To Whom It May Concern,

I am writing to confirm that Rebar X Glass Fiber Reinforced Polymer (GFRP) rebar E-Series complies with the building codes listed within and is suitable as a substitute for conventional steel rebar in slabs-on-grade, foundation footings, and stem walls. This document focuses on the equivalency of E-Series GFRP Reinforcing Bar to Grade 60 Steel Reinforcement

Substitution in Footings, Stem Walls, and Slabs-on-Grade

Rebar X sizes E4, E5, and E6 may replace steel rebar sizes #4, #5 and #6, respectively, in typical residential and commercial foundation elements:

- Inverted-T footings
- Slabs-on-grade with continuous exterior footings
- Stem walls with top and bottom longitudinal reinforcement
- Driveways and light-duty slabs

Rebar X Glass Fiber Reinforced Polymer (GFRP) bar has been tested and evaluated in accordance with ASTM D7205/D7205M-06 (2020) "Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars." Testing was conducted under controlled independent laboratory conditions to determine the bar's properties as shown in **Table 1**.

Test	Results
Tensile Strength (ASTM D7205 21)	◇ **Avg. Peak Load:** 28,497 lbf ◇ **Avg. Strength:** 142,500 psi ◇ **Ultimate Elongation:** 2.28% ◇ **Elastic Modulus:** 6.65 Msi
Transverse Shear Strength (ASTM D7617-11)	**Avg. Peak Load:** 22,227 lbf **Avg. Peak Strength:** 32,460 psi
Bond Strength to Concrete (ASTM D7913-14)	**Avg. Load:** 5,070 lbf **Avg. Strength:** 1,291 psi (2.5 in bonded length, 0.5 in diameter)
Thermal Expansion (ASTM E831-24)	5.72 µm/m°C
Glass Content (ASTM D2584-18)	78.3% average by mass

Table 1

TENSILE CAPACITY

To validate the substitution claim, the tensile capacity of each bar is calculated as:

- Tensile Capacity = A ⇥ f_t (1)

Where:

- *A* is the nominal cross-sectional area (2)
- f_t is the tensile strength (GFRP) or yield strength (steel). (3)

Applying the tensile capacity formula:

Grade 60 Steel Rebar:

- #4 bar (Area = 0.20 in²): 0.20 ⇥ 60, 000 = 12.0 kips
- #5 bar (Area = 0.31 in²): 0.31 ⇥ 60, 000 = 18.6 kips
- #6 bar (Area = 0.44 in²): 0.44 ⇥ 60, 000 = 26.5 kips

Rebar X E-Series GFRP Rebar (based on ASTM D7205-21 lab results):

- E4™ Rebar X (est. Area = 0.10 in²): 0.10 ⇥ 142, 500 = 14.2 kips
- E5™ Rebar X (Area = 0.20 in²): 0.20 ⇥ 142, 500 = 28.5 kips
- E6™ Rebar X (Area = 0.31 in²): 0.31 ⇥ 142, 500 = 44.2 kips

Comparison with Grade 60 Steel Reinforcement

E4™ Rebar X (14.2 kips)	>	#4 Grade 60 Steel (12.0 kips)
E5™ Rebar X (28.5 kips)	>	#5 Grade 60 Steel (18.6 kips)
E6™ Rebar X (44.2 kips)	>	#6 Grade 60 Steel (26.5 kips)

As shown above, the Rebar X E-series (GFRP) provides greater tensile capacity than the #4, #5 and #6 Grade 60 steel bar. Accordingly, E4™, E5™, and E6™ GFRP bars meet or exceeds the tensile capacity of #4, #5 and #6 steel bars (respectively) conforming to ASTM A615 Grade 60 requirements.

Drag Equation: Shrinkage & Temp. Reinforcement Comparison Using ACI 440.1R

The **required reinforcement ratio** for shrinkage and temperature in slabs-on-grade is given by the drag equation as follows:

$$\rho_f = \frac{\mu L\, w_c}{E_f \varepsilon_{fu}},$$

Where:

- ***μ*:** subgrade friction coefficient
- ***L*:** slab length or spacing
- **w_c:** concrete weight
- **E_f :** elastic modulus (6.65 Msi)
- **ε_{fu}:** 2.28% ultimate strain

Assumptions/Values

- μ = 1.5
- L = 20 ft = 240 in
- w_c = 145 pcf = 0.145 kip/ft3
- GFRP modulus: E_f = 6.65 ⇥ 106 psi
- Ultimate strain: ε_{fu} = 0.0228

$$\rho_f = \frac{1.5 \times 20 \times 0.145}{6.65 \times 10^6 \times 0.0228} = 2.87 \times 10^{-5}$$

Comparison with Grade 60 Steel

- #4 Steel: $E_s = 29 \times 10^6$ psi, yield strain: $\varepsilon_y = 60,000/29,000,000 = 0.00201$
- #5 Steel: Area = 0.31 in^2, spacing = 12"

$\rho_{\#4\ STEEL} = 1.67 \times 10^{-2}$	$\rho_{E4\ GFRP} = 9.17 \times 10^{-3}$
$\rho_{\#5\ STEEL} = 2.58 \times 10^{-2}$	$\rho_{E5\ GFRP} = 1.67 \times 10^{-2}$
$\rho_{\#6\ STEEL} = 3.67 \times 10^{-2}$	$\rho_{E6\ GFRP} = 2.58 \times 10^{-2}$

E4™, E5™, and E6™ quite easily exceed the required reinforcement ratio **(ρ_f) by over 300x**. Similarly, steel bars at typical spacing far exceed shrinkage requirements, but GFRP offers higher strength-to-weight ratio and corrosion resistance.

Design Reference

Design of concrete members reinforced with GFRP bars shall comply with:

• ACI 440.1R-15 “Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars”

• ACI 318-19, as referenced by the Florida Building Code 2023, for concrete detailing and cover requirements.

Conclusion

Based on tensile-strength and reinforcement ratio analyses performed using ASTM D7205 test data and calculation methods outlined in ACI 440.1R, the results indicate that E4, E5 & E6 GFRP bars demonstrate tensile performance comparable to #4, #5, & #6 Grade 60 steel reinforcement. These findings suggest that, where design requirements are otherwise satisfied under ACI 440.1R provisions, substitution of GFRP reinforcement of the indicated sizes may be considered functionally equivalent for tensile capacity.

Rebar X meets structural standards and is code-compliant across the following jurisdictions:

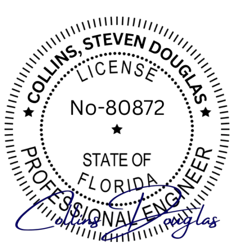
- Florida: 2023 Florida Building Code (8th Ed.)

Please contact me with any questions.

See stamp below.

Sincerely,
Engr Collins, Steven, PE

*Engineer’s seal covers design only. Engineer assumes no liability for product defects, fabrication, installation, or construction means and methods.



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