BRANZ Appraised

Appraisal No. 1218 [2022]

QOROX™ 3D PRINTED CONCRETE WALL SYSTEM

Appraisal No. 1218 (2022)

Amended 13 November 2023

BRANZ Appraisals

Technical Assessments of products for building and construction.

XD Innovations Limited

353 Raynes Road
Rukuhia
Hamilton 3282

Tel: 021 806 185

Email: info@qorox.co.nz

Web: www.qorox.co.nz

BRANZ

1222 Moonshine Rd,
RD1, Porirua 5381
Private Bag 50 908
Porirua 5240,
New Zealand
Tel: 04 237 1170
branz.co.nz

Product

1.1 The QOROX™ 3D Printed Concrete Wall System incorporates 3D printed concrete panels that are used as wall components for buildings subject to specific engineering design. The panels are printed to form two outer faces with webs in between. This provides a hollow core that allows the placement of reinforcing and infill concrete. Panels are fixed to concrete floors through typical steel reinforced connections. A concrete bond beam is placed around the top of the panels to lock them together at this level. Buildings of more than one storey are possible using the QOROX 3D Printed Concrete Wall System.

Scope

2.1 Buildings constructed using the QOROX™ 3D Printed Concrete Wall System must be subject to specific engineering design in accordance with NZS 4229, NZS 4230 or NZS 3101 as appropriate.

2.2 The QOROX™ 3D Printed Concrete Wall System has been appraised as external and internal walls for buildings with external weathertightness detailing in accordance with NZBC Acceptable Solution E2/AS3.

2.3 The QOROX™ 3D Printed Concrete Wall System has been appraised for use with window and door joinery that is installed with vertical jambs and horizontal heads and sills. *[Note: The Appraisal of the QOROX™ 3D Printed Concrete Wall System relies on the joinery meeting the requirements of NZS 4211, or being BRANZ Appraised, for the relevant Wind Zone or design wind pressure.]*

2.4 The foundation, floor, roof, waterproofing membranes, weatherproof coatings and insulation are not covered by this Appraisal.

2.5 The use of the QOROX™ 3D Printed Concrete Wall System is not suitable where the QOROX™ mortar will be exposed to temperatures of greater than 60°C for long periods in service.

Building Regulations

New Zealand Building Code (NZBC)

3.1 **In the opinion of BRANZ, the QOROX™ 3D Printed Concrete Wall System, if designed, installed, used and maintained in accordance with the statements and conditions of this Appraisal, will meet the following provisions of the NZBC:**

Clause B1 STRUCTURE: Performance B1.3.1, B1.3.2 and B1.3.4. The QOROX™ 3D Printed Concrete Wall System meets the requirements for loads arising from self-weight, imposed gravity loads, earthquake, snow, wind, impact and creep [i.e. B1.3.3 [a], [b], [f], [g], [h], [j] and [q]]. See Paragraphs 8.1–8.3.

Clause B2 DURABILITY: Performance B2.3.1 [a] 50 years and B2.3.2. The QOROX™ 3D Printed Concrete Wall System meets this requirement. See Paragraphs 9.1–9.4.

Clause E2 EXTERNAL MOISTURE: Performance E2.3.2. The QOROX™ 3D Printed Concrete Wall System contributes to meeting this requirement. See Paragraph 13.1.

Clause F2 HAZARDOUS BUILDING MATERIALS: Performance F2.3.1. The QOROX™ 3D Printed Wall System meets this requirement.

Technical Specification

4.1 The following components and accessories used with the QOROX™ 3D Printed Concrete Wall System are supplied by XD Innovations Limited:

- **QOROX™ 3D Printed Concrete Wall panels** – specifically designed and individually printed from a proprietary mortar. Individual panels can be up to 4.5 m high and 6 m long.
- **Steel reinforcing** – in accordance with AS/NZS 4671, is cast into the panels as they are manufactured, in accordance with the specific engineering design.

4.2 The following components used with the QOROX™ 3D Printed Concrete Wall System are supplied by the builder:

- **Steel reinforcing** – in accordance with AS/NZS 4671, to be installed vertically into the panels prior to the placing of the infill mortar, in accordance with the specific engineering design.
- Cementitious block mortar used in the placing of the panels.
- **Waterproof membranes** – as specified by CCANZ CP01 Code of Practice for Weathertight Concrete and Concrete Masonry Construction.
- **Weatherproof coatings** – as specified by CCANZ CP01 Code of Practice for Weathertight Concrete and Concrete Masonry Construction.
- **Sealants** – as specified by CCANZ CP01 Code of Practice for Weathertight Concrete and Concrete Masonry Construction.

Handling and Storage

5.1 QOROX™ 3D Printed Concrete Wall Panels are trucked to site and are normally craned into position. If it is necessary to store the QOROX™ 3D Printed Concrete Wall Panels on-site, care should be taken to ensure that they will not be damaged or fall over.

5.2 QOROX™ 3D Printed Concrete Wall Panels can also be printed on-site.

Technical Literature

6.1 This Appraisal must be read in conjunction with:

- QOROX™ Technical Information, Rev 01, dated 2022/05.

6.2 All aspects of design, use, installation and maintenance contained in the Technical Literature and within the scope of this Appraisal must be followed.

Design Information

General

7.1 All buildings constructed using the QOROX™ 3D Printed Concrete Wall System must be subject to specific engineering design with respect to the panels. All other aspects of the building must be in accordance with the relevant sections of the NZBC.

Structure

8.1 Design of the QOROX™ 3D Printed Concrete Wall System must be undertaken by a suitably qualified structural engineer to take account of all loadings likely to be experienced by the structure, including loads arising from self-weight, imposed gravity loads, earthquake, snow, wind, impact and creep.

8.2 For the purposes of structural design, the compressive strength of the mortar used to make the QOROX™ 3D Printed Concrete Wall Panels may be taken as 30 MPa.

Service Penetrations

8.3 Any service penetrations made in the QOROX™ 3D Printed Concrete Wall Panels must be allowed for during the design.

Durability

9.1 Covers to reinforcement used in the QOROX™ 3D Printed Concrete Wall System must be in accordance with the requirements of NZS 4230 or NZS 3101.

9.2 To achieve a durable life of 50 years, exposed surfaces of QOROX™ 3D Printed Concrete Wall System must be coated with a weatherproof coating that is resistant to the ingress of moisture and atmospheric carbon dioxide. Pigmented high-build acrylic coatings applied in accordance with NZS 4210 or CCANZ CP01 to achieve the watertightness requirements of NZCB Clause E2 are one means of achieving this.

9.3 QOROX™ 3D Printed Concrete Wall Panels must not be exposed to temperatures of greater than 60°C for long periods in service.

9.4 Where the QOROX™ 3D Printed Concrete Wall System is used to form the external surface of the building, any joints, openings and perimeter junctions must be detailed and maintained to ensure adequate protection is provided against water ingress in accordance with the requirements of CCANZ CP01.

Maintenance

10.1 The QOROX™ 3D Printed Concrete Wall Panels should need very little in terms of maintenance themselves. Regular inspections (at least annually) of the external weatherproofing and the internal linings/finishes must be made, and any damage or deterioration repaired. External weatherproofing must be cleaned and reapplied as necessary to maintain a weathertight surface. This work must be carried out in accordance with the relevant coating manufacturers' instructions.

Prevention of Fire Occurring

11.1 Whilst the QOROX™ 3D Printed Concrete Wall Panels are made from non-combustible concrete, consideration must be given to any surface finishes or linings. Separation or protection must be provided to these linings from heat sources such as fireplaces, heating appliances, flues and chimneys. Part 7 of NZBC Acceptable Solutions C/AS1 and C/AS2 and NZBC Verification Method C/VM1 provide methods for separation and protection of combustible materials from heat sources.

Fire Affecting Areas Beyond the Fire Source

12.1 Except where foamed plastic building materials or combustible insulating materials are used, there is no internal surface finish requirement for the QOROX™ 3D Printed Concrete Wall System when it is used in buildings with an SH Risk Group classification.

12.2 Where foamed plastics form part of the QOROX™ 3D Printed Concrete Wall System, the completed system, including any applied finish, must achieve a Group Number of not more than 3. The foamed plastics shall comply with the flame propagation criteria as specified in AS 1366 for the type of material being used.

12.3 NZBC Verification Method C/VM2 Table A1 states that concrete and masonry greater than or equal to 15 mm thick, with or without the coatings defined in the Table, can be taken as having a Group Number of 1-S. When an applied finish or lining is used over the QOROX™ 3D Printed Concrete Wall System, the Group Number must be obtained from the manufacturer or supplier of the finish product or system for the complete lining system.

External Moisture

13.1 The QOROX™ 3D Printed Concrete Wall System, when used as part of an external wall, will meet the requirements of NZBC Clause E2 by being detailed and constructed in accordance with CCANZ CP01 in terms of weathertightness details.

Internal Moisture

14.1 For buildings constructed incorporating the QOROX™ 3D Printed Concrete Wall System (as with all buildings), ventilation must meet the performance requirements of NZBC Clause G4.3.1. Exterior walls of buildings must be designed to comply with minimum R-values as specified by NZBC Acceptable Solution E3/AS1.

14.2 To meet NZBC Clause E3.3.4, wall surfaces adjacent to sanitary fixtures or sanitary appliances must be impervious and easily cleaned. This may require a specific finish or lining to be applied to QOROX™ 3D Printed Concrete Wall Panels in these situations.

Hazardous Building Materials

15.1 The QOROX™ 3D Printed Concrete Wall System will not present a health hazard to people.

15.2 If it is necessary to cut QOROX™ 3D Printed Concrete Wall Panels, suitable personal protective equipment should be worn, especially to protect against concrete dust.

Energy Efficiency

16.1 Compliance to NZBC Clause H1.3.1 and H1.3.2E is achieved by using NZBC Acceptable Solutions H1/AS1 and H1/AS2, and NZBC Verification Methods H1/VM1 and H1/VM2, as applicable, and the Building Performance Index for Housing.

Installation Information

Installation Skill Level Requirement

17.1 All building work must be carried out in accordance with the instructions of XD Innovations Limited and this Appraisal by competent and experienced tradespersons conversant with the QOROX™ 3D Printed Concrete Wall System and concrete or concrete masonry construction. Where the work involves Restricted Building Work (RBW) this must be completed by, or under the supervision of, a Licensed Building Practitioner (LBP) with the relevant License class.

General

18.1 QOROX™ 3D Printed Concrete Wall System installations must be constructed in accordance with the specific design information provided by the designer. The following is a summary of important aspects.

18.2 Particular care must be taken that the foundations and building platform are level and square, that perimeter dimensions are accurate and that any starter bars are in the correct location. This is important as the QOROX™ 3D Printed Concrete Wall Panels are accurately printed to size.

18.3 The QOROX™ 3D Printed Concrete Wall Panels are placed over reinforcing steel on to a grout bed. The cavities of the QOROX™ 3D Printed Concrete Wall Panels are then filled with concrete to complete the installation.

18.4 A concrete bond-beam is installed at the top of the walls to tie them together. This is also subject to specific engineering design.

Services

19.1 Electrical switch box holes are cut into the QOROX™ 3D Printed Concrete Wall Panels. Ducting for services can be installed in the cavities of the QOROX™ 3D Printed Concrete Wall Panels. This is done prior to the concrete being installed if the ducting is to go through a cavity that is to be filled.

19.2 Plumbing and pipework is run through the foundation platform, and where possible, up behind or in fitted joinery, or through ducts mounted on face of the QOROX™ 3D Printed Concrete Wall Panels.

Joinery

20.1 Exterior windows and doors are conventional. They are fitted and fastened into openings with all required seals and flashings in accordance with the details in CCANZ CP01 and the relevant manufacturers' instructions.

20.2 The QOROX™ 3D Printed Concrete Wall System has been appraised for use with window and door joinery that is installed with vertical jambs and horizontal heads and sills. *[Note: The Appraisal of the QOROX™ 3D Printed Concrete Wall System relies on the joinery meeting the requirements of NZS 4211, or being BRANZ Appraised, for the relevant Wind Zone or design wind pressure.]*

Health and Safety

21.1 Suitable personal protective equipment must be worn when handling or cutting the QOROX™ 3D Printed Concrete Wall Panels.

Basis of Appraisal

The following is a summary of the technical investigations carried out.

Tests

22.1 Tests on sample panels of QOROX™ 3D Printed Concrete Wall Panels were undertaken by BRANZ to determine their properties.

22.2 Tests have been carried out by independent testing laboratories to establish the compressive strength of the QOROX™ mortar at different ages. These results have been reviewed by BRANZ.

Other Investigations

23.1 An independent Durability Assessment has been undertaken on the QOROX™ 3D Printed Concrete Wall System by WSP.

Quality

24.1 Details of materials and components used, and methods adopted for quality control have been obtained by BRANZ and found to be satisfactory.

24.2 The manufacture of QOROX™ 3D Printed Concrete Wall Panels by XD Innovations Limited has been assessed by BRANZ.

24.3 The structural engineer is responsible for incorporating the QOROX™ 3D Printed Concrete Wall System into the design of the structure.

24.4 The quality of materials, components and accessories supplied by XD Innovations Limited is the responsibility of XD Innovations Limited.

24.5 Quality on-site is the responsibility of the builder.

24.6 Building owners are responsible for the maintenance of the QOROX™ 3D Printed Concrete Wall System in accordance with the instructions of XD Innovations Limited.

Sources of Information

- AS 1366-1992 Rigid cellular plastics sheets for thermal insulation.
- AS/NZS 4671:2019 Steel for the reinforcement of concrete.
- CCANZ–CP01:2014 Code of Practice for weathertight concrete and concrete masonry construction, incorporating errata 1, January 2015.
- NZS 3101.1&2:2006 Concrete structures standard.
- NZS 4229:2013 Concrete masonry buildings not requiring specific engineering design.
- NZS 4230:2004 Design of reinforced concrete masonry structures.
- Ministry of Business, Innovation and Employment Record of amendments – Acceptable Solutions, Verification Methods and handbooks.
- The Building Regulations 1992.

Amendments

Amendment No. 1, dated 13 November 2023

This Appraisal has been amended to update the contact details of the Appraisal holder.

An example of a wall which can be achieved using the QOROX™ 3D Printed Concrete Wall System.

BRANZ

In the opinion of BRANZ, QOROX™ 3D Printed Concrete Wall System is fit for purpose and will comply with the Building Code to the extent specified in this Appraisal provided it is used, designed, installed and maintained as set out in this Appraisal.

The Appraisal is issued only to XD Innovations Limited, and is valid until further notice, subject to the Conditions of Appraisal.

Conditions of Appraisal

1. This Appraisal:
   a) relates only to the product as described herein;
   b) must be read, considered and used in full together with the Technical Literature;
   c) does not address any Legislation, Regulations, Codes or Standards, not specifically named herein;
   d) is copyright of BRANZ.
2. XD Innovations Limited:
   a) continues to have the product reviewed by BRANZ;
   b) shall notify BRANZ of any changes in product specification or quality assurance measures prior to the product being marketed;
   c) abides by the BRANZ Appraisals Services Terms and Conditions;
   d) warrants that the product and the manufacturing process for the product are maintained at or above the standards, levels and quality assessed and found satisfactory by BRANZ pursuant to BRANZ's Appraisal of the product.
3. BRANZ makes no representation or warranty as to:
   a) the nature of individual examples of, batches of, or individual installations of the product, including methods and workmanship;
   b) the presence or absence of any patent or similar rights subsisting in the product or any other product;
   c) any guarantee or warranty offered by XD Innovations Limited.
4. Any reference in this Appraisal to any other publication shall be read as a reference to the version of the publication specified in this Appraisal.
5. BRANZ provides no certification, guarantee, indemnity or warranty, to XD Innovations Limited or any third party.

For BRANZ

Chelydra Percy
Chief Executive

Date of Issue:
14 June 2022