THE
Railway and Shipping World
With which is incorporated The Western World. Established 1890.
Devoted to Steam & Electric Railway, Shipping, Express, Telegraph & Telephone Interests.

OLD SERIES, NO. 118. NEW SERIES, NO. 36. | TORONTO, CANADA, FEBRUARY, 1901. | 10 CENTS A COPY. $1 A YEAR.

Great Achievements in Modern Bridge-Building.

By Frank W. Skinner, C.E.

Bridge-building is one of the oldest of the engineering arts, & yet in the principles and methods which it follows to-day it is one of the newest. It is impossible to say when the first bridge was built, so shrouded in antiquity is the date. But the first metal truss bridge, the erection of which marks the beginning of modern methods of construction, was put up no longer ago than 1840. Almost all the great bridges of the world have been built within the past quarter-century. In 1863, a bridge was thrown across the Ohio river with a span of 320 ft., then an unprecedented length. At the present time the limit of a single span has been extended to 1,710 ft. in actual construction, while others of nearly 3,000 ft. have been designed by able builders & undoubtedly will be erected.

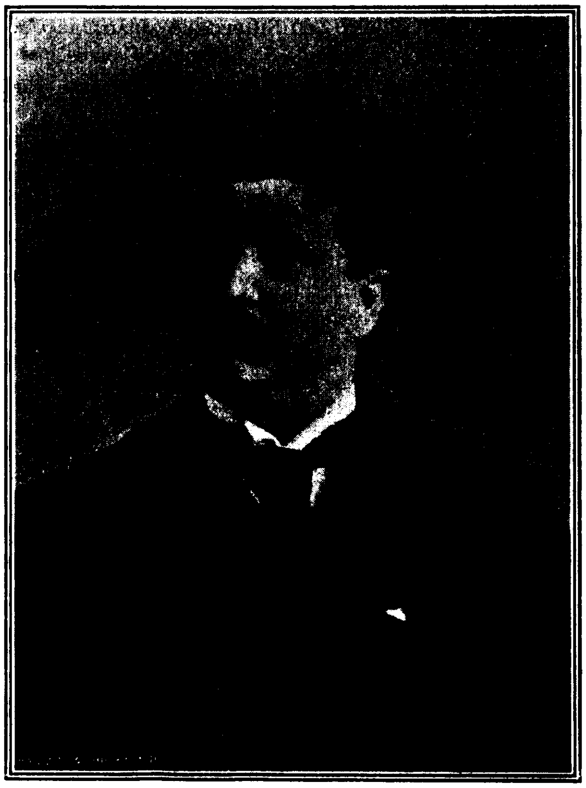
It may be seen, therefore, that in spite of its newness, bridge-building as it is carried on to-day is not an undeveloped art. Within the space of an ordinary lifetime it has attained to a perfection & a final standard that is comparable with the progress of architecture through all the centuries since the time of the Pyramid-builders. It is safe to say, indeed, that as an art bridge-building has reached a point where it must await the invention of some new material to afford it scope for any radical improvement.

The great factor in this advance has been the improvement in the manufacture of steel & its extension to this branch of construction. Bridges may be built of materials other than steel. Many such have been built, & are now in use. Stone was one of the early materials employed, but stone has never been extended to spans of more than 250 ft. Wooden bridges have been built with spans above 200 ft. in length, while others of wood & iron combined have exceeded 300 ft. For all of these materials comparatively low limits are defined by the rapidity with which strains and weights increase with the increase of span. The same consideration applies to steel, but for the performance of any given duty steel is actually much lighter than timber. Steel has no competitor as a material for great bridges at the present day. Even with steel, however, the cost of construction increases approximately with the square of the increase in span. This factor of cost, rather than mechanical difficulties, is likely to set the final limit to the length of bridge spans.

While steel has been the chief element in making possible the big bridges of to-day, it has been by no means the only one. The invention of powerful tools & hydraulic machinery, which forge & lift & rivet massive pieces that previously could not have been made or handled, has contributed to the same result. Every process in the production of these immense structures is carried on now on a scale undreamed of 25 years ago.

The methods of modern bridge-building form a subject on which it is difficult to generalize effectively. The conditions surrounding the erection of two great bridges are never alike. The engineer's problem is always one of adaptability, while new & perplexing difficulties must be met & overcome in every fresh undertaking. The building of each immense span must be looked upon & judged as a separate engineering feat, rather than an incident in the general industry. The location of the structure, the conditions surrounding it, & the general purpose for which it is intended, are the fixed factors with which the engineer sets about his task. With these in mind, he plans the finished work, & the results are such as to astonish those unfamiliar with the progress attained by the engineering art.

The truss, or skeleton, of separate steel pieces must be so arranged as to convey to the abutments in proper proportions the loads from its own weight & the weights it is intended to carry. The impact & vibration from the vehicles which are to cross it must be determined. The strain of wind & storm beating against it must be calculated. The almost irresistible expansion & contraction of the mass of metal under the influence of summer heat & winter frost must be provided for. All these problems are solved by the computer in his plan. His designs predetermine to the fraction of an inch how much a thousand-foot span will deflect under a load of one or 20 locomotives. It is all figured out before a bar is cut or a stroke given toward actual construction.



EPHRAIM TIFFIN,
Traffic Manager Intercolonial & Prince Edward Island Railways.

After verifying the designs, which are in the field of the mathematician, the next step is to put these designs into form, a task which falls to the lot of the metallurgist & steel-maker. This is by no means an unimportant part of the process. The steel which is to form the bridge is turned out in bars, many of them so strong that singly they could sustain the pull of 14,000 horses hauling on common roads, so ductile that a short bar will still stretch half its own length before giving way, so tough that great bars when perfectly cold can be tied into hard knots without cracking.

Following the plans, the bars, plates, & shapes are formed into flexible chains, the weakest links of which can sustain loads of a million pounds each; into huge girders which alone could carry the heaviest trains across an ordinary street; into riveted braces so large and long that eight-oared rowing shells might easily be stored in them. To join the separate parts together, solid steel bolts as large as stove pipes are provided. And the holes for which these bolts are destined are bored & polished to an accuracy of a hundredth of an inch in position & diameter. These features of the work are the best measures of the tools, hydraulic forgings, & electric machinery employed by the manufacturers, who have capital aggregating many millions invested in shops equipped solely for turning out bridge-material.

The outcome of all this is the finished bridge in the form of a hundred carloads of rods, bars, braces, girders, columns, & boxes of rivets. They are dumped down at some spot, perhaps in the heart of the wilderness, where the problem of handling them may become one of appalling difficulty. From them the builder must evolve his bridge. The huge, inflexible pieces must be fitted together with watchmaker's precision, & the 100,000 lbs. masses must be swung high in air to form part of a self-sustaining structure over a hitherto impassable torrent. Or perhaps the situation is of another sort, and the acres of forged and riveted members are destined to span a river in angry flood or with treacher-