THE ERECTION OF THE GOKTEIK BRIDGE.

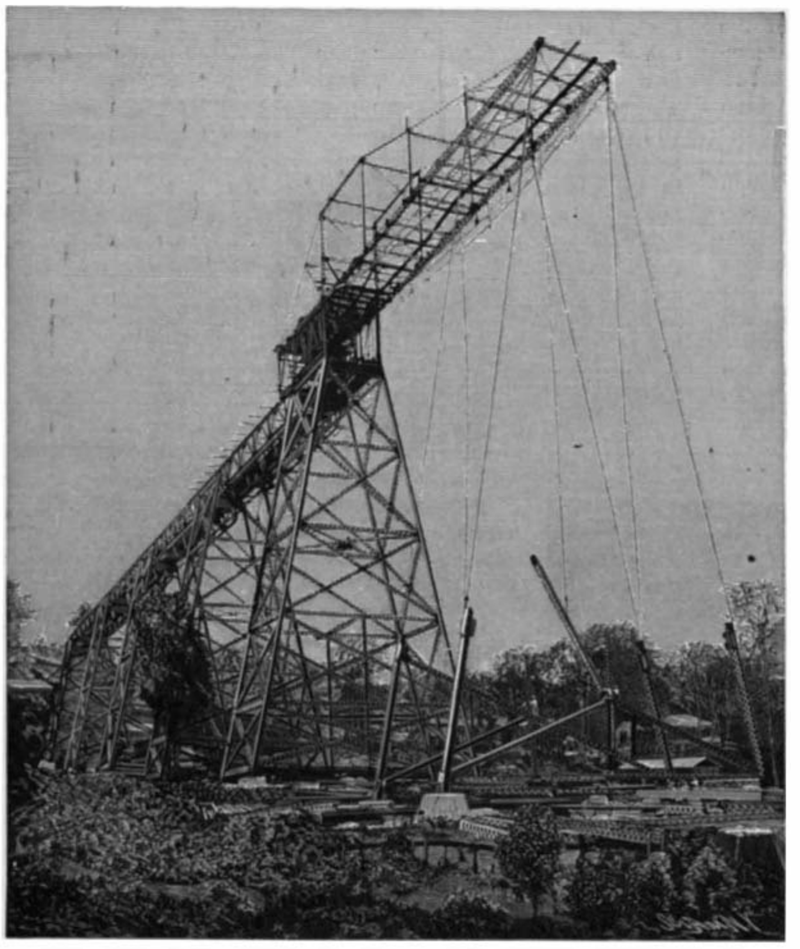
BY DAY ALLEN WILLEY.

What is known as the Gokteik Viaduct, recently completed in Burma, Asia, is notable for its height, length and the remarkably short time in which it was built, considering the obstacles to be overcome. As the bridge was planned and the material made in this country, and most of the important work was done by Americans, it forms another indication of the progress which our bridge-building industry is making abroad. The structure, which is located about 80 miles from Mandalay, connects portions of the line of the Burma Railway Company between Mandalay and Rangoon. It is one of the long railway bridges of the world, being 2,260 feet in length, and, with two exceptions, it is the highest, the railway track being 320 feet above the natural bridge which forms its foundation. The famous Loa Viaduct in South America is 336 feet high, but only 800 feet in length. The Pecos Viaduct in Texas is 321 feet in height, but 80 feet shorter than the Gokteik structure, while it contains but 1,820 tons of metal. The new Kinzua bridge on the Erie Railway in Pennsylvania is but 2,035 feet long and 19 feet lower at its highest point, although it contains 3,250 tons of metal.

The erection of the bridge was begun December 1, 1899, and completed on October 16 last, the construction force consisting of 35 employes of the Pennsylvania Steel Company, which took the contract; 15 Europeans, and about 450 native laborers, secured principally from the vicinity of Calcutta, India. The plans, which were prepared by Mr. J. V. W. Reynders, superintendent of bridge construction of the Pennsylvania company, called for a series of 14 single towers, one double tower, and a rocker bent, which, with the abutments, carry ten 120-foot truss spans and seven 60-foot plate-girder spans. The viaduct, for 281 feet at one end and 341 feet at the other end, is curved to a radius of 800 feet, and between these two curves there is a tangent of 1,638 feet. The height of the structure above the ground is 130 feet at one end and 213 feet at the other end. The viaduct was designed to carry a double-track road and a footwalk, but the floor system for the footwalk and one track only is constructed at present. The single towers consist of two transverse trestle bents, braced together in all directions. The double tower consists of three trestle bents. So far as practicable, the members of all bents were made interchangeable.

Except seven plate-girder spans, located at the ends of the viaduct, all of the connecting spans are made up of two 120-foot deck trusses. These trusses carry 27-inch plate-girder floor beams spaced 13 feet apart, which in turn support the track stringers. The top flanges of the trusses, floor beams and stringers are made flush, and are covered over with a solid floor of 5-16 inch flat plates.

To handle the material a special traveler was designed and constructed at the works of the Pennsylvania company, shipped to Asia with the bridge material, and put together at the gorge. This is by far the largest traveler ever built, having an overhang of 165 feet and weighing 80 tons. Its maximum lifting capacity is 30 tons. It consists of 3 trusses, two of which are connected by transverse bracing, built on the cantilever plan, each being 219 feet in length, 40 feet in height, and separated by a width of 24½ feet. The lower chords of the traveler supported four trolleys, each provided with a chain hoist having a lifting capacity of 16 tons. Powerful clamps were especially designed for holding the rear end of the traveler to the girders of the viaduct, and it was supported on a series of wheels enabling it to be easily moved as the work progressed. Most of the material was lowered from above by the traveler. In erecting the towers crossing the deepest portion of the gorge a temporary track was built on a wooden trestle at an elevation of about 100 feet above the base, and material for the lower parts of the towers hauled to the spot and transferred to their positions by special derricks.



TRAVELER SUPPORTING COLUMNS DURING TOWER CONSTRUCTION.

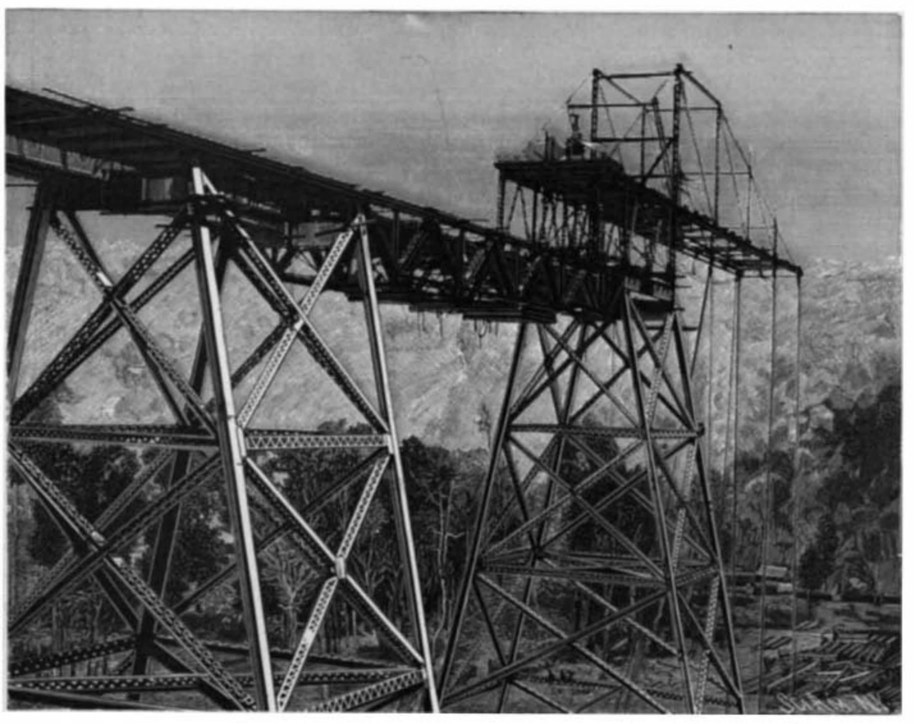
An idea of the quantity of material placed in position can be gained when it is stated that it comprised most of the cargoes of three steamships, and when loaded on the cars at Steelton, Pa., represented a solid train 1½ miles long. The erection plant alone weighed 250 tons, and, in addition to the traveler, included three hoisting engines, a series of air compressors, a telephone system for communication between the gangs working at each end of the viaduct, and the necessary chisels, hammers and other tools for bridge construction. At the outset heavy rains interfered considerably with the progress of the work, the violence of the storms being so great that it was seldom possible to do any work between noon and sundown. The temperature ranged from below the freezing point at night to over 90 deg. in the shade in the forenoon. Another delay was caused by the refusal of the native laborers, on account of their superstition, to use compressed air in riveting, and nearly all of this was done by hand, although the plans called for 192,000 rivets in the field work alone.

The usual plan followed in bridge construction, of indicating the locations of different parts by numbers and letters could not be followed in this case, owing to the ignorance of the natives; so a color scheme was adopted, by which each column and girder was given a distinctive color and the joints between the columns painted with a combination of stripes. All the erection outfit was painted black to distinguish it from the bridge material proper. In this way the thousands of pieces were handled and put in position without difficulty. In beginning the construction of the viaduct, the steel was hauled to the end of the track and deposited in a temporary storage yard in such a manner that it could be lifted by the traveler. Thus the first towers were erected. As these were placed in position, the superstructure was fastened to them and the traveler moved forward. Then the material was loaded on flat cars, pushed out upon the bridge, and transferred from the cars into position.

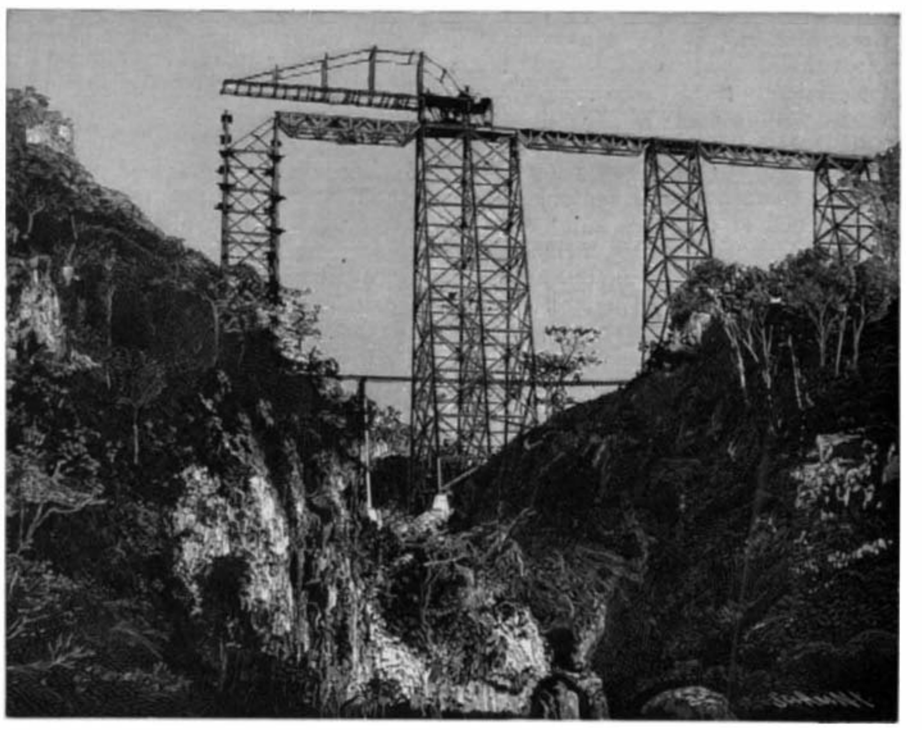
Owing to the height of the bridge, and the extreme changes in temperature, careful provision had to be made both for the wind pressure and the unusual contraction and expansion of the metal. The bridge was built to carry a load of 2,240 pounds to each linear foot of track, in addition to two locomotives, each weighing 54 tons. It is to withstand a wind pressure of about 34 pounds per square foot when a train is upon it, and about 56 pounds per square foot at other times. These calculations were made by the consulting engineers of the railway company—Messrs. Sir Alexander Rendel & Co., of London, represented by Mr. W. H. Clark. The viaduct was erected under the supervision of Mr. D. Duchars, chief engineer, and Mr. J. A. White, resident engineer.

As already stated, a portion of the viaduct is located upon a natural bridge. This is a rocky formation which is just wide enough to safely support the towers. Two hundred feet below its summit flows a river which has forced a channel beneath the formation, so that the total height of the bridge above the water is 520 feet.

Some interesting experiments have recently been carried out with the wireless telegraphy system of M. Victor Popp, whose work in compressed air and electrical engineering is well known. Col. Pilowski, of the Russian army, is associated with M. Popp in this invention. No tall masts are required and the system is terrestrial rather than aerial, the electric waves following the contour of the earth. The apparatus consists of two electrodes separated by a distance that varies according to the distance of the place with which it is desired to communicate. The negative electrode is placed on a sheet of glass to insulate it and the positive is buried in the earth at a depth of from twelve to fourteen feet. These two electrodes are connected with the transmitting apparatus. The receiving station is similarly equipped. M. Popp considers that the radius of his system is virtually unlimited. The experiments, however, have only been over short distances. He first devised a sort of reflector-insulator which allows of the electric waves being compelled to travel in a given direction.



VIEW OF TRAVELER SHOWING OPPOSITE SIDE OF GORGE IN THE DISTANCE.



GORGE AND MAIN TOWERS WITH BRIDGE UNDER CONSTRUCTION.