AIRCRAFT GROUND-FLOTATION INVESTIGATION
PART VII DATA REPORT ON TEST SECTION 6

W. BRABSTON and W. HILL, JR.
U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

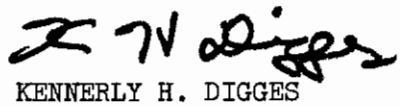
FOREWORD

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., 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.



KENNERLY H. DIGGES
Chief, Mechanical Branch
Vehicle Equipment Division
AF Flight Dynamics Laboratory

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 was surfaced with M8 steel landing mat, and item 3 was unsurfaced. Traffic was applied to one lane using a 35,000-lb load on a single-wheel assembly consisting of one 25.00-28, 30-ply aircraft tire inflated to 50 psi. When this combination of load and wheel assembly did not produce failure in the traffic lane, the same assembly with a 60,000-lb load and 100-psi tire inflation pressure was applied. On the other test lane, traffic was applied with a 120,000-lb load on a twin-wheel assembly consisting of two 25.00-28, 30-ply aircraft tires spaced 56 in. c-c and inflated to 100 psi.

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.

CONTENTS

ILLUSTRATIONS AND TABLES

SUMMARY

Tests on Section 6 are one phase of a comprehensive research program to develop ground-flotation criteria for heavy cargo-type aircraft. Section 6 was laid out to accommodate two test lanes, lanes 11 and 12, each of which was divided into three items having different subgrade CBR values and different traffic surfaces (figure 18). 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 lane 11 with a 35,000-lb load on a single-wheel assembly consisting of one 25.00-28, 30-ply aircraft tire inflated to 50 psi. No failure condition was reached on lane 11 and the lane was redesignated lane 11A for additional trafficking with the same single-wheel assembly but with a 60,000-lb load and tire inflation pressure of 100 psi. Traffic was applied to lane 12 with a 120,000-lb load on a twin-wheel assembly consisting of two 25.00-28, 30-ply aircraft tires spaced 56 in. c-c and inflated to 100 psi. Figure 20 gives pertinent tire-print dimensions and tire characteristics.

Except for lane 11 on which traffic was suspended due to increasing subgrade CBR values, 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 different wheel assemblies. Basic performance data are summarized in the following paragraphs.

Lane 11

Traffic was discontinued at 600 coverages on lane 11 because the CBR was increasing with traffic and an excessive amount of time would have been required to develop a failure.

Item 1

The item showed no significant damage when traffic was suspended at 600 coverages. The rated CBR was 1.5.

Item 2

The item showed no significant damage when traffic was suspended at 600 coverages. The rated CBR was 4.1.

Item 3

The item showed no significant damage when traffic was suspended at 600 coverages. The rated CBR was 12.

Lane 11A

Item 1

The item was considered failed due to roughness at 130 coverages. The rated CBR was 2.3.

Item 2

The item was considered failed due to roughness at 130 coverages. The rated CBR was 4.3.

Item 3

The south end of the item (designated 3A) was considered failed due to rutting at 112 coverages. Traffic on the item was continued to 130 coverages at which time the remaining segment (designated 3B) was considered failed due to rutting. Segment 3A had a rated CBR of 12 and segment 3B a rated CBR of 16.

Lane 12

Item 1

The item was considered failed due to roughness at 90 coverages. The rated CBR was 2.9.

Item 2

The item was considered failed due to roughness at 44 coverages. The rated CBR was 4.2.

Item 3

The item was considered failed due to roughness at 44 coverages. The rated CBR was 9.0.

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART VII DATA REPORT ON TEST SECTION 6

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 effects of trafficking with a single-wheel assembly and a twin-wheel assembly on landing mat and unsurfaced soils.

Prosecution of this investigation consisted of constructing two similar traffic lanes and subjecting them to traffic of a single-wheel, 35,000-lb load; a single-wheel, 60,000-lb load; and a twin-wheel, 120,000-lb load.

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

Test Section 6 (figure 18) was constructed within a roofed area in order to allow control of the subgrade CBR (California Bearing Ratio) in the test items. Section 6 was located on the same site as Sections 2 and 4 of this series. The construction of Section 2 is described in Part III of this report. The underlying subgrade was undisturbed by the two prior tests so that in construction of Section 6 only the upper 2 ft of soil was excavated. The excavated area was backfilled in four lifts with a heavy clay soil (buckshot; classified as CH according to the Unified Soil Classification System, MIL-STD-619). The fill material used was a local clay with a plastic limit of 27, liquid limit of 58, and plasticity index of 31. 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 (figure 18) by controlling the water content and compaction effort. Items 1 and 2 were surfaced with modified T11 aluminum and M8 steel landing mat, respectively (figure 19). Item 3 remained unsurfaced. The landing mats used are described and illustrated in Part I.

Load Vehicle

The load vehicle used for trafficking Section 6 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. For trafficking lanes 11 and 11A, a single-wheel assembly was used with 35,000- and 60,000-lb loads, respectively. A 25.00-28, 30-ply aircraft tire was used on both lanes with inflation pressures of 50 and 100 psi on lanes 11 and 11A, respectively. On lane 12, a 120,000-lb load was used on a twin-wheel assembly consisting of two 25.00-28, 30-ply aircraft tires spaced 56 in. c-c and inflated to 100 psi. Tire-print data and pertinent tire characteristics are given in figure 20.

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

Application of Traffic

On lanes 11 and 11A, the load vehicle was operated to produce uniform traffic coverage. 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 1a shows the general method of applying uniform coverages on lanes 11 and 11A.

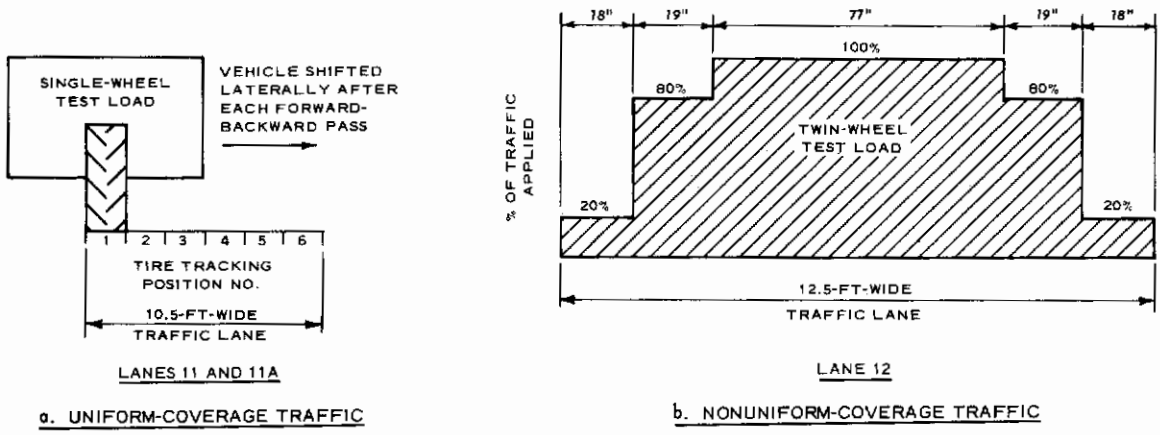


Figure 1. Traffic distribution

Traffic was applied to lane 12 in a nonuniform fashion with the intensity of traffic being varied across the lane width to produce three zones of approximately 100, 80, and 20 percent traffic coverage. The coverage levels referred to in the tables and text in this report 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 proportionally less in accord with the percentage factor for the respective zones, as shown in figure 1b.

Failure Criteria and Data Collected

Failure criteria used in this investigation and descriptive terms used in presentation and discussion of data in all parts in this report 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 11

Behavior of items under traffic

All items in lane 11 were relatively undamaged at 600 coverages when traffic was suspended due to increasing subgrade CBR.

Item 1. Figure 3 shows item 1 prior to traffic. The item sustained 600 traffic coverages without developing appreciable deformations or roughness. No signs of failure were in evidence when traffic was suspended at 600 coverages (figure 4). The rated CBR of the item was 1.5.

Item 2. Figure 5 shows item 2 prior to traffic. Traffic was suspended at 600 coverages with no discernible damage evident (figure 6). The rated CBR was 4.1.

Item 3. Figure 7 shows item 3 prior to traffic. Very shallow surface deformations were evident when traffic was suspended at 600 coverages (figure 8). The item remained in good condition. The rated CBR was 12.

Test results

Results of trafficking lane 11 are summarized in table 1. Soil test data are shown in table 2. Table 1 contains drawbar pull values for the load vehicle operated over an asphalt strip for comparison with drawbar pull values recorded on the test items.

Item 1. Item 1 showed no signs of failure when traffic was suspended at 600 coverages. The following information was obtained from traffic tests on item 1.

a. Roughness. Table 1 shows the very slow development of differential deformations. Practically no increase occurred between 300 and 600 coverages. Average longitudinal, transverse, and diagonal differential deformations measured 0.43, 0.28, and 0.38 in., respectively, at 600 coverages. Dishing averaged 0.21 in.

b. Deformation. Figure 21 shows average cross-section deformations for two typical mat runs at 20 and 600 coverages. Center-line profiles along the item at 20 and 600 coverages are presented in figure 22. The uniform subsidence of the item is illustrated in the profile plots.

c. Deflection. Average elastic mat deflections measured at 0 and 600 coverages are shown in figure 23 for three positions of wheel assembly relative to mat end joints.

d. Rolling resistance. Drawbar pull values for numerous coverage levels are presented in table 1. Rolling drawbar pull values registered a very slight increase with trafficking. Initial and peak values were less consistent with some erratic measurements.

e. Mat breaks. No breaks occurred in the T11 landing mat surface before traffic was suspended at 600 coverages.

Item 2. Item 2 showed no signs of failure when traffic was suspended at 600 coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. Table 1 shows the small magnitude of differential deformations at 600 coverages. Average longitudinal, transverse, and diagonal differential deformations measured 0.43, 0.25, and 0.30 in., respectively, at 600 coverages. Dishing effects were negligible.

b. Deformation. Average cross-section deformations at 20 and 600 coverages are shown in figure 21 for two typical mat runs. Center-line profiles along the item are shown in figure 22 for the 20- and 600-coverage levels. The profile plots illustrate the uniform subsidence of the item under traffic.

c. Deflection. Average elastic mat deflections measured at 0 and 600 coverages are shown in figure 23 for three positions of wheel assembly relative to mat end joints. Elastic soil deflections are shown in table 1 for several coverage levels.

d. Rolling resistance. Drawbar pull values for several coverage levels are listed in table 1. Peak and rolling drawbar pull values were nearly constant throughout testing while initial drawbar pull measurements varied some and showed a marked decrease at the 600-coverage level.

e. Mat breaks. No breaks developed in the M8 landing mat surface before traffic was suspended at 600 coverages.

Item 3. Item 3 did not show signs of failure when traffic was suspended at 600 coverages.

a. Roughness. Table 1 shows the development of small differential deformations with traffic. There was some decrease in transverse and diagonal differential deformations between 300 and 600 coverages. Rut depths also showed a decrease at 600 coverages.

b. Deformation. Figure 21 presents the average cross-section deformations at the 20- and 600-coverage levels. Profile plots along the item center line are shown in figure 22. Cross-section and profile plots illustrate the generally uniform subsidence of the item under traffic.

c. Deflection. Average total soil deflections measured at 0 and 600 coverages are presented in figure 23. Elastic soil deflections are given in table 1.

d. Rolling resistance. Drawbar pull values measured at several coverage levels are shown in table 1. Peak and rolling drawbar pull values were practically unchanged with trafficking. Initial drawbar pull values registered a large decrease between 300 and 600 coverages.

Lane 11A

After 600 traffic coverages, items in lane 11 were essentially undamaged so the lane was redesignated 11A for renewed trafficking under increased load and tire inflation pressure. All items were tracked to failure.

Behavior of items under traffic

Item 1. Item 1 prior to renewed trafficking is shown in figure 4. At 130 coverages, the item was considered failed due to roughness (figure 9). The rated CBR of the item was 2.3.

Item 2. Item 2 prior to renewed trafficking is shown in figure 6. The item was considered failed due to roughness at 130 coverages (figure 10). The rated CBR was 4.3.

Item 3. Item 3 prior to renewed trafficking is shown in figure 8. At 112 coverages the south end of the item (sta 0+80 to 0+95) was considered failed due to rutting; the north end of the item was in good condition. The north and south ends were then designated segments 3B and 3A, respectively, and traffic was continued to 130 coverages at which time segment 3B was considered failed due to rutting (figure 11). As the figure shows, the principal area of deterioration was along one side of the lane where a severe rut developed reaching a maximum depth of 3.32 in. The rated CBR of segment 3A was 12. Segment 3B had a rated CBR of 16.

Test results

Results of trafficking lane 11A are summarized in table 1. Soil test data are given in table 2. Table 1 contains drawbar pull values for the load vehicle operated over an asphalt strip for comparison with drawbar pull values recorded on the test lane.

Item 1. Item 1 was considered failed due to roughness at 130 coverages. 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 failure the average longitudinal, transverse, and diagonal differential deformations measured 1.16, 2.19, and 1.88 in., respectively. Average dishing reached 0.47 in. at failure.

b. Deformation. Figure 21 shows average cross-section deformations at 20 and 130 coverages for two typical mat runs. Center-line profiles at the same coverage levels are shown in figure 22.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are shown in figure 23 for three positions of the assembly relative to mat end joints. Elastic soil deflection at failure was 2.1 in.

d. Rolling resistance. Drawbar pull values recorded at intervals during the test period are shown in table 1. Rolling drawbar pull registered a slight decrease at 130 coverages from prior measurements. Peak drawbar pull values were relatively constant throughout testing while the initial drawbar pull registered a substantial decrease at 130 coverages.

e. Mat breaks. The number and type of mat breaks are shown in table 1 for several traffic-coverage levels. No breaks were evident at 20 coverages, but breaks increased rapidly thereafter to failure.

Item 2. Item 2 was considered failed due to roughness at 130 coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. Differential deformations that developed with trafficking are shown in table 1. A consistent increase in differential deformations occurred up to the time of failure. At failure the average longitudinal, transverse, and diagonal differential deformations were 1.47, 2.00, and 1.91 in., respectively. Average dishing reached 0.41 in.

b. Deformation. Figure 21 shows average cross-section deformations at 20 and 130 coverages for two typical mat runs. Center-line profiles for the same coverage levels are presented in figure 22.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are presented in figure 23 for three positions of the assembly relative to mat end joints. Elastic soil deflections are shown in table 1 and reached 0.9 in. at failure.

d. Rolling resistance. Drawbar pull values recorded at intervals during the test period are shown in table 1. All drawbar pull values showed small increases at 130 coverages over the values recorded at 0 coverages.

e. Mat breaks. As shown in table 1, very few breaks occurred in the M8 mat surface during the test period.

Item 3. Item 3 failed in two segments at different coverage levels. Segment 3A (sta 0+80 to 0+95) was considered failed due to rutting at 112 coverages. Traffic was continued on the item until segment 3B (sta 0+95 to 1+10) was considered failed due to rutting at 130 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. Development of differential deformations and rut depths with trafficking is shown in table 1. In segment 3A, rut depths averaged 2.88 in. at 112 coverages (failure). Rutting of segment 3B was limited to one side of the lane and measured 3.32 in. at 130 coverages.

b. Deformation. Figure 21 shows average cross-section deformations measured at 20 and 130 coverages. The severe rut that developed along one side of the lane is illustrated in the plot at 130 coverages. Center-line profiles along the item are shown in figure 22 for 20 and 130 coverages.

c. Deflection. Average total soil deflections are shown in figure 23 for 0, 20, and 130 coverages. The elastic subgrade deflections (see table 1) reached 0.9 in. at 130 coverages.

d. Rolling resistance. Drawbar pull values measured on the item are shown in table 1 for each of the two segments. All drawbar pull values on segment 3A registered increases at 130 coverages over the values measured prior to trafficking. On segment 3B, the initial drawbar pull increased substantially with trafficking but rolling and peak drawbar values changed insignificantly.

Lane 12

Behavior of items under traffic

Item 1. Figure 12 shows item 1 prior to traffic. The item was still in good condition when measurements were recorded at 44 traffic coverages. Additional trafficking produced progressive deterioration of the item until it was considered failed due to roughness at 90 coverages (figure 13). The rated CBR was 2.9.

Item 2. Figure 14 shows item 2 prior to traffic. The item was considered failed due to roughness at 44 coverages (figure 15). At failure the plank ends along the mat joint line near the lane center were bent downward into the subgrade in contrast to the upward protrusion of plank ends encountered in previous test lanes. The rated CBR was 4.2.

Item 3. Figure 16 shows item 3 prior to traffic. After 20 coverages the surface remained in good condition. At the 44-coverage level the

item was considered failed due to roughness (figure 17). The rated CBR was 9.0.

Test results

Results of trafficking lane 12 are summarized in table 1. Soil test data are given in table 2. Table 1 contains drawbar pull values for the load vehicle operated over an asphalt paved strip for comparison with drawbar pull values recorded on the test lane.

Item 1. Item 1 was considered failed due to roughness at 90 coverages. The following information was obtained from traffic tests on item 1.

a. Roughness. Table 1 shows the consistent increase in differential deformations with trafficking. At failure the average longitudinal, transverse, and diagonal differential deformations were 1.47, 3.34, and 2.53 in., respectively. The average dishing was 0.38 in.

b. Deformation. Figure 24 shows average cross-section deformations at several coverage levels for two typical mat runs. Center-line profiles are shown in figure 25. Deformations are seen to follow a consistent pattern of increasing severity with trafficking, reaching maximum values at failure of the item.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are shown in figure 26 for three positions of the assembly relative to mat end joints. Deflection measurements were not always consistently greater with higher coverage levels, but decreased in some cases from earlier measurements. Elastic soil deflection at failure measured 2.5 in.

d. Rolling resistance. Drawbar pull values are shown in table 1 for several coverage levels during testing. Changes in drawbar pull with trafficking were small and all values were less at failure than at 44 coverages.

e. Mat breaks. The T11 mat surface did not have an excessive number of breaks at failure. The most common type of break was shearing of rivets along the center line of panel splice joints.

Item 2. Item 2 was considered failed due to roughness at 44 traffic coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. Differential deformations as measured at intervals during trafficking are shown in table 1. Average longitudinal differential deformation decreased to 0.44 in. at failure from the value of 0.85 in. at 20 coverages. Average transverse

and diagonal differential deformations were 2.22 and 1.88 in., respectively, at failure. Dishing was slight, averaging 0.25 in. at failure.

b. Deformation. Figure 24 shows average cross-section deformations at 20 and 44 coverages for two typical mat runs. Center-line profiles are shown in figure 25 for the same coverage levels. The downward bend of the panel ends along the mat joint line near the lane center is illustrated in a cross-section plot (figure 24). In previous tests, the panel ends along a mat joint line most commonly protruded upward at failure, as was the case at 20 coverages in this item.

c. Deflection. Average elastic mat deflections under static load of the load-wheel assembly are shown in figure 26 for three positions of the assembly relative to mat end joints. In some instances, it is seen that the greatest deflections did not always correspond with higher coverage levels. Elastic soil deflections, shown in table 1, measured 1.2 in. at failure.

d. Rolling resistance. Drawbar pull values measured at intervals during trafficking are shown in table 1. All drawbar pull values increased with number of coverages.

e. Mat breaks. No breaks in the M8 mat surface were observed during the course of testing.

Item 3. Item 3 was considered failed due to roughness at 44 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. Differential deformations and rut depths measured at 20 and 44 coverages are shown in table 1. Rut depths at failure averaged 2.75 in. Transverse and diagonal differential deformations averaged 3.75 and 3.44 in., respectively, at failure.

b. Deformation. Average cross-section deformations are shown in figure 24 for 20 and 44 coverages; severe rutting of the surface is reflected. Center-line profile deformations are shown in figure 25.

c. Deflection. Average total soil deflections are shown in figure 26 for 0, 20, and 44 coverages. A large increase in total deflection is noted at 44 coverages. Elastic soil deflections are shown in table 1. The maximum elastic deflection value recorded was 0.7 in. at failure of the item.

d. Rolling resistance. Drawbar pull values are shown in table 1 for 0, 20, and 44 coverages. Rolling drawbar pull increased consistently with increasing coverages. Little change was noted in initial drawbar pull. Peak drawbar pull values showed an increase only at the 44-coverage level.

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
35,000-lb load; single-wheel assembly; 25.00-28, 30-ply tire at 50-psi inflation pressure	Modified T11 aluminum mat	1.5	No failure; traffic suspended at 600 coverages
	M8 steel mat	4.1	
	Unsurfaced	12.0	
60,000-lb load; single-wheel assembly; 25.00-28, 30-ply tire at 100-psi inflation pressure	Modified T11 aluminum mat	2.3	130
	M8 steel mat	4.3	130
	Unsurfaced	12.0	112
		16.0	130
120,000-lb load; twin-wheel assembly (56 in. c-c); 25.00-28, 30-ply tires at 100-psi inflation pressure	Modified T11 aluminum mat	2.9	90
	M8 steel mat	4.2	44
	Unsurfaced	9.0	44

TABLE 1

SUMMARY OF TRAFFIC DATA, TEST SECTION 6

Test Item	Traffic Coverages	Rated CBR	No. of Mat Breaks* A	B	C	D	E	Differential Deformations (in.) Longitudinal Max	Longitudinal Avg	Transverse Max	Transverse Avg	Diagonal Max	Diagonal Avg	Dishing or Rutting (in.) Max	Dishing or Rutting (in.) Avg	Drawbar Pull (kips) Initial	Drawbar Pull (kips) Peak	Drawbar Pull (kips) Rolling	Average Total Deflection (in.) with Center Line of Wheel Assembly Located on: Unsurfaced Item, Center Line of Assembly	Quarter Point of Panel, Center Line of Assembly	Half Point of Panel, Center Line of Assembly	Joint of Panel, Center Line of Assembly	Elastic Subgrade Deflection (in.)	Remarks
Lane 11																									
1 Modified T11 aluminum landing mat	0	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	2.8	1.0	--	--	--	0.7	--	0.7	--	0.8	--	Traffic suspended at 600 coverages; no failure
	20		0	0	0	0	0	--	--	--	--	--	--	--	--	4.9	2.2	1.0	--	--	--	0.8	--	0.7	--	0.9	--	
	100		0	0	0	0	0	0.25	0.25	0.25	0.25	--	--	0.13	0.04	--	--	--	--	--	--	--	--	--	--	--	--	
	200		0	0	0	0	0	0.38	0.38	0.25	0.25	0.50	0.31	0.13	0.13	--	--	--	--	--	--	--	--	--	--	--	--	
	300		0	0	0	0	0	0.50	0.38	0.25	0.22	0.38	0.28	0.25	0.16	6.5	2.6	1.0	--	--	--	--	--	--	--	--	--	
	600		0	0	0	0	0	0.50	0.43	0.38	0.28	0.38	0.38	0.25	0.21	3.8	2.9	1.2	--	--	--	0.8	--	0.9	--	0.9	--	
2 M8 steel landing mat	0	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0	2.2	1.0	--	--	--	0.5	--	0.6	--	0.4	0.5	Traffic suspended at 600 coverages; no failure
	20		0	0	0	0	0	--	--	--	--	--	--	--	--	4.5	1.7	1.0	--	--	--	0.5	--	0.7	--	0.5	0.3	
	100		0	0	0	0	0	0.38	0.29	0.25	0.17	0.25	0.25	↑	↑	--	--	--	--	--	--	--	--	--	--	--	--	
	200		0	0	0	0	0	0.63	0.50	0.25	0.17	0.38	0.29	Negligible	Negligible	--	--	--	--	--	--	--	--	--	--	--	--	
	300		0	0	0	0	0	0.38	0.38	0.25	0.25	0.25	0.22	↓	↓	6.4	1.9	1.0	--	--	--	--	--	--	--	--	0.4	
	600		0	0	0	0	0	0.50	0.43	0.25	0.25	0.38	0.30			3.2	2.1	1.2	--	--	--	0.6	--	0.7	--	0.5	0.3	
3 Unsurfaced	0	12.0	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	2.0	1.0	--	0.2	--	--	--	--	--	--	0.1	Traffic suspended at 600 coverages; no failure
	20		--	--	--	--	--	0.38	0.25	0.25	0.25	0.38	0.25	--	--	4.4	2.1	0.9	--	0.2	--	--	--	--	--	--	0.1	
	100		--	--	--	--	--	0.25	0.21	0.50	0.46	0.50	0.42	0.38	0.29	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	0.63	0.42	0.63	0.58	0.63	0.46	0.63	0.46	--	--	--	--	--	--	--	--	--	--	--	--	
	300		--	--	--	--	--	0.38	0.28	0.75	0.60	0.75	0.53	0.75	0.69	7.4	2.2	0.9	--	0.2	--	--	--	--	--	--	0.1	
	600		--	--	--	--	--	0.50	0.38	0.50	0.50	0.63	0.47	0.50	0.44	3.1	2.2	1.1	--	0.3	--	--	--	--	--	--	0.2	
Asphalt test strip	--		--	--	--	--	--	--	--	--	--	--	--	--	--	5.5	2.3	0.8	--	--	--	--	--	--	--	--	--	
Lane 11A																									
1 Modified T11 aluminum landing mat	0	2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	4.3	3.0	--	--	--	0.4	--	1.3	--	1.7	--	Item failed at 130 coverages due to roughness
	20		0	0	0	0	0	1.00	0.92	1.13	0.95	1.25	1.10	0.50	0.38	7.8	4.6	3.0	--	--	--	0.7	--	1.7	--	1.9	--	
	62		6	48	0	0	0	1.13	1.03	1.63	1.47	1.50	1.35	0.38	0.32	--	--	--	--	--	--	--	--	--	--	--	--	
	112		13	75	10	0	1	1.25	1.19	2.13	1.91	1.88	1.78	0.38	0.32	--	--	--	--	--	--	--	--	--	--	--	--	
	130		13	93	21	5	1	1.25	1.16	2.38	2.19	2.00	1.88	0.50	0.47	3.9	4.4	2.4	--	--	--	0.6	--	1.6	--	2.0	2.1	
2 M8 steel landing mat	0	4.3	--	--	--	--	--	--	--	--	--	--	--	--	--	5.6	4.0	2.4	--	--	--	1.3	--	0.9	--	1.1	0.7	Item failed at 130 coverages due to roughness
	20		12	0	0	0	0	1.38	1.23	1.38	1.17	1.50	1.22	0.50	0.35	7.7	4.1	3.0	--	--	--	1.3	--	1.1	--	1.3	0.8	
	62		12	0	0	0	0	1.38	1.32	1.50	1.28	1.63	1.41	0.38	0.32	--	--	--	--	--	--	--	--	--	--	--	--	
	112		12	0	0	0	0	1.63	1.38	1.88	1.47	2.00	1.63	0.38	0.38	--	--	--	--	--	--	--	--	--	--	--	--	
	130		12	0	9	0	0	1.75	1.47	2.13	2.00	2.25	1.91	0.50	0.41	6.3	5.0	3.1	--	--	--	1.4	--	1.8	--	1.6	0.9	

(Continued)

Note: A 35-kip load on a single-wheel assembly consisting of one 25.00-28, 30-ply tire inflated to 50 psi was used for trafficking lane 11. The same assembly was used for trafficking lane 11A, except the load was increased to 60 kips and the tire inflation pressure was 100 psi. A 120-kip load on a twin-wheel assembly consisting of two 25.00-28, 30-ply tires (56 in. c-c) inflated to 100 psi was used on lane 12.

* Break types are defined and illustrated in Part 1.

TABLE 1 (CONCLUDED)

Test Item	Traffic Coverages	Rated CBR	No. of Mat Breaks* A	B	C	D	E	Differential Deformations (in.) Longitudinal Max	Longitudinal Avg	Transverse Max	Transverse Avg	Diagonal Max	Diagonal Avg	Dishing or Rutting (in.) Max	Dishing or Rutting (in.) Avg	Drawbar Pull (kips) Initial	Peak	Rolling	Average Total Deflection (in.) with Center Line of Wheel Assembly Located on: Unsurfaced Item, Max	Unsurfaced Item, Center Line of Assembly	Quarter Point of Panel, Max	Quarter Point of Panel, Center Line of Assembly	Half Point of Panel, Max	Half Point of Panel, Center Line of Assembly	Joint of Panel, Max	Joint of Panel, Center Line of Assembly	Elastic Subgrade Deflection (in.)	Remarks
Lane 11A (Continued)																											
3 Unsurfaced	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.6	4.3	2.2	--	0.6	--	--	--	--	--	--	0.5	
	20	--	--	--	--	--	--	0.38	0.25	0.75	0.58	0.63	0.50	0.50	0.30	7.9	5.2	2.9	--	0.6	--	--	--	--	--	--	0.5	
	62	--	--	--	--	--	--	0.50	0.35	2.00	1.41	1.75	1.13	1.25	0.91	--	--	--	--	--	--	--	--	--	--	--	--	
Segment 3A sta 0+80 to 0+95	112	12.0	--	--	--	--	--	0.75	0.53	5.13	3.10	4.63	2.47	5.13	2.88	--	--	--	--	--	--	--	--	--	--	--	--	Segment 3A failed at 112 coverages due to rutting
	130		--	--	--	--	--	--	--	--	--	--	--	--	--	9.5	8.3	4.5	--	1.9	--	--	--	--	--	--	0.9	
Segment 3B sta 0+95 to 1+10	112	16.0	--	--	--	--	--	0.50	0.41	1.25	0.79	1.13	0.91	0.88	0.60	--	--	--	--	--	--	--	--	--	--	--	--	Segment 3B failed at 130 coverages due to rutting
	130		--	--	--	--	--	0.25	0.22	3.38	1.41	2.25	1.03	3.32	3.32	9.5	4.1	2.2	--	1.9	--	--	--	--	--	--	0.9	
Asphalt test strip	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.7	2.4	1.2	--	--	--	--	--	--	--	--	--	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.2	2.1	0.9	--	--	--	--	--	--	--	--	--	
Lane 12																											
1 Modified T11 aluminum landing mat	0	2.9	--	--	--	--	--	--	--	--	--	--	--	--	--	12.2	8.4	6.1	--	--	2.0	1.3	2.2	1.5	2.0	1.2	--	Item failed at 90 coverages due to roughness
	20		0	0	0	0	0	1.13	0.88	1.38	1.28	1.00	0.97	0.38	0.38	13.2	10.1	7.5	--	--	2.7	2.2	2.3	1.9	2.3	1.7	--	
	44		0	1	15	0	0	1.00	0.75	2.50	2.28	1.63	1.44	0.25	0.25	13.5	11.3	7.5	--	--	--	--	--	--	--	--	--	
	90		0	34	68	9	0	1.75	1.47	3.75	3.34	2.75	2.53	0.38	0.38	12.5	9.4	7.3	--	--	2.2	1.5	1.9	1.5	2.5	1.7	2.5	
2 M8 steel landing mat	0	4.2	--	--	--	--	--	--	--	--	--	--	--	--	--	11.4	6.0	4.9	--	--	1.5	0.4	1.0	0.3	1.2	+0.1	1.0	Item failed at 44 coverages due to excessive roughness
	20		0	0	0	0	0	0.88	0.85	1.75	1.47	1.63	1.63	0.38	0.35	12.2	8.7	6.0	--	--	2.3	0.3	1.5	0.8	1.7	0.3	1.3	
	44		0	0	0	0	0	0.50	0.44	2.63	2.22	2.25	1.88	0.25	0.25	12.3	10.3	6.8	--	--	1.9	0.6	1.8	0.5	1.5	0.0	1.2	
3 Unsurfaced	0	9.0	--	--	--	--	--	--	--	--	--	--	--	--	--	10.6	7.4	5.2	0.9	0.1	--	--	--	--	--	--	0.4	Item failed at 44 coverages due to excessive roughness
	20		--	--	--	--	--	0.63	0.41	1.25	1.13	1.38	1.22	1.00	0.85	12.8	7.4	6.0	1.1	+0.1	--	--	--	--	--	--	0.5	
	44		--	--	--	--	--	0.88	0.50	5.38	3.75	5.38	3.44	3.50	2.75	10.5	11.0	7.6	2.6	+0.3	--	--	--	--	--	--	0.7	
Asphalt test strip	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.8	5.1	2.7	--	--	--	--	--	--	--	--	--	

TABLE 2

SUMMARY OF CBR, DENSITY, AND WATER CONTENT DATA, TEST SECTION 6

Test Item*	Type of Surface	Number of Traffic Coverages	Depth (in.)	CBR	Water Content (%)	Dry Density (lb/cu ft)	Remarks
				Lane 11			
1	Modified T11 aluminum landing mat	0	0	1.2	31.0	86.6	Traffic suspended at 600 coverages; no failure
			6	1.4	29.8	89.2	
			12	1.8	31.3	87.6	
			18	1.4	32.2	85.9	
2	M8 steel landing mat	0	0	3.8	28.1	90.2	Traffic suspended at 600 coverages; no failure
			6	3.1	26.2	89.1	
			12	5.4	27.4	92.7	
			18	4.9	27.5	91.8	
3	Unsurfaced	0	0	9.0	23.9	93.0	Traffic suspended at 600 coverages; no failure
			6	11.0	25.2	96.8	
			12	11.0	28.0	93.1	
			18	8.0	26.0	89.3	
		600	0	15.0	24.9	98.2	
			6	17.0	24.2	96.6	
			12	11.0	24.2	96.8	
				Lane 11A			
1	Modified T11 aluminum landing mat	130	0	2.7	31.5	88.7	Item failed at 130 coverages due to roughness
			6	3.3	30.7	89.7	
			12	3.5	29.8	89.2	
			18	4.2	30.6	89.6	
2	M8 steel landing mat	130	0	4.3	29.5	91.0	Item failed at 130 coverages due to roughness
			6	4.1	26.7	94.5	
			12	5.1	25.6	95.8	
			18	6.5	27.8	90.9	
3	Unsurfaced	0	0	15.0	24.9	98.2	Item failed due to rutting in two segments (3A and 3B)
			6	17.0	24.2	96.6	
			12	11.0	24.2	96.8	
				(Segment 3A)			
		130	0	12.0	24.2	98.4	Segment 3A failed due to rutting at 112 coverages. Traffic continued to 130 coverages
			6	10.0	24.5	98.7	
			12	8.0	26.8	94.8	
			18	9.0	26.7	95.2	
				(Segment 3B)			
		130	0	24.0	22.4	100.8	Segment 3B failed due to rutting at 130 coverages
			6	16.0	23.6	98.8	
			12	11.0	25.9	95.1	
			18	11.0	23.4	96.7	
				Lane 12			
1	Modified T11 aluminum landing mat	0	0	2.0	31.0	85.7	Item failed due to roughness at 90 coverages
			6	2.7	28.4	89.4	
			12	2.6	28.8	90.8	
			18	2.3	28.4	91.0	
		90	0	3.3	30.5	88.6	
			6	3.2	29.9	89.6	
			12	3.6	29.6	90.2	
			18	3.4	29.8	89.9	
2	M8 steel landing mat	0	0	4.0	28.2	90.7	Item failed due to roughness at 44 coverages
			6	3.2	27.6	92.2	
			12	5.6	28.4	93.6	
			18	5.6	28.5	92.1	
		44	0	3.6	30.5	89.6	
			6	3.6	29.1	91.7	
			12	5.0	28.6	90.5	
			18	4.6	29.3	89.9	
3	Unsurfaced	0	0	9.0	21.8	92.9	Item failed due to roughness at 44 coverages
			6	11.0	23.3	94.1	
			12	8.0	25.1	93.7	
			18	11.0	26.0	93.1	
		44	0	6.0	25.7	96.3	
			6	11.0	22.9	100.1	
			12	8.0	24.2	98.0	
			18	10.0	25.1	96.4	

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

Figure 2. Test load vehicle

Figure 3. Lane 11, item 1, prior to traffic

Figure 4. Lane 11, item 1. Diagonal straightedge shows slight deformations at 600 coverages

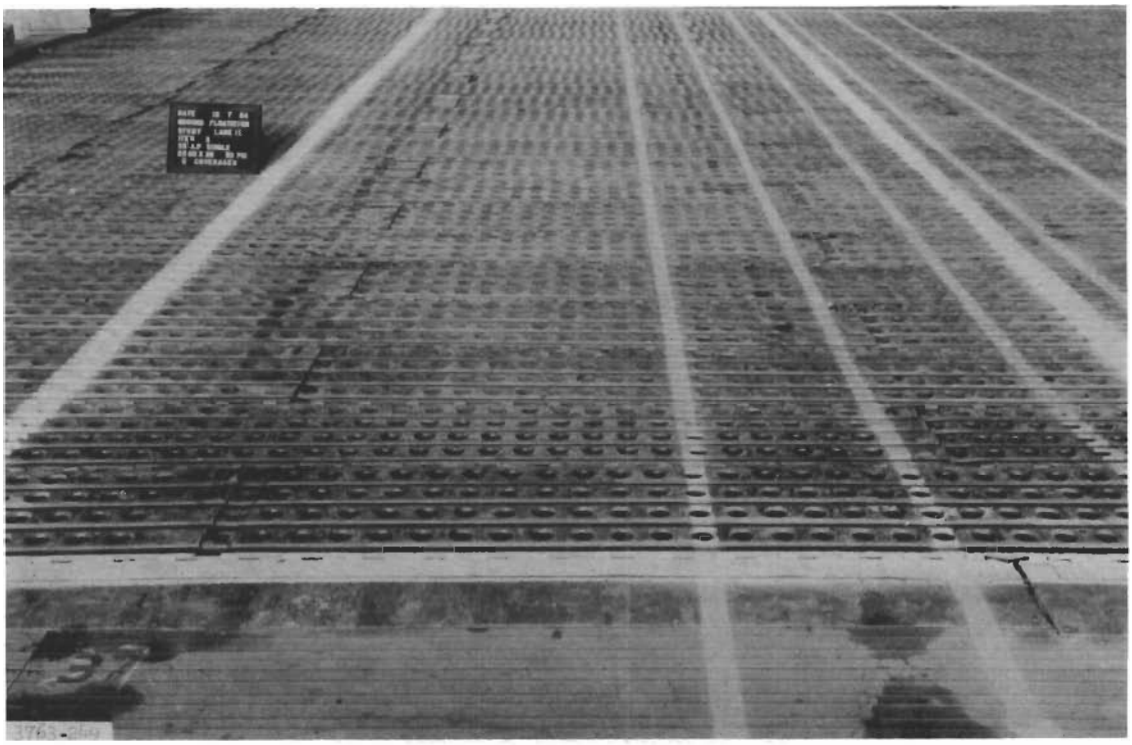


Figure 5. Lane 11, item 2, prior to traffic

Figure 6. Lane 11, item 2. Transverse straightedge shows slight deformations at 600 coverages

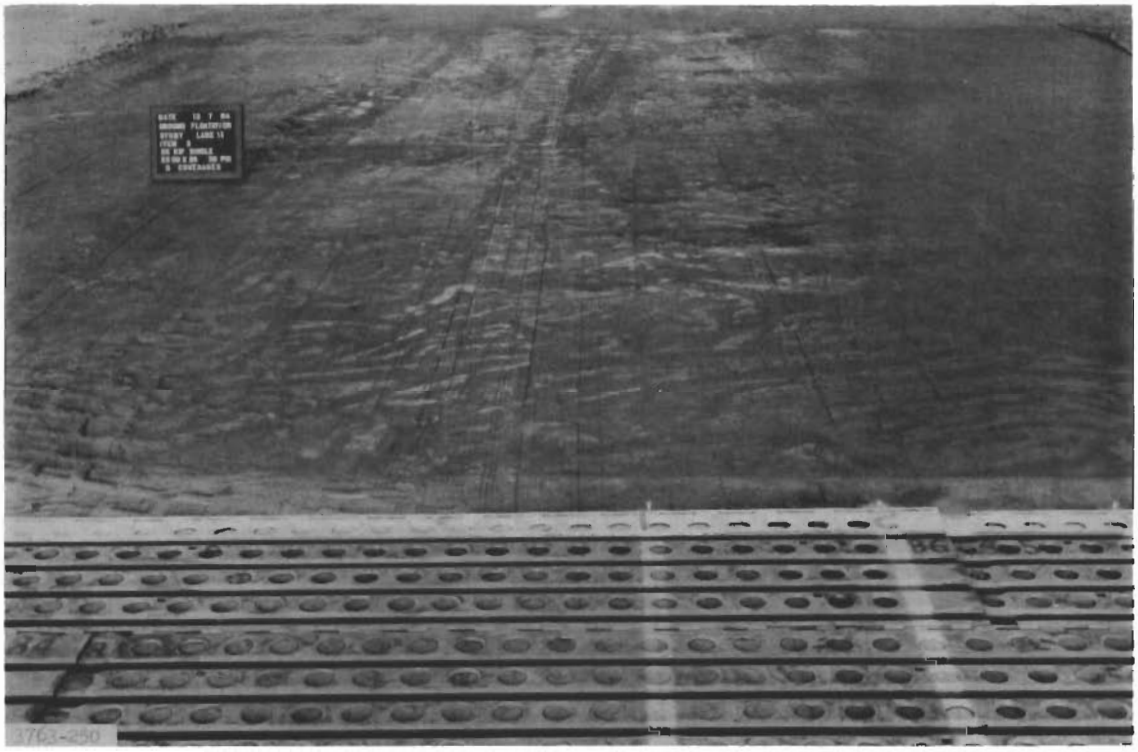


Figure 7. Lane 11, item 3, prior to traffic

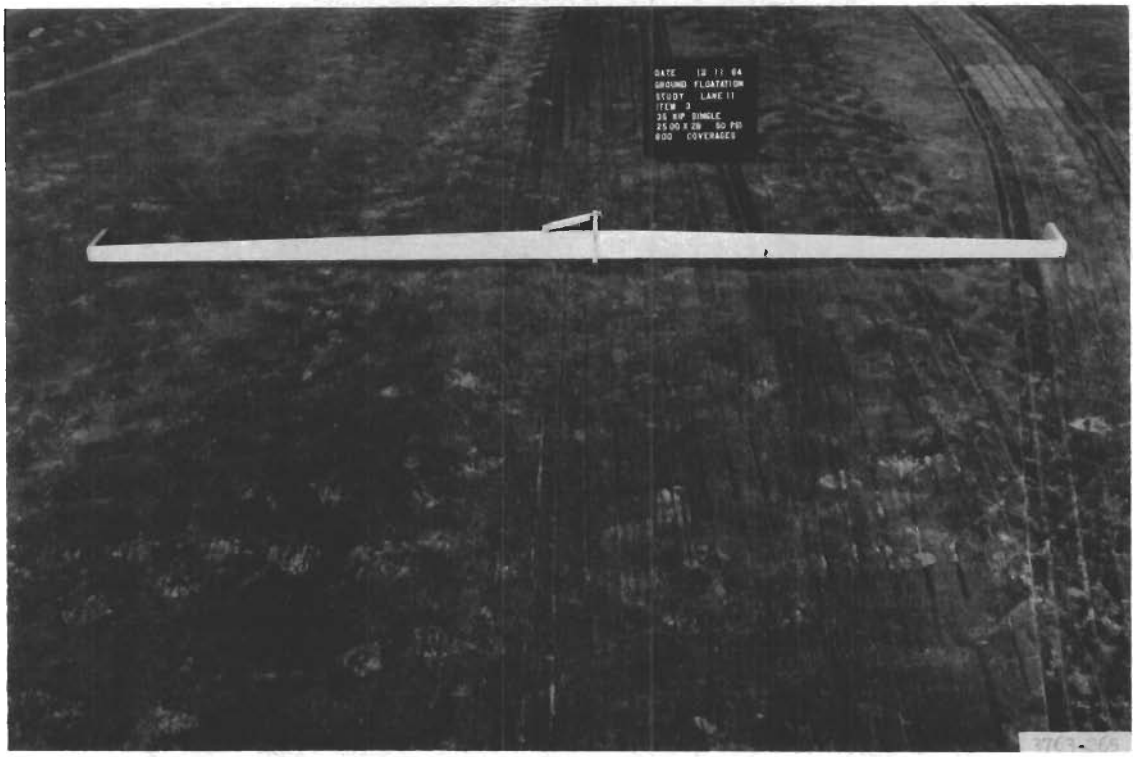


Figure 8. Lane 11, item 3. Transverse straightedge shows slight deformations at 600 coverages

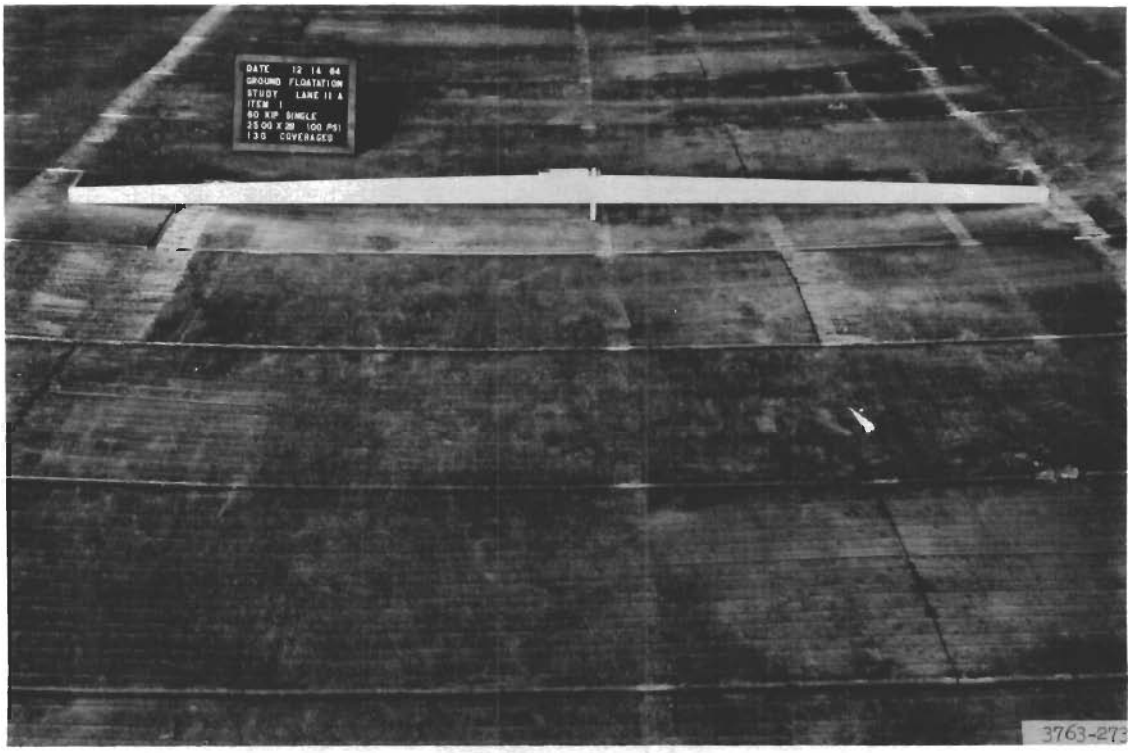


Figure 9. Lane 11A, item 1. Transverse straightedge shows deformations at 130 coverages (failure)

Figure 10. Lane 11A, item 2. Transverse straightedge shows deformations at 130 coverages (failure)

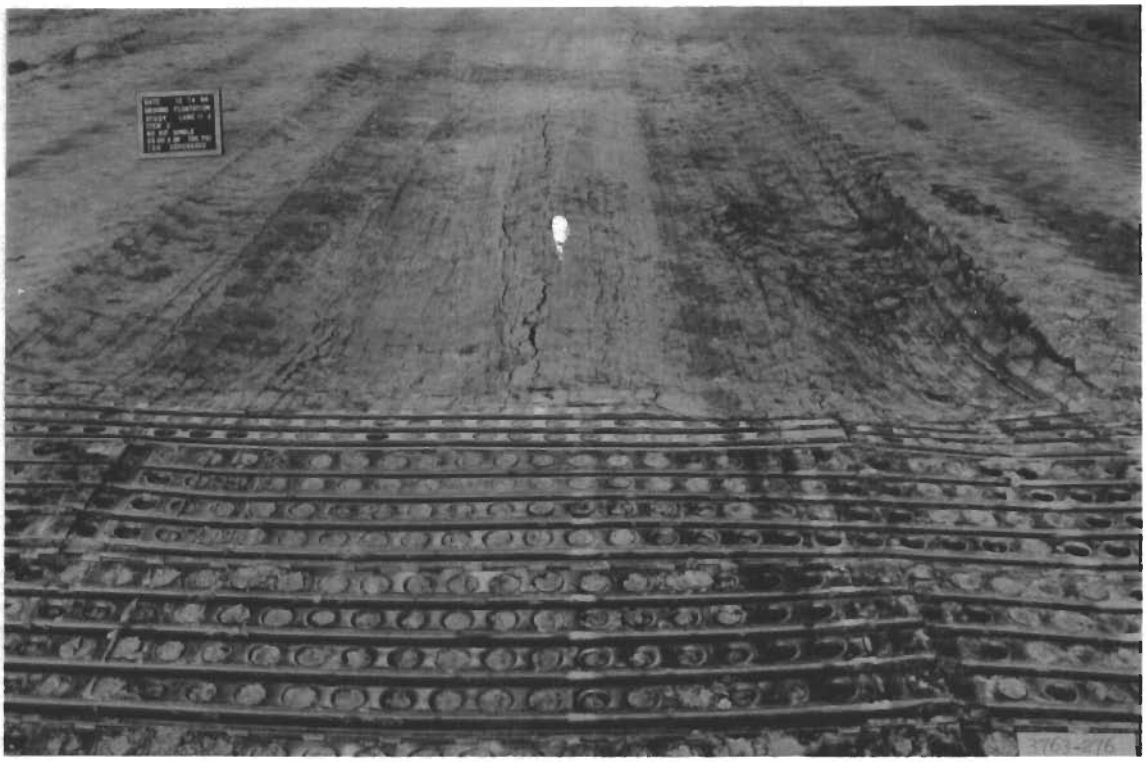


Figure 11. Lane 11A, item 3; general view of item at 130 coverages (failure)

Figure 12. Lane 12, item 1, prior to traffic

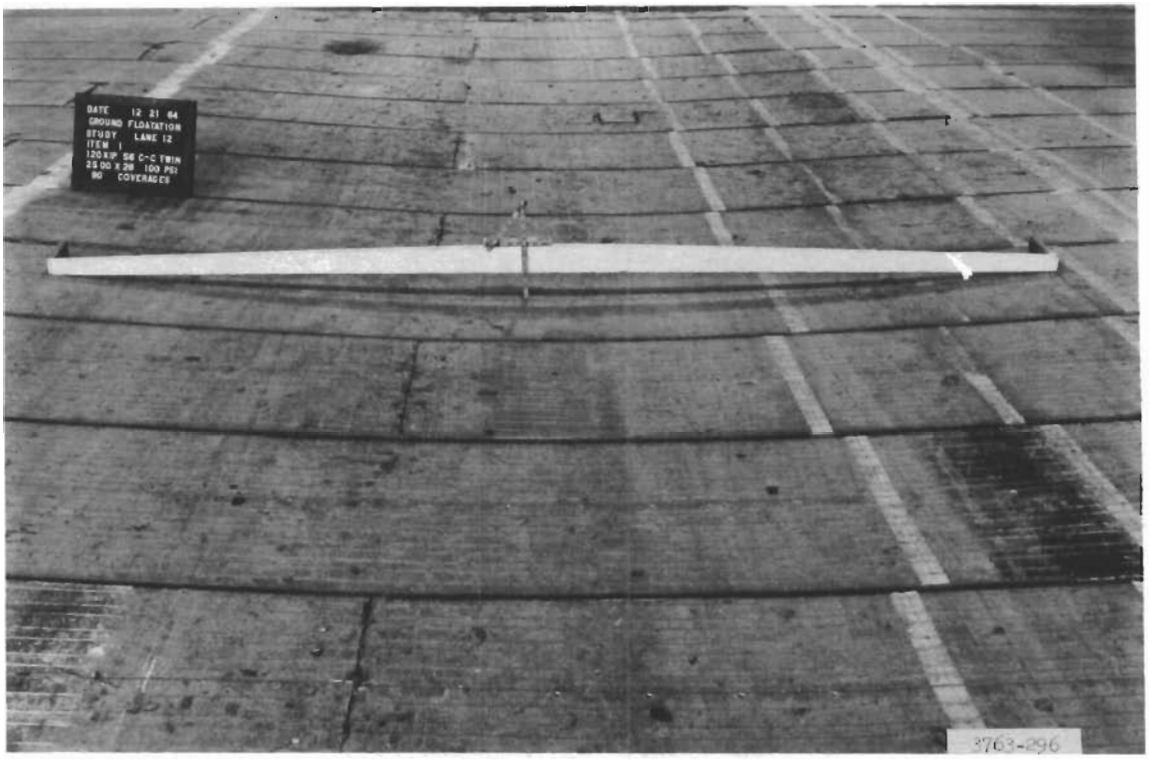


Figure 13. Lane 12, item 1. Transverse straightedge shows deformations at 90 coverages (failure)

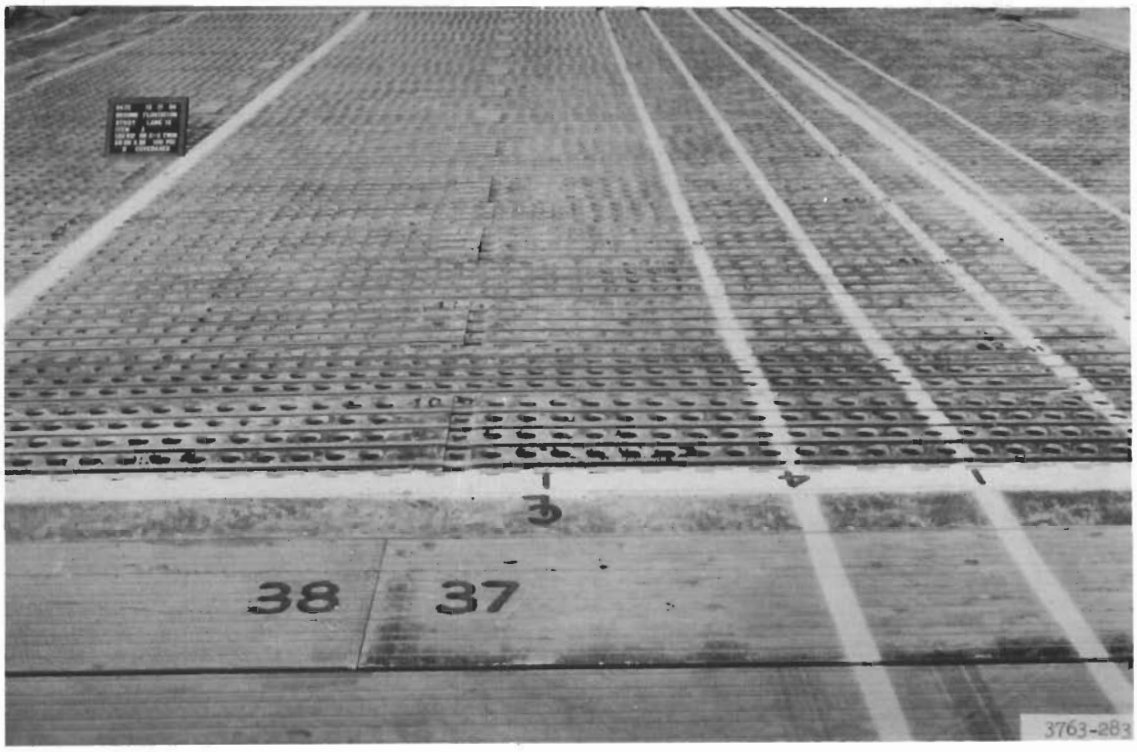


Figure 14. Lane 12, item 2, prior to traffic

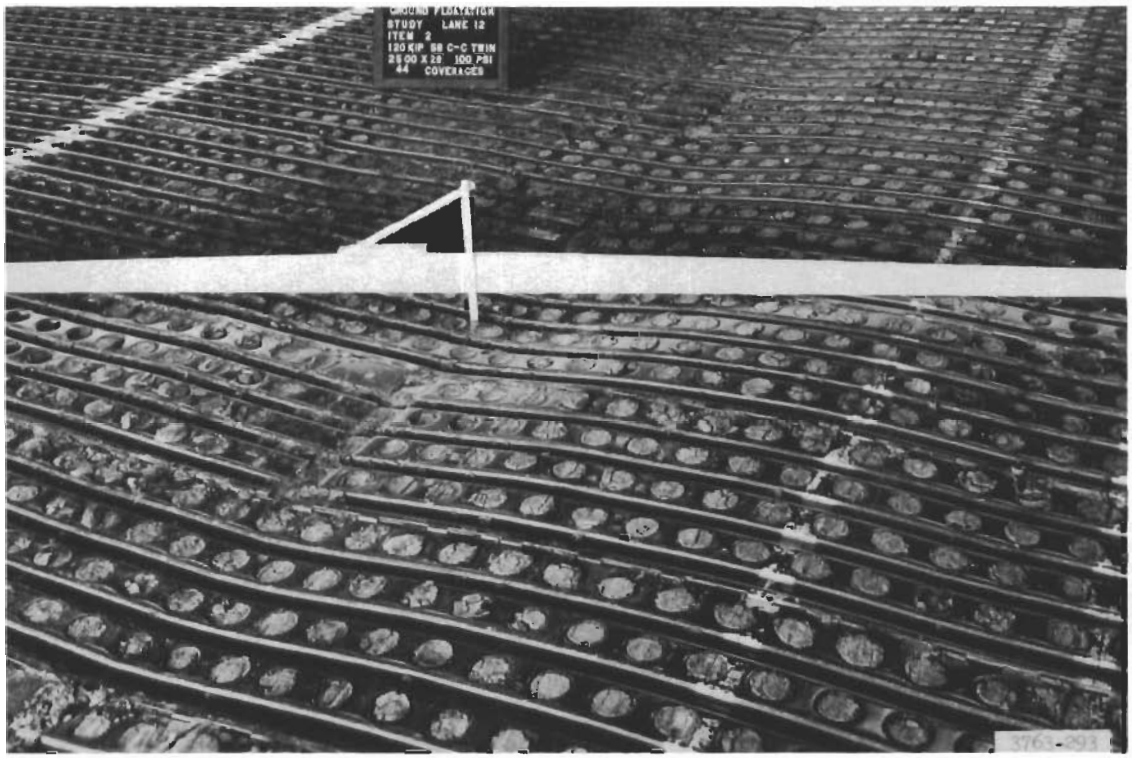


Figure 15. Lane 12, item 2. Transverse straightedge shows deformations at 44 coverages (failure)

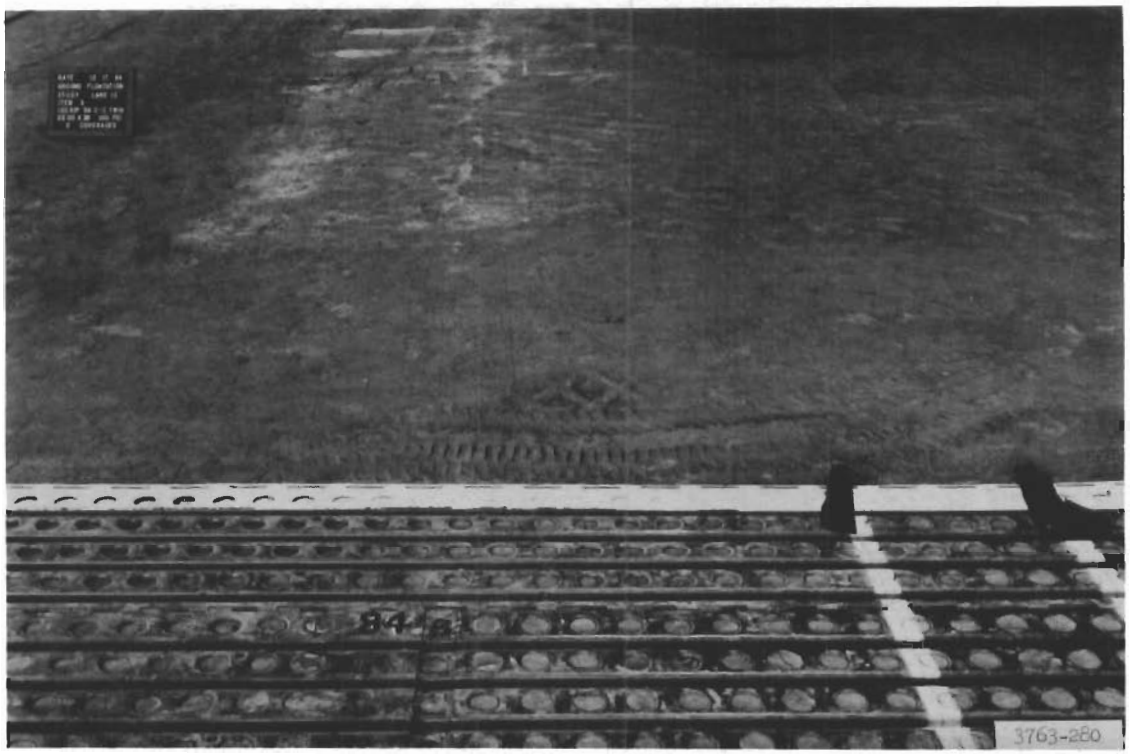


Figure 16. Lane 12, item 3, prior to traffic

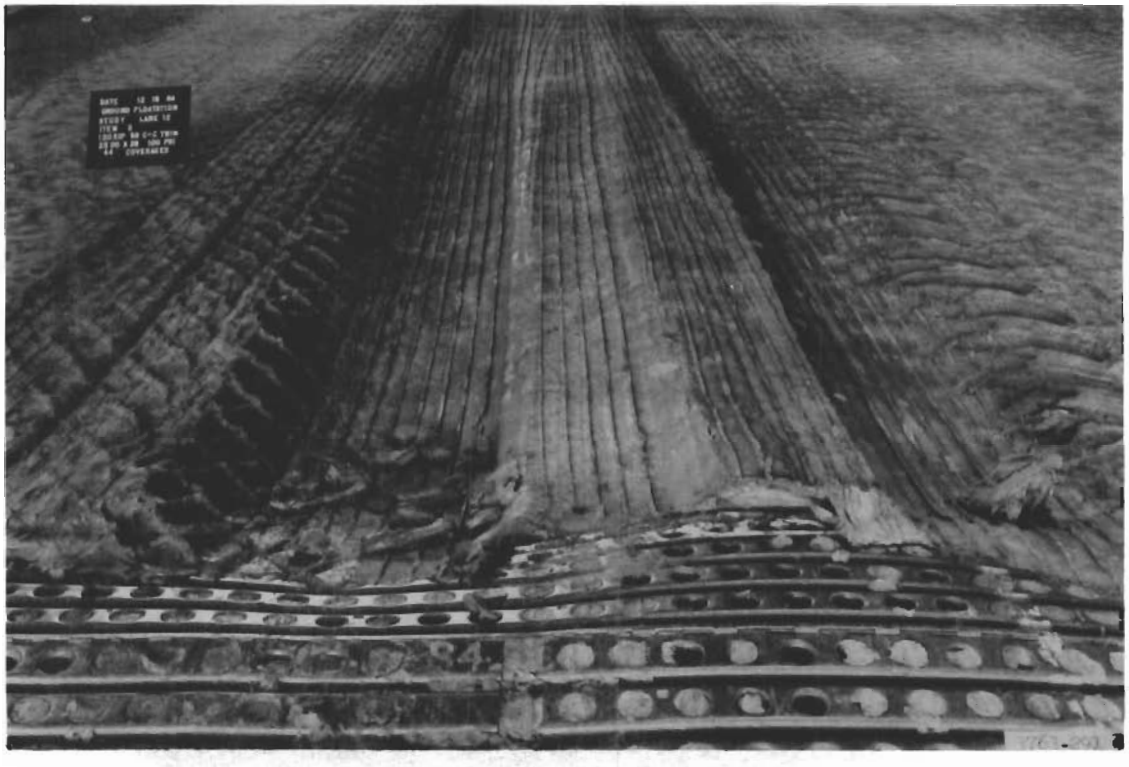


Figure 17. Lane 12, item 3; general view of item at 44 coverages (failure)

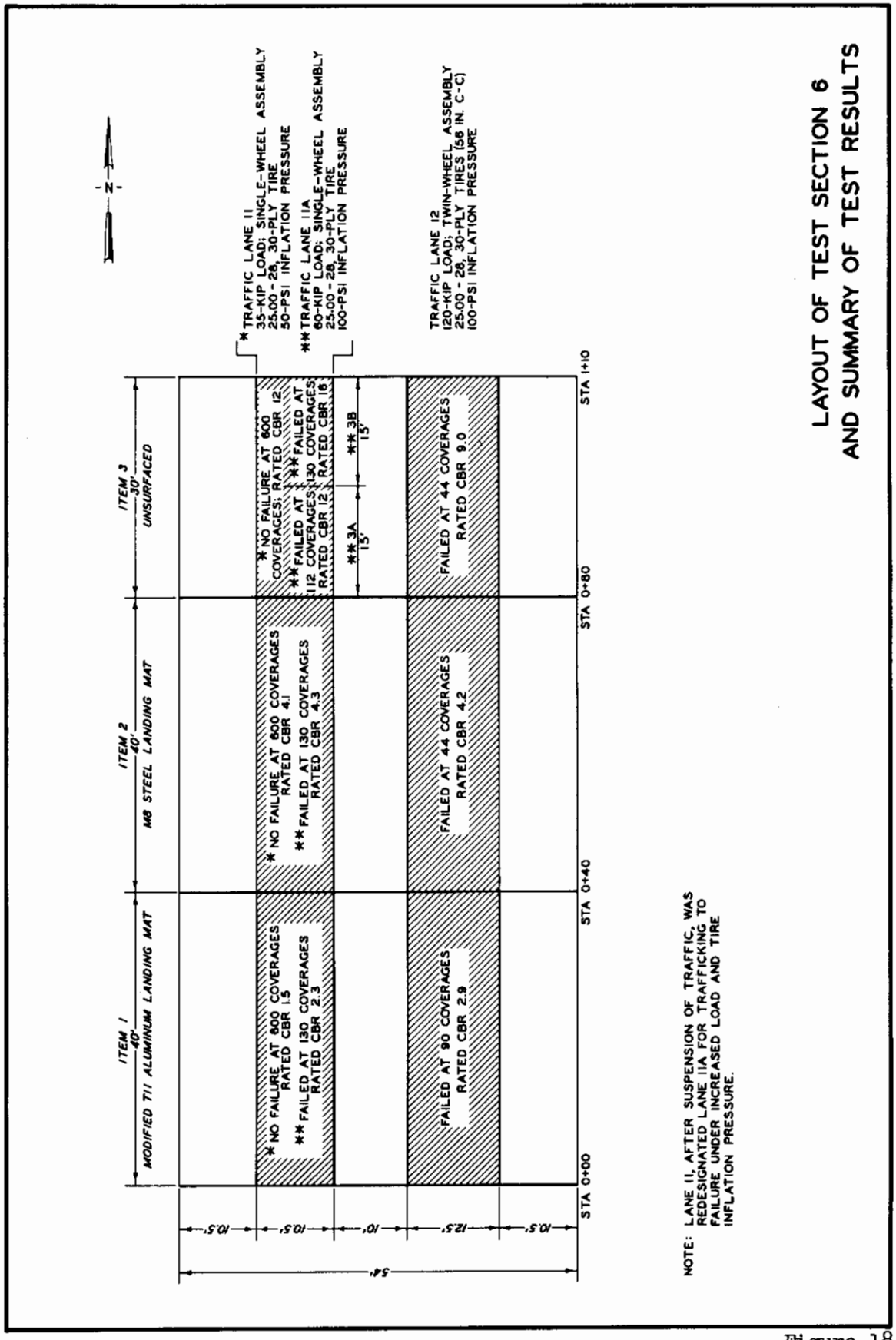


Figure 18

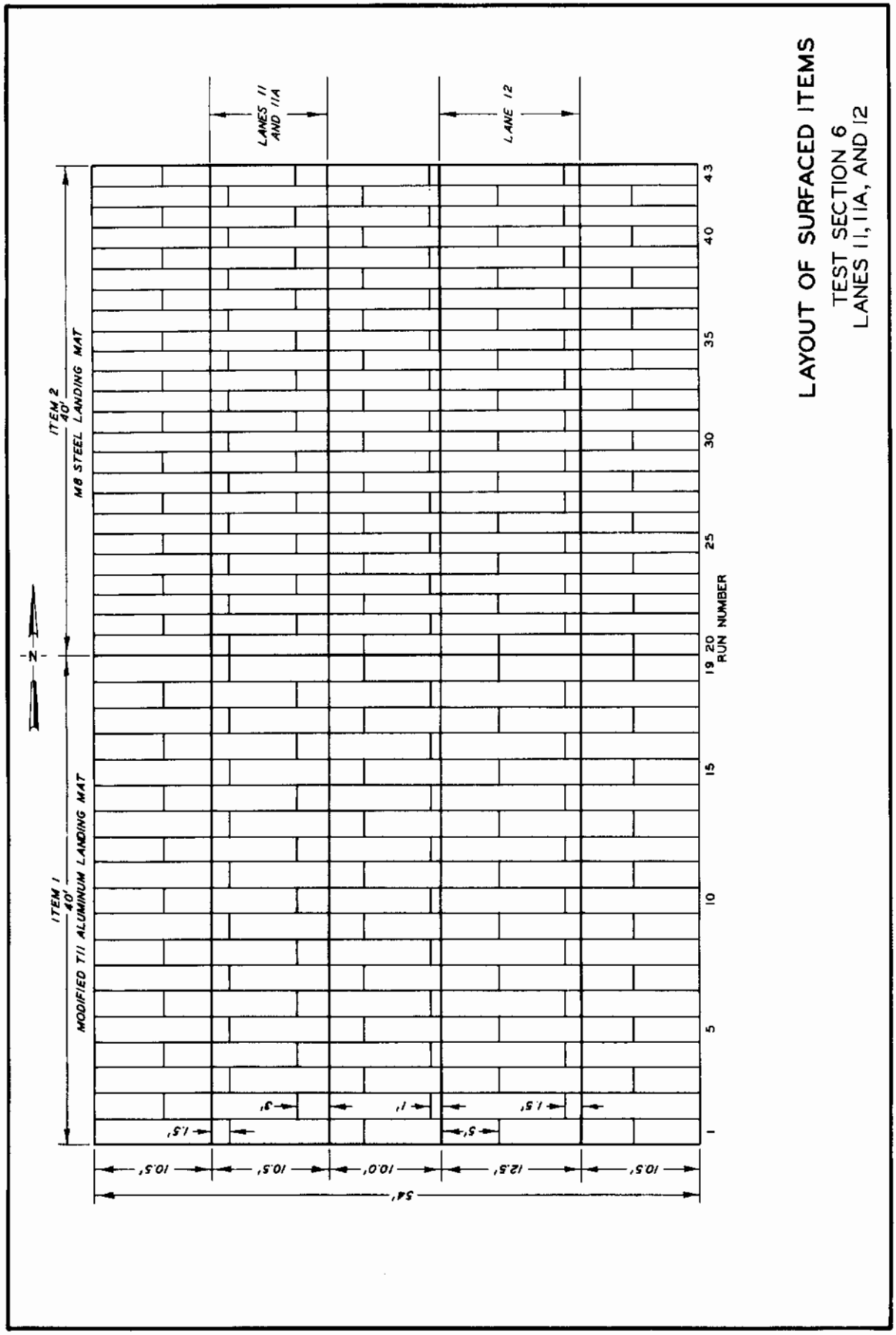
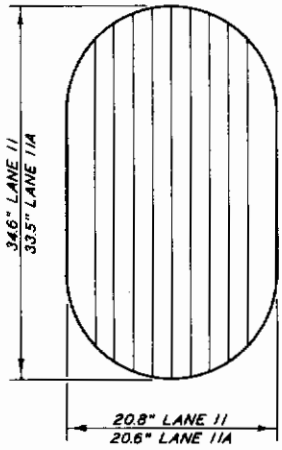
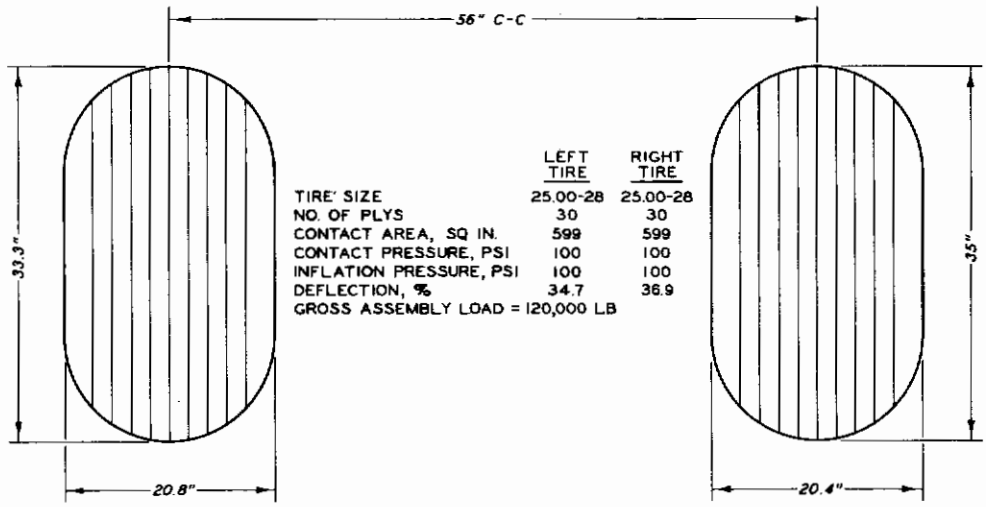


Figure 19



	LANE 11	LANE 11A
TIRE SIZE	25.00-28	25.00-28
NO. OF PLYS	30	30
CONTACT AREA, SQ IN.	640	606
CONTACT PRESSURE, PSI	55	99
INFLATION PRESSURE, PSI	50	100
DEFLECTION, %	33.8	31.9
GROSS ASSEMBLY LOAD, LB	35,000	60,000

LANES 11 AND 11A



	LEFT TIRE	RIGHT TIRE
TIRE SIZE	25.00-28	25.00-28
NO. OF PLYS	30	30
CONTACT AREA, SQ IN.	599	599
CONTACT PRESSURE, PSI	100	100
INFLATION PRESSURE, PSI	100	100
DEFLECTION, %	34.7	36.9

GROSS ASSEMBLY LOAD = 120,000 LB

LANE 12

TIRE-PRINT DIMENSIONS AND TIRE CHARACTERISTICS

TEST SECTION 6
LANES 11, 11A, AND 12

Figure 20

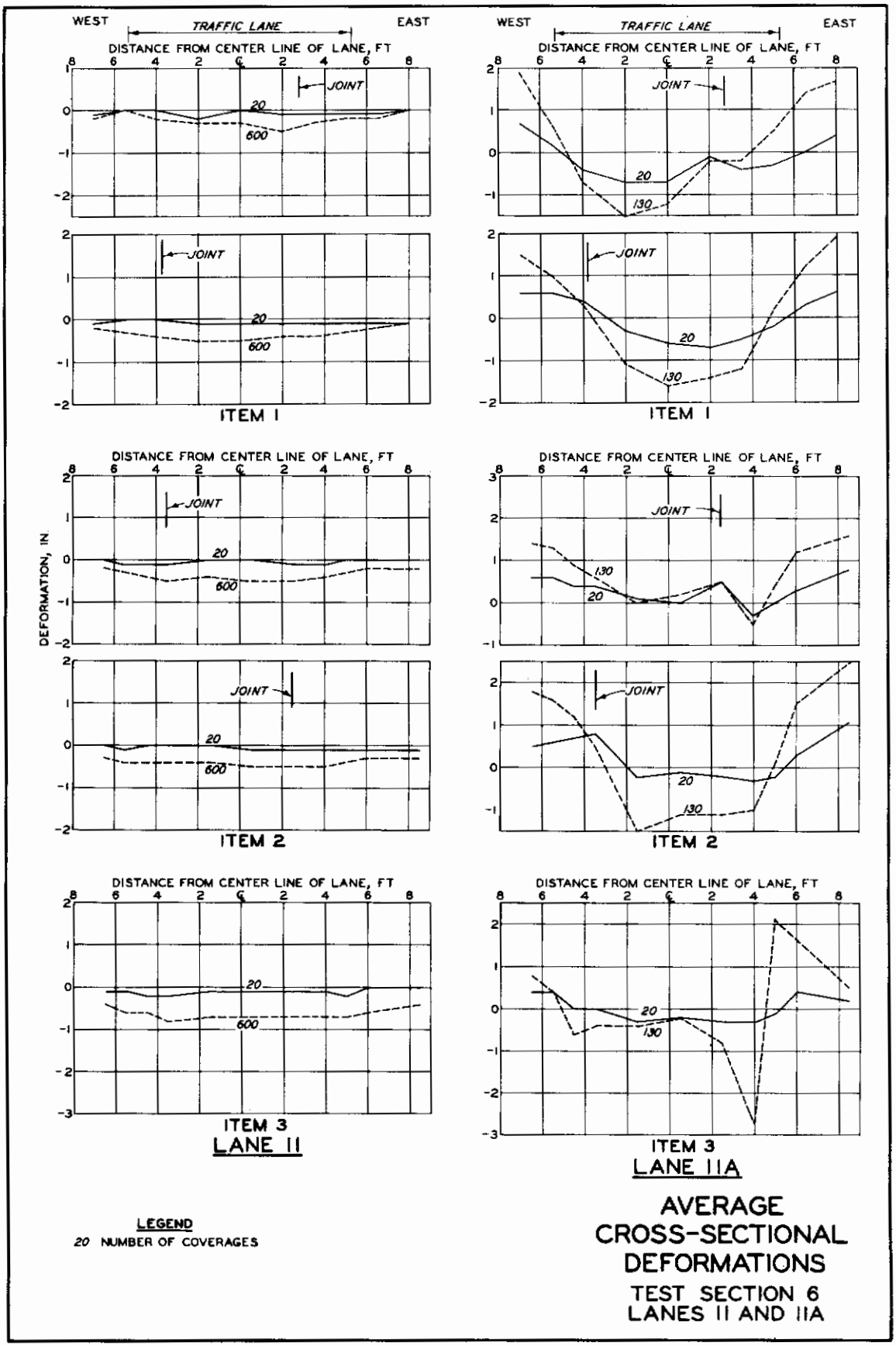


Figure 21

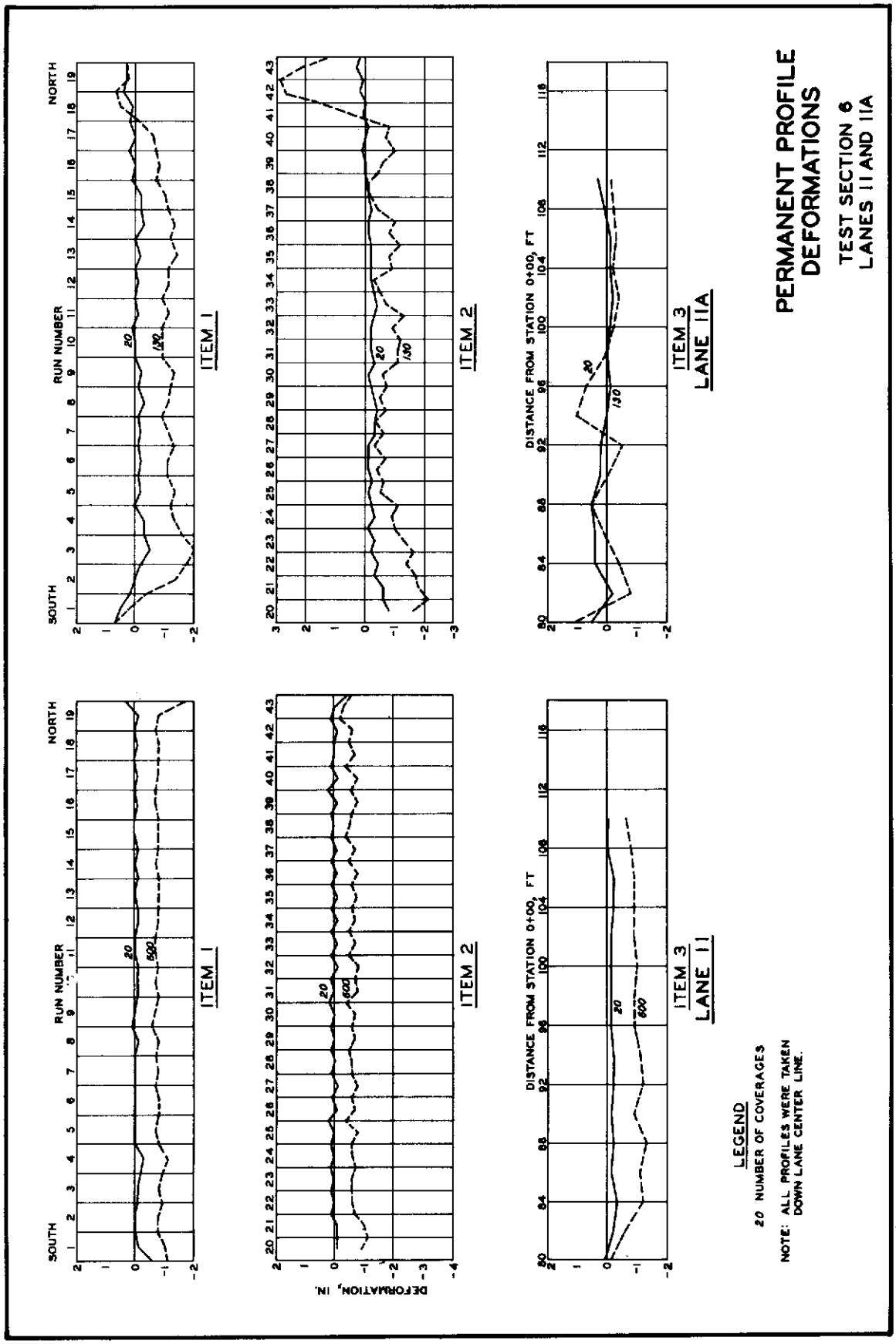


Figure 22

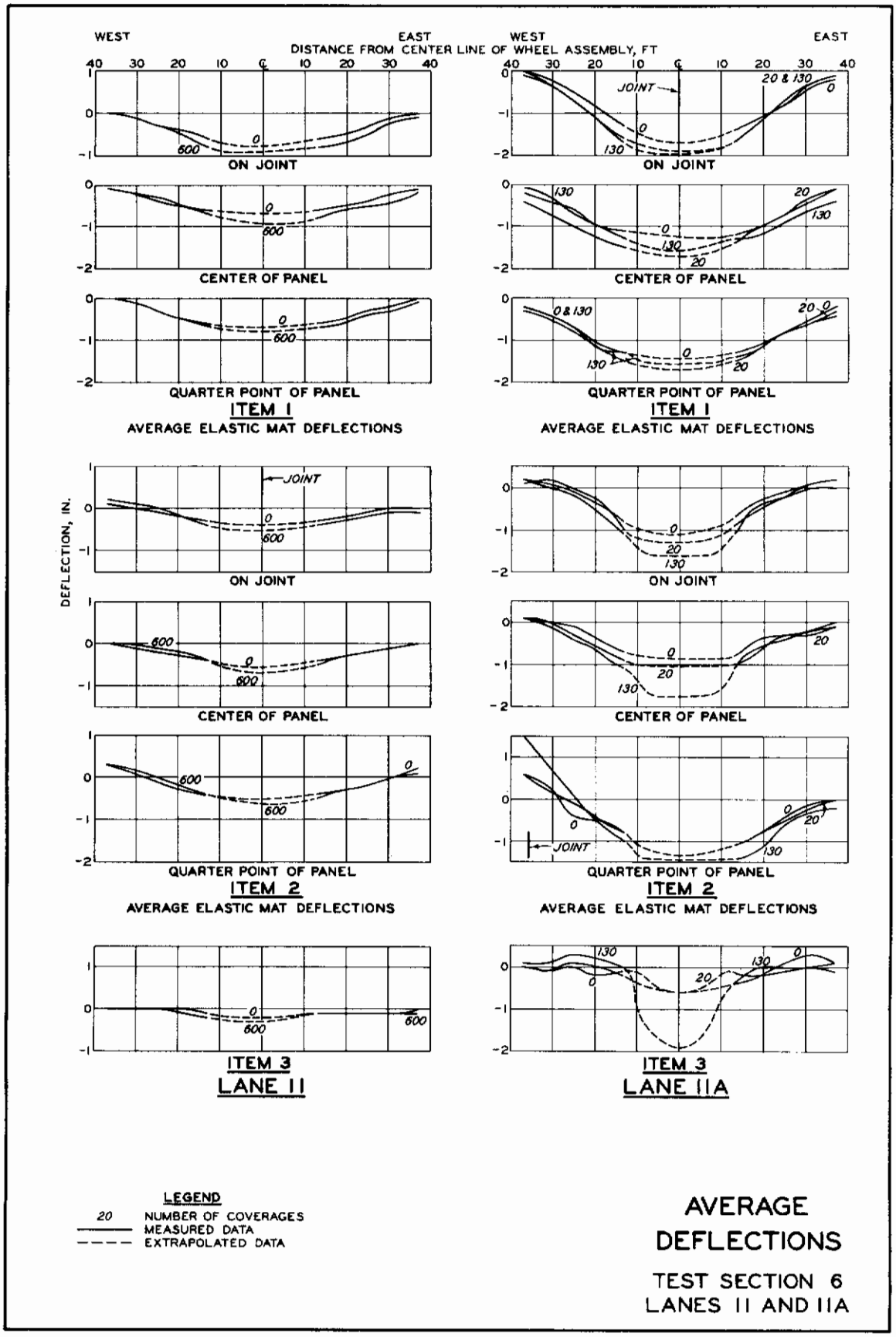


Figure 23

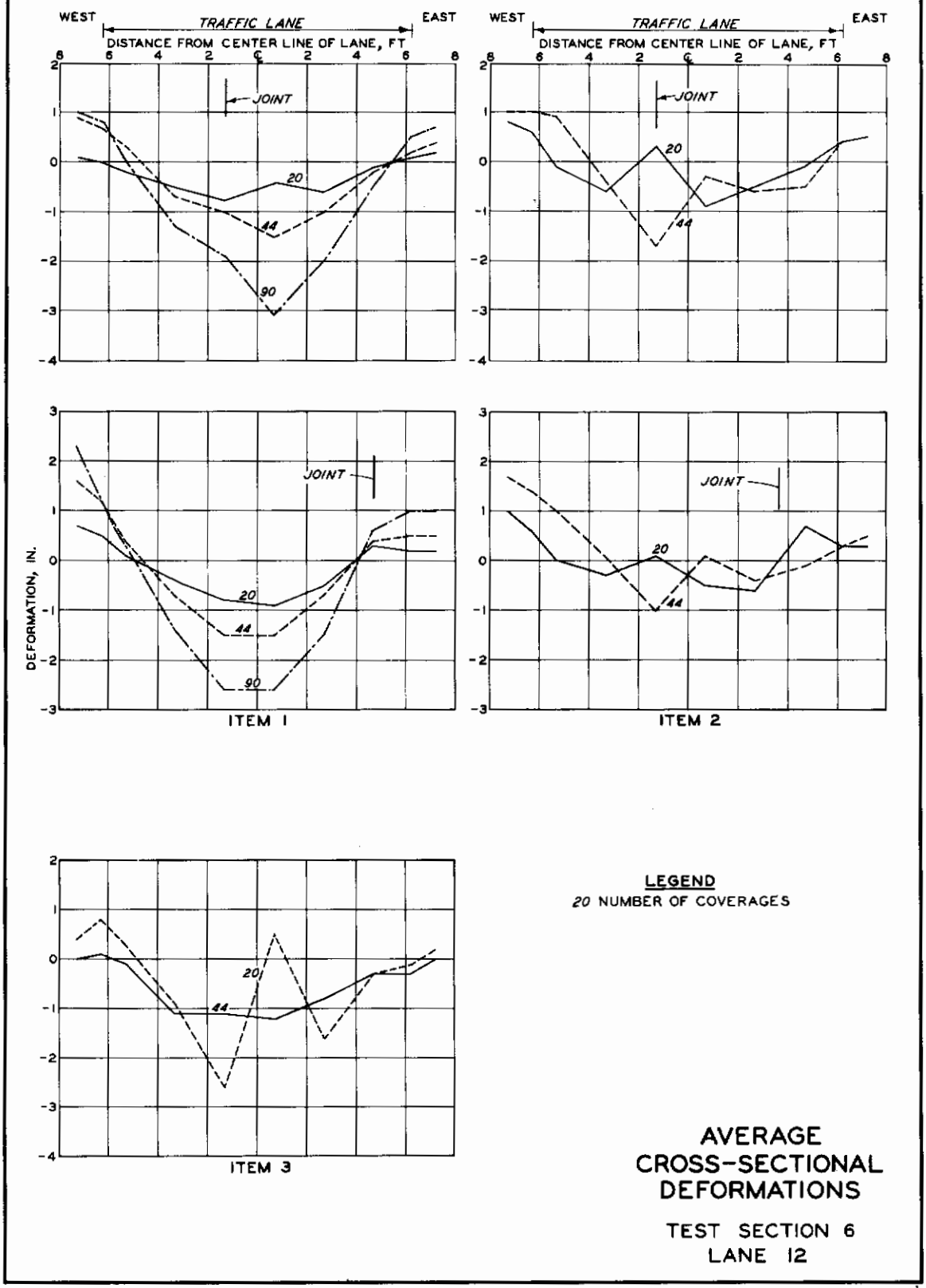
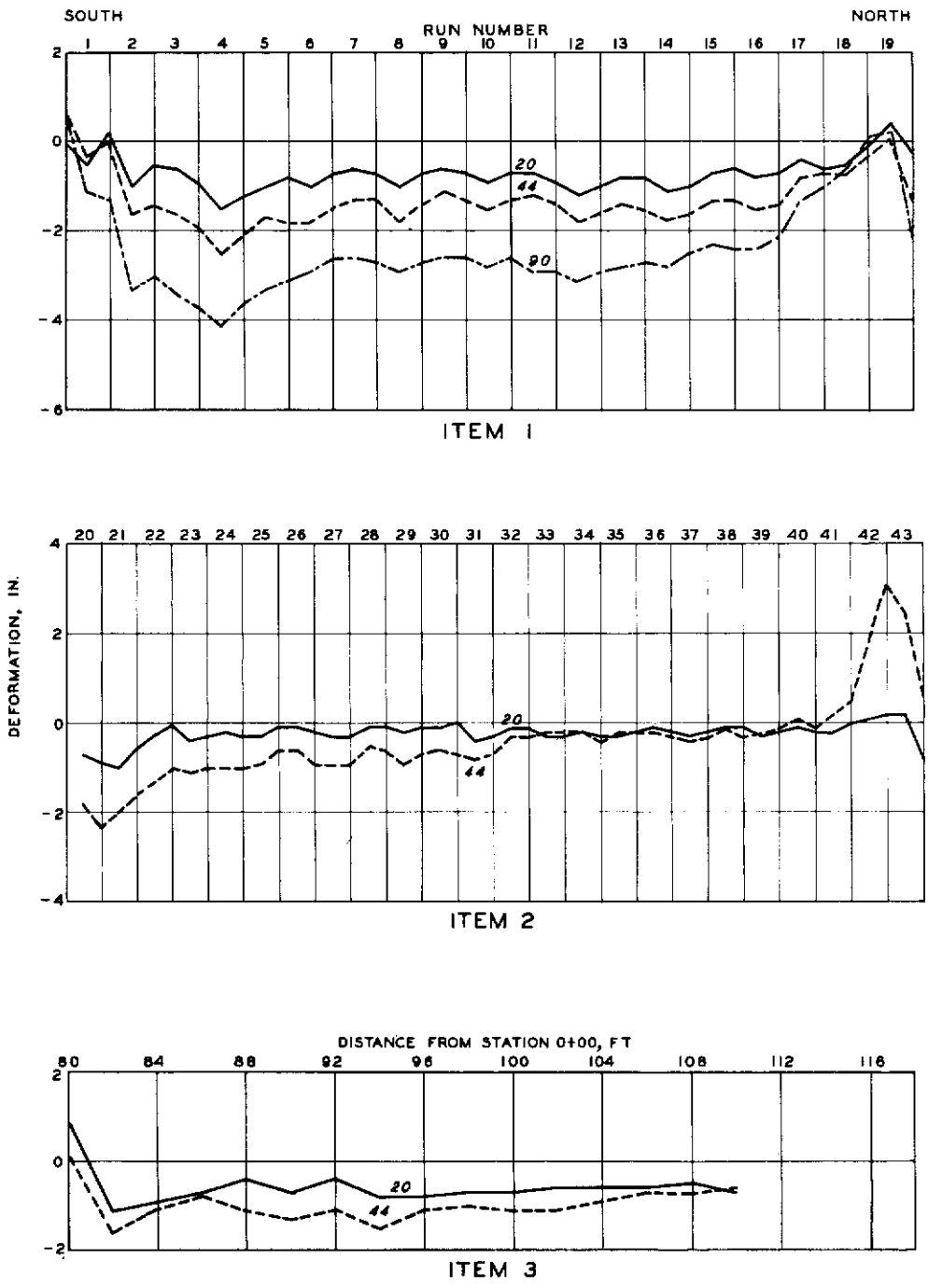


Figure 24



LEGEND

20 NUMBER OF COVERAGES

NOTE: PROFILES ARE ALONG CENTER LINE OF TRAFFIC LANE.

PERMANENT PROFILE DEFORMATIONS
TEST SECTION 6
LANE 12

Figure 25

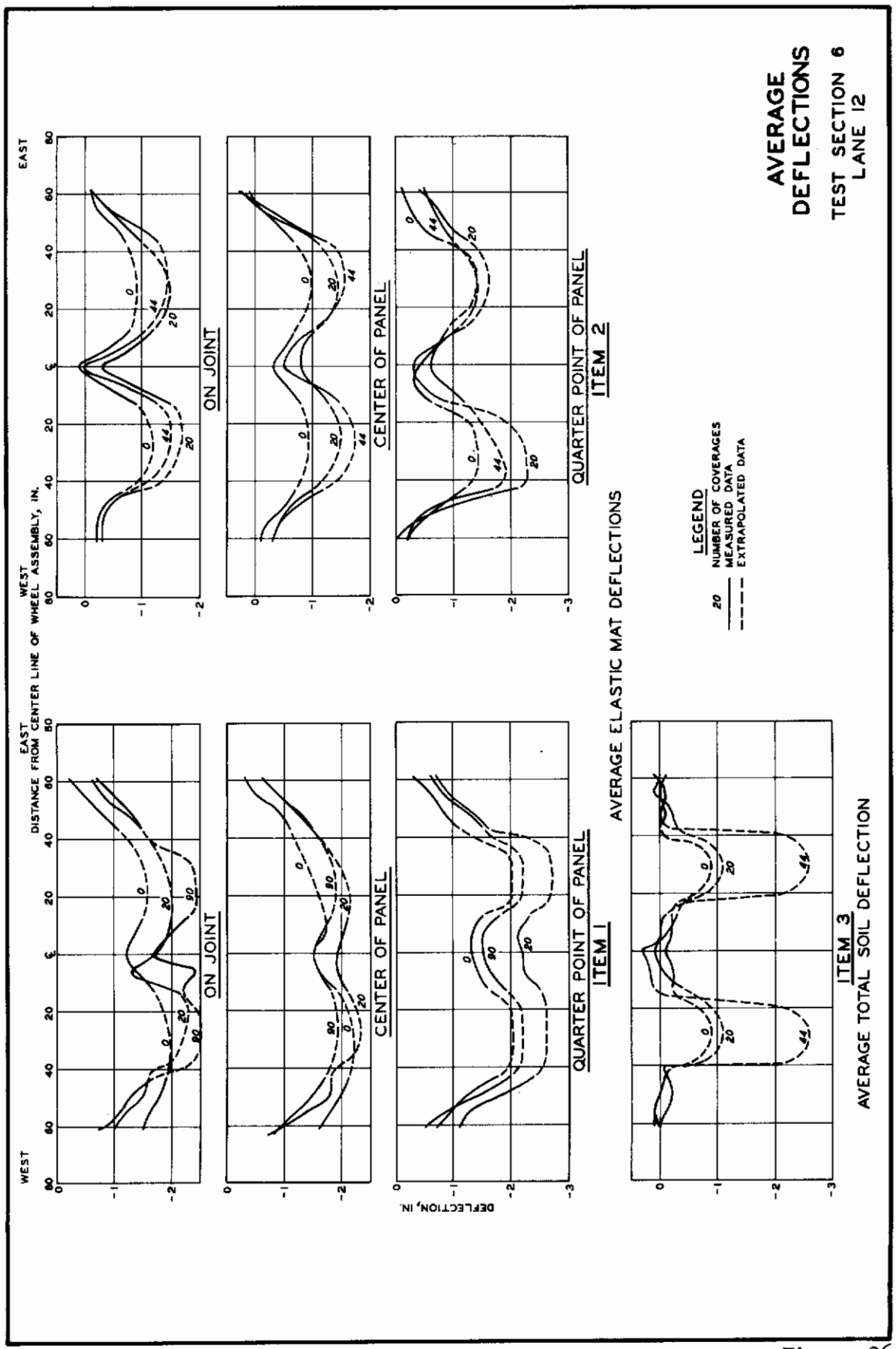


Figure 26

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
Aircraft Ground-Flotation Investigation
Part VII Data Report on Test Section 6

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Technical Report

5. AUTHOR(S) *(Last name, first name, initial)*
Brabston, W. N.
Hill, W. J., Jr.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1966	33	

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
MIPR AS 4-177 b. PROJECT NO. 410A c. d.	AFFDL-TR-66-43, Part VII 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* None

10. AVAILABILITY/LIMITATION NOTICES This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Flight Dynamics Laboratory (FDFM), Wright-Patterson AFB, Ohio 45433.

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

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

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.