Bridge Durability and Preservative Issues

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SmallWood 2010
April 20-22
Hot Springs, AR
Timber bridges can provide superior performance for many years with proper maintenance.
Modern engineered timber bridges

Cost effective
Aesthetically pleasing
Periodic inspections assure long service life

Problems:
- Improper installation
- Lack of inspection
- Lack of maintenance
- Lack of in-place treatment
- Improper retrofit techniques
Causes of deterioration

- Chemical
- Physical
- Biological
Chemical Deterioration

- Acidic wood
- Salt water
- Non-galvanized fasteners
- Salt water + certain water based preservatives

Salt damage causes a “fuzzy” appearance

Bridge fastener damage following exposure to water-based preservative
Physical deterioration

- Salt
- Vehicular damage
- Spillage of fertilizer
  Causes degradation to wood and corrosion to fasteners
- Fire
- Overload
- Animal damage
Biological degradation

Fungal
- Brown rot (#1)
- White rot
- Soft rot
- Mold and sapstain

Insects
- Termites (#2)
- Carpenter ants
- Powder post beetles

Marine borers
- Mollusks
- Crustaceans
Types of fungal decay

- Mold and sapstain
  - no strength loss
- Brown rot decay
  - rapid strength loss
- White-rot decay
  - gradual strength loss
- Soft rot decay
  - slow progression inward
Two main types of decay

**White-rot**
- Prefers hardwoods
- Gradual strength loss
- Wood becomes bleached and spongy
- Normally retain shape and size

**Brown-rot**
- Prefers softwoods, but not fussy eaters
- Rapid strength loss
- Wood becomes dark brown and crumbles
- Wood eventually collapses
- Can survive for years in dry wood and then reactivate when wet
Brown rot Decay fungi

- Decrease strength
- Darkens wood
- Requires food, water, temp.
- Starts where end grain (cross-section) is exposed to weather (pile tops cut on-site)
Termites

- Most common insect problem
- Can severely damage support or structural members
- Especially problematic
  - In soil contact
  - Near bridge abutments
Corrective actions

- Pile caps
- Back fill backwalls
- In-place treatments
Marine borers

Mollusks
- Small entrance holes below water surface
- Remain unnoticed until piling failure
- Create shell-lined galleries
- Bore into wood for protection not food
- Intolerant of creosote
- May cause significant strength loss
Crustaceans

- Attack wood surface near waterline
- Result in decrease in pile diameter
- Move from pile to pile
- Creosote tolerant
Control options for marine borers

General protection
  – Plastic barriers around piles
  – Steel/metal sleeves around piles
  – Concrete barriers

Specific protection
  – Creosote treatment for mollusk control
  – Dual treatment for crustacean control
    (ACZA or CCA plus creosote)
Problems occur when

- Pile tops are cut on site
- Components are notched
- Components are drilled for fasteners
Inspect on regular intervals

- Inspect: 5 -10 yr rotation
- Piles
- Joints
- Ground contact areas (retaining walls, posts, piles)
- Deck
- Fasteners
Critical areas for inspection and remedial treatment

- Joints
- Fasteners
- Checks
- Splits
- Pile tops
- Pile groundline
- Pile waterline
Inspection methods

- Visual assessment
- Probing/pick test
- Moisture measurement
- Sounding
- Drill resistance
- Core boring
Supplemental (in-place) Treatments

Chemical barrier
- Diffusible
  - Borates or fluorides (pastes, liquids, rods)
  - Can penetrate 100% of the wood member
- Non-diffusible
  - “Envelope” treatments
  - Topical protective barrier
  - Normally oil-based (creosote) = water repellent
- Fumigants
  - Liquid or gas → drilled holes

Physical barrier
## Properties and uses of in-place preservatives

<table>
<thead>
<tr>
<th>In-place Preservative Type</th>
<th>Active Ingredient</th>
<th>Solvent Type</th>
<th>Internal vs. External</th>
<th>Leeching or Diffusing</th>
<th>Bridge Location</th>
<th>Handling &amp; other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface treatment liquid</td>
<td>Copper naphthenate</td>
<td>Oil</td>
<td>External sprayed or brushed</td>
<td>Insoluble in water</td>
<td>Bolt holes, exposed end grain, checks &amp; splits</td>
<td>Non-RUP</td>
</tr>
<tr>
<td>Surface treatment liquid or powder</td>
<td>Borate solutions</td>
<td>Water</td>
<td>External sprayed or brushed</td>
<td>Leech away by precipitation</td>
<td>Bolt holes, exposed end grain, checks &amp; splits</td>
<td>Non-RUP</td>
</tr>
<tr>
<td>Surface treatment paste</td>
<td>CuNap, sodium fluoride, Cu-Hydroxide, borates</td>
<td>Water</td>
<td>External &amp; covered with wrap</td>
<td>Boron &amp; fluoride move into wood, Copper stays at surface</td>
<td>Ground line area of terrestrial piles &amp; under pile caps</td>
<td>Non-RUP</td>
</tr>
<tr>
<td>Diffusible Chemical Liquid</td>
<td>Boron, fluoride, copper</td>
<td>Water</td>
<td>Internal through drilled holes</td>
<td>Needs moisture to diffuse into wood</td>
<td>Pile &amp; deep timbers w/ drill accessibility</td>
<td>Non-RUP, Low toxicity &amp; ease of handling</td>
</tr>
<tr>
<td>Fumigant liquid</td>
<td>Chloropicrin</td>
<td>NA</td>
<td>Internal through drilled holes</td>
<td>Volatizes into gas &amp; move into wood</td>
<td>Pile &amp; deep timbers w/ drill accessibility</td>
<td>RUP</td>
</tr>
<tr>
<td>Fumigant Solid</td>
<td>Solid-melt MITC</td>
<td>NA</td>
<td>Internal through drilled holes</td>
<td>Volatizes into gas &amp; move into wood</td>
<td>Pile &amp; deep timbers w/ drill accessibility</td>
<td>RUP</td>
</tr>
<tr>
<td>Fumigant liquid</td>
<td>Methan Sodium (Vapam)</td>
<td>NA</td>
<td>Internal through drilled holes</td>
<td>Volatizes into gas &amp; move into wood</td>
<td>Pile &amp; deep timbers w/ drill accessibility</td>
<td>RUP</td>
</tr>
<tr>
<td>Fumigant Solid</td>
<td>Granular Dazomet</td>
<td>NA</td>
<td>Internal through drilled holes</td>
<td>Volatizes into gas &amp; move into wood</td>
<td>Pile &amp; deep timbers w/ drill accessibility</td>
<td>RUP</td>
</tr>
</tbody>
</table>
Methods of applying in-place treatments

- Brush
- Spray
- Pastes/Gels
- Rods
- Pads/Bandages
- Liquids
Where to apply in-place treatments

- Joints
- Fasteners
- Checks, voids, splits (normal weathering)
- Structural members at joints
- Exposed ends
- Areas in ground contact
- Decking
- Piling
– Penetrates
– Performed prior to delivery to the site
– All end grain surfaces are treated
AWPA Use Category System

- UC1-Interior, above ground dry
- UC2-Interior, above ground, damp
- UC3-Exterior, above ground
- UC4-Ground contact or fresh water
- UC5-Salt water exposure
<table>
<thead>
<tr>
<th>Bridge Element</th>
<th>Commodity</th>
<th>Use</th>
<th>Exposure</th>
<th>Use Category</th>
<th>Commodity Specification (U1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Section</td>
</tr>
<tr>
<td>Piling</td>
<td>Piles, round</td>
<td>Highway construction</td>
<td>Ground contact or fresh water</td>
<td>4C</td>
<td>E</td>
</tr>
<tr>
<td>Backwall</td>
<td>Lumber &amp; timbers</td>
<td>Highway construction</td>
<td>Ground contact or fresh water</td>
<td>4B</td>
<td>A</td>
</tr>
<tr>
<td>Cap beam</td>
<td>Lumber &amp; timbers</td>
<td>Highway construction</td>
<td>Ground contact or fresh water</td>
<td>4B</td>
<td>A</td>
</tr>
<tr>
<td>Stringer</td>
<td>Lumber &amp; timbers</td>
<td>Highway construction</td>
<td>Ground contact or fresh water</td>
<td>4B</td>
<td>A</td>
</tr>
<tr>
<td>Decking</td>
<td>Decking</td>
<td>Highway bridge structural</td>
<td>Above ground</td>
<td>4B</td>
<td>A</td>
</tr>
<tr>
<td>Glue-laminated beams and panels</td>
<td>Glue-laminated beams</td>
<td>Highway important structural</td>
<td>Ground contact or fresh water</td>
<td>4B</td>
<td>F</td>
</tr>
<tr>
<td>Glue-laminated beams and panels</td>
<td>Glue-laminated beams</td>
<td>Highway critical structural</td>
<td>Ground contact or fresh water</td>
<td>4C</td>
<td>F</td>
</tr>
<tr>
<td>Handrails &amp; guardrails</td>
<td>Handrails &amp; guardrails</td>
<td>Highway construction</td>
<td>Above ground, exterior</td>
<td>3B</td>
<td>A</td>
</tr>
<tr>
<td>Guide, Sign, &amp; Site Post</td>
<td>Post round</td>
<td>Highway construction including guide, sign and sight</td>
<td>Ground contact or fresh water</td>
<td>4A</td>
<td>B</td>
</tr>
<tr>
<td>Guardrail post &amp; spacer block</td>
<td>Post round</td>
<td>Highway construction including guardrail posts, spacer blocks</td>
<td>Ground contact or fresh water, moderate decay</td>
<td>4B</td>
<td>B</td>
</tr>
<tr>
<td>Guardrail post &amp; sign post</td>
<td>Post (sawn 4 sides)</td>
<td>Highway construction, general</td>
<td>Ground contact or fresh water</td>
<td>4A</td>
<td>A</td>
</tr>
</tbody>
</table>
Thank you!