THE BRITISH COUNCIL
BRITAIN – TURKEY PARTNERSHIP PROGRAMME

METU (Ankara) / AA (London)

WALL CONSTRUCTIONS THAT OPTIMISE THE ENVIRONMENTAL PERFORMANCE OF BUILDINGS

A comparative study of building materials and construction techniques in Turkey

INTERIM REPORT

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Figure 1. Workshop on Ecotect v.5.20 given by Dr.Andrew Marsh in the Architectural Association Graduate School, London.

PARTICIPANTS

We have been delighted to welcome two new participants in the active research group. Berrin Zeytun Çakmaklı has joined Françoise Summers, Soofia T. Elias-Özkan, Ayşem and Ömer Tuğrul Karagüzel at METU while Simos Yannas has recruited Mariana Gomez at the AA. Several postgraduate students in the Environmental and Energy Programme have expressed interest in our research, one of whom will accompany Simos Yannas on the AA visit to Turkey in May 2004. Yasemin Somuncu from the AA and Nevin Gezer from METU both successfully completed their Masters Thesis in 2003; we were sorry to see them go but we wish them every success in their future endeavours. At METU we continue to welcome students who want to use the Ecotect software.

PARTNERSHIP VISIT TO UK IN OCTOBER 2003

This Partnership Visit took place in November 2003. Françoise Summers combined a trip to Berlin, where she presented a paper at the Modern Earth Conference, with a visit to the UK from the 19th to the 23rd of October. Tuğrul Karagüzel, thanks to affordable accommodation at the International Students House, was able to spend a valuable two weeks in UK between the 20th of October and 2nd of November 2003.

During their stay in London the two METU participants attended lectures, seminars and visited exhibitions. Their visit to the UK also included a trip to the Parry Associates Workshop in Cradley Heath, Birmingham. They welcomed an invitation to stay overnight in the company's cottage, which made possible their participation in a workshop session as well as a visit to Chasewater Heath where the lightweight railcar was in operation.

Visit to The Architectural Association Graduate School, London (21st October – 2nd November 2003)

Françoise Summers arrived in London on the 19th of October and met Tuğrul Karagüzel at Heathrow the next morning. After checking in at the International Student House they went to the Architectural Association where they spent the afternoon the afternoon discussing the programme and research progress with Simos Yannas. Both Françoise Summers and Tuğrul Karagüzel attended the full day workshop on Ecotect. Tuğrul Karagüzel was invited to all the other talks and seminars that were taking place during his two-week stay in which he also finalised the poster for the 2003 PLEA conference.

Workshop and Lectures

The highlight of the visit was a full day workshop (Fig. 1) given by Dr. Andrew Marsh, author of the computer program Ecotect, released by the Centre for Research in the Built Environment, Cardiff University, UK. The workshop on Ecotect v.5.20, a tool to simulate and analyse the environmental performance of buildings, started with a general overview and ended with detailed explanations of its specific features. Dr. Marsh presented the basic functions of the programme such as solar, thermal, acoustics and lighting analysis and he then continued with the demonstrations of results from a number of buildings in UK. During the workshop Dr.

Marsh gave guidance on how to create a simple building model in Ecotect v.5.20 and conduct thermal simulations on this model.

Tuğrul Karagüzel was also able to participate in a digital tools workshop on Ecotect v.5.20 given by Raul Moura and Werner Gaiser, staff members from the AA Environment & Energy Programme. During this workshop the creation of a weather file from an existing database and its importation into the modelling interface of Ecotect v.5.20 was demonstrated. The wealth of options for graphic representation contained in this software was also presented (Fig. 2).

Simos Yannas lectured on aspects of urban climatology, employing rich verbal and visual information, which stimulated vibrant student participation in the discussion.

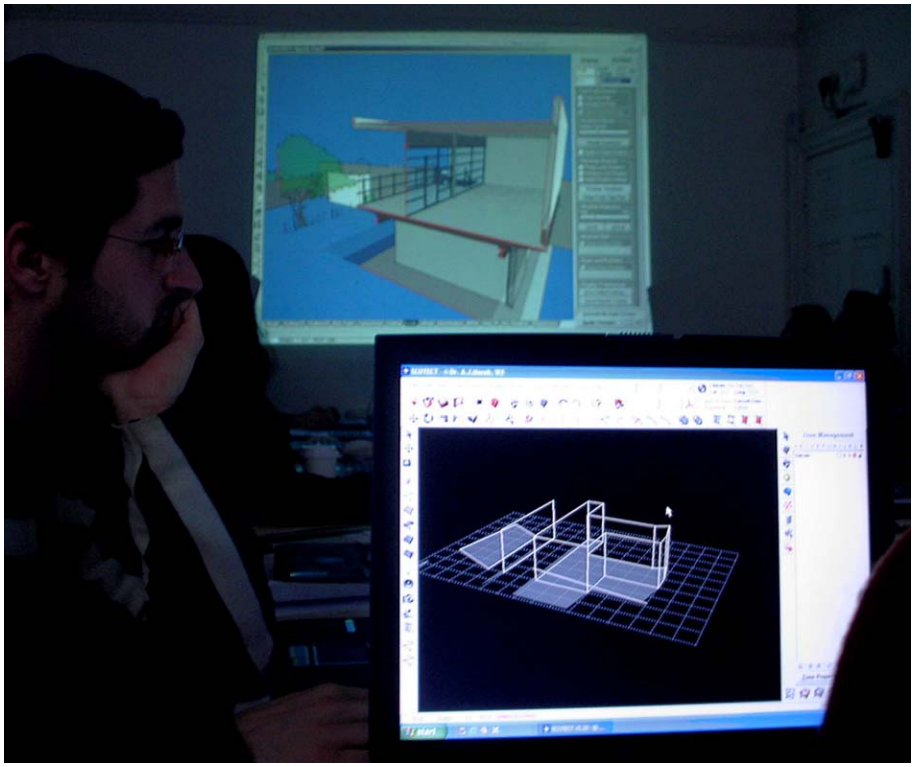

Figure 2. Features of the program "Ecotect v5.20" were explained and illustrated with graphic material during the workshop given by Dr. Andrew Marsh.

Poster for the PLEA Conference

Tuğrul Karagüzel, with advice from Simos Yannas, designed and prepared the poster (84 by 120cm) to be presented at the 2003 PLEA (Passive and Low Energy Architecture) Conference in Santiago, Chile. Illustrating the results of the comparative studies on traditional and contemporary construction in Turkey, the poster (Fig. 3) was presented by Simos Yannas at this conference, which took place in November 2003.

Exhibitions and Visits

A number of exhibitions presenting the architectural projects of both undergraduate and graduate students from the AA were of interest. Visits to famous buildings and exhibitions in London were an additional bonus.

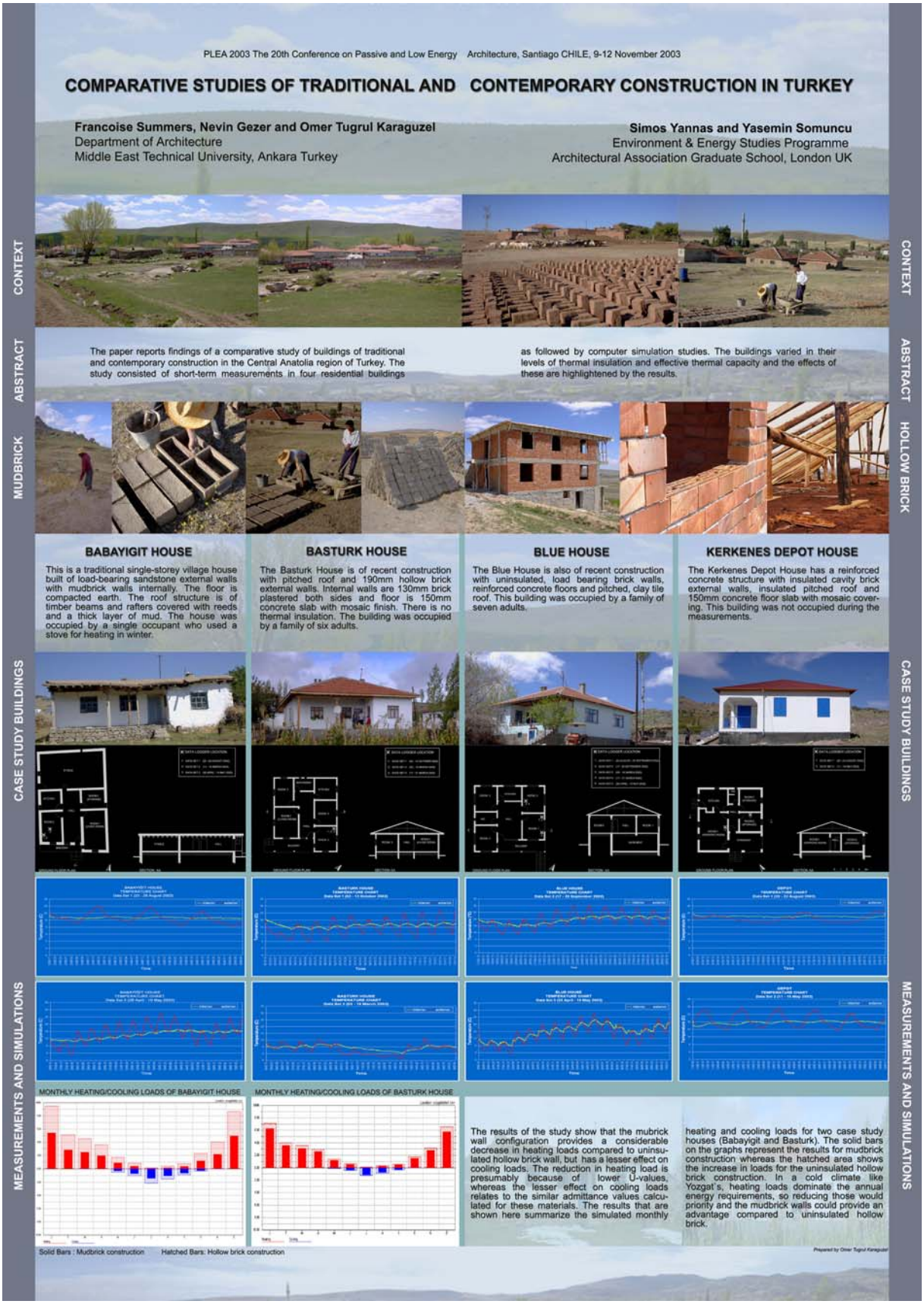

Figure 3. The Poster for the PLEA Conference prepared by Ömer Tuğrul Karagüzel and Simos Yannas at the Architectural Association Graduate School, London.

Visit to Parry Associates in Birmingham
(20th - 21st October 2003)

The main aim of the visit to the Parry Associates Workshop was to acquire information about the latest developments in equipment and services for the production and use of appropriate building materials. This company has developed equipment for small-scale production of building elements and is also now well known for its down-sized light rail transport including railcars and tramways.

A basic training session on practical aspects of production, illustrated below (Figs 4 to 11), was given during this informative visit to the Parry Associates Workshop. The Parry Brick Press can produce up to 1000 bricks per day using a clay mix stabilised with about 10% cement. Our studies have shown that houses built with 20cm thick walling made of industrially produced extruded clay blocks have a low environmental performance. An alternative ought to be proposed, especially for the rural areas where the new building techniques are rapidly replacing the use of the traditional mudbrick, and the Parry Brick Press is an ideal choice for the promotion of stabilised mudbrick as an appropriate building material.

Samples were also produced using the Parry Multivibe Vibrating Table, a machine that can operate either with human power or electricity. This vibrating table can be used for micro cement building elements such as roofing tiles, floor tiles, building blocks and paving slabs.

Cylindrical water tanks designed and constructed by Parry Associates are built with specially shaped, curved and interlocking micro cement blocks. These water tanks can be built in 2 or 3 days from Parry's concrete blocks, which could be produced on site with a Multivibe Table. Such water tanks could help resolve seasonal lack of water in many Anatolian villages and could be included in the Kerkenes Eco-Center development program.

Finally, an added bonus was a visit to the Chasewater Railway where the Parry People Movers light rail car is operating (Fig. 12). This is another promising development in the search for energy saving devices to promote sustainability and an environmentally friendly way of life.

The *Parry News,* Issue 37 (see extract below), included an article mentioning some of the ongoing activities related to our ongoing research. John Parry also introduced our project to Anthony Burdens of the Burdens Charitable Foundation. Financial help has been requested from the Foundation for the purchase of the necessary equipment to set up a small workshop in Turkey.

The Parry websites contain a wealth of information about their products and projects.

http://www.parryassociates.com

http://www.parrypeoplemovers.com

Figure 4. Pressure is applied to the mixture of clay, sand, cement and water in the Parry's Brick Press mould by means of a long handle.

Figure 5. The lid of the brick press is opened and the brick pushed up as the handle is released.

Figure 6. Once pushed up the brick can be taken out by holding it with two plywood pieces to avoid damage. The bricks are then stacked for drying.

Figure 7. Production of micro cement building elements in a small workshop will not require a large capital investment.

Figure 8. The Human powered Parry's Multivibe Vibrating Table can also be connected to the electricity circuit. De-aerating the concrete mix by means of vibrations will strengthen the product and reduce the thickness required.

Figure 9. The plastic sheet on which the cement mix was poured can be pulled over the roof tile mould. Up to 20 moulds can be stacked for drying.

Figure 10. Moulds for the similar production of different types of roof tiles and paving slabs are also available.

Figure 11. Cylindrical water tank built from curved interlocking concrete blocks could help solving the seasonal water shortages that occur in many Turkish villages.

Figure 12. John Parry and the Chasewater Railway light railcar.

PARRY NEWS - Issue 37

http://www.parryassociates.com/pdf/NL37.pdf

TURKISH UNIVERSITY GROUP PLAN TECHNOLOGY CENTRE DEMONSTRATING PARRY SYSTEMS

Representatives of the Faculty of Architecture at the Middle East Technical University in Ankara visited Cradley Heath in October to begin to implement a long-standing plan. This is to apply the JPA approach for production of building materials at an Eco-Center established in the mountain village of Kerkenes in Central Turkey.

The leader of the METU deputation Francoise Summers, originally from Mauritius, had attended a practical training course at Parry Workshops in the 1980's when she saw some of the now well-establ ished technologies, prior to commercialisation. In contrast to the relative wealth of urbanised Turkey, the mountain people have to live much simpler lives, burning firewood and living in traditionally constructed houses. These, though crude in appearance, are actually suited to a dry, semi-tropical climate where the thick walls even out the temperature which is high in daytime, cold at night.

The Eco-center's plan is to modernise the traditional method of construction by using machine-pressed mud blocks which are very consistent in size and dimension, and large format micro concrete roofing materials which require far less supporting timber in the roof structure than the traditional clay tiles presently used. It is also planned to introduce rain water storage using the Parry curved interlocking block method of construction. Work on the project will be done by Kerkenes villagers assisted by students from the university.

ENVIRONMENTAL STUDIES ON THE MUDBRICK UNIT IN ŞAHMURATLI

A Small Unit Stucture

The small unit structure was built in the village of Şahmuratlı, Yozgat, within the Kerkenes Expedition House complex. Consisting of a single room and a balcony, the new building with its traditional mud-brick walls and mud roof was completed in November 2003. This mudbrick unit is an ideal structure for the ongoing study of indigenous building materials and traditional construction techniques because it offers a simple configuration. Once its physical properties have been recorded and a virtual 3D model created, the building material configuration and other parameters can be changed so that a variety of simulations can be produced and compared. Tinytag data loggers are used to record temperature and relative humidity both outside and inside the building. This data is then used to check, and adjust if necessary, the virtual model. Extensive environmental studies on actual and theoretical data can thus performed.

Figure 13. The unit structure within the Kerkenes expedition house complex in the village of Şahmuratlı. The Kerkenes Dağ with the ruins of the Iron Age city is seen in the background.

Three Dimensional (3D) Model in AutoCAD

The 3D Model of the structure is first created in AutoCAD from measurements and information collected during construction. Careful creation of layers for different elements of the building (such as foundation, mud walls, mud roof, balcony, window and door) allows the easy manipulation of those features when exported to Ecotect.

Figure 14. The mudbrick walls of the unit structure have stone foundations. The flat mud roof, with its timber ceiling and rafters, is supported by beams and posts built into the walls so as to make the structure earthquake resistant.

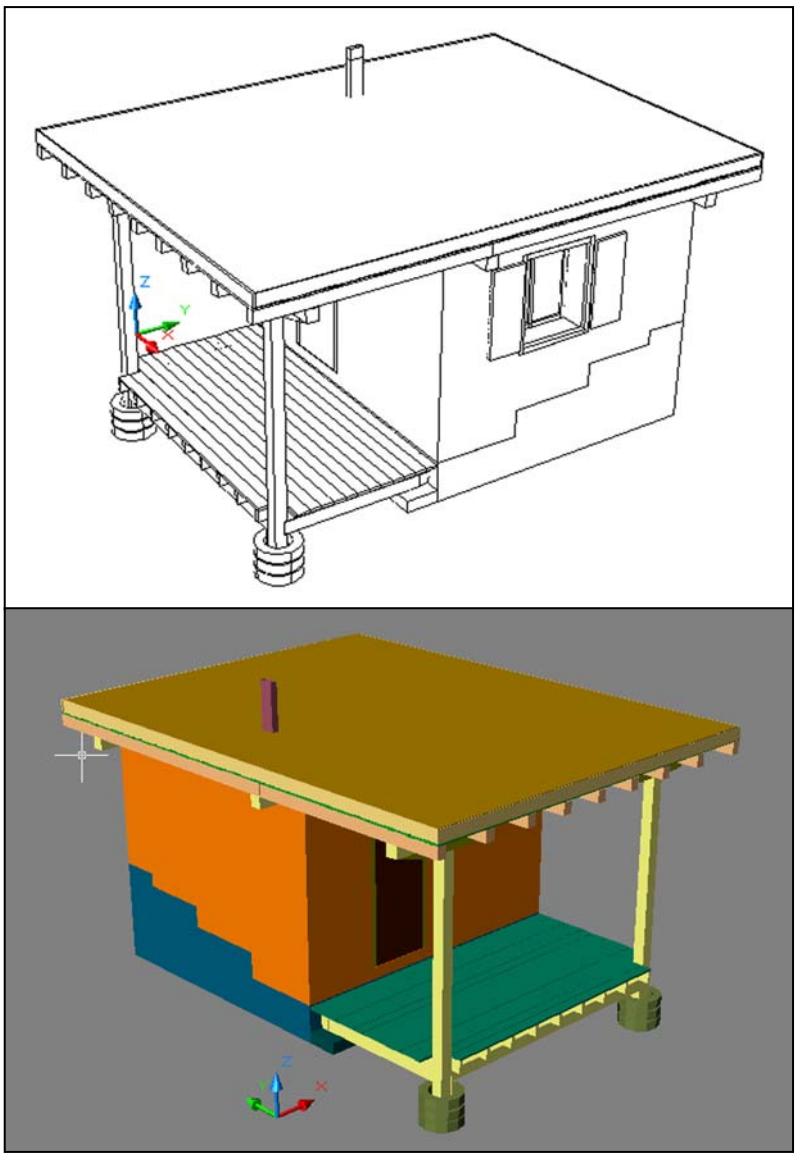

Figure 15. 3D model (above) created in AutoCAD and then rendered (below).

Three Dimensional (3D) Geometric Model in Ecotect v.5.20

The model exported from AutoCAD is manipulated in Ecotect v.5.20 so as to assign to the different elements their respective characteristics and properties. The type of modelling used has to be compatible with the analysis performed. For example, solar shading and lighting analysis requires a model that contains all the necessary geometric information while a different and type of model is needed for thermal simulations.

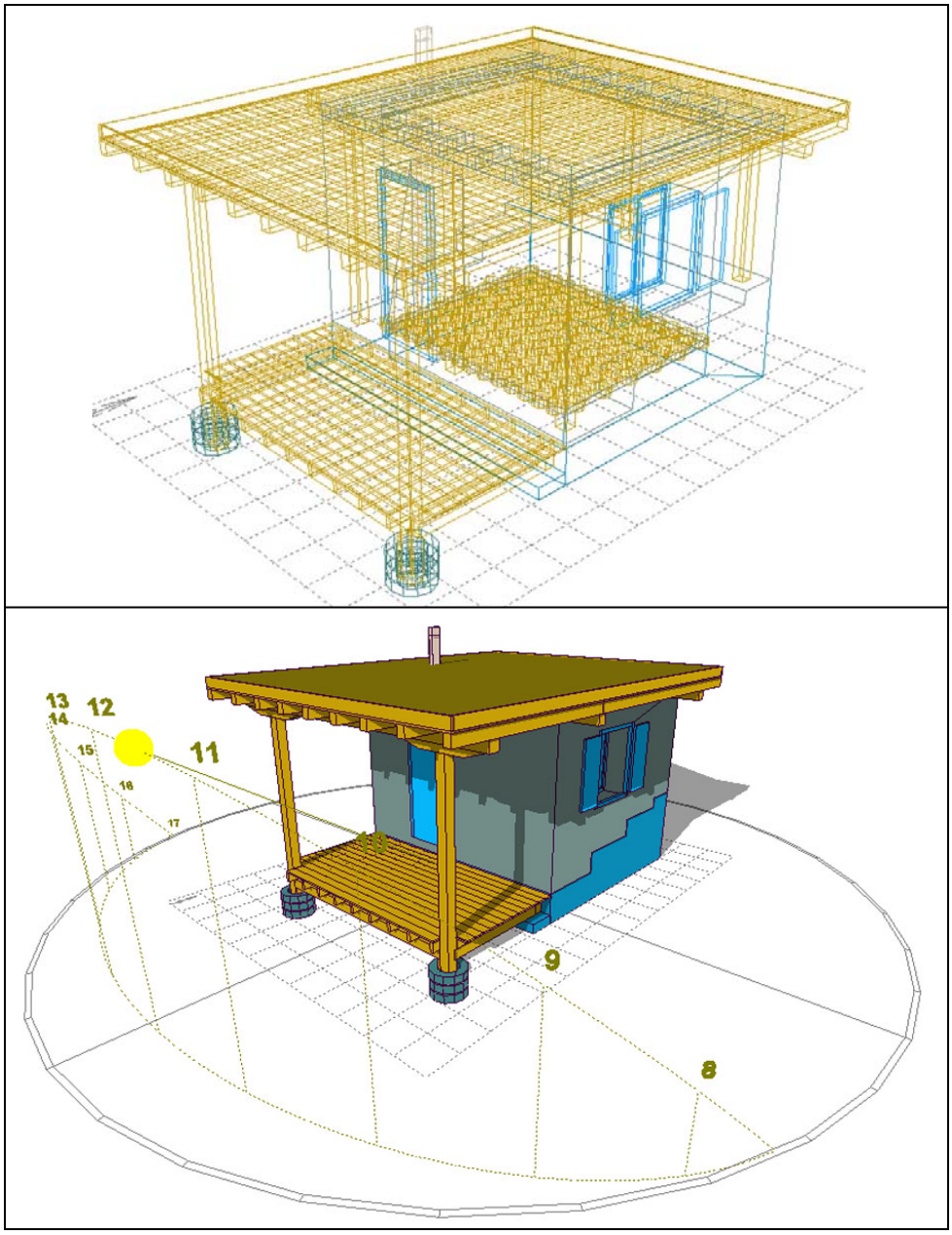

Figure 16. The basic 3D model (above) in Ecotect v.5.20 is then rendered and shaded (below) for more realistic visualisation of shading analysis with the sunpath diagram on a particular date and time for the geographic location of Yozgat.

Thermal Model in Ecotect v.5.20

A model created for thermal analysis is geometrically simplified since the relevant attributes here are the thermo-physical properties (such as U-values and thermal admittance values) of the building envelope and fenestrations.

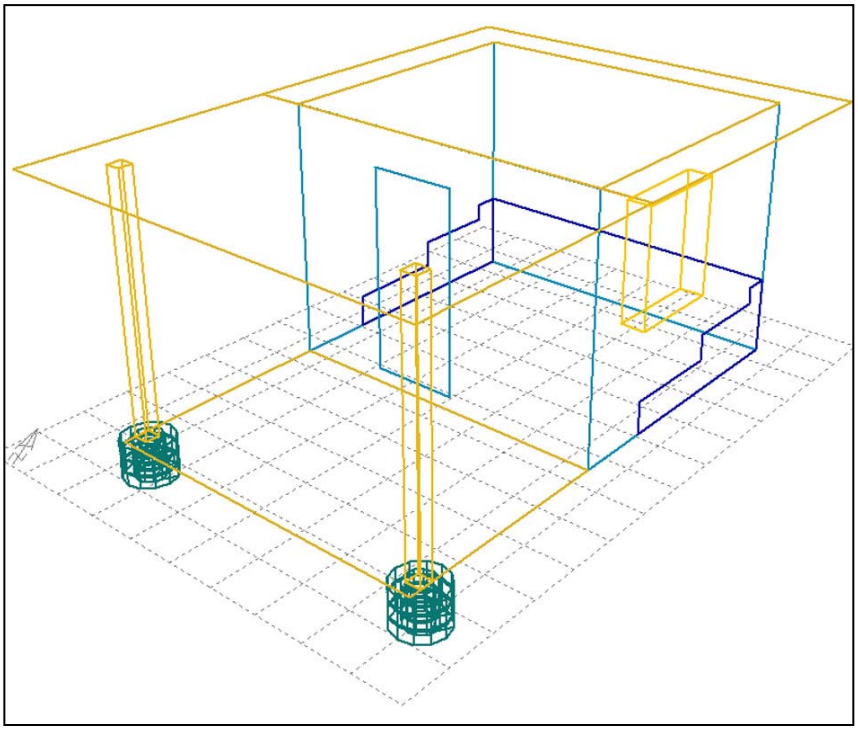

Figure 17. A 3D view of the thermal model of mudbrick building developed in Ecotect v.5.20.

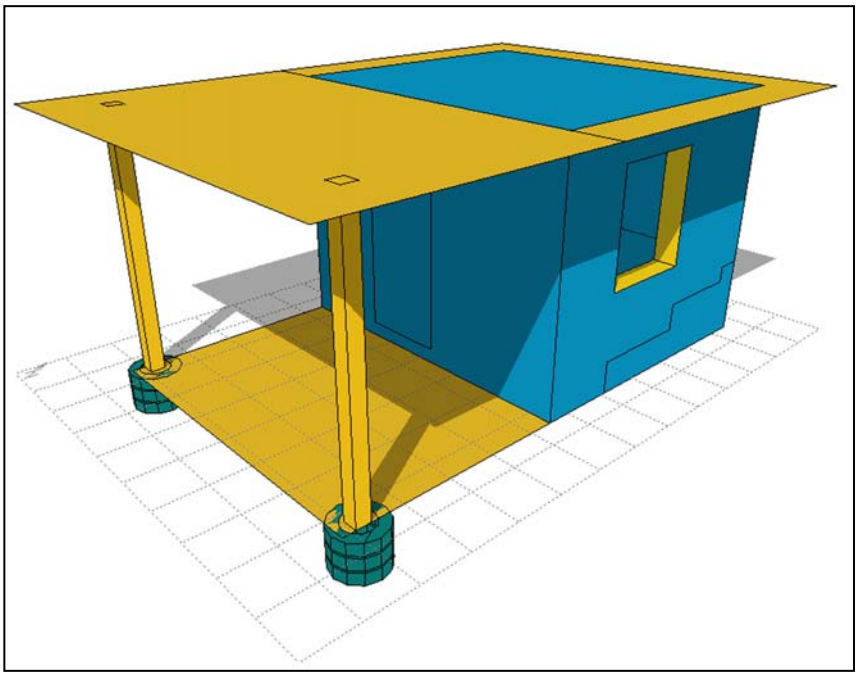

Figure 18. Captured view of the rendered thermal model with shade and shadows as calculated with Ecotect v.5.20.

Environmental Studies

Environmental studies conducted on the mudbrick building not only provided valuable insights on its thermal performance but made it possible to compare the results from the computer model with which the dynamic thermal performance of the building was simulated with the real performance as recorded. The building was neither occupied nor heated during this period.

Actual temperature and relative humidity measurements collected by data loggers for a one-month period were compared with the computer predictions for the same period. Graphs displaying both the real and calculated data can be used to judge accuracy of the simulations and if discrepancy occurs the relevant parameters can be adjusted.

When the weather data for the given region is available, simulations can be done for different times of the year. It is also possible to test a model with the climatic data of other regions. Thus it is possible to evaluate the effect of building materials and climatic factors on thermal comfort inside a given building. It is also possible to calculate the amount of energy required for space heating and cooling in order to maintain the ideal conditions for thermal comfort. The environmental performance of traditional materials (mud-brick, stone, timber frames, mud roofs) against those of contemporary materials (kiln fired bricks and tiles, cement blocks, and insulation materials) can be evaluated. Other parametric studies relating to building form and orientation, window size, type and orientation can also be performed. Sample graphs used for these studies are illustrated below.

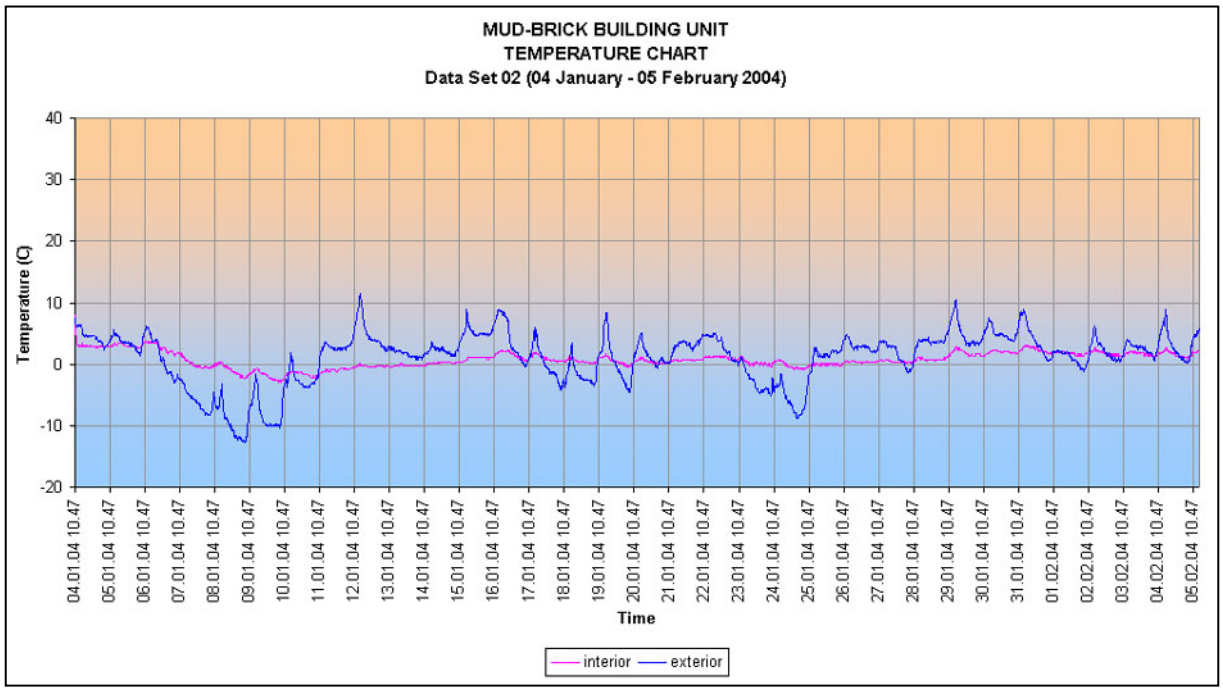

Figure 19: Diurnal range of indoor temperature (shown by pink lines) for the mud-brick building plotted against outdoor air temperature (shown by blue lines) for one-month period between 04 January and 05 February 2004 during which the building was neither occupied nor heated.

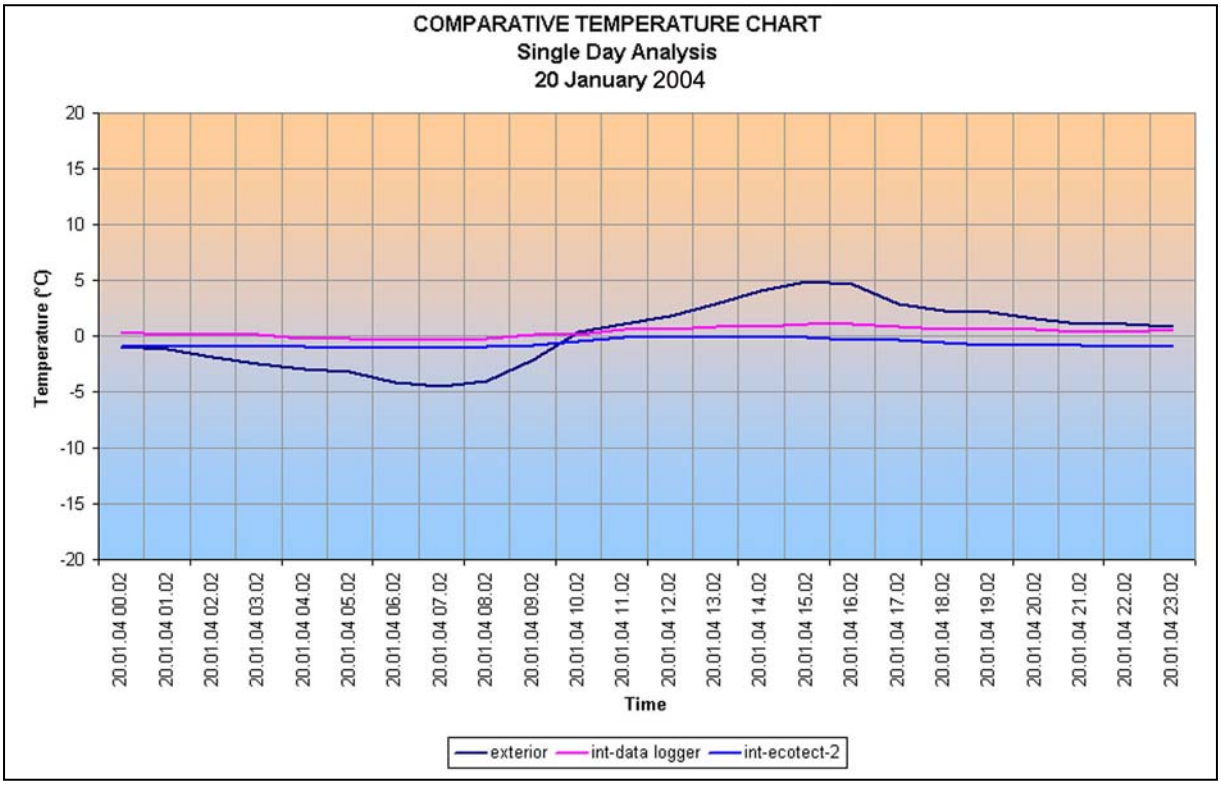

Figure 20. Comparison of hourly temperature profiles for a single day analysis (20 January 2004) obtained from interior datalogger (pink line) and profiles obtained from computer simulations performed in Ecotect v.5.20 (blue line). Air temperature recorded by exterior datalogger (dark blue line) is also given here.

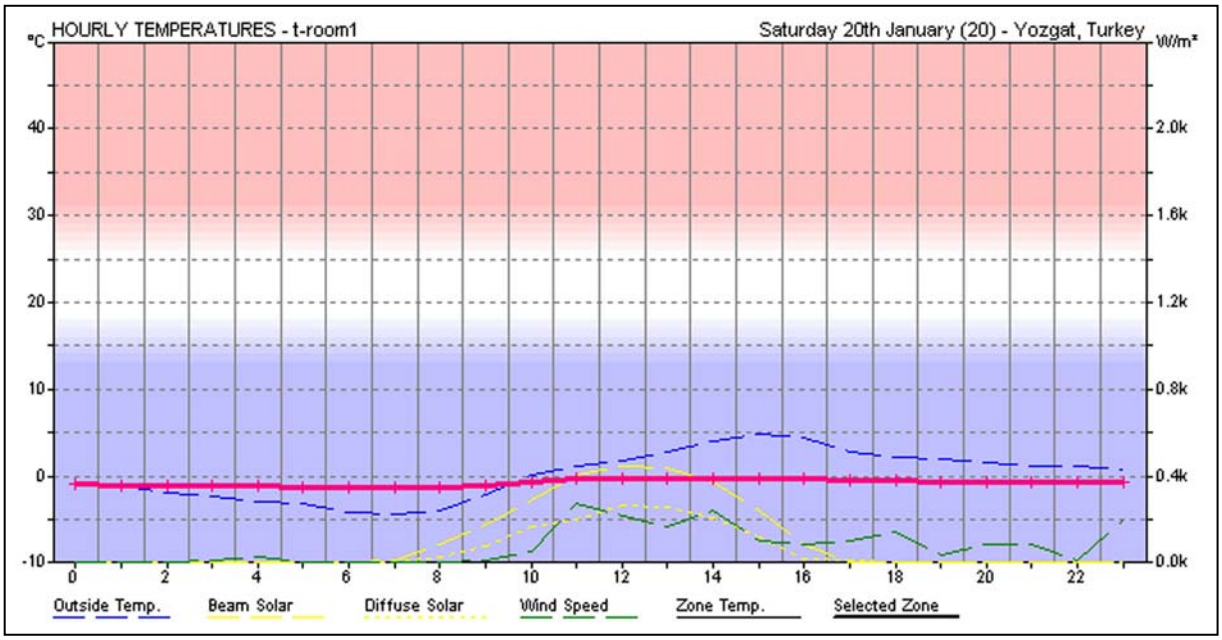

Figure 21. Hourly temperature profile inside the mud-brick building (pink line) on the 20th of January 2004 compared with weather data (5 years average) for Yozgat displayed in Ecotect v.5.20.

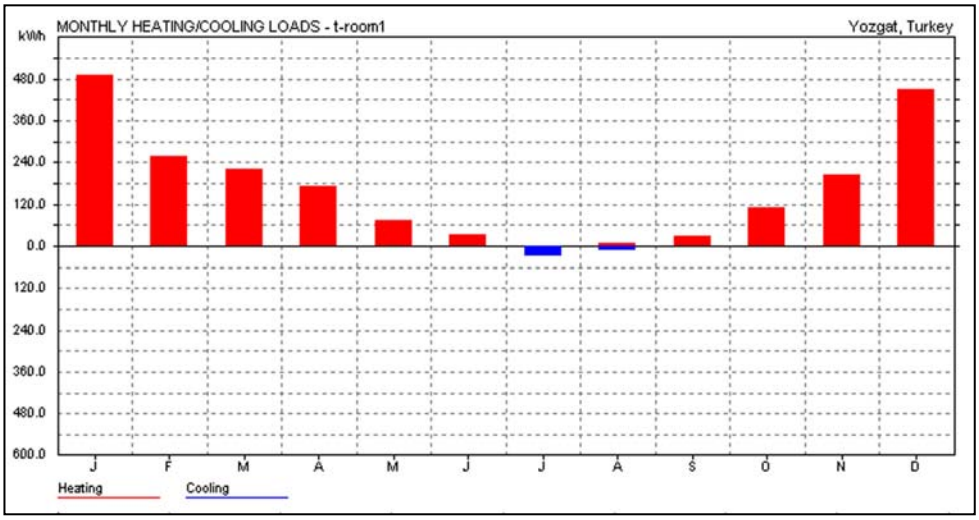

Figure 22: Monthly heating and cooling loads of an air-conditioning system assumed to be located in the mud-brick building as calculated by using thermal analysis function of Ecotect v.5.20.

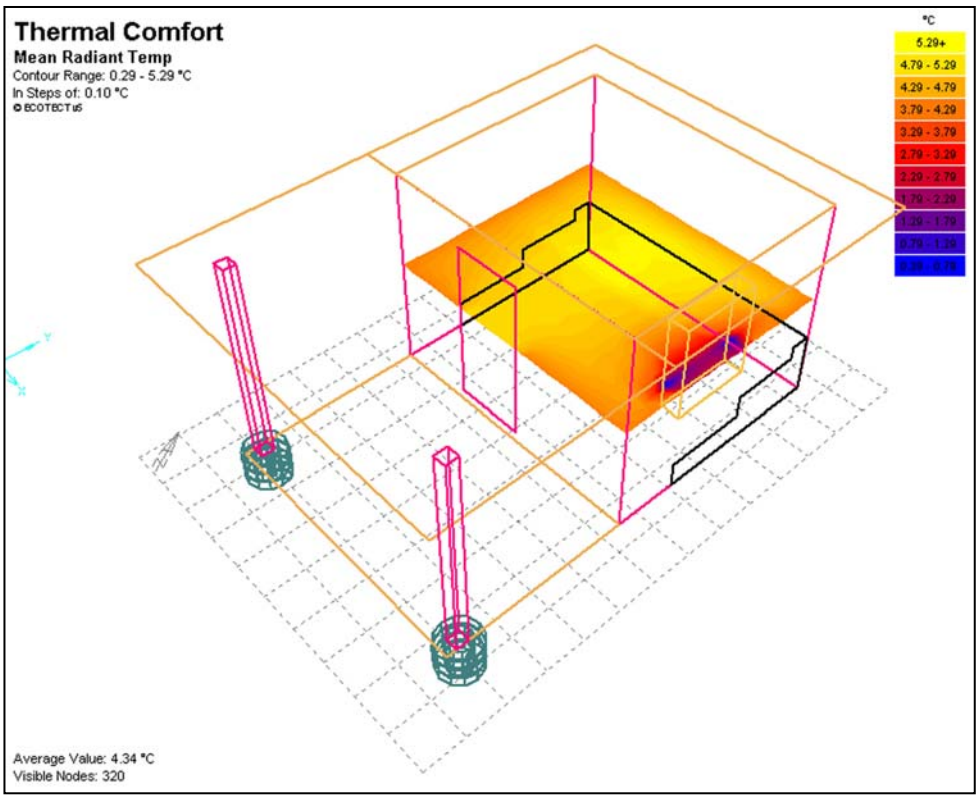

Figure 23: Results of the thermal analysis performed with Ecotect v.5.20 showing the mean radiant temperature levels shown (colour scale ranging from 5.29 °C to 0.29°C) on a grid inside the mud-brick building for the 20th of January 2004 under the climate conditions of Yozgat. The building is assumed to be unoccupied and there is no air-conditioning system in operation.