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ENERGY CONTAINMENT: EXAMPLE OF BIO-CLIMATIC DESIGN METHODOLOGIES

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ABSTRACT

Analysis of energy consumption in Europe shows that the sector is the industry's most energy (40% of total) in Europe has established a new legislative framework in order to reduce consumption: Directive 2002/91 EC. With the introduction of energy certification Directive is one of the objectives for the energy efficiency of buildings and generate a new offer aimed at building models less dissipative. The case study presented examines the restructuring of a building in Pozzuoli (Naples) on the basis of the principles of bioclimatic engineering through the use of spreadsheet Casa Clima. Casa Clima, was developed by the Province of Bolzano (IT), in 2002 established a minimum standard to be observed (C>FEAP =70 kWh/m2a), its the first Italian example of mandatory energy certification. The authors present a design example of a planned maintenance using the methods of bioclimatic engineering to obtain a passive response in terms of energy.

Key words: Casa Clima, energy consumption, bioclimatic engineering, energy certification.

INTRODUCTION

In Italy, the 44% national energy needs is addressed to civil sector and the 75% of it comes from residential sector; to satisfy these needs we have to get from non renewable resources and that brings to changes, sometimes invisible ecosystem balances. To reduce consumptions the EU during the last years, has paid attention to the problem and thanks to various agreements (Geneva 1979, Kyoto 1997) and instructions we have come to a new legislation. In Europe the last instruction 2002/91/EC is about the energy efficiency and the building energy certificate that says: in every EU country a common methodology must be applied to calculate the energy production of every building considering the local weather conditions. The member States decide about the minimum standards for energy production to apply to new buildings and to big existent building renovations.
According to EU instructions and regulations, Italy in 2005 made the legislative decrees 192 that define how to calculate the energy production. These decrees introducing the FEAP and the transmittance limit values of structural components. The energy certificate of a building or a property unit is a document about the necessary quantity for the primary energy need in a year, like:

room heating;
sanitary warm water;
air-conditioning.

This certificate also inform about the agreed conventional useful energy need, calculated according to UNI regulation, the production according to the plant type, the conventional consumption of electric energy.
This certification has more objectives:

- have an available document that describe the energy characteristics of a building and its plant;
- improve the property market clearness, the energy certification is a good knowledge for consumers and gives sellers the opportunity to point out the thermal qualities of a building;
- encourage investments for a rational use of energy.
- certificate will increase the value for building subjected to improvement. The increase will be a good reason for an owner to make the necessary investments;
- choice for investments. A good knowledge of parameters (heat loss coefficient, production, ect.) makes owners choose the best investment energy consumption;
- reduction. If we consider the energy efficiency of a building and the investment development for a

rational energy use, we can reduce the energy consumptions.

Element	Transmittance U_i
Outsider wall	1.08 kWh/m^{2}a
Roof covering	1.57 kWh/m^{2}a
Basement floor	1.71 kWh/m^{2}a
Windows	1.98-2.44 kWh/m^2

Table 1. Elements transmittance.

Casa Clima, the spread sheet for the valuation is on line free and, like other European examples is simple to use, clear and easy to read certificates. It is a good mean to estimate the FEAP but in according to the 192/05 legislative decrees, the designer needs other instruments. In fact, there is no FEAP limit calculation value, calculation, a comparison between the transmittance limit and there aren't any thermo hygrometric test.

Cork 06	42%
Cork 09	67%
Polystyrene 06	13%
Polystyrene 09	27%

Table 2. Cost for different insulation.

For the property market the certification should produce a balance for the sustainability principles to be respected. The low costs for a certificate kindle the entrepreneur's and private person's interest in having a certificate for their properties or a guarantee quality to be showed. All that makes entrepreneurs produce patterns with the best energy classes and user, would choose the best product on the market, that's the one which has the best certificate.

It is clear that if we want to solve the energy problem and the non renewable resources impoverishment, the certification is a valid mean through which both demand and offer can be addressed towards sustainable solution on the property market, but the study reveals that both the energy needs and resources should be put in evidence.

Think about two properties units, one served by a photovoltaic sun system and the other one by traditional mains, according the Casa Clima project, they would have the same energy class, as Casa Clima defines the class through the FEAP and doesn't consider how it is satisfied.

This lacking doesn't help for the renewable resources use and in fact the spread sheet isn't able to value renewable solutions as it hasn't specified parameters, then a designer choose to use renewable resources according to his experience and knowledge, a user instead could lose relying on the certification, any possible alternatives for saving and the environment respect.

Fig.1. Casa Clima certificate.

Fig. 2. Hotel Tennis.

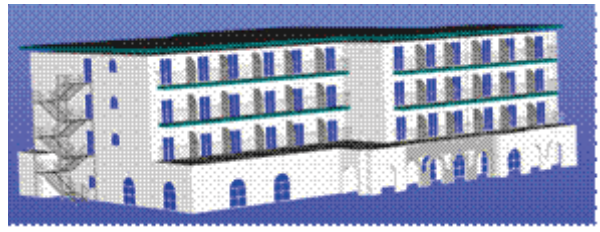

Fig.3. Hotel Tennis, different view perspective.

Besides, Casa Clima, according to 2002/91/CE instruction and 192/05 legislative decree, puts in evidence the heating problem in winter and doesn't consider the air-conditioning one in summer. So, the

energy needs are related mainly to heating in winter. In this case we have considered an accommodation situated in Agnano Pozzuoli (Italy) "Hotel Tennis" of 62000 m^2 area (15% roads, 10% tennis courts, 13% five-a-side football, 4% residence, 10% private residence, 8% car park, 5 % swimming pool, 5% dance and free time hall, 3% open spaces and garden).

Fig. 4. Insulating material.

The accommodation has 100 rooms for an amount of 200 beds, coffee bar, restaurant, garden, swimming pool, large car park and two lifts, it has a 1238 m2 area plus a 93 m2 balcony area, three floors and roof covering; storey height is 3,20 m and the total one is of 16 m; the inter floor volume is of 3700 m3 and the total one is of 14600 m3. The bearing walls are made of reinforced concrete and it is divided into three connected and T arranged buildings which the largest side to the South-North. The vertical walls are made of clay block finished with lime plaster and white painted. The footstep is made of concrete joist and clay laying on over site concrete, finished with tile floor, the roof ceiling is made of concrete joist and clay, finished on the outsider with waterproof layer with tile floor, finished on the inside with lime plaster. The windows are made of aluminum extrusion and sealed glazing unit.

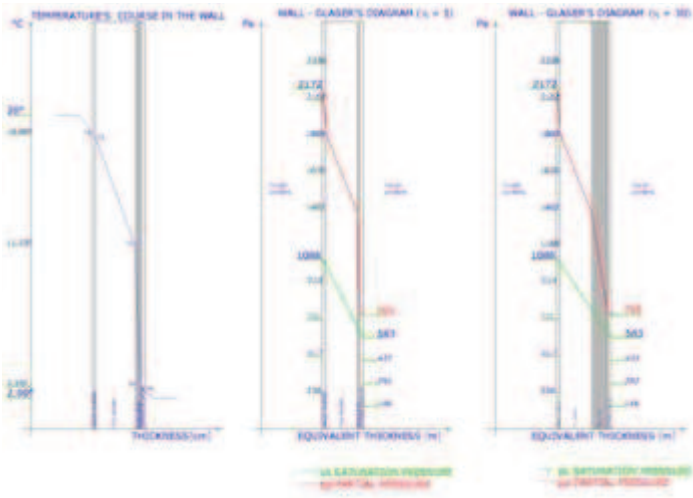

Fig.5. Glaser diagram.

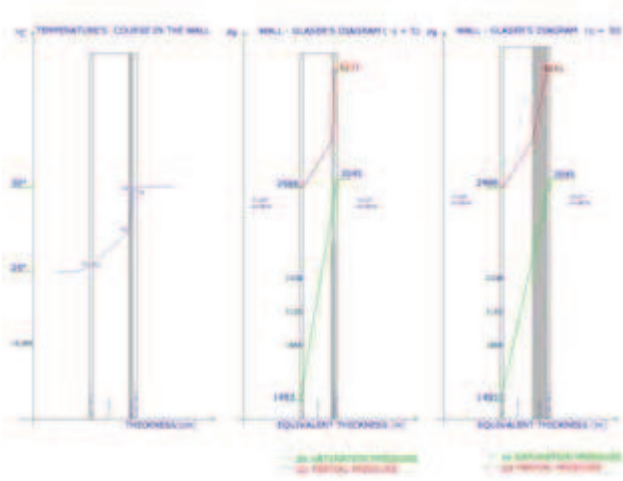

Fig. 6. Thermohygrometrics test of green wall.

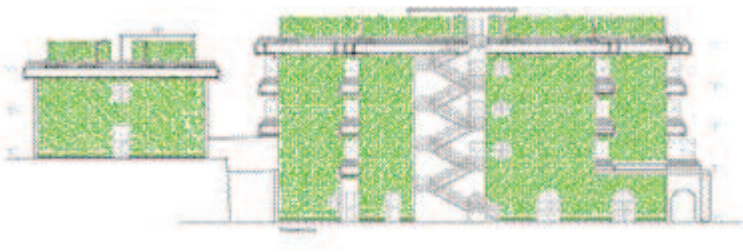

Fig. 7. South wall views with caduceus leave plant and new balcony.

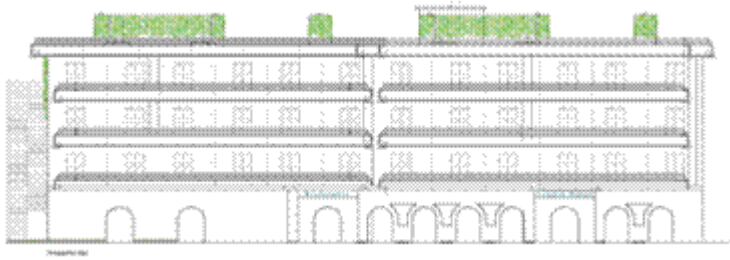

Fig. 8. Front west - balconies and gazeboes.

Thanks to Casa Clima the transmittance values of each component have been settled and then to the FEAP definition and the building's energy class; the classes have been calculated by considering the building setting in Pozzuoli - Naples and the hypothetical setting in Bolzano. From the Hotel Tennis study in Pozzuoli resulted an A class with FEAP=28 kWh/m^{2}a, whereas the same one settled in Bolzano would result E class 109 kWh/m^{2}a. In a renovating case, according to the legislative decrees that orders for buildings more than 1000 m^2 area to observe the FEAP limit parameters or the transmittance limit volumes of each component, we have calculated with a double linear interpolation the FEAP limit (=25 kWh/m^{2}a), comparing also the transmittance values of each component to the limit ones. We have realized the necessary to intervene but the windows, so as to observe the limit values. We intervene, by opposing insulating panels according to shell thermal insulation system. We have considered that the material chosen must assure well-begin to users, satisfy their cultural and perceptive needs, a building must be in accordance with the environment. One of the main objectives, when projecting a good building is the reduction of humidity through evaporation and preventing concentration of the harmful substances.

The building walls must act as preservation and filter so they must breathe naturally as the body skin, make humidity produced from inside activities perspire. Materials must optimize the change with outside through thermoregulatory properties that follow the seasonal and day rhythms when the inside-outside temperature ranges changes.

The attention paid on environmental has required the introduction of two parameters:

- environmental effects, waste production, recycling and recovery;
- energy consumption during life cycle.

MATERIAL AND METHODS

For this study the insulating material chosen is the cork, produced at low energy consumption with reduced release of pollution substances. Antistatic with reduced electric conductivity, permeable to microwaves to water vapor and air, there are no release of polluting substances, it is fireproof, strong mould and insect proof pleasant to touch, sight and smell. Besides, it is lacking in synthetic resin adhesives that cause release of polluting substances in buildings. To referring these characteristics we calculated the necessary thickness to reduce the transmittance; then, we obtained a heat loss reduction and so an improvement of the energy class. Respect to thermohygrometrics verifications we calculated the temperatures of each material layer starting from the project temperatures established by 412/93 Dpr (for Naples is 20°C on the inside and 2° on the outside).

With the same methodology, we calculated the polystyrene thickness sintered to make then an economic analysis. It reveals higher inertial costs and for lack of financial government support, the sustainable materials and system can't be considered

economically advantageous for private people and users. Through Casa Clima project it has been difficult value the advantages by opposing a green wall to an other wall: for this case, for the air conditioning problem, we have chosen such solution for the southern wall of 394 m^2 size and by subtracting 175 m^2 glass area and 75 m^2 fire escape area. The anchorage project to the building, and the steel cable frame on which a plant will grow, prevent the flora biological warfare to the wall. We have chosen a caduceus leave plant (Parthenocissus tricuspidata) in winter the wall is placed in the sun whereas, it isn't in summer.

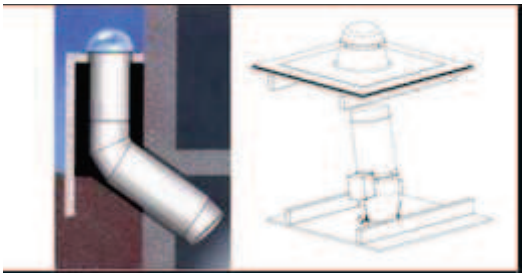

Fig. 9. Light conveyors.

Moreover, between the green wall and the outside wall a chimney effect is produced so as to have steady humidity values close to the optimal ones. Through the photosynthesis reaction plants remove warmth and change it into chemical energy, with a consequent reduction of the outer surface temperature and the thermal flux whose reducing coefficient is equal to 7.
Thought the same system we have projected the arrangement of gazeboes made of circular hallow section and steel cables where to put caduceus leaves, 2,5 m height, 7 m large, 7 m deep whose covering area is equal to 49 m. In accordance to this modification the thermal flux was reduced of 4 times. The building expands along north-south axis and by putting the green wall we can have a temperature gradient between the surface that are displayed in a different way bringing about a natural ventilation advantage that hasn't been considered in the above analysis. The replacement of the steel railing with balustrade has allowed to reduce the temperature excursions as the stone has a higher thermal inertia and then can accumulate more warmth. Another bioclimatic engineering solution, that hasn't been considered by Casa Clima, but considered in the study, is the employment of light conveyors. These are metal circular deadlights covered outside with anticorrosive material and inside with a high reflectivity material. The natural lighting not only reduces the electric energy but life is better.
Cost/Benefit of the main interventions: with the 192/05 legislation decrees in case of renovation or new building we must observed the limit parameters (FEAP and transmittance components) and then use more expensive construction techniques, for this study the increasing of insulation cost, according to the insulator material and limit parameter, is between 13% and 67% and thanks to the energy consumption reduction for heating, the amortization period of cost is between 3 and 15 years according to the insulator material and limit parameter. Light conveyors, with a cost of 300 euros for conveyor (and we know that it can replace 4 lamps of 18 W and it works about 8 hours a day from 8.00 at 18.00, the daily energy saving is 4x18x8 = 576 W with an economic saving of 15 € cent/day; the cost of each conveyor (300 €), amortized in 5 years. Green wall, we know that the air conditioners work 120 days in a year for 8 hours a day and, if we appose the green wall and gazeboes, we reduce the energy consumption of 3 euros a day, so their cost will be amortized in about 8 years.

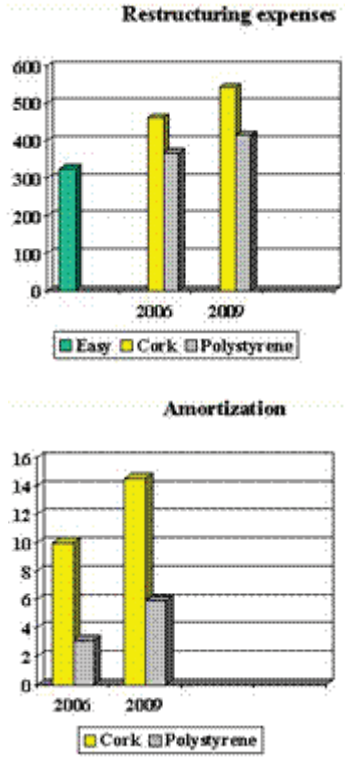

Fig. 10. Economical estimation diagram.

RESULT AND DISCUSSIONS

Hotel Tennis solutions can't be considered through Casa Clima certification even if it offers economic

advantages, energy saving comfort environmental respect. That is a limitation and if the certification hadn't rectified soon, it might have as a consequence a property demand that consider the need reduction only. A designer might project a building insulation so as to reduce the FEAP and increasing energy class as he can choose any insulating material. It should pay attention in particular to insulating materials so as to avoid an economic increase.

The certification doesn't consider the material features and the sustainable system, ones we risk to have buildings with a higher thermal insulating that may cause pollution and energy waste.

In conclusion we can say that a designer can use Casa Clima spread sheet to consider energy needs but for other verifications, such as thermo hygrometric verifications, according to the 192/05 legislative decrees, he must add more algorithms.

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