NEW HAMPSHIRE DIVISION OF HISTORICAL RESOURCES
State of New Hampshire, Department of Cultural Resources 603-271-3483
19 Pillsbury Street, 2nd floor, Concord NH 03301-3570 603-271-3558
Voice/ TDD ACCESS: RELAY NH 1-800-735-2964 FAX 603-271-3433
http://www.nh.gov/nhdhr preservation@nhdhr.state.nh.us

Garvin 6/4/04

WOODEN BRIDGES ON THE BOSTON & MAINE RAILROAD

(Synopsis of a talk given to the National Society for the Preservation of Covered bridges on June 5, 2004)

New Hampshire is fortunate to have the majority of surviving wooden railroad bridges in the United States. The bridges that survive on their original sites in New Hampshire all stand on what were small branch lines of the Boston & Maine Railroad.

Those that survive:

Contoocook (1889), double-web Town lattice truss; the oldest covered railroad bridge in the world.

Sulphite Bridge, Franklin, Pratt truss (1896); the only surviving deck truss railroad bridge in the world.

Wright's Bridge, Newport (1906); the only double-web Town lattice truss railroad bridge with integral laminated arches.

Pier Bridge, Newport (1907), double-web Town lattice truss; the longest covered railroad bridge in the world.

Boxed pony Howe truss, Randolph (1918).

Boxed pony Howe truss, Gorham (1918); damaged by fire, May 2004.

Other wooden railroad bridges that survived until fairly recently:

Bennington, N. H. (1877); burned 1965.
Goffstown, N. H. (1901—with laminated arches, like Wright's Bridge in Newport); burned 1976.
Hillsborough, N. H. (1903—2 span, no arches, like Contoocook and Pier Bridges); burned 1985.

The bridge in Contoocook (1889) is the oldest surviving covered railroad bridge in the world. It is also important because it was built at the time of transition between bridges designed and built by bridge carpenters, and bridges designed by trained engineers.

Until 1890, most of the wooden bridges on what became the Boston & Maine system were constructed by **David Hazelton (1832-1908), Bridge Master of the Boston & Lowell Railroad**, and his crew. Hazelton was born at Dorchester, N. H. (near Rumney) in 1832. He grew up on a farm, with a stepfather who was an oxbow maker. Where he learned bridge building is unknown, but by 1864, in his early thirties, Hazelton began to work continuously for 25 years on various railroads, eventually becoming Master of Bridges and Buildings for the entire Boston & Lowell system. The Boston & Maine Railroad acquired control over the Boston & Lowell system by lease in 1887. Hazelton died in Concord on August 11, 1908 (*Concord City Directory*).

After **1888, the Boston & Maine Railroad employed Jonathan Parker Snow as bridge engineer**. Snow was born in Concord, N. H., November 19, 1848. He received his degree of C. E. at Dartmouth's Thayer School of Civil Engineering in 1875 (at age 27). Because Snow attended engineering school relatively late in life, and because Robert Fletcher, his chief professor at Dartmouth, was an engineering prodigy, Fletcher was only one year older than his student, and the two became lifelong associates.

Robert Fletcher was born in New York City in 1847, but his parents were both from Vermont. He graduated from the U. S. Military Academy at West Point in 1868, and was immediately hired to teach mathematics at West Point at the age of 21. Sylvanus Thayer, who reformed the Military Academy at West Point and brought it up to the standard of the best military schools in the world, endowed the Thayer School of Civil Engineering at Dartmouth with a gift of $70,000. Thayer is said to have hand-picked Robert Fletcher to direct the Thayer School in 1871 when Fletcher was only 24. Fletcher served on the Dartmouth faculty for 47 years, retiring in 1918.

Fletcher and Snow collaborated on one of the great documents of bridge building history when they co-authored the paper **"A History of the Development of Wooden Bridges,"** which was published in the *Proceedings* of the American Society of Civil Engineers in November 1932 when both authors were in their mid-80s. This paper is so highly valued as a pioneering study that it was reprinted by the American Society of Civil Engineers in their publication *American Wooden Bridges* in 1976, and in several reprints since 1976.

One would think that the highly-trained Snow would repudiate the unschooled Hazelton.

Not so. **Snow read a paper entitled "Wooden Bridge Construction on the Boston and Maine Railroad" before the Boston Society of Civil Engineers in 1895.** This paper was quickly published in the *Journal of the Association of Engineering Societies*.

Snow praised the skill of Hazelton, stating that "These [B&M] bridges as built to-day are, in all their important details, direct descendants of, and very near kin to, those built in years past by the bridge carpenters of Northern and Central New England. Those built by David Hazelton and his men furnish the basis of the current practice on this [rail]road, and though they were built without engineering advice, they bear analysis well, with the possible exception of the bottom chords."

Snow went on to point out an interesting fact about the older wooden railroad bridges that were built before his time: "It has come within the observation of the writer many times that when an intelligent master-carpenter has had the care for a term of years of a line of wooden bridges covering any given style of truss, he gradually brings their parts, when building new ones, to almost the exact size called for by scientific analysis when actual loads [encountered in practice] are used in calculation."

Even after he retired to Concord in 1890, Hazelton continued to list himself as a bridge builder until 1897, when he fully retired at age 65. At age 63, Hazelton was working as a bridge builder in private practice in Concord when Snow presented his paper, and there was evidently a bond of respect between the two men whose railroad careers had overlapped by a few years.

Snow saw many **virtues in wooden structures**. He stated that "wooden bridges are seldom discussed [in our technical literature], and when mentioned, are generally treated as temporary structures or excuses [are] offered for their use. The building of such bridges is, however, a live business on the Boston and Maine Railroad, although the impression seems to be prevalent in many quarters that such construction is obsolete and out of fashion."

Snow noted that **in 1895, there were a total of 1,561 bridges on the rail system then operated by the Boston & Maine. Of these, 1,085 were wooden bridges—almost 70%.** These wooden bridges ranged from stringers to trestles to pony trusses to through trusses like our bridge in Contoocook.

Among the virtues that Snow saw in wooden bridges were:

Expense. In 1895, inexpensive steel was just becoming available. Most metal truss bridges were still built of wrought iron. For a bridge of 120-foot span, Snow calculated the cost of an all-iron bridge at $5,300, a wood-and-iron Howe truss bridge using southern yellow pine at $5,000, and a Town lattice truss of spruce at only $3,500. For spans under 120 feet, wooden bridges were even more economical than metal bridges.

Strength. Wooden railroad bridges on the B&M were designed to bear the weight of a train of Consolidation class locomotives (2-8-0) weighing each, with tender, 172,000 pounds. This was less than the design loading used for iron bridges, but for secondary lines, the strength of wooden bridges was ample, and the expense of such bridges, as noted above, was considerably less than that of iron spans. In fact, as Snow noted, the trains that actually ran on most of these lines were pulled by engines that were lighter than Consolidation locomotives. Most of the locomotives were Moguls (2-6-0), which weighed on average 20-40,000 pounds less than Consolidation class locomotives.

Resilience. Snow noted that "a wooden bridge . . . will give abundant notice of distress before it will fail entirely" and that "it is this property of a timber bridge, of giving warning of approaching weakness, that has kept the record of wooden truss bridges so clear from fatal disasters. It is *not* reasonably safe to use a light iron bridge until it is worn out, but a wooden one may be used till its deterioration is rapidly approaching the end."

Snow's assistant in 1895, **Benjamin Wilder Guppy** (MIT Class of 1889; employed by the Boston & Maine Railroad from 1890 to 1950), shared Snow's respect for wooden railroad bridges. In his commentary on Snow's paper of 1895, Guppy described several instances of resilience in the wooden bridges of the B&M. "In use, these bridges stand a great deal of abuse. A butting collision on the approach to one bridge piled the cars of one train up through the roof. Beyond breaking a hole in the roof, and cutting up a few ties, no damage was done to the bridge." In another case, "during the recent floods in New Hampshire, a pier was washed out from under a two-span bridge. As the invariable practice is to make these bridges continuous over all intermediate piers, the bridge was saved." The same thing happened to the Hillsborough railroad bridge (which hadn't been built when Guppy related his story) in the 1938 hurricane, when the central stone pier washed out. The bridge sustained its own dead weight until wooden trestles were placed in the river where the masonry support had been. And our own Contoocook railroad bridge has been washed off its abutments and pier twice, so far, in 1936 and 1938.

Fire resistance. Fire is the natural enemy of wooden bridges, and was especially so until the 1880s, when locomotives in northern New England began the transition from wood fuel to coal. In commenting on Snow's paper, Assistant Bridge Engineer Benjamin Wilder Guppy said of the hazard of fire in 1895, "the danger has become much less since the introduction of coal burning engines. The fires usually start in the roof and are generally extinguished before they do any damage to the trusses. A good coat of white-wash, together with water barrels, buckets and a ladder at each bridge are the means of protection."

Thirty-seven years after Snow delivered this paper in 1895, he and Robert Fletcher wrote their great work on "A History of the Development of Wooden Bridges." In the decades that intervened between these two papers, steel had become universally available, and available cheaply. By 1932, metal truss and girder bridges had largely replaced wooden bridges on the B&M. Snow and Fletcher wrote, "Railroad freight traffic in the United States has become so enormously heavy that its economic handling requires equipment so ponderous that wooden truss bridges have become obsolete, even on branch lines, because [even] rural industries must transport their supplies and products in the same equipment that is used on the main lines."

The authors do add one rather plaintive hope for the continuation of wooden bridges: "where suitable lumber for lattice bridges is abundant and where fabricated steel is costly, as was the case in New England during the Nineteenth Century, and is now the case in Southern Alaska, Northern Russia, and Siberia, and perhaps in some parts of South

America, lattice truss bridges are economical and can be made perfectly good up to spans of 200 ft. for railroad trains not exceeding Cooper's E-40 loading. If properly covered and maintained, such bridges will give from 50 to 100 years' service."

In a final postscript to Jonathan Parker Snow's career, his co-author and former teacher wrote a memorial at the end of their joint article on "A History of the Development of Wooden Bridges." Robert Fletcher said of Snow, "Within less than a month after the publication of the closure of the discussion on 'A History of the Development of Wooden Bridges,' Mr. Snow, joint author of the paper . . . died suddenly on September 4, 1933, in his eighty-fifth year. His associate in the research can do no less than testify that whatever of authoritative value this paper may possess, is due in very large measure to Mr. Snow's part in its production. Mr. Snow's long experience as Bridge Engineer and, later, as Chief Engineer of the Boston and Maine Railroad—covering the period when wrought iron [and steel] gradually superseded timber in bridge construction—made him an outstanding authority on the subject. His knowledge of details and his experience in maintenance of such bridges constrained him to adopt a conservative policy in retaining timber bridges as long as they could be made assuredly safe under increasing loadings."

Biographies:
Jonathan Parker Snow, civil engineer. Born Concord, N. H., November 19, 1848, son of Jonathan and Lydia A. (Parker) Snow. C. E. Dartmouth 1875 (aged 27). Married Mrs. Marietta H. Eaton, of Wilton, N. H. Instructor in civil engineering, 1877-78. Overseer since 1879(?) Thayer School of Civil Engineering, Dartmouth College. Bridge engineer, 1888-1909 (chief engineer 1909-11), Boston & Maine Railroad. Consulting engineer, 1911—. Member of the American Society of Civil Engineers; American Railway Engineering Association; American Association of Superintendents of Bridges and Buildings; American Institute of Mining Engineers; American Society for Testing Materials; Boston Society of Civil Engineers; Boston Chamber of Commerce; Thayer Society of New York; American Civic Association. Republican. Universalist. *Clubs:* New England Railroad; New Hampshire (Somerville), etc. *Home:* 58 Chandler Street, Somerville, Mass. *Office:* North Union Station, Boston (1910-11); 18 Tremont Street, Boston (1912-13). Died, September 4, 1933.

Robert Fletcher, educator, civil engineer. Born New York City, August 23, 1847, son of Edward H. and Mary A. (Hill) Fletcher (both from Cavendish, Vermont). Educated in public schools, the College of the City of New York (three years); U. S. Military Academy at West Point, 1868. Second Lieutenant, U. S. Artillery, serving at Brownsville, Texas and Fort Trumbull, New London, Connecticut. Instructor in Mathematics, U. S. Military Academy, 1869-70. Resigned to become senior professor and director of the Thayer School of Civil Engineering at Dartmouth College in 1871, serving in that capacity for 47 years, retiring in 1918. Consulting engineer on water works and sanitation; engineer in charge of construction of Hanover Water Works, Enfield, N. H., 1893; reservoir for the water works of Hartford, Vermont. Consulting engineer for steel bridges of four spans each across the Connecticut River at West Lebanon, N. H., and across the White River at Hartford, Vermont. Conducted half of the

New Hampshire-Vermont Boundary Survey, 1917. Contributor to technical papers and New Hampshire Bulletins on sanitation and engineering construction. Baptist. Republican. School trustee 17 years; member of the New Hampshire State Board of Health since 1895 (president since 1913); president and engineer, Hanover Water Works Company. Member, American Society of Civil Engineers since 1875. Member and past president of the Society for Promotion of Engineering Education. Honorary A. M., Dartmouth, 1871, Ph.D. 1881. Married Ellen M. Huntington, July 2, 1872; children: Mary A. Fletcher, Robert H. Fletcher (died 1919). Resided in Hanover, N. H. Died January 7, 1936.