Assessing structural insulated panels

Structural insulated panels are relatively new in New Zealand. To ensure they are suitable for local conditions, BRANZ has developed a robust test method. This gives manufacturers a way to demonstrate their durability.

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STRUCTURAL INSULATED PANELS (SIPs) are prefabricated sandwich panels that are used for wall, roof and floor systems. SIPs are typically made of a layer of rigid insulating material between metal or timber-based outer skins (Figure 1).

Figure 1: Timber-based SIPs with an expanded polystyrene core.

Fast solution, but what about durability?

Overseas and in New Zealand, SIPs are used to achieve buildings with good thermal performance that are fast to construct. New Zealand has an immediate need for large-scale affordable housing solutions that can be constructed quickly, and SIPs could be part of the solution.

SIPs must comply with the relevant sections of the New Zealand Building Code including clause B2 *Durability,* which sets a minimum durability requirement of 50 years for structural materials.

Proof of durability should consider the product's history of use, results from laboratory testing and the performance of similar building elements. Although SIPs are widely used in regions such as North America and Europe, their history of use in New Zealand is relatively short.

BRANZ stepped in to fill gap

Prior to BRANZ's research in this area, there was no laboratory test method to assess SIPs durability under New Zealand conditions. This meant that SIPs manufacturers had no reliable means of demonstrating compliance with the New Zealand Building Code.

By 2014, the increasing popularity of SIPs - both imported and locally manufactured - was reflected in the number of requests for BRANZ to evaluate SIP systems. It was evident there was a clear need in the building industry to understand the durability of these structural panels.

In response, BRANZ included SIPs in the research project *Materials performance testing methodologies* funded by the Building Research Levy and completed in October 2019.

Durability test method developed

The aim of this project was to develop ways to assess the long-term performance of a range of building materials. The SIPs workstream sought to address the need for a robust, reliable test method to predict the durability performance of SIPs.

Assessment method

The assessment method developed for SIPs involved accelerated ageing, which exposed SIPs samples to realistic in-service maximums of temperature and humidity. The ageing methods were based on existing well-accepted accelerated ageing tests for SIPs, which were adapted to align with New Zealand climatic conditions.

Because of the range of different components or products that can make a SIPs system, developing appropriate and consistent methodologies was essential. Therefore, this project focused on defining test criteria for each of the SIPs component parts as well as tests for the finished SIPs panel.

Experimental work tested methodology

The experimental work tested the developed methodology on a small selection of timber-based SIPs to see whether performance differences could be identified between products made from different components of varying quality. Both laboratory-made and commercial samples were tested. SIPs samples were selected to be representative of some of the SIPs types that are available in New Zealand but did not include the full range of available compositions.

Samples were aged in climate-controlled chambers that were programmed to one of four different ageing conditions (Figure 2). The ageing conditions included freeze-thaw cycling between -20°C and +90°C and relative humidity of between 0-100%. Samples were tensile tested after ageing and their tensile strength compared with unaged control samples to give an indication of durability.

Figure 2: SIPs samples in climate chamber before ageing.

Accelerated ageing attempts to replicate in-service degradation pathways in order to give a realistic indication of actual performance.

Performance varied according to components

The results showed that there were differences in the performance of SIPs made from different components. These findings provided a first step in our understanding of how different SIPs perform long term in New Zealand conditions.

The results were used to inform the criteria for some SIPs options to evaluate durability performance. These criteria are now being used within the BRANZ Appraisal processes to assess whether wood-based SIPs meet the durability requirements of the Building Code.

Recently, BRANZ issued its first SIPs Appraisal. This marks a significant step in BRANZ's ability to support industry innovation.

Next stage – a more holistic approach

To further refine the durability assessment method and ensure its applicability to a range of SIP types, a new research project starting in January 2020 will build on the previous work.

The project will have three main workstreams to not only investigate the methodologies for durability performance of a wider range of SIPs but also include other critical perspectives, such as seismic and fire performance.

This holistic approach will investigate and identify the impact of the interconnections between the different requirements such as structure and durability.

Durability workstream

Durability work will extend the experimental work described above. It will include a greater range of SIP types and investigate the long-term performance of different component materials as well as their interactions with typical connection details.

Test samples may include SIPs with magnesium oxide board (MgO), timber and metal face layers.

Seismic performance

The seismic performance workstream aims to determine how SIP structural bracing systems perform when subjected to seismic loading. Testing and analysis will provide load and displacement data for SIP wall configurations. This will be compared with New Zealand Building Code requirements for structural performance and control specimens representing existing bracing systems used in New Zealand buildings.

The intersection of durability and seismic performance will also be considered through cyclic testing of aged SIP specimens and connections.

Fire performance

The fire performance of SIPs will be investigated by a review of existing literature. The aim of this workstream is to better understand the known issues relating to the fire performance of typical SIP systems used in New Zealand.