New Folder Name Service Road Access to the Beam Tube Fiberglas Reinforced Pastic Rebar

LIGO-T950041-00-B

FACSIMILE MESSAGE

CBI
1501 North Division Street
Plainfield, Illinois 60544-8929

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June 6, 1995

To: Larry Jones
LIGO Project - Caltech - Pasadena, California

Fax No. (818)304-9834

From: M. L. Tellalian Phone (815)439-6517

Plainfield Engineering - PAE

RE: Service Road Access to the Beam Tube
Fiberglass Reinforced Plastic Rebar

Larry,

Service Road Access to the Beam Tube
CBI's previous Construction Plan contained in the Final Design Review Data Package included a drawing showing an 18 ton Grove rough terrain type crane on a 20' wide pavement with a 5' wide drainage ditch between the road and the beam tube slab. Your recent fax shows a 23' wide area between the beam tube cover and the edge of the berm so the access area has not changed significantly. There is enough room to place the beam tube sections. Naturally, the roadway will be blocked by CBI during tube placement and other contractors will also be working in the area. For the purpose of our proposal, CBI will base the construction plans on the presence of an unobstructed "6 meter wide gravel service road along each arm at each site" as stated in the RFP document. Please note that the gravel road could be a source of dirt and dust in the construction area which will impact the effectiveness of the cleanliness maintenance plans and procedures. Similarly, the use of asphalt instead of the beam tube slab may also impact the cleanliness maintenance of the beam tube by being a potential source of hydrocarbons.

Fiberglass Reinforced Plastic Rebar
Attached are a couple of pages from a brochure on fiberglass reinforced plastic rebar for your information. It may be possible to reinforce a small area of the concrete cover with this plastic rebar to effectively provide a "window" for the GPS receiver without changing the shape of the concrete cover.

I have passed your welding comments on to Ron Johnson in Houston who has been named as our Welding and QA Manager for the LIGO project. He has been discussing your questions with Bob Grimsley and Larry Reed. I will give you a call later this morning to discuss the weld procedure questions which came up yesterday.

Regards,

Marty

M. L. Tellalian
Plainfield Engineering

KODIAK

FIBERGLASS-REINFORCED PLASTIC REBAR

For reinforced-concrete applications where magnetic or electrical interference or corrosive environments prohibit the use of steel.

IGi International Grating, Inc.

Strength, deflection and crack widths are affected because of FRP rebar's lower modulus of elasticity. Reinforced concrete members must be designed specifically for FRP rebar. Some designers use 30,000 psi maximum working stress, others use ultimate design strength and a multiplier of 2.5 to 3.0 for deflection criteria.

FRP rebar should not be used where deflection in a member is critical.

EXTREME TEMPERATURES

Low temperatures do not affect FRP rebar, which has been tested for brittleness at -60°F (-51°C); there was no change. FRP rebar exhibits higher strength characteristics at low temperatures.

High temperatures become a factor if the members are exposed to temperatures above 230°F (110°C) for extended periods. For example, at 300°F (149°C), tensile strength is reduced by 10 percent, flexural modulus by 33 percent.

ULTIMATE TENSILE STRENGTH

Test results have varied widely depending on test methodology, ranging from 100 KSI to 200 KSI. Until there is a standard test procedure, the manufacturer has adopted the conservative 100 KSI figure as a minimum.

TYPE OF CONCRETE

The manufacturer recommends that 4,000 psi or better concrete be used with FRP rebar.

TYPICAL STRESS-STRAIN

The typical stress-strain diagram for FRP rebar is a straight line to almost the point of failure. The yield point is 3 to 4 percent before the break.

TYPICAL APPLICATIONS

- Hospital magnetic resonance imaging facilities
- Radar installations
- Electricity generating and transmission facilities
- Marine structures exposed to salt water
- Chemical plants and storage sites
- Architectural concrete
- Tilt walls where rust from steel rebar might discolor the surface

PHYSICAL PROPERTIES

Ultimate tensile strength	100,000 psi
Tensile modulus	6 to 7.2 x 10^6 psi
Modulus of elasticity	7.21 x 10^6 psi
Compressive strength	60,000 psi
Bond strength*	1,200 psi
Shear strength	8,500 psi
Coefficient of thermal expansion	5.2 x 10^{-6} in./in./°C
Yield	100,000 psi
Water absorption	0.25% maximum
Specific gravity	2.0
Density	0.074 lb/in.^{3}

**5/8-inch rebar and 4,440-psi concrete were used for test.*

STOCK SIZES

Nominal diameter, in.	Nominal cross-section, in.^{2}	Weight per linear foot, lb
3/8	0.11	0.096
1/2	0.20	0.172
5/8	0.31	0.267
3/4	0.44	0.380
7/8	0.60	0.520
1	0.79	0.678

Standard length is 20 feet. Other lengths and diameters available.

Standard configuration is straight lengths. Other configurations—bends, curves, spirals, hooks—are available.

Fiberglass-reinforced-plastic (FRP) rebar, like other FRP products, offers important advantages over its steel counterpart. Two of these advantages are:

1. Fiberglass-reinforced plastic is nonmagnetic and electrically nonconducting.
2. It will not rust and is immune to electrolytic corrosion and to a wide range of acids, salts, and other chemicals that attack steel.

Because of these two advantages, Kodiak FRP rebar has gained acceptance for use in reinforced concrete applications where conventional steel-reinforced concrete would be unacceptable. The first advantage makes it possible to use reinforced concrete in areas where electrical or magnetic interference is undesirable; for example, near magnetic resonance imaging systems and radar stations. And, because it is nonconducting, Kodiak FRP rebar is finding increased application in electrical generating and transmission facilities.

Its corrosion resistance makes Kodiak FRP rebar preferable to steel for marine structures exposed to salt water and for chemical plants and similar installations. Also, since FRP rebar won't rust, it is used in thin tilt-wall panels where rust from steel rebar might discolor the surface.

Yet another advantage FRP has over steel is a high strength-to-weight ratio. FRP rebar has twice the tensile strength of steel at one-fourth of the weight. Although this property is less important for reinforcing concrete than for some other applications (fiberglass grating, for example), Kodiak rebar is frequently used in architectural (nonstructural) concrete castings because it is light and easy to handle and will not rust.

MADE BY PULTRUSION

Kodiak FRP rebar is made by the pultrusion process, the same technique used in making fiberglass structural components—I-beams, tubes, rods, and channels. In this process, strands of glass fiber (the roving) are pulled through a resin bath and then through a die that strips away excess resin. As the resin-impregnated roving leaves the die, a band of glass fibers is wound around it in a spiral. This roving band creates the final "deformed" surface that provides outstanding rebar-to-concrete bond strength. Finally, the rebar is heated to cure the resin and then is cut to 20-ft lengths in a continuous operation.

INSTALLATION CONSIDERATIONS

Kodiak FRP rebar does not deform as steel rebar does, so it cannot be bent into different shapes at the job site. Instead, bends, hook-ends, and spiral cages must be manufactured before delivery to the job site. Otherwise, rebar installation is straightforward. The FRP rebar is light and easy to handle, and it is easily cut to length using a carbide or masonry saw or hack saw. Electrical type nylon ties are used for splicing and crosses.

GENERAL APPLICATION GUIDELINES

Although no standard design codes have yet been developed for fiberglass rebar, there is sufficient technical data available for safe design of many applications. In addition to laboratory testing, and research being conducted by, among others, West Virginia University and the Federal Highway Administration, there has been a wide variety of applications over the past decade. Following is a brief list of design considerations.

> NOTE: This information is general in nature and is not intended for use in specific design situations.

SUBSTITUTION FOR STEEL REBAR
FRP rebar should not be substituted for steel rebar on an equal area basis.

KODIAK

FIBERGLASS-REINFORCED PLASTIC REBAR

Manufactured by

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