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JET BLAST TESTS ON FIBERGLASS-REINFORCED DCA-1295

by

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Final Report

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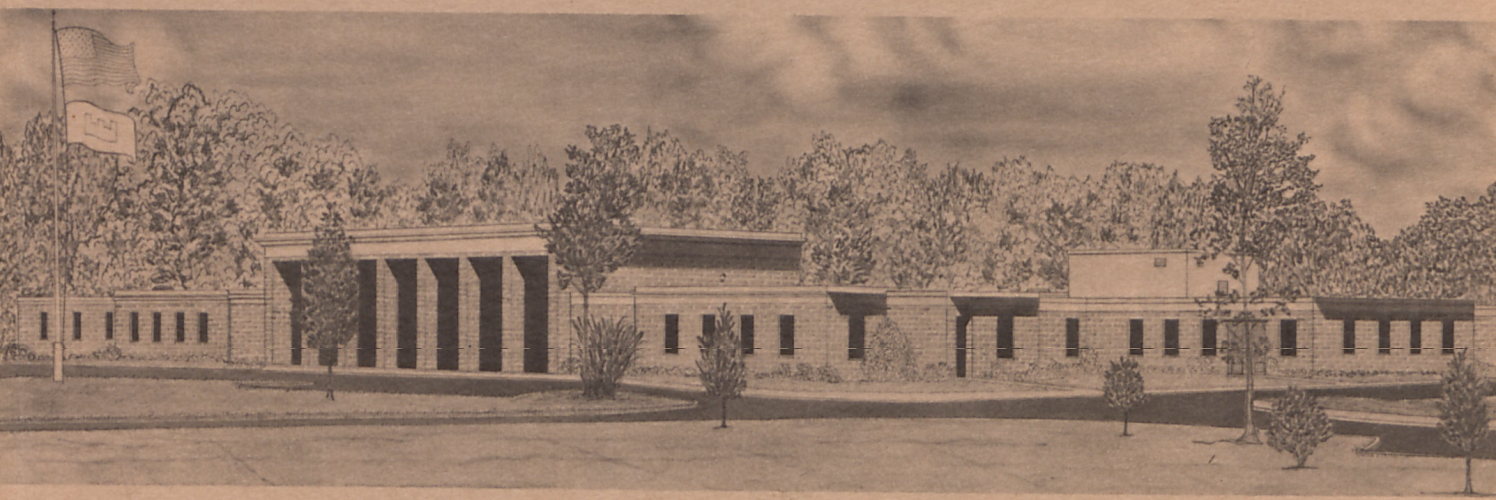

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This report describes an effort to evaluate a dust-control system consisting of DCA-1295 reinforced with fiberglass scrim when subjected to jet blast tests with associated wind velocities in the range of those caused by operating C-5A aircraft. A sand panel and two clay panels were treated with DCA-1295 and reinforced with fiberglass scrim and found to withstand air blast velocities greater than 125 mph. It was recommended that the dust-control system be tested for the heavy-lift helicopter and that additional testing under actual C-5A operations be conducted using multiple layers of the dust-control materials.

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Preface

The project reported herein was conducted by the U. S. Army Engineer Waterways Experiment Station (WES). The general authorization for this investigation is contained in Research and Development Project 1T162103A046, "Trafficability and Mobility Research." Additionally, a part of the research effort connected with the C-5A aircraft was conducted under Project 1T162112A131, "Environmental Constraints on Materiel, C-5A Expedient Surfacing Research." The investigation was completed under Project 1T162112A528, "Environmental Effects on Materiel Development." This investigation was performed under the sponsorship of the Research, Development, and Engineering Directorate, U. S. Army Materiel Command.

The project was performed during the period 28 May-6 September 1974 under the general supervision of Messrs. James P. Sale, Chief, and Richard G. Ahlvin, Assistant Chief, of the Soils and Pavements Laboratory, and the direct supervision of Messrs. William L. McInnis, Chief, Materiel Development Division, and Royce C. Eaves, Chief, Stabilization Branch. Emplacement of materials and the jet blast tests were performed by Messrs. John T. Knight, James W. Carr, John F. Kolb, and Ben Brown, Jr., of the Surface Blast Effects Research Facility. Mr. Clarence R. Styron III was the principal investigator of this project. This report was prepared by Mr. Styron.

COL G. H. Hilt was Director of WES during the conduct of this study and the preparation of this report. Mr. F. R. Brown was Technical Director.

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Conversion Factors, U. S. Customary to Metric (SI) Units of Measurement

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles per hour (U. S. statute)	1.609344	kilometers per hour
pounds (force)	4.448222	newtons
pounds (mass)	0.4535924	kilograms
tons (short, 2000 lb)	907.1847	kilograms
ounces per square yard (mass)	0.03390575	kilograms per square meter
Fahrenheit degrees	5/9	Celsius or Kelvin degrees*

* 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: $K = (5/9)(F - 32) + 273.15$.

JET BLAST TESTS ON FIBERGLASS-REINFORCED DCA-1295

Background

1. A polyvinyl acetate (PVA) fiberglass dust-control system for controlling surface blasts from C-130 aircraft and CH-47 helicopters was developed under the sponsorship of the U. S. Army Materiel Command and tested successfully at various locations in the field during 1972-1974 by the U. S. Army Test and Evaluation Command.* The system materials were exempt from type classification and were placed in the Army Supply System in late 1974.

2. Observation of C-5A aircraft operations indicated the possibility of the jet engine blasts causing severe soil erosion and/or formation of dust clouds in unprotected shoulder and overrun areas. Since the PVA/fiberglass system had proved successful in controlling ground blasts of the C-130 aircraft, it was decided to test the material under simulated C-5A jet blasts.

Objective

3. The objective of these tests was to determine if DCA-1295 with fiberglass reinforcing could maintain a dust-free environment when subjected to wind velocities in excess of 125 mph.

Description of Materials

DCA-1295

4. DCA-1295 is a PVA emulsion modified with plasticizers, surfactants, and other organic elements. Upon cure, the material sets to form a highly flexible film possessing good elongation properties on most soils. This material is supplied as a concentrate and must be diluted with one part water to three parts concentrate for spraying.

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* C. R. Styron III and Royce C. Eaves, "Investigation of Dust-Control Materials," Miscellaneous Paper S-73-70, Dec 1973, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Fiberglass scrim

5. Fiberglass scrim is a lightweight fabric of plain weave and greige finish with a 10 by 10 thread count which weighs 1.6 oz per sq yd.* Fiberglass is supplied in 6-ft-wide rolls having approximately 3000 lin ft on each roll.

Dust-control material

6. Dust-control material is placed at rates of 3, 5, and 7 lb per sq yd, depending on the purpose of protection. A Liquid Distributor for Dust Control has been developed by the U. S. Army Mobility Equipment Research and Development Center that prewets the surface with water, places fiberglass scrim, and places DCA-1295 in a single-pass operation.

Test Program

Location and site preparation

7. The site selected for these tests had been used previously by the Surface Blast Facility, Pavement Investigations Division, to conduct similar tests of other materials. The site is located on a hilltop at the U. S. Army Engineer Waterways Experiment Station that is relatively flat and well drained and measures approximately 200 by 300 ft. Site preparation consisted of blading residual test materials and existing vegetation out of the test area, then blading the test area to a smooth surface.

Layout and test soil

8. Figure 1 shows the layout of the test area. Panel 1 was prepared by placing 6 in. of concrete sand over lean clay on an area measuring 39 by 90 ft. The sand was delivered in a saturated condition, and after it was spread, required several days to dry to a satisfactory condition. Shallow anchor ditches were dug around the perimeter of panel 1 with hand shovels.

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 4.

9. Anchor ditches were not used in the preparation of panel 2, and the natural soil surface of lean clay was the test soil. This section was 30 by 90 ft.

10. Panel 3 was natural lean clay soil, and shallow anchor ditches were dug around the perimeter with a motor grader. This section was 39 by 90 ft.

Application of material

11. Fiberglass scrim was placed by hand on all sections. The material was unrolled over the sections in the 90-ft direction with adjacent edges overlapped 6 in. All end and side edges extended into the anchor ditches on the two sections where anchor ditches were located.

12. DCA-1295 was sprayed on the section after application of fiberglass was completed. Panel 1 (sand sample) was applied at 7 lb per sq yd; panel 2 was applied at 3 lb per sq yd; and panel 3 was applied at 5 lb per sq yd. On panels 1 and 3, the anchor ditches were backfilled and compacted, and the compacted soil oversprayed with DCA-1295. Panel 2 was sprayed after completion of work on panels 1 and 3.

Cure

13. Normally, DCA-1295 will cure in approximately 4 hr; however, the two clay sections cured slowly due to rain and high humidity. No tests were conducted until cure was complete.

Mobile test facility

14. The mobile test facility is a truck-trailer combination that is readily moved from place to place. For this test, the trailer was mounted with an Allison J35-A-35B jet engine rated at 5500 lb of thrust without the afterburner. The engine was calibrated at the test area with the engine exhaust outlet 6 ft above the ground surface and inclined 4 deg toward the ground. Pitot tubes and chromel-alumel thermocouples were placed in the test area. Data reduction was plotted

as percent engine power setting versus velocity at the ground surface. From this plot, power settings to produce the requested blast velocities were taken. The ground wash velocity pattern is shown in Figure 2.

15. The trailer was positioned in front of each test section so that the jet blast would strike the section approximately 30 ft from the leading edge. The maximum area of blast impingement was probably 12-16 ft wide and 30-50 ft long.

Blast test procedure

16. The blast tests were conducted by placing the mobile test facility in position as described in Paragraph 15. The engine was started and power adjusted to produce ground surface velocities of 72, 106, and 125 mph. Each condition was maintained for 1 min. After no damage occurred to any of the treated sections as a result of these tests, a second series of blasts was conducted. This procedure was modified, and a 155-mph velocity phase for 3 min was added to the 1-min durations, respectively, of 72-, 106-, and 125-mph velocities. At the 155-mph velocity, the temperature of the jet blast at the treated surface was approximately 275°F.

Blast test results

17. The clay section treated with 5 lb of DCA-1295 (panel 3) was not affected by either series of blasts. The clay section treated with 3 lb (panel 2) and the sand section treated with 7 lb (panel 1) of DCA-1295 were not torn or disrupted; however, on both panels 1 and 3, the bond between the film and soil was broken during the last series of 155-mph blasts, as indicated by wrinkling and rippling of the film in areas of the 155-mph blast impingement. Again, there was no failure of the film on either soil; however, 155-mph blasts of longer duration would probably have caused a break or rupture.

Wheel vehicle traffic tests and results

18. After the jet blast tests were completed, it was decided to place vehicular traffic on the three test pads. Military trucks (1/4

and 3/4 ton) shown in Figure 3 and a four-door station wagon were used as the test vehicles. Each vehicle was driven twice across the south end of each test pad and backed off with an attempt to keep in the same tracks. The sand section rutted 1-1/2 in. under the 3/4-ton truck, a lesser amount under the four-door station wagon, and very little under the 1/4-ton truck (Figures 4 and 5). Neither of the test sections covering the clay soil rutted a measurable amount (Figure 6).

19. This test of vehicular traffic on DCA-1295 reinforced with fiberglass scrim is indicative of the durability of this dust-control system. As long as reasonable care is exercised while trafficking the dust-control system (i.e. no fast takeoffs, sudden stops, or sharp turns), these pads can be expected to meet, and in most cases, exceed their design life. In general, the design life of a dust-control pad reflects directly the care taken in preparing the soil surface and especially the soil strength.

Weathering test

20. Periodic observations of the test panels were made to determine effects of natural weathering. Some vegetation grew through the film on the clay sections, but no extensive damage was observed during the 90 days after blast and traffic tests were completed.

Conclusions

21. The following conclusions are drawn:

a. All test panels withstood 125-mph blasts for 2 min

b. Panel 3, the 5-lb-per-sq-yd application of DCA-1295, withstood an additional blast of 155 mph for 3 min without losing bond between the film and the soil.

c. DCA-1295 will survive weathering for a minimum period of 90 days without maintenance.*

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* M. M. Culpepper, "Emplacement and Maintenance of Dust-Control Materials," Instruction Report S-72-3, Sep 1972, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Recommendations

22. It is recommended that:

a. Additional testing be conducted under actual C-5A operations when sites and C-5A aircraft become available.

b. These materials be evaluated as a dust-control system for the heavy-lift helicopter.

c. DCA-1295 with multiple layers of fiberglass scrim be tested under C-5A type blasts.

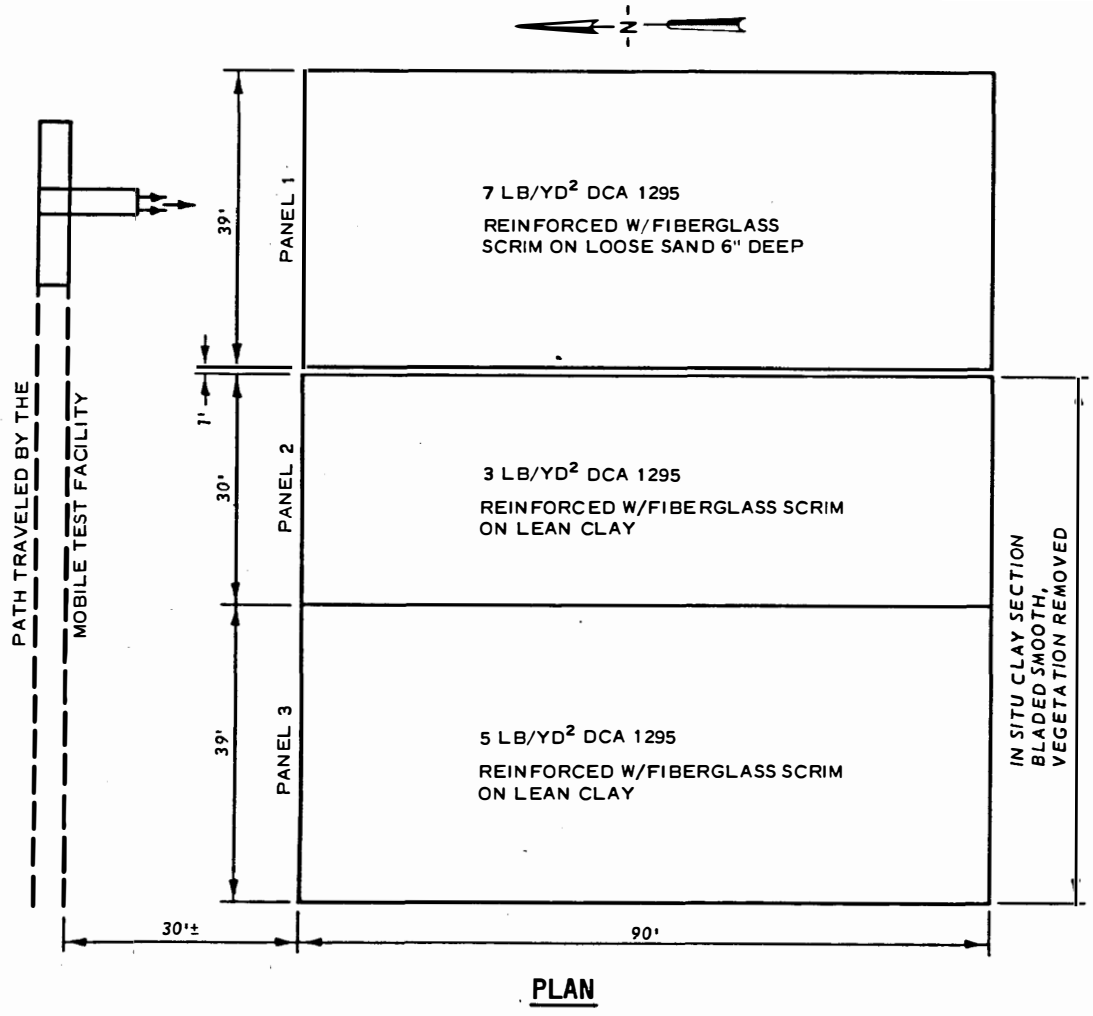

Figure 1. Layout of test area

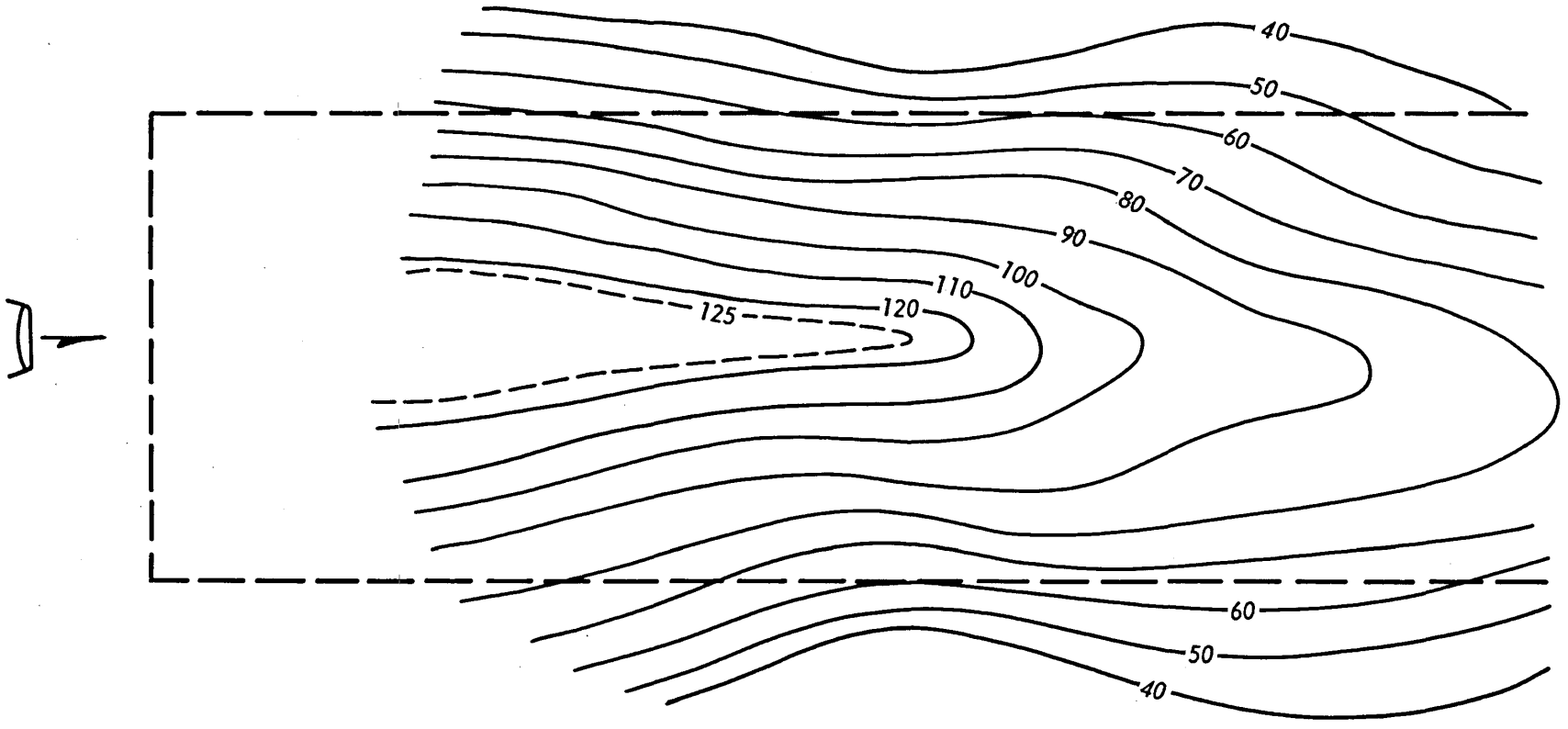

Figure 2. Ground wash velocity pattern of the test engine

Figure 3. Military trucks used in wheeled vehicle traffic tests

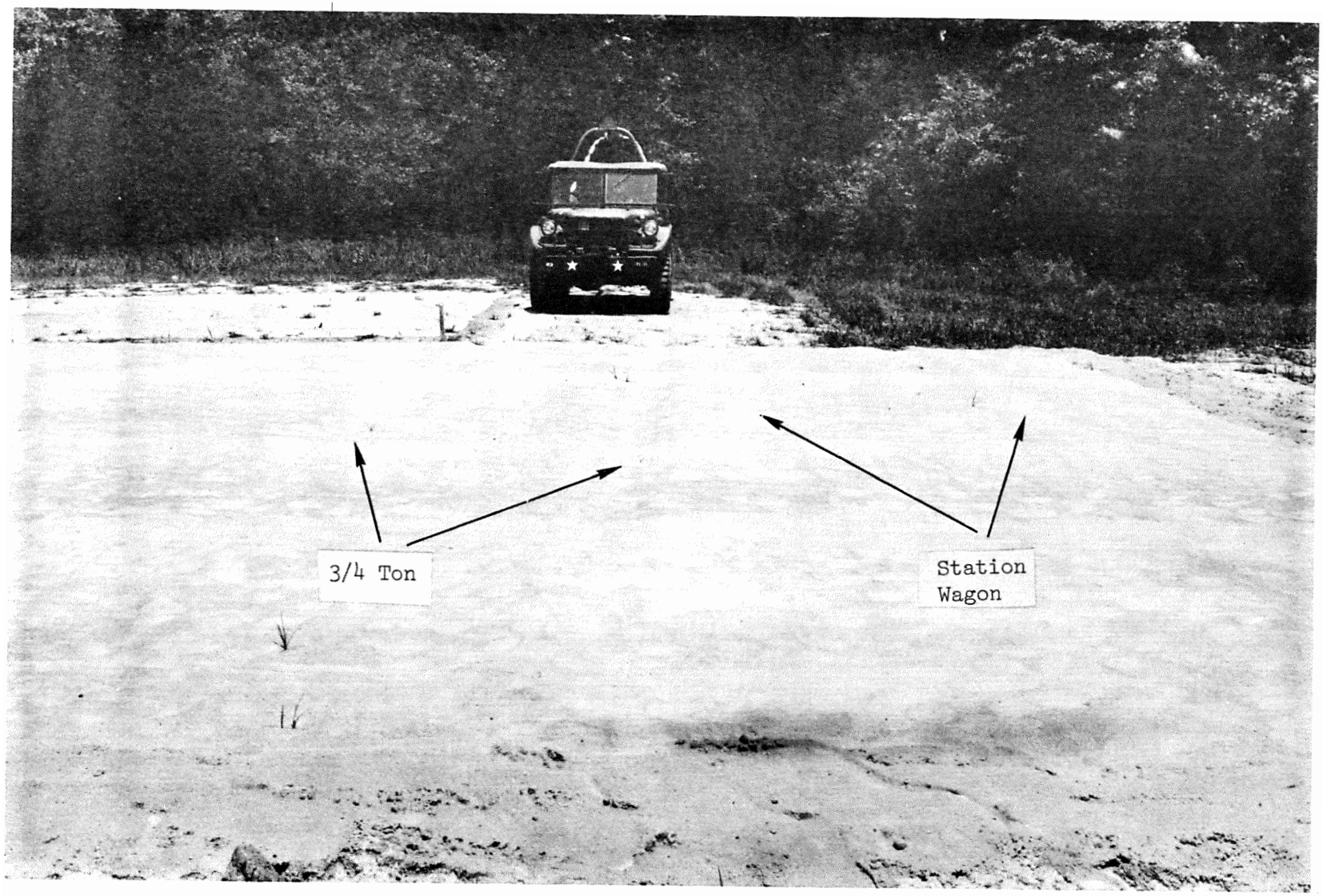

Figure 4. Wheel ruts depicted for various test vehicles, panel 1

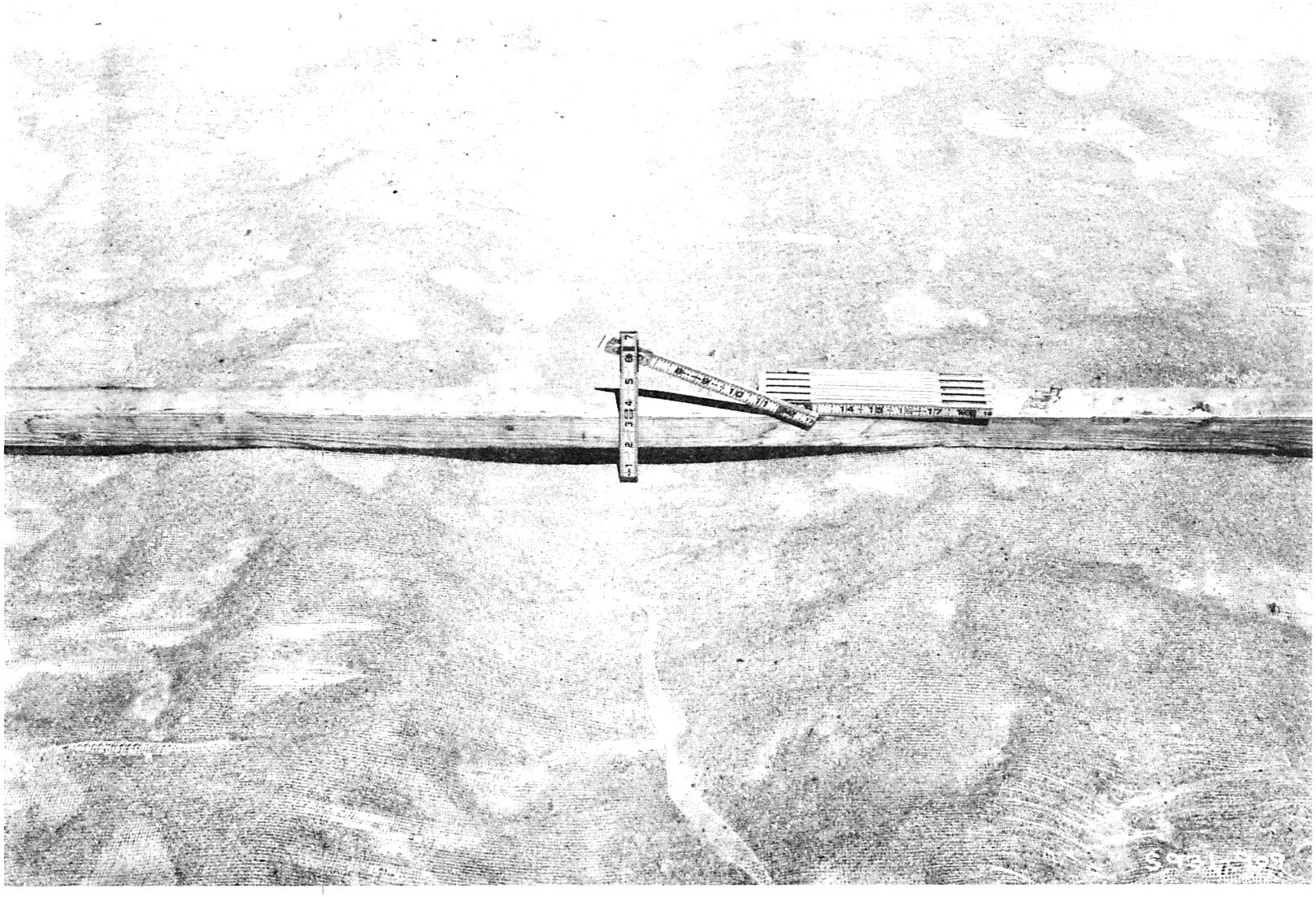

Figure 5. Panel 1, maximum rut depth 1-1/2 in.

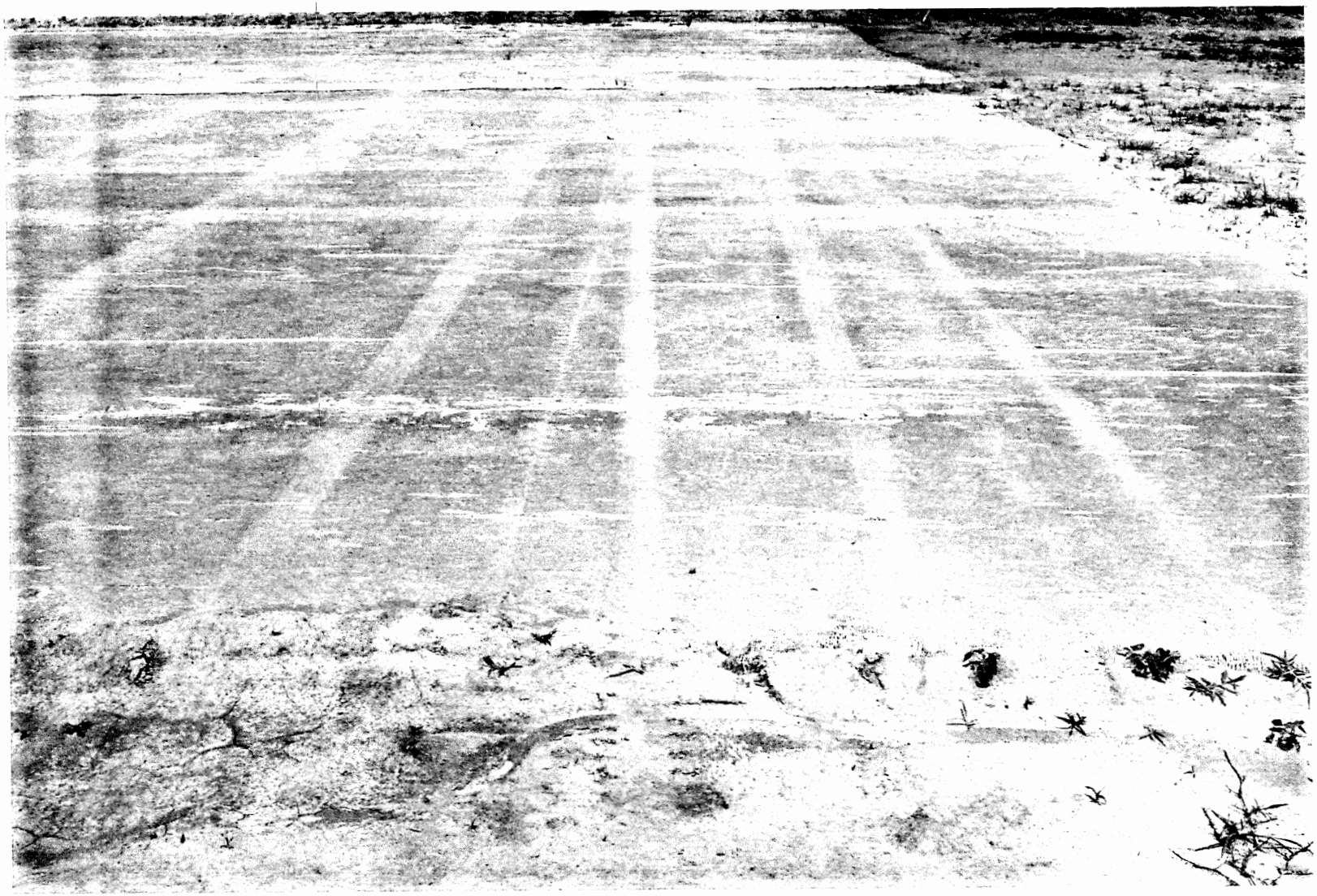

Figure 6. Panels 2 and 3 after traffic