Improvement of the energy performance of a housing Mono-Oriented Case of Ain Malha in Algiers.

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Summary_ The single-oriented prototype of collective housing was designed to meet the needs of the acute crisis in housing, a study was made which aims to study the thermal behavior of single-oriented housing and contribute to the improvement of its energy efficiency, which includes a thermal modeling using a dynamic thermal simulation software Pleiades + comfie 2.3, and a static study which made it possible to verify its conformity with the DTR (C3-2) for heating. According to the results obtained the South orientation is the most favorable but it remains energy-intensive; after the integration of passive solutions: Thermal insulation and choice of efficient openings and the addition of vegetation we were able to reduce up to 33% of energy consumption.

Key words_collective housing, mono-orientation, energy efficiency, thermal insulation, green wall.

I. Introduction

The desire to build quickly and in large quantities to mitigate the effects of the acute housing crisis, results in a significant gap between quality and achievement including finishes and sustainability; Which thermal comfort often neglected by designers.

Given the lack of thermal comfort in Algerian buildings, the State is developing regulations to encourage the reduction of energy consumption. And to reach this one, it is necessary to conceive with the concepts of the bioclimatic one.

Amongst the major stakes of the State are the satisfaction of housing needs, the improvement of thermal comfort and at the same time the reduction of energy consumption in the building sector being the energy-consuming sector, the final consumption of energy in the sector was estimated at 41% of the country's total consumption [1].

According to our observation in Algeria, most dwellings have a unique orientation that influences thermal comfort as well as energy consumption in the context of this problem; A thermal study was carried out in order to evaluate the thermal behavior of mono-oriented collective dwellings and to improve their energy efficiency.

II. Methodology of work

Our methodology is to do:

-A comparative study between different mono-orientations of a collective housing through a dynamic thermal simulation.

-Identification of the most favorable cell.

- A static study to verify its compliance with the DTR (C3-2) for heating.

-Integration of passive bioclimatic solutions (insulation, choice of efficient openings and integration of vegetation).

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A. Case study presentation

The project is located in Algeria in the wilayaAinMalha of Algiers, (Latitude: 47 ° Longitude: 7.4 ° Altitude: 560m) [2].

Fig. 1. Mass Plan.

Fig.2. Plan level +24, 48m.

The studied prototype is a mono-oriented F4 type of housing with a living area of 104.15 m², this type was built without taking into account thermal comfort and energy consumption.

B. Dynamic thermal modeling

The numerical simulation was done using the software PLEIADES + COMFIE (version 2.3), the software is based on its calculation engine Comfie developed by the laboratory of the Mines of Paris, It calculates in a precise and fast way the flows of the thermal zones to from the description of the building, its environment and the occupants [3].

Table I.

Thermo physical characteristics of the constructive elements

REPRESENTATION	EXTERIOR BRICK WALL
COMPOSITION OF THE WALL, TH.[CM]	Cement mortar1 Hollow brick 15 Blade of air 5 Hollow brick 10 Plaster mortar 1
R=e/λ [m2.c°/w]	0.57
K=1 /R [w/m2℃]	1.75

III. RESULTS AND DISCUSSIONS

A. Comparison of different mono-orientations

1) Winter period

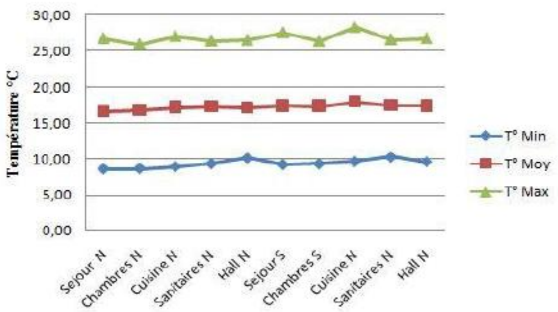

Fig.3. Graphical visualization of temperatures

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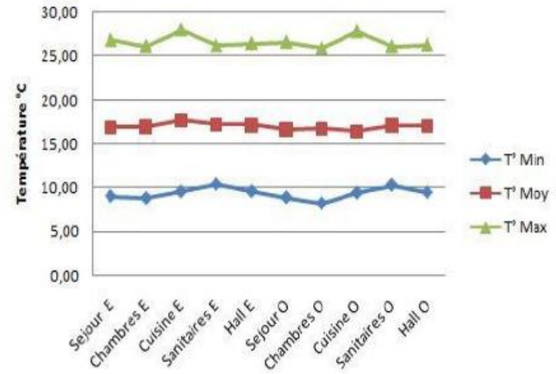

Fig.4. Graphical visualization of temperatures

1) Summer period

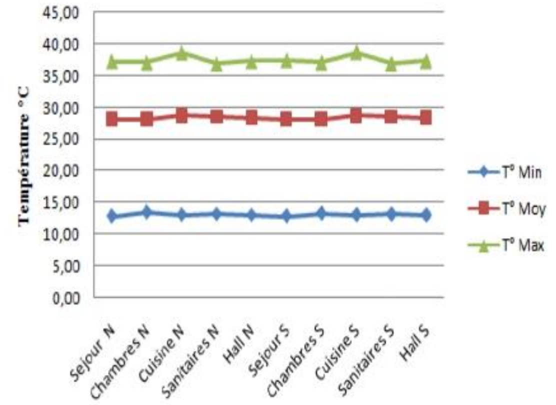

Fig.5. Graphical visualization of temperatures

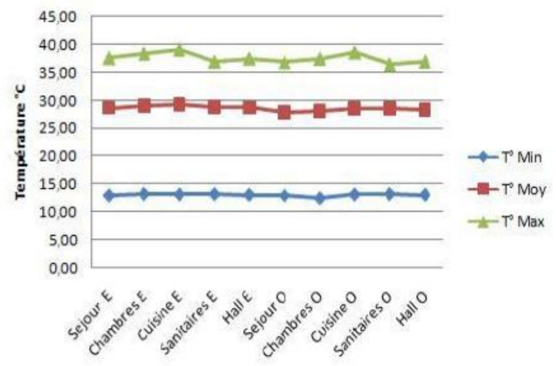

Fig.6. Graphical visualization of temperatures

According to the results obtained, on the temperature inside the comfort zones for the four mono-orientations: north, south, east and west does not comply with the standards of the temperature of comfort (20 ° - 24 °) which imposes the discomfort.

B. Integration of the thermostat setpoint

1) Housing simulation result

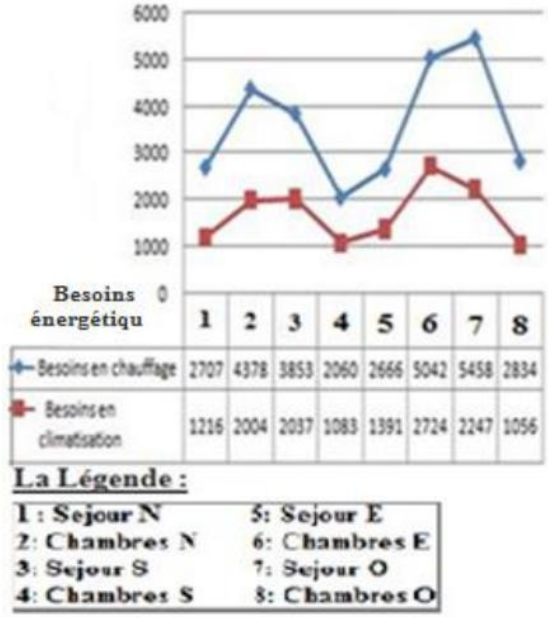

Fig.7. Graphic visualization of energy needs

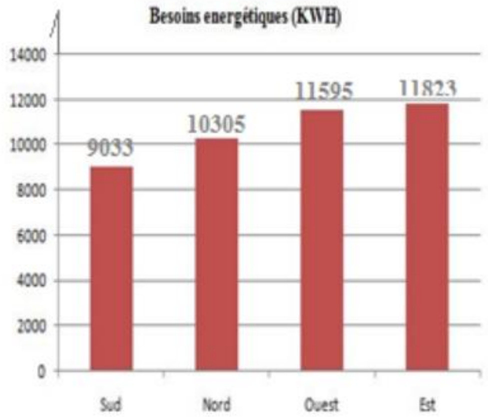

Fig.8. Comparison of Energy Requirements / Yr.

According to the results obtained; we find that the energy needs of single-oriented housing South are estimated at 9033 KWH / year and are less important than those of other single-oriented housing (see fig.8); but it appears that energy consumption to reach comfort is very important.

We have deduced that the South mono-orientation remains the most comfortable compared to the others however; it remains insufficient from the point of view of energy consumption, whose purpose of improving the efficiency of housing we have introduced an operational hypothesis

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Thermal insulation plus favorable mono-orientation reduces energy consumption.

Static study

This step includes a comparative study between the housing before and after the reinforcement of the outer casing, the verification of conformity was made using the (DTR C 3 2) for heating.

Table II.

Comparison of the results obtained

HOUSING	NON INSULATED HOUSING
Losses(w/°c)	258.06 (DT≤ 210.98)
ComplianceVerification	Unauditedresult

According to the results obtained, the housing does not comply with DTR C 3.2 for heating.

C. Integration of thermal insulation with choice of efficient openings

Our choice fell on the use of the Rockwoolwhich is an ecological insulation which has advantages by its characteristics: Airtight, its thermal resistance equal to R: 0.04 m2.c ° / w. for the implementation we opted for a choice of intermediate insulation that preserves the living space [4].

Table III.

Thermo physical characteristics of constructive elements after reinforcement of the insulation

REPRESENTATION	EXTERIOR WALL WITH INSULATION
COMPOSITION OF THE WALL, TH.[CM]	Cement mortar 1 Hollow brick 15 Rockwool 7 Hollow brick 10 Plastermortar 1
R=e/ʎ [m2.c°/w	2.31
K=1 /[R [w/m2°C]	0.43

The use of walls with high thermal resistance as well as the choice of efficient openings can limit heat loss and consequently reduce energy consumption.

Table IV.

Comparison of the results obtained

HOUSING	HOUSING NOT INSULATED	INSULATED HOUSING
Déperditions (w/°c)	258.06 (DT≤ 210.98)	108.86 (DT≤ 210.98)
Verification of compliance with the DTR	Unauditedresult	Verified result

After checking the heat losses of the housing against the reference losses according to DTR C3-2, we found that the housing became compliant following the integration of insulation and efficient openings.

In order to study the thermal behavior of our case study after reinforcement of the insulation, we opted for dynamic thermal modeling.

Results obtained

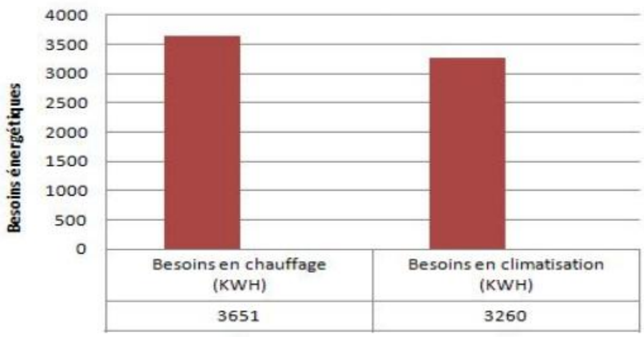

Fig.9. Comparison of Energy Requirements.

According to the results obtained we have found that through the integration of thermal insulation and choice of efficient openings, we have been able to guarantee comfort, and reduce the energy consumption in heating and cooling of our case study up to 23.5%. But the energy consumption in air conditioning remains a problem in summer; to this end we proposed the integration of vegetation.

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D. Integration of vegetation

We opted for the integration of vegetation in the south wall, whose goal is to minimize solar gain during the summer period.

1) Results obtained

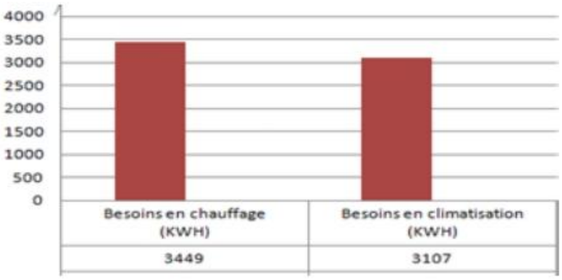

Fig.10. Comparison of Energy Requirements.

According to the results obtained, we note that the energy consumption has decreased compared to the previous simulation.

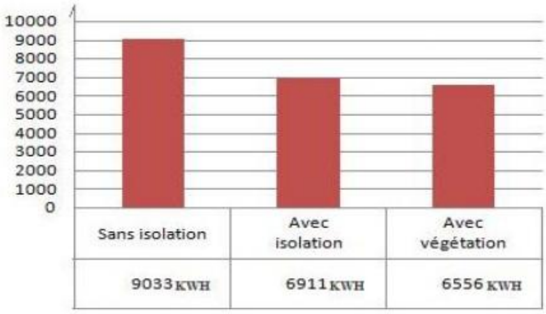

Fig. 11.Comparison of Energy Requirements / Yr.

Thanks to the integration of vegetation in the wall of the house, we were able to improve comfort during the summer period and reduce energy consumption by up to 33%.

IV. CONCLUSION

Through this study to have the same favorable food as the favorable, but the sustaining of the thermal insulation and performance of the opening envelope, we have been able to reduce consumption by up to 33%. Compared to poorly isolate mono-oriented housing. The treatment of the envelope is an adequate solution to improve its energy efficiency which can be optimized by the addition of vegetation.

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LIST OF ACRONYMS

DTR: Regulatory Technical Document.

Ep .: Thickness in centimeters.

R: Thermal resistance [m2.c ° / w].

K: Coefficient of the wall [w / m2 °C].

ʎ: Thermal conductivity [J / Kg ° C].

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