Section 2 — Ceramic Investigations

by W. St. C. Manson and P. L. James.

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30. CLAY FROM WYNYARD

Six samples of clay from Wynyard, Tasmania, were obtained by departmental geologist Mr. D. Gee, from the area adjacent to the old brick pit. The deposit was sampled on behalf of Brian R. Archer Pty. Ltd., and the samples were forwarded for testing for brick manufacture by de-aired extrusion and tests reported herewith are restricted to this method of manufacture.

Summary

Six samples of clay from Wynyard and a blend of equal parts of each of the six samples were tested for brick manufacture by de-aired extrusion. The investigation shows that five of the samples extrude in a satisfactory manner and that these clays produce moderate quality fired bricks in a range of colours from orange to reds in accordance with temperatures of firing. Satisfactory bricks were produced in all samples except No. 3 at the temperature shown below.

No. 1 clay (A): 950°-1100°C.

No. 2 clay (B): to 1050°C.

No. 4 clay (D): 950°-1100°C.

No. 5 clay (E): 950°C.

No. 6 clay (F): 950°-1100°C.

Blend G : 950°-1100°C.

All clays except E show curved surfaces to some degree.

No. 3 clay (C) extrudes with excessive dog-earing.

No. 5 clay (E) shows excessive shrinkage and core cracking at temperatures of 1000°C or higher.

No. 2 clay (B) bloats significantly when fired at 1100°C.

Most of the clays show traces of vanadium efflorescence, but not to any marked extent. White incrustations appeared on odd bricks of A and D and to a less extent on F.

Chemical analysis of a composite sample of the clays. (G).

	%
Silica	72.3
Ferric Oxide	5.47
Alumina	12.35
Titania	0.96
Lime	0.40
Magnesia	1.28
Soda	0.55
Potash	1.83
Moisture	1.22
Loss in Ignition	4.08

The Samples

The Wynyard clay deposit was described by Gee (1953).

Six holes were excavated with a trench digger and were sampled by Gee. Hole No. 1 is adjacent to the old clay pit and successive holes are located at 200 feet intervals in a south westerly line along the length of the deposit. Details of the samples were supplied by Gee.

Hole No. 1 = Sample A

0 — 6″	:	clay top soil.
6″— 2′	:	fine white quartzose sand.
2′ — 2′ 6″	:	sandy clay.
2′ 6″— 8′	:	brown plastic clay with two thin sandy bands (4″ thick) at depths of 4′ and 6′.
8′	:	pebbly bedrock.

Sample weight was 20 Kg.

Hole No. 2 = Sample B

0 — 6″	:	clay top soil.
6″— 3′	:	sandy clay.
3′ — 8′ 6″	:	blue clay with 5 per cent (by volume) of small quartzite pebbles.
8′ 6″— 9′ 6″	:	sandy red clay.
9′ 6″	:	pebbly claystone bedrock.

Sample weight was 20 Kg.

Hole No. 3 = Sample C

0 — 6″	:	clay top soil.
6″— 2′	:	sandy clay.
2′ —10′ 6″	:	brown and white clay with 4 per cent quartzite pebbles.
10′ 6″	:	pebbly claystone bedrock.

Sample weight was 21 Kg.

Hole No. 4 = Sample D

0 — 2′	:	sand.
2′ — 9′ 6″	:	brown clay with a 6″ thick band of quartz sand and pebbles at a depth of 8′.
9′ 6″	:	pebbly claystone bedrock.

Sample weight was 17 Kg.

Hole No. 5 = Sample E

0 — 1′ 6″	:	sand.
1′ 6″— 8′	:	pale blue clay.
8′	:	pebbly claystone bedrock.

Sample weight was 19 Kg.

Hole No. 6 = Sample F

0 — 1′ 6″	:	clay top soil.
1′ 6″— 6′ 6″	:	hard sandy clay.
6′ 6″	:	bedrock, pebbly claystone.

Sample weight was 23 Kg.

The samples do not include any material from the clay top soil, but are otherwise representative.

All samples contained quartzite pebbles (generally water worn) up to almost egg size.

Sample G was composed of equal weight of samples A-F inclusive.

Preparation and Testing

All samples were dried and then jaw and roll crushed to minus 10 mesh.

The samples were mixed in the dry state and thoroughly pugged in a Rawdon pug mill after the addition of the required water.

Sizing analyses of the minus 10 mesh materials by wet and dry screening:—

Clay	Per Cent Weight		
	Plus 200 mesh	Minus 200 mesh	Total
A	26.8	73.2	100.0
B	31.9	68.1	100.0
C	29.5	70.5	100.0
D	20.1	79.9	100.0
E	8.5	91.5	100.0
F	13.2	86.8	100.0
G (calculated)	21.7	78.3	100.0

Extrusion

Clay columns were extruded with de-airing at 28 inches of mercury vacuum. Clays A, B, D, E, F and G extruded reasonably satisfactorily; all showed negligible to slight corner notching. Clay C did not extrude satisfactorily, and showed major dog-earing. Clay G extruded with difficulty but the extruded column was satisfactory.

All clay columns had good green strength. All clay columns cut roughly due to the presence of comparatively large pieces of quartz. This last could probably be minimized by crushing to say minus 20 mesh instead of minus 10 mesh as was done in the test work.

Moisture Contents of the Extruded Clays

The tabulation below shows A, per cent moisture in the green brick and B, per cent water added to the dry clay.

Clay	(A)	(B)
A	13.4	15.5
B	13.6	15.7
C	11.3	12.7
D	16.8	20.2
E	20.0	25.0
F	16.8	20.2
G	12.7	14.6

Power consumptions in kilowatt hours needed to extrude 1000 grams (wet weight) of clay 1.25 x 1.5 inches cross section were:—

Clay	Power: Kilowatt hours/1000 grams
A	0.0180
B	0.0229
C	Not taken: clay did not extrude satisfactorily.
D	0.0284
E	0.0237
F	0.0253
G	0.0377

Drying and Firing

The extruded bricks were dried naturally for several days and were finished by heating to 105°C in an electric oven.

The dried bricks were fired at the temperatures shown, soaking for two hours at the maximum temperatures.

Drying and firing contractions of the various bricks are shown below. All contractions are based on the original 5 cm length of green brick.

	Contractions: Per Cent				
		Firing			
Clay	Drying	950°C	1000°C	1050°C	1100°C
A	4.5	1	2	3	3
B	3.5	1	3	7	*
C	2.5	1	2	3	3
D	4.5	2	5	7	7
E	5.0	4	8	9	8
F	4.5	3	5	6	6
G	2.0	1	2	4	6

* These bricks have bloated, but not uniformly, so that measured contractions are inaccurate.

Losses of weight on firing the various bricks are shown below. Calculations are based on bricks dried at 105°C.

Clay	Firing Loss: Per Cent Weight
A	2.2
B	3.1
C	2.3
D	4.3
E	5.7
F	4.1
G	5.1

These firing losses indicate low clay contents.

Bricks of clay A show curved surfaces when fired at 950°C; at higher temperatures this increases, but even at 1100°C it is not serious.

Bricks of clay B show curved surfaces when fired at 950°C, and bloating becomes serious at a temperature of 1100°C.

Bricks of clay C show curved surfaces at all temperatures.

Bricks of clay D show negligible curved surfaces at 950°C, gradually increasing with increased temperature, but is less than clays A and C.

Bricks of clay E show longtitudinal core cracks when fired at 1000°C, 1050°C and 1100°C. Cracks were not observed in bricks fired at 950°C.

Bricks of clay F show less curved surfaces than bricks of D.

Bricks of clay G show negligible curved surfaces when fired at 950°C, gradually increasing with increased firing temperatures, but is less than A and C. Longtitudinal core cracks were observed at all temperatures.

Bricks of clay B, D, E and F show signs of fritting at 1050°C. Bricks of clay A show signs of fritting at 1100°C. Clay C is unaffected in the temperature range tested.

Bricks of G show slight signs of fritting at 1100°C.

Colour of Fired Bricks

	Firing Temperature			
Clay	950°C	1000°C	1050°C	1100°C
A	orange-tangarine	light rust-red	rust-red	brownish rust red
B	rust-orange	rust-red	brownish rust red	brownish red
C	orange-tangarine	light rust-red	rust red	red-rust
D	orange-tangarine	light rust-red	rust red	brownish rust red
E	orange-tangarine	medium light rust-red	medium dark rust red	brownish rust red
F	orange-tangarine	medium light rust-red	medium dark rust red	brownish rust red
G	orange-tangarine	orange-tangarine	light rust red	red-rust

Refractory Tests

A — Softens at 1360°C. Increase to temperature of 1480°C has no further marked effect, apart from surface glazing and slight bloating.

B — Softens at 1340°C. Increase to temperature of 1480°C produces near total fusion with marked bloating.

C — Softens at 1480°C. Somewhat bloated with surface glazing.

D — Softens at 1250°C. Increase to temperature of 1480°C produces near total fusion with considerable bloating.

E, F & G — Softens at 1290°C. Increase to temperature of 1480°C results in near total fusion with considerable bloating.

Modulus of Rupture

Modulus of rupture results are calculated from the weight necessary to rupture a bar 1.25 x 1.5 inch cross section, supported by knife edges 2.75 inches apart. These tests were undertaken by Mr. K. Payne, Officer-in-Charge, Engineering Department, Technical College, Launceston.

Modulus of Rupture: lb./sq. inch.

Clay	Dried	950°C	1000°C	1050°C	1100°C
A	500	1900	2400	3000	1900
B	400	2500	3400	3300	3600
C	300	800	1400	2000	2200
D	300	2400	2900	3500	2700
E	200	3500	3600	2300	3500
F	300	3100	2500	3000	2400
G	600	1100	1000	2000	2300

The above were determined on one only brick specimen for each temperature.

S.A.A. Interim 323 shows an average requirement of 400 lb. per square inch. All fired bricks easily meet this specification. Clay C fired at 950°C has considerably lower strength than all other fired bricks.

Efflorescence

The fired bricks were tested for efflorescence with the following results:—

A: fired at 950°C: thick white incrustation.
fired at 1000°, 1050° and 1100° C: nil.
B: fired at 950°, 1000°, 1050° and 1100°C: nil.
C: fired at 950°C: slight orange vanadium efflorescence.
fired at 1000°C: trace of vanadium efflorescence.
fired at 1050°C and 1100°C: several small specks of vanadium efflorescence.
D: fired at 950°C: slight to moderate thin white efflorescence, plus separate patches of vanadium efflorescence.
fired at 1000°C: rather thick white incrustation.
fired at 1050°C: slight white incrustation.
fired at 1100°C: nil.
E: fired at 950°C: trace of vanadium efflorescence.
fired at 1000°, 1050° and 1100°C: nil.
F: fired at 950°C: trace of vanadium efflorescence.
fired at 1000°C: small patch of white incrustation.
fired at 1050°C: trace of vanadium efflorescence.
fired at 1100°C: nil.

Appendix

WYNYARD CLAY—BLEND "G"

This appendix deals with manufacture of bricks by pressing.

The bricks produced by de-aired extrusions showed some evidence of faults and production of bricks by pressing was undertaken for comparative purposes.

Pressing was conducted by stiff plastic and semi-dry methods and good quality bricks were manufactured by both methods and fired satisfactorily at 1000°C and 1050°C. Specimens of bricks by the semi-dry process have been submitted to Brian Archer Pty. Ltd. for assessment. Brick formation by pressing produced bricks of more accurate dimensions than those produced by de-aired extrusion.

Moisture Content of the Pressed Bricks

The tabulation shows (A) per cent moisture in the green brick and (B) the per cent water added to the dry clay.

	(A)	(B)
Semi-dry press	10.2	11.4
Stiff-plastic press	13.3	15.4

Drying and Firing

The pressed bricks were dried naturally for several days and then finally dried at 105°C.

The dried bricks were fired at 1000°C and 1050°C, soaking for two hours at these temperatures.

Drying and firing contractions are shown below. All contractions are based on the original green brick.

	Contractions—Per Cent		
	Drying	1000°C	1050°C
Semi-dry press	1	2	2
Stiff-plastic press	4	2	2

Firing Loss

Losses of weight on firing the bricks to the indicated temperature are shown below. The per cent firing losses are based on bricks dried at 105°C.

	Firing Loss—Per Cent Weight	
	1000°C	1050°C
Semi-dry press	3.8	4.0
Stiff-plastic press	3.5	4.0

Modulus of Rupture

Modulus of rupture tests were performed on one brick specimen only for each firing temperature.

	Modulus of Rupture—lbs./sq. inch	
	1000°C	1050°C
Semi-dry pressed	1000	1100
Stiff-plastic pressed	1200	1600

Colour of Fired Bricks

All test pieces fired to a colour approximation, light to medium rust red.

Reference

GEE, R. D., 1963.—Report on clay in the Wynyard District. *Tech. Rep. Dep. Min. Tas.*, 7, 55-57.