



Load sharing on log bridges

by C. Kevin Lyons, Department of Forest Resource Management, University of British Columbia; and Matthew Lansdowne, Department of Forest Resource Management, University of British Columbia

In British Columbia, bridge designers for logging roads have shifted to using steel or concrete for more permanent structures; however, for temporary structures



Rob Shelly photo

Log bridge across the Kingcome River.

gravel-decked log stringer bridges can still be a cost-effective alternative. As companies move into smaller second-growth timber, bridge designers have to rely more heavily on load sharing between the stringers in order

to achieve sufficient load-bearing capacity. Therefore, there is need for a design method that considers variable load sharing between the stringers in log bridges.

Problem

Current design methods for log bridges either assume full load sharing between the stringers or load sharing based on the depth of the gravel surfacing material. In full load sharing, it is assumed that all the stringers share the applied loads equally over the length of the bridge; thus, a combined section modulus can be used in the structural analysis. For load sharing due to the gravel surfacing material, it is assumed the stringers sharing the live loads are the critical stringers; therefore, a combined section modulus for the stringers supporting the live loads can be used in the structural analysis.

Using a combined section modulus in the structural analysis of gravel-decked log bridges does not permit proper consideration of load sharing through lashing because with lashing, the live loads are not shared equally between the stringers over the full length of the bridge.

The objectives of this project were:

1. to produce a computer program for modelling load sharing in gravel-decked log bridges that is accessible to forest bridge designers, and
2. to identify trends which affect the appropriate

level of load sharing to be used in bridge design.

Solution

A Finite Element Model (FEM) permits analysis of structures with the individual components in a combined form rather than analyzing each component separately. This is particularly important when considering structures such as log bridges, where the relative strain rates of the components are important in the analysis. Therefore, a FEM written in Visual Basic and running as a macro in EXCEL was developed in this project. By running the program as a macro in EXCEL, it will be accessible to bridge designers even in remote camps with minimal computing resources.

The FEM allows the designer to enter the actual bridge geometry, including individual stringer details, gravel depth, material properties, lashing location, and relative lashing stiffness. The ability to enter detailed geometric and material property information for the stringers and to adjust the load sharing provided by the lashing will make this program a useful tool for *in situ* bridge assessment, where it is important to take rot and slackened lashing into account.

Results

Initial results indicate that in some cases it is important to consider the effect of the stringers not sharing the applied loads equally over the length of the bridge. When the applied loads are not centred over the lashing, the stringers act independently at the point where the loads are applied and the load sharing is a function only of the gravel depth. Under certain loading and lashing configurations, it is possible to have higher stresses in the stringers than would be predicted when assuming a combined section modulus.

Load sharing due to lashing is dependent on the relative stiffness of the components of the log bridge. There has to be some strain in the lashing in order for it to transfer a load to the stringers not directly loaded by the live loads; however, to have a significant load transfer, it is necessary for the lashing to be stiff enough to restrain the loaded stringers. Stringer stiffness can be a function of the section modulus and the span length. Therefore, if the stringers are stiff it will be necessary to have a corresponding increase in the lashing stiffness for there to be significant load sharing due to the lashing. 🌲

More Information

Funding for this project was provided by the Forest Investment Account, Forest Science Program. Copies of the FEM are available for testing at no charge. Contact Dr. C. Kevin Lyons at 604-822-3559 or kevelyons@interchange.ubc.ca