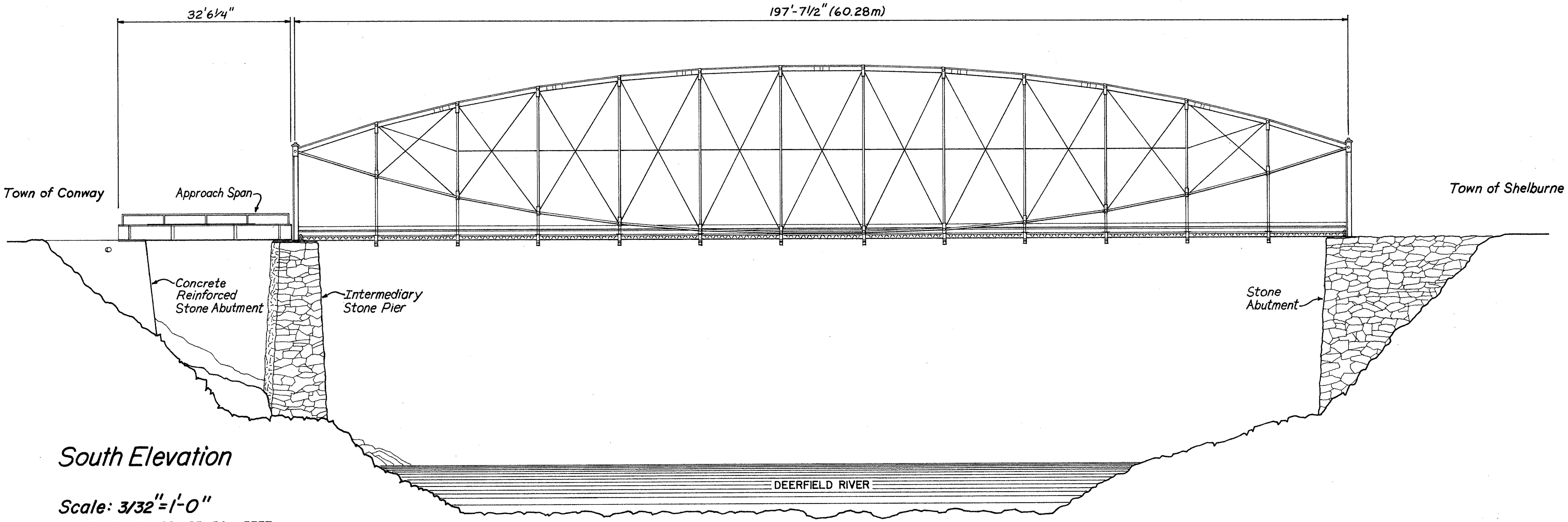
BARDWELL'S FERRY BRIDGE · 1882

CONWAY / SHELBURNE, MASSACHUSETTS

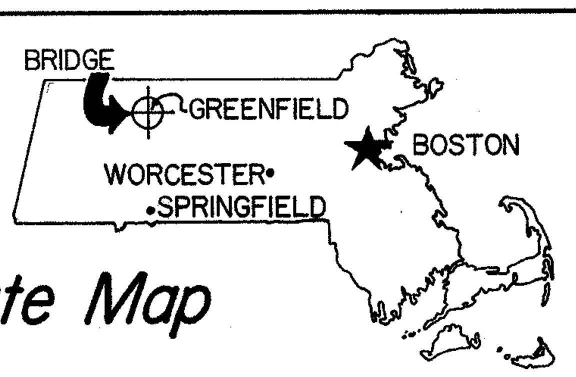


South Elevation

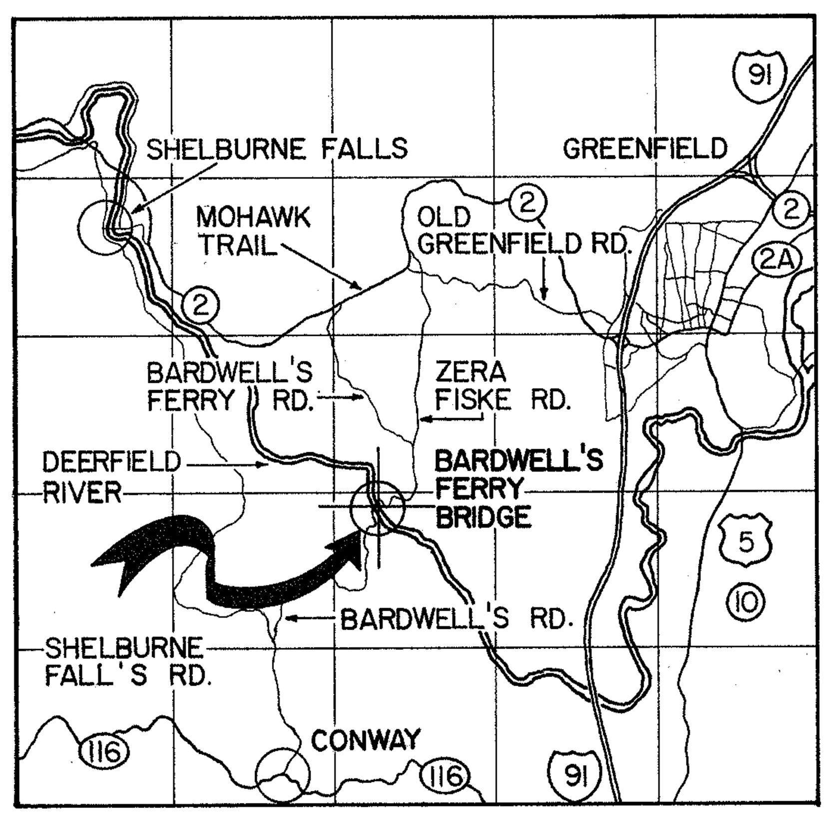
Scale: 3/32" = 1'-0"

0 5 10 15 20 25 30 FEET

0 1 2 3 4 5 10 METERS



State Map



Local Map

UTM 18.69060.471384

Based on Massachusetts D.P.W. General Highway Map (1975) Region B, Sheets 5-8

Scale:

0 1 2 3 4 5 MI.

0 1 2 3 4 5 6 7 8 KM.

The Bardwell's Ferry Bridge is an excellent, virtually unaltered, example of William Douglas's 1878 patent for an "elliptical" truss bridge, now usually called a lenticular truss. The lenticular (lens-shaped) truss was unique among truss forms of the time in that it combined many of the advantages of arch, cable and truss structures. The bridge is nationally significant as one of the oldest and longest surviving lenticular truss spans in the United States built by a bridge company. The Bardwell's Ferry Bridge is the oldest of ten known surviving lenticular bridges in Massachusetts, and has the longest singular lenticular span in the state.

Beginning about 1780, Gideon Bardwell and his descendents operated a ferry over the Deerfield River at this site, and the southernmost section of Shelburne became widely known as "Bardwell's Ferry." In 1867, when the Troy and Greenfield Railroad was built through the Deerfield River Valley, the town of Shelburne paid for the erection of a covered wooden bridge to replace the ferry, so as to provide freer access to the railroad station on the Shelburne side of the river. Shortly after the covered bridge blew down in a windstorm in January of 1882, the towns of Shelburne and Conway contracted for the construction of the present Bardwell's Ferry Bridge. It was erected during the summer of that year by the Corrugated Metal Company of East Berlin, Connecticut, which became the Berlin Iron Bridge Company in 1883 and was one of the leading bridge companies in New England in the late - nineteenth century.

The Massachusetts Historic Bridge Project is part of the Historic American Engineering Record (HAER), a long-range program to document historically signficant engineering and industrial sites in the United States. The National Park Service, U.S. Department of the Interior, administers the HAER program. The Massachusetts Department of Public Works, Jane F. Garvey, Commissioner, George R. Turner, Jr., Chief Engineer, and Stephen J. Roper, Historic Bridge Specialist; and the Historic American Engineering Record (HABS/HAER), Dr. Robert J. Kapsch, Chief, co-sponsored the Massachusetts Historic Bridge Project with the cooperation of the Massachusetts Historical Commission, Elsa Fitzgerald, Acting Exec. Director. The field team under the direction of Eric DeLony, Chief and Principal Architect, HAER, consisted of Daniel L. Schodek, professor of architectural technology (Harvard University), field supervisor, Patricia Reese (Boston Architectural Center), Gary Kleinschmidt (Harvard University), Chris Payne (Columbia University), Morgen Fleisig (Harvard University), Mark Rowan (Catholic University of America), and Rudolf Sosef (Technical University of Delft, the Netherlands, US/ICOMOS), architectural technicians; Lola Bennett (University of Vermont), Patrick Harshbarger (University of Delaware/Hagley Museum and Library), and John Healey (University of Birmingham, England; US/ICOMOS), historians; and Marty Stupich (Massachusetts College of Art), photographer.

DELINEATED BY: Chris Payne, 1990

MASSACHUSETTS HISTORIC BRIDGE PROJECT

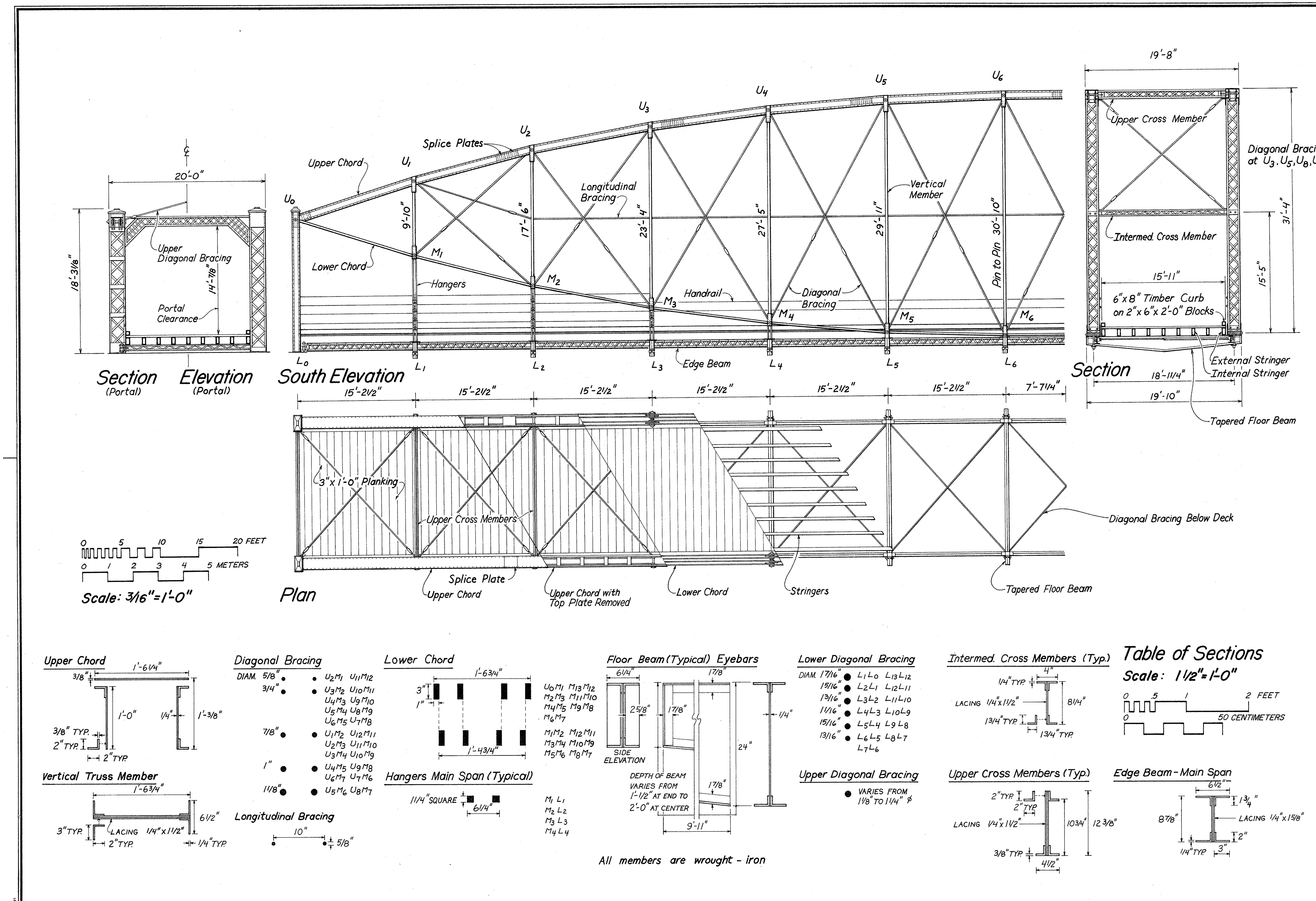
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

CONWAY / SHELBURNE

BARDWELL'S FERRY BRIDGE - 1882
SPANNING DEERFIELD RIVER ON BARDWELL'S FERRY ROAD
FRANKLIN COUNTY

MASSACHUSETTS

HISTORIC AMERICAN ENGINEERING RECORD
MA-98



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BARDWELL'S FERRY BRIDGE – 1882

SPANNING DEERFIELD RIVER ON BARDWELL'S FERRY ROAD

FRANKLIN COUNTY

CONWAY / SHELBURNE

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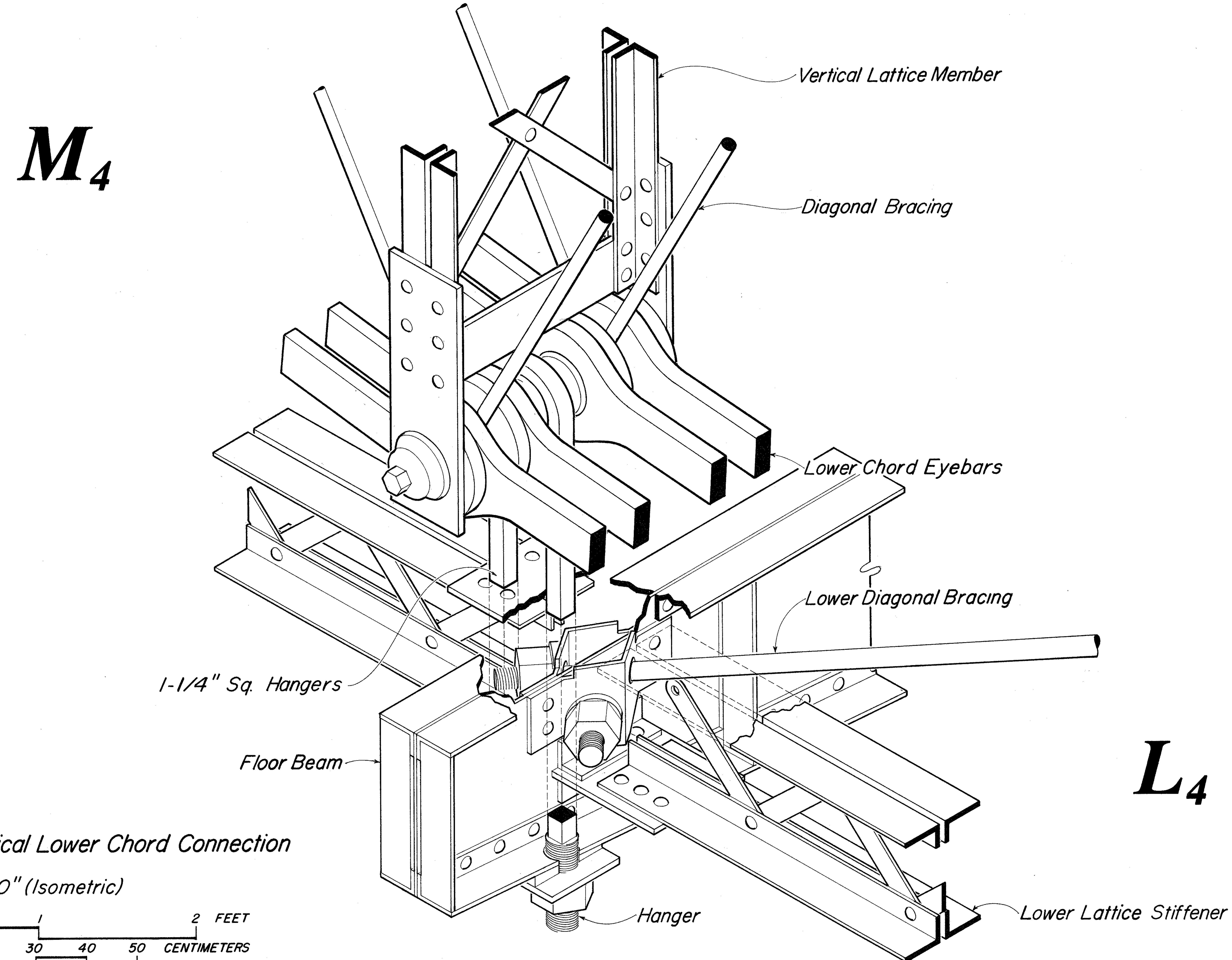

Detail: Typical Lower Chord Connection

Scale: 3"=1'-0" (Isometric)

0 1 2 FEET
0 10 20 30 40 50 CENTIMETERS

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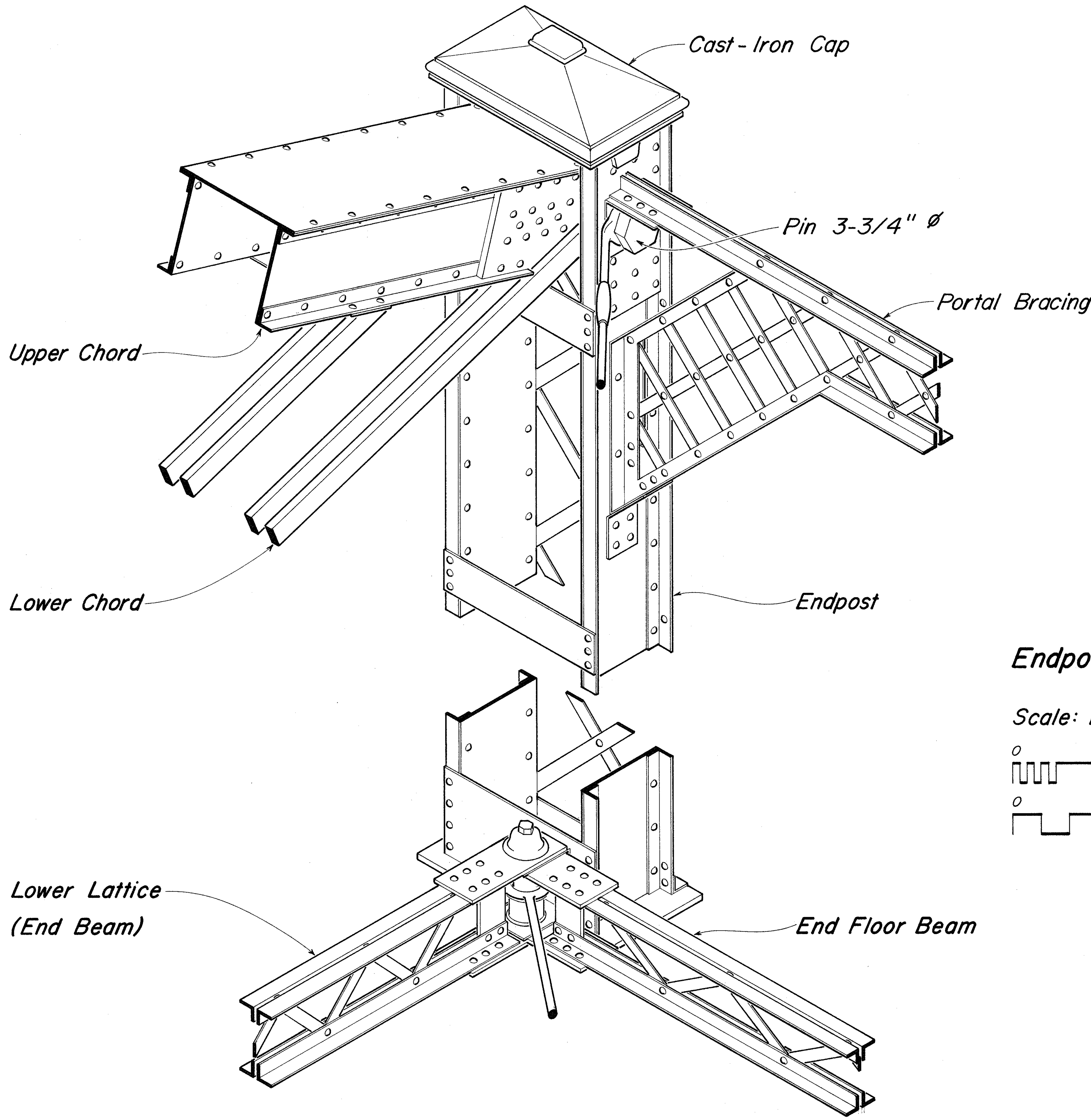
TRIM LINE



Endpost Detail

Scale: 1 1/2" = 1'-0" (Isometric)

0 1 2 FEET

0 50 CENTIMETERS

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BARDWELL'S FERRY BRIDGE - 1882

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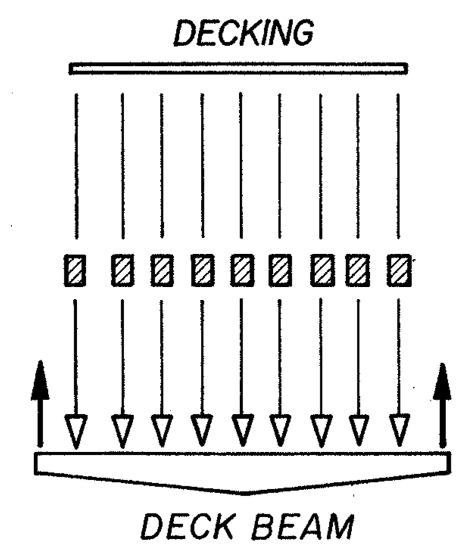
TRIM LINE

STRUCTURAL CHARACTERISTICS OF A LENTICULAR TRUSS

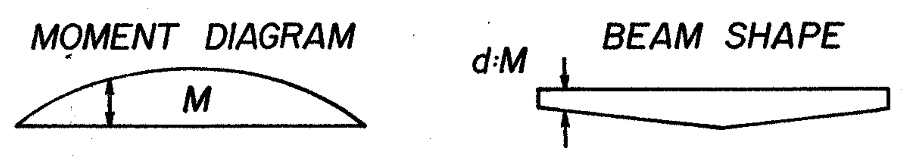
Live loads from vehicles or pedestrians are carried by the decking to the longitudinal beams.

Longitudinal stringer carry loads to the wrought-iron transverse deck beams.

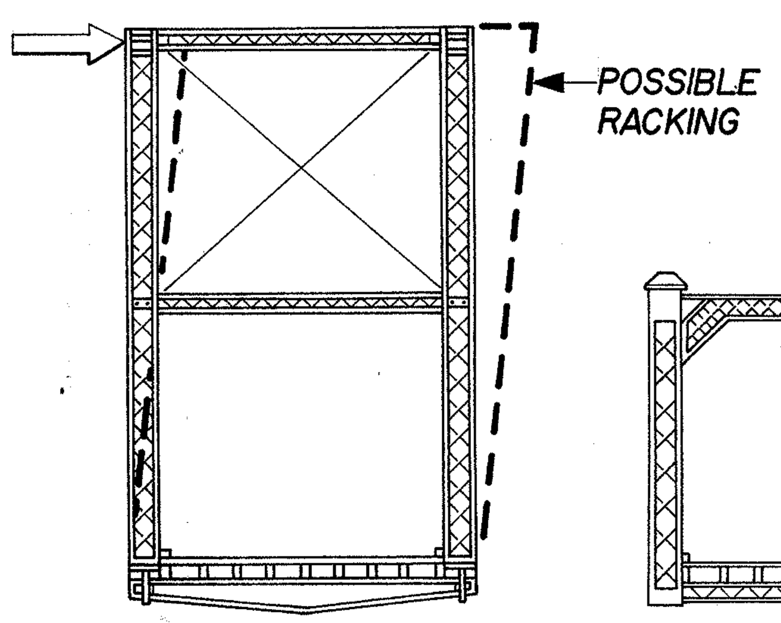
Transverse beams carry loads to the vertical tension hangers on the trusses.



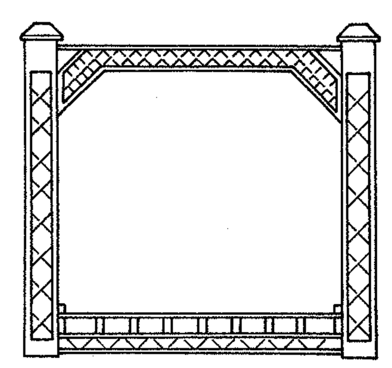
Transverse beams of the Bardwell's Ferry Bridge and other Berlin Iron Bridge Company bridges were generally designed to vary in depth in response to the bending moment present.



Trusses carry all loads to the supports. Tension or compression forces are consequently induced in truss members. The member configuration shown is characteristic of "lenticular" truss shapes produced by the Berlin Iron Bridge Company.



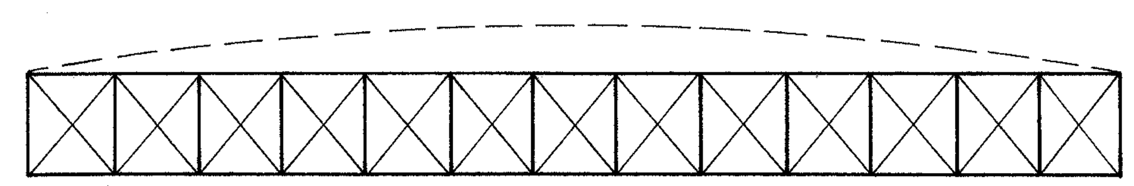
CROSS-BRACING AT FOUR MID POINTS



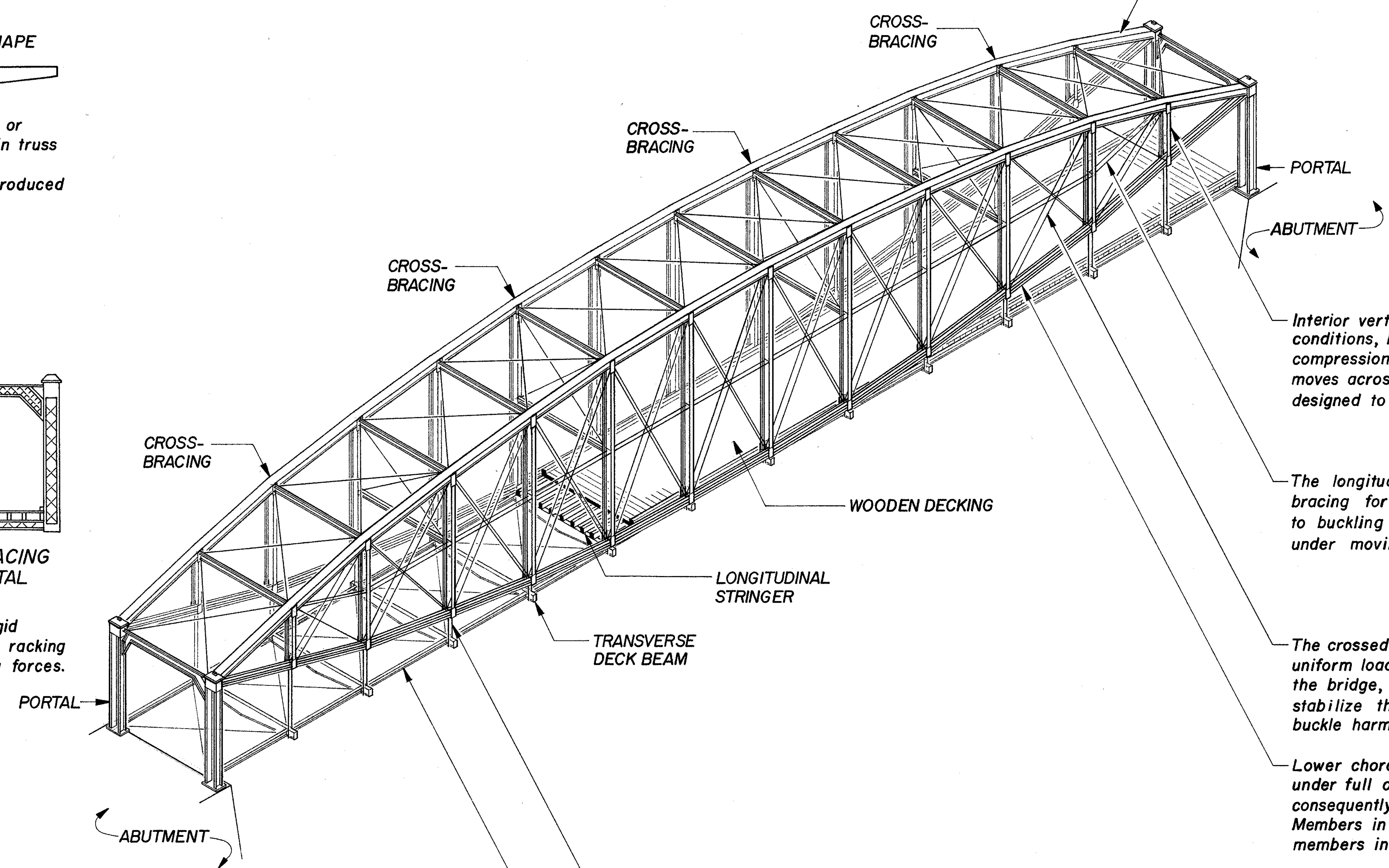
CROSS-BRACING AT PORTAL

Cross-bracing at four midpoints and at the rigid portals at both ends prevent the bridge from racking sideways due to wind or other laterally-acting forces.

Cross-bracing in the top plane and in the horizontal plane below the deck prevents the bridge from deflecting sideways as well as helping to prevent torsional deformations.



Plan (not to scale)



Top chord members are in nearly constant compression under full or partial loadings. Member sizes are consequently constant throughout the top chord and designed as rigid members capable of resisting buckling.

Interior verticals are in tension under full loading conditions, but may be required to carry some compression when a live load (such as a vehicle) moves across the bridge. Consequently, members are designed to carry both tension and compression forces.

The longitudinal tie apparently provides midheight bracing for verticals to improve their resistance to buckling when they are subjected to compression under moving load conditions.

The crossed-diagonals carry no forces under normal uniform loading conditions. When a load moves across the bridge, some diagonals will go into tension to stabilize the truss while others remain inactive or buckle harmlessly out of the way.

Lower chord members are in nearly constant tension under full or partial loadings. Member sizes are consequently constant throughout the lower chord. Members in tension can be much smaller than members in compression.

Vertical hangers beneath the truss are always in tension.

The bottom lattice member is primarily for alignment, but can carry small tension and compression forces caused by the braking action of vehicles or other longitudinal loadings. It also provides some additional stiffening for the road deck.

Scale: 3/32" = 1'-0"

0 5 10 15 20 25 30 FEET

0 1 2 3 4 5 10 METERS

DELINEATED BY: PAT REESE, 1991

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UNITED STATES DEPARTMENT OF THE INTERIOR

CONWAY / SHELBURNE

BARDWELL'S FERRY BRIDGE - 1882

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FRANKLIN COUNTY

MASSACHUSETTS

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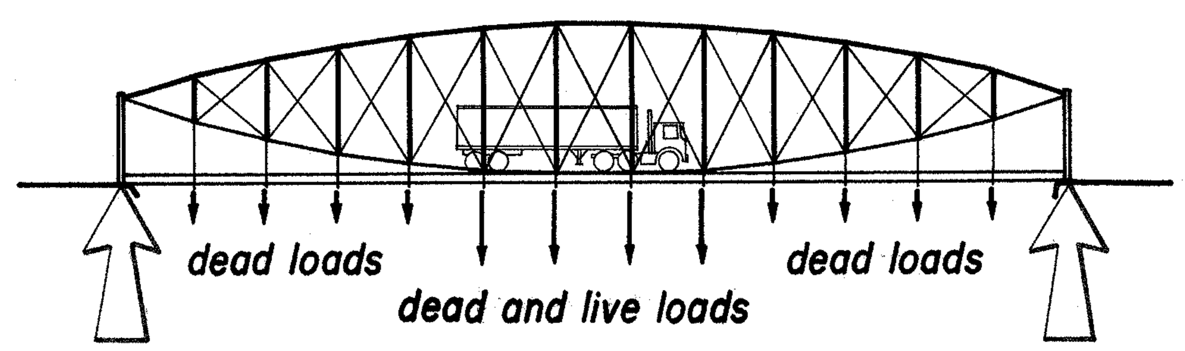
TRIM LINE

STRUCTURAL BEHAVIOR OF LENTICULAR TRUSSES

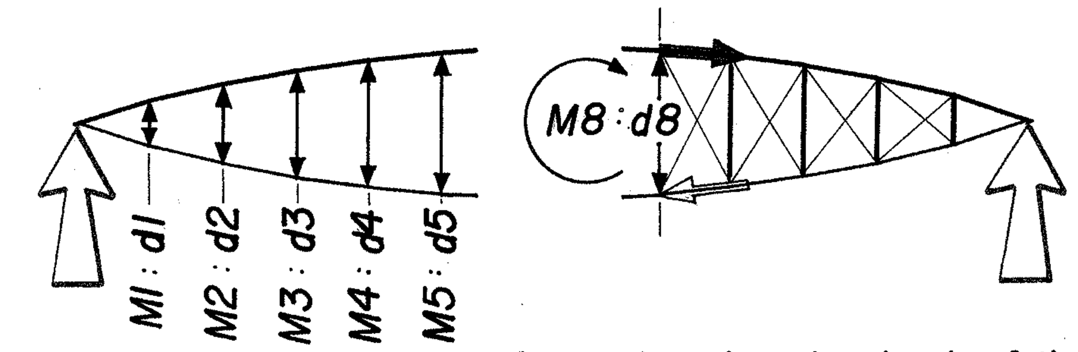
TYPES OF LOADS

Loadings on the bridge include both "dead loads" and "live loads." Dead loads include the self-weights of the trusses, beams, and decking, 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 vehicles or people move across its length.



MOMENTS AND STRUCTURAL DEPTH

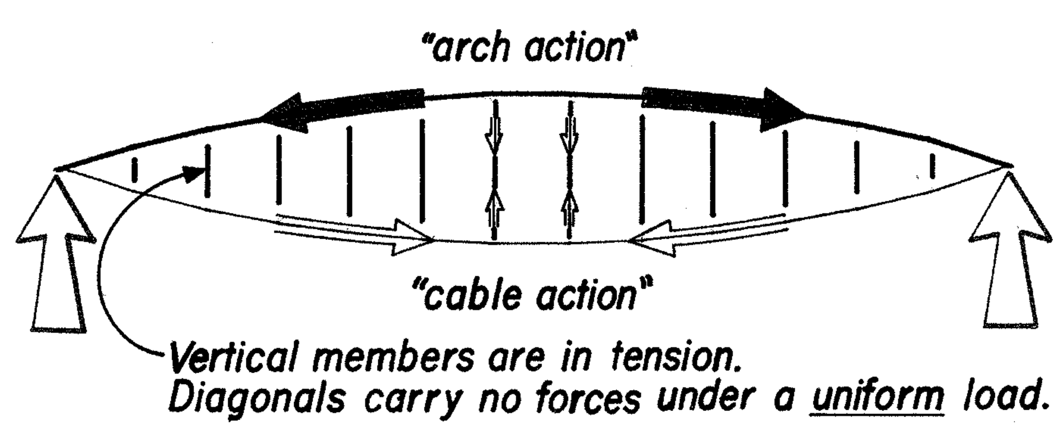
In the lenticular truss, the relative depths of the structure at different sections along its length are made directly proportional to the bending moment diagram. The maximum depth of the truss corresponds to the location of maximum bending moment present as obtained from the moment diagram. Where the bending moment decreases, so does the depth of the structure. The internal shear and moment forces are carried by forces developed in the upper and lower chords.



At any location the depth of the truss reflects the moment present.

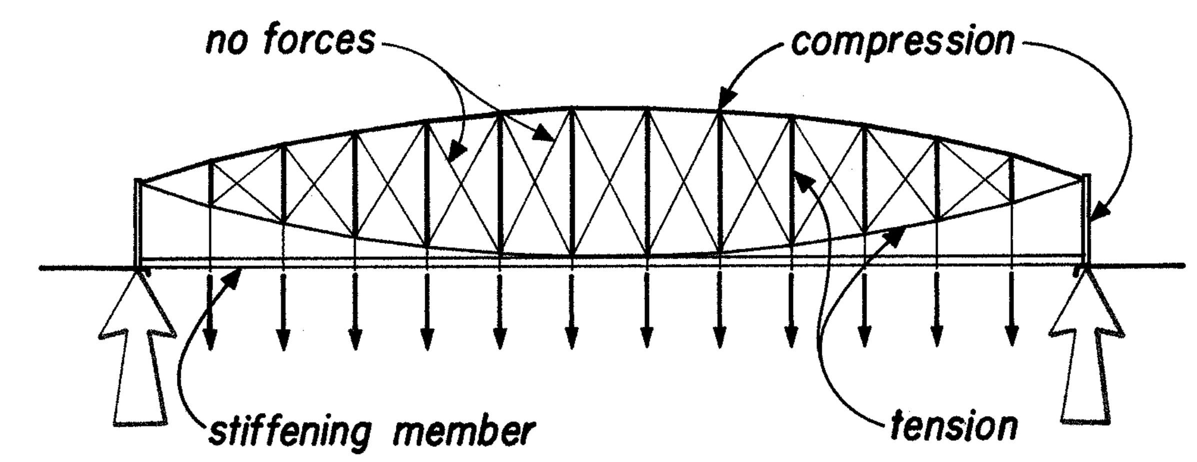
STRUCTURAL ACTIONS

The overall shape of the truss has been carefully designed to give the structure a uniquely efficient load-carrying action. One simple way of viewing the structural action of this lens-shaped truss is as a combined "ARCH/CABLE" system. The upper chord is analogous to an "arch" and the lower chord to a "cable." The upper chord is consequently in a state of compression, and the lower chord in tension. At the end posts, the problematic horizontal thrusts of the arches and cables balance each other. Only a downward acting force on the end post results. This model helps one understand how the truss works, but is not the kind of analysis used by engineers in the design of the truss.



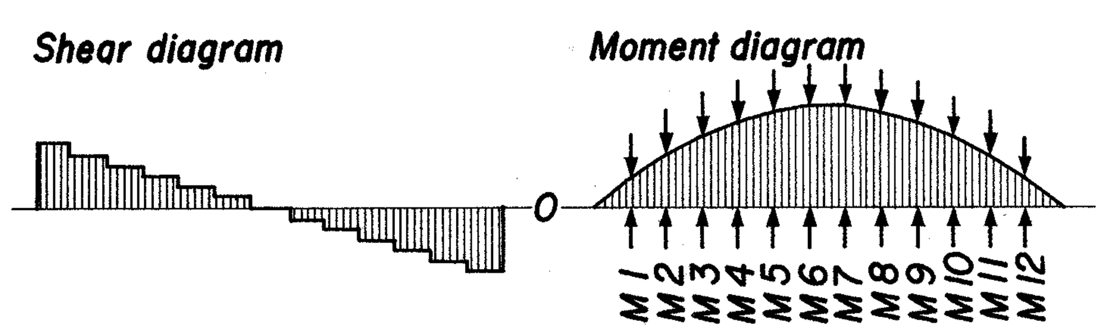
BEHAVIOR UNDER A FULL LOAD

Making truss depths proportional to the bending moment diagram results in a structure with a remarkably simple and elegant load carrying action wherein only the upper and lower chords are primary load-carrying members. Upper chord members are always in compression. Lower chord members are always in tension. Vertical members are in tension and serve only to carry deck loads to upper and lower chord members. No forces are developed in the cross-diagonals under the full dead and live load condition (these members come into play under partial loading conditions).



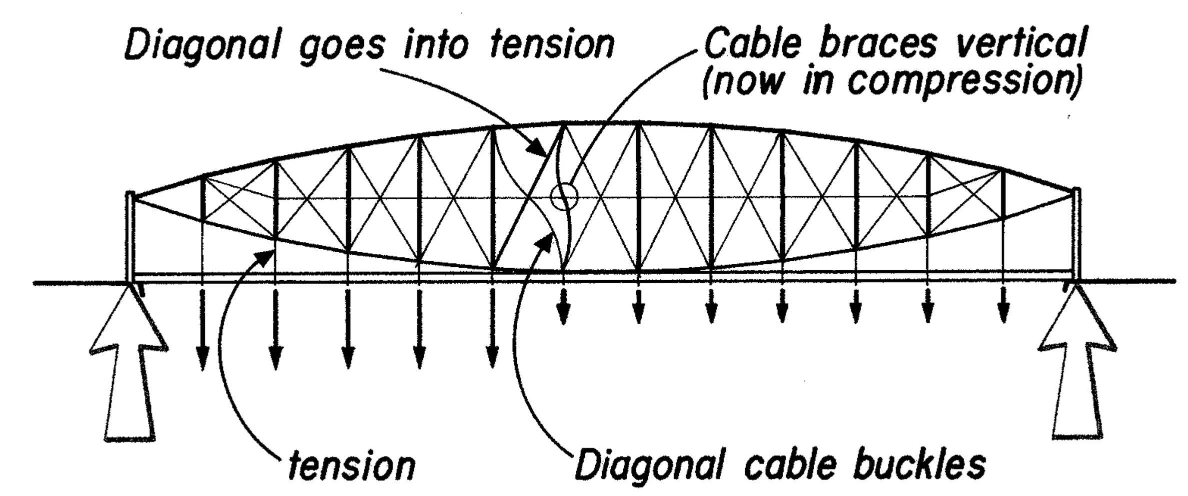
SHEAR AND MOMENT DIAGRAMS

A much more sophisticated analytical model of the structural action of a lenticular truss that is capable of being used to determine exact truss geometries and member sizes is based on the use of "shear and moment diagrams" commonly used by structural engineers. These diagrams describe in abstract mathematical terms the overall magnitudes and distributions of internal forces in the structure (caused by the live and dead loadings) that tend to shear it apart and to break it by bending.



BEHAVIOR UNDER A PARTIAL LOAD

When a live load moves across the bridge, upper chord members remain in compression and lower chord members remain in tension. Some vertical members within the truss may have some compressive forces developed in them. Some diagonals will go into tension and others will remain inactive or buckle harmlessly out of the way.



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MASSACHUSETTS

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