***Main Catenary Cables*:** These cables provide for the distinctive parabolic silhouette. Cables are in tension. To be correct in a technical sense, what are generally called the cables are more properly called wire rope. Groups of individual wires make up a strand. Groups of strands make up a wire rope. When a wire rope reaches a large diameter, it is generally called a cable. There does not appear to be a common consensus as to the threshold diameter that differentiates between a wire rope and a cable.

***Backstays*:** That portion of the main tension catenary cables (wire rope) that extends from the tower top saddles to the subsurface anchorages.

***Suspenders*:** The vertical wire ropes that run from the main cables to the rigid floor system. Normally these are significantly smaller in diameter than the main cables, and these are equally spaced. They distribute the roadway load to the main cable.

***Center Span*:** The horizontal distance between the towers.

***Towers*:** Also called piers or pylons. The towers support the main cables. They must address wind, temperature, and live and dead loads.

***Sag*:** Also known as dip. The vertical distance between the high and low points of the main cable.

***Sag-Span Ratio*:** The ratio of the cable sag to the span. A critical design element.

***Cradle*:** The horizontal offset distance between the midpoint of the main cable to the straight line established by the cable saddles.

***Flare*:** The horizontal offset distance between the straight line established by the cable saddles and connection of the main cable to the anchorage.

***Stiffening Trusses*:** These act to distribute a concentrated live load over a length on the main cable by loading several suspenders. They provide support for the floor system.

***Camber*:** The arch of the walkway. The vertical distance from the underside of the truss chords at the bridge midpoint to the straight line drawn between the tower walkway support points.

***Tower Footing*:** This component transfers the axial load of the bridge towers to suitable bearing subsurface stratum. It is designed to address uplift, overturning, and sliding.

***Anchorages*:** Mechanisms that counter-act the inclined tension load of the backstays.

Design Standards

A problem that presented itself during the 1994 design phase of this project is that no formal design criteria for any type of pedestrian bridge had ever been addressed by any of the major recognized design codes. Pedestrian bridges seem to have "fallen through the cracks." This was verified by a review of the literature and discussion with engineers nationwide. In order to address this void, in 1997, AASHTO published the "Guide Specifications for Design of Pedestrian Bridges." Excerpts of this guide specifications are provided in Appendix B. Liability by not meeting recognized "design standards" on the part of project partners in the event of an accident or misuse on the bridge became a major concern.

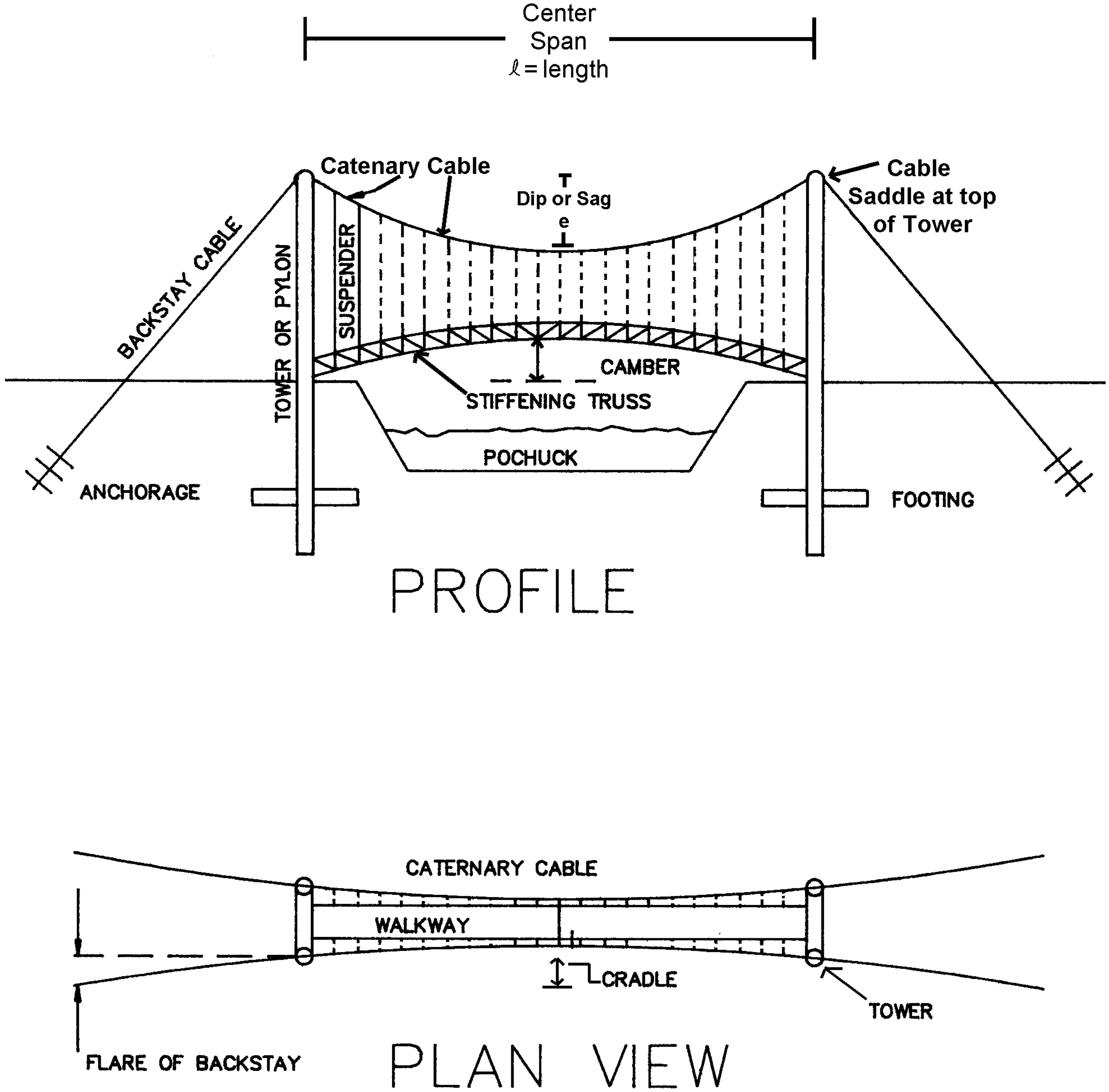

Figure 2. Sketch of Suspension Bridge Components.

The project engineer applied design standards from various codes in effect at the time of design and construction as good judgment dictated. A list of references is provided in Appendix F. The results of the bridge inventory defined what is standard or customary in the field. Examples of the appropriate application of design standards are as follows:

- Utilization of braced-guyed transmission pole standards in concert with BOCA® Loading and Timber Construction Standards for the Trussed Tower Design. The design of the bridge walkway rail system as a Howe Truss, so that the walkway would act as a live load and wind load distribution member, consistent with civil engineering practice. The layout of the rail system horizontal members meets the 1992 AASHTO standard 2.7, 2.2.1, and 2.2 for Pedestrian Walkways. The rail system at the platform at either end was upgraded to meet BOCA® standards for swimming pool enclosures 421.10.1.2, 1.4 by the addition of 1-inch by 1-inch poly coated galvanized wire mesh. The rail system and handrail also meet ADA requirements.
- A common-sense practical approach was utilized in recognition of the resources of the project partners, public safety, long-term maintenance, and appropriate design for a wilderness footbridge. The combination of dead load, live load (20,800 pounds or 110 people at 189 pounds each spaced 1-foot apart), and snow load became the primary design load. Although checked independently, these loads were not combined with wind load or seismic loads, recognizing the improbable occurrence of 110 people on the bridge during a snowstorm with 70 miles per hour (MPH) winds and a simultaneous earthquake.
- A live load of 60 pounds per square foot (PSF) was used. This is consistent with BOCA® standard 1606.1 which specifies 60 PSF for exterior decks. In the early 1990s, well-known bridge manufacturers also used 60 PSF live load for bridges longer than 50 feet.
- The snow load for the Pochuck Quagmire Bridge is relatively low. The reader is advised that in some parts of the country the snow load will be the primary design load.

The bridge was designed and constructed to comply with applicable portions of the following codes and standards as identified in the design calculations:

- 1993 BOCA® National Building Code
- American Institute of Timber Construction (AITC) Timber Construction Manual
- National Design Specifications and Load Factors for Southern Yellow Pine
- Building Code Requirements for Reinforced Concrete, American Concrete Institute (ACI) 318
- Uniform Construction Code — State of New Jersey
- Transmission Line Design, U.S. Department of Agriculture
- Federal Emergency Management Agency (FEMA) Floodproofing Non-Residential Structures
- Title III of the Americans With Disabilities Act
- New Jersey N.J.A.C. 5:23-7 Barrier Free Subcode
- 1992 AASHTO Hand Rail Standard 2.7, 2.2.1, and 2.2 for the walkway

The bridge was constructed to meet or exceed the following:

1. Live load of 60 PSF in combination with a walkway dead load of 9,550 pounds, which results in a design load of 39,400 pounds across the 110-foot span. Dead, live, and snow load translates to maximum cable tension load of 23,455 pounds, and a column load of 21,698 pounds.

2. A ground snow load of 30 PSF, which translates to 18 PSF on an elevated suspension bridge.
3. A 50-year 70 MPH wind on the profile cross-section of the bridge.
4. The span-sag-elevation of the bridge provides a 6.68-foot freeboard to the historical 100-year floodwater elevation of 400 feet for Pochuck Creek at the bridge center and 4.5 feet at the platforms.
5. Allowable soil bearing capacity of 500 PSF.
6. Wire rope safety factor of 4.5.
7. Soil power installed screw anchor safety factor of 3.

Design and Construction of the Bridge Towers

The design of the bridge towers required answers to a number of philosophical and practical questions. The first question was whether the towers should consist of a large number of lightweight structural members (like a "stickbuilt" framed house) or a few massive members (like a log cabin). The original design for the Pochuck Quagmire Bridge consisted of framed, built-up towers consisting of dimension CCA .60 southern yellow pine. This was a design necessity at the time because all material would have had to be hand-carried to the site, assembly would be done by layperson volunteers, and the total budget was $10,000.

This design premise was modified when GPU Energy joined the project as a volunteer. GPU Energy offered to provide, transport, install, and guy 40-foot tall #1 SYP transmission poles to serve as the catenary cable towers. Mr. John Karcher, a professional engineer with GPU Energy, provided technical literature on GPU Energy material and procedures.

The use of round non-uniform transmission poles for the primary structural members of the towers set a certain standard or premise for the project. Heavy timber connections are difficult to make efficiently, particularly when the connection is between a round pole and flat dimension lumber. It is similar to installing a square peg in a round hole. There is very little direct bearing between the two surfaces. The single curve spike grids do assist in addressing this problem. However, the problem in this project was compounded by the fact that the tower joint connections would be made in a remote field location, installed with hand tools, 34 feet in the air, accompanied by friendly mosquitoes. These practical considerations dictated that while the towers are H-Frame, X-braced structures (indeterminate), no allowance would be made for the benefits of the truss construction. The joints are the weak link. The design premise for the towers is that they are designed as simple tapered columns restrained at the base and braced at the top. The Euler effective length of the tower columns was taken as the distance between the top of the foundation and the upper guylines. The intermediate timber cross-members will act to reduce the effective length and increase the load-bearing capacity. But discounting the benefits of these intermediate members and designing the towers as a simple column resulted in a more conservative design.

The design of the towers was a several step process. The following steps were performed:

1. Identify the basic dimensions and geometry of the bridge. Span and the width of the walkway needed to meet the ADA code. These dimensions in concert with a live load of 60 PSF and a snow load of 18 PSF determine the total live load.
2. Design of the walkway structure, i.e., the ribs, chords, diagonals, joists, rails, and decking. The specific design and material used identified the dead load.