Wood In Transportation Program, Superstructure Costs Report for Vehicular Timber Bridges, 1989-1995

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Abstract

The Wood In Transportation Program, formerly called the National Timber Bridge Initiative, began funding demonstration timber bridges in Fiscal Year 1989. Since the beginning of the Program, 349 demonstration vehicular and pedestrian timber bridges and 58 special projects have been funded in 48 states. The purpose of this report is to provide information on the superstructure costs of vehicular timber bridges funded through the Wood In Transportation Program. This report focuses on the final cost data that the Timber Bridge Information Resource Center (TBIRC) has for vehicular timber bridges. The final cost data is supplied by our cooperators, and the cost averages in this report are presented by region, bridge type, length, and species.

Keywords: timber bridges, superstructure costs, wood transportation structures.

Introduction

All costs in this report are made up of final cost data from completed projects from fiscal years 1989 through 1995. The source of the final cost data is from individual cooperators. As of April 1996, the TBIRC has final cost information on 112 vehicular timber bridge projects throughout the United States. A listing of states with the number of projects in which we have cost information is as follows: Alabama-2, Arkansas-2, Colorado-3, Florida-1, Georgia-2, Idaho-1, Illinois-3, Kansas-3, Maryland-2, Michigan-2, Minnesota-1, Mississippi-2, Montana-4, Nebraska-1, Nevada-1, New Mexico-1, New York-9, North Dakota-1, Ohio-4, Oklahoma-2, Oregon-2, Pennsylvania-10, South Dakota-4, Washington-1, West Virginia-46, Wyoming-2.

Cost information is provided to the TBIRC by cooperators in three formats. The most common is bid tabulation sheets; second is material, labor, design, and engineering receipts; and third is a summary form provided by the TBIRC. At times the TBIRC has requested cost information and has provided the cooperator with a Final Costs and Specifications form for summarizing the cost data. The form is divided into five major sections: preliminary, which includes design, survey, and other related costs; substructure, which includes excavation, abutment, and demolition; superstructure, which includes structure, deck, railing, fabrication, and erection; other costs, which includes site work, approaches, and detours; and surfacing. A small percentage of our cooperators have returned cost data using the Final Cost and Specifications summary form.

Much of the data is provided by cooperators with bid tabulation sheets or project receipts. When cost data is provided with bid tabulation sheets or with project receipts, the costs are summarized by TBIRC using the Final Costs and Specifications form. In previous reports published in *Crossings,* the newsletter of the Timber Bridge Information Resource Center, estimated cost information was included in the calculations. This report uses only final cost information.

Average Regional Cost

In Figure 1, the numbers in the large boxes represent the average dollar superstructure cost for that area. The numbers in the smaller boxes represent the number of bridges for which the TBIRC has final cost information for that region and is used in the calculation average.

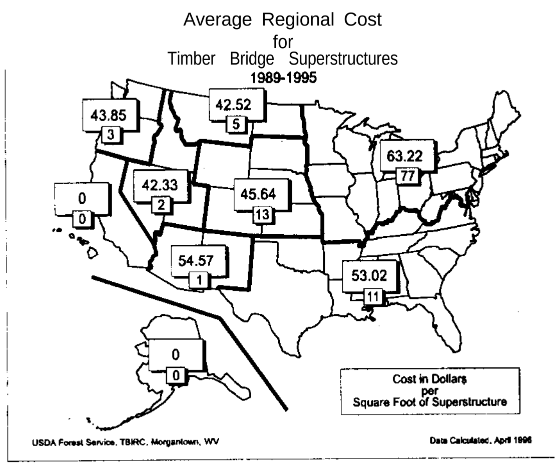

Figure 1

The total number of bridges included in the cost data calculation is 112, with overall average cost at $58.28 per square foot of superstructure. The Program has funded 310 vehicular bridge projects from 1989 through 1995, and from that the TBIRC has 254 bridge projects that are completed or are in the process of being completed. The TBIRC has final cost information for 44 percent of our completed projects. We have no final cost information for vehicular bridge projects in Forest Service Region 5 (California) or Region 10 (Alaska).

Average Cost By Type

Through the Wood In Transportation Program, 17 types of vehicular timber bridges have been funded from 1989 through 1995. The types are general classifications for analysis purposes. The bridges are classified as closely as possible to the general type. In Figure 2, average costs have been calculated for 9 of the 17 types of bridges. Seven of the 17 types have no more than two bridges in the database and have not been included in Figure 2. The number in the small box on the right hand side of the chart represents the number of bridges used in the calculation. The most expensive type of bridge is the Mozingo steel/wood composite design developed from research performed at Pennsylvania State University. The Mozingo bridge average cost is $113.42 per square foot of superstructure. The stressed-t and stressed-box designs follow, with average superstructure costs of $68.18 and $64.83 respectively. The average cost of a timber box culvert is $56.23 per square foot of superstructure. Next in cost is the transverse glulam deck with glulam stringers, with a cost of $53.02 per square foot. The stress laminated deck bridge type is also over $50 per square foot, with a cost of $51.07 per square foot of superstructure.

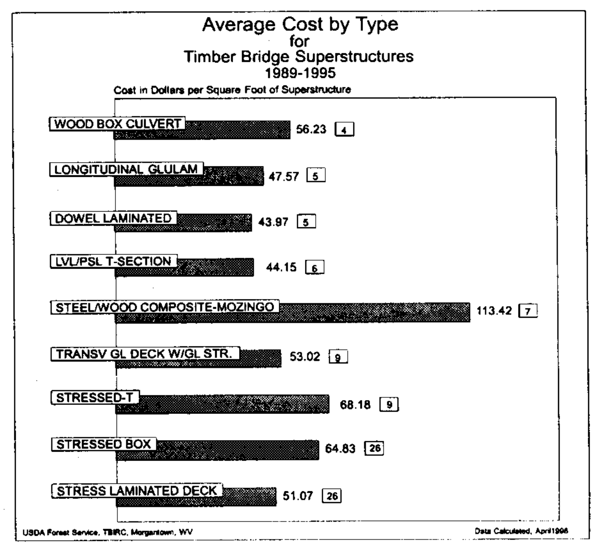

Figure 2

The least costly bridge is the dowel-laminated structure, with a cost of $43.97 per square foot of superstructure. Next are the laminated veneer lumber/parallel strand lumber t-system bridges, with an average cost of $44.15 per foot of superstructure. Following are longitudinal glulam bridges, with a cost of $47.57 per foot of superstructure.

The data indicates that the dowel-laminated structures are the least expensive along with structures using glulam material and engineered wood products, such as laminated veneer lumber (LVL) and parallel strand lumber (PSL).

Average Cost By Length

In Figure 3, average cost by length is divided into seven categories. The categories begin with greater than 50 feet in length and end with less than 20 feet in length, with five divisions between. The number in the small box on the right hand side of Figure 3 represents the number of bridges used in the calculation.

It should be understood that many of the longer span bridges are experimental demonstration bridges and that the average cost does not take into consideration the number of spans involved in the bridges. Of the 31 bridges greater than 50 feet in length, 16 are single span structures, with an average cost of $68.41 per square foot of superstructure. Fifteen bridges are multiple span bridges, with an average cost of $42.64 per square foot of superstructure. Forty-eight percent of the bridges in the greater than 50 foot category are multiple-span.

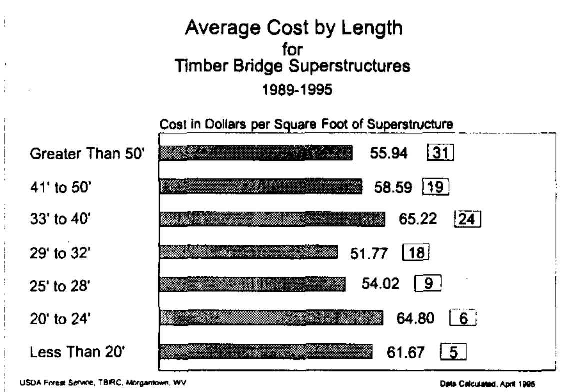

Figure 3

In the 41 to 50 foot category, only one bridge is multiple-span, and its cost per square foot is $36.37. The balance of the 18 bridges in this category average $59.82 per square foot of superstructure. One of these bridges was a deck replacement on a 252-foot structure.

Average Cost By Species

The data in Figure 4 indicates that the species of wood used to construct a bridge influences the cost of bridge superstructures. Table 1 expands on the data given in Figure 4. Additional information is given for the number of bridges by length, width, and spans for bridges by species.

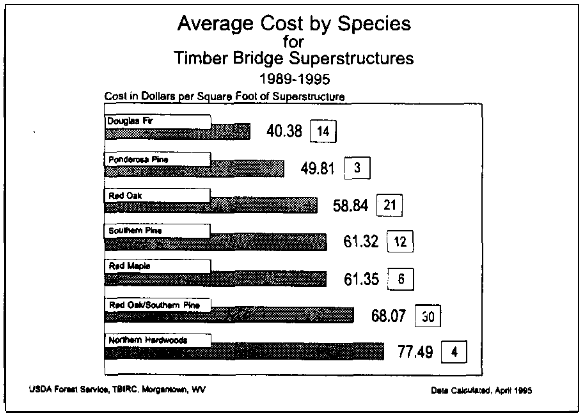

Figure 4

The 14 bridges built with Douglas fir are the least expensive structures to date. Of these, five are laminated veneer lumber (LVL) t-sections, two are dowel-laminated bridges, two are logitudinal glulam, and two are transverse glulam decks with glulam stringers. All of these bridge types are among the least expensive to build.

Table 1. Number of bridges by length, width, span, by species

Species	No. Bridges	Length <32	Length >=32	Width <=18	Width >18	Single Span	Multiple Span
Douglas Fir	14	3	11	3	11	9	5
Northern Hardwoods	4	1	3	0	4	4	0
Ponderosa Pine	3	1	2	1	2	3	0
Red Maple	6	5	1	0	6	5	1
Red Oak	21	9	12	5	16	20	1
Red Oak/ Southern Pine	30	2	28	7	23	28	2
Southern Pine	12	4	8	3	9	6	6

The three bridges constructed of Ponderosa pine are the second in the Average Cost by Species graphic, with a superstructure cost of $49.81 per square foot of superstructure and are all longitudinal glulam structures.

Third in cost are 21 bridges constructed of red oak. Fourteen of these bridges are logitudinal stress-laminated structures built in West Virginia, with one being a deck replacement. It should be noted that 13 of the red oak structures are a West Virginia Division of Highways design that is no longer used. Five bridges are in Pennsylvania. Four of the Pennsylvania bridges are the Mozingo steel/wood composite design and one is a transverse glulam deck with glulam stringers. One of the 21 red oak bridges is an A-frame design in Maryland, and one is a logitudinal stress-laminated bridge in Ohio.

The 12 structures built with southern pine vary in bridge type and are fourth in the cost graphic. Four of the bridges are transverse glulam panels over glulam stringers, two are box culverts, two are logitudinal glulam, two are logitudinal stress-laminated, and two are not classified because they do not fit the bridge types listed on the Final Costs with Specifications form. Eight of the bridges are in the south, and four are in the northeast.

Red maple species are fifth in cost. All of these bridges are in the northeast, with structure type being three longitudinal stressed decks, one logitudinal stress-laminated and, one transverse glulam panels over glulam girders. One bridge is not classified, because it does not fit the bridge types listed on the Final Costs with Specifications form.

The red oak/southern pine species classification contains the largest number of projects with thirty, of which all are in West Virginia. The classification contains two bridge types; t-stressed and box-stressed, two of the three bridge types used in West Virginia. The square foot superstructure costs are $68.07.

The species classification of northern hardwoods shows the greatest cost in this report, with a cost of $77.49 per square foot of superstructure. The Mozingo design bridge make up two of the four bridges with this classification. One structure is a longitudinal stress-laminated deck over steel girders, and one is a transverse glulam deck over steel girders.

Conclusion

This reports indicates that bridge design type, species of wood, and the region where the bridge is constructed influence the superstructure cost of timber bridges. Regional costs indicate that timber bridges constructed in the northwestern states are less expensive to construct than in the south and east. Superstructure costs for bridge types such as dowel-laminated types, along with bridges using engineered wood products such as laminated veneer lumber, are less expensive structures. The five longitudinal glulam bridges in Figure 2 also cost less than $50 per square foot of superstructure.

Length of timber bridges does not seem to affect costs per square foot of superstructure. Shorter span bridges are sometimes more expensive than longer span bridges. Average cost by species indicates a clear trend of western softwood species costing less than eastern hardwoods and southern pine. The data indicates similar average costs when comparing southern pine structures with red oak structures. Structures constructed of red maple also showed an almost identical cost per square foot of superstructure as compared to southern pine, although bridge design varied greatly between the two species.

Several conclusions may be drawn from this data: regions may make a difference in cost of timber bridges, bridge type makes a difference in cost of timber bridges, and, most importantly, species may not be as important as once thought in the cost of timber bridges. Additional analysis of the data is needed to conclusively answer questions as to relationships between costs, region, species, and bridge type.

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