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SOME NOTES ON SYDNEY BUILDING STONES.

(BY JAMES NANGLE.)

THE object of this Paper is to bring before the Association the results of a few tests made on some of the building stones mostly used in and around Sydney.

As the rain-fall, temperature, and conditions of the atmosphere have such an important bearing on the question of durability of building stones, it has been thought well to collect the following information about the climatic conditions of Sydney. During the year rain falls, on an average, 157 days; while the average rain-fall for the year is 49.85 inches. The climate is consequently by no means a dry one. The range of temperature is severe, being as much as 36 deg. in one day.

As far as the writer has been able to ascertain, a complete analysis of the Sydney air has not yet been made; but it has been found—as would be expected on account of the nearness of the sea—that the air had a large amount of salt in it. But, on account of the small amount of manufacturing done, and on account of its general cleanliness, the air is rather more free from acids than is usually the case with a place of the size of Sydney. From the foregoing, the following summary of the leading features of the Sydney climate as regards the decay of building stones may be made:—

(a) Frequency of water saturation, upon which follows, owing to the action of the water, a change in the form of the constituents of the stones, and, as a consequence, gradual disintegration and decay. In addition to this, the salt contained in the air will be deposited in the pores of the stone. During the dry periods the salt crystallises and increases in bulk, and causes disintegration. It follows, therefore, that for Sydney climate durability will only come as a result of a compact dense stone which does not absorb moisture to any great extent.

(b) On account of the rapid change of temperature, to which Sydney is liable, there is always a chance of extremely hard and brittle stones being cracked.

(c) Extraordinary trouble from acids need not be apprehended, though it is at all times unwise to use stones for city work which contain bodies liable to be easily destroyed by acids.

Since it seems that smallness of water absorption is of great importance as regards stones to be used in Sydney (though it would be hard to find a place where this matter could be altogether disregarded), the tests by the writer embrace those for finding the amount of water taken up. The stones were prepared so as to have as nearly as possible a uniform amount of surface. All the specimens were carefully dried at a temperature of 100 deg. centigrade. They were then carefully weighed and put, resting on pin-points, in a bath; the water being all the time 2ft. deep. After being left for 24 hours in the water, they were again weighed, and the increase noted. The results are recorded in the table herewith.

The cubic specimens were afterwards tested, in the large testing machine at the Sydney Technical College, to ascertain their resistance to compression. It is always a difficult matter to dress such specimens with accuracy, but the best attempt possible was made to get the specimens with at least two opposite faces quite parallel. Perfect accuracy was not altogether reached, but the shape was fairly good, excepting in the case of No. 8, which was a little out. The cubes were tested between pieces of stout mill-board, which seemed to serve well.

Specimens Nos. 11 to 17 were samples from various places of the much-used Hawkesbury sandstone.

An analysis of a good specimen of this stone from Pyrmont, gives as follows:—*

Moisture at 100c.	.45
Combined water	1.40
Silica..	87.60
Aluminia	8.53
Ferric Oxide	.03
Ferrous Oxide	.10
Magnesia	.29
Lime	.60
Potash	.28
Soda	.45
Sulphuric Acid	.11
Soluble Silica	.40

Traces of Phosphoric Acid and Chloride of Sodium.

Many of these constituents are quickly affected by water, and, as will be seen, some of the samples increased in weight by 1½ ozs. of water in 24 hours. All the samples took up a fair amount, so that the life of the stone will probably not be much. It stands weight fairly well, one specimen (No. 14) going to 3.19 tons per square inch.

No. 9 in the table is a sample of the Bowral stone, which by the way, is, according to the Government Geologist, not a "trachyte," but a syenite. This piece took up 3 ozs. of water, and stood 5.69 tons per square inch, failing very suddenly and going to pieces. This so-called "trachyte" is very dense and brittle, and seems likely to be affected by rapid change of temperature. It

* Made by the Mineralogist, Department Mines, N.S.W.

is well known that this stone has caused great anxiety in several cases where it has been used in the City, by cracking in a most serious way. It is hard to assign with certainty a cause for this failure; but, on account of the great range of temperature in such a short time as often occurs in Sydney, it may be that destructive internal stresses are set up. Until the matter is cleared up, it is unwise to use it for piers carrying critical loads.

The Gabo Island syenite proved to be a very strong stone. The specimen (No. 8 in the table) stood up to 11.20 tons per square inch, and even then collapse did not take place, the destruction being slowly developed. The specimen was not perfect in shape, otherwise the cube would have withstood the whole 100 tons of the machine. This specimen only showed a trace of water absorption.

Melbourne bluestone has been to a great extent supplanted by the Bowral stone, but it is still used enough to justify a test. The sample was rather much honeycombed to be a good example of basalt, and consequently shows a larger soakage of water. The case only stood 4.87 tons per square inch, which, when compared with some of the sandstone tests, does not seem good for one of the igneous rocks.

Moruya granite is well known in Sydney, having been used at the Post Office, where it may be seen in the columns of the arcades. It is a fine grey granite, but not so pleasing in appearance as, for instance, the famous Scotch granites, being marked with ugly veins. The specimen, No. 7 in table, broke at 6.97 tons per square inch, and the increase of weight by absorption was 3drs.

The specimens of Australians slates, Mintaro and Castlemaine, behaved well as regards water soakage, and the small cube of one kind (Mintaro) proved a compressive resistance of up to 8.59 tons per square inch.

A few tests of marble—one from near Orange, N.S.W.—and samples of imported kinds were tested for water soakage only, the Australian sample showing only a trace of absorption.

The thanks of the writer are due to the Superintendent of Technical Education for permitting the compressive tests to be made at the College free of cost, and to Mr. Owen Blackett, who kindly attended and made the tests. Messrs. Creak and Ford are also to be thanked for having procured and prepared many of the specimens.

Table Showing Water Absorption and Crushing Strength of Some of the Stones used in Sydney.

No.	Kind.	Locality whence obtained.	Size of Specimens.	Weight Dry.	Weight Wet.	Weight of Water Absorbed.	Percentage of Absorption.	Area Exposed to Crushing in sq. inches.	Weight when Crushed in tons.	Strength in tons, per sq. inch.	Remarks.
			in. in. in.	lbs. oz. dr.	lbs. oz. dr.	lbs. oz. dr.					
1	Slate	Mintaro, S. Australia	6 x 3 x 1	1 13 14	1 14 1	0 0 3	·614	...	...	...	
2	,,	,, ,,	2 x 2 x $2\frac{1}{8}$	0 12 13	0 12 14	0 0 1	·487	4	34·376	8·59	
3	,,	Castlemaine, Victoria	6 x 3 x 1	2 3 7	2 3 9	0 0 2	·352	...	...	...	
4	Marble	Orange, N.S.W.	6 x 3 x 1	1 10 12	...	Trace	...	...	...	...	
5	,,	St. Annes, Italy	6 x 3 x 1	1 14 1	1 14 3	0 0 2	·415	...	...	...	
6	,,	Sicilian, Italy	6 x 3 x 1	1 13 4	1 13 5	0 0 1	·213	...	...	...	
7	Granite	Moruya, N.S.W.	3 x 3 x 3	2 12 13	2 13 0	0 0 3	·418	9	62·789	6·97	
8	Syenite	Gabo Island, Victoria	$2\frac{7}{8}$ x 3 x $2\frac{3}{4}$	2 1 1	...	Trace	...	$8\frac{5}{8}$	96·611	11·20	
9	,,	Bowral, N.S.W.	3 x 3 x 3	2 14 8	2 14 11	0 0 3	·403	9	51·245	5·69	
10	Basalt	Melbourne, Victoria	3 x 3 x 3	2 5 15	2 6 6	0 0 7	1·153	9	43·832	4·87	
11	Sandstone	Marrickville, N.S.W.	3 x 3 x $3\frac{1}{8}$	2 7 12	2 9 4	0 1 8	3·773	9	16·246	1·80	Benson's Quarry.
12	,,	,, ,,	3 x 3 x $3\frac{1}{8}$	2 7 4	2 8 9	0 1 5	3·343	9	22·176	2·46	Green's Quarry.
13	,,	Waverley, ,,	3 x 3 x 3	2 4 8	2 5 11	0 1 3	3·253	9	18·221	2·02	
14	,,	Pyrmont, ,,	3 x 3 x 3	2 4 12	2 5 15	0 1 3	3·231	9	28·711	3·19	Purgatory Quarry } Saunders
15	,,	,, ,,	3 x 3 x 3	2 7 4	2 8 5	0 1 1	2·7[illegible]0	9	25·321	2·81	Old Quarry. } Saunders
16	,,	Parramatta, ,,	3 x 3 x 3	2 5 3	2 6 8	0 1 5	3·528	9	13·655	1·51	
17	,,	,, ,,	3 x 3 x 3	2 4 1	2 5 5	0 1 4	3·466	9	10·976	1·21	