

**ENGINEERING SPECIFICATION**  
**PULTRUDED DYNARAIL<sup>®</sup>**  
**FIBERGLASS LADDER & LADDER CAGES**

## SECTION 06610

### FIBERGLASS REINFORCED PLASTICS (FRP) FABRICATIONS

#### PULTRUDED SQUARE TUBE LADDER & LADDER CAGES

#### PART 1 - GENERAL

##### 1.1 SCOPE OF WORK

- A. This specification is for a pultruded fiberglass ladder system in compliance with OSHA 1910.27.

##### 1.2 REFERENCES

- A. 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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:

ASTM D-638-Tensile Properties of Plastics

ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics

ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method

ASTM D-495-High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics

ASTM E-84-Surface Burning Characteristics of Building Materials

THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)  
Code of Federal Regulations (CFR), Title 29, Section 1910.27

##### 1.3 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall furnish shop drawings of all fabricated ladder, cages and accessories in accordance with the provisions of this Section.
- B. 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.
- C. 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.

- D. The CONTRACTOR may be required to submit sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

#### 1.4 QUALITY ASSURANCE

- A. 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, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
- B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
- C. Manufacturer shall be certified to the ISO 9001-2008 standard.
- D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

#### 1.5 PRODUCT DELIVERY AND STORAGE

- A. 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.
- B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- A. Ladder and cage components shall be Dynarail® as manufactured by

**Fibergrate Composite Structures Inc.**  
5151 Belt Line Road, Suite 1212  
Dallas, Texas 75254-7028 USA  
(800) 527-4043 Phone (972) 250-1530 Fax

Website: [www.fibergrate.com](http://www.fibergrate.com)  
E-mail: [info@fibergrate.com](mailto:info@fibergrate.com)

## 2.2 GENERAL

- H. All ladder side rails, rungs, ladder mounting brackets and cage straps are to be FRP structural shapes manufactured by the pultrusion process. Cage hoops and brackets shall be produced by the open molded hand lay-up method. All 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.
- B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, bi-directional roving mat and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
- C. Resins shall be DYNAFORM<sup>®</sup> {ISOFR, an isophthalic polyester *or* VEFR, a vinyl ester - *choose one*} with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.
- D. 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.
- E. All pultruded ladder components shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface
- F. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.
- G. The ladder side rail shall be 1-3/4" square tube with a wall thickness of 1/4" or greater. The rungs shall be 1-1/4" diameter pultruded structural shapes, continuously fluted to provide a non-slip surface. Rungs that are gritted as a secondary operation shall not be permitted. Ladder wall and floor mount shall be fabricated from pultruded angles, 3/8" minimum thickness.
- H. The ladder cage vertical bars shall be 1.5" wide by 5/8" pultruded I-beam shapes to offer protection to workers from exposed hardware. Cage hoops and cage brackets shall be manufactured by the open mold hand lay-up process. All cage hoops shall be 3" wide by 1/4" thick minimum.
- I. Type 316 stainless steel bolts shall be provided for attaching ladder cage vertical bars to hoops, ladder hoops to brackets, ladder cage brackets to the ladder, and wall brackets to the ladder.
- J. All rungs shall be both mechanically attached to the ladder with stainless steel rivets and chemically bonded with epoxy.
- K. All ladder and cage components are to be integrally pigmented yellow. All wall and floor mount brackets shall be Dynaform<sup>®</sup> ISOFR light gray.

- L. Pultruded structural shapes used in the ladder system are to have the minimum longitudinal mechanical properties listed below:

| Property                         | ASTM Method | Value  | Units                  |
|----------------------------------|-------------|--|------------------------|
| Tensile Strength                 | D-638       | 30,000 (206)                                     | psi (MPa)              |
| Tensile Modulus                  | D-638       | $2.5 \times 10^6$ (17.2)                         | psi (GPa)              |
| Flexural Strength                | D-790       | 30,000 (206)                                     | psi (MPa)              |
| Flexural Modulus                 | D-790       | $1.8 \times 10^6$ (12.4)                         | psi (GPa)              |
| Flexural Modulus (Full Section)  | N/A         | $2.8 \times 10^6$ (19.3)                         | psi (GPa)              |
| Short Beam Shear (Transverse)    | D-2344      | 4,500 (31)                                       | psi (MPa)              |
| Shear Modulus (Transverse)       | N/A         | $4.5 \times 10^5$ (3.1)                          | psi (GPa)              |
| Coefficient of Thermal Expansion | D-696       | $8.0 \times 10^{-6}$<br>( $1.4 \times 10^{-6}$ ) | in/in/°F<br>(cm/cm/°C) |
| Flame Spread                     | E-84        | 25 or less                                       | N/A                    |

- M. All fasteners used in the ladder system are to be 316 SS. Rivets will be 18-8 stainless steel.

## PART 3 - EXECUTION

### 3.0 FABRICATION

- A. All ladders and cages shall be designed and laid out in strict accordance with OSHA 1910.27.
- B. All rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both epoxy and rivets to provide both a chemical and mechanical lock, respectively.
- C. Ladders shall be fully shop assembled. Ladder cages shall be test assembled and drilled to ensure a proper fit in the field. Ladder cage brackets shall remain attached to the ladder for shipping, but ladder cage components shall be disassembled, packaged, and shipped separately to ensure the lowest freight costs and to prevent damage in transit. Cage components shall be bundled with each respective ladder.
- D. The hoop brackets shall be shop attached to the ladder with bolts. The hoops shall be field attached to the hoop brackets.
- E. All cut or machined edges, holes and notches shall be sealed to provide maximum corrosion resistance. All field fabricated cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

### 4.0 PERFORMANCE REQUIREMENTS

- A. The completed ladder and cage system installation shall meet the following load requirements set forth in OSHA 1910.27. The ladder shall also be capable of supporting a concentrated vertical load of 1,200 pounds applied at the mid-span of the rung. Manufacturer shall be required to provide supporting test data for rung capacity.

## 5.0 INSTALLATION

- A. Contractor shall be required to assemble and install ladder in strict accordance with manufacturer's assembly drawing and installation brochure.
- B. 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; provide adequate ventilation.