

Particular Specification

Precast GRC Panel / Cladding

## **1.0 GENERAL**

- 1.1** This Particular Specification is to be read in conjunction with the General Specification for Building, 2017 Edition, ("the General Specification" or the "G.S.") together with all current amendments thereto issued by the Architectural Services Department.

In the event of any doubt or discrepancy in the PS, the Architect's attention shall be drawn to such discrepancy or lack of information as soon as possible in order that he may advise the Contractor of the required Specification.

- 1.2** All clauses and descriptions in the General Specification are relevant to the Works and are to apply wherever applicable. The Particular Specification is an amplification of the General Specification and refers only to those clauses and items, which are at variance with or are not specified in the General Specification. In the event of any doubt or discrepancy, the Particular Specification shall prevail, and the Architect's attention shall be drawn to such discrepancy or lack of information as soon as possible in order that he may advise the Contractor of the required specification.
- 1.3** The Contractor shall include all demolition, alteration, subsequent make good and any other incidental and enabling work, whether stated or not, required for the completion of the work shown in the drawing/specification.
- 1.4** Should instances arise for which the technical/design standards or specification do not exist in this Particular Specification or the General Specification, the British Standard Codes of Practice and Specification shall be followed.
- 1.5** The Contractor shall check for any discrepancy between drawings and the site condition, and report to the Architect before the commencement of work. Such the discrepancy shall be included in the Tender Sum and so forth in the Contract Sum.
- 1.6** Possession of Site/ Time for Completion  
The Contractor shall take possession of the site from the date of commencement as notified in the letter of acceptance.  
Contractor is to incorporate the above time frames for site possession and completion into the programme of work to be submitted.
- 1.7** In the performance of the contract, the Contractor shall comply with all laws, ordinances, rules and regulations with respect to the authorities concerned, bearing on the conduct of the work as shown and specified. It is the Contractor's obligation to notify the Architect at the early stage of the work of any work, materials or equipment specified which do not conform to the requirements of the said laws, ordinances, rules and regulations and the Contractor to conform thereto.
- 1.8** Submission of Shop Drawings and Material Samples

The Contractor shall submit shop drawings for the Precast GRC Panel / Claddings, including but not limited to connection to fixing method, assembly system and installation details to the Architect for approval.

The Contractor shall submit full size samples of all materials in true colour to the Architect for approval.

## **2.0 PRECAST GRC PANEL / CLADDING & MISCELLANEOUS ITEMS**

### **2.1 General Requirements**

1. The work is for the design, engineering, supply, delivery, testing and commissioning of proprietary precast GRC Panel / Cladding and all necessary work for a complete functioning system to client's satisfaction. The Contractor is responsible to ensure a high and satisfactory quality, design, colour operation of products to the satisfaction of the Supervising Officer.
2. The precast GRC Panel / Cladding shall be a proprietary product of an internationally established specialist manufacturer with a minimum of 35 years proven track record in precast GRC manufacturing.
3. The precast GRC Panel / Cladding manufacturer should be a current member of International Glassfibre Reinforced Concrete Association (GRCA). The manufacturer shall supply proof of current membership for approval.
4. All Glass Reinforced Concrete (GRC) Panel / Cladding wall shall be designed, supplied and installed by a Specialist Contractors in the "Supply and Installation of Glass (or Fibre) Reinforced Plastic Units" category of the list of approved Suppliers of Materials and Specialist Contractors for Public Works of HKSAR Government. The Panel / Cladding manufacturer shall obtain and fulfil ISO 9001 : 2015 (Quality Management System) for the scope of "Design, Supply and Install of GRC Products for Architectural, Civil, Construction and Decoration Application, with Provision of Associated Connection and Structural Element Design", and ISO 14001 : 2015 (Environmental Management System) which shall also fully comply with health and safety standard in Hong Kong. Valid ISO ACI certificates should be submitted for proof of the standards.
5. The Contractor should be in the approved list of registered sub-contractor under PROVISIONAL CONSTRUCTION INDUSTRY CO-ORDINATION BOARD of Hong Kong.

The Tenderers shall submit the above information together with tender return for assessment. Failure to submit may cause tender invalid.

6. The design and manufacturer of the precast GRC Panel / Cladding shall be in compliance with BS standards (British Standards)
  - i. BS EN 1170 : Part 1 : 1993 "Precast concrete products. Test method for glass-fibre reinforced cement. Measuring the consistency of the matrix. 'Slump test' method";
  - ii. BS EN 1170 : Part 2 : 1986 "Precast concrete products. Test method for glass-fibre reinforced cement. Measuring the fibre content in fresh GRC, 'Wash out test'";
  - iii. BS EN 1170 : Part 5 : 1998 "Precast concrete products. Test method for glass-fibre reinforced cement. Measuring bending strength, "complete bending test" method"
7. The approved specialist supplier should have at least 35 years local experience in handling GRC Works installation. Details company profile should be submitted for approval.
8. Construction of GRC Panel / Cladding with the design calculations shall be verified and signed by a Registered Structural Engineer.
9. The project team list with project organization chart and relevant curriculum vitae of the individuals must be submitted for approval. The Project Manager of supplier should be a Registered Professional Engineer registered under Hong Kong Engineers Ordinance.
10. The site engineer shall be technically qualified and be required to have a minimum five years design and construction experience to projects of similar nature.
11. The Contractor shall submit a complete set of design intention and outline details of the precast GRC Panel / Cladding offered including manufacturer and country of origin of each proprietary material. No local modification to any parts of the Panel / Cladding is allowed.

12. The Contractor warrants the precast GRC Panel / Cladding shall be free from defects for a period of Five (5) years from Date of Completion of Whole of Quotation Contract Work. All water-play equipment, accessories and fixtures shall be in operation and shall be of proved design for the application.
13. Catalogues, specification, samples and shop drawings of fittings and fixtures listed in this section shall be submitted for the Architect's approval.
14. The Contractor is to take field measurements to verify or supplement dimensions indicated in the Drawings. The Contractor is responsible for accurate fit of work to various site conditions and room shape.
15. The Contractor shall submit O&M manual and as-built drawings before completion of this quotation contract.
16. Finish and texture of GRC Panel / Cladding shall be submitted at tender stage, with sample size not less than 300mm x 300mm

## **2.2 Material Specification**

Reference British Standards:

- BS 476-4: Fire tests on building materials and structures. Non-combustibility test for materials
- BS 476-7: Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
- BS EN 1170: Precast concrete products. Test method for glass-fibre reinforced cement.
- BS 12: Specification for Portland cement
- BS 5328: Concrete
- BS 882: Specification for aggregates from natural sources for concrete.
- BS 8110: Structural use of concrete. Code of practice for design and construction.
- BS EN ISO 1461: Specification for Hot Dip Galvanized Coatings on Iron and

## **2.3 Warranty**

1. 5 Years Limited Warranty shall be provided for the materials of the precast GRC Panel / Cladding against manufacturer's defect.
2. 1 Year Limited Warranty shall be provided from Contractor for workmanship under Normal and Proper Use, excluding defects caused by sub-base structural settlement, force majeure, improper cleaning method, maintenance works by other trade, vandalism and improper use of facilities. Movable parts that are used to control the equipments in high frequency such as handles, peddles, hand wheels etc, which are commonly vandalized by public, would be excluded from the warranty.
3. A lifetime warranty against corrosion for the precast GRC Panel / Cladding shall be provided.

## **2.4 Apart from the above installation works, the Contractor shall include the following works:**

1. Submission of installation programmes and statutory submission checklist
2. Submission of equipment/material and drawing schedules.
3. Provision of installation/shop drawings, builder's work drawings, manufacturer's shop drawings, progress drawings and record drawings.
4. Provision of colour equipment catalogue and technical information.
5. Submission of installation details for all services installation work,
6. Supply equipment calibrated by laboratories accredited by the Hong Kong Laboratory Accreditation (HOKLAS) or other recognized accredited laboratories for measurement and testing.
7. Submission of testing and commissioning procedure and related method statement.
8. Testing, commissioning, balancing, painting, labeling and identification of all building systems.
9. The Contractor shall be responsible for adjustments, modifications and diversion of all affected existing building services installation.
10. Provision of all equipotential bonding terminals.

## 2.5 Submittals

### A. Tests

1. Compressive Strength of GRC
2. Dry Density and Water Absorption test to BS EN 1170-6:1998
3. Fibre “Wash Out” test to BS EN 1170-2:1998
4. Interlaminar Shear Strength Test
5. Complete Bending Test to BS EN 1170-5:1996
6. Shear Testing of Structural Fixings in Concrete and Masonry to BS 5080 Part 3 : 1986
7. Proof Load of Structural Fixings in Concrete and Masonry
8. Pull Out Testing of Structural Fixings in Concrete and Masonry

### B. **Submit the following to the Project Manager to approval before fabrication:**

1. Product Data and Certifications: Provide product data for each system component, including manufacturer’s instructions for installation, ISO 9001:2015 and ISO 14001:2015 certificates.
2. Design Mixtures: For each concrete mixture.
3. Structural Calculations: Including live, dead and other loads, deflection, and comprehensive engineering analysis for Project Manager’s approval and subject to the approval of Buildings Department submission for External Cladding system.
4. Shop Drawings: Show fabrication and installation details for GFRC panels, including the followings for Project Manager’s approval and subject to the approval of Buildings Department submission for External Cladding system:
  - a) Dimensioned elevations, sections, and assembly details of all panels and GFRC panel cladding assemblies.
  - b) Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
  - c) Finishes.
  - d) Items sprayed into panels.
  - e) Description of loose, cast-in, and field hardware.
  - f) Joint and connection details.
  - g) Relationship to adjacent materials.
  - h) Panel support details for typical panels, including sizes, spacings, thickness, and material used for all members.
  - i) Locations and connection hardware where panel supports are attached to building structure.
  - j) Size, location, and details of flex, gravity, and seismic anchors for typical panels.
  - k) Erection sequence for special conditions.
5. Samples: For each selected colour, finish, and texture; submit two samples of each type in GFRC, 400 x 400 mm in size, of actual thickness to be installed, with finished faces representing full range of colours and textures expected.
6. Qualification Data: For GFRC manufacturer, including proof of current GRCA certification.
7. The Contractor shall appoint RSE to prepare all necessary structural calculations, drawings and details for Buildings Department approval.
8. Mock Up for GRC Panel / Cladding:
  - a) Physical model made of Foam and/or Polymer Clay in scale 1:200
  - b) Computer model drawn by software of AutoCAD, 3D Studio or Architectural Desktop for Setting out of GRC Panel / Cladding.
  - c) Full scale Off Site Clay Model 1:1 as positive mold for GRC Panel / Cladding.

### C. **Apart from the above requirements, the Contractor shall submit the following prior to work commence**

1. Submission of installation programmes and statutory submission checklist
2. Submission of equipment/material and drawing schedules.
3. Provision of installation/shop drawings, builder's work drawings, manufacturer's shop drawings, progress drawings and record drawings.

4. Provision of colour equipment catalogue and technical information.
5. Submission of installation details for all services installation work,
6. Supply equipment calibrated by laboratories accredited by the Hong Kong Laboratory Accreditation (HOKLAS) or other recognized accredited laboratories for measurement and testing.
7. Submission of testing and commissioning procedure and related method statement.
8. Testing, commissioning, balancing, painting, labeling and identification of all building systems.
9. The Contractor shall be responsible for adjustments, modifications and diversion of all affected existing building services installation.
10. Provision of all equipotential bonding terminals.

### **3.0 PRECAST GRC PANEL / CLADDING & MISCELLANEOUS ITEMS**

#### **3.1 MANUFACTURER**

Yeung's Fiberglass Company or approved equivalent  
Unit F, 23/FL., CNT Tower, 338 Hennessy Road, Wanchai, Hong Kong  
Contact : Ir. Herbert Yeung 8222 8882

#### **3.2 MOLD MATERIALS**

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces; non-reactive with GFRC and capable of producing required finish surfaces.

B. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.

#### **3.3 GFRC/GRC CLADDING SYSTEM**

- A. Design, fabricate and install component parts in conformance with Performance Criteria specified herein.
- B. Design Safety Factors: The minimum safety factors to be used in the flexural design of the the anchorages shall be as specified herein.
  1. Flexural Safety Factor (F.S.F.): The minimum safety factor to be used in the flexural design of cladding panels shall be as specified herein. The Architect will review the production cladding testing data and may further modify the safety factor as he deems appropriate.
  2. Anchorage Safety Factor (A.S.F.): The minimum safety factor to be used in checking cladding stresses at anchorage zones shall be calculated as follows:  
$$A.S.F. = F.S.F. \times 1.4$$
- C. The Panel / Cladding work shall accommodate the following movements without any permanent deformation or reduction in the specified performance:
  1. Deflection under design loads.
  2. The effects of repeated wind and internal pressure loading including pressures related to the movements of trains.
  3. Changes in dimension and shape of components arising from building movements, including settlement, creep, twisting and racking.
  4. Movement of any joint whether designed to permit movement or not.
- D. Dead Loads: The exterior wall cladding work shall be capable of accommodating the following dead loads without any reduction in performance:
  1. The dead loads derived from permanent fixtures or services attached to either the internal or external surfaces of the exterior wall cladding work.
  2. When calculating loads it shall be ensured that the worst combination load cases have been considered, bearing in mind that the pressure coefficients at various locations may determine more than one design criteria.

- E. Live Loads: The exterior wall cladding work shall be capable of accommodating the following live loads without any reduction in performance:
1. All loads resulting from movements of the building structure and cladding support structure.
  2. Horizontally applied loads acting on the surface arising from maintenance and cleaning operations. The exterior wall cladding work shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any part of the framing.
  3. Impact loads, or transferred impact loads, that occur during its service life, without deterioration in performance and without sustaining nonrepairable damage.
  4. Loads imposed during replacement of panels/units.
  5. When calculating loads the worst combination shall be considered, taking account of the fact that the pressure coefficients at various locations may determine more than one design criteria.
- F. Deflections
1. The exterior wall cladding work shall not deflect under loading in any way that is detrimental to any element of the Exterior wall cladding work or adjacent structural or building elements.
  2. All components, couplings and fixings shall be capable of accommodating all specified deflections without permanent distortion, deformation or failure.
  3. The exterior wall cladding work shall accommodate differential structural movements arising from any loads imposed by adjacent structures.
  4. The magnitude of the allowable deflections shall be reduced if they are detrimental to any part of the Exterior wall cladding work, its support structure or internal finishes.
- G. Moisture Movement: The exterior cladding system shall withstand the following movement without permanent deformation or any reduction in the specified performance:
1. Due to changes in the moisture content of its components, resulting from variations in the moisture content of the air.
  2. Due to drying shrinkage in cladding components or supporting structures, both short term and long term to BS 8297 section 3, and BS 8298.
- H. Anchorage: The ultimate strength of anchors, inclusive of the derived or specified safety factor shall be developed completely by the mechanical action of the anchor. Adhesives shall not be allowed to contribute to the structural capacity of the anchor assembly.
- I. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Use materials that do not stain exposed surfaces of cladding and joint materials.
- J. All fixings shall be capable of providing adequate adjustment with the minimal use of packing shims, which shall be agreed with the Design Consultant. All necessary movement joints shall be designed to accommodate the maximum movements that can be derived from the specified and determined design loads and movements. Under

maximum movements the joints shall meet all the performance requirements of the Performance Specification.

- K. The exterior wall cladding work shall resist all specified static and dynamic design loads likely to be encountered without causing permanent deformation of components or the failure of members or seals and shall transmit such loads safely to the points of support.
- L. The exterior wall cladding work shall not deflect under loading in any way that is detrimental to any element of the Works or adjacent structural or building elements
- M. Shipping and Handling: The cladding and the cladding anchorage shall not be compromised to any degree by distress in the assembly which may occur as a result of shipping and handling of the assembly.
- N. Design Modifications: Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work. Variations in details and materials which do not adversely affect appearance, durability or strength shall be submitted to the Architect for review. Maintain the general exterior design concept without altering profiles and alignments shown.
- O. Anchors: Comply with BS 8298, clauses 2.3 and 3.10 unless more stringent requirements are specified herein. Metal components in contact with cladding shall be stainless steel. Exterior metal components not in contact with exterior cladding may be stainless steel or ferrous steel hot-dip galvanized in accordance with BS 729. Ferrous metals may be used for purposes not in contact with interior cladding and shall be either galvanized or shop prime painted. Select metals to be compatible with adjacent materials and to be non-staining to cladding. Separate dissimilar metals in contact by using appropriate separators to prevent galvanic action. Provide anchors embedded within cladding in sizes, configurations and profiles as shown or as required to sustain imposed loads without exceeding allowable design stresses, and install anchorages and supports free from rattle or displacement.
  - 1. Exterior Cladding Anchors: BS 1449, Part 2, Type 316 stainless steel, 5mm minimum thickness. Provide cladding anchors complying with the "Performance Criteria" specified hereinbefore.
  - 2. Fixings and Anchorage Devices: Type, grade, class and style best suited for the respective purpose.
    - a. Fixings for Steel Subframe Components: either hot-dip or mechanically zinc coated.
    - b. Fixings for Stainless Steel Anchors: Fixings for stainless-Steel Anchors: Stainless steel fasteners, bolts, screws, nuts and other fixings shall be either grade A2 or grade A4 to BS 6105 (ISO 3506).

## **4.0 GRC MATERIALS**

### **4.1 MATERIALS**

- A. Portland Cement : ASTM C 150, Type I, II, or III for surfaces exposed to view in finished structure, use white of same type, brand, and source throughout GFRC production
- B. Metakaolin : ASTM C 618, Class N for supplementary cementing material if its use by GFRC manufacturer has been proven in service to maintain GFRC ductility
- C. Glass Fibers: Alkali resistant, produced under a quality management

system approved to ISO 9001 standard.

- D. Sand: Washed and dried silica, complying with composition requirements of ASTM C 144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.
- E. Coloring Admixture: ASTM C 979, Maximum of 10% synthetic mineral-oxide pigments or colored
- F. Water-reducing Admixtures: Temperature stable, non-fading, and alkali resistant.
- G. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130.
- H. Polymer-Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL 130 if wet curing is not used.
- I. Chemical Admixtures: ASTM C 494/C 494M, containing not more than 0.1 percent chloride ions.
- J. Traditionally sprayed GRC shall achieve Grade 18 or 18P as per GRCA specification or equivalent.

#### **4.2 GRC SPRAY APPLICATION**

- A. Portland Cement: ASTM C 150. Use only one brand and type of cement for Project.
- B. Fly Ash: ASTM C 618, Class C or F.
- C. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- D. Blended Hydraulic Cement: ASTM C 595
- E. Silica Fume: ASTM C 1240, amorphous silica.
- F. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
- G. Aggregate Gradation: ACI 506R, Gradation No. 2 with 100 percent passing 13-mm sieve.
- H. Lightweight Aggregates: ASTM C 330.
- I. Aggregate Gradation: ACI 506R, Gradation No. 2 with 100 percent passing 13-mm sieve.
- J. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored, water-reducing admixtures, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
- K. Color: As selected by Architect from manufacturer's full range
- L. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
- M. Carbon-Steel Fiber: ASTM C 1116, Type 1, carbon-steel fiber and ASTM A 820, Type 1, not less than 25 mm long.
- N. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116, Type III, not less than 19 mm long.
- O. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.
- P. Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

#### **4.3 ANCILLARY MATERIALS**

- A. Supports, Anchors, and Attachments for GFRC: All components shall be Grade 304 stainless steel complying with the following:
  - 1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
  - 2. Bars and Shapes: ASTM A 276.
  - 3. Rolled Floor Plate: ASTM A 793
  - 4. Bolts, Nuts, and Washers: ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).
  - 5. Fasteners: ASTM A 962.

- B. Sealants: Silicon sealant complying with requirements of 07 90 00 “Joint Sealers”.

#### **4.4 GFRC MIXES**

- A. Backing- and Face-mix Proportions: As determined by GFRC fabricator to meet performance requirements.
- B. Backing Mix: Proportion backing mix of Portland cement, glass fibers, sand, and admixtures to comply with performance requirements. Provide nominal glass-fiber. GRC.
- C. Face Mix: Proportion face mix of Portland cement, sand, facing aggregates, and admixtures to comply with design requirements.
- D. Polymer-Curing Admixture: 6 to 7 percent by weight of polymer-curing admixture solids to dry Portland cement only needed if wet curing is not used.
- E. Coloring Admixture: Not of exceed 10 percent of cement weight.

#### **4.5 MOLD FABRICATION**

- A. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
- B. Coat contact surfaces of molds with form-release agent.

#### **4.6 GFRC FABRICATION**

- A. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures
- B. Spray Application: Comply with general procedures as follows:
  - 1. Spray or place face mix in thickness indicated on Shop Drawings.
  - 2. Proceed with spraying backing mix before face mix has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
  - 3. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass.
- C. Fibers and compaction:
  - 1. Measure thickness with a pin gage or other acceptable method at least once for each 0.5 m<sup>2</sup> of panel surface. Take not less than six measurements per panel.
  - 2. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.
- D. Inserts and Embedded items: Build up homogeneous GFRC bosses or bonding pads over inserts and embedded items to provide sufficient anchorage and embedment to comply with design requirements.
- E. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold as set out in the PCI/GRCA handbook.
  - 1. After initial curing, remove panel from mold and place in a controlled curing environment.
  - 2. Keep GFRC panels continuously moist for a minimum of seven days unless polymer-curing admixture was used. Maintain temperature between 60 and 120 deg F (16 and 49 deg C) during this period.
- F. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date / mould number and PSD number.

#### **4.7 FABRICATION TOLERANCES**

- A. Manufacturing Tolerances: Manufacture GFRC panels as each finished unit complies with PCI MNL 130 for dimension, position, and tolerances, and as follows.
- B. Dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.
- C. Overall Height and Width of Units, Measured at the Face Adjacent to Mold:
  - 1. 10 feet (3m) or less, plus or minus 1/8 inch (3 mm).
  - 2. More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.
- D. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).
- E. Project Managerural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
- F. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
- G. Panel Depth form Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
- H. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
- I. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
- J. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
- K. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
- L. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
- M. Location of Window Opening within Panel: Plus or minus 1/4 inch (6 mm).
- N. Maximum Permissible Warp of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.
- O. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
- P. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
- Q. Flashing Reglets at Edge of Panel: Plus or minus 1/4 inch (6 mm).
- R. Inserts: Plus or minus 1/2 inch (13 mm).
- S. Special Handing Devices: Plus or minus 3 inches (75 mm).
- T. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
- U. Blockouts: Plus or minus 3/8 inch (10 mm).
- V. Panel Frame Tolerances: As follows:
  - 1. Vertical and Horizontal Alignment: 1/4 inch per 10 feet (6 mm per 3 m).
  - 2. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
  - 3. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
  - 4. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

#### **4.8 FINISHES**

- A. Finish exposed-face surfaces and returns of GFRC as follows to match approved Design Reference Sample and mockups.
- B. Panel faces shall be free of joint marks, grain, and other defects.
- C. Textured-surfaces Finish: Impart by form liners to provide surfaces free of sand streaks, honeycombs, and excessive air voids, with uniform color and texture.

#### **4.9 CLEANING AND PROTECTION**

- A. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions.
- B. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clear water. Prevent damage to GFRC surfaces and staining of adjacent materials.

-End-