DYMAT CONSTRUCTION PRODUCTS INC.
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DYMAT® BT FRP SYSTEM

CSI Sections:
03 01 00 Maintenance of Concrete
04 01 20 Maintenance of Unit Masonry

1.0 RECOGNITION

This report recognizes that DYMAT® BT FRP System has been evaluated by IAPMO UES in accordance with ICC-ES AC125. DYMAT® BT FRP System recognized in this report has been evaluated for use to strengthen concrete and masonry structural elements. The structural, weather protection, interior finish, and toxicity performance properties of the DYMAT® BT FRP System comply with the provisions of the following codes and regulations:

- 2018, 2015, 2012, 2009, and 2006 International Building Code® (IBC)
- 2018, 2015, 2012, 2009, and 2006 Uniform Plumbing Code ® (UPC)
- 2018, 2015, 2012, 2009, and 2006 International Plumbing Code ® (IPC)
- ICC-ES AC125
- 2019 California Building Code® (CBC) – attached Supplement
- California Lead Plumbing Law, Section 116875 of California Health and Safety Code – attached Supplement
- 2020 City of Los Angeles Building Code (LABC) – attached Supplement

2.0 LIMITATIONS

Use of the DYMAT® BT FRP System recognized in this report is subject to the following limitations:

2.1 The DYMAT® BT FRP System shall be installed in accordance with the applicable code, the manufacturer's published installation instructions, and this report. Where there is a conflict, the more restrictive requirements shall govern.

2.2 Plans and calculations shall be submitted to the building official for each project at the time of permit application. The plans and calculations shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

2.3 Special inspections for jobsite application of the DYMAT® BT FRP System shall be provided in accordance with Section 3.5 of this report.

2.4 The DYMAT® DCF-D Fire-Resistance-Rated assemblies are described in Section 3.3.3.4 of this report.

2.5 The DYMAT® BT FRP System recognized in this report is produced by DYMAT® Construction Products Inc. in La Conner, WA.

3.0 PRODUCT USE

3.1 General: The DYMAT® BT FRP System is used to strengthen concrete and masonry structural elements.

3.2 Design: The DYMAT® BT FRP System shall be designed to resist tensile forces while maintaining strain compatibility between the FRP and the concrete or masonry substrate. The strength design requirements for concrete or masonry shall be in accordance with Chapter 19 or 21 of the IBC, respectively. The owner and registered design professional shall be responsible for determining, through analysis, the capacities and demands of the structural elements to be strengthened by the DYMAT® BT FRP System, subject to the approval of the building official.

3.2.1 Composite Design Properties: Structural design properties for the DYMAT® BT FRP System are found in Research Report 2000-3, Department of Civil Engineering, University of Canterbury Christchurch, New Zealand – Retrofit of Reinforced Concrete Members Using Advanced Composite Materials by Yung-Chih Wang, Jose I. Restrepo, and Robert Park, dated February 2000 (referenced in this report as Research Report 2000-3).

3.2.2 Design Details: Design equations described in the Research Report 2000-3 are based on test results and principles of structural analysis. Bases of design include strain compatibility, load equilibrium, and limit states. All design shall comply with the requirements set forth in the IBC and in Research Report 2000-3.

3.2.3 Load Combinations: The LRFD load combinations used in the design shall comply with Section 1605.2 of the IBC. Strength reduction factors shall comply with Chapter 19 of the IBC (ACI 318) for concrete or Chapter 21 of the IBC (TMS 402) for masonry.

3.2.4 Columns:

3.2.4.1 Potential Applications: The DYMAT® BT FRP System is applied to columns to enhance their ductility and their axial, flexural, and shear strengths, and for confinement of lap splices of steel reinforcement.

3.2.4.2 Structural Design Requirements: Concrete column design shall comply with Chapter 19 of the IBC (ACI 318) and Research Report 2000-3. Masonry column design shall comply with Chapter 21 of the IBC (TMS 402).

3.2.5 Beams and Slabs:

3.2.5.1 Potential Applications: The DYMAT® BT FRP System is applied to beams to enhance their ductility and their flexural and shear strength; or to slabs to enhance flexural and in-plane shear and punching shear strengths. Slab flexural design shall be limited to gravity load resistance only.

3.2.5.2 Structural Design Requirements: Concrete design shall comply with Chapter 19 of the IBC (ACI 318) and Research Report 2000-3.

3.2.6 Walls and Wall-Slab Connections:

3.2.6.1 Potential Applications: The DYMAT® BT FRP System is applied to concrete walls to enhance out-of-plane flexural, in-plane flexural and shear strengths; or masonry walls or lintels to enhance out-of-plane flexural and in-plane flexural strengths.

3.2.6.2 Structural Design Requirements: Concrete design shall comply with Chapter 19 of the IBC (ACI 318) and Research Report 2000-3. Masonry design shall comply with Chapter 21 of the IBC (TMS 402).

3.2.7 Beam-to-Column Joints:

3.2.7.1 Potential Application: The DYMAT® BT FRP System is applied to concrete to enhance shear strength on the beam-column joints and allow ductile flexural hinge to develop in the beam.

3.2.7.2 Structural Design Requirements: Concrete beam-to-column joint design shall comply with Chapter 19 of the IBC (ACI 318) and Research Report 2000-3.

3.2.8 Bond Strength: Where the bond is critical to system design, the bond strength of the system applied to a properly prepared surface shall exceed the tensile strength of the substrate. Bond strength shall be at least 200 psi (1378 kPa) for concrete or at least $2.5(f'_m)^{1/2}$ for masonry. The number of tests and test locations shall be specified by the registered design professional and approved by the building official. Bond testing shall exhibit failure in the concrete or masonry substrate. Testing in accordance with ASTM C297 or ASTM D7234 may be used to estimate the bond strength of bond-critical installations.

3.3 Installation: Installation of the DYMAT® FRP System shall be by DYMAT® trained and certified applicators. Installation of the system shall be in accordance with the manufacturer's published installation instructions.

3.3.1 Saturation: The fibers and the matrix shall be combined in accordance with an established weight-and-volume ratio, using the calibrated DYMAT® Saturator or manual methods.

3.3.2 Application: The saturated composite fabric shall be applied to the concrete or masonry substrates using hand-applied methods. The use of a roller or hand pressure shall be used to remove air bubbles and to ensure that each individual layer is firmly bedded and adhered to the preceding layer or substrate. Pot life of the saturated fabric is four to six hours at 70°F (21.1°C) and varies with temperature; higher temperatures result in a lesser pot life, and lower temperatures result in a longer pot life.

3.3.3 Finishing: A final coat of thickened DYMAT® D Epoxy shall be applied as described in Section 4.2.2.2 of this report and may be coated with one of the following:

3.3.3.1 Paint: Paint may be applied as required for weather protection and aesthetic considerations.

3.3.3.2 Flame-spread Coatings: Where required to comply with the IBC for interior finish, the DYMAT® DCF-D Fire-Resistant coating shall be applied in combination with the DYMAT® BT FRP System or the DYMAT® D Epoxy System. The system provides Class A flame spread and a smoke developed index in accordance with Section 803.1 of the IBC. The first part is the DYMAT® DCF Basecoat, applied at 2 lbs/yd^2 (1.1 kg/m^2), approximately 0.8 mm (.0315 in) thick. The second part is DYMAT® D Coat, a thin coating applied by brush, roller, or spray in three coats to 0.36 lbs/yd^2 (0.2 kg/m^2) per coat.

3.3.3.3 Health Effects Exposure: The DYMAT® BT System using DYMAT® D resin and DYMAT® DHC fabric complies with Sections 604.1 and 607.2 of the 2018, 2015, and 2012 UPC and Section 604.1 of the 2009 and 2006 UPC; Section 605 of the International Plumbing Code (IPC) and may be in contact with potable water based on testing in accordance with Section 5 of NSF 61-2017. The DYMAT® D epoxy shall be applied over the DYMAT® DHC Fabric to a total dry film thickness of 0.072 inches (1.83 mm). Surfaces include concrete, masonry, and steel. All surfaces shall be clean, dry, and free of contaminants. In service temperatures are -40°F (-40°C) to 120°F (49°C). Mixing and application shall comply with DYMAT Construction Products Inc. Installation Manual.

3.3.3.4 Fire-resistance-rated Assemblies:

3.3.3.4.1 DYMAT® DCF-D Fire-Resistant System: The use of the DYMAT® DCF-D Fire Resistant System complies with up to a two-hour fire-resistance rating in load-bearing walls constructed as described in Section 3.3.3.4.2 of this report. The concrete masonry unit surface shall be coated with DYMAT® D Epoxy at an application rate of 0.0589 lb/ft^2 (0.288 kg/m^2). Three layers of DYMAT® DHE-272 fiberglass fabric shall be saturated with DYMAT®

D Epoxy matrix and applied at a rate of 0.623 lb/ft^2 (3.04 kg/m^2) on both sides of the concrete masonry unit assembly and allowed to cure for two hours minimum. The DYMAT® DCF Basecoat shall be applied over the DYMAT® DHE-272 fiberglass fabric at a rate of 0.211 lb/ft^2 (1.03 kg/m^2) and allowed to cure for eight hours minimum. The concrete masonry unit surface is finished with DYMAT® RealRock applied at a rate of 0.0567 lb/ft^2 (0.28 kg/m^2) over the DYMAT® DHE-272 fiberglass fabric.

3.3.3.4.2 Masonry Wall: The DYMAT® DCF-D System described in Section 3.3.3.4.1 of this report shall be applied to masonry walls with minimum nominal 8-inch (203 mm) wide concrete masonry units. The fire-resistance rating for walls with concrete masonry units shall comply with Item 3 in Table 721.1(2) of the 2018, 2015, and 2012 IBC (Table 720.1(2) of the 2009 and 2006 IBC). The masonry wall is strengthened with DYMAT® DHE-272 glass fiber composite. The strength of the wall shall be calculated in accordance with Chapter 21 of the IBC and shall not be increased with the application of DYMAT® BT FRP System.

3.4 Cure Time Prior to Loading: The DYMAT® DCF composites shall be allowed to cure for a minimum of 72 hours at an average temperature of 70°F (21.1°C) prior to loading the structural member.

3.5 Special Inspection: Special Inspection shall comply with the applicable requirements in Sections 1704 through 1707 of the 2018, 2015, and 2012 IBC; or Sections 1704 through 1709 of the 2009 and 2006 IBC, as applicable. Special inspection during the installation of the system shall be in accordance with AC178, Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems, dated October 2017 (editorially revised December 2017).

4.0 PRODUCT DESCRIPTION

4.1 General: The DYMAT® BT FRP System is an externally bonded fiber-reinforced polymer (FRP) applied to strengthen normal-weight concrete and masonry substrates. The system consists of carbon and glass fabrics combined with resins which, in combination, create the FRP composite system.

4.2 Materials

4.2.1 DYMAT® DHC-190 and DHC-410 2X

4.2.1.1 DYMAT® DHC-190 and DHC-410 2X Fabrics: The DYMAT® DHC-190 and DHC-410 2X fabrics are composed of unidirectional carbon fibers. Standard rolls measuring 300 feet (91.4 m) long by 24 inches (610 mm) wide for DYMAT® DHC-190 and DHC 410 2X fabrics are shipped in individual boxes. The fabric weight is 19 oz/yd^2 (644 g/m^2).

4.2.1.2 DYMAT® DHC Epoxy Matrix: The DYMAT® DHC Epoxy is a two-component epoxy matrix used to strengthen the fibers. The DYMAT® DHC Epoxy comes in 55-gallon (208 L) drums or in 5-gallon (19 L) containers. For a standard 4-gallon (15.1 L) unit, 2.96 gallons (11.2 L) of Component A and 1.04 gallons (3.94 L) of Component B shall be blended by Volume. This mixture is 28.7 lbs (13.0 kg) of Component A to 8.2 lbs (3.7 kg) of Component B for a total of 36.9 lbs (16.7 kg) by weight. This mixture shall be blended thoroughly for five minutes with a low-speed mixer at 400 to 600 rpm until uniformly blended. Pot life is four to six hours at 70°F (21.1°C).

4.2.1.3 DYMAT® DHC Composites

4.2.1.3.1 DYMAT® DHC-190 Composite: In the primary direction (0°), the carbon fiber composite has a minimum ultimate tensile strength of 200 ksi (1379 MPa), a minimum tensile modulus of 15,000 ksi (103 GPa), and an elongation of 1.30 percent. Layer thickness is 0.036 in (0.91 mm).

4.2.1.3.2 DYMAT® DHC 410 2X Composite: In the primary direction (0˚), the carbon fiber composite has a minimum ultimate tensile strength of 200 ksi (1379 MPa), a minimum tensile modulus of 15,000 ksi (103 GPa), and an elongation of 1.30 percent. Layer thickness is 0.072 inch (1.82 mm).

4.2.2 DYMAT® DHE-272

4.2.2.1 DYMAT® DHE-272 Fabric: The DYMAT® DHE-272 fabric is composed of unidirectional glass fibers. Standard rolls measuring 169 feet (51.5 m) long by 24 inches (610 mm) wide for DYMAT® DHE-272 are shipped in individual boxes. The fabric weight is 27.2 oz/yd^2 (922 g/m^2).

4.2.2.2 DYMAT® D Epoxy: The DYMAT® D Epoxy is a two-component epoxy matrix used to strengthen the fibers. The DYMAT® D Epoxy comes in 55-gallon (208 L) drums or in 5-gallon (19 L) containers. For a standard 4-gallon (15.1 L) unit, 2.96 gallons (11.2 L) of Component A and 1.04 gallons (3.94 L) of Component B shall be blended by Volume. This mixture is 28.7 lbs (13.0 kg) of Component A to 8.2 lbs (3.7 kg) of Component B for a total of 36.9 lbs (16.7 kg) by weight. This mixture shall be blended thoroughly for five minutes with a low-speed mixer at 400 to 600 rpm until uniformly blended. Pot life is four to six hours at 70°F (21.1°C)

4.2.2.3 DYMAT® DHE-272 Composite: In the primary direction (0°), the glass fiber composite has a minimum ultimate tensile strength of 110 ksi (759 MPa), a minimum tensile modulus of 5,000 ksi (34.5 GPa), and an elongation of 2.2 percent. Layer thickness is 0.035 inch (0.89 mm).

4.2.3 DYMAT® DCB Fabric

4.2.3.1 DYMAT® DCB Fabric: The DYMAT® DCB fabric is composed of bidirectional glass fibers. Standard rolls

measuring 600 feet (183 m) long by 24 inches (610 mm) wide for DYMAT® DCB are shipped in individual boxes. The fabric weight is 24 oz/yd^2 (814 g/m^2).

4.2.3.2 DYMAT® D Epoxy: The DYMAT® D Epoxy is as described in Section 4.2.2.2 of this report.

4.2.3.3 DYMAT® DCB Glass Composite: In both directions (±45˚), the glass fiber composite has a minimum ultimate tensile strength of 32 ksi (221 MPa), a minimum tensile modulus of 2,160 ksi (14.9 GPa), and a corresponding elongation of 1.2 percent. Layer thickness is 0.034 inch (0.86 mm).

4.2.4 DYMAT® DEWBC

4.2.4.1 DYMAT® DEWBC Fabric: The DYMAT® DEWBC fabric is composed of bidirectional carbon fibers. Standard rolls measuring 375 feet (114 m) long by 50 inches (1270 mm) wide for DYMAT® DEWBC Fabric are shipped in individual boxes. The fabric weight is 8.7 oz/yd^2 (295 g/m^2).

4.2.4.2 DYMAT® D Epoxy: The DYMAT® D Epoxy is as described in Section 4.2.2.2 of this report.

4.2.4.3 DYMAT® DEWBC Composite: In both directions (45°), the carbon fiber composite has a minimum ultimate tensile strength of 120 ksi (828 MPa), a minimum tensile modulus of 6,600 ksi (45.5 GPa), and an elongation of 1.88 percent. Layer thickness is 0.034 in (0.86 mm).

4.3 DYMAT® DCF Basecoat: The DYMAT® DCF Basecoat is a two-component epoxy material. The first component is applied at 1.1 kg/m^2 (2 lbs/yd^2), approximately 0.8 mm (0.32 in) thick. The second part is a thin coating applied in three coats to 0.04 lb/ft^2 (0.2 kg/m^2).

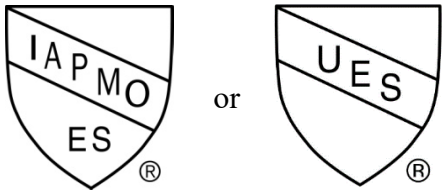
4.4 DYMAT® RealRock: The DYMAT® RealRock is an acrylic-based liquid material with natural stone, is packaged in 3½ -gallon (13.2 L) containers and used as a final coating.

4.5 Storage Recommendations: For the epoxy, coatings, and fibers, water contamination and temperature below 40°F (4°C) or above 90°F (32°C) shall be avoided. Storage life shall not exceed one year for the coating, two years for the epoxy, and ten years for the fabric.

5.0 IDENTIFICATION

The DYMAT® BT FRP system components shall be labeled in accordance with the DYMAT® Construction Products name and address, product name, expiration date, and the evaluation report number (ER-663).

Either IAPMO UES Mark of Conformity may also be used as shown below:



IAPMO UES ER-663

6.0 SUBSTANTIATING DATA

6.1 Data in accordance with ICC-ES AC125, Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems, dated August 2014 (editorially revised November 2017).

6.2 Research Report 2000-3, Department of Civil Engineering University of Canterbury Christchurch, New Zealand – Retrofit of Reinforced Concrete Members Using Advanced Composite Materials by Yung-Chih Wang, Jose I. Restrepo, and Robert Park, dated February 2000.

6.3 A. Ghobarah and A. Said (2000): "Seismic Rehabilitation of Beam-Column Joints using FRP Laminates," Department of Civil Engineering, McMaster University, Hamilton, Ontario, Canada.

6.4 Reports of testing in accordance with ASTM E119.

6.5 Test reports are from laboratories in compliance with ISO/IEC 17025.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on DYMAT® BT FRP System to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification. DYMAT® BT FRP System is manufactured at the location noted in Section 2.5 of this report under a quality control program with periodic inspections under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

CALIFORNIA SUPPLEMENT

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1.0 RECOGNITION

DYMAT® BT FRP System described in ER-663 and this supplement has been evaluated for use to strengthen concrete and masonry structural elements. DYMAT® BT FRP System has been evaluated for structural, weather protection, interior finish, and toxicity performance properties subject to the requirements in ER-663 and this supplemental report. DYMAT® BT FRP System complies with the provisions of the following codes and regulations:

- 2019 California Building Code® (CBC)
- California Lead Plumbing Law, Section 116875 of California Health and Safety Code.

2.0 LIMITATIONS

Use of the DYMAT® BT FRP System recognized in this supplement is subject to the following limitations:

2.1 The DYMAT® BT System using DYMAT® D epoxy and DYMAT® DHC fabric complies with Section 116875 (AB1953) of the California Health & Safety Code based on testing in accordance with the requirement of NSF/ANSI 372-2016, Drinking Water System Components – Lead Content.

2.2 The DYMAT® BT System is permitted to strengthen existing concrete structures as set forth in Sections 1911.3 and 1911.A3 of the CBC.

2.3 The DYMAT® BT System has not been evaluated in accordance with Chapter 7A of the CBC for use in the exterior design and construction of new buildings located within a Wildland-Urban Interface Fire Area.

2.4 The DYMAT® BT System has not been evaluated for compliance with the International Wildland-Urban Interface Code.

2.5 This supplement expires concurrently with ER-663.

CITY OF LOS ANGELES SUPPLEMENT

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1.0 RECOGNITION

DYMAT® BT FRP System described in ER-663, the California Supplement to ER-663, and this supplement has been evaluated for use to strengthen concrete and masonry structural elements. DYMAT® BT FRP System has been evaluated for structural, weather protection, interior finish, and toxicity performance properties subject to the requirements in ER-663, the California Supplement to ER-663, and this supplemental report. DYMAT® BT FRP System complies with the provisions of the following codes and regulations:

- 2020 City of Los Angeles Building Code (LABC)

2.0 LIMITATIONS

Use of the DYMAT® BT FRP System recognized in this supplement is subject to the following limitations:

2.1 The design and installation of the DYMAT® BT FRP System shall be in accordance with ER-663, the manufacturer's published installation instructions and the City of Los Angeles Building Code. Where conflicts occur, the more restrictive shall govern.

2.2 Prior to installation, calculations and details demonstrating compliance with ER-663 and the LABC shall be submitted to the structural plan check section for review and approval. The calculations and details shall be prepared by a registered design professional, licensed in the State of California.

2.3 Special Inspections shall be provided by the Registered Deputy Inspector in accordance with Sections 1704 through 1707 of the 2020 LABC, as applicable during the installation of the DYMAT® BT System.

2.4 The design and installation of the DYMAT® BT FRP System shall be in accordance with Chapters 16 and 17 of the 2020 LABC.

2.5 The DYMAT® BT System is permitted to strengthen existing concrete structures as set forth in Sections 1911.3 and 1911.A3 of the 2020 LABC.

2.6 The DYMAT® BT System is permitted to strengthen existing unreinforced masonry structures as set forth in Chapter A1 of the 2020 City of Los Angeles Existing Building Code.

2.7 The DYMAT® BT System is permitted to be used on the exterior side of concrete or masonry exterior walls without additional weather protection. However, the site-specific exposure conditions shall be evaluated by the registered design professional for each application.

2.8 This supplement expires concurrently with ER-663.