BRIDGES OF COIGNET'S ARTIFICIAL STONE.

PLATES XXIII. AND XXIV.

For about fourteen years the "béton aggloméré" of M. F. Coignet has been employed in France, at first sparingly, and with hesitation, but of late so largely and with so much confidence, that many of the large works in and near Paris have been constructed for the most part, or entirely, with this material.

So early as 1850, M. Coignet had experimented further than his predecessors Fleuret (1800) and Lebrun (1829), but the conglomerate he then produced was unsatisfactory. In the commencement he employed a crude mixture of coal cinder with lime, and subsequently he substituted sand for the former ingredient, and mixed it with powdered lime, moistening both together instead of wetting the lime as he had at first done. The second process to which he arrived, after modification and a long series of experiments with materials from different districts, and under varying circumstances, to ascertain the best proportions, is the system which has now grown into such a vast industry, and which bears his name.

The béton Coignet is a mixture of a large proportion of sand with a small proportion of lime, to which is added a percentage of cement varying with the amount of hardness or the rapidity of setting required. Only a very small quantity of water is employed to moisten the lime and sand. Thus tempered the mass is reduced, in a grinding mill, to a stiff paste, and is introduced into moulds of any desired form, being then subjected to the action of repeated and heavy blows. By this means it is thoroughly agglomerated, and the mould being almost immediately removed, the béton, shaped to the desired figure, shortly becomes set, and acquires the hardness of stone.

The material thus mixed and compressed under the hammer, when placed in the mould, receives a weight, strength, and density which renders it a thoroughly trustworthy building material. On the average 1.31 bushels of component parts, sand, lime, and cement, make a cubic foot of béton, which will weigh about 140 lb., and offer a resistance of some 2½ tons per square inch, while ordinary mortar, formed of the same constituents, will exhibit very insignificant powers of resistance. The difference arises principally from the difference in manipulation; in mixing mortar an excess of water is always used, which is distributed throughout the mass, and separates the particles of lime and sand, retarding the setting, and when after a time the water evaporates, leaves the mortar more or less porous.

Theoretically, the Coignet process fills all the necessary conditions, and produces a perfect béton, the sand and lime being moistened with a minimum of water, and mingled as intimately as possible. Besides the thorough cohesion of the particles induced by the mixing and compression, the small quantity of water used makes the setting more rapid and more uniform.

In all cases the lime used should be hydraulic, in fine powder, and well screened, to free it from lumps; for if there are any lumps admitted into the béton they swell when the mixture is diluted, and weaken the material.

The cements used are always, if possible, heavy and slow setting. The quantity used is proportioned to the rapidity of setting required, and the hardness of stone which it is sought to obtain. For the third ingredient, river sand, mingled with small pebbles, is the best. If the pebbles are large, the concrete produced is rough and unsightly; if it is too fine, it retards the setting, and reduces the hardness. Pit sand will make very good work, but to produce a stone so good as that formed on a base of river sand, the proportions of cement and lime have to be increased. Very fine sands, like those of the Landes, require very careful mixing and a prolonged compression in the mould to produce a first-class béton.

The ingredients are measured into a mixing mill in barrels, and during the process small quantities of water are gradually added as the mixing proceeds, until the béton becomes in the necessary condition; the more completely this part of the work is done the more rapid will be the setting, and the harder will the stone become.

The ordinary form of grinding mill employed consists of an iron cistern, the bottom of which is perforated, and in the centre of which revolves a vertical shaft, armed with a number of helical knives, and carrying beneath it a cycloidal arm, which in each revolution discharges a part of the paste. A penstock covering the outlet regulates the discharge of the béton. The material thus obtained from the mill is in a firm but plastic state, and it is thrown into a mould, in thin layers, and each layer, as it is laid in, is beaten and compressed by the regular and even blow of a sixteen-