Earth Construction in the Netherlands

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Abstract
In the Netherlands we have a limited clay construction tradition. The most common traditional application is that of the half-timbered houses in Zuid-Limburg. But in the past 20 years, clay construction has once again gained more popularity. In this, the growing environmental awareness and the increase of environmental problems such as the climate change, are important factors. Initially, a thin clay layer was used for the finishing of walls, but nowadays, clay is used more and more as a component of a system. The combination of heating hoses on walls or ceilings, finished with a thick layer of clay, is fully accepted with regard to 'sustainable construction' and is a comfortable, energy efficient way of heating. However, sustainable construction is currently largely synonymous with CO_2-neutral and energy efficient. Since in the design of very energy efficient buildings the material aspect becomes more and more important, the future focus will be on the use of materials with the least environmental impact. Then, clay will achieve a very good score, which will lead to increased possibilities for the large scaled application of clay in the Netherlands. As a construction company, Leemwerk wants to play an active part in developments to a large scaled application of clay in individual and utility construction, with our expertise.

1. INTRODUCTION

Hello, I'm from Amsterdam, the Netherlands. I own a clay construction company that performs different kinds of work for individuals, architects and contractors. It concerns stucco work of houses with clay as well as constructive work such as rammed earth. In the next 15 minutes I will paint a brief image of the current clay construction in the Netherlands. Which kinds of clay construction do we know in the Netherlands from way back when? What have been the contemporary applications in the past 20 years? Which developments are taking place and what are the perspectives for the future application of clay.
The Netherlands, also called le Pays-Bas, die Niederlande, los Países Bajos, Países Baixos. In other words, a country that is partially below sea level. 60% of the Dutchmen live below sea level. (HHN, 2009). The Netherlands is a delta of large rivers such as the Maas, Waal and the Rijn, and these rivers supply large amounts of sand and clay that sinks in at the floodplains. So in the Netherlands we do have tradition with respect to clay construction. The brick! The floodplains contain the brickworks in which bricks are baked from this clay at a temperature of 800-1100 ^{0}C. So, in the Netherlands, clay is often applied in the brick, that's the biggest clay application in the Netherlands.

2. HISTORY

But this is not what sparks my interest, and neither yours I presume. What does spark my interest is the application of 'raw earth'. The Netherlands has a limited tradition in 'raw' clay construction. The climate is an important factor in this. The Netherlands has a sea climate, with mild summers and cool, wet winters, with 775 mm of rain falling from the sky annually (KNMI, 2009). Combined with a stormy Southwest Wind, this is a

heavy load for the exterior walls. Pure, raw, unbaked earth was only used in the south, in the province of Limburg for the construction of houses, the so-called half-timbered houses. An oak frame is filled with thin braided spikes and then finished with a greasy clay. Sometimes, this clay is mixed with straw. To make sure that the clay would be sufficiently hydrophobic, it is periodically painted with a limewash. The wooden frame remains visible. This construction method is familiar to you, as it also is used in other countries. Partly because this method doesn't meat the current Dutch Building Act – it has insufficient insulation value – it is no longer used in the construction of houses. Renovation of the old half-timbered houses does occur, by applying insulation plates to the interior side.

Photo 1 – Half-timbered house in Zuid-Limburg, the Netherlands. (credits: http://www.wandelgidszuidlimburg.com/LANDSCHAP/VAKWERKHUIZEN/10.jpg

3. MODERN CLAY CONSTRUCTION

The last couple of years, clay has been applied more and more. This started about 20 years ago with the arrival of Tierrafino BV. As a producer of colored clay plaster, they actually reintroduced the application of clay. This colored clay plaster is applied to wallpaper-ready surfaces, such as concrete, plasterboard or old plaster, in a thickness of 3mm. Application of this clay plaster as wall- and ceiling finish, is purely esthetic. The soft earth colors and visible sand grains provide the surface with a subtle, lively structure.

The environmental awareness grows half way the nineties, influenced by a number of large scaled environmental problems that became more and more visible. For instance, the climate change, the hole in the ozone layer, the acidification of the atmosphere, the accident at Chernobyl in 1986 and the attention for the so-called 'Sick Building Syndrome'. The environmental movement gains influence and the environment enters the political agenda. People become more and more aware of the importance of a good climate. Outside, but also at home and at the office. There is more focus on the

used materials and the way the impact the interior climate. Chipboard emits formaldehyde, many paints contain volatile organic compounds (VOC), asbestos, radon gas from the soil etc. Natural minerals have none, or a lot less of these negative properties. Moreover: if applied in large quantities, natural minerals can have a positive impact on the interior climate. So in the case of clay, the layer becomes thicker. Houses are still constructed in the traditional way, but instead of the common gypsum plaster layer, a layer of clay plaster is applied of at least 10 mm, possibly finished with a clay finish in color (3mm.). This layer has sufficient mass to impact the interior climate by/because of:

- Buffering the moisture which stabilizes the relative humidity, in case of high humidity, moisture is absorbed, in case of low humidity it is emitted
- Heat accumulation: clay reduces fluctuations in temperature, because it can quickly absorb heat and retain it for a long time
- The 'course' porous structure which has a positive impact on the acoustics
- It's electrostatic neutrality (Minke, 2009, p19-35)

The beginning of the 21st century marks another shift. No longer does the individual customer decide to apply clay, but the architect that integrates clay into his/her design. That leads to a shift of the application of clay as a mainly decorative wall finishing, to clay as part of a system, for instance, combined with wall heating. Since clay easily absorbs heat, it is a comfortable and energy efficient heating method. Two systems can be distinguished: the mounted system and the integrated system. In the mounted system, the hoses are attached to the wall up to a height of 2 meters. The hoses have a diameter of ∅16-20 mm. and are plastered with clay. The thickness of the total clay package is around the 30-35 mm. In integrated systems, the hoses are placed in the currently present slots which requires a thinner clay layer to finish, meaning that a shorter drying period is required, which leads to a shorter construction time. (Technea, 2009)

Photo 2 – Spraying clayplaster WWF Zeist, the Netherlands. (credits: Michel Leeman)

A great example of clay plaster used as an actual component of the total concept, is the main office of the WWF. We implemented this project a couple of years ago. In the design, a thick clay layer was applied to the ceiling, containing hoses; so-called heating mats, for cooling and heating of the building. These mats consist capillary tubes, ∅ 7 mm that are attached to the subsurface and then plastered. Because of the large surface 3500 m2 and the thickness of the clay layer 45 mm, spraying the 90 tons of clay was required. The clay was sprayed in several layers from a silo mortar pump and finished with white clay plaster. The rounded walls of the central hall have also been plastered with clay.

The growing awareness in the Netherlands and the climate changes have contributed to increased attention for sustainable construction. However, sustainable construction currently still is synonymous with CO_2-neutral, energy efficient and high insulation values. The Netherlands is well on their way to establish a National Database for construction materials. This database contains environmental details of the most construction materials. Several computer programs have been developed that can map the total environmental impact of a building based on these details. These tools are used more and more to reach the design that constitutes the least environmental impact.

Based on Greencalc+[1] the environmental impact of a utility building is caused by 80-85% energy, 15-20% material and 1% water. (Kuijpers-van Gaalen, 2009, pg 8)

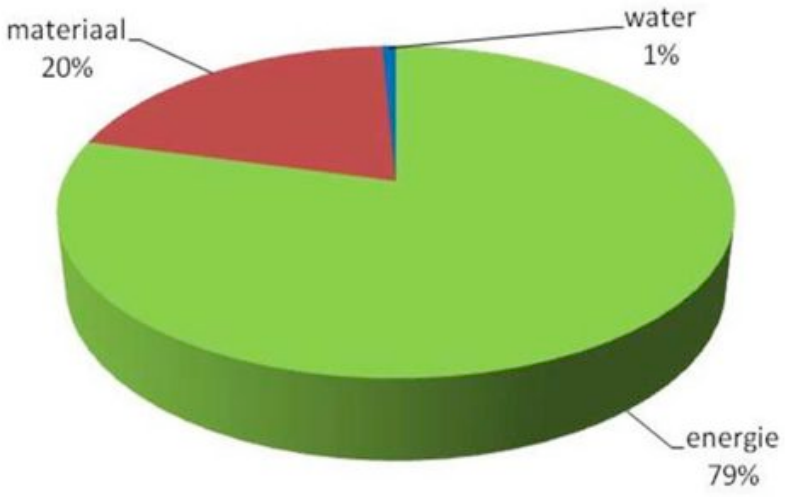

Fig. 1- Distribution environmental impact utility construction (credits: Ieke Kuijpers-van Gaalen, 2009)

In the years to come, this will lead to designs that score really well with regard to energy efficiency. Easily measured and very important. But there is also an increasing amount of attention for materials. In the design of very energy efficient buildings, the material aspect is increasingly important. In a 0-energy building, the environmental impact is mainly caused by the materials. This means that in the future, the use of materials that have the least environmental impact will be more important. The so-called 0-material building in which the environmental aspects of materials will be reduced and compensated (Haas, 2009). Then, clay will achieve a very good score, which will lead to increased possibilities for the large scaled application of clay in the Netherlands.

4. FUTURE

These developments offer good perspectives for the large scaled application of clay in the Netherlands. This means more clay plaster, in thicker layers but also on larger surfaces, insulation by means of wood-chip-clay and for instance the application of compressed earth blocks for massive clay interior walls. A different clay construction application is rammed earth.
In the past years, we have realized a number of rammed earth projects, commissioned by several municipalities, architects and individuals. Such as a number of detached walls on a cemetery in Spijk, a chimney in a residence, a front desk in an architecture agency and the walls of an office in a factory hall.

Photo 3 – Rammed earth wall cemetery Spijk, the Netherlands (credits: Pieter Boer)

Rammed earth has several advantages, which makes it perfect for a 0-material building:

- Low energy requirement, mainly caused by transport
- Zero/low emission (Keefe, 2009, pg 4-6)
- Regional stock
- Reusable/recyclable
- Improving air quality: regulating internal rel. humidity between 40-70% (Minke, 2009, pg 16-17)
- High thermal mass contributes to passive energy management
- Very decorative, sedimentary rock

Rammed earth also has a number of disadvantages however. It is sensitive to water, large dimensions are needed because of the work method and material properties, the relatively heavy labor conditions during production, the poor insulation values and the formwork determine the design (Walker et al., 2005, pg 10-16). This means that there are restrictions with regard to the application options.

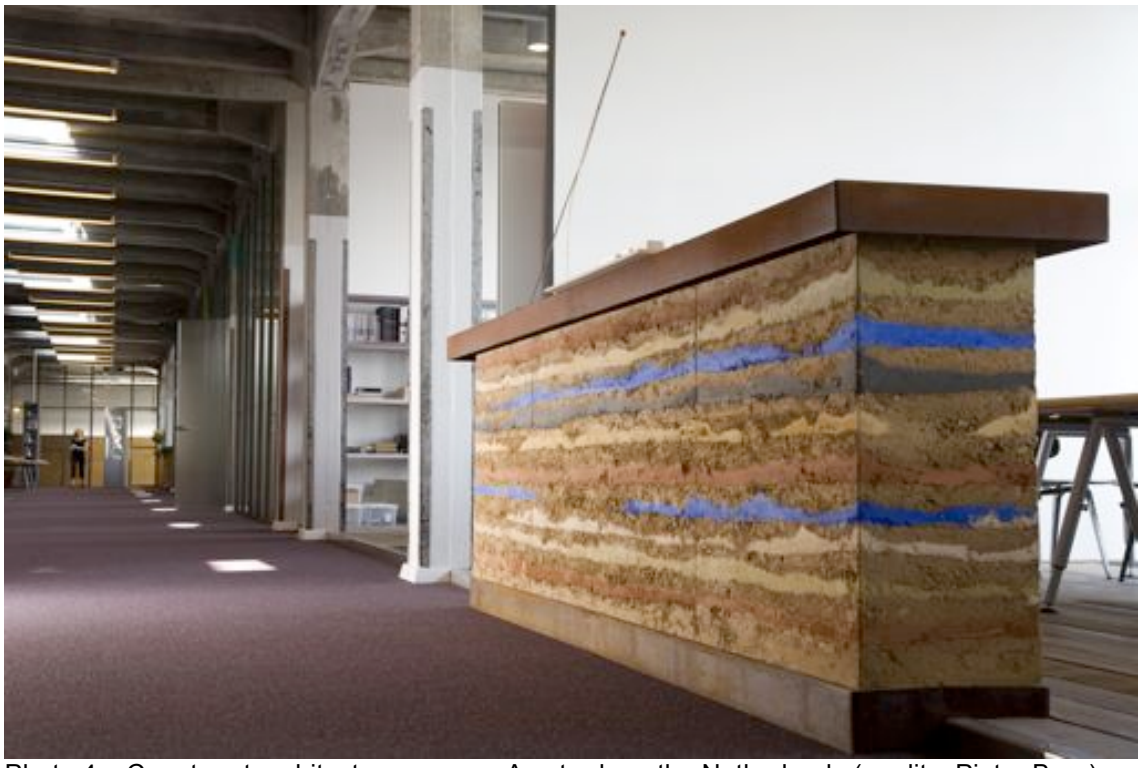

Photo 4 – Counter at architecture agency, Amsterdam, the Netherlands (credits: Pieter Boer)

Photo 5 – Office Amsterdam, the Netherlands (credits: Leemwerk)

The projects earlier mentioned, but mainly the considerations above, were important to us in the choice and development of the rammed earth technique in the Netherlands. We determined that it is our objective to actively bring rammed earth to the attention of architects, contractors, project developers and researchers as a full and professional use of solid clay construction.

A condition for the 'introduction' to succeed is that the clay is regionally available and therefore has a limited transport distance. However, the clay that is available in the Netherlands is unsuitable for use as a ready made mixture. It contains too much clay. Industrial mixing can optimize the composition. This is currently being researched in collaboration with the TU Delft and Tierrafino BV. The different clay samples are tested for several properties, such as pressure- and traction strength, shrinkage, tear forming and with that the usefulness for rammed earth.
The creation of prefab rammed earth is a second condition. This makes it simpler to fit the labor intensive technique into the tightly organized Dutch construction planning. It also makes it possible to work in the winter under controlled circumstances, meaning better labor conditions, which in turn will lead to a reduction in costs.

2 projects are planned for 2010. In the new town hall of Coevorden, at the location where, according to excavations, the ramparts used to be located, a wall will be placed made of rammed earth of 15 meters wide, 8 meter high and 30 centimeter thick against a concrete wall.
The second project is a '*Rammed earth shelter*' designed by interior architecture student Marianne Kruyt of the Royal Academy of Fine Arts in The Hague. The shelter of about 22m^2 will be constructed from local wood and clay and is located in woody Dutch nature. It's not just the exterior walls will be built from clay; the entire building, including floors on different levels, will be made from rammed earth.

We are currently also looking for interested architects, technicians, manufacturers, universities and research institutions. With these parties we'd like to research the possibilities of, for instance, the isolated rammed earth walls, adding recycled concrete granulate to the mixture and optimizing a prefab method. This has a dual purpose: gaining more knowledge and promoting the technique. In this context a symposium will be organized in September 2010 on the different modern clay construction techniques. We are involved in the organization, to shape the technology and possibilities of rammed earth.

So I certainly expect possibilities in the future to take a number of steps forward. Our ambition is to play an active role in the developments to a large-scale application of clay, both in individual and utility construction.

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Notes

[1] Greencalc+: calculation program to map the total environmental impact of a building.

Curriculum

Charles Thuijls studied Environmental Health at the Agricultural University Wageningen Netherlands. Graduated in 1996, specializing in healthy construction and living: the use of natural materials at home in relation to the interior climate. Employed at several construction projects abroad until 1999, specialization clay construction. Founded his own company in 1998, Euroleem, straw and clay construction. Founded Leemwerk: advice and implementation of clay construction projects in 2007.