Gujarat University

TECHNICAL SPECIFICATIONS

Additional Items

TENDER NO: GU/ESTATE/RP/2018-19/01

Tender Document
For
Construction of Research Park (Phase-1)
at
Gujarat University

TECHNICAL SPECIFICATION FOR DESIGN AND CONSTRUCTION OF PRECAST BUILDING

A. DESIGN DATA AND SPECIFICATION FOR THE PROJECT

The Layout plan and architecture drawings of the proposed Building are attached.

B. DESIGN DATA

The Agency is required to design and prepared the structural working drawings for the proposed building on basis of architecture drawings/design. The design shall base on following parameters of latest IS codes to be refereed.

DESIGN CRITERIA AND REQUIREMENTS IN THE PRECAST CONSTRUCTION OF BUILDINGS:

a) Use of materials for plain and reinforced precast concrete & in-situ concrete shall satisfy the requirements of IS 456: (latest Revision)
b) Components of Precast RCC structure shall be designed for loads in accordance with I.S. 875 (Parts l to 5) and IS 1893-(latest Revision) (Part 1). In addition, loads that might be expected during handling, considered in the design.
c) Design of In-situ as well as precast structural units shall conform to the Design requirements of IS : 456 : (latest Revision)
d) The permissible stresses for plain and reinforced precast concrete & in-situ concrete shall be in accordance with the requirements of IS : 456: (latest Revision)
e) Resistance to horizontal loading shall be provided by having appropriate moment and shear resisting joints or placing the shear walls. Where shear wall are provided, rotational stiffness of the floor wall joint is not to be considered.
f) Buttressing in the external walls shall be provided as external wall elements are not fully restrained on both sides by floor panels and that external wall panel connections are the weakest points in a precast panel building.
g) In all load bearing elements, adequate restraint shall be provided at corners of the building. These elements and the external ends of cross wall units should be stiffened either by introducing columns as connecting units or by jointing them to non- structural wall units.
h) All concrete to be used at site shall be Design Mix concrete Minimum grade of concrete for In-situ concrete and the precast concrete shall be of M-30 Or Higher Grade as per IS : 456 : (latest Revision).
i) High yield strength deformed bars or equivalent TMT bars of grade Fe 500 confirming to IS 1786-(latest Revision) shall only be used in all RCC work.
j) Bearing for Precast Units shall be as per clause 8.3 of IS 15916: (latest Revision) Slab panels shall be interconnected through joints at regular intervals to provide monolithic / diaphragm action.
k) RCC decking/topping reinforced screed shall be overlaid on precast panels for providing rigid diaphragm action, under seismic conditions.
l) In designing the prefabricated buildings over G+7 storeys, the possibility of progressive collapse of the structure should be considered, in which failure or displacement of one structural element causes failure or displacement of another element and results in partial or total collapse of the building.

DESIGN REQUIREMENTS FOR SAFETY AGAINST PROGRESSIVE COLLAPSE:

a) All buildings should be capable of safely resisting the minimum horizontal load of 1.5 percent of characteristic dead load applied at each floor or roof level simultaneously.
b) All buildings shall be provided with effective Horizontal Ties i.e,
  I. Horizontal ties around the periphery.
  II. Horizontal ties internally in both directions
  III. Horizontal ties to columns and walls,
c) Design considerations for the Horizontal Ties shall be as per clause 8.2.3.1 to 8.2.3.3 of IS

15915: (latest Revision)..All buildings of five or more storeys shall be provided with vertical ties

d) Design considerations of vertical ties for buildings of five or more storeys shall be as under: Each column and each wall carrying vertical load will be tied continuously from the foundation to the roof level. Reinforcement in vertical ties to be provided only to resist a tensile force equal to maximum design ultimate load (dead and imposed) received from any one storey. In situation where provision of vertical ties cannot be done, the element should be considered to be removed and the surrounding members designed to bridge the gap.

C. JOINTS/CONNECTION

a) Requirements of a structural joint:
   - **i.** It shall be capable of being designed to transfer the imposed load and moments with a known margin of safety;
   - **ii.** It shall accept the loads without marked displacement or rotation and avoid high local stresses.
   - **iii.** It shall accommodate tolerances in elements;
   - **iv.** It shall enable the structure to absorb sufficient energy during earthquakes so as to avoid sudden failure of the structure.

b) Precast Components of the structure shall be designed for Fire rating of one hour. Fire rating for joints of the components shall be higher or at least equal to the Fire rating of connecting members.

c) The appearance of precast components joint shall merge with architectural aesthetic appearance and shall not be physically prominent compared to other parts of structural components.

d) Precast structures may have continuous or hinged connections subject to providing sufficient rigidity to withstand horizontal loading. When only compressive forces are to be taken, hinged joints may be adopted. In case of prefabricated concrete elements, load is transmitted via the concrete. When both compressive force and bending moment are to be taken, rigid or welded joints may be adopted. The shearing force is usually small in the column and can be taken up by the friction resistance of the joint. Here load transmission is accomplished by steel inserted parts together with concrete.

e) When considering thermal shrinkage and heat effects, provisions of Expansion Joints as per IS 3414: (latest Revision).shall be provided.

D. FOUNDATION DESIGN AND REQUIREMENTS

a) Subsurface investigation shall be carried out indicating vertical sections of the strata, testing of soil samples on the site and in a laboratory for determining shear strength parameters, bearing capacity of the soil, permeability, index properties, water table, compressibility characteristics, swelling properties type & classification of soil and other geophysical information in the field to decide economical & sound foundation.

b) The cement concrete foundation (plain or reinforced) should be designed in accordance with IS 456: (latest Revision). and masonry foundation in accordance with IS : 1905 (Latest version).

c) Design Consideration for Spread of pad or Strip foundation shall be as per I.S. 1080: 1985 (Reaffirmed 1997).

E. CHOICE OF RAFT TYPE FOUNDATION

- For fairly small and uniform column spacing and when the supporting soil is not too compressible, a flat concrete slab having uniform thickness throughout (a true mat) shall be provided. The slab may be thickened under heavily loaded columns to provide adequate strength for shear and negative moment. Pedestals may also be provided in such cases. A slab and beam type of raft shall be preferred in large column spacing and unequal column loads, particularly when the supporting soil is very compressible.
- In cohesive soils, the effect of long term settlement due to consolidation shall be taken into consideration. In case the structure supported by the raft consists of several parts with varying heights and loads, expansion joints between these parts shall be provided.

F. PILE FOUNDATION

- When adequate load-bearing strata at shallow zone are not available Pile foundation may be provided. Choice of piling system shall be made based on the soil report values, load characteristics of the structure and the limitations of total settlement & differential settlement. Design Consideration for Piling system shall be as per relevant provisions in IS 2911(Latest version). The integrity testing of piles and other requirements shall be as per IS 2911(Latest version).

COMPOSITE CONSTRUCTION WITH PRECAST ELEMENTS AND *CAST-IN-SITU* CONSTRUCTION

a) Protrusions or recesses on the top surface of precast concrete units shall be provided for necessary monolithic action between the cast-in-situ concrete and precast units.
b) The composite section should preferably be proportioned in such a way that the neutral axis of the composite section is located below the in-situ concrete slab. If the neutral axis is located inside the in-situ concrete slab, the portion of the slab below the neutral axis shall not be considered effective for computing moments of inertia or resisting moments except for deflection calculations. The modular ratio between precast concrete and cast in situ concrete shall be determined on the basis of values of moduli of elasticity for the two concretes.
c) Differential Shrinkage and Creep of Concrete:- The effects of shrinkage & creep of cast-in-situ concrete on the prefabricated member shall be considered. It shall be ensured that stresses in the prefabricated member do not exceed the permissible stresses by more than 25 percent when-these effects are superimposed on the stresses caused by the worst combination of other loads.
d) Composite structures in which the *in-situ* concrete is assumed to act integrally with the precast beam shall be inter-connected to transfer the horizontal shear along the contact surfaces and to prevent the vertical separation of these units. Transfer of shear shall be by shear bars, castellation and by bond. The units shall further be tied together by the extension of web reinforcement.
e) Ties - Separation of the component elements in the direction perpendicular to the contact surface shall be prevented by ties adequately embedded on each side of the contact surface; The spacing of such ties shall not exceed four times the thickness of the slab or 60 cm whichever is less. The minimum cross-sectional area of the ties, in each meter of the span shall not be less than 0.15 percent of the contact area or 130 sq mm. All web reinforcement of the prefabricated unit shall be extended into the cast *in- situ* concrete.
f) Bond Strength at the Inter-face - The inter-face shall always be made rough for effective bonding. The bond strength at the inter-face shall be checked for ultimate load. The ultimate values of the horizontal shear stress at the interface shall be calculated in accordance with the formula given under clause 6.5.2 of IS : 3935: 1966(Reaffirmed 1998). If the calculated shear stresses are more than the values given under no slip condition in Table 1 for strength of the in-situ concrete, it shall be taken that the slip has occurred. The design shall then be made taking a frictional shear resistance of 10 kg/cm2 and the balance stress to, be resisted by steel shear connectors stressed to a maximum of 1340 kg/cm2. The inter-face shear shall not, however, exceed the value given under the maximum permissible shear stress prescribed in Table 1of IS : 3935: 1966(Reaffirmed 1998).
g) Specifications and Design considerations shall be in accordance with IS : 3935: 1966(Reaffirmed 1998).

SEISMIC CONSIDERATIONS:

- RC building frame system and shear walls shall be designed and detailed to comply with the requirements given in IS 4326, IS 1893:2016 and IS 13920.-(Latest Revision)

TECHNICAL SPECIFICATION 100MM PRECAST DESIGNER WALL:-

Design, supply and erection of 100/150 mm thick concrete decorative free standing wall panels of M-30/40 grade of concrete with proper graded aggregate, cement OPC 53 grade, admixtures confirming to IS 9103 with mould finish on one side and smooth trowel finish on other side with ready to paint surface including reinforcement steel, including mould cost, necessary corrugated ducts for connection including grouts, lifting hooks for erection. The material casting should take place in Synthetic Rubber / FRP mould manufactured by RECKLI or equivalent.

❖ TECHNICAL SPECIFICATION STRUCTURAL GLAZING SYSTEM

Designing, fabricating, testing, protection, installing and fixing in position semi (grid) unitized system of structural glazing (with open joints) for linear as well as curvilinear portions of the building for all heights and all levels, including:

(A) Structural analysis and design and preparation of shop drawings for the specified design loads conforming to IS 875 part III (the system must passed the proof test at 1.5 times design wind pressure without any failure), including functional design of the aluminum sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)-cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation and drainage and protection against fire hazard including:

(B) Fabricating and supplying serrated M.S. hot dip galvanised / Aluminium alloy of 6005 T5 brackets of required sizes, sections and profiles etc. to accommodate 3 Dimentional movement for achieving perfect verticality and fixing structural glazing system rigidly to the RCC/ masonry/structural steel framework of building structure using stainless steel anchor fasteners/ bolts, nylon seperator to prevent bimetallic contacts with nuts and washers etc. of stainless steel grade 316, of the required capacity and in required numbers.

(C) Providing and filling, two part pump filled, structural silicone sealant and one part weather silicone sealant compatible with the structural silicone sealant of required bite size in a clean and controlled factory / work shop environment, including double sided spacer tape, setting blocks and backer rod, all of approved grade, brand and manufacture, as per the approved sealant design, within and all around the perimeter for holding glass.

(D) Providing and fixing in position flashings of solid aluminium sheet 1 mm thick and of sizes, shapes and profiles, as required as per the site conditions, to seal the gap between the building structure and all its interfaces with curtain glazing to make it watertight.

(E) Making provision for drainage of moisture/ water that enters the curtain glazing system to make it watertight, by incorporating principles of pressure equalization, providing suitable gutter profiles at bottom (if required), making necessary holes of required sizes and of required numbers etc. complete. This item includes cost of all inputs of designing, labour for fabricating and installation of aluminum grid, installation of glazed units, Tend, scaffolding and other incidental charges including wastages etc., enabling temporary structures and services, cranes or cradles etc. as described above and as specified. The item includes the cost of getting all the structural and functional design including shop drawings checked by a structural designer, dully approved by Engineer-in-charge. The item also includes the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working structural glazing as specified, cleaning and protection till the handing over of the building for occupation. In the end, the Contractor shall provide a water tight structural glazing .having all the performance characteristics etc. all complete as required, as per the

Architectural drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Engineer-IN- Charge.

Measurements:
The area of Glazing shall be measured in Sq.mt.

TECHNICAL SPECIFICATION OF GLASS FIBER REINFORCED CONCRETE

Glass fiber Reinforced Concrete (Sometime called Glass Reinforced Concrete.) is a mixture of cement, fine aggregate, water, chemical admixtures and ***Alkali resistant Glass fibers*** There are numbers of different manufacturing process: the most common are Hands Spray andPre-mix,

Glass fiber reinforced Concrete (GRC) is a material which today is making a significant contribution to the economics, to the technology and to the aesthetics of the construction industries worldwide.

This environment friendly composite , with its look consumption of energy and natural raw material is being forming to a great variety of product and has won firm friends among designers, engineers and end users for its flexible ability to meet performance, appetence and cost parameter.

Since its introduction in 1969 , GRC has matured and today's designers has available to him depending up on his performance requirement, a range of matrix modifier such as acrylic polymer, rapid set cement and additives to improve the long term stability of the material. ***Extensive independent tests and performance data are available on all aspect of matrixformulation***.

The *Alkali Resistant Glass fiber* is generally used at the 3-5 % level in the manufacture of factory finish pre fabricated product either by the spray process or using traditional concrete casting method.
It is also used in the 1 – 2 % range for reinforced renders as a site applied mix and can also be used to control plastic shrinkage cracking, micro cracking and bleeding in site –cast concrete

A. WorkIncluded

a. Providing and Fixing of GRC Jali (Glass Fibre Reinforced Jali) 50 mm thick of required size, pattern, design, and colour with 50% area covered to be fixed on/between RCC / Block work Column or structural steel work with Dry Fixing method.
b. GFRC panel fabrication shall include all labor, materials, equipment, and related services necessary to manufacture the panels as indicated and described by the contractdocuments.
c. GFRC panel erection shall include all labor, materials, equipment, and related services necessary for the erection of the panels as indicated and described by the contractdocuments.
d. The GFRC manufacturer shall furnish all GFRC-embedded hardware; he shall furnish all loose connection hardware, unless specified elsewhere. The placement of the hardware in cast-in-place concrete will be the responsibility of that contractor placing the cast-in-placeconcrete.
e. Furnishing and attaching all hardware required to be placed in the cast-in-place concrete or attached to the structure for the connection of the GFRC panels shall be clearlyspecified.
f. Responsibility for the design and detailing of hardware attached to or cast into the support structure, as well as layouts for placement, should bespecified.

B. Related Work SpecifiedElsewhere

a. Cast-in-Place Concrete - Placement of anchorage devices in cast-in-place concrete for GFRCpanels.

b. Precast floor and roof slabs, beams, columns, and other structuralelements.
c. Steel supporting structure and loose anchors, ifapplicable.
d. Miscellaneous iron, anchor bolts or other anchorage devices required for installing GFRCpanels.
e. For exposed face of panels, responsibility should be specified if applicable. Generally done by the panel manufacturer.
f. Insulation applied to GFRCpanels.
g. Counterflashing inserts and receivers, unless included in thissection.
h. Sealing joints between panels, or caulking between panels and othermaterials.
i. Field touch-up painting of metal parts. Delete when specified in thissection.

C. DesignResponsibility

GFRC panels shall be designed under the supervision of a registered professional engineer employed or retained by the manufacturer.

D. QUALITY ASSURANCE –

4.1 Acceptable Manufacturers
4.2 Manufacturer with a demonstrated capability to produce GFRC products of the quality and scope required on this project, and with a GFRC industry involvement of at least 10 years. Experience required is a minimum of 2 to 5 years. The manufacture of CFRC requires a greater degree of craftsmanship than most other concrete products, and therefore requires prequalification of the manufacturer. Plant certification, as provided in the Plant Certification Program, is satisfactory evidence. Or as approved by Engineer incharge
4.3 When requested by the Engineer, the manufacturer shall submit written evidence of having experienced personnel, physical facilities, established quality control procedures, and a management capability sufficient to produce the required units without causing delay of theproject.

E. ErectorQualifications

5.1 Regularly engaged for erection of GFRC or architectural precast concrete panels similar to those required on this project, and the present erection management capability sufficient to erect the required units without causing delay of theproject.

F. Job Mock Up

6.1 After standard samples are accepted for color and texture produce full sacle unit meeting design requirements full scales samples or inspection of the first production unit are sometimes desired but the efforts of this requirement on scheduling must be considered. When a new design concept or new manufacturing process or other unusual circumstance indicates that proper evaluation cannot otherwise be made a mock-up may be justified.
6.2 Mock up to be the standard of quality for GFRC Panel work when accepted by Engineer. Use to Determine range of acceptability with respect to color and texture variations, surface defects and overall appearance. It is difficult to access appearance from small samples .
6.3 Incorporate mock up into work in location reviewed by engineer in charge after keeping unit in plant for checking purpose.

G. Submittals

Prior to commencement of manufacture, submit samples representative of finished exposed face showing typical range of color and texture. If the back face of a GFRC unit is to be exposed, samples of the workmanship, color and texture of the hacking should heron as well as thefacing.

7.1 Sample Size: Approximately 12 in. x 12 in. (3.05 x 3.05 m) and of appropriate thickness, representative of the proposed finishedproduct

H. Drawings

Prior to commencement of manufacture, submit samples representative of finished exposed face showing typical range of color and texture. If the back face of a GFRC unit is to be exposed, samples of the workmanship, color and texture of the hacking should heron as well as thefacing.

8.1 Production drawings, except for shape drawings, are not usually submitted for approval, except in special cases where the Engineer or Contractor agrees to assume responsibility. However, record copies are frequently requested. Guidelines for the preparation of drawings are given in the "PC!.

8.2 Architectural Precast Concrete DraftingHandbook.
Unit shapes (elevations and sections) anddimensions.

8.2.1 Unit Shapes (Elevations and Sections) and dimensions
8.2.2 Finishes
8.2.3 Joint/Connection
8.2.4 Lifting/Erection inserts
8.2.5 Location and details of hardware attached to structure
8.2.6 Other items sprayed in panels.
8.2.7 Handling Procedures
8.2.8 Sequence Erection for special conditions
8.2.9 Relationship to adjacent material
8.2.10 Description of all loose, cast in and field hardware.
8.2.11 Shop drawings by same identification marks placed on panels
8.2.12 The manufactures shall not proceed with fabrication of any products prior to receiving approval of erecting drawings by the engineer shop drawings approval by engineer means that the engineer has reviewed the shop drawings for general or design compliance with contrary documents design approval by the Engineer means that the engineer has reviewed the design panel.

I. Test Reports

9.1 Submits on request, copies of test reports. Scheduled of required test is included in section 1.02G. Numbers of copies of test reports, and how reports should be distributed are included in testing laboratory Services Sections .

J. Design Calculation

10.1 Submit entire design calculation in line with all relevant Indian and international codes. Submission of calculation isnecessary.

K. Material –

Glass Fiber Reinforced Concrete-

Glass Fiber Reinforced Concrete (GRC) is generally manufactured by either “Spray “or the “Pre Mix” vibrator casting process. The process chosen is normally dictated by factor such as strength requirement, size of mold, design of elements. As a general rules, larger items, such as building cladding panels are normally “Sprayed” whereas small item are manufactured from “Pre Mix” process.

i. **SPRAYED GRCPROCESS**

1. The water and admixtures (and polymer if used) are placed in a “ High Shear Mixture” and the sand/ cement are slowly added until smooth creamy slurry is achieved. The consistency of the slurry can be checked using a simple slump test kit. Mixing time is about 1 – 2minutes.

2. When ready the mix is transferred to a “Pump / Spray Unit” . The Pump conveys the slurry at a regulated rate of flow to the spray gun. At the spray gun fiber , in the form of a roving is

chopped to a length of 25 – 32 mm and added to the slurry. The two materials are projected on to the mold surface using controlled air pressure from aircompressor The GRC material is s prayed and built up in thin layers until the required thickness is achieved normally 10 – 15 mm . Simple hand roller is used to compact the material inlayers.

3. The product is left in mould and covered with polythene to prevent moisture loss until 8 hrs. The product is then demolded.
4. After demoulding the GRC element is either cover with polythene or water cure for approximately 4 days. Alternately if polymer curing compound is used in mix then GRC element is can be exposed to the atmosphere immediately,althoughitisadvisabletokeepthemfromdirectsunlightorseverconditionsfordayortwo.

ii. **PRE-MIX GRCPROCESS**

1. The Sand and Cement are mixed dry and then the water/admixture and polymer (If used) are added, Generally Slow speed slurry / fiber blender mixer is used. With this type of mixer the fast speed is design to create smooth creamy slurry. This takes about 1 to 2 minutes The mixture is then switch to slow speed and fiber in the form of chopped strand (length approx. 20 mm) is added slowly. The fiber is blended in to the mix for an approximately 1minute.

2. Once the mix is ready , it is pour in to mould which are vibrated using vibratingtable.

3. The product is left in mould to set and covered with polythene sheet to prevent moisture loss. The product is de mould nextday.

4. After de molding the product are cured under polythene sheet to maintain moist condition for approximately 4 days. Alternatively a polymer curing compound can be used as describe for the sprayedprocess.

iii. FIBER

1. Alkali Resistant Glass fiber for used in cement basedSystem

2. AR fibers are made by the continuous filament process. Molten glass is fed through a platinum (bushing) which contain very large numbers of small holes (tips). The molten glass is pulling through bushing as a continuous fiber. It is passes through the fine water mist and is then pass over roller that applies an organic processing: The fibers are then wound on to a former to make a cake. This cake is then put through a time / temperature regime to cure the size. The cake are then either wound together to form a roving (or cheese) or put through a chopping unit to cut the fiber to required length (Chopped / strand)

3. The selection of the type and amount of size used apex the end fiber product in term of stiffness, resistance to abrasion and can have other effect. The diameter is uniform with little variation. The alkali resistance is confirmed by the composition of glass itself and not on a protectivecoating.

4. The description of continuous filament glass fiber are usually asfollows

1. Filament A single fiber
2 Diameter CF Glass fiber have a uniform cylindrical cross section normally between 10 –

	20micron	
3	Strand	A no of filament bonded together by thesize
4.	StrandTex	The weight (linerdensity) of the strand express In gm/Km . Typically commercialproducthas a strand Tex in the region of 20 –100
5.	Chopped	A length of strand cut a particular length. Usually these are in the range of 3 – 25 Chopped strands are used in GRC Pre mix process and to renders and concrete to Toughness and suppress cracking.
6	Roving	An assembly of CF fiber wound together to create a self-supporting product. Roving are used in GRC Spray process and continuous reinforcement
7	End Count	The no of strand collected together to form a roving
8	***Roving Tex***	The weight (Linear density) of the roving express in gm / Km. For e.g. if a roving ends of strand each having a strand tex of 76.5 the roving tex would be 32 x 76.5

iv. **Fineaggregates**

Fine aggregate or sand shall be washed and dried to remove soluble matter and permit accurate control of the water/cement ratio. The particle shape should be round or irregular and should have a smooth surface without honeycombing. For spray GRC, the maximum particle size shall be 1.2mm; for premix GRC, the maximum particle size shall be 2.4mm. In both cases the fine fraction, i.e. sand passing a 150 micron sieve, shall be less than 10% of the total weight of sand. Silica sands are widely used and should conform to the specification in Table 1. Sands with a higher moisture content may be used provided the moisture content is known and the mix design is altered accordingly. Sands other than silica sands may be used but the producer should provide evidence of their suitability. Soft building sands must not beused

v. **Admixtures**

Admixtures are permitted and their use is encouraged as they can enhance the properties of GRC. They should always be used strictly in accordance with the suppliers' recommendations and the producer must ensure that their use has no adverse effect on the product. Calcium chloride-based admixtures must not be used if the GRC component contains steel reinforcement, fixing sockets or other cast-in devices.

vi. **Pigments**

Powder pigments or dispersions may be used to produce colored GRC. The pigments should conform to international or national standards. The purchaser should recognize that colour variation may occur and must agree an acceptable range of variation with the producer.

vii. **Other componentmaterials**

Other component materials (e.g. silica fume, metakaolin, fly ash, reinforcing fillers, admixtures, meshes), may be added to modify the properties of the mix. They must be used in accordance with the supplier's instruction and the producer must demonstrate that their use will not adversely affect the properties of theGRC

L. TYPICAL PROPETIES OF GRC (AT 28 DAYS)

Properties	**Spraymethod**	**Pre mixmethod**
Glass fiber % by wt	5	3
Bending Ultimate Strength (MOR)	Mpa 20 – 30	10 – 14
Elastic Limit (LOR)	Mpa 7 – 11	5 – 8

Tensile Ultimate strength (UTS)	Mpa 8 – 11	4 – 7
Elastic limit	Mpa 5 – 7	4 – 6
Shear Interlaminer Strength	Mpa 3 – 5	N /A
In planer strength Mpa 8 – 11 4 – 7		
Compressive Strength	Mpa 50 – 80	40 – 60
Impact Strength	Kg/ M2 10 – 25	10 – 15
Modules of Elasticity	GPa 10 – 20	10 – 20
Strain of failure %	0.6 – 1.2	0.1 –
Dry Density T / M3	1.9 – 2.1	1.8 – 2.0

M. FABRICATION

a) Proportioning andMixing

I. All measurements of mix constituents shall be carried out in a careful manner to achieve the desired mix proportions.

II. The glass fiber and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glasscontent.

III. These shall be checked in accordance with standard procedures described in "Recommended Practice for Glass Fiber ReinforcedConcrete".

IV. Cleanliness of equipment and working procedures shall be maintained at alltimes.

N. Hand SprayApplication

These requirements apply to hand spray only. Some shapes or products lend themselves to machine spray (possibly with vacuum compaction and dewatering) which would require changes to these specifications.-

I. Spray operators shall be trainedpersonnel.

II. A mist coat consisting of the matrix without fiber may if necessary be sprayed onto the form. The thickness of this coating shall generally not exceed 1/32 in. (0.79 mm) in order to avoid an unreinforcedsurface.

III. Spray-up of the main body of material shall proceed before any mist coat hasset.

IV. Application shall be by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the applicationprocess.

V. Consolidation shall he by rolling or such other techniques as necessary to achieve complete encapsulation of fibers aridcompaction.

VI. Control of thickness shall be achieved by using a pin gauge or other approved method.

O. Cover

Provide embedded anchors, inserts, and other sprayed in items with sufficient anchorage and

embedment for design requirements.

P. Curing

I. Immediately after the completion of spraying of the panel, a curing method shall be used to ensure sufficient strength for removing the units from theform.

II. After initial curing, remove panel from form and place in a controlled curing environment. Panels shall be kept continuously wet for a minimum of 7 days in accordance with manufacturer's standard curing practice. The temperature shall be maintained between 60 F and 110 F (16 C and 43 C) during this period. Curing less than 7 days, temperature below 60 F, or atmosphere less than 95 percent relative humidity will reduce the material property values and hence design strengths. Accelerated curing with temperatures above 110 F (43 C) maybe detrimental tostrength.

Q. EXECUTION

a) PRODUCT DELIVERY, STORAGE ANDHANDLING

I. Delivery and Handling

i. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses or damage. Panels shall be handled and transported so that panels are not subject to undue stress. If panels are "nested" or stacked vertically, consideration must be given to transfer of vertical load in order to prevent progressive crushing or otherdamage.

ii. Lift or support units only at the points shown on the erection shopdrawings.

iii. Place no staining resilient spacers of even thickness betweenunits

iv. Support units during shipment on no staining shock absorbingmaterial.

v. Protect units from dirt and damage during handling andtransport.

b) Storage at job site

i. Store units to protect them from contact with soil, staining, and from physical darnage. Units should never be placed directly onground

ii. Store units, unless otherwise specified, with no staining, resilient supports located in same positions as when Transported

iii. Store units on firm, level, and smoothsurfaces

iv. Place stored units so that identification marks are easilyreadable.

R. PRE-INSTALLATIONRESPONSIBILITY

a) Contractor'sResponsibility

I. The Contractor shall provide building lines, center and grades in sufficient detail to allow installation of the GFRC units.

II. The Contractor shall provide true, level bearing surfaces. Construction tolerances for cast-in-place concrete, steel, masonry etc., should be specified in applicable sections of thespecifications.

III. The Contractor shall provide for the accurate placement and alignment of anchor bolts, plates or dowels on the structure.

b) Festering

I. Fasten GFRC units in place by bolting or welding or both as shown on

approved erection drawings. Fastening detail should provide sufficient three-directional allowance to accommodate creep, thermal and moisture- induced panel movement, field tolerances, and dimensional changes in the structural frame of the building. Slotted and/or oversize holes in connections and attachments, or the use of special fasteners are the usual means to accommodate the above. Usually, panels are fixed at one point while the other connections have freedom tomove.

II. Field welding shall be done by qualified welders using equipment and materials compatible to the base material. Field welds should be avoided if possible or kept to a minimum. When field welding is required, the erector shall protect units from damage caused by field welding or cutting operations and provide non- combustibleshields as necessary during theseoperations.

c) Tolerance of Erected Units

I. Tolerances for location of GFRC units shall be non-cumulative and as listed below. For erection tolerances not listed below, those given in PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products," shall apply.

II. Face Width of Joint: Panel dimension 10 ft (3.05 m) or less ±^/ls in. (4.77 mm) Panel dimension 10 to 20 ft(3.05to6.10m)+''lsin.–14in.(4.77mm,6.35mm)Paneldimensiongreaterthan20ft(6.10m)+1/4in.—^/is in. (6.35 mm, 7.95 mm)

III. Warpage: Maximum permissible warpage of one corner out of the plane of the other three shall be fha in, per ft (5.2 mmlm) distance from the nearest adjacent corner, or 1I8 in. (3.18 mm) total afterinstallation.

IV. Bowing: Not over L/360, A. where L is the panellength.

S. Measurements

The surface area (sq.mt) of Jali shall be measured for payment.

T. Rate

The rates shall be includes the cost of labour, material involved in all the operations described in Bill of Quantities**.**

U. Reference Codes &Guide

GRCA “Methods of Testing Glassfibre Reinforced Concrete (GRC) Material” GRCA “Specifiers Guide to Glassfibre Reinforced Concrete”
GRCA “Assessment of GRC Test Results” GRCA “Approved Manufacturer Scheme (AMS).

European Standards

a. BS EN 1169: 1999: Precast concrete products — General rules for factory production control of glass-fibre reinforced cementproducts.

b. BS EN 1170: 1998: Parts 1-8 Precast concrete products: Test methods for glass-fibre reinforcedcement.

i. Part 1. Measuring the plasticity of the mortar— 'Slump test'method.

ii. Part 2. Measuring the fibre content in fresh GRC, Wash outtest'.

iii. Part 3. Measuring the fibre content of sprayedGRC.
iv. Part 4. Measuring bending strength — 'Simplified bending test'method.
v. Part 5. Measuring bending strength — 'Complete bending test'method.
vi. Part 6. Determination of the absorption of water by immersion and determination the drydensity
vii. Part 7. Measurement of extremes of dimensional variations dueto moisture content.
viii. Part 8. Cyclic weathering typetest

c. BS EN 14649: 2005 Precast concrete products — Test method for strength retention of glass fibres in cement and concrete (SICTEST).

d. BS EN 15422: 2008 Precast Concrete Products - Specification of glassfibres for reinforcement of mortars andconcretes.

e. BS EN 1169: 1999. Precast concrete products – General rules for factory production control of glassfibre reinforcedcement.

ASTM

a) C948 Standard Test Method for Wet Bulk Density, Water Absorption and Apparent Porosity of Thin Section Glass Fiber ReinforcedConcrete.

b) C1229 Standard Practice for Preparing Coupons for Flexural and Washout Test for Glass Fiber ReinforcedConcrete.

c) C1229 Standard Test Method for Determination of Glass Fiber Content in Glass Fiber ReinforcedConcrete

d) C1230 Standard Test Method for Performing Tension Tests on Glass Fiber Reinforced Concrete [GFRC] BondingPads

e) C1560 Standard Test Method for Hot Water Accelerated Aging of Glass Fiber ReinforcedConcrete

ITEM DESCRIPTION : Water Proofing

Providing and applying **2 coats of WPM 004**, two components acrylic modified flexible cementations waterproof coating using brush / roller over well prepared dry surface, including sandwiching WPM Deck Web at all corners, cracks, construction joints and pipe penetrations, grinding all sharp edges, cleaning all surfaces to make them free from all contaminants, etc and complete as per manufacturer's specification.

Surface preparation: All sharp edges and protrusions shall be grinded to make them flush with the surface. All floor and wall surfaces up to required height shall be cleaned to make it free from dirt, dust, loose particles, wax polish, efflorescence, laitance, curing compound and other contaminants by mechanical means and wire brushing.

Note: All new surfaces shall be allowed to cure and dry completely according to standard practice. The proper slope shall be provided to the outlet pipes. Any other miscellaneous items like covings, if required, shall be installed using polymer modified mortar admixed with E 135 (SBR, multipurpose concentrated liquid polymer additive and bonding agent), vertical bore packing shall be treated using B 30 (non shrink cementations structural grout), horizontal bore packing shall be treated using polymer modified mortar admixed with E 135, cracks or construction joints, if found, shall be treated using polymer modified mortar admixed with E 135, etc.

Waterproofing membrane: WPM 004 (two component acrylic modified flexible cementations waterproof coating) product consisting of part A and part B, which needs to be mixed together with adding 50% of water to part A in suitable size mixing vessel, using heavy duty slow speed drilling machine fixed with mixing paddle to obtain a uniform mix. Two coats of WPM 004 are required to achieve the correct thickness of 0.8 - 1.0 mm. Apply the first coat over well prepared surface. Install the WPM Deck Web (non-woven polyester glass filament reinforced reinforcing cloth) at all corners and pipe penetrations over the wet surface of WPM 004 by ensuring the WPM Deck Web is completely embedded in the coat of WPM 004 and allowed to dry completely. Apply the second coat of WPM 004 in opposite direction to the first coat and allow it to dry completely.