SECTION 03 49 00

GLASS FIBER REINFORCED CONCRETE (GFRC)

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\*\* NOTE TO SPECIFIER \*\* DeVinci Precast LLC; Architectural Stone, Precast, Cast Stone and GFRC.
This section is based on the GFRC products of DeVinci Precast LLC, located at:
4520 MacArthur Blvd.
Oklahoma City, OK 73179
Tele: (405) 680-5600
Email: info@devinciprecast.com
Web: <https://devinciprecast.com>
[Click Here] for additional information.
DeVinci has been producing GFRC, cast stone and architectural precast sinceCurrently located on a 6+ acre complex with over 32,000 sq. ft. of indoor manufacturing, DeVinci continues to be a leader in the cast stone and GFRC industry through innovation, craftsmanship, superior customer service, integrity, and continual improvement. Design professionals choose to specify DeVinci Precast when projects demand state of the art technology combined with old world craftmanship, or just peace of mind that materials will be delivered when promised.
DeVinci offers design assist and budgeting services. Many aspects of our product can be customized to meet unique needs for specialized applications.
This specification covers Glass-Fiber Reinforced Precast Concrete, GFRC. Glass Fiber Reinforced Concrete (GFRC) is a designation used to refer to a broad category of cementitious products manufactured using Portland cement, sand, aggregate, alkali resistant glass fiber and admixtures in different proportions to meet performance and aesthetic requirements. In architectural applications, GFRC is most associated with the large decorative panels used on building facades and cladding. These panels often require a structural steel panel frame to be bonded to the inside of the molded GFRC composite material for support, which is also used to attach the GFRC panel to the building structure.

1. GENERAL
	1. SECTION INCLUDES

\*\* NOTE TO SPECIFIER \*\* Delete items below not required for project.

* + 1. Glass Fiber Reinforced Concrete (GFRC): Performance criteria, materials, design, production, and erection of GFRC.
			1. GFRC Panels:
				1. Wall panels.
				2. Decorative wall units.
				3. Mullions.
				4. Column covers.
				5. Fascia units.
				6. Cornices.
				7. Soffits.
				8. Coping.
				9. Caps.
				10. Other shapes and applications.
			2. Mold materials.
			3. GFRC materials.
			4. Anchors, connectors, and miscellaneous materials.
			5. Panel frames materials.
			6. GFRC mixes.
			7. Panel frame fabrication.
			8. Mold fabrication.
			9. GFRC fabrication.
			10. Fabrication tolerances.
			11. Finishes.
	1. RELATED SECTIONS

\*\* NOTE TO SPECIFIER \*\* Delete any sections below not relevant to this project; add others as required.

* + 1. Section 03 30 00 - Cast-in-Place Concrete. For embedding weld plates and angles in concrete for attaching connection devices.
		2. Section 03 45 13 - Faced Architectural Precast Concrete. For use in combination with GFRC where structural performance is required.
		3. Section 04 72 00 - Cast Stone Masonry. For use in combination with GFRC where application allows for facings, trim, and accessories.
		4. Section 05 12 13 - Architecturally-Exposed Structural Steel Framing. For attaching connection devices to steel framing.
		5. Section 05 50 00 - Metal Fabrications. For furnishing and installing loose hardware items and other miscellaneous steel shapes.
		6. Section 07 91 23 - Backer Rods. For elastomeric joint sealants and sealant backings.
	1. REFERENCES
		1. ASTM International (ASTM):
			1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
			2. ASTM A108 - Standard Test Method for Evaluating Bond of Seven-Wire Steel Prestressing Strand.
			3. ASTM A123/A123M- Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
			4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
			5. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
			6. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
			7. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
			8. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
			9. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
			10. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
			11. ASTM C150/C150M - Standard Specification for Portland Cement.
			12. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
			13. ASTM C947 - Standard Test Method for Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam with Third-Point Loading).
			14. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete.
			15. ASTM C1228 - Standard Practice for Preparing Coupons for Flexural and Washout Tests on Glass Fiber Reinforced Concrete.
			16. ASTM C1229 - Standard Test Method for Determination of Glass Fiber Content in Glass Fiber Reinforced Concrete (GFRC) (Wash-Out Test).
			17. ASTM C1230 - Standard Test Method for Performing Tension Tests on Glass-Fiber Reinforced Concrete (GFRC) Bonding Pads.
			18. ASTM C1666/C1666M - Standard Specification for Alkali Resistant (AR) Glass Fiber for GFRC and Fiber-Reinforced Concrete and Cement.
			19. ASTM C1866 - Standard Specification for Ground-Glass Pozzolan for Use in Concrete.
			20. ASTM F568M - Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.
			21. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
		2. American Welding Society (AWS):
			1. AWS D1.1/D1.1M - Structural Welding - Steel.
		3. American Institute of Steel Construction (AISC):
			1. AISC 360 - Specification for Structural Steel Buildings.
		4. Precast/Prestressed Concrete Institute (PCI):
			1. PCI MNL 128 - Recommended Practice for Glass Fiber Reinforced Concrete Panels.
			2. PCI MNL 130 - Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products.
	2. DEFINITIONS

\*\* NOTE TO SPECIFIER \*\* Design reference samples are samples available for viewing at bidding or submitted at bidding. Delete if not required.

* + 1. Design Reference Sample: Sample of GFRC color, finish, and texture that has been preapproved by Architect before execution of the Contract.

\*\* NOTE TO SPECIFIER \*\* Insert description of approved design reference samples.

* + - 1. Design Reference Sample Identification Description: \_\_\_\_\_\_\_\_.
	1. SUBMITTALS
		1. Submit under provisions of Section 01 30 00 - Administrative Requirements.
		2. Product Data: For each product.
			1. GFRC design mixes.
			2. Manufacturer's data sheets on each product to be used.
			3. Preparation instructions and recommendations.
			4. Storage and handling requirements and recommendations.
			5. Typical installation methods.
		3. Shop Drawings: Fabrication and installation details for GFRC panels.
			1. Elevations, sections, and dimensions.
			2. Thickness, GFRC backing, and bonding pads for typical panels.
			3. Finishes.
			4. Joint and connection details.
			5. Erection details.
			6. Panel Frames: Sizes, spacings, and thicknesses
			7. Connection Hardware Attached to Structure: Locations and details
			8. Sizes, locations, and details of anchors for panels.
			9. Items sprayed into panels.
			10. Erection sequences.
			11. Relationship to adjacent materials.
			12. Loose, cast-in, and field hardware.
		4. Verification Samples: 12 by 12 inches (305 by 305 mm). For expose surface finishes. Representative of finish, color, and texture expected.

\*\* NOTE TO SPECIFIER \*\* Delete Delegated-Design Submittal Paragraph if not required.

* + 1. Delegated-Design Submittal: Panel and analysis data signed and sealed by the responsible Professional Engineer.
		2. Qualification Data:
			1. For manufacturer.

\*\* NOTE TO SPECIFIER \*\* Delete welding certificates Paragraph not required.

* + - 1. Welding certificates.

\*\* NOTE TO SPECIFIER \*\* Delete mill certificates Paragraph id not required.

* + - 1. Mill Certificates: For structural-steel shapes and hollow structural sections used in panel framing.
		1. Source Quality-Control Program: For GFRC manufacturer.
			1. Test Reports: For inserts, and anchors.
	1. QUALITY ASSURANCE
		1. Manufacturer Qualifications: Designated an APA-certified plant for GFRC production

\*\* NOTE TO SPECIFIER \*\* Delete welding qualifications paraph if not required.

* + 1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
		2. Installer Qualifications: Company specializing in performing Work of this section with minimum two years documented experience with projects of similar scope and complexity.
		3. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

\*\* NOTE TO SPECIFIER \*\* Include mock-up if the project size or quality warrant the expense.

* + 1. Mock-Up: Construct a mock-up with actual materials in sufficient time for Architect's review and to not delay construction progress. Demonstrate aesthetic effects and set quality standards for fabrication and installation along with reviewing interaction of other construction materials.
			1. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
			2. Retain mock-up during construction as a standard for comparison with completed work.

\*\* NOTE TO SPECIFIER \*\* Delete one of the two following paragraphs.

* + - 1. Do not alter or remove mock-up until work is completed or removal is authorized.
			2. Approved Mockups: May become part of the completed project.

\*\* NOTE TO SPECIFIER \*\* Indicate portion of wall and or features represented by mockup on Drawings or draw mockup as separate element.

* + - 1. Build mockup of typical wall area as shown on Drawings.
				1. Typical Components: Building structure attachments, and installation methods.
				2. Window Openings: GFRC accents where required.
				3. Sealant-Filled Joints: Complying with requirements in Section 07 91 23 - Backer Rods.
	1. PRE-INSTALLATION CONFERENCE
		1. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Architect, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.
	2. DELIVERY, STORAGE, AND HANDLING
		1. Handle and transport GFRC panels supported on protective material and with protective spacers between panels.
		2. Special storage, handling, and shipping apparatuses may be required for some pieces where geometry and other conditions dictate.
		3. Store GFRC panels off ground on firm, level, and smooth surfaces supported on protective material and with protective resilient spacers between panels. Place stored panels so identification marks are clearly visible.
		4. Prevent prolonged contact of materials that retain moisture.
1. PRODUCTS
	1. MANUFACTURERS

\*\* NOTE TO SPECIFIER \*\* Retain "Manufacturers" Paragraph belowif naming GFRC manufacturers. See APA's Web site, www.archprecast.org, for current APA-certified plant listings

* + 1. Acceptable Manufacturer: DeVinci PreCast, which is located at:4520 S. MacArthur Blvd.Oklahoma City, OK 73179Tel: 405-680-5600Fax: 405-680-5614Email: [request info (ericsutliff@devinciprecast.com)](https://arcat.com/rfi?action=email&company=DeVinci%252BPreCast&message=RE%253A%2520Spec%2520Question%2520(03490dvp)%253A%2520&coid=42066&spec=03490dvp&rep=&fax=405-680-5614);Web: <https://devinciprecast.com>

\*\* NOTE TO SPECIFIER \*\* Delete one of the following two paragraphs; coordinate with requirements of Division 1 section on product options and substitutions.

* + 1. Substitutions: Not permitted.
		2. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
	1. PERFORMANCE REQUIREMENTS

\*\* NOTE TO SPECIFIER \*\* Retain "Delegated Design" Paragraph below if Supplier is required to assume responsibility for design.

* + 1. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements to design GFRC panel systems.
		2. Structural Performance: GFRC panel systems, must withstand design loads and dimensional changes due to thermal and moisture extremes. as governed by applicable codes and standards.

\*\* NOTE TO SPECIFIER \*\* Delete paragraph if not required.

* + - 1. Comply with AISC 360.
		1. PCI Manuals: Comply with requirements and recommendations in the PCI manuals below unless more stringent requirements are indicated:
			1. PCI MNL 128 - Recommended Practice for Glass Fiber Reinforced Concrete Panels.
			2. PCI MNL 130 - Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products.
	1. MOLD MATERIALS
		1. Molds: Rigid, dimensionally stable, non-absorptive alkali resistant, warp, and buckle free. Provide continuous GFRC surfaces within tolerances; and capable of producing required finish surfaces.
			1. Mold-Release Agent: Commercial liquid-release. Must not bond with, stain, or affect GFRC surfaces

\*\* NOTE TO SPECIFIER \*\* Delete form liner option not required or delete both if form liners are not required.

* + - 1. Form Liners: Units of face design, texture, arrangement, and configuration indicated.
				1. Solid backing and form supports ensure liners remain in place during GFRC application. Use manufacturer's recommended liquid-release agent
			2. Form Liners: Units of face design, texture, arrangement, and configuration to match GFRC design reference sample.
				1. Solid backing and form supports ensure liners remain in place during GFRC application. Use manufacturer's recommended liquid-release agent

\*\* NOTE TO SPECIFIER \*\* Retain "Surface Retarder" Paragraph below if using retarder to help obtain exposed-aggregate finish.

* + 1. Surface Retarder: Liquid used to delay hardening of newly placed GFRC face mix to depth of reveal specified.
	1. GFRC MATERIALS
		1. Portland Cement: ASTM C150/C150M; Type I, II, or III. Surfaces Exposed to View in Finished Structure: Use white of same type, brand, and source throughout GFRC production.
		2. Glass Pozzolan: ASTM C1866. 98 percent passing through No. 325 Mesh.
		3. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches (25 to 50 mm) long, specifically produced for use in GFRC, and complying with ASTM C1666/C1666M.
		4. Sand: Washed and dried per ASTM C144; passing a No. 20 (0.85 mm) sieve with a maximum of 2 percent passing a No. 100 (0.15 mm) sieve.

\*\* NOTE TO SPECIFIER \*\* Retain "Facing Aggregate" Paragraph below if face mix is required.

* + 1. Facing Aggregate: ASTM C33/C33M, except for gradation, and PCI MNL 130, 1/4 inch (6 mm) maximum size.

\*\* NOTE TO SPECIFIER \*\* Delete coloring admixture if not required. Delete color options not required.

* + 1. Coloring Admixture: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.
			1. Color: As determined by the Architect.
			2. Color: As detailed on the Drawings.
			3. Color: \_\_\_\_\_\_\_\_.
		2. Potable Water: No material affecting color stability, setting, or strength of GFRC and meet chemical limits in PCI MNL 130.

\*\* NOTE TO SPECIFIER \*\* DeVinci uses an acrylic thermoplastic copolymer dispersion in all GFRC products. Delete polymer-curing admixture if not required.

* + 1. Polymer-Curing Admixture: Comply with PCI MNL 130.

\*\* NOTE TO SPECIFIER \*\* DeVinci Precast uses high range water reducer in all GFRC products.

* + 1. Chemical Admixtures: ASTM C494/C494M, containing 0.1 percent or less chloride ions.
			1. Admixture: To be determined by the precast manufacturer.
			2. Admixture: \_\_\_\_\_\_\_\_.
		2. Glass Fiber Reinforced Concrete Physical Material Properties as follow:
			1. Ultimate Flexural Strength: 2200 to 4000 psi.
			2. Yield Flexural Strength: 1000 to 1500 psi.
	1. ANCHORS, CONNECTORS, AND MISCELLANEOUS MATERIALS
		1. Carbon-Steel Shapes and Plates: ASTM A36/A36M. Finished as follows:

\*\* NOTE TO SPECIFIER \*\* Delete finish option not required. Hot-dip galvanized provides maximum corrosion resistance. MPI#79 provides some corrosion protection at lesser cost.

* + - 1. Finish: Hot-dip zinc coated per ASTM A123/A123M, after fabrication.
			2. Finish: Shop paint primer per MPI 79 on prepared surfaces per SSPC-SP 2 - Hand Tool Cleaning, or better.

\*\* NOTE TO SPECIFIER \*\* Carbon-steel bars are used as flex, gravity, and seismic anchors.

* + 1. Carbon-Steel Bars: ASTM A108, Grade 1018, not less than 1/4 inch (6 mm) in diameter, finished as follows:

\*\* NOTE TO SPECIFIER \*\* Delete finish option not required. Hot-dip galvanized provides maximum corrosion resistance. MPI#79 provides some corrosion protection at lesser cost.

* + - 1. Finish: Hot-dip zinc coated per ASTM A123/A123M, after fabrication.
			2. Finish: Shop paint primer per MPI 79 on prepared surfaces per SSPC-SP 2 - Hand Tool Cleaning, or better.
		1. Bolts: ASTM A307 (ASTM F568M) or ASTM F3125/F3125M, Grade A325 (Grade A325M).

\*\* NOTE TO SPECIFIER \*\* Delete finish option not required or delete both. Hot-dip galvanized finish provides maximum corrosion resistance. Electrodeposited zinc coatings provide some corrosion protection.

* + - 1. Finish: Hot-dip zinc coated per ASTM A123/A123M, after fabrication.
			2. Finish: Electrodeposition per ASTM B633, SC 3.
	1. PANEL FRAME MATERIALS
		1. Hollow Structural Sections: Steel tubing, ASTM A500/A500M, Grade B, or ASTM A513.

\*\* NOTE TO SPECIFIER \*\* Delete finish option not required.

* + - 1. Finish: Hot-dip zinc coated per ASTM A123/A123M, after fabrication.
			2. Finish: Shop paint primer per MPI 79 on prepared surfaces per SSPC-SP 2 - Hand Tool Cleaning, or better.
		1. Steel Channels and Angles: ASTM A36/A36M, finished as follows:

\*\* NOTE TO SPECIFIER \*\* Delete finish option not required.

* + - 1. Finish: Hot-dip zinc coated per ASTM A123/A123M, after fabrication.
			2. Finish: Shop paint primer per MPI 79 on prepared surfaces per SSPC-SP 2 - Hand Tool Cleaning, or better.
	1. GFRC MIXES

\*\* NOTE TO SPECIFIER \*\* Delete mist coat if using a face mix or if GFRC is faced with dimension stone or another veneer. Mist Coat is usually used with backing mix if there is no face mix.

* + 1. Mist Coat: Portland cement, sand slurry, and admixtures. Same as backing mix without glass fibers.
		2. Face Mix: Proportion Portland cement, sand, facing aggregates, and admixtures complying with design requirements.
		3. Backing Mix: Proportion Portland cement, glass fibers, sand, and admixtures to comply with design requirements. Nominal Glass-Fiber Content: Not less than 5 percent by weight of total mix.
		4. Polymer-Curing Admixture: 5 to 7 percent by weight of polymer-curing admixture solids to dry Portland cement.
		5. Coloring Admixture: Not to exceed 5 percent of cement weight.
	1. PANEL FRAME FABRICATION
		1. Panel Frames and Accessories: Fabricate flat, square, true to line, with securely fastened components using jigs or templates.
			1. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1/D1.1M.
			2. Weld anchors to panel frames.
		2. Reinforce framing assemblies, as necessary, to withstand erection stresses.
		3. Touch Up:
			1. Damaged galvanized surfaces per ASTM A780/A780M.
			2. Damaged painted surfaces using same primer.
	2. MOLD FABRICATION
		1. Mold Construction: To result in finished GFRC with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Prevent water leakage and loss of cement paste.

\*\* NOTE TO SPECIFIER \*\* Delete one of the two following options not required. Keep the second paragraph if exposed-aggregate surfaces require surface retarder to achieve desired finish.

* + - 1. Coat contact surfaces of molds with form-release agent.
			2. Coat contact surfaces of molds with surface retarder.

\*\* NOTE TO SPECIFIER \*\* Delete the following paragraph if form liners are not required.

* + 1. Form Liners: Place accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during GFRC application. Coat form liner with form-release agent.
	1. GFRC FABRICATION
		1. Proportioning and Mixing Backing Mix: Meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content per PCI MNL 130 procedures.
		2. Spray Application: Comply with general procedures as follows:

\*\* NOTE TO SPECIFIER \*\* Retain one of first two subparagraphs below unless neither is required.

* + - 1. Mist Coat: Spray over molds to 1/8 inch (3 mm) nominal thickness on planar surfaces.
			2. Face Mix: Spray or place in thickness indicated on Shop Drawings.
			3. Backing Mix: Spray before face mix or mist coat has set. Use procedures that produce uniform thickness and even distribution of glass fibers and matrix.
				1. Backing Mix Consolidation: By rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
			4. Thickness Measurements: Pin gage or other acceptable method once every 5 sq. ft. (0.5 sq. m) of panel surface. At least six measurements per panel.
		1. Hand form and consolidate details. Incorporate form or infill materials, and overspray before material reaches initial set to ensure complete bonding.
		2. Attach panel frame to GFRC before initial set of backing. Maintain clearance of 1/4 inch (6 mm) minimum from GFRC backing, and without anchors protruding into GFRC backing.
		3. Bonding Pads: Build up over anchor feet. Maintain thickness of 1/2 inch (13 mm) over tops of anchor feet before initial set of backing.
			1. Measure bonding pad thickness at 10 percent of anchor locations.
		4. Inserts and Embeds: Build up homogeneous bosses or bonding pads over inserts and embeds. Provide anchorage and embedment complying with design requirements.
		5. Curing Method: Ensure sufficient strength for removing units from mold per PCI MNL 130 procedures.
			1. Keep moisture off mixes with polymer curing admixtures during first three hours of curing.
			2. Temperature Range: 60 to 120 degrees F (16 to 49 degrees C) during first 16 hours.
		6. Panel Identification: Mark GFRC panels with identification marks on Shop Drawings. Mark casting date on each panel.
	1. FABRICATION TOLERANCES

\*\* NOTE TO SPECIFIER \*\* Delete manufacturing tolerances option not required. First paragraph incorporates tolerances by reference.

* + 1. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with PCI MNL 130 for dimension, position, and tolerances.
		2. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.

\*\* NOTE TO SPECIFIER \*\* Tolerances in subparagraphs below are PCI recommendations. Manufacturers may be able to comply with closer tolerances if required. Consult DeVinci Precast if closer tolerances are required.

* + - 1. Height and Width of Units Measured at Face Adjacent to Mold:
				1. 10 feet (3 m) or Less: Plus or minus 1/8 inch (3 mm).
				2. Greater than 10 feet (3 m): Plus or minus 1/8 inch per 10 feet (3 mm per 3 m);1/4 inch (6 mm) maximum.
			2. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).
			3. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
			4. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
			5. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
			6. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth, or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
			7. Variation from Square or Designated Skew; Difference in Length of Two Diagonal Measurements: Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 -inch (6 mm) total, whichever is greater.
			8. Local Smoothness: 1/4 inch per 10 ft (6 mm per 3 m).
			9. Bowing: Not to exceed L/240 unless unit complies with erection tolerances using connection adjustments.
			10. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
			11. Location of Window Opening within Panel: Plus or minus 1/4 inch (6 mm).
			12. Maximum Permissible Warpage of One Corner out of Plane with the Other Three: 1/16 inch per 12 inches (1.5 mm per 305 mm) of distance from nearest adjacent corner.
		1. Position Tolerances: From datum line locations, as indicated on Shop Drawings.
			1. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
			2. Inserts: Plus or minus 1/2 inch (13 mm).
			3. Special Handling Devices: Plus or minus 2 inches (50 mm).
			4. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
			5. Block-Outs: Plus or minus 1/4 inch (6 mm).
		2. Panel Frame Tolerances:
			1. Vertical and Horizontal Alignment: 1/4 inch per 10 ft (6 mm per 3 m).
			2. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
			3. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
			4. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

\*\* NOTE TO SPECIFIER \*\* Revise this article to add requirements if GFRC finish is to match another product such as architectural precast concrete or Cast stone.

* 1. FINISHES
		1. Exposed Faces: Free of joint marks, grain, and obvious defects.
		2. Corners Including False Joints: Uniform, straight, and defined.
		3. Finish exposed-face surfaces of GFRC to match approved design reference sample or mockups and Cast Stone and Architectural Precast where intent is to match finish.

\*\* NOTE TO SPECIFIER \*\* Delete finish paragraphs below that are not required. If more than one finish is required, insert locations, or indicate on Drawings. Add more detail if greater definition is required. Standard finish is Acid etched to give the appearance and texture of natural limestone. Contact DeVinci Precast for complete or custom finish options.

* + - 1. As-Cast-Surface Finish: Surfaces to match approved sample for acceptable surface, air voids, sand streaks, and honeycomb, with uniform color and texture.
			2. Textured-Surface Finish: Impart by form liners.
			3. Retarded Finish: Use chemical-retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
			4. Acid-Etched Finish: Use acid and hot-water solution equipment, application techniques, and cleaning procedures to expose fine aggregate and surrounding matrix surfaces.
	1. SOURCE QUALITY CONTROL

\*\* NOTE TO SPECIFIER \*\* PCI MNL 130 mandates source testing requirements. APA or PCI certification also ensures periodic auditing of plants for compliance with standards in PCI MNL 130.

* + 1. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL 130.
			1. Test materials and inspect production techniques.
			2. Quality-Control Program: Monitor glass-fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
			3. Tests and Test Specimens: Prepare per ASTM C1228, PCI MNL 130, and PCI MNL 128 procedures.
			4. Test GFRC inserts and anchors per ASTM C1230 to validate design values.

\*\* NOTE TO SPECIFIER \*\* Revise frequency of testing in subparagraph below to suit Project.

* + - 1. Produce test boards at a minimum rate of one per work shift per operator for each spray machine and for each mix design.
				1. For each test board, determine glass-fiber content according to ASTM C1229 and flexural yield and ultimate strength according to ASTM C947.
1. EXECUTION
	1. EXAMINATION
		1. Do not begin installation until substrates have been properly constructed and prepared.
		2. If substrate preparation is the responsibility of another installer, notify Architect in writing of unsatisfactory preparation before proceeding.
	2. PREPARATION
		1. Clean surfaces thoroughly prior to installation.
		2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
	3. ERECTION
		1. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.
		2. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
			1. Maintain horizontal and vertical joint alignment and uniform joint width.
			2. Remove projecting hoisting devices.
		3. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.
		4. Welding: Comply with applicable AWS D1.1/D1.1M requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
			1. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.
		5. Bolted Connections: Use lock washers or other acceptable means to prevent loosening of nuts.
		6. Comply with noncumulative tolerances:
			1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
			2. Top Elevation from Nominal Top Elevation:
				1. Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
				2. Nonexposed Individual Panel: Plus or minus 1/2 inch (13 mm).
				3. Exposed Panel Relative to Adjacent Panel: 1/4 inch (6 mm).
				4. Nonexposed Panel Relative to Adjacent Panel: 1/2 inch (13 mm).
			3. Support Elevation from Nominal Elevation:
				1. Maximum Low: 1/2 inch (13 mm).
				2. Maximum High: 1/4 inch (6 mm).
			4. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
			5. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
			6. Maximum Offset in Alignment of Matching Edges: 1/4 inch (6 mm).
			7. Face Width of Joint: As follows (governs over joint taper):
				1. Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
				2. Panel Dimension More Than 20 Feet (6 m):Plus or minus 3/8 inch (9.5 mm).
			8. Maximum Joint Taper: 3/8 inch (10 mm).
			9. Maximum Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
			10. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).
	4. REPAIRS

\*\* NOTE TO SPECIFIER \*\* Production blemishes are generally corrected at manufacturer's plant. Blemishes occurring after delivery are normally repaired before final joint cleaning and sealing.

* + 1. Maintain structural adequacy of panel do not impair appearance. Must be approved by Architect.
		2. Patches must blend with color, texture, and uniformity of adjacent exposed surfaces.

\*\* NOTE TO SPECIFIER \*\* Retain first paragraph below if using galvanized framing, anchors, connections, and other items; retain second paragraph below if items are prime painted.

* + 1. Repair damaged galvanized coatings with galvanizing repair paint per ASTM A780/A780M.
		2. Remove and replace damaged GFRC panels if repairs do not comply with requirements.
	1. CLEANING AND PROTECTION
		1. Clean per GFRC manufacturer's written instructions.
			1. Soiled GFRC Surfaces: Clean with detergent and water, with soft fiber brushes and sponges. Rinse with clean water.
			2. Prevent damage to GFRC surfaces.

END OF SECTION