



pass over the support towers via cable saddles and are connected to subsurface anchorages. From Lackawaxen to the Brooklyn Bridge, from the Golden Gate to the Verazzano Narrows, and now the diminutive Pochuck, the suspension bridge has provided the answer for challenging long-span crossings. For heavy-loaded vehicular bridges, the suspension bridge is the exclusive bridge type when the clear span exceeds 1,800 feet. For remote pedestrian trail locations that are inaccessible by heavy equipment, suspension bridge engineering provides a solution for clear spans ranging from 75 to 400 feet in length.

For the Pochuck Quagmire, the suspension bridge concept provided the following advantages.

- By their inherent geometry, suspension bridges lend themselves to tall, high clearance, and wide-span situations. This addressed the unstable stream banks and floodwater clearance problems.
- For a given span and loading, they are the lightest bridge system. Suspension bridges are an “efficient” structural solution because of the predominance of tensile stresses and the direct stress paths from the load to the support points. This assisted in addressing the dead load foundation requirements for the extremely poor soil conditions. This also resulted in economic and practical advantages in terms of material, transportation, and workforce costs.
- A structure is the sum of its parts. In this case, all of the material utilized was common construction material, available on relatively short notice.
- The design centered around the off-site prefabrication of the suspended truss walkway by volunteers of the NY-NJ Trail Conference. Common carpentry skills were sufficient to complete the project.
- All the material and prefabricated elements were transportable to the remote site.
- The towers provided support for an overhead erection cableway which, in turn, doubled as guy lines.

Historical Significance of Suspension Bridges to the Appalachian Trail

Interestingly, there is a direct historical parallel in the use of a suspension bridge for the Appalachian Trail route in the metropolitan New York area. Benton MacKaye presented his concept of the Appalachian Trail in 1921, when the NY-NJ Trail Conference was a fledgling one-year-old organization. In 1923, the NY-NJ Trail Conference built the first section of the Appalachian Trail in Bear Mountain-Harriman State Park, beginning at the west bank of the Hudson River and working southwestward toward New Jersey.

The next year, 1924, the Bear Mountain Vehicular Suspension Bridge, the longest suspension span in the world at the time, opened across the Hudson River. The bridge provided for passage of the Appalachian Trail over the mighty Hudson River as well as being the first roadway over the Hudson between New York City and Albany. The cablewire and steel rope for the bridge were manufactured by John A. Roebling & Sons Company of Trenton, New Jersey, as were the wire rope used on almost every major suspension bridge in the 19th and 20th centuries. John Roebling is revered as the father of modern suspension bridges.

The offices of the NJDEP Division of Parks and Forestry are also located in Trenton, a stones throw from the former Roebling Mills. The NJDEP acquired the first of its recreational pedestrian suspension bridges in the same era. The 350-foot long Cranberry Lake Pedestrian Suspension Bridge located in Allamuchy State Forest was constructed in 1928. It seemed appropriate that the NY-NJ Trail Conference would be utilizing a suspension bridge to provide a critical “Missing Link” of the Appalachian Trail in its 75th anniversary year.



The Pochuck Quagmire Bridge design contains all the classic components of a suspension bridge: diagonally braced towers, main catenary cables, deep anchorages, vertical suspenders, cable saddles, stiffening trusses, and the deck system. A comprehensive approach was employed in the design of this bridge.

The first step was to research the literature from the Grand Era of Suspension Bridges (1924 Bear Mountain Bridge to 10:30 a.m., November 7, 1940, Tacoma Narrows Dance of Death). This included review of classic texts, transactions of the American Society of Civil Engineers, the Roebling Papers at Rutgers University, and numerous other sources. A listing is provided in Appendix F and G.

The second step was to inspect similar pedestrian structures. Upon discussion with the project partners it became evident that there was no available data or material on similar structures.

Over a period of one year, a field reconnaissance of pedestrian suspension bridges from North Carolina to Maine was performed by the author of this publication. The purpose was to establish de facto design standards as well as to learn from the successes and problems of others. Six of the bridges are on the Appalachian Trail.

Following is a brief listing of the inventoried bridges. Those appearing in bold print are “good” examples of bridges built using USDA Forest Service design and construction methods.

- *Bear Mountain Bridge*: Hudson River, Appalachian Trail, Bear Mountain, New York
- *Bemis Bridge*: Saco River, White Mountain National Forest, New Hampshire
- *Brooklyn, George Washington, Verazzano Narrows, & Golden Gate Bridges*
- *Bull’s Island Suspension Bridge*: Delaware River, D & R Canal State Park, New Jersey
- *Clarendon Gorge*: (Robert Brugman Memorial Bridge) Appalachian Trail, Vermont
- *Cranberry Lake Suspension Bridge*: Allamuchy State Forest, New Jersey
- *Deerfield Creek Bridges I & II*: Green Mountain National Forest, Vermont
- *Dry River Bridge*: White Mountain National Forest, New Hampshire
- *Grandfather Mountain Swing Bridge*: North Carolina
- ***Great Gulf Wilderness Bridge***: Appalachian Trail, White Mountain National Forest, New Hampshire
- ***Hastings Trail Bridge***: Wild River, White Mountain National Forest, New Hampshire
- ***Jackson River Bridge***: George Washington and Jefferson National Forest, Virginia
- ***Kimberly Creek Bridge***: Appalachian Trail, George Washington and Jefferson National Forest, Virginia
- *Libby Bridge*: Peabody River, White Mountain National Forest, New Hampshire
- ***Lincoln Woods Trail Bridge***: White Mountain National Forest, New Hampshire
- *Mackinaw River Bridge at Parkland*: Bloomington, Illinois
- *Murray River Swing Bridges I & II*: Virginia
- *Northville - Lake Placid Trail Bridge*: West Branch Sacandaga River, Adirondacks, New York
- *Old Job Trail Bridge*: Lake Brook, Green Mountain National Forest, Vermont
- *Orange County Golf Course Bridge*: Orange County, New York
- *Rattle River Bridge*: Appalachian Trail, White Mountain National Forest, New Hampshire



- *Roebing Aqueduct*: Delaware River at Lackawaxen
- *Saxton River Bridge at Bellow Falls*: Vermont Association of Snow Travelers (VAST), Vermont
- *Saxton River Bridge at Grafton*: Vermont Association of Snow Travelers (VAST), Vermont
- *School House Road Bridge*: Chester, Vermont
- *Smokey Angel Bridge*: Hartland, Maine
- *Tye River Bridge*: Appalachian Trail, George Washington and Jefferson National Forest, Virginia
- *Wallace Tract Trail Bridge*: George Washington and Jefferson National Forest, Virginia
- *Wilderness Trail Bridge*: White Mountain National Forest, New Hampshire
- *Winooski Wonder Bridge*: Vermont Association of Snow Travelers (VAST), Waterbury, Vermont

The difference between the Pochuck Quagmire Bridge and the pedestrian bridges listed above became readily apparent in this inventory. Almost all of the bridge sites were easily accessible by a paved roadway. All of the bridges were located on solid rock outcrops or had similar good foundation conditions and crossed a well-defined river in a gorge or sheltered valley. The Pochuck Quagmire site did not have any of these benefits. In addition, the majority of the bridges were located in out-of-the-way rural locations as opposed to the Pochuck site, which is on the fringe of the New York City Metropolitan area. This necessitates a greater emphasis on public safety and anticipation of misuse.

USDA Forest Service's Use of Suspension Bridges

With this inventory it became apparent that USDA Forest Service bridges were the only pedestrian suspension bridges that were built to a consistent, identifiable standard. The USDA Forest Service appears to use the same basic plans for its trail suspension bridges with regional variations. It seems that these plans originated in the 1930s.

During the development of this publication, the author learned of an additional 31 USDA Forest Service suspension bridges in Idaho and Montana. Photographs of a few of these bridges are included in Appendix H. The Appalachian Trail Tye River Bridge was originally built in 1972 and reconstructed in 1992. The Kimberly Creek Appalachian Trail Bridge is the most recent USDA Forest Service Suspension Bridge on the Appalachian Trail, having been built in 1992. The Pochuck Quagmire Bridge design incorporates some of the proven features of the Forest Service bridges and provides alternatives to other elements. The author acknowledges the valuable input of the USDA Forest Service. The Pochuck Quagmire Bridge upgrades structural and public safety elements to Building Officials and Code Administrators® International (BOCA®), American Association of State and Highway Transportation Officials (AASHTO), and the Americans With Disabilities Act (ADA) standards where practical. Based on the field inventory by the author, the Pochuck Quagmire Bridge meets or exceeds the standards utilized for the USDA Forest Service Suspension Bridges on the Appalachian Trail.

Suspension Bridge Nomenclature

Following are some definitions and simple sketches (Figure 2, page 15) of suspension bridge components. These are provided at this time to give the reader an overview. Greater detail is provided later in this case study. As stated previously, suspension bridges consist of a rigid flooring system hung by suspender cables from main catenary cables. The main catenary cables pass over the support towers via cable saddles and are connected to subsurface anchorages.