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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, October 10, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2116.

Investigation of a Natural Bonded
Quebec Moulding Sand.

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(Copy No. 3.)

Ottawa, Ontario.
April 16, 1947.

ADDENDUM NOTE
TO INVESTIGATION REPORT
NO. 2116.

In a letter dated April 14, 1947, Mr. A. E. Cartwright stated that this sand was taken from the Magdalen Islands, Quebec.

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

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OF
MINES AND RESOURCES

O T T A W A October 10, 1946.

REPORT

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2116.

Investigation of a Natural Bonded Quebec Moulding Sand.

Introduction:

On June 28, 1946, Mr. A. E. Cartwright, metallurgist for Canadian Foundry Supplies and Equipment Limited, Montreal, Quebec, submitted a small sample of moulding sand from the province of Quebec, with a verbal request that it be tested to determine its potentialities as a moulding sand.

Preliminary investigation at the Physical Metallurgical Research Laboratories indicated that the sample submitted possessed the properties of a good moulding sand. On August 8, 1946, a request was sent to Mr. Cartwright for a larger sample, to enable more comprehensive tests to be made. In accordance with this request, a 500-lb. sample of sand was received on August 13. This report covers the tests made on this larger sample of sand.

Method of Testing:

The methods and equipment recommended by the American Foundrymen's Association (Foundry Sand Testing Handbook, A.F.A., 1944) were used in testing the sand. High temperature tests were made using 1-1/8-inch-diameter specimens in a high temperature dilatometer. Results of tests on an Albany sand, which is being used with good results, are included for comparative purposes.

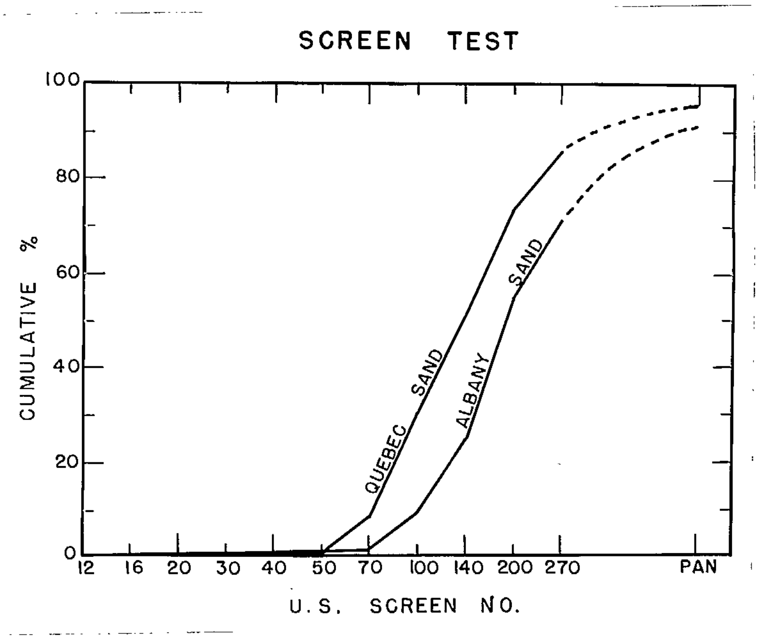
Screen Tests:

TABLE I. - Screen Tests.

U.S. Screen No.	Per Cent Sand Retained: Quebec Sand	Per Cent Sand Retained: Albany Sand
12	Trace.	0.2
16	0.1	0.1
20	0.2	0.1
30	0.1	0.1
40	0.1	0.2
50	0.8	0.2
70	7.0	0.4
100	11.9	8.2
140	20.4	15.3
200	32.9	29.6
270	12.3	17.2
Pan	9.7	19.0
A.F.A. Clay	4.4	9.4
A.F.A. Fineness No.	138.7	170.0

These results are shown in the form of a cumulative per cent curve in Figure 1.

Figure 1.



SCREEN TEST OF TWO SANDS.

Moulding Properties:

The moulding properties of the sand were tested at various moisture contents, to determine the working characteristics. The properties specifically so tested were: permeability, green compression, dry compression, and toughness (green compression multiplied by deformation of the A.F.A. test specimen in thousandths of an inch per inch). The values obtained, together with those of the Albany sand, are recorded in Table II.

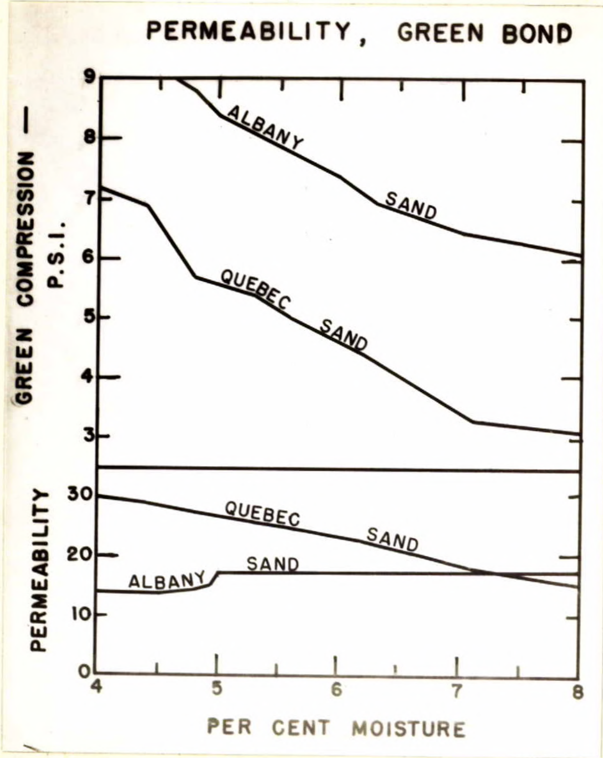
TABLE II. - Moulding Properties.

Moisture, per cent	Permeability	Green Compression, p.s.i.	Toughness	Dry Compression, p.s.i.
Quebec Sand				
4.0	30.0	7.2	65	26
4.4	29.0	6.9	75	30
4.8	27.5	5.7	76.5	34
5.3	25.8	5.4	73	39
5.6	25.0	5.0	69	42
6.2	22.7	4.4	65	48
7.1	18.1	3.3	48	55
8.0	15.7	3.1	42	60
Albany Sand				
4.0	13.7	9.8	49	14
4.5	13.7	9.3	55	16
4.8	14.5	8.8	61.5	17
4.9	15.0	8.6	64.5	18
5.0	17.0	8.4	67	18
6.0	17.0	7.4	89	23
6.3	17.0	7.0	80.5	25
7.0	17.0	6.5	71.5	30
7.5	18.0	6.3	69.5	35
8.0	18.0	6.1	69	42

These results are recorded graphically in Figures 2 and 3.

(Figures 2 and 3 follow,)
(on Page 4.)

Figure 2.

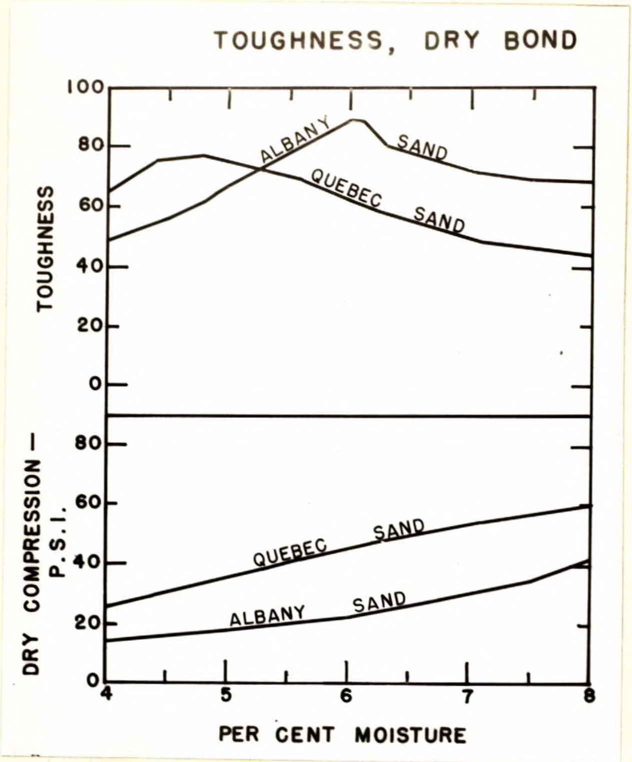


MOULDING PROPERTIES OF TWO SANDS.

Permeability, Green Bond.

-

Figure 3.



MOULDING PROPERTIES OF TWO SANDS.

Toughness, Dry Bond.

-

Elevated Temperature Properties:

Heat Shock Resistance -

The ability of a sand to resist the shock of molten metal is an important characteristic. If the sand cracks or spalls badly under a sudden thermal shock it is likely to cause casting defects such as scabs, buckles, and metal penetration.

The sands were subjected to a heat shock by inserting them into a furnace at 2500° F. Specimens of both sands showed moderate spalling under this severe treatment.

Hot Strength -

The hot strength of sand is an important factor in foundry work. If the hot strength is too low the metal will cut and wash the sand. Excessive hot strength results in hot tears and casting cracks in the metal.

The specimens used in the hot strength test were cylinders 1-1/8 inches in diameter by 2 inches long. They were soaked in a dilatometer furnace at the given temperatures for twelve minutes before they were broken. The results of these tests are tabulated below in Table III, and are shown in graphical form in Figure 4.

TABLE III. - Hot Strength.

Temperature, Deg. F.	Compressive Strength, p.s.i. Quebec Sand	Compressive Strength, p.s.i. Albany Sand
Room	47	45
500	47	45
1,000	57	70
1,500	77	90
1,750	145	120
2,000	49	87
2,100	29	--
2,200	13	40
2,300	9	--
2,400	7	20
2,500	6	1

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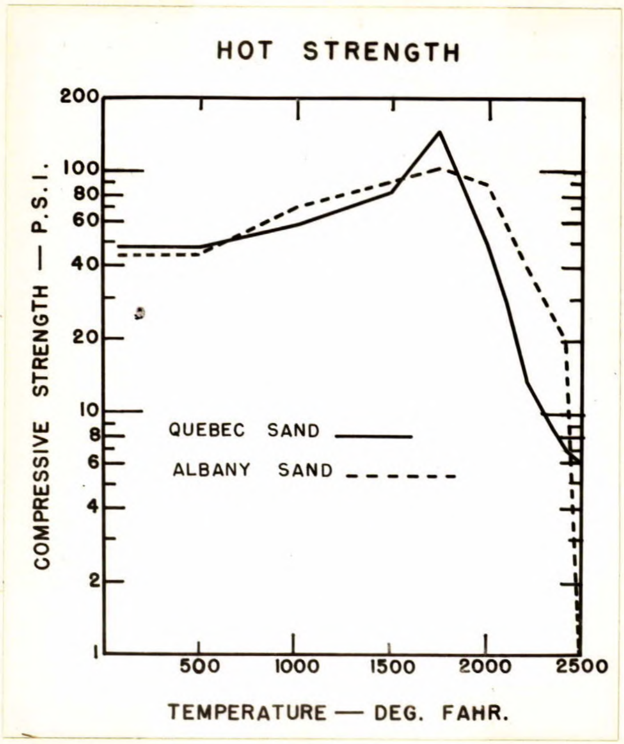
(Elevated Temperature Properties, cont'd) -

Figure 4.



HOT STRENGTH OF TWO SANDS.

Durability -

The durability of a sand depends upon the nature of the clay minerals. When the clay is heated, water of crystallization is driven off and the bonding properties deteriorate. Measuring the loss of green and dry bond of the sand after it has been heated and retempered is one means of measuring the durability of a clay or moulding sand.

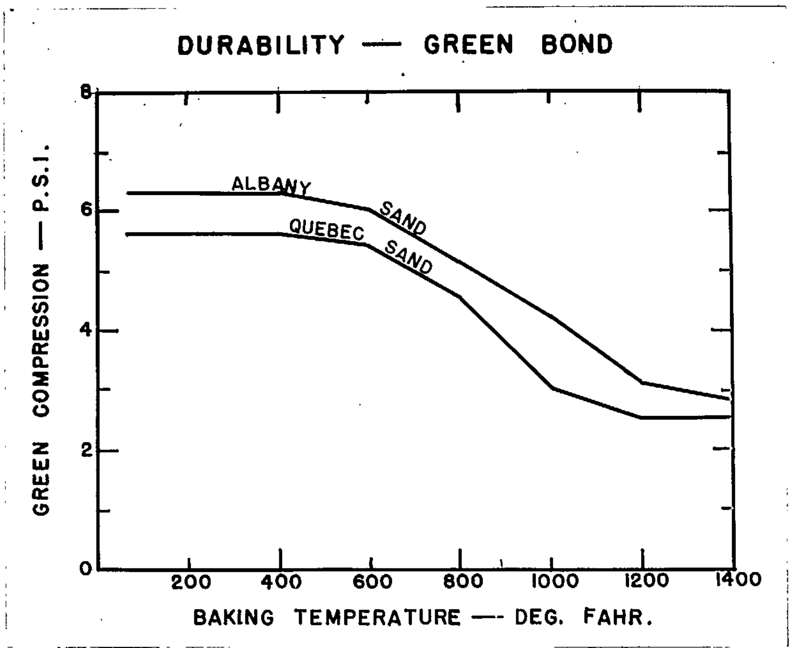
The durability was tested by baking test batches at temperatures of 400°, 600°, 800°, 1,000°, 1,200°, and 1,400° F. The properties of the sands were tested after baking at each of these temperatures. These results are tabulated below in Table IV, and are also shown graphically in Figures 5 and 6.

TABLE IV. - Durability.

Temp.	Green Compression, p.s.i.		Dry Compression, p.s.i.	
Deg. F.	Quebec Sand	Albany Sand	Quebec Sand	Albany Sand
Room	5.6	6.3	39	35
400	5.6	6.3	47	30
600	5.4	6.0	45	25
800	4.5	5.1	45	13
1,000	3.0	4.2	31	2
1,200	2.5	3.1	13	1
1,400	2.5	2.8	7	1

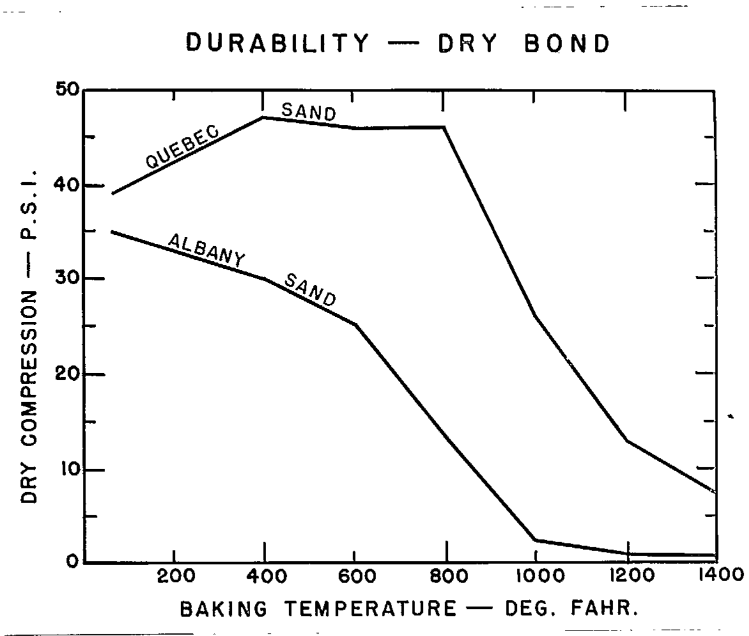
(Elevated Temperature Properties, cont'd) -

Figure 5.



GREEN BOND DURABILITY OF TWO SANDS.

Figure 6.

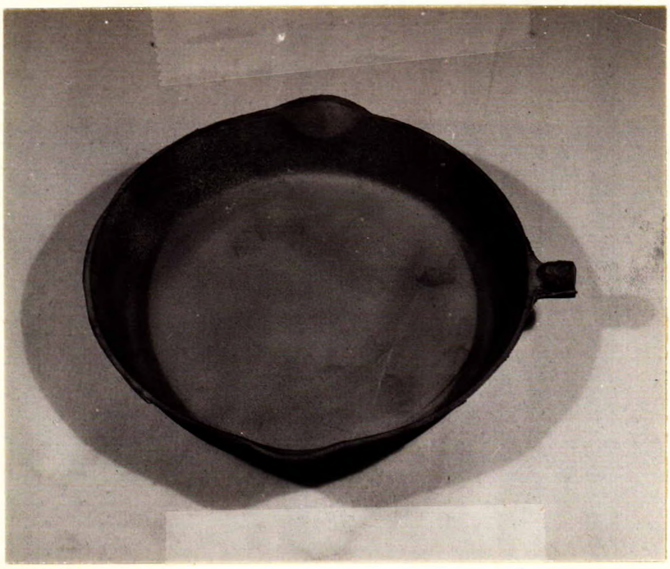


DRY BOND DURABILITY OF TWO SANDS.

Practical Foundry Test:

Some of the sand sample was tempered at 5 per cent moisture and made into moulds in the experimental foundry operated by the Physical Metallurgy Research Laboratories. The sand was easy to work, and dried out very little upon standing. It rammed evenly, and drew out well from difficult portions. Among the castings made with the Quebec sand sample were a frying pan and a chopper plate. These castings, made in grey iron, are shown in Figures 7 and 8. No additions were made to the sand, and no facing or blacking was used on the moulds. There was some metal penetration on the chopper plate. The frying pan had a good surface finish. There was good reproduction of detail in both castings.

Figure 7.



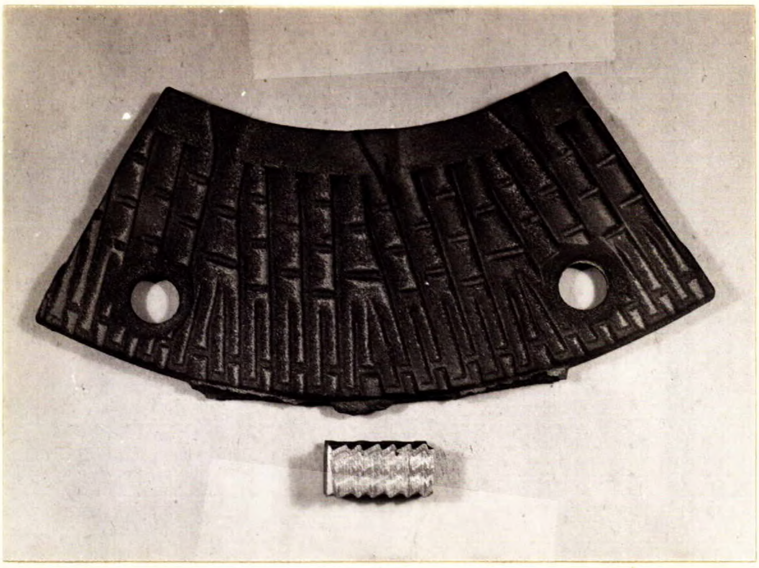
GREY IRON FRYING PAN CAST
IN QUEBEC SAND.

Good surface finish.

-

(Practical Foundry Test, cont'd) -

Figure 8.



GREY IRON CHOPPER PLATE CAST
IN QUEBEC SAND.

Good reproduction of detail, but some "burning in" or metal penetration.

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Discussion:

The screen distribution curve for this Quebec sand sample has a shape similar to that for the Albany sands (Figure 1). The unusually low A.F.A. clay content indicates a low proportion of fine silt. This sand should maintain its permeability very well under repeated use.

This sand can be worked at between 4 per cent and 6 per cent moisture, and is best when it contains about 5 per cent moisture by weight. Although this is somewhat lower than usual for natural moulding sands of this fineness, the sand does not dry out badly on standing, and the working range is sufficiently wide to permit adequate control in small foundries which do not possess sand testing equipment. The low moisture requirements, low clay content and high permeability should help to eliminate such casting defects as

(Discussion, cont'd) -

blows, pinholes and scabs.

The sample submitted was somewhat low in toughness (green bond and deformation). This might cause trouble in with some castings from drops, or the sand might cut and wash under the metal, carrying dirt into the castings. These troubles were not experienced in the moulds made in the experimental foundry operated by the F.M.R.L., however.

The sand did not prove to be as refractory as is usually considered desirable in grey iron or malleable sands (see Figure 4). At 2,300° F. the sand was quite plastic, or sintered, and had a hot strength of only 13 p.s.i. The sample of Albany sand did not become sintered till the temperature had exceeded 2,400° F. This low refractoriness may cause trouble from wash and metal penetration when the sand is used for grey iron or malleable iron founding. There was some metal penetration in the chopper plate cast in the experimental heat (see Figure 8).

The durability of the sand is very good, and compared favourably with other commercial sands in use. The durability of the dry bond is somewhat better than average (see Figure 6). Deterioration of dry bond causes sand to wash under a stream of metal, and makes edges and corners of moulds friable, causing dirty castings. As dry bond usually deteriorates more rapidly than green bond under repeated use, the high dry bond durability of the Quebec sample is a very desirable characteristic.

CONCLUSIONS:

(1) Disadvantages of Quebec Sand Sample:

(a) The sand is somewhat low in green bond and toughness. Because of this, drops might be experienced when moulding parts which subject the sand to a high mechanical stress.

(Continued on next page)

(Conclusions, cont'd) -

(b) The refractory properties of this sand are not suitable for some types of work. The sand spalls when it is subjected to a sudden shock of 2,500° F. This is probably due to the low clay content. The shrinkage of clay upon heating sands with a high clay content compensates for the expansion of the silica grains. The weakness of this Quebec sand under heat shock might cause such defects as "rat-tails," scabs, buckles, and dirt.

As sintering occurs at about 2,300° F., the sand is not sufficiently refractory for heavy to medium grey iron, or for malleable iron work.

(2) Advantages of Quebec Sand Sample:

(a) Low clay and silt content makes for a high permeability.

(b) High percentage of material through 50 mesh screen makes for a good surface finish.

(c) Sand retains its moisture well upon standing.

(d) Low moisture requirements help to eliminate such defects as blows, pinholes and scabs.

(e) The durability of the sand is very good, and compares favourably with the best natural bonded sands from the United States.

(3) This sand should prove satisfactory for brass, bronze, or light grey iron foundry work. It is too coarse for aluminium foundry use, and is not refractory enough for malleable iron or for heavy to medium grey iron foundry work.

(4) A more extensive trial in a production foundry is recommended.

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