Weathertightness and Timber Durability Issues

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creative wood-based solutions

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What is decay?

- Breakdown of moist wood by fungi
- Extracellular enzymes released by microscopic fungi attack wood lignin and cellulose, reducing the wood's strength

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What causes decay?

- Wood + water + fungi = decay
- Fungal spores are ubiquitous

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Wood moisture content

- <18% MC, decay will not occur

- <Fibre saturation point (approx. 30% MC) decay unusual except for dry rot (*Serpula lacrymans*)

- 30 - 200% MC (close to wood saturation) decay is common

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Types of decay

Dry rot

Wet rot

Soft rot

Dry rot

- Optimum of 21^0C
- Low max growth temp of 26^0C
- Temp range for growth, 9-24^0C
- Requires high humidity and acidity for establishment
- Affect of alkaline plaster on spread?
- Common on drying wood (after repairs)
- Sub-floor spaces (masonry)

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Wet rot -
e.g. *Coniophora puteana*

- Very common in buildings (>90%, UK)
- High moisture / sensitive to drying
- Opt temp of 23^{0}C, max of 35^{0}C
- 40% wood weight loss in 4 months
- Tolerant to many preservatives
- Mostly associated with leaks

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Soft rot

- Prefers high moisture
- Growth temperature range 6 - 40^{0}C

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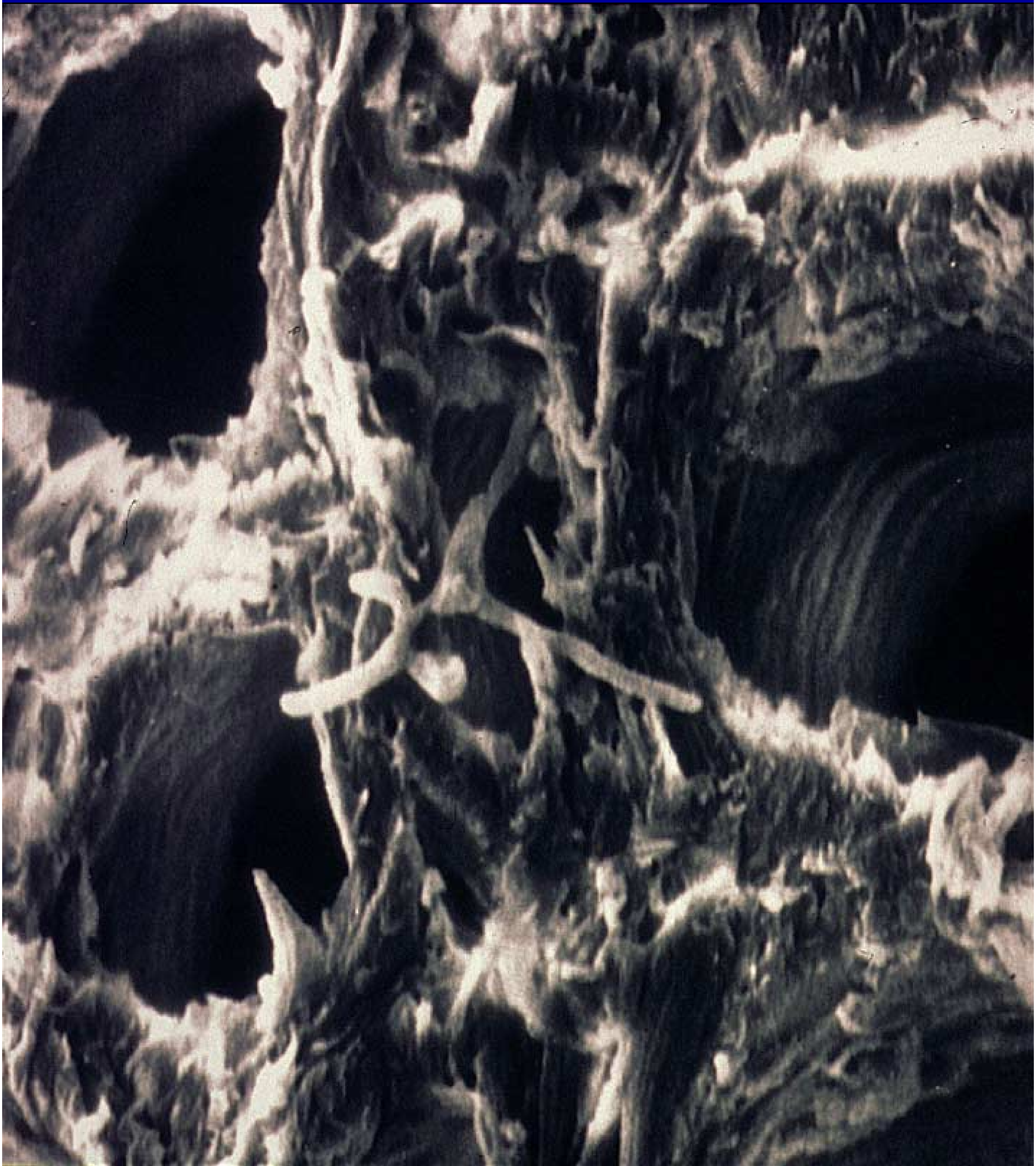

Background to decay problems

- Kiln-dried untreated framing introduced mid-1990s
- Survey of 1950s housing showed little borer attack in untreated framing
- Potential for decay was not an issue
- Current monolithic cladding systems are ***NOT*** the building style on which conclusions were reached that untreated, kiln-dried is an acceptable alternative to treated

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Main arguments for preservative treatment of framing

- Relatively inexpensive insurance against decay should framing become wet for extended periods
- Reduces cost of remediation of leaking buildings by removing timber replacement cost
- Reduces risk of undetected decay causing structural failure

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Main arguments against preservative treatment of framing

- Will not cure the problem of buildings leaking through poor design
- Is seen by some seen as a retrograde step
- Is not necessary for *all* framing in *all* situations if kept dry from kiln to enclosing
- Will do nothing to improve building practice

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FRAMING TREATMENTS

DECAY RESISTANCE DATA

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Laboratory decay tests

Objective

- To determine the decay resistance of:
  - H1 (and higher levels) Diffusol® (boron)
  - H1 Permethrin LOSP
  - H1 Permethrin+fungicide (IPBC)
  - Untreated kiln dried

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Test Fungi

- *Coniophora puteana* (wet rot) preservative tolerant
- *Serpula lacrymans* (dry rot) European strain
- N4 unidentified. Isolated from rotting Auckland house

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Diffusol®

Analysed	% Weight Loss		
% BAE	C.p.	S.l.	N4
Untreated	25.90	17.50	19.12
0.08	16.02	-0.29	0.61
0.15	0.41	-0.26	-0.05
0.19	-0.04	-0.31	-0.29
0.32	-0.20	-0.56	-0.41
0.35	-0.29	-0.39	-0.42
0.43	-0.21	-0.25	-0.45

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LOSP Permethrin + IPBC

	% Weight Loss		
Nominal %	C.p.	S.l.	N4
Untreated	25.90	17.50	19.12
Perm 0.006	26.70	9.35	17.74
Perm + IPBC			
0.006 + 0.008	28.35	3.93	2.52
0.006 + 0.012	22.36	1.92	-0.40
0.006 + 0.016	15.36	1.10	-0.74
0.006 + 0.024	9.86	-0.39	-0.87

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Key Results

- All three fungi caused significant weight loss in untreated blocks
- *C. puteana* caused significant weight loss in blocks treated with Diffusol® to a retention of 0.08 % boric acid equivalent (BAE)
- *C. puteana* caused no decay in blocks treated to retentions of 0.15 % BAE and above

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Key Results

- *S. lacrymans* and the unidentified isolate caused no decay in any of the Diffusol® treated blocks

- All three fungi caused significant decay in permethrin/LOSP treated blocks.

  - Weight losses caused by *C. puteana* and N4 were very similar to those caused in untreated blocks, but *S. lacrymans* caused only half the decay of untreated blocks

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Key Results

- Addition of IPBC increased the fungicidal effectiveness of permethrin/ LOSP.
- At the highest addition level (0.024%) it did not fully control decay by *C. puteana*
- The lowest retention markedly inhibited decay by the other two fungi and controlled it (< 3% weight loss) at an addition of 0.012%.

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BORON TREATMENT

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Decay risk based on TPC H1 boron specifications

- Wet framing, 0.1% o.d. wt. core
- Dry framing, 0.04% o.d. wt. core, 0.1% o.d. wt. cross-section
- Wet rot decays wood of 0.08% o.d. wt. (0.15% o.d. wt. was resistant)
- Typical TPC sample (treatment plant) values, 0.27 - 1.59% o.d. wt.

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Typical H1 boron retentions by analysis

Sample set No.	Boric acid x-section retention % m/m o.d. wood (range)
161	0.36 (0.23-0.58)
179	0.67 (0.42-0.94)
264	0.27 (0.02*-0.46)
265	0.67 (0.30-2.02)
307	0.90 (0.45-1.58)
308	0.37 (0.13-0.75)
321	1.59 (0.53-2.91)
328	0.72 (0.40-1.25)

* Probably heartwood

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H1 boron retentions

- Routine TPC analyses of boron treated H1 framing suggest minimum requirements are frequently well exceeded

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H3 Treatments

- LOSP:

  TBTN: 0.08% Sn

  TBTO: 0.08% Sn

- Waterborne:

  CCA: 0.37 % TAE m/m

  ACQ: 0.35 % Cu+DDAC m/m

  CuAz: 0.30 % Cu+ azole m/m

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LOSP TBTN or TBTO

- Effective against brown and white rots
- Less effective against soft-rot
- Water repellents can be added
- Relatively expensive
- Framing at lower end of product value
- Profitability better served by treating higher value products,e.g. export fascia, weatherboards

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Waterborne CCA, ACQ, CuAz

- Effective against all types of decay
- Costs of redrying after treatment
- Perceived health issues over CCA being used in the domestic environment
- Substantially higher costs for ACQ and CuAz over CCA

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H3 Summary

- Substantial increase in cost
- Is H3 level necessary for all framing?
- More chemical in buildings
- Potential environmental and health issues

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H1½ Treatments for Framing

- Fungicidal and insecticidal but less than H3 protection
- “Temporary” protection of framing, so that weathertightness failures could be corrected before decay occurs.
- Difficulties of including such treatments in a Standard

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Risk Assessment

- Can we make a best estimate of the decay risk in modern buildings (<5 yrs old) with a face-seal type construction and with untreated or treated framing?

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Decay risk

Drainage/drying cavity	Preservative treatment	Decay risk
No	No	very high if poor design/ construction (3-6 months)
Yes	No	medium but good design critical
No	Yes	low, some decay possible with time. Water damage to linings
Yes	Yes	very low

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Decay of untreated framing before construction

- Block stacked untreated framing, once wet can develop serious decay in 3 months
- Block-stacked wet H1 boron treated framing is largely resistant to decay for many months and is known to have been decay free after 3 - 4 years in a number of instances

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Remedial treatments

- Expensive option
- Often difficult to gain access to all areas
- Effective preservative penetration into framing difficult to achieve in situ
- Health and environmental concerns?
- Potential products track records under NZ conditions

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Decay hazard in wall cavity

- Some uses of building wraps may exacerbate decay hazard by creating favorable moisture microclimates
- The assumption that a wall cavity is less at risk than a typical H3 situation maybe questionable

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Unknown (unresearched)

- Moisture content required to initiate decay
- Period of time at this moisture content for decay to become established
- Minimum moisture content needed to sustain decay
- Rates of decay in framing

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MOULD IN BUILDINGS

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Mould in Buildings

- Major issue in North America
- Moulds that are dangerous or perceived as dangerous are cosmopolitan
- Moulds will grow on a great diversity of building materials but especially those with cellulose
- Control options for mould not necessarily the same as for decay

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Mould Issues

- Degradation of building materials
  - Structural damage
  - Appearance damage
- Health problems
  - Insurance / litigation issues in North America

Mould issues - Where?

- Within buildings where weather-tightness or ventilation are inadequate
  - Living space (flooring/carpet, walls)
  - Wall cavities (wood, wraps, cladding, linings, insulation)
- Exterior materials
  - Cladding
  - Roofing

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Degradation of building materials by mould fungi

- Essentially, all materials are susceptible to appearance damage if damp

- Materials (e.g. cement based) that contain biodegradable polymers (e.g. wood fibre) can be damaged structurally
  - Cladding
  - Roofing

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Health issues

- All moulds are a potential problem (respiratory irritation, allergenic)
  - Spore concentration
  - Ventilation
- Particularly dangerous moulds (pathogenic or toxigenic)
  - e.g. *Stachybotrys, Aspergillus*
  - Presence is a potential problem

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Solutions

- Solutions for moulds not necessarily same as for decay
  - Ventilation
  - Type of building material
  - Water repellants
  - Physical barriers
  - Mouldicides
  - Encapsulation technology

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Conclusions

- Preservative treatment of framing will NOT solve the problem of leaking buildings
- It will ***NOT*** prevent subsequent damage to linings, fixings, coverings etc which are susceptible to damage when wetted, if buildings continue to leak
- It would reduce remediation costs
- It would considerably reduce the risk of structural failure from decay

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Conclusions

- Current treatment options are H1 or H3
- H1 LOSP is mainly ineffective in controlling decay
- H1 boron seems to be very effective
- H3 could be “overkill”
- Optimum requirements for treatment of framing which maybe at risk from decay have not been established

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Conclusions

- Based on current knowledge, drainage - drying cavity plus use of treated framing (~ H3) is the most *reliable* solution for higher risk buildings
- Is smart design of drainage cavity, linings and associated wall cavity detail enough to guarantee untreated framing remains dry?
- Need to manage risk based on sound knowledge

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