INTERIM REPORT

THE ECONOMICS OF THE INTRODUCTION OF MODERN TIMBER BRIDGES IN VIRGINIA

JOSÉ P. GOMEZ, Ph.D., P.E.
Senior Research Scientist

WALLACE T. McKEEL, JR., P.E.
Research Manager

V·I·R·G·I·N·I·A
VTRC
TRANSPORTATION RESEARCH COUNCIL

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

Technical Report Documentation Page

1. Report No. FHWA/VA-97-IR2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle The Economics of the Introduction of Modern Timber Bridges in Virginia		5. Report Date November 1996 6. Performing Organization Code
7. Author(s) Jose P. Gomez and Wallace T. McKeel, Jr.		8. Performing Organization Report No. VTRC 97-IR2
9. Performing Organization Name and Address Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903-0817		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project #0579-020
12. Sponsoring Agency Name and Address Virginia Department of Transportation 1401 E. Broad Street Richmond, VA 23219		13. Type of Report and Period Covered Interim Report 14. Sponsoring Agency Code

15. Supplementary Notes

In cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

In 1990, the Virginia Assembly established a commission to propose recommendations to enhance the economic development of the southside region of the Commonwealth. The commission's 1991 report, House Document 42, included a recommendation for a timber bridge initiative to replace Virginia's structurally deficient bridges. The commission noted that timber bridges could save highway construction funds and stimulate the forest products industry in southside Virginia. This report addresses some of the economic issues. The long-term performance, and thus the life cycle cost competitiveness, of timber bridges cannot be determined at this time. However, timber bridges are not economically competitive from a cost standpoint. The economic viability of timber bridges is adversely affected by the lack of an industry presence in Virginia. This lack also casts doubt on the ability of the Virginia timber bridge initiative to enhance the economic development in the southside region of the Commonwealth.

17. Key Words timber bridges, initial costs, economic analysis, Virginia timber bridge initiative	18. Distribution Statement No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. Of Pages 6	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

INTERIM REPORT

THE ECONOMICS OF THE INTRODUCTION OF MODERN TIMBER BRIDGES IN VIRGINIA

J. P. Gomez, Ph.D., P.E.
Research Scientist

W. T. McKeel, Jr., P.E.
Research Manager

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the
Virginia Department of Transportation and
the University of Virginia)

In Cooperation with the U.S. Department of Transportation
Federal Highway Administration

Charlottesville, Virginia

November 1996
VTRC 97-IR2

ABSTRACT

In 1990, the Virginia General Assembly established a commission to propose recommendations to enhance the economic development of the southside region of the Commonwealth. The commission's 1991 report, House Document 42, included a recommendation for a timber bridge initiative to replace Virginia's structurally deficient bridges. The commission noted that timber bridges could save highway construction funds and stimulate the forest products industry in southside Virginia.

This report addresses some of the related economic issues. The long-term performance, and thus the life cycle cost competitiveness, of timber bridges cannot be determined at this time. However, timber bridges are not economically competitive from a first cost standpoint. Their economic viability is adversely affected by the lack of an industry presence in Virginia. This lack also casts doubt on the ability of the Virginia Timber Bridge Initiative to enhance economic development in the southside region of the Commonwealth.

INTERIM REPORT

THE ECONOMICS OF THE INTRODUCTION OF MODERN TIMBER BRIDGES IN VIRGINIA

J. P. Gomez, Ph.D., P.E.
Research Scientist

W. T. McKeel, Jr., P.E.
Research Manager

INTRODUCTION

In 1990, the Virginia General Assembly established a commission to propose recommendations to enhance the economic development of the southside region of the Commonwealth. The commission's 1991 report, House Document 42, included a recommendation for a timber bridge initiative to replace Virginia's structurally deficient bridges.[1] The commission noted that timber bridges could save highway construction funds and stimulate the forest products industry in southside Virginia.

After the commission presented its recommendations, the Commissioner of the Virginia Department of Transportation (VDOT) appointed a committee to investigate further the feasibility of using timber in the construction of bridges. The committee was composed of representatives of VDOT's Structure & Bridge Division, the Department of Forestry, the Division of Legislative Services, and the Virginia Transportation Research Council.

The committee called for a three-phase program to implement the timber bridge initiative.[1] In Phase I, one timber bridge was to be constructed in each of VDOT's nine construction districts. The bridges were to be placed on low-volume secondary roads and would have spans varying in length from 4.9 to 9.1 m (16 to 30 ft). Both stress-laminated (stresslam) and glued-laminated (glulam) bridge designs were to be used. When initiated, Phase II will expand the use of these short-span bridges, and Phase III will include the construction of longer, more complicated structures.

Stresslam bridges are composed of timbers placed on edge and tensioned together by high-strength steel rods running normal to the bridge. The rods are post tensioned to such a degree that the individual timbers act as an integral system to resist the applied loads. In glulam systems, the timbers are bound together by a high-strength adhesive to produce an integral system.[2]

Virginia is one of several states considering an expanded use of timber bridges. West Virginia has taken the lead in their research, development, and construction. The Constructed

Facilities Center, located on the campus of West Virginia University, has conducted significant research in this area. Pennsylvania has also constructed a significant number of timber bridges.

The Intermodal Surface Transportation Efficiency Act (ISTEA) provides for funds for research in the development of new timber bridges and design criteria. Further, ISTEA funding is available for construction of timber bridges on all public roads.[3]

The special report on Virginia's timber bridge initiative projected that timber construction might be adaptable to 5,612 short- and medium-span bridges in the Commonwealth. Realization of this potential depends, however, on several factors, including design and construction considerations, the economic feasibility of timber bridges and their components, and the structural performance of the Phase I bridges.

OBJECTIVES AND SCOPE

The objective of this study is to evaluate the long-term performance and economic viability of timber bridges. The results of this study will be used to assess the implementation of Phases II and III of Virginia's timber bridge initiative. Further, it is anticipated that this study will aid in the enhancement of current VDOT design standards for timber bridges. This interim report addresses only some of the economic issues.

DISCUSSION OF RESULTS

Table 1 is a summary of Phase I of VDOT's timber bridge initiative. All costs shown are for bridge superstructure only. The costs for the bridges in the Bristol, Salem, Suffolk, Fredericksburg, and Culpeper districts are from actual bid tabulations provided by the successful bidder. The costs for the bridge in the Staunton District are for materials and state force labor and equipment. All of the bridges were fabricated with Southern pine, with the exception of the Bristol District bridge, which was fabricated with red oak. All of the structures were treated with creosote and designed for HS-20 loading.

Comparing the costs of the structures in the Salem and Fredericksburg districts, one can see a trend in cost reduction when multiple spans are used. The trend can be seen when comparing the costs in the Northern Virginia and Suffolk districts, as well. However, the bridges in these districts are of different fabrication.

Several districts did cost estimates of bridge superstructures constructed of conventional materials for comparison purposes. These costs were normalized with respect to square meters of deck to enable a direct comparison with the timber data as they were reported. In the Lynchburg District, it was estimated an equivalent prestressed concrete slab span would cost

Table 1. Summary of Phase I

District and Location	Type and Length	Date Completed	Fabricator	Cost per Square Meter of Superstructure and Total Superstructure Cost
Northern Va., Rte. 662, Loudon County	Glulam, 1-4.9 m span	Fall 1992	Laminated Concepts, Elmira, N.Y.	\$652/\$23,040
Staunton, Rte. 708, Shenandoah County	Stresslam, 1-6.1 m span	Summer 1993	Burke, Parsons, Bowlby Corporation, Ripley, W.Va.	\$598/\$26,500
Bristol, Rte. 622, Smyth County	Stresslam, 2-5.2 m continuous spans	Fall 1993	Burke, Parsons, Bowlby Corporation	\$630/\$53,500
Culpeper, Rte. 708, Faquier County	Stresslam, 1-7.9 m span	Fall 1993	Laminated Concepts	\$935/\$43,000
Salem, Rte. 635, Roanoke County	Glulam, 1-6.1 m span	Winter 1993/94	Unit Structures' Specialty Products Group, Inc., Morrisville, N.C.	\$837/\$31,080
Fredericksburg, Rte. 622, Richmond County	Glulam, 3-6.1 m spans	Spring 1994	Unit Structures' Specialty Products Group, Inc.	\$413/\$68,770
Suffolk, Rte. T-1303, Accomack County	Stresslam, 9-4.9 m spans	Summer 1994	Atlantic Wood Industries, Hainesville, N.J.	\$413/\$76,044
Lynchburg, Rte. 725, Buckingham County	Stresslam, 1-7.3 m span	Winter 1994/95	Burke, Parsons, Bowlby Corporation	\$652/\$37,244
Richmond, Rte. 610, Nottoway County	Glulam, 2-9.1 m spans	Winter 1994/95	Laminated Concepts	\$587/\$88,680

$392 per square meter and that of a steel beam and concrete slab superstructure would cost $424 per square meter. In the Richmond District, it was estimated an equivalent span prestressed concrete slab span would cost $315 per square meter. The Culpeper District reported that an equivalent precast concrete slab structure would cost $380 per square meter. In the Bristol District, a reinforced concrete rigid frame bridge structure was estimated to cost $544 per square meter. The average cost statewide for short-span bridges consisting of steel beams and concrete decking is $326 per square meter. There were 22 bridges constructed in Virginia under the federal-aid highways program in 1995 and, although not a direct comparison because both superstructure and substructure costs are included, the average total cost per square meter for these bridges was $674.77.

Clearly, from an initial cost viewpoint, timber bridges are not yet competitive with conventional bridge structures. There is no discernible relationship among the timber bridges between span length and cost per square meter. Nor is there a relationship between types (stresslam versus glulam). After discussion with key personnel in each district, it is evident that the initial costs were inflated because of the contractors' lack of experience with this material. It was felt that the initial costs would be reduced with more usage.

It is also evident that the high initial costs were the result of all of the structures being manufactured out of state. As shown in Table 1, none of the nine structures was fabricated in Virginia. Thus, shipping costs alone contributed to the high initial costs. For the bridge structure erected in the Culpeper District, the wood was shipped from a supplier in Minnesota to the fabricator, Laminated Concepts. The structure was then shipped to Indiana for creosote treatment before arriving in Virginia.

There has been a degree of acceptance of timber bridges in the Northern Virginia District, particularly in Loudon County. Several have been constructed since the first one on Route 662. Loudon County, which borders the Washington, D.C., metropolitan area, is still very rural and rustic. There are many unpaved secondary roads throughout the county, and the timber bridges constructed there have been well received by the community because of their aesthetic appeal. A study conducted in 1993 focusing on perceptions of timber bridges reported that they rated very high in terms of aesthetics.[4]

In another report published in 1992,[5] it was reported that the use of timber bridges has declined by more than 33 percent in the last 10 years. This decline was determined to be the result of the perception that timber is too expensive and a poor performer over the long term, thus requiring higher maintenance costs. VDOT bridge designers echoed these perceptions. Timber bridges will remain a niche market in Virginia until initial costs are reduced and improvement in long-term performance is demonstrated.

CONCLUSIONS

The following can be concluded from this initial study:

- At this time, timber bridges are not economically competitive from a first cost standpoint.
- The long-term performance and thus the life cycle cost competitiveness of timber bridges cannot be determined at this time.
- The economic viability of timber bridges is adversely affected by the lack of an industry presence in Virginia.
- The lack of an industry presence also casts doubt on the ability of the Virginia timber bridge initiative to enhance the economic development in the southside region of the Commonwealth.

RECOMMENDATIONS

At this time, it is recommended that Phase II of the Virginia timber bridge initiative, which calls for the expanded use of these short-span bridges, proceed cautiously. Bridges of this type could be built where strong local preference warrants them. It is anticipated that with more use, contractors will gain confidence in the constructibility of the bridges, and the Virginia timber industry may move to fabricate these bridges, thus reducing initial costs. The long-term viability of timber bridges will ultimately depend on their cost competitiveness and overall acceptance by bridge engineers and contractors.

REFERENCES

1. *Report of the Commission to Propose and Enhance Development of the Southside Region of the Commonwealth of Virginia.* House Document No. 42. Richmond, 1991.

2. Davalos, J.F., Wolcott, M.P., Dickson, B.D., and Brokaw, J. *Quality Assurance and Inspection Manual for Timber Bridges.* West Virginia University, Constructed Facilities Center, Morgantown, 1992.

3. Intermodal Surface Transportation Efficiency Act of 1991. U.S. Public Law 102-240. 102nd Congress, 18 December 1991.

4. Smith, R.L., and Bush, R.J. *A Perceptional Investigation into the Adoption of Timber Bridges.* Timber Information Resource Center, Morgantown, 1992.

5. Smith, R.L., and Bush, R.J. *Factors Influencing the Adoption of Timber Bridges (Literature Review).* Timber Information Resource Center, Morgantown, 1992.