

Natural Heater Construction

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ABSTRACT: In the south states of Brazil the buildings of social interest do not have any kind of heating possibility. Although it is hot in the most part of the country, in the winter there are some regions in south with negative temperatures. The costs of the energy and technology for heating are expensive. This makes with those who doesn't have financial conditions do not have thermal quality in the winter, because in this cases there are not any kind of heating systems in the buildings. For this reason, it has been developed, in the Architecture Department of Passo Fundo University, Brazil, a new natural heater to be used in building with social interest. The objective of this work is to create equipments with low costs. The equipment uses solar radiation to heat internal spaces in the buildings, and uses solar energy to reduce the costs of the artificial acclimatization in the internal spaces. When the temperature is lower than 18 °C, the system will be used. The equipment is composed by a metal structure with 1.00×0, 60×0, 30 meters, with glasses and an external protection for the hot seasons of the year. Inside the prototype, there are black rocks which receive solar radiation and heat both air and the wall. There are windows in the wall that control the heated airflow entrance. The prototype has already been made. The tests will start next June. The paper presents the project of the natural heater and the first results of the verification in loco.

Keywords: natural heater, passive energy, passive solar heating;

1. INTRODUCTION: ENERGY IN THE CITY AND IN THE BUILDING AND THE ARCHITECTURAL CONCEPTION PROCESS

According to Cunha et al. (2005, p. 1) [1], the effect of the energy consumption in global heating is one of the most important reasons for adopting electrical energy waste reduction politics. In 1995, 62% of the world electrical energy was generated by the thermoelectrics, causing great ambiental

pollution. Therefore, nowadays, the generation of electrical energy in Brazil is concentrated in hydroelectrics plant, it has been already in course, plans to implantation of central gas thermoelectric plants, some of them are already working in Rio Grande do Sul. However, the condition to the sustainable development is the consumption reduction, more than the change of electrical energy production, especially by burning of unrenovable fuel and by the reduction of the

generated pollution, including the residues. The great disparity between the industrialized countries and those in development has taken to the increase of pressure in order to raise and improve energy services, providing them to those that do not have them. Those have decided interpreted this pressure as the indicative to the increase of operative energy. An implementation of these measurements, together with the population growing, to the uncontrolled urban densification and to the consumption of electro electronic products took to an almost linear growth in the energy consumption of the developed countries during the last three decades. These increase is unsustainable, in such a way that a new point of view of the energetic problem o is essential, because besides the economical implications, which the actual energy consumption tendency causes serious ambiental consequences. (CUNHA et. al., 2005, p.1) [1]

According to Reddy and Goldenberg (1998) [2], a new paradigm to the urban final of energy is essential. The energy does not have to be seen as an end in itself or as a service, but as a way to provide the services. It is not the energy but the services that directly satisfy the population necessities. The change, concerning to the use of renewable energies, passes, initially, by the review of an architectural project method. On a large scale of concepts presented in the conception process, the aspects linked to the environment and sustainability must be emphasized in a systematized way. The emphasis passes through different implementation spheres, once those aspects such as orientation in the architectural universities and specific bibliographies that treat the theme are fundamental to the consolidation exit of a more compromised repertory with the contemporary ambiental necessity. Nowadays, in the architectural production, the ambiental aspects have been highly valued through the emphasis in the development process of the architectural project. Cunha et al. (2005, p.22) [1],

characterizes in the building project method the relevance of sustainability and interaction consideration with the natural environment. In the scope of the relation between Architectural and Environment it is presented the use of renewable energies as project strategy. In consequence of aspects like costs, investment lack and public power support, deprivation in the technical architect's formation and local culture, many difficulties in implementation and development of air-conditioning passive systems and use of renewable sources like solar radiation, for instance, are found. In the case of Brazil, where rigorous winter is found, with negative temperatures in some moments, the quantity of energy spent with heating of spaces is considerable. As the cost spent by users of spaces as also the infra-structure necessary to generation of energy used to such task are high. The objective of this paper is the presentation of an architectural element proposal whose main function is the heating of interior spaces, through the use of energy originating from solar radiation.

1.1. The weather of Passo Fundo – RS

The city of Passo Fundo is located in the rio-grandense-south, at the average quota of 680m over sea level, whose attitude considered to simulations is of 687,00m, according to data collect station location, with urban centre at 709m altitude (maximum cote quota), situated in the 28°15'46" south and 52°24'39" west coordinates. By the geographic location, Passo Fundo presents, according to Köpen's climatic classification, modified by Trewartha (1954, p. 233-238; 302-312) [3], the temperate weather, kind of subtropical Cfa, characterized by average temperatures, in the coldest month, between 18°C and 0°C and in the hottest month over 22°C, or with hot summers and a rain pluviometric regime well distributed during the year (not one month with less than 60 mm). Being these aspects considered, it can be defined the local climate as being subtropical humid of

altitude. The air thermo metrical gradient is nearly 1°C to each 200m high (3,6°F to each 1000ft), with little variation in relation to latitude, or: to locals with the same altitude can exist differences of temperature (Trewartha, 1954, p. 28) [3]. To such classification, it has as comparison, at priority, Porto Alegre (latitude 30°02' S), situated to 4m over the sea level, relation that presents to Passo Fundo a difference of 3,5°C less. The climatic evaluation method of Givoni (1969, p. 317-355) [4] was the object of study of the applications in the case of Passo Fundo, thus, besides offering elements for association of projectual strategies and thermal comfort, also involves estimation of the building interior conditions. For this reason, it was used the Psychometric Analysis through application of the computer program Analysis 2.0 Bio – developed by the Energetic Efficiency Laboratory of Santa Catarina Federal University – Labeec-UFSC (UFSC,1999). This simulation already includes the adaptation suggested by Givoni (1992, p.15) [5], When understanding that the method elaborated in 1969 should suffer from Brazil, considering still, the differences of individual metabolism. In practical terms, the inferior limits are enlarged – for cold – and superiors – for hot – of the comfort zone, being suggested the intervals of 18 to 25°C for winter and 20 to 27°C for summer. In practice, Givoni suggests that these limits, in fact, should receive studies related to individual acclimation, according to their local/regional specifications, in this case, adapted to climatic classification of Passo Fundo, different from predominant conditions in Brazil. Such temperature limits, associated to air humidity, imply progressive reduction in comfort temperature limits. Givoni (1992, p.20-22) [5] considers, still, adaptations to comfort limits due to probable thermal gain intern to air velocity adapted to the developed activities in the ambient. Using the temperature and air relative humidity data of 2000, defined as Reference Climatic Year –

TRY, according to the data observed by Embrapa (2001), the 8.760 hours of the years observed, the local climatic analysis resulted in a letter. Regarding the minimum temperatures it observed that the strategies of continuum additional heating is necessary, because the limits are lower than those considered as minimum for comfort. Thus, the proportional results to the situations of comfort and discomfort to cold and hot are the following: Comfort situation in 29,1% of the year; situations of cold in 57,5% of the year; situations of hot in 13,4% of the year.

Complementing the subject, the characterization of the climate in Passo Fundo as composed results in difficulties on the solution of environmental comfort problems since that the fourth seasons being well defined, with hot and cold periods marked – for cooling with base on 23°C are 112 degrees-day, and for heating, with base in 18°C, are 857 degrees-day (Frاندолоso, 2001, p. 77) [6], having as consequence the adoption of, at least, two kinds of project strategies. The same way, differentiated situations are put in during short periods of time, due to climatic boarding, with the possibility of alteration occurrence in momentary time configurations: first cold masses move forward, then hot masses. In this climatic complexity, the determination of building drawing principles and the choice of material to be used it must be done in such way of associate the solutions to several weathers which must be used with caution with eventual adjustments, according to Frандолоso (2001, p.84) [6].

2. THERMO ACCUMULATOR PROJECT

2.1 Passive solar heating

The differentiation between the handling of the ambient and energetic aspects in the architecture project put in opposite position two forms of these aspects control. Banham (1975) [7] and Hawkes (1996) [8] say that

these forms are called inclusive and exclusive posture. In the inclusive posture the characteristics of the physic context are essential for the project development, and the control of the consumed energy in the edification. In the exclusive one the context has a secondary role, considering that the spaces are completely artificially controlled.

Banham (1975) [7] and Hawkes (1996) [8] also say that in the selective way, the use of the forms and the materials of the envelop works as a filter from de external mean. The results are scatterer forms, that reach the maximization of the external energy use, and try to stop the undesirable natural conditions and admit the convenient conditions. Then, the energy is a combination between the external factors and the own internal ambient, according to the cold or warm necessity.

Simplifying the used classifications by Bardou e Arzoumanian (1980, p. 54-59) [9], the internal space, considering the selective control, is divided in active and passive. It is active when the capitation, the storage and the energy distribution need, for its working, external energy, that comes into the house by automatic means. It is passive, when the energy process can work alone, without the need from the external energy.

As passive controls, the same authors (p.58) consider the use of simple equipments, such as ventilators, when they occasionally allow thermal changes, considering that they are not essential for the system.

Serra (1999, p.78) [10] assures that even nowadays [1999], the flexibility and the adaptation capacity of the passive systems are not overcome by the active systems, although, such argumentation the author presents the concepts of the smart buildings. In these buildings occurs a global and integral control of all edification systems with the utilization of the computerization in the ambient condition as well as in the decisions to define the procedures to get environmental comfort.

Considering the diagnostic of the bioclimatic chart, the strategies of passive heating correspond to 13,70% of the total of the year days. The solar heating system carries out three basic functions: it receives and converts the solar radiation in to warm, it stores and distributes to the internal spaces in necessary moments. The passive systems are defined as systems, in which the three activities occur with spontaneous form, without the utilization of external energy sources, only exploring the solar energy.

2.2 Passive solar heating systems

Szokolay (1983, p.23) [11] presents five basics techniques of passive solar heating: a) direct gain; b) collector or massive wall storage; c) collector or water storage wall; d) water roof and; e) thermo-syphon.

The characterization of a passive solar system is variable and it is related with the bibliography used, differing in the denominations and in some constructive aspects. Any bibliography, however, points out that a passive solar project can not be faced as only having one correct solution.

“The correct solution is variable, and depends on the designer’s imagination” (Habitat, 1990, p. 46).

Roaf (2006, p.173)[12] presents the direct and indirect thermal gain systems. He emphasizes the indirect gain systems, Trombe-Michel wall, water wall, Barra-Constantini wall, solar greenhouses or indirect, semi-direct or hybrid gain winter gardens. Considering the systems presented by Roaf (2006, p. 175) [12] the solar greenhouse with thermo-syphon is outstanding. The solar radiation that gets into the greenhouse heats the air and rise the internal temperature of the space that is served. The greenhouse air is transferred to the interior of the building through the small windows in the walls. A convective effect is produced, exploring the thermal stratification in the greenhouse, and optimizing the thermal gain in the edification. Brown (2004, p.304) [13] emphasizes, among the indirect gain

systems, the stone tanks, which is a increasing way the edification thermal mass. The author also says that in heating passive systems it is positive to rise the thermal storage besides the available one in the edification structure.

The thermo-accumulator working principle is similar to the solar greenhouse with thermo-syphon, with a differentiation regarding the air retro-feeding. The heated air, in the thermo-accumulator, has as origin, the external ambient, but in the greenhouse with thermo-syphon, the air comes from the internal space. In other words, from the heated space.

2.3 Thermo accumulator

The objective of the system is the heating of internal spaces through the use of direct solar radiation in winter periods. The device is composed by a metallic structure, prismatic, with dimensions of 0,80 x 0,50 x 0,20 m, with horizontal and vertical closure in transparent normal glass. In the superior face of the device was implemented a plastic blind in order to protect from direct solar radiation in hot periods. It must be implemented in the north façade, considering the solar radiation in every hour of the day in the winter. In the interior of the device were projected granite rocks in order to accumulate the hot created by direct solar radiation. The figures 01 and 02 illustrate the prototype already built. In hot situation the solar radiation control system impedes the entry of direct rays in the period between September and March, minimizing the thermal unpleasant gains. In this period, it must be opened the horizontal window contained in the superior part of the device, making the heat air leave possible by diffuse solar radiation. The opening in the wall must be closed impeding the entry of heat air in the thermo-accumulator to the interior ambient. In the winter situation the direct solar radiation passes through the transparent closure heating the granite rocks in the interior space of the device. The energy radiated by the opaque closure is

accumulated in the interior of the device, causing a temperature increase of the interior air. The most light air enters the ambient through small windows in the wall.

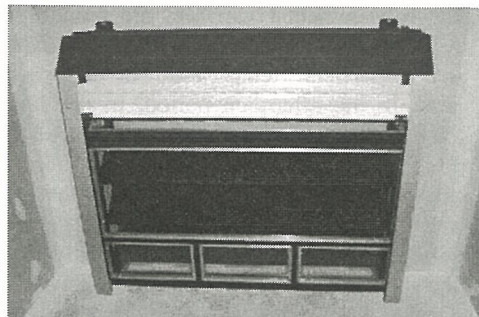


Figure 1 – Front view of the thermo-accumulator
Source: Own collection

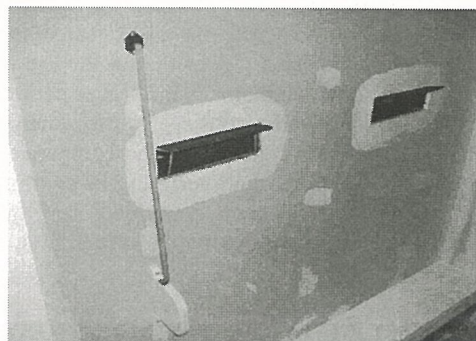


Figure 2 – Intern wall view with thermo-accumulator installed. Source: Own collection



Figure 3 – External view of the thermo-accumulator installed. Source: Own collection

3. RESULTS ANALYSIS METHODOLOGY

From the installation of the prototype in the Architecture and Urbanism general office, the environmental variables are monitored, dry bulb temperature, air relative humidity and superficial temperature of the room wall, in the afternoon period, in the June, July and August, to the achievement of the first winter analysis. The direction room is also monitored, which has physical features and of similar use to those of the general office. Two studies based on the analysis of the surveyed data, in the controlling, will be carried out. The first one will be the verification of the Fanger Estimate Medium Voter (1970), in which with based on the reading of the environmental variables it will possible to verify the users' satisfying degree of the spaces, considering the use of the thermo-accumulator in the winter period. The second study consists of the energy saving analysis considering the comparison of both rooms through verifying of comfort and discomfort hours provided by low temperature and necessity of artificial heat.

4. PRELIMINARY CONSIDERATIONS

The prototype was already built and installed in the Anemometric laboratory of the Architecture and Engineering College of the Passo Fundo University. The chosen model for the prototype conception was based on the Roaf (2006) [12] work. The model used was the solar greenhouse with thermo-syphon with some adaptations of scale and of the air retro-alimentation to be heated. The preliminary verifications during the physical analysis, point to the equipment efficiency, regarding to the heat production (500 to 1000 Watts/hour). It is important to emphasize that the success of the projected and built equipment depends on the field work, in other words, on the analysis of the date collection that will start next May and will finish in September.

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