

about seven hundred dollars. The interest on this sum, and an allowance for wear of double the amount in locomotives, with the expense of fuel, oil, etc., and all other expenses, would not amount to so much as it costs to keep one horse and his vehicle. It is therefore probable that private carriages will come into extensive use as roads improve. And the sooner the main roads are improved, the sooner will this convenience be within the reach of all industrious and economical persons.

Observations on Artificial Hydraulic or Portland Cement; with an Account of the Testing of the Brick Beam erected at the Great Exhibition. By MR. G. F. WHITE, Assoc. C. E.*

After detailing the experiments made by the late Sir Isambard Brunel, the paper noticed the peculiarities in the practice of the English and foreign engineers in the use of cements and limes. It was stated, that in England, the natural cements were plentiful, and the mode of construction being generally in brickwork, quick setting cements were preferred; whereas, abroad, the natural cement stones were, comparatively speaking, rare, and the use of bricks rather the exception than the rule. In some cases it was found, that even the best natural hydraulic limes did not set with sufficient rapidity in salt water, to do away with the necessity for using pozzalanos; and some of the attempts made at various periods to substitute artificial pozzalanos for the very expensive natural products of that nature, were then described. The unfavorable results of these attempts, and the manner in which M. Vicat explained them, were detailed. A sketch was then given of the course of investigation followed in England by Mr. Frost, and General Sir Charles Pasley, from which it appeared that, until the introduction of the Portland cements, no artificial compound had been discovered, which possessed the same, or greater powers of resistance than those of the natural cements. The advantages of the Portland cement were stated to be that it had nearly all the qualities of rapid setting presented by the natural materials of the same class; and, in addition, that as it was capable of supporting variable proportions of sand, it could be used as a mortar, the rate of setting of which might be modified at will, and the powers of resistance of which were stated to be much greater than those of either the cements or the limes thus replaced.

A general description of the manner in which the Portland cement was now manufactured, and of the methods of testing the article, were then given; and it appeared, that, after seven days, the cohesive strength of the neat cement was equal to about 100 lbs. on the square inch; and that after six months, this became equal to not less than 414 lbs. per square inch. M. Vicat had stated, in 1851, in a communication to the *Annales des Ponts et Chaussées*, that by the use of Portland cement alone, or what he termed "overburnt lime," it would be possible to form immense artificial blocks, capable of resisting the action of the waves and of the shingle upon the sea shore; an action which it was well known rapidly destroyed the natural cements, and the pozzalanic mixtures, whether of natural or artificial pozzalanos.

* From the London Journal of Arts and Sciences, July, 1852.

The several applications of the Portland cement as a concrete, as a mortar, and as a stucco, were then alluded to, and reference was made to the early failures in forming large artificial blocks; and an account was given of the mode now adopted in constructing them at Dover and Alderney harbors of refuge, and likewise of those employed to protect the extremities of the breakwater of Cherbourg. At Dover, the hearting of the piers, below high-water mark, was executed in blocks of concrete, composed of cement and shingle in the proportions of 1 to 10, and occupying about three-fourths of the volume of the separate materials measured in the dry state. Each block contained from 30 cubic feet to 120 cubic feet, and weighed from 2 tons to 7 tons. At Alderney, a species of concrete, composed of cement, sand, and shingle, was placed in a mould, with rubble stone, bedded irregularly in the mass; the proportions being about one part of cement to ten parts of foreign materials. At Cherbourg, the system adopted was to build immense blocks of rubble masonry of not less than 712 cubic feet, and weighing about 52 tons. These blocks were floated out from the places where they were constructed, and sunk as "pierre perdue;" but this had not on all occasions been able to resist the transporting power of the waves. The manner of using the cement was in the form of mortar, composed of one part of cement to three parts of sand.

It had been stated by M. Vicat, that the powers of resistance to compression absolutely required, in substances exposed to the action of the sea, must be at least equal to 40 lbs. per square inch, and of that to tension at least equal to 9 lbs. on the square inch. Now, the resistance of the artificial stone blocks, after an interval of nine months, was not less than 1700 lbs. per square inch, when the effort was one of compression, or than 200 lbs. per square inch, when it became an effort of tension, or little inferior to that of Portland stone itself.

Attention was called to the fact, that the Portland cement adhered more energetically to the Portland stone than to any other material. This degree of adhesion did not seem to depend so much upon the absorbent powers of the substances connected together by the cement, as upon some coincidence in the manner of their crystalization.

The applications of Portland cement to the purposes of stucco, for external works, were noticed. Its advantages were stated to consist in its agreeable color, without the intervention of paint or lime-white, its power of resisting frost, and its freedom from vegetation: all which were attributed to the close contact of its constituent parts, and to the surface being perfectly non-absorbent. For the same reason, it was asserted that the Portland cement was eminently adapted for the construction of cisterns and baths, and for the various descriptions of statues and fountains, &c., now made of artificial stone.

The paper concluded by a description of the experiments on the brick beam at the Great Exhibition of 1851: from which it was deduced that the strength of Portland cement, as compared with Roman cement, was in the ratio of $2\frac{1}{3}$ th to 1. Attention was called to the several tables and diagrams, which were exhibited, illustrative of the various power of resistance of the cement under efforts of compression, extension, and tearing asunder.—*Proc. Inst. Mech. Engineers.*