

## Investigation of Glulam Girder Bridges with Composite Concrete Decks

Nationwide, state departments of transportation, counties, cities, and other bridge owners are facing a rapidly deteriorating inventory of bridges. In response, the focus has turned to developing bridge design and construction alternatives that are sustainable, cost effective, and construction friendly. For decades, timber bridges were the foundation of the bridge inventory on secondary road systems of numerous states, from Vermont, to Iowa and Minnesota, to Oregon. Recent research has found that the performance of those timber bridges, some constructed 50 to 70 years ago, was and still is well above average; yet the number of newly constructed timber bridges built with graded and engineered lumber is only a small percentage of the total of new bridges built each year.

Bridge engineers, designers, and contractors are in need of cost-effective bridge designs utilizing durable, long-lasting materials that are construction friendly and allow them to rehabilitate their debilitating bridge inventories quickly and with confidence. For decades, timber girder bridges with concrete decks have seen limited exposure in the United States but have seen widespread success in the international community. This combination, engineered glued-laminated timber girders with concrete decks, is a design that has great potential to fill this gap.

### Background

A composite timber–concrete bridge consists of a concrete slab rigidly connected to supporting timber sections so that the combination functions as a unit. On single, simple spans, the concrete deck resists compression while the timber resists tension. At intermediate



Example of composite timber girder–concrete deck bridge (Lola Coombe, USDA Forest Service).

supports of continuous spans, the opposite is true. The two basic types of composite timber–concrete bridges are T-beam decks and slab decks.

Composite T-beam decks are constructed by casting a concrete deck, which forms the flange of the T, on a glulam beam, which forms the web of the T. Composite action between the timber and concrete is developed by shear connectors along the beam tops. Numerous T-beam composite decks have been constructed in the past, but they have not been widely used recently because of the misconceived high cost of glulam beam fabrication and the cost of in-place casting of concrete.

Composite slab decks are constructed by casting a concrete layer on a continuous base of longitudinal nail-laminated sawn lumber. The lumber is placed edgewise in the direction of traffic flow, with alternate laminations raised 1-3/8 to 2 in. to form grooves in the base.

### Partners of the National Center for Wood Transportation Structures

IOWA STATE UNIVERSITY  
OF SCIENCE AND TECHNOLOGY



Forest Products  
Laboratory



U.S. Department of Transportation  
**Federal Highway  
Administration**

Composite action between the timber and concrete is most commonly achieved through the use of triangular steel shear developers driven into the grooves. Composite slab decks were first built in 1932 and were used mostly during the 1930s and 1940s (Ritter 1990).

### **Objective**

The objective of this project is to research the state-of-the-practice related to the use of concrete decks in conjunction with glued-laminated timber girders for highway bridge applications.

### **Approach**

Several tasks will be completed to accomplish the project objective:

- Conduct a literature review of bridge designs involving timber girders with concrete decks in the United States. The literature search will be extended to countries such as Germany, Sweden, Finland, and Portugal where this design has recently gained popularity. In addition, literature related to laboratory testing of timber–concrete connection details will be reviewed and documented.
- Complete several sight visits to composite timber–concrete bridges in the United States to evaluate their condition and performance.
- Document existing design details for timber–concrete composite bridges and their state of performance and make recommendations for improvements to existing details and/or development of new details for further evaluation.
- Draft a final report.

### **Expected Outcomes**

The final report from this study will guide bridge engineers on best practices for construction of timber–concrete bridges and development of new details for constructing composite timber–concrete bridges using both cast-in-place concrete decks and precast concrete deck panels. Findings from this study will help to formulate research problem statements that will advance the implementation of timber–concrete bridge technology in the United States.

### **Timeline**

This project will commence June 2015 and be completed by June 2017.

### **Cooperators**

Iowa State University  
USDA Forest Service, Forest Products Laboratory

### **Contact Information**

Travis K. Hosteng  
Iowa State University  
Ames, Iowa  
(515) 294-7197; [kickhos@iastate.edu](mailto:kickhos@iastate.edu)

Jim Wacker  
USDA Forest Service, Forest Products Laboratory  
Madison, Wisconsin  
(608) 231-9224; [jwacker@fs.fed.us](mailto:jwacker@fs.fed.us)

### **Reference**

Ritter, M.A. 1990. Timber Bridges: Design, Construction, Inspection, and Maintenance. Washington, D.C.: USDA Forest Service. 944 p.