SECTION 03490

TUSCAN FIBER REINFORCED CONCRETE SYSTEM

PART 1 GENERAL

1.1 SCOPE

A. This specification covers the requirements for the manufacture, curing and testing of TFRC; a Tuscan Fiber Reinforced Concrete product. It gives detailed requirements for grade 18P for TFRC certified producers:
   1. **'Pre-engineered Spray' Grades 18P** 'P' refers to the use of acrylic polymer emulsion in the TFRC mix design.

1.2 SECTION INCLUDES

A. Exterior Cladding
B. Interior Cladding
C. Architectural Elements
D. Insulated Panel Systems
E. Countertops
F. Flooring
G. Roofing Tile

1.3 REFERENCES

A. British Standards EN 1170: 1998: Parts 1-7: *Precast concrete products: Test methods for glass-fiber reinforced cement* (replaces BS 6432: 1984) International Glassfiber Reinforced Concrete Association. *Methods of testing glassfiber reinforced cement (GRC) material.* 1981.
B. British Standards EN 1169:1999: *Precast concrete products - General rules for factory production control of glass-fiber reinforced cement.*
C. American Welding Society (AWS)

1.4 DEFINITIONS

A. **TFRC**: Tuscan Fiber Reinforced Concrete: A pre-engineered backing coat consisting of an optimization of aggregates, chopped alkali resistant glass fiber, and cement.
B. **TFRC System**: The complete system used to produce TFRC, including approved equipment and all material as supplied by Tuscan Stoneworx. i.e. Face coat, backing coat, glass fiber, flow aid, color, sealer and adhesive.
C. **Optimization of TFRC**: Particle packing of aggregate and cement for increased strength and flow.
D. **Aggregate/Cement Ratio**: The ratio of the mass of total dry aggregate to the mass of dry cement in the TFRC.
E. **Water/Cement Ratio**: The ratio of the mass of total water to the mass of dry cement in the TFRC.
F. **Glass fiber content by weight (WF)**: The ratio (expressed as a percentage) of the mass of glass fiber to the mass of TFRC in the uncured state.
G. **Test Board**: A sheet of TFRC manufactured during production for the purpose of assessing the quality of the TFRC products being made. The test board should be made in the same way and at the same time as the TFRC in the product so that it is representative of the quality and thickness of the TFRC.
H. **Test Coupons**: Specimens taken from a test board for the purpose of determining a property.

I. **Test Sample**: The total number of coupons taken from a test board and tested to determine a property of that test board.
J. **Test Board Mean**: The arithmetic mean value for a property calculated from all the individual test coupon results from one test board. For statistical analysis, this mean is regarded as one result.
K. **Manufacture**: Pre-engineered TFRC and accessories as made by Architectural Mall, Inc.
L. **Certified Producer**: The person or authority entering into a contract to produce a TFRC product that has received training and certification from Architectural Mall, Inc.
M. **Purchaser**: The person or authority entering into a contract to buy a TFRC product.
N. **Engineer**: The person or authority responsible for the design of the TFRC component.
O. **Slump Test**: A test for measuring the consistency of the TFRC spray.
P. **Flow Tests**: Methods for the calibration of TFRC spray equipment.
Q. **Facing Coat**: An initial layer without fiber but containing decorative sands or aggregates and often pigment used to achieve different finishes per 2.5.
R. **GRCA**: The International Glassfiber Reinforced Concrete Association.
S. **High Shear Variable Speed Mixer**: A two-stage mixer designed to prepare fine sand/ cement slurries (stage 1) and to blend in chopped glass fibers (stage 2) in the pre-engineered process.
T. **MFFT**: Minimum film formation temperature (for acrylic polymers).
U. **Limit of Proportionality (LOP) / Flexural Yield**: Also known as elastic limit. The stress in a flexural bending test where the stress/strain plot deviates from a straight line.
V. **Modulus of Rupture (MOR) / Ultimate Flexural**: The highest stress on a stress/strain plot during a flexural bending test.
W. **Top/Bottom Ratio**: The ratio of the MOR results of samples tested with the mold face in tension to those with the trowelled face in tension.
X. **Units**: The unit of force/area used in this standard is the Newton per square millimeter (N/mm^2) which is numerically equal to the Mega Pascal (MPa) and Mega Newton per square meter (MN/m^2).

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.
B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Shop Drawings: Indicate dimensions, cross-sections and edge details; metal framing details, location, size and type of reinforcement, including reinforcement necessary for safe handling and erection; and connection details, and relationship to adjacent materials:
   1. Design calculations demonstrating compliance with indicated loading conditions and showing flexural ultimate strengths assumed for design, stamped by a structural professional engineer registered in the location of the project.
   2. Layout, dimensions, and identification of each panel segment corresponding to installation sequence.
   3. Location and details of anchorage devices embedded in panels and shapes, and connection details to building.
D. Samples:
   1. Provide two complete sets of samples showing color and finish, minimum size 6 inches (150 mm) square.
   2. Do not start fabrication until samples are approved.
E. Maintain plant records and quality control program during production of units. Make records and access to plant available to Architect upon request.

1.6 QUALITY ASSURANCE

A. The person or authority entering into a contract to produce a TFRC product must have certification from Architectural Mall, Inc as a Certified TFRC Producer.

B. Installer Qualifications: A firm which has specialized in erection of glass-fiber reinforced precast concrete panels or architectural precast concrete items similar to those required on this project for not less than 5 years.
C. Welder Qualifications: Use welders who have been qualified in accordance with AWS D1.1 and AWS D1.4 within the last year.
D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

1.7 STORAGE, HANDLING AND TRANSPORT

A. TFRC components must be stored, handled and transported in such a way that:
   1. No part of the component is overstressed.
   2. Bowing or twisting is not induced in the component.
   3. No damage is caused to any part of the component, particularly edges and corners.
   4. No permanent staining or discoloration is caused either by the storage conditions or the stacking/protection material. For large components, the method of handling, storage, loading and transporting shall be agreed with the engineer.

1.8 LIMITED MATERIALS WARRANTY

A. Architectural Mall, Inc shall provide a written limited materials warranty against defective material upon written request. Architectural Mall, Inc shall make no other warranties, expressed or implied.
B. The TFRC Certified Producer shall warrant workmanship separately. Architectural Mall, Inc shall not be responsible for workmanship associated with the production of TFRC products.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Producers: Architectural Mall, Inc, 642 W Winthrop Ave, Addison, IL 60101
   T. 877-279-9993 F. 877-271-9994 E: sales@architecturalmall.com
B. Substitutions: Not permitted.
C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 MATERIALS

A. Alkali Resistant Glass Fiber
   1. Glass fiber shall be an alkali-resistant continuous filament fiber developed and formulated to have high strength retention in hydraulic cement environments. Suitable alkali-resistant glass fibers are:
      (a) 'Tuscan ARG Fiber' as supplied by Architectural Mall, Inc.
B. Face Coat Material
   1. Shall be a Architectural Mall, Inc product compatible with TFRC and produced to recognized standards acceptable to the specifier and other parties involved and supported by suitable certification. Face coat shall be correctly stored and kept dry to avoid deterioration. Finishes per section 2.5.
C. Water
   1. Water shall be clean, potable and free from deleterious matter.
D. Ad-Mixtures

1. There shall be no allowance for adding any admixtures unless approved and provided by Architectural Mall, Inc.

E. Pigments
1. Powder pigment supplied by Architectural Mall, Inc may be used to produce colored TFRC. The pigments conform to international or national standards. The purchaser should recognize that color variation may occur and must agree on an acceptable range of variation with the certified producer.

2.3 MIX DESIGN

A. TFRC, as manufactured by Architectural Mall, Inc, meets all the mechanical properties of section 2.6 of this Specification. The mix design is shown below in Table 1.

TFRC Spray Grad	**Grade 18P**
Aggregate/Cement Ratio	0.75
Water/Cement Ratio	0.325 – 0.375
Glass Fiber Content (% by total mix weight)	3.0% - 4.0%
Polymer Solids Content (% by cement weight)	2.5%

Table 1

2.4 FABRICATION

A. Mixing Procedure
1. Weighing/batching
(a) Liquids should be weighed, volume batched or automatically dispensed. The producer must demonstrate that the method employed will give an accuracy of ± 0.5%.
2. Mixing
(a) The TFRC should be mixed in a 'high shear variable speed mixer' such as Power Spray's GRC 125 Combination Mixer or equivalent. First, the TFRC powder mix and liquid should be mixed at a high speed. Second, the 'high shear variable speed mixer' is put on low speed and the chopped glass fiber added manually or automatically to achieve a folding effect.

B. Spraying Procedure
1. Spraying should be carried out using Power Sprays PS38TS equipment or equivalent, which allows the TFRC to be sprayed in a random pattern. The certified producer must demonstrate that the equipment is suitable for spraying TFRC. Before starting production, the spray equipment must be calibrated to ensure that the flow rate meets standards. See 2.6A7. These tests should be carried out weekly, or after any alteration of the equipment.
2. A mist coat without fiber may be sprayed; this coat should be as thin as practicable and should be followed immediately by the first TFRC spray.
3. When a facing coat is used this may be sprayed or poured and vibrated. TFRC coat must be applied before initial set takes place.
4. The TFRC materials must be sprayed and built up in thin layers of 3–4 mm (0.118 – 0.157in) until the required thickness is achieved. The sprayed TFRC should be compacted by a hand roller before spraying the next layer. After the final layer has been sprayed the thickness of the TFRC must be checked using a template or depth gauge and compared to the design thickness. Unless specifically stated in the agreed product manufacturing specification, the design thickness should be considered as a minimum and no part of the component should be below this thickness. Over thickness will be permitted and is to be expected particularly at corners or areas with a deep profile. It will not be permitted if:
(a) Any flat areas exceed the design thickness by 4 mm (0.157in).
(b) The weight of the component exceeds the maximum design weight as specified by the engineer.
5. After checking the thickness, any areas of under thickness should be re-sprayed and areas of over thickness removed and the material discarded. The specified finish to the ' back' of the unit should be applied using a float or roller.

C. Storage Before Demolding
   1. Filled molds must be stored at temperatures between 5°C and 40°C (40°F – 104°F) 'P' grades must be stored at a temperature higher than the MFFT but below 40°C (104°F). Molds must be stored on a level surface and supported in such a manner that they will not bow or twist. Once the initial set has taken place the mold shall be covered with visqueen and should not be moved until demolding.

D. Demolding
   1. The TFRC component must not be demolded until it has gained sufficient strength to be removed from the mold and transported without being over-stressed. Demolding must be carried out in such a manner that no damage occurs to the component. If a component is too large to be demolded by hand special demolding sockets or loops must be embedded in the component and demolding should be done with a lifting frame. The procedure to be used should be agreed with the engineer before starting production.

E. Curing
   1. Curing of polymer grades
      (a) TFRC Components are produced using P grades and should be dry cured after demolding. Moist curing can be detrimental. Temperature above 35°C (95°F) or below 5°C (40°F) should be avoided for the first two days after manufacture.

F. Sealer
   1. Avoid application in direct sunlight.
   2. Apply Tuscan Exterior Sealer by sprayer, roller, or brush in a continuous application over entire part.

G. Panel Identification
   1. Mark each TFRC panel to correspond to identification mark on shop drawings for panel location.
   2. Apply marking to surface that will not be exposed in the final installation.

2.5 FINISHES

A. Finish exposed TFRC face as follows to match approved samples. Panel shall be free of joint marks, grain, or other obvious defects.
   1. New Age Stone
   2. Sand Blast
   3. Acid Wash (Etch)
   4. Polish
   5. Travertine

2.6 SOURCE QUALITY CONTROL

A. Testing
   1. TFRC tests are to be carried out on all test boards at 28 days and should meet the required properties as shown in Table 2.

Grade	**18P**
Minimum Glass fiber Content (% by weight)	3% - 4%
Characteristic LOP/Flexural Yield (N/mm^2)	LOP 8 / 1160psi
Characteristic MOR/Ultimate Flexural Yield (N/mm^2)	MOR 18 / 2610psi
MOR Top/Bottom Ratio	0.8 – 1.25
Minimum Bulk Density (kg/m^3)	
Dry	1800
Wet	2000

Table 2

   2. Test Boards
      (a) Where possible, tests should be carried out on the TFRC components themselves. If this is not possible a test board should be manufactured, stored and cured in the same manner as the component it represents. Its quality and thickness should be the same as the

component, as far as possible. Test boards must be large enough for sufficient coupons to be cut to meet the testing requirements of this specification; 600 x 600 mm (24"x24") is a commonly used size.

(b) The producer shall be responsible for testing at a rate that will ensure compliance with this specification. This rate is to be agreed with the purchaser but shall be not less than 1 board per TFRC lot #.

3. Glass Fiber Content
   (a) The glass fiber content shall be determined at 28 days in accordance with either British Standard EN 1170 or *GRCA Method of testing glass fiber reinforced cement (GRC) material* Part 1.
4. Limit Of Proportionality (LOP) And Modulus Of Rupture (MOR)
   (a) The LOP and MOR shall be determined at 28 days in accordance with either British Standard EN 1170 or *GRCA Methods of testing glassfiber reinforced cement (GRC) material* Part 4 procedure A and B.
5. Bulk Density, Water Absorption And Apparent Porosity
   (a) These properties shall be determined in accordance with either British Standard EN 1170 or *GRCA Methods of testing Glass fiber reinforced cement (GRC) material*. The tests shall be carried out at a frequency agreed between the producer and the purchaser.
6. Slump Test
   (a) A perspex plate scribed with concentric circles numbered 1 to 9 diameter of 65, 85, 105, 125, 145, 165, 185, 205 and 225mm.
   (b) Metal Tube: Inside Diameter 57mm Height 55mm
   (c) Place the tube over the central ring of the place.
   (d) Fill the tube with slurry. Remove entrapped air by rodding and tapping the side of the tube.
   (e) Screed the slurry level with the top of the tube.
   (f) Lift the tube vertically away from the plate allowing the slurry to spread over the plate. Note the number of rings covered by the slurry.
   (g) Record and compare to the required value.
7. Flow Test
   (a) Stop Watch
   (b) Bucket
   (c) Balance capable of weighing at least 10kg (22lbs) accurate to ± 50g (.11lbs).
   (d) Weigh the bucket empty.
   (e) Spray TFRC into the bucket for 30 seconds.
   (f) Weigh the bucket and TFRC.
   (g) Subtract the weight of the empty bucket.
   (h) Multiply the TFRC weight by 2.
   (i) Record the TFRC output per minute.
   (j) Compare with the required output.
8. Other Tests
   (a) Other tests of TFRC may be carried out when required by the purchaser, including full-scale load tests of products and components, fire tests, etc. These tests should be supervised by the engineer.

B. Compliance
   1. TFRC constituent materials will comply with the requirements of Section 2.2 and the composition of the TFRC will comply with Section 2.3. The TFRC will be produced by a certified producer and cured in accordance with Section 2.4E. It will be tested at a frequency complying with Section 2.6A and tested as Section 2.6A. It will meet the requirements of Section 2.6A.
   2. Compliance is generally assumed to have been met if the strengths in Table 3 are attained at 28 days. If other properties i.e. density or porosity are considered to be critical for an application compliance values should be agreed between the purchaser and the producer.

Grade	18P
LOP (N/mm2) / Flexural Yield	
Average of 4 consecutive test samples	9 / 1305psi
Minimum individual test sample	7 / 1015psi
MOR (N/mm2) / Ultimate Flexural Yield	
Average of 4 consecutive test samples	21 / 3045psi
Minimum individual test sample	18 / 2610psi

Table 3

C. Non-Compliance
   1. Failure to comply
      (a) If any single test board fails to meet any of the compliance requirements, the TFRC at risk shall be that produced between the previous complying test board and the next complying test board.
      (b) If failure to comply arises from consideration of consecutive groups of four boards the TFRC at risk shall be that represented by the first and fourth test boards together with all intervening material.
   2. Action in the event of non-compliance.
      (a) The action to be taken over TFRC products that do not comply with this specification should be agreed between the manufacture, producer and the purchaser. In determining the action to be taken, due regard should be paid to the technical consequences of the kind and degree of non-compliance and to the economic consequences of adopting remedial measures or replacing the rejected products. In estimating the quality of the sub-standard TFRC and in determining the action to be taken, the following should be established wherever possible:
      (b) The validity of the testing shall be confirmed by checking that the sampling, testing and calculations have been carried out in accordance with this specification.
      (c) That the raw materials and mix proportions used in the TFRC under investigation comply with both the specifications and/or with those agreed between manufacture, purchaser and producer.
      (d) That the curing regime adopted before testing complies with the recommendations in this Specification. Re-testing of test boards may be appropriate when it is considered that the storage conditions of the product might result in improved properties because of extended curing.
      (e) The effect of any reduction in TFRC properties on the strength and durability of the product. Two points should be considered:
         (i) The safety factors adopted in the design.
         (ii) The thickness of TFRC produced compared to the design thickness.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Check structural support system to assure a true and level surface for attachment of TFRC. Do not begin installation until discrepancies have been corrected.
   B. If substrate preparation is the responsibility of another; notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION
   A. Repair damaged or cracked surfaces.
   B. Level surfaces to comply with required tolerances in this specification.
   C. Remove surface contaminants on concrete and concrete masonry surfaces, such a form release oils, dust, paint, efflorescence, waterproofing, and similar items.

3.3 INSTALLATION
   A. Install in accordance with applicable code and erection drawings.
   B. Setting:

1. Lift TFRC units with suitable lifting devices at points provided by the manufacturer.
2. Set TFRC units level, plumb, square and true within the allowable tolerances.

C. Supports and Bracing: Provide temporary supports and bracing required to maintain stability, position and alignment as units are being permanently connected.
D. Fastening:
   1. Fasten TFRC units in place by bolting or welding or both as shown on erection drawings.
   2. Field welding shall be done by qualified welders using equipment and materials compatible with the base material.
   3. Use non-combustible shields during welding operations to protect adjacent work.

3.4 PATCHING AND CLEANING

A. Patch and clean panels using methods and materials in accordance with manufacturer's instructions.
B. Patch blemishes using a patching mixture matching the color and texture of surrounding surface.
C. Use care to prevent damage to panel surfaces and to adjacent materials. Provide protection to adjacent surfaces if required.
D. Surface must be thoroughly rinsed with clean water immediately after using cleaner.

3.5 PROTECTION

A. Protect installed products until completion of project.
B. Clean if necessary according to manufacturer’s written instructions.

END OF SECTION