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THE KERKENES ECO-CENTER: A SHOW-CASE FOR APPROPRIATE HOUSING AND SUSTAINABLE DEVELOPMENT IN RURAL TURKEY

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Fig 1: Construction of the straw-bale house at the Kerkenes Eco-center.

Research summary

A fast developing country, Turkey faces many challenges including an urgent need for sustainable economic development in rural and remote areas. Villagers in Central Anatolia, where climatic conditions are typified by very cold winters and hot, sunny and dry summers, are migrating to cities where they seek a more comfortable life style. Thus village economies have worsened and buildings have been abandoned. The Kerkenes Eco-Center, located on the edge of Şahmuratlı Village in central Anatolia, was founded in 2002 as a response to this situation. By bringing together village residents, local and state officials, NGOs, students and academics, the Eco-Center strives to advocate sustainable rural development and to act as a dynamic experimental base where buildings of traditional and alternative designs can be constructed and monitored. As a response to villagers' needs for comfort, low-cost construction, and low-maintenance buildings "new" designs and techniques, such as straw-bale walls, have been introduced while traditional practices such as flat roofs and sun-drying techniques have been improved.

This paper presents the results of research and hands-on activities which go a long way towards demonstrating the viability of alternative building techniques. Not only is the efficiency of the proposed solutions evaluated, but also the social impact and advantages brought to the village are examined. Buildings within the Kerkenes Eco-Center are continuously monitored and results analyzed while simulations are used to generate the optimum models for energy efficient designs. New buildings and solutions are implemented according to the results obtained. Hence on-going studies, including straw-bale construction, passive solar heating and integrated rocket stoves, make it possible to propose solutions for a sustainable rural life and viable future.

Keywords: Energy efficiency, appropriate building material, sustainable rural development.

1. Introduction

Village life in Turkey is a victim of the post-World War II economic development policies. Modernization of agriculture, development of economy and job opportunities in neighboring cities are the principal reasons for the large scale migration towards the city, leaving those who cannot follow to suffer from a weakening economy and unsustainable way of life. (Snyder, 2005) The built environment is suffering from the consequences of migration as villagers seek for a modern life-style and transform or abandon traditional building for less comfortable modern looking houses. (Dittermore, 2007) The Kerkenes Eco-Center Project was initiated in 2002 advocating an environmentally friendly approach to the improvement of rural settlements through research and promotion of renewable energy and sustainable village life. ŞAHDER, the Şahmuratlı Village Association, together with the Kerkenes Eco-center, was set up to combat this decline, raise living standards and provide new opportunities within the village economy so as to halt or even reverse migration from rural areas to urban centers.

The Kerkenes Eco-Center pursues the following objectives:

1. To advocate the use of renewable sources of energy;
2. To act as a stimulus and a catalyst for environment-friendly building with appropriate materials and energy efficient designs;
3. To act as a dynamic experimental base for testing designs, materials and activities suitable for viable and sustainable village life.
4. To encourage village development and income generating activities that might halt and even reverse migration from rural areas to the cities.

In 2003, the first experimental structure, the Ecomud Unit, was built with mud bricks (Fig. 2) replicating traditional building and providing information on traditional techniques. The village itself also provided the opportunity to monitor different buildings and study their environmental performance. (Elias-Ozkan, Summers, Surmeli, & Yannas, 2006) In 2004, a small experimental greenhouse was constructed with the help of students (Fig 3) while masons started building the stone foundations for a larger straw-bale house (Figs 1 and 2).

Fig 2: The Ecomud Unit (left) and Strawbale House (right).

Fig 3: Construction of the Strawbale Greenhouse.

As momentum increased and support was forthcoming, a broad range of activities related to improvement of rural life, energy saving and the use of renewable energy were conducted.

This ongoing program of activities include experimenting with appropriate building materials and energy efficient designs, drip irrigation for organic gardens, the promotion of solar energy for drying and cooking garden products, recycling, stimulating and creating income generating activities for both men and women.

The Erdoğan Akdağ Center for Research and Education (Fig. 4) was subsequently built to host an increasing number of researchers, educators, students and visitors. Analysis of data collected and simulations helped with the design of the Solar House which was then built to provide additional facilities for solar cooking and drying (Fig 5).

Fig 4: Demonstration of solar cookers at the Erdoğan Akdağ Center.

Fig 5: Solar cookers and dryers in front of the Passive Solar House.

This selection of buildings, together with an innovative hybrid construction of straw and AAC blocks (Fig. 6) housing the archaeological conservation of stone elements, are constantly monitored and their environmental performance assessed. (Elias-Ozkan, Summers, Karaguzel, Taner, 2008)

Fig 6: Innovative hybrid wall construction with AAC blocks and straw bales.

2. Research Projects at the Eco-Center

In order to fulfil the aforementioned objectives, research is being conducted in the following areas: solar energy; appropriate building materials and technologies; innovative materials, energy efficient stoves and recycling. The experimental buildings are being monitored for their thermal performance and the innovative materials tested for their properties. These projects are described further in the following sections.

2.1 Promotion of Solar Energy

Promotion of solar energy was first targeting activities which had the potential to become income generating and to involve the villagers, in particular the women. Workshops were scheduled to prepare solar cooked and solar dried garden produce. The Strawbale Greenhouse served the purpose of demonstrating how the growing season could be extended and results obtained by collecting temperature and humidity data. (Elias-Ozkan, and Summers, 2013)

A Solar House with the traditional mudbrick, flat mud roof and a solar space facing south was the next step to demonstrate the improved environmental performance of buildings harvesting solar energy to heat its thermal mass. (Elias-Ozkan, Summers, and Taner, 2009) Once the building was completed, continued monitoring produced temperature and humidity data sets that could be compared with that of buildings made of different materials as well as with simulations produced by specialized software.

The recent addition to the Kerkenes Eco-Center facilities is the refurbished village school to which a south facing solar space is being added (Fig 7). The anticipated energy savings and improved thermal comfort will make it possible to use the building even during the colder months.

Fig 7: Building a solar space on the south facing side of the Sahmuratlı School.

2.2 Appropriate Materials and Energy Efficient Designs

The research and educational activities at the Kerkenes Eco-Center have stimulated students who have taken on related topics for their studies. A wide range of experiments has been carried out on the premises. Mud bricks with different admixtures are produced with a mechanical press, tested and their physical properties compared. One very successful study was that of lightweight loam made with pine needles.

In order to test the thermal properties of these mixes, boxes were made out of the different materials and data loggers were placed inside to record temperature and humidity (Fig 8). These data are presented in Figure 10.

Fig 8: Dataloggers are placed inside boxes made from different materials.

Thermal comfort all year round but more critically in winter remains one of the major concerns in a village house. In 2014 the first rocket stove was built in the refurbished Şahmuratlı School. The aim is to demonstrate that much less fuel is needed to heat a house using this type of mass heater that functions with remarkable energy efficiency. Results obtained are discussed in the following section.

2.3 Activities for Sustainable Rural Development

The Eco-Center is a platform used by researchers, educators and students to further the field of energy and sustainability. Students taking part in the “Hands-on courses” develop new ideas and experiments. Many of the experimental buildings at Kerkenes have been designed and built within the scope of Hands-on sessions with the collaboration of local masons and villagers.

During the past two years new projects have developed ways of building vaults with AAC blocks. Because this material is light and easy to cut it offers obvious advantages. A small shelter was built for storing glass and plastic to be recycled (Fig. 9) while an outside toilet was roofed with a Nubian vault, successfully constructed without the use of formwork, leaning against the back wall of the Erdoğan Akdağ Center (Fig. 10).

Fig 9: A vault built with AAC blocks by architecture students

Fig 10: A Nubian vault built with AAC blocks.

3. Results and Design Potential

It is not possible to present here all the results obtained since the start of the project, but only to highlight the most significant. These concern, firstly, employment of appropriate building materials and, secondly, energy efficient designs.

3.1. The Study of Appropriate Materials

Natural and traditional materials have been studied under different conditions and compared with conventional materials. One of the main outcomes of this research was to understand the possibilities and advantages of using mud bricks, straw-bales, or AAC blocks rather than conventional kiln-fired hollow bricks (tugla).

To this end, research was conducted on the thermal and mechanical behaviour of stabilized mud bricks in comparison to local traditional ones (Fig 10). Mud bricks incorporating cement, lime or straw as stabilizers have been compared with traditional mud bricks. It can be seen that the addition of straw enhances the thermal properties of mud bricks whereas as the addition of cement has an adverse effect, especially on the humidity level in rooms.

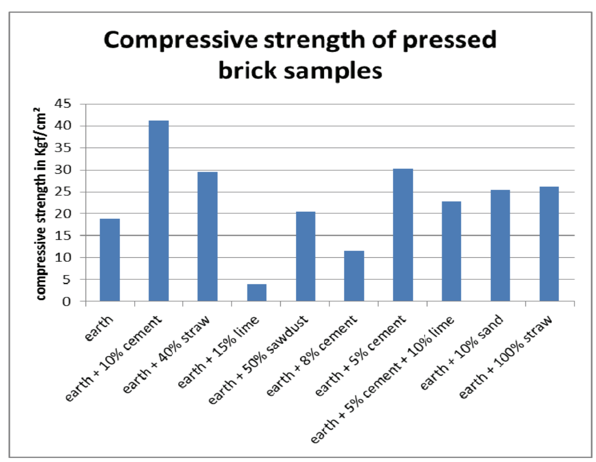

Fig 11: Impact of different stabilizers on the compressive strength of pressed mud bricks.

On-going research on the use of pine-needles as an insulating material has produced excellent results. Lightweight loam boxes and bricks have been prepared and tested in the eco-center to determine the suitability of these mixes (Pedergnana and Aslan, 2013). The thermal boxes have been monitored over two years, during which they were exposed to harsh winter weather conditions. It has been seen that when it contains enough clay (more than 1/12 by volume) the material is fairly resistant to humidity and rain without too much degradation. This material has the capacity to regulate the temperature and humidity by reducing the daily swing.

Candles have been lit in the boxes to test the insulating properties of different materials. By this means it was possible to compare the efficiency of light weight loam with that of other selected materials (Fig. 12). It can be observed that the light weight loam has good insulation properties because the temperature inside the box rises significantly when the candles are burning (violet line). The behaviour of mud-brick (green line) is different, with lower heat gain but a longer period of release. The red and orange lines show a similar behaviour even when the candles were only half burnt because of lack of ventilation in the boxes.

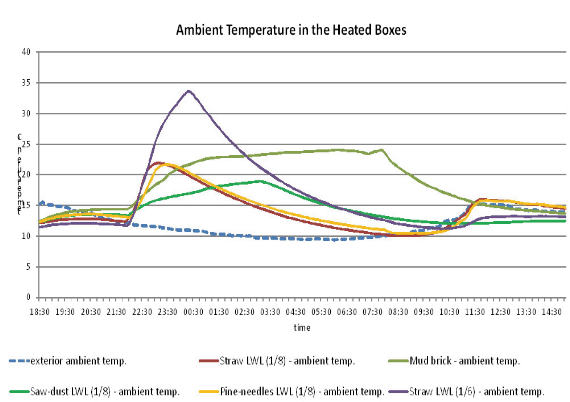

Fig 12: Ambient temperature in the heated boxes.

3.2 *Passive Solar Heating and Energy Efficient Designs*

Monitoring of the Kerkenes Solar House, comprising a large room with a solar space in front, has demonstrated that solar energy can contribute to energy savings and thermal comfort during winter time. To understand the impact of the solar space on the temperature in the adjacent room, even with closed doors, a temperature surface sensor was installed at the same height on each side of the mud-brick wall that separated them so as to measure the heat flow through the wall.

It can be noted on Figure 13 that even when the temperature inside the room and the solar space attains 35°C while exterior temperature is under 10°C, and the temperature difference between day and night is around 25°C, the interior surface of the mud-brick partition wall is almost constant and as low as 5°C.

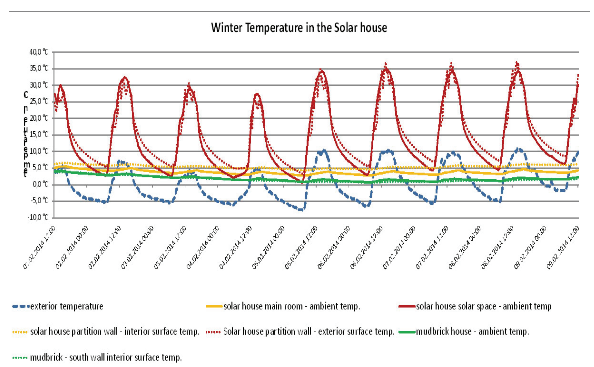

Fig 13: Graph showing temperatures reached

However, when compared to the Ecomud Unit which has the same orientation, but a covered terrace instead of the solar space on the south façade, it is noted that the wall temperature is higher and therefore contributing to the higher ambient temperature. In winter, the temperature inside the mud-brick house changes from 10°C during the day to 3°C at night. In summer, on the other hand, the high temperature of the partition wall combined with the very high temperature within the solar space provides an adverse effect with uncomfortably high ambient temperatures sometimes attained in the Solar House.

3.3 *Rocket Stoves*

Development and studies of rocket stoves and rocket stove burning chambers are being conducted at the Kerkenes Eco-center (Fig 14).

Fig 14: Rocket Stove under construction in the Strawbale House.

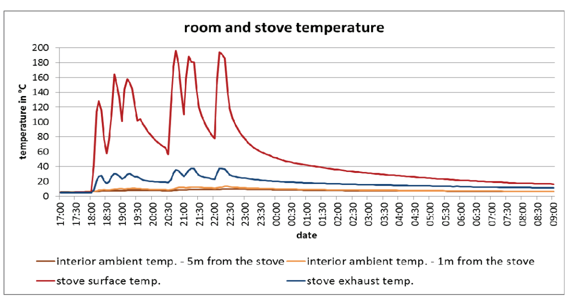

Fig 15: Temperature of the combustion chamber.

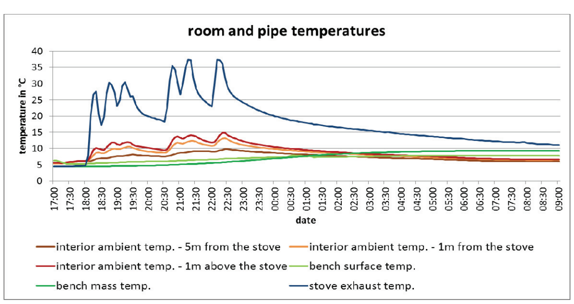

Fig 16: Temperature of the room, bench and pipes

During the 2014 spring and autumn semesters different rocket stoves were built in the Eco-center. The combustion chamber of the rocket stove in the Kerkenes Strawbale House was modified during the winter of 2015 because of an excess of smoke released into the room. In March 2015 the new combustion chamber was tested and yielded interesting results (Figs 15 and 16). The amount of wood burnt remained low but temperatures higher than 200°C were reached (but not recorded) on the top of the combustion chamber while the temperature at the entrance of the chamber was lower than 60°C.

4. Future implementation

The Kerkenes Eco-Center Team will seek support as more active components will have to come together before it can claim autonomy. The venture is however on the right track and the enthusiastic response and appreciation of the general public is encouraging. It is hoped that sufficient funding will be forthcoming to allow the project to develop further its income generating activities and to become economically viable.

In the Spring of 2015 the Sorgun Governorate engaged in the final phase of the solar space on the south side of the Şahmuratlı School. It is anticipated that by the time the group of 30 students arrive for the Hands-on session in June, the solar space will have been completed and the collection of data over a year can start. This refurbished building made of massive stone walls will demonstrate the advantage of using passive solar energy and it is expected that the need for heating in the winter will be minimized, thus making the School a place usable place for educational and social activities throughout the year.

5. Conclusions

To halt and even reverse migration from rural areas to the cities is a daunting task. Projects initiated have aroused awareness amongst officials and the public but economic viability has not been reached. To convince all stakeholders that profit should not be the main objective of any enterprise is difficult. Villages that once had over 500 families are now the permanent residence a mere 50 to 60 families and the number continues to decrease as young villagers opt for the comfort and social life of the nearby town especially in winter when they are not burdened with heating their house with the conventional stove or *soba*. Will the Kerkenes Eco-Center demonstrate that village life can be economically viable and provide the desired comfort if much thought and care was to be given to the selection of building materials, construction techniques and heating methods? Fifty years ago villages were often cut off for days from the nearest town but today the Government has opted to close the schools and centralize education; and hence provide the minibuses. Roads are much improved and kept clear of snow in the winter while internet has reached the villages… What else will be demanded by the educated young generation? Will the village remain a place for retirement only? The challenge is to prove otherwise!

6. Acknowledgments

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