

CONCRETE RAILWAY BRIDGES.

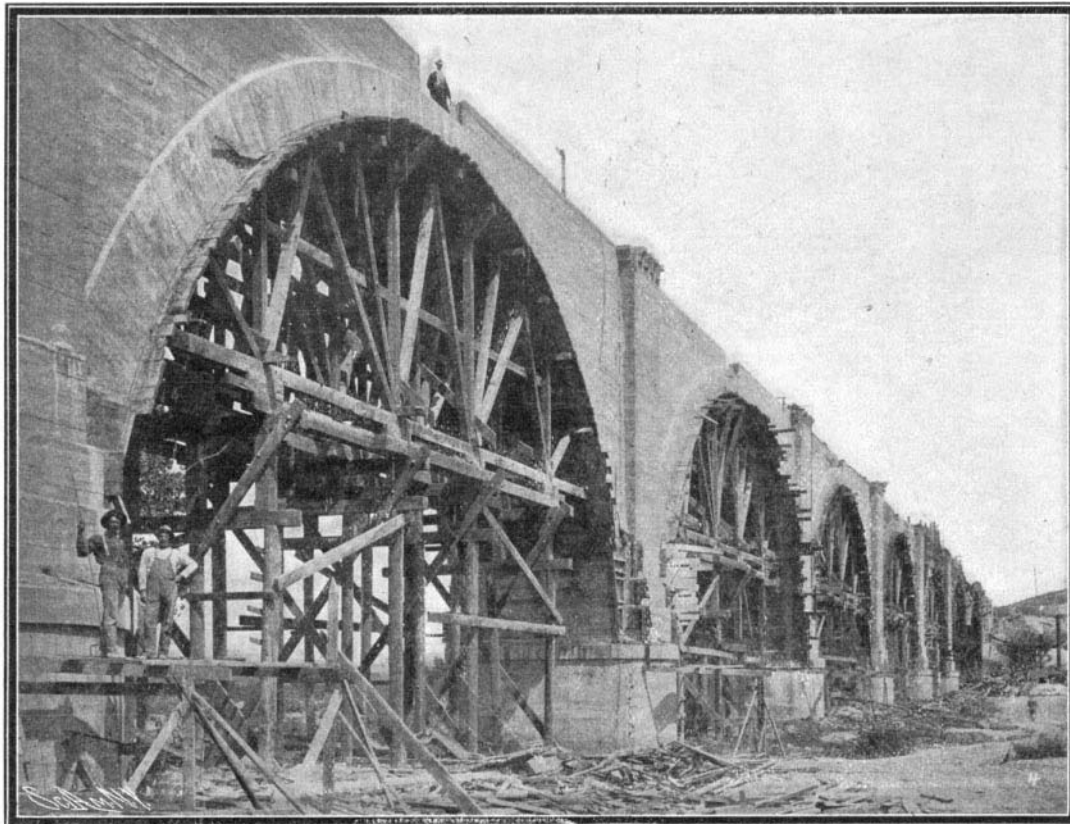
The increasing use of concrete in construction work of the most varied kinds is well illustrated by the instances given below of building railway bridges of concrete.

It is a curious fact, and characteristic of the recent rush of prosperity in the iron and steel industry, that the largest concrete railroad bridge in the world, here-with illustrated, should owe its existence to that prosperity. This bridge, which is now under construction for the San Pedro, Los Angeles and Salt Lake Railroad Company, carries the tracks across the Santa Ana River, at a point some four miles from Riverside, Cal. As originally planned, the bridge was to have been built of steel; but when it came to placing the contract for the same, it was found that the great rush of work in the various bridge-building establishments of the country had thrown them several months behind their orders. Rather than undergo the serious delay that would result if the bridge were built of steel, the chief engineer of the road determined to go ahead and build the structure at once of concrete, the materials for the manufacture of which were readily available, and the nature of the building material being such that it could be prepared immediately.

The viaduct, which has a total length of 984 feet, consists of ten arches flanked by two massive abutments. Eight of these arches have a clear span of 86 feet, and the two end spans adjoining the abutments are about 35 feet clear span. The piers measure 14 feet by 28 feet in plan, and are built of solid concrete.

The arches are semicircular, and the greatest height of the structure above the river bed is about 70 feet. The excavations for foundations were carried down to bed rock, which was found at a depth of from 12 to 30 feet, the excavation being done by means of coffer dams. The estimated weight on each foundation is about 1,050 tons. But little difficulty was experienced in finding satisfactory bearing material, except in the case of the last pier, which, after the work had been carried up to a height of 20 or 30 feet, began to show signs of settlement. The matter was remedied by driving cement grouting into the material below the foundation, the grouting being forced in by means of pumps. After the piers had been carried up to the springing of the arches, the falsework and centering were erected, the outer timber form built up, and the concrete rammed in place. The concrete was prepared in a large mixer located near one of the abutments, from which it was loaded into cars and hauled to the particular part of the work where it was needed. The design of the bridge is simple, and suitable to the char-

This is remarkable from an engineering standpoint, because its arches are the longest of the kind ever constructed. The bridge consists of three 140-foot spans, the limit hitherto having been about 90 feet. The total length of the bridge is 574 feet 6 inches, and width 34 feet 2 inches. In the construction of the three centers for the elliptical arches, the fan-shaped grillage was supported on three rows of piles. The rise of the arches is 30 feet. About 12,000 cubic yards of concrete were used in the structure, which cost \$75,000. This is less than the cost of a modern double-track steel bridge of the same dimensions. This type marks an era in railroad bridge construction, as the



Looking Southeast Along the Santa Ana Viaduct.

Illinois Central is replacing all wooden and steel structures, where replacement is necessary, with concrete bridges when conditions permit of so doing. The credit of constructing concrete arches of such length belongs to J. F. Wallace.

Count Zeppelin's Experiments.

In a letter addressed to the National Zeitung, Count Zeppelin states that his appeal to the German public had not met with the response he anticipated, but that by the aid of several subscriptions he had succeeded in raising the sum of 16,000 marks (\$4,000) for the construction of a new airship. To aid in the new project, the leading German constructors will furnish him with the necessary material at a greatly reduced price. Under these conditions, and seeing that the Minister of War, as well as the King of Wurtemberg, have offered him their support, Count Zeppelin has decided to begin the construction of his new airship. After a careful study of the subject since his last trials over Lake Constance, he expects to bring out a

Mining Ore in the Mesabi District.

BY KIRBY THOMAS.

In the Special Iron and Steel Number of the SCIENTIFIC AMERICAN reference was made to the rich Mesabi iron deposit in Northern Minnesota, as being one of the chief contributory causes of our supremacy in the iron and steel industry. This range was first opened in 1893; since which date it has produced 66,800,898 tons of iron ore. In 1902 nearly 45 per cent of the total iron output of the Lake Superior district came from the Mesabi range, or 33 per cent of the total iron ore output of the United States, the greatest iron-producing country in the world. In 1903 the Mesabi district produced 53 per cent of the Lake Superior output.

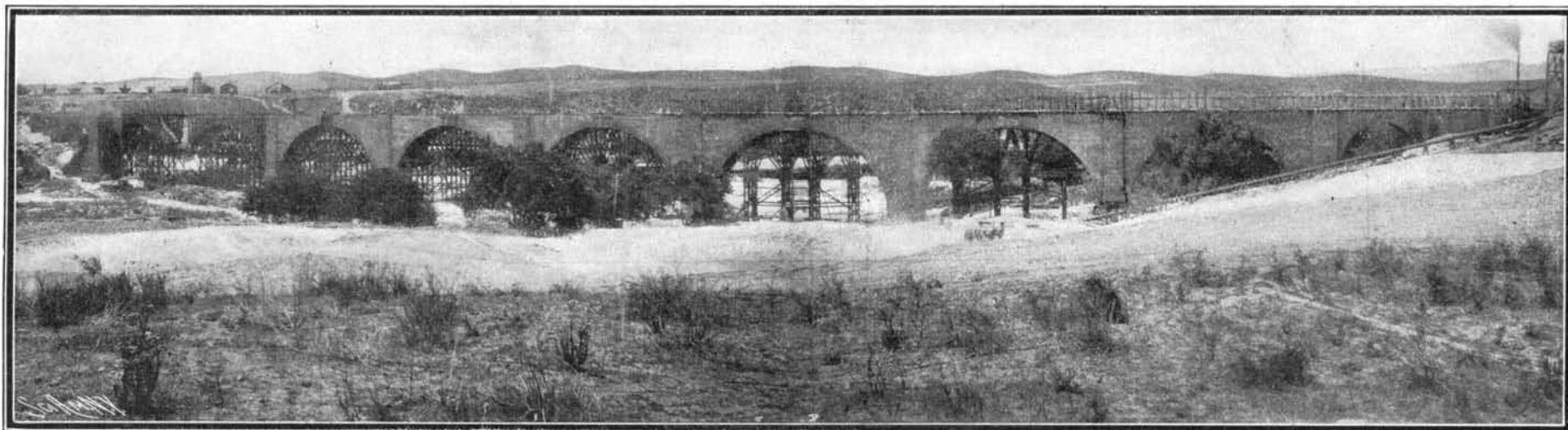
Owing to the shallow nature of the ore deposit and the soft character of the ores, it has been found possible and economical to mine this Mesabi ore with steam shovels in open cuts, and it is on this range that this method of mining is developed to a remarkable extent. The ore lies in broad basins in the rock, covered with glacial drift from a few feet to 100 or more feet thick. The method of mining most used is to strip off the overburden of gravel and load the ore direct into steam cars with steam shovels for transportation to the lake ports. A steam shovel will load 2,000 cubic yards of gravel in twenty hours, and considerably more ore. A fair output in ore for a steam shovel is 75 cars of 25 tons capacity in ten hours. The cost of "stripping," as the process of removing the gravel is called, is about 40 cents a cubic yard, and most of this work is done by contract. The

cost of removing 40 feet of gravel from an acre then would be \$16,000. The ore can be mined and put on the tracks for less than 5 cents a ton, to which must be added the distributed cost of the shipping and general management.

The work of excavating the ore is carried on in parallel benches, the ore being scooped up directly from the natural bed and loaded into the adjacent train of cars. The rich, loose ore in the richest mines will run over 60 per cent of iron to the ton. Several of these mines shipped last year over a million tons of ore each, and the total shipment of ore reached thirteen and a half millions in 1902 and almost as much in 1903. A number of the Mesabi mines are worked by the underground methods, but it is as an example of steam-shovel mining that the range is known to the world over.

Carrara Marble.

Carrara marble, which is of universal repute, is produced in Italy. The strata from which 319,887 metric



Santa Ana Viaduct at Riverside, California; 984 Feet Long.

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acter of the structure, plain rectangular pilasters running from the piers between each arch to the parapet line, where they are relieved by a series of corbels. It will be seen from our illustration that the concrete construction harmonizes well with the natural characteristics of the country.

Another notable concrete structure is the double-track bridge which the Illinois Central has recently completed over the Big Muddy River, near Carbondale, Ill.

greatly improved airship. According to reports, an immense balloon shed is to be erected near Manzell, on the lake, from which the trials are to be held.

A dispatch has been received from the British vice-consul at Sevastopol, reporting that the Russian government had decided to construct an electric railway between Sevastopol and Yalta, to pass via Balaclava, Bida, Aloupka, and Livadia.

tons were quarried in 1902, partly for export to America, cover an area of 80 square miles, and reach in places the depth of three-quarters of a mile. The mines, some of which were worked by the Romans, are surface workings, at an altitude of 700 to 3,000 feet above sea level.

More than two hundred kinds of rice are shown in Siam's agricultural display at the World's Fair.