Alkaline Copper Treated Wood for Residential Use

University of British Columbia
Professor John Ruddick

Preservative mobility in decking

Objectives

Investigate:

- How shell treatments work in treated wood exposed above ground;
- The factors influencing the migration of copper in amine copper wood preservative treated decking
- Monitor depletion during natural weathering

Shell treated wood

2 - 4 mm

Typical lumber yard production

Approach

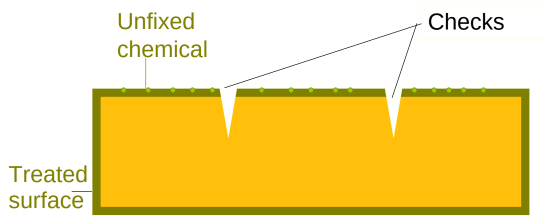
- Isolate fungi from exposed CCA treated decking after 10, 15 and 20 years
- Identify fungi
- Recover samples for chemical analysis
- Confirm the difference between spore and mycelial tolerance

Possible explanations for good performance of CCA shell treated wood used above ground

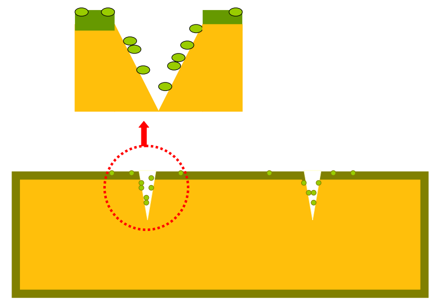
- Limited moisture content
- High proportion of heartwood
- The role of minor amount of mobile CCA preservative

Check –main avenue for fungi to access treated wood used above ground

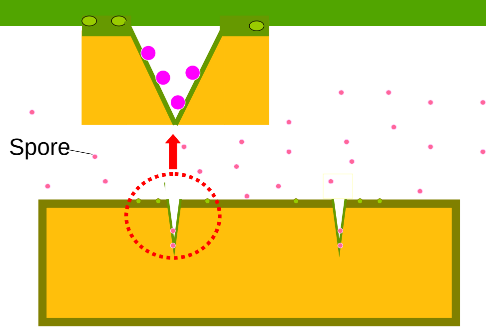
Spore germination in above ground wood



Migration of chemical onto check surface

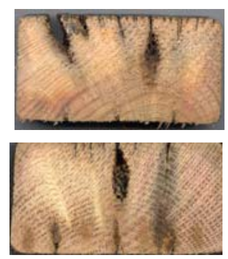


Spore germination in above ground wood



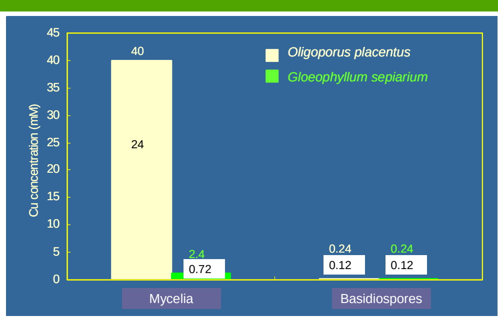
Decay of treated decking associated with checks

Fruiting body on decking



Externally Sound

Minimum Inhibitory Copper Concentration (on agar media)



Approach

- Install pressure treated boards
- Section to provide samples for chemical analysis and field exposure
- Sections for field exposure are approximately 300 mm long
- Support two 2 x 6 samples or three 2 x 4 samples over basins and collect run off

Chemical analysis

- Treated surface of reference section removed using a computerised routing system
- Analysed by x-ray spectroscopy to provide reference retention
- Penetration of the copper determined for each surface, including end penetration

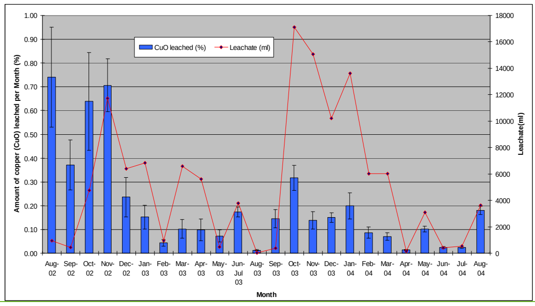
Chemical analysis

Factors being examined

- Wood species
- Preservative retention
- Preservative penetration
- 2 x 4 vs 2 x 6
- Treated vs untreated ends
- Water repellants
- Pressure wash
- Redistribution into checks

Preservative mobility in decking

Monthly amount (%) of copper leached - ACQ



Influence of the environmental conditions in the field leaching

- Amount Cu Leached = *f* (time of exposure, volume of leachate, sun hours, temperature)
- **Cu leached(mg)=12.573-3.347*T*+0.003*V*+0.55*S*-0.923*Temp*.**

Where: *T*: time of exposure in months

V: volume of leachate (ml)

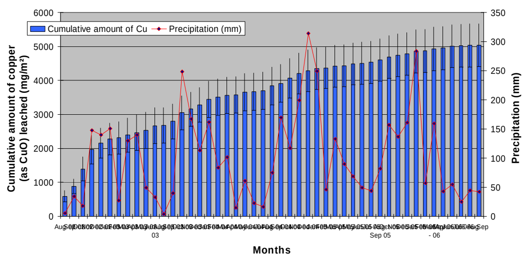
S: sun hours

Temp: Temperature

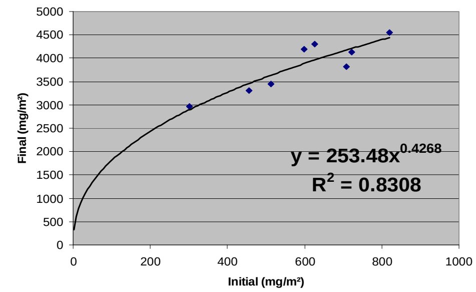
Coefficient of determination: R^2=0.74

At retention of 5.21 kg/m^3

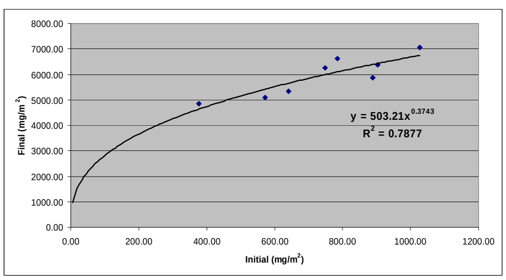
Cumulative amount (mg/m^2) of copper leached after 4 years exposure - ACQ



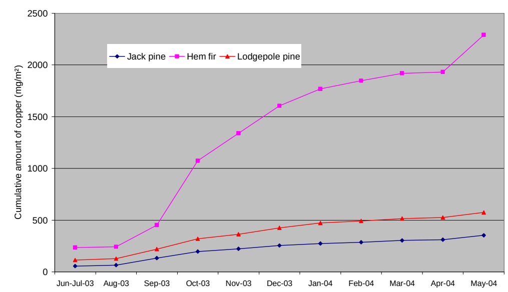
Final vs Initial losses after 2 years exposure



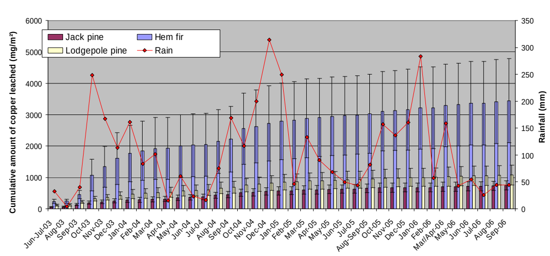
Final vs Initial losses after 4 years exposure



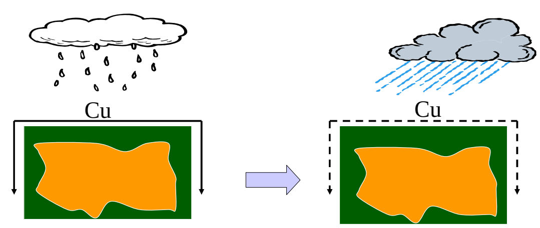
Cumulative amount (mg/m^2) of copper leached – CA-B



Cumulative amount (mg/m^2) of copper leached after 3 years – CA-B



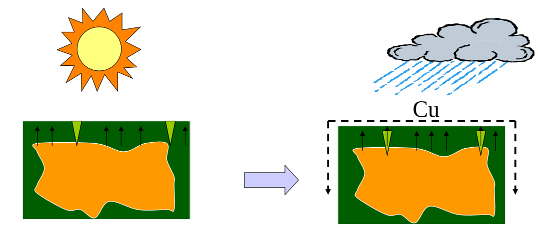
Leaching of copper



Unfixed copper leached from the surface

Surface content is depleted during initial rain events

Leaching of copper



During drying mobile copper moves to the surface

During further rain events mobile copper at the surface is moves into checks or is leached

Migration of copper into checks

CA-B – hem-fir
- Avge. 0.43 mg Cu/g wood
  (0.26 – 0.54 mg Cu/g wood)

ACQ – hem-fir
- Avge. 0.49 mg Cu/g of wood
  (0.47 – 0.52 mg Cu/g wood

CCA – hem-fir
- Avge. 0.29 mg Cu/g wood

Corrosion of fasteners and connectors in contact with treated wood

Objectives

- Investigate the performance of commercial fasteners and connectors in contact with alkaline copper treated wood
- Evaluate field performance of fasteners and connectors

What is corrosion?

- Metals react with oxygen in the presence of water to form oxides.
- The problem with iron (and many metals) is that the oxide formed does not attach well to the metal surface.
- It flakes off easily causing “pitting” which weakens the fastener.

What is corrosion?

- The amount of water complexed with the iron controls the colour of rust.
- It may be black to yellow to orange brown (red).

Wood is corrosive to metals

Factors affecting iron reactions are
- Tannin content
- pH
- Moisture Content
- Oxygen
- Temperature

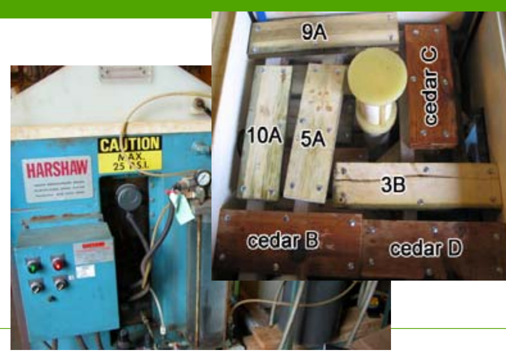
Treated wood

Factors affecting corrosion in treated wood
- Same as untreated plus-
- Corrosion inhibitors (Cr, As etc.)
- Residual solvent (ammonia, amine, acids, etc)
- Mobile noble metal e.g. copper

How do we control corrosion?

- **Organic and Inorganic coatings**
- **Metallic coatings**
- **Combination coatings**

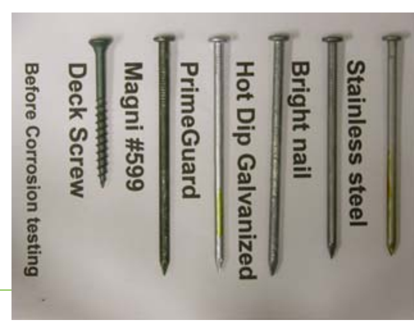
How do we test fasteners?



Materials

- ACQ treated wood purchased from local Home Depot stores
- CX and ACQ supplied from commercial treatment
- CCA wood samples purchased from Home Hardware, Vancouver
- Nails selected for the corrosion research based on suppliers recommendation as suitable for alkaline copper treated wood

Fasteners before exposure



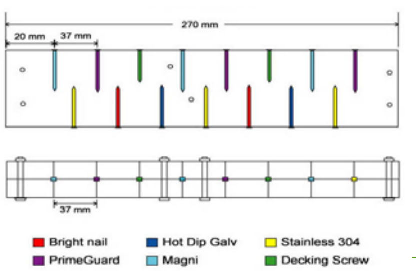
Fastener preparation

Nails hammered into wood and removed by carefully splitting wood

Nails weighed before placing in the sandwiched samples

Effects of mechanical action

Fasteners placed in wood sandwich



Climate conditions

- Harshaw Environmental chamber 0.7 x 0.76 x 1 m
- Water temperature – 32 ° C
- Water mist pressure – 10 Pa
- No direct spraying of fastener heads
- Continuous misting except during evaluation

Evaluation Protocol

Evaluation of Corrosion Level

- Visual Observation (ASTM D610-01 based on white rust and red rust formation. 100% red rust = 100 %)
- Weight Loss
- Diameter Loss (Steel Core Cross-Section Reduction)
- Pit depth
- Bending Yield Strength Testing

Treated wood

- ACQ treated spruce
- CCA treated hem-fir
- ACQ treated lodgepole pine
- CX treated hem-fir
- Western red cedar

Visual Results Bright – 830 hrs

- CCA

- ACQ

Visual Results - hot dipped Zn – 830 hrs

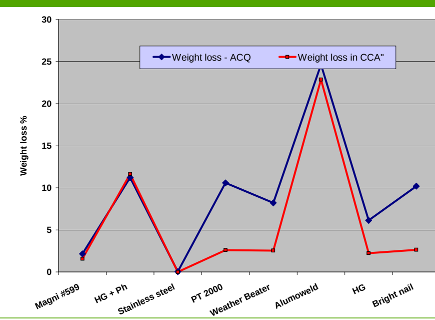
- CCA

- ACQ

Weight loss

- Weight Loss.
- Ultrasonic Bath used to clean the corrosion Products.
- Less accurate than diameter measurement due to difficulty of removing corrosion products.

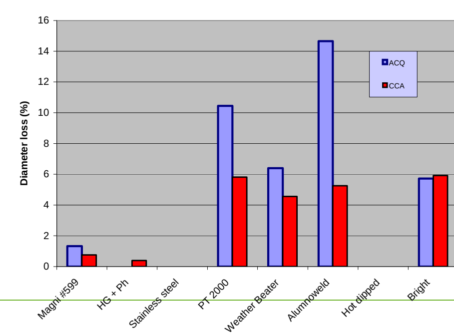
Weight loss CCA vs ACQ



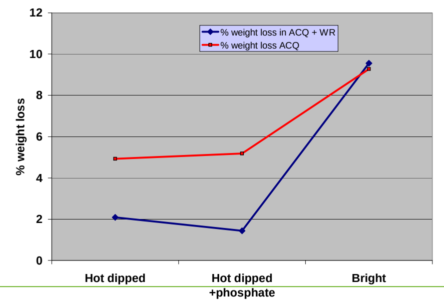
Diameter loss (%)

- Diameter loss (Steel Core Cross-Section Reduction)
- Measured with Caliper to 0.0025 mm
- Can also be used to calculate cross sectional area loss
- Fails to assess pitting corrosion – pit depth

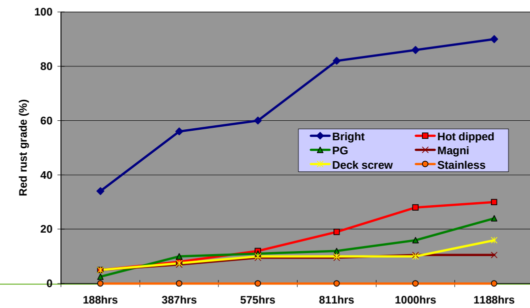
Diameter loss (%)



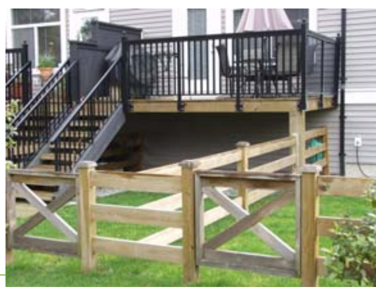
Influence of water repellants on ACQ spruce – weight loss



Visual corrosion rate ACQ+WR



What happens in the real world and why?



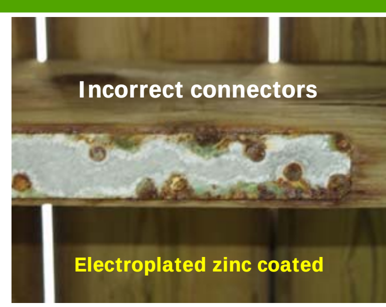
What happens in the real world and why?

- **Incorrect fasteners and connectors**
  - Common nails
  - Electroplated galvanized nails
  - Aluminum connectors
  - Inadequate barrier coatings

What happens in the real world and why?

Incorrect fasteners

What happens in the real world and why?



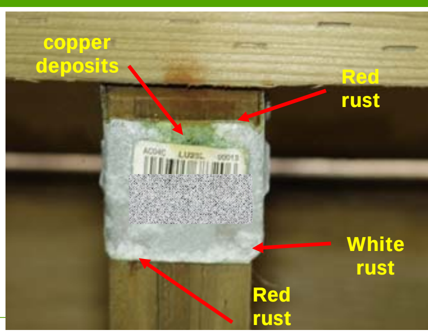
What happens in the real world and why?

- Incorrect fasteners and connectors
- Incompletely fixed copper in alkaline copper treated wood

What happens in the real world and why?

Copper deposits on wood surface, but no watermarking, suggesting reaction with unfixed copper in wet wood

What happens in the real world and why?



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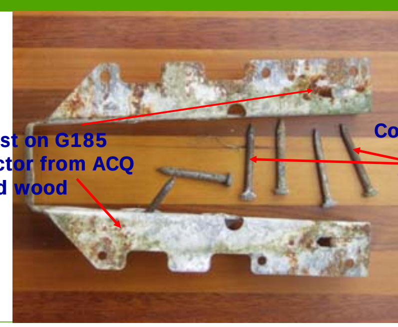
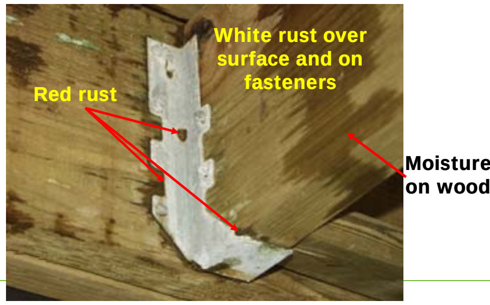


What happens in the real world and why?

- Incorrect fasteners and connectors
- Incompletely fixed copper in alkaline copper treated wood
- Red rust formed on unprotected edges of G185 connectors
  - Will this red rust lead to accelerated corrosion of galvanized face?

What happens in the real world and why?

What happens in the real world and why?



What happens in the real world and why?

Damage to heads and shank during nailing?

What happens in the real world and why?

- **Incorrect fasteners and connectors**
- **Incompletely fixed copper in alkaline copper treated wood**
- **Red rust formed on unprotected edges of G185 connectors**
- **Surface loading of copper due to perceived end use or incising**

What happens in the real world and why?

What happens in the real world and why?

- **Not all fasteners or connectors corrode**

What happens in the real world and why?

What happens in the real world and why?

Real world

- Alkaline copper treated wood is more corrosive than CCA treated wood
- Some connectors with G185 galvanizing showed red rust in less than 2 years
- Red rust was found on some galvanized connectors, even though no signs of wetting, suggesting mobile chemical in wet wood when delivered was causing corrosion
- Incised lumber appeared more corrosive than unincised lumber

Real world

- Fastener heads appeared susceptible to damage of the galvanizing during hammering resulting in corrosion
- Aluminum connectors, brackets, and flashing should not be used in contact with alkaline copper treated wood
- Lack of fixation of alkaline copper treated wood prior to use, will increase corrosion

Acknowledgements

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