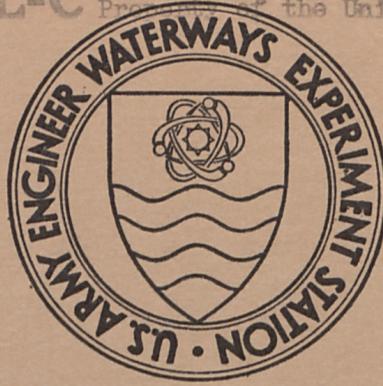


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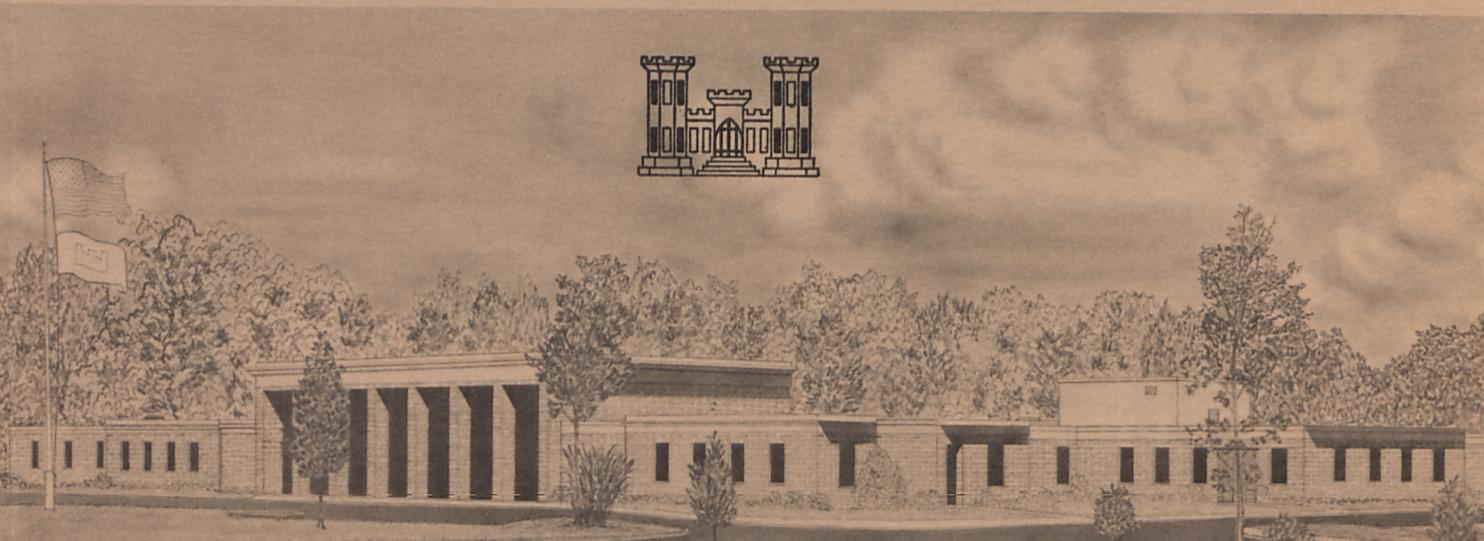


MISCELLANEOUS PAPER S-74-14

EVALUATION OF XM18Q EXTRUDED ALUMINUM LANDING MAT

by

C. J. Smith, D. W. White, Jr.



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US ARMY ENGINEER WATERWAYS EXPERIMENT STATION
VICKSBURG, MISSISSIPPI
May 1974

Sponsored by U. S. Army Materiel Command

Conducted by U. S. Army Engineer Waterways Experiment Station
Soils and Pavements Laboratory
Vicksburg, Mississippi



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Project No. IG764717DH01-10

Conducted by **U. S. Army Engineer Waterways Experiment Station**
Soils and Pavements Laboratory
Vicksburg, Mississippi

FOREWORD

This study was conducted as a part of the work authorized by the Troop Support Division (formerly Ground Mobility Division), Directorate of Research, Development, and Engineering, U. S. Army Materiel Command (AMC), under the title, "Combat Engineer Equipment," DA Project No. 1G764717DH01, Task 10, "Landing Mat."

The engineer design tests (EDT) pertinent to this investigation were performed at the U. S. Army Engineer Waterways Experiment Station (WES) during October-November 1969 and May 1970 under the general supervision of Mr. J. P. Sale, Chief, Soils and Pavements Laboratory (S&PL). Personnel of the Materiel Development Division, S&PL, actively engaged in the planning, testing, analyzing, and reporting phases of the investigation were Messrs. W. L. McInnis, H. L. Green, D. W. White, Jr., and C. J. Smith. The Pavement Design Division, S&PL, had the responsibility of constructing and trafficking the test section and also of performing the necessary soil tests under the supervision of Messrs. R. G. Ahlvin, R. L. Hutchinson, and C. D. Burns. This report was prepared by Messrs. Smith and White.

Directors of WES during the conduct of this study and the preparation of this report were COL L. A. Brown, CE, BG E. D. Peixotto, CE, and COL G. H. Hilt, CE. The Technical Director was Mr. F. R. Brown.

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	2.54	centimeters
feet	0.3048	meters
square feet	0.092903	square meters
pounds (mass)	0.4535924	kilograms
pounds (force)	4.448222	newtons
pounds (force) per square inch	0.6894757	newtons per square centimeter

SUMMARY

The investigation reported herein was conducted to evaluate an extruded aluminum alloy landing mat (designated XM18Q) supplied by the Dow Chemical Company, Madison, Ill. The mat, which was fabricated by the Washington Aluminum Company (WACO), Enterprise, Ala. (Dow's subcontractor), is a one-piece extrusion fabricated from 6061 aluminum alloy artificially aged to the T6 condition. The mat panels are interlocked along the sides by means of a hinge-type connector, the components of which are an integral part of the basic panel extrusion. End connectors, composed of extruded connectors welded to the basic panel, consist of overlap and underlap sections secured by a locking bar after individual panels have been joined together. The mat mentioned herein was different from modified MX18-B* mat in that the inserted tubes in the ends of the mat panels were shortened by 3/4 in. and the amount of metal was increased in the area of the female connector and first cavity adjacent to this connector. The method of attaching the end connectors to the mat extrusion was changed to allow improved welds at the corners.

The investigation consisted of traffic, skid, cable roll-over, and laboratory tests to obtain information for use in evaluating the XM18Q mat for potential use as a medium-duty landing mat. The test data reported herein were evaluated against the criteria for medium-duty mat as established in the revised Qualitative Materiel Requirement (QMR).

Traffic tests were conducted with the mat placed on a prepared subgrade and trafficked with a rolling wheel load simulating actual aircraft operations. The XM18Q mat, which weighs 4.8 lb per square foot of placing area, was assembled at an average rate of 600 sq ft per man-hour. The mat's weight exceeds the maximum QMR requirement for a medium-duty mat of 4.5 lb per square foot of placing area, and the placing rate exceeds the minimum QMR requirement of 250 sq ft per man-hour. The traffic tests were conducted using the F-4C loading, which consists of a single-wheel load of 25,000 lb with a tire inflation pressure of 250 psi, on a mat-surfaced subgrade with a rated CBR of 4.1. Results of this investigation revealed that the XM18Q mat sustained 940 actual coverages of traffic on a subgrade with a rated CBR of 4.1, which is

* The modified MX18-B mat was type classified for limited production as XM18 in September 1967 and is shown in Supply Catalog SC-5680-97-CL-E04, "Mat Set, Landing," dated January 1968.

equivalent to 850 coverages on a 4-CBR subgrade. This falls short of the QMR 1000-coverage requirement for a medium-duty mat on a 4-CBR subgrade.

The average coefficients of friction obtained from skid tests on wet and dry surfaces were 0.45 and 0.52, respectively. These coefficients of friction fall within the QMR range of 0.4 to 0.8. The tire wear resulting from skidding on both the wet and dry surfaces was not considered significant.

Cable roll-over tests were conducted on the XM18Q mat with a 1-in.-diam arresting cable trafficked with a 25,000-lb single-wheel load with a tire inflated to 250 psi. Results indicated that the mat will withstand the 20 cable roll-overs stipulated in the QMR.

Laboratory tests conducted on the mat indicated that the 6061-T6 alloy exceeded the minimum physical requirements.

EVALUATION OF XM18Q EXTRUDED

ALUMINUM LANDING MAT

1. During October-November 1969, traffic tests were conducted at the Waterways Experiment Station (WES) on Dow 2- by 12-ft XM18Q medium-duty mat (Incl 1). This mat, which weighs 4.8 lb per sq ft of placing area including antiskid compound, was supplied by the Dow Chemical Co., Midland, Mich. under a contract with WES.
2. The layout of the test section is shown on Incl 2. The subgrade was processed to a depth of 2⁴ in. and prepared with an in-place CBR of 3.8 (Incl 3). A polyethylene membrane was placed on the subgrade prior to the placement of mat to help prevent the subgrade from drying and causing the CBR to rise. The mat was placed at the rate of 600 sq ft per man-hour with a seven man crew. No difficulties were encountered in the placement of this mat.
3. Skid tests were conducted on both dry and wet surfaces using a skid cart with a 30,000-lb load and a tire-inflation pressure of 100 psi. The coefficient of friction was 0.52 for the dry surface and 0.45 for the wet surface. No antiskid was removed during this test and only a small amount of rubber was removed from the tire (Incl 4).
4. The traffic tests were conducted with a 25,000-lb single-wheel load using a 30 by 11.5, 2⁴-ply tire with 250-psi tire-inflation pressure (Incl 5). The pattern of traffic was applied in accordance with the standard pattern of 20, 80, and 100 percent coverages as shown on Incl 6.
5. Prior to the application of traffic, the mat surface was generally smooth (Incl 7). After 44 coverages, a slight turndown of the male edge of panel 12 was observed. This turndown was adjacent to the end joint of panels 13 and 14. After 72 coverages (Incl 8), the turndown had progressed to a length of 4 ft. (Panel 9 also contained a turndown, however, not as severe as panel 12 nor did it progress as on panel 12.) As traffic was continued, the turndown increased and at 160 coverages, the deviation from flat was 1/2 in. at the male edge at the center of the panel. The top skin was split 1-1/2 in. away from and parallel with the male edge at the midpoint of the panel. The length of the split was 18-1/2 in. At this coverage level, panel 12 was considered failed since

WESSS

18 December 1969

SUBJECT: Engineer Traffic Test of Dow XM18Q Medium-Duty Landing Mat

it had developed into a tire hazard. The panel was removed from the section and was replaced with a new panel. In addition to the split in the top skin of the mat, the male connector was split for a length of 7 ft (Incl 9).

6. Traffic was continued until 500 coverages were completed. There were eight panels which contained a slight turndown similar to panel 12. The deviation from flat on these panels was $1/32$ to $1/16$ in. The mat was removed from the test section and CBR data were taken. The CBR of the subgrade at the time was 4.1. The mat was replaced and traffic was resumed.

7. At 540 coverages, popping noises were noticed in panel 21 as the load wheel moved over the panel and as traffic was continued, the panel began to depress adjacent to the end joint of panels 22 and 23 (Incl 10). Panels 18, 24, and 27 also contained depressions similar to panel 21. As traffic was continued, the depressions and turndown at the male edges did not increase rapidly; however, the popping noises continued, which were an indication that the internal ribs were breaking. The condition of panels 21 and 24 after 780 coverages is shown on Incls 11 and 12, respectively. After 880 coverages, all ten panels with the center of the panels located in the 100 percent coverage portion of the test section contained depressions varying from a minimum of $1/16$ in. to a maximum of $11/32$ in. on panel 24. Nine other panels contained depressions which began approximately 12 in. from the end joints and extended approximately 30 in. Traffic was continued until 940 coverages were completed (Incl 13). The test section was considered failed due to roughness and a tire hazard. Panels 21 and 24 were failed due to roughness (Incl 14), and panel 29 contained a split and curl at the female-overlap corner of the panel (Incl 15) which was a tire hazard. As the load wheel passed over or adjacent to the end joint of panels 28 and 29, these panels separated. The failure of these panels in addition to panel 12 which had previously failed constituted failure of the section based on the allowable 10 percent replacement of panels in the 100 percent area of the traffic lane. The CBR at the end of 940 coverages was 4.6. The rated CBR for the test section was 4.1.

8. Results of the tests on the Dow XM18Q mat are as follows:

a. The mat will withstand 850 coverages of the 25,000-lb single-wheel load with the 250-psi tire-inflation pressure on a 4 CBR.

WESSS

18 December 1969

SUBJECT: Engineer Traffic Test of Dow XM18Q Medium-Duty Landing Mat

b. The coefficient of friction on wet and dry surfaces meets the requirements of the revised QMR (RCR of 13-25 or coefficient of friction of 0.4 to 0.8).

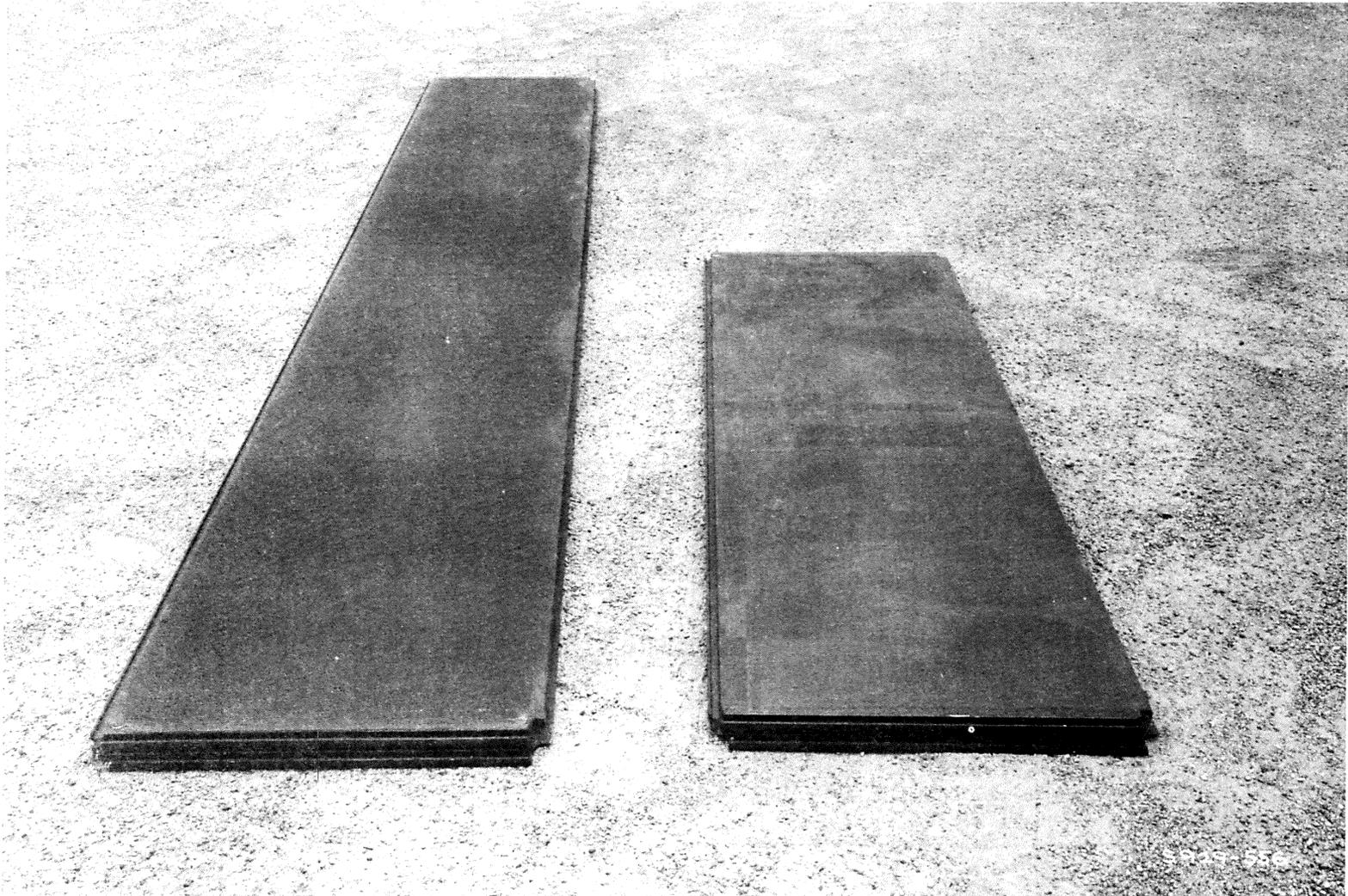
15 Incl*
as

D. W. White

D. W. WHITE
Engineer
Mat Section

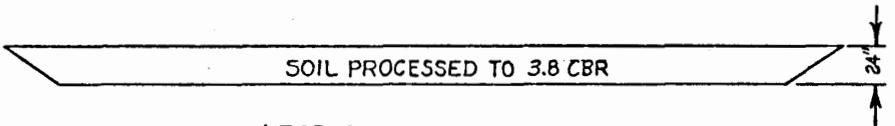
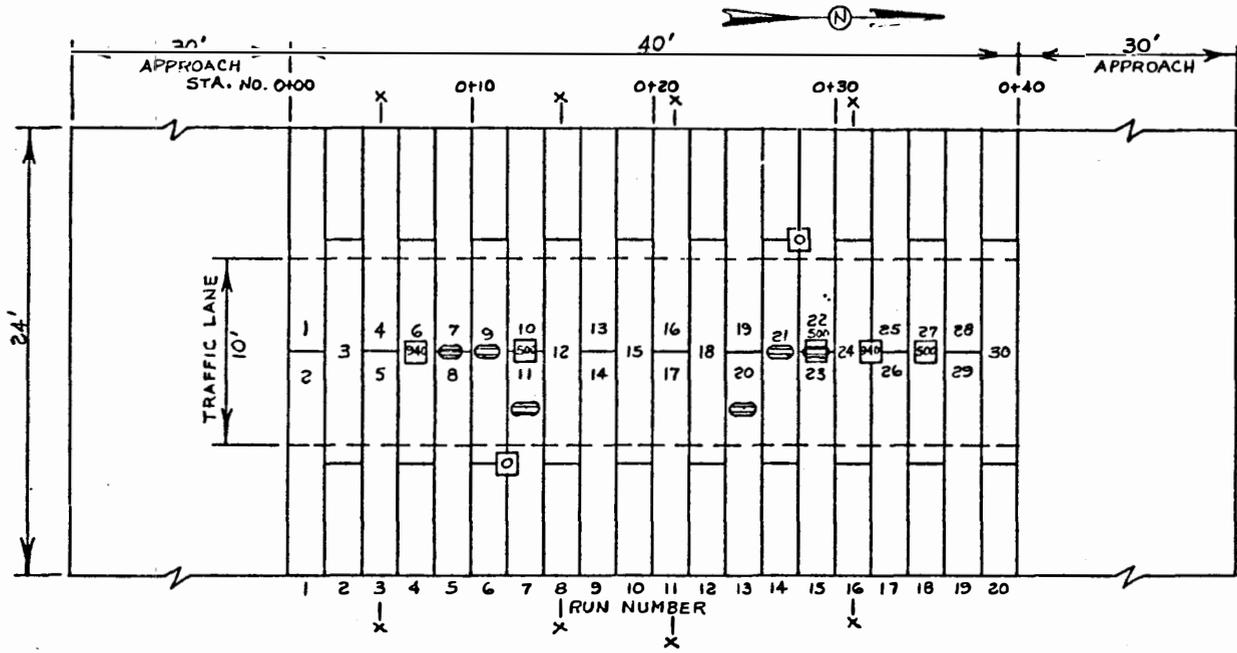
CF w/incl:
AMCRD-GME (Mr. W. R. Barwick)
AMCRD-TV (Mr. P. F. Carlton)
ENGME-RD (Mr. Leo Price)

* Inclosure 16 (with five inclosures) is an MFR on the cable roll-over tests. Inclosures 17-22 have been added as additional information for the reader. These include laboratory test data (Incls 17-18); deflection (Incl 19), cross-section (Incl 20), and profile (Incl 21) level data; and a strength evaluation curve (Incl 22) for the XM18Q mat.



Incl 1

Full and half panels of XML8Q mat



LEGEND

-  TEST WHEEL LOCATION FOR DEFLECTION MEASUREMENTS
-  CBR TEST PIT LOCATION AND COVERAGE LEVEL
-  X-X LOCATION FOR CROSS SECTION DATA

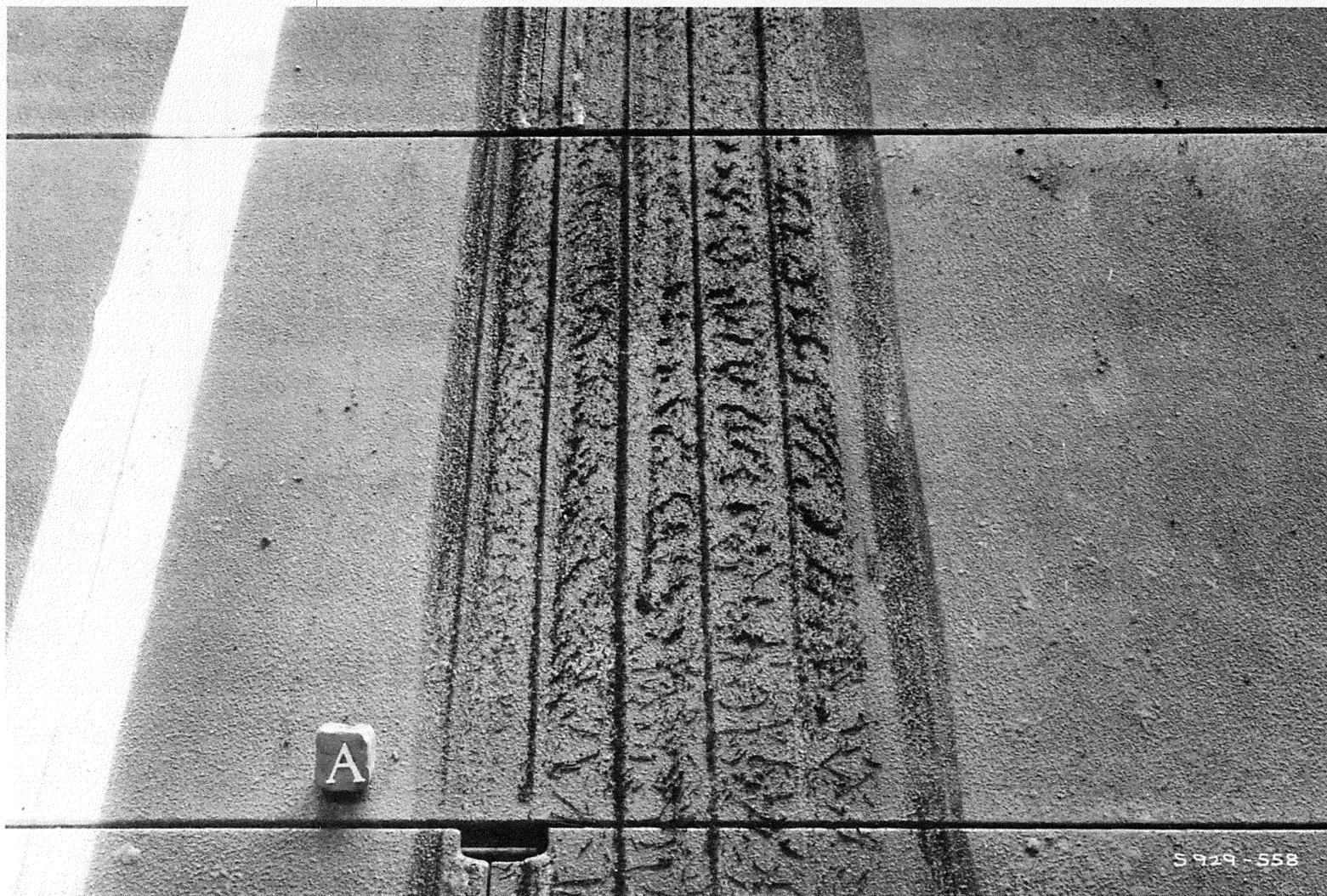
NOTE: NUMBERS INSIDE PANELS INDICATE PANEL NUMBERS.

LAYOUT OF TEST SECTION
EVALUATION OF
XM18Q MAT

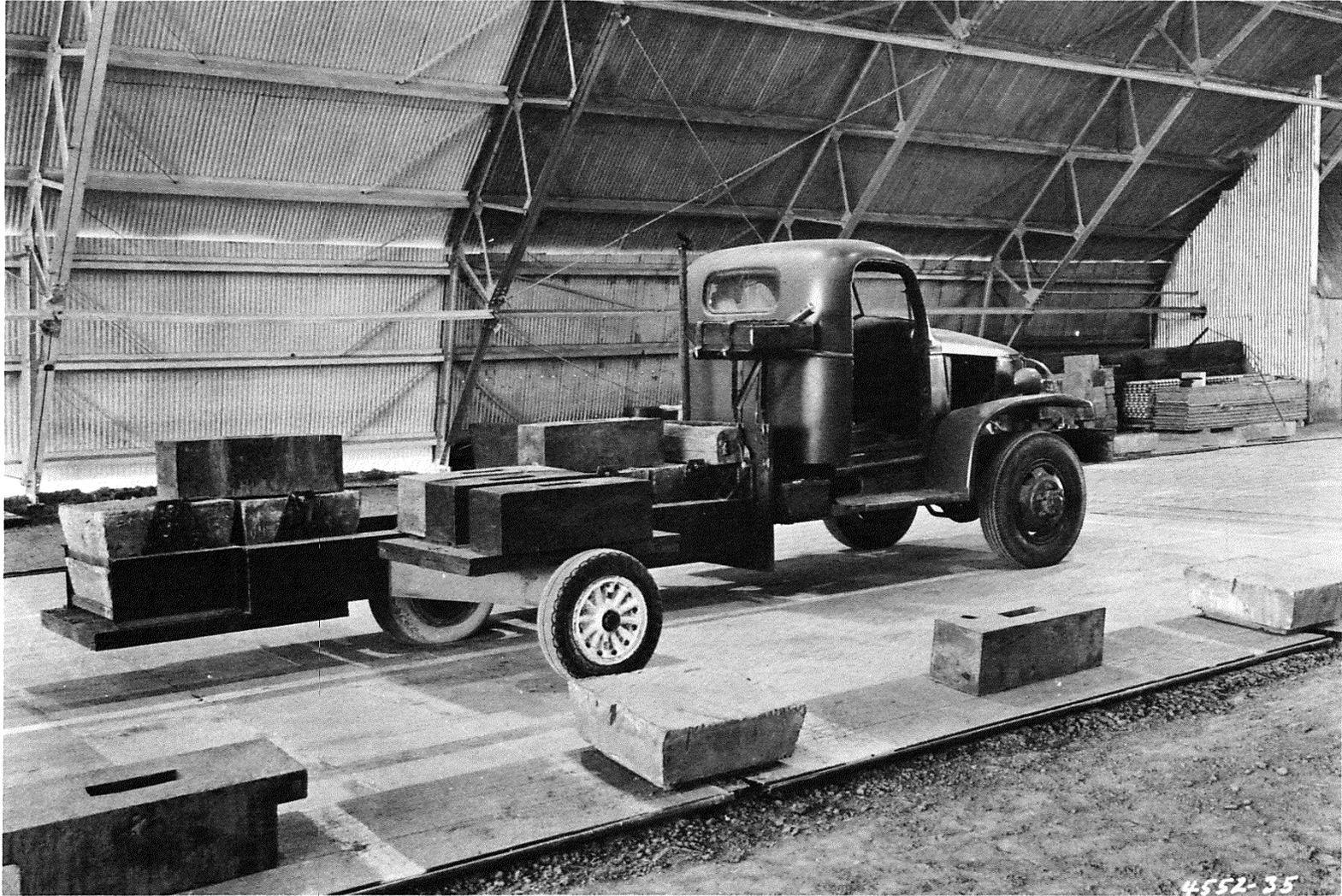
SUMMARY OF WATER CONTENT, DENSITY, AND CBR DATA

<u>Station</u>	<u>Coverages</u>	<u>Depth in.</u>	<u>Water Content %</u>	<u>Dry Density pcf</u>	<u>CBR</u>	<u>Rated CBR</u>
0+12	0	0	30.1	87.2	3.5	↑ 4.1 ↓
		6	29.7	87.8	3.8	
		12	<u>29.8</u>	<u>89.0</u>	<u>4.4</u>	
		Avg	29.9	88.0	3.9	
0+28	0	0	30.2	86.5	3.2	
		6	29.1	87.1	3.6	
		12	<u>30.4</u>	<u>87.5</u>	<u>4.2</u>	
		Avg	29.9	87.0	3.7	
0+13	500	0	32.0	87.5	3.5	
		6	28.9	88.4	4.3	
		12	<u>29.2</u>	<u>89.4</u>	<u>4.2</u>	
		Avg	30.0	88.4	4.0	
0+29	500	0	30.8	87.9	4.1	
		6	28.8	89.4	5.7	
		12	<u>30.7</u>	<u>89.1</u>	<u>4.7</u>	
		Avg	30.1	88.8	4.8	
0+35	500	0	30.9	88.8	3.2	
		6	29.0	88.2	3.7	
		12	<u>29.5</u>	<u>91.2</u>	<u>3.7</u>	
		Avg	29.8	89.4	3.5	
0+07	940	0	31.3	89.6	3.3	
		6	30.0	88.8	4.1	
		12	<u>29.8</u>	<u>90.2</u>	<u>4.9</u>	
		Avg	30.4	89.5	4.1	
0+32	940	0	30.1	89.1	5.1	
		6	30.1	90.2	4.9	
		12	<u>30.2</u>	<u>89.1</u>	<u>5.5</u>	
		Avg	30.1	89.5	5.2	

Incl 4

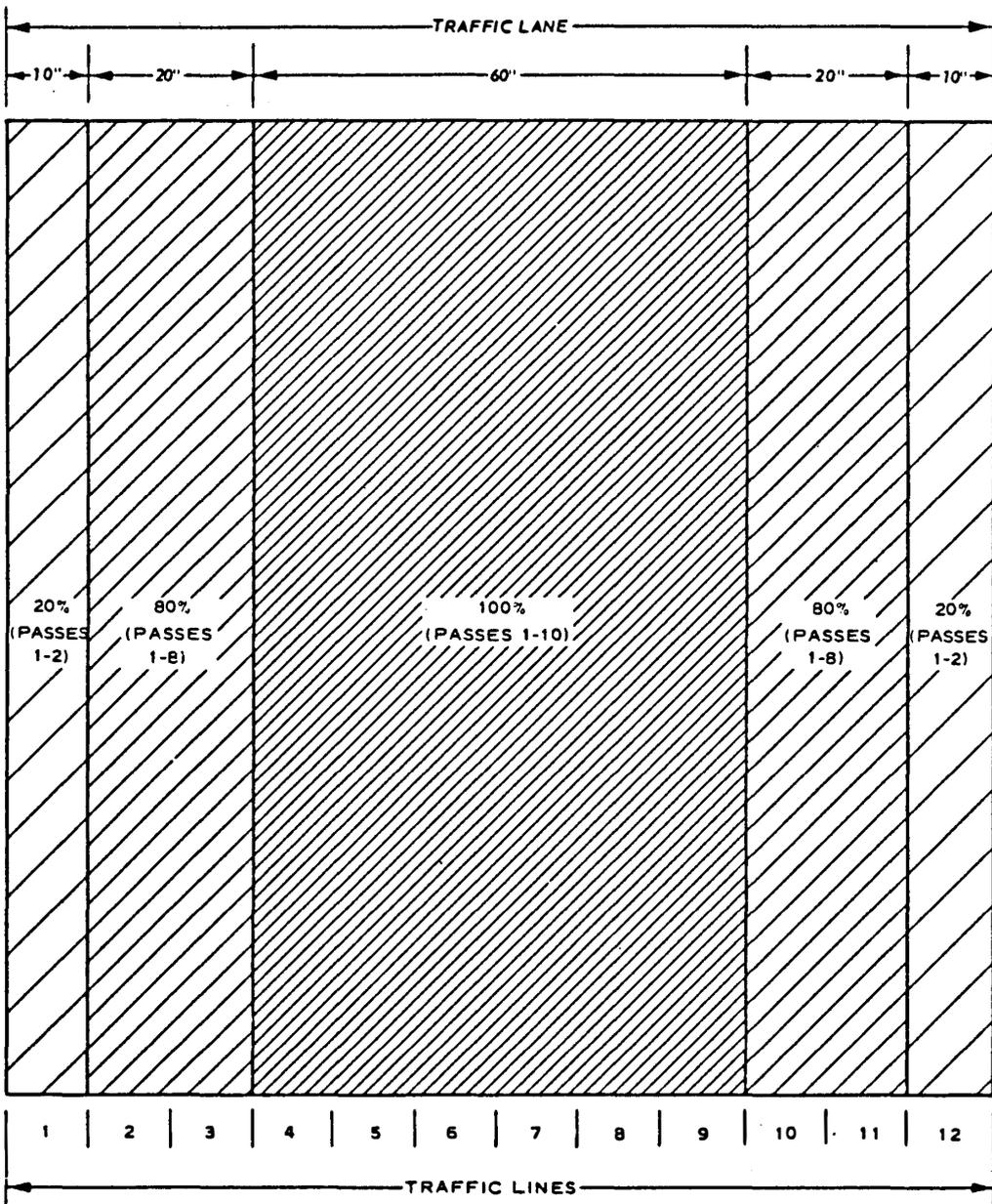


Mat surface after dry skid



Incl 5

25,000-lb single-wheel load cart used in traffic test



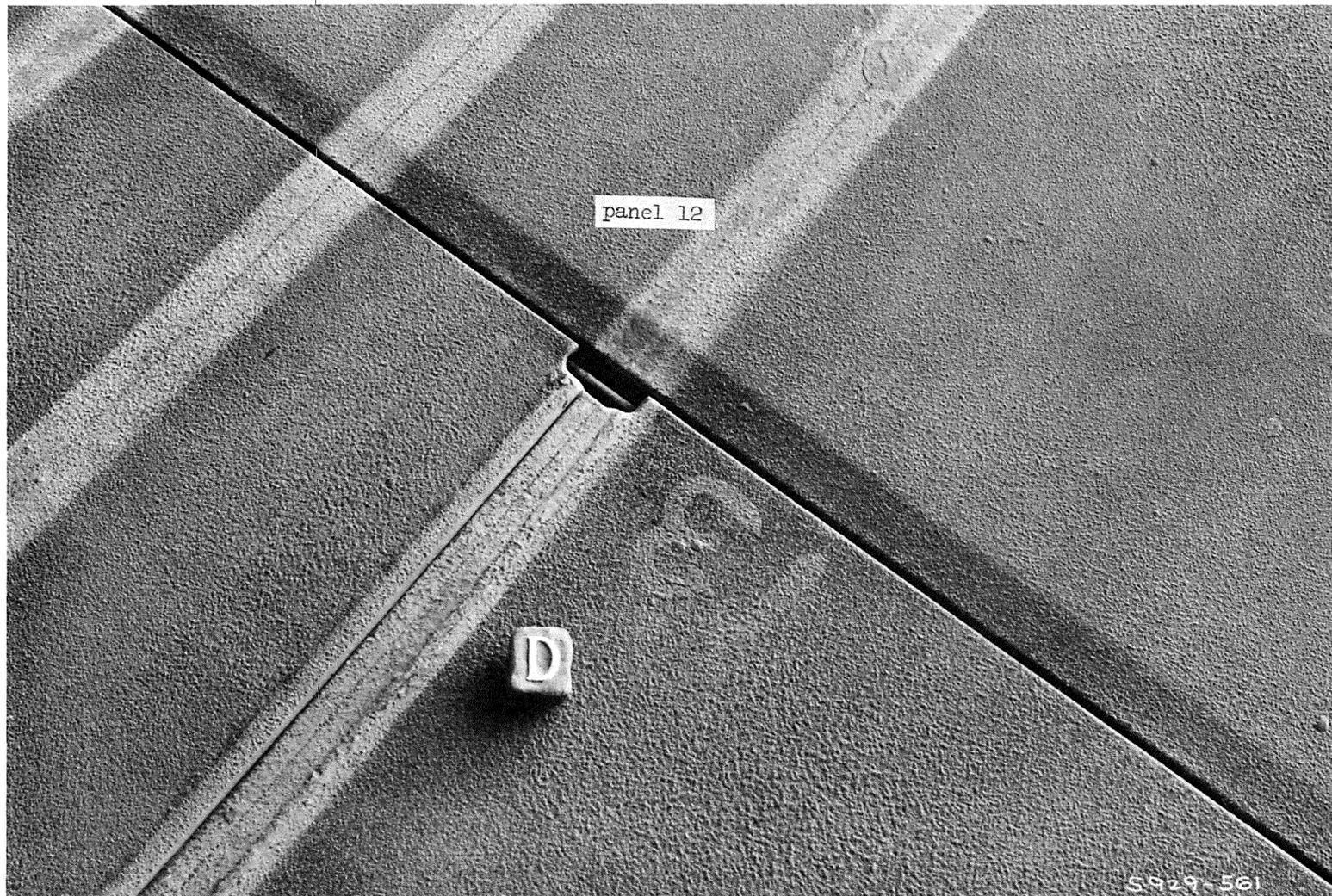
NOTE: EACH PASS IS EQUAL TO A COVERAGE BY A 10-IN.-WIDE LOAD WHEEL OVER EACH TRAFFIC LINE.

**TRAFFIC DISTRIBUTION
PATTERN FOR LANDING
MAT TESTS**

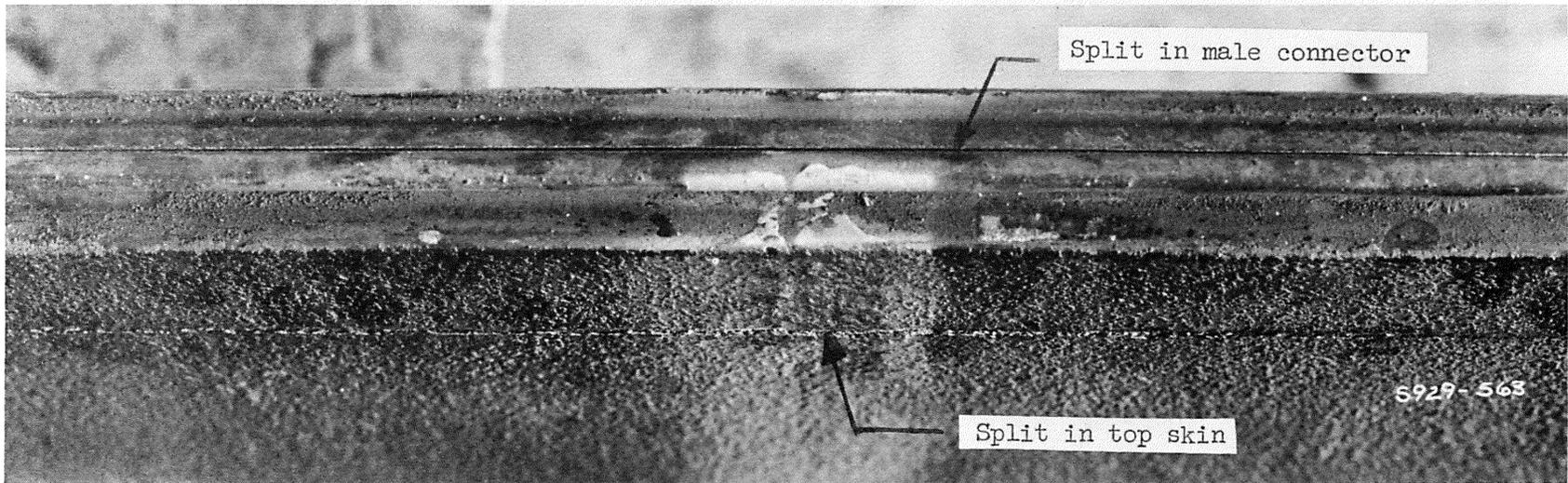


Incl 7

Test section prior to traffic



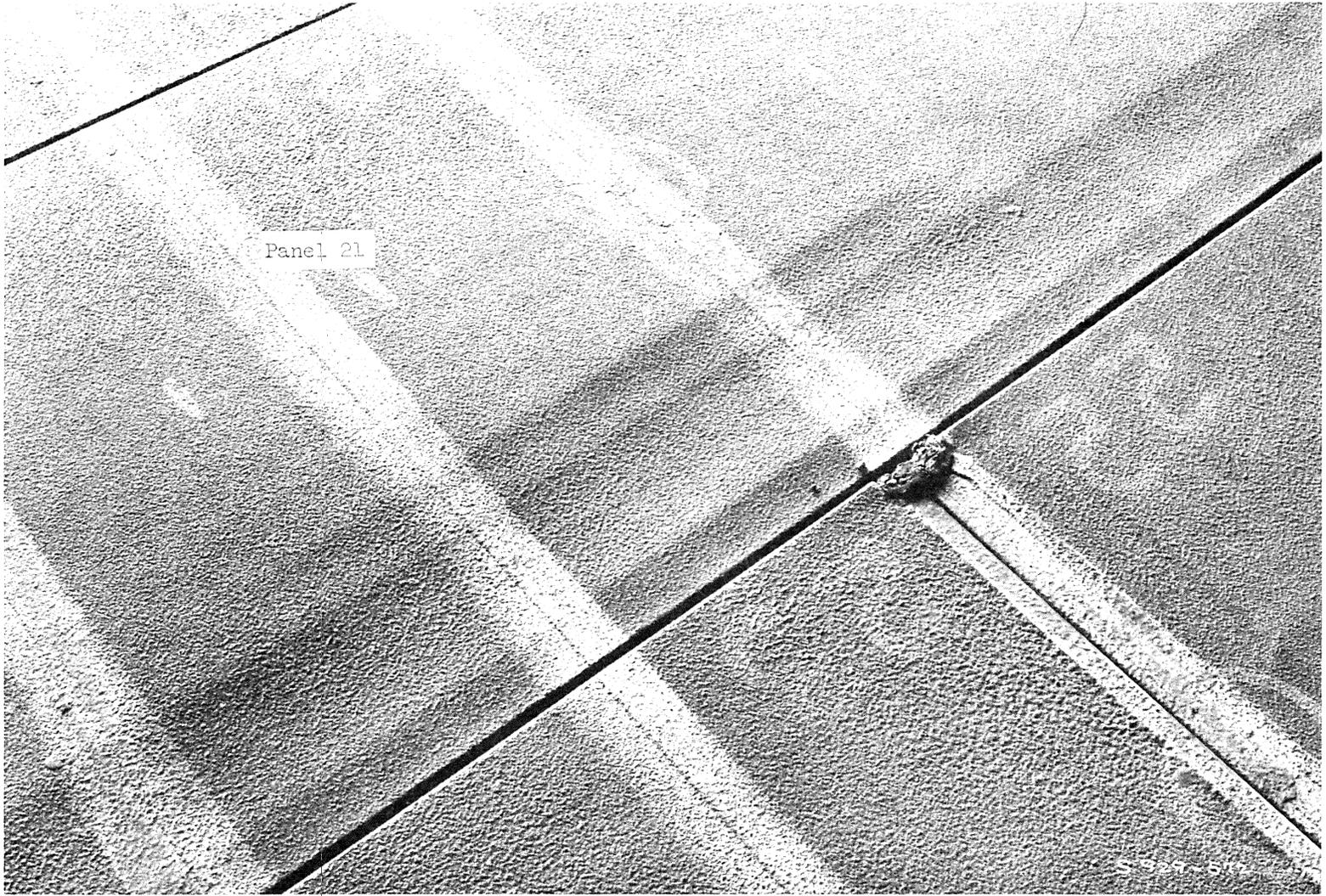
Depression along male rail of panel 12 after 72 coverages



Split in male connector and top skin of panel 12 after 160 coverages



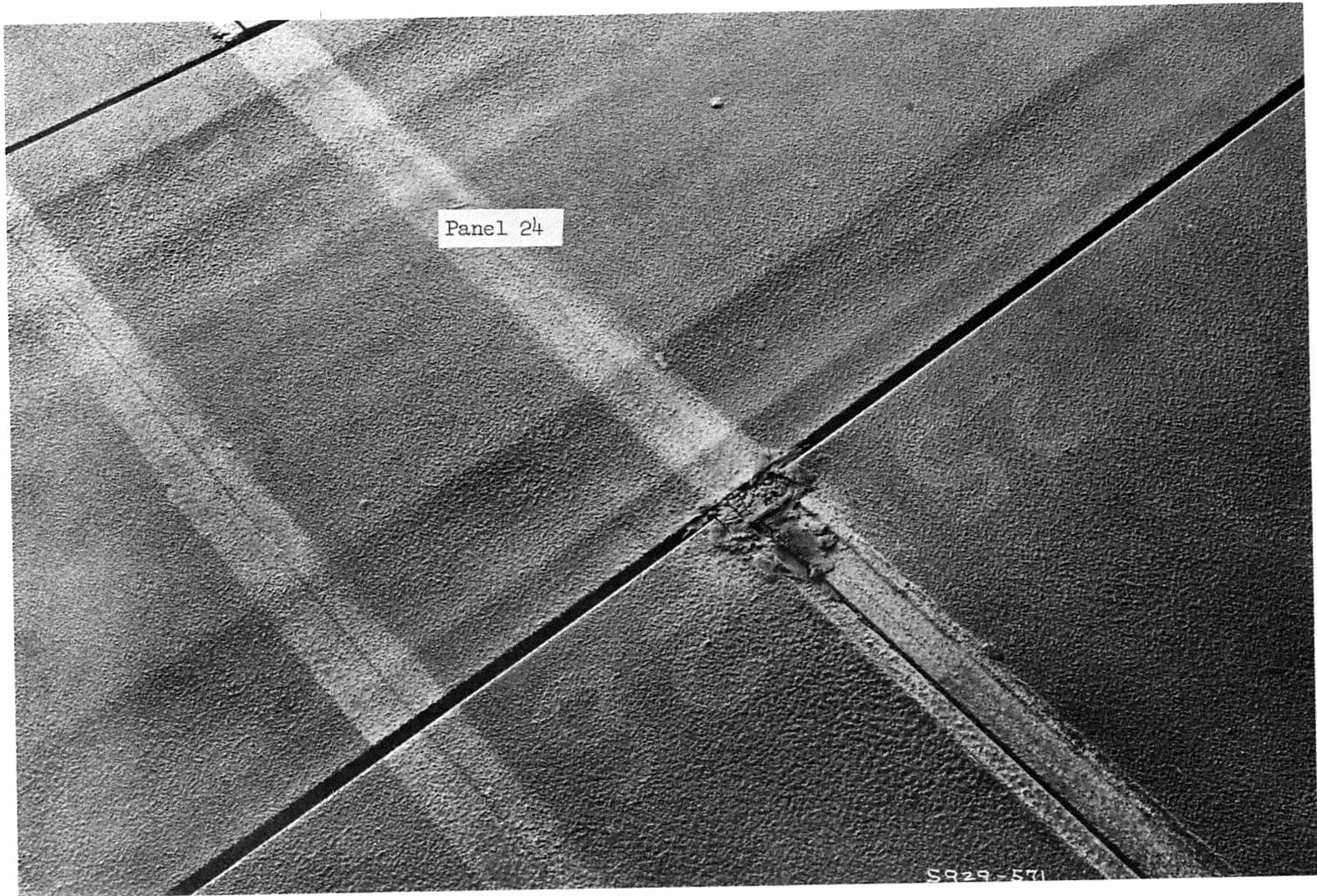
Depression in panel 21 after 650 coverages



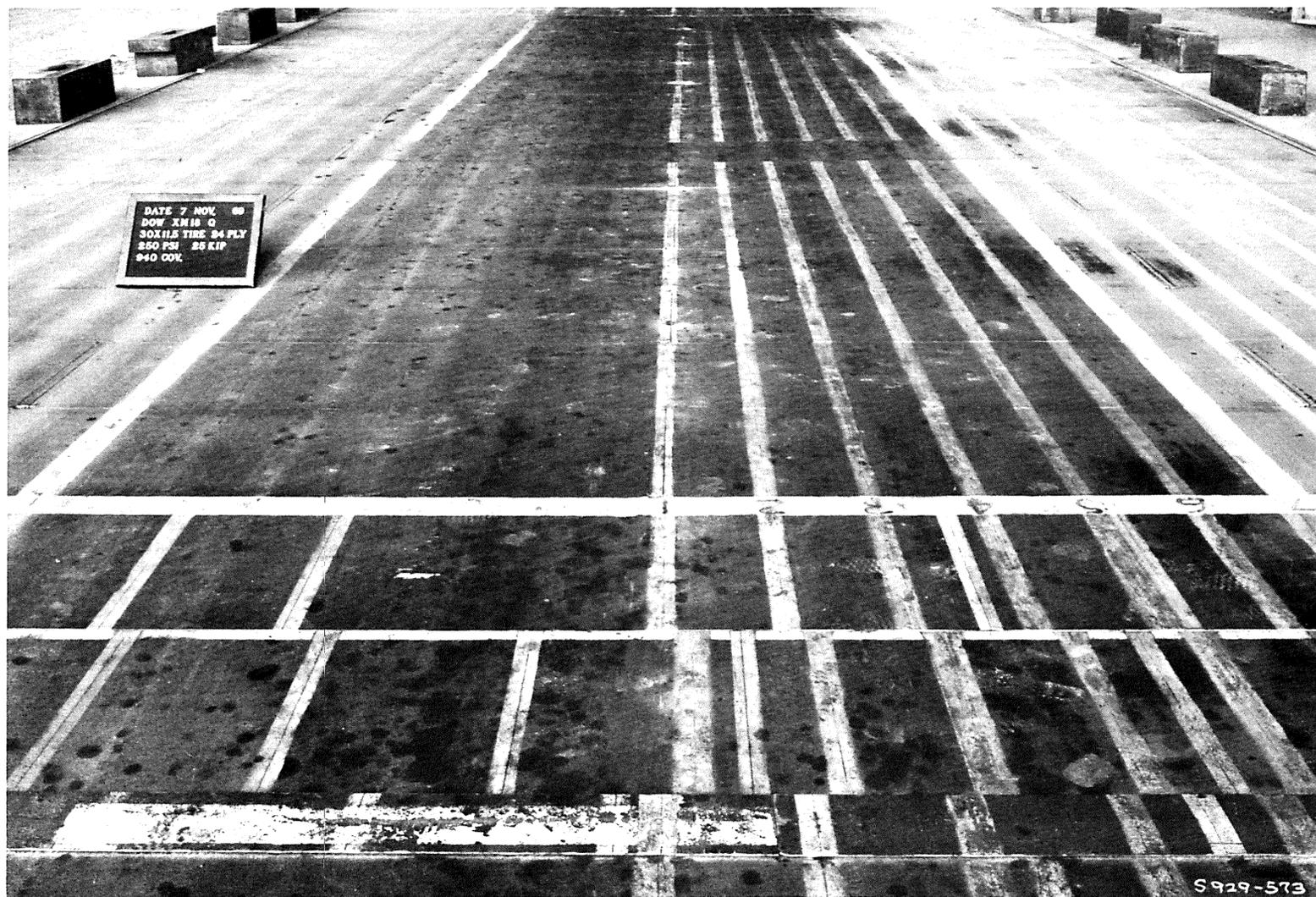
Panel 21

Incl 11

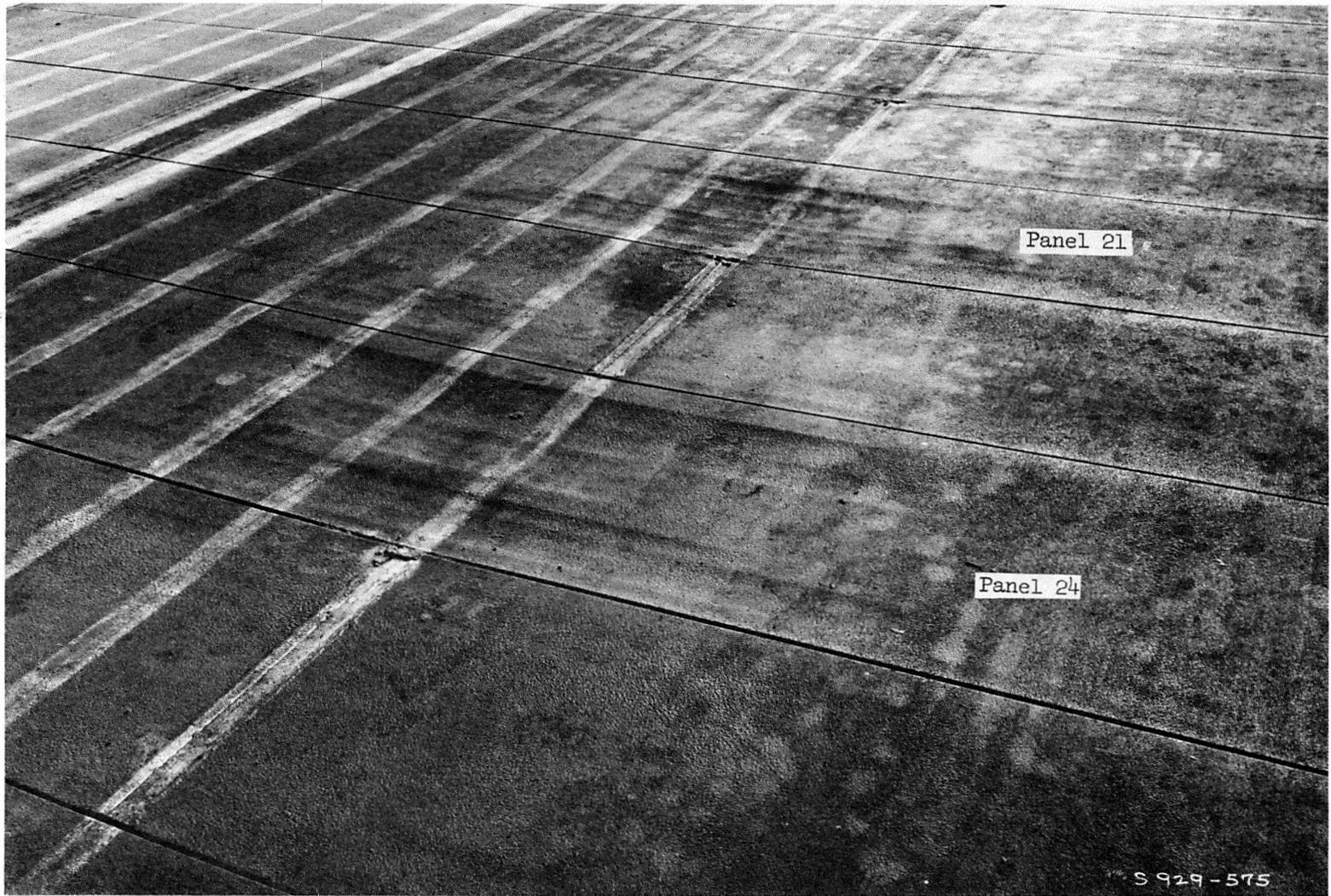
Panel 21 after 780 coverages of traffic



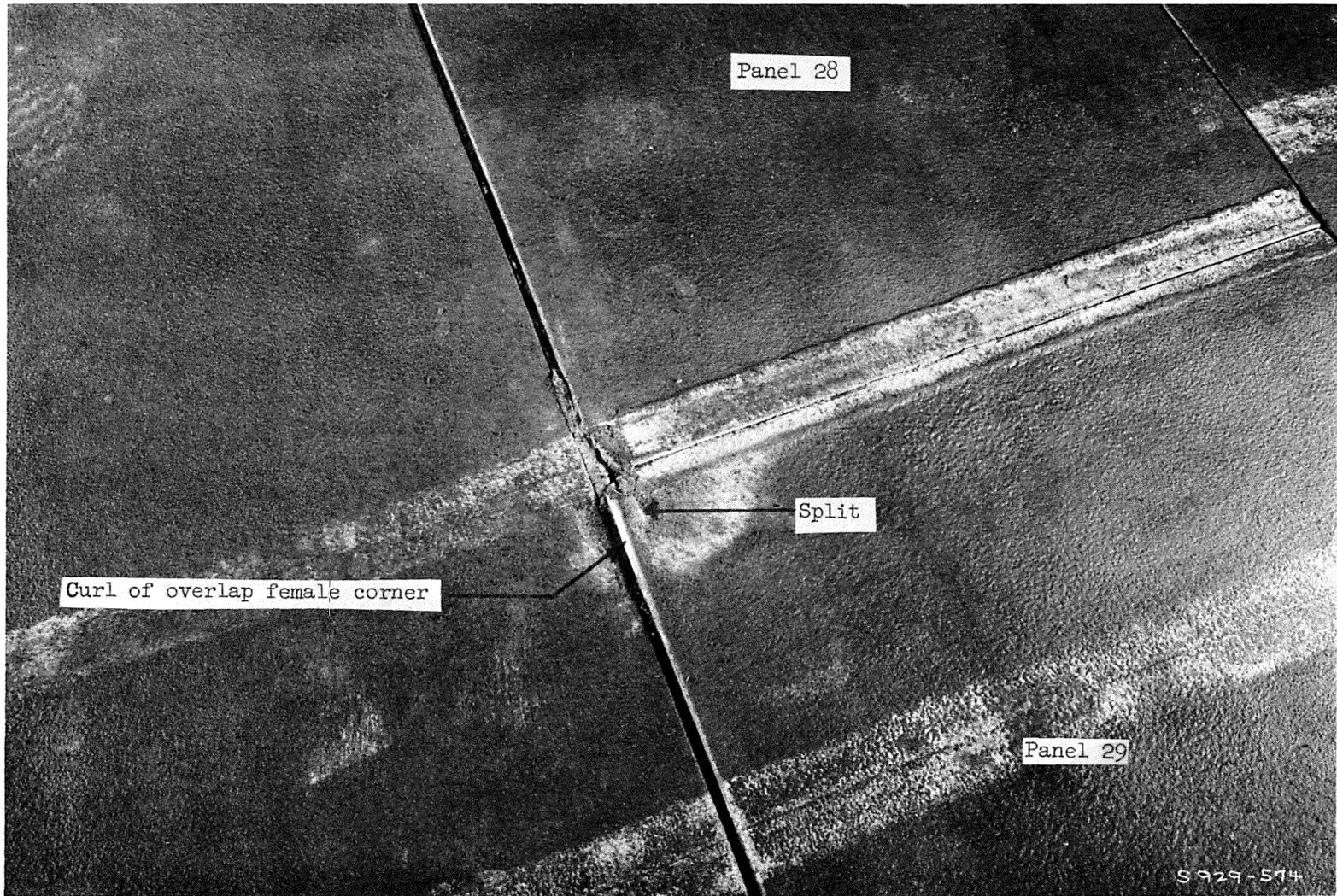
Panel 24 after 780 coverages of traffic



Overall view of test section after 940 coverages of traffic



Panels 21 and 24 after 940 coverages of traffic



Panels 28 and 29 after 940 coverages of traffic



DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI 39160

IN REPLY REFER TO: WESSS

26 May 1970

MEMORANDUM FOR RECORD

SUBJECT: Cable Roll-Over Tests on XM18Q Mat

1. On 21 May 1970, cable roll-over tests were conducted on XM18Q mat with a 1-in.-diam arresting cable (Incl 1) with a 25,000-lb single-wheel load and a 250-psi tire-inflation pressure (F-4C load conditions).
2. An overall view of the three areas where the mat was subjected to 20 cable roll-overs is shown on Incl 2. A close-up view of the end joint, side joint, and center of panel is shown on Incls 3-5, respectively. The depth of the depressions at the end joint, side joint, and center of panel was 3/16, 5/16, and 3/16 in., respectively. There were no tears or breaks in the surface of the mat.
3. The cable roll-over tests proved that the XM18Q mat will support 20 cable roll-overs on a 1-in.-diam arresting cable as required by the QMR.

5 Incl
as


D. W. WHITE, JR.
Engineer
Mat Section

Incl 16



Incl 1 to Incl 16

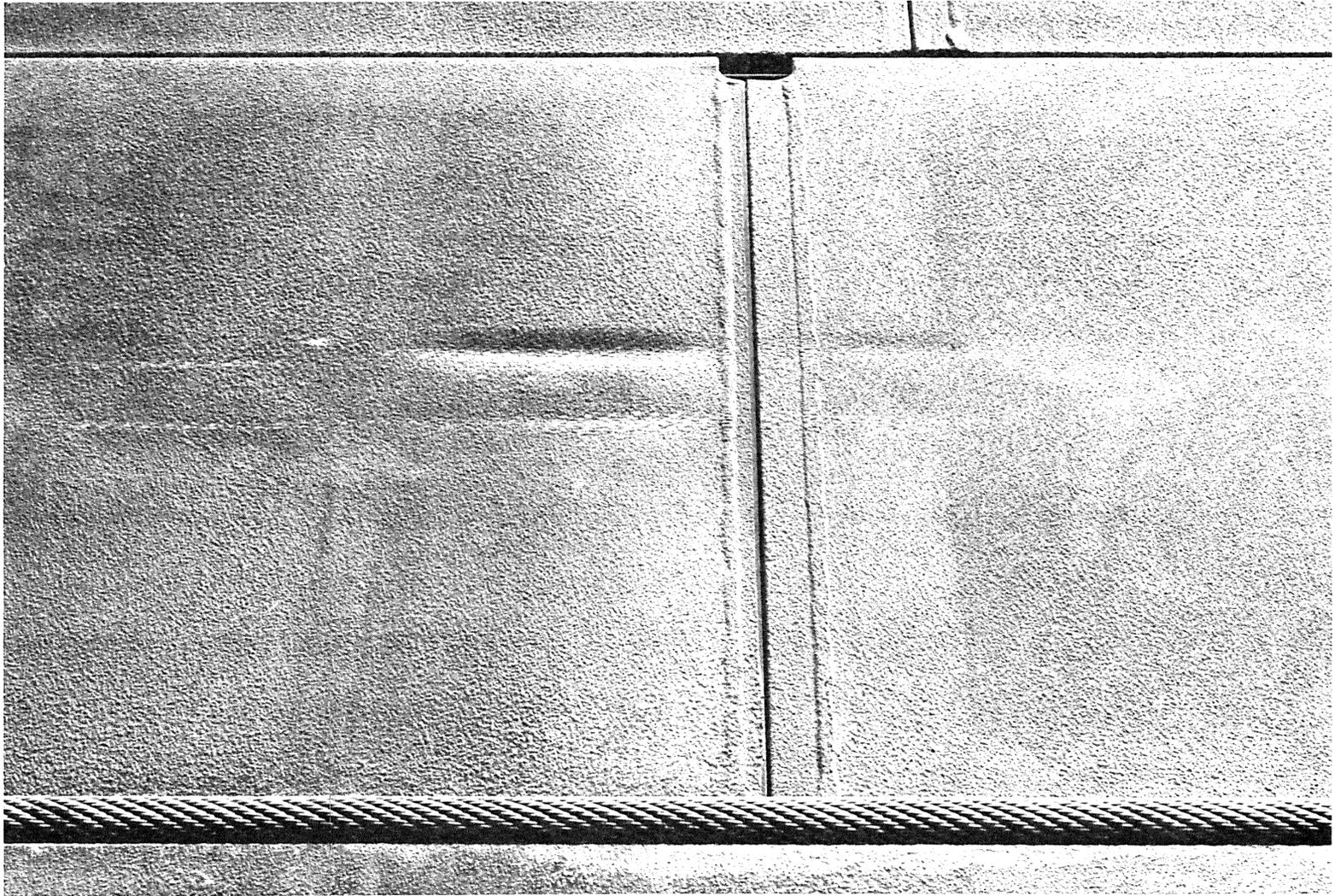
Overall view of mat for cable roll-over tests

Incl 2 to Incl 16



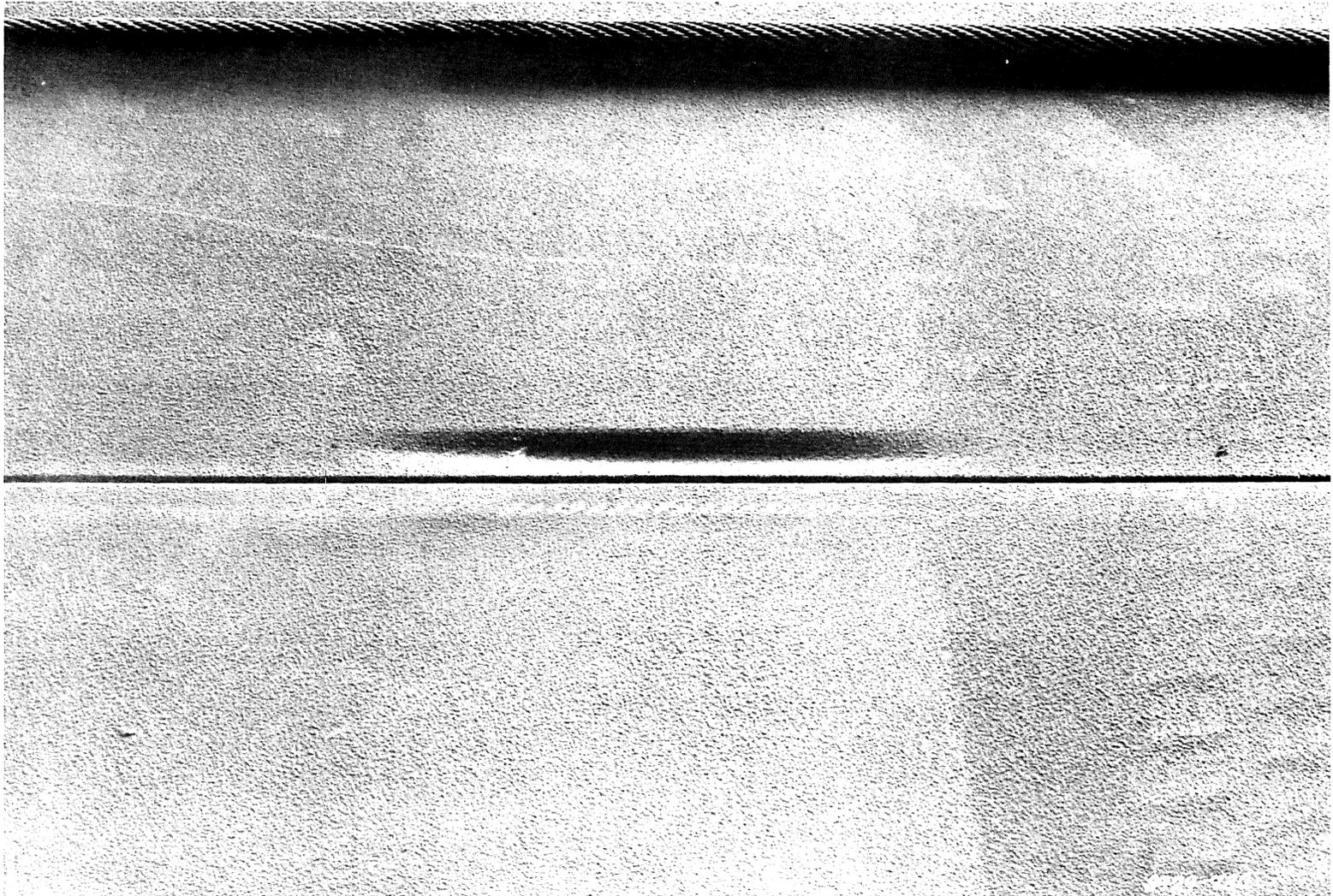
Overall view of mat after cable roll-over tests

Incl 3 to Incl 16



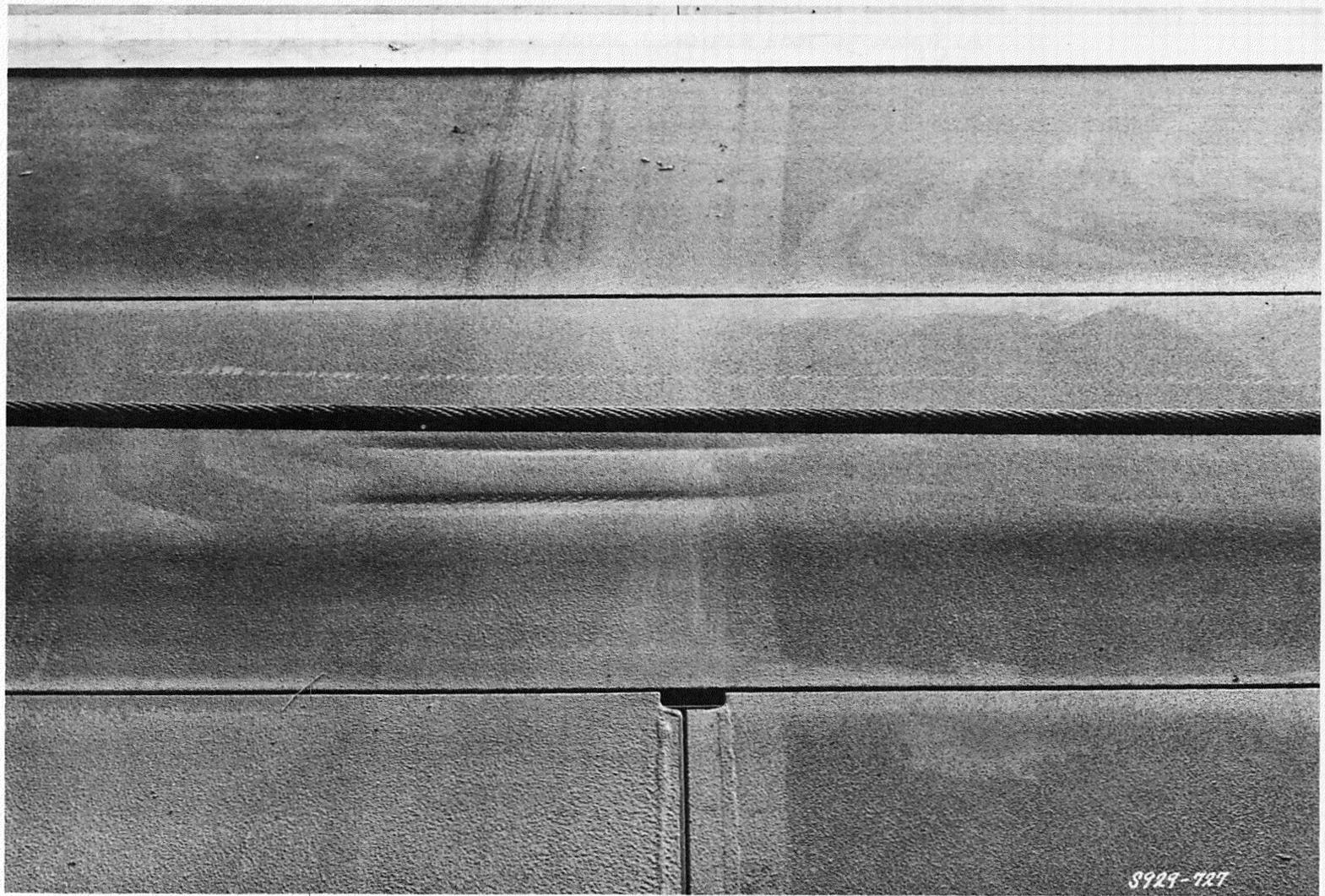
End joint after cable roll-over tests

Incl 4 to Incl 16



Side joint after cable roll-over tests

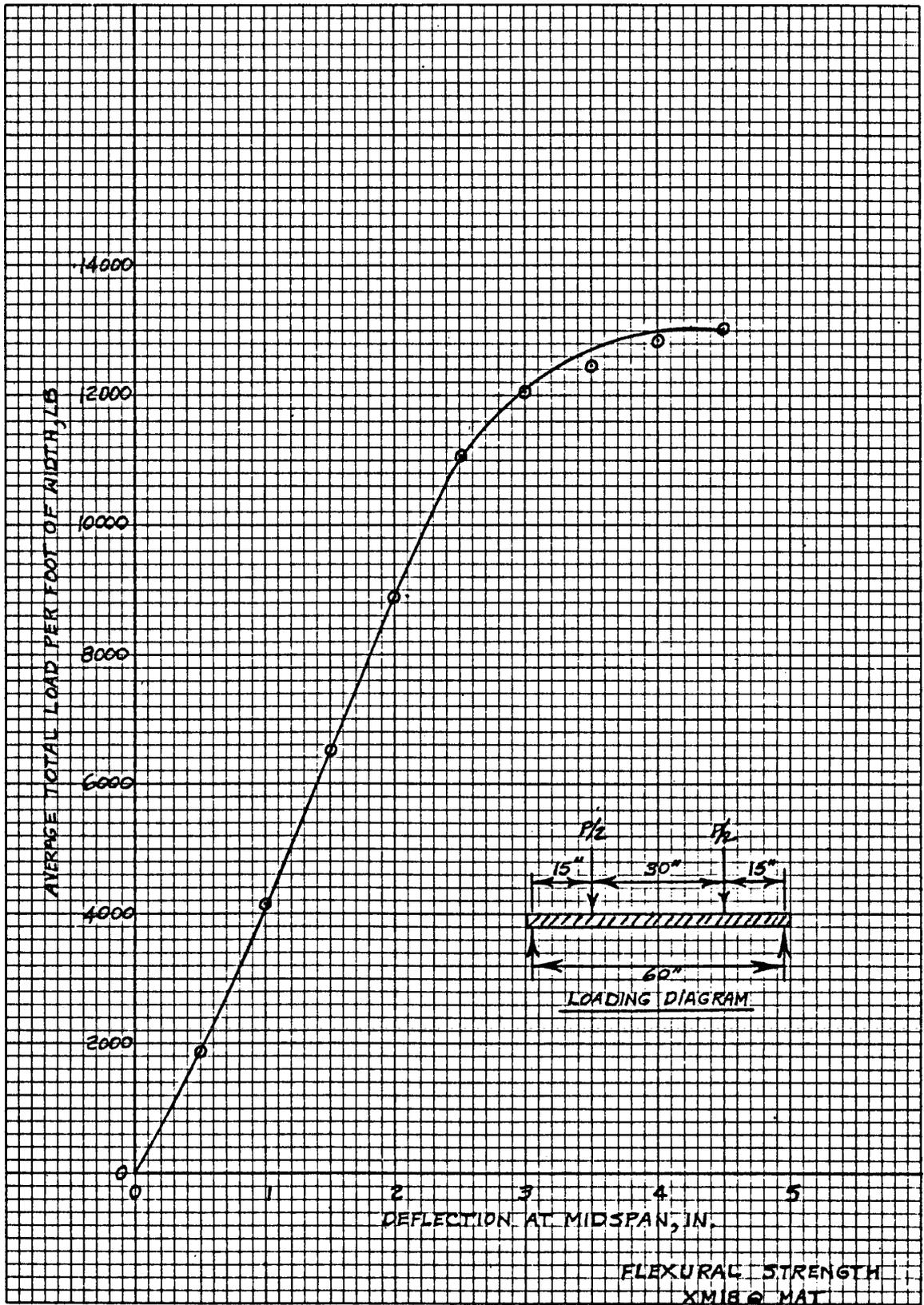
Incl 5 to Incl 16

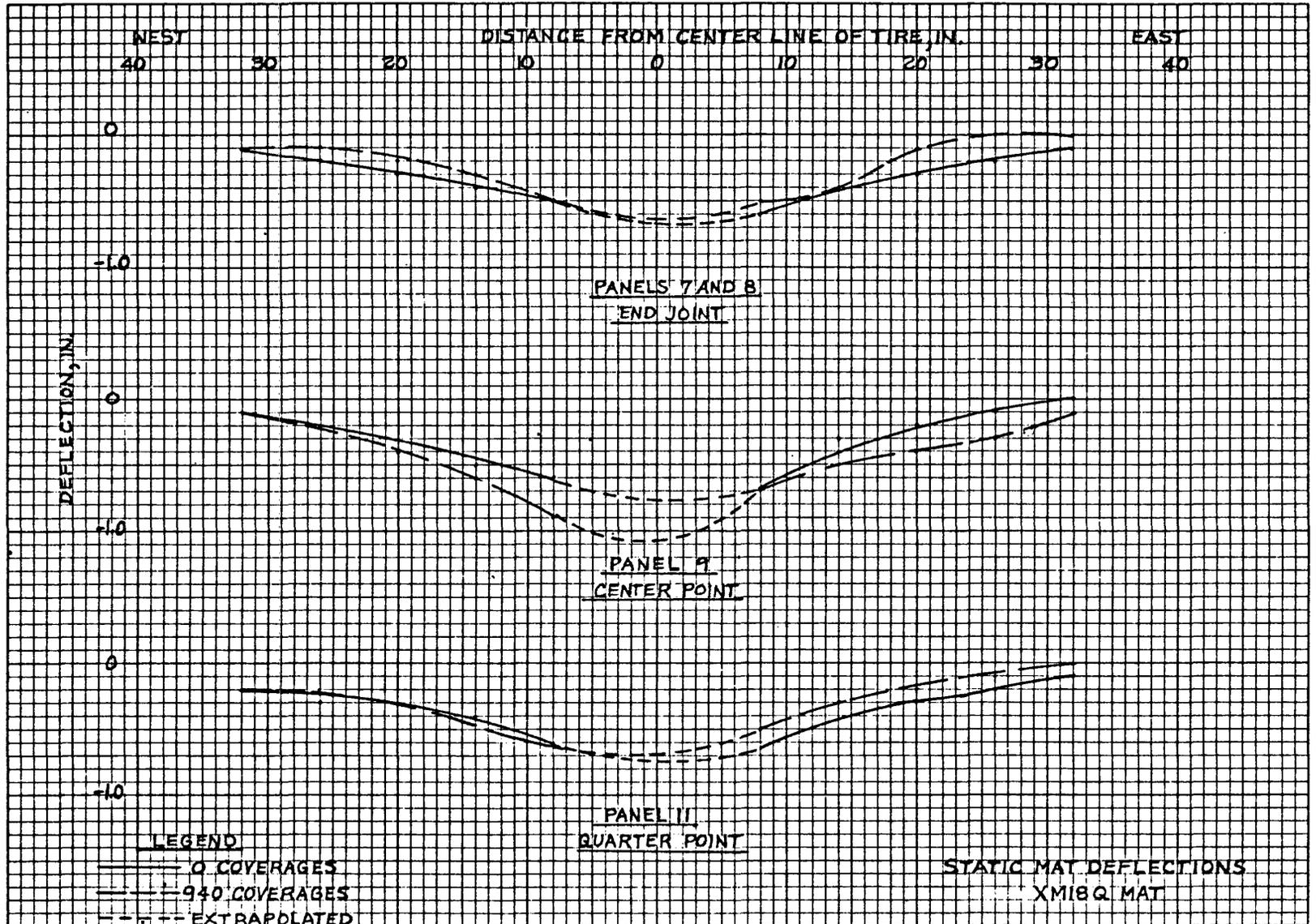


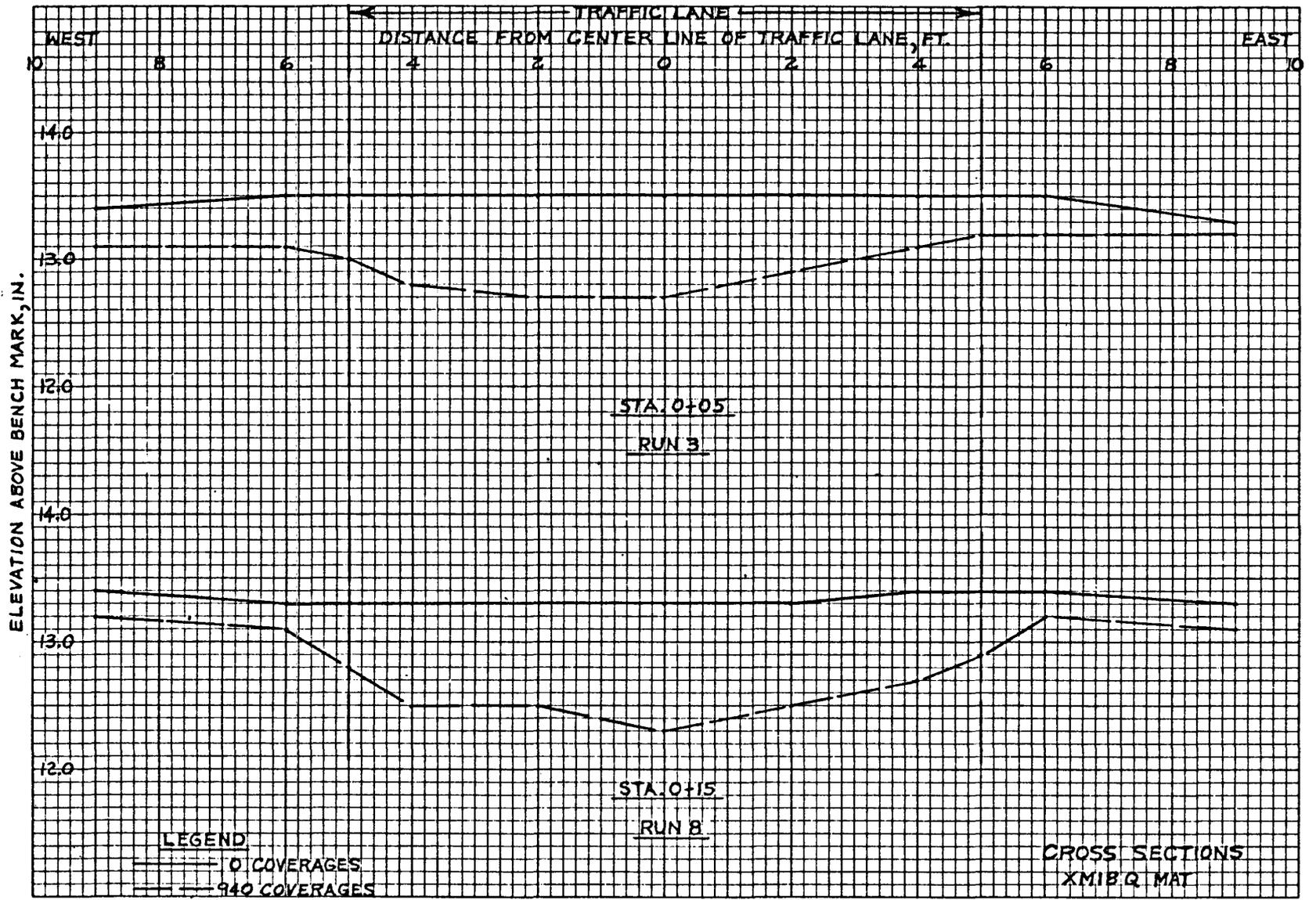
Center of panel after cable roll-over tests

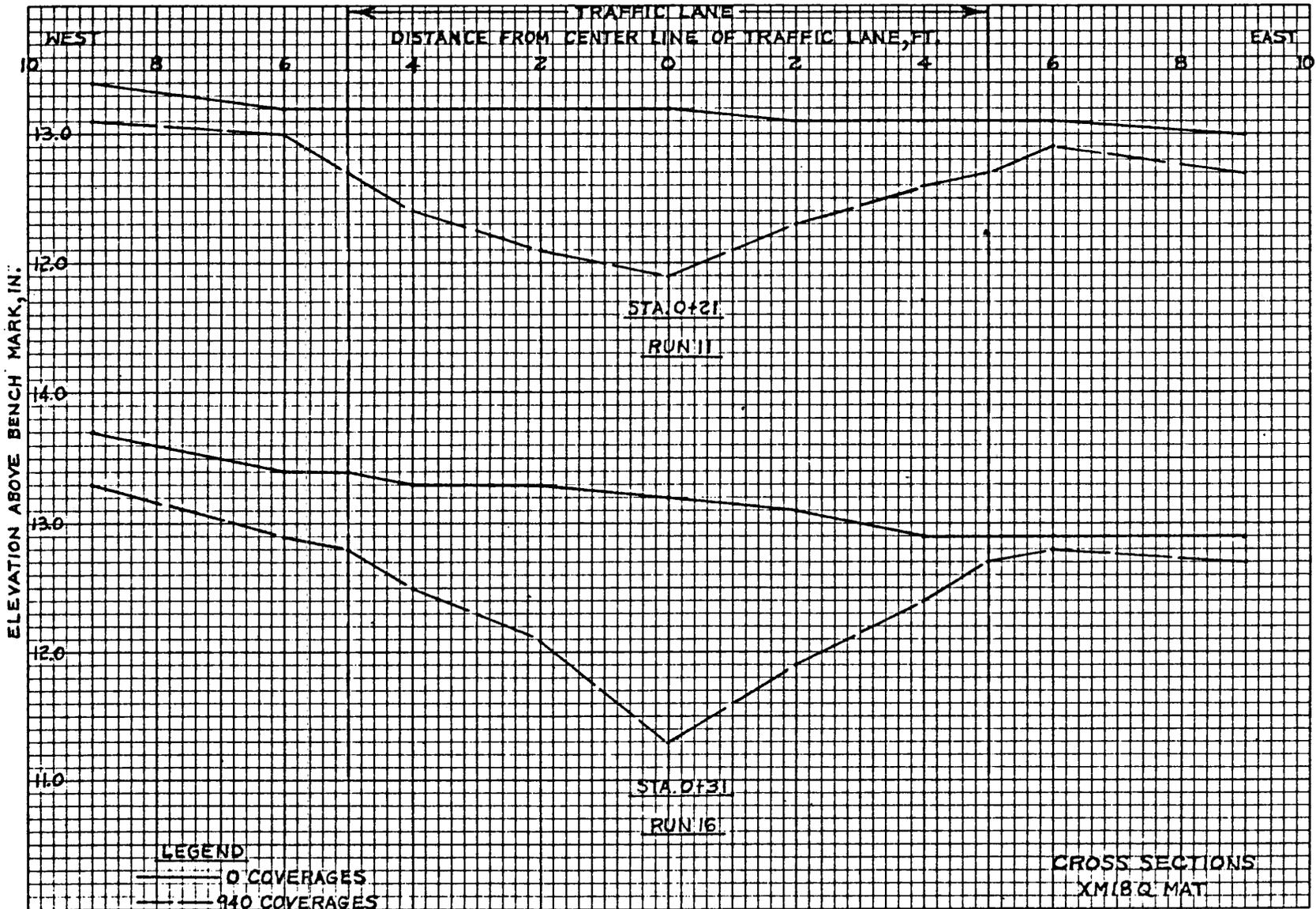
RESULTS OF STANDARD TENSION TESTS OF XM18Q MAT COMPONENTS

<u>Specimen</u>	<u>Gage Length</u> <u>in.</u>	<u>Width</u> <u>in.</u>	<u>Thickness</u> <u>in.</u>	<u>Area</u> <u>sq in.</u>	<u>Ultimate Load</u> <u>lb</u>	<u>Stress</u> <u>psi</u>	<u>Final Gage Length</u> <u>in.</u>	<u>Percent Elongation</u> <u>in 2 in.</u>
Top surfacing	2.0	0.111	0.500	0.056	2475	44,196	2.280	14
		0.115	0.500	0.058	2550	43,966	2.240	12
		0.114	0.500	0.057	2565	45,000	2.260	13
Vertical rib	2.0	0.105	0.499	0.052	2350	45,192	2.240	12
		0.121	0.500	0.061	2675	43,852	2.280	14
		0.102	0.500	0.051	2300	45,098	2.280	14
Bottom surfacing	2.0	0.084	0.499	0.042	1900	45,238	2.220	11
		0.091	0.498	0.045	2025	45,000	2.280	14
		0.080	0.500	0.040	1755	<u>43,875</u>	2.200	<u>10</u>
				Avg	44,602		Avg	13

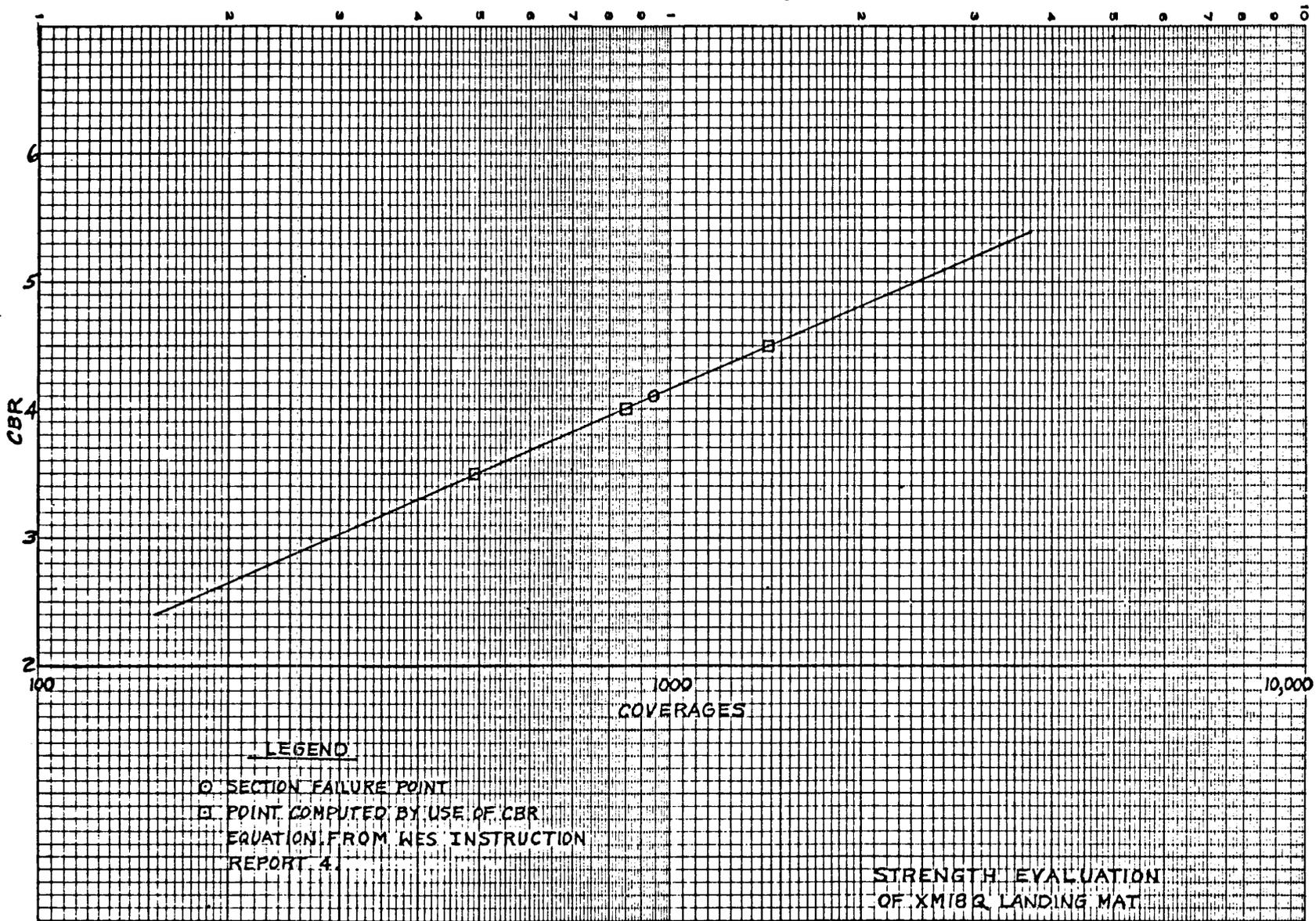












DOCUMENT CONTROL DATA - R & D		
<i>(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)</i>		
1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Engineer Waterways Experiment Station Vicksburg, Miss.		2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP
3. REPORT TITLE EVALUATION OF XML8Q EXTRUDED ALUMINUM LANDING MAT		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Memorandum for record		
5. AUTHOR(S) (First name, middle initial, last name) Carroll J. Smith Dewey W. White, Jr.		
6. REPORT DATE May 1974	7a. TOTAL NO. OF PAGES 37	7b. NO. OF REFS 0
8a. CONTRACT OR GRANT NO. b. PROJECT NO. 1G764717DH01-10 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Miscellaneous Paper S-74-14 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
10. DISTRIBUTION STATEMENT Approved for public release; distribution unlimited.		
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY U. S. Army Materiel Command Washington, D. C.
13. ABSTRACT The investigation reported herein was conducted to evaluate an extruded aluminum alloy landing mat (designated XML8Q) supplied by the Dow Chemical Company, Madison, Ill. The mat, which was fabricated by the Washington Aluminum Company (WACO), Enterprise, Ala. (Dow's subcontractor), is a one-piece extrusion fabricated from 6061 aluminum alloy artificially aged to the T6 condition. The mat panels are interlocked along the sides by means of a hinge-type connector, the components of which are an integral part of the basic panel extrusion. End connectors, composed of extruded connectors welded to the basic panel, consist of overlap and underlap sections secured by a locking bar after individual panels have been joined together. The mat mentioned herein was different from modified MX18-B mat in that the insert tubes in the ends of the mat panels were shortened by 3/4 in. and the amount of metal was increased in the area of the female connector and first cavity adjacent to this connector. The method of attaching the end connectors to the mat extrusion was changed to allow improved welds at the corners. The investigation consisted of traffic, skid, cable roll-over, and laboratory tests to obtain information for use in evaluating the XML8Q mat for potential use as a medium-duty landing mat. The test data reported herein were evaluated against the criteria for medium-duty mat as established in the revised Qualitative Materiel Requirement (QMR). Traffic tests were conducted with the mat placed on a prepared subgrade and trafficked with a rolling wheel load simulating actual aircraft operations. The XML8Q mat, which weighs 4.8 lb per square foot of placing area, was assembled at an average rate of 600 sq ft per man-hour. The mat's weight exceeds the maximum QMR requirement for a medium-duty mat of 4.5 lb per square foot of placing area, and the placing rate exceeds the minimum QMR requirement of 250 sq ft per man-hour. The traffic tests were conducted using the F-4C loading, which consists of a single-wheel load of 25,000 lb with a tire inflation pressure of 250 psi, on a mat-surfaced subgrade with a rated CBR of 4.1. Results of this investigation revealed that the XML8Q mat sustained 940 actual coverages of traffic on a subgrade with a rated CBR of 4.1, which is equivalent to 850 coverages on a 4-CBR subgrade. This falls short of the QMR 1000-coverage requirement for a medium-duty mat on a 4-CBR subgrade. The average coefficients of friction obtained from skid tests on wet and dry surfaces were 0.45 and 0.52, respectively. These coefficients of friction fall within the QMR range of 0.4 to 0.8. The tire wear resulting from skidding on both the wet and dry surfaces was not considered significant. Cable roll-over tests were conducted on the XML8Q mat with a 1-in.-diam arresting cable trafficked with a 25,000-lb single-wheel load with a tire inflated to 250 psi. Results indicated that the mat will withstand the 20 cable roll-overs stipulated in the QMR. Laboratory tests conducted on the mat indicated that the 6061 T-6 alloy exceeded the minimum physical requirements.		

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Aluminum landing mats Cable roll-over tests Dow landing mats Extruded aluminum Landing mats Skid tests Traffic tests XM18Q landing mat						