PLATE 1: **Typical Timber Covered Bridge: Bridge at Hickory**

SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, 1926)

PLATE 2: **Typical Timber Multiple-Span Beam Bridge: Bridge at Friendsville** SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, 1932)

an arch bridge over the Piscataqua River near Portsmouth, New Hampshire. Known locally as the "Great Arch," the arch-truss section of the 2,362-foot bridge, which spanned the navigable channel of the river, had a vertically curved floor system supported by three concentric ribs. Palmer modified the floor system of his later bridges to give them only a moderate rise, reducing the risk to life and limb (American Society of Civil Engineers 1976:152).

In the early nineteenth century, Theodore Burr (1771-1822) developed a truss-arch combination, which he patented as the Burr truss in 1817. By combining the arch with the truss form, Burr was able to increase the length of the individual spans; the arch reduced the longitudinal sag of the road surface which had constrained the span-length of the earlier beam bridges (Lay 1992:278). Burr truss bridges were constructed over many significant crossings including the crossing over the Hudson River at Waterford, New York and the Susquehanna River crossing at McCall's Ferry, Pennsylvania.

Ithiel Town (1784-1844) is credited with having designed the first true truss in America. In 1820, he designed the Town lattice truss. This truss is composed of a stiff web of closely spaced diagonal timbers. The Town truss was exceptionally strong and easy to construct, and competed well with the Burr truss. Although Town lattice truss bridges were almost exclusively made of wood, the truss became the prototype for later wood and metal truss forms.

One early successor to the lattice truss was the Long truss. Patented by Colonel Stephen Long in 1829, the Long truss was a lattice truss that was refined to its essential elements. Long calculated the stresses in each of the individual members and sized them according to the load that they would carry (Lay 1992:279).

Because the wood members of these bridge types were subject to deterioration, the majority of the timber bridges were covered with roofs and wood siding to protect against the elements. Thus the "covered bridge" became a particularly versatile early American bridge form. When properly maintained, these wood bridges could have a long service life. The most frequent causes of covered bridge failures resulted from the lack of maintenance, fires, or floods (Armstrong 1976:109).

The railroads had a significant impact on the construction as well as on the continuing popularity of the timber bridge. During the 1830s, the Baltimore and Ohio Railroad employed bridge builders such as Lewis Wernwag to construct bridges over its major crossings. Burr, Town, and Long trusses were all extensively employed and became standard for railroad-bridge construction (Waddell 1916:21).

Another type, the timber trestle bridge, also was used extensively by the railroads. The first timber trestle was built by the Philadelphia and Reading Railroad in 1840 (Waddell 1916:22). With timber in abundant supply, the railroads used this functional design as an inexpensive and practical bridge option for its lines, particularly in remote locations of the country (Plate 3).

The popularity of the timber bridge continued into the 1880s even with the ascension of iron and steel as bridge materials. The combination of timber with other materials began with the invention of the Howe truss in 1840. William Howe patented a truss which utilized iron verticals as tension members and wood diagonals as compression members. The Howe truss became a standard of railroad bridge design. By the 1860s, the problem of wood deterioration was under better control with the invention of pressure creosote treatments, which extended the life of the wood members. Timber pile bent structures remained popular, in particular in tidal areas, into the twentieth century. These were most often used in combination with concrete.

Timber bridges continued to be constructed in the United States during the twentieth century. A significant technological development of the 1930s permitted construction of timber-concrete composite structures, featuring decks utilizing both timber and reinforced concrete. The 1975 American Society of Civil Engineers *Design Guide and Commentary on Wood Structures* offered the following description of composite decks of timber and concrete:

> Composite timber-concrete decks are commonly used in bridge construction. Construction is such that timber carries most of the tension forces. Composite construction is of two basic types, T-beams and slab decks. . . .Composite T-beam sections consist of timber stringers, which form the stem, and concrete slab for the flange area. Notches are cut into the top edge of the stringers to resist horizontal shear and mechanical fasteners are driven into the top to prevent vertical separation so that the two components perform integrally. Stresses due to temperature changes must be considered in the concrete section.
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> Composite slabs consist of nominal 2-inch lumber, usually nailed-laminated with the wide faces vertical, and a concrete section cast monolithically in place. Grooves are formed by using alternate laminations that differ in width by 2 inches or by fabricating panels with a 2-inch offset between laminations. Horizontal shear is resisted by grooves cut into the projecting laminations or by metal shear plates. Transverse joints in the timber portion are made by dapping or cutting alternate laminations to a different length to provide finger joints. The concrete slab should be reinforced for temperature stress and for negative bending stresses when the deck is continuous over a support. No falsework or extensive forming is necessary with this construction [American Society of Civil Engineers 1975:372-73].

The timber-concrete composite slab type of bridge construction was pioneered in the United States by James F. Seiler and the American Wood-Preservers Association between 1932 and 1935. The latter organization's 1935 patent for "composite wood and concrete construction" became the basis for such technology.

PLATE 3: **Typical Timber Trestle: Bridge Crossing Gwynns Falls in Baltimore**

SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, early 1930s)