

## MateenBar – Technical Submittal

### Reference Standards and Reports

The references below should be referred to by the engineer regarding the application of Mateenbar for concrete reinforcement.

Additional information is available from Pultron Composites for design assistance for specific applications.

References	Titles
ACI 318-95	“Building Code Requirements for Concrete” (1995) American Concrete Institute, Farmington Hills, MI, USA.
ACI 440.3R-12	Guide Test Methods for Fiber-Reinforced Polymer (FRP) Composites for Reinforcing or Strengthening Concrete and Masonry Structures
ACI 440.3R-08	Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement
ACI 440.1R-06	Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars
ACI 440.1R-06	“Guide for the Design and Construction of Concrete Reinforced with FRP Bars” American Concrete Institute, Farmington Hills, MI, USA.
CSA S807-10	Specification for fibre-reinforced polymers
CSA S806-12	Design and construction of building structures with fibre-reinforced polymers
AASHTO GFRP - 1	“American Association of State Highway and Transport Officials” ISBN 978 – 1 – 56051-458-9

### Standards Compliance

MateenBar meets and exceeds the requirements of Canadian Standard CSA S807-10 for a Grade III (High Strength and High Elastic Modulus) DI (High Durability) GFRP Rebar.

MateenBar manufacturing facilities and production quality control system are certified to ISO 9001:2008.

## Mechanical Properties

Property / Diameter	Unit	6	8	10	12	14	16	17.5	18	19	21	22	25	27.5	32	38	Standard
Product		Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	Bar	
Root Diameter	mm	5.2	7.2	9.2	11.0	13.2	15.2	16.7	17.2	18.2	20.0	21.0	24.2	26.7	30.6	36.7	
Outside Diameter	mm	6.0	8.0	10.0	11.8	14.0	16.0	17.5	18.0	19.0	20.8	21.8	25.0	27.5	31.4	37.5	
Nominal Area (Af)	mm <sup>2</sup>	21.2	40.7	66.5	95.0	136.8	181.5	219.0	232.4	260.2	314.2	346.4	460.0	559.9	735.4	1057.8	
Ultimate Tensile Load (Average)	kN	19.8	37.9	61.8	88.4	127.3	168.8	203.7	216.1	242.0	292.2	322.2	427.8	520.8	684.0	983.9	ASTM D7205, ACI 440.3R-04
Ultimate Tensile Strength (Average)	MPa	930	930	930	930	930	930	930	930	930	930	930	930	930	930	930	ASTM D7205, ACI 440.3R-04
Ultimate Tensile Load (Guaranteed)	kN	19	37	60	86	123	163	196	207	231	278	305	400	482	620	860	ASTM D7205, ACI 440.3R-04
Ultimate Tensile Strength (Guaranteed)	MPa	911	910	907	904	900	896	893	891	889	884	881	870	860	844	813	ASTM D7205, ACI 440.3R-04
Tensile Modulus of Elasticity (Guaranteed)	GPa	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	ASTM D7205, ACI 440.3R-04
Ultimate Tensile Rupture Strain		0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	ACI 440.6-08 8.4
Ultimate Elongation (Guaranteed)	%	1.545	1.542	1.537	1.533	1.526	1.519	1.513	1.511	1.506	1.498	1.492	1.474	1.458	1.430	1.378	
Transverse Shear Strength (Average)	MPa	190	190	190	190	189	179	174	173	170	166	165	161	159	157	154	ACI 440.3R-04
Flexural Strength	MPa	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	> 900	ASTM D790
Flexural Modulus	GPa	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	> 53	ASTM D790
Compressive Strength	MPa	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	ASTM D695
Short Beam Shear Strength (Average)	kN	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80	ASTM D447
Bond Strength at Failure (Average)	kN	24.6	22.4	20.4	18.6	16.7	15.1	14.0	13.7	13.0	11.9	11.3	9.8	8.9	8.0	7.7	ACI 440.3R-04
Bond-dependent Coefficient kb (Average)		0.59	0.63	0.66	0.70	0.74	0.78	0.81	0.82	0.84	0.87	0.89	0.95	1.00	1.07	1.19	ACI 440.1R-06
Barcol Hardness		> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	> 60	ASTM D2583
Glass Transition Temperature (Minimum)	°C	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	> 100	ASTM D3418 by DSC
Thermal Expansion Coefficient Transverse	/ °C x10 <sup>-6</sup>	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	ASTM D 696
Thermal Expansion Coefficient Longitudinal	/ °C x10 <sup>-6</sup>	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	ASTM D 696
Volume Resistivity	Ω.m x 10 <sup>9</sup>	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	DIN 53 481
Dielectric Strength	kV/m	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	ASTM D149
Moisture Uptake (24 hour)	%	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	ASTM D570 at 50°C
Moisture Uptake at Saturation (Maximum)	%	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	ASTM D570 at 50°C
Specific Gravity		2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	CAN/CSA-S806 (Annex A)
Weight	kg/m	0.043	0.087	0.144	0.208	0.302	0.402	0.486	0.516	0.578	0.699	0.771	1.026	1.249	1.643	2.365	

<sup>1</sup> Guaranteed Ultimate Tensile Strength: CSA S807-10 - 8.2 Classification Based on Tensile Strength.

<sup>2</sup> The tensile properties of 38mm MateenBar cannot be guaranteed due to inability to achieve a valid bar as per the requirements of ASTM D7205 and ACI440.3R-04.

## Design Requirements

Please refer to the appropriate design guide for your project or jurisdiction, e.g. ACI 440.1R “Guide for the Design and Construction of Concrete Reinforced with FRP Bars” for guidance on the use of GFRP Bars such as MateenBar.

Requirements
Do not substitute FRP reinforcing bars for steel or other supplier GFRP bars on an equal area basis, due to differences in material properties.
Design requirements on crack width, moment capacity and deflection with respect to material properties such as tensile strength, elastic modulus must be accounted for. Please consult with Pultron for structural design considerations.
In most cases, deflection will control design of concrete structures reinforced with FRP bars based on value of modulus of elasticity of FRP bars.
Stress under sustained load should be limited in accordance with the <i>ACI 440.1R Section 8.4 - Creep rupture and fatigue</i> recommendations for GFRP bars.
A minimum overlap length of 40 diameters is recommended.

## Bends

MateenBar cannot be bent on site and must be fabricated into the required shape at the MateenBar factory. Due to the differences in GFRP manufacturing processes compared to steel rebar bends, there are limitations in the shape and sizes of bends available.

MateenBends are significantly slower to fabricate than the steel rebar equivalent, please allow sufficient lead time in your schedule to avoid delays.

## Mechanical Properties

Property / Diameter	Unit	10	12	14	16	20	25
Root diameter	mm	10	12	14	16	20	25
Nominal area	mm <sup>2</sup>	79	113	154	201	314	491
Tensile strength (average)	MPa	900	900	900	900	900	900
Tensile strength (Guaranteed) <sup>1</sup>	MPa	750	750	750	750	750	750
Tensile modulus of elasticity	GPa	54	54	54	54	54	54

Please contact MateenBar to discuss your specific bends requirements and estimated lead times.

## Durability

Property	Value	Test Method
Moisture Uptake	< 0.1%	ISO 62-1980 ASTM D 570
Resistance to alkaline environment	After 6 months (typical): <ul style="list-style-type: none"> <li>• Tensile strength retention by 87%</li> <li>• Elastic modulus retained by 100%</li> <li>• Transverse shear strength retention by 92%</li> <li>• Short beam shear strength retention by 100%</li> <li>• Moisture absorption <math>\leq</math> 0.4%</li> <li>• Glass transition temperature retention by 100%</li> </ul>	ACI 440.3R-4 B.6  Test Conditions: pH: 12.6-13.0 at 60 °C

## Manufacturing QC Testing Standards

MateenBar is a GFRP rebar manufactured from materials fully conforming to ACI 440-6 *Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement*.

MateenBar is manufactured from materials sourced on long term supply contracts with internationally approved suppliers. Raw materials purchased on the “spot market” are not used in the manufacture of MateenBar.

### Quality Control requirements for raw materials:

Property	Value	Test Method / Comment
Resin Type ACI 440-6 6.2-Matrix Resins	Epoxy vinyl ester resin	Required for long term corrosion resistance and mechanical strength. <i>Polyester resin not allowed for permanent structures in accordance with ACI 440-6.</i>
Glass Type ACI 440-6 6.1-Fibers	ECR-glass	ECR Glass (ASTM D578) is essential due to long-term corrosion resistance and immunity to alkaline attack. <b><i>E-Glass not allowed</i></b>
Fillers ACI 440-6 6.3-Fillers and additives	Commercial Grade Inorganic Filler	Commercial grade inorganic fillers only used < 20% by mass.
Glass Content	> 75% by weight	ASTM D 3171

### Manufacturing Quality Control Testing Standards:

A test certificate with every shipment shall be supplied which contains:

Test with every shipment	Test Method / Requirement
Incoming resin	Enthalpy of reaction and Glass transition temperature analysis by DSC prior processing Minimum of 1 per resin batch (may apply to more than one batch of dowel production)
Diameter	As measured from tolerance sheets at 2 hourly checks.
Glass fibre content ACI 440-6 7.1-Fibre Content	Fibre content > 55% by Volume Glass fibre content continuously monitored and manually confirmed every 2 hours
Short Beam Shear Strength (ASTM D 4475)	Average and standard deviation derived from production tolerance sheets Short beam shear tests performed from each product stream every 2 hours
Glass transition temperature (ASTM E1640-04 DMTA Method) ACI 440-6 7.2-Glass Transition Temperature	Tg >= 100°C. Minimum of 1 test every 10,000 meters. For production runs of less than 10,000 meters, one test per batch is considered
Surface	That the surface is crack free, as per the two hourly tolerance sheet information

## Handling and Storage Instructions

Instructions	Notes
Placement and Fastening	<ul style="list-style-type: none"> <li>Place Mateenbar in accordance to CRSI Placing Reinforcing Bars, unless otherwise specified.</li> <li>Place Mateenbar accurately in accordance with approved placing drawings, schedules, typical details and notes.</li> <li>Secure Mateenbar in formwork to prevent displacement by concrete placement or workers.</li> <li>Fasten Mateenbar with nylon ties (preferable), coated or stainless steel tie wire.</li> </ul>
Tolerances	<ul style="list-style-type: none"> <li>Do not exceed placing tolerances as per ACI117</li> </ul>
Splicing	<ul style="list-style-type: none"> <li>Use lap splices</li> </ul>
Form Ties	<ul style="list-style-type: none"> <li>Use coated tie wire, plastic or nylon cable ties or plastic form ties only.</li> </ul>
Cutting Mateenbar	<ul style="list-style-type: none"> <li>Mateenbar can be cut in the field with a standard handsaw or small grinder or cutoff saw.</li> <li>For long blade life time use diamond blades.</li> </ul>
Scrapes and cuts	<ul style="list-style-type: none"> <li>Nicks, scrapes, and cuts that do not exceed 5% of the depth of the bar are acceptable.</li> <li>Beyond 5% we recommend replacement of the bar.</li> </ul>
Storage	<ul style="list-style-type: none"> <li>Mateenbar not used immediately should be kept on a pallet and covered with a tarp to avoid exposure to UV rays.</li> <li>Mateenbar can be kept for an indefinite period of time without losing its performance.</li> <li>Contamination with form releasing oil shall be avoided as this may reduce bonding with concrete</li> <li>Do not store in areas subject to high temperatures (&gt;85 degrees Celsius) and avoid contact with chemical substances.</li> </ul>
Handling	<ul style="list-style-type: none"> <li>It is recommended that gloves are worn when handling Mateenbar.</li> </ul>
Comparison	<ul style="list-style-type: none"> <li>Mateenbar can be handled in the same way as steel equivalents in the field.</li> </ul>
Chemical reaction	<ul style="list-style-type: none"> <li>With Mateenbar there is no degradation from contact with salt, alkaline, diesel, gas, or other typical chemicals.</li> </ul>

See also ACI 440.1R-06 Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars.

## Warranty

Mateenbar is sold subject to Pultron Composite's standard warranty and nothing herein shall expand or extend such warranty.

## Disclaimer

The data contained herein is considered representative of present production and believed to be reliable. Pultron Composites Limited reserves the right to make improvements in the product and process which may result in benefits and/or changes to some physical and mechanical properties.