BARRIERS TO THE SPECIFICATION AND ADOPTION OF EARTH BUILDING IN THE U.K.

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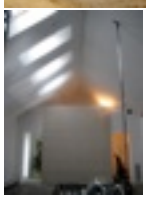
Introduction

Conker Conservation has been designing sustainable and energy efficient buildings since 1999. During which time we have used rammed chalk, rammed earth, straw bales, green oak, sweet chestnut round wood, timbrel vaults and Hemcrete in addition to using conventional materials to their maximum thermal potential.

I review here the barriers to the wider use of earth building techniques in the U.K from the perspective of a designer and specifier. My experience is based on four projects I was directly involved with:



1. The Pines Calyx
   Community and conference centre in rammed chalk.

2. The Living Classroom
   Teaching block in rammed earth.

3. Diploma Exemplar Projects East Sussex County Council -
   3 classrooms in rammed earth.

4. Greendale Studio
   Passivhaus industrial unit with rammed chalk mass wall.

Awareness

In order for any form of construction to come into common use, building designers, professionals, clients and builders need to become aware of it. A good PR department could achieve this for a marketable trade product or building system. Problems arise however, with an unregistered, non-patented, method of construction such as earth building. The role of promoting the method falls to enthusiasts and small organisations such as EBUK, perhaps with the help of CPD providers such as RIBA and RICS. With limited resources this can inevitably be a slow process.

Material Properties, Availability of Information

Once industry awareness is created, specifiers will have a hunger for more information. Availability of information is key to providing designers with the confidence to specify a product or method of construction.

If, for example, we were selecting a concrete block, we can look up all of its properties, and be confident that regardless of location and time of year, these properties will be fairly consistent. We can check these properties against alternative blocks, and against the norms in British Standards and Euro Codes. Such information is freely available on websites, in Trade literature and BBA certificates.

This is not so simple with earth as the material properties vary according to the nature of the subsoils available, mix of the constituents chosen, the moisture content and the type of test performed. Earth is not available at builder's merchants, but clay and chalk can be obtained from stockists. Soil samples will need to be obtained, and samples made up by a specialist in order to achieve a workable structural mix.

Even when the material properties are known, there are variables such as bulk, density, speed of construction and cost, which in turn are dependent on location, time of year and prevailing weather conditions.

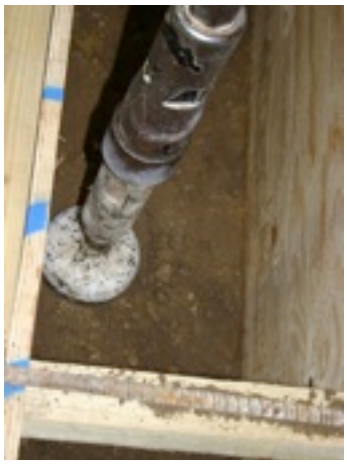
Construction

The construction industry is notoriously conservative. Asking experienced builders to learn a new method of building using a new material can be daunting. Ask the right builder however, and you will be met with excitement and enthusiasm. Personal experience has shown that builders used to dealing with historic conservation have the best attitude as they are more open minded to construction variations and generally have more patience.

Setting out a building with earth walls needs careful consideration. Shrinkage joints or daywork joints need to be placed according to the shrinkage factor of the material. Walls will also need stabilising against returns, buttresses or internal partitions.

The material can be rammed by hand or mechanically. Hand ramming is exceptionally hard work and very slow; I would venture that it is not viable except on the smallest project.

1. Hand ramming chalk



2. Pneumatic rammer

Mechanical ramming can be very productive, but is still hard physical work. Risk assessments must be carried out by the contractor, which they may find difficult due to lack of experience.

Ideally the subsoil should be extracted before the main contract starts, so it can be dried, then mixed with suitable additives. This can create a problem due to release of funds at such an early stage in the contract. The premixed material then needs to be stored near the works, kept dry, and transported to the place of work in manageable quantities. This process is highly flexible and will be different for every job.

Most contractors will be familiar with shuttering and scaffolding, but consideration needs to be given to using the two in close proximity, whilst allowing sufficient room to manoeuvre the equipment and deliver the earth into the shuttering. This additional planning adds to the workload and organisation of the contract and may cause conflicts with other trades.

3. Earth stored in covered skips - high risk of covers letting in water and saturating material

4. Chalk (in distance) stored under tarpaulins remained dry

5. Chalk being delivered to shutter by Bob-cat

6. Shuttering with built-in access stages

7. Shuttering protected against rain. Independent scaffolding.

Protection

It is common for earth walls to be left fully exposed on one or both sides due to its inherent beauty and interest, as a result the surface of the wall is vulnerable to damage from an early stage of the build all the way through to completion. Repairs can be made where damage occurs, but protection is needed, both against weather

during construction and against marks and impacts later. These are not normal considerations with materials that will be plastered or decorated later, therefore some cost and time penalties may result.

Whilst walls are under construction they are subject to wind loads, rain, frost, impact from vehicles, etc. The formwork provides a degree of protection, but once it is removed weather and frost protection is needed, ideally spaced off the earth walls to create a pocket of air for drying out and frost protection. Some costs must be attributable to this, although these are very modest in my experience.

There is conflict between protection and preventing the walls from drying which will vary for every site, a system needs to be established which provides for both. Some soils will develop mould growth at particular moisture contents, which can be very alarming for clients when their crisp white walls (in the case of rammed chalk) turn green. As the walls dry out, the mould dies and can be gently brushed off. These are small issues but add a degree of cost and time to a project.

Any absorbent materials in contact with the earth must be isolated, especially end grain of timber, otherwise the material will wick moisture for a very long time and discolour, be un-paintable, resulting in delays.

8. Plaster protection rolled up to allow drying. Note staining

9. Light plastic protection damaged by wind

10. Wall damaged by over-zealous propping

Thermal Performance

11. Ultra-light blocks used under window

Any heated building will need to be insulated; rammed earth provides only nominal thermal insulation, although it has excellent thermal mass and admittance. To benefit from the thermal mass in the UK the insulation should be external. This also serves to protect the walls from the weather and external damage, and avoids the need to stabilise the walls with lime or cement. The walls will undoubtedly end up thicker than a lightweight wall of the same thermal performance, in some instances there will not be enough space to accommodate such wall thicknesses.

As the walls are monolithic, they are relatively airtight, as

long as the shrinkage joints are sealed. Some advance planning is needed to insert expanded foam sheets, air barriers, etc, necessary for highly airtight construction.

Thermal bridging is an issue especially below DPC level. There are many ways to detail the wall at low level, but all must be able to support the weight of the earth walls, resist the vibration and impact of the ramming process, support the external insulation, provide moisture resistance, support a DPC. This requires extra planning at design stage and careful execution on site.

Design Issues

Unlike choosing a material from a catalogue, earth is natural and highly variable, to many this is its main quality, others will find it confusing. If the earth is to be obtained from the site, the colour and texture can be influenced by the aggregate additives, and if necessary, by adding coloured powdered clay or chalk. If necessary, materials can be imported to achieve the desired colour. The process of choosing, mixing, testing, batching takes time and adds cost to a project, and needs to be undertaken at an early stage when funding may be uncertain.


12. Chalk from Dover, being tested alongside earth from Yorkshire at Bath University

Walls can take a long time to dry out fully and this has a bearing on the remainder of the contract. Surfaces cannot be sealed, condensation will occur in the building and other finishes may take longer to dry in the damp environment; unvented rooms will take a particularly long time to dry.

Hanging a picture is not easy, small fixings will damage the surface, but a plug and screw is usually fine. Heavier items will need a deeper fixing; many types are suitable, carry out some tests to see which work best. Where many fixings are needed it is best to fix a wainscot, dado, or backing board. These boards may also provide physical protection against damage from chairs and tables.

Detailing


13. Small window in ply lining on DPC

Positioning and fixing window and door frames needs more thought than on a conventional build. Direct fixing of frames into the earth can cause thermal bridges and lead to damp and air leakage issues. I always use a plywood subframe on a DPC and project the window/door out into the insulation zone. This has a cost implication, and can cause problems if the earthwork is not plumb or square.

Lintels need careful consideration, as the ramming can dislodge them. Sometimes it is easier to avoid lintels and extend openings up to ceiling level. Thresholds and shallow walls under

windows need particular care, as the earth is not easy to form into small detailed zones.

Protecting the earth from ingress of moisture and wind creates a well sealed external skin but does prevent drying out of the walls. A ventilated cavity between the wall and external insulation would negate the effectiveness of the insulation dramatically, so breathable materials which are tolerant of a damp environment for some time should be used.

Weather and Climate


13. East Sussex in winter

The variable British weather can have a profound effect on the success of an earth project. At the Living Classroom project in East Sussex, an area with clay subsoil, the ground was so dry in the summer of 2006 that a mini excavator could barely scratch the surface to extract sample material. By the winter of 2006, when works were finally approved, the ground was so wet that the clay was unusable, as a result powdered clay had to be obtained.


14. Botswana in summer

The case could be very different in other climates, for example in Botswana, the problem is maintaining enough moisture to allow the materials to fully bond during compaction.

This issue of timing adds a degree of risk and uncertainty to earth building, which is much less pronounced in conventional construction. Certainly the weather affects all types of construction to some degree, but publicly funded projects in particular cannot wait for suitable weather before commencing, and are intolerant of delays.

Cost

Rates from recent tenders make the work comparable with masonry, but these rates do not include scaffolding, insulation, protection or finishes.

	Rate, measured in elevation
Rammed earth, clay from site mixed with aggregate 300mm thick, 2010	£110 to £155/m²
Rammed chalk, no additives, large scale work, 650mm thick, 2005	£160/m²
Rammed chalk mass wall, 600mm thick, 5m wide, 4.5m tall, 2010	£350/m²

The Future

The continuing pressure for rapid, high volume, low cost buildings is bringing lightweight timber and steel systems to the fore. These lack any thermal mass, other than plasterboard or thin layers of phase change material. Thermal modelling shows that heavier buildings are more comfortable in the summer, an important consideration if global temperatures continue to rise.

Martin Rauch in Austria has perfected pre-fabricated panels, could these be incorporated into an insulated panel?

There is great interest in Passivhaus standards, which leaves the choice of material entirely to the designer. Developing a set of details that can comply with thermal bridge-free construction should be an EBUK priority.

Conclusion

There are many barriers to using earth in construction, ranging from the weather, the season of construction, variations in soil type, protection from damage, variation in colour and texture, uncertain speed and drying times. But who said that high quality, beautiful, sustainable building was ever going to be easy? I am sure it will get easier as the industry gradually learns to understand the material, which will extend its use beyond the small number of brave pioneers that use it today.

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