

SECTION 03490

GLASS-FIBER REINFORCED PRECAST CONCRETE

This document provides a basis for specifying in-plant fabrication of glass fiber reinforced concrete (GFRC) units, shapes and panels. Processes, techniques and finished product design may vary between manufacturers to obtain the desired finish and physical properties required for the project. Compliance with this specification will insure the highest quality product designed for its specific application.
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PART 1 GENERAL

1.1 SECTION INCLUDES

** NOTE TO SPECIFIER ** Delete items below not required for project.

- A. Plant-cast, glass-fiber-reinforced precast concrete panels.
- B. Embedded hardware and anchors.
- C. Loose connection hardware.
- D. Integrated steel support framing.

1.2 RELATED SECTIONS

** NOTE TO SPECIFIER ** Delete any sections below not relevant to this project; add others as required.

- A. Section 03300 - Cast-in-Place Concrete: Building structural frame.
- B. Section 04800 – Unit Masonry: Back-up masonry.
- C. Section 05120 - Structural Steel: Building structural frame.
- D. Section 05400 - Cold-Formed Metal Framing: Structural stud members.
- E. Section 07190 - Water Repellent Coating.
- F. Section 07600 - Metal flashings.
- G. Section 07840 - Firestopping: Fire barrier seal between units and edge of floor slab.
- H. Section 07900 - Joint Sealers: Application of backer rods or bond breakers and joint sealers.

1.3 REFERENCES

** NOTE TO SPECIFIER ** Delete references from the list below that are not actually required by the text of the edited section.

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- A. ASTM A 27/A 27M – Standard Specification for Steel Castings, Carbon for General Application.
- B. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
- C. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
- D. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A 108 – Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
- F. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- G. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- H. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- I. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- J. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- K. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- L. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - M. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
 - N. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - O. ASTM C 33 - Standard Specification for Concrete Aggregates.
 - P. ASTM C 150 - Standard Specification for Portland Cement.
 - Q. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - R. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
 - S. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 - T. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
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- U. ANSI - American Iron and Steel Institute (AISI), Specification for the Design of Cold-Formed Steel Structural Members
 - V. AWS D1.1 - Structural Welding Code - Steel.
 - W. AWS D1.3 - Structural Welding Code - Sheet Steel.
 - X. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
 - Y. PCI MNL-117 – Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
 - Z. PCI MNL-128 – Recommended Practice for Glass Fiber Reinforced Concrete Panels.
 - AA. PCI MNL-130 – Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products.
 - BB. SSPC 2 – Hand Tool Cleaning.
 - CC. SSPC 3 – Power Tool Cleaning.
 - DD. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
 - EE. SSPC Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II
 - FF. CIELAB - International Commission of Illumination, 1976 Standards.

1.4 SYSTEM DESCRIPTION

- A. System: Plant fabricated glass-fiber-reinforced precast concrete panels consisting of face mix, back-up mix, steel support frame attached via pins, gravity anchors and flex anchors, steel connections for panel attachment to structure, and other inclusions for attachments to panels.
- B. Design Requirements: Design glass-fiber-reinforced precast concrete panels and shapes under the supervision of a professional engineer and in accordance with procedures of PCI MNL-128, Recommended Practices for Glass Fiber Reinforced Concrete Panels using property data generated from the manufacturer's actual production.

**** NOTE TO SPECIFIER **** Edit design references from the list below to suit the project requirements. Indicate design loads on the Drawings or include here.

C. Performance Requirements:

1. Provide glass-fiber-reinforced precast concrete panels and panel frames capable of withstanding gravity, wind, seismic, and erection design loads as well as the effects of thermal and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128.
2. Design Loads: As indicated.
3. Design framing systems to withstand design loads with lateral deflections no greater than 1/240 of the wall height.
4. Provide for movement of framing members without damage or overstressing, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 100 degrees F.

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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.

**** NOTE TO SPECIFIER **** Use Selection Samples if color and texture required is not specified and delete Verification Samples. Delete Selection Samples and include Verification Samples if colors have already been selected and are specified in this specification.

D. Samples:

1. Selection Samples: For each finish product specified, two complete sets of color sample, minimum size 6 inches (150 mm) square, representing manufacturer's full range of available colors and patterns for the exposed face of panels.
2. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns for the exposed face of panels.
3. 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.

F. Submit certificates of compliance for the following:

1. Admixtures.
2. Portland Cement: Identify the cement brand name, type and mill location used for the quality control sample.
3. Glass Fibers: Submit evidence that glass composition, Portland cement matrix, or both have been designed for glass-fiber reinforced precast concrete panel applications.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with PCI MNL 128, Recommended Practice for Glass Fiber Reinforced Concrete Panels

B. Manufacturer Qualifications: Provide panels and shapes only from a manufacturer who has demonstrated capability to produce products of the quality and scope required for this project, and with not less than 5 years of successful experience in manufacturing glass-fiber reinforced precast concrete panels and shapes and who is certified in one or more of the following programs:

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1. Certified Participant in the Architectural Precast Association's Plant Certification Program for GFRC.
2. Designated PCI-Certified Plant for Group G, Glass Fiber Reinforced Concrete by PCI's Plant Certification Program
3. Retains licensed Professional Engineer for plant and record inspection indicating production, testing and quality control methods comply with PCI MNL-130, Manual for Quality Control: Glass Fiber Reinforced Concrete.

C. 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 and who is acceptable to manufacturer of glass-fiber

reinforced precast concrete panels.

D. Welder Qualifications: Use welders who have been qualified in accordance with AWS D1.1 and AWS D1.4 within the last year.

**** NOTE TO SPECIFIER **** Include a mock-up if the project size and/or quality warrant taking such a precaution. The following is one example of how a mock-up on a large project might be specified. When deciding on the extent of the mock-up, consider all the major different types of work on the project.

E. 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 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the project site palletized, safely wrapped, packed and labeled and retain until erected.

B. Store materials in a dry location off the ground, and in such a manner to prevent damage or intrusion of foreign matter.

C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses or damage.

D. Store units to protect them from contact with soil, staining, and from physical damage.

E. Place stored units so that identification marks are easily readable.

PART 2 PRODUCTS

2.1 MANUFACTURERS

**** NOTE TO SPECIFIER **** Select manufacturer from list of producer members found on the APA website.

A. Acceptable Manufacturer: Company; address, City, ST 00000. ASD. Tel: (000) 000-0000.

Fax: (000) 000-0000. Email: _____ www. _____

**** NOTE TO SPECIFIER **** Delete one of the following two paragraphs; coordinate with requirements of Division 1 section on product options and substitutions.

B. Substitutions: Not permitted.

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C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 MATERIALS

A. Aggregates:

1. Back-up Mix: Washed and dried silica sand or other sand having a history of successful use in glass-fiber-reinforced precast concrete panel construction; passing through a No. 20 sieve.

2. Facing Mix: Fine and course aggregate for face mix shall conform to ASTM C 33 except for gradation. Aggregates shall be clean, hard, strong, durable, inert, and free of staining and deleterious materials. Provide aggregate in colors and sizes as required to achieve the panel finish texture and colors indicated on the Drawings.

B. Portland Cement: ASTM C 150, Type I, II or III. Use the same type, brand and color of portland cement for all panels and shapes. Color shall be as required to obtain the panel facing color indicated.

C. Admixtures:

1. Air-entraining admixtures, ASTM C 260. ASTM C260, ASTM C494, ASTM C618 or acrylic thermoplastic copolymer dispersion conforming to PCI MNL-130, Appendix E.

2. Polymer Compound: Conform to requirements of PCI MNL-128, Appendix L.

D. Coloring Agent: ASTM C 979; shall have no adverse effects to glass-fiber-reinforced precast concrete panel set and strength; shall be stable at high temperature; and shall be sunlight fast and alkali-resistant. Color shall be as required to obtain panel facing color selected.

E. Water for Mixing Concrete: Use potable water.

F. Glass Fiber: Conforming to PCI MNL-130, Appendix D and specifically designed to be

compatible with the aggressive alkaline environment of portland cement based composites or fibers with a history of successful use in portland cement based composites that has been modified to be compatible with the fiber.

G. Anchors and Loose Attachment Hardware:

** NOTE TO SPECIFIER ** Retain one or more of the following 10 paragraphs to suit the project requirements.

1. Structural Steel: ASTM A 36/A 36M.
2. Cold Drawn Wire:
3. Anchor Bolts: ASTM A 325.
4. Pipe: ASTM A 500 Grades A or B.
5. Tube Steel: ASTM A 500 Grade A or B.
6. Carbon-Steel Rods: ASTM A 108, cold drawn.
7. Carbon-Steel Plate: ASTM A 283/A 283M.
8. Malleable-Steel Castings: ASTM A 47/A 47M.
9. Carbon-Steel Castings: ASTM A 27/A27M, Grade 60-30.
10. Finish: Galvanized in accordance with ASTM A 153/A 153M.

** NOTE TO SPECIFIER ** Select the panel framing member materials required and delete those not required.

H. Panel Frame Materials:

1. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI "Specification for the Design of Cold-Formed Steel Structural 03490-7

Members," minimum uncoated steel thickness of 0.0538 inch (1.37mm) of web depth indicated, with stiffened flanges, V-shaped steel track, and of the following steel sheet:

** NOTE TO SPECIFIER ** Select zinc coating thickness required and delete the one not required.

a. Metallic-Coated Steel Sheet: ASTM A 653/A653M, structural-steel sheet, of grade required by structural performance of framing and with zinc coating thickness of:

** NOTE TO SPECIFIER ** Select zinc coating thickness required and delete the one not required.

- 1) G60 (Z180).
- 2) G90 (Z275).

b. Painted, Nonmetallic-Coated Steel Sheet: ASTM A1011/A1011M hot rolled or ASTM A1008/ A1008M cold rolled; nonmetallic coated according to ASTM A 1003/ A 1003M; of grade required by structural performance of framing.

2. Hollow Structural Sections: Steel tubing, ASTM A500, Grade B, or ASTM A513. Finish hollow structural sections with wall thickness less than 3/16 inch (4.76 mm) as follows:

** NOTE TO SPECIFIER ** Select the primer required and delete the one not required

a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP6/NACE No.3, "Commercial Blast Cleaning."

b. Primer: SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

3. Steel Channels and Angles: ASTM A36/ A36M, finished as follows:

** NOTE TO SPECIFIER ** Select the primer required and delete the one not required.

a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP6/NACE No.3, "Commercial Blast Cleaning."

b. Primer: SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

I. Form Materials: Provide form materials that will produce panels having the profile, dimensions and tolerances indicated. Use release agents which are compatible with finish specified and joint sealants proposed for use.

J. Mixes: Portland cement, water, glass fibers and sand mixed in proportions determined in accordance with PCI MNL-128.

2.3 FABRICATION

A. Fabricate panels in general compliance with PCI MNL-128 and MNL-130.

B. Molds:

1. Rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated on the Drawings.
2. Release agents; apply and use according to manufacturer's instructions.

C. Proportioning and Mixing:

1. Carefully measure mix constituents in a manner to achieve the desired mix proportions.
2. Meter the glass fiber and cement slurry to the spray head at rates to achieve the desired mix proportion and glass content. Check rates in accordance with standard procedures described in PCI MNL-128.
3. Maintain cleanliness of equipment and working procedures at all times.

D. Hand Spray Application:

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1. Spray apply a mist coat consisting of the matrix without fiber. Applied coating not to exceed 1/8 inch thick in order to avoid an un reinforced surface.
2. Spray or place face mix in thickness shown on shop drawings.
3. Spray-up main body of material before the mist coat has set.
4. Apply by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the application process.
5. Consolidate by rolling or such other techniques as necessary to achieve complete encapsulation of fibers and compaction.
6. Control thickness by using a pin gauge or other approved method. Perform a minimum of 2 measurements per 5 square feet of panel surface with at least 3 measurements per panel.
7. Perform hand forming of intricate details, incorporate formers or infill material, and overspray before the material has achieved its initial set so as to insure complete bonding.

E. Inserts and Embedments:

1. Properly embed inserts in built up homogeneous glass-fiber reinforced precast concrete panel bosses to develop their strength. Waste material or overspray is not acceptable to encapsulate inserts or for bonding pads.
2. Test inserts to establish test data and reduce test values by the appropriate safety factors to determine connection strength to be used in design.
3. Rigid embedded items bonded to the glass-fiber reinforced precast concrete panel shall not create undesirable restraint to volume changes.

F. Panel Frame Fabrication:

1. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened in accordance with design requirements.
 - a. Fabricate panel frames using jigs or templates.
 - b. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
 - c. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedure for welding, appearance and quality of welds, and methods used in correcting welding work.
 - d. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS DI.1 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - e. Weld flex, gravity, and seismic anchors to panel frames.
2. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.

3. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A 780.

G. Finish of Exposed Faces: Panel faces shall be free of honeycombs, form marks, concrete droppings or other blemishes that would telegraph through the panel. Provide a finish surface free of laitance, grease, form release treatments, efflorescence, curing compounds or other foreign material that would adversely affect bonding of any subsequent coating.

**** NOTE TO SPECIFIER **** Retain one of the following paragraphs to suit the project requirements and delete those not required.

1. Color and texture of exposed face surfaces shall match Architect's design reference panel.

2. Color and texture of exposed face surfaces shall match _____.
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3. Color and texture of exposed face surfaces shall match one of the manufacturers standard finishes as selected by the Architect.

H. Dimensional Tolerances of Finished Units: Provide in accordance with PCI MNL-117 and PCI MNL-128.

I. Cover: Provide embedded anchors, inserts, and other sprayed in items with sufficient anchorage and embedment for design requirements.

J. Curing:

1. Immediately after the completion of spraying of the panel, cure panels using a method to ensure sufficient strength for removing the units from the form.

2. After initial curing, remove panel from form and place in a controlled curing environment.

3. An acrylic thermoplastic copolymer dispersion may be used as a curing admixture. Only copolymers shown to eliminate the need for moist curing through independent laboratory test data shall be used.

K. Panel Identification:

1. Mark each glass-fiber reinforced precast concrete panel to correspond to identification mark on shop drawings for panel location.

2. Mark each glass-fiber reinforced precast concrete panel with date on which it was cast.

3. Apply markings on surface that will not be exposed in the finished construction.

SOURCE QUALITY CONTROL

**** NOTE TO SPECIFIER **** Include independent testing if required. Delete if not required.

L. Independent Testing:

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities.

2. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

3. Test glass-fiber reinforced precast concrete panel units in accordance with PCI MNL-130.

**** NOTE TO SPECIFIER **** Producers certified by APA or PCI may conduct their own Quality Control operations with reports to designated authorities.

M. Plant Testing:

1. Test glass-fiber reinforced precast concrete panel units in accordance with PCI MNL-130.

2. Perform testing by an independent testing agency capable of performing the specified tests. Submit copies to the Architect and designated authorities.

N. Acceptability of Appearance:

1. Finished construction in place shall present a uniform, pleasing appearance when viewed in good typical lighting with the naked eye at a distance of 10 feet and shall show no imperfections at a distance of 20 feet.

2. The range of total acceptable color (lightness, color saturation and hue) variation shall not exceed CIELAB 3.0 provided that the difference in hue alone does not exceed

CIELAB 1.0 as defined by the International Commission of Illumination, 1976 Standards.

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PART 3 EXECUTION

3.1 EXAMINATION

A. Check placement of structural support system to assure a true and level surface for attachment of panels. Do not begin construction until discrepancies that could adversely affect installation of panels have been corrected.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Setting:

1. Lift glass-fiber reinforced precast concrete panel units with suitable lifting devices at points provided by the manufacturer.

2. Set glass-fiber reinforced precast concrete panel units level, plumb, square and true within the allowable tolerances.

3. Site cutting of panels is not permitted.

C. Supports and Bracing: Provide temporary supports and bracing required to maintain position, stability, and alignment as units are being permanently connected.

D. Fastening:

1. Fasten glass-fiber reinforced precast concrete panel 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.

E. Tolerances of Erected Units:

1. Tolerances for location of glass-fiber reinforced precast concrete panel units shall be noncumulative and as listed below. For erection tolerances not listed below, those listed in PCI MNL 117 shall apply.

2. Face width of joint:

a. Panel dimension 10 feet or less plus 3/16 inch.

b. Panel dimension 10 to 20 feet plus 3/16 inch, minus 1/4 inch.

c. Panel dimension greater than 20 feet plus 1/4 inch, minus 5/16 inch

3. Warpage: Maximum permissible warpage of one corner out of plane of the other three shall be 1/16 inch per foot of distance from the nearest adjacent corner or 1/8 inch total after installation.

4. Bowing: Not over $L/360$, where L is the panel length.

3.4 PATCHING AND CLEANING

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A. Patch and clean panels using methods and materials in accordance with manufacturer's instructions.

B. Patching blemishes using a patching mixture matching the color and texture of surrounding surface.

C. Use extreme care to prevent damage to panel surfaces and to adjacent materials. Provide protection of adjacent surfaces if required.

D. Surface must be thoroughly rinsed with clean water immediately after using cleaner.

3.5 FIELD TESTS AND INSPECTION

A. Quality Control Program: Panel manufacturer shall have an established quality control program if effect at the plant or shall employ an independent testing laboratory approved by the Architect to monitor glass content, spray rate, physical properties and curing period and conditions.

B. Sampling and Testing:

1. Prepare test specimens and use test procedures in accordance with PCI MNL-128, Chapter 8 and Appendix A.
2. Prepare a minimum of 2 test boards per work shift until a production uniformity acceptable to the quality control personnel has been achieved. At such time frequency may be reduced to one board per work shift.
3. For each board determine glass content by the washout test, flexural ultimate strength and flexural yield strength.
4. Glass content shall be considered satisfactory if within minus 0.5 and plus 1.0 percent, by weight, of the glass content in the design mix.
5. Flexural yield strength shall be considered satisfactory if both of the following requirements are met.
 - a. The average of all sets of 3 consecutive strength tests equal or exceed assumed ultimate flexural strength for design purposes.
 - b. No individual test (average of 6 coupons) fall below required assumed ultimate flexural strength for design purposes by more than 10 percent.
6. Submit reports giving proportions, test results, inspection results, unit identification numbers and casting date for each work shift.

C. Rejection:

1. Panels in place may be rejected for any one of the following product defects or installation deficiencies:
 - a. Non-repairable damage incurred during construction operations.
 - b. Ragged or irregular edges.
 - c. Visible form joints or irregular surfaces.
 - d. Panels not conforming to tolerance requirements.
 - e. Foreign material embedded in the face.
 - f. Visible repairs.
 - g. Cracks visible at a distance of 10 feet.
 - h. Panels do not meet design strength requirements.

3.6 PROTECTION

- A. Protect installed products until completion of project.
 - B. Touch-up, repair or replace damaged products before Substantial Completion.
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