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NOTES ON BRICKS AND BRICK-MAKING IN AND AROUND SYDNEY.

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A CAREFUL inspection of the methods of working, together with an investigation of the results obtained, will lead to the conclusion that there has not been much effort made, in the first place, to thoroughly understand the properties of the clay, and, in the second, to work them as they should be worked to obtain the best results. There are, of course, notable exceptions in a few cases, where double-pressed and ordinary bricks are produced that will defy criticism; but as a rule the brick does not do justice to the material at hand.

The proper sorting and mixing of the clays is of the utmost importance, and, in conjunction with good burning, has all to do with the strength and appearance of the brick. But selection in a great measure depends on the knowledge possessed regarding the constituents of the clays, and whether such knowledge is best gained by analysis or by trials of the clays is a moot point among authorities on the subject. It is, however, generally admitted that at least some information by analysis concerning the properties of the clays is necessary, and, together with trials based thereon, serves to fully illustrate the characteristics and behaviour during working and burning.

The method generally adopted in the district under notice has been that by trial only; and it would be well if more attention were paid to analysis, not only generally, but also in the case of each special locality. Clays are found in fair quantities which contain, approximately, three-fifths of silica, one-fifth of alumina, with a balance of the ordinary attending constituents—lime, iron, magnesia, alkalies and moisture. Such clays, as is well known, will burn into good ordinary building bricks, the proportion of silica being such that the cracking and warping tendencies of the alumina are counteracted, and the presence of about just sufficient of the fluxing factors as to cause partial vitrification without complete fusion at a fairly high temperature. Of course, such clays are not the rule, even in the same pit, and it is in the manipulation of those that are either "too weak" or "too strong" that experience and care are necessary. For instance, cracked and misshapen bricks most certainly will result where there is an excess of alumina, or, in other words, where the clay is very plastic or strong.

Silica should be added in such cases, or clay, burnt at a high temperature and pulverised, will effect the desired result. Again, bricks which are too porous or brittle are usually so constituted by reason of the large quantity of silica present. Most of the troubles, however, arise from the excess of fluxing materials. The alkalies, metallic oxides and lime, individually or collectively in excess, cause fusion of the clay at anything like high temperature, and the result must either be a "callow" brick from a low temperature, or a fused misshapen mass of "clinkers" from the heat required to thoroughly burn a good brick.

Clays which are rich in lime and alkalies will not serve to make bricks, and it must be determined that there is only just enough to cause partial fusion at a high temperature before time may be lost burning unsuitable material.

Another important matter for the consideration of the brickmaker is the presence of iron, for not only is it troublesome as a flux when present in large percentage, but as oxide governs in a very comprehensive manner the appearance of the brick, as far as color is concerned, yielding tints from light yellow to orange, red, purple and dark blue as the percentage, and temperature increases, whilst its absence or insensible presence enables the production of white brick. When present in the form of pyrites, weathering is most necessary to allow of the decomposition, for if oxidation is escaped in the kiln, such will gradually take place in the brick afterwards, and fretting will result. Careful grinding is advised by authorities as effective in mitigating the evil results of the impurity, inasmuch as distribution throughout the brick facilitates oxidation during burning. Troubles are continually occurring which, though due to one or the other of the influences mentioned above, are erroneously put down to bad burning. Such is unfortunate, for no matter how good the burning, a satisfactory brick cannot be obtained if in the first instance the constituents of the clay are prohibitive.

Many instances might be cited where the clay varies in such a manner that from a white brick to any tint hereinbefore mentioned, as well as a fire brick, might be obtained, and the most unsuitable (naturally) with proper treatment made usable; yet the working is such that the clay is simply used as met with in digging.

A great deal might be written concerning the adaptability or otherwise of the clays for fire bricks, but it is not within the proposed range of this Paper to make other than a mere reference to such. A series of valuable tests for information in this direction have been made by Mr. Mingaye, F.C.S., Assayer in the Department of Mines, N.S.W., with the result that it is clear that as a rule without artificial treatment the clays are not sufficiently refractory to make first-class fire bricks, as, for instance, those required for metallurgical operations, the preventative being alkalies. It is to be marked that the term "as a rule" is mentioned, for several of the tests show that good fire clay may be found, and perhaps as time goes on more may be discovered. Certain it is that plenty of suitable clay may be found which, if treated with sand or burnt clay, quartz chippings, etc., will make fire bricks for any purpose, however severe the requirements may be. But very little, if anything, is done in the way of fire brick production in the district, and it is to be hoped that attention will be paid to it, by reason of the undoubted future which is held forth for such an industry, both in the way of material and demand.

For the making of the brick the dry-press process has been gradually gaining ground, until, at the present, all the large brick-making concerns are running it. Much has been said antagonistic to the system, and with some cause, for the very nature of the process, which consists of grinding the clay into a powder, as it were, and pressing it into shape, makes it most necessary that the particles shall have sufficient heat to cause partial fusion into a homogeneous mass, otherwise a loose, crumbling "body" will occur; for it will be seen that all good to be derived from the kneading or tempering in the plastic or wet process is lost, and the particles must separate unless cemented together by fusion. As it was before stated, the mixing, if not good, will disallow more than the outside of the brick to be partially fused, and all sorts of troubles eventuate. Either the bricks, if burnt through, will have the external portion completely vitrified, or, if the faces of the brick are preserved as they should be, the middle of the brick will remain unburnt, crumbling and inferior.

It is argued by friends of the process that during the steaming of the kiln the bricks are so saturated that a state of plasticity is attained. Such is quite true, but absence of the kneading is still to be deplored. Of the bricks from the two methods, the dry-press is the one which demands the most attention when mixing the clays. It is admittedly the cheapest way by many points, for no sooner is the clay dug than it is through the grinding rollers, into the machine, and stacked in the kiln for burning. Kilns have had a great deal of attention at the hands of the makers, and there is no doubt that they are to be complimented on their enterprise in this direction. In almost every yard there is to be found a large patent kiln on the continuous principle, with varying output capacities of from 100,000 to 240,000 per week. The majority are either Hoffman's, or on a similar principle, but a couple of instances occur where the railway kiln is in operation. The one most in favour may be described as a series of domed chambers, side by side, and at right angles to the length of the kiln, the fire passing from one to another through the openings in the sides of the chambers.

The old-fashioned kilns are, however, not yet extinct, and where worked with down draft, are turning out bricks much better on the average than those from the patent kilns.

There can be no doubt that the patent continuous kiln is far from its perfected state, for in most of the cases under notice the percentage of poor bricks is very large, and much in excess of that from the old style of kiln. Moreover, it has not yet been found capable of burning facing bricks, either as regards color or shape. The bricks are of a pale and most uninviting color, due, it might be suggested, either to the bleaching action of the aciduous fumes in the close chambers, or to the possibility that the oxygen admitted is sufficient only for the needs of combustion, and oxidation of the iron does not take place, for it may be noted as a significant fact that bricks of the same constitution put in the old kilns burn a strong red color. It is contended that nearly perfect combustion takes place in these kilns, and there is no doubt that such would be the case, provided that they were carefully managed and adjusted as regards entry of sufficient air and use of proper fuel. In practice this is not always arrived at, and the residue from imperfect combustion is a troublesome factor, especially when it is remembered that the fuel is applied about and on the brick in the kiln.

A source of some trouble in the patent kiln is the "steaming," and despite all care the bricks are sometimes rendered into "slush." The great feature of the continuous kiln is, however, to be found in the cost of operation. In the old kiln it costs about 8s. 6d. per 1,000, and in the continuous only about 2s. 6d. per 1,000 to burn, so that it may at once be seen that a great saving is effected, and in this period of "low cost" this counts above everything.

The double-pressed bricks are burnt in small-domed or oven kilns, and it is to be noted that as a rule the burner makes as much as is possible out of the material he has to burn.

Speaking of burners, it is interesting to note the indications of the finish of the burning which they accept. Generally, it is by the "shrinkage," or by the color of the heated bricks, but sometimes by trials drawn from the different parts of the kiln.

The following table, compiled from the test book at the Department of Public Works, is interesting, as indicating the water-resisting capacities of the local bricks. The selection from among a great number has been made in a careful manner, with a view of obtaining a fair average of the building bricks. The samples were dried, and soaked in water for 24 hours. It will be seen that the percentage of absorption of the common bricks has been fairly high, and may in a manner account for the damp walls so prevalent in the district.

A matter of considerable importance is the resistance to compression, and up to the present but little has been known concerning the behaviour of our bricks in this direction. The tests shown in the subjoined tables were made in the engineering laboratory at the Sydney University, by Professor Warren, M.I.C.E., to whom the author is indebted for their appearance herein. The results do not compare very favorably with published tests of English and American bricks, and in a great measure confirm the opinions hereinbefore expressed *re* the making of the bricks. Some consideration must, of course, be given to the fact that the bricks were tested as received, whereas, in some of the English and American tests the faces were prepared; but it cannot be altogether due to this cause.

TABLE SHOWING ABSORPTION OF WATER BY DIFFERENT VARIETIES OF BRICKS MADE IN SYDNEY DISTRICT.

No.	Locality.	wt. recd lb. oz.	wt dried lb. oz.	wt. wet lb. oz.	per cent porosity	Dimension in inches.
1	Petersham—Double Pressed	8 7¼	8 7¼	8 12	3·51	
2	Petersham—Double Pressed	8 1¼	8 1	8 6¾	4·51	9 x 4⅜ x 3
3	St. Peters—Common	8 0	8 0	8 7¾	6·06	,, ,, ,,
4	St. Peters—Common	9 1¼	9 0¾	9 8	5·01	9¼ x 4¼ x 3
5	Surry Hills—Common	8 1	8 1	8 12½	8·92	8¾ x 4¼ x 3
6	Hurstville—Common	8 4¼	8 4½	8 12	5·68	9 x 4½ x 3
7		4 8¼	4 8	4 14	8·33	9 x 4½ x 3
8		4 9½	4 9¼	4 15½	8·53	
9		4 13	4 12	5 2¾	8·88	11 x 11 x 11
	Merrylands—Common	4 2¼	4 1¾	4 7¼	8·35	
		8 13	8 13	9 13½	11·70	,, ,, ,,
10		9 2	9 1	9 14¼	9·14	,, ,, ,,
11		7 10½	7 10¼	8 6¼	9 8	8¾ x 4¼ x 33/16
12	Surry Hills—Common	8 3½	8 2¾	8 10¼	5 7	,, ,, ,,
13		7 12¼	7 12¼	8 7½	9·05	,, ,, ,,

In tests Nos. 7 and 8 the bricks were broken in two and the weight of each half given.

CRUSHING STRENGTH OF BRICK TESTED AS RECEIVED WITHOUT PREPARATION.

Description.	Crushing force per sq. in. in lbs.	Crushing force in lbs.	Total force to crack in lbs.	Area exposed in sq. in.	Size in inches.	Remarks.
White	2,035	28,500	23,000	14 1/16	4½ x 3⅛	
Blue	2,720	34,000		12⅜	4⅛ x 3	Tested with ends bedded in sheet lead.
Red	750	10,500		14 1/16	4½ x 3⅛	
Yellow	2,087	24,000		11½	4¾ x 3⅛ x 2¾	
White	4,300	38,750	31,000	11⅛	4 x 3 x 1½	
Blue	2,700	30,000			4¼ x 2¾ x 2½	
Blue	2,800	31,000	10,000	11	4 x 3¼ x 2¼	

Crushing force per sq. in. in lbs.	Crushing force in lbs.	Total force to crack in lbs.	Area exposed in sq. in.	Size in inches.	Common lots.	Remarks.
1,537	20,750	17,500	13½	4½ x 3	a 1	
1,600	21,500	16,250	13½	4½ x 3	a 2	
1,130	14,000		13½	4½ x 3	a 3	
1,130	14,000		12⅜	4½ x 2¾	b 1	Tested on bed of Brick.
1,940	24,000	19,000	12⅜	4½ x 2¾	b 2	
1,370	17,000	13,250	12⅜	4½ x 2¼	b 3	
1,238	16,250	15,000	13⅛	4⅜ x 3	c 2	
1,370	18,000	15,250	13⅛	4⅜ x 3	d 3	
1,350	17,750		13⅛	4⅜ x 3	e 1	

ANALYSIS OF FIRE BRICK CLAYS MADE IN DEPARTMENT OF MINES, N.S.W.

Location.	Description.	Moisture at 100 c.	Combined Water.	Silica.	Alumina.	Oxide of Iron.	Lime.	Magnesia.	Potash.	Soda.	Metallic Copper.	Phosphoric Acid.	Titanic Acid.	Organic Matter.	
Sydney	Clay	3·03	7.80	68·50	18·50	2·40	trace	trace	nil	trace	—	—	trace	—	100·23
St. Leonards	Clay	2·29	5 96	64·89	22·66	1 60	·46	·62	1·92	·02	—	trace	heavy trace	trace	100·42
Parramatta	Shale with plant impressions	1 05	2·35	85·35	8·81	·79	nil	·43	1·48	trace	—	trace	trace	—	100·26
Dent's Creek, Holt Sutherland Es.	Dark green and purple grey clay shale	3·38	5·32	56·28	24·21	7·34	1·10	2·36	—	—	·08	—	—	—	100·07