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AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART X — DATA REPORT ON TEST SECTION 9

W. BRABSTON and W. HILL, JR.

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

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

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AIR FORCE FLIGHT DYNAMICS LABORATORY
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

The investigation described herein constitutes one phase of studies conducted during 1964 and 1965 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, H. H. Ulery, Jr., G. M. Hammitt II, and W. J. Hill, Jr. This report was prepared by Messrs. Brabston 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.

K H Digges

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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 one lane with a 35,000-lb load on a single-wheel assembly consisting of a 25.00-28, 30-ply aircraft tire inflated to 50 psi. The other lane was trafficked with a 70,000-lb load on a twin-wheel assembly consisting of two 25.00-28, 30-ply aircraft tires inflated to 50 psi. Wheel spacing was 42 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 each test item was considered failed.

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SUMMARY

Tests on Section 9 are one phase of a comprehensive research program to develop ground-flotation criteria for heavy cargo-type aircraft. Section 9 consisted of two similar lanes, lanes 21 and 22, each of which was divided into three items (figure 15). 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 a 35,000-lb load on a single-wheel assembly and a 70,000-lb load on a twin-wheel assembly on lanes 21 and 22, respectively. Tire inflation pressure was 50 psi. A single 25.00-28, 30-ply aircraft tire was used on lane 21 and two 25.00-28, 30-ply aircraft tires with 42-in. c-c spacing were used on lane 22. Figure 17 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 compare the trafficking effects of a single-wheel assembly and a twin-wheel assembly having double the test load on the single-wheel assembly. Basic performance data are summarized in the following paragraphs.

Lane 21

Item 1

At 600 coverages the surface was still in good condition and traffic was suspended. The rated CBR for the item was 1.5.

Item 2

The item was considered failed due to roughness at 300 coverages. The rated CBR for the item was 1.9.

Item 3

The item was considered failed due to roughness at 300 coverages. The rated CBR for the item was 4.7.

Lane 22

Item 1

The item was considered failed due to roughness at 400 coverages. The rated CBR for the item was 1.8.

Item 2

The item was considered failed due to roughness at 100 coverages. The rated CBR for the item was 1.9.

Item 3

The item was considered failed due to roughness at 100 coverages. The rated CBR for the item was 4.8.

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART X DATA REPORT ON TEST SECTION 9

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 were conducted to compare the trafficking effects on landing mat and unsurfaced soils of a single-wheel assembly and a twin-wheel assembly having double the test load on the single-wheel assembly.

Prosecution of this investigation consisted of constructing two similar traffic lanes and subjecting them to traffic of a single-wheel, 35,000-lb load, and a twin-wheel, 70,000-lb load. This part 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 summarized herein with more complete explanations and illustrations given in Part I of this report.

SECTION II: DESCRIPTION OF TEST SECTION AND LOAD VEHICLE

Description of Test Section

The test section (figure 15) was located within a roofed area in order to allow control of the subgrade CBR (California Bearing Ratio) in the test items. Section 9 was located on the same site as prior Test Sections 6, 4, and 2. The construction of Test Section 2 is described in Part III. The underlying subgrade was undisturbed by prior tests on the site so that in construction of Test Section 9 only the upper 24 in. of soil was excavated. 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 divided into three items each were constructed in the test section. Different subgrade strengths were obtained in the items by controlling water content and compaction effort (figure 15). Items 1 and 2 were surfaced with modified T11 aluminum landing mat and M8 steel landing mat, respectively (figure 16), and item 3 remained unsurfaced. The landing mats used are described and illustrated in Part I.

Load Vehicle

The load vehicle is shown in figure 2. Load cart construction, details of linkage between the load compartment and prime mover, and method of applying load are explained in Part I. A 35,000-lb load on a single-wheel assembly and a 70,000-lb load on a twin-wheel assembly were used for trafficking lanes 21 and 22, respectively. Wheel spacing was 42 in. c-c on the twin-wheel assembly. Tires used on both assemblies were 25.00-28, 30 ply with inflation pressure of 50 psi. Tire-print dimensions and tire characteristics are shown in figure 17.

SECTION III: APPLICATION OF TRAFFIC, FAILURE CRITERIA, AND DATA COLLECTED

Application of Traffic

Traffic was applied to the test lanes in a nonuniform pattern with intensity of traffic being varied within each lane to produce three zones of approximately 100, 80, and 20 percent traffic coverage. Traffic so distributed within a traffic lane simulates as nearly as possible the bell-shaped traffic distribution curve which results from the wander of aircraft from the lane center line. The coverage levels referred to in the tables and text herein are the total number of coverages applied to the 100 percent coverage zone. The corresponding number of coverages applied to the outer traffic zones is proportional to the percentage factor for the respective zones as shown in figure 1.

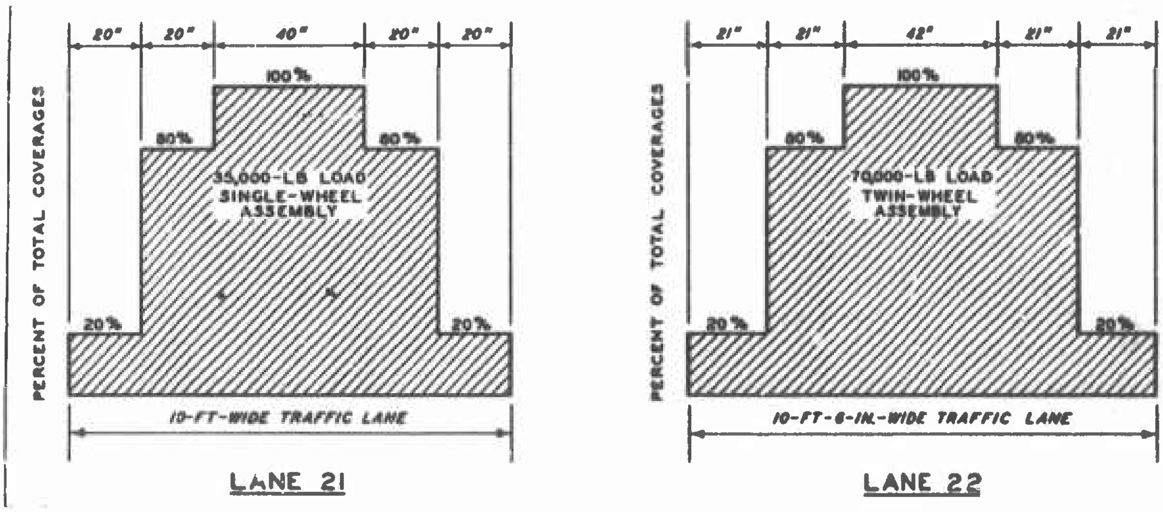

Figure 1. Traffic distribution patterns, Test Section 9

Failure Criteria and Data Collected

Failure criteria used in this investigation and descriptive terms used in presentation and discussion of data in this report are presented in Part I. A general outline of types of data collected is given in the following paragraphs.

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 the unsurfaced items, and dishing effects of individual mat panels in the mat-surfaced items were recorded.

Deformations

Deformations, defined as permanent 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 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 at various coverage levels. Illustrations and descriptions of each type of break are given in Part I.

SECTION IV: BEHAVIOR OF ITEMS UNDER TRAFFIC AND TEST RESULTS

Lane 21

Behavior of items under traffic

Item 1. Figure 3 shows item 1 prior to traffic. The item sustained 600 traffic coverages without developing appreciable roughness or mat breakage. Traffic was suspended at 600 coverages with the item surface remaining in good condtion (figure 4). The rated CBR of the item was 1.5.

Item 2. Figure 5 shows item 2 prior to traffic. At 20 coverages the item evidenced average transverse and diagonal differential deformations of about 1 in. The item held up well under continued trafficking until 300 coverages when it was considered failed due to roughness (figure 6). The rated CBR for the item was 1.9.

Item 3. Figure 7 shows item 3 prior to traffic. The item resisted rutting throughout trafficking. At 300 coverages the item was considered failed due to roughness (figure 8). The rated CBR for the item was 4.7.

Test results

Results of trafficking lane 21 are summarized in table 1. Soil test data are shown in table 2.

Item 1. Item 1 sustained 600 coverages without evidencing signs of failure and remained in good condition when traffic was suspended. The following information was obtained from traffic tests on item 1.

a. Roughness. Differential deformations that developed with trafficking are recorded in table 1. At 600 coverages (suspension of traffic), the item was still in good condition with average transverse and diagonal differential deformations of 0.97 and 1.10 in., respectively. Average dishing measurement (table 1) was 0.50 in.

b. Deformation. Figure 18 shows average cross-section deformations at 20, 200, and 600 coverages for each of two typical mat runs. Cross-section deformations remained small throughout trafficking, although there was considerable general subgrade subsidence. Profile deformations along the mat end-joint line nearest the lane center line are shown in figure 19.

c. Deflection. Average elastic mat deflections shown in figure 20 for three positions of the wheel assembly relative to mat end joints show a steady increase at measurement intervals ranging from 0 to 600 coverages.

d. Rolling resistance. Drawbar pull values for several coverage levels are shown in table 1. The trend was for drawbar pull values to increase with coverages.

e. Mat breaks. Only six mat breaks were recorded when traffic was suspended at 600 coverages.

Item 2. Item 2 was considered failed due to roughness at 300 coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. Differential deformations shown in table 1 indicate a steady increase with number of traffic coverages. At failure the average transverse and diagonal differential deformations were 2.97 and 3.03 in., respectively. Dishing measurements were small, averaging 0.19 in. at failure.

b. Deformation. Figure 18 shows average cross-section deformations at 20, 200, and 300 coverages for each of two typical mat runs. The greatest deformation is seen to occur at the lane center line. Profile deformations along the mat end-joint line nearest the lane center line are shown in figure 19. General subgrade subsidence along the length of the lane is evident as well as surface irregularities in the mat.

c. Deflection. Average elastic mat deflections are shown in figure 20 for three positions of wheel assembly relative to mat end joints. The increasing magnitude of deflections was consistent with increasing number of coverage levels when the mat joint was at center line of the wheel assembly. Plots shown for other positions of the load wheel on the mat surface indicated variable results with no consistent pattern.

d. Rolling resistance. Drawbar pull values for 0, 20, and 300 coverages are shown in table 1. All drawbar values registered consistent increases with higher coverage levels.

e. Mat breaks. The number and types of mat breaks are shown in table 1. The first observed break was recorded at 100 coverages. Some protrusion of the overlapping mat end joints occurred with continued traffic with only a few additional breaks being noted.

Item 3. Item 3 was considered failed due to roughness at 300 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. Differential deformations and rut depths measured at intervals throughout trafficking are shown in table 1. Rut depths did not reach serious proportions at any time, but transverse and diagonal differential deformation showed steady increases with trafficking. At 300 coverages both the transverse and diagonal differential deformations averaged 3.50 in. Average rut depth was 0.91 in.

b. **Deformation.** Figure 18 shows average cross-section deformations measured at 20, 200, and 300 coverages. Subsidence of the traffic lane near the center line of the cross section, as illustrated in the deformation plot, contributed to the excessive differential deformations that were the primary factor in failure of the item. Profile plots along a line 2 ft east of the lane center line are shown in figure 19.

c. **Deflection.** Average total deflections measured at 0, 20, 200, and 300 coverages are shown in figure 20. Deflections increased consistently with traffic coverages. Elastic soil deflections measured at intervals during trafficking are shown in table 1.

d. **Rolling resistance.** Drawbar pull values are shown in table 1 for 0, 20, and 300 coverages. Peak and rolling drawbar values increased steadily with trafficking while initial values decreased slightly.

Lane 22

Behavior of items under traffic

Item 1. Figure 9 shows item 1 prior to traffic. The item was considered failed due to roughness at 400 coverages (figure 10). The mat surface was not severely damaged at failure. The rated CBR was 1.8.

Item 2. Figure 11 shows item 2 prior to traffic. The item settled along the center line with trafficking and was considered failed due to roughness at 100 coverages (figure 12). The rated CBR was 1.9.

Item 3. Figure 13 shows item 3 prior to traffic. The item was considered failed due to roughness at 100 coverages (figure 14). The rated CBR was 4.8.

Test results

Results of trafficking lane 22 are summarized in table 1. Soil test data are shown in table 2. Table 1 contains drawbar pull values for the test vehicle operating over an asphalt-paved strip for comparison with drawbar pull measurements obtained on the test lane.

Item 1. Item 1 was considered failed due to roughness at 400 coverages. The following information was obtained from traffic tests on item 1.

a. **Roughness.** Differential deformations, shown in table 1, increased steadily with traffic coverages throughout testing. At failure the average transverse and diagonal differential deformations were both 2.63 in. Average longitudinal differential deformation was 1.38 in. Table 1 shows an average dishing measurement of 0.60 in. at failure.

b. Deformation. Figure 18 shows average cross-section deformations at 20 and 400 coverages for two typical mat runs. The cross section did not show uniform deformation with trafficking, but due to mat standoff, surface measurements were erratic. The particular mat run plotted, showing joint line 1.75 ft left of lane center line, was higher at 400 coverages than at 20 coverages due to extreme mat bridging in that area.* The profile deformation plot shown in figure 19 illustrates the progressive development of surface irregularities on the item.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are shown in figure 20 for three positions of the assembly relative to mat end joints. Deflections measured at 0, 20, and 400 coverages increased steadily throughout testing. Elastic soil deflection at 400 coverages was 1.0 in.

d. Rolling resistance. Drawbar pull values are shown in table 1 for several coverage levels during testing. Except for initial drawbar pull which changed little with trafficking, the drawbar values tended to increase with number of coverages.

e. Mat breaks. Mat breaks were first recorded at 100 coverages. Table 1 shows breaks as they developed with trafficking. The principal form of mat break was rivet failure.

Item 2. The item was considered failed due to roughness at 100 coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. Differential deformations that developed with trafficking are recorded in table 1. At 100 coverages the average transverse and diagonal differential deformations were 4.19 and 3.88 in., respectively. Dishing of individual mat panels averaged 0.25 in. at 100 coverages.

b. Deformation. Figure 18 shows average cross-section deformations at 20 and 100 coverages for two typical mat runs. Deformation measurements increased consistently between the two coverage levels shown. The surface was depressed across the center portion of the cross section with ridges forming along the lane edges. The profile plot in figure 19 shows the progressive settlement along the full length of the item.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are shown in figure 20 for three positions of the assembly relative to mat end joints. Elastic subgrade deflections are shown in table 1 for several coverage

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* The normal procedure is to plot the average of the deformations of two similar runs, but in this case the other run measured was eliminated at 300 coverages due to necessary subgrade repairs.

levels. At 100 coverages the elastic subgrade deflection was 1.0 in.

d. Rolling resistance. Drawbar pull values are shown in table 1 for 0, 20, and 100 coverages. Drawbar values showed overall increases with trafficking.

e. Mat breaks. No breaks were observed in the M8 mat surface during trafficking.

Item 3. Item 3 was considered failed due to roughness at 100 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. Differential deformations and rut depths measured at intervals throughout trafficking are shown in table 1. Transverse and diagonal differential deformations were most severe with average readings of 4.07 and 4.10 in., respectively, at 100 coverages. Rut depths averaged 3.62 in. at 100 coverages.

b. Deformation. Figure 18 shows average cross-section deformations measured at 20 and 100 coverages. The surface was greatly deteriorated at 100 coverages with a high ridge along the lane center line and smaller ridges near the lane edges. Figure 19 shows a profile along a line 1.75 ft west of the lane center line. The greatest deformations occurred in the segment of the item adjoining the mat-surfaced item.

c. Deflection. Average total soil deflections measured at 0, 20, and 100 coverages are shown in figure 20. Total soil deflection was greater at 20 coverages than at 100 coverages. Elastic soil deflections shown in table 1 follow a similar pattern with the maximum value occurring at 20 coverages.

d. Rolling resistance. Drawbar pull values are shown in table 1 for 0, 20, and 100 coverages. All drawbar values showed progressive increases with number of traffic 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:

Load, Wheel Assembly, and Tire Pressure	Type of Surface	Rated Subgrade CBR	Coverages at Failure
	Lane 21		
35,000-lb load; single-wheel assembly; 25.00-28, 30-ply tire at 50-psi inflation pressure	Modified T11 aluminum mat	1.5	600 (no failure)
	M8 steel mat	1.9	300
	Unsurfaced	4.7	300
	Lane 22		
70,000-lb load; twin-wheel assembly (42 in. c-c); 25.00-28, 30-ply tire at 50-psi inflation pressure	Modified T11 aluminum mat	1.8	400
	M8 steel mat	1.9	100
	Unsurfaced	4.8	100

TABLE 1

SUMMARY OF TRAFFIC DATA, TEST SECTION 9

Test Item	Cover-ages	Rated CBR	No. of Mat Breaks* A	B	C	D	E	Differential Deformation (in.) Longi-tudinal Max	Avg	Trans-verse Max	Avg	Diagonal Max	Avg	Dishing or Rutting (in.) Max	Avg	Drawbar Pull (kips) Ini-tial	Peak	Roll-ing	Average Total Deflection (in.) with Center Line of Wheel Assembly Located on: Unsurfaced Item Max	Center Line of Assembly	Quarter Point of Panel Max	Center Line of Assembly	Half Point of Panel Max	Center Line of Assembly	Joint of Panel Max	Center Line of Assembly	Elastic Sub-grade Deflec-tion (in.)	Remarks
Lane 21																												
1	0		--	--	--	--	--	--	--	--	--	--	--	--	--	3.5	2.8	0.7	--	--	--	1.5	--	0.3	--	1.6	--	Traffic suspended
Modified T11	20		--	--	--	--	--	0.63	0.50	0.63	0.50	0.50	0.47	0.50	0.35	3.1	1.6	0.7	--	--	--	1.5	--	0.7	--	1.6	--	at 600 cover-
aluminum	40		--	--	--	--	--	0.75	0.56	0.63	0.50	1.63	1.22	0.38	0.38	--	--	--	--	--	--	--	--	--	--	--	--	ages; no failure
landing mat	100		--	--	--	--	--	0.88	0.69	0.75	0.69	0.88	0.78	0.50	0.38	--	--	--	--	--	--	--	--	--	--	--	--	
	150	1.5	--	1	--	--	--	0.88	0.72	0.75	0.66	1.13	0.85	0.50	0.41	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	1	--	--	--	1.00	0.82	0.75	0.72	0.75	0.72	0.50	0.41	--	--	--	--	--	--	2.0	--	1.9	--	1.7	--	
	300		--	2	--	--	--	1.25	0.97	1.13	0.91	1.30	1.00	0.50	0.38	4.0	3.2	1.6	--	--	--	2.2	--	2.1	--	1.9	--	
	400		--	2	--	--	--	1.50	1.07	1.13	0.88	1.13	0.97	0.50	0.47	--	--	--	--	--	--	--	--	--	--	--	--	
	500		1	2	--	--	--	1.25	1.03	1.00	0.76	1.25	1.10	0.50	0.47	--	--	--	--	--	--	--	--	--	--	--	--	
	600		4	2	--	--	--	1.25	1.10	1.13	0.97	1.25	1.10	0.50	0.50	4.3	2.9	1.6	--	--	--	2.4	--	2.3	--	2.1	1.2	
2	0		--	--	--	--	--	--	--	--	--	--	--	--	--	3.1	2.5	0.5	--	--	--	1.9	--	1.1	--	1.1	1.7	Item failed at 300
M8 steel	20		--	--	--	--	--	0.63	0.38	1.13	1.00	1.13	0.91	0.13	0.13	3.5	1.5	0.6	--	--	--	1.0	--	1.2	--	1.3	--	coverages due to
landing mat	40		--	--	--	--	--	0.75	0.63	1.38	1.19	1.25	1.06	0.25	0.25	--	--	--	--	--	--	--	--	--	--	--	--	roughness
	100	1.9	--	--	1	--	--	0.88	0.81	1.75	1.50	1.75	1.44	0.25	0.25	--	--	--	--	--	--	--	--	--	--	--	--	
	150		4	--	1	--	--	0.88	0.85	2.00	1.78	2.13	1.91	0.13	0.13	--	--	--	--	--	--	--	--	--	--	--	--	
	200		5	--	1	--	--	1.00	0.88	2.13	1.78	2.13	1.85	0.13	0.13	--	--	--	--	--	--	1.4	--	1.4	--	1.7	1.2	
	300		10	0	2	3	0	1.38	1.26	3.25	2.97	3.50	3.03	0.25	0.19	3.9	3.5	1.7	--	--	--	1.9	--	1.3	--	1.9	1.5	
3	0		--	--	--	--	--	--	--	--	--	--	--	--	--	4.6	2.0	0.9	--	0.6	--	--	--	--	--	--	0.5	Item failed at 300
Unsurfaced	20		--	--	--	--	--	0.50	0.35	1.25	0.94	1.25	1.00	0.50	0.31	3.9	2.5	1.1	--	0.7	--	--	--	--	--	--	0.6	coverages due to
	40		--	--	--	--	--	0.50	0.25	2.50	1.78	--	--	0.75	0.50	--	--	--	--	--	--	--	--	--	--	--	--	roughness
	100	4.7	--	--	--	--	--	0.50	0.34	2.63	1.69	2.38	1.72	1.00	0.69	--	--	--	--	--	--	--	--	--	--	--	--	
	150		--	--	--	--	--	0.25	0.25	3.13	1.79	3.25	1.88	1.25	0.78	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	0.25	0.25	4.13	2.28	3.50	2.13	1.38	0.88	--	--	--	--	1.1	--	--	--	--	--	--	0.7	
	300		--	--	--	--	--	0.50	0.35	5.13	3.50	5.00	3.50	1.50	0.91	4.4	3.5	2.1	--	1.2	--	--	--	--	--	--	0.9	
Lane 22																												
1	0		--	--	--	--	--	--	--	--	--	--	--	--	--	8.0	5.6	3.9	--	--	2.3	2.1	2.2	2.1	2.4	2.4	--	Item failed at 400
Modified T11	20		--	--	--	--	--	0.75	0.63	1.00	0.75	1.00	0.94	0.50	0.38	8.4	7.8	5.3	--	--	3.1	3.1	3.0	3.7	2.1	2.1	--	coverages due to
aluminum	100	1.8	--	--	--	5	--	1.25	0.97	1.25	1.00	1.13	1.04	0.50	0.41	8.9	6.6	5.1	--	--	--	--	--	--	--	--	--	roughness
landing mat	200		--	--	--	12	--	1.63	1.19	1.75	1.50	2.00	1.38	0.75	0.41	--	--	--	--	--	--	--	--	--	--	--	--	
	300		6	33	23	24	--	1.50	1.22	2.38	2.00	2.25	1.97	0.75	0.63	--	--	--	--	--	--	--	--	--	--	--	--	
	400		7	60	42	27	--	1.63	1.38	2.75	2.63	2.88	2.63	0.63	0.60	7.9	7.8	5.6	--	--	5.0	4.8	5.0	4.4	5.8	5.7	1.0	
2	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.2	6.7	3.8	--	--	1.8	1.6	2.0	1.7	1.8	1.3	0.9	Item failed at 100
M8 steel	20	1.9	--	--	--	--	--	0.75	0.57	1.88	1.63	1.75	1.53	--	--	7.9	6.4	4.6	--	--	2.1	1.7	1.8	1.7	1.8	1.3	1.3	coverages due
landing mat	100		--	--	--	--	--	0.88	0.78	4.35	4.19	4.50	3.88	0.38	0.25	8.3	7.2	4.8	--	--	2.3	2.2	2.1	1.8	2.2	1.8	1.0	to roughness
3	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	4.6	2.7	1.2	0	--	--	--	--	--	--	0.5	Item failed at 100
Unsurfaced	20	4.8	--	--	--	--	--	0.25	0.22	2.00	1.78	2.25	1.75	1.88	0.88	7.2	6.8	3.5	1.6	0	--	--	--	--	--	--	0.7	coverages due
	100		--	--	--	--	--	1.00	0.91	5.00	4.07	6.00	4.10	3.75	3.62	9.7	7.8	5.1	1.4	+0.6	--	--	--	--	--	--	0.5	to roughness
Asphalt strip			--	--	--	--	--	--	--	--	--	--	--	--	--	5.3	1.7	3.0	--	--	--	--	--	--	--	--	--	

Note: For trafficking lane 21, a single-wheel assembly loaded to 35 kips was used. For lane 22, a twin-wheel assembly loaded to 70 kips was used. On both lanes, 25.00-28, 30-ply tires inflated to 50 psi were used.

* Break types are defined and illustrated in Part I.

TABLE 2

SUMMARY OF CBR, DENSITY, AND WATER CONTENT DATA, TEST SECTION 9

Test Item*	Type of Surface	Coverages	Depth (in.)	CBR	Water Content (%)	Dry Density (lb/cu ft)
			Lane 21			
1	Modified T11 aluminum landing mat	0	0	1.2	32.4	86.0
			6	0.7	34.1	83.8
			12	1.4	34.9	83.2
			18	1.7	35.0	82.9
		600	0	2.8	31.9	86.5
			6	1.6	35.2	84.0
			12	1.4	33.6	85.0
			18	1.6	34.3	85.4
2	M8 steel landing mat	0	0	1.6	31.5	86.9
			6	1.7	32.8	84.0
			12	2.7	32.2	85.9
			18	2.9	31.2	88.3
		300	0	2.1	31.7	88.6
			6	1.6	33.1	86.4
			12	1.6	34.0	85.7
			18	2.2	33.1	86.4
3	Unsurfaced	0	0	3.8	28.2	90.8
			6	4.4	28.0	92.5
			12	6.0	26.2	94.8
			18	4.8	28.7	91.6
		300	0	4.7	26.1	95.1
			6	5.3	27.6	92.9
			12	4.2	29.5	90.1
			18	3.8	31.9	86.5
			Lane 22			
1	Modified T11 aluminum landing mat	0	0	1.4	33.5	84.2
			6	0.7	35.6	82.5
			12	2.2	33.0	85.8
			18	1.3	35.1	82.8
		400	0	2.0	34.2	83.8
			6	1.8	34.7	83.8
			12	1.7	34.3	84.5
			18	2.0	35.0	83.4
2	M8 steel landing mat		0	1.2	32.3	86.5
			6	1.2	36.6	81.5
			12	2.4	34.0	84.5
			18	3.1	33.0	85.3
		100	0	2.2	32.1	86.4
			6	2.0	33.6	84.5
			12	2.1	32.4	87.5
			18	3.2	32.7	87.2
3	Unsurfaced	0	0	4.4	25.8	93.7
			6	4.5	28.9	91.7
			12	6.7	26.1	94.2
			18	3.0	29.8	89.1
		100	0	4.2	28.4	92.6
			6	4.1	28.7	92.8
			12	5.0	27.6	92.7
			18	3.5	29.8	91.2

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

Figure 2. Test load vehicle

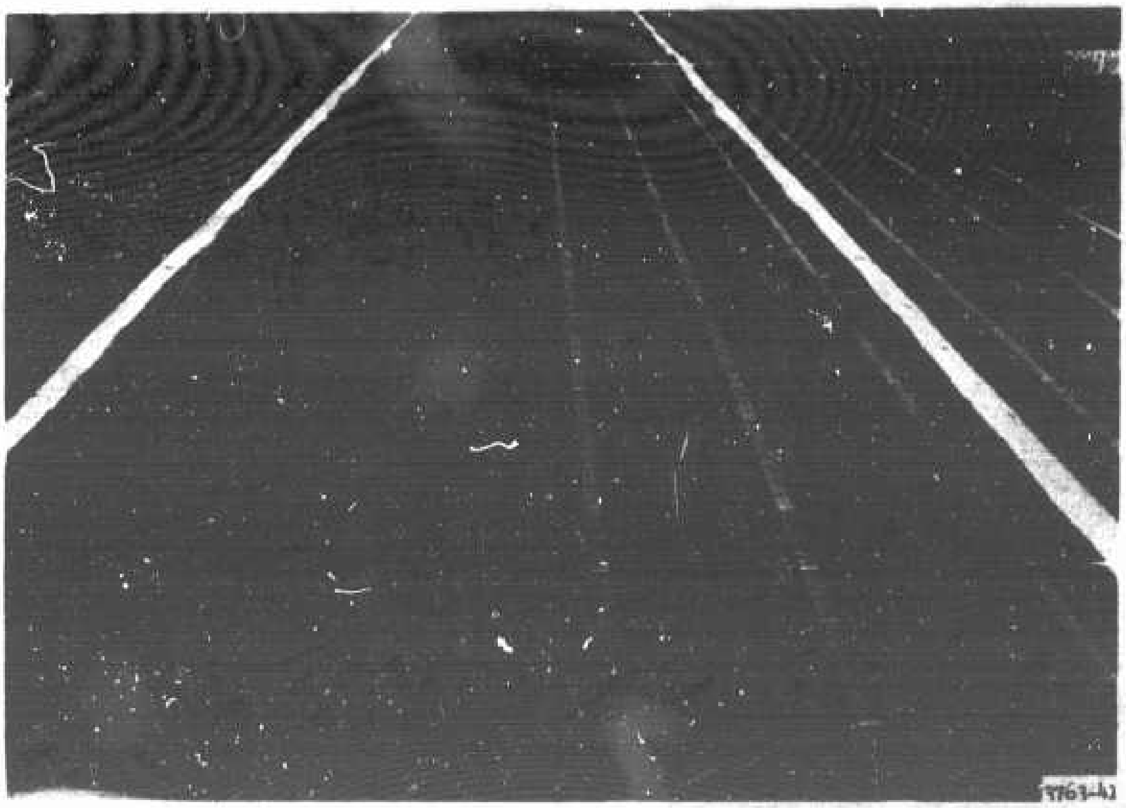


Figure 3. Lane 21, item 1, prior to traffic

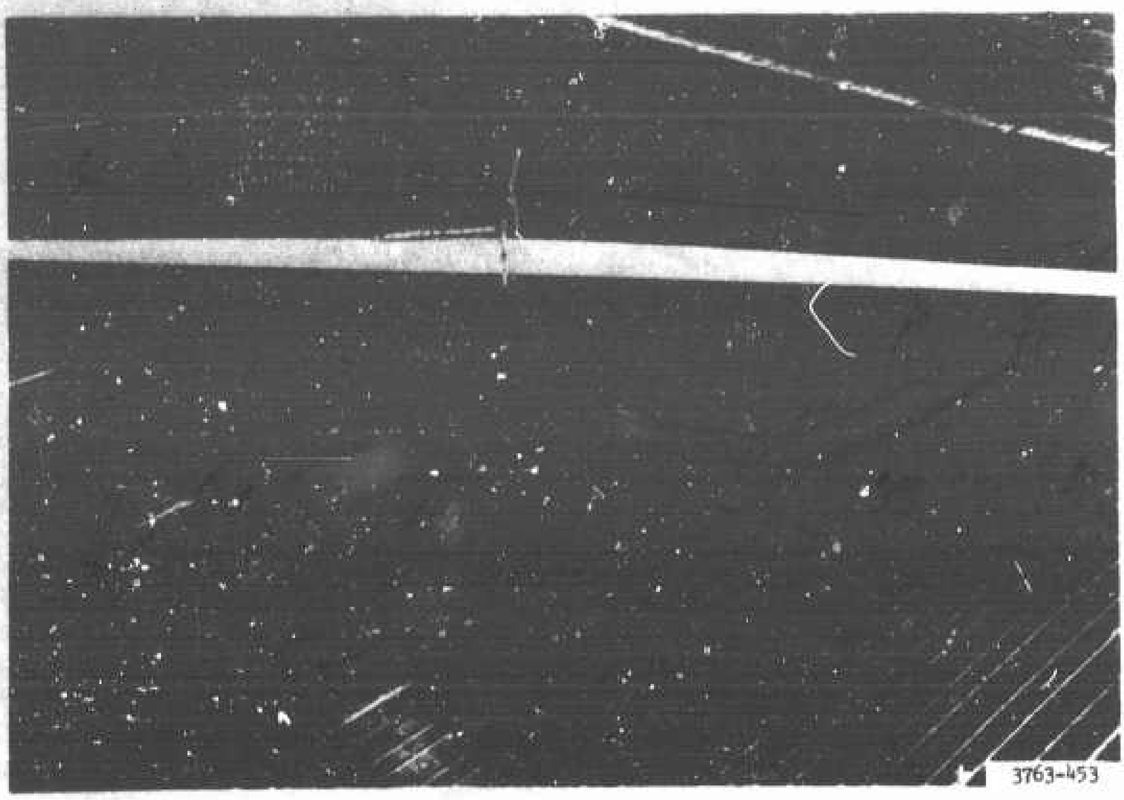


Figure 4. Lane 21, item 1. Diagonal straightedge shows small deformations existing at 600 coverages (traffic suspended)

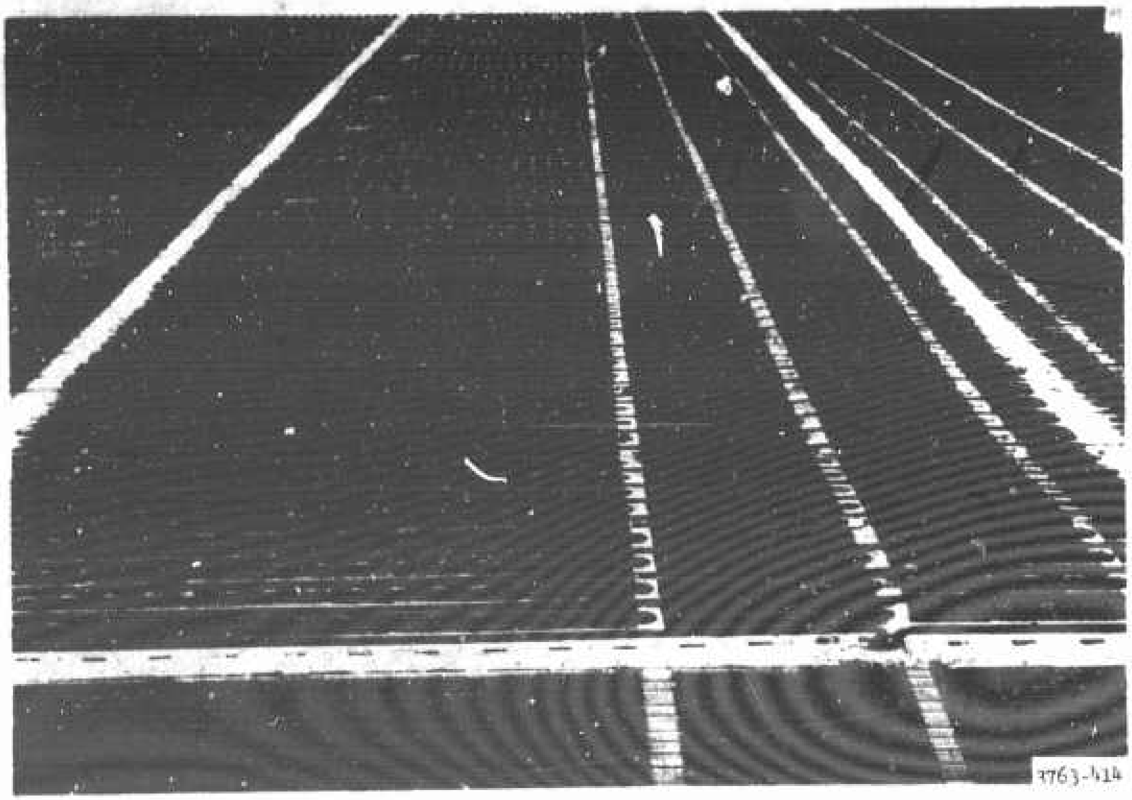


Figure 5. Lane 21, item 2, prior to traffic

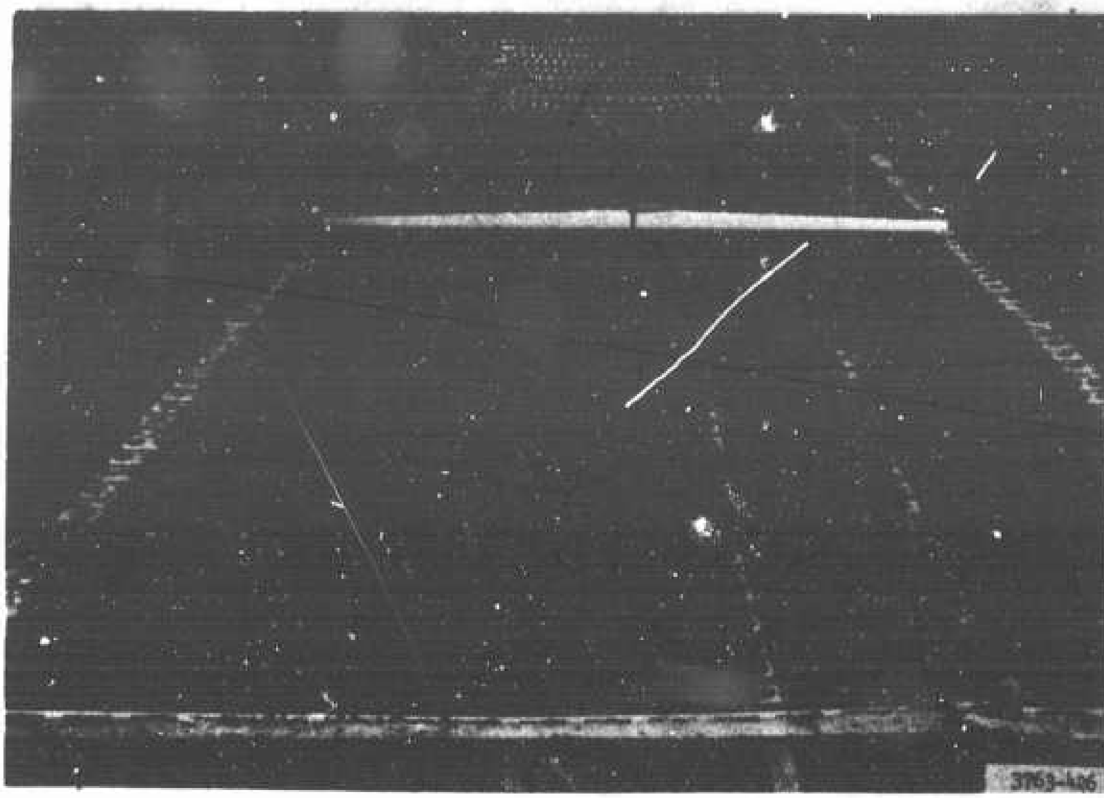


Figure 6. Lane 21, item 2. Transverse straightedge shows roughness at 300 coverages (failure)

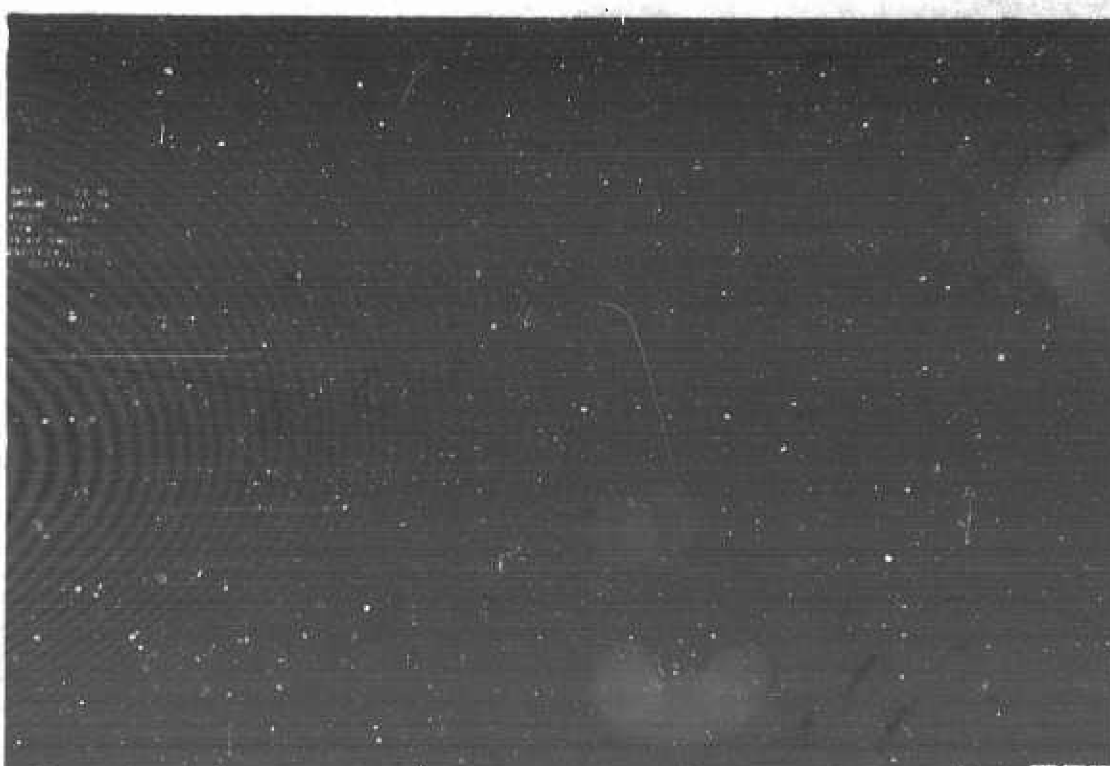


Figure 7. Lane 21, item 3, prior to traffic

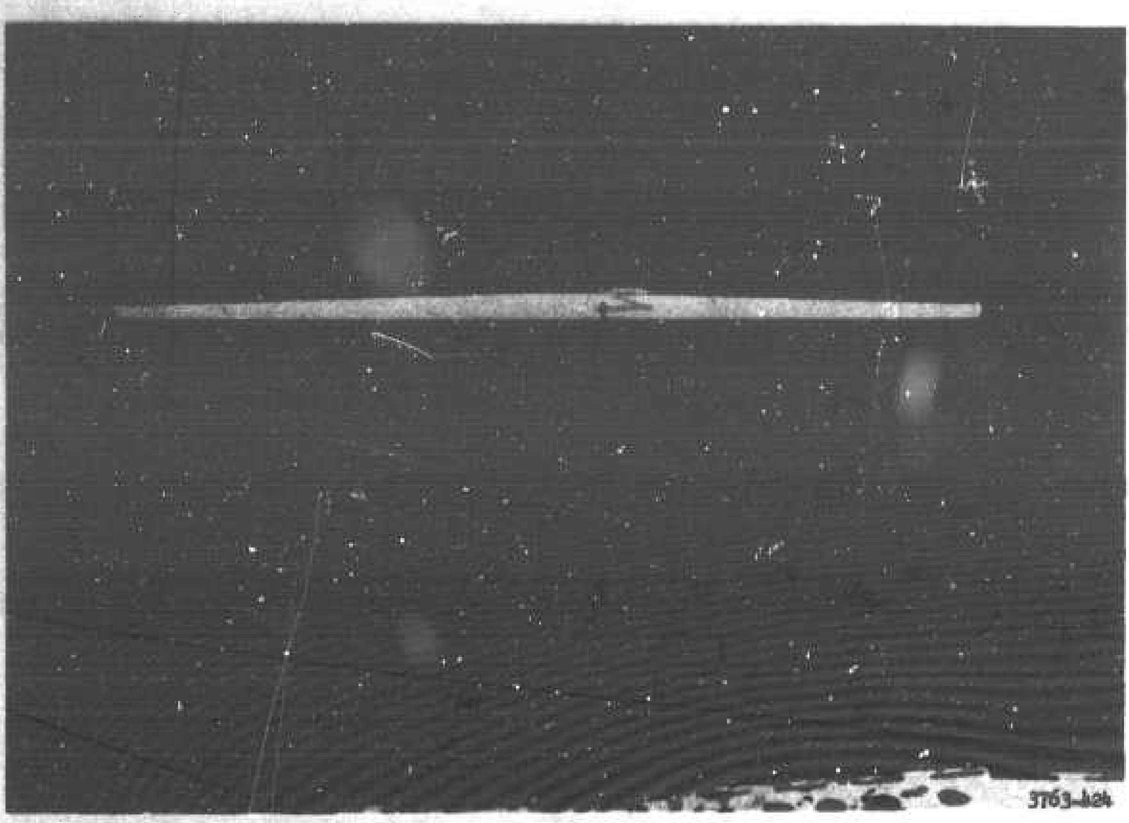


Figure 8. Lane 21, item 3. Transverse straightedge shows roughness at 300 coverages (failure)

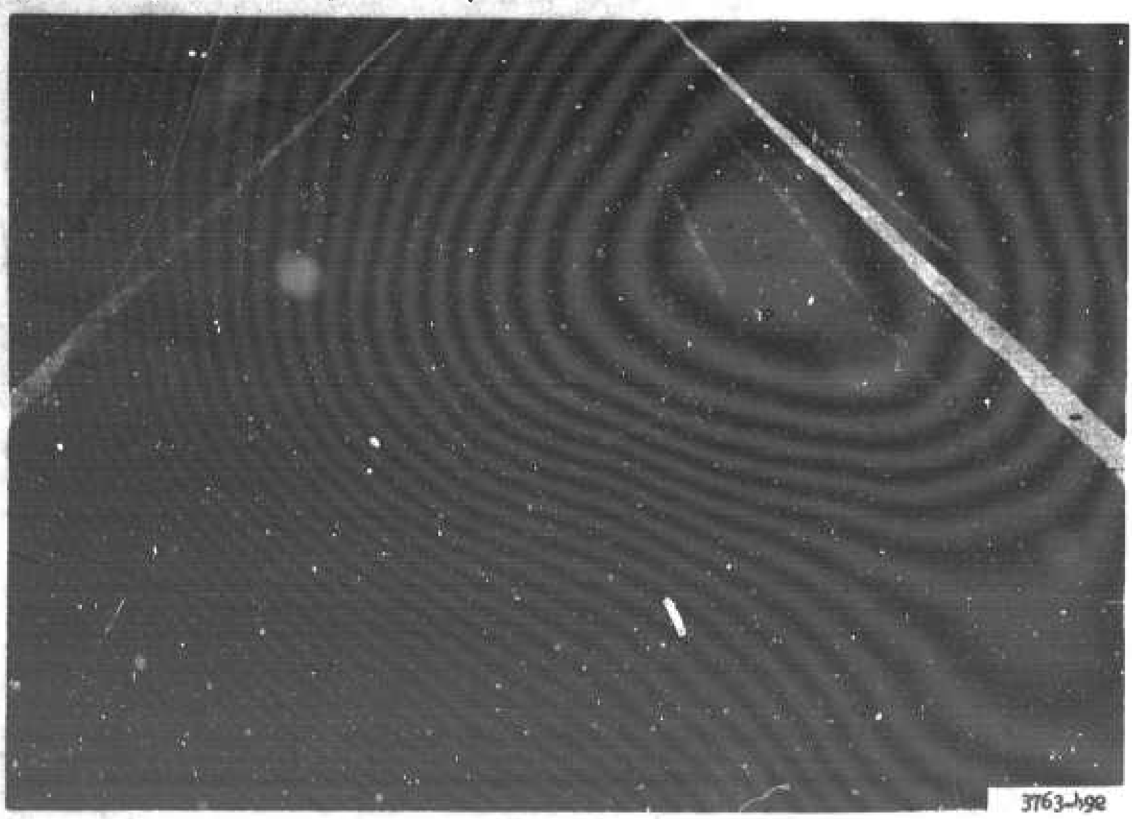


Figure 9. Lane 22, item 1, prior to traffic

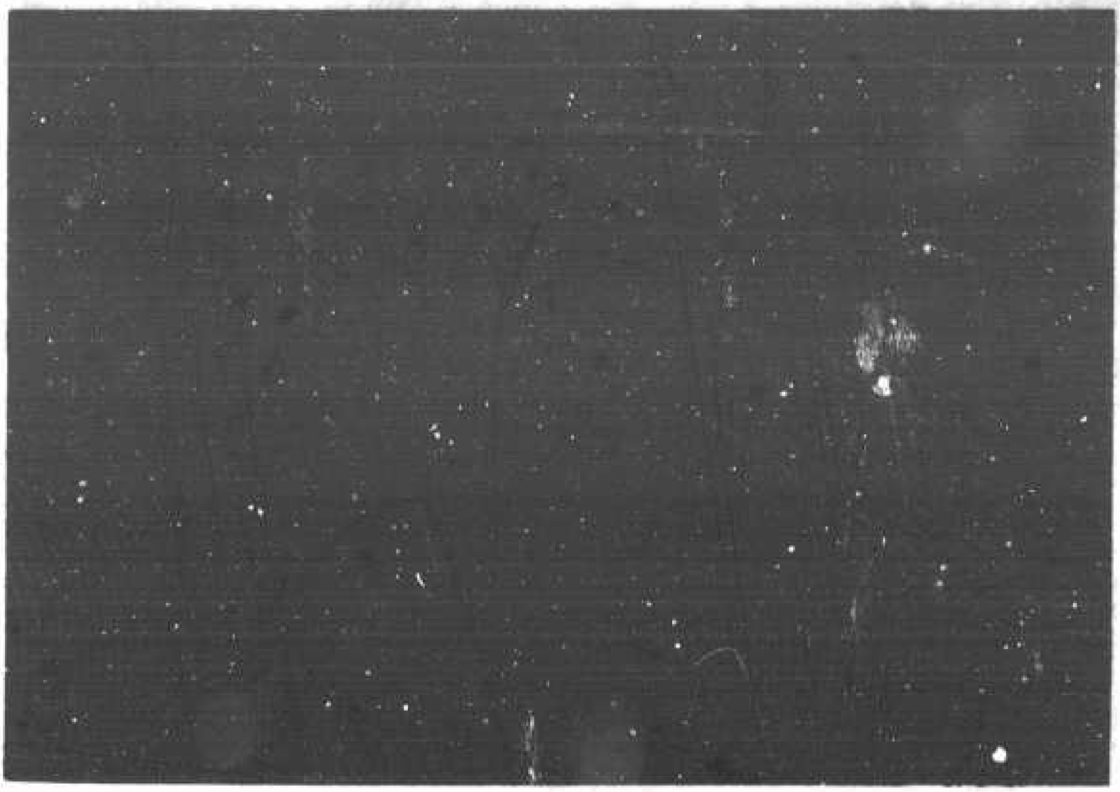


Figure 10. Lane 22, item 1. Transverse straightedge shows roughness at 400 coverages (failure)

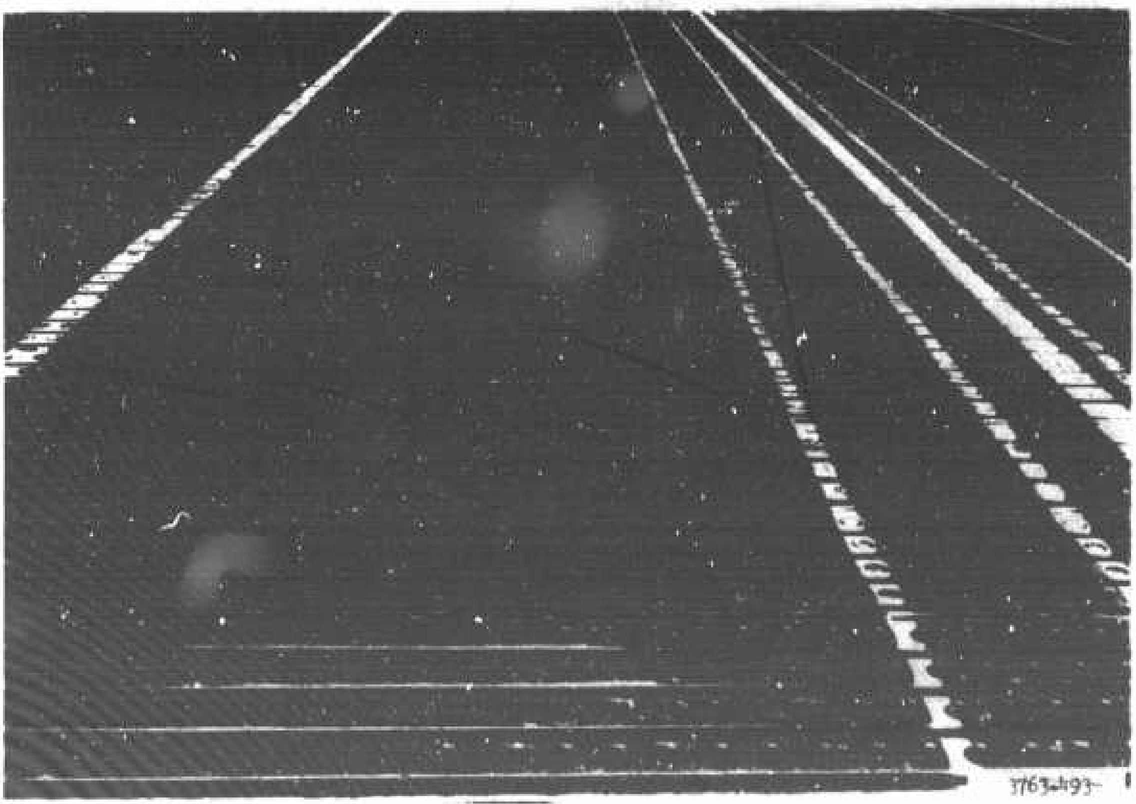


Figure 11. Lane 22, item 2, prior to traffic

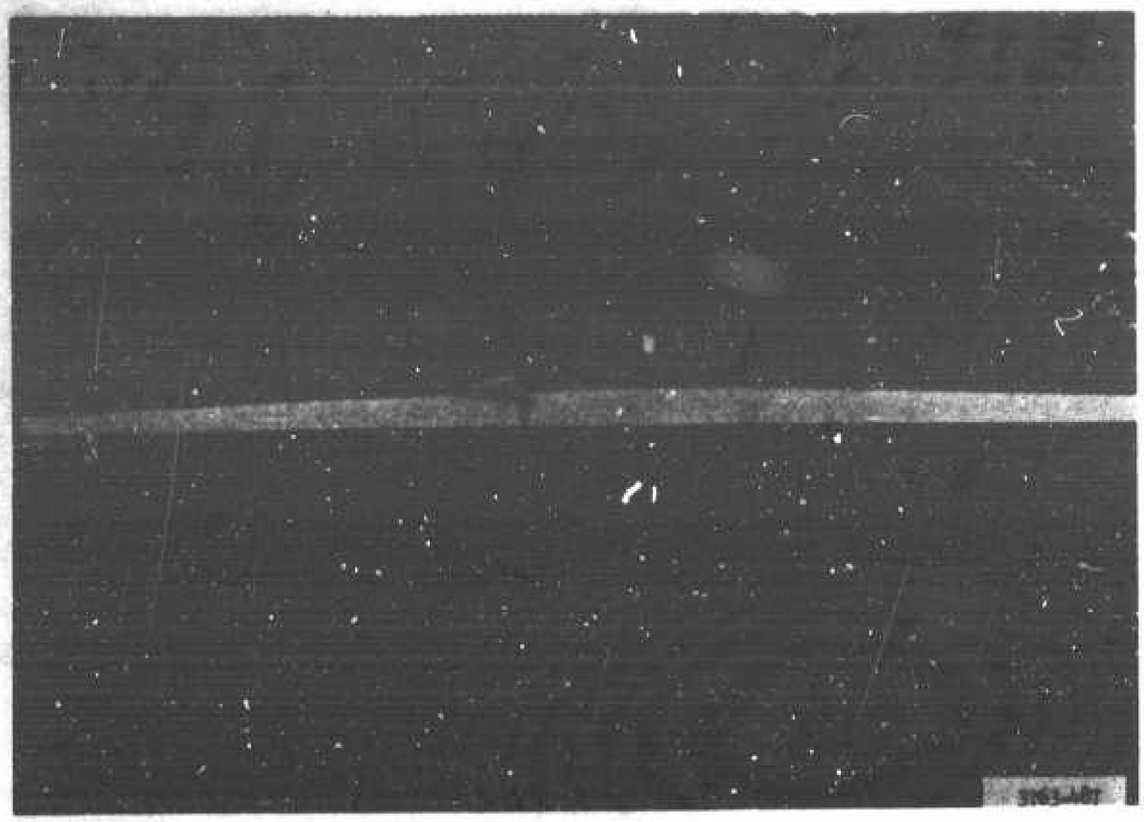


Figure 12. Lane 22, item 2. Transverse straightedge shows roughness at 100 coverages (failure)

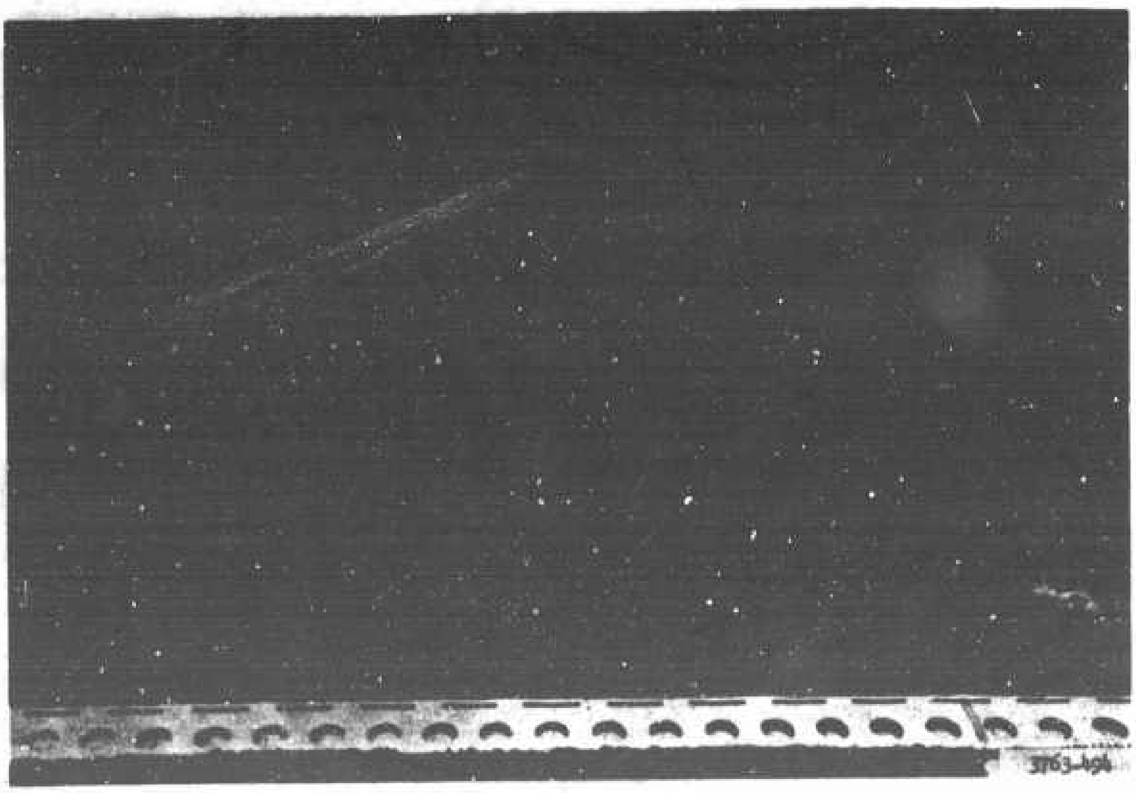


Figure 13. Lane 22, item 3, prior to traffic

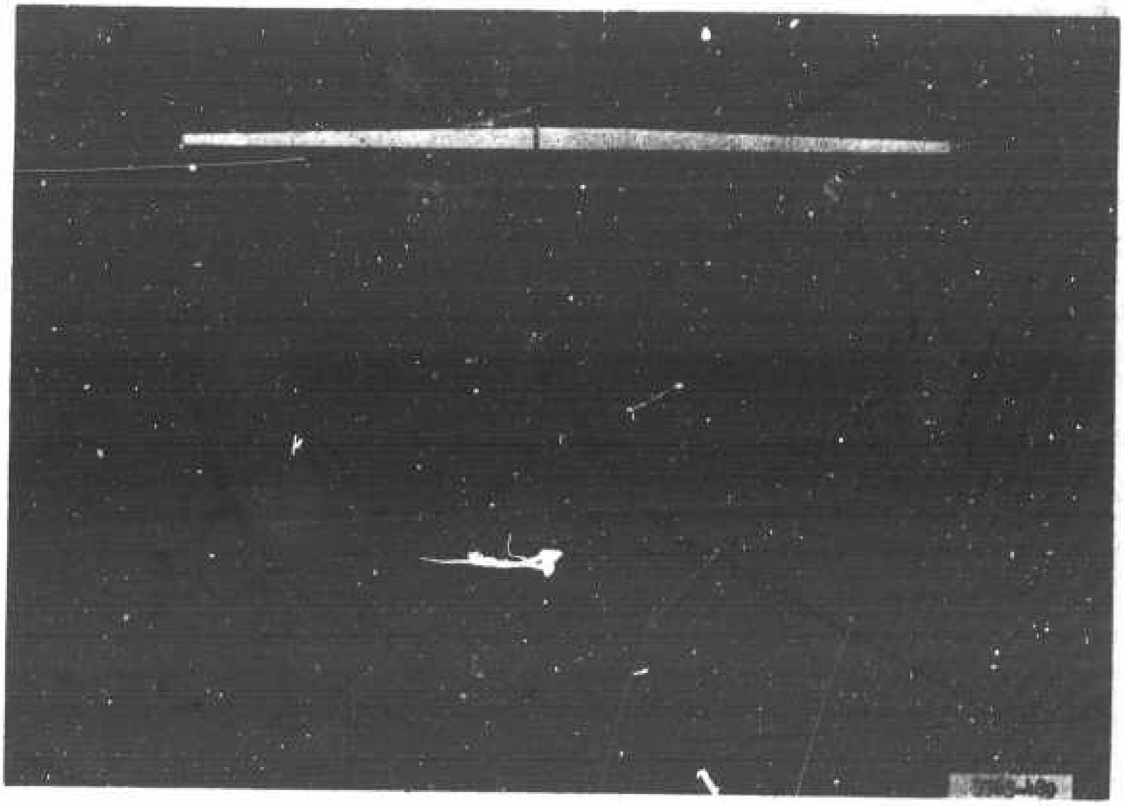
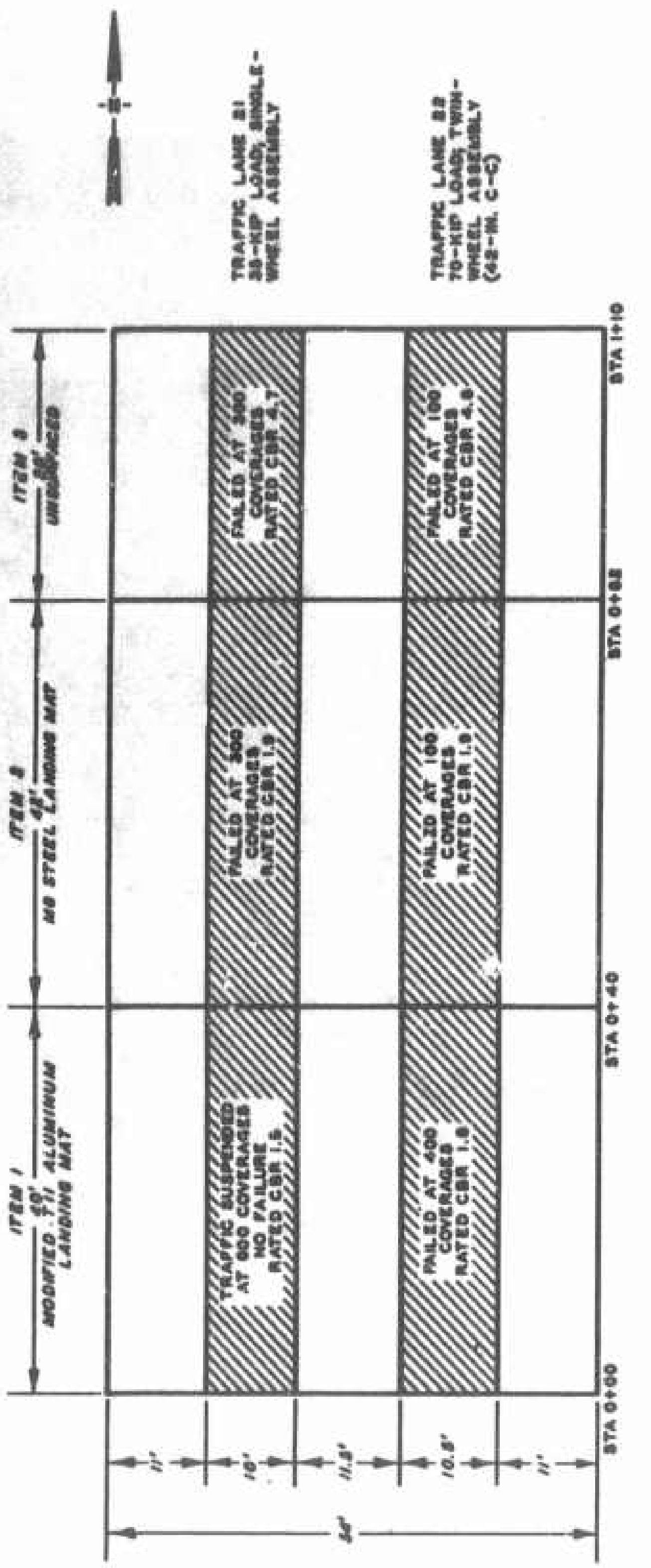


Figure 14. Lane 22, item 3. Transverse straightedge shows roughness at 100 coverages (failure)



LAYOUT OF TEST SECTION 9
AND SUMMARY OF TEST RESULTS
25.00 X 28, 30-PLY TIRES
50-PSI INFLATION PRESSURE

Figure 15

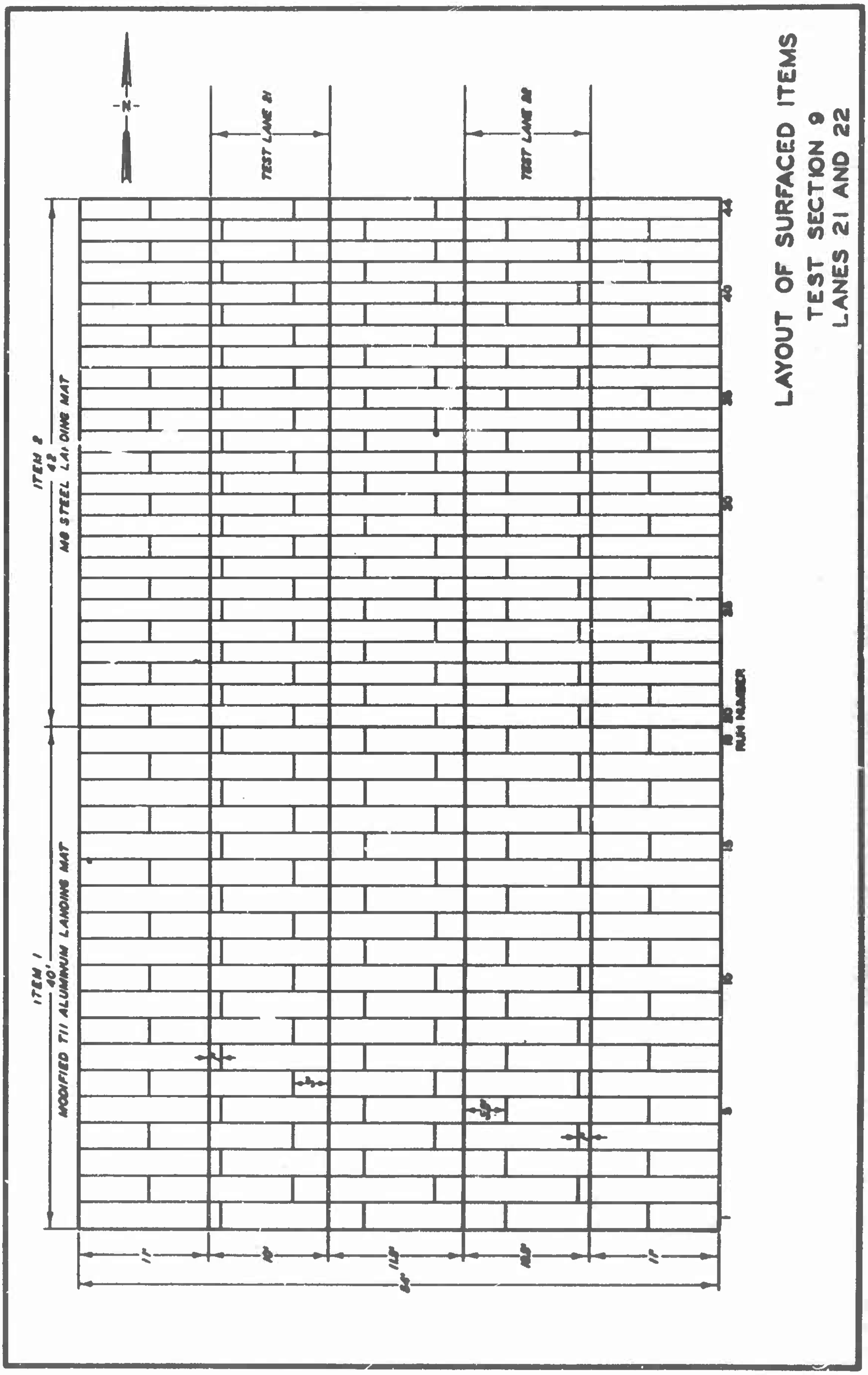

LAYOUT OF SURFACED ITEMS
TEST SECTION 9
LANES 21 AND 22
ITEM 1
40'
MODIFIED T11 ALUMINUM LANDING MAT
ITEM 2
42'
M8 STEEL LANDING MAT
TEST LANE 21
TEST LANE 22
RUN NUMBER

Figure 16

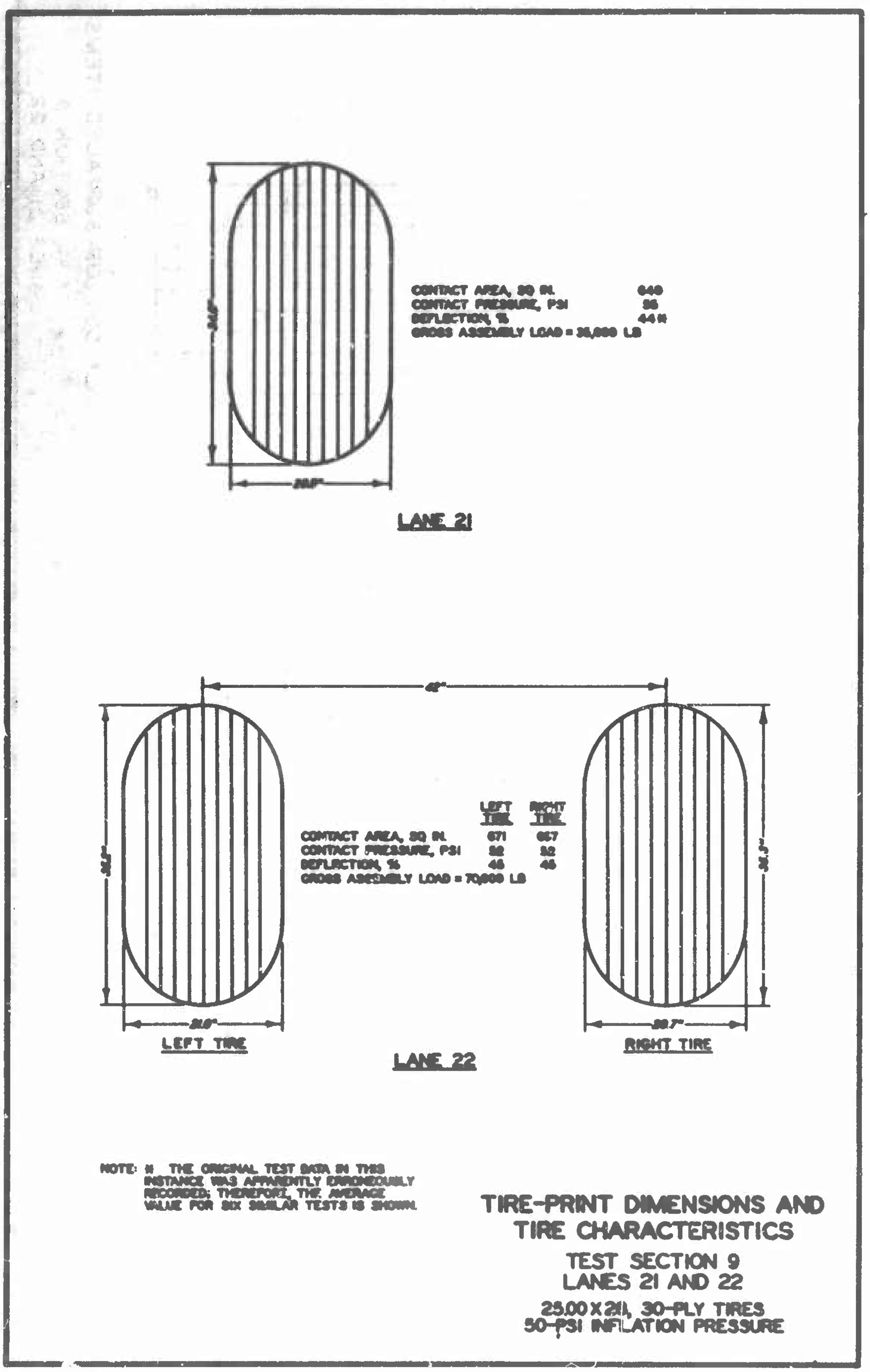
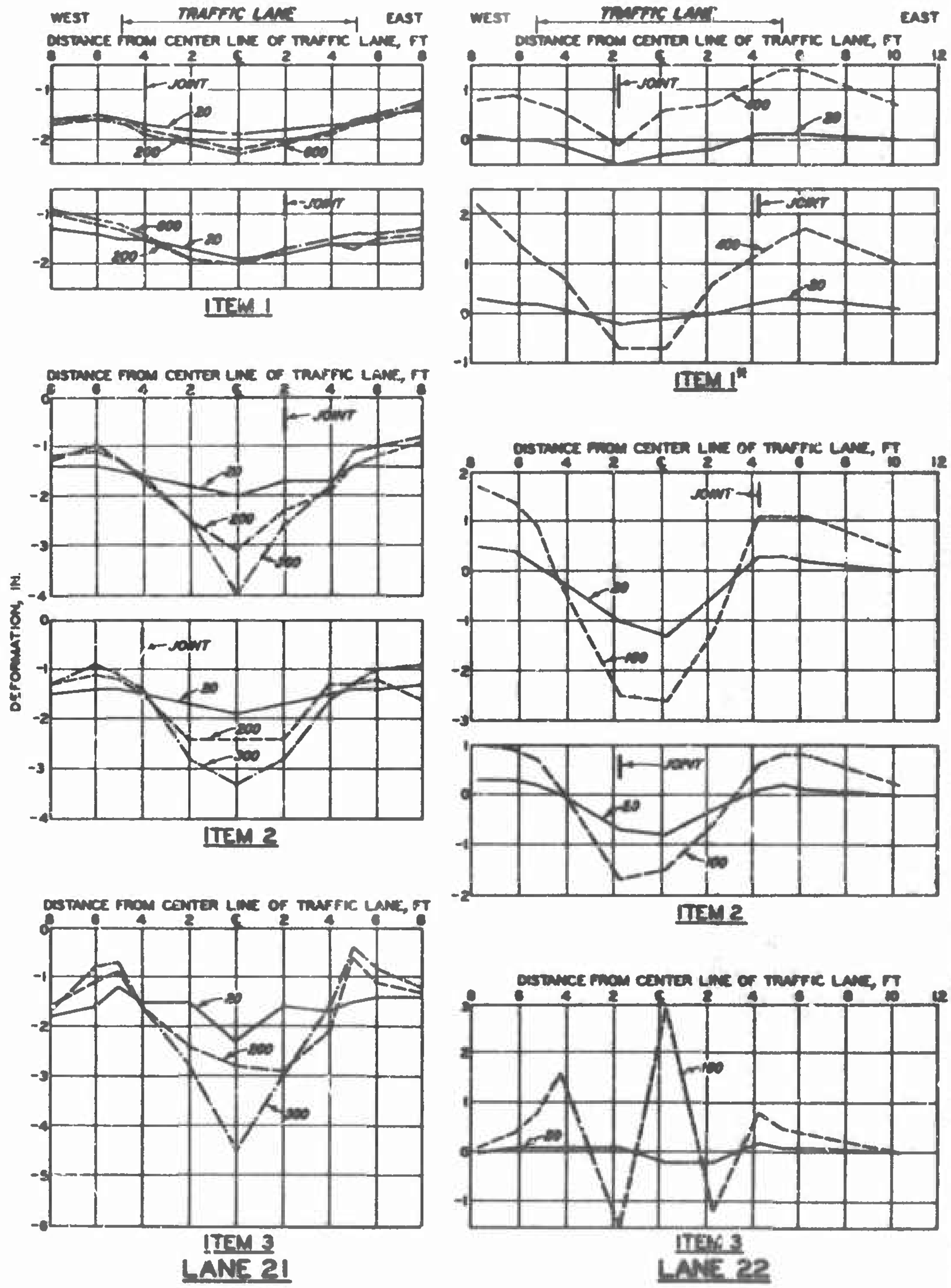

CONTACT AREA, SQ IN. 649
CONTACT PRESSURE, PSI 55
DEFLECTION, % 44*
GROSS ASSEMBLY LOAD = 35,000 LB
LANE 21
LEFT TIRE RIGHT TIRE
CONTACT AREA, SQ IN. 671 667
CONTACT PRESSURE, PSI 52 52
DEFLECTION, % 46 46
GROSS ASSEMBLY LOAD = 70,000 LB
LEFT TIRE
RIGHT TIRE
LANE 22
NOTE: * THE ORIGINAL TEST DATA IN THIS INSTANCE WAS APPARENTLY ERRONEOUSLY RECORDED; THEREFORE, THE AVERAGE VALUE FOR SIX SIMILAR TESTS IS SHOWN.
TIRE-PRINT DIMENSIONS AND TIRE CHARACTERISTICS
TEST SECTION 9
LANES 21 AND 22
25.00 X 24, 30-PLY TIRES
50-PSI INFLATION PRESSURE

Figure 17



LEGEND

20 NUMBER OF COVERAGES

NOTE: * DEFORMATIONS SHOWN AT 400 COVERAGES REPRESENT ONLY ONE MAT RUN DUE TO REMOVAL AT 300 COVERAGES OF SIMILAR MAT RUN BEING MEASURED.

AVERAGE CROSS-SECTIONAL DEFORMATIONS

TEST SECTION 9
LANES 21 AND 22

Figure 18

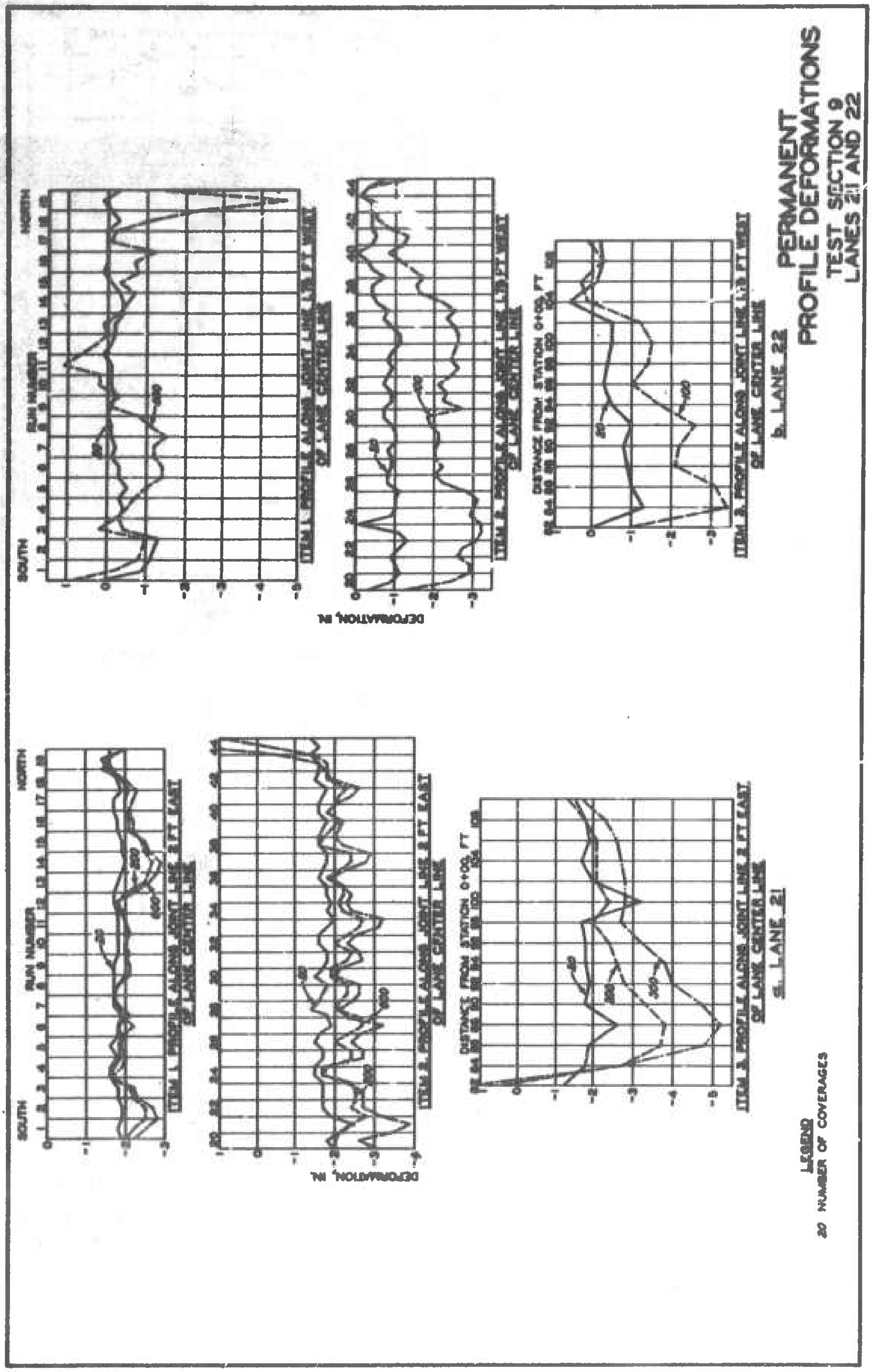
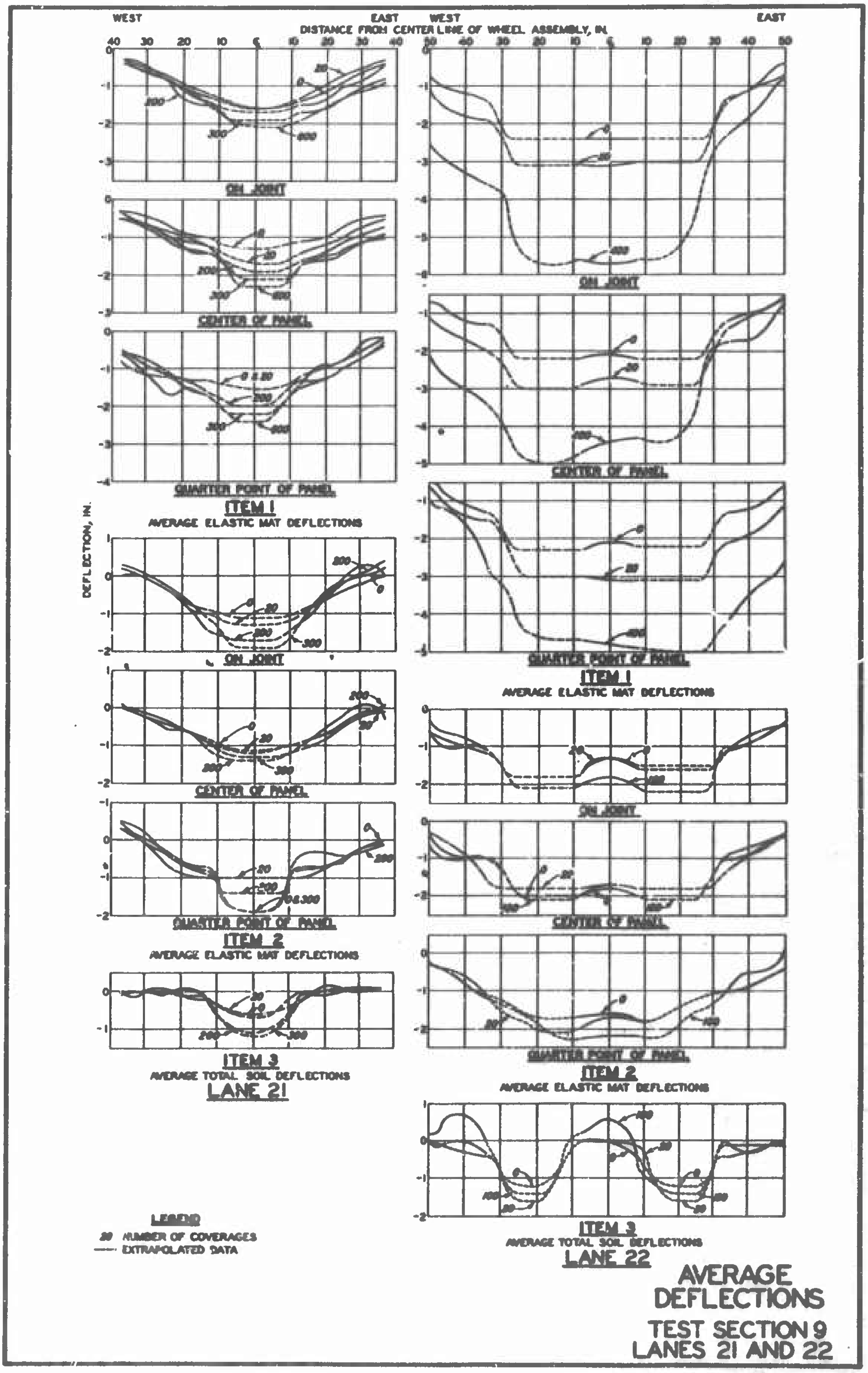

PERMANENT
PROFILE DEFORMATIONS
TEST SECTION 9
LANES 21 AND 22
a. LANE 21
b. LANE 22
DEFORMATION, IN.
RUN NUMBER
SOUTH
NORTH
LEGEND
20 NUMBER OF COVERAGES

Figure 19



WEST
EAST
WEST
EAST
DISTANCE FROM CENTER LINE OF WHEEL ASSEMBLY, IN.
DEFLECTION, IN.
ON JOINT
CENTER OF PANEL
QUARTER POINT OF PANEL
ITEM 1
AVERAGE ELASTIC MAT DEFLECTIONS
ITEM 2
AVERAGE ELASTIC MAT DEFLECTIONS
ITEM 3
AVERAGE TOTAL SOIL DEFLECTIONS
LANE 21
LANE 22
LEGEND
20 NUMBER OF COVERAGES
---- EXTRAPOLATED DATA
AVERAGE DEFLECTIONS
TEST SECTION 9
LANES 21 AND 22

Figure 20

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Engineer Waterways Experiment Station	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

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Part X Data Report on Test Section 9

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Final Technical Report

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Hill, W. J., Jr.

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Air Force Flight Dynamics Laboratory Research and Technology Division AF Systems Command, WPAFB, Ohio

13. ABSTRACT

This data report describes the results of work undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft.

DD FORM 1 JAN 64 1473

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
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Rolling Resistance						
Rear Area Airfields						
Support Area Airfields						
Forward Area Airfields						
Vehicle Mobility						

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