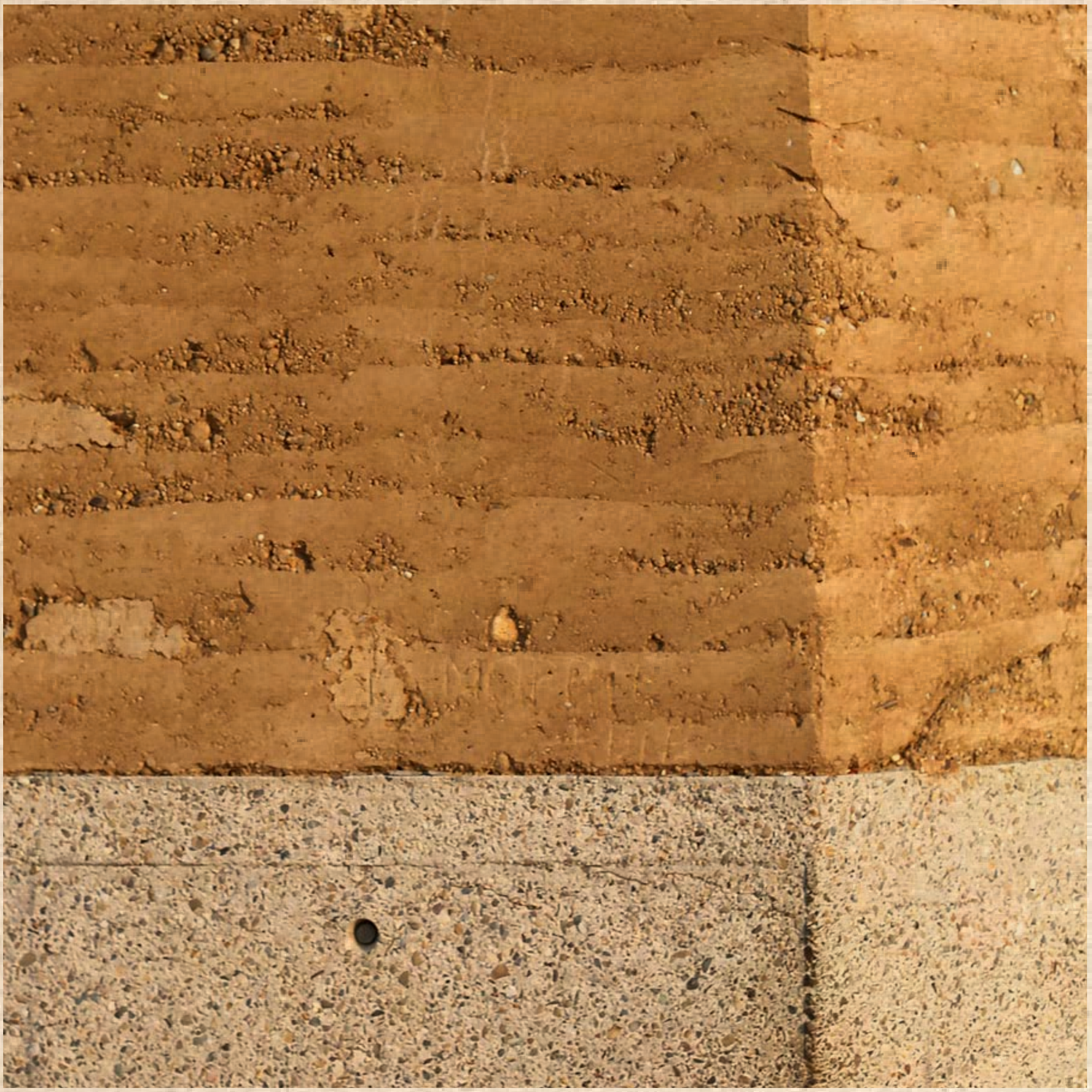


UNFIRED EARTH

fragility as power

instinctive

Pachamama

graceful aging

purity

future-proof

regional

erosion

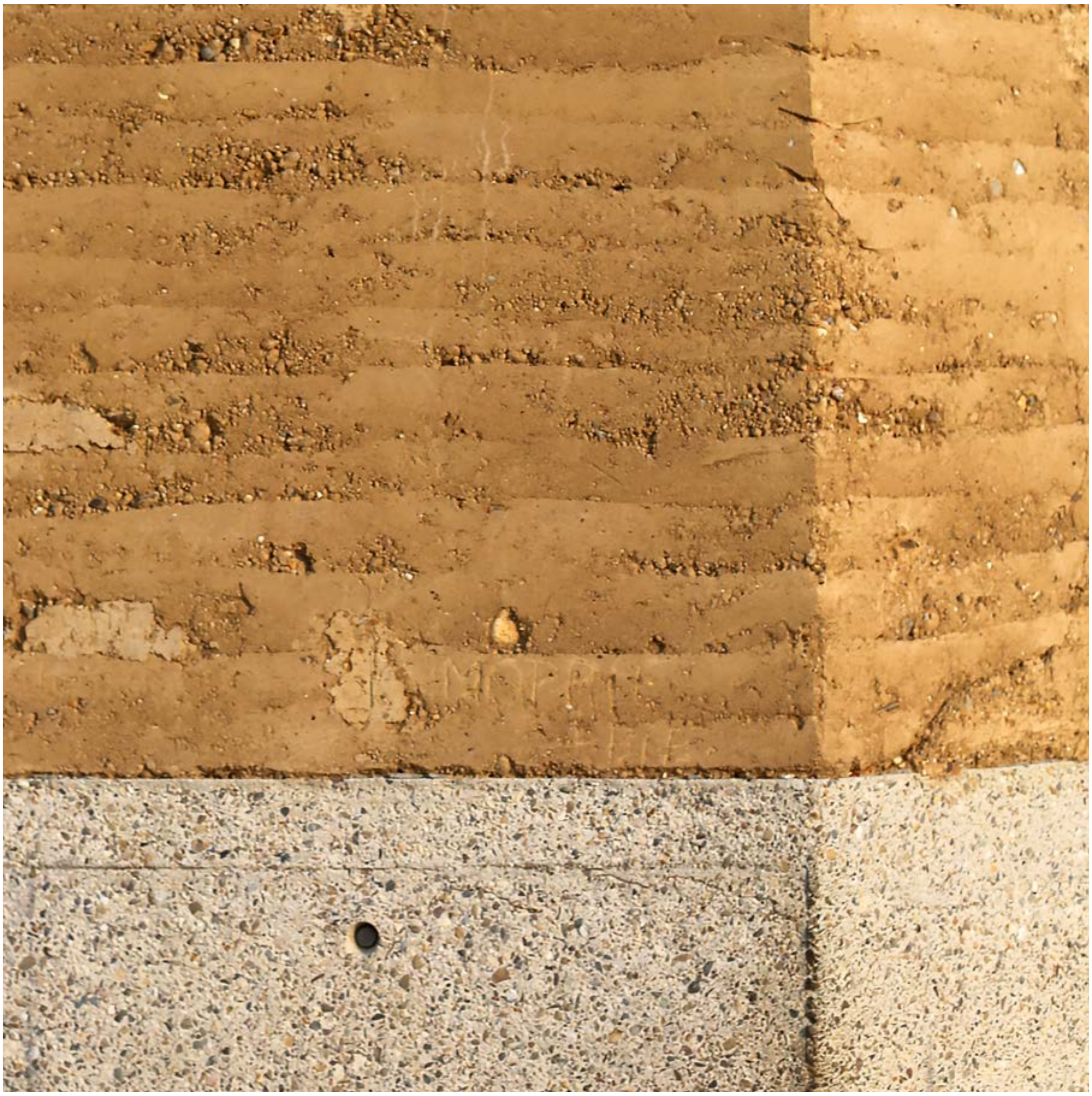
ephemerality

sensorial

mindshift

experience

texture



UNFIRED EARTH
in a post-industrial society

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Jasper Van der Linden is an architect, who obtained his master 'architecture: resilient and sustainable strategies' from Sint-Lucas, school of arts and architecture in 2014. He studied in Belgium, Istanbul and Buenos Aires and has been involved in earth construction projects in Europe and Africa since 2012.
From the end of 2017 till end 2019, Jasper was involved in a PhD trajectory at Hasselt University, faculty of Architecture and Arts. The trajectory focussed on the possibilities of earth architecture in a contemporary Western European context.

Those two years have been a time to explore, to research and experiment. This book is both the catalogue and a form of synthesis of this period.

PREFACE

UNFIRED EARTH
IN A POST-INDUSTRIAL SOCIETY

This book got titled 'unfired earth in a post-industrial society', encapsulating different stages and focusses that this project has followed. Earth refers to the primary, raw material, an inspiring resource that can be approached from different perspectives.

The first perspective being the ecological one, following from a desire to find solutions for the massive environmental challenges that are put on our plate nowadays, and which are not in the least created by the building sector. It is our duty to evolve to a future in which materials leave a minimal impact on our environment in the long run. As a reminder of the positive role that earth could take in this challenge, 'unfired' has been prepositioned to earth. The state of being unfired is a prerequisite for keeping earth as a material which demands a minimal energy during production. Unfired earth takes the future into account, it can get brought back to its original status leaving less traces when the earth has 'done its job' and gets disposed.

A second perspective is a social one. Hassan Fathy introduces in 'architecture for the poor' in 1969 [1] how the use of earth as a building material is a very adequate and democratic choice. This follows from the reasoning that it is a material that is widely available, requires little tools to transform from material into a building, and is therefore available for everyone. Surely, this might be a strong point for a non-industrialised context such as rural Egypt, in an industrialised Western-European context, numerous competing building materials are available ready-made and at affordable prices. The use of earth as 'architecture for the poor' also points out a weakness; the association with a poor man's material might lead to a low social acceptance.

To trigger a positive social acceptance, an understanding of how people experience earth is of great value. During several earth workshops and visits of earth buildings, I encountered many people who were passionately dragged towards the earth material for various reasons. For how it erodes through time, or how there are always variations within the material surface, or how it is possible to construct something with a material that was simply seen as useless soil before. Can the enthusiasm of earth adepts be declared by a fatigue of anonymous and identical mass production materials? Can we perhaps call these people from the 'aspirational class'? Elizabeth Curidd-Halkett describes this class as a new elite that tries to distinguish itself by the search of leading a good life [2]. Self-development and morality are key-points for the people from the aspirational class. Nina Polak continues on this concept, describing how the contemporary men is in search of experiences. This idea builds further on the foundations of the 'experience economy' [3], claiming that clients need to get offered experiences, not materials.

To follow up on this perspective, to fulfil the desires of the contemporary men, the focus in this book does not only go towards earth as a matter, but also to how this matter is experienced. Earth, one of the four primary natural elements, is a material that invites to be experienced; being a very sensorial material that evokes a close relationship between man and material. Besides the craving for experiences, Nina Polak continues with advocating that the aspirational class, in search for leading a good life, might become a class that excels in ecological ascese. Could it then be that the use of earth matches the search of the aspirational class very well; a search towards experience, self-development and morality? Earth as a material that is closely linked to locality, which on itself relates again to identity and ecological proximity, on craftsmanship, the passing on of knowledge and skill.

The importance of material experience of earth has been nicely put in words by Romain Anger and Laetitia Fontaine, founders of the research group Amaco [4];

[1] Fathy H. 2010 Architecture for the poor: an experiment in rural Egypt: University of Chicago press.
[2] Elizabeth Currid-Halkett describes in The Sum of Small things, a theory of the aspirational class (2017) a new elite that does not get defined by income, but by cultural capital'. Taken from the thorough analysis by Nina Polak (zo leeft denkt en klaagt de elite van nu)
[3] The experience economy, by Joseph B Pine & James H. Gilmore (1998) describes how companies should mostly offer their clients memorable experiences. Memories do become the product.
[4] Amaco is a French institute dedicated to the research and communication around grain and fibrous materials
[5] From: pisé tradition and potential (2019), p.168; Rammed earth, texture and function By Romain Anger & Laetitia Fontaine

"Beyond all ecological, social, economic and cultural reflections, earth, in its simplest and purest material expression, has an overwhelming emotional potential. This material is a part of us, charged with our emotions. Today, numerous artists draw on this substance for its expressiveness, plasticity, colors, textures, cracks, traces or impressions, and ability to preserve these attributes. Through these works of art, earth challenges the abnormal relationship of man and matter - a relationship that turns the oceans acidic, pollutes the air and downgrades Mother Earth, the source of all life, to a trash can. All human achievements, including architecture, reflect a certain view of the world. Most buildings today are not contextual, but rather reflect our likeness: uprooted and lifted. Conversely, the emotional charge of certain local architectures stems precisely from the fact that they are not cut off and disconnected from their milie and only appeal to the people who shaped them. They are contextual, rooted in their territory. They are one with the earth from which they originated. Such architecture touches our very core and shows us that matter is not just the "flesh" of architecture but of the world, of all being. Our flesh. It connects us with ourselves and with the world. All you have to do is reach into a heap of earth in order to connect with this original emotional and symbolic epidermic charge, in which the forgotten internal intelligence has its origins." [5]

The aim of the 2-year project was to scout the potential of earth as a building material in contemporary Western-Europe. Such potential could be easily approached from a purely technical or economical point of view. You might be surprised how earth is not at all a low-cost material in Western-Europe. Given the amount of man-hours, in the preparation and execution from raw material to finished product, prices rise quickly. This economic point of view, following from a capitalistic viewpoint, is one that can't be ignored.
Technically, the conventional construction market demands high standardisation, precision and predictability. If the goal is to respond to the demands of the conventional market, norms and certification that are now lacking would have to be put in place and production processes would have to be approached with more industrial methods.

It remains an open question, and discussion for debate how the earth material can further develop to fit within the contemporary market, while staying true to its qualities of being a material that is strongly intuitive, a material that has a story of locality, ecology, craftsmanship and tactility. Could it be that to satisfy these post-industrial desires, that an industrialisation of the material production would be necessary, so that it can respond the quality and quantity of today's market?

Or is it the strong point of earth that it is not yet part of this conventional building market? That it allows us to rethink the way we build, experimenting with a model where environmental solutions get the upper hand on financial reasonings. Where a social and cooperative way of building is deemed more important than efficiency. Where surprises, imperfections and fragility are embraced.

In this book, I'm offering insights, visions and reflections.
I'm showing you examples and experiences around earth, architecture, craftsmanship, ecology and society. To nourish and evoke further debate and action on how we can shape our world, and the world around us.

Jasper Van der Linden, October 2019

1

THE MATTER EARTH

Earth is an intuitive material, it's known to everyone and therefore ordinary. But earth is also a mysterious material. Every earth has a geological history. It is the result of a long erosion, decomposition and weathering process. This results into a mixture of grains, water and air. These three elements together create a solid material with which walls, a structure or a building can be built. There is a magical cohesion between all these particles. In order to understand this cohesion, and therefore the potential of transforming an ordinary material into a powerful building material, it is essential to look at the ingredients from a new angle.

Earth is a grain mixture that can be separated into different components by sieving it with different size meshes. Rinsed with water, the grains are clearly visible. Depending on their size, they have different names: broken stone, gravel, sand, silt and clays.
The clay, which makes up the finest part of the earth, can be very different. Mixed with water, these microscopic particles form a paste of homogeneous colour, reminiscent of a type of 'glue' and similar substances that, like clay, have a sticky texture and consist of very small particles. Just as cement binds aggregates in concrete, clays are the binder for earth.
However, water is the actual binding agent within the clay. A wall of earth, even when dry, contains a small amount of water trapped between the clay sheets. This water never completely evaporates because it is in balance with the humidity. Between the clay sheets, water forms capillary bridges, which ensure the cohesion of the dry clay binder.
The bigger particles (silt, sand, gravel) are necessary to give structure to the material. When combining different grain sizes, empty spaces between the grains are filled by ever finer grains, so that the entire space can be filled with entities. This is called the Apollonian stacking (see figure on next spread).

Text based on extracts from 'rammed earth, texture and function' by Romain Anger & Laetitia Fontaine in pisé-rammed earth, tradition and potential, 2019, p.168-171

TERMINOLOGY

"Terminology vary depending on language, history, culture. Definitions vary depending on the research field and scope. Variations in soil types, diverse climatic conditions and a wide range of building techniques and numerous architectural details have resulted in culturally and geographically distinctive architecture. These differences are precious for the survival of local distinctiveness.

To match this diversity earthen architecture has generated variation within its nomenclature. Clay, loam, soil, mud or earthen architecture are interchangeable terms used to describe the same type of building, where earth is the major constructional material. The name of the same construction techniques also differs from country to country and sometime across regions." [1]

Different terms in different languages already suggest some of the characteristics of earth. For example 'mud architecture' in English suggests that earth should be mixed with water, since the definition of mud is a mixture of earth and water. In Dutch and German, 'leembouw' or 'lehmbau' hints to a specific type of earth that contains clay since 'lehm' is a specific type of earth that contains a significant amount of clay. And in French often 'architecture en terre crue' is used, or raw earth architecture. The raw, unfired earth indicates the difference between a classic 'fired brick' or an unfired brick. Both can be made from similar ingredients, but the unfired brick distinguishes itself through its process.

terre crue
lehm
earth
loam
mud
clay
soil
adobe
aarde
leem

INGREDIENTS

"Clay-rich soils are part of the top layer of the earth's solid crust which was formed under the influence of weathering, flora, and fauna. This makes them available nearly everywhere.

The inorganic, solid components are formed from residual parent rock and parent minerals. Inorganic or mineral soils can be divided into four main types according to their prevalent grain size; clay, silt, sand and gravel (see fig. next page).

Generally, soil consists of a blend of these main types. Clay-rich soils are typical examples of mixed-grain soils. The cohesive clay minerals fulfil the task of holding together the coarse grains of silt, sand, and gravel which make up the soil's 'skeleton'. Clay-rich soils are cohesive soils.

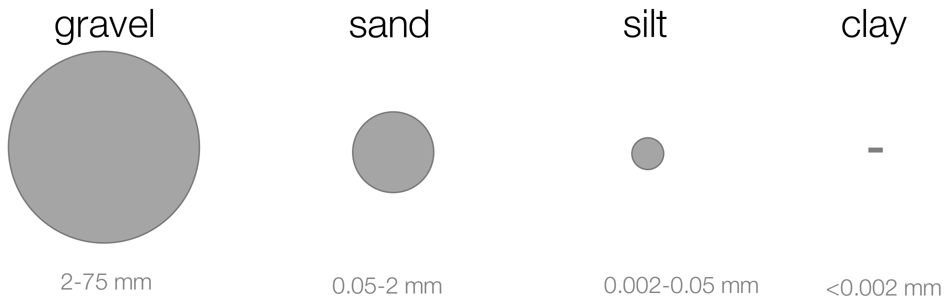
Besides the solid components, earth also contains liquid and gaseous components; water and air." [2]

A specific mixture of these ingredients will be available in the earth anywhere. Depending on the distribution of the grain sizes; bigger gravel or only small gravel, much clay or few, etc., one type of earth might be better suited for one earth technique or another. For example adobes typically consist of smaller material, while the rammed earth technique allows to use bigger gravel.

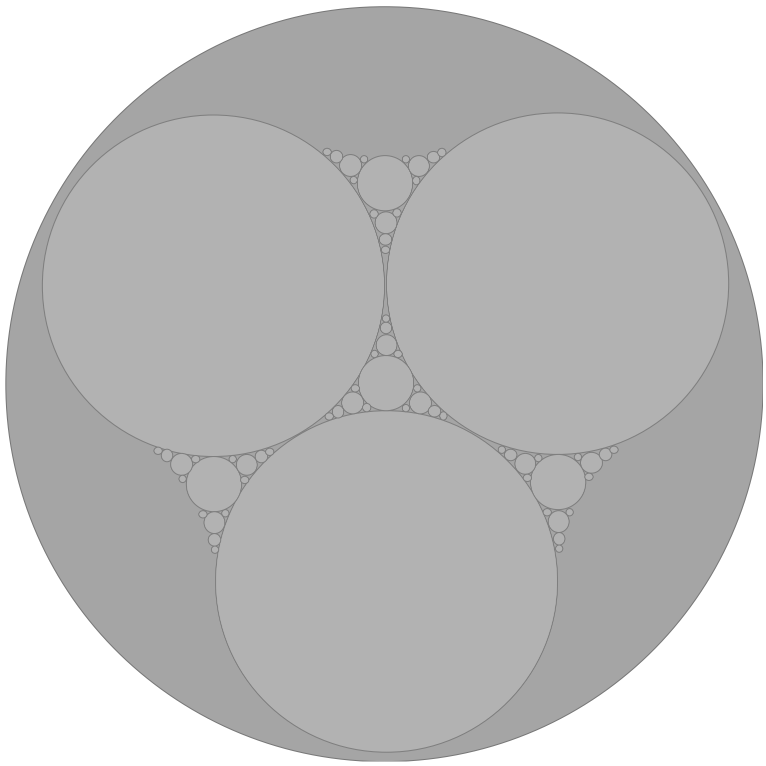
Only certain earth mixtures are suitable for construction purposes. It is rare to find naturally-occurring earth mixtures with ideal relative proportions of binding and non-binding constituents. [3] In order to control exactly the distribution of the grain sizes, contemporary earth construction mixtures are recomposed mixtures with the desired amount of particle sizes, allowing a more controlled and consistent mix.

Finally, for some techniques fibres are added to the mixture. Fibres hinder cracking, accelerate drying, lighten the material and increase tensile strength.[4]

[1] Text based on 'Earthen architecture. (2006). In G. M. Reeves, I. Sims, & J. C. Cripps (Eds.), Clay Materials Used in Construction: Geological Society of London.
[2] Text based on 'Schroeder H. 2016 Sustainable building with earth. Basel, Switzerland: Springer., p.49
[3] Röhlen U, Ziegert C. 2011 Earth Building Practice: Planning-Design-Building: Beuth Verlag., p.7
[4] Houben H, Guillaud H. 1994 Earth construction: a comprehensive guide. London: Intermediate Technology Publications., p82
[5] The following spread demonstrates a library of different clays, sand, gravel and fibres, all sourced in Belgium. Depending on the exact mixture and applied shaping technique they can result in a large variety of materials with different properties and characteristics.



particles present in
earth mixture



particles binding in
appolonian gasket

TECHNIQUES

adobe:
The adobe is an unfired earth brick. A mixture gets thrown into a formwork in a malleable, plastic state. Then the formwork is slided off and the brick needs to dry. The earth mixture contains clay and sand, but no gravel and gets usually mixed with fibres such as straw. After drying, the bricks are used to mason walls.

compressed earth brick/block:
Compressed earth block (CEB), are bricks made by compressing an earth mixture at high pressure into a mould. The press can be either manual or hydraulic. The earth mixture is usually rather sandy, it should not contain gravel. When compressing it should be contain a low amount of water, so be in the humid state.

rammed earth:
Rammed earth is constructed by ramming earth, layer by layer, in a formwork. This way monolithic walls are constructed, the formwork can be taken away immediately after ramming. The mixture for rammed earth consists of aggregates, including gravel, sand, silt and clay and should be rammed in a humid state.

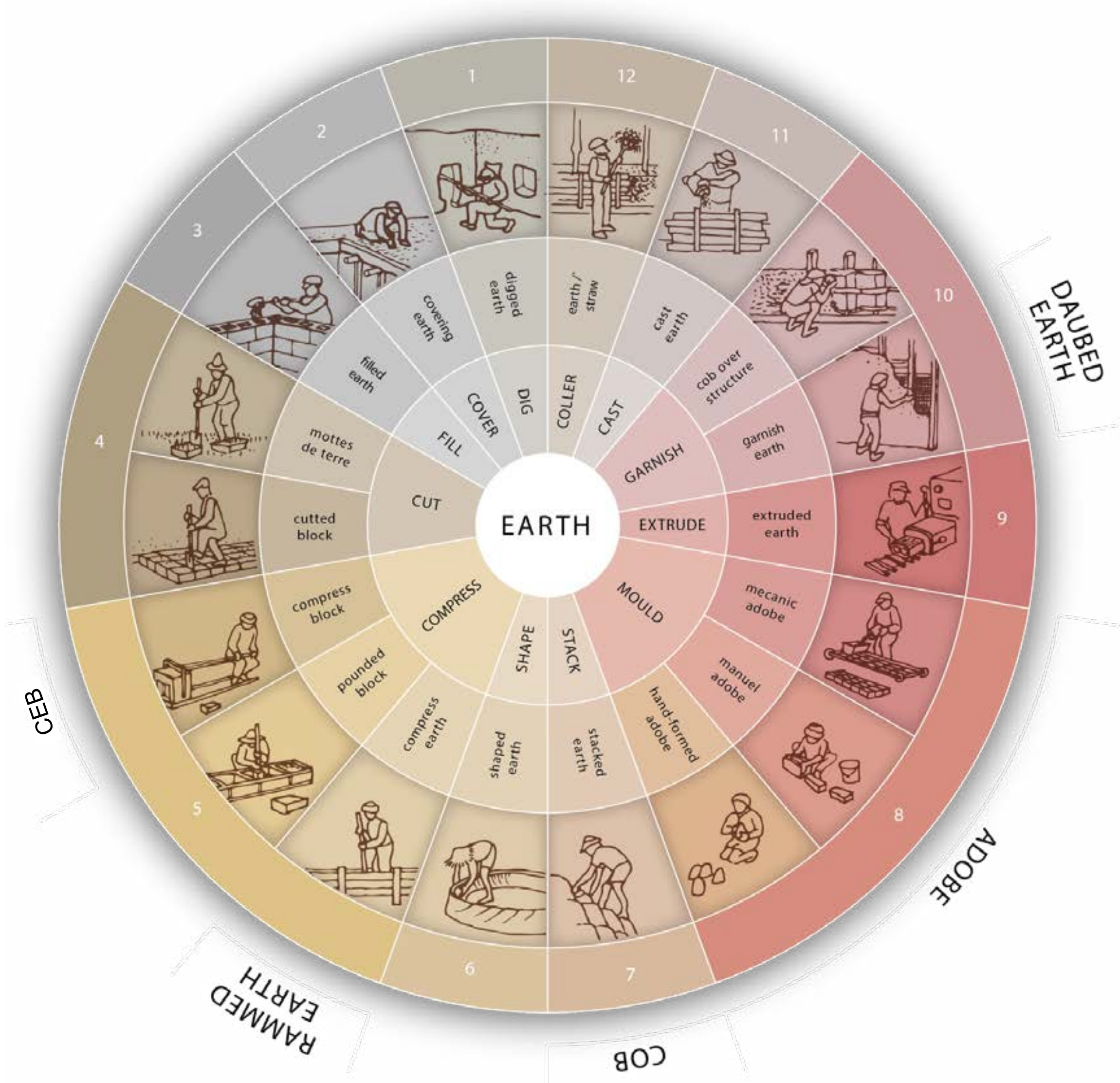
cob:
Basically the cob procedure consists of stacking earth balls on top of one another and lightly tamping them to form walls. The earth mixture is similar to the one used for adobes. This mixture gets stacked in a wet state, in order to build monolithic walls.

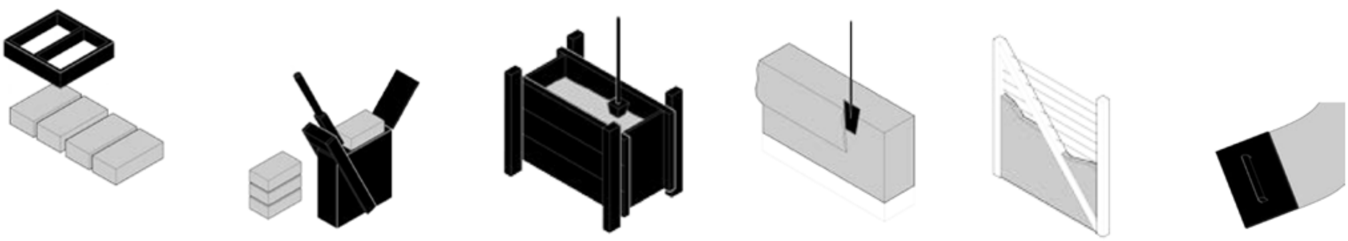
wattle and daub:
A bearing structure, usually wooden, is filled with a daubed lattice or netting woven from vegetable matter. An extremely clayey earth is used which is mixed with a straw or other sort of vegetable fibre to prevent shrinkage upon drying. [4]

plaster:
Earth plaster may be a finishing rather than a construction technique, it is the most used earth building application. A fine mix (usually with fibres) gets applied on a wall. Depending on the basis of the wall and desired roughness of finishing one or more layers can be applied.

more info can be found on the sources mentioned at chapter terminology, as well as in:

[1] Houben H, Guillaud H. 1994 Earth construction: a comprehensive guide. London: Intermediate Technology Publications., p82
[2] Maskell, D., Reddy, B., Walker, P., & Heath, A. (2016). Modern earth construction techniques—an overview: Proceedings of the 16th International Brick and Block Masonry Conference, Padova, Italy, 26-30 June 2016.
[3] Niroumand, H., Barcelo, J. A., Kibert, C. J., & Saaly, M. (2017). Evaluation of Earth Building Tools in Construction (EBTC) in earth architecture and earth buildings. Renewable and Sustainable Energy Reviews, 70(Supplement C), 861-866. doi:https://doi.org/10.1016/j.rser.2016.11.267
[4] Tbe logo's on the right page were presented in: Gauzin-Müller D. 2016 Architecture en terre d'aujourd'hui.
[5] The wheel on the right page is a reworked version by amaco from the overview originally shown in [1]





(eng.)	**adobe**	**compressed earth brick** (CEB)	**rammed earth**	**cob**	**wattle and daub**	**plaster**
(fr.)	adobe	bloc de terre comprimée (BTC)	pisé	bauge	torchis	enduit
(nl.)	adobe	leemsteen	stampleem	stapelleem	leem en vitswerk	plaaster
(de.)	lehmstein	lehmstein, gepreßt	stampflehm	wellerbauweise	leichtlehm	putz
	wet moulded	dry compressed	dry compressed	wet stacked	wet garnished	

illustrations: Amaco

2

THE POWER OF VERNACULAR

The following story [1] depicts in a very concrete way the power of vernacular;
"When the Dutch mission, the Herrnhuten, came to Labrador in 1771, the Eskimos lived in large family groups in houses of stone and peat. The rooms were small and warmed by lamps fuelled by blubber. One of the first things that the new settlers did was to introduce a new form of house. They built a series of timber houses with large rooms heated by wood-fired iron stoves. This had a radical effect on the whole of the Eskimo society. They had earlier obtained fuel oil from seals by hunting. The meat provided food and the hides could be used for clothes and boats.
The change of house made fetching wood a very important task for them. The forest was a long way away and the sleigh dogs needed to eat more meat to manage the transport, so seal hunting had to increase as well as wood gathering. The need for wood became so great during winter that it took longer than all the other tasks put together. Despite all their efforts, it became clear that the new timber houses could not give the same warmth and comfort as the original earth houses."

Vernacular architecture embodies a plurality of constraints from places where it belongs, in which the use of local materials and techniques is one of the main features. In their paper 'vernacular architecture as a model for contemporary design' [2], the authors state the following; compared with industrially-produced materials, vernacular materials have low environmental impacts, being an alternative for sustainable construction. The increasing use of new industrially-produced and standardized materials led to the homogenization of the different used construction approaches, and spawned a universal architecture that in many cases is out of the environmental context and is very dependent on energy and other resources.

They continue mentioning that the quest for a deeper approach of contemporary architecture to nature sometimes conceals the achievements of the past. Vernacular architecture is, by its definition, aim and structure, the most integrated architectural form in communion with the environment. "*Two important traces of vernacular architecture can be resources for contemporary architecture: the deep respect and perfect communion with the natural environment and the perfect relation and understanding of users need. As the result of a complex balance between material, shape and natural context, vernacular architecture could become an extremely useful model of inspiration for the present.*" It is exactly within this complex balance between material, shape and natural context, that earth could play a role in creating adequate, contemporary, humble architecture.

"*Traditional earth building materials were the mainstay of a significant proportion of past societies, and today it is estimated that around one-third of the world's population live in buildings made from unfired earth.*[3] *Since these materials and techniques are the most prolific, both historically and in modern times, and have one of the greatest proven track records in terms of longevity (some buildings being several hundred years old) it might well seem reasonable to argue that by definition they are the most conventional construction material of all. Ironically, they are commonly referred to with terms such as 'non-conventional', 'alternative' and 'low environmental impact' within the modern construction industries of western society.*" [4]

[1] Berge B, Henley F. 2001 The Ecology of Building Materials: Architectural Press.
[2] Creang E, Ciotoiu I, Gheorghiu D, Nash G. 2010 Vernacular architecture as a model for contemporary design. WIT Transactions on Ecology and the Environment;128:157-71.
[3] Houben H, Guillaud H. 1994 Earth construction: a comprehensive guide. London: Intermediate Technology Publications.
[4] Hall MR, Lindsay R, Krayenhoff M. 2012 Modern earth buildings: Materials, engineering, constructions and applications: Woodhead Publishing. 776 p.

TRADITION
WORLDWIDE

Unfired earth has been used as a building material for millennia. Architecture in the ancient cultures of Egypt, the Middle East, China, Central Asia, and Latin America was closely tied to this material. In Central Europe, as well, there is archaeological evidence of the use of earth as a building material for thousands of years. Schroeder opens his book 'sustainable building with earth' [1] by mentioning how *within the individual regions, practical experiences with the material and the resulting building rules were passed down for generations leading to construction methods which were affordable and optimally developed for the respective climates. The buildings were constructed from locally available materials, earthen structures blended well into the landscape and shaped the picture of rural regions and urban settlements over the centuries.*

Contrary to the perception of earth as a fragile, ephemeral material, earth buildings also represent the oldest extant buildings on the planet. Using approximately 7,000,000 mud bricks, the Ziggurat at Ur was constructed in 4000 B.C. [2]
The typologies of earthen architecture extend beyond buildings for living, and include structures for working and worshiping, as well as the countless forms of earthen architecture that are not inhabited by humans, such as agricultural buildings, city walls, and monuments [2]. Minke [3] refers to discovery of mud brick (adobe) houses dating from 8000 to 6000 BC in Russian Turkestan. And the discovery of rammed earth foundations dating from ca. 5000 BC in Assyria. The upper image on the next page shows the historical city of Yazd in Iran. It is listed by Unesco as the world's largest inhabited adobe city. The bottom image shows a fort in Skoura, Morocco, constructed in the 17th century.

"Earth is often typically seen as a building material only used in rural environments; however, a wealth of earth architecture can be found in urban environments. Called "the Manhattan of the Desert," the city of Shibam, Yemen, has a population density approaching that of New York City, with thirty-two people per acre, and is home to the world's first skyscrapers: a dense cluster of five hundred tower houses rising up to nine stories high constructed entirely of mud brick." [2]

"Even today, one third of the human population resides in earthen houses; in developing countries this figure is more than one half [4]. It has proven impossible to fulfil the immense requirements for shelter in the developing countries with industrial building materials, i.e. brick, concrete and steel, nor with industrialised construction techniques. Worldwide, no region is endowed with the productive capacity or financial resources needed to satisfy this demand. In the developing countries, requirements for shelter can be met only by using local building materials and relying on do-it-yourself construction techniques." [3]

[1] Schroeder H. 2016 Sustainable building with earth. Basel, Switzerland: Springer.
[2] Rael R. 2009 Earth architecture: Princeton architectural press., p9
[3] Minke G. 2007 Building with Earth: Design and Technology of a Sustainable Architecture: Birkhäuser Basel.
[4] Many academics, authors, builders, writers, and architects have noted that between one-third and one-half of the population of the planet lives in buildings constructed of earth, although none have cited the origin of this number directly. These sources might also be outdated. Although the exact number seems vague, the main message that earth is a widespread material stays standing.


Historal city of Yazd, Iran (picture taken 2011)


Skoura Kasbah Amridil, Morocco (17th century) (picture taken 2019)

TRADITION
WESTERN EUROPE & BELGIUM

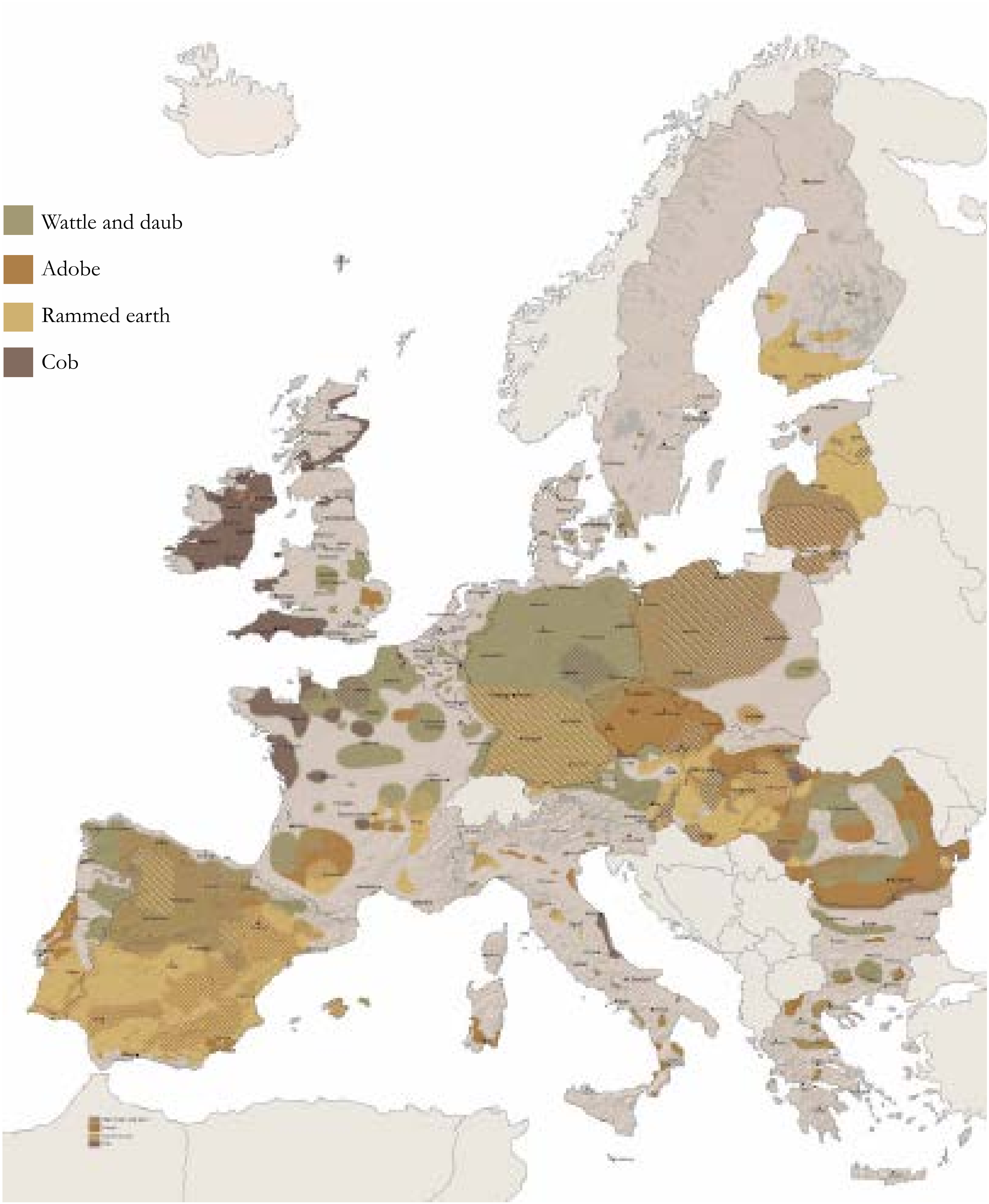
Western-Europe
Within Western-Europe, in each individual region various construction methods were applied based on practical experiences with the material and optimally developed for the respective climates and available materials. A map of Earthen Heritage in the European Union was published as part of an EU-funded project in 2011 [1]. The map was created in cooperation with 50 authors from 27 European countries, and shows the overall traditional earth building technique for each region (see next page).

In the Medieval period (13th to 17th centuries), earth was used throughout Central Europe as infill in timber-framed buildings, as well as to cover straw roofs to make them fire-resistant. In France, the rammed earth technique, called terre pisé, was widespread from the 15th to the 19th centuries. Near the city of Lyon, there are several rammed earth buildings that are more than 300 years old and are still inhabited. [2] Cob was, and still is, most present in the UK and Ireland.

Belgium
"*Following early industrialization in the 19th century, Belgium has known a quick generalization of the appeal to materials coming from industrial production (terracotta, stone and metal). This fact left deep marks on the monumental heritage. This explains why remaining examples of earthen architecture are rather scarce in Belgium and why the general public is unaware of the potential of this architecture, as well as many institutional contributors in the field of heritage conservation. However, scarce does not mean absence or insignificant residue.*" [1]

Wattle and daub (vakwerk)
Wattle and daub in timber frame construction is the most frequent technique identified in particularly the northeast and west of Belgium. It is also the most visible and the best-known technique. Significant remains have been recognized in all parts of the country. Particularly in Limburg, hundreds of buildings have been preserved. [3] *This tradition resulted from the abundance of forest resources (particularly in Ardennes) and also from the importance of clay soils. In towns such as Liège, as in the whole Meuse valley, timber frame dwellings filled with wattle and daub were revealed when the concealing plasters fell. In the countryside, the most visible timber frame appears as an efficient, as well as economical technique (as in the Pays des Collines, in Hainaut). This technique requires expertise of construction, which excludes self-building. The use of wattle and daub in timber frame construction was abandoned in the mid-nineties and in many cases, was replaced with fired bricks. In spite of its disuse, timber frame remains symbolically present in the collective imaginary, which is why much architectural heritage enjoys value given to its preservation and restoration.* [1]

[1] Correia M, Dipascuale L, Mecca S. TERRA EUROPAE. Earthen Architecture in the European Union. Pisa, Italia: Edizioni ETS.[Links]; 2011.
[2] Minke G. 2007 Building with Earth: Design and Technology of a Sustainable Architecture: Birkhäuser Basel.
[3] 'vakwerkhoeves', retrieved online on february 7th 2018 from https://inventaris.onroerenderfgoed.be/themas/83>
[4] see for example house Tackoen on the next spread


Wattle and daub
Adobe
Rammed earth
Cob

HOUSE TACKOEN

Building	Shop and office
Location	Hasselt, Belgium
Year of construction	1655
Year of renovation	1999
Earth technique	Wattle and daub
Architect renovation	Lens°Ass architects
Site visit(s)	March 18th 2018

The upper floors of House Tackoen are traditionally built with a wooden structure and earth (leem) infill. It is one of the oldest houses of Hasselt, the building dates back to 1655 [1]. It has been transformed into an optic store, while respecting the presence of the original timber-earth techniques. The image is typical for the traditional wattle and daub technique that used to be very common in Belgium.

The wattle and daub (staken en vlechtwerk) have been renewed completely. All outer and inner fillings were filled again with earth-straw mixture, and has been insulated on the inside with reed-panels. The outside has been finished with a historical lime plaster. The final result is an impressive showcase of how a contemporary renovation can be merged with the preservation of the traditional earth building techniques, present in this cultural patrimony. [2]

The current owner pointed out his enthusiasm on the inner climate of the building, despite the use of such old techniques. Acoustical qualities are less convincing, possibly related to poor detailing of the connections between the wood and earth parts. [3]

[1] information from www.2014.openmonumenten.be/limburg/hasselt/het-leerskehuis-tackoen
[2] information from www.claytec.be/nl/bauherren/lehmbaubeispiele/
[3] interview with owner on March 18th 2018


ARTLUX
LEDERWAREN

3

TOWARDS A CONTEMPORARY APPLICATION

Acknowledging the power of vernacular construction methods, includes to seek value in the practical experiences that have been traditionally built around earth materials. Schroeder [1] states that '*the traditional earth buildings were constructed from locally available materials which were sourced using environmentally friendly methods. Recycling of the buildings did not pose any problems: earth building materials could be reused indefinitely or could be returned to the natural cycle without harming the environment.*' While being wary to not romanticise or idealise traditional earth construction, there is definitely a lot to learn from the used principles. It offers the potential for using a local and abundantly available material, with a low need of energy to process the material; and the potential for harmless disposal at its end of life. Schroeder points out that in modern times, all of these aspects can be more or less summed up under the term 'sustainable building'.

"*For a long time, building materials and architectural design were mainly assessed in terms of structural design, material technology, and economy. Today, however, ecological criteria, particularly a building's energy consumption and its impact on the environment, have become increasingly important in the interest of sustainable development. Clients are requesting non-toxic, healthy building materials which create a comfortable indoor climate. Other popular aspects are the sensual characteristics of building elements, such as unusual textures as well as pleasant tactile surface qualities and a wide range of colours. These add to the desirability of earth as a building material.*

In this context, earth can be seen in a new light after years of being marginalized from conventional construction by industrially mass-produced building materials. For the conventional building materials, concrete, steel, reinforced concrete and fired brick, and specialized fields of science have developed within the area of civil engineering, particularly over the past 50 years. This development has also led to intensive teaching and research activities at universities. Later, the same became true for timber construction. As described above, for earth as a building material, things have developed differently. A separate field of science for "earth building" is only in its beginning stages." [1]

It might be exactly this disconnection from the 'conventional' building materials that result in a will to maintain the initial potential for low impact building when using earth. There is a search to keep using unstabilised earth materials, in order to minimise impact at the start and end of the life-cycle of the building. [2] Another example is the aim for smart sourcing and processing to avoid finite material excavation. Instead of mining material, one can gather suitable excavation soil and process it to earth building products or mixtures. [3,4]

Besides these gracious aims, there are also different advancements within the field of earth construction to fit within the current economic system. A system where time- and cost-efficiency are dominant. One way of lowering the costs would be to scale-up the production of earth material products, doing this in a more industrialised and standardised way. This prefabrication process is mentioned later on this book. Another way of dealing with it could be to accept the additional price and to approach earth as a unique building product, which reflects certain values such as locality and craftsmanship.

[1] Schroeder H. 2016 Sustainable building with earth. Basel, Switzerland: Springer.
[2] Especially in Europe, protagonists such as Martin Rauch have been advocating the use of unstabilised earth construction. Besides, especially in the US and Australia, it is much more standard to apply stabilisation with lime or cement.
[3,4] Terres de Paris and BC materials (Brussels) are two projects that aim at using excavation material in a city-context.

3.1

CONTEMPORARY USE OF EARTH IN BELGIUM

In Belgium, the use of unfired earth is currently not very present. Elsewhere, the tradition of unfired earth survived much longer; in Japan for example, the traditional techniques and art of sublime earth plastering is still alive [1]. In Iran and Morocco, the heritage of earth construction is immense and therefore very visible (see tradition worldwide). In Europe, Cob heritage is still very widespread in the UK, rammed earth in the southeast of France, Spain and Portugal. In Belgium, some wattle and daub constructions remain and have been restored with respect to the original technique (see House Tackoen). In general, the earth material is used in buildings from the past.

But, as advocated before, also in contemporary Western-Europe and Belgium, the use of earth material has a potential. Especially on an environmental level, it could be beneficial to use unfired earth. However, there are only a limited amount of references using unfired earth, both in the field of heritage as in contemporary architecture. This makes the material float between a material from the past, almost forgotten or 'afgeschreven' and a material of the future, that gets fresh chances since it fits within a forward-looking approach, corresponding with current ecological challenges. Meanwhile it's a 'new' material since it is unknown in this form by the majority of the people.

Although earth building is an experimental niche in Belgium [2], the material received significant interest; exhibitions specifically about earth construction (Terra award in Mons, Brussels, Tienen) and contemporary architectural projects using unfired earth (see following spread) have emerged the past decade. Based on this current interest, there might be the potential for the field to transit from an experimental niche towards a growth market. Ideally, a growing market of earth construction materials would substitute a part of the conventional materials with much higher environmental impact, such as concrete, and fired bricks, where adequate.

[1] Referring to the Sakan technique, as observed during a study trip in Japan in september 2019, organised by Terramigaki and GEN
[2] Lefebvre P. 2018 BC architects & studies - The Act of Building: Flanders Architecture Institute.

BELGIUM
15 CONTEMPORARY PROJECTS

1 Hunting house Oordegem - 2012
rammed earth - pavilion
BC architects&studies
2 Youth complex de Zandberg -2018
compressed earth bricks - walls
Robuust architectuur & onderzoek
3 private house Buggenhout - 2018
rammed earth+compressed earth bricks - earthship
architect Maarten Martens
4 private house Tienen - 2017
rammed earth - 15m interior wall
architect ast77
5 bioclass Edegem - 2017
compressed earth bricks - walls
BC architects&studies
6 rammed earth tower Negenoord - 2016
rammed earth - exterior walls
de gouden liniaal architecten
7 Community house De Okelaar Wolvertem - 2015
compressed earth bricks - interior walls
architect Maarten Martens
8 Hotel Sleep Wood - 2015
rammed earth - walls
Druwid
9 De Helix Grimminge - 2019
rammed earth - pavilion
Dam architecten
10 Source O Rama Chaudfontaine -2004
rammed earth - interior wall
A2 / ZRS
11 Group housing Profondsart - 2018
compressed earth bricks - walls
Karbon architecture et urbanisme
12 Private house
rammed earth - walls
Druwid
13 private house Kapelle-op-den-bos - 2014
rammed earth trombe-wall
Wannes Thienpont
14 private house Erpe - 2013
rammed earth - exterior wall house extension
BC architects&studies
15 Bakery Bokrijk - 2015
rammed earth - floors and bar in patrimonium building
BC architects&studies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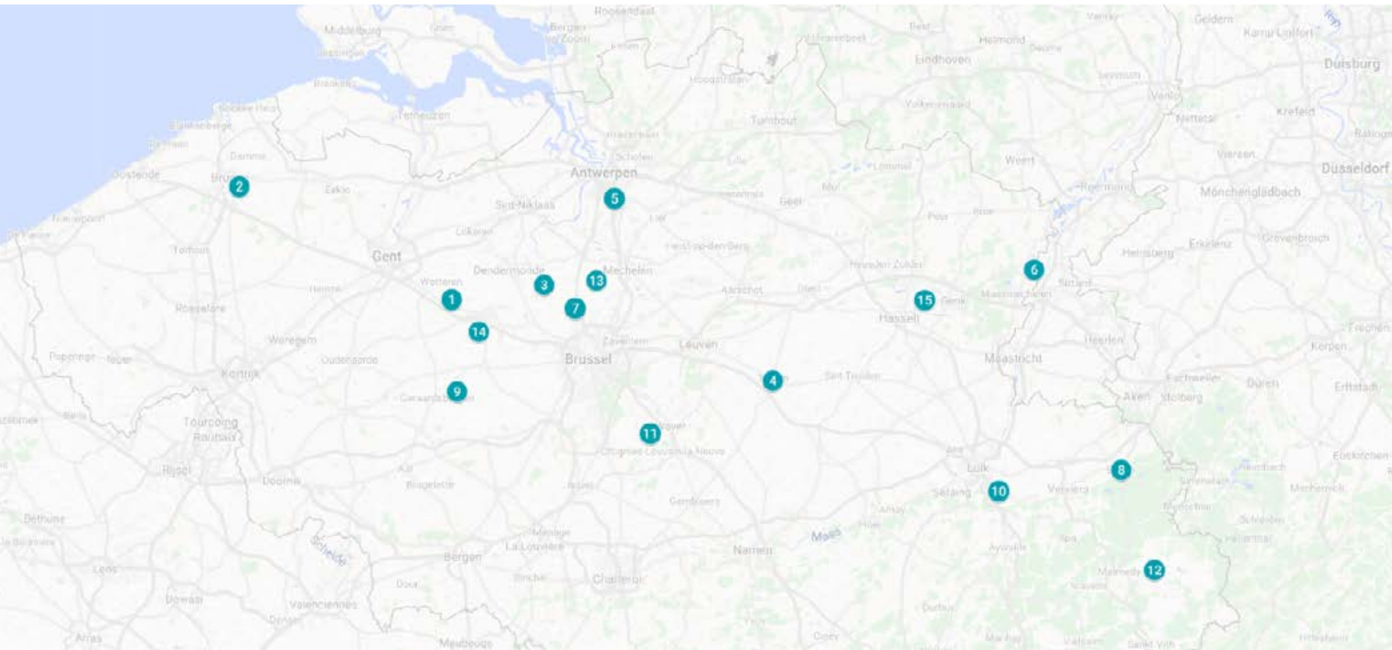
12


15



WATCHTOWER

Building	watchtower
Location	Negenoord, Limburg
Year of construction	2016
Earth technique	Rammed earth
Architect	De gouden liniaal
Earth consultant	BC studies, Craterre, Vessiere&Cie
Site visit(s)	25th of August 2015 12th of July 2019

On a former gravel excavation area in Negenoord, a watchtower has been erected to overlook the natural reserve. The watchtower is designed with external rammed earth walls and a concrete core, with in between concrete prefab spiralling stairs resting onto the stabilized rammed earth walls of 80 cm thick and 12 m high. The surface of the rammed earth external walls slowly erodes, exposing the gravel after a while. (bottom images; on the left is the west facade, which erodes significantly faster than the other sides)

The tower is one of the first contemporary public earthen building in the Benelux region. At the moment of writing, there are no standards for earth construction technique, which makes it difficult to describe rammed earth for use in a public project.
To guarantee the quality of the earth construction, the design and construction team was supported by an international team of experts in rammed earth. These consultants defined a material mix (20% gravel, 40% sand, and 40% loess, stabilized with 6% hydraulic lime), using materials from nearby excavation sites. Also, they advised on how to organise the construction site for in-situ earth mixing and rammed earth construction. Despite the consultancy, training of the contractor and follow-up, difficulties with the maintaining of a correct humidity level arose during construction. This resulted in the choice of the contractor to use of cement instead of lime as stabilizer. The rammed earth works took 7 weeks, carried out by a professional contractor.

[1] De Gouden Liniaal Architecten. Uitkijktoren Negenoord, Dilsen-Stokkem [cited 2018 jul 27]. Available from: www.degoudenliniaal.be/index.php?/albums/uitkijktoren-negenoord-dilsen-stokkem/.
[2] Van der Linden J, Knapen E, Janssens B. 2019 Potential of contemporary earth architecture for low impact building in Belgium. SBE19; Graz.

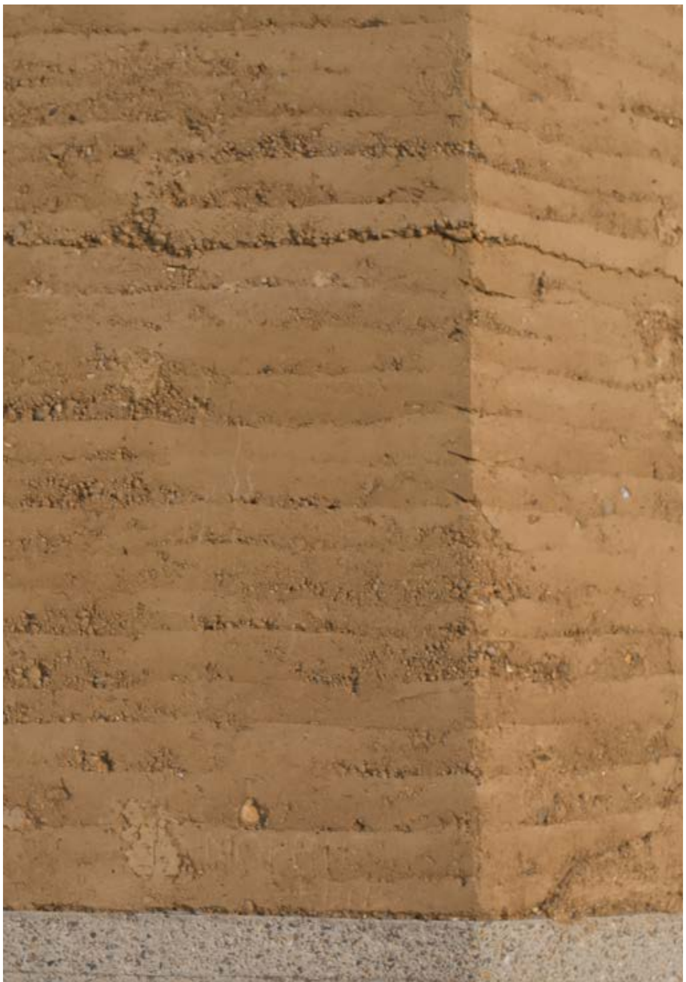



image: Thomas Noceto

BIOCLASS

Building	bioclass
Location	Edegem, Antwerp
Year of construction	2017
Earth technique	compressed earth brick (CEB)
Architect	BC architects
Structural engineer	Util
Site visit(s)	15th of December 2017 10th of July 2018

The bioclass, a class for nature education built in an existing warehouse was constructed with compressed earth bricks (CEB). These bricks, masoned into one floor high walls, are the loadbearing construction of the building. Towards the inside, the bricks are left apparent without extra finishing (see image). An insulating exterior façade and roof of hempcrete is left apparent as exterior finishing.

The bricks are made in-situ using clay from a nearby quarry, mixed with sand (Benor, 0/8) and without addition of a chemical stabiliser such as lime or cement. During a 3 week workshop with volunteers, 19000 bricks were produced using a hydraulic CEB machine [1].

The bioclass demonstrates that it is possible to construct with unstabilised CEB in a loadbearing way if construction conditions are dry. The design and detailing takes into account the nature of the material by using its compressive strength (3,3MPa) through arches and by avoiding contact with water. This was done by offsetting the brick from the floor and not using it near the bathroom.

[1] BC architects. Regional house edegem [cited 2019 jan 22]. Available from: http://architects.bc-as.org/Regional-House-Edeghem.
[2] Van der Linden J, Knapen E, Janssens B. 2019 Potential of contemporary earth architecture for low impact building in Belgium. SBE19; Graz.

image: Thomas Noceto

REFLECTION ON
THE APPLICATION OF EARTH IN BELGIUM

In 2016, Egenti & Khatib [1] made an overview of advantages and limitations commonly associated with earth construction, based on a literature review. However, it is not possible to generalise these to the Belgian or Western-European context due to the case-specific context and constraints.

Advantages
Low cost
Encourages self-help with less skilled labour
Good sound insulation
Good heat insulation and fire resistance
Capable of providing strong and secured structure
Promotes culture, natural material
Improves indoor air quality
Low impact
Reusable
Low embodied energy
Saves energy and no emission of CO_2
Sufficiently available

Limitations
Non-standardised material
Non-resistant to water and less resilient
Needs high maintenance
Structurally limited
Suitable only for in situ construction
Special skills (required for plastering)

Based on own case study analysis of two contemporary architectural projects (presented on the former pages), the points in the literature review are being verified. These projects were recently built in Belgium and contain main walls of unfired earth. Meanwhile, they reflect an image of contemporary material use. Both are public tenders, therefore needing to fulfil common standards for Belgian construction.

A semi-structured interview was done with the architects of both projects to identify important financial, technical and environmental aspects of building with earth in Belgium. A preparatory and subsequent analysis was done based on the architectural plans and technical reports and through site visit(s) of the projects.

Case I: watchtower Negenoord [2]
Case II: Bioclass Edegem [3]

[1] Egenti C, Khatib J. 2016 Sustainability of compressed earth as a construction material. Sustainability of Construction Materials (Second Edition): Elsevier. p. 309-41.
[2] interview with architect Jan Thys, Januari 25th 2019
[3] interview with architect Nicolas Coeckelberghs, Januari 25th 2019

Environmental impact

In the literature review of Egenti & Khatib [1], it was mentioned that earth construction has 'low embodied energy' and 'no emission of CO_2'. Such claims have been nuanced for contemporary earth construction by Schroeder [4]. He mentions that "*the traditional manual processing of suitable excavation material into earth building materials and structures on the building site was and still is the ideal situation as far as the embodied energy is concerned*". He continues with the analysis that "*contemporary earth building is largely mechanized and characterized by the physical separation of building material production and product use on the building site. This automatically leads to energy consumption and transportation.*" This is also the case for the studied projects. The material on the site of the watchtower was a priori not suitable for construction. The former gravel extraction area where the tower is situated has been refilled and the earth was therefore inconsistent [2]. Also for the bioclass, no earth from the site has been used for the same reason. Additionally, it was practically difficult to specify a local earth mix already during the public tender phase since it would need an allocated budget for local soil investigation and specification of a reformulated earth mix [3].

However, in both projects, special attention went to the transportation distance between the excavation site of the earth materials and the construction site. The architect of the watchtower project mentioned that pre-mixed earth with specified material characteristics can be bought (f.e. from a producer in Germany), but they preferred a mix of locally sourced materials. Testing was done with different mixtures of material in the region resulting in an earth mix with material taken from within a range of 25km. For the bioclass, clay was bought from a nearby quarry, sand was bought at a local distributor. As the exact sand source is unknown, the distance on figure 3 represents the distributor.

Both projects used material from quarries; such choice is made because it is practical, the continuous availability is assured and the quality guaranteed. Sand, clay and gravel are indeed sufficiently available (in those regions) but are originating from finite resources. An alternative for this would be the industrial processing of suitable 'excavation soil' into earth building. This could result in a lower demand for landfill space and lower transportation impacts, both for excavation soil and for construction materials, which could be major environmental benefits for contemporary earth building [3].

In both projects, parts of the production and construction process have been mechanized. In the case of CEB, Schroeder [4] reports a duplication of the CO_2 emission as well as a tripling of the energy demand when mechanically instead of manually producing CEB's. However; it is clear that this are still very low amounts compared to fired bricks or concrete. Schroeder [4] claimed a CO_2 emission that is 63% lower for a mechanically produced and stabilised CEB compared to a fired brick.
For the rammed earth watchtower, 6% of cement has been added. Despite the absence of cement in the proposed mix of the earth consultants, cement was added. This to avoid any risk after a series of irregularities took place at the start of construction. The used mixture was differing from the prescribed mixture, either by being more wet or not respecting the prescribed particle size distribution. Although the amount of added cement is less than a common concrete construction, the 12m high walls of 80cm thick contain a not negligible amount of cement. This is negatively impacting the CO_2 emissions during production.

A last topic concerns the possible future reuse and recyclability of the material. For the bioclass, a simple wooden structure and hempcrete is mounted on the CEB. This should make it easy to take apart the pure earth material, which can then be recycled or reused. If unstabilized, reversible clay binding allows a complete and low-energy reuse of earth at end of life [4,5]. Therefore, the lack of cement or lime as a stabiliser in the mixture is of significant importance. In the bioclass, a small amount of lime was added to the mixture, it has not been studied if this would negatively affect the recycling options. For the watchtower on the other hand, cement is contaminating the earth mixture, which eliminates the reversible binding process. Although the architect aimed to make a solid structure that will survive for a long-time, in the worst case needing some retouches [2], the end of life should be taken into account. In that context not stabilizing earth to improve recyclability is an important consideration, that could be of particular value for applications which are typically changed in a shorter time span, such as indoor walls.

[4] Schroeder H. 2016 Sustainable building with earth. Basel, Switzerland: Springer.
[5] Röhlen U, Ziegert C. 2011 Earth Building Practice: Planning-Design-Building: Beuth Verlag.
[6] Hamard E. 2017 Rediscovering of vernacular adaptative construction strategies for sustainable modern building: application to cob and rammed earth [PhD thesis]: Lyon.

Financial cost

Whereas the existing literature review [1] presents the use of earth in construction as an economic advantage, in an industrialized country with high labour costs, such as Belgium, low-quantity, non-industrial production for on-demand projects results in a significantly higher cost. In both case studies, earth was mixed on-site and processed in small amounts for the specific projects. When preparing construction materials on-site, the organization of the construction site becomes more complex and costly. Such on-demand material processing in small quantities is very different from the large-scale industrial production of conventional building materials.

Depending on the size, a non-industrial CEB would be around 30-40% more expensive than a conventional industrially produced fired brick [3]. However, with greater demand the unit cost of production would reduce [5] and through industrial mass production it might be possible to make unfired bricks which are cheaper than the fired brick [3]. A rammed earth construction, rammed on site, would be around 60% more expensive then exposed concrete [8].

Self-help can potentially lower the cost, but it is not always evident to do so. In the case of the watchtower, the involvement of unskilled labour in the construction process was impossible because the public client did not allow it. For the bioclass, workshop sessions with unskilled labour lowered the price of on-site brick production. During the workshops, the participants were offered practical experience and knowledge sharing. However, the cost to organize such workshop on a high level, as including the training of the participants and preparation, should be taken into account. Although self-help is mentioned as an advantage, Schroeder warns that people should only execute the construction work under professional guidance. Earth as a building material can only be accepted by society if it is seen as a "normal" building material [2]. This requires the existence and application of current building regulations. At the moment, earth is not a conventional building material in Belgium and advice and study work of experts is needed when designing and constructing with earth. Especially when dealing with a public construction, as is the case of the two studied projects, a professional expertise is necessary to fulfil building regulations, deliver a high quality construction and provide the technical certainties necessary for a public tender. This expertise also leads to an additional cost.

Technical aspects

Interviews with the architects of both projects did not indicate any technical reasons for not using earth construction in Belgium. But, where and how the material is applied should correspond to the potential and limitations of the applied earth construction technique. This means that in the design and detailing, the material properties should be taken into account, such as the low water resistance and low strength when compared to more conventional building materials [6, 7]. Some examples:

Water resistance:
• (case I+II) Use of a concrete plinth to prevent capillary water rise
• (case I) Specific attention to water drainage on the inside of the tower to avoid excessive contact
with rainwater, special attention went to the detailing of drainage along the concrete stairs
• (case II) Earth for interior use only
• (case II) Glazed bricks instead of CEB in the bathroom area

Mechanical strength:
• (case II) Arches, loading the bricks with only compressive stresses
• (case II) The limited height of one level avoids high loads
• (case I) Wall thickness of 80cm to carry the 12meter high massive walls
• (case I) Concrete plinth to prevent that the cows grazing around the tower scrape the RE wall

Meanwhile, the limited amount of regulation, standardization and experienced craftsman might form a barrier for implementation [9]. In both projects, it was emphasised that the need of an expert in earth construction is essential. Since standards and norms are currently lacking, each project should be followed up by an expert to avoid mistakes by stakeholders that are less familiar with the material. One architect mentioned the need for a building team, with the architect, constructor, client that includes an earth consultant to follow up the project from the very start till the process of maintenance. This makes it possible to avoid mistakes in a building environment where earth construction is not common knowledge and which is not guided (yet) by standards and regulations.

[7] Williams C, Goodhew S, Griffiths R, Watson L. 2010 The feasibility of earth block masonry for building sustainable walling in the United Kingdom. Journal of Building Appraisal;6(2):99-108.
[8] Coeckelberghs N. 2014 du pisé en Belgique: ecole nationale superieure d'architecture de Grenoble.
[9] Minke G. 2007 Building with Earth: Design and Technology of a Sustainable Architecture: Birkhäuser Basel.

SUMMARISING SWOT
OF EARTH ARCHITECTURE
IN BELGIAN CONTEXT

STRENGTHS

Environmental
- Sufficiently available
- Reusable
- Low embodied energy

Technical
- Hygroscopic material (moisture buffering)
- Inert material (heat buffering)
- Sound absorption
- Fire resistance

Social - material experience
- Gamma of colours and textures
- Textured, emotional material

WEAKNESSES

Economical
- Non-standardised material
- High price since need for many man hours

Technical
- Limited load-bearing capacity
- Limited water resistance leading to a limited or carefull use of earth in exterior environment
- Heavy weight
- Limited thermal insulation

OPPORTUNITIES

Environmental
- Evolution towards a less carbon emissive society
- Use of urban mining

Economical
- Emerging of new market

Technical
- Response to a lack of thermal inertia in passive buildings
- Masoning of earth bricks is similar as with fired bricks, therefore the available craftsmanship in Belgium can be used

Social - material experience
- Participatory construction
- Possible self help with less skilled labour
- The image of the material is in evolution, and seems to become more positive

THREATS

Economical
- High price of the execution today

Technical
- Lack of experienced craftsman and technical knowledge
- Cold weather; drying time and freeze/thaw cycle
- Need for very detailed material prescriptions
- Lack of adequate norms and juridical framework leading to the need of high engagement by architects, companies and client

Social - material experience
- Reluctance of certain public (towards non-conventional materials)

Based on consensus based practice; interviews with professionals in the Belgian earth construction sector in 2014 and 2019 as presented by [1,2].

[1] Van der Linden J, Knapen E, Janssens B. 2019 Potential of contemporary earth architecture for low impact building in Belgium. SBE19; Graz.
[2] Depret, L. (2015). La terre crue, en route vers une architecture eco-responsable. (Master thesis), UCL - architecture Saint-Luc Bruxelles

3.2

EARTH IN WESTERN-EUROPE

Intensified interest is causing this timeless way of building (with earth) to experience a paradigm shift. Compressed earth blocks and rammed earth, in particular, have begun to trickle in to contemporary architectural projects thanks to an awakened environmental consciousness: [1]

"*In addition to the strong aesthetic and spatial potential of earth, the desire for value creation through the use of regional building materials and a revived appreciation of craftsmanship are at the centre of resource-saving, sustainable construction. This is of further importance considering that earth represents the largest amount of waste material in our western society, since the excavated material of construction sites by far exceeds the total amount of municipal waste. Until today, we have not really been able to use this earth in the construction sector in a meaningful way. Due to its varying material properties of the earth mixture, rammed earth construction is still difficult to integrate into our standardized processes. A particular challenge and an often-cited obstacle is the concern for the water and erosion resistance of rammed earth and the implications this could have on its related load-bearing behaviour. In order to increase erosion resistance, the earth is partially mixed with cement or lime. Additional stabilization, however, is often not necessary. As current buildings in France, Switzerland and Vorarlberg (Austria) show, a few constructive proactive measures are sufficient to curb the weathering of the facade and make it calculable. Hurdles and challenges in rammed earth construction are just as diverse as the above advantages and arguments: most importantly, the integration of the largely non-standardized building material earth into today's highly regulated and meticulously planned building processes.*" [1]

Some ground-breaking projects provide new findings in (rammed) earth construction. They illustrate the state of the art and showcase possibilities for further developments using this material in future construction projects.
The projects that are shown in this chapter are mainly rammed earth buildings. Since these projects are found to be a powerful representation of a contemporary image of earth architecture through a visual language of straight lines, design of careful detailing and industrial production techniques such as wall panel prefabrication. Meanwhile, the philosophy behind the projects executed by Martin Rauch (see the projects in Sempach, Laufen, Schlins) fit very well the desire to search for environmentally conscious projects (avoidance of stabilisers for example) that are at the same time experientially pleasing. Such approach enhances the creation of future-proof buildings.

[1] Mileto C, Vegas F, Soriano LG, Cristini V. (2014) Earthen Architecture: Past, Present and Future: crc Press.
[2] From: pisé tradition and potential (2019); Rammed earth, texture and function By Martin Scheideron

WESTERN-EUROPE
15 CONTEMPORARY PROJECTS

1 Dierenpark Emmen (NL) - 2016
compressed earth bricks - walls
Oskam (earth expertise & production)
2 Private house, Deitingen (CH) - 2011
cob walls
Spaceshop (architects)
3 Rauch house, Schlins (AU) - 2005
rammed earth walls
Roger Boltshauser (architects)
4 La Villa Dehlingen (FR) - 2014
rammed earth walls
Nunc (architects)
5 Ricola Kräuterzentrum Laufen (CH) - 2013
rammed earth walls
Herzog & De Meuron (architedcts)
6 chapel of reconciliation Berlin (GE) - 2000
rammed earth walls
Reitermann + Sassenroth (architects)
7 Ivry-sur-Seine - Paris (FR) - future project
rammed earth walls
Joly et Loiret (architects)
8 Alnatura Darmstadt (GE) - 2015-2019
Rammed earth walls
Haas cook Zemmrich (architects) + Lehm Ton Erde
9 prototype Terra Nostra (FR) - 2016
mixed earth techniques - walls
Craterre (architect & earth expertise)
10 L'orangerie office building Lyon (FR) - 2019
rammed earth - 3 levels loadbearing
Nicolas Meunier (earth expertise & construction)
11 Kindergarden Sorsum (GE) - 1996
compressed earth bricks
Gernot Minke (architect + earth)
12 Youth centre Spandau (GE) - 2006
rammed earth walls
Gernot Minke (architect & earth expertise)
13 Centre for Alternative Technology Powys (UK) - 2000
rammed earth walls and columns
Pat Borer (architects)
14 Environmental edu. centre Oxfordshire (UK) - 2002
compressed earth bricks
Andy Simmonds & Adele Mills (architects & consultants)
15 Mortuary chapel, Batschuns (AU) 2001
rammed earth walls
Marte.Marte (architects)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11


Limerick
Cork
13
ENGELAND
WALES
Cambridge
Oxford
14
Londen
Bristol
Cardiff
Brighton
Southampton
Plymouth
Guernsey
Jersey
Brest
Rennes
Nantes
Tours
Paris
7
Frankrijk
La Rochelle
Limoges
Clermont-Ferrand
Bordeaux
1
Amsterdam
Den Haag
Nederland
Rotterdam
Antwerpen
Brussel
Rijsel
België
Essen
Dortmund
Keulen
Hannover
11
Wolfsburg
Braunschweig
Maagdenburg
12
Leipzig
Dresden
Duitsland
Frankfurt am Main
8
Mannheim
Luxemburg
Neurenberg
Praag
Tsjechië
Brno
4
Stuttgart
Straatsburg
München
Wenen
Salzburg
Oostenrijk
Graz
5
2
Zürich
15
Zwitserland
Genève
10
9
Milaan
Turijn
Verona
Venetië
Padua
Slovenië
Zagreb
Triest
Kroatië

PREFABRICATION

Locality vs. centralised earth processing:
"*It is inherent to the nature of the material that it should maximize its regional content. Nevertheless, financial constraints can necessitate imports from other regions: the costs of transport – visible and hidden – must be weighed against the efforts required to prepare the material in a decentralized manner. It is for this reason that the elements for the Swiss Ornithological Institute in Sempach, for example, were prefabricated 90 km away in Zwingen rather than constructed in situ. The production hall had already been equipped to produce the Ricola Kräuterzentrum in Laufen.*" [1]

The concept of prefabricating rammed earth blocks in controlled conditions, fabricated in a hall and then transported and assembled on site has proven itself in the projects in Laufen and Sempach. [2] Drying time, technical control and convenience of working conditions are all benefiting from a serial work in a production hall. After the initial projects in Laufen and Sempach, the company Lehm Ton Erde applied a similar concept for other projects, each time trying to produce the walls in the area of the final construction. In an attempt to improve quality and efficiency, they are now constructing a prefabrication hall in their homebase; Schlins. And from what else then… rammed earth? The works are still ongoing, but the idea sounds totally promising, perhaps an new step in the continuous search for advancing earth construction towards contemporary needs.

Although the necessary process of creating individual mixtures may be perceived as too labour intensive or as an anachronistic constraint, it leads to precisely customized and well-balanced solutions made of local materials and uniquely suited to the specific design requirements. Back in the atelier you can sense what a continuous amelioration can lead to; here they produce custom-made rammed earth stoves. The Lehmo ovens produced at Lehm Ton Erde have passed through several stages of improvement, and are masterpieces of rammed earth craftsmanship.

[1] Kapfinger O, Sauer M. 2015 Martin Rauch, Refined Earth: Construction & Design with Rammed Earth: Detail - Institut für internationale Architektur-Dokumentation GmbH & Company KG.
[2] on the vimeo page of Amaco, several videos are showing the process
[3] In Spain, also Fetdeterra makes prefabricated rammed earth elements

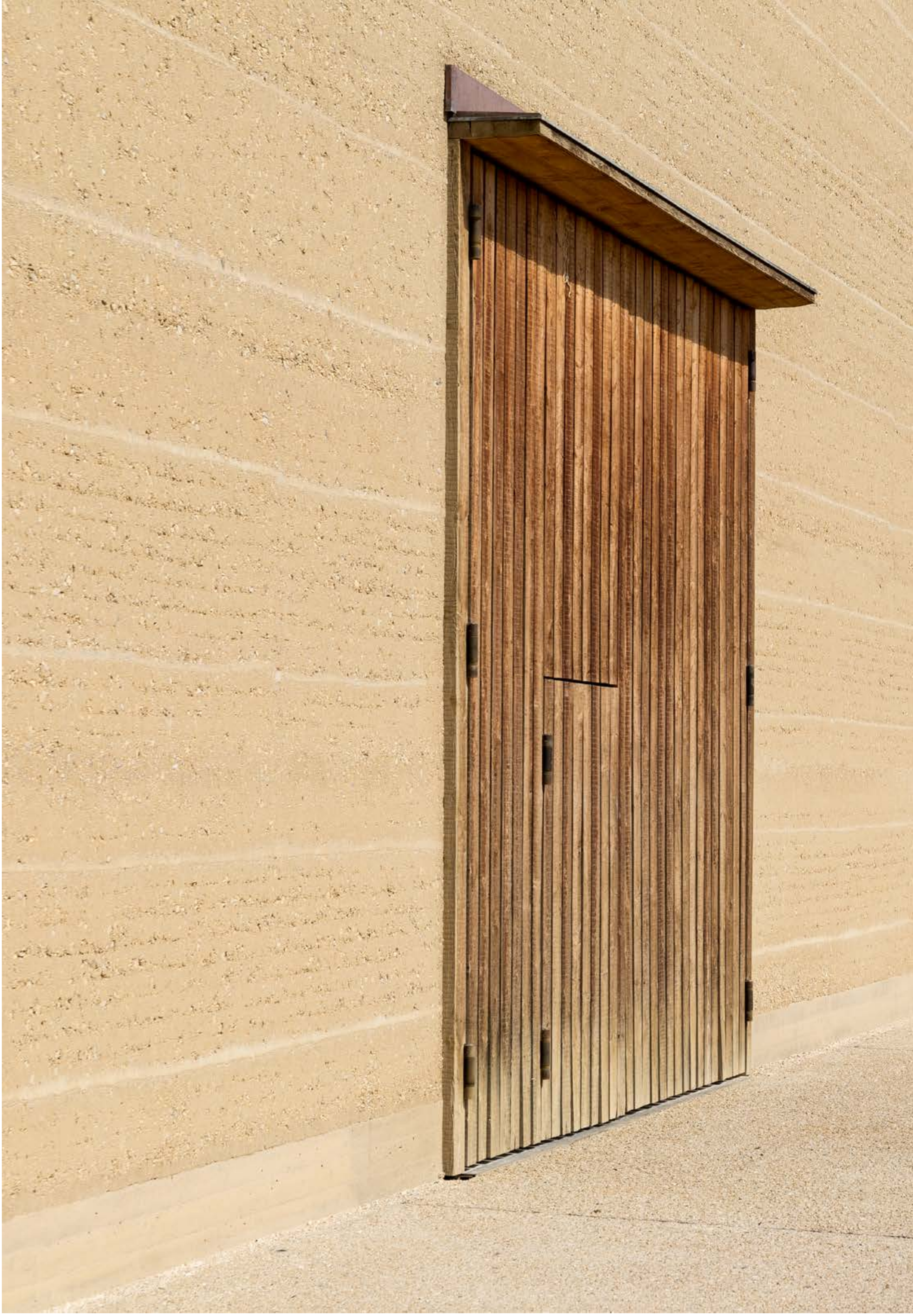
RICOLA HERB CENTRE

Building	Ricola herb centre
Location	Laufen, Switzerland
Year of construction	2013
Earth technique	(prefab) rammed earth
Architect	Herzog & De Meuron
Earth experta	Lehm Ton Erde
Site visit(s)	September 7th 2019

During the design of the new Ricola storage building, architecture office Herzog & De Meuron came up with the idea to build the outer walls from rammed earth. In order to erect such walls, a new approach was needed. With Lehm Ton Erde, the firm of Martin Rauch, in charge of the rammed earth construction, an abandoned factory close to the final construction was transformed into a prefabrication hall. This way it became a factory for massive rammed earth bricks, which would then be stacked on site.

The rammed earth is used to keep a stabile microclimate inside the herb storage building. In the stocking part earthen walls keep the stabile microclimate for storing of herbs without any other ventilation system which decreases the energy demand in operation phase of the building, makes it energy efficient and decreases negative environmental impact.[1] The volume of earth that can have an active hygrothermal effect is large, since the building dimensions are approximately 50 x 30m with almost 10m height.

[1] Ruzicka J, Havlik F, Richter J, Stanek K. 2015 Advanced Prefabricated Rammed Earth Structures–mechanical, building physical and environmental properties. Rammed Earth Construction: Cutting-Edge Research on Traditional and Modern Rammed Earth:139.



PREFABRICATION HALL

Building	Construction hall
Location	Schlins, Austria
Year of construction	2019
Earth technique	(prefab) rammed earth
Architect	Lehm Ton Erde
Earth experta	Lehm Ton Erde
Site visit(s)	September 9th 2019

Following earlier prefabrication projects such as the Ricola hall, the company Lehm Ton Erde decided to build their own production hall in Schlins, Austria.
The construction of the building started in May 2019, and will be especially remarkable for its size (67m on 24m). The open-plan workshop has a combined construction in rammed earth and solid wood. [1]

So far, Lehm Ton Erde searched in the surrounding of their projects for a place where it would be possible to produce prefabricated rammed earth elements. In this new hall, it will be possible to produce with earth ingredients that are familiar to the company, coming from the surrounding of Schlins. This way they avoid the time consuming process of local material research on locations that are less familiar for them.
The standardisation of the production process can lead to a better time and cost-efficiency. The quality and predictability of the performance of the elements will probably improve as well. Therefore, this new step in rammed earth fabrication might help the further standardisation of such constructions.
At the same time, the centralisation of production needs to be looked at critically. A possible strength of earth construction is it's locality [see chapter locality], using local materials, local craftsman and limit transportation distances. If this project results in the production of prefabricated rammed earth elements in Austria, and these get transported all over Europe, this particular strength might be weakened.

[1] New Construction: Factory Workshop Lehm Ton Erde: available online at http://www.lehmtonerde.at/en/news/
[2] Site visit and interviews on September 9th 2019

FUTURE-PROOF
on fragility, erosion, recyclability, stabilisation & water resistance

If we expect a material to be future-proof, this does not necessarily mean that it should be the most solid material.
When we think in a different way about what we expect from a material, other qualities emerge. Imagine an earth building with exterior walls that are slightly eroding, this might not seem acceptable in some cases. But the fragility of the earth in this case might be a good fit for a building that eventually can disappear with a minimal harm. This delicate balance between ephemerality and permanence is well explained in the following paragraphs of the book 'Refined earth' [1]:

"*Through the ramming and compacting of the material, an element is constructed that is capable of withstanding the influences of both time and weather. At the same time, this earth remains part of the natural cycle: if the wall is exposed to the elements, over the years rain will gradually wear away at the façade. Rammed earth will ultimately return without a trace to the soil from whence it came. Even an appropriately protected wall will eventually change: rain softens the surface, as the water washes away the finer clay granules. The colour of the wall will also alter with time, as loam is rinsed away and the stones begin to emerge. The integration of erosion checks made of trasslime or fired clay helps to control the loss of material.*

The challenge in building an earthen wall lies in precisely foreseeing this balance between ephemerality and permanence, and envisaging all the possible ramifications. And this also constitutes the special allure of earth construction. All these aspects are interrelated; for example, if the rammed earth were stabilized and not water soluble, it would be incapable of absorbing water vapour, which is the source of the pleasant indoor climate it can create. Without the rain eroding fine-grained material from the surface, the resulting patina, which gives the material its vibrant, tactile structure, would not exist. Over time, a balance between durability and transformation occurs naturally. While erosion never completely comes to a halt, the loam becomes harder and the stones in the eroded wall serve to stabilize it – as such, it is unnecessary to further weatherproof the façade with cement or other artificial aggregates. On the contrary, additives can significantly impede the positive natural qualities of earth – for example, its ability to be completely recycled."

Furthermore, when the architectural goal is to make a building future-proof; its materials should succeed in aging gracefully [2]. The graceful aging of earth materials has been mentioned by people that I interviewed during user studies. Somehow, the aging is an argument in favour of earth materials.
"*It is clear that earth buildings do not just age well and with dignity. In each and every condition, they can easily be repaired, so that "aging" does not actually describe an aesthetic category or any other stage of their life cycle – and all of this is diametrically opposed to the tendency of contemporary architecture to emulate the model of mechanized and high-tech production, with its high levels of energy expenditure and complex transformations of natural substances. Allegedly low-maintenance, their extrinsic brilliancy and "patinophobic" glamour means that these modern buildings cannot age but only fade into obsolescence.*
The reality of economic globalization, characterized by the ever-increasing monopolies controlled by the industrialized nations, perhaps argues against a concept that cultivates resources which are readily available at practically no cost (!)' [1]

[1] Kapfinger O, Sauer M. 2015 Martin Rauch, Refined Earth: Construction & Design with Rammed Earth: Detail - Institut für internationale Architektur-Dokumentation GmbH & Company KG.
[2] Rognoli V, Karana E. 2014 Chapter 11 - Toward a New Materials Aesthetic Based on Imperfection and Graceful Aging. In: Karana E, Pedgley O, Rognoli V, editors. Materials Experience. Boston: Butterworth-Heinemann. p. 145-54.

SWISS ORNITHOLOGICAL INSTITUTE

Building	birdwatch visitor centre
Location	Sempach, Switserland
Year of construction	2013
Earth technique	(prefab) rammed earth
Architect	:mlzd
Earth experts	Lehm Ton Erde
Site visit(s)	September 7th 2019

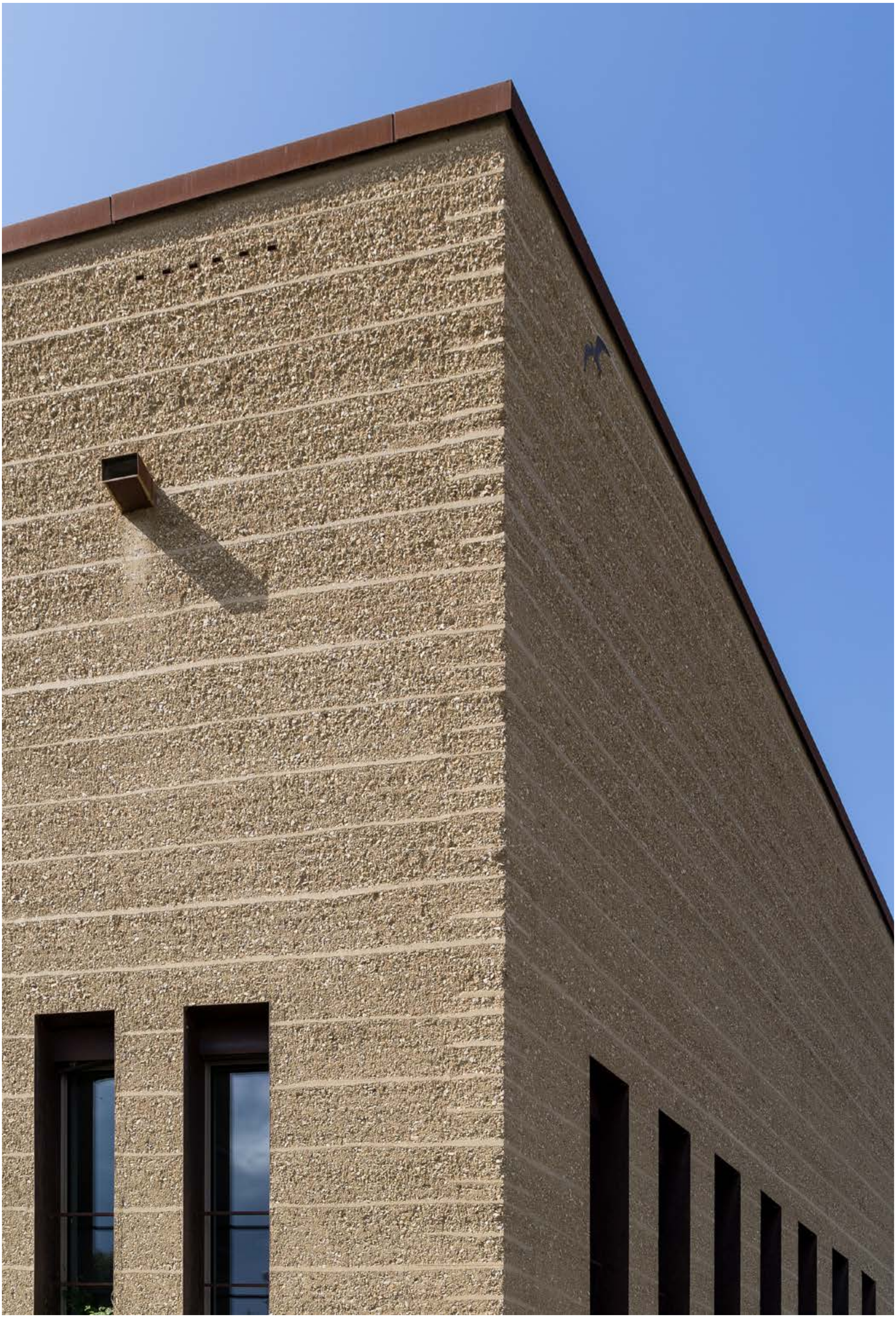
At the shore of a lake, the Swiss ornithological institute decided to build its visitor centre. Following a competition, the chosen design was from :mlzd, a young Swiss practice. When they'd looked at the brief, one immediate thought had come to mind; using a natural material connected explicitly to the institute's mission; care for the winged avian aspect of life in the natural world. It was an obvious statement of intent. [1]

It was during the preparation of the work for the production of the Ricola production hall that :mlzd handed in a competition proposal for the swiss ornithological institute, using an earthen building as a key concept. The institute fell in love with the idea, and together they went to look for a way to get it done. The convenience of using the same blocks that could get produced in Laufen for Ricola was bigger than the effort to transport them to Sempach, and so the prefab hall would be used to also produce rammed earth blocks for the Swiss ornithological institute.

The prefabricated elements are not stabilised, using only the horizontal lime-lines, the signature technique from Martin Rauch for controlled erosion. With the west façade oriented directly towards the lake, which regularly brings heavy winds, rainfall and hail, the wall gets it rough. This resulted in an erosion that is much heavier (see bottom image) than the other façades, and also much more than the west facade of the Ricola building. [3]

On the inside of the visitor centre, the main hall has approachable rammed earth walls. Intriguing as they are, it is tempting for visitors to touch the walls. Surprisingly, this has so far not resulted in any signs of zones in the walls that have been wearing off.

[1] info on the structure and details: Detail magazine 2015, 12. p 1256-1261
[2] background info on the project in article Earthen Nest, from http://www.fourthdoor.co.uk/unstructured/unstructured_07/swiss_ornithological_visitor_centre.php
[3] Site visit and interview with Felix Tobler, responsible from Vogelwarte Sempach on September 7th 2019



CRAFTSMANSHIP

The appreciation of earth construction often seems to be related to the charms of the necessary craftsmanship involved. Good craftsmanship is characterised by personal skill and experience being key to deliver a qualitative final result and meet the requirements of the client [1]. Sennett [2] defines craftsmanship as the desire to do a job well for its own sake. Cardoso [3] describes how craftsmanship, which was moved to the sidelines since the upcome of industrialisation, comes back into the ring, albeit redefined and not necessarily to fight. Craftsmanship doesn't have to mean fully 'hand-made', since through the impact of digital technology, it is now possible to produce high-quality and custom-made 'crafted' products – industrialisation and craftsmanship are not necessarily a paradox, they might complement each other.

Recent exhibitions have been aiming to highlight the importance of craftsmanship in today's architecture and design landscape. The Homo Faber exhibition at the 2018 Venice Biennale [4] exposed carefully crafted earthen materials, serving as a pedestal for other craftworks.
"*Crafting a more human future; as today's technology-driven society pushes us to move faster, consume more and think less, Homo Faber invites you to slow down, take a breath, and meet the people choosing a different approach. Discover the unique contribution to our modern world made by master artisans, the remarkable craftsmen and women using their hands and minds to create exceptional objects of lasting excellence. Come and experience the human spirit and talent of man the maker: Homo Faber.*"

Also at the exhibition 'Ensembles. Architecture and Craft' in Desingel, Antwerp [5] that the 'craftsmanship' is more than a production-based concept, perhaps even a collective process;
"*Craftsmanship is often associated with a sense of nostalgia, and with the kind of workmanship that has disappeared from contemporary building. But craftsmanship can also be a key to architectural innovation: by combining traditional techniques with new technologies and sustainable solutions, or by reassessing the organization of thought processes and handwork.*"

As Richard Sennett argues in The Craftsman, craftsmanship is a basic human impulse. With that comes pride in one's work, a sense of purpose, a distinction that has more to do with the motivation that informed the production than the production itself [3]. It might be this proudness that distinguishes a carefully crafted material, as earth often is, from a standardised material that gets implemented at large scale and high speed. As Timur Ersen [6] declared during the advanced rammed earth workshop in Brussels, it is remarkable how much attention one receives when building with earth. The job of someone placing a concrete floor usually gets by unnoticed by a regular client, where the earth builder gets a pleasant amount of attention and appreciation for his work.
Part of the power of good craftsmanship is also the thoroughness and integrity that define a product, it's ability to stand the test of time not only through its durability but also its aesthetic beauty.

The rammed earth 'Lehmo' ovens, as produced in the atelier of Martin Rauch in Schlins (pictures next spread) are a beautiful embodiment of this craftsmanship. Carefully built up; layer by layer, and retouched meticulously, the craft in these products allows the rough, raw earth material to get exalted towards a fine quality product.

[1] Schukken A. 2016 Craftsmanship and Architecture [Master Thesis]: TU Delft.
[2] Sennett, the craftsman
[3] Cardoso, Rafael. "Craft Versus Design: Moving Beyond a Tired Dichotomy." In The Craft Reader, edited by Glenn Adamson. Oxford: Berg, 2008.
[4] Homo faber. European craftsmanship. Venice 2018. Taken from www.homofaberevent.com
[5] Expo Ensembles. Architecture and Craft. Desingel, 2016
[6] French rammed earth craftsman. Learned the craft at LehmTonErde, and has now its own company Atelier Kara (www.timurersen.com)


STAMPFLEHMPLATTEN 19STUCK
GELB

BATSCHUNS CEMETERY

Building	mortuary chapel
Location	Batschuns
Year of construction	2001
Earth technique	Rammed earth
Architect	Marte.Marte
Earth expert	LehmTonErde
Site visit(s)	September 10th 2019

"*The chapel walls and the enclosure to this cemetery extension in Austria were executed with tamped clay in a pisé form of construction. The lively surface texture and coloration achieved with this material is contrasted with the minimal, yet remarkably powerful, cubic forms. In combination with the horizontal layering of the clay, a vertical strip of oak in the wall of the chapel suffices to suggest the form of a cross. Light enters via a narrow opening in the roof and via a slit in the wall just above the floor, which relieves the structure of any sense of heaviness. The work was executed in collaboration with the artist and clay construction specialist Martin Rauch. The clay, without any additives, was laid in roughly 12cm layers between shuttering and compacted. Precise working, carefully articulated details and the insertion of concrete and steel members in the walls ensure that the building is not of a temporary nature. In view of the slight surface erosion caused by rain, a long life was ensured by minimally overdimensioning the clay walls.*" [1]

[1] Retreived from 'cemetery extension with chapel in Batschuns', in detail magazine 06/2003

→ Kapelle Salgenreute
contemporary chapel, architect Bernardo Bader

The quality of architecture present is Vorarlberg is of a strikingly suberb quality. Magnificent craftsmanship, awareness of nature and financial possibilities seem to blend together into powerful architecture.
These ingredients seem to create a good breeding ground for rammed earth buildings, allowing the creation of earth building examples that have refined details, a contemporary look, and which are in coherence with the surrounding landscape.

HAUS RAUCH

Building	Private house
Location	Schlins, Austria
Year of construction	2008
Earth technique	(in-situ) rammed earth
Architect	Roger Boltshauser
Earth expert	Martin Rauch
Site visit(s)	September 9th 2019

Martin Rauch has played a key role in the renaissance of rammed earth in Western-Europe. His first projects were artistic interventions, but gradually it grew to the creation of exemplary buildings, challenging and showcasing the possibilities of the material. With its own house, he created a key reference, demonstrating that an elegant building, counting up to three storeys high, with exterior walls out of local rammed earth, without added stabilisers, can arise in contemporary Western-Europe.

The private house of Martin Rauch is located on the property of The Rauch family. "*The site oversees the village of Schlins in Vorarlberg, Austria, on a steep south slanted hill. A monolithic structure becomes a sculptural bloc, an abstract and artificial nature pressed upward from the underlying earth. Through this process the technique of solid rammed earth walls results in the wish to build a house exclusively with ecological materials. The construction shows, because of the planning cooperation with Roger Boltshauser and the resulting construction of the house through the constructor and earthen structure craftsman Martin Rauch, a consistently experimental approach. Martin Rauchs experiences and self-contained knowledge in the course of his works, led to subsequent fine tuning on the building process.*" [1]

[1] cited from http://www.lehmtonerde.at/en/projects/project.php?pID=7

→ Atelier Karak tiles
Bludenz, Austria

Martin Rauch is not the only family member involved in the creation of materiality. His sister is also working in the company LehmTonErde and his son is leading atelier Karak, a craftsmanship workshop for ceramic tiles. The values of crafting something beautiful, with care and respect for the clay product is also here very present.

STANDARDS & NORMS

Ronald Rael states some of the challenges related to building with earth in a very clear way in his book 'earth architecture' [1]:

"*The makeup of soil, which differs from one place to another, makes it difficult to create material standards for earth, an important consideration in the processing and selling of building materials. This does not bode well for earth's role in a capitalist society. Increasingly, it is illegal to build with earth because of building codes that are enforced by municipalities. While these decisions are made in the name of safety, it is more likely that manufacturers of industrialized products have lobbied to prevent the use of a free and versatile material such as earth—similar to Cointeraux's experience centuries ago. In the cases where earth is part of accepted building codes, particularly in the United States, the over-building of bond beams and foundations to allow for the lack of knowledge of traditional methods results in higher building costs. These unnecessary enhancements also often require skilled labour and specialized equipment, keeping earth architecture far out of reach from anyone but the most wealthy.*"

Rael has mostly experienced the situation in America, but the situation on earth construction standards is not much different in Europe. Standards and normative documents do exist [2], But examples show that they can turn out very costly, and over-dimensioning and stabilisation might happen as a result of extra safety. Take for example the rammed earth building in Dehlingen, France (see next spread) as an example [3,4]. For this building, the architects had to provide an ATEx attestation, which is a technical prove of their building material, which had to be made for this one particular project. Simply getting such a single attestation, including all material tests are already a significant cost, before the project is even started.

[1] Rael R. 2009 Earth architecture: Princeton architectural press.
[2] Schroeder H. 2016 chapter Standards and Regulations in sustainable building with earth. Basel, Switzerland: Springer.
[3] lecture by Nunc architects, caue92 Paris, October 9th 2018
[4] technical report of the project from http://www.nunc.fr/pise.html

LA VILLA

Building	La Villa, museum
Location	Dehlingen, France
Year of construction	2014
Earth technique	rammed earth
Architect	Nunc architectes
Earth experta	Caracol
Site visit(s)	September 14th 2019

Situated in a sleepy village in the North of France, this archaeological museum contains two distinct earth construction techniques. Wattle and daub construction, as renovated original part of the building, and rammed earth in the newly built extension. The earth layers visible in the rammed earth intend to represent the different earth layers in the ground.

The thick rammed earth walls do offer a lot of thermal inertia, but would not be sufficient for delivering the required thermal insulation. Therefore the wall has been split; the interior wall was rammed in-situ, the exterior wall has been built with prefabricated rammed earth modules. In between 20cm cork insulation has been added.
The south facade has been set-up as a trombewall; a glass facade in front of the rammed earth wall heats up the rammed earth, functioning as a passive solar heating system.

The walls have been stabilised (2% lime, 2% cement) at the inside (loadbearing) and the outside walls with 6% cement (non-loadbearing) [1]

[1] info based on a lecture by Nunc architects, caue92 Paris, October 9th 2018, the technical documents and a personal site visit.


LA
VI
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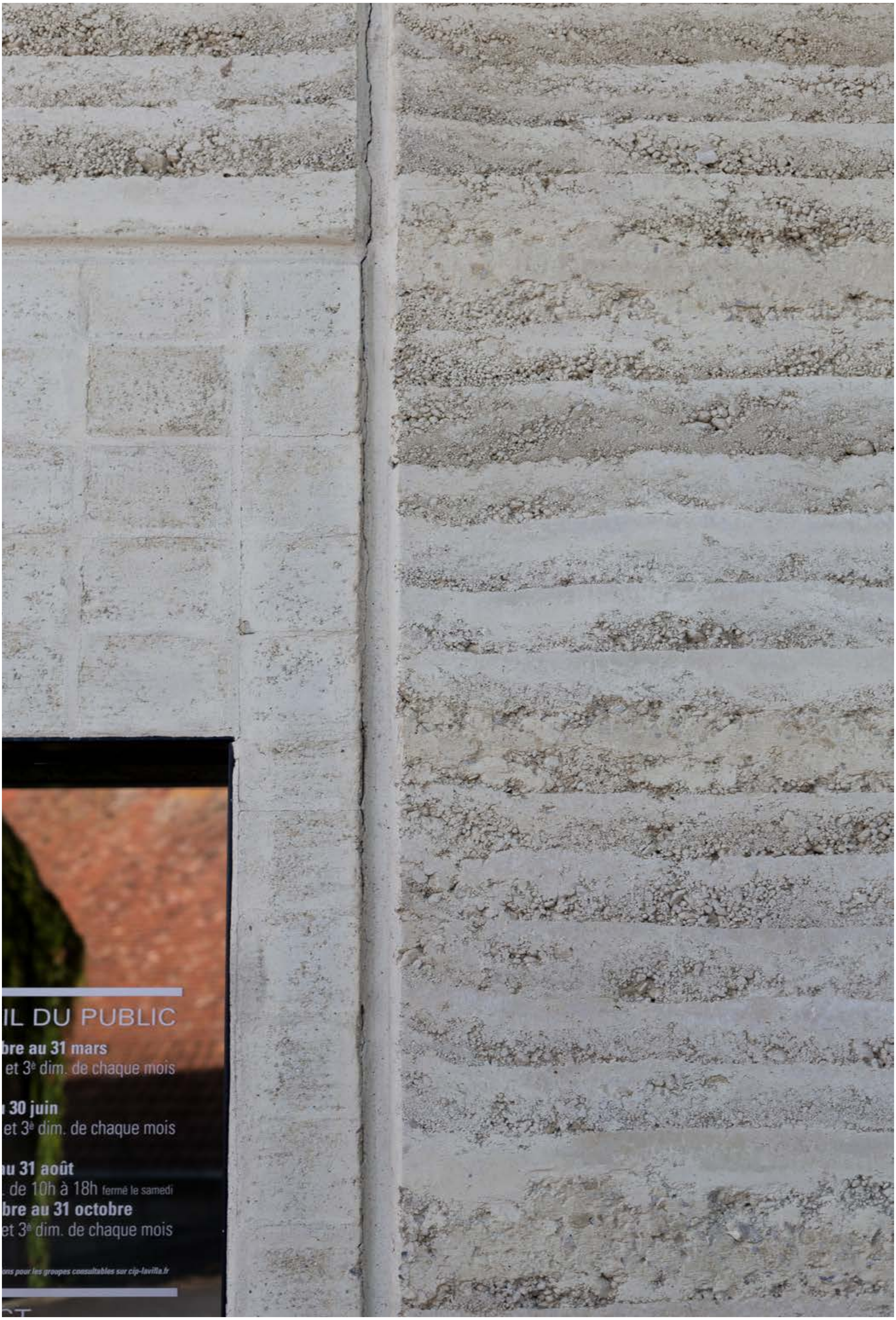
ENTRÉE



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bre au 31 mars
et 3e dim. de chaque mois
30 juin
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au 31 août
de 10h à 18h fermé le samedi
bre au 31 octobre
et 3e dim. de chaque mois
ons pour les groupes consultables sur cip-lavilla.fr

4

METHODS
EXPLORATION, COMMUNICATION & DESIGN

The field of earth construction is developing on diverse levels. Material producers offer earth products, either as modules or as prepared mixtures [1]. Research is done to understand the functioning of the material better, to unravel the traditional building methods and recipes [2] or to find new ways of using the material [3], constructors search for more feasible ways to apply the material [4]. But to support exploration, communication and design of earth materials, there is a set of more hands-on methods available.

Earth can be a very approachable material. In order to spread the ideas on how the material can be used, to get a feel for how a local material can be transformed to a building material, to explore new ideas on how to apply it or design with it; different methods have been used. They allow to approach the material in a collective way, to open up expertise of the material towards non-experts, or to build up expertise all together. Using these methods is an approach to keep earth this intuitive material, that would put the engineer, the architect, the builder, the client around the same table, in order to research, think and act together. Offering the right methods is of importance to read the material, interprete how it might behave and understand how it can be transformed into something to build with. As opposed to the creation of materials that we have been disconnected from, because of their excessive processing and industrial fabrication.

a. The field tests are a method to explore what a specific earth material is composed of. It's a compilation of intuitive tests that allow to discover a local earth mixture.

b. The Carazas test is a method to explore how a specific earth behaves under different actions, such as adding water or ramming it. This is also a communication tool, didactic in the sense that it allows to see different situations next to one another.

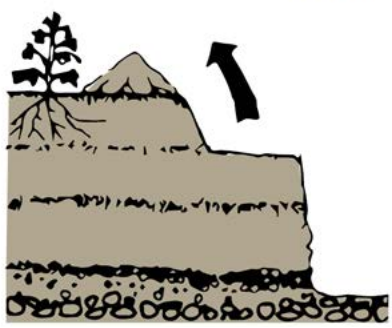
c. The adobe game is a method to explore and design adobe blocks. Designing specific blocks allows to discover in a very hands on way what the adobe technique is capable of. Meanwhile it pushes the discovery of small innovations or new opportunities.

d. Claystorming is a method to design rapidly, using a block of modelling clay. Designing and a graspable, physical communication to others of this design is the main goal of this method.

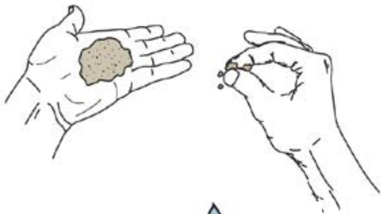
[1] Some producers offering unfired earth blocks or mixtures are BC materials in Belgium, Claytec in Germany, and Tierafino in the Netherlands.
[2] Vissac A, Bourgès A, Gandreau D, Anger R, Fontaine L. 2017 argiles & biopolymères-les stabilisants naturels pour la construction en terre.
[3] for example the research towards poured earth, a new techniques that draws inspiration from the concrete technique, without the use of cement. see for example: Ronsoux L, Moevus M, Jorand Y, Maximilien S, Olagnon C, Anger R, et al., editors. Poured Earth as concrete 2012.
[4] See for example the page on prefabrication, earlier in this book.

FIELD TESTS
GET A FEELING FOR THE EARTH

Every soil, in every different location, will have a certain composition and balance of the elements (clay, silt, sand, aggregates) composing its structure. Each specific composition can be determined through laboratory analysis. However, in order to obtain a first approximation and understanding of the type of soil we encounter on site, it is possible to perform some simple field tests. The tests shown here are a collection of intuitive field tests as originally described in the book earth construction [1, 2, 3]. Performing a combination of these tests can give you certain clues about a specific soil being rather sandy, silty or clayey, and accordingly how cohesive it is or how much it will shrink. Still, you should bear in mind that these tests become most valuable when you can compare them with other soils and former experiences. By creating references to other soils, one can built up a sensory feel for the material. Therefore, it is also preferred that the tests are done by one person, since the exact way of doing them might slightly vary from person to person.



SOIL COLLECTION
Before starting any type of soil test, it is necessary to collect samples of soil. The topsoil containing organic matter is removed. The soil sample is extracted from layers above the rock strata. For each soil sample note on the bag: "location, depth, date".
When the soil is wet, it is preferred to dry the material before doing the tests. Crush the material to avoid clustered fine material. And finally, remove the thicker material, such as aggregates larger than 4mm diameter, the aim is to test the fine material.



TOUCH TEST
Place a portion of dry soil on the palm of the hand. Crumble the soil by rubbing the sample between the fingers and between the fingers and the palm of the hand. Repeat the same operation adding some drops of water in the soil. If the soil is:
- Rough, non-sticky and the different grains can be distinctly felt, the soil is SANDY.
- Fine texture, easy to crush into a slightly sticky powder, the soil is SILTY.
- Difficult to crush, slow to disintegrate in water, very sticky when moistened with water, the soil is CLAYEY.

TASTE TEST
To effectuate this test it is necessary to nibble a small portion of soil. Generally, sandy soil produces a disagreeable sensation as opposed to silty soil, which gives a less objectionable sensation. Clayey soil, on the other hand, gives a sticky, smooth or floury sensation.

WASHING HANDS TEST
Confirm if the sand is silty or clayey.
Rub the hands with moistened soil, then rinse gently with water.
- If the hands are easy to rinse clean, this implies that the soil is SANDY.
- If the soil appears to be powdery and the hands can be rinsed clean fairly easily the soil is SILTY.
- If the soil has a soapy feel and the hands cannot be rinsed easily the soil is CLAYEY.

[1] Houben H, Guillaud H. 1994 Earth construction: a comprehensive guide. London: Intermediate Technology Publications., p82
[2] Later on, they have been published elsewhere, this overview has been adapted based on the experiences during different workshops. The illustrations were done by N. Coeckelberghs from BC architects, and part of the description is based on the oral explanation by Dorian Vauzelle and the written soil testing manual by LEVS architecten.
[3] For more instructive videos on these field tests, a series of videos has been made by Amaco, as available on their Vimeo platform.


Slovenia

COHESION TEST (CIGAR TEST)

The clay represents the binder which holds together the other particles of the soil mixture. This test will help to verify if the quantity of clay of a certain type of soil is suitable for earth blocks production. Take a loam sample, make sure to remove the thicker parts, such as aggregates larger than 4mm diameter.

(Use a sieve if necessary).

Make the soil moist enough to be able to shape a ball with the dimension of an orange. The soil has to be at the plastic state, in other words:

- easy to be modelled
- not crumbly
- does not stick to fingers

From the ball created, shape a cylinder shape by pressing homogeneously the ball. Do not roll the cylinder but simply model it by pressing it multiple times in different points with both hands.

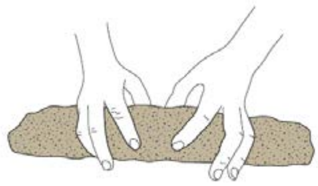
The cylinder will be from 2 to 3 cm in diameter and at least 30 cm long.

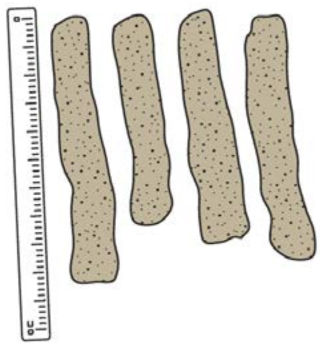
Place the cylinder on the palm of your hand and push it until it breaks and falls down.

Measure the part of cylinder that fell from your hand and repeat the test with at least 2 more samples of the same type of soil. (In order to have more accurate results, it is advisable to perform the test with 5 different samples for each type of soil).

After having measured all the fallen pieces from the same type of soil, calculate the average. If the average is:

- less than 5cm: we have a poorly cohesive SANDY soil
- between 5-15cm: we have an average cohesive soil
- more than 20cm: we have a very cohesive CLAYEY soil





BISCUIT TEST

Proceed as with the cigar test, by removing all the thicker gravels and model the sample well until a smooth paste is obtained. Mould it into flat biscuit-shaped disc approximately 3 cm in diameter and 1 cm thick. Use a mould such as a metal ring if available. Make a biscuit with each type of soil you intend to test.

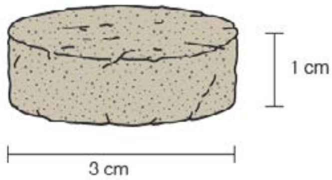
- Let it dry in the shade until the sample will be completely dry. It might take few up to 24 hours depending on the type of soil, temperature and humidity of the room. When the samples are dry, observe any signs of shrinkage by:

Checking if the biscuit is cracked or/and there is a gap between the dried sample and the sides of the mould.

If so, it means that the soil contains a considerable amount of clay which made the sample cracking and shrinking while drying. In this case some sand will have to be added to the soil to make it suitable for earth blocks production. After adding sand you can repeat the biscuit test again.

Using the same dry biscuit samples, it is possible to perform an additional test by cracking them with your hands. In doing so, observe how easily the biscuit breaks. If:

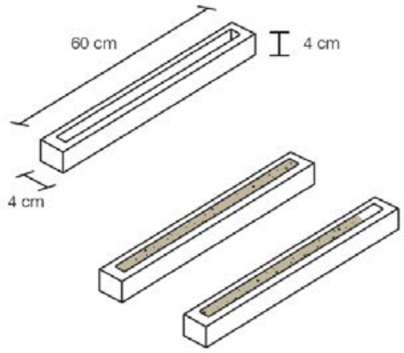
- very hard to break and difficult to reduce to powder, then the soil has a HIGH CLAY content.
- brittle, but it breaks fairly easily, then the sample is made of a good SANDY-CLAYEY soil.
- breaks readily and it is easy to reduce to powder, then the soil has high SAND or SILT content. If when crushed in between the fingers, only very fine powder is left, then the sample is for the most part SILTY.



LINEAR SHRINKAGE MOULD TEST

The linear shrinkage test, is performed using a wooden mould, 60cm long, 4cm wide and 4cm deep.

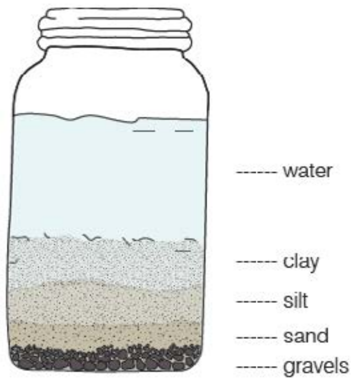
- moist the inside surfaces of the mould with a thin layer of humid soil.
- fill the mould with moist soil and ensure that this is pressed into all corners of the box, you can help yourself by using a small wooden spatula that can also be used to smooth the surface.
- expose the mould to the sun for a period of three days or in the shade for seven days. After this period measure the length of the hardened and dried soil as compared to the length of the mould and calculate the shrinkage length of the soil.



SEDIMENTATION TEST

The mixture is stirred with a lot of water in a glass jar and then is let to rest on a flat surface. The largest particles will settle at the bottom, the finest on top. Analysing the different layers in the glass jar allows to have an approximated idea of the composition and the proportion of the different particles types included in the soil examined.

This test provides only a rough approximation of the soil composition, it is a wrong to assert that the height of each layer corresponds to the proportion of clay, silt, sand and gravel in the soil sample. Taking this assumption could lead to a large margin of error.



CARAZAS TEST

BECOME FAMILIAR WITH EARTH BEHAVIOUR

Earth is a material composed of matter under three states: liquid (water), solid (clay particles and aggregates) and gas (air and vapour). The relative proportions of these three states determines the intrinsic properties of the material. Invented by Wilfredo Carazas, the Carazas test looks at the relationship between the amount of water in the soil (hydric state), and the mechanical action applied on it (how much the soil is compressed inside a mould). Each earth construction technique requires a determinate balance between amount of water and compaction of the soil. This exercise allows to teach by doing, the possible existing choices and variability in order to achieve a desired property.

In order to prepare the Carazas test, you need a wooden mould, water and measuring cup, a stick to compact the soil and enough material to fill the mould with soil at least 9 times. In order to have a good overview and understanding of the way each soil reacts depending on different amount of water added and level of compaction, it is necessary to bring the soil to its DRY, HUMID and PLASTIC state.

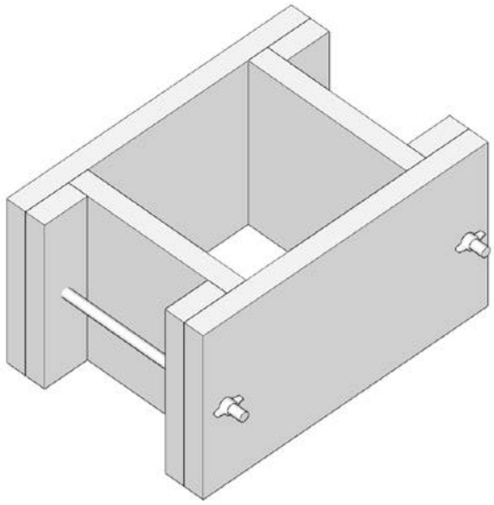
HUMIDITY

- DRY state, make sure that the material is free from humidity. To do so, it is possible to expose the soil sample in a sunny spot to let evaporate the water included completely.
- HUMID state, mix it with a small amount of water just enough to make it moist and to make possible to model a ball of soil with your hands. The ball will have a rough, crumbly surface.
- PLASTIC state, mix it with a moderate amount of water just enough to make possible to model a ball of soil with your hands. The ball will have a fairly smooth surface but make sure that the soil will not be too sticky and wet otherwise the sample will achieve a state closer to viscous/liquid.

COMPACTION

- FILL place the mould on the ground and loosely fill it with soil. Carefully remove the mould
- PRESS. again, loosely fill the mould with the same type of soil, and tamp the soil a little with your hands.
- COMPACT. repeat again, this time compact the soil well with the help of a wooden stick before removing the mould by unscrewing it.

Combining some parameters would result in samples corresponding to particular building techniques. For example the adobe technique would rather need a soil with fine material, and would be pressed in the plastic state. While rammed earth would need to contain more gravely material, applied in the humid state by compaction.



↑ Wooden mould typically used for the Carazas test, with inner dimension of 15/15cm.

→ Result of Carazas test during workshop at Uhasselt (2018) and in Ouled Merzoug (2019).

↓ Carazas grid, typically with grids of 40/40cm. Leaving out the viscous and liquid state is a simplified version of the original Carazas test.

HYDRIC → / MECHANICAL ↓	DRY	HUMID	PLASTIC	VISCOUS	LIQUID
FILL					
PRESS					
COMPACT					

This text has been written based on following documents, and practical knowledge gained during the performance of the test during workshops

[1] the Workshop activity reports by Amaco, and CRAterre
[2] Workshop report by LEVS architects and BC architects

ADOBE GAME
DESIGN, MAKE, DO

adobe bricks in Western-Europe

An adobe is a brick made of unfired earth. This building material has been used for thousands of years. Traditionally it was shaped by hand, in wood or metal moulds and then sun-dried. Nowadays, industrially produced bricks are also available, formed by machines and air-dried.

There has been an evolution in the use of earth construction techniques. Rammed earth for example seems to have moved on from a rural material; massive and heavy, to a noble material; exactly controlled and rather technological. Rammed earth walls have made their way into contemporary construction and design projects. So what about adobes? Few projects using adobe in contemporary (architectural) design are known.
The adobe game [1] aims to explore the endless possible shapes and appearances, that the intuitive technique of adobe-making offers. Investigating in which appearance adobe can find its way into contemporary Western European architecture.

a search towards future possibilities

Postgraduate students of the building beyond borders programme at Hasselt University were given the task to design a wall of 1 by 1 meter, made of adobe bricks [2]. The walls should only be able to function as interior walls. This way the material doesn't have to withstand rainfall, taking into account the Belgian climate. Each wall should exist of repeated brick modules, made by the students with material from the region.

The construction of a reusable formwork is an important step before the production. The formwork will affect the final design through its shape, the possibilities of material mixture (adapted hydric state or fibres to uncast in a proper way) and possibly its texture (visible direction of the brick, texture of the mould).

The material mixture was a redefined local soil. In the region of South-Limburg loess is a common raw material. Sand 0/2 was added to this soil, based on the Carazas test and reference mixtures. Depending on the size and shape of the mould, the wetness of the mix and the desires of the team fibres were added to the mixture.

[1] exercise inspired on Vauzelle, D., & Noriega, G. F. (2014). Jeux d'adobes, une pédagogie autour de la brique de terre crue. Craterre, Ensag Grenoble, Amaco. Retrieved from http://www.amaco.org/webapp/website/website.html?id=101&pageId=91
[2] see images of some workshop results on the right. Exercise done in December 2018.

CLAYSTORMING
FAST THINKING THROUGH SHAPES

During the advanced rammed earth workshop in summer 2019 in Brussels, a Claystorming exercise has been introduced in order to design rapidly, using a block of model clay (see picture on the right). Intuitive hands-on designing and a graspable, physical communication to others of this design is the main goal of this method.

Anna Heringer, who introduced the method of Claystorming [1] at several universities and workshops, describes it as follows: *an intuitive way of designing on clay models in larger scale, in a fast, productive way, without judging and analyzing. It was difficult over the first days to "think" with the hands and not with the intellect, but it helped a lot getting into an intuitive flow. The outcome was an amazing diversity of high quality designs. Working as a group on the same media is very inclusive so the team spirit was developing as much as the models*

"Clay Storming emphasises human intuition and deep experience with materials as an alternative tool-set for investigating and designing our built environment. Anna Heringer remarks that rammed earth buildings do not perform as they are predicted by simulation, and actually require significantly less heat than current methods can estimate. While her experience and intuition about building with earthen material cannot yet be predicted by simulation, her methods and mastery of craft offer a compelling alternative to purely quantitative models of design decision-making. At last I can articulate my observation that deep knowledge and intuition are essential human qualities that should be used to guide, interpret and enhance scientific tools. This marriage of techniques could liberate designers from the confined set of design solutions delimited by existing regulations and quantitative performance standards."[2]

[1] retrieved from http://www.anna-heringer.com/index.php?id=84
[2] Claystorming description of a Harvard workshop with Anna Heringer, as described by Aurora Jensen, from https://medium.com/@aurorajensen/humility-and-mastery-in-sustainable-design-reflections-on-the-work-of-kiel-moe-michael-pollan-2f48791fa81d

5

MATERIALEXPERIENCE

The former chapters have been introducing earth as a matter, an ingredient for both traditional and contemporary architecture. The urgency of climate change and the search for a just, well-balanced and sustainable environment has forced us to look further than simply continuing the way we're building today. Unfired earth materials present an opportunity for an alternative way of building with a lower environmental impact.
Additionally, in order to create a successful sustainable design, the material needs to be appreciated, whether it is used for a building, building component or an object. This chapter focuses rather on how the material earth is experienced. Earth, one of the four primary natural elements, is a material that invites to be experienced; it is a very sensorial material that evokes a close relationship between man and material. Earth, in its simplest and purest material expression, has an overwhelming emotional potential (see preface).

The term material experience has been widely used in the field of product design, and is concerned with investigating how a material is received, what it makes people think, feel and do [1]. In order to investigate how we can design and build with earth in a way that takes into account different desires and material experiences, a few focusses or working methods are highlighted.

a. material driven design
Material Driven Design (MDD) is a method to facilitate designing for material experiences [2]. Material driven design method can be used to explore how to design with a specific material, in this case unfired earth, as the point of departure in the design process.

b. context & culture
Specific contexts and cultures affect the way a material, an object, or a building is experienced. In order to pave ways for a future use of unfired earth in a contemporary Western-European context, we like to learn from what happens in other contexts. Some examples of the use of earth in other parts of the world, and the exchange between the two contexts, are shown here.

c. workshops
The concept of workshops create an invitation to use a hands-on, active approach on materiality, mixing technical know-how, tacit knowledge and material experience. Workshops can also be an invitation to rediscover the qualities of craftsmanship (see craftsmanship), the passing on of knowledge and skill.

d. debate
Material experiences differ depending on the context, the people that experience it, the design, the moment, the intentions. Debating is a great way to get insight in and share different individual material experiences of earth. This allows people to reflect more purposely on how they experience the material, while also creating a platform to discuss how earth can further develop to fit within our contemporary society.

These topics fit within a continuous search to facilitate the making of designs which start from a better understanding of how earth material is experienced, in equilibrium with a good technical understanding of the material, and a clear vision of what the designer/maker wants to achieve with it.

[1] Karana E, Pedgley O, Rognoli V. 2015 On materials experience. Design Issues;31(3):16-27.
[2] developed by Karana E, Barati B, Rognoli V, Zeeuw van der Laan A. 2015 Material Driven Design (MDD): A Method to Design for Material Experiences. International Journal of design;9(2).

MATERIAL DRIVEN DESIGN

Material Driven Design (MDD) is a method to facilitate designing for material experiences [1]. The goal of the method is to facilitate a conscious way of designing with earth materials, while taking into account material experiences. The initiators of the MDD method emphasize that when the experiential qualities of a material are probed and mapped alongside the material's technical properties and performances, a thorough understanding of the material is achieved to guide the design process [2]. This way Material Driven Design can help to put forward appropriate ways of using earth in a contemporary society.

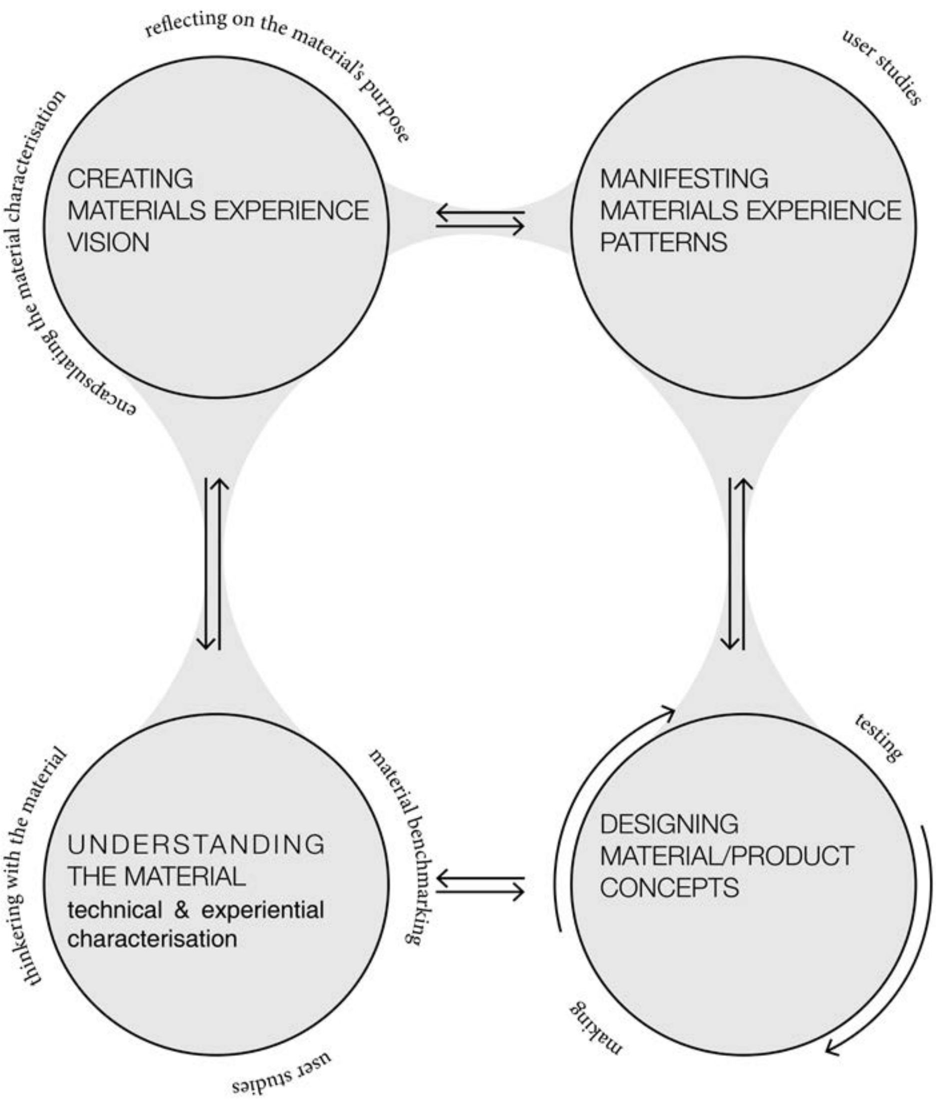
The material driven design method can be used to explore how to design with a specific material, in this case unfired earth, as the point of departure in the design process. Four main action steps are used in this method (as shown in figure on the right). These steps are applied for using a material, in this research unfired earth, as the point of departure in the design process:

1. Understand the material through a technical and experiential characterization.
    1.1. Tinkering with the material
    1.2. User studies
    1.3. Benchmark studies
2. Create a vision on the design, based on reflections of the potential purpose of earth material and the given constraints of the design task.
    2.1. encapsulate the material characterization
    2.2. reflect on the material's purpose
3. Do user studies to verify if the desired material experience vision is indeed received as such.
    3.1. User studies
4. Build the design into an actual physical object, taking into account the former steps, but make practical decisions during the building process.
    4.1. Testing
    4.2. Making

Material driven design can be used as a tool to approach another way of building, with eye for both technical-ecological and social needs. Such approach might also happen intuitively, but this method at least invites and challenges architects and designers to think about it in a structured matter.

The following chapter is structured along the different steps of the Material Driven Design method, as applied during the design process of the MONK.

[1] developed by Karana E, Barati B, Rognoli V, Zeeuw van der Laan A. 2015 Material Driven Design (MDD): A Method to Design for Material Experiences. International Journal of design;9(2).
[2] Camere S, Karana E. 2018 Experiential characterization of materials: Toward a toolkit. Design research society; 25-28 june 2018; Limerick.



Material Driven Design, action scheme. Adapted from scheme by Karana et al., 2015 [1]

MONK

Object	phone vault
Year	2019
Earth technique	Rammed earth
a cooperation of	Jasper Van der Linden Auranne Leray Biniam Hailu

MONK is a bedside object made out of earth.

It has a dual purpose, functioning as a phone vault and a night lamp. When you go to sleep, putting your phone in the vault will help to block high-frequency electromagnetic radiation, and sound.

Beside its practical/functional role, MONK is a beautiful design object which seeks to show that earth can be more than dirt.

Eventually, at the end of its life, it is also a product which can easily be dissolved in water, freeing the built-in lamp to be used elsewhere.

Its material composition is:
Clay + sand 0/2 + small gravel + recycled newspaper particles (cellulose flocks) moulded in a formwork through dry ramming.

As input for the design brief, a yearly design competition was used. The Terramigaki design competition focuses on designing contemporary products manufactured with unfired earth (TMD, 2019). In short, the aims as described in the competition brief are the following:
• create an object or furniture with unfired earth
• it should be sustainable
• it should use the specific properties of unfired earth
• it should be contemporary
The MONK won the first price on the TerraMigaki design award 2019.

During the design and building of the MONK different steps of the material driven design framework have been applied. A description of this process, documenting how this design takes both experiential and technical parameters into account, can be found on the next spread.

MONK
A MATERIAL DRIVEN DESIGN EXERCISE

For the design of MONK, the design and build process applied the Material Driven Design method. As input for the design brief, a yearly design competition was used. The Terramigaki design competition focuses on designing contemporary products manufactured with unfired earth. The design and build challenge in this project is to propose unfired earth material applied in a way that is attractive to the user and, meanwhile, taking into account environmental aspects.

The final result of the design and build process is the earth design object Monk; a phone vault and bedside lamp. In accordance to the different steps of the Material Driven Design, exploratory interviews and a survey with a public of laymen and architect/designers were done to analyse the way they experience (unfired) earth. This input was used during the designing and building of the object.

Rather than designing a building or building part, an object allows to go more profound into refining the shape, texture, production process and finishing method. Meanwhile, the deliberate choice of making a daily object, allows to introduce a more general public in order to provoke discussion on the material experience of earth. Through the reflections that the object and process arises around fragility, sourcing, acceptability of roughness and naturalness, or simply by showcasing an example, the hope is that such design can function as a catalyst for potential tracks of using earth (or materials, building methods with a similar 'philosophy') in a contemporary western European context.

1. Understanding the material: technical and experiential characterization

<u>State of the art on earth materials</u>
A first aim is to gain an understanding of the main technical properties of earth materials, the constraints and opportunities and the most convenient manufacturing processes to form the material. Hands-on workshops with earth, building case studies and interviews with architects, experts and users have been used to gain empiric knowledge, as presented throughout this book.

<u>Tinkering with earth</u>
Through a process of material tinkering, a series of material samples from unfired earth were developed (see image on page 15). These samples present a variety of tactile and visual properties through variation in mixture, polishing, colouring of material, grain sizes, etc. Material tinkering is a practical and creative approach through experiential learning [1]. On a material sample scale, the goal was to create a variety of sensorial and experiential qualities. Therefore, the gathered raw materials included clays in different colours, sand and gravel in different grain sizes and fibres in different length and thickness (see image on page 14). The material samples are later on used in user studies to investigate the sensorial and experiential qualities.

2. Create material experience vision

The following topics guided the vision that
<u>Function</u>
For the Terramigaki competition, it was a demand that the object should use specific characteristics of unfired earth. Based on the state of the art of earth materials, a distinctive technical characteristic of unfired earth is its hygrothermal buffering; the potential to slowly take up or release heat or moisture. After analysing the design proposals of former competition editions, it was clear that several of the winning designs already used the valorisation of the thermal buffering potential, usually by integrating a heating element. Also the potential to buffer moisture had been valorised in the winning design of last year in the form of a moisturiser. This meant that, when wanting to point a unique opportunity of earth, another characteristic had to be selected.

In the book building with earth: design and technology of a sustainable architecture [2], Minke refers to experiments that pointed out the potential of earth as a shelter against high-frequency electromagnetic radiation. The idea of a phone case from unfired earth that can block the radiation and sound of your phone, for example while sleeping, would originally point out technical properties of earth. Meanwhile it could also be interpreted as a very contemporary function, as a reaction to the ever increasing presence of technology, wireless signals, sounds and impulses. Unfortunately, the current prototype did not succeed in fulfilling this function of effectively blocking the radiation and sound.

<u>Materiality</u>
attraction.
The intended experience for this earth design is that the material elicits attraction. The proposal was to reach this by striking a balance between refinedness and imperfections, which can both be reached with earth materials, thanks to the variety of possible mixtures and shaping processes.

refined.
Material tinkering resulted into several samples with a very irregular texture due to the use of bigger gravel particles or the

[1] Parisi, S., Rognoli, V., & Sonneveld, M. (2017). Material Tinkering. An inspirational approach for experiential learning and envisioning in product design education. The design journal, 20(sup1), S1167-S1184.
[2] Minke, G. (2007). Building with Earth: Design and Technology of a Sustainable Architecture: Birkhäuser Basel.
[3] Tsaknaki, V., & Fernaeus, Y. (2016). Expanding on Wabi-Sabi as a design resource in HCI. Paper presented at the Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems.
[4] as presented in Rognoli, V., & Karana, E. (2014). Chapter 11 - Toward a New Materials Aesthetic Based on Imperfection and Graceful Aging. In E. Karana, O. Pedgley, & V. Rognoli (Eds.), Materials Experience (pp. 145-154). Boston: Butterworth-Heinemann.

use of big fibre particles. These 4 samples were given the lowest score for 'attraction' during user studies. Based on these results, it was decided that refined seems an interesting property to reach attraction.

imperfections.

Aiming for a material that is refined does not automatically mean that it should resist as much as possible to become imperfect. The goal is that the material has a finishing that is still associated to the original earth material. This goal derives inspiration from the concept of Wabi-Sabi; a philosophy that embraces three basic realities of the material world: 'nothing lasts', 'nothing is finished', and 'nothing is perfect' [3]. In the case of earth, it is intrinsic to the material that there are certain imperfections in its texture. An approach based on imperfection and graceful aging of materials has been proposed in 'Toward a New Materials Aesthetic Based on Imperfection and Graceful Aging' [4]. They propose that the consideration of imperfection and graceful aging can lead to create an 'aesthetics of sustainability'. In other words, the goal is the creation of unique, positively experienced, aesthetically pleasing products that can elicit long-term user attachment.

naturalness.

Following the Wabi-Sabi philosophy, it is suggested that a natural material should communicate its naturalness (till a certain extent). Based on exploratory interviews, it was concluded that a materiality that is perceived as natural is related to more ecological materials, which is positive in the sense that through such an association the material can communicate its ecological value, and it might be a trigger for material selection.

Shape

When envisioning the shape that the phone vault should have, it was the will to create an object that could appeal to a larger public than the people that are already enthusiastic about earth. To do so it was envisioned to develop a daily object that fits in the living environment of people. In parallel to what conventional materials often offer, it was envisioned that the object would follow a contemporary style of straight lines and corners. With these ideas in mind, the design of the MONK grew; a bedside design object with a built-in lamp, inspired by popular minimalistic design lamps.

3. User studies:

experiential characterization and manifesting material experience characters

User studies have been used to verify if the intended material experience vision has indeed been successful for the material sample that was used in the Monk design. A survey and a series of semi-structured interviews were done to unravel the material experiences of users as proposed in the MDD method; what are certain associations or elicited emotions? A wide range of experiential characteristics have been gathered based on 120 surveys with 30 different persons, on 8 selected material samples.

The sample (s4) that finally has been used for the Monk design was experienced as not too rough, while it still has some texture and incoherencies. Also it's rather soft with a warm colour. Meanwhile the colour is coherent with the natural earth colour that is predominantly present in the area where the survey was done, which might have influenced the association of a natural material to the respondents.

S4 also scored the highest in trust, which might be related to the particle sizes, being smaller than a regular rammed earth, making it more solid, more trustworthy. An addition of cellulose fibres adds to this strength, while making the material slightly fibrous as well. This in turn recalls the natural and ecological image of the material.

4. Design/build earth object

The shaping process

Based on the experiences during the material tinkering, the use of a formwork turned out to be very thankful. It allows to work rather precise, create straight surfaces and relatively sharp corners. Further design factors were the technical material restraints such as the minimum size that seemed feasible to make a solid earth object as well as functional restraints such as the size of a phone, and the incision of an electrical element.

The mixture

The choice of mixture was based on a typical rammed earth mixture of clay, sand and gravel. But the gravel size used was much smaller than usual, with the maximum size being 4mm. This to create surfaces that are not too irregular or rough, while still showing some of the granular texture of rammed earth. To allow the creation of rigid corners and to improve the strength of a rather thin top lid, cellulose fibres (recycled newspaper) were added.

The idea that the design should be sustainable has been defined as a prerequisite by both the design competition and the research project. In order to have a low environmental impact, the target was to avoid the addition of stabilisers (such as lime or cement) as this would negatively affect both the environmental impact of both the production phase and the end-of-life.

BENCH
EARTH AS A CARRIER OF CIRCULAR DESIGN

Object	bench
Year	2018
Earth technique	Rammed earth
a cooperation of	postgraduate Building Beyond Borders at UHasselt

The rammed earth bench is small-scale design and build project intending to demonstrate and explore further the possibilities of rammed earth construction, meanwhile incorporating and exploring architectural and design solutions with a minimal environmental impact. This in a Western-European context, in this case in Diepenbeek (Belgium, South Limburg).

The middle part of the bench is made of rammed earth, manually rammed on site. The design takes into account the vulnerability to moisture of unstabilised rammed earth. Since the bench is situated in an outside environment a stone plinth and top cover are foreseen. The material choice and connections aim to fulfil the prerequisite that the bench should be able to be taken apart easily and rebuilt with the same material. Fitting within this idea of circularity, the bench is made from unfired, unstabilised earth and reclaimed stone. At the end of life, it can be easily taken apart, no fixtures are made between the different elements. The blue stone was selected as a material that is local (from Belgium), durable and needs few processing to get from the natural resource to final product. Reused stone was chosen at the depot of Rotor, a provider of reclaimed materials.

The rammed earth mixture was made with an even distribution of different particle sizes from clay till gravel of 24mm. The used materials were gathered within a regional distance and the mixture tested during a Carazas test. Sand and gravel comes from the nearby Maas river, and was processed and organised by size at a gravel processing company. The clay comes from Boom, and was added in a dried, crushed state. No stabiliser or finishing has been added, which should allow for an easy re-use when desired, by crumbling the material and re-ramming it in a formwork.

The construction happened in winter time, around half November, and was followed by cold (a few times freezing at night) and wet days. This weather is not adequate for rammed earth construction because of unusually long drying time and potential damage through freezing/drying cycle. These conditions might thus have been the cause of a corner that eroded.

CONTEXT & CULTURE

Specific contexts and cultures affect the way a material, an object, or a building is experienced. In order to pave ways for a future use of earth material in a contemporary Western-European context, we like to learn from what happens in other contexts. Some examples of the use of earth in other parts of the world, and the exchange between the two contexts, are shown on the upcoming spreads.

In 'Architecture as material culture', Serena Love [1] argues how, by culturally defining natural resources, the materials used in construction can be seen to have greater meaning. Cultural knowledge of resources dictates the use of materials and may have had a stronger influence over material choices than their simple practicality. Nature provided the resources but culture decided the architectural form and choice of materials. Environmental motivations might contribute to the selection of earth materials but Love argues here that the choices for earth sources were initially socially informed and were already perceived as 'cultural' through an embodied social knowledge. Thus, material choice might be more indicative of culture than it is of environmental conditions.

When linking the importance of culture as a trigger for material selection with the topic of material experience, it is interesting to notice how Evans [2] describes that the textures of building materials physically alter both the appearance and experience, even if all the materials originate from the same source. Resulting in the idea that material expression and textures are a medium for social agency and expression.

Serena Love mentions how the choice of building materials and their use in architecture, are essentially codes of social practice and even ideology. This refers back to the preface of this book, suggesting how the use of earth could be understood within the evolution towards a post-industrial society. Following from a point of view that architecture represents the social choices made by the people. When creating architecture, selecting a material or building method, it is therefore of major importance to understand the context and culture of the people who will experience the architecture.

[1] Love S. 2013 Architecture as material culture: Building form and materiality in the Pre-Pottery Neolithic of Anatolia and Levant746–58 p.
[2] Evans, J., 2003. Environmental Archaeology and Social Order. Routledge, London.

WORKSHOP BEYOND BORDERS

Location	Ouled Merzoug
Year	2019 (July)
Earth technique	Mixed
a cooperation of	Bregt Hoppenbrouwers UHasselt (Jasper Van der Linden) Alice Chang, Giulia Ventre community of Ouled Merzoug & 15 enthusiastic participants

A one week workshop took place in a small village in the province of Ouarzazate, Morocco to valorise local knowledge and spread vernacular knowledge on ecological, natural ways of building. Each day a different earth construction technique was introduced to the workshop participants, through the combined knowledge of local craftsman and Belgian experts.

Meanwhile the workshop questions today's way of constructing. by confronting different techniques, habits and attitudes from different contexts, cultures and locations (notably north-Africa and Western-Europe).

During the construction of a few rammed earth benches (see images on the right), a traditional local formwork had been used, as well as an adapted version with more 'European influences' (for example smoothened plywood and metal screws for the formwork). Contrastingly, the Moroccan formwork was a traditional one, similar to the ones that they used centuries ago. From these formworks both parties can start to reflect on a technical or practical improvement of their formwork. But at least as interesting is what can be learned from cultural differences that are linked to the use of this specific formwork. The Moroccan formwork allowed much less precision, while allowing to work at higher speed. The mind-set of working less precise, allowing a margin for error is often taboo in standard Belgian construction. Maybe this injects a certain charm into the building process?

Meanwhile, the ability to adapt a technique depending on your local materials is also something to learn from. Almost the complete Moroccan formwork can be made with regional materials, where the 'European' formwork counts on imported materials.
A similar adaptation to the local situation can be found in the choice of earth techniques. When the local soil contains a lot of gravel parts, it is rather suitable for a rammed earth technique, where a soil with clay and rather small particles might be better suitable for an adobe technique. This became very physical in the Moroccan context where craftsman in one village use rather the adobe technique, while the craftsman in another village use rammed earth, depending on available resources.

→ Nubian Vault:
a technique without wood or formwork
Construction experiment, Workshop Beyond Borders

In dry climatic zones where wood is scarce, construction techniques were developed in which buildings were covered with mud brick vaults or domes without formwork or support during construction.

Hassan Fathy introduces in architecture for the poor in 1969 [1] how the use of earth as a building material is a very adequate and democratic choice. This follows from the reasoning that it is a material that is widely available, requires little tools to transform from material into a building, and is therefore available for everyone. In line with the paragraph in 'learning from vernacular knowledge', this is again a story about using what is available. In the case described by Fathy, earth was the only material available. Even wood was scarce, and therefore imported and too expensive.
In the contemporary Western-European context, an abundance of materials are available. One can wonder if this does not risk to make us lose the connection with building and materiality? When everything gets standardised, and industrialised, does it get harder to stay in touch with the most basic procedures building a house?

The Nubian vault was a technique developed from necessity, with the ability to make an earth vault without the use of wood. This resulted in an intriguing technique of angled stacking. The simplicity of using one material, combined with the complexity of shaping the structure has been tested at the Workshop Beyond Borders (as depicted on the right)

[1] Fathy H. 2010 Architecture for the poor: an experiment in rural Egypt: University of Chicago press.

MUYINGA LIBRARY

Building	Library
Location	Muyinga, Burundi
Year of construction	2012
Earth technique	Compressed earth bricks
Architect	BC architects
Site visit(s)	summer 2012

"Thorough study of vernacular architectural practices in Burundi was the basis of the design of the building. Two months of fieldwork in the region and surrounding provinces gave us insight in the local materials, techniques and building typologies. These findings were applied, updated, reinterpreted and framed within the local know-how and traditions of Muyinga."

The general form of the library is the result of a structural logic, derived on one hand from the material choice (Compressed Earth Blocks masonry and baked clay roof tiles). The locally produced roof tiles were considerably more heavy than imported corrugated iron sheets. This inspired the structural system of closely spaced columns at 1m30 intervals, which also act as buttresses for the high walls of the library. This rhythmic repetition of columns is a recognizable feature of the building, on the outside as well as on the inside.
The roof has a slope of 35% with an overhang to protect the unbaked CEB blocks, and contributes to the architecture of the library." [1,2]

This project has been one of the projects of a debate on the material experience of earth. How this experience is dependent on the context and of the project and culture of the respondents is discussed later on in 'debate'.

[1] retrieved from http://architects.bc-as.org/Library-of-Muyinga
[2] A post script on the project (IN)FORMATION, built in Burundi from May until October 2012. The booklet is written and published by Eva Gheysen and Jasper Van der Linden, interns at Brussels Cooperation and master students from Sint-Lucas University Brussels/Ghent.


image: bc architects & studies

WORKSHOP FORMAT

Earth workshops create an invitation to use a hands-on, active approach on materiality. Mixing technical know-how, tacit knowledge and material experience. Workshops can also be an invitation to rediscover the qualities of craftsmanship, the passing on of knowledge and skill.

The passing on of knowledge and skills can happen through methods as described earlier; the Carazas test, the adobe game, claystorming,... But another important aspect of the earth workshops is that they enable to do fast design exercises to create additional insights on the potential use of earth, both on a technical and experiential level. Meanwhile, the workshop format enables to put designers, builders, makers, craftsmen, researchers, clients together for creation, debate and reflection.

A series of designs happened during the advanced rammed earth construction workshop in August 2019, Brussels. The strength of this series is the repetition of the design and build process with earth for material experience. Repetition, but through different scales and different designers. This way more elaborate visions on potential tracks of using earth when applied in a contemporary Western-European context, get created.

ADVANCED RAMMED EARTH WORKSHOP

Location	Brussels
Year	2019 (August)
Earth technique	Rammed earth
a cooperation of	BC architects&studies Vai (Vlaams arch. instituut) Casedesign atelier Kara (Timur Ersen) UHasselt (Jasper Van der Linden) Fetdeterra Aardig gedacht & 25 enthusiastic participants

During this workshop, 25 designers and builders have been introduced to earth as a contemporary construction material and reflected upon its relevance in today's global societies. BC architects&studies and other lecturers shared their knowledge and vision on the use of earth in Western-Europe. Case Design on the other hand introduced their upcoming project: the Peace Pavilion in India. Together with BC and Case Design, the participants designed and prototyped the formwork and rammed earth 'building blocks' to be used for the construction of the Peace Pavilion. These 'building blocks' were to be conceived in such a way that they can also function as design objects or design furniture.

The specific aim to explore the use of earth in design objects or design furniture for the Western-European context follows from an economic reality that rammed earth is expensive in industrialised countries with high salaries, and therefore gets directed to the high-end gamma of materials. Meanwhile, the same block can be produced as a building block in an Indian context, where salaries are way lower.

Through the advanced application of earth, different ways of using the material in a designerly matter are being explored, with the aim to reach for specific material experiences. The high-end use allows for a dedicated focus on the possibilities in form and finishing of the rammed earth material.

high-end
design object

BELGIUM

bigger production of
building elements

INDIA

REFLECTION ON
THE DESIGN, MANUFACTURING & MATERIAL ASPECTS

At the advanced rammed earth workshop diverse designers, makers and designer/makers were put together. This situation enabled the exploration of different ways of using the rammed earth material in a designerly matter, with the aim to reach for specific material experiences. These experiences are influenced by the context, the design, the manufacturing and material aspects. The high-end use allows for a dedicated focus on the possibilities in form and finishing of the rammed earth material.

Form
A specific form is generally guided by the imagination of the maker/designer towards a certain aesthetic or functional target. In the specific case of this workshop it was limited it is possible to distinguish two types of constraints. One is the possibilities of the material itself. For example the use of rammed earth material does create opportunities in a form where compressive forces are present, however tensile forces should be limited. Also, there are some practical constraints, for example the use of the foreseen base formwork systems proposed for the production of the building blocks. Within these formworks the participants could put inserts, which allow a variation of the base form. Although the formworks give a certain constraint, within these outlines, there are numerous possibilities.

Finishings
The final appearance of the rammed earth elements/objects are influenced through the use of different finishings. These would differ in colour and texture.

Colour;
Three base mixtures were proposed, based on a red, brown and grey clay. In some prototypes, these were used together by layering one colour after another, usually at random to create some diversity and visualise the layering technique used during construction. A more conscious application of colour use was a design where a gradient was used (see images next spreads).

Texture;

Roughness through particle size:
All the designs were made with pre-defined rammed earth mixtures with similar particle sizes. Still, the roughness of the rammed earth objects could still slightly vary depending on the presence of bigger gravel on the outside layer. Some participants payed attention to avoid bigger gravel on the outside layer, others didn't mind or even did it on purpose.

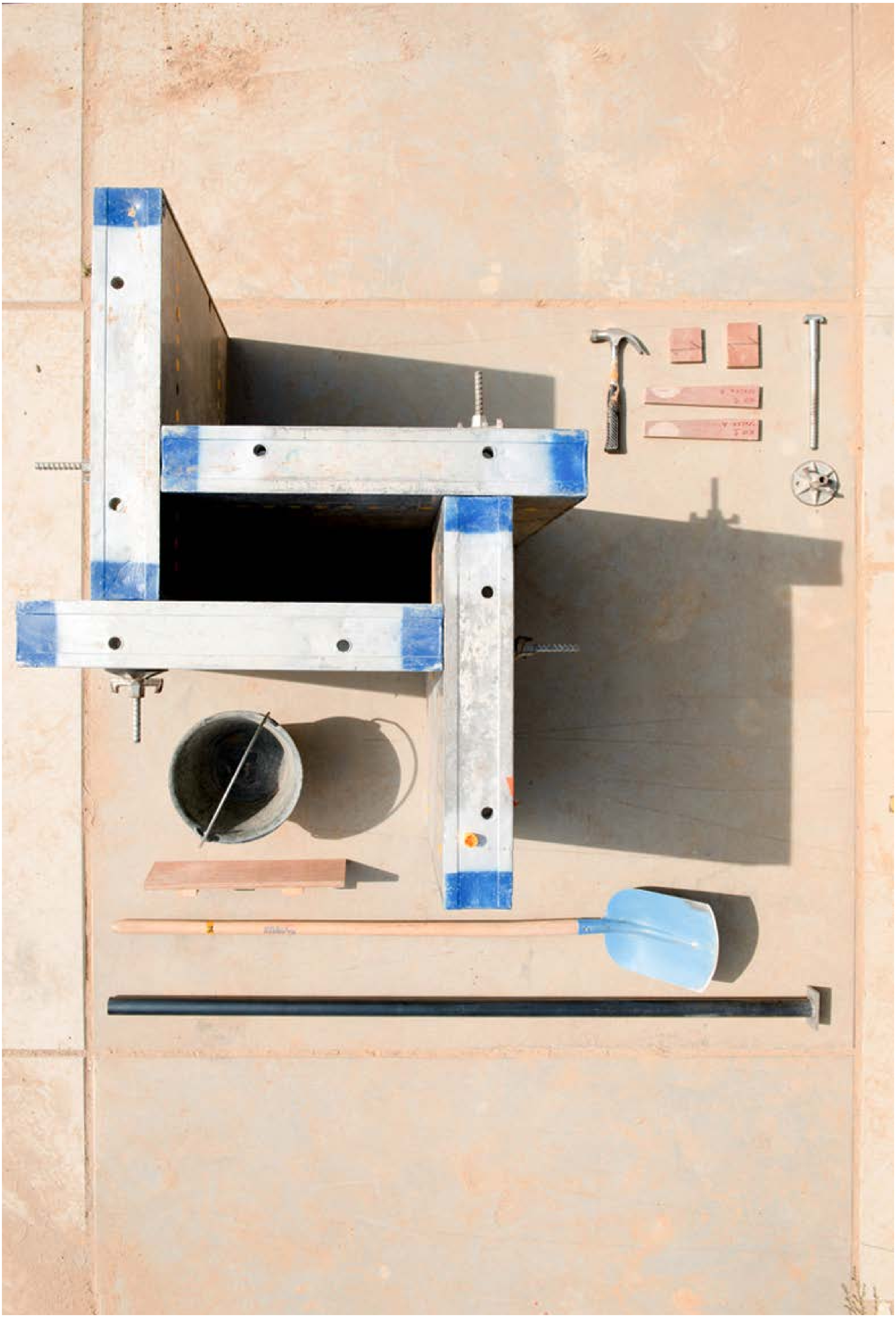
Roughness through erosion:
One design deliberately played with the rough texture that appears when rammed earth erodes. By not ramming a certain part of their element, the earth simply falls out when removing the formwork. The face on the side that was rammed does now appear very smooth, in contrast with the eroded part.

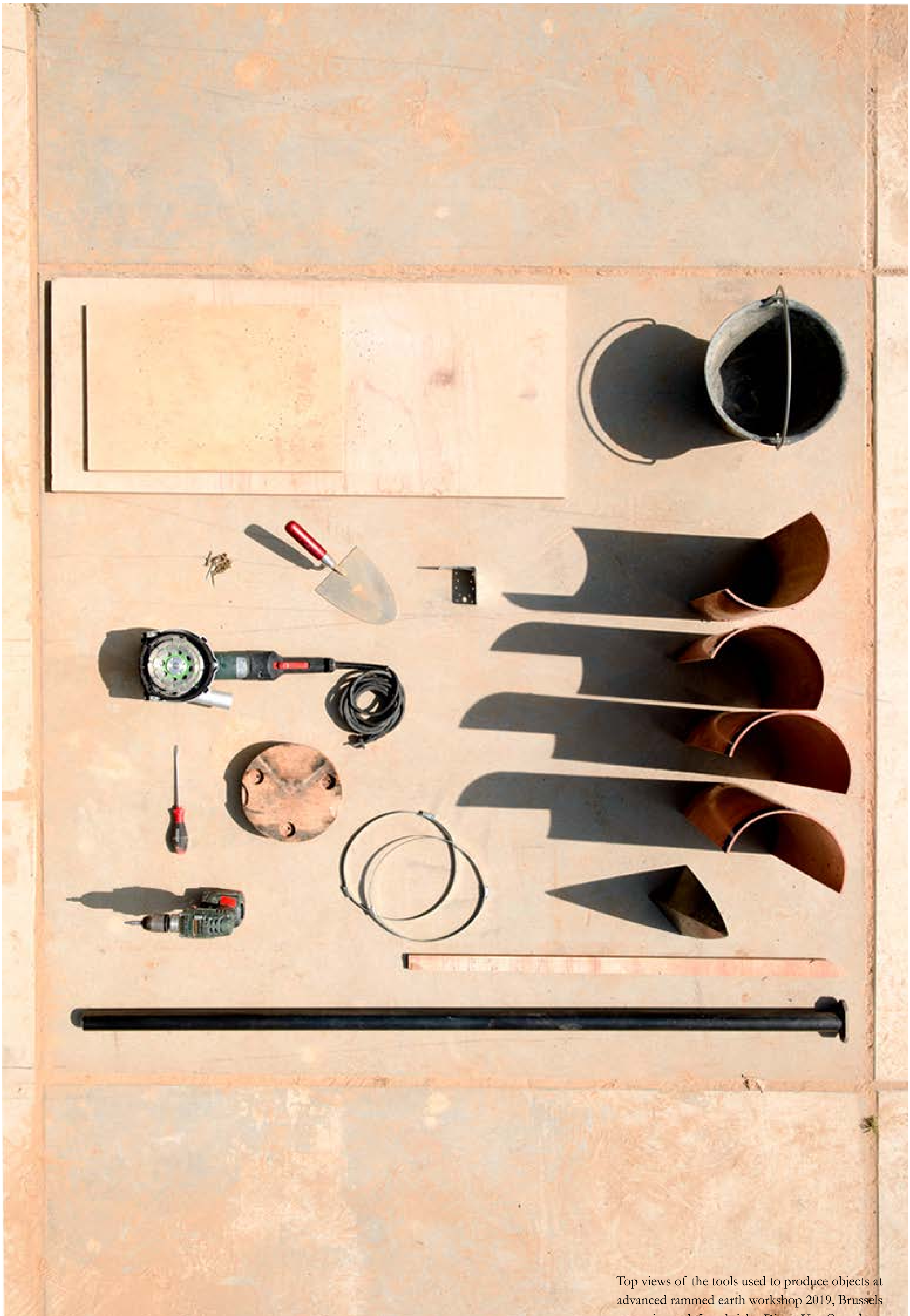
Roughness through brushing:
By brushing with a steel brush, the smaller particles erode and expose the gravel particles. This is a type of forced erosion, creating a rougher surface.

Smoothness through polishing:
By grinding the surface with a diamond pad, it is possible to polish the rammed earth surface. The gravel is being cut and a smoothened terrazzo-type surface becomes visible. This technique is usually used for floors, but can be applied also on objects. During this workshop the polishing was selected for its visual attractiveness, the communicative function of showcasing what particles are in the material, and for its additional resistance against abrasion.

Smoothness through plastering:
A technique tested during this workshop was the addition of lime-plaster on rammed earth. The plaster allows to create a smooth surface where desired, while also making it more water resistant. However by plastering a surface the rammed earth technique gets visually covered, and can therefore be understood as a less 'honest' addition.

In this specific workshop, the participants were usually looking for finishings that would pronounce the range of possibilities of the rammed earth material. By contrasting; the combination of a very smooth finishing with a very rough one, it is an goal to elicit surprise (see debate at the rammed earth workshop).





Top views of the tools used to produce objects at
advanced rammed earth workshop 2019, Brussels
image left and right: Dieter Van Caneghem

DEBATE

Material experiences differ depending on the context, the people that experience it, the design, the moment and the intentions that come along with these. Debating is a great way to get insight in different individual material experiences of earth and to share them. This allows people to reflect more purposely on how they experience the material, while also creating a platform to discuss how earth can further develop to fit within our contemporary society.

During the hands-on earth workshops (such as workshop beyond borders or advanced earth workshop) this happened naturally, since participants do reflect on the wider use and purpose of the material while experimenting or when confronted with certain themes during a lecture. Since the workshops are set-up in a collaborative way, having several participants working together, people often feel encouraged to raise certain topics and talk about it.

To take these naturally created discussions a step further, debates have been organised during the workshops. Through these debates it is possible to get a deeper understanding how earth can further develop to fit within our contemporary society.
The first discussion (see further, debate at advanced rammed earth workshop) was directed towards the understanding of the visions of designer/makers; how do designers cope with the creation of specific experience patterns that they want to create with earth? And how is it possible to pursue an actual built version of this?
The second discussion (see further, debate at workshop beyond borders) aims at a more shared view on how the material earth is experienced, what the potential of earth is from different points of view, and what different visions are on how the use of the material earth could evolve.

DEBATE
THE USE OF EARTH FROM A SOCIETAL POINT OF VIEW

Fragments from debate at advanced rammed earth workshop A conversation about the potential and evolution of rammed earth.

Moderator:
Jasper Van der Linden

Participants:
All participants of the advanced rammed earth workshop, with former experience on earth construction.

parI: Portuguese architect
parII: UK-based self-builder
parIII: Belgian architect
parIV: Spanish producer of prefab rammed earth blocks
ParV: Belgian carpenter
ParVI: French architect

parI: The one side is a straight earth wall, the other side is more closed to the natural earth. It's a bit this contradiction, you try to control it but then you have this surprise that it's only this earth that we see everywhere. This can have an impact when it is a building, when you get in you get surprised. You see like a monolith, you see bricks, and you're not expecting that you'll go in and you will have this fragility.
mod: So you use this fragility as a power of the material?
parI: the idea would be to create an atmosphere. The idea of the erosion is to let the material act as it will act. If you ram only here this side will fall. It's something where you are not making the sculpture, it lets the material speak for itself.
mod: so it is as an art intervention where you try to make a point?
parII: It's about process, how is it going to erode? You can make a certain choice, but this process is out of our hands. You're controlling the uncontrollable aspects.
parI: If it's another material, this … You create a relation, if you're in a building and you don't understand the building you get triggered, you create an emotion. It's something that stays in your mind.
mod: So it's to trigger, to surprise?
parI: It's to show what earth is. It's also this duality, it's so strong on the one side, it looks so fragile on the other
parIII: It's also the process, by polishing you do an action where you try to show what's inside, with the erosion it's the non-action that is shown.
parIII: It's as in this photo, it's because of polishing this side that you start to appreciate the rough side.
mod: so you have to contrast, or find a balance between the two sides?
parIII: if you don't do anything, when it's a clear block. You might appreciate it rather as a building material [rather than a self-standing design piece].

mod: I wonder if this 'uncontrolledness' is indeed a goal on itself. As with the Fetdeterra blocks, you were really trying to search for differences in the walls. If you industrialise, it will all look very similar blocks, as concrete would be. In search to communicate this naturality, were you purposely finding ways to make the blocks different?
parIV: you have to modify the machinery and the formulation so that every block would be different.
mod:
parV: I would say there is something more. As in the example we just saw, the children immediately look for contact. Other people might be a bit reserved, but children not, they touch it immediately. It's an amazing quality of earth that is reconnects. When you have

a polished side, or a crumbled side, you really have a way of showing the processes. A material that erodes, a material that is stacked. All the processes that are inside every building. In our mind we don't think of concrete as eroding. Look at our concrete bridges in Belgium, it's a mess. In an earthen building it's clear that it's for a definite period of time, but it's no problem because you can just break down the material and reuse it. It's the purity of the act of building.
mod: If this is what you want to communicate, then people have to read it also like this. Because with a rammed concrete for example, would it be so much different? With the Zumthor (Bruder Klaus kapelle) for example, would you realise it? In the end it looks kind of similar.
It's more storytelling; some people know that you can re-use the earth material. Therefore this is a debate because if this is an important element, it's a challenge to communicate to people that are not familiar with this world yet.

parI: It's ephemeral (lasting for a short time). We are not prepared to not have things forever. When we do something, I found also the process of removing interesting. It's nice to show that this, in this case it's earth, you can destroy it and some day it's another thing.
mod: So in this case I read it again as an artistic act, where you let people think about something?
parI: I don't know. It lets people think. And sometimes you need emotion, to let people think. I don't think it's necessary to prove anything, you just have to show it. There is moments that you can provoke, you create something that creates emotion.
mod: you can also create surprise and emotion with a concrete building. As with the Zumthor building, also the inside is quite surprising.
parI: If you make the same building with concrete, it will not have the same effect. The relation and the connection will not be the same, in my opinion.

parVI: I think that this discussion that we have, on the smoothness and the roughness of the material on the one side it's an artefact. It expresses the raw material. There is something about its structure, and the nature of the material that is nicely expressed this way. It shows the act of building.
parI: It's not about the technology, it's just earth.
parIII: We are a very selective public here. All with a fascination to not have full control of the process. Creating designs by humans and nature. The power of showing this is incredible.

parIII: I think we are forgetting one thing, this is a building material. We are focussing a lot on the design, but most of the walls are covered, not shown.
mod: in our Western-European context it is expensive, and then you might want to show it?
parIV: our customers choose our products for the aesthetics, and the ecology. But our products are never covered.

parV: I would like to add some context, we are clearly in a transition. It might be that our economic system might collapse. Still you can fill up a wall with earth that is nearby. So in a way all this experimenting is about construction a new model that might become of use in the future. And here it's important that we try to push the limits.
parI: We are talking about an economical cost now. It might be that at one point the social, ecological and health cost might get considered.
parII: Let's hope that at one point, there are some governments that start connecting the dots...

DEBATE

THE USE OF EARTH FROM A CULTURAL POINT OF VIEW

Conclusions from the debate at the Workshop Beyond Borders in Ouled Merzoug. The participants were divided in groups to each discuss the material experience of one presented project.

Moderator
Jasper Van der Linden

Participants
project Negenoord (see project watchtower)
- Italian - architect
- Belgian - architect (2)
- Dutch - architect (2)

project Edegem (see project bioclass)
- Belgian – architecture student (4)
- French - architect

project Muyinga (see project library)
- Belgian – architecture student (2)
- Moroccan – PhD tourism
- Belgian – design student
- Moroccan – tourist guide

Roughly all participants of the focus group already had an interest in building with earth. After all, they subscribed for a workshop on earth building in Morocco. The focus group was done on the second day, after one day of visiting the village. At that point all of them were familiar with the traditional earth buildings that surrounded them in the Moroccan context, since the big majority of the buildings in Ouled Merzoug are earthen buildings. In the morning before the discussion group, a brief introduction on the material earth was given without further explanation or discussion on its architectural possibilities, advantages or disadvantages. The hands-on experience with the material, presentation of case studies and deeper introduction to the material's possibilities happened later in the workshop. However, it was clear that many of the participants were already influenced by projects and insights built up through their studies or work.
At the start of the focus group, each participant noted down individually what images, ideas they relate to building with earth, not linked to a specific project or materiality. A list of keywords was also given to inspire the participants with keywords that were studied in earlier phases of this PhD. Although it was not demanded, many participants scored the list of keywords, specifying their material experience for earth material in general. These ideas were noted down and then shared with the group. A recurring topic was the value of a local and traditional construction material with low environmental impact that fits well in its environment.
After sharing these opinions and visions, three projects using earth were shown, with a very brief introduction on where the project is situated and which technique was used. Each group of 5 people discussed about 20 minutes on how they experience the building and the earth material within it. They used the list of keywords as a guideline, and tried to come to some conclusions on the material experience which they noted down (as presented further on). Followed on this discussion within the individual groups, each group briefly presented their overall conclusions.

The first group discussed the watchtower in Negenoord. Two of the participants had visited the tower recently, and had a personal real life experience. This influenced their vision, resulting in the idea that the building has several contradictions. Depending on the scale that you perceive it, it evolves from a monolith to a welcoming building. When you come closer the materiality becomes visible. They claim that this really inherent to the earth material, and is not so much a design choice. Also the dimension of time is very present, the building that evolves with the landscape is seen as a powerful element. But meanwhile it needs a lot of aesthetical maintenance.

The second group discussed the library in Muyinga. This is the only group that had non-Europeans and non-architects 2 Moroccans that are having a tourist background. It became immediately clear that this difference in cultural background resulted in a split on opinion with the European architect-participants. The Moroccans claimed loudly that the building is aggressive, through its red colour. And scary, because it has few window openings, like a stable. They associate it with buildings that were placed by the French in colonial times because of the pitched roof. This is a building style that is not common in traditional Moroccan architecture, but the French introduced buildings with pitched roofs that are now abandoned. These associations differ quite a bit with the other three European discussion participants. They do appreciate the red colour since it's the same as the surrounding, and see the building as playful, curious and cosy. The cultural context and references were a major influence in the difference in material experience.

The last building discussed was the bioclass in Edegem. The participants were confused about how they experienced the building. It's an unexpected look for earth construction, combining unusual methods from industrial and vernacular building methods. Later that week we showed and explained the full project, including its context, the outside and the reason why certain choices were made. This resulted in the comment that with that information, more contextualised pictures and background information they would have rated the building very differently. But here it was specifically chosen to only show inside pictures of the earth, since that's the material we wanted to question. Also, users of the building spend a major time here, so it is true to how the building is being experienced for a big part of the day. (beside the limitation of two pictures instead of a real life experience). The influence of context may not surprise however, also in the Negenoord project the opinion of the participants was probably influenced by the fact that they visited the project while knowing the intentions of the building (controlled erosion, exposure of the gravel, …). This concludes a third big influence on the material experience: physical context and background information on the manufacturing and technical aspects.


FUR

AFTERWORD

The urgency of climate change and the search for a just, well-balanced and sustainable environment has forced us to look further than simply continuing the way we're building today. Environmental concerns have led to an increased awareness on the environmental impacts associated with a material and building's life cycle and an increased interest in natural and bio-based materials (such as wood, hemp, earth, bamboo, mycelium,…). Unfired earth is one of these materials that present an opportunity for an alternative way of building with a lower environmental impact. The first chapter in this book has been introducing earth as a matter, decomposing the material into different particles. It is by understanding how the material is composed and transformed that one can understand its relationship to other natural elements, to its environment. It might be a good strategy to approach earth as a living organism; one that needs water to function, one that needs care from time to time, one that will slowly decompose if it does not get this care.

The book continues by discussing earth as an ingredient for both traditional and contemporary architecture. The complex balance between material, shape and natural context that vernacular architecture provides is a useful model of inspiration for contemporary projects. Such contemporary projects, directed by a good understanding of the material and inspired by vernacular architecture have been shared and discussed in this book. But also a series of own research by design, exploring further ways of deploying the material.

Earth building received significant interest; exhibitions specifically about earth construction and contemporary architectural projects using unfired earth have emerged the past decade. Still, the use of earth is an experimental niche in Western-Europe, and can be described as a non-conventional building material. Specifically because earth is a non-conventional, non-standardised material, it might lead us to innovative production processes and design solutions. Triggered by a lack of formal material distributors, ready-made building materials and standardised building regulations, it is a material that invites for experiment and an alternative way of 'doing architecture'. From this point of view, the use of earth should not necessarily become conventional; it could create impact by simply showing another way of building, a way of building a future-proof world. Being future-proof does not mean that it should be the strongest material; on the contrary, maybe it should be made to eventually disappear with minimal harm to the environment. Accepting the fragility of a material could be an alternative path of thinking about materiality. Maybe we have to adapt ourselves, instead of the materials adapting to us.

One approach could be to have a higher amount of involvement in the creation process by the client, architect, craftsman, or 'do-it-yourselfers'. Someone who engages to follow up the full transformation process, who understands how the material behaves and what it is able to do, will experience the material very different than someone just receiving the final product. That is why there is a specific part of this book focussing on hands-on methods that support exploration, communication and design of earth materials. These have been used in several workshop formats; where knowledge and skills are passed on, shared or developed. Such format can empower the transformation of unfired earth materials in a way that they function best, based on a well-thought and well-informed design process. This design process should enable the material to perform technically, environmentally and aesthetically in a way that suits the design demand.

The last part of this book spins around the idea that a material can only create a successful sustainable design if it gets appreciated by people. To increase the uptake of unfired earth material, it would be necessary to understand how the material is experienced. An exploratory study aimed to trace how a variation in colour or texture would affect the way that the material is experienced. So we created a variety of earth material samples; differing in colour, roughness and fibrousness. Different people were questioned about the way they experience earth material, and these samples specifically. A further study was to discuss the experience of earth architecture through focus groups. When having a good understanding of how people experience the material, we can take this understanding into account to create designs with earth that get selected and appreciated. ¬¬The facilitation of a conscious way of designing with earth materials, while taking into account material experiences has been tested trough the method of Material Driven Design (MDD).

Possibly the biggest variable in the material experience of earth are the people themselves. The differentiation between laymen and architects-designers acquainted with the topic for example; the laymen is more often inclined to select a conventional material whereas the imagination of the architect-designer allows to imagine the material in specific situations, adapted to the desired application and potential of the material. But also the (cultural) background of the participants, being dependant on different references, influences heavily the way we experience buildings, and therefore the building material. This differentiation in material experience results from a diversity in references, interpretations and preferences that people have.

From this observation, a final insight on the potential evolution of the use of earth in a Western-European context is that, instead of improving the product for the 'desired' material experience, correct communication around the product might be at least as important. Improving such communication can be done in numerous ways. By creating and disseminating good projects, in a way that clearly communicates the reasoning of the material. This does not only benefit communication around the topic, but also pushes forward technological knowledge, craftsmanship and potentially even economical evolution (cost decrease through volume increase) and political support (implementation of standards arising from exemplary projects).

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FIGURES

UNFIRED EARTH
in a post-industrial society

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