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INTRODUCTION

The INTERNATIONAL SUMMER SCHOOL ON MODERN EARTHEN ARCHITECTURE AND BAMBOO CONSTRUCTIONS 2014 was organized by BASEhabitat organisation in partnership with the University of Art and Design of Linz, the Research Center, Risc, Infrastructure, Security and Conflict, Bundeswehr Universität Munich, CRATerre-ENSAG, École Nationale Supérieure d’Architecture de Grenoble in France and amàco («atelier matières à construire») which is a project based in France and supported by «Investissements d’Avenir» through the governmental Initiatives for Excellence in Innovative Training programme (IDEFI) for a period of eight years, up until December, 2019.

The aim of the Summer School is to get an intensive Hands-On experience and to gain practical knowledge in building with earth and bamboo, to associate these timeless materials to innovative architecture.

About BASEhabitat

BASEhabitat is a project studio for architecture in developing countries developed in the University of Art and Design of Linz. It stands for basics and beauty, architecture and aesthetics, social and sustainable, energy and education. BASE does not mean specialisation but the development and expansion of the existing classical and comprehensive study of architecture. It represents a step into the reality of life, into the reality of politics and society. Today we can erect buildings in which no outside energy is needed to provide a pleasant internal climate, buildings that use the resources of their location rather than destroying them, that enrich the environment and offer people new challenges and new work. To achieve this we do not need more responsibility, nor must we restrict ourselves or do without something. All that is necessary is additional intelligence, more teamwork, sensuality, joy and beauty.
About the site
The Summer School took place in the ABZ (AgrarBildungsZentrum) Salzkammergut that is an agricultural education center. This place inspires not only because of its situation at the shore of lake Traunsee, but also through the quality of a passive building design that has won several architecture prices.
The main material is untreated wood that comes directly from the region, and it is used in walls, floors, frontages, ceilings and furniture.
All participants were host in the building students rooms.
BASEHABITAT SUMMER SCHOOL
ABZ Salzkammergut,

AUSTRIA
Four parallel workshops:

LIGHT EARTH & COB
WORKSHOP LEADERS: Stefan Neumann & Jule von Hertell

RAMMED EARTH
WORKSHOP LEADERS: Martin Rauch & Dominik Abbrederis
BAMBOO
WORKSHOP LEADERS: Andrés Bäppler Ramirez, Gretta Tresserra & Ruben Calambas Bermudez

ADOBE
WORKSHOP LEADERS: Dorian Vauzelle, Lucile Couvreur & Gian Franco Noriega
Time schedule

**Mon, 14.7.**
- **10:00-18:00** Check in
- **19:30-21:30** Welcome

**Tue, 15.7.**
- **8:00-12:00** Material Science
- **13:17-17:30** Material Science
- **19:30-20:30** M. Science

**Wed, 16.7.**
- **8:00-12:00** Workshop 1
- **13:17-17:30** Workshop 1

**Thu, 17.7.**
- **8:00-12:00** Workshop 1
- **13:17-17:30** Workshop 1

**Fri, 18.7.**
- **8:00-12:00** Workshop 1
- **13:17-17:30** Workshop 1

**Sat, 19.7.**
- **8:00-12:00** Workshop 1
- **13:17-17:30** Workshop 1

**Sun, 20.7.**
- **Excursion**

**Arrival**
**10:00-18:00** Check in

**MATERIAL SCIENCE**
- The experienced team of amàco (CRAterre) will give basic information on different materials. They will also offer practical experiments in small groups.

**SEISMOLOGY**
- Theory input and practical tests with a vibratory plate organized by the Research Center RISK (“risk, infrastructure, security and conflict”) from Bundeswehr Universität Munich.

**PEER LECTURES**
- In the evening we give the stage to the participants. You can present your projects and discuss them with the others.

**WORKSHOPS**
- On different materials & building methods
  - Adobe CRAterre, amàco team
  - Straw & Earth Stefan Neumann
  - Rammed Earth Martin Rauch and team
  - Bamboo Andrés Bäppler & team

**EXCURSION**
- The excursion takes 2 days. We will travel to the east of Austria (Vorarlberg) and to Switzerland to see some outraging buildings made of earth. Highlights might be Martin Rauch’s factory, and building site.

**THEORY CLASSES**
- We will get different insights concerning sustainable architecture and discuss about social, economic, climatic, ecologic and aesthetic aspects.

**CLOSING SESSION & PARTY**
- The end of the program will be a closing session with reflection and prospects and a farewell party.
**BASEhabitat International Summer School 2014**

**Time Schedule**

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**Workshops**

- Adobe CRAterre, amàco team
- Straw & Earth Stefan Neumann
- Rammed Earth Martin Rauch and team
- Bamboo Andrés Bäppler & team

All the workshops will take place at the same time. Participants can choose 2 workshops, each one lasts 4 days. We are going to present all the workshop tutors and their projects and plans for this Summer School later on.

**Theory Classes**

- We will get different insights concerning sustainable architecture and discuss about social, economic, climatic, ecological and aesthetic aspects.
- We will welcome Andrés Bäppler, Anna Heringer, Dominique Gauzin-Müller, Elias Rubin, Helmut Krapmeier and others.

**Closing Session & Party**

The end of the program will be a closing session with reflection and prospects and a farewell party.

**Material Science**

- We will start with a whole day on material science. The experienced team of amàco (CRAterre) will give basic information on different materials. They will also offer practical experiments in small groups.
- Martin Rauch will give an input on rammed earth.

**Seismology**

- Theory input and practical tests with a vibratory plate organized by the Research Center RISK (“risk, infrastructure, security and conflict”) from Bundeswehr Universität Munich.

**Peer Lectures**

- In the evening we give the stage to the participants. You can present your projects and discuss them with the others.

**Excursion**

- The excursion takes 2 days. We will travel to the east of Austria (Vorarlberg) and to Switzerland to see some outstanding buildings made of earth. Highlights might be Martin Rauch’s factory, and building site.

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**BASE architecture for development**

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amàco project is an educational resource center that aims to make visible, in sensory and poetic ways, the physic-chemical behavior of the most common natural materials, such as sand, water, earth, wood, straw, etc. The project aims to disseminate knowledge regarding their application in construction, so as to promote the emergence of eco-friendly practices. amàco brings together physicists, engineers, artists and architects, under the same roof. Magic, emotion and creativity are the watchwords of the project.
MATERIAL SCIENCE LECTURES

Amàco was invited to be in charge of the material science day lectures at the beginning of Basehabitat summer school. This challenge and responsibility was to think and decide about an adapted theory content and experimental practice for the 80 participants of the workshop.

So this day, after a little presentation of amàco project aims, vision and philosophy, the lectures were organized around two main subjects:

1.- «Building with Earth (grains)»
2.- «Building with Fibers».

The «experimental» lectures included some live experiments that were filmed and presented to the participants in order to increase the magic and emotion of the different scientific experiments.

Also, the participants were invited to get involved in the experiments by doing a planned exercise with earth and fibers.

1- Earth exercise (Carazas test)
2- Fibers exercise
The lecture «building with earth - from matter to architecture» was divided in two parts. The first part focused in presenting an overview of earth architecture heritage and contemporary examples and also the functions earth material can have in relationship with a building technique (to carry, to insulate, to cover, to fill, etc.).

Trying to answer the question : How it stands? Scientific experiences with grains were presented to understand the physics of earth that is composed of grains, air, water and a binder (clay).

In the second part, we get more deep in the matter and explain the physic-chemical interaction of this components.
The lecture «Building with Fibers - from matter to architecture» was also divided in two parts. The main objective of the first part of the lecture was to show the use of natural fibers in architecture and explore all possibilities and qualities that can inspire as architects, engineers, artists, designers, etc. A short overview of fibers architecture in vernacular and contemporary habitats and some architecture projects linked to the functions that fibers have. (filter, insulate, dress, cover, reinforce, etc.)

In the second part, we get more deep in the matter and explain the origin of fibers, their diversity and their inner physic-chemical properties, for example when there is interaction with other elements. (water, grains, etc)
EARTH EXERCISE  TEST CARAZAS

As explained in the previous lectures, earth is a material composed of three matter states: liquid, solid and gas. A simple gesture in manipulation and a different proportional interaction between these three states will determine the inner properties of the final material.

The aim of this exercise is to observe, by changing the hydric state of the earth (dry, humid, plastic, viscous and liquid) and the manipulation (fill, pressed and compacted), the variations and characteristics that the material can have. It will help us to «understand by doing» the better use and application in different building techniques.

A hole game of actions, techniques and building systems are the result of the change of the hydric state and the mechanic action applied.

In this case, four types of earth were compared by the participants to also make evident that earth soil qualities are not always the same.
FIBERS EXERCISE

Inspired in the previous exercise with earth, different kind of fibers where proposed to observe and compare their behavior changing some parameters.

Fibers were filled dry, pressed with water, pressed with a clay binder and compacted with the same clay binder.

The result were immediately compared.
WORKSHOP ADOBE

The aim of the “Adobe” workshop is to experiment and to explore the aesthetic potential of mud bricks for contemporary design and architecture. Manipulating basic principles of this ancestral building technique the participants will follow a creative process in order to explore the variations and effects of earth matter building expressions.

The participants will design & build an architectural element learning in this practice about different aspects of matter behavior, molding principles and construction parameters of earth-based bricks to stimulate and feed their own design creative process.

Amàco teaching method is based on experimentation and hands-on approach. Our creations appeals to aesthetic and emotion to whet the participant’s curiosity. We believe that these methods foster open-mindedness and pleasure of learning. We give a priority to teamwork to encourage knowledge exchange, interdisciplinary and collective intelligence. Moreover, we are specialized in developing building techniques using local materials like earth and natural fibers. Every workshop we take part is the opportunity for us to put into practice our teaching methods and to experiment with other participants.
«ADOBE BUILDING TECHNIQUE» LECTURE
A basic principle

Mud bricks or “adobe” is a material based in an very ancient and intuitive technique used since the beginning of civilizations.

It consist in transforming raw earth in a plastic matter by the use of water so the mix can be molded, and after that, dried under the sun to produce a “handleable” construction material.

As experienced, the evolution of this technique is based in a very basic construction principle : molding a handleable material that can be stacked together later in a way to compose an intelligent construction technique.

1. left : bricks production in «Huaca de l sol», Lambayeque, Peru. © Nathan Benn/CORBIS
2. right : Petite structure faite par des enfants lors du «Festival Grains sIsère» © Craterre
The most ancient mud brick formed by hand was found at Jericho, Palestine in the VIII millennium B.C. And the oldest molded brick was found in Catal Höyük, Anatolia, Turkey, VI century B.C.

As we can see, there was a long process in which the form of earth bricks evolve from hand-made forms (ball of earth, cone, hemisphere, piriform, etc) to the molding of parallelepipeds of square or rectangular plan as we commonly use today.

Depending on the region of the world, not only the forms but also the dimensions of the bricks are very different from each other. Also because their wher adjusted to the function of the element or the building to construct.
In our heritage architecture

Even if this technique is universal and based in the same principles, we can find different expressions an morphology of adobe-based architectures around the world. This a good example of it’s versatility and an infinite source of inspiration for now a days practices and designs.

1. Left : La ville de Shibam, YEMEN, «le manhattan du désert» © Yann Arthus Bertrand
2. Above : Ancien city of ChanChan, Trujillo, Peru © Dave G. Houser / CORBIS
3. Above: Cité de Merv, Turkmenistan © Peretz Partensky
for contemporary architecture

Architects and constructors still experiment and try to develop this technique exploring their potentialities as a natural and accessible material. We also believe in their architectural qualities and the particularities of its architectural language.

1. Left: Cassia Co-op Training Centre, TYIN Architects, Indonesia © Pasi Aalto / www.archidaily.com
2. Right: “Los Robles” cellar, Chile. Architects: José Cruz + Hernán Cruz + Ana Turell © www.eartharchitecture.com
3-4. Below: Primary school, Maosi village, Xiansheng Town, Qingyang City, Gansu Province, China. Architects: Edward NG, Jun MU © Jun Mu - Department of Architecture, The Chinese University of Hong Kong
Adobe production techniques

If we see the wheel of earth building techniques we are referring as adobe for a technique that is placed next to other masonry techniques. Depending on the production process, adobe technique can be differentiated in three categories:

1. Hand-made formed adobes
2. Manual molded adobes
3. Mechanized adobes.

1. Above: Production de briques coniques, Tubali, NIGERIA, musée de MATNA; ville de jos, état du plateau © CRAterre
2. Above: Manual molded bricks © reserved rights
3. Right: Mechanized production of bricks, Fresno California USA, 1992 © Christine Bastin & Jacques Evrard
4. Right: In Germany an industrialized production of bricks is used to dry the bricks in ovens. This helps to reduce drying area costs © CRAterre-ENSAG
atelier matières à construire
1. Above: Cycle de production de la brick de terre crue © CRAterre - ENSAG

2. Left: Drawings from the book «Batir en Terre» © CRAterre - ENSAG
Adobe production line

The choice of the raw earth matter should fit the technique requirements. Fields test can be made to determine the cohesion properties of clay before extracting the soil and transporting it to the material production site.

After extraction, raw earth can be stabilized by some aggregates if needed (ex. Sand) to optimize the quality of the final brick. Then water is added to let the mix «rest» to activate clay properties. Mix can be made manually or with the help of animals or mixing machines.

Earth mix is transported to the molding area. The mix is directly placed beside molding area. Molding process is made in a flat compact surface. The mold is filled by the prepared mix and unmolded immediately after.

After sufficient drying that means that they can be manipulated. Bricks are turned to dry efficiently. Dried bricks are stocked together.
EARTH CHARACTERISATION

Some fields tests were applied in order to understand raw earth and to decide the «right» mix for making our bricks with the local soil. Four different kinds of soil have been used for pedagogic reasons. Compare to understand. There was not so much clay in the local soil. We conclude it was a «silty soil». If sand was used it should be only to stabilize the mix for having a relative comfort molding the bricks.
BOTTLE TEST
Measure the proportion of the inert grains and the fine grains

**Procedure:**
In a transparent bottle, fill with ¼ soil and ¾ water. Agitate vigorously and leave to settle down till the water on top is clear.

**Results:**
Note the proportions of the different constituents:
- Gravel and sand at the bottom
- Silt and clay at the top.

CIGAR TEST
To determine the cohesive properties of the soil. To verify if the quantity of clay in the soil is suitable for the production of bricks.

**Procedure:**
Eliminate the particles larger than 5mm
Prepare the sample to a plastic state
Fabricate a cigar of 3 cm thickness and push it gently off the hand.

**Results:**
Measure the length L :
- If the length is less than 5cm is a SANDY SOIL
- If the cigar is more than 20 cm is a CLAYEY SOIL
(*) between 5cm et 20cm is good for mud bricks

PILL TEST
To test the resistance when dry. Determine the percentage of shrinkage.

**Procedure:**
Remove the gravel in the soil sample and prepare the soil to a plastic state.
Cast 2 discs in a piece of PVC tube or similar.
After drying :
- Observe the eventual shrinkage behavior.
- Evaluate the resistance of the soil to cracking and crushing by testing between the thumb and the index finger

**Results:**
- No shrinkage, easily crushed to powder : SANDY SOIL
- Shrinkage, easily reduced to powder:  SILTY SOIL
- High shrinkage, difficult to reduce to powder : CLAYEY SOIL
FROM MATTER TO MATERIAL - ADOBES

EARTH

STRAW

SAND
The material came from local environment. We had at our disposal raw earth soil and sand that was directly delivered when needed. We had also 2 big straw bales of straw already cut between 5 to 10cm.

The earth used was “tricky” because it has a very sticky behavior when putted in a plastic consistence. That make us think about stabilizing it with the addition of sand. Not too much because of a high percentage of silt inside and maybe no too much clay. It was a matter of testing to find the right proportion of the mix that was comfortable enough to mold and resistant enough after drying.

First we only had sand 0/4 that was considered too big to achieve quality results. The hypothesis was that there was a big granulometry gap that didn’t help to find a balanced mix. Anyway we use this sand the first round of bricks. Later we’ve got fine sand 0/1 that we think helped for the second round of production.
Mix preparation

After deciding the proportions of the mix, a short explanation of the line of production help to organize the group in teams to get a continuous flow of the production.

The mix was prepared following low technology methods (by feet) but some times with the help of a planetary mixing machine to have a preliminary mix of earth soil and sand. The straw was always added and mixed by feet on the floor.

The prepared mix was transported to the production site under the tent when ready.

Touching and feeling the earth texture and plasticity always captures the attention and fascinate the students. The motivation of the group who waited impatiently for that moment was clear.
Brick molding

A big challenge was made for each group in the first day of adobe workshop: to produce as much as possible of adobe bricks. The teams get a technical explanation before starting the work. Only with little supervision the participant handle to produce around 400 bricks in a few hours.

The main idea of this part of the workshop is to introduce some “classical” production knowledge and to have enough bricks to play with later.
Summer time in Altmünster was very hot, almost ideal to dry adobe bricks. But as usual in summer time, rain can happen and weather forecast can’t be 100% trustful around the mountains. For this reason, adobe molding took place under a tent trying to prevent an eventual rain. Nevertheless, during the day, and after the bricks where dry enough to move around, the adobes where transported outside the tent in human chain. The adobes were turned to dry more homogeneous and quicker, so we can use them to build little architectural elements (arch, vault, dome) at the third day of the workshop.
STACKING EXPERIMENTS – «ELADIO DIESTE» EXERCISE

«A building con not be profound as a work of art unless it has an earnest and subtle fidelity to the laws of matter. Only the reverence that this fidelity requires can make our building serious, lasting and worthy partners in our contemplative journey.»

Eladio Dieste 1924-1995
STACKING EXPERIMENTS - «TOWERS» EXERCISE

A geometrical game

Inspired in the teaching methods of the architect Patrice Doat with the first year students in the school of architecture in Grenoble, the participants organized in three groups explore the nature of the brick experimenting different stacking compositions.

The aim of this exercise is to stimulate creativity introducing some structural principles. A play of lights and shadows, texture and shapes start to reveal the aesthetic potential of the brick to create spatial qualities and formal expression with a simple geometrical shape.
STACKING EXPERIMENTS - «TOWERS» EXERCISE
JEUX D'ADOBES

DESIGN YOUR OWN MUD BRICK
Aims of the exercise

The workshop studio entitled “Jeux d’adobes” or “Adobe’s game” in English, is an artistic exercise of free creation to freely explore the aesthetic qualities possibilities of the material. This exercise is about studying, working and playing with the material (earth). More specifically thinking about the shape, texture and qualities of dry earth modules, assembled with a mortar to constitute an architectural element.

A creative approach implies not necessarily working with the traditional sizes or formats already existing for a brick of raw earth, and also not an obligation to follow the rules of classic masonry for assembling them.

Following an open design process, the participant develop a sensitive approach of the material exploring creatively and intuitively using the knowledge acquired and their own imaginary, the aesthetic potential of adobe bricks building techniques in contemporary architecture.

This exercise offers the learner the possibility of question and explore different ways to express a concept by simple transformation and manipulation of material, the earth. To develop his concept the participant will have to formalize his idea and he will be confronted with the realities of gestures and physical constraints of a construction adobes.
« Only people who understand the nature of materials can make art using them »  Wang SHU - architecte

1. Left : mains de potiers à l'ouvrage, © https://onepassiononedevotion.wordpress.com
2. Left : terre à pisé © AMACO
Design in progress

The students have to produce one or several ideas to produce a 1m² wall element. They have at their disposal a wooden base of 1m long by 30cm thick. They have the possibility of creating their own mold and the tools necessary for the production (shovel, trowel, etc). They had to use earth material but they had also the possibility to add fibers (straw) and sand to create their own material formulation according to their idea. The prototype principle is to be composed by bricks (modules) that when assembled reveals the composition idea.

The preliminary ideas elaborate by the participants in a brainstorming were explained to the group and then associated in general research subjects to create the working teams (stacking, pattern & texture). The teams worked their projects according to this themes chosen by the teachers in a second phase of design to decide the final prototype.

The production phase was done by each team in complete autonomy putting in practice all the knowledge learned in the previous part of the workshop.
MEMBERS: STEFANO GARIGLIO, ANDREA HILMBAUER, NICOLA LUXEN, LAURA SARCHI, GEHRARD.

ELEVATION

STRAW AND EARTH

EMPTY HOLE

PROCESS:
ONE SIDE IS RATIONALY DESIGNED REGULAR PATTERN, THE OTHER IDENTITY EXPRESS THE CONSEQUENCE OF THE ASSEMBLY OF THE FIRST SIDE.
GROUP: The brick stackers
NAME OF PROTOTYPE: A punch in the wall

STACKING
Production (encountered difficulties, technique used...):

30 x 6 x 4 cm³ brick, very fragile overlapping bricks built with extending each brick out by 2 cm³ each & long. Since the bricks were very thin, lot of brick broke & while making the brick it was difficult to take out the mould, since it was sticking the frame because of light weight.

Scale 1/1 (ambient and qualities of the space you have drawn):
**Concept:** The concept for this wall was to experiment with different textures. We wanted to showcase how various materials and processes could create different finishes. The main idea was to build a solid and textured wall.

**Prototype (drawings and process):**

- **Texures:**
  - Different materials, shades, and gradients.
  - Side 1 and Side 2 with varying materials and textures.
  - A gradient effect in the drawings.
  - Mixed different mix and stone.

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GROUP:

NAME OF PROTOTYPE:

Concept:
- Series of vertical planes
- Broken planes
- Alteration: full openings - light concept
- Dynamic equilibration: pattern
- Using the standard brick sizes to design a creative pattern

Prototype (drawings and process):

[Hand-drawn diagrams showing concept, dimensions, and process]

CONCEPT

HORIZONTAL VIEW

DIMENSIONS

操作

所需：160块砖

操作：堆叠

Roof direction

viewings
ADOBE BUILDING ELEMENTS - ARCH & VAULT

learning from tradition

The arch, the vault and the dome are all applications of the same concept. The vault, or open-ended tunnel, is only an exceptionally deep arch. The dome is in effect a collection of arches all sharing the same center. In each case the pressure of gravity on the material forming the arch will hold it together as long as the outward thrust is contained by buttresses.

Participants get to explore building methods of this bricks traditional architectural elements.
A dome is a rounded vault made of either curved segments or a shell of revolution, meaning an arch rotated around its central vertical axis. Unlike arches, which require support for each element until the keystone is in place, domes are stable during construction as each level is made a complete and self-supporting ring.
omàco
ATELIER MATIÈRES À CONSTRUIRE