ASSESSING THE TECHNICAL PROBLEMS OF BRICK PRODUCTION

A GUIDE FOR BRICKMAKERS AND FIELD-WORKERS

Introduction

These notes should help identify brickmakers' technical problems. The problems need to be identified correctly for a solution to be found; not always easy when faced with a faulty brick or batch of bricks. So, the notes try to highlight the main problems, the reasons for them, and possible solutions. We'll consider the final product, the fired brick, and trace faults back to their cause[1]. In reality small-scale brickmakers often face many problems, such as marketing, business management, record keeping, and fuel scarcity. Quality control is only one aspect of running a successful enterprise. In fact, the main problem is seldom technical. For example, it's no good upgrading the output of a brickworks, causing extra work and expense, if customers aren't prepared to pay more for improved quality. Nevertheless, it *is* worth knowing where problems originate and how they might be solved, particularly for brickworks suffering heavy losses or unable to meet the standard their market demands.

Figure 2: A pile of fired bricks, Alto Mayo, Peru. To be noted are the cracks and deficiencies in the bricks. Photo: Practical Action / Theo Schilderman.

Field testing

Specific defects are illustrated in the tables. However, there are some simple tests which can be done in the field. Firstly, when you handle a brick, see if it's soft. Can you pick off the edges? Can you scratch the surface with your fingernail? If so, the brick is probably underfired - one of the most common problems. Now, break a brick in half. Was it easy? Is there a 'core' of different colour material? If the brick breaks easily or has a core like this, then it's underfired. What about the cross section? Are there lumps or stones, internal cracks or holes? If so, the soil probably wasn't mixed well enough.

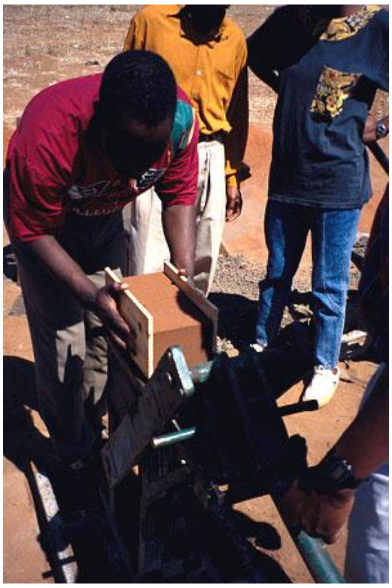

Figure 1: Brick moulding, Zimbabwe. Photo: Practical Action / Theo Schilderman.

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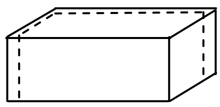
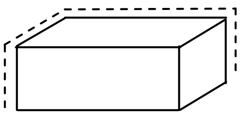
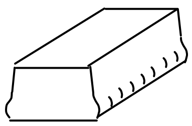
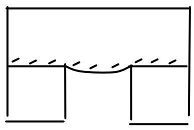
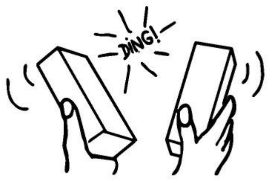
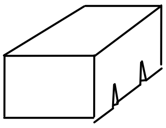
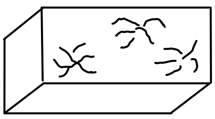
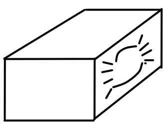
You can tell a lot about bricks by soaking them in cold water for 48 hours. If you weigh bricks before and after soaking, you can calculate the percentage of water they absorb. A good brick shouldn't absorb more than 15% of its dry mass. If bricks are too absorbent they suck moisture out of mortar and weaken the bond. You may find the brick dissolves altogether. In this case, it's definitely underfired - and dangerous to use in any building. The presence of lime may also be detected by soaking bricks. If lime is present as lumps, it may expand and cause fractures, exposing powdery white deposits.

BRICK PROBLEM	PROBABLE REASON	POSSIBLE SOLUTION
1. SIZE (a) Too big in all dimensions (*all types)* 	(i) Too many coarse particles in raw material (ii)Underfired *(Either way,(i) or (ii), bricks are not shrinking as allowed for)* (iii) Mould or extrusion die is too big - worn?	(i) Sieve out coarse material or crush soil before moulding (ii) Increase firing temperature &/or time (increase fuel?) (iii) Replace
(b) Too thin *(sand moulded & slop moulded)*	Squashed in handling - probably when laid to dry on edge	More care handling bricks & try moulding a little drier
(c) Too thick *(extruded bricks)*	Cutting wires set wrongly	Adjust settings
(d) Too small in all dimension *(all types)* 	(i) Die or mould too small (ii) Too high clay content - excessive drying shrinkage (iii) Overburned - excessive firing shrinkage - may affect bricks only in hot-spots in kiln	(i) Change (ii) Add sand (iii) Use less fuel. Try to avoid hot-spots by distributing fuel differently

2. SHAPE (a) Slumping - one stretcher face is wider with a bulge running the length of the brick *(all types)* 	(i) Too soft when moulded (ii) Handling too rough	(i) Use a drier mix (2) Take more care
(b) Rounded corners *(sand moulded)*	Not enough clay pressed into mould box, or rough handling	Make sure mould box is filled, or handle wet bricks more gently
(c) Raised corners *(slop moulded)*	Corners stick to mould when brick is released	Use sand in mould or make sure mould is wet enough
(d) Stacking marks *(all types)* 	Bricks moved too soon from drying singly on edge to stacking	Make sure bricks are dry enough before stacking
(e) 'Lips' or 'flashing' *(usually sand or slop moulded)*	Mould worn, clay 'seeps' out, or moulder not 'striking off' excess	Replace mould, or take more care striking off excess flash
(f) 'Banana' shapes *(all types)*	Top drying faster than bottom	Gently turn bricks during drying

BRICK PROBLEM	PROBABLE REASON	POSSIBLE SOLUTION
3. STRENGTH/SOUNDNESS (a) Weak and crumbly *(all types)*  	(i) Underfired - detectable by dull 'clunk' not sharp ring when bricks are knocked together	(i) Use more fuel, or change fuel distribution, or modify kiln design
(b) Cracking *(all types)* (i) Straight cracks at right angles from one long face 	(i) Drying too fast	Dry more slowly or add sand to mix to decease shrinkage
(ii) Random surface cracks 	Differential drying shrinkage caused by presence of lumps of drier material or stones	Mix better and/or sieve out stones
(iii) Buling cracks or blisters 	(i) Surface heated too quickly - vitrifies before gases escape (ii) Presence of lime in soil causes blister - even 'popping' (can appear after manufacture - lime blowing)	(i) Slower firing - especially around firing tunnels or near fuel (ii) Sieve out lime or crush and mix better (powdered lime can act as a flux and reduces the energy/fuel needed)
4. APPEARANCE (a) Contaminated or distorted surface *(all types)*	Drying floor not clean or smooth	Ensure floor is clean & smooth
(b) 'Spalling' - part of surface 'blown away' *(all types but particularly extruded)*	Heating too fast in kiln, residual water turns to steam & explodes	Slow down initial kiln firing process (up to 100°C)
(c) Drag marks *(extruded & slop moulded)*	Cutting wires contaminated with leaves or dry lumps of clay	Make sure wires are clean &/or lubricated with water
(d) Efflorescence - crystalline deposit on surface *(all types - appears after manufacture)*	Soluble salts in clay or water	Salts tend to be near surface, so discard top most soil

Laboratory tests

If bricks have to satisfy an official standard, they will probably have to be tested in a laboratory. These tests will need to be repeated periodically to maintain quality control. Tests normally specify the sizes for bricks and the acceptable compressive strength - how much weight they can bear before crushing[2]. For example, in Zimbabwe 'common' bricks are nominally 220 x 105 x 75 mm and have a crushing strength of 7 MPa. For certain uses, such as damp-proof courses, water absorption or suction rate may also be specified.

Figure 3: Coal fired bricks drying in sun Zimbabwe. Photo: Practical Action / Theo Schilderman.

Raw material tests

The quality of brick which can be made at a particular site is largely predetermined by the type of soil available. There are some simple soil tests which don't need very special equipment. In the sedimentation jar test, a sample of soil is dissolved in a jar of water. When the soil settles you can get an idea of the fractions of clay, fine and coarse sand that are present. Another test is the linear shrinkage test. A sample column of wetted and mixed soil is pressed into a mould and allowed to dry. The shrinkage indicates how much clay there is in the soil and whether problems can be expected when drying bricks[3]. Soil test are useful indicators, but you really only find out whether good bricks can be made by firing samples. Before investing in a full size kiln, however, it is possible to fire cubes or eggs of soil either in a laboratory kiln or a simple field oven.

Conclusion

These guidelines will help field-workers judge the quality of bricks. Furthermore, if the information presented is used as a basis by those working with brickmakers, it will go some way to establishing an agreed approach to assessing the technical problems they face and proposing appropriate solutions That is, solutions which make the best use of available resources: are affordable, manageable, cost effective, and - ultimately - 'successful'[4].

Reference and further reading

- *Ten Rules for Energy Efficient, Cost Effective Brick Firing: A Guide for Brickmakers and Field-workers* Practical Action Technical Brief
- *How to Measure the Energy Used to Fire Clay Bricks: A Practical Guide for Brickmakers, Field-workers and Researchers* Practical Action Technical Brief
- *Sustainable Small Scale Brick Production: A question of energy*, Practical Action Technical Brief
- *Drying of Clay Bricks and Tiles* GTZ Technical Brief, Gerhard Merschmeyer, 1999,
- *Moulding of Clay* GTZ Technical Brief, Gerhard Merschmeyer, 2001,
- *Brick Clamps* GTZ Technical Brief, Tim Jones, 1995,
- *Bull's Trench Brick Kiln* GTZ Technical Brief, Henrik Norske, 1995,
- *Hoffmann Kilns* GTZ Technical Brief, Tim Jones, 1995,
- *The Vertical Shaft Brick Kiln* GTZ Technical Brief, Tim Jones, 1997,
- *Firing of Clay Bricks & Tiles*, GTZ Technical Brief, Gerhard Merschmeyer, 2000,
- *Preparation of clay for Brickmaking*, Gerhard Merschmeyer, 1999,
- *Village Level Brickmaking*, Anne Beamish & Will Donovan, GTZ / Friedr. Vieweg & Sohn, Braunschweig, Wiesbaden, 1989,
- *The Clay Industry: Improvement of Resource Efficiency and Environmental*

Performance, CleanerProduction.Com,
- *How to Start a Small Clay Brick and Tile Making Enterprise*, GTZ Question & Answer, Responses to Frequently Asked Questions,
- *What Type of Kiln Should Be Chosen for Firing Clay Brick and Roofing* Tiles, GTZ Question & Answer, Responses to Frequently Asked Questions,
- *Brick by Brick* Kelvin Mason, Practical Action Publishing, 2001 ISBN 9781853395291

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[1] See Brickmaking in Developing Countries (Parry, BRE, 1979) and Village-Level Brickmaking (Beamish & Donovan, Vieweg, 1989) for additional information.
[2] See Building Materials in Developing Countries (Spence & Cook, John Wiley, 1983) and Materials of Construction (Smith & Andres, McGraw-Hill, 1988) for examples of specifications.
[3] These and other tests are specified in Small Scale Brickmaking (Smith, ILO Technical Memorandum No. 6)
[4] Technology and Underdevelopment (Stewart, Macmillan, 1978)