MODERN SIMPLE BRIDGE TRUSSES OF LONG SPAN.

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Simple bridges are those which involve free-end support for the superstructure of each span, and consequently wholly vertical reactions. They do not, therefore, include structures which exert horizontal forces upon their supports, as suspension bridges or arches, or those in which the principle of continuity over piers is introduced, as cantilever or continuous spans.

The length of span of a simple bridge truss entitling it to be termed "long" depends upon the time of its building. Half a century ago the maximum attainable span was about 250 feet, but with the development of rational design and the improvement of methods of construction this limit was more than doubled many years ago. Spans up to 300 feet are now regarded as of moderate length, and in the present discussion only those over this limit will be considered.

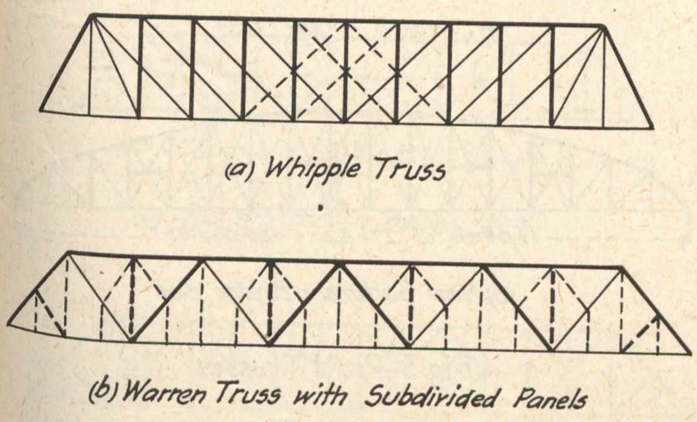

Fig. 1 - The Whipple Truss and its Successor

In countries with large, navigable rivers, where transportation facilities are constantly improving, the necessity for long-span bridges frequently arises. This is not because of the requirements of navigation alone, for in many instances the maximum economy for the whole structure is attained by the use of long spans, due to the depth and great expense of mid-stream foundations. In America these natural conditions often occur, and this continent has not inaptly been called the home of the long-span bridge.

Unfortunately, the solution of the problem of spanning wide spaces has not always been scientific. From an imperfect understanding of the situation superstructures lacking the essentials of economy and rigidity have often been erected. Of course, he would be ungrateful who would arraign Stephenson for placing the enormously heavy and expensive tubes over the Menai Straits at the Britannia Rock, for at that time (1850) simple truss spans of such length (460 feet) had not been developed. The same charity cannot be extended to some of his successors, however, who, long after simple trusses of long span had been successfully employed, adopted less satisfactory structures where the conditions were favorable for the former.

The cantilever type of bridge in particular has been built in most uncalled-for places. Despite lay opinion, such bridges are heavier, less rigid, and nearly always more expensive than simple truss structures. The two conditions under which cantilever spans may be economically employed are where other methods of erection than those usually adopted for such structures would be prohibitively expensive, due to deep gorges or rivers, or highly uncertain, because of the probability of sudden washouts carrying away the falsework. Dr. J. A. L. Waddell in "De Pontibus" deprecates the irrational use of cantilever bridges in no uncertain manner. "There was no good reason whatsoever for making the great Poughkeepsie Bridge a cantilever structure, because, by using the same number of piers and making all the spans alike, the cost of the sub-structure would not have been at all increased, but probably diminished, while the weight of metal in the superstructure and towers would have been lessened materially . . . ." There is a small cantilever bridge in Philadelphia, close to the Pennsylvania Railroad where it approaches the depot, which as a cantilever has absolutely no raison d'etre. It makes the observer think that, before it was built, some of the city fathers felt that Philadelphia would be behind the times if she did not have a cantilever bridge of some kind or other, and that they erected this one in consequence." The particular advantage of such structures—ease of erection—is now offset to some extent by erecting simple truss spans by the cantilever method, connecting the hips of the spans being erected to the hips of adjacent spans by a toggle arrangement, thus permitting vertical adjustment of the height of the free ends. A stiff bottom chord, capable of taking the compressive stresses arising during erection, is consequently rendered necessary. This method was successfully adopted in the erection of the Rerheugh Bridge over the River Tyne, between Newcastle and Gateshead, England, in 1901, and in the Baltimore and Ohio Railroad bridge over the Ohio River at Benwood, West Virginia, in 1904. In the case of the erection of the Great Northern

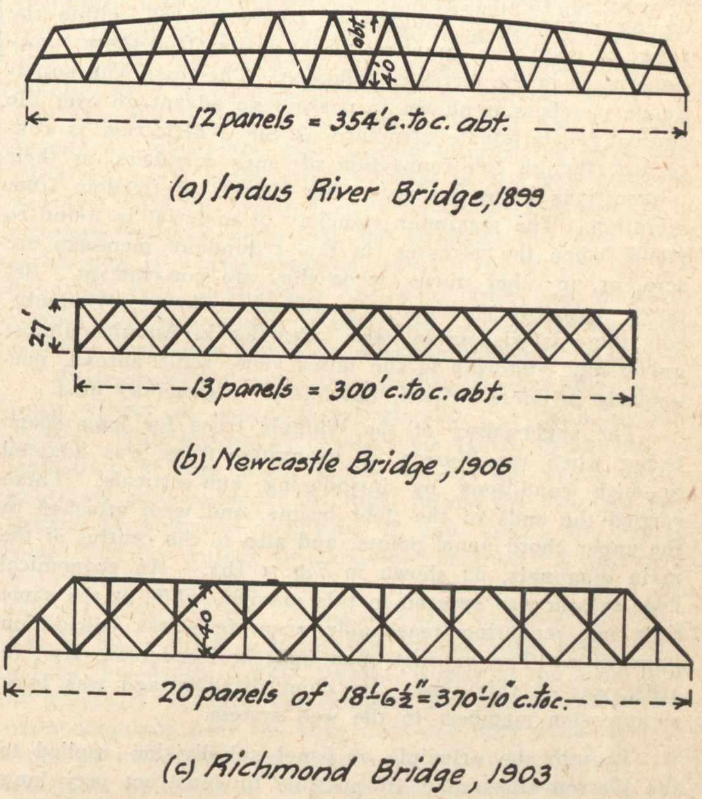

Fig. 2 - Warren Trusses

Railroad bridge over the Columbia River at Rock Island, Washington Territory, in 1893, the hips of the channel span were connected to the halves of an adjacent deck span, which had been temporarily erected upside down on falsework on each side of the channel span.

In America the beginning of modern simple truss bridges of long span was in 1852, when Squire Whipple devised the truss which bears his name. Up to that time the Howe and Pratt trusses, with parallel chords, had been used for such structures. Panels longer than twenty-five feet were found to make expensive floors, however, and, since the depth of the trusses should not be much greater than the panel length for economy, and the span not more than about ten times the depth, the upper limit of length was, therefore, set at about 250 feet. Whipple was able to practically double the depth, and consequently the span, of the largest trusses built up to that time by introducing a double system of webbing, as shown in Fig. 1 (a). By this means the economic inclination of diagonals to the chords, about 45 degrees, was preserved, while at the same