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PROJECT NUMBER: PNA025.0809

MAY 2011

Reducing Fire Regulatory Barriers and Standards on Timber and Wood Products

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Reducing Fire Regulatory Barriers and Standards on Timber and Wood Products

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by

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Publication: Final Report - Reducing Fire Regulatory Barriers and Standards on Timber and Wood Products

Project No: PNA025.0809

This work is supported by funding provided to FWPA by the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF).

ISBN: 978-1-921763-26-7

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Final report received by FWPA in May, 2011

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Executive Summary

The principal barrier to increased sales of timber and wood based products in commercial and multi-residential buildings are the deemed-to-satisfy fire performance limitations that the Building Code of Australia places on timber and wood products.

This research project investigated a number of these issues that were seen as foremost limiting factors for increase market opportunity for timber and wood products. The areas of investigation included;

- Applications of timber in bushfire-prone areas
- Fire Hazard Properties for timber in Class 2 to 9 buildings
- Extension of Class 2 (MRTFC) timber concession to include Class 3 (resorts, hotels)
- Timber facades on Class 2 to 9 buildings
- Effects of thin veneers on fire retardant MDF substrate

The project generally added to the knowledge base of timber and wood product performance in various fire conditions occurring in building regulations. The project was able to;

- Add data and information on the fire performance of timber in bushfire resisting construction. However the project was not able to advance the use of timber because of issues relating to the Standard test method that could not be overcome;

- Expand the general fire hazard properties database for timber and wood product required for commercial building application, as well as show that common configuration, profiles and preservative treatment do not affect the fire hazard properties;

- Demonstrate that fire rated timber framed construction performed equally to non-combustible framed construction and that the timber framing used to support the fire rated linings do not significantly contribute to the overall fire load;

- Develop a methodology to demonstrate how a non-complying timber cladding can be used on commercial buildings. The work included the development of a fire engineering guide and industry intermediate test method standard that can be used to demonstrate compliance to building regulations; and

- Successfully demonstrate that the attachment of a thin veneer did not significantly alter the Group Number obtained for the MDF substrate.

All in all, the project has made an enormous step in the knowledge surround fire resistance of timber in buildings that can assist the timber industry in providing products into a market that they are current either previously restricted or prevented from supplying.

The project has also assisted the industry by removing the need for individual companies to conduct these tests or source the data themselves, saving much expense and duplication of testing.

The project uncovered a number of issues surrounding the use of various test method standards and building regulations that delayed or affected the outcome of the project. This was due to the fact that many of the tests and methods used were used for the first time,

therefore issues never envisaged by the Standards committees that developed the test methods in the first instance were experienced and had to be addressed before progress could be made.

A number of recommendations are been made including:

- Industry to assist in improving the relevant bushfire test method standards so that they can better cater for timber products;
- Investment be made to assist the timber industry in commercialising fire retardant timber products;
- Examine thinner samples for White Baltic pine in regard to their Early Fire Hazard indices; and
- Conduct research to better understand the affects of polyurethane adhesives on test results to meet BCA Specification C1.10.

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Introduction

The building regulations regarding fire are one of the principal barriers to increased sales of timber and wood based products in commercial and multi-residential buildings.

Timber and wood based products are predominately used in single family homes and more recently in low rise multi-residential timber-framed construction (MRTFC) due to their acceptance in building regulations through inclusion in deemed-to-satisfy solutions in the Building Code of Australia (BCA).

Timber used as structural components in commercial buildings is generally limited to a maximum of 2 storeys (except MRTFC) by the BCA's deemed-to-satisfy regulations. With the increase in the environmental awareness of building designers and specifiers, timber and wood based products are being requested in non-conforming deemed-to-satisfy applications in commercial building construction more than ever before.

The only road open for designers to use timber and wood based products in these applications is to have the design accepted through an "alternative solution" path. This path is generally disliked due to the extra costs, delays in approvals and difficult in gaining building insurance. In many instances "alternative solutions" are beyond the capabilities of designers and specifiers.

In addition to the above, and as a consequence of recent devastating bushfires, there has been a growth in restrictions placed on timber used in and around buildings.

The project aims to provide information for building designers, specifiers and regulators to either provide technical information required for building design, be the basis of alternative solution compliance or a foundation for regulatory changes.

As there are a number of areas that limit timber use in buildings the project is divided into sub-projects and these are:

- Applications of timber in bushfire-prone areas
- Fire Hazard Properties for Class 2 to 9 buildings
- Extension of Class 2 (MRTFC) concession to include Class 3 (resorts, hotels)
- Timber facades on Class 2 to 9 buildings

A further sub-project was added mid-way through the project to address the effect of timber veneers on fire retarded substrate, as the expertise and providers on this project had the appropriate skills to carry out this work.

Note that throughout this report the term timber is generally used to describe timber as well as wood-based building products.

Bushfire

Objective of the research sub-project

New bushfire test method Standards AS 1530.8.1 and AS 1530.8.2; *Methods for fire tests on building materials, components and structures - Tests on elements of construction for buildings exposed to simulated bushfire attack*, were published in 2007. These Standards allow systems that do not comply with deemed-to-satisfy solutions in *AS 3959-2009 Construction in bushfire-prone areas* to be verified as being bushfire resisting by subjecting specimen systems to simulated bushfire conditions.

As the bushfire test method Standards require testing full scale facades, the intention of this research work was to investigate as many timber building elements in the work program to gain as much acceptance of timber products as possible. Elements investigated included;

- Decking
- Cladding
- Fencing
- Posts and fascia
- Glazing frames

The extent to which the research sub-project objectives were achieved

Hardwood decking

The objective of this part of the sub-project was to add six additional timber species to the "bushfire resisting timber" range as defined in AS 3959. Six timber species were selected by surveying the timber industry Australian wide. This resulted in the selection of grey ironbark, karri, rose (flooded) gum, New England blackbutt, tallowwood and yellow stringybark. These species were carefully chosen because they represented the most readily available and likely to pass the test.

After extensive screening test process, including the inclusion of metal flashing over timber joists, and configuring of gaps at the walls interface, the program was unable to successfully obtain a pass for any of the decking species selected. The issue causing failure identified was the rise in the wall cavity temperature to a point beyond the test method's acceptability criteria.

Figure 1 Metal flashing above timber joists

It was initially thought that the contribution to the fire load from the combustible cladding used in the tests added to the total fire load causing the wall cavity temperature criteria to exceed the test method Standard's criteria limit. Exova Warringtonfire Aus, the fire testing agency, was disappointed with the outcome and subsequently conducted an additional test at their expense to see if the combustible cladding was a factor. This was achieved by investigating timber decking against a non-combustible wall cladding system, being fibre cement. A surprise consequence of this test was that the AS 3959 complying 7.5 mm fibre cement wall cladding also failed the test. An increase in wall cavity temperature above the criteria was also found to occur for this non-combustible cladding.

The conclusion was that there were two possibilities for this, the first being an issue with the criteria in the test method Standards' for temperature rise within the wall and the second being a genuine issue with these cladding products investigated. These two conclusions and the ramifications are discussed further in this report.

The end result of this was that it was not possible to pass with the current test criteria and consequently no hardwood decking species passed the tests.

Outcome
No additional hardwood decking species were added to the list of bushfire resisting timbers.

Timber clad external walls

Similar to the process for decking, a screening test process for timber species cladding was carried out. The timber species examined were again selected by an Australian wide timber industry survey. This process resulted in the selection of radiate pine plywood, western red cedar, yellow stringybark and karri timber cladding.

The objective of this investigation was not necessarily to pass the bushfire resisting timber criteria for Bushfire Attack Level (BAL) 29 but to find a BAL that these timber species would pass. For example, a pass for western red cedar at BAL 19 level would increase the market acceptance for this species. The idea of the screening process was to establish candidates for later proving tests.

Figure 2 Hardwood cladding after exposure to timber crib screen test

As found in the series of screening tests of decking timber species, the wall cavity temperature rise was also unacceptable for all cladding species. The reason was identified as the timber crib, which is set alight and used to model burning debris collection on a facade, dominated performance. The burning timber crib is placed near the wall cladding in a re-entrant corner of the facade. This placement results in quite a concentration of applied heat and consequently a large increase in temperature within the wall cavity near this burning timber crib.

This issue of wall cavity temperature rise was found to occur at all BAL radiation levels as the only difference between each BAL level test was the applied radiant heat load, i.e. the same timber crib was used at each BAL level. The timber crib used was found to be the dominated discriminator within the test, irrespective of the BAL applied radiation.

Consequently it did not depend on what BAL radiant heat being applied but whether a timber crib was used. The result of the screening process was that it was not possible to find a candidate timber cladding for the proving test at any BAL level (BAL 29, 19 or 12.5).

Outcome
No cladding species passed the tests for any BAL.

Eaves, fascia and gutter details

This part of the sub-project's aim was to improve the performance of pine fascia at BAL 29 by the use of guttering systems as a shield. This project investigated the use of steel and UPVC guttering on standard pine fascia at a BAL 29 level. The project also looked at the use of gutter guards as a way to manage the fuel build-up within guttering.

Gutters made from UPVC were found to fall away during the test, preventing analysis of the effect of the timber crib. As the fuel source is taken away from the fascia the chance of it being affected by the crib has been removed. Unfortunately the consequence of the early removal of the UPVC was to expose the pine fascia fully to the radiant heat load, preventing any positive conclusion.

Figure 3 PVC guttering used in fascia test

The testing showed that when the timber fascia was not directly exposed to a burning timber crib, that is for a system incorporating a steel gutter guard, the pine fascia can pass BAL 29 criteria. The system without a gutter guard, or with a UPVC gutter guard, would not pass the test for use in this BAL level.

Outcome
The outcome of this work supports the use of steel gutter guarded protected pine fascia to BAL 29 level. This information has been forward onto the Standards Australia FP-20 committee responsible for AS 3959 Construction in bushfire-prone areas standard.

Pine paling fencing

This part of the sub-project investigated the performance of pine fencing as a mechanism for fire spread. Two pine fencing configurations were investigated, a standard single paling fence and a lapped fence.

The research demonstrated that regardless of the type of fencing used, timber or steel, the neighbouring combustible material, that is, vegetation, planters, mulch, and so on, will promote fire spread, on the side of the fence.

The research also gave heat loads that can be used to develop fire engineered solutions suitable to withstand close proximity to timber fencing. The research showed that at BAL FZ the radiation intensity of the pine fence was 44 kW/m^2 for lapped fences and 32 kW/m^2 for a standard paling fence. At BAL 19 the radiation from the fences was greatly reduced, 2 kW/m^2 for lapped fences and 9 kW/m^2 for a standard paling fence.

The research showed that timber fences do provide a degree of shielding and that there is a time delay along the fence line to allow occupant’s intervention.

Outcome
As there is presently no restriction on the use of timber fencing in AS 3959 however as it is likely there will be in the future the work awaits the time when this may become an issue.

Minor features

The original research was to investigate what was the highest BAL that pine handrails and the like could be used externally. This work program was changed as a result of the publishing of the 2009 edition of AS3959, which adopted this early output and removed any controls on handrails greater than 125 m from an exterior wall.

Consequently any need to conduct further research work on handrails was not necessary and the available testing work program was transferred to investigate different construction methods for the base of pine posts as the solutions in the AS3959 2009. The inclusion of pine posts in the 2009 of edition of AS3959 had been strongly criticized by CSIRO. The work investigated standard pine post on stirrups as well as a 200 mm aluminium sleeve around its base.

The results showed that pine posts protected by the 200 mm aluminium sleeve out performed pine posts on stirrups.

Figure 4 Results from various post configurations being exposed to radiant heat and timber crib

Outcome
These results showed the use of aluminium sleeves around the base of pine posts would support their inclusion within AS 3959 to BAL 29.

Glazing elements

The purpose of this phase of research was to add to the knowledge base on timber window system's performance at BAL 29. The number of tests available could never fully deliver a comprehensive solution for windows, so this part of the sub-project was more about providing help for others to refine their individual window system work programs. It is envisaged that this will save industry time and money.

Two window systems were incorporated in two proving tests for other elements being investigated. Western red cedar frames with the AS 3959 BAL 29 complying 5.0 mm toughened glass were tested as this was the common solution most wanted by industry.

Figure 5 WRC window and hardwood deck facade test being exposed to radiant panel

The work showed that the ignition of the western red cedar window frame contribute to the failure of the toughened glass. It was concluded that for western red cedar to be used at BAL 29 the glazing needs to be either double glazed or the western red cedar needs to be rendered bushfire resisting in conformity to Appendix F of AS 3959.

Outcome
The work has demonstrated that for western red cedar to be used at BAL 29 the glazing needs to be double glazed or the western red cedar needs to be made bushfire-resisting by means of impregnation or coating with fire-retardant. . The latter solution would require the western red cedar to be tested to conformity to Appendix F of AS 3959.

Commercial implications of the results

Although difficulties where encountered with the test method there were a number of immediately useful results, these being;

- design details which significantly enhance timber decking bushfire resistance:
    - flashing on top of timber joists enhances timber decking bushfire resistance;
    - a larger gap between decking boards and the cladding
- pine fascia performed well under metal guttering and gutter guards;
- aluminium apron around pine posts is superior to metal stirrups; and
- a clear recommendation on the way forward for window frame manufacturers.

The findings of this sub-project have already helped industry in their own efforts to develop bushfire resisting systems. As well, where appropriate, relevant information has been transferred to the Construction In bushfire-prone areas Standards Committee and, as a result, some of these outputs have already found their way into AS 3959.

Difficulties encountered

As discussed above there were a number of difficulties encountered in this sub-project. The main difficulty was found in the bushfire test method Standard AS1530 8.1 where the heat and flame emitted by the burning timber crib used to simulate cumulated burning debris caused failure of all timber (and fibre-cement) at all BALs.

When investigating decking elements, the test method requires the construction of a full facade. When using a non-combustible wall cladding like fibre cement, the burning timber cribs, not the decking, caused the temperature rise within the wall cavity to be greater than the test method allows, resulting in an inability to pass the test. This failure occurred irrespective of the decking timber used and for all BAL exposure levels.

Likewise for the timber cladding tests, the heat and flame output from the timber crib, causing ignition of the timber cladding irrespective of the BAL level being investigated.

Exova Warringtonfire Aust at their own cost conducted additional tests and found that fibre cement cladding of all thicknesses up to 12 mm also failed the test.

This phenomenon also caused failures for the wood/plastic composite industry that was at the same time testing wood/plastic composite decking and they also were not able to obtain successful results.

These results caused a concern for the project steering committee as it had information that deemed-to-satisfy solutions within bushfire construction standard were not passing the bushfire test method Standards.

It is not known whether the test method is overly conservative or that there is a genuine issue with the performance of materials, including thermally thin material like fibre cement. Australia's development of Bushfire test methods is more advanced than any other country and consequently it is difficult to gauge the effectiveness of the test methods as there is no history or experience to draw from.

As a result of these tests, the project steering committee for this project felt obliged to pass this information onto the relevant Standards Australia committee *FP-20 Construction In Bushfire Prone Areas* as the issue could have life safety consequences. At the time of writing of this report this issue has been discussed at length by the members of FP-20. As a result they are presently asking thermally thin product manufacturers, i.e. metal, fibre cement and calcium silicate sheet manufacturers to share their results with the committee. The aim is to better understand if the issue is an overly conservative test method issue or actual underperforming building systems.

Recommendations for further research or actions

Presently there are two methods to assess the performance of timber systems for compliance with *AS 3959 Construction in bushfire-prone areas* to BAL 29, this being utilise the test method standard AS1530.8.1 or using the cone calorimeter method in Appendix F of the standard.

Both methods are not producing satisfactory results for timber and wood products. Since the cone calorimeter method in Appendix F of the bushfire standard has been in place for more than 12 years (since 1999), there has not been one manufacturer that has been able to develop a commercial product whilst it is known that many have tried. This highlights that there are issues with both tests methods and until there is resolution of this, industry will not be able to expand acceptable timber and wood products in bushfire-prone areas.

With the ever growing expansion of regions requiring construction to comply with AS 3959 the market share of timber in exterior applications in and around a building will be further eroded.

Serious attention is needed by the industry to ensure that there is a valid, appropriate life safety test method available to assess the performance of timber in simulated bushfire conditions. This will require further research to investigate appropriate crib sizes, distance from wall or alternative source such as gas flame. Support of the work through the standards development process is also needed to ensure a valid solution is included in the relevant building regulations.

List of scientific papers

Exova Warringtonfire Aus

2293100-PT04-2; Bushfire Research Report - Evaluation of cost effective forms of construction for buildings in bushfire prone areas

Fire Hazard Properties

Objective of the research sub-project

Fire Hazard properties requirements for timber and wood based products in commercial construction are not well understood or appreciated by the design community or timber industry. The Building Code of Australia requires coverings in buildings i.e. wall, floor and ceiling, other than single family houses to meet Specification C1.10a whilst the traditional Early Fire Hazard Properties (Specification C1.10) is required for all structural components used in commercial or medium density residential construction.

A great deal of work has already been carried out developing generic information for the use of timber for covering on floors, walls and ceilings in commercial buildings, but there remains many gaps in the available information.

The referenced test method requires each product to be individually tested in the configuration that it is to be used including species, combination of species, thickness, glues, profiles, joints, and so on. For the timber industry there are many thousands of configurations for timber building products that are or could be used in commercial buildings. Testing of each configuration is laborious and costly to individual companies.

This research sub-project aims to develop credible assessment that reducing the need to perform individual tests for thickness, glues, profiles, joints, etc. The benefit to the timber industry will be a reduced need to research each variables or redo testing when a change in the product's configuration occurs, reducing the expense for individual companies and the industry as a whole.

In addition, Early Fire Hazard Properties (Specification C1.10), used for limiting material use in all structural application in commercial buildings is also lacking. With the growth in understanding on fire hazard properties for coverings there is an increased demand for information on Early Fire Hazard Properties for structural products. There exists a data base of information on timber that was completed by the Timber Development Association NSW in the late 1970's, but this information is well out of date as it includes species no longer available.

The outputs of the research for this sub-project is an increased range of timber species data for Early Fire Hazard properties and an assessment of the affect of common variable and their affect on fire hazard properties.

The extent to which the research sub-project objectives were achieved

Early Fire Hazard Properties

Twenty seven timber species were tested and their properties are listed in Table 1 below.

Many months after receiving the results and test certificates the testing agency CSIRO reported that there were a number of errors in the calculation they made to assign the indices value. This caused the need to recalculate some of the timber species and in a number of cases completely re-test samples of some species to obtain results.

	Early Fire Hazard Property			
Species	Ignitability Index (0-20)	Spread-of-Flame Index (0-10)	Heat Evolved Index (0-10)	Smoke Developed Index (0-10)
Blackbutt	14	7	6	3
Brownbarrel	14	8	7	3
Karri	13	7	6	3
Flood Gum/Rose	14	8	8	3
Grey Box	13	4	4	3
New England Black Butt	14	10	9	4
Merbau	12	8	6	5
Hoop Pine	14	9	8	3
Ironbark – Grey	13	3	4	3
Ironbark – Red	13	5	4	3
Mahogany – Red	13	6	5	3
Mountain Grey Gum	13	5	4	3
Red Baltic	14	9	9	3
Red Bloodwood	13	8	7	3
River Red Gum	13	6	5	3
Rose Gum (plywood)	13	8	7	3
Shining Gum	13	8	8	4
Silvertop Ash	13	7	6	3
Silvertop Stringy Bark	13	6	5	3
Slash Pine	14	8	8	3
Slash Pine (plywood)	14	8	8	3
Spotted Gum (plywood)	13	8	7	3
Sydney Blue Gum	13	7	5	3
Turpentine	13	6	5	3
White Baltic (45 mm thick)	12	9	8	4
White Mahogany	13	0	4	3
Yellow Stringy Bark	13	7	6	3

One issue that was found during the test program was the Spread-of-Flame Index for 19 mm thick White Baltic pine had a value of 10. This value prevented its being used in commercial construction. 45 mm thick samples of this species were tested at another testing agency (AWTA) as confidence in CSIRO conducting the further work was undermined by errors noted previously. The result of the new testing showed 45 mm thick White Baltic pine achieved a Spread of Flame Index of 9, meeting building regulations minimum requirements.

It would be prudent to carry out further testing of 35 mm thick White Baltic pine as it is commonly used for structural purposes in this thickness.

Variables in Specification C1.10a

The intent of this research was to provide information on variables that may commonly occur for products used as wall, floor and ceiling linings required to meet Clause C1.10a of the BCA. Factors include thickness, profile, glues, joints, substrates, treatment, and a combination of species or material etc which influence the performance of timber products when tested in accordance to *AS/NZS 3837 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter* and *AS/ISO 9239.1 Reaction to fire tests to floorings Part 1: Determination of the burning behaviour using a radiant heat source*.

Both test method Standards require all products to be individually tested in the configuration in which it is to be used. The number of configurations or profiles that timber and wood products may occur in is extremely large and would be costly and laborious for industry to carry out each configuration or profile individually. To overcome this, an assessment approach was used considering the affect of the variable on a range of fire properties.

The first phase of this sub-project was to uncover common variables. As market trends influence the use of products in the marketplace a variety of timber merchants, saw millers and secondary product manufacturers were contacted to assess the then current products usage and variables. This ensured that not only specific gaps of the existing data were filled but also provided the timber industry with the appropriate certification needed for new products imported in high quantities.

The result of this survey the variables indicated to be assessed were;

- New species
    - American oak (10 mm)
    - American walnut (10 mm)
    - Burmese teak (10 mm)
    - New Guinea rose wood (10 mm)
- Thickness to a minimum of 9 mm
- Glue types, PVA, Resorcinol or Polyurethane
- Profiles
    - V-joint
    - Shiplap
    - Regency
- Preservative treatment.

A summary of the outcomes are any timber used as a ceiling or wall lining that meets the assessment may be;

- Minimum thickness of 9 mm
- May be constructed from various profiles
    - V-joint
    - Shiplap
    - Regency
    - Or any other profile having at least 5 mm thickness at discrete location across the profile
- Allowable glues; PVA or resorcinol
- Untreated or CCA treated timber

Polyurethane adhesive
The result of investigating polyurethane adhesive was not successful and consequently more work is required to understand why this is the case. One issue that may have affected the result was that the sample was not commercially manufactured. The application of adhesive may have been applied heavier than in a commercial manufacturing environment, affecting the results i.e. the polyurethane adhesive's fire hazard properties may have dominated the test. More research work is recommended in this area.

CCA Preservative Treatment
Only CCA preservative treatment was investigated as this was the only treatment that was generic in nature. Other treatments use formulations that are proprietary in nature and after consultation with various chemical companies that supply timber preservatives; it was concluded that it was not possible to describe these products in a generic way. Consequently no other preservatives were investigated.

Commercial implications of the results

The results of this work support the timber industry in the use of timber in commercial buildings. This research work has saved timber companies from conducting the same work individually and preventing repeating these test many times, lessening the expense to them.

The project researchers were also successful in having the Early Fire Hazard results included into the last amendment of AS1684 Residential timber-framed construction, Appendix H Timber Properties. AS1684 is a primary reference in the Building Code of Australia, therefore obtaining deemed-to-satisfy status. As discussed earlier some changes were reported by the testing agency CSIRO, after the inclusion of the certificated results. Standards Australia has been informed of the changes to this data.

The outcomes of the variables for Specification C1.10a work has now been consolidated into the one report titled *Exova Warringtonfire Aus 45982.6 - Assessment of timber veneer on medium density fibre board (MDF), fire retardant treated medium density fibre board (FR MDF) and particleboard substrate for use as wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a*. This is available for download on respective timber industry web sites.

Difficulties encountered

Early Fire Hazard Indices

Eight months after completing the testing and receiving certificates, CSIRO the agency conducting the testing work, advised that they made calculation errors in the results. CSIRO reviewed their results and advised of new early fire hazard properties for a number of the species. The reviewed data was more conservative than the original certificated results.

This caused as issue as the previous certificated results had been forward onto Standard Australia for inclusion into the species information in Appendix H in AS 1684 Residential timber-framed.

The project's researchers have formally advised the relevant Standards committee of the errors discovered by CSIRO and this is now in the hands of the committee to be amended.

CSIRO revised result reassessed 19 mm thick White Baltic pine at level that would prevent its use in commercial buildings. Consequently White Baltic Pine was tested at a thicker dimension (45 mm) and successfully passed. The thickness that passed the test does not cover all of the commercial thicknesses for White Baltic (35 mm for example) is commercially available in, and it recommended that more work is carried out in the area.

Specification C1.10a

An issue was uncovered in the use of polyurethane adhesive for veneers attached to MDF or particleboard substrates. The adhesive caused the veneer panel to obtain a Group Number 4 result, preventing its use in commercial buildings. The issue maybe more of a manufacturing issue, as the sample tested was not prepared in factory conditions.

Although this adhesive is not often used by the veneer industry, it is expected to grow with greater take-up of this adhesive. It is therefore recommended that this issue is investigated further.

Exploitation of the research results

The data generated for the Early Fire Hazard Indices has already been incorporated in to the Australian Standard AS1684 Parts 2 and 3 Appendix G. This document is primary reference document of the Building Codes of Australia.

The discussion on the variability of linings used in Specification C1.10a i.e. glues, joints, thickness and preservative treatment has been included in the consolidated report titled - *Exova Warringtonfire Aus 45982.6 - Assessment of timber veneer on medium density fibre board (MDF), fire retardant treated medium density fibre board (FR MDF) and particleboard substrate for use as wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a*. This is available for download on respective timber industry's web sites.

List of scientific papers

Early Fire Hazard Indices

AWTA

7-571470-CN; Test Report Baltic Pine

CSIRO Certificate of test:

FNE9353, FNE9354, FNE9355, FNE9356, FNE9357, FNE9358, FNE9359, FNE9360, FNE9361, FNE9362, FNE9363, FNE9364, FNE9365, FNE9366, FNE9367, FNE9368, FNE9369, FNE9370, FNE9371, FNE9372, FNE9373, FNE9374, FNE9375, FNE9376, FNE9377, FNE9378, FNE9379

Specification C1.10a

Exova Warringtonfire Aus

45980.4; Assessment of solid timber wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a

45981.4; Assessment of plywood used as a wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a

45982.5; Assessment of timber veneer on medium density fibre board (MDF) and particleboard substrate for use as wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a

RIR 45980.4; Regulatory Information Assessment Report - Assessment of solid timber, plywood and veneer board materials used as wall and ceiling lining with respect to the Building Code of Australia Specifications C1.10a

Extension of Class 2 concession to include Class 3 Buildings

Objective of the research sub-project

This sub-projects objective was to develop support information for the extension of the concession for Class 2 Buildings to also include Class 3 buildings. This concession is given in BCA Specification C1.1 Clause 3.10 and Clause 4.3 for Type A and Type B buildings and allows the use of combustible fire rated lightweight timber-framed construction.

Class 3 buildings (hotels and resort accommodation) deemed-to-satisfy solutions within the BCA are presently limited to two storeys only. The BCA already contains a concession for Class 2 buildings (apartments), which is known to the industry as MRTFC and allows timber framing up to three storeys or four if the first level is concrete. The aim of this sub-project is to provide the evidence that will support a proposal for change to the BCA to extend the current concession for Class 2 building to Class 3 buildings.

This sub-project continues two other pieces of work supported by the timber industry. The first was initially conducted under the Fire Code Reform Centre and the second was an extension of that work carried out in the early 2000s.

The second piece of work, a risk assessment undertaken by researchers at Victoria University, was funded by the industry but commissioned by the Australian Building Codes Board. The outcome of both these pieces of work did not adequately provide the information to support a building regulation change, creating more issues than they solved. However the second piece of work did clarify the key issue which is the basis for this sub-project, that is, does the timber framing in fire rated systems added significantly to the fire load?

A risk assessment (Verghese, et al., 2002) raised the possibility that combustible materials may increase the effective fire load and hence severity of a fire and therefore recommended that:

> *"If it determined that the (effective) fire load is not increased then the proposed concession be allowed in similar terms to those for Class 2 buildings"*

The risk assessment made no attempt to model or quantify the increase in fire severity due to the timber studs in the bounding wall and did not consider the protection of timber studs and framing by plasterboard or other fire protective linings but simply concluded that if the fire load in the room of fire origin is increased then there is an increased risk of fire spread.

Experiment Methodology

Based on the literature review and considering the recommendations from the Victoria University risk assessment, an experiment was developed which was designed to compare the severity of fires within a compartment constructed using a non-combustible fire rated steel framed system with non-combustible cavity insulation and an otherwise similar compartment constructed using fire rated timber construction with combustible insulation.

Two full scale experiments were designed and performed to investigate the contribution of timber studs protected by fire rated plasterboard to the severity of a compartment fire in a typical Class 3 building. The tests were undertaken by Exova Warringtonfire Aus at Victoria University's Fiskville facility.

Two room enclosures were constructed. One enclosure was constructed using a fire rated non-combustible steel stud and steel joist system with non-combustible insulation and is termed the “control” test. The other enclosure was constructed using a fire rated timber framed system with timber I-beam joists with combustible insulation. This type of construction, other than for the combustible insulation, is currently allowed for low rise and medium rise Class 2 buildings under the current concession.

Each fire room had the dimensions 4 m x 4 m x 2.4 m. An opening of 2 m width x 1.2 m height was located in the center of the front wall with the sill at a height of 0.5 m above the floor. Both enclosures were lined with fire rated plasterboard to achieve the same nominal FRL of 90/90/90. The FRL was achieved by lining the timber and steel studs with two layers of 13 mm fire rated plasterboard on either side of the studs for the walls and two layers of 16 mm on the underside of the ceiling joists. Particleboard flooring was placed above the floor joists. A diagram of the test setup is shown in Figure 6 and a photograph in Figure 7 below.

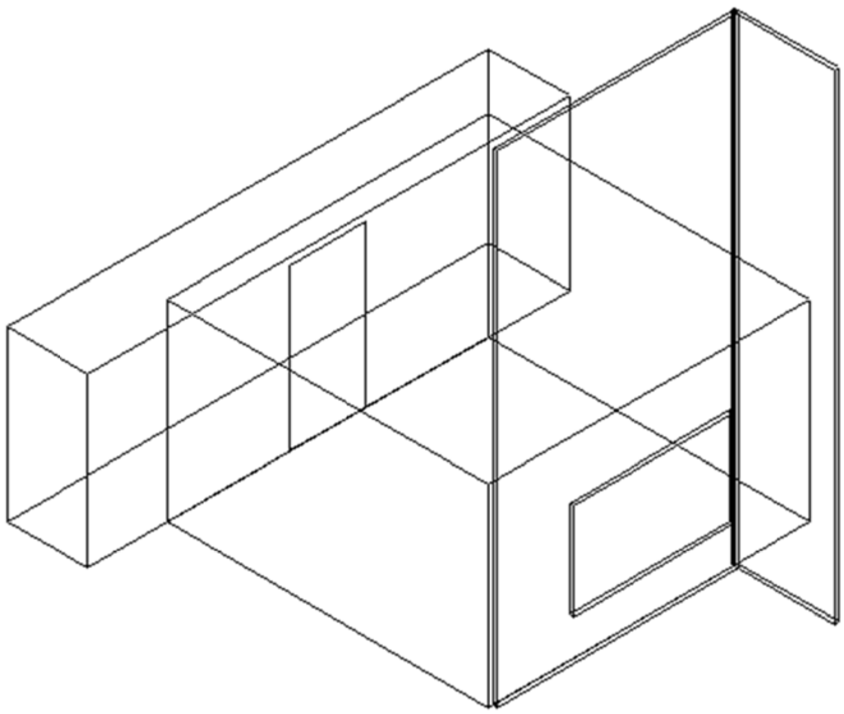

Figure 6 Diagram showing layout of test specimen

Figure 7 Completed Test Specimen with timber cribs in foreground

The fire load of 41 kg/m^2 (kg wood per m^2 floor area), was calculated for the compartment which equates to approximately 740 MJ/m^2. The fire load consisted of 16 timber cribs constructed from 40 mm x 40 mm radiata pine.

This high fire load of 41 kg/m^2 was considered conservative for the reasons that as the fire load increases the duration and / or severity of fire, and thus the likelihood that the building envelop would become involved in the fire, also increases. This fire load gives an estimated equivalent fire exposure of 61 minutes using the International Council for Research & Innovation in Building & Construction Working Commission 14 (CIB W14) calculation method. This exposure is consistent with the BCA's deemed-to-satisfy provisions for Class 2 and Class 3 buildings which require non-load-bearing construction bounding sole occupancy units to achieve an FRL of - /60/60 in Type A and Type B construction. The total mass of timber cribs in each experiment was 656 kg.

A protected steel 200UC59 column was located in the center of the room. The steel column was clad with one layer of 25 mm thick ceramic wool of nominal 96 kg/m^3 density. The temperature rise of the steel column was measured and this was considered the primary means of comparing the fire severity of the two compartment fires; however other measurements were also taken and these are described below.

As noted in the guide that forms the output to this sub-project; *Extension of the Concession which Allows Timber Framed Construction in Class 2 Buildings to Include Class 3 Buildings* that a number of fire load surveys have shown that the fire load tends to be less for Class 3 buildings compared to Class 2 buildings. The literature review found that the fire load in Class 3 buildings was generally half the fire load in Class 2 building which provides further comfort in extending the concession to apply to Class 3 buildings.

Figure 8– Photo of cribs in fire room. Steel column is visible in centre of room.

Instrumentation

A nominally evenly spaced array (3 x 3 x 3) of thermocouples was located in the fire room to measure the gas temperature. The heights of the thermocouples in the array were 0.6 m, 1.2 m and 1.8 m. The array was placed so as not to be immediately adjacent to a crib.

One wall of the room was instrumented. Five surface thermocouples were located on the unexposed face of the exposed plasterboard. Five surface thermocouples were located on the unexposed surface of the unexposed plasterboard and five thermocouples were located in the cavity of the wall, in the insulation, to measure gas temperature. The thermocouples were located at the center and at the quarter points.

Figure 9 Thermocouple array

The ceiling was instrumented with five surface thermocouples on the unexposed face of the plasterboard. These were located at the center and quarter points.

The protected steel column which was located in the center of the room was instrumented in accordance with AS 1530.4 at two transverse sections. There were four surface thermocouples at each section, as shown in Figure 10, located at 1 m and 2 m heights.

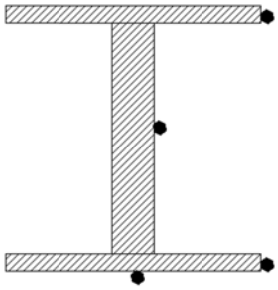

Figure 10 – Nominal steel column thermocouple locations

A timber noggin in one wall of the timber framed test was instrumented. A thermocouple was located at the interface of the stud and the fire resistant plasterboard. Thermocouples were located at depths of 3 mm, 6 mm, 9 mm and 12 mm in the timber stud at a height of 1.2 m.

Figure 11 Fire within room shortly after ignition

Pressure differential was measured between atmospheric pressure (at a location outside the fire room) and points towards a corner of the room at heights of 0.3 m and 2.1 m. The pressure tapping were orientated to minimize the affect of vertical fire induced flow by aligning them so that the openings were not in line with this flow.

The extent to which the research sub-project objectives were achieved

The experiment results showed that the severity of fires within the two compartments was comparable and that the timber studs in the bounding walls, timber joists and combustible insulation did not increase the fire severity. This conclusion was based on a number of key measurements, including gas temperatures in the compartment, non-fire side temperatures of the fire rated bounding walls and temperature rise of a protected steel column in the center of the room. None of these parameters indicated that the fire in the compartment constructed with timber studs, timber joists and combustible insulation was more severe than the fire in the compartment constructed with steel framing and non-combustible insulation.

Figure 12 Showing condition of studs post fire test

Based on the literature review, if volatiles from timber framing contribute to the fire load the maximum increase in fire load was estimated to be in the region of 4 % to 20 %. If the high level of a 20% increase in fire load is assumed the fire load for a Class 2 timber framed building would be expected to be approximately 60% of that of a Class 2 building of non-combustible framing and insulation construction.

The experimental study also showed that if the timber framed walls are lined with two layers of 13 mm thick fire grade plasterboard and ceilings with two layers of 16 mm thick fire grade plasterboard combustible insulation can also be included without increasing the fire severity.

Therefore it is concluded that the concession in the BCA deemed-to-satisfy provisions which allows the use of fire rated lightweight timber construction in Class 2 buildings could be extended to include Class 3 buildings without an increase in risk to life.

Commercial implications of the results

A successful expansion of Class 2 concession to include Class 3 buildings will expand the market for timber structural products. Presently Class 3 buildings greater than 2 storeys in height require the generation of an Alternative Solution, which is generally beyond the capabilities of all building projects other than major ones.

Class 3 building include building types such as hotels, motels and resorts. These building types are commonly low rise and in locations that are entirely suitable for standard timber-framed construction. Therefore the successful adoption of this project outcome will see greater markets opportunities for structural timber products.

Until the research outcomes are successfully adopted in the BCA as a deemed-to-comply solution the research findings can be used to support design professionals using the Alternative Solutions compliance path.

Difficulties encountered

No difficulties were encountered on this sub-project. The only issue encountered was that the steel framed control system tested underperformed but this may have been the result of a faulty instrument rather than any inherent weakness in steel frame system.

Exploitation of the research results

The paper reporting the test outcome will be used by the industry as evidence that non-compliant timber-framed construction does not contribute significantly to the fire load of a compartment. A “Proposal for Change” submission will be made to the Australian Building Codes Board for consideration of an amendment to the BCA. This activity is underway.

Until the building regulations are modified the research result will be made available for building professionals wishing to utilise the alternative solution approval process within the BCA.

List of scientific papers

Exova Warringtonfire Aus

Test Report

240440-RPT12-1; Extension of the Concession which Allows Timber Framed Construction in Class 2 Buildings to Include Class 3 Buildings

Guide

Extension of the Concession which Allows Timber Framed Construction in Class 2 Buildings to Include Class 3 Buildings

Timber Facades on Commercial Buildings

Objective of the research sub-project

The use of timber on the exterior of commercial buildings is growing; recent examples have been seen of major shopping centres, apartment buildings, sport stadiums and even high-rise buildings using plywood or timber cladding.

Combustible products are currently excluded from use in deemed-to-satisfy solutions within the BCA for any commercial building greater than one storey, the exception being Class 2 building up to and including 4 storeys high. The only regulatory path available for the inclusion of timber products other than this circumstance has been an “alternative solution” path. This path is generally cost prohibitive except for very large projects where fire engineers can be cost effectively employed.

This sub-project continues on from a previous research commissioned by FWPA’s predecessor the FWPRDC through the Fire Code Reform Centre (FCRC). The research was conducted and reported by BRANZ; Fire Performance of Exterior Claddings, 2000. The recommendation of this report, and of the FCRC, was that a test method be adopted to demonstrate the performance of combustible cladding. This recommendation remains unimplemented mainly because of the low priority placed on this by building regulators.

This sub-project aims to develop a guide for design professionals to incorporate timber facades on commercial building. It is to achieve this by setting out a procedure that can be used by design professionals and, if possible, provide sample tests on common timber cladding that illustrate the methodology.

The methodology used by this sub-project fell into four parts

1. Establish commonly used cladding and common commercial building types;
2. Develop a screen method for candidate timber cladding for use in full scale tests;
3. Conduct full scale facade tests;
4. Develop guide for use by design professionals.

Experiment methodology

Commonly used cladding and building types

A review of entries into the Australian Timber Design Awards over an eight year period which used timber and wood products externally that did not meet the deemed-to-satisfy requirements of the BCA was initially conducted.

Twenty-six examples were found with over half of the examples found being Class 9b public buildings such as schools and visitor/exhibition centres. The other examples were mainly Class 3 buildings such as hotels, lodges or resorts. A small proportion of projects found were Class 2 residential buildings. Single examples of an office and a shopping centre were also found.

Screen candidate timber cladding for use in full scale testing

This part of the sub-project involved developing an intermediate scale test method to screen cladding candidates for future full scale tests. This intermediate scale test method will also be the basis of methodology to screen other timber products in the future.

This was achieved by modifying *ISO 13785 Part One Reaction-to-fire tests for façades - Part 1: Intermediate-scale test* and introduce a more realistic and practical and cost effect fuel source being timber cribs and 10 kW/m^2 radiant panel heat flux to simulate fire spread from adjacent buildings.

Candidates Test

Two candidate timber products were selected. One being forest red gum and the other fire retardant treated pine cladding. The fire retardant pine cladding utilised fire retardants that were shown to meet the AS 3959 bushfire resisting timber requirements and was considered likely to be commercially available in the near future. The exact formulation is confidential commercial information.

Exova Warringtonfire Aus tests reports 2404401 and 2404402 document the screening test but unfortunately both products performed poorly. The fire retardant pine product did not perform as expected, causing the supplying company to revaluate their products commercial prospects.

Neither candidate was considered adequate to include into the full scale facade so a third candidate timber product was secured. This was fire retardant treated pine plywood that used the well established fire retardant product Fire-X®.

Figure 13 Intermediate test of fire retardant plywood without radiant heat load applied

Test Report 2404403 documents the test. Unfortunately again the cladding performed poorly. Exova Warringtonfire Aus at their own expense conducted the test again but this time without the radiant panel to see what the affect the radiant panel had. Again the result was unsatisfactory, see tests report 2404403a.

The outcome of this part of the project developed an intermediate test method that is available for use. This is titled Exova Warringtonfire Aus: Test Procedure for Combustible Facades (Intermediate Scale). Unfortunately for the project no timber cladding was considered adequate to promote as a candidate for the full scale test.

Full scale facade test

Two full scale facades where investigated and carried out in accordance with *ISO 13785 Part 2 Reaction-to-fire tests for façades - Part 2: Large-scale test* and *Exova Warringtonfire Aus: Test Procedure for Combustible Facades (Intermediate Scale).*

Each facade was attached to the Extension of Class 2 concession to include Class 3 Buildings room test. Refer to Figure 14 below.

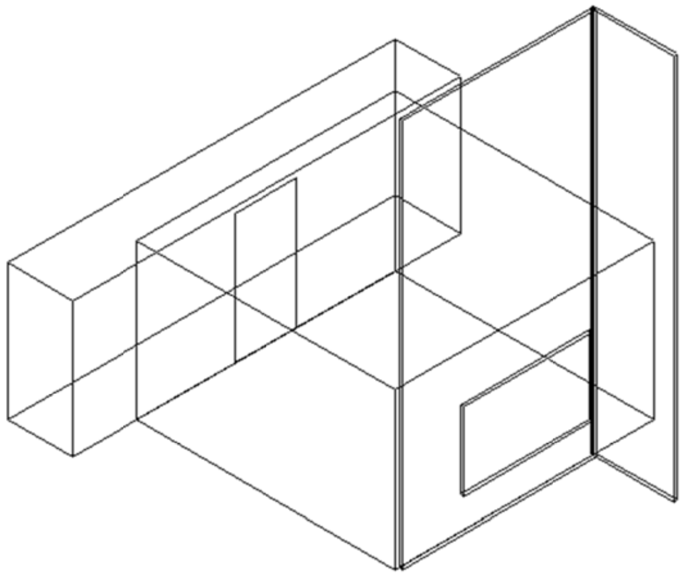

Figure 14 Diagram of facade test

Due to not having a suitable candidate timber cladding the facade test went ahead using a fibre cement cladding but with the facade fully instrumented to measure temperature profile over the facade. The purpose of this was the guide develop will allow a correlation of performance between the intermediate test results and the temperature measured on the full scale.

Two facade option were examined, one being a completely flat facade the other having a 600 mm projection over the window.

Figure 15 Flames coming out of room and wrapping around 600 mm projection

The outcome of the test clearly demonstrated a temperature difference at different locations of the facade, between the flat facade and the facade containing a projection, referred to in the report as a baloney.

Outcomes of the two tests are found in Exova Warringtonfire Aus report 240440-RPT23. The reduced temperature affect on the wall by the 600 mm projection can clearly be seen with the sudden increase in temperature rise that occurred for the "Balcony Test" at the 40 minute mark. The increase in temperature is due to the 600 mm projection being taken away at this time, resulting the temperature then matching the "Control Test".

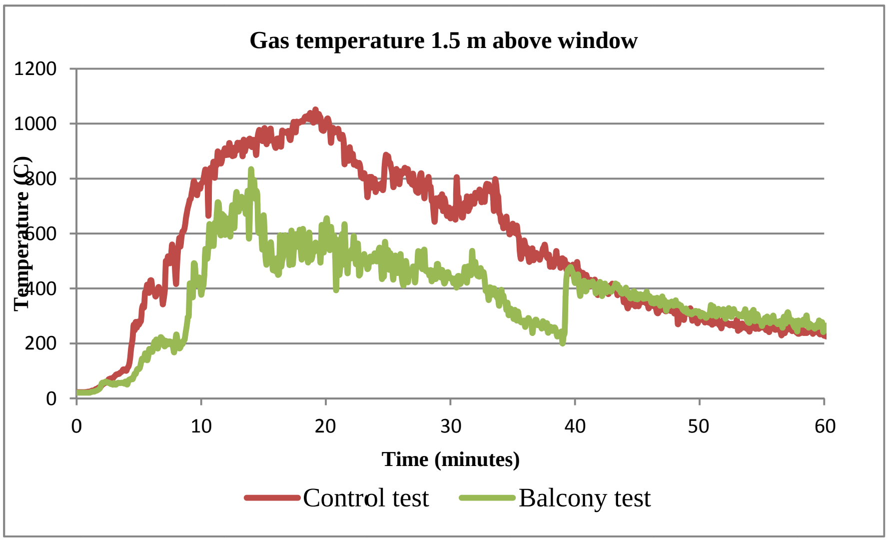

Figure 16 Comparing the temperature with and without the projection on the facade, at 1.5 m above opening

The extent to which the research sub-project objectives were achieved

Combustible facade guide

A guideline was produced that provides methods, data and references which may be used by a Fire Safety Engineer while analysing a trial fire safety design that comprises of combustible external wall cladding. The title of this guide is Fire Safety Engineering Design of Combustible Façades.

Commercial implications of the results

The end result of this sub-project was a documented procedure to justify the inclusion of a combustible facade onto a commercial building.

Exova Warringtonfire Aus's Fire Safety Engineering Design of Combustible Façades provides advice to fire engineers on analysing the system's performance in relation to vertical fire spread within a building and fire spread to and from adjacent buildings.

The procedure uses an intermediate test procedure, titled Exova Warringtonfire Aus's Test Procedure for Combustible Facades (Intermediate Scale) to evaluate the performance of timber for application on combustible external wall systems (façades).

The Fire Safety Engineering Design guide ties the Intermediate Test procedure to the results of the full scale facade allowing an engineered solution to be developed. The intermediate test method also allows the industry to examine new product or formulations and compare then back to this test, removing the need to conduct a full scale tests.

Therefore, there is now a cost effective methodology for design professional and/or industry to incorporate timber cladding onto commercial buildings. With time and a number of successful uses of this methodology this procedure could become the basis of a solution within building regulations.

Difficulties encountered

The main difficulty encountered on this sub-project was there was no timber cladding suitable for the full scale test.

From overseas experience and the expectation of researchers it was expected that a fire retardant wood product would easily meet the intermediate test method developed. Natural timber, even high density hardwood, was not expected to easily qualify but fire retardant treated pine was. Two fire retardants products were investigated, one a new commercial in confidence product and the other a product that has been in use for many years. No fire retardant treated timber product investigated was considered adequate.

The aim of the fire retardant was to use products that could have dual purpose and be acceptable under the bushfire resisting timber definition in *AS3959 Construction of buildings in bushfire-prone areas* as well as adequate for a commercial facade. Unfortunately no candidate timber product was suitable. In addition to this, as noted above in other sub-projects, the fire retardant requirement in AS3959 has been in place since 1999, and to this day there has been no timber product that is commercially available. This highlights that the industry is struggling to develop fire retardant treated timber products.

Exploitation of the research results

The guide and intermediate test method will be made available through industry web sites. TDA is also conducting a new project on encouraging fire engineered alternative solutions using timber to assist designers. This guide and the intermediate test method will be one of the tools used in this project.

List of scientific papers

Exova Warringtonfire Aus

Intermediate Tests

240440-RPT02-0; Exterior Combustible Cladding on Commercial Buildings and Extension of the MRTFC concession to include Class 3 Buildings – Experimental Specification

2404401.2; Fire Spread test of an external wall system comprising of hardwood weatherboard external facade and plasterboard protected timber frame

2404402.2; Fire Spread test of an external wall system comprising of a fire retardant treated timber weatherboard external facade and plasterboard protected timber frame

2404403.2; Fire Spread test of an external wall system comprising of Fire-X fire retardant treated plywood lined facade with radiant panel exposure.

2404403a.2; Fire Spread test of an external wall system comprising of Fire-X fire retardant treated plywood lined facade without radiant panel exposure.

2404400-RPT22-0; Exterior Combustible Cladding on Commercial Buildings – Intermediate Scale Test Results and Recommendations

Full Scale Tests

240440-RPT23-1; Exterior Combustible Cladding on Commercial Buildings - Report on Full Scale Test Results

Guides

Test Procedure for Combustible Facades (Intermediate Scale)

Fire Safety Engineering Design of Combustible Façades

Affect of Wood Veneers on Fire Retardant MDF Substrate

Objective of the research sub-project

At the request of the decorative wood veneer industry and FWPA the original research program was expanded to include an assessment of the impact of thin wood veneer on fire retarded MDF substrate. The objective of the research is to provide evidence that the inclusion of any thin veneer onto a fire retarded substrate is dominated by the substrate not the veneer. This will allow veneer manufacturers to change veneer without the need to conduct test on each new veneer species.

The reason the variation was assigned to this project was because Sub-Project 2 on Fire Hazard Properties was very similar work, using the same testing agencies and the final regulatory report could be consolidated into the one report for all wall and ceiling linings used by building professionals.

The sub-project research aimed at establishing data on thin veneers on fire retarded substrate to allow a generic assessment to be made.

Research results and benefits

The research, considered simple at the start, struggled with a range of issues challenging the basis of building regulations and test methods. The following steps were required to arrive at a final positive outcome.

Phase one

This phase of the work required cone calorimeter testing and related assessment work to establish the materials group number. A series of veneers were tested on the 6 mm fire retarded MDF, using veneer that represented wood that were considered to be poor performing. In addition four veneer species that had densities below 500 kg/m^3 were tested individually as previous work showed that these veneers affected the fire performance of the combined system.

This work was completed however the results were unsatisfactory. It was found that the veneer and 6.0 mm fire retarded MDF combination only achieved a Group 3 result, the same result expect without a fire retarded substrate being used.

The results where mystifying and to assist the understanding if a fire retarded MDF was used in the first instance, a sample substrate without the veneer attached was tested and it was also found to only achieve Group 3, contrary to the expectation of Group 1.

This result indicated that the base fire retardant MDF was deficient in some way. To assess this further another 6.0 mm MDF sample from a different batch without a veneer was tested and this product performed as expected, Group Number 1.

To save costs and as there was nothing positive to report, no formal reports were completed.

Phase Two

The unsatisfactory results found in the previous phase prompted further research.

A new 6.0 mm fire retarded MDF substrate was found and a similar testing program described above was implemented. A non-veneered 6.0 mm fire retarded MDF (control) was tested initially and in isolation of the other programmed test samples to see if the fire retarded MDF on its own conclude achieve Group 1 or 2. The non-veneered 6.0 mm fire retarded MDF was shown to have likely performance of Group 1 or 2.

A full testing program was conducted but unfortunately the subsequent results showed that a thin veneer on the 6.0 mm fire retarded MDF board showed that it would only be able to be rated a Group 3 material, again a disappointing result. No explanation for the poor result could be found at this stage of the work program.

Phase Three

Although there had been disappointment on 6.0 mm fire retarded MDF board some veneer manufacturers have had seen success on 12.0 mm fire retarded MDF on individual veneer species. The reason for this is not known as this area of fire research is unpredictable but it is thought that the 6.0 mm fire retarded MDF is not thermally thick enough or does not have enough fire retardant in its depth to overcome the effect of the thin veneer initial ignition. The thicker MDF is thought to be thermally thicker and able to mobilise more fire retardant when required, but this premise remains untested.

Therefore a third round of testing was conducted. As in Phase Two a control was tested independently of any veneer attached first. The test on the base substrate yielded a Group Number 3, not the hoped Group 1 or 2. Consequently any further testing was abandoned immediately. As per Phase One, no formal reports were issued.

An investigation was carried out to find why results were getting worse, when in theory the response should be getting better. It was also frustrating that independent veneer companies own research had obtained satisfactory results on individual veneer species, obtaining Group 2 or better, whilst this testing program could not.

The problem was found to lie in the testing agencies interpretation of test Standard. During the period of research testing agencies who conduct Cone Calorimeter work, the apparatus used in this assessment, agreed to change the interpretation of the clause which specifies the end point of testing. This change resulted in a more conservative approach, where the apparatus was left on for a longer period of time, accumulating energy that affected the assignment of the Group Number.

Previously it was interpreted that if there was smoke but no flaming occurred after a set period of time the cone calorimeter test ceased. This new interpretation saw the test not stop when smoke was seen but continue on for the complete time period. The increased time in exposing the sample to the cone calorimeter saw greater accumulated data. When the calculations were carried out in correlating the cone test data, this great amount of exposure pushed a potentially Group Number 1 material into the lower Group Number 3.

Other reasons given where that the threshold separating Group Number 1 and Group Number 3 is much closer together than the group number might indicate. So for example Fire Retardant (FR) treated timber falls usually within a reported ±2% of the threshold between Group Number 1 and 3. With a cone calorimeter test there seems hardly any chance timber will fall into Group 2.

This may point to an error in the basis of the regulations as Group 2 material was always intended to be for products such as fire retardant treated timber.

Therefore this sub-project, initially intended to be a minor variation to projects activities, raised fundamental issues that could not be resolved within the project scope. It revealed a fundamental disparity between the regulations intent and the test method and interpretation. As the project had no resources to resolve regulatory and test method issues, the testing agency Exova Warringtonfire Aus suggested that the alternative approach be utilised, this being conducting a full scale ISO room test, the actual test method used in building regulation. ISO room tests are not readily used or available in this country as they are expensive.

Phase Four

A further variation to this project was sought to test a 12 mm fire retardant MDF with veneer attached in another testing configuration and *AS ISO 9705-2003 Fire tests - Full-scale room test for surface products*, known as the ISO room test. As established above the cone calorimeter test methodology (AS/NZS 3837:1998) is an allowed solution by the BCA to establish a material's Group Number via a correlation between the Cone Calorimeter and the ISO room. The actual test referred to in the BCA to establish a Group Number is the ISO room.

Again the same approach as establish in the previous phases was taken being explore the lower bound performing thin veneer on the fire retarded MDF substrate. In this case two species were identified as candidates being radiata pine and western red cedar. As western red cedar is the lowest know density veneer species used and that it did not previous meet the required Early Fire Hazard Properties, it was the preferred choice as a thin veneer.

The test required the lining of a 3.0 m x 3.0 m room, walls and ceiling and assessing the performance when a gas burner is ignited in the room corner.

The test was successfully conducted giving a Group Number 2 performance. From this test an assessment report was able to be produced that allows the use of any veneer on this fire retarded MDF substrate. Refer Exova Warringtonfire Aus report 45982.5.

Figure 17 ISO room test - western red cedar linings

The extent to which the research sub-project objectives were achieved

After four attempts at obtaining a result, the original aim of the work was finally achieved. It is now possible to obtain a Group Number 2 with any veneer on 12 mm fire retarded MDF.

Research results and benefits

This sub-project was able to establish that the inclusion of a thin timber veneer did not dominate the performance of the substrate so that once the substrate Group Number is established then any veneer species can be added without affecting the Group Number. The only limiting aspect is that PVA or resorcinol glues can be used and the veneer is to have a density of 350 kg/m^3 or better.

Commercial implications of the results

The results will allow veneer manufacturers to achieve a Group Number 2 assessment of thin veneer on 12 mm thick fire retarded MDF with any timber veneer of density of 350 $kg/m^{3,}$ provided PVA or resorcinol glues are used. This removes the need of industry to conduct individual cone tests for every species or combination of species used by the industry as it was shown above to be problematic.

For manufacturers wishing to use other fire retarded substrate, they now only have to establish that the substrate performance is the same or better than the fire retarded MDF used in the test program. The result will save the industry much expense as they no longer need to conduct tests for every species they may have, but just investigate the performance of the substrate.

Difficulties encountered

This sub-project encountered many difficulties in carrying out the research. The fact that four separate phases were required to finally obtain a positive result is an indication of the difficulties that this sub-project encountered. At times the project was exploring unknown territory that was either at the limit or sometimes beyond both the resources and knowledge of the testing agencies.

The project highlighted issue with the cone calorimeters, the preferred test method, interpretation issue by testing agencies, problems with the correlation of the cone calorimeter to the ISO room and issues with the building regulation itself. Some of these issues, through the relevant testing agencies, have been forwarded to the FP-018 the Standards Australia committee responsible for the fire test standard for consideration.

All these difficulties much delayed the progress of this sub-project as the issues first needed to be resolved before progress could be made.

Exploitation of the research results

This sub-project came about by a request to FWPA by the Decorative Wood Veneer Association. This association has been a partner to this sub-project, both by supplying materials as well as a financial contribution. This association will receive the assessment and will make it available to its members and interested parties. This activity will see the exploitation of the results and this sector will receive the benefits of this work.

List of scientific papers

Bodycote Warrington Fire

Various Cone Calorimeter Test reports

231200b.cc.rep 1, 231200c.cc.rep 1, 231200c.bca.rep 1, 231200d.cc.rep 1, 231200d.bca.rep 1, 231200e.cc.rep 1, 231200e.bca.rep 1, 231200f.cc.rep 1, 231200f.bca.rep 1, 231200g.cc.rep 1, 231200g.bca.rep 1,

BRANZ

Various Cone Calorimeter Test reports

FH4384, FH4385, FH4386, FH4387, FH4388, FH4389, FH4390, FH4391, FH4392, FH4393, FH4394,

Exova Warringtonfire Aus

45980.4; Assessment of solid timber wall and ceiling linings with respect to the Building Code of Australia Specification C1.10a

45981.4; Assessment of Plywood for use as wall and ceiling linings with respect to the Building Code of Australia Specification C1.10a

45982.5; Assessment of Timber Veneers on Medium density fibreboard (MDF), fire retardant treated Medium density fibreboard (FR MDF) and particleboard substrates for use as wall and ceiling linings with respect to the requirements of the Building Code of Australia Specification C1.10a

RIR45980.4; Regulatory Information Assessment Report - Assessment of solid timber, plywood and veneered board material used as wall and ceiling linings with respect to the Building Code of Australia Specification C1.10a

Fire Test Report Data Base

Objective of the research sub-project

In the last 15 years, there has been many fire tests and data accumulated by the industry to change building regulations or to support the use of timber products. Many of these reports are not readily known or accessible to the timber industry.

This sub-project aimed to consolidated and make available, where practical, a list of available fire test results or assessments. The target audience for direct benefit was the timber industry but also fire engineers and testing agencies.

Research results and benefits

The output of this work is an excel spread sheet that is available in two parts. The first is a list of publicly available reports and assessments whilst a second part is a protected database of reports and assessments that could confuse users or conflict with public access reports as they are preliminary investigations.

A spread sheet can be used as the basis for a substantial section on the WoodSolutions web site. As this website was still in development at the completion of this project, a web based database was not possible.

Typical reports are cone calorimeter, floor radiant a panel, facade test, bushfire test and assessments, MRTFC, and Early Fire Hazard properties. The data is available in timber species as well in building applications.

The extent to which the research sub-project objectives were achieved

The development of the data base has met all expectations.

Commercial implications of the results

There is no commercial implication of the results.

Difficulties encountered

In developing the database it became obvious that some earlier reports are not in a form to be made publicly available. These reports may have assisted in development of the final solution but looked at in isolation may confuse users or be misused.

An example of this is the four phases of work required to find a successful outcome for thin veneer on fire retarded MDF. The final ISO room result, which was positive and met the intent and the requirements of the building regulations, may be clouded by previous work conducted on the Cone Calorimeter. This is because approval agencies prefer the cone calorimeter results instead of the ISO results as these are more common.

To prevent confusion, two databases where developed, one a general public version the other requiring permission before access.

Discussion

The principal barriers to increased sales of timber and wood based products in commercial and multi-residential buildings are the deemed-to-satisfy limitations that the BCA places on timber and wood products.

This research project investigated a number of issues that were seen as major limiting factors for increase market opportunity for timber and wood products. The areas of investigation included;

- Applications of timber in bushfire-prone areas;
- Fire Hazard Properties for Class 2 to 9 buildings;
- Extension of Class 2 (MRTFC) concession to include Class 3 (resorts, hotels);
- Timber facades on Class 2 to 9 buildings; and
- Effects of thin veneers on fire retardant MDF substrate.

Each component of the project investigated timber and wood products performance under particular fire conditions and applications. Each area investigated had to deal with a different set performance criteria including test methods. Each area of work therefore had their own set of issues and challenges to be overcome as a number of the areas investigated were using test methods never used before e.g. ISO room, bushfire test methods, facade test.

At times issues occurred that were at the heart of the test method standard or building regulation that was used to regulate the subject. The project needed to deal with issues and unfortunately for solutions for bushfire testing, these issues could not be resolved i.e. the failure of the fibre cement wall in the bushfire test prevented a successful outcome for any timber decking species.

For more detailed discussion of each sub-project's issues and outcomes refer to each sub-project area. The following is discussion on global issues resulting from the testing program.

Fire retardant treated wood products

Three sub-projects relied on the use of chemical treatment to enhance fire performance of timber or wood based products. All three sub-projects had difficult in the use of fire retardant treated timber as the use of these products is not well understood by the timber industry or are not readily available.

With the increased restrictions on fire performance of materials used in bushfire-prone areas and efforts by timber industry to capture an increased share of the commercial facades markets there will be an increased reliance on fire retardant products. The project looked at the bushfire construction Standard AS 3959 as a basis for a fire retardant product used interior condition as it was commonsense to have the one product performance used in the market place for many applications and hence, to reduce stock holding.

This project has found that the industry is having trouble in developing products in this area to satisfy this performance. The test method in AS 3959 has been included the Standard since 1999 and to this day no timber or chemical supply company has successfully commercialised a timber fire retardant product. During this period of time many timber and chemical companies have tried but failed to commercialise the product. There have been a number of successful attempts in finding products that work within the laboratory but the actual commercialisation of products seems to be beyond the industry.

The lack of fire retarded pine products is especially worrying as the recent amendments to AS 3959 will see an increased demand for bushfire resisting products. This is due to the 2009 edition of the Standard now covering more regions in Australia than it previously did as well as the inclusion of grassland vegetation. The end result will be a dramatic increase in the number of buildings and structures considered to be in bushfire-prone areas, and therefore an increase in the market looking for bushfire resisting timbers.

This project has demonstrated that assistance is required for the industry in either processes to commercialise the fire retardant treated timber products or investigate and change the test methods as they may overly conservative or both.

Bushfire products test method

Timber products performance in bushfire construction has two means of demonstrating compliance as being considered bushfire resisting. The first is to use Appendix F within AS 3959 utilising a cone calorimeter test. The alternative method is to use the test method standards AS1530 8.1 or AS1530 8.2 and conduct a full scale test on sample facades which incorporate the timber product undergoing testing.

The project found that timber products did not pass either test method The cone calorimeter test was found to be very inconsistent at the 25 kW/m^2 level and the full scale test method AS1530 8.1 did not result in passing any tested timber products as the burning timber crib caused unacceptable temperature rise in the facade cavity.

Timber manufactures wishing to develop bushfire resisting products have no avenue to successfully test new products as a pass is unlikely through any of the test methods available. The discussion included within the bushfire sub-project section explains that there are reasons for these difficulties but these difficulties remain.

As these test methods are the only ways to demonstrate performance the industry should invest in ensuring that the test methods are able to pass timber and wood products whilst ensuring that they demonstrate the appropriate life safety performance the test methods are intended to simulate.

Conclusions

The principal barriers to increased sales of timber and wood based products in commercial and multi-residential buildings are the deemed-to-satisfy fire performance limitations that the Building Code of Australia places on timber and wood products.

This research project investigated a number of these issues that were seen as the foremost limiting factors for increase market opportunities for timber and wood products. The areas of investigation included;

- Applications of timber in bush fire prone areas;
- Fire Hazard Properties for Class 2 to 9 buildings;
- Extension of Class 2 (MRTFC) timber concession to include Class 3 (resorts, hotels);
- Timber facades on Class 2 to 9 buildings; and
- Effects of thin veneers on fire retardant MDF substrate

The project generally added to the knowledge base of timber and wood product performance in various fire conditions occurring in building regulations. The project was able to;

- Add data and information on the fire performance of timber in bushfire construction. However it was not able to advance the use of timber because of issues relating to the test method Standard that could not be overcome;

- Expand the generally fire hazard properties data base for timber and wood product required for commercial building application, as well as show that common configuration, profiles and preservative treatments did not affect the fire hazard properties;

- Demonstrate that fire rated timber framed construction performed equally to non-combustible construction and that the timber framing used to support the fire rated linings do not significantly contribute to the overall fire load;

- Develop a methodology to demonstrate how a non-complying timber cladding can be used on commercial building. The work included the development of a fire engineering guide and industry intermediate test method standard that can be used to demonstrate compliance to building regulations; and

- Successfully demonstrate that the attachment of a thin veneer did not significantly alter the Group Number obtained for the substrate.

All in all, the project has made an enormous step in the knowledge surround fire resistance in buildings that can assist the timber industry in providing products into a market that they are either previously restricted or prevented from supplying.

The project has also assisted the industry by removing the need for individual companies to conduct these tests or source the date themselves, saving much expense and duplication of testing.

The project uncovered a number of issue surrounding the use of various test method standards and building regulations that delayed or affect the outcome of the project. This was due to many of the tests and methods used were used for the first time, therefore issues never envisaged by the Standards committees that developed the test methods in the first instance were experienced and had to be addressed before progress could be made.

A number of recommendations are made these include:

- Industry to assist in improving the relevant bushfire test method standards so that they can better cater for timber and wood products;
- Investment be made to assist the timber industry to commercialising fire retardant timber products;
- Examine thinner samples for White Baltic pine in regard to their Early Fire Hazard indices;
- Conduct research to better understand the affects of polyurethane adhesive affects on test results to meet BCA Specification C1.10.

References

Australian Standard

1530.4 Methods for fire tests on building materials, components and structures - Fire-resistance test of elements of construction

1530.8.1 Tests on elements of construction for building exposed to simulated bushfire attack – Radiant heat and small flaming source

1530.8.2 Tests on elements of construction for building exposed to simulated bushfire attack – Large flaming source

1684 Residential Timber-Framed Construction

3959 Construction in Bushfire Prone Area

AS/NZS 3837 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter and

AS/ISO 9239.1 Reaction to fire tests to floorings Part 1: Determination of the burning behaviour using a radiant heat source.

AS/ ISO 9705 Fire tests - Full-scale room test for surface products

BRANZ

Fire Performance of Exterior Claddings, 2000

International Standards Organisation

ISO 13785 Part 1 Reaction-to-fire tests for façades - Part 1: Intermediate-scale test

ISO 13785 Part 2 Reaction-to-fire tests for façades - Part 2: Large-scale test

Acknowledgements

The timber Development association would like to acknowledge the following organisation that assisted in the research project. Without their help and support the result from this project would not be possible.

Timber samples

We would like to thank the following companies for their assistance in source, supplying and delivering timber sample for the various sub-project. Companies include

Australian Solar Timber
Austral Plywood
Big River Timber
Boral Timber
Blue Ridge Hardwoods
CWC carpenters
Decorative Wood Veneer Association
Harper Timber
Hurford Hardwoods
Hyne Timber
J Notaras and Sons
Sharp Plywood
Worthington Industries

Fire testing agency

We would like to particularly thank Exova Warringtonfire Aus who assisted in the numerous technical issues this project generated. Their ability and willingness to work through issues, suggest solutions and strategies distinguish them from other agencies in this area.

Exova Warringtonfire Aus assisted in many ways but it was particularly noted that they were willing to conduct additional tests at no charge or test at a subsidised rate to see through a particular issue or problem. Without the additional assistance progress on many of the issues addressed above would not have been possible.

Steering committee

Many thanks are also given to the steering committee assisting in conducting this project as without their support, cooperation and guidance a successful outcome would not have been possible.

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