SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year, for the United States or Mexico $3.00
One copy, one year, for Canada 3.75
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) .... $3.00 a year
Scientific American Supplement (Established 1876) .... 5.00 "
American Homes and Gardens .... 3.00 "
Scientific American Export Edition (Established 1878) .... 3.00 "

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, MAY 25, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

NEEDED—A RATIONAL RAILROAD TRACK.

In our last issue we showed that the rails which are now being furnished by the mills are far inferior to those which were made a few years ago, and that to this fact, chiefly, is to be attributed the alarming increase in breakages. We also made it clear that the present Bessemer process, because of its limitations, is altogether unsuitable for the production of first-class rails, and that the only way open to the manufacturers to meet the present emergency is to abandon the Bessemer in favor of the open-hearth process, under which alone it is possible to make rails of the desired high quality.

But even if the above facts be admitted—and they cannot be denied—the fact remains that the roadbed and track of to-day are crude in design, and quite inadequate to meet the heavy duty which is laid upon them. Even the best of our Eastern tracks are subject to stresses which are far beyond those which are considered to be reasonable and safe in the general engineering practice of the day. We are certain that if an engineer who (we will suppose for the sake of argument) had never seen a railroad track were supplied with a statement of the weight, speed, concentrated wheel loads, and other data regarding modern railroad trains, and were asked to design a suitable and safe roadbed for the same—we are confident, we say, that he would design a structure very different from that upon which trains are run to-day. Certain it is that he would never adopt the T-rail with its wide, thin base, so inadequate to withstand compressive strains when it is bent in the reverse direction. Nor would he adopt a soft-wood tie. And if, for the want of other available material, he did use the wooden tie, it is certain that he would ridicule the idea that the miserable little spikes which we now use would be sufficient to hold the rails in place. Moreover, with one or two exceptions, he would reject the present methods adopted in splicing the ends of the rails.

It is certain that, if the very best track construction of the present day were offered for his consideration, he would reject it as being altogether inadequate for its work. He would find that the extreme fiber stress in the rails, subjected as they are to heavy impacts, is far higher, in fact, possibly two or three times as great as is permitted in the structure of a bridge. He would discover that there was the same excessive fiber stress in the tie; and that the bearing load on the ballast was also far beyond what was desirable.

As a matter of fact, we question if in the whole field of engineering, there can be found any construction of first-class importance which has received so little scientific investigation, take it as a whole, as modern railroad track. Certainly, it has received no such careful thought as the steel railroad bridge. If it has, we would very much like to know where is to be found a published document corresponding to Cooper's specifications for railroad bridges. No such paper exists, nor anything that approaches it. And yet, we do not hesitate to say that the steel rail, in view of the extraordinary duty that is laid upon it, and the perils attending its failure, and above all in view of the fact that it is continuous from end to end of the railroad, is a far more important element of the track even than the bridges themselves. The truth of the matter is, that for some reason which is rather difficult to determine, the track, although it lies literally at the very foundation of a successful railroad, has been left by the engineers very largely to work out its own salvation. Its present form, even to details (as witness the survival of the railroad spike) was determined by the exigencies of a day when railroading was a new and comparatively untried art; when technically-qualified engineers were scarce; and when the paucity of capital made it necessary to adopt the simplest and cheapest forms of construction. It was these considerations which led to the adoption of the flat-bottomed T-rail; for when once the use of cross-ties had been decided upon, necessitating that the rail should act as a continuous girder from tie to tie, good engineering would have suggested the use of some metal bearing plate upon each tie, and the construction of a rail with its bottom tensional member of a compact bulbous section, suitable to take the alternate compressive and tensile stresses to which it would be subjected. But this would have been too expensive a construction; and hence the necessity for a separate metal foundation plate was obviated by rolling the rail with a flat face suitable to act as a bearing surface, and capable of being fastened to the tie with a couple of good stout spikes—an admirable provision for the light locomotives and cars and the scanty funds of those pioneer days; but a very inadequate construction for these days of 200-ton locomotives and speeds of from 50 to 80 miles an hour.

An authority on track construction recently stated to the American Railway Engineering and Maintenance of Way Association that the proper rail to meet modern requirements would be one with a 6-inch base and 7 inches in height, and weighing 115 pounds per yard. Between rail base and tie should be a plate measuring 6¼ inches by 8 inches. The ties should have at least a 9-inch base; they should be spaced not over 20 inches center to center; and the bearing of the tie on the ballast should be reduced from the present 5 tons per square foot to 3.8 tons. This would give an increase in the rail alone of about 37 per cent of resistance. Such a track would be an advance, provided that the place of the spike were taken by some form of bolted connection, the bolts passing entirely through the tie, and not less than three bolts, two on the outside and one on the inside, being used at each tie plate.

EXCELLENT FOUNDATIONS FOR THE GATUN LOCKS.

The particular storm center around which has raged the fiercest of all the technical controversies of the Panama Canal, is to be found at the Gatun dam and locks; and, of all the questions debated in this connection, perhaps the most important is that of the character of the rock underlying the site of the locks. The opponents of the high-level canal, and notably Mr. Lindon W. Bates, have bitterly opposed the creation of the Gatun Lake, mainly on the ground that the character of the whole underlying ground throughout the 7,000 or 8,000 feet covered by the dam and locks was unsuitable, either to carry the heavy superincumbent load of the structures, or to resist the tendency of the impounded waters to break through by extensive seepage through the subsoil. Mr. Bates has claimed, moreover, that the hill which has been chosen for the site of the locks does not present a sufficient length, measured along the axis of the locks, to contain the whole structure from entrance to entrance.

For many months past an extensive series of borings has been made at the site, and several test-pits have been sunk to the full depth of the lowest lock foundation, the latter being constructed of sufficient size to allow the engineers to descend and make an inspection of the successive strata of ground as thus exposed to view. Furthermore, these test-pits render it possible to excavate the material in large enough masses to make adequate tests to determine the bearing power of the rock and its permanence when exposed to the atmosphere.

When the borings and test-pits were completed, and with a view to a final determination of the question, a special committee composed of three of our leading hydraulic engineers, Messrs. Alfred Noble, chief engineer of the East River tunnels of the Pennsylvania Railway Company; Frederick P. Stearns, of Wachusett Dam fame, and John R. Freeman, who was largely responsible for the adopted plans of the new Catskill water supply of this city, went to the Isthmus, and after an exhaustive examination have reported favorably to the Secretary of War. Not only does the report remove the very serious doubts which have been aroused by the criticism above referred to; but it discloses apparently an even better condition of things than the sponsors of the Gatun dam and locks had supposed to exist. These engineers, individually, entered each of the test-pits, the deepest of which was extended to a depth of 87.4 feet, and they found that after passing through a few feet of overlying clay, the pits entered a rock formation and continued in the same to the bottom. Timbering was required only in the overlying clay, except in one or two cases, where it extended for a few feet below it; but from the clay down to the bottom of the pits the rock was standing well in the vertical walls, and this in spite of the blasting which is required during excavation.

With one exception the rock is of a fine-grained, bluish-gray, argillaceous sandstone character, being, in fact, the same material that has often been referred to as indurated clay. In hardness it may be compared with some of the clay shales; but it is massive rather than laminated. The exception mentioned was a conglomerate rock found in the lower eight feet of the first test pit. Although a small amount of water filtered into each of the pits, in no case was the quantity large enough to be of practical importance. During the visit of the engineers, a test of the supporting power of the rock was made by loading one square foot of a portion which had been uncovered in making the excavations with 72,000 pounds of steel rail. This weight, although it was several times as great as that which would come upon an equal surface under the walls at this lock, caused no appreciable indentation upon the surface of the rock.

Seven samples of the conglomerate from the first pit showed an average bearing power of 867 pounds per square inch. Five samples of the bluish-gray rock from the four other test-pits failed at an average pressure of 1,686 pounds to the square inch. Other samples taken from the pits showed no signs of failing at a maximum of 6,000 pounds per square inch.

The cores which were brought up by the diamond drills from all parts of the rock site showed that the rock was of the same kind as was found in the test-pits, and these borings have been sufficiently extensive to prove that the whole of the locks, and at least a portion of the approach wall, can be founded upon the rock. As the result of their investigation, these engineers expressed the belief that the material on which the Gatun locks would rest would afford an ample and safe foundation. Equally good results were shown in the test-pit and borings at the site of the regulation works in the center of the dam.

The Pedro Miguel locks will rest, for the greater part of their length, upon a hard trap rock, and for the rest of their length upon a softer rock similar to that at Gatun. The rock underlying the Sosa locks was shown by several excavations and by borings to be so satisfactory, that no test-pits were considered to be necessary.

The high professional standing of the board of engineers, the thorough character of the sub-surface examination, and the highly favorable character of the findings, may be taken by the American public to have settled this vexed question once and for all. With this out of the way, the last of the serious uncertainties as to the ultimate and satisfactory completion of this great work may be considered to have been removed.

THE SMOKE PERIL AT FIRES.

If New York still cherishes the delusion that it has the best-equipped fire department in the world, the fire which recently ruined the building of a well-known firm of typewriter makers ought certainly to shock the fire department to a livelier sense of their error. The fire in question entailed no loss of life, yet it taxed to the utmost the resources of the fire brigades of the lower part of the city, and tested the courage of the men whose duty it was to save the structure. It was not fierce heat that they were called upon to combat, but dense smoke and suffocating gases. More than forty firemen were dragged out from the building by their comrades, stupefied and unconscious, and laid out on the sidewalk until they recovered sufficiently either to be taken to hospitals or to return to their duties. The delay which this rescue work naturally occasioned, and which resulted no doubt in some loss to the owners of the building, would lead one to suppose that smoke helmets and respiratory apparatus were never invented, or at least never heard of in New York. Yet for years self-contained breathing apparatus has been used in various industries by operatives who are hourly compelled to face dangers compared with which the perils of this fire seem trifling. In mines saturated with poisonous fire damp, in gas and chemical works where noxious fumes are generated in dangerous quantities, in sewers, coal bunkers, and ammonia chambers, breweries and well-sinking plants, men work with little inconvenience, all because they are equipped with apparatus for supplying an adequate amount of fresh air or oxygen. The fire brigades of Europe have used such breathing devices with conspicuous success; and yet the richest city in the most enterprising country in the world still displays a lamentable reluctance to use inventions which so far from being untried, have proven their worth in many a perilous trade.

The type of breathing apparatus which would be required by firemen would probably be the simplest kind of respiratory device, because its wearer would be compelled to pursue his task for a comparatively unprotracted period. Cost can hardly be offered as an argument against the adoption of breathing helmets. One type of European apparatus, which has done excellent service in various colliery explosions, weighs 29 pounds, costs $40, and enables its wearer to work comfortably in a suffocating atmosphere for an hour and a half. Less expensive and equally serviceable is a respiratory apparatus invented by three German scientists after a careful study of the requirements which must be met by smoke jackets and helmets. Their contrivance weighs but three pounds, costs about $10.