TRI-SERVICE PAVEMENTS WORKING GROUP (TSPWG)

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O&M: Airfield Damage Repair

5 MAY 2022

RAPID AIRFIELD DAMAGE REPAIR IN COLD WEATHER

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RAPID AIRFIELD DAMAGE REPAIR IN COLD WEATHER

Indicate the preparing activity beside the Service responsible for preparing the document.

U.S. ARMY CORPS OF ENGINEERS

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FOREWORD

This Tri-Service Pavements Working Group Pocket Manual supplements guidance found in other Unified Facilities Criteria, Unified Facility Guide Specifications, Defense Logistics Agency Specifications, and Service-specific publications. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and, in some instances, Bilateral Infrastructure Agreements (BIA). Therefore, the acquisition team must ensure compliance with the most stringent of the TSPWG Pocket Manual, the SOFA, the HNFA, and the BIA, as applicable. This pocket manual provides guidance on materials for conducting rapid airfield damage repair in cold weather. The information in this pocket manual is referenced in technical publications found on the Whole Building Design Guide. It is not intended to take the place of Service-specific doctrine, technical orders (TOs), field manuals, technical manuals, handbooks, Tactics, Techniques or Procedures (TTPs), or contract specifications, but should be used along with these to help ensure pavements meet mission requirements.

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NEW SUMMARY SHEET

Document: TSPWGPM 3-272-01.21-05, *Rapid Airfield Damage Repair in Cold Weather*.

Superseding: No other documents

Application: This document is authoritative but not directive and serves as a starting point for making field adjustments. The information in this publication takes precedence over conflicting information found in other nondirective publications.

Description: This publication describes the use of rapid-setting concrete capping materials used to repair damaged airfields in cold weather. These technical solutions were validated during technical demonstrations and field applications.

Reasons for Document: This document provides information to engineers for rapid airfield damage recovery (RADR) during cold weather operations using approved rapid-setting materials and accelerants that decrease cure time.

Note: The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Department of Defense (DOD).

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TABLE OF CONTENTS

TABLES

CHAPTER 1 INTRODUCTION

1-1 OVERVIEW.

ACI 306, *Guide to Cold Weather Concreting*, defines cold weather concrete as "a period when for more than three successive days the average daily air temperature drops below 40 degrees Fahrenheit and stays below 50 degrees Fahrenheit for more than one-half of any 24 hour period." Many military airfields are in northern tier locations or overseas where temperatures often remain in this defined temperature range for extended periods of time. These airfields require a capability for rapid airfield damage recovery (RADR) during cold weather. Research, development, test and evaluation (RDT&E) identified materials and processes to effectively repair craters and spalls on aircraft operating surfaces during periods of cold weather below freezing temperatures. Additionally, colder climates often require an accelerant additive to reduce the set time of rapid-setting concrete.

1-2 PURPOSE AND SCOPE.

This publication describes materials and augments processes for capping cratered runways in temperatures below 50 °F (10 °C) using approved rapid-setting concrete and flowable fill materials with and without accelerants. This manual supplements UFC 3-270-01, *O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair*, and *Interim Process for Rapid Airfield Damage Recovery (RADR)*, or AFTTP 3-32.17, *Rapid Airfield Crater and Spall Repair*, whichever is published and current.

1-3 APPLICABILITY.

The information in this publication takes precedence over conflicting information in other nondirective publications. Use this manual when no other guidance is available or when other guidance does not meet mission needs.

1-4 GENERAL BUILDING REQUIREMENTS.

Comply with UFC 1-200-01, *DoD Building Code*, outlining applicability of model building codes and government-unique criteria. Use this publication in addition to UFC 1-200-01.

1-5 GLOSSARY.

Appendix A contains acronyms, abbreviations, and terms.

1-6 REFERENCES.

Appendix B contains a list of references used in this document. The publication date of the code or standard is not included in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

CHAPTER 2 CAPPING MATERIALS

2-1 OVERVIEW.

Although flowable fill and rapid-setting concrete perform best when mixed with water between 70 °F (21 °C) and 80 °F (27 °C), northern tier and overseas installations frequently experience temperatures below 50 °F (10 °C) and require a concrete capping material for RADR that will support aircraft operations in a short time period. The two rapid-setting concrete capping materials for RADR that were tested by the Army Engineer Research and Development Center (ERDC) and approved by AFCEC are CTS Rapid Set and Buzzi Unicem. This chapter covers testing data and application of CTS Rapid Set and Buzzi Unicem rapid-setting concrete and flowable fill products. Also covered is the use of compacted snow as an alternative expedient material.

Note: All approved products are located on the Tri-Service Transportation Pavements Transportation Community of Practice (CoP) at the following link: https://transportation.erdc.dren.mil/cacsites/TriService/qpl_rscrcm.aspx

2-2 MATERIAL TESTING BACKGROUND.

CTS Rapid Set and Buzzi Unicem products have been employed in cold weather locations, including the USACE Cold Regions Research Engineering Laboratory (CRREL), Malmstrom AFB, Goose Bay AB, Yokota AB, and Misawa AB. The materials were tested in temperatures down to -10 °F (-23 °C). During the Goose Bay AB exercise, temperatures ranged from -19 °F to 29 °F (-28 °C to -2 °C). Notably, materials tested at Goose Bay AB did not use accelerants and the cure times ranged from three hours to 12 hours as compared to the standard two hours obtained at temperatures above freezing or with the use of accelerants. Furthermore, in the case of Goose Bay AB, the water was heated to 50 °F (10 °C) before application or addition to the cements. The cements were at ambient temperature and stored in unprotected areas. During testing at Yokota AB, the temperature was 43 °F (6 °C) at the first placement. Accelerants were used to ensure the cure time was no more than two hours. Based on the testing and experiences at these locations, the accelerant dosage rates were modified.

2-3 RAPID SETTING CONCRETE AND FLOWABLE FILL WITHOUT ACCELERANTS.

Use Table 2-1 as an estimate for cure times when using CTS Rapid Set and Buzzi Unicem products if the water used for hydration is at or above 50 °F (10 °C) at the time of mixing and the material is at ambient temperature.

Table 2-1 Water Temperature Above 50 °F (10 °C)

Cure Time	Temperature
2 hours	40 °F (4.5 °C) and higher
2–3 hours	25 °F (-4 °C) to 40 °F (4.5 °C)
3–12 hours	-10 °F (-23 °C) to 25 °F (-4 °C)

Note: If the water and the rapid-setting material are at 50 °F (10 °C) or higher at the time of mixing (rapid-setting materials are stored in a temperature-controlled facility), then the cure times are two to three hours down to 15 °F (-9.5 °C).

2-4 RAPID SETTING CONCRETE AND FLOWABLE WITH ACCELERANTS.

2-4.1 The preferred accelerant for both CTS Rapid Set and Buzzi Unicem products is aluminum sulfate, $Al_2(so_4)_3$. Currently, there are no DoD Unit Type Codes (UTC) that have aluminum sulfate on the inventory. Aluminum sulfate is used as a flocculent or coagulant in water and waste water treatment facilities. Aluminum sulfate may be readily available if a water or waste water treatment plant is located on the installation. Furthermore, aluminum sulfate is used as a fertilizer (typically in areas with high-alkaline soils); check local hardware stores, gardening centers, or AAFES for availability.

2-4.2 See Table 2-2 for recommended dosage rates for aluminum sulfate. It is recommended to start with the lower dose for super sacks in order to maintain a two- to three-hour cure time. Adjust dosage rates for local conditions.

***Note:** Mix aluminum sulfate in powder form with approximately 5 gallons of water to form slurry before adding to volumetric mixer water tanks.

Table 2-2 Aluminum Sulfate Dosage Rate for Super Sacks

Ambient Temperature	Dosage Rate (lb./super sack)*
50 °F and above	None
45 °F	7.25–9
40 °F	9.6–12
35 °F	12–15
30 °F	14.5–18
25 °F	19.25–24
20 °F	23.25–29
15 °F	28–35
10 °F	33–41

* Recommended dosage rate per 3,000-pound super sack of dry concrete material.

2-4.3 A second method for measuring the required amount of aluminum sulfate is by gallons of water required for the mix. Table 2-3 shows the amount of aluminum sulfate required per 100 gallons of water in 5 °F degree increments. The recommendation is to start with the lower dose for super sacks and the higher dose for 5-gallon buckets. Approximately 445 gallons of water is required per 3,000-pound super sack.

Table 2-3 Aluminum Sulfate Lbs. per 100 Gal. of Water 5 °F Increments

Ambient Temperature	Lb./100 Gal. of Water*
50 °F and above (10 °C)	None
45 °F (7 °C)	16–20
40 °F (4.5 °C)	21.5–27
35 °F (1.5 °C)	27–34
30 °F (-1 °C)	32–40
25 °F (-4 °C)	43–54
20 °F (-6.5 °C)	52–65
15 °F (-9.5 °C)	63–79
10 °F (-12 °C)	74.5–93

2-5 SNOW REPAIRS.

2-5.1 Use of compacted snow with fiber reinforced polymer (FRP) FOD cover matting can support up to 100 aircraft passes eight hours after compaction when the temperature is below 25 °F (-4 °C). Compact the snow in 2- to 3-inch lifts using a plate compactor.

2-5.2 Another option is to add a water slurry (water and snow mixture) to the snow and compact the surface. The frozen surface can withstand traffic (500+ passes) without an FRP cover eight hours after compaction and refreezing when the temperature is below 25 °F (-4 °C). Use the same compaction methods described in paragraph 2-5.1.

CHAPTER 3 SPALL (PARTIAL-DEPTH) REPAIRS

3-1 OVERVIEW.

Concrete spalling frequently leads to significant distresses to airfield pavement, resulting in FOD. The purpose of partial-depth repairs is to correct localized areas of concrete pavement distress. Repairs of this type restore rideability, deter further deterioration, reduce FOD potential, and provide proper edges so joints can be effectively resealed. Spall repairs are often required when temperatures are below 50 °F (10 °C). The information in this chapter describes rapid-setting concrete options for repairing spalls with CTS Rapid Set and Buzzi Unicem rapid-setting concrete below 50 °F (10 °C). Refer to UFC 3-270-01 for partial-depth pavement repair procedures.

3-2 REPAIR AND PROPORTIONING DETAILS.

3-2.1 Partial-depth spall repairs are typically conducted using repair material in 5-gallon buckets. If repair material in 5-gallon buckets is not available, measure the quantity required from super sacks containing CTS Rapid Set or Buzzi Unicem rapid-setting concrete.

3-2.2 If aluminum sulfate is available, use the applicable dosing charts in Table 3-1 by weight of rapid-setting repair material or Table 3-2 for pounds per 100 gallons of water.

Table 3-1 Aluminum Sulfate Dosage Rate

By Weight of Rapid-Setting Repair Material	Temperature
0.35% to 0.13%	40 °F to 50 °F (4.5 °C to 10 °C)
0.71% to 0.57%	20 °F to 40 °F (-6.5 °C to 4.5 °C)
1.41% to 1.13%	10 °F to 20 °F (-12 °C to -6.5 °C)

Table 3-2 Aluminum Sulfate Lbs. per 100 Gal. of Water

Temperature	Lbs. per 100 Gal. Water
40 °F to 50 °F	22 to 17.5
20 °F to 40 °F	43 to 34.5
10 °F to 20 °F	85 to 68

3-2.3 If aluminum sulfate is not available, consider the following steps to reduce the risk of problems and produce a longer-lasting repair.

3-2.3.1 Store concrete materials used for repairs in a heated location, preferably at 50 °F (10 °C) or higher until needed. If a heated storage facility is unavailable, one option is to place the 5-gallon buckets of repair material (the Sustainment Pavement Repair [SuPR] kit has CTS Rapid Set in 5-gallon buckets) in the heated cab of a vehicle at the job site before mixing.

3-2.3.2 Heat water used for mixing concrete to a temperature above 50 °F (10 °C), preferably 60 °F to 80 °F (15 °C to 26 °C). Once heated, use insulated coolers or other containers that will maintain water temperature while transporting to the job site.

3-2.3.3 Prepare the existing spall surface using the following steps after all debris has been cleared and the surface area has been properly cleaned.

- Wet or saturate the surface using steam or hot water.
    - Leave steam or hot water on the surface until the desired pavement temperature is reached.
    - Dry partial-depth repair surfaces.
    - If available, use a heat lance in place of steam or hot water to heat spall surfaces.
- Place and finish spall repair material using hand tools. Ensure the surface is finished level with surrounding concrete, smooth with a trowel, and broom finish. Ensure all surrounding edges of the patch are cleaned even with the patch area and no excess material is left on the existing surface.

- Cover the spall repair with plastic, insulated tarp, or straw. Use snow if none of the suggested cover materials are available. If available, apply heat or steam under the plastic or tarp to maintain a temperature above 50 °F (10 °C).

- For permanent or semi-permanent repairs, reestablish the joint or crack after curing.

3-2.4 If the material and water for concrete hydration is above 50 °F (10 °C) at the time of mixing, open the repair to traffic in two to three hours.

3-2.5 For permanent repairs, check weekly for cracks. If cracking develops around the repair's edge or on the repair's surface, clean, dry, and seal the crack with an injectable epoxy or squeegee a high-molecular-weight methyl methacrylate (HMW MMA) into the crack to keep it sealed from water intrusion.

3-2.6 The SuPR kit contains asphalt that can be heated in the supplied recycler to produce hot mix asphalt. Once heated, placed, and compacted, open the hot mix asphalt patch to traffic within two hours. If the temperature is 32 °F (0 °C) or below for a long period of time, use cold patch asphalt for an emergency repair and replace the patch with a permanent repair material once the ambient temperature rises above freezing.

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APPENDIX A GLOSSARY

°C	Degree Celsius
°F	Degree Fahrenheit
AB	Air Base
ACI	American Concrete Institute
AFB	Air Force Base
AFTTP	Air Force Tactics, Techniques, and Procedures
FOD	Foreign Object Damage/Debris
FRP	Fiber-Reinforced Polymer
RADR	Rapid Airfield Damage Recovery
SuPR	Sustainment Pavement Repair
UFC	Unified Facilities Criteria

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APPENDIX B REFERENCES

DEPARTMENT OF DEFENSE

TSPWG PM 3-270-01.20-02, *Rapid-Setting Concrete Repair Capping Using Type I and Type III Cements*, https://www.wbdg.org/ffc/dod/supplemental-technical-criteria

UFC 3-270-01, *O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

ARMY

https://www.dtic.mil/

ERDC GSL TR 13-32, *Cold Weather Crater Repair Testing at Malmstrom AFB, MT*

ERDC TR-14-10, *Laboratory Evaluation of Expedient Low-Temperature Admixtures for Runway Craters in Cold Weather*

AIR FORCE

https://www.e-publishing.af.mil/

AFTTP 3-32.10, *Introduction to Rapid Airfield Damage Recovery (RADR)*

AFTTP 3-32.16, *Sustaining Airfield Pavement at Enduring Contingency Locations*

AFTTP 3-32.17, *Rapid Airfield Crater and Spall Repair*

Interim Process for Rapid Airfield Damage Recovery (RADR), 30 Nov 2018, Rev 12.0, https://usaf.dps.mil/:b:/r/teams/cedash/_layouts/15/wopiframe.aspx?sourcedoc={63a1067d-6ca8-4e20-bb27-ad5df45afe3b}&action=interactivepreview

AMERICAN CONCRETE INSTITUTE

ACI 306, *Guide to Cold Weather Concreting*, https://www.concrete.org/