mixtures of foreign substances can be made to secure the best result.

Among cements, terra cotta, and artificial stones may be included. There are many varieties, and some of them are very much used. Terra cotta as used in ancient times by the Greeks and Romans was unquestionably a material of great importance, but the great difficulty of counteracting the unequal shrinking consequent on burning has never been quite overcome. The best modern manufacturers in this material for architectural purposes are, however, very good, as may have been seen in the recent Paris Exhibition. A material of a very different kind put together rapidly and finished without burning has been introduced and is now being manufactured by the Siliceous Stone Company. Its adaptability to architectural work has been well shown by some gigantic capitals of columns sent to Calcutta for the University recently constructed. Its value as an enduring material, thoroughly safe in case of fire, may, I think be safely assumed, and if it could be provided at a cost sufficiently low to compete with other imitative stone there could be little doubt of its general us.

7. Conclusion.—I am unwilling to trespass longer on your time, in continuing these illustrations of the intimate relation of geological science with architecture. They are so numerous, varied and so important, that the time at my disposal would be so exhausted long before the subject. On the principle that every intelligent person making use of a substance on a large scale, would desire to learn as much as possible of its history and nature, should be able to look for it in the right place, to use it in the right way, and to manipulate it properly and economically, I have assumed that you who practice architecture should be interested in stone. I have therefore ventured to point out briefly, the principal directions in which the study of stones may assist in the practice of architecture.

TESTING STEAM BOILERS.

By S. W. Robinson,
Assistant Professor of Mining Engineering and Geodesy, University of Michigan.

It is generally believed that steam-boilers become weakened, for resistance to internal pressure, after continued use, from various known and unknown causes; so that the engineer cannot judge of the pressure to which his boiler can be worked with safety. But this he may determine by a very simple process, and means which are always at his command. It is as follows:—Let the boiler be filled entirely full of cold water, even to the throttle and safety-valves, and all closed tight to prevent any escape. Now, by lighting a fire under the boiler, the water will be gradually expanded, and produce a pressure sufficient even to rupture the iron before the temperature of the water arrives at the boiling point. While the pressure is increasing, let the steam-gauge or pressure indicator be watched; and when the test pressure, which may be twice or more times as great as the working pressure, is reached, a portion of the water may be allowed to escape and the pressure reduced. The pressure results from the fact that water is expanded more by heat than iron. The process above given is attended with as much safety as the use of the hydrostatic press, unless the water be heated above 212°, which would not be required unless the boiler leaks. Below this temperature no disastrous consequences would follow, even if the boiler should be torn asunder, inasmuch as explosions result from the sudden expansion of gases or vapors.

Ann Arbor, Michigan, U.S., December 9th, 1867.

CONCRETE AS A MATERIAL FOR HOUSE AND WALL CONSTRUCTION.

To the Editor of the Civil Engineer and Architect's Journal.

Sir,—I had hoped that in my paper read before the Architectural Association,* I had exhausted all arguments, answered all objections, and decidedly proved the applicability, economy, strength, and durability, and other advantages of Portland Cement Concrete, as a material for wall construction. While thanking you for your impartial report of the discussion subsequent to my paper, I wish to make a few conclusive remarks upon the whole discussion. The more so, as it was not possible in the short time available on the evening of the discussion, to reply to the many questions and objections then put. Many of those had already been completely answered in my paper, (to which I desire to refer the gentlemen who engaged in the discussion and all who are interested in the matter). Others are answered beyond controversy, by the practical experience of every one who has worked in Concrete. I would remark that there was scarcely an objection or question mentioned at the meeting, but was answered by some other gentlemen taking part in the discussion. Reference was made by Mr. Mathews and others, to the block of cement which was tested and broken at the time of my reading, on the 6th of December. This block was 3 feet long, 11 inches high, and 4½ inches thick; it had a bearing of about half an inch, at each end on blocks, being perfectly clear, and without abutments at the ends; and from the centre was suspended for some time without breaking a weight of one ton sixteen hundred weight. An ordinary door or window-head would have been at least 9 inches thick, and about 3 feet high, having solid abutments at the ends, and would carry, as a little calculation would show, at least 33 tons, without arch or wood lintel. From this, your intelligent readers can form their own opinion of the relative strength of concrete and brickwork; and I have no doubt they will think I was correct in saying, as I did a short time since in published correspondence, that I could afford to give brickwork long odds. However on this point there was no discussion, and it was admitted by every one who expressed an opinion, that concrete was sufficiently strong for any building purposes whatever. Mr. Mathews also expressed doubts as to the cheapness of Concrete. Referring your readers to pages 7 and 29 in my pamphlet, I will here make a few remarks on this question, which will also answer the objections and statements of Mr. Blashill, who said he was satisfied I could not build at half the cost of brickwork. My answer at the time was, that in many parts concrete walls might be built at one third the cost of brickwork; but one half might be taken as a fair average of the cost of concrete walls, compared with brick or stone walls in all parts of the kingdom. I also stated the particulars of a case where concrete walls had been built at one third the cost of brickwork. Mr. Simmonds, a builder of Maidstone, purchased of me an apparatus at a cost of £100, to build four 5-roomed cottages in a block. The cottages were built at Marden, about 7 miles from Maidstone, for J. Whatman, Esq., M.P. Here an excellent peagravel clean washed from the Medway was obtained at 2s 6d per cubic yard, Kentish Rag stone close at hand at 1s 6d per cubic yard, Messrs. Lee's cement within 6 miles and delivered at 2s 2d per bushel. Thus the detail of cost was as follows:—

7 yards of Kentish rag for packing at 1s 6d ...	0	10	6
7 yards of Gravel 2s 6d ...	0	17	6
1 yard of Portland cement, 16 bushels ...	1	14	8
Labor at 2s per cubic yard	1	10	0
Superintendance by working foreman or carpenter at 6d per yard	0	7	6
Thus the cost of 15 cubic yards of concrete work was	£5	0	2

As to this last item of superintendance it is best to employ a carpenter and joiner, who will first fix and level the frames (after the first day the apparatus will not require any further attention from him) he will have to set all door and window frames, prints for joists, &c., and insert all fixing blocks where required, as the apparatus proceeds. He must also see the concrete mixed and be responsible that the proper proportion of cement is used; this will occupy about 15 to 20 minutes to the cubic yard of concrete, and his time is made remunerative in fixing frames, &c., (which cost much less in concrete than in other buildings) sixpence per yard for his superintendance of the concrete is ample. The walls of the houses above mentioned contained about 70 cubic yards of concrete, and were built up to the roof plate in 14 days. I will next consider the cost of apparatus. The cost of that to build the above mentioned four houses was £100. I have repeatedly stated that one apparatus will build 500 houses, and I am fully persuaded this is under the mark, but as before stated I can afford to give brickwork long odds, and I will even suppose this apparatus will build only 100 blocks. Thus the cost of apparatus for building 400 five-roomed cottages will be £100, being only £1 for a block of four or 5s per house. Now Sir will any one assert that he can provide scaffold poles, putlogs, cords, and the usual building plant for a less sum than 5s per cottage. And I would here wish to ask Mr. Potter (who mentioned the matter at the time of the discussion) whether it was just or fair in the builder who gave him an estimate for building in concrete, to include the whole cost of the apparatus, in the cost of the two houses for building which he furnished Mr. Potter an estimate. In cases where only a limited amount of building is to be done, and the apparatus is not required to be kept constantly at work, I have made and am prepared to make arrangements, to take it back, and give 50 per cent. of first cost for it. And, moreover, if it is kept at work, year after year till worn out, it may then be broken up, being all covered or lined with 26 ounce zinc, and having a large proportion of iron in its construc-

* See Civil Engineer and Architect's Journal for December 1867, page 343.