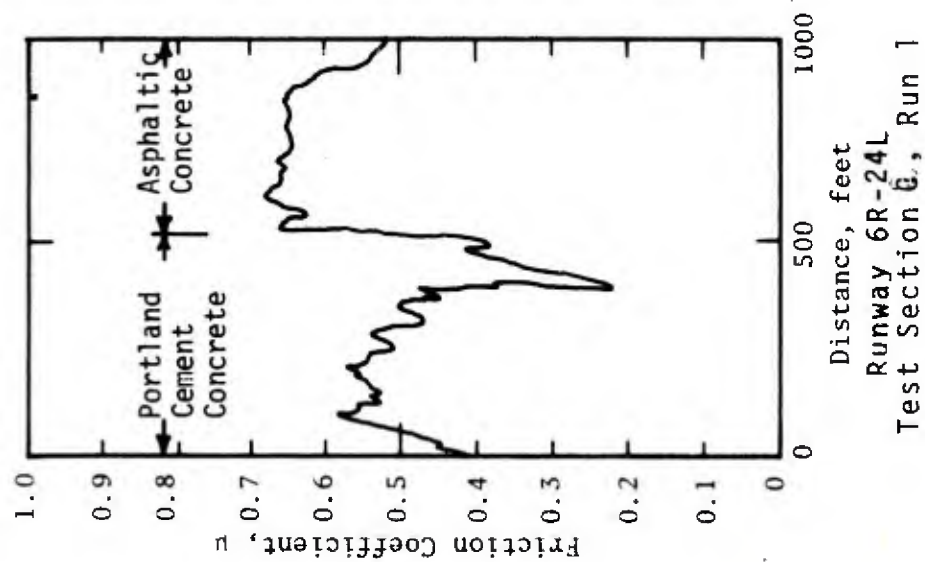


Figure 17. Friction Coefficient versus Distance,  
USNAS Miramar, California

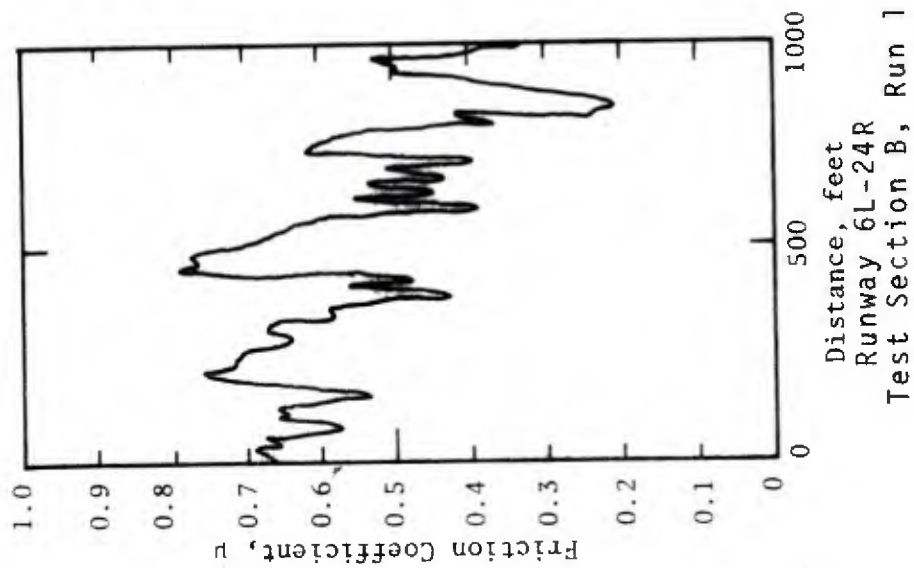
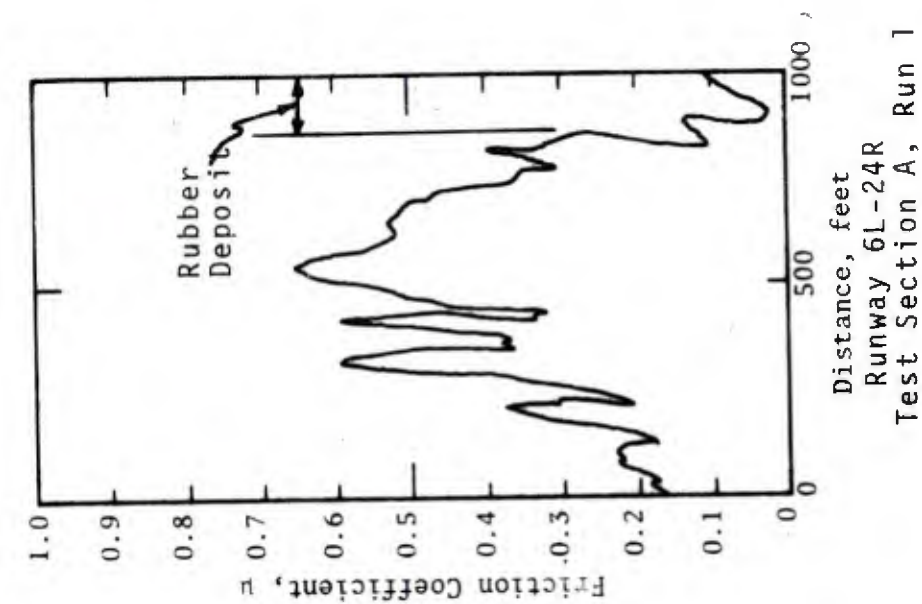


Figure 18. Friction Coefficient versus Distance, USNAS Miramar, California

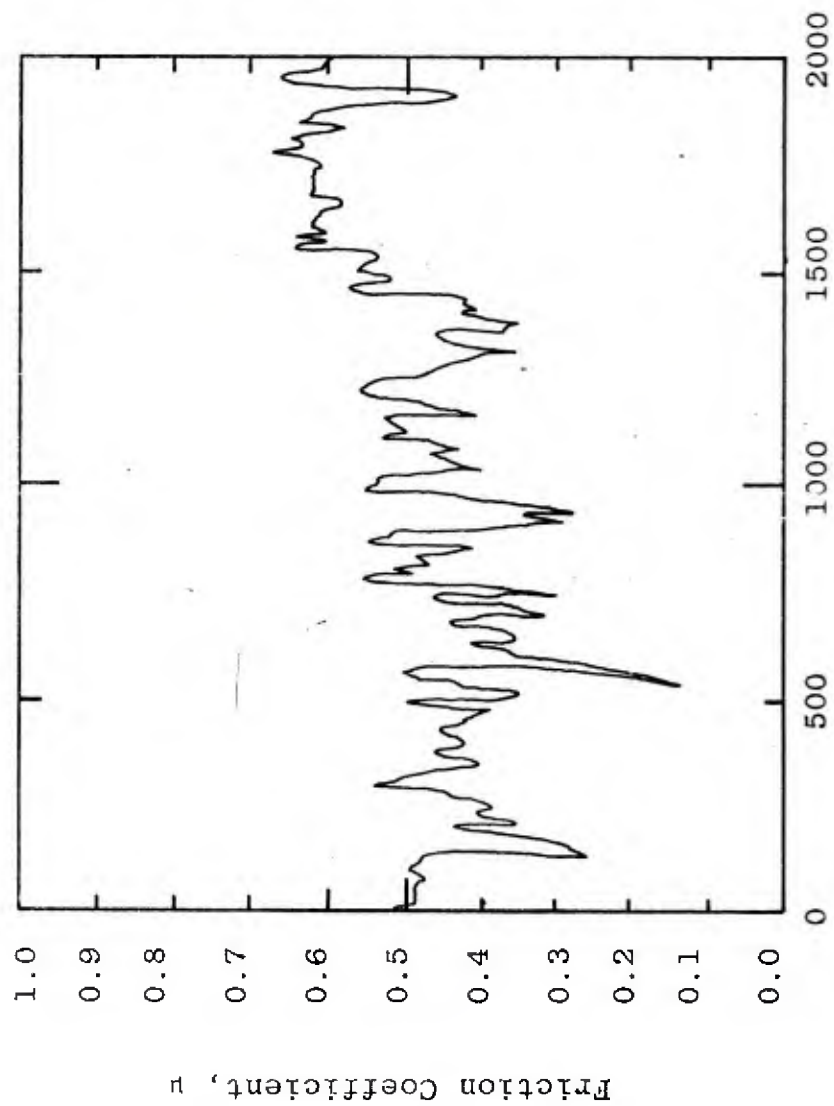


Figure 19. Friction Coefficient versus Distance,  
 USNAS Miramar, California  
 Test Section C, Run 1

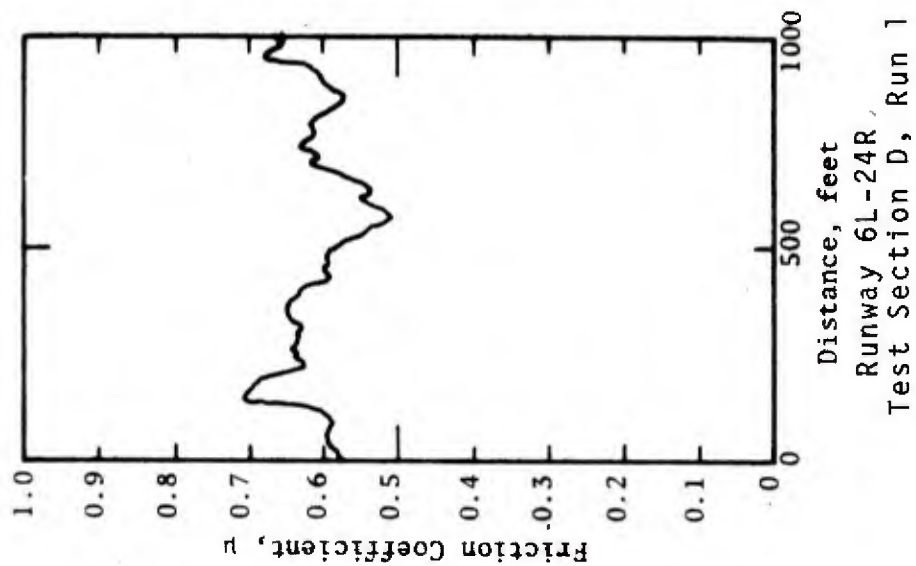


Figure 20. Friction Coefficient versus Distance,  
Runway 6L-24R,  
Test Section D, Run 1  
USNAS Miramar, California

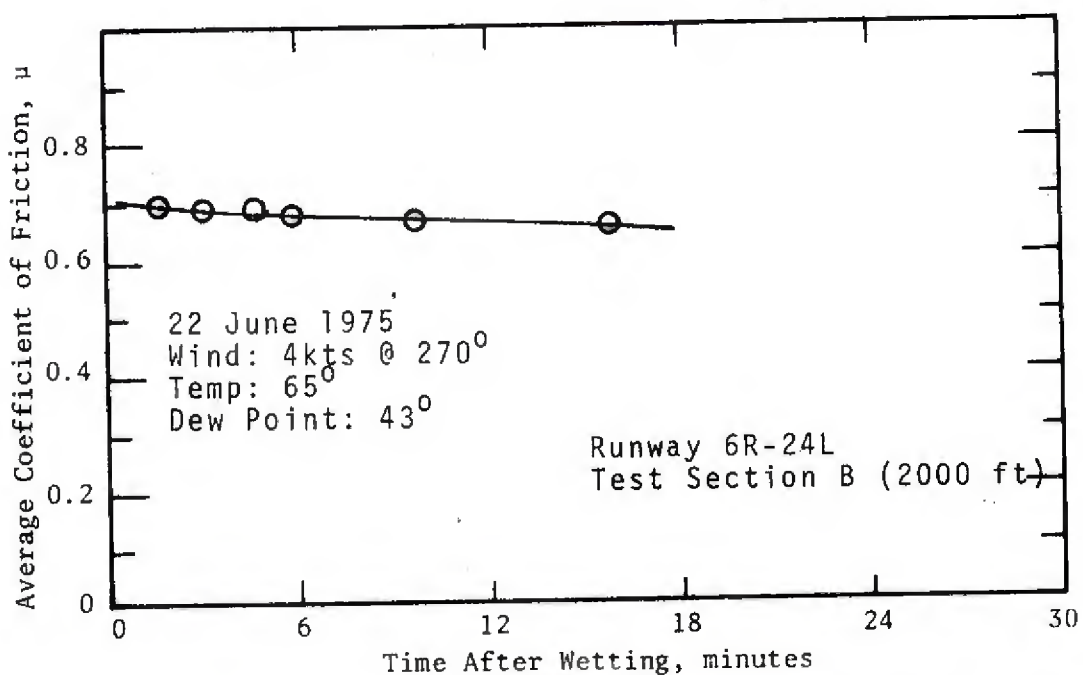
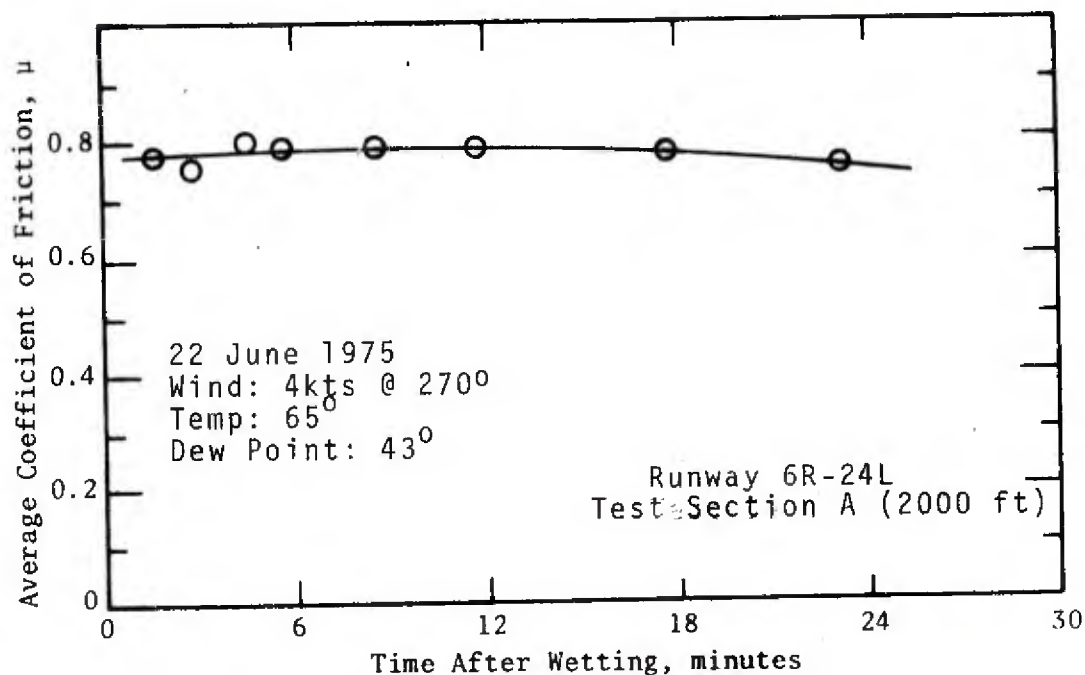


Figure 21. Average Friction Coefficient Versus Time After Wetting, USNAS Miramar, California

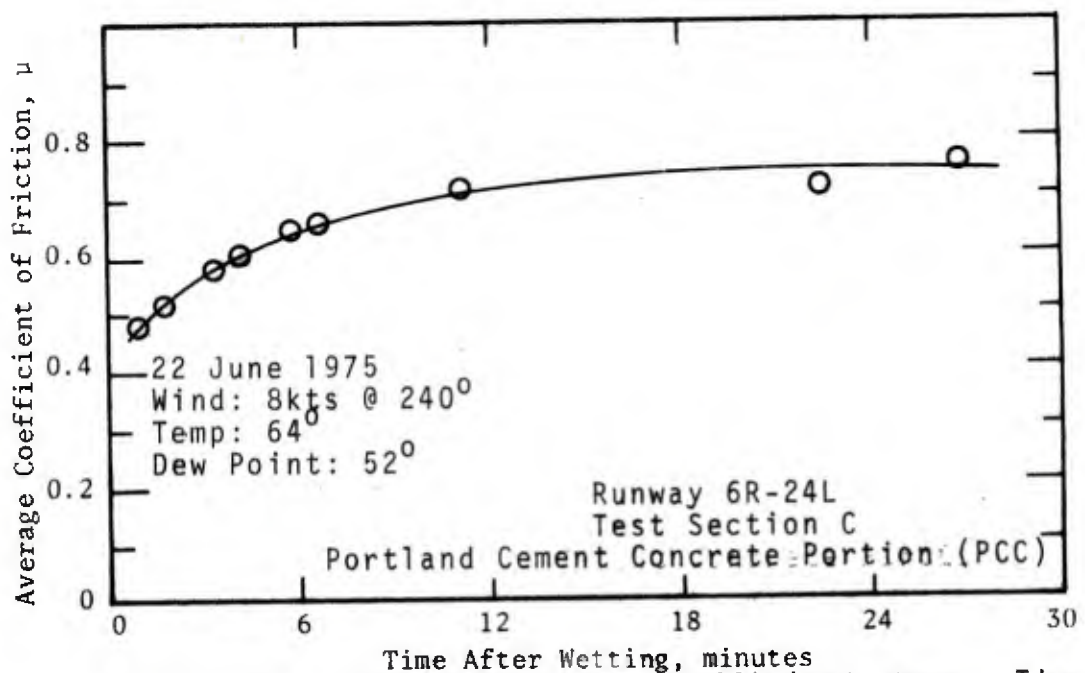
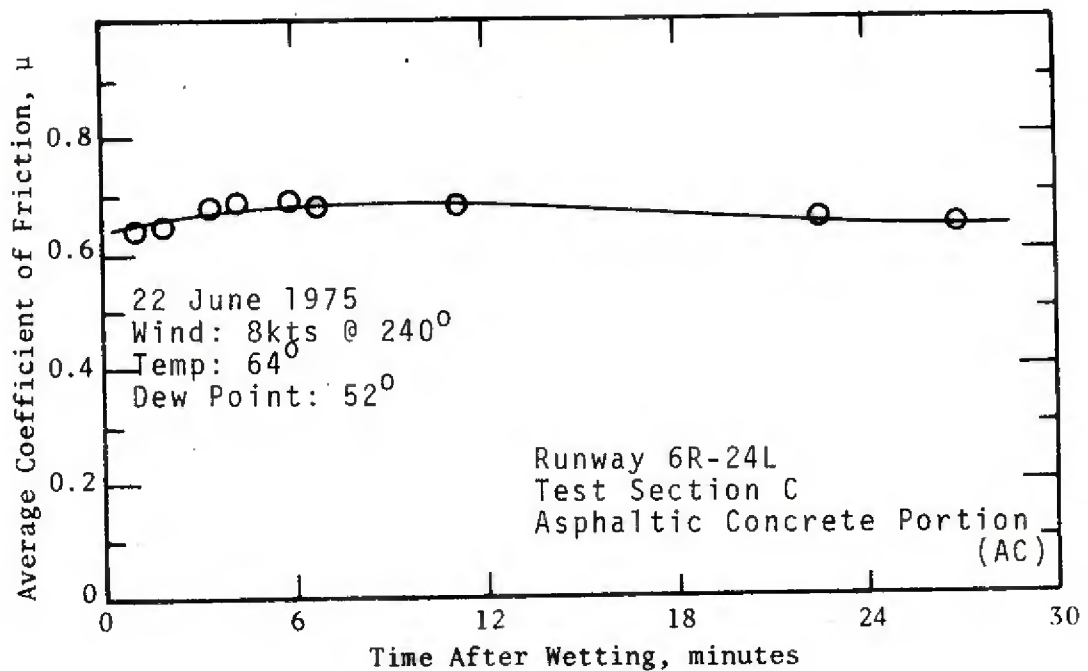


Figure 22. Average friction Coefficient Versus Time After Wetting, USNAS Miramar, California

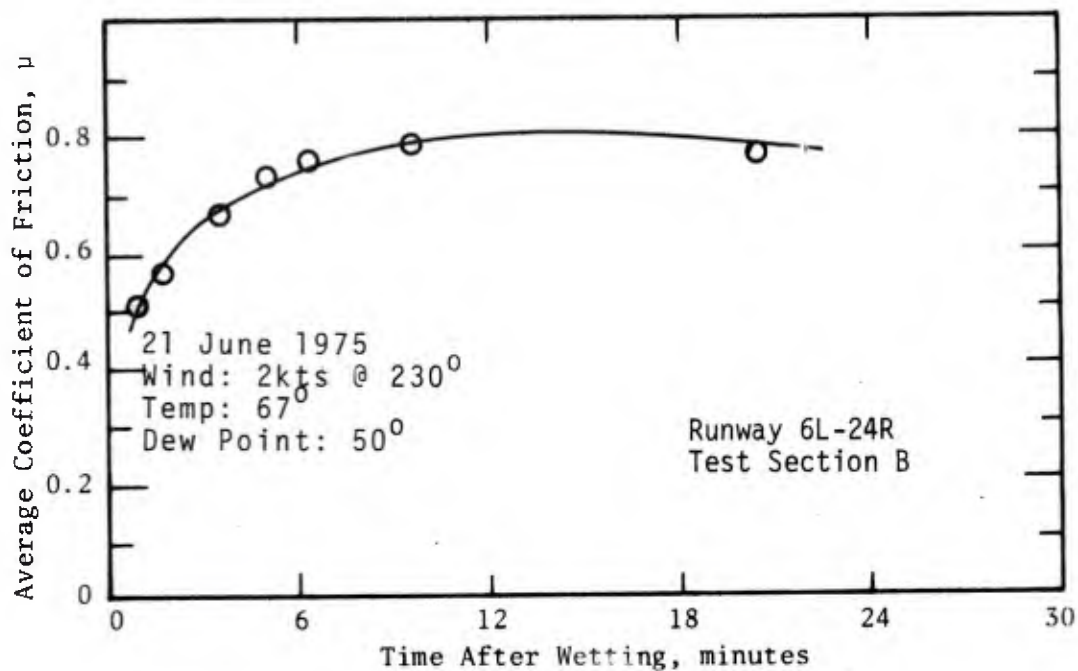
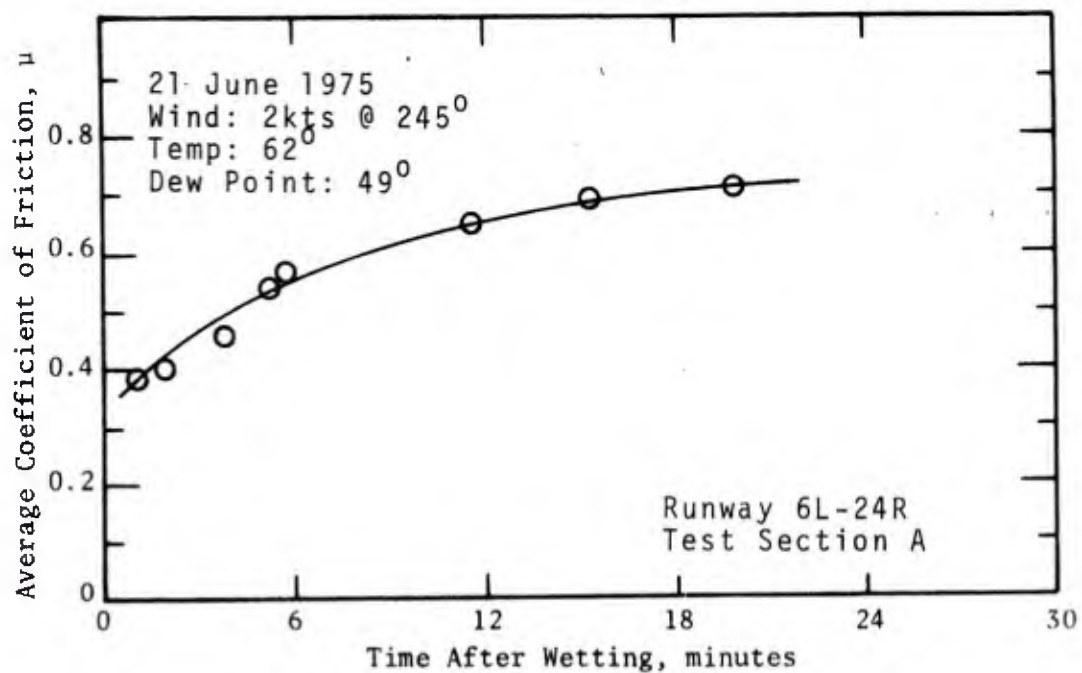


Figure 23. Average Friction Coefficient versus Time After Wetting, USNAS Miramar, California

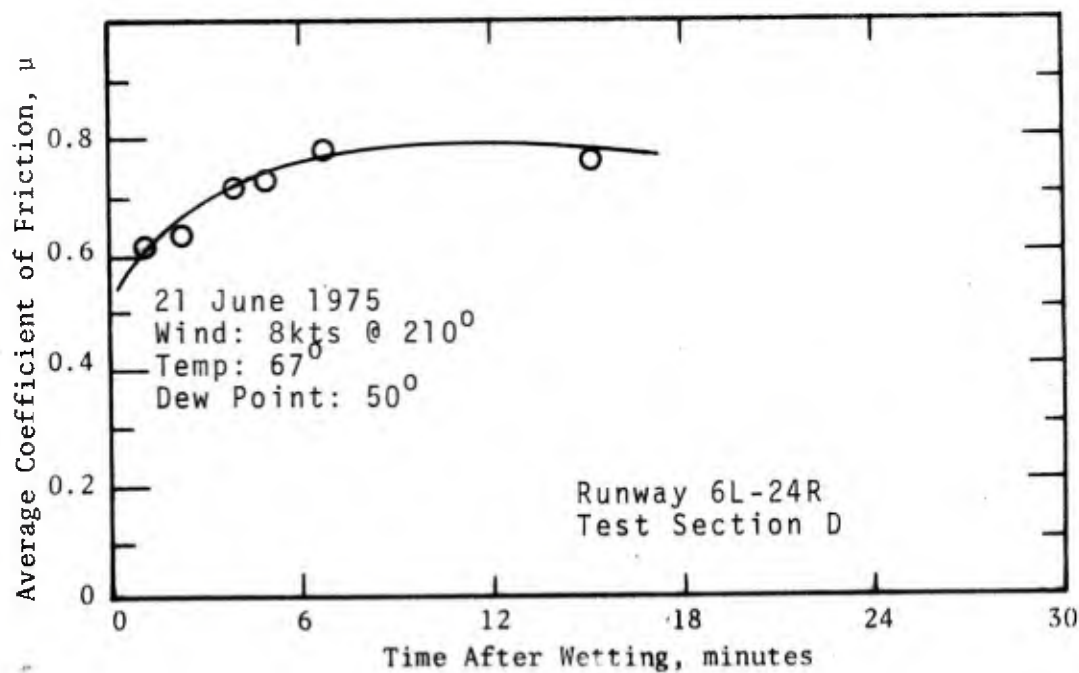
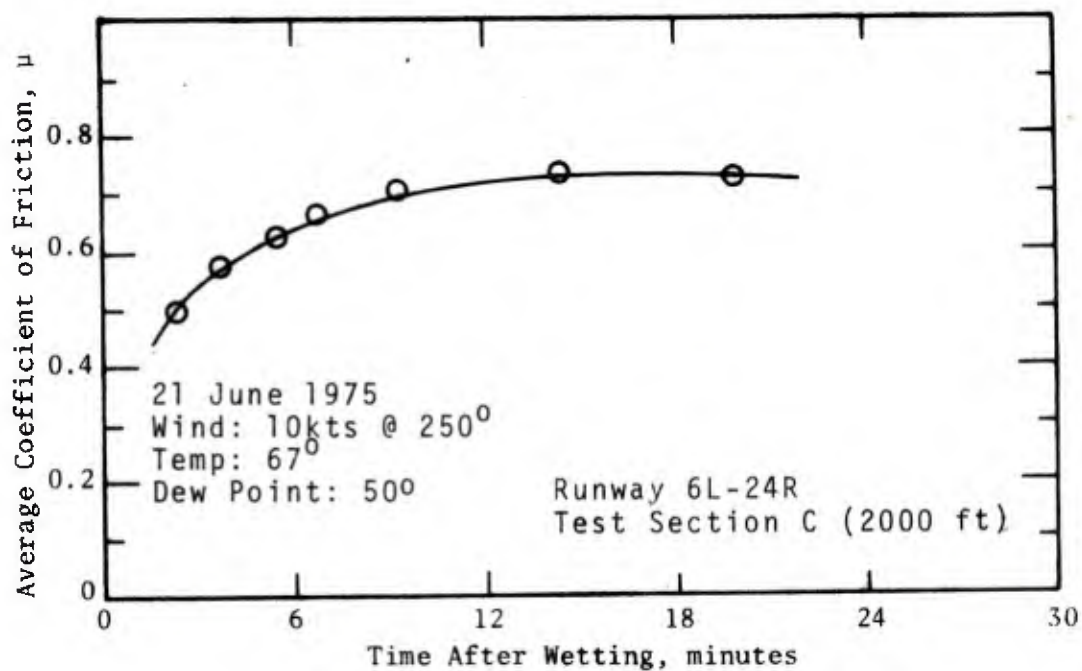


Figure 24. Average Friction Coefficient versus Time After Wetting, USNAS Miramar, California

# ASPHALTIC CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6R-24L  
 Discrete Area R24L-3 Area of Discrete Area (a) 347,800 ft<sup>2</sup>  
 No. of Sample Areas (b) 14 Ratio: (a/2500b) 9.94

| 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*       |                                   |                                                  |                                        |                        |                                    |
| Reflection Crack         |                                   |                                                  |                                        |                        |                                    |
| Faulting                 |                                   |                                                  |                                        |                        |                                    |
| Patching                 | No Defects Measured               |                                                  |                                        |                        |                                    |
| Settlement or Depression |                                   |                                                  |                                        |                        |                                    |
| Pattern Cracking         |                                   |                                                  |                                        |                        |                                    |
| Rutting                  |                                   |                                                  |                                        |                        |                                    |
| Raveling                 |                                   |                                                  |                                        |                        |                                    |
| Erosion—Jet Blast        |                                   |                                                  |                                        |                        |                                    |
| Oil Spillage             |                                   |                                                  |                                        |                        |                                    |
| Broken-up Area           |                                   |                                                  |                                        |                        |                                    |
| Total                    |                                   |                                                  |                                        |                        |                                    |

## Remarks on Pavement Condition

The rubber-asphalt seal coat placed in October, 1974 has covered any cracks. The seal coat is losing some aggregate, necessitating periodic sweeping (See Figure 3). The application of chips during the construction of the seal coat was apparently uneven as evidenced by a wash-board effect in some lanes (see Figure 4).

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

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6R-24L

Discrete Area R24 L-1 Total Slabs in Discrete Area (a) 1072

No. of Slabs Sampled (b) 178 Ratio a/b = 6.0

| Defect Type                                                                                                                                                                                                                                                                                                                                  | No. of Sample<br>Slabs w/Defect | Total Slabs<br>w/Defect:<br>c x a/b | Defect<br>Density<br>(per slab)<br>d/a | Defect<br>Severity<br>Weight | Weighted<br>Defect<br>Density<br>e x f |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|----------------------------------------|------------------------------|----------------------------------------|
|                                                                                                                                                                                                                                                                                                                                              | (c)                             | (d)                                 | (e)                                    | (f)                          | (g)                                    |
| Faulting                                                                                                                                                                                                                                                                                                                                     |                                 |                                     |                                        |                              |                                        |
| Corner Break                                                                                                                                                                                                                                                                                                                                 |                                 |                                     |                                        |                              |                                        |
| L.C. or T.C.*                                                                                                                                                                                                                                                                                                                                |                                 |                                     |                                        |                              |                                        |
| I.C.**                                                                                                                                                                                                                                                                                                                                       |                                 |                                     |                                        |                              |                                        |
| Depression                                                                                                                                                                                                                                                                                                                                   |                                 |                                     |                                        |                              |                                        |
| Spalling                                                                                                                                                                                                                                                                                                                                     | 16                              | 96                                  | 0.0896                                 | 7.5                          | 0.672                                  |
| Scaling                                                                                                                                                                                                                                                                                                                                      |                                 |                                     |                                        |                              |                                        |
| Shattered<br>Slab                                                                                                                                                                                                                                                                                                                            |                                 |                                     |                                        |                              |                                        |
| Joint Seal                                                                                                                                                                                                                                                                                                                                   | 85                              | 510                                 | 0.4757                                 | 3.0                          | 1.427                                  |
| Pumping                                                                                                                                                                                                                                                                                                                                      |                                 |                                     |                                        |                              |                                        |
| "D-line" cracking                                                                                                                                                                                                                                                                                                                            |                                 |                                     |                                        |                              |                                        |
| Remarks on Pavement Condition                                                                                                                                                                                                                                                                                                                |                                 |                                     |                                        |                              | Total                                  |
| Joint seal was very hard and occasionally was burned by jet blast (see Figure 5). Many spalls had been repaired during 1974 and most repairs were effective (see Figure 6). The remaining spalls were generally small, 1" to 4" in length and less than 1" wide. A moderately heavy buildup of rubber was noted on the 24 end of the runway. |                                 |                                     |                                        |                              | 2.100 ***                              |

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

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6R-24L

Discrete Area R24 L-2 Total Slabs in Discrete Area (a) 1112

No. of Slabs Sampled (b) 185 Ratio a/b = 6.0

| 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.*                                                                                                                                                                                                                                                                      | 2                            | 12                            | 0.0108                        | 1.5                    | 0.016                         |
| I.C.**                                                                                                                                                                                                                                                                             |                              |                               |                               |                        |                               |
| Depression                                                                                                                                                                                                                                                                         |                              |                               |                               |                        |                               |
| Spalling                                                                                                                                                                                                                                                                           | 6                            | 36                            | 0.0324                        | 7.5                    | 0.243                         |
| Scaling                                                                                                                                                                                                                                                                            |                              |                               |                               |                        |                               |
| Shattered Slab                                                                                                                                                                                                                                                                     |                              |                               |                               |                        |                               |
| Joint Seal                                                                                                                                                                                                                                                                         | 185                          | 1112                          | 1.00                          | 3.0                    | 3.00                          |
| Pumping                                                                                                                                                                                                                                                                            |                              |                               |                               |                        |                               |
| "D-line" cracking                                                                                                                                                                                                                                                                  |                              |                               |                               |                        |                               |
| Remarks on Pavement Condition                                                                                                                                                                                                                                                      |                              |                               |                               |                        | Total 3.26C ***               |
| <p>The joint seal was shriveled and hardened. The joint seal had lost bond in some joints. Most spalls were small, less than one inch wide. The rubber buildup in the FCLP area is very heavy (see Figure 7). It is possible to peel up strips of rubber 1/32" to 1/16" thick.</p> |                              |                               |                               |                        |                               |

\* Longitudinal crack or Transverse crack

\*\* Intersecting crack

\*\*\* Letter suffix "C" represents PCC pavement

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6L-24R

Discrete Area R24 R-1 Total Slabs in Discrete Area (a) 3544

No. of Slabs Sampled (b) 177 Ratio a/b = 20.0

| 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                            | 20                            | 0.006                         | 1.5                    | 0.009                         |
| I.C.**            |                              |                               |                               |                        |                               |
| Depression        |                              |                               |                               |                        |                               |
| Spalling          | 16                           | 320                           | 0.090                         | 7.5                    | 0.677                         |
| Scaling           |                              |                               |                               |                        |                               |
| Shattered Slab    |                              |                               |                               |                        |                               |
| Joint Seal        | 177                          | 3544                          | 1.00                          | 3.0                    | 3.000                         |
| Pumping           |                              |                               |                               |                        |                               |
| "D-line" cracking |                              |                               |                               |                        |                               |

Remarks on Pavement Condition \_\_\_\_\_ Total 3.690 \*\*\*

Spalls ranged up to 4" wide and 12" long (see Figure 8). Some of the spalls noted were on old spall repairs. Spall repairs with the date 1972 on them were in generally good condition. The joint seal was hardened over the entire area and was burned and blown at the runway end (see Figure 9).

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

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6L-24R

Discrete Area R24 R-2 Total Slabs in Discrete Area (a) 1064

No. of Slabs Sampled (b) 266 Ratio a/b = 4.0

| Defect Type                                                                                                                                                                | No. of Sample<br>Slabs w/Defect | Total Slabs<br>w/Defect:<br>c x a/b | Defect<br>Density<br>(per slab)<br>d/a | Defect<br>Severity<br>Weight | Weighted<br>Defect<br>Density<br>e x f |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|----------------------------------------|------------------------------|----------------------------------------|
|                                                                                                                                                                            | (c)                             | (d)                                 | (e)                                    | (f)                          | (g)                                    |
| Faulting                                                                                                                                                                   |                                 |                                     |                                        |                              |                                        |
| Corner Break                                                                                                                                                               |                                 |                                     |                                        |                              |                                        |
| L.C. or T.C.*                                                                                                                                                              | 3                               | 12                                  | 0.0112                                 | 1.5                          | 0.017                                  |
| I.C.**                                                                                                                                                                     |                                 |                                     |                                        |                              |                                        |
| Depression                                                                                                                                                                 | 41                              | 164                                 | 0.1541                                 | 7.5                          | 1.156                                  |
| Spalling                                                                                                                                                                   |                                 |                                     |                                        |                              |                                        |
| Scaling                                                                                                                                                                    |                                 |                                     |                                        |                              |                                        |
| Shattered<br>Slab                                                                                                                                                          |                                 |                                     |                                        |                              |                                        |
| Joint Seal                                                                                                                                                                 | 266                             | 1064                                | 1.00                                   | 3.0                          | 3.000                                  |
| Pumping                                                                                                                                                                    |                                 |                                     |                                        |                              |                                        |
| "D-line" cracking                                                                                                                                                          |                                 |                                     |                                        |                              |                                        |
| Remarks on Pavement Condition_____ Total                                                                                                                                   |                                 |                                     |                                        |                              | 4.17C ***                              |
| <p>The joint seal was hardened and shriveled over almost the entire area (see Figure 10). Approximately 50 percent of the spalls noted were located on repaired areas.</p> |                                 |                                     |                                        |                              |                                        |

\* Longitudinal crack or Transverse crack

\*\* Intersecting crack

\*\*\* Letter suffix "C" represents PCC pavement

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6L-24R

Discrete Area R24 R-3 Total Slabs in Discrete Area (a) 1600

No. of Slabs Sampled (b) 160 Ratio a/b = 10.0

| Defect Type       | No. of Sample<br>Slabs w/Defect | Total Slabs<br>w/Defect:<br>c x a/b | Defect<br>Density<br>(per slab)<br>d/a | Defect<br>Severity<br>Weight | Weighted<br>Defect<br>Density<br>e x f |
|-------------------|---------------------------------|-------------------------------------|----------------------------------------|------------------------------|----------------------------------------|
|                   | (c)                             | (d)                                 | (e)                                    | (f)                          | (g)                                    |
| Faulting          |                                 |                                     |                                        |                              |                                        |
| Corner Break      |                                 |                                     |                                        |                              |                                        |
| L.C. or T.C.*     |                                 |                                     |                                        |                              |                                        |
| I.C.**            |                                 |                                     |                                        |                              |                                        |
| Depression        |                                 |                                     |                                        |                              |                                        |
| Spalling          | 15                              | 150                                 | 0.0937                                 | 7.5                          | 0.703                                  |
| Scaling           |                                 |                                     |                                        |                              |                                        |
| Shattered<br>Slab |                                 |                                     |                                        |                              |                                        |
| Joint Seal        | 160                             | 1600                                | 1.00                                   | 3.0                          | 3.000                                  |
| Pumping           |                                 |                                     |                                        |                              |                                        |
| "D-line" cracking |                                 |                                     |                                        |                              |                                        |
| Total             |                                 |                                     |                                        |                              | 3.700                                  |

Remarks on Pavement Condition

The joint seal was hardened and shriveled. Joint was completely missing from a few joints. Spalls were primarily located on slab corners (see Figure 11).

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

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 6L-24R

Discrete Area R24 R-4 Total Slabs in Discrete Area (a) 528

No. of Slabs Sampled (b) 132 Ratio a/b = 4.00

| Defect Type                                                                                                                | No. of Sample<br>Slabs w/Defect | Total Slabs<br>w/Defect:<br>c x a/b | Defect<br>Density<br>(per slab)<br>d/a | Defect<br>Severity<br>Weight | Weighted<br>Defect<br>Density<br>e x f |
|----------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|----------------------------------------|------------------------------|----------------------------------------|
|                                                                                                                            | (c)                             | (d)                                 | (e)                                    | (f)                          | (g)                                    |
| Faulting                                                                                                                   |                                 |                                     |                                        |                              |                                        |
| Corner Break                                                                                                               |                                 |                                     |                                        |                              |                                        |
| L.C. or T.C.*                                                                                                              |                                 |                                     |                                        |                              |                                        |
| I.C.**                                                                                                                     |                                 |                                     |                                        |                              |                                        |
| Depression                                                                                                                 |                                 |                                     |                                        |                              |                                        |
| Spalling                                                                                                                   | 21                              | 84                                  | 0.1590                                 | 7.5                          | 1.192                                  |
| Scaling                                                                                                                    |                                 |                                     |                                        |                              |                                        |
| Shattered<br>Slab                                                                                                          |                                 |                                     |                                        |                              |                                        |
| Joint Seal                                                                                                                 | 132                             | 528                                 | 1.00                                   | 3.00                         | 3.000                                  |
| Pumping                                                                                                                    |                                 |                                     |                                        |                              |                                        |
| "D-line" cracking                                                                                                          |                                 |                                     |                                        |                              |                                        |
| Remarks on Pavement Condition                                                                                              |                                 |                                     |                                        |                              | Total 4.19C ***                        |
| <p>Joint seal was hardened and shriveled (see Figure 12).<br/>Many spalls were located on transverse expansion joints.</p> |                                 |                                     |                                        |                              |                                        |

\* Longitudinal crack or Transverse crack

\*\* Intersecting crack

\*\*\* Letter suffix "C" represents PCC pavement

# PORTLAND CEMENT CONCRETE DISCRETE AREA DEFECT SUMMARY

Airfield USNAS Miramar Facility Runway 10-28

Discrete Area R28-1 Total Slabs in Discrete Area (a) 3200

No. of Slabs Sampled (b) 160 Ratio a/b = 20.0

| 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          | 15                           | 300                           | 0.094                         | 7.5                    | 0.703                         |
| Scaling           |                              |                               |                               |                        |                               |
| Shattered Slab    |                              |                               |                               |                        |                               |
| Joint Seal        | 32                           | 640                           | 0.0200                        | 3.0                    | 0.600                         |
| Pumping           |                              |                               |                               |                        |                               |
| "D-line" cracking |                              |                               |                               |                        |                               |

Remarks on Pavement Condition Total \*\*\*

Most spalls noted were on old epoxy repairs. Most spalls were small, less than 2" wide. The joint seal was pliable and performing adequately. Vegetation growing in the joints was the only joint seal defect noted (see Figure 13).

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

| PORTLAND CEMENT CONCRETE FACILITY DEFECT SUMMARY<br>Airfield <u>USNAS Miramar, California</u><br>Date Surveyed <u>November 1974</u> |                                        |                                                        |                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------------------------------------------------------|-------------------------------------------------|
| Facility (or portion)                                                                                                               | Weighted<br>Defect<br>Density<br>Total | Ratio:<br><u>Discrete Area</u><br>Total Facility Area* | Average Weighted<br>Defect Density<br>(a) x (b) |
|                                                                                                                                     | (a)                                    | (b)                                                    | (c)**                                           |
| 1974 Condition Survey                                                                                                               |                                        |                                                        |                                                 |
| Runway 6R-24L                                                                                                                       |                                        |                                                        |                                                 |
| R24L-1                                                                                                                              | 2.10C                                  | 0.49                                                   | 1.03                                            |
| R24L-2                                                                                                                              | 3.26C                                  | 0.51                                                   | 1.66                                            |
|                                                                                                                                     |                                        |                                                        | 2.69C (Total)                                   |
| Runway 6L-24R                                                                                                                       |                                        |                                                        |                                                 |
| R24R-1                                                                                                                              | 3.69C                                  | 0.57                                                   | 2.10                                            |
| R24R-2                                                                                                                              | 4.17C                                  | 0.085                                                  | 0.35                                            |
| R24R-3                                                                                                                              | 3.70C                                  | 0.26                                                   | 0.96                                            |
| R24R-4                                                                                                                              | 4.19C                                  | 0.085                                                  | 0.36                                            |
|                                                                                                                                     |                                        |                                                        | 3.77C (Total)                                   |
| Runway 10-28                                                                                                                        |                                        |                                                        |                                                 |
| R28-1                                                                                                                               | 1.30                                   | 1.00                                                   | 1.30C                                           |
| 1970 Condition Survey                                                                                                               |                                        |                                                        |                                                 |
| Runway 6R-24L                                                                                                                       |                                        |                                                        |                                                 |
| R24L-1                                                                                                                              | 2.88C                                  | 0.49                                                   | 1.41                                            |
| R24L-2                                                                                                                              | 4.46C                                  | 0.51                                                   | 2.27                                            |
|                                                                                                                                     |                                        |                                                        | 3.68C (Total)                                   |
| Runway 6L-24R                                                                                                                       |                                        |                                                        |                                                 |
| R24R-1                                                                                                                              | 2.71C                                  | 0.51                                                   | 1.54                                            |
| R24R-2                                                                                                                              | 1.82C                                  | 0.085                                                  | 0.15                                            |
| R24R-3                                                                                                                              | 1.58C                                  | 0.26                                                   | 0.41                                            |
| R24R-4                                                                                                                              | 3.19C                                  | 0.085                                                  | 0.27                                            |
|                                                                                                                                     |                                        |                                                        | 2.37C (Total)                                   |
| Runway 10-28                                                                                                                        |                                        |                                                        |                                                 |
| R28-1                                                                                                                               | 2.97                                   | 1.00                                                   | 2.97C                                           |

\* 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 average weighted defect densities indicates Portland cement concrete pavements.

# PORTLAND CEMENT CONCRETE FACILITY DEFECT SUMMARY

Airfield USNAS Miramar, California

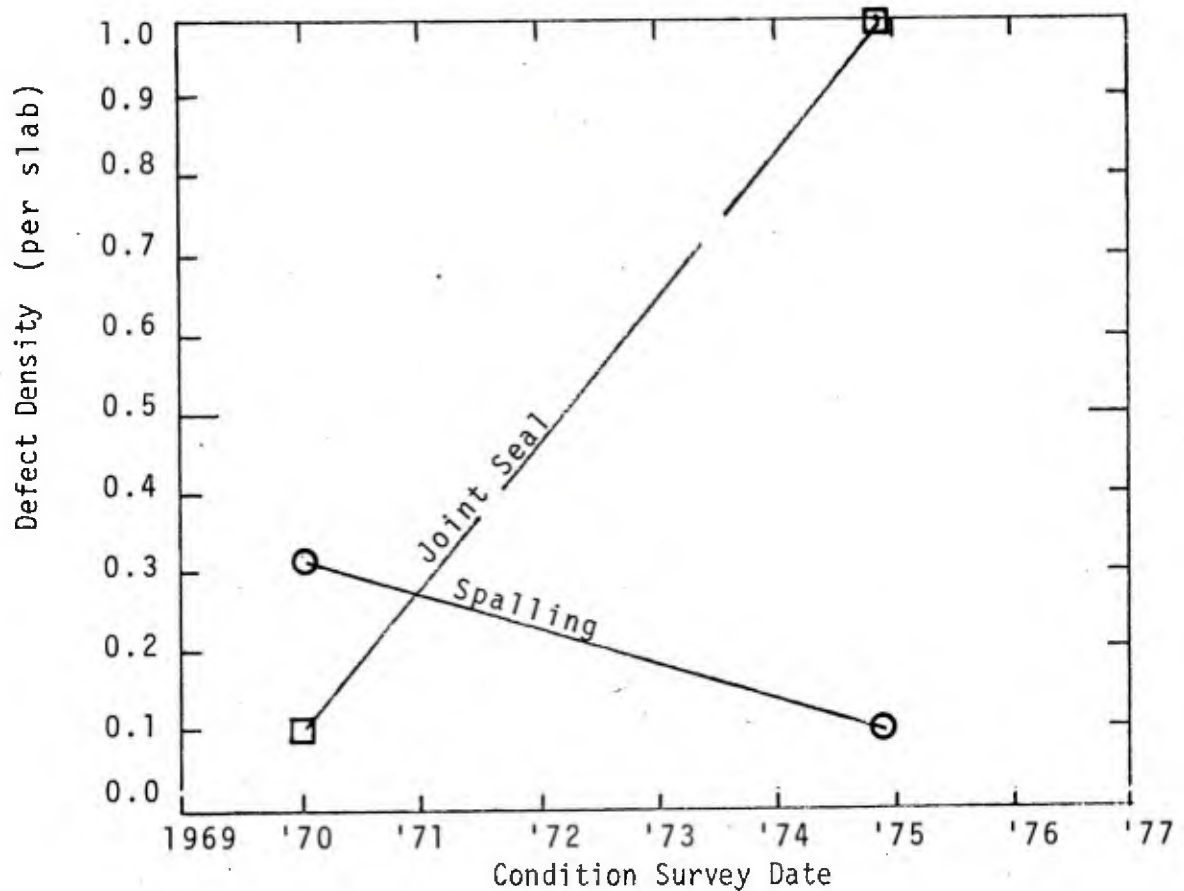
Date Surveyed November 1974

| Facility (or portion)                               | Weighted<br>Defect<br>Density<br>Total | Ratio:<br>$\frac{\text{Discrete Area}}{\text{Total Facility Area}^*}$ | Average Weighted<br>Defect Density<br>(a) x (b) |
|-----------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------|
|                                                     | (a)**                                  | (b)                                                                   | (c)**                                           |
| 1974 Condition<br>Survey<br>Runway 6R-24L<br>R24L-3 | 0.00A                                  | 1.00                                                                  | 0.00A                                           |
| 1970 Condition<br>Survey<br>R24L-3                  | 0.11A                                  | 1.00                                                                  | 0.11A                                           |

\* 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 ANALYSIS



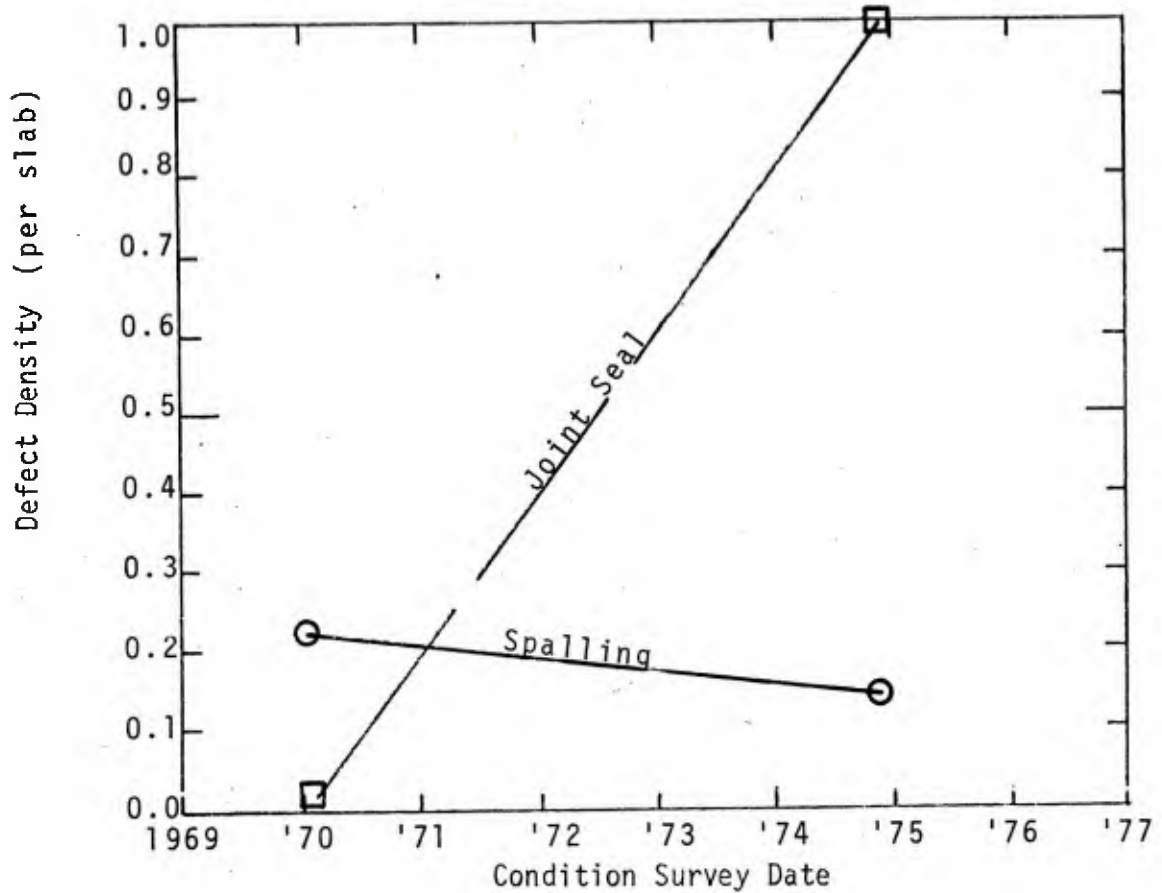
Airfield NAS Miramar Facility Runway 6L-24R  
 Discrete Area R24R-1 Pavement Type PCC  
Discussion

The increase in the amount of defective joint seal is attributed to effects of aging and oxidation. Most of the joint seal was placed 14 years ago.

A continuing program of spall repairs has reduced the incidence of spalling substantially.

Other defects noted in the survey are not significant and are not included in this analysis.

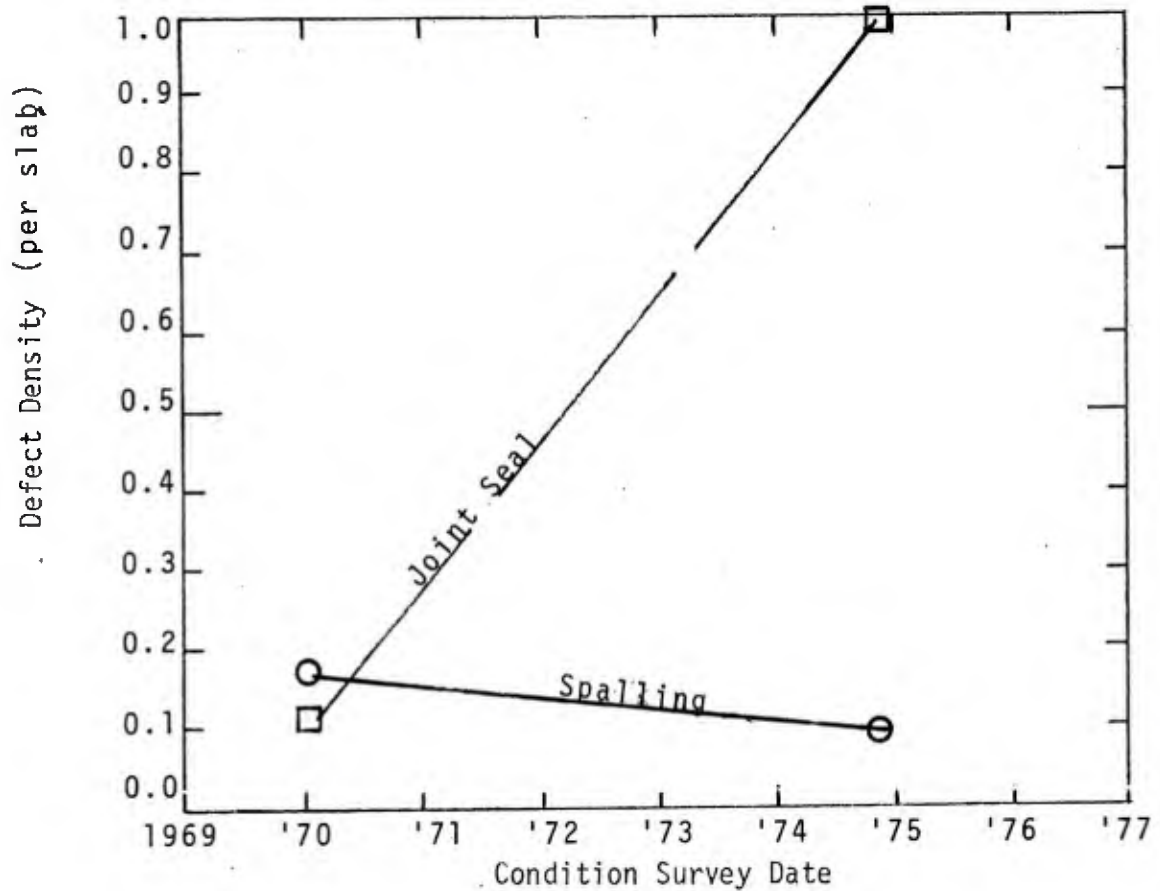
# DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Miramar Facility Runway 6L-24R  
 Discrete Area R24R-2 Pavement Type PCC  
Discussion

Increased joint seal defects were attributed to aging and oxidation. Spall repairs have decreased the incidence of spalling.

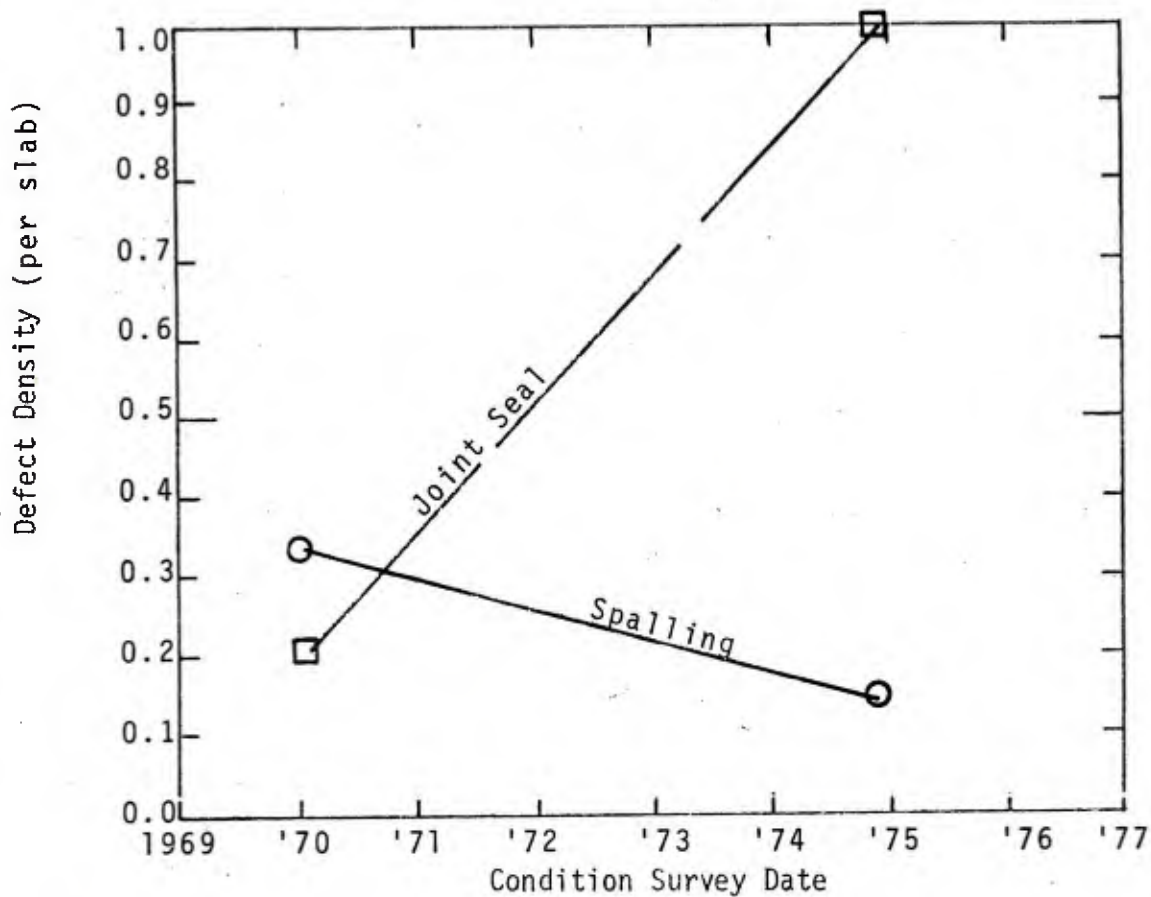
# DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Miramar Facility Runway 6R-24L  
 Discrete Area R24R-3 Pavement Type OCC  
Discussion

Increased joint seal defects were attributed to aging and oxidation. Spall repairs have decreased the incidence of spalling.

# DISCRETE AREA CONDITION ANALYSIS



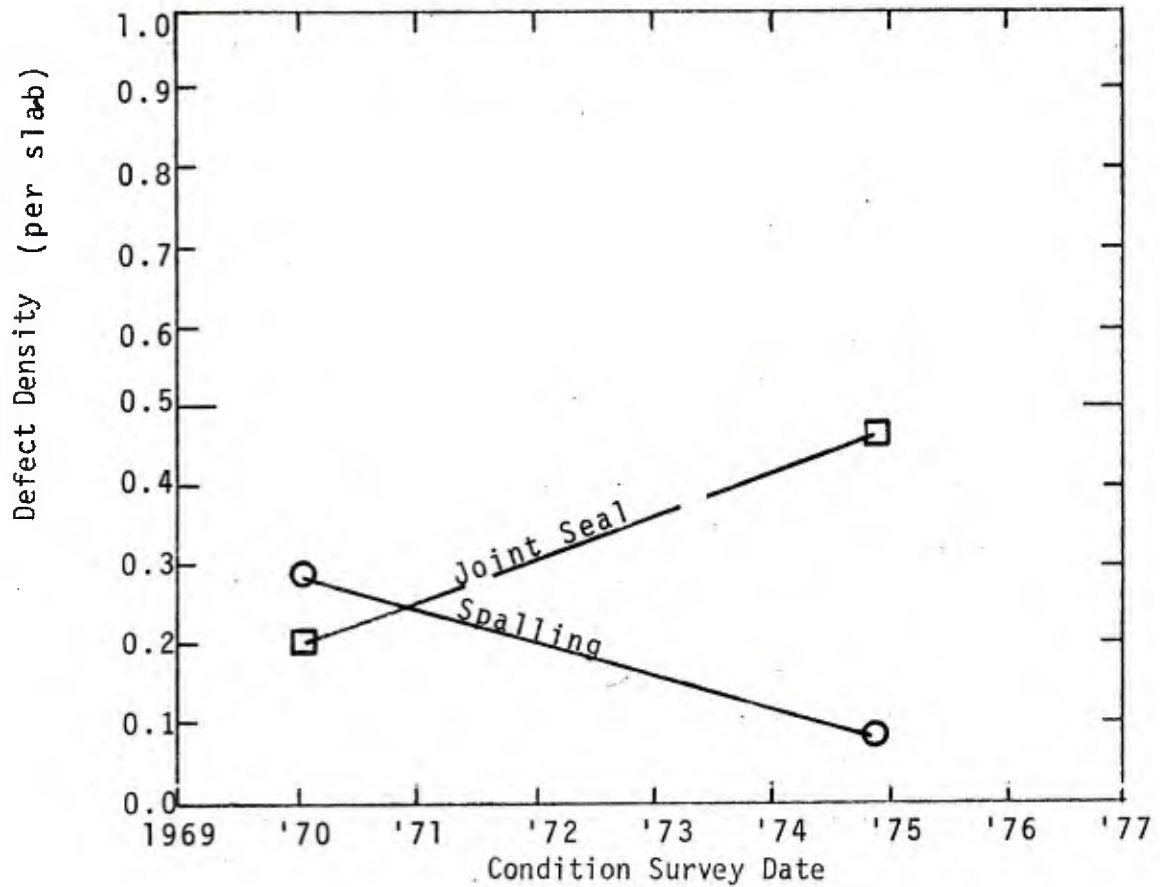
Airfield NAS Miramar Facility Runway 6L-24R

Discrete Area R24R-4 Pavement Type PCC

## Discussion

Increased joint seal defects were attributed to aging and oxidation. Spall repairs have decreased the incidence of spalling.

# DISCRETE AREA CONDITION ANALYSIS



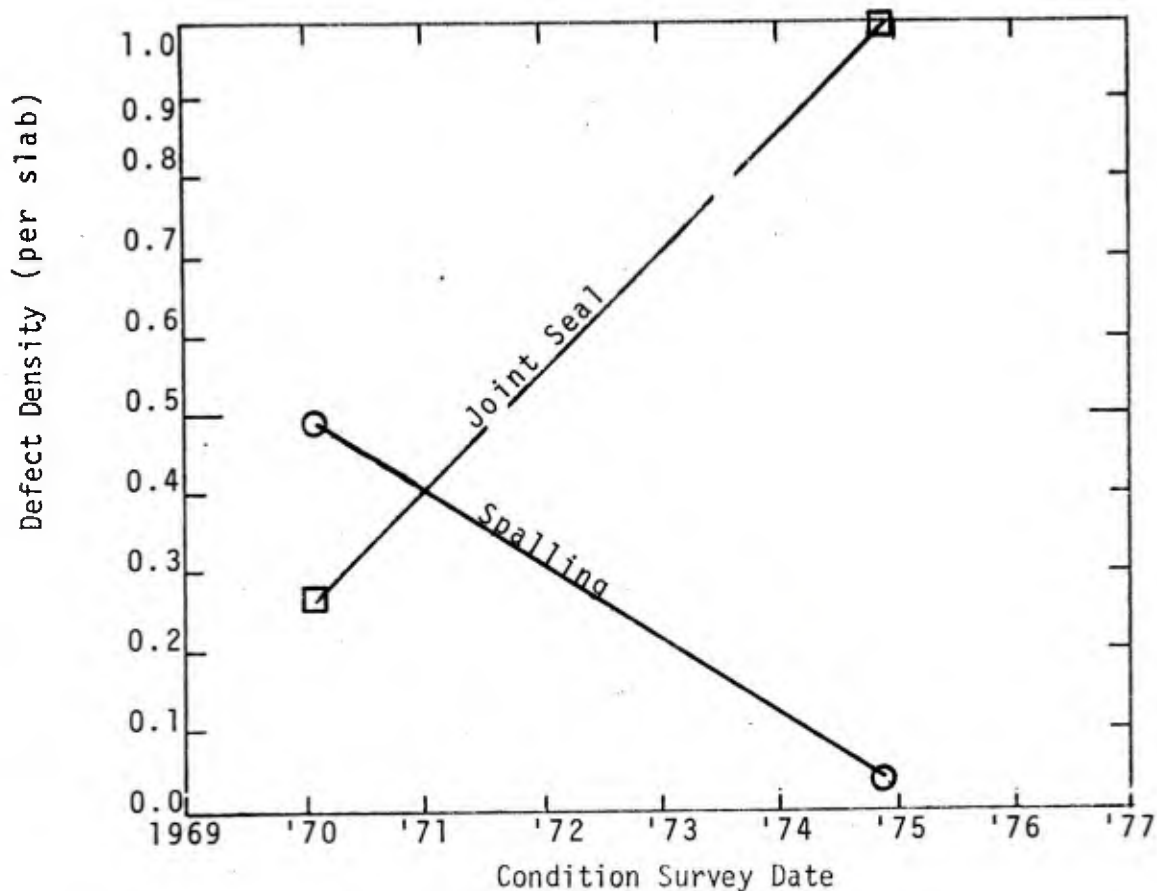
Airfield NAS Miramar Facility Runway 6R-24L

Discrete Area R 24L-1 Pavement Type PCC

## Discussion

Joint seal defects have increased primarily due to age and oxidation. Spall repairs completed in 1974 have decreased the incidence of spalling.

# DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Miramar

Facility Runway 6R-24L

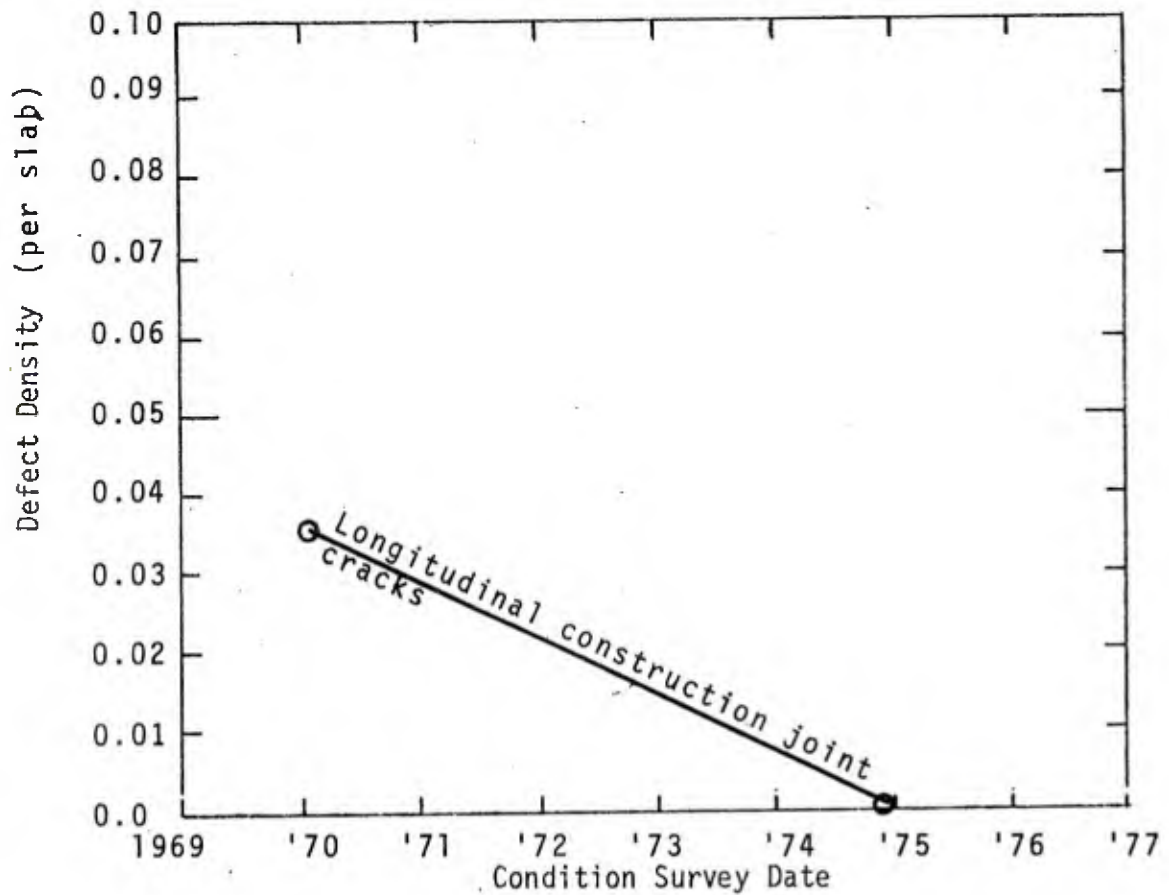
Discrete Area R24L-2

Pavement Type PCC

## Discussion

Joint seal defects have increased primarily due to age and oxidation. Spall repairs completed in 1974 have decreased the incidence of spalling.

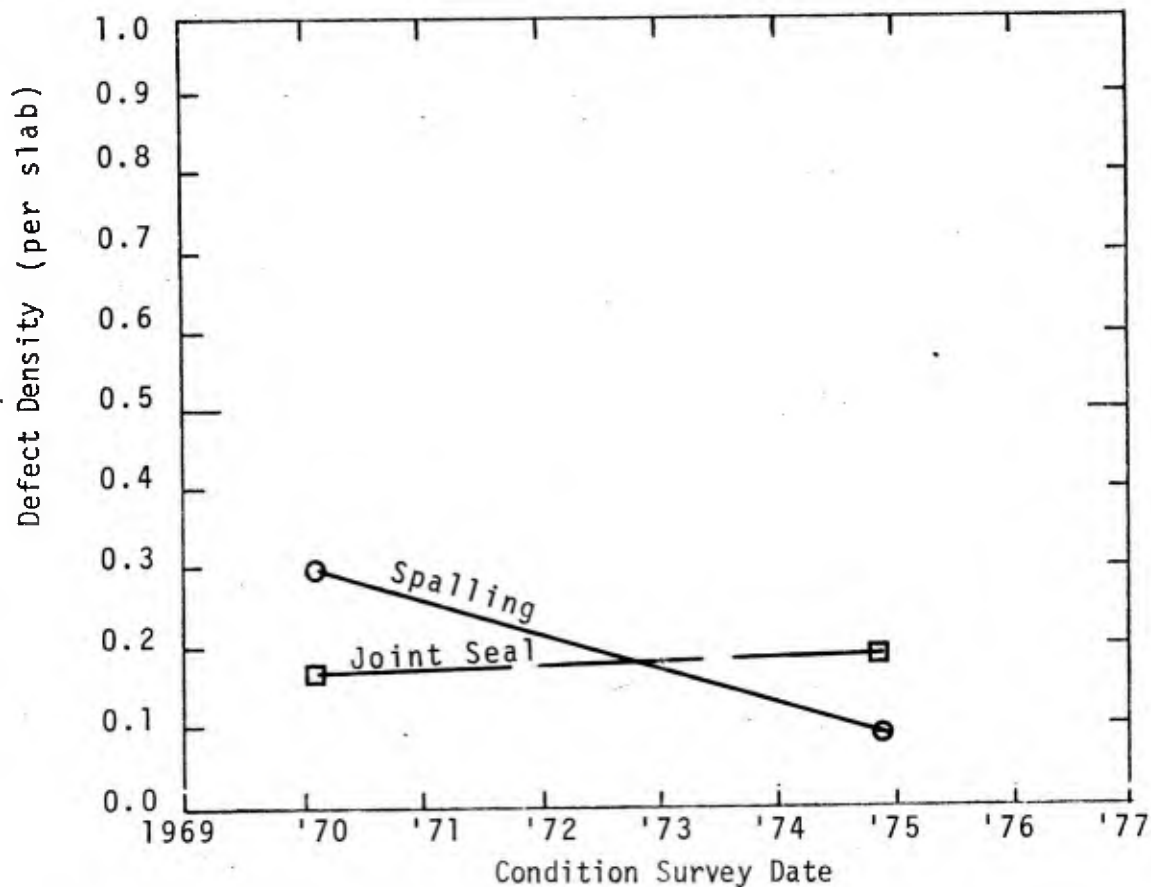
# DISCRETE AREA CONDITION ANALYSIS



|                   |             |               |               |
|-------------------|-------------|---------------|---------------|
| Airfield          | NAS Miramar | Facility      | Runway 6R-24L |
| Discrete Area     | R24L-3      | Pavement Type | AC            |
| <u>Discussion</u> |             |               |               |

The rubber asphalt seal coat placed in October 1974 has covered the cracks measured in 1970. See the discrete area summary R24L-3 for additional comments.

# DISCRETE AREA CONDITION ANALYSIS



Airfield NAS Miramar Facility Runway 10-28  
 Discrete Area R28-1 Pavement Type PCC  
Discussion

Repairs have apparently reduced the number of spalls noted on this seldom-used runway.



Appendix A  
CONSTRUCTION HISTORY

# APPENDIX A

## CONSTRUCTION HISTORY FOR USNAS MIRAMAR, CALIFORNIA

| Item No. | Section From Surface to Subgrade                                           | Date Constructed | Date Strengthened or Sealed |
|----------|----------------------------------------------------------------------------|------------------|-----------------------------|
| 1        | <u>Runway 10-28</u>                                                        |                  |                             |
|          | Spalls repaired with epoxy concrete and joints resealed with SS-S-164      |                  | 1967                        |
|          | 12" Portland cement concrete                                               | 1943             |                             |
|          | 10" Base crusher run                                                       | 1943             |                             |
|          | 4" Plant mix                                                               | 1943             |                             |
|          | Shoulders (150' wide):                                                     |                  |                             |
|          | Slurry seal                                                                |                  | 1956                        |
|          | Seal coat first 50'                                                        |                  | 1946                        |
|          | 2" Asphaltic concrete                                                      | 1943             |                             |
|          | 24" Base                                                                   | 1943             |                             |
| 2        | <u>Runway 6R-24L</u>                                                       |                  |                             |
|          | Rubber-asphalt seal coat                                                   |                  | 1974                        |
|          | 2" Asphaltic concrete overlay                                              |                  | 1965                        |
|          | Seal coat                                                                  |                  | 1954                        |
|          | 3" Asphaltic concrete                                                      | 1951             |                             |
|          | 9" Base                                                                    | 1951             |                             |
|          | 15" Subbase                                                                | 1951             |                             |
| 2A       | <u>Runway 6R-24L (Ends)</u>                                                |                  |                             |
|          | Rubber removal                                                             |                  | 1975                        |
|          | Spalls repaired by Public Works                                            |                  | 1974                        |
|          | Rubber removal                                                             |                  | 1973                        |
|          | Spalls repaired at various times by Public Works                           |                  | --                          |
|          | Joints resealed (SS-S-200a in first 500' on 24 end, SS-S-164 in remainder) |                  | 1961                        |
|          | 12" Portland cement concrete                                               | 1951             |                             |
|          | 12" Base                                                                   | 1951             |                             |
|          | 12" Subbase(compact native material)                                       | 1951             |                             |

| Item No. | Section From Surface to Subgrade                                                                           | Date Constructed | Date Strengthened or Sealed |
|----------|------------------------------------------------------------------------------------------------------------|------------------|-----------------------------|
|          | Shoulders (50' wide):                                                                                      |                  |                             |
|          | 2" Asphaltic concrete                                                                                      |                  | 1954                        |
|          | Seal coat                                                                                                  |                  | 1954                        |
|          | Oil penetration                                                                                            | 1951             |                             |
|          | 24" Subbase                                                                                                | 1951             |                             |
| 2B       | <u>Runway 6R-24L (Asphaltic Concrete Pavement Removed)</u>                                                 |                  |                             |
|          | Rubber removal                                                                                             |                  | 1975                        |
|          | Rubber removal                                                                                             |                  | 1973                        |
|          | Continuing spall repairs by Public Works                                                                   |                  | --                          |
|          | Joints resealed (SS-S-200b)                                                                                |                  | 1963                        |
|          | 11" Portland cement concrete                                                                               | 1960             |                             |
|          | 6" Base and subbase (material compacted 95% AASHO)                                                         | 1960             |                             |
|          | <u>Runway 6R-24L (Overrun)</u>                                                                             |                  |                             |
|          | 8" Base compacted 95% AASHO on                                                                             | 1960             |                             |
|          | 6" compacted native material                                                                               |                  |                             |
| 3        | <u>Runway 6L-24R</u>                                                                                       |                  |                             |
|          | Rubber removal                                                                                             |                  | 1975                        |
|          | Rubber removal                                                                                             |                  | 1973                        |
|          | Continuing spall repairs by Public Works                                                                   |                  | --                          |
|          | Joints resealed and spalls repaired (SS-S-200b in first 500' on 24 end, SS-S-164 in second 500' on 24 end) |                  | 1963                        |
|          | Joints resealed and spalls repaired (SS-S-164 in remaining 5000')                                          |                  | 1961                        |
|          | 12" Portland cement concrete                                                                               | 1944             |                             |
|          | 10" Base crusher run                                                                                       | 1944             |                             |
|          | 4" Plant mix                                                                                               | 1944             |                             |
|          | Shoulders (50'):                                                                                           |                  |                             |
|          | Slurry seal                                                                                                |                  | 1956                        |
|          | Seal coat first 50'                                                                                        |                  | 1946                        |
|          | 2" Asphaltic concrete                                                                                      | 1943             |                             |
|          | 24" Base                                                                                                   | 1943             |                             |

| Item No. | Section From Surface to Subgrade                  | Date Constructed | Date Strengthened or Sealed |
|----------|---------------------------------------------------|------------------|-----------------------------|
| 3A       | <u>Runway 6L-24R (Extension)</u>                  |                  |                             |
|          | 12" Portland cement concrete                      | 1951             |                             |
|          | 12" Base                                          | 1951             |                             |
|          | 12" Subbase                                       | 1951             |                             |
| 3B       | <u>Runway 6L-24R (Extension)</u>                  |                  |                             |
|          | 11" Portland cement concrete                      | 1959             |                             |
|          | 10" Base crusher run                              | 1959             |                             |
|          | 6" Compacted fill on 6" compacted native material | 1959             |                             |
| 3C       | <u>Runway 6L-24R (End)</u>                        |                  |                             |
|          | 13" Portland cement concrete                      | 1959             |                             |
|          | 10" Base crusher run                              | 1959             |                             |
|          | 6" Compacted fill on 6" compacted native material | 1959             |                             |
|          | Shoulders 50':                                    |                  |                             |
|          | Slurry seal                                       |                  | 1956                        |
|          | 2" Asphaltic concrete                             | 1951             |                             |
|          | 22" Subbase                                       | 1951             |                             |
|          | Overrun:                                          |                  |                             |
|          | 8" Subbase material                               | 1959             |                             |
| 4        | <u>Taxiway 5 (75' wide)</u>                       |                  |                             |
|          | 12" Portland cement concrete                      | 1951             |                             |
|          | 12" Base                                          | 1951             |                             |
|          | 12" Subbase (compacted native material)           | 1951             |                             |
|          | Shoulders (25" wide):                             |                  |                             |
|          | Slurry seal                                       |                  | 1956                        |
|          | Slurry seal                                       |                  | 1952                        |
|          | Seal coat                                         |                  | 1946                        |
|          | 2" Asphaltic concrete                             | 1943             |                             |
|          | 22" Subbase                                       | 1943             |                             |

| Item No. | Section From Surface to Subgrade         | Date Constructed | Date Strengthened or Sealed |
|----------|------------------------------------------|------------------|-----------------------------|
| 5        | 12" Portland cement concrete<br>10" Base | 1944<br>1944     |                             |
|          | Shoulders:                               |                  |                             |
|          | Slurry seal                              |                  | 1956                        |
|          | Seal coat                                |                  | 1946                        |
|          | 2" Asphaltic concrete                    | 1944             |                             |
|          | 24" Base                                 | 1944             |                             |
| 6        | <u>Taxiway 1</u>                         |                  |                             |
|          | 13" Portland cement concrete             | 1959             |                             |
|          | 10" Base                                 | 1959             |                             |
|          | 6" Compacted native material             | 1959             |                             |
|          | Shoulders 25' wide:                      |                  |                             |
|          | 24" Compacted fill                       | 1959             |                             |
|          | 6" Compacted native material             | 1959             |                             |
| 6A       | <u>Taxiway 1</u>                         |                  |                             |
|          | 12" Portland cement concrete             | 1951             |                             |
|          | 12" Base                                 | 1951             |                             |
|          | 12" Subbase (Compacted native material)  | 1951             |                             |
|          | 4" Plant mix                             | 1951             |                             |
| 6B       | <u>Taxiway 1</u>                         |                  |                             |
|          | 2" Overlay (on 3" exist, NOY 27062)      |                  | 1965                        |
|          | 3" Asphaltic concrete                    | 1951             |                             |
|          | 9" Base                                  | 1951             |                             |
|          | 15" Subbase                              | 1951             |                             |
|          | Shoulders 25' wide:                      |                  |                             |
|          | 2" Overlay                               | 1954             |                             |
|          | 12" Native compacted material            | 1954             |                             |
| 6C       | <u>Taxiway 1</u>                         |                  |                             |
|          | 12" Portland cement concrete             | 1944             |                             |
|          | 10" Crusher run base                     | 1944             |                             |
|          | 4" Plant mix                             | 1944             |                             |

| Item No. | Section from Surface to Subgrade        | Date Constructed | Date Strengthened or Sealed |
|----------|-----------------------------------------|------------------|-----------------------------|
| 7        | <u>Parking Apron 1</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1951             |                             |
|          | 12" Base                                | 1951             |                             |
|          | 12" Subbase (compacted native material) | 1951             |                             |
| 7A       | <u>Parking Apron 1</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1944             |                             |
|          | 10" Base crusher run                    | 1944             |                             |
|          | 4" Plant mix                            | 1944             |                             |
| 7B       | <u>Parking Apron 1</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1962             |                             |
|          | 12" Base                                | 1962             |                             |
|          | 6" Compacted native material            | 1962             |                             |
| 7C       | <u>Parking Apron 1</u>                  |                  |                             |
|          | 9" Portland cement concrete             | 1969             |                             |
|          | 6" Base                                 | 1969             |                             |
|          | 6" Compacted native material            | 1969             |                             |
| 7D       | <u>Parking Apron 1</u>                  |                  |                             |
|          | 8" Portland cement concrete             | 1953             |                             |
|          | 12" Select base material                | 1953             |                             |
| 8        | <u>Parking Apron 2</u>                  |                  |                             |
|          | 8" Portland cement concrete             | 1944             |                             |
|          | 12" Base crusher run                    | 1944             |                             |
| 9        | <u>Parking Apron 3</u>                  |                  |                             |
|          | 10" Portland cement concrete            | 1954             |                             |
|          | 8" Base                                 | 1954             |                             |
|          | 6" Subbase (compacted native material)  | 1954             |                             |

| Item No. | Section From Surface to Subgrade        | Date Constructed | Date Strengthened or Sealed |
|----------|-----------------------------------------|------------------|-----------------------------|
| 9A       | <u>Parking Apron 3</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1951             |                             |
|          | 12" Base                                | 1951             |                             |
|          | 12" Base (compacted native material)    | 1951             |                             |
| 10       | <u>Parking Apron 4</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1952             |                             |
|          | 12" Base                                | 1952             |                             |
|          | 12" Subbase (compacted native material) | 1952             |                             |
| 10A      | <u>Parking Apron 4</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1944             |                             |
|          | 4" Crusher run base "A"                 | 1944             |                             |
|          | 6" Crusher run base "B"                 | 1944             |                             |
|          | 4" Plant mix                            | 1944             |                             |
| 11       | <u>Parking Apron 5</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1951             |                             |
|          | 12" Base                                | 1951             |                             |
|          | 12" Subbase (compacted native material) | 1951             |                             |
| 11A      | <u>Parking Apron 5</u>                  |                  |                             |
|          | 8" Portland cement concrete             | 1944             |                             |
|          | 12" Base crusher run                    | 1944             |                             |
| 11B      | <u>Parking Apron 5</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1944             |                             |
|          | 4" Crusher run base "A"                 | 1944             |                             |
|          | 6" Crusher run base "B"                 | 1944             |                             |
| 11C      | <u>Parking Apron 5</u>                  |                  |                             |
|          | 12" Portland cement concrete            | 1951             |                             |
|          | 12" Base                                | 1951             |                             |
|          | 12" Compacted native material           | 1951             |                             |

| Item No . | Section From Surface to Subgrade                                      | Date Constructed | Date Strengthened or Sealed |
|-----------|-----------------------------------------------------------------------|------------------|-----------------------------|
| 12        | <u>Parking Apron 6</u>                                                |                  |                             |
|           | 10" Portland cement concrete                                          | 1953             |                             |
|           | 8" Base                                                               | 1953             |                             |
|           | 6" Compacted native material                                          | 1953             |                             |
| 13        | <u>Parking Apron 7</u>                                                |                  |                             |
|           | 10" Portland cement concrete                                          | 1965             |                             |
|           | 6" Base                                                               | 1965             |                             |
|           | 6" Subbase (compacted native material)                                | 1965             |                             |
|           | Shoulders (50'):                                                      |                  |                             |
|           | 2" Asphaltic concrete                                                 | 1968             |                             |
| 14        | <u>Fueling lanes 3 to 8</u>                                           |                  |                             |
|           | 10" Portland cement concrete                                          | 1959             |                             |
|           | 8" Base                                                               | 1959             |                             |
|           | 6" Subbase (compacted native material)                                | 1959             |                             |
| 15        | <u>Circular Fueling Lanes</u>                                         |                  |                             |
|           | 10" Portland cement concrete                                          | 1970             |                             |
|           | 6" Base                                                               | 1970             |                             |
| 15A       | <u>Circular Fueling Hub</u>                                           |                  |                             |
|           | 6" Portland cement concrete                                           | 1970             |                             |
|           | 6" Base                                                               | 1970             |                             |
| 16        | <u>Parking Apron (under construction at time of condition survey)</u> |                  |                             |
|           | Portland cement concrete                                              | 1975             |                             |
|           | Cement treated base course                                            | 1975             |                             |





Appendix B  
CLIMATOLOGICAL DATA

Temperature Data  
(Degrees Fahrenheit)

| Month     | Means         |               |         | Extremes       |       |               |       |
|-----------|---------------|---------------|---------|----------------|-------|---------------|-------|
|           | Daily Maximum | Daily Minimum | Monthly | Record Highest | Year  | Record Lowest | Year  |
| #         | 18            | 18            | 18      | 18             |       | 18            |       |
| January   | 64.1          | 44.9          | 54.8    | 87             | 1965  | 30            | 1952  |
| February  | 65.1          | 46.2          | 56.0    | 93             | 1962  | 34            | 1965+ |
| March     | 65.2          | 47.9          | 56.8    | 87             | 1964  | 33            | 1966  |
| April     | 67.4          | 51.1          | 59.5    | 95             | 1966+ | 39            | 1953  |
| May       | 69.7          | 54.3          | 62.2    | 96             | 1956  | 42            | 1967  |
| June      | 72.8          | 57.3          | 65.3    | 100            | 1957  | 46            | 1967  |
| July      | 78.8          | 61.3          | 70.3    | 101            | 1957  | 52            | 1952  |
| August    | 80.4          | 63.0          | 71.9    | 97             | 1967+ | 53            | 1952+ |
| September | 79.8          | 61.0          | 70.7    | 111            | 1963  | 49            | 1954+ |
| October   | 77.0          | 57.0          | 67.2    | 105            | 1961  | 46            | 1952  |
| November  | 71.4          | 51.6          | 61.8    | 100            | 1966  | 38            | 1958  |
| December  | 67.3          | 47.1          | 57.5    | 98             | 1963+ | 33            | 1960  |

# Length of weather record in years.

+ Also occurred on earlier day, month, or year.

Weather data source: Naval Weather Service Command, "Local Climatological Data for Selected U.S. Navy and Marine Corps Stations," June, 1968

Precipitation Data  
(Inches)

| Month     | Mean | Maximum<br>Monthly | Year | Minimum<br>Monthly | Year  | Maximum<br>in 24 hrs. | Year |
|-----------|------|--------------------|------|--------------------|-------|-----------------------|------|
| #         | 18   | 18                 |      | 18                 |       | 18                    |      |
| January   | 2.25 | 6.48               | 1957 | 0.31               | 1965  | 1.75                  | 1952 |
| February  | 1.34 | 3.69               | 1959 | T                  | 1967  | 1.60                  | 1958 |
| March     | 1.55 | 5.40               | 1954 | T                  | 1959  | 1.37                  | 1954 |
| April     | 1.16 | 3.84               | 1965 | T                  | 1966+ | 1.41                  | 1965 |
| May       | 0.34 | 1.55               | 1957 | T                  | 1966+ | 1.05                  | 1950 |
| June      | 0.08 | 0.40               | 1957 | T                  | 1959+ | 0.37                  | 1957 |
| July      | 0.03 | 0.17               | 1954 | 0.00               | 1964+ | 0.12                  | 1951 |
| August    | 0.04 | 0.65               | 1951 | 0.00               | 1962  | 0.58                  | 1951 |
| September | 0.19 | 2.10               | 1963 | 0.00               | 1956  | 1.04                  | 1963 |
| October   | 0.32 | 1.63               | 1957 | 0.00               | 1967  | 1.34                  | 1951 |
| November  | 1.22 | 5.66               | 1965 | 0.00               | 1956  | 2.03                  | 1965 |
| December  | 1.32 | 4.95               | 1951 | 0.05               | 1956  | 2.27                  | 1951 |

# Length of weather record in years.

+ Also occurred on earlier day, month, or year.

Weather data source: Naval Weather Service Command, "Local Climatological  
Data for Selected U.S. Navy and Marine Corps Stations,"  
June, 1968

# Wind Data

| Month     | Mean Speed (Kts) | Prevailing Direction | Peak Gust   |           |       |
|-----------|------------------|----------------------|-------------|-----------|-------|
|           |                  |                      | Speed (Kts) | Direction | Year  |
| #         | 18               |                      | 18          |           |       |
| January   | 4.4              | E                    | 39          | W         | 1951  |
| February  | 4.5              | E                    | 38          | W         | 1960  |
| March     | 4.6              | E                    | 37          | WSW       | 1958+ |
| April     | 4.7              | WNW                  | 41          | WSW       | 1958  |
| May       | 4.7              | W                    | 31          | ENE       | 1956+ |
| June      | 4.3              | W                    | 22          | SSW       | 1951  |
| July      | 3.8              | WNW                  | 21          | NNE       | 1960+ |
| August    | 3.8              | WNW                  | 88          | NE        | 1950  |
| September | 3.8              | NW                   | 41          | NE        | 1959  |
| October   | 3.8              | WNW                  | 33          | E         | 1967  |
| November  | 4.1              | E                    | 38          | W         | 1958+ |
| December  | 4.1              | E                    | 38          | WSW       | 1949  |

# Length of weather record in years

+ Also occurred on earlier day, month, or year

Weather data source: Naval Weather Service Command,  
 "Local Climatological Data  
 for Selected U.S. Navy and Marine  
 Corps Stations", June, 1968

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  $12\frac{1}{2} \times 15$  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-foot 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 bigger the area, the larger the defect count), the total defect 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;

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

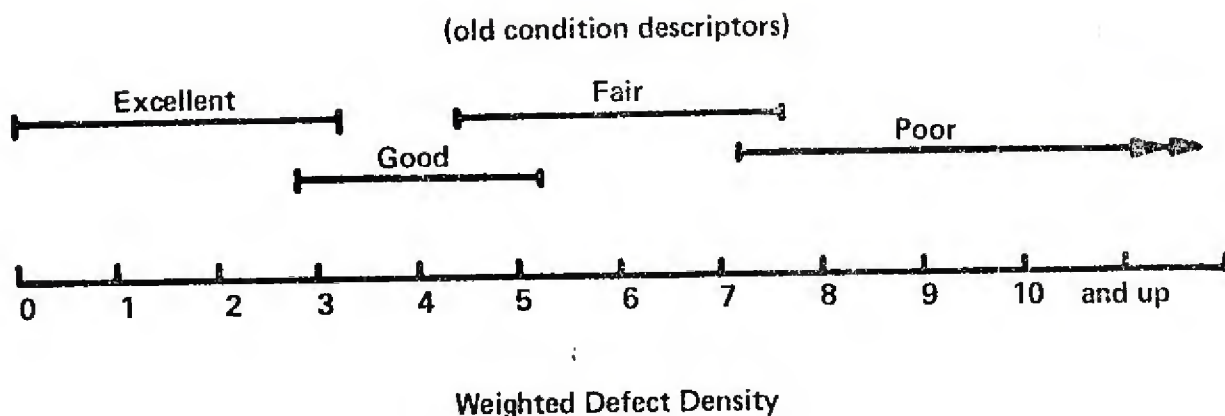
facility (or portion) has been designated a single discrete area (as often occurs), the proportionality factor in column (b) is obviously 1.00 and the discrete area weighted defect density from column (a) becomes the average weighted defect density for the entire facility (or portion) in column (c).

#### 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 indicate 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 individual discrete area 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 averaged 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 include 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 strengths, traffic usage, etc. It is possible that additional measurements or modifications may be considered necessary or desirable in future condition survey programs.

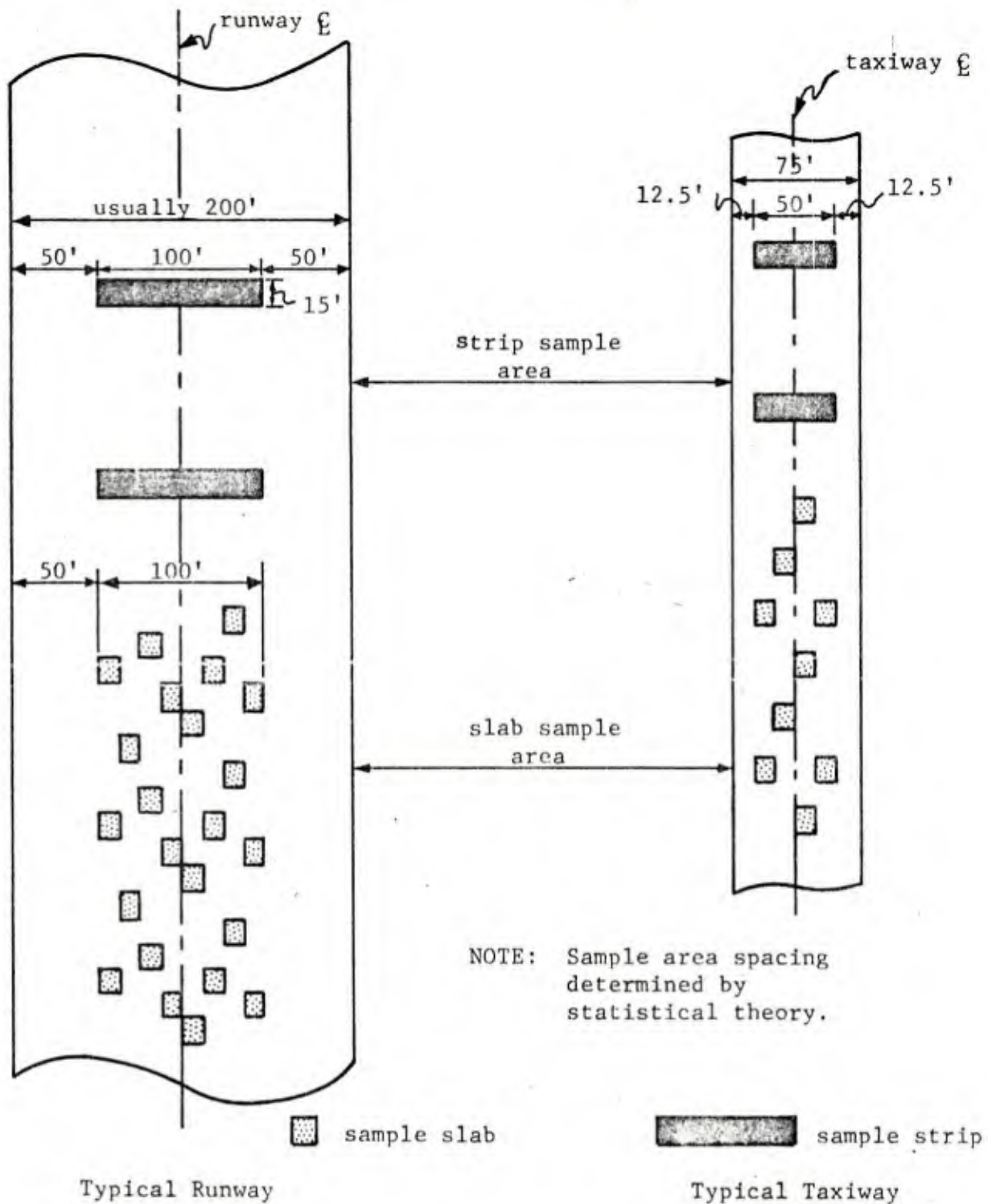


Figure C-1 Portland cement concrete sample areas.

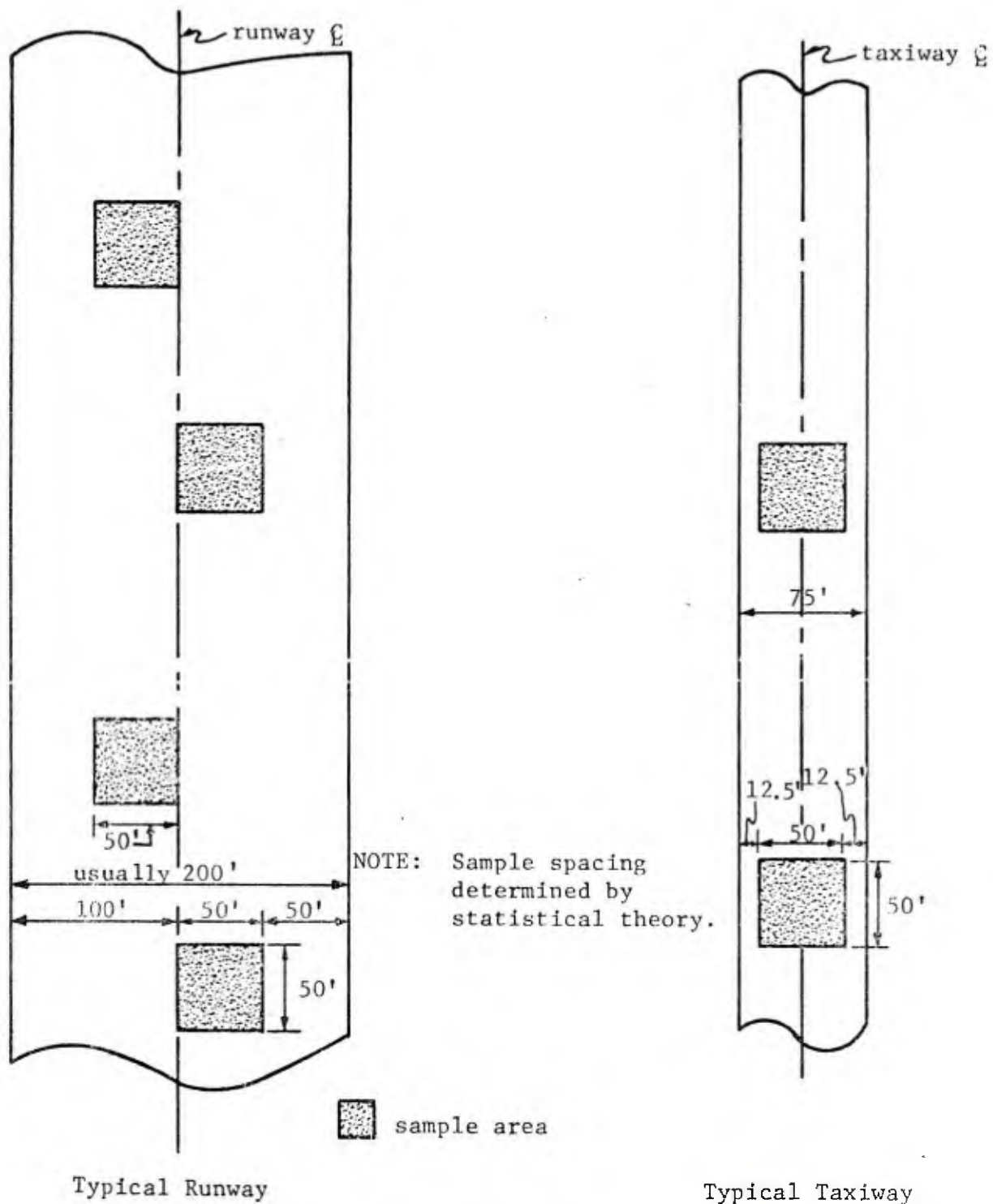


Figure C-2 Asphaltic concrete sample areas.

# 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<sup>2</sup>  
 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 <sup>2</sup>               | 2,067 ft <sup>2</sup>                            | 0.2116                                 | 9.0                    | 1.9041                             |
| Pattern Cracking                                                                                                                                                                                                                    | 126 ft <sup>2</sup>               | 491.4 ft <sup>2</sup>                            | 0.0503                                 | 2.5                    | 0.1257                             |
| Rutting                                                                                                                                                                                                                             |                                   |                                                  |                                        |                        |                                    |
| Heaving                                                                                                                                                                                                                             |                                   |                                                  |                                        |                        |                                    |
| Erosion—Jet Blast                                                                                                                                                                                                                   |                                   |                                                  |                                        |                        |                                    |
| Oil Spillage                                                                                                                                                                                                                        |                                   |                                                  |                                        |                        |                                    |
| Broken-up Area                                                                                                                                                                                                                      |                                   |                                                  |                                        |                        |                                    |
| Total                                                                                                                                                                                                                               |                                   |                                                  |                                        |                        | 2.11 A**                           |
| Remarks on Pavement Condition<br><br>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                         |
| Sealing            |                              |                               |                               |                        |                               |
| 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<br>Airfield <u>E X A M P L E</u><br>Date Surveyed _____ |                                        |                                                        |                                                 |
|----------------------------------------------------------------------------------------------------|----------------------------------------|--------------------------------------------------------|-------------------------------------------------|
| Facility (or portion)                                                                              | Weighted<br>Defect<br>Density<br>Total | Ratio:<br><u>Discrete Area</u><br>Total Facility Area* | Average Weighted<br>Defect Density<br>(a) x (b) |
|                                                                                                    | (a)**                                  | (b)                                                    | (c)**                                           |
| Taxiway 2<br>T2-1                                                                                  | 2.11 A                                 | 1.00                                                   | 2.11 A                                          |
| Taxiway 10<br>T10-2                                                                                | 0.004 A                                | 1.00                                                   | 0.004 A                                         |
| Towway 1<br>TOW-1                                                                                  | 3.77 A                                 | 1.00                                                   | 3.77 A                                          |
| Parking Apron 2<br>PA2-1                                                                           | 7.29 A                                 | 1.00                                                   | 7.29 A                                          |
| Parking Apron 6<br>PA6-1                                                                           | 7.44 A                                 | 1.00                                                   | 7.44 A                                          |
| Parking Apron 7<br>PA7-1                                                                           | 4.97 A                                 | 0.79                                                   | 3.93                                            |
| PA7-2                                                                                              | 23.18 A                                | 0.21                                                   | 4.87                                            |
|                                                                                                    |                                        |                                                        | <u>8.80 A (Total)</u>                           |
| Parking Apron 8<br>PA8-1                                                                           | 2.76 A                                 | 1.00                                                   | 2.76 A                                          |
| Central Mat<br>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<br>Airfield <u>EXAMPLE</u><br>Date Surveyed _____ |                                        |                                                                       |                                                 |
|----------------------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------|
| Facility (or portion)                                                                              | Weighted<br>Defect<br>Density<br>Total | Ratio:<br>$\frac{\text{Discrete Area}}{\text{Total Facility Area}^*}$ | Average Weighted<br>Defect Density<br>(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                                            |
|                                                                                                    |                                        |                                                                       | <u>3.35 C (Total)</u>                           |
| Runway 18-36                                                                                       |                                        |                                                                       |                                                 |
| R18-1                                                                                              | 1.25 C                                 | 0.68                                                                  | 0.85                                            |
| R18-2                                                                                              | 0.76 C                                 | 0.32                                                                  | 0.28                                            |
|                                                                                                    |                                        |                                                                       | <u>1.13 C (Total)</u>                           |
| Taxiway 1                                                                                          |                                        |                                                                       |                                                 |
| T1-1                                                                                               | 2.82 C                                 | 0.12                                                                  | 0.34                                            |
| T1-2                                                                                               | 0.98 C                                 | 0.88                                                                  | 0.86                                            |
|                                                                                                    |                                        |                                                                       | <u>1.20 C (Total)</u>                           |
| 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<br>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 Miramar, California

| Test Location<br>Run #      | Runway<br>Heading | Average Time<br>After Wetting<br>Min. | Average<br>Coefficient<br>of Friction<br>(Mu) | Maximum<br>Coefficient<br>of Friction<br>(Mu) | Minimum<br>Coefficient<br>of Friction<br>(Mu) |
|-----------------------------|-------------------|---------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Runway 6L-24R               |                   |                                       |                                               |                                               |                                               |
| Test Section A              |                   |                                       |                                               |                                               |                                               |
| 1                           | 24                | 0.94                                  | 0.38                                          | 0.64                                          | 0.02                                          |
| 2                           | 6                 | 1.91                                  | 0.40                                          | 0.75                                          | 0.03                                          |
| 3                           | 24                | 3.71                                  | 0.46                                          | 0.76                                          | 0.03                                          |
| 4                           | 6                 | 5.18                                  | 0.54                                          | 0.77                                          | 0.08                                          |
| 5                           | 24                | 5.74                                  | 0.57                                          | 0.79                                          | 0.12                                          |
| 6                           | 6                 | 11.58                                 | 0.65                                          | 0.82                                          | 0.12                                          |
| 7                           | 24                | 15.34                                 | 0.69                                          | 0.84                                          | 0.09                                          |
| 8                           | 6                 | 19.88                                 | 0.71                                          | 0.81                                          | 0.20                                          |
| Test Section B              |                   |                                       |                                               |                                               |                                               |
| 1                           | 24                | 0.92                                  | 0.51                                          | 0.64                                          | 0.27                                          |
| 2                           | 6                 | 1.73                                  | 0.57                                          | 0.79                                          | 0.18                                          |
| 3                           | 24                | 3.44                                  | 0.67                                          | 0.76                                          | 0.33                                          |
| 4                           | 6                 | 5.06                                  | 0.73                                          | 0.81                                          | 0.32                                          |
| 5                           | 24                | 6.45                                  | 0.76                                          | 0.81                                          | 0.43                                          |
| 6                           | 6                 | 9.77                                  | 0.78                                          | 0.84                                          | 0.50                                          |
| 7                           | 24                | 20.55                                 | 0.77                                          | 0.79                                          | 0.64                                          |
| Test Section C<br>(2000 ft) |                   |                                       |                                               |                                               |                                               |
| 1                           | 24                | 2.25                                  | 0.50                                          | 0.68                                          | 0.14                                          |
| 2                           | 6                 | 3.62                                  | 0.58                                          | 0.71                                          | 0.30                                          |
| 3                           | 24                | 5.43                                  | 0.63                                          | 0.75                                          | 0.38                                          |
| 4                           | 6                 | 6.80                                  | 0.67                                          | 0.75                                          | 0.37                                          |
| 5                           | 24                | 9.33                                  | 0.71                                          | 0.77                                          | 0.48                                          |
| 6                           | 6                 | 14.47                                 | 0.74                                          | 0.80                                          | 0.48                                          |
| 7                           | 24                | 19.93                                 | 0.73                                          | 0.77                                          | 0.54                                          |
| Test Section D              |                   |                                       |                                               |                                               |                                               |
| 1                           | 6                 | 1.06                                  | 0.62                                          | 0.70                                          | 0.50                                          |
| 2                           | 24                | 2.24                                  | 0.64                                          | 0.72                                          | 0.51                                          |
| 3                           | 6                 | 3.92                                  | 0.72                                          | 0.77                                          | 0.62                                          |
| 4                           | 24                | 4.93                                  | 0.73                                          | 0.79                                          | 0.62                                          |
| 5                           | 6                 | 6.86                                  | 0.78                                          | 0.80                                          | 0.70                                          |
| 6                           | 24                | 15.18                                 | 0.76                                          | 0.80                                          | 0.70                                          |

Mu-Meter Test Results  
USNAS Miramar, California (Continued)

| Test Location<br>Run #      | Runway<br>Heading | Average Time<br>After Wetting<br>(Min.) | Average<br>Coefficient<br>of Friction<br>(Mu) | Maximum<br>Coefficient<br>of Friction<br>(Mu) | Minimum<br>Coefficient<br>of Friction<br>(Mu) |
|-----------------------------|-------------------|-----------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Runway 6R-24L               |                   |                                         |                                               |                                               |                                               |
| Test Section A<br>(2000 ft) |                   |                                         |                                               |                                               |                                               |
| 1                           | 6                 | 1.62                                    | 0.78                                          | 0.84                                          | 0.58                                          |
| 2                           | 24                | 2.74                                    | 0.76                                          | 0.80                                          | 0.51                                          |
| 3                           | 6                 | 4.44                                    | 0.80                                          | 0.85                                          | 0.56                                          |
| 4                           | 24                | 5.63                                    | 0.79                                          | 0.84                                          | 0.54                                          |
| 5                           | 6                 | 8.64                                    | 0.79                                          | 0.84                                          | 0.55                                          |
| 6                           | 24                | 11.78                                   | 0.79                                          | 0.84                                          | 0.57                                          |
| 7                           | 6                 | 17.67                                   | 0.78                                          | 0.82                                          | 0.63                                          |
| 8                           | 24                | 23.15                                   | 0.76                                          | 0.80                                          | 0.64                                          |
| Test Section B<br>(2000 ft) |                   |                                         |                                               |                                               |                                               |
| 1                           | 24                | 1.64                                    | 0.70                                          | 0.73                                          | 0.59                                          |
| 2                           | 6                 | 3.02                                    | 0.69                                          | 0.71                                          | 0.64                                          |
| 3                           | 24                | 4.70                                    | 0.69                                          | 0.72                                          | 0.64                                          |
| 4                           | 6                 | 5.92                                    | 0.68                                          | 0.71                                          | 0.64                                          |
| 5                           | 24                | 9.81                                    | 0.67                                          | 0.71                                          | 0.63                                          |
| 6                           | 6                 | 15.88                                   | 0.66                                          | 0.69                                          | 0.62                                          |
| Test Section C              |                   |                                         |                                               |                                               |                                               |
| 1 (AC)                      | 24                | 0.95                                    | 0.64                                          | 0.68                                          | 0.52                                          |
| (PCC)                       |                   |                                         | 0.48                                          | 0.58                                          | 0.21                                          |
| 2 (AC)                      | 6                 | 1.82                                    | 0.65                                          | 0.68                                          | 0.50                                          |
| (PCC)                       |                   |                                         | 0.52                                          | 0.64                                          | 0.22                                          |
| 3 (AC)                      | 24                | 3.28                                    | 0.68                                          | 0.72                                          | 0.45                                          |
| (PCC)                       |                   |                                         | 0.58                                          | 0.70                                          | 0.28                                          |
| 4 (AC)                      | 6                 | 4.16                                    | 0.69                                          | 0.73                                          | 0.56                                          |
| (PCC)                       |                   |                                         | 0.61                                          | 0.71                                          | 0.32                                          |
| 5 (AC)                      | 24                | 5.88                                    | 0.69                                          | 0.72                                          | 0.46                                          |
| (PCC)                       |                   |                                         | 0.65                                          | 0.74                                          | 0.36                                          |
| 6 (AC)                      | 6                 | 6.78                                    | 0.68                                          | 0.72                                          | 0.58                                          |
| (PCC)                       |                   |                                         | 0.66                                          | 0.72                                          | 0.38                                          |
| 7 (AC)                      | 24                | 11.18                                   | 0.68                                          | 0.70                                          | 0.52                                          |
| (PCC)                       |                   |                                         | 0.72                                          | 0.76                                          | 0.56                                          |
| 8 (AC)                      | 6                 | 22.53                                   | 0.66                                          | 0.68                                          | 0.48                                          |
| (PCC)                       |                   |                                         | 0.72                                          | 0.75                                          | 0.48                                          |
| 9 (AC)                      | 24                | 26.91                                   | 0.65                                          | 0.68                                          | 0.50                                          |
| (PCC)                       |                   |                                         | 0.76                                          | 0.79                                          | 0.58                                          |

NCEL  
TM-  
53-75-2  
c.2

LIBRARY (CODE L08A)  
CIVIL ENGINEERING LABORATORY  
NAVAL CONSTRUCTION BATTALION CENTER  
PORT HUENEME, CALIFORNIA 93043