ERECTION OF THE NEW HARLEM RIVER BRIDGE AT 181ST STREET.

The series of bridges of various epochs and types of construction that cross the River Thames have long been one of the most impressive features of London. From a similar standpoint, and as far as bridge architecture is concerned, the Harlem River, more diminutive than the Thames, bids fair to fill a similar *rôle* in the city of New York. The High Bridge, carrying the water of the Croton aqueduct across the river, has long been a famous structure, though in the present age it must take a lower position in the engineering world. A short distance from it, where One Hundred and Eighty-first Street intersects the Harlem River, the greatest of the bridges over the river is rapidly approaching completion.

At this point the Harlem has high banks, the west being the more precipitous of the two. On the eastern side the low shore runs back a short distance and then somewhat more gradually rises to a height corresponding to the other side. On the low ground on the east bank of the river the New York City and Northern and the New York Central railroads have their tracks. This character of the ground necessitated the peculiar disposition of the bridge which we are about to describe.

It is a combined masonry, steel, and wrought iron structure, affording a carriageway and foot walks. It includes in general two approaches and the bridge proper. The total length, including these approaches, from Tenth Avenue on the west to Aqueduct Avenue on the east, is 2,380 feet.

The general plan may be thus stated: The length is divided into three parts. Each approach is 660 feet long. Two steel arches and a central stone pier fill up the remaining 1,060 feet left between the approaches. The western approach is for 260 feet in earth supported by stone work. The next 400 feet are in masonry, three semicircular arches of 60 feet span, carried on piers, with some viaduct or solid work completing this portion. On the eastern side a similar division exists. In the approach 300 feet are in earth supported by masonry, while the remaining 360 feet in masonry include one seven centered 56 feet arch, three semicircular 60 feet arches. In common with the bridge, the approaches furnish a clear width of 80 feet, 50 of which is devoted to the central carriageway, and 30 feet are equally divided between the two sidewalks.

We illustrate the general operation of erecting the arches. As will be seen, the work is far from complete, but the difficult parts are pretty well disposed of. We have already described and illustrated the sinking of the foundations.* A good rock bottom was obtained for the piers. When all is in place, the maximum pressure on the pier bases will be about eight tons per square foot. This is well within the limits. The primitive gneiss rock of the New York district could safely be trusted with a much greater load.

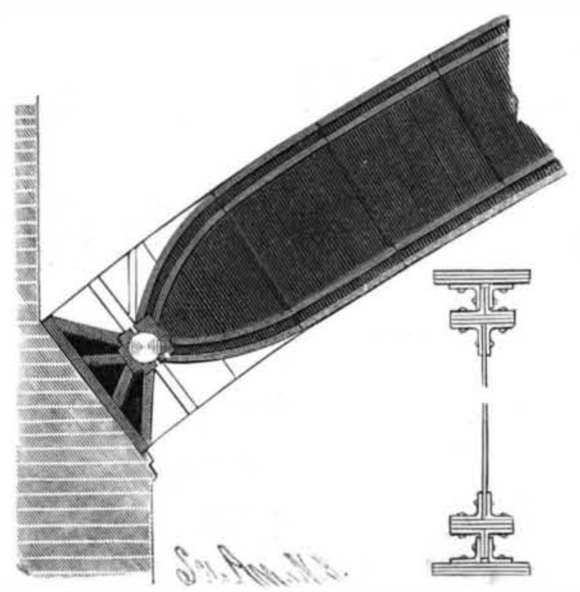
Each approach terminates in a pier, and midway between these is a central pier forty feet deep. The three are carried up to the level of the roadway. The central pier stands on the east shore of the river. Near the foot of each pier the skewbacks, from which the arches spring, are placed. Thus the spandrel is defined by the steel arch on one side, and by the stone pier on the other.

Each arch consists of six ribs, composed of steel plate web, with divided upper and lower chords. The divisions are so arranged as to divide the ribs into voussoirs, that drop into place exactly as do the stone blocks in a masonry arch. Taking a single rib, we find it characterized by heavy top and bottom chords, divided at each joint and connected by steel web plates ⅜ inch in thickness, except the end web plates, which are ¾ inch in thickness. The cross section is shown in the small cut.

The top and bottom members are built up of six angle irons 6 inches by 6 inches by ⅝ inch, of two plates 12 inches by ¾ inch, and three or four plates 20 inches by ¾ inch. These pieces are riveted together so as to form two lines of flanges, one pair resembling a top chord and the other a bottom chord of a curved plate girder. The voussoir divisions of each rib are of varying length, but of a uniform horizontal dimension or projection of fifteen feet. The abutting faces are planed. To unite them, angle irons 5 inches by 3½ inches by ⅜ inch, four in number for each splice, are used. The ribs are 13 feet deep. Each one has its own pair of skewbacks. These bear against the masonry, and support the end thrust. They are thirteen feet long and four feet four inches wide. They have bearings for pins, against which the corresponding ribs abut. Each pin is of forged steel, eighteen inches in diameter and thirty-five inches long. For its entire length it is supported in its bearing by the skewback, a little over one-half its cylindrical or circumferential surface projecting therefrom. At the end of each rib the top and bottom chords converge, and a second bearing or bed is formed, that receives the projecting surface of the pin, a free space being left between the skewback bearing and terminal of the rib. Thus a species of hinge joint is formed that secures a true thrust undisturbed by varying load and changes of temperature. As the rib can oscillate freely in such a bearing, no destructive strain is possible. This joint is also illustrated in the small cut.

Each rib should thus end in a sort of point. To preserve appearances, the general contour of parallel top and bottom lines of the rib was preserved, although the extra plates used are loosely joined and really do no work. This is a concession to the public. To the engineering eye, the display of the pivotal bearing would have been an interesting feature. With an extreme range of temperature, a rise and fall of the crown of arch through a space of three inches may occur, and many times this amount is provided for by the pivotal bearing.

The six ribs thus constructed and supported are spaced laterally 14 feet from center to center. Their rise is 90 feet. They are connected by bracing that may be resolved into two systems. One set, of wind bracing, lies in the line of upper and lower flanges or chords of the ribs; the other, of sway bracing, extends from rib to rib at each junction of the voussoirs or panels. From the upper surfaces of the arch vertical columns rise, upon which the cross floor beams rest. These columns are 15 feet from center to center, and they determine the varying length of the rib panels, already alluded to, as each column starts from the termination of a joint between the voussoirs. The two main arches, one spanning the river, the other the railroads, streets, and low ground on the east bank, are identical in construction. In their construction about seven thousand five hundred tons of iron and steel are employed.



PIVOT BEARING AND SKEWBACK—CROSS SECTION OF ARCH RIB.

The skewbacks, pins, and bearings are of forged steel. The arch ribs are of steel. Both open hearth and Bessemer steel is used, provided the contract requirements are fulfilled. These requirements call for an ultimate tensile strength of 62,000 to 70,000 pounds to the square inch, an elastic limit of not less than 32,000 pounds, with a minimum elongation of 18 per cent. The bracing, vertical posts, and floor beams are of wrought iron. Most of the riveting is done by machine, air riveters being used for work *in situ*. Before being riveted together, all abutting surfaces were painted. Rivets ⅞ inch diameter are used throughout.

The roadway is to be in granite blocks. Its surface is 151 feet above the level of the river. The intrados of the arch is 133 feet above the same.

The structure has been erected so as to carry out in all respects the best engineering practice. Thus the rivet holes are so accurately spaced that when abutting pieces are in place, a rivet one-sixteenth inch less in diameter than the hole can be passed through the corresponding holes when it is hot. Where holes are punched in steel, they are reamed one-eighth inch larger, to remove all the sheared surface. Where steel has been sheared, it is planed off one-fourth inch back of the cut. The strains allowed vary from 10,000 to 20,000 pounds per square inch. In estimating bending strains the web plate of girders is not included, and for shearing strains the web and no other part is assumed as acting. This insures a still larger factor of safety. These are cited as sample requirements. Through all the details of masonry and iron work the same careful practice prevails.

The arches are built on centering or false work, which for so large and high a span is itself no small construction. We illustrate the false work under one of the great arches, showing how complicated it is.

The bridge is erected under the supervision of Mr. William R. Hutton, chief engineer. He is assisted by Mr. Theodore Cooper as consulting engineer. To both of these our thanks are due for their courtesy. The contractors are the Passaic Rolling Mill Co. and Mr. Myles Tierney. With its two immense archways and general boldness of design, it will for many years be an ornament to the city. But a few years ago a single span of this length, save in a suspension bridge, would have been considered wonderful. At the present day we are inclined to the opposite extreme, and accept all engineering achievements with too little appreciation of their merit.

* See SCIENTIFIC AMERICAN, vol. 56, No. 16.

The Recent Foggy Week in London.

Day after day there was no perceptible movement of the air; and as a natural consequence, the fog grew blacker and more dismal, until at last the distinction between night and day became purely imaginary. An enormous amount of gas must have been consumed, for the fog was very general over the United Kingdom. Fortunate were the gas managers who were able to begin the week with full stocks, and were prepared day after day to let the public have as much gas as they wanted.

To read of fleets of vessels kept outside harbors, of trains running into each other, of men walking into canals, mail carts going astray, and the other results of a dense and universal fog, is far more impressive than anything that newspaper writers can remark upon the subject. The worst of it is that the world which suffers from fog, reads of the mischief brought about thereby, and would do anything to be delivered from fog, forgets all about the matter as soon as a breath of wind drives the unpleasant visitor away. It is more than probable that if a kind of respirator and eye protector for use in foggy weather were to be offered for sale in shops, it would remain dead stock all the year round, even although its merits were so conspicuous as to insure a great sale during the actual prevalence of fog. The climate of the British Isles is so notoriously inconstant in all its modes that we who have to endure its fickleness do so without any more thought than that a change will be sure to come speedily over whatever meteorological conditions may prevail at the moment. Thus it is that we suffer more from cold than Russians or Canadians, and from heat more than West Indians, simply because we cannot depend upon any such continuance of frost or sunshine as would warrant our adapting our way of living to either condition. So it is with fogs. We know perfectly well that there will be a dozen or more foggy days every winter, but this knowledge does not make the slightest difference in our domestic arrangements, even though we may know that there is a clear connection between the two. No Englishman will think it worth while to seriously modify his fire grates and cooking stoves solely on account of fog. His fire in winter is a permanent institution, while fog, which the smoke of the fire makes more objectionable than would otherwise be the case, is a passing infliction. Consequently, the fire blazes, glows, and smokes indoors, winter after winter, while the fog crawls over the land fitfully, and its nauseousness to him while out of doors only makes the Briton stir his fire more briskly when he gets home.

Some of the newspapers have published the usual flood of nonsense, to the effect that smoky household fires, which are admittedly the cause of the most irritating characteristics of town fogs in England, are willful productions of the callous or ignorant householder and his yet more reactionary builder; and one writer whom we have noticed goes so far as to declare that nothing but a severe law, rendering it penal in anybody to purchase or use a smoky fire grate, will ever awaken Englishmen to a proper sense of their duties in this respect.

Before we can pass an act for the suppression, under penalty, of smoke from house chimneys, we must be in possession of the material means for carrying out the reform, and of this there is no prospect. There are, of course, degrees of excellence, in the smoke prevention sense, in fire grates, but calling a grate smokeless is like calling a building fireproof. In both cases the point really depends upon the quality of the contents. No grate is smokeless until the fire is out, just as no building is fireproof if it contains combustible materials.

If the virulence of English town fogs is ever to be abated, it will be by dint of steady, quiet, unobtrusive alterations of domestic arrangements which it would be beneath the dignity of a newspaper writer to notice. It is not too much to hope that in time the production of smoke from house chimneys will be stopped for at least the summer half of the year, owing to a general use of gas cooking stoves and kitcheners burning small coke. Already there is a very sensible difference in this respect, for in entire rows of houses in many towns not a single fire is lighted for months together. The more that gas is popularized among the poor, by weekly collections of rental, automatic prepayment meters, and similar devices, the more smokeless will our towns become, for the humblest workman's wife is the most likely to appreciate the labor and time saving capabilities of the simple boiling stove for preparing the early cup of tea, and it is the small fires otherwise required for such a purpose that make the most smoke. Smokelessness in summer is a very good object for immediate endeavor; winter smokelessness is a more serious problem. Abuse it as we may, the cheerful open fire of coals is most suitable for combating the chills and damps which make up an English winter.—*Journal of Gas Lighting.*