Montana Trail Bridge Combines Historical Design, Modern Sustainability

By Brad Miller, P.E.

Suspension pack-trail bridges have enjoyed a colorful history in the Northwest, dating back to the formative years of the U.S. Forest Service (USFS) in the early 1900s. The majority of these mostly timber structures were built between 1930 and 1960. They range in length from 75 to almost 400 feet between towers, with short approach spans at each end. A more recent example, the Rattlesnake Creek Bridge near Missoula, Mont., includes many details found in earlier USFS suspension pack-trail bridges but also features modern improvements in design and materials.

One component of the Rattlesnake Creek project that is perhaps most indicative of the hybrid modern/historical nature of the bridge was a conscious effort toward sustainability and incorporation of a local natural resource. Pine bark beetles are killing large areas of lodgepole pine in the Northwest, leaving most of these standing dead trees to go to waste. At 6 to 9 inches in diameter, this material, referred to as smallwood, is well-suited for joists and intermediate members when constructing buildings and bridges. As such, there is a tremendous opportunity to harvest the dead timber and develop it as a natural resource.

The nonprofit group Friends of Missoula Parks received a grant from the USFS to promote the use of smallwood for construction of a new suspension pack-trail bridge over Rattlesnake Creek. To keep the bridge abutments out of the 100-year floodplain, the structure was designed with a single 90-foot span. This practice is common for shorter bridges in mountainous terrain to avoid scour and permitting issues. The towers were placed at the abutments; there were no back spans that are typically used with a suspension bridge of this type. Friends of Missoula Parks chose a suspension bridge alternative over a prefabricated steel bridge. The design uses smallwood as a primary superstructure material—offering aesthetic benefits and qualifying the project for the grant money. The towers, cables and structural tees are fabricated from steel and a wood/composite material was used in the decking. The main cables connect to 10-foot by 18-foot by 4-foot concrete anchors buried at each end of the bridge.

Photo by Michael Gallacher Photography

Smallwood that might otherwise have gone to waste proved useful in construction of a trail bridge over Rattlesnake Creek.

Historical Inspiration

Because of the remote locations of USFS pack-trail bridges, they have traditionally been constructed using as much local material as possible. Additional materials had to be packed in by mule train. The main steel cables were too heavy for a single pack animal, so loops of cable were attached to several mules, with straight portions of cable between them. The mules had to maintain a relatively synchronized step for up to 25 miles. This went against their independent nature and delicate temperament, making for some interesting pack trips.

Planks for decks and cement for pier footings and cable anchors also had to be packed in. Work was done manually with axes, picks, shovels, hand saws and augers. Concrete was mixed by hand using local aggregate and trees were felled without benefit of motorized chain saws. Heavy pieces were lifted into place with winches and pulleys.

Untreated logs were used for the towers, floor beams and stringers. Once the towers and cables were erected, construction proceeded from one side to the other entirely above ground and stream. Hanger cables and floor beams were installed one section at a time. Stringers and deck followed, providing a work platform for the next section.

Little was done in the way of dampening the undulating movements of early bridge decks under the load of pedestrians and pack animals. Decks and rail systems were the only stiffening elements. Deck movements intensified as a person traversed a bridge, especially when one's walking rhythm closely matched the natural frequency of the bridge. Many animals refused to cross, or got part of the way across a bridge and bolted. It was especially hard for those poor mules already mentally challenged from packing cables as described above. Sometimes you had to ford the river next to the bridge.

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Stiffening trusses were soon added to suspension trail bridges for the comfort and safety of both man and beast. They were constructed as lattice trusses consisting of 1-inch by 6-inch diagonals with double 2-inch by 6-inch boards for top and bottom chords. The stiffening trusses served to dampen undulations and also acted as railings. But these required frequent maintenance since the connections tended to break or work loose. Some later bridges used continuous steel stringers as stiffening elements.

The original untreated wood on USFS trail bridges generally rotted after 10 to 15 years of service and was replaced with treated wood that was packed in. The towers required special jacking frames or brackets for changing out the posts and caps under the cables. Even so, many of these bridges have survived a harsh wilderness environment for up to 75 years. They are an integral part of the Northwest wilderness experience that is both historical and practical.

Modern Application

The Rattlesnake Creek Bridge uses an updated lattice stiffening truss design for aesthetics and constructability. These trusses consist of 6-inch half-rounds for diagonal members and steel structural tees for top and bottom chords to facilitate connections and eliminate the chord splice weakness inherent in the USFS detail. The 6-inch half-rounds were fabricated from standing dead trees harvested from the Nez Perce National Forest in Idaho. They were stress graded and stockpiled for use in this bridge and other community projects. USFS provided the roundwood material and additional funding to encourage its use.

Some of the roundwood was cut into half-rounds. Most post-and-pole fabricators are set up to do this since half-round fence rails are common. The flat surfaces made constructing the lattice truss much easier. The structural-tee used for top and bottom chords made it easy to connect the diagonals to the top and bottom chords and facilitate splicing the chords. The resulting stiffening trusses are much stiffer than the ones on USFS bridges and less prone to loosening of connections. The slight perceptible movement under live load quickly dampens out. The diagonals were detailed to be the same across the truss for ease of construction. The connections were detailed to make it easy to replace individual members in the future.

The spacing between floor beams was set at 6 feet to allow longitudinal decking in lieu of stringers and transverse decking, and for aesthetics considering the relatively short bridge span. This simplified construction produced a low-profile deck system and maximized the freeboard under

Rattlesnake Creek bridge combines natural and man-made materials in a functional and visually pleasing structure.

the bridge. The design called for glued laminated decking, lightly re-sawn on the top surface for traction. USFS proposed using an alternative wood/plastic composite decking that is made from 50 percent finely ground sawdust and 50 percent recycled plastic. This decking was being developed for the U.S. Navy by Washington State University in cooperation with McFarland Cascade Manufacturing. Originally designed for use in docks, the 4-inch by 6-inch composite decking was modified for the Rattlesnake Creek project. A new extrusion die was made to manufacture the 4-inch by 12-inch members needed to accommodate the 1,000-pound concentrated load required for horse traffic. These planks were fastened to the floor beams with special tee-clips recessed between the planks to provide a smooth deck surface and minimize penetration of the composite decking with screws or nails. Heavy rubber mats created from recycled tires were installed on the deck, again for horse traffic. The mats came in 4-foot by 8-foot sheets, 5/8 inch thick and weighed about 130 pounds each.

The tower legs were constructed of 12-inch nominal diameter steel pipe with 3/8-inch wall thickness. The towers were braced laterally using timber half-rounds on either side of steel gusset plates for ease of construction and to appear as round timber members. Steel cones (pipe pile-driving points) and plates were added to the tops of the towers at the request of the Bonneville Power Administration, to keep people from standing on the towers, an important safety feature since this bridge is under high-voltage transmission lines. Vinyl-coated chain link fence was placed on the inside face of the stiffening trusses to satisfy minimum opening requirements.

Summary

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

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