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ALTERNATE LAUNCH AND RECOVERY SURFACE TEST SECTION, DESIGN, CONSTRUCTION, AND EVALUATION, NORTH FIELD, SOUTH CAROLINA

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The objective of this investigation was to design, construct, and evaluate two promising ALRS concepts for full-scale operations of the F-4 aircraft. After aircraft traffic was completed, test sections were trafficked to failure with loadcarts simulacing maximum loaded F-4 and F-15 aircraft. Aircraft and pavement surface interaction were evaluated for a thin asphalt surfaced pavement and for unsurfaced stabilized soil pavement.

Significant findings included: (1) an asphalt surface course thickness of 2 inches over a conventionally designed pavement will support 150 passes of the F-4 aircraft, (2) a surface course is required for stabilized soil structures, particularly in areas subjected to jet blast for the prevention of foreign object damage to engines, (3) deflections from the falling weight deflectometer can be used with a layered elastic model to predict performance of the pavement structures, and (4) the CBR design procedure should not be modified for the design of ALRS pavements.

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PREFACE

This investigation was conducted by the Geotechnical Library (GL), US Army Engineer Waterways Experiment Station (WES), between April 1983 and September 1984. The study was sponsored by the US Air Force Engineering and Services Center (AFESC), Tyndall Air Force Base, Florida, under Military Interdepartmental Purchase Request (MIPR) N-83-6 and N-84-26 entitled "Aircraft Testing of ALRS." AFESC project officers were Captains Henry F. Kelly, J. D. Wilson, David F. Ruschmann, Bruce A. Walton, and Ms Patricia C. Suggs.

The study was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, GL; Mr H. H. Ulery, Jr., Chief, Pavement Systems Division; Mr J. W. Hall, Jr., Chief Engineering Investigations Testing and Validation Group; and Mr. R. W. Grau, Chief, Prototype Testing and Validation Unit. Personnel of the Pavement Systems Division who took part in the study were Mr. S. J. Alford, Ms. M. D. Alexander, Mr. A. J. Bush II, and Mr. C. W. Dorman. This report was written by Messrs. Alford and Bush.

Director of WES during this investigation was COL Allen F. Grum, USA, CE. Technical Director was Dr. Robert W. Whalin.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public including foreign nationals.

This technical report has been reviewed and is approved for publication.

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

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

Multiply	By	To Obtain
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[a]
feet	0.3048	meters
inches	2.54	centimeters
kips (force)	4.448222	kilonewtons
knots (international)	0.5144444	meters per second
mils	0.0254	millimeters
miles	1.609347	kilometers
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 meter
pounds (mass) per cubic inch	27.6799	grams per cubic centimeter
square feet	0.09290304	square meters
square inches	6.4516	square centimeters

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[a] 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 $K = (5/9)(F - 32) + 273.15$.

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SECTION I

INTRODUCTION

A. BACKGROUND

With the development of hardened aircraft shelters for protection of aircraft and support equipment during conventional air attacks, the vulnerability to conventional bombing shifts toward the mission-essential runway system. To counteract this threat, the US Air Force outlined a 9-year research program to provide the capability to launch and recover aircraft after an attack directed at runways and taxiways. One alternative is to construct and maintain Alternate Launch and Recovery Surfaces (ALRS). ALRS are large areas of relatively low-quality pavement surfaces. ALRS can be constructed away from the main runway to effectively reduce the probability that all landing and takeoff areas would be destroyed in a given attack. The ALRS must (1) be relatively inexpensive in comparison to permanent pavements, (2) support the imposed loads, (3) be easily maintained over a 20-year life, and (4) provide an adequate surface for a limited number of sorties of the design aircraft.

Research on ALRS has been reported by several investigators (References 1-8). From these efforts, two pavement systems were selected, based on costs and performance requirements: (1) a conventional asphalt/crushed stone pavement with a minimum thickness of asphaltic concrete (AC) and, (2) a stabilized section of soil cement.

A full-scale Developmental Test and Evaluation (DT&E) Program is required to validate designs/concepts presented in various ALRS studies before the Air Force initiates a major ALRS construction program. This DT&E program is divided into two phases. Phase I validates promising ALRS concepts with F-4 and F-15 aircraft loadings over test sections constructed in existing runways. The best concept(s) identified in Phase I were planned for use in Phase II, which is the design, construction, test, and evaluation of a full-scale ALRS at a US Air Force Base in Europe in 1984-1985.

B. PURPOSE AND SCOPE

The purpose of this investigation was to design and construct two promising ALRS concepts for Phase I full-scale operations of the F-4 aircraft. After aircraft traffic was completed, test sections were trafficked to failure with load carts simulating maximum loaded F-4 and F-15 aircraft. Aircraft and pavement surface interaction were evaluated for a thin AC-surfaced pavement and for unsurfaced stabilized soil pavement.

This study includes the design, construction, and trafficking of the test items. The construction, field testing, and trafficking took place at North Air Force Base, SC. A laboratory and field testing program was implemented to describe the material properties of each of the pavement layers as well as the pavement system. Analysis includes comparisons of the performance of the items to the design levels of performance reported in References 6 and 8.

For the reader's convenience, all tables, figures, and photos are contained in Appendices at the back of the text.

SECTION II

TEST SITE AND DATA COLLECTION

A. SITE INVESTIGATION

North Auxiliary Airfield (North Field), SC, was selected by the sponsor as a test site because of the availability of an isolated runway large enough to support F-4 aircraft operations. North Field is located approximately 30 miles south of Columbia, SC, 18 miles west of Orangeburg, SC, and just east of the small village of North, SC.

A layout of the airfield features and the location of the test site are shown in Figure 1. The test site was located on the east-west runway, approximately 2,300 feet from the east end.

A preliminary site investigation was conducted to evaluate the properties of the materials at the site and to determine the material properties of available base course aggregates, aggregates for the bituminous mix, and asphaltic cement. Site testing consisted of taking four cores from the existing 6-inch portland cement concrete (PCC) runway and conducting California Bearing Ratio (CBR) tests at four depths into the subgrade. The existing pavement contained no subbase. Results from these tests are given below:

Depth from Surface of Subgrade, inches	Average CBR percent
0	9.5
6	51.0
12	49.0
18	31.0

B. LABORATORY TESTS

1. Subgrade

The natural soil at the test site was used for the subgrade. The soil was classified as a silty sand (SP-SM) according to the Unified Soil Classification System (curve 2 in Figure 2). Moisture-density relations were determined for the silty sand compacted at the CE-12 and CE-55 efforts (Reference 9), as shown in Figure 3. Soaked CBR tests performed on the two compaction efforts ranged from a 26 CBR to a 48 CBR for the CE-12 effort and from a 41 CBR to a 77 CBR for the CE-55 effort.

2. Base Course

A well-graded crushed granite was selected for the base course material. The gradation of the crushed granite is shown in Figure 2 as curve 1. Moisture-density and CBR relations were determined for the crushed granite compaction at the CE-55 effort (Reference 9), as shown in Figure 4.

3. Stabilized Soil

The in-place silty sand (curve 2 in Figure 2) at North Field was selected for stabilization with portland cement (PC). Moisture-density relations were determined for the silty sand with 7 percent PC (by weight) stabilizer added using the CE-12 effort. The optimum moisture-density values were used to mold samples of the silty sand material with 5, 7, and 9 percent PC for compressive, splitting tensile, and flexural strength tests. Two sets (three samples to a set) of samples were molded for each test. The samples were cured in a humid room. One set of samples was tested after 7 days of curing and the other set after 28 days. The tests were performed according to the American Society for Testing and Materials (ASTM) standard methods listed below. The test results are shown in Table 1.

Test	Method
Compressive strength	ASTM D 1633 (Reference 10)
Flexural strength of soil cement using simple beam with third-point loading	ASTM D 1635 (Reference 11)
Splitting tensile strength of cylindrical concrete specimens	ASTM C 496 (Reference 12)

4. Asphaltic Concrete

A mix design for the asphaltic concrete was prepared in the laboratory at the US Army Engineer Waterways Experiment Station (WES) using 1/2-inch maximum-size crushed granite, sand filler, and AC-20 asphalt obtained from a supplier in the North Field area. Two sizes of crushed granite were used in the asphalt mix: 1/2-inch to number 30 aggregate (curve 2 in Figure 6) and a minus number 4 unwashed screening (curve 3 in Figure 6). The asphalt mix was designed using 1/2-inch maximum-size aggregate for a high-pressure tire surface course according to "Bituminous Pavement Standard Practice" (Reference 13). Table 2 shows the specified limits for the mix design and the job-mix formula with a percent of each aggregate used in the mix.

A local paving contract was issued for mixing and placing the asphaltic concrete. When WES personnel arrived to calibrate the asphalt plant, gradations were determined on the aggregate to be used in the asphalt mix. These gradations are shown in Figure 7. The gradation of the minus number 4 unwashed screening (curve 3 in Figure 7) showed the gradation of the material to be slightly coarser than the sample used by WES (curve 3 in Figure 6). A new job-mix formula was prepared and is shown in Table 2 with the percent of each aggregate used in the mix. Because of the lack of time, no determinations were made on the job-mix formula for stability, flow, and percent of voids. However, properties were determined on the plant mix (asphalt placed in the test section) and the results are shown in Table 2. The gradation of the mix is shown as curve 1 of Figure 7. All of the specified limits (Table 2) for an asphalt mix were met with the exception of 2.1 percent of the aggregate which was larger than 1/2 inch. This is considered acceptable due to the small amount of asphaltic concrete purchased and the time and cost constraints placed on the job.

SECTION III

DESIGN AND CONSTRUCTION OF TEST ITEMS

A. DESIGN

The design of the two test items was based on criteria presented in References 6 and 8 for stabilized and asphaltic concrete ALRS pavements. Criteria presented in "Flexible Pavement Design for Airfields" (Reference 14) were used when a parameter was not covered by References 6 and 8.

1. Asphaltic Concrete Item

As recommended in Reference 6, the thickness of the AC surface course was selected as 2 inches. The total pavement thickness for a flexible pavement is based on the subgrade CBR, aircraft type and weight, and the number of operations. The following data were used to determine the total thickness from Figure B-54 of Reference 6:

Property	Value
CBR	20 percent
Aircraft	F-4
Weight	60,000 pounds
Tire pressure	265 pounds per square inch (psi)
Contact area	100 square inches
Pass-to-coverage ratio	8.58
Coverages	17
Passes[a]	150

[a] A pass is defined as one movement of an aircraft over a section of pavements. In terms of loadings and takeoffs, only takeoffs are considered as passes.

From these data a thickness of 5 inches was selected. Reference 11 stipulates that a minimum base course thickness of 6 inches is required for this type of aircraft. Therefore, the AC section would consist of 2 inches of AC over 6 inches of crushed stone base course over a compacted silty sand subgrade.

2. Stabilized Soil Item

The design methodology presented in Reference 8 contains a range of subgrade strengths with resilient modulus values from 1,000 to around 17,000 psi. Because the subgrade strength at North Field was estimated to range from 25,000 to 30,000 psi, this procedure could not be used to develop thickness requirements.

The thickness of the stabilized item was determined using several analysis techniques. Techniques used were (1) rigid pavement design, (2) rigid pavement design with criteria developed for the stabilized test items constructed at the WES (Reference 7), and (3) unsurfaced CBR design. Thicknesses determined from these methods were compared to the thicknesses and performance data collected during the earlier North Field study (Reference 4).

The design for a pavement rigid pavement using a modulus of soil reaction of 400 pounds per cubic inch (pci) and a flexural strength of 78 psi (see Table 1) yields a thickness requirement of 19.0 inches. This design procedure is based on the first crack and was developed for plain jointed rigid pavements with flexural strengths five to nine times the strength of the stabilized materials in this study.

One design was based on results of traffic test sections constructed at WES of a similar design consisting of varying stabilized layer thicknesses and cement contents over a CH subgrade. The assumption was that the stabilized layer would crack and the maximum stress would be an edge stress. The tensile stress at the bottom of the stabilized sections was calculated with the H-51 computer program based on Westergaard type analysis. The stress was reduced by 25 percent to account for load transfer between the edges of the cracks. A design factor, DF, was then calculated as follows:

$$DF = R/(\text{edge stress})(0.75)$$

where

R = flexural strength, psi

The design factors calculated for the channelized F-4 load cart traffic on the test section items with stabilized layer thickness of 8, 12 and 16 inches ranged from 0.1 to 0.275. When plotted against passes to 3-inch rut depth, a design factor of 0.15 to 0.2 appeared to be reasonable for a design for 150 to 200 passes. A design factor of 0.15 yields a thickness requirement of 9.5 inches; whereas, a design factor of 0.2 yields a thickness of 11.5 inches.

The thicknesses design for unsurfaced pavements is based on the following relationship:

$$T = (0.176 \log C + 0.12) \sqrt{\frac{p}{8.1(CBR)} \frac{A}{\pi}}$$

where

T = thickness of pavement structural layer above subgrade

C = coverages of the aircraft (an index of the amount of traffic)

p = equivalent single wheel load of aircraft, pounds

CBR = California Bearing Ratio of the subgrade, percent

A = contact area of the tire, square inches

This design is based on a 3-inch rut depth and is generally applicable where granular materials of a specific range of gradation are used as a surface course.

The test section constructed during the earlier North Field testing (Reference 4) which performed satisfactorily consisted of 10 inches of the local sand stabilized with 9 percent PC over the sand subgrade. The section sustained 440 passes of the F-4 load cart.

Therefore, based on the results of previous test section data both at North Field under similar conditions and data from test items constructed at the WES (Reference 7), a final design thickness of 10 inches was selected. An admixture design of 7 percent PC by weight was selected. This was increased by 2 percent to compensate for losses during the construction procedure.

B. CONSTRUCTION

A plan and profile for the test items are shown in Figure 8. Each item was 100 feet long and 50 feet wide. The north edge of the items was located along the centerline of the runway. The stabilized soil item was 10 inches thick and placed on a silty sand subgrade. This flexible pavement item consisted of 2 inches of asphaltic concrete and 6 inches of well-graded crushed granite base material placed on a silty subgrade.

The test items were constructed during the period July to August 1983. The construction was performed by personnel of the 823rd Civil Engineer Squadron (CES), Red Horse and a local paving contractor. The 823rd CES prepared the subgrade and mix, and placed the stabilized soil and the base course material. The paving contractor furnished and placed the asphaltic concrete. Details of the construction operation are given in the following paragraphs.

1. Removal of PCC

The test items were located on the south side of the E-W runway at North Field, approximately 2,300 feet from the east end. The runway had been constructed in the late 1940's of 6-inch PCC slabs, 25 feet long and 12.5 feet wide. Photo 1 shows the runway.

To reduce the size and weight of PCC slabs to a workable size for handling with a front-end loader, an attempt was made to crack the slabs with 3-, 3.5-, and 9-pound TNT charges. Initially, four 3-pound and four 3.5-pound charges were placed on separate slabs (two charges on the longitudinal centerline at the quarter points). Sand bags were placed over the charges to direct the blast into the slab. These changes caused a minor spall, 10 inches long by 12 inches wide by 2 inches deep.

This procedure was repeated on six slabs with the 3.5-pound charges. The damage to the slabs was essentially the same (Photo 2) as the trial blasting.

The 9-pound charges were then placed on six slabs. Three charges covered with sand bags were placed along the centerline of each slab, one at each quarter point and one in the center. The PCC around the charges was broken up in approximately a 3-foot-diameter circular area (Photo 3). Longitudinal cracks connected the circles. It was decided at this time that this method was impractical for breaking up the PCC.

A 1,100-pound pneumatic pavement breaker was mounted on a Case 680E backhoe and was used to break up the PCC. The pavement breaker broke the slabs into pieces of sufficient size to be handled by a tracked front-end loader with a 4-way bucket (Photo 4). The broken PCC was removed from the runway to a preselected disposal site.

2. Subgrade

During the removal of the PCC, a small amount of subgrade material was also removed. To ensure that an adequate amount of subgrade material was in place, a borrow area was located adjacent to the runway. All vegetation was removed from the area and enough material was placed in the test item to ensure that the thickness of the test items would not be exceeded.

The fill material was incorporated into the existing material by use of a pulvimixer. The average water content of the subgrade was 4.2 percent. The water content was increased to near the optimum water content (9.7 percent) for the CE-12 compaction effort (Figure 2) by spraying the surface of the subgrade with water from a fire truck and mixing it in with a pulvimixer. When the water content averaged 9.8 percent, compaction of the subgrade was attempted. A 25,000-pound tandem vibratory roller equipped with two 78-inch-wide drums, producing 21,000 pounds of dynamic force per drum for a total applied force of 33,500 pounds per drum, was used in this attempt. The subgrade material pumped because of the 9.8 percent water content when the roller was applied. The subgrade was then aerated with the pulvimixer to lower the water content. After the material was dried to an average water content of 6.2 percent, the subgrade was compacted with the vibratory roller (Photo 5). Two passes were applied with the roller operating at a total applied force of 33,500 pounds per drum. One pass was accomplished by the roller starting on one side of the test items, traveling the length of the test items forward, and then reversing and returning in the same track. The roller was then shifted laterally and the test items were traversed forward and backward in the same track with an overlap of approximately 6 inches with the previous track. This was continued until the entire width of the test items had been covered. After the subgrade had been tested to determine the water content, density, CBR, and modulus of soil reaction, the subgrade was fine-bladed to the desired elevation and sealed with one pass of the vibratory roller in the static mode (not vibrating). The average strength of the top 12 inches of subgrade was 30 CBR (Table 3). Three of the four locations tested had a pattern of increasing CBR with depth. The range of data was 13 to 45 CBR.

3. Instrumentation

Two sets of instruments were installed in each test item. One set consisted of a WES 50-psi pressure gage, a WES 100-psi pressure gage, and a direct current linear variable differential transducer (DCVDT). In each item, one set was installed along a line 107.5 inches north of the centerline of the test items and one set 107.5 inches south of the centerline (Figure 9). The lines, 107.5 inches each side of the centerline, are the centers of the main gear wheel paths for the F-4 aircraft and the centers of the F-4 and F-15 load cart traffic lanes. The 50-psi pressure gages were installed in the subgrade at a depth of 12 inches below the surface of the subgrade (Figure 9). An area approximately 12 inches square was excavated by hand to the 12-inch depth and then just enough soil was removed to accommodate the gage (Photo 6). After placement of the gage, the excavated soil was replaced in layers and each layer was compacted with a hand tamp. The 100-psi pressure gages were installed at the surface of the subgrade (Figure 9). After enough soil was removed, the gage was placed and covered with a thin layer of silty sand to protect it during placement of the stabilized soil and the base course material. The DCVDTs in the stabilized soil item were placed at the surface of the subgrade. The DCVDTs and component parts required for installation are shown in Photo 7. The DCVDTs were mounted in waterproof housings and referenced to 6-foot rods anchored in the subgrade. A 3-inch auger was used to drill a hole approximately 6.5 feet deep for the placement of the reference rod. The rod was placed in the hole and the foot of the rod was anchored in place at the correct elevation using cement mixed with sand. The waterproof housing with the DCVDT inside was then placed over the reference rod with the top of the housing mounted flush with the surface of the subgrade. Final adjustments to the DCVDT were made through the top of the housing.

4. Nondestructive Testing

The Fall Weight Deflectometer (FWD) tests were conducted on the surface of the subgrade after final grading and compacting. The FWD data were collected on lines 107.5 inches north and south of the test item's centerline at three locations per line, per item, for a total of six locations per test item. Force levels of 5,000 and 9,000 pounds were applied to the subgrade at each location through a 17.7-inch-diameter plate. Results of these tests are shown in Table 4.

5. Stabilized Soil

The stabilized soil for the test item was mixed and placed in two lifts. The soil (silty sand) for the stabilized soil was obtained from a borrow area near the runway. The gradation of the soil was the same as the subgrade material (curve 2 in Figure 2). Two stockpiles of material (100 feet by 48 feet by 1 foot) were placed on the runway adjacent to the test item for blending with PC for the two lifts.

The dry density of the silty sand stockpile was determined to be 105.0 pcf using a nuclear moisture-density gage. The dry density and volume (100 feet by 48 feet by 1 foot) were used to compute the amount of PC required. The design of the stabilized soil item calls for 7 percent of PC by weight. It was decided to add 2 percent to this, to compensate for loss during the mixing of the soil and PC. The first lift of stabilized soil was mixed and placed in one day and the second lift was mixed and placed the following day. The following paragraphs describe the mixing and placement of the stabilized soil.

The material to be used in the first lift had an initial water content of 7.8 percent. Prior to adding PC the stockpile was sprayed lightly with water. The PC was placed on the stockpile by positioning the tractor-trailer PC transporter on one side of the stockpile and then backing down the stockpile, discharging the PC through an 8-foot spreader bar attached to the rear of the trailer. When the tractor-trailer reached the end of the stockpile, it was stopped and then driven forward in the same wheel path, discharging the PC. At the end of the stockpile the tractor-trailer was shifted over 8 feet (the width of the spreader bar) and driven backward and forward in the same path, discharging the PC. This was repeated until the entire width of the stockpile had been covered. Four trips across the stockpile were required to discharge all the PC (47,340 pounds) from the trailer. Photo 8 shows the PC being placed on the stockpile. After the PC was placed on the stockpile, it was blended into the silty sand with a pulvimixer (Photo 9). Six passes with the pulvimixer were used to blend the PC with the silty sand. One pass consisted of the pulvimixer starting on one side of the stockpile and blending the soil and PC from one end of the stockpile to the other end. At the end of the stockpile the pulvimixer turned around and returned through the stockpile, moving over the width of the pulvimixer. This was repeated until the width of the stockpile had been covered. After mixing, the stockpile was piled using two front-end loaders (Photo 10). The bottom of the stockpile was turned over when the material was placed in the pile. Turning over and piling the material helped to further mix the soil and PC. To ensure a thorough mixing, the material was respread on the runway into a workable stockpile, approximately the same size as before. After respreading of the material, blending of the PC and soil was continued with the pulvimixer. During this time the water content of the material was checked with a nuclear moisture-density gage and found to be lower than optimum for the CE-12 moisture-density relations (Figure 5). Water was sprayed onto the stockpile from fire truck and mixed into the material as the pulvimixer continued the blending of the PC and soil. After the PC and soil were thoroughly mixed, the material was piled again with the two front-end loaders.

The subgrade was sprayed lightly with water before placement of the stabilized soil. The first lift of the stabilized soil was placed in a 6-inch-thick uncompacted lift with an asphalt spreader (Photo 11). The water content of the stabilized soil was 6.9 percent when placed. The asphalt finisher placed a 10-foot-wide lane of stabilized soil with each pass. Five passes were required to place the first lift in the test lane.

The lift was rolled with a 25,000-pound tandem vibratory roller equipped with two 78-inch-wide drums. During vibratory compaction, the roller was operated at either a low- or high-force level on one or both drums. The total applied force (operating weight plus dynamic force) per drum was 25,000 pounds at the low-force level and 33,500 pounds at the high-force level. The roller was also operated statically. Rolling of the first lift was started on the south side of the test item after two lanes of the stabilized soil had been placed. On the first attempt the roller was operated with the front drum at the low-force level and the rear drum operated statically. The roller produced a slight bow wave in front of the roller drums and transverse tears in the stabilized soil. The roller was stopped at the end of the test item and reversed. The roller returned in the same track with the lead drum operating at the low-force level and the rear drum operating statically.

This pass, with the roller traveling in reverse, produced what appeared to be twice as many transverse tears in the stabilized soil. After this, the roller was not operated in the vibratory mode when traveling in reverse. Density determinations were made with a nuclear moisture-density gage to determine the optimum compaction effort with the roller. A dry density of 104.2 pcf was recorded after the two passes with the roller. After completing the two previous passes, the roller was shifted laterally so the drums would cover uncompacted material. The roller then traveled forward with the front drum operating at the high-force level and the rear drum operating statically. The roller stopped at the end of the test item and reversed, returning in the same track in static mode. This roller pass produced transverse tears in the stabilized soil but not to the same extent as when the roller was operated at the low-force level. The roller was shifted laterally to cover uncompacted soil and the roller was operated forward and backward as described above. This was continued until the width of the test item had been covered and this was counted as one pass with the roller. Dry density determinations were made after the second pass and continued through the sixth pass. The dry density of the stabilized soil after the second pass was 107.1 pcf; the third pass, 108.2 pcf; the fourth pass, 110.4 pcf; the fifth pass, 112.4 pcf; and the sixth pass, 111.5 pcf. The roller operation was stopped after the sixth pass due to the drop in density recorded between the fifth and sixth passes. The 111.5-pcf dry density is 90 percent of the laboratory CE-12 maximum dry density shown in Figure 5.

During the roller operation, the transverse tears continued to develop. The tears were spaced approximately 1.5 inches apart and extended across the width of the roller passes (78 inches). The number of tears varied per roller pass and the area of the roller passes containing the tears ranged from 30 to 70 percent of the area in a roller pass. Also during the roller operation, along the line where the roller front drum overlapped the previous roller path, some minor shoving (lateral movement) of the stabilized soil occurred in one to three spots along the roller path. This produced loose material approximately 3/8 inches deep over an area approximately 18 inches square.

After compaction of the first lift, cross-section data were recorded at three locations to determine the thickness of the lift. Typical cross-section data for the lift are shown in Figure 10.

The lift was covered overnight with polyethylene to prevent rapid moisture loss from the stabilized soil before placement of the second lift.

The blending and placement of the stabilized soil for the second and final lift were essentially the same as for the first lift. However, some exceptions are described in the following paragraphs.

The water content of the stockpile was raised to 10 percent before the PC was placed on the stockpile. This reduced the required amount of water to be added during the blending of the PC and silty sand.

PC, weighing 50,820 pounds, was delivered in bulk to the test site for the second lift. This was 3,480 pounds more than ordered, enough to add 1 percent more PC to the mix. The PC was weighed at the shipping point;

therefore, adjustments could not be made at the test site. All of the PC was placed on the stockpile.

After blending the PC with the silty sand, adjusting the water content, removing the polyethylene from the first lift, and spraying the lift lightly with water, placement of the second lift was started. The thickness of the uncompacted lift was increased from 6 inches (thickness of the first lift) to 7 inches. The water content of the stabilized soil was 7.1 percent at placement. After the first lane (10 feet wide) had been placed, rain moved into the area. The test item and stockpile were covered with waterproof material to protect them. After about 1 hour, the rain stopped and the test item and stockpile were uncovered. Placement of the stabilized soil continued until two lanes (20 feet of material) had been placed when it started to rain again. The test item and stockpile were covered again. This rain lasted for 1 1/2 hours. After the rain stopped, only that part of the test item and stockpile to allow for continual placement of the stabilized soil were uncovered.

After placement of the stabilized soil, compaction was applied using the tandem vibratory roller. The same roller pattern used on the first lift was used for the second: the front drum operating at the high-force level and the rear drum operating statically, traveling in the forward direction the length of the test item, stopping, and reversing, returning in the same track with both drums operating statically. The roller drums produced bow waves in the stabilized soil in front of each of the drums and created transverse tears in 80 to 90 percent of the length of the roller path. Photo 12 illustrates the transverse tears. During the roller compaction, the edge of the drums produced shoving (lateral movement) in the stabilized material almost the entire length of the roller path, where the roller drums overlapped with the previous roller path (Photo 13). This produced loose material approximately 3/8 inch deep extending approximately 12 inches into the last roller path. Compaction of the stabilized soil with roller in the vibratory mode was stopped after the fourth pass because of a drop in the density of the material between the third and fourth passes of the roller. Dry density determinations with a nuclear moisture-density gage were as follows: 106.6 pcf after two passes, 108.2 pcf after three passes, and 107.7 pcf after four passes. The 107.7 pcf density is 87 percent of the laboratory density shown in Figure 6. The initial four passes were applied with the roller in the vibratory mode and the final pass was in the static mode. The additional compaction effort removed most of the loose material from the surface of the stabilized material (Photo 14). The final pass in the static mode did not remove any of the transverse tears. Photo 15 shows a closeup view of the transverse tears in the surface of the stabilized soil after all roller operations. These tears may have been prevented by using a multiple-wheel rubber-tired roller.

Cross-section data were recorded at three locations to determine the thickness of the lift and the test item. Typical cross-section data for the test item are shown in Figure 10. The average thickness of the stabilized soil for the test item was 10.4 inches.

The stabilized soil test item was covered with polyethylene for 12 days of curing.

Compressive and splitting tensile strength tests were run on samples of the stabilized soil as placed in each of the lifts in the test item. The material for the samples was obtained from the stockpiles as the material was being placed in the test item (after all mixing had been done). The samples for each lift were molded to the density of the lift as placed, 111.5 pcf for the first lift and 107.7 pcf for the second lift. The sample was field-cured in moist sand for 28 days and tested according to ASTM 1633 (Reference 10) for compressive strength and ASTM C 496 (Reference 12) for splitting tensile strength of cylindrical concrete specimens. The results of the tests are shown in Table 5.

Seven days after placement of the second lift (top layer) of the test item, coring of the stabilized soil was attempted. Although water is normally used to wash away the fines produced during the coring operation and to cool the bit, it was not used in this instance because it could have weakened the stabilized soil in a large area surrounding the core location. Two attempts were made to core the stabilized soil. On the first attempt the core barrel became stuck in the stabilized soil after coring approximately halfway through, and on the second attempt the core stuck in the core barrel after the coring was completed. A visual inspection of the core holes showed the top lift (second lift placed) of the stabilized soil to be layered (Photo 16). Also, when the core barrel was cut away from the second core, the portion of core representing the second lift placed came apart in layers. The layers in this lift may have been caused by the bow wave created in front of the drums on the tandem vibratory roller.

6. Base Course for Flexible Pavement Item

A well-graded crushed granite was used for the base course material (curve 2 in Figure 2). The crushed granite was placed on the subgrade of the test item with an asphalt finisher. The asphalt finisher placed a 10-foot-wide lane of crushed granite the length of the test item in one pass. Five passes were required to place the crushed granite in the 50- by 100-foot test item (Figure 8). After placement, the crushed granite was compacted with the tandem vibratory roller. Sixteen passes with the roller were applied. The roller was operated with both drums at the high-force level (33,500 pounds total applied force per drum) in both the forward and reverse directions. To apply two passes with the roller, the roller was positioned at one side and one end of the test item. The roller then traveled in the forward direction to the end of the test item, and then traveled in reverse in the same track. The roller was then shifted laterally to cover uncompacted material and operated in the forward and reverse directions in the same track. This was repeated until the width of the test item had been covered.

After the compaction was completed on the crushed granite, CBR, density, water content, and modulus of soil reaction tests were conducted. Results are shown in Table 3.

FWD tests were conducted on the crushed granite base course. Data were collected on lines 107.5 inches north and south of the test item centerline at three locations per line for a total of six locations. Force levels of 5,000, 9,000, and 12,000 pounds were applied to the base course at each location. Data are presented in Table 6.

Cross-section data were recorded at three locations on the surface of the base course to determine the thickness of the base course. Figure 11 shows typical cross-section data for the base course. The average thickness for the base course was 6.3 inches.

7. Prime-coated Application

The crushed granite base course was primed with an asphalt emulsion containing approximately 37 percent water (by volume). The asphalt emulsion was applied at the rate of 0.05 to 0.1 gallon per square yard (Photo 17).

8. Asphaltic Concrete

The AC was placed with an asphalt finisher placing a 10-foot-wide paving lane. The placement of the AC was started on the north side of the test item at the end of the stabilized soil test item. The AC was tied into the stabilized soil to form a smooth transition between the two test items. The paving contractor placing and supplying the AC used four trucks in transporting the AC from the batch plant to the test item. The AC contained in the four trucks was just enough to place four and one-half paving lanes; five paving lanes were required to complete the test item. There was a 45-minute downtime before AC could be supplied to finish the test item. The temperature of the AC mix at laydown was 290° F. Initial compaction was applied with the 25,000-pound tandem vibratory roller operating statically (Photo 18). The temperature of the AC was 185° F at the start of compaction. Two passes were applied to the AC with the roller in the static mode. An attempt was made to compact one paving lane at the high-force level (33,500 pounds total applied force per drum). This effort produced tears in the AC surface. The force level was reduced to 25,000 pounds per drum. The compaction effort was applied by vibrating while moving forward and operating statically while in reverse. The roller operating at the low-force level reduced the number of tears in the AC. A 20,000-pound tandem steel-wheel roller with 54-inch-wide drums was applied to the AC immediately behind the vibratory roller for final compaction (Photo 19). The tandem steel-wheel roller mended (closed) the tears produced by the vibratory roller. While the compaction operation was under way, placement of the AC (one-half of a paving lane) was completed in the test item. This material was compacted but with extensive tearing.

The total compaction effort on the test item consisted of the following: two passes with the 25,000-pound tandem vibratory roller, operating statically; one pass with the 25,000-pound tandem vibratory roller, operating at the low-force level (25,000 pounds total applied force per drum); and six passes with the 20,000-pound tandem steel-wheel roller. After compaction, cores were taken and tested for asphalt content and density. The average asphalt content was 5.5 percent and the average density was 140.0 pcf, 95.2 percent of laboratory density (Table 2).

Cross-section data were recorded at three locations in the test item. The average thickness of the AC was 2.1 inches. Figure 11 shows typical cross-section data for the AC test item.

FWD data were collected on the AC surface at the same force levels and locations as that of the base course. The results are shown in Table 7.

Two DCVDTs were installed in the surface of the AC at the locations shown in Figure 9. The components of the DCVDTs and installation were the same as for those placed in the subgrade under the stabilized soil item, but with two exceptions. A 3-inch core was removed from the AC and a groove was cut from the DCVDT to the edge of the test item. The core removal was required to install the reference rod and mount the DCVDT at the surface of the AC. The groove was required to run instrument wire from the DCVDT to a recorder. Photo 20 shows the installation of the DCVDT in the waterproof housing at the surface of the AC.

SECTION IV

TESTING AND BEHAVIOR UNDER TRAFFIC

A. GENERAL

Traffic tests were performed on the two 50- by 100-foot test items with an F-4 aircraft and with a specially designed load cart on two separate lanes within the test section. The test vehicles, test lanes, traffic patterns, and pavement conditions during traffic are discussed in the following paragraphs. Traffic testing began 25 days after completion of the stabilized soil section and 19 days after completion of the AC section.

B. TEST VEHICLES

Traffic was applied to the test items with an F-4 aircraft and with a specially designed single-wheel test cart (Photo 21) which simulated F-4 and F-15 aircraft traffic. The test cart was equipped with an F-4 tire inflated to 265 psi and loaded to 27,000 pounds for F-4 traffic and later was equipped with an F-15 tire inflated to 355 psi and loaded to 30,000 pounds for F-15 traffic.

C. TRAFFIC PATTERNS AND TEST LANES

The two traffic patterns shown in Figure 12 were used in applying the test cart traffic in the F-15 and F-4 traffic lane (Figure 13). The traffic pattern widths were varied depending on the tire print width to get the desired distribution of traffic over the width at the respective lane.

The F-15 load cart traffic was distributed in a traffic lane 80 inches wide to simulate the distribution normally encountered in the actual aircraft takeoffs and landings. The traffic sequence started at one side of the lane with traffic applied forward and backward in the same path for the length of the traffic lane. The path of the cart was then shifted laterally 8 inches (the width of the tire print) on each successive forward trip. The full width of the traffic lane (80 inches) was trafficked in this manner, resulting in all points being subjected to two applications of a loaded tire. The interior 64 inches of the traffic lane was then trafficked for two additional applications and then the center 32 inches received two additional applications. This traffic pattern (Figure 12) required a total of 44 passes of the load cart and resulted in a maximum of six applications of the load wheel over each 8-inch segment of the center 32 inches of the traffic lanes. This pattern of traffic was repeated until the completion of trafficking. Based on traffic distribution studies (Reference 15) of aircraft on runways, the pass-to-coverage ratio for the F-15 aircraft is 9.36. Thus, one coverage of traffic is equivalent to 9.36 takeoffs and landings on a runway.

The F-4 cart traffic was applied on its traffic lane in the same manner as was the F-15 traffic. However, the load cart was shifted laterally 10 inches (the width for the F-4 tire) instead of the 8 inches for the F-15 traffic. This resulted in a 100-inch-wide F-4 traffic lane. Figure 12 shows the traffic pattern for the F-4 traffic. The pass-to-coverage ratio for the F-4 is

8.58. The F-4 aircraft traffic consisted of taxi runs, touch-and-go's on the test item, takeoffs (from touch-and-go) with the afterburners in a takeoff attitude over the test item, turns, and braking runs. Generally, the sequence of test traffic applied to the test items was as follows: (1) prooftesting the entire width of the test items with the F-4 test cart, (2) F-4 aircraft operations over items, (3) F-15 test cart traffic on the south lane, and (4) F-4 test cart traffic on the north lane.

D. FAILURE CRITERIA

Failure criteria for each of the traffic lanes (Figure 13), located in each of the test items, were when 3 inches of surface deformation (rutting) could be measured at any location inside the traffic lane. Surface deformation (rutting) is the distance from the bottom of 10-foot straightedge to the surface of the test item when the straightedge is placed on the test item perpendicular to the direction of traffic.

E. DATA COLLECTED BEFORE AND DURING TRAFFIC

1. General

The various types of data that were recorded to document the results of the traffic tests applied on the stabilized soil and AC test items are described in the following paragraphs. Visual observations and photo documentation will be presented later in the report.

2. Cross-section and Profile Data

Cross-section and profile data were recorded before the start of traffic, at the end of each type of traffic (F-4 aircraft, and F-15 or F-4 load cart), and at various coverage levels during the application of load cart traffic. Cross-section data were collected at those locations in each test item in a north-south direction, transverse to the test item's centerline and perpendicular to the direction of traffic. Profile data were collected parallel to the direction of traffic along the wheel paths of the F-4 aircraft which were also the centerlines of the load cart traffic lanes.

3. FWD Data

FWD data were collected on the surface of the test items before the start of traffic, at the end of each type of traffic, and at various coverage levels during the application of load cart traffic. Data were collected on lines 107.5 inches north and south of each test item's centerline (the locations of the F-4 aircraft wheel paths, which were also the centerlines for the F-4 and F-15 load cart traffic lanes), at three locations per test item, for a total of six locations per test item. Two levels of 9,000 and 15,000 pounds were applied at each location in the stabilized soil test item. Table 8 shows the data for the south wheel path of the F-4 aircraft and the F-15 load cart traffic lane. Table 9 contains the data for the north wheel path of the F-4 aircraft and F-4 load cart traffic lane. Force levels of 5,000, 9,000, 12,000, and 15,000 pounds were applied to the AC test item surface. The 5,000- and 12,000-pound force levels were applied when the pavement section became weak from traffic and the higher force levels produced deflections in the pavement that exceeded the range of the FWD deflection sensors. Table 10 contains the FWD data for the south wheel path of the F-4 aircraft and the F-15 load cart traffic lane. Table 11 shows the data for the north wheel path of the F-4 aircraft and the F-4 load cart traffic lane.

4. Instrumentation Data

Instrumentation data collected from the pressure gages and DCVDT (deflection) gages (Figure 10) during the application of F-4 aircraft traffic and F-4 load cart traffic on the stabilized soil test item and the AC test item are presented in Tables 12 and 13, respectively. Both dynamic and static data were collected with the F-4 load cart; only dynamic data were collected with the F-15 aircraft. Dynamic data were collected as the load wheel rolled over the gage location without stopping; static data were recorded after the load wheel had been in position over the gage location for 4 minutes. Only one static reading was recorded for each gage and these gages were located in the F-4 load cart traffic lanes. Because of recording limitations, data were not obtained from all the gages in the two test items during F-4 aircraft traffic. All the pressure gages located in the AC test item failed early in the traffic tests. The 50- and 100-psi pressure gages installed south of the test item's centerline (F-15 traffic lane) failed during prooftesting with the F-4 load cart. The 50- and 100-psi pressure gages located in the F-4 traffic lane failed after two and six coverages, respectively, of the F-4 load cart traffic.

Instrumentation data collected in the test items during the application of F-15 load cart traffic are presented in Table 14. Both dynamic and static data were collected with the F-15 load cart on the gages that were still operable after the prooftesting with the F-4 load cart. After eight coverages of F-15 load cart traffic, the field generator supplying power to the recording equipment became damaged. The only data obtainable after this were the total displacement (percent deflection) measured with the DCVDTs at the end of traffic.

A comparison was made between the deflection measured with the DCVDTs and the deflection measured with the FWD (Table 15). The comparison was made by placing the FWD directly over the gage location and recording the deflection measured by both the DCVDTs and the FWD, using the load applied by the FWD. It should be noted that the DCVDTs installed in the stabilized soil test item were 10 inches below the surface of the test item and measured the deflection at this depth, while the FWD measured the deflection at the surface of the test item.

5. Surface Deformation

Surface deformation (rutting) was measured and recorded throughout traffic testing. The degree of surface deformation was obtained using a 10-foot straightedge and a folding rule, graduated in inches. The straightedge was placed on the surface of the test item perpendicular to the direction of traffic, and the distance between the bottom of the straightedge and the surface of the test item was measured with the rule and recorded as surface deformation. The surface deformation (rutting) recorded during the application of traffic on the stabilized soil test item is presented in Table 16.

With the start of traffic, surface deformation (rutting) developed on the west end of the AC test item, at the transition with the stabilized soil test item. The premature surface deformation (rutting) was disregarded at this transition section because adequate compaction was not achieved during construction. The stabilized soil test item was constructed first and when the base course and AC surface were placed adjoining the stabilized soil test item, extra care with the vibratory roller (compaction equipment) had to be taken to keep from damaging the stabilized soil at the transition of the two test items (Figure 8). Table 17 contains the surface deformation measurements recorded during the trafficking of the AC test item.

6. AC Nuclear Density

The density of the AC was measured with a nuclear moisture-density gage before the start of traffic and then after every 10 coverages of F-15 and F-4 load cart traffic. Six density determinations were made at each of the coverage levels described above. The average and the spread of the density determinations for the F-15 and F-4 traffic lanes are shown in Figures 14 and 15, respectively.

F. BEHAVIOR UNDER TRAFFIC

1. Stabilized Soil Test Item

Prior to prooftesting the test item with the F-4 load cart, the item was swept with a towed power kickbroom to remove any loose material from the surface (Photo 22). During the sweeping operation, some pieces of the stabilized soil approximately 1 cubic inch in size were dislodged from the surface of the test item. Pieces of stabilized soil were removed from areas of the test item where the drums of the vibratory roller had overlapped with previous passes of the vibratory roller (covering the width of the test item) during compaction of the stabilized soil.

After sweeping the test item, two coverages of F-4 load cart traffic were applied for prooftesting the test item. The prooftesting was accomplished by starting the F-4 load cart on the north side of the test item with the load wheel half on the original PCC runway and half on the stabilized soil test item. The load cart was driven forward and backward in the same wheel path and then shifted over one wheel path (10 inches) and the load cart again driven forward and backward. This traffic pattern, which results in two of F-4 load cart traffic, was repeated until the entire width of the test item had been trafficked. There was no damage to the test item during the application of the prooftesting traffic. Photo 23 shows the stabilized soil test item after prooftesting was completed.

F-4 aircraft traffic followed the prooftesting. First, 10 taxi runs were applied with no apparent damage to the test item (Table 18). The 10 runs (passes) were applied in the same wheel paths (Figure 8). The taxi runs were followed by touch-and-go operations with the aircraft. Two touchdowns (landings) were made on the test item. The first one was 5 feet into the test item from the west (PCC end), and the other was 77 feet into the test item from the south end. On both touchdowns, the blast from the engines blew a small amount of stabilized soil loose from the surface of the test item. The loose material was considered a foreign object damage (FOD) problem and was removed from the test item with hand brooms and shovels. After the landing operations, two passes with the aircraft were made over the test item with the aircraft at takeoff attitude with afterburners on. On the first pass, there was no damage to the test item, but on the second pass a great amount of the stabilized soil was dislodged and scattered over an area at least 50 by 200 feet (Photo 24). The majority of the dislodged material came from the south half of the test item. Photo 25 shows an area of the test item where the stabilized soil was blown away. Approximately six of these areas were located in the test item, and stabilized soil in these areas was layered, not in one uniform lift (Photo 26). After the dislodged material was removed (definitely an FOD problem) aircraft operations were completed. These operations included turns and light and heavy braking runs on the test item. There was no damage to the test item from these operations. However, the F-4 aircraft test pilot observed that the nose gear of the aircraft seemed to reach its limits when crossing the areas where the engine blast had removed the stabilized soil from the surface of the test item (Photos 25 and 26). Photo 27 shows this stabilized soil test item after the F-4 aircraft traffic was completed. Figure 16 shows typical cross-section data for the test item before traffic was started (0 coverages), after two coverages of F-4 loaded cart traffic (prooftesting), and after the F-4 aircraft traffic. Figure 17 presents profile data for the same coverage level as above for the north and south wheel paths of the F-4 aircraft.

F-15 load cart traffic applied in an 8-inch-wide traffic lane located south of the centerline (Figure 13) followed the F-4 aircraft traffic. Traffic was started late in the day and only two coverages were applied, with the load wheel causing very minor abrasion of the stabilized soil. Rain fell during the night at the test site and water was ponded in the traffic area, in the areas where the jet blast from the F-4 aircraft had dislodged the stabilized soil (Photo 28). Traffic was continued in this wet condition with the load wheel starting to break up the stabilized soil approximately 1 inch deep. This 1 inch of material that was breaking up appeared to be in a layer, probably caused by the vibratory roller during construction of the test item. With traffic continuing to eight coverages, there was almost a complete breakup of the stabilized soil approximately 1 inch deep in the center 32 inches of the traffic lane. After 10 coverages of traffic, the breakup of material covered almost 70 percent of the traffic lane. Photo 29 shows a closeup of the traffic lane and Table 16 shows that a maximum rut depth of 2.19 inches was measured after 10 coverages of F-15 traffic. With traffic continuing, the F-15 load wheel continued to break up the top 1 inch of the stabilized soil and in some areas the depth of the breakup was greater than 1 inch. After 16 coverages, approximately 95 percent of the traffic lane contained loose (broken up) material on the surface. The maximum rut depth was 2.63 inches after 16 coverages, but the maximum rut had decreased to 1.88 inches after 20 coverages. This decrease in rut depth was due to the F-15 load wheel shifting the loose (broken up) material around inside the traffic lane. After 20 coverages the depth of the loose material ranged from 0.5 to 3.0 inches inside the traffic lane. With traffic continually being applied, the F-15 load wheel continued to abrade and grind up the surface of the stabilized soils. After 24 coverages, the maximum rut depth was 2.63 inches again and increased to 2.75 inches after 30 coverages. Photo 30 shows a closeup of the surface condition in the traffic lane after 30 coverages. By 30 coverages, the rain-dampened loose stabilized soil had dried. Between 30 and 33 coverages, the load cart generated dust from the loose stabilized soil. Traffic was stopped at 38 coverages when a 3.25-inch maximum rut was measured. Photo 31 shows the traffic lane when traffic was stopped. Typical cross sections for the F-15 traffic lane, stabilized soil test item, after the F-4 aircraft (0 coverages F-15), after 20 coverages, and after 38 coverages are shown in Figure 18. Profile for the centerline of the F-15 traffic lane, after the F-4 aircraft (0 coverages), 20 coverages, and 38 coverages are shown in Figure 19.

F-4 load cart traffic was applied in a 100-inch-wide traffic lane located north of the stabilized soil test item's centerline (Figure 14) after the F-15 load cart traffic was completed. The two coverages of F-4 load cart traffic that were placed on the test item during the prooftesting are included in the coverage count. The F-4 load wheel ground up and/or abraded the surface of the stabilized soil in much the same way as the F-15 load wheel, only at a slower rate. Eighty coverages of F-4 traffic were required to produce 3.25 inches of surface deformation (rutting) as compared to 38 coverages of F-15 traffic (Table 16). Photo 32 shows the traffic lane after 10 coverages of traffic when the maximum rut (surface deformation) measurement was 1.5 inches (Table 16). After 20 coverages of traffic there was enough loose (abraded) material on the surface of the traffic lane that the load cart was producing dust from it during traffic. After 30 coverages, the loose material ranged from 0.5 to 1.5 inches deep and covered over 80 percent of the traffic lane (Photo 33). The maximum rut measurement was 2.44 inches at this time. Traffic applied after 30 coverages completely broke up the already loose stabilized material in the traffic lane, returning it to the original state of silty sand (curve 2 in Figure 2) and PC. This material (silty sand and cement) in a very dry condition was then shifted around and spread out inside the traffic lane by the load cart, thus reducing the maximum surface deformation (Table 16). Photo 34 shows the surface condition of the traffic lane after 50 coverages with the loose material covering the width of the traffic lane to a depth of 1 to 1.5 inches. The surface deformation of rutting started to increase in depth again after 60 coverages (Table 16) of traffic and reached 3.25 inches after 80 coverages of traffic had been applied. Traffic was stopped at this time. Photo 35 is a closeup of the traffic lane with a 10-foot straightedge across the lane after 80 coverages of F-4 traffic. Typical cross sections for the F-4 traffic lane after the F-4 aircraft traffic, after 20 coverages of F-4 load cart traffic, and after 80 coverages of F-4 traffic load cart traffic are shown in Figure 20. Figure 21 shows profiles along the centerline of the F-4 traffic lane after the F-4 aircraft traffic, 20 coverages of F-4 load cart traffic, and after 80 coverages of F-4 load cart traffic.

The top lift of the stabilized soil was in layers (Photos 16 and 26) and not a single uniform 5- or 6-inch-thick lift as it should have been. This should be considered a construction failure. Jet blast from the F-4 aircraft probably would not have dislodged the stabilized soil at the surface and the breakup or abrasion of the stabilized soil under load cart traffic would have been at a slower rate had the top lift of stabilized soil been in one uniform lift. As stated earlier in this report, the layering was probably caused by the vibratory roller used in compacting the stabilized soil. The F-15 and F-4 load cart traffic showed that the test item as constructed, with the layers, would support 38 and 80 coverages of traffic, respectively. However, the F-4 aircraft proved the test item could not support aircraft traffic because of the FOD potential caused by particle removal by the aircraft engine blast.

2. Asphaltic Concrete Test Item

Prooftesting of the AC test item with two coverages of F-4 load cart traffic was accomplished in the same manner as the prooftesting of the stabilized soil test item. Before prooftesting traffic was applied, the surface of the AC contained minor shrinkage cracks. Photo 36 shows the surface before traffic. The two coverages of F-4 load cart traffic removed (closed) almost of these cracks. The maximum surface deformation (rutting) measurements after the prooftesting was 0.48 inch (Table 17) located south of the test item's centerline.

F-4 aircraft traffic followed the prooftesting of the test item (Photo 37). The order of aircraft testing was taxiing, touch-and-go, sharp turns, and then braking operations. Events are shown in Table 18. Figure 8 shows the location of the aircraft wheel paths on the test item for all aircraft operations except the sharp turns. All of the F-4 aircraft traffic applied to the test item were uneventful with the exception of minor rutting (surface deformation). After two passes (taxiing) of the aircraft, the maximum surface deformation (rutting) was 0.63 inch (Table 17) located south of the test item's centerline. After all of the aircraft operations had been completed, this maximum surface deformation had decreased to 0.44 inch. Photo 38 shows the test item after F-4 aircraft operations were completed. Typical cross sections at the start of traffic (0 coverages), after two coverages of the F-4 load cart, and after the F-4 aircraft traffic are shown in Figure 22. Figure 23 presents profiles for the north and south wheel paths of the F-4 aircraft at the same coverage levels as above.

F-15 load cart traffic was applied after the F-4 aircraft traffic was completed. The F-15 traffic lane was located south of the test item's centerline, as shown in Figure 13. After two coverages of F-15 traffic, the maximum surface deformation in the traffic lane was 0.63 inch (Table 17). Photo 39 shows the surface condition of the F-15 traffic lane after two coverages with rainwater ponded along the centerline. Between 2 and 10 coverages of F-15 traffic, the AC started showing distress in the form of hairline transverse cracks across the traffic lane. After 10 coverages, the transverse crack had developed into low-severity alligator cracking (110 square feet) in the middle one-third of the traffic lane. The rest of the traffic lane contained hairline transverse tears across the traffic lane spaced just over 2 inches apart. The maximum surface deformation was 1.38 inches at this time (Table 17). After 16 coverages, the maximum surface deformation increased to 1.88 inches and the severity of cracking increased as well. The traffic lane at this time contained approximately 105 square feet of low-severity alligator cracking and 20 square feet of medium-severity alligator cracking. Photo 40 shows the surface condition of the traffic lane after 16 coverages of traffic. At 20 coverages the maximum surface deformation decreased slightly (Table 17) as compared to 16 coverages, but the severity of the alligator cracking increased, as can be seen in Photo 41. Approximately 40 square feet of low-severity and 123 square feet of medium-severity alligator cracking occurred in the traffic lane. After 30 coverages of F-15 traffic, the traffic lane contained approximately 40 square feet of high-severity alligator cracks. Between 30 and

38 coverages, two longitudinal fatigue cracks developed in the traffic lane. They were located approximately 1 foot either side of the centerline of the traffic lane and ran the complete length of the traffic lane. Photo 42 shows a close up of one of the cracks. Also during this traffic period, the maximum surface deformation increased from 2.06 to 4.25 inches. The rapid increase was apparently due to the longitudinal fatigue cracks. Traffic was stopped at this time. The traffic lane contained approximately 10 square feet of low-severity, 100 square feet of medium-severity, and 60 square feet of high-severity alligator cracking after 38 coverages. Photo 43 shows a close up of the traffic lane with a 10-foot straightedge at the 38-coverage level. Figure 24 shows typical cross sections for the traffic lane after the F-4 aircraft (0 coverages for F-15), after 20 coverages of F-15 traffic, and after 38 coverages of F-15 traffic. Profiles along the centerline of the traffic lane for the same coverage levels are presented in Figure 25.

F-4 load cart traffic was applied in a 100-inch-wide traffic lane located north of the AC test item's centerline (Figure 13) after the F-15 load cart traffic was completed. The two coverages of F-4 load cart traffic placed on the test item during the prooftesting are included in the coverage count. Other than the minor rutting (surface deformation) shown in Table 17, the AC did not show any distress until 20 coverages of traffic had been applied. At this time, the traffic lane contained approximately 35 square feet of low-severity alligator cracking. At 30 coverages the traffic lane contained approximately 8 square feet of medium-severity alligator cracking and 35 square feet of low-severity alligator cracking. Four longitudinal fatigue cracks had also developed in the traffic lane; one was approximately 60 feet long while the other three were 15 feet in length. The cracks were spaced 10 inches apart, the width of the F-4 load tire. Photo 44 shows the traffic lane after 30 coverages of traffic. After 50 coverages, the traffic lane contained approximately 50 square feet of low-severity and 20 square feet of maximum-severity alligator cracking and six longitudinal fatigue cracks. At 70 coverages, the AC started moving under the load wheel. The bond between the AC and base course was broken. This movement was located in the center of the traffic lane. With traffic continuing, the AC started raveling along the longitudinal fatigue cracks where movement in the AC was taking place. Between 90 and 100 coverages, the maximum surface deformation increased from 2.50 inches to 4.31 inches (Table 17) and traffic was stopped. The defects observed in the AC were the longitudinal fatigue cracks, approximately 203 square feet of medium-severity alligator cracking and raveling. The raveling of the AC could have been a FOD problem for aircraft operations. Photo 45 is a close up of the surface condition in the traffic lane after 100 coverages. Figure 26 shows typical cross sections for the traffic lane after the F-4 aircraft, after 10 coverages, after 50 coverages, and after 100 coverages of F-4 load cart traffic. Profiles along the centerline of the traffic lane for the same coverage levels are presented in Figure 27.

The AC test item supported the F-4 aircraft operations (Table 18) with no problems, and the F-4 test pilot had no adverse comments about operating the F-4 on the AC test item. The test item supported 38 coverages of F-15 and 100 coverages of F-4 load cart traffic before 3 inches of surface deformation was reached. There was, however, extensive cracking or breakup of the AC before the coverage levels were reached. These traffic tests were conducted in a dry condition (very little or no rainfall). Had traffic been conducted in a wet condition, the amount of cracking in the AC would have allowed the base and possibly the subgrade to become wet or saturated and the volume of traffic to failure probably would have been less.

SECTION V

AFTER-TRAFFIC DATA

A. STABILIZED SOIL TEST ITEM

After-traffic data collected consisted of splitting tensile strength of the stabilized soil, cement content of the stabilized soil, and CBR data on the surface under the stabilized soil.

Splitting tensile strength tests were run on cores taken outside of the F-4 and F-15 traffic lanes. The stabilized soil was abraded and broken up too much to obtain cores from inside the traffic lane. Six cores were taken for the tests; two of these were broken in transit to WES. The cores were tested at WES according to ASTM C 496 (Reference 12), and the results are shown in Table 19. An average of 33 psi tensile strength was obtained from these cores. This compares with the 35 and 19 psi values obtained from the before-traffic tests (Table 5).

Cement content tests were run on eight samples of the stabilized soil at WES to determine the amount of cement in the stabilized soil as placed. The tests were run on four samples from each lift or layer that was placed in the test item. The tests were run according to ASTM D 806 (Reference 16), and the results are shown in Table 20.

CBR, water content, and density determinations were made on the subgrade after a sufficient amount of the stabilized soil had been removed to allow for testing. The average strength of the top 12 inches of subgrade was 36 CBR (Table 21). The strength increased slightly from the before-traffic average of 30 CBR (Table 3).

B. ASPHALTIC CONCRETE TEST ITEM

After-traffic data collected consisted of density of AC, asphalt content, penetration of asphalt, gradation of AC mix, and CBR data in both traffic lanes.

Cores went cut from each of the traffic lanes and tested for asphalt content, density, and penetration of asphalt (Table 22). Gradation of the AC mix for the test item is shown in Figure 28.

CBR, water content, and density determinations were made on the crushed stone base and subgrade in each of the traffic lanes. A summary of the results is shown in Table 21. Photo 46 shows the CBR pit placed in the F-15 traffic lane; note the minor rutting in the base course.

SECTION VI

ANALYSIS OF RESULTS

A. GENERAL

Traffic test results from the test items at North Field were compared to performance predicted by the CBR design procedure presently used by the Air Force and to a layered elastic design method. Since testing was conducted with the F-4 and F-15 load carts on both the asphaltic and soil stabilized item, comparisons can be made for four different traffic sections. Results from the traffic tests on ALRS type pavements in the study reported in Reference 6 are also presented for comparison.

B. PAVEMENT PERFORMANCE UNDER AIRCRAFT TRAFFIC

The 40 aircraft operations on the asphalt test section produced no pavement distress. Instrumentation data presented in Table 13 indicate significantly lower pressure from the F-4 aircraft than for the F-4 load cart. The aircraft load was approximately 50,000 pounds as compared to 60,000 pounds equivalent for the load cart. Another cause for the difference may be that the aircraft tire did not pass directly over the gage. One touch-and-go operation did occur directly over a deflection gage. The deflection was approximately 50 percent of the load cart deflection (Table 13). This was probably caused by the reduced wheel load due to lift from the wings at touch-and-go speeds.

The performance of the stabilized soil item under aircraft traffic was unsatisfactory. Structurally, the item supported the traffic with no apparent distress. Functionally, the item failed due to the FOD potential caused when the aircraft rotated over the item with maximum thrust dislodging surface particles and spreading them over the runway (Photo 24, 25, and 26). Based on these results, an asphalt surface layer or a FOD cover should be required for stabilized soil ALRS-designed pavements.

C. CBR DESIGN

The failure criterion for the conventional CBR design for flexible pavements is a 1-inch rut depth or cracking of the surface course to the extent that water can enter the base. The failure criterion selected for the ALRS pavements was a 3-inch rut depth. An evaluation of whether the CBR design criterion should be modified to account for the increased rutting was made.

Maximum rut depth is shown versus coverages in Figure 29 for the F-4 and F-15 lanes in the asphalt test item. Rut depths were measured with a 10-foot straightedge at the point within the traffic lane at which the maximum depth occurred. The pass-to-coverage ratio for the F-4 is 8.58 and for the F-15, 9.36. Thus, the coverages at the 1-inch rut depth are equivalent to more than 189 aircraft passes for the F-4 and 114 aircraft passes for the F-15.

To evaluate the design procedure, data from previous traffic test sections reported in Reference 6 were included. Characteristics of all the test sections are presented in Table 23. All traffic data (except the last line) were obtained with the F-4 load cart loaded with 27,000 pounds and with 265-psi tire pressure. Data for the 1-inch rut depth are shown in Figure 30, which is the current relationship for which the flexible pavement design curves are derived. The alpha factor depends on the gear configuration and number of coverages.

Using the passes to a 3-inch rut depth and data from Table 23, the relationship to the CBR curve is shown in Figure 31. Although more data points are above the curve (Figure 31) for the 3-inch rut depth, the relationship is not strong enough to justify changing the CBR curve. If significantly more data were available, a change might be justified to require a reduced thickness in design.

D. LAYERED-ELASTIC DESIGN

The performance of the test items was also analyzed as a layered-elastic system. Modulus values for the pavement layers were determined from deflection basin results from the falling weight deflectometer. Tests conducted on each layer during construction and on the pavement surface before traffic were used to back-calculate the modulus values of the layers. Results are presented in Table 24. Generally, the modulus value increased slightly for each layer when the next layer was added. The increase was expected due to the increase in confinement for these granular layers.

Laboratory tests were conducted on the subgrade material to determine the resilient modulus properties of the sand at different confining pressures and normal stresses. Results of these tests are presented in Figure 32. Results indicate those modulus values determined from deflection basin data are similar to those determined in the laboratory.

The use of a layered-elastic model offers a method to compare stresses and deflections measured with pressure and deflection transducers to those calculated with a multilayered elastic model. A comparison of stresses under the F-4 load cart is shown in Figure 33. Measured and computed stresses were closer when the Boussinesq stress distribution was assumed.

The rut-depth-versus-coverage relations for the stabilized test items are shown in Figure 34. The rut depths were mainly due to abrasion of the surface of the stabilized layer by the load cart's F-4 and F-15 tires (Photos 29 through 35).

Moduli values were back-calculated for the stabilized items and are shown in Table 24. These moduli values were used in a layered-elastic model to calculate vertical stresses for each loading condition (F-4 and F-15). These stresses are shown in Figures 35 and 36. For comparison, measured stresses from the pressure cells placed in the subgrade are also shown. As for the asphalt items, this method of back-calculating moduli and modeling with a layered-elastic model reasonably predicts stresses within the pavement structure.

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based on results of a full-scale test section constructed on a runway at North Field, SC, and subjected to F-4 aircraft traffic and F-4 and F-15 load cart traffic, the following conclusions are presented:

1. A 2-inch asphalt surface course supported on an 80-CBR course will support F-4 aircraft operations for the required 150 passes provided the total thickness above the subgrade meets the criteria as specified in AFM-88-6 (Reference 14).

2. Results of traffic tests with the F-15 with a gross aircraft weight of 68,000 pounds do not indicate that the asphalt surface thickness of 2 inches is adequate unless the number of aircraft operations is reduced to 100 passes.

3. A surface course is required for stabilized soil structures, particularly in areas subjected to jet blast for the prevention of foreign object damage to the engines.

4. Deflections from the falling weight deflectometer can be used with a layered-elastic model to predict stresses in the pavement structure. These stresses can be used to predict performance.

5. The CBR design procedure should not be modified for the design of ALRS pavements even though the rut depth is increased from 1 to 3 inches.

6. The design techniques used for both the stabilized and asphalt test items were adequate in predicting the performance.

B. RECOMMENDATIONS

Based on the above conclusions, the following recommendations are presented:

1. For ALRS flexible pavement thickness design, the CBR design method should be used.

2. The thickness of the asphalt surface can be reduced to 2 inches for pavements used by the F-4 aircraft.

3. Additional study is recommended for the design of ALRS pavements to support the heavyweight F-15 aircraft with high tire pressures.

4. A surface course is recommended for pavements containing stabilized layers.

5. A mechanistic design procedure as demonstrated with the layered-elastic method should be developed for implementation that could be used for design of all types of ALRS including AC and stabilized layered pavements.

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APPENDIX A: TABLES

TABLE 1. COMPRESSIVE STRENGTH, FLEXURAL STRENGTH, AND SPLITTING TENSILE STRENGTH.

Portland cement percent	Percent moisture As molded	Percent moisture As tested	Compressive strength psi
	7-Day cure		
5	6.8	1.6	95
7	7.2	3.3	109
9	7.0	2.8	136
	28-Day cure		
5	6.9	3.4	177
7	7.2	1.2	297
9	6.5	1.1	459

Portland cement percent	Percent moisture As molded	Percent moisture As tested	Flexural strength psi
	7-Day cure		
5	6.9	2.9	11
7	7.0	4.4	15
9	7.1	4.1	25
	28-Day cure		
5	6.8	3.0	56
7	6.9	1.6	88
9	6.9	1.5	104

Portland cement percent	Percent moisture As molded	Percent moisture As tested	Splitting tensile strength psi
	7-Day cure		
5	6.9	3.2	7.4
7	7.0	4.4	11.4
9	6.9	4.3	15.1
	28-Day cure		
5	7.0	4.6	26.0
7	6.8	1.6	44.0
9	6.9	1.7	69.0

TABLE 2. ASPHALTIC CONCRETE MIXTURES.

		Laboratory mix at WES				Laboratory mix and plant mix at test site				
Size of sieve	Specified limits	Job-mix formula	50% Coarse aggregate	35% Unwashed screening	15% Sand	Job-mix formula	Plant mix (laydown)	40% Coarse aggregate	45% Unwashed screening	15% Sand
3/4 inch	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2 inch	100	99.8	99.7	100.0	100.0	100.0	97.9	100.0	100.0	100.0
3/8 inch	79-93	95.0	89.9	100.0	100.0	96.0	85.6	90.0	100.0	100.0
No. 4	59-73	61.6	23.6	99.6	99.3	69.0	65.7	24.0	100.0	99.0
No. 8	46-60	50.7	8.9	91.5	95.5	58.4	57.6	9.0	91.0	96.0
No. 16	34-48	39.0	3.8	70.5	82.7		48.9	3.8		83.0
No. 30	24-38	28.9	2.4	53.8	58.6	31.0	36.4	2.4	48.0	59.0
No. 50	15-27	19.8	1.8	39.6	33.3		22.3			33.0
No. 100	8-18	12.1	1.2	26.0	16.1	9.6	11.8		16.0	16.0
No. 200	3-6	7.7	0.8	17.0	8.5	3.8	6.4		5.5	8.5
Percent bitumen	5.4-4.8	5.6				5.6	5.3			
Grade bitumen		AC-20					AC-20			
Stability (Marshall), pounds	1,800 min.	2,220					2,959			
Flow, 0.01 inch	16 max.	11					11			
Percent voids total mix	3-5	4.2					3.4			
Percent voids filled	70-80	75.0					79.1			
Laboratory density, pcf							147.0			

TABLE 3. BEFORE-TRAFFIC SOIL DATA.

Test item	Station	Material	Depth inches	In-place CBR	Modulus of soil reaction, k pci	Water content percent	Dry density pcf
Stabilized soil	0+25	Subgrade silty sand	0	13		5.9	111.8
			6	28		6.2	114.4
			12	30		5.7	110.2
	0+50				375		
	0+75		0	27		6.3	113.2
			6	41		6.5	113.6
			12	38		4.9	109.1
Flexible pavement	1+25		0	16		6.4	111.3
			6	44		4.8	115.2
			12	45		5.0	109.1
	1+50				444		
	1+75		0	27		5.2	115.4
			6	26		5.2	115.6
			12	25		6.7	116.2
	1+25	Base crushed granite	0	52		5.2	143.2
	1+40		0	96		5.2	143.2
	1+50				526		
	1+75		0	69		143.2	5.2

TABLE 4. FWD DATA, SUBGRADE[a].

Station	Force pounds	Deflection, mils						
		$\Delta_{0\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$	$\Delta_{60\text{-in.}}$
107.5 inches north of centerline of stabilized soil item (F-4 lane)								
0+25	4,864	11.1	6.5	3.0	1.9	1.0	0.5	0.4
0+50	4,752	13.7	6.3	3.2	2.1	1.1	0.7	0.5
0+75	4,816	12.0	5.8	2.8	1.9	0.9	0.6	0.5
0+25	8,840	21.0	11.3	5.3	3.5	1.9	1.1	0.9
0+50	8,728	25.2	11.2	5.9	4.1	2.1	1.2	0.9
0+75	8,832	21.7	11.1	4.7	3.2	1.7	1.1	0.8
107.5 inches south of centerline of stabilized soil item (F-15 lane)								
0+25	4,792	9.3	6.9	3.1	2.1	1.1	0.7	0.5
0+50	4,784	11.3	5.5	3.0	2.1	1.1	0.6	0.5
0+75	4,920	12.4	5.3	3.0	2.1	1.1	0.7	0.5
0+25	8,880	19.2	11.7	5.5	3.6	2.0	1.3	0.9
0+50	8,832	21.1	10.7	5.6	3.8	1.8	1.1	0.8
0+75	8,816	22.2	9.5	5.3	3.8	1.7	1.2	0.9
107.5 inches north of centerline of flexible pavement item (F-4 lane)								
1+25	4,856	11.7	6.3	2.9	1.8	0.9	0.5	0.4
1+50	4,728	14.5	8.7	3.8	2.3	1.1	0.6	0.5
1+75	4,848	14.5	6.0	2.8	1.7	0.7	0.5	0.3
1+25	8,664	22.6	11.5	5.2	3.4	1.7	1.1	0.8
1+50	8,648	26.5	16.5	6.4	4.2	2.0	1.2	0.8
1+75	8,784	25.9	10.8	4.9	2.8	1.3	0.9	0.7
107.5 inches south of centerline of flexible pavement item (F-15 lane)								
1+25	4,824	13.8	6.0	3.5	2.3	0.8	0.7	0.5
1+50	4,707	15.9	6.5	3.0	2.0	1.0	0.6	0.4
1+75	4,768	11.8	6.9	3.3	2.1	1.1	0.6	0.5
1+25	8,832	25.4	11.2	6.2	4.3	2.2	1.3	1.0
1+50	8,776	22.8	11.6	5.7	3.9	1.9	1.3	0.9
1+75	8,768	24.7	12.6	5.8	3.6	2.0	1.2	0.9

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[a] 17.7-inch-diameter plate.

TABLE 5. COMPRESSIVE AND SPLITTING TENSILE STRENGTHS FOR STABILIZED SOIL TEST ITEM.

Sample number	Percent moisture as tested	Compressive strength at 28 days psi	Sample number	Percent moisture as tested	Splitting tensile strength at 28 days psi
	First lift			First lift	
1	6.4	253.6	1	5.9	33.7
2	6.4	282.4	2	5.8	32.5
3	8.5	210.8	3	6.7	36.5
4	6.4	237.5	4	7.4	39.9
			5	7.1	39.2
			6	6.4	30.1
Average	6.9	246.0		6.6	35.3
	Second lift			Second lift	
1	7.6	143.2	1	7.6	13.2
2	6.3	112.0	2	6.3	15.4
3	5.8	92.6	3	5.8	15.7
4	7.3	167.6	4	7.3	27.3
5	6.9	161.2	5	6.9	22.3
6	7.3	141.1	6	7.3	21.8
Average	6.9	136.0		6.9	19.3

TABLE 6. FWD DATA, BASE COURSE[a].

Station	Force pounds	Deflection, mils						
		$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
107.5 inches north of centerline (F-4 lane)								
1+25	5,160	19.9	6.2	3.2	2.1	1.6	1.0	0.7
1+50	4,840	23.8	7.3	3.4	2.0	1.3	1.0	0.7
1+75	4,816	23.3	6.8	3.8	2.5	1.7	1.1	0.7
1+25	9,080	27.5	12.6	6.3	4.0	2.7	1.9	1.3
1+50	8,832	35.6	12.9	6.2	3.9	2.6	1.8	1.3
1+75	8,872	34.7	12.4	7.1	4.2	2.8	1.9	1.3
1+25	11,720	32.0	16.9	8.8	5.5	3.9	2.6	1.8
1+50	11,584	43.6	16.3	7.7	4.3	3.1	2.2	1.5
1+75	11,720	42.2	16.3	8.5	4.7	3.2	2.1	1.5
107.5 inches south of centerline (F-15 lane)								
1+25	4,824	22.6	7.8	4.0	2.7	1.9	1.1	0.7
1+50	4,912	19.4	9.0	4.7	2.9	1.2	1.3	0.9
1+75	4,760	23.8	8.5	4.1	2.7	1.7	1.2	0.8
1+25	8,928	34.7	14.0	7.3	4.7	3.3	2.0	1.3
1+50	8,888	32.2	16.2	8.7	5.1	3.7	2.3	1.5
1+75	8,840	37.1	15.0	7.4	4.6	3.2	2.0	1.3
1+25	11,712	43.8	18.6	9.2	5.6	3.8	2.4	1.5
1+50	11,600	41.8	21.6	11.1	6.0	4.4	2.7	1.8
1+75	11,584	47.7	19.9	9.6	5.2	3.6	2.3	1.4

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[a] 11.8-inch-diameter plate.

TABLE 7. FWD DATA, ASPHALTIC CONCRETE[a].

		Deflection, mils						
Station	Force pounds	$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
107.5 inches north of centerline (F-4 lane)								
1+25	4,960	15.6	6.6	3.1	1.9	1.7	0.8	0.5
1+50	4,888	16.3	7.6	3.6	2.3	1.6	0.9	0.6
1+75	4,976	14.8	6.8	3.4	2.0	1.4	0.8	0.5
1+25	9,024	26.2	12.0	6.0	3.6	2.6	1.5	1.1
1+50	8,880	27.4	13.3	6.7	4.2	2.9	1.7	1.2
1+75	8,928	24.9	12.2	6.3	3.7	2.6	1.6	1.0
1+25	11,904	37.4	16.1	7.3	4.3	3.1	1.9	1.3
1+50	11,736	39.1	18.1	8.2	5.1	3.5	2.0	1.4
1+75	11,760	34.7	16.1	7.5	4.3	3.1	1.9	1.2
107.5 inches south of centerline (F-15 lane)								
1+25	4,840	22.3	9.9	4.3	2.1	1.6	1.0	0.7
1+50	4,808	26.6	11.9	4.6	2.1	1.6	1.1	0.8
1+75	4,872	18.2	8.7	4.2	2.4	1.8	1.0	0.7
1+25	8,920	36.0	16.8	7.9	4.0	2.8	1.9	1.2
1+50	8,896	40.7	19.6	8.5	3.9	2.9	1.9	1.3
1+75	8,832	30.5	15.4	7.9	4.5	2.8	1.9	1.2
1+25	11,712	52.9	23.2	9.4	4.1	2.7	2.0	1.4
1+50	11,608	60.4	27.8	10.3	4.1	3.2	2.3	1.5
1+75	11,536	46.8	22.0	10.3	5.6	4.0	2.3	1.5

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[a] 11.8-inch-diameter plate.

TABLE 8. FWD DATA, F-15 STABILIZED SOIL TEST ITEM[a].

Station	Force pounds	Deflection, mils						
		$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
				0 Coverages				
0+25	9,192	11.9	6.5	5.5	3.9	5.0	1.9	1.3
0+50	9,144	12.3	8.0	6.4	5.0	4.6	2.0	1.3
0+75	FWD impaired							
0+25	14,376	18.8	11.2	8.2	6.3	3.8	3.0	2.0
0+50	14,336	21.9	13.4	9.9	7.2	2.8	3.0	2.1
0+75	FWD impaired							
				After prooftesting, 2 coverages, F-4 load cart				
0+25	9,112	16.2	8.7	7.5	5.2	4.3	2.0	1.5
0+50	9,016	16.7	8.7	7.1	5.2	3.7	2.0	1.3
0+75	9,144	12.9	9.4	6.5	4.5	3.2	1.8	1.2
0+25	14,392	23.4	13.6	11.1	7.5	6.2	3.2	2.1
0+50	14,352	24.3	13.8	11.9	8.6	6.4	3.2	2.0
0+75	14,416	19.3	14.2	10.4	7.8	5.3	2.9	2.0
				After F-4 aircraft				
0+25	9,440	15.5	10.1	7.8	6.2	3.5	2.4	1.6
0+50	9,304	16.3	10.2	8.3	5.8	4.2	2.3	1.5
0+75	9,144	15.6	10.5	8.4	5.9	4.2	2.2	1.5
0+25	14,696	23.1	15.9	12.4	9.4	5.7	3.5	2.4
0+50	14,560	24.0	16.1	13.3	9.3	6.1	3.6	2.4
0+75	14,344	22.9	15.9	13.4	8.7	5.9	3.3	2.3
				2 Coverages, F-15 load cart				
0+25	9,024	15.3	9.8	7.4	5.6	3.9	2.3	1.5
0+50	9,192	14.4	10.1	9.5	6.9	4.9	2.4	1.6
0+75	8,968	14.9	9.8	8.0	5.3	4.1	2.3	1.5
0+25	14,544	23.3	15.5	12.0	8.7	5.8	3.4	2.3
0+50	14,496	22.0	15.5	13.6	8.9	7.0	3.8	2.3
0+75	14,424	22.4	15.5	11.8	7.9	6.2	3.3	2.0

(Continued)

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[a] 107.5 inches south of centerline (F-15 traffic lane).

TABLE 8. FWD DATA, STABILIZED SOIL TEST ITEM (CONCLUDED).

Station	Force pounds	Deflection, mils $\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
10 Coverages, F-15[b] load cart								
0+25	9,064	21.9	15.4	11.7	7.4	4.9	2.6	1.8
0+50	9,120	19.5	15.2	11.5	7.9	5.0	2.5	1.6
0+75	8,136	22.1	14.0	10.6	7.1	5.3	2.7	1.7
0+25	14,440	32.2	23.8	18.5	11.9	7.6	3.9	2.7
0+50	14,192	28.9	23.4	18.7	13.5	8.8	3.9	2.4
0+75	11,632	36.3	22.8	17.7	11.9	7.2	4.1	2.4
20 Coverages, F-15[b] load cart								
0+25	8,992	21.8	22.2	12.1	9.3	6.2	2.7	2.1
0+50	8,816	22.3	18.6	12.9	8.0	5.1	2.5	1.7
0+75	9,040	20.1	15.0	10.2	6.3	4.2	2.3	1.6
0+25	14,376	32.0	34.6	24.5	14.0	9.1	4.0	3.3
0+50	14,328	33.7	27.5	23.2	13.0	8.1	3.8	2.4
0+75	14,312	31.4	23.6	17.2	10.0	6.7	3.5	2.2
30 Coverages, F-15[b] load cart								
0+25	9,072	27.7	17.3	13.3	8.0	5.2	3.2	2.2
0+50	8,536	31.0	19.0	13.9	10.3	5.9	3.1	2.1
0+75	9,256	23.0	19.8	13.6	7.9	4.9	2.8	2.0
0+25	14,192	45.1	24.7	16.3	11.8	7.8	4.2	3.0
0+50	13,456	43.9	26.3	20.2	15.1	8.9	4.5	3.0
0+75	14,200	35.6	29.3	20.4	12.4	7.5	3.9	2.7
38 Coverages, F-15[b] load cart								
0+25	8,904	43.1	24.7	17.3	10.7	6.4	3.8	2.8
0+50	8,984	37.1	32.5	23.5	20.1	8.2	3.7	2.5
0+75	9,136	28.5	18.9	11.9	8.7	5.1	2.7	2.0
0+25	14,136	67.9	36.0	27.0	15.2	9.2	5.0	3.7
0+50	14,456	48.8	15.7	13.3	10.3	11.5	5.3	3.4
0+75	14,506	39.8	19.0	18.8	13.1	6.9	3.7	2.7

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[b] Loose, abraded stabilized material on the surface of the traffic lane.

TABLE 9. FWD DATA, F-4 STABILIZED SOIL TEST ITEM[a].

Station	Force pounds	Deflection, mils						
		Δ0-in.	Δ8-in.	Δ12-in.	Δ18-in.	Δ24-in.	Δ36-in.	Δ48-in.
				0 Coverages				
0+25	9,296	13.2	7.8	5.2	3.9	3.4	2.2	1.2
0+50	9,208	14.0	8.0	6.0	5.1	3.2	2.2	1.5
0+75	9,280	12.5	6.6	--	4.1	3.5	1.5	1.0
0+25	14,640	20.5	12.6	9.0	5.9	5.3	3.3	2.0
0+50	14,336	20.5	12.9	9.5	7.8	5.1	3.2	1.9
0+75	14,400	18.8	10.1	--	5.8	5.1	2.5	1.5
				After prooftesting, 2 coverages, F-4				
0+25	8,952	15.1	9.5	6.3	4.4	1.4	1.7	1.2
0+50	9,024	15.8	10.2	7.6	5.2	1.5	2.0	1.3
0+75	8,848	14.6	7.5	6.0	4.5	2.6	1.6	1.1
0+25	14,264	23.2	15.0	10.1	7.4	3.4	2.8	1.9
0+50	14,168	22.9	15.5	10.9	8.4	5.5	3.0	1.9
0+75	14,200	21.8	11.5	10.0	7.1	4.7	2.6	1.7
				After F-4 aircraft				
0+25	9,064	16.1	10.4	7.1	5.0	3.7	2.0	1.5
0+50	9,280	14.5	10.4	8.0	5.7	3.9	2.3	1.5
0+75	9,432	12.4	9.3	8.4	5.3	3.2	2.1	1.3
0+25	14,408	24.5	16.1	11.3	7.8	5.6	3.1	2.2
0+50	14,464	22.0	16.2	12.7	8.9	5.8	3.4	2.1
0+75	14,336	18.3	15.2	12.0	7.8	5.7	3.0	1.3
				10 Coverages, F-4				
0+25	9,256	21.9	19.5	13.9	7.8	4.9	2.7	1.9
0+50	9,032	22.1	16.1	13.4	7.9	5.3	2.9	2.1
0+75	8,808	22.5	15.1	10.1	6.9	4.3	2.3	1.5
0+25	14,336	30.7	21.5	17.6	11.6	14.5	4.1	2.7
0+50	14,392	33.0	17.5	18.2	12.1	7.5	4.2	2.9
0+75	13,856	30.7	21.4	15.5	10.2	6.8	3.5	2.2

(Continued)

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[a] 107.5 inches north of centerline (F-4 traffic lane).

TABLE 9. FWD DATA, F-4 STABILIZED SOIL TEST ITEM (CONCLUDED).

		Deflection, mils						
Station	Force pounds	$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
20 Coverages, F-4[b]								
0+25	9,048	21.4	12.1	8.3	7.6	5.0	2.5	1.9
0+50	9,184	22.2	14.9	11.5	7.5	5.4	2.7	1.9
0+75	8,904	17.5	13.3	10.2	6.6	4.2	2.2	1.5
0+25	14,512	28.7	20.9	27.3	10.6	6.3	3.8	5.6
0+50	14,384	31.6	22.3	17.3	10.6	7.7	4.2	2.8
0+75	13,576	24.5	17.0	13.1	9.7	5.9	3.3	1.9
30 Coverages, F-4[b]								
0+25	9,368	21.3	13.5	10.5	6.9	5.6	2.4	1.8
0+50	10,296	22.6	21.0	12.1	10.4	6.1	3.8	2.3
0+75	9,304	20.4	13.8	10.6	8.1	5.0	2.7	1.8
0+25	14,584	30.1	18.3	15.7	10.7	9.4	3.6	2.6
0+50	14,352	32.4	25.1	17.4	14.0	7.8	5.5	3.3
0+75	14,584	29.9	18.7	14.6	9.9	7.5	4.4	2.4
50 Coverages, F-4[b]								
0+25	8,856	20.9	14.0	10.4	8.1	5.6	2.5	1.7
0+50	8,624	21.8	16.1	11.7	9.4	4.9	2.8	1.9
0+75	8,960	19.9	12.3	12.0	7.4	4.6	2.3	1.5
0+25	13,888	32.7	7.5	6.2	14.3	5.6	3.6	2.6
0+50	13,136	33.2	25.2	18.2	13.1	6.9	3.9	2.6
0+75	14,088	32.7	18.5	17.8	12.1	6.3	3.2	2.2
80 Coverages, F-4[b]								
0+25	9,272	20.1	15.6	12.1	10.1	4.0	2.5	1.8
0+50	9,104	36.4	24.3	16.1	9.5	7.0	4.2	3.4
0+75	9,824	27.8	15.1	11.8	9.0	5.6	2.7	1.7
0+25	14,616	55.3	12.9	15.9	12.9	6.4	3.8	2.7
0+50	14,264	48.4	27.3	23.4	14.3	11.1	8.4	4.6
0+75	13,784	36.9	20.1	16.1	10.5	8.1	3.6	2.9

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[b] Loose, abraded stabilized material on the surface of the traffic lane.

TABLE 10. FWD DATA, F-15 FLEXIBLE PAVEMENT TEST ITEM[a].

			Deflection, mils						
Station	Temp ° F	Force pounds	$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
			After prooftesting, 2 coverages, F-4						
1+25	117.1	8,552	40.5	18.3	8.7	4.8	3.3	2.1	1.4
1+50	117.1	8,528	45.3	19.3	8.8	4.5	3.0	2.0	1.5
1+75	117.1	8,688	27.1	13.2	7.7	4.8	3.3	1.8	1.2
1+25	117.1	13,976	68.6	30.2	13.7	7.1	4.6	2.7	1.8
1+50	117.1	14,024	66.8	29.4	13.9	6.9	4.9	2.9	2.0
1+75	117.1	14,136	46.6	22.4	12.8	7.6	5.1	2.6	1.7
				After F-4 aircraft					
1+25	90.9	8,784	32.3	17.0	9.7	5.4	3.4	2.1	1.4
1+50	90.9	8,672	41.2	19.7	9.6	4.9	3.4	2.1	1.5
1+75	90.9	8,888	25.8	14.0	8.2	4.9	3.2	1.9	1.3
1+25	90.9	14,200	51.1	27.1	15.5	8.4	5.3	3.0	2.0
1+50	90.9	14,208	60.2	29.5	15.0	7.6	6.3	3.1	2.1
1+75	90.9	14,320	45.1	23.9	13.6	7.8	4.3	2.7	1.8
				2 Coverages, F-15					
1+25	122.4	8,496	42.4	19.7	10.1	5.5	5.4	2.3	1.5
1+50	84.1	8,968	43.9	20.5	10.9	5.6	3.8	2.3	1.6
1+75	84.1	9,056	30.9	17.4	10.7	6.0	3.9	2.1	1.4
1+25	122.4	13,968	68.5	32.8	16.4	8.2	5.6	3.1	2.0
1+50	84.1	14,160	67.4	31.9	17.0	8.5	5.5	3.3	2.3
1+75	84.1	14,440	60.0	31.4	18.2	9.5	5.6	2.9	1.9

(Continued)

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[a] 107.5 inches south of centerline (F-15 traffic lane).

TABLE 10. FWD DATA, F-15 FLEXIBLE PAVEMENT TEST ITEM (CONTINUED).

Station	Temp ° F	Force pounds	Deflection, mils						
			$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
				10 Coverages, F-15					
1+25	83.6	8,728	50.6	23.2	12.3	6.6	4.3	2.4	1.6
1+50	83.6	9,312	43.8	24.7	11.7	5.8	4.3	2.6	1.9
1+75	FWD impaired								
1+25	83.6	14,416	78.0	37.8	20.1	10.4	6.4	3.4	2.2
1+50	83.6	13,784	65.2	37.9	18.1	8.4	5.9	3.5	2.4
1+75	83.6	14,360	68.1	36.6	20.5	10.4	6.0	2.9	2.0
				20 Coverages, F-15					
1+25	111.7	8,600	65.0	25.9	12.7	6.9	4.3	2.5	1.7
1+50	111.7	8,888	69.5	25.2	11.0	6.0	3.9	2.4	1.7
1+75	111.7	8,496	47.2	21.6	11.5	6.0	3.8	2.2	1.5
1+25	111.7	11,368	79.9	34.1	16.9	9.0	5.5	3.0	2.1
1+50	Over-ranged	12,000 15,000							
1+75	111.7	11,440	64.9	30.4	15.9	7.9	4.8	2.6	1.8
				30 Coverages, F-15					
1+25	92.7	8,920	69.5	28.9	12.1	5.8	4.2	2.5	1.7
1+50	92.7	9,168	75.9	27.5	10.6	5.1	3.8	2.1	1.5
1+75	92.7	8,528	55.4	25.2	12.5	5.8	3.7	2.1	1.5
1+25	92.7	4,848	41.7	16.0	6.3	3.0	2.2	1.2	0.8
1+50	92.7	4,952	47.1	14.7	5.4	2.8	2.0	1.1	0.8
1+75	92.7	4,707	32.9	14.2	6.6	2.9	1.9	1.1	0.7

(Continued)

TABLE 10. FWD DATA, F-15 FLEXIBLE PAVEMENT TEST ITEM (CONCLUDED).

Station	Temp ° F	Force pounds	Deflection, mils $\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
				38 Coverages, F-15					
1+25	109.0	9,072	65.4	21.4	8.9	5.0	3.3	1.7	1.2
1+50	109.0	8,936	76.3	19.2	6.9	3.7	2.4	1.4	1.1
1+75	109.0	8,912	72.6	29.4	13.8	6.9	4.1	2.1	1.5
1+25	109.0	5,328	42.1	13.5	6.2	3.8	2.7	1.5	0.9
1+50	109.0	5,264	45.6	11.2	5.5	3.4	2.4	1.4	1.0
1+75	109.0	5,120	40.0	15.3	7.3	3.9	2.6	1.4	0.9

TABLE 11. FWD DATA, F-4 FLEXIBLE PAVEMENT TEST ITEM[a].

Station	Temp °F	Force pounds	Deflection, mils $\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
				0 Coverages					
1+25	123.0	8,952	22.4	9.7	--	3.5	2.5	1.4	1.0
1+50	123.0	8,816	24.5	10.5	6.2	4.0	3.0	1.6	1.1
1+75	123.0	8,986	21.1	9.7	5.4	3.4	2.4	1.4	0.9
1+25	123.0	14,288	35.5	15.2	--	5.4	3.3	2.1	1.5
1+50	123.0	14,152	38.8	16.4	9.5	6.1	4.2	2.4	1.4
1+75	123.0	14,208	33.5	14.8	7.7	5.0	3.6	2.0	1.3
				After prooftesting, 2 coverages, F-4					
1+25	117.1	8,688	26.2	11.7	6.7	4.2	2.8	1.6	1.1
1+50	117.1	8,680	25.8	11.5	7.0	4.5	3.2	1.8	1.2
1+75	117.1	8,672	25.6	12.0	6.9	4.1	2.8	1.5	1.0
1+25	117.1	13,976	43.8	19.1	10.6	6.5	3.6	2.4	1.6
1+50	117.1	13,992	43.2	18.9	11.1	6.9	4.7	2.7	1.8
1+75	117.1	14,016	42.9	19.5	10.9	6.4	2.8	2.3	1.5
				After F-4 aircraft					
1+25	90.9	8,992	25.1	13.0	7.0	4.3	3.1	1.8	1.2
1+50	90.9	8,848	30.2	12.5	7.2	4.8	3.4	1.9	1.3
1+75	90.9	8,896	23.5	12.5	6.9	4.3	3.1	1.7	1.1
1+25	90.9	14,408	41.0	20.9	11.0	6.7	4.6	2.7	1.9
1+50	90.9	14,200	46.3	21.7	12.3	7.4	4.8	2.8	1.9
1+75	90.9	14,272	39.3	20.1	10.8	6.6	5.0	2.5	1.6

(Continued)

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[a] 107.5 inches north of centerline (F-4 traffic lane).

TABLE 11. FWD DATA, F-4 FLEXIBLE PAVEMENT TEST ITEM (CONTINUED).

Station	Temp ° F	Force pounds	Deflection, mils						
			$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
				10 Coverages, F-4					
1+25	106.1	9,312	27.9	12.2	7.1	4.6	3.2	2.0	1.4
1+50	106.1	9,168	32.2	14.2	8.5	5.5	4.0	2.7	1.6
1+75	106.1	9,168	27.7	13.0	7.8	5.0	3.5	1.9	1.3
1+25	106.1	14,576	47.0	19.9	10.9	6.9	4.9	2.8	1.9
1+50	106.1	14,352	54.0	22.7	12.7	7.9	5.4	3.5	2.1
1+75	106.1	14,672	46.7	20.9	12.0	7.4	4.9	2.7	1.7
				20 Coverages, F-4					
1+25	114.0	9,032	29.4	13.3	7.5	4.7	3.3	1.9	1.3
1+50	114.0	8,904	35.9	15.1	8.7	5.5	4.0	2.4	1.6
1+75	114.0	8,920	30.0	13.7	8.0	5.0	3.4	1.9	1.2
1+25	114.0	14,528	44.8	20.9	11.8	7.2	5.0	2.8	1.9
1+50	114.0	14,136	60.9	25.1	13.7	8.0	5.4	3.1	2.2
1+75	114.0	14,424	50.9	22.3	12.5	7.4	5.0	2.6	1.7
				30 Coverages, F-4					
1+25	82.4	9,296	31.6	16.1	9.2	5.3	3.7	2.1	1.5
1+50	82.4	9,184	39.5	17.1	9.3	5.5	3.8	2.2	1.5
1+75	82.4	9,272	29.6	15.0	9.0	5.4	3.7	2.0	1.4
1+25	82.4	14,600	57.8	28.2	15.0	8.2	5.4	3.0	2.0
1+50	82.4	14,720	68.6	28.7	14.5	7.9	5.4	3.0	2.0
1+75	82.4	14,800	54.6	25.7	14.4	8.1	5.3	2.8	1.8

(Continued)

TABLE 11. FWD DATA, F-4 FLEXIBLE PAVEMENT TEST ITEM (CONCLUDED).

Station	Temp ° F	Force pounds	Deflection, mils						
			$\Delta_{0\text{-in.}}$	$\Delta_{8\text{-in.}}$	$\Delta_{12\text{-in.}}$	$\Delta_{18\text{-in.}}$	$\Delta_{24\text{-in.}}$	$\Delta_{36\text{-in.}}$	$\Delta_{48\text{-in.}}$
50 Coverages, F-4									
1+25	105.7	9,096	37.8	16.7	8.5	5.0	3.6	2.2	1.5
1+50	105.7	8,936	55.5	21.2	9.8	5.3	3.8	2.3	1.6
1+75	105.7	9,120	30.1	15.0	8.7	5.3	3.8	2.1	1.4
1+25	105.7	14,120	62.8	27.5	13.3	7.5	5.2	3.1	2.2
1+50	105.7	11,720	68.8	26.9	12.5	6.7	4.7	2.8	2.0
1+75	105.7	14,424	51.8	25.0	13.7	8.0	5.4	2.9	2.0
100 Coverages, F-4									
1+25	125.1	9,200	52.0	18.5	8.8	5.4	4.0	2.3	1.6
1+50	125.1	9,416	77.9	24.9	9.1	5.6	4.1	2.4	1.7
1+75	125.1	8,832	49.1	17.8	8.9	5.5	3.9	2.1	1.5
1+25	125.1	11,672	73.6	27.6	11.2	6.8	5.0	2.8	2.0
1+50	Over-ranged	12,000 15,000							
1+75	125.1	11,728	68.6	24.6	11.4	6.8	4.7	2.5	1.7

TABLE 12. INSTRUMENTATION DATA, STABILIZED SOIL ITEM.

Aircraft taxi			Moving F-4 load cart			Static F-4 load cart after 4 min.
Passes	North lane	South lane	Coverages	North lane	South lane	North lane
50-psi pressure gage						
1	11.0 psi		1	13.0 psi	14.0 psi	
2	8.6 psi		2	13.5 psi	13.0 psi	16.666 psi
3	10.8 psi		4	10.9 psi		
4	9.8 psi		6	9.3 psi		
5	9.8 psi		10	10.7 psi		
6	9.8 psi		15	8.7 psi		
7	10.0 psi		20	9.5 psi		
8	10.0 psi		25	13.2 psi		
9	11.7 psi		30	13.3 psi		
10	9.8 psi		35	14.2 psi		
			40	14.6 psi		
			45	12.1 psi		
			50	22.9 psi		
			55	18.0 psi		
			60	26.3 psi		
			65	30.1 psi		
			70	28.2 psi		
			75	26.7 psi		
			80	32.9 psi		
100-psi pressure gage						
			1	68.0 psi	64.0 psi	
			2	67.0 psi	50.0 psi	73.237 psi
			4	74.0 psi		
			6	86.0 psi		
			10	104.0 psi		
			15	132.0 psi		
			20	136.0 psi		
			25	150.0 psi		
			30	150.0 psi		
			35	132.4 psi		
			40	134.0 psi		
			45	85.0 psi		
			50	154.0 psi		
			55	115.4 psi		
			60	129.0 psi		
			65	137.0 psi		
			70	121.0 psi		
			75	134.0 psi		
			80	142.0 psi		

(Continued)

TABLE 12. INSTRUMENTATION DATA, STABILIZED SOIL ITEM (CONCLUDED).

	Aircraft taxi			Moving F-4 load cart		Static F-4 load cart after 4 min.
Passes	North lane	South lane	Coverages	North lane	South lane	North lane
			DCVDT (deflection)			
1	0.0080 in.	0.0181 in.	1		0.0295 in.	
2	0.0067 in.	0.0139 in.	2		0.0315 in.	
3	0.0085 in.	0.0161 in.	3	0.0348 in.		
4	0.0080 in.	0.0149 in.	4	0.0115 in.		
5	0.0095 in.	0.0170 in.	6	0.0161 in.		0.01 in.
6	0.0089 in.	0.0155 in.	10	0.0185 in.		
7	0.0075 in.	0.0129 in.	15	0.0187 in.		
8	0.0087 in.	0.0152 in.	20	0.0185 in.		
9	0.0071 in.	0.0138 in.	25	0.0200 in.		
10	0.0082 in.	0.0153 in.	30	0.0200 in.		
			35	0.0232 in.		
			40	0.0250 in.		
			45	0.0195 in.		
			50	0.0242 in.		
			55	0.0259 in.		
			60	0.0275 in.		
			65	0.0235 in.		
			70	0.0250 in.		
			75	0.0299 in.		
			80	0.0336 in.		

TABLE 13. INSTRUMENTATION DATA, FLEXIBLE PAVEMENT ITEM.

	Aircraft taxi		Moving F-4 load cart			Static F-4 load cart after 4 min.
Passes	North lane	South lane	Coverages	North lane	South lane	North lane
			50-psi pressure gage			
			1	46.5 psi	50 psi	
			2	46.0 psi	50 psi	45.4 psi
			Gage out			
			100-psi pressure gage			
1	20.0 psi		1	171.0 psi	298 psi	
2	28.0 psi		2	188.0 psi		132.0 psi
3	84.0 psi		4	136.0 psi		
4	24.0 psi		6	170.0 psi		
5	132.0 psi		Gage out			
6	118.0 psi					
7	51.0 psi					
8	63.6 psi					
9	127.0 psi					
10	109.0 psi					
			DCVDT (deflection)			
[a]	0.184 in.	0.147 in.	1	0.312 in.	0.362 in.	
			2	--	--	0.3553 in.
			6	0.320 in.		
			10	0.360 in.		
			15	0.421 in.		
			20	0.450 in.		
			25	0.435 in.		
			30	0.454 in.		
			35	0.440 in.		
			40	0.463 in.		
			45	0.465 in.		
			50	0.479 in.		
			55	0.490 in.		
			60	0.535 in.		
			65	0.507 in.		
			70	0.500 in.		
			75	0.497 in.		
			80	0.562 in.		
			85	0.434 in.		
			90	0.479 in.		
			95	0.570 in.		
			100	0.550 in.		

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[a] Indicates touch-and-go instead of passes.

TABLE 14. F-15 INSTRUMENTATION DATA.

Coverages	Moving load cart South lane	Static Load Cart After 4 min. South lane
	Stabilized soil item	
	50-psi pressure gage	
1	13.9 psi	24.47 psi
5	14.7 psi	
6	21.2 psi	
7	18.1 psi	
8	18.0 psi	
	100-psi pressure gage	
1	7.0 psi	99.04 psi
5	152.0 psi	
6	118.4 psi	
7	124.0 psi	
8	138.0 psi	
	DCVDT (deflection)	
1	0.0210 in.	0.0230 in.
5	0.0430 in.	
6	0.0290 in.	
7	0.0358 in.	
8	0.0313 in.	
	Flexible pavement item	
	DCVDT (deflection)	
1	0.422 in.	0.4892 in.
5	0.557 in.	
6	0.230 in.	
7	0.554 in.	
8	0.361 in.	

TABLE 15. COMPARISON OF FWD AND DCVDT DEFLECTIONS.

Distance from plate inches	FWD deflection mils	DCVDT deflection mils	FWD deflection mils	DCVDT deflection mils
	North lane, stabilized soil item			
	Load = 9,208 pounds		Load = 14,336 pounds	
0	14.0	6.0[a]	20.5	11.0[a]
8	8.0		12.9	
12	6.0		9.5	
18	5.1		7.8	
24	3.2		5.1	
36	2.2		3.2	
48	1.5		1.9	
	South lane, stabilized soil item			
	Load = 8,976 pounds		Load = 11,632 pounds	
0	25.0	12.0[a]	36.3	16.0[a]
8	18.1		22.8	
12	12.3		17.7	
18	6.9		11.9	
24	4.5		7.2	
36	2.4		4.1	
48	1.6		2.4	
	North lane, asphalt item			
	Load = 9,064 pounds		Load = 14,232 pounds	
0	37.9	38.0[b]	55.9	57.5[b]
8	14.2		21.0	
12	7.4		10.9	
18	4.5		6.5	
24	4.6		6.4	
36	2.0		2.8	
48	1.4		2.9	

(Continued)

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[a] DCVDT located 10 inches below the surface of the stabilized soil.

[b] DCVDT located at surface of the AC.

TABLE 15. COMPARISON OF FWD AND DCVDT DEFLECTIONS (CONCLUDED).

Distance from plate inches	FWD deflection mils	DCVDT deflection mils	FWD deflection mils	DCVDT deflection mils
	South lane - asphalt item			
	Load = 13,784 pounds			
0	65.2	64.0[b]		
8	37.9			
12	18.1			
18	8.4			
24	5.9			
36	3.5			
48	2.4			

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[b] DCVDT located at surface of the AC.

TABLE 16. SURFACE DEFORMATION, STABILIZED SOIL TEST ITEM[a].

F-15 traffic lane[b]		F-4 traffic lane after prooftesting[c]	
Station	2 Coverages	Station	2 Coverages
0+25	0.48	0+25	0.19
0+50	0.13	0+50	0.44
0+75	0.13	0+75	0.50
	10 Coverages		10 Coverages
0+25	1.38	0+25	1.50
0+30	2.19	0+50	1.38
0+50	1.00	0+75	1.25
0+75	0.85		
	16 Coverages		20 Coverages
0+25	2.63	0+20	2.19
0+50	1.75	0+38	2.00
0+75	1.88	0+75	1.50
	20 Coverages		30 Coverages
0+25	1.88	0+25	2.44
0+45	1.75	0+45	2.00
0+75	1.63	0+70	2.00
	24 Coverages		40 Coverages
0+25	2.63	0+20	2.25
0+45	2.38	0+45	1.63
0+75	1.38	0+75	1.63
	30 Coverages		50 Coverages
0+30	2.75	0+25	1.88
0+45	2.63	0+45	1.75
0+75	2.25	0+70	1.75

(Continued)

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[a] Surface deformation in inches, 10-foot straightedge.
[b] 107.5 inches south of centerline of the test item.
[c] 107.5 inches north of centerline of the test item.

TABLE 16. SURFACE DEFORMATION, STABILIZED SOIL TEST ITEM (CONCLUDED).

F-15 traffic lane[b]

Station	38 Coverages
0+25	3.25
0+45	3.00
0+62	2.75

F-4 traffic lane after prooftesting[c]

Station	60 Coverages
0+25	2.06
0+45	2.00
0+75	1.75
	80 Coverages
0+25	3.25
0+50	2.34
0+80	1.34

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[b] 107.5 inches south of centerline of the test item.
[c] 107.5 inches north of centerline of the test item.

TABLE 17. SURFACE DEFORMATION, FLEXIBLE PAVEMENT TEST ITEM[a]

F-15 traffic lane After prooftesting[b]		F-4 traffic lane after prooftesting[c]	
Station	2 Coverages, F-4	Station	60 Coverages, F-4
1+25	0.13	1+25	0.13
1+50	0.48	1+50	0.25
1+75	0.38	1+75	0.13
	2 Passes, F-4 aircraft		2 Passes, F-4 aircraft
1+50	0.63	1+50	0.38
	After F-4 traffic		After F-4 traffic
1+25	0.25	1+25	0.44
1+50	0.44	1+50	0.31
1+75	0.38	1+75	0.25
	2 Coverages, F-15		10 Coverages, F-4
1+25	0.19	1+25	0.38
1+50	0.44	1+50	0.75
1+75	0.63	1+75	0.50
	10 Coverages, F-15		20 Coverages, F-4
1+25	0.63	1+20	0.75
1+48	1.38	1+48	0.81
1+72	0.56	1+75	0.56
	16 Coverages, F-15		30 Coverages, F-4
1+25	1.25	1+25	1.00
1+50	1.88	1+50	0.69
1+70	1.00	1+90	1.25
	20 Coverages, F-15		40 Coverages, F-4
1+25	1.38	1+25	0.88
1+48	1.63	1+48	1.25
1+70	0.75	1+90	0.81

(Continued)

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[a] Surface deformation in inches, 10-foot straightedge.
[b] 107.5 inches south of centerline of the test item.
[c] 107.5 inches north of centerline of the test item.

TABLE 17. SURFACE DEFORMATION, FLEXIBLE PAVEMENT TEST ITEM (CONCLUDED).

F-15 traffic lane[b] After prooftesting	
Station	24 Coverages, F-15
1+25	1.25
1+48	1.38
1+70	1.13
	30 Coverages, F-15
1+25	1.75
1+50	2.06
1+70	1.50
	38 Coverages, F-15
1+25	2.00
1+48	4.25
1+75	1.75

F-4 traffic lane after prooftesting[c]	
Station	50 Coverages, F-4
1+25	1.00
1+50	1.38
1+75	0.75
	60 Coverages, F-4
1+25	1.31
1+48	1.31
1+90	1.31
	80 Coverages, F-4
1+25	1.75
1+48	1.94
1+70	1.75
	90 Coverages, F-4
1+25	2.50
1+48	2.38
1+90	2.50
	100 Coverages, F-4
1+20	3.13
1+48	4.31
1+88	3.00

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[b] 107.5 inches south of centerline of the test item.
[c] 107.5 inches north of centerline of the test item.

TABLE 18. F-4 AIRCRAFT EVENTS.

Run No.	Load kips	Event	Speed knots	Comments
1	50.8	Taxi	10-15	
2	50.4	Taxi	10-15	
3	50.1	Taxi	10-15	
4	49.9	Taxi	10-15	
5	49.6	Taxi	10-15	
6	48.2	Taxi	10-15	
7	47.9	Taxi	10-15	
8		Taxi	10-15	
9	47.6	Taxi	10-15	
10	47.5	Taxi	10-15	
16	44.0	Touch-and-go (landing)	160	AC item, Sta 1+70 on gages
17		Tough-and-go (landing)	160	AC item, Sta 1+30
18		Touch-and-go (landing)	160	Stabilized soil item, Sta 0+05 (FOD)
19		Touch-and-go (landing)	160	Stabilized soil item, Sta 0+77 (FOD)
20		Touch-and-go (takeoff)	160	
21		Touch-and-go (takeoff)	160	Blew FOD over both items
30		Turns	5-10	
31		Turns	5-10	
32		Turns	5-10	
33		Light braking	20	AC item
34		Light braking	20	AC item
35		Light braking	20	Stabilized soil item
36		Light braking	20	Stabilized soil item
37		Heavy braking	45-50	AC item
38		Heavy braking	45-50	AC item
39		Heavy braking	45-50	Stabilized soil item
40		Heavy braking	45-50	Stabilized soil item

TABLE 19. AFTER-TRAFFIC SPLITTING TENSILE STRENGTH TEST.

Core		Splitting tensile strength, psi
1		Broken in transit
2		29.5
3		41.0
4		27.1
5		Broken in transit
6		35.9
	Average	33.0

TABLE 20. CEMENT CONTENT OF STABILIZED SOIL.

Sample	Surface layer[a] percent	Bottom layer[b] percent
1	10.3	10.3
2	10.4	10.1
3	11.0	9.4
4	10.9	9.3
Average	10.7	9.8

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[a] Second lift placed.
[b] First lift placed.

TABLE 21. AFTER-TRAFFIC SOILS DATA.

Test item	Station	Traffic lane	Material	Depth inches	CBR	Water content percent	Dry density pcf
Stabilized soil	0+45	F-15	Subgrade Silty sand	0	47	4.5	112.9
				6	35	4.3	111.4
				12	27	4.5	109.4
Flexible pavement	1+45	F-15	Base Crushed granite	0	41	3.7	144.2
			Subgrade Silty sand	0	41	4.7	109.7
				6	45	4.3	112.1
				12	44	4.1	111.7
	1+35	F-4	Base Crushed granite	0	100+	4.1	147.2
			Subgrade Silty sand	0	63	3.8	112.7
				6	79	3.5	111.5
				12	53	3.4	110.0

TABLE 22. AFTER-TRAFFIC ASPHALTIC CONCRETE DATA.

	F-15 traffic lane	F-4 traffic lane
Average density, pcf	144.3	145.2
Percent laboratory density, pcf	98.2	98.8
Asphalt content, percent	5.5	5.9
Penetration, 0.1 millimeter	48.0	61.0

TABLE 23. CHARACTERISTICS OF ALRS TRAFFIC TEST SECTIONS.

	Surface		Base			Subgrade		Total	Maximum 1-inch rut		Maximum 3-inch rut	
Item	Type[a]	Thickness inches	Type[b]	Thickness inches	CBR	Type[b]	CBR	Thickness inches	Passes	Coverages	Passes	Coverages
WES-1	AC	1.7	GW	8.2	100	CH	6.6	9.9	150	17.5	338	39.4
WES-2	AC	1.4	GW	9.0	100	CH	6.3	10.4	120	14.0	150	17.5
WES-3	DBST	0.5	GW	9.4	100	CH	6.0	9.9	12	1.4	48	5.6
WP-1	AC	3.0	GW	6.0	12	--	--	3.0	39	4.5	44	5.1
WP-2	AC	3.0	GP-GC	47.0	33	--	--	3.0	400	46.6	643	74.9
WP-3	AC	2.0	GP	12.0	33	SC	7.0	2.0	60	7.0	90	10.5
WP-4	AC	2.0	GW-GM	12.0	72	SC	8.0	2.0	100	11.7	162	18.9
W-1	DBST	1.0	GC	29.0	33	--	--	1.0	105	12.2	280	32.6
W-2	AC	2.5	GC	12.0	102	CH	4.2	14.5	25	2.9	132	15.4
W-3	AC	2.5	GC	16.0	37	CL	4.2	2.5	33	3.8	86	10.0
NFACF4	AC	2.1	GM	6.3	100	SP-SM	20.0	8.4	189	22.0	858	100.0
NFACF15	AC	2.1	GW	6.3	41	SP-SM	41.0	2.1	114	12.1	359	37.9

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[a] AC = asphaltic concrete; DBST = double bituminous surface treatment.
[b] Classified according to the Unified Soil Classification System.

TABLE 24. RESULTS OF FALLING WEIGHT DEFLECTOMETER TESTS ON NORTH FIELD TEST ITEMS.

Traffic lane	Section[a]	Station feet	Test location	FWD load pounds	Plate size, inches	Deflection, mils, at distance from applied load, inches					Back-calculated modulus, psi		
						0	12	18	24	36	AC	Base	Subgrade
F-4	STAB	0.75	Subgrade	8,832	18	21.7	11.1	3.2	1.7	1.1	--	--	23,729
F-4	AC	1.75	Subgrade	8,784	18	25.9	10.8	2.8	1.3	0.9	--	--	22,924
F-15	STAB	0.5	Subgrade	8,832	18	21.1	10.7	3.8	1.8	1.1	--	--	23,716
F-15	AC	1.75	Subgrade	8,768	18	24.7	12.6	3.6	2.0	1.2	--	--	20,865
						Distance from the applied load, inches							
						0	8	18	24	36			
F-4	AC	1.75	Base	8,872	12	34.7	12.4	4.2	2.8	1.9	--	23,125	25,000
F-15	AC	1.75	Base	8,840	12	37.1	15.0	4.6	3.2	2.0	--	19,608	25,000
F-4	STAB	0.25	Surface	9,296	12	13.2	7.8	3.9	3.4	2.2	--	128,189	30,000
F-4	AC	1.75	Surface	8,896	12	21.1	9.7	3.4	2.4	1.4	50,000	41,969	30,000
F-15	STAB	0.5	Surface	9,144	12	12.3	8.0	5.0	4.6	2.0	--	166,102	25,946
F-15	AC	1.5	Surface	8,528	12	45.3	19.3	4.5	3.0	2.0	79,148	8,212	26,754
											Average modulus		25,587
											Standard deviation		2,937
											Coefficient of Variation		0.12

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[a] STAB = stabilized soil test item; AC = asphaltic concrete test item.

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APPENDIX B: FIGURES

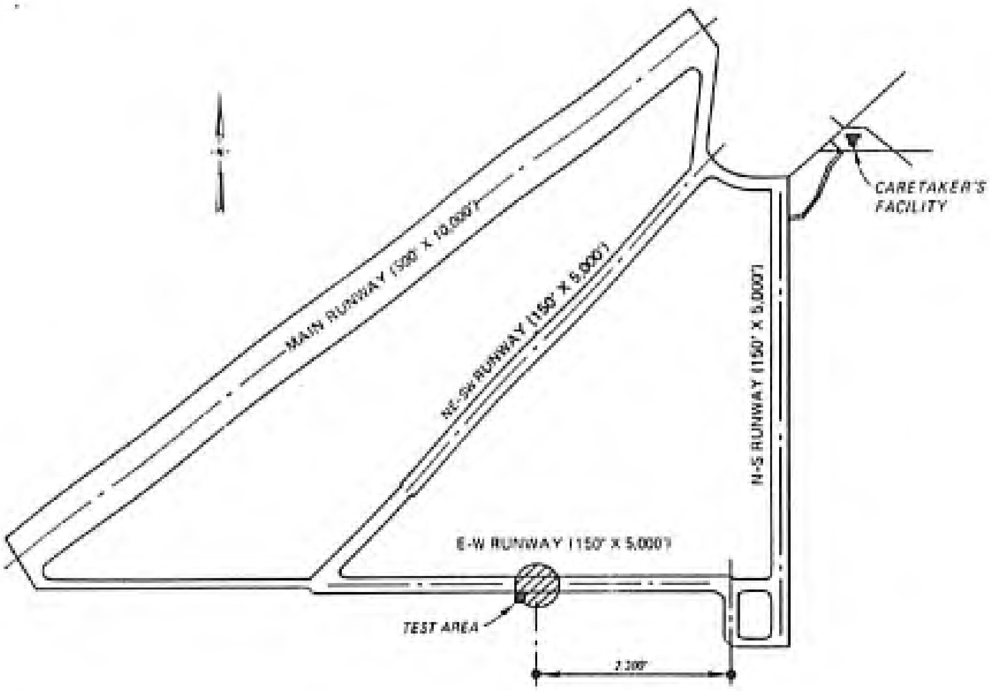
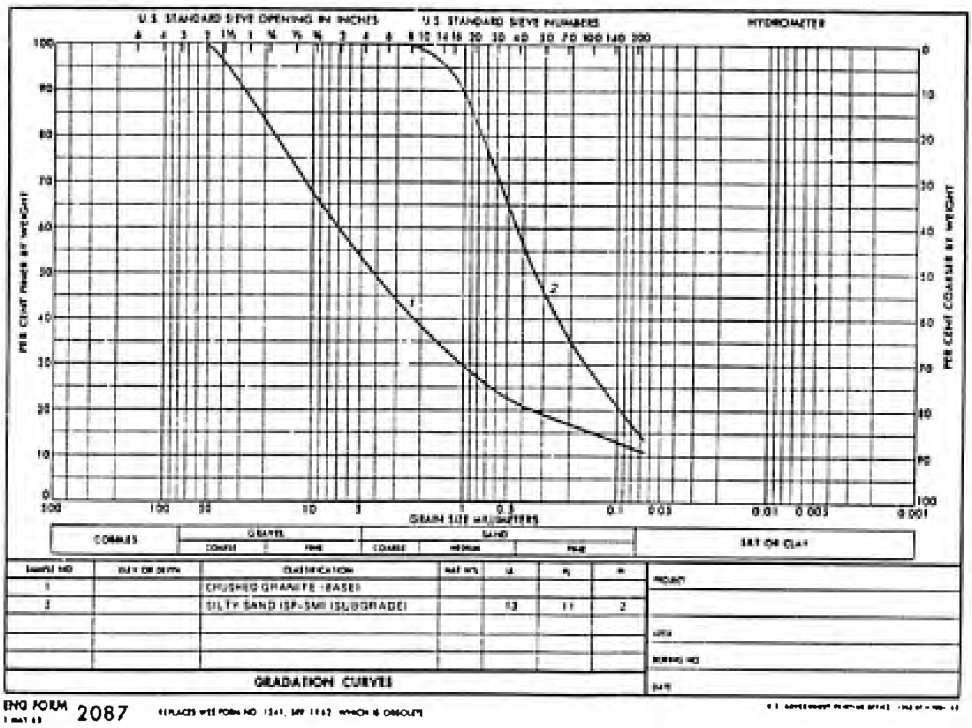


Figure 1. Layout of Airfield Features at North Field.



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1		CRUSHED GRANITE (BASE)				
2		SILTY SAND (SP-SM) (SUBGRADE)		13	11	2

Figure 2. Gradation of Crushed Granite and Silty Sand Used in the Test Items.

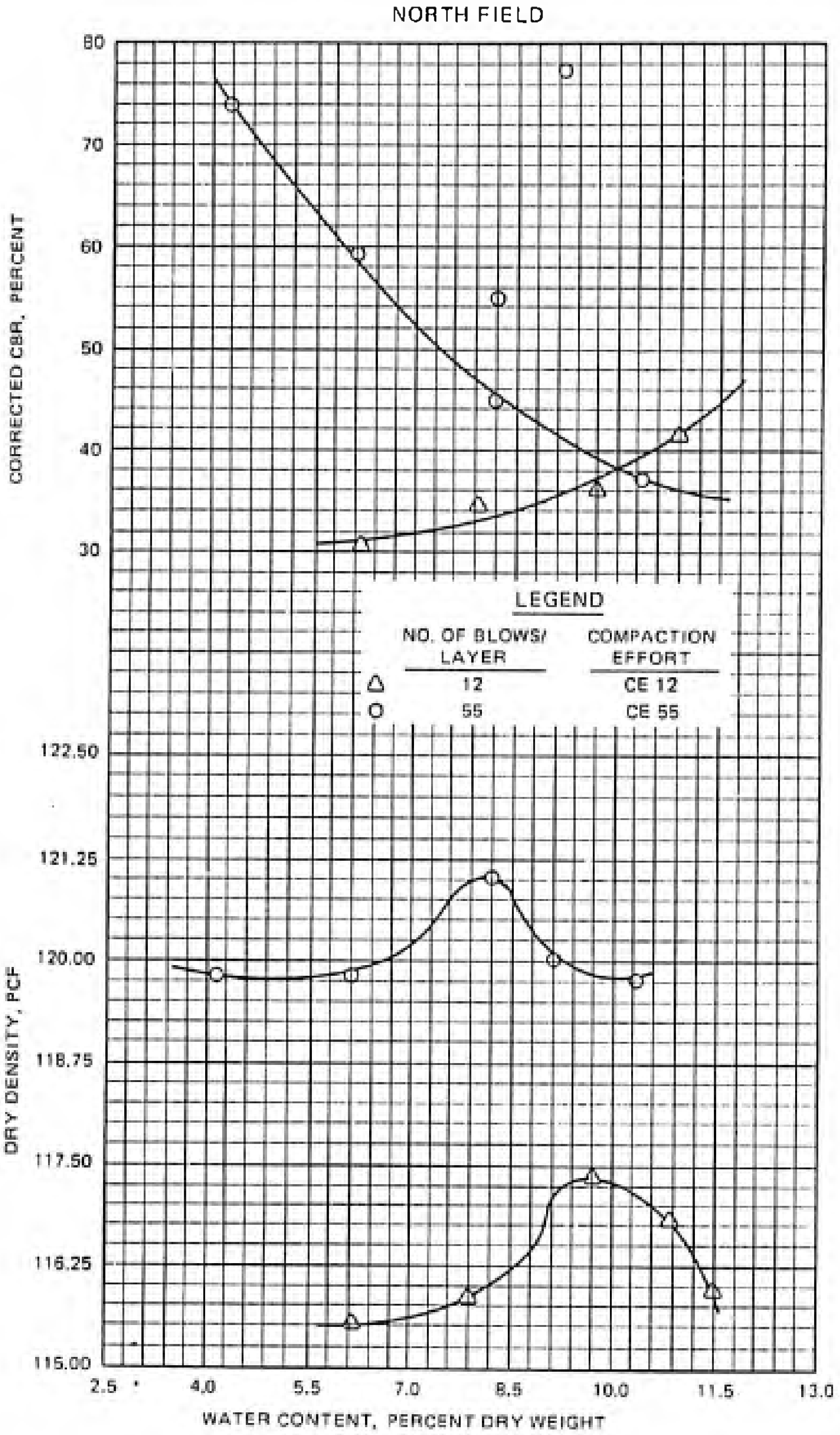


Figure 3. CE-12 and CE-55 Compaction Efforts for the Silty Sand.

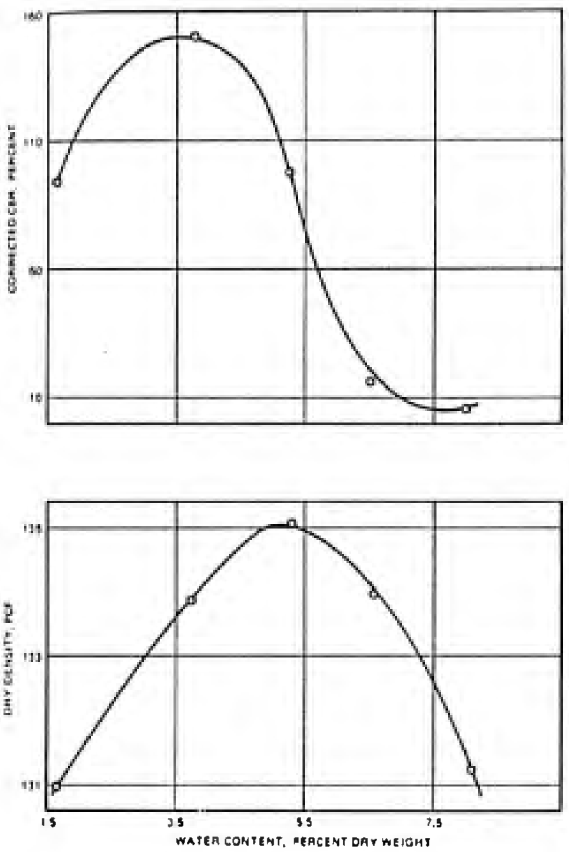


Figure 4. CE-55 Compaction Effort for the Well-Graded Crushed Granite.

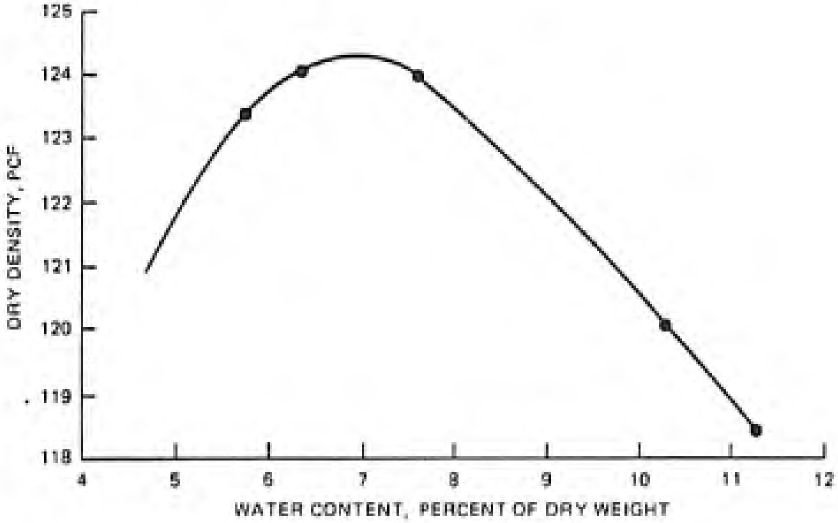
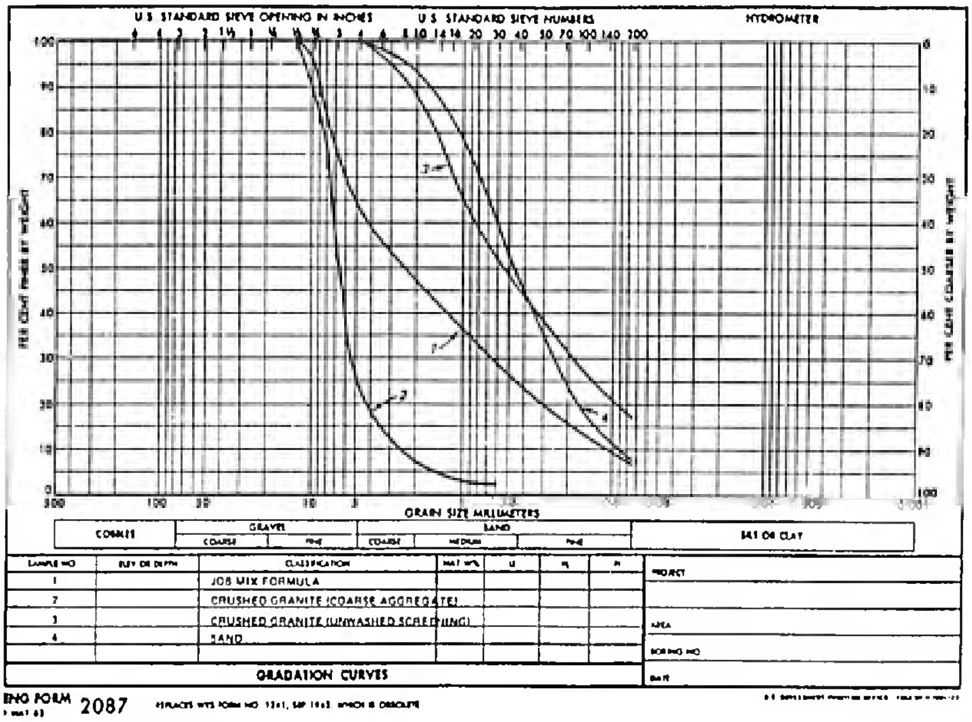
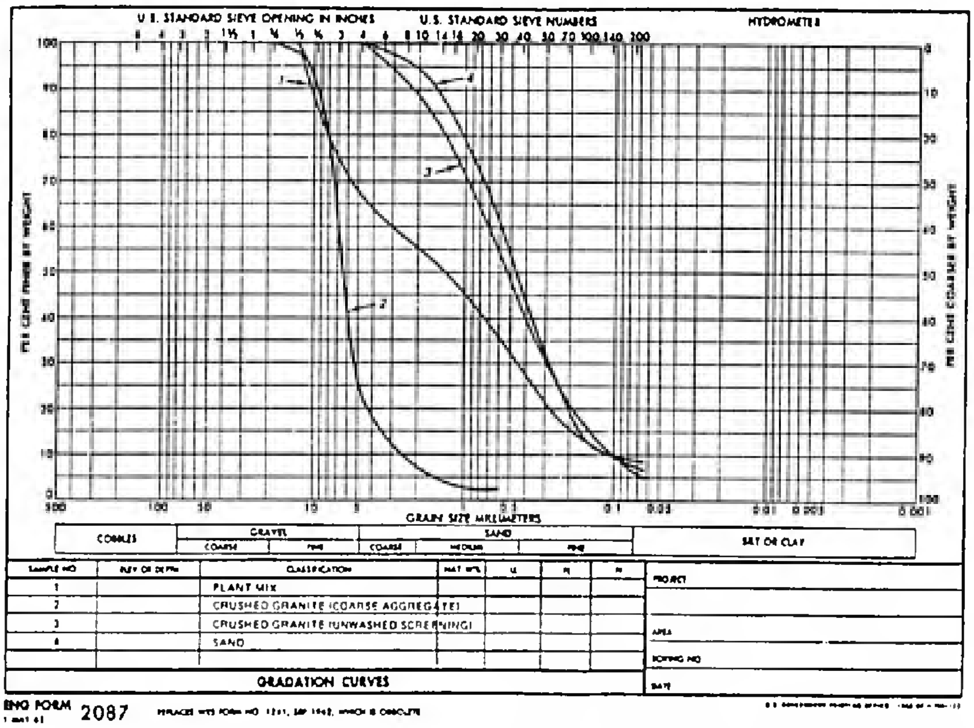


Figure 5. Moisture-Density Relations for the Silty Sand with 7 Percent PC Using the CE-12 Compaction Effort.



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1		JOB MIX FORMULA				
2		CRUSHED GRANITE (COARSE AGGREGATE)				
3		CRUSHED GRANITE (UNWASHED SCREENING)				
4		SAND				

Figure 6. Gradation of Materials Used in AC Mix Design Developed at WES.



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1		PLANT MIX				
2		CRUSHED GRANITE (COARSE AGGREGATE)				
3		CRUSHED GRANITE (UNWASHED SCREENING)				
4		SAND				

Figure 7. Gradation of Materials Used in AC Placed in the Test Item.

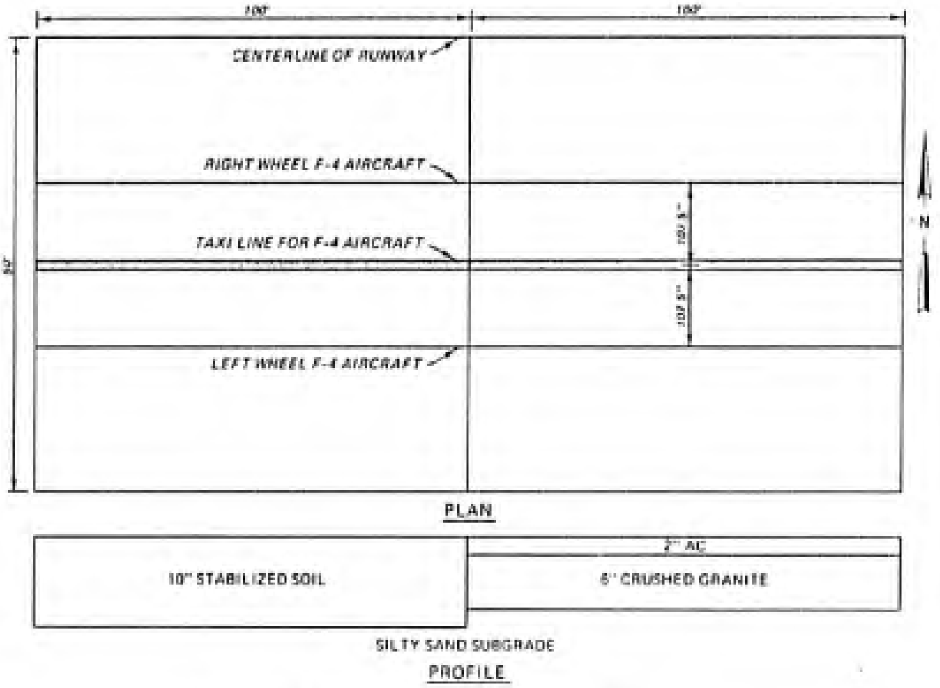


Figure 8. Layout of Test Items.

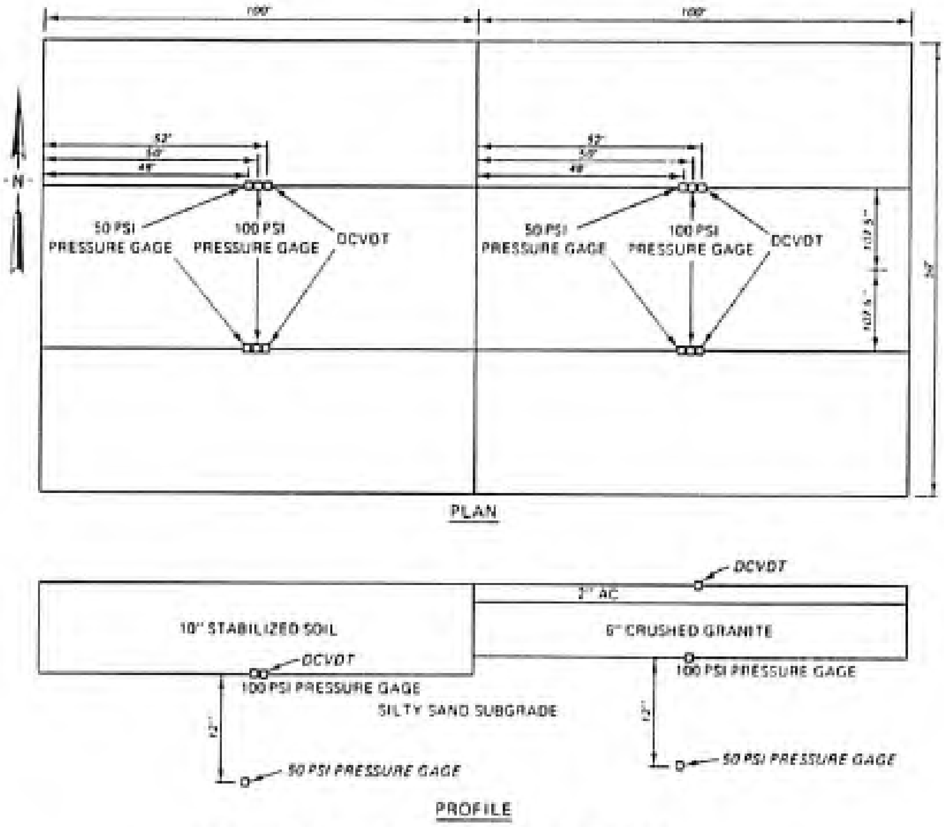


Figure 9. Placement of DCVDTs.

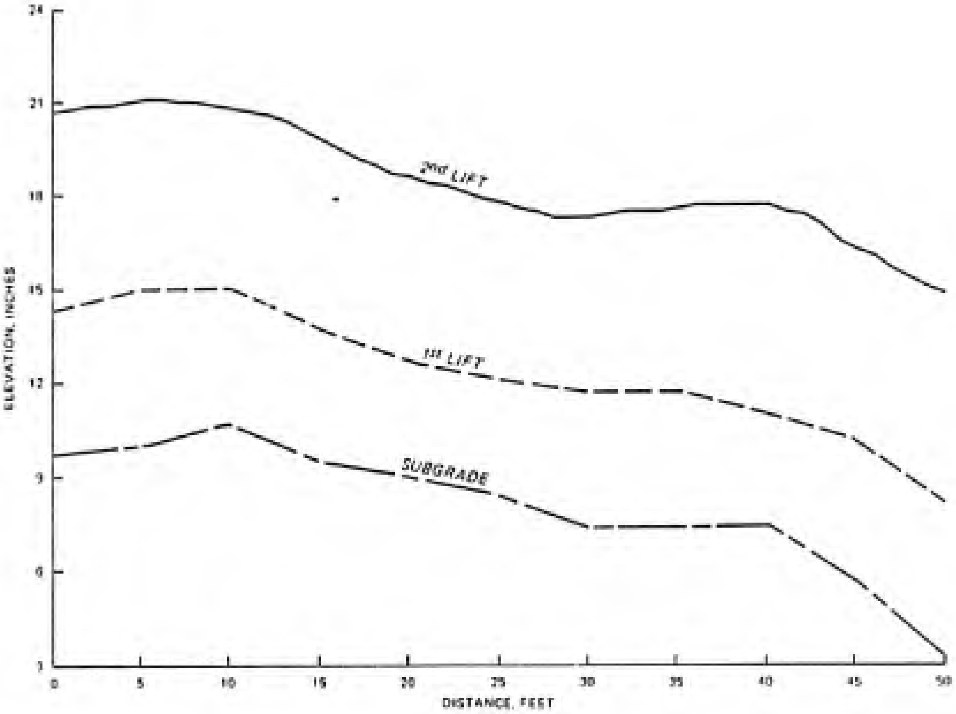


Figure 10. Typical Cross Section Showing Thickness of Stabilized Soil Test Items.

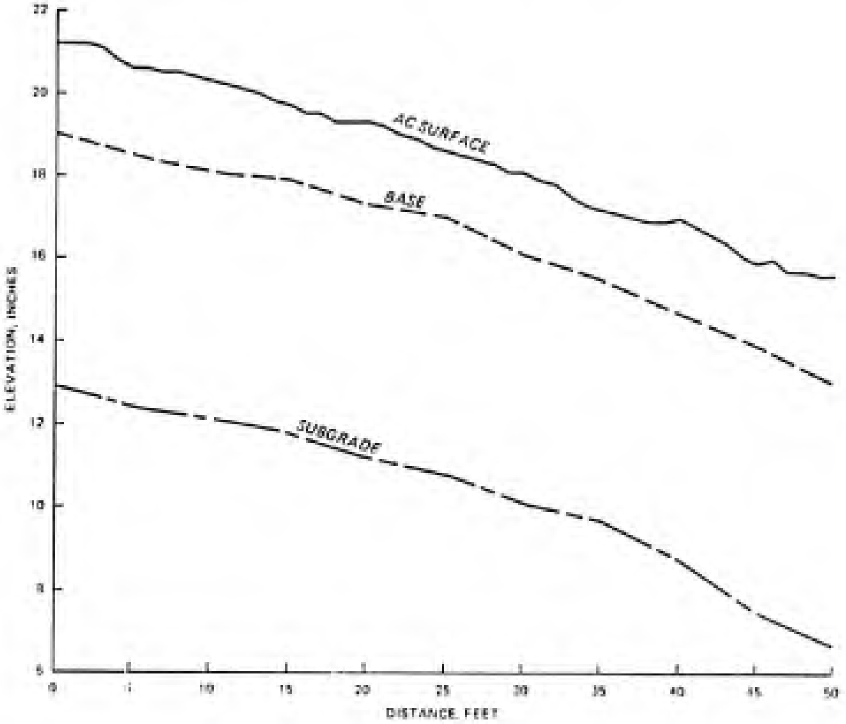
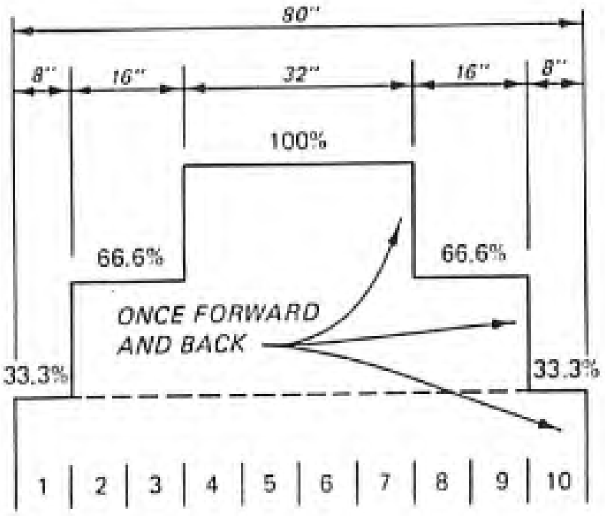
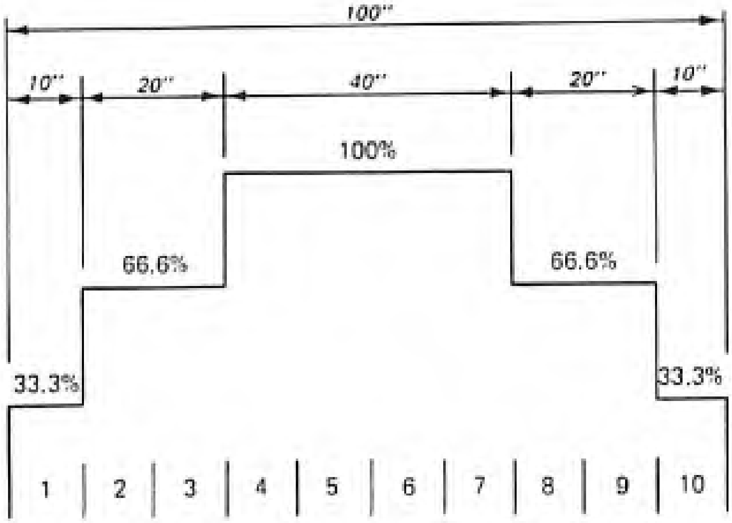


Figure 11. Typical Cross Sections Showing Thickness of Base Course and AC.



F-15 TRAFFIC PATTERN



F-4 TRAFFIC PATTERN

Figure 12. Traffic Distribution Patterns for the F-15 and F-4 Load Carts.

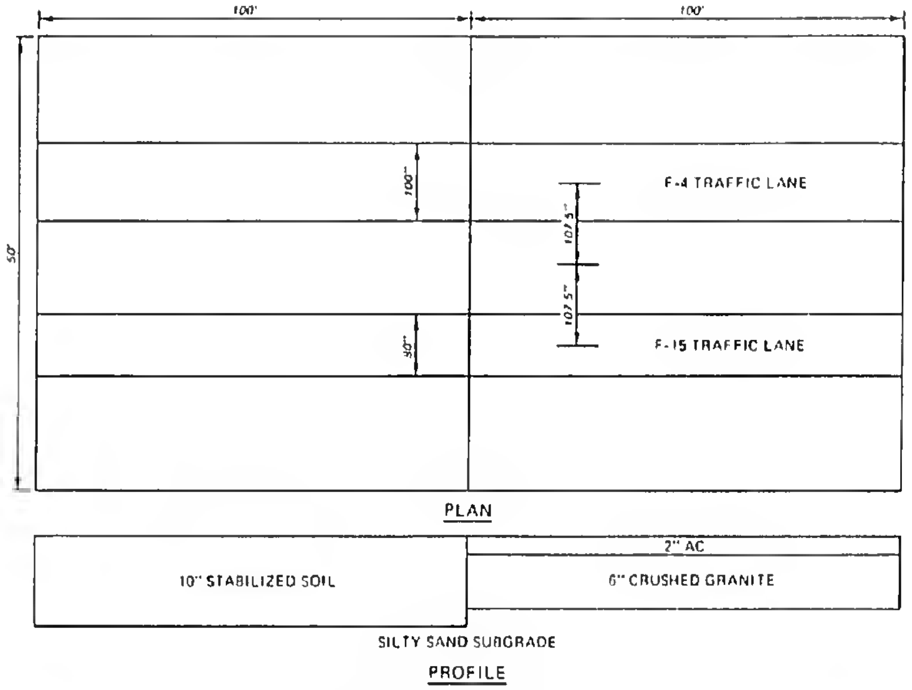
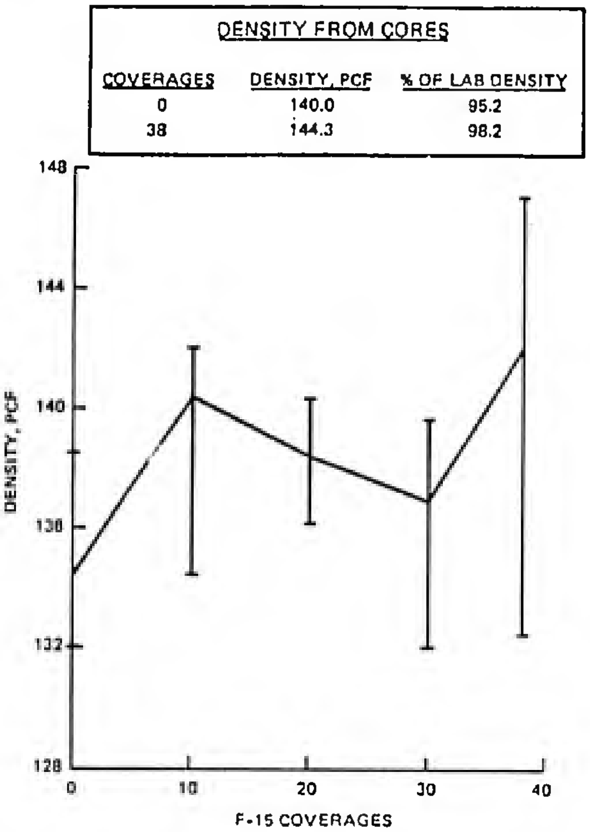


Figure 13. Layout of Test Items with F-15 and F-4 Traffic Lanes.


DENSITY FROM CORES

COVERAGES	DENSITY, PCF	% OF LAB DENSITY
0	140.0	95.2
38	144.3	98.2

Figure 14. Nuclear Densities of the AC in the F-15 Traffic Lane.

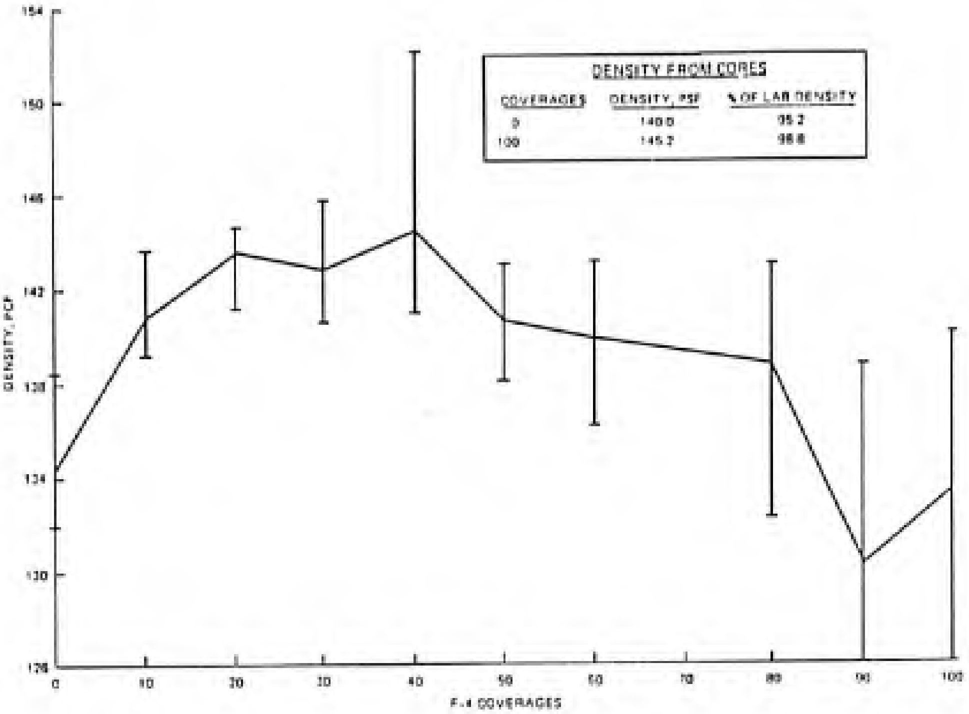


Figure 15. Nuclear Densities of the AC in the F-4 Traffic Lane.

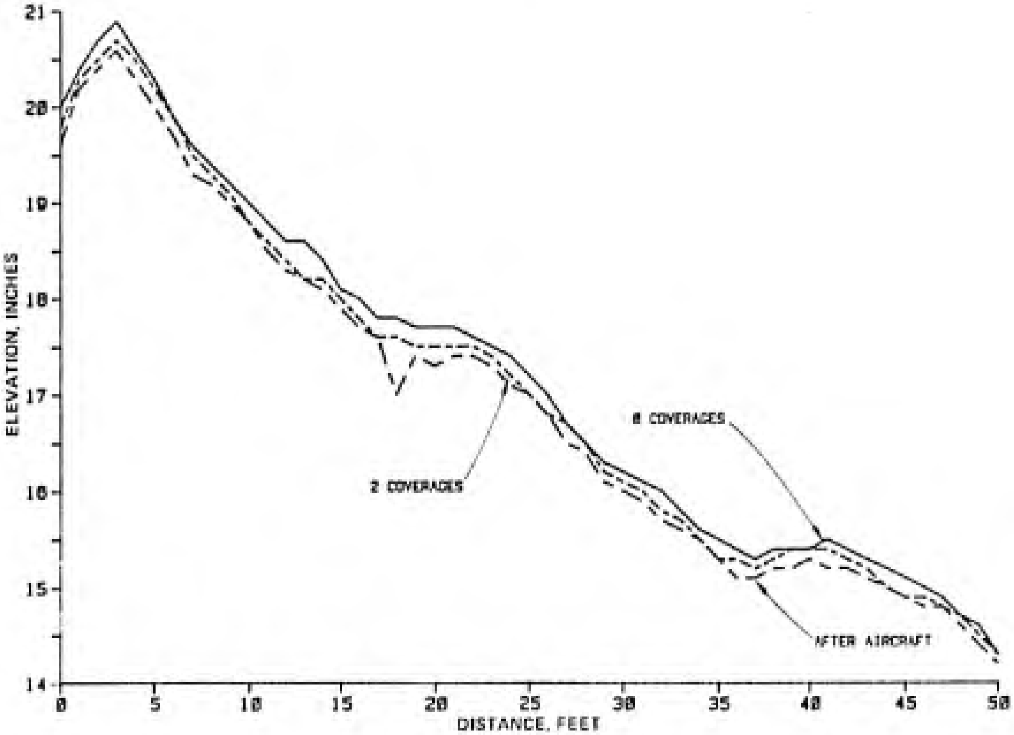


Figure 16. Typical Cross Sections for the Stabilized Soil Test Item, 0 Coverages, after 2 Coverages of F-4 Load Cart Traffic and after F-4 Aircraft Traffic.

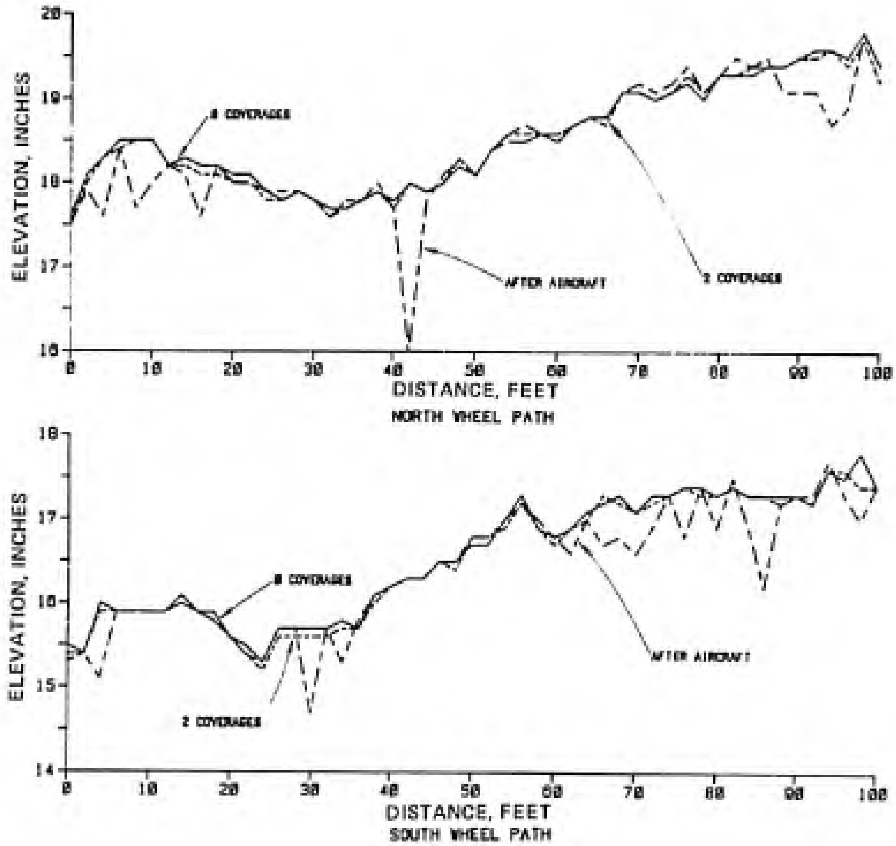


Figure 17. Profiles for the North and South Wheel Paths of F-4 Aircraft, Stabilized Soil Test Item, 0 Coverages of F-4 Load Cart Traffic, and after F-4 Aircraft Traffic.

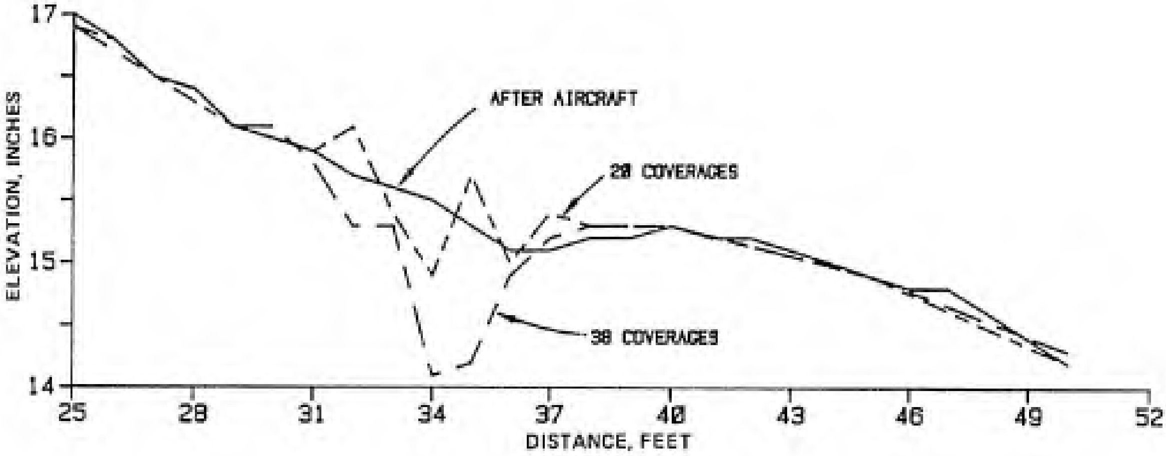


Figure 18. Typical Cross Sections for the F-15 Traffic Lane, Stabilized Soil Test Item.

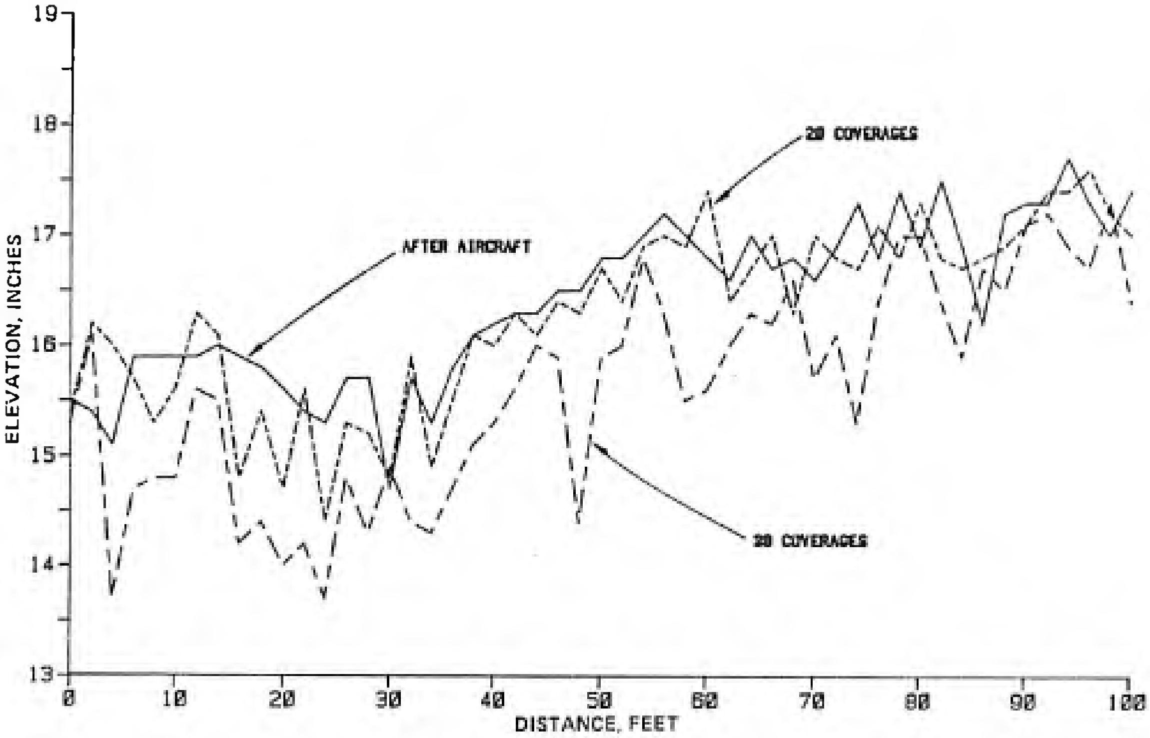


Figure 19. Profile, F-15 Traffic Lane, Stabilized Soil Test Item.

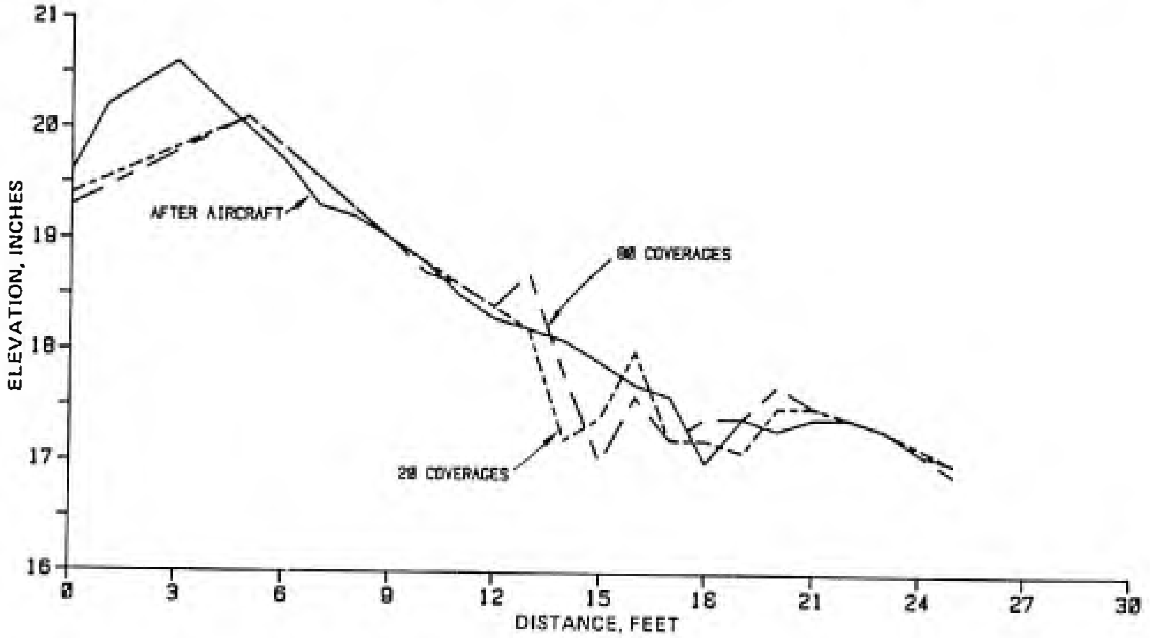


Figure 20. Typical Cross Sections for the F-4 Traffic Lane, Stabilized Soil Test Item.

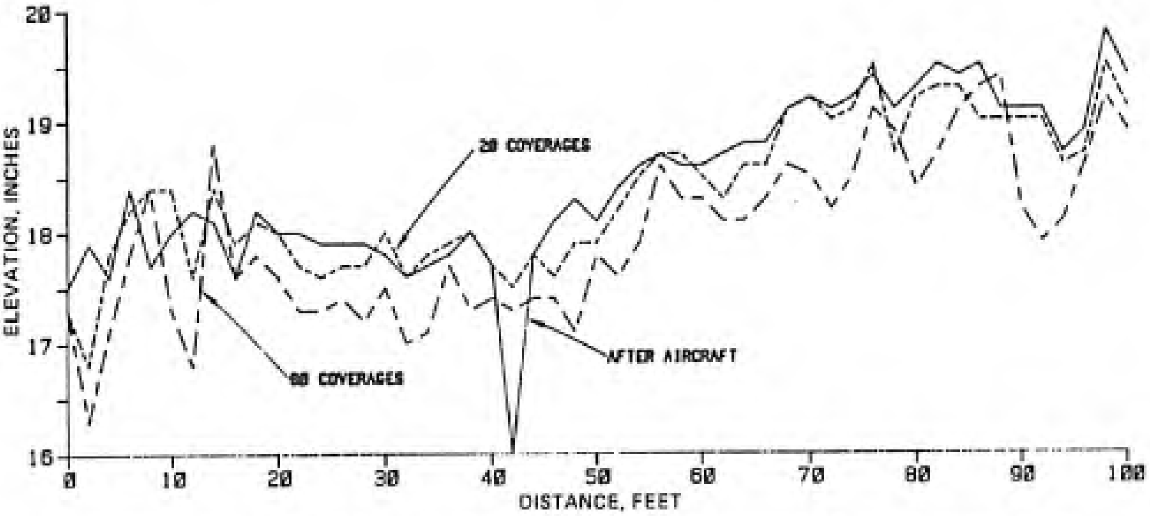


Figure 21. Profile, F-4 Traffic Lane, Stabilized Soil Test Item.

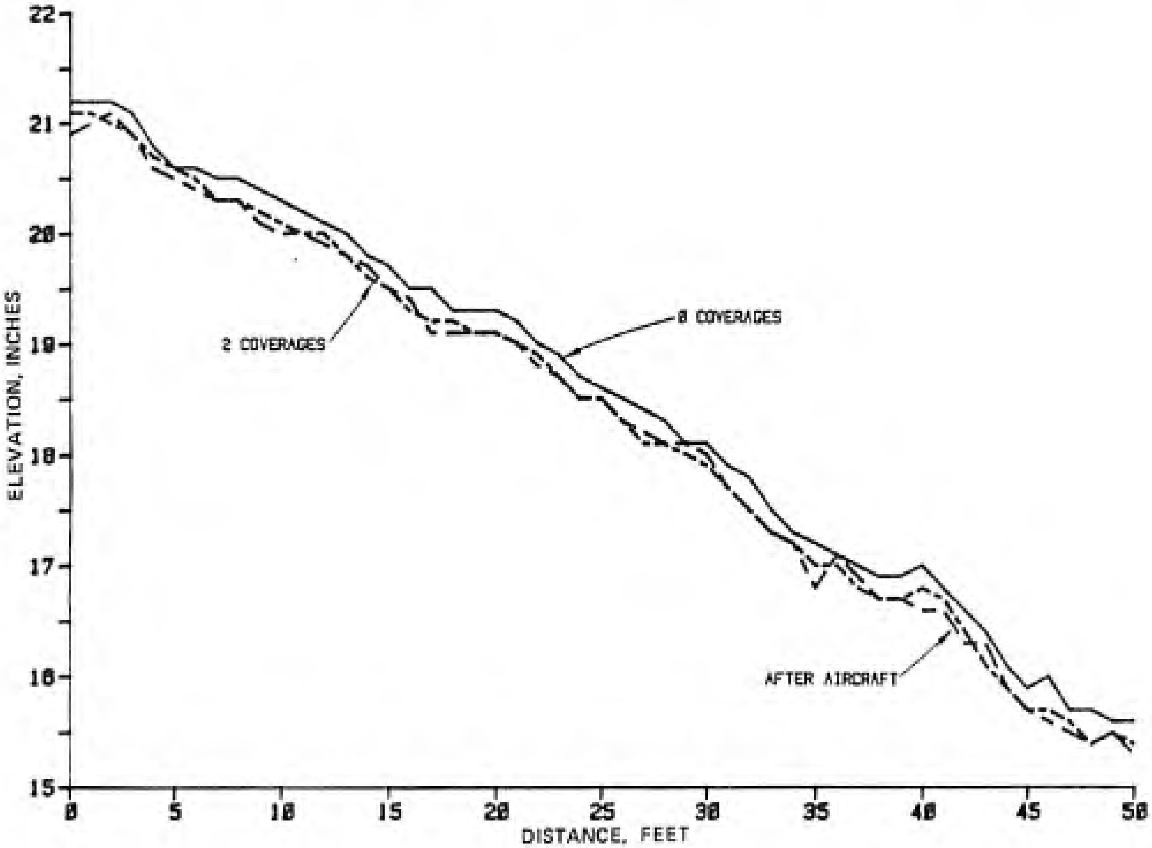
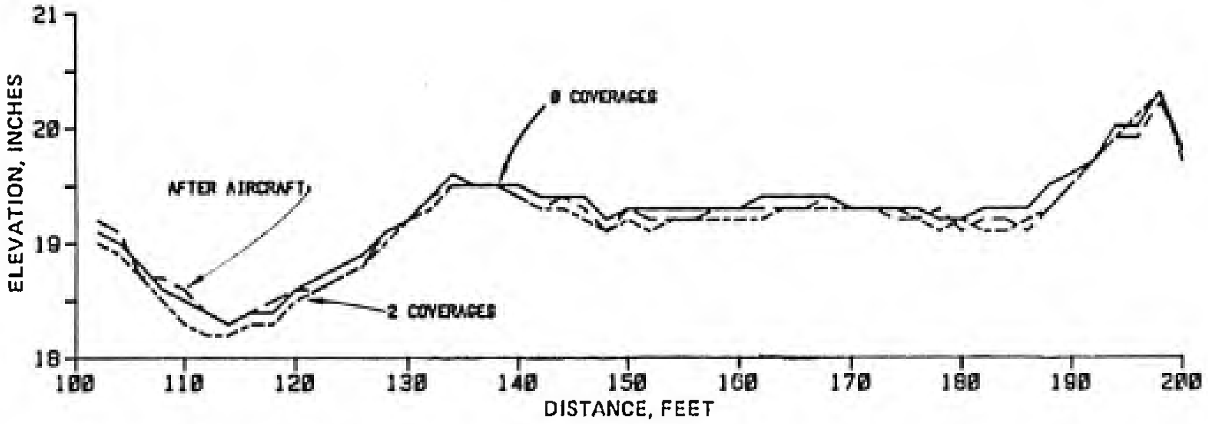
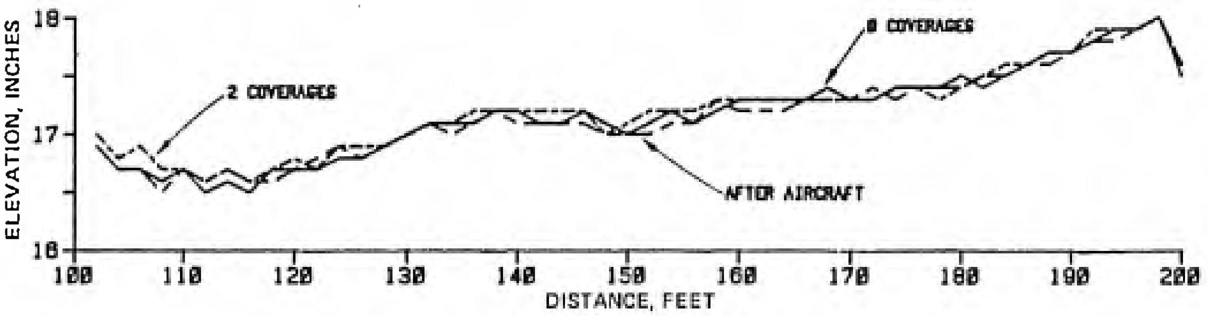


Figure 22. Typical Cross Sections for the AC Test Item after the F-4 Aircraft Traffic.



NORTH WHEEL PATH



SOUTH WHEEL PATH

Figure 23. Profiles for the North and South Wheel Paths of the F-4 Aircraft, AC Test Item, after the F-4 Aircraft.

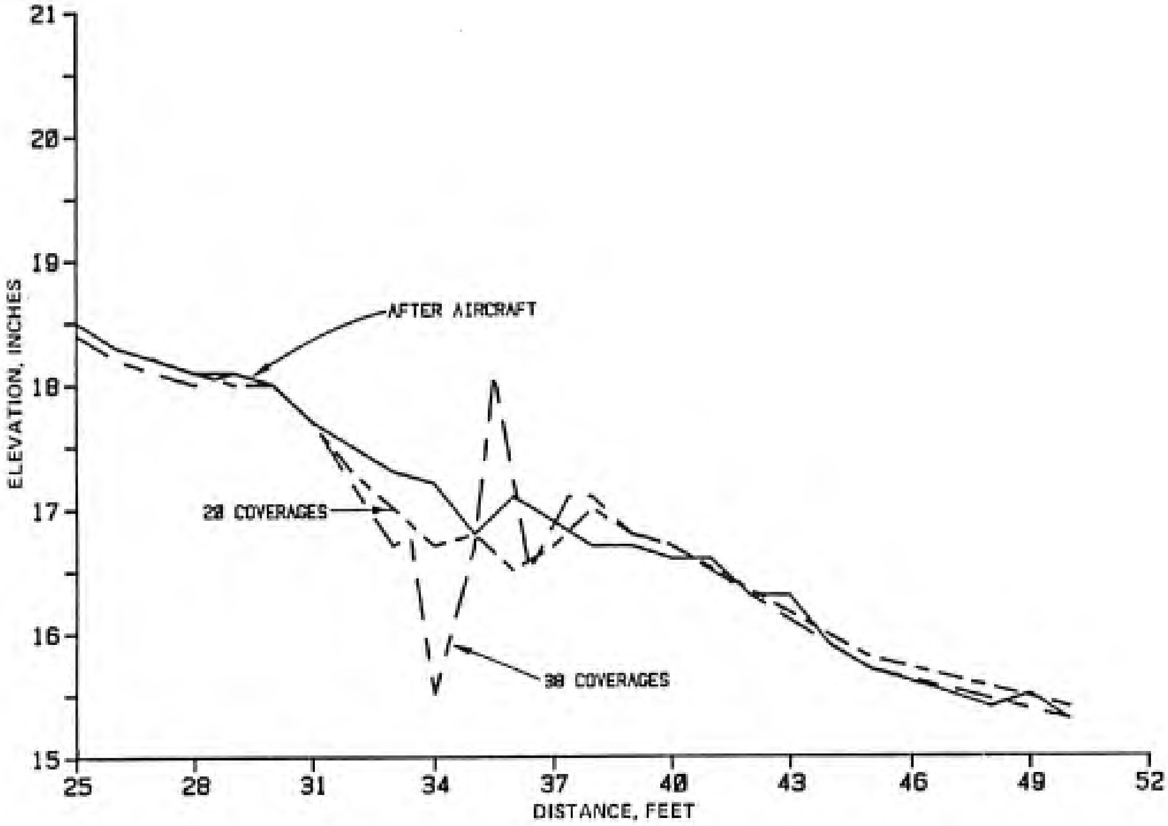


Figure 24. Typical Cross Sections for the F-15 Traffic Lane, AC Test Item.

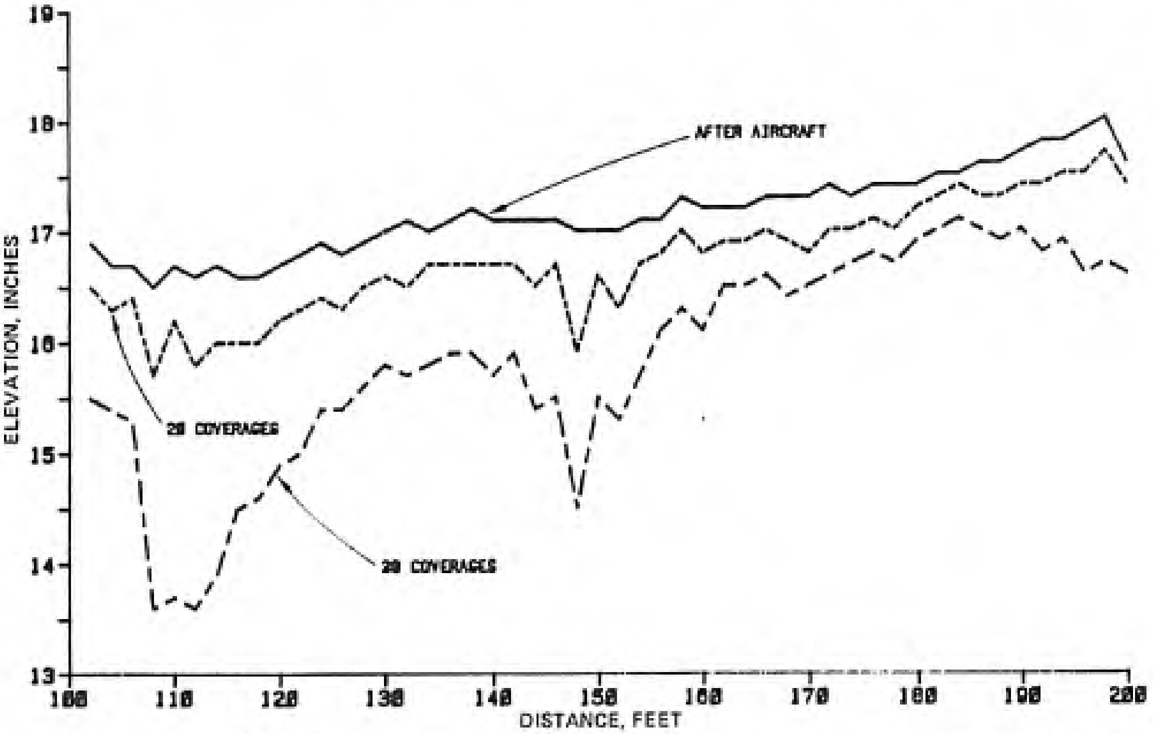


Figure 25. Profile, F-15 Traffic Lane, AC Test Item.

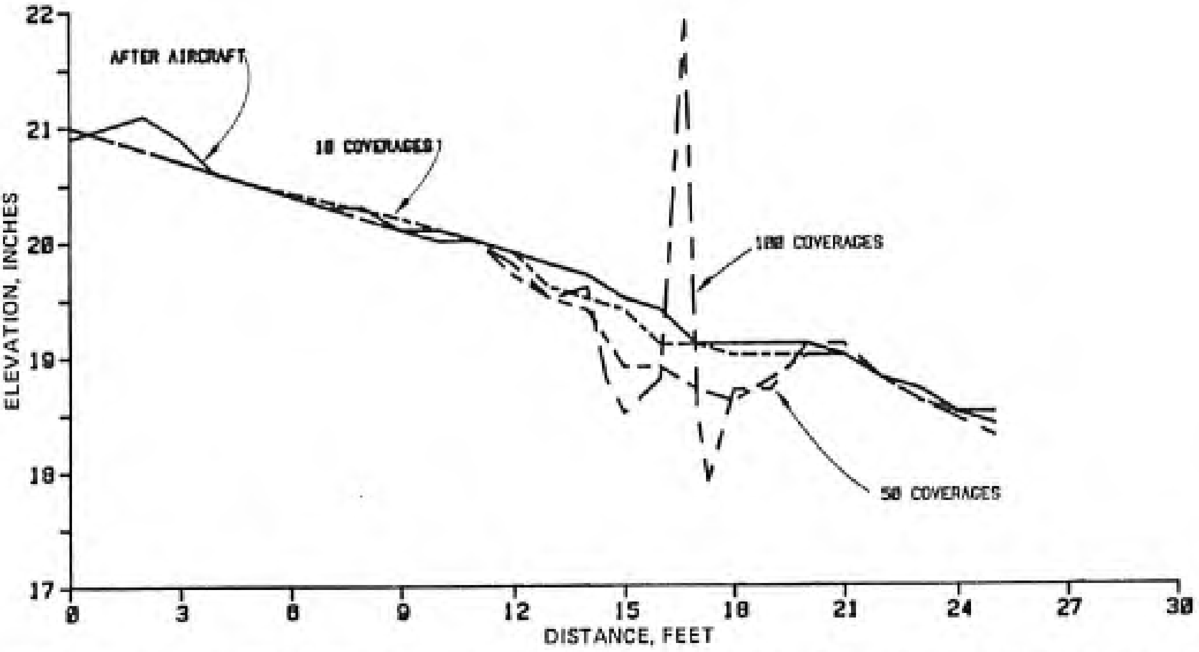


Figure 26. Typical Cross Sections for the F-4 Traffic Lane, AC Test Item.

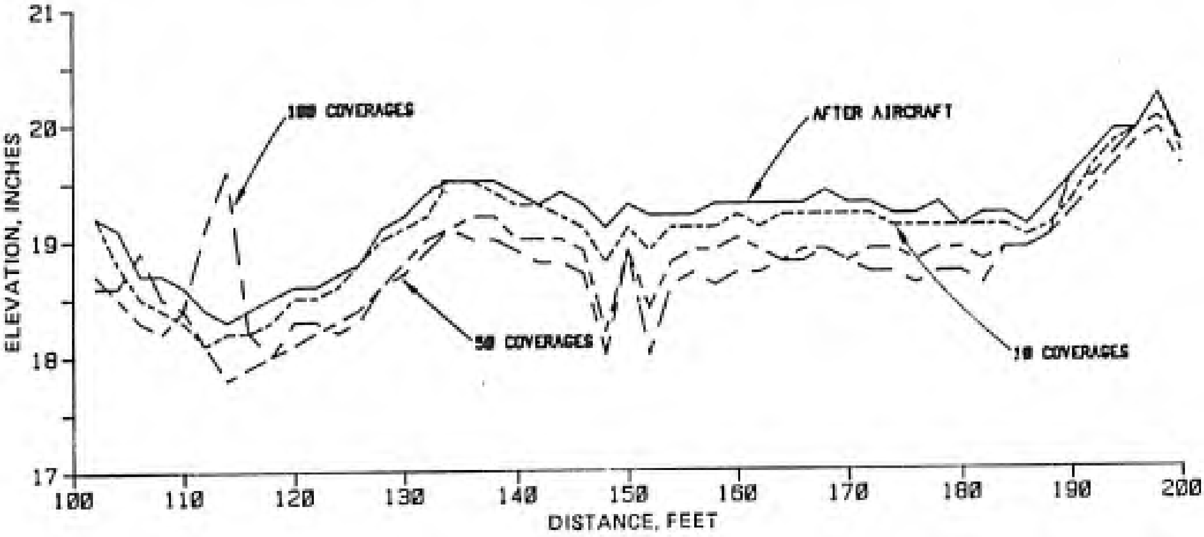


Figure 27. Profile, F-4 Traffic Lane, AC Test Item.

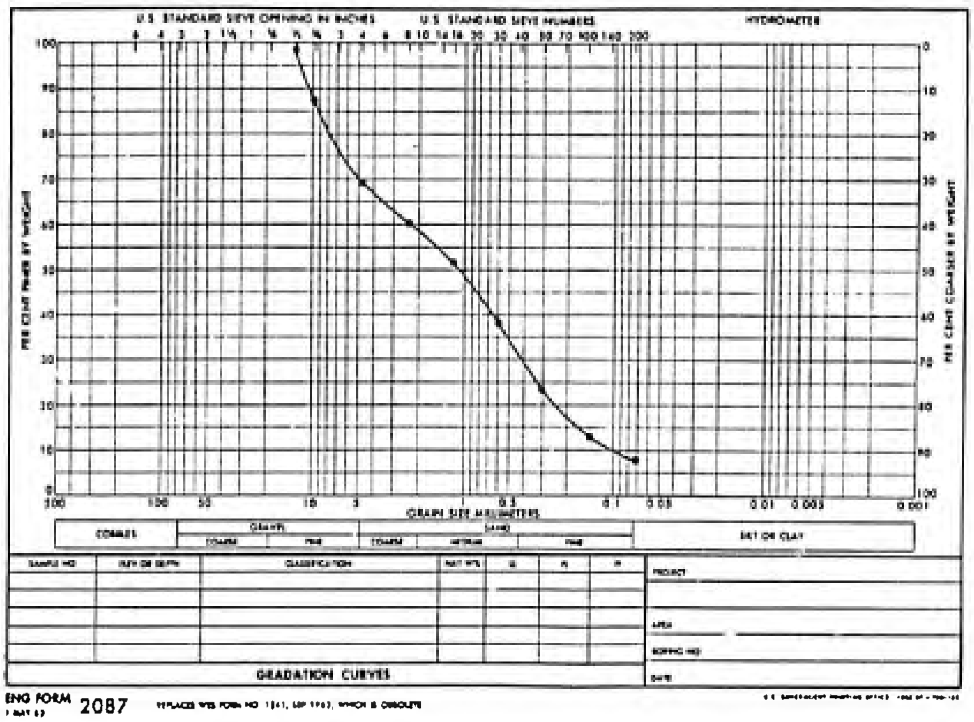


Figure 28. Gradation of the AC Mix Obtained from Cores after Traffic.

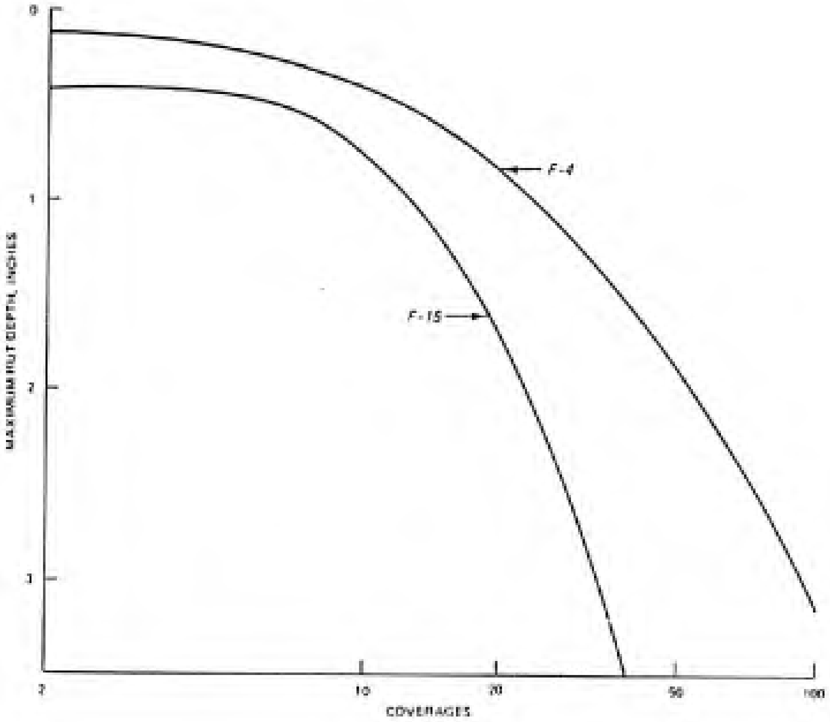


Figure 29. Surface Deformation, AC Test Item.

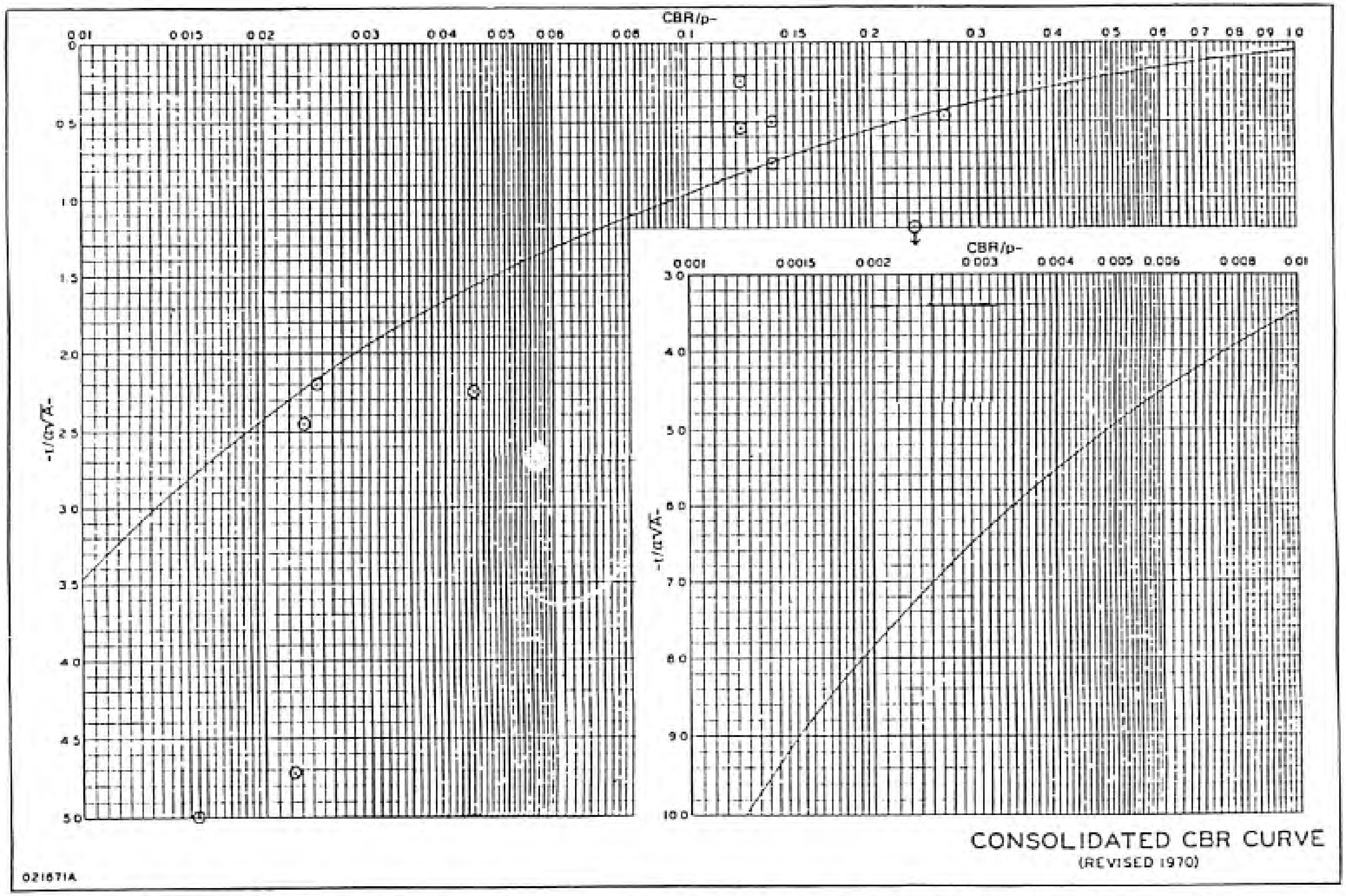


Figure 30. ALRS Traffic Test Section Data for 1-inch Rut Depth as Related to Current CBR/p versus $t/\alpha\sqrt{A}$ Relationship.

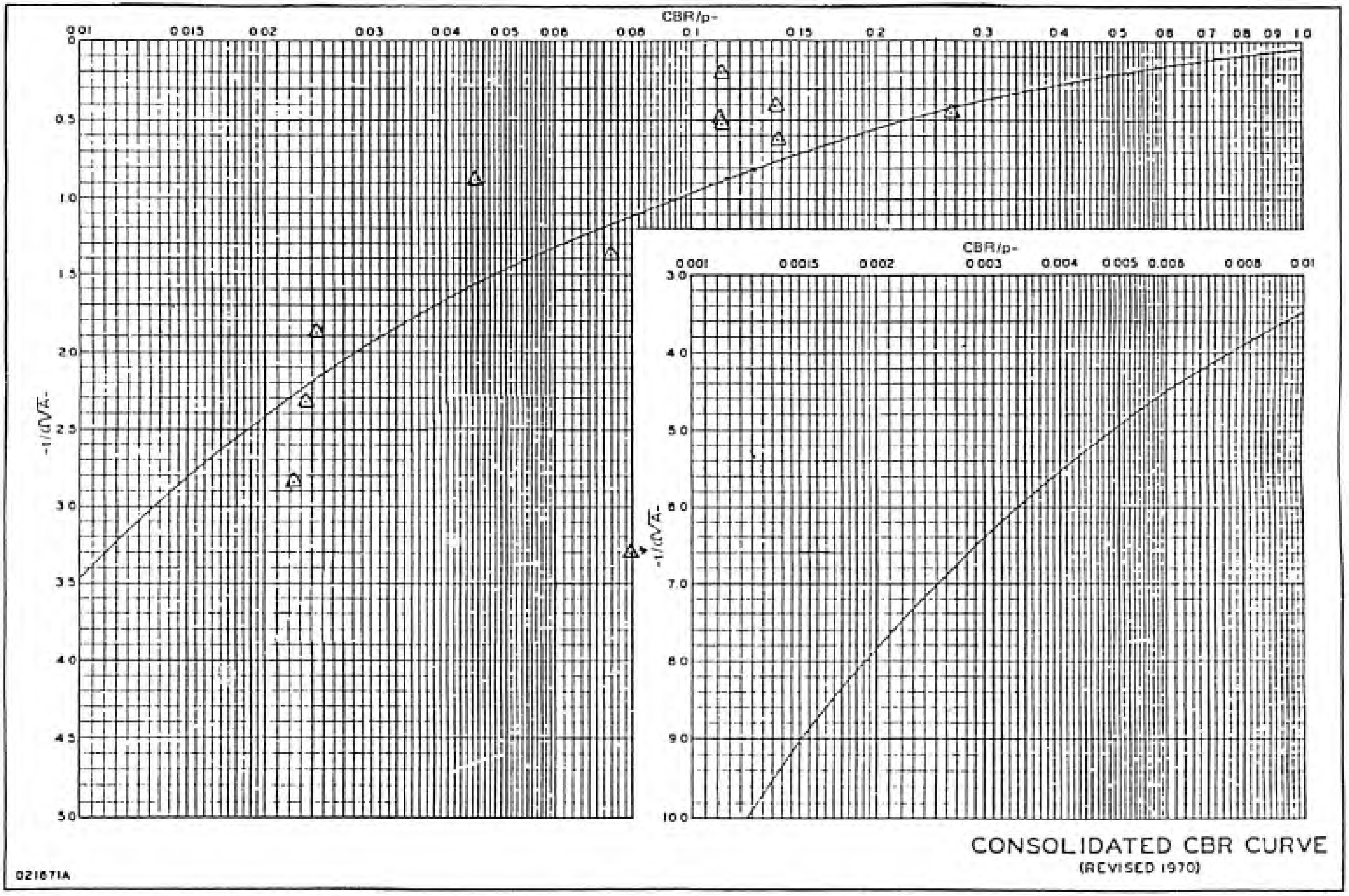


Figure 31. ALRS Traffic Test Section Data for 3-inch Rut Depth as Related to Current CBR/p versus $t/\alpha\sqrt{A}$ Relationship.

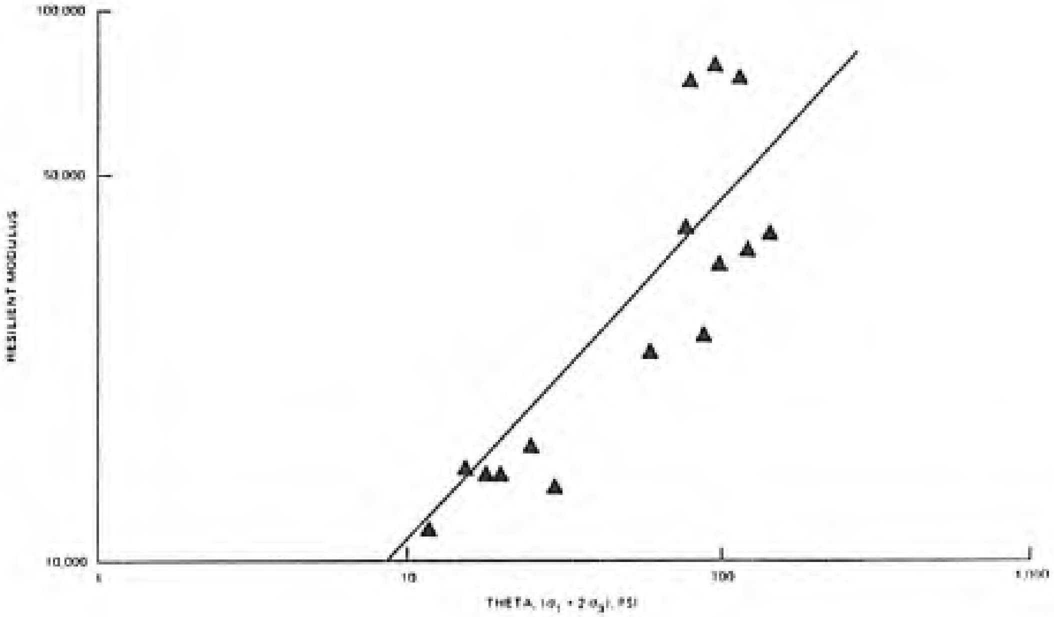


Figure 32. Laboratory Resilient Modulus Test Results on Subgrade.

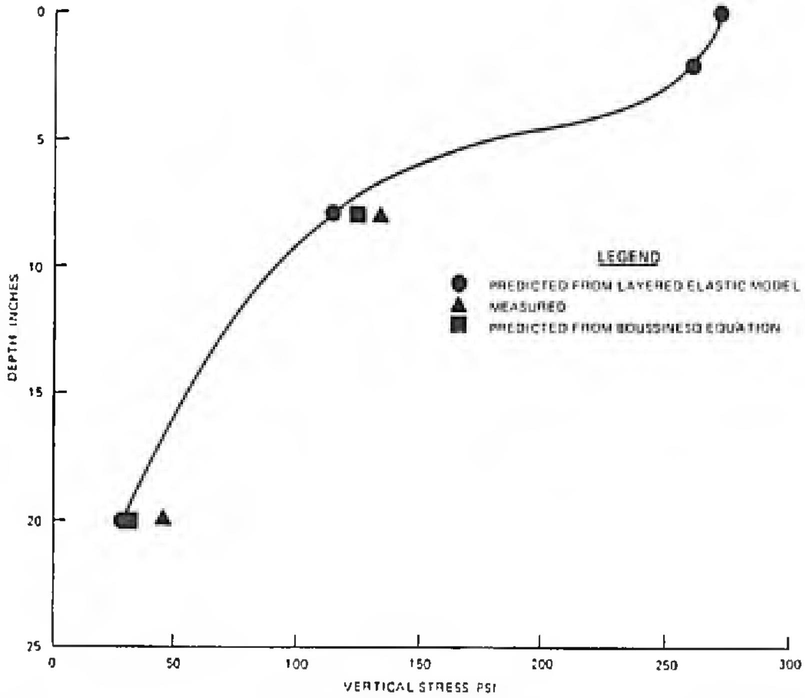


Figure 33. Measured and Predicted Stresses on Asphalt Item under F-4 Loading.

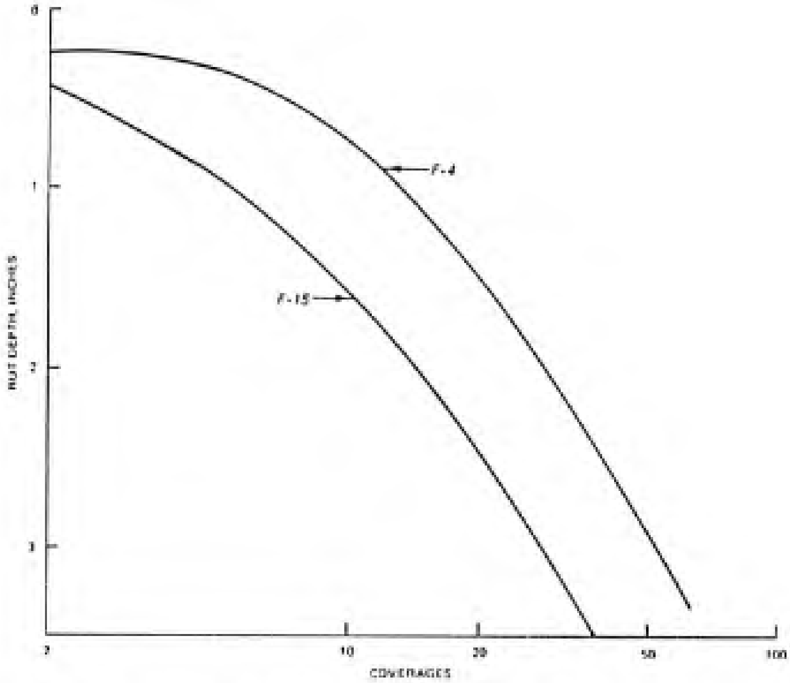


Figure 34. Surface Deformation, Stabilized Soil Test Item.

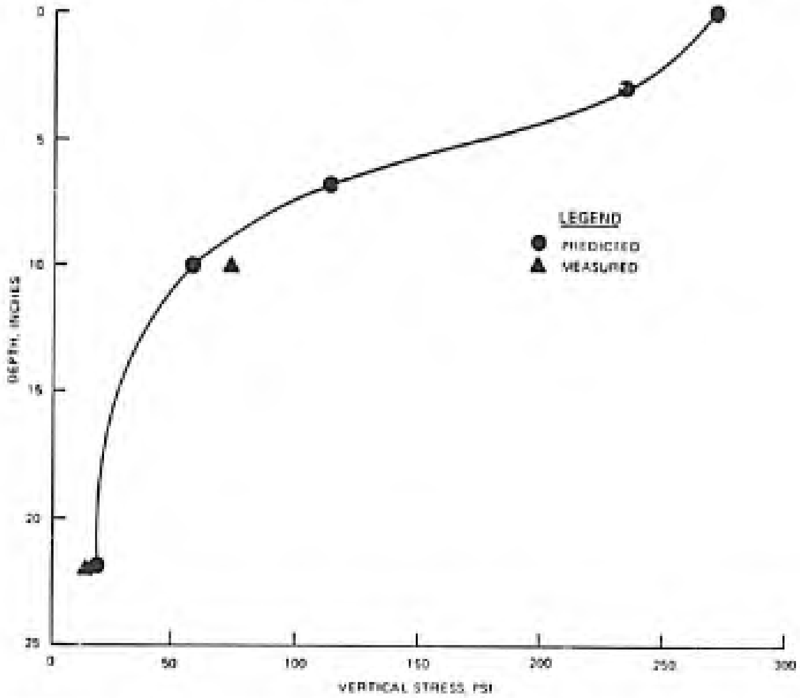


Figure 35. Measured and Predicted Stresses under F-4 Loading on Stabilized Item.

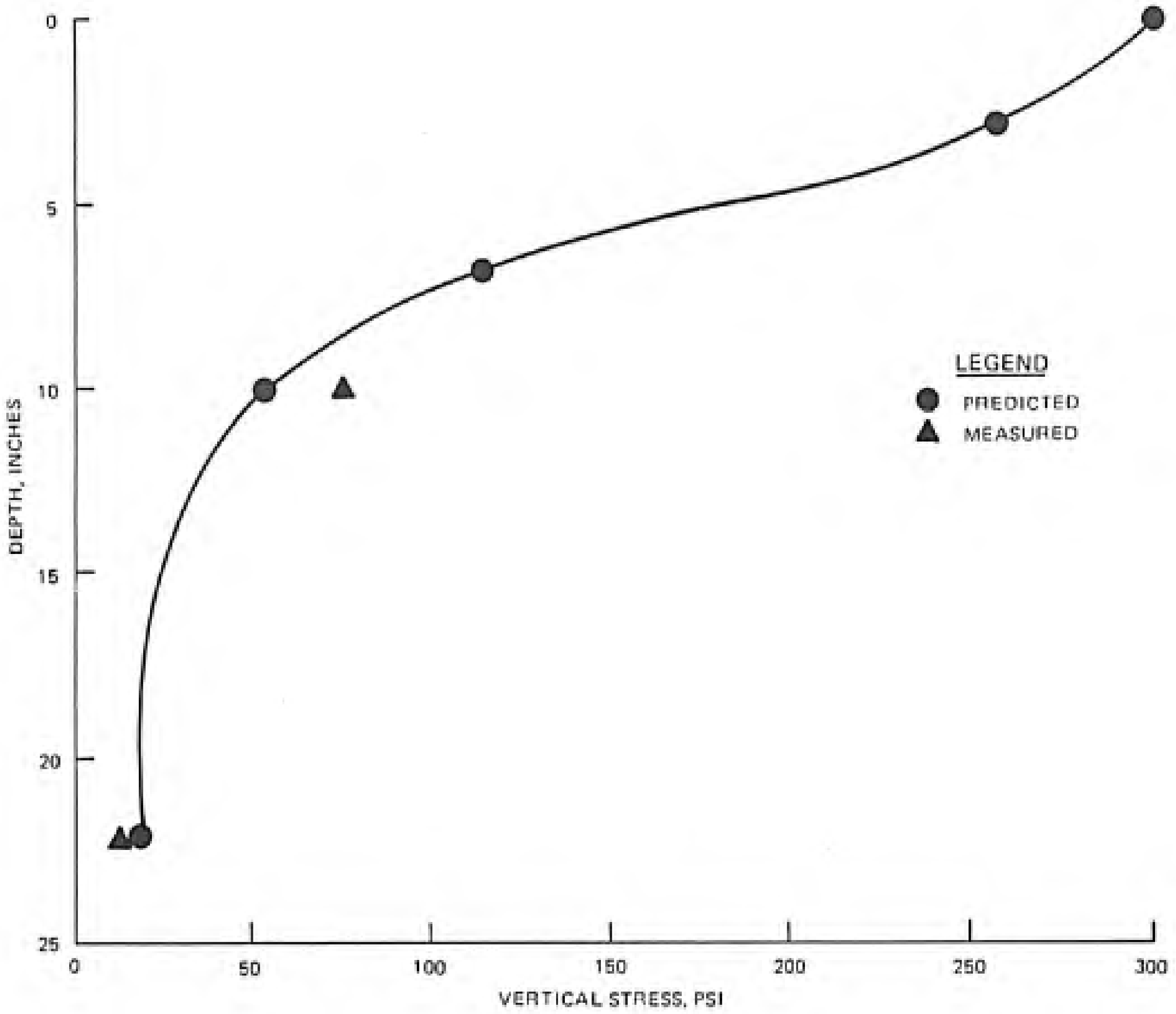


Figure 36. Measured and Predicted Stresses under F-15 Loading on Stabilized Item.

APPENDIX C: PHOTOS

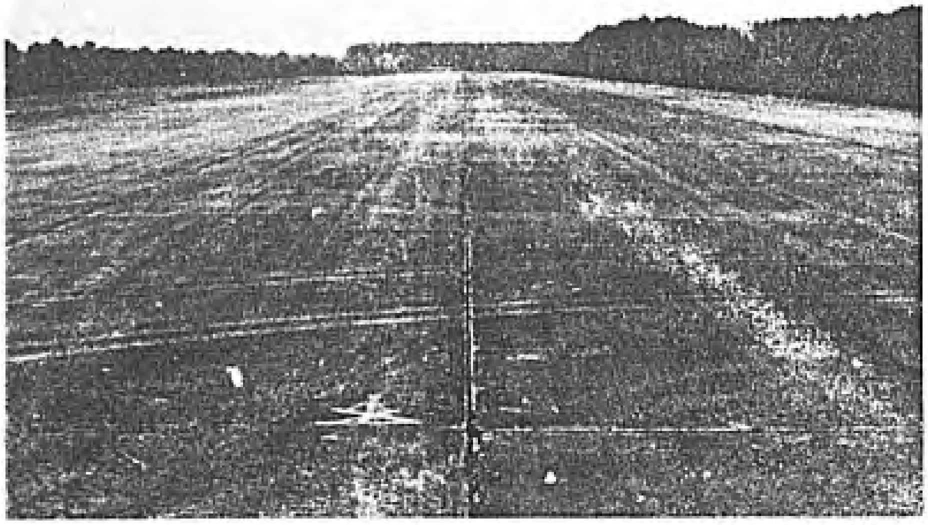


Photo 1. E-W Runway.

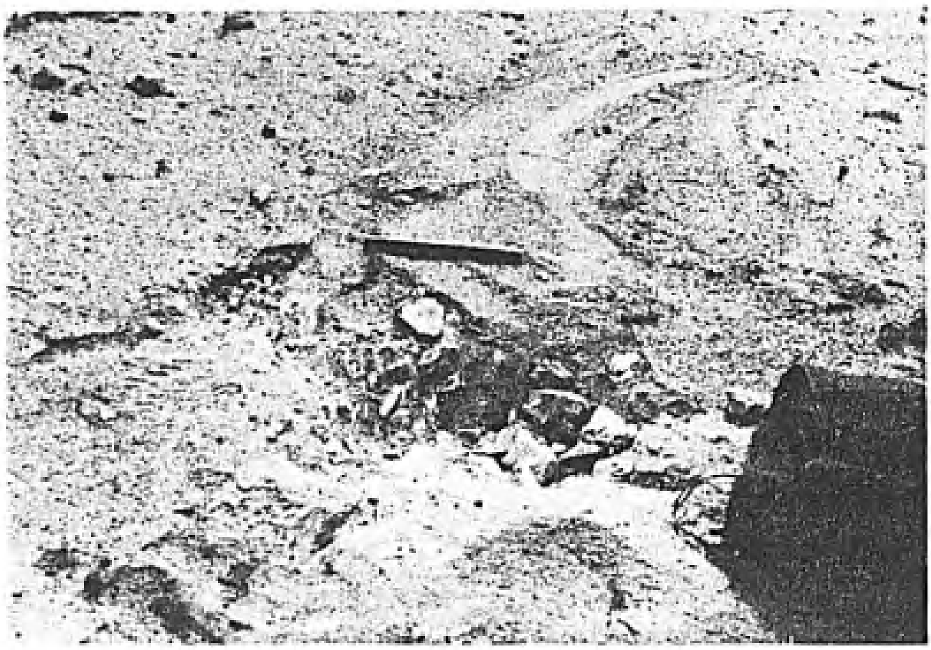


Photo 2. Damage to a Slab From a 3.5-pound Charge of TNT.

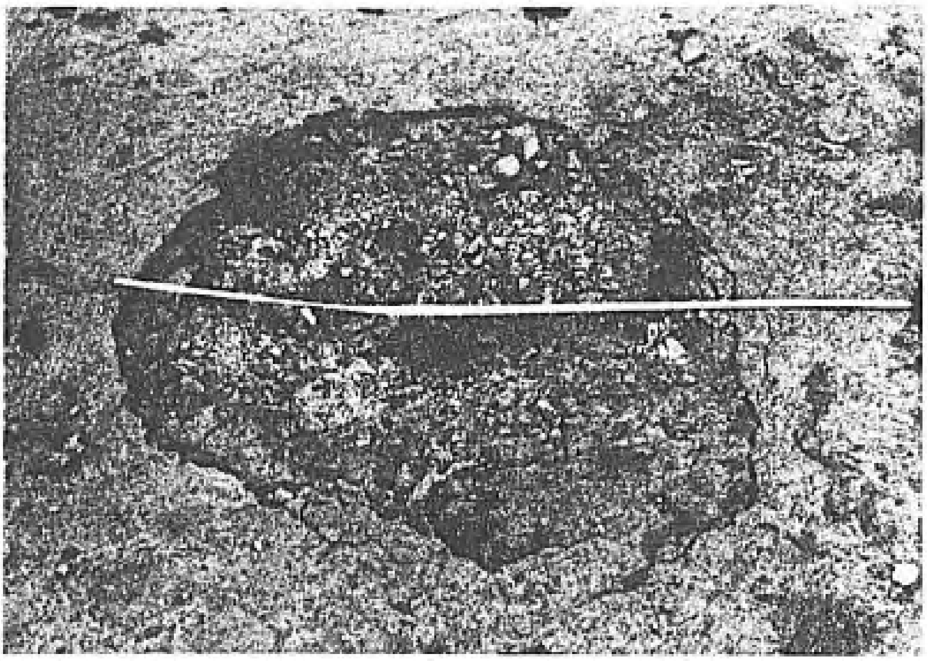


Photo 3. Damage to a Slab From a 9-pound Charge of TNT.

Photo 4. Removal of PCC With Pavement Breaker and Front-end Loader.

Photo 5. Compacting the Subgrade With a Tandem Vibratory Roller.

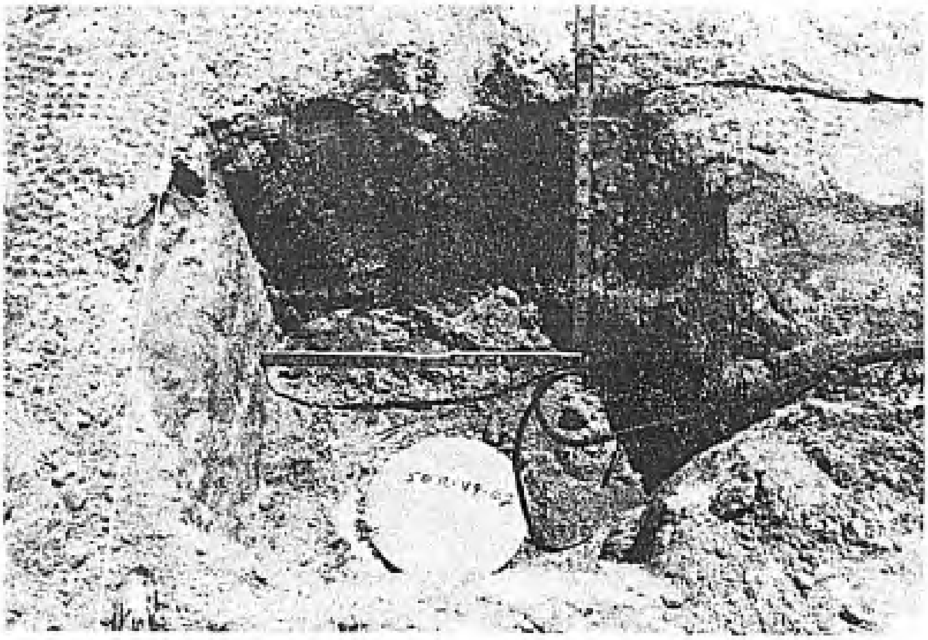


Photo 6. Installation of a Pressure Gage in the Subgrade.

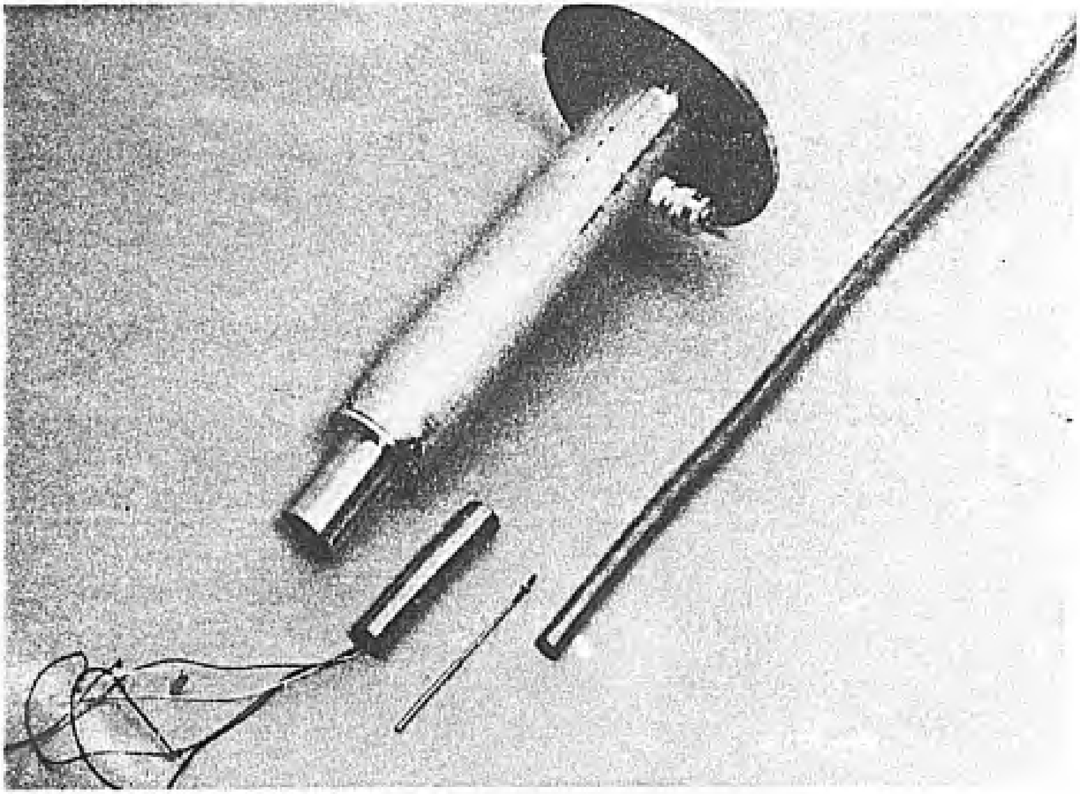


Photo 7. DCVDT and Components Required for Installation.

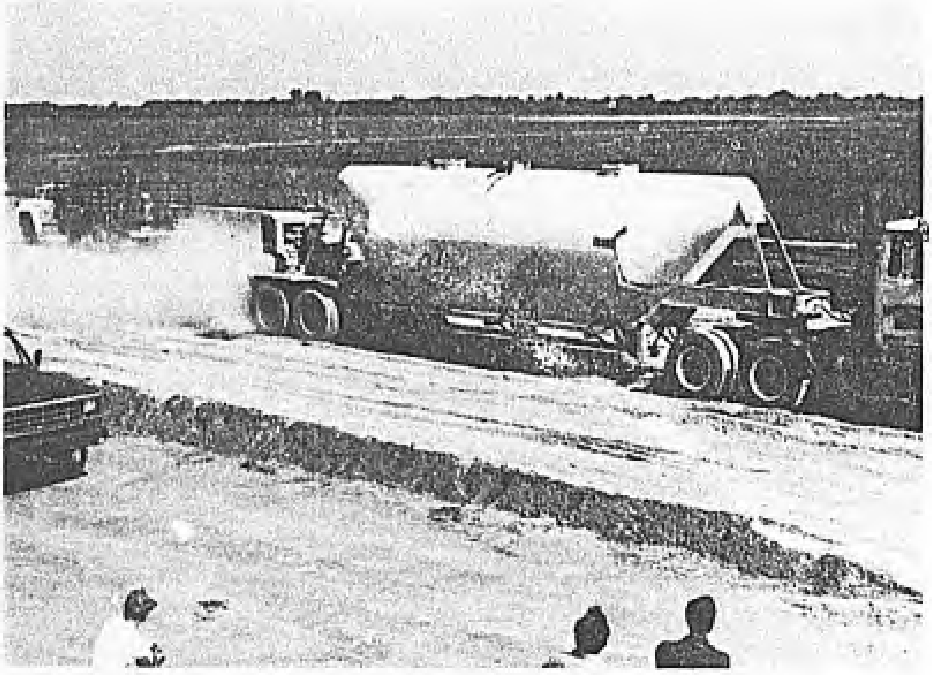


Photo 8. Discharging of PC onto the Stockpile.

Photo 9. Blending PC and Silty Sand with a Pulvimixer.

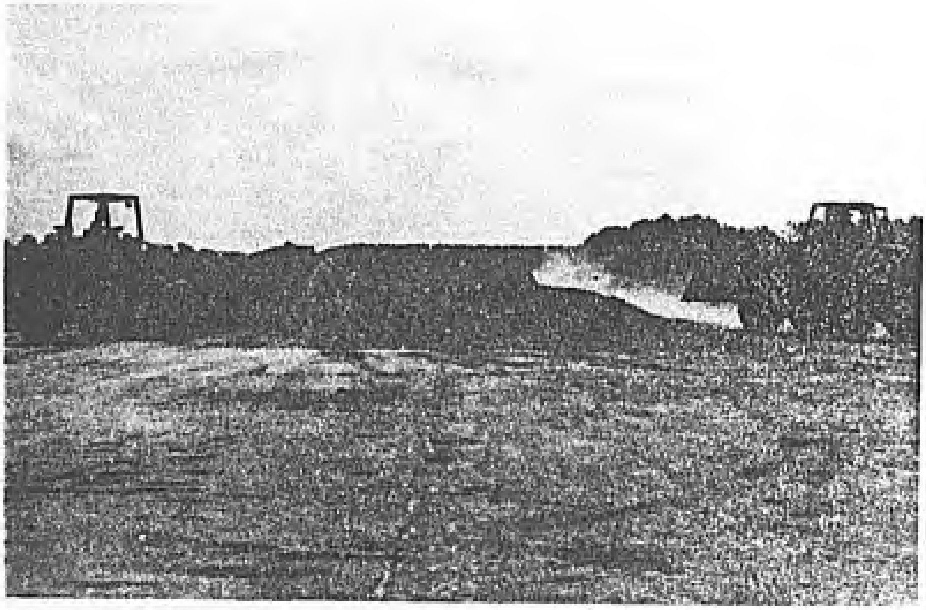


Photo 10. Piling of Blended PC and Silty Sand for Additional Mixing.

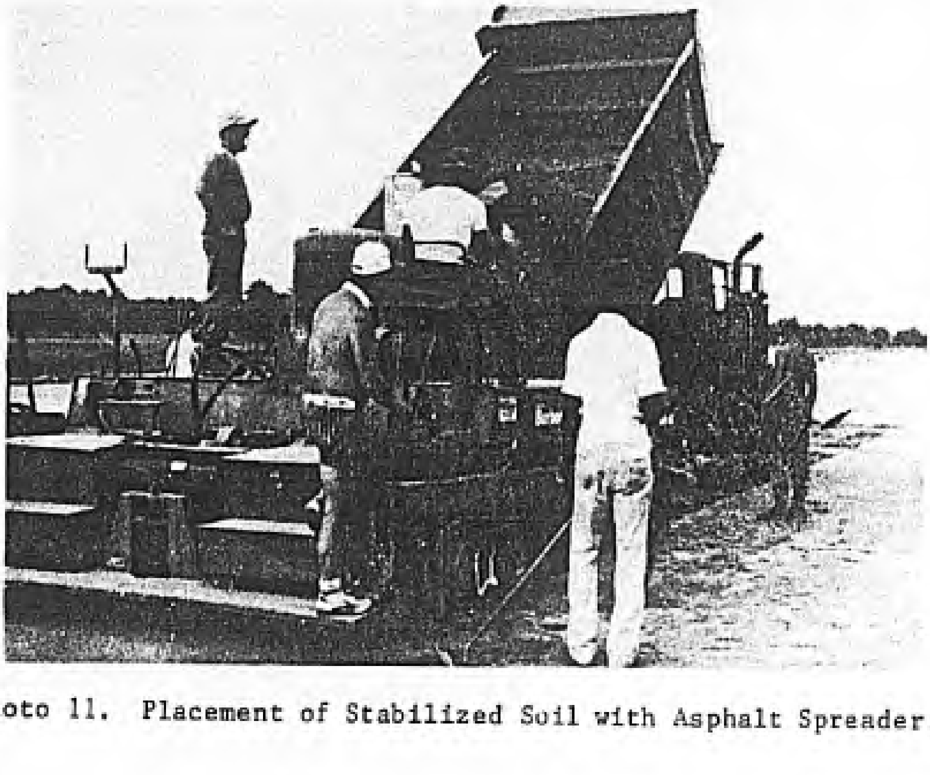


Photo 11. Placement of Stabilized Soil with Asphalt Spreader.

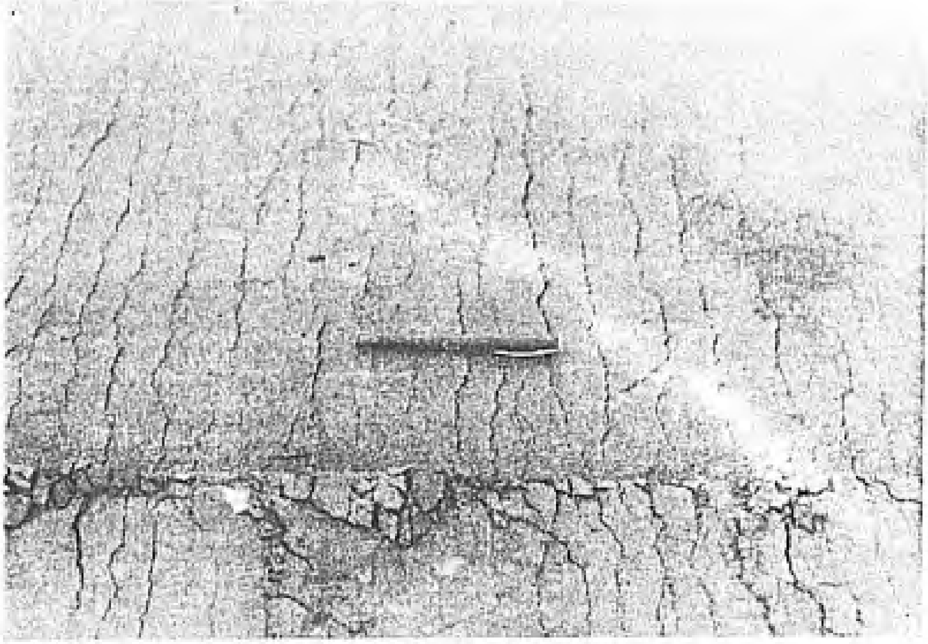


Photo 12. Tears in the Stabilized Soil during Compaction.

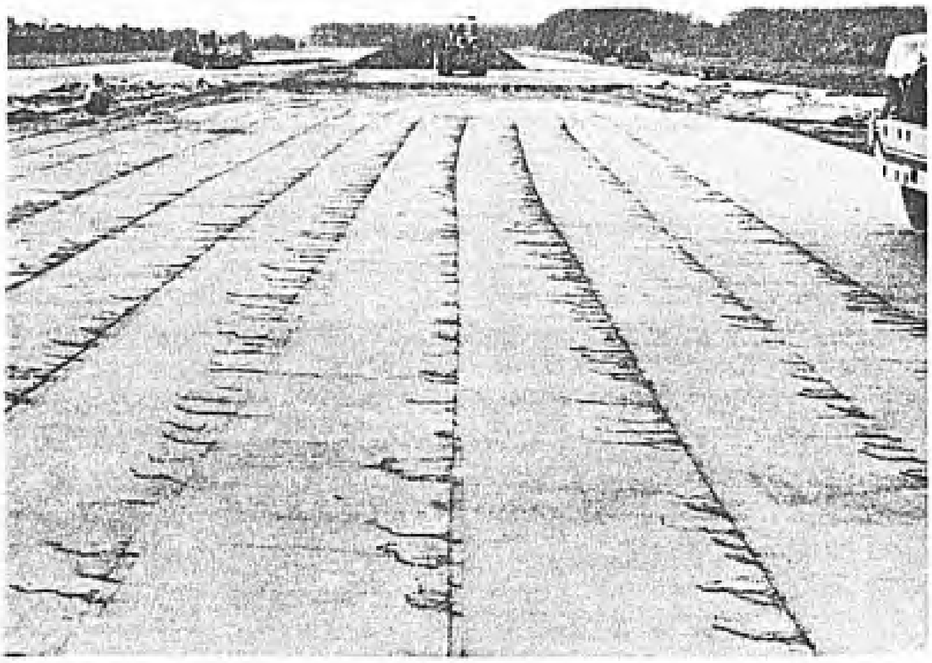


Photo 13. Tandem Shoving Produced by the Vibratory Roller during Compaction.

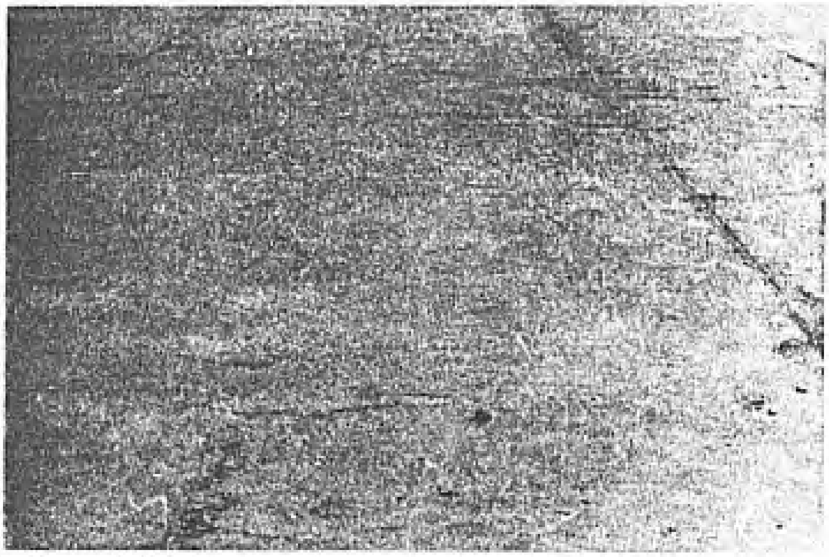


Photo 14. Stabilized Soil after Compaction.

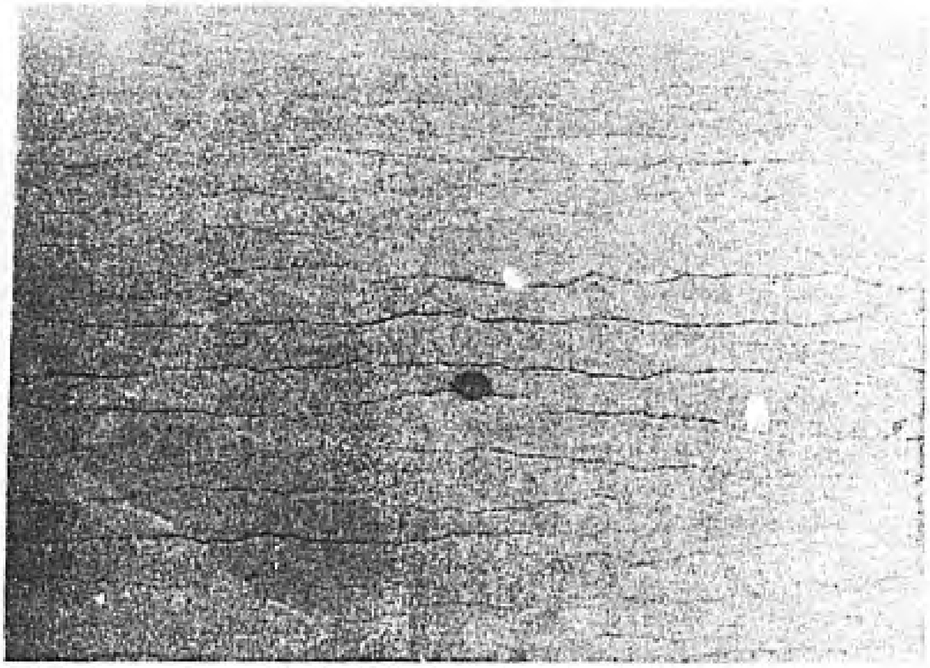


Photo 15. Close up of Tears in the Stabilized Soil after Compaction.

Photo 16. Top Layer (Second Lift) of the Stabilized Soil Through a Core Hole.

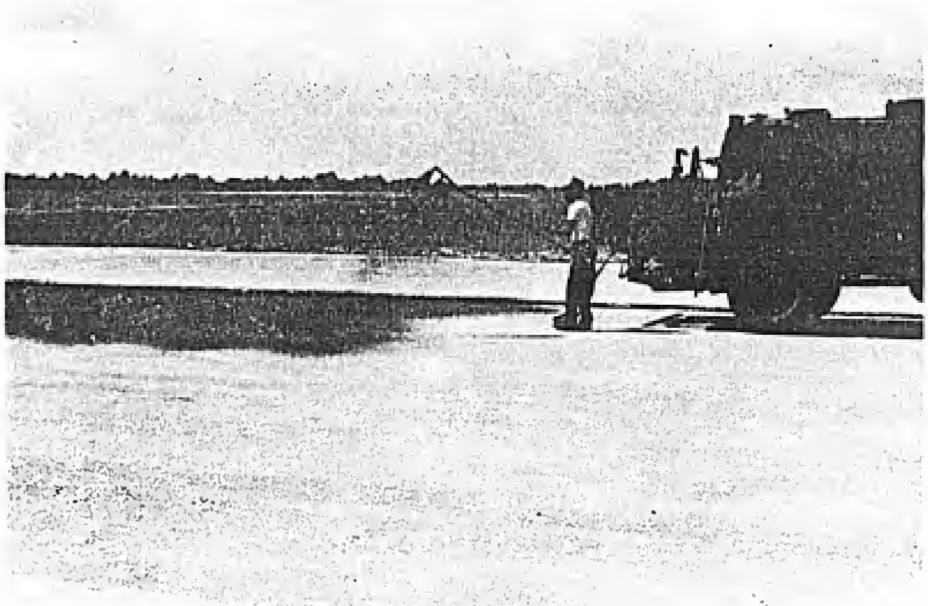


Photo 17. Priming of the Crushed Granite Base Course with an Asphalt Emulsion.

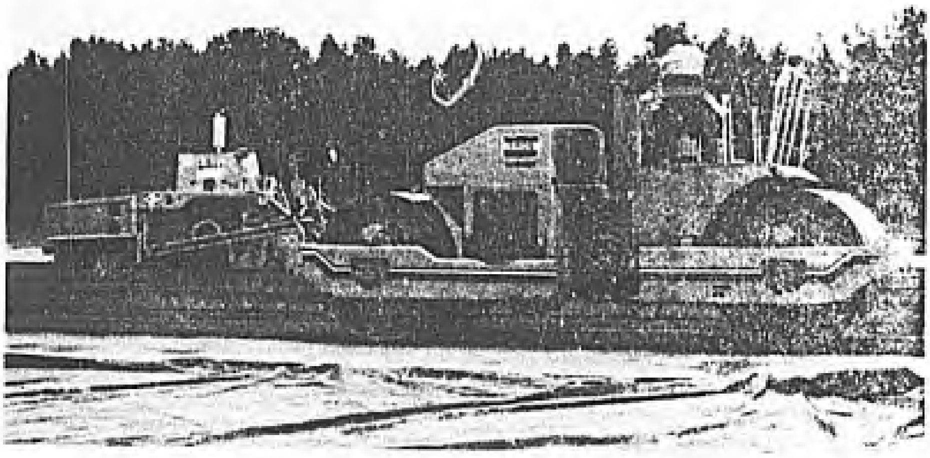


Photo 18. Compaction of the AC with a Tandem Vibratory Roller.

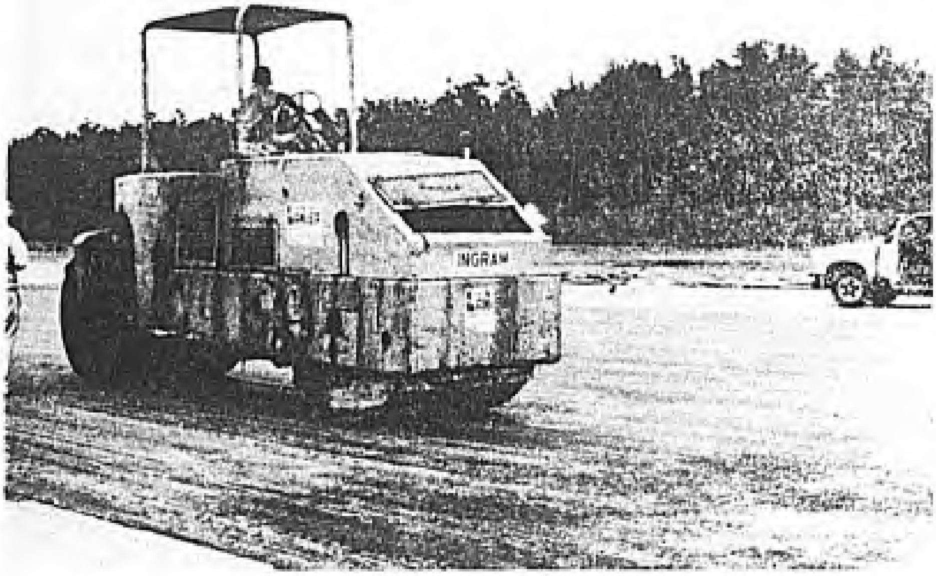


Photo 19. Final Compaction of the AC with a Tandem Steel-Wheel Roller.

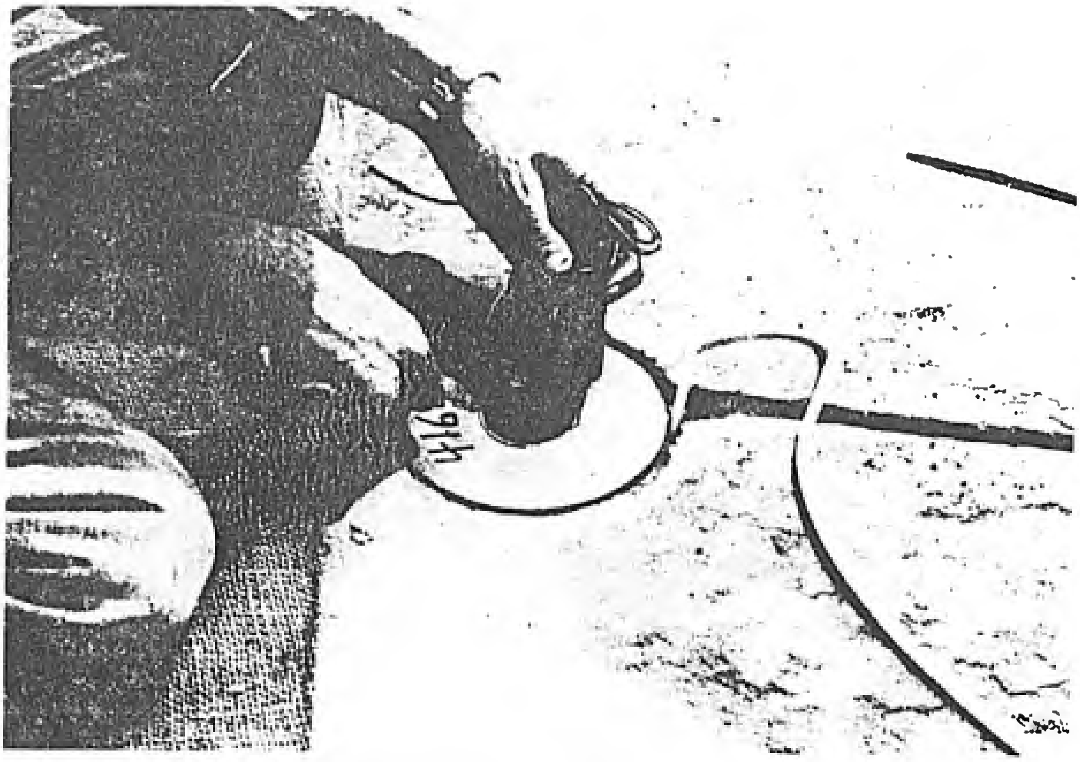


Photo 20. Installation of DCVDT in a Waterproof Housing at the Surface of the AC.

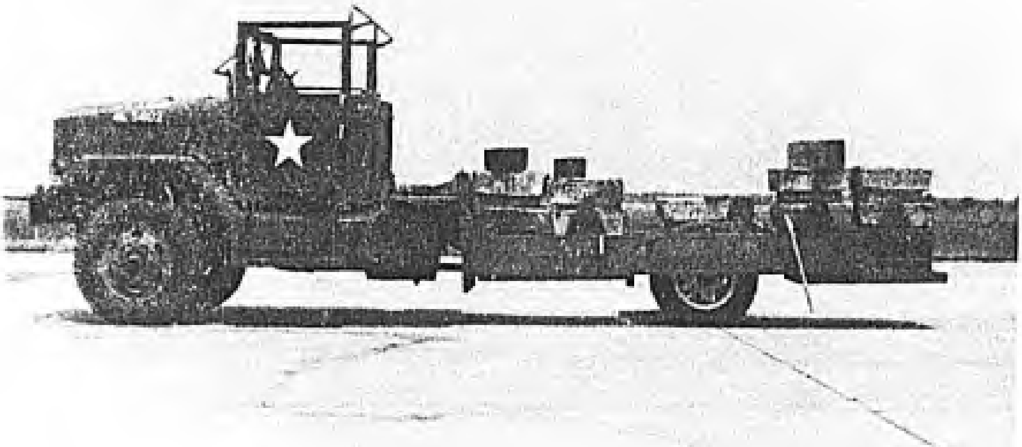


Photo 21. Loadcart Used to Apply Traffic.

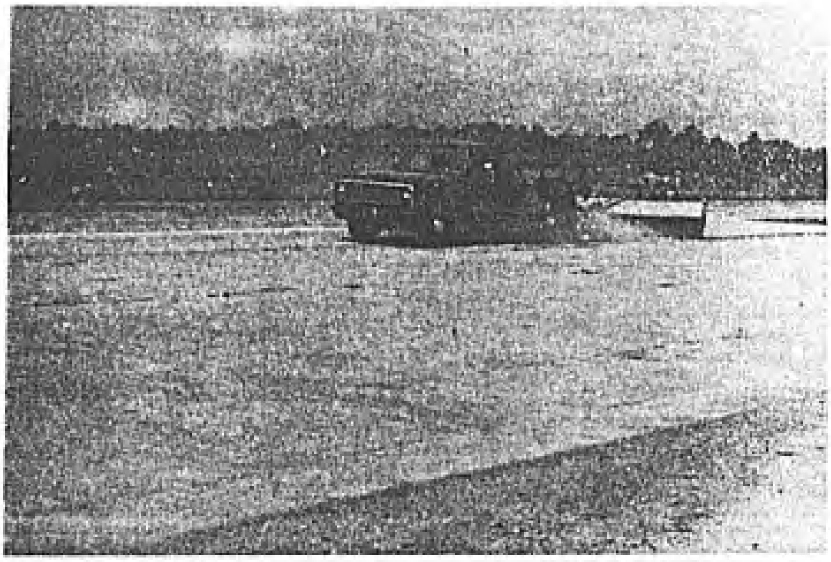


Photo 22. Sweeping the Stabilized Soil Test item.

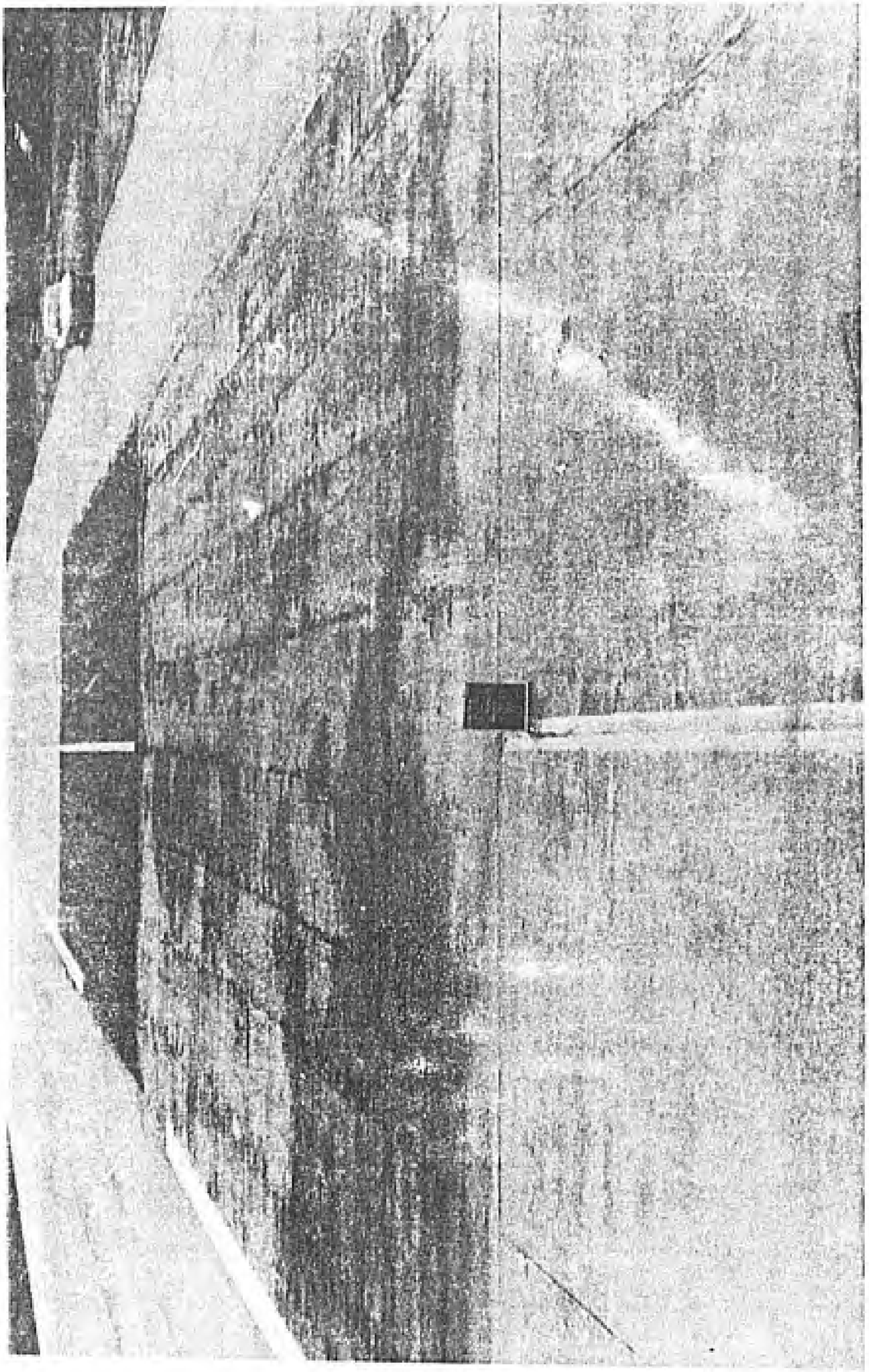


Photo 23. Stabilized Soil Test Item after Prooftesting.

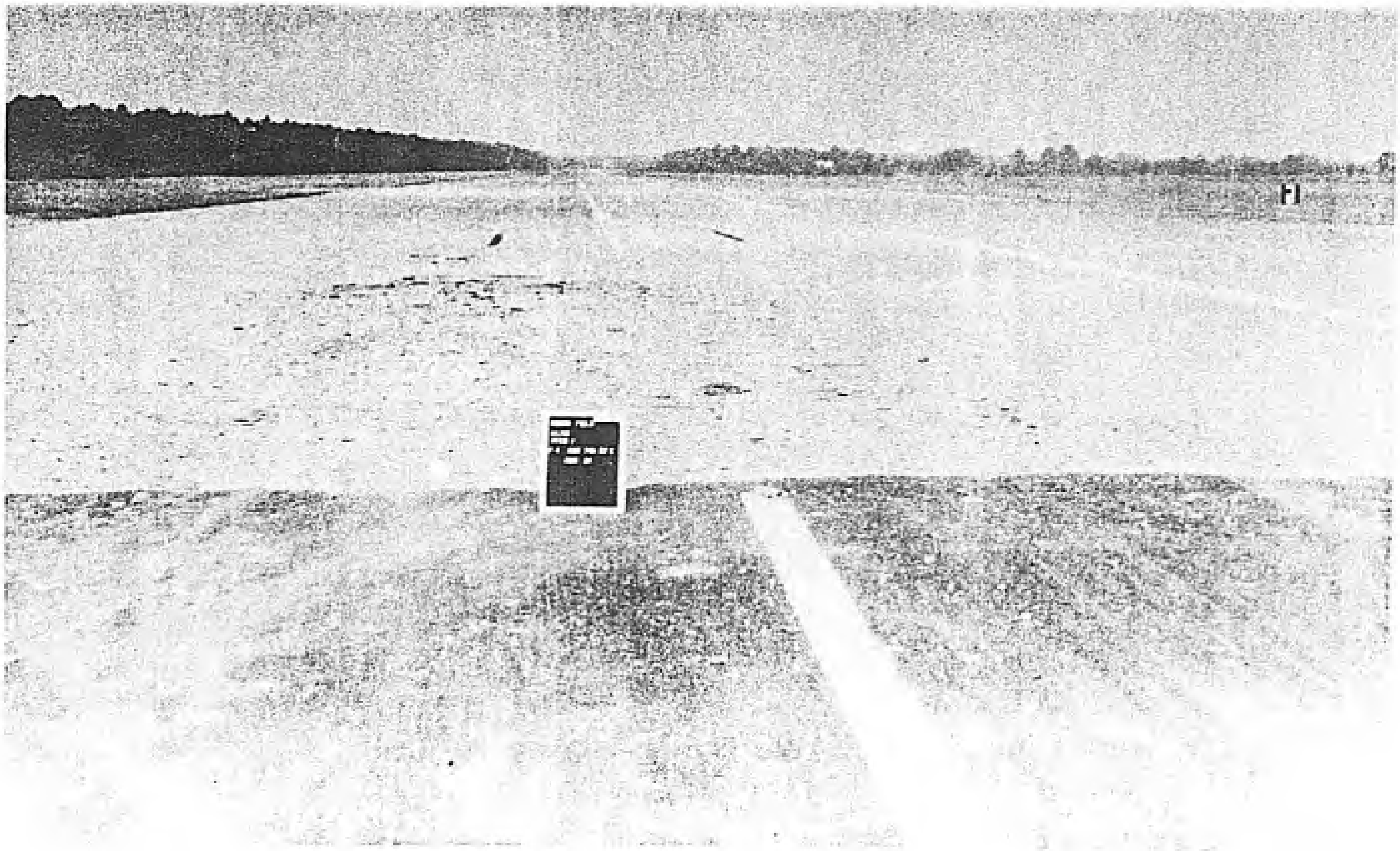


Photo 24. Stabilized Soil Dislodged by F-4 Aircraft.

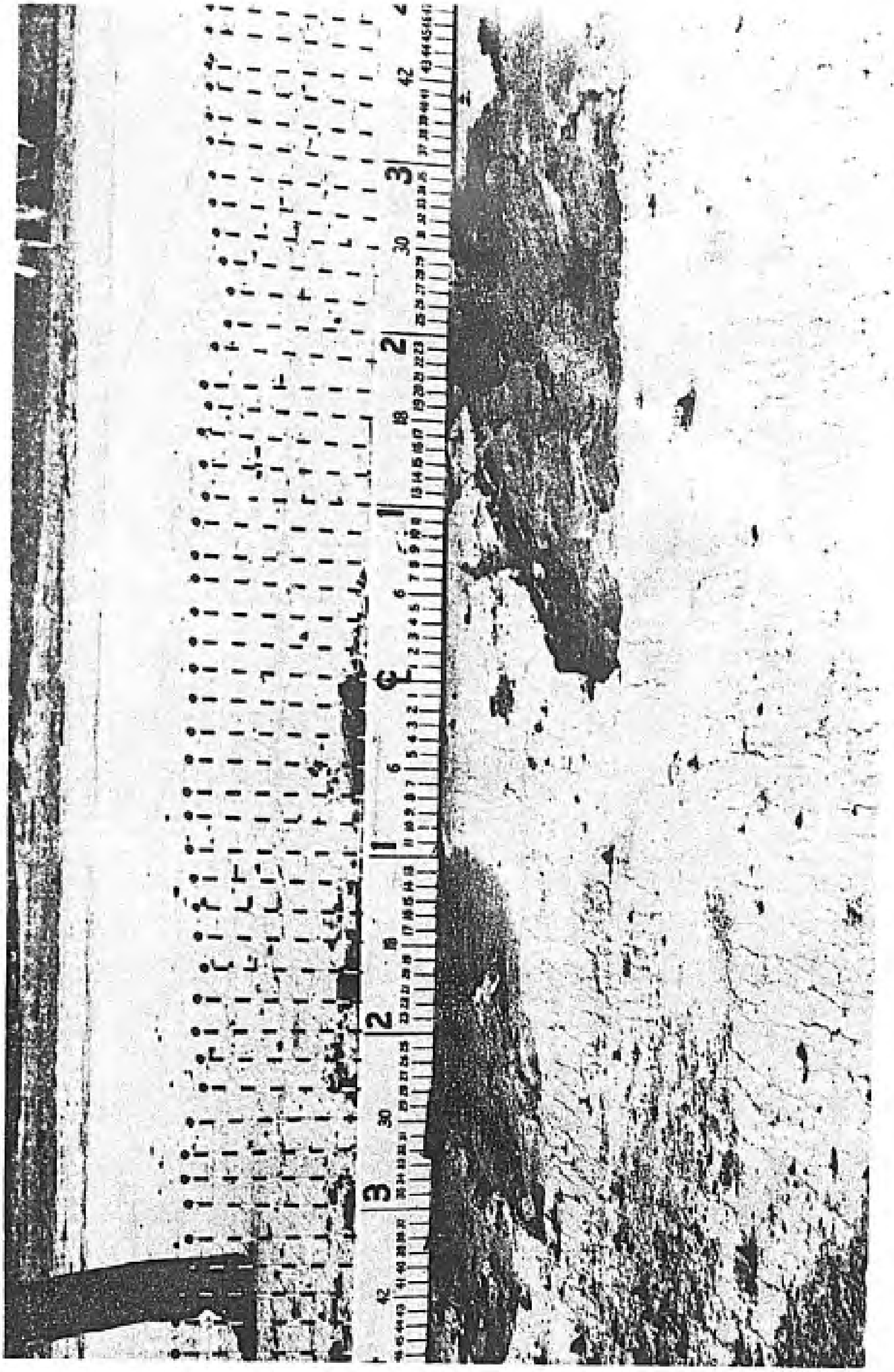


Photo 25. Areas Where Stabilized Soil Was Dislodged.

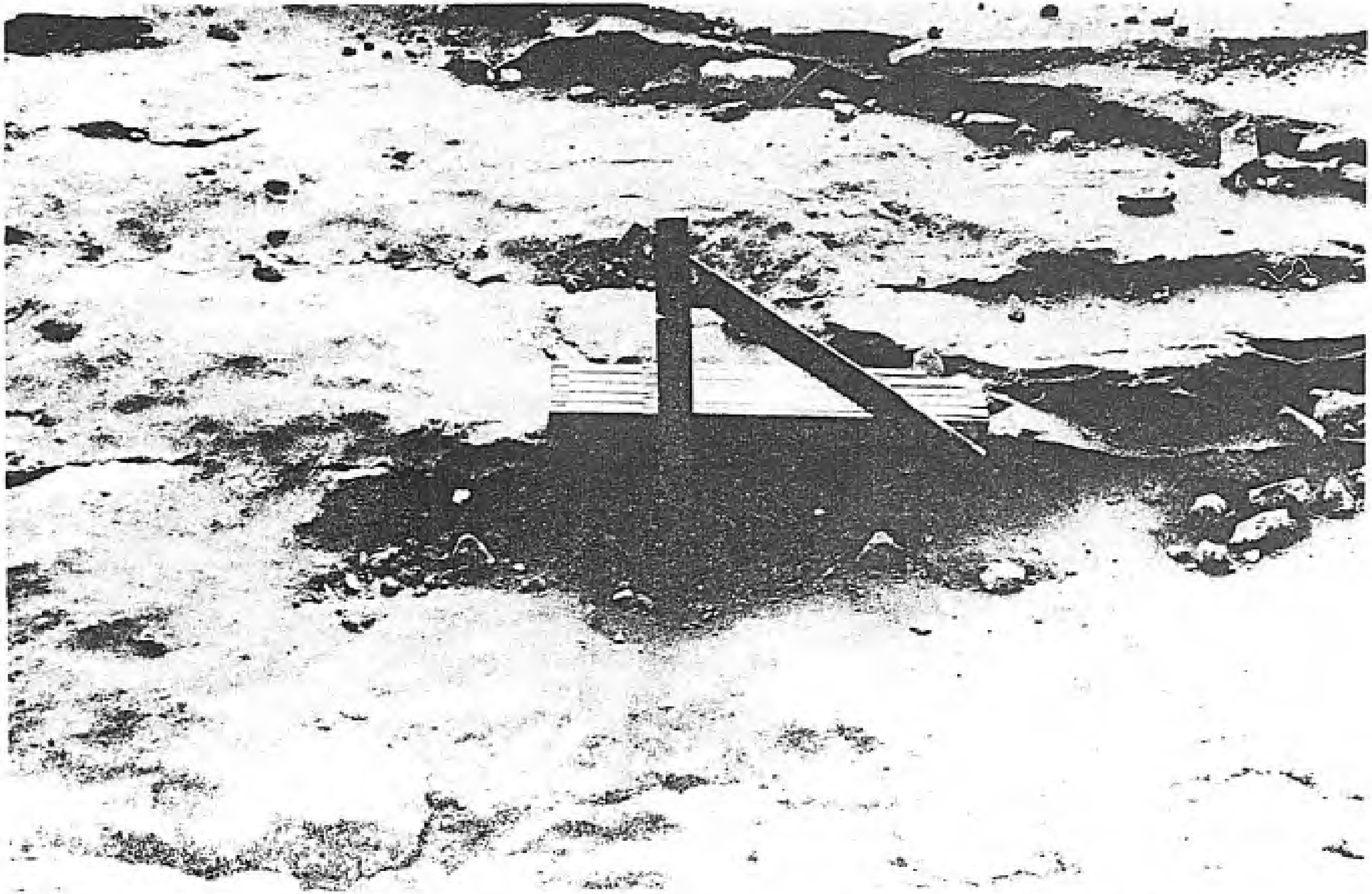


Photo 26. Close Up of an Area Where Stabilized Soil Was Dislodged; Note Layers in Stabilized Soil.

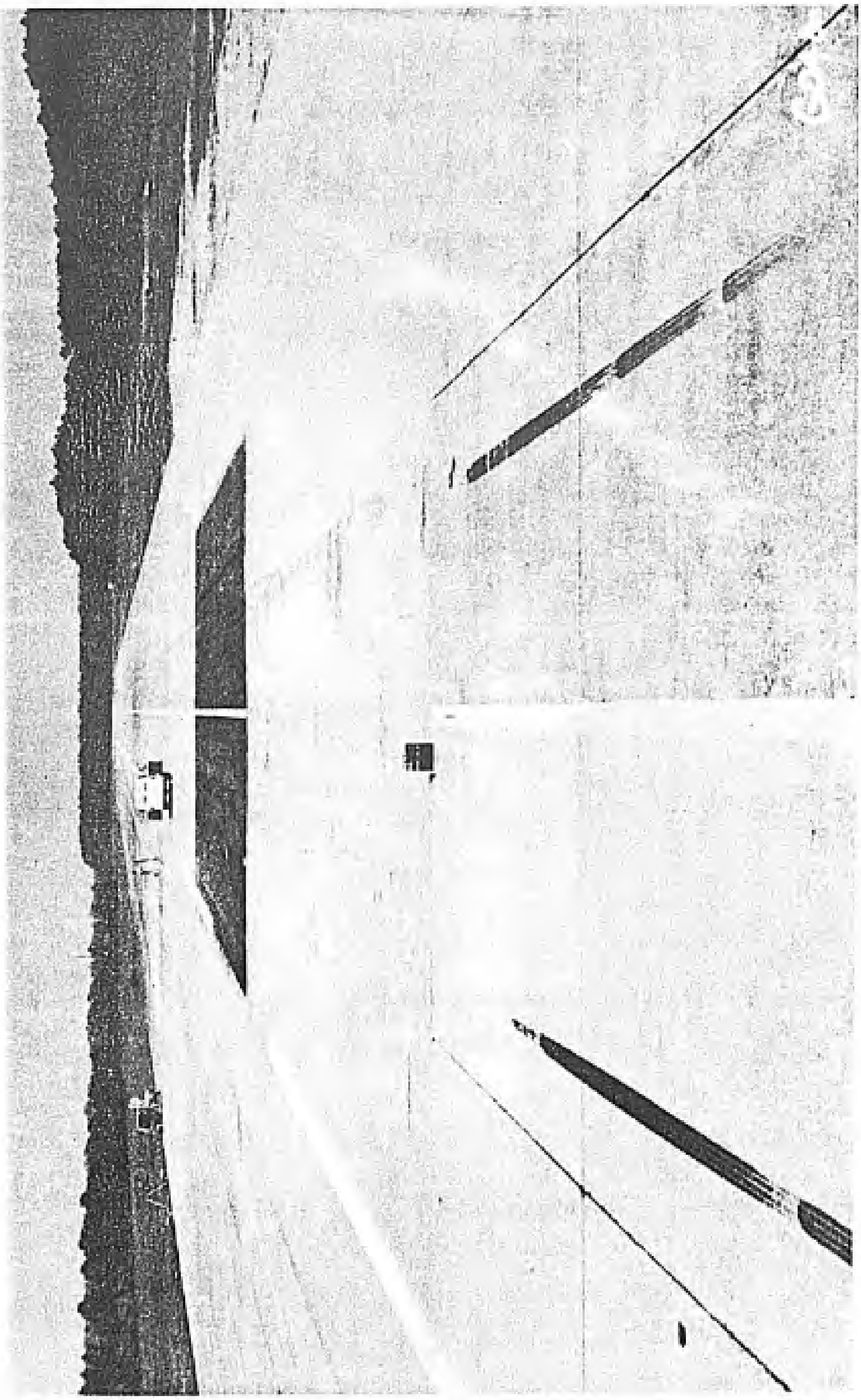


Photo 27. General View of the Stabilized Soil Test Item after F-4 Aircraft Traffic.

Photo 28. F-15 Traffic Lane after Two Coverages of Traffic, with Rainwater Ponded in Areas Where Stabilized Soil Was Dislodged during F-4 Aircraft Traffic.

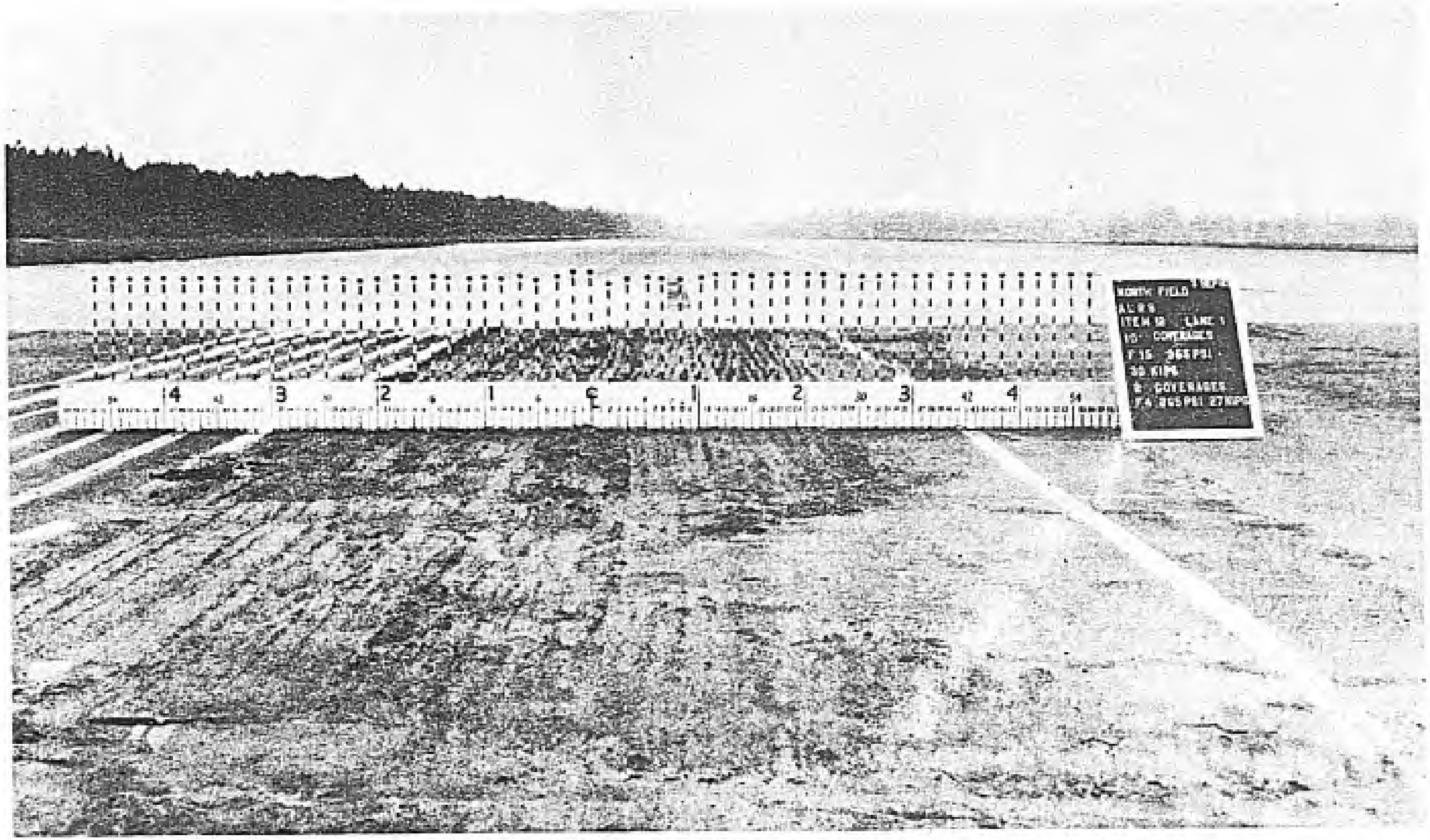


Photo 29. Close Up of the F-15 Traffic Lane after 10 Coverages.

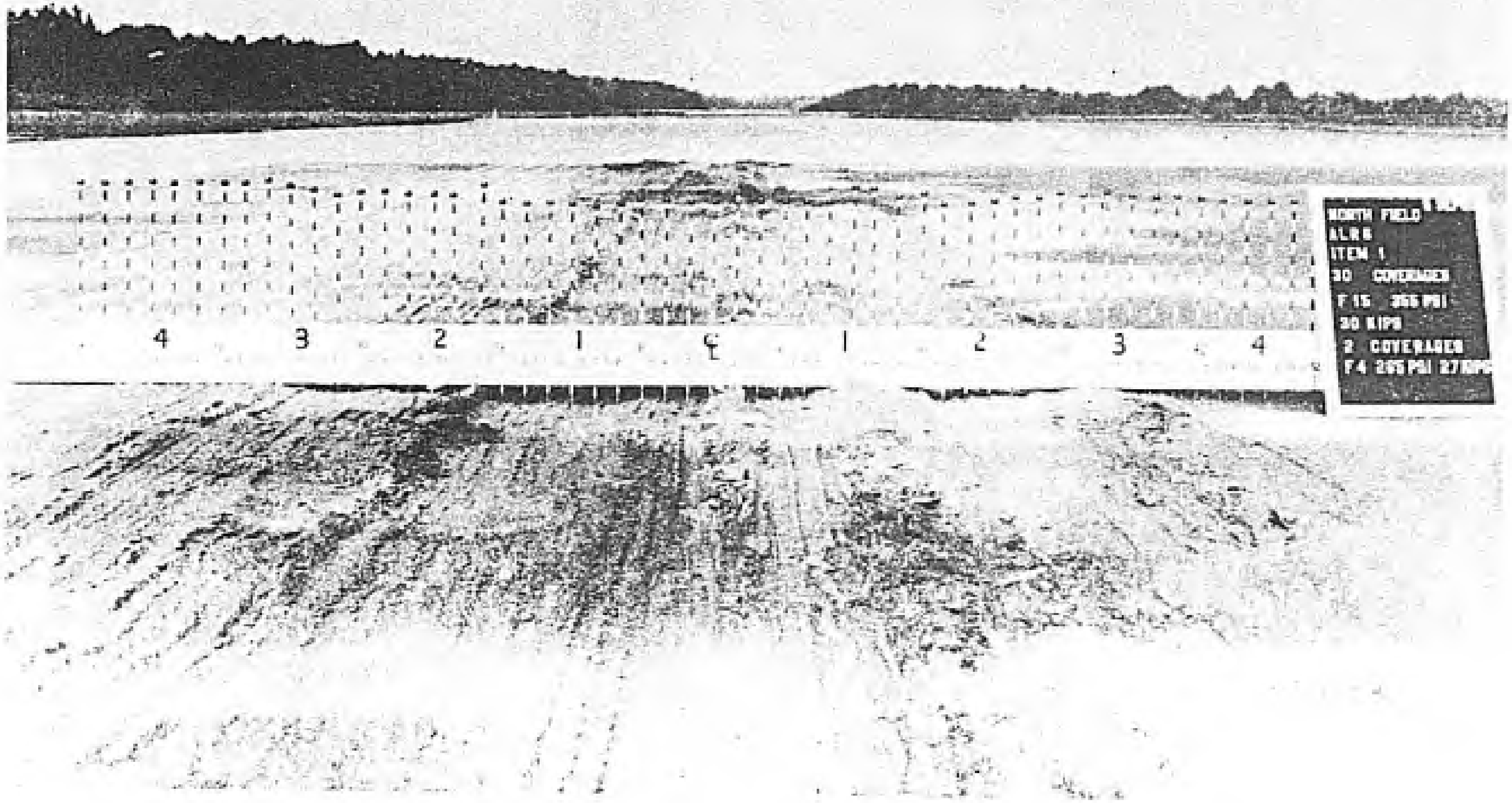


Photo 30. Close Up of the F-15 Traffic Lane after 30 Coverages.

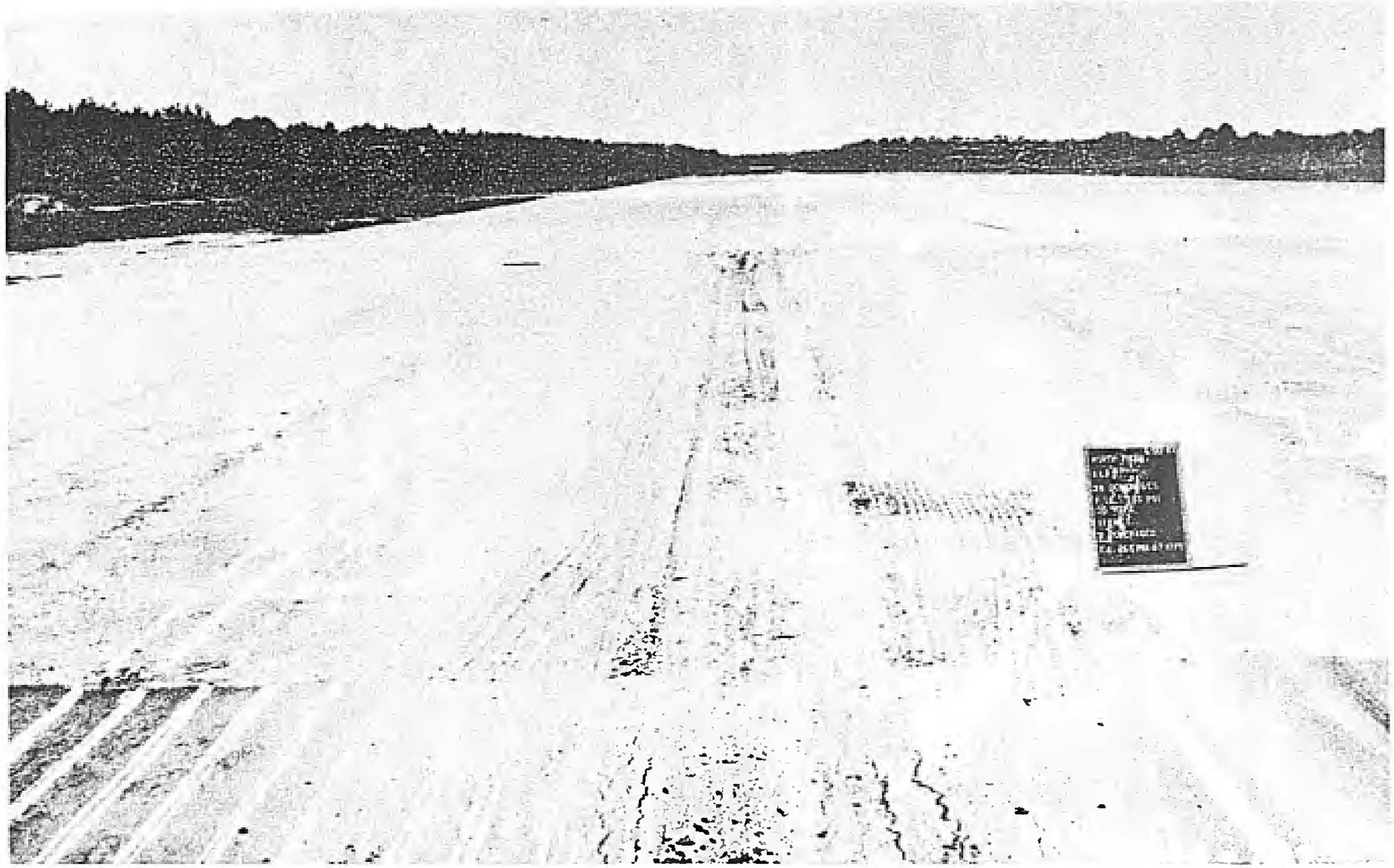


Photo 31. F-15 Traffic Lane after 38 Coverages.

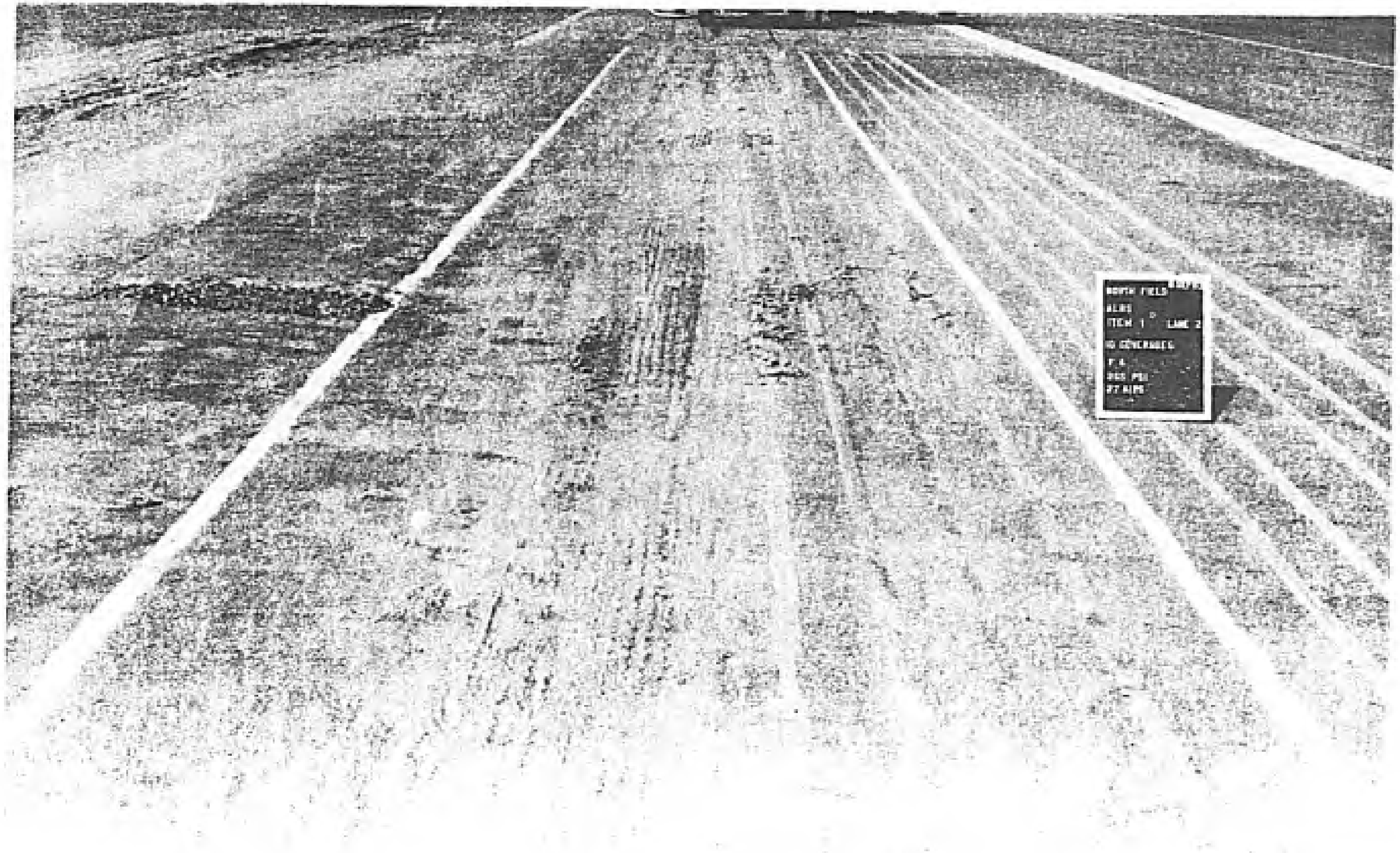


Photo 32. F-4 Traffic Lane after 10 Coverages.

Photo 33. Surface Condition of the F-4 Traffic Lane after 30 Coverages.

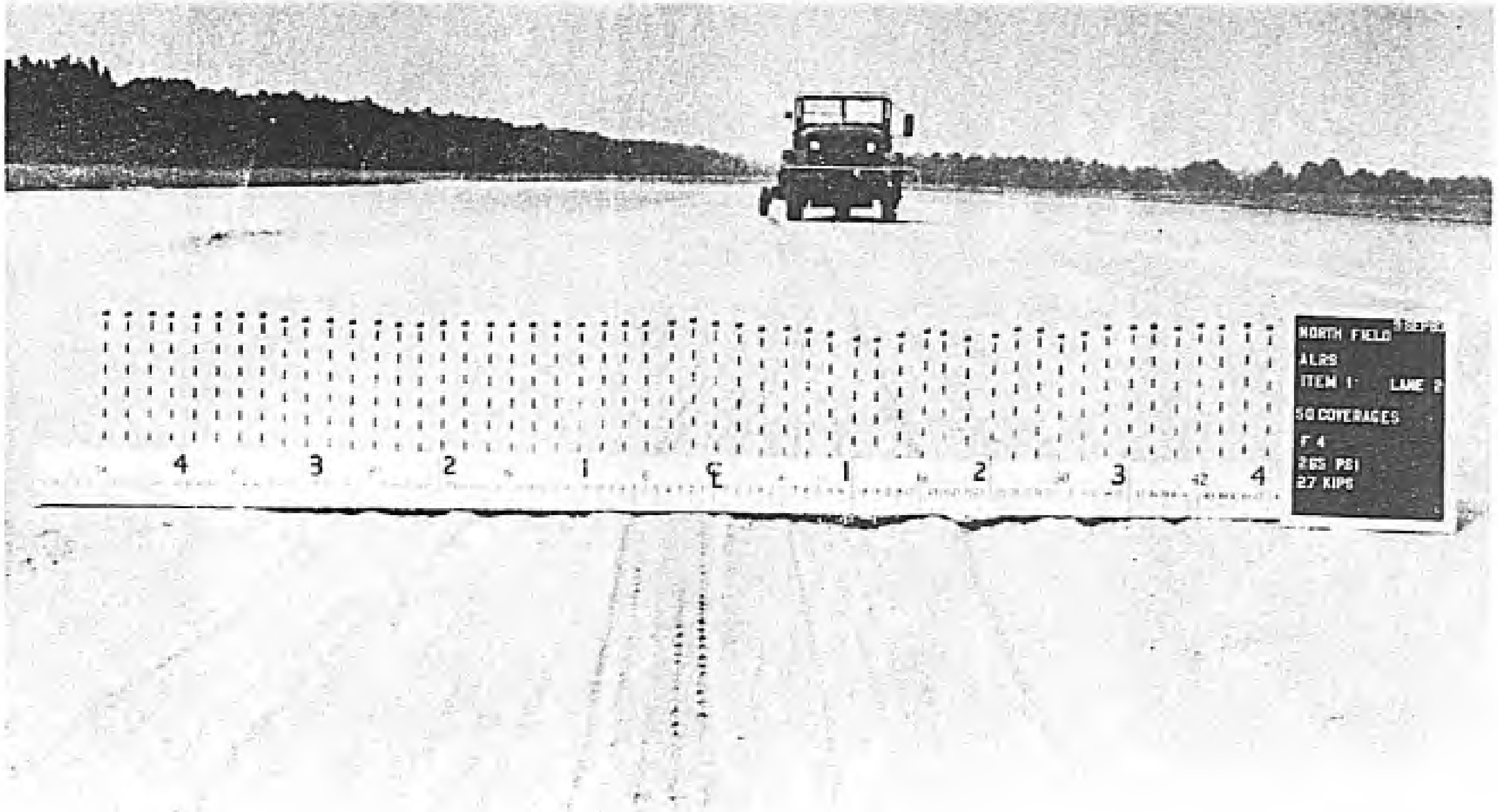


Photo 34. Surface Condition of the F-4 Traffic Lane after 50 Coverages.

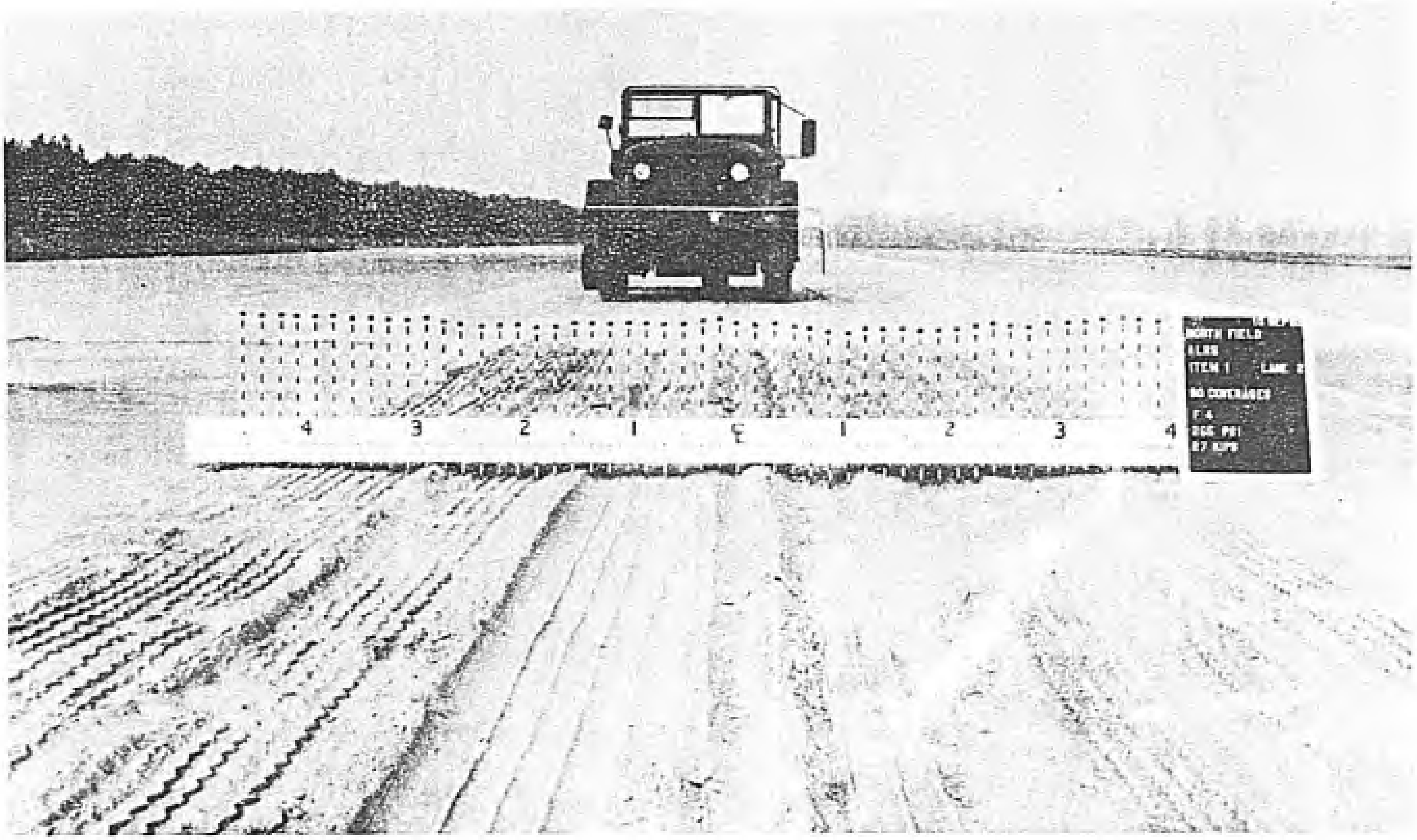


Photo 35. Close Up of the F-4 Traffic Lane after 80 Coverages.

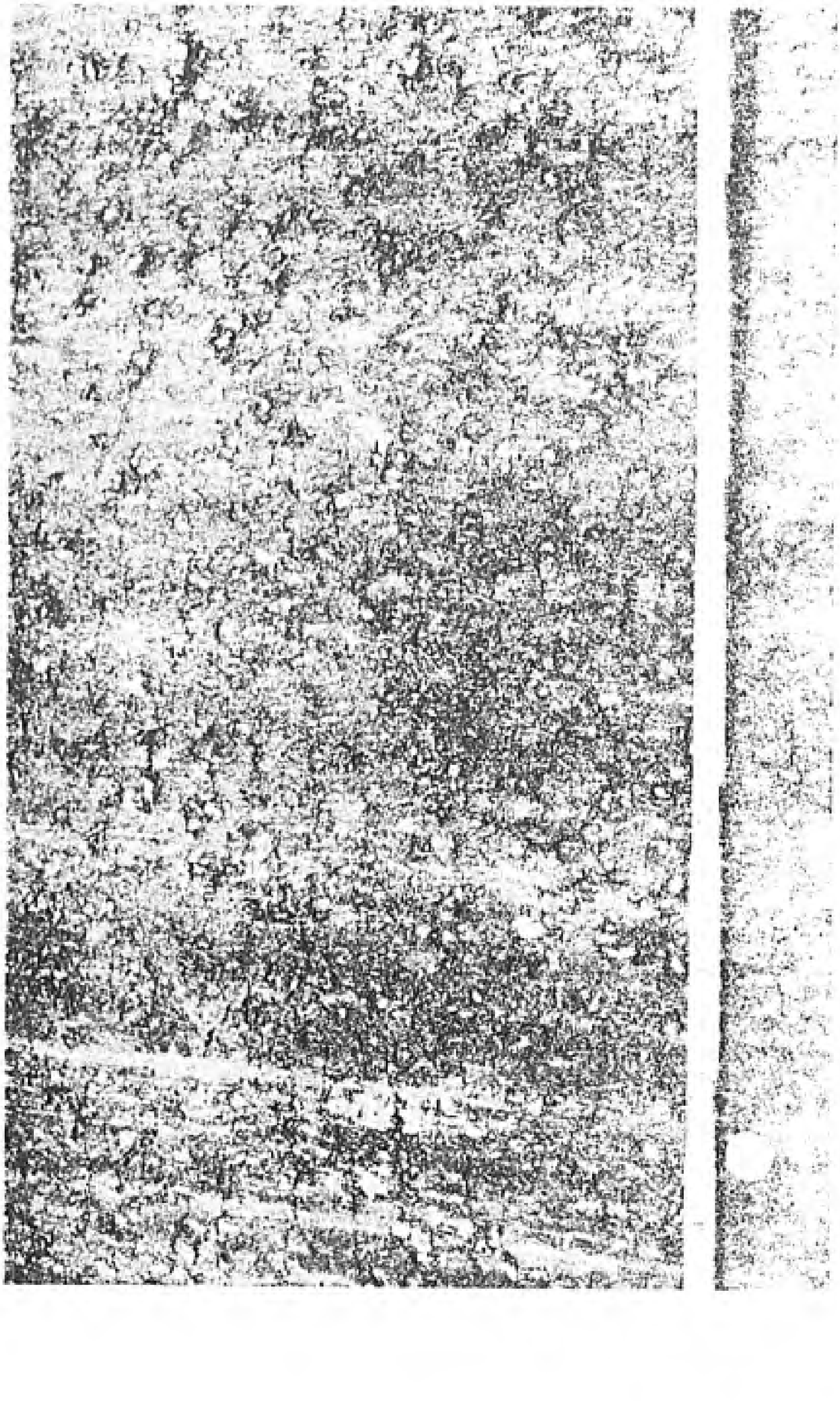


Photo 36. Close up of AC Surface before Traffic Was Applied.

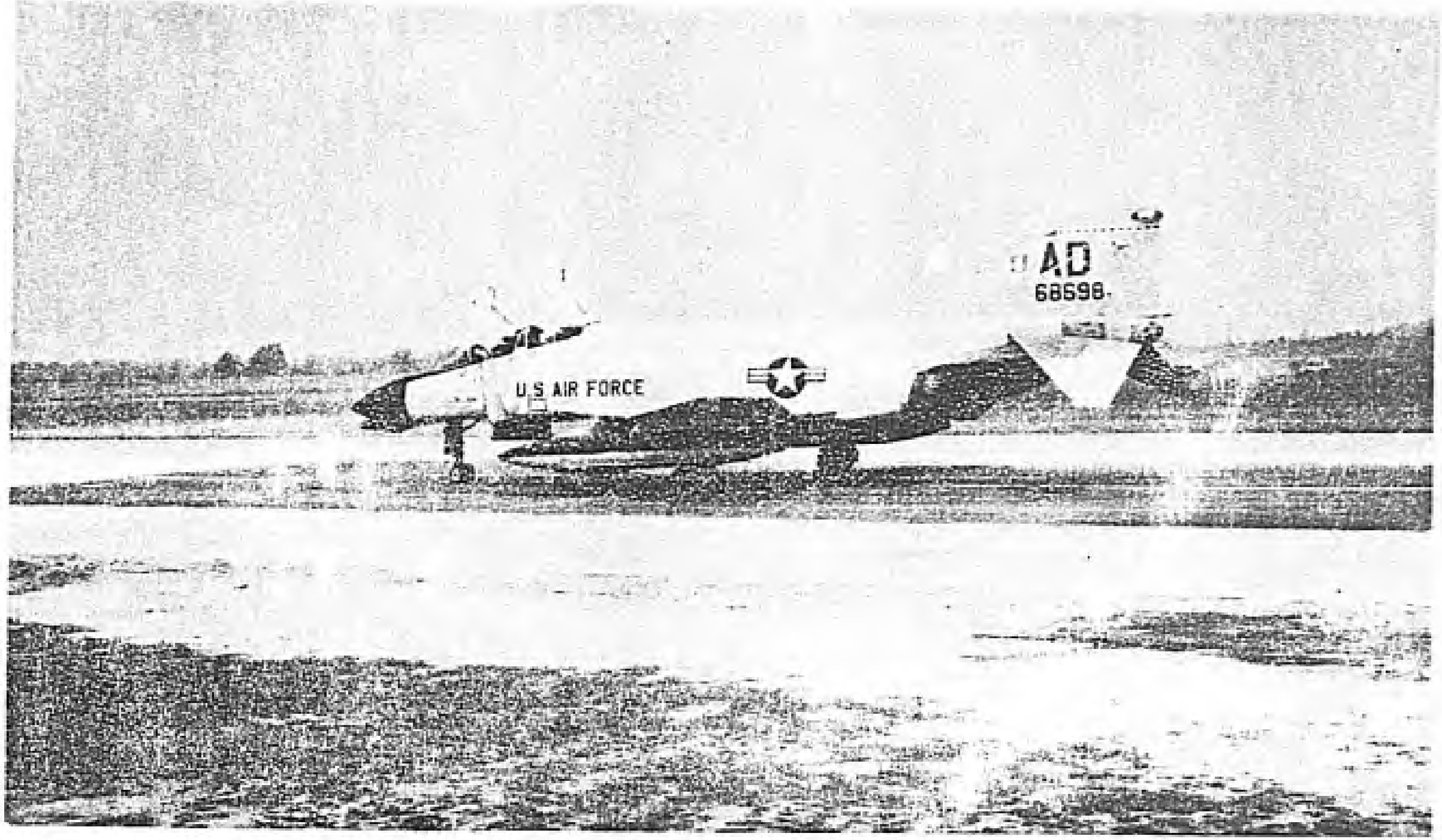


Photo 37. F-4 Aircraft Traffic on the AC Test Item.

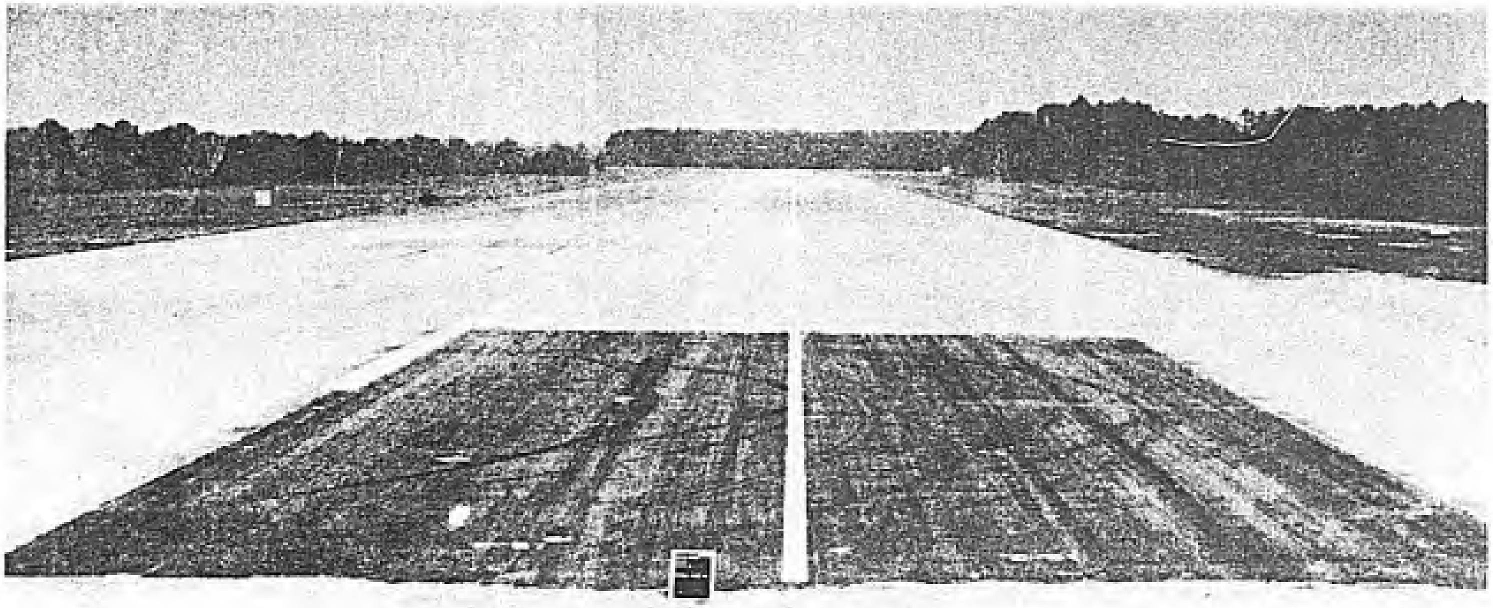


Photo 38. AC Test Item after F-4 Aircraft Traffic.

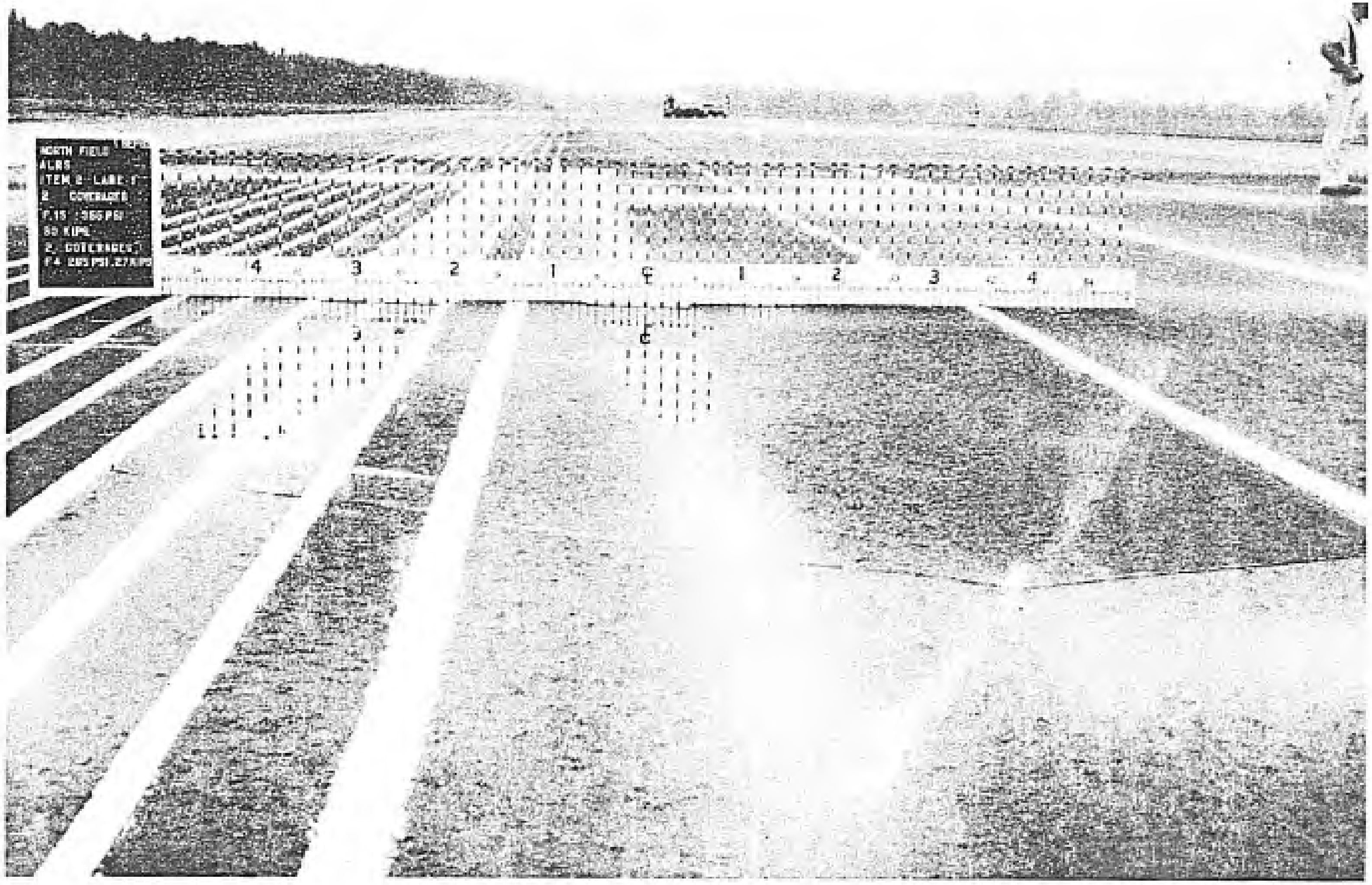


Photo 39. Surface Condition of the F-15 Traffic Lane after 2 Coverages.

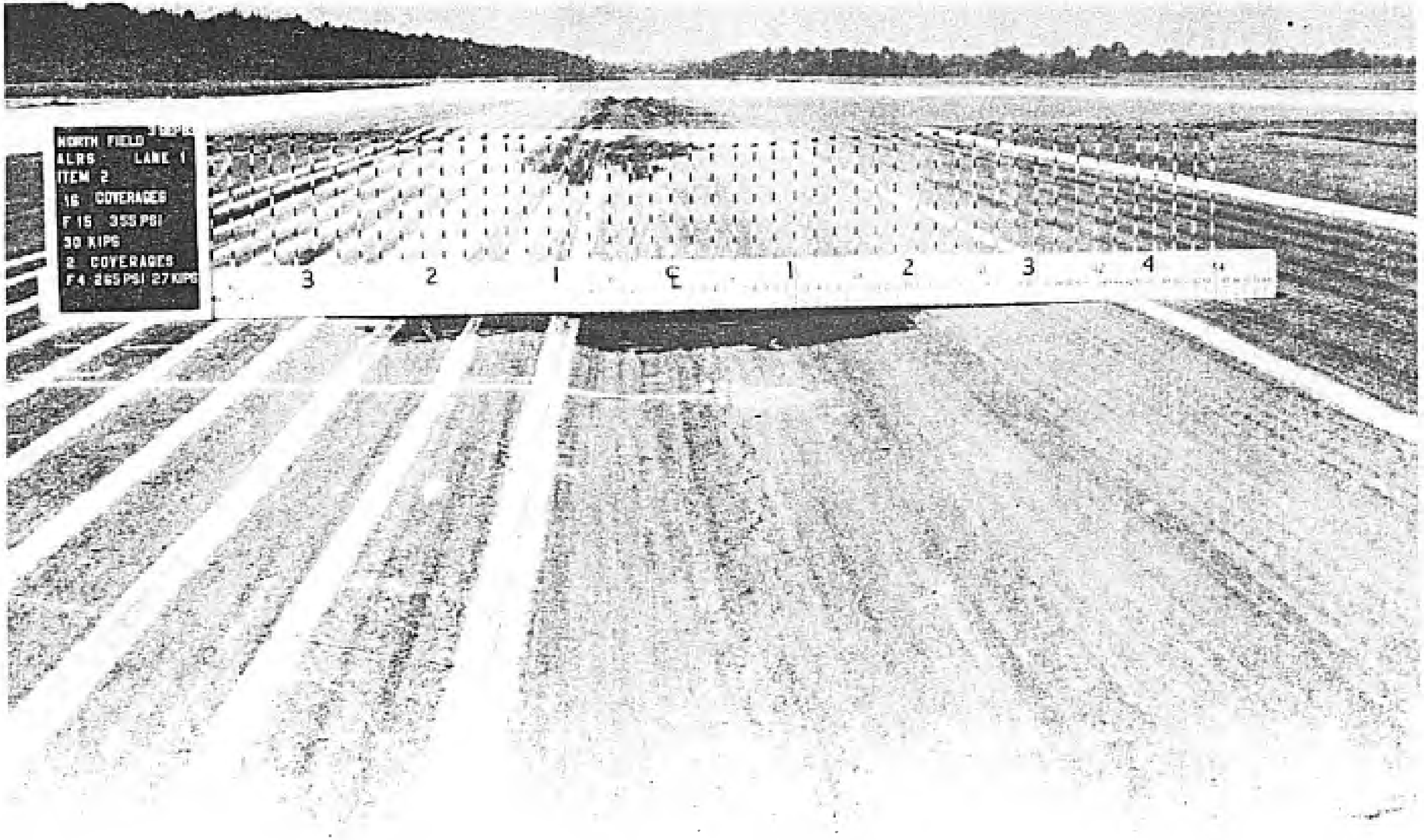


Photo 40. Surface Condition of the F-15 Traffic Lane after 16 Coverages.

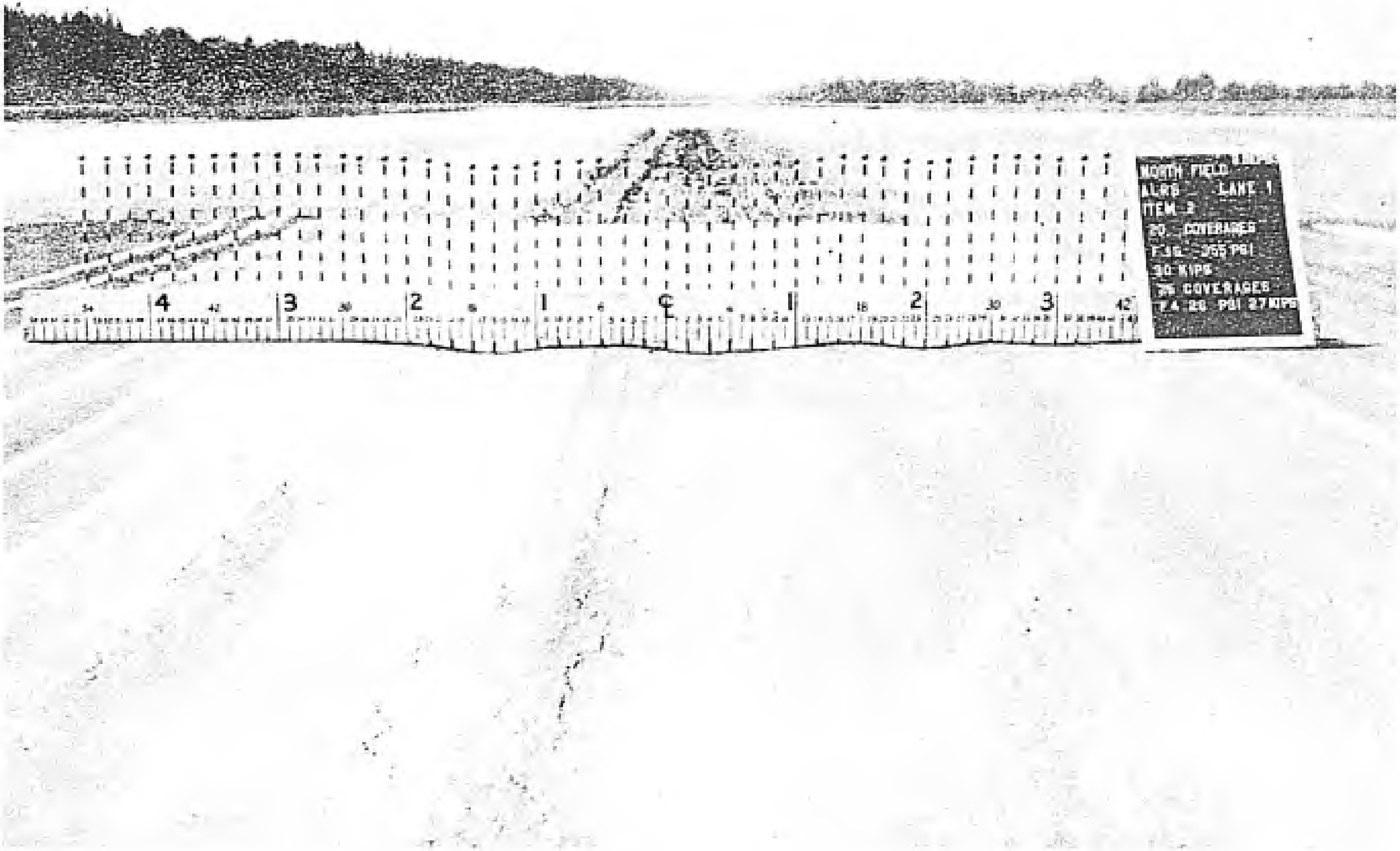


Photo 41. Alligator Cracks in the F-15 Traffic Lane after 20 Coverages.

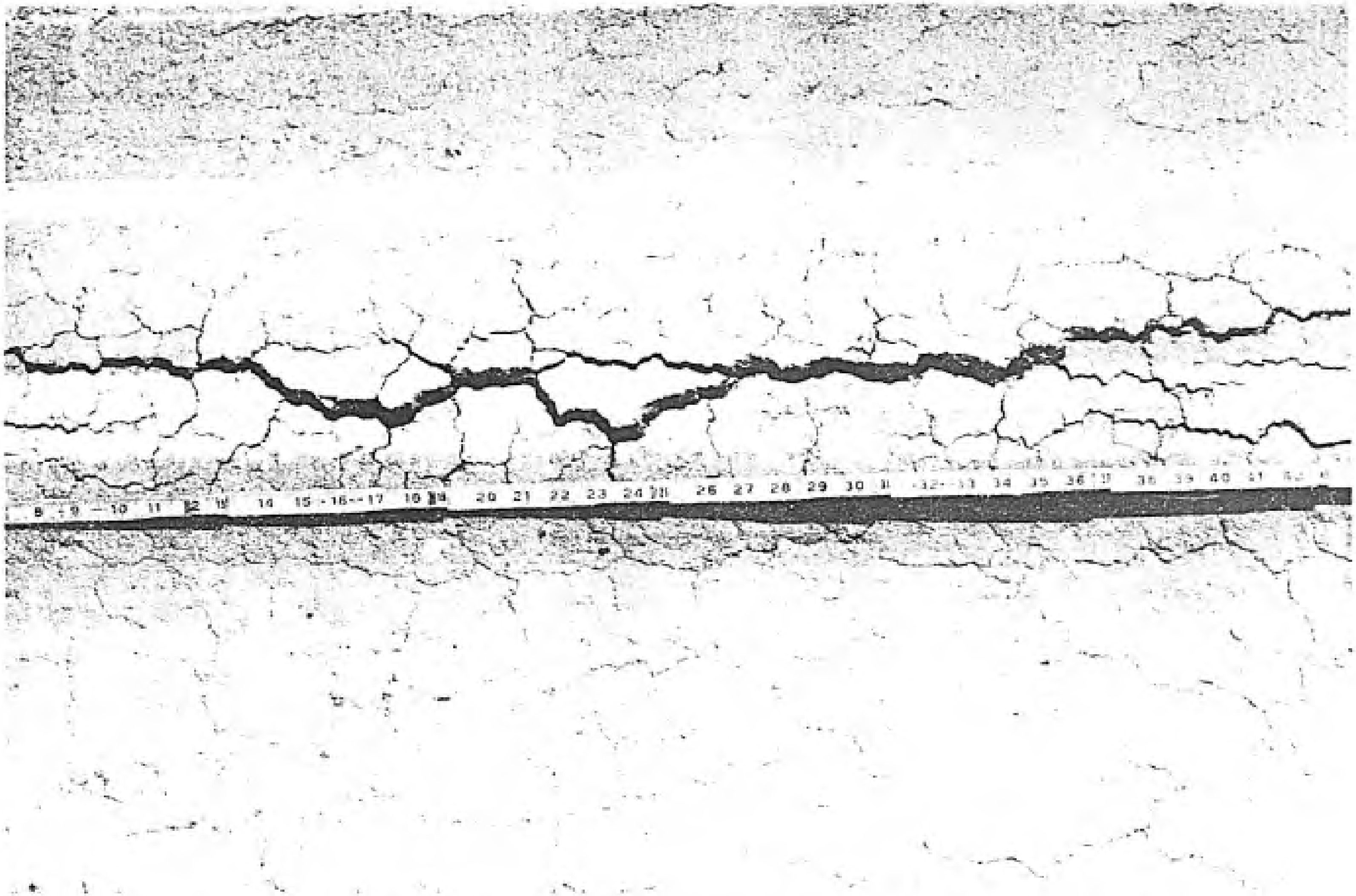


Photo 42. Close Up of Longitudinal Fatigue Crack Located in the F-15 Traffic Lane.

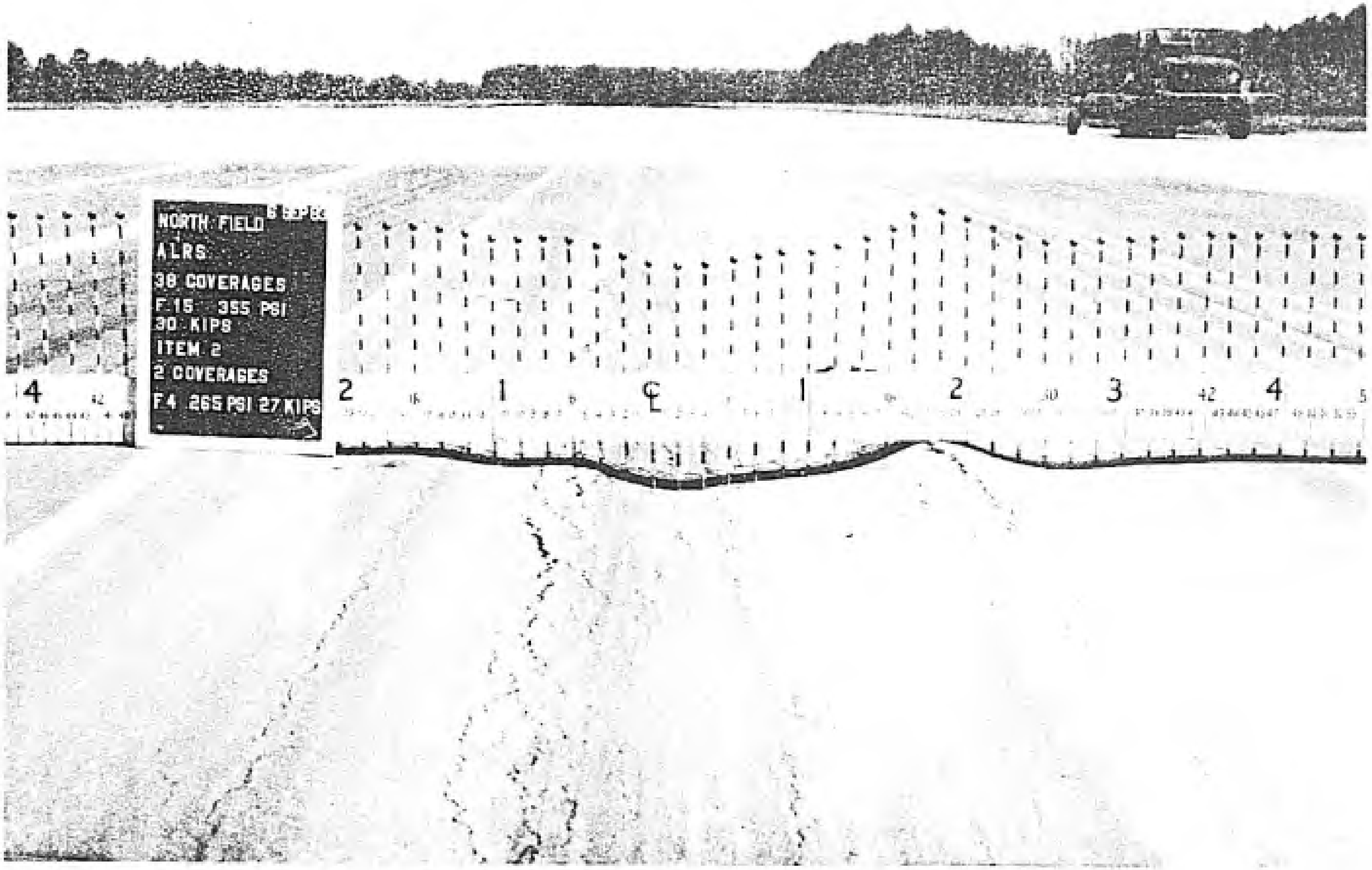


Photo 43. Close Up of the F-15 Traffic Lane after 38 Coverages.

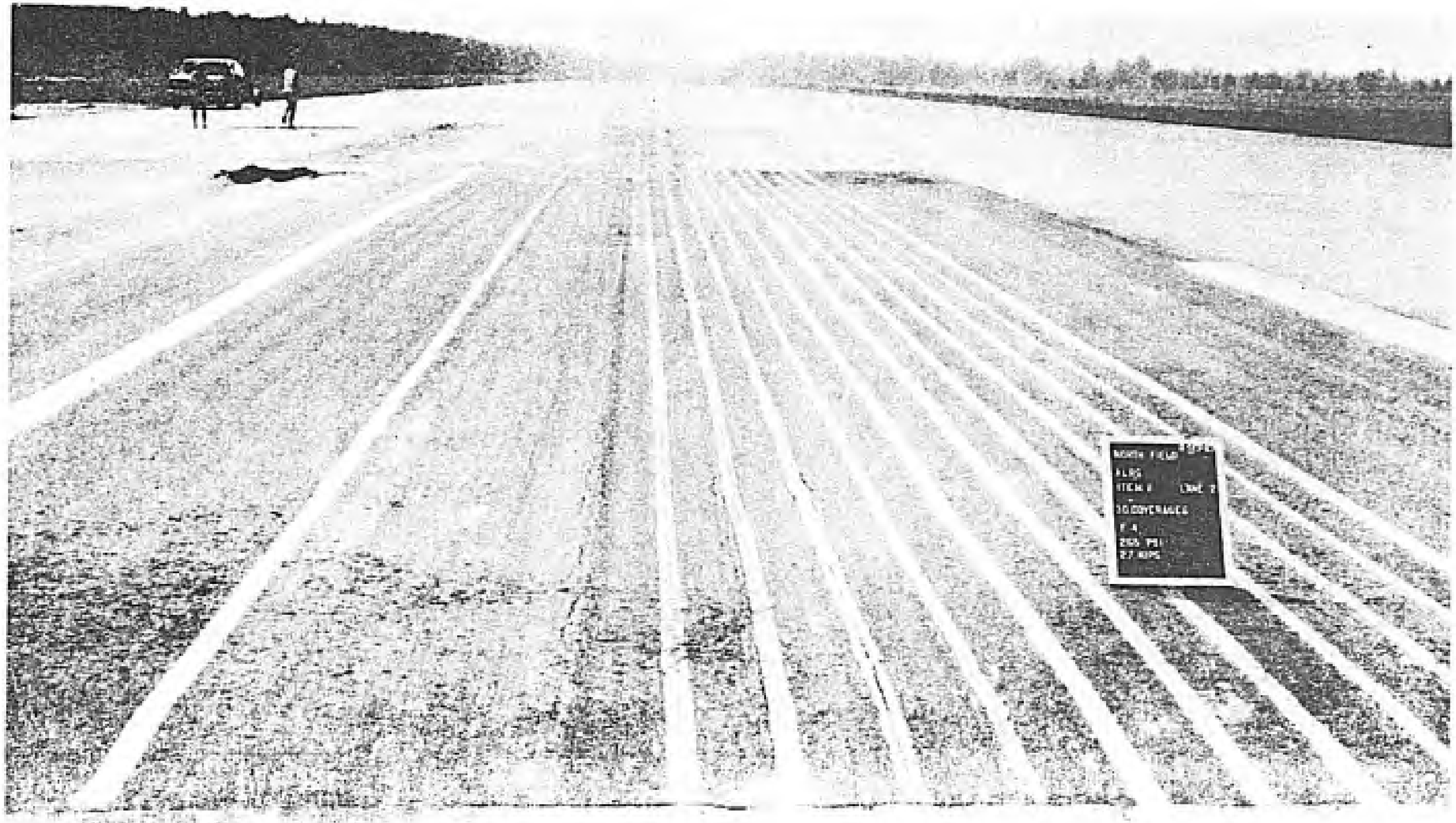


Photo 44. F-4 Traffic Lane after 30 Coverages.

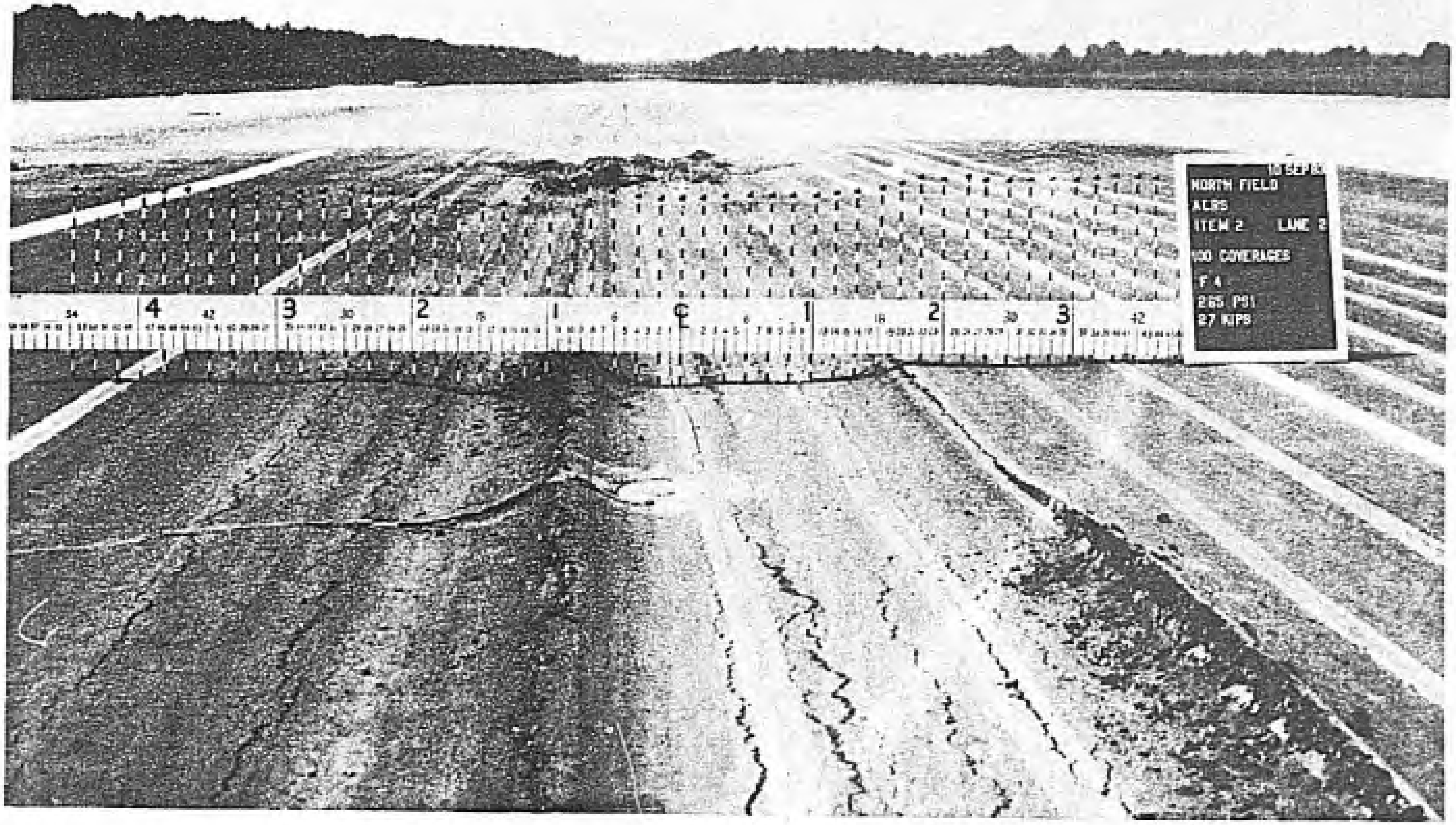


Photo 45. Surface Condition of the F-4 Traffic Lane after 100 Coverages.

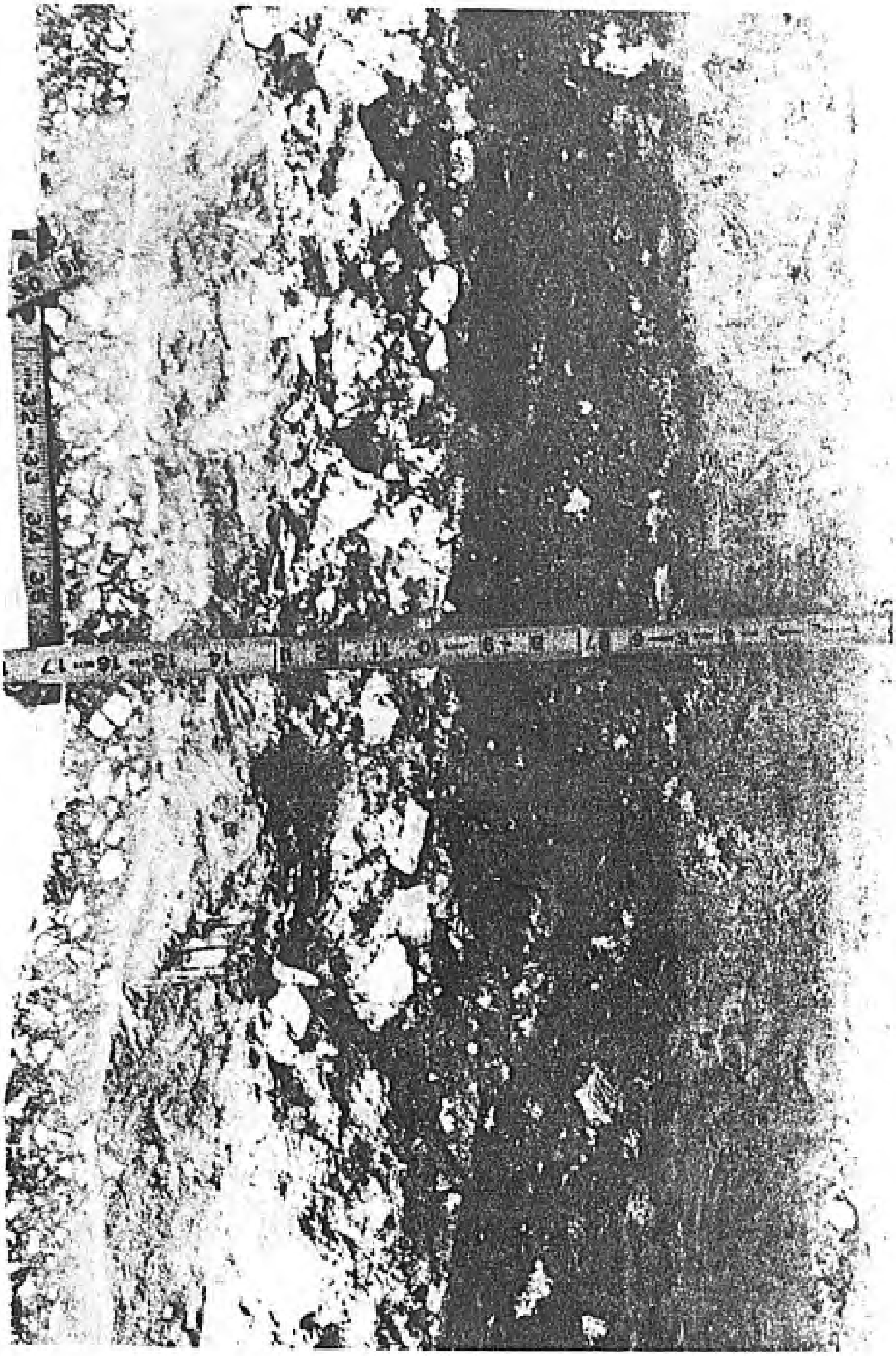


Photo 46. CBR Pit (Test Trench) in the F-15 Traffic Lane after 38 Coverages.

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