Hybrid timber buildings
An approvals perspective

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Auckland Council

Hybrid Building Seminar
Timber Unlimited
New Zealand Timber Design Society

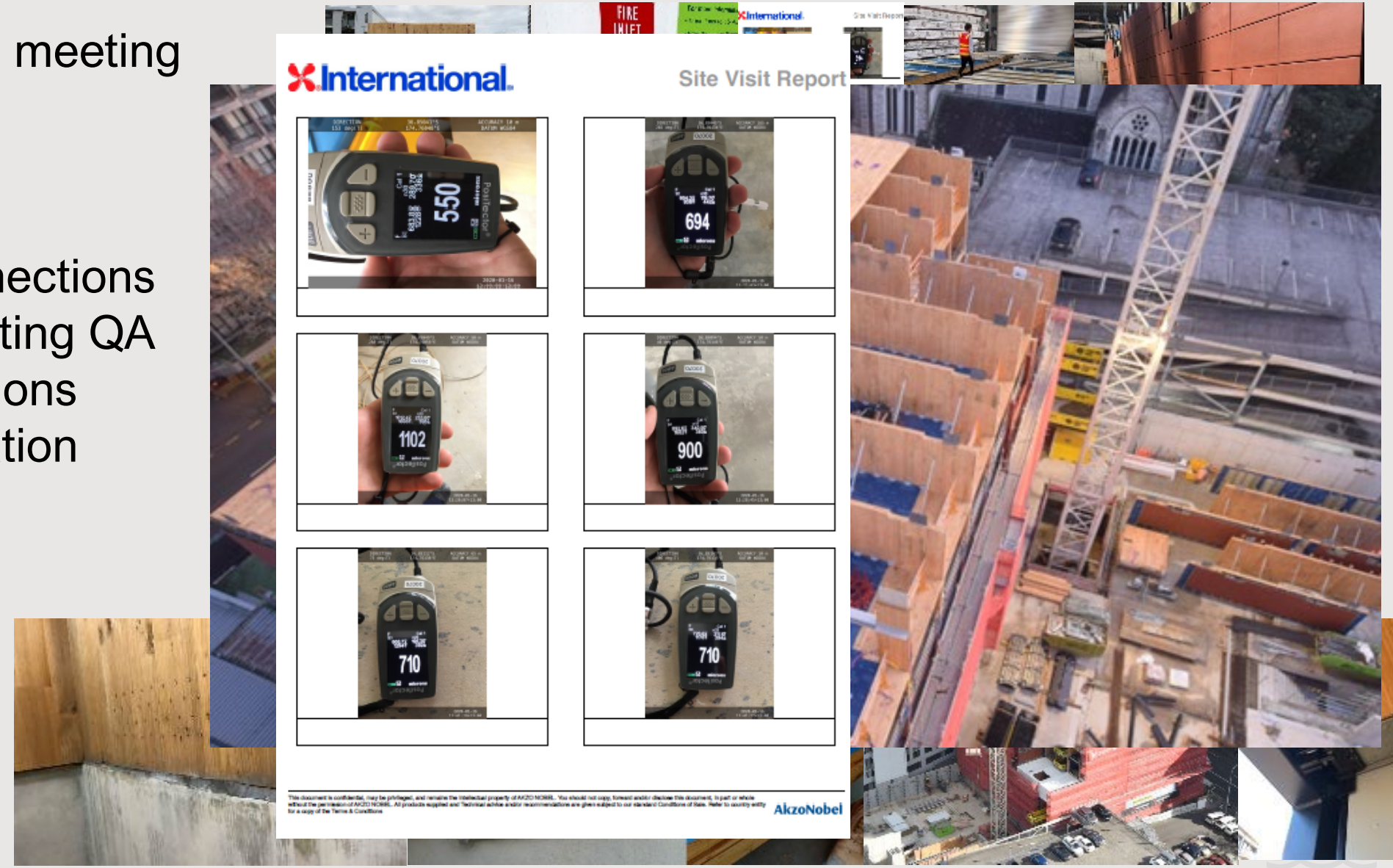
Consenting

B1 Structure, B2 Durability, C1-6 Fire Safety, F3 Hazardous substances and processes.

- SED and peer reviews
- Treatment
- Fire design
- Deflection / shrinkage
- Exposed timber surfaces
- Intumescent design
- Passive fire stopping

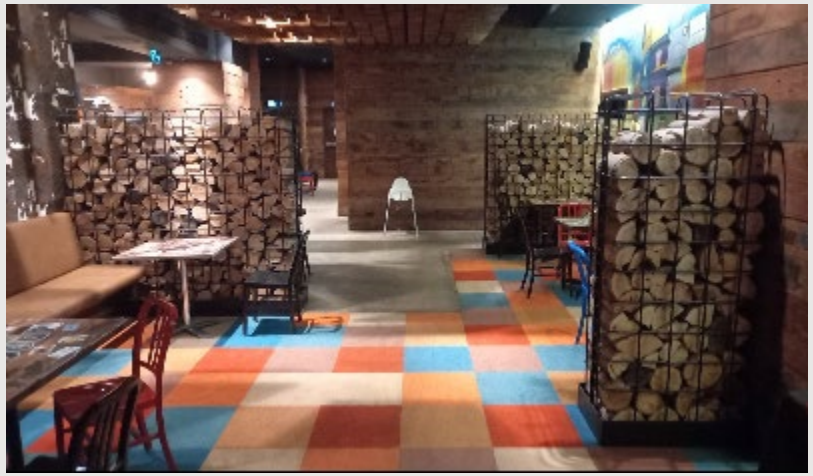
Construction compliance

- Pre-construction meeting
- Off-site / On-site
- QA process
- Fire safety
- Fixings and connections
- Intumescent coating QA
- Changes / variations
- CCC documentation



A few learnings

- Moisture control
- Splits and gaps
- Intumescent coatings
- QA auditing
- Onsite QC



Legislation

1854

Province of Auckland.

AUCKLAND BUILDING ACT.

SCHEDULE C.

Every wall of a building, including chimney stacks and fire-places, must be built of sound brick or stone, laid in mortar and cement, in such manner as to produce solid work.

1946

POST-WAR BUILDING STUDIES
NO. 20

FIRE GRADING OF BUILDINGS

PART I
GENERAL PRINCIPLES
AND STRUCTURAL PRECAUTIONS

USE OF COMBUSTIBLE MATERIALS

59. Although a relatively high standard of fire resistance may be obtained with certain combustible elements of structure by taking special precautions, their incorporation in buildings of Types 1–3 construction would defeat the object aimed at in those types. For example, a timber joist floor may be protected by means of pugging and special ceilings so that it affords 1 hour or more fire resistance under test conditions, but fire on the upper surface may ignite the structure and lead to a complete burn-out. We therefore consider that all structural parts of buildings of Types 1–3 construction which are required to have a specified grade of fire resistance should be of incombustible material, except that timber doors which attain the required grade may be used.

1957

As to building construction - residential property is invariably built of timber construction but fortunately not as dense as the average housing area in this country. Building sites have to be of fairly large dimension with the result that houses are of the detached type with at least a garden between adjoining houses. The centre of towns are, of course, densely built and whilst we have many old timbered buildings, concrete is the favoured building material. In the centre of towns it is now compulsory to build in concrete, brick or stone, although the latter two materials are not as readily obtainable as they are in this country.

NEW ZEALAND / EMERGENCY SERVICES

Firefighters were not meeting their response target - so FENZ changed it

2:08 pm on 7 June 2023

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EMERGENCY SERVICES

Auckland firefighters frustrated by growing delays in city

From **Midday Report**, 12:41 pm on 19 June 2023

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Firefighters in Auckland say delays caused by the rapidly growing city could be the difference between life and death.

Documents obtained by RNZ have shown crews are sometimes struggling to reach burning houses in high density areas, and that access to water can be a problem.

Auckland fire fighter Martin Campbell is the Auckland secretary of the Professional Firefighters Union.

He told Rowan Quinn the situation is incredibly frustrating because every second counts.

Auckland housing growth puts water supply for firefighters at risk, FENZ says

The permitted "maximum received radiation" values (at 1.0 m beyond the *relevant boundary*), are higher than values commonly accepted at present. Those assume the absence of Fire Service intervention. While it is not possible to give 100% guarantee of timely Fire Service intervention, the history of past *fires* indicates that the risk of *fire* spread to adjacent property is low (approximately 0.3% of all structure *fires* according to NZFS Emergency Incident Statistics 1993-97). The historically low risk of *fire* spread is the basis for permitting the higher received radiation values.

Storeys	New Zealand		USA		Australia		Canada		England**	
	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers
20	30		180		90		120		120	
19	30		180		90		120		120	
18	30		180		90		120		120	
17	30		180		90		120		120	
16	30		180		90		120		120	
15	30		180		90		120		120	
14	30		180		90		120		120	
13	30		180		90		120		120	
12	30		120		90		120		120	
11	30		120		90		120		120	
10	30		120		90		120		120	
9	30	60	120		90		120		90	
8	30	60	120		90		120		90	
7	30	60	120		90		120		90	
6	30	60	60		90		60		60	
5	30	60	60		90		60		60	
4	30	60	60		90		60		60	60
3	30	60	0*		90	90	45	45	60	60
2	30	60	0*		90	90	45	45	30	30
1	0*	0*	0*	§	0*	0*	0*	0*	0*	0*
	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR

§ International Residential Code can be used for one and two-family dwellings and townhouses up to 3 storeys without fire sprinklers.
* FRR may be required to protect tenancies and egress routes, or to limit fire spread across boundaries.
** Approved Document B only applies to 'common building situations' and may not apply to some buildings with a combustible structure.

Key:

- Combustible materials generally permitted.
- Fire-protected timber (typically requires two layers of fire grade plasterboard).
- Fire-protected timber (limited areas of wood can be exposed on walls and ceiling).
- Non-combustible materials required.
- Primary structure can be combustible, except external wall (unless proven by test).
- Primary structure can be combustible except external wall.

There are three choices for modelling the full *burnout design fire*:

a) Use a time-equivalent formula to calculate the equivalent *fire* severity and specify *building elements* with a *fire resistance rating* not less than the calculated *fire* severity. In this case, an equivalent *fire* severity of 20 minutes shall be used, if the calculated value is less.

C/VM2 minimum is 20 minutes

Worst case apartments FHC = 1
(typical floor, Apt b, c, d, e, h, i, j or k)

k_b = 0.065
Firecell height = 2.4m
A_f = 36.5sqm
A_h = 0.0sqm A_h/A_f = 0
A_v = 9.1sqm A_v/A_f = 25%

$S = kt_e$ = 10 minutes **S = 10 minutes**

10 minutes – 30 stories!

New-York Tribune.

SUNDAY, OCTOBER 19, 1902.

"Fireproof wood," he said recently, "is really a misnomer. It should rather be called fire resisting wood." P. M. Stewart 1902

"when fearful consequences may result from a failure of a structure due to fire, no test is too severe which reasonable care and expense in construction can resist". Ira Woolson 1902

Building Department Experts Applying the Fire Test To Alleged Fireproof Building Materials

Standard fire testing – Hybrid/composite construction

"it always must be borne in mind that in a strict sense standard fire (testing) is not a measure of the actual performance of an element in fire, and, furthermore, that it is not even a perfect measure for comparison"

Harmathy and Lie 1970

The structural fire engineering community is now waking up to the pitfalls of using standard fire testing and the opportunities that a more rational approach might present. A gradual shift in testing philosophy to large scale non-standard fire testing using real fires, rather than standard temperature-time curves, seems now to be underway, and a fire testing renaissance is occurring aimed at not merely capturing the comparative structural performance of isolated materials, but at rationally defining the full suite of interactions to be expected in real buildings in real fires.

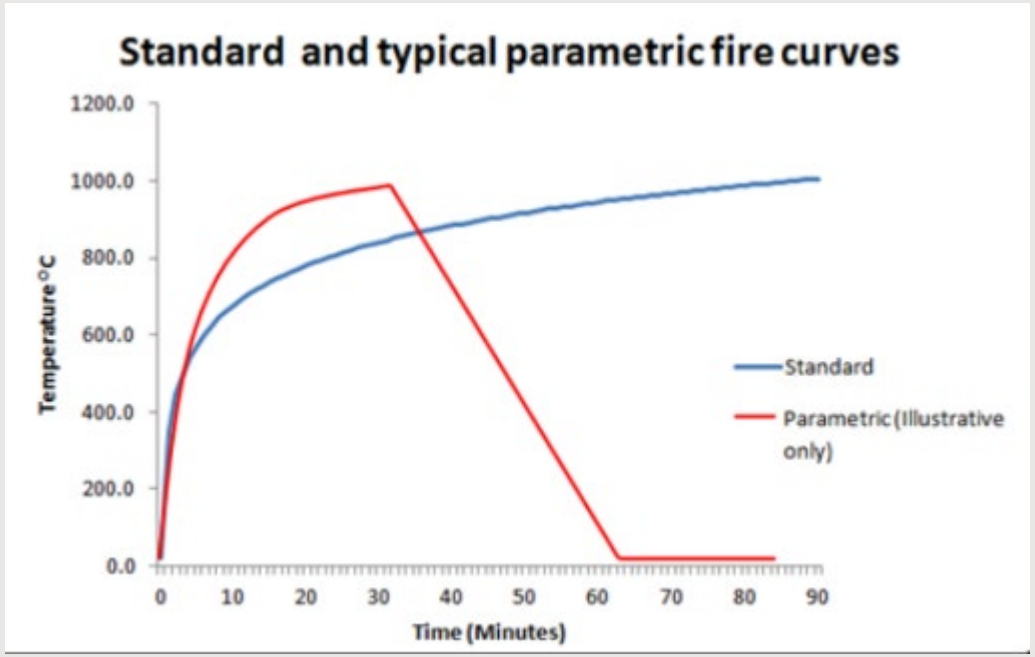
Gales, J., Maluk, C., and Bisby, LA . Structural fire testing- where are we, how did we get here, and where are we going. 15th International conference on experimental mechanics: Fire symposium. 2012

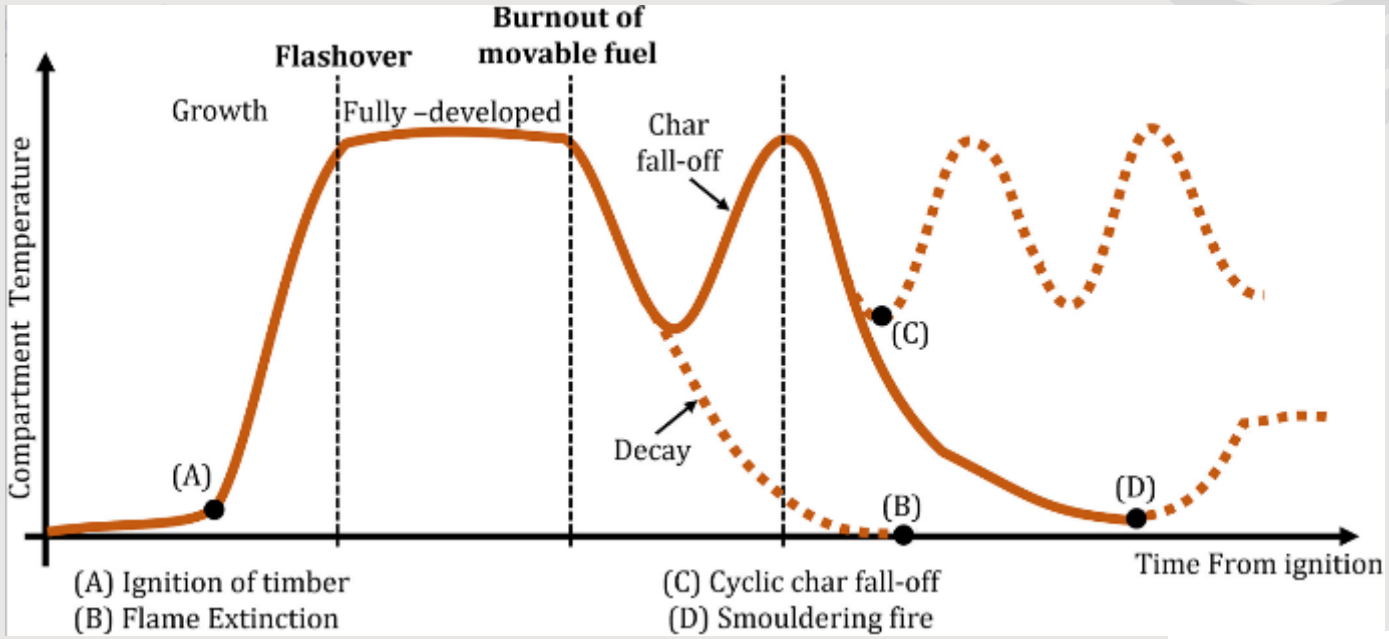
Building Regulations and the Code

Building Regulations 1992

burnout means exposure to *fire* for a time that includes fire growth, full development, and decay in the absence of intervention or automatic suppression, beyond which the *fire* is no longer a threat to *building elements* intended to perform loadbearing or *fire separation* functions, or both

Standard fire resistance testing





Time temperature curve for periods of fire development

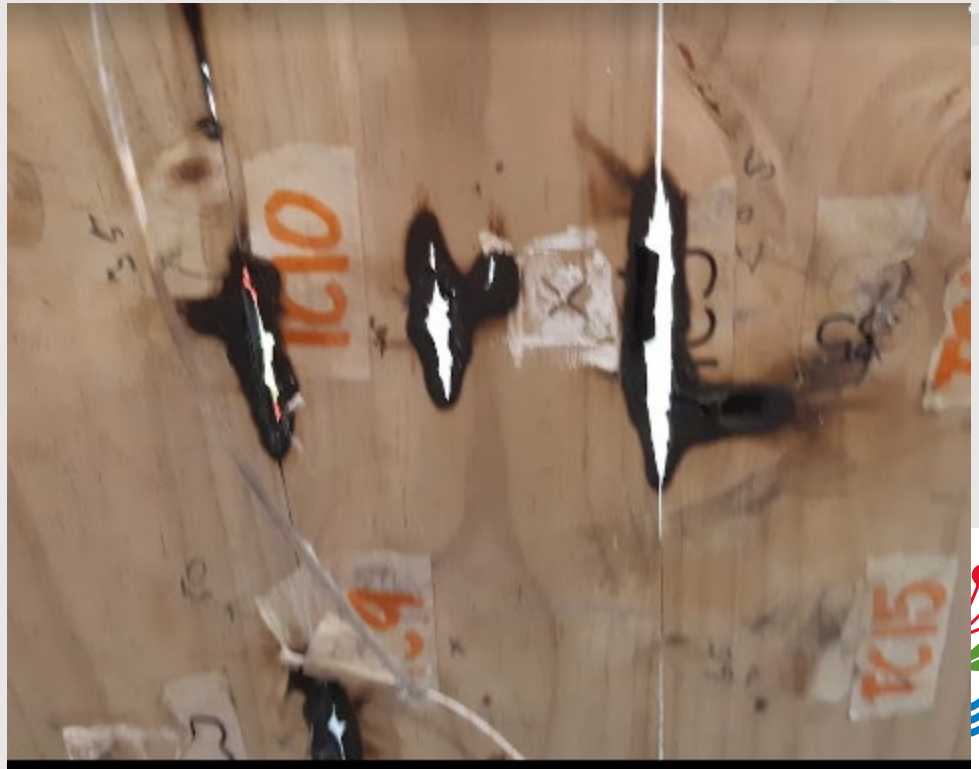
*** Review of fire experiments in mass timber compartments: Current understanding, limitations, and research gaps**
https://doi.org/10.1002/fam.3121

Charring rates - 0.65mm/min

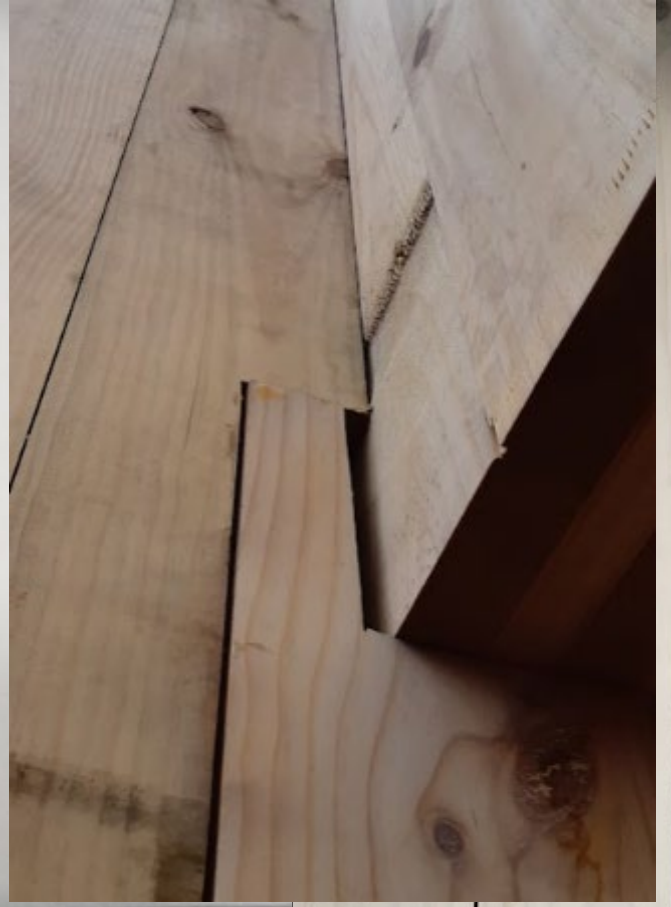
- Charring is burning
- AS/NZS 1720.4 does not apply to CLT
- Numerous NZ tests show charring rates of >0.65mm/min – 2.3mm/min
- Idealised testing, not representative and no agreement!

*"the location of mass timber elements within a compartment was found to have a significant impact on the charring behaviour. Exposed timber ceilings were found to have charring rates on average 16% lower than exposed timber walls in the same experiment. Furthermore, charring rate is predominantly driven by ventilation conditions and movable fuel load density, with average charring rate decreasing as the proportion of timber surface area to opening surface area increases. However, the influence of key compartment design parameters on timber charring rate requires further understanding to progress the current understanding of compartment fire dynamics." **

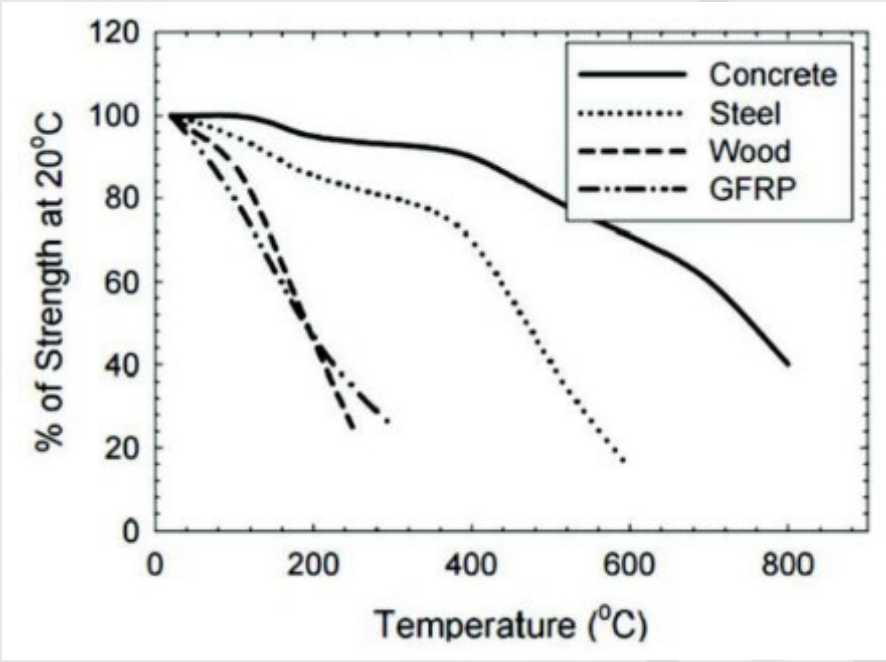
Char fall off and burn through



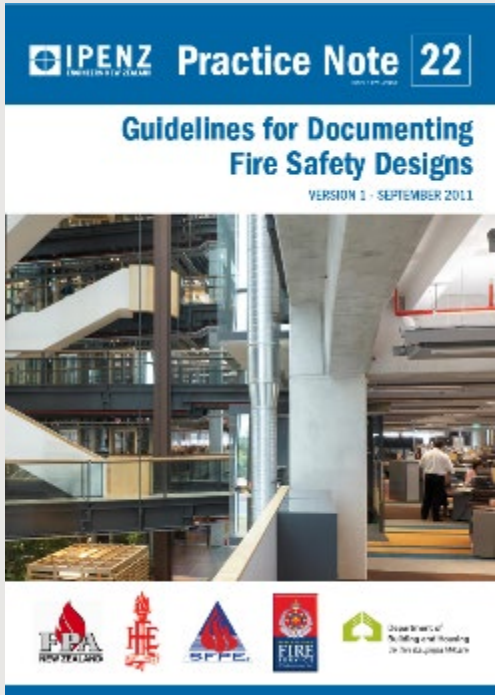
GAPS



Structural and fire engineering



"we don't need fire engineering input at this stage"



The risk of collapse of multi-storey CLT buildings during a fire -
Report ID: 966

CROSS UK

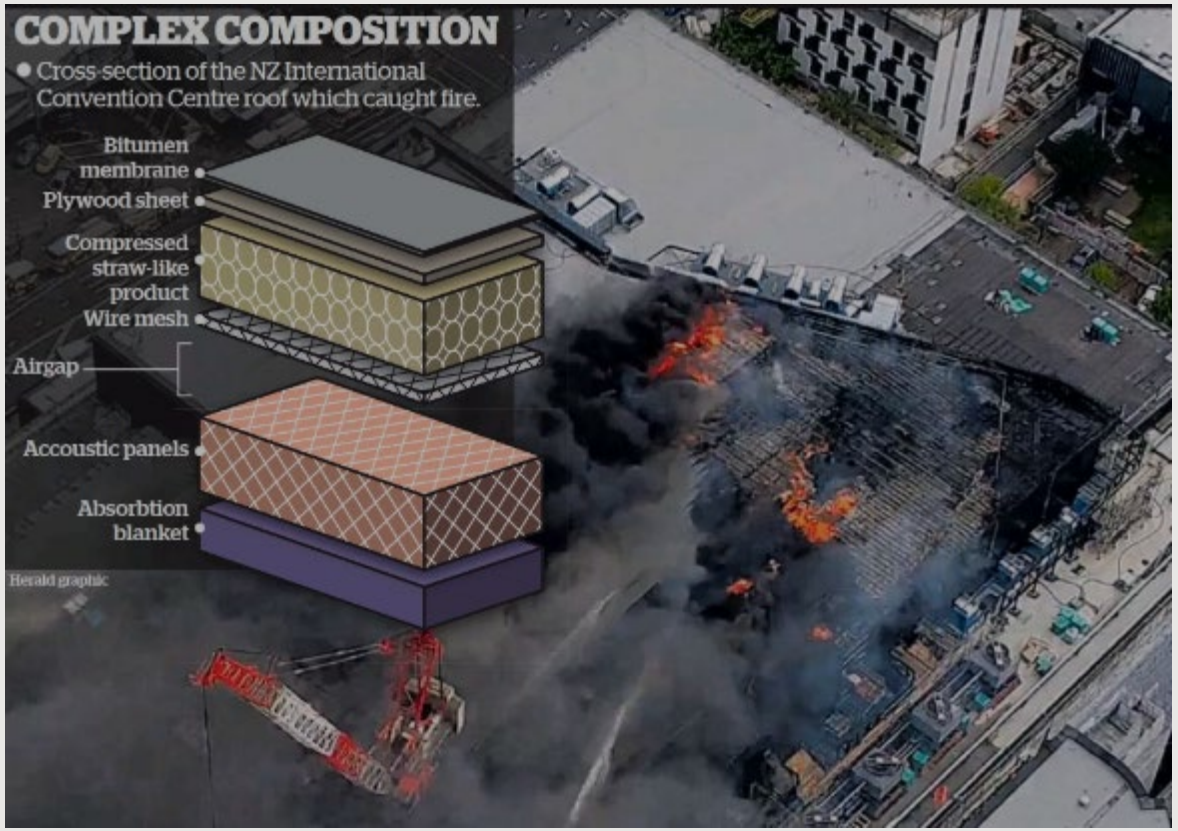
Trust

Confidence

Credibility

Sprinklers

- 99.996% reliable?
- “Belts and braces”
- Construction, demolition, maintenance, repair, replacement, earthquake, stupidity…



Your Challenge!

- Absence of a Compliance document that specifically deals with structural mass timber (CLT), hybrid buildings and complex methods of construction
- Reliance on ‘Actors’ competence and behaviour, including that of the regulators
- NZ Specific fire testing
  - Appropriate
  - Agreed methodology
  - Open and transparent results
- Interim solution - TimberUnlimited – “Fire Supplement”
- Talk to the stakeholders, including FENZ and the BCA