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COMPARATIVE STUDY OF NONDESTRUCTIVE PAVEMENT TESTING MACDILL AIR FORCE BASE, FLORIDA

by
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This project is the most comprehensive single undertaking to date which is directed toward an evaluation of the validity of concepts of nondestructive evaluation of the load-carrying capacity of airfield pavements. Seven nondestructive test devices tested five sections of airfield pavements at MacDill Air Force Base (AFB) which consisted of two rigid, two flexible, and one composite pavements, ranging from 20-in. portland cement concrete (PCC) to 5.5-in. asphaltic concrete. Analytical treatments of the test data included empirical correlation analyses, and layered-elastic and finite element computer analyses. Six private firms each with a different nondestructive testing (NDT) evaluation method provided evaluation results in terms of allowable aircraft loads and overlay thicknesses. The Air Force produced one set of results using its new nondestructive pavement testing method, and Waterways Experiment Station provided three sets of results.

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The NDT evaluation methods characterize the pavement structural layers based on the response measured with the NDT devices. Most procedures produce moduli values for the pavement layers and subgrade. Most of the evaluation methods used a back-calculating technique whereby moduli are determined through an iterative process of matching calculated deflection basins to measured basins. The Air Force method determines the velocity of waves propagated through the pavement layers and converts these to moduli.

However, as carefully as the project was planned and conducted, the results are not conclusive. There is a lack of agreement between the allowable load ratings and overlay thickness predictions of the NDT evaluation methods to the standard test pit rating, and a lack of agreement among results from the NDT evaluation methods themselves.

None of the NDT evaluation methods agree perfectly with the standard test-pit method in terms of allowable loads or overlay thicknesses. However, the standard test-pit results make assumptions as to factors such as the quality of base and subbase material, load transfer at joints, condition of the existing pavement, and traffic distribution that might be different from the manner that the NDT evaluation methods treated the same variables. Conventional tests such as California Bearing Ratio and plate-bearing tests are performed on partially disturbed materials because the pavement must be excavated to perform the tests. In contrast, the NDT is a truly in situ test that evaluates the pavement without any disturbance or modification. The allowable aircraft loads from the NDT evaluation methods appear to agree better with the test-pit method than do the predicted overlay thicknesses. The reason for this is not readily apparent since the same basic approaches are used by most evaluation methods for both sets of results.

This study has shown that NDT technology exists for evaluation of airfield pavements. For the pavements at MacDill AFB, some NDT evaluation methods agreed better with the standard test-pit method than others. However, the pavements at MacDill AFB are rather nontypical, and those NDT evaluation methods that did not give good results at MacDill may give more agreeable results on different pavements. The lack of agreement between results of the NDT evaluation methods does justify concern and may point to the need for a standard evaluation method.

EXECUTIVE SUMMARY

This project, which is directed toward an evaluation of the validity of concepts of nondestructive evaluation of the load-carrying capacity of airfield pavements, has been the most comprehensive single undertaking to date. Seven nondestructive test devices were used to test five sections of airfield pavement at MacDill Air Force Base (AFB), consisting of two rigid, two flexible, and one composite pavements and ranging from 20-in. portland cement concrete (PCC) to 5.5-in. asphaltic concrete (AC). Analytical treatments of the test data included empirical correlation analyses, and layered-elastic and finite-element computer analyses. Six private firms each with a different nondestructive testing (NDT) evaluation method provided evaluation results in terms of allowable aircraft loads and overlay thicknesses. The Air Force produced one set of results using its new nondestructive pavement testing (NDPT) method, and the US Army Engineer Waterways Experiment Station (WES) provided three sets of results with the Dynamic Stiffness Modulus method and layered-elastic analysis using data from the WES 16-kip vibrator and a Dynatest Model 8000 Falling Weight Deflectometer (FWD) using layered-elastic analysis. The participants in the project and the NDT equipment used by each were:

Participant	NDT Equipment
ARE, Inc.	Dynaflect
Louis Berger International	Pavement Profiler Model 2000
Dynatest Consulting	Dynatest Model 8000 FWD
ERES Consultants, Inc.	Dynatest Model 8000 FWD*
Reinard W. Brandley	Dynatest Model 8000 FWD*
	Brandley Centilever Beam
Pavement Consultancy Services	Shell FWD
WES	WES 16-kip vibrator
	Dynatest Model 8000 FWD
Air Force Engineering and Services Center (AFESC)	NDPT wave velocity van

* Tests were conducted by Dynatest Consulting for these participants.

The tests were conducted on pavement sections where test pits for density and California Bearing Ratio (CBR) had been placed 2 years earlier by the AFESC.

However, as carefully as the project was planned and conducted, the results are not conclusive. There is a lack of agreement between the allowable load ratings and overlay thickness predictions of the NDT evaluation methods to the standard test-pit rating, and a lack of agreement between results from the NDT evaluation methods themselves.

The pavement materials such as limerock base and the sand subgrade at MacDill AFB are not typical of most other airfield pavements. The standard test-pit data were collected 2 years prior to the NDT, although conditions and material strengths probably had changed little. The test-pit measurements reported by AFESC were suspected in the area of flexural strength (R) of PCC and plate-bearing measurements. Standard test-pit measurements in terms of CBR and subgrade modulus k in a cohesionless material such as the sand subgrade are difficult to obtain accurately. For the standard rating based on test-pit measurements, test data collected in the 1940's were used to supplement the AFESC test-pit data. The pavement properties used for the standard evaluation were:

Test Area	Pavement Properties
1	20-in. PCC, R = 750 psi 6-in. stabilized subbase, k = 300 pci Subgrade (SP-SM)
2	11-in. AC 8-in. limerock base, CBR = 80 7-in. stabilized subbase, CBR = 30 Subgrade (SP) CBR = 25
3	5.5-in. AC 8.0-in. limerock base, CBR = 80 7.0-in. stabilized subbase, CBR = 30 Subgrade (SP), CBR = 25
4	7.5-in. AC 6.0-in. PCC, R = 650 psi Subgrade (SP), k = 250 pci Alternate as flexible pavement
5	7.5-in. AC 6.0-in. base, CBR = 80 Subgrade (SP), CBR = 25 10.5-in. PCC, R = 650 psi Subgrade (SP), k = 250 pci

The NDT evaluation methods characterize the pavement structural layers based on the response measured with the NDT devices. Most procedures produce moduli values for the pavement layers and subgrade. Most of the evaluation methods used a back-calculating technique whereby moduli are determined through as iterative process of matching calculated deflection basins to measured basins. The Air Force method determines the velocity of stress waves propagated through the pavement layers and converts these to moduli.

A critical part of each pavement evaluation method is the relationship v to performance. The link to performance in this study has been of a measured or calculated parameter in the form of limiting stress or strain in the pavement components, limiting deflection of the subgrade, and as correlations to established pavement parameters such as CBR and k . All of these factors are someway related to the number of load repetitions to cause failure of the pavement system. The performance criteria must be based on real-world performance of airfield pavements. The evaluation methods involved in this study included such features as considerations of existing pavement conditions, seasonal effects, load transfer at joints, and other important items. Some evaluation methods make predictions of rut depth and cracking as a function of applied traffic. However, the performance predictions can only be as good as the limiting criteria on which the predictions are based. This performance criteria must be compatible with the evaluation method in which it is used; i.e., it must be a closed system in that the computed moduli, limiting criteria, and predicted performance have been derived and validated against true performance standards. Different performance criteria may account for the major differences in the evaluations of the test areas at MacDill AFB.

None of the NDT evaluation methods agreed perfectly with the standard test-pit method in terms of allowable loads or overlay thicknesses. However, the standard test-pit results make assumptions as to factors such as the quality of base and subbase material, load transfer at joints, condition of the existing pavement, and traffic distribution that might be different from the manner which the NDT evaluation methods treated the same variables. Conventional tests such as CBR and plate-bearing tests are performed on partially disturbed materials, because the pavement must be excavated to perform the tests. In contrast, the NDT is a truly in situ test that evaluates the pavement without any disturbance or modification. The allowable aircraft loads from the NDT evaluation methods appear to agree better with the test-pit

method than do the predicted overlay thicknesses. The reason for this is not readily apparent since the same basic approaches are used by most evaluation methods for both sets of results.

This study has shown that NDT technology exists for evaluation of airfield pavements. For the pavements at MacDill AFB, some NDT evaluation methods agreed better with the standard test-pit method than others. However, the pavements at MacDill AFB are rather nontypical, and those NDT evaluation methods that did not give good results at MacDill may give more agreeable results on different pavements. The lack of agreement between results of the NDT evaluation methods does justify concern and may point to the need for a standard evaluation method.

This study has also indicated that further comparisons of the NDT evaluation methods should be made on an airfield with pavements more representative of typical conditions such as on a clay subgrade. The clay subgrade would allow more exact CBR and k measurements with higher confidence. Test-pit measurements should be made concurrently with the NDT. The airfield should be of a medium-load design so that the allowable loads would not be at the maximum-design loads, and the required overlay thicknesses would be produced for comparison. This would provide for a better comparison to the NDT results, and a more definite assessment of the validity of NDT.

PREFACE

This report was prepared by the Pavement Systems Division (PSD), Geotechnical Laboratory (GL), of the US Army Engineer Waterways Experiment Station (WES) under Air Force Project Order No. F-82-74. The work was sponsored by the Air Force Engineering and Services Center, Tyndall Air Force Base, Fla. The Project Monitor was LTC Bill Tolson.

The work reported herein was performed during the period August 1982-September 1983. WES engineers actively engaged in the project were Messrs. Jim W. Hall, Jr., and Don R. Alexander. This report was prepared by Mr. Hall. The work was performed under the direction of Dr. T. D. White, Chief, PSD, and Dr. W. F. Marcuson III, Chief, GL.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*
feet	0.3048	metres
inches	2.54	centimetres
kips (force)	4.448222	kilonewtons
kips (force) per square inch	6.894757	megapascals
miles (US statue)	1.609347	kilometres
mils	0.0254	millimetres
pounds (force)	4.448222	newtons
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
pounds (mass) per cubic inch	27.6799	grams per cubic centimetre
square feet	0.09290304	square metres
square inches	6.4516	square centimetres

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use $K = (5/9)(F - 32) + 273.15$.

COMPARATIVE STUDY OF NONDESTRUCTIVE PAVEMENT TESTING, MACDILL AIR FORCE BASE, FLORIDA

PART I: INTRODUCTION

Background

1. The Air Force Engineering Services Center (AFESC), Tyndall Air Force Base, (AFB) Fla., requested that the US Army Engineer Waterways Experiment Station (WES) conduct a study of various pavement evaluation techniques based on nondestructive testing (NDT). In the 1982 statement of work for the project the following background was given:

> During recent years several nondestructive (NDT) pavement evaluation systems have been developed by government agencies and civilian firms to analyze the load-carrying capability of airfield pavements. The use of NDT devices is seen as a great advance over costly and time-consuming destructive evaluation techniques. Although the NDT devices do not allow the same analysis as destructive testing, the benefits of minimal operational impact and reduced effort to produce a final report are particularly attractive. The use of NDT by the Air Force for airfield evaluation is now feasible and desirable; however, the newness of the systems and the disparities in data reporting format (between NDT systems and destructive testing) make a prudent selection of any type of NDT system difficult. To insure the Air Force receives the kind of information it needs in a given situation, familiarity with the NDT systems and the data they produce is needed. A side-by-side field comparison of available NDT systems which could be contracted by the Air Force would allow USAF personnel to make intelligent decisions about which system to use in any given situation. This side-by-side comparison will be conducted at an airfield designated by AFESC that has been evaluated by destructive techniques which will provide comparison of NDT results with the traditional system results.

2. The NDT of pavements was begun as early as 1933 by the German Research Society for Soil Mechanics and was further developed by the Royal Dutch Shell Laboratory in The Netherlands and the Road Research Laboratory in the United Kingdom. This early work used vibratory devices generally consisting of counter-rotating eccentric masses arranged to produce vertical

loadings. Within the past 10 years or so, more advanced equipment such as the electrohydraulic and electromagnetic vibrators and falling weight impulse devices have been introduced.

3. WES has kept current in the advancement of NDT technology, particularly as related to airfield pavements. WES followed the early work of the Shell researchers and participated in joint efforts during the 1950's (Heukelom and Foster 1960; Maxwell 1960a, 1960b). As part of this early WES work, wave propagation measurements were conducted at the American Association of State Highway Officials (AASHO) Road Test (WES 1963) at Foss Field (WES 1964), and on military airfields (Maxwell and Joseph 1967) and roadways. The Air Force sponsored early work (Hall 1970, 1972, 1973) at WES that led to the development of the present WES NDT procedures. Additional work funded by the Army, the Air Force, and the Federal Aviation Administration (FAA) produced the present WES equipment and WES NDT evaluation method called the Dynamic Stiffness Modulus (DSM) method (Ahlvin 1971, Green and Hall 1975). The DSM method has been adopted by the FAA (1976) and the Department of the Army (Hall 1978). WES also conducted studies based on layered-elastic theory and developed procedures for NDT (Green 1978, Weiss 1980, Bush 1980a). In a study conducted by WES for the FAA, several NDT devices were evaluated for use on light airport pavements, and comparisons were made of the measurements made by each (Bush 1980b). However, no attempt was made in that study to compare analytical methodologies.

4. During the past 10 to 15 years, much effort has been applied by various research organizations to the area of NDT, and as a result, numerous methods have been developed using a range of equipment. The Transportation Research Board (TRB) made a review of nondestructive evaluation of pavements in 1978, and TRB formed a Task Force (A2T56) in January 1981 to make a state-of-the-art review of NDT of airfield pavements (Moore, Hansen, and Hall 1978). Some 15 different procedures have been brought before the Task Force of which the author is a member. Table 1 gives a list of the evaluation methods presented to the Task Force. The information and procedures being reviewed by the Task Force provided some of the background for selection of the participants in this project. The evaluation methods selected for the study and reported herein were those complete evaluation procedures that had been demonstrated on airfield evaluation projects. Also selected were those methods providing the full range of available NDT equipment and analysis techniques.

Purpose and Scope

5. The primary purpose of this study was to provide the AFESC with an assessment of the nondestructive approach to pavement evaluation so that the Air Force can make sound decisions as to the possible uses and benefits of NDT pavement evaluation methods. It was not the purpose of this investigation to identify any "best method" but rather to assess the state of the art, demonstrate differences in test and analysis methods, and study the impact of these differences on results at one airfield. Because it is possible to obtain the best answer for the wrong reason (accidentally compensating mistakes), a comparative evaluation at a single airfield (that is, a single type of subgrade and base course) could never be used as a basis for defining one method as best (Hadala 1975). Comparative evaluation of different methods will give the decision maker a reasonably good exposure to the differences in the methods, their individual strengths and weaknesses, their areas of commonality, and a feel for the effect of the differences on practical engineering decisions.

6. The scope of the project involved comparisons of selected NDT equipment and procedures on representative airfield pavements and a comparison of the NDT results with those obtained from the standard Air Force evaluation procedures based on test-pit measurements. WES selected six leading firms with demonstrated NDT capabilities. These firms are believed to represent the state of the art or terms of commercial NDT equipment and available analytical evaluation methods. In addition, WES demonstrated three NDT procedures that it had developed and the AFESC demonstrated its new NDT evaluation method. The field demonstrations were conducted on five selected test areas at MacDill AFB, Tampa, Fla., during October and November 1982. The test areas at MacDill AFB had each been evaluated in March 1980 by test-pit measurements in each of the five test areas. Each participant made an evaluation of the test areas and independently submitted a report to WES. Allowable gross aircraft loadings were computed for each test area for the 13 aircraft groups and 4 pass intensity levels as given in Air Force Regulation AFR 93-5 (Headquarters, Department of the Air Force 1981). Also, overlay thickness requirements were determined for the KC10A (DC-10-30) aircraft at a total of 1,000 passes and for the E4 (B-747) aircraft at 10,000 passes. This report contains results presented by each of the participants and makes comparisons with the standard Air Force evaluation procedure based on test-pit measurements.

Site Selection

7. The AFESC selected MacDill AFB as the demonstration site. A visit was made to MacDill AFB on 30 August 1982 by LTC Bill Tolson and CPT Paul Foxworthy of AFESC and Mr. Jim W. Hall, Jr., of WES. Five test areas were selected to provide a range of pavement types and strengths. Figure 1 shows a layout of the airfield at MacDill AFB indicating the five test areas. A test pit had been placed in each of the test areas during a pavement evaluation conducted by AFESC in March 1980. The information obtained from each test pit as reported in the pavement evaluation report is shown in Figure 2 (AFESC 1980). Note that the subgrade material was classified as an SP sand* in Test Areas 2-5 and as an SP-SM sand in Test Area 1; therefore, the subgrade was nearly the same for all test areas. A construction history for each of the test areas is shown in Table 2.

Description of Test Areas

8. Each of the test areas contained approximately 50,000 sq ft** of pavement. This size was selected to be large enough to provide a representative amount of pavement and yet permit all five test areas to be studied in 1 day by each participant. The test areas were selected so as to provide the least interference with MacDill AFB's daily aircraft operations. Each test area was outlined and marked so that location of all tests could be identified.

Test Area 1

9. The pavement in Test Area 1 consisted of a 20-in. portland cement concrete (PCC) pavement. The 25- by 20-ft slabs constructed in 1959 were in excellent condition. The test area, located on Taxiway 33 at MacDill AFB, was 3 slabs wide (75 ft) by 28 slabs long (700 ft). A layout of the area is shown in Figure 3; the marking system was used to locate all NDT measurements. Test Area 1 contained no observable surface distress. An overall view of Test Area 1 is shown in Figure 4.

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* Classified according to the Unified Soil Classification System (USCS).
** A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 7.

Test Area 2

10. Test Area 2 was located on the Parallel Taxiway (Taxiway 3B) to the Main Runway and was constructed in 1943. An asphalt concrete (AC) overlay was placed in the center 18 ft of the taxiway in 1956, and additional overlays were placed in 1963 and 1971. The pavement was in good condition, but contained longitudinal and transverse cracking. This test area, shown in Figure 5, was 75 ft wide and 700 ft long. Station numbers, beginning with 0+00 at the south end of the test area, were marked every 100 ft along the center line. Figure 6 is an overall view of this test area.

Test Area 3

11. Test Area 3 was along the same parallel taxiway as Test Area 2 but farther north. This pavement was also constructed in 1943 and was originally identical to Test Area 2. The original asphalt surface had been overlayed with AC in 1956 and again in 1969. This area was considered in fair condition, although exhibiting considerable distress in the form of block cracking. This test area shown in Figure 7 was 40 ft wide by 1,000 ft long. This area was confined to the 40-ft width because the pavement outside this width was apparently not the same thickness. Station numbers were marked at 100-ft intervals beginning with 0+00 at the south end. Figure 8 gives an overall view of Test Area 3.

Test Area 4

12. Test Area 4 was a composite section located in Apron 1-A-1. The original 6-in. PCC pavement was constructed in 1941 with a slab size of 25 by 25 ft. An AC overlay was placed on this pavement in 1952 followed by a slurry seal in 1966. Considerable reflective cracking of the joints and cracks in the underlying slabs had occurred. The overall condition was considered good. The layout in Figure 9 shows the identification scheme used. Letters A-E were marked every 50 ft along one side and station numbers were marked every 50 ft along the other direction. The area was 200 by 250 ft. Test Area 4 is shown in Figure 10.

Test Area 5

13. Test Area 5 was a 10.5-in. PCC pavement with 15- by 12.5-ft slabs. The pavement, constructed in 1975, consists of the slabs placed directly on the sand subgrade. This apron area, designated Apron 1-A, is actively used for F-16 aircraft parking. The pavement was in excellent condition with only minor distress in the form of corner spalls and joint spalls. Figure 11 gives

a layout of this test area and shows the identification scheme used. The rectangular area consisted of a total of 270 slabs with 18 slabs along the 12.5-ft slab dimension and 15 slabs along the 15-ft-slab dimension. Letters A-O were used to identify the slabs along the 15-ft slab dimension and numbers 1-18 were used to label the side with the 12.5-ft-slab dimension. Figure 12 is an overall view of Test Area 5.

Physical Properties of Test Pavements

14. The pavement properties (California Bearing Ratio (CBR), subgrade modulus k, flexural strength) used by AFESC for evaluation differed from those reported in earlier pavement evaluation reports (US Engineer Office, Jacksonville, Fla. 1944; Office, District Engineer, Savannah, Ga. 1947; US Army Engineer District, Jacksonville, Fla. 1960) and condition survey reports (US Army Engineer, Ohio River Division Laboratories 1954; the Rigid Pavement Laboratory, Ohio River Division Laboratories 1960; Construction Engineering Laboratory, Ohio River Division Laboratories 1964). Table 3 compares these pavement properties for the pavements located in each of the five test areas. Two primary differences are the flexural strength R of the PCC and the subgrade modulus k.

15. For Test Areas 1, 4, and 5, AFESC reports flexural strengths of 480, 580, and 470 psi, respectively (Table 3 (AFESC 1980)). Earlier reports showed flexural strengths of 750 psi for Area 4 (Table 3, US Engineer Office, Jacksonville, Fla. 1944; US Army Engineer District, Jacksonville, Fla. 1960; US Army Engineer, Ohio River Division Laboratories 1954). The AFESC used results from tensile-split tests on 4-in.-diam cores and obtained the flexural strength from correlations of tensile-split test results to flexural strengths. Generally, fairly good correlation results by using 6-in.-diam cores, but the correlation with 4-in.-diam cores is poor (Hammitt 1974). Flexural strength generally does not decrease with time; therefore, the values given in the earlier reports are probably more representative of actual flexural strengths.

16. Some subgrade strengths in terms of subgrade modulus k are not consistent with values reported in the earlier evaluations. Subgrade modulus k of 85 and 80 pci for Test Areas 4 and 5 are in disagreement with values ranging between 250 and 400 pci measured in the earlier evaluations. CBR

values of 35 and 30 were measured by AFESC on the sand subgrade in Test Areas 2 and 3, respectively. The sand subgrade, classified as a poorly graded sand (SP), appears to be fairly uniform throughout the airfield. According to the correlation between CBR and k, a CBR of 30 corresponds to a k value of 300 pci or greater, and a CBR of 25 corresponds to a k of approximately 250 pci (Hall and Elsea 1974). Therefore, the k values of 80 and 85 pci seem unreasonably low for these conditions.

17. Also, some discrepancy exists as to the thickness of pavement layers. Thicknesses reported by AFESC for evaluation (Table 3, (AFESC 1980)) are not the same as indicated by AFESC test-pit data (Figure 2). Thicknesses given by earlier pavement studies are also somewhat different (US Engineer Office, Jacksonville, Fla. 1944; Office, District Engineer, Savannah, Ga. 1947; US Army Engineer District, Jacksonville, Fla. 1960; US Army Engineer, Ohio River Division Laboratories 1954; the Rigid Pavement Laboratory, Ohio River Division Laboratories 1960; Construction Engineering Laboratory, Ohio River Division Laboratories 1964). The AFESC report gives additional thickness measurements made from core borings (AFESC 1980). All of the available thickness information was used to select a set of values for each of the five test areas for use in the study reported herein.

18. Based on the above considerations and a review of all available information on the test area pavements, the following properties have been selected for the standard test-pit analysis for this study:

Test Area	Pavement Properties
1	20-in. PCC, R = 750 psi where R denotes flexural strength 6-in.-stabilized subbase, k = 300 pci Subgrade (SP-SM)
2	11-in. AC 8-in. limerock base, CBR = 80 7-in. stabilized subbase, CBR = 30 Subgrade (SP), CBR = 25
3	5.5-in. AC 8.0-in. limerock base, CBR = 80 7.0-in. stabilized subbase, CBR = 30 Subgrade (SP), CBR = 25

(Continued)

Test Area	Pavement Properties
4	7.5-in. AC 6.0-in. PCC, R = 650 psi Subgrade (SP), k = 250 pci
	Alternate as Flexible Pavement
5	7.5-in. AC 6.0-in. base, CBR = 80 Subgrade (SP), CBR = 25
	10.5-in. PCC, R = 650 psi Subgrade (SP), k = 250 pci

Project Requirements

19. The specific requirements of the project were to (a) select several of the better NDT procedures and equipment for demonstration, (b) have each procedure demonstrated through field tests on each of the five test areas at MacDill AFB, (c) obtain pavement evaluation reports from each procedure giving allowable loadings and overlay requirements for each test area, and (d) compare the results from each method with the standard Air Force evaluation based on test-pit measurements. The original plan was to use the test-pit data collected in 1981 by AFESC; however, some changes were made to these data as previously discussed.

20. Each participant in this demonstration project was given a full day at MacDill AFB to test all five test areas. With the exception of the AFESC, who performed tests for several days, only one participant was on the field for any given day of the demonstration. At the completion of the field tests, each participant provided WES a copy of the field test data.

21. Each participant prepared an evaluation report of the five test areas. This evaluation required the assessment of the allowable gross aircraft loads (AGAL's) for all 13 military aircraft groups at four specified pass intensity levels as given in AFR 93-5 (Headquarters, Department of the Air Force 1981). A pass intensity level is a specified number of aircraft passes (operational movements) for which the AGAL is to be determined. Therefore, the AGAL for pass intensity I would be less than the AGAL for pass intensity II, etc., since pass intensity I requires more passes than pass intensity II. The 13 aircraft groups and the various aircraft in each group are

shown in Table 4. Table 5 shows the controlling aircraft (primary aircraft to be considered) in each group and gives the number of passes for each group for each of four pass intensity levels. Note that the number of passes for a given pass intensity level is not the same for all 13 aircraft groups. The characteristics of the controlling aircraft in each of the 13 aircraft groups to be used for pavement evaluations are shown in Table 6. The evaluation by each participant also included overlay thickness requirements for each of the five test areas for two design loads: (a) 1,000 passes of the DC-10-30 aircraft (KC 10A), and (b) 10,000 passes of the B-747 aircraft (E-4).

PART II: NONDESTRUCTIVE TESTING EVALUATION METHODS

Selection of NDT Evaluation Methods

22. In the selection of the NDT evaluation methods to be demonstrated, both equipment and analytical procedures were considered. The participants selected were those with a unique and demonstrated capability (experience in evaluating airfield pavements). Because several types of NDT equipment were available for nondestructive pavement testing (NDPT), attempts were made to include evaluation methods that would demonstrate all equipment types. Evaluation methods in use included a range of analytical treatments, and again, effort was made to include a cross section of various analysis schemes. Six private firms, WES, and AFESC were selected to participate, and sole-source contracts were negotiated with each private firm. WES also contracted with the New Mexico Engineering Research Institute (NMERI) to have its representative assist in the demonstration of the AFESC methodology. The NMERI was the developer of the AFESC procedure. The following is a list of the participants and the equipment used by each:

Participant	NDT Equipment
ARE, Inc.	Dynaflect
Louis Berger International (Berger)	Pavement Profiler Model 2000
Dynatest Consulting (Dynatest)	Falling weight deflectometer (FWD) Dynatest Model 8000
ERES Consultants, Inc.	Dynatest Model 8000 FWD*
Reinard W. Brandley (Brandley)	Dynatest Model 8000 FWD* Brandley Centilever Beam
Pavement Consultancy Services (PCS)	Shell FWD
WES	WES 16-kip vibrator Dynatest Model 8000 FWD
AFESC	NDPT wave velocity van

* Tests were conducted by Dynatest Consulting for these participants.

23. Each participant demonstrated its analytical procedure using test data from the NDT device used. Ten different analysis schemes were considered in the study. These consisted of six evaluation methods from the six private firms, the AFESC evaluation method, and three evaluation methods from WES.

Field Demonstrations

24. The field tests were conducted during the period 26 October to 3 November 1982. The date on which the areas were tested by each participant were:

Participant	Date
PCS	27 October 1982
ARE	28 October 1982
Dynatest	29 October 1982
ERES	30 October 1982
Berger	31 October 1982
Brandley	1 November 1982
WES	2 November 1982
AFESC	27 October- 3 November 1982

25. The field tests were coordinated with MacDill AFB operations. All test areas were fairly free of aircraft movement during the 6-day test period except Test Area 5. In this area, which is the parking apron for F-16 aircraft, some delays in the testing were experienced because of frequent aircraft movements. Test Area 4 was used as a parking apron for F-111 aircraft on 2 November, making some of this area unavailable to WES.

Description of NDT Equipment

26. Seven NDT devices were used in the project and characteristics of each are presented in Table 7. Three devices--the WES 16-kip vibrator, the Berger Pavement Profiler, and the ARE Dynaflect--operate with a vibratory loading. All of the other devices use an impulse (drop-weight) loading. All devices except the Air Force NDPT device measure the deflection response of the pavement surface to the applied load. The Air Force NDPT device operates on the principle of wave propagation. A brief description of each NDT equipment used in the project is given.

ARE Dynaflect

27. The Dynaflect is an electromechanical system for measuring the dynamic deflection of a pavement caused by an oscillatory load. It is manufactured by SIE, Inc., Fort Worth, Tex. This trailer-mounted device (Figure 13) applies a 1,000-lb peak-to-peak sinusoidal load to the pavement. The load is generated by two counterrotating masses that rotate at a constant

frequency of 8 Hz. The force is transmitted to the pavement through two 4-in.-wide, 16-in.-outside-diam polyurethane-coated steel wheels spaced 20 in. apart. The Dynaflect applies a 2,000-lb static weight to the pavement.

28. The pavement response to the dynamically applied load is measured with 210-Ω, 4.5-Hz geophones that are shunted to a damping factor of approximately 0.7. One geophone is located directly between the two steel wheels. The other four geophones are spaced at 1-ft intervals toward the front of the trailer.

Berger Pavement Profiler Model 2000

29. This device is a Road-Rater Model 2000 manufactured by Foundation Mechanics, Inc., El Segundo, Calif. The Model 2000 applies a peak-to-peak cyclic load of 4.5 kip at a frequency of 25 Hz. The trailer-mounted device (Figure 14) is an electrohydraulic system. The Model 2000 has a self-contained power supply. The gasoline engine supports the hydraulic and electrical systems of the device. The reaction mass of the Model 2000 is 2,000 lb.

30. Three load cells mounted on the load plate monitor the force. The three load cells are summed for total-force output. Deflection is monitored by four velocity sensors. The first is located in the center of the 18-in.-diam load plate, and the other three are at 12, 24, and 36 in. or 12, 24, and 60 in. from the center of the load plate.

Dynatest FWD

31. The Dynatest 8000 FWD is an impact load device that applies a single-pulse transient load of approximately 25-30 msec duration. This trailer-mounted device (Figure 15) measures both applied load and seven deflection points on the pavement with the maximum distance of the deflection point being 7 ft from the center of the load plate. The load is adjustable to a maximum of 24,000 lb and is applied through a 300-mm (approximately 12-in.) diam load plate. The system is controlled with a Hewlett-Packard HP-85 computer that also records the output data. This equipment is shown in Figure 16.

Brandley deflection beam

32. The Brandley deflection beam (Figure 17) is used for testing joints in PCC pavement sections to determine the effectiveness of the load transfer at the joints. The test procedure consists of placing a cantilever deflection beam on the slab with two linear potentiometers located at the free end of the

beam. The beam is set on the slab such that one of the potentiometers is located on one side of the joint and the other potentiometer is located on the other side of the joint. A rubber-tired wheel, which imposes approximately the same total load as the aircraft using the pavements, is then pulled or driven across the joint perpendicular to the joint and passes immediately adjacent to the location of the potentiometers. In this manner, the total relative deflection of the slab at the joint and the relative movement of one slab with respect to the other slab (slab rocking) as the wheel moves over the joint can be measured and recorded. A test vehicle with 50,000 lb per single wheel would normally be used, but the only equipment available at MacDill AFB was a truck-mounted crane with three axles. The rear axles had dual wheels, and each of dual wheels was loaded to 7,000-8,000 lb. Because this was the only equipment available, the tests were conducted using these loads.

PCS FWD

33. The PCS FWD applies a pulse load to the pavement surface by dropping a mass on a baseplate that is connected to the load plate by a set of springs. The maximum force is 22.4 kips, and the force is varied by adjusting the drop height. Both force and deflection are electronically recorded. Velocity transducers, which are electronically integrated to measure deflection, are located at the center of the load plate and at three radial distances of 60, 100, and 200 cm. This trailer-mounted device is shown in Figure 18, and the data recording equipment is shown in Figure 19.

WES 16-kip vibrator

34. The WES 16-kip vibrator shown in Figures 20 and 21 is an electrohydraulic vibratory loading system. The unit is contained in a 36-ft semitrailer along with supporting power supplies and automatic data recording equipment. A 16,000-lb preload is applied to the pavement with a superimposed dynamic load ranging up to 30,000 lb peak-to-peak. The dynamic load can be applied over a frequency range of 5 to 100 Hz but the standard test frequency is 15 Hz. The dynamic load is measured with a set of three load cells mounted on an 18-in.-diam load plate. Velocity transducers located on the load plate and at points away from the plate are calibrated to measure deflection. Test results are recorded on X-Y plotters and a digital printer.

35. Data collected with the WES 16-kip vibrator are the DSM and deflection basins. DSM is the slope (load/deflection) of the dynamic load versus deflection curve obtained by sweeping the force from zero to maximum at a

constant frequency of 15 Hz. This slope is taken at the maximum force levels. The deflection basin is obtained by measuring deflections at distances of 0, 18, 36, and 60 in. from the center of the load plate. The deflection ratio $\Delta 60/\Delta 18$ (obtained by taking the deflection at 60 in. and dividing by the deflection at 18 in.) is used to determine the radius of relative stiffness ℓ for rigid pavements using the developed correlations.

WES FWD

36. The FWD used by WES is a Model 8000 manufactured by Dynatest (Figure 22). A dynamic force is applied to the pavement surface by dropping a 440-lb weight onto a set of rubber cushions, resulting in an impulse loading. The applied force and pavement deflections are measured with load cells and velocity transducers, respectively. The drop height can be varied from 0 to 15.7 in. to produce a force from 0 to 15,000 lb. The load is transmitted to the pavement through an 11.8-in.-diam plate. The signal-conditioning equipment displays the resulting average pressure in kilopascals and the maximum peak displacement in micrometers. As many as three displacement sensors may be recorded at one time.

37. FWD data collected were deflection basin measurements. Displacements were measured on the load plate and at distances of 12, 24, 36, and 48 in. from the center of the load plate. Because this particular model has only two transducers for deflection basin measurements, the four deflection points were obtained by dropping the weight twice and shifting the transducers to the additional spacings.

Air Force NDPT device

38. The AFESC NDPT device is an impact hammer used to excite the pavement system to measure wave velocity response. The hydraulically operated hammer can be dropped from 6 to 36 in. and the drop weight varied from 220 to 500 lb. The assembly is equipped with grippers that lift the hammer, release it, and then catch the hammer after the first impact to prevent the hammer from striking the pavement more than once. A 12-in.-diam loading plate is used with a rubber mat on PCC pavement and without the mat on AC surfaces. Accelerometers are generally placed on the pavement surface at 1, 2, 4, 8, and 16 ft from the edge of the load plate. Signals from the accelerometers are collected through a Hewlett-Packard HP-6942 multiprogrammer and transferred to an HP-9845B computer for analysis and stored on an HP-9895 floppy disk.

39. The computer is primarily used to compute fast Fourier transforms

(FFT) for phase angle versus frequency and wave velocity versus wavelength (dispersion) plots immediately after the data are acquired. When sufficient data are collected for interpretation of the dispersion curve (based on operator experience), the data are stored on the floppy disk and a hard copy is made.

40. It is from this hard copy that the operator selects the velocity values that will ultimately be used in the computer analysis for load-carrying capability of the pavement. The van containing the NDPT device is shown in Figure 23. A close-up of the impact hammer and load plate is shown in Figure 24.

Summary of NDT Evaluation Methods

41. A brief description of the analytical procedures used by each evaluation method is given here. Table 8 gives a summary of some important characteristics of the methods. A more detailed description is given in Appendix A.

ARE, Inc. (1983)

42. Deflection basin data from the Dynaflect are used with the BASFIT program, which is a deflection-basin fitting program that prodicts moduli of the pavement layers and subgrade. A layered-elastic program AIRPOD is used in a fatigue analysis to predict remaining pavement life and allowable loadings. Another layered-elastic program ELSYM-5 is used to compute overlay thickness requirements.

Louis Berger International Inc. (1983)

43. The evaluation method used by Berger is a combination of layered-elastic theory and a modified version of the WES DSM method (Hall 1978). Test data were collected with the Model 2000 pavement profiler. Deflection basin data were used to back-calculate elastic moduli of the pavement layers and subgrade. These moduli were used for an apparent quality assessment of the pavement materials. A correlation was used to convert the DSM's measured with the pavement profiler to the DSM that would be obtained with the WES 16-kip vibrator. Then the DSM procedure with some modifications was used to evaluate the load capacity. For flexible pavements, a subgrade CBR was determined from both the DSM procedure and from the calculated subgrade moduli. The CBR values were then used with the CBR design curve to determine allowable load

and overlay requirements. The DSM was used to determine allowable loadings for rigid pavements using a modified relationship of DSM to allowable gross load. Load transfers at joints in rigid pavements were evaluated with the pavement profiler.

Dynatest Consulting (1983)

44. Dynatest uses the Dynatest 8000 FWD to measure deflection basins, and these measurements are the input for a computer program called ELMOD developed for an HP-85 microcomputer. The ELMOD program includes the method of equivalent thicknesses (MET) to calculate the elastic modulus of up to four pavement layers (Ullidtz 1973, 1977). Nonlinearity of the subgrade is considered in these calculations. Evaluations of joints and corners of rigid-pavement slabs are made with the FWD tests and Westergaard equations (Westergaard 1948). The ELMOD program allows consideration of seasonal temperature effects in the load evaluation. The performance criteria used by Dynatest are permissible normal stress in unbound materials and subgrade, horizontal strain at the bottom of AC, and a fatigue relationship based on flexural strength for PCC (Herholdt et al. 1979).

ERES Consultants, Inc. (1982)

45. The ERES procedure for NDT evaluation uses the Dynatest Model 8000 FWD test results; three load magnitudes are used including the maximum of 24 kips. Pavement layer stiffness values are back-calculated from the measured deflection basins using a layered-elastic program for flexible pavement and a finite element program (ILLISLAB) for rigid pavement. The method for flexible pavements is to model the pavement as a two-layered system to determine the subgrade modulus, and then to calculate other layer moduli that match the theoretical deflection basin to the measured basin (Hoffman and Thompson 1981). Failure criteria for flexible pavement includes radial strain in the asphalt and vertical strain in the subgrade; both rutting (Chou 1976) and fatigue (Bonnaure, Gravois, and Udron 1980) are considered. Fatigue life of the limerock base course was also part of the flexible pavement analysis (Larson and Nussbaum 1967). For rigid pavements, an E modulus of the concrete and a subgrade k modulus are calculated by matching the area of the center slab delfection basin and the maximum deflection. Failure criteria are a relationship of aircraft coverages to concrete modulus of rupture stress ratio. The modulus of rupture is estimated from the E of the slab. Measured load transfer at joints is accounted for in the evaluation.

Reinard W. Brandley (1983)

46. Brandley used test results from the Dynatest 8000 FWD, the WES 16-kip vibrator, and the cantilever deflection beam. Two loads were applied with the FWD, 830 and 1,500 kPa. Test data from both the FWD and the 16-kip vibrator were used with the Dynatest programs of the ELMOD and ISSEM4. These programs, along with the Chevron layered elastic model program, were used to calculate moduli of the pavement layers and subgrade from the FWD deflection data. These moduli were used to compute subgrade deflection under different aircraft loadings; these were compared to the Brandley limiting subgrade deflection criteria to obtain the evaluation results (Brandley 1975). Joint conditions in rigid pavements were evaluated using the cantilever beam. It is the opinion of Brandley that neither the FWD nor the 16-kip vibrator can adequately load joints to measure load transfer.

PCS (1983)

47. The general approach of PCS demonstrated in this project is the collection of deflection data with the PCS FWD, input of these measured deflection basins into the BISAR layered-elastic computer program, and back-calculated elastic moduli (E) for the pavement layers. These moduli are then translated to CBR and/or subgrade k modulus from correlations such as

$E = 1{,}500\ CBR$

$E = 10^x$ where $x = 1.415 + 1.284 \log k$

E in units of psi and k in units of pci

The values of CBR were used for flexible pavements, while k values were obtained on the rigid pavements, and these values were used with the conventional Air Force load evaluation procedures to determine the allowable aircraft loadings and overlay thickness requirements (Headquarters, Department of the Air Force 1981). The method used by PCS for load evaluation used the flexible pavement design equation developed by WES and the equivalent single-wheel analysis (Yoder and Witczak 1975). For rigid pavements the evaluations were based on the Westergaard free-edge stress.

WES DSM method
(Hall and Alexander 1983)

48. The DSM procedure is based on correlations between DSM (load/deflection) measurements with the WES 16-kip vibrator and the allowable single-wheel load (ASWL) as determined from test-pit measurements. DSM is a

ratio of dynamic load:deflection. The correlations were developed from tests on a large number of inservice airfield pavements. The procedure for NDT evaluation provides for correction of deflection measurements on AC for temperature effects, calculation of the effective subgrade CBR for flexible pavement, and determination of the raduis of relative stiffness for rigid pavement (Asphalt Institute 1969). Existing analytical relationships from the standard US Army Corps of Engineers design procedures convert the ASWL to AGAL and compute overlay thicknesses (Headquarters, Departments of the Navy, Army, and Air Force 1978; Headquarters, Departments of the Army and Air Force 1979). A load reduction factor based on joint load transfer measurements is included in the procedure.

WES layered-elastic
method (Hall and Alexander 1983)

49. This evaluation method (Bush 1980a, Alexander 1982) uses deflection basin measurements from the WES 16-kip vibrator or FWD as input to layered-elastic computer programs (Bush 1980a, Alexander 1982). The program used is BISDEF, which is a modification of the BISAR program (Bush 1980a, Peutz 1968). Elastic moduli of the pavement layers and subgrade are back-calculated, and these moduli are then used in the AIRPAV layered-elastic program to determine allowable loads and overlay thicknesses (Alexander 1982). Failure criteria consists of limiting tensile stress in the bottom of PCC slabs, and limiting horizontal tensile strain in AC and vertical subgrade strain in flexible pavement subgrade. A load reduction factor based on joint load-transfer measurements is included in the procedure.

AFESC (1983)

50. Data from the Air Force NDPT impulse load device are interpreted to give shear wave velocity values for each pavement layer and subgrade. These velocity values are converted to elastic moduli, which are used with the PREDICT computer program to determine allowable aircraft loads. Performance criteria are based on tensile stress or strain in the pavement surface layer and subgrade compressive strain. Overlay thicknesses are not presently determined by the method. Load transfer at joints is not measured.

PART III: COMPARISON OF RESULTS

Test Data Comparisons

51. The scope of this project does not provide for an indepth study of NDT equipment capabilities and comparison but, instead, concentrates on the complete evaluation method. However, some comparisons of results from different equipment that are readily available are offered here. Test data collected with each NDT device are presented in Appendix B. Some study of pavement response in terms of measured parameters, such as deflections, deflection basin, applied load, loading frequency, and wave velocity, may aid understanding of NDT equipment requirements.

52. Most of the NDT evaluation methods make use of the deflection basin (shape of deflected pavement surface) for calculation of layer moduli. A comparison of the deflection basins measured with each of the test devices near the 1980 test-pit locations is presented in Figures 25 through 29. The Air Force NDPT device does not measure deflection, and is, therefore, not included. These figures show the relative magnitude of displacements corresponding to the maximum dynamic/impulse force for each particular test device. These deflection data were then normalized in terms of a unit force of 1,000 lb by dividing measured deflection by applied force; the resulting value is termed unit deflection. The static load (preload) applied by some devices (WES 16-kip vibrator, Berger Pavement Profiler, and ARE Dynaflect) is not considered in these comparisons; only the applied dynamic load was used. Unit deflections in mils per 1,000 lb of applied force are presented in Figures 30 through 34. The Dynaflect, which has the smallest measured deflection at all test areas, gives the largest unit deflection for Test Areas 1, 4, and 5. Test Areas 1 and 5 are rigid pavements and Test Area 4 is a composite pavement.

53. A quantity often used to express the pavement response to nondestructive testing is a ratio of load/deflection or stiffness. To make additional comparisons of the pavement response with the NDT devices used in the project, a comparison of stiffness measurements is presented in Table 9. Table 9 gives an average stiffness for each test area for each NDT device. The number of tests conducted on each test area and used for the average stiffness is shown. Also shown is an average stiffness for each test area

which was obtained by averaging the average stiffness for each NDT device for that test area. The standard deviation and coefficient of variation are shown for each set of data. The coefficient of variation is of interest because it gives some indication of the variability of each NDT test device on the different test areas. A graphical comparison of the stiffness measured by each NDT device is a ratio of the average stiffness from all devices (Figure 35). Differences in load plate diameter, static preload, and dynamic load may produce different stiffness values, and these factors are not considered in Figure 35. However, a study of Figure 35 shows how the measurements vary from the average as a function of pavement strength. The PCS FWD and Dynaflect FWD have very similar characteristics, yet these do not closely agree in this comparison. The two devices manufactured by Dynatest (Dynatest FWD and WES FWD) do agree well even though the dynamic load magnitude is different. The greatest variation occurred in Test Area 3, the composite pavement. No consistent trend developed as to which device had greater or lesser variation in Figure 35, and maximum variation of results from all test areas combined is a factor of approximately 2 (maximum stiffness divided by minimum stiffness).

54. Because the stiffness value can be used with the WES DSM evaluation method to determine allowable load, that method was used to indicate the significance of the range in stiffness values from the NDT devices. Allowable gross aircraft loads were computed for three aircraft using the upper and lower limits of the stiffness range. The following comparison was made for only two of the test areas and three aircraft but gives a representative set of results.

Test Area	Pavement Type	Range in Stiffness, kips/in.	Aircraft	Range in Allowable Load, kips	Increase from Lower Value, percent
3	Flexible	509-1,139	F-4	26-60	131
			C-141	110-291	165
			B-52	143-379	165
5	Rigid	1,924-3,200	F-4	52-60	15
			C-141	249-345	39
			B-52	231-385	67

55. The range of stiffness values is highly significant on the weaker flexible pavement (Test Area 3) and not as significant on the rigid pavement (Test Area 5). On pavements with high stiffness values, such as Test Areas 1,

2, and 4, the range is not important since the low side of the range evaluates the pavement at a high allowable load level.

56. The WES computer program BISDEF was used to calculate modulus values for each of the five test areas using the deflection basins in Figures 25 through 29. Because most evaluation methods use a back-calculating technique to obtain layer moduli, this comparison is of interest. The moduli obtained using BISDEF and deflection data from all six devices are provided in Table 10. The Dynaflect loading area was difficult to model in this program, and values presented for that device in Table 10 may be suspect. Table 10 does show that the back-calculated moduli can vary considerably as a function of the deflection basin.

Comparison of Predicted In Situ Moduli

57. All evaluation methods characterized the pavement sections through prediction of the moduli of the pavement layers and subgrade except the WES DSM procedure. Table 11 summarizes these predicted moduli. A graphical comparison of the subgrade moduli for each of the five test areas is presented in Figure 36. By some evaluation methods, the subgrade modulus for Test Area 1 was treated as a composite of the 6-in. subbase and the sand subgrade with a single modulus computed for the composite materials. This causes the appearance of a large variation in predicted subgrade moduli of Area 1 until this is understood; i.e., that the subgrade modulus for Test Area 1 was not computed on the same basis by all methods. Brandley, ARE, and AFESC were the participants making the separation of a subbase and subgrade, and therefore computing a modulus for each material. All others treated the material beneath the PCC slab in Test Area 1 as subgrade only and did not identify the subbase as a separate layer. The procedure of ERES gives only a subgrade modulus k for the subgrade beneath rigid pavements and, therefore, no elastic moduli for the subgrade by that method are available for Test Areas 1, 4, and 5.

58. An analysis of the elastic moduli of the subgrade predicted by all methods for all five test areas gives the following (Area 1 includes data from only Brandley, ARE, and AFESC):

Area	Subgrade Moduli, psi		
	Mean	Standard Deviation	Spread of Data
1	20,250	9,820	19,250
2	30,910	12,550	39,450
3	22,570	8,640	29,250
4	21,450	5,170	15,800
5	21,210	7,570	22,850

The mean value shows approximately the same subgrade moduli for all areas except Test Area 2, but the spread of data indicates the significant range in the individual values by each evaluation method. The spread of data is defined as the maximum value less the minimum value.

59. With the exception of Test Area 1, the highest moduli of the subgrade were determined by PCS, and in all areas the lowest values came from the AFESC method. For Test Area 1, Brandley, ARE, and AFESC gave E values for both the subgrade and subbase, whereas the other evaluation methods combined the subbase and subgrade; however, for Test Area 1 only the moduli from Brandley, ARE, and AFESC were used for the above statistics.

60. Only ARE predicted modulus values for the subbase layers of Test Areas 2 and 3; the other participants determined a combined modulus of the base and subbase. A presentation of the base course moduli is shown in Figure 37. By all evaluation methods (except by Brandley where both areas have the same value), the base course in Test Area 3 was rated with a lower modulus than the base course of Test Area 2. A significant range in the base course moduli occurs as shown.

Area	Base Course Moduli, psi		
	Mean	Standard Deviation	Spread of Data
2	74,700	47,950	148,000
3	42,280	25,620	75,000

61. Because the modulus of AC is temperature-dependent, values were selected from temperature-modulus relationships by most participants. However, a fairly wide range of values was used for the AC. The moduli for the AC surface from all test areas combined gave the following.

AC Moduli, psi		
Mean	Standard Deviation	Spread of Data
410,000	217,000	852,000

The value of 1,391,000 psi predicted by AFESC for Test Area 4 was not included in the above statistics.

62. For design and evaluation purposes, most evaluation methods provide for a variable moduli of the AC layer (as well as the subgrade) to allow for changing seasonal conditions throughout the design life. This appears to be an important feature since the layered-elastic procedures use the limiting stress/strain concept to predict number of aircraft passes, and the strain is a function of the seasonal/environmental fluctuations in the layer moduli.

63. It is of interest to note in Table 11 the values of subgrade modulus k were determined from some evaluation methods (Dynatest, ERES, Berger). The k values range from 195 to 500 pci, which tends to confirm the value of 250 pci selected earlier in this report for the standard evaluation procedure. As could be expected, the moduli determined for the PCC layers were more consistent with most values being in the range of 4×10^6 to 5×10^6 psi. The AFESC did predict a low value of 2.1×10^6 psi for Test Area 5.

64. In addition to the moduli values presented for the evaluation analysis, both Brandley and Berger offered additional comparisons. These values are of interest because some moduli are computed with deflection basin data from the same equipment using different analytical procedures; whereas, some moduli are computed with the same analytical procedure using deflection measurements from different NDT equipment. These results are shown in Table 12. Similar comparisons can be made by looking at the two columns in Table 11 where WES made computations with the same analytical procedure using deflection data from two NDT devices.

Comparisons of Performance Criteria

65. Performance criteria are the link between pavement characterization and evaluation in terms of predicted allowable loadings and remaining pavement life. The evaluation methods demonstrated in this project use several approaches to performance criteria. Some methods such as PCS, Berger, and WES DSM correlate the NDT-pavement characterization to conventional parameters of CBR and k and then apply the standard relationships in terms of design curves from existing Air Force manuals (or use computer codes using these criteria). Other methods, such as Dynatest, ERES, ARE, and AFESC, use allowable stress/strain levels in the various pavement components to predict when pavement failure will occur. Another approach is the use of limiting levels of subgrade deflection, such as Brandley. Table 13 summarizes the various

performance criteria used in the evaluation method demonstated in this study. These criteria differ considerably in format, and, therefore, a direct comparison is difficult.

66. The existing pavement evaluation procedure used by the Air Force uses test-pit measurements based on many years of performance data collected on both inservice pavements and special test sections which were trafficked to failure. This approach uses values of CBR and k to characterize the strength of subgrade and of base and subbase layers. Moisture and density are accounted for as well as other important material properties such as gradation and plasticity. Failure of pavements in this system is characterized by cracking and/or rutting. This method has been validated through the years and is considered as the standard (Headquarters, Departments of the Navy, Army, and Air Force 1978; Headquarters, Departments of the Army and Air Force 1979).

67. Those evaluation methods using the standard Air Force evaluation curves make use of this established performance criteria. However, the relationships used to predict the CBR and k values become the critical elements. PCS used a direct correlation between predicted modulus and CBR or k . The Berger and WES DSM methods also used correlations to the existing Air Force procedure, but, by making correlations to ASWL as obtained from CBR or k , the methods are more indirect.

68. Other methods, such as Dynatest, ERES, ARE, and AFESC, have limiting criteria placed on critical elements of the pavement structure such as the AC, PCC, and subgrade. PCS states that they have a similar evaluation method, but it was not demonstrated for this project. Brandley bases the link to the performance on subgrade deflection criteria. Although the subgrade deflection criteria are presented in graphical form by Brandley, the curves have been converted to an equation that approximates the curves for inclusion in Table 13.

Comparison of Allowable Load Predictions

69. The project requirements called for evaluation of the five test areas in terms of AGAL's for each of the 13 aircraft groups, each at four pass-intensity levels. Each aircraft group has a controlling aircraft (the most critical aircraft for the group), and the evaluations are actually made for these controlling aircraft. These controlling aircraft for each group and

pass-intensity level are presented in Table 5. The aircraft characteristics including maximum design loads and empty loads are shown in Table 6.

70. The AGAL's for the 13 aircraft groups were computed using the standard Air Force method based on test-pit measurements. The test-pit data used for the standard evaluation have been previously discussed. The rigid pavement AGAL's were determined using extended traffic (shattered slab) criteria as set forth in TM 5-827-1 (Headquarters, Departments of the Army and Air Force 1981) and TM 5-827-3 (Headquarters, Department of the Army 1982). The flexible pavement AGAL's were determined as set forth in TM 5-827-2 (Headquarters, Departments of the Army and Air Force 1981). The AGAL's based on the standard are shown in Table 14. Overlay thicknesses, which are discussed later, are also shown in Table 14. Pavement properties used for evaluation are also shown in this table. Test Areas 1 and 2 rate as adequate to support the maximum design loads for all 13 aircraft groups at all pass intensity levels. (Note that + indicates the allowable load is greater than maximum weight of the aircraft.) Test Areas 3 and 4 rate adequate for the maximum load at pass intensity levels III and IV. Test Area 5 has the lowest load rating of all the five areas, but it too has a fairly high load rating.

71. Allowable loads and overlays were also computed for Test Areas 1 and 5 using test-pit data reported in the 1980 AFESC Evaluation Report (AFESC 1980). These results are shown in Table 15. Test Area 4 was evaluated as an equivalent flexible pavement in Table 14, and therefore the discrepancy between 1980 AFESC test-pit data and the values selected for use in Table 14 would not change the results for Test Area 4. The allowable loads and overlays in Table 15 can be compared with those in Table 14. No significant change occurs for Test Area 1; however, a significant difference results for Test Area 5.

72. Each participant was furnished a copy of pages 5-16, 21-22, and 24-51 of the 1980 AFESC Pavement Evaluation Report (AFESC 1980). These pages contain the data summarized in the first column of Table 3.

73. The allowable load results from each NDT evaluation method are compared to the standard rating, as shown in Table 16. The comparisons are made only for three aircraft, the F-4, C-141, and B-52, which represent light-, medium-, and heavy-load aircraft, respectively. Because the allowable loads represented by + mean that the rating exceeds the maximum design load (see Table 6 for maximum values), a comparison of these ratings could be

misleading. This is because, in this case, the amount that the predicted load rating exceeds the maximum design load is not known. Obviously, most of the test area pavements were more than adequate for all aircraft. This fact makes the comparisons difficult.

74. Figures 38 through 43 graphically display the allowable load comparisons. Figures 38, 39, and 40 are for Test Area 3; whereas, Figures 41, 42, and 43 show results for Test Area 5. The three aircraft, F-4, C-141, and B-52, are shown for pass intensity level I. Test Areas 3 and 5 were selected for these comparisons because the allowable loads from the NDT evaluation methods for these areas are not all at the maximum design loads. Similar comparisons for the other three test areas are not possible because the allowable loads are at the maximum.

75. Figures 38, 39, and 40 show that all NDT evaluation methods predicted the allowable loads for Test Area 3 to be generally lower than the standard load rating. The pattern, however, varies with the different aircraft, and this may indicate some difference in the way the evaluation methods consider multiple-wheel gear configurations. The evaluation methods agree better with the standard load rating for the rigid pavement of Test Area 5 (Figures 41, 42, and 43). The distribution is very similar for the F-4 and C-141 but somewhat different for the B-52.

76. The fatigue relationships inherent in all the evaluation methods adjust the allowable loads as a function of number of passes (load repetitions). Figures 44 and 45 show the relationship of allowable load to passes for flexible (Test Area 3) and rigid (Test Area 5) pavements, respectively.

Comparison of Overlay Thickness

77. Overlay thickness computations were made using the standard Air Force procedure and each of the NDT evaluation methods. The overlays were computed for two design load conditions--1,000 passes of KC-10A (DC-10-30) aircraft, and 10,000 passes of an E-4 (B-747) aircraft. Table 17 shows the predicted overlay thicknesses from the standard procedure (minimum overlay criteria has not been included) and from the various NDT evaluation methods. The AFESC NDT procedure does not presently produce overlay thicknesses, so it is absent from the table. Some evaluation methods presented only AC overlays; whereas, others gave both AC and PCC options.

78. By the standard procedure, overlay thickesses were only required for Test Area 5 because all other test areas evaluated as adequate to support the design aircraft. The overlay calculations (for Test Area 5 which is PCC pavement) were performed as set forth in TM 5-824-3/AFM 88-6 (Headquarters, Departments of the Army and Air Force 1979). All overlay designs are based on initial failure criteria. Thickness of nonrigid (AC) overlay on a rigid pavement, t_{ac}, is determined by

$$t_{ac} = 2.5 \ [F(h_d) - Ch]$$

where

F = factor that projects the cracking that may be expected to occur in the base pavement

h_d = required single slab thickness, in.

C = condition factor (0.5 to 1.0)

h = existing rigid slab thickness, in.

Rigid overlays to be placed directly on the existing rigid base pavement were designed using the partial bond equation

$$h_o = 1.4 \sqrt{h_d^{1.4} - Ch^{1.4}}$$

and for the base where the rigid slab is to be placed on a flexible leveling course or bond breaker the unbonded equation was used.

$$h_o = h_d^2 - Ch^2$$

where

h_d = required single slab thickness, in.

C = condition factor (0.35 to 1.0)

h = existing rigid slab thickness, in.

For the overlay designs for Test Area 5, the condition factor C in the above equations was taken as 1.0 because of the excellent condition of the existing pavement. The F factor was also 1.0.

79. Most NDT evaluation methods showed little, if any, overlay needed for Test Areas 1 and 2. The methods indicated some overlay for Test Area 3. AC overlays predicted for Test Areas 4 and 5 ranged considerably. Statistics

from all evaluation methods indicate the following.

		AC Overlays, in.			
Test Area	Design Aircraft	Mean	Standard Deviation	Spread of Data	Standard Air Force Test-Pit Method, in.
1	KC10A	0	0	0	0
	E4	0.30	0.90	0-2.7	0
2	KC10A	0.20	0.60	0-1.8	0
	E4	0.41	1.23	0-3.7	0
3	KC10A	5.94	9.62	0-31.1	0
	E4	8.71	8.45	0-26.1	0
4	KC10A	2.74	3.27	0-8	0
	E4	4.05	5.98	0-17	0
5	KC10A	4.58	6.39	0-18.9	1.8
	E4	8.40	8.67	0-21.0	4.5

80. This same type of information cannot be presented for PCC overlays, because not all evaluation methods give PCC overlays; not enough information is available for the statistical computations.

PART IV: CONCLUSIONS

81. As earlier stated, the main purpose of the study reported herein was to assess several NDT evaluation methods and to provide the Air Force with information to make sound decisions for the possible uses and benefits of NDT. The results of this study led to the following conclusions:

a. The study did not set out to identify any best method for NDT, and no best method for general application at all airfields was identified as a result of the data collected and comparisons made.

b. It appears that the site selected (MacDill AFB) proved to be a poor choice for the following reasons: (1) unusual subgrade (sand) and base course (limerock) materials are nontypical; (2) the pavements were strong enough so that most evaluated as being adequate for all loading conditions using the current standard method which reduced one's ability to compare the results of evaluation techniques (Headquarters, Department of the Air Force 1981); and (3) the baseline test-pit data were not collected concurrently with the NDT results (test-pit data were 2 years old), and some test-pit data are suspected of being in error.

c. Based on use of the NDT evaluation method at MacDill, wide variation occurs in terms of allowable loads among the results and substantial disagreement of some methods with the standard test-pit method (Figures 38 through 43). Some NDT methods predicted overlay thicknesses that were in agreement with the overlay thickness predicted by the test-pit standard; others did not agree (Table 17). Some methods agreed well on some pavement test areas, but did not agree on other test areas. In general, the various NDT evaluation methods produced inconsistent results for the pavement areas evaluated. However, in almost all cases, the NDT methods gave results more conservative (i.e., smaller allowable load and thicker overlay) than those from the test-pit standard method. Overlay thicknesses from some methods generally agreed with the standard. Because of the unusual base course and subgrade conditions, the relative ranking of the various methods in terms of overlay thickness prediction should not be generalized to other airfields.

d. Significant differences were noted in measurements made by the various NDT devices, and no one device can be said to give the best results on the pavement test areas studied. Deflection basin data from the various NDT devices were compared (Figures 25 through 29). The devices with higher load magnitudes, i.e., WES 16-kip vibrator, PCS FWD, and Dynatest FWD, produced larger deflections and steeper deflection basins than did the smaller ARE Dynaflect and Berger Pavement Profiler devices. Input of deflection basin data from each device into a common layered-elastic theory analysis gave inconsistent and variable elastic moduli using the back-calculating technique (Table 10).

e. Stiffness values (maximum load divided by maximum deflection) from each device on each test area were compared. The overall range of stiffness values was a factor of approximately two with no consistent trends of high or low mean value from any device common to all or nearly all of the five test areas. The Berger Pavement Profiler consistently gave the highest coefficient of variation in terms of stiffness value.

f. All evaluation methods, except the WES DSM method, determine elastic moduli for the pavement layers and subgrade. Considerable variation in these moduli occurred from one technique to another (Figures 36 and 37).

g. The performance criteria, which translates the NDT measurements to evaluated load-carrying capacity and overlay requirements, were quite different for the various NDT evaluation methods (Table 13). The performance criteria were given in terms of limiting stress or strain for pavement components, limiting subgrade deflection, and correlations to existing Air Force criteria and are functions of pass intensity level. No direct comparisons could be made of the performance criteria from different methods because of fundamental differences in the nature of the criteria. A comparison of predicted allowable loads at different pass intensities indicated that the rate of change in allowable load with pass intensity was significantly different by some methods (Figures 44 and 45). Because the performance criteria are the only parts of the methods which are functions of pass intensity, a conclusion is drawn that the performance criteria used in some of the methods are more sensitive to the number of passes than others for the conditions at MacDill AFB.

h. Most of the NDT procedures provide for testing of the load transfer capacity at joints in PCC pavement. This was typically done by applying a load on one slab near the joint, and measuring the deflection of each slab at the joint. Not all methods used the load transfer measurements in the allowable load and overlay computations. The standard Air Force evaluation method for PCC pavement assumes an average load transfer of 25 percent at the joints, which may not be true for all pavement conditions. This may account for some of the variation in results, particularly for Test Area 5.

i. Use of the NDT procedures to evaluate the load transfer capacity of joints in PCC pavements appears to be a viable approach and is an important aspect of any structural evaluation. Further work needs to be devoted to development of this concept to validate the various methods demonstrated in this project.

PART V: RECOMMENDATIONS

82. The following recommendations are made:

a. The study reported herein should be repeated at other sites to produce more conclusive results. These sites should cover more typical pavements over fine-grained soils (clays and silts), test-pit data should be collected concurrently with the NDT data, and the pavements should be of such design that a range of allowable loads and overlay thicknesses would be anticipated so that a better comparison of results could be made. What is needed is a set of test areas where the standard method predicts some areas are in danger of incipient failure under common aircraft loads and other areas are not. At MacDill, this was not the case.

b. A standard NDT evaluation method is apparently needed. The standard could be a general procedure (based on an appropriate analytical theory); the performance criteria must be compatible with the system and based on known performance of airfield pavements and the method should be validated. Such a standard could be used to assess the validity of new or more simplified methods. Further study should be made of performance criteria, such as limiting stress, strain, and deflection, and criteria should be selected for use with the standard NDT evaluation method.

c. Further work with NDT equipment is needed to determine limitations (if any) of different NDT devices. A desirable goal is a standard analysis method that would accept input from any one of several different test devices. A sensitivity study could be made using the standard NDT evaluation method with input from various NDT devices to identify limitations.

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Table 1

NDT Method Presented to Transportation Research Board

Task Force AZT56, August 11-14, 1981

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Ilves, G. J. and Majidzadeh, K. (Resource International), "Nondestructive Evaluation of Airfield Pavements"

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Harr, M. E. and Elton, D. J. (Purdue), "Non Contact - Non Destructive Evaluation Using Prototype Loads"

Hall, J. W. (WES), "Nondestructive Evaluation of Airfield Pavements - DSM Method"

Walker, F. K. (Greiner Engineering Sciences), "Evaluation of Flexible Airfield Pavement Using the Corps of Engineers WES 16 Kip Vibratory Loading Device"

Marien, H. R. and Baird, G. T. (U. S. Air Force), "US Air Force Nondestructive Airfield Pavement Evaluation Method"

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Table 2

Construction History

Area	Description	Approximate Construction Period	Remarks
1	Taxiway 33	1959	COE Project AP 86-04-16
2	Taxiway 3B	1943	Original construction by COE
		1956	18-ft-keel overlay, MacDill Project 22-57
		1963	MacDill Project 5-62, overlay
		1971	MacDill Project 62-0, overlay
3	Taxiway 3	1943	Original construction by COE
		1956	MacDill Project 22-57, 18-ft-keel overlay
		1969	MacDill Project 8-5, overlay
4	Apron 1A-1	1941	Original construction by COE
		1952	COE Project 85-04-04, overlay
		1966	Slurry seal, MacDill Project 7-5
		1968	Seal coat, MacDill Project 214-8
5	Apron 1A	1941	Original construction by COE
		1952	COE Project 06-06-02
		1975	MacDill Project 90-3, remove existing pavement and replace

Table 3

Summary of Pavement Physical Properties

Test Area	Air Force Engineering and Services Center (1980)	US Engineer Office, Jacksonville, Fla. (1944)	Office, District Engineer, Savannah, Ga. (1947)
1	20-in. PCC, R = 480 11.5-in. subbase (SP-SM), k = 230 Subgrade (SP-SM), γ_d = 98.3, ω = 23.9	---	---
2	11-in. AC 11-in. base, CBR = 80 4-in. base, CBR = 80 Subgrade, CBR = 35, γ_d = 105.4 , ω = 6.7	---	3-in. AC 8-in. limerock, CBR = 80 Subgrade (GP), CBR = 30
3	5.5-in. AC 8.5-in base, CBR = 80 5.5-inch SP-SM, CBR = 25 , γ_d = 107.3 , ω = 9.1 SP, CBR = 30, γ_d = 97.0 , ω = 10.8	---	3-in. AC 8-in. limerock, CBR = 80 Subgrade (GP), CBR = 30
4	7.5-in. AC 6.5-in. PCC, R = 580 SP, k = 85 , γ_d = 101.4 , ω = 9.0 Alternate for Area 4 as flexible pavement: 7.5-in. AC 6.5-in. base, CBR = 80 SP, CBR = 30	R = 591 Subgrade (SP), k = 440 γ_d = 110 , ω = 7.8, 0-6 in. depth γ_d = 106 , ω = 9.5, 6-18 in. depth	8-6 in. PCC* Sand (SP), k = 370
5	10.5-in. PCC, R = 470 SP, k = 80 , γ_d = 109.8 , ω = 11.7	k = 360 pci γ_d = ω = 107 , 4.3 , 0-6 in. depth γ_d = ω = 100 , 15.8 , 6-18 in. depth	8-6-8 in. PCC* Sand (SP), k = 370 psi

(Continued)

Note: γ_d = dry density, pcf; ω = moisture content, percent; SP-SM = poorly graded silty sand; SP = poorly graded sand; and GP = poorly graded gravel.

* Working stress of PCC = 345 psi.

Table 3 (Concluded)

Test Area	US Army Engineer District, Jacksonsville, Fla. (1960)	US Army Engineer, Ohio River Laboratories (1954)	Rigid Pavement Laboratory of the Ohio River Division (1960)	Construction Engineering Laboratory, Ohio River Division Laboratories (1964)
1	20-in. PCC, R = 750 6-in. stabilized subbase, k = 300 Sand (SP)	--	--	20-in. PCC, R = 750 6-in. stabilized subgrade, k = 300 Sand (SP-SM)
2	6-in. AC 8-in. limerock, CBR = 80 7-in. stabilized subbase, CBR = 30 Sand (SP), CBR = 25	3-in. AC 8-in. limerock base, CBR = 80 7-in. limerock stabilized subbase, CBR = 30 Sand (SP), CBR = 30	--	--
3	6-in. AC 8-in. limerock, CBR = 80 7-in. stabilized subbase, CBR = 30 Sand (SP), CBR = 25	3-in. AC 8-in. limerock base, CBR = 80 7-in. limerock stabilized subbase, CBR = 30 Sand (SP), CBR = 30	--	--
4	6-in. AC 6-in. PCC, R = 650 Sand (SP), k = 250	6-in. AC 8-6-8-in. PCC, R = 700 Sand (SP), k = 370, CBR = 40	6-in. AC 8-6-8 in. PCC, ¢ = 650 Sand (SP-SM), k = 250 CBR = 25	6-in. AC 8-6-8 in. PCC, R = 650 Sand (SP-SM), k = 250
5	6-in. AC 6-in. PCC, R = 650 Sand (SP), k = 250	6-in. AC 8-6-8-in. PCC, R = 700 Sand (SP), k = 370, CBR = 40	6-in. AC 9-6-9 in. PCC, R = 650 Sand (SP-SM), k = 250, CBR = 25	6-in. AC 9-6-9-in. PCC, R = 650 Sand (SP--SM), k = 250

Table 4

Thirteen Aircraft Groups

Aircraft Group	Aircraft
1	C-123
2	A-7, A-10, A-37, F-4, F-5, F-14, F-15, F-16, F-100, F-101, F-102, F-105, F-106, T-33, T-37, T-38, T-39, OV-10
3	F-111, FB-111
4	C-130
5	C-7, C-9, DC-9, C-54, C-131, C-140, T-29
6	737, T-43, C-119, EC-121
7	727, KC-97
8	707, E-3, C-135, KC-135, VC-137
9	C-141
10	C-5A
11	KC-10A, DC-10, L-1011
12	747, E-4
13	B-52

Table 5

Pass Levels for Pavement Evaluation

Aircraft Group	Controlling Aircraft	Number of Passes for Four Pass Intensities			
		I	II	III	IV
1	C-123	300,000	50,000	15,000	3,000
2	F-4	300,000	50,000	15,000	3,000
3	F-111	300,000	50,000	15,000	3,000
4	C-130	50,000	15,000	3,000	500
5	C-9	50,000	15,000	3,000	500
6	T-43 (B-737)	50,000	15,000	3,000	500
7	B-727	50,000	15,000	3,000	500
8	KC-135	50,000	15,000	3,000	500
9	C-141	50,000	15,000	3,000	500
10	C-5A	50,000	15,000	3,000	500
11	KC-10A	15,000	3,000	500	100
12	E-4	15,000	3,000	500	100
13	B-52	15,000	3,000	500	100

Table 6

Aircraft Characteristics for Pavement Evaluation

Aircraft Group	Controlling Aircraft	Tire Spacing in.	Tire Contact Area sq in.	Tire Pressure psi	Main Gear Load percent	Group Load Range* Minimum kips	Group Load Range* Maximum kips
1	C-123	--	270	100	84.3	35	60
2	F-4	--	100	--	87.7	5	60
3	F-111	--	241	--	95.0	50	120
4	C-130	60	400	--	95.7	60	175
5	C-9	26	165	--	93.6	20	110
6	T-43	30.5	174	--	92.8	40	150
7	B-727	34	237	--	92.4	85	175
8	KC-135/ E-3	34.5 × 56	218	--	93.5	105	335
9	C-141	32.5 × 48	208	--	94.4	135	345
10	C-5A	35 × 53 × 65	265	--	94.2	325	770
11	KC-10A (DC 10-30)	54 × 64	294	--	92.2	230	590
12	E-4 (B-747)	44 × 58	245	--	93.5	300	780
13	B-52	37 × 62	267	--	52.0	175	490

* Group Load Range is the minimum (empty) and maximum (loaded) aircraft weights used for evaluation.

Table 7

Characteristics of Nondestructive Testing Equipment

	WES 16-kip	WES FWD	Dynatest FWD	PCS FWD	Berger Pavement Profiler	ARE Dynaflect	AF NDPT Van
Type of load applied	Vibratory	Impulse	Impulse	Impulse	Vibratory	Vibratory	Impulse
Type deflection output	Peak-Peak	Peak	Peak	Peak	Peak-Peak	Peak-Peak	#
Contact area, sq in.	254	110	110	110	254	8.6	113
Maximum dynamic/impulse force (peak-to-peak), lb	30,000	15,000	24,000	22,400	4,500	1,000	520-lb weight dropped 30 in.
Static weight, lb	16,000	--	--	--	3,800	2,000	--
Test frequency, Hz	15	--	--	--	25	8	--
Loading time, msec	--	25-30	25-30	--	--	--	--
Number of displacement sensors	4	3	7	4	4	5	##
Location of displacement sensors, distance from center of loaded area, in.:							
0	+	+	+	+	+	+	
8			+				
12		+	+		+	+	
18	+						
24		+	+	+	+	+	
36	+	+	+*		+*	+	
39				+			
48		+	+			+	
60	+		+*		+**		
71					+**		
79				+			
96			+**				

Note: # = Accelerometers spaced at 1, 2, 4, 8, and 16 ft from plate to measure wave velocity.
= Measures phase difference between transducers.
* = Flexible pavements only.
** = Rigid pavements only.
+ = Locations of sensors.

Table 8

Summary of NDT Evaluation Methods

Method	Data Analysis	Type Theory	Performance Criteria
PCS	Back-calculate modulus of pavement layers from deflection basin	Layered-elastic (BISAR)	Correlation of E to California Bearing Ratio and k , then use AF design curves
Dynatest	Back-calculate moduli of pavement layers from deflection basin	Layered-elastic (ELMOD) (MET)	Normal stress in unbound materials, horizontal strain bottom of AC, fatigue based on flexural strength of PCC
ERES	Back-calculate moduli of pavement layers from deflection basin (subgrade k modulus determined for subgrade under PCC)	Finite element (ILLISLAB) for rigid pavement; layered-elastic for flexible pavement	For rigid pavement--relationship of aircraft coverages to computed stress in concrete; for flexible pavement--radial strain in AC and vertical strain in subgrade; fatigue of base layer
Brandley	Back-calculate moduli of pavement layers from deflection basin	Layered-elastic (ELMOD) (ISSEM4) (CHEVRON)	Limiting subgrade deflection
Berger	Back-calculate moduli of pavement layers from deflection basin and correlation analysis to allowable load and overlay	Layered-elastic (CRANLAY) (GWLB-100) (COMRIGID) (COMPLAYER)	Correlation of stiffness to existing AF design criteria
ARE	Back-calculated moduli of pavement layers from deflection basin (BASFIT)	Layered-elastic (AIRPOD) (ELSYM-5)	Limiting stress in PCC; limiting strain in AC
AFESC	Elastic moduli of pavement layers from wave velocity dispersion curves	Finite element (PREDICT)	Limiting tensile strain in AC; limiting stress in PCC; limiting vertical strain in subgrade
WES DSM	DSM of composite pavement from load-deflection data; radius of relative stiffness, ℓ , from deflection basin	Correlation relationships and analysis of computer (FLEXEVAL) (RIGEVAL)	Correlation of DSM to existing Corps of Engineers/AF design criteria
WES layered-elastic	Back-calculate moduli of pavement layers from deflection basin	Layered-elastic (BISDEF) (AIRPAV)	Limiting strain in subgrade and AC for flexible pavement; limiting tensile stress in PCC for rigid pavement

Table 9

Comparison of Stiffness Measurements

Nondestructive Testing Device	Number of Test	Average Stiffness kips/in.	Standard Deviation	Coefficient of Variation
		Test Area 1		
WES 16-kip vibrator	28	6,053	617	10.2
WES FWD	28	7,689	665	8.6
Dynatest FWD	14	8,575	582	6.8
PCS FWD	28	9,367	512	5.5
Berger Pavement Profiler	8	10,249	1,260	12.3
ARE Dynaflect	14	6,366	627	9.85
Average for Test Area	--	8,050	--	--
		Test Area 2		
WES 16-kip vibrator	30	1,762	212	12.0
WES FWD	30	1,481	167	11.3
Dynatest FWD	16	1,304	225	17.2
PCS FWD	18	1,719	205	11.9
Berger Pavement Profiler	16	2,348	337	14.4
ARE Dynaflect	15	2,453	240	9.8
Average for Test Area	--	1,845	--	--
		Test Area 3		
WES 16-kip vibrator	22	865	102	11.7
WES FWD	21	509	49	9.6
Dynatest FWD	22	499	55	11.1
PCS FWD	26	676	66	9.3
Berger Pavement Profiler	22	808	126	15.6
ARE Dynaflect	22	1,189	155	13.0
Average for Test Area	--	--	--	--
		Test Area 4		
WES 16-kip vibrator	12	2,233	287	12.8
WES FWD	12	2,125	305	14.4
Dynatest FWD	12	2,230	400	18.0
PCS FWD	20	2,362	540	22.8
Berger Pavement Profiler	10	2,933	686	23.4
ARE Dynaflect	25	2,274	419	18.4
Average for Test Area	--	2,360	--	--

(Continued)

Table 9 (Concluded)

Nondestructive Testing Device	Number of Test	Average Stiffness kips/in.	Standard Deviation	Coefficient of Variation
		Test Area 5		
WES 16-kip vibrator	35	2,588	186	7.2
WES FWD	34	2,762	188	6.8
Dynatest FWD	25	2,554	297	11.6
PCS FWD	28	3,200	285	8.9
Berger Pavement Profiler	22	2,896	316	10.9
ARE Dynaflect	14	1,924	181	9.4
Average for Test Area	--	2,654	--	--
			Variation, All Areas	
WES 16-kip vibrator			10.8	
WES FWD			10.1	
Dynatest FWD			12.9	
PCS FWD			11.7	
Berger Pavement Profiler			15.3	
ARE Dynaflect			12.1	

Table 10

Moduli Predicted from Deflection Basins

from Different NDT Equipment

NDT Device	Elastic Modulus, psi		
	20-in. PCC		Subgrade Sand
	Test Area 1		
WES 16-kip vibrator	3,440,538		46,244
WES FWD	6,928,316		35,639
Dynatest FWD	9,117,088		31,499
PCS FWD	9,452,344		35,080
Berger Pavement Profiler	6,111,868		59,205
ARE Dynaflect	11,530,20		10,367
	10-in. AC	15-in. Limerock-Stabilized Base	Subgrade Sand
	Test Area 2		
WES 16-kip vibrator	680,279	59,740	37,209
WES FWD	572,022	30,116	37,438
Dynatest FWD	538,205	36,649	29,799
PCS FWD	559,951	65,255	31,818
Berger Pavement Profiler	452,499	90,633	50,928
ARE Dynaflect	154,052	403,405	22,579
	5.5-in. AC	15-in. Limerock-Stabilized Base	Subgrade Sand
	Test Area 3		
WES 16-kip vibrator	691,229	40,926	26,753
WES FWD	185,244	16,241	31,738
Dynatest FWD	185,952	20,682	20,375
PCS FWD	332,768	18,244	27,155
Berger Pavement Profiler	537,513	35,074	24,344
ARE Dynaflect	52,175	40,381	23,872

(Continued)

Table 10. (Concluded)

NDT Device	Elastic Modulus, psi		
	7-in. AC	6-in. Limerock-Stabilized Base	Subgrade Sand
	Test Area 4		
WES 16-kip vibrator	1,440,817	3,227,078	25,157
WES FWD	1,982,382	2,047,265	23,242
Dynatest FWD	1,903,426	1,841,818	22,108
PCS FWD	2,334,218	1,387,285	17,160
Berger Pavement Profiler	6,878,414	248,228	23,376
ARE Dynaflect	12,030,469	716,935	10,687
		10.5-in. AC	Subgrade Sand
	Test Area 5		
WES 16-kip vibrator		3,119,032	26,580
WES FWD		3,756,947	23,448
Dynatest FWD		4,040,810	19,496
PCS FWD		6,846,501	22,938
Berger Pavement Profiler		3,652,117	24,131
ARE Dynaflect		3,562,470	11,292

Table 11
Summary of Predicted Moduli

Test Area	Layer	Modulus of Pavement Layers, psi								
		Dynatest*	ERES**	PCS†	Brandley	Berger	ARE	AFESC	WES 16-kip	WES FWD
1	PCC	4,400,000	4,000,000	4,000,000	4,000,000	4,000,000	5,000,000	3,150,000	3,200,000	3,950,000
	Base	--	--	--	60,000	--	200,000	65,000	--	--
	Subgrade	63,300 k = 345 pci	k = 450 pci	63,300	18,000	70,000 k = 500 pci	31,000	11,750	39,000	47,000
2	AC	348,000	180.000	63,000	330,000	400,000	500,000	782,000	250,000	250,000
	Base	32,000	80.000	35,300	60,000	100,000	120,000	78,000	51,000	36,000
	Subbase	--	--	--	--	--	60,000	--	--	--
	Subgrade	26,000	23,400	51,200	16,000	37,000	34,500	11,750	39,000	39,000
3	AC	401,000	150,000	635,000	330,000	300,000	200,000	1,002,000	250,000	250,000
	Base	16,000	40,000	10,000	60,000	50,000	60,000	85,000	44,000	13,500
	Subbase	--	--	--	--	--	35,000	--	--	--
	Subgrade	20,000	19,300	41,000	13,000	24,000	27,000	11,750	24,000	24,000
4	AC	533,000	400,000	635,000	330,000	800,000	300,000	1,391,000	250,000	250,000
	PCC	4,500,000	5,800,000	900,000	4,000,000	4,000,000	6,000,000	2,796,000	500,000	500,000
	Subgrade	26,000 k = 270 pci	k = 375 pci	30,600	18,000	24,000	21,000	14,800	19,000	18,000
5	PCC	4,900,000	4,500,000	4,900,000	4,000,000	4,000,000	3,300,000	2,100,000	4,300,000	5,900,000
	Subgrade	15,800 k = 195 pci	k = 315 pci	34,600	18,000	30,000 k = 250 pci	17,500	11,750	22,000	20,000

* For evaluation, k = 310 and CBR = 27 were selected for subgrade by PCS.
** Moduli shown for Test Areas 2 and 3 are for 8 ft left of center line.
† Moduli shown for Test Area 2 are for 20 ft left of center line and 10 ft left for Test Area 3.

Table 12

Moduli Comparison from Brandley and Berger

Test Area	Pavement Layer	Modulus of Pavement Layers, kips per square inch								Boussinesq Equivalent Thickness†		CHEVRON N-Layer†	
		Burmister-Hogg*			Matching Deflection Bowls-GWLB-100*			ELMOD**	ISSEM 4**				
		PP	WES 16-kip	WES FWD	PP	WES 16-kip	WES FWD	WES FWD†	WES FWD†	WES FWD†	WES 16-kip	WES FWD	WES 16-kip
1	PCC	4,400	2,090	2,990	4,880	2,200	3,780	4,250		75	—	60	42
	Subgrade	67.5	46.7	53.0	53.8	45.0	46.0	62					
2	AC	400††	400††	400††	500	500	365	340		27	—	13	
	Base	414	150	127	180	135	68	54					
	Subgrade	51.5	39.2	36.2	44.0	34.0	38.0	31					
3	AC	400††	400††	400††	450	400	407	446	227	64	—	5	
	Base	172	163	70.6	200	270	59	7	14				
	Subgrade	25.7	23.5	21.5	25.0	21.3	22.3	26	25				
4	AC	800††	800††	800††	800	800	800	140		30	—	32	
	PCC	11,100	5,300	1,400	8,000	4,000	4,000	4,500					
	Subgrade	25.1	21.8	23.7	20.0	20.0	20.0	25					
5	PCC	3,810	3,480	4,150	3,000	2,900	3,640	3,863		29	—	25	
	Subgrade	28.5	26.0	25.2	24.0	25.0	24.0	27					

* Louis Burger International, Inc. 1983.
** Both the ELMOD and ISSEM 4 are programs provided by Dynatest, Inc.
† Brandley 1983.
†† Assumed value.

Table 13

Summary of Performance Criteria

Methodology	Rigid Pavement	Flexible Pavement	Subgrade
Dynatest	$FS = A \times (E/E_o)^d$ A = 1.18 MPa (170 psi) E = modulus of PCC E_o = 1,000 Mpa (1,450,000 psi) $N = 10^{[12 \times (1-\Sigma DS/FS)/(1-PS/\Sigma DS)]}$ ΣDS = static + dynamic load FS = flexural strength PS = static load	$\varepsilon_t = 0.000228 \times VB \times N^{-0.178}$ ε_t = permissible horizontal strain at bottom of AC VB = volume percentage of asphalt, approximately 12 N = load applications	$\sigma = 0.05 \times n^{-0.0667} \times (E/E_o)^d$ σ = permissible normal stress n = load applications E = modulus E_o = 160 MPa (23,000 psi) d = power equal to 1.0 where $E > E_o$, otherwise 1.16
ERES	$\text{Log}_{10} C = 2.27 \times \left(\frac{MR}{\sigma}\right) + 0.056$ $\text{Log}_{10} C$ = coverage to 50 percent slab cracking MR = modulus of rupture determined from modulus FWD σ = critical stress in slab using load transfer in ILLISLAB	$\varepsilon_r = \left(4.102 \times PI - 0.205 \times PI \times Vb + 1.049 \times Vb - 2.707\right) \times S_m^{-0.28} \times N_{cov}^{-0.2}$ ε_r = radical strain PI = penetration index (assumed = 0) Vb = volumetric bitumen content (15 percent) S_m = stiffness of mix (N/m**2) N_{cov} = number of coverages	$\varepsilon_v = 5.511 \times 10^{-3} \frac{1}{N_{cov}^{0.1532}}$ ε_v = vertical strain on subgrade N_{cov} = number of coverages of the specified aircraft producing strain

(Continued)

Table 13. (Continued)

Methodology	Rigid Pavement	Flexible Pavement	Subgrade
ARE	$N = a\left(\frac{f}{\sigma}\right)^b$ N = number of aircraft loads until failure (fatigue life) f = concrete flixural strength, psi σ = computed stress due to aircraft load on rigid pavement, psi a, b = constants $L_R = 100 - \left(\Sigma \frac{n}{N}\right) \times 100$ L_R = fatigue life remaining in pavement. n = aircraft operations to date for an individual craft N = allowable number of aircraft loads until failure for an individual aircraft	$N = c\left(\frac{1}{\varepsilon}\right)^d$ N = number of aircraft loads until failure (fatigue life) c, d = constants ε = computed strain due to aircraft load on flexible pavement, psi $L_R = 100 - \left(\Sigma \frac{n}{N}\right) \times 100$ L_R = fatigue life remaining in pavement n = aircraft operations to date for an individual aircraft N = allowable number of aircraft loads until failure for an individual aircraft	
PCS	E-k Relationship* E = 10 X with E in psi units with X = 1.415 + 1.284 log k	E-CBR Relationship* E = 1,500 (CBR) with E in psi units	

(Continued)

* X and CBR used with standard Air Force pavement evaluation procedure.

Table 13 (Continued)

Methology	Rigid Pavement	Flexible Pavement	Subgrade
Berger	$P_G = 0.0159 \times DSM \times F_L \times T_c$ Composite pavement $P_G = 0.0162 \times DSM \times F_L \times T_c$ DSM = measured ratio of load/deflection from pavement profiler F_L = load factor T_c = traffic factor	$CBR = \frac{a^2 \times 1,000 \times ASWL}{8.1 \times \left(T_t^2 + a^2 A/\pi\right)}$ ASWL = 0.0437 x DSM T_t = equivalent thickness from predicted layer modulus Then CBR and T_t used with standard Air Force pavement evaluation procedure DSM = measured ratio of load/deflection from pavement profiler	
Brandley			$C = 0.00036\ T^{2.68325_D - 2.8641}$ C = coverages to failure T = total thickness of pavement above subgrade D = subgrade deflection, in.

(Continued)

Table 13 (Continued)

Methodlogy	Rigid Pavement	Flexible Pavement	Subgrade
WES-DSM	$P_G = 0.0819(DSM)F_L T_C$ Compositive pavement $P_G = 0.0172(DSM)F_L T_C$ F_L = load factor T_C = traffic factor	$P_G = \frac{F_{K(DSM)}}{S(\%ESWL)} \times \frac{N_m}{N_c} \times 100$ F_K = load factor S = load on rose gear %ESWL = equivalert single-wheel load in percent N_m = number of main gear wheels N_c = number of controlling wheels	
WES Layered Elastic	$\epsilon_{All} = \frac{R}{A + B(LOG_{10}COV)}$ R = flexural strength of PCC, psi A = 0.58901 B = 0.35486 COV = number of passes divided by pass to coverage ratio	$\epsilon_{All_{(AC)}} = 10^A$ $A = \frac{N + 2.665\left(LOG_{10}\frac{E_{AC}}{14.22}\right) + 0.392}{5.0}$ N = aircraft repetitions E_{AC} = AC modulus	Allowable repetitions = $10{,}000\left(\frac{A}{S_s}\right)^B$ where $A = 0.000247 + 0.000245 \log M_R$ S_s = vertical strain at the top of the subgrade $B = 0.0658\ M_R^{0.559}$ M_R = resilient modulus in pounds per square inch of the subgrade

(Continued)

Table 13 (Concluded)

Methodology	Rigid Pavement	Flexible Pavement	Subgrade
AFESC	$\text{Operations} = \text{CPC} \times 10^{(96-\text{PERMR})/8.0}$ CPC = cycles per coverage $\text{PERMR} = \frac{\text{Max. Element Stress}}{\text{Mod of Rupt of PCC}} \times 100\%$	$\text{CONSTM} = 1.054 - \{0.1370 \times [\text{ALOG}_{10}(\text{PROPTY})]\}$ $\text{CONSTL} = -4.15490 + \text{CONSTM} \times 6.60206$ PROPTY = Young's modulus EXZMAX = asphaltic concrete tensile strain	Weak flexible pavement - $\text{Operations} = \text{CPC} \times (4.7188\ \text{E} - 22) \times [\text{ABS}(\text{EY}_{max})^{-8.6615}]$ Heavy multiple-wheel aircraft- $\text{Operations} = \text{CPC} \times (1.448\ \text{E} - 15) \times [\text{ABS}(\text{EY}_{max})^{-6.605}]$ Rigid pavement and strong flexible pavement - $\text{Operations} = \text{CPC} \times (1.07\ \text{E} - 8) \times [\text{ABS}(\text{EY}_{max})^{-4.4}]$ EY_{max} = vertical subgrade strain

Table 14

Evaluation of Test Areas Based on Standard Air Force Test-Pit Procedures

Test Area	Pavement Properties for Evaluation		Pass Intensity Level	Allowable Aircraft Loads, kips													Overlay Thickness, in.					
																	PC-10-30, 1,000 passes			B-747, 10,000 passes		
				C123	F4	F111	C130	C9	T43	B727	E4	C141	C5A	KC10	B747	B52	AC	PCC Partial (Bonded)	PCC (Unbonded)	AC	PCC Partial (Bonded)	PCC (Unbonded)
1	20-in. PCC	R = 750	I	+	+	+	+	+	+	+	+	+	+	+	+	+	0	0	0	0	0	0
	6-in. subbase	k = 300	II																			
	Sand subgrade (SP)		III																			
			IV																			
2	10-in. AC		I														0			0		
	8-in. limerock base	CBR = 80	II																			
	7-in. limerock stabilized subbase	CBR = 30	III																			
	Sand subgrade (SP)	CBR = 25	IV																			
3	5.5-in. AC		I													415	0			0		
	8-in. limerock base	CBR = 80	II													451						
	7-in. limerock stabilized subbase	CBR = 30	III													+						
	Sand subgrade (SP)	CBR = 25	IV													+						
4*	7.5-in. AC		I			106										346	0			0		
	6-in. PCC	CBR = 80	II			+										400						
	Sand subgrade (SP)	k = 250-300	III			+										+						
		CBR = 25	IV			+										+						
5	10.5-in. PCC	R = 650	I		57	67		102	108	119	268	263		480	646	198	1.8	1.9	3.9	6.4	3.9	6.4
	Sand subgrade (SP)	k = 250	II		+	80		110	116	128	286	280		510	685	216						
			III		+	85		+	125	138	304	298		547	735	233						
			IV		+	92		+	137	151	328	321		585	+	252						

Note: Plus (+) sign indicates allowable gross load was greater than maximum weight of aircraft.

* Evaluated as flexible pavement.

Table 15

Evaluation of Test Areas 1 and 5 Based on Test-Pit Data From 1980 AFESC Evaluation Report

Test Area	Pavement Properties for Evaluation		Pass Intensity Level	Allowable Aircraft Loads, kips													Overlay Thickness, in.					
																	PCC-10-30, 1,000 passes			B-747, 10,000 passes		
				C123	F4	F111	C130	C9	T43	B727	E4	C141	C5A	KC10	B747	B52	AC	PCC Partial (Bonded)	PCC (Unbonded)	AC	PCC Partial (Bonded)	PCC (Unbonded)
1	20-in. PCC	R = 480	I	+	+	+	+	+	+	+	+	+	+	+	+	385	0	0	0	0	0	0
	6-in. subbase	k = 230	II	+	+	+	+	+	+	+	+	+	+	+	+	467						
	Sand subgrade (SP)		III	+	+	+	+	+	+	+	+	+	+	+	+	+						
			IV	+	+	+	+	+	+	+	+	+	+	+	+	+						
5	10.5-in. PCC	R = 470	I	43	36	0	108	62	65	0	144	141	524	259	351	0	19.2	13.4	16.6	20.0	13.9	17.1
	Sand subgrade (SP)	k = 80	II	53	45	50	120	70	73	0	159	156	582	292	398	0						
			III	60	51	57	140	82	86	92	182	178	658	340	467	0						
			IV	+	+	68	169	101	105	113	214	210	762	399	352	181						

Note: Plus (+) sign indicates allowable gross load was greater than maximum weight of aircraft.

Table 16

Comparisons of Allowable Load

Allowable Gross Aircraft Load, kips

Procedure	Pass Intensity: Level I F4	Level I C141	Level I B52	Level II F4	Level II C141	Level II B52	Level III F4	Level III C141	Level III B52	Level IV F4	Level IV C141	Level IV B52
Test Area 1												
Standard evaluation from test-pit data	60+	345+	490+	+	+	+	+	+	+	+	+	+
Dynatest*	60+	345+	490+	+	+	+	+	+	+	+	+	+
ERES**	60+	345+	292	+	+	+	+	+	+	+	+	+
PCS†	60+	345+	480+	+	+	+	+	+	+	+	+	+
Brandley††	60	345	490	60	345	490	60	345	490	60	345	490
Berger	60+	345+	490+	+	+	+	+	+	+	+	+	+
ARE	62	317	488	62	317	488	62	317	488	62	317	488
AFESC	60+	345+	460	+	+	490+	+	+	+	+	+	+
WES (DSM)	60+	345+	490+	+	+	+	+	+	+	+	+	+
WES (layered-elastic, 16-kip)	60+	345+	490+	+	+	+	+	+	+	+	+	+
Wes (layered-elastic, FWD data)	60+	345+	490+	+	+	+	+	+	+	+	+	+
Test Area 2												
Standard evaluation from test-pit data	60+	345+	490+	+	+	+	+	+	+	+	+	+
Dynatest*	60+	345+	490+	+	+	+	+	+	+	+	+	+
ERES**	60+	345+	490+	+	+	+	+	+	+	+	+	+
PCS†	45	225	240	55	250	290	60+	300	380	+	345+	480+
Brandley††	60	179	353	60	272	490	60	345	490	60	345	490
Berger	60+	345+	490+	+	+	+	+	+	+	+	+	+
ARE	62	317	488	62	317	488	62	317	488	62	317	488
AFESC	60+	345+	300	+	+	377	+	+	490	+	+	+
WES (DSM)	60+	345+	490+	+	+	+	+	+	+	+	+	+
WES (layered-elastic, 16-kip	60+	345+	490+	+	+	+	+	+	+	+	+	+
WES (layered-elastic FWD data)	60+	345+	455	+	+	490+	+	+	+	+	+	+

(Continued)

Note: Plus (+) sign denotes allowable gross load greater than maximum gross weight of aircraft; A denotes allowable gross load less than minimum (basic) gross weight of aircraft.

* Eighty percent of test points.

** Fifty percent slab cracking for PCC pavement, 0.5-inch rutting for Asphalt Concrete pavement.

† Initial crack for PCC pavement.

†† Allowable load presented as percent of gross in report.

Table 16 (Continued)

Procedure	Pass Intensity: Level I F4	Level I C141	Level I B52	Level II F4	Level II C141	Level II B52	Level III F4	Level III C141	Level III B52	Level IV F4	Level IV C141	Level IV B52
Test Area 3												
Standard evaluation from test-pit data	60+	345+	415	+	+	451	+	+	490+	+	+	+
Dynatest*	25	A	217	28	A	241	30	137	272	34	154	303
ERES**	55	195	490+	60+	248	+	+	345	+	+	345+	+
PCS†	A	A	A	A	A	A	A	A	A	A	A	A
Brandley††	50	128	225	60	190	392	60	331	490	60	345	490
Berger	58	212	255	60+	230	245	+	280	305	+	345+	405
ARE	7	51	65	10	64	72	11	158	135	12	317	488
AFESC	27	200	A	48	295	200	60+	345+	261	60+	+	330
WES (DSM)	59	237	298	60+	261	347	+	321	433	+	345+	490+
WES (layered-elastic, 16-kip)	48	223	225	52	237	246	55	257	271	59	281	296
WES (layered-elastic data)	32	172	213	43	222	248	52	263	273	60+	287	298
Test Area 4												
Standard evaluation from test-pit data	60+	345+	346	+	+	400	+	+	490+	+	+	+
Dynatest*	60+	275	490+	+	295	+	+	321	+	+	345+	+
ERES**	30	165	<175	36	188	<175	42	216	210	54	318	282
PCS†	60+	345+	480+	+	+	+	+	+	+	+	+	+
Brandley††	43	100	196	60	148	343	60	262	490	60	345	490
Berger	52	241	190	60+	272	215	+	295	230	+	325	250
ARE	41	244	350	54	278	425	62	317	488	62	317	488
AFESC	60+	345+	457	+	+	490+	+	+	+	+	+	+
WES (layered-elastic, 16-kip)	60+	295	305	+	316	336	+	345+	376	+	+	415
WES (layered-elastic, FWD data)	60+	285	292	+	306	324	+	337	363	+	345+	402

(Continued)

* Eighty percent of test points.
** Fifty percent slab cracking for PCC pavement, 0.5-inch rutting for Asphalt Concrete pavement.
† Initial crack for PCC pavement.
†† Allowable load presented as percent of gross in report.

Table 16 (Concluded)

Procedure	Pass Intensity: Level I F4	Level I C141	Level I B52	Level II F4	Level II C141	Level II B52	Level III F4	Level III C141	Level III B52	Level IV F4	Level IV C141	Level IV B52
					Test Area 5							
Standard evaluation from test-pit data	57	263	198	60+	280	216	+	298	233	+	321	252
Dynatest*	32	A	401	36	A	437	39	139	477	42	152	490+
ERES**	30	177	<175	37	200	<175	42	250	187	54	>345	265
PCS†	40	210	195	50	235	220	55	260	240	60	290	270
Brandley††	41	86	181	60	135	308	60	231	490	60	345	490
Berger	52	241	190	60+	273	215	+	295	230	+	325	250
ARE	51	271	385	62	317	467	62	317	488	62	317	488
AFESC	28	267	184	31	288	202	34	318	223	37	345+	241
WES (DSM)	60+	345+	315	+	+	348	+	+	386	+	+	430
WES (layered-elastic, 16 kip)	60+	245	217	+	269	248	+	309	295	+	345	357
WES (layered-elastic, FWD data)	60+	215	190	+	235	217	+	270	259	+	325	313

† Initial crack for PCC pavement.
†† Allowable load presented as percent of gross in report.

Table 17

Comparison of Overlay Thickness, in.

Procedure	Aircraft	Test Area 1				Test Area 2				Test Area 3				Test Area 4				Test Area 5			
		AC	PCC*	PCC**	PCC†	AC	PCC*	PCC**	PCC†	AC	PCC*	PCC**	PCC†	AC	PCC*	PCC**	PCC†	AC	PCC*	PCC**	PCC†
Standard	KC10A	0	0	0		0	0	0		0		0		0		0		1.8	1.8	3.0	
	E-4	0	0	0		0		0		0		0		0		0		4.5	3.9	6.4	
Dynatest	KC10A	0				0				5.60				1.90				18.0††			
	E-4	0				0				6.40				2.93				21.0††			
ERES	KC10A	0	0			0				5.25-6.0				5.5				5.0	1.2	4.8	
	E-4	2.7	0			0				7.75-9.0				11.3				13.7	5.8	10.7	
PCS‡	KC10A	0				1.8				31.1‡‡				7.3				0			
	E-4	0				3.7				26.1‡‡				0				0			
Brandley	KC10A	0			0	0			0	0			0	8			13	6			12
	E-4				0	9			13	20			16	17			14	19			15
ARE	KC10A	0				0				3.0				0				0			
	E-4	0				0				5.7				1.0				0			
Berger	KC10A	0	0	0		0	0	0		2.9				1.5					1.5		
	E-4	0	0	0		0	0	0		3.5				2.5					2.5		
WES DSM Method	KC10A	0	0	0		0				0.6				0				0	0	0	
	E-4	0	0	0		0				2.4				0				0	0	0	
WES layered-elastic (16-kip vibrator)	KC10A	0	0	0		0	0	0		3.3				0.2				0.8	1.1	2.6	
	E-4	0	0	0		0	0	0		3.3				0.7				4.5	3.9	6.4	
WES layered-elastic (FWD)	KC10A	0	0	0		0	0	0		2.6				0.4				5.0	4.2	6.8	
	E-4	0	0	0		0	0	0		3.2				1.0				9.0	6.5	9.4	

* PCC overlay, bonded.
** PCC overlay, unbonded.
† Recommends a 12-in. minimum PCC overlay for load transfer at joints.
†† Alternative is to break up existing PCC and overlay with 3.3 in. and 4.2 in., respectively.
‡ PCS overlay thicknesses are based upon the use of "weakest layer concept" derived from nondestructive testing studies.
‡‡ The shear of the base layer controlled the overlay and not the subgrade.

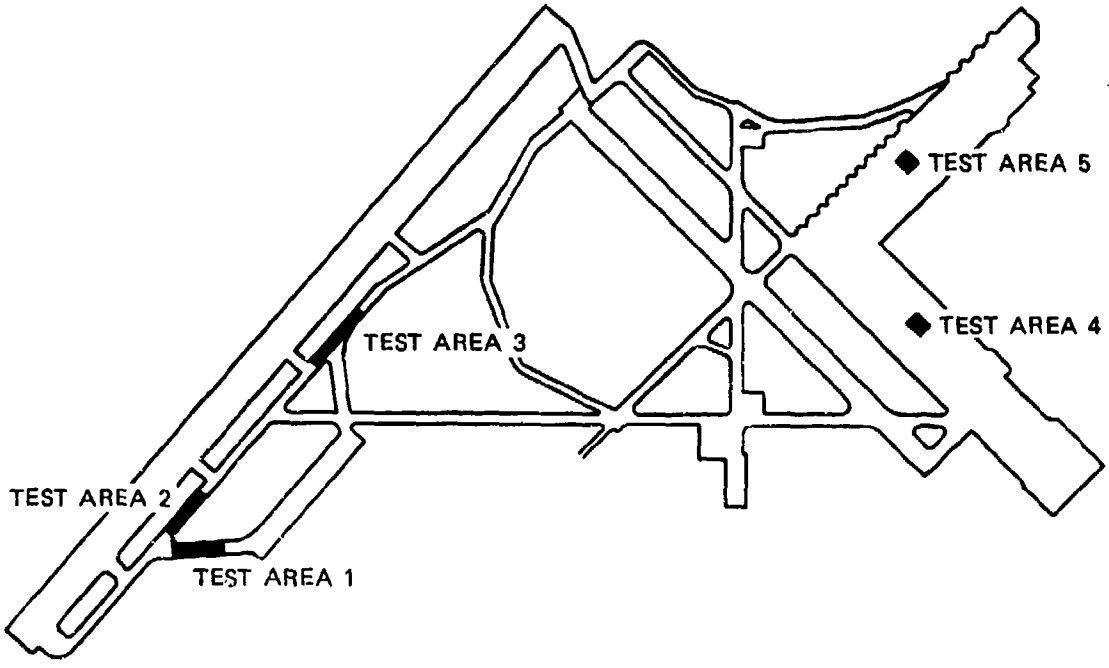
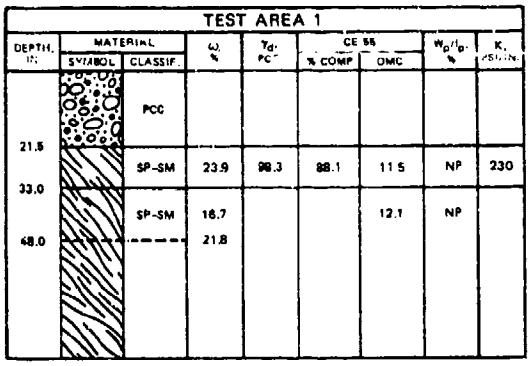
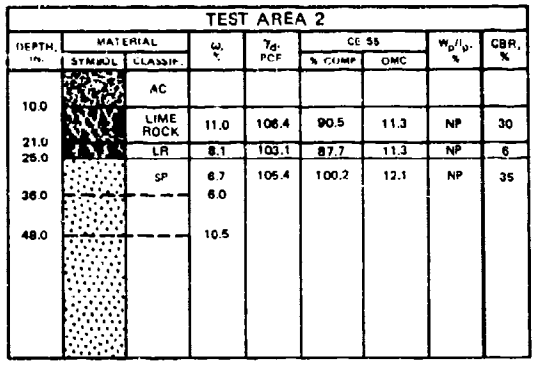
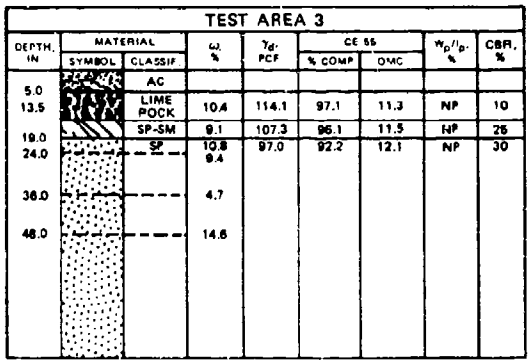
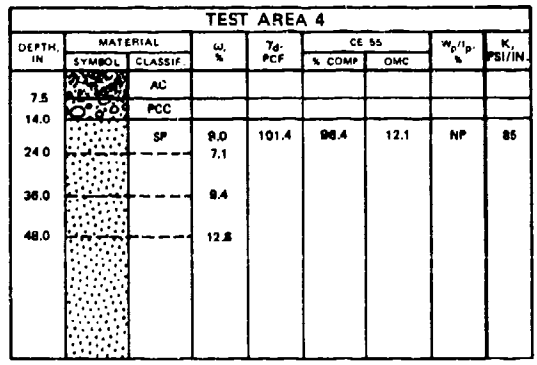


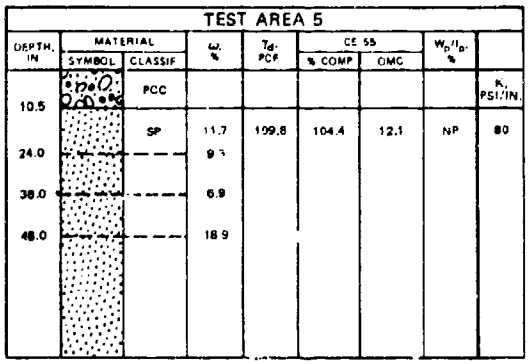
Figure 1. Airfield layout at MacDill AFB showing location of test area











LEGEND

K	=	SUBGRADE MODULUS, PCI
CBR	=	CALIFORNIA BEARING RATIO, PERCENT
OMC	=	OPTIMUM MOISTURE CONTENT, PERCENT
% COMP	=	FIELD DENSITY AS PERCENT OF LABORATORY DENSITY
ω	=	IN-PLACE MOISTURE CONTENT, PERCENT
γ_d	=	IN-PLACE DENSITY, PCF

Figure 2. Test-pit data for each test area as presented by AFESC

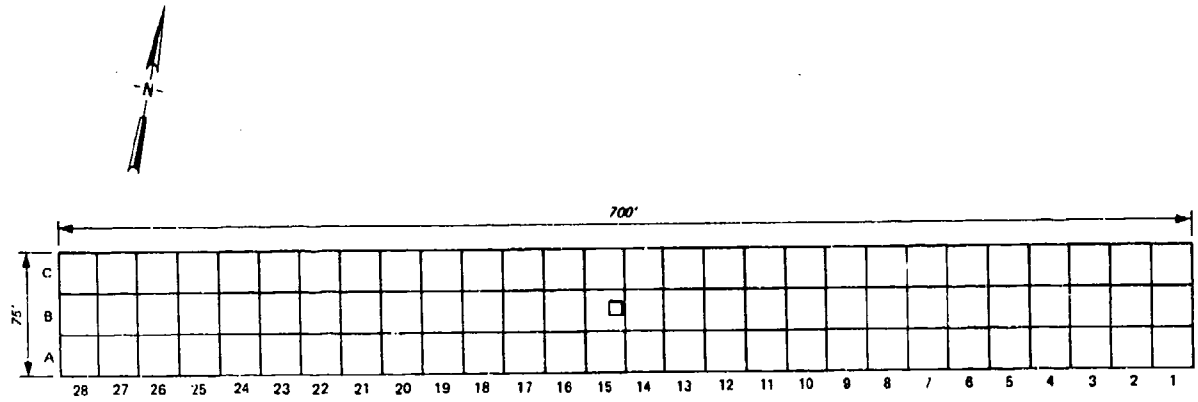


Figure 3. Layout of Test Area 1

Figure 4. Test Area 1

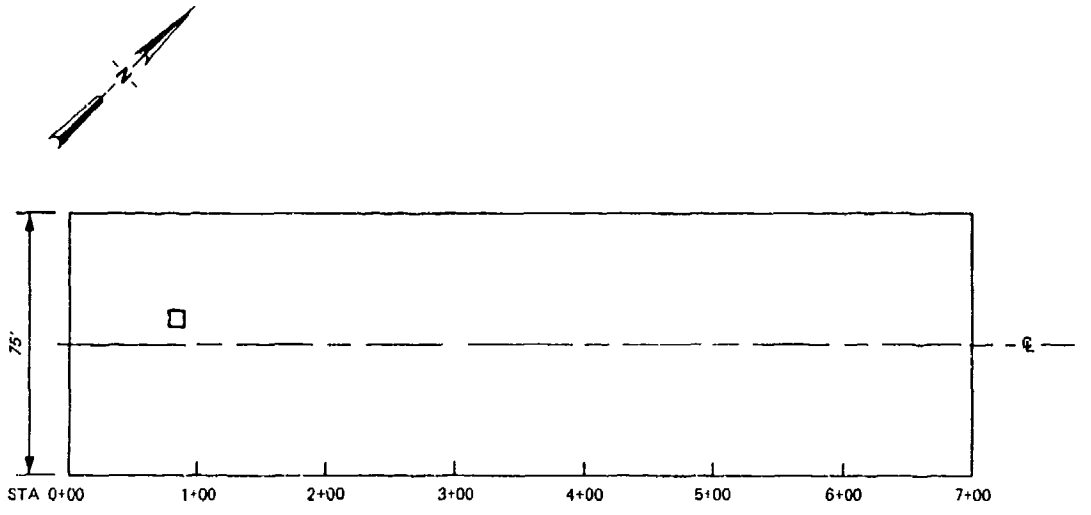


Figure 5. Layout of Test Area 2

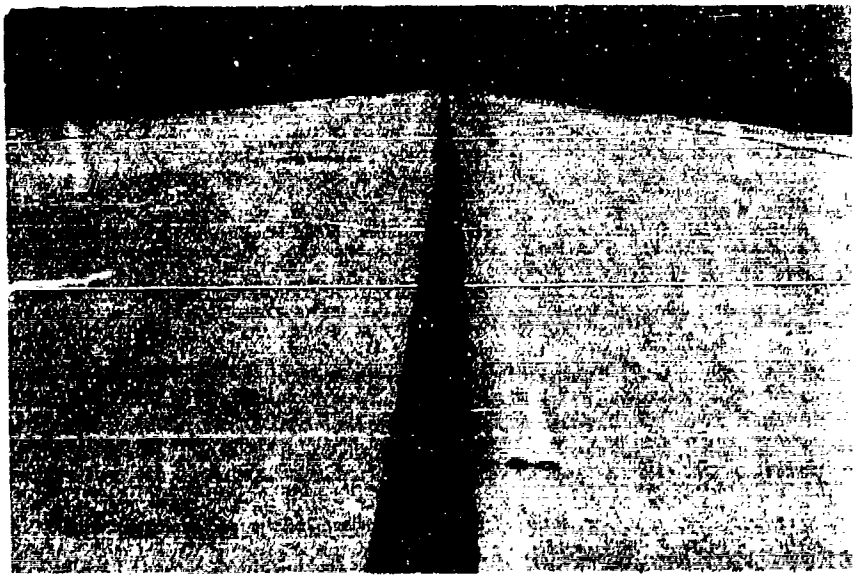


Figure 6. Test Area 2

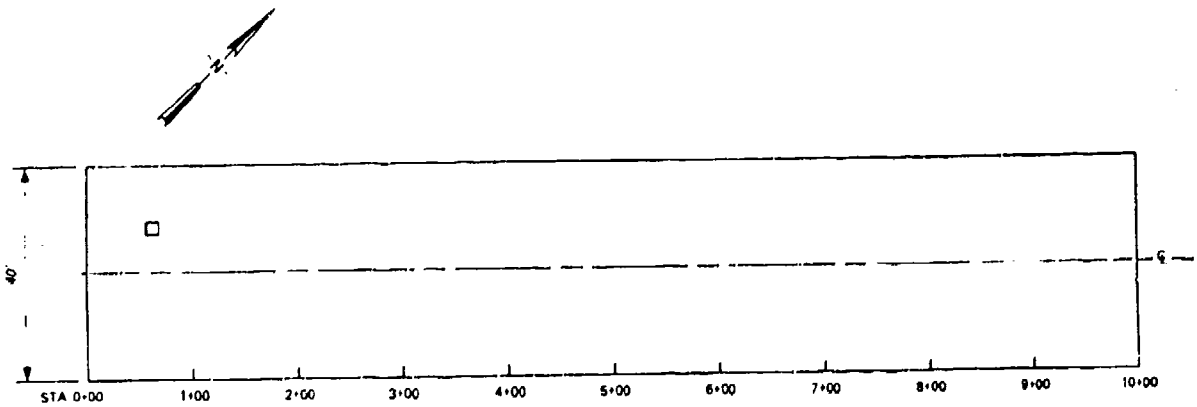


Figure 7. Layout of Test Area 3

Figure 8. Test Area 3

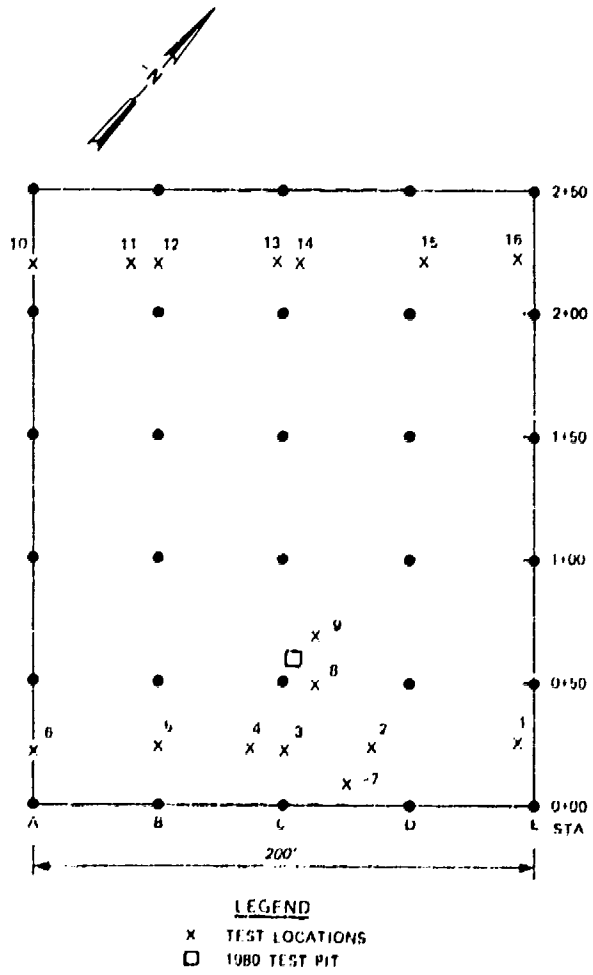


Figure 9. Layout of Test Area 4

Figure 10. Test Area 4

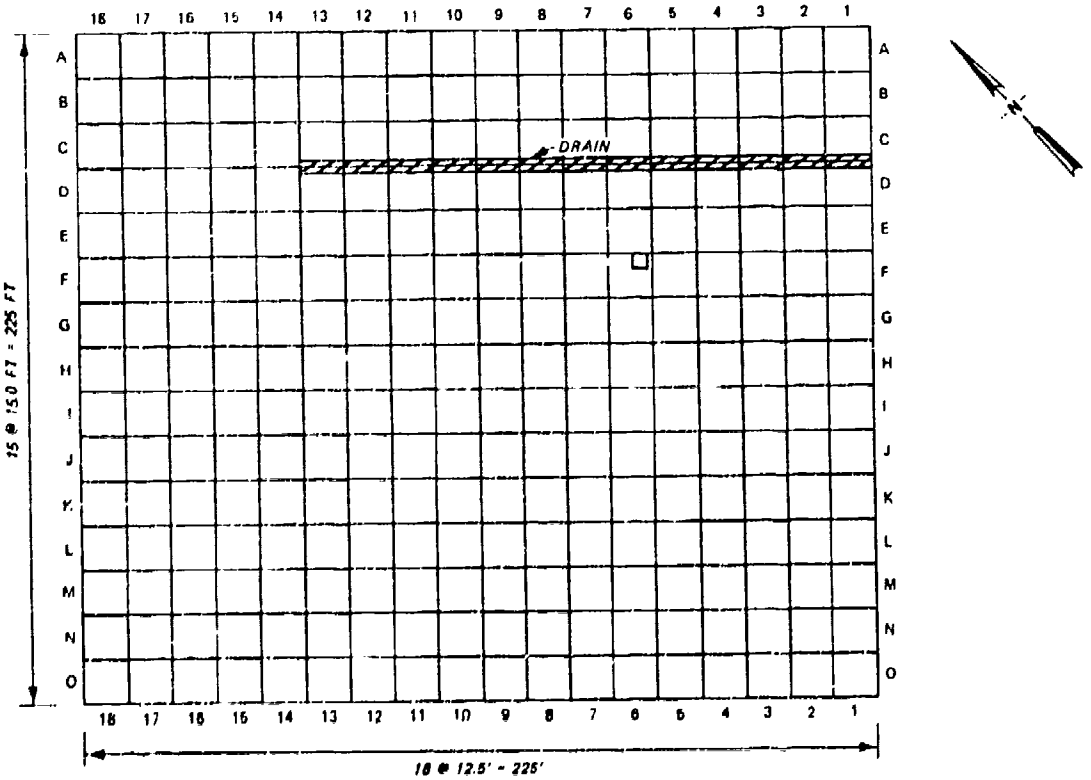


Figure 11. Layout of Test Area 5

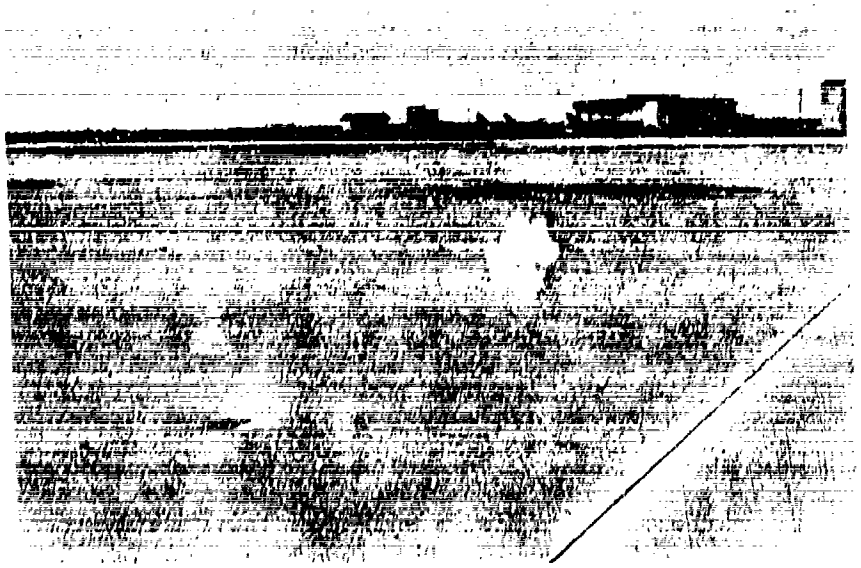


Figure 12. Test Area 5

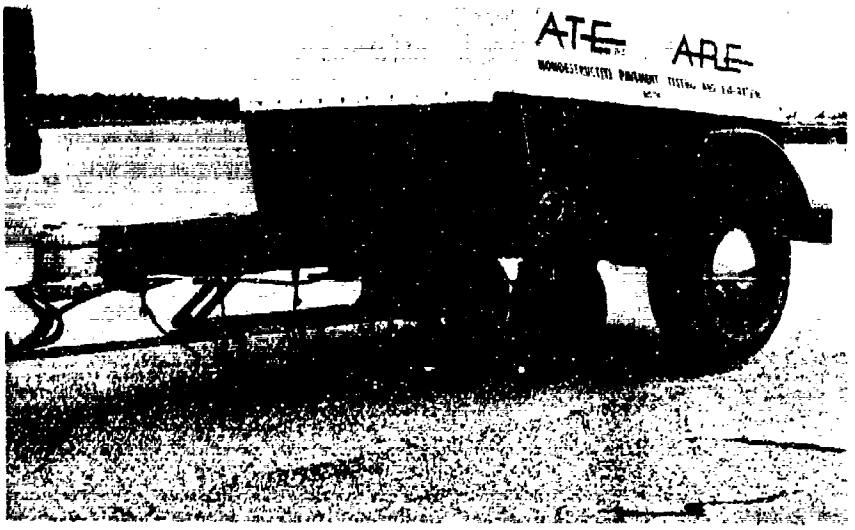


Figure 13. Dynaflect used by ARE, Inc.

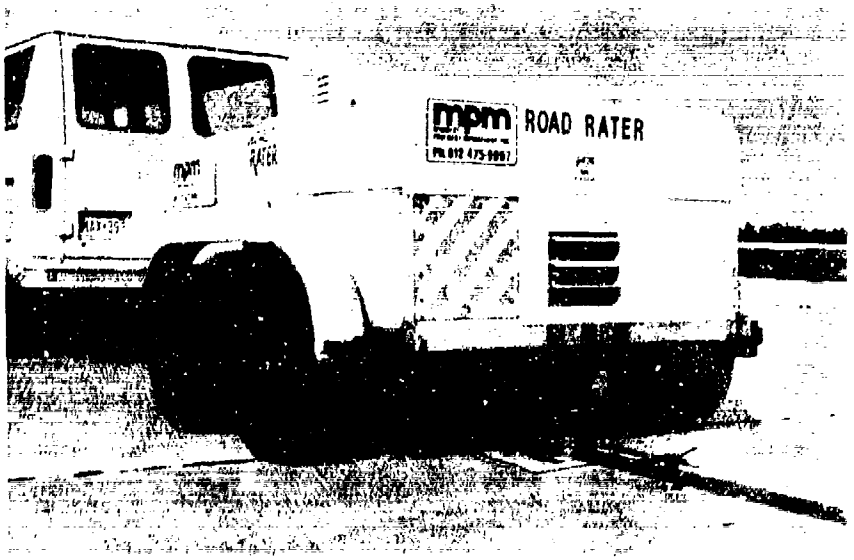


Figure 14. Road-Rater Model 2000 used by Berger

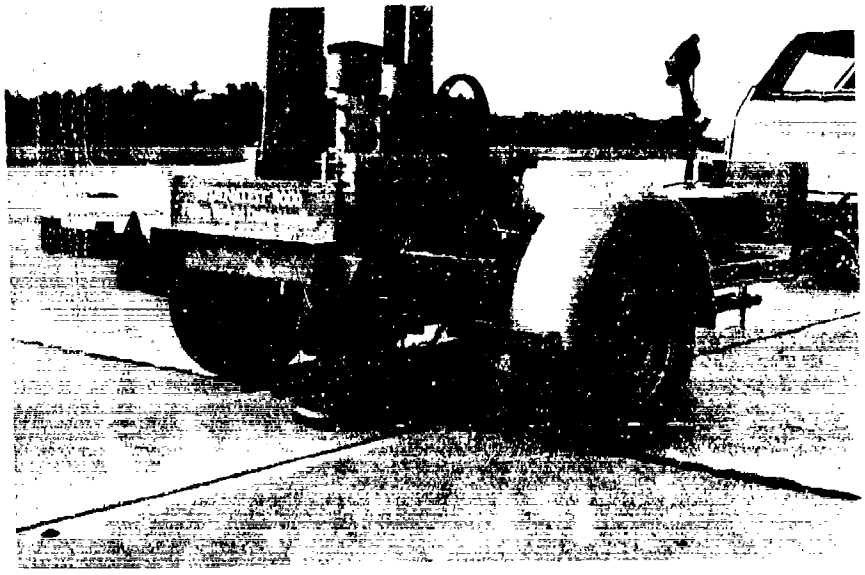


Figure 15. Dynatest Model 8000 FWD

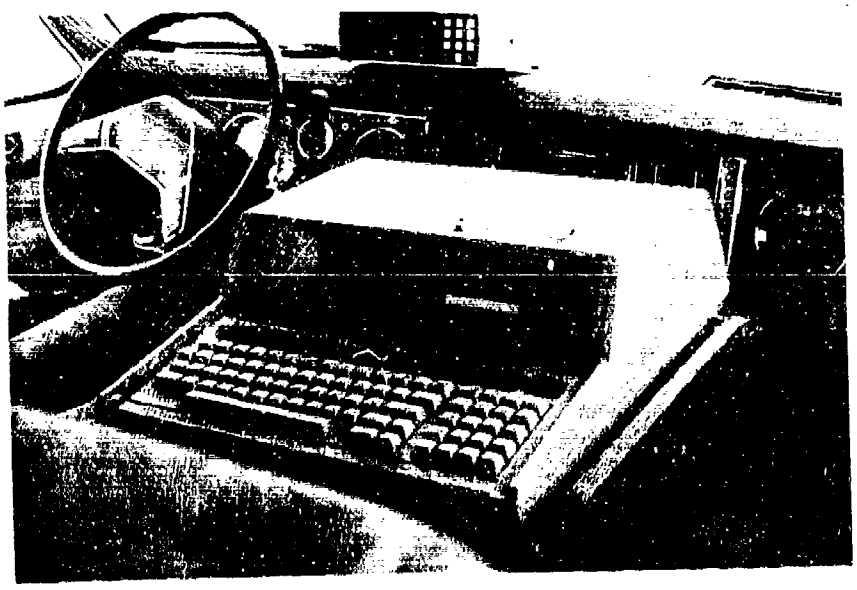


Figure 16. HP-85 computer used with
Dynatest Model 8000 FWD

Figure 17. Brandley Cantilever Deflection Beam

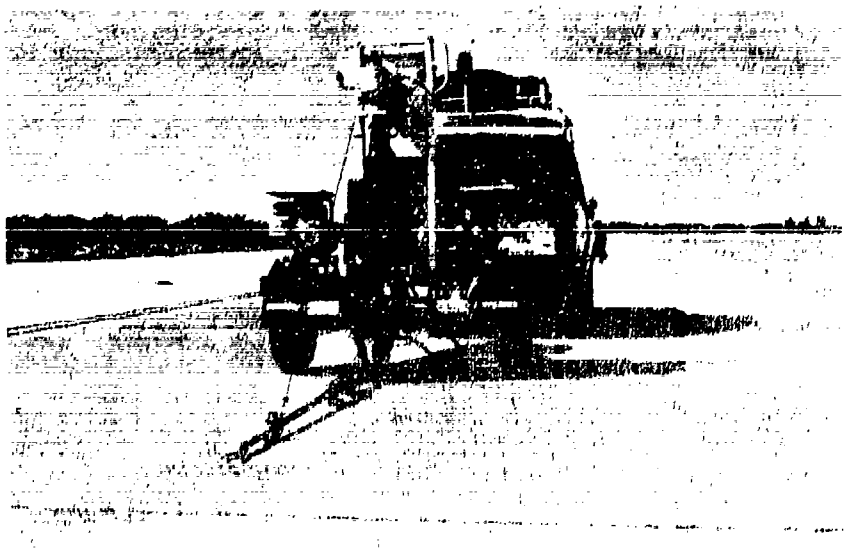


Figure 18. PCS FWD

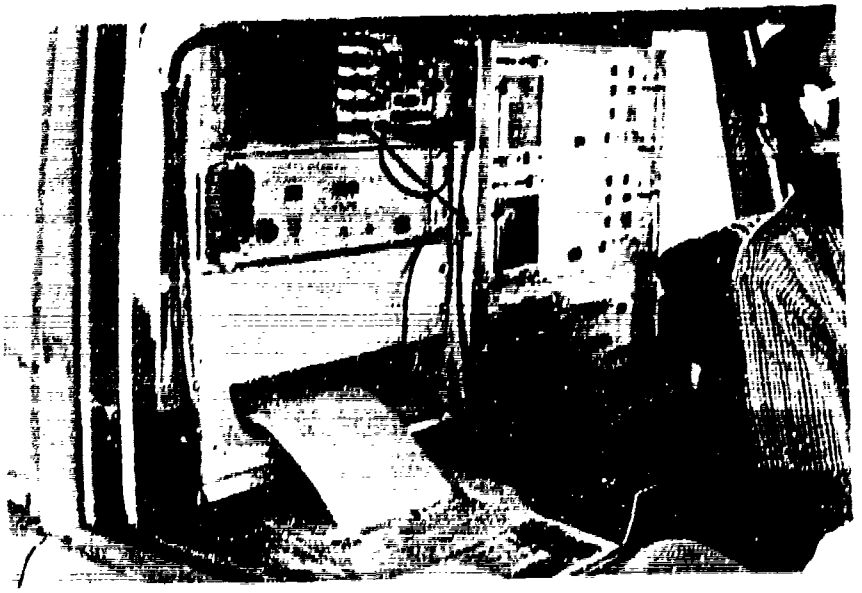


Figure 19. Data recording equipment used by PCS

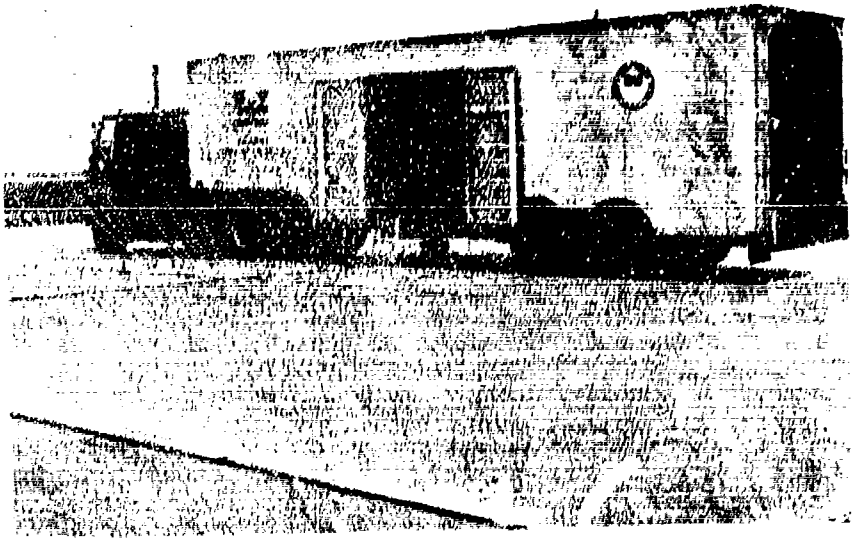


Figure 20. WES 16-kip vibrator

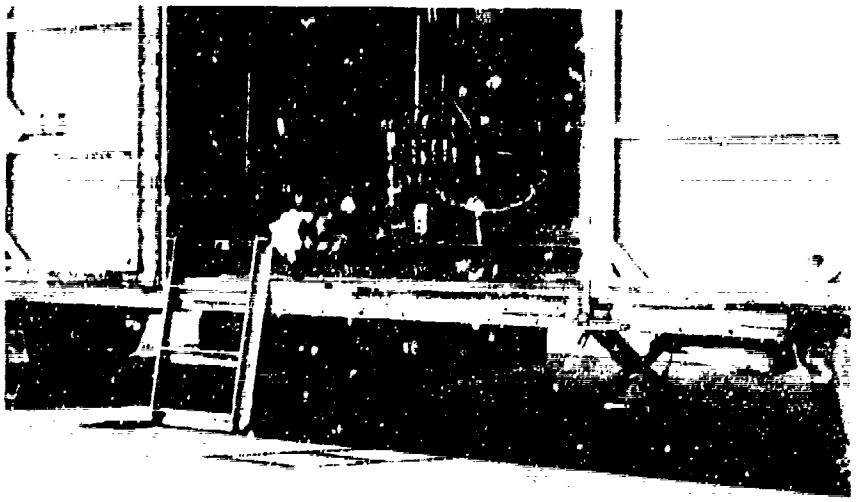


Figure 21. Load plate of WES 16-kip vibrator

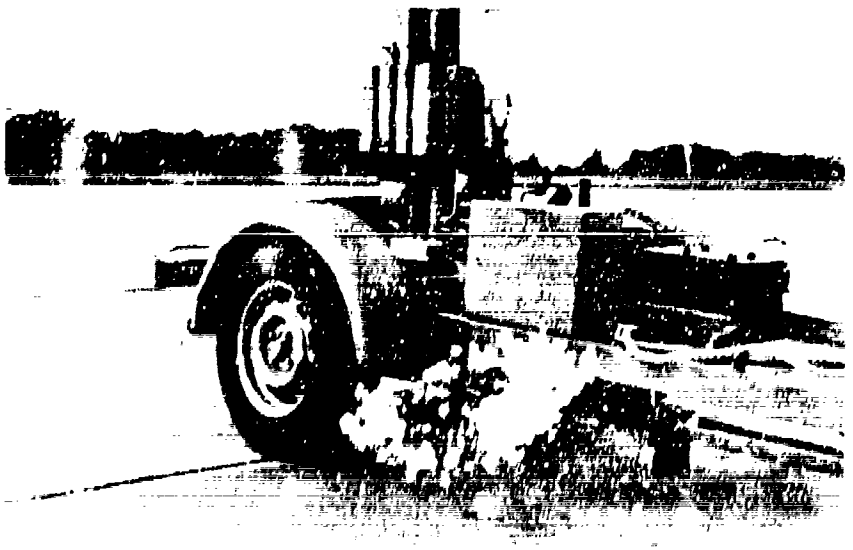


Figure 22. WES FWD (manufactured by Dynatest)

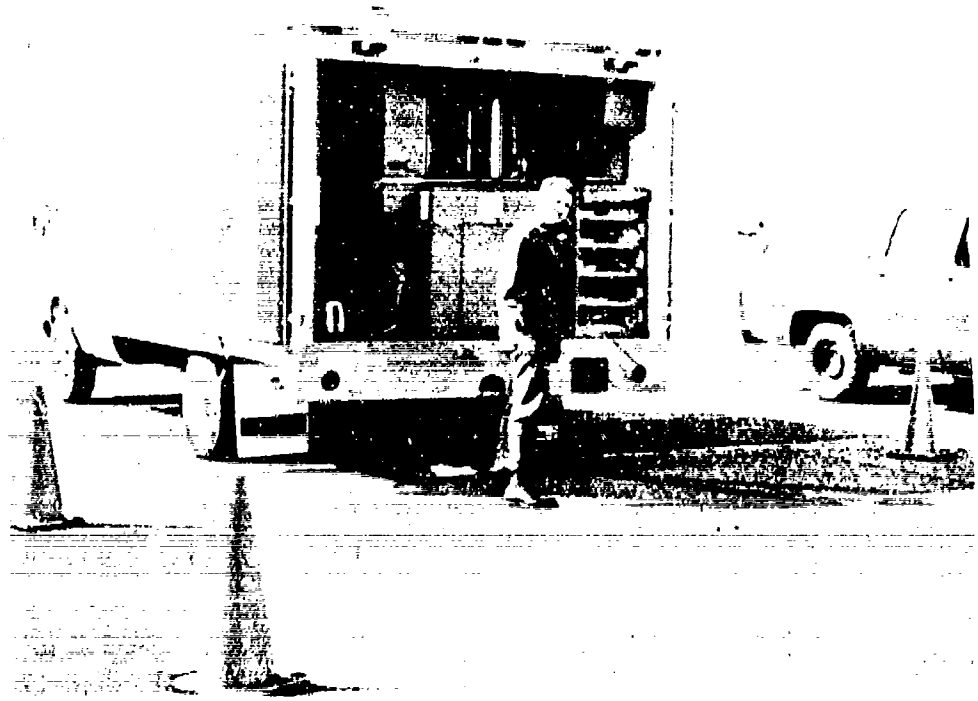


Figure 23. AFESC NDPT van

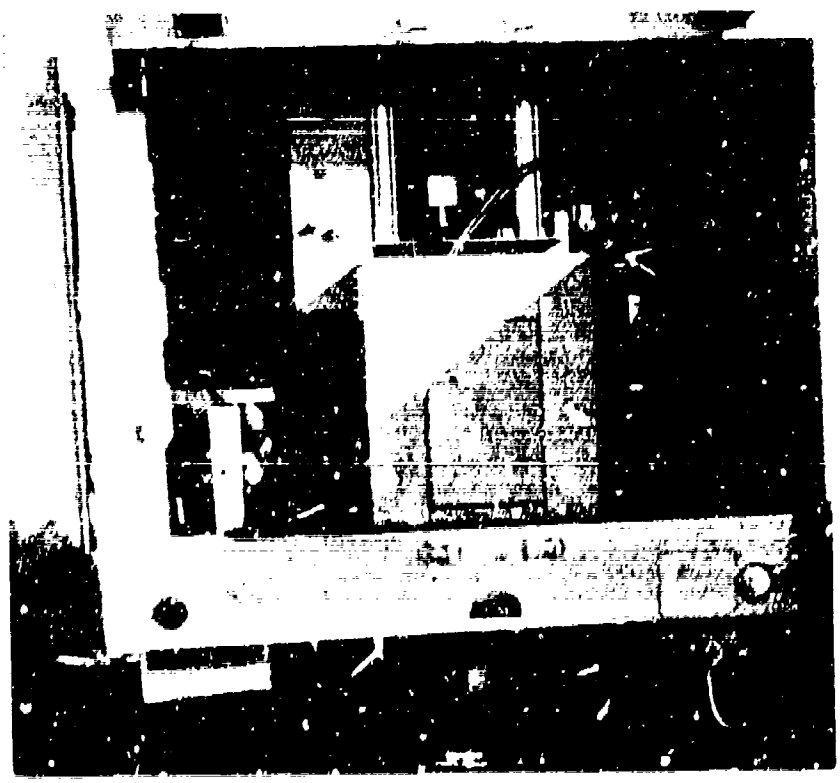


Figure 24. Load plate and impact hammer of AFESC NDPT device

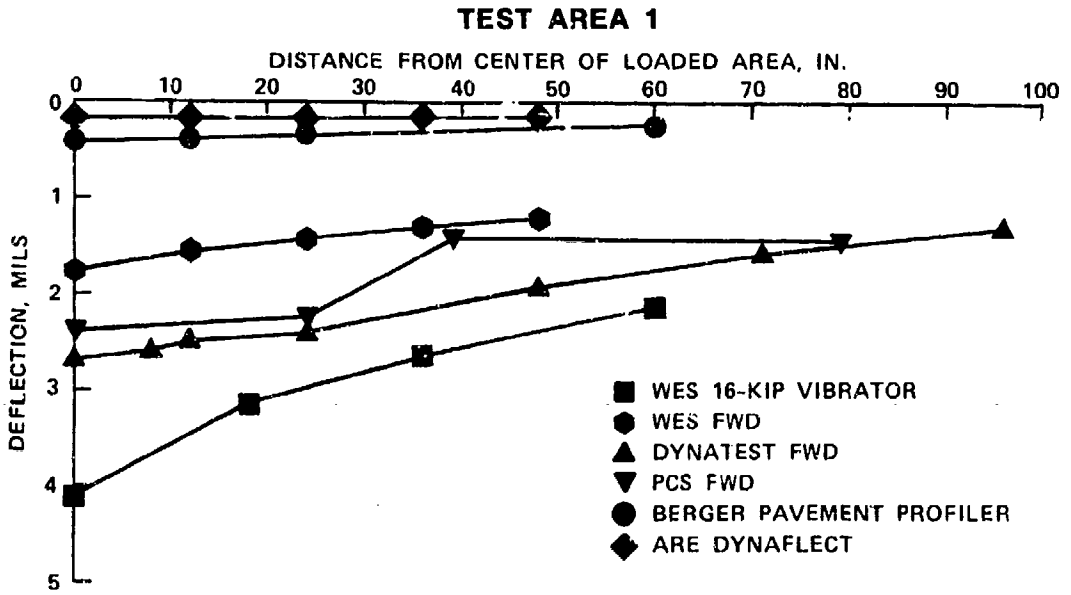


Figure 25. Comparison of measured deflector basins for Test Area 1

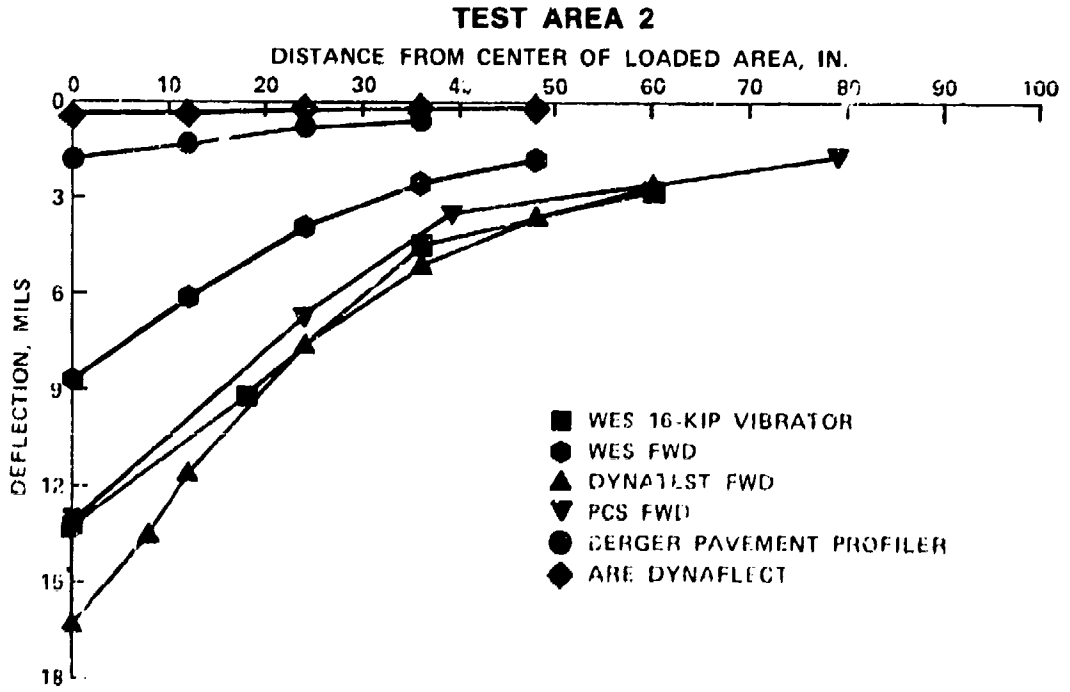


Figure 26. Comparison of measured deflector basins for Test Area 2

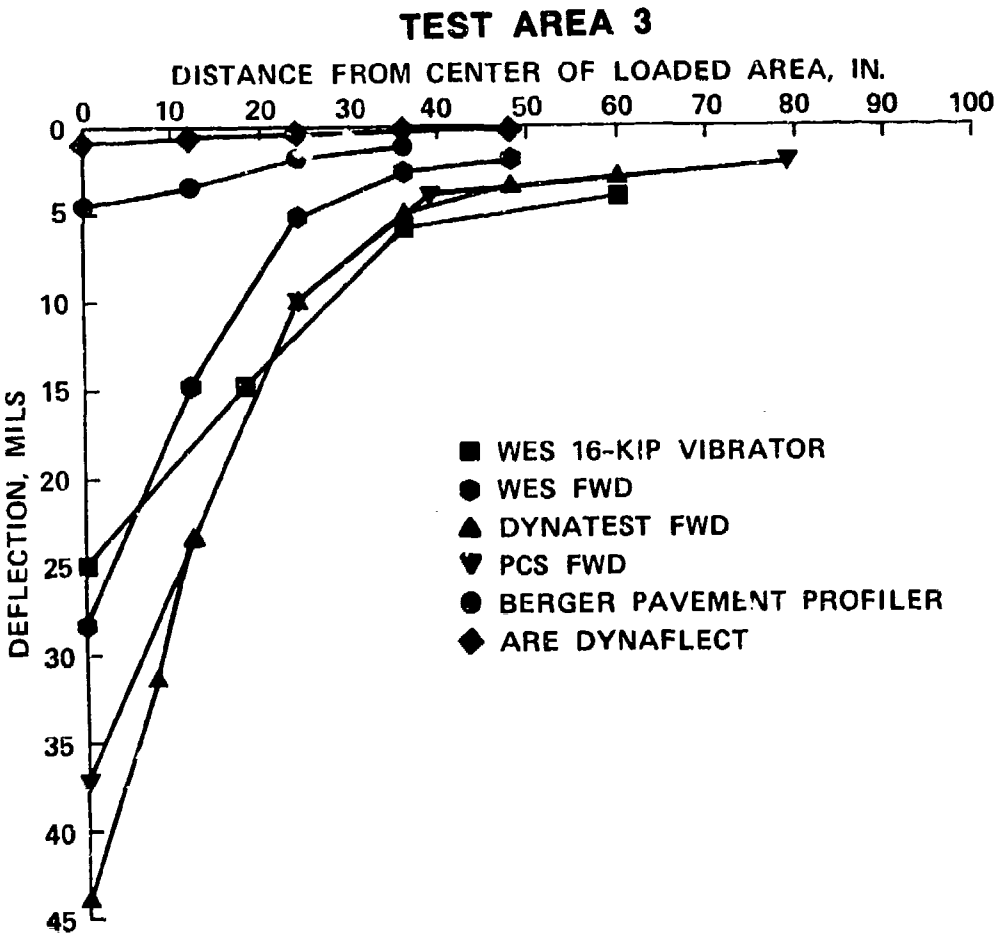


Figure 27. Comparison of measured deflector basins for Test Area 3

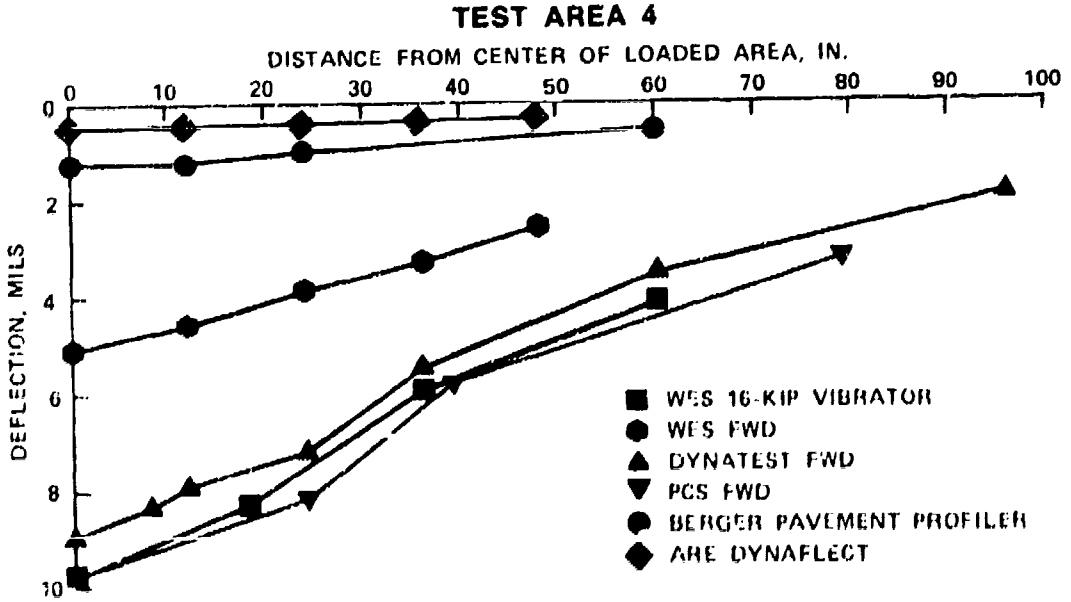


Figure 28. Comparison of measured deflector basins for Test Area 4

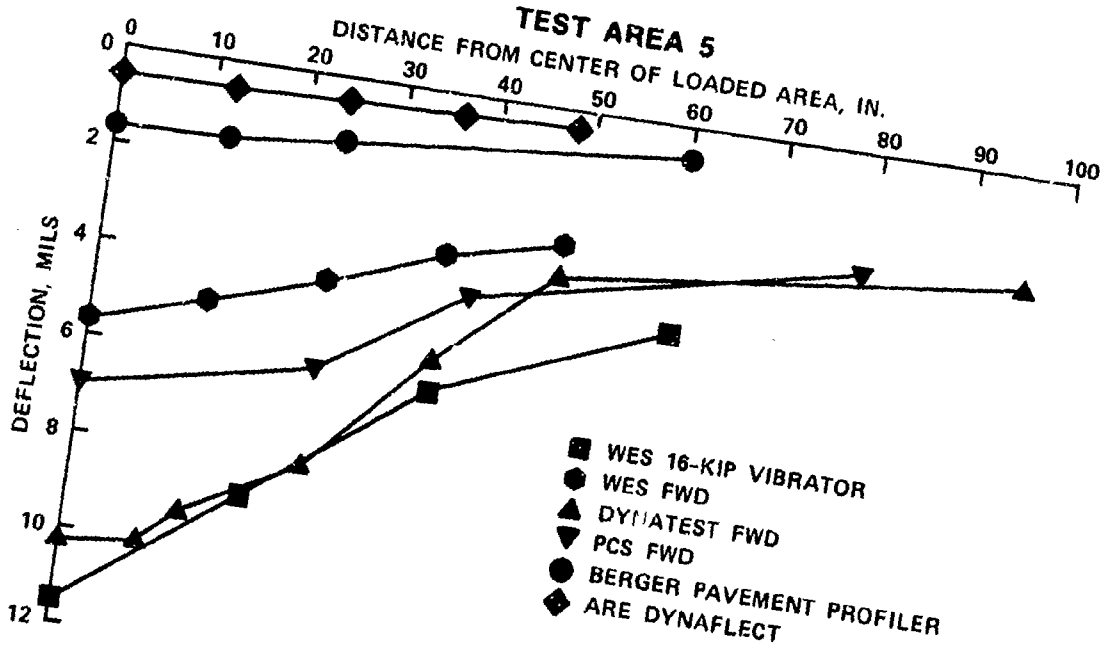


Figure 29. Comparison of measured deflector basins for Test Area 5

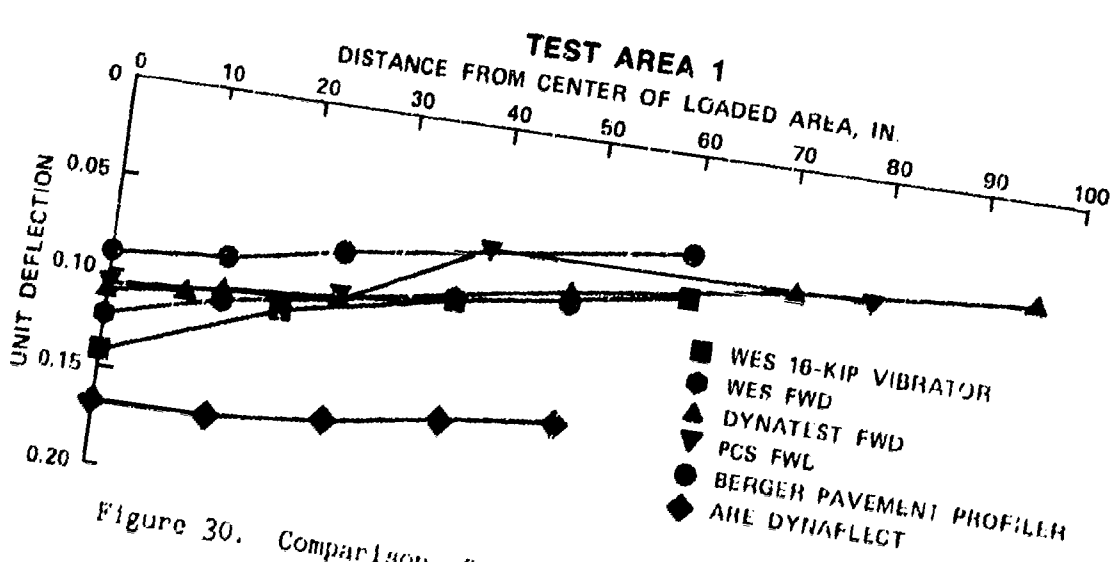


Figure 30. Comparison of normalized deflector basins for Test Area 1

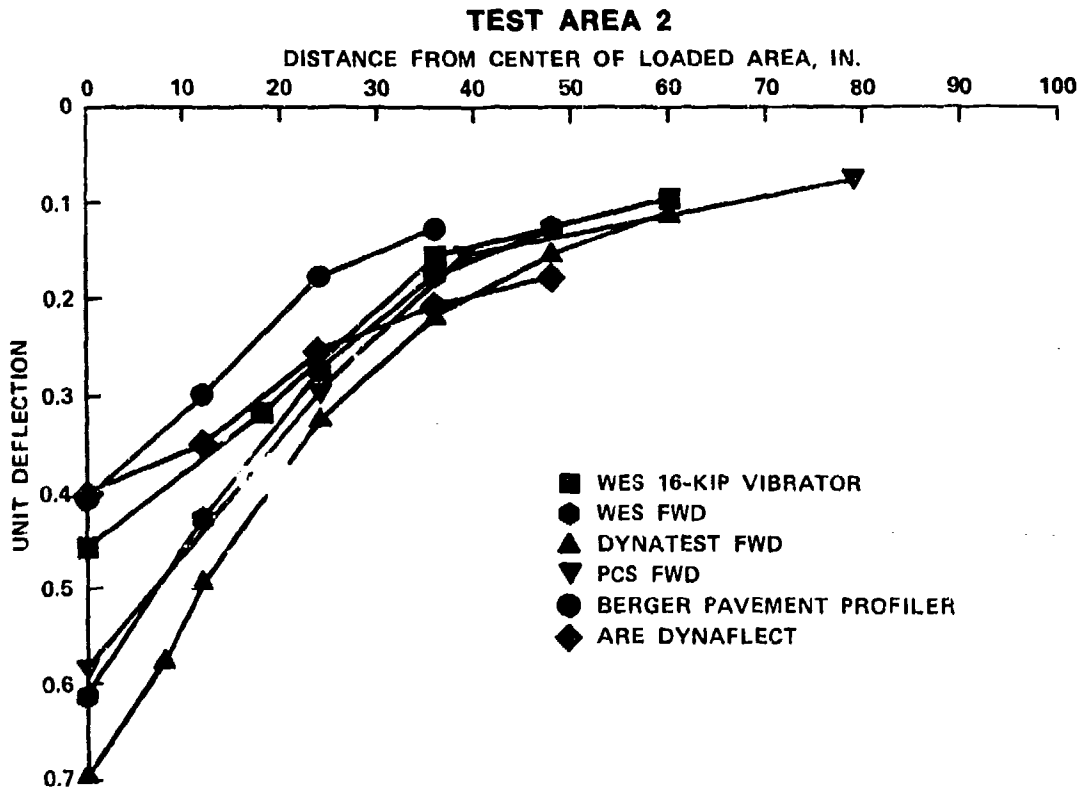


Figure 31. Comparison of normalized deflection basins for Test Area 2

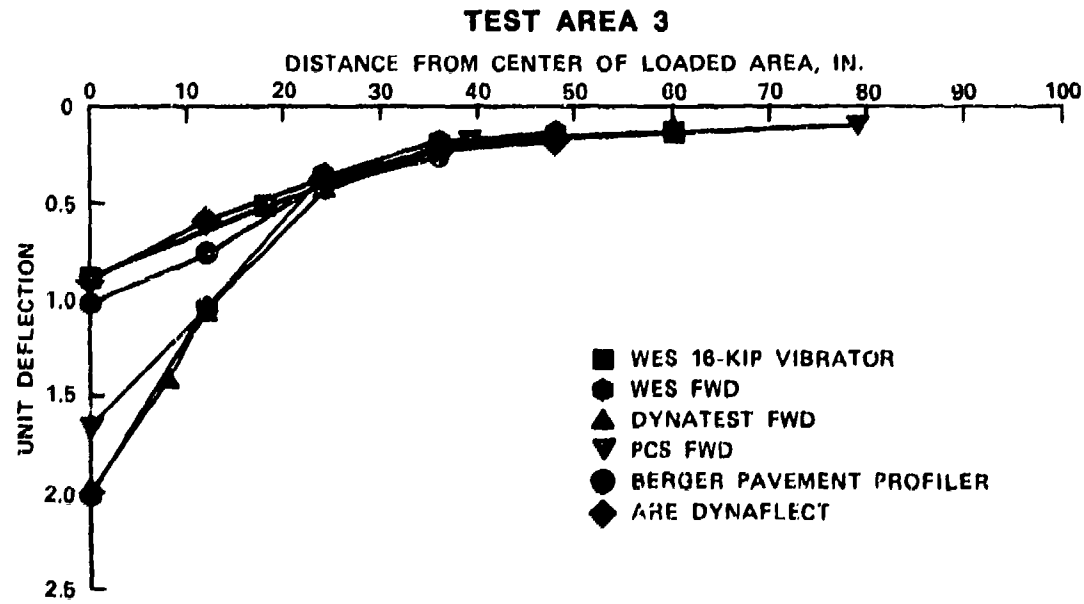


Figure 32. Comparison of normalized deflection basins for Test Area 3

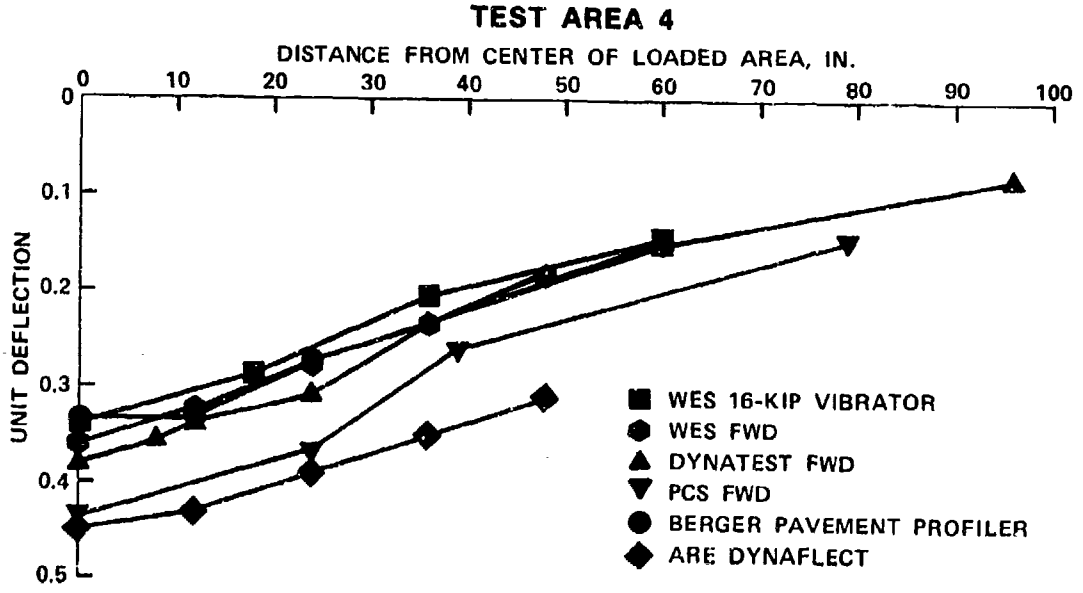


Figure 33. Comparison of normalized deflection basins for Test Area 4

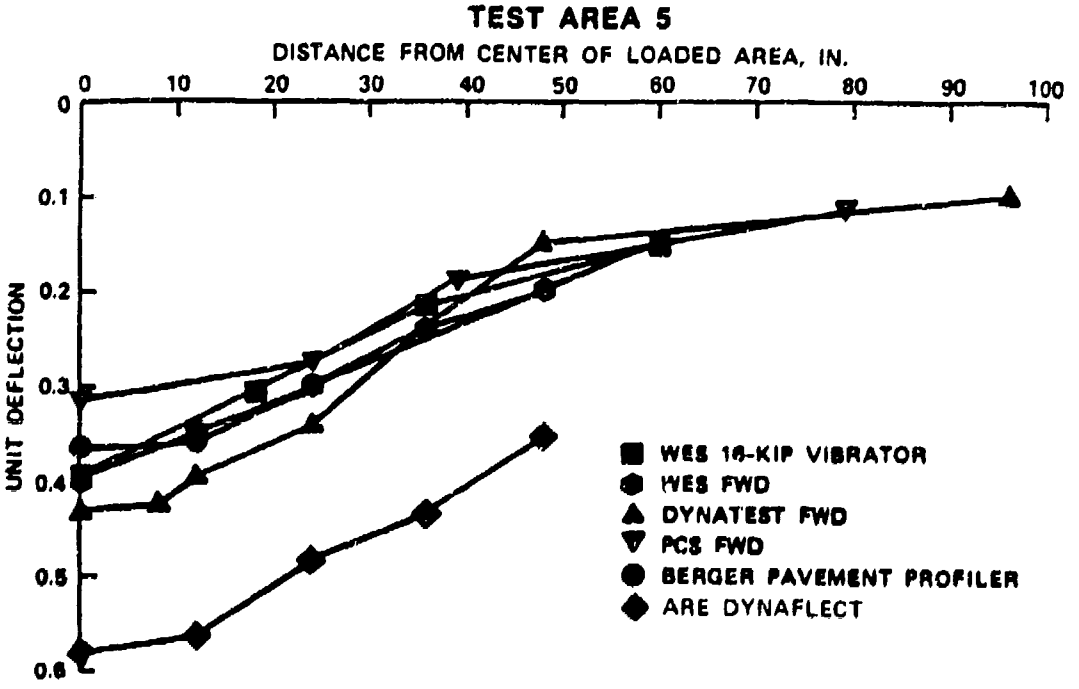


Figure 34. Comparison of normalized deflection basins for Test Area 5

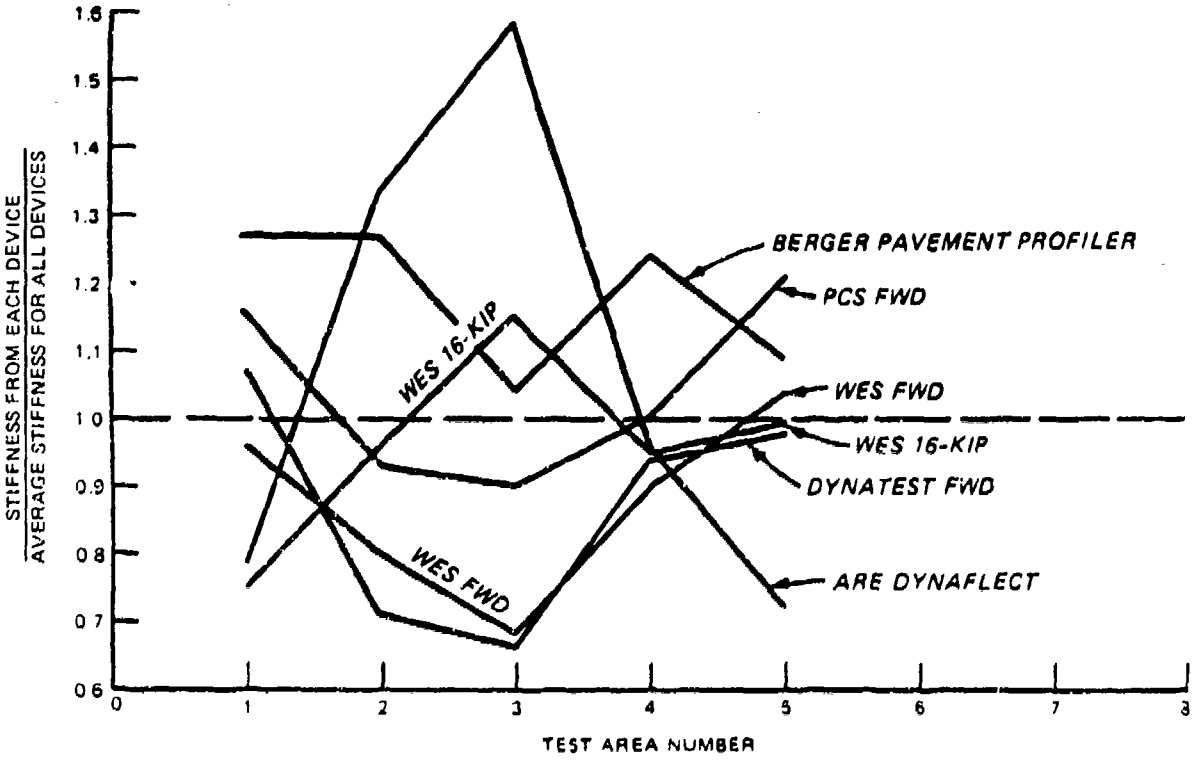


Figure 35. Comparison of stiffness measurements

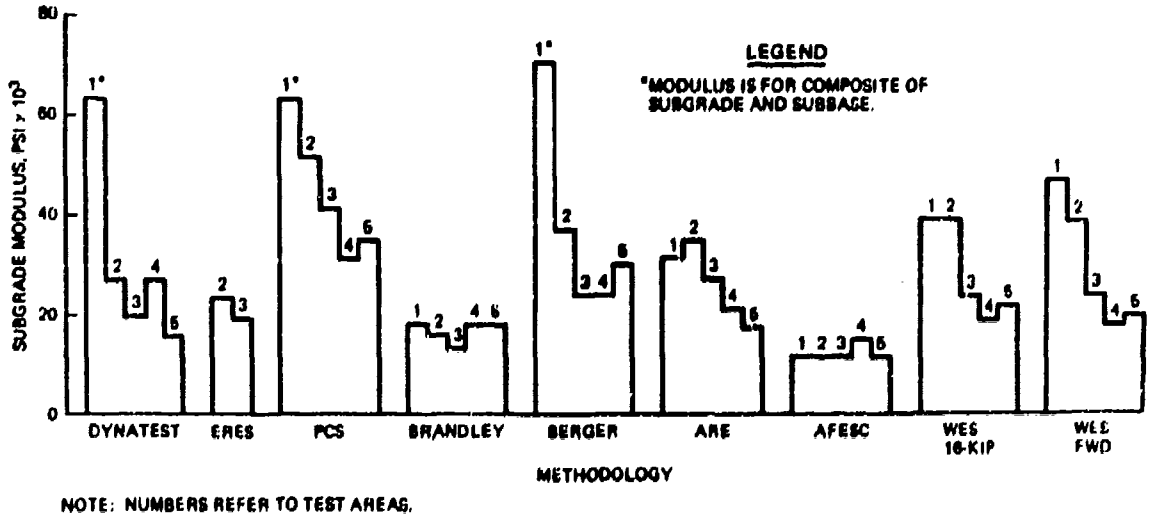


Figure 36. Presentation of predicted subgrade moduli

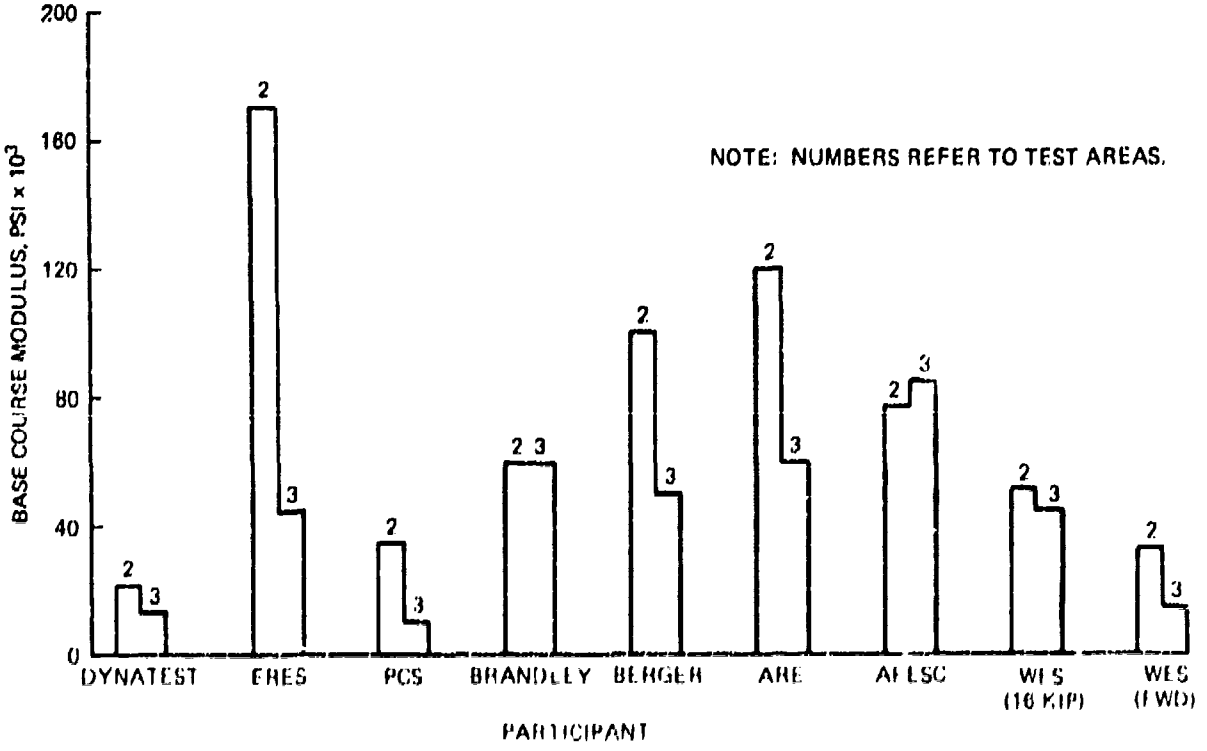


Figure 37. Presentation of predicted base course moduli

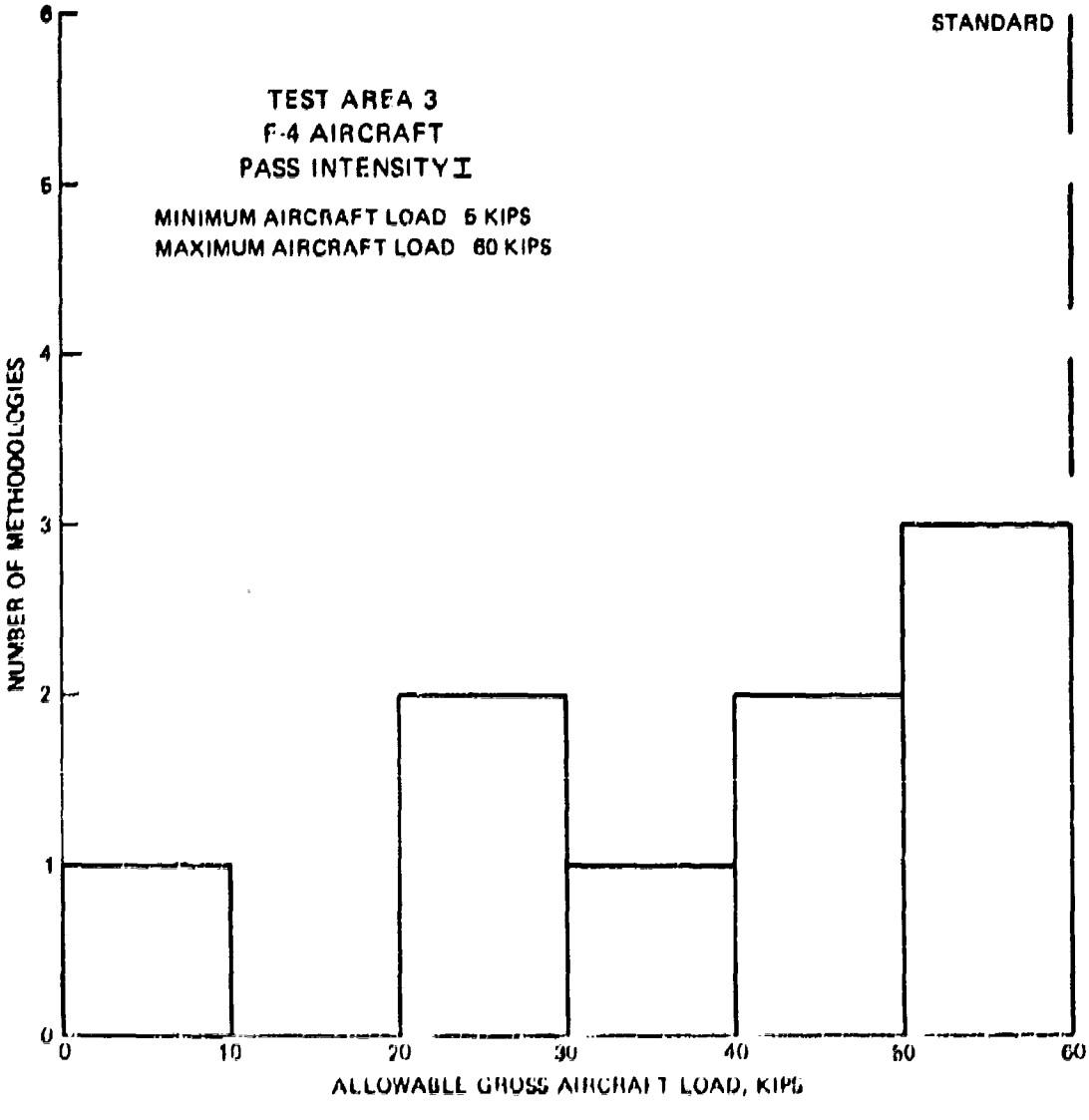


Figure 38. Comparison of predicted loads, Test Area 3, F-4 aircraft

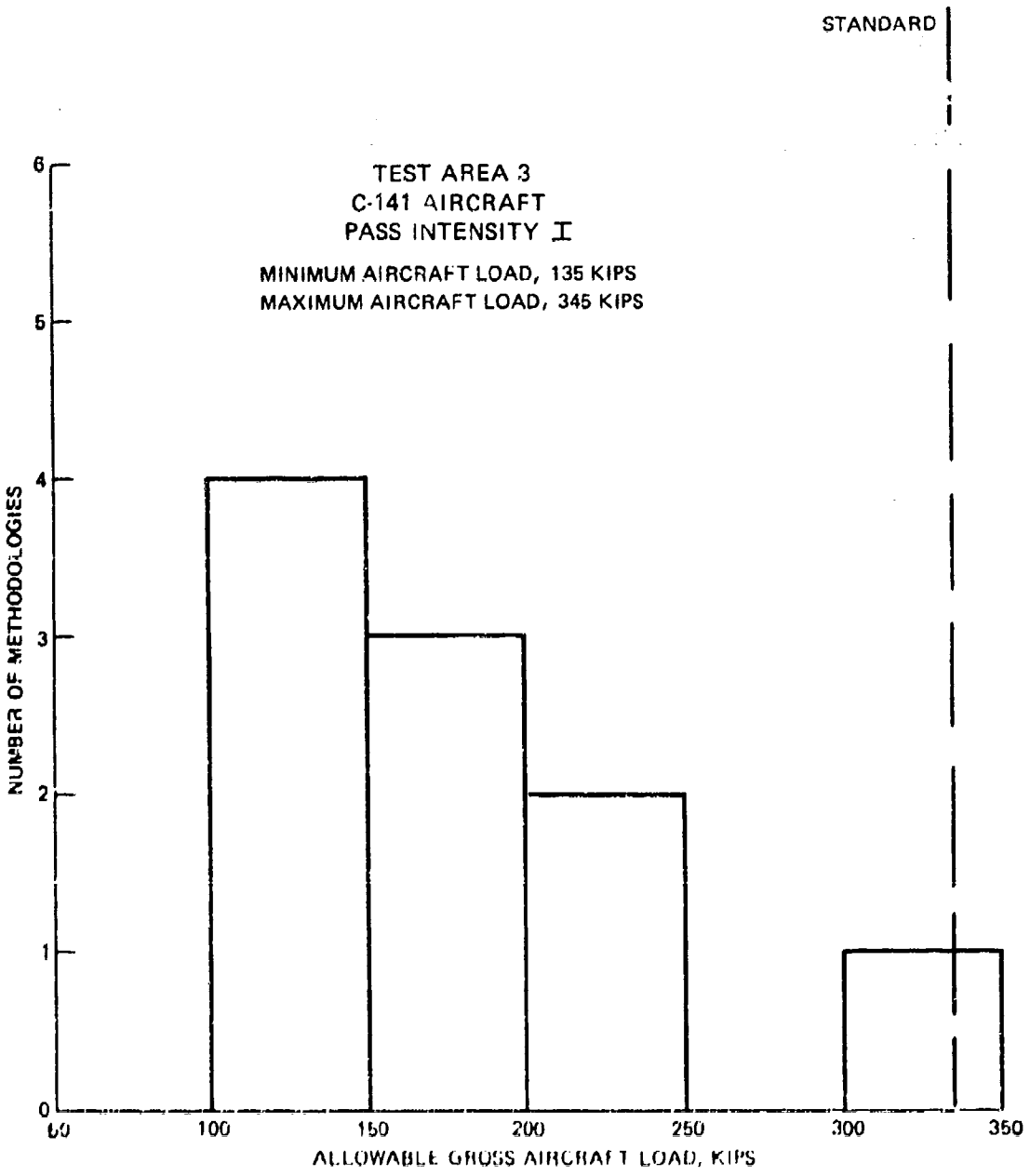


Figure 39. Comparison of predicted loads, Test Area 3, C-141 aircraft

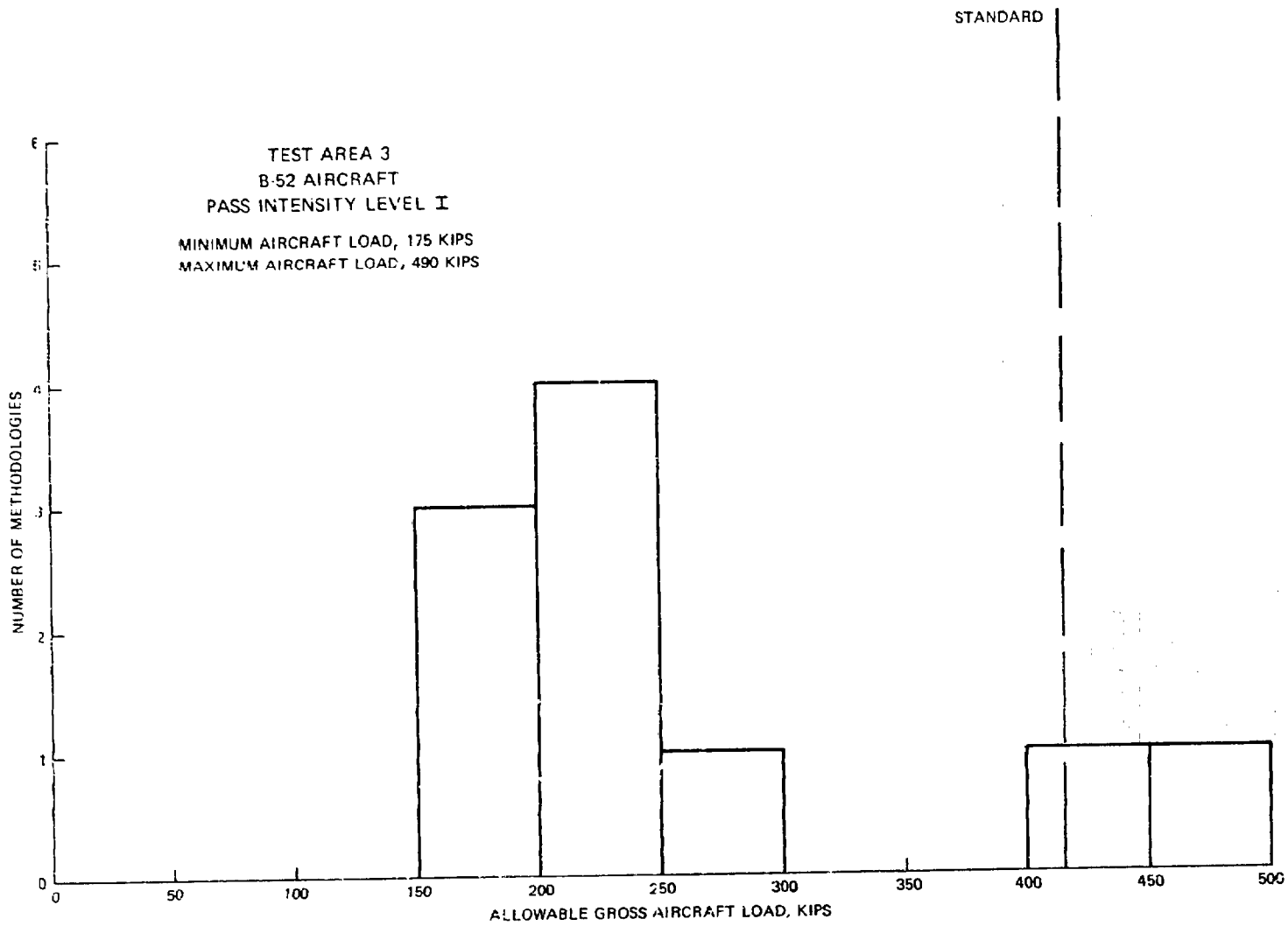


Figure 40. Comparison of predicted loads, Test Area 3, B-52 aircraft

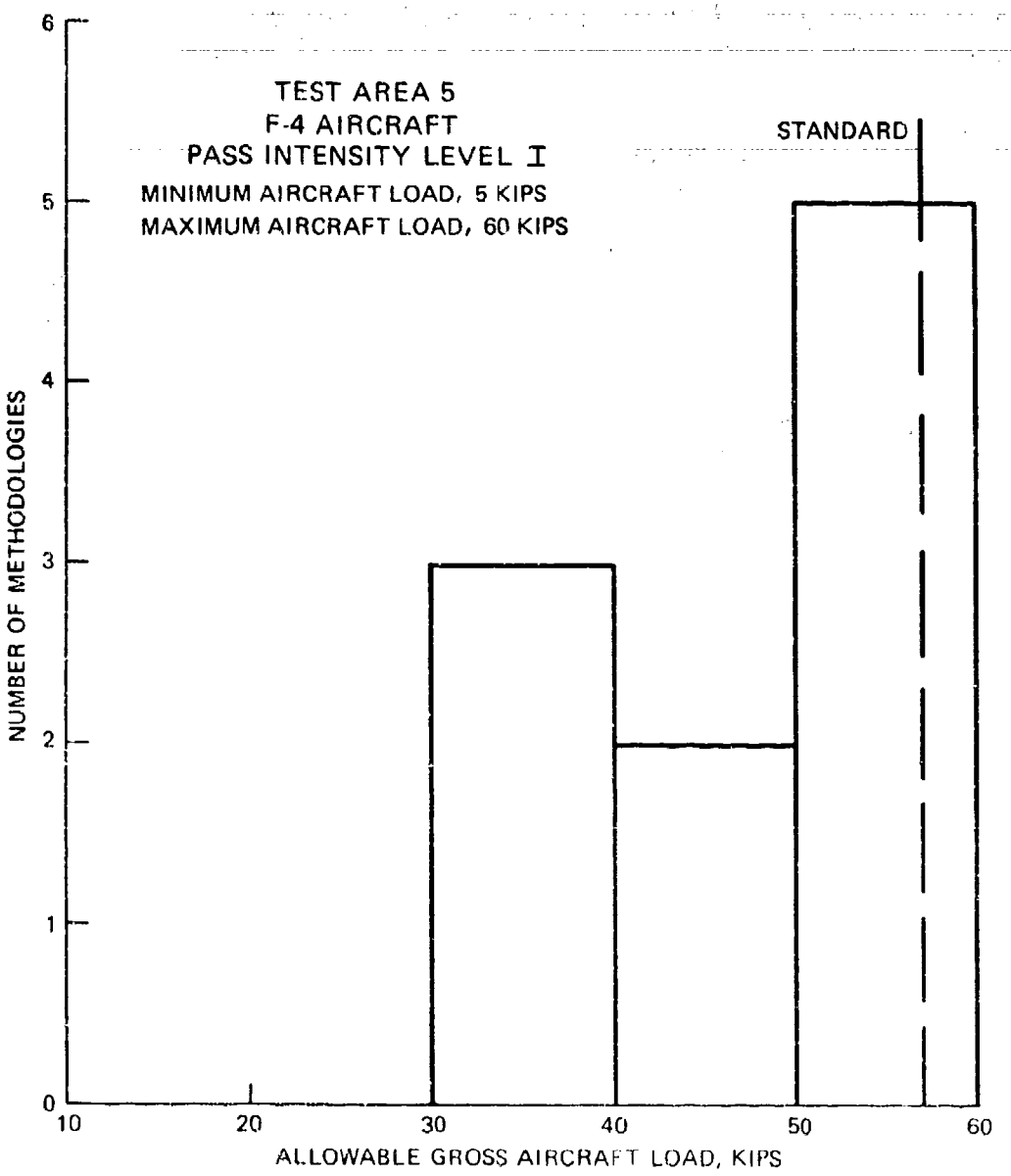


Figure 41. Comparison of predicted loads, Test Area 5, F-4 aircraft

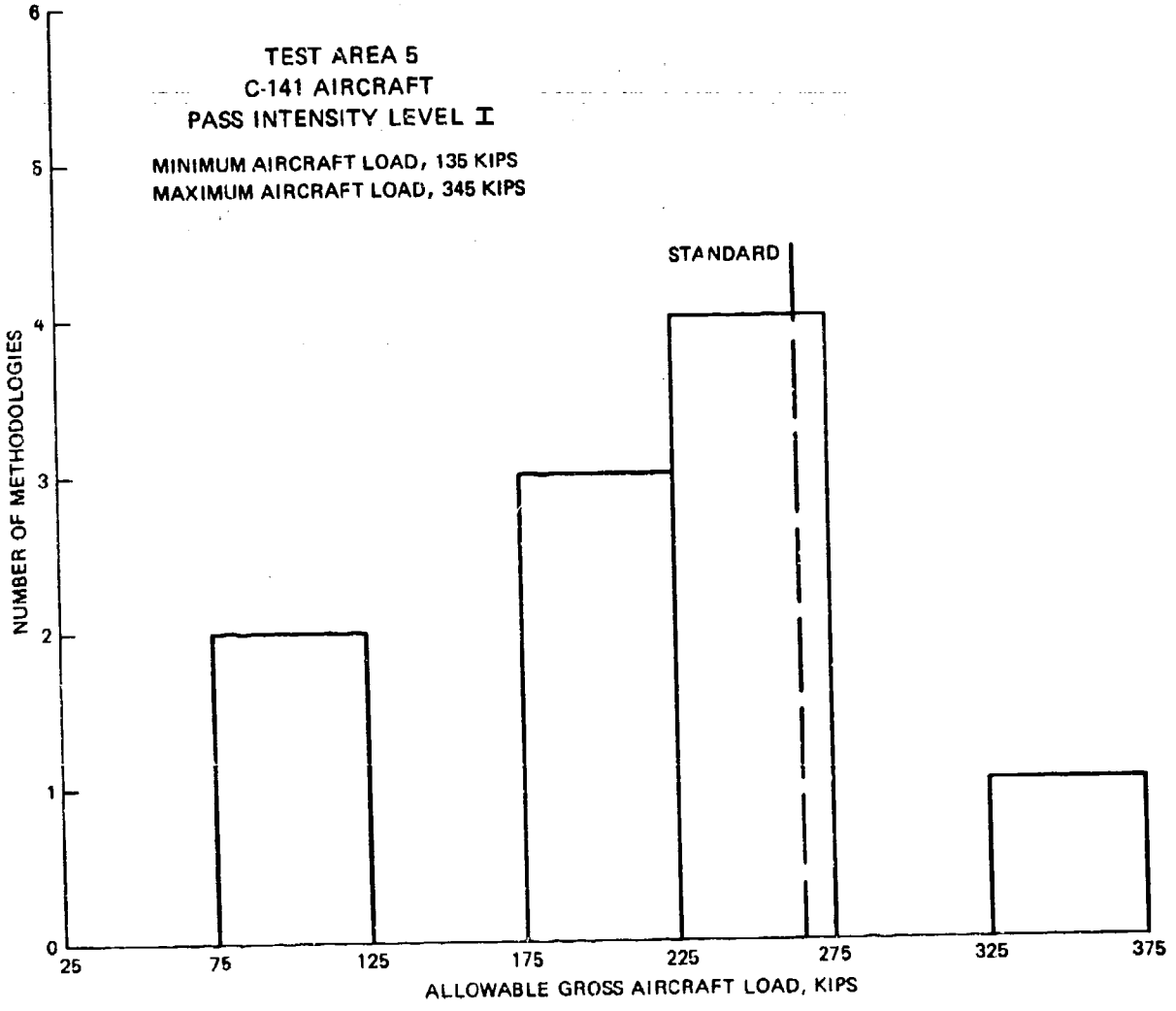


Figure 42. Comparison of predicted loads, Test Area 5, C-141 aircraft

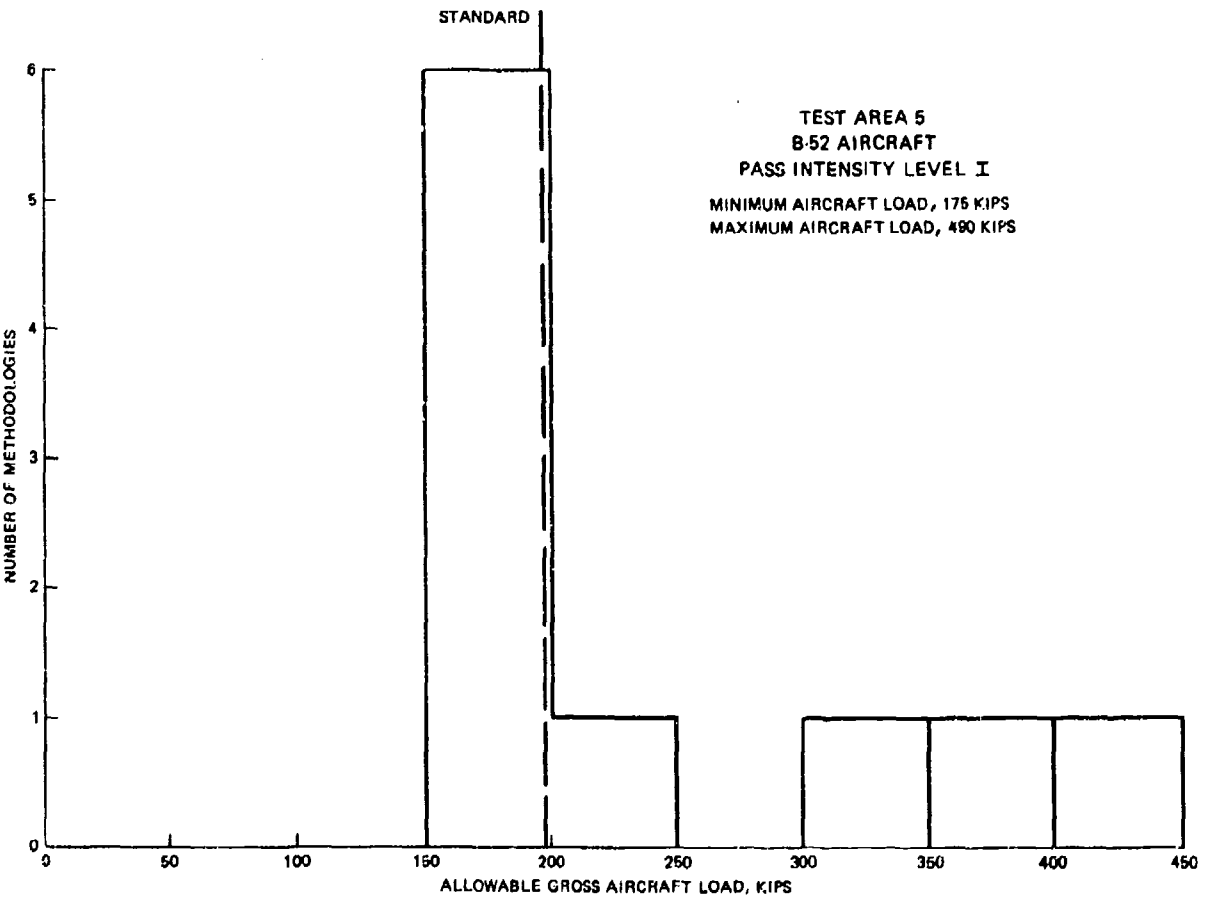


Figure 43. Comparison of predicted loads, Test Area 5, B-52 aircraft

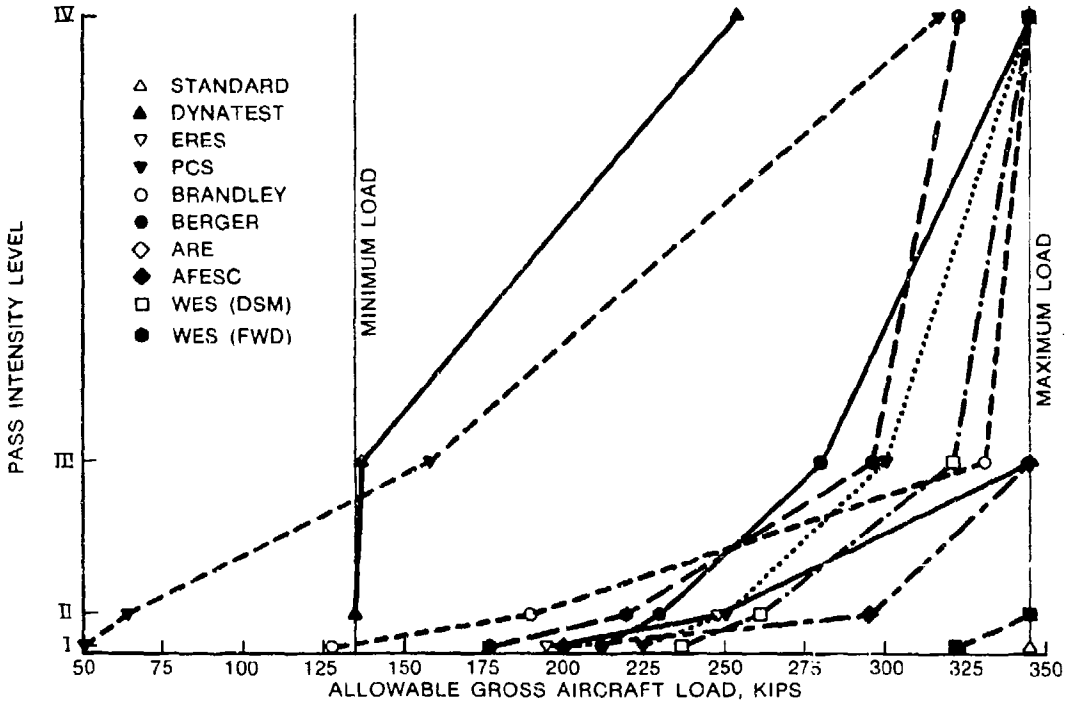


Figure 44. Relationship of allowable loads to passes for flexible pavement. (Allowable load by the standard procedure exceeded the maximum design load for all pass intensity levels)

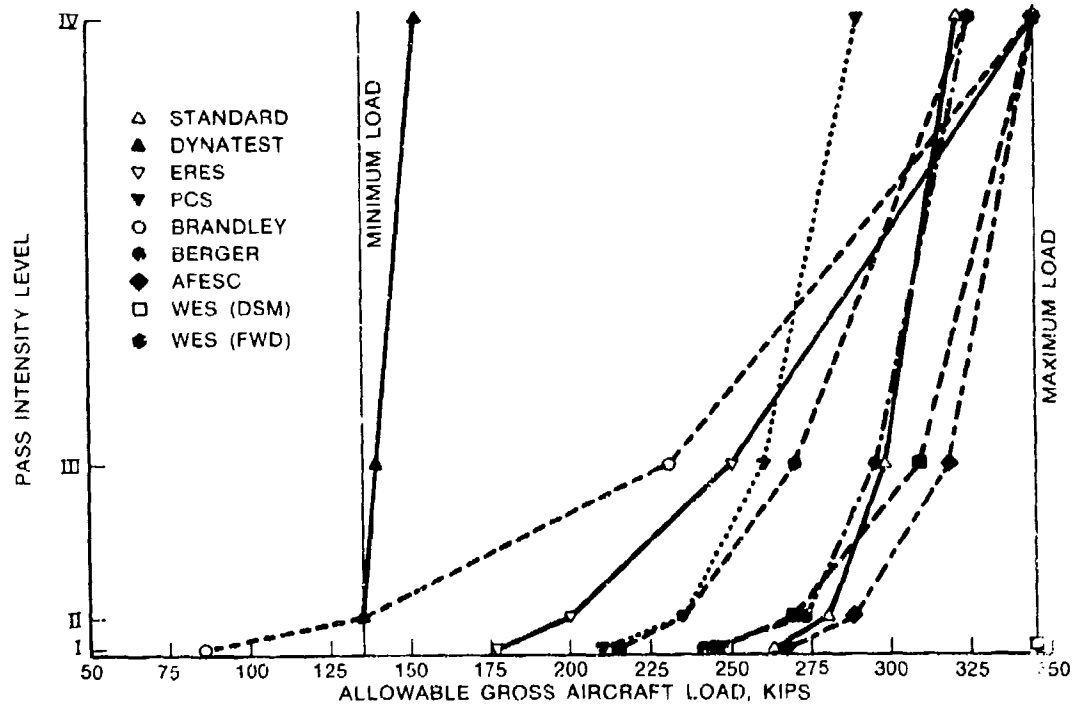


Figure 45. Relationship of allowable load to passes for rigid pavement

APPENDIX A: DESCRIPTION OF NONDESTRUCTIVE TESTING EVALUATION METHODS

1. The purpose of this appendix is to provide a general description of the evaluation method used by each participant in the project. This information is needed to understand the different approaches to nondestructive testing (NDT) pavement evaluation and to explain some of the differences in final results as presented in the main text of this report. These descriptions were extracted from information presented in the reports from each participant.

Pavement Consultancy Services, Inc. (PCS)

2. The basic approach of PCS is based upon the use of the Shell BISAR multilayered elastic program to evaluate the in situ moduli of pavement layers present. To use these results within current military design approaches, correlations relating moduli either to the modulus of subgrade reaction value (Westergaard "k") or to layer California Bearing Ratio (CBR) are necessary. The use of the current US Air Force Load Evaluation Procedure was selected by PCS to illustrate the complete system applicability of NDT testing and subsequent interpretation within current military conventional design methods (Headquarters, Department of the Air Force 1981.*)

3. PCS uses NDT measurements performed with a heavy falling weight deflectometer (FWD) at a force level of 100 kN (22.4 kips). A mass falls on a baseplate that is connected to a 12-in.-diam rigid foot plate by means of a set of springs, thus exerting a pulse load onto the pavement surface. The duration of the pulse load is comparable to the duration of the pulse load exerted by actual traffic. The force level can be changed by adjusting the drop height. The deflection of the pavement is measured by four velocity transducers (geophones): one in the center of the foot plate (δ_0) and at three other radial distances-- $r_1(\delta_1)$, $r_2(\delta_2)$, and $r_3(\delta_3)$. At MacDill Air Force Base (AFB), the radial distances were 0, 60, 100, and 200 cm. The deflection signals are obtained by a single integration of the velocity signals from the geophones, which is performed electronically, by integrated circuits. PCS uses the BISAR computer program developed by the Koninklijke Shell Laboratory in Amsterdam in their NDT evaluation program. The BISAR is a linear-elastic multilayer computer program that is used for the calculation of

* References cited in this Appendix are included in the References at the end of the main text.

stresses, strains, and displacements because of one or more uniform circular surface loads (vertical as well as surface shear loads) and allows the use of a variable degree of interface friction (smooth to rough) between any two adjacent layers within the pavement system.

4. For any given multilayer system having known thicknesses h_i and moduli E_i, the surface deflections at various radial locations (from the center of the uniformly loaded area) can be computed from the BISAR. In NDT analysis, layer thicknesses are known but layer moduli (in situ E_i and Poisson's ratio) values are unknown parameters. By assuming that the predicted deflection, at any radial distance, is equal to the measured FWD deflection at the same radial location, the BISAR can be used in a searching routine to evaluate the set of layer moduli that predict the same measured radial deflections as that determined by the FWD geophones. Thus, by measuring the surface deflection basin under a known load and known set of layer thickness, it is possible to determine the in situ response of layer material properties at the specific test location.

5. The layer moduli are developed through an existing PCS software program that sequences through several BISAR iterations until predicted deflections agree within a preselected percentage error of the FWD measured deflections. The PCS evaluation method demonstrated for this project consisted of determination of layer moduli from NDT data and conversion to conventional pavement properties through correlations between the E derived layer values and the classical CBR and k values.

6. The correlations that have been used are:

   a. E-CBR relationship. $E = 1{,}500\ (CBR)$ with E in psi units. This is the widely known Shell Oil relationship developed by Heukelom and Foster (1960) from in situ dynamic vibratory tests.

   b. E-k relationship. $E = 10^x$ with E in psi units with $x = 1.415 + 1.284 \log k$ with k in pci units. This relationship has been developed by the US Army Corps of Engineers and is based upon laboratory resilient modulus results and in situ measured plate-bearing (k) evaluations (Chou 1981).

Whereas, E-CBR relationships are valid for individual layers, the E-k correlation is only valid for subgrade.

7. The results of the NDT testing program obtained by PCS at MacDill AFB on five test sections resulted in the following general observations relative to the in situ layer properties:

a. The sand subgrade (SP) appears to be relatively uniform, but inherently variable, within all individual sections. The most significant deviation occurs on the SP-SM subgrade of section TW-33.

b. Using the $E = 1{,}500$ (CBR) correlation equation, the average CBR of the subgrade is 27 with an associated range of 16 to 44. These NDT-predicted CBR values appear to be in excellent agreement with test-pit studies.

c. The average NDT predicted k value is 310 pci with a general range of 210 to 450 pci. These values appear to be higher than values obtained from test-pit data.

d. The analysis of the results of the limerock base layer material (SM) indicate that this material exhibits very poor in situ strength/response characteristics. The range of NDT-predicted CBR was found to be between 4 and 50 (overall average near 15). These NDT-predicted CBR values appear to be in excellent agreement with test-pit studies.

e. The asphalt concrete moduli predicted from NDT results show an average E value of 635 ksi and range of approximately 300 to 900 ksi.

f. NDT-predicted values of portland cement concrete (PCC) layer moduli indicated an average moduli of 4.9×10^6 psi and a range from 3.5×10^6 to 6.2×10^6 psi.

g. NDT analysis of the only composite pavement indicated that the existing PCC layer is severely cracked. This conclusion was based on the abnormally low PCC layer moduli that was predicted from the NDT deflection test results on this pavement section ($\bar{E} = 1 \times 10^6$ psi).

8. The flexible pavement load evaluation used by PCS in this study was based upon the CBR equation developed by the WES. This equation is:

$$t = \alpha_i \left\{ A_c \left[0.0481 - 1.1562\,(x) - 0.6414\,(x)^2 - 0.473\,(x)^3 \right] \right\} \qquad \text{(A1)}$$

where

t = flexible pavement thickness, in.

α_i = load repetition factor

A_c = contact area of one tire in the known gear system, sq in.

CBR = strength of layer considered

$x = \log_{10} \text{CBR}/p_e = \log_{10} (\text{CBR} \times a_c)/P_e$

p_e = equivalent tire pressure at depth z used in calculating the P_e value

P_e = equivalent single-wheel load

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CBR = strength of layer considered

$x = \log_{10} CBR/p_e = \log_{10} (CBR \times a_c)/P_e$

p_e = equivalent tire pressure at depth z used in calculating the P_e value

P_e = equivalent single-wheel load

The alpha α_i traffic factor is a function of the number of aircraft passes (N_p) and number of tires used in the equivalent single-wheel load analysis (n_t) (Yoder and Witczak 1975).

9. For each controlling aircraft in the Aircraft Group Index (AGI), single-wheel/load depth relationships were determined from a Chevron elastic-layered computer solution (Boussinesq solution) using the well-known principles of the equivalent single-wheel procedure of the Corps of Engineers (i.e., equal interface deflection theory). Various deflection locations were used within the gear representing the controlling aircraft of the specific AGI to determine the maximum deflection location. The results of the deflection analysis were then used to establish closed-form solutions of equivalent single-wheel load-depth relationships for each AGI.

10. Rigid-pavement evaluations were based upon the Westergaard free edge stress. The theoretical free edge stress is modified by a load-transfer factor β (taken in design to be $\beta = 0.75$) to account for observed differences in joint load transfer, and hence actual stress, to that predicted by the Westergaard theory. Westergaard free edge stresses were computed for all 13 AGI (controlling aircraft) and closed-form solutions were developed for each aircraft. The model form used was:

$$\sigma_{fe} = \frac{1}{h^2}\left(b_0 + b_1 \text{ Ln } \ell + b_2 \ell^{-1}\right) \tag{A2}$$

11. The allowable load equation, using this stress equation form, and the existing Air Force (Corps of Engineers) relationship was then:

$$P_a = \frac{P_s \times h^2 \times MR}{\beta\left[g(k,C_f)\right] \times \left(b_0 + b_1 \text{ Ln } \ell + b_2 \ell^{-1}\right)} \tag{A3}$$

where

P_a = allowable load

P_s = standard load used in the H-51 Westergaard stress analysis

h = PCC slab thickness

MR = design flexural strength (modulus of rupture)

β = load transfer factor

$g(k,C_f)$ = mathematical function relating the modulus of reaction k and coverage to failure level (C_f) to the parameter called the design factor

b_0, b_1, b_2 = statistical regression coefficients that are functions of the specific AGI (aircraft type)

ℓ = radius of relative stiffness

12. The load evaluation summary presented in the PCS report is based upon the initial failure (first crack) criterion. Pass-to-coverage ratios which were necessary for each AGI to perform the load evaluation were calculated using taxiway conditions and assuming that 75 percent of the total traffic volume covered the assumed traffic lane. While not all test sections evaluated in this study were taxiways, this assumption was used for all sections simply for computational expediency.

Dynatest Consulting, Inc. (1983)

13. Below are listed some of the most important steps in the Dynatest procedure for evaluation and overlay design.

a. Layer thicknesses are measured, and the modulus of each layer, including the subgrade, is calculated from deflection tests.

b. The moduli are adjusted to correspond to the climate conditions of each season in the design procedure.

c. The permissible stresses or strains in each material are established as a function of the condition of the material (i.e., modulus) and of the number of load repetitions.

d. The reductions in residual life caused by previous loads are either calculated from the previous loads or are considered (indirectly) through their influence on the present structural condition.

e. Number, size, and position of future loads are established.

f. The needed overlay thickness of a given material to provide the desired serviceability or structural condition for the design period is calculated.

14. The Dynatest 800 FWD Test System was used for the NDT. The adjustable load was set to its maximum capacity of approximately 24,000 lb (force), and a loading plate of approximate 6-in. radius (150 mm) was used to simulate the stress level of a heavily loaded jet aircraft. The resulting stress level was somewhat in excess of 200 psi under the loading plate.

15. The FWD load is transient (as opposed to vibratory), having a time of loading of some 25-30 msec, thus corresponding to the effect of a moving aircraft wheel load. Both the load level and a series of seven simultaneous deflections are monitored for each FWD test, with the deflections measured at

the surface of the pavement from the center of the loading plate (through a small hole in the middle of it) out to a distance of more than 2 m from the center. This enables calculation of the elastic properties of each structural layer in the pavement (assuming pavement layer thicknesses are known) through the use of a reverse, iterative procedure that matches up the load and deflections measured against a unique set of material properties.

16. To obtain reasonably accurate moduli of the pavement layers, Dynatest states that it is essential to consider the nonlinearity of the subgrade. Nonlinear subgrade moduli may be considered either by using finite element methods or by using a modified version of the MET (Ullidtz 1977). If a large number of points are to be evaluated, and this is desirable because of the large variations in pavement structures and subgrades, then the use of the finite element method by Dynatest is not practical for time and cost reasons. Furthermore, MET has been found to give as good as or better agreement than the so-called exact methods (including the finite element method), when compared to actually measured stresses, strains, and deflections in road structures (Ullidtz 1973).

17. The nonlinearity of the subgrade may be determined by carrying out FWD tests at different stress levels. Another possibility is to calculate the nonlinearity from the shape of the deflection basin at one stress level. This second alternative employs the ELMOD program even though it is very easy to change stress level with the FWD, because it is preferable to include other changes in modulus with depth (e.g., layered subgrades, changes in moisture content or overburden pressure) as an "apparent" nonlinearity rather than to disregard such variations. The moduli of the pavement layers, including the subgrade, were determined with the ELMOD program, taking the nonlinearity of the subgrade into consideration.

18. MET has been incorporated into the ELMOD program (for evaluation of layer moduli and overlay design). This program has been written for the HP-85 microcomputer, the same microcomputer that controls the 8000 FWD. The ELMOD program determines the layer moduli, including the nonlinearity of the subgrade, by fitting the theoretical deflection basin to the measured deflections. When, in a later step of the calculations, the overlay thickness is to be determined, the MET is used to calculate the critical stresses and strains.

19. To consider the conditions at joints and corners of rigid

pavements, a special version of the ELMOD program is used. For the center of a slab, the same procedure as described above is used. For joints and corners, the concrete modulus is then assumed to be the same as determined at the center, and the modulus of subgrade reaction k is calculated using Westergaard's modified equations (Westergaard 1948). At joints, the degree of load transfer is calculated and considered in calculating the modulus of subgrade reaction and later when determining the required overlay thickness. Westergaard's equations are also used to calculate the modulus of subgrade reaction at the center of the slab, and, by comparing this value to the value determined at the joint, it is possible to infer the presence of voids at the joints.

20. The moduli determined from the deflection measurements obviously correspond to the climatic conditions during testing. To carry out a proper overlay design, the year should be divided into seasons of reasonably constant climatic conditions.

21. With the ELMOD program, it is possible to divide the year into up to 12 seasons. A sinusoidal relationship is used for the asphalt temperature and the asphalt modulus is determined from

$$E_T = \left[A + B \times \log_{10} \left(\frac{T}{C} \right) \right] \times E_c \qquad (A4)$$

where

E_T = modulus at T , degrees Celsius

T = measured temperature, °F

E_C = modulus at a reference temperature C, °C

C = reference temperature, °C

A and B = constants (input values)

The permissible stresses or strains will be closely related to the definition of "failure." For "bound" materials, such as PCC or asphaltic materials, "failure" may be defined as cracking of the material. In this case, the permissible stress or strain may be determined from fatigue testing in the laboratory. But a transfer function is needed between laboratory and in situ conditions.

22. Two seasons were used in the structural evaluation, each of 26 weeks. The mean temperature was assumed to be 59° F (15° C) for one season, and 94.5° F (35° C) for the other season. The subgrade modulus varies

sinusoidally with season according to the equation

$$R = \frac{1}{2} \times \left(1 + \frac{E_{min}}{E_{max}}\right) + \frac{1}{2} \left(1 - \frac{E_{min}}{E_{max}}\right) \times \sin \left[\frac{\pi}{26} (W - WM - 13)\right] \quad (A5)$$

where

R = seasonal factor

E_{min} = minimum modulus during the wet season

E_{max} = maximum modulus during the dry season

W = week number, counted from January 1

WM = the number of the week when the modulus is at its minimum (for this evaluation $WM = 6$)

$\frac{E_{min}}{E_{max}}$ = 0.67 (estimated from previous FWD testing in Florida)

The seasonal correction of the modulus is applied to the subgrade only. For asphalt, the following modulus-temperature relationship has been used:

$$\frac{E(T)}{E(C)} = 1 - 2 \log_{10} \left(\frac{T - 32}{45}\right) \quad (A6)$$

where

$E(T)$ = modulus at T, °F

$E(C)$ = a reference modulus corresponding to a temperature of $45 + 32 = 77°$ F

The nonlinear properties of the subgrade are expressed as:

$$E = C \times \left(\frac{\sigma_1}{\sigma'}\right)^n \quad (A7)$$

where

σ_1 = major principal stress

σ' = reference stress (a value of 0.1 MPa (14.5 psi) has been used)

C and n = constants (n is negative)

23. For the nonlinear subgrade the modulus used in the structural evaluation E_m is the modulus corresponding to a plate-loading test on the top of the subgrade with a 450-mm- (17.7-in.-) diam slab at a magnitude of deflection of 1 mm (39 mils).

24. For composite pavements, a fixed modulus is used for the concrete and the asphalt modulus is calculated by the program.

25. A standard overlay material is used with a modulus of 650 ksi (4,500 MPa) in one season and 290 ksi (2,000 MPa) in the other season. A Poisson's ratio of 0.35 is used for all materials except concrete where Poisson's ratio is assumed to be 0.15.

26. For the unbound materials, including the subgrade, the following stress criteria has been used:

$$\sigma = 0.5 \times N^{-0.0667} \times \left(\frac{E}{Eo}\right)^{d} \qquad (A8)$$

where

σ = permissible normal stress for N number of load applications, MPa

E = modulus of the material, MPa

Eo = reference value, here equal to 160 MPa (2,300 psi)

d = a power which is equal to 1 when E is greater than Eo, otherwise 1.16

This relationship has been derived from a combination of full-scale field testing and dynamic testing of permanent deformations. The E/Eo relationship was derived from the American Association of State Highway Officials (AASHO) Road Test.

27. For asphalt materials the following failure strain criteria was used:

$$\varepsilon_t = 0.000228 \times VB \times N^{-0.178} \qquad (A9)$$

where

ε_t = permissible horizontal strain at the bottom of the asphalt layer for N number of load applications

VB = volume percentage of bitumen, here approximately 12

For PCC the flexural strength corresponding to static loading was determined from

$$ZP = A \times \left(\frac{E}{Eo}\right)^{d} \qquad (A10)$$

where

ZP = flexural strength of PCC, MPa

A = a constant, here 1.18 MPa (170 psi)

E = modulus of the concrete, MPa

Eo = a reference modulus, here 10,000 MPa (1,450 ksi),

d = a power, here 1 for $E > Eo$ and 0.77 for $E < Eo$

Flexural strength, psi = $9 \times \sqrt{\text{compressive strength, psi}}$

28. A maximum flexural strength of 610 psi was assumed, because this is the maximum value measured by the Air Force Engineering and Services Center (AFESC) at MacDill AFB.

29. The permissible number of load repetitions, when the dynamic, repeated loading is superimposed by a static load from temperature gradient is (Herholdt et al. 1979)

$$N = 10^{[12\times(1-\Sigma DS/FS)/(1-PS/\Sigma DS)]} \qquad (A11)$$

where

ΣDS = sum of dynamic and static load (in this analysis static load assumed to be insignificant)

FS = flexural strength

PS = static load

30. It is recommended by Dynatest that the allowable gross aircraft load be taken as the load that can be sustained by more than 80 percent of the test points.

31. A pass-to-coverage ratio of 1 is used throughout by Dynatest. Furthermore, for the concrete sections, the loading corresponds to early morning conditions. Corners and joints of concrete slabs were evaluated during the morning hours because this is the critical period from a structural point of view.

32. Test Area 1 was treated as a two-layer system, because it was impossible to distinguish the limerock-stabilized sand base from the subgrade. Test Areas 2 and 3 were both considered as three-layer systems. For both of these test areas, the subbase was included as part of the subgrade. An asphalt overlay has been assumed with a winter modulus of 650 ksi and a summer modulus of 290 ksi. The maximum gross load used for the B-747 was 825 kips and for the DC-10-30, 555 kips.

ERES Consultants, Inc. (1982)

33. The overall procedures used by ERES to evaluate the pavements were as follows:

a. A condition survey was first conducted to determine what distress exists and the present overall condition of the pavement using the Pavement Condition Index (PCI).

b. The pavement structural response to aircraft loads was measured with a Dynatest Model 8000 FWD; the heavy load (24,000 lb) was required to simulate the heavy aircraft wheel loads using the pavements. ERES states that the FWD closely simulates the deflection basin obtained under actual moving wheel loads. The entire deflection basin 6 ft from the load plate was measured. The load-carrying capacity of the joints was measured, and the critical load location determined.

c. The stiffness of the pavement layers were back-calculated from the deflection basin curvature using an elastic layer model for AC pavements and a finite element model for concrete and composite pavements.

d. The critical stresses and strains were calculated for various aircraft loads placed at the critical location on the pavement using the same elastic layer and finite element pavement models used to characterize the pavements. The measured load transfer at the joints was directly taken into account in the analysis.

e. The number of load coverages to a selected proportion of cracking (and rutting) was then calculated using field-verified damage models for given aircraft types and loads.

34. The FWD used by ERES was manufactured by Dynatest Engineering, Ltd., of Denmark. The unit can produce loads from 1,500 to 24,000 lb with a duration of approximately 27 msec.

35. The load is applied to the loading plate by dropping a weight package on a dampening system and is measured directly by a load cell. The resulting pavement deflection is measured by seven seismic deflection transducers spaced at predetermined intervals from the loading plate (12-in. intervals in this study). The signals from the load cell and deflection transducers are fed into the system processor which selects the peak values and transfers this information to the HP-85 computer. Three different load magnitudes were used in this evaluation ranging up to 24,000 lb.

36. According to ERES, characterization of jointed concrete pavement is best modeled with a finite element model that can accurately represent the joints. ERES uses the ILLISLAB finite element program (modified) that was developed at the University of Illinois.

37. The pavement can be accurately characterized by back-calculating the modulus of elasticity of the slab and the k-value of the foundation from the measured deflection basin. ERES has used several different methods to determine the best modulus of elasticity E and k values for given pavements. The most consistent method is to use the area of the center slab deflection basin and maximum deflection. A graphical relationship of area versus maximum deflection as functions of the modulus of the concrete slab and the foundation support modulus k is then developed over a reasonable range of E modulus values and k values until the average area and maximum deflection of the pavement are bound using the ILLISLAB program. The E modulus and k value determined will normally accurately give the slab curvature measured with the FWD. The area and maximum deflection basin of individual slabs can be used to determine an E and k value, or the average of all the slabs can be used (excluding any very unrepresentative slabs). The mean area and maximum deflection were used herein to obtain an average E and k value for the pavement section.

38. The concrete modulus of elasticity E and the k value of the foundation are not the standard static E and k value measured by long-term static tests, but represent the dynamic response of the pavement to the FWD load, and consequently the moving aircraft wheel load. For example, for Test Area 5 (10.5-in. PCC), the following was obtained.

E modulus (dynamic) = 4,500,000 psi
Poisson's ratio = 0.20 (assumed)
k value (dynamic) = 315 pci

ERES has developed an empirical relationship between the measured dynamic modulus of elasticity of a standard beam and its standard third-point loading modulus of rupture. The estimated modulus of rupture of the concrete slab is 632 psi based on a dynamic modulus of elasticity of 4,500,000 psi.

39. The pavement model characterized as described was then loaded with each of the 13 critical aircraft. The critical location for the aircraft gear is at the joints. The critical joint having the lowest load transfer was determined. The aircraft gear was positioned so as to give the critical stress in the slab. This position was normally with a wheel load parallel to the joint (similar to standard Corps of Engineers and Federal Aviation Administration (FAA) design methods).

40. The critical tensile stress in the slab was then calculated for

each aircraft. These stresses are located at the bottom of the slab and parallel to the joint. The joint was modeled with a deflection load transfer.

41. The next step was to estimate the number of stress repetitions that the slab could withstand until cracking occurs. To accomplish this difficult task, ERES used a relationship between the ratio of the modulus of rupture to the critical stress in the slab and the number of actual coverages of the aircraft gear to cracking of the slab. This relationship was developed using field data from 52 Corps of Engineers test sections that were run over the past 40 years. The critical stress in each of these pavements was calculated using the ILLISLAB finite element program for the actual loading used. The dynamic modulus of elasticity of the concrete was used and an estimate of the repeated load k value was used in the stress calculation. The damage model derived from these data is shown below.

$$\log_{10} (\text{coverages}) = 2.27 \times \frac{MR}{STRESS} + 0.056 \qquad \text{(A12)}$$

where

$\log_{10}$ (coverages) = number of coverages to 50 percent slab cracking

MR = third-point modulus of rupture calculated from dynamic modulus of elasticity from FWD, psi

STRESS = critical stress in the slab using appropriate load transfer in the ILLISLAB finite element program, psi

42. Graphs of gross aircraft load versus the number of coverages to 50-, 25-, and 10-percent slab cracking were plotted for a given aircraft. The allowable aircraft gross load can then be read from these graphs for the specified pass intensity levels.

43. Pass-to-coverage ratios calculated using the normal distribution were used to convert coverages to passes. Allowable gross aircraft loads to 50-, 25-, and 10-percent slab cracking for the given pass load intensity levels are given. It must be remembered that these loadings are for the aircraft oriented in the critical direction (parallel to the joint with the lowest load transfer for this apron). If the joint had much higher load transfer, as would occur with mechanical load-transfer devices, the load-carrying capacity would be substantially higher. The load-transfer capability of the joints will always control the load-carrying capacity of the overall jointed concrete pavement.

44. Since the overlay is to be designed for only one aircraft, a simplification of the normal ERES procedures can be made. If more than one heavy aircraft were to use the pavement, a different analysis would be conducted to analyze the need for strengthening the pavement (using the Miner's cumulative damage law).

45. If past load damage were evident, the Miner's cumulative damage law would be employed as follows.

$$\text{Total damage} = \underbrace{\sum \frac{n_p}{N_p}}_{\substack{\text{past} \\ \text{damage}}} + \underbrace{\sum \frac{n_f}{N_f}}_{\substack{\text{future} \\ \text{damage}}} \tag{A13}$$

46. If adequate data are available, then a summation of load damage can be made using the Miner's damage law. However, if there are inadequate past traffic data, then the amount of past damage can be estimated using existing load-associated slab cracking.

47. A series of stress calculations are made using the ILLISLAB finite element program over a range of overlay thicknesses for a given pavement and aircraft. The critical stress is still in the same location at the bottom of the slab parallel to the joint for the AC and the bonded PCC overlays. The critical stress for the unbonded PCC overlay is either at the bottom of the existing slab or at the bottom of the new PCC overlay at the joint. The moduli and Poisson's ratio used for the AC and PCC overlays are as follows:

$$\text{AC overlay: } E = 350{,}000 \text{ psi}, \quad u = 0.35 \tag{A14}$$

$$\text{PCC overlay: } E = 4{,}000{,}000 \text{ psi}, \quad u = 0.20 \tag{A15}$$

48. The same load transfer that exists in the base slab was used for the AC and PCC bonded overlay since they will not increase the load transfer at the joint. The load transfer for the unbonded PCC overlays was increased to that normally used in new design for joints with mechanical load transfer or tied keyways (75 percent).

49. The number of aircraft coverages until slab cracking for each overlay thickness was then calculated. The allowable coverages were converted to passes. A failure criteria of 25 percent cracked slabs is believed to be

reasonable for major rehabilitation purposes.

50. For the composite pavement section, the finite element model was used to model the critical joint area. The ILLISLAB model was used with the two layers (AC and PCC) bonded together. The pavement layers and subgrade support were characterized by back-calculating the modulus of elasticity of the asphalt concrete and concrete slab and the k value from the measured deflection basin. The area method was used.

51. FWD deflection tests were conducted at the slab center, transverse joint, longitudinal joint, and slab corner. Load-transfer tests were also taken across random cracks in the overlay. Six different slab areas were tested overall. The reflective crack/joint load transfer was determined. The determination of allowable loads and overlays followed the same approach as used for jointed concrete pavement.

52. For flexible pavement characterization, the general procedures used to determine the moduli values required modeling the pavement as a two-layered system and modeling the deflection basin to determine the subgrade modulus (Hoffman and Thompson 1981). With the subgrade modulus known, a factorial design was conducted with varying moduli values to match the deflection basin. This procedure provides a unique solution for the previously selected subgrade modulus used. Relationships were developed for each pavement structural section. The FWD deflection data plotted on these relationships provide the moduli for the two layers, completing the chatacterization with a unique match to the deflection basin measured in the field.

53. The AC modulus was found to be very sensitive to the modulus obtained for the subgrade. The base course, however, showed little sensitivity for the pavements analyzed in this study.

54. Flexible pavements will generally fail because of permanent deformation (rutting) or fatigue cracking of the AC layer. When cement-stabilized layers are used for the base course, the problem of fatigue failure in the cement-stabilized layer must be examined. Rutting is generally characterized by the vertical stress on the subgrade, the vertical strain on the subgrade, or the vertical deflection of the pavement surface. Fatigue cracking is generally related to the radial tensile strain that develops at the bottom of the AC layer or the stabilized layer. These pavement response parameters are related to the number of loads producing a response that will cause a specified level of failure to occur.

55. Critical stresses and strains were calculated at the interfaces of the layers. The multiple-wheel load (MWL) elastic-layered program was used to analyze the multiple-wheel gears of the aircraft and calculate the stresses and strains used in the analysis. The critical values were calculated as a function of the gross aircraft load. In these calculations, the gross aircraft loads were decreased in increments with the resulting tire pressure changing to keep the contact area the same for all load levels.

56. The MWL elastic-layered system was used in this analysis because the materials in the pavement structure were primarily granular and acted linearly. Excellent deflection matches were obtained with the elastic-layered analysis used in the characterization. The outputs of the program are the vertical stresses and strains at the subgrade, the vertical deflection of the surface, and the radial strain in the AC layer.

57. The failure criteria used in this analysis include radial strain in the AC and the vertical strain on the subgrade.

58. The rutting failure criterion used in the analysis was the one developed by Chou (1976). This relationship is in the following form:

$$\varepsilon_v = 5.511 \times 10^{-3} \left(\frac{1}{N_{cov}^{0.1532}} \right) \tag{A16}$$

where

ε_v = vertical strain on the subgrade

N_{cov} = number of coverages of the specified aircraft producing that strain

59. This equation was used to calculate the allowable strain for each aircraft being analyzed as a function of the number of coverages specified for that aircraft. The allowable strain calculated in this manner was used as the failure criteria in this analysis.

60. The French Shell method of evaluating fatigue damage is one of the most flexible procedures for evaluating fatigue in different asphalt materials (Bonnaure, Gravois, and Udron 1980). The equation is presented.

$$\varepsilon_r = (4.102 \times PI - 0.205 \times PI \times Vb + 1.049 \times Vb - 2.707) \times S_m^{-0.28} \times N_{cov}^{-0.2} \tag{A17}$$

where

ε_r = radial strain

PI = penetration index, assumed = 0

Vb = volumetric bitumen content, 15 percent

Sm = stiffness of the mix, N/m^2

N = number of coverages

61. For a totally nondestructive type of analysis, typical asphalt properties can be assumed that consider the condition of the pavement, the age of the asphalt materials used, and the properties of the original materials used. The temperature variation can be accounted for in the stiffness modulus of the AC.

62. The fatigue curve developed from the French Shell method represents the median of a large number of fatigue samples, and use of this curve should produce values representative of 50 percent wheel path area cracking in the pavement. A more accepted level of fatigue cracking is approximately 10 percent cracking. Curves were also calculated representing the strain and loadings that would produce cracking levels of 10 and 25 percent.

63. The pavement response values were obtained for each aircraft for each level of loading. Graphs were then prepared showing the relationship between the response values and the gross aircraft loadings.

64. The allowable strains for rutting and fatigue were calculated from the equations using the number of coverages. Different allowable loads are calculated for conditions of rutting--fatigue 50 percent, fatigue 25 percent, and fatigue 10 percent of the area. The comparison that produces the lowest allowable gross load between fatigue and rutting should be the one selected for a particular pavement. The acceptable level of fatigue cracking is an engineering management decision.

65. The modulus value for the AC surface layer could be changed for a seasonal analysis to show temperature influences. Additionally, the subgrade modulus value could be altered to indicate seasonal variability. The values determined in October 1982 are deemed representative of the Tampa, Fla., area; over a year or so no changes were made in this analysis (no frost problem existed and the water table was relatively high).

66. Because the limerock base appears to be cemented to some extent (the modulus value is much higher than nonstabilized granular materials), an analysis was carried out to examine the fatigue life of a cement-treated

soil. The analyses conducted relate primarily to true portland cement-stabilized materials, not naturally cementitious materials. The first method of analysis used Portland Cement Association data on fatigue of soil cement using the radius of curvature of the stabilized layer (Larsen and Nussbaum 1967). The damage model for a low quality cement-stabilized material is

$$R = \frac{Rc \times N^{0.032}}{1.05 - 0.042h} \tag{A18}$$

where

R = radius of curvature

Rc = critical radius of curvature = 7,000 in.

N = number of load repetitions the section will carry

h = thickness of stabilized layer

67. The second analysis used results from ERES employing AASHO road test data for the cement-stabilized layers and elastic-layer analysis to obtain appropriate critical strains. The damage model is

$$\log N_{2.5} = 8.559 - 3.488 \log \varepsilon \tag{A19}$$

where

$N_{2.5}$ = number of loads to reduce serviceability to a failure level

ε = strain in cement-treated material

68. Because the limerock base is not a true portland cement-stabilized layer, these analyses are more approximate than the rutting and fatigue analyses. These analyses cautiously use existing pavement conditions. The results do show a substantial reduction in allowable loading.

69. For overlay design the pavement section is characterized as previously described. It is then modeled with the aircraft placed on the pavement structure at its maximum load and the pavement response values calculated by the MWL program. The thickness of the overlay is varied and the response values for each thickness calculated. The allowable strains are then calculated for each aircraft using the field-developed equations presented in the previous section for the number of coverages of each aircraft. Overlay thicknesses are selected based on the rutting and fatigue analyses. These thicknesses would be increased somewhat if the pavement showed signs of load-related distress indicating that some fatigue or rutting damage had already

been produced by the previous traffic on the pavement.

70. For multiple-aircraft loadings, the Miner's fatigue damage concept is used to compute total damage from all aircraft using the pavement. This total damage is correlated to percent cracking of the pavement to determine the limiting criteria. This procedure of directly considering existing load transfer will give reduced allowable loads and increased overlay thickness if the load transfer is poor. Poor load transfer existed on both jointed concrete test areas.

R. W. Brandley (RWB)(1983)

71. The test program conducted by RWB consisted of the following:

a. A survey was performed to determine the condition of the existing pavements by visual observations.

b. Dynatest FWD tests using the Dynatest 24-kip unit were conducted.

c. Joint efficiency tests using loaded vehicles and cantilever deflection beam were carried out.

d. Tests using the WES 16-kip vibrator were conducted.

72. Each test site was visually inspected in some detail to determine the existing conditions of pavement at each test area. The purpose of this condition survey was to provide information on distress that had occurred in the pavements as the result of traffic.

73. The Dynatest FWD test equipment was used to conduct the FWD tests. At each location tested, the test load was dropped from such a height as to provide a load of approximately 830 kPa and a load of 1,500 kPa on a 5.91-in.-radius plate. Deflection readings were measured directly under the plate at distances of 200, 305, 610, 914, 1,524, and 2,438 mm away from the plate. These deflection measurements were automatically recorded.

74. On the PCC pavement sections, tests were conducted in the center of the slab, at the edge of the slab, and at the corner of the slab to determine the effect of load transfer in the slab itself. The tests conducted at the edge and corner of the slab were conducted in such a manner that the joint was located between the gauges set at 200 and 305 mm from the plate.

75. On the AC pavement sections, the tests were conducted both along the center line of the test section and 18 ft on each side of the test section. Representative values of deflection at each distance measured from

the center of the plate were determined. These data were used in a computer program for evaluation of the pavement sections.

76. On Test Areas 2 and 3, considerable variation occurred between the pavement section at the center of the taxiway and the section at the edge of the taxiway. To obtain information as to the relative effect of this change in section, a series of FWD tests was conducted across the taxiways, which provided a cross section of deflection across these taxiways.

77. The test data obtained on the PCC pavement sections were such as to determine the support characteristics of the pavement section at the center of the slab and also to get some indication of the load transfer at the joints. This was accomplished by applying the load adjacent to a joint and measuring the induced deflections on both sides of the joint.

78. WES made data from the WES 16-kip vibrator available for evaluation. The 16-kip vibrator test data were evaluated in a manner similar to that for the FWD data in that profiles were plotted of the deflections obtained and representative values of deflection at each test location and at each distance from the applied load were determined.

79. In all of the WES 16-kip vibrator tests, dynamic loads were applied and the imposed deflections were measured under the plate at a distance of 18, 36, and 60 in. from the plate. The plate diameter for the WES 16-kip vibrator was 18 in.

80. The office of RWB had developed a method of testing joints in PCC pavements sections to determine the effectiveness of the load transfer at the joints and the resistance to deflection at the joints under load. The test procedure consists of placing a cantilever deflection beam on the slab with two linear potentiometers located at the free end of the beam. The beam is set on the slab such that one of the potentiometers is located on one side of the joint and the other potentiometer is located on the other side of the joint. A rubber-tired wheel which imposes approximately the same total load as the aircraft using the pavements is then pulled or driven across the joint perpendicular to the joint and passes immediately adjacent to the location of the potentiometers. In this manner, the total relative deflection of the slab at the joint and the relative movement of one slab with respect to the other (slab rocking) as the wheel moves over the joint can be measured and recorded.

81. This type of testing was undertaken at Test Areas 1 and 5, which had a PCC pavement. The Air Force had agreed to furnish a loaded vehicle of

approximately 50,000 lb per single wheel; however, the only equipment available was a truck-mounted crane which had three axles. The rear axles had dual wheels, and each pair of duals was loaded to 7,000 to 8,000 lb. These loads were very light and did not adequately represent the wheel loadings on any of the design aircraft other than perhaps the F-16. Because this was the only equipment available, the tests were conducted using this equipment.

82. RWB used the fatigue analysis method (Brandley 1975) for pavement evaluation and design for subgrade support, the standard CBR method for flexible pavements, and the Westergaard method for rigid pavements for evaluation of the pavement section itself. The nondestructive test data were used at MacDill AFB to obtain modulus of elasticity values for each material within the pavement section and for the subgrade soils at each test location.

83. The moduli of elasticity calculations were made using the data from both the FWD tests and the WES 16-kip vibrator tests. Using the data from the FWD tests, the entire deflection basin was evaluated using the ELMOD and the ISSEM 4 programs employed by Dynatest Consulting, Inc. In addition, the program for the Boussinesq theory using the equivalent thickness theory was put to use. The N-layer theory as developed by Chevron Asphalt Institute was also utilized, in which the center deflection and the edge deflection are used in the N-layer computer program to compute the modulus of elasticity of the subgrade layers. The values assumed for the pavement layers were those obtained from the ELMOD or ISSEM 4 evaluations.

84. For the WES 16-kip vibrator, the Boussinesq equivalent thickness program and the N-layer theory were used with the deflections obtained from this test procedure to calculate modulus of elasticity values. Part of these variations in subgrade E-values calculated by each method can be accounted for by the fact that the Boussinesq equivalent thickness theory and the N-layer theory assume a linear elastic condition for the support materials; whereas, the ELMOD and ISSEM 4 programs allow stress-dependent characteristics. Applying a factor of 2 to 3 to the E-values obtained for the subgrade soils in the concrete sections at MacDill AFB produces subgrade E-values which are reasonably uniform throughout the site.

85. Using this type of evaluation, soil and pavement section parameters to be used in the evaluation and design were determined. The E-values for the pavement section itself used in the analysis were those obtained in evaluating the deflection basin data taken from the FWD tests. Using the modulus of

elasticity values and the aircraft loading at each pavement section, subgrade deflections for each aircraft were calculated using the N-layer theory. After subgrade deflection under each aircraft loading at each pavement section had been determined, the limiting subgrade deflection criteria were used to determine the allowable aircraft coverages to failure for each aircraft. One coverage is obtained on the critical pavement section for each two passes of aircraft over the pavement section depending on type of aircraft and location, i.e., taxiway or runway.

86. The pavement evaluation by the fatigue analysis method was then determined by comparing the allowable coverages to failure with the pass levels for each of the four levels of operation established for this study. Knowing the pass level required for each aircraft type at each test location, it is now a simple matter to determine the ability of the pavement section to carry the aircraft loading and to determine what overlays are required to strengthen the deficient pavement sections enough to carry the anticipated number of aircraft operations for each aircraft.

87. This same type of analysis can be used to determine the allowable load at which each aircraft can operate without failure of the subgrade for each pass level. All of this evaluation with the fatigue analysis method is for subgrade protection only and assumes that the pavement section is adequate to distribute the loads to the subgrade without failure of these materials themselves. It is necessary to evaluate the adequacy of the pavement section itself for support of the aircraft without failure in this pavement section. This analysis was conducted using standard procedures with CBR analysis for flexible pavement and the Westergaard analysis for rigid pavement. The minimum PCC overlay presented in this analysis is 12 in., even where a thinner section theoretically would perform. It is considered that a minimum 12-in. section is required to install the necessary load transfer at the joints.

88. Joint efficiency tests were conducted using the FWD, the WES 16-kip vibrator, and a moving wheel load with a cantilever-type deflection beam. Research conducted by RWB has shown that pavements 12 in. thick can tolerate slab rocking up to 0.020 in. without inducing stresses sufficient to cause failures. However, any slab rocking or relative deflection of magnitude greater than this will contribute to early failure. This 0.020-in. maximum slab rocking or deflection criteria for the edge of the slab has been determined for 12-in. concrete slabs. For thicker slabs, less deflection can

be tolerated; and for thinner slabs, more deflection can be tolerated.

89. It appears that the amount of movement measured under the FWD test when joint efficiency tests are conducted is so small that the joint efficiency cannot be properly evaluated. All joints move a certain amount, and it has been shown that joints can move up to 0.020 in. with 12-in. slabs without imposing serious stresses. The light loading of the FWD does not produce enough movement at the joint to determine whether adequate load transfer exists. The same analysis holds true for the WES 16-kip vibrator.

90. Full-scale testing is apparently still required for joint efficiency. While the data are not adequate because of lack of loading to confidently predict adequacy of load transfer, the data do indicate that adequate load transfer is available in Test Area 1 but that there are sections of Test Area 5 in which adequate load transfer will not be available.

Louis Berger International, Inc. (1983)

91. The report submitted by Berger consisted not only of the requested pavement evaluation in terms of allowable loads and overlays but also provided results of comparisons with different NDT equipment and different layer analyses. The method used by Berger for NDT evaluation is a combination of layered-elastic theory and a modified version of the WES DSM method (Hall 1978). This method can be implemented with the pavement profiler, FWD, or the WES 16-kip vibrator, and similar results would be obtained. The description given here will briefly discuss some of the Berger results using information from the report submitted by Berger.

92. The method used in the Berger report for determining the allowable gross aircraft load (AGAL) is the CBR method for flexible pavements and the Westergaard analysis for edge loading for rigid pavements. These methods are also the basis for the current DSM procedure, as outlined by Hall (1978).

93. The NDT data used to perform the pavement evaluation were collected with the Model 2000 pavement profiler which applied a peak-to-peak cyclic load of 4.5 kips at a frequency of 25 Hz. Deflection sensors are placed either 12, 24, and 36 in. or 12, 24, and 60 in. from the center of the load plate. One sensor is mounted at the center of the 18-in.-diam plate. Berger also made use of the data collected by WES with the WES 16-kip vibrator and the Model 8000 FWD (15 kip). The WES data were not used for upgrading the pavement

systems but for comparisons of the elastic parameters obtained for the subgrade and pavement.

94. For flexible pavements, the critical strain concept shows promise, but it is Berger's opinion that, in view of the range of critical strain values, this method requires site calibration. This can be done when past traffic records are available and when an opportunity is provided for NDT testing of both areas with satisfactory pavement sections and traffic-induced failures.

95. The method for determining a representative DSM value for each pavement based on measurements with the WES 16-kip vibrator is described in detail by Hall (1978). The DSM can be determined from measurements made with the pavement profiler using the following expression:

$$DSM = 0.8 \times \frac{P}{\Delta_o} \tag{A20}$$

where

P = peak-to-peak load for Model 2000 pavement profiler (about 4.5 kips)

Δ_o = double amplitude of the pavement center deflection on an 18-in. diam plate

This is the design DSM which is equivalent to WES DSM ksi. In determining the representative (P/Δ_o) values to use for the pavement evaluation of the five test areas, the 50-percentile values obtained on both the center line and near wheel path were considered.

Flexible Pavements

$$ASWL = 0.0437 \times (DSM) \tag{A21}$$

Rigid Pavements

$$ASWL = 0.01896 \times (DSM) \tag{A22}$$

Composite Pavements

$$ASWL = 0.0172 \times (DSM) \tag{A23}$$

where allowable single-wheel load (ASWL) is in kips and (DSM) is in ksi.

The following values of allowable single-wheel load were obtained:

Values, Single-Wheel Load	
Test Area	ASWL, kips
1	150
2	87
3	35
4	40
5	44

96. Because the CBR method was used in determining the ASWL in the WES study on flexible pavements, it is pertinent to compute the implied CBR of the subgrade associated with the ASWL for Test Areas 2 and 3. This requires converting the existing pavement thickness to an equivalent pavement thickness, T_t, having 3 in. of AC and 6 in. of high-quality base. Assuming that the AC has a 1.7 equivalency to subbase and a 1.4 equivalency to high-quality base (as assumed in the original WES study), T_t can be computed for the two flexible pavements if equivalencies are assigned for the existing AC and base materials. Based on the NDT moduli, it seems reasonable to assign an equivalency factor of 1.7 to the existing AC, 1.15 for the existing base in Test Area 2, and 1.05 for the existing base in Test Area 3. The representative values of the elastic moduli for the base course in Test Areas 2 and 3 are 100,000 and 50,000 psi, respectively.

97. Using the CBR equation and the ASWL determined from the DSM as outlined above, one can compute the associated CBR.

$$CBR = \frac{\alpha^2 \times 1{,}000 \times (ASWL)}{8.1 \times (T_t^2 + \alpha^2 A/\pi)} \qquad (A24)$$

where

α = 0.94, for 24,000 passes

ASWL = allowable single-wheel load, kips

T_t = equivalent thickness, sq in.

A = 254 sq in.

This gives a subgrade CBR of 9 for Test Area 2 and a CBR of about 14 for Test Area 3. These results are not consistent with the subgrade modulus E_3 of about 37,000 psi for Test Area 3 determined from the NDT testing.

98. An implied linear relationship between ASWL and DSM indicates that the measured DSM would increase proportionately to the square of the pavement thickness. This has not been observed at various sites. Therefore, for the

purposes of pavement evaluation, a better procedure is to evaluate the CBR of the subgrade using deflection bowls to determine the subgrade modulus E_3 and then evaluate the CBR using this subgrade modulus. The elastic modulus of the base E_2 and the asphalt layer E_1 determined from the interpretation of the deflection bowl are used to estimate the equivalency factors. These are used to determine the equivalent flexible pavement thickness T_t . The ASWL bowl is then computed using the CBR equation. This procedure yields a subgrade CBR of about 25 for Test Area 2 (as compare to 9) and a CBR of about 15 for Test Area 3 (as compared to 14). The equivalent flexible pavement thickness equals 31 and 14 for Test Areas 2 and 3, respectively. Consequently, the DSM procedure for determining ASWL for flexible pavement in Test Area 2 is very conservative; whereas, for Test Area 3 this procedure appears to be more reasonable.

99. The deflection bowls measured on rigid pavements can be used directly to determine all the parameters necessary for determining the ASWL if the flexural strength of the concrete is known. The following results were obtained.

Test Area	Thickness in.	DSM kips/in.	E_1 psi	k pci	ℓ in.
1	20.0	8,000	4,000,000	500	48
5	10.5	2,300	4,000,000	250	36

Using the above values for Test Area 5 with a C-141 aircraft, one can calculate the allowable gross load for 24,000 passes:

$$P_G = 0.0189 \times (DSM) \times (F_L) \times (T_C) \qquad (A25)$$

where

P_G = allowable gross load aircraft, kips

F_L = load factor, which depends on the characteristic length ℓ

T_C = traffic factor, which depends on the aircraft gear configuration and the required number passes

For Test Area 5, DSM = 2,300 , ℓ = 36 , F_L = 7.4 , and T_C = 0.95 , and

$$P_G = 0.0189 \times (DSM = 2,300) \times (F_L = 7.4) \times (T_C = 0.95) \cong 310 \text{ kips} \qquad (A26)$$

100. Using the rigid pavement evaluation curve for the same aircraft (C-141), an allowable gross load of 310 kips, 24,000 departures, and 10.5 in. of PCC pavement (with a k = 250 pci) yields a concrete flexural strength of 780 psi. PCC cores tested by splitting and converted to flexural strength by an empirical relationship produced flexural strengths ranging from 420 to 610 psi (AFESC 1980). Fifty percent of the reported flexural strengths were 500 psi or less. In view of the above and in the absence of a direct determination of the flexural strength, a flexural strength of 650 psi was assumed for the rigid pavement evaluation. The allowable gross load is therefore 260 kips from the C-141 evaluation curve. Therefore, the following expression was used for evaluating the rigid pavement of Areas 1 and 5.

$$P_G = 0.0159 \times (DSM) \times (F_L) \times (T_C) \qquad (A27)$$

where 0.0159 = 0.0189 (260/310). The allowable gross load is determined using this equation which has been developed for flexural strength of 650 psi.

101. Based on the similarity of the deflection bowls and the same design DSM for Test Areas 4 and 5 (DSM = 2,300), the same parameters can be used for pavement evaluation of Test Area 4 (composite pavement); i.e., k = 250 pci and (ℓ = 36.0 in.), where determined previously for Test Area 5.

102. The equivalent thickness of PCC pavement is given by the following expression.

$$h_e = \frac{1}{F}(h + 0.4t) = 11.0 \text{ in.} \qquad (A28)$$

where

F = 0.8

h = 6 in. (thickness of PCC)

t = 7 in. (thickness of AC overlay)

Following the same procedure outlined for Test Area 5,

$$P_G = 0.0172 \times (2,300) \times (7.4) \times 0.95 = \quad \text{kips} \qquad (A29)$$

103. This implies a concrete flexural strength of 690 psi for an equivalent thickness of PCC of 11 in. Following the same procedure as outlined for Test Areas 1 and 5, the following expression was used for evaluating the rigid pavements of Test Area 4.

$$P_G = 0.0162 \times (DSM) \times (F_L) \times (T_C) \quad \text{(A30)}$$

where $0.0162 = 0.0172\ (650/690)$.

104. The AGAL for flexible pavements is computed using the evaluation curves for flexible pavements for 13 aircraft groups. When using these curves, T_t values were used for thickness (e.g., T_t = 31 in. for Test Area 2 and 14 in. for Test Area 3). The subgrade CBR values were those determined from the subgrade modulus E_3 values found from interpretation of the deflection bowls (i.e., CBR = 25 for Test Area 2 and CBR = 15 for Test Area 3). Based on these CBR design curves, no load limitations exit for the 13 aircraft groups at all pass intensity levels for Test Area 2.

105. The load limitations for Test Area 3 are based on the design curves for each pass level. For example, the allowable gross load of aircraft group 11 (DC-10-30) and 3,000 passes is 430 kips.

106. In Test Area 3, the CBR of the subgrade associated with the DSM method is 14. The CBR of the subgrade from E_3 is 15. Because these two values are similar, it is of interest to determine the AGAL for Test Area 3 using the DSM method as outlined. The AGAL is determined by the following expression.

$$P_G = \frac{F_K \times (DSM)}{S \times (\%ESWL)} \times \frac{N_m}{NC} \times 100 \quad \text{(A31)}$$

where

F_K = load factor depending on the number of wheels and the total aircraft coverages; F_K depends on the total number of passes and on the pass-to-coverage ratio for the aircraft

S = main gear load, percent

% ESWL = percent equivalent single-wheel load depends on equivalent flexible pavement thickness the aircraft

N_m = number of controlling wheels for computing (percent ESWL)

The following overlay thickness recommendations for each test area were determined.

Areas 1 and 2

107. No upgrading is required for the rigid pavement of Test Area 1 (20-in. concrete) and the flexible pavement of Test Area 2 (15-in. base plus 11-in. AC) to accommodate the design traffic of the B-747 or the DC-10-30.

Area 3

108. The design subgrade CBR is 15, and the equivalent thickness T_t = 14 in. Using the CBR curves, a total required flexible pavement thickness of T_t = 20 in. is determined for the B-747. In other words, DT_t = 20-14 = 6 in. of subbase. Based on an equivalency factor of 1 in. of AC = 1.7 to 2.0 in. of subbase, an overlay of 3.5 in. of AC is recommended for this aircraft. The actual overlay thickness will be based on the pavement elevation profile and the minimum overlay should be 3.0 in. For the DC-10-30 aircraft, the total required flexible pavement thickness is 17 in. Therefore, a minimum 1.75 to 2.0 in. of AC is recommended.

Area 4

109. The most economical overlay design is based on the flexible pavement analysis. The design subgrade CBR is 15. The existing 6.0 in. of PCC is assumed to be equivalent to 6.0 in. of high-quality base course. The equivalent existing pavement thickness T_t is therefore T_t = (6 base + 3 asphalt) + (7 - 3) × 1.7 = 15.8 in. Using the CBR design curve, a total required flexible pavement thickness of T_t = 20 in. is determined for the B-747. Therefore, the recommended overlay thickness is (20.0 - 15.8)/(1.8) = 2.3 , say 2.5 in. Following this same design procedure for the DC-10-30 results in a required AC overlay thickness of less than 1.5 in. In conclusion for Test Area 4, 2-1/2 and 1-1/2 in. of AC are recommended for the B-747 and DC-10-30, respectively.

Area 5

110. Based on the FAA design procedures for rigid pavements, the required total thickness of the PCC for Test Area 5 is 13 in. and 12 in. for the B-747 and DC-10, respectively. Because the existing pavement slabs are distress-free, the bonded or monolithic PCC overlay is recommended. In this case, the required thickness of the PCC is 13 - 10.5 = 2.5 in. and 12 - 10.5 = 1.5 in. for the B-747 and D-10-30, respectively. The joints in the overlay must be matched to thejoints in the existing pavement by both location and type.

111. Measurements of deflection bowls near joints were performed in Test Areas 1 and 5. The tests included:

a. Measurement of deflection bowls on the same side of the joint where the load was applied.

b. Measurement of the deflection bowls on two sides of the joint.

The results are analyzed using the Westergaard theory, as summarized below. The load transfer efficiency of a joint is defined as

$$Zj - Z'j = (1 - j)(Ze - Z'e) \tag{A32}$$

where

Zj = deflection of loaded slab at joint with j-efficiency

Z'j = deflection of adjacent slab

j = joint efficiency

Ze = deflection of loaded slab at joint with zero efficiency (free edge)

Z'e = deflection of adjacent slab with zero efficiency at joint

When the load is applied on only one side of the joint, Z'e = 0. Therefore

$$j = 1 - \left(\frac{Zj - Z'j}{Ze}\right) \tag{A33}$$

The free edge deflection Ze can be either measured wherever a free edge condition exists or computed using the approximate Westergaard formulas as follows.

$$Ze = \frac{P\sqrt{2 + 1.2\mu}}{\sqrt{Eh^3k}}\left[1 - (0.76 + 0.4\mu)\frac{\bar{Y}}{\ell}\right] \tag{A34}$$

where

P = load

μ = Poisson's ratio of concrete

E = modulus of elasticity of concrete

h = slab thickness

k = subgrade modulus of reaction

$\bar{Y}$ = distance of center of gravity of load edge

$\ell = Eh^3/\left[12\left(1 - \mu^2\right)k\right]$

112. According to Westergaard, the deflections at the edge of a joint with efficiency j can also be computed using these equations:

$$Zj = \left(1 - \frac{1}{2}j\right) Ze + \frac{1}{2}\, j\, Z'e \tag{A35}$$

$$Z'J = \frac{1}{2} j\, Ze + \left(1 - \frac{1}{2} j\right) Z'e \qquad \text{(A36)}$$

In the case of the load being applied on one side of the joint $Z'e = 0$, the joint efficiency can be computed using either the first or second equation.

$$j = 2\, \frac{(Ze - Zj)}{Ze} \qquad \text{(A37)}$$

$$j = 2\, \frac{Z'j}{Ze} \qquad \text{(A38)}$$

Dividing the equation for Zj by the equation for $Z'j$ gives

$$j = \frac{2\, Z'j}{Zj + Z'j} \qquad \text{(A39)}$$

113. Two cases are dealt with for evaluating joint efficiency:

a. The deflection bowl is measured on one side of the joint where the load is applied. Equation A37 is used to compute the joint efficiency. The free edge deflection Ze is computed using Equation A34 and material properties (h, k) derived from pavement evaluation (Hertz theory) of the center load of the same slab. The deflection at the joint Zj is found from extrapolation of the measured deflections.

b. The deflection bowl is measured on both sides of the joint. The joint efficiency can be computed using:

(1) Equation A33 which comes from the definition of joint efficiency (Equation A1). (In this case, the free edge deflection Ze is computed using Equation A3 and material properties (h, k) derived from pavement evaluation (Hertz theory) of the center load of the same slab.)

(2) Equation A32 which comes from the approximate Equations A35 and A36 (In this case, Ze is not needed). The deflections Zj and $Z'j$ at the edge are found from extrapolation of the measured deflection. The main conclusion of the joint transfer analysis, both in Test Areas 1 and 5, is that the load-transfer efficiency of the joints may be taken as 0.5.

114. The following conclusions were made by Berger:

a. The pavement profiler, the 16-kip vibrator, and the WES FWD all have satisfactory instrumentation for measuring both applied force and resulting deflections. This was indicated by the almost identical deflection bowls for the 10.5-in. concrete pavement of Test Area 5 when normalized with respect to applied load.

b. The coefficient of variation of the normalized deflections is approximately 10 percent for each of the three NDT devices.

c. The shapes of the deflection bowls produced by the three NDT devices are sufficiently close to those predicted by the Hogg model, so that the model can be used in pavement evaluation.

d. Generally, good agreement was obtained between the moduli of the pavement layers as computed by the various methods outlined. The Hogg model can be used for determining the subgrade modulus E_3 and of the concrete E_1 for rigid pavements. For flexible pavments, E_1, E_2, and E_3 can be determined using the method of equivalent thicknesses. If E_1 is known, E_2 may be determined using the center deflection and the Burmister two-layer model, when combined with the determination of E_3 using the Hogg model. Reasonable results were obtained using these methods for analyzing deflection bowls produced by all three NDT devices.

e. The three NDT devices gave similar layer moduli for PCC, AC, and the subgrade. The moduli for the base course determined from the deflection bowls produced by the FWD were significantly lower than those obtained from analyzing the deflection bowls produced by either the pavement profiler or the 16-kip vibrator.

f. All of the layer moduli values for the five test areas obtained with the three NDT devices are reasonable.

ARE, Inc. (1983)

115. The data gathered for this project included physical property data or construction history data on the five pavement sections, traffic data as furnished by the sponsor, and NDT data acquired on location at MacDill AFB.

116. The only actual tests made on location at MacDill AFB were the NDT deflection tests. These tests were performed using a Dynaflect which is a rapid mobile NDT machine available since the early 1960's. The data include deflection readings for each of the five sensors which are part of the standard Dynaflect apparatus, sensor 1 being midway between the load test wheels and the other four sensors being spaced 1 ft apart on a radius from the center between the two load wheels. The test points were located for each of the five test areas using a grid pattern on the apron areas, and on the taxiways test points were located on each side of the center line on flexible pavements. On the rigid pavements, tests were performed at transverse joints and in the center of the same slab on which the test was done at the joint.

117. The numerical computation of elastic properties for each of the

five pavement cross sections includes the stress-strain analysis and the prediction of critical aircraft.

118. Normally, the first step in the analysis is a visual and graphical evaluation of the NDT deflection data, a process used to delineate different areas of pavement response to load. However, because these pavement areas were designated and are only approximately 1,000 ft in length, the technique of dividing pavement into various response sections was bypassed. For each of the areas, various statistical parameters were computed for further use in the analysis. The mean standard deviation and coefficient of variation were computed for each of the data groupings. The mean values of the deflections at all five sensors are the most important data elements that are used in the development of the materials properties for each of the five cross sections.

119. The next step in the analysis was to analytically characterize the elastic materials properties for each of the major layers in each of the five pavement cross sections. This is accomplished using a computer program called BASFIT. BASFIT is a deflection basin fitting program that predicts deflection values under a known load and loading conditions using the cross-section geometry furnished by the sponsor, which included known layer thicknesses together with construction history and word description of the materials. Approximate values of Poission's ratio were assigned along with approximate values of elastic moduli as the initial input to the program BASFIT. The program predicts the deflection basin response. Moduli are adjusted until the predicted basin sufficiently accurately simulates the measured basin using whatever field testing device is specified. In the case of this application the Dynaflect loading was used. This process is an iterative one and is generalized; i.e., it is not unique to any particular type of NDT load but could be used with any one that can be adequately described in terms of load and geometry.

120. Normally, the ARE design procedure takes into account the relative load magnitude of the NDT apparatus and the larger magnitude of actual aircraft load. As for clay or fine-grained soils, it is believed and has been shown from extensive laboratory work that as the loads increase, the elastic moduli decrease. However, the subgrade materials that prevail on all five sections at MacDill AFB are classified as sands, thus indicating that there would be no stress sensitivity characteristics associated with the subgrade soils. For this reason, further adjustments to the elastic

properties determined in the deflection basin fitting through the use of a BASFIT program need not be made.

121. Pavement evaluation computations were next accomplished using a series of computer programs referred to as ELSYM-5 and AIRPOD. ELSYM-5 is a five-layer elastic-layered analysis program publicly available, and AIRPOD is a first-generation airport pavement overlay design procedure in the form of a computer program developed in the late 1970's by ARE for use on civil airport evaluation and runway design projects. This program likewise is based on elastic-layered theory and uses fatigue criteria for the assessment of pavement damage and the remaining life under specified traffic circumstances. ELSYM-5 and AIRPOD have been used on many past projects. A brief description of the pavement life analysis built into the AIRPOD program follows.

122. The present amount of life remaining in the pavement and the projected future life are determined with the computer program AIRPOD. The program determines the allowable number of aircraft operations for the pavement using the following fatigue equations.

$$N = a \left(\frac{f}{\sigma}\right)^b \tag{A40}$$

or

$$N = c \left(\frac{1}{\varepsilon}\right)^d \tag{A41}$$

where

N = number of aircraft loads until failure (fatigue life)

f = concrete flexural strength, psi

σ = computed stress due to aircraft load on rigid pavement, psi

ε = computed strain due to aircraft load on flexible pavement, psi

a, b, c, d = constants

123. The program AIRPOD computes the stress and strain in the pavement using an elastic-layered theory subroutine. This computation requires the aircraft load and materials property inputs previously discussed. The number of aircraft passes until failure is determined for each individual aircraft.

124. The percentage of life remaining in the pavement is computed using an equation of the following form.

$$L_R = 100 - \left(\sum \frac{n}{N}\right) \cdot 100 \qquad \text{(A42)}$$

where

L_R = fatigue life remaining in the pavement

n = aircraft operations to date for an individual aircraft

N = allowable number of aircraft loads until failure of an individual aircraft

125. The program computes the amount of damage contributed by each aircraft n/N and then sums these damage ratios to determine the total damage from which the remaining life is calculated. The remaining life can be determined for any point in time by inputting the appropriate number of aircraft operations for each aircraft n up to that point in time. By computing the remaining life at various points in time, the estimated end of the pavement's useful fatigue life can be determined by projecting the relationship of remaining life to time.

126. To accomplish the pavement life analysis for those pavements with PCC layers, a concrete flexural strength was estimated. Based on engineering judgment and some of the generalized relationships available, it was determined that the concrete flexural strength for Test Area 1 on Taxiway 33 was 650 psi, Test Area 4 on Apron 1-A-1 was 700 psi, and Test Area 5 on Apron 1-A was 600 psi.

127. Using the stress and strain information previously computed and documented, the allowable number of aircraft loads was computed for each of the pavement areas. These allowable traffic levels together with the four pass intensity levels of traffic for each of the five pavement sections allowed the computation of the remaining life in each of the five pavments at each of the four pass intensity levels of aircraft traffic; allowable loads for the 13 aircrafts groups were then computed for each of the four pass intensity levels.

128. The computer program AIRPOD designs overlay thicknesses for either AC or PCC pavements using the same concepts as for the pavement life analysis. The materials inputs are the same as those determined for the remaining life analysis, except that properties of the proposed overlay material must be added as imputs. The traffic imput must include the projected number of future loads of each aircraft type. The program considers the amount of life remaining in the existing pavement when computing the overlay thickness.

AFESC (1982)

129. The Air Force system uses an impulse load applied to the pavement surface. Analysis of collected time-domain accelerometer data by discrete Fourier transform techniques provides the phase angle/frequency information needed for pavement evaluation. Knowing the frequency f and phase angle θ a velocity versus wave length dispersion curve can be developed from the relationships.

$$T = \frac{360d}{\theta} \tag{A43}$$

and

$$v = f\lambda \tag{A44}$$

where

d = accelerometer spacing

θ = phase angle

v = phase velocity

f = frequency

λ = wavelength

130. Interpretation of the dispersion curves must be made by the operator to determine velocity values to be used for each layer in the pavement. These velocity values are used with known or assumed material densities γ and Poisson's ratio ν to determine the elastic moduli of the material layers. The shear modulus G is calculated from

$$G = V_s^2 \left(\frac{\gamma}{g}\right) \tag{A45}$$

where

G = shear modulus

V_s = shear wave velocity

$V_s = (Vr/a)$

V_r = Rayleigh wave velocity

a = varies from 0.875 for Poisson's ratio of 0.0 to 0.955 for Poisson's ratio of 0.5

γ = unit weight of materials

g = acceleration constant

E = Young's modulus is computed from: $E = 2(1 + \nu)G$

ν = Poisson's ratio (assumed)

Corrections are required in the shear wave velocity of subsurface layers to account for variations in the pavement surface. The following general relationship is used for any layer.

$$V_s = \sqrt{\frac{Gg}{\gamma}} \tag{A46}$$

131. Specifically, for layer 2 (base course), the shear wave velocity from the dispersion curve is

$$V'_{s_2} = \sqrt{\frac{G_2 g}{\gamma_2}} \tag{A47}$$

However, to correct for the velocity increase as the wave is propagated into the surface the following expression is used.

$$V_{s_2} = \sqrt{\frac{\gamma_1}{G_1} \frac{G'_2}{\gamma_2}} \; V'_{s_2} \tag{A48}$$

where

V_{s_2} = actual shear wave velocity in the base course

G_1 = shear modulus for the surface layer

G'_2 = shear modulus for the base course using V'_{s_2}

V'_{s_2} = shear wave in the base course from the uncorrected dispersion curve

132. The procedure used is to first calculate shear modulus G for the surface layer and then to calculate G for subsurface layers using the uncorrected shear wave velocity. After shear wave velocities are corrected, then they are used to calculate shear modulus G and Young's modulus E values for each layer. These values are then used in the computer analysis.

133. The primary component of the Air Force nondestructive pavement evaluation system is the field equipment that collects data pertinent to the strength of the materials composing the pavement system. The field equipment

used by the Air Force is contained in a 1978 Ford parcel delivery van with a custom-engineered cargo area to meet air-transportability requirements, so important to the Air Force for rapid deployment capability. The total vehicle weight for field deployment is approximately 11,000 lb. The vehicle is equipped with an aircraft radio for direct communication with the airfield tower and safety beacons which make it highly visible from the air and ground while operating on the airfield.

134. Contained in the rear of the vehicle is a hydraulically operated impact hammer which provides the impulse energy required to obtain pavement response information through a series of pavement-mounted accelerometers. Operation of the system is by a programmable controller with manual override capability. Hammer weights can be varied from 100 to 500 lb by manual addition of weight to the hammer. The drop height can be varied from 0 to 36 in. The assembly is equipped with grippers that lift the hammer, release it, and then catch the hammer after the first impact to prevent the hammer from striking the pavement more than once.

135. Various types of impact plates are employed to enhance the signal frequency content. Typically, an aluminum plate is used. The impact plate is equipped with a switch which provides information for hydraulic control of the grippers and for triggering the data recording equipment.

136. Up to eight accelerometers are mounted to the pavement on 1/4-in.-diam steel studs 1/4 in. long. A quick-setting epoxy cement is used to attach the mounting studs to the pavement. The accelerometers are then screwed into the studs. Spacing between the accelerometers varies as to pavement type and thickness and requires some operating experience. The mounting operation can be completed in less than 20 min.

137. Each accelerometer is hooked up to a power supply and data acquisition equipment. The data acquisition equipment located in the front portion of the cargo area of the vehicle consists of an HP-9845B desktop computer with CRT display, hard copy printer, and 500-kilobyte memory. Data collected through an HP-6942 multiprogrammmer is transferred to the computer for analysis and stored on an HP-9895 floppy disk.

138. In-line filters can be put into the data acquisition system and are designed as gate-type low-pass filters to remove unwanted signals. Filters available to the operator are, 1,000, 2,000, and 5,000 Hz.

139. The computer is primarily used to compute Fast Fourier Transform

(FFT) for phase angle versus frequency and wave velocity versus wavelength (dispersion) plots immediately after the data are obtained. The operator must then decide whether or not the data are acceptable for storage on flexible disks. If they are not, then additional data are collected and analyzed as a separate event or are averaged with previously collected data. When sufficient data are collected for interpretation of the dispersion curve (based on operator experience), the data are stored on a flexible disk and a hard copy made.

140. It is from this hard copy that the operator selects the velocity values that will ultimately be used in the computer analysis for the load-carrying capability of the pavement. The computer analysis on a main-frame computer uses the Air Force-developed PREDICT code.

141. The PREDICT computer code is the second component of the Air Force nondestructive pavement evaluation system. The code uses the field data from the Nondestructive Pavement Testing (NDPT) van, the elastic moduli determined from the field velocity values, to calculate the stresses and strains produced in the pavement as a result of an aircraft wheel load. Stresses and strains are critical locations in the pavement and are compared with fatigue algorithms for the materials to predict the number of cycles to failure for the particular aircraft.

142. The input data required by the PREDICT code are:

a. Type of aircraft for analysis
b. Channelized or nonchannelized traffic analysis
c. Number of material layers composing the pavement
d. Aircraft wheel load and tire pressure
e. Concrete split tensile strength
f. For each material layer:
    (1) Thickness
    (2) Elastic modulus
    (3) Poisson's ratio
    (4) Soil type
    (5) Void ratio
    (6) Degree of saturation
    (7) Plasticity index

143. The aircraft must be specified and selected from the aircraft available in the computer code aircraft library. The aircraft presently in

the library are the A-10, F-4, F-15, F-16, F-105, F-111, FB-111A, T-38, T-43, B-1, B-52, B-747, C-5, C-9A, C-130, C-141, KC-97, and KC-135.

144. The selection of a channelized or nonchannelized traffic analysis will depend on the location of the pavement on the airfield. Different values of a pass-to-coverage ratio are used for the channelized versus nonchannelized sections.

145. The number of layers composing the pavement must be determined from the as-built drawings or previously obtained destructive testing reports. However, some instances will occur when the NDT data from the dispersion curves may indicate a different number of material layers than the reports. An example of this may be a concrete pavement over a subgrade soil. Destructive tests indicate a two-layer system, but NDT may indicate a third layer that would be a compacted subgrade layer just beneath the concrete surface layer.

146. Concrete split tensile data are obtained from destructive test results. This material property is used in the evaluation process to determine the modulus of rupture of the concrete. The equation is given as

$$MR = 1.02T + 210.5 \qquad \text{(A49)}$$

where

MR = modulus of rupture, psi

T = split tensile strength, psi

Calculated tensile stresses at the bottom of the concrete are converted to a percentage of the modulus of rupture and compared to a fatigue algorithm to predict the number of cycles.

147. Material layer thickness, soil type, void ratio, degree of saturation, and plasticity index can be obtained with some minor calculations from the destructive testing reports. Poisson's ratio must be selected as a representative value for the specific material.

148. The elastic modulus for each material layer, as stated earlier, is calculated from the dispersion curves developed in the NDT van.

149. The output of the PREDICT code has been minimized to provide an analysis summary for each pavement section input. The output specifies the number of operations for the concrete or AC surface course and the subgrade material. The number of operations were calculated from the predicted tensile

stress or strain in the surface layer and the subgrade compressive strain.

150. To prepare an allowable gross load table in the format shown in Headquarters, Department of the Air Force (1981), a minimum of three runs of the PREDICT code must be made for each airfield feature and each aircraft evaluated, varying the weights of that aircraft. These varying weights are then plotted versus their respective number of allowable operations, as determined by the code. The curve formed by these points is then used to select permissible aircraft weights at the operation or pass intensity levels corresponding with levels I through IV, as specified in Headquarters, Department of the Air Force (1981).

WES DSM Method (Hall and Alexander 1983)

151. The evaluation method for the DSM procedure is based on correlations between the nondestructive DSM measurements and the computed ASWL as determined on a number of inservice airfield pavements representing a range of pavement types and conditions. DSM is a ratio of dynamic load over deflection obtained with the WES 16-kip vibrator (Hall 1978). The ASWL's were computed from existing Corps of Engineers pavement design procedures, using in place pavement strength measurements determined through test pits and direct sampling procedures.

152. The WES 16-kip vibrator is an electrohydraulic steady-state vibratory loading system. The unit is contained in a 36-ft semitrailer along with supporting power supplies and automatic data recording equipment. A 16,000-lb preload is applied to the pavement with a superimposed dynamic load ranging up to 30,000 lb peak-to-peak. The dynamic load can be applied over a frequency range of 5 to 100 Hz, but the standard test frequency is 15 Hz. The dynamic load is measured with a set of three load cells mounted on an 18-in. diam load plate. Velocity transducers which are located on the load plate and at points away from the plate are calibrated to measure elastic deflection. Test results are recorded on X-Y plotters and a digital printer.

153. Data collected with the WES 16-kip vibrator are the DSM and deflection basins. DSM is obtained from the slope (load/deflection) of the dynamic load versus deflection data obtained by sweeping the force to maximum at a constant frequency of 15 Hz. This slope is taken at the higher force levels. Deflection basins are obtained by measuring deflections at distances of

18, 36, and 60 in. away from the center of the load plate. The deflection ratio Δ_{60}/Δ_{18} is used to determine the radius of relative stiffness ℓ for rigid pavements.

154. The conventional theory used to evaluate military airfield flexible pavements is based on a determination of strength parameters, such as the CBR, moisture, density, classification of materials, and other values, using criteria developed from performance studies. To use the proven performance of the conventional methodology, the nondestructive quantity of the DSM was directly correlated (Green and Hall 1975) to the ASWL, as determined from the standard evaluation procedure based on test-pit measurements. The measured DSM for flexible pavements is corrected to a commom pavement temperature of 70° F, because deflection measurements on AC are sensitive to temperature. A method adopted from the Asphalt Institute (1969) is used to determined the median temperature of the AC layer. This procedure uses the pavement surface temperature at the time of the test plus the previous 5-day air temperatures. This median pavement temperature is then used with relationships developed by WES to correct the measured DSM to 70° F. The temperature-corrected DSM values are used to determine the ASWL using the correlations developed. The ASWL is then converted to AGAL on any desired aircraft at any level of operations (passes) using existing analytical relationships found in the CBR procedure (Headquarters, Departments of the Navy, Army, and Air Force 1978). Overlay thickness requirements for aircraft loads greater than the existing capacity of the pavement can be determined from similar analysis. Once the allowable load is determined, an effective subgrade CBR can be computed. This CBR along with the existing pavement thickness (thickness from existing records or core borings) can be used with CBR procedure to compute AC overlay thickness. PCC overlays for use over flexible pavements cannot be determined with this evaluation.

155. The methodology for NDT evaluation of rigid pavements using the DSM method uses a correlation between the DSM measured at the slab center to the ASWL as determined from standard evaluation procedure based on test-pit measurements. This standard procedure for rigid pavements is based on the Westergaard analysis using material properties such as thickness, subgrade modulus, and flexural strength (Headquarters, Departments of the Army and Air Force 1979).

156. To determine the allowable loading for aircraft having gears with

different geometries, relationships between the loads of these aircraft and the ASWL are used. These relationships are based upon the equivalency of maximum bending stress in the concrete slab. The radius of relative stiffness ℓ is used to interrelate the ASWL to the wheel loads of different geometries through a ratio of the AGAL to the ASWL.

157. The radius of relative stiffness ℓ of a rigid pavement is obtained through deflection basin measurements. A correlation between ℓ determined from nondestructive deflection basin data and ℓ determined by the Westergaard theory gives the relationship between a ratio of deflections measured at points 18 and 60 in. from the center of the load plate as a function of ℓ.

158. The effects of stress repetition levels (aircraft passes) on the AGAL are considered by the use of traffic factors. The traffic factors are a function of the aircraft gear geometry, the lateral distribution of aircraft traffic on the pavement being evaluated, and the traffic volume and are independent of the pavement structure. The AGAL for a specified number of aircraft passes is computed from the equation (Hall 1978)

$$P_G = 0.0189(DSM)(F_L)(T_c) \tag{A50}$$

where

F_L = load factor

T_c = traffic factor

159. Overlays of PCC or AC to strengthen existing PCC pavements are determined from overlay equations from the Corps of Engineers conventional procedure (Headquarters, Departments of the Army and Air Force 1979). These overlay equations consider the condition of the existing slabs, the anticipated degree of cracking to occur in the existing slab, and the structural requirements.

160. The procedure for evaluation of composite pavements is to convert AC overlay and PCC slab to an equivalent thickness of PCC and use the procedure for plain rigid pavement substituting the following equation for the AGAL: $P_G = 0.0172(DSM)(F_L)(T_c)$. The radius of relative stiffness ℓ for a composite pavement cannot be determined from reflection basin measurements. The subgrade modulus k can be estimated from the subgrade soil classification, and ℓ can be computed from the Westergaard analysis.

161. Overlays for composite pavements are determined in a manner similar that for rigid pavements except an equivalent slab concept is used for the composite section.

WES Layered-Elastic Method (Holl and Alexander 1983)

162. The layered-elastic methodology was developed under FAA-sponsored research (Bush 1980b) and was initially developed for light aircraft pavements. It has also been found applicable to heavy aircraft pavements (Alexander 1982). The general approach is to use a linear layered-elastic model with measured deflection basins to predict in situ modulus values for a one- to four-layer pavement system. Different NDT loadings are used to describe the nonlinear, stress-dependent modulus of the subgrade. Allowable aircraft loads and overlay thicknesses are determined using limited tensile strain at the bottom of the asphalt layer and vertical compressive strain at the top of the subgrade for flexible pavements. For rigid pavements, a limiting tensile stress at the bottom of the PCC layer is used.

163. The layered-elastic procedure was demonstrated with data from both the WES 16-kip vibrator (previously described) and a FWD. The FWD used by WES is a Dynatest Model 8000 (15 kip). A dynamic force is applied to the pavement surface by dropping a 440-lb weight onto a set of rubber cushions, resulting in an impulse loading. The applied force and pavement deflections are measured with load cells and velocity transducers. The drop height can be varied from 0 to 15.7 in. to produce an impact force from 0 to 15,000 lb. The load is transmitted to the pavement through an 11.8-in.-diam plate. The signal-conditioning equipment displays the resulting pressure in kilopascals and the maximum peak displacement in micrometres. As many as three displacement sensors may be recorded at one time by this data acquisition equipment.

164. FWD data collected were deflection basin measurements. Displacements were measured on the load plate and at distances of 12, 24, 36, and 48 in. away from the center of the load plate. Since this particular model has only two transducers for deflection basin measurement, the four deflection points were obtained by dropping the weight twice at each location and shifting the transducers to the additional spacings.

165. The computer program BISDEF was developed at WES to determine modulus values for pavement layers. BISDEF uses the Shell BISAR (Headquarters,

Department of the Army and Air Force 1979) multilayered linear elastic program. In this procedure, the thicknesses of the layers are determined from historical data or from cores. Poisson's ratios are assumed and a rigid boundary is placed at a depth of 20 ft. Initial modulus values are assumed for each layer as well as an upper and lower limit for the modulus. The layered-elastic program is used to calculate a deflection basin produced by the loading of the NDT device. The calculated basin is compared to the measured basin. If the basins do not agree, the modulus values are changed through an iterative procedure until a set of modulus values is determined, producing a basin from the layered-elastic theory that matches the basin measured with the NDT device. A match is considered adequate when the sum of the absolute values of the differences in the measured and calculated deflections is less than 10 percent. Hence, the average difference for each deflection is less than plus or minus 2.5 percent. For this study, a modulus value of 250,000 psi was assigned to the asphalt layers to account for seasonally higher temperatures than were encountered during the test period.

166. Allowable load-carrying capacities and required overlay thicknesses were evaluated using the WES-developed computer program AIRPAV. For a particular aircraft (gear configuration, load, pass intensity level, etc.), AIRPAV uses the modulus values determined from BISDEF and the BISAR program to compute stresses (for rigid pavement) and strains (for flexible pavement) that will occur in the pavement system. AIRPAV then calculates the limiting stress or strain values based on present Corps of Engineers design and evaluation criteria. The allowable load for the aircraft is determined by comparing the predicted stress or strain to the limiting value.

167. The evaluation of rigid pavements is based on the tensile stress at the bottom of the slab which is determined as follows.

$$\sigma_{All} = \frac{R}{A + B\left(\text{LOG}_{10}\ \text{COV}\right)} \tag{A51}$$

where

R = PCC flexural strength

A = 0.58901

B = 0.35486

COV = aircraft coverages

The horizontal tensile strain at the bottom of the AC and the vertical

subgrade strain are both considered in the evaluation of flexible pavements. The allowable AC strain criteria used is as follows (Heukelom and Klomp 1962):

$$\varepsilon_{All_{(AC)}} = 10^{-A} \tag{A52}$$

where

$$A = \frac{N + 2.665\left(LOG_{10}\ \frac{E_{AC}}{14.22}\right) + 0.392}{5.0}$$

$N = LOG_{10}$ (aircraft coverages)

E_{AC} = AC modulus

The allowable subgrade strains are computed using the following.

$$N = 10{,}000\left(\frac{A}{\varepsilon_{All_{subg}}}\right)^{B} \tag{A53}$$

where

N = repetitions

A = 0.000247 + 0.000245 log $E_{subgrade}$

B = 0.0658 $(E_{subgrade})^{0.559}$

168. For overlay computations, the required pavement thicknesses are computed by increasing the thickness of the upper layer until the stress or strain criteria are satisfied. AIRPAV accepts as input an initial thickness and uses an iterative procedure to close in on the actual thickness needed to support the aircraft under consideration. AC overlays on AC pavements are simply the difference between the required thickness and the existing AC thickness. Overlays were computed for the PCC pavements using the following.

$$\text{AC overlay} = 2.5\ (Fh_d - C_b h) \tag{A54}$$

$$\text{PCC (partially bonded)} = \sqrt{h_d^2 - C_r h^2} \tag{A55}$$

$$\text{PCC unbonded} = \sqrt[1.4]{h_d^{1.4} - C_r h^{1.4}} \tag{A56}$$

where

F = factor projecting the cracking that may be expected in existing PCC pavements

h_d = required thickness of PCC, in.

C_b = condition factor of existing pavement, ranges between 0.75 and 1.00

h = thickness of existing PCC pavement, in.

C_r = condition factor of existing pavement, ranges between 0.35 and 1.00

WES Evaluation of Load Transfer

169. The ability of joints in PCC slabs to transfer load is measured with the NDT device. The ratio of deflections measured on each side of the joint (deflection of unloaded slab/deflection of loaded slab) is related to joint efficiency or load transfer. The allowable loads determined at the slab centers can be reduced for poor joint transfer using load-reduction factors. These factors are a function of the deflection ratio.

170. This procedure was developed by first relating the deflection ratios to the percent edge stress. The maximum edge stress condition is a free edge with no load transfer. The edge stress is reduced as more load is transferred across the joint. The design use by the Air Force assumes 75-percent-maximum edge stress (25 percent is carried by adjacent slab). Computations were made with both the ILLISLAB program (Tabatabie and Barenberg 1979) and the WESLIQUID (Chou 1981) (both are finite element programs) for a range of pavement thicknesses and subgrade moduli k . By computing the allowable percent of design load at different deflection ratios, a relationship was developed between the deflection ratio and load-reduction factors. The procedure provided for reducing the allowable load determined at the slab center to account for the load-transfer capabilities at the joint. The load-reduction factor falls between 0.75 and 1.00.

APPENDIX B: TEST DATA

This appendix contains test data collected on the five test area pavements at MacDill AFB during the period 27 October-3 November 1982. The data presented herein were furnished by the following participants using the NDT equipment indicated:

Participant	NDT Equipment
Pavement Consultancy Services, Inc	PCS Falling Weight Deflectometer (FWD)
ARE, Inc.	ARE Dynaflect
Dynatest Consulting, Inc.	Dynatest Model 8000 FWD
ERES	Dynatest Model 8000 FWD
Louis Berger International, Inc	Berger Model 2000 Pavement Profiler
Reinard W. Brandley	Dynatest Model 8000 FWD Brandley Cantilever Beam
Waterways Experiment Station	WES 16-kip Vibrator WES 15-kip FWD (Dynatest)

TEST DATA FROM PAVEMENT CONSULTANCY

SERVICES, INC.

Data Collected with PCS Falling

Weight Deflectometer

TABLE 1

MACDILL AIRFORCE BASE TAMPA FLORIDA
Taxiway 33 Deflection measurements (27-10-82)

POSITION-IDENTIFICATION sect-code		time hh.mm	dist. km	DEFLECTIONS (um/10kN) Delta 0	Delta 60	Delta 100	Delta 200	FORCE fwd. x10kN	Q-VALUES (-) Q 60	Q 100	Q 200
CENTRE LINE	1	11.41	0.0	5.9	5.8=	3.7	3.6	10.0	0.983	0.627	0.610
CENTRE LINE	2	11.44	0.023	6.3	6.2(	3.9	3.9	10.0	0.984	0.619	0.619
CENTRE LINE	3	11.45	0.046	5.7)	5.7	4.0	3.9	10.0	1.000(	0.702	0.684
CENTRE LINE	4	11.47	0.069	5.5	5.5)	3.7	3.5)	10.0	1.000	0.673	0.636
CENTRE LINE	5	11.49	0.092	6.4(	5.7	3.7	3.6	10.0	0.891	0.578	0.563
CENTRE LINE	6	11.50	0.116	6.1=	5.7	3.6)	3.6	10.0	0.934	0.590)	0.590
CENTRE LINE	7	11.52	0.139	6.1	6.1	4.0	4.0(	10.0	1.000	0.656	0.656
CENTRE LINE	8	11.53	0.161	6.3	5.4	3.5	3.3	10.0	0.857	0.556	0.524
CENTRE LINE	9	11.55	0.183	6.0	5.7	3.9	3.9	10.0	0.950	0.650	0.650
CENTRE LINE	10	11.56	0.206	6.0	5.7	3.8=	3.8	10.0	0.950	0.633	0.633
LEFT CL	11	12.02	0.0	6.1	5.8	3.9	3.8	10.0	0.951	0.639	0.623
LEFT CL	12	12.03	0.023	6.3	5.8	3.8	3.5	10.0	0.921	0.603	0.556
LEFT CL	13	12.05	0.046	6.2	6.0	3.8	3.8	10.0	0.968=	0.613	0.613=
LEFT CL	14	12.06	0.069	5.6	5.5	3.7	3.6	10.0	0.982	0.661	0.643
LEFT CL	15	12.07	0.092	6.3	5.8	3.6	3.6	10.0	0.921	0.571	0.571
LEFT CL	16	12.09	0.115	6.3	6.3	4.1(	3.9	10.0	1.000	0.651	0.619
LEFT CL	17	12.11	0.137	7.0	6.6	4.4	4.4	10.0	0.943	0.629=	0.629
LEFT CL	18	12.12	0.161	6.0	5.7	3.6	3.5	10.0	0.950	0.600	0.583
LEFT CL	19	12.13	0.183	6.2	5.8	3.7	3.7=	10.0	0.935	0.597	0.597
RIGHT CL	20	12.18	0.0	6.2	6.1	4.0	4.0	10.0	0.984	0.645	0.645
RIGHT CL	21	12.19	0.023	6.4	5.9	3.8	3.7	10.0	0.922)	0.594	0.578)
RIGHT CL	22	12.20	0.046	5.7	5.7	3.7	3.7	10.0	1.000	0.649	0.649(
RIGHT CL	23	12.22	0.069	5.8	5.8	3.9	3.7	10.0	1.000	0.672(	0.638
RIGHT CL	24	12.23	0.092	5.9	5.9	4.2	3.6	10.0	1.000	0.712	0.610
RIGHT CL	25	12.24	0.116	6.8	6.6	4.3	4.1	10.0	0.971	0.632	0.603
RIGHT CL	26	12.26	0.138	5.7	5.6	3.5	3.5	10.0	0.982	0.614	0.614
RIGHT CL	27	12.27	0.161	5.8	5.7	3.8	3.6	10.0	0.983	0.655	0.621
RIGHT CL	28	12.29	0.184	6.0	5.7	3.6	3.6	10.0	0.950	0.600	0.600
S T A T I S T I C S											
85-PERCENTILE VALUES (()				6.4	6.2	4.1	4.0		0.999	0.668	0.649
MEAN VALUES (=)				6.1	5.8	3.8	3.7		0.961	0.629	0.613
15-PERCENTILE VALUES ())				5.7	5.5	3.6	3.5		0.923	0.590	0.577

END

TABLE 5

MACDILL AIRFORCE BASE TAMPA FLORIDA
Taxiway 3-B Deflection measurements (27-10-82)

POSITION-IDENTIFICATION sect-code		time hh.mm	dist. km	DEFLECTIONS (um/10kN) Delta 0	Delta 60	Delta 100	Delta 200	FORCE fwd. x10kN	Q-VALUES Q 60	Q 100	(-) Q 200
CENTRE LINE	1	14.07	0.0	29.3	14.3	7.7	4.0	10.0	0.488	0.263	0.137
CENTRE LINE	2	14.09	0.051	28.8)	16.1	8.5	4.1	10.0	0.559	0.295	0.142
CENTRE LINE	3	14.10	0.102	36.8	16.2	8.4=	4.0	10.0	0.440	0.228	0.109
CENTRE LINE	4	14.12	0.153	27.3	14.6)	8.1	3.7	10.0	0.535	0.297	0.136
CENTRE LINE	5	14.14	0.204	32.1	16.6	9.2	4.5(	10.0	0.517	0.287	0.140(
3.5M LEFT CL	6	14.21	0.0	34.3	19.0	9.8	4.5	10.0	0.554	0.286(	0.131
3.5M LEFT CL	7	14.23	0.026	33.3=	16.9	8.8	4.3	10.0	0.508	0.264	0.129=
3.5M LEFT CL	8	14.24	0.051	37.1(	19.3	9.9	4.6	10.0	0.520	0.267	0.124
3.5M LEFT CL	9	14.26	0.077	38.8	18.3(	9.4(	4.5	10.0	0.472)	0.242	0.116)
3.5M LEFT CL	10	14.27	0.104	33.6	16.8	8.3	4.2=	10.0	0.500	0.247	0.125
3.5M LEFT CL	11	14.29	0.129	31.4	16.1	7.9	4.1	10.0	0.513	0.252=	0.131
3.5M LEFT CL	12	14.31	0.159	32.0	17.4	8.8	4.5	10.0	0.544(	0.275	0.141
3.5M LEFT CL	13	14.32	0.185	30.1	16.9	8.5	4.4	10.0	0.561	0.282	0.146
3.5M LEFT CL	14	14.33	0.211	36.8	19.5	10.3	4.8	10.0	0.530	0.280	0.130
3.5M RIGHT CL	15	14.38	0.0	30.5	16.4=	8.0	4.2	10.0	0.538	0.262	0.138
3.5M RIGHT CL	16	14.40	0.025	34.5	16.4	7.6	4.1	10.0	0.475	0.220)	0.119
3.5M RIGHT CL	17	14.42	0.050	35.0	16.8	8.0	4.3	10.0	0.480	0.229	0.123
3.5M RIGHT CL	18	14.43	0.075	29.8	14.6	6.8	3.9)	10.0	0.490	0.228	0.131
3.5M RIGHT CL	19	14.48	0.101	38.4	16.2	7.6	4.2	10.0	0.422	0.198	0.109
3.5M RIGHT CL	20	14.50	0.126	30.5	14.4	6.9)	3.9	10.0	0.472	0.226	0.128
3.5M RIGHT CL	21	14.52	0.152	25.6	12.1	5.5	3.4	10.0	0.473	0.215	0.133
3.5M RIGHT CL	22	14.53	0.177	30.5	15.3	9.2	4.9	10.0	0.502=	0.302	0.131
3.5M RIGHT CL	23	14.59	0.202	41.5	18.2	8.9	4.5	10.0	0.439	0.214	0.108
S T A T I S T I C S											
85-PERCENTILE VALUES	(()			37.1	18.3	9.5	4.5		0.542	0.286	0.140
MEAN VALUES	(=)			33.0	16.5	8.4	4.2		0.501	0.255	0.129
15-PERCENTILE VALUES	())			28.8	14.6	7.2	3.9		0.461	0.223	0.117

END

TABLE 11

MACDILL AIRFORCE BASE TAMPA FLORIDA
Taxiway 3 Deflection measurements (27-10-82)

POSITION-IDENTIFICATION sect-code		time hh.mm	dist. km	DEFLECTIONS (um/10kN) Delta 0	Delta 60	Delta 100	Delta 200	FORCE fwd. x10kN	Q-VALUES Q 60	Q 100	(-) Q 200
CENTRE LINE	1	15.16	0.0	46.9	24.5	11.3(	4.8	10.0	0.522	0.241	0.102
CENTRE LINE	2	15.18	0.050	48.8	25.6	12.1	5.4	10.0	0.525	0.248	0.111
CENTRE LINE	3	15.19	0.101	42.0	24.3	12.2	5.0)	10.0	0.579	0.290	0.119
CENTRE LINE	4	15.21	0.151	48.5	24.3	11.7	5.1	10.0	0.501	0.241	0.105
CENTRE LINE	5	15.23	0.202	48.9	22.2	11.0	5.3	10.0	0.454(	0.225	0.108
CENTRE LINE	6	15.25	0.253	39.4	22.8	10.5	5.3	10.0	0.579	0.266	0.135
CENTRE LINE	7	15.27	0.303	51.8)	22.4	11.1	5.1	10.0	0.432	0.214(	0.098(
3.5M LEFT CL	8	15.31	0.0	82.4	24.4	10.3=	5.2=	10.0	0.296	0.125	0.063
3.5M LEFT CL	9	15.36	0.025	94.4	25.3	10.0	5.3	10.0	0.268	0.106)	0.056
3.5M LEFT CL	10	15.38	0.050	80.7	26.4(	11.2	5.8	10.0	0.327	0.139	0.072
3.5M LEFT CL	11	15.40	0.075	81.7	29.0	11.7	5.3	10.0	0.355=	0.143=	0.065
3.5M LEFT CL	12	15.41	0.100	78.1	26.2	10.4	5.0	10.0	0.335	0.133	0.064
3.5M LEFT CL	13	15.43	0.126	86.4	22.4	10.4	5.0	10.0	0.259	0.120	0.058
3.5M LEFT CL	14	15.45	0.151	89.9(	26.8	10.6	5.0	10.0	0.298	0.118	0.056
3.5M LEFT CL	15	15.47	0.176	81.8	24.0=	10.5	5.6	10.0	0.293	0.128	0.068
3.5M LEFT CL	16	15.48	0.201	79.5	20.4	9.0	5.2	10.0	0.257)	0.113	0.065
3.5M LEFT CL	17	15.50	0.226	76.8	22.8	9.5)	5.3	10.0	0.297	0.124	0.069
3.5M LEFT CL	18	15.52	0.251	76.5	22.1	10.9	5.4	10.0	0.289	0.142	0.071
3.5M LEFT CL	19	15.54	0.276	70.7	20.9	8.6	5.1	10.0	0.283	0.122	0.072
3.5M LEFT CL	20	15.56	0.301	71.8	22.2	9.0	5.0	10.0	0.309	0.125	0.070
3.5M RIGHT CL	21	16.01	0.0	78.8	24.8	9.6	4.9	10.0	0.315	0.122	0.062
3.5M RIGHT CL	22	16.03	0.025	82.0	24.3	10.1	5.4	10.0	0.296	0.123	0.066
3.5M RIGHT CL	23	16.06	0.050	79.4	23.6	10.0	5.4	10.0	0.297	0.126	0.068
3.5M RIGHT CL	24	16.08	0.076	83.4	25.1	10.2	5.4	10.0	0.301	0.122	0.065
3.5M RIGHT CL	25	16.10	0.101	83.0	25.3	10.4	5.1	10.0	0.305	0.125	0.061
3.5M RIGHT CL	26	16.12	0.126	89.6	27.2	10.7	5.0	10.0	0.304	0.119	0.056
3.5M RIGHT CL	27	16.14	0.152	92.2	27.9	10.6	5.0	10.0	0.303	0.115	0.054)
3.5M RIGHT CL	28	16.16	0.177	94.5	26.4	11.8	5.5(	10.0	0.279	0.125	0.058
3.5M RIGHT CL	29	16.18	0.202	82.9	24.3	10.4	5.6	10.0	0.293	0.125	0.068
3.5M RIGHT CL	30	16.20	0.227	66.3	21.6)	8.8	5.1	10.0	0.326	0.133	0.077
3.5M RIGHT CL	31	16.22	0.252	70.9	25.8	9.8	5.3	10.0	0.364	0.138	0.075=
3.5M RIGHT CL	32	16.24	0.277	72.9=	20.3	7.9	4.3	10.0	0.278	0.108	0.066
3.5M RIGHT CL	33	16.26	0.302	72.5	20.8	8.8	5.1	10.0	0.287	0.121	0.070
S T A T I S T I C S											
85-PERCENTILE VALUES (()				89.8	26.4	11.4	5.5		0.443	0.205	0.096
MEAN VALUES (=)				73.5	24.1	10.3	5.2		0.346	0.150	0.075
15-PERCENTILE VALUES ())				57.2	21.8	9.3	5.0		0.248	0.096	0.054

END

TABLE 17

MACDILL AIRFORCE BASE TAMPA FLORIDA
Apron 1-A-1 Deflection measurements (27-10-82)

POSITION-IDENTIFICATION sect-code		time hh.mm	dist. km	DEFLECTIONS (um/10kN) Delta 0	Delta 60	Delta 100	Delta 200	FORCE fwd. x10kN	Q-VALUES Q 60	Q 100	(-) Q 200
APRON 1-A-1	1	8.38	0.0	19.0)	17.9	12.2	7.5	10.0	0.942	0.642(	0.395
APRON 1-A-1	2	8.40	0.025	19.3	18.7	11.5	5.8	10.0	0.969	0.596	0.301=
APRON 1-A-1	3	8.43	0.050	22.8	21.8=	14.0	7.6=	10.0	0.956	0.614	0.333
APRON 1-A-1	4	8.45	0.075	42.8	40.3	24.3	12.3	10.0	0.942	0.568	0.287
APRON 1-A-1	5	8.49	0.0	27.4	27.6	17.8	10.0	10.0	1.007	0.650	0.365
APRON 1-A-1	6	8.51	0.025	26.6	27.9	17.1	9.4	10.0	1.049	0.643	0.353
APRON 1-A-1	7	8.53	0.050	26.6	24.6	15.8	7.4	10.0	0.925	0.594	0.278
APRON 1-A-1	8	8.54	0.075	36.2	35.9	20.4	12.9	10.0	0.992(	0.564	0.356(
APRON 1-A-1	9	9.00	0.0	31.5	30.5	17.9(	10.9(	10.0	0.968	0.568	0.346
APRON 1-A-1	10	9.07	0.025	24.9=	20.8	14.8=	8.3	10.0	0.835	0.594	0.333
APRON 1-A-1	11	9.09	0.050	29.4	24.2	16.8	7.0	10.0	0.823	0.571=	0.238)
APRON 1-A-1	12	9.10	0.075	32.8(	30.4(	22.1	12.4	10.0	0.927	0.674	0.378
APRON 1-A-1	13	9.12	0.0	26.4	18.9	12.1	5.1	10.0	0.716	0.458	0.193
APRON 1-A-1	14	9.14	0.025	21.0	15.9	11.1	5.5	10.0	0.757	0.529)	0.262
APRON 1-A-1	15	9.15	0.050	19.9	16.3	12.3	5.4	10.0	0.819	0.618	0.271
APRON 1-A-1	16	9.17	0.075	16.6	13.2	9.1	5.0	10.0	0.795)	0.548	0.301
APRON 1-A-1	17	9.19	0.0	22.2	18.3	11.8	4.9)	10.0	0.824	0.532	0.221
APRON 1-A-1	18	9.21	0.025	22.5	15.3)	10.3)	5.3	10.0	0.680	0.458	0.236
APRON 1-A-1	19	9.23	0.050	20.7	18.0	12.4	5.3	10.0	0.870=	0.599	0.256
APRON 1-A-1	20	9.25	0.075	19.9	16.6	11.2	5.4	10.0	0.834	0.563	0.271
S T A T I S T I C S											
85-PERCENTILE VALUES			(()	32.2	30.3	19.1	10.5		0.986	0.638	0.357
MEAN VALUES			(=)	25.4	22.7	14.7	7.7		0.881	0.579	0.299
15-PERCENTILE VALUES			())	18.6	15.0	10.4	4.8		0.777	0.520	0.240

END

TABLE 23

MACDILL AIRFORCE BASE TAMPA FLORIDA
Apron 1-A Deflection measurements (27-10-82)

POSITION-IDENTIFICATION sect-code -		time hh.mm	dist. km	DEFLECTIONS (um/10kN): Delta 0	Delta 60	Delta 100	Delta 200	FORCE fwd. x10kN	Q-VALUES (-) Q 60	Q 100	Q 200
APRON 1-A	1	9.51	0.000	19.3	14.3	10.0	6.1	10.0	0.741	0.518	0.316
APRON 1-A	2	9.53	0.015	17.0	14.5	10.1)	5.8	10.0	0.853	0.594	0.341
APRON 1-A	3	9.55	0.030	16.8	15.5	10.6	6.2	10.0	0.923(	0.631(	0.369
APRON 1-A	4	9.56	0.045	19.3	16.2	11.3	6.0)	10.0	0.839	0.585	0.311
APRON 1-A	5	9.58	0.060	17.0	15.3	10.7	7.0(	10.0	0.900	0.629	0.412
APRON 1-A	6	10.03	0.000	18.1=	15.1	10.4	6.4	10.0	0.834	0.575)	0.354
APRON 1-A	7	10.04	0.015	17.8	15.4	10.5	6.3	10.0	0.865	0.590	0.354
APRON 1-A	8	10.07	0.030	18.8	16.7	11.5	6.7	10.0	0.888	0.612	0.356
APRON 1-A	9	10.09	0.045	18.9	17.1(	11.6	6.1	10.0	0.905	0.614	0.323)
APRON 1-A	10	10.11	0.060	17.9	15.5	10.4	6.4	10.0	0.866	0.581	0.358=
APRON 1-A	11	10.16	0.030	19.0	17.1	11.9	7.9	10.0	0.900	0.626	0.416
APRON 1-A	12	10.18	0.045	18.2	16.4	11.2	6.9	10.0	0.901	0.615	0.379
APRON 1-A	13	10.19	0.060	17.4	15.4	10.8=	7.0	10.0	0.885	0.621	0.402
APRON 1-A	14	10.22	0.000	21.1	18.7	12.8	6.8	10.0	0.886	0.607	0.322
APRON 1-A	15	10.23	0.015	17.3	15.3	10.8	6.3	10.0	0.884	0.624	0.364
APRON 1-A	16	10.24	0.030	18.8	17.2	10.8	6.9	10.0	0.915	0.574	0.367
APRON 1-A	17	10.26	0.045	18.3	15.3	10.6	6.3	10.0	0.836)	0.579	0.344
APRON 1-A	18	10.27	0.060	15.8	14.9	9.9	6.3	10.0	0.943	0.627	0.399(
APRON 1-A	19	10.31	0.000	21.5	18.1	12.7	6.9	10.0	0.842	0.591	0.321
APRON 1-A	20	10.32	0.015	17.8	16.6	11.8(	7.6	10.0	0.933	0.663	0.427
APRON 1-A	21	10.33	0.030	20.4	17.6	11.9	6.4	10.0	0.863	0.583	0.314
APRON 1-A	22	10.35	0.045	19.4(	16.5	11.3	6.4	10.0	0.851	0.582	0.330
APRON 1-A	23	10.36	0.060	16.6)	15.1	10.6	6.8	10.0	0.910	0.639	0.410
APRON 1-A	24	10.39	0.000	17.4	16.1=	11.2	6.1	10.0	0.925	0.644	0.351
APRON 1-A	25	10.40	0.015	16.9	14.9	10.2	5.6	10.0	0.882=	0.604=	0.331
APRON 1-A	26	10.41	0.030	16.1	14.7)	10.1	6.5=	10.0	0.913	0.627	0.404
APRON 1-A	27	10.43	0.045	16.7	14.4	9.8	5.8	10.0	0.862	0.587	0.347
APRON 1-A	28	10.44	0.060	16.8	15.0	10.3	6.4	10.0	0.893	0.613	0.381
S T A T I S T I C S											
85-PERCENTILE VALUES (()				19.6	17.1	11.7	7.0		0.922	0.635	0.397
MEAN VALUES (=)				18.1	15.9	10.9	6.5		0.880	0.605	0.361
15-PERCENTILE VALUES ())				16.6	14.7	10.1	6.0		0.837	0.575	0.325

END

TEST DATA FROM ARE, INC.

Data Collected with ARE Dynaflect

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL. PROJECT NO: AF-8
PAVEMENT ID : TAXIWAY 33, AREA 1 CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	DYNAFLECT READINGS #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
1	0.00	.470	.420	.340	.310	.252	0.	1115	1	1
5	1.00	.330	.300	.237	.213	.186	0.		1	1
9	2.00	.330	.300	.240	.213	.180	0.		1	1
13	3.00	.340	.300	.258	.222	.198	0.	1135	1	1
17	4.00	.390	.360	.320	.267	.234	0.		1	1
21	5.00	.310	.270	.234	.204	.183	0.		1	1
25	6.00	.267	.240	.210	.174	.156	0.	1149	1	1
	MEAN =	.348	.313	.263	.229	.198				
	STD.DEV =	.065	.060	.048	.045	.033				
	COEF.VAR=	18.676	19.064	18.424	19.704	16.800				
	#OF PTS =	7								
2	.12	.147	.147	.138	.126	.126	0.		1	2
6	1.12	.162	.162	.153	.141	.135	0.		1	2
10	2.12	.150	.150	.141	.126	.126	0.		1	2
14	3.12	.162	.162	.159	.150	.141	0.		1	2
18	4.12	.189	.189	.186	.171	.165	0.		1	2
22	5.12	.159	.159	.150	.141	.132	0.		1	2
26	6.12	.138	.138	.129	.123	.114	0.		1	2
	MEAN =	.158	.158	.151	.140	.134				
	STD.DEV =	.016	.016	.018	.017	.016				
	COEF.VAR=	10.257	10.257	12.243	12.201	11.954				
	#OF PTS =	7								
3	.50	.390	.340	.300	.225	.207	0.		2	1
7	1.50	.330	.300	.231	.204	.180	0.	1127	2	1
11	2.50	.300	.255	.222	.186	.171	0.		2	1
15	3.50	.390	.360	.310	.240	.219	0.		2	1
19	4.50	.400	.370	.330	.261	.249	0.		2	1
23	5.50	.243	.213	.192	.159	.144	0.		2	1
27	6.50	.310	.264	.219	.189	.159	0.		2	1
	MEAN =	.338	.300	.258	.209	.190				
	STD.DEV =	.059	.059	.054	.035	.037				
	COEF.VAR=	17.344	19.697	20.988	16.763	19.411				

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID ; TAXIWAY 33, AREA 1

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	D Y N A F L E C T R E A D I N G S #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
4	.62	.162	.156	.153	.144	.135	0.		2	2
8	1.62	.150	.150	.138	.132	.126	0.		2	2
12	2.62	.156	.156	.153	.141	.132	0.		2	2
16	3.62	.168	.168	.162	.153	.147	0.		2	2
20	4.62	.192	.192	.186	.177	.168	0.		2	2
24	5.62	.135	.135	.132	.117	.111	0.		2	2
28	6.62	.150	.150	.141	.132	.123	0.		2	2
	MEAN =	.159	.158	.152	.142	.135				
	STD.DEV =	.018	.018	.018	.019	.018				
	COEF.VAR=	11.268	11.314	11.924	13.382	13.708				
	#OF PTS =	7								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT : TAXIWAY 3B, AREA 2

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	DYNAFLECT READINGS #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
1	0.00	.400	.350	.255	.231	.177	0.	259	3	
3	1.00	.380	.320	.228	.186	.159	0.		3	
5	2.00	.440	.360	.249	.198	.168	0.		3	
7	3.00	.410	.350	.237	.189	.150	0.		3	
9	4.00	.360	.310	.219	.177	.144	0.	313	3	
11	5.00	.340	.264	.186	.156	.129	0.		3	
13	6.00	.390	.340	.225	.198	.168	0.		3	
15	7.00	.480	.400	.320	.234	.198	0.	321	3	
	MEAN =	.400	.337	.240	.196	.162				
	STD.DEV =	.044	.040	.039	.026	.021				
	COEF.VAR=	11.100	11.874	16.100	13.334	13.141				
	#OF PTS =	8								
2	.50	.440	.390	.310	.231	.201	0.		4	
4	1.50	.430	.380	.300	.231	.192	0.	306	4	
6	2.50	.450	.400	.310	.222	.183	0.		4	
8	3.50	.420	.360	.249	.186	.153	0.		4	
10	4.50	.400	.350	.249	.195	.162	0.		4	
12	5.50	.370	.330	.240	.189	.156	0.		4	
14	6.50	.460	.410	.300	.237	.201	0.		4	
	MEAN =	.424	.374	.280	.213	.178				
	STD.DEV =	.031	.029	.032	.022	.021				
	COEF.VAR=	7.310	7.691	11.419	10.382	11.773				
	#OF PTS =	7								
16	.84	.400	.350	.255	.207	.177	0.		5	
	MEAN =	.400	.350	.255	.207	.177				
	STD.DEV =	0.000	0.000	0.000	0.000	0.000				
	COEF.VAR=	0.000	0.000	0.000	0.000	0.000				
	#OF PTS =	1								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID : TAXIWAY 3, AREA 3

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	D Y N A F L E C T R E A D I N G S #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
1	0.00	.790	.570	.360	.237	.180	0.	401	3	
3	1.00	.790	.590	.400	.300	.219	0.		3	
5	2.00	.800	.570	.370	.243	.216	0.		3	
7	3.00	.810	.590	.390	.264	.201	0.		3	
9	4.00	.990	.670	.410	.270	.201	0.		3	
11	5.00	.960	.630	.390	.267	.201	0.		3	
13	6.00	.990	.670	.440	.258	.228	0.	417	3	
15	7.00	.900	.600	.390	.246	.210	0.		3	
17	8.00	.800	.600	.380	.258	.201	0.		3	
19	9.00	.800	.600	.370	.240	.195	0.		3	
21	10.00	.830	.600	.400	.300	.210	0.		3	
	MEAN =	.860	.608	.391	.259	.206				
	STD.DEV =	.083	.035	.022	.026	.013				
	COEF.VAR=	9.687	5.687	5.657	10.115	6.304				
	#OF PTS =	11								
2	.50	.900	.590	.400	.243	.219	0.		4	
22	.62	.900	.600	.380	.225	.189	0.		4	
4	1.50	.990	.700	.460	.320	.240	0.		4	
6	2.50	.960	.670	.430	.300	.225	0.		4	
8	3.50	.790	.580	.380	.258	.198	0.		4	
10	4.50	.580	.490	.370	.252	.228	0.		4	
12	5.50	.900	.640	.420	.300	.219	0.		4	
14	6.50	.900	.630	.410	.300	.222	0.		4	
16	7.50	.810	.600	.380	.258	.207	0.		4	
18	8.50	.770	.550	.350	.240	.183	0.		4	
20	9.50	.810	.580	.370	.249	.195	0.		4	
	MEAN =	.846	.603	.395	.268	.211				
	STD.DEV =	.113	.057	.032	.031	.018				
	COEF.VAR=	13.349	9.505	8.105	11.723	8.572				
	#OF PTS =	11								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID : APRON 1A1, AREA 4

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	DYNAFLECT READINGS #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
26	.55	.450	.430	.390	.350	.310	0.			
	MEAN =	.450	.430	.390	.350	.310				
	STD.DEV =	0.000	0.000	0.000	0.000	0.000				
	COEF.VAR=	0.000	0.000	0.000	0.000	0.000				
	#OF PTS =	1								
1	0.00	.400	.380	.340	.290	.246	0.	1006		A
2	.50	.340	.330	.310	.258	.234	0.			A
3	1.00	.400	.380	.350	.310	.267	0.			A
4	1.50	.500	.490	.450	.390	.350	0.			A
5	2.00	.360	.350	.330	.267	.246	0.			A
	MEAN =	.400	.386	.356	.303	.269				
	STD.DEV =	.062	.062	.055	.053	.047				
	COEF.VAR=	15.411	16.033	15.334	17.392	17.509				
	#OF PTS =	5								
10	.50	.380	.370	.350	.300	.267	0.			B
9	1.00	.430	.420	.390	.370	.320	0.			B
8	1.50	.510	.500	.460	.400	.360	0.			B
7	2.00	.410	.390	.340	.300	.258	0.			B
6	2.50	.340	.340	.330	.261	.231	0.	1017		B
	MEAN =	.414	.404	.374	.326	.287				
	STD.DEV =	.063	.061	.053	.057	.052				
	COEF.VAR=	15.334	15.117	14.224	17.469	18.088				
	#OF PTS =	5								
11	0.00	.430	.410	.380	.310	.285	0.			C
12	.50	.440	.440	.430	.390	.370	0.			C
13	1.00	.580	.500	.400	.300	.261	0.			C
14	1.50	.490	.480	.450	.390	.340	0.			C
15	2.00	.820	.700	.580	.450	.360	0.			C
	MEAN =	.552	.506	.448	.368	.323				
	STD.DEV =	.161	.114	.079	.063	.048				
	COEF.VAR=	29.194	22.516	17.533	17.014	14.802				
	#OF PTS =	5								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID : APRON 1A1, AREA 4

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	DYNAFLECT READINGS #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
20	.50	.400	.380	.350	.270	.258	0.		D	
19	1.00	.460	.430	.390	.330	.300	0.		D	
18	1.50	.410	.400	.370	.320	.270	0.		D	
17	2.00	.490	.490	.440	.360	.300	0.		D	
16	2.50	.400	.370	.360	.320	.267	0.		D	
	MEAN =	.432	.414	.382	.320	.279				
	STD.DEV =	.041	.048	.036	.032	.020				
	COEF.VAR=	9.460	11.659	9.329	10.126	7.051				
	#OF PTS =	5								
21	0.00	.530	.490	.450	.400	.360	0.		E	
22	.50	.350	.340	.320	.258	.204	0.		E	
23	1.00	.560	.500	.420	.310	.273	0.		E	
24	1.50	.440	.400	.370	.330	.300	0.		E	
25	2.00	.560	.510	.390	.300	.267	0.	1047	E	
	MEAN =	.488	.448	.390	.320	.281				
	STD.DEV =	.091	.075	.049	.052	.057				
	COEF.VAR=	18.747	16.659	12.692	16.291	20.138				
	#OF PTS =	5								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID : APRON 1A, AREA 5

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	DYNAFLECT READINGS #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
1	0.00	.620	.560	.480	.400	.350	0.	121	E	1
3	.50	.700	.610	.500	.420	.350	0.		E	1
5	1.00	.550	.500	.410	.360	.310	0.		E	1
7	1.50	.760	.630	.490	.400	.330	0.		E	1
9	2.00	.640	.560	.440	.390	.330	0.		E	1
	MEAN =	.654	.572	.464	.394	.334				
	STD.DEV =	.080	.051	.038	.022	.017				
	COEF.VAR=	12.213	8.863	8.150	5.561	5.010				
	#OF PTS =	5								
2	.06	.520	.500	.440	.380	.320	0.		E	2
4	.56	.580	.560	.480	.430	.350	0.		E	2
6	1.06	.540	.520	.460	.400	.340	0.		E	2
8	1.56	.510	.490	.440	.380	.320	0.		E	2
	MEAN =	.538	.518	.455	.398	.333				
	STD.DEV =	.031	.031	.019	.024	.015				
	COEF.VAR=	5.759	5.982	4.208	5.945	4.511				
	#OF PTS =	4								
10	0.00	.650	.570	.480	.390	.340	0.		I	1
12	.50	.650	.570	.460	.390	.330	0.		I	1
14	1.00	.720	.600	.500	.400	.340	0.		I	1
16	1.50	.750	.640	.530	.430	.350	0.		I	1
18	2.00	.540	.480	.410	.340	.300	0.		I	1
	MEAN =	.662	.572	.476	.390	.332				
	STD.DEV =	.081	.059	.045	.032	.019				
	COEF.VAR=	12.244	10.298	9.465	8.309	5.794				
	#OF PTS =	5								
11	.06	.500	.480	.440	.380	.330	0.		I	2
13	.56	.520	.490	.420	.370	.310	0.		I	2
1	1.06	.560	.550	.500	.420	.350	0.		I	2
17	1.56	.570	.540	.460	.380	.300	0.		I	2
19	2.06	.410	.400	.360	.300	.207	0.		I	2
	MEAN =	.512	.492	.436	.370	.299				
	STD.DEV =	.064	.060	.052	.044	.055				
	COEF.VAR=	12.460	12.144	11.874	11.781	18.406				
	#OF PTS =	5								

MACDILL AIR FORCE BASE
DYNAFLECT MEASUREMENTS

LOCATION : TAMPA, FL.
PAVEMENT ID : APRON 1A, AREA 5

PROJECT NO: AF-8
CLIENT : U.S. AIR FORCE
DATE : 10/82

RDG NO	STATION	D Y N A F L E C T R E A D I N G S #1	#2	#3	#4	#5	TEMP.	TIME	I/E	C/M
20	0.00	.560	.510	.440	.370	.320	0.		M	1
22	.50	.540	.500	.440	.370	.320	0.		M	1
24	1.00	.570	.530	.460	.380	.340	0.	142	M	1
26	1.50	.560	.510	.450	.360	.330	0.		M	1
28	2.00	.550	.490	.420	.350	.300	0.		M	1
	MEAN =	.556	.508	.442	.366	.322				
	STD.DEV =	.011	.015	.015	.011	.015				
	COEF.VAR=	2.051	2.920	3.356	3.115	4.606				
	#OF PTS =	5								
21	.06	.490	.480	.430	.360	.310	0.	140	M	2
23	.56	.560	.540	.490	.390	.330	0.		M	2
25	1.06	.560	.540	.490	.400	.340	0.		M	2
27	1.56	.510	.490	.440	.370	.320	0.		M	2
29	2.06	.500	.490	.440	.340	.310	0.		M	2
	MEAN =	.524	.508	.458	.372	.322				
	STD.DEV =	.034	.029	.029	.024	.013				
	COEF.VAR=	6.415	5.806	6.440	6.418	4.049				
	#OF PTS =	5								

TEST DATA FROM DYNATEST CONSULTING, INC.

Data Collected with Dynatest Model 8000
Falling Weight Deflectometer

Test Area #1: Centerslab tests, morning of Oct. 29.

Input File: TA1-1

Date: OCT 29 1982 Temp: 20.6 C.
Roadway: TEST AREA #1 (20"PCC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 300 600 1200 1800 2400
for d1 d2 d3 d4 d5 d6 d7

Station	Pressure	d1	d2
d3	d4	d5	d6	d7
6.000C		1534	73	67
65	60	49	39	31
6.000C		1551	77	67
64	59	49	39	30
12.000C		1550	69	64
62	57	47	36	28
12.000C		1555	72	65
63	57	47	36	29
18.000C		1559	77	70
67	62	52	42	35
18.000C		1557	77	70
68	63	52	42	35
24.000C		852	39	36
35	31	27	23	18
24.000C		1164	53	49
46	42	35	32	26
24.000C		1570	68	62
61	57	47	39	34
24.000C		1566	60	64
61	56	46	39	33
2.100C		849	42	40
38	35	29	25	23
2.100C		1169	57	52
50	47	38	33	27
2.100C		1562	72	66
63	59	49	40	35
2.100C		1564	78	68
65	61	52	42	36
8.100C		1523	71	63
62	57	45	38	34
8.100C		1516	68	63
62	55	45	37	34
14.100C		1527	67	65
63	59	48	40	33
14.100C		1537	68	66
63	61	49	40	33
20.100C		1541	71	70
69	63	53	44	37
20.100C		1535	87	70
66	62	54	43	39
26.100C		845	39	38
35	32	27	24	21
26.100C		1146	51	48
45	42	35	29	27
26.100C		1539	68	65
61	57	47	39	36
26.100C		1549	69	63
59	55	46	38	34
4.200C		1537	77	71
67	63	52	43	35
4.200C		1540	75	70
66	62	51	43	35
10.200C		1517	71	66
63	58	49	38	31
10.200C		1531	72	67
64	61	50	40	33
16.200C		1524	71	67
63	59	49	37	29
16.200C		1514	73	66
63	59	48	38	29
22.200C		1535	70	64
63	58	46	37	29
22.200C		1520	75	65
63	58	48	36	28
28.200C		1558	69	68
64	59	48	38	31
28.200C		1546	67	66
63	59	48	37	29

Left row of slabs — Center row of slabs — Right row of slabs

Test Area #1: Corner & Edges, afternoon of Oct. 29.

Input File: TA1-2

Date: OCT 29 1982 Temp: 34 C.
Roadway: TEST AREA #1(20"PCC)
Load Radius (mm): 150
Sensor Positions (mm): -200 -300
0 200 300 600 900 -1200 -2400
for d1 d2 d3 d4 d5 d6 d7

See File TA1-1 & Slab Diagram below!

Station	Pressure	d1	d2
d3	d4	d5	d6	d7
6.000A		1557	98	94
85	74	64	83	79
6.000A		1557	90	91
84	73	63	81	86
6.000B		1542	97	86
80	70	62	88	81
6.000B		1541	94	96
79	69	61	97	93
12.000A		1537	85	88
79	69	61	77	77
12.000A		1548	82	83
76	66	58	73	69
12.000B		1541	83	76
71	63	56	81	74
12.000B		1538	83	76
72	66	58	83	77
24.000A		847	55	55
45	40	35	48	47
24.000A		1121	72	75
60	53	47	65	63
24.000A		1534	101	103
78	67	59	85	80
24.000A		1546	97	102
76	65	57	83	77
24.000B		845	54	49
43	39	35	57	41
24.000B		1125	73	66
61	53	45	75	56
24.000B		1536	97	90
82	71	62	102	72
24.000B		1536	100	91
84	72	62	104	73
12.000D		1468	163	161
71	64	57	130	123
12.000D		1435	145	155
70	63	57	124	118
12.000E		1510	173	158
146	128	109	180	86
12.000E		1484	160	149
135	116	100	163	86
12.000F		1522	108	103
96	88	79	100	96
12.000F		1525	106	98
90	83	74	94	91
18.000D		1509	219	277
88	78	67	194	193
18.000D		1513	208	228
86	77	67	187	175
18.000E		1510	153	142
129	112	93	159	129
18.000E		1523	147	136
124	106	91	153	133
18.000F		1533	111	106
10[illegible]	93	85	104	98
1[illegible]30F		1524	102	103
9[illegible]	90	82	101	96
2.100A		1531	101	111
79	70	60	94	89
[illegible].100A		1541	106	109
[illegible]	71	63	92	89
2.100B		1531	135	127
115	98	84	147	63
2.100B		1539	127	123
112	95	81	142	65
14.100A		1515	116	119
73	65	58	100	95
14.100A		1514	110	111
72	63	57	94	88
14.100B		1543	103	91
86	75	65	106	79

```
14.100B      1534     94     89
 84    72    63    102    82
20.100A      1523    128    133
 68    63    55    113    108
20.100A      1521    123    131
 67    62    54    109    105
20.100B      1522    156    134
125   108    92    162     60
20.100B      1522    143    125
117   100    85    152     61
 2.100D      1519    142    155
 70    64    56    125    117
 2.100D      1523    141    153
 70    64    57    122    113
 2.100E      1523    143    133
120   102    87    153     60
 2.100E      1524    140    129
117    99    85    149     63
 2.100F      1500    110    105
 99    91    82    104    101
 2.100F      1499    112    104
 99    90    81    105    100
 8.100D       856     97    107
 43    36    35     86     80
 8.100D      1134    128    141
 56    50    44    111    104
 8.100D      1463    167    172
 71    63    56    142    134
 8.100D      1474    164    173
 71    63    56    142    134
 8.100E       829     81     73
 70    60    51     87     40
 8.100E      1111    110     99
 92    79    68    115     54
 8.100E      1552    145    136
126   106    91    159     69
 8.100E      1550    149    136
127   107    92    157     66
 8.100F       840     69     65
 63    57    50     66     63
 8.100F      1125     92     89
 84    78    69     88     85
 8.100F      1538    120    120
113   103    92    116    114
 8.100F      1526    123    119
112   101    91    115    111
20.100D      1501    332    437
 78    69    60    297    276
20.100D      1500    228    254
114    99    87    205    193
20.100E      1509    135    132
122   110    99    141    128
20.100E      1555    176    126
117   105    95    133    127
20.100F      1502    165    158
164   152   135    160    157
20.100F      1499    166    158
153   142   127    157    156
26.100D       846    114    123
 38    35    31     98     91
26.100D      1125    158    170
 49    44    40    132    124
26.100D      1485    210    227
 59    54    50    176    165
26.100D      1474    207    228
 61    55    50    177    166
26.100E       845    117    106
 38    84    68    128     38
26.100E      1131    149    136
124   105    88    161     52
26.100E      1533    193    179
164   140   116    215     68
26.100E      1533    194    179
169   140   117    219     68
26.100F       839     53     53
 48    45    40     49     47
26.100F      1115     71     68
 62    57    51     64     61
26.100F      1557     98     87
 85    78    70     88     85
26.100F      1557     97     74
 82    73    68     81     74
10.200A      1508     92    100
 85    74    55     85     81
10.20JA      1513     90     97
 83    71    63     82     78
10.200B      1538     90     85
 78    69    62     95     85
10.200B      1540     93     82
 76    68    63     93     86
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16.200A      1523    120    138
 64    58    52    111    105
16.200A      1529    126    136
 64    59    53    109    103
16.200F      1527    123    115
104    98    79    135     61
16.200B      1525    126    115
107    93    79    134     65
22.200A      1501     92     99
 80    69    62     83     78
22.200A      1496     93     96
 78    68    59     81     76
22.200B      1527     88     81
 75    65    57     93     76
22.200B      1521     88     80
 76    65    57     91     76
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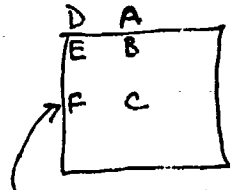


No joint transfer obtained during this round of tests for point F!

Test Area #1: Corners & Edges (Cont'd), afternoon of Oct. 29.

Date: OCT 29 1982 Temp: 31 C
Roadway TEST AREA #1(20"PCC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 300 600 900 -199 -299

```
Station     Pressure      d1      d2
   d3     d4     d5     d6     d7

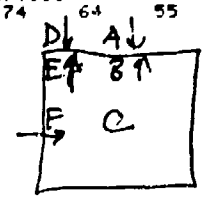
 4.200D      1527    179    195
165   145    126    169    163
 4.200D      1518    174    189
162   143    123    165    161
 4.200E      1522    174    176
163   144    125    191    163
 4.200E      1527    178    173
161   142    124    187    166
 4.200F      1479    155    147
141   135    122    146    145
 4.200F      1475    144    142
137   128    119    141    137
16.200D      1534    160    156
138   126    109    144    140
16.200D      1533    157    161
140   120    110    142    135
16.200E      1492    153    147
138   123    108    161    146
16.200E      1466    156    146
138   124    109    161    146
16.200F      1406    138    134
130   123    112    132    129
16.200F      1488    138    132
128   119    110    130    127
28.200D      1516    152    168
138   138    101    138    133
28.200D      1526    146    188
135   117     98    134    129
28.200E      1520    159    152
138   120    104    166    129
28.200E      1519    154    144
132   117    100    158    132
28.200F      1524    139    144
137   125    114    140    135
28.200F      1531    142    142
133   121    110    135    131
```

Test Area #1: All tests, morning of Nov. 1.

Input File: AREA#1

Date: NOV 1 1982 Temp: 30.5 C
Roadway: TEST AREA #1 E20"PCC]
Load Radius (mm) 150
Sensor Positions (mm):
0 200 305 610 914 1524 2438

Station	Pressure	d1	d2
d3 d4	d5	d6	d7
2.200C	833	43	42
39 37	34	29	18
2.200C	1524	73	71
67 62	56	47	32
2.200C	1530	74	72
67 62	57	47	31
2.200B	850	65	66
50 43	38	29	19
2.200B	1535	109	117
87 74	65	48	31
2.200B	1540	107	114
83 71	63	46	28
4.100C	838	47	45
42 40	36	31	19
4.100C	1528	[illegible]	79
73 67	62	51	34
4.100C	1527	80	78
72 68	61	51	35
4.100B	844	84	87
35 31	29	25	17
4.100B	1511	135	143
59 50	47	37	25
4.100B	1514	136	148
60 54	49	39	27
4.100F	847	78	80
42 38	33	26	17
4.100F	1512	139	155
75 67	59	46	31
4.100F	1514	138	150
74 65	58	45	31
4.100E	841	116	121
43 40	36	29	20
4.100E	1512	176	194
91 75	68	53	33
4.100E	1515	179	187
88 77	69	53	35
6.000C	836	46	41
39 36	34	27	18
6.000C	1525	74	70
66 60	55	45	29
6.000C	1531	75	72
67 61	55	45	30
6.000B	838	64	65
48 41	37	27	18
6.000B	1510	107	116
83 71	63	46	29
6.000B	1513	106	110
82 71	62	46	35
13.200C	833	45	44
41 37	35	29	20
13.200C	1530	73	74
70 66	60	49	33
13.200C	1531	74	72
68 62	57	46	31
13.200B	836	59	60
52 46	40	31	19
13.200B	1529	100	108
90 81	68	52	32
13.200B	1532	98	104
87 79	67	51	30
14.100C	832	42	40
38 36	32	27	21
14.100C	1528	74	69
66 59	54	44	31
14.100C	1536	75	70
66 60	55	44	31
14.100B	839	78	82
36 32	30	24	17
14.100B	1514	132	143
60 53	50	38	29
14.100B	1519	133	146
60 53	49	38	29
15.000C	833	44	42
39 36	33	27	19
15.000C	1537	79	72
68 61	55	44	32
15.000C	1540	76	72
68 62	56	45	31
15.000B	843	68	71
44 38	33	25	16
15.000B	1523	117	124
76 67	59	44	29
15.000F	1528	117	124
77 67	59	45	31
23.200C	830	43	39
37 34	31	25	17
23.200C	1535	71	67
64 58	53	41	28
23.200C	1543	74	70
66 59	53	43	29
23.200B	836	79	91
38 34	30	24	16
23.200B	1506	139	166
66 58	50	39	26
23.200B	1512	136	179
63 55	49	37	26
25.100C	838	43	39
38 34	31	26	16
25.100C	1526	79	73
65 59	53	43	28
25.100C	1531	76	74
68 61	56	45	30
25.100B	836	76	82
30 27	23	19	13
25.100B	1499	138	157
53 48	43	35	24
25.100B	1503	133	149
51 48	42	35	24
25.100F	815	70	76
35 31	27	22	15
25.100F	1490	125	135
61 54	47	35	24
25.100F	1496	123	136
60 53	47	37	26
25.100E	826	82	85
41 37	33	25	18
25.100E	1509	136	150
80 74	62	48	32
25.100E	1515	202	140
77 63	60	46	28
27.000C	821	43	39
37 34	33	26	15
27.000C	1515	75	69
67 63	56	44	28
27.000C	1537	76	70
67 63	56	44	29
27.000B	837	68	70
43 38	34	26	16
27.000B	1509	114	123
74 64	56	48	25
27.000B	1513	305	123
74 64	55	42	29



Joint Transfer obtained on all corners & edges by placing FWD in the shown direction.

SHUNTVAL in VOLTS 7.07545
STEP 3 "T2"

TA2->156 ft, 8' Lt of Centerline
Station 7+[illegible]+[illegible]
TEST POINT FOR ALL!

Ld.(lbs)	9059	9143	13888	13888
Df1(mil)	5.4	5.2	8.7	8.7
Df2(mil)	3.7	3.6	6.1	6.1
Df3(mil)	2.4	2.3	3.9	4.0
Df4(mil)	1.6	1.5	2.7	2.7
Df5(mil)	1.1	1.0	1.9	1.9
Df6(mil)	.9	.9	1.5	1.5
Df7(mil)	4.5	4.3	7.1	7.1
Area(in)	21.4	21.4	21.7	21.8
dsm(kPa)	1679	1759	1603	1603
DSM(kPa)	1378			

TA2->60
Station 7+[illegible]+[illegible]
TEST POINT FOR ALL!

_d.(lbs)	18229	18201	23613	23473
Df1(mil)	11.8	11.9	16.3	16.3
Df2(mil)	8.3	8.4	11.7	11.6
Df3(mil)	5.4	5.5	7.6	7.6
Df4(mil)	3.6	3.6	5.1	5.1
Df5(mil)	2.5	2.6	3.5	3.6
Df6(mil)	1.9	2.0	2.6	2.6
Df7(mil)	9.8	9.8	13.6	13.5
Area(in)	21.8	21.9	22.0	22.0
dsm(kPa)	1549	1536	1449	1437
DSM(kPa)	1175			

Date: OCT 30 1982 Temp 33.6 C
Roadway: TEST AREAS 3,3 &4/MCOIL
Time: 14 50

Load Radius [a] = [illegible]m 150mm
r's=0 12 24 36 48 60 200mm

Results, printed out in lbs. & mils for "T2", Test Area #2.

Input File: TA2-1

Test Area #2: Summary of FWD tests (test drop only) run Oct. 29.

NOTE: A = Cl. 1 Cracks near plate.
B = Cl. 2 Cracks near plate

Date: OCT 29 1982 Temp: 30 C
Roadway: TEST AREA #2 (11"AC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 300 600 900 1200 1500
(in feet)

Station	Pressure	d1				
	d3	d4	d5	d6	d7	
-0.000A		1503	407	349		
	302	210	145	102	74	
-100.000A		1482	410	309		
	264	186	128	91	67	
-200.000		1480	462	356		
	302	200	134	93	68	
-300.000		1480	444	341		
	286	189	127	90	69	
-400.000		1454	585	427		
	342	202	25	85	61	
-500.000A		1482	457	335		
	266	156	96	67	49	
-600.000A		1484	450	350		
	296	196	125	90	65	
-700.000B		1470	515	420		
	359	235	161	108	77	
-50.100A		1507	350	261		
	235	164	11	95	64	
-150.100A		1	245	293		
	25F	176	121	86	65	
-250.100		1507	302	258		
	222	154	106	75	56	
350.100A		1483	315	275		
	239	169	119	86	64	
450.100A		1496	303			
	225	160	119	86	6	
550.100		1500			224	
	200	153	116	81	66	
650.100		1486			276	
	244	183	133		72	
200A		1443	471	347		
	285	186	123	87	66	
100.200A		1446	475	319		
	256	159	103	73	55	
200.200		1430	547	392		
	2??	195	124	9?	75	
300.200		1456	500	763		
	39?	184	119	83	62	
400.200		1464	349	292		
	24?	164	113	82	61	
500.200A		1487	360	293		
	251	151	97	66	50	
600.200A		1497	394	341		
	293	35	142	101	75	
700.2..		1423	613	486		
	394	241	149	100	72	

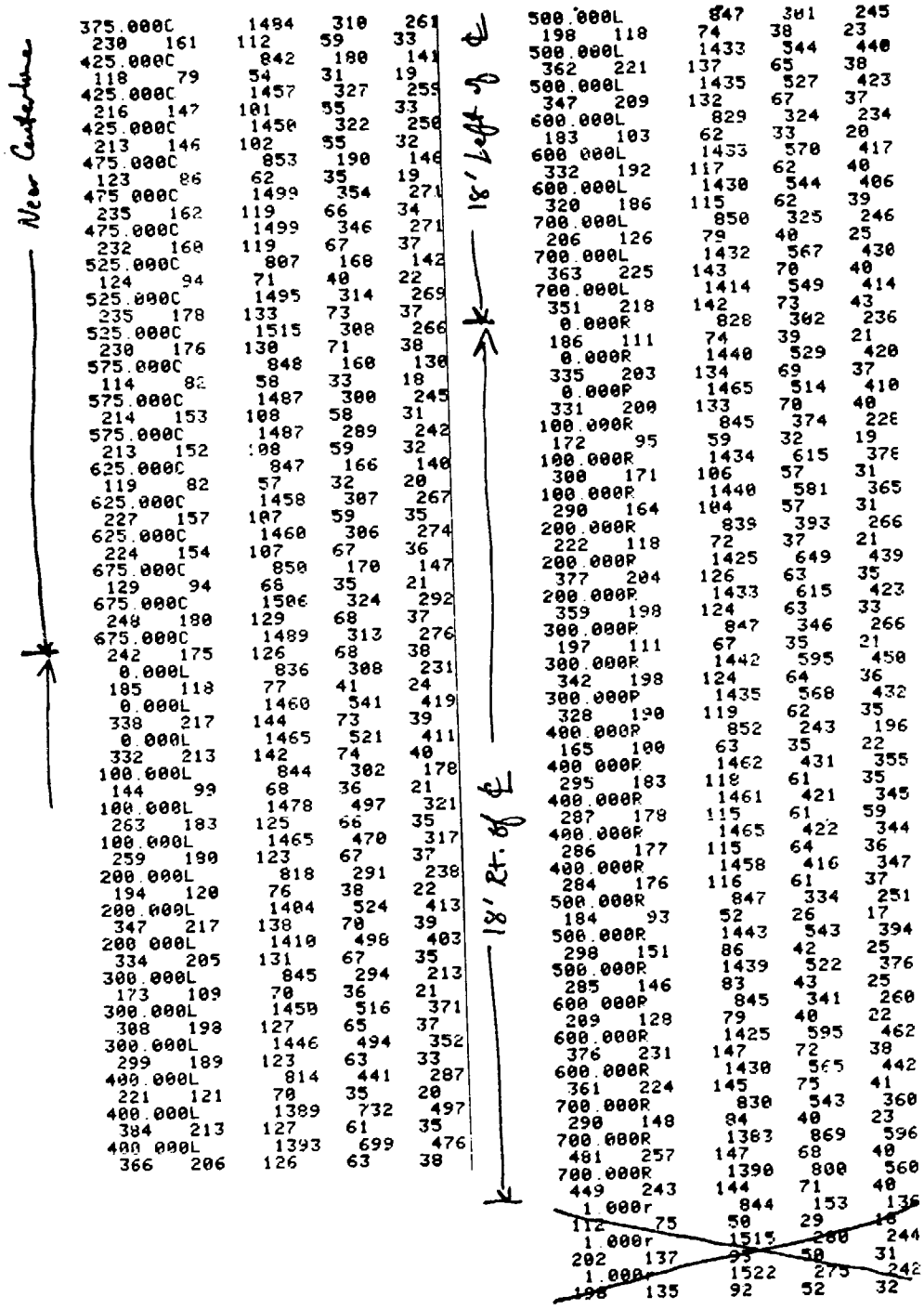
← 15' Right of Cable
← 1' Rt. of Cable
← 15' Left of Cable
New Centerline

Input File: AP#

Test Area #2: All tests run Nov. 1.

Date: NOV 1 1982 Temp: 33 C
Roadway: TEST AREA #2 (11" AC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 305 610 914 1524 243?
(in feet)

Station	Pressure	d1				
	d3	d4	d5	d6	d7	
25.000C			829	159	133	
	114	81	58	34	19	
25.000C			1470	295	250	
	218	154	110	62	35	
25.000C			1482	291	244	
	214	151	108	65	34	
75.000C			833	182	154	
	133	90	63	34	19	
75.000C			1488	339	293	
	250	168	116	61	34	
75.000C			1482	333	284	
	248	165	114	61	37	
125.000C			852	202	165	
	139	93	63	35	20	
125.000C			1455	373	294	
	259	173	119	62	33	
125.000C			1453	363	293	
	254	170	118	62	35	
175.000C			817	208	171	
	145	94	62	32	18	
175.000C			1443	378	309	
	269	178	118	61	35	
175.000C			1444	371	303	
	265	175	116	60	35	
225.000C			857	155	137	
	117	81	56	33	18	
225.000C			1468	297	254	
	223	156	108	59	36	
225.000C			1467	286	247	
	217	150	105	57	29	
275.000C			853	173	149	
	130	92	65	35	20	
275.000C			1472	323	277	
	243	173	122	67	35	
275.000C			1469	317	27?	
	23?	169	123	65	35	
325.000C			819	181	153	
	135	92	64	35	20	
325.000C			1450	333	288	
	246	173	118	63	35	
325.000C			1457	329	282	
	243	169	117	63	36	
375.000C			843	169	143	
	125	86	64	33	18	
375.000C			1477	314	269	
	235	165	114	61	34	



375.000C		1484	310	261	500.000L		847	381	245	625.000C		1458	307	267
230	161	112	59	33	198	118	74	38	23	227	157	107	59	35
425.000C		842	180	141	500.000L		1433	544	440	625.000C		1460	306	274
118	79	54	31	19	362	221	137	65	38	224	154	107	67	36
425.000C		1457	327	255	500.000L		1435	527	423	675.000C		850	170	147
216	147	101	55	33	347	209	132	67	37	129	94	68	35	21
425.000C		1450	322	250	600.000L		829	324	234	675.000C		1506	324	292
213	146	102	55	32	183	103	62	33	20	248	180	129	68	37
475.000C		853	190	146	600.000L		1433	570	417	675.000C		1489	313	276
123	86	62	35	19	332	192	117	62	40	242	175	126	68	38
475.000C		1499	354	271	600.000L		1430	544	406	0.000L		836	308	231
235	162	119	66	34	320	186	115	62	39	185	118	77	41	24
475.000C		1499	346	271	700.000L		850	325	246	0.000L		1460	541	419
232	168	119	67	37	206	126	79	40	25	338	217	144	73	39
525.000C		807	168	142	700.000L		1432	567	430	0.000L		1465	521	411
124	94	71	40	22	363	225	143	70	40	332	213	142	74	40
525.000C		1495	314	269	700.000L		1414	549	414	100.000L		844	302	178
235	178	133	73	37	351	218	142	73	43	144	99	68	36	21
525.000C		1515	308	266	0.000R		828	302	236	100.000L		1478	497	321
230	176	130	71	38	186	111	74	39	21	263	183	125	66	35
575.000C		848	160	130	0.000R		1440	529	420	100.000L		1465	470	317
114	82	58	33	18	335	203	134	69	37	259	190	123	67	37
575.000C		1487	300	245	0.000R		1465	514	410	200.000L		818	291	238
214	153	108	58	31	331	209	133	70	40	194	120	76	38	22
575.000C		1487	289	242	100.000R		845	374	228	200.000L		1404	524	413
213	152	108	59	32	172	95	59	32	19	347	217	138	70	39
625.000C		847	166	140	100.000R		1434	615	378	200.000L		1410	498	403
119	82	57	32	20	300	171	106	57	31	334	205	131	67	35
625.000C		1458	307	267	100.000R		1440	581	365	300.000L		845	294	213
227	157	107	59	35	290	164	104	57	31	173	109	70	36	21
625.000C		1460	306	274	200.000R		839	393	266	300.000L		1458	516	371
224	154	107	67	36	222	118	72	37	21	308	198	127	65	37
675.000C		850	170	147	200.000R		1425	649	439	300.000L		1446	494	352
129	94	68	35	21	377	204	126	63	35	299	189	123	63	33
675.000C		1506	324	292	200.000R		1433	615	423	400.000L		814	441	287
248	180	129	68	37	359	198	124	63	33	221	121	70	35	20
675.000C		1489	313	276	300.000R		847	346	266	400.000L		1389	732	497
242	175	126	68	38	197	111	67	35	21	384	213	127	61	35
0.000L		836	308	231	300.000R		1442	595	458	400.000L		1393	699	476
185	118	77	41	24	342	198	124	64	36	366	206	126	63	38
0.000L		1460	541	419	300.000R		1435	568	432					
338	217	144	73	39	328	190	119	62	35					
0.000L		1465	521	411	400.000R		852	243	196					
332	213	142	74	40	165	100	63	35	22					
100.000L		844	302	178	400.000R		1462	431	355					
144	99	68	36	21	295	183	118	61	35					
100.000L		1478	497	321	400.000R		1461	421	345					
263	183	125	66	35	287	178	115	61	59					
100.000L		1465	470	317	400.000R		1465	422	344					
259	190	123	67	37	286	177	115	64	36					
200.000L		818	291	238	400.000R		1458	416	347					
194	120	76	38	22	284	176	116	61	37					
200.000L		1404	524	413	500.000R		847	334	251					
347	217	138	70	39	184	93	52	26	17					
200.000L		1410	498	403	500.000R		1443	543	394					
334	205	131	67	35	298	151	86	42	25					
300.000L		845	294	213	500.000R		1439	522	376					
173	109	70	36	21	285	146	83	43	25					
300.000L		1458	516	371	600.000R		845	341	260					
308	198	127	65	37	209	128	79	40	22					
300.000L		1446	494	352	600.000R		1425	595	462					
299	189	123	63	33	376	231	147	72	38					
400.000L		814	441	287	600.000R		1430	565	442					
221	121	70	35	20	361	224	145	75	41					
400.000L		1389	732	497	700.000R		830	543	360					
384	213	127	61	35	290	148	84	40	23					
400.000L		1393	699	476	700.000R		1383	869	596					
366	206	126	63	38	481	257	147	68	40					
					700.000R		1390	800	560					
					449	243	144	71	40					
					1.000r		844	153	136					
					112	75	50	29	18					
					1.000r		1515	280	244					
					202	137	93	58	31					
					1.000r		1522	275	242					
					198	135	92	52	32					

Input File: #2-500

Test Area #1: All tests run laterally across runway at Station #500 on Nov. 1, 82

NOTE:
r = right of centerline
l = left of centerline.

Date: NOV 1 1982 Temp: 37 C
Roadway: ACROSS TAXIWAY (T.A.#2)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 305 610 914 1524 2438

(in ft.) right (r) or left (l) to CL

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
1.000r	849	150	130	106	72	49	28	19
1.000r	1511	277	235	195	133	90	51	32
1.000r	1513	278	240	197	134	92	52	32
4.0001	850	183	152	127	77	47	25	17
4.0001	1468	336	277	236	141	87	45	32
4.0001	1466	329	270	231	138	84	45	31
8.0001	848	235	176	142	80	48	25	17
8.0001	1437	430	311	257	143	86	46	36
8.0001	1434	416	301	248	139	82	47	34
12.0001	850	236	204	139	79	41	25	18
12.0001	1437	424	345	252	127	76	48	35
12.0001	1436	409	336	241	120	73	46	34
16.0001	844	347	232	162	83	46	27	20
16.0001	1423	58	377	276	139	76	47	33
16.0001	1423	553	363	264	134	75	47	34
21.0001	836	434	285	213	90	47	31	22
21.0001	1391	691	450	339	147	77	51	38
21.0001	1395	643	427	325	145	76	49	36
26.0001	813	532	369	231	84	45	28	23
26.0001	1381	909	530	340	131	78	46	39
26.0001	1385	841	499	318	127	77	49	40
31.0001	823	445	312	224	104	55	31	547
31.0001	1394	714	510	360	170	90	55	1738
31.0001	1396	681	488	348	167	92	58	1747
1.000r	862	161	138	112	75	51	30	20
1.000r	1498	295	241	203	135	92	54	34
1.000r	1488	293	239	201	133	90	53	35
4.000r	853	158	128	108	74	51	31	19
4.000r	1474	289	230	201	133	91	54	32
4.000r	1475	284	229	198	133	91	54	33
8.000r	863	204	168	134	79	48	27	18
8.000r	1514	377	307	239	139	84	44	28
8.000r	1516	369	296	233	137	83	45	30
12.000r	857	203	155	127	72	45	24	16
12.000r	1454	367	281	230	131	82	44	29
12.000r	1449	356	272	222	126	80	42	28
16.000r	860	233	166	133	77	46	25	19
16.000r	1448	410	286	234	135	78	43	31
16.000r	1450	399	281	228	131	79	45	32
21.000r	849	335	239	184	90	50	31	22
21.000r	1422	544	382	295	144	84	50	33
21.000r	1429	525	371	285	142	84	52	34
26.000r	857	336	288	219	110	61	32	23
26.000r	1426	564	468	363	183	105	58	42
26.000r	557	188	160	121	62	38	22	18
26.000r	1122	411	323	261	133	80	45	32
26.000r	1440	540	438	344	176	104	59	42
26.000r	1439	528	430	338	173	103	58	40
31.000r	1101	651	429	328	155	67	44	37
31.000r	1392	789	507	393	189	83	58	49
31.000r	534	260	175	134	65	33	22	18
31.000r	1101	565	358	286	137	66	44	38
31.000r	832	405	277	211	103	51	33	31
31.000r	1400	728	486	376	180	84	59	53
31.000r	1401	709	476	368	178	82	57	35

Input File: TA3-1

Test Area #3 ; All tests run Oct. 29.

NOTE:
A = Cl. 1 Cracks near plate
B = Cl. 2 — " —

Date: OCT 29 1982 Temp: 32 C
Roadway: TEST AREA #3 (5.5"AC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 300 600 900 1200 1500
(in 74.)

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
50 100	1513	718	644	533	341	211	132	88
50 100	1509	672	585	489	333	195	130	88
150 100B	851	440	366	305	176	105	67	47
150 100B	1134	554	459	336	225	136	90	63
150 100B	1476	725	631	596	284	180	110	81
150 100B	1476	709	596	489	296	177	121	87
250 100	1448	909	703	556	333	210	131	84
250 100	1471	823	635	514	314	205	132	90
350 100	1528	775	676	593	372	225	136	83
350 100	1538	731	633	549	349	215	136	89
450 100	1500	654	5..	491	288	168	104	71
450 100	1510	619	544	459	278	169	108	76
550.100B	853	557	425	345	190	106	65	45
550.100B	1095	693	530	431	243	141	90	63
550.100B	1409	913	705	599	326	187	119	83
550.100B	1434	897	653	557	323	198	122	87
650.100B	1385	965	802	597	296	165	108	76
650.100B	1427	862	722	553	277	172	118	87
750 100	1431	899	645	507	280	176	120	82
750 100	1494	791	595	459	263	171	118	84
750.100	1521	626	544	472	297	182	121	84
750 100	1521	587	506	427	274	173	117	84
950 100	872	475	384	305	160	92	59	42
950.100	1125	569	463	366	201	120	81	61
950.100	1504	736	624	500	271	161	106	75
950.100	1503	718	584					

4' Rt. of Centerline

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
2458 26n	160	108	78					
200	804	987	705					
526 226	99	53	35					
200	1087	1035	74[illegible]					
557 252	121	73	57					
200	1387	1274	90[illegible]					
703 321	156	92	67					
200	1383	1202	87[illegible]					
669 310	155	96	70					
100 200	1385	1289	93[illegible]					
732 330	156	96	72					
100 200	1387	1061	78[illegible]					
602 287	153	106	82					
200.200	1389	1263	87[illegible]					
622 243	110	76	63					
200 200	1392	1043	72[illegible]					
527 225	122	89	73					
300 200	1393	1484	105[illegible]					
797 323	140	81	61					
300.200	1405	1252	89[illegible]					
681 301	148	92	69					
400.200	820	973	66					
501 198	80	43	3.					
400.200	1091	1117	77[illegible]					
594 253	112	66	48					
400 200	1411	1391	102[illegible]					
764 334	151	89	63					
400 200	1415	1343	98[illegible]					
755 331	154	93	67					
500 200	1370	1577	112[illegible]					
811 325	141	90	59					
500 200	1393	1331	95[illegible]					
701 309	153	97	72					
600 200	1364	1635	116[illegible]					
878 379	173	97	68					
600.200	1356	1382	99[illegible]					
771 356	183	113	82					
700 200	1403	1223	89[illegible]					
653 304	148	91	68					
700 200	1416	1050	78[illegible]					
589 283	158	106	82					
800 200	801	741	49[illegible]					
354 146	73	48	39					
800 200	1055	838	56[illegible]					
407 182	98	68	55					
800 200	1377	1035	72[illegible]					
529 241	128	87	68					
800.200	1364	999	68.					
518 241	133	94	74					
900 200	134	1228	83[illegible]					
585 230	107	72	58					
900.200	1399	1045	70[illegible]					
510 218	116	83	66					
1000.200	1388	1124	78[illegible]					
575 239	114	73	57					
1000.200	1366	969	67[illegible]					
504 228	125	87	68					
0.000A	1413	1305	94[illegible]					
692 295	141	88	67					
0 000A	1426	1103	79[illegible]					
605 281	150	98	76					
100.000	1375	1654	118[illegible]					
884 329	124	74	63					
100.000	1384	1239	89[illegible]					
667 273	131	98	76					
200 000	1365	1387	170[illegible]					
2706 325	155	92	67					
200.000	1375	1084	81[illegible]					
585 322	141	93	83					
300.000	937	800	57[illegible]					
475 214	104	60	42					
300.000	1105	921	68[illegible]					
535 251	128	82	58					
300.000	1422	1154	92[illegible]					
716 328	171	106	73					
300.000	1432	1114	86[illegible]					
683 318	170	106	77					

15' Rt of Centerline

12' Left of Centerline

400.000B		1387	1534	1154
878	39	176	96	68
400.000B		1400	1301	972
742	344	170	104	75
500.000B		1389	1604	1062
795	328	148	85	62
500.000B		1406	1282	377
639	282	149	99	74
600.000A		1391	1442	976
754	317	148	92	71
600.000A		1407	1187	845
629	284	150	102	79
700.000A		818	801	555
392	154	76	54	43
700.000A		1079	918	645
467	200	108	77	61
700.000A		1395	1124	815
608	266	142	99	78
700.000A		1389	1077	781
579	259	144	102	83
800.000		1404	1148	852
635	287	179	87	68
800.000		1405	975	697
543	259	139	94	76
900.000		1378	1287	868
650	248	114	74	60
900.000		1393	1076	730
553	229	121	84	68
1000.000		1391	1213	895
646	276	132	84	65
1000.000		1384	990	709
526	241	131	91	73

Input File: AR#3-1

Test Area #3: All tests
run. Nov. 1.,

Date: NOV 1 1982 Temp 38 C
Roadway: TEST AREA #3 (5.5"AC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 305 610 914 1524 2438
(2 Ft.)

Station	Pressure	d1	d2
d3	d4 d5	d6	d7
25.000C	858	503	384
299 160	92	40	36
25.000C	1469	811	559
490 266	156	67	51
25.000C	1472	772	600
468 259	156	71	42
75.000C	861	378	299
254 158	99	48	23
75.000C	1506	648	511
429 265	169	79	41
75.000C	1500	626	499
416 259	168	82	46
125.000C	845	372	298
251 156	99	45	27
125.000C	1462	651	519
437 275	173	79	44
125.000C	1460	626	490
420 263	168	80	46
175.000C	866	391	323
270 164	99	42	24
175.000C	1527	695	548
529 291	180	75	42
175.000C	1522	673	511
527 280	171	79	43
225.000C	860	413	337
285 176	107	47	30
225.000C	1492	721	580
503 300	182	77	50
225.000C	579	230	186
152 93	58	31	19
225.000C	858	372	289
241 147	93	44	28
225.000C	1133	501	390
327 202	127	60	70
225.000C	1493	728	545
462 283	178	81	47
275.000C	873	344	285
240 151	96	45	24
275.000C	1143	442	371
305 193	123	60	74
275.000C	1543	607	516
425 269	172	78	42
325.000C	864	361	300
260 168	109	46	25
325.000C	1137	461	378
325 211	136	61	32
325.000C	1519	628	522
448 289	187	82	42
375.000C	839	553	419
337 200	118	44	23
375.000C	1447	952	675
567 333	203	90	3.
375.000C	1447	896	686
543 325	200	86	48
425.000C	858	366	249
201 131	91	54	31
425.000C	1504	674	438
371 246	170	100	48
425.000C	1506	658	439
365 244	171	100	53
475.000C	851	482	352
280 167	102	45	27
475.000C	1451	870	637
496 293	182	78	31
475.000C	1463	828	575
473 287	183	78	48
525.000C	867	391	332
280 170	102	43	24
525.000C	1505	699	602
501 303	185	80	54
525.000C	1513	678	573
484 295	183	84	48
575.000C	856	462	347
274 151	93	45	23
575.000C	1478	798	563
471 263	165	79	32
575.000C	1454	768	581
462 263	167	85	67
625.000C	834	516	382
296 159	95	44	26
625.000C	1417	934	645
529 282	174	81	48
625.000C	1407	1183	611
506 260	177	85	48
625.000C	832	467	352
271 150	96	48	27
625.000C	1445	815	582
507 273	172	81	44
625.000C	1421	815	606
500 273	174	82	49
675.000C	831	549	390
294 149	86	43	25
675.000C	1417	930	642
486 257	152	74	46
675.000C	1423	866	607
468 246	154	80	48
725.000C	863	363	293
240 147	92	45	25
725.000C	1513	655	513
442 261	162	81	42
725.000C	1506	634	462
415 229	160	88	48
775.000C	846	441	343
251 137	87	44	25
775.000C	1463	768	567
428 228	151	76	45
775.000C	1463	732	522
410 220	147	78	47
825.000C	844	442	354
270 144	81	41	23
825.000C	1438	722	585
452 248	145	76	43
825.000C	1454	700	570
434 245	150	78	43
875.000C	871	362	292
241 150	96	43	24
875.000C	1503	657	512
431 266	171	79	39
875.000C	1512	642	487
414 258	168	78	44
925.000C	862	316	257
216 136	88	44	25
925.000C	1500	567	460
393 246	159	79	46
925.000C	1502	544	429
371 236	155	79	46
975.000C	844	359	303
236 143	93	45	25

975.000C		1478	698	508
417	254	164	80	45
975.000C		1456	601	484
397	244	160	80	46
0.000R		791	1011	681
467	170	80	38	21
0.000R		1367	1415	956
700	281	139	70	39
0.000R		1377	1302	878
656	276	145	74	44
100.000R		806	843	601
403	151	75	44	28
100.000R		1376	1135	849
606	256	135	76	47
100.000R		1381	1106	792
580	257	143	85	49
200.000R		800	923	629
427	151	75	42	25
200.000R		1364	1200	952
624	246	129	75	46
200.000R		1377	1174	803
584	239	134	81	49
300.000R		809	906	657
169	193	87	38	24
300.000R		1368	1297	927
683	296	145	71	43
300.000R		1366	1201	885
641	287	148	77	77
500.000R		794	1010	715
508	203	94	37	23
500.000R		1364	1404	892
721	295	148	68	40
500.000R		1369	1305	849
565	283	150	75	46
500.000R		813	796	553
383	152	83	45	25
500.000R		1372	1262	929
645	273	147	76	45
500.000R		1373	1240	869
647	275	148	79	45
600.000R		797	1104	802
577	236	108	39	24
600.000R		1361	1483	974
813	352	173	74	44
600.000R		1365	1367	925
726	337	175	83	49
700.000R		806	906	592
429	190	97	46	29
700.000R		1356	1277	848
629	295	159	83	52
700.000R		1369	1169	786
588	283	159	86	49
800.000R		811	740	520
367	157	82	40	26
800.000R		1375	1077	750
545	249	148	75	45
800.000R		1377	988	690
518	238	140	78	48
900.000R		804	933	631
444	182	84	35	24
900.000R		1375	1297	884
519	261	131	64	40
900.000R		1382	1182	788

Input File: AR#3-2

(cont'd) (Vol. 1)

Test Area #3

Date: NOV 1 1982 Temp 36.5 C
Roadway: TEST AREA #3 (5.5"AC)
Load Radius (mm): 150
Sensor Positions (mm):
0, 200, 305, 610, 914, 1524, 2438

(in μ)

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
0.000L	800	980	680					
480	183	89	40	22				
0.000L	1370	1318	887					
672	274	140	74	43				
0.000L	1379	1186	826					
616	258	141	74	44				
100.000L	706	1195	779					
513	169	72	42	29				
100.000L	1370	1445	1014					
680	235	112	74	50				
100.000L	1381	1284	945					
620	229	117	78	49				
200.000L	815	880	587					
398	143	70	40	26				
200.000L	1396	1234	822					
561	226	116	66	41				
200.000L	1412	1185	799					
548	256	233	66	39				
300.000L	810	803	573					
415	158	79	40	25				
300.000L	1436	1179	893					
1506	253	125	64	36				
300.000L	1446	1122	815					
639	258	137	72	48				
400.000L	794	1047	720					
508	189	78	38	21				
400.000L	1367	1479	990					
738	302	139	61	39				
400.000L	1372	1377	924					
701	302	153	72	46				
500.000L	794	1000	656					
436	151	65	32	23				
500.000L	1376	1350	932					
628	244	122	59	41				
500.000L	1380	1243	1408					
595	248	137	74	48				
600.000L	798	914	614					
412	144	67	36	25				
600.000L	1374	1280	870					
616	244	127	70	44				
600.000L	1373	1192	790					
583	248	138	80	48				
700.000L	796	831	564					
398	146	66	35	24				
700.000L	1379	1151	782					
561	237	125	68	44				
700.000L	1374	1076	747					
541	240	135	77	48				
800.000L	784	796	556					
389	146	67	35	25				
800.000L	1374	1106	809					
566	234	122	66	45				
800.000L	1379	1072	862					
537	234	130	76	49				
900.000L	808	792	547					
356	127	58	32	23				
900.000L	1386	1061	766					
502	201	104	59	40				
900.000L	1387	981	708					
485	205	113	66	42				
1000.000L	819	653	456					
334	126	58	33	21				
1000.000L	1388	944	659					
496	209	110	62	40				
1000.000L	1390	888	629					
474	211	121	71	45				

SHUNT [illegible] in VOLTS= 7.07E STEP
3

I3 0+62 10.5' Lt. Centerline.

TR2-/2 96
Station ~~50+01~~
BGN T3

Ld.(lbs)	7997	8154	12914	~~12942~~
Df1(mils)	22.1	18.9	28.2	[illegible]
Df2(mils)	10.1	8.8	14.3	[illegible]
Df3(mils)	3.6	3.3	5.6	5.6
Df4(mils)	1.4	1.6	2.7	2.8
Df5(mils)	.9	.1	1.8	1.9
Df6(mils)	.9	.9	1.6	1.7
Df7(mils)	14.7	12.6	19.9	19.1
Area(in)	13.8	14.2	14.7	14.9
dsm(kpi)	362	431	443	462
DSM(kpi)	524			

TR2-/2 100
Station ~~50+01~~
BGN T3

Ld.(lbs)	17198	17237	22121	22042
Df1(mils)	35.9	35.2	45.8	43.9
Df2(mils)	18.1	18.0	23.9	23.4
Df3(mils)	7.4	7.5	9.6	9.8
Df4(mils)	3.5	3.8	4.[illegible]	4.9
Df5(mils)	2.4	2.6	3.2	3.4
Df6(mils)	2.1	2.2	3.7	2.8
Df7(mils)	25.1	14.7	32.7	31.4
Area(in)	15.1	15.3	15.6	15.7
dsm(kpi)	479	490	483	502
DSM(kpi)	547			

Prev cmt-t3,temp=34.5 L Oct.30,1982.

Results, printed out in lbs. & mils for "T3", Test Area #3.

$d = 150\ mm\ (5.91")$

r's = 0", 12", 24", 36", 48", 60" & 200mm

Df1 Df2 Df3 Df4 Df5 Df6 Df7

Input File: AR#4-2

Test Area # 4: A few select points from Oct. 30.

Note: E = edge
I = interior
C = corner

Date: 19821030 Temp 34
Roadway TEST SECT #4 (COMPOSITE)
Load Radius (mm) 150
Sensor Positions (mm)
0 200 305 610 914 1219 1524

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
~Sta.	11 230E	1450	328	335	239	130	137	107	81
35A	11 100I	1459	316	183	180	152	127	104	84
	11 320E	1453	295	190	216	168	132	102	81
	12 320C	1524	347	259	203	157	124	96	74
~Sta.	12 230E	1458	287	202	226	175	135	103	81
150A	12 100I	1464	326	201	191	157	132	107	86
	13 220E	1447	343	360	170	137	112	92	71
	41 320C	1440	479	450	203	165	135	107	81
~Sta.	41 230E	1550	378	385	198	157	170	102	81
35D	41 220E	1476	330	363	180	147	114	91	74
~Sta.	42 230E	1478	447	493	208	168	135	107	84
150D	42 100I	1459	269	251	239	203	168	137	109
~Sta.	31 230E	1479	434	445	236	191	152	122	97
75C	31 100I	1456	305	284	254	211	173	142	114
~Sta	32 320C	1439	576	577	315	254	203	145	114
225C	32 230E	1473	384	395	252	208	165	127	94
	32 100I	1468	220	211	201	175	147	120	99
	32 220E	1452	363	305	225	190	147	117	91
Sta. 350	10	1438	244	221	215	173	140	112	91

These FWD points were read in by hand from test results which were only printed out. All unneeded "drops" & test points are eliminated from this file.

Input File: AREA#4

Test Area #4: All tests run Nov. 1. Planes covered most of the area, so only points from Sta.'s 0 - 50' were run.
NOTE: Tart = Test Point T4 A, B, C, D, E & F, as below.

Date: NOV. 1 1982 Temp [illegible] 33-
Roadway TEST AREA #4 (COMPOSITE) C
Load Radius (mm) 150
Sensor Positions (mm)
0 200 305 610 914 1524 2438

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
	4 000T	527	[illegible]	68	64	55	45	28	15
	4 000T	516	[illegible]	58	66	57	47	32	17
	4 000T	827	129	131	[illegible]	94	79	52	28
	4 000T	830	130	119	110	96	79	52	28
	4 000T	1087	174	157	146	127	105	69	37
	4 000T	1091	173	158	147	127	107	68	36
	4 000T	1455	230	209	193	156	139	90	45
	4 000T	1458	229	206	193	166	139	90	45
	4 000T	536	79	72	69	64	47	31	18
	4 000T	533	80	72	70	63	46	31	18
	4 000T	842	133	117	113	102	76	50	29
	4 000T	841	131	119	114	104	79	52	29
	4 000T	1104	174	158	152	130	105	69	39
	4 000T	1104	174	159	153	140	105	69	38
	4 000T	1478	223	211	200	183	139	90	48
	4 000T	1472	227	212	201	183	139	90	48
	[illegible]	849	137	127	[illegible]	105	86	54	[illegible]
	50 5000	1104	179	167	156	138	111	71	[illegible]
	50 5000	1458	234	218	203	178	142	92	4[illegible]
	50 5000	1459	233	216	202	179	141	90	46
	50 500B	836	159	166	121	98	[illegible]	43	25
	50 500B	1098	203	210	159	129	102	63	35
	50 500B	1452	369	275	[illegible]	181	137	83	47
	50 500B	1459	369	273	208	169	134	83	47

Approx. Sta. 50 E → Test Point "T4" ↑

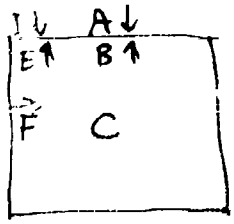
← Approx Sta. 20 A →|← Approx Sta. 50 B →|← Approx. Sta. 50 D →

50 400C	845	140	125
117 90	83	53	29
50 400C	1105	184	166
156 131	109	73	39
50 400C	1452	240	212
201 171	143	94	48
50 400C	1453	239	211
200 170	141	94	48
50 400B	829	195	205
118 98	80	53	30
50 400B	1085	245	255
153 128	104	68	40
50 400B	1469	325	338
201 166	136	87	50
50 400B	1471	321	340
199 165	134	86	50
50 400E	843	224	244
119 96	78	50	31
50 400E	1094	282	304
149 120	96	62	38
50 400E	1453	370	401
195 157	126	91	51
50 400E	1458	365	399
189 152	122	78	50
50 200C	831	202	16
141 111	84	54	32
50 200C	1105	267	221
187 146	111	72	42
50 200C	1503	351	298
249 196	148	93	55
50 200C	1508	349	298
245 190	144	93	52
50 200B	824	169	170
136 107	83	51	28
50 200B	1099	217	219
177 139	108	64	38
50 200B	1456	290	293
235 185	143	85	50
50 200B	1456	283	288
233 182	141	84	49
20 100C	858	145	147
132 105	84	56	27
20 100C	1129	310	201
180 143	114	72	40
20 100C	1470	406	260
238 191	151	94	50
20 100C	1469	406	269
237 189	150	94	51
20 100B	839	239	243
143 110	84	53	28
20 100B	11 9	304	304
197 149	115	68	36
20 100B	1440	402	395
269 198	149	91	47
20 100B	1442	405	397
265 198	149	89	46
20 300C	842	158	1
123 109	88	58	29
20 300C	1115	207	182
170 144	116	77	39
20 300C	1468	279	236
226 191	155	99	50
20 300C	1464	272	235
225 190	154	99	51
20 300B	849	188	197
120 99	79	52	31

Near smaller forces in A.C. ← Approx Sta. 20 C

At 9 depths

20.300B	1112	245	260
158 129	105	69	39
20.300B	1469	326	332
209 173	139	87	51
20 300B	1465	327	339
204 168	136	86	50
20 300c	830	179	170
150 125	99	61	32
20.300c	1087	232	215
194 159	126	78	39
20.300c	1440	312	280
258 212	169	104	51
20 300c	1436	307	283
254 209	166	101	51
20 300c	841	169	160
143 120	94	59	31
20.300c	1092	228	213
191 158	126	77	39
20.300c	1448	299	287
254 209	166	102	50
20.300c	1439	302	277
252 208	165	101	49
20 300C	839	174	162
143 9	95	59	31
20.300c	1093	230	214
191 159	125	77	39
20 300c	1439	301	289
251 208	164	100	50
20 300c	1435	307	283
253 206	166	104	51
20.300d	870	154	144
136 113	93	60	31
20 300d	1157	203	192
179 147	121	79	41
20 300d	1575	268	247
238 198	160	105	53
20 300d	1528	270	253
237 197	161	103	52
20 300f	866	156	182
171 142	112	66	32
20 300f	1131	251	233
216 177	140	84	41
20 300f	1467	331	304
285 234	196	110	51
20 300f	1456	330	306
284 234	125	111	54
20 300g	860	200	
153 120	92	55	
20 300g	1113	2	
197 149	114	7	
20 300g	1457		
259 197	152		
20 300g	1463		
259 197	152	90	



↑↓ = Direction of Sensor

Input File: TA5-1

Test Area #5: All tests run, morning & evening of Oct. 29, 1982.

[Centerslab Tests] = C

Date: OCT 29 1982 Temp: 26.2 C
Roadway: TEST AREA #5 (10.5"PCC)
Load Radius (mm): 150
Sensor Positions (mm):
0 200 300 600 1200 1800 2400
0 12 24 36 48 60

Slab #	Station	Pressure	d1	d2	d3	d4	d5	d6	d7
E1	5 010C	1510	232	220	209	183	135	101	44
	-5 010C	1517	234	218	209	182	133	100	
	8 030C	1529	234	226	215	192	142	89	
H2	8 020C	1533	235	227	217	193	142	90	44
	12 030C	840	130	133	116	101	71	48	21
	12 030C	1142		162	156	135	95	6	30
L3	12 030C	1538	234	223	210	181	127	88	40
	-12 030C	1535	233	223	210	181	126	87	41
	3 040C	1523	259	256	238	202	173	79	52
	3 040C	1521	267	252	237	200	131	78	51
C4	-3 040C	1523	267	253	239	201	134	80	53
	7 050C	1515	261	260	239	207	142	88	59
G5	-7 050C	1504	261	250	238	205	141	88	58
	11 060C	1506	241	224	221	190	129	81	50
K6	-11 060C	1508	240	232	221	189	129	81	52
	14 070C	1524	210	201	194	166	112	74	47
N7	14 070C	1527	207	200	187	163	111	73	45
	6 080C	1509	248	45	231	202		88	
F8	-6 080C	1514	250		231	203	141	93	
	10 090C	846	175	4	118	103	70	44	
J9	10 090C	1178	246		59	50	45	53	41
	10 090C	1498	273	256	242	196	127	87	52
	-10 090C	1492	274	254	214	186	98	67	56
	14 100C	1501	209	204	189	165	116	75	50
N10	-14 100C	1507	207	201	188	164	115	76	50
	1 110C	1522	258	240	239	210	151	96	57
A11	-1 110C	1516	255	251	234	217	153	97	61
	1 120C	1494	240	271	214	191	131	82	53
E12	-1 120C	1496	238	230	215	189	130	82	50
	5 130C	840	152	147	140	120	79	47	25
I13	-9 130C	1128	209	196	188	161	106	64	37
	9 130C	1481	274	257	251	213	143	85	50
	-9 130C	1500	278	267	252	218	145	86	54
	13 140C	1499	290	275	221	197	141	97	66
M14	-13 140C	1487	242	243	219	195	140	96	66
	5 150C	828	134	128	122	106	74	47	
E15	5 150C	1114	179	170	163	142	98	62	40
	5 150C	1521	238		212	185	127	81	
	-5 150C	1513	235		213	184	128	81	50
	9 160C	1509	201	194	182	160	113	75	50
I16	-9 160C	1513	199	193	179	158	112	73	48
	13 170C	1512	220	217	203	176	124	79	50
M17	-13 170C	1506	220	215					

Input File: TA5-2

NOTE:
See below for location of tests on each slab.
[Pos. F not run w Joint Efficiency]

Date: OCT 29 1982 Temp: 2 C
Roadway: TEST AREA #5 10 PCC)
Load Radius (mm): 150
Sensor Positions (mm): -200 -300
0 200 300 600 900 -1200 -1500

	Station	Pressure	d1	d2	d3	d4	d5	d6	d7
	5 00A	1464	437	482	135	118	94	374	347
E1	5 010A	1469	417	462	130	114	97	354	325
	5 010B	1465	448	792	356	279	214	507	115
	5 010B	1454	426	367	334	261	199	479	129
	5 010C	1488	229	230	215	189	161	223	213
	5 010C	1497	214	214	204	173	148	207	200
	5 010D	1455	658	762	113	99	88	572	528
	5 010D	1452	647	714	118	105	93	650	519
	5 010E	1442	745	616	560	436	332	870	151
	5 010E	1430	691	603	556	436	326	780	152

Input File: TA5-2b

Date: OCT 29 1982 Temp: 28 C
Roadway: TEST AREA #5
Load Radius (mm): 150
Sensor Positions (mm): ~~-200~~ ~~-300~~
0 200 300 600 900 ~~-100~~ ~~-200~~

Station	Pressure	d1	d2
d3	d4	d5	d6	d7
5 010F		1475	384	390
383	352	312	374	364
5 010F		1477	374	379
366	339	303	359	379
8 020A		1451	481	550
129	110	95	414	381
8 020A		1463	468	534
132	113	97	395	366
8 020B		1487	461	402
365	287	218	529	129
8 020B		1467	435	360
348	269	204	499	137
12 030D		852	375	424
81	71	58	324	304
12 030D		1123	450	504
128	111	90	389	367
12 030D		1449	546	591
198	168	139	471	454
12 030D		1442	540	590
199	167	137	464	429
12 030E		848	394	352
324	262	203	451	131
12 030E		1113	462	406
379	305	238	553	204
12 030E		1443	543	484
451	365	282	617	283
12 030E		1439	536	483
448	361	279	608	288
12 030F		846	195	192
183	168	149	189	183
12 030F		1117	241	240
226	204	183	234	227
12 030F		1494	305	303
285	253	229	295	297
12 030F		1492	303	301
282	257	227	291	283
3 040A		1462	547	635
126	109	92	462	420
3 040A		1473	526	616
131	112	95	445	402
3 040B		1461	538	465
418	318	237	608	136
3 040B		1470	516	442
396	299	223	580	142
7 050D		1427	980	1129
182	156	138	918	852
7 050D		1425	978	2280
188	162	138	910	821
7 050E		1434	745	665
627	507	386	840	277
7 050E		1431	717	623
598	502	367	803	298
7 050F		1473	511	426
418	380	303	414	405
7 050F		1468	412	405
395	359	314	397	387
11 060A		1485	296	439
176	145	117	339	314
11 060B		1489	385	425
183	151	22	326	304
11 060B		1461	397	341
317	246	189	172	205
11 060B		1462	377	325
296	232	177	439	215
11 060C		1512	230	223
209	184	153	217	309
11 060C		1508	316	209
195	159	143	202	195
14 070D		1444	569	631
213	177	145	506	468
14 070D		1439	563	621
214	177	145	494	458
14 070E		442	633	569
530	426	333	786	538
14 070E		1445	617	553
520	411	321	825	139
14 070F		1504	332	331
324	303	274	324	313
14 070F		1494	324	321
312	299	260	312	302
6 080D		1437	821	1229
160	137	115	760	691
6 080D		1436	800	1339
158	136	115	729	708
6 080E		1442	766	700
661	528	420	886	336
6 080E		1439	728	665
629	506	398	836	350
6 080F		1474	433	427
416	379	339	422	410
6 080F		1474	416	405
392	356	315	401	390
10 090A		832	238	264
118	96	77	207	191
10 090A		1100	297	329
167	135	107	255	238
10 090A		1458	379	414
233	186	148	328	305
10 090A		1468	385	414
234	187	149	326	304
10 090B		823	261	226
208	163	126	295	80
10 090B		1120	321	281
257	201	155	360	134
10 090B		1454	406	358
357	278	201	460	199
10 090B		1460	403	355
324	255	197	453	197
10 090C		853	125	120
114	101	87	118	115
10 090C		1123	161	153
146	128	108	152	148
10 090C		154	214	206
196	171	144	203	195
10 090C		1492	210	204
192	168	142	201	194
14 100D		1452	667	722
240	203	165	574	521
14 100D		1449	616	648
247	209	170	603	510
14 100E		1450	690	652
577	465	370	781	212
14 100E		1446	671	627
571	452	355	768	222
14 100F		1487	315	321
304	280	250	302	292
14 100F		1496	303	300
288	265	236	288	281
1 110A		1481	428	502
243	200	160	466	352
1 110A		1474	406	450
243	198	160	359	333
1 110B		1477	448	398
368	297	233	504	174
1 1108		1475	425	375
349	278	219	478	184
5 1200		1443	671	771

H2 L3 C4 G5 K6 N7 F8 J9 N0 A11

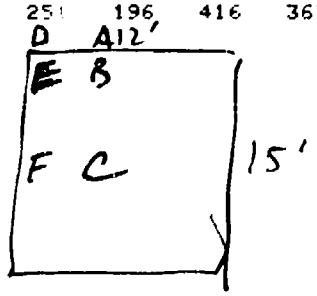
E12

187	159	136	596	542
5.120D		1438	666	771
179	152	129	601	536
5.120E		1445	703	613
503	430	352	838	195
5.120E		1432	690	597
575	461	347	798	197
5.120E		1442	413	395
384	345	304	392	379
5.120E		1445	387	379
365	327	285	374	362
9.130A		849	268	299
170	133	104	233	216
9.130A		1125	329	365
241	188	144	285	266
9.130A		1455	414	453
323	246	190	358	335
9.130A		1454	410	452
318	249	190	356	333
9.130B		832	310	267
243	185	137	354	87
9.130B		1467	494	426
386	296	221	536	211
9.130B		1466	478	415
375	287	212	541	214
9.130C		849	146	139
171	114	94	137	132
9.130C		1478	241	237
221	190	156	236	226
9.130C		1470	239	231
215	184	152	231	217
9.130D		832	349	392
229	187	148	314	290
9.130D		1448	525	575
435	336	262	483	440
9.130D		1452	525	574
427	336	264	471	438
9.130E		834	408	360
335	267	203	494	110
9.130E		1450	591	517
489	393	304	685	253
9.130E		1445	584	473
486	389	304	655	255
9.130F		1496	313	313
295	263	230	312	303
9.130F		1502	305	302
285	254	220	301	293
13.140A		1475	434	507
318	256	197	379	353
13.140A		1464	420	474
330	255	197	366	336
13.140B		1481	397	351
326	261	205	434	375
13.140B		1477	382	337
314	251	196	416	363

I13

M14

E15, I16 & H17 from Unit 1.



TEST DATA FROM DRES CONSULTANTS, INC.

Data Collected with Dynatest Model 8000

Falling Weight Deflectometer

Input File: AR#5-1

Test Area #5: All tests run, morning of Nov. 1.

NOTE: See direction of Sensors & location of test points on Slabs below!

Date: NOV 1 1982 Temp: 22.5 C
Roadway: TEST AREA #5 [10.5"PCC]
Load Radius (mm): 150
Sensor Positions (mm):
0 200 305 610 914 1524 2438
0 8 12 24 36 60 90

Slab

Station	Pressure	d1	d2	d3	d4	d5	d6	d7
5.010A	1461	501	611					
121	105	88	62	44				
5.010A	1461	476	531					
124	107	92	64	38				
5.010C	1521	227	224					
208	181	152	105	67				
5.010C	1518	219	212					
201	174	146	101	66				
5.010B	1458	479	702					
117	99	86	60	37				
5.010B	1461	467	536					
122	105	90	63	41				
5.010D	1425	773	953					
131	113	95	68	45				
5.010D	1434	758	1074					
132	114	97	71	45				
5.010E	1431	783	1018					
[illegible]	122	102	71	42				
010E	1431	777	846					
147	124	107	74	44				
5.010F	1460	440	[illegible]					
299	230	173	103	37				
5.010F	1474	475	459					
291	224	171	102	40				
5.150F	848	256	284					
74	61	50	34	25				
5.150F	1153	309	349					
[illegible]	103	82	53	[illegible]				
5.150F	1547	380	[illegible]					
182	148	119	74	[illegible]				
5.150F	1547	367	445					
184	151	120	79	[illegible]				
5.150A	855	249	[illegible]					
93	[illegible]	61	41	[illegible]				
5.150A	1129	304	[illegible]					
141	115	92	61	34				
5.150A	1479	373	420					
200	160	127	78	44				
5.150A	1481	367	414					
195	157	124	77	43				
5.150C	852	120	[illegible]					
109	93	79	55	34				
5.150C	1138	161	152					
146	124	104	72	45				
5.150C	1504	211	205					
193	165	138	92	59				
5.150C	1507	212	202					
190	163	136	91	58				
5.150B	843	220	247					
96	80	64	42	26				
5.150B	1124	271	298					
153	122	97	61	35				
5.150B	1473	334	374					
251	173	136	83	46				
5.150B	1476	329	364					
299	173	138	83	45				
5.150D	835	484	393					
222	157	125	80	36				
5.150D	1111	463	502					
288	212	168	107	50				
5.150D	1451	555	1433					
403	283	220	141	63				
5.150D	1442	552	1081					
386	282	223	139	64				
5.150D	836	398	440					
198	160	129	80	37				
5.150D	1108	468	496					
267	211	185	107	51				
5.150D	1442	543	584					
357	273	223	139	61				
5.150D	1438	548	601					
359	274	222	137	61				
5.150E	838	321	274					
176	143	111	68	30				
5.150E	1154	382	4					
244	194	155	97	42				
5.150E	1523	461	[illegible]					
346	261	204	127	56				
5.150E	1522	459	483					
340	269	205	133	58				
160A	850	197	223					
112	87	69	42	23				
9.160A	1487	308	339					
221	174	136	81	43				
9.160A	1496	306	332					
227	172	134	81	44				
9.160C	848	102	9					
92	81	67	47	28				
9.160C	1506	185	179					
168	143	121	84	51				
9.160C	1506	185	176					
168	144	121	84	51				
9.160B	847	202	226					
105	84	67	42	25				
9.160B	1491	315	343					
217	168	131	79	43				
9.160B	1495	309	337					
216	167	130	79	45				
13.170C	844	113	108					
103	88	74	53	34				
13.170C	1497	206	190					
183	156	130	87	56				
13.170C	1504	201	191					
182	156	130	86	56				
13.170E	844	336	297					
172	136	115	63	30				
13.170E	1489	416	436					
311	250	198	116	54				
13.170E	1481	420	437					
318	247	194	116	55				
13.170D	848	286	313					
136	109	86	53	28				
13.170D	1472	437	462					
292	224	177	107	51				
13.170D	1481	436	461					
297	227	180	110	54				
13.170F	832	176	236					
144	109	85	50	25				
13.170F	1529	291	318					
270	200	153	92	44				
13.170F	1533	289	311					
259	200	152	88	43				
2.030A	847	251	285					
64	55	47	75	22				
2.030A	148[illegible]	[illegible]99	443					
140	115	93	[illegible]	36				
2.030A	1486	399	434					
141	115	96	60	37				
2.030B	842	278	236					
215	160	118	67	27				
2.030B	1466	469	402					
364	270	200	110	47				
2.030B	1476	462	392					

E1 (repeat!)

E15 (cont'd) From Oct. 29

I16 (cont'd) From Oct. 29

M17 (cont'd) From Oct. 29

B3 [illegible]

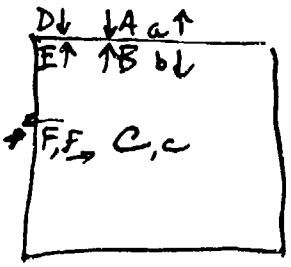
355	262	195	110	45
2.030C		851	128	121
117	98	82	54	28
2.030C		1498	225	216
206	174	145	91	53
2.030C		1499	225	213
203	172	142	90	50
2.030b		847	247	283
66	56	48	35	21
2.030b		1478	419	476
113	97	84	59	38
2.030b		1486	418	477
118	100	86	61	39
10.020A		826	275	310
77	65	55	39	24
10.020A		1459	433	492
160	132	107	69	39
10.020A		1466	435	493
156	130	106	71	40
10.020C		841	128	122
118	101	85	56	31
10.020C		1518	229	219
209	181	151	96	54
10.020C		1517	229	220
209	181	152	97	55
10.020B		847	257	290
75	63	53	35	23
10.020B		1489	402	448
193	157	125	78	43
10.020B		1483	394	445
194	158	126	79	45
10.020F		825	282	321
69	59	50	36	22
10.020F		1470	436	523
173	141	112	71	31
10.020F		1485	430	486
172	142	113	73	35
14.040C		843	239	271
68	58	49	35	20
14.040C		1480	393	443
139	115	94	62	37
14.040C		1486	384	432
139	115	95	64	38
14.040B		847	252	289
69	56	47	34	19
14.040B		1476	429	490
121	102	86	61	35
14.040B		1474	419	479
135	107	90	62	37

Input File: AR#5-2

Date: NOV 1 19 Temp: 28 5
Headway: TEST AREA #5 [11.5"POC]
Loc: Radius (mm): 150
Sensor Positions (mm):
0 200 [illegible] 1524 2438

start	pressure	d1	d2
d3	d5	d6	d7
6.050C	840	142	132
127 108	89	58	30
6.050C	1496	246	252
224 191	158	101	58
6.050C	1500	247	238
224 191	157	101	56
6.050F	837	262	301
82 71	59	41	23
6.050F	1461	458	510
147 125	105	72	35
6.050F	1467	441	499
147 119	106	73	34
1.070C	846	148	138
172 115	93	59	29
1.070C	1500	265	252
202	162	109	51
1.070C	1505	260	247
200	161	107	52
1.070F	846	228	253
101 84	69	46	27
1.070F	1465	365	401
234 188	151	93	40
1.070F	1478	357	390

330	186	149	93	43
10.0[illegible]		810	4131	124
118	103	84	54	25
10.030C		1495	229	222
211	192	151	96	47
10.030C		1515	231	226
212	193	153	96	49
10.080E		840	227	250
100	91	66	41	24
10.080B		1496	363	399
234	177	134	83	45
10.080B		498	353	389
217	170	125	82	45
7.110B		822	249	283
77	67	55	38	23
7.110B		1469	429	481
135	[illegible]	95	64	37
7.[illegible]		1484	421	47[illegible]
139	[illegible]	99	68	[illegible]
7.11[illegible]		832	265	[illegible]
213	167	125	73	38
[illegible]	[illegible]	1479	434	377
241	263	201	116	46
7.110b		1480	420	371
274	259	198	117	48
7.110C		821	128	121
117	102	86	57	28
7.110C		1487	231	224
210	182	154	103	55
7.110C		1504	231	223
211	183	155	103	56
7.110E		838	257	289
78	66	56	40	23
7.110B		1470	435	480
151	125	103	67	39
7.110E		1474	433	498
153	128	104	69	40
7.110[illegible]		824	237	206
130	151	118	69	27
7.110[illegible]		1472	410	364
334	262	206	121	41
7.110[illegible]		1486	410	356
333	256	203	123	41
7.110F		842	219	248
80	70	57	39	20
7.110F		1488	399	453
135	11[illegible]	99	70	38
7.110F		1493	399	454
135	116	99	71	38
7.110E		829	442	492
141	117	97	61	31
7.110E		1448	698	713
402	314	246	148	67
7.110E		1434	690	708
410	315	245	147	67
12.120C		838	130	122
119	103	88	59	27
12.120C		1498	232	220
212	184	155	103	52
12.120C		1496	231	220
213	184	155	105	52
12.120F		838	254	288
67	57	49	37	21
12.120F		1478	410	455
166	135	109	73	35
12.120F		1482	404	449
164	135	109	75	37



Interior Slab FWD Deflection Results from
Apron 1-A (10-1/2 in. PCC)

Station	D1*	D2	D3	D4	Area	Wt (lbf)
O15I	8.1**	7.6	6.4	5.4	30.8	25106
K15I	8.5	7.7	6.6	5.5	30.0	23764
G15I	8.9	8.1	6.9	5.8	30.3	23672
C15I	8.8	8.0	6.9	5.7	30.2	24042
L11I	8.2	7.5	6.5	5.4	30.5	23913
H11I	9.5	8.8	7.6	6.5	30.8	23871
D11I	9.6	8.9	7.7	6.4	30.9	23831
M7I	8.9	8.0	6.9	5.7	30.0	23902
I7I	9.0	8.5	7.3	6.2	31.1	23669
F7I	9.8	9.1	7.8	6.7	30.9	23781
N3I	8.1	7.5	6.2	5.2	30.2	23778
J3I	8.9	8.3	7.1	5.9	30.7	23812
F3I	9.1	8.2	7.1	6.0	30.2	24092
B3I	8.7	8.1	6.9	5.7	30.5	23851
Ave.	8.864	8.164	6.993	5.864	30.507	23935

*D1 = Def. in Center of Plate
D2, D3, D4 = Def. 12, 36, 48 ins. from plate
**Deflection ins. x 10^{-3}

Slab Edge (15 ft. side) FWD Deflection Results
from Apron 1-A (10-1/2 in. PCC)

Slab	Load	D1	D2	LT*	LT adj.**
O15E1	23249	15.8	6.7	42	46
K15E1	23588	15.7	7.3	47	51
G15E1	23204	16.0	7.2	45	49
C15E1	24445	12.5	8.8	70	76
L11E1	23557	14.6	8.7	59	64
H11E1	23507	18.3	5.3	29	31
D11E1	23840	15.2	8.4	56	61
M7E1	23666	12.0	10.1	83	90
I7E1	24081	13.1	11.0	84	91
F7E1	23560	15.7	12.1	77	84
N3E1	23475	13.8	8.7	63	68
J3E1	23688	14.8	10.5	71	77
F3E1	23731	13.9	11.5	83	90
B3E1	23353	16.7	7.8	47	51
Ave.		14.864	8.864	61	66

*LT = D2/D1
**LTx1.0857 (Adjustment for slab bending 8.864/8.164)

Slab Edge (12.5 ft. side) FWD Deflection Results
from Apron 1-A

Slab	Load	D1	D2	LT	LT adj.*
O15E2	23663	14.5	6.7	46	50
K15E2	23579	14.1	8.6	61	66
G15E2	23428	16.0	7.8	49	53
C15E2	23495	13.8	8.3	60	65
L11E2	23314	15.4	6.9	45	49
H11E2	23537	18.6	7.8	42	46
D11E2	23406	19.6	5.2	26	28
M7E2	23378	18.4	4.2	23	25
I7E2	23277	18.7	7.3	39	42
F7E2	22938	21.0	6.1	29	31
N3E2	23397	15.9	4.5	28	30
J3E2	23268	17.5	6.5	37	40
F3E2	23562	17.5	6.4	37	40
B3E2	23271	19.9	5.1	26	28
Ave.		17.21	6.53	39	42

* LT x 8.864/8.164

Slab Corner FWD Deflection Results from Apron 1-A

Slab	Load	D1	D2	LT	LT adj.
O15C	22584	28.2	16.5	58	63
K15C	22868	22.6	15.4	68	74
G15C	23221	23.9	14.3	60	65
C15C	23557	18.3	14.2	77	84
L11C	23336	18.9	11.1	59	64
H11C	23008	26.8	17.4	65	71
D11C	23179	25.3	4.8	19	21
M7C	22896	22.7	4.9	21	23
I7C	23078	22.1	9.1	41	45
F7C	22961	26.9	5.5	21	23
N3C	22840	27.5	6.9	25	27
J3C	22924	25.8	9.5	37	40
F3C	23307	26.6	10.1	38	41
B3C	22935	28.9	5.3	18	20
Ave.		24.61	10.36	43	47

Interior Slab FWD Deflection Results for
Apron 1-A-1 (AC/PCC)

Slab	Load	D1	D2	D3	D4	Area
A1	23179	8.5	7.1	6.0	5.0	27.9
A2	23260	8.9	7.5	6.2	5.2	28.0
D1	23627	9.2	7.5	6.4	5.3	27.5
D2	23176	10.6	9.4	8.0	6.6	29.4
C1	23137	12.0	10.0	8.3	6.8	27.7
C2	23316	9.0	7.9	6.9	5.8	29.6
Ave.	23282	9.7	8.2	7.0	5.8	28.35

Longitudinal Edge Joint FWD Deflection Results
for Apron 1-A-1 (AC/PCC)

Slab	Load	D1	D2	LT	LT adj.*
A1E1	23039	12.9	9.4	73	86
A2E1	23159	11.3	8.9	79	93
D1E1	23829	14.9	7.8	53	63
D2E1	23482	17.6	8.2	47	56
C1E1	23501	17.1	9.3	54	64
C2E1	23403	15.1	10.2	67	79
Ave.		14.8	9.0	62	73

* LT x 9.7/8.2

Transverse Edge Joint FWD Deflection Results for Apron 1-A-1 (AC/PCC)

Slab	Load	D1	D2	LT	LT adj.*
A1E2	23078	11.6	8.5	74	88
A2E2	22980	13.5	6.7	50	59
D1E2	23454	13.0	7.1	54	64
D2E2	23039	10.2	9.2	90	100
C1E2	23198	10.4	9.0	87	100
C2E2	23073	14.3	8.9	62	73
Ave.		12.2	8.2	70	81

* LT x 9.7/8.2

Corner FWD Deflection Results for Apron 1-A-1 (AC/PCC)

Slab	Load	D1	D2	LT	LT adj.*
A1C	23498	14.8	11.1	75	89
A2C	24207	13.5	8.0	59	70
D1C	22882	17.3	8.0	46	54
D2C	23002	16.0	15.0	94	100
C1C	23739	12.1	10.5	86	100
C2C	22857	21.1	12.4	59	70
Ave.		15.8	10.8	70	81

* LT x 9.7/8.2

FWD Deflection Taken at Random Cracks in AC for Apron 1-A-1 (AC/PCC)

Slab	Load	D1	D2	LT	LT adj.*
C2E3	23159	10.7	9.3	87	100
C2E4	23411	9.6	9.0	93	100
D1E3	23792	9.6	8.5	88	100
D1E4	23159	9.8	8.5	87	100
A1E3	23935	10.0	8.3	83	98
A1E4	23206	9.1	7.6	84	99
A2E3	23210	9.2	8.1	88	100
A2E4	23030	10.4	8.4	80	95
Ave.		9.8	8.5	86	99

* LT x 9.7/8.2

Slab Interior FWD Deflection Results for Taxiway 33
(PCC)

Slab	Load	D1	D2	D3	D4	Area
6760	25114	3.1	2.8	2.6	2.4	31.0
6804	24506	2.8	2.6	2.3	2.2	31.6
5256	24467	3.3	3.0	2.8	2.6	32.1
4604	24092	3.6	3.3	3.0	2.7	32.0	
3756	24148	3.1	2.7	2.4	2.2	30.1
3504	24306	2.9	2.6	2.4	2.3	31.6
3008	24280	2.8	2.6	2.3	2.2	31.8
2756	24210	2.8	2.6	2.4	2.2	31.9
1504	24094	2.8	2.6	2.3	2.1	31.8
756	24770	3.1	2.8	2.6	2.3	30.9
Ave.	24446	3.02	2.73	2.51	2.32	31.40

Longitudinal Joint FWD Deflection Results for
Taxiway 33 (PCC)

Slab	Load	D1	D2	LT	LT adj.*
675BE1	24170	4.9	3.0	61	67
600AE1	24655	5.2	2.3	44	49
525BE1	24562	4.7	3.5	73	81
450CE1	24299	7.8	2.5	33	36
375AE1	24047	6.7	1.9	28	31
300BE1	24350	4.5	3.2	71	79
300BE1	24478	4.8	3.9	81	90
225CE1	24148	7.9	2.1	27	30
150AE1	24056	6.6	2.5	37	41
75BE1	24591	5.3	4.0	75	83
Ave.	FWD Plate on Outer Slab $\overline{A}$			36	40
	FWD Plate on Inner Slab $\overline{B}$			72	80
	FWD Plate on Outer Slab C			30	33 (critical)

* LT x 3.02/2.73

Transverse Joint FWD Deflection Results for
Taxiway 33 (PCC)

Slab	Load	D1	D2	LT	LT adj.*
675BE2	25223	6.1	2.0	33	36
600AE2	24591	6.5	2.3	35	39
525BE2	24330	5.8	1.9	33	36
450CE2	24546	4.1	3.5	87	96
375AE2	23924	5.2	3.2	62	69
300BE2	24170	4.7	2.8	59	65
300BE2	23857	6 1	2.3	38	42
225CE2	24050	6.4	3.5	56	62
150AE2	24403	5.7	3.9	67	74
75BE2	24187	8.7	1.8	21	23
Ave.	Plate on Outer Slab A			55	61
	Plate on Inner Slab B			37	40
	Plate on Outer Slab C			72	79

* LT x 3.02/2.73

Slab Corner FWD Deflection Results for Taxiway 33 (PCC)

Slab	Load	D1	D2	LT	LT adj.*
675BC	24125	8.2	4.0	48	53
600AC	25145	10.4	3.4	33	36
525BC	24039	10.0	4.4	44	49
450CC	24582	7.2	6.2	87	96
375AC	23154	9.4	4.1	43	48
300BC	23442	10.9	2.6	24	27
300BC	23336	14.3	2.0	14	15
225CC	24064	14.7	6.0	41	45
150AC	24683	10.4	8.7	84	93
75BC	23538	20.9	1.9	9	10
Ave.	Plate on Outer Slab A			53	59
	Plate on Inner Slab B			28	31
	Plate on Outer Slab C			64	71

* LT x 3.02/2.73

FWD Deflections for Taxiway 3B

Position	Load	D_1	D_2	D_3	D_4	D_5	D_6	Area
Centerline								
Sta. 50	25092	11.8*	8.9	6.3	4.5	3.3	2.4	23.8
150	23762	12.4	9.5	6.6	4.5	3.3	2.5	23.7
250	23694	11.0	8.2	5.7	3.9	2.9	2.2	23.3
350	24198	11.5	8.5	6.2	4.4	3.1	2.4	23.7
450	24162	11.8	8.9	6.4	4.5	3.3	2.5	23.9
550	24372	9.9	7.8	5.7	4.3	3.2	2.4	24.9
650	23739	12.2	9.4	6.9	5.0	3.7	2.8	29.5
Averages	24146	11.61						23.97
8-10' Right								
Sta. 100	23717	14.1	9.9	6.1	3.9	2.6	2.1	21.3
300	23146	18.2	12.2	7.6	5.0	3.4	2.6	20.6
600	23955	14.8	11.3	8.0	6.6	4.0	3.0	24.0
Averages	23606	15.70						21.97
8-10' Left								
Sta. 200	23165	19.3	18.1	8.2	6.3	3.7	2.9	20.9
400	24378	17.0	11.9	7.7	6.0	3.6	2.5	21.5
600	23638	15.0	10.8	7.6	6.1	3.7	2.8	22.7
Averages	23727	17.10						21.70
18-20' Right								
Sta. 200	22758	23.7	14.6	7.8	4.9	3.3	2.5	18.6
400	23215	17.6	12.0	7.2	4.6	3.2	2.5	20.7
600	23050	23.3	15.7	9.7	6.2	4.1	3.0	20.6
Averages	23007	21.5						19.97
18-20' Left								
Sta. 100	23310	17.0	12.4	8.2	6.6	3.8	2.7	22.4
300	22629	14.0	14.0	8.3	6.3	3.6	2.8	20.3
600	22636	25.2	13.6	7.3	4.4	2.8	2.2	17.0
Averages	22858	21.03						19.90

* [illegible] x 10^{-3}

FWD Deflection for Taxiway 3

Position	Load	D_1	D_2	D_3	D_4	D_5	D_6	Area
Centerline								
Sta. 950	23179	22.6	15.5	8.8	5.7	3.9	3.0	20.6
650	22266	27.1	17.4	10.9	7.1	4.8	3.4	20.1
750	22112	26.1	16.1	9.7	6.2	4.4	3.2	19.3
850	23579	21.7	16.0	10.4	6.7	4.6	3.4	22.4
550	23070	24.6	16.9	10.9	7.3	4.9	3.4	21.3
450	25011	24.5	17.9	11.0	6 7	4.3	2.9	21.8
350	24509	23.4	18.0	11.9	7.8	5.0	3.4	23.3
250	22552	29.2	18.6	11.7	7.7	5.2	3.6	20.0
150	22470	30.6	18.9	11.4	7.0	4.4	2.9	19.3
50	25058	22.1	16.8	10.9	7.1	4.7	3.3	22.9
Averages	23381	25.19						21.08
10' Right								
Sta. 200	22235	39.5	20.0	9.0	5.1	3.6	2.9	15.6
400	22026	40.9	22.6	10.3	5.6	3.6	2.9	16.5
600	22233	50.2	29.0	13.9	7.2	4.4	3.2	17.1
800	21869	59.9	34.3	14.5	6.6	3.7	2.7	16.4
Averages	22090	45.08						16.55
10' Left								
Sta. 100	22085	50.5	26.3	10.8	5.2	3.5	2.8	15.4
300	22938	45.8	25.9	11.5	6.2	4.1	3.2	16.6
500	21757	55.6	28.1	11.7	5.8	3.7	2.7	15.2
700	22059	45.4	23.6	9.9	5.5	3.8	3.1	15.6
900	22177	43.2	21.9	9.2	4.8	3.2	2.6	15.3
Averages	22203	48.10						15.62

TEST DATA FROM LOUIS BERGER
INTERNATIONAL, INC.

Data Collected with Model 2000
Pavement Profiler

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM: AREA #4
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:
TIME START: ~7:15

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
T4A	144	135	114	98	4.49			
T4A	65	63	49	45	2.23			
T4B	55	57	45	41	2.24			
T4B	123	121	96	58	4.48			
T4B	123	122	100	54	4.51			2 Feet back
T4B	62	55	48	27	2.23			" " "
T4C	85	64	50	30	2.23			" " "
T4C	185	134	102	67	4.52			" " "
B41	130	128	118	67	4.49			0
B41	65	62	44	31	2.18			0
B42	67	64	49	31	2.18			50'
B42	142	136	103	61	4.49			50'
B43	158	127	99	62	4.51			100'

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM: AREA # 4
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
B43	71	60	44	29	2.19	*		100'
B44	57	52	41	30	2.20	*		150'
B44	117	115	79	60	4.49	*		150'
B45	174	162	118	64	4.53	*		210'
B45	82	75	55	30	2.21	*		210'
C1A	264	222	163	84	4.51	*		Before Joint
C1B	253	331	80	52	4.50	*		After Joint
D1A	200	178	121	75	4.51	*		Before Joint
D1B	221	254	84	57	4.48	*		After Joint
D2	260	252	240	150	4.48	y		
D2	123	116	101	68	2.22	*		

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

* = 2 ft back

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE: AREA

THICKNESS: INCH

TEMPERATURE: °C TIME: 4√

DATE:
TIME START: 2-9-22

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
D3	202	171	137	80	4.46	*		100'
D3	93	88	68	40	2.19	*		100'
D41	126	123	116	43	4.48	*		151' before J
D42	162	140	89	52	4.49	*		151' After J
D5	132	123	93	87	4.48	*		200'
D5	66	59	45	28	2.24	*		200'
C2A	188	168	139	81	4.48	*		Before J
C2B	199	202	143	87	4.51	*		After J
T4A	66	72	66	25	2.25	*		
T4A	69	73	64	70	2.19			
T4A	141	138	148	113	4.52			Test point
T4A	140	158	144	51	4.51	*		
T4A	151	147	129	126	4.51			
T4A	149	145	129	47		*		

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

* = 2 ft back - sensor dog

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM: AREA #1
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

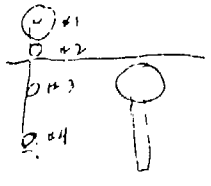
TIME START: 9:20

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
T1A	46	43	37	27	4.50	X		
T1B	50	44	43	32	4.52	X		
T1C	9	9	8	5	1.08	X		
T1C	19	18	16	11	2.22	X		
T1C	29	28	25	17	3.32	X		
T1C	41	39	34	23	4.53	X		
T1D	54	53	47	36	4.49	X	C.L.	4+00 Center
T1E^A	131	115	92	53	4.51	X	C.L.	B. Joint 5+00
T1E^B	96	109	27	21	4.52		C.L.	A. Joint " "
T1F	44	43	39	27	4.49		C.L.	MID SLAB
T1F^A	93	73	62	35	4.51		C.L.	B. Joint 4 sensors on slab
T1F^B	88	100	31	26	4.52		C.L.	A. Joint D1, D2 on next slab
T1G	40	38	34	22	4.51		C.L.	MID SLAB

TIME FINISH:

REMARKS AND SKETCHES:

UNITS:



MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM: AREA #1
TO:

Facility:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °c TIME:

STARTING POINT:

DATE:

TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
T1A	37	36	31	23	4.53	*	P.C.C.	MID SLAB
T1 JA	85	63	56	31	4.49	*		B. Joint Long. Joint
T1 JB	80	99	28	22	4.51	*		A Joint Long. Joint
T1K	45	42	35	26	4.54	*		MID SLAB
T11C^A	113	86	78	48	4.48	*		B FREE EDGE
T11C^B	537	334	157	62	4.50	*		C.L. of Shoulder
T11C^B	250	139	72	28	2.21	*		C.L. of Shoulder

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM: Area #5
TO:

Facility:

PAVEMENT TYPE:

STARTING POINT:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

TIME START: 10:10

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
F5C	176	168	137	80	4.49	*		Peat - Center
F5E	232	202	152	68	4.53	*		Peat - edge
3A	155	149	120	60	4.51	*		Center
3C	155	142	118	63	4.52	*		Center
3E	230	236	172	71	4.52	*		edge Before
3E	130	107	78	31	2.22	*		edge Before
3E-F	99	110	39	19	2.21	*		after Joint
3E-F	235	254	87	44	4.54	*		After Joint
3I	166	159	126	67	4.53	*		Center
3I	79	76	61	31	2.20	*		Center
3I	130	107	73	32	2.20	*		edge
3I	299	247	178	76	4.52	*		edge
3I-J	215	244	77	40	4.47	*		After J.
3I-J	102	113	37	18	2.25	*		

REMARKS AND SKETCHES:

UNITS:

TIME FINISH: "

MacDill Afb, Florida

PAVEMENT DEFLECTION SURVEY

Lab. I.I.

FROM:
TO: (NW) 8 C.

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °F TIME:

Facility:

Station/Unit:

DATE:

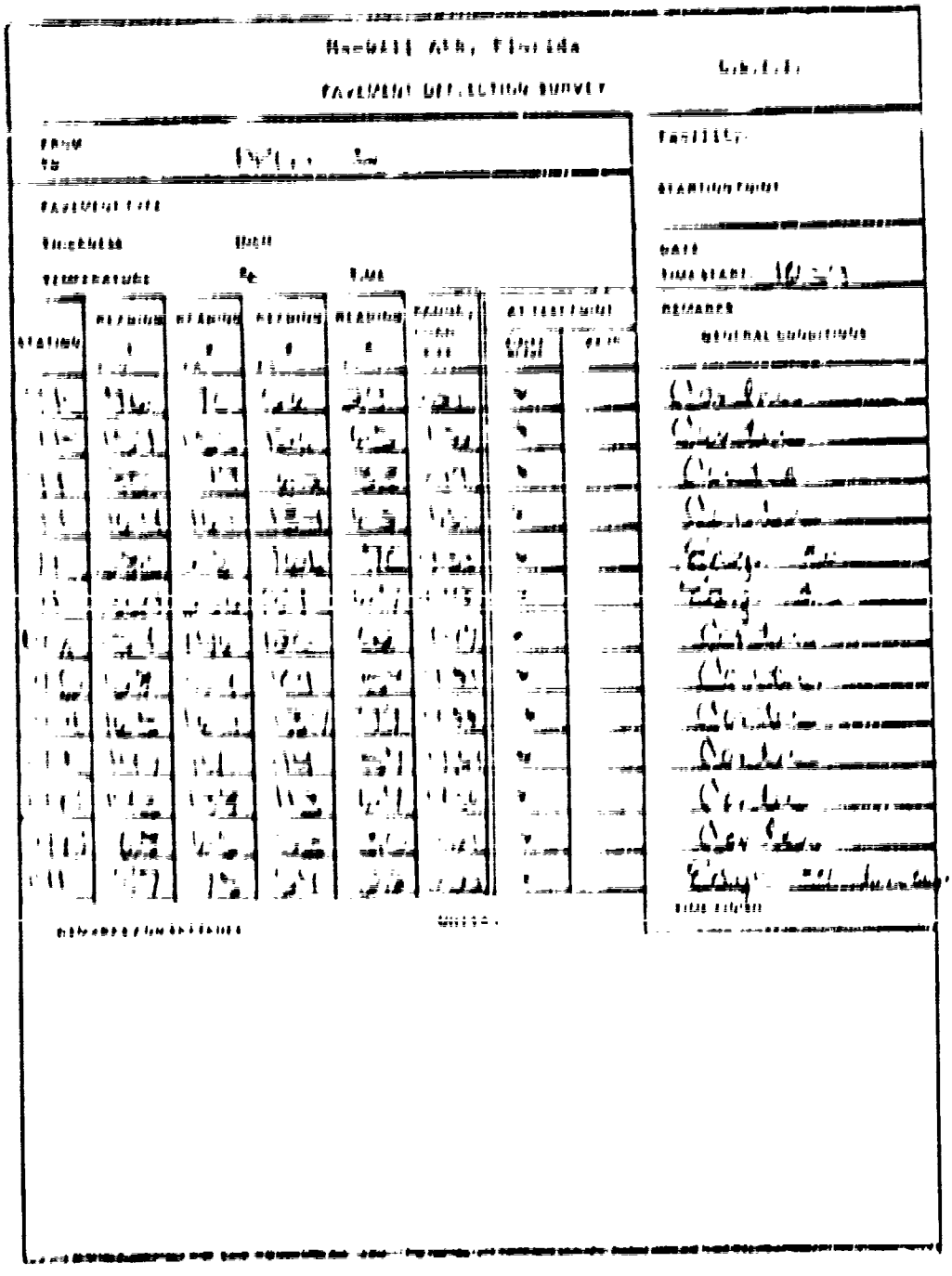
TIME START: 12 (12)

STATION	READING 1	READING 2	READING 3	READING 4	FAILED (Ads XIE	AT TEST POINT	REMARKS
							GENERAL CONDITIONS
311	115	102	93	70	0.20		Cracks
310	101	101	116	91	1.01		Cracks
309	101	121	101	81	1.00		Cracks
308	102	82	80	75	0.77		Cracks
307	93	91	81	76	0.13		Light Cracks
306	121	102	103	86	0.16		Light Cracks
1 C	102	91	116	92	0.24		Cracks
1 C	121	120	93	93	1.00		Cracks
1 C	111	91	102	86	0.21		Cracks
1 C	216	116	101	92	4.13		Cracks
1 CN	101	92	91	81	1.00		Cracks
1 CN	92	102	91	76	0.30		Cracks

REMARKS AND SKETCHES:

Units:

TIME FINISH:



MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM:
TO: AREA #5

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE: 11:23
TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
14N	317	170	138	52	4.55	x		Edge -4" from edge
14N	311	183	136	53	4.53	x		Edge at edge
14N	110	88	62	24	2.19	x		Edge at edge
14N	195	163	115	44	4.49	x		On Edge
14N	92	74	54	20	2.21	x		On Edge
14N	89	73	56	24	2.25	x		Edge -8"
14N	162	165	117	51	4.52	x		Edge -8"
14N	154	136	104	51	4.50	x		Edge -12"
14N	71	62	47	23	2.20	x		Edge -12"
17O	144	128	114	61	4.46	x		Center
17M	157	148	118	54	4.54	x		Center
17H	147	141	114	58	4.58	x		Center
17E	154	146	125	60	4.46	x		Center

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM:
TO: AREA 5

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:
TIME START: 11:39

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
17C	174	170	139	67	4.51	X		Center
17A	155	151	123	62	4.53	X		" "
10A	198	191	154	70	4.50	X		" "
10D	159	144	118	62	4.53	X		" "
10H	200	198	167	89	4.54	X		" "

REMARKS AND SKETCHES:

UNITS:

TIME FINISH: 11:48

MacDill AFB, Florida

L.B.F.L.

PAVEMENT DEFLECTION SURVEY

FROM:
TO: AREA 2

Facility:

PAVEMENT TYPE:

STARTING POINT:

THICKNESS: INCH

TEMPERATURE: °F TIME:

DATE:
TIME START 12 56

STATION	READING 1	READING 2	READING 3	READING 4	LOAD KIP	AT TEST POINT: Cracks or Rut	AT TEST POINT: Patch
0	217	151	72	64	4.50		
0							
1	174	121	77	52	4.50		
1	75	48	20	22	2.0		
2	93	63	39	28	2.00		
2	200	156	81	55	4.50		
3	225	171	99	69	4.50		
3	92	60	43	30	2.00		
4	81	51	35	21	2.00		
4	187	123	80	58	4.50		
5	151	113	70	47	4.50		
5	71	52	31	23	2.00		
6	76	56	38	21	2.00		

REMARKS: GENERAL CONDITIONS

Light [illegible]

At 10' [illegible]

TIME FINISH:

REMARKS AND SKETCHES:

MacDill AFB, Florida

L.B.J.I.

PAVEMENT DEFLECTION SURVEY

FROM:

TO:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE °F TIME

DATE:

TIME START

REMARKS:

GENERAL CONDITIONS

STATION	READING 1	READING 2	READING 3	READING 4	LOAD LBS	AT TEST POINT: CRACKS OPEN	AT TEST POINT: SPALL

REMARKS AND SKETCHES

UNITS:

TIME FINISH

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:
TIME START:

STATION	READING 1 (mm)	READING 2 (mm)	READING 3 (mm)	READING 4 (mm)	LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
5	32	60	4-	30	9.33			@ ℄
2	64	52	34	27	2.33			
2	153	111	74	53	1.49			
1	143	107	68	47	4.34			
1	66	46	30	23	2.33			
0	40	31	24	21	2.01			
0	144	101	75	52	4.47			
7	320	236	226	141	1.49			RIGHT LANE
7	211	151	97	65	2.18			≈ 30' from ℄
6	264	145	86	62	2.33			
6	458	241	171	133	1.47			
5	249	151	151	102	1.49			

REMARKS AND SKETCHES:

UNIT:

TIME FINISH:

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: AREA 2

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
5	148	113	66	46	2.23			EIGHT LANE
4	142	108	57	40	2.16			@ 30' from ℄
4	353	265	142	85	4.51			
3	373	276	165	106	4.46			
3	152	117	66	49	2.19			
2	168	121	65	41	2.24			
2	355	284	146	87	4.46			
1	327	228	129	81	4.48			
1	142	100	57	37	2.26			
0	134	104	61	39	2.21			
0	303	210	138	93	4.47			
0	144	159	104	74	4.49			LEFT LANE, 10' off ℄

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: AREA 2

Facility:

PAVEMENT TYPE:

STARTING POINT:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:
TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
0	80	67	44	32	2.18			LEFT LANE
1	76	59	35	26	2.19			@ 10', OFFCL
1	174	153	85	58	4.53			
2	198	156	95	69	4.49			
2	89	70	44	33	2.25			
3	88	67	43	34	2.21			
3	194	151	94	71	4.51			
4	220	161	96	66	4.48			
4	89	65	39	28	2.18			
5	72	53	41	21	2.21			
5	170	129	65	41	4.47			
6	158	131	81	63	4.64			
6	71	58	38	29	2.23			

REMARKS AND SKETCHES:

UNITS

TIME FINISH:

7	88	72	47	35	2.17
7	203	171	112	81	4.54

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: AREA 2 PROFILE

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: 30 °C TIME:

DATE:

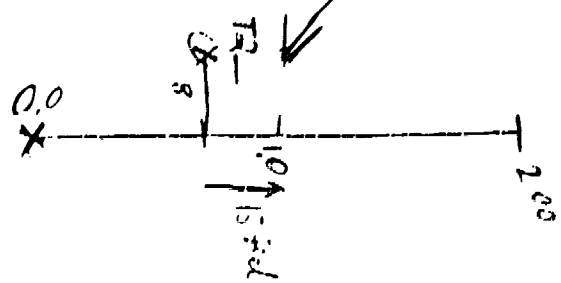
TIME START:

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
1	191	143	89	55	4.43			10' from C.L. / Runway
2	164	134	84	52	4.47			5' " " "
3	165	118	67	55	4.3			@ C.L.
4	182	135	80	51	4.51	T2		5' from C.L. (Left)
5	179	60	37	21	2.24	T2		5' " " "

TIME FINISH:

REMARKS AND SKETCHES:

UNITS:



MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: AREA # 3

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:
TIME START: 2:28

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch
0	235	153	77	49	2.20		
0	617	423	191	115	4.46		
1	601	393	197	136	4.53		
1	232	154	80	54	2.22		
2	238	148	70	48	2.19		
2	593	394	176	107	4.44		
3	722	509	236	146	4.52		
3	282	190	91	56	2.36		
4	265	172	86	55	2.23		
4	737	464	222	135	4.52		
5	713	456	226	140	4.50		
5	259	170	88	58	2.24		

REMARKS:

GENERAL CONDITIONS

RIGHT LANE

↓ 12' off C.L.

TIME FINISH:

REMARKS AND SKETCHES:

UNITS:

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM:
TO: APEH # 3

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

TIME START: 2:37

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
6	218	142	78	53	2.23			RIGHT WHEEL ± 12' from C.L.
6	585	333	195	127	4.51			
7	600	377	184	118	4.49			
7	230	145	76	52	2.20			
8	214	136	72	43	2.23			
8	549	336	172	111	4.50			
9	499	314	178	108	4.48			
9	209	153	74	48	2.27			
10	179	124	66	47	2.21			
10	442	309	146	102	4.50			

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM:
TO: APRN #3

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

TIME START: 2146

STATION	READING 1 E=0	READING 2 E=	READING 3 E=	READING 4 E=	LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
10	384	233	148	105	4.47			@ C.L.
10	178	102	65	59	2.24			
9	133	95	60	40	2.21			
9	311	247	141	100	4.48			
8	270	192	139	101	4.50			
8	129	88	62	42	2.21			
7	133	96	57	41	2.21			
7	308	221	129	89	4.42			
6	334	212	176	125	4.47			
6	159	113	73	54	2.21			
5	151	114	75	55	2.24			
5	309	237	182	133	4.47			

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:

MacDill AFB, Florida

L.B.I.I.

PAVEMENT DEFLECTION SURVEY

FROM: AIRFIELD # 3
TO:

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

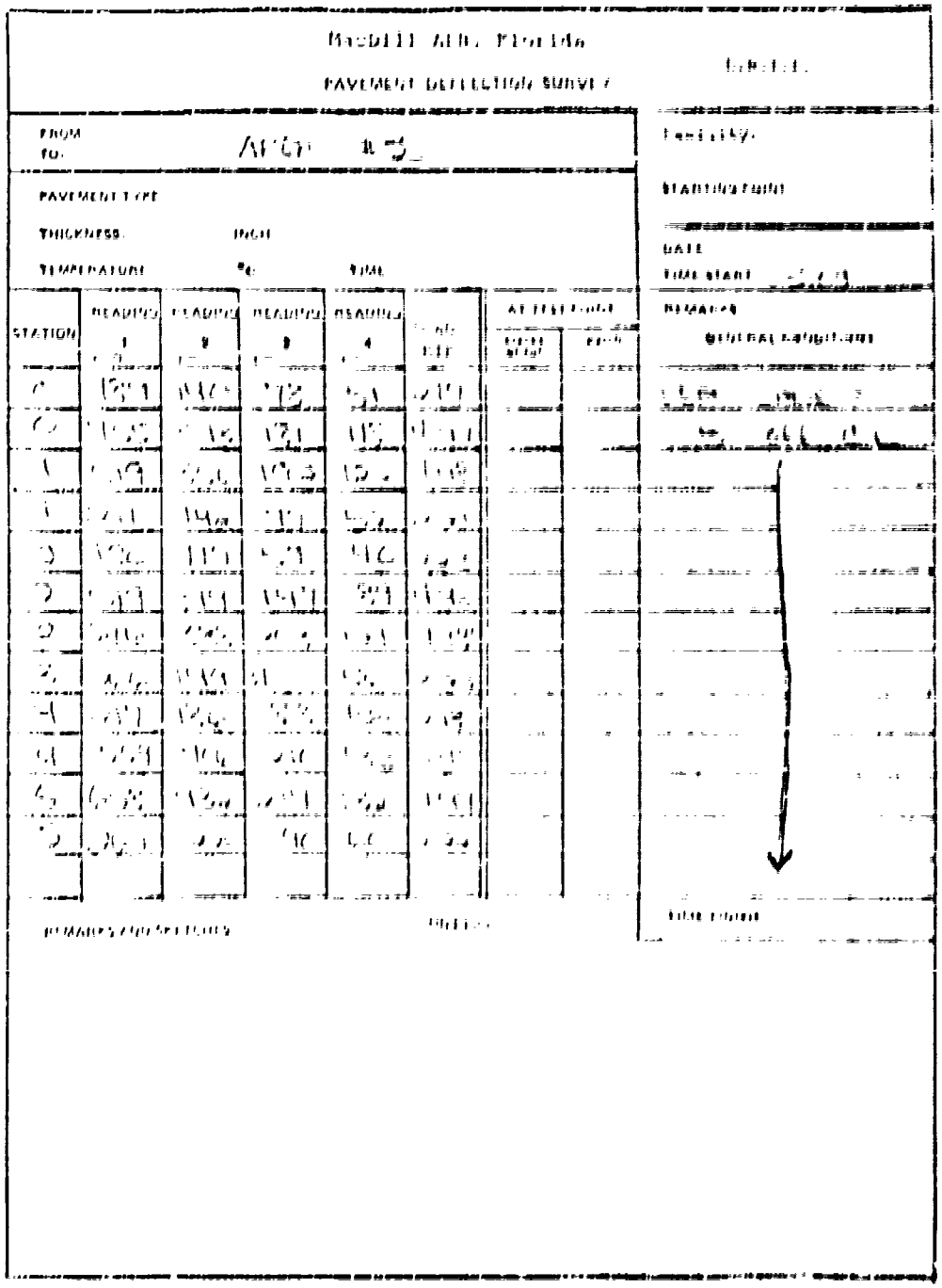
TIME START: 2.59

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	RANGE, LOAD KIP	AT TEST POINT cracks or rut	AT TEST POINT patch	REMARKS: GENERAL CONDITIONS
4	451	324	193	136	4.48			@ C L
4	164	122	69	53	2.21			
3	145	109	73	56	2.23			
3	336	261	172	128	4.51			
2	301	213	116	94	4.51			
2	127	94	61	42	2.22			
1	138	114	75	55	2.23			
1	316	266	173	126	4.47			
0	321	268	159	112	4.52			
0	142	104	69	47	2.22			

REMARKS AND SKETCHES:

UNITS:

TIME FINISH:



PAVEMENT DEFECTION SURVEY

FROM
TO:

PAVEMENT TYPE

THICKNESS: INCH

TEMPERATURE °F: TIME

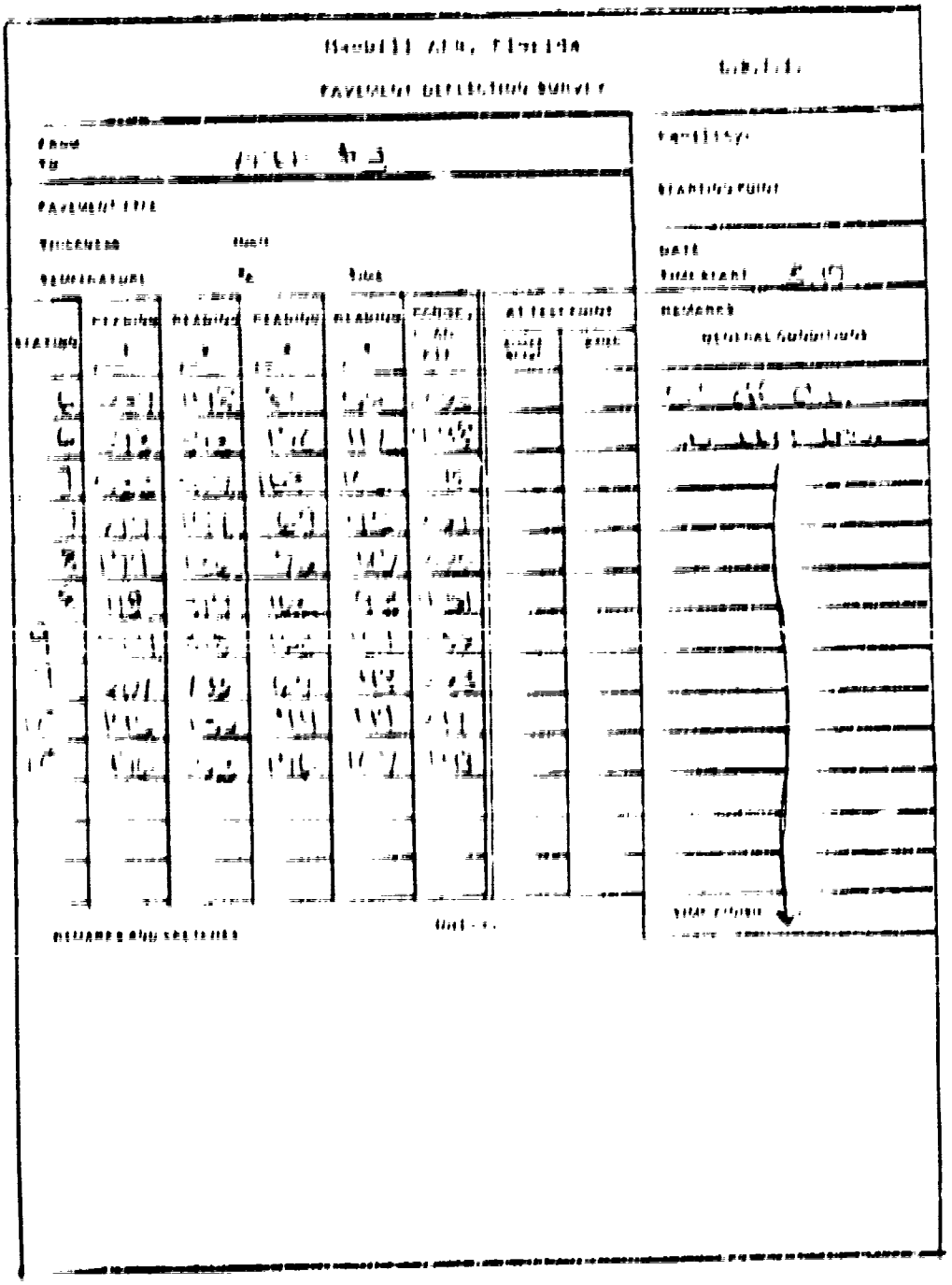
DATE

TIME START

REMARKS

STATION | READING 1 | READING 2 | READING 3 | READING 4 | AVG

REMARKS AND SKETCHES



PAVEMENT DEFLECTION SURVEY

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: AREA # 3

Facility:

STARTING POINT:

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

DATE:

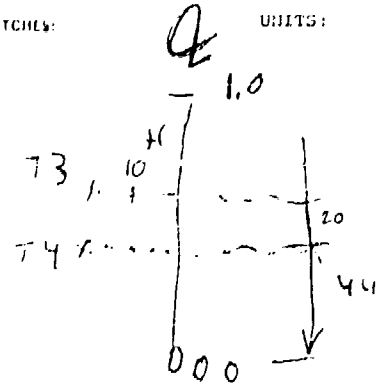
TIME START: 330

STATION	READING 1	READING 2	READING 3	READING 4	LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
T3	101	78	37	25	1.10			T3
T3	233	106	81	53	2.29			T3
T3	401	251	139	81	3.33			T3
T3	651	446	184	111	4.49			T3
A	110	78	40	24	1.14			T4
B	245	141	76	48	2.24			T4
C	321	221	132	74	2.81			T4
D	633	426	182	113	4.49			T4

TIME FINISH:

REMARKS AND SKETCHES:

UNITS:



MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.B.I.I.

FROM:
TO: APRON #3

Facility:

PAVEMENT TYPE:

THICKNESS: INCH

T3- PROFILE

STARTING POINT:

TEMPERATURE: °C TIME:

DATE:

TIME START: 3:42

STATION	READING 1 r=0	READING 2 r=	READING 3 r=	READING 4 r=	LOAD KIP	AT TEST POINT: cracks or rut	AT TEST POINT: patch	REMARKS: GENERAL CONDITIONS
1	460	291	167	105	4.49			LEFT LANE 5' off ℄
1	183	120	73	38	2.21			" " "
2	137	106	70	45	2.24			on ℄
2	305	235	154	107	4.49			on ℄
3	449	316	186	99	4.49			RIGHT LANE, 5' off ℄
3	192	137	62	53	2.24			" " "
4	296	179	55	53	2.20			" " 10' off ℄
4	627	407	215	126	4.49			" " "
5	729	465	173	117	4.49			" " 22' off ℄
5	307	255	85	56	2.24			" " "
6	404	314	129	80	2.20			" " 32' off ℄
6	1036	723	326	197	4.49			" " "

MacDill AFB, Florida

PAVEMENT DEFLECTION SURVEY

L.b.f.t.

FROM:
TO: Apron #3

PAVEMENT TYPE:

THICKNESS: INCH

TEMPERATURE: °C TIME:

Facility:

STARTING POINT:

DATE:

TIME START: 1407

STATION	READING 1	READING 2	READING 3	READING 4	LOAD KN	AT TEST POINT		REMARKS GENERAL CONDITIONS
P1	1038	607	305	210	41.50			Visual Crack
P7	4660	332	157	102	9.21			P1 - P7 @ 10 mm
	398	241	86	63	9.21			Asphalt
	752	166	191	102	41.50			" " "

REMARKS AND SKETCHES:

UNITS:

TIME FINISH

TEST DATA FROM REINARD W. BRANDLEY

Data Collected with Dynatest Model
8000 Falling Weight Deflectometer
and Brandley Cantilever Beam

TABLE NO A2

Load Radius 150mm
20" PCC

FWD DATA - TEST AREA "I"

AFC DILL AFB
Nov. 1, 1982

Station	Offset	Load kips	Temp °C	Deflection in Microns at Distance R from Load mm						
				R=0	R=200	R=305	R=610	R=914	R=1524	R=2438
Outside of Slab										
0+01	4.5 R	1527	38	74	72	67	62	57	47	32
0+03	C	1528		80	74	73	67	61	51	35
0+07	2.5 L	1528		75	71	67	61	55	45	30
0+12	2.5 R	1530		74	73	69	64	58	47	32
0+37	C	1528		75	70	66	59	54	44	31
0+62	4.5 L	1529		78	72	68	62	56	45	31
0+62	4.5 R	1529		73	68	65	59	53	42	29
0+71	C	1526		77	73	66	60		44	29
0+62	2.5 L	1526		75	69	67	63	56	44	29
Outside of Slab										
0+31	2.5 R	333		43	42	39	37	34	29	18
0+31	C	338		47	45	42	40	36	31	19
0+37	2.5 L	336		46	41	39	36	34	27	18
0+	2.5 R	333		45	44	41	37	35	29	20
0+	C	332		42	40	38	36	32	27	20
0+	4.5 L	333		44	42	39	36	33	27	19
0+	4.5 R	330		43	39	37	34	31	25	17
0+	C	334		43	39	38	34	31	26	18
0+	2.5 L	331		43	39	37	34	32	26	19
Inside of Slab										
0+31	2.5 R (1)	1531		108	116	95	73	64	47	33
0+33	1.5 R	1513		106	98	80	62	48	38	26
	(1)	1513		129	123	75	66	59	46	31
0+	2.5 L (2)	1512		107	103	83	71	63	46	30
0+	4.5 L (2)	1533		79	106	98	80	68	52	31
0+37	C (1)	1		134	126	60	53	43	33	23
0+	C (2)	1		111	124	77	67	58	47	30
0+	C (3)	1501		133	122	65	57	50	37	24
0+	C (4)	1501		135	133	52	31	27	22	16
	C (5)	1503		135	135	61	54	47	35	21
0+	4.5 L (3)	1511		114	113	74	64	55	41	27
Outside of Slab										
0+	C	1511		122	120	90	76	68	53	37
0+	C	1511		136	125	78	68	61	47	30

TABLE A 3

Area 2 — 11 TAC — FWD DATA - TEST AREA # 2. — MCD/11 AFB

Load Radius — 150 mm — 18 FT Right of ℄ — Nov 1, 1982

Sta	Line	Load KPa	Load lb	Deflection in Microns at Distance R from Load - mm R=0	R=200	R=305	R=610	R=914	R=1524	R=2438	Temp °C
0+00	2:C4	B28		302	236	186	111	74	39	21	
		1952		521	415	333	202	134	70	38	38°
											13:30 h
1+00	2:72	B45		374	228	172	95	59	32	19	
		N37		598	471	295	167	105	57	31	
2+00	2:75	B39		393	266	222	118	72	37	21	
		1424		632	431	368	201	125	63	34	
3+00	2:78	B47		346	266	197	111	67	35	21	
		1938		581	441	335	194	122	63	35	
4+00	2.82	B52		243	196	165	100	63	35	22	
		1462		422	345	287	178	115	63	36	
4+00	2.83	1458		416	347	284	176	116	61	37	
5+00	2:86	B:47		334	251	184	93	52	26	17	
		1441		533	385	291	149	84	43	25	
6+00	2:89	B45		341	260	209	128	79	40	22	
		1427		580	452	368	228	146	74	38	
7+00	2:92	B30		543	360	290	148	84	40	23	
		1387		834	578	465	250	148	70	40	

TABLE A4

FWD DATA - TEST AREA #2

Area 2 11 JAC
Load Radius 150 mm

18 ft Left of ℄

Mc D.11 AFB
Nov. 1, 1982

				0	200	305	610	914	1524	2438	
Sta	Line	Load kPa	Load lb	Deflection μm #1	#2	#3	#4	#5	#6	#7	Temp °C
0+00	2:45	836		308	231	185	118	77	41	24	13:10
		1462		531	415	335	215	143	73	39	
1+00	2:48	844		302	178	144	99	68	36	21	
		1471		483	319	261	181	124	67	36	
2+00	2:51	818		291	238	194	128	76	38	22	
		1407		511	408	340	211	135	67	37	
3+00	2:54	845		294	213	173	109	70	36	21	
		1448		505	362	304	194	125	64	35	
4+00	2:57	814		441	287	221	121	70	35	20	
		1391		711	486	375	210	127	62	37	
5+00	2:60	847		301	245	198	118	74	38	23	
		1434		535	431	354	215	134	66	37	
6+00	2:63	829		324	234	183	103	62	33	20	
		1431		557	411	326	189	116	62	39	
7+00	2:66	850		325	246	206	126	79	40	25	38.0°
		1423		556	422	358	222	143	71	41	13:30

TABLE A-5

Area 2 11 TAC — FWD DATA - TEST AREA No 2 — McDill AFB
Load Radius 150 mm — L of R of Center Line — Nov 1, 1982

STA	Line	Load WP	Load lb	Deflection in Microns at Distance R from Load - mm R=0	R=200	R=305	R=610	R=914	R=1219	R=1524	Temp °C
0425	2:3	829		158	132	114	81	58	34	19	33
		1476		293	247	216	152	105	63	35	
0475	2:6	833		182	154	133	90	63	34	19	
		1485		331	288	246	167	115	71	35	
1125	2:9	852		202	165	136	93	63	35	20	
		1454		368	294	250	171	119	72	34	
1175	2:12	817		208	171	145	94	62	32	18	
		1444		374	306	267	176	117	70	35	
2125	2:15	857		155	127	117	81	56	33	18	
		1476		280	230	220	153	106	58	33	
2175	2:18	853		173	148	130	92	65	35	20	11 WDA
		1470		320	276	241	171	121	66	35	
2225	2:21	819		181	153	135	98	69	35	20	
		1453		331	280	244	171	118	63	35	
2275	2:24	843		165	143	125	86	59	33	18	
		1480		311	263	233	163	113	60	34	
2325	2:27	842		180	141	118	79	54	31	19	
		1453		314	254	215	147	102	55	33	
2375	2:30	853		180	146	123	86	62	35	19	
		1465		330	271	233	161	115	66	35	
2425	2:33	867		168	142	124	84	71	40	22	
		1505		311	267	232	177	131	72	37	
2475	2:36	846		160	130	114	76	55	33	18	
		1487		293	243	214	153	108	58	31	
2525	2:39	847		166	140	114	81	57	32	20	
		1456		307	270	225	155	107	63	36	
4475	4:2	850		170	147	119	84	58	35	21	
		1499		313	278	245	179	85	39	20	

TABLE A.6

Area No3 SR "AC" Nov 1, 1982 McDill AFB
Load Radius 150mm FWD DATA.
T/W Center Line.

STA	Line	Load KPa	Load lb	Deflection in Microns at Distance R from Load - mm R=0	R=200	R=305	R=610	R=914	R=1524	R=2438	Temp °C
0+25	#3:3	858		503	384	299	160	92	40	36	38
		1476		772	578	419	263	156	69	49	
0+75	3:C	861		378	299	254	158	99	48	23	
		1503		637	505	423	262	168	80	44	
1+25	3:9	845		372	298	251	156	99	45	27	1440A.
		1471		638	505	428	269	171	80	45	
1+75	3:12	866		391	323	276	164	99	42	24	
		1524		684	536	528	285	176	77	43	
2+25	3:15	579		230	186	152	83	58	31	19	
		860		392	313	263	162	100	45	26	
		1133		501	390	327	202	127	60	70	
		1493		724	562	482	292	179	79	48	
2+75	3:21	873		344	285	240	151	96	45	24	
		1193		442	371	305	193	123	60	34	
		1583		607	516	425	269	172	78	42	
3+25	3:24	864		361	300	260	166	108	46	25	
		1137		461	378	325	211	136	61	32	
		1518		618	512	448	289	187	82	42	
3+75	3:27	839		353	418	337	200	118	44	23	34.5
		1447		594	681	555	329	201	83	41	
4+25	3:30	858		368	296	201	131	91	54	31	
		1505		666	436	368	245	170	100	60	
4+75	3:33	851		402	352	285	187	102	45	27	
		1497		849	616	485	270	183	78	36	
5+25	3:36	827		391	332	290	170	102	43	24	
		1509		680	568	492	299	184	82	51	
5+75	3:39	856		412	349	294	181	113	45	23	
		1466		701	592	467	263	166	82	50	

TABLE A6 Cont

Area No 3 5½" AC — Nov 1, 1982 — Mc Dill AFB
Load Radius 150 mm
PWD DATA
T/W Combination - Cont.

Sta	Line	Load KPa	16	Deflection in Microns at Distance R from Load - mm R=0	R=200	R=305	R=610	R=914	R=1524	R=2438	Temp °C
6+25	3:42	834		516	382	296	159	95	44	26	
		1412									
6+25	3:45	832		467	352	271	150	96	48	27	
		1433		815	594	503	273	173	81	46	
6+75	3:48	831		548	390	259	149	86	43	25	
		1420		898	624	477	257	153	77	47	
7+25	3:51	823		363	293	240	147	92	45	25	
		1510		644	487	429	245	161	81	45	
7+75	3:54	846		441	343	251	137	87	44	25	
		1463		750	545	419	224	149	77	46	
8+25	3:57	844		442	354	270	144	81	41	23	
		1441		711	577	543	246	147	77	43	
8+75	3:60	871		362	282	241	150	96	43	28	
		1508		649	500	422	262	169	78	42	
9+25	3:63	862		316	257	216	136	88	44	25	
		1501		556	445	382	241	157	79	46	
9+75	3:66	844		359	303	236	143	93	45	25	
		1463		610	495	407	249	162	80	46	

AREA No 3 — FWD Test Data — TABLE 2.7

Load Radius 150 mm — 18'L of Taxiway L — McDill AFB

Nov 1, 1982

STA	Line	Load kips	Load lb	Deflection in Microns at Distance R From Load = mm							Temp °C
				R=0	R=200	R=305	R=610	R=914	R=1524	R=2438	
0+00	2:3	800		980	680	480	183	89	40	22	
		1375		1252	850	644	266	140	74	43	
1+00	2:6	786		1195	775	573	169	72	42	29	
		1375		1310	980	630	231	114	76	49	
2+00	2:9	815		880	587	398	143	70	40	26	
		1404		1210	811	555	241	116	66	40	
3+00	2:12	810		803	573	415	158	79	40	23	
		1441		1150	854	639	255	131	66	42	
4+00	2:15	794		1047	720	508	189	78	30	21	
		1370		1328	959	720	302	145	66	42	
5+00	2:18	794		1000	656	436	151	65	32	23	34.0
		1378		1245	932	672	246	128	67	44	
6+00	2:21	798		914	619	412	144	67	36	23	
		1374		1235	830	600	242	132	75	46	
7+00	2:24	796		831	564	350	146	66	35	24	
		1376		1113	763	551	238	130	73	46	
8+00	2:27	754		796	556	389	146	67	35	23	
		1376		1067	388	552	234	126	71	47	
9+00	2:30	808		792	547	356	127	58	32	23	
		1388		1021	738	494	203	109	62	41	
10+00	2:33	814		655	456	334	126	53	33	21	
		1389		914	644	485	210	115	67	42	

93.2 93.1 92.6 92.1 92.1 91.9 92.1 94.2 94.6 96.3 97.6 ← Load 23,000 lb Def in Mils

1' 1' 1' 1' 1' 1' 1' 2' 2' 2' 4' 4' 4' 4' 4' 4'

Cross Section Sta. 400 = 52' 6"

TABLE A 8

5½" AC FWD TEST DATA McD-11 AP2

Load Radius 150 mm 18' R of Taxiway Centerline Nov 1, 1983

Area No 3

STA	Line	LOAD KPa	LOAD lb	Deflection in Microns at Distance R from Load = mm R=0	R=200	R=305	R=610	R=914	R=1524	R=2438	Temp °C
0+00	3:C4	791		1011	681	467	170	80	38	21	
		1372		1358	818	678	278	142	72	41	
1+00	3:72	806		843	601	409	151	75	44	28	36.5°
		1378		1146	821	593	257	139	90	48	1520 Hr
2+00	3:75	800		923	629	427	151	75	42	25	
		1370		1227	877	594	242	131	78	47	
4+00	3:78	809		906	657	469	193	87	38	24	
		1367		1247	906	662	292	146	74	43	
4+00	3:81	794		1010	715	508	203	94	37	23	
		1366		1355	870	693	289	149	71	43	
5+00	3:84	813		796	553	383	152	93	45	25	
		1372		1251	898	646	274	147	77	45	
6+00	3:87	797		1804	802	577	236	108	59	24	
		1363		1425	950	770	343	174	78	46	
7+00	3:90	806		906	592	429	190	97	46	29	
		1363		1222	816	609	286	159	84	50	
8+00	3:93	811		740	520	367	157	82	40	26	
		1376		1032	720	527	243	140	76	46	
9+00	3:96	804		933	631	444	182	84	35	24	
		1378		1239	840	594	253	131	65	44	

McDill AFB — WD DATA 11/18/81

Test Area No. 4, * Year Region 120 mm.

Test Location	Pavement Temp °C	Load lbs	Deflections in Thousandths of Inches Below Load no.						
			1	2	3	4	5	6	7
T.P. 14	36.0	9436	130	105	123	111	101	90	75
T P 11		9475*	115	102	101	103	97	79	68
0130 I		9430	137	118	116	106	101	91	77
0130 K		9455*	169	144	130	120	103	81	64
0130 L		9455	140	115	101	111	101	77	59
0130 D		9470	123	100	91	96	85	71	56
0130 C		9435	158	128	101	109	92	73	57
0130 B		9405	120	102	97	91	86	71	58
0130 U		9484	101	90	87	89	82	69	60
0120 A		9470	96	80	73	86	77	62	50
0120 A		9491	104	90	79	89	82	67	54
0110 C		9465	93	84	84	90	85	71	61
0110 C		9469	101	92	105	98	88	81	71
0110 C		9437	121	108	91	91	84	70	57
0110 C		9433	114	98	93	88	81	69	56
0110 C		9476	111	102	87	94	88	77	63
0110 C		9479	118	102	98	92	84	70	57

TABLE [illegible] A10

[illegible] Date [illegible]

Test No.	Test Location	Pavement Temp. °F	Load lb	Deflection in Mils at Distance R' from Load Line						
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] of Slab										
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	191	164	137	91	[illegible]
[illegible]	[illegible]		[illegible]	231	[illegible]	[illegible]	182	154	103	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108	51
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	191	[illegible]	[illegible]	57
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	173	[illegible]	[illegible]	51
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	117	149	103	66
[illegible]	[illegible]		[illegible]	[illegible]	196	[illegible]	136	170	[illegible]	[illegible]
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[illegible]	[illegible]		-	-	-	-	-	-	-	-
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96	[illegible]
[illegible] of Slab										
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible] of Slab										
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX C

PCC JOINT EFFICIENCY TEST DATA:

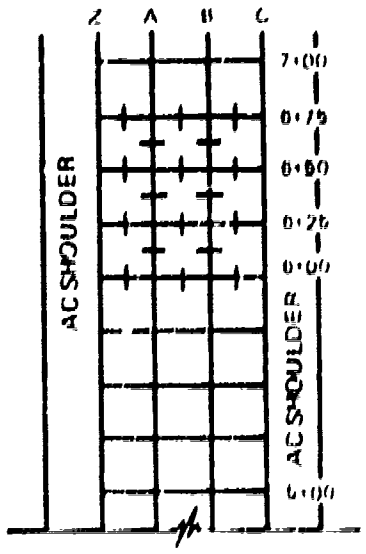
INDEX, PLATES and TABLES

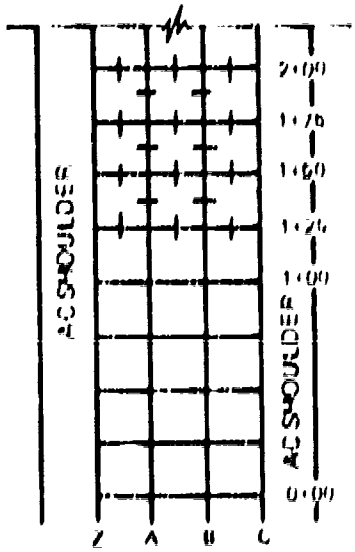
PLATES

Plate No.	Title
C1	Test Area No. 1 - Location Map
C2	Test Area No. 5 - Location Map

TABLES

Table No.	Title
C1	Test Area No. 1 - Joint Testing - Slab Rocking
C2	Test AREa No. 5 - Joint Testing - Slab Rocking





LEGEND

JOINT NUMBERS

SLAB TESTING
MCDILL AFB
11 2-82
TEST AREA 1

PLATE C1

[illegible] - SLAB ROCKING
[illegible]
[illegible]

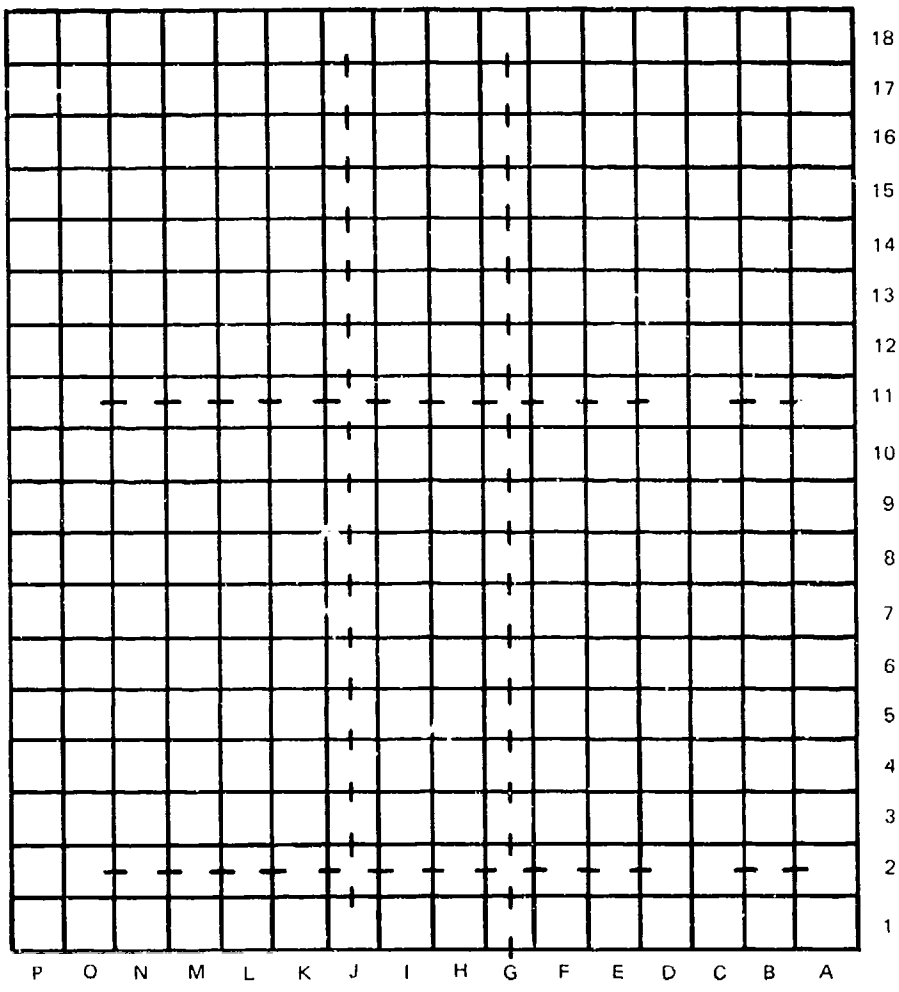
Joint No.	Slab Rocking - mm/s Wheel #1	Slab Rocking - mm/s Wheel #2
[illegible]	.001	.001
[illegible]	.001	0
[illegible]	.002	.001
[illegible]	.001	.001
[illegible]	.002	.001
[illegible]	.002	.002
[illegible]	0	.001
[illegible]	.001	.001
[illegible]	.001	0
[illegible]	.002	.001
[illegible]	.002	.002
[illegible]	.003	.003
[illegible]	.001	.001
[illegible]	.003	.002
[illegible]	0	0
[illegible]	0	0
[illegible]	0	.001
[illegible]	0	0
[illegible]	.001	0
[illegible]	.001	0
[illegible]	.001	0
[illegible]	.002	0
[illegible]	.001	.003
[illegible]	.002	.002
[illegible]	.002	.001
[illegible]	.001	0
[illegible]	.001	.002
[illegible]	.001	.002
[illegible]	.001	.001
[illegible]	.001	0

TABLE C1 (cont)

SLAB TESTING
NOVEMBER 2, 1982
TEST SITE NO 1

McDILL AFB

Joint No.	SLAB ROCKING-INCH Wheel #1	Wheel #2
650-675A	.002	.001
650-675B	.001	.002
625-650A	.002	.002
625-650B	.001	.001
600-625 A	.003	.001
600-625 B	.003	.002



LEGEND

2-SLAB NUMBER

JOINT TESTED

SLAB TESTING
11-2-82
MCDILL AFB
TEST AREA 5

PLATE C2

TABLE C2

Slab Testing - Slab Rocking — MacDill AFB
Flower Mesh 2.19CZ
T-L Site #5

	Joint No.	SLAB ROCKING - INCH Wheel #1	Wheel #2
See attached sketch	J 1-2	.010	.003
	J 2-3	.008	.007
	J 3-4	.005	.003
	J 4-5	.010	.007
	J 5-6	.007	.005
	J 6-7	.006	.006
	J 7-8	.004	.002
	J 8-9	.008	.004
	J 9-10	.003	.002
	J 10-11	.006	.004
	J 11-12	.006	.011
	J 12-13	.006	.003
	J 13-14	.005	.002
	J 14-15	.005	.002
	J 15-16	.004	.002
	J 16-17	.004	.002
	J 17-18	.002	.002
	G 17-18	.004	.002
	G 16-17	.004	.002
	G 15-16	.004	.003
	G 14-15	.006	.001
	G 13-14	.006	.004
	G 12-13	.006	.005
	G 11-12	.006	.002
	G 10-11	.007	.004
	G 9-10	.004	.003
	G 8-9	.009	.035
	G 7-8	.024	.009
	G 6-7	.009	.005
	G 5-6	.007	.004
	G 4-5	.003	.004
	G 3-4	.003	.006
	G 2-3	.007	.011
	G 1-2	.003	.003
	G 0-1	.003	.003

TABLE C-2 (Sheet 1)

Mac Dill AFB

Construction - Slab Raising
November 2, 1972
Test Slab #5

Joint No.	SLAB RAISING - INCH	
	When #1	When #2
2 N-O	.004	.002
2 M-N	.010	.004
2 L-M	.006	.003
2 K-L	.007	.003
2 J-K	.006	.003
2 I-J	.006	.003
2 H-I	.005	.003
2 G-H	.003	.004
2 F-G	.005	.003
2 E-F	.006	.004
2 D-E	.007	.004
2 B-C	.004	.005
2 A-B	.002	.002
11 A-B	.005	.005
11 B-C	.009	.003
11 D-E	.005	.003
11 E-F	.004	.003
11 F-G	.001	.001
11 G-H Center	.010	.006
11 G-H Middle	.009	.006
11 H-I	.006	.005
11 I-J	.004	.003
11 J-K	.006	.003
11 K-L	.005	.003
11 L-M	.005	.002
11 M-N	.001	.005
11 N-O	.003	.005

TEST DATA FROM WATERWAYS EXPERIMENT STATION

Data Collected with WES 16-kip vibrator
and WES Falling Weight Deflectometer
(Dynatest 15-kip FWD)

Table 2

Pavement Condition Rating

of Test Areas

Test Area	PCI	Rating
1	100	Excellent
2	62	Good
3	46	Fair
4	48	Fair
5	95	Excellent

Table 3

Test Data - WES 16-Kip Vibrator

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	DSM kips/in.	Temperature Correction Factor	Corrected DSM kips/in.	Force lb	Deflection, mils Distance from Center of Plate, in. 0	18	36	60
1	A-1	0+12.5	2 Nov 82	1437		6240			15,047	2.31	1.70	1.44	1.17
	A-4	0+87.5		1436		5760			14,643	2.45	1.92	1.62	1.31
	A-7	1+62.5		1435		5850			14,841	2.44	1.85	1.52	1.21
	A-10	2+37.5		1434		6600			14,514	2.02	1.66	1.37	1.09
	A-13	3+12.5		1433		6640			14,480	2.07	1.54	1.26	1.00
	A-16	3+87.5		1433		6040			14,910	2.38	1.89	1.57	1.23
	A-19	4+62.5		1432		5640			14,463	2.50	2.02	1.67	1.33
	A-22	5+37.5		1431		6320			14,895	2.30	1.86	1.53	1.23
	A-25	6+12.5		1430		6240			14,732	2.30	1.84	1.54	1.24
	A-28	6+87.5		1428	94.6	6360			14,854	2.30	1.86	1.57	1.31
	B-2	0+37.5		1438		6400			15,052	2.20	1.75	1.46	1.18
	B-5	1+12.5		1439		6280			14,033	2.14	1.71	1.43	1.17
	B-8	1+87.5		1440		5400			14,585	2.68	1.73	1.46	1.18
	B-11	2+62.5		1441		5560			14,69[illegible]	2.62	1.57	1.31	1.05
	B-14	3+37.5		1442		6880			14,349	2.05	1.57	1.32	1.06
	B-17	4+12.5		1443		5440			14,715	2.67	1.80	1.51	1.22
	B-20	4+87.5		1444		5240			14,444	2.72	1.77	1.46	1.15
	B-23	5+62.5		1444		6920			14,925	2.14	1.70	1.42	1.14
	B-26	6+37.5		1445		6560			14,495	2.20	1.71	1.43	1.17
	C-3	0+62.5		1421		5400			14,223	2.58	1.92	1.63	1.33
	C-6	1+37.5		1421		6360			14,584	2.20	1.76	1.48	1.20
	C-9	2+12.5		1422		6000			14,091	2.19	1.68	1.40	1.11
	C-12	2+87.5		1423		7000			14,466	2.00	1.65	1.37	1.09
	C-15	3+62.5		1424		5880			14,672	2.36	1.80	1.51	1.21
	C-18	4+37.5		1424		5320			14,930	2.71	2.11	1.79	1.44
	C-21	5+12.5		1425		6920			14,704	2.06	1.58	1.28	1.01
	C-24	5+87.5		1426		4400			14,340	3.12	1.83	1.56	1.28
	C-27	6+62.5		1427		5840			14,614	2.39	1.85	1.57	1.30
2	T-2	0+84 8 ft 1f	1 Nov 82	0458	85.8	1860	1.10	2046	4,299	1.47	0.03	0.54	0.37
									9,790	4.08	2.82	1.40	0.90
									14,480	6.63	4.59	2.24	1.37

(Continued)

Table 7 (Continued)

Test Series	Test No.	Station or Location	Date	Time	Surface Temperature °F	DSM kips/in.	Temperature Correction Factor	Corrected DSM kips/in.	Force lb	Deflection, mils Distance from Center of Plate, in. 0	18	36	60
2	A-0+00	722 ft If	1 Nov 82	0402	90.0	1370	1.12	1534	14,793	9.15	6.06	2.74	1.51
	A-1+00			0401		1420		1590	15,056	8.95	5.79	2.70	1.65
	A-2+00			0400		1270		1422	15,686	9.73	5.69	2.73	1.67
	A-3+00			0359		1360		1523	14,484	9.04	5.75	2.72	1.78
	A-4+00			0358		1120		1254	14,081	10.48	6.39	2.83	1.84
	A-5+00			0358		1540		1725	14,706	8.32	4.35	2.03	1.47
	A-6+00			0357		1250		1400	14,336	9.67	6.13	2.83	1.83
	A-7+00			0356		1110		1243	14,616	11.15	6.86	3.15	2.03
	B-0+00	712 ft If		0350		1620		1814	14,330	7.36	4.80	2.45	1.37
	B-0+50			0349		1670		1870	14,731	7.65	5.22	2.53	1.44
	B-1+00			0346		1820		2038	14,239	6.56	4.45	2.27	1.33
	B-1+50			0339		1960		2195	14,918	6.69	5.03	2.39	1.33
	B-2+00			0334		1660		1859	14,770	7.72	5.11	2.64	1.52
	B-2+50			0334		1600		1792	14,368	7.90	5.38	2.86	1.64
	B-3+00			0333		1680		1882	15,030	7.80	5.26	2.73	1.65
	B-3+50			0333		1670		1870	14,316	7.39	5.18	2.76	1.75
	B-4+00			0332	91.0	1460	1.13	1650	14,802	8.71	5.86	2.88	1.76
	B-4+50			0332		1710		1932	14,721	7.61	5.40	2.69	1.56
	B-5+00			0331		2220		2509	14,553	5.99	3.52	1.75	1.19
	B-5+50			0330		1840		2079	14,457	7.11	4.89	2.65	1.63
	B-6+00			0330		1880		2124	14,739	6.97	4.65	2.62	1.55
	B-6+50			0329		1550		1751	14,873	8.30	6.19	2.96	1.72
	B-7+00			0328		1530		1729	14,830	8.37	5.88	3.12	1.78
	C-0+00	Center line		0403	90.0	2060	1.12	2307	14,478	6.05	4.13	2.09	1.24
	C-1+00			0404		2260		2531	14,893	5.87	3.84	2.00	1.22
	C-2+00			0405		1900		2128	14,453	6.76	4.16	2.26	1.40
	C-3+00			0405		1720		1926	14,974	7.60	5.03	2.75	1.68
	C-4+00			0406	89.0	2040		2285	14,714	6.47	4.49	2.50	1.59
	C-5+00			0407		2480		2778	14,495	5.48	3.23	1.92	1.43
	C-6+00			0407		1840		2061	14,513	6.76	4.59	2.45	1.58
	C-7+00			0408	89.4	1900		2128	14,344	6.77	4.71	2.71	1.65

(Continued)

Table 3 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	k, psi/in.	Temperature Correction Factor	Corrected k, psi/in.	Force lb	Deflection, mils, Distance from Center of Plate, in. 0	12	36	60
2	P-3450	712 61 62	1 Nov 82	0314	41.0	1520	1.13	2057	17,078	6.62	4.47	2.09	1.13
	P-3450			0315		1720		1681	14,569	7.40	4.73	2.11	1.18
	P-3450			0316		2120		2306	35,186	6.34	4.09	1.82	1.01
	P-3450			0317		1760		1668	14,564	7.28	4.62	2.14	1.22
	P-3450			0318	41.5	1740		1806	14,849	7.27	4.67	2.15	1.30
	P-3450			0320	41.0	1820		1943	14,491	6.78	4.23	1.97	1.11
	P-3450			0322		1620		1631	14,152	7.70	4.97	2.38	1.43
	P-3450			0323		1880		1976	14,638	7.19	5.03	2.51	1.51
	P-3450			0324		1880		2241	15,298	7.37	4.82	2.44	1.44
	P-3450			0324		1720		1921	14,673	7.48	5.07	2.46	1.35
	P-3450			0325		1720		1712	14,734	5.56	3.61	1.55	1.06
	P-3450			0325		1760		1985	14,359	7.38	4.87	2.42	1.51
	P-3450			0326		1720		1988	14,354	7.03	4.68	2.44	1.50
	P-3450			0326		1620		1826	14,758	7.64	5.08	2.55	1.39
	P-3450			0327		1560		1805	14,670	8.32	5.64	2.61	1.45
	P-3450	722 61 61		0342	42.0	1560	1.12	1755	14,388	8.02	5.41	2.53	1.44
	P-3450			0343		1520		1642	14,572	8.26	5.65	2.65	1.51
	P-3450			0343		1440		1666	14,514	8.55	5.87	2.69	1.51
	P-3450			0344		1480		1656	14,353	8.48	5.86	2.75	1.57
	P-3450			0345		1480		1682	14,247	8.44	5.83	2.75	1.57
	P-3450			0354		1540		1741	14,611	7.19	4.88	2.44	1.36
	P-3450			0355		1520		1739	14,555	10.46	7.05	3.06	1.53
	P-3450			0355		1520		1774	14,718	11.31	8.42	3.97	1.74
3	P-3	0+62		0455	39.0	930	1.19	1261	4,238	2.83	1.57	0.73	0.47
		722 61 71							26,642	6.48	4.07	2.02	1.26
									14,224	12.46	7.37	3.30	1.83
	P-3450	722 61 71		0544	57.0	1720		1924	14,729	13.13	8.55	3.82	2.02
	P-3450			0545		1720		1921	14,718	12.92	8.42	3.81	2.04
	P-3450			0546		1720		1923	14,558	13.00	8.45	3.80	2.02
	P-3450			0547		1720		1922	14,641	12.93	8.45	3.84	2.03
	P-3450			0548		1720		1922	14,613	13.34	8.86	4.22	2.44
	P-3450			0549		1720		1924	14,687	13.34	8.83	3.84	2.04
	P-3450			0550		1720		1925	14,555	13.57	8.94	3.87	2.05

(Continued)

(Sheet 3 of 5)

Table 3 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Dᵒ mils	Temperature Correction Factor	Corrected Dᵒ mils	Force lb	Deflection, mils Distance from center of Plate, in. 0	12	24	36
3	A-7+50	712 ft lt	2 Nov 82	0430	99.0	980	1.10	1078	14,857	12.52	7.65	3.00	2.04
	A-8+50			0434		870		957	14,736	11.38	7.43	2.85	1.83
	A-9+50			0438		848		933	14,949	12.38	7.52	3.00	1.99
	C-0+00	Center line		0441		1770		2177	14,851	11.59	7.47	3.61	2.03
	C-1+00			0445	99.1	660		812	14,712	12.97	8.52	4.28	1.50
	C-2+00			0450	99.0	1000		1100	14,873	11.47	7.49	3.75	2.26
	C-3+00			0453		1000		1100	14,742	11.65	8.03	4.03	2.35
	C-4+00			0457		560		616	14,824	13.54	8.14	3.86	2.17
	C-5+00			0500		550		605	14,873	12.22	8.21	3.84	2.24
	C-6+00			0504		550		605	14,778	11.26	8.06	4.47	1.95
	C-7+00			0508		1020		1122	15,010	12.11	7.86	3.58	2.30
	C-8+00			0511		1210		1331	14,778	10.11	6.78	3.50	2.17
	C-9+00			0515		1065		1172	14,465	10.77	7.42	3.24	1.95
	C-10+00			0518		1060		1166	14,612	11.34	7.23	3.49	2.12
	B-0+00	712 ft rt		0445	97.0	820		902	14,691	14.03	8.69	3.29	1.96
	B-1+00			0446		820		902	14,755	13.12	8.35	3.53	2.23
	B-2+00			0447		820		902	14,978	13.73	8.91	3.35	2.15
	B-3+00			0448		730		803	14,816	14.53	9.46	3.46	2.06
	B-4+00			0449		710		781	14,653	15.90	10.41	3.67	2.17
	B-5+00			0449		720		847	14,654	15.23	10.53	3.57	2.07
	B-6+00			0449		650		748	14,395	16.68	10.68	4.00	2.43
	B-7+00			0450		820		857	14,722	14.04	9.52	3.75	2.16
	B-8+00			0450		690		1069	14,215	12.45	7.95	3.18	2.11
	B-9+00			0451		950		1045	14,836	12.76	7.58	2.92	1.78
	B-10+00			0452	99.5	1120		1232	14,745	11.29	7.03	2.62	1.77
4	7-4		2 Nov 82	1538	101.0	2940	1.16	3284	4,345	1.40	1.25	0.92	0.66
									9,147	3.48	2.93	2.11	1.46
									14,697	4.90	4.15	2.97	2.07
	1			1513	101.0	2420		2807	14,751	5.89	4.84	3.35	2.27
	2			1514	100.7	2480		2877	14,326	5.71	5.03	3.71	2.66
	J-3			1516	101.0	1900		2204	14,846	7.36	5.81	3.76	2.38
	4			1517	101.0	1940		2250	14,218	6.93	5.60	3.92	2.59

(Continued)

(Sheet 4 of 6)

Table 3 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	DSM kips/in.	Temperature Correction Factor	Corrected DSM kips/in.	Force lb	Deflection, mils Distance from Center of Plate, in. 0	18	36	60
4	5		2 Nov 82	1518	101.0	2580	1.16	2993	14,348	5.48	4.54	3.27	2.26
	6			1520		2620		3039	14,611	5.47	4.42	3.20	2.32
	7			1521		2160		2506	14,618	6.56	5.56	3.99	2.77
	J-8			1524		1780		2065	14,529	7.51	5.14	3.15	2.12
	9			1532		2300		2668	14,737	6.26	5.23	3.59	2.43
	10			1542		2360		2738	14,739	6.12	5.11	3.40	2.32
	J-11			1544		1940		2250	14,432	7.04	5.64	3.74	2.56
	12			1546		2300		2668	14,966	6.34	5.22	3.62	2.53
	J-13			1547		1330		1543	14,618	10.09	7.99	4.93	3.40
	14			1549		1720		1995	14,571	8.07	6.90	5.33	4.18
	15			1551		1910		2216	14,535	7.46	6.25	4.45	3.32
	16			1552		2000		2320	14,735	7.19	6.04	4.46	3.08
5	A-1			0838		2620			14,322	5.32	3.95	2.80	2.10
	E-1			0840		2780			14,184	5.05	4.21	3.06	2.17
	I-1			0840		2400			14,657	6.04	4.48	3.11	2.07
	M-1			0841		2740			14,779	5.38	4.54	3.27	2.35
	N-3			0844		2800			14,462	5.16	4.03	2.92	2.20
	J-3			0853		2520			14,574	5.59	4.55	3.23	2.31
	F-3			0855		2500			14,593	5.79	4.29	2.99	2.03
	B-3			0855		2900			14,416	4.95	4.01	2.75	1.97
	G-5			0900		2220			14,937	6.62	5.19	3.77	2.81
	K-5			0901		2380			14,619	5.80	4.46	3.09	2.21
	O-5			0903		2720			14,575	5.30	4.03	2.92	2.16
	M-7			0907		2720			14,482	5.23	4.23	2.94	2.08
	I-7			0909		2520			14,350	5.64	4.35	3.20	2.34
	F-7			0909		2360			14,650	5.76	4.43	3.09	2.14
	D-9			0920		2380			14,300	5.87	4.73	3.35	2.22
	F-9			0922		2480			14,301	5.55	4.62	3.34	2.43
	J-9			0923		2620			14,492	5.40	4.25	3.12	2.33
	O-11			0929		2760			14,893	5.24	4.20	3.17	2.44
	K-11			0930		2700			14,620	5.29	4.09	2.97	2.15
	G-11			0931		2400			14,051	5.68	4.31	3.11	2.16

(Continued)

Table 3 (Concluded)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	DSM kips/in.	Temperature Correction Factor	Corrected DSM kips/in.	Force lb	Deflection, mils Distance from Center of Plate, in. 0	18	36	60
5	C-11		2 Nov 82	0931		2380			14,674	6.01	5.04	3.72	2.64
	A-13			0933		2340			14,664	6.05	5.10	3.60	2.49
	E-13			0934		2740			14,464	5.27	4.38	3.22	2.40
	I-13			0934		2440			14,581	5.96	4.97	3.48	2.31
	M-13			0935		2760			14,401	5.07	4.12	2.97	2.26
	N-15			0937		2720			14,595	5.17	4.03	2.92	2.13
	J-15			0933		2520			15,087	5.88	4.73	3.40	2.50
	F-15			0939		2580			14,584	5.53	4.28	3.06	2.16
	B-15			0939		2720			14,522	5.27	4.18	3.02	1.99
	C-17			0941		2720			14,530	5.26	4.52	5.63	2.18
	G-17			0943		2700			14,748	5.41	4.49	3.34	2.47
	K-17			0944		2200			14,545	6.55	5.38	4.09	2.96
	O-17			0945		2900			14,863	5.06	4.09	3.00	2.17
	L-18			0948		2600			14,952	5.69	4.78	3.60	2.72
	H-18			0949		2740			14,619	5.30	4.32	3.12	2.28

Table 4

Test Data WES 16 kip Vibrator - Joint Tests

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	PSI Edge of Slab kips/in.	Force lb	Deflection, mils Distance from Center of Plate, in. 0	18	Deflection Ratio
1	TJ-1	C3-C2	2 Nov 82	1152	89.1	4720	14,270	2.93	2.32	0.79
	TJ-2	C12-C11		1158		4,700	14,872	3.42	2.10	0.61
	TJ-3	C21-C20		1200		5720	14,401	2.44	1.62	0.69
	TJ-4	A22-A23		1210		3420	14,715	4.20	1.93	0.46
	TJ-5	A13-A14		1211		5800	14,579	2.40	2.00	0.83
	TJ-6	A4-A5		1213		4960	14,741	2.82	2.35	0.83
	TJ-7	B2-B1		1215		1580	14,582	6.03	1.59	0.39
	TJ-8	B11-B10		1218		5520	14,523	2.55	1.89	0.74
	TJ-9	B20-B19		1219		3600	14,592	4.08	1.58	0.39
	TJ-10	B26-B25		1220		4560	14,325	3.06	1.85	0.60
	LJ-11	A1-B1		1224		3660	14,368	3.82	1.79	0.47
	LJ-12	B5-A5		1226		4080	14,479	3.11	1.98	0.64
	LJ-13	B8-C8		1227		3650	13,851	3.71	1.58	0.43
	LJ-14	C12-B12		1229		5040	14,529	2.86	1.88	0.67
	LJ-15	A16-B16		1230		3840	14,097	3.67	1.30	0.35
	LJ-16	C18-B18		1232		3760	14,281	3.78	1.47	0.38
	LJ-17	B20-C20		1233		3420	14,156	4.09	1.35	0.33
	LJ-18	B23-A23		1234		5560	14,441	2.47	1.75	0.71
	LJ-19	B26-C26		1236		3960	14,328	3.65	2.12	0.58
5	TJ-1	J15-J16		1019		2100	4,566	1.98	1.66	0.84
							10,009	4.55	3.83	0.84
							14,586	6.71	5.59	0.83
	TJ-2	J17-J18		1021		1790	14,401	7.54	4.97	0.66
	TJ-3	J19-J20		1023		2060	14,178	6.76	5.75	0.85
	TJ-4	J6-J7		1025		1610	14,747	8.76	5.22	0.59
	TJ-5	J3-J4		1026		1770	14,611	7.89	6.16	0.81
	TJ-6	G5-G4		1029		1570	14,547	8.76	5.86	0.67
	TJ-7	G8-G7		1030		1850	14,217	7.51	6.22	0.83
	TJ-8	G11-G10		1031		1740	14,904	7.91	6.13	0.77
	TJ-9	G14-G13		1032		1760	14,552	7.92	4.65	0.59
	TJ-10	G17-G16		1033		2399	14,617	6.22	5.15	0.83
	LJ-11	A1-B1		1040		1740	14,601	7.87	3.91	0.50
	LJ-12	L1-L1		1042		1420	14,700	10.15	3.49	0.34
	LJ-13	G1-H1		1046		1580	14,606	8.17	5.92	0.71
	LJ-14	I1-J1		1045		1770	14,765	7.81	4.86	0.62
	LJ-15	H1-N1		1049		1680	14,823	8.62	4.04	0.47
	LJ-16	G11-B11		1048		1340	14,417	10.05	4.28	0.42
	LJ-17	G11-I11		1049		1560	14,735	8.67	5.17	0.60
	LJ-18	K11-J11		1040		1960	14,618	7.13	5.43	0.76
	LJ-19	G11-N11		1041		1960	14,661	7.10	3.31	0.47
	J1	J2-I2		1052		1840	14,560	7.22	5.49	0.76
	2	J2		1056		2560	14,772	5.61	4.75	0.85
	J3	K2-I2		1057		1800	14,410	7.34	5.04	0.69
	J4	J2-I1		1108		1760	14,552	7.87	4.88	0.62
	J5	J3-I2		1108		1680	14,527	7.96	5.50	0.70
	J6	J2-I1		1104		1470	14,624	9.07	3.81	0.42
	J7	J3-I2		1105		1190	14,466	9.30	7.07	0.76

Table 5

Test Data - Falling Weight Deflectometer

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils: Distance from Center of Plate, in. 0	12	24	36	48
1	A-1	0+12.5	3 Nov 82		91.0	14,428	1.77	1.57	--	1.42	--
						14,269	1.73	1.54	--	1.38	--
						14,428	1.73	--	1.38	--	1.14
						14,476	1.73	--	1.42	--	1.06
	A-4	0+87.5				14,587	2.01	1.73	--	1.50	--
						14,587	2.01	1.73	--	1.42	--
						14,506	1.89	--	1.61	--	1.26
						14,571	1.97	--	1.61	--	1.30
	A-7	1+62.5		10:50	91.3	14,365	2.01	1.69	--	1.34	--
						14,460	2.05	1.73	--	1.50	--
						14,380	2.05	--	1.50	--	1.14
						14,317	2.01	--	1.50	--	1.18
	A-10	2+37.5			91.0	14,476	2.05	1.54	--	1.42	--
						14,380	2.01	1.65	--	1.46	--
						14,269	2.05	--	1.57	--	1.18
						14,396	2.01	--	1.57	--	1.18
	A-13	3+12.5				14,317	2.13	1.57	--	1.42	--
						14,412	2.09	1.57	--	1.42	--
						14,444	2.17	--	1.46	--	1.14
						14,396	2.05	--	1.50	--	1.18
	A-16	3+87.5				14,317	2.20	1.61	--	1.50	--
						14,269	2.17	1.69	--	1.38	--
						14,253	2.17	--	1.54	--	1.26
						14,285	2.20	--	1.50	--	1.26
	A-19	4+62.5			92.0	14,285	2.17	1.81	--	1.34	--
						14,333	2.13	1.85	--	1.50	--
						14,333	2.09	--	1.61	--	1.34
						14,317	2.17	--	1.65	--	1.34
	A-22	5+37.5				14,365	1.97	1.69	--	1.30	--
						14,396	2.05	1.65	--	1.34	--
						14,317	2.01	--	1.57	--	1.22
						14,380	1.93	--	1.54	--	1.26
	A-25	6+12.5				14,285	1.89	1.46	--	1.22	--
						14,285	1.77	1.54	--	1.22	--
						14,285	1.69	--	1.50	--	1.14
						14,301	1.81	--	1.42	--	1.10
	A-28	6+87.5				14,333	1.73	1.50	--	1.22	--
						14,380	1.73	1.46	--	1.22	--
						14,285	1.69	--	1.46	--	1.14
						14,333	1.69	--	1.38	--	1.18
	B-2	0+37.5				14,126	1.89	1.57	--	1.30	--
						14,174	1.89	1.50	--	1.34	--
						14,301	1.89	--	1.46	--	1.14
						14,253	1.85	--	1.46	--	1.14
	B-5	1+12.5				14,476	1.85	1.65	--	1.42	--
						14,333	1.85	1.73	--	1.42	--
						14,333	2.01	--	1.57	--	1.30
						14,349	1.97	--	1.61	--	1.26

(Continued)

(Sheet 1 of 15)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
1	B-8	1+87.5	3 Nov 82		92.0	14,253	1.73	1.57	--	1.30	--
						14,333	1.73	1.57	--	1.30	--
						14,301	1.73	--	1.42	--	1.18
						14,349	1.77	--	1.50	--	1.14
	B-11	2+62.5				14,158	1.61	1.50	--	1.22	--
						14,126	1.65	1.54	--	1.26	--
						14,206	1.69	--	1.54	--	1.10
						14,174	1.73	--	1.46	--	1.14
	B-14	3+37.5				14,301	1.85	1.57	--	1.30	--
						14,333	1.69	1.54	--	1.30	--
						14,333	1.77	--	1.42	--	1.18
						14,365	1.73	--	1.42	--	1.22
	B-17	4+12.5				14,317	1.81	1.77	--	1.38	--
						14,269	1.77	1.85	--	1.42	--
						13,936	1.81	--	1.46	--	1.22
						14,285	1.73	--	1.50	--	1.26
	B-20	4+87.5				14,444	1.81	1.61	--	1.38	--
						14,460	1.85	1.65	--	1.38	--
						14,460	1.81	--	1.38	--	1.22
						14,460	1.81	--	1.42	--	1.18
	B-23	5+62.5				14,365	1.73	1.42	--	1.22	--
						14,380	1.61	1.46	--	1.14	--
						14,301	1.65	--	1.30	--	1.06
						14,301	1.65	--	1.26	--	1.06
	B-26	6+37.5				14,333	1.65	1.50	--	1.26	--
						14,365	1.65	1.50	--	1.26	--
						14,380	1.69	--	1.34	--	1.10
						14,365	1.65	--	1.38	--	1.10
	C-3	0+62.5				14,237	1.89	1.69	--	1.42	--
						14,253	1.89	1.54	--	1.42	--
						14,269	1.89	--	1.69	--	1.34
						15,159	1.97	--	1.77	--	1.38
	C-6	1+37.5				14,110	1.85	1.77	--	1.34	--
						14,222	1.85	1.85	--	1.30	--
						14,301	1.85	--	1.54	--	1.14
						14,222	1.81	--	1.50	--	1.14
	C-9	2+12.5				14,094	1.65	1.54	--	1.26	--
						14,126	1.77	1.61	--	1.30	--
						14,237	1.69	--	1.26	--	1.18
						14,110	1.73	--	1.26	--	1.30
	C-12	2+87.5			93.0	14,253	1.97	1.65	--	1.46	--
						14,349	1.93	1.69	--	1.46	--
						14,333	1.93	--	1.85	--	1.30
						14,380	1.93	--	1.61	--	1.18
	C-15	3+62.5				14,444	1.81	1.61	--	1.34	--
						14,476	1.81	1.61	--	1.34	--
						14,221	1.81	--	1.54	--	1.22
						14,476	1.81	--	1.57	--	1.26

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
1	C-18	4+37.5	3 Nov 82		93.0	14,174	2.20	1.81	--	1.54	--
						14,269	2.13	1.85	--	1.54	--
						14,349	2.20	--	1.61	--	1.38
						14,301	2.24	--	1.77	--	1.38
	C-21	5+12.5				14,476	1.65	1.50	--	1.22	--
						14,492	1.57	1.18	--	1.26	--
						14,285	1.61	--	1.34	--	1.10
						14,460	1.61	--	1.26	--	1.14
	C-24	5+87.5				13,983	1.97	1.50	--	1.18	--
						14,237	1.89	1.54	--	1.22	--
						14,285	1.93	--	1.42	--	1.10
						14,269	1.93	--	1.38	--	1.10
	C-27	6+62.5		11:30		14,142	1.97	1.50	--	1.30	--
						14,333	1.97	1.61	--	1.30	--
						13,999	1.97	--	1.46	--	1.14
						14,078	1.97	--	1.42	--	1.26
2	T-2	0+84 8 ft lf		2:10	97.0	4,036	2.17	1.50	--	0.63	--
						4,052	2.24	1.54	--	0.63	--
						3,988	2.32	--	0.94	--	0.47
						4,020	2.28	--	0.94	--	0.47
						8,755	5.08	3.54	--	1.42	--
						8,771	5.04	3.54	--	1.42	--
						8,740	5.31	--	2.28	--	1.06
						8,740	5.31	--	2.28	--	1.06
						14,174	8.62	6.06	--	2.44	--
						14,253	8.70	6.10	--	2.52	--
						14,206	8.74	--	3.90	--	1.77
						14,190	8.66	--	3.86	--	1.77
	A-0+00	≈22 ft lf			98.0	13,983	14.80	8.62	--	3.15	--
						14,094	14.09	8.62	--	3.19	--
						14,047	13.70	--	5.08	--	2.20
						--	--	--	--	--	--
	A-1+00					14,110	12.13	8.15	--	2.87	--
						14,126	12.09	8.15	--	2.91	--
						14,047	12.52	--	4.84	--	2.01
						14,110	12.32	--	4.84	--	2.05
	A-2+00				97.0	14,158	16.38	9.41	--	2.68	--
						14,126	15.63	9.25	--	2.72	--
						14,126	15.43	--	4.96	--	1.93
						14,158	15.31	--	5.04	--	1.93
	A-3+00					14,078	14.57	9.02	--	2.87	--
						14,094	14.45	9.06	--	2.83	--
						14,031	15.75	--	4.92	--	--
						14,031	14.92	--	4.80	--	1.89
	A-4+00					14,078	20.08	10.35	--	2.72	--
						14,126	18.90	10.08	--	2.80	--
						14,126	18.19	--	4.80	--	1.93
						14,110	18.74	--	4.96	--	1.93

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
2	A-5+00	≈22 ft lf	3 Nov 82		97.0	14,063	15.24	7.72	--	1.73	--
						14,078	15.00	7.72	--	1.69	--
						14,031	16.77	--	3.50	--	1.26
						14,031	15.79	--	3.43	--	1.30
	A-6+00	≈22 ft lf				14,063	19.92	10.31	--	2.83	--
						14,078	18.27	10.00	--	2.83	--
						14,063	17.68	--	4.80	--	2.01
						14,078	17.28	--	4.84	--	2.01
	A-700					13,729	17.28	10.39	--	2.99	--
						14,047	17.28	10.83	--	3.03	--
						13,935	18.70	--	5.31	--	1.93
						14,031	17.60	--	5.28	--	2.01
	B-0+00	≈12 ft lf				14,063	10.28	6.97	--	2.83	--
						--	--	--	--	--	--
						14,174	10.24	--	4.41	--	1.93
						14,190	10.24	--	4.41	--	1.97
	B-0+50					14,078	9.96	6.46	--	2.68	--
						14,094	9.84	6.40	--	2.68	--
						14,063	11.02	--	4.09	--	1.89
						14,047	10.16	--	4.13	--	1.93
	B-1+00					14,206	9.37	5.87	--	2.52	--
						14,126	8.98	5.94	--	2.56	--
						14,142	10.00	--	3.86	--	1.81
						--	--	--	--	--	--
	B-1+50					14,190	8.11	5.75	--	2.56	--
						14,221	7.99	5.75	--	2.68	--
						14,190	8.03	--	3.82	--	1.89
						14,253	7.91	--	3.66	--	1.85
	B-2+00					14,237	9.72	6.65	--	2.68	--
						14,221	9.69	6.50	--	2.40	--
						14,206	9.80	--	4.09	--	1.77
						14,253	9.76	--	4.13	--	1.85
	B-2+50					13,872	11.61	6.77	--	2.68	--
						14,015	11.18	6.81	--	2.72	--
						14,031	11.14	--	4.33	--	1.93
						14,126	11.18	--	4.33	--	1.93
	B-3+00					14,158	9.69	3.94	--	1.73	--
						14,206	9.37	4.02	--	1.77	--
						14,174	9.41	--	6.46	--	2.52
						14,206	9.53	--	6.50	--	2.44
	B-3+50					13,999	10.51	6.30	--	2.44	--
						14,063	10.20	6.34	--	2.48	--
						14,063	9.96	--	3.70	--	1.61
						14,094	9.96	--	3.98	--	1.69
	B-4+00					14,190	9.65	6.54	--	2.44	--
						14,158	9.57	6.57	--	2.44	--
						14,126	9.41	--	4.06	--	1.77
						14,142	9.49	--	4.09	--	1.81
	B-4+50					14,158	9.33	6.06	--	2.28	--
						14,190	9.09	6.06	--	2.36	--
						14,110	8.94	--	3.70	--	1.50
						14,174	8.94	--	3.66	--	1.61

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
2	B-5+00	712 ft 11	3 Nov 82		97.0	14,094	9.21	5.39	--	1.54	--
						14,206	9.29	5.43	--	1.61	--
						14,126	9.69	--	2.80	--	1.14
						14,190	9.45	--	2.83	--	1.14
	B-5+50					14,063	8.31	5.63	--	2.44	--
						14,206	8.15	5.67	--	2.48	--
						14,206	8.11	--	3.78	--	1.77
						14,190	8.03	--	3.74	--	1.77
	B-6+00					14,158	7.40	5.47	--	2.28	--
						14,301	7.36	5.63	--	2.36	--
						14,142	7.44	--	3.54	--	1.69
						14,237	7.52	--	3.58	--	1.73
	B-6+50					--	10 83	7.01	--	2.80	--
						13,999	10.59	7.01	--	2.76	--
						13,983	10.39	-	4.33	--	2.05
						14,063	10.47	--	4.37	--	2.09
	B-7+00					14,094	10.08	7.20	--	2.80	--
						14,253	10.20	7.32	--	2 87	--
						14,158	10.59	--	4.76	--	2.09
						14,237	10.35	--	4.72	--	2.09
	C-0+00	Center Line			98.0	14,126	9.02	5.04	--	2.24	--
						14,110	8.78	5.17	--	2.20	--
						14,078	9.33	--	3.43	--	1.61
						--	--	--	--	--	--
	C-1+00					14,158	6.77	4.65	--	2.05	--
						14,206	6.81	4.65	--	2.01	--
						14,237	6.77	--	3.39	--	1.65
						14,237	6.89	--	3.07	--	1.46
	C-2+00					14,110	8.39	4.76	--	1.97	--
						14,158	8.23	5.08	--	2.20	--
						14,110	8.90	--	3.31	--	1.61
						14,094	8.58	--	3.27	--	1.69
	C-3+00					14,047	11.22	5.91	--	2.44	--
						14,094	10.43	5.91	--	2.48	--
						14,094	9.92	--	3.70	--	1.73
						14,078	9.72	--	3.74	--	1.73
	C-4+00					14,078	9.49	5.35	--	2.20	--
						--	--	--	--	--	--
						14,015	10.59	--	3.46	--	1.54
						14,047	9.96	--	3.46	--	1.54
	C-5+00					13,983	8.11	4.53	--	1.81	--
						13,999	7.83	[illegible]	--	1.85	--
						14,094	7.56	--	2.91	--	1.42
						14,094	7.40	--	2.91	--	1.42
	C-6+00					13,967	9.72	4.88	--	2.13	--
						14,047	9.49	4.88	--	2.20	--
						14,047	11.50	--	3.27	--	1.61
						14,015	10.31	--	3.31	--	1.61
	C-7+00			2:50		14,110	9.49	6.30	--	2.87	--
						14,110	9.17	6.22	--	2.87	--
						14,094	9.09	--	4.13	--	2.01
						14,063	8.98	--	4.17	--	2.01

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils, Distance from Center of Plate, in. 0	12	24	36	48
2	D-0+00	≈12 ft rt	3 Nov 82		97.0	14,190	9.06	6.22	--	2.44	--
						14,317	9.09	6.46	--	2.44	--
						14,301	9.02	--	3.82	--	1.73
						14,333	9.13	--	3.82	--	1.73
	D-0+50					14,349	10.00	6.61	--	2.36	--
						14,349	9.96	6.65	--	2.36	--
						14,206	10.12	--	3.78	--	1.65
						14,301	9.96	--	3.86	--	1.69
	D-1+00					14,253	8.58	5.43	--	1.97	--
						14,237	8.39	5.35	--	2.05	--
						14,237	8.27	--	3.23	--	1.42
						14,158	8.31	--	3.58	--	1.30
	D-1+50					14,142	11.22	7.28	--	2.52	--
						14,174	11.10	7.36	--	2.56	--
						14,174	11.77	--	4.02	--	1.77
						14,174	11.42	--	4.09	--	1.77
	D-2+00					14,206	10.55	6.85	--	2.32	--
						14,269	10.35	6.69	--	2.40	--
						14,269	10.39	--	3.90	--	1.61
						14,285	10.31	--	3.86	--	1.65
	D-2+50					14,110	8.50	5.75	--	2.09	--
						14,269	8.43	5.83	--	2.17	--
						14 174	8.86	--	3.27	--	1.46
						14,253	8.62	--	3.35	--	1.46
	D-3+00					14,174	11.38	7.09	--	2.40	--
						14,190	10.79	7.01	--	2.44	--
						14,142	10.43	--	3.82	--	1.73
						14,221	10.39	--	3.90	--	1.73
	D-3+50					14,158	10.31	6.61	--	2.44	--
						14,206	10.28	6.57	--	2.40	--
						14,142	10.55	--	3.94	--	1.73
						14,158	10.47	--	3.94	--	1.77
	D-4+00					14,094	9.33	5.51	--	2.28	--
						14,158	9.06	5.43	--	2.20	--
						14,158	8.86	--	3.31	--	1.54
						14,190	8.82	--	3.39	--	1.57
	D-4+50					14,221	9.33	6.38	--	2.56	--
						14,269	9.29	6.54	--	2.60	--
						14,174	9.53	--	4.02	--	1.81
						14,221	9.41	--	4.06	--	1.81
	D-5+00					14,174	9.13	5.12	--	1.73	--
						14,190	8.90	5.08	--	1.73	--
						14,126	8.70	--	2.95	--	1.22
						14,158	8.62	--	3.03	--	1.22
	D-5+50					14,063	9.17	6.26	--	2.64	--
						14,174	9.02	6.46	--	2.76	--
						14,126	9.84	--	4.17	--	1.93
						14,126	9.21	--	4.13	--	2.05

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
2	D-6+00	≈12 ft rt	3 Nov 82		97.0	14,110	9.92	6.10	--	2.52	--
						14,174	9.25	6.10	--	2.56	--
						14,126	8.82	--	3.78	--	1.81
						14,206	8.86	--	3.82	--	1.89
	D-6+50					14,047	10.20	6.50	--	2.48	--
						14,110	10.20	6.57	--	2.48	--
						14,063	10.59	--	3.98	--	1.73
						14,078	10.31	--	3.98	--	1.77
	D-7+00					14,110	12.56	8.03	--	2.76	--
						14,158	12.20	7.91	--	2.80	--
						14,174	11.97	--	4.61	--	2.01
						14,174	11.97	--	4.69	--	2.01
	E-0+00	≈22 ft rt				14,126	12.76	8.11	--	2.83	--
						14,094	12.68	7.99	--	2.83	--
						14,047	12.95	--	4.80	--	2.13
						--	--	--	--	--	--
	E-1+00					14,063	13.43	7.68	--	2.20	--
						14,142	12.80	7.56	--	2.24	--
						14,142	12.72	--	3.94	--	1.65
						14,158	12.64	--	3.94	--	1.65
	E-2+00					14,078	12.91	8.11	--	2.64	--
						14,158	12.95	8.15	--	2.72	--
						14,094	13.27	--	4.53	--	1.89
						14,094	13.07	--	4.53	--	1.89
	E-3+00					14,047	16.89	8.90	--	2.60	--
						14,078	15.47	8.74	--	2.64	--
						14,078	14.76	--	4.53	--	1.89
						14,110	14.61	--	4.37	--	1.89
	E-4+00					14,047	10.28	7.01	--	2.32	--
						14,110	10.79	7.17	--	2.44	--
						14,047	11.54	--	4.09	--	1.65
						14,094	11.06	--	4.09	--	1.69
	E-5+00					14,063	12.52	7.52	--	1.97	--
						14,110	12.09	7.32	--	1.89	--
						14,110	12.05	--	3.39	--	1.30
						14,126	11.97	--	3.43	--	1.34
	E-6+00					14,047	15.47	9.88	--	3.23	--
						14,078	15.35	9.84	--	3.27	--
						14,031	16.61	--	5.43	--	2.28
						14,047	16.34	--	5.51	--	2.32
	E-7+00					13,904	23.46	11.54	--	2.87	--
						13,951	21.46	11.02	--	2.95	--
						14,047	20.55	--	5.20	--	2.13
						14,078	20.31	--	5.16	--	2.13
3	T-3				92.0	3,957	9.57	4.25	--	0.75	--
						3,909	9.33	4.13	--	0.75	--
						3,988	11.02	--	1.38	--	0.51
						3,941	10.12	--	1.42	--	0.51

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
3	T-3	≈22 ft rt	3 Nov 82		92.0	8,708	18.50	9.09	--	1.69	--
						8,724	18.46	9.17	--	1.61	--
						8,708	19.65	--	3.15	--	1.22
						8,724	19.13	--	3.15	--	1.22
						14,078	27.72	14.61	--	2.56	--
						14,047	27.68	14.76	--	2.60	--
						14,047	29.13	--	5.08	--	1.85
						14,047	28.82	--	5.16	--	1.89
	A-0+50	≈12 ft lf				14,094	27.99	15.04	--	2.83	--
						14,110	24.40	14.76	--	2.91	--
						14,078	26.42	--	5.63	--	1.93
						14,126	25.98	--	5.63	--	1.89
	A-1+50					13,983	29.25	15.43	--	3.35	--
						13,999	27.72	15.28	--	3.54	--
						14,047	26.97	--	6.22	--	2.48
						14,078	26.97	--	6.46	--	2.52
	A-2+50					13,983	27.95	15.91	--	4.02	--
						13,983	27.68	15.83	--	4.13	--
						14,047	29.09	--	7.52	--	2.56
						13,983	28.39	--	7.28	--	2.36
	A-3+50					14,063	29.57	16.26	--	3.54	--
						14,470	28.23	15.83	--	3.50	--
						13,951	27.40	--	6.42	--	2.24
						14,063	27.09	--	6.38	--	2.20
	A-4+50					13,872	21.34	11.61	--	4.17	--
						13,999	21.50	11.02	--	4.21	--
						13,872	22.87	--	5.98	--	3.07
						13,904	22.28	--	6.06	--	3.07
	A-5+50					13,983	27.56	14.88	--	3.39	--
						13,935	26.42	14.53	--	3.39	--
						13,951	25.79	--	6.34	--	2.32
						13,951	25.47	--	6.34	--	2.32
	A-6+50					13,872	28.62	14.80	--	2.99	--
						13,904	28.03	14.76	--	3.11	--
						13,856	30.59	--	5.79	--	2.17
						13,920	29.29	--	5.79	--	2.20
	A-7+50					13,920	26.97	13.19	--	2.76	--
						13,888	25.55	12.87	--	2.80	--
						13,920	25.51	--	5.08	--	2.01
						13,920	25.91	--	5.08	--	2.05
	A-8+50					13,872	24.84	13.90	--	2.64	--
						13,904	25.00	13.46	--	2.60	--
						13,872	27.17	--	5.28	--	1.85
						13,920	25.67	--	5.24	--	1.89
	A-9+50					13,840	27.56	14.41	--	3.15	--
						13,888	26.85	14.29	--	3.11	--
						13,840	26.34	--	5.94	--	2.17
						13,856	26.18	--	6.02	--	2.20

(Continued)

Table 5 (Continued)

Test Grid	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
3	C-0+00	Center line	3 Nov 82	3:43	92.1	13,824	15.31	10.47	--	3.67	--
						14,031	15.55	10.63	--	3.78	--
						14,078	16.18	--	6.34	--	2.40
						14,047	15.83	--	6.22	--	2.20
	C-1+00				92.0	14,063	17.48	11.10	--	4.17	--
						14,078	17.12	10.98	--	4.21	--
						13,824	16.13	--	6 46	--	2.52
						13,983	16.61	--	6 61	--	2.80
	C-2+00					14,047	16.16	10.24	--	3.31	--
						14,094	16.80	10.72	--	3 35	--
						14,156	16.73	--	5.79	--	2.20
						14,078	16.50	--	5.71	--	2.24
	C-3+00					14,063	16.73	11.02	--	4.21	--
						13,999	16.20	10.91	--	4.21	--
						13,967	16.02	--	6.34	--	2.60
						14,015	15 91	--	6.28	--	2.52
	C-4+00					13,951	23.39	13.90	--	4.21	--
						13,935	23.27	13.78	--	4.06	--
						13,983	24.25	--	7.05	--	2.68
						13,904	23.54	--	6.97	--	2.72
	C-5+00				91.6	14,031	26.63	12.01	--	3.90	--
						14,015	19.89	11.85	--	3 90	--
						13,951	19.37	--	6.38	--	2.52
						13,920	19.06	--	6 42	--	2.56
	C-6+00					14,015	20.00	11.18	--	4.13	--
						14,047	19.84	11.27	--	4.13	--
						14,047	20.24	--	6.57	--	2.95
						13,999	20.28	--	6.54	--	2.91
	C-7+00					14,078	17.28	10.63	--	3 43	--
						14,047	16.97	10.63	--	3.54	--
						14,047	16.77	--	5.51	--	2.09
						14,110	16 77	--	5.43	--	2.17
	C-8+00					14,300	15.39	8.82	--	3.35	--
						12,632	15 41	8.78	--	3.43	--
						13,792	15.94	--	5.39	--	2.40
						13,792	15.83	--	5.31	--	2.44
	C-9+00					14,015	18.78	10.12	--	3.11	--
						14,094	18.11	10.16	--	3.07	--
						14,063	17.60	--	5.24	--	2.13
						14,110	17.48	--	5.12	--	2.13
	C-10+00			4:30	90.8	13,808	15.71	9.53	--	3.31	--
						14,015	15.94	9.65	--	3.43	--
						14,031	16.54	--	5.51	--	2.44
						14,047	16.32	--	5.51	--	2.40
	B-0+00	"12 ft W			92.9	13,935	30.31	15.43	--	3.11	--
						13,935	28.46	15 04	--	3.15	--
						14,792	27.32	--	6.06	--	2.09
						13,920	27.13	--	5.91	--	2.13

(Continued)

(Sheet 9 of 15)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
3	B-1+00	≈12 ft rt	3 Nov 82		92.0	13,840	25.39	14.33	--	3.27	--
						13,904	24.96	14.21	--	3.31	--
						13,920	27.48	--	6.14	--	2.32
						13,935	26.30	--	6.22	--	2.28
	B-2+00					13,920	31.38	15.31	--	2.83	--
						13,935	29.88	15.00	--	2.83	--
						13,935	29.49	--	5.47	--	2.09
						13,935	29.02	--	5.39	--	2.01
	B-3+00					13,888	31.50	17.09	--	3.31	--
						13,888	30.98	17.13	--	3.39	--
						13,872	33.94	--	6.89	--	2.20
						13,920	32.72	--	6.73	--	2.24
	B-4+00					13,951	34.29	18.07	--	3.62	--
						13,888	30.67	16.65	--	3.46	--
						13,792	31.30	--	7.68	--	2.28
						13,904	31.14	--	7.76	--	2.24
	B-5+00					13,935	32.32	17.36	--	3.35	--
						13,935	31.18	16.97	--	3.43	--
						13,935	30.43	--	6.97	--	2.17
						13,888	30.04	--	7.13	--	2.17
	B-6+00					13,904	36.55	20.75	--	4.02	--
						13,935	30.47	17.48	--	4.02	--
						13,920	32.28	--	7.72	--	2.56
						13,888	31.14	--	7.87	--	2.56
	B-7+00					14,031	25.55	13.66	--	3.31	--
						13,983	24.72	13.54	--	3.35	--
						13,999	24.37	--	6.10	--	2.28
						13,983	24.13	--	6.18	--	2.36
	B-8+00					13,888	24.41	12.91	--	2.87	--
						13,935	24.13	12.95	--	2.99	--
						13,920	25.75	--	5.47	--	2.01
						13,920	24.84	--	5.55	--	2.05
	B-9+00					13,856	27.60	13.90	--	2.56	--
						13,856	26.46	13.58	--	2.68	--
						13,872	25.47	--	5.16	--	1.81
						13,856	26.42	--	5.24	--	1.85
	B-10+00					13,792	23.62	11.57	--	2.60	--
						13,983	22.60	11.61	--	2.68	--
						13,920	23.98	--	4.76	--	1.85
						13,967	25.24	--	4.76	--	1.85
4	T-4				0	4,338	1.77	1.42	--	1.02	--
						4,290	1.69	1.42	--	0.98	--
						4,306	1.73	--	1.18	--	0.94
						4,338	1.69	--	1.18	--	0.94
						8,771	3.31	2.91	--	2.05	--
						9,010	3.39	2.95	--	2.13	--
						8,946	3.39	--	2.48	--	1.54
						9,137	3.50	--	2.52	--	1.65

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
4	T-4		3 Nov 82		86.0	14,063	5.08	4.57	--	3.27	--
						14,126	5.12	4.57	--	3.31	--
						14,078	5.04	--	3.90	--	2.52
						14,126	5.08	--	3.82	--	2.60
	1					14,221	5.79	5.04	--	3.46	--
						14,285	5.83	5.16	--	3.58	--
						14,206	5.83	--	4.29	--	2.87
						14,285	5.83	--	4.33	--	2.99
	2					14,221	6.10	5.16	--	3.62	--
						14,221	6.02	5.16	--	3.54	--
						14,190	5.87	--	4.41	--	3.03
						14,221	5.87	--	4.25	--	2.83
	J-3					14,031	7.87	4.76	--	3.15	--
						14,047	7.83	4.65	--	3.03	--
						14,078	7.83	--	3.94	--	2.44
						14,063	7.83	--	3.90	--	2.48
	4			5:45		14,094	7.36	5.94	--	4.25	--
						14,126	7.32	5.98	--	4.33	--
						14,126	7.36	--	5.24	--	3.58
						14,126	7.36	--	5.24	--	3.35
	5					14,078	5.79	4.84	--	3.27	--
						14,174	5.83	4.88	--	3.35	--
						14 142	5.91	--	4.29	--	2.80
						14,190	5.87	--	4.29	--	2.72
	6					14,126	5.43	4.45	--	3.07	--
						14,142	5.43	4.45	--	3.11	--
						14,126	5.59	--	3.78	--	2.46
						14,158	5.31	--	3.82	--	2.48
	7					13,935	7.95	5.20	--	3.46	--
						13,951	7.83	5.20	--	3.43	--
						13,967	8.43	--	4.41	--	2.91
						13,983	8.27	--	4.45	--	2.95
	J-8					14,031	8.11	5 94	--	3.43	--
						14,047	8.07	5.94	--	3.50	--
						14,015	8.07	--	4.41	--	2.64
						14,031	8.03	--	4.45	--	2.60
	9					13,983	7.72	6.10	--	3.70	--
						14,094	7.64	6.22	--	3.86	--
						14,063	7.76	--	4.92	--	2.95
						14,078	7.64	--	4.84	--	2.99
	10					14,174	6.10	5 08	--	3.50	--
						14,206	6.06	5.20	--	3.58	--
						14,237	6.14	--	4.45	--	2.83
						14,237	6.10	--	4.45	--	2.80
	J-V					14,094	6.34	5.98	--	3.50	--
						13,951	6.22	5.83	--	3.43	--
						14,031	6.30	--	4.69	--	2.72
						14,094	6.22	--	4.69	--	2.76

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils, Distance from Center of Plate, in. 0	12	24	36	48
4	12		3 Nov 82		86.0	14,126	7.52	5.67	--	3.50	--
						14,174	7.72	5.71	--	3.50	--
						14,110	7.68	--	4.57	--	2.72
						14,158	7.80	--	4.57	--	2.72
	J-13					14,047	12.48	5.28	--	3.43	--
						14,078	12.44	5.28	--	3.43	--
						13,872	12.24	--	4.13	--	2.56
						14,047	12.36	--	4.13	--	2.56
	14					14,174	7.36	6.30	--	4.37	--
						14,285	7.44	6.38	--	4.45	--
						14,221	7.40	--	5.55	--	3.58
						14,206	7.44	--	5.51	--	3.54
	15					14,047	7.60	6.38	--	4.45	--
						14,142	7.64	6.46	--	4.45	--
						14,078	7.56	--	5.28	--	3.62
						14,094	7.56	--	5.28	--	3.39
	16			6:30		14,174	6.30	5.28	--	3.74	--
						14,126	6.34	5.24	--	3.70	--
						14,078	6.38	--	4.57	--	2.99
						14,094	6.26	--	4.57	--	2.95
5	A-1			0820	78.4	14,809	5.00	4.65	--	3.54	--
						14,746	4.96	4.65	--	3.50	--
						14,746	4.96	--	4.25	--	3.11
						14,714	5.00	--	4.37	--	3.15
	E-1				79.0	14,619	5.71	4.80	--	3.70	--
						14,571	5.51	4.76	--	3.66	--
						14,571	5.51	--	4.17	--	2.95
						14,603	5.71	--	4.21	--	2.99
	I-1				80.0	14,635	6.02	5.43	--	3.90	--
						14,539	5.94	5.47	--	3.94	--
						14,555	5.94	--	4.61	--	3.27
						14,555	5.79	--	4.65	--	3.27
	M-1					14,698	5.31	4.84	--	3.43	--
						14,651	5.20	4.88	--	3.43	--
						14,651	5.35	--	3.86	--	2.83
						14,619	5.31	--	4.06	--	2.76
	N-3					14,619	5.28	4.29	--	2.95	--
						14,365	5.24	4.29	--	2.95	--
						14,508	4.92	--	3.46	--	2.52
						14,571	4.84	--	3.50	--	2.48
	J-3				81.0	14,524	5.28	4.80	--	3.31	--
						14,619	5.35	4.72	--	3.31	--
						14,651	5.35	--	4.25	--	2.80
						14,651	5.35	--	4.21	--	2.80
	F-3					14,714	5.20	4.88	--	3.50	--
						14,698	5.20	4.84	--	3.50	--
						14,666	5.20	--	4.21	--	3.03
						14,603	5.24	--	4.21	--	2.99

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
5	B-3		3 Nov 82		81.0	14,619	5.16	4.41	--	3.07	--
						14,603	5.12	4.53	--	3.23	--
						14,555	5.16	--	3.90	--	2.60
						14,635	5.04	--	3.90	--	2.56
	G-5					14,444	5.98	5.39	--	3.90	--
						14,508	6.02	5.43	--	3.90	--
						14,555	5.98	--	4.72	--	3.23
						14,476	5.94	--	4.72	--	3.27
	K-5					14,539	5.31	4.65	--	3.22	--
						14,492	5.35	4.72	--	3.27	--
						14,555	5.28	--	3.98	--	2.68
						14,555	5.39	--	3.98	--	2.68
	O-5				82.0	14,508	4.92	4.37	--	2.87	--
						14,523	4.88	4.37	--	2.80	--
						14,539	4.96	--	3.74	--	2.40
						14,476	4.80	--	3.74	--	2.36
	M-7					14,444	4.92	4.45	--	3.03	--
						14,476	4.92	4.45	--	3.15	--
						14,428	5.12	--	3.70	--	2.68
						14,476	5.00	--	3.74	--	2.64
	I-7					14,444	5.04	4.57	--	3.27	--
						14,396	5.08	4.61	--	3.27	--
						14,412	5.08	--	4.02	--	2.91
						14,444	5.08	--	3.94	--	2.91
	F-7					14,253	5.67	4.96	--	3.35	--
						14,285	5.79	5.06	--	3.35	--
						14,333	5.55	--	4.25	--	2.80
						14,317	5.63	--	4.25	--	2.80
	D-9					14,253	5.71	5.16	--	3.23	--
						14,253	5.71	5.16	--	3.27	--
						14,174	5.83	--	4.29	--	2.99
						14,221	5.83	--	4.41	--	2.87
	F-9				83.0	14,396	5.39	4.88	--	3.39	--
						14,396	5.47	4.88	--	3.43	--
						14,365	5.35	--	4.06	--	2.80
						14,380	5.35	--	4.09	--	2.83
	J-9					14,365	5.04	4.53	--	3.54	--
						14,365	5.00	4.61	--	3.58	--
						14,285	5.08	--	3.94	--	3.23
						14,349	5.08	--	4.09	--	3.19
	O-11					14,333	4.61	4.29	--	3.07	--
						14,380	4.69	4.25	--	3.11	--
						14,333	4.53	--	3.82	--	2.80
						14,412	4.61	--	3.78	--	2.80
	K-11				84.0	14,285	5.51	4.21	--	3.23	--
						14,221	5.35	4.37	--	3.19	--
						14,206	5.28	--	3.82	--	2.44
						14,190	5.28	--	4.06	--	2.72
	G-11					14,190	4.92	4.88	--	3.27	--
						14,237	4.99	4.92	--	3.27	--
						14,253	5.00	--	4.06	--	2.72
						14,206	4.99	--	4.02	--	2.72

(Continued)

Table 5 (Continued)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
5	C-11		3 Nov 82		86.0	14,180	5.28	4.96	--	3.91	--
						14,428	5.28	4.92	--	3.91	--
						14,444	5.39	--	4.53	--	2.72
						14,460	5.35	--	4.61	--	2.87
	A-13					14,174	6.18	5.20	--	3.66	--
						14,221	6.10	5.28	--	3.83	--
						14,126	6.10	--	4.45	--	2.95
						14,158	6.10	--	4.59	--	2.87
	E-13				85.0	14,428	5.08	4.65	--	3.11	--
						14,492	5.00	4.49	--	3.15	--
						14,412	5.09	--	3.78	--	2.64
						14,412	5.04	--	3.86	--	2.64
	I-13					14,396	5.67	4.84	--	3.35	--
						14,333	5.51	4.88	--	3.23	--
						14,349	5.83	--	4.09	--	2.76
						14,285	5.67	--	4.21	--	2.76
	N-13					14,158	4.88	4.37	--	3.35	--
						14,174	4.96	4.45	--	3.25	--
						14,206	5.08	--	3.94	--	2.87
						14,158	4.96	--	3.90	--	2.91
	S-15					14,476	4.96	4.21	--	3.43	--
						14,508	4.72	4.25	--	3.07	--
						14,555	4.76	--	3.74	--	2.52
						14,587	4.84	--	3.74	--	2.56
	J-15					14,237	5.20	4.49	--	3.07	--
						14,237	5.20	4.45	--	3.07	--
						14,190	5.28	--	3.86	--	2.56
						14,221	5.31	--	3.98	--	2.56
	I-15					14,206	5.08	4.57	--	3.15	--
						14,158	4.96	4.69	--	3.11	--
						14,301	5.04	--	4.29	--	2.64
						14,190	5.00	--	4.06	--	2.56
	N-15				86.0	14,460	5.28	4.65	--	3.31	--
						14,476	5.28	4.69	--	3.35	--
						14,444	5.27	--	4.21	--	2.68
						14,444	5.24	--	4.13	--	2.76
	C-17					14,365	5.24	4.45	--	3.11	--
						14,349	5.35	4.53	--	3.11	--
						14,285	5.39	--	3.70	--	2.52
						14,253	5.31	--	3.82	--	2.52
	G-17					14,206	5.08	4.53	--	3.15	--
						14,190	5.08	4.41	--	3.15	--
						14,285	5.00	--	3.74	--	2.68
						14,190	4.96	--	3.74	--	2.60
	K-17					14,380	5.20	5.04	--	3.50	--
						14,444	5.28	5.04	--	3.58	--
						14,349	5.35	--	3.90	--	2.80
						14,365	5.43	--	4.09	--	2.83
	L-18					14,301	4.80	4.21	--	2.95	--
						14,380	4.84	4.25	--	2.91	--
						14,301	4.88	--	3.58	--	2.44
						14,428	4.92	--	3.66	--	2.48

(Continued)

(Sheet 1 of 4)

Table 5 (Concluded)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	24	36	48
5	H-18		3 Nov 82		86.0	14,317	4.72	4.29	--	3.03	--
						14,412	4.65	4.21	--	3.03	--
						14,380	4.76	--	3.46	--	2.52
						14,428	4.69	--	3.62	--	2.52
	J-6				87.0	4,211	1.50	1.34	--	1.10	--
						4,227	1.57	1.42	--	0.94	--
						4,115	1.54	--	1.14	--	0.75
						4,195	1 38	--	1.14	--	0.79
						9,153	3.07	2.95	--	2.01	--
						9,184	3.15	2.83	--	2.01	--
						9,105	3.07	--	2.40	--	1.77
						9,153	3.15	--	2.44	--	1.77
						14,206	4.76	4.45	--	2.87	--
						14,237	4.76	4.41	--	2.87	--
						14,237	4.76	--	3.62	--	2.64
						14,237	4.80	--	3.58	--	2.64

Table 6

Test Data - Falling Weight Deflectometer - Joint Tests

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	36	Deflection Ratio
1	TJ-1	C3-C2	3 Nov 82		91.0	14,349	2.80	2.24	1.69	0.80
						14,316	2.68	2.20	1.65	0.82
	TJ-2	C12-C11			90.0	14,412	2.68	2.44	1.69	0.91
						14,412	2.68	2.36	1.65	0.88
	TJ-3	C21-C20			90.0	14,459	2.52	1 81	1.38	0.72
						14,444	2.52	1.77	1.38	0.70
	TJ-4	A22-A23			87.0	14,428	2.87	1.93	1.50	0.67
						14,476	2.87	1.93	1.54	0.67
	TJ-5	A13-A14		10:20	86.5	14,476	2.48	2.20	1.54	0.89
						14,492	2.48	2.20	1.50	0.89
	TJ-6	A4-A5				14,380	2.60	2.36	1.77	0.90
						14,555	2.60	2.36	1.77	
	TJ-7	B2-B1			88.0	14,492	5.39	1.10	0.91	0.20
						14,476	5.39	1.06	0.87	0.20
	TJ-8	B11-B10			87.0	14,460	3.27	1.42	1.06	0.43
						14,396	3.19	1.38	1.06	0.43
	TJ-9	B20-B19			87.0	14,237	5.24	1.38	1.10	0.26
						14,221	5.28	1.54	1.10	0.29
	TJ-10	B26-B25			87.0	14,523	3.66	1.26	1.02	0.34
						14,317	3.62	1.34	0.98	0.37
	LJ-11	A1-B1			88.0	14,444	2.91	2.17	1.54	0.75
						14,539	2.91	2.17	1.50	0.75
	LJ-12	B5-A5			88.0	14,444	3.86	1.69	1.22	0.44
						14,317	3.66	1.57	1.18	0.43
	LJ-13	B8-C8			88.0	14,396	4.13	1.34	0.98	0.32
						14,460	4.13	1.34	1.02	0.32
	LJ-14	C12-B12			89.0	14,301	3.27	1.93	1.42	0.59
						14,428	3.19	1.89	1.42	0.59
	LJ-15	A16-B16			89.0	14,476	4.69	1.26	1.02	0.27
						14,364	4.69	1.30	1.06	0.27
	LJ-16	C18-B18			89.0	14,333	5.35	1.54	1.22	0.29
						14,365	5.28	1.54	1.18	0.29
	LJ-17	B20-C20			89.0	14,365	5.39	1.22	1.02	0.23
						14,396	5.43	1.22	0.98	0.23
	LJ-18	B23-A23			90.0	14,285	2.87	1.77	1.34	0.62
						14,396	2.87	1.69	1.30	0.56
	LJ-19	B26-C26			90.0	14,285	2.56	2.09	1.46	0.82
						14,428	2.56	2.05	1.42	0.80
5	TJ-1	J15-J16			87.0	14,285	9.09	5.51	3.19	0.61
						14,317	8.98	5.39	3.15	0.60
	TJ-2	J12-J13			87.0	14,253	11.46	3.11	2.17	0.27
						14,269	11.50	3.03	2.17	0.26

(Continued)

Table 6 (Concluded)

Test Area	Test No.	Station or Location	Date	Time	Surface Temperature °F	Force lb	Deflection, mils Distance from Center of Plate, in. 0	12	36	Deflection Ratio
5	TJ-3	J9-J10	3 Nov 82		87.0	14,269	8.31	7.28	4.09	0.88
						14,317	8.27	7.24	4.02	0.88
	TJ-4	J6-J7			87.0	14,237	12.95	3.11	2.24	0.24
						14,237	12.91	3.11	2.17	0.24
	TJ-5	J3-J4			87.0	14,349	10.00	6.22	3.66	0.62
						14,396	9.96	6.26	3.62	0.63
	TJ-6	G5-G4			87.0	14,285	13.94	3.03	2.09	0.22
						14,269	13.94	3.03	2.09	0.22
	TJ-7	G8-G7			86.0	14,349	11.65	6.69	3.62	0.57
						14,380	11.69	6.73	3.70	0.58
	TJ-8	G11-G10			86.0	14,333	11.97	4.61	2.87	0.39
						14,221	11.85	4.57	2.87	0.39
	TJ-9	G14-G13		0930	86.2	14,253	11.02	5.71	3.46	0.52
						14,301	10.91	5.75	3.43	0.53
	TJ-10	G17-G16			86.0	14,317	7.36	5.39	3.19	0.73
						14,380	7.32	5.39	3.15	0.74
	LJ-11	A1-B1			78.0	14,587	13.03	3.70	2.24	0.28
						14,603	12.91	3.35	2.13	0.26
	LJ-12	E1-F1			79.0	14,682	16.54	2.91	1.97	0.18
						14,635	16.42	2.95	2.01	0.18
	LJ-13	G1-H1			79.0	14,746	14.53	4.45	2.83	0.31
						14,682	14.45	4.53	2.87	0.31
	LJ-14	I1-J1			79.0	14,619	15.63	4.17	2.76	0.27
						14,555	15.51	4.21	2.80	0.27
	LJ-15	M1-N1			80.0	14,555	12.80	2.72	1.97	0.21
						14,571	12.72	2.72	1.97	0.21
	LJ-16	C11-B11			84.0	14,269	13.98	3.46	2.24	0.25
						14,206	13.78	3.50	2.28	0.25
	LJ-17	G11-F11			84.0	14,365	13.31	3.43	2.28	0.26
						14,365	13.03	3.43	2.24	0.26
	LJ-18	K11-J11			83.0	14,253	13.23	3.66	2.44	0.28
						14,253	13.31	3.70	2.32	0.28
	LJ-19	O11-N11		0900	83.3	14,269	12.99	2.36	1.77	0.18
						14,253	13.11	2.36	1.77	0.18

Table 7

Air Temperature Data

Date 1982	Maximum Temperature °F	Minimum Temperature °F
20 Oct	85	68
21 Oct	84	69
22 Oct	84	70
23 Oct	72	63
24 Oct	68	56
25 Oct	72	52
26 Oct	75	53
27 Oct	78	58
28 Oct	81	62
29 Oct	82	65
30 Oct	83	68
31 Oct	82	71
1 Nov	84	68
2 Nov	84	66
3 Nov	83	71