# Fire performance requirements for structural insulated panels (SIPs) in New Zealand residential builds

Structural insulated panels (SIPs) could provide an affordable solution for New Zealand's current housing shortage. Although these products have been used in overseas residential buildings for some time, the building system is different from our traditional light timber-framed construction. BRANZ reviewed documentation on fire-performance requirements in New Zealand and overseas. The availability of standards and design guidance on SIPs shows that this type of building is being taken seriously in other developed countries. Much of the overseas information is relevant to New Zealand.

New Zealand has an urgent need for quality housing that can be built quickly and affordably. Residential construction using SIPs is one possible solution.

SIPs are sandwich panels of two face layers and an insulating inner core that are generally prefabricated and assembled on site. They are used extensively overseas. SIPs with wood-based panels as the outer face layers have been used for residential construction in North America since the early 1990s and are being used more frequently in parts of Europe. They are also an effective solution for seismically active parts of the world, including Japan. However, because of their relatively short history of use in New Zealand, less is known about their performance here. SIPs building systems are different to New Zealand's traditional light timber-framed construction in the way they are built, the materials involved and the performance of the completed building. SIPs can be manufactured from a range of materials for both the core and face-layer components and configured using different connections and assembly methods (Figure 1), so there are a number of factors that can influence their performance during fires. BRANZ reviewed how the fire safety requirements in the New Zealand Building Code (NZBC) apply to SIPs and considered available overseas information, standards, and documentation to investigate SIPs' suitability and performance in fires as materials and at the building level.

## SIPs and New Zealand regulations

In general, buildings including those constructed using SIPs must comply with all relevant NZBC requirements. The key NZBC clauses for fire safety are the C clauses. NZBC compliance is usually demonstrated using Acceptable Solution or Verification Method pathways. Current Acceptable Solution (C/AS1 and C/AS2) and Verification Method (C/VM2) compliance pathways do not include any specific requirements for SIPs. In all three current NZBC protection from fire compliance documents, there are specific reaction-to-fire requirements for building systems that include foamed plastic or combustible insulation. Depending on usage and building configuration, specific SIP elements may also be required to meet a fire resistance rating (FRR).

**Requirements for foamed plastics**

All foamed plastic must comply with AS 1366-1992 *Rigid cellular plastic sheets for thermal insulation*. The four parts to this standard, each covering a different type of foamed plastic, are:

- AS 1366.1 - rigid cellular polyurethane
- AS 1366.2 - rigid cellular polyisocyanurate
- AS 1366.3 - rigid cellular polystyrene - moulded
- AS 1366.4 - rigid cellular polystyrene - extruded.

In most cases, building elements including foamed plastics or combustible insulation also require a Group Number that covers the performance of the whole building element before they can be specified. See BRANZ Study Report SR468 for more information about the standards for testing and determining Group Numbers for certain products.

NZS 4541:2020 *Automatic fire sprinkler systems* also includes requirements for buildings built with expanded plastic cored insulated panels, with options for laboratory-approved panels and panels that are not laboratory-approved.

**Requirements for different building types**

Acceptable Solution C/AS1 can be applied to low-rise stand-alone or multi-unit dwellings if each unit is independent of all other units (classified as risk group SH). C/AS1 requires that wall systems that include foamed plastics or combustible insulation must achieve a Group Number of 3 or less. This applies to SIPs with a foamed plastic core. There are no other surface lining requirements in C/AS1 for the SH risk group. SIPs used for fire separations - such as inter-tenancy walls or for external walls close to a boundary - may also require a 30-minute FRR in SH buildings.

For higher-risk construction types such as multi-unit residential, commercial or education buildings, additional fire safety requirements apply depending on the building purpose and form. Acceptable Solution C/AS2 or Verification Method C/VM2 may be used to determine fire requirements for the building types not covered by C/AS1. This includes non-institutional buildings where people are sleeping (classified as risk group SM) or multi-unit residential buildings with a shared means of escape.

Similar to C/AS1, fire resistance ratings are required where wall or floor elements will act as fire separations or for external walls near boundaries. The required FRR for residential buildings in C/AS2 depends on whether the building is sprinklered (30 minutes required) or without sprinklers (60 minutes required). FRRs required under C/VM2 must be evaluated by a fire safety practitioner.

**Third-party verification**

Some New Zealand SIP suppliers have organised third-party verification that demonstrates compliance with specified NZBC requirements within a specified scope of use. These include systems with BRANZ Appraisals and CodeMark. Not all relevant NZBC aspects may be included in the scope of these verification documents. This includes fire safety requirements, particularly when they are dependent on the application. As they do not generally describe what is not in scope, BRANZ recommends caution when employing these verification systems to establish NZBC compliance.

## SIP components and building systems

SIPs are sandwich panels of two face layers and an insulating inner core. As SIPs are generally prefabricated and assembled quickly on site, their use could increase construction speed and reduce overall building cost. SIP face layers are usually engineered wood panels, cement-based panels or metal sheets. The insulating core is commonly expanded polystyrene (EPS), extruded polystyrene (XPS), polyurethane (PUR) or polyisocyanurate (PIR) rigid foams. Fibrous insulation products such as mineral wool are also sometimes used. Bio-based panel and insulation materials are sometimes used overseas in SIPs, but these are currently uncommon in New Zealand. The core layer is bonded to the face layers by an adhesive or by self-adhesion.

SIPs-based building systems can be used as structural wall, roof and floor elements. The face layers are the primary load-carrying components. The core - and how this is bonded to the face layers - provides stability to the face layers and is integral to the fire and structural performance of SIP buildings. Combustible foamed insulation products used as the core are often the component in SIPs most susceptible to heat degradation and the most reactive to fire.

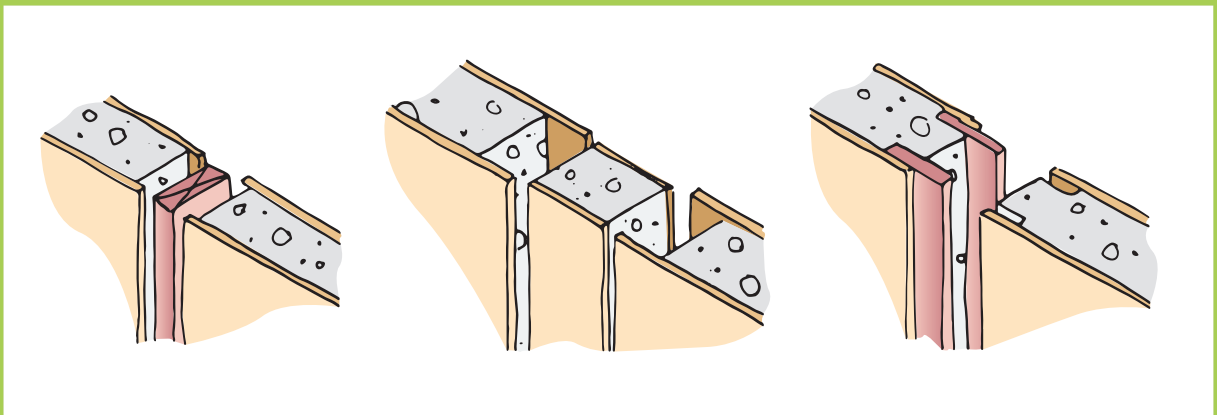

Figure 1. From left to right: Examples of connections between panels include solid timber or laminated veneer lumber splines, foam block or mini-splines or thin splines (plywood or oriented strand board). These types of connections are only for use with SIPs with timber-based panels for the face layers. SIPs that have cement-based panels or metal sheets for face layers typically use different spline options.

## Relevant overseas requirements and documentation

The collection of standards and design guidance available on SIPs internationally shows that this type of building is being taken seriously in developed countries around the world.

**United States**

The growth in SIP usage in North America since the early 1990s meant increased research and documentation on the design and detailing of SIP structures. This resulted in a joint standard between the American National Standards Institute (ANSI) and APA – The Engineered Wood Association. ANSI/APA PRS 610.1 *Standard for performance-rated structural insulated panels in wall applications* provides requirements and test methods for qualification of SIPs for use within building standards such as the International Residential Code (IRC). A SIPs product guide published by APA also includes a brief discussion about achieving code-compliant fire resistance for residential and commercial buildings using SIPs.

The International Code Council adopted SIPs into the IRC in 2007 for loadbearing walls up to 2 storeys high. For fire performance compliance, the IRC requires that:

- SIPs must comply with the requirements of ANSI/APA PRS 610.1 for flame spread and smoke development
- SIPs with foamed plastic insulation must be separated from the interior of a building by an approved thermal barrier to meet IRC requirements for foamed plastics (section 316.4).

**United Kingdom**

SIPs are not explicitly considered in UK building regulations, but the Structural Timber Association (STA) does provide a series of technical bulletins on designing and building with SIPs, including one on fire. This includes general guidance for SIP buildings to comply with national building regulations.

Similar guidance in an information sheet was also published by BM TRADA, which provides independent guidance on best-practice design, specification and use of wood in the built environment. This includes an overview of fire performance considerations for SIP construction. It states that SIPs will be able to meet given building regulations as long as they are designed, manufactured and installed correctly.

Currently, combustible materials are not allowed in external walls for residential buildings in England over 18 m in building height. Insulated core panels used internally must meet these requirements:

- Panels should be sealed such that the core is not exposed to fire, including at joints and service penetrations.
- Only non-combustible (class A1) panels should be used in high fire risk areas such as kitchens.
- Delamination of panels should be accounted for in the panel fixing system.

**Australia**

SIPs are not specifically included in Australian building regulations. Testing and certification authorities are advised to ensure that products meet the necessary fire safety requirements. Several different SIP systems are manufactured and supplied across Australia, including some that have received third-party verification of their performance against selected Australian Building Code requirements.

Australia's National Construction Code (NCC) section C *Fire resistance* classifies construction into three types (A, B and C) with specified fire resistance ratings and combustible material allowances for specific applications. Following the deemed-to-satisfy compliance pathway, SIPs with combustible insulation or face layers would not be permitted for higher-risk buildings above 2-3 storeys (type A or B constructions). SIPs with combustible components may be allowed for buildings of 1-2 storeys (type C construction), depending on the building classification.

Following the deemed-to-satisfy compliance pathway, timber can be allowed up to 25 m building height, but it has to be fire protected (meaning incipient spread of fire test or 2 x 13 mm fire-protective grade plasterboard protection) and with no combustible insulation. There are also requirements to install sprinkler protection. Alternative solutions may be possible.

The fire resistance test AS 1530.4 *Methods for fire tests on building materials, components and structures. Part 4: Fire-resistance test of elements of construction* is used in both Australia and New Zealand, although there may be variation in the versions of the standard adopted in different jurisdictions.

## Conclusion

There are currently no direct references to SIPs in New Zealand building codes or standards. However, there are specific reaction-to-fire requirements for building systems that include foamed plastic or combustible insulation. In addition, there is international documentation available for the design and fire-performance evaluation of SIP products and systems.

In countries where SIPs have been used for several decades, guidance documents developed suggest that SIPs buildings can meet fire safety regulatory requirements with the use of suitable lining materials if specific fire resistance ratings are specified. Also, the inclusion of SIPs in some building codes around the world indicates confidence in their use.

Our research showed that much of the overseas information and documentation is relevant to New Zealand. To ensure that systems comply with our local regulations, some testing may be needed. The type of building will determine what fire performance requirements apply. Different fire safety requirements will apply for various SIPs building components depending on the building form, usage and occupancy.

## More information

BRANZ Study Report SR468. *Fire performance of structural insulated panels (SIPs) for residential buildings – a review of literature* (2022).

APA. (2018). *Structural insulated panels product guide*. Form No. H650A. Tacoma, WA: APA – The Engineered Wood Association.

ANSI/APA PRS 610.1 *Standard for performance-rated structural insulated panels in wall applications*

BM TRADA. (2014). *Fire*. SIPs Technical Bulletin 2. Alloa, Scotland: Structural Timber Association.

BM TRADA. (2020). *Structural insulated panels (SIPs): structural principles and design*. Wood Information Sheet WIS 2/3-69. High Wycombe, UK: BM TRADA.