of a combination of diagonal struts and vertical ties, and are divided into spans of 65 ft. 7½ in. each. That shown in the plate is an example of one over the River Aranuyas at its embouchure with the Maros. It is the smallest of the series, and consists of twelve bays. The elevation, Fig. 1, shows four spans of 65 ft. 7½ in., supported on lofty piers of timber, which are flanked by ice-breakers between the flood and lowest water levels. The deep water piers are built upon a platform, supported by twenty-two piles, on which is reared the superstructure, and, lastly, the saddle that carries the girders, which is 16 ft. 5 in. in length from end to end, formed of two blocks of oak of the largest scantling obtainable, viz., 15 3/4 in. x 13 in., and bolted by 1 in. bolts transversely. The superstructure consists of eight vertical piles and fourteen rakers, while the ice fenders are horizontal casing timbers strongly bolted and spiked to them. The arrangement of the timbers in the piers is clearly shown in the drawings.

Another kind of ice-breaker used consists of a vertical structure of piles, closely driven, and placed at a distance of about 32 ft. 9 in. from the pier, up the stream, and facing the current, the piles being cut obliquely from low to high water, cased with strong walings and 3½ in. thick planking; the whole being surmounted with iron-shod cover-piece of best oak timber.

Great care was obviously necessary to protect the face of the timber piers by these fenders, not only from the momentum and abrasion of floating ice—which, at the breaking up of the frost, sweeps down the river at a velocity of not less than five miles an hour, in great masses of considerable thickness—but also from the swollen current and the floating fragments of timber in the rainy seasons of spring and autumn. A fender altogether detached from the pier has the advantage of saving the latter from the shock of collision, while a protection, no matter how strong, fixed to the pier, obtains its greatest resistance from the stability of the pier itself, and consequently in time becomes a source of weakness to the whole.

In the abutments of these bridges, timber and a protected bank has generally been preferred to stone, in consequence of the time and labour expended in the transport from the quarry, and, further, on account of the great depth required to be excavated for a stable foundation in a soil which retains a large proportion of water in its bulk.

The superstructure of these bridges consists, as we have said, of Howe trusses or girders, which have a general span of 65 ft. 7 in.; they are continuous throughout their entire length, resting upon the saddles at the pier head, as shown in elevation in Fig. 5 of the illustration already referred to. A transverse section is given in Fig. 4, from which the construction of the bridge may be easily understood. The chords or booms are as usual formed of three timbers, 13 in. x 9 3/4 in. in section; they are bolted together by bolts 1 ½ in. in diameter, with cast-iron washers, and are jointed by the aid of heavy cover-plates of wrought iron for the tension boom, and cast iron for the compression boom. A difference is observed between a centre and side joint, by the use of single and double joint plates respectively, to increase the strength of the joint where required. This will be readily understood from the drawings. The struts or diagonals are composed of white wood, having a section 9 7/8 x 9 3/4 in., and are doubled in the direction of the strain upon them, as shown in the transverse section, Fig. 4, and in the plan, Fig. 6. They differ slightly in length, so as to conform with a camber of 3 1/2 in. to which the girders are braced up by the ties in the centre of each span. The blocks, upon which the struts abut, are cut from the hardest oak, and let into the chords 3 in.; through their centre the large tie bolts pass to a cross timber above the upper chord, and through a transom below the bottom or tension chord, the former piece consisting of hard wood, and the latter of pine timber well seasoned. The plan of the strut blocks can be seen in Fig. 3, with two bolt holes for the tie rods. These tie rods are in duplicate throughout each span and girder; the largest, at the piers and abutments, are 2 ½ in. in diameter, the size being reduced to 1 ½ in. in the centre of the span, and being proportioned to the strains they have to bear. At each extremity are screws and nuts, which are fitted upon wrought-iron washers, ½ in., bearing by cast-iron bed-plates, ¾ in. thick, upon the timbers. They are shown in Figs. 4 and 7.

The lengths of the struts decrease from the ends of the span towards the centre, to suit the camber as before mentioned; they are arranged so that the counter-braces are single timbers of the same sectional area, and cross them in the centre immediately, the three being bolted transversely as shown in Fig. 6. On either side of the strut blocks transoms of proper scantling are let into the tension chord, in order to carry the rail stringers or longitudinal sleepers to which they are fixed by bolts 1 in. diameter; these transoms are 2 ft. 8½ in. apart, and over the piers and abutments they are bolted to the corbels underneath the line of rails, as shown in Fig. 2.

In the half-plan, Fig. 3, are shown wind ties or lateral braces between the girders. It will be seen that they are bolted to the transoms above and below the boom: they are halved in their cross joints, are of white wood, and have a scantling of 7 3/4 in. by 7 3/4 in. The planking is 3½ in. in thickness, and is carried by the upper transoms. To obtain further stiffness, the girders are connected over the piers by raking timbers.