

APPENDIX I

SELECTION OF STAINLESS STEEL FOR LOCAL REINFORCEMENT IN MODULAR HYBRID PIER

Background

Phase 1A of the modular hybrid pier program tested high-strength carbon fiber reinforced plastic (CFRP) reinforcing grids and bars with minimal cover (1/2 inch) (13 mm) as a means of controlling crack width and distributing local loads within the lightweight concrete panels.

The conclusions drawn from this program were that while the CFRP grids functioned as intended, it was felt that the same structural performance could be achieved by using high-strength stainless steel (or some other noncorroding steel) in place of the much more costly CFRP.

Thus, we are interested in identifying the most appropriate stainless steel for this purpose. Since our design approach of combining high-strength local reinforcement with post-tensioning for global strength allows the use of local reinforcement with up to 150 ksi (134 MPa) yield strength, we are interested in finding a source for such high-strength material. We are interested in bars that are equivalent in diameter to a No. 3 (3/8-inch) (9 mm) or No. 4 (1/2-inch) (13 mm) conventional reinforcing bar. We would prefer that the bars had deformations similar to those of conventional ASTM - _____ reinforcing bars. This type of deformation is not absolutely essential, however, without such deformation we will need to perform some development length confirmation tests for lapped bars and standard hooks.

There are very few firms who supply stainless steel reinforcing bars in the United States. We have been told that Types 316LN or Type 2205 duplex are recommended for saltwater exposures. Stainless rebar is available in lengths from 20 feet (6.1 meters) to 33 feet (10.0 meters). Longer lengths of smooth stainless rebars are available in coil form. The coiled bars have to be straightened and deformed by a steel fabricator.

316LN is apparently the most popular and most available material for rebars. 2205 duplex is reported to be more difficult to manufacture. If stainless steel rebars come in contact with other types of steel, the two materials should be electrically isolated.

The stainless steel bar suppliers that we are aware of are listed below.

Al Tech Specialty Steel	Phone: 800/828-8600
P.O. Box 152	Phone: 716/366-1000
90 Willowbrook Avenue	Fax: 716-366-0478
Dunkirk, NY 14048	e mail: altech@netsync.net
Contacts:	
Jeffery Martin	
Gary Asffalon	

Type of business: Al Tech is both a mill and a distributor
Available bar sizes: They provide bars from No. 4 to No. 11 in size.
Available bar lengths: 33 feet (10.0 meters) maximum, 24 feet (7.3 meters) typical
Can be provided in coils
Delivery: 8 to 10 weeks for special order
Shipping: Delivery charge is \$.02 per pound to coastal New Jersey

Type 304	Type 316L	Type 316LN	Type 2205
(\$/lb)	(\$/lb)	(\$/lb)	(\$/lb)
\$1.28	\$1.40	\$1.40	\$1.60

Slater Steels
2400 Taylor Street
West Fort Wayne, IN 46802

Phone: 800/982-9075
Phone: 219/434-2800
Fax: 219-434-2801
www.slaterstainless.com

Contacts:

Dan Schram

dscaram@slaterstainless.com

Type of business: Slater is both a mill and a distributor
Available bar sizes: They provide bars from No. 5 to No. 8 in size
Available bar lengths: 25 feet (7.6 meters) maximum
Cannot be provided in coils
Delivery: 8 to 10 weeks for special order
Shipping: Delivery charge is not included in pricing

Type 304	Type 316L	Type 316LN	Type 2205
(\$/lb)	(\$/lb)	(\$/lb)	(\$/lb)
N/A	N/A	\$1.25	\$1.15

Tell Steel
2345 W. 17th Street
Long Beach, CA 90813

Phone: 800/734-8355
Phone: 562/435-4826
Fax: 562/437-6894
www.tellsteel.com

Contacts:

Bary Davidson

sales@tellsteel.com

Type of business: Tell Steel is distributor for bars manufactured in Italy
Available bar sizes: They provide bars from No. 3 to No. 8 in size
Available bar lengths: 26 feet (7.9 meters) maximum, 20 feet(6.1 meters) standard
Can be provided in coils
Delivery: 8 to 10 weeks for special order
Shipping: Price is FOB New Jersey. Trucking to site is NIC

Type 304	Type 316L	Type 316LN	Type 2205
(\$/lb)	(\$/lb)	(\$/lb)	(\$/lb)
\$1.23	\$1.60	\$1.65	\$1.82

MMFX Steel Corporation of America

5001 Birch Street
Newport Beach, CA 92660

Phone: 949/476-7600
Fax: 949/476-7605

Contacts

David Miller

david.miller@MMFXSTEEL.com

Type of business: New company that produces and sells this material
Available bar sizes: They provide bars from No. 3 to No. 11 in size
Available bar lengths: ___ ft maximum, ___ ft. standard

Delivery: First production was to have been in November 2000
Shipping: Price

MMFX-I MMFX-II
(\$/lb) (\$/lb)

Source of Nitronic Steel

Florida Wire and Cable
525 North Lane Avenue
P.O. Box 6835
Jacksonville, FL 32236

Type of business: 230 ksi prestressing strand that could be used to make up reinforcing mats
Delivery:
Shipping: Price

Nitronic
(\$/lb)

Steel Selection Task

Contract the above steel suppliers and consult the available literature on corrosion resistant reinforcing steel (we have a lot of the FHWA research literature). Use Woosak Ahn as a resource for the steel selection. Identify two or three candidate steels (high as possible strength to 150 ksi (1,034 MPa) while still having acceptable ductility and corrosion resistant characteristics). We are looking for No. 3 or No. 4 bars in high strength. We will want other bars that are galvanically compatible that can be bent into conventional hooks for corners, joints, etc.

Collaborate with NFESC regarding the selection of the steels. George Warren to provide contact (Jim Jenkins?).

Steel Performance Confirmation Task

Once the steels have been selected, collaborate with NFESC to develop some simple confirmation tests to assure that the steel is in fact sufficiently corrosion resistant in concrete. This will involve corrosion testing in concrete with cracked specimens exposed to a corrosive agent or seawater. We should be looking at bend areas and perhaps at rebar welds to assure that we know the steel selected performs as intended. We will need to understand how to use the steel in combination with other steel embeds (angles, weld plates, hatch frames, post-tensioning anchors, etc.) We will want to be sure that we don't accidentally set up galvanic cells.

Collaborate with NFESC for the development and performance of these tests.

Possible Bond Strength Test Task

We are assuming that we can get high-strength, corrosion-resistant bars that we do not need to do bond testing on. If we end up deciding to use smooth wire rather than deformed bars, we may need to develop some bond strength tests for hooks and laps.