EXPERIENCE OF OUTPUT VISUALISATION IN THERMAL PERFORMANCE ANALYSIS AND DESIGN.

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Abstract: GKS didactic application in output visualisation of thermal behavior simulation in building analysis and design.

Energy analysis is performed by BEETA (Built Environment Energy Test and Analysis) code (fig. 1).
It is a numerical simulation code which allows to simulate the building multizone thermal behaviour with different passive devices (Direct Gain, Greenhouse, Solar Chimney, Trombe, Convective and Radiative Cooling etc..).

The code is based on thermal network theory and methods; the set of thermal equation is normally solved every hour or less by the coefficient matrix inversion method. An interactive loop is provide for dealing with non linear thermal conductance problems with continuous or step variation (i.e. air mixing through an opening between two spaces, Trombe wall convective loop, etc.)
The code allows to take into account urban obstructions and shading devices.
Air temperature control system is simulated by two set points:

- if room temperature drops below the lower level, the auxiliary energy system starts;
- if the temperature overcomes higher level, ventilation starts and wasted energy is computed for feasibility evaluation of storage system.

The BEETA code comes from PASYDY, which was developed for the Italian Research Council (2 Fanchiotti, 1979). For the validation of BEETA we refer to the PASYDY validation (3 Fanchiotti, 1983).

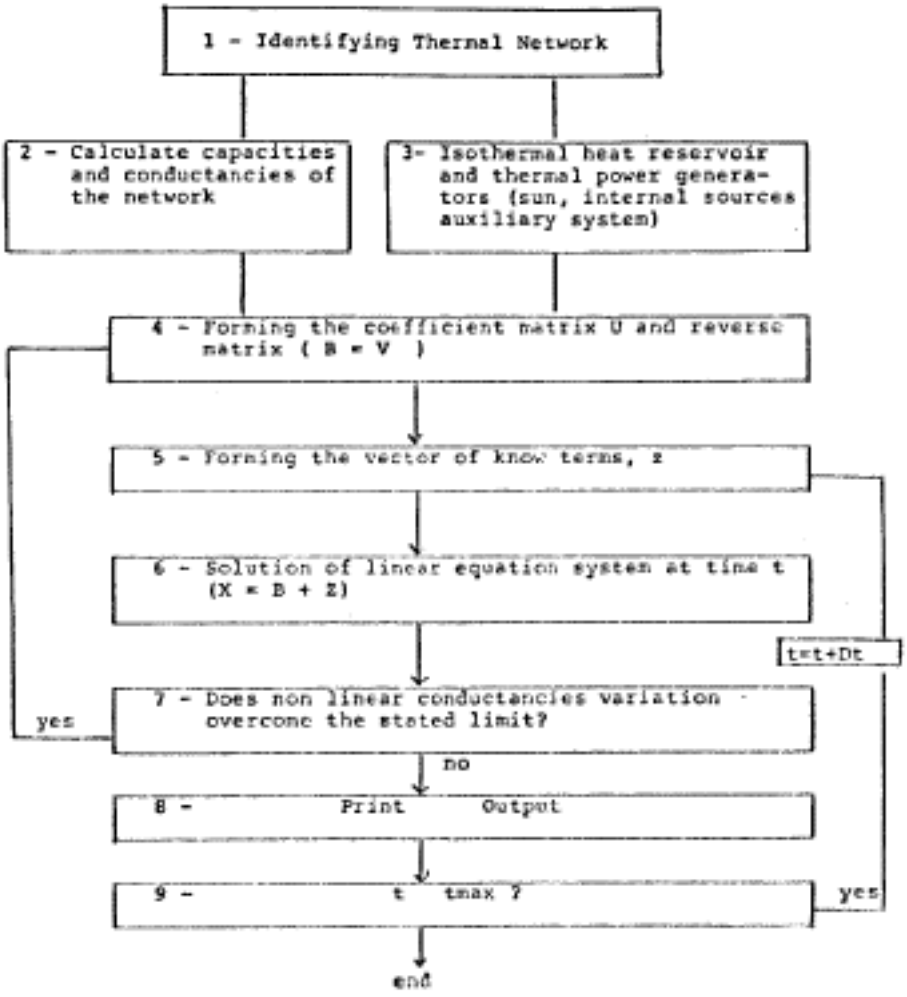

Fig. 1 - Block diagram of BEETA simulation code

VERNACULAR ARCHITECTURE IN PUGLIA

In spite of the regional richness of traditional architecture, Italy carefully follows the above-mentioned trend, having few people, working on locally based research programs.

The aim of the ongoing research is the evaluation of the appropriateness of the main traditional dwelling types to the local past and present conditions of Centra1 Puglia, with particular reference to thermal response response to microclimate of the underground-troglodite dwelling, ttie vault dwelling and "trullo".

The tree types provide summer cooling in a region with different microclimates ranging from hot arid in inland areas to hot humid near the sea; both have average summer daily temperature swings of about 10 C.

The underground dwelling, the excavated under tender stone (limestone) at different depths depending on local geology; entrances and chimneys allow ventilation and evaculation of smoke (fig. 2). The vault dwelling (fig. 3) is a two-story building covered with terrace and aggregated around a common court to form an urban unitsimilar of the Arab "patio house".

All the villages of the "Trullo" area, with the only exception of Alberobello, are formed by such units.

Cooling is provided by a massive structure and night radiation through terraces.

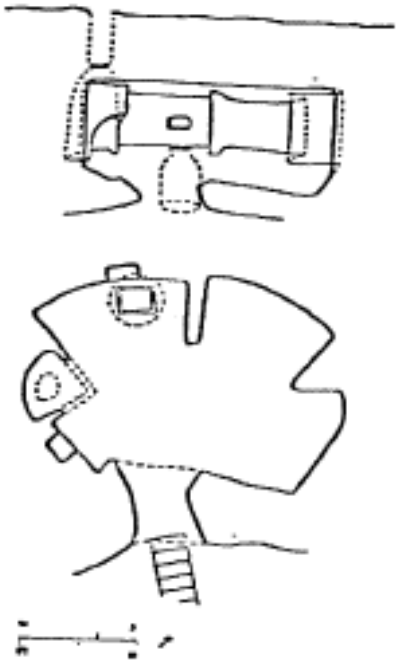

Fig. 2 An underground dwelling

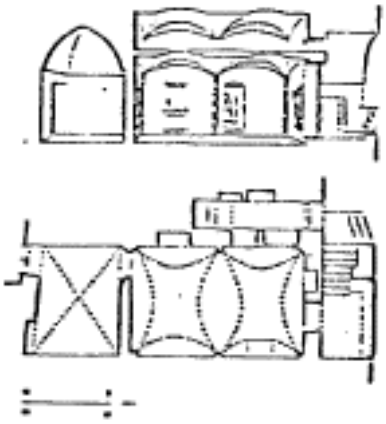

Fig. 3 A typical vault dwelling

THE TRULLO CULTURE

The "Trullo" is a massive square or around building unit covered by a conical shape stone roof.
The dwelling is usually formed by tree or four units, the biggest in the center.
A single door and one window open to the South, and a small window to provide ventilation opens to the North.
Grape and wine containers and rain water cisterns were often carved out of the sides or floor of the underground chambers.
The "Trullo" is a seasonal dwelling used from April to October; the farmer and family migrate to the town in winter.
The "Trullo" is strongly connected with the agricultural use of land, vineyards, olive trees, and fruit, for example, and are built with the stone picked up to clear the fields like many other rural huts throughout the world.
The peculiarity of the culture developed in the "Trullo" area derives from a structural reason: the area was developed during Spanish domination of the 17th century, which tried to prevent any development of marginal areas by forbidding any new building.
A local nobleman bypassed the law, advising and helping people to build permanent dwellings with dry wall technology; in case of inspection from Naples, the "Trullo" stone covering could have been quickly demolished with the help of some horses, and later on rebuilt.
The "Trullo" culture survived its historical roots for centuries.
Its existence now does not have any strong productive reason.
The new tradition consists of shopping centers (Alberobello) and tourist villages (Club Valtur).

A secondary aim of the research is the cost-benefit analysis of local building technologies involving different levels of building skill, from self-building the "Trullo" dry wall technology to the specialization of the master mason necessary for the village vault dwelling.

THERMAL PERFORMANCE OF A TYPICAL "TRULLO"

The thermal performance of an isolated "Trullo" (fig. 4) was measured during a summer week. indoor maximum air temperature in the day was 4 C below the outdoor temperature (Fig. 5).

Inside temperature swing was around 4 C, and outside was around 10 C.

A summer day was simulated with a numerical code based on thermal network model development for testing the performance of buildings under dynamic conditions(2).

Energy source equations are solved by hourly steps.

Hourly values of solar radiation and ambient temperature are derived from analytical correlation of the standard monthly average data. Fig. 6 shows the thermal network of the "Trullo"; is simulated temperatures shows close correlation with the measured ones.

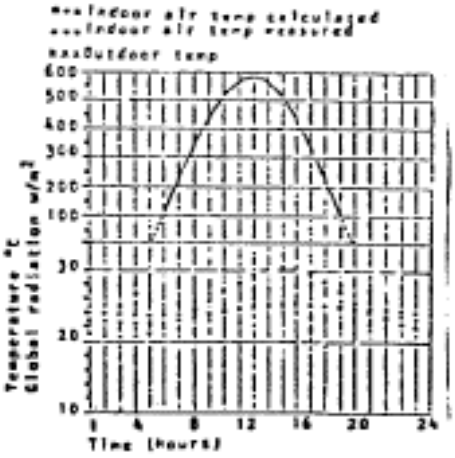

Fig. 5 solar radiation, indoor and outdoor air temperature

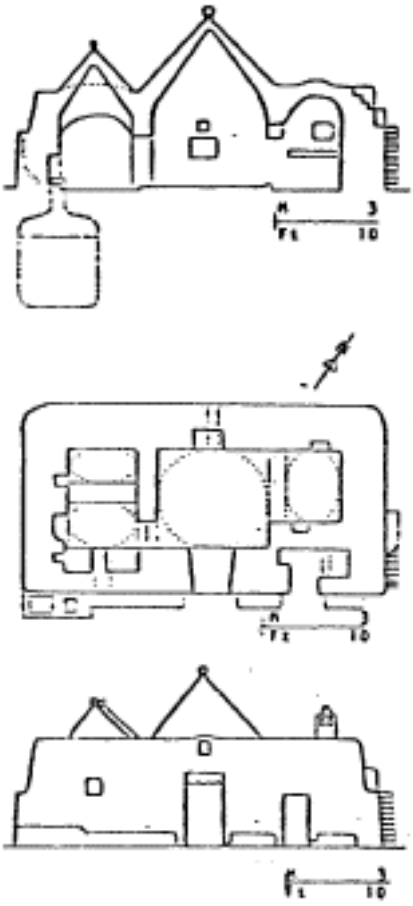

Fig. 4 Longitudinal cross section, plan and south elevation of the "Trullo" studied.

DATA RENDERING

A graphic visualisation programme of geometric and numerical data of the "trullo" thermal simulation has been implemented.
The programme uses the graphic standard GKS (Graphical Kernel System) in a personal computer IBM/AT.
The GKS performance facilitates implementation in didactic field because:

- it is independent both from programme language and from workstation hardware;

- it has a very simple syntax and use 250 contemporaneous colours can be chosen from a 4096 colour range.

Actually GKS has not guarantee good interactive performance, nevertheless it remain an useful and simple graphic tool if employed in rendering.

References and Notes

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(5) D. Blasi, B. Merello, G. Scudo, G.C. Possi, Heating and Cooling Performance of Traditional Italian Architecture, Solar World Congress Perth,1983.