21st Century Covered Bridge Design
John Smolen P.E., P.S.
Presentation Overview

• Background on Covered Bridges
  • Current Covered Bridge Numbers
  • Truss Types
• Advantages of Covered Timber Bridges
• New Construction- Old verses Modern
  • Truss Loadings & Stresses
  • Timber Treatments
  • Glue Lamination
  • Galvanization
• Smolen Gulf Covered Bridge Construction
• Liberty Street Covered Bridge
• Miscellaneous Covered Bridge Examples
Covered Bridge Numbers

- Only ~880 remain today
- Majority are in 6 states
- Pennsylvania has 227
**Kingpost Truss**
- Clear span: 7 – 21 meters
- 30 surviving structures

**Queenpost Truss**
- Clear span: 8 – 40 meters
- 101 surviving structures

**Multiple Kingpost Truss**
- Clear span: 11 – 38 meters
- 95 surviving structures

**Burr Arch Truss**
- Patented 1804
- Clear span: 10 – 68m
- 224 surviving bridges
- Longest single spans
- Increased stability

**Town Lattice Truss**
- Patented 1820
- Clear span: 8 – 50 meters
- 135 surviving structures
- Sawn timbers (vs. hand hewn)

**Howe Truss**
- Patented 1840
- Clear Span: 6 – 60 meters
- 143 surviving structures
**Timber Covered Bridges - Advantages:**

- Designed to Carry Modern Truck Traffic
- Aesthetically Pleasing
- Long Useful Life
- Low Dead Weight
- Resistant to Deicing Salt
- Timber is a Renewable Resource
- Absorbs Impact Loading
- Year Round Construction
- Negligible Thermal Expansion
- Low Total Cost of Ownership
- A Destination that Provides Shelter

*Oldest Known Covered Bridge*

*Asia, Circa 975 AD*
MODERN COVERED BRIDGE CONSTRUCTION
Truss Member Stresses

- **Tension**
- **Compression**
# Common Pressure Preservatives for Wood Treatment

## Water Borne

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Primary Constituents</th>
<th>Applications</th>
<th>Approvals</th>
<th>Attributes</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCA</strong></td>
<td>Chromated Copper Arsenate</td>
<td>2, 3B, 4A, 4B, 4C, 5A, 5B, 6C</td>
<td>AWPA, AASHTO</td>
<td>Proven durability</td>
<td>Only allowed for industrial applications. No longer acceptable for consumer applications and intimate skin contact. Should not be used for Douglas Fir (See ACZA).</td>
</tr>
<tr>
<td><strong>ACZA</strong></td>
<td>Amonical Copper Zinc Arsenate</td>
<td>2, 3A, 3B, 4A, 4B, 4C, 5A, 5B, 6C</td>
<td>AWPA, AASHTO</td>
<td>Bonds w/ Douglas Fir</td>
<td>Primarily used w/ Douglas Fir. Corrosivity similar to ACQ. Wood can be very dark brown in color w/ green streaks.</td>
</tr>
<tr>
<td><strong>ACQ</strong></td>
<td>Alkaline Copper Quat</td>
<td>2, 3A, 3B, 4A, 4B, 4C</td>
<td>AWPA, AASHTO</td>
<td>Alternative to CCA. Bonds w/ Douglas Fir</td>
<td>Elevated copper content can be corrosive to plated steel and aluminum. Do use in contact with aluminum. Requires hot-dipped or stainless hardware. Harder to find in SYP, being replaced by MCQ/MCA.</td>
</tr>
<tr>
<td><strong>CA</strong></td>
<td>Copper Azole</td>
<td>2, 3A, 3B, 4A, 4B, 4C</td>
<td>AWPA, AASHTO</td>
<td>Alternative to CCA.</td>
<td>Elevated copper content can be corrosive to plated steel and aluminum. Do use in contact with aluminum. Requires hot-dipped or stainless hardware.</td>
</tr>
<tr>
<td><strong>MCQ/MCA</strong></td>
<td>Micronized Copper Quat/Azole</td>
<td>2, 3A, 3B, 4A, 4B, 4C</td>
<td>ICC, AASHTO</td>
<td>Less corrosive than ACQ. Natural wood color.</td>
<td>Can not be used with Douglas Fir. Natural wood color can make it hard to identify compared to untreated wood (look for end tag). Quat vs Azole depends on source of chemical.</td>
</tr>
<tr>
<td><strong>JICA-C</strong></td>
<td>Dispersed Copper Azole</td>
<td>2, 3A, 3B, 4A, 4B, 4C</td>
<td>ICC</td>
<td>Less corrosive than CA. Natural wood color.</td>
<td>Can not be used with Douglas Fir. Equivalent to MCQ. Some suppliers refer to &quot;Micronized&quot; others &quot;Dispersed&quot;.</td>
</tr>
<tr>
<td><strong>PTI</strong></td>
<td>Propaconazole Tebuconazole Imidacloprid</td>
<td>2, 3A, 3B</td>
<td>AWPA</td>
<td>Metal free. Natural wood color.</td>
<td>Approved for above ground contact only.</td>
</tr>
<tr>
<td><strong>Ecolife</strong></td>
<td>DCOIT Imidacloprid</td>
<td>2, 3A, 3B</td>
<td>ICC</td>
<td>Metal free. Natural wood color.</td>
<td>Approved for above ground contact only.</td>
</tr>
<tr>
<td><strong>Borate</strong></td>
<td>Disodium Octaborate Tetrahydrate</td>
<td>UC2, UC3A</td>
<td>AWPA (not for exterior)</td>
<td>Completely penetrates wood.</td>
<td>Does not bond with wood. Must be protected from weather or borates will leach out. Should not be used for exterior applications.</td>
</tr>
</tbody>
</table>
# Common Pressure Preservatives for Wood Treatment-2

## Oil-Borne

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Constituents</th>
<th>Applications</th>
<th>Approvals</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penta Type A</td>
<td>Penta-chlorophenol</td>
<td>3B, 4A, 4B, 4C, 5A, 5B, 5C</td>
<td>AWPA, AASHTO</td>
<td>Waterproof. Durability similar to creosote. Limited use pesticide. Oil residue may be present, limit intimate skin contact. Can migrate in wood.</td>
</tr>
<tr>
<td>Penta Type C</td>
<td>Penta-chlorophenol</td>
<td>3A, 3B, 4A, 4B, 4C</td>
<td>AWPA, AASHTO</td>
<td>Dry to the touch. Limited waterproofing. Color will fade.</td>
</tr>
<tr>
<td>CuNap</td>
<td>Copper Naphthenate</td>
<td>3B, 4A, 4B, 4C, 5A, 5B, 5C</td>
<td>AWPA, AASHTO</td>
<td>Waterproof. Durability similar to creosote. Not a dermal toxin - skin contact okay. Some aroma.</td>
</tr>
<tr>
<td>Creosote</td>
<td>Creosote</td>
<td>4A, 4B, 4C, 5A, 5B, 5C</td>
<td>AWPA, AASHTO</td>
<td>Waterproof. Benchmark for durability. Limited supply. Restricted use pesticide. Dermal toxin, workers should wear skin protection, avoid intimate skin contact.</td>
</tr>
</tbody>
</table>

This list has been compiled as a quick reference for the growing number of pressure preservatives available for wood treatment. Applications are based on American Wood Protection Association Use Categories. This summary should not be used exclusively when determining the appropriate preservative(s) for a specific project. AASHTO M168 recognizes preservatives with an appropriate ICC-ESR (International Code Council Evaluation Service Report). Additional information can be found at the following websites:

- Western Wood Preservers Institute: [www.wwpinstitute.org](http://www.wwpinstitute.org)
- American Wood Protection Association: [www.awpa.com](http://www.awpa.com)
Modern Glue Laminated Timber Structural Members
The Glue Lamination Manufacturing Process

1. Spruce logs
2. Sawn timber
3. Kiln drying
4. Stress grading
5. Finger jointing
6. Planing
7. Glue application
8. Glue line pressure applied
9. Planing
10. Wrapping
The Manufacturing Plant Should Be An American Institute of Timber Construction Plant

An AITC Inspected And Approved Manufacturing Plant Assures Tight Quality Control
Final Size Planing

Bridge Members are Glued With A Waterproof Glue Such As Resorcinol
Hot Dip Galvanizing of All Steel Bridge Parts for Corrosion Control
Smolen Gulf Covered Bridge
Ashtabula, Ohio

Contractor: Union Industrial Contractors
Owner: Ashtabula County Engineer
Sixty Year Old Stringer Bridge to Be Removed
The Substructure Included Three Piers and Two Stub Abutments. Note the Galvanized Rebar
Prefabricated Glued Laminated Treated Floor Beam Being Installed
Prefabriacated Structure Being Assembled

Structure Will Be Launched Onto Substructure
Floor Beam Being Positioned. Note that structural timber treated glued laminated Southern Pine.
Some Site Fabrication Was Necessary
The Two Midspans Were Assembled In the Valley and Tarped For the Winter. Note the 40,000 CuYd Approach Embankment.
The Forward Span In Position
Erection Sequence
Galvanized Roofing Being Assembled
Crew's Take Extra Pride in Constructing a Timber Covered Bridge Because They Are High Profile and Long-Lasting.
Longest Covered Bridge In The Nation
Liberty Street Covered Bridge

Geneva, Ohio

Substructure Contractor: Schwartz Construction
Superstructure: Ashtabula County JVS
Kingpost Main Truss Treated with Copper Napthenate
Timber Sawn From Donated Local Logs
CDBG paid for road paving
18’ – shortest authentic timber covered bridge in USA
Giddings Road Covered Bridge - Ashtabula County, Ohio