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DEMONSTRATIVE THERMAL REHABILITATION OF A STUDENT'S HOSTEL BUILDING

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ABSTRACT

Nowadays the energy conservation and environment protection measures have become very important in Romania. In order to stimulate the thermal rehabilitation of the existing civil buildings and select suitable technical systems, a demonstrative action was organised with the support of the international PHARE-ENERGIE Programme. An old five-floor students' hostel of the T.U.Iaşi was recommended. The structural system (large reinforced concrete prefab panels with important thermal bridges) is representative for the industrialized civil buildings erected in the country between 1955-1985. At the beginning, important strengthening works were realized to eliminate the damage caused by successive earthquakes and climatic variations and reduce the corrosion effects. To ensure the energy conservation, an additional external thermal insulation, a double-peau wall system (expanded polystyrene, ventilated air layer and POLYALPAN covering bands), vertical passive solar collectors and triple glazed windows were employed. The thermal insulation of the flat roof was supplemented. Now the students' hostel is very attractive and persuasive example for this kind of actiones. Important reductions of heat losses and CO_2 emissions will be ensured on the condition to adapt the energy input and the students' behaviour. A "keep watch over" programme must be organized.

1. INTRODUCTION

After a very long period of artificially low price energy use and considering today's rapid diminution of the internal resources of oil gas (Figure 1) concomitantly with other imperative requirements (reduction of currency efforts, protection of environment [1], healthy indoor conditions in buildings, limitation of growing expenses for heating, etc.) it is necessary to establish and to adopt efficient measures for energy conservation. Actually, fore the building sector it is necessary :

- to select suitable technical solutions for thermal rehabilitation of the existing buildings considering general and specific requirements in Romania ;

- to work out a longterm strategy for energy conservation measures in the building sector;

- to obtain a large support to the people and of the local authorities.

With this aim, a demonstrative thermal rehabilitation of a students' hostel building was organized with the support of the TU-RO PHARE-ENERGY Programme and the Romanian authorities. The design was realised at the Faculty of Constructions and Architecture and the site work by the Romanian Company CONEST Iaşi.

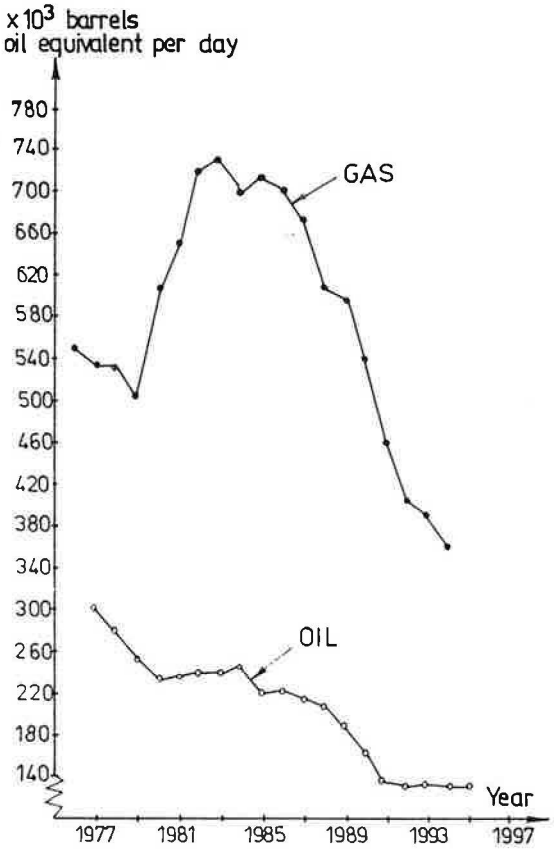

Figure 1 - The impressive Romanian [2] production of oil and natural gas (9000 barrels of oil equivalent per day)

2. THE BUILDING CHARACTERISTICS

The building specific features are presented in Figure 2 : floor area 3300 m²; flat roof; technical basement; longitudinal and transversal diaphragms (walls and floors) of large reinforced concrete prefab panels. The external prefab sandwich panels have a poor thermal insulation of light cellular concrete with important thermal bridges. The same weakness is present at the flat roof covering.

Due to the periodic thermai earthquake, the entire reinforced concrete structure was affected by a lot of fissures, cracks and corrosion effects. The necessity of a structural consolidation was evident. It was realised using injections with epoxy resin and reconstitution of the concrete reinforcement bars at the joints between the panels.

The most important hygrothermic characteristics of the building elements before the rehabilitation are presented in table 1.

Hygrothermal characteristics and structure of thermal energy consumption (calculated) before and after the thermal rehabilitation

Building elements	Before thermal rehabilitation			After thermal rehabilitation		
	K(W/m²·K)	Q(kwh/an)	%	K(W/m²·K)	Q*(kwh/an)	% of Q
1. Flat roof	0.860	88400	6.9	0.516	53040	4.17
2. External walls blind	0.650	312330	24.5	0.071	34404	2.7
3. Internal walls	2.898	125708	9.8	1.73	75425	5.93
4. Windows	1.90	115454	9.09	1.50	69273	5.4
5. Basement floor	0.310	264605	20.8	0.10	84928	6.6
Total heat transmission		906497	71.3	-	317070	24.9
- Ventilation	-	204630	16.1	-	88607	6.9
- Heat water	-	158749	12.5	-	158749	12.5
6. Solar gains	-	-		-	97667	7.69
7. Internal gains	-	46800	3.6	-	46800	3.68
TOTAL	-	1269829	-	-	389959	30.7
Specific energy consumption	-	385.73	-	-	118.456	30.7

Table 1

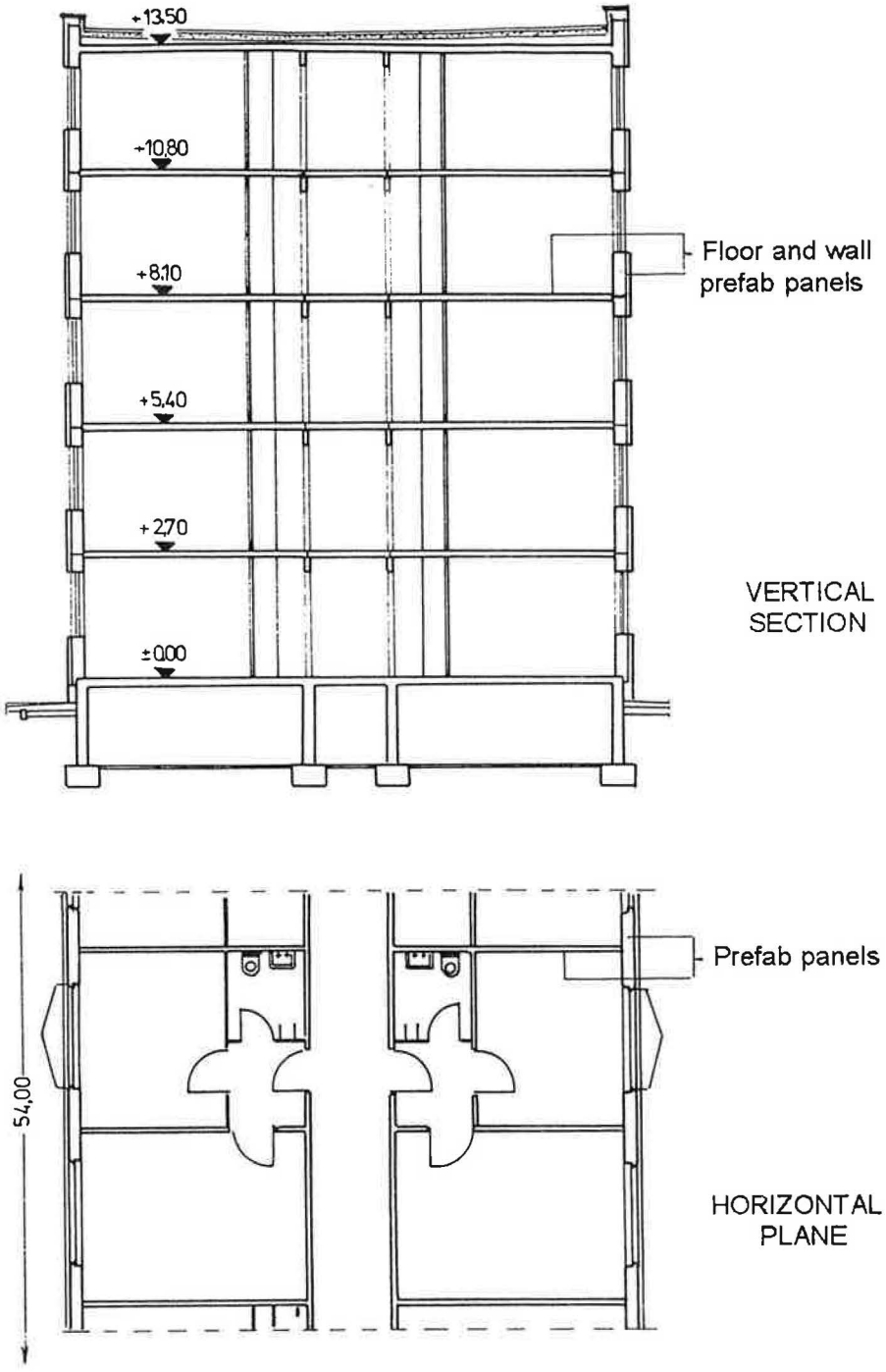

Figure 2 - Principal building characteristics

3. THE THERMAL REHABILITATION MEASURES

In order to improve the energy conservation conditions by means of constructive systems, the following systems were adopted :

i - additional external thermoinsulation on the flat roof and on the external walls ;

ii - reduction of the conductive heat losses through the windows ;

iii - increased capacity of solar gains

Some special requirements have been considered as essential :

- lighting systems ;
- compatibility with the important deformations of the reinforced concrete structure due to the seismic actions and variations of temperature and humidity [3] ;
- adjustment to the initial important deviations (10...15 cm) of the existing external walls, because of the poor accuracy in the prefab panels assembly ;
- dry technology an short duration of the site works ;
- poorly qualified workers.

The adopted constructive systems are presented inf fig.3.

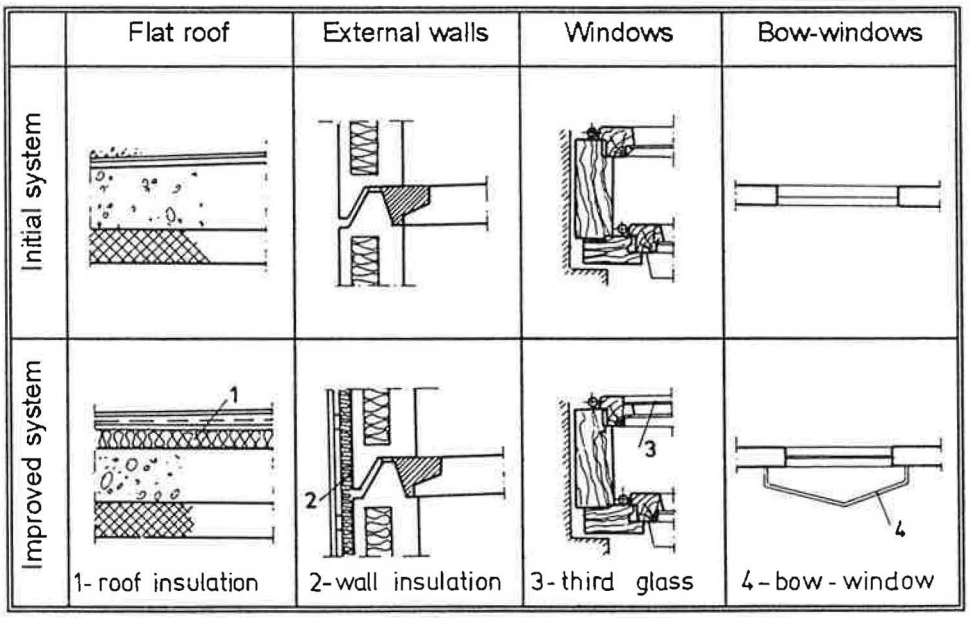

Figure 3

It is important to underline some aspects concerning the employed systems.

i- The POLYALPAN prefab plates

The increased thermal insulation of the external walls, the protection against driving rain infiltrations and the aesthetic blind surfaces were realised using :

- a 5 cm thick layer of expanded fireproof polystyrene lying between vertical wooden laths ;

- a ventilated air layer of variable thickness ;

- POLYALPAN prefab vertical bands of polyurethane foam covered by a thin aluminium sheet. These bands are 12...15 m long, 0.60 m large and 0.024 m thick, in various colours.

In order to correct the important deviations of the initial external walls from the vertical plane, special distance-pieces of wood between the vertical and horizontal laths were used (fig.4). In this manner all the thermal bridges were practically cancelled.

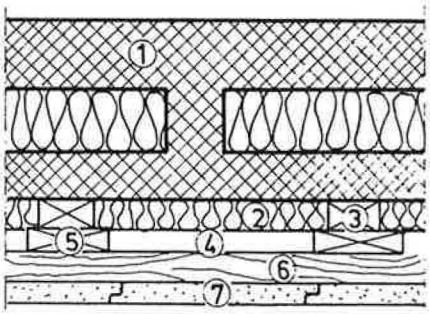

Figure 4 - Horizontal section through the external wall : 1- initial wall with thermal bridges; 2- expanded polystyrene; 3- vertical laths; 4- air layers; 5- distance-pieces; 6- horizontal laths; 7- POLYALPAN band

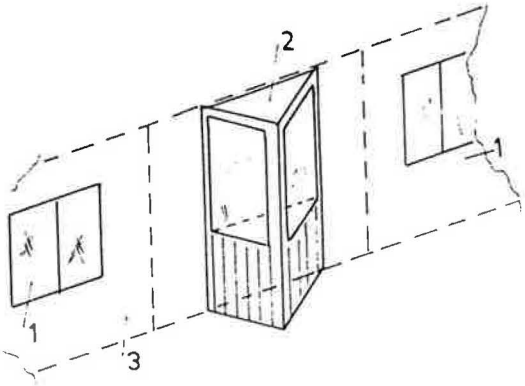

Figure 5 - The bow-windows acting as buffer zone and vertical passive solar collectors : 1- triple glazed windows; 2- usual double glazed window and exterior bow-window; 3- blind surface (see figure 4)

ii- The bow-windows

Verandas are traditional in the Romanian architecture [4] and most of the apartment-houses have glazed loggias. They are very popular as one of the cheapest and efficient systems to improve the heat balance during the cold season. Half of the window have been provided with triangular section bow-windows (fig.5). They work as a buffer space and vertical solar collectors.

4. ECOLOGICAL FAVOURABLE EFFECTS

The adopted solutions allowed some favourable ecological effects.

i. Improvement of the hygrothermic comfort conditions. The better, healthier microclimate, is contributing to the student's working capacity and to their attitude concerning a better built environment.

ii. Diminution of the pollutant emissions. Considering the saved heat energy of Q = 879870 KWh/year the reduction of the carbon dioxide emission can be evaluated

175861 Kg CO_2 for gas fired heating system

or

251230 Kg CO_2 for oil fired heating system .

iii. The vertical solar-collectors give relief to the longitudinal façades. So the initial flat, monotonous and mournful appearance of the students' hostel and even the local environment are now entirely changed and truly delightful, Photo 1.

Photo 1

5. FINAL REMARKS

In order to obtain efficient results it is necessary to correlate the improvement of the thermal protection and solar gains with the heat supply. If not, the indoor temperature will be too high than necessary for comfort. Such a situation arrived at the beginning of January, when in the rooms it was 28°C (the outside temperature was -5...-10°C). The inhabitants must be informed about a judicious natural ventilation.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

[1] Karl Gertis - Verstärkter baulicher Wärmeschutz - ein Weg zur Vermeidung der bevorstehenden Klimaveränderung ? Bauphysik 13 (1991), Heft 5

[2] Nigel Bance, Neil Campbell - World Energy Yearbook 1996, Petroleum Economist and Ernest & Young, London

[3] Adrian Radu, Maricica Vasilache - Réhabilitation thermique des logements exposés a la corrosion et aux séismes. Proceedings of the CIB-67 International Symposium "Energy efficient buildings", Leinfelden-Echterdingem, 1993, Germany

[4] Adrian Radu, Maricica Vasilache - Glazed loggias - A popular solution to improve thermal protection in multilevel buildings. CIB W 67, Energy conservation in the built environment, Publication 140, SINTEF, Trondheim