The Ponkin Bridge (1871) is the only known surviving iron bridge to incorporate all of the design features of Simon J. Post's Patent Diagonal Truss Bridge. Post trusses enjoyed a brief period of popularity in the late 1860s and early 1870s. Railroads often chose Post's bridge for long-span river crossings. The Ponkin Bridge is an unusual example of a Post truss used for a relatively short-span highway bridge.

The Ponkin Bridge has joints that match the drawings of Post's patent (No. 36,910), granted in 1863. A special cast-iron joint box connects the top chord to the posts, struts, and braces. The bottom of the end posts are rounded and fit into cylindrical joints where they meet the bottom chord; and, a pin passes through a slot in the bottom chord to tie the end posts to the chord. Post claimed that these joints allowed the bridge to expand and contract without injury to its structure.

Although Post patented his joints, he never patented the unique combination of posts and diagonals that became the signature of his bridges. The Ponkin Bridge bears the Post truss's hallmark of cast-iron posts that incline towards the center of the bridge and double-intersecting, wrought-iron diagonals that incline toward the abutments. This truss also has the characteristic upper and lower laterial bracing, and counters with adjustable turnbuckles.

The Watson Manufacturing Company of Paterson, New Jersey built the 100-foot-long, 20-foot-wide, single-span Ponkin Bridge. The firm held the license for Post's patented trusses, and Andrew J. Post, Simon S. Post's son, worked for the bridge manufacturer. The company probably built most of the iron Post trusses erected in this country. The Ponkin Bridge replaced a series of wooden bridges that had crossed the North Nashua River at the village of Ponkin since the eighteenth century. The new iron truss served a small cotton textile village on the west bank until the factory closed in the early 1930s. The Ponkin Road remained the major thoroughfare between Lancaster and Lunenburg until 1965 when Route 117 bypassed the bridge. In 1978 the Ponkin Bridge was placed on the National Register of Historic Places.
Details L0 and U4
Scale: 2" x 1'-0" (Isometric)

Endpost Fabricated From
7" I-Section and 7-3/4" x 1/4" Plates
Riveted Together (7/8"

1" Diagonal Rod

Cash-Iron Shoe

4" x 1/2" Eyebars

Connections of Upper Chord
U4 Typical

Members are connected by a bar pin
soldered in place by an internal cast-iron box inside the housing formed by the
cast-iron upper chord members.

This connection looks like the patent drawing for a
feature of the first type that allowed the force to
carry the metal cross-beam, and the diagonal to
be housed within a casing and clamped so that
true movement can occur. The plate, if present, seems
certainly seen. Rusting is present and buckling has
occurred in adjacent lower chord members.
STRUCTURAL BEHAVIOR OF POST TRUSSES

The crossed diagonals in the planes of the top and bottom chords prevent the bridge from deflecting sideways due to wind or other laterally acting forces as well as helping to prevent torsional deformations.

The rigid portals at both ends, along with the stiffening provided by the upper cross members at panel points, prevent the bridge from rocking sideways due to wind or other laterally acting forces.

Possible rocking

Rigid frame action

Live loads from vehicles or pedestrians are carried by the decking to the timber beams.

Timber beams carry loads to the wrought-iron transverse beams.

Transverse wrought-iron beams carry loads to the truss joints.

Trusses carry all loads to the supports. Tension or compression forces are consequently induced in truss members. The member configuration shown is entirely characteristic of other Post trusses.

Top chord members are in compression under full or partial loadings, with maximum forces normally developed in members at midspan. Rigid members are used to provide resistance to buckling.

The inwardly - sloping diagonals are in compression, with maximum forces normally developed in end members. Rigid members are used to provide resistance to buckling.

Outwardly - sloping diagonals are in tension, with maximum forces developed in end members. Slender bars are used to carry the tension forces. Under partial loading conditions, compressive forces may begin to develop in some of these members and they harmlessly buckle out of the way.

Outwardly - sloping rods (the "counters") carry no forces under normal uniform loading conditions. When a load moves across the bridge, some of these members may go into tension to stabilize the truss while others remain inactive.

Lower chord members are in tension under full or partial loadings, with the maximum forces developed in members at midspan. Slender bars are used to carry the tension forces. The varying numbers of these bars reflect differences in the magnitude of the forces present.

Patent drawings for Post trusses show an abutment connection housing a slotted lower chord end which would allow free thermal expansion and contraction to occur.

(Conjectural drawing)
FORCES IN TRUSS MEMBERS: FULL LOADING CONDITION

Loading on the bridge include both "Dead Loads" and "Live Loads". Dead loads include the self-weights of the trusses, beams, and deckings, and are always present. Live loads reflect the weights of vehicles and pedestrians and may or may not be present (the bridge may be only partially loaded with live loads as a vehicle moves across a bridge). A full loading condition with the maximum live and dead loading present is shown.

When a truss is loaded, tension or compression forces of varying magnitudes are developed in the truss members. These forces could be accurately predicted by 19th-century engineers through a variety of analytical methods based on a mathematical understanding of the equilibrium of different points in the truss, and subsequently used to determine the size and shape of truss members.

TRUSS MEMBERS: OTHER LOADING CONDITIONS

When vehicles or other loads move across the bridge (creating a nonuniform loading condition), the force types and magnitudes present in truss members changes. Only one of many possible partial-loading conditions that could exist is shown below.

Stress-reversals may occur in some truss members. Compression forces may begin to develop in slender diagonal members designed primarily to carry tension forces only (these members buckle harmlessly out of the way as long as counters are present which go into tension and stabilize the truss). In some loading conditions, minor compression forces can develop in the lower chord members adjacent to the end supports (e.g., due to the braking action of vehicles, longitudinal earthquake or wind forces, or a failure of the expansion joint).

The forces in these members change from tension to compression, as the members buckle harmlessly out of the way.

The counters, which previously carried no forces, go into tension to stabilize the truss.

The member goes into tension.

Compressive forces are potentially devoting in these members due to longitudinally-acting loadings.

MEMBER DESIGN

Members in the Ponakon Bridge have been sized and shaped in direct response to the nature and type of forces present. Members that have been designed to resist tension forces only are usually relatively slender and have small cross-sections. Members that have been designed to resist compression, and are hence susceptible to buckling, are always larger and stiffer.

There are small but obvious size differences in many of the truss members used in the Ponakon Bridge. These size differences reflect the variation in type and magnitude of forces in the truss as described to the left. These variations are diagrammed below and noted in detail in the Table of Member Sections (Sheet 2 of 6).

Some variations, however, are associated with partial loading conditions described in the lower left figure.

Diagram of Member Types and Sizes Required

Member size is based on maximum force present at midspan and is used throughout the length of the upper chord for tension force.

Actual Member Sizes Used in Bridge

Required upper chord member sizes increase towards midspan. Member sizes must be used.

Required tension diagonal sizes increase towards the ends.

Maximum size of lower tension chord member is at midspan. Tension diagonals and compression diagonals are largest near the ends. Counters are necessary in the smaller end of a crossing.

These are primarily slender tension members but have stress-lags that provide some additional stiffness to carry minor compressive forces.

CAMBER

Excessive downward deflections were often problematic in 19th-century bridges. The Ponakon Bridge was apparently designed with an upward camber to counteract these adverse deflections. The bridge tends to level out when subjected to a downward load. Levels taken on the bridge indicate that an upward camber still exists.

The final height of midspan of bridge relative to supports under full dead load. Original camber is upward resulting in the truss being slightly arched.