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Facade Quality Plan

Adair Street Hotel
30th April 2020



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02 Introduction

- 02.1 The purpose of this document is to set out the quality control procedure for the selection, design, manufacture, delivery and installation of the GRC panel cladding system to the Adair Street Hotel, Manchester.



03 Design concept

- 03.1 Stephenson Studio Ltd has been commissioned by local developer, Capital & Centric, to develop a design for a 275 bed hotel scheme to the north east perimeter of the city centre zone.
- 03.2 The site is located on the corner of Adair Street and Great Ancoats Street. Within this neighbourhood is an area that has been identified for development as a Strategic Regional Framework (SRF), known as the Portugal Street East SRF (March 2018). This site is one of six plots within the SRF.
- 03.3 The proposed Adair Street scheme has been designed with the principles of the Manchester Strategy at its core. This is an intrinsically Manchester project. The proposal has been borne out of a commitment to delivering a scheme that is innovative and a high-quality design. Indeed, the project has already won a coveted President's Award at the MSA Awards 2019 for the best project.
- 03.4 The design is conceived as being 'carved' out of a single material to give the impression of solid blocks. It is essential the protruding boxes are constructed from the same material as the rest of the building to ensure the building is one single, homogeneous and consistent material that will achieve the architectural design brief.
- 03.5 Utilising GRC will achieve this aesthetic. We explored the use of pre-cast concrete for the façade, but no manufacturer could find a solution for constructing the protruding boxes in pre-cast concrete. Therefore, the use of pre-cast concrete is not an option for this project. Another benefit of using GRC is the size of the GRC cladding panels that can be procured. The GRC cladding panels that have been designed into the Adair Street Hotel are 5.2m x 2.8m. When we looked at pre-cast, as well as not being able to use precast to clad the protruding boxes and soffits, another shortfall of pre-cast concrete was that the size of the panels was much smaller resulting in more joint lines in the facade, which would detract from the aesthetic aspiration for a monolithic sculpture.

04 Sub-contractor Selection and Management

- 04.1 The selection of the right sub-contractors is key to achieving the required quality. The key to any successful project is not only dependant on the selection of the materials specification, whilst considering the sourcing and availability of materials in the current market but also the selection of suitable contractors to complete the works. The design solution relies on the use of GRC to achieve the required aesthetic.
- 04.2 Following a rigorous tender process, the main contractor, Bowmer + Kirkland, was chosen for their proven experience with hotels and the use of GRC panels.
- 04.3 Bowmer + Kirkland operate an approved supply chain data base. All contractors working on the project have been assessed and attained approved status on their data base of approved supply chain partners. All contractors on their supply chain are assessed and go through an approval process at maximum two-year intervals. They also monitor and score the performance of all contractors with whom they place orders as well as undertaking regular credit checks at intervals not exceeding 3 months prior to the placing of any order. Contractors undertaking works have their performance reviewed at maximum 6 monthly intervals or at the end of each work package completed. This performance review is then inputted on to their performance management data base which collates scores across their projects. This performance information is then available to their staff to review prior to placing future orders with those contractors. This process also allows Bowmer + Kirkland to manage their supply chain and address any issues of poor performance ensuring they maintain a consistent high standard of performance for the benefit of the project and ultimately the communities within which we work.
- 04.4 There are several basic factors to identify suitable sub-contractors, including:
1. Financial strength to sustain the required cash flow
 2. Quality Management
 3. Standard of workmanship
 4. Adequacy of experienced staff
 5. Number of relevant projects completed
 6. Adherence to programme
 7. Sufficiency of resource
 8. Provision of Safety information and safety performance history.
 9. Past relationship
 10. Current order book / workload
 11. Reputation / references
 12. Price
- 04.5 Bowmer + Kirkland adopted the above procedures to select Telling Architectural as suppliers of the GRC panels. Telling are the foremost supplier of GRC in Britain.

05 Roles and Responsibility

05.1 The design and construction team members all have important roles and responsibilities in managing the quality of the façade materials for the Adair Street Hotel. The key team members include Stephenson Studio as architects, Bowmer + Kirkland as main contractor, either NET Project Management & Consultancy Ltd or Sandberg Consulting Engineers as façade engineer and Telling Architectural as GRC manufacturer.

05.2 Stephenson Studio

Stephenson Studio is responsible for the development of the design from RIBA Stages 1 to 6 inclusive. They are also responsible as lead designer for checking and coordinating sub-contractor design information and coordination of information from other design team members. This includes building product specification / selection and the policing of the quality of all installations, including the GRC panels.

05.3 Bowmer + Kirkland

Bowmer + Kirkland is the principle contractor with total responsibility for the delivery of the project. This includes the selection and management of all subcontract package contractors. Telling Architectural have been appointed by Bowmer + Kirkland to manufacture the GRC cladding panels for the façade.

Delivery of a defect free project is also a very important factor. Regular and at a maximum of monthly intervals, factory visits take place to inspect the manufacturing process and the quality of the panels and components that are under production or have been completed in the previous period.

In line with Bowmer + Kirkland's ISO 9001 certified Quality Management system, a Project Quality Plan will be produced prior to commencement on site. As part of this quality management system B+K will undertake a thorough inspection/snag of each element of works throughout the various stages of production. These inspection intervals will be detailed in the trade specific inspections and test plans that form part of the project quality plan.

05.4 Façade engineer

Bowmer + Kirkland will be employing a façade engineer dedicated to the project. They are currently interviewing candidates, who are either NET Project Management & Consultancy Ltd or Sandberg Consulting Engineers. Their role will be:

- Review subcontractor's QA procedures in their manufacturing facilities and on-site, verify compliance with specification and good standards. Carry out reasonable audits in the subcontractors manufacturing facilities and on site, to check their QA procedures
- Attend 4 No. visits of the GRC manufacturing facility including 1 No. visits for the initial fact finding and design. Complete full QA on their compliance with specification, including but not limited to connection detailing and fixings and PPC QA checks, to ensure compliance with relevant UK standards
- Input into and return comment on the architect's façade drawings & schedules
- Review and return comment on all sub-contractor product, technical and drawn proposals, including all drawings
- Review and return comment on all sub-contractor calculations

- Review the wind analysis undertaken and ensure compliance with / inclusion of its outcomes in sub-contractor designs
- Review the engineer's movement and tolerance report and ensure compliance with / inclusion of its outcomes in sub-contractor designs
- Attend site in Manchester 6 No. times to carry out installation inspections, including provision of a written report
- Attend 4 No. 1 day design meetings in Manchester
- Provide PI insurance to appropriate level

05.5 **Telling Architectural**

Telling Architectural is responsible for the design, manufacture and delivery of the GRC cladding panels. They adopt stringent QA procedures, which are documented in the appended Telling Quality Plan in Appendix D.

06 Interface Management

- 06.1 The main interfaces on the façade are the GRC wall panels, protruding boxes and windows. Typical bay studies / details are shown in Appendix A.
- 06.2 To ensure the interface of these components remains consistent it is of paramount importance that each panel is manufactured and installed to the correct dimensional accuracy and remains within the permitted tolerances for both panel to panel joints and panel to curtain walling structural openings.

All GRC panels including the workmanship of units during the production process will comply with GRCA publications 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products' and 'Practical fixing guide for glassfibre reinforced concrete (GRC)'.

The dimensional accuracy of the panel installation will be controlled and checked by Stephenson Studio as architects, Bowmer + Kirkland as main contractor, either NET Project Management & Consultancy Ltd or Sandberg Consulting Engineers as façade engineer.

Bowmer + Kirkland will provide the primary setting out grid lines and datums whilst the GRC sub-contractor will be responsible for the dimensional accuracy of the GRC panel installation. Bowmer + Kirkland will then independently check the as installed position of the precast panel before the glazing installation is able to progress ensuring the structural opening is provided to correct dimensional accuracy.

- 06.3 A sample panel of these interface has been mocked up within the off-site compound area. This panel was visited by Dave Roscoe and Angela Leckie of MCC on 17th February 2020.



07 Off-site Quality Management and Transportation

- 07.1 Prior to appointment an audit of the Telling Architectural factory and their Quality Management systems was undertaken by Bowmer + Kirkland and Stephenson Studio. Telling Architectural are Britain's foremost fabricator of GRC panels. Consequently, their own QA procedures ensure exemplary standards are met.
- 07.02 Telling Architectural's 'Quality Method Statement for GRC Production' (see Appendix C) and 'Quality Plan' (see Appendix D) documents their rigorous procedures and policies to ensure Telling Architectural's quality management ensures the highest standards are met.
- 07.03 All of the quality management procedures of Telling Architectural will be underpinned by the following key industry guidelines:
- GRCA Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products October 2017.
 - GRCA Practical Design Guide Version 1.1 March 2018
 - GRCA MOT October 2017

08 Tolerances

08.1 All GRC units including the workmanship of units during the production process will comply with GRCA publications 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products' and 'Practical fixing guide for glassfibre reinforced concrete (GRC)'. Dimensional accuracy and tolerances are checked as part of the inspection process that forms part of Telling Architectural's 'Quality Method Statement for GRC Production' (see Appendix C) and 'Quality Plan' (see Appendix D).

08.2 Stephenson Studio's specification (see Appendix B) described all the required tolerances for the 'accuracy of erection of cladding' and 'accuracy of erection of GRC components'. These standards are documented below and will ensure a high quality of manufacture and installation of the GRC panels.

08.3 Accuracy of erection of cladding

- Elevation joint widths: Within joint lengths, including in-line continuations across transverse joints, as follows:
 - Tolerance: Greatest width not to exceed least width by more than vertical and horizontal panel joints, for panels up to 6m:
3mm (joints between glass fibre reinforced concrete elements and windows/other cladding).
4mm (joints between glass fibre reinforced concrete elements) vertical and horizontal panel joints, for elements larger than 6m:
4mm (joints between glass fibre reinforced concrete elements and windows / other cladding
6mm joints between glass fibre reinforced concrete elements.
 - Variations: Evenly distribute, with no sudden changes.
- Offset in elevation: Between nominally in-line edges across transverse joints not to exceed +/- 2mm in any direction, on elevation or plan.
- Offset in plan or section: Between flat faces or adjacent panels across joints not to exceed +/-2mm in any direction, on elevation or plan.
- Sealant joints width limitations: To recommendations of sealant manufacturer.
- Finished work: Square, regular, true to line and plane with satisfactory fit at junctions.

08.4 Accuracy of erection of GRC components

- Joint widths: Within joint lengths, including in-line continuations across transverse joints, as follows:
 - Tolerance: Greatest width not to exceed least width by more than 20% width of joint.
 - Variations: Evenly distribute, with no sudden changes.
- Offset in elevation: Between component edges across transverse joints not to exceed 20% width of joint.
- Offset in plan or section: Between flat faces of adjacent units across joints not to exceed 20% width of joint.
- Sealant joints width limitations: To recommendations of sealant manufacturer.
- Finished work: True to line and plane with satisfactory fit at junctions.

09 Ensuring on-site quality and rectifying damage

9.1 The quality control of both the product and installation is paramount to achieve the requisite finish. To ensure the delivery of a high-quality finish requires several policies to be implemented, including the preparation of an Architect's Specification (see Appendix B) and the implementation of the Sub-contractor's Quality Plan (see Appendix D). It also requires a stringent policing of quality by the contractor, Bowmer + Kirkland as well as their Façade Engineer.

9.2 To ensure quality, it will also be a fundamental requirement for the architect, in collaboration with MCC planning department, to sign-off a full-scale mock-up before works commence. These samples are to demonstrate the abutment and interface details between all components.

Following the inspection by Dave Roscoe and Angela Leckie of MCC on 17th February 2020 of the first sample panel, there were quality issues identified with regard hair-line cracks. During the inspection of the sample panel we identified a few hairline cracks. We have since spoken to the manufacture to establish the cause of these blemishes. Apparently, the GRC panels were manufactured then delivered straight to site without being given time for the concrete to 'cure', which created the cracks. To compound the issue, the sample panel was exposed to the rear and was subject to driving rain during Storm Dennis. The normal installation of GRC would not be subject to these blemishes.

To alleviate the concerns about the cracks, Keith Hamilton of Stephenson Studio and Dave Roscoe and Angela Leckie of MCC visited John McAslan's Health Innovation Campus at Lancaster University on 4th March 2020. The inspection of the panels used on this building were crack free and demonstrated the high quality of the product.

Following this visit, Stephenson Studio is now arranging for Bowmer + Kirkland to construct another and much larger sample panel. This will form the benchmark that all installations of GRC on site will be required to match.

A 'schedule of external elevation materials' revision 01 dated 11th March 2020 has already been agreed with MCC following the submission of this schedule for the discharge of planning condition 4. This schedule describes the agreed material samples that will be provided during the contract and the dates for submission to MCC for their approval. This document is contained in Appendix E.

9.3 The architect has prepared and will ensure the implementation of a detailed specification for the GRC panels. A key aim of this specification (see Appendix B) is to establish the benchmark for quality. The architect's specification describes the exacting detail and quality measures requested by the installation. Of note, the following clauses are important:

H40.800 Post Contract Samples

Provide post contract samples in accordance with Section A.4000 as follows:

a) Sample GRC panels, including large wall panel (5.2m x 2.8m), soffit panel and corner detail panel. Panels of finished GRC panels to illustrate the range in variation of aggregate mix, colour and surface finishes available for acceptance by the Contractor.

H40.810 Quality of Finishes

- a) All finish to exposed edges and surfaces shall match the accepted sample.
- b) The finishes shall be uniform in colour and appearance throughout the Contract.
- c) Components having arises or faces that are broken, chipped, cracked, discoloured crazing, honeycombed, irregular, inconsistent, stained or otherwise marred such that their appearance or performance is significantly impaired shall not be accepted. All finishes to be fully compliant with GRCA and British Standards.
- d) Submit finished samples to the Contractor for acceptance prior to manufacturing.
- f) Discard and replace or correct any GRC units that do not appear identical to the accepted samples.
- g) GRC panels may be rejected for the following reasons:
 - i) Exceeding specified installation tolerances.
 - ii) Chipped, spalled, cracked or otherwise damaged during construction operations.
 - iii) Exposed to view surfaces that develop surface finish deficiencies.
 - iv) Other defects as listed include:
 - Ragged or irregular edges.
 - Excessive air voids on exposed surfaces.
 - Casting lines evident from different placements.
 - Visible form joints or irregular surfaces.
 - Stains on panel surfaces.
 - Non-uniformity of colour and texture.
 - Foreign material embedded in face.
 - Visible repairs.
 - Reinforcement shadow lines.
 - Visible cracks.

H40.820 Production Control Units(s)

The first unit produced of each of the panels listed below shall be inspected by the Contractor, and if its appearance is acceptable, it shall be clearly marked and kept safely at the factory as a control standard for the appearance of subsequently produced units.

- a) large wall panel (5.2m x 2.8m)
- b) soffit panel
- c) corner detail panel.

H40.830 Inspection

Carefully inspect all completed units and check for match with accepted sample(s) or control unit(s) and for compliance with the Architectural Specification before dispatch to Site. Make arrangements with the Contractor for the inspection of completed units in the factory adopting the Glassfibre Reinforced Concrete Association (GRCA) inspection methods.

H40.840 Construction Generally

- a) Conform to the procedures of the International Glassfibre Reinforced Concrete Association (GRCA).
- b) All works shall be true to detail with continuous profiles, free from marks, defects, flaws, steps, waves, or damage of any nature.

H40.850 Storage

Store GRC panels on the ground, protect from inclement weather and keep dry. Prevent soiling, chipping and contamination by salts and other deleterious substances.

H40.860 Damaged Units

Do not repair without acceptance.

Such acceptance shall not be given where the units are badly damaged or where the proposed repair would impair appearance or performance.

H40.870 Cleaning

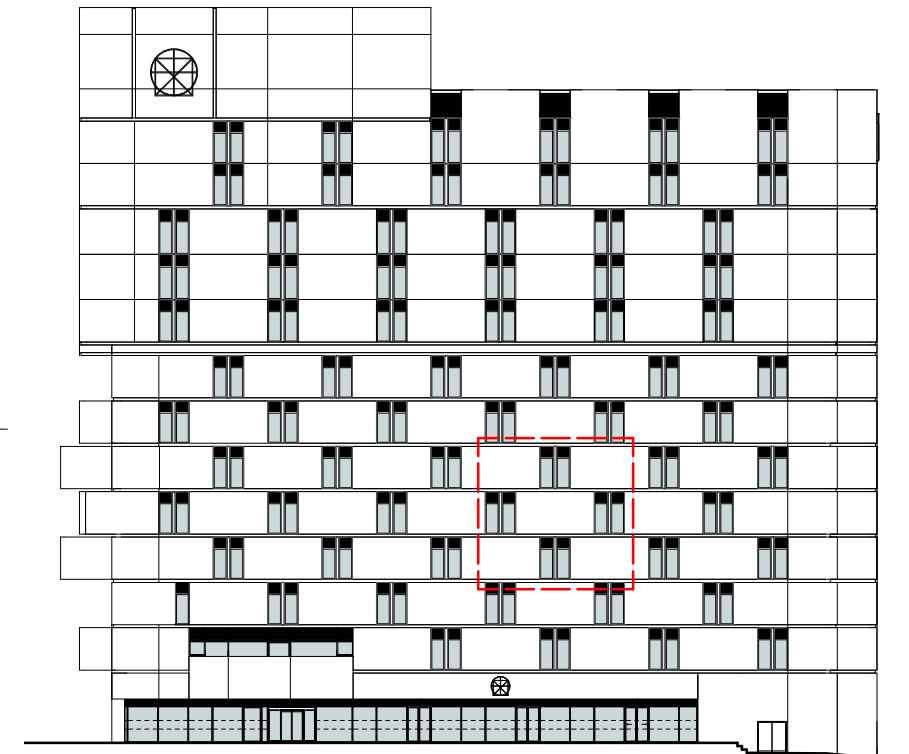
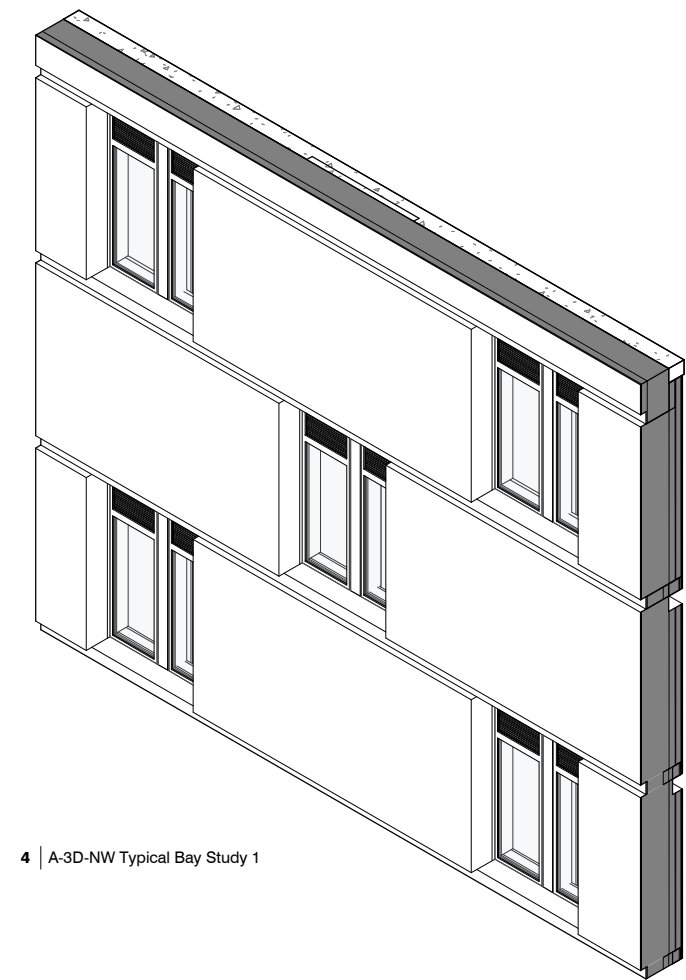
- a) Clean any dirt or blemishes from exposed surfaces.
- b) Wash and rinse in accordance with the precast manufacturer's recommendations.
- c) Protect adjacent surfaces from damage due to cleaning operations.

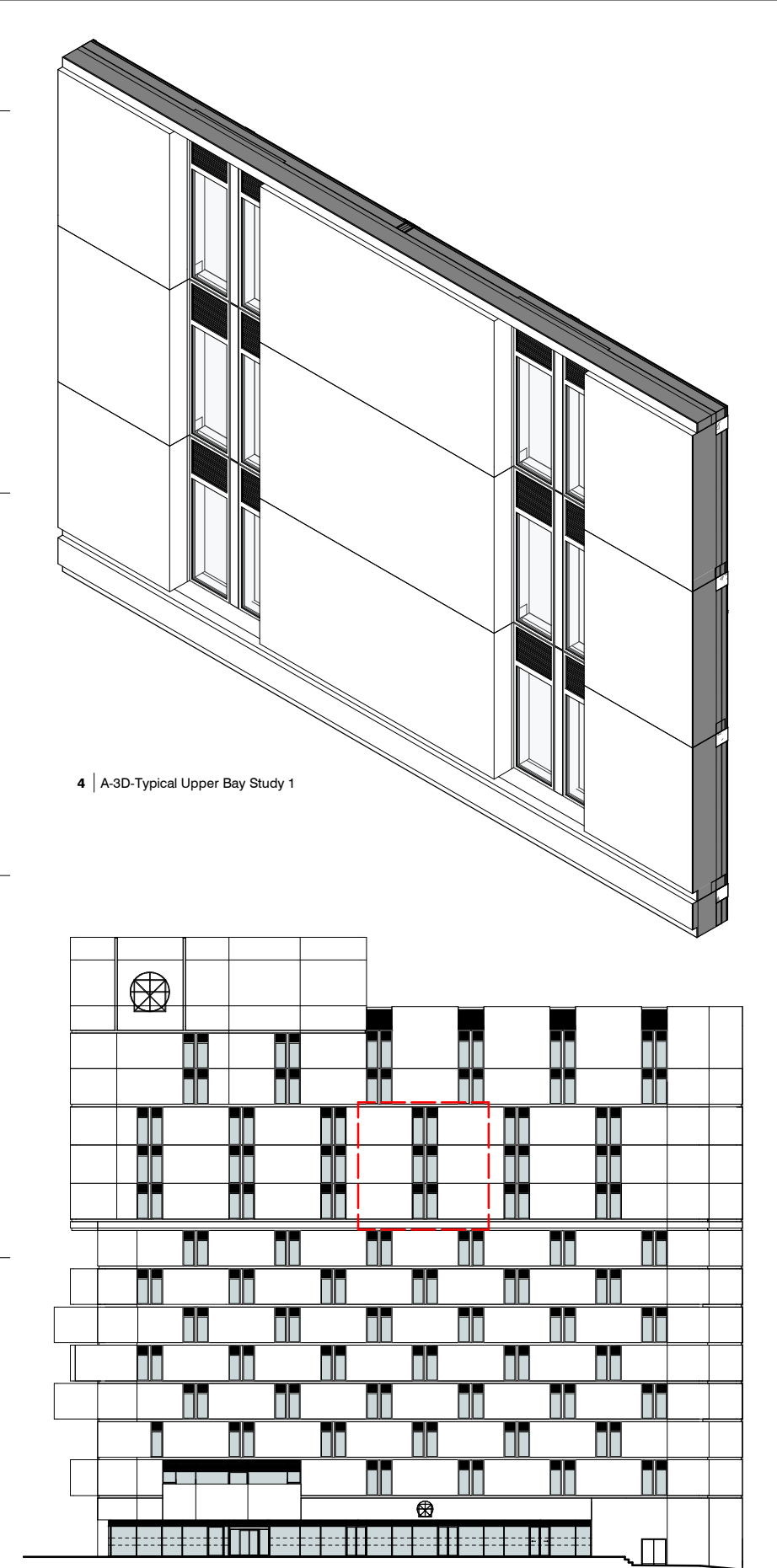
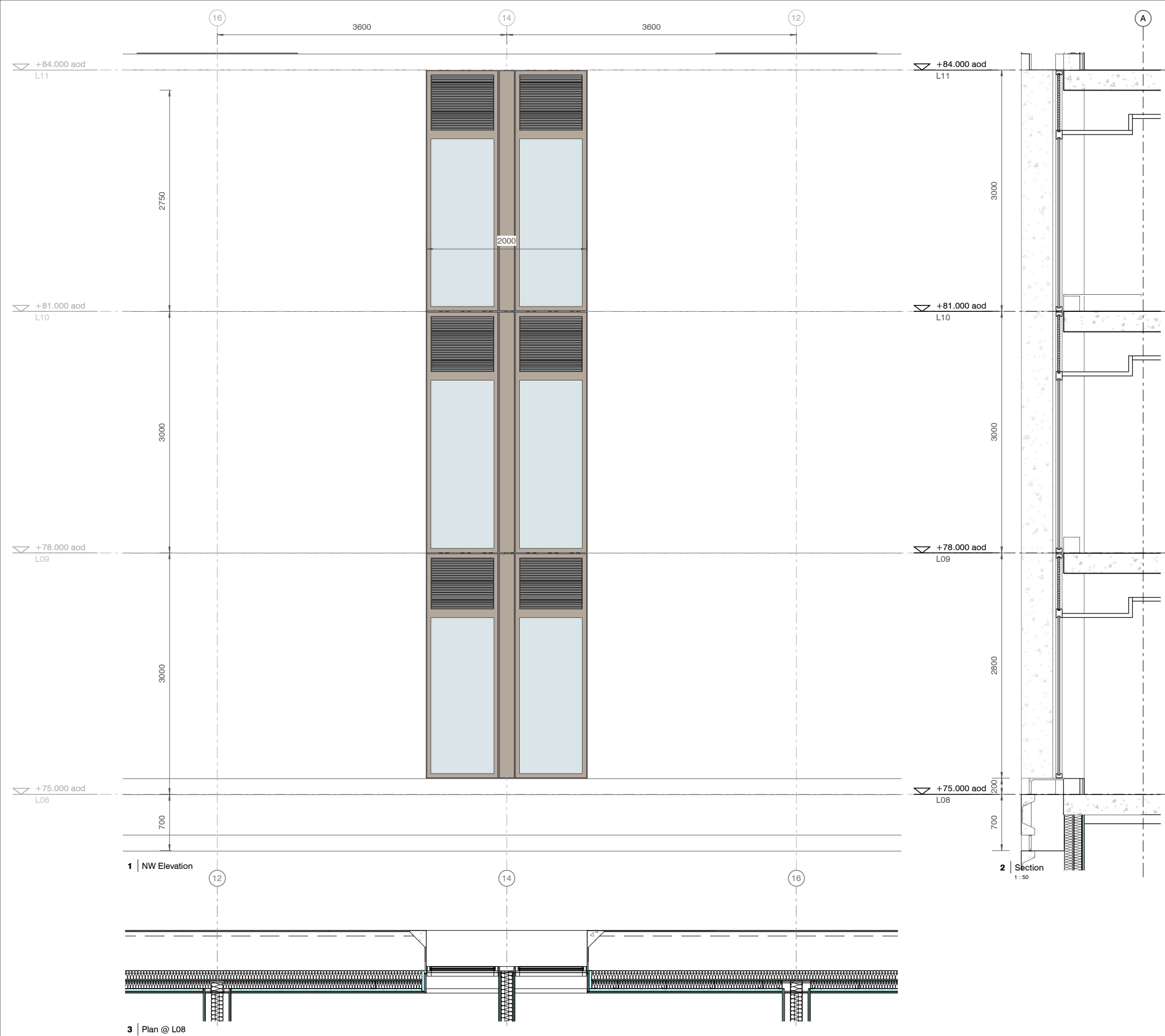
The architect's role is to check all works for compliance against the above specification.

- 9.4 The GRC sub-contractor will have to comply with the architect's specification and be subject to rigorous inspection procedures. It will be the responsibility of Bowmer + Kirkland, their Façade Engineer and Stephenson Studio to 'police' the sub-contractor to ensure all policies and procedures are adopted in full. All inspection methods will comply with the Glassfibre Reinforced Concrete Association (GRCA). These inspection procedures will be undertaken by Bowmer + Kirkland, their Façade Engineer and Stephenson Studio at the following stages of the project:

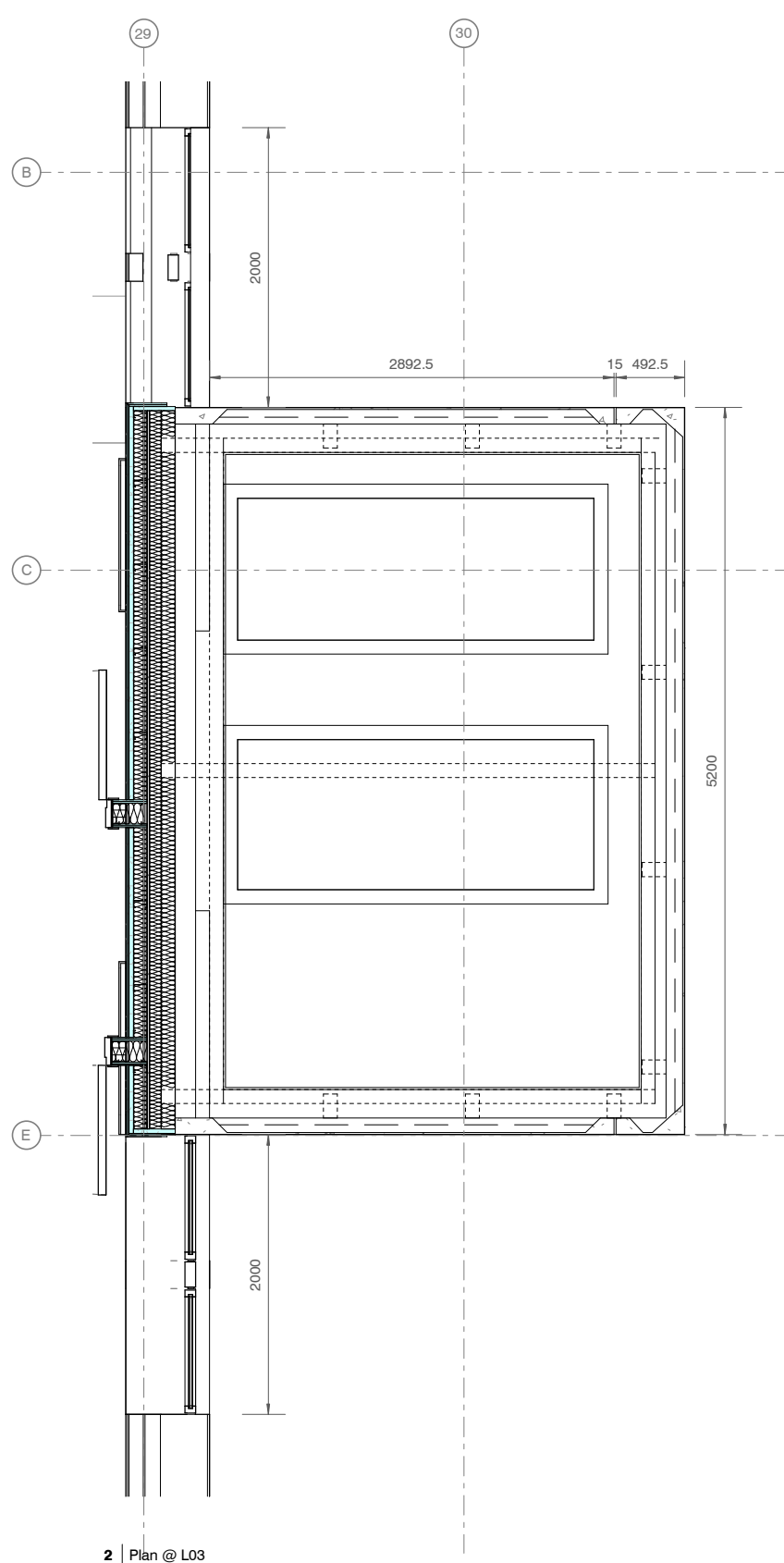
- QA inspection of the cast panels in Telling Architectural's factory.
- Any remedial action required to the panels within the factory will be re-inspected before the panels are delivered to site.
- All panels delivered to site will be inspected for quality and damage. Damaged panels will not be repaired without acceptance. Such acceptance shall not be given where the units are badly damaged or where the proposed repair would impair appearance or performance.
- Once the GRC panels are finally fixed, plumbed, lined and levelled they will be subject to checking procedures as laid down in Facade Quality Plan and inspection and test plans. Once the units are incorporated into the works any defects etc existing at this time will be agreed and noted on the QA inspection sheets. The units will then be handed over for acceptance to Bowmer + Kirkland, the façade engineer and Stephenson Studio.

Appendix A Architect's bay studies

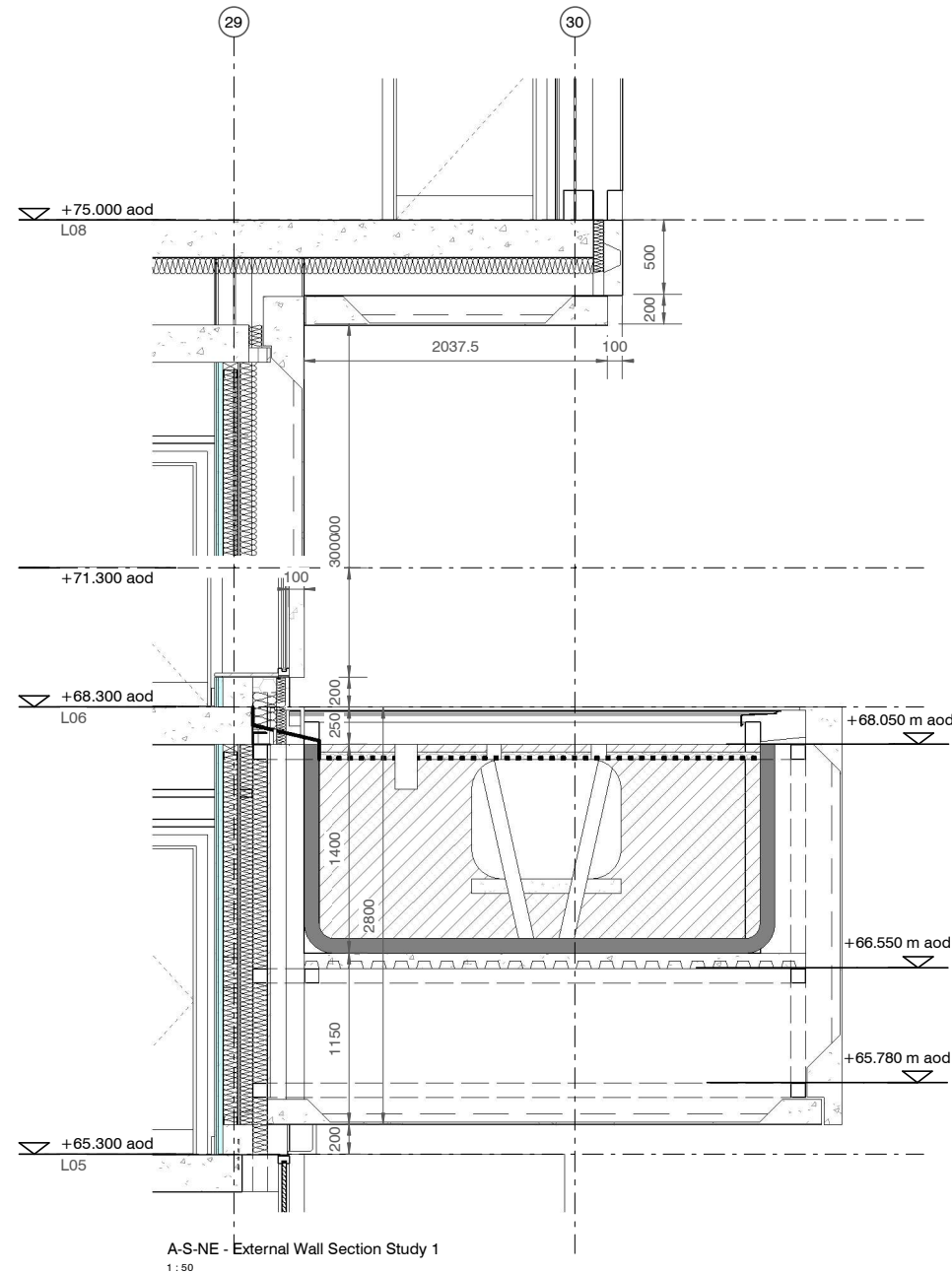




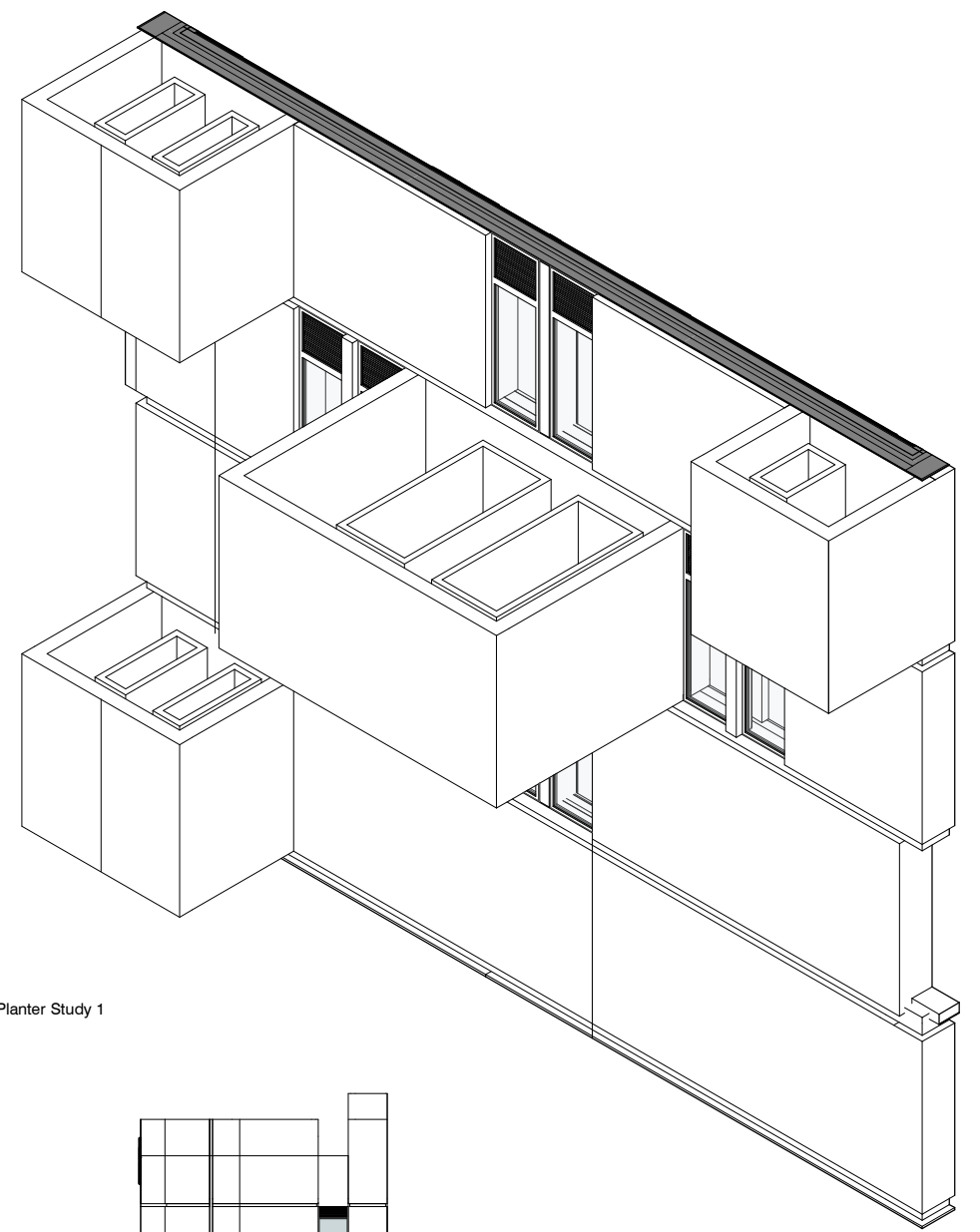
revision:	date:	note:
P1	2019.07.16	number changed
P2	2019.09.06	general update following coordination review
P3	2019.10.10	stage 4 information update
P4	2020.03.05	general updates



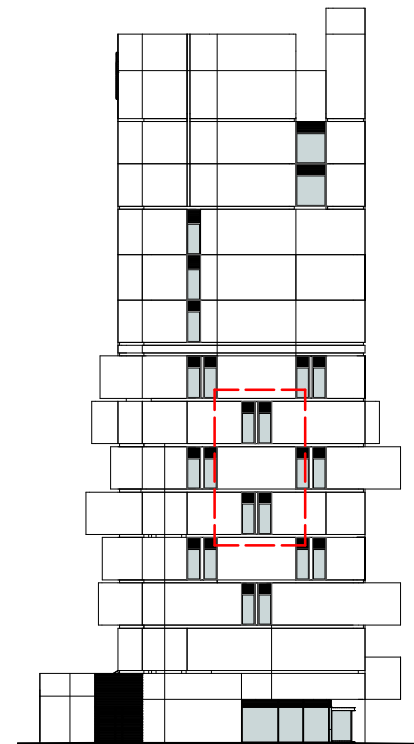
2 | Plan @ L03



A-S-NE - External Wall Section Study 1
1 : 50



3 | A-3D-Typical Planter Study 1



revision:	date:	note:
P1	2019.07.16	number changed
P2	2019.09.06	general update following coordination review
P3	2019.10.10	stage 4 information update
P4	2020.03.05	general updates

project
Adair Street

job no.
7396

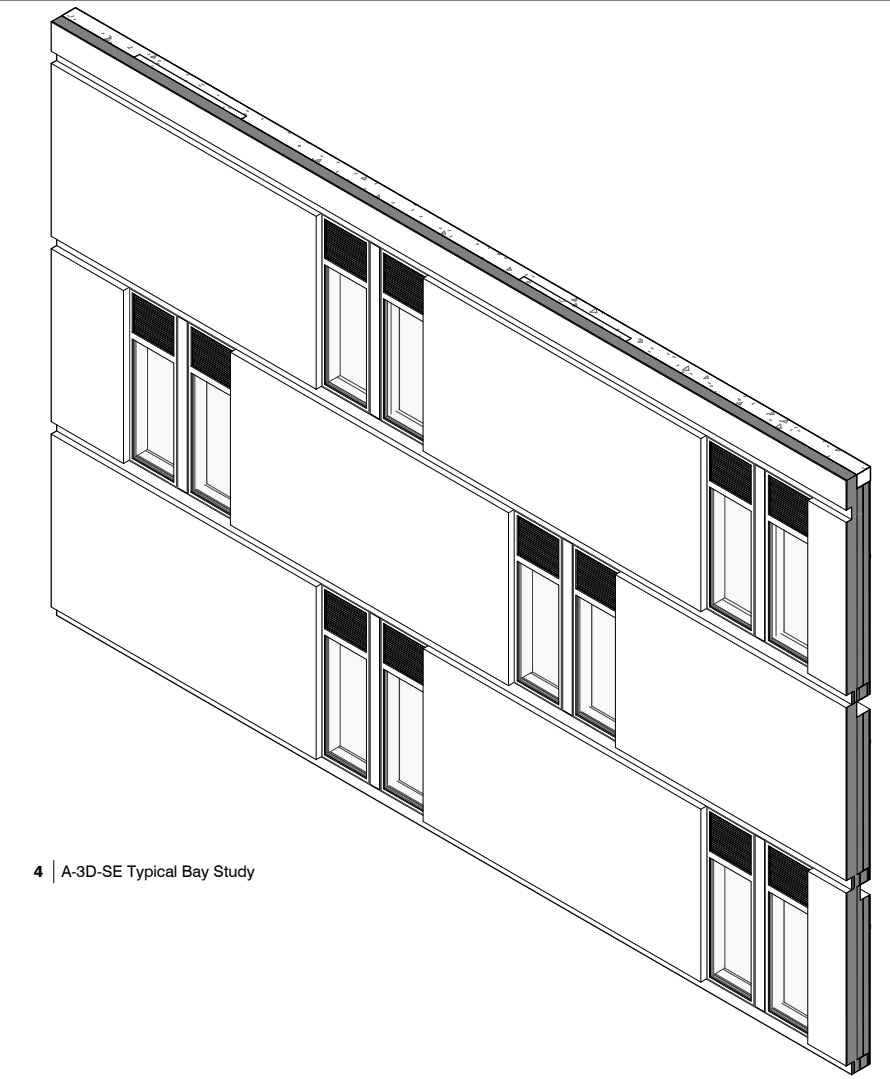
title
Façade Assembly- NE Ele-Typical Upper Bay Study

scale
As indicated @ A3

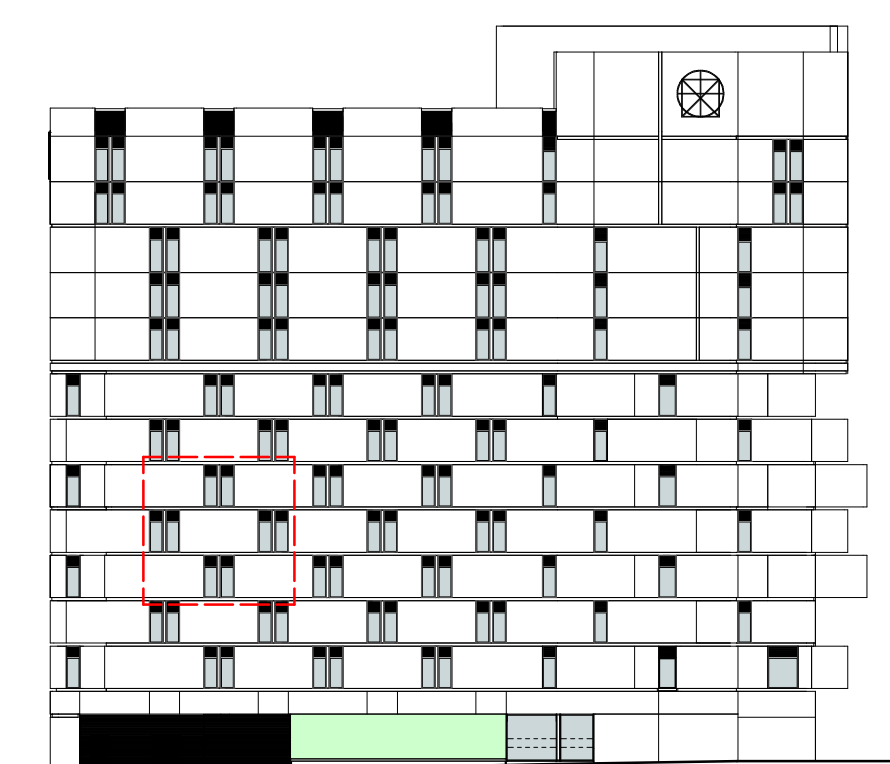
drawing no.
7396-SSL-ZZ-ZZ-DR-A-2123

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4 | A-3D-SE Typical Bay Study



revision:	date:	note:
P1	2019.09.06	general update following coordination review
P2	2019.10.10	stage 4 information update
P3	2020.03.05	general updates

project
Adair Street
7396

job no.
7396

title
Facade Assembly-SE Ele - Typical Bay Study

scale
As indicated @ A3

drawing no.
7396-SSL-ZZ-ZZ-DR-A-2124

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Appendix B **Architect's specification for GRC
cladding**



Adair Street Hotel_Specification Stage 4

7396-SSL-ZZ-ZZ-SP-A-0007

H40_Glass fibre reinforced concrete cladding / components

7396 Specification - Adair Street

09 March 2020

This document includes:

Code	Section	Revision	Dated
H40	Glass fibre reinforced concrete cladding/ components	P3	9 Mar 2020

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H40	Glass fibre reinforced concrete cladding/ components	3

H40 Glass fibre reinforced concrete cladding/ components

To be read with Preliminaries/ General Conditions.

TYPES OF CLADDING/ COMPONENTS

- 110 GRC CLADDING to all external facades of the hotel
- Primary support structure: Cast in situ concrete frame.
 - GRC units:
 - Backing mix and production method: Spray-up grade 18P.
 - Construction: Single skin panels attached to stud frames, to panel sizes as indicated in Design Drawings.
 - Finish: as agreed special development samples, White 037, Light Blast - subject to review of full on site sample panel. Requires a combined aqueous, oleophobic and hydrophobic treatment in accordance with EN1504-2.
 - Fire rating: in accordance with clause 340.
 - Additional performance requirements: vapour control barrier and air barrier must continuous.
 - Fixings and fasteners: As clause 205.
 - Joints: vertical joints are to be ideally 10-15mm filled with flexible sealant to match GRC panels. Joints to be flush as indicated in Design Drawings. Horizontal joints are to be open, size tba with contractor all to the acceptance of the Employer - will require insect mesh and visual break.
 - Breather membrane: As clause P10/320.
 - Cavity fire barriers: refer to architect's drawings and fire engineer's report.
 - Horizontal cavity fire barriers: Sleeved mineral wool cavity barrier (with intumescent facing) as section P10, clause 420..
 - Vertical cavity fire barriers: Sleeved mineral wool cavity barrier as section P10, clause 420..
 - Thermal insulation: Insulation of a type, thickness and density to achieve the requirements of the Architect's Specification, fitted between studs as section P10.
 - Air barrier: As Design Drawings.
 - Accessories/ Other requirements: Refer to Design Drawings, including: 7396-SSL-ZZ-ZZ-DR-A-2121; 2122; 2123; 2124; 2130; 2131; 2132; 2133; 2134; 2101; 2102; 2103.
Any damaged panels must be replaced if repairs are not acceptable..
- 130 PROPRIETARY GRC COMPONENTS Where required, all items are to work in conjunction with
- Primary support structure: varies.
 - GRC components:
 - Manufacturer: to be the same manufacturer as for the cladding to the rest of the building.
Product reference: to match the cladding to the main building facade.
 - Construction: Manufacturer's standard.
 - Finish: as agreed special development samples, White 037, Light Blast - subject to review of full on site sample.
 - Fire rating: In accordance with clause 340.
 - Fixings and fasteners: As clause 225.
 - Joints: 10-15 mm filled with colour matched sealant as clause 780.
 - Accessories/ Other requirements: As detailed drawings.

GENERAL REQUIREMENTS/ PREPARATORY WORK

205 CONTRACTOR'S DESIGN OF CLADDING TO ALL FACADES AND SOFFITS

- Design responsibility: Determine sizes and thickness of cladding panels and type size, number and spacing of fixings, panel sizes and joint locations tba with architect.
- Structural and fire requirements:
 - Generally: As section B50.
 - Modifications: None.
 - Design: Complete the design in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements: As clause 330 and 760.
- Additional requirements: Comply with the recommendations of GRCA publications 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products' and 'Practical fixing guide for glassfibre reinforced concrete (GRC)'.

207 COMPLETION OF DESIGN FOR CLADDING TO ALL FACADES AND SOFFITS

- Description: All to be carried out in accordance with the principles in the Architect's detailed drawings.
- Requirement: Complete the detailed design to satisfy specified performance criteria and coordinate with the detailed design of related and adjacent work.
 - Standards: Comply with GRCA publications 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products' and 'Practical fixing guide for glassfibre reinforced concrete (GRC)'.
- Structural requirements: As section B50.
- Additional requirements: Responsibility and coordination at design interfaces.

209 STRUCTURAL DESIGN PROVIDED

- Description: to be coordinated with Structural Engineer's design information.
- Requirements:
 - Generally: As section B50.
 - Additional requirements: refer to Structural Engineer's documentation of anticipated movement of the building structure and relevant elements..

220 FIXINGS AND FASTENERS TO CLADDING

- Loadbearing fixing type: Contractor's choice.
 - Material: galvanised to design BS EN 10346.
- Restraint fixing type: Contractor's choice.
 - Material: galvanised to design BS EN 10346.
- Extent of adjustment: To accommodate support structure and cladding fabrication/ installation tolerances.
- Method of fixing to primary support structure: Contractor's choice.
 - Material: galvanised to design BS EN 10346.
 - Isolation of fixings: Separate dissimilar metals at risk of bimetallic corrosion with suitable plastics washer, sleeves etc.

225 FIXINGS AND FASTENERS TO COMPONENTS

- Fixing type: Contractor's choice.
 - Material: galvanised to design BS EN 10346.
 - Isolation of fixings: Separate dissimilar metals at risk of bimetallic corrosion with suitable plastic washers, sleeves etc.

230 AIR BARRIER

- Type: As Design Drawings.
- Position: As Design Drawing.
- Jointing to adjacent areas: Ensure continuity of air barrier to adjacent wall/ roof areas.

240 INFORMATION TO BE PROVIDED DURING DETAILED DESIGN

- Submit the following GRC particulars:
 - A schedule of detailed drawings and dates for submission for comment.
 - A schedule of loads that will be transmitted from GRC to the support structure/ background.
 - Proposed fixing details and systems relevant to structural design and construction with methods of adjustment and tolerances.
 - A schedule of fabrication tolerances/ size tolerances.
 - A schedule of mix details with design limit of proportionality (LOP) and modulus of rupture (MOR) for each mix.
 - A detailed testing programme in compliance with Main Contract master programme.
 - A detailed fabrication and installation programme in compliance with Main Contract master programme.
- Timing of submissions: As Preliminaries section A31.

250 PRODUCT CONTROL SAMPLES

- GRC samples: Before general manufacture obtain approval of appearance of fully tested compliant control samples of: full height cladding panel, with recessed joint detail and return into another panel. Also typical example of corner return and also parapet section. This should all be in the specified finishes and textures, including joint details, including insulation.
 - Finish: Include all variations of face mix and applied surface finish

260 FIXING SAMPLES

- Fixings: At an agreed stage during detailed design, submit samples of: All proposed GRC fixings.

270 MOCK-UP

- Element: At an agreed stage during detailed design construct in approved location a mock-up of: As Sample Panel Design Drawings.
- Function: As installation reference panel.
- Inspection: Obtain approval of appearance before proceeding. Retain mock-up in undisturbed condition until completion of GRC installation.

DESIGN/ PERFORMANCE REQUIREMENTS

330 PANEL ACCURACY

- Finished dimensions of completed panels: Within the permissible deviations given in BS 8297, Table 11.
- Accuracy of moulds: Check overall dimensions, straightness, squareness, twist and flatness of moulds immediately before each reuse, and of each unit as soon as possible after demoulding. Make adjustments to moulds as necessary.

340 FIRE PERFORMANCE

- Combustibility: Any cladding material, insulation product, filler material (not including gaskets, sealants and similar), etc, used in the external wall construction as a whole, must be of limited combustibility (achieve Class A2-s3, d2 or better, in accordance with 13501-1 20).
- Reaction to fire/ surface spread of flame:
 - External surfaces: the surface of external walls will achieve Class 0 (national class) or Class B-S3, d2 or better (European Class). Cavity barriers must be provided.
 - Internal (cavity) surfaces: To BS EN 13501-1, class A2-s3, d2 or better, in accordance with 13501-1.
- Verification of fire performance (excluding 'relevant buildings'): In accordance with BRE BR 135 and BS 8414-1 or BS 8414-2.

TESTING

415 QUALITY CONTROL

- Production control standard: To BS EN ISO 9001.
- Quality control standard: To BS EN ISO 9001 or the GRCA Approved Manufacturers Scheme.

420 DRY MATERIALS

- Production samples: Take during manufacture.
- Constituent samples: Take roving, sand, cement and facing material samples from each consignment. Store until test data has been processed.
- Admixtures, curing agents, formwork release agents: Retain manufacturers' certificates.

430 WET MATERIALS

- Production samples: Take before production starts and when mix or equipment settings are changed.
 - Matrix consistency standard: To BS EN 1170-1.
 - Roving delivery rate: Bag test to GRCA, 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products'.
- Test boards: Take from each shift.
 - Fibre content standard: To BS EN 1170-2.
- Thickness tests: At regular intervals over area of each production panel.
- Values for compliance:
 - Minimum fibre content requirement (for all mixes): As mix design.

445 CURED MATERIALS

- Test board frequency: Take from each production team at each shift.
 - Curing: Under water.
- Test for structural requirements:
 - Bending strength standard: To GRCA, 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products'.
 - Time: 28 days after production.
- Tests for other requirements:
 - Absorption and dry density standard: To GRCA, 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products'.
 - Time: to be agreed.
- Values for compliance: Minimum test board requirements are:
 - Vibration cast (grade 8 or 8P):
 - Average limit of proportionality (LOP) of 4 consecutive test samples: 7.25 N/mm².
 - Minimum LOP of individual test sample: 5.75 N/mm².
 - Average modulus of rupture (MOR) of 4 consecutive test samples: 9.5 N/mm².
 - Minimum MOR of individual test sample: 7.5 N/mm².
 - Minimum bulk density (dry): 1800 kg/m³.
 - Minimum bulk density (wet): 2000 kg/m³.
 - Vibration cast (grade 10 or 10P):
 - Average LOP of 4 consecutive test samples: 8.0 N/mm².
 - Minimum LOP of individual test sample: 6.0 N/mm².
 - Average MOR of 4 consecutive test samples: 12.0 N/mm².
 - Minimum MOR of individual test sample: 8.50 N/mm².
 - Minimum bulk density (dry): 1800 kg/m³.
 - Minimum bulk density (wet): 2000 kg/m³.
 - Spray-up (grade 18 or 18P):
 - Average LOP of 4 consecutive test samples: 8.0 N/mm².
 - Minimum LOP of individual test sample: 6.0 N/mm².
 - Average MOR of 4 consecutive test samples: 21.0 N/mm².
 - Minimum MOR of individual test sample: 15.0 N/mm².
 - Minimum bulk density (dry): 1800 kg/m³.
 - Minimum bulk density (wet): 2000 kg/m³.
- Other tests: Submit proposals for structural pull out tests.

450 PRODUCTION NON-COMPLIANCE

- Extent of GRC at risk:
 - Failure of single test board: Material produced between previous complying test board and next complying test board.
 - Failure of consecutive groups of four boards: First and fourth test boards together with all intervening material.
- Action in the event of production non-compliance: Submit proposals.

MATERIALS

510 ALKALI-RESISTANT GLASS FIBRE

- Standard: To BS EN 15422.
 - Type: Alkali-resistant, continuous filament glass fibre.
- Manufacturer: Contractor's choice.
 - Product reference: Contractor's choice.

520 CEMENT

- Standard: To BS EN 197-1, CEM 1 Portland cement.
 - Type: Contractor's choice- tba with Architect to achieve correct colour and finish.

530 SAND

- Type: Silica sand to GRCA 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products'.

540 MIXING WATER

- Standard: To BS EN 1008.

550 ADMIXTURES

- Type: Submit proposals.
- Calcium chloride based admixtures: Do not use if GRC contains cast-in steel.

570 AGGREGATE FINISH

- Aggregate:
 - Type: Submit proposals.
 - Size: Submit proposals.
- Application: Submit proposals.
 - Quantity: As sample.

580 SURFACE COATING

- Coating: Requires a combined aqueous, oleophobic and hydrophobic treatment in accordance with EN1504-2.
 - Manufacturer: Contractor's choice.
 - Product reference: Contractor's choice.
- Application: Submit proposals.

MANUFACTURE

610 GENERALLY

- Standard: In accordance with GRCA 'Specification for the manufacture, curing and testing of glassfibre reinforced concrete (GRC) products' and BS EN 1169 for factory production.

615 MOULDS

- Material and construction: To accommodate the panel size, complexity and detail incorporated in the product.

- 620 CEMENTITIOUS SLURRY
- Mixing: In high shear mixer in accordance with the mixer manufacturer's instructions and loading sequence.
- 625 PREMIX GRC
- Mixing: In forced pan mixer, gradually incorporating AR fibres into cementitious slurry.
- 630 SPRAY-UP GRC
- Spraying: Use proprietary equipment that incorporates simultaneous deposition of known quantities of matrix and chopped glass fibre.
- 640 MIST COAT
- Mix: As backing mix without fibres
 - Additives: Acrylic polymer may be included in mist coat slurry.
 - Thickness: As thin as practicable.
 - Pigments: Not required.
- 645 FACE MIX
- Consolidation: To a uniform, consistent thickness appropriate for proposed finish and to prevent backing mix being visible once unit has cured.
 - Thickness measurement: Check and record at regular intervals over entire unit.
- 650 BACKING MIX
- Consolidation: In thin layers of 3-4 mm to achieve the required thickness.
 - Thickness measurement: Check and record total thickness of GRC at same locations as facing mix.
- 660 CONSOLIDATION
- Method: By trowelling, tamping, rolling or vibration, combinations of these or by vacuum de-watering.
 - Layers: Compact each sprayed layer and final layer before matrix has set.
- 670 STUD FRAME
- Fabrication: In accordance with GRCA 'Practical fixing guide for glassfibre reinforced concrete (GRC)'.
 - Material: Cold formed hot-dip zinc coated steel strip to BS EN 10346.
 - Stud depth: To meet design requirements.
- 680 CURING NON-POLYMER GRADE GRC
- Before demoulding: Cover filled mould with polyethylene immediately after spraying and compacting.
 - Temperature: Minimum 5°C, maximum 50°C.
 - Duration: Until component has gained sufficient strength for demoulding and transporting.
 - After demoulding:
 - Temperature: Minimum 16°C, maximum 30°C.
 - Duration: Minimum seven days.
 - Humidity: 95% relative humidity.
- 685 CURING POLYMER GRADE GRC
- Dry cure:
 - Protection: Polyethylene wrap units.
 - Temperature: Above film formation temperature but below 50°C.
 - Duration: 12 - 16 hours.
 - Shrinkage cracks: Prevent excessive heat and/ or preheated moulds drying out units prematurely and causing drying shrinkage cracks.

INSTALLATION

710 GENERALLY

- Prefabrication: Complete products and attach fixings in workshop wherever possible.
- Identification: Mark or tag products. Do not mark surfaces visible in the complete installation.
- Electrolytic corrosion: Isolate dissimilar metals.

720 SUITABILITY OF STRUCTURE

- Contractor's survey:
 - Programme: Submit proposals.
 - Scope: Geometric survey of supporting structure, checking line, level and fixing points.
 - Coordinate: With surveys for adjacent cladding.
 - Give notice: If the structure will not allow the required accuracy or security of erection.
- Setting out: Establish erection datum points, lines and levels for a complete elevation at a time unless otherwise agreed.

730 INSTALLATION OF INTERFACES

- General: Locate flashings, closers etc. correctly with neat overlaps to cladding to form weatherproof junctions.

740 METALWORK

- Material standards and fabrication: As section Z11.

755 WELDING

- In situ welding: Permitted subject to completion of a 'hot work permit' form and compliance with its requirements.

760 ACCURACY OF ERECTION OF CLADDING

- Elevation joint widths: Within joint lengths, including in-line continuations across transverse joints, as follows:
 - Tolerance: Greatest width not to exceed least width by more than vertical and horizontal panel joints, for panels up to 6m:
 - 3mm (joints between glass fibre reinforced concrete elements and windows/other cladding).
 - 4mm (joints between glass fibre reinforced concrete elements)
 - vertical and horizontal panel joints, for elements larger than 6m:
 - 4mm (joints between glass fibre reinforced concrete elements and windows / other cladding)
 - 6mm joints between glass fibre reinforced concrete elements.
 - Variations: Evenly distribute, with no sudden changes.
- Offset in elevation: Between nominally in-line edges across transverse joints not to exceed +/- 2mm in any direction, on elevation or plan.
- Offset in plan or section: Between flat faces or adjacent panels across joints not to exceed +/-2mm in any direction, on elevation or plan.
- Sealant joints width limitations: To recommendations of sealant manufacturer.
- Finished work: Square, regular, true to line and plane with satisfactory fit at junctions.

765 ACCURACY OF ERECTION OF GRC COMPONENTS

- Joint widths: Within joint lengths, including in-line continuations across transverse joints, as follows:
 - Tolerance: Greatest width not to exceed least width by more than 20% width of joint.
 - Variations: Evenly distribute, with no sudden changes.
- Offset in elevation: Between component edges across transverse joints not to exceed 20% width of joint.
- Offset in plan or section: Between flat faces of adjacent units across joints not to exceed 20% width of joint.
- Sealant joints width limitations: To recommendations of sealant manufacturer.
- Finished work: True to line and plane with satisfactory fit at junctions.

770 FIXING

- Torque figures and shim dimensions: Do not exceed fixing manufacturer's recommendations.
- Grouting: Fill at dowel positions to panel base supports with resilient filler as recommended by GRC manufacturer.
- Give notice: Before covering up loadbearing fixings.

780 SEALANT JOINTING

- Sealant: Submit proposals.
 - Class to BS EN ISO 11600: Contractor selection to suit anticipated moisture and thermal movement.
 - Colour: to match cladding panels as accepted by the Employer.
 - Other requirements: profiles of joints shall be to the acceptance of the Employer and shall maintain the performance requirements. Locations shall be as indicated on the Design Drawings or to the acceptance of the Employer. Where not specified joint widths are to be as small as practicable. Allow for shrinkage, thermal and other movements in structure and cladding.
 - Application: As section Z22.

800 POST CONTRACT SAMPLES

- Provide post contract samples in accordance with Section "samples" as follows:
 - Sample GRC panels, including large wall panel (5.2m x 2.8m), soffit panel and corner detail panel. Panels of finished GRC panels to illustrate the range in variation of aggregate mix, colour and surface finishes available for acceptance by the Contractor.

810 QUALITY OF FINISHES

- All finish to exposed edges and surfaces shall match the accepted sample.
- The finishes shall be uniform in colour and appearance throughout the Contract.
- Components having arises or faces that are broken, chipped, cracked, discoloured, crazing, honeycombed, irregular, inconsistent, stained or otherwise marred such that their appearance or performance is significantly impaired shall not be accepted. All finishes to be fully compliant with GRCA and British Standards.
- Submit finished samples to the Contractor for acceptance prior to manufacturing.
- Discard and replace or correct any GRC units that do not appear identical to the accepted samples.
- GRC panels may be rejected for the following reasons:
 - i) Exceeding specified installation tolerances.
 - ii) Chipped, spalled, cracked or otherwise damaged during construction operations.
 - iii) Exposed to view surfaces that develop surface finish deficiencies.
 - iv) Other defects as listed include:
 - " Ragged or irregular edges.
 - " Excessive air voids on exposed surfaces.
 - " Casting lines evident from different placements.
 - " Visible form joints or irregular surfaces.
 - " Stains on panel surfaces.
 - " Non-uniformity of colour and texture.
 - " Foreign material embedded in face.
 - " Visible repairs.
 - " Reinforcement shadow lines.
 - " Visible cracks.

820 PRODUCTION CONTROL UNIT(S)

- The first unit produced of each of the panels listed below shall be inspected by the Contractor, and if its appearance is acceptable, it shall be clearly marked and kept safely at the factory as a control standard for the appearance of subsequently produced units.
 - i) large wall panel (5.2m x 2.8m).
 - ii) soffit panel.
 - iii) corner detail panel.

830 INSPECTION

- Carefully inspect all completed units and check for match with accepted sample(s) or control unit(s) and for compliance with the Architectural Specification before dispatch to Site. Make arrangements with the Contractor for the inspection of completed units in the factory adopting the Glassfibre Reinforced Concrete Association (GRCA) inspection methods.

840 CONSTRUCTION GENERALLY

- Conform to the procedures of the International Glassfibre Reinforced Concrete Association (GRCA).
- All works shall be true to detail with continuous profiles, free from marks, defects, flaws, steps, waves, or damage of any nature.

850 STORAGE

- Store GRC panels on the ground, protect from inclement weather and keep dry. Prevent soiling, chipping and contamination by salts and other deleterious substances.

860 DAMAGED UNITS

- Do not repair without acceptance.
- Such acceptance shall not be given where the units are badly damaged or where the proposed repair would impair appearance or performance.

870 CLEANING

- Clean any dirt or blemishes from exposed surfaces.
- Wash and rinse in accordance with the precast manufacturer's recommendations.
- Protect adjacent surfaces from damage due to cleaning operations.

Appendix C Telling Architectural ‘Quality Method Statement for GRC Production’

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QUALITY METHOD STATEMENT GRC PRODUCTION

All Health and Safety procedures must be followed ensuring that all personnel are either trained or competent with the tools and equipment they are using.

The production schedule will be approved by sales and engineering with the Production / Plant Manager prior to commencement of any works.

Elevation, Section and Detail drawings will be produced with panel type, numbers, and sequence of production to suit site requirements.

Drawings received from the design department are to be checked for dimensional discrepancies and signed off for acceptance on a production check sheet. Any modification /change made to a drawing will be issued on the issue sheet sent from the drawing office

Mould Construction

There are many materials that can be used in the construction of moulds and patterns needed to replicate the desired shapes and designs that GRC lends itself to.

Moulds must be constructed in a manner to minimize any warping, twisting, deflection and deviation from measurements derived from the approved workshop drawings. Moulds must be stored on a level base, prior to and after casting or spraying. Moulds must be re-levelled before being completed. (TCQ1)

Moulds must be signed off by the designated supervisor and documented before being sent to production. All dimensions, angles, returns, penetrations, fixings, lifting sockets have to be in accordance with the approved work shop drawing.

Moulds must be constructed to withstand the application process of GRC by being made rigid enough, or braced to allow the GRC material to be sprayed, premixed/vibrated or spray-premixed into the openings and profile.

QA/QC Function

Moulds will be checked with the relevant updated drawing. Any revised drawings that are issued to the shop floor must be dated with all revisions, and stamped with the new issue date. Any modification /change made to a drawing will be issued on the issue sheet sent from the drawing office. Old drawings will be removed from the shop floor and quality control by the designated supervisor. Dimensions will be checked, length, width, depth of returns /mould sides, square of the mould and mould side being square in relation to the face of the mould.

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The moulds are individually numbered 1, 2, 3, etc. The mould is identifiable with the Job Number, Panel Reference and Casting Date. (TQC 1)

The mould must be clean, free from damage and release oil minimally applied before being signed by QC allowing the mould to be sprayed. (TQC 1)

Depending on the materials the mould has been made from the appropriate release agent will be used. Water base release agent / mould release is preferred.

Mould cleanliness, fixing detail /fixing sockets /rib placement and lifting sockets will be checked prior to being approved for production. There is a possibility that these details will have to be inspected after the panel has been completed in production. Due to the nature of the fixation / erection on site. (TQC 1)

When the final material application has been applied and completed, the unit reference number will be inscribed into a flat towelled area on the curing cement surface. An identifying plastic tag will also be attached to the fresh uncured GRC. The information on the tag will have the Job Number, Panel Reference and Casting Date.

Once completed and signed off the mould can be moved to overnight curing. The table/mould /trolley must be placed on a flat level clean surface and levelled by a laser level.

All information has to be documented, and signed by the designated supervisor before production and at the end of spraying / vibrating premix, or Spray premix.

The table/mould/trolley must be covered with a plastic sheet preventing any escape of moisture or temperature. During colder weather an insulated blanket will also be used to cover the unit. As moisture and heat are the two main essentials of the Hydration process it is advised to insure the plastic is tucked under the table or mould. This will help prevent any escape of moisture and heat losses.

Material testing methods to be in accordance with the published recommendation of the International Glass Reinforced Concrete Association (GRCA).

Part 1.

Measuring the consistency of the matrix ---Slump Test method. (TQC 2)

This will be conducted at the beginning of each shift. All test and data will be performed in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material - Part 5 Measuring Flow of Slurry – Slump Test.

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Part 2.

Measuring the fibre content in fresh GRC, wash out test. (TQC 4)

Telling Parameters for conducting further wash out test are below 4.75% and above 5.3% glass content.

If the test is out of the parameters another test board will be done and on the second test if the parameter are still not met the machine is recalibrated.

This will be conducted at the beginning of each shift. All test and data will be performed in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 1- Determination of Glass Content of Uncured Glassfibre Reinforced Concrete (GRC) Material.

Part 3.

Fibre content of sprayed GRC (Bag and Bucket test). (TQC 3).

This will be conducted at the beginning of each shift. All test and data will be performed in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 4 Calibration of GRC Spray Equipment (Bag and Bucket Test)

Part 4.

‘Complete bending test’ method. LOP + MOR recorded on Testometric testing machine in house – Telling Architectural. Results for this test can be made available upon request.

The test will be conducted and monitored by the designated supervisor. All test and data will be performed in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 3 Determination of Flexural Properties of Glassfibre Reinforced Concrete (GRC) Material.

Part 5.

Determination of the absorption of water by immersion and determination of the dry density. (TQC 6)

The test will be conducted and monitored by the designated supervisor. All test and data will be performed in compliance to BS 1170-6:1998.

Part 6.

Measurement of extremes of dimensional variations due to moisture content.

The test may be conducted and monitored by the designated supervisor. All test and data will be performed in compliance to BS EN 1170-7:1998. The test will be conducted and monitored by the designated supervisor. Procedure will be performed if required and agreed with client/customer prior to production start.

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Part 7.

Tolerance.

Tolerance: - Permissible deviations in the manufacture of Cladding units

In accordance with GRCA recommendations.

GRC Characteristics

Grade numerically equivalent to the characteristic MOR Minimum Strengths.			
	8 or 8P	10 or 10P	18 or 18P
LOP N/mm ²			
Mean of 4 consecutive test samples	7.25	8.00	8.00
Minimum individual test sample	5.75	6.00	6.00
MOR N/mm ²			
Mean of 4 consecutive test samples	9.50	12.00	21.00
Minimum individual test sample	7.50	8.50	15.00

				Spray - up	Premix
Strength	Compressive	out-of-plane	(N/mm ²)	50 ~ 80	40 ~ 60
		in-plane	(N/mm ²)	40 ~ 70	40 ~ 60

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Mixing

Prior to starting the mixing process the mixer will be checked over to insure that there is not a possibility of any damaged connection, loose part, cable to any electric, water, compressed air, and admixture deliverance system . Any faults must be reported to the Foreman/Manager if damage or faults are found.

There should not be any items, tools, left on any surface that is not permanently attached to the mixing equipment. Full operation should be checked to see if any limit / emergency switches are fully functioning prior to starting production. Any damage / malfunction will be recorded on an inspection sheet by the designated supervisor.

1. Sand and Cement will be weighted to insure the correct weight has been bagged by the vendor. Any variance from the stated weight has to be re- adjusted to the correct weight in accordance to the mix design approved. (TQC 2)
2. Water, polymer, super plasticizer, retarders, accelerators will be metered from a liquid dispensing system.
3. Liquid dispensing equipment must be calibrated once a month, or, after any repair to the system has been made.
4. If any change in the mix design is implemented, the dispensing equipment must be recalibrated and documented.
5. Every month the polymer electrodes must be cleaned by the designated supervisor from any build up in the measuring cylinder. Failure to do this will cause a malfunction to the dispensing equipment and create the polymer not to be discharged to the prescribed quantities. (TQC 10)

Any correction, deviation fault in item 1, 3, 4, and 5 will be documented and recorded by the designated supervisor.

Pigment will be added at the required amount, by weight, to obtain a preapproved shade / colour. (TQC 2)

The mix (slurry) will be made in order / addition of material:-

Water, Polymer and Flowaid is added to a pre wet mixing vessel (mixer bucket).

Other Admixture.

Mixer is started on a slow speed.

Addition of all Silica Sand.

Addition of all Cement.

Addition of Glass Fibre (Pre- Mix)

The mixer speed is then increased to its full capacity and run until the mixer vortex is heard, approximately 20 – 30 sec. The mixer blade (switched off) is raised from the mixer drum.

Any material that is deemed dry and unmixed will be scraped into the slurry and then remixed, approximately 20 – 30 sec. This slurry will be ready for Hand Spray and transported to the pump.

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The slump test will be conducted in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material - Part 5 Measuring Flow of Slurry – Slump Test.

If the mix is used for Premix / Spray premix, the addition of 3% fibre has to be added. The 3% is the percentage of the sum of the total weight of the wet mix. A wet mix is made up from Cement, Silica Sand, Polymer (47 -50 % solids) water and super plasticizer. Once a consistent mix of slurry has been achieved the addition of fibre may proceed. The fibre must be dispensed directly into the mix on a very slow speed as to prevent any “balling”, “clumping”. The fibre has to be sprinkled into the mix and not all discharged at once.

Once all the fibre has been added, the mixer speed can be increased to half full speed for 5 seconds ONLY.

If the mixer is left to agitate/mix the slurry and fibre for a longer period of time the fibre will become damaged, splitting the filaments, thus making it very difficult to vibrate into small sections of decoration.

Once the mixer bucket- cement slurry, or premix has been removed, a clean pre wet bucket can be installed to the mixer and liquids for the next mix added.

The mixer is then started and stopped briefly. This will help wash down the mixer blade ready for the next mix.

Face Coat

This is the material that will astatically simulate the finish to the surface of a panel required by the client. The face coat will be pre-approved prior to application as to the texture, colour, and finish. Two sample panels 300mm x 300mm will be signed by the client, dated with the project reference number clearly written on the trowel surface. One sample will remain with the client/consultant and other approved sample will remain in the QC office at Telling.

The nominal thickness of the face coat is 3 to 4 mm thick. The thickness of the face coat will be randomly checked for consistency with a pin gauge once applied to the mould. Any excess, build-up of more than the required thickness must be removed especially in the corners and at the panel edge return. (Telling Architectural Inspected Mould / Completed Sprayed – Premix Panel Check Sheet) (TQC 1). A paint brush is ideally used to level up the face mix before applying the backing GRC.

The face mix must be allowed to lose the sheen/wet shimmer before applying the backing mix (GRC). Care must be taken when consolidating the layers of GRC backing as too much pressure will push the fibre to the base of the mould.

When the panel receives the surface treatment, sandblast, acid wash, or surface retarded, if care is not taken the fibre will protrude into the decorative, textured finish. The process of exposing the sand, aggregate, or approved finish will be a minimum of 3 days from the casting day.

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Backing Mix (GRC)

Nominally the overall thickness will be built up in 3-4 passes of the spray gun to a design thickness. The design thickness will be clearly indicated on the approved drawing. This has to be checked using a daily calibrated pin gauge after the material has been compacted each time. An allowance must be made for the face coat if a face coat has been applied prior. Each time the material is checked for thickness with the calibrated pin gauge, the penetration hole must be filled in.

The appropriate spray pattern will be followed. The first directional pass will be from left to right on the horizontal mould. The second directional pass will be from top to bottom on a horizontal mould.

At the spray station / spray pump

Pre assembly of the Spray station will be done at the beginning of each shift by the spray man .The stator must be reattached to the pump by lubricating the inside of the stator with silicone spray lube ONLY.

The oil dispenser that lubricates the chopper motor on the concentric spray gun has to be checked once a month the designated supervisor, or when the warning light appears on.

The cutting blades should be visually inspected by the designated supervisor and replaced as needed. When in full production, once a spray utilization of more than 25% in an 8 hour shift has been reached the cutter blades need to be replaced.

The backing roller needs to be inspected and adjusted so the cutting block and backing roller can be pushed in opposite direction to insure good contact with the cutting blades.

The spray nozzle should be inspected for any blockages from sand, or hard cement.

Care must be taken to reassemble the spray gun with all the "O" rings in place.

All safety cages must remain attached and documented to acknowledge is removed for maintenance.

Excess water designed to allow the auger to run freely inside the Stator has to be removed, prior to discharging the slurry into the hopper on the spray station. This also applies to pumping Premix from the peristaltic pump. Excess water will affect the water /cement ratio.

The concentric Spray Gun will then be calibrated using the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 4 Calibration of GRC Spray Equipment test also known as a "Bag and Bucket Test

Once continuous spraying with slurry and fibre are apparent, a sample board (800mm x 500mm x 12 mm) should be sprayed going from left to right and then from top to bottom on the sample board mould . If conducted correctly an even, consistent layer of GRC will be applied to the mould surface.

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Compaction using a spring roller will be used to insure removal of any trapped air and to help consolidate the material. The thickness will be built up over 3 layers of 4mm.

This test will be conducted in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 1- Determination of Glass Content of Uncured Glassfibre Reinforced Concrete (GRC) Material. This test is also known as a “Wash out Test”

Test boards will be made to allow testing in accordance with the International Glassfibre Reinforced Concrete Association document, Methods of Testing Glassfibre Reinforced Concrete (GRC) Material – Part 3 Determination of Flexural Properties of Glassfibre Reinforced Concrete (GRC) Material. This test is also known as a “Complete Bending Test”

Test boards have to be placed along with the panels made the same day, under the same conditions. This will reflect a true representation as to the test panels being cured the same as the produced panel/units. All test boards and coupons both have to be marked up clearly identifying which pump it was produced from and which date it was produced. This will be checked and signed off every Monday by the QA supervisor. Records will be kept in the lab and a copy will be put on to the server.

Spraying GRC Panels

Before commencement of Hand Spraying / Premix/ Sprayed Premix.

1. The moulds must be cleaned, checked for any mould surface defects, mould oil applied and checked to the latest drawings. Too much mould release / mould oil will possibly lead to staining and excessive blow holes on the panel surface. Any discrepancy / difference between the mould and workshop drawing will be rectified by the mould makers before being checked again by the designated supervisor and passed to production. No mould must be sprayed, or premixed without approval from the designated supervisor. Each time there is any change to the mould it has to be checked, approved and documented by the designated supervisor. This is then scanned in at stage 2 in the system.
2. A mist coat will be applied if no face mix is required. The mist coat is sprayed from the concentric gun and is usually at a depth of 1/2mm. The purpose of the mist coat is to prevent the fibre from blowing into the corners and out of the mould. This is then scanned in at stage 3 in the system.
3. The GRC will be built up using 3-4 passes to achieve the required design thickness. Between each pass of the spray gun the material slurry and fibre glass will be brushed into the corners and rolled with a spring roller to remove voids. The process of rolling with a spring roller, and brushing the matrix into the corners and reveals, removes any trapped air. This helps maintain the density and prevents any segregation or delimitation.
4. Once the mould sides and mould face have been sprayed and compacted to the correct thickness in accordance to the drawing, the installation of the rib formers, polystyrene, foam inserts, fixing and lifting sockets can be installed if not already connected to the mould. This is then scanned in at stage 4 in the system.

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5. GRC can then be applied to the design thickness in accordance to the work shop drawing over the rib formers, penetrations, fixing sockets etc. A profile of the rib can be used to insure correct coverage over the former / polystyrene, and socket.

Once the GRC application has been completed and approved by the designated supervisor, the panel can be moved for overnight curing/storage. The units and moulds must be covered with a plastic sheet and an insulated tarpaulin. Care must be taken to insure the moulds and panels are covered completely, preventing any heat losses. Care must also be taken not to move accidentally any fixing, rib, or lifting socket.

By covering the moulds with a plastic sheet and adding an insulated trampoline the chemical process called “hydration” will after the initial set start to react. This is then scanned in at stage 5 in the system.

Covering the finished product Hand spray, spray premix, and vibrated premix does help improve the test characteristics of the material.

6. All finished product left in moulds to cure overnight, “MUST” be left on a level base with no twisting or warping.

Item 1-6 will be documented on Telling Document ... TQC 1.

Vibrating Premix GRC

A mould or moulds can be strapped to the top of the vibrating table using ratchet straps. Nobody, will not hold onto the mould while being filled and vibrated, it has to be strapped. Once the premix mixture is brought to the vibrating table, the variable speed control is switched on.

The mould has to be filled in a manner that allows any air to be evacuated from any undercuts, or recess that form part of the decoration, so as not to trap pockets of air in the finished decorative face of a unit / panel.

The design and complicity of the pattern governs the rate at which the mould is filled with Premix. If the frequency of the vibration appears to be reduced as the mould is filled, the variable switch can be adjusted to increase the frequency allowing more vibration to move the premix inside the mould. Once the mould is full of premix and minimal air is escaping from the matrix the vibration can be switched off and racket straps removed.

The mould and GRC can then be moved to a level location for finishing. If needed, lifting / fixing sockets can then be added to the correct location and the edge of the panel finished in accordance to the drawing.

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Steel Strong-Back Stud Frame

Instead of using GRC ribs and stiffeners it is possible to use a frame, most commonly in steel. The stud frame provides support to the skin whilst permitting thermal and moisture movements. This recognized form of construction is adopted particularly when very large and generally flat panels are to be made.

The stud frame system allows panels of 10-20m² to be manufactured, transported and erected.

A GRC stud frame cladding panel consists of a single skin of GRC attached to a prefabricated galvanized steel frame, by means of L shaped flexible anchors (termed flex anchors) and support anchors (known as gravity anchors). Regular spacing of the flex anchors ensures that the effects of wind loading are evenly distributed over large areas of the panels. The cold formed pre drilled hot dipped zinc coated stud frames are bolt assembled in-house. Dimensional checks are made prior to mounting the stud frame to the GRC panels. Predetermined mounting zones in the form of GRC pads are sprayed to receive the anchors which, when in position, are subsequently over sprayed to the appropriate embedment – Refer to diagram below. The flex anchors provide lateral support to the GRC facing whilst allowing some degree of rotation and shrinkage/moisture movement of the GRC. The gravity anchors are positioned along the bottom of the panels and support the self-weight of the GRC.

Once the finishing is complete and signed off by the designated supervisor the unit, will be covered with a plastic sheet along with an insulated tarpaulin.

Curing

Polymer Grade Panels and none polymer panels must not be stored in excessive or extreme temperatures. Below 7 degree and up to a high of 35 degree c.

They should be protected and allowed to hydrate for the first 48 -60 hours after de-moulding.

The film form temperature of the polymer is above 7 - 12 degree c.

Polymer stored in containers must not be allowed to freeze before being added to the mix.

Polymer must be agitated once a week to insure the solids 48- 51 % are suspended in the water. If the polymer solids are allowed to settle at the bottom of the container / IBC, incorrect curing might occur, leading to poor test results.

De-moulding Hand sprayed / premix / spray premix units from the moulds

After curing the units must be removed from the moulds in such a way as to not over-stress the units. Any connection to the mould sides, screws, bolts, fixing sockets, and lifting sockets need to be removed. The bond between the mould and the panel / unit must be broken using bond breaker pads, compressed air, or other means to allow for easy of de-moulding. Edge detail must be protected as much as practically possible. Screw driver, chisels should not be allowed to lever the units out of the

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mould. In some cases a lifting jig might have to be attached to the unit to help support the unit while being de-moulded. Panels are checked by the Quality supervisor to the drawing and the TQC1.

De-moulding with Counter balance Forklift and Overhead Crane

Before commencement of any lifting operation all attachments, chains, slings and fixing devices must be checked for safe working loads (SWL). All lifting equipment must be visually inspected for damage or wear.

Lifting eyes must be fully screwed into the sockets, if this is not possible Do Not Use and contact your Supervisor or Forman.

Lift panel slowly out of the mould, only 2 operatives are required to assist in this operation all other operatives/ personnel should stay clear. Operatives must stand to the sides of the panel as it is raised out of the mould, keeping away as far as practical. Clear directions should be given to the fork lift driver to ensure he is aware of any obstructions or problems with the lift.

As the panel is being transported to the storage pallet operatives shall walk either side to prevent excess movement and guide the forklift driver especially if his line of sight is obstructed.

Panel is lowered into the pallet and spacers/restraints screwed to the sides. Prior to the panel being released from the forklift a substantial rail must be fixed to prevent the possibility of the panel falling. This operation must be repeated for all movements of the panels. This is then scanned and will be at staged 6 in the system.

Rework / Finishing to the panels prior to packing and shipping.

Once a panel has been removed from the mould it should be inspected for any defects / blow holes / damage, any damage incurred in de-moulding and handling when stored appropriately.

Any overspray must be removed with a finishing stone. Any remedial work has to be signed off prior to being packed ready for transportation on the TCQ1. This is then scanned and will be at stage 7 in the system. If required the panel is sealed with a specific sealer as stated on the drawing.

Storage and Transportation

All panels should be stored in the direction that they are intended to be erected on the building. Any packing material must not come in contact with the visible face of any panel. Insulation / polystyrene are renowned for leaving discoloration on the finished surface.

Panels / units must be packed covered preventing any water penetration, or staining to the units.

Panels must be stored in adequate frames, pallets, or other approved means of storage rack.

All panels and packing frames, pallet must be stored on a level foundation.

Pallets, frames, storage racks must be secured in a way that the panel / units are not in contact with the tie down straps.



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Non-Conforming Panels/Failed Test Rejects

Panel/s test results that do not comply with the designed specification and fail the approved test will be marked as “Rejected” and stored in the designated area “Reject: Subject to further inspection”. Telling documentation TQC 1 will also be marked as Rejected with whatever reason and filled away.

Storage on Site

Panels must be stored on level firm foundation. They must be protected from damage, and any possible source of pollution.

Disposal of Waste

All waste is disposed of into the correct recycling skip situated on the yard. All rejected/damaged panels and cubed concrete blocks are to be put into the Concrete Roro Skip. All wood is to be put into the Recycled Wood Skip and all other waste to go into the General Waste Skip apart from cardboard and paper which goes into the recycling euro bin.

Appendix D Telling Architectural ‘Quality Plan’



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Quality Plan

for

Manufacturing of Glass Fibre Reinforced Concrete
ADAIR STREET HOTEL MANCHESTER



Product name:

Telling Architectural Norscreen M4 GRC Concrete mounted on steel strongback frame

Product range:

Project Specific to samples coded as below:

Example

Grade 18P
Grit Blasted
Sealed
Brick Faced
Silicate
Polished

Finishes – project specific

Grades: 18P Handspray –

Supplier – Aggregate Industries/Fibre Technologies/Bathgate Silica/Hanson Plywood/HAZ Metals

Production location:

Produced by: Telling Architectural Limited

Address: 4E Station Road

Four Ashes

Wolverhampton

Postcode: WV10 7DB

Telephone: 01902 797700

Fax: 01902 797720

Management representative (Contact): Mike Wood

Title: Director

Please note that there is only one production plant, with a support facility at Unit 1, Four Ashes, Wolverhampton:

Purchasing data & Receiving inspection and testing:

Incoming product	Identification (type, class, grade, specification, etc.)	Original supplier	Property measured	Method of test	Action on rejection
OP Cement	EN 197-1 52.5	CIMSA Aggregate Industries	Batch Date	Flexural Testing 7 and 28days	Panels to be traced and Rejected
Silica Sand	Bathgate Course	Bathgate Silica Sands Limited	Batch Date	Flexural Testing 7 and 28days	Panels to be traced and Rejected
Alkali Resistant Fibre	NEG ARG Fibre ACS13H350Y	Fibre Technologies Limited	Batch Date	Flexural Testing 7 and 28days	Panels to be traced and Rejected
Liquid Plasticiser	Flowaid FT Super Plasticiser	Fibre Technologies Limited	Batch Date		Panels to be traced and Rejected
Acrylic Polymer Curing Agent	Polycure FT	Fibre Technologies Limited	Batch Date		Panels to be traced and Rejected
Inorganic Colour Pigment	Bayferrox 920, 330 686 & 110	Lanxess Thermovac	Batch Date		Panels to be traced and Rejected

Product identification and traceability:

The company operates a wireless bar code scanning system that commences once the panels are released from our in house design department to production. Each panel has a unique reference number which identifies the operative involved in the 2-9 stages from manufacture through to the final packing.

At each stage the front office server is updated and no panel can jump a process as this is a barred function of the scanner that cannot be over written.

The panel reference numbers dictate the phasing and packing of the production which must be advised to us by the client. The final function of the scanner is in the packing in to stillage's and the production of the delivery ticket.

Method of production and Process Control:

Property measured	Method used	Frequency	Acceptance limits	Action upon rejection
Fibre as ratio of concrete in production	Test coupon, weighed and measured, cement and aggregate washed away, fibre dried and weighed	Each production spray gun each morning	5% Volume +/-5% 4.75% -5.30%	Cease production and discard panels
Bending Test – 7 day and 28 day	Testometric calibrated machinery	Three samples per week Test each Monday Wednesday Friday / Saturday. Extra boards if requested	Grade 18 concrete (LOP:7-13) (MOR: 21-31)	Identify and dispose of any panels from that day of production – check production batches back to the previous and forward to the next test
Cement/sand content	Weigh each bag	Repetitive	Absolute accuracy with calibrated scales	Disciplinary
Water Content	Slump test	Daily to calibrate flow from automated dispenser	Measure level of slump	Adjust/check calibration
Pigmentation	Calibrated scales to measure formula of design	Repetitive	None – must be accurate to avoid colour variation	Discard panels
Steel Strong-Back Stud Frame	Cold formed pre drilled hot dipped zinc coated steel - bolted assembly in-house	Dimensionally checked Prior to spray mounting to GRC panels within in the mould	Embedment and alignment check within stated tolerance	Discard unacceptable GRC panels
De- moulding	Visual upon removal of the panel from the mould	Each panel	No cracking or unacceptable compaction of face coat to edges	Discard unacceptable panels

Final inspection and testing:

Property measured	Method used	Frequency	Acceptance limits	Action upon rejection
Aesthetic	Visual	Each unit	No visual defect or blemish visible from viewing at 5.0 metres	Repair where possible but otherwise re-make
Tolerance	Measurement	Each unit	Industry stated tolerances	Re make

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Packaging:

Panels are stacked in purpose built timber stillage's. The panels sit on soft rubber dunnage's and are secured so as to allow safe removal of individual panels.

The company must be advised of any specific loading or offloading requirements

The panels have protection pads placed between them to prevent abrasion during transit.

These pallets are IPPS treated for supply to countries that require this.

The number of panels on a pallet varies according to the size and shape of the panel, the method of offloading at site and when advised the delivery sequence required.

The pallets are shrink wrapped.

Labelling of the product:

Each panel carries a bar scanned unique reference number label identifying the date of manufacture and the operative involved in the 6-9 stages of manufacture from the design office to the final packing. In some cases for sequencing the pallets can be numbered to suit the clients' delivery plan

Quality policy: We undertake that the products produced are manufactured in accordance with the criteria below copies of which are available upon request:

- GRCA Specification for the Manufacture, Curing & Testing of Glassfibre Reinforced Concrete (GRC) Products October 2017.
- GRCA Practical Design Guide Version 1.1 March 2018
- GRCA MOT October 2017

End of Quality Plan

Appendix E **Schedule of External Elevation Materials',
revision 01 dated 11th March 2020**

Adair Street Hotel, Manchester
Schedule of External Elevation Materials
Planning Condition 4 from Planning Permission 122599/FO/2019 issued 23/9/19



Rev.01 - 11/03/20

Item No.	Material Key Reference on Elevation Drawings (See note 1 below)	Material Description	Location on Building Elevation	Sample, Specification or Details Proposed	Date for Submission to Manchester City Council (See note 6 below)	Date for Incorporating into the Finished Works
1	1	Off white coloured glass reinforced concrete (GRC) cladding panels with mastic pointed butt joints and projecting planter box with soffit panel	All Levels (Ground to L13)	Visual Mock-up sample. See note 2 below.	Mid May 2020 See note 2 below.	January 2021
2	2 and 3	Powder coated aluminium windows / curtain walling system with micro louvre panel above (RAL 8000 30% gloss)	All Levels (Ground to L13)	Visual Mock-up sample. See note 2 below.	17/02/2020 See note 5 below.	September 2020
3	4	Powder coated aluminium louvres (RAL 8000 30% gloss)	Ground Floor	300mm x 300mm sample	October 2020	May 2021
4	5	Off white coloured glass reinforced concrete (GRC) cladding recessed joints	All Levels (Ground to L13)	Visual Mock-up sample. See note 2 below.	Mid May 2020 See note 2 below.	January 2021
5	1 and 5	Off white coloured glass reinforced concrete (GRC) cladding panel 5.2m x 2.8m GRC panel with window reveal returns and horizontal recessed joint at the top (Drawing for MCC review)	All Levels (Ground to L13)	Drawing of Visual Mock-up sample. See note 3 below.	20/03/2020	
6	1 and 5	Off white coloured glass reinforced concrete (GRC) cladding panel 5.2m x 2.8m GRC panel with window reveal returns and horizontal recessed joint at the top	All Levels (Ground to L13)	Visual Mock-up sample. See note 3 below.	Early June 2020. See note 3 below.	January 2021
7	1 and 5	GRC Quality Management Plan	All Levels (Ground to L13)	Document	20/03/2020	See note 4 below
8	6	Green wall	Ground Floor	Images and Specification	February 2021	September 2021
9	Not Referenced	Powder coated steel doorsets (RAL 8000 30% gloss)	Ground Floor	300mm x 300mm sample of the PPC surface finish	July 2020	November 2020
10	Not Referenced	Granite plinth below GRC cladding	Ground Floor	300mm x 300mm sample	October 2020	April 2021

- Notes:**
- Stephenson Studio's approved planning elevation drawings 7396-al-(04)055 rev.P11, 7396-al-(04)056 rev.P12, 7396-al-(04)057 rev.P11 and 7396-al-(04)058 rev.P11 and the material key detailed on the drawings should be referenced when reviewing this list of proposed material samples and specifications.
 - A visual mock-up sample that incorporates the material samples and interface details between the GRC cladding, windows / curtain walling, micro louvres to the windows and projecting planter box with soffit panel as detailed on the Stephenson Studio drawings 7396-SSL-ZZ-ZZ-DR-A-2160 rev.P07 and 7396-SSL-ZZ-ZZ-DR-A-2161 rev.P03 was inspected by MCC Planning on 17/2/20. Updated GRC sample panels and interface details will be made available for a further MCC Planning inspection.
 - A visual mock-up sample that incorporates a 5.2m x 2.8m GRC cladding panel, window reveals and a horizontal recessed joint as detailed on the Stephenson Studio drawing will be available for MCC Planning inspection.
 - The GRC Quality Management Plan outlines both the off site and on site inspections that will be undertaken on the GRC cladding panels.
 - A sample of the window and micro louvre was inspected by MCC Planning on 17/2/20 as part of the visual mock-up sample. MCC approval / comments are awaited.
 - The dates in this schedule are based on commencing on Bowmer & Kirkland's construction programme detailing a start on site 16/3/2020.

Revisions: (Latest revisions highlighted red)

00	14/11/2019	1. Initial issue for submission to MCC
01	11/03/2020	1. 5.2m x 2.8m GRC cladding panel added 2. GRC Quality Management Plan added 3. Dates for submitting the materials samples to MCC and incorporating into the finished works updated to the latest Bowmer + Kirkland programme 4. Start on site date updated