



Addendum to:

Kingspan TEK® Building System

**CONSTRUCTION MANUAL FOR 142MM STRUCTURAL
INSULATED PANELS (Second Issue – October 2015)**

Document Control

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24/04/2018	Ian Hay-Smith	1.0	Original document issue.
21/05/2018	Ian Hay-Smith	2.0	Added Appendix 1 – reference to Ruamoko TEK Structural Assessment document.

Contents

1	Document Purpose	4
2	General Variations for New Zealand Conditions	4
3	Section 4 – Soleplate Installation	5
4	Section 5 – Wall Assembly	8
5	Section 10 – Prefabrication and Installation of Roof Sections	8
6	Section 11 – Attaching Breather Membranes to Walls	8
7	Section 12 – Attaching Breather Membranes to, and Battening of the Roof	9
8	Section 14 – Finishing	10
	Appendix 1 – Ruamoko TEK Structural Assessment	11

1 Document Purpose

This document is a supplementary document to the Kingspan TEK® Building System Construction Manual for 142mm Structurally Insulated Panels (Second Issue – October 2015).

It describes acceptable variations in fixings, timbers and construction processes in light of standard offerings and conditions of the New Zealand Construction Industry.

This document will reference specific clauses of the “Kingspan TEK® Building System Construction Manual for 142mm Structurally Insulated Panels” document, but also will also make general statements in regard to acceptable variations as they may apply throughout the whole of that “document.”

2 General Variations for New Zealand Conditions

In general, throughout the “Kingspan TEK® Building System Construction Manual for 142mm Structurally Insulated Panels” document, the following topics have an acceptable variation for New Zealand conditions and product offerings as follows:

Bottom-plate, Head-plates, and Edge Timbers

The standard European timber sizes are 50mm x 110mm whereas in New Zealand **45mm x 110mm** timbers are the common size on offer and are an acceptable variation.

2.8mm x 63mm Galvanised Ring Shank Nails

In New Zealand the standard nail used for these types of applications would typically be a **2.9mm x 65mm** Galvanised Ring Shank Nail, which exceeds the European requirement.

All panel fixes to splines, edge timbers, and head-plates should be done with this 2.9mm x 65mm nail and most typically applied via a nail gun.

Panel Strap Fixings 2.8mm x 60mm Galvanised Ring Shank Nails

In New Zealand the standard nail used for panel strap fixings is a **2.8mm x 60mm** Galvanised Flat Head Nail, hand-nailed.

4.8mm x 203 mm FastenMaster Headlock Screws

Used for wall panel joints, roof sections at wall/floor junctions, Roof panel into ridge beams, intermediate purlins and gable walls.

In New Zealand the standard screw used for these applications is a minimum of 8mm **x 220mm long** screw (e.g. Wurth or Spax) which exceeds the European requirement.

P5 Decking

Used mid-floors as a decking element. In New Zealand an acceptable variation is to use 18mm to 22mm plywood, or high strength chipboard of similar thicknesses.

Specific Engineering Design

Structural design of buildings must be supported by specific engineering design following the procedures specified by the report attached – see Appendix 1 –

“Ruamoko_TEK_Structural_Assessment_to_NZBC_20170720.pdf”

3 Section 4 – Soleplate Installation

The following text and illustrations replace section 4 (in its entirety) of the “Kingspan TEK® Building System Construction Manual for 142mm Structurally Insulated Panels” document with the approved New Zealand approach for soleplate and bottom-plate installation.

Section 4 Combination Soleplate/Bottom-plate Installation

The bottom and soleplate timbers can be fixed to a timber or concrete foundation.

Section 4.1 Preparation of the Base

The base or foundation should be swept and cleaned of all material and debris before starting erection of the Kingspan TEK® Building System.

As detailed in Section 3 (Foundation Assessment), the foundation should be within +/- 5mm of level around the entire perimeter of the foundation, otherwise the erection of panel will be more difficult and result in the need to buzz or adjust panels as they are erected. Obviously this adds to the risks of achieving an air-tight build, and also adds to time and cost in erecting the panel.

If the foundation is found to be significantly out of level (e.g. more than +/- 5mm) at certain points then consider the practicality of chipping/buzzing or otherwise levelling those points as much as possible BEFORE putting the soleplate down. If significantly out-of-level points remain then this will result in the need to buzz more material off the soleplate than is ideal, simply to achieve that level plane before the TEK® panel can be erected.

Section 4.2 Preparation and Fixing of the Soleplate

Soleplate timbers must be a minimum of H1.2 grade, need to be 140mm wide, and may be either 45mm deep, or alternatively a plywood with minimum depth of 18mm.

Prepare soleplates (cut to length for position as per the cutting plan, including allowance window and door openings etc.)

A DPC (Damp Proof Course) must be laid between foundation and soleplate (see figure 4b). The DPC should be fixed to the underside of the treated timber soleplate, flush to the inside edge, using two rows of staples at 100 mm centres (rows should be staggered).

Position any bracing straps as per structural engineer's drawings, and fix the Soleplate to the foundation (with DPC underneath, then straps in between) with ramset nails (or similar) at approx 900mm to 1000mm centres (see figure 3a). This is purely just to hold the soleplate in place during installation of the bottom plate.

- NOTE: It is perfectly acceptable for any window and door openings that go direct to the foundation level to be cut out of the soleplate before that soleplate is fixed to the foundation.

Now spend time checking the level of all soleplates around the perimeter of the building using a laser-level. For any spots that are out of level by more than +/- 1mm use a wood plane to level those areas as close to perfect level as possible.

- NOTE: If using an 18mm plywood as a soleplate you will obviously have limited opportunity to level the soleplate in this manner. In this scenario you should spend



Figure 4a Fixing soleplate to foundation

Section 4.3 Preparation and Fixing of the Bottom-plate

Prepare bottom-plates with markings on top for:

- Panel references (as matched with the Cutting Plan) for easy position of the correct panels later
- Markings for locating edges of panels to support structural posts/beams etc.
- Markings for where to drill anchor bolt holes, avoiding straps and panel joints, and also in accordance with structural engineer's drawings to support bracing elements.
- **Caution:** Ensure butt joints in the bottom-plate are a minimum of 300 mm away from Kingspan TEK® Building System wall panel joints to maximise structural strength.

Apply two beads of silicone to the top of the soleplate in preparation for fixing the bottom-plate on top (see figure 4a and 4b).

Place bottom-plate on top of soleplate (with the two beads of silicone in between) and fix to soleplate with 3.1 x 90mm galvanised ring-shank nails (typically nailed by hand), at 200mm centres in 2 staggered rows (see figure 4b).

- NOTE: need to avoid markings for drilling of anchor-bolt holes.

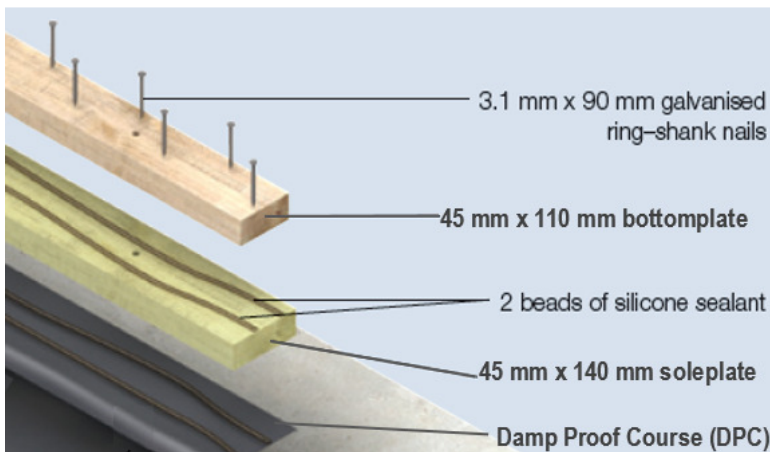


Figure 4b bottom-plate to soleplate to foundation

The centreline of the bottom-plate should be co-incident with the centreline of the soleplate such that the soleplate overhangs the bottom-plate by 15 mm on each side.

- NOTE: In areas where you need a channel between intersecting bottom-plates to allow one of the panels to slide thru and butt up against the leading edge of the intersecting bottom-plate you can use a scrap of OSB/3 to position the other bottom-plate and preserve a wide-enough channel (see figure 3b)

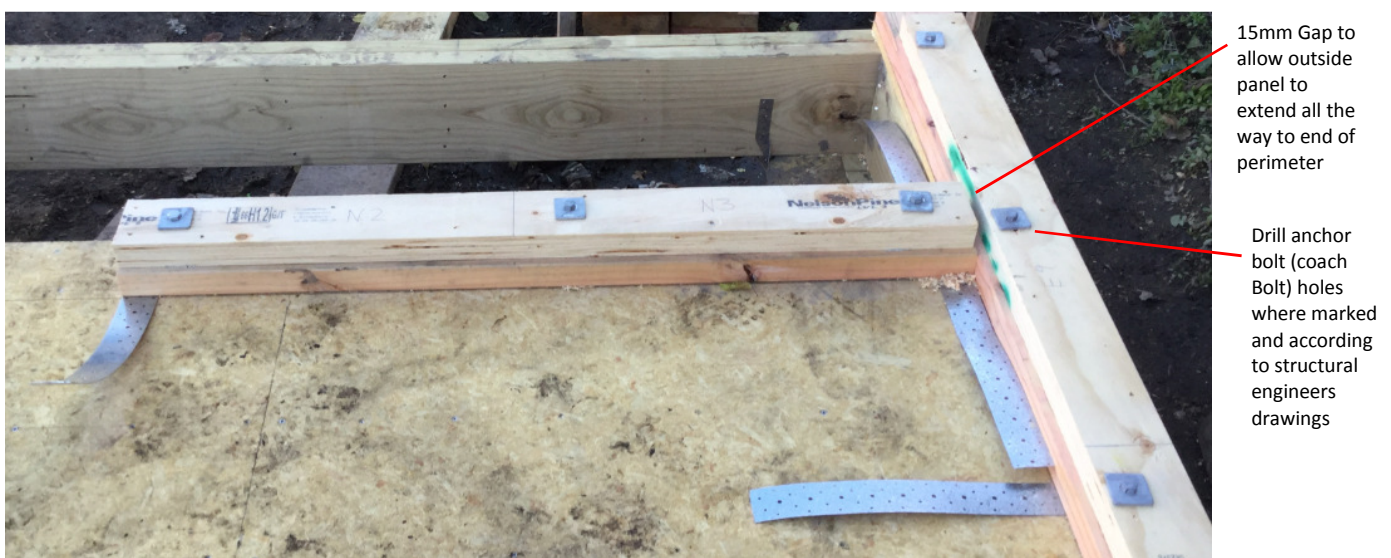


Figure 4c Anchoring bottom-plate and soleplate to foundation.

Now drill holes for the M12 anchor bolts (or equivalent coach bolts if a timber foundation) at points marked out on the bottom-plates. You will be drilling through all of bottom-plate, soleplate and foundation to achieve this.

For concrete foundations the M12 anchor bolt can be a Tru-bolt fixed direct into the concrete foundation, or can be a threaded rod that is chem-set into the concrete foundation, depending on specifications as per structural engineer's drawings.

All bolts must be supported by a 50mm x 50mm x 6mm thick washer under the head of the bolt, to comply with bracing and structural requirements.

At corners, overlap the soleplate and bottom-plate and leave a 15 mm gap in the bottom-plate to accommodate the OSB/3 facer on the overlapping panel, as shown in Figure 4c and 4d.

- HINT: In areas where you need a channel between intersecting bottom-plates to allow one of the panels to slide thru and butt up against the leading edge of the intersecting bottom-plate you can use a scrap of OSB/3 to position the other bottom-plate and preserve a wide-enough channel (see figure 4c and 4d)

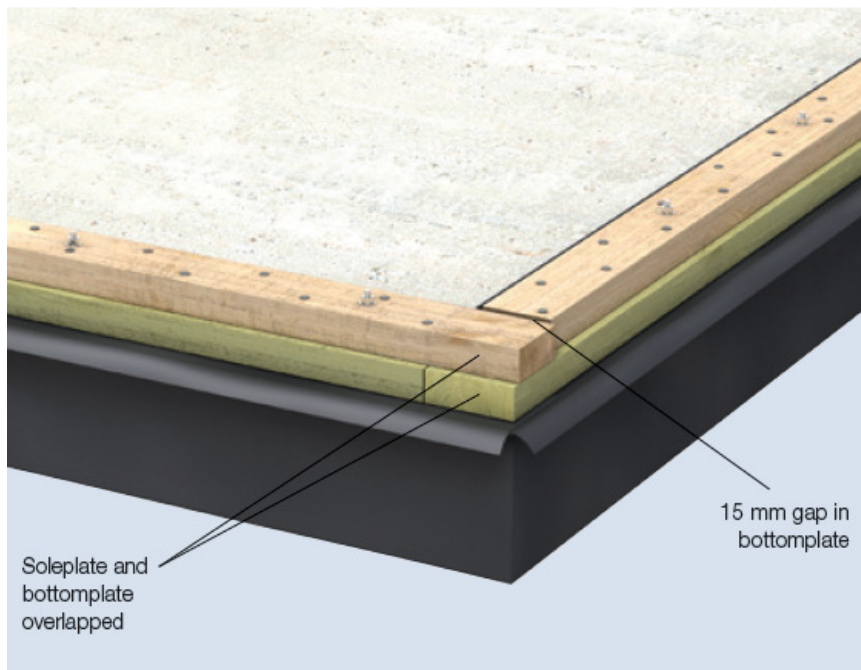


Figure 4d Combination bottom-plate and soleplate ready to receive wall panels.

4 Section 5 – Wall Assembly

Section 5.9 Standard Door and Window Openings

In this section there are references to 50mm x 110mm or 100mm x 110mm timber edge posts. For New Zealand conditions an acceptable variation in standards and product offerings would be timbers of 45mm x 110mm or 90mm x 110mm sizes.

NOTE: this also applies to section 6.1 and Figure 12, and also Appendix B of the “the Kingspan TEK® Building System Construction Manual for 142mm Structurally Insulated Panels”.

5 Section 10 – Prefabrication and Installation of Roof Sections

Throughout this section there are references to 6mm x 210mm nails for fixing roofing panels to ridge beams, corner sections etc.

For New Zealand conditions an acceptable variation is to use a **minimum** specification of 8mm x 220mm long screws instead. The use of screws gives greater flexibility in correcting mistakes and de-construction should it ever be necessary, and in the process gives superior hold-down strength.

6 Section 11 – Attaching Breather Membranes to Walls

This section references Kingspan’s Nilvent breather membrane which is not commercially available in New Zealand.

For New Zealand conditions an acceptable variation is to use a product of a similar or better technical specification such as **Proclima Solitex Extasana**.

7 Section 12 – Attaching Breather Membranes to, and Battening of the Roof

This section references Kingspan's Nilvent breather membrane which is not commercially available in New Zealand.

For New Zealand conditions an acceptable variation is to use a product of a similar or better technical specification such as ***Proclima Mento 3000***.

NOTE: for roofing applications a breather membrane of a superior moisture resistance to the wall breather membrane is required, hence the use of ***Proclima Mento 3000*** which meets the higher standard for New Zealand conditions.

8 Section 14 – Finishing

Section 14.6 Wiring

In this section there are references to 12.5 mm plasterboard. For New Zealand conditions an acceptable variation in standards and product offerings would be plasterboards of 10mm or 13mm thickness.

Refer to design documents for the building as the required thicknesses for plasterboard will be specified in that documentation.

Also in this section there are references to 25mm deep x 50mm wide timber battens between TEK® panel and the plasterboard. For New Zealand conditions an acceptable variation in standards and product offerings would be battens 35mm deep in order to create an appropriate-sized cavity for wiring.

Appendix 1 – Ruamoko TEK Structural Assessment



DOCUMENT CONTROL RECORD

KINGSPAN TEK STRUCTURAL INSULATED PANEL (SIP) ALTERNATIVE SOLUTION TO NZBC CLAUSES B1 & B2

DOCUMENT

Report Title:	Kingspan Tek Structural Insulated Panel (sip) Alternative Solution to NZBC Clauses B1 & B2
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A	20/07/2017	Initial Issue	Grant Wilkinson	Cameron MacPherson

APPROVAL

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REPORT CONTENTS

KINGSPAN TEK STRUCTURAL INSULATED PANEL (SIP)	1
ALTERNATIVE SOLUTION TO NZBC CLAUSES B1 & B2	1
1. INTRODUCTION AND LIMITATIONS	1
2. PRODUCT DESCRIPTION	1
3. HISTORY, CERTIFICATIONS & APPROVALS	2
4. NZBC CLAUSE B1 – STRUCTURE	3
4.1 Ultimate Limit State Loading	3
4.2 Axial and Flexural Loading	4
4.3 In-plane Wall Bracing	4
5. CONSTRUCTION SPECIFICATION	4
6. NZBC CLAUSE B2 – DURABILITY	5



KINGSPAN TEK STRUCTURAL INSULATED PANEL (SIP) ALTERNATIVE SOLUTION TO NZBC CLAUSES B1 & B2

20th JULY 2017

1. INTRODUCTION AND LIMITATIONS

This document is to inform structural engineers and Building Consent Authorities of the building compliance details and limitations for the use of Kingspan TEK panels as an alternative solution to NZS3604. This document only considers an alternative solution to New Zealand Building Code Clauses B1: Structure and Clause B2: Durability.

The Kingspan TEK panels provide an alternative solution to insulated, load bearing and non-load bearing timber framed walls and skillion roof framing.

The Kingspan TEK panel construction, covered by this paper is limited to the size and scope of buildings that are described in Section 1 of NZS3604 and shown on Figure 1.2 of NZS3604. Kingspan TEK is also well suited to structures that are beyond the scope of NZS3604 where the design of the Kingspan TEK structure will be supported by specific structural engineering design.

2. PRODUCT DESCRIPTION

Kingspan TEK panel (KnightBuilt NZ) consists of a structural insulated panel (SIP) built up of a polyurethane core sandwiched between two outer layers of 15mm orientated strand board (OSB) with the total thickness of the SIP being 142mm.

OSB is an engineered plane and rigid wood panel made of wood strands of selected quality with controlled cross orientation, bound with a synthetic resin under high temperature and pressure. The internal core of the panel is Polyurethane (PUR), a rigid thermosetting foam which provides excellent thermal properties. Polyurethane is hydrophobic and doesn't absorb water, unlike polystyrene EPS which is hygroscopic.

The structural insulated panel is constructed by a thermosetting process where polyurethane foam is injected between the OSB layers under high pressure and temperature in a mould to auto-adhesively bond the layers to form the structural panel, therefore eliminating introduced adhesives to amalgamate the three layers. The construction of the panels provides a composite structural wall fully insulated in lieu of conventional timber framing with inserted insulation and linings.

The panel construction requires the sheet perimeters to be strengthened to allow for sheet jointing to continuous walls, and also at change of planes such as roof-to-wall or wall-to-wall joint locations.

Jointing is carried out by one of four methods for the 142mm SIP panels:

1. 110mm thick splines made of the same SIP material
2. 110 x 45mm LVL jointing members
3. 110 x 45 solid timber jointing members
4. Steel posts

To insert one of the above jointers, the internal PUR is removed around the perimeter of the sheets with top, bottom and splines to be inserted into the panel and fixed in accordance with Kingspan TEK details around the perimeter to complete the structural integrity of the panels.

The SIP is a structural and insulation component only and requires an external envelope cladding over cavity battens and building wrap to make it weathertight and meet New Zealand Building Code (NZBC) durability requirements.

3. HISTORY, CERTIFICATIONS & APPROVALS

The panel construction is of a system developed in Germany in the 1950's and has been widely used in Europe, UK and North America for the last 40 years, with multiple factories throughout Europe manufacturing the SIPs.

The Kingspan Group plc was formed in 1960, and has been manufacturing SIPs since the late 1960's. The panel, imported by Knightbuild Ltd into New Zealand, is from the Selby plant located in Sherburn, Enterprise Park, Enterprise Way, Sherburn-on-Elmet, Selby, North Yorkshire, England. This plant has the latest technology and was commissioned in 2011.

The panel was first imported into New Zealand in 2008 and has been installed in several consented projects throughout the South Island along with code compliance certificates being issued on completed projects. The panel has been installed into new residential dwellings, residential extensions and commercial applications including the establishment of the Court Theatre, in Addington, Christchurch.

The Kingspan TEK wall and roof panels and building wrap can only be installed by KnightBuilt NZ Ltd approved and trained installers.

Given its long and successful history in the Northern Hemisphere it has extensive certifications, approvals, and literature including the following:

- (a) British Board of Agreement
 - Agreement Certificate, 02/S029, 2001, Kingspan Structural Insulated Panel (SIP) Systems, Kingspan TEK Building System
 - European Technical Approval ETA-11/0466, valid to 04 January 2017. Plus letter from BBA of 27 January 2017 explaining that ETA-15/0234 will likely replace ETA-11/0466
- (b) Local Authority Building Control (LABC)
 - Certificate No: EWW5546, Kingspan TEK Building System, valid to 07 May 2019
- (c) European Organisation for Technical Approvals (EOTA)
 - ETAG 019, Nov 2004, Guideline for European Technical Approval for Prefabricated Wood-based
 - Loadbearing Stressed Skin Panels', EOTA
 - TR 019, 'Calculation models for prefabricated wood-based loadbearing stresses skin panels for use in roofs.'
- (d) KnightBuilt NZ
 - A paper Kingspan TEK Structural Insulated Panel (SIP) Alternative Solution, version 1, June 2017
 - Engineered Timber Systems 'Kingspan TEK Building System Specification Manual' July 2015



4. NZBC CLAUSE B1 – STRUCTURE

All KnightBuilt NZ projects shall be specifically designed and certified for B1 – Structure as an Alternative Solution by a Chartered Professional Engineer (CPEng) using the tabulated structural design properties and loads contained in the BBA Approval and Certificate European Technical Approval ETA-11/0466, valid to 4th January 2017. The CPEng structural designer shall certify its design with a Producer Statement – Design (PS1).

While the BBA approval was valid to 4th January 2017, we are satisfied that it is still relevant based on the letter from BBA dated 27th January 2017 explaining that ETA-15/0234 will likely replace ETA-11/0466.

The Kingspan TEK acts as composite ‘stressed skin’ panels within the limitations of loads and properties that are tabulated by BBA ETA-11/0466.

4.1 Ultimate Limit State Loading

Specific structural design is required to use the factored load cases as set out in AS/NZS1170, for example 1.2G + 1.5Q, to quantify the ultimate demand on the SIP element and then check that against the capacity of the SIP.

The ultimate limit state, which corresponds to the maximum load-carrying ultimate capacity of the SIP panel, shall be governed by the most critical of the following failure modes either individually or in combination:

- (1) Wrinkling (local buckling) of a face of the panel leading to consequential failure
- (2) Shear failure of the core
- (3) Shear failure of the bond between the face and the core
- (4) Crushing of the core at a support
- (5) Failure of the panels at the points of attachment to the supporting structure or where the panels support heavy point or line loads
- (6) A combination of bending and compression failure of the face of the panel
- (7) A combination of bending and tension failure at the face of the panel
- (8) A combination of bending and compression failure of the core
- (9) A combination of bending and tension failure of the core

The tabulated load capacities in BBA ETA-11/0466 include the strength reduction factors set out in EOTA ETAG 019 ‘Guidelines for European Technical Approval for Prefabricated Wood-Based Loadbearing Stressed Skin Panels’ and EOTA TR 019, ‘Calculation Models for Prefabricated Wood-based Loadbearing Stressed Skin Panels for use in Roofs’ for use in ultimate limit state design of the Kingspan TEK building elements.

Structural designers should avoid using the ‘permissible design values’ set out in BBA 02/S029 as they are not compatible with the factored design load cases in AS/NZS 1170 for ultimate strength design.



4.3 Axial and Flexural Loading

Kingspan TEK panels have well understood load bearing properties that are significantly different to conventional New Zealand light timber frame construction.

We recommend that designers adopt the EOTA documents and guidelines ETAG 019 and TR 019. The Kingspan TEK panels are Type A Stressed skin panels; closed box type double-skin, without wooden ribs, with load bearing insulation as described in TR 019.

Because the OSB is required to take the entire axial and/or flexural load within the walls and roof panels, it is essential that loads are uniformly applied into and out of the SIP walls and roof panels. To achieve this, the wall panels are required to bear evenly on a 142mm wide LVL timber sole plate that is carefully packed to provide a level supporting surface. The panels are fixed to the top and bottom plates and to all vertical jointers, trimmers and lintels at much closer centres than equivalent plywood bracing panels used in conventional timber framing construction. The close fixings are intended to spread the applied loads into and out of the SIP elements.

4.4 In-plane Wall Bracing

NZS3604 has wall bracing requirements that are specific to New Zealand light timber framed construction. Whilst the BBA 'European Technical Approval' ETA-11/0466 document tabulates wall 'Racking Resistance', designers for New Zealand construction should use the P21 test results that have been expressed as Bracing Units/metre (BU/m) just like any other wall bracing element used when designing to NZS3604.

The Kingspan TEK walls have been tested as wall bracing elements by SCION and have wall bracing units per metre assigned to them calculated using the New Zealand industry standard P21 test methodology. SCION have published bracing capacities for two 600mm long test samples; one using 50mm Multibrace strap and M12 bolts with 50mm square washers at each end of the wall, and the other test using 27 x 0.7mm strip brace strap and M12 bolts with 50mm square washers at each end of the wall.

Both tests have the standard Kingspan TEK nailing pattern to the walls. Ruamoko Solutions drawings 257-P21-1A and 257-P21-2A dated 2nd June 2009 show the size and spacing of the nails to:

- Top and bottom plates: 60 x 2.8mm flat head galvanised nails at 50mm centres to both sides of the plates
- All vertical jointers: 60 x 2.8mm flat head galvanised nails at 100mm centres to both sides of the jointers and to both edges of the adjacent SIP panels

As expected, the braced wall tests gave relatively high 'BU/m' capacities compared to other braced wall types. The P21 test results can be used directly with the standard NZS3604 bracing calculators for all Kingspan TEK walls that are at least 600mm long.

5. CONSTRUCTION SPECIFICATION

All construction must be done in full accordance with the 'Kingspan TEK Building System Specification Manual' dated July 2015 (160 pages) with the exception of the nailing, strapping and hold-down details for wall bracing which shall be done to the details on the SCION P21 tests dated 29th March 2012 and the Ruamoko Solutions drawings 257-P21-1A and 257-P21-2A dated 2nd June 2009.



6. NZBC CLAUSE B2 – DURABILITY

The NZBC Clause B2 requires that Kingspan TEK walls must satisfy the performance requirements of the code for the specified intended life of the building being not less than 50 years, because:

- (i) The Kingspan TEK building elements (including floors, walls, and fixings) provide structural stability to the building, and/or,
- (ii) The Kingspan TEK building elements are difficult to access or replace, or where failure of the Kingspan TEK building elements to comply with the building code would go undetected during both normal use and maintenance of the building.

Kingspan TEK SIP panels have a long history of durability provided that they are designed and installed by experienced personnel and in full accordance with Kingspan TEK specifications and manufacturers recommendations.

The TEK panel is dimensionally stable as neither OSB or foam component is hygroscopic, and both layers exhibit minimal expansion or contraction when subject to differing climatic conditions.

Kingspan TEK Building Systems have been extensively evaluated and tested for durability by several appraising authorities. A selection of statements on durability that have been published by these appraising authorities include the following:

- (a) The Engineered Timber Systems, 'Kingspan TEK Building System Specification Manual' July 2015 states in part:

Durability: 'The Kingspan TEK Building System panels will have comparable durability to that of OSB/3 to BS EN 300 ('Code of Practice for the Selection and Application of Particle Board, Orientated Strand Board, (OSB) Cement Bonded Particle Board and Wood Fibre for Specific Purposes. '), therefore as long as the System remains weather-tight, a life of at least 60 years can be expected'.

- (b) Local Authority Building Control (LABC): Certificate No: EWW5546, Kingspan TEK Building System, states in part:

'The panels have a minimum service life of 60 years provided they are protected from damage/weather prior to installation. Protection is achieved by the external and internal finishes. The anticipated working life of 60 years is subject to packaging, transport, storage and installation. Damaged panels should not be used or repaired. The indications of working life should be indicative rather than prescriptive as conditions on site are beyond the scope of the manufacturer'.

And continues:

- *'The SIP building system should be erected only by Kingspan approved Delivery partners.*
- *A residual cavity will be required with all wall cladding proposals.*
- *A suitable breather membrane and roofing must be provided to protect the he SIP panels from water penetration through the claddings.*
- *Projects with balconies or parapets are not covered by this assessment and will be required to be approved in advance by LABC Warranty on a job by job basis with particular emphasis on how water penetration and rainwater disposal (through the panels) will be managed.'*



(c) European Organisation for Technical Approvals (EOTA) ETAG 019, Nov 2004, Guideline for European Technical Approval for Prefabricated Wood-based states in part:

Working life (durability) and Serviceability: *The provisions, test and assessment methods in this Guideline or referred to, have been written, based upon the assumed intended working life of the stressed skin panels for the intended use of at least 50 years, provided that the stressed skin panels are subject to appropriate use and maintenance (cfr. Ch 7). These provisions are based on the current state of the art and the available knowledge and experience.*

An 'assumed intended working life' means that it is expected that, when an assessment following the ETAG provisions is made, and when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting Essential Requirements.

The indications given as to the working life of a stressed skin panel cannot be interpreted as a guarantee given by the producer or the approval body. They should only be regarded as a means for specifiers to choose the appropriate criteria for stressed skin panels in relation to the expected, economically reasonable working life of the works (based on ID. Paragraph 5.22).'

(d) British Board of Agreement, Agreement Certificate, 02/S029, 2001, Kingspan Structural Insulated Panel (SIP) Systems, Kingspan TEK Building System states in part:

Durability: *The panels will have comparable durability to that of OSB/3 to BS EN 300 – 1997, therefore provided that the installation remains weathertight, a life of at least 60 years may be expected. Timber used in areas that could be at risk, eg sole plates, should be preservative treated in accordance with the recommendations of BS 1282:1999.'*

Given its long and successful history in the Northern Hemisphere, its extensive product certifications and approvals together with its use in climates that are less temperate than we have in New Zealand, we accept that Kingspan TEK has a functional life of at least 50 years provided it is protected from damage and the weather. The protection is achieved in part by the external and internal finishes together with construction design and detailing in strict accordance with Kingspan TEK recommendations.

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