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Unstabilised rammed earth – 100% EARTH. Why is it so hard to trust in 100%?

Growing awareness of the need for more sustainable building materials as part of the global climate change debate has led to an increase in interest in rammed earth construction. As one of the most stable and durable of all earth building techniques, rammed earth offers excellent potential for use in architecture and design, not least due to its distinctive stratified structure.

Many projects have since been published in the architectural press, but for the uninitiated it is hard to tell whether the examples shown are 100% rammed earth or have been stabilised in one way or another.

Stabilisation

We are all familiar with the Terra Award from 2016. Of the nominated earth projects, probably half are not actually 100% earth. All across the globe, too, there are many examples of rammed earth or adobe earth block projects that have been stabilised with either cement, lime, bitumen or other chemicals. Typically, they claim to contain just a few percent of cement or lime – 2, 4, 6 or maybe 8%, it's hard to tell exactly. A closer look at the recipes can reveal percentages as high as 10%.

Let us consider this for a moment in terms of weight by volume. For comparison, a high-quality reinforced concrete construction can be made using gravel, sand and 12% cement.

In earth building, wall constructions are typically thicker. Using a typical stabilised rammed earth mix it can therefore transpire that more cement is added per m^2 wall area than in most common concrete constructions.

01 Preparation of the excavated material into a rammed earth mixture

One might now ask why using cement as a stabilising agent is so problematic? From a technical point of view, cement is without doubt very useful as a binding agent for concrete constructions. The biggest problem is its inflationary use. Due to the building boom, especially in China, global cement production has quadrupled in the last 30 years. If we continue to use cement in concrete as we do now, we can forget all the ambitious climate goals.

The reasons why stabilisation came to be used are complex. On the one hand, people began to employ stabilisation additives before sustainability became such an issue. On the other, the use of stabilising agents to improve structural strength was seen as a modern evolution of a traditional earth building technique, bringing it so-to-speak into the modern age. Now, however, people are gradually beginning to question the use of stabilising additives, and rightly so. I would argue that this type of stabilised construction should not be called earth building, and it is time to strip it of its misleading label!

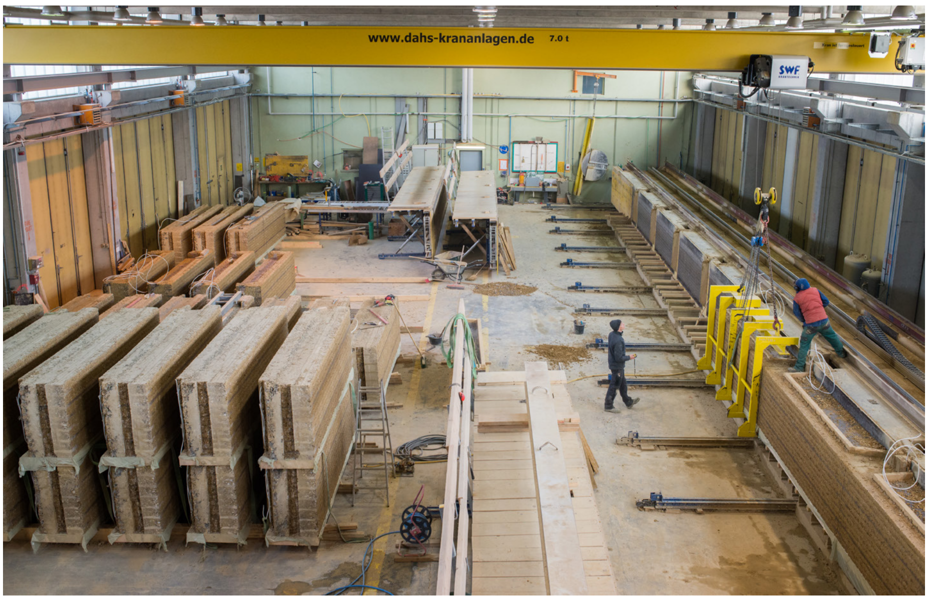
In my opinion, it is essential that we do not contaminate earthen material with additives such as cement or other chemicals. Instead, we must concentrate on developing the tools and processes of earth construction so that we can demonstrate the unsurpassed advantages of the recyclability of earth buildings.

We must learn to design and build with the material-specific limits of the earth building material. This means in-depth study of the characteristics of the material and its construction techniques through applied research and demonstrating its benefits and contemporary applicability over and over again in building projects large and small. Through this, one can consistently build up trust in this truly honest and sustainable building material. And that is a logical prerequisite for the wider adoption of this natural building material.

Since 1982, I have realised several hundred rammed earth projects locally and internationally, initially working on them myself, and later as the companies Lehm Ton Erde Baukunst GmbH and ERDEN Lehmbau GmbH – and always without stabilisation. In the last 20 years, our focus has shifted to the prefabrication of unstabilised rammed earth elements that are then assembled on the construction site. For large projects it was, of course, important to use locally available earth material in order to as far as possible minimise the transportation of heavy material. To this end, four temporary 'field factories' for producing rammed earth elements were established at different locations: from 2007–2012 in Sulz, Austria, from 2012–2014 in Zwingen near Basel, Switzerland, from 2014–2015 in Dahram, Saudi Arabia, and 2015–2017 in Darmstadt, Germany.

In my view, innovation lies in the development of new industrial process technologies and not in altering the composition of the material mixtures. This also includes developing new technologies for assembling components and organising earth building construction sites.

02 Field factory for the production of prefabricated rammed earth elements



03 Ramming: compaction of the rammed earth mixture in the formwork

04 “Roberta” – a machine for the production of prefabricated rammed earth elements

05 Cutting the prefabricated rammed earth wall into sections

06 Drying the prefabricated rammed earth elements

07 Craning a prefabricated rammed earth element into place

08 Completed assembly of the rammed earth elements – Alnatura Campus Darmstadt

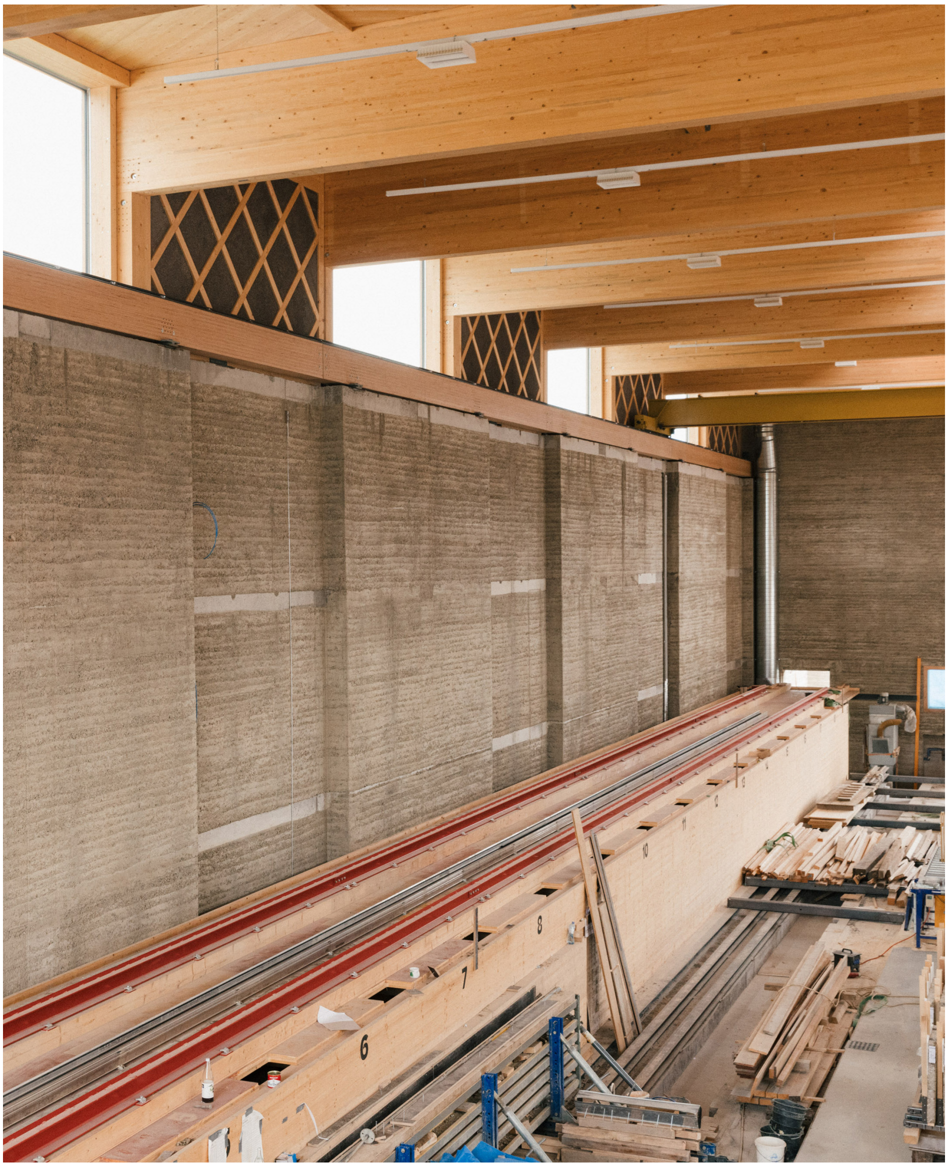
ERDEN factory workshop for Lehm Ton Erde Baukunst GmbH, Schlins, Austria

Since June 2019, "Lehm-Ton-Erde Baukunst GmbH" has been building a new factory workshop with an accompanying design office as an additional production facility for the manufacture of rammed earth products in the municipality of Schlins in Austria.

The factory building has a total length of 67 m and a width of between 21 and 24 m, resulting in a footprint of 1,537 m^2. The column-free production hall rests on concrete strip foundations, and the main structure is a hybrid solid timber and rammed earth construction. The 8 m high rammed earth walls of the workshop were produced on site and the roof structure as well as the works crane with a load capacity of 8 tonnes rest on them. For the three-storey office wing, individual rammed earth elements will be machine-prefabricated in the production hall and then assembled into a loadbearing structure.

The construction technology of the hall employs several earth building and timber construction methods in one building, for example for the facades and interiors. The building represents a significant innovation in the field of rammed earth construction, not least through its size and scale but also through the mechanical loading of the rammed earth material.

09 The solid timber roof rests on the loadbearing rammed earth walls



10 ERDEN factory workshop for prefabricating rammed earth elements

11 The building is a hybrid rammed earth/solid wood construction

Calculated erosion

Like many of our other projects, all the rammed earth walls of this hall are exposed to the weather. This means that over time the finer surface particles will weather, and the exposed rammed earth surfaces become rougher. Due to its stony material composition, rammed earth acts as a natural erosion barrier. After the first few years, the outermost, fine layer of earth washes away, allowing the stone chippings and pebbles to come to the fore, giving the wall a rougher surface. These inhibit further erosion of the wall: the exposed coarser particles serve to stabilise the structure of the earth, while the deeper lying finer earth in which they are bedded swells when it rains. This swelling prevents driving rain from penetrating deeper into the wall and decisively slows down erosion. We call this "calculated erosion".

There are many ways to inhibit wall erosion, such as embedding mortar strips, tiles or similar in the wall. We have used these successfully in many projects, but it turns out that calculated erosion is more of a psychological problem than a technical one.

An eroding facade is for many a cause for concern, but this is mostly due to a lack of knowledge and a lack of trust in the inherently changeable and impermanent nature of earth structures.

It is therefore important that we develop an architectural language appropriate to these material characteristics that can then help facilitate a broader acceptance and more widespread implementation of rammed earth constructions.

Prefabrication of rammed earth elements

Prefabrication offers several key advantages over earth building on site: it makes production independent of weather conditions, can be precisely calculated, and shortens the duration of construction works on the building site.
All these aspects allow optimal integration in modern, industrialised building processes. Through the advantages of prefabrication, the range of products and possible applications of earth building elements has also expanded considerably.

12 Calculated erosion: The weather-exposed facade of the Rauch House after two years of erosion

These advantages include the ability to carry out numerous work steps in a workshop or 'field factory' near to the site in optimal conditions unaffected by the weather. The assembly of the structures themselves can be carried out relatively quickly and on schedule. Finally, the water-solubility and malleable, formable material properties of earth make it possible to repair components and close joints between prefabricated elements easily and quickly, so that after drying they are practically no longer visible.

Currently, we are working together with GBD Lab GmbH in Dornbirn, Austria, on a two-year research project to develop a market-ready modular system of prefabricated rammed earth elements that can serve both as loadbearing and insulating elements, for example in facade construction.

The goal is to simplify the realisation of earth building constructions in urban contexts so that building with rammed earth can be made easier and become more widespread.

Photo credits

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