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

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Ranking of Research Needs by Overall Priority

Research needs were ranked, from highest to lowest priority, as follows:

1. Develop crash-tested bridge rails for longitudinal and transverse timber decks, including approach rail transitions, at American Association of State Highway and Transportation Officials (AASHTO) PL-1 and PL-2.
2. Prepare guidelines and standard design details for designing timber bridges for minimum maintenance and long life.
3. Develop economical, easy-to-use equipment and methods to conduct nondestructive testing of in-place timber bridge components, including piles.
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.
5. Develop standard designs, details, and specifications for timber bridge superstructures.
6. Develop and test new wood preservative chemicals that do not pose environmental hazards.
7. Develop crashworthy bridge rails for low-volume roads.
8. Prepare a comprehensive manual for inspection and evaluation of timber bridges.
9. Develop guide specifications for timber bridge construction.
10. Develop standardized procedures and specifications for nondestructive evaluation of timber bridge components.
11. Prepare a comprehensive manual on maintenance practices for timber bridges.

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

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

14. Develop initial cost, lifecycle cost and design-life comparisons of timber as opposed to steel bridges and culverts.

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.

16. Develop standardized methods for load testing and load rating of existing timber bridges.

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

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

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

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

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

22. Develop an informational summary on restrictions, use recommendations, and application of wood preservatives.

23. Develop materials for sealing wood against moisture in areas subject to prolonged moisture.

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

25. Develop guidelines for comparing relative cost and design-life of various types of timber bridges, including composite construction.

26. Develop guidelines for disposal and/or reuse of treated timber in accordance with Environmental Protection Agency, (EPA) guidelines.

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

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

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

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

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

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

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

34. Evaluate effects of chromated copper arsenate (CCA), and other waterborne preservatives on physical and mechanical properties of wood.

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

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

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

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

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

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.

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

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.).

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

44. Develop methods and comprehensive guidelines for restoring, increasing capacity of, or replacing deteriorated bridge timber components and piles with an emphasis on accuracy and minimal traffic disruption.

45. Investigate methods for determining post-decay strength of timber components.

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

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

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

49. Develop guidelines for use of treated timber.

50. Develop serviceability requirements for timber bridges based on use requirements.

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

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

53. Develop methods for determining embedment length of timber piles.

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.

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

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

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.

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

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

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

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

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

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

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

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

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

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.

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

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

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

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

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

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

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

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

76. Determine effect of moisture content on properties of hardwood lumber.

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

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

79. Investigate suitability of borate treatments for softwoods and hardwoods in exposed bridge applications.

80. Develop methods and design criteria for longitudinal stress-lamination of timber bridges.

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

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

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

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

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

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

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

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

89. Refine National Design Specification (NDS) properties for visually graded hardwood lumber through in-grade testing.

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

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

92. Develop technology for glulam timber manufactured from mixed species.

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

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

95. Refine applications of stress lamination to include rehabilitation of existing components.

96. Develop designs for retaining walls and evaluate field performance.

97. Refine methods for assigning property values to hardwood lumber.

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

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

100. Develop design criteria for stress-laminated box-beam bridges through laboratory and field evaluations.

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

102. Develop economical, portable, reliable, and simple-to-use methods and equipment for machine grading hardwood and softwood lumber.

103. Refine duration of load adjustments for bridge applications.

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

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

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

107. Investigate suitability of diffusible borate for bridges.

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

109. Develop quality control procedures appropriate for mechanical grading of lumber from mixed species that are applicable to small mills.

110. Develop and field-test bridges constructed of stress-laminated trusses manufactured with toothed metal plate connectors.

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

112. Develop designs and evaluate field performance of noise barriers constructed of timber and of timber with other materials.

113. Document economic multiplier effect of using local materials and labor for transportation structures.

114. Evaluate feasibility of developing small, mobile pressure-treating units for applying wood preservatives.

115. Conduct grade and yield studies for hardwood logs, considering commercially viable species.

116. Complete analysis of U.S. bridge needs in next 30 years based on span and functional classification.

117. Develop economical, portable equipment to scan and evaluate suitability of log for structural lumber before cutting the log.

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