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In dialogue with the landscape

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ABSTRACT: The buildings of "Hortobagy-Ecolodge" Visitor Center (Hungary) was created using local vernacular technology, local materials and labour. The Visitor Centre is the architectural part of a complex program for landscape rehabilitation, the purpose of which is to preserve the values of the landscape and at the same time to increase the attendance of Hortobagy National Park. The environmental impact caused by the construction and operation of a new public building was examined and the design methods based on renewable resources (Sustainable House) were introduced. The Visitor Center serves as an example on how to use the enery sources of the surrounding environment, like vernacular buildings that were built decades ago.

1 BUILDING WITH EARTH, WOOD AND STRAW IN HUNGARY

For centuries building with earth and wood was common in Hungary. Nature provided the necessary resources, and these building structures were adequate for the climate. Load-bearing walls were made of adobe or rammed earth, the ceiling and roof structure were mainly built with wood and the roof itself was thatched or made of local reed. This was the most common building method in the villages, and in some cases in towns. Even today, in the peripheries of big cities like Budapest or Debrecen one can find dwellings with earth walls today. Straw and hay was used as an additive to earth (to make adobe bricks and rammed earth structures) in order to avoid cracking, and it was used for cheap roof covering (Novák 1996).

The new technologies and materials of the second part of twentieth-century dismantled these buildings, but a number of them had survived, and provide good examples for architects. The positive attitude towards natural materials draws attention again to the vernacular heritage (Novák, 2001). However, it is inevitable to take into account the modern requirements regarding safety, thermal performance and accessibility. From the year 2000, a number of strawbale homes were erected, and strawbale was used as thermal insulation in agricultural buildings and dwellings. In addition, earth has a good reputation for a feeling of comfort during summer and for a healthy indoor environment. The architects and promoters shown in the article had put into practice the heritage, and verified that tradition meets modern standards.

1.1 *Hungary in numbers*

Hungary is a Central European country with a population of 9.9 million (decreasing) and an area of 93,030 km^2. GDP is 22 635 USD/capita, the domestic purchasing power of the population is below the 40 percent of the European average.

The data taken into account during the calculation of energy needs is the following:

– winter design temperature: −11°C
– summer design temperature: +28°C
– Heating degree days: 2771 per annum
– solar radiation: 1170–1360 kWh/m^2/year

The average energy consumption of existing residential buildings in Hungary is the following:

– heating: 225 kWh/m^2/year
– domestic hot water: 60 kWh/m^2/year
– electricity: 40–60 kWh/m^2/year

The energy consumption standards for new buildings depend on the site and on the building form, and must be in the following range:

– heating: 60–90 kWh/m^2/year
– domestic hot water: 32–35 kWh/m^2/year
– electricity: 15–35 kWh/m^2/year

Because of the large gap between the existing average energy consumption and the expected low energy demand, fundamental changes are necessary during the design and construction.

Figure 1. The view of Visitor Center from the parking lot (Authors).

Figure 2. The Great-Saline. Aerial view of the site in between the last street of the town and the Hortobagy National Park (Authors).

1.2 *Brief description of local climate and nature regarding the project*

Hungary has a continental climate with hot summers and low overall humidity levels but with frequent showers and mildly cold, snowy winters. The average annual temperature is 7.9°C, average high temperature in summer is 23°C to 28°C and average low temperature in winter is –3°C to –7°C. The average yearly rainfall is approximately 600 mm.

The location of the project is at the edge of Hortobagy. Hortobagy is an 800 km² national park in Eastern Hungary, rich in folklore and in cultural history and was approved as a World Heritage site in 1999. The Hortobagy is Hungary's largest protected area and the largest semi-natural grassland in Europe. It is a steppe, a grassy plain with Hungarian grey cattle, Racka sheep, water buffalo and horses. It provides habitat for various kinds of species including 342 species of birds. The area is an important stopover site for migrating common cranes, dotterels, and lesser white-fronted geese. Hortobagy is also a centre for the breeding of taurus cattle, taking part in one of several ongoing attempts to breed back the aurochs.

The project presented in the article is located in such a unique landscape (Fig. 1).

2 THE PROJECT: "HORTOBAGY-ECOLODGE" VISITOR CENTER, ITS FUNCTION AND ENVIRONMENT

2.1 *Description of the site of the project*

The site is at the edge of the urban zone near Balmazujvaros, directly adjacent to the Hortobagy National Park. The area is known as the "Big Salin" and it is periodically flooded by local water sources. Some special features of the landscape are the salt enriched soil, the seasonally flooded area during specific times of the year and the particularly rich flora and fauna (Fig. 2).

The unique flora and fauna were substantially endangered in the 1960s, when the communist idea was to transform the nature, and to drain the lake system. In addition, over the past 30 years, the number of grazing livestock gradually fell along with the significant values of flora and fauna.

2.2 *Stopping the landscape destruction*

In order to ensure the long-term development of the landscape, a complex conservation program was developed by the research team of the Hortobagy National Park. The wildlife is considered necessary for the rehabilitation of the landscape, by influencing and shaping the land. The former hydrological conditions could also be restored.

As part of a related landscape development project in 2009—within the framework of a LIFE+ project—a unique 2,034 acres saline area was transformed by burying the sewage canal system. It was also necessary to revitalise the traditional grazing, in order to provide good natural mixture for the original steppe (Figs. 3–5).

The problem of today is that grazing management alone is not economically sustainable. It was important to increase the number of species of livestock (eg 100 ewes Racka were settled), and this brought to life which was once called "the edge of the village grazing system".

These agricultural elements of the project have now achieved spectacular results. Invasive wetland vegetation has decreased dramatically. However, the general problem of the high-value area is that the landscape must be kept in its original form and the local economy usually cannot develop.

Despite the high environmental value, visitors who want to see this unique natural site cannot find adequate infrastructure. The innovators developed a plan to improve this situation and began building the visitor center. The declared aim of the project is to meet the sustainability criteria, to adapt the function and implementation of the building to local resources and values (Medgyasszay 2012).

Figure 3. The "Mangalitza" pig belongs to European unimproved lard-type breeds as well as Iberian Black and Alentejana pigs. The Hungarian grey cattle belongs to the podolic cattle.

Figures 4–5. Birds of the Hortobagy National Park. (Oláh János).

The future hotel will ensure the economic sustainability of the center and will help to show the environment and the unique flora and fauna (Medgyasszay 2013).

During the design process beyond general design principles, the following site-specific conditions were considered—beyond overall design principles:

- low environmental impact on the landscape
- least possible disturbance of the unique soil structure
- site specific foundation for the building
- proper orientation for passive solar principles.

In terms of materials:

- use of local materials which traditionally were common for centuries in the area: adobe, straw, wood, tiles
- use of local labour which is familiar with traditional solutions
- use of traditional principles and techniques to ensure low energy consumption
- application of advanced and cost-effective engineering solutions, highly insulated structures, effective ventilation system
- application of renewable resources in terms of building materials and energy sources.

3 THE PROJECT IN DETAILS

3.1 *The architectural layout*

The two main elements of the visitor center are the nest-shaped demonstration center and the bird shaped accommodation building.

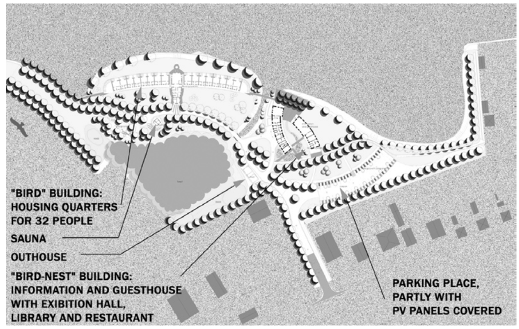

Figure 6. Site plan. (Authors).

Both elements are located in a peninsula-like rampart in order to be close to the saline lake, which is rich in birdlife. An important principle of the concept was that the greenery and the pavement elements create a harmonious transition between the edge of the urban area and the rural salt meadows (Fig. 6).

The first phase of the demonstration centre was implemented into an EU-financed "competitive tourism products and attractions" program. The design period started in 2005 and after making several changes the authorities accepted the final project in 2009. The construction started in 2012, and was finished in 2013. During this period, legal restrictions endangered the original idea. At one point there was a need by authorities to change all the materials to commonly used industrial products, and neither wood, nor adobe or strawbale was allowed. However, fortunately the original plan had succeeded in the end.

Visitors are received in a two-building complex, with a small restaurant and kitchen on one side, the reception, auditorium and other functions on the other side. Both buildings have a big sheltered terrace with a view to the surrounding nature. The two buildings form an inner yard where an artificial lake was created, which has intermittent connection with the great-saline area.

Buildings with similar form and color (like barns, homesteads) can still be found in the area, but this plan shows a new architectural value in term of arrangement and shape. One end of each building is lower by 80 cm than the other. This arrangement of curved walls results in a sense of fake perspective, and this very interesting effect is increased by the enclosed space of the two buildings.

Near the entrance is the car park, from there a slight ramp leads to the buildings of visitor centre. The large covered terrace and long porch provide access to the reception, library, and restaurant and exhibition area. All the facilities are accessible for people with disability (moving-, visual—or hearing impairment). Even the kitchen is designed for intellectually disabled kitchen helpers.

The exhibition area is a large (93 m^2) space, which has an open attic in order to create good acoustics and provide enough fresh air for a larger group of visitors during a conference or other meetings. It has a direct link with and a great view of the meadow. The other building includes two functions: the restaurant and the serving background functions (kitchen, storage room, boiler room and office room). The area is directly connected to the large terrace overlooking the open land, and has direct connection with the exhibition area. One of the key elements of the project—in economic terms—is the accommodation building, which has not been realized yet, as the owners were not able to find financial sources. This building will have a shape of bird, with spread wings, where each wing contains eight double-bed hotel units. The guest rooms are reached via a covered porch. Each room has a partially covered terrace and a wide view of the great-saline. Guest areas are partially covered with nets, in order to protect them from mosquitos of the shallow water surfaces. Some rooms are wider and complete with special bath unit, which offer proper accessibility for handicapped users. The central part of the building—between the wings—forms a bird-head and serves for other purposes necessary for the hotel function.

3.2 *Selected materials and structures*

3.2.1 *Foundation*

The primary consideration during the choice of materials for the visitor center was to find materials and structures which are adequate and fulfill the life cycle test. Under the foundation of the buildings the landfill material was extracted from a nearby fishpond, so the soil used for filling was similar to the local soil. Due to the deep loadbearing soil level and the considerable size but smooth movement of the underground water table, it was necessary to use pile foundation and beam grid under the walls. The beam grid structure should be highly insulated due to low energy demand of passive house criteria (Figs. 7–8).

3.2.2 *Supporting structures, masonry*

The outer wall structure is constructed from wooden post and beam structure. The wooden "ladder" frame consist of 10/15 cm poles at the inner side and 5/10 cm poles at the outer side at the average of 90 cm distance. The 15 cm thick adobe wall is positioned between the wooden loadbearing columns. The adobe bricks are hand-made by local workers. The outer side of the walls are insulated with 35 cm thick strawbales harvested and collected from the nearby fields. This thick straw insulation layer has to be attached with a special auxiliary structure. The 5/10 cm columns were installed to solve this issue (Fig. 9). This means that

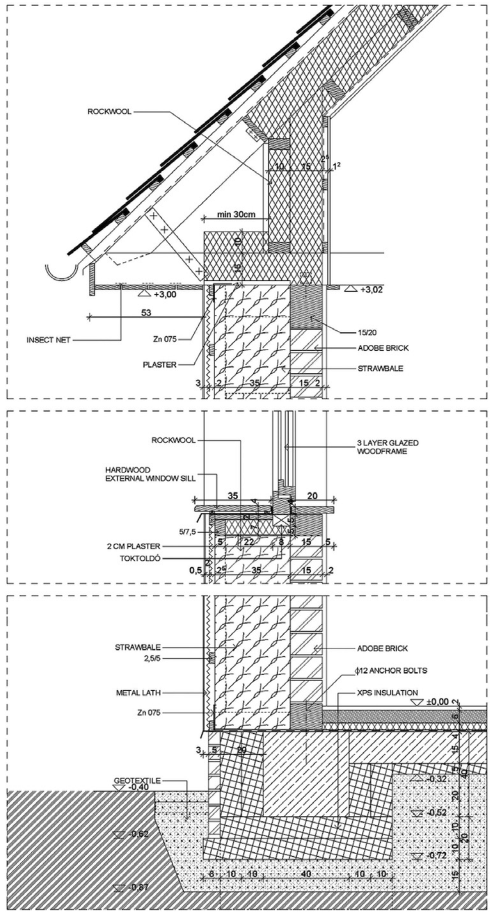

Figure 7. Cross section of external wall, showing the details of foundation, window and roof (authors).

Figure 8. The picture of structure before the masonry work (Authors).

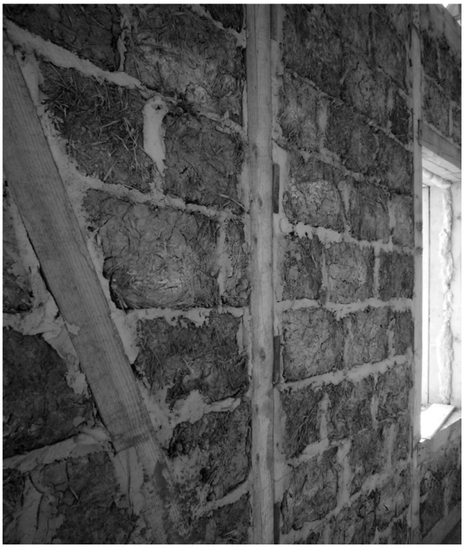

Figure 9. The picture of handmade adobe bricks between the wood posts (Authors).

Figure 10. The picture of walls after the first layer of plaster was put on (Authors).

the heat transfer is very low, the U value of the structure is 0.16 W/m^2K.

To create a good outer finishing surface another wooden lathing was added, arranged by 40 cm and a metal mash was strained. This layer is also necessary, because without it, it is difficult to control the plaster thickness (Novák, 2002).

Past experience showed that without lathing, up to 10 cm thick plaster had to be done in order to create a plane surface. The battens and metal mesh covered with three layers of plaster are. The first layer is a rough loam plaster, and then a 0.5 cm thick lime mortar plaster is put the walls. The third layer of lime mortar plaster on the outer side is finished by lime wash (Fig. 10).

3.2.3 *Roof, doors and windows*

During the design process, the first version of roof system was designed using reed for thatched roof for architectural reasons. However, fire safety standards and secure placement of the solar panels changed the idea into roof tiles. The ceramic floor tiles, brick, wood and stone, the whitewashed sidewalls and lime mortar dominate the appearance of the building. The colors of the windows and doors are locally common and all these are made from wood using highly insulated glass surfaces.

3.2.4 *Mechanical systems*

The construction had to meet the following requirements, due to the function of the building:

- low energy demand for heating and cooling,
- domestic hot water production using solar energy,
- effective ventilation in the kitchen and other areas,
- electric lighting from solar PV-s,
- environmentally friendly treatment of wastewater.

3.2.5 *Heating and Cooling*

The building is not in use in winter due to the life cycle of nature. The return of investment is not comparable with other buildings that are in use all the year-round: though the building costs are the same, the potential solar gains are reduced by this fact compared to a permanently heated building. Due to the "sustainable house" concept, the biomass-fueled heating system was a clear choice. The heating of the two buildings and the domestic hot water system required 25 kW output. The system is designed for burning wood chips for the boiler, and from there the distribution system transports the heat to the heated areas. The whole system is based on a weather sensor control system.

According to our calculations, there is no need for summer cooling system because there is no risk of summer warming, thanks to the big shading overheads, good natural ventilation capability, and the thermal mass of the floor and adobe walls.

During the design process, we calculated the technical possibility and the potential economic benefit of using a heat recovery ventilation system. Finally, instead of using heat recovery ventilation in the entire building, only the kitchen hood is designed in this way, and toilets are equipped with timed extractors.

3.2.6 *Domestic hot water production*

The roof was designed originally as a thatched roof, using the local reed from nearby sources, and workforce from the town. During the design process this idea had changed, because burnt roof tiles had the

Figure 11. PV panels were installed above the visitors' car-park (Authors).

advantage of good potential of rainwater collection. The tiled roof also provides better possibility to place the solar collectors—which are necessary for the low-energy consuming domestic hot water system—onto the south-facing roof. This solution ensures the majority of the domestic hot water demand during the operation period. The huge red-colored tiled roof emerges above the white walls and green fields, meanwhile fits to the surrounding street view, and reflects to the Hungarian colors: red-white-green.

3.2.7 *Electricity*

Kitchen ventilation and the cooking technology (stove and oven), refrigerators and the ventilation system are operated with electricity, and all these create the significant part of the peak load. In most parts of the Great Plain the solar gains show a high value: there is no shielding effect of the clouds like in other urban areas. The car-park shading system was designed as a pergola, offering excellent place for 16 kW solar PV cells (Fig. 11). The given solar power panels' capacity covers the annual electricity demand but in different temporal distribution, the overall the energy gains and consumption are balanced.

3.2.8 *Lighting and other appliances*

During the planning phase, we used a rule of thumb: to offer a good natural lighting during the day in order to reduce the electrical power needs. In terms of artificial lighting, we tried the application of energy-saving solutions, such as fluorescent, compact fluorescent and LED technology units.

3.2.9 *Waste water system*

Kitchen and toilets need running water; therefore, the treatment of wastewater is a planning issue. We did some calculations and measurements that clearly showed that we have to use the sewage system provided by the town. However, thanks to the water-saving solutions and the well calculated rain-water collectors, we feed the toilet flush from the rainwater tanks, and only the decreased amount waste water runs down to the urban sewage system.

The building was qualified to take part in the "Holcim Awards for Sustainable Construction 2011" international competition. In 2011, the jury received 6,000 entries, and among these applicants, this project has been qualified for participating in the second round of evaluation among 600 entries. We consider it as a success for the Hungarian architects who are working with adobe and straw-bale at their projects.

4 LESSONS TO BE LEARNED

In terms of the buildings' energy use and the original expectations, the "sustainable housing" goals were fulfilled. According to approximate calculationswhich are based on similar building models in terms of function and size, the computer program calculated in advance the net heating demand to be around 34 kWh/m^2/year. It meets the current 36 kWh/m^2/year values based on measurements. If we count the solar power production from the PV panels the overall building energy performance is 13 kWh/m^2/year (Medgyasszay 2012).

This project clearly demonstrates that the well-founded, specialised knowledge of site-specific materials and methods is essential if we are working on a protected, natural reserve area.

And what is more, the well designed building which take local resources as a basis is in harmony with the landscape. Good design maximises the benefits of sun, wind and of precipitation. Furthermore, it is evident that the high-tech methods are not in conflict with traditions.

Our ancestors acted similar: they used developed technics and counted environment as a potential source of energy, material, and labour force, and they took into account the future needs of the next generations.

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