RenewWrap®
Aslan® NSM CFRP Bars

Carbon Fiber Reinforced Polymer (CFRP) Bars for Structural Strengthening

GEOTREE®

www.GeoTreeSolutions.com
1-855-655-6750

COMPOSITE REINFORCING FOR LONG LASTING CONCRETE STRUCTURES

- DRAMATICALLY INCREASE FLEXURAL & SHEAR CAPACITY
- EXTEND THE LIFE OF THE STRUCTURE
- USED IN THE NEAR SURFACE MOUNT TECHNIQUE
- ALTERNATIVE TO FIELD WET LAY UP

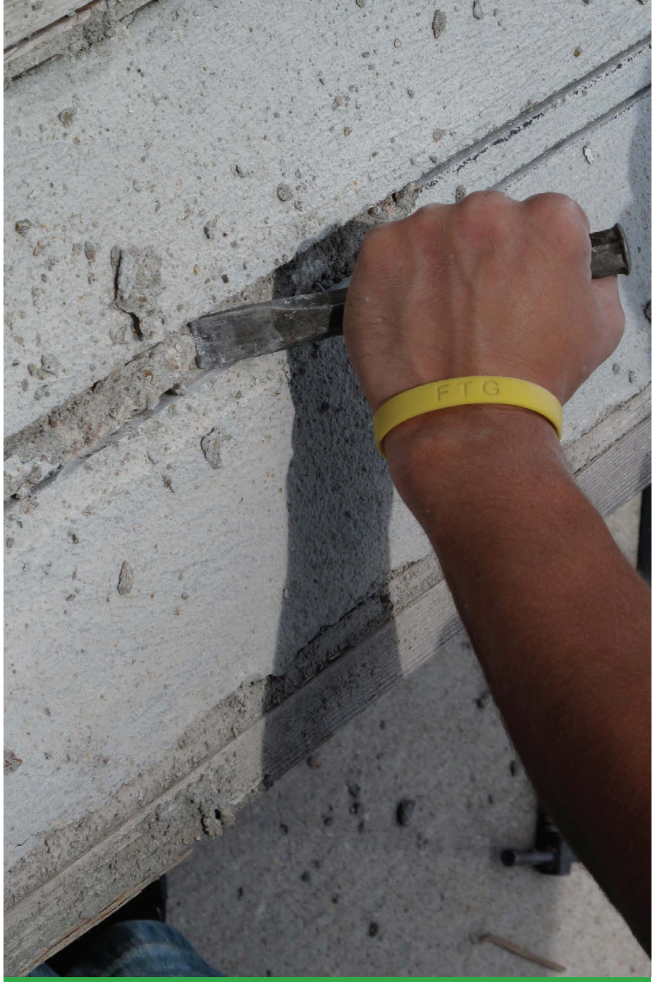
BENEFITS & MECHANICAL PROPERTIES

BENEFITS

- Impervious to Chloride Ion and chemical attack
- Tensile strengths greater than steel
- Modulus approaching that of steel & much greater than GFRP
- Can withstand greater sustained loads
- 1/5th the weight of steel rebar
- "Consumable" by excavating equipment

RenewWrap NSM bars are typically used to strengthen existing structural members (concrete, wood, stone or masonry) in flexure and shear. Structures that are deficient due to either a structural flaw, deterioration or because of a change in use can often achieve a useful capacity using RenewWrap NSM bars. Due to their extremely high strength and stiffness, along with the fact that they will not rust or corrode and are very light weight, NSM bars are often added to the concrete cover of an existing structure using a technique called Near Surface Mount or NSM strengthening. The method is analogous to adding supplement rebar to the structure. When combined with a proprietary factory applied anchorage, the NSM bars can be used as pre-stressing or un-bonded post tension tendons or earth anchors. Occasionally, the NSM bars are used as traditional concrete reinforcing bars, typically in restoration or repair situations.

Since 1993, we have been at the forefront of worldwide academic and industry efforts to define consensus FRP standards and methods. Hundreds of structures have extended service lives due to RenewWrap NSM bars



NEAR SURFACE MOUNT (NSM) STRUCTURAL STRENGTHENING

- Bridge Decks & Railings: cantilevers, negative moment regions, parapets
- Parking Garages
- Floor Slabs
- Column to Slab Connections
- Columns
- Crack Stitching & Adjoining Members

CONCRETE SUSCEPTIBLE TO **CORROSION**

- Repair Situations
- Inadequate Concrete Cover
- Historic Preservation

MASONRY STRENGTHENING

MECHANICAL PROPERTIES

Nominal Diameter			Nominal Area		f^*_{fu} Guaranteed Tensile Strength		Ultimate Tensile Load		E_f Tensile Modulus of Elasticity		Ultimate Strain
Size	mm	in	mm^2	in^2	MPa	ksi	kN	kips	GPa	psi 10^6	%
2	6	$^1/_4$	32	0.049	2241	325	71	15.92	124	18	1.81%
3	10	$^3/_8$	71	0.110	2172	315	154	34.65	124	18	1.75%
4	13	$^1/_2$	127	0.196	2068	300	262	58.80	124	18	1.67%

We reserve 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 July 2011. Maximum available length is 40ft (12m)

DESIGN TENSILE & MODULUS PROPERTIES

Tensile and Modulus Properties are measured per ASTM D7205-06, Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars. The ultimate tensile load is measured and the tensile modulus is measured at approximately 10% to 50% of the ultimate load. The slope of the stress-strain curve is determined as the tensile modulus. Ultimate Strain is extrapolated from the ultimate load divided by the nominal area and modulus. The area used in calculating the tensile strength is the nominal cross sectional area. The "Guaranteed Tensile Strength", f^*_{fu} is as defined by ACI 440.1R as the mean tensile strength of a given production lot, minus three times the standard deviation or $f^*_{fu} = fu_{,ave} - 3\sigma$. The "Design or Guaranteed Modulus of Elasticity is as defined by ACI 440.1R as the mean modulus of a production lot or $E_f = E_{f,ave}$.

MATERIAL CERTS

Material test certs are available for any production lot of the RenewWrap NSM bar. In addition to ASTM D7205 Tensile, Modulus and Strain values, the test cert includes a full accounting of various additional properties and lab tests performed on the production lot.

CROSS SECTIONAL AREA

The design properties are determined using "Nominal" diameters and equivalent calculated cross sectional areas. Surface undulations and sand coatings that facilitate bond are accommodated in ASTM D7205, section 11.2.5, with a tolerance of minus zero, plus 20% as determined by the Archimedes method of volume displacement in a fluid.

NEAR SURFACE MOUNT OR NSM ADHESIVE BOND

For NSM strengthening, the bond of the strengthening system is a function of the properties of the high strength structural adhesive AND the characteristics of the bar itself. To replicate the typical mode of failure for flexural strengthening, we perform tests using different structural adhesives in an inverted hinged "tee beam". This loading replicates a bond mode component along the axis of the beam in combination with a pull-off mode. The result is a design parameter, τ_b or l_{db} describing the development length for a given adhesive used in conjunction with the bar. The system uses several readily available commercial high strength structural adhesives typically purchased locally. Details of the various adhesives are described elsewhere.

DIRECT TENSION BOND - PULLOUT

Often it is necessary to adhesively anchor bars into adjacent members such as at column to slab intersections, wall to slab or to simply anchor an end of the bar into an existing concrete member. The pull-out capacity of the bars using various adhesives has been measured. Reports are available on request.

DURABILITY / CREEP RUPTURE / SUSTAINED LOADS

FRP bars subjected to a constant load over time can suddenly fail after a time period called the endurance time. The endurance time of Carbon FRP is generally not as affected by environmental conditions in comparison to Glass FRP. For instance the environmental reduction factors for the bar are C_E = 1.0 for concrete not exposed to earth and weather and C_E = 0.9 for exposed concrete. Accordingly, consensus design guides, such as ACI 440.1R for reinforced concrete, 440.2R for structural strengthening and 440.4R for prestressing, all allow a creep rupture stress limit of 0.55 f_{fu} or f_{pu}.

GLASS TRANSITION TEMPERATURE OF RESIN(T_g)

Known as the "glass transition temperature" or the temperature at which the resin changes from a "glassy state" and begins to soften. T_g = 230°F (110°C)

DENSITY

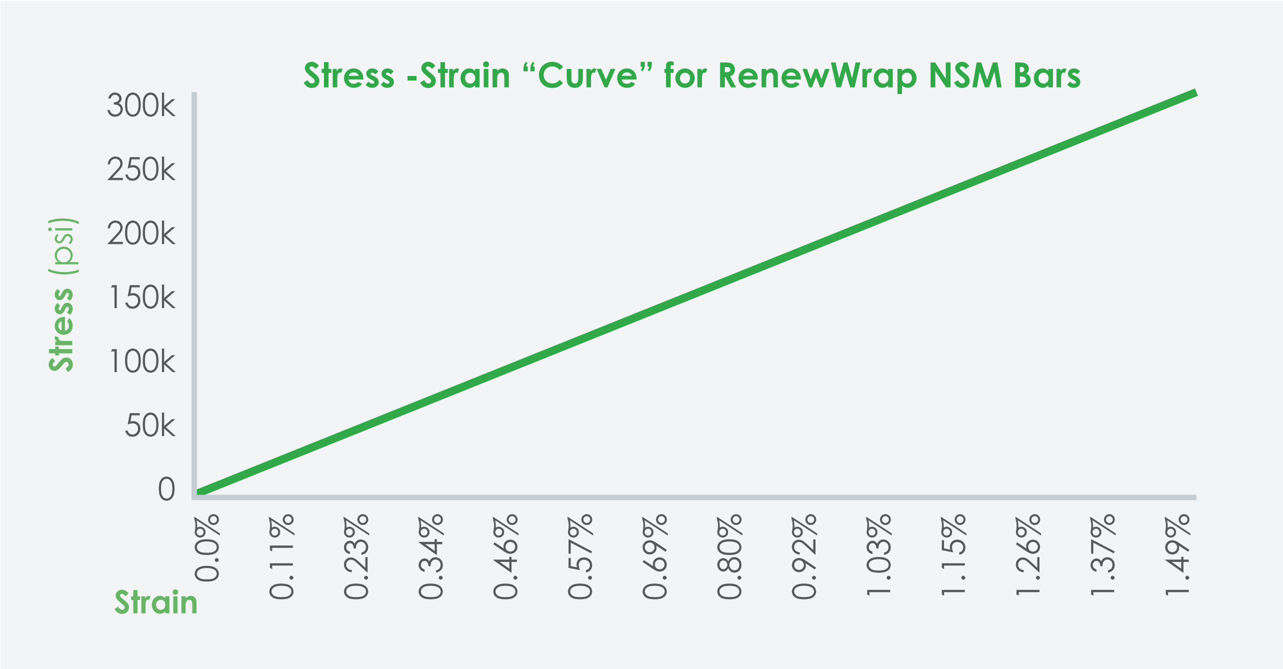
CFRP bars are approximately one fifth the weight of steel rebar.

Nominal Diameter			Unit Weight/length	
Size	mm	in	kg/m	lbs/ft
2	6	$^1/_4$	0.052	0.035
3	10	$^3/_8$	0.112	0.075
4	13	$^1/_2$	0.186	0.125

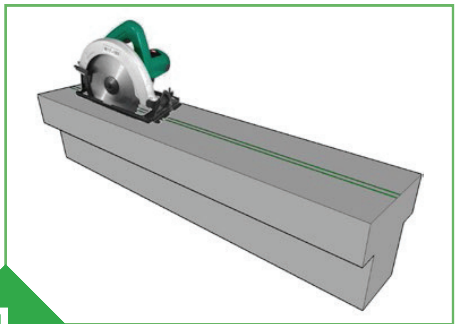
DESIGN CONSIDERATIONS

Although the FRP bars themselves are not ductile, an FRP reinforced concrete section is characterized by large deformability i.e. significant deflections and crack widths are a warning of pending failure of the section. The designer should follow the recommendations in the appropriate consensus design guideline. To aid the designer who might not be familiar with these guides and standards, we maintain a staff of registered professional engineers to assist the engineer of record in safely implementing our products.

- **ACI 440.2R "Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures"** Provides authoritative, consensus guidelines that include provisions for flexural strengthening using Near Surface Mount Strengthening.
- **ACI 440.7R "Guide for the Design and Construction of Externally Bonded Fiber-Reinforced Polymer Systems for Strengthening Unreinforced Masonry Structures"** An ACI "Emerging Technology Series" document provides state of the art guidance for masonry strengthening with FRP bars.



NSM INSTALLATION INSTRUCTIONS



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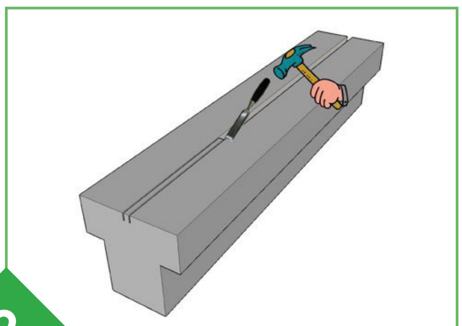
Step #1 Grooves are cut after marking the layout as per the Engineer of Records' specifications. Generally the final groove dimension is 1.5 times the bar diameter in depth and width. Dado cuts are also effective if possible. Note: Proper equipment such as diamond crack chasing blades, guide rails and sufficiently sized power tools make cutting of the grooves easier. Rather than cut the groove in a single pass, sometimes its more effective to cut parallel grooves and remove the concrete between the saw cuts.



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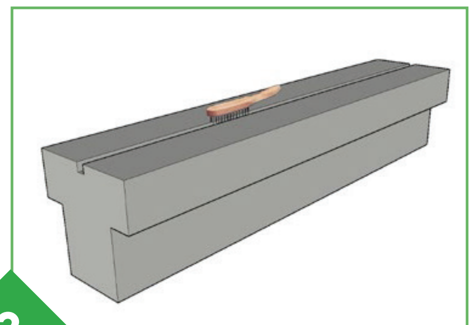
Step #2 Chisel any remaining concrete between cut paths.



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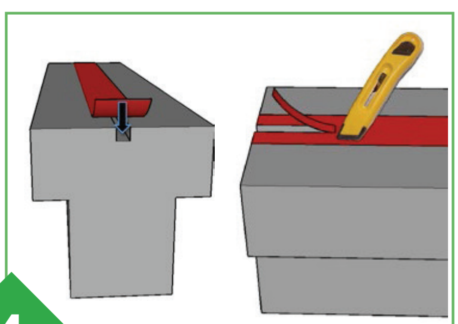
Step #3 Clean the groove and eliminate any residual dust with compressed air or vacuum. Note: It is not necessary to roughen the interior of the groove with additional abrasion, or brushing.



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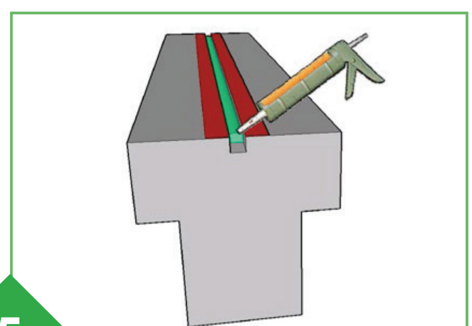
Step #4 For a clean appearance, mask the concrete adjacent to the groove. Note: A time saving tip is to mask over the groove and then trim the masking to each edge.



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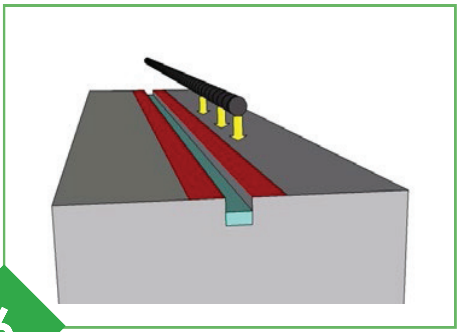
Step #5 Fill the groove approximately half way with RenewWrap NSM Gel. Note: Consider bulk dispensing of adhesive when making your choice of adhesive for the project.



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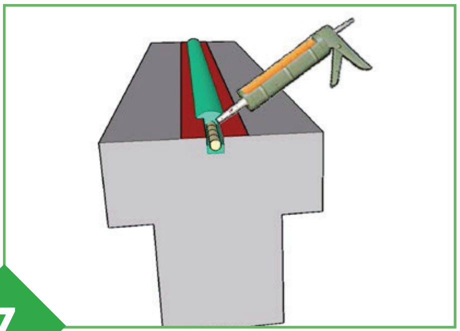
Step #6 Press the Aslan 200 bar into the groove partially filled with adhesive. The objective is to ensure adhesive is well consolidated around the bar without air pockets. Note: Some contractors have developed their own system based on epoxy crack injection methods using a low viscosity epoxy crack injection resin.



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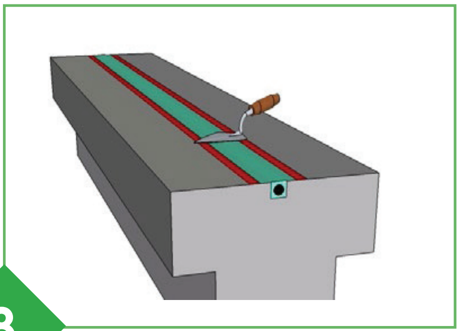
Step #7 Completely fill the groove with adhesive ensuring the bar is fully covered.



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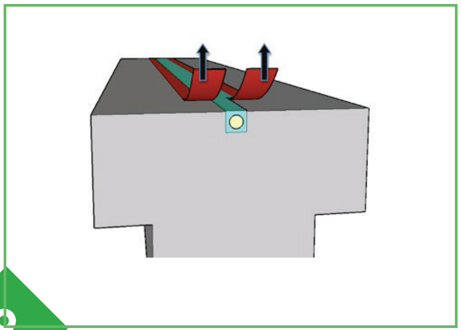
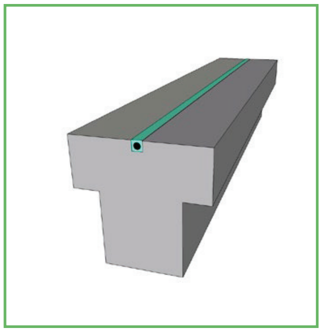
Step #8 Level off the excess adhesive with a trowel or putty knife.





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Step #9 Remove masking. Note: pull the masking off before adhesive is fully cured.



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