WATTLE-AND-DAUB and LIGHT EARTH

BIØN II- Follow-up report

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Building Impact Zero Network

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ARCHITETTURA A KILOMETRO ZERO ETS

Raw earth constructions involve heavy masses of natural material contribute to balanced inner climates. In certain conditions, however, light constructions can provide advantages such as making the structure less subjected to seismic risks or facilitating processes of prefabrication. Aspects that deserve further exploration.
Wattle-and-Daub as well as Light Earth are techniques that allow merging lightness and mass.
They were the central focus of LearnBI0N workshop #2.

Architettura a kilometro zero ETS started its activities in 2009 as an informal work group. Since 2014 it is a registered non-for-profit association which endeavours and promotes design and building solutions in the field of sustainable architecture.

AK0's work focuses mainly on low-impact environmental construction methods with high social outcomes, rooted in the principles of co-design and co-creation, circular economy, and international cooperation.

In 2016, AK0 decided to partner with *SabinArti*, an association that aims at promoting local development through art interventions and cultural activities in Casaprota, a small town 60km north-east from Rome. Casaprota is part of the hilly Sabina region which has not been involved in the industrial

Opposite page
1. Structure under construction, July 2017.

This page
1. Same structure with accomplished renders, November 2017.

and infrastructural developments that changed many other Italian landscapes during the post-war years. It is representative for a large number of small towns of Italy's inner areas along the Apennines, the mountain strip that stretches all along the peninsula. These settlements are witnessing a demographic involution since more than four decades.

Through *SabinArti*, *AK0* got in touch with the municipality of Casaprota which accepted the proposal of hosting a practical four weeks *LearnBIØN* workshop a never completed public building from the early '80s at the entrance to town as training site. The skeleton with its solid concrete structure and the tiled roof could provide appropriate shelter for an educational building site.

The challenge of grafting a little architecture completely made of natural materials and built within a self-construction process into an example of an overpassed idea of development was again a provocation that could, according to the organising team, provide food for thoughts with respect to similar situations in other contexts. The Italian "borghi" are full of structures that are out of scale and in bad shape with respect to the harmonic architecture of its more vernacular urban cores. Thinking of alternative and soft ways of using them can activate local resources.

1. SOCIAL LANDSCAPE AND PLACEMAKING

Italy, as other European countries, suffers a tendency of displacement from less connected inner areas towards larger cities. Most of these small towns have a deep legacy, cultural heritage and are often embedded in integer landscapes.

These features are now acknowledged to attract people from larger cities back to these realities. The perspective of living in the countryside with permanent electronic connection to the metropolitan areas appears as a convincing possibility of our times, however the actual figures of re-population are low.

Casaprota, a small town 60km north-east from Rome is one of these places that offer a comfortable life, beautiful landscapes and interesting cultural inputs but which still suffers demographic decline.

When AK0 got in contact with SabinArti, the association who then acted as local partner for the LearnBI0N project in Casaprota, we had an inspiring meeting with Renato Vivaldi, a local architect of Chilean origin. He invited us to think about a possibility to reuse a structure that he used to call "il mostro" (the monster), an abandoned concrete skeleton at the entrance of the village.

The inner areas of Italy are full of such episodes of in-concluded development. The issue seemed interesting to us so we accepted the challenge to turn the "monster" into a place to be used by local associations or informal groups.

We were aware that a 4-weeks building-workshop would not be sufficient to turn the place into a highly frequented cultural spot. However we wanted to measure ourselves with the challenge of looking at such abandoned places with the eyes of possible changes.

Since its completion the structure has been used for sporadic cultural activities with children, mainly during village festivals. Contemporarily, our association made an agreement with the municipality to use the place further as an experimental and educational building site.

Opposite page
One of the participants assembles timber frames for the "Quincha diamantata" wall.

Activities after completion

Main goal of the built structures for the LearnBIØN-workshop was to erect a complete wall system made with lightweight raw-earth techniques and assess its behaviour with respect to structural stability and climatic comfort. The heatable space occupies a small part of the whole building but its presence makes it possible to host small events also during the winter.

The building was first used for a whole day by a local association that "colonised" the space to invite children from Casaprota and beyond to spend some time with a set of creative games that were exposed in the free space of the skeleton-building during the traditional festival held each January to celebrate the production of local native olive oil. The wattle-and-daub building provided a shelter for the staff while the playing activities were held in the unshielded parts of the building.

Besides these sporadic uses by local operators, AK0 itself animated the spot as an experimental training building site.

This page
A team of trainees and tutors after having completed a layer of lime render on the wattle-and-daub structure.

_ Render 0.1

Render 0.1 was the title of a practical training course organised some months after the LearnBIØN-workshop that involved Mariastefania Bianco, an expert in lime-renders from southern Italy. The initiative offered the opportunity to provide part of the facade with a cocciopesto render, an antique Roman technique used to make aqueducts and other surfaces waterproof.

The group of trainees decided to run their exercise with the traditional plaster on the south-western facade panels; the building's most exposed part. After more than four years it can be stated that the cocciopesto layer provided an effective protection for the raw earth wall.

The same workshop also involved Silvano, a local retired craftsman, who taught the participants the basics of how to hold a trowel and how to apply a straight render. During the workshop he admitted that it was him who was learning since he never applied a pure earth plaster before.

_ TU Braunschweig

In May 2018 AK0 partnered with the Architecture Faculty of the Technical University Braunschweig in Germany. Their students were running an experimental research on building with rammed earth and needed an introductory training on the technique. Together with AK0's staff members they managed to build a piece of fixed furniture which offered the opportunity to test different modalities of assembly, different earth blends as well as other detail aspects.The spot in Casaprota proved to be a suitable venue for these investigations.

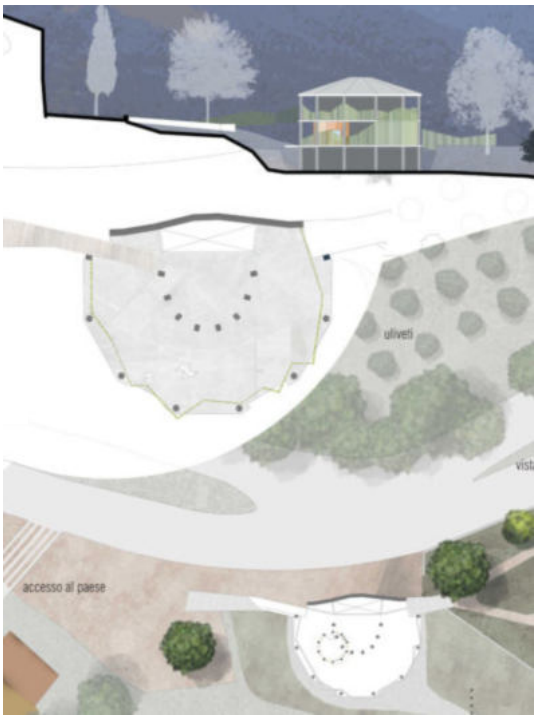
_ Cantiere in Festa

The tradition of adding small improvements to the building during shared working sessions that include phases of training and phases of practical application has then been replicated in other opportunities. Each workshop hosted a group of different participants.

This page

1. Students from the Technical University of Braunschweig with the rammed earth bench built during a practical workshop. Casaprota 2018.

2. Inhabitants from Casaprota on the building site at the end of a shared self-construction session.



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1. Children exploring the basics raw earth as a building material.

2. Plan for an urban regeneration process proposed as a consequence of inputs gathered from the local community during the LearnBI0N project.

_ Children's workshop

Raw earth as a completely natural and non-toxic material is very suitable as a building material for creative activities with children. They have the possibility to explore concepts like plasticity, cohesion and stability as a direct experience. As a result the children's curiosity also triggers an easier connection between adults; a good base for inspiring discussions on sustainability or issues of the local community.

_ Mecenate '90

Some of the reflections done with the local community have been condensed in a proposal for a spatial reorganisation of the area around the building that hosted the LearnBIØN-workshop. A team of architects gathered to answer a call for action from Mecenate 90, a foundation that promotes ecological planning in Italy. The proposal included a reorganisation of the nearby communal garden and traced a perspective of integrating the area into a broader network of spatial connections that could be explored by walking or cycling.

_ Sagra della bruschetta

One of the crucial productions in Casaprota is extra-virgin olive oil. Virtually all inhabitants own an olive grove or at least a bunch of trees. November is harvest time and, after some weeks of rest, the oil is ready to be tasted. In Casaprota this is celebrated with an important village festival in January.
For two years, the local associations invited AK0 to participate and present their work to the festival audience. This offered the possibility to open the building site also for other activities like an exhibition of handcrafted wooden toys by a local artist and educational activities for children.

This page
The newly built facility makes it possible to use the nearby open space for activities. Exhibition of self-built toys during a village festival.

Reflection

Even if the main purpose of building a heatable space within an abandoned concrete skeleton was to run a practical training activity and to trigger some debate on how we use our built heritage, our organisation, as well as our local partners, had the ambition that some local group or association might want to take the place over after completion and care about the later maintenance. Unfortunately this did non happen if not on the sporadic occasions described above.

In April 2022, almost five years after the workshop, we had the opportunity to interview some of the inhabitants and asked them about their perspective of the experience. The sample of interviewed people included persons who had some kind of role in the project; i.e. as sellers of building material, caterers, or as representatives of the local authority, as well as other inhabitants who were informed about the project but didn't interact actively with the workshop team.

Asked on their opinion on the building techniques that were used during the workshop, 66% of the interviewed persons stated that they "knew that it was possible to build with naturally sourced materials but seeing it done during the workshop raised their curiosity further". 56% are convinced that using similar techniques can contribute to saving the planet and 55% would appreciate building their home with similar techniques and consider themselves interested in the perspective of self-building a house with the help of friends, relatives and other volunteers.

One in four of the interviewed inhabitants states that the workshop activity "made me curious, however I think there are technical details to solve".

With respect to the intervention on the built reality in town, the statements were less sharp. Some citizens pointed out that the activities run by the BIØN-network triggered a reflection on the lower part of Casaprota and especially on the communal garden at the entrance of the town. According to some of the interviewed persons the small improvements that have been put in place in the last few years are a result of the attention that the BIØN-workshop brought towards this part of the town. Others were more disillusioned, stating that they would have expected more radical changes to happen, especially on the building skeleton, after the activities run by AK0 in Casaprota.

Asked if the interventions realised during the workshop brought an improvement to the skeleton itself, one third of the interviewed persons answered "absolutely yes" followed by another third that expressed weaker but still positive judgements while one in three persons expressed a rather sceptical evaluation.

The opinions were much clearer on the issue if hosting activities like the BIØN-workshop brings benefits to the local community. 77,8 % of the sample agrees on "absolutely yes" with the remaining 22,2% expressing less enthusiastic but still positive values. Actually all persons agree on the fact that the workshop triggered some thoughts on who the local community could live its town. However, all of them also highlighted that only very

few physical changes emerged from these reflections.

As a conclusion it is evident that our association managed to have an exchange with the local community but that more methodological tools of participation and interaction as well as more funds are needed in order to achieve deeper results with lasting changes on the built environment.

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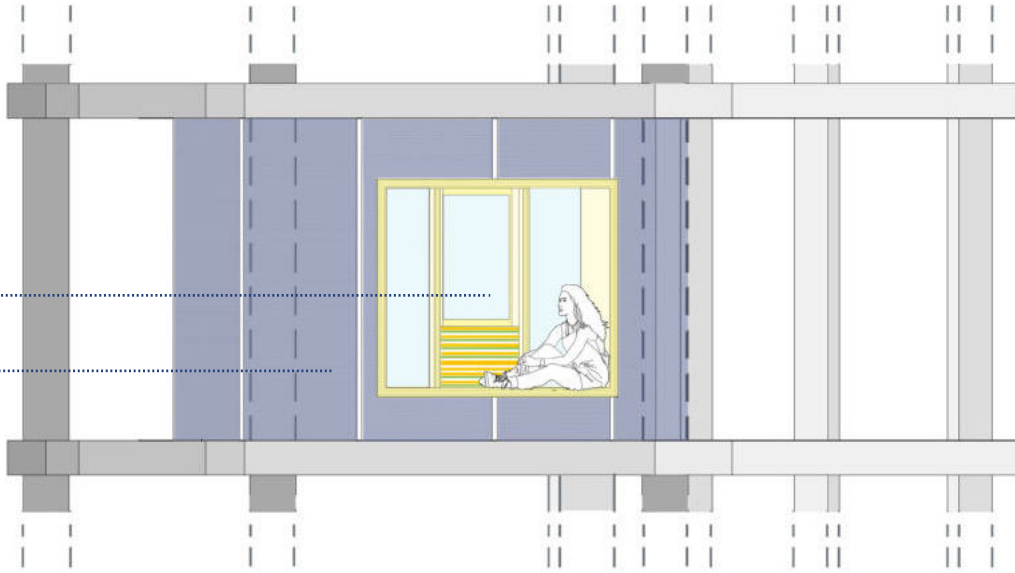
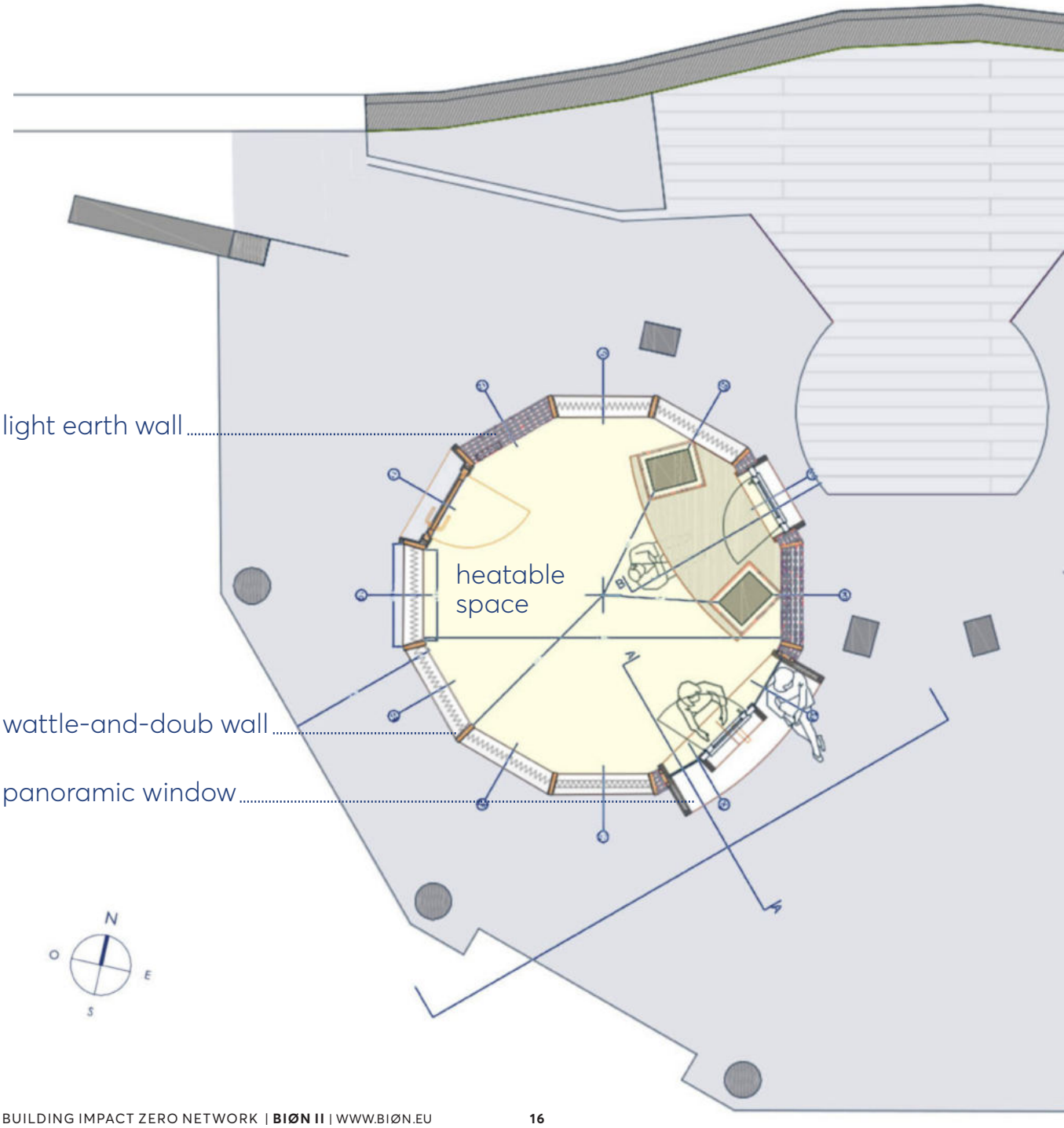
1. AK0 chairman Stefan Pollak explaining the *LearnBIØN* project to the local authorities.

Drawings


panoramic window
grafted building


light earth wall
heatable space
wattle-and-doub wall
panoramic window
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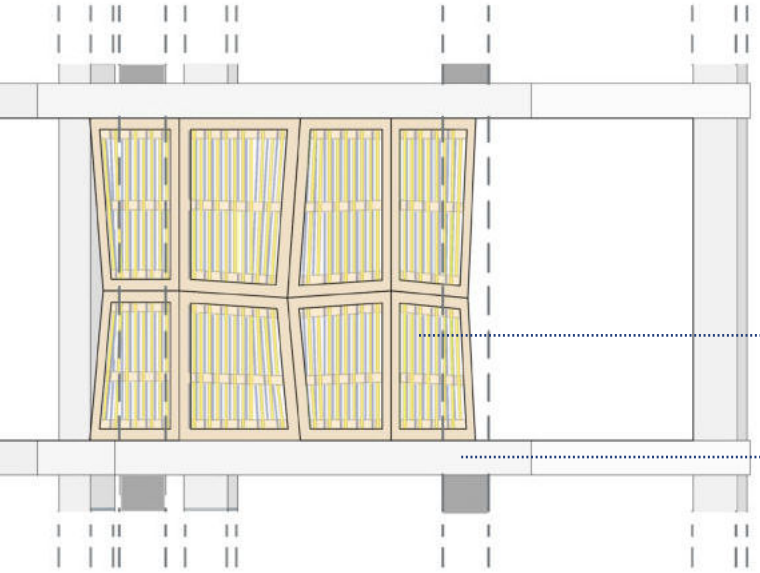


"quincha diamantata"
tridimensional wattle-and-doub screen

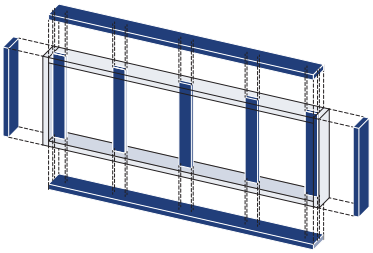
existing concrete structure

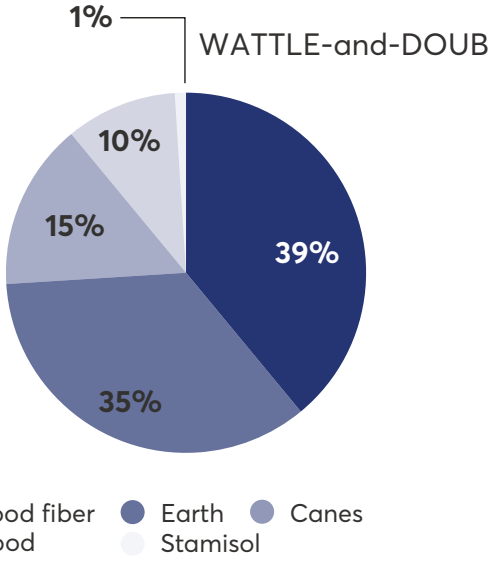
existing concrete structure

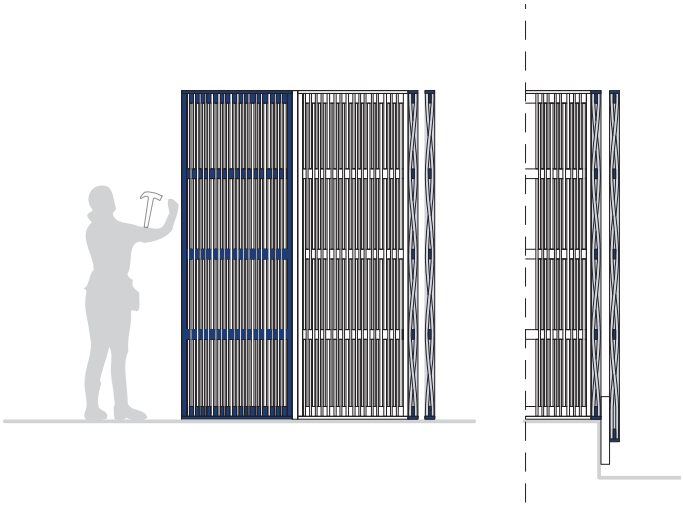
protected
outdoor space

"quincha diamantata"
tridimensional wattle-and-doub screen

Types of techniques







_ Wattle-and-Doub

39% wood fiber - comprata in Svizzera: 700km

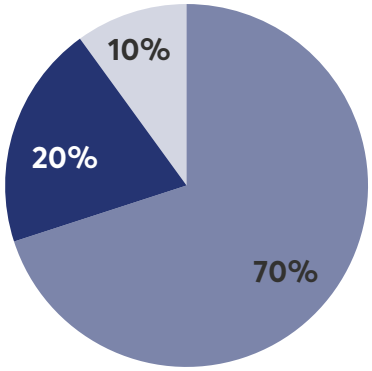
35% earth - proveniente 0,1 km

15% canes - proveniente 0,9 km

10% wood - proveniente dall'Austria: 570 km

1% stamisol - proveniente da Bolzano: 480 km

LIGHT EARTH



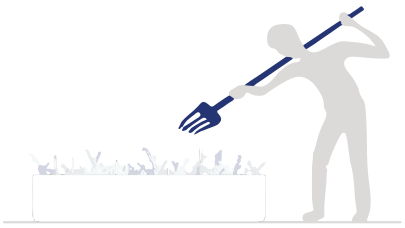
Straw Earth Wood

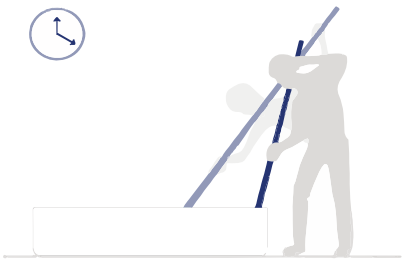
_ Light Earth

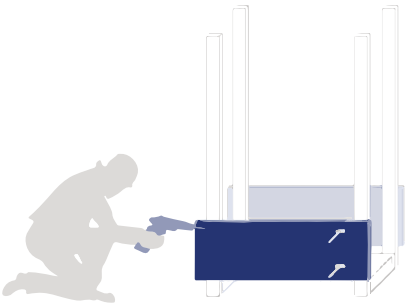
70% straw - proveniente 15 km

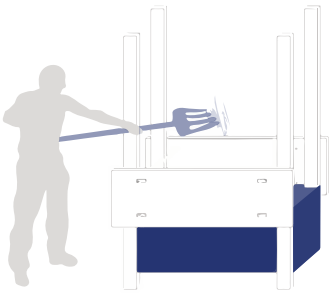
20% earth - 0,1 km

10% wood - proveniente proveniente dall'Austria: 570 km

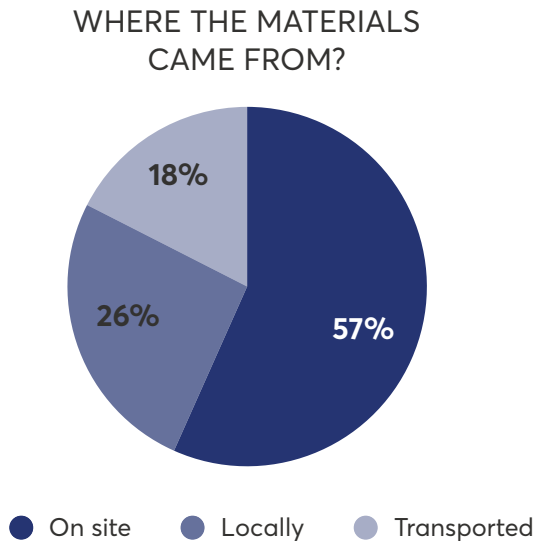








Excavation and harvest



The little cultural facility that has been grafted into the concrete structure was designed to be build with locally sourced materials as much as possible. The main materials for the wall structures are reed canes (*Arundo donax*), straw and raw earth. The earth samples taken directly near the building site proved to provide a good quality with just a slight excess of clay which can be easily fixed by adding sand. This made it possible to dig earth within a distance of 100m and transport it to the site.

Volunteers cut the canes for the wattle-and-daub walls in a private garden at approximately 1,5km from the building site. The straw for the light-earth was donated by a local riding school who procures it directly from farmers in the area during the harvest season.

The insulation material (wood fiber panels) and the vapour barrier (Stamisol) have been purchased through a regional dealer specialised in green building materials and delivered on site. They are produced in Switzerland (approx. 700km from the building site). This rather long transport way has been accept for a lack of equivalent products from central Italy.

Most of the more conventional materials have been purchased by a local dealer in Casaprota who informed us about his delivery chains. River sand is sourced within the Lazio region at approximately 80km from Casaprota while the timber elements

are imported from Austria (approx. 570km from site). The local timber production offers mainly hardwood (beech and chestnut) which was considered not suitable for the building excercise both for economic as for workability reasons. The small amounts of hardware like nails or screws that were needed are from national productions in nothern Italy (approx. 400km from site).

This page
1. A volunteer during the cane harvest in January 2017

2. TECHNICAL APPROACH

From an educational point of view the building process had its main focus on lightweight techniques with raw earth, namely wattle-and-daub and light-earth.

After almost 5 years, the cores of the building components are in a good shape despite some executional errors that can be seen on the external shell of the building. The fact that the experimental building is grafted into a pre-existing structure that, although abandoned for years, acts as a weather shield for the newer walls and ceilings reduces the need for maintenance. A further protective effect comes as a result from later workshops that were activated after completion and that added new layers of render to the building.

Opposite page
The panoramic window can be used as a bench.

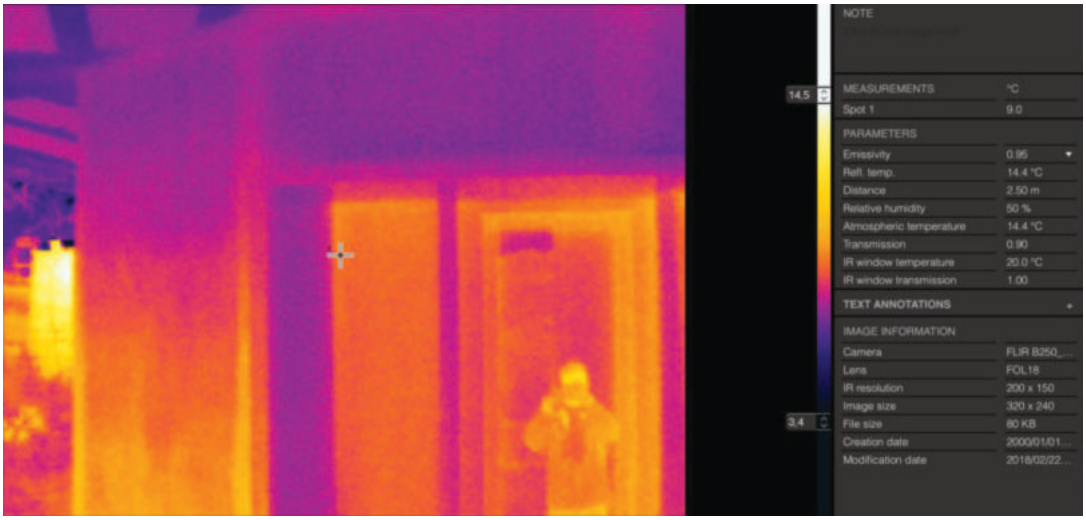
The follow-up activities also allowed for the reparation of smaller building mistakes that got visible after completion. One of them concerned the light-earth elements, which settled too much during the drying process and left unprotected wall openings in the facade. A survey made with a thermographic camera clearly highlighted the spots that needed to be touched up.

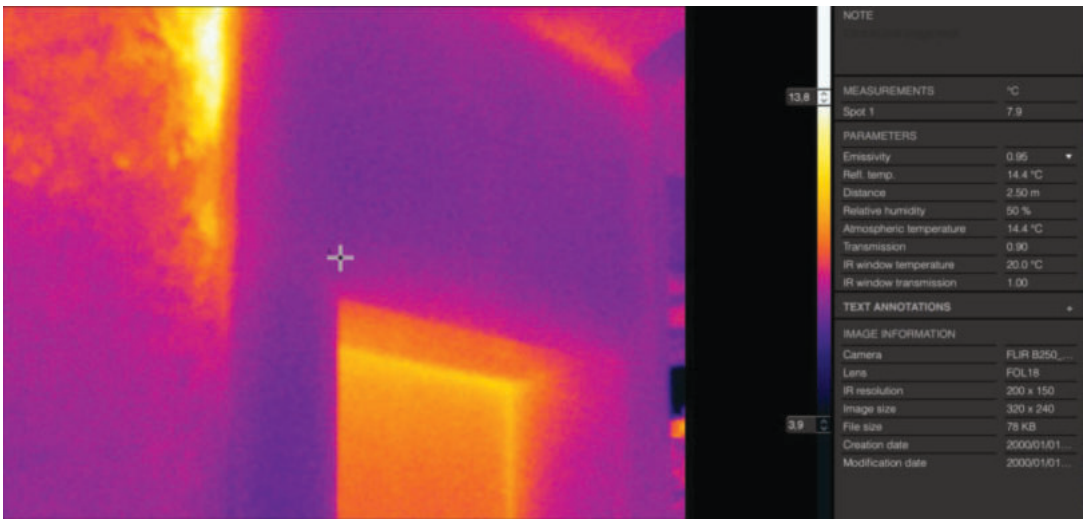
Other empirical surveys on place showed that the building's overall energetic performance is effective. Especially on cold days the differences in comfort between inside and outside are immediately perceptive.

With respect to the building envelope, the two main errors that got evident concern the quality of the external earth-render and the insufficient protection at the base of the facade elements.

Opposite page
Working steps for the preparation of light earth walls.

This page
The thermal assessment highlights execution errors in the wattle-and-daub and light earth walls.





_ external earth render

The external earth render that shields the wattle-and-daub surfaces has been applied during the last day of workshop. The working schedule was influenced by the wish of all participants to have the building ready within the same night, when the whole community of Casaprota had been invited to assist the building's inauguration.

On some surfaces the render application was extremely inaccurate. The errors include an insufficient use of glassfibre-mesh on the facade's edges, excessive thickness of applied layers as well as inordinate differences in applied material between different facade fields.

On some of these inaccurately rendered surfaces, later training workshops provided the opportunity to fix the most problematic zones. A total lack of maintenance on the other spots caused the detachment of entire pieces of render. Since the facade panel's core is not excessively affected the problem could be easily fixed.

Opposite page
Intervention on cracked render surface.

This page
Knowledge exchange: Silvano, an experienced local bricklayer shows the workshop participants how to render a wall during his first time doing it with a clay based, natural render.

_ base of facade panels

The base of the facade panels are suffering due to a misinterpretation of the existing situation the experimental pavilion has been grafted in. The pavilion's design didn't include sufficient base protection since it was taken for granted that the space that hosts the infill would already be dry thanks to the top protection coming from the existing concrete roof. Furthermore the designers expected to intervene on two other factors that would have protected the base: the outer facade of the existing building and its flooring.
The outer facade was supposed to be shielded with additional vegetable screens that would have contributed to break the access of rain and wind. During the workshop only one facade span received such a screen while the others stood unprotected. Moreover, the place would need a new floor layer with a slope away from the building. In case of strong rains, the lack of this detail causes the formation of water puddles that affect the base of the wall panels.

Opposite page
1. "Quincha diamantata" wall.
2. Insufficient protection at the volumes base strip has caused render detachments.

Some positive observations shall also be highlighted here:

_ additional renders

Render 0.1 was the title of a practical training course organised some months after the LearnBIØN-workshop that involved Mariastefania Bianco, an expert in lime-renders from southern Italy. The initiative offered the opportunity to provide part of the facade with a cocciopesto render, an antique Roman technique used to make aqueducts and other surfaces waterproof.

The group of trainees decided to run their exercise with the traditional plaster on the south-western facade panels; the building's most exposed part. After more than four years it can be stated that the cocciopesto layer provided an effective protection for the raw earth wall.

_ false ceiling

Another workshop run in June 2018 was used to clad the inner space with a false ceiling made of a layer of wood fibre as insulation material and a composition made of parallel elements made from recycled timber.

This installation completed the insulation layer of the small heatable space and still appears efficient.

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1. A render surface that was applied too quickly during one of the workshops did not resist the weathering process due to insufficient cohesion with the supporting layer.
2. Unexpected water infiltration has damaged the render-layer at the foot of the structure.

Opposite page

Part of the outer surface protected with a coating of cocciopesto, a mix of lime, pozzolan sand and crushed bricks according to an old Roman recipe.

This page

1. Installation of an insulating false ceiling.
2. Wood-fiber panels with supporting structure in timber.
3. Application of vapour barrier.

_ windows

The windows in the experimental building had been conceived as tailored compositions of formwork boards with standard formats of windows bought at a hardware store and fixed glazing elements provided by a local glazier. This solution proved to be in a very good shape even without maintenance.

_ interior

None of the highlighted criticalities affected the inner space of the little building. The handmade clay renders that have been applied during one of the workshops are in perfect shape, even at the bottom, where infiltrated water could have threatened the layer. This highlights the great resilience that raw earth structures have with respect to humidity as long as they have the possibility to breathe and dry.

This page

Different soils for different wall renders.

Opposite page

Thermal assessment in cooperation with Prof. Gabriele Bellingeri from University Roma Tre.

Energetic behaviour

One of the crucial aspects in running a workshop on lightweight raw earth constructions was understanding the thermal behaviour of the applied wall systems, both the wattle-and-daub walls as well as the light-earth closures.

At the end of the LearnBIØN-workshop, the little volume was affected by important thermal bridges due to the missing ceiling insulation.

In February 2018 a team from the University Roma Tre accepted to follow us on a field trip to assess the building's thermal behaviour. Scans taken with a thermal imaging camera highlight that the uninsulated ceiling was one of the most dispersant parts of the structure. The same series of pictures also evidenced the effect of settled light earth, which caused a discontinuity in the separation wall and a consequent loss of energy from inside to outside.

As described above, during a later workshop, participants and association staff installed a false ceiling of wood fibre panels protected by a natural membrane (Stamisol) and a pattern of slats made of recycled wood. The team also fixed the light-earth walls; an intervention which was easy to manage since there was still enough building material stored on the site.

This page
Different moments of the thermal assessment campaign run in February 2018.

Energetic design

The main purpose of introducing light materials in a raw earth construction is enhancing the wall's energetic behaviour. The cultural facility in Casaprota is built with two different wall-solutions: wattle-and-daub (quincha) and light-earth. Both combine light material for insulation with mineral masses for thermal inertia.

Quincha is a technique derived from the Andean regions in South America. In order to cope with the requirements of Europe's building sector, the simple wall, traditionally made of interwoven canes with a thick layer of earth and straw, has been doubled and provided with an insulation layer in between. The single elements have a timber frame that holds the canes. The complete stratification includes 7 layers as shown in table 1 with a thickness of 29cm.

The light-earth wall has a simpler stratification with only 3 layers (light-earth corpus with render on each side) and a total thickness of 31 cm as described in table 3.

For the energetic assessment the two walls have been modelled with a specific software (PAN 7.1, programmed by the Italian National Association for Thermal and Acoustic Insulation, ANIT) considering the described layers.

According to Italian planning regulations, Casaprota is part of the climatic zone E, so one of the chillier spots on the peninsula. It reaches 2.559 heating degree days with monthly averages of 3,5 and 7,0°C in winter and between 15,8 and 21,1°C in summer. Peaks can reach – 9,0°C in winter and up to 35,5°C in summer.

The calculated data include the thermal transmittance of walls or panels, the phase shift or, in other therms, the mitigation effects as well as the hygrometric performance of the building component. The thermal transmittance [U] summarizes the wall's capacity of retaining heat from an internal source within the building's envelope. The figure is expressed in W/m2K. The light earth wall has a transmittance of U=0,36 W/m2K while the layered wattle-and-daub construction results with a better performance (U=0,25 W/m2K) thanks to the interposed insulating layer of wood-fibre panels. The tables 2 and 5 illustrate the performance values for the single layers of both structures.

Considering the rather rough layering of the light-earth wall it might come as a surprise that the two wall solutions have an extremely similar mitigation behaviour. Both have a phase shift of more than 12 hours, which means that the wall structures can efficiently absorb heat peaks in the external air temperature, both in winter as in summer conditions. The quincha wall has slightly better values with 14h 32' in winter and 14h 39' in summer. The equivalent values for light earth are 12h 43' in winter and 12h 53' in summer.

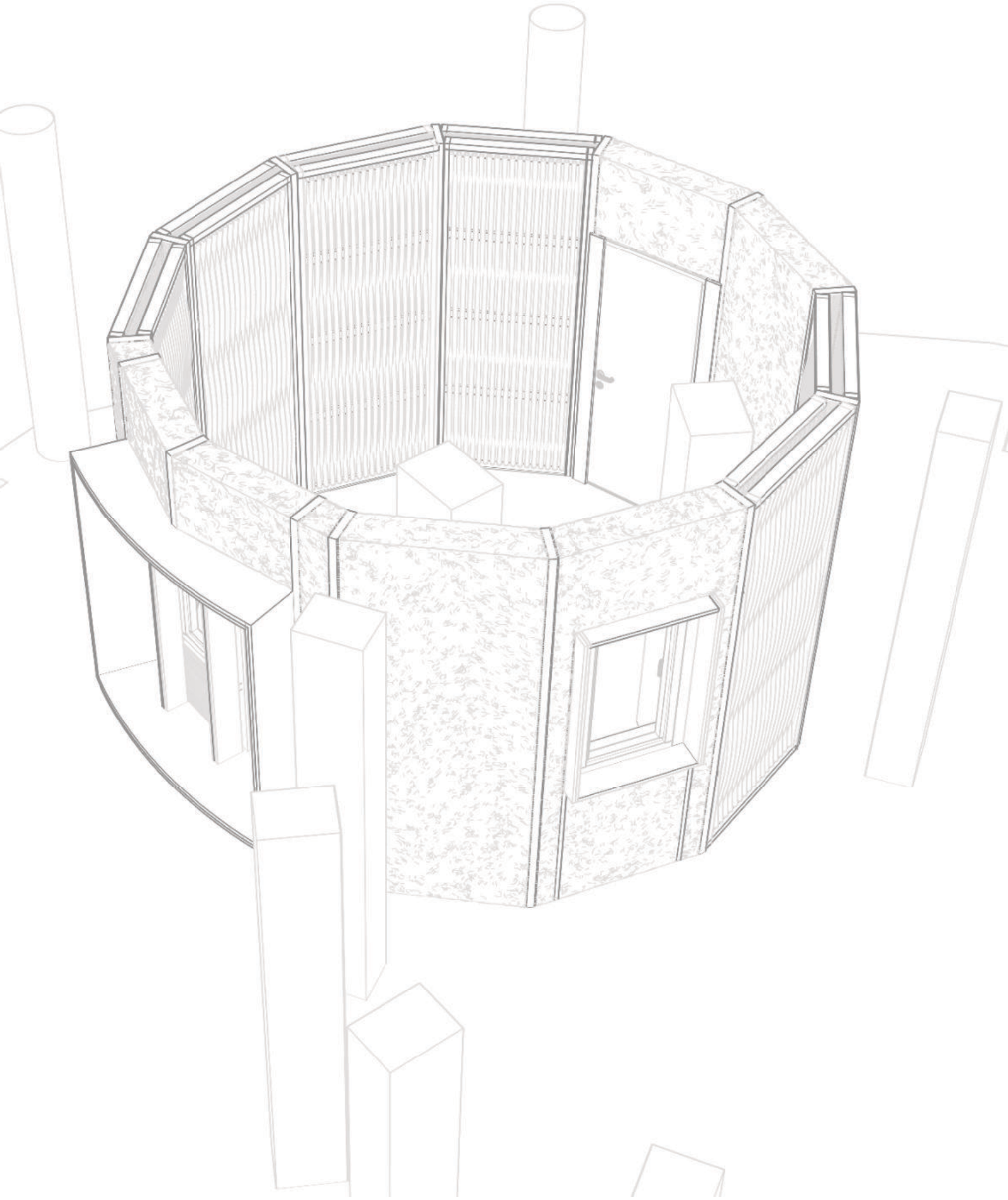
The diagrams 1 and 3 show the mitigation effect referred to a random day. An excursion of approximately 13°K of the external temperature results in an almost horizontal line representing inner temperatures that are always close to comfort conditions.

The table 2 and 4 confirm this with inner temperatures that oscillate

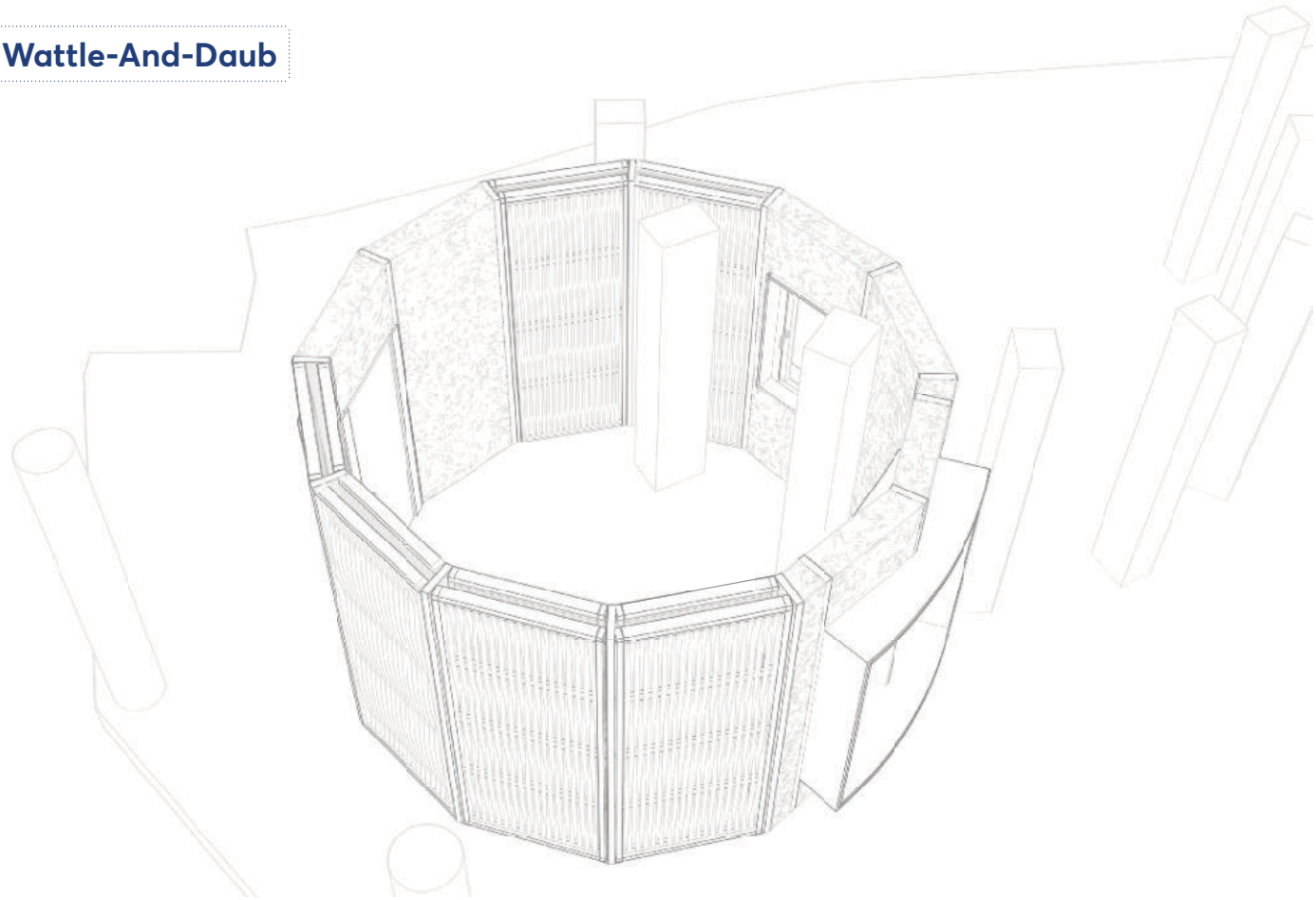
between 20,0 and 21,1°C for the wattle-and-daub wall and between 18 and 21,1°C temperature. This highlights a need for the light-earth wall to be slightly thicker than it was built in Casaprota, where the design team decided to sacrifice a little part of energetic performance in order to align the thick wall with the other building components.

Opposite page

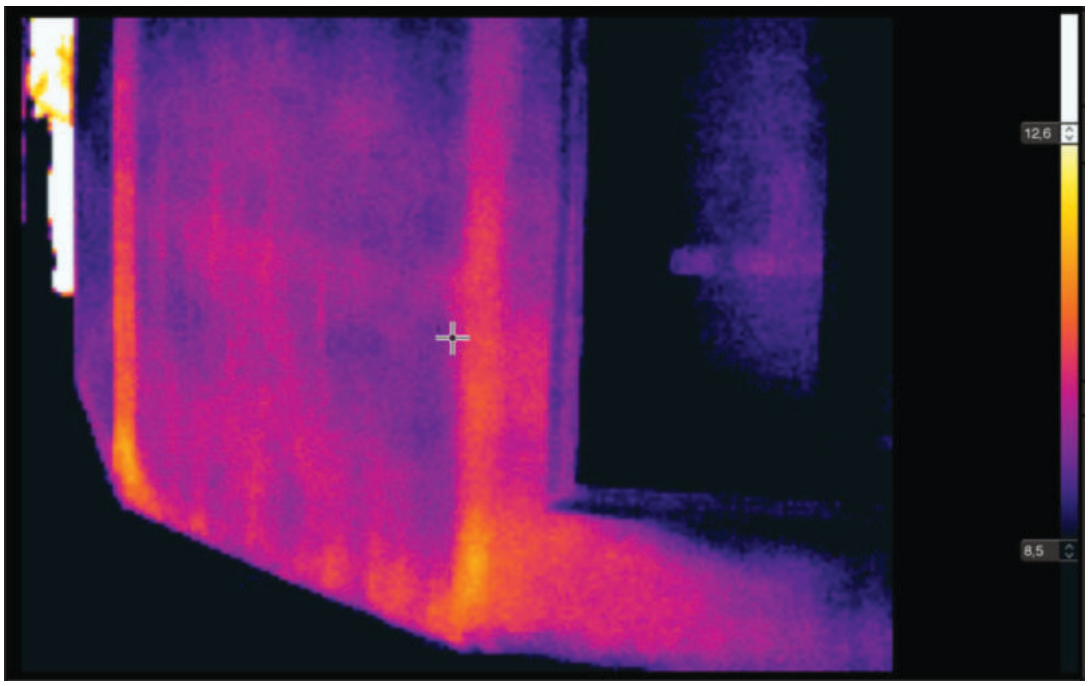
Axonometric view of the polygonal wall components



Wattle-And-Daub



The images taken with thermal camera show large areas of blue which indicates an efficient insulating performance of the building envelope. The wattle-and-daub components show thermal bridge effects that correspond to the timber frames and the connections between one frame and another. Here an additional insulation layer to protect the edges could remedy.



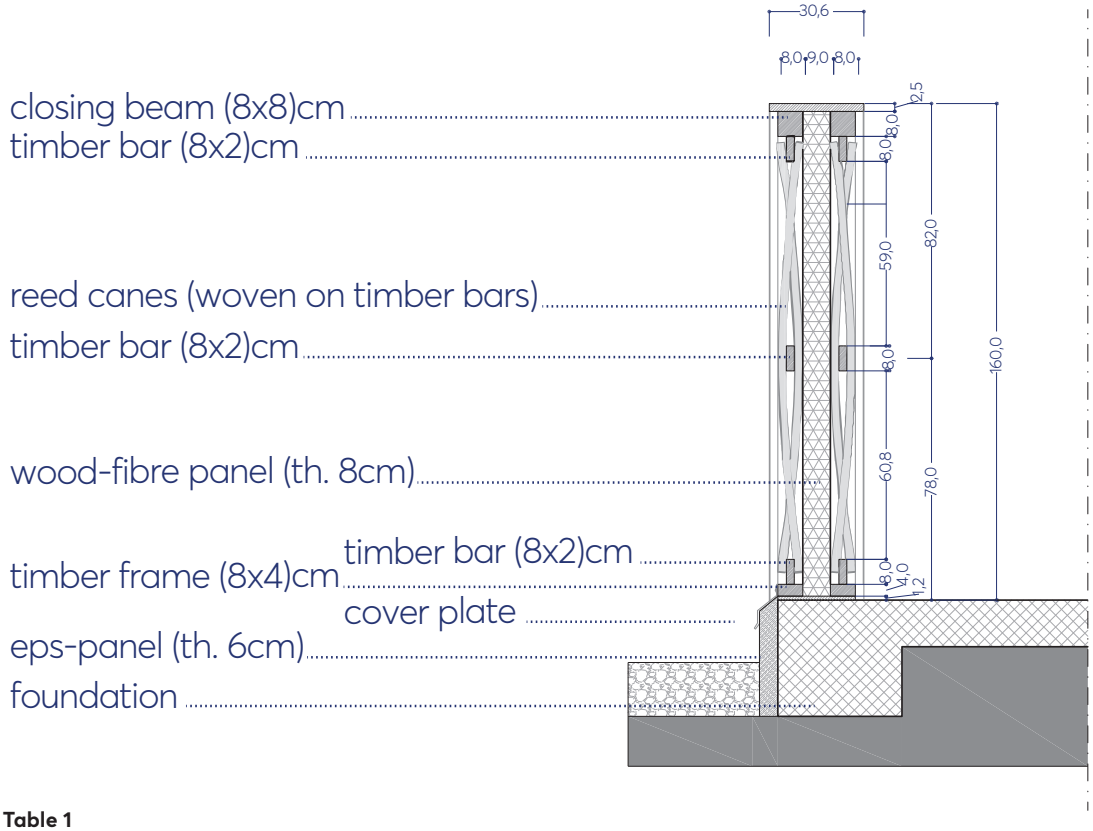
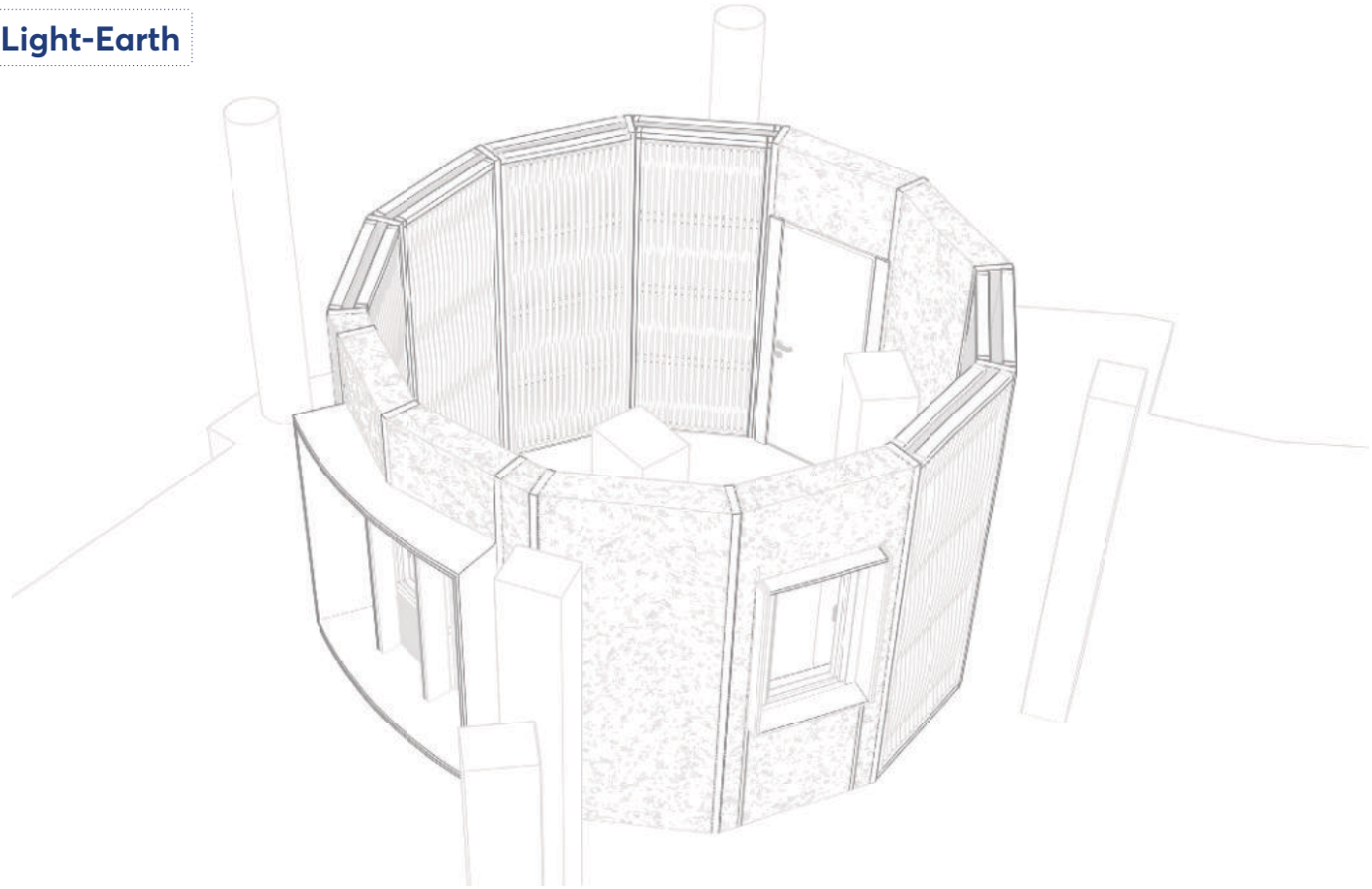


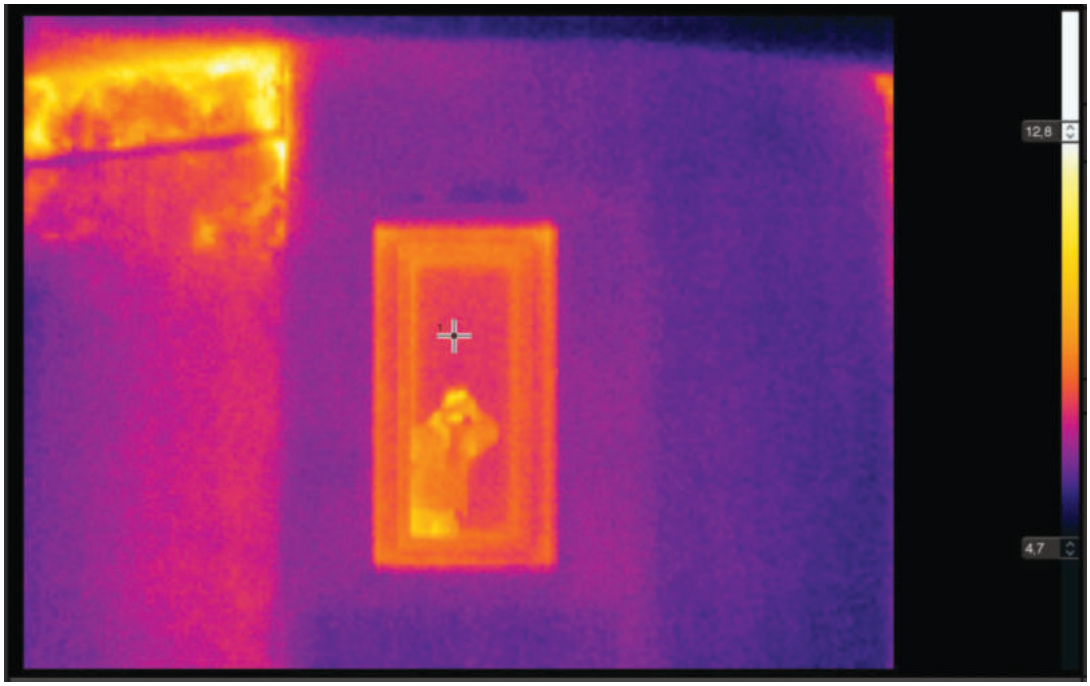
Table 1
Performance values wattle-and-daub wall (quincha)

	layer	t thikness [m]	ρ density [kg/m³]	λ conduct. [W/mK]	c spec. heat [J/kgK]	μ vapour resist. [-]	R thermal resist. [m²K/W]
	ext. surface resistance						0,04
1	External render (earth,sand+lime)	0,02	500,0	0,120	1500,0	4,5	0,17
2	Quincha panel (raw earth on cane structure)	0,08	700,0	0,130	1100,0	18,0	0,62
3	non ventilated cavity	0,01	1,0	0,067	1004,2	1,0	0,15
4	insulating layer (wood fibre panel)	0,08	145,0	0,040	2250,0	3,0	2,00
5	non ventilated cavity	0,01	1,0	0,067	1004,2	1,0	0,15
6	Quincha panel	0,08	700,0	0,130	1100,0	18,0	0,62
7	iInternal render (raw earth with straw fibres)	0,01	500,0	0,120	1500,0	4,5	0,08
	ext. surface resistance						0,13

Light-Earth



The light-earth walls have a more homogeneous behaviour due to less interruptions on the edges. However, the thermal-camera image highlights an important construction error:
The upper edge of the wall element on the left has not been sufficiently compacted causing critical heat losses. Minor losses are visible all around the wooden window frame which acts as thermal bridge while the glazing itself provides an effective thermal barrier.



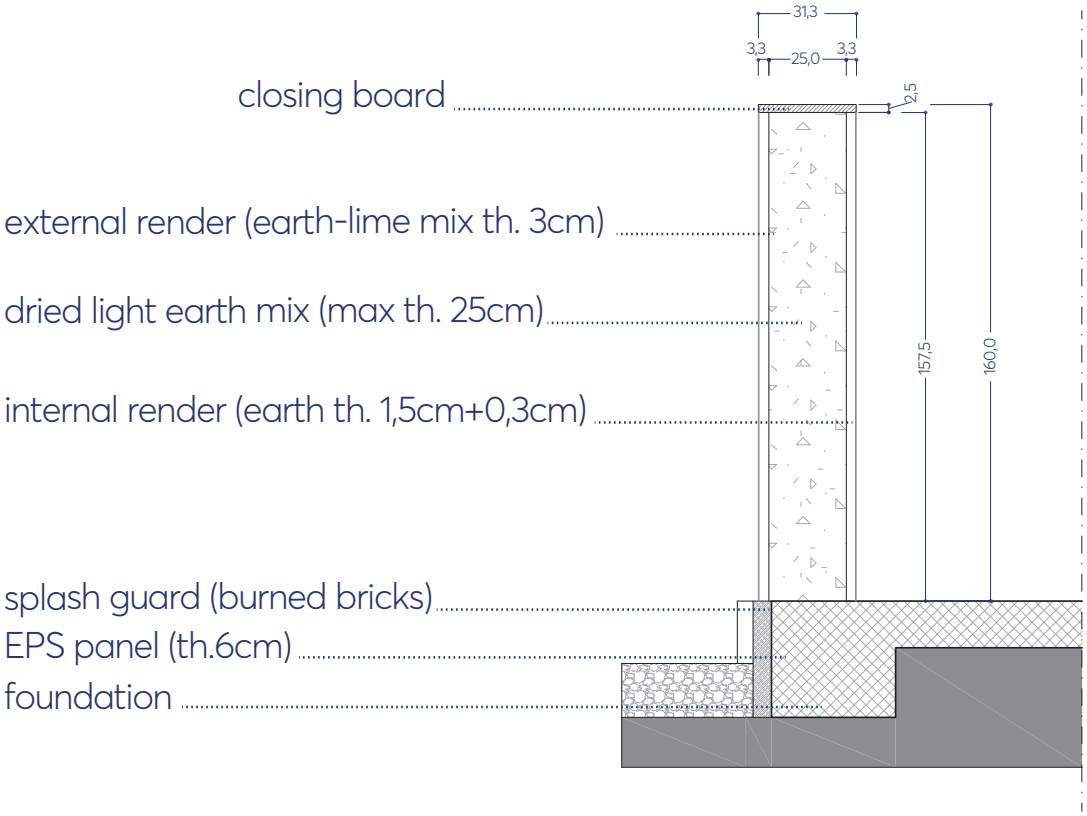
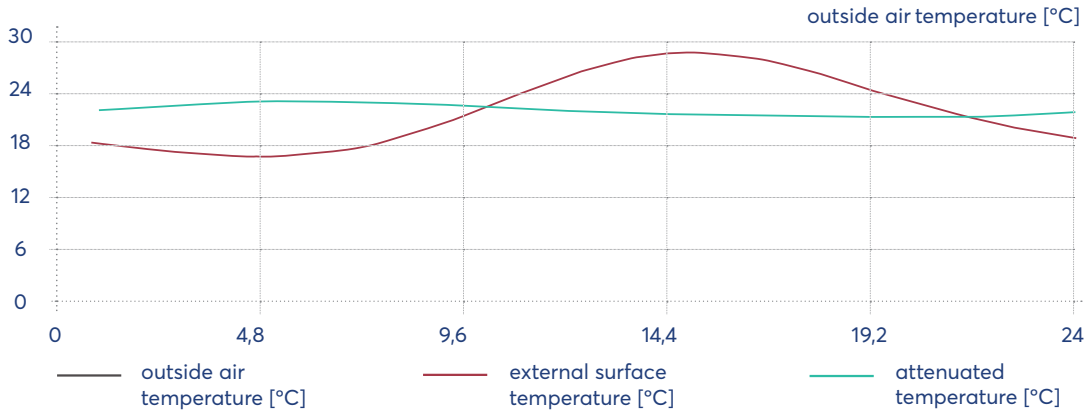


Table 2
Performance values light-earth wall

	layer	t thikness [m]	ρ density [kg/m³]	λ conduct. [W/mK]	c specific heat [J/kgK]	μ vapour resistance [-]	R thermal resistance [m²K/W]
	external surface resistance						0,04
1	External render (earth, sand + lime)	0,030	500,0	0,120	1500,0	4,5	0,25
2	Light-earth 400kg/m³	0,250	400,0	0,120	1200,0	5,0	2,08
3	IInternal render (raw earth with straw fibres)	0,030	500,0	0,120	1500,0	4,5	0,25
	external surface resistance						0,13

Wattle-And-Daub

Diagram 1
mitigation effect through thermal inertia – referred to wattle-and-daub wall



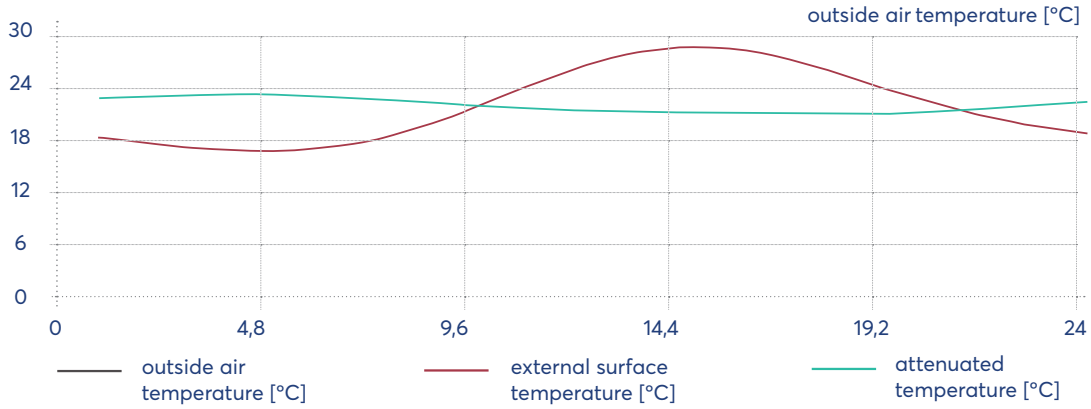
Thanks to its thick clay based renders, the wattle-and-daub walls have a fair thermal inertia and a capacity of mitigating thermal oscillations as shown in Diagram 1. During a typical summer day with peek temperatures far above 30°C the inner temperature stays close to the desired average of approximately 22°C. Moreover the lower peeks that still exist (green line) arrive with an offset of more than 12 hours.

Table 3
resulting climatic conditions along the year – referred to wattle-and-daub wall

Month	external temperature [°C]	external relative humidity [%]	internal temperature [°C]	internal relative humidity [%]
Jenuary	4,1	86,2	20,0	55,0
February	3,6	77,3	20,0	55,0
March	7,0	80,6	20,0	55,0
April	11,5	72,2	20,0	55,0
May	15,1	72,0	20,0	55,0
June	18,7	71,6	20,0	55,0
July	21,0	59,8	21,0	55,0
August	21,1	56,0	21,1	55,0
September	15,8	62,7	20,0	55,0
October	11,7	74,5	20,0	55,0
November	7,0	84,5	20,0	55,0
December	3,9	87,8	20,0	55,0

Light-Earth

Diagram 2
mitigation effect through thermal inertia - referred to light earth wall



The mitigation effect of the light-earth walls is only slightly weaker compared to the stratified wattle-and-daub wall commented on the opposite page. Again the presence of raw earth within the straw mix provides thermal inertia and a time offset of approximately 12 hours.

Table 4
resulting climatic conditions along the year - referred to light earth wall

Month	external temperature [°C]	external relative humidity [%]	internal temperature [°C]	internal relative humidity [%]
Jenuary	4,1	86,2	20,0	58,6
February	3,6	77,3	20,0	55,3
March	7,0	80,6	20,0	58,6
April	11,5	72,2	20,0	59,1
May	15,1	72,0	18,0	73,2
June	18,7	71,6	18,0	78,5
July	21,0	59,8	21,0	63,8
August	21,1	56,0	21,0	60,0
September	15,8	62,7	18,0	66,6
October	11,7	74,5	20,0	60,7
November	7,0	84,5	20,0	60,2
December	3,9	87,8	20,0	59,1

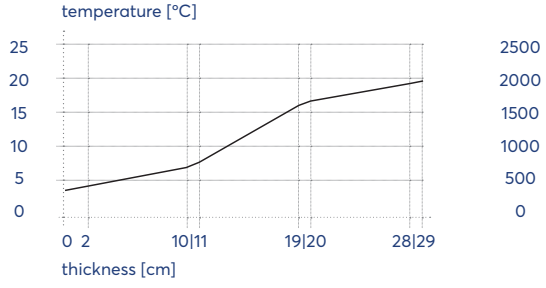
Wattle-And-Daub

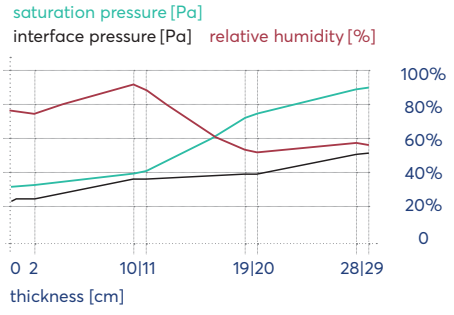
	condensation risk		risk of mouldformation	
Month	**min. surface temperature [°C]**	**temperature factor**	**min. surface temperature [°C]**	**temperature factor**
Jenuary	10,7	0,415	14,1	0,628
February	10,7	0,432	14,1	0,639
March	10,7	0,281	14,1	0,543
April	10,7	- 0,100	14,1	0,301
May	10,7	- 0,917	14,1	- 0,218
June	10,7	- 6,095	14,1	- 3,507
July	11,7	-	15,1	-
August	11,7	-	15,1	-
September	10,7	- 1,228	14,1	- 0,416
October	10,7	- 0,123	14,1	0,286
November	10,7	0,285	14,1	0,546
December	10,7	0,421	14,1	0,632

	condensation risk	risk of mould formation
critical month	February	February
temperature factor	0,432	0,639
minimum accetable resistance	0,44 m^2K/W	0,69 m^2K/W
actual component's resistance	**3,95 m^2K/W**	verified!

The temperature factor *fRsi* is a figure between 0 and 1 that indicates the level of discontinuity due to thermal bridges within a wall structure.
The factor is calculated as relation between two differences: the delta between the thermal bridge's surface temperature (Tmin) and the external temperature (Te) on one hand and the difference between inner (Ti) and outer temperature (Te) on the other. Higher values indicate more homogeneity while lower values are an index of thermal gaps in the wall structure.

Such gaps can lead to condensation or mould formation and cause problems for the inhabitant's well-being. The software indicates the most critical month for these undesirable





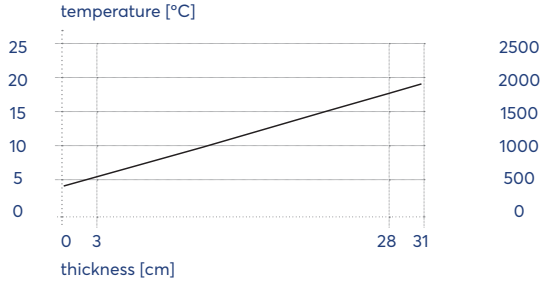
Light-Earth

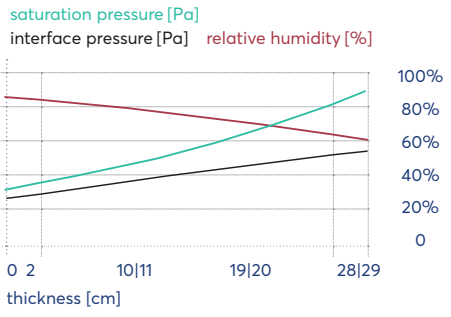
	condensation risk		risk of mouldformation	
Month	**min. surface temperature [°C]**	**temperature factor**	**min. surface temperature [°C]**	**temperature factor**
Jenuary	11,6	0,475	15,1	0,690
February	10,8	0,438	14,2	0,645
March	11,6	0,355	15,1	0,619
April	11,8	0,029	15,2	0,433
May	13,1	- 0,702	16,6	0,510
June	14,9	-	18,4	-
July	13,9	-	17,4	-
August	13,0	-	16,5	-
September	11,7	- 1,892	15,1	-0,320
October	12,2	0,057	15,6	0,472
November	12,1	0,390	15,5	0,654
December	11,8	0,488	15,2	0,701

	condensation risk	risk of mould formation
critical month	December	December
temperature factor	0,488	0,701
minimum accetable resistance	0,49 m^2K/W	0,84 m^2K/W
actual component's resistance	**2,75 m^2K/W**	verified!

phenomenons along with the minimal threshold the wall-structure needs to provide in terms of resistance to these risks. Both wall structures analysed here provide a good protection from condensation and mould formation.

The Glaser diagram highlights the risk of interstitial condensation along the component's layering. If the interstitial pressure (dark line) overpasses the threshold of saturation pressure (green line), the included humidity condensates into water droplets with the risk of damage for the whole structure. In none of the two wall systems the lines intersect each other; the risk of interstitial condensation is under control. under control.





3. EDUCATIONAL AND NETWORKING APPROACH

AK0 ran its BIØN-workshop in July 2017. The four workshop weeks each had a thematic focus in order to make the training interesting both for participants who just attended a few days or those who participated in the whole period.

> The links between all involved persons are still very strong. New friendships were born and the shared experience is a trigger to exchange impressions or tips on other professional issues within the group.

Naturally a difference must be mentioned between participants that attended coming from far away (we had participants from other European countries, Argentina and Chile) and those who reached the workshop from the same region; mostly from the city of Rome.
Social network contacts still help to keep the contact with participants abroad alive.
It might be interesting to highlight that some of the locally rooted participants decided to actively enter the association and are now solidly involved in its activities, including some of them being elected as board members during the last election.

Blended mobilities have proven to be a good tool to enhance the connection between partner organisations. The presence of participants linked to the other organisations for a long period allows the team to understand peculiarities of the respective local context as well as organisational ways of working much deeper. In the same way, sending persons from our association abroad helped strengthen the bonds between partner associations, including ideas on new collaborations.

This page
Discussion on detail solutions with trainees and workshop tutors.

4. REFLECTIONS

The prototype building in Casaprota showed that the use of quincha can be a viable solution in the European building sector.

The energetic performance is suitable for applications in all climatic zones of Italy and the technique triggered curiosity among those who had the opportunity to attend or visit the workshop.

Locally, no direct changes that can be related to the introduced building techniques have been witnessed, which may also be explained with very little new construction activity in Casaprota. As illustrated with the interviews, the local community however seems to have appreciated the possibility of building with locally sourced, natural materials; an option that can be activated if needed.

This page
Inhabitants of Casaprota come to visit the installation during the inauguration celebration.

This page
Urban Lab in Divjaka, Albania by ARCò, Milan 2020. An example of contemporary architecture using the wattle-and-daub technique.

_ Urban Lab - ARCò

From the perspective of the network, it might be interesting to highlight the experience of the Urban Lab in Divjaka, Albania; a project built under the responsibility of our network partners ARCò from Milan.
During one of the BIØN-Talks, the little conferences we organised in Casaprota during the workshop, we had the opportunity to host Allessio Battistella, ARCò's chairman, as a speaker. During a visit on the building site he got in touch with the wattle-and-daub walls that were under construction and decided to include this technical solution in the building he was designing in Albania.

_ Diamond-wall - AK0

Other impulses linked with the workshop-activities concerned the research on prefabrication and self-construction with natural materials. The wattle-and-daub technique itself allows for a debate on this since it is easy to imagine to scale the technique to a level where a well equipped timber building company could provide prefabricated frame elements and the end users could participate with relatives, friends and other volunteers in installing the cane support and the raw earth finishes.

This principle opens even more possibilities if the prefabrication process includes some kind of numerical control. This was the sense of the Diamond-wall experiment done during the workshop.

_ DigitalNature - R. Siani, S. Pollak
AK0 has later been involved in DigitalNature, a research program by architects Rossella Siani and Stefan Pollak that has the ambition to investigate methods that make algorithmic design processes cope with the uncontrollable irregularities of natural materials. Beyond the inputs from the above-mentioned Diamond-wall, the LearnBIØN program hosted an experiment on parametrically designed rammed earth furniture during the workshop in Valverde de Burguillos, Extremadura, Spain on these items.

This page
Tapial Digital, a fixed furniture installation designed by Stefan Pollak and Rossella Siani for the workshop on rammed earth in Extremadura, May 2018.

Learning by doing

Practical learning is the very centre of LearnBIØN and the network's activities in general. As frequently theorised, activating hands and brain together accelerates the process of assimilation of new knowledge. On training building sites like the ones we run within the BIØN-network this is further supported by the exchange within a group of people who share a constructive goal.

This exchange often happens at different levels and involves soft skills such as empathy or capacity of listening as well as specific technical skills. During practical activities with a shared goal it is rather easy to activate both of these skills and integrate the training's core issues. The workshop in Casaprota was focussed on lightweight earth-building techniques. Since these techniques are not self-bearing they need a support structure which can be made in timber.

The team in Casaprota took great advantage from the presence of one participant who works as a teacher for wood-working in a technical school in Spain. He introduced a series of improvements to the design solutions and helped others to execute the working steps linked to timber in the correct way. On this specific topic the borders between teacher and participants were definitely blurred.

Another participant who normally earns his living as a documentarist and cameraman proposed himself to donate a video that resumes the learning experience on site. All these skill add real value to the activity; at the same time, a shared building site seems to be a good hummus to make such contributions emerge and grow.

This page
Workshop participants assemble a wattle-and-daub frame

What didn't work?

Some technical defects have already been highlighted in chapter two. They include executive errors in the light-earth wall, where the closing layer was not compacted enough and hence suffered excessive thermal losses or in the rendering layers that have been applied too quickly during one of the training sessions and then detached from the supporting surface calling for reparation.

Minor design errors include the lack of protection at the base of all raw earth walls. Despite the installation under a roof these walls suffered an exposure to infiltrated rainwater which has been underestimated. Here a skirting of fired bricks or tiles would protect the bases.

The described technical aspects are easy to fix. The fact that this is not done with the due regularity can be explained with a generally rare use of the facility. After 5 years it becomes evident that the little room

grafted into the existing concrete structure is not the first choice for local associations that need space for cultural events or educational activities. The town offers alternatives within the historical urban fabric which makes it difficult to compete for the new, self-built venue. During an interview session with citizens of Casaprota done in 2022 it became clear that this part of the settlement is still not considered really part of it.

The place stays equipped as educational building site and can host further workshops.

Opposite page
Technical inspection

This page
1. Welcoming climate inside
2. The panoramic window

BIØN - Building Impact Zero Network
A network of partners active in low impact building techniques. Our aim is to share knowledge, practices and experiences, in order to contribute to the built environment and to our communities.

BIØN – Building Impact Zero Network is a group of partners, created in 2015, active in low environmental impact building techniques with positive social impact. Our aim is to share knowledge, practices and experiences, in order to contribute to the built environment and engage our communities.

Our objectives are:

– Improve the access to quality information about low impact building techniques through our platform, and through actively participating in our local communities. We will document our work an provide open access documents through our website and multinational network.

– Increase the skills for construction workers, NEET, migrants, refugees, students, professionals and other adults interested in the topics about low impact building techniques through workshops.

– Increase awareness about low impact techniques on an environmental-, economical-, social- and cultural level.

– Develop strategies to maximise participation and generate inclusive communities, by the use of architecture as a tool. Improve the connection between formal and informal learning systems, developing or using existing accreditation systems.

– Improve standards of natural and recycled materials use in building, by integrating the building legislation of each country and discuss possibilities with stakeholders, councils and communities.

More info at: www.bi0n.eu

ERASMUS +

Erasmus+ is the European Union programme for education, training, youth and sport. It runs for seven years, from 2014 to 2020, with organisations invited to apply for funding each year to undertake creative and worthwhile activities. Erasmus+ aims to modernise education, training and youth work across Europe.

Written and edited by Stefan Pollak and Laura Di Virgilio, 2022.

Photos by AK0.

Drawings and illustrations by AK0.
Graphic layout TIP.

BIØN
Building Impact Zero Network

Erasmus+

ISBN 978-989-33-4401-9

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