

Timber Bridge Deterioration Issues and Performance Measures

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Presentation Outline

- ❑ Committee Membership
- ❑ Background on Timber Bridges
- ❑ Key Deterioration Issues
- ❑ Key Performance Measures
- ❑ Summary

Membership - ASCE Timber Bridges

□ 10 committee members currently

- William Davids U. Maine
- Scott Groenier Missoula T&D Center
- Phil Pierce Clough, Harbour & Assoc
- Doug Rammer Forest Products Lab
- Mike Twiss NY-DOT
- Art Johnston USDA Forest Service
- Paul Gilham Western Wood Structures
- Nur Yazdani U. Texas at Arlington
- Pizhong Qiao Washington State U.
- James Wacker Forest Products Lab

Timber Highway Bridge Profile

- ❑ ~80,000 timber bridges (National Bridge Inventory)
- ❑ 1 out of every 6 bridges
- ❑ Low-volume, rural roadways
- ❑ Typically 10-60 ft span range
- ❑ Unique as a bridge material
 - Strength/weight ratio
 - Short-term overload
 - Long-term durability relies on effective moisture control



Historical Covered Timber Bridges

- ❑ Primary structural components kept dry
- ❑ Some lasting 100+ yrs with proper maintenance & repairs
- ❑ Need to strive for higher durability for modern bridges



Timber Bridge Deterioration Issues

- Widespread problems which can significantly reduce bridge service lives.

Timber Bridge Deterioration Issues

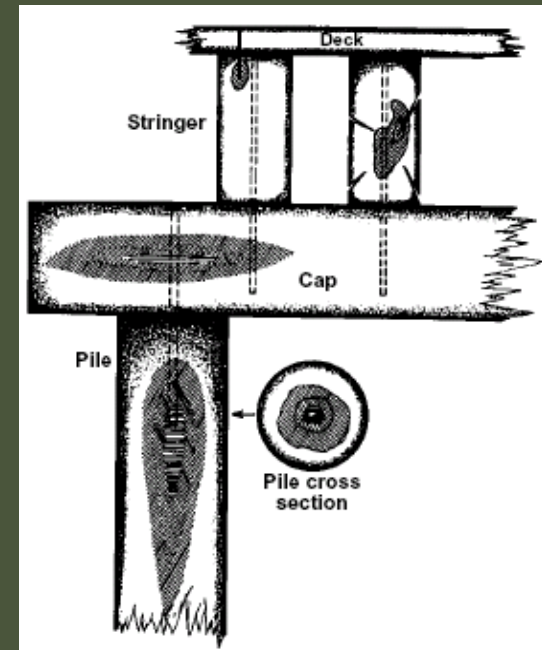
Over reliance on preservative treatment

- Protective shell of treated wood
 - Pressure-treatment of all structural members
 - Field treatment of all field cuts & borings



- Avenues for deterioration

- Vertical connections into beams and caps
- Field "brush" treatments not as effective
- In-service checking (top surface worst)



Timber Bridge Deterioration Issues

Over reliance on preservative treatment

❑ Short term solutions

- Do not allow on-site drilling or boring
- Alternative connection details
- Saw-kerfing underside to minimize checking

❑ Long-term Solutions

- Develop more durable protection measures



Timber Bridge Deterioration Issues

Poor moisture-drainage details

❑ Current Practice—precipitation

- Waterproof membrane & crowned asphalt
- Place bridge on slight grade to facilitate drainage

❑ Moisture traps prevent proper drainage

- Debris accumulates
- Favorable conditions for incipient decay



Timber Bridge Deterioration Issues

Poor moisture-drainage details

□ Possible solutions

- End grain areas, maintain air movement
- Introduce overhangs, drip edges, and flashing
- Extend membranes when feasible
- Joint detail for reflective cracking



Timber Bridge Deterioration Issues

Insufficient inspection practices

□ Routine Inspection

- Visual techniques, with some hammer-sounding
- Shell-thickness boring seldom

□ Condition ratings unreliable

- High variability, inspector dependent
- Unfamiliarity with timber bridge components
- Overly conservative



Timber Bridge Deterioration Issues

Insufficient inspection practices

□ Possible Solutions

- Measures of internal integrity
 - Stress-wave, resistance drilling, etc.
- Designing for inspection
- Develop effective monitoring system w/sensors for early detection of problems



Timber Bridge Deterioration Issues

Inconsistent maintenance & repairs

- ❑ Current Practice—
 - Maintenance/ minor repairs
 - Routine maintenance sporadic
 - Most repairs occur after significant decay

- ❑ Common bridge problem
 - New Emphasis Needed
 - Re-prioritize funding process
 - More diligent maintenance practices AND timely repairs



Timber Bridge Deterioration Issues

Elevated moisture contents

- ❑ Current Practice—Moisture Content @ Installation
 - Specify 19% maximum MC for all bridge components
 - Compliance is poor (enforcement, drying defects, cost)
 - Post treatment drying - waterbornes

- ❑ Conditions favorable for internal deterioration
 - Oil-type treatments slow drying process
 - Field cuts and borings become highly susceptible

- ❑ Possible solutions
 - Glulam components must be dried for manufacture
 - Utilize new drying (RF, microwave) technologies for improved large timbers

Timber Bridge Performance Measures

- Needed performance indicators to achieve reliable system for long-term bridge monitoring.

Timber Bridge Performance Measures

Early warning of internal damage activity

- ❑ Current Practice—Internal decay detection
 - Wait for visual detection
 - Significant internal damage has occurred

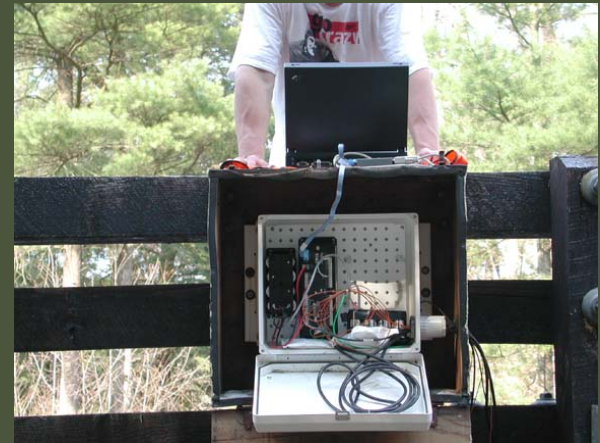
- ❑ Embedded array sensors approach
 - Triggers appropriate remedial action

- ❑ Possible solutions
 - Decay detection kit within routine inspection
 - Develop new sensors technologies

Timber Bridge Performance Measures

Moisture contents conducive for decay

- ❑ Current Practice—
 - Measuring in-situ moisture
 - Hand-held electrical resistance probe
 - Localized data with 3 inches probes
- ❑ Embedded array sensor approach
 - Triggers appropriate remedial action
- ❑ Wetness sensors at topside timbers (beams & caps)
 - Triggers appropriate repair action
- ❑ Reliable sensors for measuring wood moisture



Timber Bridge Performance Measures

Deflection/Strain under service live loads

- ❑ Current Practice—
Load test performance
 - Triggered by low overall bridge rating
 - Static testing methods
 - Costly & time-consuming
- ❑ Embedded sensor approach (target areas)
 - Estimate axle loads or pre-weighed vehicle
 - Burst of deflection/strain data
- ❑ Fiber-optic & other technologies



Timber Bridge Performance Measures

Vibration as measure of system integrity

□ In-place vibration testing

- Automated control system
- Detects changes in vibration characteristics
- Potential for estimating overall stiffness and strength
- Environmental issues



Summary

□ Main Deterioration Issues

- Over reliance on preservative treatment
- Poor moisture management / drainage
- Insufficient inspection practices
- Inconsistent maintenance and repairs
- Elevated moisture content at installation

- Requires major shift in all aspects: design, construction, inspection, maintenance, and repairs

Summary, Cont'd

- Proposed Long-Term Perf. Indicators
 - Early warning of internal decay / insect activity
 - Moisture content levels conducive for decay
 - Deflection & Strain under service live loads
 - Vibration as a measure of system integrity
- Need new technologies to fully implement a reliable long-term health monitoring system

**Timber Bridge
Deterioration Issues and Performance Measures**



Thanks for your attention!

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