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CONTRACTOR SUBMITTAL ASSISTANCE PACKET

Assisting Fortress & Fortec Certified Contractors with Bid Submittal Requirements

SUMMARY

This document provides Fortress & Fortec Certified Contractors much of the documentation required by many federal, military, and state project specifications to bid on and secure contracts for FRP strengthening projects.

PRODUCT APPLICATION

This submittal assistance packet applies to the following Fortress & Fortec Stabilization Systems products:

- ❖ **Fortress & Fortec Tow Sheet** Unidirectional Textile
- ❖ **Fortress Carbon-Kevlar Strap System** Hybrid Grid
- ❖ **Fortress & Fortec Carbon Fiber Strap System** Pre-Cured Unidirectional Laminate
- ❖ **Fortress & Fortec Corner Strap** Pre-Cured Carbon-Kevlar Hybrid Grid
- ❖ **Fortress & Fortec L-Bracket Stirrup**, Pre-Cured Carbon Fiber Laminate



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- Appendix A Fortress/Fortec Installation Guide
- Appendix B Zoltek ISO 9001 Certification

SUBMITTAL ITEMS

1.0 GENERAL

1.1 Purpose

Some project specifications require FRP installation contractors to provide a vast amount of data to be able to bid on or to secure a contract. This Contractor Submittal Assistance Packet is intended to provide, or to show where to find, the documentation required by most project specifications.

1.2 Our Commitment to You

Fortress Stabilization Systems, LLC and its Fortec Stabilization Systems division is committed to providing the best service to its Certified Installers. The information shown here should allow you to bid on and secure the most rigid project or contract specifications. If you find that a project requires additional information, Fortress is ready to help. Contact Fortress at solutions@fortressstabilization.com or (800) 207-6204.

1.3 Fortress Information Provided

Following this section are the most commonly requested manufacturer documentation items by typical federal, military and state department of transportation project specifications. Items are either included here, or links are provided to PDF documents available on the Fortress <http://www.fortressstabilization.com> or Fortec <http://www.fortecstabilization.com> websites.

2.0 SUBMITTAL ITEMS

2.1 Working Drawings (Shop Drawings)

Working (also known as Shop) Drawings are required by some project specifications and are unique to each project. As a service to our Certified Contractors, Fortec Stabilization Systems offers preparation of shop drawings in exchange for a nominal fee. Contact Fortec for more information.

2.2 Design Calculations

As with shop drawings, some project specifications require design calculations to be submitted. Fortec Stabilization Systems can provide project specific design calculations to Certified Contractors in exchange for a nominal fee. Contact Fortec for more information.

2.3 Product Material Safety Data Sheets (MSDS)

2.3.1 Carbon Fiber MSDS

<http://www.fortecstabilization.com/datasheets/CarbonMSDS.pdf>

SUBMITTAL ITEMS

2.3.2. Epoxy MSDS

Fortress #526 Epoxy Component A MSDS
http://www.fortressstabilization.com/specs/pdf/MSDS_526A-Fortress.pdf

Fortress #526 Epoxy Component B MSDS
http://www.fortressstabilization.com/specs/pdf/MSDS_526B-Fortress.pdf

Fortress #4020 Epoxy Component A MSDS
<http://www.fortecstabilization.com/datasheets/4020EpoxyA-MSDS.pdf>

Fortress #4020 Epoxy Component B MSDS
<http://www.fortecstabilization.com/datasheets/4020EpoxyB-MSDS.pdf>

Fortress #4550 Epoxy Component A MSDS
<http://www.fortressstabilization.com/specs/pdf/fortress4550epoxyA.pdf>

Fortress #4550 Epoxy Component B MSDS
<http://www.fortressstabilization.com/specs/pdf/fortress4550epoxyB.pdf>

2.4 Fortec Product Data Sheets

2.4.1. Tow Sheet

Fortec 150GSM Unidirectional Tow Sheet
<http://www.fortecstabilization.com/datasheets/TowSheet150GSM.pdf>

Fortec 300GSM Unidirectional Tow Sheet
<http://www.fortecstabilization.com/datasheets/TowSheet300GSM.pdf>

Fortec 600GSM Unidirectional Tow Sheet
<http://www.fortecstabilization.com/datasheets/TowSheet600GSM.pdf>

Fortec 720GSM Unidirectional Tow Sheet
<http://www.fortecstabilization.com/datasheets/TowSheet720GSM.pdf>

Fortec 600GSM-VHS Unidirectional Tow Sheet
(Contact Fortec for the latest data sheet)

2.4.2. Carbon Fiber Plate System

Fortec Carbon Fiber Pre-Preg Plate
<http://www.fortecstabilization.com/datasheets/CarbonStrapSys.pdf>

SUBMITTAL ITEMS

2.4.3. Epoxy Systems

Fortec #105 Epoxy Coating System

<http://www.fortecstabilization.com/datasheets/105EpoxyDataSheet.pdf>

Fortec #590 Epoxy Superstick Hi-Mod Gel

<http://www.fortecstabilization.com/datasheets/Fortec590pds.pdf>

Fortec #4020 Epoxy Hardened Hi-Mod Gel

(Contact Fortec for the latest data sheet)

Fortec #4124 Epoxy System

<http://www.fortecstabilization.com/datasheets/Fortec4124Epoxy.pdf>

Fortec #4550 LPL Epoxy Hi-Mod Fiber Matrix

<http://www.fortecstabilization.com/datasheets/4550LPLEpoxy.pdf>

2.5 Independent Laboratory Test Reports

Fortress/Fortec Unidirectional Carbon Fiber Tow Sheet tensile test

<http://www.fortressstabilization.com/specs/pdf/CFClothSpecimens.pdf>

Fortress Carbon-Kevlar Strap tensile test

<http://www.fortressstabilization.com/specs/pdf/CFClothSpecimens.pdf>

Fortress Carbon-Kevlar Strap, Fortress 300GSM & #4020 Epoxy system

<http://www.fortressstabilization.com/specs/stripstest.php>

Fortress/Fortec #4020 Epoxy lap shear test

<http://www.fortressstabilization.com/specs/pdf/CFWeaveLap.pdf>

Fortress Kevlar Necktie tensile test

<http://www.fortressstabilization.com/specs/necktietest.php>

2.6 Fortress/Fortec Installation Guide

The Fortress/Fortec Installation Guide is enclosed in Appendix A

SUBMITTAL ITEMS

3.0 FORTRESS & FORTEC STABILIZATION SYSTEMS EXPERIENCE

3.1 History

Fortress Stabilization Systems, LLC was established in 2001 and has continued to provide carbon, glass, and aramid FRP products to a broad range of structural applications.

In 2010, Fortress created the Fortec Stabilization Systems brand, building on the quality products and systems of Fortress to provide better service to customers in the governmental and institutional markets including State departments of transportation, military, and federal.

3.2 Contractor Certification Program

The Fortress and Fortec Stabilization Systems Contractor Certification Program is an effective educational and practical system of initiating contractor and installer fulfillment with Fortress/Fortec product application and installation procedures and provides for continuing education and practical knowledge of continuously improving products.

Training for contractors is provided via a two-way online session where the Fortress/Fortec provider and contractor representatives can participate in real-time instruction and discussion.

The initial training is a 1½ hr session covering the basics of carbon fiber reinforced polymer (CFRP) reinforcement including fiber and epoxy matrix products and properties used in Residential and Commercial industries. Application and installation training covers proper substrate surface preparation, Fortress Carbon Kevlar grid strap, Fortress staples, Fortress & Fortec pre-preg, pre-cured Carbon Fiber Strap system, and Fortress & Fortec Carbon Fiber Tow Sheet installation using wet and dry layup techniques.

Contractor Certification training is offered on a monthly basis and is continually updated to reflect new products and improved installation techniques.

3.3 ISO 9001 Certification

Fortress Stabilization Systems and Fortec Stabilization System receives its raw and partially completed product materials from Zoltek Companies, Inc. of Bridgeton, Missouri. Zoltek's ISO 9001 Certification is provided in Appendix B.

PROJECT EXPERIENCE

3.4 Project Experience:

3.4.1. Project Highway 340 Overpass, Elkton, Virginia



Project Description	To incorporate composite grid as repair and waterproofing to leaking joints on highway 33 at the 340 overpass.
Type of Project	Joint repair and strengthening
Material Used	FORTRESS Carbon/Kevlar Grid 48K with 4020 epoxy resin
Dates of Work	November 2005
Contractor Name:	Lanford Brothers Co.
Address:	Roanoke, Virginia
Telephone:	(540) 992-2140
Owner Name	Virginia DOT
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.2. Project

Bridge Strengthening, Equador



Project Description

Double box culvert bridge was under-designed for the load.

Type of Project

Reinforced Concrete Slab Flexural Strengthening

Material Used

Fortress 300GSM Tow Sheet, wet-layup

Dates of Work

March 2003

Contractor Name:

Consulambiente Sanitaria y Ambiental Cia. Ltda.

Address:

Guayaquil, Equador

Telephone:

(593-4) 2693235

Owner Name

Address:

Telephone:

PROJECT EXPERIENCE

3.4.3. Project

FRP Reinforced Masonry, Wixom, Michigan

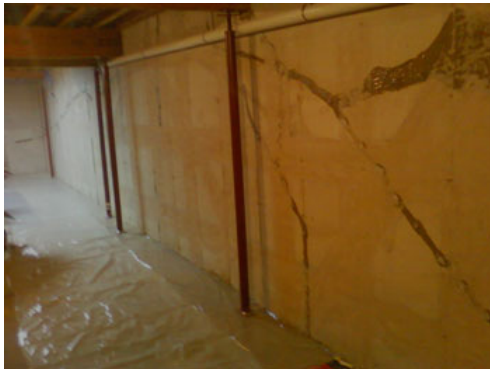


Project Description	Prefabricate masonry structures - walls, arches, corners, even whole buildings using Fortress FRP Systems
Type of Project	Masonry Reinforcement and Strengthening
Material Used	Fortress Grid, Fortress Unidirectional Fabric, Fortress 3/8 inch peel ply plates
Dates of Work	May 2011
Contractor Name:	Constructive LLC
Address:	Wixom, Michigan 48393
Telephone:	(248) 529-6244
Owner Name	Constructive LLC
Address:	Wixom, Michigan 48393
Telephone:	(248) 529-6244

PROJECT EXPERIENCE

3.4.5. Project

Wall Strengthening, Indianapolis, Indiana



Project Description

Strengthening of precast concrete wall panels that failed due to building gravity and shear loads.

Type of Project

Strengthening of reinforced concrete walls

Material Used

Fortress 600GSM Unidirectional Tow Sheet

Dates of Work

February 2011

Contractor Name:

AccuLevel

Address:

Rossville, Indiana

Telephone:

Owner Name

Address:

Telephone:

PROJECT EXPERIENCE

3.4.6. Project

Parking Garage Repair, Birmingham, MI



Project Description	Repair/strengthening of steel rebar cuts in the floors of a parking garage
Type of Project	Repair and strengthening of reinforced concrete
Material Used	Fortress Carbon/Kevlar Grid Strap
Dates of Work	April 2003
Contractor Name:	Eagle Construction
Address:	
Telephone:	
Owner Name	
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.7. Project

Manhole Strengthening, Sandusky, OH



Project Description	Repair, waterproofing and strengthening of sewer manhole structures
Type of Project	Repair, waterproofing, and strengthening of reinforced concrete
Material Used	Fortress Carbon/Kevlar Grid
Dates of Work	May 2002
Contractor Name:	Lee Infrastructure Restoration
Address:	Independence, Ohio
Telephone:	(216) 986-1800
Owner Name	Sandusky Water Works
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.8. Project

Wall Strengthening



Project Description

Axial and flexural strengthening of commercial building foundation walls

Type of Project

Strengthening of reinforced concrete walls

Material Used

Fortress 300 GSM Unidirectional Tow Sheet and Fortress #1276 Epoxy system

Dates of Work

March 2003

Contractor Name:

Concrete & Waterproofing Solutions

Address:

Telephone:

Owner Name

Address:

Telephone:

PROJECT EXPERIENCE

3.4.9. Project

Masonry Wall Strengthening, Cleveland, OH



Project Description	Increase axial and shear strength of unreinforced masonry walls
Type of Project	Shear strengthening of unreinforced masonry walls
Material Used	Fortress Carbon-Kevlar Grid Strap
Dates of Work	April 2004
Contractor Name:	Geotech Services, Inc.
Address:	
Telephone:	
Owner Name	Legal Aid Society of Cleveland
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.10. Project

Masonry Strengthening, Philadelphia, PA



Project Description	Increase flexural strength of 12-inch unreinforced masonry walls
Type of Project	Flexural strengthening of unreinforced masonry walls
Material Used	Fortress Carbon-Kevlar Grid Strap
Dates of Work	June 2004
Contractor Name:	Ram Jack of Tri-States
Address:	Newton Square, Pennsylvania
Telephone:	(610) 325-7731
Owner Name	Roland Industrial Building
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.11. Project

Masonry Strengthening, Ann Arbor, MI



Project Description	Increase strength of masonry walls to resist wind loading
Type of Project	Flexural and shear strengthening of under-reinforced masonry walls
Material Used	
Dates of Work	December 2004
Contractor Name:	Seris Castle Masonry
Address:	
Telephone:	
Owner Name	
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.12. Project

Masonry Strengthening, Coldwater, MI

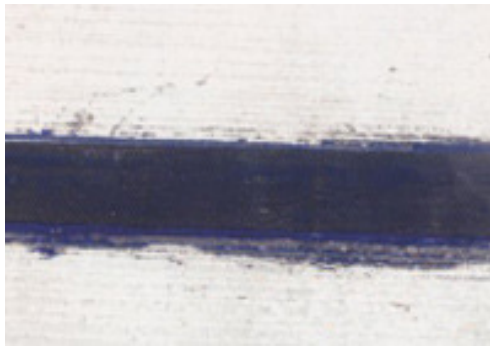


Project Description	Increase strength of clay-brick masonry walls of a church bell tower to resist current code wind loading.
Type of Project	Flexural and shear strengthening of under-reinforced masonry walls
Material Used	Fortress 900GSM Unidirectional Carbon Fiber Plate
Dates of Work	April 2005
Contractor Name:	Bomer Restoration, Inc.
Address:	
Telephone:	
Owner Name	First Presbyterian Church
Address:	Coldwater, Michigan
Telephone:	

PROJECT EXPERIENCE

3.4.13. Project

Segmental Bridge, Fort Lauderdale, FL



Project Description	Waterproof and strengthen transverse joints of the I-75 connector to Sawgrass SR869 concrete segmental bridge.
Type of Project	Joint strengthening and waterproofing between concrete segmental bridge units
Material Used	FORTRESS Carbon/Kevlar Grid 8" wide with FORTRESS #4020 epoxy resin
Dates of Work	January 2006
Contractor Name:	Lanford Brothers
Address:	Roanoke, Virginia
Telephone:	(540) 992-2140
Owner Name	Florida DOT, Larry Sessions, PE
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.14. Project Bridge Strengthening, Cherokee County, GA



Project Description	Increase shear and flexural load capacity by 30% of bridge T-beams
Type of Project	Shear and flexural strengthening of reinforced concrete beams
Material Used	FORTRESS Carbon L-bracket, FORTRESS Unidirectional Carbon Fiber Plate
Dates of Work	2004
Contractor Name:	Engineered Restoration Company
Address:	Lawrenceville, Georgia
Telephone:	
Owner Name	Georgia Department of Transportation
Address:	Atlanta, Georgia
Telephone:	

PROJECT EXPERIENCE

3.4.15. Project

Column Strengthening, Staunton, VA



Project Description	Repair and increase shear strength of Route 994 bridge columns over Interstate 81
Type of Project	Shear strengthening and repair of reinforced concrete bridge columns
Material Used	FORTRESS 300GSM Unidirectional Tow Sheet with FORTRESS #4550 Epoxy resin
Dates of Work	November 2006
Contractor Name:	Lanford Brothers
Address:	Roanoke, Virginia
Telephone:	(540) 992-2140
Owner Name	Virginia Department of Transportation, Chuck Snyder and Jungi Meng PHD, PE
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.16. Project

Building Strengthening, Myrtle Beach, SC



Project Description	Strengthen beam to column joint at the exterior columns of a reinforced concrete frame building
Type of Project	Joint strengthening of reinforced concrete frame members
Material Used	FORTRESS Pre-cured Pre-preg Carbon Fiber Plate w/peel-ply and FORTRESS #4550 Epoxy resin
Dates of Work	September 2007
Contractor Name:	Sandcastle Construction
Address:	Hilton Head, South Carolina
Telephone:	
Owner Name	Grande Shores Ocean Resort
Address:	Myrtle Beach, South Carolina
Telephone:	

PROJECT EXPERIENCE

3.4.17. Project

Blast Protection, Questa, NM



Project Description	Increase blast protection and strength of mine access tunnels
Type of Project	Blast protection and strengthening of reinforced concrete walls and arches
Material Used	Fortress Carbon-Kevlar Grid Strap
Dates of Work	December 2007
Contractor Name:	Smith's Waterproofing
Address:	Almont, Michigan
Telephone:	(810) 798-2371
Owner Name	Chevron Mining Corporation, Kevin Sparks P.E.
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.18. Project

Masonry Strengthening



Project Description	Increase flexural and axial capacity of masonry walls at a food processing plant
Type of Project	Flexural and axial strengthening of masonry walls
Material Used	Fortress 300GSM Unidirectional Tow Sheet and Fortress #4550 Epoxy resin
Dates of Work	February 2009
Contractor Name:	Smith's Waterproofing
Address:	Almont, Michigan
Telephone:	(810) 798-2371
Owner Name	
Address:	
Telephone:	

PROJECT EXPERIENCE

3.4.19. Project

Column Strengthening, Honesdale, PA



Project Description

Increase axial and shear capacity of columns that were cast without horizontal ties to support outdoor water park structures

Type of Project

Axial and shear strengthening of under-reinforced concrete columns

Material Used

Fortress 300GSM Unidirectional Carbon Fiber Tow Sheet and Fortress #4550 Epoxy resin

Dates of Work

June 2010

Contractor Name:

Ram Jack of Tri States, Inc.

Address:

Newton Square, Pennsylvania

Telephone:

(610) 325-7731

Owner Name

Costa's Family Fun Park

Address:

Honesdale, Pennsylvania

Telephone:

(570)

226-8585



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APPENDIX A

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FORTRESS

STABILIZATION SYSTEMS

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INSTALLATION GUIDE

For Externally Applied Fortress Stabilization Systems Products

SUMMARY

This document describes the methods to prepare, prime, and fill substrates, and to apply Fortress Stabilization strengthening systems to concrete and masonry structures.

PRODUCT APPLICATION

This installation guide applies to the following Fortress Stabilization Systems products:

- ❖ **Carbon-Kevlar Strap System** Hybrid Grid
- ❖ **Carbon Fiber Strap System** Pre-Cured Unidirectional Laminate
- ❖ **Corner Strap** Pre-Cured Carbon-Kevlar Hybrid Grid
- ❖ **L-Bracket Stirrup**, Pre-Cured Carbon Fiber Laminate

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INSTALLATION GUIDE for EXTERNALLY APPLIED FORTRESS PRODUCTS

3.0 REFERENCES

- 3.1 American Concrete Institute (ACI) 224.1R-07, "Causes, Evaluation and Repair of Cracks in Concrete Structures."
- 3.2 American Concrete Institute (ACI) 440.2R-08, "Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures."
- 3.3 American Concrete Institute (ACI) 546R-04 "Concrete Repair Guide."
- 3.4 International Concrete Repair Institute (ICRI) Guideline 310.1R-2008 "Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion."
- 3.5 International Concrete Repair Institute (ICRI) Guideline 310.2-1997 "Selecting and Specifying concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays."
- 3.6 International Concrete Repair Institute (ICRI) Guideline 320.2R-2009 "Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces."

4.0 WORK AREA & TECHNICIAN PREPARATION

- 4.1 Collect all necessary tools, materials and documentation required to complete the work including plans, specifications, product data sheets, and instructions.
- 4.2 Post all Safety Plans and Material Safety Data Sheets (MSDS) in a conspicuous area.
- 4.3 Prepare a work area sufficient to complete the project and protect all surfaces to remain with plastic sheeting.
- 4.4 Don protective clothing, gloves, respirators, and/or dust masks as required for the work and materials used. Read the instructions and MSDS for each product to determine what protective gear to use.
- 4.5 See that the right products of the appropriate quantity are available at the site.
- 4.6 For best results and workability, have epoxy components placed in a conditioned space at 75°F (24°C) for 24 hours prior to use. Keep Fortress Stabilization products in their original container, clean, and dry prior to use.

5.0 SURFACE PREPARATION

5.1 CONCRETE

- 5.1.1. SURFACES MUST BE CLEAN, SOUND, AND DRY. Substrate temperatures shall comply with the epoxy resin used.
- 5.1.2. Where bond of the FRP to the concrete substrate is required for structural performance (Bond-Critical applications), remove paint, grease, wax, oil, and any other films or coatings by mechanical means or with an appropriate solvent. Remove dust, laitance and debris.
- 5.1.3. Sound the substrate to which FRP products will be applied to identify areas of delamination, spalling or otherwise unsound concrete.
- 5.1.4. Remove unsound concrete in accordance with ICRI 310.1R-2008. Grinding, chipping, scarifying, shot blasting, sand blasting, or water jet are all acceptable methods. If corroded steel reinforcing exists, repair or replace per ICRI 310.1R-2008 and engineer prior to application of patching material. **DO NOT COVER CORRODED REINFORCING STEEL OR UNSOUND CONCRETE WITH FRP PRODUCTS.**
- 5.1.5. Remove all weak, contaminated or deteriorated concrete, asphaltic or bituminous materials, oils, dirt, rubber, curing compounds, paint, carbonation, laitance, and any other potentially detrimental materials
- 5.1.6. Use oil-free compressed air to remove any dust debris immediately prior to application of epoxy resins or patching mixtures.
- 5.1.7. Cracks in the concrete substrate greater than 0.010 in (0.3 mm) wide must be injected with an approved epoxy in accordance with ACI 224.1R-07.

- 5.1.8. For Bond Critical applications, the surface of the substrate must be prepared using abrasive blasting and/or disc grinding to a minimum profile of ICRI CSP 3 as described by ICRI 310.2-1997.
- 5.1.9. Uneven surface irregularities, out of plane variations including form lines must be ground and smoothed to less than 0.04 in (1 mm).
- 5.1.10. Where fibers are intended to wrap around the corners of rectangular sections, the corners shall be rounded to a minimum of 0.5 inch (13 mm). No corner rounding is required if fibers are intended to run parallel to corners.

5.2 MASONRY

- 3.2.1. SURFACES MUST BE CLEAN, SOUND, AND DRY. Substrate temperatures shall comply with the epoxy resin used.
- 3.2.2. For Bond-Critical applications, remove paint, grease, wax, oil, and any other films or coatings by mechanical means or with an appropriate solvent. Remove dust, laitance and debris. Grinding, chipping, scarifying, shot blasting, sand blasting, or water jet are all acceptable methods.
- 3.2.3. Avoid excessive removal of mortar during abrasive blasting.
- 3.2.4. Cracks in the masonry substrate greater than 0.010 in (0.3 mm) wide must be injected with an approved epoxy in accordance with ACI 224.1R-07.
- 3.2.5. Uneven surface irregularities, out of plane variations must be ground and smoothed to less than 0.04 in (1 mm).
- 3.2.6. Where fibers are intended to wrap around the corners of rectangular sections, the corners shall be rounded to a minimum of a 0.5 inch (13 mm) radius. No corner rounding is required if fibers are intended to run parallel to corners.

4.0 EPOXY RESINS

- 4.1 All epoxy resins including primers, fillers, saturants, and protective coatings are supplied in two component parts that required thorough mixing prior to application.
- 4.2 Prepare each two-part epoxy in accordance with its instructions. Constituent parts must be accurately metered and thoroughly mixed. Do not dilute with solvents.
- 4.3 Do not apply epoxy in ambient temperatures of less than 40 °F (4 °C). If needed, use exterior heating sources to heat the work area and substrate to temperatures between 40 °F (4 °C) and 80 °F (27 °C).
- 4.4 Mix only the quantity of primer that can be used within its pot life. Pot life will be reduced in higher temperatures and when mixed in higher volumes. Do not use any epoxy that has exceeded its pot life. Keep containers closed when not in use.
- 4.5 For best results, condition the components to 75 °F (24 °C) for 24 hours prior to mixing. For epoxy supplied in cartridges, use the attached static mixer. No further mixing is required.
- 4.6 Accurately mix component parts. Stir each component prior to blending. Proportion each component part in the quantity specified into a clean container with flat wall and bottom. Mix thoroughly for a minimum of three (3) minutes using a low speed drill (400-600 rpm) and a mixing paddle (e.g. a Jiffy® or Plunge Mixer™). Keep the paddle below the surface of the material to avoid entrapment of air. CAUTION: WEAR EYE PROTECTION.
- 4.7 Carefully transfer the mixture into a second, clean container. Scrape the sides and bottom of the first container into the second. Mix for another 90 seconds. The epoxy is thoroughly mixed when the color of the mixture is uniform, without streaking. CAUTION: PROLONGED EXPOSURE TO EPOXY CAN CAUSE SKIN IRRITATION.

5.0 PRIMER APPLICATION

- 5.1 Apply primer only after preparing the substrate as directed above.
- 5.2 All surfaces must be clean, dry and free of all dust and debris.
- 5.3 Prime the substrate with Fortress #4550 LPL or #1276 Hi-Modulus Fiber Matrix epoxy resin using a rate of approximately 160 ft²/gal, about a thickness of 10 mils (3.9 m²/L, 0.25mm) to the prepared substrate to seal the surface and to provide a tacky surface to apply the Strap or Laminate product. The primer resin will tack at 30 minutes at 70 °F (21 °C).

- 5.4 Apply the primer to surfaces that will receive FRP products with a medium nap roller or non-shedding brush. Where the primer is absorbed by the substrate and especially mortar lines in masonry, apply a second coat. Apply the primer only to substrates that will receive filler or FRP products within one (1) hour.
- 5.5 The FRP reinforcement must be applied to the substrate while the primer is still tacky. Do not allow primer to cure or blush (initial set) prior to filler or FRP reinforcement installation.

6.0 FILLER MATRIX APPLICATION

- 6.1 All surfaces must be primed prior to application of the filler. Primer which has cured for over 24 hours or where amine blush (described in Section 10.0, below) has occurred must be abraded by light sandblasting, sandpaper, or abrasive pad.
- 6.2 Use Fortress #1276 Hi-Modulus Fiber Matrix epoxy resin to fill voids, mortar lines, bug holes, and other out-of-plane variations.
- 6.3 Apply filler to surface voids using a steel or stiff plastic trowel or spatula. Ensure all voids and offsets are completely filled and excess filler is removed. Broadcast silica sand on epoxy patches to avoid amine blush.
- 6.4 Avoid allowing filler to cure or blush prior to FRP reinforcement application. Apply filler only to substrates that will receive FRP products within one (1) hour.

7.0 APPLICATION

- 7.1 All surfaces must be prepared, primed and where needed, filled as described above. Primer and filler which have cured over 12 hours must be abraded with light sandblasting, wet sanding or other abrasive methods to remove amine blush and to create a suitable bonding surface.
- 7.2 Cut Strap or Laminate to required lengths and widths and label clearly prior to application of epoxy.
- 7.3 Use Fortress #4550 LPL or Fortress #1276 Hi-Modulus Fiber Matrix epoxy for all applications. Prepare the epoxy in accordance with Section 4.0, above. For best results, the epoxy shall be applied to both the substrate and the Strap or Laminate.
- 7.4 Apply epoxy resin to the substrate at a uniform rate of approximately 45 ft²/gal or 1.1 m²/L (approximately 35 mils or 0.9 mm thick). Coverage yield will vary with substrate roughness.
- 7.5 Apply epoxy resin to the side of the Strap or Laminate facing the substrate at a uniform rate of approximately 100 ft²/gal or 2.5 m²/L (approximately 15 mils or 0.4 mm thick).
- 7.6 Using gloved hands and a plastic laminating roller, press Fortress Strap or Laminate into the resin pressing out any wrinkles and air voids. For grid strap applications, allow the resin to squeeze through the grid openings to assure complete coverage and a proper bond.
- 7.7 For a single Strap or Laminate layer or for the final layer of a multiple layer application, apply an epoxy resin top coat at a rate of approximately 160 ft²/gal or 3.9 m²/L (approximately 10 mils or 0.25 mm thick) while the base resin is still within its working limit (depending on temperature) and smooth for a finished appearance.
- 7.8 If more than one layer of Strap or Laminate is used, apply intermediate epoxy resin layer at a rate of approximately 100 ft²/gal or 2.5 m²/L (approximately 15 mils or 0.4 mm thick).
- 7.9 A good measure for dry lay-up applications will use approximately twice the weight of resin to textile.
- 7.10 Protect the installed Strap or Laminate from inclement weather, nuisance water, dust, and debris for 24 hours.

8.0 SPLICES, TERMINATIONS AND ANCHORS

9.1 SPLICES

- 9.1.1. If allowed under the project specifications, lap splices may be used to splice multiple lengths of Strap or Laminate to create a long span.
- 9.1.2. Lap splices shall match the direction and orientation of the fibers.
- 9.1.3. Lap the Strap or Laminate the minimum length as described in the project plans and specifications.
- 9.1.4. Lap splices on multiple layer applications shall be offset a minimum distance as described in the plans and specifications.

9.2 TERMINATIONS

9.2.1. Straps or Laminates shall be terminated at the point shown on the plans and specifications. On multiple layer applications, termination points of plies shall be tapered. Successive plies shall be terminated not less than 6 inches (150 mm) from the point of termination of the previous ply or as shown on the project plans.

9.2.2. Termination anchors shall be installed where specified.

9.3 PRE-CURED ANCHORS

9.3.1. Anchors should be installed between FRP layers where called for on the project plans or specifications.

9.3.2. Cut a saw kerf 2-1/2 inches (63 mm) wide and 1/2 inch (13 mm) deeper than the embedment depth of the anchor.

9.3.3. Use oil-free, compressed air to clean saw kerf of all dust.

9.3.4. Use Fortress #4020 Epoxy Gel to install the anchor. Using the static mixer on the two-barrel cartridge, fill the saw kerf 80 percent full with the Epoxy Gel. Spread the Epoxy Gel onto the surface receiving the anchor to a thickness of 40 mils (1 mm).

9.3.5. On a clean, plastic covered work surface, coat the anchor with Fortress #4020 Epoxy Gel ensuring all fibers are thoroughly saturated.

9.3.6. Insert one end of the anchor fully into the saw kerf and remove excess adhesive. Press the anchor into the Epoxy Gel on the surface allowing the resin to squeeze through the anchor. Smooth out the excess and add more Epoxy Gel, if needed, so that the anchor is covered with 10 mils (0.25 mm) of resin.

9.3.7. Install additional layers of Strap or Laminate if specified.

10.0 AMINE BLUSH

10.1 REMOVE AMINE BLUSH PRIOR TO SUCCESSIVE APPLICATIONS OF EPOXY RESINS OR STRAPS AND LAMINATES. Amine Blush is the phenomenon where a wax-like or greasy film on the surface of the cured epoxy is formed where certain temperatures and humidity exist during the cure of epoxy resins.

10.2 An Amine blush is usually formed after the initial set of the epoxy. AMINE BLUSH CAN HINDER THE ADHESION OF A SUCCESSIVE APPLICATION OF EPOXY. If the blush is slight it may be hard to detect visually or by touch. Blush will be more noticeable in cool, damp or humid conditions.

10.3 Remove amine blush before applying additional layers of epoxy. If a second layer of epoxy cannot be applied within 12 hours after the previous application, remove any blush that may have occurred. Light sandblasting between epoxy coats is the recommended procedure for surface preparation to remove blush or contaminants that may create inter-coat adhesion problems. Amine blush may also be removed by wet sanding.

10.4 Some amine blushes may be water soluble. Test with a soap and water pressure wash at a minimum 750 psi with sufficient Dawn® dishwashing detergent (usually 2-3%) to remove and clean the surface of contaminants. As an alternative, manually scrub the surface between applications with a soap and water solution of Dawn® dishwashing detergent. Rinse with plenty of fresh water to thoroughly remove the dissolved blush and allow to dry completely before application of the next layer of epoxy. Do not use solvents to remove the blush.

10.5 Evaluate a small test area of successive epoxy applications for proper preparation and bond before proceeding with a full scale operation.

11.0 QUALITY CONTROL AND QUALITY ASSURANCE

11.1 Supervision

11.1.1. Preparation of substrates and installation of Straps and Laminates shall be performed and supervised by a Fortress Stabilization Systems trained and approved installer.

11.1.2. The supervisor on site shall inspect all materials, including Strap and Laminate products, epoxy components and epoxy mixtures, and all progress of the work to ensure a carefully prepared substrate, prevention or removal of amine blush, thorough epoxy coating of the substrate and Strap or Laminate, continuous contact between plies and the substrate, accurate alignment of fibers and location of lap splices and terminations.

11.2 Inspection

- 11.2.1. Allow at least 24 hours for resins to cure prior to final inspection. Perform a visual and sounding inspection of the Strap and Laminate surfaces, noting the size and number of delaminations or voids encountered.
- 11.2.2. Delaminations or voids should be marked and categorized.
- 11.2.3. The bond strength of the Strap or Laminate to the substrate may be verified by pull testing per ASTM D4541. The minimum strength required of a pull-off test is 200 psi (1.4 MPa).
- 11.2.4. Pull-off test locations may be patched by first filling the void with Fortress #4550 LPL or Fortress #1276 Hi-Modulus Fiber Matrix epoxy and repaired as described in Section 12.0, below.
- 11.2.5. Perform strength tests of field sample or witness panels if required in the project plans and specifications.

12.0 REPAIRS

- 12.1 Small delaminations less than 2 in² (1,300 mm²) may remain as they are unless there are more than 10 such delaminations in 10 ft² (1 m²) and if the sum of the small delamination areas is less than 5 percent of the total laminate area.
- 12.2 Large delaminations greater than 25 in² (16,000 mm²) should be repaired by cutting away the affected sheet and applying an overlapping patch of equivalent plies.
- 12.3 Delaminations less than 25 in² (16,000 mm²) should be repaired by injection with resin or by cutting and replacing with overlapping patches depending on the size and number of delaminations.
- 12.4 Patches shall overlap a minimum of 6 inches (150 mm) in the direction of the fibers, unless described otherwise in the project plans and specifications.

13.0 QUALIFICATIONS

- 13.1 This document may be referenced to assist the owner and engineer-of-record in the preparation of project plans and specifications
- 13.2 The project owner and/or the engineer-of-record may modify or approve other procedures than that described herein. All installations shall be completed in accordance with the project plans and specifications as published by the project owner and/or engineer-of-record.

The information contained herein is included for illustrative purposes only and is, to the best of our knowledge, accurate and reliable. Fortress Stabilizations Systems (Fortress) cannot however under any circumstances make any guarantee of results or assume any obligation or liability in connection with the use of this information. As Fortress has no control over the use to which others may put its product, the products are to be tested to determine if suitable for a specific application and to verify if our information is valid for a particular application. Responsibility remains with the specifier, contractor, installer, user, and owner for the design, application and proper installation of each product. Fortress reserves the right to change the properties of its products without notice. **Prior to each use of any Fortress product, the user must always read, understand, and follow the warnings and instructions on the product's most current Technical Product Data Sheet, product label and Material Safety Data Sheet available at www.FortressStabilization.com.**



+1 800-207-6204 <http://www.FortressStabilization.com> 184 West 64th Street, Holland, Michigan 49423 USA

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APPENDIX B

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BUREAU VERITAS
Certification



Certification

Awarded To

ZOLTEK CORPORATION

HQ: 3101 MCKELVEY RD., ST. LOUIS, MISSOURI, USA

SITE 1: 11 MISSOURI RESEARCH PARK (MRP), ST. LOUIS, MISSOURI, USA

SITE 2: 1221 FULWILER ROAD, ABILENE, TEXAS, USA

Bureau Veritas Certification North America, Inc. certifies that the management system of the above organization has been audited and found to be in accordance with the requirements of the management system standards and scope of supply detailed below

STANDARDS

ISO 9001:2008 AND AS9100-B IN ACCORDANCE WITH AS9104A

Bureau Veritas Certification North America, Inc. is accredited under the
Aerospace Registrar Management Program

SCOPE OF SUPPLY

THE PRODUCTION OF CARBON FIBERS FOR COMPOSITE REINFORCEMENT AND OXIDIZED PAN FOR VARIOUS INDUSTRIAL USES

Original Approval Date: 09 September 2009

Subject to the continued satisfactory operation of the Organization's Management System, this certificate will remain valid until: 08 September 2012

Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organization.

Certificate No: US 09000636

Issue Date : 09 September 2009

For Bureau Veritas Certification North America, Inc.
3663 North Sam Houston Pkwy, Houston, Texas, USA
www.us.bureauveritas.com/bvc

