Basanite Industries

BASALT FIBER REINFORCED POLYMER

Design Guide

Corrosion Proof, Composite Reinforcement for Residential, Commercial and Industrial Warehouse Floors, Slabs on Grade, Multi-Story Structures and Precast Concrete Elements

Basanite manufactures BasaFlex™, an enhanced Basalt Rebar, engineered to add intrinsic value to structural concrete, and as a sustainable, non-corrodible FRP and High Strength Corrosion Proof steel reinforcement.

BASAFLEX™ BFRP REBAR BENEFITS

- 2.5 X Stronger and 4 X lighter than steel
- Reduced costs for shipping, handling and placement.
- 100% Corrosion Resistant – Rust Proof
- Piling
- Eliminate ongoing costs for maintenance & repair.
- Sustainable and Eco-Friendly 100+ year product
- Similar thermal expansion coefficient as concrete eliminates cracking in freeze/thaw concern.
- Chemical, and UV resistant
- Non-conductive, non-magnetic, no RF interference

APPLICATIONS

Tunneling & Mining

- Sequential Excavation or MATM Tunneling
- Temporary Reinforcement; Rock Bolts

Concrete Containment Structures

- Wastewater Treatment Facilities
- Swimming Pools, Petro Chemical Tanks

Reduced weight in Architectural Elements

Masonry Strengthening

- Seismic, Wind or Blast Strengthening
- Strengthening for "Event & Cycle Loading"

Concrete Exposed to De-Icing or Marine Chlorides

- Bridges & Railings; Median Barriers
- Parking Structures
- Continuously Reinforced Concrete Paving
- Precast Elements; Sea Walls; Dry Docks; Port Aprons

Transparency in High Voltage and Electromagnetic Fields

- High Voltage Substations; Radio Frequency Sensitive Areas
- Hospital MRI Areas, Cable Ducts and Banks
- Aluminum Smelters and Steel Mills

BASALT PRODUCTS ADD INTRINSIC VALUE TO A CONCRETE STRUCTURE

Compelling technology is emerging from the shadows of structural failures making world news including the NYC parking garage and Surfside, Florida condo collapse. In conventional Concrete Reinforcement Systems, cracking concrete exposes steel rebar to the effects of salt water, sulfide gas, and other aggressive chemicals.

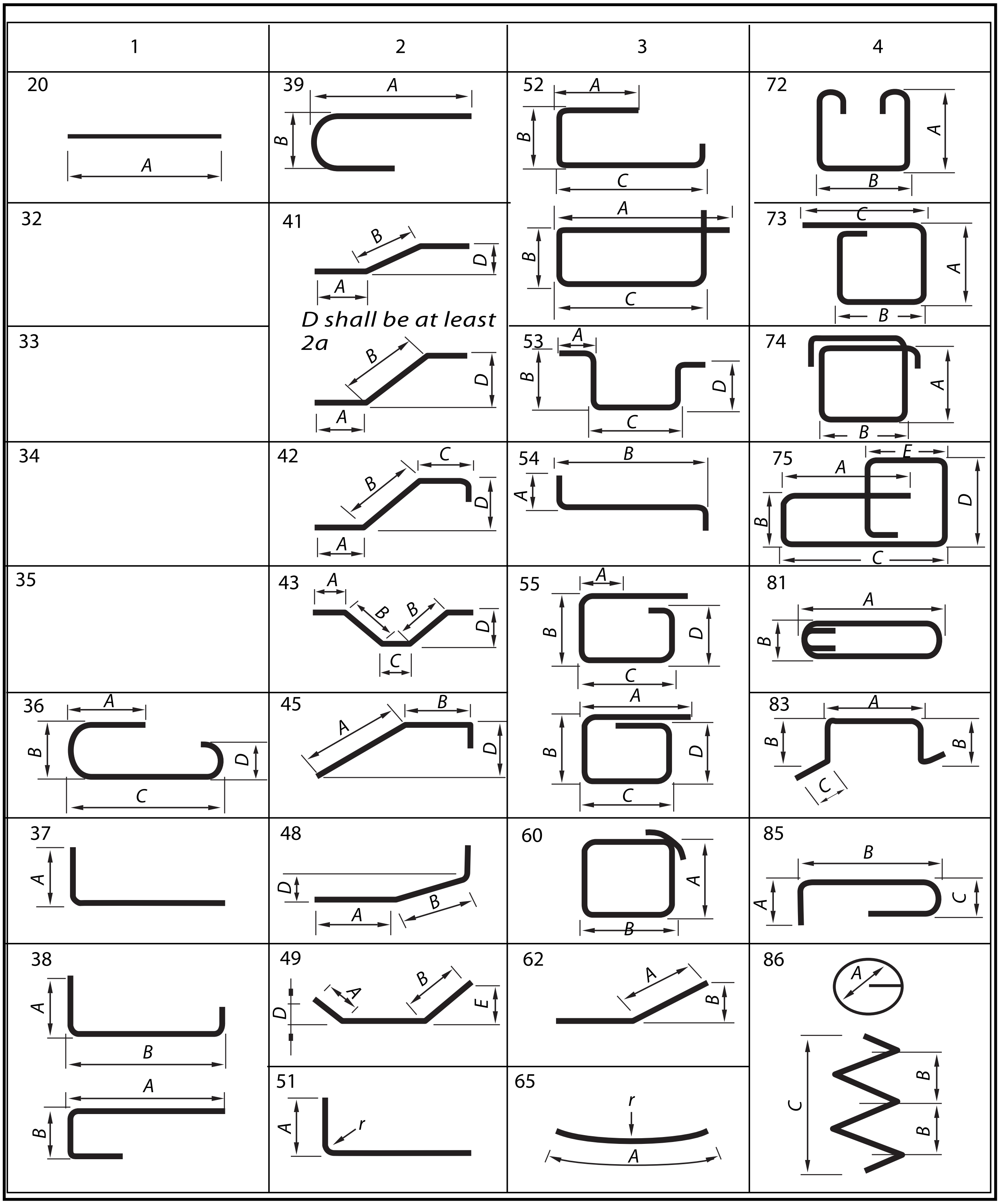
Basalt Fiber Reinforced Polymer or "BFRP" offers an economical, practical and "Green" means of structural reinforcement. BFRP has a strength 2.5 times that of steel, and a weight 25% that of its ferrous counterpart. This LOW CARBON FOOTPRINT "Green" material is inert in acids, caustics, salt and sulfide gas, making it corrosion proof. BFRP enjoys a Carbon Footprint of approximately one-tenth that of steel.

BFRP is produced in all common rebar sizes, as a reinforcement mesh and as loose fibers for direct inclusion into concrete ready mixes. BASAFLEX™ Rebar is manufactured in #2 thru #8.

SUSTAINABLE, NON-CORROSIVE ALTERNATE TO TYPICAL STEEL REINFORCEMENT

Basalt Rock is one of the most common materials on the planet occurring naturally throughout the United States. The purity and fine-grained nature of Basalt Rock allows smelting at 1500°C for extruded into long filaments called "Roving's". These are chopped into small fibers, woven into geogrid or "pultruded" into Basalt Fiber/Epoxy composite REBAR.

BFRP Rebar eliminates corrosion as a design consideration, and offers competitive toolbox of raw materials, without SUPPLY CHAIN DISRUPTIONS for use in many forms of concrete reinforcements. Applications include Seawalls, Sewer Manholes, Pilings, Slabs, Bridge Decks and structures were cracking concrete otherwise exposes steel to corrosion.


1
2
3
4
20
32
33
34
35
36
37
38
39
41
D shall be at least 2a
42
43
45
48
49
51
52
53
54
55
60
62
65
72
73
74
75
81
83
85
86

BFRP WILL NOT RUST AND IS STRONGER/LIGHTER THAN STEEL

Challenging the construction industry are shortages of steel and other raw materials, Supply Chain Disruption and Buy America Clauses", challenge the use of foreign steel which otherwise alleviate long lead-times for adequate supply of domestic product.

There has been extensive testing of Fiber Reinforced Polymer products which represented in standards published by ACI, USDOT, AASHTO ICC ES and ASTM including FDOT inclusion of these products categorically into their Standards for Road and Bridge Construction.

Basanite Products

These products exceed requisite strength and durability properties while offering service life rated at two (2) times that of materials they are replacing. Less Trucking, smaller equipment and installation efficiencies augment the primary benefit which is "Non-Corrodable" in Salt Water and Sulfide Gas environments. This lighter, "Environmentally Greener", and Cost Saving product group is emerging as a major player in today's construction markets.

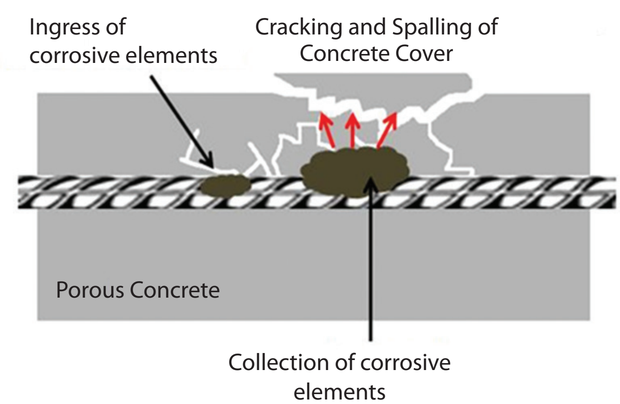
In seawalls, roadways, bridges, concrete storm and sanitary structures, pilings, beams and decks; Basalt Fiber Reinforced Fiber technology serves wherever concrete reinforcement is required and corrosion is not.

Basanite Products are defined in many ACI Code Documents and have most recently been the beneficiary of the recent ratification of ICC ES Certification ESR 5092, ASTM D8505-23, ASTM D8448-22, FDOT Facility approval FRP-22.

THE PROBLEM

- Failing Infrastructure Due to Corrosion
- Extremely High Cost of Repair / Replacement
- Shortened Concrete Life Cycles
- Serious Safety Concerns

This happens to ALL steel rebar & mesh



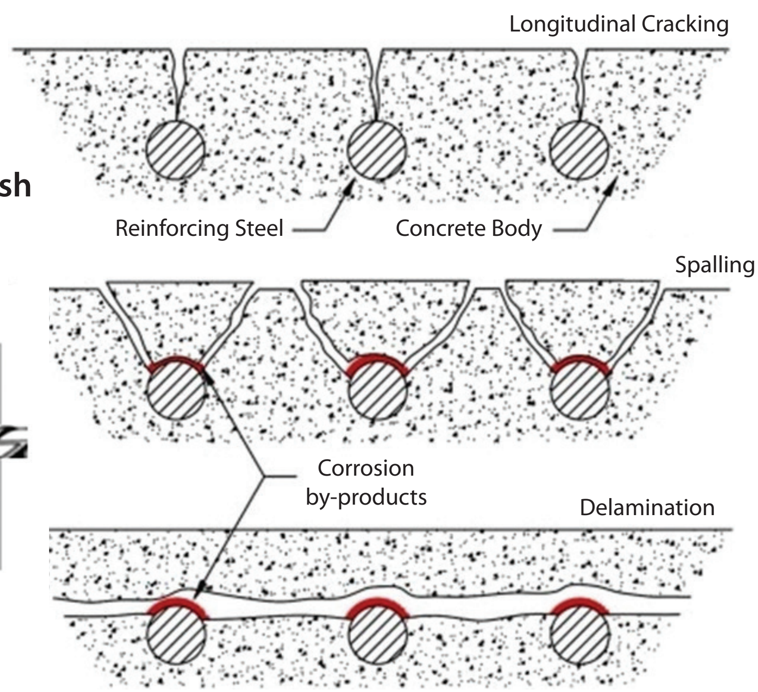


TABLE OF CONTENTS

http://basaniteindustries.com

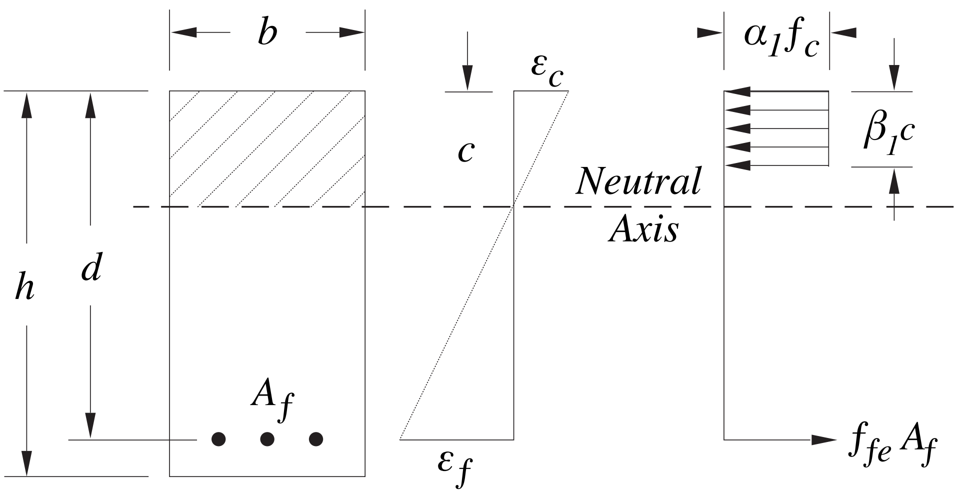
OTCQB: BASA

FRP REBAR

FRP reinforcing bars are manufactured using a variety of fibers in a polymer matrix. Glass fiber is the most popular; however, basalt, carbon, aramid, PBO and other fibers are also used in FRP bars. The matrix is a thermoset compound and is usually epoxy or vinyl ester although other polymer matrices are used. Unlike steel rebar that is manufactured to uniform standards, each manufacturer's FRP reinforcing bars will have unique physical and strength characteristics. A manufacturer's FRP bar product data sheet that identifies these characteristics is required for the calculation of strength and serviceability criteria for FRP reinforced concrete members.

DESIGN METHODOLOGY

Design loads on a reinforced concrete structure are determined using the same methods whether reinforced using steel or using high strength, fiber reinforced polymer (FRP) reinforcing bars. Steel and FRP reinforced concrete members are analyzed using similar methods to meet the following strength and serviceability criteria: Factored moment, factored shear, crack width, and long-term deflection. Additionally, FRP reinforced members are analyzed for creep-rupture stress in FRP bars where steel reinforced members are not.



Stress-strain on a FRP rebar reinforced concrete section

In the U.S. and other countries of the world, the American Concrete Institute (ACI) 440.1-06, "Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars" is used as the design guidance to calculate the design criteria above for FRP bar reinforced concrete members. In addition, The American Association of State Highway and Transportation Officials (AASHTO) provides guidance in its 2009 "AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings, First Edition."

Other standards that provide design guidance are the Canadian Standards Association (CSA) and Federation International du Beton (International Federation for Structural Concrete (fib)

For most members, the design of FRP reinforced sections is driven primarily by serviceability requirements: crack width and long-term deflection. This is due to the generally lower modulus of elasticity of FRP bars as compared to steel bars. When these criteria are met, flexural strength (?Mn), minimum reinforcement (Af), and creep-rupture stress are generally easily met.

Different types of FRP rebar

FLEXURAL STRENGTH DESIGN

The flexural strength of a section using ACI 440.1 is calculated similarly to ACI 318, "Building Code Requirements for Structural Concrete and Commentary." Because FRP rebars do not yield like steel bars, FRP reinforced members are generally over-reinforced (that is, the ratio of FRP reinforcement to concrete is greater than the balanced ratio) so that concrete crushing of the member controls the failure mode. A FRP reinforced section that is under-reinforced (that is, the ratio of FRP reinforcement to concrete is less than the balanced ratio) may result in a failure mode of FRP rupture, which is not a preferred ductile failure mode.

Because of the relative lack of ductility in FRP reinforced failure modes, the flexural strength reduction factor ranges between 0.55 and 0.65, based on the ratio of proposed reinforcement to the balanced reinforcement ratio. For failure by FRP rupture, the strength reduction factor is 0.55. Where failure is by concrete crushing, the strength reduction factor increases to 0.65 where the ratio of proposed FRP reinforcing is greater than 1.4 times the balanced reinforcement ratio.

SHEAR STRENGTH DESIGN

Shear strength design is based on familiar ACI 318 methods. ACI 440.1, however, does not allow for dowel action of FRP rebar to resist shear, as ACI 318 allows steel bars to resist shear. To resist shear forces a FRP reinforced member must contain ties or stirrups to resist shear, or if not practical as in the case of reinforced concrete tanks, rely only on the shear resistance of concrete. A RC design without shear reinforcing leads to deeper sections where shear is critical.

Although a deeper member may not initially be desired, a deep member corresponds to an increase of the cracking moment of the section. A cracking moment that is 25 percent greater than the applied service moment allows the gross moment of inertia to be used to calculate deflections and the full section of the concrete member to resist shear loads.

The tensile strengths of FRP rebar can be much greater than that of steel, most FRP bars have a much lower modulus of elasticity, or stiffness. Decreased stiffness means that more reinforcing is needed to mitigate long-term deflections and limit crack widths or a deeper member may be needed.

SERVICEABILITY DESIGN

Crack Width Design

Crack width calculations are based on the same concept for FRP rebar as it is for steel reinforced members, except that it is modified by a bond quality coefficient, kb. The bond of FRP bars to concrete is generally less than that of steel bars due to less prominent deformations, which according to ACI 440.1 has a long-term effect on crack widths. ACI 440.1 recommends that the crack width calculation be increased by the bond quality coefficient of kb equal to 1.4, unless a FRP bar manufacturer can prove by testing that its bond with concrete results in a lower bond quality coefficient.

Deflection Design

Long-term deflection calculations are based on ACI 318 section 9.5, direct method of limiting computed deflections. Where the applied, unfactored moment exceeds the cracking moment, the effective moment of inertia is reduced by the reduced tension stiffening in FRP reinforced sections as compared to steel reinforced sections. The degree of tension stiffening in FRP reinforced sections decreases with the amount of reinforcing compared to the balanced reinforcing ratio.

Creep Rupture and Fatigue Design

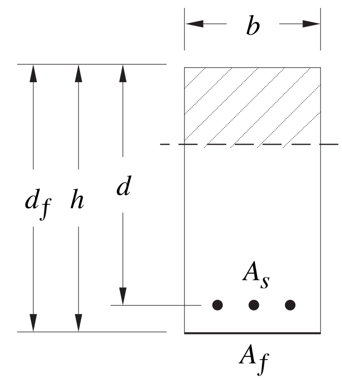
Creep-rupture and fatigue effects on a FRP reinforced concrete member limit the amount of stress allowed on FRP rebar. ACI 440.1 provides creep-rupture strength reduction coefficients for carbon, glass, and aramid FRP bars. Click to see this chart for each of the factors. Although ACI 440.1 does not recommend a creep-rupture stress limit for basalt FRPs, research by Dr. Anil Patnaik at the University of Akron recommends a maximum creep-rupture stress limit on basalt FRPs to 0.15 times the environmentally factored, ultimate tensile strength, ffu.

FRP PRO BEAM

Worksheet for design of the strengthening of a standard, singly reinforced concrete beam with externally applied FRP laminates based on the procedures of the American Concrete Institute ACI 44Ø.2R -Ø8.

1 - Beam Geometry and Capacity

Beam length, l	ft
Beam width, b	12.0 in
Effective depth, d	21.5 in
Depth to FRP, d_1	24.0 in
Concrete compressive strength, f_c	5.0 ksi
Steel yield strength, f_y	60.0 ksi
Modulus of elasticity of steel, E_s	29000 ksi
Areas of tension steel, A_s	3.00 in²
Existing dead-load moment, $M_{DL,\ existing}$	72.0 kip-ft
Moment resistance of unstrengthened beam, ΦM_n	224.0 kip-ft



2 - Loadings and Corresponding moments

Design Dead-load moment, M_{DL}	72.0 kip-ft	
Design Live-load moment, M_{LL}	130.0 kip-ft	
Design Service-load moment, $M_S = 1.0 \cdot M_{DL} + 1.0\ M_{LL}$	202.0 kip-ft	
Factored moment, $M_u = 1.2 \cdot M_{DL} + 1.6\ M_{LL}$	294.4 kip-ft	(ACI 318-11 eq. 9.2)
Extended and heavy (greater than 150 lbs/ft²) live load?	No	
Unstrengthened moment limit, $(\Phi R_n)_{existing}$	176.7 kip-ft	(ACI 440.2R-08, eq. 9-1, sec 9.2)
Does $\Phi Mn \geq (\Phi R_n)_{existing}$?	224.0 kip-ft	ksi 176.7 kip-ft

3 - Manufacturer's reported FRP system properties

FRP Manufacturer		
FRP Product	CFRP textile	
Properties of textile, laminate, or NSM bar?	Textile	
Fiber material in the FRP	carbon	
Ultimate tensile strength f_{tu}	250.0	ksi
Modulus or elasticity of FRP laminates E_f	19230.0	ksi
Rupture strain ε^*_{fu}	0.013	in/in

Properties of externally bonded FRP reinforcement

FRP Product	Ply thickness t f, in	Ply width, w f, in	Number of ply layers, n f	Number of ply groups, m f	Area of ply, t f, w f, n f, m f in2	Location
CFRP Textile	0.040	121	1	1	0.48	Beam Soffit
	0	0	0	0	0	
	0	0	0	0	0	
				$A_f =$	0.480	in²

4 - Calculate the FRP system design material properties

Environmental reduction factor C_E

$$C_E = 0.95 \qquad \text{(ACI 440. 2R-08, Table 9.1)}$$

$$f_{fu} = C_E \cdot f^*_{fu}$$
$$f_{fu} = 237.5\ ksi$$

$$\varepsilon_{fu} = C_E \cdot \varepsilon^*_{fu}$$
$$\varepsilon_{fu} = 0.0124\ ksi$$

5 - Existing Beam Properties

β_1 from ACI 318-11, § 10.2.7.3:

$$\beta_1 = \begin{cases} \text{for } 2500 \text{ psi} \le f^1c \le 4000 \text{ psi}, \beta_1 - 0.85 \\ \text{for } f_c > 4000 \text{ psi}, \beta_1 = 0.85 - 0.05 \left(\dfrac{f^1. - 4000}{1000} \right) \\ \text{but } \beta_1 \text{ shall not be less than } 0.65 \end{cases}$$

therefore, $\beta_1 = 0.8$

Modules of elasticity of Normal Weight Weight Concrete E_c

$$E_c = 57{,}000\sqrt{f^1{}_c} \qquad \text{(ACI -3168-11, §8.5.1)}$$
$$E_c = 4030.5 \text{ ksi}$$

The modular ratio of elasticity between steel and concrete n_s

$$n_s = \frac{E_s}{E_c}$$

$$n_s = 7.2$$

6 - Existing strain on the beam soffit

Using cracked beam analysis, calculate the depth to the neutral axis, *y*, and the moment of inertia of the cracked section , I_a

Ratio of steel reinforcing to the concrete section

$$\rho_s = \frac{A_1}{b \cdot d}$$

$$\rho_s = 0.01163$$

Ratio of FRP reinforcing to the concrete section

$$\rho_f = \frac{A_f}{b \cdot h}$$

$$\rho_f = 0.00186$$

The ratio of depth of the neutral axis to the depth of the steel reinforcement, *k*

$$k = \sqrt{\left(\rho_s \cdot \frac{E_s}{E_c} + \rho_f \cdot \frac{E_f}{E_c}\right)^2 + 2 \cdot \left[\rho_f \cdot \frac{E_s}{E_c} + \rho_f \cdot \frac{E_f}{E_c}\left(\frac{d_f}{d}\right)\right]} - \left(\rho_s \cdot \frac{E_s}{E_c} + \rho_f \cdot \frac{E_f}{E_c}\right)$$

$$k = 0.35$$

Calculate the elastic depth to the cracked neutral axis

$$y = k \cdot d$$

$$y = 7.52 \text{ in}$$

The moment of inertia of the cracked section can be found by

$$I_{cr} = \frac{b \cdot y^3}{3} + n_s \cdot A_s \cdot (d - y)^2$$

$$I_{cr} = 5{,}920 \text{ in}^4$$

Finally, the strain on the soffit due to the existing dead load can be found by

$$\varepsilon_{bl} = \frac{M_{DL, existing} \cdot (d_f - k \cdot d)}{I_{cf} \cdot E_c}$$

$$\varepsilon_{bl} = 0.00060$$

7 - Design strain of the FRP system

$$\varepsilon_{td} = 0.083\sqrt{\frac{f^1{}_c}{n_f \cdot E_f \cdot T_f}} \leq 0.9\,\varepsilon_{tu} \qquad \text{(ACI 440.2R-08, eq. 10-2)}$$

$$\varepsilon_{td} = 0.0067 \leq 0.0111$$

Therefore FRP debonding controls design so use

$$\varepsilon_{td} = 0.0067$$

8 - Estimate *c*, the depth to the neutral axis

For a first estimate, try $C_{est} = 0.20 \cdot d$

$$C_{est} = 5.79 \text{ in}$$

9 - Effective strain on the FRP reinforcement

$$\varepsilon_{te} = 0.003\left(\frac{d_f - c}{c}\right) - \varepsilon_{bl} \leq \varepsilon_{fd} \cdot K_M \qquad \text{(ACI 440.2R-08, eq. 10-3)}$$

$$\varepsilon_{te} = 0.0088 > 0.0067$$

FRP debonding is failure mode
Therefore, $\varepsilon_{te} = 0.0067$

The concrete strain:

$$\varepsilon_c = (\varepsilon_{fe} + \varepsilon_{bl}) \cdot \left(\frac{c}{d_f - c}\right) \leq \varepsilon_{CM} = 0.003$$

$$\varepsilon_c = 0.0023 \leq 0.003$$

$$\varepsilon_c = 0.0023$$

The strain in the existing reinforced steel:

$$\varepsilon_s = (e_{fe} + e_{bl}) \cdot \left(\frac{d - c}{d_f - c} \right)$$ (ACI 440.2R-08, eq. 10-10)

$$\varepsilon_s = 0.0063$$

10 - Stress level in the reinforcing steel and FRP

Stress on the reinforcing steel:

$$f_s = E_s \cdot \varepsilon_s \le f_y$$ (ACI 440.2R-08, eq. 10-9 and 10-11)

$$f_s = 182.4 \text{ ksi} \quad > \quad 60.0 \text{ ksi}$$

Stress on the steel is greater than the yield stress, therefore use

$$f_s = 60.0 \text{ ksi}$$

Stress on the FRP

$$f_{te} = E_t \cdot \varepsilon_{te}$$

$$f_{te} = 128.7 \text{ ksi}$$

11 - Internal force resultants and check equilibrium

Calculate the strain ε'_c corresponding to f'_c

$$\varepsilon'_c = \frac{1.7 \cdot f'_c}{E_c}$$

$$\varepsilon'_c = 0.0021$$

Calculate β_1, the ratio of the equivalent rectangular compressive stress block depth to the natural axis depth, *c*, and α_1, and the ratio of average concrete stress.

$$\beta_1 = \frac{4 \cdot \varepsilon'_c - \varepsilon_c}{6 \cdot \varepsilon'_c - 2 \cdot \varepsilon_c}$$

$$\beta_1 = 0.76$$

$$\alpha_1 = \frac{3 \cdot \varepsilon'_c \cdot \varepsilon_c - \varepsilon_c^2}{3 \cdot \beta_1 \cdot \varepsilon'^2_c}$$

$$\alpha_1 = 0.913$$

Force equilibrium is verified by checking the initial estimate of c_1

$$c = \frac{A_s \cdot f_s + A_f \cdot f_{fe}}{\alpha_1 \cdot f'_c \cdot \beta_1 \cdot b}$$ (ACI 440.2R-08, eq. 10-12)

$$c = 5.79 \text{ in} \quad = \quad c_{est} \quad = \quad 5.79 \text{ in}$$

12 - Adjust c_{est} until forced equilibrium is satisfied

Equilibrium is acheived when c equals c_{est}. If not, try another value for c_{est} in Step 8.

13 - Flexural strength components

Steel contribution to bending resistance

$$M_{ns} = A_s \cdot f_s \cdot \left(d - \frac{\beta_1 - c}{2} \right) \qquad \text{(ACI 440.2R-08, eq. 10-13)}$$

$M_{ns} =$ 289.4 kip-ft

FRP contribution to bending resistance

$$M_{nf} = A_f \cdot f_{fe} \cdot \left(d_f - \frac{\beta_1 - c}{2} \right) \qquad \text{(ACI 440.2R-08, eq. 10-13)}$$

$M_{nf} =$ 112.2 kip-ft

14 - Design flexural strength of the section

First check the strength reduction factor, Φ based on the strain of the reinforcing steel, ε_s

$$\Phi = \begin{cases} 0.90 \text{ for } \varepsilon_s \geq 0.005 \\ 0.65 + (\varepsilon_s\text{-}0.002)(250/3) \text{ for } 0.002 < \varepsilon_s < 0.005 \\ 065 \text{ for } \varepsilon_s \leq 0.002 \end{cases} \qquad \text{(ACI 318-11, fig. R 9.3.2)}$$

In step 10, ε_s was found to be 0.0063 therefore,
$\Phi =$ 0.90

Calculate the design flexural strength

$$\Phi M_n = \Phi (M_{ns} + \psi_f \cdot M_{nf}) \geq M_n \qquad \text{(ACI 440.2R-08, eq. 10-1 \& 10-13)}$$

$\Phi M_n =$ 346.3 ksi $\geq$ 294.4 kip-ft

where $\psi_f = 0.85$

Therefore the strengthened section IS capable of sustaining the new required moment strength.

15 - Reinforcing steel stress check at the service load level

Calculate the service stress level in the reinforcing steel. Verify that it is less than the recommended limit.

$$f_{s_1s} = \frac{\left[Ms + \varepsilon_{bl} \cdot A_f \cdot E_f \cdot \left(d_f - \frac{y}{3} \right) \right] \cdot (d - y) \cdot E_l}{A_1 \cdot E_1 \cdot \left(d - \frac{y}{3} \right) \cdot (d - y) \cdot + A_f \cdot E_f \cdot \left(d_f - \frac{y}{3} \right) \cdot (d_f - y)} \leq 0.80 f_y \qquad \text{(ACI 440.2R-08, eq. 10-6 \& 10-14)}$$

Therefore the stress level in the reinforcing steel IS within the recommended limit.

16 - Creep rupture limit of FRP check at the service load level

Calculate the stress level in the FRP. Verify that it is less than creep-rupture stress limit given in Table 10-1.

(ACI 440.2R-08, eq. 10-15 & table 1.0.1)

$$f t_1 s = f_{s_1 f} \cdot \left(\frac{E_f}{E_s} \right) \cdot \left(\frac{d_1 - y}{d - y} \right) - \varepsilon_{bI} \cdot E_f \qquad \leq 0.55 \cdot ffe \text{ for carbon FRP}$$

$f t_1 s =$ 19.1 ksi ≤ 130.6 ksi

Therefore the stress level in the FRP IS within the recommended sustained + cyclic stress limit.

17 - Summary of Results

Summary of factors and moment resistance				
FRP reduction factor ψ_f	Strength reduction factor Φ	Beam strength without FRP reinforcing ΦMn (unreinf.) kip-ft	Beam strength with FRP reinforcing ΦMn (reinf.) kip-ft	Required ultimate flexural strength Mu kip-ft
0.85	0.90	224.0	346.3	294.4

Summary of FRP product specifications and locations						
FRP product	Ply thickness t_{f_1} in	Ply width, w_f, in	Number of ply layers, n_f	Number of ply groups , m_f	Area of ply t_f, w_f, n_f, m_f in2	Location
CFRP textile	0.040	12	1	1	0.48	Beam soffit
	0	0	0	0	0	
	0	0	0	0	0	
				$A_f =$	0.48	in^2

Notes: **1. Symbols and notations follow the conventions of ACI 440.2R-08.**

BASANITE PRODUCTS

Basanite Industries LLC., is a manufacturer of the basalt fiber reinforced polymer (BFRP) products used as an alternative to steel for concrete reinforcement. The company's products include BasaFlex™, BasaMix™, BasaMesh™, and BasaLinks™. Basanite Industries is positioned to become the leading supplier of engineered BFRP composite products for the concrete industry.

Basanite Industries' Products:
a) BasaFlex™
b) BasaMix™
c) BasaMesh™
d) BasaFlex™Coated
e) BasaLinks™

BasaFlex™ is a high performance, state-of-the-art basalt composite rebar. The manufacturing methodology, resin matrix and profile design are proprietary and Patent Pending. The core engineered advantages and competitive price, places BasaFlex™ as the preferred (non-metallic) composite rebar supplier for concrete reinforcement.

The standard inventory, for BasaFlex™ BFRP Rebar, for domestic and international markets, is presented in Table 1.

Table 1. Standard Inventory of BasaFlex™

BAR #	DIAMETER mm (in)	DOMESTIC MARKET LENGTH Ft (M)	INTERNATIONAL MARKET LENGTH M(Ft)
2	6 (0.250)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
2.5	8 (0.315)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
3	10 (0.375)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
4	13 (0.500)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
5	16 (0.675)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
6	19 (0.750)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
7	22 (0.875)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)
8	25 (1.00)	10 (3.05) 20 (6.10) 40 (12.12)	3 (9.84) 6 (19.68) 12 (39.36)

Basanite Industries has certification test data from the University of Miami, and the University of Sherbrooke; certified by FDOT. The certification test results are summarized in Table 2.

Table 2. Independent University Data for BasaFlex™ Rebar

BAR #	Cross Section (mm^2)	Ultimate Tensile Strength (MPa)	Ultimate Strain (%)	Interlaminar Shear Strength (MPa)	Tensile Modulus (GPa)	24 Hr. Water Absorption (%)
3	91	1125	2	59	57	0.20
4	167	1252	2.1	53	60	0.15
5	236	1156	2	60	58	0.13
6	309	1011	1.9	51	54	0.09
7	429	914	1.8	51	52	0.15
8	565	817	1.7	51	49	0.22

Table 3. Types and Sizes of BasaMesh™

Mesh Type	Cell Size (mm)	Roll Width (M)	Roll Length (M)	Max Load (Weft)	Max Load (Warp)
340g/mtr	25	1	50	75,000 N/mtr	80,000 N/mtr
370g/mtr	50	1	50	80,000 N/mtr	110,000 N/mtr
370g/mtr	50	4	50	80,000 N/mtr	110,000 N/mtr

Table 4. Chopped Basalt Fiber per ASTM D8448-22 for Direct inclusion in Concrete or Asphalt, BasaMix™

Fiber Diam (μ)	Fiber Length (mm)	Bag Weight (lbs)	Codification of Sizing
9-19	12,18,24	1.5, 2.0 or Bulk	5X1

COMMITMENT TO QUALITY

Basanite Industries, LLC is a new business headquartered in Pompano Beach, FL, and formed to meet the market opportunity of increased acceptance and use of Basalt Fiber Reinforced Polymer (BFRP) rebars in the civil, precast and general construction industry.

The construction industry is seeking alternative materials to eliminate the exposure to corrosion; resulting in concrete failure. The continued use of traditional black steel as reinforcing bars is the primary reason for the occurrence of corrosion in concrete.

Basanite is positioning itself as a leading resource, manufacturer and market developer of high-performance, high-quality BFRP reinforcing products.

Basanite Industries is committed to manufacturing products in compliance with all quality requirements set forth through industry standards. An approved, systematic Quality Control Program is in place to assure the high-quality industry standards are consistently achieved.

The Company continuously monitors the Quality Control processes for improvement, and to ensure its products consistently exceed quality requirements as defined by customers, statutory or regulatory institutions. Basanite's management and employees are dedicated to the continuous improvement and effectiveness of the Quality Management System; to achieve total product excellence and customer satisfaction.

Fred Tingberg Jr. — Vesna Stanic

Fred Tingberg Jr.
Director/ CTO

Vesna Stanic, PhD
Director of Quality Assurance

Basanite Industries, LLC
2041 NW 15th Avenue, Pompano Beach, FL 33069
+1 954.532.4653
www.BasaniteIndustries.com Ft@BasaniteIndustries.com

RAW MATERIALS

Acceptance/Certification

The list of Basanite's raw material is shown below.

Raw Material

Constituent Elements
Epoxy resin
Curing reagent
Filler
Diluent
Basalt Fibers

Incoming raw material containers are kept in quarantine and labeled with "ON HOLD" stickers and remain that way until the QC testing is completed.

The QC test methods selected for the raw material acceptance are listed in Table 7. All tests shall be completed at Basanite's lab. The testing will be outsourced only in the event of a nonconformance resolution.

Accepted raw material containers are labeled with "ACCEPTED" green stickers, which clearly show that the material has been tested and accepted. The stickers are dated and initialed by QC person who performed the test. The test results are recorded in a QC Test Report that shows the material was accepted and is released for use.

Rejected raw materials have their containers relabeled with "REJECTED" red stickers, to show that the material failed the QC testing and will remain in Quarantine until a resolution has been determined. The QC Test Report and Non-Conforming Product Notification will be filled out and submitted to Purchasing and Production.

Nonconforming materials will remain in Quarantine until they are either cleared for return to the supplier, disposed of, or sent for additional testing by a third-party laboratory.

Raw materials received without proper documentation such as COA's, receive an "OH HOLD" sticker, and are considered nonconforming. They will remain in Quarantine until the documenta-tion is provided by the supplier, and internally tested for conformance.

Table 7. Raw Material QC Testing Methods completed at Basanite Industries' Lab.

Raw Material	QC Test	ASTM Standard/ Specifications
All Tests	Sampling	E300/E122/D3665
Epoxy	EEW	D1652
	Glass transition temperature	E1356/E1640
	Viscosity	Brookfield
	Color	D1544/ D1209
	Density	D1475
	Gel time	D4217/3532
Curing Agent	EEW	D1652
	Viscosity	Brookfield
	Density	D1475
	Color	D1544/D1209
	Gel time	D4217/3532
Diluent	Appearance	Internal SOP
	EEW	D1652
	Viscosity	Brookfield
	Color	AHPA
	Density	D1475
Filler	Surface area	D1510
	Bulk density	D1513
	Moisture	Internal SOP
Basalt Roving	Bobbin, Visual / Weight	Internal SOP
	Tensile/Modulus/Elongation	D2343
	Moisture content	Internal SOP
	Tex	Internal SOP

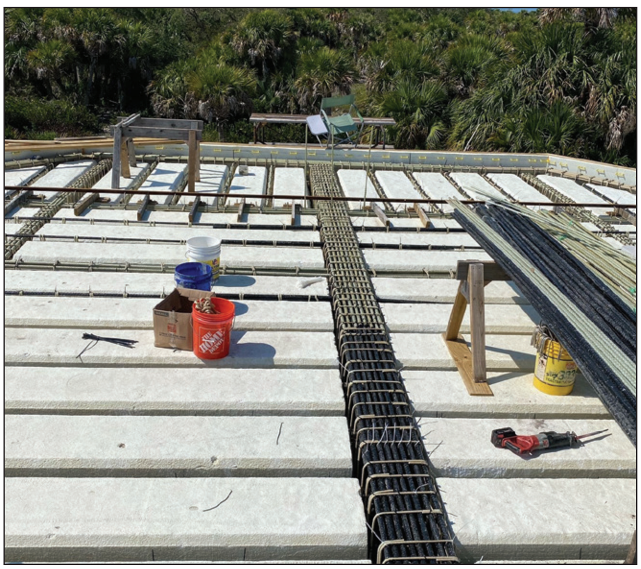
3.4 RAW MATERIAL STORAGE

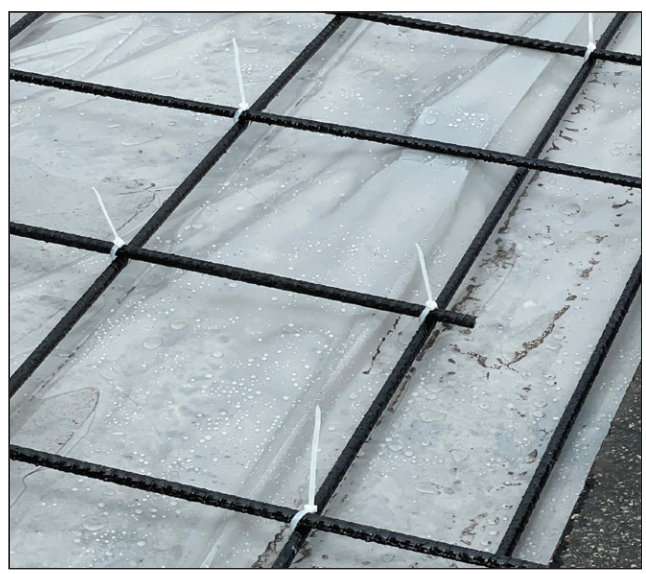
Accepted raw materials are stored in designated areas; in their original containers, further identified by the supplier's labels and Basanite's QC inspection stickers. Liquid raw materials are received in either totes or drums, while powdered materials are received in bulk bags. Wrapped individual bobbins of basalt roving are individually packaged and shrink-wrapped on pallets.

The raw material storage areas are separated from the manufacturing process flow and secured to ensure that proper identification and segregation of the materials are maintained. Storage areas are kept clean and at suitable environmental conditions required for storing. Periodic audits of the raw materials and storage areas are conducted to detect any possible deterioration of goods and to ensure that shelf-life requirements have not been exceeded.

Only authorized personnel are approved to manage material within the storage areas. A formal system has been established and maintained for movement of raw materials in and out of the storage areas. Movement and handling of raw materials from storage to the spill containment area (transfer station), or to manufacturing is completed while the materials are still in their original containers to keep the materials protected and labeled.

Whenever a raw material with a new lot number is released and moved to the spill containment or manufacturing area, the QC Department is notified. This information automatically creates the change in the lot number of the final [finished goods] product.

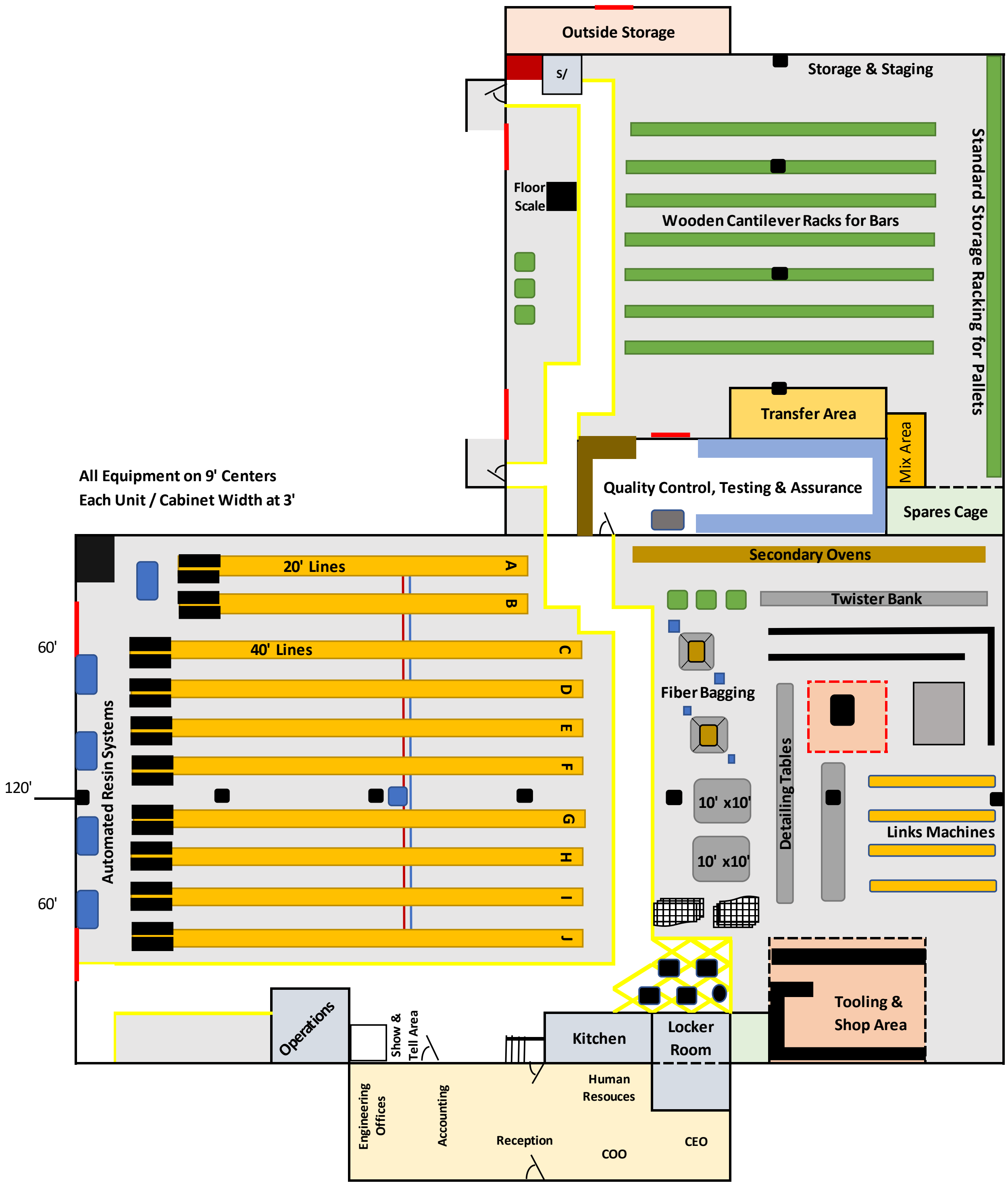




4. PRODUCTION

4.1 Current Plant Layout 34,000 ft^2 - Pompano Beach, FL

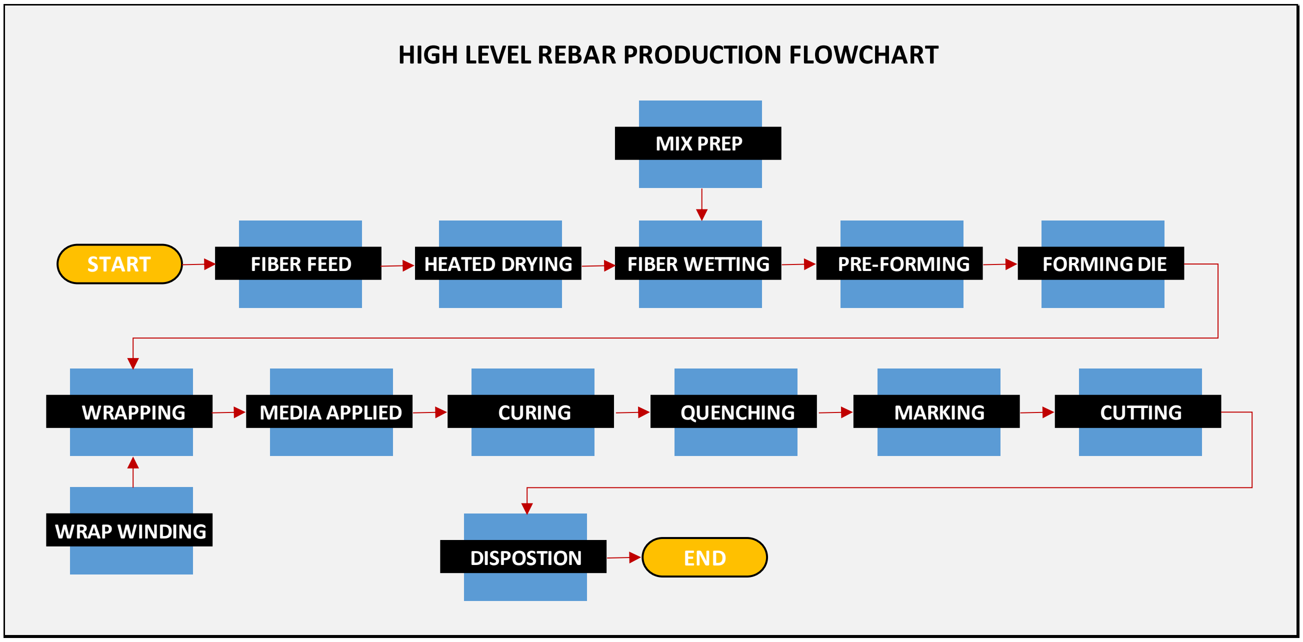
Basanite Industries' plant layout is shown in the following schematic:



4.2 Production Equipment

Basanite Industries uses a pultrusion process for the manufacturing of BasaFlex™ Rebar. The process involves pulling basalt fibers through the liquid epoxy resin matrix; then forming the fibers into a bar through ambient, and then hot steps. Figure 2 shows high level rebar manufacturing steps involved in BasaFlex™ pultrusion.

Figure 2. Pultrusion Process Flow Chart of BasaFlex™



The manufacturing process follows a strict set of rules required to efficiently transform raw materials into quality finished products:

1. **Standardized Production Run Setup Procedure:** Well-documented and detailed SOP's and OD's describing the exact steps required to set up and effectively run any bar production.
2. **Preventive Maintenance Procedures and Notification:** Protocols for standard preventive maintenance processes for each pultrusion machine; or other equipment impacting the manufacturing process.
3. **Identification of Root Causes of Defects:** Analysis of manufacturing process, in step-by-step detail, to identify which activities may lead to potential defects or higher scrap rates (FMEA).

Table 8. Frequency of preventive maintenance and accuracy check performed on production equipment.

Process	Equipment	Maintenance	Accuracy Check
Fiber Feed	Creel	Bobbins are oriented and threaded daily	Bobbins are counted twice per shift
Fiber Drying	Heater	As need	Temperature measured daily
Resin Mix Preparation	Mixers	Cleaned between each batch	NA
	Scales	Cleaned after any spill during mixing	Calibrated once a month internally and once a year externally
Fiber Wetting	Wetting bath	Cleaned during shutdown	NA
Preforming Die	Multiple hole die	Visually inspected daily	Diameter checked during shutdown
Forming Die	Die	Cleaned as needed	Diameter measured daily
Wrap Winding	Twister	Preventive maintenance performed regularly	NA
Wrap	Helical wrap mechanism	Cleaned when needed during operation	NA
Curing	Oven	Cleaned once a week	Temperature measured twice per shift
Cooling	Water bath	Preventive maintenance performed regularly	NA
Pooling	Pooler	Preventive maintenance performed as needed	Speed measure measured minimum twice a day
Cutting	Saw	Blade replaced as needed	NA
	Cutting table	Keep the table aligned	Length measured twice a day
Product Disposition	Portable conveyers	NA	NA

4.3 PROCESS CONTROLS

Quality The consistent quality of BasaFlex™ rebar is ensured through:

- Product Specifications
- Process QC
- Product QC
- Document Implementation

Product Specification outlines key requirements for physical and mechanical properties of BasaFlex™ rebar.

Process QC[1] is performed at a minimum of twice per shift. The QC testing includes:

1. Resin mix viscosity
2. Gel point and peak exotherm of resin mix
3. Number of strands
4. Line Speed
5. Oven temperatures

Product QC[2] is done for checking product conformance during production twice per shift. The test methods used are:

1. Visual inspection
2. Diameter
3. Length
4. Density

Document Implementation

When a Purchase Order is received and entered into the ERP system, it is automatically linked to a product specification and generates a Work Order (WO). In addition, the QC testing methods that are to be completed "in-process", and as part of the final bar inspection will also be automatically added to WO.

4.4 TRACEABILITY

Finished product is identified through an assigned and unique lot number. A production lot format is established in terms of bar size, basalt fiber roving lot number, resin matrix batch and production date, and shift as presented in this example:

Lot # 4201-C1111-121020-I

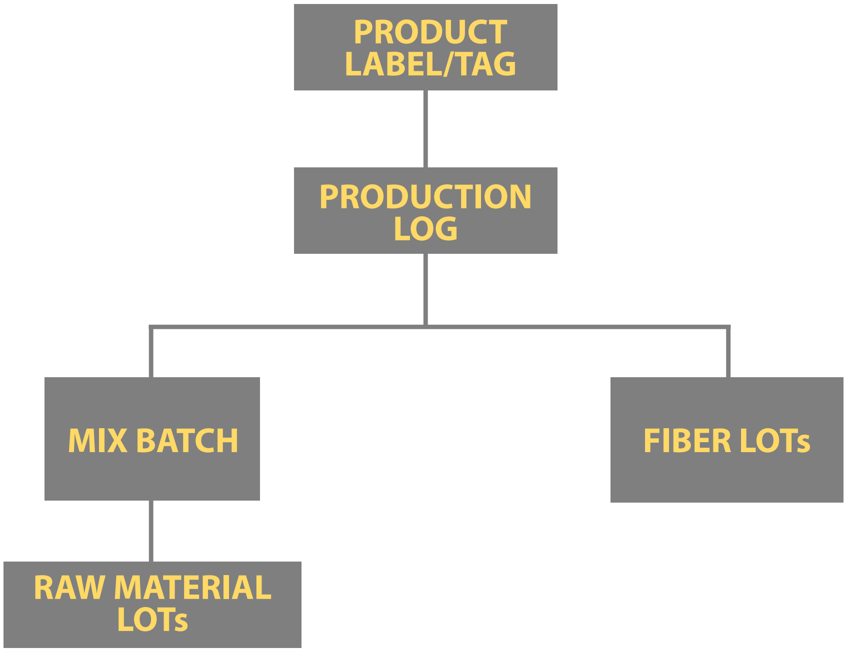
Whereas:

4 - bar size
20 - bar length
1- Basalt fiber lot on 121020 and shift I
C1111- mix batch on line C on 121020 and shift I
121020 - production date
I – (roman number) production shift

Traceability of the complete epoxy matrix, the epoxy resin, curing agent, filler and diluent, is maintained as a mix batch number, combined with production date and shift.

The QC Department assigns "rebar" lot numbers, and releases the accepted products to inventory. Each product bundle is labeled with the attached tags and QC sticker. The production record / log, which identifies each raw material's lot number, is issued for every product lot and kept on record.

PRODUCT TRACEBILITY FLOW CHART



The traceability of raw materials from product tag and product log / report is explained in the following examples:

Production Log / Record shows that Work Order number 101010 was issued for the production of 120 ea., 20 ft. long, #4 BasaFlex rebars. The WO was issued on 11/18/2020 but the produc-tion was completed on 12/10/2020 in the first shift. Raw materials from the same lots were used for all 120 bars. The bars were tied in 10 bundles of 12, and tagged. The attached tags have numbers from 0001 through 0010 and the same bar lot number 4201-C1111-121020-I as the Product Log.

The number 1 in the first four digits of the bar lot number 4201, signifies that 66 bobbins from the Basalt fiber lot #11/28/2020 were used for the production of the entire bar lot. Raw materials used for the mix are similarly identified from the mix batch #C1111. The first number "1" indicates the epoxy resin lot from the Product Log, the second number "1" stands for the curing agent lot number, and the third number for the diluent lot, with the last number "1" is for the filler lot number.

When any of the raw materials are consumed during the same date and shift, the lot number of the particular raw material will be replaced with number 2 in the bar lot number. For instance, 3 bobbins out of 66 are replaced with bobbins from lot #11/29/2020. This change will result in a new bar lot # 4202-C1111-121020-I. Consequently, a new tag and Production Log will be issued for the new bar lot number.

Bundles may include bars with different lot numbers and identified accordingly.

4.5 HANDLING AND STORAGE

Handling

Finished products are identified by tags, handled and stored on racks in a manner that prevents damage, deterioration, loss or substitution.

Figure 3. A view of a the BasaFlex storage area

Storage

The storage area is separate from the manufacturing process and secured to ensure the proper identification and segregation of the finished goods in inventory are maintained. Storage area is kept clean and fully protected from adverse environmental conditions.

Only authorized personnel are allowed to handle products within the storage area. A formal system has been established and maintained for movement of finished products in and out of the storage area.

Loading

Tagged bundles are manually loaded on a long cart and transferred from manufacturing to dedicated areas in storage, or onto transportation vehicles.

5. QUALITY CONTROL

5.1 Quality Control Training

Personnel performing QC must be qualified to perform tasks on the basis of training, experience and appropriate education. In addition, QC personnel and other employees who have an impact on, or responsibility for product quality, must complete a job specific training program provided by the Company.

Table 9. Level of personnel proficiency required to perform QC testing

	QC Test	Standard	Proficiency
Epoxy Curing Agent Diluent Mix	Equivalent Weight	D1652	Level III
	Viscosity	Internal SOP	Level III
	Color	D1544/ D1209	Level I
	Density	D1475	Level II
	Gel time and Peak Exotherm	D2471	Level III
Filler	Moisture content	Internal SOP	Level I
	Powder Bulk density	D7481	Level II
	Loss on Ignition	D1248	Level II
Basalt Fibers	Bobbin appearance/weight	Internal SOP	Level I
	Ultimate Tensile Force	D2343	Level III
	Fiber Bulk Density	D3800	Level II
	Moisture content	Internal SOP	Level II
	Tex	Internal SOP	Level II
	Sizing	D3171	Level II
Process	Oven temperature	Internal SOP	Level I
	Pulling speed	Internal SOP	Level I
	Number of strands per bar	Internal SOP	Level I
Rebar	Appearance	Internal SOP	Level I
	Diameter / Length	Internal SOP	Level I
	Density	D792	Level II
	Cross – sectional area	D792	Level II
	Horizontal shear strength	D4475	Level III
	Fiber content	D2584	Level II
	Long /short term water absorption	D570/D517	Level II

The training program for QC personnel is described in the SOP "Employee Training and Documentation Procedure". All new employees must be trained on-the-job, to properly perform their job function. The records of the training history are kept and maintained by the QC Director and Human Resource department.

The QC employees shall receive training in the following categories:

- New Employee Orientation (Job Description, SOP's)
- Personnel Expectations
- Safety Procedures
- Basic Production Processes
- Quality Assurance and Quality Control Plan
- Specific Job or Task-Related Training

In addition to the general training, employees involved in QC process are trained and certified to perform the assigned job function. Re-certification of the personnel is done on an as-needed basis.

Formal policies and procedures are managed by the Human Resources department which defines the existing training programs at the top level.

5.2 QUALITY CONTROL TESTING

Testing Performed at Basanite

Quality Control testing and inspections are performed on all incoming materials, the manufact-uring processes, and the finished products. The products in final stage, which includes tagging, will not proceed to inventory unless the quality status is verified through documented QC procedures.

The list of the tests performed at Basanite's lab is shown in Table 9. Governing documents for the QC testing and inspection are Standard Operating Procedures. In sections 5.2.1 - 5.2.3, a brief description of each test method performed at Basanite is given. However, the SOP's can be reviewed and downloaded from the QC file on the Shared drive in their entirety. The SOP's listed in the Appendix are linked to the files on the Shared drive.

5.2.1. RECEIVING INSPECTION

Raw materials are tested at Basanite's lab using the following methods:

1. Equivalent Weight

The equivalent weight of epoxy resin, curing agent or reactive diluent is tested using volumetric titrations. The sample of material is dissolved in a suitable solvent and titrated with reagent. When an indicator added to the sample solution before the titration changes color, the volume of titrate is recorded and used to calculate the equivalent weight of the material. This test procedure is developed partially based on ASTM D1652 and SOPs provided by the suppliers.

Test Frequency

Epoxy resin, anhydride-based curing agent and reactive diluent are tested once upon receiving. A minimum of five specimens is required for each test.

2. Density

The test procedure is based on ASTM D1475. An empty, clean and dry weight-to-gallon cup is weighed on an analytical balance first. Then it is filled with distilled water and weighed again. From the water weight and density at test temperature, calculate the cup volume. Dry the cup, fill out with sample and weigh. Calculate the material density from the weight and cup volume.

Test Frequency

Epoxy resin, curing agent and diluent are tested once upon receiving. Five specimens are required for the test.

3. Viscosity

The viscosity is measured using a Brookfield viscometer. A sample of ~200ml is poured into a suitable cup. After an adequate spindle is immersed into the sample, the viscometer is turned on and let to spin until the rotational velocity is stabilized and a steady viscosity measurement is displayed. This method is developed in conjunction with the supplier's SOP.

Test Frequency

Epoxy resin, curing agent and diluent are tested once upon receiving. Typically, five specimens are required for the test.

4. Color

This is a visual test performed on liquid raw materials. The change of material color or the presence of precipitate in the container may be a reason for material rejection.

Test Frequency

Epoxy resin, curing agent and diluent are tested once upon receiving. The number of test specimens is optional.

5. Gel Time and Peak Exotherm

This method is used to test epoxy resin or curing agent. First, a 1:1 equivalent weight ratio of resin and curing reagent is mixed for 30 minutes. Then, a 20g sample is taken from the mix and poured into an aluminum cup. The sample is placed in a heated cavity of the Gardner gel timer. A K-type thermocouple is immediately immersed into the sample and the stopwatch turned on. The temperature of the mix is measured and recorded every 15 seconds. Measurements are taken until the temperature starts to drop after the peak exotherm. Gel time is a point when the mix suddenly solidifies and the exothermic peak is the highest temperature reached during test. This test procedure is developed in conjunction with ASTM D2471.

Test Frequency

Epoxy resin and curing agent are tested once upon receiving. A minimum of five specimens is tested.

6. Moisture Content

Place a sample of a raw material (epoxy, curing agent, filler or basalt roving) in a pan of Ohaus Moisture Analyzer. Record the sample weight and select drying cycle. When the sample weight reaches the plateau, record the value and calculate the percentage of weight loss.

Test Frequency

Epoxy resin, curing agent, filler and basalt roving are tested any time a new raw material container is opened. The number of test specimens is optional in this test.

7. Loss on Ignition / Sizing

This method for a filler is based on ASTM D1248, and ASTM D 3171 for the basalt fiber sizing. First, an empty ceramic crucible is weighed, and then weighed again with a sample. The crucible is placed within a muffle furnace at appropriate temperature and left in the furnace for minimum 4 hours. Then, the crucible is taken out of the furnace and placed in desiccator to cool down. When the crucible is cooled to room temperature, it is weighed again. The percent of weight loss is calculated from the weight difference.

Test Frequency

Loss on Ignition and sizing are performed only once upon receiving the raw materials. Five specimens are required for the test.

8. Bulk Density

This test is based on ASTM D7481. A graduated cylinder is weighed with a known weight of a sample. After distilled water is added at a certain volume, it is weighed again. The graduated cylinder is emptied, rinsed and refilled with distilled water to the same volume as with the sample and re-weighed. The bulk density of the material is calculated from the sample weight and volume calculated from the water density at the test temperature.

Test Frequency

This test is performed once upon a new lot of filler or Basalt rowing is received. A minimum of five specimens is required to be tested.

9. Bobbin Appearance/Weight

Bobbins are sampled from a pallet and inspected visually for physical damages. Minimum five samples per pallet are weighed to get the bobbin average weight. The average weight is then compared to the average weight of a bobbin calculated from the pallet net weight and number of bobbins on the pallet.

Test Frequency

This test is performed once when the new roving shipment is received.

10. Basalt Fiber Peak Tensile Load

This test is developed based on ASTM D1557. A fiber strand is mounted on a tab and placed in the grips of tensile testing machine. Test is performed at constant speed and applied load. Record the peak tensile load at the break.

Test Frequency

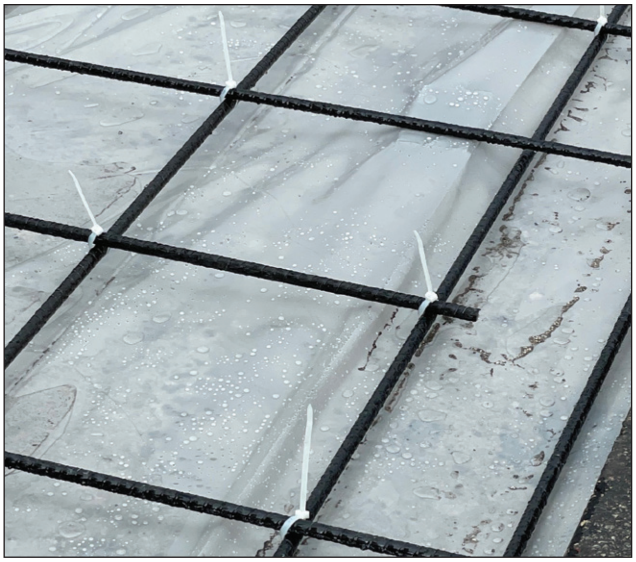
The test is performed once upon receiving the Basalt roving. Five specimens must be tested.

11. Basalt Roving Tex

Weigh one foot of a strand taken from a bobbin. Divide the weight with the length and calculate the weight in kilograms per 1 kilometer (Tex).

Test Frequency

Tex is tested when the new shipment of basalt roving is received. A minimum of 1% of bobbins per shipment is required for testing.



5.2.2 IN-PROCESS INSPECTION

Manufacturing equipment, resin matrix and finished rebar are tested during processing to compare with readings and set points of the controller. The methods used for testing and inspection are:

1. Oven Temperature

Insert K-type thermocouple in the hole provided for testing at the back of the oven. Record "set" temperature, and the thermal controller's minimum and maximum temperatures; record & compare the measured maximum and minimum temperatures.

Test Frequency

This test is done two times per shift.

2. Pulling Speed

Mark a point on a cured bar with masking tape right after it comes out form the cooling bath and turn on stop watch. Measure the time the bar travels until it travels determined distance. Calculate the pulling speed by dividing the distance measured in meters with time in minutes.

Test Frequency

Pulling speed is measured two times per shift or as needed.

3. Number of Strands

Count the number of strands coming out of the guide plates of a creel and going into dryer. Compare the counted strands with the number of bobbins shown on the creel sketch and OD associated with the specific bar size being produced.

Test Frequency

Strands are counted two times during one shift.

4. Viscosity of Resin Mix

This test is performed the same way as it was described in §5.2.1 test 3.

Test Frequency

The samples are taken from the wetting bath two times per each shift.

5. Gel Point and Exothermic Peak of Resin Mix

Resin mix is tested using the method described in §5.2.1, method 5.

Test Frequency

The mix samples are taken from the wetting bath two times per each shift.

6. Diameter/Length

Bar diameter is measured using a digital caliper. Places of the bar where the thickness is measure must be clear of any surface imperfections. The bar length is measured with measuring tape as soon as the bar is cut. The measurement is done while the bar is on cutting table.

Test Frequency

Both diameter and length are controlled minimum twice per shift.

7. Appearance

This test is used to detect visible defects on the bar's surface or cross section. The results are used to adjust manufacturing processes and eliminate visible, or potentially more critical defects.

Test Frequency

QC technicians perform visual inspection twice per shift.

8. Rebar Density

This method is based on ASTM D792. A graduated cylinder is filled with water to a selected volume. The weight of a one-inch-long bar sample is measured and carefully placed in the cylinder. The weight of the cylinder with the sample and water is then measured. The cylinder is emptied and filled with water only to the same volume as it was with sample in water. Bar density is calculated from the weight difference, density of water at test temperature, and the sample's weight.

Test Frequency

Density test is performed twice per bar lot. A minimum of five specimens is required to be tested.

5.2.3 Final Inspection

The final inspection of rebars completed at Basanite are as follows:

1. Cross-section Area

This test is based on ASTM D792. The procedure is the same as explained in Test 8 for Rebar Density. The only difference is the calculation. Instead of using the sample weight, the sample volume is divided by length to get the cross-section.

Test Frequency

The number of test specimen is optional. However, five specimens per lot are required for COAs.

2. Horizontal Shear Strength

Test procedure of this test is based on ASTM D4475. The sample is placed in the support bottom fixture and its midpoint is centered to the loading arbor. The compression load is applied on the sample until failure. The load at the break is recorded and divided by the cross-section of the sample to calculate the horizontal shear strength.

Test Frequency

The number of test specimen is optional. However, five specimens per lot are required for COAs.

3. Short-term/ Long-term Water Absorption

The test is based on ASTM D 570. The specimens are initially dried in an oven for 24 hours and weighed after cooling in a desiccator. After conditioning, the specimens are immersed in distilled water at 50°C and kept for another 24 hours and then weighed. Saturation is confirmed when the increase in weight over three consecutive weight measurements is less than 1%. The first weight measurement is taken to calculate short-term water absorption, and the last for the long-term water absorption.

Test Frequency

The number of test specimen is optional. However, five specimens per lot are required for COAs.

Approved off-site Laboratories

Basanite has approved two independent and accredited labs for its rebar testing:

- University of Miami, Structures and Materials Laboratory,
- University of Sherbrook, Department of Civil and Building Engineering, Research Center on FRP Composite Materials.

The test methods completed off-site are listed in Table 10.

Table 10. Rebar testing completed by approved Labs.

		Test Method	Standard
Rebar	1	Tensile / Elongation/Modulus	ASTM D7205
	2	Tg / Curing degree	ASTM E2160
	3	Transverse shear strength	ASTM D7617
	4	Bond strength to concrete	ACI 440.3R, B3
	5	Resistance to alkaline environment	ACI 440.3R

5.3 Quality Control Approval

Production technicians who are trained and have passed QC training for visual inspection, are responsible to separate products with and without visual defects. Defect-free bars from the same lot are placed on a conveyer cart, bundled and tagged. The bundles will stay in manufacturing area until the final QC inspection is completed and QC technician places stickers on the tags. The examples of the QC stickers are given in Figure 4.

Figure 4. QC stickers used for the product lot approval, rejection, or for product hold

5.4 EQUIPMENT CALIBRATION

Inspection, measuring and test equipment used for QC at Basanite must be calibrated and controlled in accordance with standard specifications. All testing equipment, fixtures, measurement tools and software that are used by QC Department must be identified by a unique QC number.

QC personnel must maintain current calibration to assure that all inspection, measuring

and test equipment is up to date through required periodic intervals, or prior to use. Any inspection, measuring and test equipment found to be out of tolerance must be immediately removed from service until recalibration.

An inventory record is maintained for all equipment in the electronic and hard copy file system. The record contains the name, location, description, identification number, frequency of calibration, calibration method or procedure, acceptance criteria/accuracy, and the calibration status for each QC item that is required to be calibrated.

An identification tag and calibration label are affixed to all inspection, measuring and test equipment; to identify the calibration status.

The date of calibration, recall date, and calibration results, including certificates of calibration and test data from outside calibration services, must be documented and maintained in a calibration physical and electronic record file; to demonstrate that established schedules and procedures are followed.

Environmental conditions must be controlled during the calibration and use of inspection, measuring and test equipment to the extent necessary to assure acceptable accuracy.

Inspection, measuring and test equipment must be handled, preserved and stored in a manner to ensure accuracy and fitness for use are maintained.

The list of inspection, measuring and test equipment requiring calibration, and corresponding calibration standard specifications / procedures are provided in Table 11.

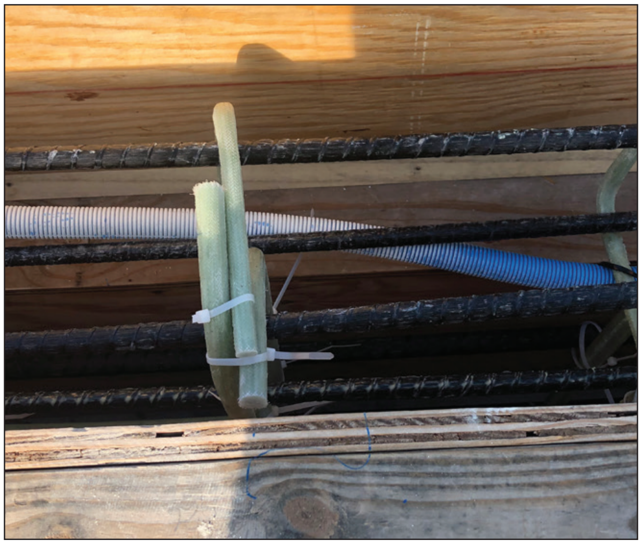


Table 11. List of equipment at Basanite Industries LLC which requires routine calibration

Equipment Name	Serial/ID Number	Calibration Date
Hygrometer - Humidity	1732-10	4/15/2023
Hygrometer - Humidity	1732-10	4/15/2023
Hygrometer - Humidity	1732-10	4/15/2023
Hygrometer - Humidity	1732-10	4/15/2023
Analyticall Balance	1115443090	4/15/2023
Moisture Analyzer	B837404283	4/15/2023
Labe Timer	9YAY2	4/15/2023
Analytical Balance Printer	1122011905	4/15/2023
Brookfield	RTP78803	4/15/2023
Weight/Gallon Cup	3121	4/15/2023
150 Kg Scale	E6B1400715	4/15/2023
150 Kg Scale	E6B1400777	4/15/2023
Bench Scale	N0096493	4/15/2023
Hot Pot Gel Timer	S-1583	4/15/2023
Digital Calipers	15100728	4/15/2023
Digital Calipers	15101114	4/15/2023
BS Scale	BN1812200	4/15/2023
Digital Thermometer	T206858	4/15/2023
Digital Thermometer	2678485	4/15/2023
Measuring Tape	N/A	4/15/2023
Load Cell - 5 kN	90417 A	4/15/2023
Extensometer	N/A	4/15/2023

Life- Cycle Assessment Environmental Impact

Basalt Fiber vs. Glass Fiber

Scale: 1-10 (The lower the number, the less the impact) *Source: Grandview Research*

Product	Human Toxicity	Photochemical Oxidant	Terrestrial Acidification	Freshwater Eutrophication	Marine Eutrophication	Terrestrial Ecotoxicity	Freshwater Ecotoxicity	Water Depletion	Metal Depletion	Average
BFRP	0.2	2.8	1.5	0.65	2.2	0.5	0.7	1.1	0.85	1.17
GFRP	9.85	9.7	9.7	9.7	9.8	9.75	9.8	9.65	9.7	9.74

According to ACMA, the production and installation of BasaFlex™, from mining the rock all the way to fully installed rebar, *offers just 1/10th the carbon footprint of steel.*

6. QUALITY CONTROL RECORDS

The Quality Control system at Basanite was developed to verify that every step of the QC testing and inspection process is performed in accordance with standard ASTM and manufacturer's specifications, and to ensure that the products conform to internal and external material specifications and requirements.

The QC system includes interconnected documentation at three different levels which regulates the entire QC function:

Level I – Quality Control Manual

The QC Manual dictates the Basanite's quality policy, and further describes its Quality Control system and internal QC structure. Each section of the Manual describes how the requirements of each element of the Manual are implemented and satisfied.

Copies of the Manual are distributed as controlled copies. The Director of QC is responsible for maintaining a current list of the holders of all controlled copies to confirm all copies are up-to-date, and for the removal of all obsolete ones. The holders of controlled copies are responsible for assuring that the Manual assigned to them are readily available to all individuals requiring it.

Level II – Standard Operating Procedures

Standard operating procedures detail the steps that must be completed to perform a particular Quality Control test or inspection. The newest revision of SOP's must be available to the QC technicians at all times.

Copies of the SOP's are distributed as controlled or uncontrolled. The Director of QC is responsible for maintaining a current list of holders of controlled copies to confirm all copies are up-to-date, and for the removal of all obsolete ones. Uncontrolled copies are distributed as appropriate, but are not maintained current. The users of SOP's are responsible for holding controlled, up-to-date copies at all times.

Level III – Quality Control Test Records and Reports

The copies of official QC records (COA's and nonconformance reports) and test reports of raw materials, products and process testing and inspection performed daily are maintained to provide evidence of raw material, finished product and process compliance with quality requirements.

Test records and reports are maintained as hard copies and electronic files for a minimum of three years. Obsolete records and reports are deleted or shredded by appointed personnel.

All official QC documents must be reviewed and approved prior to use. Hard copies of the appropriate documents are kept in QC lab and / or the Director of Quality's office. Electronic copies are saved in the QC file; on the Shared drive.

7. FINISHED PRODUCTS

7.1 Disposition of Non-Compliant Products

Products that do not meet product specification requirements must be rejected, then placed and kept in quarantine until disposition is resolved.

7.2 Rejected Non-Compliant Products

When nonconforming products are found, the QC personnel will label as "QC REJECTED". The technician must also provide the copy of the Product QC Report to the Production Manager and verbally notify him / her. Production Manager is responsible for organizing the removal of nonconforming products from the manufacturing area to quarantine. The non-compliant products will stay in quarantine until disposition is resolved. QC Director and Director of Operations will determine the product's final disposition.

7.3 Shipping Procedures

Packaging

Finished products that are ready for shipping must have attached bundle tags and green QC stickers, appropriately initialed and dated on every package of BasaFlex Bundles, BasaMesh Rolls, BasaMix™ boxes or BasaLinks™ stirrups / shapes.

Protective materials are standardized and must be used for packaging to avoid product damage during loading and transit.

- Bundled BasaFlex™ products are strapped together with protective boxed ends
- BasaMesh™ rolls are protected with plastic wrap
- BasaLinks™ are boxed or palletized depending on the order and product size, with protective wrap and a protective barrier
- BasaMix™ is individually bagged, then packed into individual boxes, then palletized into 36 boxes per pallet (1080 lbs.)

Every product must be visually inspected for damage prior to packaging and loading; then photographed as FOB ready to ship (prior to loading and once loaded). The shipping documentation must show that the product was inspected and signed off, as well as the WO and inventory release documentation.

Shipping Documentation (Mill Report)

Shipping documents sent with each shipment must include the following information:

- Packing List of products
- Product description
- Production lot numbers
- Bundle tag identification
- Quantities of each product
- COA' s for each product lot

The shipping documents must be signed by Logistics Manager. However, in his / her absence, the Director of Operations can sign the shipping documentation. (For signatures see Table 3, page 8).

APPENDIX

1.1 List of SOPs

MATERIAL	TEST	ASTM/ SPECIFICATIONS	QC TEST REPORT
RECEIVING INSPECTION			
Epoxy Curing Agent Diluent	EEW	D1652	SOP-QC-RM-001
	Viscosity	Internal SOP	SOP-QC-RM-002
	Gel time and peak exothermic temperature	D2471	SOP-QC-RM-003
	Density	D1475	SOP-QC-RM-004
	Visual Inspection	Internal SOP	SOP-QC-RM-005
	MW of curing agent	Internal SOP	SOP-QC-RM-006
Filler	Bulk density	D7481	SOP-QC-RM-007
	Moisture content	Internal SOP	SOP-QC-RM-008
Basalt Roving	Bobbin visual inspection/ weight	Internal SOP	SOP-QC-RM-009
	Tex	Internal SOP	SOP-QC-RM-010
	Fiber tensile strength	D1557	SOP-QC-RM-011
	Loss on ignition	D3171	SOP-QC-RM-012
IN-PROCESS INSPECTION			
Resin Mix	Viscosity	Internal SOP	SOP-QC-MP-001
	Gel time and peak exotherm temperatures	D2471	SOP-QC-MP-002
Production Line	Oven/bath temperature	Internal SOP	SOP-QC-MP-003
	Pulling Speed	Internal SOP	SOP-QC-MP-004
	Number of Strands	Internal SOP	SOP-QC-MP-005
Rebar	Diameter	Internal SOP	SOP-QC-MP-006
	Visual Inspection	D4385	SOP-QC-MP-007
	Length	Internal SOP	SOP-QC-MP-008
	Density	D792	SOP-QC-MP-009
FINAL INSPECTION			
Rebar	Cross-sectional area	D792/D7205	SOP-QC-PR-001
	Horizontal shear strength	D4475	SOP-QC-PR-002
	Short-term and long-term water absorption	D570	SOP-QC-PR-003
	Fiber content	D2584	SOP-QC-PR-004

MATERIAL	TEST	QC TEST REPORT
RECEIVING INSPECTION		
Epoxy Curing Agent Diluent	EEW of epoxy resin	QC-RM-001
	Viscosity	QC-RM-002
	Gel time and peak exotherm temperature	QC-RM-003
	Density	QC-RM-004
	Visual Inspection	QC-RM-005
	MW of curing agent	QC-RM-006
	Test Result Summary	Test Report - 001
Filler	Bulk Density	QC-RM-007
	Color	QC-RM-008
	Moisture content	QC-RM-009
	Test Result Summary	Test Report - 002
Basalt Roving	Bobbin visual inspection/weight	QC-RM-010
	Tex	QC-RM-011
	Fiber tensile/modulus/elongation	QC-RM-012
	Loss on ignition	QC-RM-013
	Test Result Summary	Test Report - 003
IN-PROCESS INSPECTION		
Resin Mix	Viscosity	QC-MP-001
	Gel time and peak exotherm temperatures	QC-MP-002
Production Line	Oven/bath temperature	QC-MP-003
	Pulling Speed	QC-MP-004
	Number of Strands	QC-MP-005
Rebar	Diameter	QC-MP-006
	Visual Inspection	QC-MP-007
	Length	QC-MP-008
	Density	QC-MP-009
FINAL INSPECTION		
Rebar	Cross-sectional area	QC-PR-001
	Horizontal shear strength	QC-PR-002
	Sort-term and long-term water absorption	QC-PR-003
	Fiber content	QC-PR-004
	Internal Test Report Summary	Test Report - 004
	External Test Report	COA
	Certificate of Compliance	COC

BASALT REBAR ACI AND CODE COMPLIANCE

Here are statements which apply to Basalt rebar…

Basalt FRP Rebar is used per ACI 440.1R-06. FRP Construction use is dictated by code 440.6-08. BFRP is specified according to ACI 440.5-08, ASTM D 8505 and ESR 5092, assessed according to ASTM D7205 ASTM D 8448 and several other test methods. Basalt FRP rebar meets the performance requirements of ACI 440.6-08. Basaflex is Code Compliant per ICC ES document ESR 5092.

Basalt rebar ACI 440R-07 "Report on Fiber-Reinforced Polymer (FRP) Reinforcement for

Concrete Structures." ACI 440.6-08 describes the use of FRP including Glass, Carbon, and Aramid.

"Continuous Basalt fibers are commercially available as an alternative to glass fibers."

Basalt FRP rebar is approved as natural fiberglass, meeting the certification specifications of ACI 440.6-08 for fiberglass FRP rebar. Physical Properties of Basalt rebar are higher than fiberglass, falling between fiberglass and carbon fiber.

Basalt rebar meets code requirements using calculations and installation guidelines for fiberglass reinforcement of concrete as defined in ACI 440.6-08.

Recommendations for maximum deflection and shear of concrete elements reinforced with fiber reinforced polymer (FRP) rebar's are presented in ACI 440.1R-06. (2006) "Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars."

Basalt rebar has been assessed at various universities and meets the American Concrete Institute criteria under ACI. 440-10. Basalt rebar is used according to ACI 440. 1R-06. The construction use is dictated by code 440.6-08. It is specified by 440.5-08 and assessed according to ASTM D7205, ASTM D 8448, ASTM D 8505, and others.

ISO 9001: Basalt rebar has been assessed by several methods and been approved by ISO 9001.

In the ACI documentation, the term FRP (Fiber Reinforced Polymer) includes Basalt based FRP. The term BFRP is often used instead of saying Basalt Rebar.

EXISTING BASALT REBAR SPECIFICATIONS & TESTING REQUIREMENTS

- AACI 440.3R-4: Guide for the test methods for fiber reinforced polymers for reinforcing or strengthening concrete structures. Published by the American Concrete Institute.
- ACI 440.1R-06: Guide for the design and construction of concrete reinforced with FRP Bars. Published by the American Concrete Institute.

- CC ES Certified and listed per ESR 5092

ASTM STANDARDS

- D570 Standard test method for water absorption of plastics
- D619 Standard practice for conditioning plastics for testing
- D695 Standard test method for compressive properties of rigid plastics
- D790 Standard test methods for flexural properties of unreinforced and reinforced plastics
- D792 Standard test methods for density and specific gravity
- D2734 Void content of reinforced plastics
- D3410 Standard test method for compressive properties of polymer matrix composite materials
- D8448 Standard Specification for Basalt Fiber Strands
- D8505 Standard Specification for Basalt and Glass Fiber Reinforced Polymer (FRP) Bars for Concrete Reinforcement

TRADE AFFILIATIONS AND CERTIFICATIONS

- FDOT FACILITY CERTIFICATION : FRP 22
- ICC ES FACILITY AUDIT AND APPROVAL : 5/23
- US GREEN BUILDING COUNCIL (USGBC)

Design Manuals

Isis Design Manual No 3: Reinforcing concrete structures with fiber reinforced polymers.

Basanite Design Manual

Committees

- American Concrete Institute (ACI): 440 Composites for Concrete
- American Society of Civil Engineers (ASCE): Structural Composites and Plastics
- American Society of Testing and Materials (ASTM): D20.18.01 FRP Materials for concrete.
- American Society of Testing and Materials (ASTM): D20.18.02 Pultruded Profiles.
- American Society of Testing and Materials (ASTM): D30.30.01 Composites in Civil Engineering.
- AASHTO Bridge Subcommittee: T-21 FRP Composites
- American Composites Manufacturers Association (ACMA)

ACKNOWLEDGEMENTS

Acceptance of this compelling technology is emerging from the shadows of structural failures making world news including the Surfside Florida Condo Collapse

Basanite offerings include all common rebar sizes, a reinforcement mesh for crack control in slabs and structures and chopped fibers for direct inclusion into concrete batch mixes.

Basalt Fiber Reinforced Polymer or "BFRP" offers an economical, practical and "GREEN" means of achieving "FULL" structural reinforcement.

Our LOW CARBON FOOTPRINT "Green" material is inert in acids, caustics, salt, and sulfide gas, and corrosion proof. Basalt is transparent to electric currents or electromagnetic signals making it ideal for communication, power transmission or medical containment applications.

"Old school" Fifty (50) Year service life bows to the implied One Hundred (100+) Year plus expectation for Basanite Products. As "Sustainability" continues to set the tone for infrastructure funding BFRP inclusion can only increase.

Any technology requires the support of a vast Team of Believers.

We would be remiss if not to thank the Florida DOT for extensive vetting and ultimate inclusion of BFRP into their Road & Bridge Design Standards. We thank Dr. Brahim Benmokrane and the University of Sherbrooke for extensive Testing and belief in our products which served as threshold to critical certifications and approvals. We also must thank the tireless efforts of Dr Francisco De Caso and the university of Miami Doctoral Program for contributions to our preliminary Design Guide and testing which served as threshold to our ICC ES certification and Code Compliance Documents.

We also thank Dr Alvaro Ruiz Emparanza who along with the above-mentioned academics staffed and executed confidently at ASTM committee levels allowing the ratification of Both D 8448 and D 8505.

Finally, we thank our investors who saw Basanite as the wonderous and novel idea that it is.

For those Engineers and Owners who have taken the time to peruse these pages, thank you for your kind consideration of Basanite Industries.

Fred Tingberg Jr., Chief Technology Officer
Director

Basanite Industries

http://basaniteindustries.com

OTCQB: BASA

Design & Construction PROFESSIONALS Florida Networking Group

U.S. GREEN BUILDING COUNCIL USGBC


M·AGRIPPA·L·F·COS·TERTIVM·FECIT
Basanite
Industries, LLC
Reinforcing Excellence

BASANITE "BFRP" BASALT FIBER CONCRETE REINFORCEMENTS

Basanite Industries, LLC, is a manufacturer of BFRP and developer of technology in the environment-friendly, high performance basalt fiber reinforced polymer products industry. Basanite's sustainable products are non-corrodible, lighter, stronger and longer lasting than steel used in concrete reinforcement.

Basanite Industries, LLC
+1 (954) 982-0804
info@basaniteindustries.com
ft@basaniteindustries.com
www.basaniteindustries.com