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Development of a Six-Year Research Needs Assessment for Timber Transportation Structures

Terry J. Wipf, Micheal A. Ritter, Sheila Rimal Duwadi, Russell C. Moody

Ranking of Research Needs by Category

In this section, each research need is ranked by research category: materials, preservatives, system development and design, construction, inspection, maintenance and rehabilitation, economics, and other. The number in the far left column indicates the ranking within the category; the number in parentheses indicates the overall ranking relative to all stated research needs.

Materials

1. (27) Refine horizontal shear design values and requirements for sawn lumber and glulam timber.

2. (29) Evaluate effect of aging, moisture cycling, and repetitive loading on lumber stiffness.

3. (31) Develop specifications and standards for use of structural composite lumber, including LVL and parallel strand lumber in highway structural applications.

4. (32) Evaluate suitability and performance characteristics of structural composite lumber in exposed bridge applications.

5. (40) Evaluate effect of preservative treatment (chemicals and treating processes) on sawn lumber and glulam timber produced from hardwood species and structural composite lumber products produced from either hardwoods or softwoods.

6. (46) Evaluate effects of salt and de-icing chemicals on physical and mechanical properties of wood.

7. (47) Compile material resistance values for use in LRFD design for lumber, glulam, and timber piles.

8. (52) Compile and distribute information on use of hardwoods and secondary softwoods in bridge applications.

9. (58) Develop technology for economical glulam timber manufactured from hardwood or secondary softwood species.

10. (60) Evaluate suitability of galvanizing and epoxy coatings to protect stress-laminated bridge stressing bars from corrosion.

11. (66) Investigate feasibility of gluing wood treated with creosote or other oilborne preservatives to improve treatment of large glulam members.

12. (70) Develop innovative methods of using steel, reinforced plastics, or other materials to improve strength and stiffness of timber components.

13. (71) Evaluate effect of cold temperature on physical and mechanical properties of wood under static and dynamic loading conditions.

14. (76) Determine effect of moisture content on properties of hardwood lumber.

15. (81) Develop fatigue level (S-N) curves for softwood and hardwood lumber species.

16. (83) Determine potential creep characteristics for lumber and glulam timber manufactured from softwood and hardwood.

17. (86) Develop new methods of protecting stress-laminated deck stressing bars against corrosion, including coatings and cathodic and mechanical protection.

18. (89) Refine NDS properties for visually graded and mechanical hardwood lumber through in-grade testing.

19. (2) Develop technology for glulam timber manufactured from mixed species.

20. (7) Refine methods for assigning property values to hardwood lumber.

21. (1 02) Develop economical, portable, reliable, and simple-to-use methods and equipment for machine grading hardwood and softwood lumber.

22. (108) Develop methods for determining residual strength of fire damaged timber components.

23. (1 09) Develop quality control procedures appropriate for mechanical grading of lumber from mixed species that are applicable to small mills.

24. (111) Evaluate volume effect on strength and stiffness properties of hardwood structural lumber.

25. (1 15) Conduct grade and yield studies for hardwood logs, considering commercially viable species.

26. (1 17) Develop economical, portable equipment to scan and evaluate suitability of log for structural lumber before cutting the log.

Preservatives

1. (4) Develop guidelines on effectiveness, use, and application of wood preservatives for field treating during fabrication and construction, especially for holes and other limited access areas.

2. (6) Develop and test new wood preservative chemicals that do not pose environmental hazards.

3 (18) Evaluate leachability and potential environmental hazards posed by wood preservatives in exposed bridge applications.

4. (22) Develop an informational summary on restrictions, use recommendations, and use of wood preservatives.

5. (26) Develop guidelines for disposal and/or reuse of treated timber in accordance with EPA guidelines.

6. (34) Evaluate effects of CCA and other waterborne preservatives on physical and mechanical properties of wood.

7. (38) Develop guidelines for effectiveness and use of wood preservatives for in-place treating of deteriorated timber components.

8. (42) Develop and evaluate alternative methods of wood preservation, other than chemical preservatives, to protect bridge components from moisture exposure and deterioration (coatings, shielding, composite materials, etc.).

9. (43) Evaluate compatibility and relative bond strength of various adhesives used for glulam timber treated with different wood preservatives, both before and after gluing.

10. (49) Develop guidelines for use of treated timber.

11. (51) Evaluate suitability of waterborne preservatives for sawn lumber and glulam timber relative to dimensional stability in exposed bridge applications.

12. (57) Develop guidelines on treatability and applicability of various preservatives and treatment processes on heartwood and sapwood of all commercially viable softwood and hardwood species.

13. (59) Evaluate effectiveness and develop guidelines and standards for water-repellant additives used in conjunction with waterborne preservatives for hardwood and softwood species.

14. (61) Evaluate effects of wood preservatives on metal hardware and corrosion protection systems for metal hardware.

15. (69) Investigate potential for preservative treatment leaching and distribute information on subject.

16. (78) Establish applicable penetration and retention requirements for use of copper naphthenate in bridge components of softwood and hardwood sawn lumber and glulam timber.

17. (79) Investigate suitability of borate treatments for softwoods and hardwoods used in exposed bridge applications.

18. (84) Develop guidelines for effectiveness and use of fumigants for in-place treating of deteriorated timber components.

19. (98) Revise existing treating standards to limit quantity of untreatable heartwood and restate moisture content requirements to reflect maximum rather than average values.

20. (99) Develop base-line treating cycles for hardwoods and other underutilized species.

21. (105) Investigate suitability and efficacy of existing preservative chemicals and treatment processes for applications involving hardwoods and secondary softwood species.

22. (107) Investigate suitability of diffusible borate for bridges.

23. (1 14) Evaluate feasibility of developing small, mobile pressure-treating units for applying wood preservatives.

System Development and Design

1. (1) Develop crash-tested bridge rails for longitudinal and transverse timber decks, including approach rail transitions, at AASHTO PL-1 and PL-2.

2. (2) Prepare guidelines and standard design details for designing timber bridges for minimum maintenance and long life.

3. (5) Develop standard designs, details, and specifications for timber bridge superstructures.

4. (7) Develop crashworthy bridge rails for low-volume roads.

5. (12) Develop designs and standards for long-lasting, waterproof, skid-resistant wearing surfaces for timber bridges.

6. (13) Develop standard designs, details, and specifications for timber bridge substructures.

7. (15) Conduct field evaluations of existing structures to determine load distribution characteristics of AASHTO-approved timber bridge systems to refine procedures and criteria for design and load rating.

8. (17) Investigate and define acceptable live-load deflection criteria for various timber superstructure and deck types based on structural behavior.

9. (20) Develop prefabricated, modular timber bridge systems that are easily transported.

10. (21) Develop methods for fastening wood decks to steel and concrete stringers for both new construction and replacement decks.

11. (35) Study means for obtaining composite action between timber beams and timber decks.

12. (39) Adapt existing computerized bridge design programs (BRADD, MERLIN-DASH, etc.) to include timber bridges and timber bridge components.

13. (41) Develop interactive computer programs for design of timber bridge systems and timber components used with other bridge materials.

14. (48) Evaluate suitability of timber connections subjected to dynamic loading (fatigue).

15. (50) Develop serviceability requirements for timber bridges based on use requirements.

16. (54) Conduct field evaluations of stress-laminated decks, constructed of various species and exposed to differing environmental conditions, to determine load distribution and performance characteristics.

17. (55) Investigate use of glulam T-beam and box-beam sections for long spans.

18. (63) Develop methods for reducing live-load deflection of AASHTO-approved timber bridge systems.

19. (64) Develop methods and design criteria for post-tensioning timber beams and bridge systems.

20. (72) Investigate potential for composite construction using timber with nonwood materials.

21. (74) Develop modular timber superstructure and substructure designs for temporary applications and portability.

22. (75) Determine lateral support provided for steel beams by different timber deck systems.

23. (77) Develop design criteria for stress-laminated T-section bridges through laboratory and field evaluations.

24. (80) Develop methods and design criteria for longitudinal stress lamination of timber bridges.

25. (82) Develop and field-evaluate new methods for shear transfer between glulam deck panels.

26. (85) Investigate methods for developing bolt-laminated beams and decks.

27. (87) Develop design criteria for timber arches and trusses for submission to AASHTO.

28. (88) Evaluate longitudinal creep characteristics of stress-laminated deck bridges.

29. (91) Investigate and define acceptable live load deflection criteria for performance of wearing surfaces and human response.

30. (93) Investigate and document performance of timber bridges subjected to seismic loading.

31. (loo) Develop design criteria for stress-laminated box-beam bridges through laboratory and field evaluations.

32. (101) Evaluate suitability of using toothed metal plate connectors (truss plates) in bridge components subjected to fatigue loading and cyclic moisture changes.

33. (103) Refine duration of load adjustments for bridge applications.

34. (106) Develop methods for stress-laminating timber with nontimber materials.

35. (1 10) Develop and field test bridges constructed of stress-laminated trusses manufactured with toothed metal plate connectors.

construction

1. (9) Develop guide specifications for timber bridge construction.

2. (30) Develop appropriate guidelines for fabrication, transportation, and storage of timber components and bridge systems.

3. (36) Summarize methods of construction for various timber superstructures and substructures, including case histories.

Inspection

1. (3) Develop economical, easy-to-use equipment and methods to conduct nondestructive testing of in-place timber bridge components, including piles.

2. (8) Prepare comprehensive manual for inspection and evaluation of timber bridges.

3. (10) Develop standardized procedures and specifications for nondestructive evaluation of timber bridge components.

4. (16) Develop standardized methods for load testing and load rating existing timber bridges.

5. (24) Refine inspection methods to more accurately detect incipient decay in timber bridge components.

6. (45) Investigate methods for determining postdecay strength of timber components.

7. (53) Develop methods for determining embedment length of timber piles.

8. (56) Investigate and determine methods for evaluating residual bending strength of beams that have split or have failed in horizontal shear.

Maintenance and Rehabilitation

1. (11) Prepare comprehensive manual on maintenance practices for timber bridges.

2. (19) Develop and evaluate economical, long-lasting methods for sealing and protecting exposed end-grain.

3. (23) Develop materials for sealing wood against moisture in areas where prolonged moisture exposure is likely to occur.

4. (37) Evaluate suitability of wearing surface materials and geotextile fabrics to provide moisture protection to timber bridge decks.

5. (44) Develop methods and comprehensive guidelines for restoring, increasing capacity of, or replacing deteriorated timber components and piles used in bridges with an emphasis on accuracy and minimizing traffic disruption.

6. (73) Develop methods to restore capacity of beams with horizontal shear failures.

7. (95) Refine applications of stress-laminating to include rehabilitation of existing components.

Economics

1. (14) Develop initial cost, life-cycle cost, and design life comparisons of timber bridges and culverts as opposed to steel and concrete bridges and culverts.

2. (25) Develop guidelines for relative cost and design life comparison of various types of timber bridges including composite construction.

3. (28) Collect, analyze, and report bridge cost data obtained through Forest Service, FHWA, and State timber bridge demonstration projects.

4. (65) Develop guidelines for economically optimizing material requirements for specific bridge types.

5. (67) Develop cost-estimating guide for determining transportation, labor, and equipment requirements for timber bridge construction, based on time-in-motion studies of bridge construction projects.

Other

1. (33) implement mechanism for transferring timber bridge technology to users in a timely manner.

2. (62) Compile summary of ongoing timber bridge research and distribute quarterly to interested parties.

3. (68) Develop educational materials for use in colleges and trade schools.

4. (90) Develop data base of timber bridges, by type and material, constructed in United States and Canada over past 30 years.

5. (94) Develop designs and field tests of timber piers, abutments, and culverts.

6. (96) Develop designs for retaining walls and evaluate their field performance.

7. (104) Document experiences and lessons learned from using previously underutilized hardwood and secondary softwood species for bridge construction.

8. (1 12) Develop designs and evaluate field performance of noise barriers constructed of timber, and of timber with other materials.

9. (113) Document economic multiplier effect realized when local materials and labor are used for transportation structures.

10. (116) Complete analysis of bridge needs in United States for next 30 years based on span and functional classification.

11. (118) Evaluate comparative energy requirements for production and construction of timber, steel, and concrete bridges and culverts.