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The development of accelerated test methods to evaluate the durability of framing timber

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ABSTRACT

Various accelerated decay resistance trials, including small simulated wall units, samples exposed in enclosed tanks and 'I' samples in stacks, have been explored and used to test the durability of treated and untreated radiata pine framing at Scion since 2001. These testing methods have been established to determine the effectiveness of commercial formulations in preventing decay in framing subjected to intermittent wetting. These are relatively short term test methods requiring a minimum of 12 months testing.

Results of these tests have been used to develop suitable preservative formulations and retentions for Hazard Class H1.2 for inclusion in New Zealand Standard for Chemical Preservation of Round and Sawn Timber (NZS, 3640). In New Zealand framing hazard Class H1.2 is for timber that is protected from the weather but with a risk of wood reaching a moisture content conductive to decay.

In this communication, we discuss the advantages and disadvantages of these test methods.

1. Introduction

Timber frame construction is the predominant form of residential construction used in New Zealand, Australia, USA and many Scandinavian countries. In New Zealand, Standard NZS 3602 (NZS 3602, 2003), specifies durability requirements of wood and wood based building components. NZS 3602 refers to timber treated to hazard classes as defined by NZS 3640, Chemical Preservation of Round and Sawn Timber. Hazard Classes are divided into H1, H1.2, H3.1, H3.2, H4, H5 and H6, based on the biological hazards expected for the end use situation of timber. Hazard Class H1.2 in NZ relates to wall framing which is defined as "Protected from the weather, above ground, but with a possibility of exposure to moisture" (NZS 3640, 2003). The hazard class was developed to overcome the leaky building syndrome that has been prevalent in NZ for last 15–20 years (Hedley et al., 2002; Groufsky, 2008; Singh et al., 2013). Hazard Class H1.2 had not been regarded as at high risk to decay until some years after the use of untreated, kiln-dried radiata pine was approved in the building code in 1993 (Hunn et al., 2002).

Problems with leaky buildings and decay of framing began to show up in the late 1990's (Hardie, 1997). These were associated with changes in building design, building materials and workmanship. Many of the leaky buildings included features such as a lack of eaves, stucco style cladding, seamless wrap around cladding systems and complex roof designs (Hazleden and Morris, 1999; Hunn et al., 2002). In response to decay developing in framing, companies involved in the wood preservation industry began looking at specialised framing treatment systems that would be suitable for kiln-dried framing which may be subjected to occasional wetting (Hedley et al., 2002; Page et al., 2003). In 2003, H1.2 was introduced, an indoor decay hazard requiring temporary protection should the wood get wet through leaks in the building envelope – protection for sufficient time for the leaks to be detected and rectified (NZS 3640, 2003).

The development of protocols to assess preservative systems for temporary (up to 5 years) protection of framing timber is an ongoing activity at Scion. There are few internationally recognised methods for testing the resistance of framing to decay. Currently, only one method is listed in the Australasian Wood Preservation Committee's (AWPC, 2007) protocols for preservative evaluation in Australian and New Zealand.

This paper summarises the various test methods evaluated and developed for Hazard Class H1.2 testing since 2001. H1.2 is comparable to UC2 in the United States and hazard class 2 in Europe and many other parts of the world.

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2. Materials and methods

2.1. The simulated wall unit method

The initial approach was to build wall sections that contained most of the features found in exterior wall construction in New Zealand where there had been decay problems. This included vertical and horizontal framing components, nailed together, fibre-cement exterior cladding attached directly to the framing, insulation in the wall cavities and a lining material on what would normally be on the interior side of the frame.

The wall units were relatively small, only 0.6 m high × 0.5 m wide with two vertical "studs", a top and bottom plate and a single horizontal dwang between the two studs at their mid-point. The timber used was kiln-dried, framing grade, 90 × 45 mm, gauged radiata pine that included some heartwood. Treated or untreated timber wall units were produced, and all timber in each unit had the same treatments.

Once the timber components were assembled the frames were immersed in water and placed in a pressure cylinder. A short low pressure schedule was used for each treatment group to raise the moisture content in the framing to above 30%. Different schedules were used for each preservative type to accommodate different water absorbency rates associated with water-based and LOSP or water repellent treated wood. The back, bottom and top of the units were then covered with polythene.

Pinus radiata sapwood feeder blocks, approximately 7 × 43 × 70 mm with variable grain orientation, were sterilized by exposure to ethylene oxide gas and placed in prepared containers with 2% malt-agar nutrient medium inoculated with a pure culture of common leaky building associated fungi (Eaton and Hale, 1993); either *Coniophora puteana* or a *Oligoporus placenta*. They were then incubated for nearly four weeks at 25 °C and 85% RH (Singh et al., 2013).

The partly decayed feeder blocks were fixed to the upper surface of the bottom plate and the dwang, adjacent to the studs. On one side the two feeder blocks contained *O. placenta*, on the other side the decay fungus was *C. puteana*. Before the decay feeder blocks were installed in the units, the surfaces adjacent to the feeder block positions were swabbed with alcohol. The insulation was immersed in water and allowed to drain before it was installed in the cavities, then the building paper and fibre cement exterior cladding were attached.

Half of the assembled units were placed in a controlled conditions facility at Scion, where the temperature was constant at 25 °C and the relative humidity was approximately 95%. Frame units were stacked in racks and sprayed with water for a short period each week to simulate occasional rain wetting. The remaining units were placed on bearers in a shaded outdoor area where they were fully exposed to wetting by rain.

Units were usually assessed after 12 weeks and 26 weeks exposure and at six-monthly intervals thereafter using a standard (AWPA Standard E7-93). The fibre-cement panel, building paper and fibreglass insulation were removed. The moisture content of each framing component was measured using a resistance type moisture meter with 30 mm long probes. Each component was assessed for mould, decay mycelium spread and decay as shown in Appendix 1. Mould rating and decay mycelium spread rating were only used to check activity on the surface (data is not presented). They were ignored when samples were assessed for decay. The exposed surfaces of the framing were probed with a blunt, 3 mm diameter, steel probe to determine decay. Each component was given numerical decay ratings as shown in Appendix I. The insulation, building paper and sheathing panel were refitted and the unit returned to the exposure racks.

2.2. The enclosed tank method

The enclosed tank method was established to compare a large number of treatment variables for resistance to decay in framing. The tanks were plastic, approximately 1 m long, 750 mm wide and up to 800 mm deep. They had a drain hole about 20 mm above the bottom and a tight fitting lid. Samples were placed on 40 mm thick bearers in the bottom of the tank with subsequent layers separated by 20 mm thick fillets (Fig. 1). A rigid panel was placed on fillets on top of the stack and a 40 mm thick foam plastic blanket fitted between that and the lid. The bottom of the tank was filled with water to a depth of about 20 mm and the foam blanket was saturated with water to maintain a humid atmosphere in the tanks. The tanks were kept in the controlled conditions facility (25 °C and 95% RH), or outside and regularly opened (usually weekly) so that the samples could be sprayed with water.

In the initial test the objective was to determine the approximate moisture content in framing required to initiate decay. Framing samples approximately 700 mm long were pre-wet to give five moisture content ranges i.e., <20%, 20–25%, 25–30%, and 30–40%. Samples from each moisture content group were placed in separate tanks. They were stacked on the flat, with pre-decayed feeder blocks infected with a brown rot fungus attached on one face at each end. At one end of the samples the feeder block was colonised by *Antrodia xantha*, while the feeder block at the other end was colonised by *Oligoporus placenta*. These two fungi were included because they are often isolated from leaky building timbers (Schmidt and Moreth, 2003; Schmidt, 2007; Stahlhut, 2008).

In subsequent tests where resistance to decay was the only variable to be measured, framing samples 500–700 mm long were rewetted to above 25% moisture content and stacked in layers in the tanks. Assessments of samples were at similar intervals to those for wall units using the same mould, mycelium development and decay rating systems. Data is only presented for decay rating. The samples were weighed before each assessment and the approximate moisture content of each sample was determined.

In tests where rates of strength loss and decay were to be compared, samples were 950 mm long and a single decay feeder block, containing *O. placenta*, was attached mid-length on one edge of the samples. Samples without feeder blocks were also included. Assessments were more frequent at 2–8 week intervals and included weight, deflection as a plank under constant load (Singh et al., 2013) as well as decay development ratings.

Fig. 1. Samples in an enclosed tank test. The decay feeder block at the far end was *Antrodia xantha*, while at the near end it was infected with *O. placenta*.