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A Timber Bridge Initiative for Virginia

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Abstract

This report presents a plan for a timber bridge initiative in Virginia. It addresses (1) the immediate and future potential for using timber in the replacement of many of Virginia's bridges, (2) the available timber resources in Southside Virginia, (3) the wood species best suited for use in Phase I of the initiative, (4) factors affecting the economy with respect to timber bridges, and (5) the need for a supporting structural timber manufacturing industry in Virginia.

For those who will be involved in the implementation of the plan, the report addresses (1) the national timber bridge initiative, (2) funding for a demonstration bridge, (3) particular modern concepts regarding timber bridges, and (4) other technical issues. In addition, sources of information concerning timber bridges and the locations of structural timber manufacturers are provided.

Potentially, timber construction could be adapted to 5,612 bridges in Virginia. Of these, 521 need immediate repair or replacement. Thus, there is a potential for both immediate and long-term use of structural timber products on many of Virginia's bridges. The cost of these products are estimated to be $7.7 and $74.8 million, respectively, in 1991 dollars.

SPECIAL REPORT

A TIMBER BRIDGE INITIATIVE FOR VIRGINIA

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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

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EXECUTIVE SUMMARY

This report presents a plan for a timber bridge initiative in Virginia. It addresses (1) the immediate and future potential for using timber in the replacement of many of Virginia's bridges, (2) the available timber resources in Southside Virginia, (3) the wood species best suited for use in Phase I of the initiative, (4) factors affecting the economy with respect to timber bridges, and (5) the need for a supporting structural timber manufacturing industry in Virginia.

For those who will be involved in the implementation of the plan, the report addresses (1) the national timber bridge initiative, (2) funding for a demonstration bridge, (3) particular modern concepts regarding timber bridges, and (4) other technical issues. In addition, sources of information concerning timber bridges and the locations of structural timber manufacturers are provided.

Potentially, timber construction could be adapted to 5,612 bridges in Virginia. Of these, 521 need immediate repair or replacement. Thus, there is a potential for both immediate and long-term use of structural timber products on many of Virginia's bridges. The cost of these products are estimated to be $7.7 and $74.8 million, respectively, in 1991 dollars.

Based on the data and information compiled during the study, the following recommendations are offered:

1. The red oak and southern yellow pine species should be used to begin the timber bridge initiative in Virginia. Although House Document No. 42 noted that Virginia's yellow poplar is an underutilized species, it should not be used for bridges at this time because of preservative treatment difficulties and its slightly lower strength properties. A decision concerning its future use should await the completion of preservative treatment research being conducted at Pennsylvania State University.

2. A feasibility study should be initiated by the Department of Economic Development to investigate the possibilities associated with bringing structural timber manufacturers to the Commonwealth. This industry should have the capability of manufacturing and treating glued-laminated (glulam) and stress-laminated (stress-lam) products from Virginia's timber resources. Potentially, structural timber products produced by this industry could find a much wider market in the mid-Atlantic region for uses other than bridge construction.

3. All bridges constructed under the Virginia initiative should initially be restricted to the secondary road system.

4. The plan for a timber bridge initiative in Virginia should have three phases. The implementation of Phases II and III would depend on the successful completion of Phase I and on additional factors. Some of the factors might be continued legislative support to advance the initiative, funding, evidence of potential development of a structural timber prod-

ucts industry, interest and support of the forest products industry, and evidence that a timber bridge initiative will contribute to developing the economy of Southside Virginia. The last factor should be addressed near the completion of Phase I since there is no assurance under Virginia's contracting and bid process that the timber will be supplied from Southside Virginia.

- *Phase I.* The VDOT should construct a minimum of one timber bridge in each of its nine construction districts. These bridges should incorporate glulam and/or stress-lam structural products so that experience with the most recent design and construction technologies and the practical and technical problems associated with their construction can be gained. Preferably, the length of the bridge spans should be 20 to 30 ft. In order to strive for maximum economy, the district bridge engineers should coordinate the selection of their bridge site through VDOT's Structure and Bridge Division. An effort should be made to achieve compatibility in the nine bridge sites and, thus, in design, roadway width, span length, etc. Contracting and construction should also be coordinated such that the potential for achieving economy through multiple fabrication of similar units for different bridge sites (etc.) might be realized.

  After the nine bridge sites and the type of timber structure are selected, the Central Office should supply each district bridge engineer with design and specification information and establish a schedule for the design, contracting, and construction process.

  Demonstration project funding may be available to help finance several of the timber bridges, but probably not all. If these funds are sought, the Central Office should select the demonstration bridge site(s) and work with the district(s) to develop the submittal documents. If monitoring of the bridges is required, the Virginia Transportation Research Council will work with the USDA Forest Products Laboratory to conduct that effort.

  The first step of Phase I has been taken. J. S. Hodge, Chief Engineer of VDOT, directed each district to begin selecting a site for the construction of a timber bridge.

- *Phase II.* After the completion of Phase I and an evaluation of the factors discussed earlier, each district should review its bridge inventory to identify the bridges that are in need of immediate or near-term replacement. All the bridge sites in this group that can utilize the design adopted in Phase I should be identified and prioritized. These bridges should then be scheduled for replacement such that the design and construction experience gained in Phase I can be used to maximum advantage.

- *Phase III.* All the bridge sites that are not adaptable to the Phase I and Phase II programs should be reviewed, and each district should select a site that requires a bridge with a longer span length. The general plan for Phase I should be followed to coordinate the design and construction of these bridges. Box or "T" section timber bridges should be used at these Phase III sites. An alternative choice might be to use glulam beams and deck panels. It is anticipated that this phase will begin while Phase II is in progress.

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In 1990, the Virginia General Assembly established a commission to propose recommendations to improve and enhance economic development in the southside region of the state. In 1991, the interim recommendations of the commission's Task Force on Agriculture, Forestry, and Natural Resources were presented in House Document No. 42.[1] One of the recommendations concerned the development of a timber bridge initiative to replace Virginia's worn-out bridges. It was noted that timber bridges have the potential to save highway construction funds as well as stimulate development of the forest products industry in Southside Virginia.

In response to a request from the Speaker of the House, the Honorable A. L. Philpott, Mr. Ray D. Pethtel, Commissioner of the Virginia Department of Transportation (VDOT), requested that the Virginia Transportation Research Council (VTRC) and VDOT's Structure and Bridge Division work with the Department of Forestry to develop a plan for a timber bridge initiative. Representatives of the two divisions met with a representative of the Department of Forestry and a representative of the Division of Legislative Services on June 19, 1991, to investigate the potential for using more timber in the construction of bridges. The names of these representatives, who make up the Timber Bridge Initiative Task Group, are listed in Appendix A.

PURPOSE

The purposes of the first meeting of the task group were the following:

1. Review the status of the National Timber Bridge Initiative.
2. Investigate the state of the art of the timber bridge technology being used in the demonstration projects being conducted under the National Timber Bridge Initiative.
3. Review the economics of constructing bridges with timber.

4. Obtain information concerning the quantity and species of timber available in Southside Virginia for potential use in bridge construction.
5. Review the status and capability of the forest products industry in Virginia, in adjacent states, and nationally.
6. Review the inventory of bridges currently in use in Virginia to determine the total number that are potentially adaptable to timber usage, those that are in need of immediate replacement, and those that currently use timber decking (flooring).
7. Develop a plan to begin a timber bridge initiative in Virginia.

THE NATIONAL TIMBER BRIDGE INITIATIVE

In 1988, the U.S. Congress funded $3.35 million for a timber bridge initiative, which began in FY 1989. Again in 1990 and 1991, similar levels of funding were provided. It is not known at this time whether the funding will be continued for FY 1992, although it appears likely.

The timber bridge initiative is administered by the U.S. Department of Agriculture's (USDA) Forest Service and promotes the use of timber in highway bridge construction. The primary emphasis of the initiative is to stimulate the economies of rural areas by expanding the markets for wood products and creating service industries for timber bridge construction. Emphasis is being placed on using local wood species that are now underutilized in some regions of the country. Many of these wood species, such as hardwoods, have not typically been used in bridge construction in the past.

Funding for the timber bridge initiative is being provided to support three general efforts: (1) the construction of demonstration bridges, (2) research, and (3) technology transfer. Approximately 60 percent of the funding is being used to support the construction of timber bridges, and the remaining funds are being about equally divided between research and technology transfer.

Demonstration Timber Bridges

In 1988, 80 bridges in 30 states were approved by the U.S. Forest Service for construction using a combination of federal and local funds. In 1989, the greatest assistance went to two states. West Virginia received approximately $1,000,000 to help construct 33 demonstration timber bridges, and Pennsylvania received $150,000 to help construct 17 timber bridges. The remaining 28 states received assistance that averaged approximately $30,000 per state.

The timber bridge initiative will fund a maximum of 50 percent of the total cost of a bridge and is further limited to a maximum of $60,000 regardless of the total cost. The upper limit will be provided only for exceptionally large projects that incorporate innovative designs, have high visibility to the public, and have a funding overmatch by the cooperating agency. Projects can be submitted to obtain funding for demonstration bridges. Information concerning the design and location of the bridge as well as other documents must be submitted for review and approval. Selection of projects for funding assistance is based on particular criteria. Particular emphasis is given to the use of hardwoods or local species that are presently underutilized, innovative design, visibility, and structural and environmental integrity. The purpose of the funding is to demonstrate a timber bridge technology that offers a viable, alternative solution to the deficient bridge problem.

If the timber bridge initiative funding is continued for FY 1992, the call for proposals will probably be mailed out in November 1991.

Technology Transfer

The major thrust of the technology transfer associated with the timber bridge initiative is directed from the Timber Bridge Information Resource Center (TBIRC) in Morgantown, West Virginia. This center is responsible for overall program management. It provides technical assistance; coordinates conferences, workshops, and seminars; distributes information; and coordinates with field advisors. The American Institute of Timber Construction (AITC) is also a major source of information.

Additional information and assistance can be obtained from the USDA Forest Products Laboratory in Madison, Wisconsin, and the U.S. Forest Service technical advisors located throughout the country. For the southeast region of the nation, the coordinator for the initiative is located in Pineville, Louisiana. For Virginia, proposals for funding for demonstration projects will be handled through the southeast regional office.

Contacts and addresses for each of these major information centers are listed in Appendix B.

Research

Considerable research is being conducted to develop new design approaches to the use of timber in bridge construction. Additional research is being directed toward the use of hardwood species in timber bridges and problems associated with preservative treatments, moisture content, strength properties, grading, and construction techniques and procedures. The focus of most of the research effort has been at the USDA Forest Products Laboratory. Considerable research work is also being conducted at West Virginia University, the University of Nebraska, the University of Wisconsin, Mississippi State University, and Georgia Southern University.

State-of-the-Art Timber Bridges

Much of the research in recent years has been directed toward new design concepts to use timber in structures such as buildings and bridges. In recent years, one of the major advances in the use of timber for structures was the glued-laminated (glulam) process. In this process, regular dimensioned lumber is glued together under pressure to form panels that can be used for bridge flooring or glued together to form member heights that can be used for beams and girders. For bridge flooring, glulam panels are often fabricated to 4-ft widths and to the desired lengths to place across the bridge roadway. The panels can be transported to the bridge site and rapidly placed to construct the bridge flooring. The panels are often interconnected by dowels or other mechanical devices.

Another advantage of the glulam technique is that lower strength (or lower quality) wood can be used in the areas of a structural member where high strength is not needed, such as in the midsection of a bridge girder or beam.

Glulam deck panels were installed on three bridges in Virginia in 1977–78 in research conducted by Sprinkel.[2] These bridges have performed well to date. Glulam deck panels have been used on several other bridges in Virginia, including an installation completed in September 1990 in Grayson County.

More recent research conducted at the Forest Products Laboratory and elsewhere has used regular dimensioned lumber in a process called stress-lamination (stress-lam). In this case, the laminated lumber is brought together with steel post-tensioning rods that provide the lateral force to hold the laminations together. Thus, short-span timber bridges can be constructed from longitudinally laminated boards that are compressed together by appropriately spaced steel rods and have a panel depth sufficient to provide the required flexural strength. This general design, shown in Figure 1A, has been used extensively in West Virginia and can be used on spans on the order of 30 to 35 ft or less, as reported by Ganga Rao.[3] Stress-lam timber box sections have also been used (Figure 1B) as well as stress-lam timber "T" sections (Figure 1C). The "T" section stress-lam bridges can span on the order of 60 to 75 ft, and the box sections on the order of 100 ft. These types of timber bridges have also been built in West Virginia and are being researched further at West Virginia University (and probably elsewhere). Guide specifications for the design of stress-lam wooden deck bridges were published by the American Association of State Highway and Transportation Officials (AASHTO) and are now available.[4]

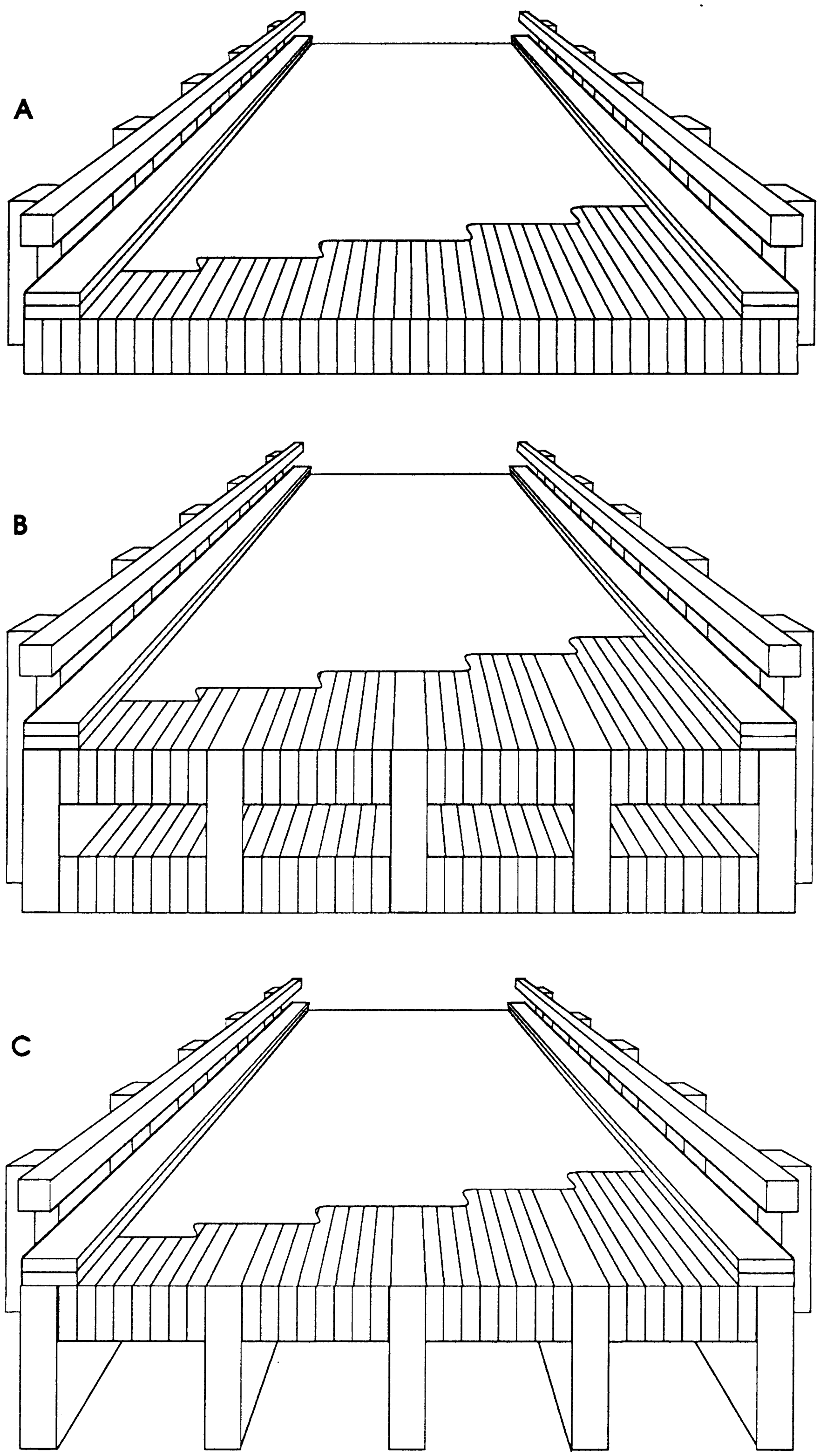

Figure 1. Configuration for Stressed-Laminated Timber Bridges. A. Basic. B. Box Section. C. "T" Section. Reprinted with permission from Ganga Rao.[3]

Timber Species and Preservative Treatment

As stated earlier, one of the goals of the timber bridge initiative is to promote the use of locally available and underutilized species of wood. In West Virginia and Pennsylvania, local hardwoods (such as red oak and red maple) are being used. One of the problems with some hardwoods, however, is that they are more difficult to treat with preservatives than softwoods, such as southern pine. Further, some hardwoods are more difficult to treat than others. Red oak, for example, can be treated more easily than white oak. Yellow poplar is difficult to treat and, as noted in House Document No. 42,[1] is one of the underutilized species available in Virginia. Research is currently underway at Pennsylvania State University and is being directed toward the development of a treatment process that will be effective on yellow poplar.

In general, all hardwood species are more difficult to treat than softwood species. However, a number of other factors (such as the geographical source of the timber, the amount of sapwood in the species, and its moisture content at the time of treatment) have a bearing on the treatability of wood. Red oak and some other hardwood species can be effectively treated with existing techniques. For timber bridges, oil preservatives are preferred. These include cold-tar creosote and pentachlorophenol with a heavy oil solvent to provide protection from the checking and splitting associated with changes in the moisture content of the wood.

Dimensional stability is particularly important with timber bridges. Because bridges are constantly subjected to wetting and drying, excess shrinkage or expansion of the wood can be crucial to the long-term integrity of the state-of-the-art stress-lam bridges and detrimental to other types of bridges as well. Consequently, preservative treatment is an important factor in the construction of timber bridges.

There are environmental and human hazards associated with both the use and disposal of treated timbers. Restrictions on the use of particular preservatives and the consequent practical and technical problems will have to be addressed in the timber bridge program.

Structural Strength and Moisture Content of Wood

The structural strength of wood varies between species and between grades within a species. In addition, the moisture content of the wood is an important factor that must be taken into account when bridges are constructed.

The expected "equilibrium" moisture content of wood varies for different locations in the United States but typically averages 18 to 20 percent.[5] Changes in moisture content can affect the strength and stiffness of a timber bridge as well as its dimensional stability. Below the wood fiber saturation point of approximately 30 percent, wood expands as moisture is gained and shrinks when moisture is lost. Typically, the lumber used in timber bridge construction has a moisture content of 24 to 28 percent. After a period of time, the moisture content tends to reach an equilibrium with the environment (i.e., it tends to move toward the 18 to 20 percent range). In stress-lam bridges, this phenomenon causes a loss of stressing rod forces as the moisture is lost. In order to counter the potential loss of post-tensioning forces, the steel rods must be either overstressed initially or retightened after several months of service or the initial moisture content of the timber should be held to a maximum of 19 percent.[6]

The average strength of structural grade lumber must also be taken into account during the design of a timber bridge. Yellow poplar, for example, has a slightly lower strength than many other wood species. The lower strength can be compensated for, however, by using slightly more of the wood for structural load-carrying members.

TIMBER BRIDGE ECONOMY

There is little information available on the life cycle costs of timber bridges. The initial cost of bridges that have been constructed under the timber bridge initiative in West Virginia, however, has not been competitive with other materials that could have been used. The total cost per square foot of bridge superstructure has ranged from $34.13 to $95.28 for the first 26 bridges constructed in West Virginia (see Appendix C for a cost summary provided by the West Virginia Department of Highways). The lowest costs per square foot were obtained when the timber deck panels were installed by the Highway Department's district crews as opposed to contracting. Comparatively, the initial costs of constructing bridge superstructures with steel beams and concrete flooring in Virginia currently average approximately $30 per square foot.

A number of factors have contributed to the high cost of the timber bridges constructed in West Virginia:

1. There was only one company available in the area that could fabricate the bridge panels. Hence, there was no competition in the processing and fabricating industry.
2. The fabrication process was labor intensive since mechanizations such as overhead cranes (etc.) were not available.
3. There was an unfamiliarity in the industry with the new timber bridge technology.
4. Some of the bridges were constructed with a higher grade, more costly lumber in the early stages of the program. However, high costs were also experienced when Grade 3 lumber was used.
5. There was a lack of standardization (i.e., each bridge was processed independently).

Researchers expect the costs of timber bridges to drop as more experience is gained using the new technology and as modifications in design and fabrication are made to expedite construction. However, it will be difficult to achieve economy in timber bridge construction as long as a competitive supporting industry does not exist. In the case of West Virginia, the nearest laminated timber manufacturer is in London, Kentucky.

A list of the companies in the United States that manufacture structural laminated timbers is presented in Appendix D. Most of these companies are in the northwest and midwest. There are none in Virginia, and, with the exception of one manufacturer located in Morrisville, North Carolina, there are none located in the adjacent states. Hence, the mid-Atlantic region does not have a strong, competitive structural timber industry at present.

The nature of the economic problem associated with timber bridge construction was clearly illustrated in research conducted by VTRC in 1977.[2] Three bridges were constructed in Virginia using glulam panel decking. For two of the bridges, the glulam panels were fabricated at Morrisville, North Carolina, using southern pine, but they were shipped to Salisbury, Maryland, for preservative treatment. The units were then shipped back to Virginia and eventually to the bridge sites. For the third bridge, the panels were fabricated in Minnesota using Douglas fir; shipped to Richmond, Virginia, for preservative treatment, and subsequently shipped to the bridge site near Martinsville, Virginia. This kind of inefficiency in the industry contributes to the high cost and noncompetitive nature of the product. There is a need not only for a more highly mechanized manufacturing industry but also for integration of all the processes.

The long-term (life cycle) costs for the new state-of-the-art timber bridges are not available since time has not permitted the development of experience records regarding maintenance costs, life span, etc. Even for the older in-service timber bridges, there is little information to support claims that they are economically competitive with concrete and steel structures. However, in northern New England, timber bridges have proven to be economically competitive. In a recent study by Behr et al.,[7] the cost of timber bridges in that region of the country were found to be lower than that of other types of bridges. In cost comparisons of bridges with 40-ft spans, for example, the median cost of timber bridge superstructures was less than that for steel beam–concrete deck superstructures. When the timber supplier's installation crews were used, as opposed to contractor crews, the median timber bridge cost of approximately $36 per square foot was substantially less than that for other types of construction. However, the median cost of steel and concrete superstructures ranged from approximately $53 to $60 per square foot for 40- to 60-ft spans. This is substantially higher than the average cost of $30 per square foot for similar bridges constructed in Virginia. Apparently, the higher costs of the alternatives to timber contribute to its favorable competitive position in the New England states. There are other instances, such as that reported in western Pennsylvania by Verna et al.,[8] where the use of timber has proven to be economical. Unfortunately, as noted by Clapp,[9] most of the evidence, including bid costs for alternatives between timber and other types of bridges, suggest that timber bridges cost more.

Although the technology for timber is advancing, that for concrete and steel is also advancing. Recent developments in concrete bridge deck and metal fatigue technologies, for example, promise to aid in extending the life span of bridges constructed of steel and concrete. Thus, life-cycle cost comparisons are made even more difficult.

VIRGINIA TIMBER SPECIES AVAILABLE FOR BRIDGE CONSTRUCTION

One of the main purposes of the timber bridge initiative is to help revive the economy of rural areas (such as Southside Virginia) by harvesting underutilized species of wood. One such species cited in House Document No. 42[1] is yellow poplar. As discussed earlier, there are difficulties associated with the application of preservative treatments to this species. In addition, it has a slightly lower structural strength. Consequently, use of this species should probably await the outcome of research that is being conducted at Pennsylvania State University. The use of certain other species, such as gums and maples, should also await more development in the technology.

Underutilized species that could be used at this time are red and white oak and southern yellow pine. Estimates of the annual growth rate and the annual harvest rate of these two species are given in Tables 1 and 2, respectively. These data

Table 1

GROWTH AND HARVEST RATE FOR RED AND WHITE OAK SAW TIMBER FOR THE SOUTHERN PIEDMONT OF VIRGINIA (1985)

Lumber Grade	Growth Rate (millions of board feet)	Harvest Rate (millions of board feet)	Surplus (millions of board feet)
High	109	63	46
Low	96	62	34
Total	205	125	80

Note: Saw timber is defined as trees of 11 inches in diameter and greater. Data furnished by the Virginia Department of Forestry.

Table 2

GROWTH AND HARVEST RATE FOR SOUTHERN YELLOW PINE SAW TIMBER FOR THE SOUTHERN PIEDMONT OF VIRGINIA (1985)

Lumber Grade	Growth Rate (millions of board feet)	Harvest Rate (millions of board feet)	Surplus (millions of board feet)
All	184	134	50

Note: Saw timber is defined as trees of 11 inches in diameter and greater. Data furnished by the Virginia Department of Forestry.

show that oak and southern yellow pine were substantially underutilized in 1985. More recent data also indicate that there is a substantial volume of surplus of these two species. If other species (such as yellow poplar, gums, maples, etc.) are included, the surplus timber volume in Virginia more than doubles.

Southern pine and red oak accept preservative treatments quite well. White oak is very difficult to treat. Although this species contains some natural preservatives, they are insufficient to provide for long-term stability in timber bridges. Therefore, white oak is not being used for timber construction in other parts of the country. As a result, red oak and southern yellow pine appear to be the best choice of species for use in Virginia bridge construction at this time.

MANUFACTURING NEEDS IN VIRGINIA FOR STRUCTURAL LAMINATED TIMBER

It was noted earlier in this report that it will be difficult to achieve economy in timber bridge construction without a supporting and competitive structural timber manufacturing industry. There is currently little or no known industry of this type in the Commonwealth. A minimum of two strategically located manufacturing plants in Virginia would be desirable. One plant should specialize in producing glulam products and another in producing treated stress-lam structural products. Glulam structural timbers are widely used in building construction in many regions of the country. Thus, these products could find a much wider market in the mid-Atlantic region for uses other than bridge construction.

By using local timber resources, several manufacturing plants could produce products that would provide greater economic benefit to the Commonwealth than facilities that produce only raw lumber. It is estimated by the Virginia Department of Forestry that a timber laminating plant would require an investment of approximately $10 million, use approximately 5 million board-feet of lumber annually, and employ more than 25 people. However, the American Institute of Timber Construction (AITC) knows of one modern plant that was built for approximately $3 million. A feasibility study should be initiated to investigate the possibilities associated with bringing these industries to Virginia. Without local structural timber manufacturing facilities, economies in timber construction will be elusive and a timber initiative will be difficult to sustain.

THE POTENTIAL FOR USING TIMBER IN VIRGINIA'S BRIDGES

VDOT currently has a substantial number of timber-deck bridges in service, primarily on the rural secondary roadway system. Some of these bridges are in need of immediate repair or replacement, and the remaining number will eventually need repair or replacement. Thus, over a period of time, this entire category of bridges could be considered potential candidates for replacement with timber construction. There are also bridges constructed of steel and concrete that could be considered as potential candidates for timber construction. Some of these bridges are also deficient and in need of immediate repair or replacement. These two groups of bridges are summarized in Table 3 and categorized with respect to immediate or future replacement potential. The estimated quantity and value for the potential use of timber in the immediate replacement category are presented in Table 4. The estimated value of timber for use in the future replacement category is presented in Table 5. These estimates are based on an average use of 10,000 board-feet of lumber to replace the superstructure of each bridge. Thus, assuming funds are made available, there could be both an immediate and a long-term market for the use of structural timber products on many of Virginia's bridges.

Table 3

TIMBER-DECK AND STEEL/CONCRETE BRIDGES
THAT ARE POTENTIAL CANDIDATES FOR TIMBER CONSTRUCTION

Replacement Category	Timber-Deck Bridges	Steel and Concrete Bridges	Total
Immediate	159	362	521
Future	3,350	1,741	5,091
Total	3,509	2,103	5,612

Data provided by VDOT, Structure and Bridge Division.

Table 4

ESTIMATED QUANTITY AND VALUE OF TIMBER FOR THE
IMMEDIATE REPLACEMENT CATEGORY

No. of Deficient Bridges	Estimated Quantity of Lumber Required (board-feet)	Average Lumber Cost per Board-foot (1990-91)	Estimated Value of Immediate Replacement Needs
521	5,210,000	$1.47	$7,658,700

Table 5

ESTIMATED POTENTIAL VALUE OF TIMBER FOR THE
FUTURE REPLACEMENT CATEGORY

No. of Bridges	Estimated Value of Replacements
5,091	$74,837,700

A PLAN FOR A TIMBER BRIDGE INITIATIVE IN VIRGINIA

Timber bridges are ideally suited for low-volume, rural secondary roads. Therefore, it is recommended that, at least initially, all bridges constructed under this initiative be restricted to the secondary road system.

The plan for a timber bridge initiative in Virginia should have three phases. The implementation of Phases II and III would depend on the successful completion of Phase I and on additional factors. Some of the factors might be continued legislative support to advance the initiative, funding, evidence of potential development of a structural timber products industry, interest and support of the forest products industry, and evidence that a timber bridge initiative will contribute to developing the economy of Southside Virginia. The last factor should be addressed near the completion of Phase I since there is no assurance under Virginia's contracting and bid process that the timber will be supplied from Southside Virginia.

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- *Phase II.* After the completion of Phase I and an evaluation of the factors discussed earlier, each district should review its bridge inventory to identify the bridges that are in need of immediate or near-term replacement. All the bridge sites in this group that can utilize the design adopted in Phase I should be identified and prioritized. These bridges should then be scheduled for replacement such that the design and construction experience gained in Phase I can be used to maximum advantage.

- *Phase III.* All the bridge sites that are not adaptable to the Phase I and Phase II programs should be reviewed, and each district should select a site that requires a bridge with a longer span length. The general plan for Phase I should be followed to coordinate the design and construction of these bridges. Box or "T" section timber bridges should be used at these Phase III sites. An alternative choice might be to use glulam beams and deck panels. It is anticipated that this phase will begin while Phase II is in progress.

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APPENDIX A

Timber Bridge Initiative Task Group

F. G. Sutherland, Chairperson	VDOT Structure and Bridge Engineer Richmond, Virginia
Nancy Roberts	Legislative Services Richmond, Virginia
Elvin D. Frame	Virginia Department of Forestry Charlottesville, Virginia
C. L. Woodward	VDOT Structure and Bridge Division Richmond, Virginia
Marvin H. Hilton	Virginia Transportation Research Council Charlottesville, Virginia

APPENDIX B

Key Contacts for Timber Bridge Information

1. USDA Forest Products Laboratory
   One Gifford Pinchot Drive
   Madison, WI 53705

   Michael A. Ritter, P.E.
   Structural Engineer
   Ph. (608) 231-9229

2. USDA Forest Products Service
   Region 8 (Southeast)
   2500 Shreveport Highway
   Pineville, LA 71360

   Robert Westbrook
   Ph. (318) 473-7272

3. American Institute of Timber Construction (AITC)
   11818 S.E. Mill Plain Boulevard, Suite 415
   Vancouver, WA 98684

   Thomas G. Williamson, P.E.
   Vice-President, Technical Operations
   Ph. (206) 254-9132

4. Timber Bridge Information Resource Center (TBIRC)
   180 Canfield Street
   P.O. Box 4360
   Morgantown, WV 26505
   Attn: Timber Bridge
   Ph. (304) 291-4905

APPENDIX C

West Virginia Timber Bridge Cost Summary

WEST VIRGINIA TIMBER BRIDGE COST SUMMARY SUPERSTRUCTURE ONLY

Bridge	Total Cost/Ft^2	Deck (\$/ft^2)	Stress Hardware (\$/ft^2)	Comments
"Birch Log Run" Greenbrier Co.	\$ 61.58	\$ 54.03	\$ 7.55	(U. S. Forest Service) 14" Type A Deck with Guardrail; Southern Pine or Red Oak; 29.83' x 12.75'; Installed by Contractor
"Tumbling Rock" Greenbrier Co.	\$ 84.28	\$ 76.94	\$ 7.35	(U.S. Forest Service) 14" Type A Deck with Guardrail; Red Oak Only; 30.17' x 12.75'; Installed by Contractor
"East Lynn" Wayne Co.	\$ 47.87	\$ 40.70	\$ 7.18	12" Type A with Guardrail; Northern Red Oak; 30.33' x 22'; Factory Stressed (Twice) in 2 Panels; 26-Degree Skew; Installed by District
"Coal Yard" Greenbrier Co.	\$ 34.13	\$ 30.72	\$ 3.41	10" Type A with Guardrail; 28.42' x 19'; Delivered in 3 Unstressed Panels; Installed by District
"Tamcliff" Mingo Co.	\$11.97	\$ 7.79	\$ 4.18	4" Type A, No Guardrail; Stressed 3 Times in Shop in 22 Panels; Installed by District (not included in average; not a superstructure)
"Fieldcrest" Monongahela Co.				Type B Deck with Guardrail; 40.5' x 28.37'; Installed by Contractor
Low Project Bid	\$ 74.23	\$ 71.99	\$ 2.23	
2nd Bid	\$ 68.51	\$ 64.65	\$ 3.87	
3rd Bid	\$ 66.81	\$ 60.48	\$ 6.33	
"Rover" Wirt Co.				10" Type A with Guardrail; 28.42' x 19'; Installed by Contractor
Low Project Bid	\$ 68.46	\$ 65.45	\$ 3.09	
2nd Bid	\$ 78.89	\$ 62.22	\$16.68	
"Dry Hollow" Pendleton Co.				11" Type A, No Guardrail; 30.83' x 20'; Installed by Contractor
Low Project Bid	\$ 57.51	\$ 51.35	\$ 6.16	
2nd Bid	\$ 59.67	\$ 44.49	\$15.17	
3rd Bid	\$ 52.32	\$ 49.64	\$ 2.68	

continues

Bridge	Total Cost/Ft^2	Deck (\$/ft^2)	Stress Hardware (\$/ft^2)	Comments
"Smoke Hole Culverts"				12" Type A, No Guardrail;
Pendleton Co.				32.83' x 29'; Installed by
Low Project Bid	$ 55.93	$ 50.87	$ 5.06	Contractor
2nd Bid	$ 60.01	$ 46.51	$13.50	
3rd Bid	$ 52.77	$ 50.24	$ 2.53	
"Upper Five Mile				Type B Deck, No Guardrail;
Creek No. 1"				41' 7 1/8" x 18' 2 1/4"; Installed
Kanawha Co.				by Contractor; Grade 2
Low Project Bid	$ 92.28	$ 85.49	$ 6.79	Lumber
2nd Bid	$ 98.78	$ 68.60	$30.18	
3rd Bid	$106.69	$ 98.74	$ 7.95	
4th Bid	$ 91.51	$ 86.58	$ 4.93	
"Upper Five Mile				Type B Deck, No Guardrail;
Creek No. 2"				41' 7 1/8" x 18' 2 1/4";
Kanawha Co.				Installed by Contractor;
Low Project Bid	$ 92.24	$ 85.46	$ 6.78	Grade 2 Lumber
2nd Bid	$ 98.78	$ 68.60	$30.18	
3rd Bid	$106.45	$ 98.51	$ 7.94	
4th Bid	$ 90.65	$ 85.77	$ 4.88	
"Upper Five Mile				11" Type A, No Guardrail;
Creek No. 3"				29' 9" x 15' 0"; Installed by
Kanawha Co.				Contractor
Low Project Bid	$ 79.10	$ 67.67	$11.43	
2nd Bid	$101.07	$ 66.31	$34.76	
3rd Bid	$ 74.53	$ 66.28	$ 8.25	
4th Bid	$ 94.31	$ 80.83	$13.48	
"Chunk Run"				11" Type A with Guardrail;
Marion Co.				29.33' x 18'; Installed by
Low Project Bid	$ 76.78	$ 72.60	$ 4.18	Contractor
2nd Bid	$ 79.98	$ 68.74	$11.24	
3rd Bid	$ 92.83	$ 90.79	$ 2.04	
"Cedar Creek"				Type B with Guardrail;
Gilmer Co.				108" x 22' 1 1/2"; Installed
Low Project Bid	$ 88.06	$ 79.82	$ 8.24	by Contractor
2nd Bid	$ 79.06	$ 76.84	$ 2.22	
3rd Bid	$ 95.80	$ 99.30	$ 3.50	
"Little Creek"	$ 95.28	$ 77.28	$18.00	12" Type A with Guardrail;
Marion Co.				18' x33' 9 3/4"; Installed by
				Contractor

continues

Bridge	Total Cost/Ft^2	Deck (\$/ft^2)	Stress Hardware (\$/ft^2)	Comments
"Badgley Fork" Wood Co.				12" Type A with Guardrail; 35' x 19'; Installed by Contractor, Grade 1 Lumber
Low Project Bid	$ 83.07	$ 79.74	$ 3.33	
2nd Bid	$ 85.19	$ 78.66	$ 6.53	
3rd Bid	$ 72.65	$ 66.25	$ 6.40	
"North Fork of Kings Creek" Hancock Co.	$ 75.03	$ 66.26	$ 8.76	Type B with Guardrail; 42.25' x 17.25'; Installed by District; Grade 3 Lumber
"Cherry Ave." Webster Co.	$ 51.30	$ 35.81	$15.49	12" Type A with Guardrail; 34.83' x 18'; Installed by District; Grade 3 Lumber
"Rock Camp Run" Wetzel Co.	$ 49.85	$ 31.41	$18.44	9" Type A with Guardrail; 23.08' x 19.25'; Installed by District; Grade 3 Lumber
"Glade Creek Mill Bridge" Fayette Co.	$ 42.96	$ 37.83	$ 5.13	11" Type A Deck with Guardrail; 77.75' x 25.5'; Installed by District; Grade 3 Lumber
"Maple Street Bridge" Greenbrier Co.	$ 86.94	$ 77.17	$ 9.76	21" All Glulam with Guardrail; 62.87' x 16.23'; Installed by District
"Mate Creek Bridge" Mingo Co.	$ 71.51	$ 60.98	$10.53	Type B Deck, No Guardrail; 52.45' x 14.81'; Installed by District; Grade 3 Lumber
"Claylick Run Bridge" Jackson Co.				Type B Deck with Guardrail; 41.87' x 22'; Installed by Contractor; Grade 3 Lumber
Low Project Bid	$ 97.77	$ 86.31	$ 8.46	
2nd Bid	$107.94	$101.25	$ 6.69	
3rd Bid	$123.15	$112.69	$10.46	
"Kessling Mill" Upshur Co.	$ 38.24	$ 34.03	$ 4.21	11" Type A with Guardrail; 28.83' x 26.0'; Installed by District
"Copley Bridge" Lewis Co.	$ 57.67	$ 48.53	$ 9.15	Type B, Grade 3 Lumber; 40' x 21.69'; Guardrail Installed by District
"Bonds Creek" Ritchie Co.	$ 86.42	$ 74.12	$12.30	Type B with Guardrail; 38.56' x 18'; Red Oak No. 3 or Better; Installed by Contractor

continues

Bridge	Total Cost/Ft^2	Deck (\$/ft^2)	Stress Hardware (\$/ft^2)	Comments
"Shannondale" Jefferson Co.	\$ 90.91	\$ 74.58	\$16.33	12" Type A with Guardrail; 33.44' x 18'; Red Oak No.3 or Better; Installed by Contractor
Current Average	\$ 70.63	\$ 62.20	\$ 8.43	Includes Only Low Project Bid; 2nd, 3rd, etc. Bids for Information; Excludes Tamcliff (not a superstructure)
(Previous Average)	(69.13	61.18	7.94)	

Note: Costs include proportional share of mobilization. Districts' installation cost not included.

APPENDIX D

Active Members of the American Institute of Timber Construction

MANUFACTURERS OF STRUCTURAL GLUED LAMINATED TIMBER*
March 7, 1991

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(503) 345-777
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Swisshome, OR

ANTHONY FOREST PRODUCTS CO.
Lamination Division
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El Dorado, AR 71730
(501) 862-5594
Laminating Plant:
El Dorado, AR

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FILLER KING COMPANY
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Homedale, ID 83628
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GLU-LAM TECHNOLOGIES
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Magna, UT 84044
(801) 250-3391

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MISSISSIPPI LAMINATORS
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Shubuta, MS 39360
(601) 687-1571

QB CORPORATION
P.O. Box 1647
Salmon, ID 83467
(208) 756-4248

RIDDLE LAMINATORS
P.O. Box 66
Riddle, OR 97469
(503) 874-3151

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Peshtigo, WI 54157
(715) 582-4544

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195 Rieblin Road
Chehalis, WA 98532-8718
(206) 748-9207
Laminating Plants:
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STRUCTURAL WOOD SYSTEMS
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Greenville, AL 36037
(205) 382-6534

TIMBERWELD MANUFACTURING
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Billings, MT 59104
(406) 652-3600
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32 Clifton Street
Unadilla, NY 13849
(607) 369-9341
Laminating Plant:
Sidney, NY

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11603 Hazelwood Road
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Magnolia, AR
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Morrisville, NC
(919) 467-6151

WESTERN STRUCTURES, INC.
P.O. Box 23355
Eugene, OR 97402
(503) 344-8878

*List supplied by American Institute of Timber Construction (AITC).

APPENDIX E

Memorandum on the Timber Bridge Initiative

APPENDIX E

Mr. Fred G. Sutherland
Structure & Bridge D
10th floor

RECEIVED VDOT
STRUCTURE & BRIDGE DIV

91 JUN 17 AM 9:53

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, 23219

RAY D. PETHTEL
COMMISSIONER

JACK HODGE
CHIEF ENGINEER

June 14, 1991

Timber Bridge Initiative

MEMORANDUM

TO: District Administrators

The Department has received requests from the State Legislature to use more timber bridges in our replacement program. These requests originate from the fact that the forestry industry in the state offers substantial potential for production of construction grade lumber. This may provide the opportunity to replace bridges at reduced cost while benefiting the forestry industry.

At our staff meeting on Wednesday, June 12, each of you were requested to program one bridge on the Secondary System on which a timber bridge would be used as a replacement. This should be a full timber superstructure rather than using our SS-7 standard. Your effort should be coordinated with Mr. G. E. Fisher, Secondary Roads Engineer.

I request you take a personal interest in this matter since it is essential that we develop cost experience with timber bridges. It will eventually be necessary to make greater use of timber, provided it is cost effective. It may also be necessary that we offer timber structures as an alternative for concrete and steel structures when advertisements for replacements are made.

Please advise Mr. Fred G. Sutherland of the location you have selected, copying my office, so that he may keep cost records and pertinent data for this program.

J. Hodge

J. S. Hodge
Chief Engineer

cc: Mr. David R. Gehr
Mr. G. E. Fisher
Mr. Fred G. Sutherland
District Structure & Bridge Engineers