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PRODUCT GUIDE SPECIFICATION

Specifier Notes: This product specification is written according to the Construction Specifications Institute (CSI) Format, including MasterFormat (2016 Edition), SectionFormat, and PageFormat, contained in the CSI Manual of Practice.

This section must be carefully reviewed by the Engineer to meet the requirements of the project and local building code. Coordinate with other specification sections and the drawings.

Delete all "Specifier Notes" after editing this section.

SECTION 03 21 21.11

GLASS FIBER REINFORCED POLYMER (GFRP) BARS FOR CONCRETE REINFORCEMENT ACCORDING TO ASTM D7957

Specifier Notes: This section covers Owens Corning® Aslan™ 100 Fiberglas™ Rebar, GRFP (Glass Fiber Reinforced Polymer) rebar; also referred to as fiberglass rebar.

Fiberglass rebar is an alternative to epoxy coated, galvanized or stainless-steel rebar. It should be considered in any concrete member susceptible to corrosion of steel reinforcement by chloride ion or chemical corrosion. In addition, any concrete member requiring non-ferrous reinforcement due to electro-magnetic consideration could be an appropriate use.

Fiberglas™ Rebar is:
- Impervious to chloride ion and chemical attack
- Tensile strength greater than steel
- 1/4th weight of steel reinforcement
- Transparent to magnetic fields and radio frequencies
- Electrically non-conductive
- Thermally non-conductive

Fiberglas™ Rebar may be a suitable alternative to steel reinforcing in: Architectural Concrete:

- cast stone
- architectural cladding
- balusters
- column facades
- window lentils
- architectural precast elements
- hand railing
- statuary and fountains

Concrete exposed to de-icing salts in:

- bridge decks
- railroad grade crossings
- median barriers
- parking garage elements
- approach slabs
- salt storage facilities

Concrete exposed to marine salts in:

- seawalls
- water breaks
- buildings & structures near waterfronts
- aquaculture operations
- floating marine docks

Concrete used near electromagnetic equipment such as:

- electrified rail pick-ups for heavy & light rail
- MRI rooms in hospitals
- airport radio & compass calibration pads
- concrete near high voltage cables, transformers, substations

Other applications include Tunnel Boring Machine "soft-eye openings" for launch & reception of TBM runs, rock nails in mining applications, reinforcing for polymer concrete, swimming pools, ice skating arenas, and other concrete elements that may not have adequate concrete cover to protect steel reinforcing

Specifier Notes: The references below should be referred to by the Engineer regarding the application of GFRP bars for concrete reinforcement. Owens Corning will assist the engineer in referencing state of the art research appropriate to the implementation of GFRP Rebar.

1. ACI 318-95, "Building Code Requirements for Concrete" (1995), American Concrete Institute, Detroit, MI, 347 pp.
2. ACI 440R-96, "State-of-the-Art Report on Fiber Reinforced Plastic Reinforcement for Concrete Structures" (1996), American Concrete Institute, Detroit, MI, 68 pp.
3. "Placing Reinforcing Bars" (1992), Concrete Reinforcing Steel Institute, Schaumburg, IL.
4. "ACI440.1R-15 "Guide for the Design and Construction of Concrete Reinforced with FRP Bars". Reported by ACI Committee 440, May 2006.
5. "ACI440.3R-04 "Guide Test Methods for FRP's for Reinforcing or Strengthening Concrete Structures. Report by ACI Committee 440, Oct 2004
6. ASTM D7205 -06 "Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars"
7. ACI 440.5-18 "Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars". Reported by ACI Committee 440, July 2008
8. ASTM D7957-17 "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement"

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Deformed and sand coated glass fiber reinforced polymer (GFRP) bars for concrete reinforcement in accordance with ASTM D7957 "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement".

1.2 RELATED SECTIONS

Specifier Notes: Edit the following list as required for the project. List other sections with work directly related to the GFRP bars.

A. Section 03300 - Cast-in-Place Concrete
B. Section 03400 - Precast Concrete.

1.3 REFERENCES

Specifier Notes: List standards referenced in this section, complete with designations and titles. This article does not require compliance with standards but is merely a listing of those used.

A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.

B. CRSI Placing Reinforcing Bars.

1.4 DESIGN REQUIREMENTS

Specifier Notes: Design with Owens Corning® Aslan™ 100 Fiberglas™ bars shall be in accordance with ACI publication ACI440.1R "Guide for the Design and Construction of Concrete Reinforced with FRP Bars" for building structures. For transportation structures, use AASHTO LRFD Bridge Design Guide Specifications for GFRP- Reinforced Concrete, 2nd Edition December 2018. Alternatively, by the provisions of the Canadian Highway Bridge Design Code Section 16. Canadian Standards Association, CSA S806-02 Design and Construction of Building Components with Fiber Reinforced Polymers, Interim design guidelines have been published by the British Institution of Structural Engineers covering modifications to BS8110 and BS5400, the Norwegian Concrete Standard NS3473, and the Japanese Society of Civil Engineers.

In general, the designer shall consider the following:

A. Do not substitute GFRP reinforcing bars for steel reinforcing bars on an equal area basis, due to differences in material properties.

B. Specifically design reinforced concrete members for GFRP bars, taking into account properties of the material and effects on strength, deflection, and crack width.

C. In most cases, deflection will control design of concrete structures reinforced with GFRP bars based on value of modulus of elasticity of GFRP bars.

1.5 SUBMITALS

A. Comply with Section 01330 – Submittal Procedures.

B. Product Data: Submit manufacturer's product data, including material and mechanical properties in accordance with ASTM D7957 "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement".

C. Test Reports: Submit manufacturer's certified test reports for source quality control testing for material and mechanical properties performed either in-house or by an independent testing agency. If independent testing is required, this shall be noted at the time of bidding.

1. Each bar size.
2. Each type of fiber reinforcement specified, such as ECR glass fibers in accordance with ASTM D578.
3. Each type of resin matrix specified, such as Vinyl Ester for permanent use or Polyester resin for temporary or non-cementitious matrix use.

1.6 QUALITY ASSURANCE

Specifier Notes: Describe requirements for reporting traceable material properties for a production lot and tolerances on field placement of fiberglass rebar in formwork.

A. ATSM D7957 material standard for fiberglass rebar describes the quality control property limits and test methods for quality control and certification with a summary in Table 2, repeated below for convenience.
B. Placing of the fiberglass rebar, handing and tolerance in formwork shall be in accordance with ACI 440.5-18 "Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars". Reported by ACI Committee 440, July 2018.

TABLE 2 Property Limits and Test Methods for Quality Control and Certification A,B

Property	Limit	Test Method
Fiber Mass Content	≥70 %	ASTM D2584 or ASTM D3171
Glass Transition Temperature	Midpoint temperature ≥100 °C [212 °F]	ASTM E1356
Degree of Cure	≥95 %	ASTM E2160
Measured Cross-Sectional Area	Table 3	ASTM D7205/D7205M, subsection 11.2.5.1
Ultimate Tensile Force	Table 3	ASTM D7205/D7205M
Tensile Modulus of Elasticity	≥44 800 MPa [6 500 000 psi]	ASTM D7205/D7205M
Ultimate Tensile Strain	≥1.1 %	ASTM D7205/D7205M
Moisture Absorption in 24 h	≤0.25 % in 24 h at 50 °C [122 °F]	ASTM D570, subsection 7.4

A. For the determination of each of the property limits, five random samples shall be obtained from each production lot. Each individual sample shall satisfy the property limits.
B. For bent bars, the tests are performed on the straight portion of the bar

1.7 DELIVERY, STORAGE, AND HANDLING

Specifier Notes: Owens Corning® Fiberglas™ Rebar should be handled and placed in a manner similar to epoxy coated steel rebar. Care should be taken to avoid damaging the surface of the rebars by abrasion, nicks or cuts.

A. General: Deliver, store, and handle FRP bars in accordance with manufacturer's instructions to prevent damage and in accordance with ACI 440.5-18 "Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars". Reported by ACI Committee 440, July 2018.

B. Storage:
1. Do not store GFRP bars directly on ground. Place timber pallets under bars to keep them free from dirt and mud and to provide easy handling.
2. Store FRP bars under covers to avoid direct sunlight and chemical substances.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Aslan FRP by Owens Corning Composite Materials, LLC.
One Owens Corning Parkway, Toledo, Ohio 43659
Phone: 1-800-GET-PINK®
Email: OCRebarSales@owenscorning.com
Web: http://www.owenscorning.com/rebar

2.2 GLASS FIBER REINFORCED POLYMER (GFRP) BARS FOR CONCRETE REINFORCEMENT

A. Glass Fiber Reinforced Polymer (GFRP) Bars: deformed and sand coated GFRP bars for concrete reinforcement. Surface of GFRP bar is provided with undulations and a sand coated to affect a mechanical and chemical bond to concrete in accordance with ASTM D7957 "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement".

B. Binding Material: Binding material is composed of Vinyl ester resin is homogeneous throughout the cross section of the bar.

C. Manufacturing Process:
1. Pultrusion process.
2. Glass rovings are drawn through a resin bath, surface undulations and sand are applied prior to thermoset of the polymeric resin.
3. Bends are produced in a similar fashion but molded over mandrel prior to thermosetting of polymeric resin.

Specifier Notes: At the present, there are eight bar diameters available from Owens Corning Infrastructure Solutions, ranging from #2 (6mm) diameter to #13 (41mm) diameter. Certs are available for bar diameters #2 through #10. Bent shapes are available in bar diameters #2 through #8.

Straight bars are labeled and designated as follows:

RB(X)-(Y)

Where X is the bar imperial bar diameter designation i.e. #2, #3 etc, and Y is the length of the stick in inches.

Bent shapes always are labeled or designated:

BRB(X)-(A)-(Y)-(Y)

Where X is the bar diameter i.e. #2, #3 etc, and A is the angle of the bend, and Y shows the length of the straight portion of each side of the bend in inches.

Shapes other than simple bends may be described by the bar mark description or other unique method of identifying the particular bar shape.

E. Dimensions: Cross Sectional Area and Nominal Diameter: Owens Corning® Aslan™ 100 Fiberglas™ Rebar

Bar Size		Cross Sectional Area*		Nominal Dia.	
(mm)	(inches)	(mm2)	(in2)	(mm)	(in)
6	#2	31.67	0.049	6.35	0.25”
9	#3	71.26	0.110	9.53	0.375”
12	#4	126.70	0.196	12.70	0.50”
16	#5	197.90	0.307	15.88	0.625”
19	#6	285.00	0.442	19.05	0.75”
22	#7	387.90	0.601	22.23	0.875”
25	#8	506.70	0.785	25.40	1.0”
29	#9	641.30	0.994	28.57	1.125”
32	#10	791.70	1.227	31.75	1.25”
35	#11	958.1	1.485	34.92	1.375
38	#12	1160	1.800	38.1	1.50
41	#13	1338	2.074	41.28	1.625

a. The cross-sectional area used for design is the nominal area of the bar. When calculating the measured cross-sectional area per ASTM D7205, the cross section is assumed to be a circle and the nominal diameter is used in the calculation.

F. Tensile Properties: Owens Corning® Aslan™ 100 Fiberglas™ Rebar as measured by ASTM D7205

Bar Size		Tensile Strength		Tensile Modulus of Elasticity	
(mm)	(inches)	(MPA)	(ksi)	GPA	psi 106
6	#2	896	130	46	6.7
9	#3	827	120	46	6.7
12	#4	758	110	46	6.7
16	#5	724	105	46	6.7
19	#6	690	100	46	6.7
22	#7	655	95	46	6.7
25	#8	620	90	46	6.7
29	#9	586	85	46	6.7
32	#10	551	80	46	6.7

* Tensile properties of #11, #12 & #13 bar are NOT guaranteed due to the inability to achieve a valid bar break per ASTM D7205. Tensile properties likely will not control design. Modulus properties can be measured and guaranteed

Owens Corning reserves the right to make improvements in the product and/or process which may result in benefits or changes to some physical-mechanical characteristics. The data contained herein is considered representative of current production and is believed to be reliable and to represent the best available characterization of the product as of October 2008. These properties are conservative and bar with better properties are possible.

Specifier Notes: Owens Corning® Fiberglas™ Rebar is made of a thermoset resin and consequently all bends must be fabricated per a schedule at the factory. No field bending or alteration is possible.

G. Shop Bending:

1. Owens Corning® Fiberglas™ Rebar bent shaped bars are formed over mandrels prior to thermoset of the resin. Bent shapes are limited to those that can be produced practically in this manner. The inside bend diameter for various bar diameters is as follows:

	Inside Bend Dia.
#2	3"
#3	4.25"
#4	4.25"
#5	4.5"
#6	4.5"
#7	6"
#8	6"

There are some dimensional limitations, see Owens Corning® Fiberglas™ Rebar Bar Bends sell sheet for full details. Bends are most economical when limited to shapes that continue in the same circular direction, otherwise lap splices are required.

2.3 SOURCE QUALITY CONTROL

A. To provide for lot or production run trace ability, each production lot of Owens Corning® Aslan™ 100 Fiberglas™ Rebar is imprinted on intervals along the length of the straight bar with the bar diameter, Aslan 100 description, stock order number, month and year of production. This marking is traceable to production lot test certs associated with that work order number.

B. Individual bars are sampled on a regular basis during production for tensile, modulus and ultimate strain testing. Testing is performed and reported per ASTM D7205-06. Tests performed and limits thereof are described in accordance with ASTM D7957. "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement".

C. Certifications of conformance are available for any given production run upon request.

D. Test certs validating material properties of full-scale bars, traceable to the job site must be furnished.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive GFRP bars. Notify the Engineer if areas are not acceptable. Do not begin placing FRP bars until unacceptable conditions have been corrected.

3.2 PLACING

Specifier Notes: Placing of FRP bars is performed similarly as for uncoated steel reinforcing bars, and common practices should apply with some key exceptions, as specified below.

A. Place FRP bars in accordance with CRSI Placing Reinforcing Bars, unless otherwise specified.

B. Place FRP bars accurately in accordance with approved placing drawings, schedules, typical details, and notes.

C. Field Cutting:
   1. Field cut FRP bars with high speed grinding cutter, fine blade saw, diamond blade or masonry blade. Do not shear bars.

Specifier Notes: Owens Corning® Aslan™ 100 Fiberglas™ Rebar is made of a thermoset resin. Bending must be carried out before the full curing of the FRP bars. No field bending or alteration is possible.

D. Field Bending: Do not field bend FRP bars.

E. Securing: Secure FRP bars in formwork to prevent displacement by concrete placement or workers.

F. Supports: Place and support FRP bars accurately using plastic or non-corrosive chairs before concrete placement is started.

G. Fastening: Fasten GFRP bars with coated tie wire, stainless steel tie wire, or nylon ties.

H. Splicing: Use lap splices, whenever continuity is required in the reinforcement. Do not use mechanical connections or welded splices.

I. Tolerances: Do not exceed placing tolerances specified in ACI 117.

J. Cleaning: Remove form oil from FRP bars by wiping bars with solvents before placing concrete.