Seventh-year durability analysis of post-treated wood-based composites

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Importance of WBCs

- Increased utilization of WBCs
  - Depletion of high quality wood
  - Wide acceptance in construction
  - New composite technologies

- Protection requirements for WBCs
  - moisture, weather, biological agents (decay fungi, insects, and marine borers) and fire when used in the exposed outdoor environments

Comparison of protection methods

Post-treatment

- Advantages
  - Easy to apply
  - No modification of manufacturing process
- Disadvantages
  - Envelope protection only
  - No processing after treatment
  - Effects on mechanical and physical properties

In-process treatment

- Advantages
  - Protection throughout the board thickness
- Disadvantages
  - Possible unfavorable chemical interaction with adhesive(s)
  - Degradation of mechanical properties
  - Emissions during manufacturing and processing

Objectives

- To examine feasibility of post-treatment of WBCs
- To investigate the effectiveness of ACQ and CA retention levels on biological performance (decay and termite) in field tests
- To inquire long term field test data (10 years)

Materials and Methods

Features of WBCs tested

Wood-based composite	Thickness (mm)	Density (g/cm^3)	Adhesive	Raw material
Softwood plywood (SWP)	12.1	0.59	PF Type-1	Softwood, 5 ply
Hardwood plywood (HWP)	11.7	0.50	PF Type-1	Hardwood, 5 ply
Medium density fiberboard (MDF)	12.0	0.71	MUF	Hardwood fibers
Oriented strand board (OSB)	12.7	0.63	PF	Aspen
Particleboard (PB)	11.9	0.71	MUF	Hard-/softwood mix

Preservative Chemicals

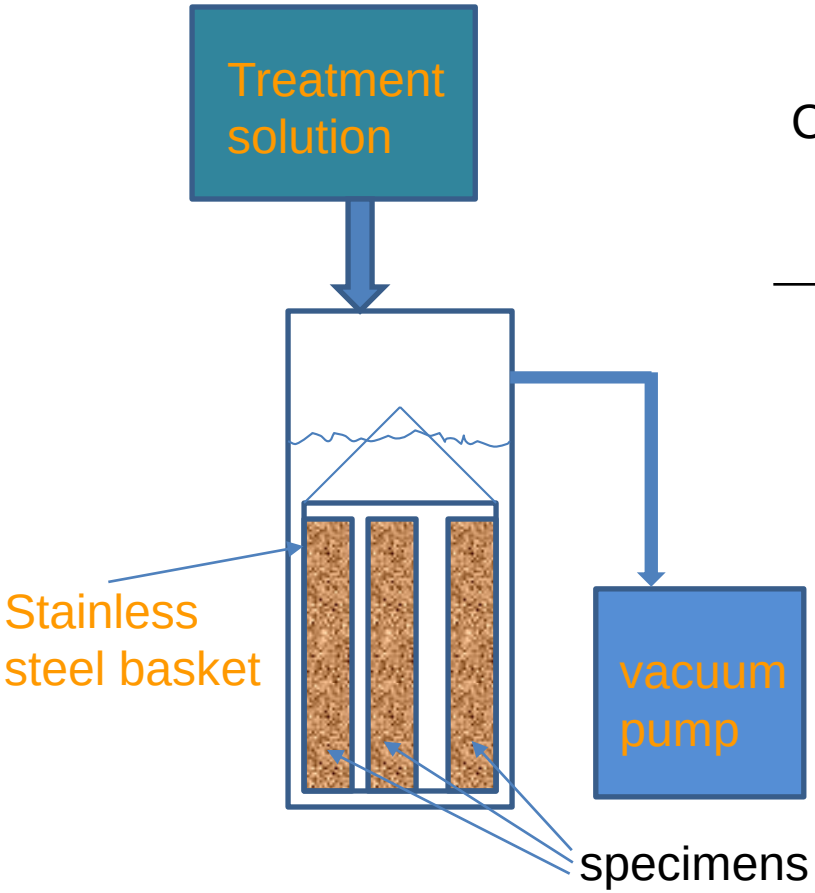
- Alkaline copper quaternary (ACQ)
- Copper azole (CA)

- Widely accepted as alternatives to CCA
- Higher treatment solution uptake and penetration when compared to acidic water-borne preservatives

Target retentions

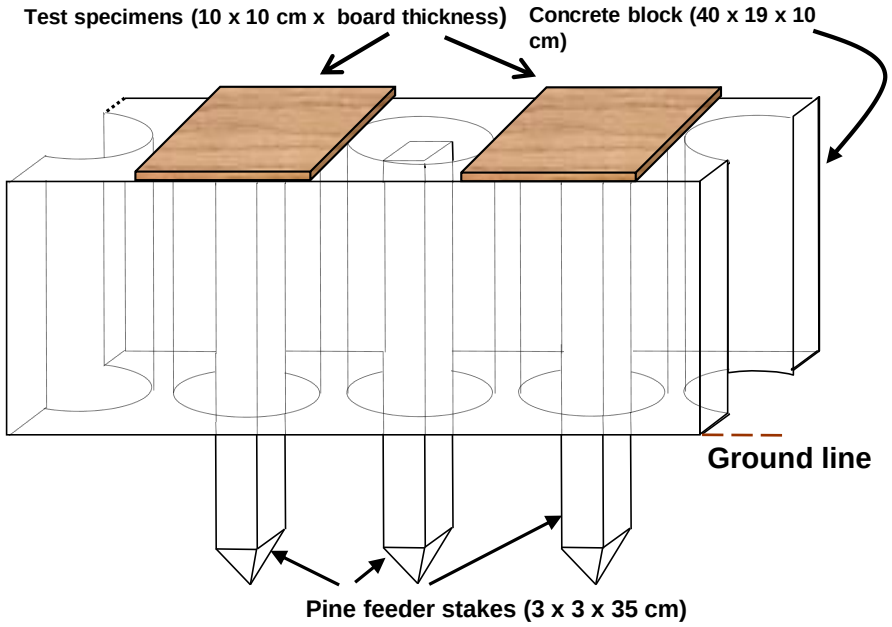
- According to JAS 2007, for sugi lumber (solid wood)
  - 0.65, 1.3 and 2.6 kg/m^3 as ACQ, respectively for K1, K2 and K3
  - 0.25, 0.5 and 1.0 kg/m^3 as CA, respectively for K1, K2 and K3
- For field tests of WBCs (no standard)
  - 2.6, 5.2 kg/m^3 as ACQ
  - 1.0, 2.0 kg/m^3 as CA

Details of Vacuum Treatments



Composite	Treatment schedule [time (min)]		Water uptake (kg/m^3)
	Dry vacuum	Wet vacuum	
SWP	30	60	153
HWP	30	20	193
MDF	10	1	398
OSB	10	1	339
PB	10	1	364

Field Test



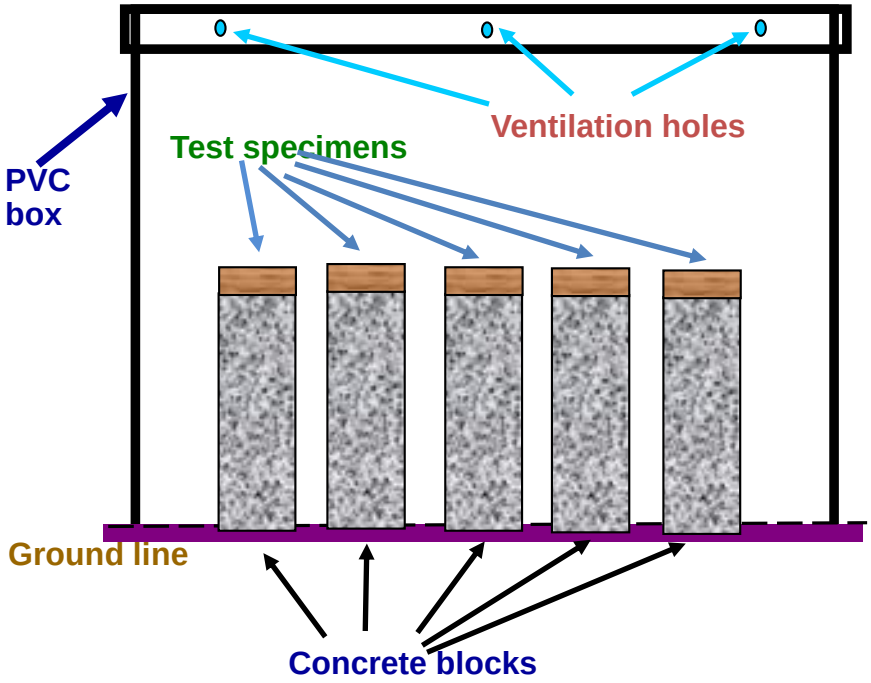
The Living Sphere Simulation Field (LSF) in Kagoshima Prefecture

Mean annual rainfall : 2265 mm

Mean annual temp.: 18ºC

Scheffer's climate index: 90

C. formosanus, R. speratus and wood-rotting basidiomycetes are present.



To simulate crawl space conditions in Japanese homes

AWPA Rating; 10 sound, 9 Trace of attack, 7 Moderate attack, 4 Heavy attack, 0 Failure, disintegration of specimen

Results

Retentions

ACQ treatments

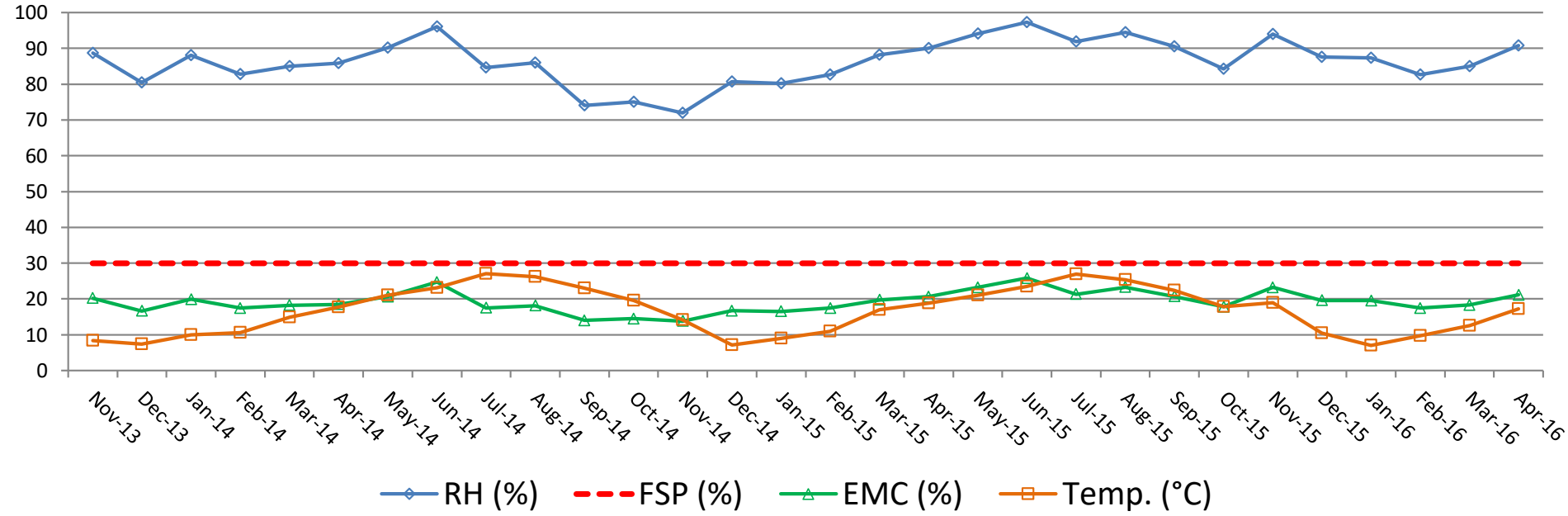
Target retentions (kg/m3)	SWP	HWP	MDF	OSB	PB
2.60	3.26 (0.19)	2.05 (0.50)	2.85 (0.07)	2.45 (0.60)	2.58 (0.15)
5.20	6.24 (0.50)	6.88 (1.45)	5.76 (0.10)	5.49 (0.97)	4.58 (0.68)

CA treatments

Target retentions (kg/m3)	SWP	HWP	MDF	OSB	PB
1.00	0.98 (0.05)	1.23 (0.29)	1.00 (0.01)	0.91 (0.29)	1.08 (0.04)
2.00	1.96 (0.18)	2.02 (0.24)	1.97 (0.04)	1.92 (0.58)	2.18 (0.04)

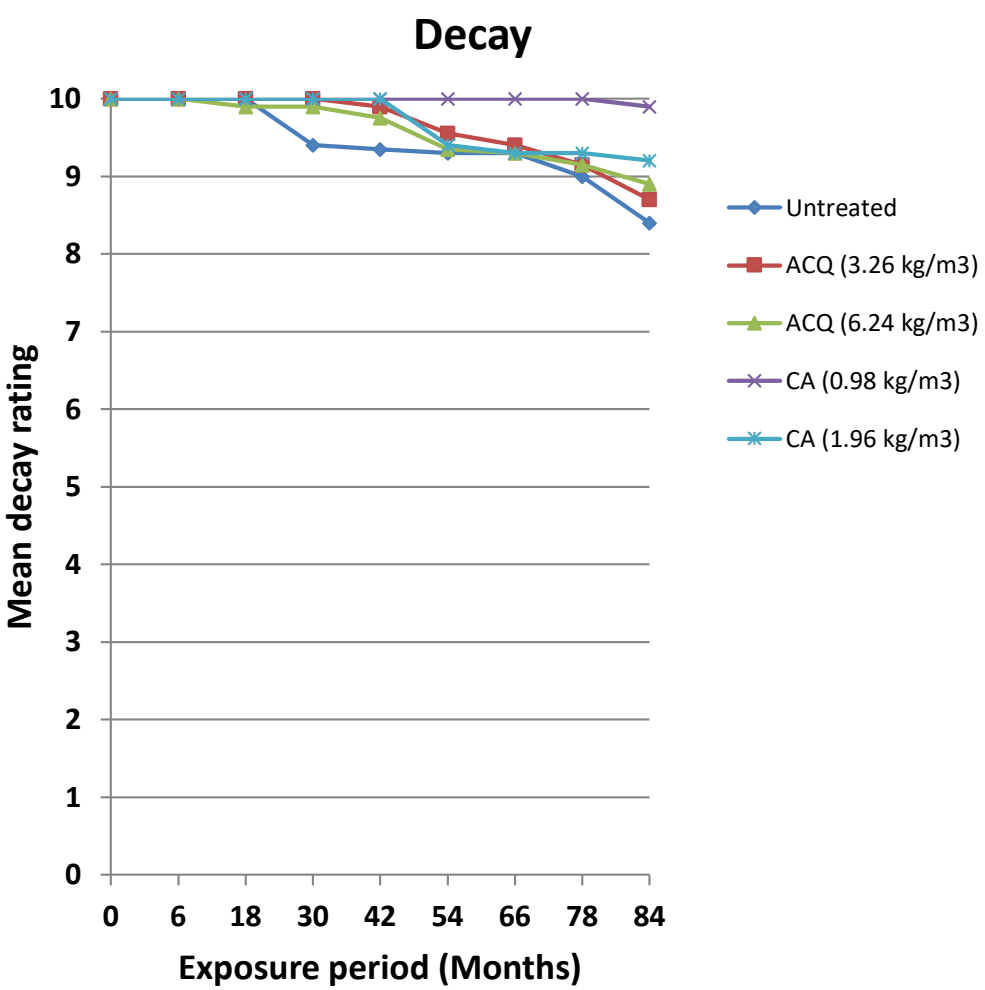
Field test set up and inspections

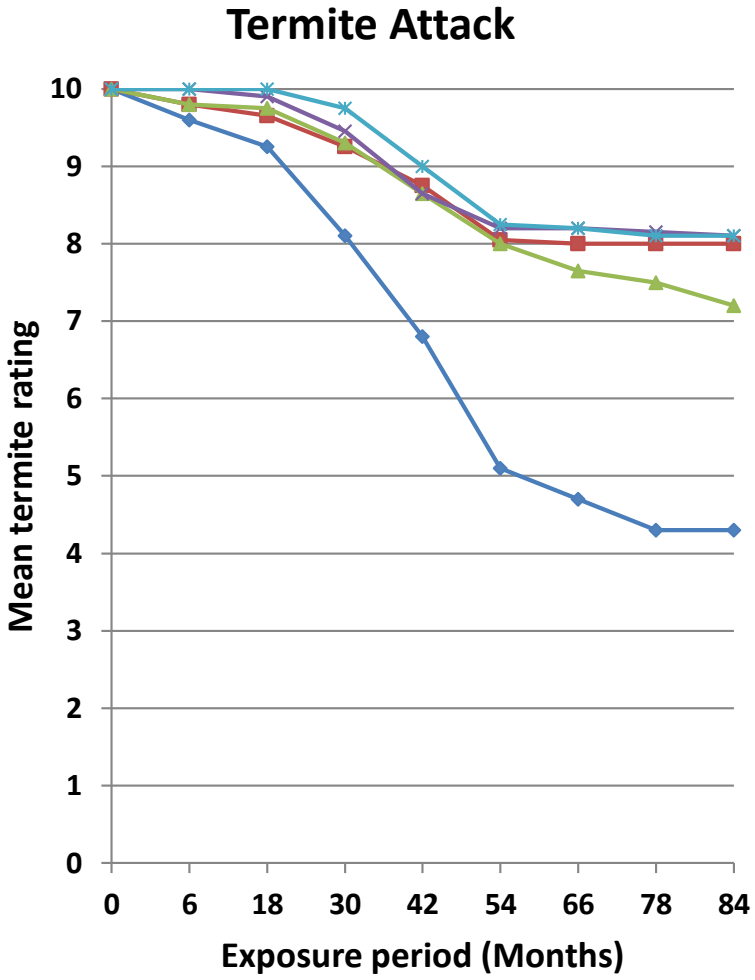
Meteorological Data



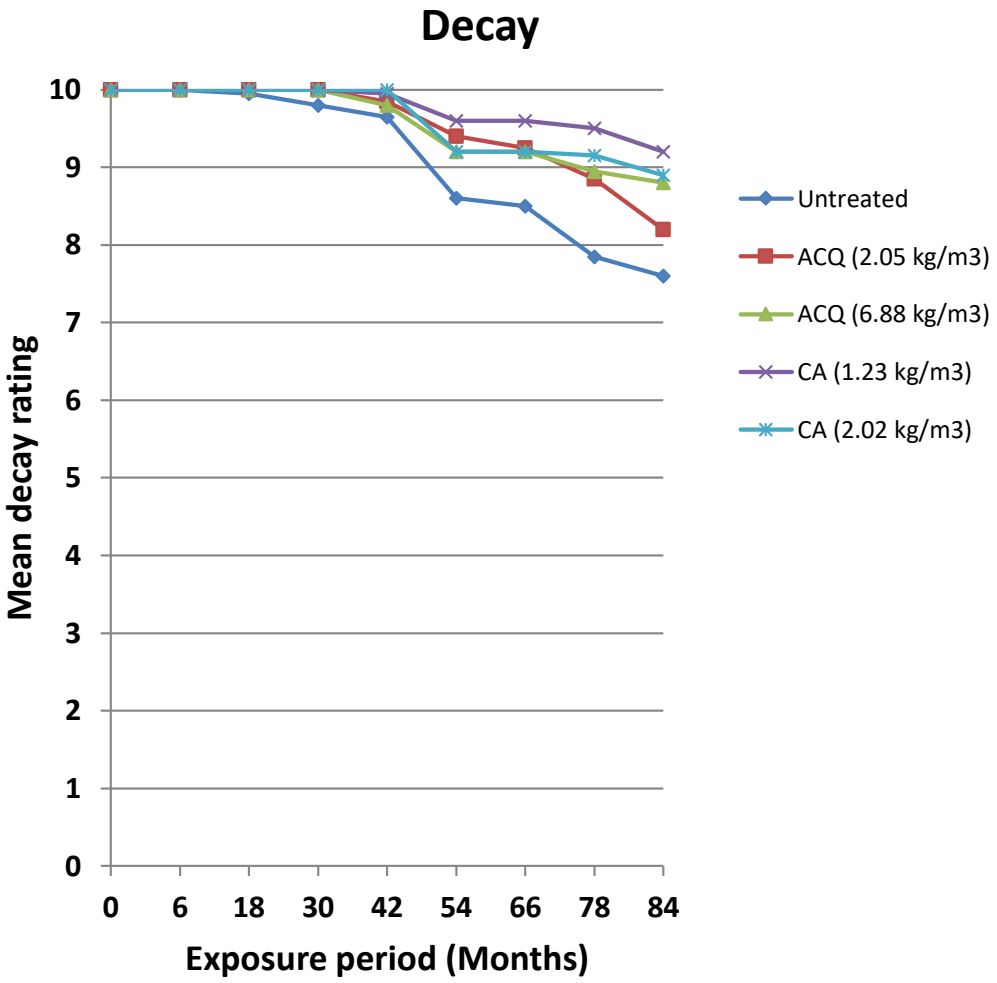
Measured data between 2013 and 2016 by HOBO meteorological station installed in LSF, Kagoshima, Japan.

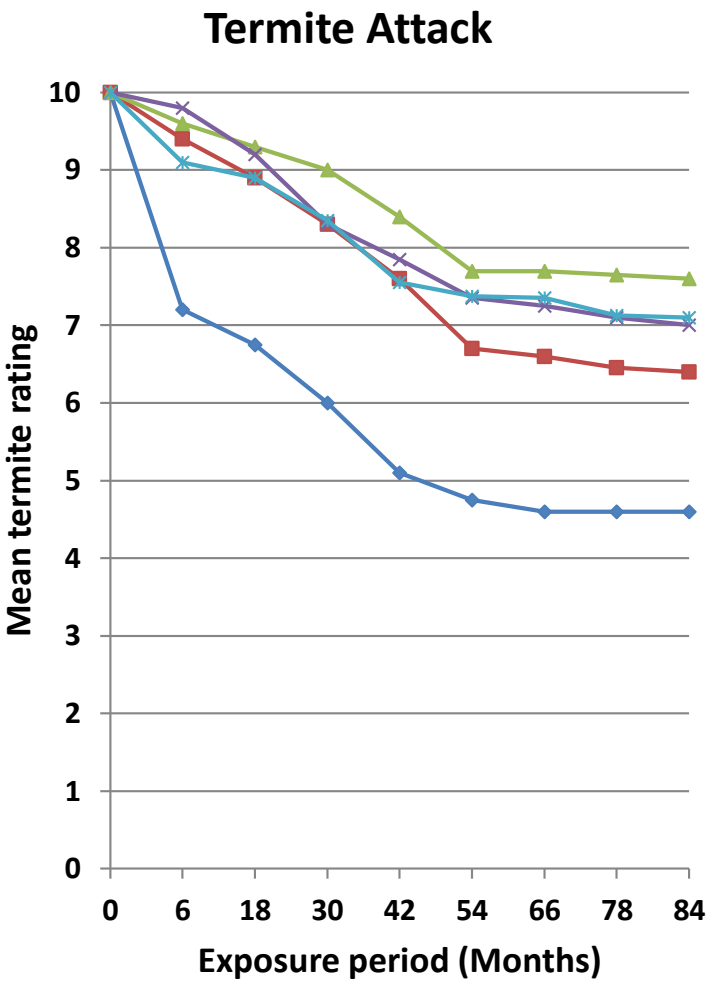
SWP; progress in decay and termite attack



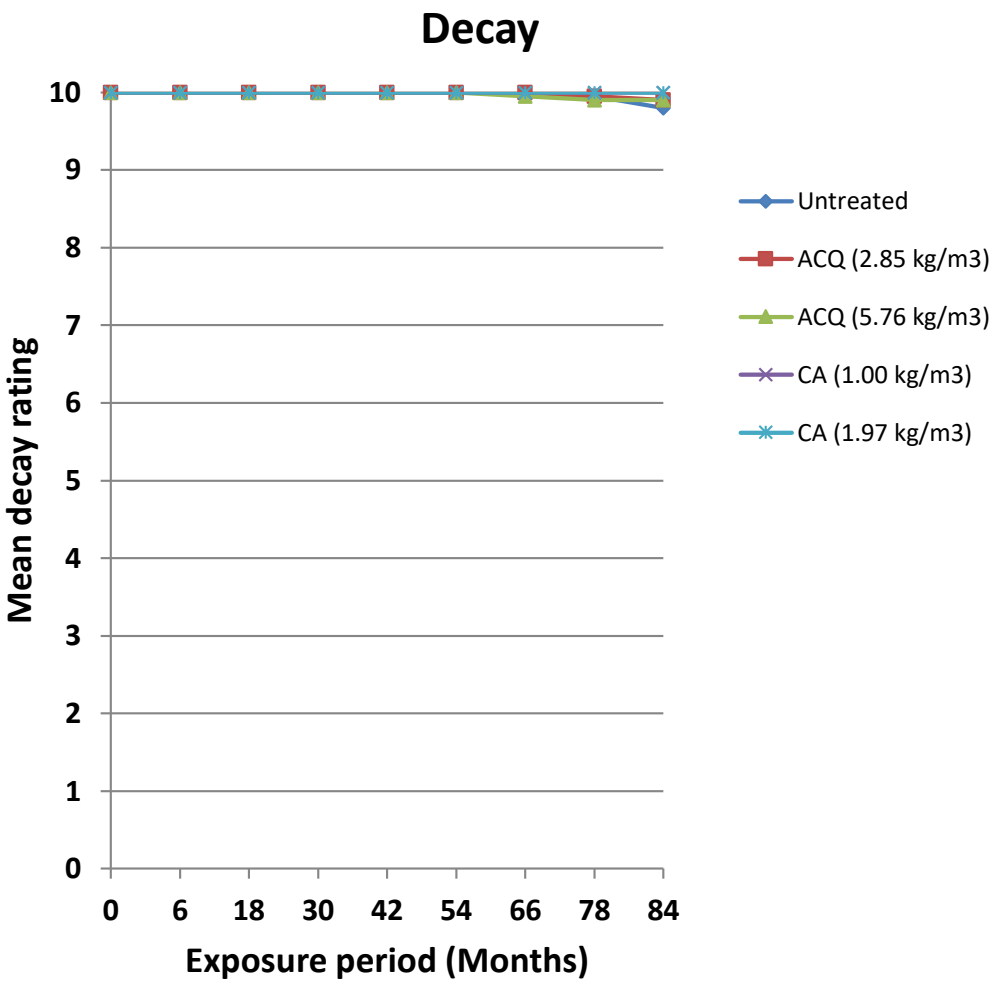


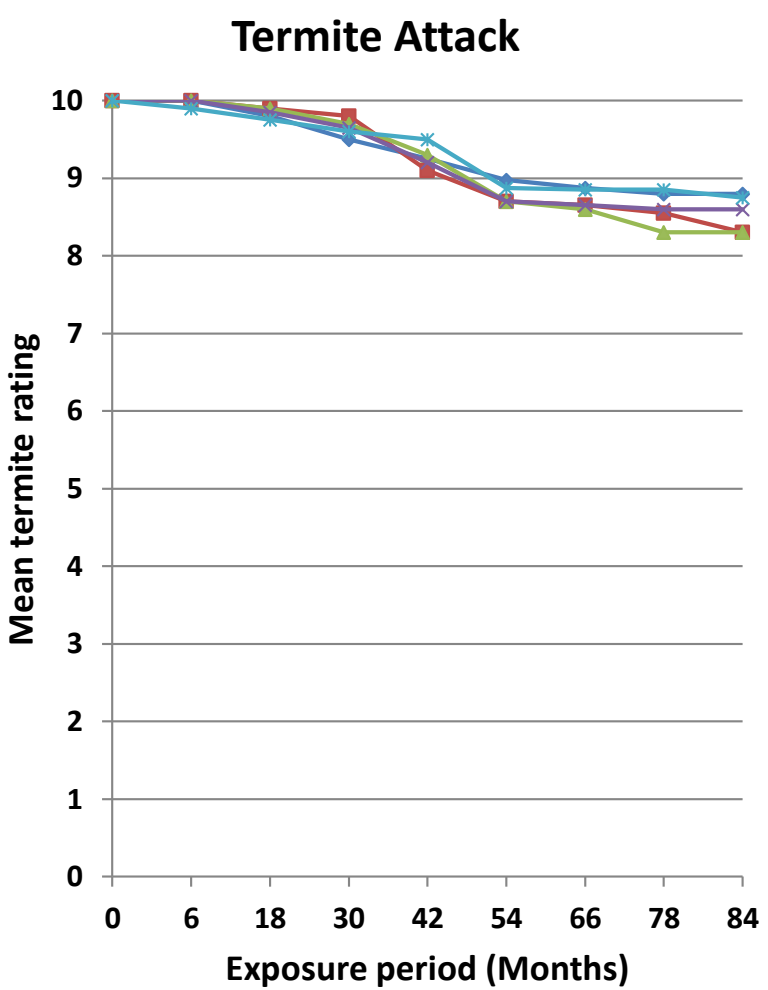
HWP; progress in decay and termite attack



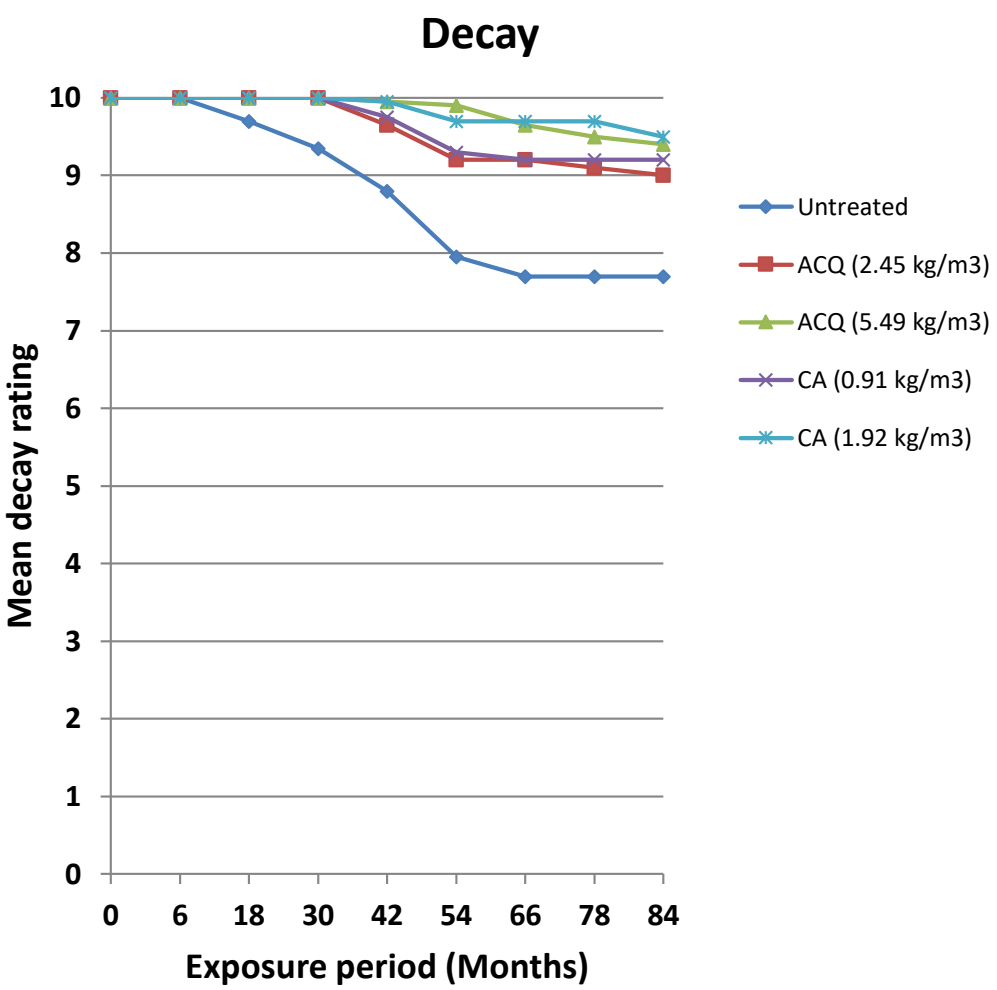


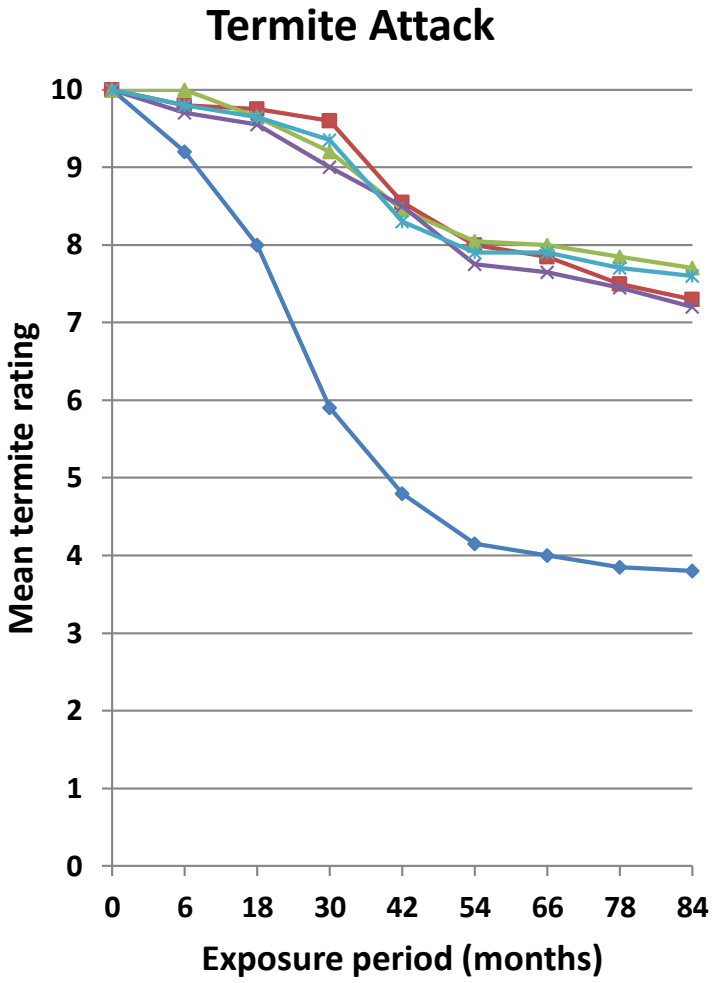
MDF; progress in decay and termite attack



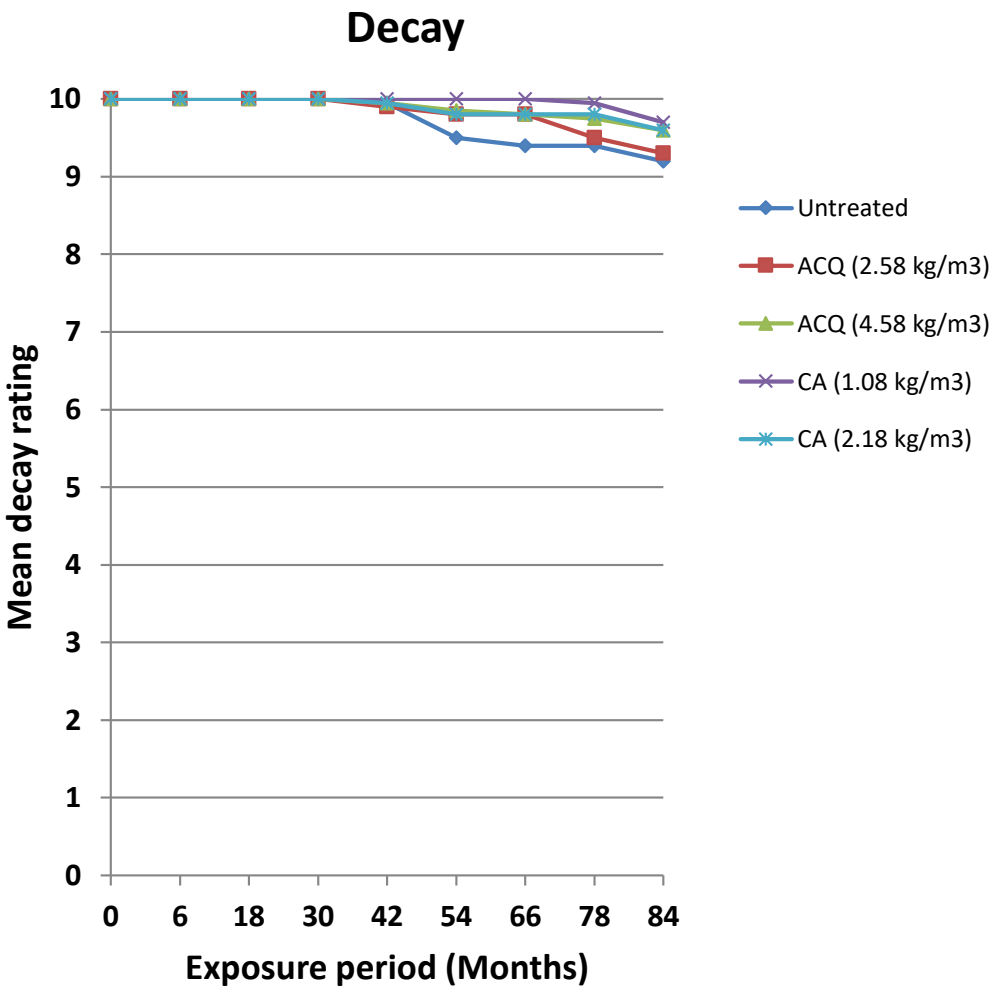


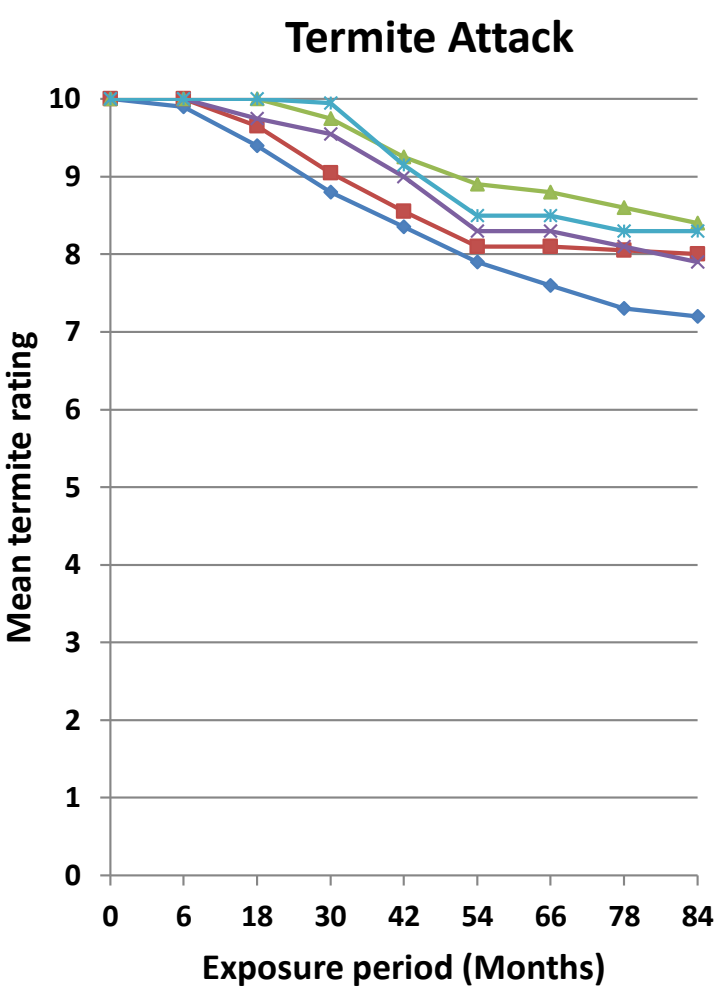
OSB; progress in decay and termite attack





PB; progress in decay and termite attack





Conclusions

- Untreated WBC are not durable enough, even in protected above ground conditions.
- MDF was naturally most resistant
- OSB showed the lowest resistance
- Post-treatment with ACQ and CA treatments at the retention levels tested significantly improved the termite resistance of SWP, HWP and OSB.
- Termite damage started earlier and the severity of attack was always higher than fungal decay regardless of composite type.
- Preservative types and increased retentions did not significantly affect the decay and termite ratings so far (The test will be terminated in 2019)
- None of the preservatives or retention levels tested was successful in providing full protection (rating 10) at the end of 84 months.

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