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**DIVISION 6**

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06610	Fibreglass Reinforced Plastics (FRP) Fabrications

**FIBERGLASS REINFORCED PLASTICS (FRP) FABRICATIONS**

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**1. GENERAL**

**1.1 Scope of Work**

- .1 The Contractor shall furnish, fabricate (where necessary), and install all fiberglass reinforced plastic (FRP) items, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as shown on the Contract Drawings and as specified herein, and in accordance with the requirements of the Contract Documents.

**1.2 References**

- .1 The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.
  - .1 ASTM Test Methods:
    - .1 ASTM D 635 - Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
    - .2 ASTM D-638 - Tensile Properties of Plastics
    - .3 ASTM D-696 - Coefficient of Linear Thermal Expansion for Plastics
    - .4 ASTM D-790 - Flexural Properties of Unreinforced and Reinforced Plastics
    - .5 ASTM D-2344 - Apparent Interlaminar Shear Strength of Parallel Fibre Composites by Short Beam Method
    - .6 ASTM E-84 - Surface Burning Characteristics of Building Materials

**1.3 Contractor Submittals**

- .1 The Contractor shall furnish shop drawings of all fabricated structural systems and accessories in accordance with the provisions of this Section.
- .2 The Contractor shall furnish manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
- .3 The Contractor shall submit the manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer, registered in the Province of Manitoba.

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- .4 The Contractor may be requested to submit sample pieces of each item specified herein for acceptance by the Contract Administrator as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

**1.4 Quality Assurance**

- .1 All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years experience in the design and manufacture of similar products and systems. Additionally, if requested by the Contract Administrator, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
- .2 Manufacturer shall offer a 2-year limited warranty on all FRP products against defects in materials and workmanship.
- .3 Manufacturer shall be certified to the ISO 9001-2000 standard.
- .4 Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR) to the Contract Administrator.

**1.5 Product Delivery and Storage**

- .1 Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- .2 Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, and other types of damage. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 21°C to 29°C until they are required.

**2. PRODUCTS**

**2.1 Manufacturers**

- .1 Pultex Series by Creative Pultrusions Inc.
- .2 Strongwell
- .3 IMCO Reinforced Plastics Inc.
- .4 Dynaform by Fibergrate Canada

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**2.2 General**

- .1 All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- .2 Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.
- .3 Resin shall be polyester or vinyl ester for all systems with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.
- .4 All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- .5 All FRP products shall have a tested flame spread rating of 25 or less per ASTM E84 Tunnel Test.

**2.3 Design Requirements:**

- .1 Loadings: Design to support, within stress and deflection limitations, following loadings:
  - .1 Gravity load: Downward vertical loads shall include weight of baffles, and appurtenant attachments to baffles.
  - .2 Buoyant load: Buoyant load shall act vertically upward, magnitude equal to weight of displaced water (baffles and support framing weights neglected).
  - .3 Lateral load: Loads acting against baffles; specifically, as follows:
    - .1 Longitudinal Baffles: Top half of baffle 2.0 kPa away from existing concrete tank wall, bottom half of baffle 2.0 kPa toward existing concrete tank wall.
    - .2 Transverse Baffles: 2.0 kPa in direction of fluid flow.
  - .4 Longitudinal load:
    - .1 Longitudinal Baffles: 1.3kN in direction of fluid flow located at the top corner joint of each baffle panel support frame.
- .2 Thermal Stress: Design to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion (contraction) between baffles and support materials.
- .3 Deflection Under Load:

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- .1 Maximum vertical deflection under full buoyant or gravity load shall be equal to or less than  $L/1,000$ , where L defined as unsupported length in mm. Maximum vertical deflection, measured at mid-point between supports, shall not exceed 5 mm.
- .2 Maximum horizontal deflection under full lateral load shall be equal to or less than  $D/100$ , where D defined as baffle height, in mm. Maximum deflection shall not exceed 5 mm.
- .4 Supports:
  - .1 Space baffle support brackets as shown on Drawings and design for maximum deflection of baffles of 3 mm; stresses encountered during installation, filling, and draining of structures in which they will be placed; and normal Operation and Maintenance of equipment.

**2.4 Structural Shapes**

- .1 All structural shapes are to be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- .2 Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
- .3 Resins shall be fire retardant isophthalic polyester or vinyl ester with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required. Resin shall be suitable for service in temperature range of 5°C to 25°C.
- .4 Pultruded structural shapes are to have the minimum longitudinal mechanical properties listed below:

<b>Property</b>	<b>ASTM Method</b>	<b>Value</b>	<b>Units</b>
Tensile Strength	D-638	206	MPa
Tensile Modulus	D-638	17.2	GPa
Flexural Strength	D-790	206	MPa
Flexural Modulus	D-790	12.4	GPa
Flexural Modulus (Full Section)	N/A	19.3	GPa
Short Beam Shear (Transverse)	D-2344	31	MPa
Shear Modulus (Transverse)	N/A	3.1	GPa
Coefficient of Thermal Expansion	D-696	$1.4 \times 10^6$	cm/cm/°C
Flame Spread	E-84	25 or less	N/A

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**2.5 FRP Plate**

- .1 **Manufacture:** Plate shall be of a one piece molded construction manufactured by building up multiple layers of resin-impregnated fiberglass reinforcements that are continuous and equally oriented in the length and width directions. The plate shall have a nominal thickness of minimum 13mm. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the Contract. After molding, no dry glass fibers shall be visible on any surface. All surfaces shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas.
- .2 **Surfacing:** Plate shall have an ungritted surface.
- .3 **Fire rating:** Plate shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E84. Certifications shall be dated within the past two years and test data performed only on the resin shall not be acceptable.
- .4 **Resin system:** The resin shall be polyester or vinyl ester for all systems with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required. Manufacturer may be required to submit corrosion data from tests performed on actual plate products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of plate product corrosion resistance and shall not be accepted. Resin shall be suitable for service in temperature range of 5°C to 25°C.
- .5 **Glass Reinforcing:**
  - .1 Type C (chemical) glass surfacing mat, 10 to 20 mils thick, with silane finish and styrene soluble binder.
  - .2 Type E (electrical borosilicate) glass mat with chrome or silane finish and styrene soluble binder of appropriate number of plies to achieve required thickness.
- .6 **Color:** yellow or dark grey as determined by Contract Administrator. Each laminate layer shall contain pigment to produce color throughout panel.
- .7 **Depth:** minimum 13 mm with a tolerance of plus or minus 1.6mm.
- .8 **Baffle panels** fabricated from plate stock with cut edges, and notches are not acceptable.
- .9 **Where baffle panels** are nonstandard length or have nonstandard mounting hole configurations, seal machined or cut edges with resin.
- .10 **Substitutions:** Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the Contract Administrator for approval in accordance with B6 Substitutes.

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- .11 FRP plates are to have the minimum mechanical properties listed below:

<b>Minimum Physical Laminate</b>	<b>Properties</b>	<b>Test method</b>
Tensile strength	96.5 MPa	ASTM D638
Flexural strength	172.4 MPa	ASTM D790
Flexural modulus	6.9 GPa	ASTM D790
Barcol hardness	40 min (minimum)	ASTM D2583
Water absorption (% - 24 hrs)	0.10% (maximum)	ASTM D570
Glass content by weight	32% +/- 3%	
Average coefficient of thermal expansion (cm/cm/°C)	$1.4 \times 10^{-6}$	ASTM D696

- .12 Manufacture to provide two additional longitudinal baffle panels for City to store on-site for maintenance repairs. Contract Administrator to designate area for storage.

## **2.6 Miscellaneous Materials**

- .1 Anchor Bolts:

- .1 Manufacturers:

- .1 Stud Anchor by Hilti, Inc.
- .2 Redhead Wedge Anchor by ITT Phillips Drill Division.
- .3 Rawl Stud by Rawl Plug Company, Inc., or equal.

- .2 Series 304 stainless steel expansion anchors.

- .2 Fasteners:

- .1 Series 316 stainless steel hex bolts, flat washers, and hex nuts of size as determined by manufacturer.

## **3. EXECUTION**

### **3.1 Fabrication**

- .1 Measurements: Structural Shapes supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. Determine correct size and locations of required holes or coping from field dimensions before structural shape fabrication. Cast each segment in one piece without joining by bonding or bolting. Use integrally molded aluminum or galvanized steel angle stiffeners to limit deflection. Do not bolt or bond stiffeners.

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- .2 Sealing: All shop fabricated cuts or drilling shall be coated with polyester or vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
- .3 Laminate shall consist of alternating layers of woven roving and chopped mat. Following hardening of final layer of laminate, flush coat of pure resin containing wax shall be applied to ensure complete cure of laminate.
- .4 Hardware: Type 316 stainless steel bolts shall be provided for assembly. Type 304SS anchor bolts shall be supplied for anchoring.

**3.2 Inspection**

- .1 Shop inspection is authorized as required by the Contract Administrator and shall be at the City's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
- .2 The plate and structural shapes shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits. The surface shall have a smooth finish (except for grit top surfaces).

**3.3 Installation**

- .1 Contractor shall install plate and structural shapes in accordance with manufacturer's assembly drawings.
- .2 Fasten materials securely in place with fasteners as specified herein.
- .3 Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products.

**3.4 FIELD QUALITY CONTROL**

- .1 After installation is complete, test baffles under normal operating conditions in the presence of the Contract Administrator.
- .2 Repair leaks or other imperfections found upon testing.
- .3 Repair damaged panels.

**END OF SECTION**