R1664 Suspension Trail Bridge Using Sustainable Materials

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Summary

Construction of the 27.5 meter (m) suspension pedestrian bridge over Rattlesnake Creek near Missoula, Montana provides an aesthetic and innovative link in the city's trail system. Engineers reviewed historic U.S. Forest Service trail suspension-bridge construction, relying on proven technology while incorporating small diameter roundwood (smallwood) salvaged from bug-killed lodgepole pine, along with other sustainable design materials. Lattice stiffening trusses, floorbeams and braces, constructed from small diameter roundwood, qualified the bridge for grants including U.S. Forest Service funds. They also provide an aesthetically pleasing context sensitive tie with the forested environment. Other sustainable materials used in the bridge construction include 100 mm x 300 mm composite decking from sawdust and recycled plastic, and an 18 mm thick rubber mat wearing surface from recycled tires.

Keywords: sustainable design; roundwood; small diameter roundwood; smallwood; pedestrian bridges; bicycle bridges; trail bridges; suspension bridges; composite decking; recycled materials.

1. Introduction

Pine bark beetles have killed large areas of Lodgepole pines across the North-Western United States. Most of these standing dead trees are going to waste and often contribute to forest fires. There is a tremendous opportunity to develop this resource for constructing buildings and bridges. Small-diameter roundwood, 150 to 230 mm in diameter, also called smallwood, is well suited for making joists and intermediate members. Friends of Missoula Parks, a non-profit group, received a grant from the U.S. Forest Service (USFS) to promote using smallwood in constructing the pedestrian bridge over Rattlesnake Creek in a forested area near Missoula as a prototype for future projects.

Fig. 1: Rattlesnake Creek Pedestrian Bridge

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Project requirements stipulated that bridge abutments not be built in the 100-year floodplain for environmental reasons and to make permitting easier. To accomplish this, a 27.5 m span was needed. Two basic alternates were considered during preliminary design: a prefabricated steel bridge and a cable suspension bridge. Friends of Missoula Parks chose the suspension bridge design for its aesthetics and to take advantage of USFS grant money. For inspiration, designers looked to USFS suspension trail bridges to see what details and materials had been used in the past.

The Rattlesnake Creek Bridge uses lattice stiffening trusses for aesthetics, constructability and to make part replacement easier during repairs. The trusses consist of 150 mm half rounds with top and bottom steel structural tees to facilitate connections and eliminate the chord splice weakness that was inherent in the USFS splice details. These stiffening trusses are much more rigid, and less prone to loosening connections, than those on USFS bridges. The diagonals were made to be the same for simplicity and ease of construction. Timber shear-plate connectors were used in the connections for added capacity.

Floor-beam spacing was set at 1.8 m to allow the use of longitudinal decking in lieu of a stringer and transverse decking system. Glued laminated decking, 80 mm thick and lightly re-sawn on the top face for improved traction, was called for in the design. The USFS proposed using alternate wood-plastic composite decking, being developed at Washington State University for use in U.S. Navy docks, to expose the new product's benefits. A new extrusion die was made to manufacture 100 mm by 300 mm members in order to accommodate the required 450 kg concentrated load for horse traffic on the 1.8 m deck span.

The composite material is made from 50 percent finely ground sawdust, or wood flour, and 50 percent polyvinyl chloride (PVC), likely from recycled plastic. This material is very dense with a specific gravity of 1.3 to 1.4. Deck planks have a layer of straight PVC bonded to the exterior for extra protection and as a medium for adding texture and color. The deck was left without texture because rubber mats were to be installed on top the deck as a running surface. McFarland Cascade manufactured the deck planks and special tee-clips to fasten these to the floor beams.

The Rattlesnake Creek Bridge is located under high-power electric transmission lines. The steel cables were specially grounded to eliminate any static charges from induction. Steel cones (pipe-pile driving points) and steel plates were added to the tops of the towers at the request of the power utility company for safety, specifically to discourage people from climbing and standing on the towers. Fused vinyl-coated chain link fence was placed inside the stiffening trusses to meet minimum opening requirements. Heavy rubber matting from recycled tires was installed on the deck for protection and to provide a non-slip surface.

Fig. 2: Left - Composite Decking installation; Right – Completed Bridge

The bridge was opened to the public on April 21, 2006, and provides a valuable connection in the Missoula city trail system. The bridge springs from its forested environment, providing an intriguing link between the historic Forest Service pack bridges and modern sustainable design.