EARTH CONSTRUCTION IN THE NETHERLANDS

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Theme 4: Vernacular and contemporary architecture
Keywords: earthen construction, rammed earth, the Netherlands.

Abstract
In the Netherlands we have a limited earth construction tradition. The most common traditional architecture is the half-timbered houses in Zuid-Limburg. But in the past 20 years, earth construction has gained more recognition. This is due to growing environmental awareness and the increase interest for environmental issues such as climate change.
It is noticed that some years ago, a thin earth layer was used for the finishing of walls, but nowadays earth 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 earth, is fully accepted with regard to 'sustainable construction' and it is a comfortable, energy efficient way of heating. However, sustainable construction is currently largely synonymous of CO_2-neutral and energy efficiency. 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, earth will achieve a very good score, which will lead to increased possibilities for the large scaled application of earth construction. As a construction company and due to its expertise, Leemwerk wants to play an active role in the Netherlands, increasing the use of earth construction.

1. INTRODUCTION

This paper aims to present a brief reflection of the current use of earth construction in the Netherlands. Which is the traditional earth construction in the Netherlands? What have been the contemporary applications in the past 20 years? Which developments are taking place and what are the perspectives for the future of earth construction in the Netherlands?

The Netherlands have 60% of its inhabitants living below sea level (HHN, 2009). The country is composed of 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 at the floodplains. So, the Netherlands have traditional use of fired earth, in brick work. In the floodplains there are brick factories, where bricks are baked at a temperature of 800ºC -1100^{0}C. Therefore, the use of brick construction is the main application in the Netherlands. However, this paper will address the application of 'raw earth'.

2. TRADITIONAL EARTH CONSTRUCTION

The Netherlands has a limited tradition in raw earth construction. The climate is an important reason for this reduced use. 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. In the past, raw earth construction was only used in the south, in the province of Limburg for the construction of the so-called half-timbered houses. An oak frame is filled with thin braided spikes and then finished with a greasy earth mixture. Sometimes, this earth mixture is mixed with straw. To make sure that the plaster would be sufficiently hydrophobic, the plaster is periodically lime washed. The wooden frame remains visible. This construction method is also is used in other countries. As this method does not fully meat the current Dutch Building Act – it has insufficient insulation

value – it is no longer used in the construction of new houses. Renovation of the old half-timbered houses does occur, by applying insulation plates to the interior side.

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

3. MODERN EARTH CONSTRUCTION

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

The environmental awareness grows during the nineties, influenced by a number of large scaled environmental issues that became increasingly visible during this decade. This is the case of 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’, etc. The environmental movement gains influence and environmental concern enters the political agenda. People become more and more aware of the importance of quality in the environment. There is more focus on the use of materials and their impact in the interior space. For instance, chipboard emits formaldehyde; many paints contain volatile organic compounds (VOC); non-removed asbestos has potential danger impact; as does the emission of radon gas from the soil, etc. The fact is that most of materials composed of natural minerals have none, or at least less of the mentioned negative impacts. Moreover, if applied in large quantities, natural materials can have a positive impact on the interior temperature. So, in the case of earth plaster, there are better results if the layer is thicker. In this case, if a

layer of earth plaster is applied with at least 10 mm, and a possible color earth finish of 3 mm, the layer has sufficient mass to impact the interior temperature. This is due to:

- Buffering the moisture stabilizes the relative humidity. In case of high humidity, moisture is absorbed and in case of low humidity it is emitted;
- Heat accumulation. Earth plaster reduces fluctuations in temperature, because it can quickly absorb heat and retain it for a long time;
- The 'course' porous finishes has a positive impact on the acoustics;
- Its electrostatic neutrality (Minke, 2009, p.19-35).

The beginning of the 21st century marks another shift in the Netherlands earthe construction. No longer does the individual customer decides to use earth mixture, but the architect also decides to integrate it as a component of the design project. This leads to a shift of the application of earth as a main decorative wall finish, to earth as part of a system, for instance, combined with wall heating. Since earth 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 earth. The thickness of the total earth package is around the 30-35 mm. In integrated systems, the hoses are placed in the currently slots, which requires a thinner earth layer to finish, meaning that a shorter drying period is required, which leads to a shorter time period construction (Technea, 2009).

Fig. 2 – Spraying earthplaster WWF Zeist, the Netherlands (credits: Michel Leeman).

A great example of earth plaster used as an actual component of the total concept, is the main office of the WW, which was implemented a couple of years ago. In the design, a thick earth layer was applied to the ceiling, containing hoses; so-called heating mats, for the cooling and heating of the building. These mats consist in capillary tubes, ∅ 7 mm that are attached to the subsurface and then plastered.

Because of the large surface 3500 m^2 and the thickness of the earth layer 45 mm, spraying the 90 tons of earth was required. The earth mixture was sprayed in several layers from a silo mortar pump and finished with white earth plaster. The rounded walls of the central hall have also been plastered with earth.

In the Netherlands, the growing awareness of the mentioned environmental issues has contributed to an increase attention for sustainable construction. However, sustainable construction is currently still synonymous of 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 most construction materials. Based on these data, several computer programs have been developed to map the total environmental impact of a building. These tools are increasingly used to reach a design with 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, p.8).

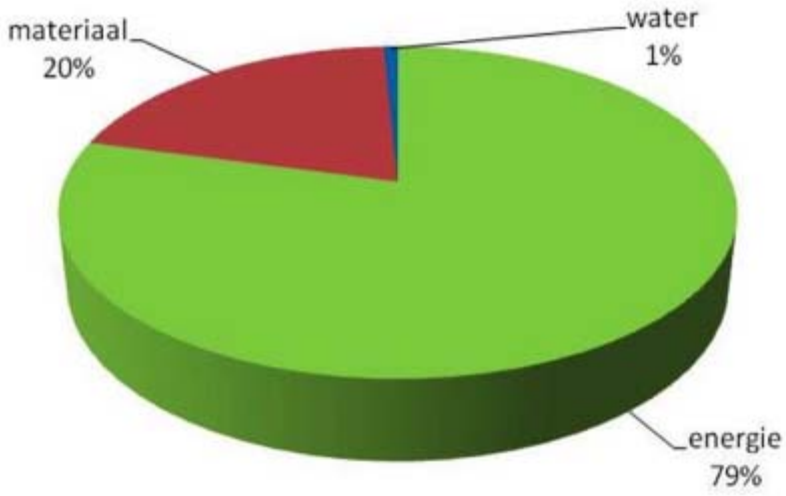

Fig. 3- Distribution environmental impact utility construction
(credits: Ieke Kuijpers-van Gaalen, 2009).

In the years to come, this will lead to designs that score really well with regard to energy efficiency that are easily measured and contribute greatly for the environment. There is also an increasing attention of the material aspect, in the design of energy efficient buildings. The fact is that in a zero emission-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. This is namely the zero emission-material building, in which the environmental aspects of materials will be reduced and compensated (Haas, 2009). Then, earth material will achieve a very good score, which will lead to increase possibilities for the large scaled application of earth in the Netherlands.

4. FUTURE EARTH CONSTRUCTION

These developments offer good perspectives for the large scaled application of earth construction in the Netherlands. This means more earth plaster, in thicker layers but also on larger surfaces, insulation by means of wood-chip-earth and for instance, the application of compressed earth blocks for massive earth interior walls.

Another possibility of earth construction has been rammed earth. In the past years, a number of rammed earth smaller projects have been commissioned by several municipalities, architects and individuals. These are the case of some detached walls on a cemetery in Spijk, a chimney in a residence, a front desk in an architecture agency, the walls of an office in a factory hall, etc.

Fig. 4 – Rammed earth wall cemetery Spijk, the Netherlands (credits: Pieter Boer).

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

- Low energy requirement, mainly caused by transport;
- Zero/low emission (Keefe, 2009, p.4-6);
- Regional stock;
- Reuse material;
- Improving air quality: regulating internal relative humidity between 40-70% (Minke, 2009, p.16-17);
- High thermal mass contributes to passive energy management;
- Very decorative;
- Etc.

Rammed earth also has a number of disadvantages. It is sensitive to water, large amounts of earth 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, p. 10-16). This means that there are restrictions with regard to the application options.

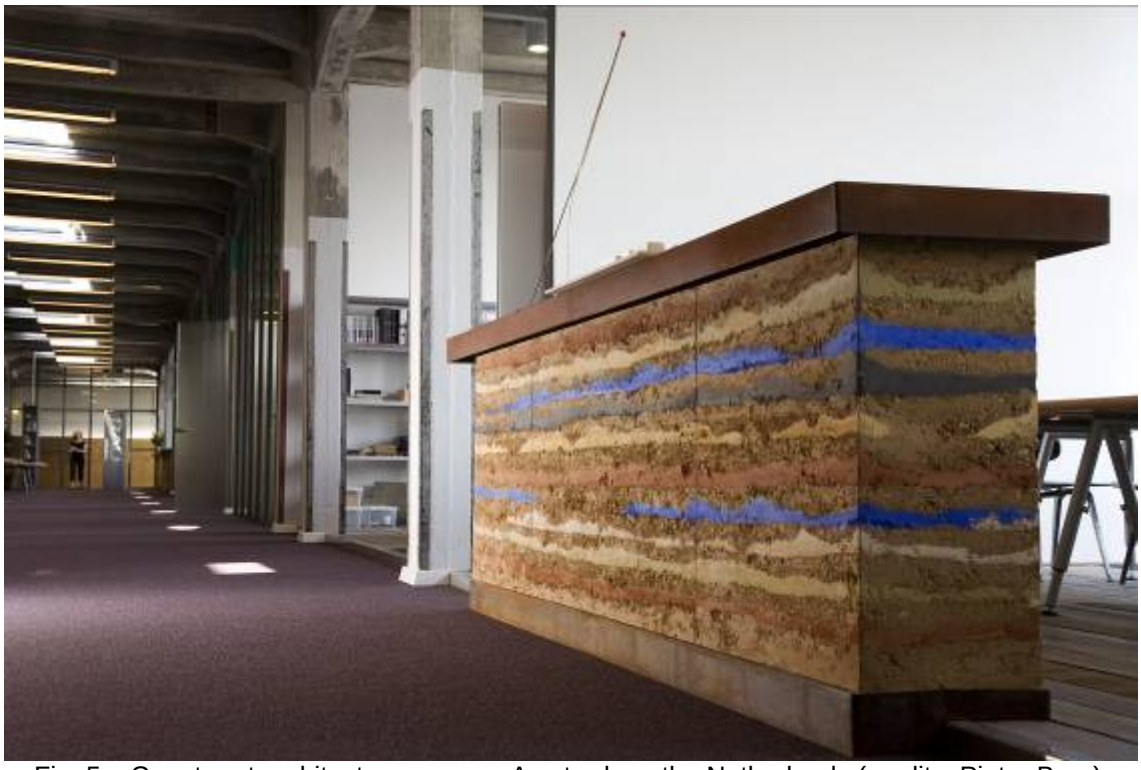

Fig. 5 – Counter at architecture agency, Amsterdam, the Netherlands (credits: Pieter Boer).

Fig. 6 – Office Amsterdam, the Netherlands (credits: Leemwerk).

The projects earlier mentioned, but mainly the considerations above were important to the choice and development of the rammed earth technique in the Netherlands. It was determined, as a main objective to actively bring rammed earth to the attention of architects, contractors, project developers and researchers as a full and professional use of consistent earth construction.

A condition for this ‘introduction’ to succeed is the fact that earth is regionally available and therefore has a limited transport distance. However, the earth that is available in the Netherlands is unsuitable for use as a ready made mixture, as it contains too much clay. Industrial mixing can optimize the composition. This is currently being researched by 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 the usefulness of rammed earth.

The creation of prefab rammed earth is a second possibility. This makes it simpler for the labor intensive technique to fit 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.

Two projects are planned for 2010 by *Leemwerk*. One is in the new town-hall of Coevorden, at the location where, according to excavations, the ramparts used to be located. A 15 meters wide, 8 meter high and 30 centimeter thick wall will be built in rammed earth. 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 with local wood and earth. It will be located in woody Dutch nature. In this case, not just the exterior walls will be built in earth, but also the entire building, including floors on different levels will be built of rammed earth.

There is also interest by the *Leemwerk* Company to look for architects, technicians, manufacturers, universities and research institutions interested to develop collaborative research. For instance, in rammed earth walls with recycled concrete granulate addition, but also in possibilities to optimize the 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 concerning the different modern earth construction techniques. *Leemwerk* is involved in the organization, to shape the technology and possibilities of rammed earth use.

Therefore, it is certainly expected for possibilities of earth construction to increase in the Netherlands in a near future. The ambition of *Leemwerk* is to play an active role in the development of a large-scale application of earth 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, in Netherlands. He graduated in 1996, with an expertise in healthy construction and living: The use of natural materials at home in relation to the interior climate. Until 1999, Thuijls was employed abroad in several construction sites, specializing in earthen construction. In 1998, he founded his own company, *Euroleem*, dedicated to straw and earthen building. In 2007, he founded *Leemwerk*, for the advice and implementation of earthen construction projects.