Earth building update...

The Earth Building Association of New Zealand (EBANZ) promotes the art and science of earth construction.

Oyster shell tadelakt

The development of a tadelakt type coating from oyster shells in West Africa

BY BEN EYERS

In 2011 I had the opportunity to spend seven weeks running a project at Sandele Eco Retreat in The Gambia, working on developing a tadelakt type polished lime plaster using local resources, with the final objective being to train local workers in using this technique to resurface some large earth brick domes.The land for the retreat was leased by Geri and Maurice, both UK expats. The intention is for the resort to be owned and operated by local people. When the 25-year lease expires the ownership of the resort, along with the land, will go back to the Kartong village. It is set up to minimize the effects of tourism on the environment and local culture. They are using a wind turbine and solar PV for electricity, have solar hot water and composting toilets in all the guest rooms.

Local construction

In building the retreat almost all the construction materials are sourced from within a five-kilometre radius of the site. A team of workers make the earth blocks using a manually operated machine. Geri and Maurice visited Auroville in India and also sent two Gambians to learn the technology and construction methods, specifically the use of CSEB (compressed stabilised earth block) technology. These blocks are produced using the *Auram 300* block press developed at Auroville, which can produce 1000 blocks per day in a wide range of block shapes and sizes. (1)

This has been so successful that a construction company, EarthWorks Construction, has been set up locally; they have completed many other projects including water towers in villages, a large theatre, five houses and a major school construction project. (2)

The accommodation units consist of CSEB buildings, four of which have domes which are rendered with Portland cement based stucco, which was beginning to crack and leak during the rainy season. This created the opportunity to find a solution more in keeping with the principles of the resort. The surfaces needed to be durable and water resistant as well as attractive. The use of local labour and materials was important.

In conversations with Maurice in 2010 we suggested building a small scale kiln as a proof of concept, demonstrating a more efficient way of producing the lime. If this was successful, a larger kiln could be built at the river near where the lime is burnt currently. As this lime is being produced anyway, a more fuel efficient method could help alleviate the pressure on the environment due to excess firewood collection.

Lime production

I had some experience with lime plaster back in NZ, learning on the job. A long time friend of mine Sam Walker had just arrived in the UK and was keen to be involved. We had both travelled in Morocco and managed to spend an

Sample patches using various methods and materials were trialled on a disused building.

afternoon with some locals working with tadelakt in Marrakech for a small fee.

Tadelakt is a water resistant coating that has been developed in Morocco. It is a lime-rich plaster that is applied in a thin layer and polished with a smooth stone. This compresses and smooths the plaster, creating a very hard surface. A preferably unrefined soap made from natural oil is applied in liquid form and further polished into the surface of the plaster. This creates a hydrophobic layer that, along with the stone compression, makes for a hard and durable surface.

The vapour permeability of a lime based plaster or mortar is generally significantly higher than one using modern Portland cement as the binder. (3) This is an important property when used in conjunction with building materials such as CSEB's and soft stone masonry, as the permeability of the lime based mortar provides an easier path for moisture to escape from masonry units. (4)

An abundantly available local resource is the oyster shells that accumulate along the tidal estuaries, as well as a by-product of the local small scale oyster harvesting industry. Lime for use as a binder can be produced by burning oyster shells. This was being done already, by making a large pile of firewood and piling the shells on top, which was then left to burn more or less uncontrolled for 3-5 days.

Kiln construction

A kiln was constructed by Sam and myself, as proposed the year before. The design was a 'continuous vertical shaft' adapted from plans available from Practical Action (*www.practicalaction.org* – How to Build a Small Vertical Shaft Lime Kiln).

Clockwise from above left: Detail of the tadelakt surface at the top of the dome; the final colourful and glossy result is much admired; the area was wet down and shaded to aid slow curing; applying the tadelakt coating required some agility.

The vertical chimney was approximately 2.5 metres high and 0.5 metres in diameter with an opening at the bottom, built in two 'skins,' like a double brick cavity wall. The gap between the two walls was filled with a clay/woodchip mixture for insulation. Two small inspection holes just big enough to insert a temperature probe were built into the kiln.

The kiln operates at a ratio of about 1 fuel : 4 shells; one 20-litre bucket of shells followed by a quarter bucket of charcoal alternated. The level is then built up gradually to about two thirds of the way up the kiln.

This level is maintained for the duration of the burn. Shells are removed from the bottom of the kiln as more shells and fuel are loaded into the top, maintaining the burn zone about one

Anticlockwise from above: The temperature in the kiln was checked regularly with a sensor; recharging during the burn with the oyster shells/charcoal mix; insulation infill for the walls of the kiln; three successful firings produced a good supply of lime.

third of the way up by checking the temperature at different heights. This seems to produce the best results.

Each burn takes around four to five hours to get up to 800 degrees C in the burning zone. We ran three successful burns with the kiln and temperatures were measured up to just over 1000 degrees C.

Once the kiln is at temperature, theoretically much less fuel needs to be consumed to maintain the heat. The thermal mass of the kiln helps maintain the heat, resulting in reduced fuel usage and also reduced temperature fluctuations.

Tadelakt application

Before attempting the domes, some 30 or so test panels on a disused CSEB building were attempted. Successful experiments were made with different ratios of lime to aggregate, plus pigments and other additions such as charcoal, ash and clay. We also tested the timing and technique of the polishing and application of the soap.

In the end we settled on the simplest ratio of 100% local shell lime along with pigment (over a scratch coat of 1 lime : 1 sand). This top coat is also what is used in Morocco, i.e. no aggregate added. I thought the shell lime, with its grainy feel due to the amount of unburnt particles, was similar to the tadelakt lime used in Morocco; quite different to bagged hydrated lime off the shelf.

The domes had previously been plastered with two layers of cement

plaster, which had then been painted. There was understandably resistance to the idea of the top layer of plaster being removed along with the painted surface. It seemed porous enough to accept a lime plaster after the paint had been scraped off. I had my reservations at the time due to the smoothness of the surface, but we went ahead anyway, mostly due to time constraints.

We tried to keep the domes as shaded as possible for as long as possible, which turned out to be less than a week in reality. We wetted them down throughout the day for the first few days then intermittently after that.

It was hard to get across to the locals just how important this is. The temperatures were around 30 degrees C with full sun all day and a sea breeze in the afternoon and this would have been detrimental to the finished surface as it repeatedly dried out. (5)

The most serious problem we had with the domes was delamination from the substrate. In every instance that this occurred the base coat and the pigmented top tadelakt layer lifted while staying very well bonded together. The thermal expansion of the surface before it has properly cured and adhered to the substrate could have caused areas to shear off and delaminate. (6).

Language barriers made it difficult when training and subsequently working with the two local masons. They were enthusiastic to learn but it was a huge challenge to communicate effectively. This caused problems further down the track, for example with the aftercare of the lime plaster surfaces in the first few days following application. At one point we were translating from English to Mandinka to Creole!

There were also problems with accessing equipment.

Latest update

Geri and Maurice visited Jess and me in New Zealand last year and were able to update us. The cement base was subsequently removed on all four domes before the tadelakt layer was applied. They reported that guests comment very favourably on the impact and beauty of the domes. The test panels have continued to show little, if any, deterioration. Six more lodges will be constructed in the future and will have tadelakt surfaced domes.

Many thanks to Geri and Maurice for the opportunity to undertake this project. ◆

Ben and his wife Jess have a design and build company in Wanaka NZ specialising in low environmental impact buildings. 0220 475 585 and ben@kiwinaturalbuilding.co.nz

This article first appeared in earthbuilding *(Winter 2013), the magazine of the Earth Building Association of New Zealand (EBANZ).*

Links & resources

◆ **Sandele Eco Retreat**
Focused on using the most appropriate technologies in order to create as small and natural a footprint as possible.

www.sandele.com,
www.facebook.com/SandeleEcoRetreat

◆ **EBANZ**
Promoting the art and science of earth and natural building.

www.earthbuilding.org.nz,
www.facebook.com/earthbuilding

◆ **Practical Action**
Using technology to challenge poverty in developing countries.

www.practicalaction.org

Clockwise from top left: The final finished coating of tadelakt on the domes is cause for pride; shells removed from the kiln at night are then left to slowly hydrate; and are then ground to form the hydrated lime to be used in the plaster surfaces.

Footnotes

(1) www.earth-auroville.com/auram_earth_equipment_introduction_en.php

(2) http://www.sandele.com/earthworks.html

(3) Straube, John. "Moisture properties of plaster and stucco for strawbale buildings." Report for CMHC, Ottawa (2000).

(4) Pavia, Sara. "Design of quality, durable mortar for the conservation of historic masonry fabrics." (2005).

(5) www.buildingconservation.com/articles/stucco/stucco.htm

(6) Lawrence, Robert. A study of carbonation in non-hydraulic lime mortars. Diss. University of Bath, 2006.