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Evaluation of Lightweight Airfield Matting for the AMX Program

Lyan Garcia and Nolan R. Hoffman

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Evaluation of Lightweight Airfield Matting for the AMX Program

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Abstract

Airfield matting systems are used for the expedient construction of temporary airfields and the expansion of existing airfields to provide temporary airfield operating surfaces for military aircraft. The primary airfield matting system used by the U.S. Military is the AM2 airfield matting system. Although the AM2 matting system has proved to be successful for supporting modern aircraft, it is difficult to transport by air because of its size and weight. The AMX program was initiated by the U.S. Air Force to identify and evaluate new, lightweight airfield mat designs optimized for C-17 transport. Three commercially available matting systems of varying materials and designs were evaluated through the construction of a full-scale test section to determine their effectiveness at sustaining modern fighter aircraft loads and at reducing the accumulation of subgrade deformation. The matting systems were tested on a subgrade with a California bearing ratio (CBR) of 6 and subjected to simulated F-15E aircraft traffic while monitoring mat breakage and deformation. The systems were compared against baseline requirements established for the AMX program, which were established to match the performance of AM2 while providing a reduced logistical footprint. The systems tested in the experiments described in this report are not suitable alternatives, but improvements to mat component designs were recommended that could increase performance.

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Preface

This study was conducted for the U.S. Air Force Civil Engineer Center (AFCEC). Technical oversight was provided by Mr. Jeb S. Tingle.

The work was performed by the Airfields and Pavements Branch (GMA) of the Engineering Systems and Materials Division (GM), U.S. Army Engineer Research and Development Center, Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Dr. Timothy W. Rushing was Chief, CEERD-GMA; Dr. Gordon W. McMahon was Chief, CEERD-GM; and Mr. R. Nicholas Boone, CEERD-GVT, was the Technical Director for Force Projection and Maneuver Support. The Deputy Director of ERDC-GSL was Dr. William Grogan, and the Director was Mr. Bartley P. Durst.

COL Bryan S. Green was the Commander of ERDC, and Dr. David Pittman was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
feet	0.3048	meters
inches	0.0254	meters
kip-inches	112.948	newton-meters
pounds (force)	4.448222	newtons
pounds (force) per square foot	47.88026	pascals
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.45359237	kilograms
square feet	0.09290304	square meters
square inches	6.4516 E-04	square meters

1 Introduction

1.1 Background

Expedient surfacing systems have been used since the 1940s to rapidly construct and expand existing airfield facilities during contingency operations. The primary expeditionary airfield surfacing for the U.S. Military is AM2 airfield matting, which has been in service as a temporary runway, taxiway, and parking apron surface since the 1960s. Although AM2 has a long history of satisfactory performance, its weight and dimensions are limiting factors in its deployability. Typically, aircraft payload limits are exceeded without approaching cubage limits, and an excessive number of aircraft are required to deliver AM2 to contingency locations.

To address AM2's logistical challenges, the AMX program was initiated by the U.S. Air Force (USAF) to develop a lightweight replacement for AM2 matting. The joint services agreed upon a thickness of 1.25 in. and a maximum unit weight of 3.8 lbf/ft², and required that the mats to be optimized for shipping on a 463L pallet, which has useable dimensions of 104 in. by 84 in. In addition, the mat system was required to sustain 1,500 passes of F-15E traffic over a 6 CBR subgrade. The pass requirement was determined by baseline testing of AM2 (Rushing and Tingle 2007). Additional details on system requirements are shown in Appendix A.

For more than a decade, several commercial systems have been investigated as part of the AMX program. A list of these results are shown in Table 1.1. Note, different versions were submitted for evaluation as the program progressed with improvements recommended in previous tests. Currently, no metal mat has been able to meet the AMX requirements. In an effort to continue with the efforts of the program and identifying potential solutions, a request for information was submitted through the Engineer Research and Development Center (ERDC) Contracting Office to solicit products from commercial vendors (Appendix A). After reviewing vendor solicitations from the RFI posting, three matting systems were selected for full-scale evaluation. Two of the vendors, Faun Trackway and Alfab Inc., have participated in the AMX program in the past. Results of previous versions of their prototypes are provided in the references listed in Table 1.1.

Table 1.1. Summary of mat testing for the AMX program.

Matting System	Material	Vendor	Subgrade CBR	Traffic type	Passes to Failure	Reference
WebCore AMX	Carbon fiber composite	WebCore Technologies, Inc.	6	F-15E	4,132	Rushing and Torres (2007)
AM2 Mod 6	Extruded aluminum	Alfab, Inc.			768	
Taber Metals AMX	Extruded aluminum	Taber Extrusions, L. P.			196	
M21	Aluminum honeycomb	Alfab, Inc.; M.C. Gill Corporation			32	
Webcore AMX	Carbon fiber composite	WebCore Technologies, Inc.	10	F-15E	908	Rushing et al. (2009)
Alfab/M.C. Gil AMX	Aluminum honeycomb / carbon fiber composite	Alfab, Inc.; M.C. Gill Corporation			1,828	
M19 Replica	Aluminum honeycomb	Alfab, Inc.			618	
Webcore AMX	Carbon fiber composite	WebCore Technologies, Inc.	10	F-15E	3,056	Rushing (2010)
Alfab/M.C. Gil AMX	Aluminum honeycomb / carbon fiber composite	Alfab, Inc.; M.C. Gill Corporation			1,008	
Lattice Block Structure	Cast aluminum core / carbon fiber skins	Federal Technologies Group			Between 8 and 492 passes	
Webcore AMX	Carbon fiber composite	WebCore Technologies, Inc.	6	F-15E	266	Rushing, et al. (2011a)
Alfab/M.C. Gil AMX	Aluminum honeycomb / carbon fiber composite	Alfab, Inc.; M.C. Gill Corporation			310	
Webcore AMX	Carbon fiber composite	WebCore Technologies, Inc.	10	F-15E	542	
Alfab/M.C. Gil AMX	Aluminum honeycomb / carbon fiber composite	Alfab, Inc.; M.C. Gill Corporation			694	
Lattice Block Structure	Cast aluminum core / carbon fiber skins	Federal Technologies Group			4	
Webcore AMX	Carbon fiber composite	WebCore Technologies, Inc.	6	F-15E	3,404	Rushing et al. (2011b)
Alfab/M.C. Gil AMX	Aluminum honeycomb / carbon fiber composite	Alfab, Inc.; M.C. Gill Corporation			662	
WebCore AMX	Carbon fiber composite	WebCore Technologies, Inc.	6	F-15E	1,434	Garcia et al. (2012)
WebCore AMX	Carbon fiber composite	WebCore Technologies, Inc.		C-17	924	

Matting System	Material	Vendor	Subgrade CBR	Traffic type	Passes to Failure	Reference
PSA	Extruded aluminum	Faun Trackway	6	F-15E	2	Rushing et al. (2012)
MLC-70					48	
ALM-X1					78	
ALM-X2					752	
PSA				C-17	8	
MLC-70					146	
PSA				C-130J	240	
MLC-70	Extruded aluminum	Faun Trackway	25	F-15E	1,008	Rushing et al. (2014)
			100		3,700	

1.2 Objectives and scope

A full-scale experiment was designed, constructed, and executed by the ERDC's Airfields and Pavements Branch over a subgrade with a CBR of 6 to gather the data required for comparison. AFCEC provided funding for the experiment, which was performed in the Hangar 2 Pavement Testing Facility at the ERDC, Vicksburg, MS. The highly controlled subgrade was constructed using "Vicksburg Buckshot" high-plasticity clay. The prepared subgrade surface was covered with the matting systems and trafficked with simulated, fully loaded F-15E aircraft traffic (35,235 lb on a single wheel with a tire pressure of 325 psi).

The research presented in this report utilizes data collected from the full-scale traffic experiments on three commercial matting systems to determine the performance under traffic. The objectives of this report are to:

1. Provide data collected during full-scale evaluations of three commercial matting systems under simulated F-15E traffic.
2. Determine the number of passes to failure of the commercial matting systems to support F-15E operations.
3. Provide recommendations for improvement to the systems.

1.3 Organization of report

The body of this report is organized into six chapters. The first chapter is the introduction and the last chapter (Chapter 6) presents the conclusions and recommendations. Chapter 2 describes the matting systems, and Chapter 3 details the experimental program. The failures are described in detail in Chapter 4 and Chapter 5 in terms of mat breakage and permanent deformation, respectively.

2 Materials

The following sections describe the three matting systems evaluated under this project, as well as the subgrade and foundation materials used for construction. Table 2.1 lists the physical properties of the tested matting systems and provides data for baseline comparison to AM2.

Table 2.1. Physical properties of matting systems tested compared to AM2.

	S46		ALMATS-V2		I-Trac	AM2	
	Full Panel	Half Panel	Full Panel	Half Panel	Full Panel	Full Panel	Half Panel
Length (in.)	83.5	41.75	102.5	51	47	144	72
Width (in.)	41.75	41.75	20	20	36	24	24
Thickness (in.)	1.17	1.17	1.07	1.07	2.13	1.5	1.5
Weight (lb)	103.9	52.9	59.9	30.6	37.9	144	75
Unit Surface Weight (psf)	4.29	4.37	4.21	4.32	4.42	6.1	6.2
Material	AA 6005A		AA 6082 – T6		High-impact polypropylene	AA 6061 – T6	
Manufacturer	Faun Trackway		Alfab, Inc.		MacroTrac	Alfab, Inc.	

2.1 Matting systems

2.1.1 Aluminum Logistics Military Airfield Take-off and Landing Surface (ALMATS) – Version 2

The ALMATS matting system was developed by Alfab Inc., the manufacturer of AM2. The mat was designed for a program initiated by the USAF to find matting solutions for Remote Piloted Aircraft. The first version of ALMATS resembled AM2 at the mechanical joints and core, but with a reduced thickness and length (Garcia et al. 2017). For this experiment, the mechanical joint was modified so that one overlap rail and one underlap rail formed a slot for the locking bar when two panels were joined (Figure 2.1). Each panel consisted of single extruded aluminum alloy 6082-T6 core with vertical supports that spanned the length of the panels and were spaced approximately 3 in. apart. End connectors were also made from aluminum alloy 6082 and welded on the short ends of the panels using a metal insert gas (MIG) welding process to create a single panel. A locking bar was specifically designed to fit the thinner joint of the ALMATS system and secure the overlap/underlap connection. Panels were coated with non-skid paint.

Figure 2.1. ALMATS modified end connector joint.

While ALMATS was not designed for the performance requirement of the AMX program (i.e., F-15E loading condition), it did meet the physical requirements. It was evaluated to understand the behavior of the new end connection under heavy loads while a test section was available to perform a full-scale experiment. Photographs of the ALMATS matting system are shown in Figure 2.2.

Figure 2.2. ALMATS matting system.

(a) ALMATS panels.

(b) ALMATS end connectors.

2.1.2 S46

The S46 aluminum mat system was developed by Faun Trackway specifically to meet the requirements of the AMX program. This is the third matting system submitted by the vendor as part of this program (Rushing et al. 2012). The S46 mat system panels consisted of two 6005A T6 aluminum alloy extrusions that were friction stir welded (FSW) to

make a single panel core. The core was composed of vertical members that were 0.08 in. thick and spaced at approximately 1.6 in. Each extrusion was manufactured such that a vertical member was located on each side of the FSW (Figure 2.3b). End connectors were then MIG welded on the short edge along the length of the connector. The corners were tungsten insert gas (TIG) bonded to the panel matrix. The connection along the four edges of the panels was the same. These were made to fit a double-arrow locking key that could be inserted once panels were placed next to each other on the ground. Half panels were manufactured to allow for a brickwork pattern. The locking key was manufactured with 6082 T6 aluminum alloy. These prototype mats did not include a non-skid coat. Photographs of the S46 matting system are shown in Figure 2.3.

Figure 2.3. S46 matting system.

2.1.3 I-Trac

I-Trac is a modular panel system produced by MacroTrac that was designed for several applications, including temporary roadways, helipads, and construction platforms. The bow-shaped panels are made of high-impact polypropylene with UV inhibitors. They are joined by two

connection systems. One is an internal connection system, where a yellow clip on one panel is introduced into receptor slots of an adjacent panel. The connection is secured by rotating the receptor from the surface with a T-bar, locking the yellow clip in place. Each panel is fitted with four clips and four black receptor slots. The other connection system is a male/female connection located along the edges. One side of each panel has protruding material, while the other side has slots to fit these. Each panel has a total of eight connection points.

Representatives from MacroTrac have long been interested in testing I-Trac in a full-scale test to verify if the mat can be used for heavier applications. Although the I-Trac matting system did not meet the physical panel requirements for the AMX program, it was included in this test to understand its performance while a full-scale test section was available. Photographs of the I-Trac mat system are shown in Figure 2.4.

Figure 2.4. I-Trac mat system.

(a) I-Trac panels

(b) T-bars.

(c) Yellow connection clip.

(d) Receptor slot.

2.2 Subgrade and foundation

2.2.1 High-plasticity clay (CH) subgrade

The CH material used for subgrade construction was procured from Buford Construction Co., a local source in Vicksburg, MS, and was subjected to the laboratory tests listed in Table 2.2. Classification data for the subgrade soil are shown in Figure 2.5. Moisture-density and CBR-moisture content relationships are shown in Figures 2.6 and 2.7, respectively. These data were used to determine the target moisture content and dry density required to obtain the target CBR of 6. As shown in Figure 2.7, the target moisture content was 33.5% to achieve a CBR of 6. The expected dry density for quality control at 33.5% moisture content was 87 lb/ft³.

Table 2.2. Laboratory tests for Vicksburg Buckshot CH.

Test Name	ASTM
Standard Practice for Classification of Soils for Engineering Purposes (USCS)	D 2487
Standard Test Method for Particle Size Analysis of Soils	D 422
Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort	D 1557
Standard Test Method for CBR of Laboratory Compacted Soils	D 1883
Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	D 4318

Figure 2.5. Classification data for Vicksburg Buckshot CH.

Figure 2.6. Modified Proctor curve for CH subgrade material.

Figure 2.7. Laboratory CBR vs. moisture content for CH subgrade material.

2.2.2 Silt backfill

The material used to backfill and level the excavated test pit to the required subgrade depth was a low plasticity silt (ML), according to ASTM D 2487. This material provided a uniform foundation for the test subgrade and was procured from a local aggregate supplier, Vinco Inc. Classification data are provided by Garcia et al. (2017).

2.2.3 Natural foundation

The natural foundation material in the Hangar 2 Pavement Testing Facility was classified as a low plasticity clay (CL), according to ASTM D 2487. Classification data are provided by Garcia et al. (2017).

3 Experimental Program

3.1 General description

The tests were conducted on a full-scale test section constructed and trafficked under shelter in the Hangar 2 Pavement Testing Facility at the ERDC. Mat panels were placed directly over a 24-in.-thick CH subgrade prepared to a CBR of 6. The subgrade was compacted over a foundation prepared with a ML, which was placed over the natural foundation in Hangar 2. A general profile of the test section is shown in Figure 3.1.

Figure 3.1. Test section profile.

A general layout of the test section is shown in Figure 3.2. Close-ups of the panel layout of each test item are provided in Appendix B. The test section was approximately 27 ft wide by 75 ft long and had one lane designated for simulated F-15E traffic. The ALMATS test item was only 16 ft long due to limited quantity of matting available from the vendor, while the other two test items were approximately 30 ft long each. The centerline was maintained throughout the length of the entire section for ease of trafficking and data collection.

Figure 3.2. Test section layout.

3.2 Subgrade construction and posttest forensics

Construction of the test section began by excavating a 75-ft-long by 27-ft-wide test pit to a depth of 3 ft below the existing finished grade in Hangar 2 (Figure 3.3). The test pit was backfilled with two 6-in.-thick (compacted) lifts of ML. The ML material was leveled with a bulldozer and compacted with a pneumatic roller and a vibratory steel-wheel compactor to ensure that the subgrade was constructed over a stable foundation. Dynamic cone penetrometer (DCP) (ASTM D 6951) tests were carried out to determine its in-situ strength. The surface of the ML backfill and the sides of the test pit

were then lined with impervious 6-mil polyethylene sheeting to minimize moisture migration from the 24 in. of new CH soil serving as the test section subgrade.

Figure 3.3. Test section excavation.

The CH subgrade material was processed at a preparatory site adjacent to Hangar 2 by spreading the material to a uniform 12-in. depth, pulverizing the material with a rotary mixer, adjusting the moisture content, pulverizing the material again, and stockpiling (Figure 3.4). This procedure was an iterative process necessary to achieve a uniform distribution of moisture throughout the material. Once the CH had been processed to the target moisture content, it was placed in the test section, spread by a bulldozer in 8-in.-thick lifts, and compacted with a pneumatic roller to a depth of 6 in. (Figure 3.5).

Figure 3.4. Pulverizing CH (left) and adding moisture (right).

Figure 3.5. Leveling (left) and compacting (right) CH.

Each compacted lift was characterized using the test methods listed in Table 3.1 to verify that target values had been met (Figure 3.6). If the average pretest CBR of a lift differed from the target value by more than +1.0 or -0.5 CBR, the lift was reconstituted. Each lift was surveyed to obtain an average thickness. After data collection, the surface was scarified an average depth of 1 in. with a rotary mixer prior to placement of the following lift to facilitate bonding at the interface. Once fully constructed, the subgrade surface was graded to allow a suitable surface for mat installation.

Table 3.1. Field tests on each constructed lift.

Test Name	Test Number	Pre-test Subgrade	Post-test Subgrade	Excavation & Silt Backfill
Standard Test Method for Density of Soil in Place by the Drive Cylinder	ASTM D 2937	X		
Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)	ASTM D 6938	X	X	
Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock Mass	ASTM D 2216	X	X	
Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications	ASTM D 6951	X	X	X
Standard Test Method for Determining the California Bearing Ratio of Soils	CRD-C654-95	X	X	

Figure 3.6. CBR test.

Once trafficking was completed, posttest forensics were conducted at the same locations to determine the depth of subgrade that might have undergone gradual drying and possible densification under traffic. Some increase in CBR was expected because of thixotropic properties of clay structures and gradual drying and densification during trafficking. Based on historic testing data, surface increases of less than 5 CBR and increases of less than 3 CBR at a depth of 6 in. are common and, therefore, acceptable (Rushing and Tingle 2007; Rushing et al. 2012).

DCP data for the ML backfill and natural foundation are provided in Appendix C. The average CBR for the ML backfill was approximately 8. Properties of the CH subgrade prior to installing mat and after completing traffic in each test item are shown in Table 3.2 through 3.4. The pretest moisture content and density measurements generally follow the trends found in laboratory measurements presented in Figures 2.6 and 2.7.

Table 3.2. Subgrade in situ properties for ALMATS test item.

Test Depth	Nuclear Gauge Test			CBR Test	
	Wet Density (pcf)	Dry Density (pcf)	Moisture (%)	Oven Moisture (%)	CBR
Pretest					
Surface	117.0	88.4	32.3	33.7	5.7
6 in.	115.1	86.5	33.0	36.1	6.1
12 in.	116.4	87.4	33.2	35.3	6.0
18 in.	116.8	88.6	31.8	34.4	6.2
<i>Average</i>	<i>116.3</i>	<i>87.7</i>	<i>32.6</i>	<i>34.9</i>	<i>6.0</i>
Posttest					
Surface	117.4	88.6	32.6	32.1	7.5
6 in.	116.6	86.0	35.6	34.6	6.4
<i>Average</i>	<i>117.0</i>	<i>87.3</i>	<i>34.1</i>	<i>33.3</i>	<i>6.9</i>

Table 3.3. Subgrade in situ properties for S46 test item.

Test Depth	Drive Cylinder Test			Nuclear Gauge Test			CBR Test	
	Wet Density (pcf)	Dry Density (pcf)	Oven Moisture (%)	Wet Density (pcf)	Dry Density (pcf)	Moisture (%)	Oven Moisture (%)	CBR
Pretest								
Surface	109.9	81.0	35.7	115.8	86.8	33.5	34.2	5.5
6 in.	110.0	81.1	35.7	115.5	86.9	32.9	35.5	5.9
12 in.	110.7	81.9	35.3	116.4	87.7	32.8	35.6	6.0
18 in.	111.3	82.0	35.8	116.5	88.2	32.4	34.6	6.2
<i>Average</i>	<i>110.5</i>	<i>81.5</i>	<i>35.6</i>	<i>116.0</i>	<i>87.4</i>	<i>32.9</i>	<i>35.0</i>	<i>5.9</i>
Posttest								
Surface	-	-	-	116.0	88.2	31.8	35.3	5.8
6 in.	-	-	-	114.3	85.7	33.7	36.3	6.2
<i>Average</i>	-	-	-	<i>115.2</i>	<i>86.9</i>	<i>32.7</i>	<i>35.8</i>	<i>6.0</i>

Table 3.4. Subgrade in situ properties for I-Trac test item.

Test Depth	Drive Cylinder Test			Nuclear Gauge Test			CBR Test	
	Wet Density (pcf)	Dry Density (pcf)	Oven Moisture (%)	Wet Density (pcf)	Dry Density (pcf)	Moisture (%)	Oven Moisture (%)	CBR
Pretest								
Surface	111.0	82.2	35.0	115.0	85.9	33.8	34.0	5.7
6 in.	111.0	81.1	36.8	114.1	85.5	33.6	35.6	5.7
12 in.	110.6	83.0	33.2	115.7	85.9	34.8	34.5	6.1
18 in.	111.8	82.0	36.3	116.2	87.7	32.6	34.7	5.9
Average	111.1	82.1	35.3	115.2	86.2	33.7	34.7	5.8
Posttest								
Surface	-	-	-	115.0	88.6	29.8	34.0	7.0
6 in.	-	-	-	111.0	82.4	34.8	34.0	5.8
Average	-	-	-	113.0	85.5	32.3	34.0	6.4

3.3 Mat installation

Assembly of the mat panels on the test section subgrade began by marking the boundaries of the test area and the individual test items. The test items were assembled in the following order: ALMATS, S46, and I-Trac. In general, panels were installed without the use of material handling equipment (MHE). However, MHE was used to transport panels to the installation site. Steel plates approximately 2 ft by 8 ft were placed underneath the mat panels at the interface of each test item to help with transition of the load cart between test items and minimize potential end effects (Figure 3.7). A rubber pad about 2 ft by 8 ft wide was placed on the mats at the same locations to avoid damage to the load carts and the mats. After assembly of all the test items, full panels of AM2 were installed along the ends of the traffic lane to facilitate the entrance and exit of the test vehicles. Three cast iron blocks, approximately 1,000 lb each, were placed on the edges of each test item to simulate the resistance to movement provided by a large expanse of matting. Lines were then painted on the mat surface at data collection locations.

Figure 3.7. Steel plate and rubber section at interface of test items.

3.3.1 ALMATS installation

Installation of the ALMATS began on the southeast corner. The first mat panel was placed on the ground with the long dimension perpendicular to the direction of traffic and with the male hinge connector facing north. The underlap end connector was facing west. The second panel was positioned adjacent to the short end of the first, allowing the overlapping end connector of the second panel to drop into position over the underlapping end connector of the first panel. A rectangular slot was formed and an aluminum locking bar was inserted into the slot to prevent the ends of the mat panels from separating. This process was continued until the first row was installed. For the second row, the female hinge connector was attached to the male hinge connector of panels from the first row, and the panel was pivoted into place. The next panel was installed by attaching the female hinge connector to the male hinge connector of panels in the first row and allowing the overlapping end connector rail to pivot over and connect to the underlapping end connector of the adjacent panel. An aluminum locking bar was inserted into the space provided to keep the panels from separating. This process was repeated until the entire test item was assembled in a brickwork configuration with half panels on the ends of every other row. Photographs of installation are shown in Figure 3.8. The final assembled test item is shown in Figure 3.9.

Figure 3.8. Installation of ALMATS.

Figure 3.9. Final assembled ALMATS test item.

The ALMATS panels were difficult to install for one main reason: the tolerances at the end connection and the male/female hinge connection were tight. Although panels were lightweight and easy to carry (one crewmember could carry a single full panel), installation was time consuming. The overlap connection had to be hammered into place with the underlap connection, which caused the overlap rail to bend. Locking bars did not slide into the slots easily and had to be hammered in, potentially damaging the joint. The female hinge connection did not rotate into place adequately, requiring the crew to lift surrounding panels with a pry bar and hammer the panel into place. Overall the installation of ALMATS was not improved with the new end connection.

3.3.2 S46 installation

The S46 mat system was installed according to manufacturer recommendations. Installation began on the southwest corner with a half panel. The next mat panel was placed east of the one on the ground with the long dimension perpendicular to the direction of traffic. It was positioned so that the two end connectors formed a double arrow-shaped slot. The locking bar was inserted into the slot. The third panel was placed on the second row, north of the first panel that was installed. A locking bar was inserted between the panel on the first row and the panel on the second row to lock them in place. The fourth panel was placed east of the third panel (second row) and a locking bar was inserted into the slot between these two panels. The fifth panel was installed on the third row and joined to the second row. Panels on the east edge were placed last to maintain the manufacturer recommended “staircase” installation process (Figure 3.10). This process was continued until nine rows were installed, with the last panel positioned on the northeast corner. The manufacturer recommended this manner because it was simpler to install a transverse locking across a longitudinal joint of an adjacent row if the locking bar on the longitudinal joint was already inserted (i.e. the longitudinal joint was already fully connected). The final assembled test item is shown in Figure 3.11.

Installation of the S46 mat system was difficult. Occasionally, the locking bars had to be hammered into the slot formed between panels. Periodically, a crewmember had to stand on the panels and vibrate them to allow a locking bar to run through. This type of connection (e.g. dogbone, double arrow) has a history of negative feedback with respect to installation because it tends to be unforgiving on uneven surfaces, especially when the same connection exists along all of the edges (Garcia et al. 2012). A recommendation provided to the manufacturer was to replace the long connection with a hinge-type (similar to AM2).

Figure 3.10. Installation of S46 mat system.

(a) “Staircase” installation process.

(b) Inserting locking bar.

Figure 3.11. Final assembled S46 test item.

3.3.3 I-Trac installation

Installation of the I-Trac mat system began on the southwest corner with a half panel. A full-sized panel was placed next and installed east of the first one with the long dimension parallel to the direction of traffic, as recommended by the manufacturer. The yellow clip from the second panel was fitted into the receptor slot of the first panel, and a T-bar was used to rotate the receptor slot to lock the connection system. The first row was installed by alternating half panels and full panels to maintain a flush edge with the S46 mat test item. The next few rows were installed with full panels, and the last row had alternating half panels to maintain a flush edge. Photographs of installation are shown in Figure 3.12. The final assembled test item is shown in Figure 3.13. Installation of the I-Trac mat system was completed within one hour. The mat system was quite simple to install and did not require significant manpower.

Figure 3.12. Installation of I-Trac mat system.

(a) Installation of full panel.

(b) Installation of half panel.

(c) Rotating receptor with slot T-bar to lock connection.

Figure 3.13. Final assembled I-Trac test item.

3.4 Traffic application

A specially designed single-wheel load cart was used to simulate F-15E aircraft traffic. The load cart was equipped with a 36-in. by 11-in., 18-ply tire inflated to 325 lbf/in.² and loaded such that the test wheel was supporting 35,235 lb. The F-15E load cart was equipped with an outrigger wheel to prevent overturning and was powered by the prime mover of a Case vibratory steel-wheel roller as shown in Figure 3.14.

Figure 3.14. F-15E test load cart.

A normally distributed pattern of simulated traffic was applied in a 3.75-ft-wide traffic area, as shown in Figure 3.15. The traffic area was broken into five lanes that were designed to simulate the traffic distribution pattern, or wander width, of the main landing gear wheel on a mat surface when taxiing to and from an active runway. The width of each lane corresponded to the measured contact width, 9 in., of the F-15E tire when fully loaded and not the overall published tire width of 11 in. The normally distributed traffic pattern was simplified for ease-of-use by the load cart operator. Traffic was applied by driving the load cart forward and then backward over the length of the test item and then shifting the path of the load cart laterally approximately one tire width on each forward path. This procedure was continued until one pattern of traffic was completed. One pattern resulted in 16 passes, or four coverages.

Figure 3.15. Plan view showing F-15E normally distributed traffic lanes.

3.5 Data collection

Data collection locations on each test item for both traffic lanes are shown in Figure 3.16. Close-ups of these locations on each test item are provided in Appendix B. Pass levels at which data were collected are provided in Table 3.5, and photographs of these activities are shown in Figure 3.17.

Data collection included:

- Robotic total station measurements along the centerline on both the subgrade and mat surface;
- Robotic total station measurements cross sections, on both the loaded and unloaded mat surface and on the subgrade surfaces;
- Rut depth measurements at cross sections, on both the loaded and unloaded mat surface and on the subgrade surface; and
- Inspection of mats during trafficking and after the tests.

3.5.1 Centerline profile

Data were collected along the traffic centerline on the pretest subgrade, on the mat surface at scheduled pass levels, and the posttest subgrade after removing the mats. Data were collected at 1-ft intervals on both the subgrade and mat surface continuously through the length of the test section.

3.5.2 Unloaded cross sections

Data were collected on the pretest subgrade, on the mat at scheduled pass levels, and on the posttest subgrade after removing the mats. Robotic total station elevation data were collected at 1-ft intervals along cross sections. Rut-depth data were collected along all cross sections at the centerline and 1 ft east and west of the centerline. Rut depth was collected with a straightedge and ruler.

Figure 3.16. Data collection locations.

Table 3.5. Data collection pass levels.

Total Passes	Profile	Unloaded Cross Sections	Loaded Cross Sections
Pretest Subgrade	X	X	
0	X	X	X
10	X	X	X
16	X	X	X
32	X	X	X
48	X	X	X
Posttest Subgrade	X	X	

Figure 3.17. Photographs of data collection activities.

(a) Unloaded cross section

(b) Loaded rut depth

3.5.3 Loaded cross sections

In an attempt to measure the permanent deformation of the subgrade underneath the mat surface, a forklift carrying two 2,000-lb lead weights was parked on the mat surface adjacent to each cross section, and elevation data were recorded at the same intervals. The wheel load applied was approximately 6,000 lb. These data are noted as “loaded cross sections” in this report. The goal of the load application was to deflect the mat enough to contact the subgrade but not so much as to induce elastic deflections in the subgrade. Rut-depth data were collected along all cross sections at the centerline and 1 ft east and west of the centerline. Rut depth was collected with a straightedge and ruler.

3.6 Failure criteria

The failure criteria established were (1) 10% mat breakage within the test area or (2) the development of 1.25 in. of permanent surface deformation. Each of the mat systems was required to sustain at least 1,500 passes before one of the failure criteria was met. These failure criteria were

developed based upon previous testing of airfield matting and USAF requirements. Failure criteria values were recorded and monitored for compliance.

3.6.1 Mat breakage criteria

Mat breakage percentages were calculated by dividing the area of the failed panel by the total area influenced by the simulated traffic application in the assembled test item. Individual panels were considered failed if observed damage posed a significant tire hazard or caused instability of the load cart. Tire hazards were defined as damage that could not be reasonably maintained by simple field maintenance procedures.

3.6.2 Permanent deformation criteria

The permanent surface deformation limit is based on roughness limitations for the F-15E aircraft. The rut depth limit is required since many connecting taxiways and aprons intersect at 90 deg, and crossing perpendicular to a pre-formed rut may cause an abrupt change in elevation, exceeding aircraft limits. Permanent surface deformation was determined from robotic total station elevation measurements of cross sections and centerline profiles. Each of the following data collection categories were analyzed for compliance with the failure criterion:

1. centerline profile deformation,
2. unloaded surface deformation, and
3. loaded surface deformation.

3.6.2.1 Centerline profile deformation

The difference in elevation between one or two stations apart (1 or 2 ft apart) was analyzed from plots of the centerline profile data to determine if an abrupt change in elevation reached failure limits during trafficking.

3.6.2.2 Unloaded surface deformation

Unloaded surface deformation was determined from data collected according to the methods described in section 3.5.2. The maximum deformation at each location was determined as the difference in elevation from the average height of the elevated material on each side of the trough to the deepest point in the bottom of the trough. Measurements were averaged to obtain a single value for comparison to the failure criterion.

3.6.2.3 *Loaded surface deformation*

Loaded surface deformation was determined from data collected according to the methods described in section 3.5.3. The maximum deformation at each location was determined as the difference in elevation from the average height of the elevated material on each side of the trough to the deepest point in the bottom of the trough. Measurements were averaged to obtain a single value for comparison to the failure criterion.

4 Mat breakage

The following sections describe the behavior of the matting systems under simulated aircraft traffic. Most of the discussion in this chapter will focus on damage observed during traffic and after removing panels from the subgrade surface. Trafficking on all test items began 31 October 2016.

4.1 ALMATS

Mat breakage on the ALMATS test item began after 32 passes when many of the end connectors along the centerline were damaged. Cracking was visible at the weld of four panels. After 48 passes, the end connectors of four panels had completely separated from the core. There were severe corner curls in four panels with their end connectors along the traffic centerline. At that point, the test item failed by mat breakage. Trafficking was concluded due to severe tire hazards throughout the traffic lane. After removing panels from the subgrade, cracking along the female hinge of seven panels was noted. Five panels had cracking at the male hinge. All panels that had their center along the traffic lane were significantly deformed (bowed). Photographs of damage are shown in Figure 4.1.

Figure 4.1. Damage on the ALMATS test item.

(a) Broken overlap end connector.

(b) Cracking along female hinge.

(c) Broken overlap end connector.

(d) Deformed center panel.

4.2 S46

The S46 test item failed after 48 passes were applied by the F-15E load cart. Deformation on the surface of the panels along the traffic lane was evident after the first pass was applied and continued to increase as trafficking progressed. Damage of the mat components began after 32 passes were applied. Many connectors curled up and locking bars were exposed. Some locking bars had rotated and no longer secured the connections of panels along the centerline. After 48 passes, most locking bars were either broken or protruding outside of the connection, creating severe tire hazards. Trafficking was stopped to avoid damage to the tire. Severe mat surface deformation was also causing instability of the load cart. At this point, the test item had failed by mat breakage and by permanent deformation.

After removing panels from the subgrade surface, it was observed that some of the end connectors had cracked along the weld. Most also had cracks at the TIG weld of panels' corners. One panel also had some cracking along the FSW, but this was most likely associated with cracking that began at the MIG weld and propagated along the FSW. Many connectors that were perpendicular to the direction of traffic also tore along the internal flange. Photographs of damage of the S46 panels are shown in Figure 4.2.

Figure 4.2. Damage on the S46 test item.

(a) Locking bar displaced from connection.

(b) Deformation on panel surface.

(c) Cracking along FSW.

(d) Cracking at TIG weld.

(e) Tear along perpendicular connector.

(f) Cracking along MIG weld.

4.3 I-Trac

The I-Trac mat system failed by crushing the core and connections during application of first pass on the outer lane. In some areas, the cross section of the panels sheared and exposed the subgrade underneath, creating severe tire hazards. The load cart tire was shifted to avoid the tire hazards as it traveled backwards on the I-Trac test item. I-Trac panels were removed from the subgrade and trafficking was continued on the remaining test items. Photographs of damage are shown in Figure 4.3.

Figure 4.3. Damage on I-Trac test item.

(a) Tear through mat core and connections.

(b) Broken connection.

(c) Damage along the traffic lane.

4.4 Mat breakage analysis

A total of 48 passes of simulated F-15E traffic were applied to the S46 and ALMATS test items before failure by mat breakage occurred. The I-Trac system failed during the first pass applied by the load cart. None of the systems met the minimum performance requirement (1,500 passes) and are not viable alternatives for the AMX program.

Some recommendations were provided to vendors to make improvements to the systems. The S46 mat system had significant deformation of the mat surface and the end connectors did not provide adequate support, causing the joints to separate and dislodge the locking bar. The ALMATS system had significant damage at the end connectors, but the core was stronger than that of the S46. However, it was expected that the performance of ALMATS would not meet minimum pass requirements because it was designed for a much lower load regime (RPAs).

5 Permanent deformation

This chapter describes the results from data collected according to the activities discussed in section 3.5.

5.1 Permanent deformation results

To limit the quantity of data presented in this section, graphs plotting the centerline profile on the subgrade, the centerline profile on the mat, cross sections on the unloaded surface of the mats, and rut depth on the unloaded surface of the mats are shown in Appendix D. The data presented in this chapter include the plots of cross sections on the subgrade, cross sections on the loaded mat surface, and rut depths on the loaded mat surface.

To show only the changes that occurred because of trafficking, the pre-traffic data collected with the robotic total station along the centerlines and cross sections were subtracted from all subsequent data collected after trafficking began to normalize the data. The discussions that follow are based on normalized data. Figure 5.1 through Figure 5.3 show the average deformation on the subgrade surface after the mats were removed. Figure 5.4 through Figure 5.6 show plots of the average cross sections on the loaded mat surface at different pass levels.

Rut-depth data collected on the mat surfaces were normalized against pretest data. Figure 5.7 shows the average maximum rut depth measured on the loaded mat surfaces. Data were plotted as a function of pass levels.

Figure 5.1. Average deformation on the subgrade surface of the ALMATS test item.

Figure 5.2. Average deformation on the subgrade surface of the S46 test item.

Figure 5.3. Average deformation on the subgrade surface of the I-Trac test item.

Figure 5.4. Average deformation on the loaded mat surface of the ALMATS test item.

Figure 5.5. Average deformation on the loaded mat surface of the S46 test item.

Figure 5.6. Average deformation on the loaded mat surface of I-Trac.

Figure 5.7. Average maximum rut depth on the loaded mat surface.

5.2 Permanent deformation analysis

The centerline profiles were analyzed to determine whether the roughness criterion was exceeded. The permanent deformation on the subgrade, the loaded mat surface, and the unloaded mat surface were also analyzed to determine whether the deformation criterion was exceeded. Table 5.1 summarizes the results of permanent deformation in terms of the pass level at which the mat systems failed to meet the criterion. The matting systems did not meet the threshold criteria for preventing subgrade deformation before 1,500 passes of the F-15E were applied.

Although slight differences can be seen between average cross-section deformation and rut-depth data, the general characteristics of the rate of increase in deformation can be seen with both measurements. Error in the data may be introduced by the matting surface features (type of joint, gap between joints, etc.) or from human/equipment error during the data collection process.

Table 5.1. Pass level at which permanent deformation criterion was exceeded.

	ALMATS	S46	I-Trac
Subgrade surface centerline roughness	— *	— *	N/A
Mat surface centerline roughness	— *	48	N/A
Deformation on subgrade surface	48	— *	N/A
Loaded deformation on mat surface	48	32	N/A
Unloaded deformation on mat surface	48	16	N/A
Rut depth on loaded mat surface	48	32	N/A
Rut depth on unloaded mat surface	48	16	N/A

*Did not exceed failure criterion of 1.25 in.

The ALMATS system appears to have performed better at preventing deformation since it reached 48 passes before the criterion was exceeded. The stiffer joint of this system in comparison to that of the S46 and I-Trac contributed to this behavior. ALMATS had behavior more consistent with previous results of deformation on matting systems, where the mat and subgrade deform at the centerline and gradual upheaval occurs on each side of the centerline.

Note the behavior of S46 in Figure 5.5. The matting embedded into the subgrade at the centerline and deformed to the point that the mat continued to lift on each side, creating what appears to be upheaval. From Figure 5.2, the subgrade upheaval was approximately 0.5 in.; however, the mat lifted between 1 in. and 1.5 in. on each side of the centerline. An air gap began to form between the bottom surface of the mats and the top of the subgrade at these locations. Eventually, the size of the air gap increased until the strain in the mat exceeded its elastic limit. Once the elastic limit was exceeded, the mat began to yield and plastically deform. Loaded and unloaded mat surface deformation on the S46 also seemed conflicting because unloaded deformation appears to be larger than the loaded deformation. This can be explained by the weight of the forklift reducing mat upheaval on the right side of the cross section while collecting loaded cross-section measurements, thus reducing the measured deformation. Mat surface centerline roughness exceeded 1.25 in. after 48 passes, but this was mostly associated with broken components of the mat.

Measurements for I-Trac are somewhat misleading because the system did not successfully support 1 pass from the load cart. The first pass occurred on the outermost lane of the east side of the traffic pattern, and the second pass was approximately 1 ft offset west of the centerline to avoid tire hazards on the outer lane. Thus, the subgrade deformed in these two lanes (Figure 5.3). Figure 5.6 shows mat uplift on the east side of the centerline, mostly associated with broken mat components.

6 Conclusions and Recommendations

The objectives of the effort described herein were to identify commercial-off-the-shelf (COTS) matting systems potentially capable of supporting fixed-wing aircraft. Three (3) matting systems were selected and evaluated in a full-scale test section consisting of a 6 CBR subgrade surfaced with each of the matting systems. The three COTS mat systems were ALMATS, S46, and I-Trac. The test section was trafficked continuously with simulated F-15E loads over the length of the three test items. Permanent deformation and mat breakage were monitored. The performance of each of the COTS systems was analyzed based on the failure criteria, and the information was used to develop recommendations for improvements to the systems.

6.1 Conclusions

1. The I-Trac mat system failed by mat breakage during the first pass of the F-15E load cart. The core and connections of the matting system were not strong enough to sustain the load of the F-15E on a moderate subgrade.
2. The S46 mat system sustained 32 passes before it failed by permanent deformation. After 48 passes, severe tire hazards were present throughout the traffic lane; therefore, trafficking was stopped. The core structure and connections of the mats were too weak to sustain the load of the F-15E on a moderate subgrade.
3. ALMATS sustained 48 passes before the matting system failed by permanent deformation and mat breakage. Mat breakage was predominant at the weld of the end connector.
4. The matting systems evaluated in this full-scale experiment are not suitable alternatives for the AMX program. Recommendations were provided to vendors for improvement, but significant material and design modifications would be required to obtain a considerable performance increase and to make them viable options.

6.2 Recommendations

1. The internal members of the S46 mat system should be thicker to allow for more support at the core. The connection along the long dimension should be changed (possibly hinge-type) to allow for better load transfer. It is also recommended that a stronger aluminum alloy be used and that the MIG

weld for joining end connectors to the core be replaced by a FSW to improve its strength.

2. It is recommended to improve the weld of ALMATS end connector by having it penetrate further into the skins and to consider a stronger welding technique, such as FSW.

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Appendix A: Request for Information

Request for Information for a Lightweight Airfield Mat System Solicitation Number: W81EWF50628637

Background:

The U.S. Military has identified a need to provide a faster, lighter weight, and more transportable means to rapidly expand parking aprons and taxiways at expeditionary airfields. To achieve this goal, an “AMX” program was initiated to evaluate temporary aircraft operating surfaces, or “airfield mats” capable of carrying fighter and cargo aircraft loads across soft soils. The AMX program is structured to provide a replacement for the AM2 matting system that is currently used by the U.S. Military to perform these airfield functions.

Information is being requested from potential providers of matting systems designed for use as aircraft taxiway and parking ramp surfaces. This document defines specific requirements developed under the AMX program for a lightweight aircraft matting system. Submissions to this request should be information regarding either an existing commercial-off-the-shelf (COTS) matting system or a fully developed prototype. The submissions will be considered based on their ability to meet the requirements described below, cost, and projected performance over soft subgrade soil conditions. Systems determined to be viable candidates meeting the requirements below may be invited to participate in full-scale validation testing by the U.S. Military.

1. Key requirements.

The most important criteria for acceptable matting are twofold: (1) support the most critical loading without catastrophic failure or damage, and (2) maintain operational integrity over time so as to minimize the need for repairs.

2. Load capacity.

Controlling, or critical aircraft for load-bearing design and evaluation, will be the F-15E fighter aircraft.

3. Minimum number of required operations.

The lightweight mat system must be capable of supporting the following operations: 1,500 passes of an F-15E single-wheel main landing gear carrying a 35,235-lb load and having a 325 psi tire.

4. Subgrade requirements.

The objective of this effort is to find a matting system capable of being placed directly on top of a semi-prepared soil surface with a California bearing ratio (CBR) of 6 and to meet requirements listed in this document.

5. Deflection limits.

Maximum mat surface deflections under aircraft load must not exceed the following: 1.25 in. at any time during the first 1,500 F-15E aircraft passes.

6. Mat panel breakage limits.

The system must also be capable of supporting the key performance parameters above without more than a 10% mat component failure. Component failure is defined as any condition rendering the component unserviceable or a safety hazard to aircraft or personnel.

7. Weight.

It is desired that the matting system weight be no more than 3.8 lb./ft², but the weight must not exceed 4.8 lb./ft². The objective of the AMX program is to achieve a 42% reduction in weight with respect to AM2, but a matting system with a reduction in weight of at least 25% may be considered for the initial evaluation.

8. Dimensions.

It is desired that the matting system dimensions be optimized for transport using a standard 463L master pallet and 20-ft ISO flat rack. Panel thickness should be minimized to the greatest extent possible to reduce shipping volume. The objective of the AMX program is to reduce panel thickness to 1.25 in., but panels with a thickness of up to 1.5 in. may be considered for the initial evaluation.

9. Foreign Object Damage (FOD) protection.

The matting system must provide FOD cover/protection. The mat system must not be a source of FOD and must also prevent small rocks/debris on the ground underneath from being sucked into engines.

10. Installation rate.

Construction personnel should be able to install the mat system at the rate of 250 ft² per man-hour.

11. Support equipment.

It is desired that the matting system not require specialized tools to assemble and maintain (with the exception of simple hand-held devices designed to expedite assembly). Assembly of the matting system should be achievable using only common hand tools contained in Civil Engineer Unit Type Code (UTC) Equipment and Supply Listing (ESL). Engineers deploy with a substantial tool and equipment inventory in order to accomplish their many airfield support tasks. Adding specialized tools will increase logistics footprint.

12. Panel replacement:

It is desired that interior panels and assembled mat sub-systems be removable to allow the replacement of damaged panels or to allow for maintenance of the subgrade below groups of panels.

13. Reusable panels:

It is desired that panels without extensive damage be recoverable and suitable for reuse after being cleaned and repacked.

14. Shear strength and braking.

The matting system should be capable of withstanding shear stresses induced by aircraft braking and turning actions on aprons and taxiways imposed by F-15E aircraft operating at maximum weights.

15. Non-slip surface.

The matting should be surfaced with a minimum nonskid profile capable of producing a coefficient of friction of at least 0.50 μ when measured

using a Griptester device at 60 mph. Correlations to other devices may be found in Section 3-19 of FAA Advisory Circular AC 150/5320-12C. The non-skid coating should be durable and remain in satisfactory condition after 1,500 aircraft operations, including braking and turning. The non-skid surface should not be easily degraded by routine sweeping for FOD removal.

16. Snow removal and sweeping.

The matting system should be capable of being cleared of snow and dirt using standard airfield plows, vacuum sweepers, and towed sweepers without damage.

17. Interoperability with adjacent pavements.

The matting system should accommodate transition of aircraft between existing airfield pavement (and/or AM-2 Mat ramps) to the matting system and provide a secure method of anchoring while ensuring that there are no tire hazards or safety issues.

18. Aircraft/flightline fluids and liquid oxygen (LOX) resistance.

The matting system should ultimately be able to withstand the following for full success under the AMX program: exposure to LOX, JP series fuels, hydraulic fluids, firefighting agents, detergents, and other liquids typically found in a flight line environment, and exposure to NBC decontamination agents. The expectation is that the matting system can withstand exposure to these materials for several days without causing permanent damage to the mat.

19. Transportability.

For full success under the AMX program, the matting system should ultimately be delivered from the manufacturer bundled for inter-modal transportability. Gaining agencies will provide the specific bundling configurations required. Basic configurations are: (a) 463-L and (b) ISO, 8-ft x 8.5-ft x 20-ft flat-rack containers.

20. Surface temperature and solar radiation.

For full success under the AMX program, the matting system should be capable of withstanding a peak ambient surface temperature of at least

205°F and withstanding ultraviolet effects for 5 years' continuous use with minimal degradation of components, including permanent deformation, delaminating, or loss of material strength.

21. Storage and reconstitution.

The matting system should be capable of outdoor storage to achieve a minimum 20-yr service life. Protective packaging may be used to meet this requirement. The mat should not become deformed if stored on dunnage.

22. Operating temperature range.

The matting system should be able to perform its designed function in all climate types (e.g., hot, basic, cold, and extremely cold) and in induced operating temperatures between -40°F and +140°F.

23. Flammability.

The matting surface must not be flammable. Inflammability shall be defined as having a burning rate slower than 0.087 in. per sec when tested in accordance with UN Manual of Tests and Criteria.

24. All-weather capability.

The matting surface should be suitable for aircraft operations typical of paved surfaces in all weather conditions.

25. Unplanned stimuli.

Matting systems and components must not be susceptible to static-charge build-up.

26. Aircraft tie-downs and grounding.

The matting system should be designed to accommodate aircraft tie-down and grounding points for full success under the AMX program, although the installed matting system does not have to be the grounding medium.

27. Crowned subgrade.

The matting system should be capable of being placed over subgrade crowned up to 1.5% to facilitate drainage. This is identified by current requirements for airfield pavement slopes outlined in UFC 3-260-01.

Appendix B: Test Section Layout

Figure B.1. ALMATS test item layout.

Figure B.2. S46 test item layout.

Figure B.3. I-Trac test item layout.

Appendix C: DCP Data of Hangar 2 Foundation

This appendix shows DCP data collected on the ML backfill. The ML backfill was 12 in. thick. The material below was the natural foundation of Hangar 2.

Appendix D: Additional Deformation Data

Figure D.1. Average deformation along the subgrade centerline of ALMATS.

Figure D.2. Average deformation along the subgrade centerline of S46.

Figure D.3. Average deformation along the subgrade centerline of I-Trac.

Figure D.4. Average deformation along the centerline of ALMATS at various pass levels.

Figure D.5. Average deformation along the centerline of S46 at various pass levels.

Figure D.6. Average deformation along the centerline of I-Trac at various pass levels.

Figure D.7. Average deformation on the unloaded mat surface of ALMATS.

Figure D.8. Average deformation on the unloaded mat surface of S46.

Figure D.9. Average deformation on the unloaded mat surface of I-Trac.

Figure D.10. Average maximum rut depth on the unloaded mat surface.

REPORT DOCUMENTATION PAGE

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14. ABSTRACT Airfield matting systems are used for the expedient construction of temporary airfields and the expansion of existing airfields to provide temporary airfield operating surfaces for military aircraft. The primary airfield matting system used by the U.S. Military is the AM2 airfield matting system. Although the AM2 matting system has proved to be successful for supporting modern aircraft, it is difficult to transport by air because of its size and weight. The AMX program was initiated by the U.S. Air Force to identify and evaluate new, lightweight airfield mat designs optimized for C-17 transport. Three commercially available matting systems of varying materials and designs were evaluated through the construction of a full-scale test section to determine their effectiveness at sustaining modern fighter aircraft loads and at reducing the accumulation of subgrade deformation. The matting systems were tested on a subgrade with a California bearing ratio (CBR) of 6 and subjected to simulated F-15E aircraft traffic while monitoring mat breakage and deformation. The systems were compared against baseline requirements established for the AMX program, which were established to match the performance of AM2 while providing a reduced logistical footprint. The systems tested in the experiments described in this report are not suitable alternatives, but improvements to mat component designs were recommended that could increase performance.					
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