

TR9-181-184 R. 481

**28. LUCK BROS. PTY. LTD., DEVONPORT: BRICK MANUFACTURING TESTS BY DE-AIRED EXTRUSION**

**Sample**

Two samples of clay and three samples of sand were submitted by Luck Bros. Pty. Ltd., Devonport, for brick manufacturing tests by de-aired extrusion.

The company supplied the following descriptions of the samples.

- No. 1. Clay—present pit.
- No. 2. Clay—new pit.
- No. 3. White sand—Port Sorell.
- No. 4. Red sand.
- No. 5. Brown sand.

A further sample of similar material was later obtained by the Chief Chemist and Metallurgist.

**Chemical Determinations**

These were made on several of the samples to assess the probable source of efflorescence to which the materials are known to be prone. Results were as follows:—

No. 1 Clay	Total Sulphur 0.41 per cent
	“SO <sub>4</sub> ” 0.25 per cent
No. 2 Clay	Total Sulphur 0.02 per cent
	“SO <sub>4</sub> ” 0.02 per cent
No. 3 Sand (Port Sorell)	Acid Insoluble 76.8 per cent
	“R <sub>2</sub> O <sub>3</sub> ” 1.7 per cent
	“CaO” 10.9 per cent
	“MgO” 0.67 per cent
	“SO <sub>4</sub> ” 0.28 per cent
	“CO <sub>2</sub> ” 8.7 per cent

### Investigation

Brick manufacturing tests by de-aired extrusion were performed on samples 1 and 2 individually and blended with one another in various proportions. The firing temperatures desired were 950° C to 1050° C. These tests were mainly to observe the colour and efflorescence effects produced under these circumstances.

Extruded bricks from blends of clay and sand were also tested in the same firing range to observe the reduction in drying and firing shrinkage caused by the sand additions.

The extruded column from No. 2 clay was badly dog-eared and extremely brittle, and unusable in this condition. The addition of sodium carbonate as a modifying agent corrected these defects by improving the plasticity of the material and a smooth very strong column could then be extruded. The sodium carbonate was added as a 1 per cent solution in water, and usage amounted to approximately 0.5 lbs per ton of the clay.

Sodium carbonate was also added in the same proportion of reagent to clay in blends of the various sands with clay No. 2.

Sodium carbonate was not added to blends of clays 1 with 2 as No. 1 imported sufficient plasticity to the blends to permit reasonably satisfactory extrusions.

### Preparation and Testing

The samples were partially dried and roll crushed to minus 10 mesh B.S.S., and then thoroughly mixed.

Blends were made up from the requisite amounts of the various samples and mixed in the semi-dry state.

In all cases the required amount of water and modifying agent if required was incorporated by repeated hand mixing, followed by at least two passes through a pug mill.

The pugged material was then fed by hand to a de-airing extrusion machine under a vacuum of 27 inches of mercury, and the extruded column wire cut into test briquettes.

The test pieces were weighed and allowed to dry naturally for several days, and drying completed in an electric oven at 110° C.

The dried bricks were then fired to the indicated temperatures allowing two hours soaking at these temperatures.

### Blending

In addition to the individual clays, tests by de-aired extrusion were performed on the following blends.

- A. 5 parts clay No. 2, 1 part clay No. 1.
- B. 3 parts clay No. 2, 1 part clay No. 1.
- C. 1 part clay No. 2, 1 part clay No. 1.
- 1/3. 3 parts clay No. 1 to 1 part sand No. 3.
- 2/3. 3 parts clay No. 2 to 1 part sand No. 3.
- 2/4. 3 parts clay No. 2 to 1 part sand No. 4.
- 2/5. 3 parts clay No. 2 to 1 part sand No. 5.

### Summary

1. *Clay No. 1* was found to be suitable for brick manufacture by de-aired extrusion, either individually, blended with clay No. 2, or blended with sand No. 3. However, the material has a short firing range, and bricks appear over fired at 1050° C. In some cases, particularly when blended with sand No. 3, incipient fusion and bloating was observed at this temperature.

Bricks made from undiluted clay were found to be subject to severe core cracking. Slow drying and firing may eliminate this defect.

All bricks containing clay No. 1 except blend A (5 parts No. 2/1 part No. 1) exhibited moderate to heavy sulphate efflorescence.

It may be possible to inhibit the sulphate efflorescence by an addition of a soluble barium salt during pugging. This would tend to fix the sulphur as barium sulphate, and hence prevent its transfer to the brick surface by capillary action. Vanadium efflorescence in most cases was slight to moderate, appearing mainly on bricks fired at 950° C.

Colours of bricks in this series ranged from light red at 950° C, medium rust red at 1000° C, to dark rust red at 1050° C.

The firing contractions of bricks from clay No. 1 and blends of this with clay No. 2 were high between 1000° C and 1050° C. Contraction was generally reduced by blending the clay with sand No. 1.

### 2. *Clay Sample No. 2—New Pit*

As mentioned previously this sample was found to be unsuitable for the manufacture of bricks by de-aired extrusion without the addition of a modifying agent to improve the plasticity and cohesive properties of the material. The only agent tested was sodium carbonate, and with this reagent added at the rate of 0.5 lbs per ton of clay the material is suitable for de-aired extrusion.

During drying, however, a transfer of salts to the surface took place giving the appearance of white efflorescent film on the corners of the dried brick. In the fired pieces the affected areas were of a slightly darker colour than the general surface. Apart from this the fired bricks are of very good appearance and quality. As with sample No. 1 contraction is rather high at 1050° C, and the bricks appear to be somewhat overfired at this temperature.

No sulphate efflorescence was noted on bricks from this material, but vanadium efflorescence was present in slight amounts.

Manufacture of bricks from blends of clays 1 and 2 has been discussed in paragraph 1 of this summary. It should be mentioned here that in these blends no modifying agent was added as it was found that the proportion of clay No. 1 used imparted sufficient plasticity and cohesion to allow extrusion with only very slight corner notching, which could probably be eliminated by adequate die lubrication.

### 3. *Blends of Clay No. 2 with Various Sands*

Blends of clay No. 2 with each of the three sands were tested. The blends were in the proportions of 3 parts clay to 1 part sand.

*Blend 2/3.* Although an apparently satisfactory column could be extruded the fired bricks proved to be of poor quality. "Blowing"

and partial disintegration occurred in bricks fired at 950° C and 1000° C, and firing to 1050° C produced bricks dark red in colour, very porous and of poor appearance. The blowing occurred after two to three weeks standing, and is attributed to the influence of the lime introduced in sand No. 3.

*Blend 2/4.* The extruded column from this blend lacked plasticity and cohesion, and showed a strong tendency to dog-earing. This tendency may be reduced by using less sand in the blend, but this aspect was not investigated. Shrinkage was somewhat lowered by the sand addition, but generally the fired bricks are not of good appearance.

No efflorescence was observed and colour varied from light red at 950° C to dark rust red at 1050° C. Bricks are obviously overfired at this latter temperature, and show roughened surfaces and in some cases deep transverse cracking.

*Blend 2/5.* The extruded column was similar in character to that from blend 2/4, but dog-earing was rather more pronounced. Efflorescence, colour, shrinkage and firing characteristics are all somewhat similar to those of blend 2/4.

#### Test Results: Brick Manufacture by De-aired Extrusion

The contractions shown are progressive and all include the drying contractions.

Sample or Blend No.	Per Cent						Remarks re Extrusion
	Moisture in Green Brick	Drying	Contractions		Firing Loss		
			950°C	1000°C	1050°C	950°C	
Clay 1	19.4	7	7½	8	10	7.9	Column smooth and strong, cuts easily.
Clay 2	21.1	4	4	7½	10	4.6	Dog-ears badly without added Na <sub>2</sub> CO <sub>3</sub> , which allows smooth, strong column to be extruded.
Blend A	21.9	5	5	7	13	5.2	Slight dog-earing.
Blend B	20.6	5	5	8	12	5.6	Slight dog-earing.
Blend C	19.6	4	4	7	10	5.9	Slight dog-earing.
Blend 1/3	16.0	6	6	7	8	6.2	Column smooth and very strong.
Blend 2/3	17.5	3	3	3	4	6.0	Slight dog-earing.
Blend 2/4	17.7	2	2	4	7	4.8	Moderate dog-earing.
Blend 2/5	17.9	2	2	2	4	3.8	Moderate dog-earing.