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PART IV

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AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART IV. DATA REPORT ON TEST SECTION 3

W. BRABSTON, A. RUTLEDGE, and W. HILL

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

TECHNICAL REPORT AFFDL-TR-66-43, PART IV

APRIL 1966

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**AIR FORCE FLIGHT DYNAMICS LABORATORY
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AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART IV. DATA REPORT ON TEST SECTION 3

W. BRABSTON, A. RUTLEDGE, and W. HILL

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FOREWORD

The investigation described herein constitutes one phase of studies conducted during 1964 at the U. S. Army Engineer Waterways Experiment Station (WES) under U. S. Air Force Project No. 410-A, MIPR No. AS-4-177, "Development of Landing Gear Design Criteria for the CX-HLS Aircraft." (The CX-HLS is now designated C-5A.) This program was sponsored and directed by the Landing Gear Group, Air Force Flight Dynamics Laboratory, Research and Technology Division, Mr. R. J. Parker, Project Engineer.

These tests were conducted by personnel of the WES Flexible Pavement Branch, Soils Division, under the general supervision of Messrs. W. J. Turnbull, A. A. Maxwell, and R. G. Ahlvin, and the direct supervision of Mr. D. N. Brown. Other personnel actively engaged in this study were Messrs. C. D. Burns, D. M. Ladd, W. N. Brabston, A. H. Rutledge, H. H. Ulery, Jr., A. J. Smith, Jr., and W. J. Hill, Jr. This report was prepared by Messrs. Brabston, Rutledge, and Hill.

Directors of WES during the conduct of this investigation and preparation of this report were Col. Alex G. Sutton, Jr., CE, and Col. John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

Publication of this technical documentary report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

FOR THE DIRECTOR

GEORGE A. SOLT, JR.
Actg Chief, Mechanical Branch
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ABSTRACT

This data report describes work undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft. A test section was constructed to a width adequate for two test lanes. Each lane was divided into three items having different subgrade CBR values and different traffic surfaces. Item 1 was surfaced with modified T11 aluminum landing mat, item 2 with M8 steel landing mat, and item 3 remained unsurfaced. Traffic was applied to the two lanes using twin-wheel assemblies with 100-psi tire inflation pressures and 70,000-lb loads. On one lane, the wheel assembly consisted of two 56x16, 32-ply aircraft tires spaced 35 in. c-c. On the other lane, two 56x16, 24-ply aircraft tires were used spaced 45 in. c-c.

The information reported herein includes layout of the test lanes, characteristics and print dimensions of the load assembly tires, and data collected on soil strengths, surface deformations and deflections, and drawbar pull. The traffic-coverage level is given at which failure was evidenced on each test item.

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SUMMARY

Tests on Section 3 are one phase of a comprehensive research program to develop ground-flotation criteria for heavy cargo-type aircraft. Section 3 consisted of two similar traffic lanes, lanes 5 and 6, each of which was divided into three items (**Fig 18**). Each item was constructed to a different subgrade CBR value and had a different traffic surface. Item 1 was surfaced with modified T11 aluminum landing mat, item 2 with M8 steel landing mat, and item 3 remained unsurfaced.

Traffic was applied to the two lanes using twin-wheel assemblies with 100-psi tire inflation pressures and 70,000-lb loads. For testing lane 5 the wheel assembly consisted of two 56x16, 32-ply aircraft tires spaced 35 in. c-c; for lane 6, two 56x16, 24-ply aircraft tires were used spaced 45 in. c-c. (**Fig 20**) gives pertinent tire-print dimensions and tire characteristics.

The lanes were trafficked to failure in accordance with the criteria designated in Part I of this report. Data were recorded throughout testing to give a behavior history of each item.

Using the test criteria mentioned above, it was possible to directly compare the effects of trafficking with the two assemblies. Basic performance data are summarized in the following paragraphs.

Lane 5

Item 1

The item was considered failed due to roughness at 28 coverages of the test load. Two postfailure coverages were applied to the item. The rated CBR of the item was 2.0.

Item 2

The item was considered failed due to roughness at 28 coverages of the test load. Two postfailure coverages were applied to the item. The rated CBR of the item was 3.8.

Item 3

The item was considered failed due to rutting at 12 coverages of the test load. The rated CBR of the item was 9.2.

Lane 6

Item 1

The item was considered failed at 130 coverages due to excessive transverse differential deformation which produced a troughing effect across the traffic lane. Traffic was continued to 156 coverages. The rated CBR of the item was 2.0.

Item 2

The item was considered failed due to roughness at 76 coverages of the test load. The rated CBR of the item was 3.6.

Item 3

The item had a localized failure due to rutting near one end at 36 coverages of the test load. The rated CBR of the item was 9.0 at the 36-coverage level. The failed area, designated 3a, was repaired and traffic was resumed for an additional 14 coverages, at which time the entire item was considered failed due to rutting. The segment that was unfailed at 36 coverages (designated 3b) was assigned a rated CBR of 10 at the 50-coverage level when the item was considered failed.

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART IV DATA REPORT ON TEST SECTION 3

SECTION I: INTRODUCTION

The investigation reported herein is one phase of a comprehensive research program being conducted at the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., as part of U. S. Air Force Project No. 410-A, MIPR NO. AS-4-177, to develop ground-flotation criteria for the C-5A, a heavy cargo-type aircraft. Specifically, the tests reported herein are part of a series of tests to determine the degree of interaction of the wheels of multiple-wheel landing-gear assemblies on landing mat and unsurfaced soils under various conditions of loading.

Prosecution of this investigation consisted of constructing two similar traffic lanes and subjecting them to equal test loads with twin-wheel landing-gear assemblies using different wheel spacings for the two lanes.

This report presents a description of the test section and wheel assemblies, and gives results of traffic. Equipment used, types of data and method of recording them, and general test criteria are explained and illustrated in Part I of this report..

SECTION II: DESCRIPTION OF TEST SECTION AND LOAD VEHICLE

Description of Test Section

The test section (**Fig 18**) was constructed within a roofed area in order to allow control of the subgrade CBR (California Bearing Ratio) in the test items. Construction of the test section was accomplished by first excavating a 48- by 110-ft area to a depth of 6 ft. The excavated area was backfilled to the original grade level in compacted lifts with a heavy clay soil (buckshot; classified as CH according to the Unified Soil Classification System, MIL-STD-619). Gradation and classification data for the subgrade material are given in Part I.

Two traffic lanes, each divided into three items, were constructed in the test section. Different subgrade strengths were obtained in the items (**Fig 18**) by controlling water content and compaction effort. Items 1 and 2 were surfaced with modified T11 aluminum and M8 steel landing mats, respectively (**Fig 19**). Item 3 remained unsurfaced. The landing mats used are described and illustrated in Part I.

Load Vehicle

The load vehicle is shown in **Figure 17**. Load cart construction, details of linkage between the load compartment and prime mover, and method of applying load are explained in Part I. For trafficking lanes 5 and 6, the load compartment was weighted to produce a load of 70,000 lb on a twin-wheel tracking assembly. For trafficking lane 5, the load wheels were spaced 35 in. c-c for two 56x16, 32-ply aircraft tires, and for lane 6, the spacing was 45 in. c-c for two 56x16, 24-ply aircraft tires. Tire inflation pressure was 100 psi for both wheel assemblies. Tire characteristics are given in **Figure 20**.

SECTION III: APPLICATION OF TRAFFIC AND FAILURE CRITERIA

Application of Traffic

The load vehicle was operated to produce uniform traffic coverage on the test lanes. The load cart was driven forward and backward along the same track longitudinally along the test lane, then shifted laterally, and the forward-backward operation repeated. In this manner, two coverages of traffic were applied to the test lane as the vehicle progressed from one side of the lane to the other. Figure 1 shows the general method of applying uniform coverages on the test lanes. Typically, the lane widths used were not exact multiples of the tracking tire widths and spacings so that it was necessary to determine a coverage factor for each lane to compensate for overlaps or gaps in the traffic pattern. In all cases, the coverage levels indicated in the text and tables represent the corrected coverage levels.

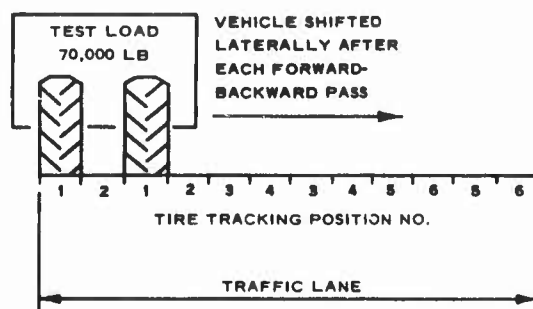


Figure 1. Sequence of traffic application for uniform coverages

Failure Criteria and Data Collected

Failure criteria used in this investigation and descriptive terms used in presentation and discussion of data in all reports in this series are presented in Part I. A general outline of types of data collected is given in the following paragraphs. Details on apparatus and procedure for obtaining specific measurements are given in Part I.

CBR, water content, and dry density

CBR, water content, and dry density of the subgrade were measured for each test item prior to application of traffic, at intermediate coverage levels, and at failure or suspension of traffic if no failure condition was reached. After traffic was concluded on an item, a measure of subgrade strength termed "rated CBR" was determined. Rated CBR is generally the average CBR value obtained from all the determinations made in the top 12 in. of soil during the test life of an item. In certain

instances, extreme or irregular values may be ignored if the analyst decides that they are not properly representative.

Surface roughness, or differential deformation

Surface roughness, or differential deformation, measurements were made using a 10-ft straightedge at various traffic-coverage levels on all items. Rut depths were measured for unsurfaced items, and dishing effects of individual mat panels in the mat-surfaced items were recorded.

Deformations

Deformations, defined as permanent cumulative surface changes in cross section or profile of an item, were charted by means of level readings at pertinent traffic-coverage levels.

Deflection

Deflection of the test surface under an individual static load of the tracking assembly was measured at various traffic-coverage levels on both surfaced and unsurfaced items. Level readings on the item surface on each side of the load wheels and on a pin and cap device directly beneath a load wheel provided deflection data. Both total (for one loading) and elastic (recoverable) deflections were measured on unsurfaced items. All mat deflection was for practical purposes recoverable, i.e. total deflection equaled elastic (spring-back) deflection. The pin and cap device for measuring deflection directly beneath load wheels was applied to the subgrade of surfaced items through a hole (existing or cut) in the mat.

Rolling resistance

Rolling resistance, or drawbar pull, measurements were performed with the load vehicle over each test item at designated coverage levels. Three types of drawbar measurements were taken: (a) maximum force required to overcome static inertia and commence forward movement of the load cart, termed "initial DBP"; (b) average force required to maintain a constant speed once the load vehicle is in motion, termed "rolling DBP"; and (c) maximum force obtained during the constant speed run, termed "peak DBP."

Mat breaks

Mat breaks on the surfaced items were inspected, classified by type, and recorded on the data sheet at various coverage levels.

SECTION IV: BEHAVIOR OF ITEMS UNDER TRAFFIC AND TEST RESULTS

Lane 5

Behavior of items under traffic

Item 1. **Figure 3** shows item 1 (foreground) prior to traffic. Mat deterioration and subgrade deformation increased steadily with trafficking. The item was considered failed due to roughness at 28 coverages. A segment of the mat at the 30-coverage level after two post-failure coverages is shown in **Figure 4**. The rated CBR for the item was 2.0.

Item 2. Item 2 prior to traffic is shown in **Figure 5**. The item was considered failed due to roughness at 28 coverages. Two postfailure coverages were applied. **Figure 6** shows the item at the 30-coverage level. As the item approached failure (28 coverages), the subgrade became less resistant to displacement and the resulting plastic deformation conformed to the impression made by the last pass of the tracking vehicle. The M8 steel landing mat was flexible enough to follow the contours of the deformed subgrade without breaking. The rated CBR for the item was 3.8.

Item 3. **Figure 7** shows item 3 prior to traffic. The item showed early distress under traffic and was considered failed due to rutting at 12 coverages (**Figure 8**). Four postfailure coverages produced 12-in. ruts rendering the item impassable by the tracking vehicle. The rated CBR for the item was 9.2.

Test results

Table 1 summarizes the results of trafficking and shows drawbar pull values for the test vehicle operated over an asphalt-paved strip. These drawbar values were recorded for comparison with values recorded on the test lane. Table 2 shows soil test data for each item.

Item 1. Item 1 was considered failed due to roughness at 28 coverages. Two postfailure coverages were applied. The following information was obtained from traffic tests on item 1.

- a. Roughness. The maximum transverse and diagonal deformations were 3.25 in. at failure (table 1). The pliable condition of the subgrade at failure is indicated by the reading of 3.0 in. for the same measurements after two postfailure coverages. Maximum dishing of individual mat panels was 0.88 in.
- b. Deformation. **Figures 21 & 22** show average cross-sectional and permanent profile deformations at 28 and 30 coverages. A maximum average cross-section deformation of 2.6 in. (at failure) is plotted.

- c. Deflection. **Fig 23** reflects substantial increases in deflection between the 0- and 30-coverage levels at each of the three locations at which measurements were made in item 1. With the mat joint at the center of the twin-wheel assembly, the resulting surface configuration resembles that typical of single-wheel loads. A similar but flatter pattern is seen in the plot showing deflections with the midpoint of the panel at the center line of the assembly. The plot with the quarter point of a panel at the center line of the assembly assumes a shape that reflects the twin-wheel loading. Elastic subgrade deflection was 2.1 in. as measured by the pin and cap device at 30 coverages.
- d. Rolling resistance. Drawbar pull values at 0, 12, and 30 coverages are shown in table 1. There is no definite trend in the drawbar pull results.
- e. Mat breaks. At 30 coverages mat breaks were counted and are listed by type in table 1. The types of breaks most numerous were sheared rivets at the mat joints and along the panel center-line joint.

Item 2. The item was considered failed due to roughness at 28 coverages. Two postfailure coverages were applied. The following information was obtained from traffic tests on item 2.

- a. Roughness. Differential deformations were subject to large changes with each pass of the load wheels as the item approached a failure condition. The great increase in differential deformations between 28 and 30 coverages reflects the plastic condition of the subgrade. The differential deformation values show the concurrent development of roughness with number of traffic coverages (table 1).
- b. Deformation. Average cross-section deformations at 28 and 30 coverages are shown in **Figure 21**. Considerable change in cross section occurred between the two coverage levels, particularly at the mat joint line. Profile deformation along a joint line 4 ft off of the lane center line is shown in **Fig 22**. Maximum dishing of about 0.50 in. was measured at failure.
- c. Deflections. Elastic mat deflections under the static load of the test vehicle were measured at 0 and 30 coverages. The average deflection plots in **Fig 23** show a configuration reflecting the twin-wheel loading. Table 1 shows elastic subgrade deflection as measured at 0 and 30 coverages.
- d. Rolling resistance. Drawbar pull values at 0, 12, and 30 coverages are shown in table 1. There is no apparent trend in the drawbar pull results.
- e. Mat breakage. The M8 steel landing mat was flexible enough to

follow the contours of the deformed subgrade and did not have a significant number of breaks at failure.

Item 3. Item 3 showed early distress under traffic, and was considered failed due to excessive rutting at 12 coverages. The following information was obtained from traffic tests on item 3.

- a. Roughness. At 12 coverages the item had 4-in.-deep ruts. With four postfailure coverages the item deteriorated badly with ruts in excess of 12 in. in depth. Table 1 gives differential deformations as measured at failure.
- b. Deformation. The center-line profile in **Fig 22** shows the general longitudinal subsidence of the traffic lane. The average cross-sectional deformation in **Fig 21** illustrates the extreme rutted condition of the item.
- c. Deflection. Total soil deflections under static load of the test vehicle are plotted in **Fig 23** for 0 and 12 coverages. The elastic component of deflection (table 1) averaged 0.65 in. prior to traffic and 0.7 in. at failure.
- d. Rolling resistance. Drawbar pull values for 0 and 12 coverages are presented in table 1. Peak and rolling drawbar values increased significantly with traffic while initial values were practically unchanged.

Lane 6

Behavior of items under traffic

Item 1. **Figure 9** shows item 1 prior to traffic. After the first 20 coverages, the rate of mat deterioration (breakage) increased. Displacement of the subgrade away from the center toward the outside of the traffic lane created a concave cross section. The item was considered failed due to roughness and mat deterioration at 130 traffic coverages. Traffic was continued to 156 coverages (**Figure 10**). The rated CBR was 2.0.

Item 2. **Figure 11** shows item 2 prior to traffic. At 50 coverages no mat breaks were observed and differential deformations were within the allowable range for serviceable surfaces. The item was considered failed due to roughness at 76 coverages (**Figure 12**). The rated CBR was 3.6.

Item 3. Item 3 is shown prior to traffic in **Figure 13**. At 36 coverages a localized failure was evidenced by rutting at one end of the item from sta 0+80 to sta 0+90 (**Figures 14 and 15**). The 10-ft failed segment of the item was designated 3a, and the still serviceable segment was designated 3b. After the ruts in 3a were repaired, traffic was resumed

over the entire item which was considered failed due to rutting at 50 coverages (**Figures 16 and 17**). Segments 3a and 3b were assigned rated CBR's of 9 and 10, respectively.

Test results

Soil data for lane 6 are summarized in table 2. Table 1 shows the results of trafficking each item. Drawbar pull values are also recorded in table 1 for the test vehicle operating on an asphalt-paved strip for comparison with drawbar pull measurements obtained on the test lane.

Item 1. The item was considered failed due to roughness at 130 coverages of the test vehicle. Traffic was continued and data were recorded to the 156-coverage level. The following information was obtained from traffic tests on item 1.

- a. Roughness. Average differential deformations (table 1) were approximately 3.0 in. and 2.3 in. for the transverse and diagonal positions, respectively, at 130 coverages. At 156 coverages an average transverse differential deformation of 3.9 in. was measured. Average dishing of individual mat panels was 0.38 in. at failure.
- b. Deformation. **Fig 21** shows the average cross-sectional deformations for 20, 76, and 156 coverages. The 156-coverage level represents 26 postfailure coverages and shows severe deformations. A profile along the item is represented in **Fig 22** for the same coverage levels.
- c. Deflection. Plots in **Fig 23** represent the average elastic mat deflections under the static load of the test vehicle. Measurements were made at various coverage levels for three relative positions of wheel assembly and mat joints. The elastic subgrade deflection was 1.5 in. at 156 coverages.
- d. Rolling resistance. Drawbar pull measurements for item 1 were incomplete due to malfunction of test equipment. The values recorded are shown in table 1.
- e. Mat breakage. Breaks in the T11 mat were numerous and are presented by type for various coverage levels in table 1.

Item 2. Item 2 was considered failed due to roughness at 76 coverages. The following information was obtained from traffic tests on item 2.

- a. Roughness. Differential deformation measurements for various coverage levels up through 76 coverages (failure) are presented in table 1. At failure the average transverse and diagonal differential deformations exceeded 2 in.
- b. Deformation. Plots in **Fig 21** represent the average

cross-sectional deformations measured at 20 and 76 coverages. **Fig 22** shows profile deformations at the same coverage levels.

- c. Deflection. Average elastic mat deflections are represented in **Fig 23** for 0, 20, and 76 coverages. Plots of deflection for three relative positions of wheel assembly and mat joints are shown. An elastic subgrade deflection of 1.4 in. was measured at failure of the item.
- d. Rolling resistance. Equipment breakdown resulted in an incomplete record of drawbar pull values (table 1), but the values recorded indicate that drawbar pull increased with traffic.
- e. Mat breakage. Very few mat breaks were observed during trafficking of the M8 mat (table 1).

Item 3. A portion of the item was considered failed due to rutting at one end at 36 coverages. The failed segment, designated 3a, was repaired to permit continued trafficking. The segment unfailed at 36 coverages (designated 3b) was trafficked to 50 coverages at which time the item was considered failed due to rutting. The following information was obtained from traffic tests on item 3.

- a. Roughness. Table 1 shows the development of differential deformations for various coverage levels up to failure. Measurements on segments 3a and 3b are tabulated separately for the 40- and 50-coverage levels.
- b. Deformation. Average cross-sectional deformations are represented in **Fig 21**. The maximum deformations were measured at 36 coverages. A profile deformation plot in **Fig 22** shows the resulting deformations at the 20-, 36-, and 50-coverage levels.
- c. Deflection. Average total soil deflections for the 0- and 36-coverage levels are shown in **Fig 23** and are representative of the entire item. The 50-coverage level deflections plotted are measurements applicable to segment 3b only. The elastic component of total soil deflection was measured with the pin and cap device at 0, 20, 36, and 50 coverages (table 1).
- d. Rolling resistance. Drawbar pull values in table 1 show an increase with number of coverages.

SECTION V: PRINCIPAL FINDINGS

From the foregoing discussion, the principal findings relating test load, wheel assembly, tire inflation pressure, surface type, subgrade CBR, and traffic coverages are as follows:

<u>Load, Wheel Assembly, and Tire Pressure</u>	<u>Type of Surface</u>	<u>Rated Subgrade CBR</u>	<u>Coverages at Failure</u>
70,000-lb load; twin-wheel assembly; 35-in. c-c, 56x16, 32-ply tires at 100-psi in- flation pressure	Modified T11 aluminum mat	2.0	28
	M8 steel mat	3.8	28
	Unsurfaced	9.2	12
70,000-lb load; twin-wheel assembly; 45-in. c-c, 56x16, 24-ply tires at 100-psi in- flation pressure	Modified T11 aluminum mat	2.0	130
	M8 steel mat	3.6	76
	Unsurfaced	9.0	36
		10	50

TABLE 1

SUMMARY OF TRAFFIC DATA, TEST SECTION 3

Test Item	Cover- ages	Rated CBR	No. of Hit Breakers					Differential Deflection (in.)				Dishing or Rutting (in.)				Average Total Deflection (in.)								Remarks				
			A B C D E					Longi- tudinal				Diagonal				Center Line of As- sembly				Quarter Point					Joint			
			1	2	3	4	5	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg		Max	Avg	Max	Avg
Lane 5																												
1	Modified T11 aluminum landing mat	0 12 26 30	0 2.0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	0.50 0.50 0.50 0.50	0.50 0.50 0.50 0.50	0.50 0.50 0.50 0.50	3.2 3.2 3.2 3.2	3.1 3.1 3.1 3.1	3.6 3.6 3.6 3.6	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	2.8 2.8 2.8 2.8	Failed at 26 cover- ages due to roughness. Two postfailure cov- erages applied		
2	148 steel landing mat	0 12 26 30	0 3.8 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	0.25 0.25 0.25 0.25	0.25 0.25 0.25 0.25	0.25 0.25 0.25 0.25	2.2 2.2 2.2 2.2	2.0 2.0 2.0 2.0	2.3 2.3 2.3 2.3	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	1.7 1.7 1.7 1.7	Failed at 26 cover- ages due to roughness. Two postfailure cov- erages applied		
3	Unsurfaced	0 12 26 30	0 9.2 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	1.25 1.25 1.25 1.25	4.00 4.00 4.00 4.00	4.00 4.00 4.00 4.00	4.00 4.00 4.00 4.00	0.2 0.2 0.2 0.2	0.2 0.2 0.2 0.2	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	0.7 0.7 0.7 0.7	Failed at 12 cover- ages due to rut- ting		
Asphalt strip																												
Lane 6																												
1	Modified T11 aluminum landing mat	0 20 40 70 90 100 130 156	0 2.0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.31 0.31 0.31 0.31 0.31 0.31 0.31	0.31 0.31 0.31 0.31 0.31 0.31 0.31	0.31 0.31 0.31 0.31 0.31 0.31 0.31	2.9 2.9 2.9 2.9 2.9 2.9 2.9	2.5 2.5 2.5 2.5 2.5 2.5 2.5	2.9 2.9 2.9 2.9 2.9 2.9 2.9	2.7 2.7 2.7 2.7 2.7 2.7 2.7	2.9 2.9 2.9 2.9 2.9 2.9 2.9	2.7 2.7 2.7 2.7 2.7 2.7 2.7	2.9 2.9 2.9 2.9 2.9 2.9 2.9	2.7 2.7 2.7 2.7 2.7 2.7 2.7	2.9 2.9 2.9 2.9 2.9 2.9 2.9	2.7 2.7 2.7 2.7 2.7 2.7 2.7	Failed at 130 cov- erages due to roughness. Traffic continued to 156 coverages			
2	148 steel landing mat	0 20 40 70 90 100 130 156	0 3.6 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.75 0.75 0.75 0.75 0.75 0.75 0.75	0.35 0.35 0.35 0.35 0.35 0.35 0.35	0.35 0.35 0.35 0.35 0.35 0.35 0.35	0.35 0.35 0.35 0.35 0.35 0.35 0.35	3.5 3.5 3.5 3.5 3.5 3.5 3.5	3.0 3.0 3.0 3.0 3.0 3.0 3.0	3.0 3.0 3.0 3.0 3.0 3.0 3.0	2.7 2.7 2.7 2.7 2.7 2.7 2.7	3.0 3.0 3.0 3.0 3.0 3.0 3.0	2.7 2.7 2.7 2.7 2.7 2.7 2.7	3.0 3.0 3.0 3.0 3.0 3.0 3.0	2.7 2.7 2.7 2.7 2.7 2.7 2.7	3.0 3.0 3.0 3.0 3.0 3.0 3.0	2.7 2.7 2.7 2.7 2.7 2.7 2.7	Failed at 76 cover- ages due to roughness			
3	Unsurfaced	0 20 40 70 90 100 130 156	0 0.8 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0.63 0.63 0.63 0.63 0.63 0.63 0.63	0.63 0.63 0.63 0.63 0.63 0.63 0.63	0.63 0.63 0.63 0.63 0.63 0.63 0.63	0.63 0.63 0.63 0.63 0.63 0.63 0.63	0.3 0.3 0.3 0.3 0.3 0.3 0.3	0.3 0.3 0.3 0.3 0.3 0.3 0.3	0.3 0.3 0.3 0.3 0.3 0.3 0.3	2.0 2.0 2.0 2.0 2.0 2.0 2.0	1.4 1.4 1.4 1.4 1.4 1.4 1.4	1.9 1.9 1.9 1.9 1.9 1.9 1.9	1.3 1.3 1.3 1.3 1.3 1.3 1.3	1.8 1.8 1.8 1.8 1.8 1.8 1.8	1.0 1.0 1.0 1.0 1.0 1.0 1.0	Localized failure at 36 coverages between 5th and 6th OAG. Failed area required and designated 36. 5th OAG to 156 designated 36 and traffic continued to failure at 50 coverages							
Asphalt strip																												
Notes: For lane 5, a twin-wheel assembly (loaded to 70,000 lb) with 56x16, 32-ply tire inflated to 100 psi was used for trafficking. For lane 6, a twin-wheel assembly (loaded to 70,000 lb) with 56x16, 32-ply tire inflated to 100 psi was used for trafficking.																												
* Break types are defined and illustrated in Part I.																												

TABLE 2
SUMMARY OF CBR, DENSITY, AND WATER CONTENT DATA, TEST SECTION 3

Test Item*	Type of Surface	No. of Traffic Coverages	Depth (in.)	CBR	Water Content %	Dry Density (lb/cu ft)	Remarks	
Lane 5								
1	Modified Tll aluminum landing mat	0	0	1.7	34.8	82.8	Item failed at 28 coverages due to roughness. 0-coverage data are average for two pits	
			6	2.1	33.9	82.7		
			12	1.8	30.3	89.6		
		30	0	2.3	34.8	83.4		
			6	1.8	34.5	87.0		
			12	2.4	28.4	92.0		
2	M8 Steel landing mat	0	0	4.2	31.9	86.6	Item failed at 28 coverages due to roughness. 0-coverage data are average for two pits	
			6	3.1	30.7	88.2		
			12	4.7	26.8	89.5		
		30	0	3.9	32.7	86.6		
			6	3.9	29.5	92.8		
			12	3.2	28.0	91.0		
3	Unsurfaced	0	0	9.2	25.4	93.9	Item failed at 12 coverages due to rutting. 0-coverage data are average for two pits	
			6	9.3	24.0	95.3		
			12	8.4	24.5	95.9		
		12	0	9.0	27.4	93.5		
			6	9.0	26.8	93.7		
			12	10.0	26.2	93.9		
Lane 6								
1	Modified Tll aluminum landing mat	0	0	1.7	33.6	83.2	Item failed at 130 coverages due to roughness	
			6	2.0	35.5	81.7		
			12	1.8	29.7	89.2		
			16	2.2	29.3	87.9		
			24	3.4	29.9	89.1		
		156	0	2.2	30.6	88.3		
			6	2.2	31.7	86.9		
			12	2.2	31.5	87.8		
			18	3.1	28.5	91.7		
2	M8 Steel landing mat	0	0	4.7	31.5	87.0	Item failed at 76 coverages due to roughness	
			6	3.3	31.6	86.2		
			12	3.8	30.1	87.1		
			18	4.0	30.3	88.2		
			24	4.6	30.6	88.0		
		76	0	4.4	32.8	86.8		
			6	2.8	33.1	84.6		
			12	2.8	30.6	89.3		
			18	3.6	30.2	88.9		
3	Unsurfaced	0	0	9.0	26.4	93.4	Item had localized failure at 36 coverages between sta 0+80 and 0+90. Failed area repaired and designated 3a. Remainder of item, sta 0+90 to 1+10, designated 3b and traffic continued to failure at 50 coverages. Failures on both segments of item were due to rutting	
			6	12.0	23.0	94.3		
			12	7.0	23.7	95.0		
			18	11.0	22.9	97.1		
			24	8.0	26.8	92.3		
		36	0	10.0	26.1	95.2		
			6	8.0	26.1	93.8		
			12	7.0	27.7	92.7		
		3a (Sta 0+80 to 0+90)	36	0	8.0	25.6		95.2
				6	13.0	24.2		97.4
12	9.0			26.1	95.3			
3b (Sta 0+90 to 1+10)	36	0	8.0	25.6	95.2			
		6	13.0	24.2	97.4			
		12	9.0	26.1	95.3			

* Subgrade material was heavy clay (buckshot; classified as CH) in all items.

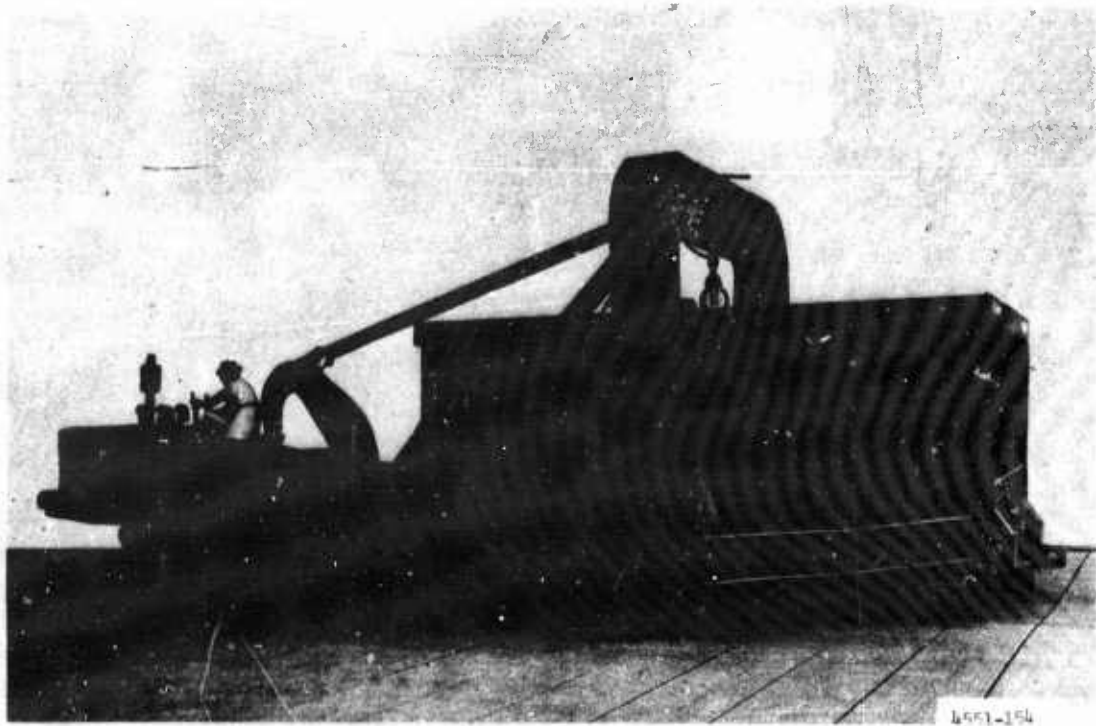


Figure 2. Test load vehicle

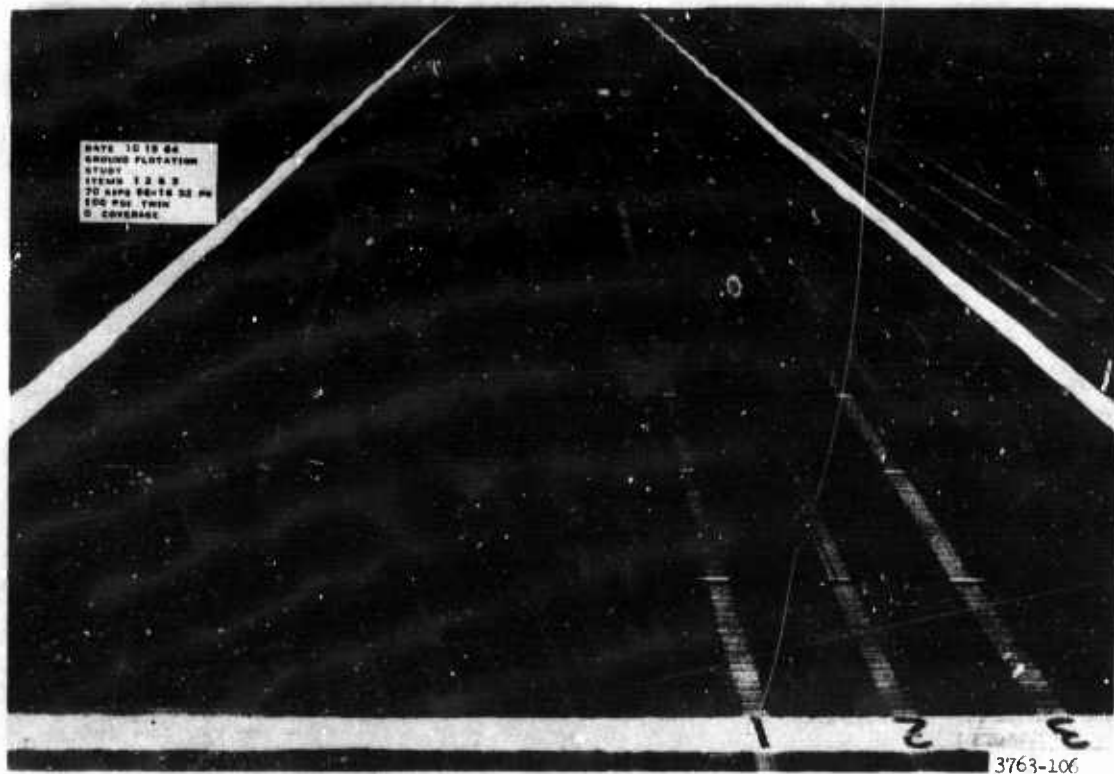


Figure 3. Lane 5, item 1, prior to traffic

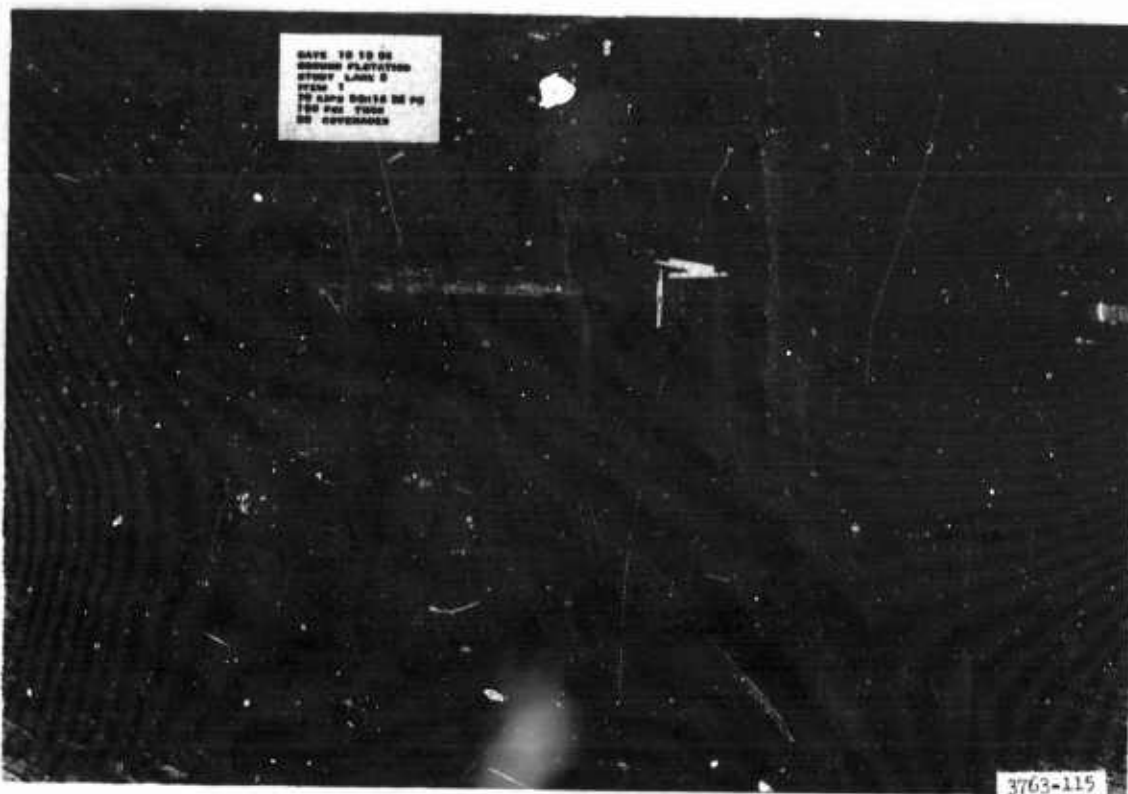


Figure 4. item 1. Diagonal straightedge shows roughness at 30 coverages (2 postfailure coverages)

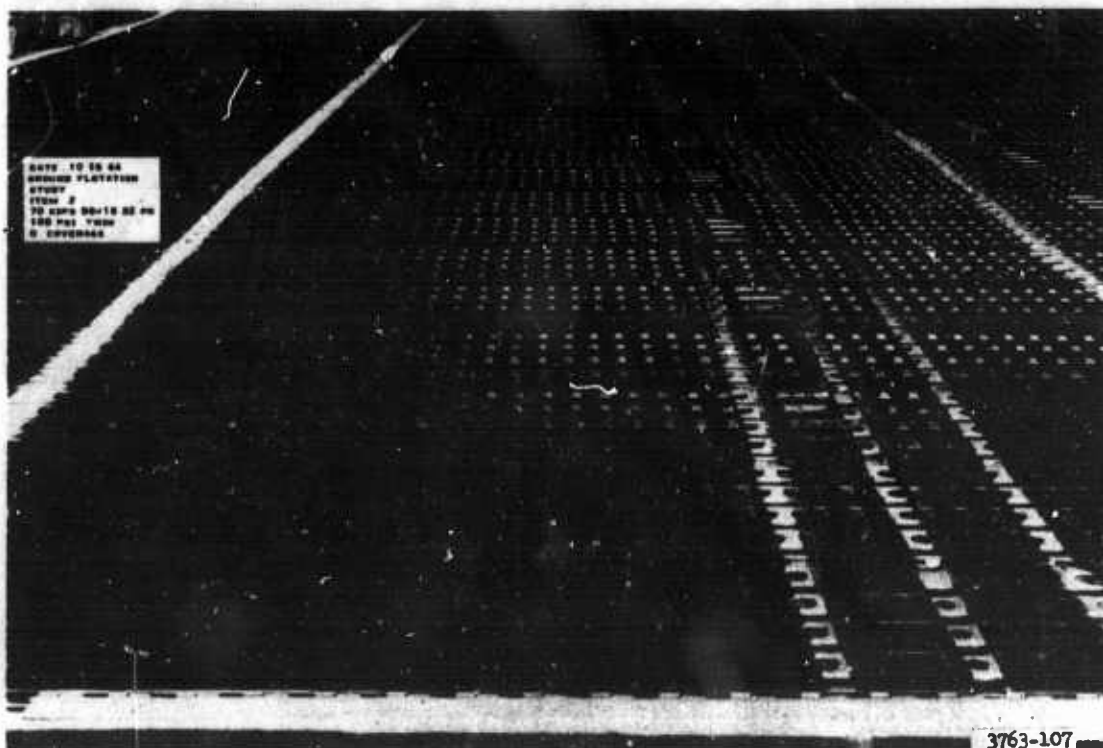


Figure 5. Lane 5, item 2, prior to traffic



Figure 6. Lane 5, item 2. Transverse straightedge shows roughness at 30 coverages (2 postfailure coverages)

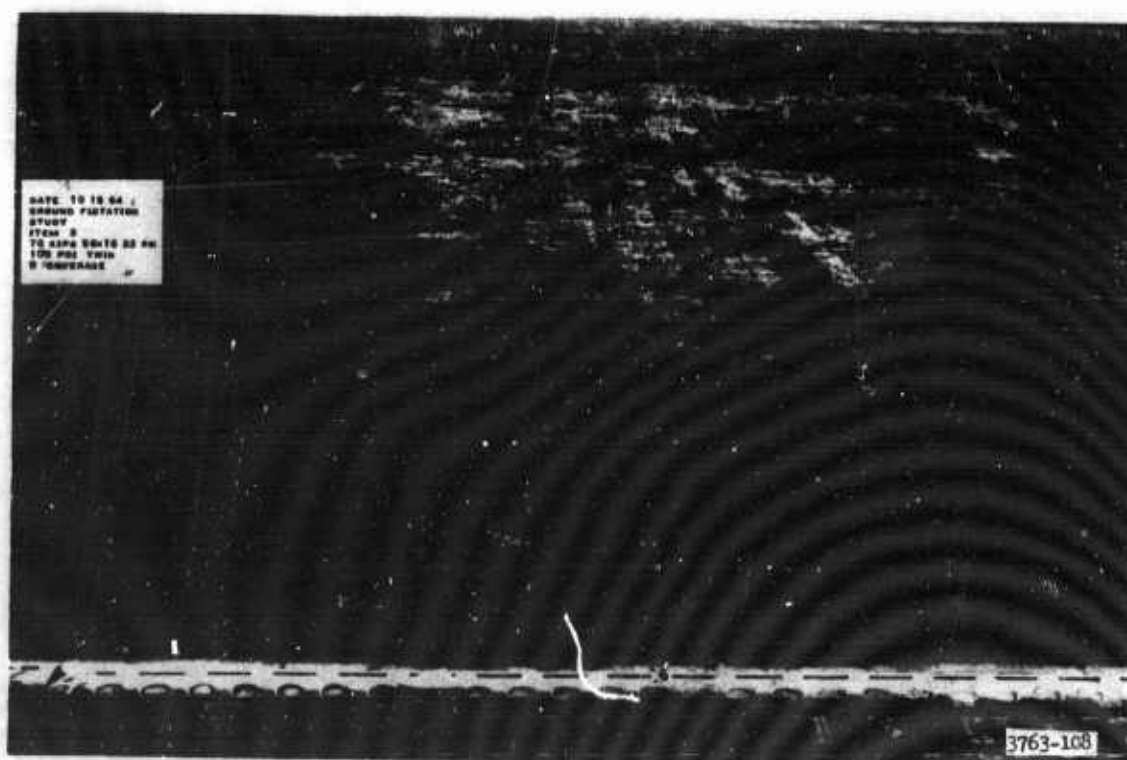


Figure 7. Lane 5, item 3, prior to traffic

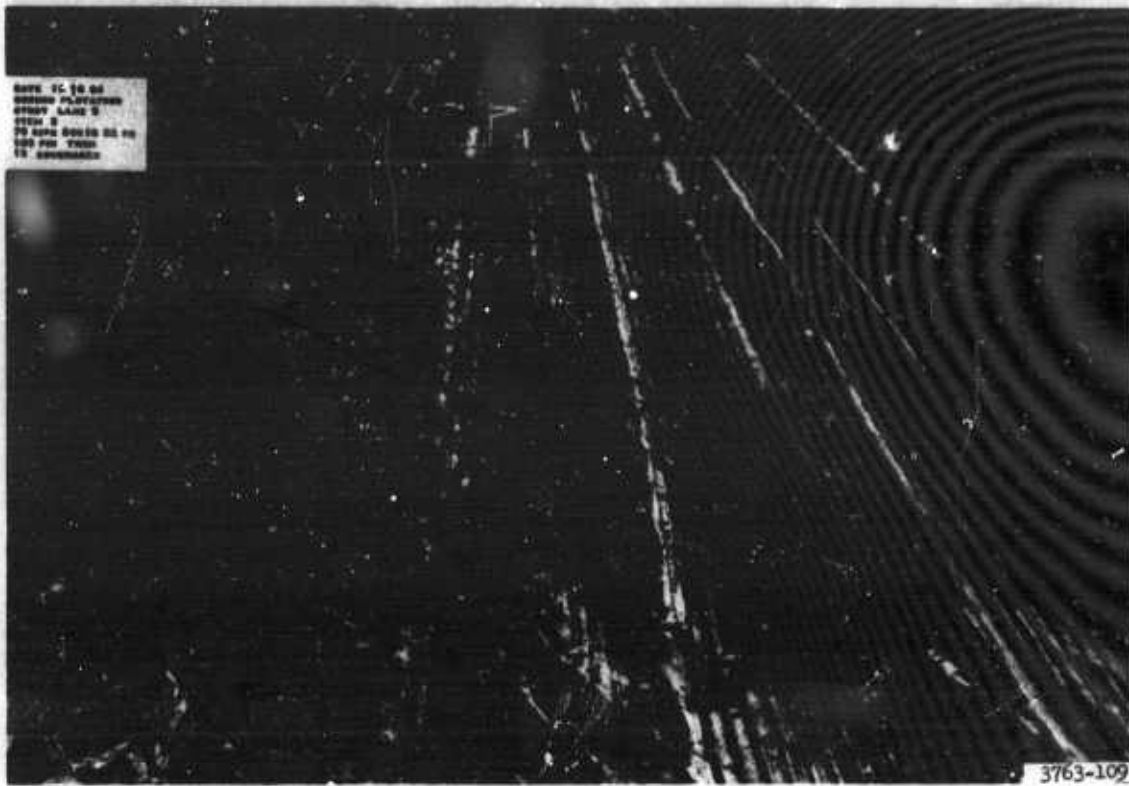


Figure 8. Lane 5, item 3, at 12 coverages (failure)

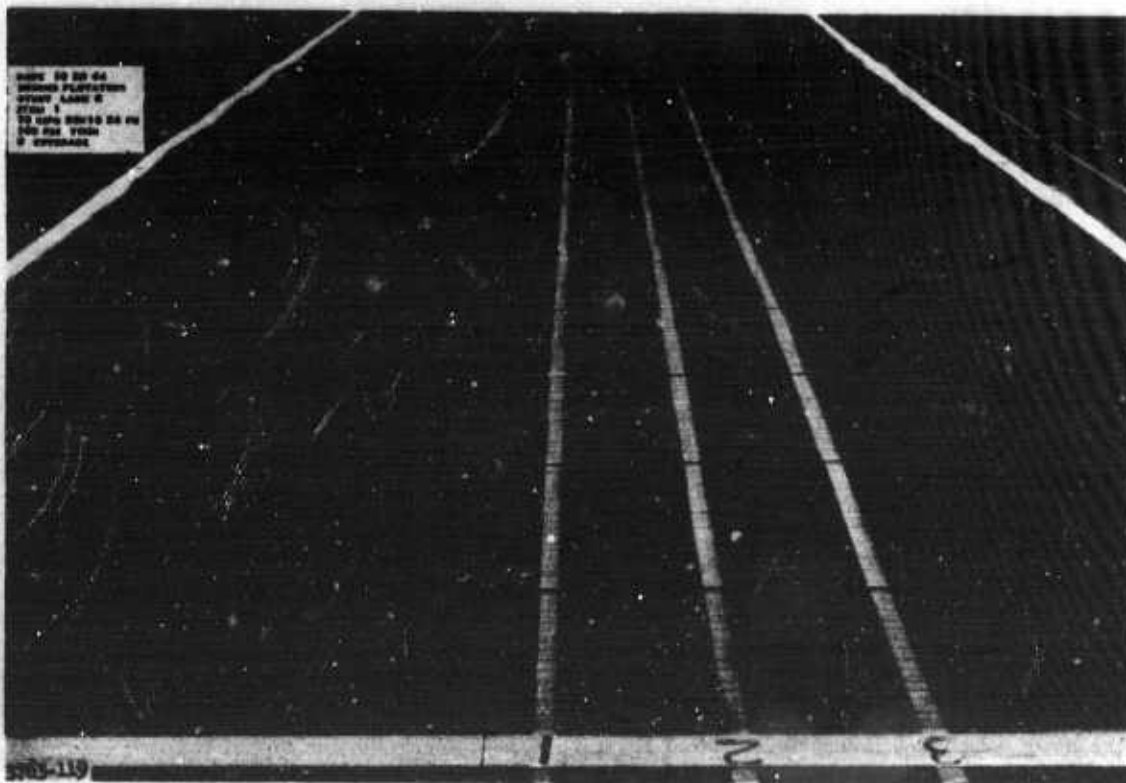


Figure 9. Lane 6, item 1, prior to traffic

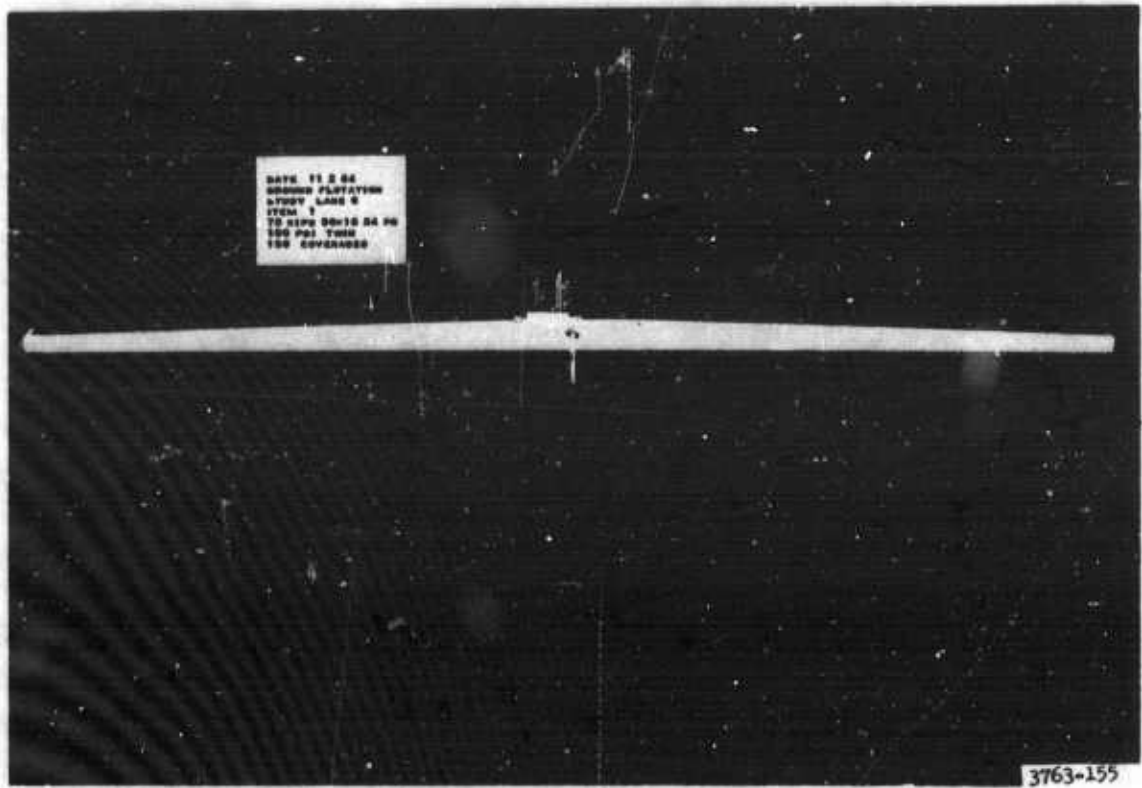


Figure 10. Lane 6, item 1. Transverse straightedge shows roughness at 156 coverages (26 postfailure coverages)

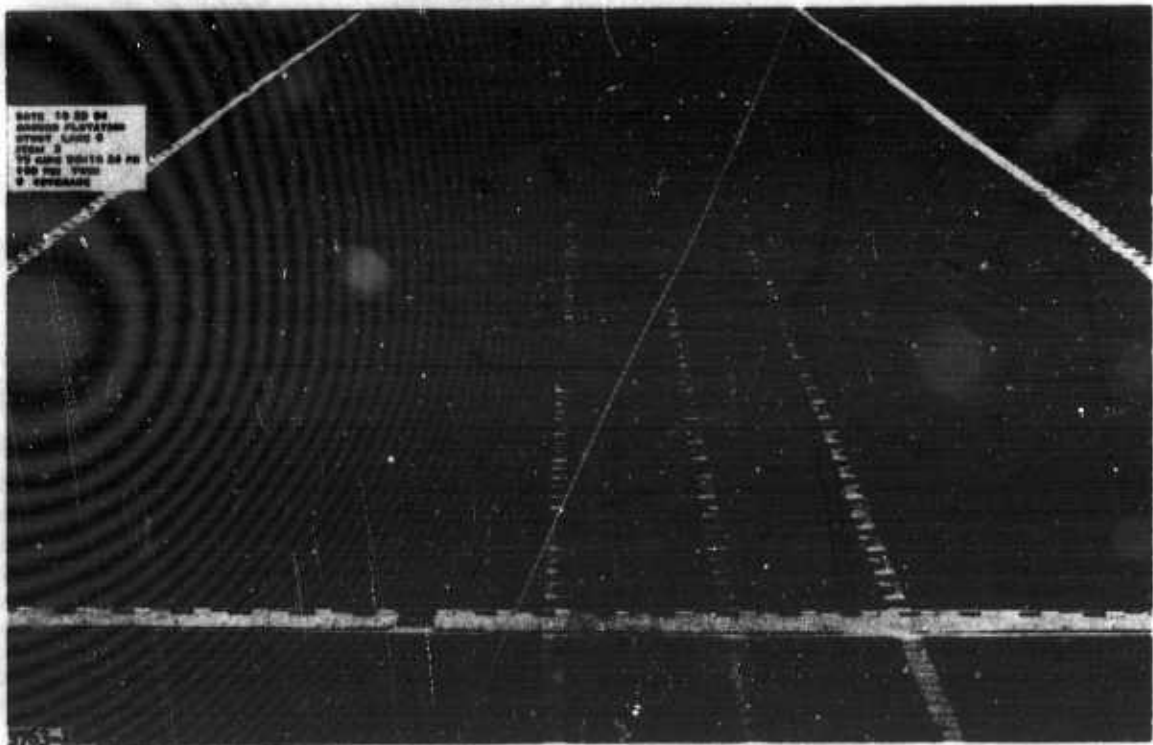


Figure 11. Lane 6, item 2, prior to traffic

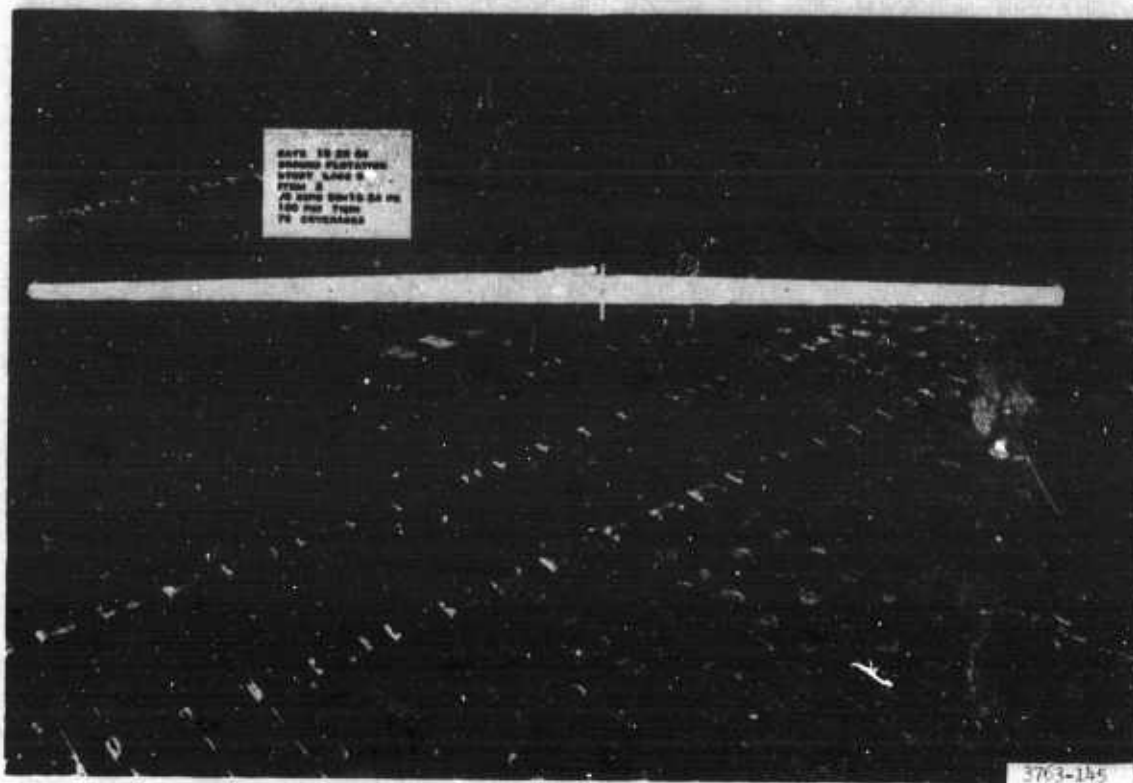


Figure 12. Lane 6, item 2. Diagonal straightedge shows roughness at 76 coverages (failure)

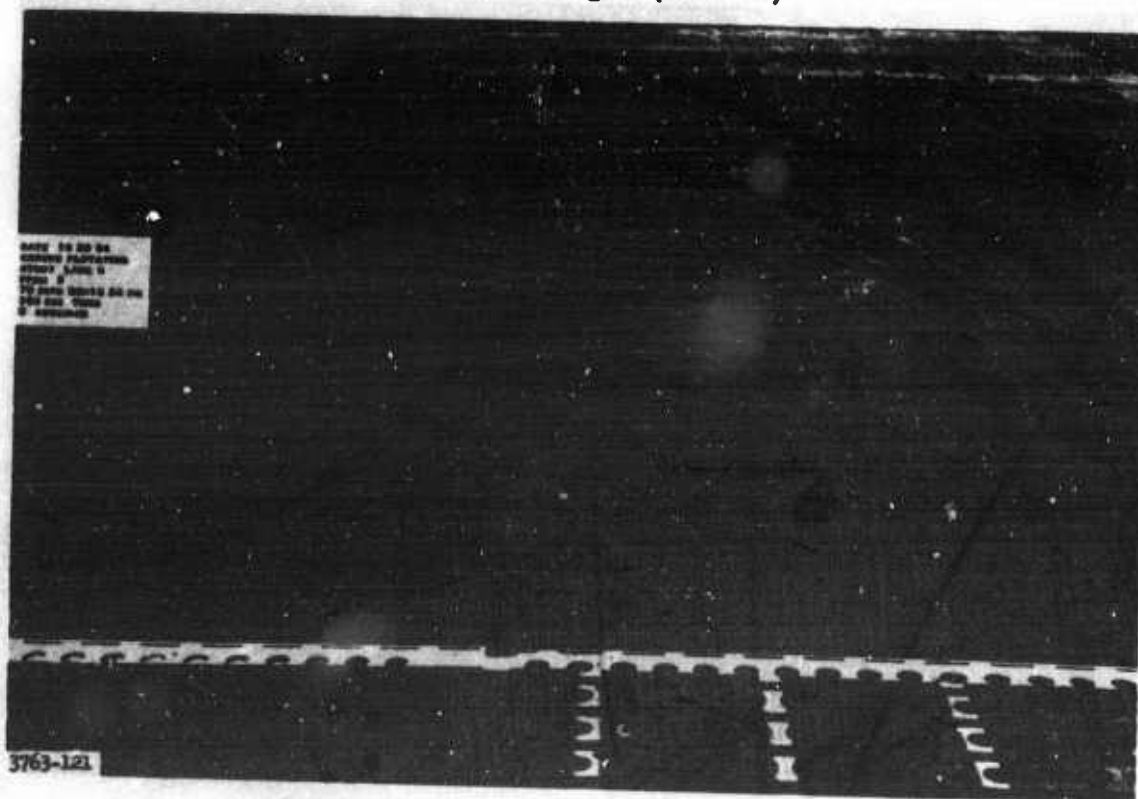


Figure 13. Lane 6, item 3, prior to traffic

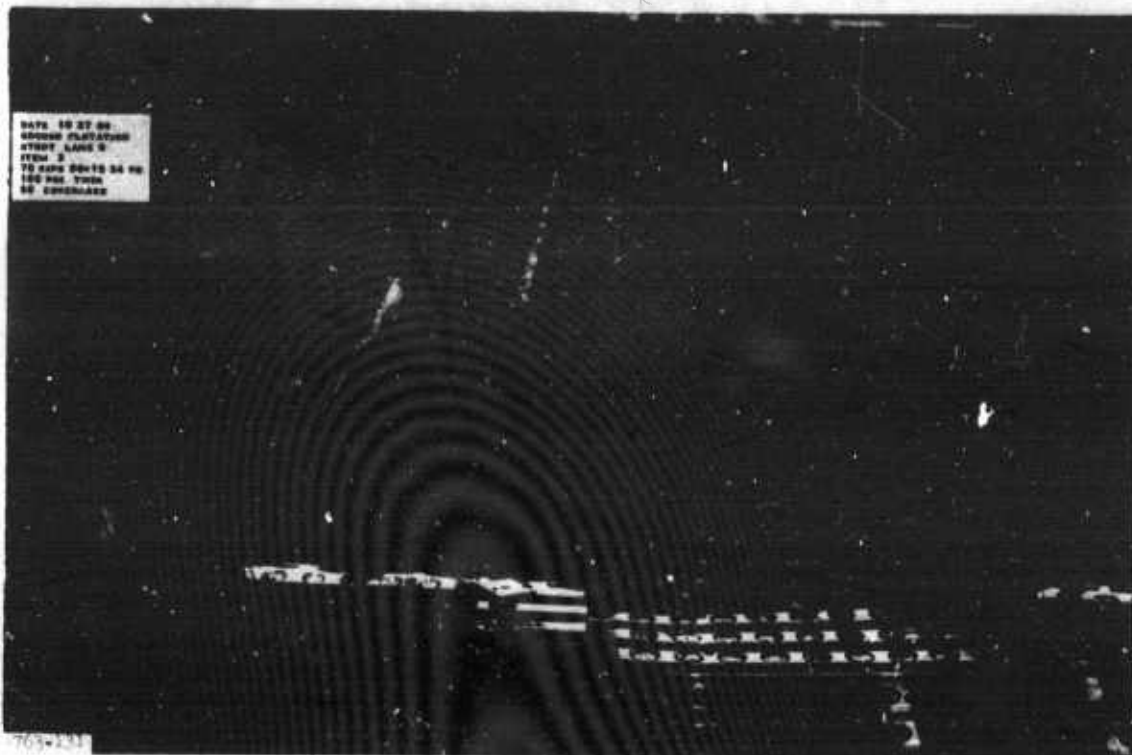


Figure 14. Lane 6, item 3, showing localized failure (segment 3a in foreground at 36 coverages)

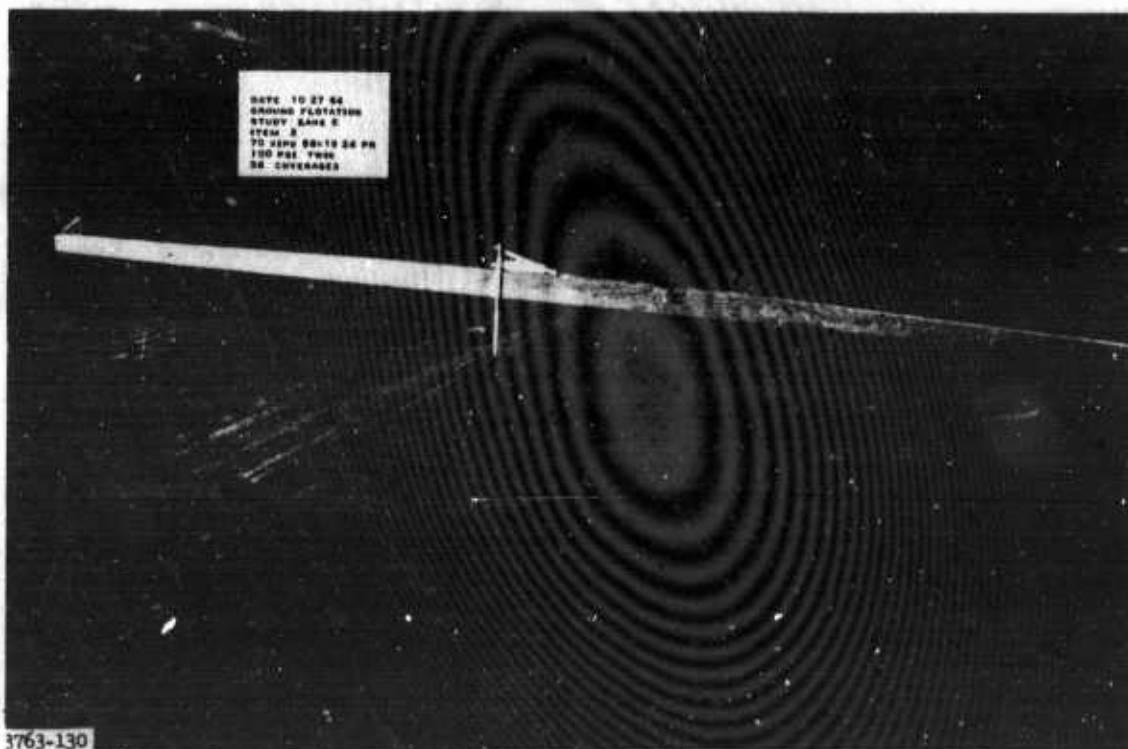


Figure 15. Lane 6, item 3. Diagonal straightedge shows rutting in segment 3a at 36 coverages (failure)

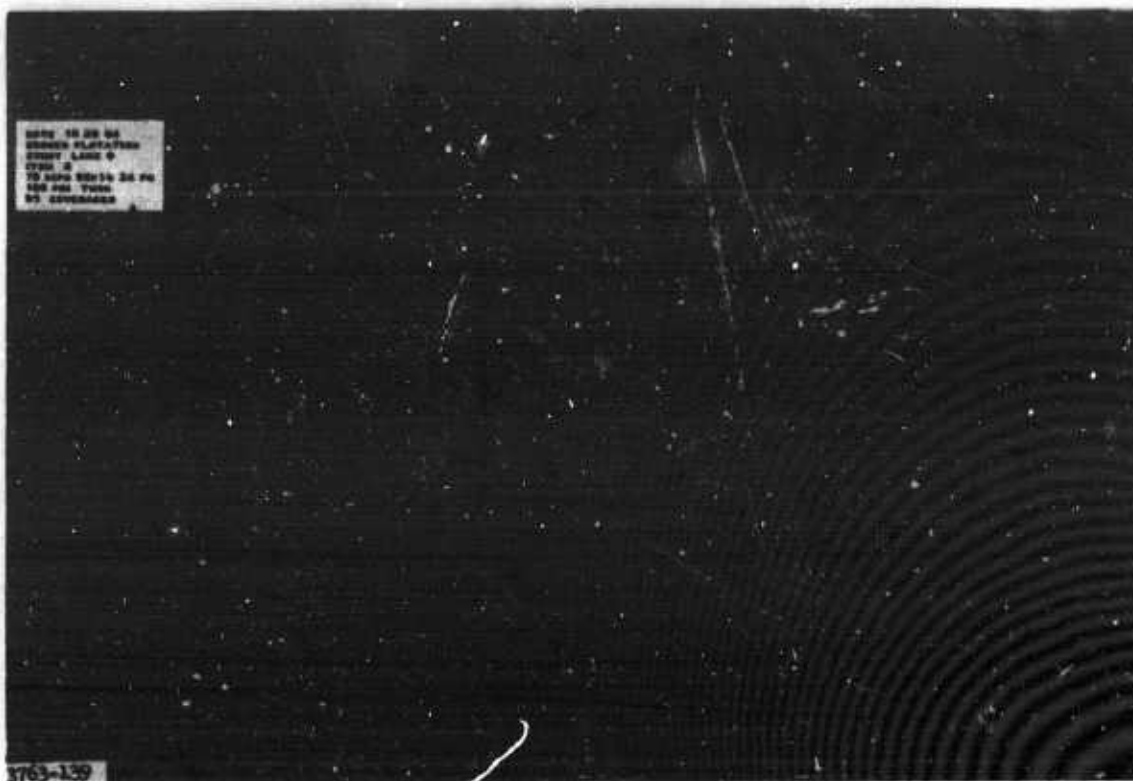


Figure 16. Lane 6, item 3, at 50 coverages (failure)

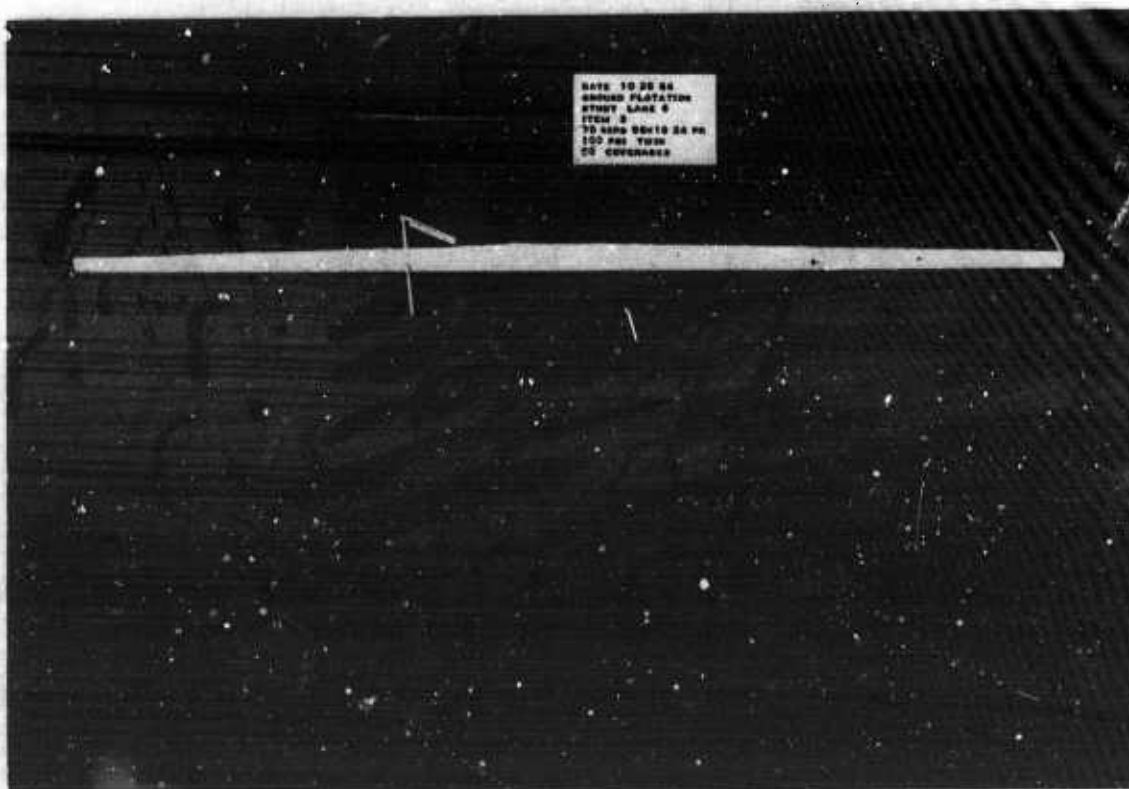


Figure 17. Lane 6, item 3. Diagonal straightedge shows rutting in segment 3b at 50 coverages (failure)

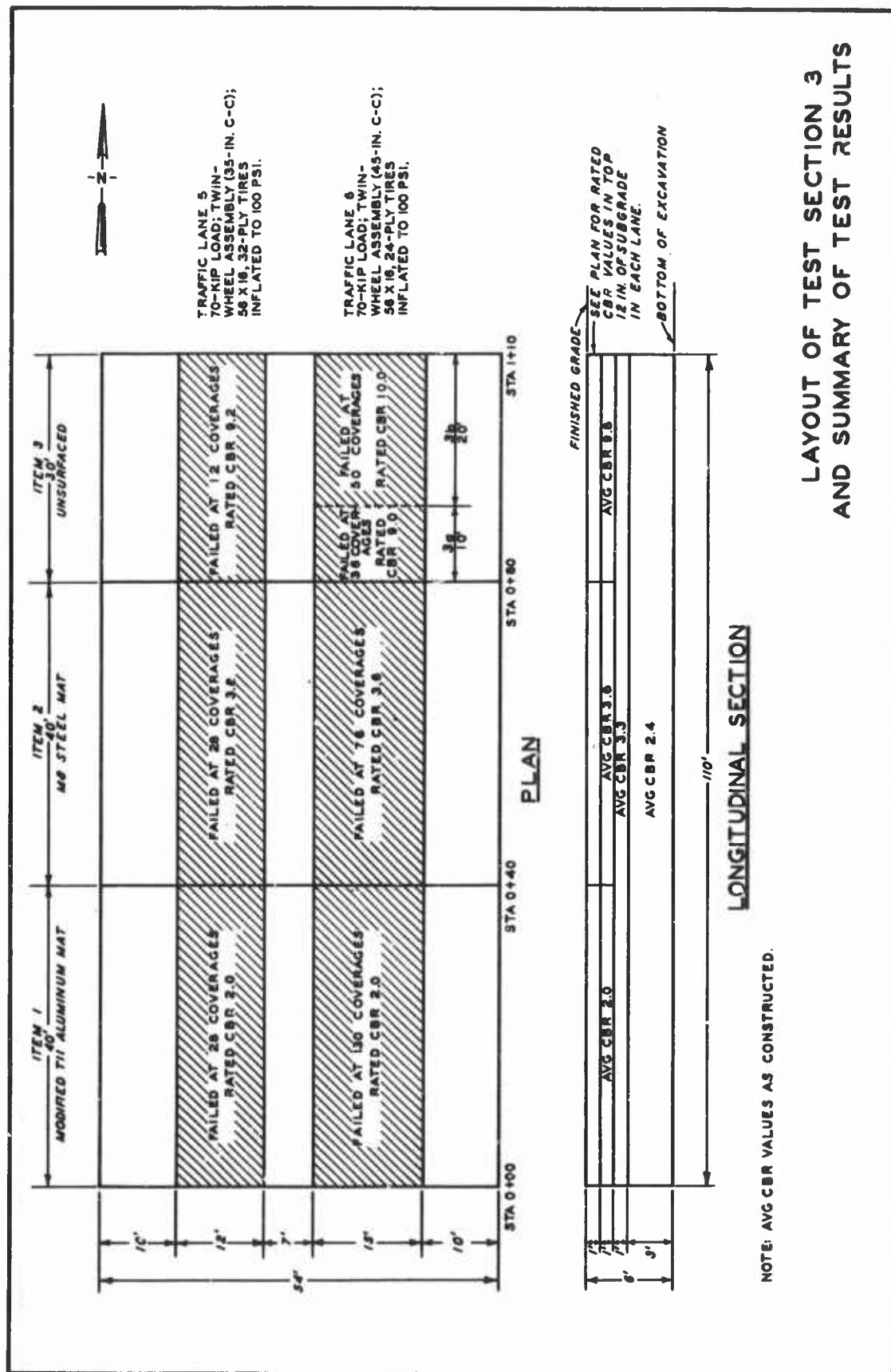
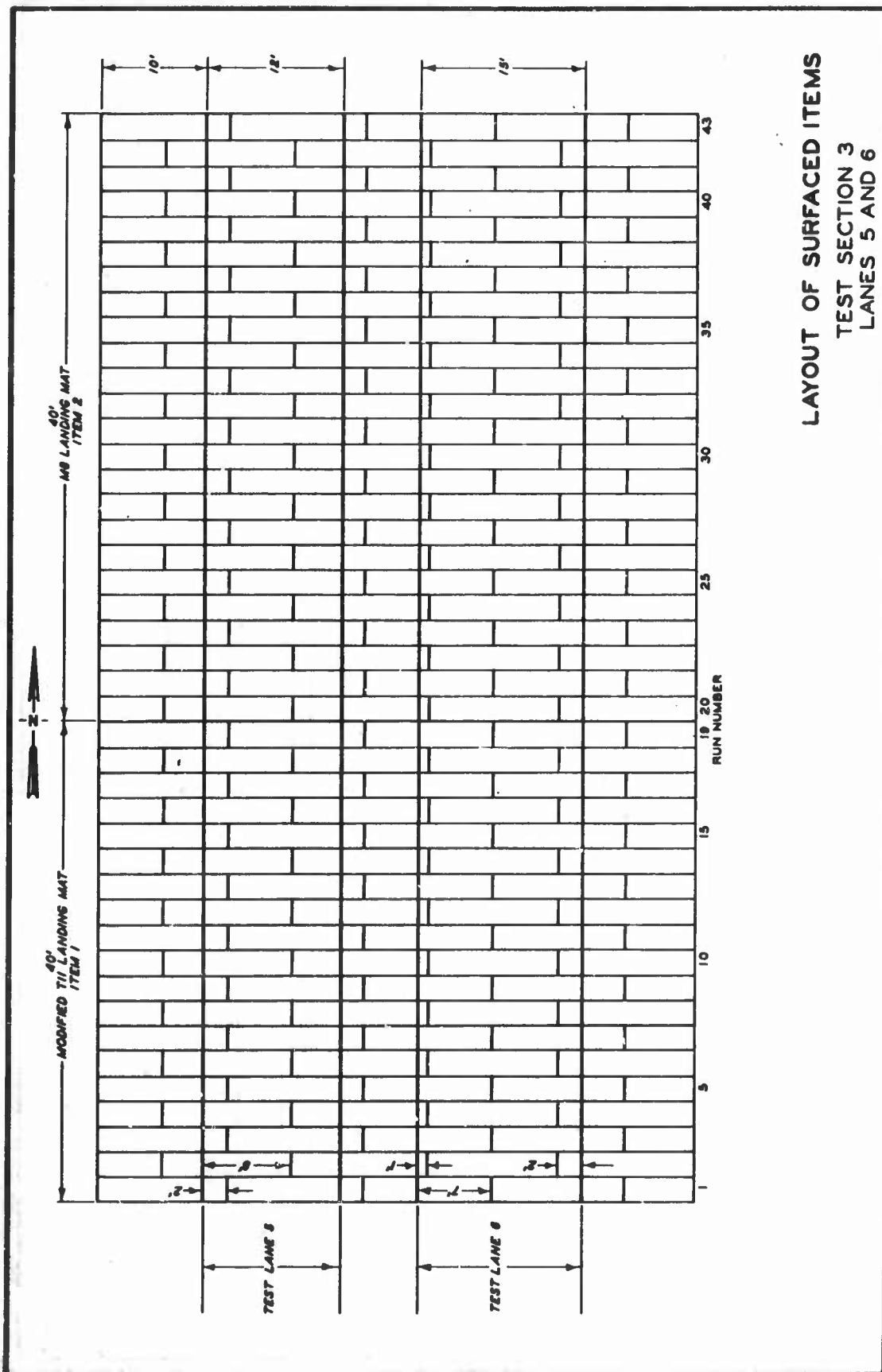
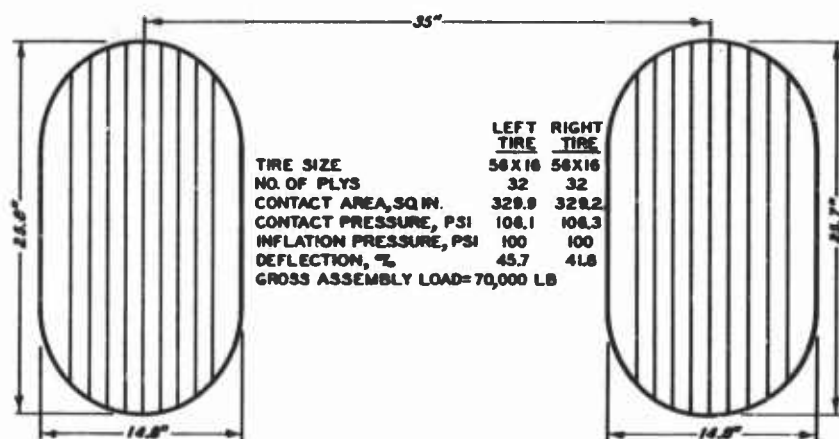


Figure 18

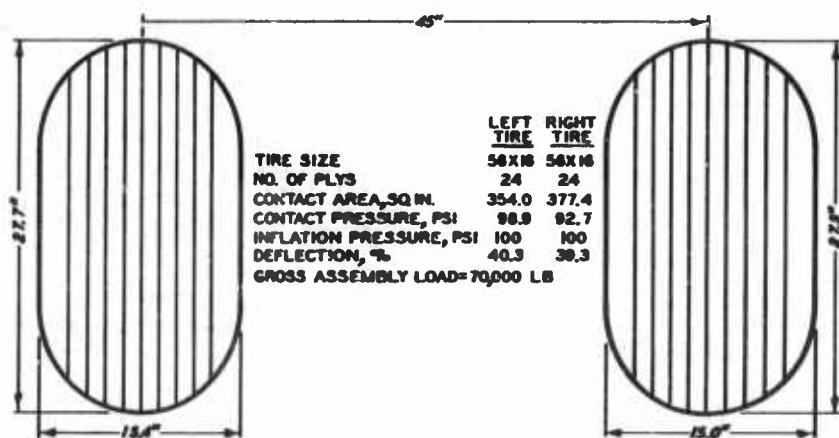


LAYOUT OF SURFACED ITEMS
TEST SECTION 3
LANES 5 AND 6

Figure 19



LANE 5



LANE 6

TIRE-PRINT DIMENSIONS AND TIRE CHARACTERISTICS

TEST SECTION 3
LANES 5 AND 6

Figure 20

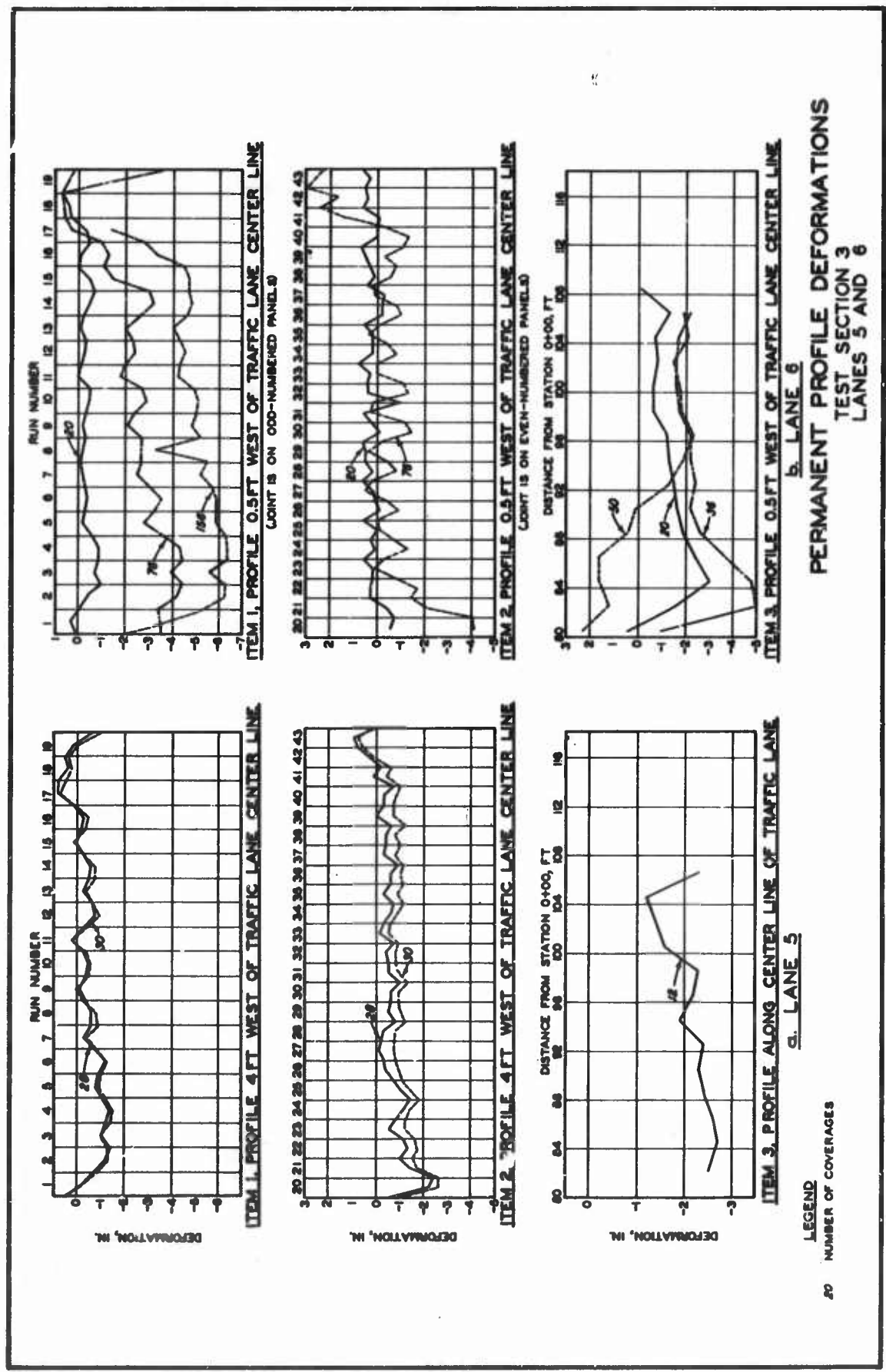


Figure 22
25

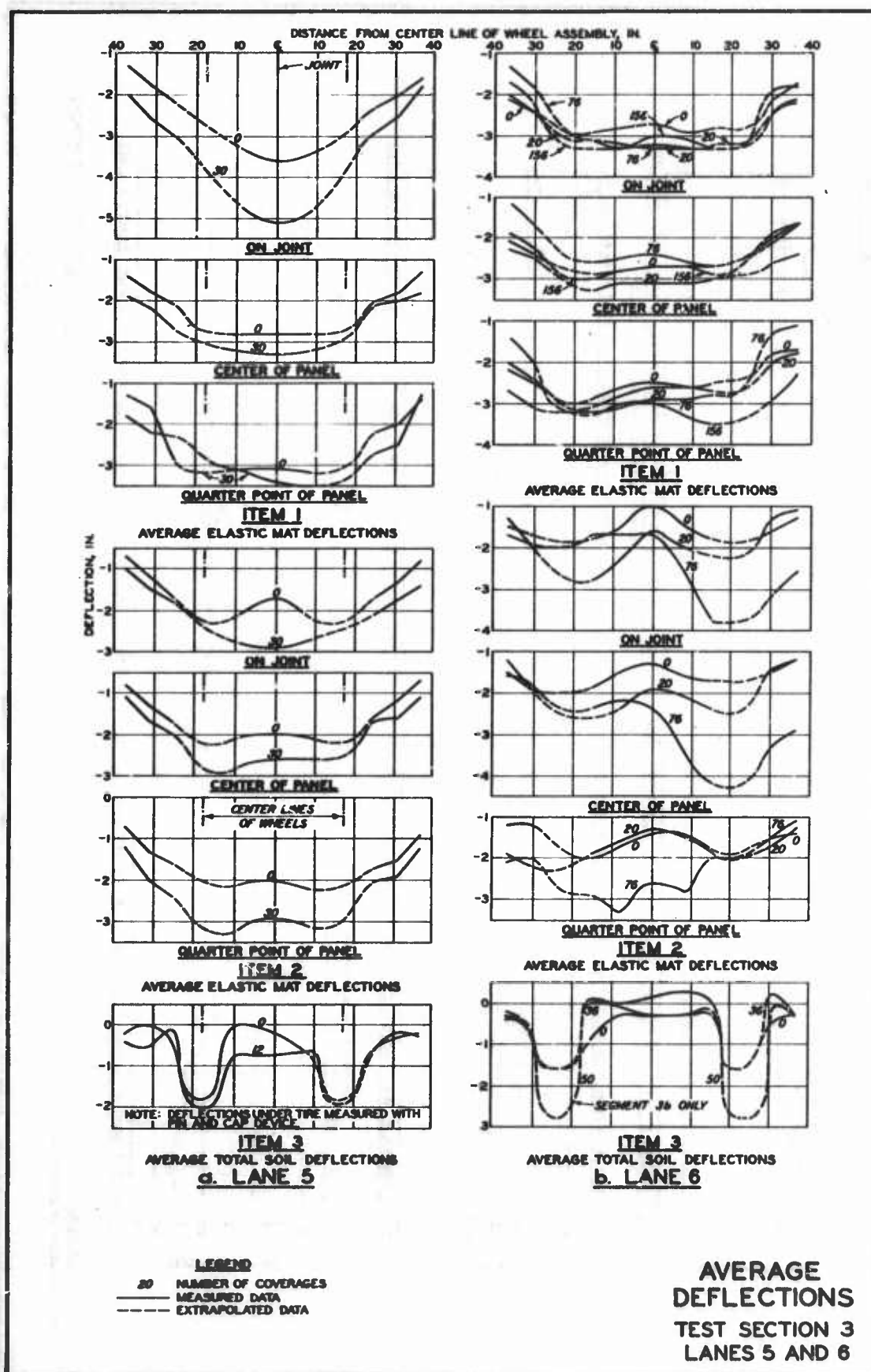


Figure 23

UNCLASSIFIED

Security Classification

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