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Bilateral central core and an external envelope and its impact on the thermal behaviour of individual self-construction housing in the city of Biskra

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Abstract

The essence of architectural design rests upon in kind of manipulation between dualism central core and external envelope of any architectural composition; there are some compositions that are concerned with the external envelope ,while other compositions the outer shell is result of the interned division. Besides there are other compositions that blend the central core and the external envelope in a harmonious dialogue . This combination between central core and the external envelope touch this diversity in houses of Biskra city through different periods of time to create a comfortable thermal environment .
The dry areas, which are distributed on a large scale over the space of Algeria, characterized by climate is hot and dry. We found Morphological diversity in houses of this region that reflects primarily adaptation to climatic conditions, social and economic through different periods.
In our research, we depend on the experimental method through digital simulation technology program ECOTECT to calculate data, for various thermal models. in addition in the selection of network studied models we adopted to the variables morphology of both core and the external envelope of the dwelling which are: 1) the oceanic layer, 2) type of the core 3) type of the external envelope. Then we calculated the temperature of various houses layers to make comparisons between various layers and various models.
The results of this study came to show the laws that control heat in the atmosphere and that is affected by alphabet elements of local architecture of Biskra region. These laws allow the architect to manipulate to these elements to search for improved thermal yield of the building and control of energy consumption in the range of what is available to him.

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Keywords: external envelope, architectural composition , central core, comfortable thermal environment ,energy consumption.

1. INTRODUCTION

The essence of architectural design rests upon in kind of manipulation between dualism central core and external envelope of any architectural composition; there are some compositions that are concerned with the external envelope ,while other compositions the outer shell is result of the interned division. Besides there are other compositions that blend the central core and the external envelope in a harmonious dialogue.

In the same context, we mention : the exploitation of a central core in traditional architecture through the fireplace placed in the center of housing in order to maintain comfortable temperature [1], The exploitation of the center of the traditional Arab house , opened to a central courtyard with plants or water that refresh the air and modify the temperature of the various rooms of this house [2], exploring the buffer areas to reinforce the role of external envelope and keep the stability of temperature inside [3].

2. PROBLEMATIC OF THE STUDY :

in the study , we touch the diversity in the exploitation of the central core and the external envelope in the city of Biskra housing through different time periods. This is actually the essence of this study: our research is about the binary relationship between central core and external envelope and its impact on the thermal behavior of the individual dwelling self-construction in the city of Biskra.

Biskra is located in the south-east of Algeria in dry areas. which are distributed on a large scale from the space of Algeria, and characterized by a dry hot climate with a large annual thermal amplitude. We find that the diversity of morphology in housing in this region reflects primarily the adaptation with these extreme climatic conditions as well as social and economic conditions through different periods: the pre-colonial, colonial and post-colonial.

3. METHODOLOGY

3.1. The studied models

Our study has included initially morphological analysis for: 73 dwelling to determine the changes on both the core and the external envelope and the layers that link them in the individual housing in Biskra through different periods. The result of this study are summarized in the table below as that follows Table 1:

Table 1. Changes in both core and the outer envelope and the surrounding layer across different time periods in the individual housing self-construction in the city of Biskra .

	The pre-colonial period	The colonial period	Post-colonial period
external envelope	Thick envelope	Thick envelope	Light envelope
	small opening	large opening	large opening
The core	Patio	hall closed	hall closed/ Rozna[1]
	Wast addar[2] with Rozna	Patio	corridor closed/ Rozna
Peripheral layer	Sgiffa[3]	Sas	Front courtyard
(space of transition)			Backyard

1 Rozna:is a small opening at the ceiling level.
2 Wast addar : The center of house.
3 Sgiffa :is a Closed space with small dimensions of the transition from outside to inside the dwelling.

On this basis, we have depended in the selection of the studied models on morphologic variables for each of the internal core and the external envelope of the house. this are:

1) the peripheral layer (courtyards position that surround houses), 2) the type of cores (shape and openness). The figure 1 below is an example of the models studied , to get finally the following alternatives Table 2:

Table 2. codes of study models

	Hall	Corridor	Hall with Rozna	Patio
models with two courtyard	IA	IIA	IIIA	IVA
models with backyard	IB	IIB	IIIB	IVB
models with front courtyard	IC	IIC	IIIC	IVC

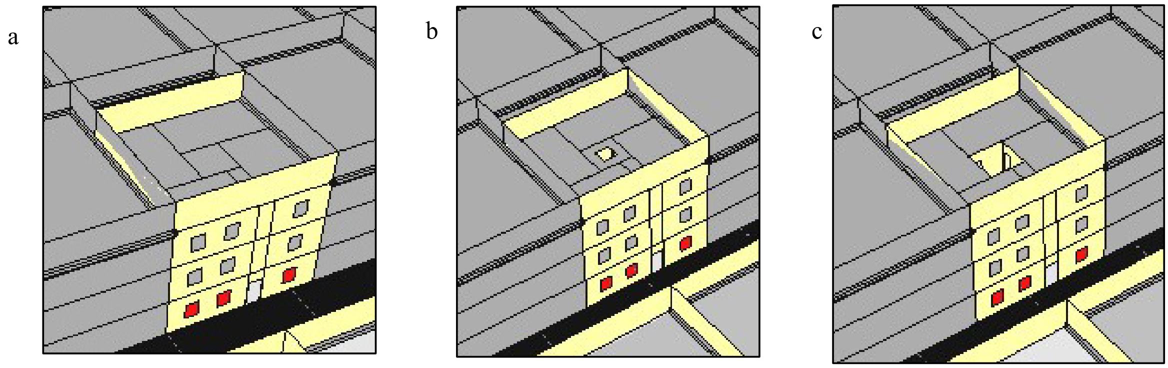

Figure 1. (a)The model IB; (b)The model IIIB; (c)The model IVB

3.2. Elements of study

In this search we have adapted (i.e., the binary relationship between the central core and the external envelope and thermal behavior of the house) ; we chose the experimental method particularly the numerical simulation with Ecotect program to calculate the thermal data for various models.

We have also calculated the temperature of various layers from the core to the external envelope of all alternatives during the hottest day in year(i.e.,13th July) , for the purpose of comparing between the temperature of various layers from the core to the periphery (Figure2).

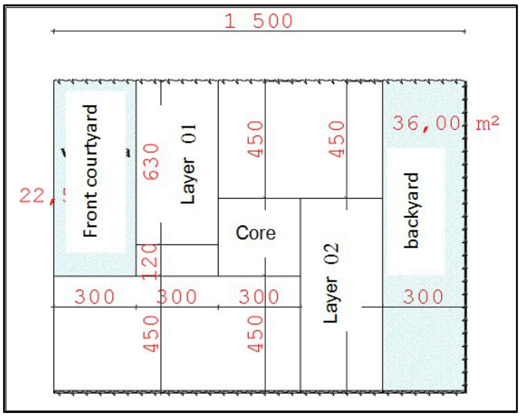

Figure 2. Dimensions of the Model With two Courtyard (Front Courtyard / Backyard) and Central Core

In order to study the effect of the type of the external envelope, we shall be compare differentiation between thick envelope and insulation envelope on the most common alternative (IA) (a closed hall with front courtyard and backyard), by calculating the temperature of each alternative of thick envelope and insulation envelope during the hottest day.

Building materials selected for each alternative as it is shown in the Table 3 and Table 4:

Table 3. Characteristics of Building Materials of Insulating Envelope

Envelope Type	envelope elements	Construction Materials	material characteristics			
			Layer width in ms	Density in Kg /m3	specific heat in J/Kg.K	Thermal conductivity /ance in W/m.K
insulating envelope	exterior Wall	Wood Pine (With Grain)	25	550	2301	3.4309
		Insulation	50	1.3	1004	0.251
		Brick Normal Fireclay	110	1980	732.2	12.97
	the roof	Wood Pine (With Grain)	25	550	2301	0.34309
		Polystyrene General Purpose	50	1050	1423	0.12552
		Plaster Building (Molded Dry)	10	1250	1088	0.43095

Table 4.Characteristics of Building Materials of Thick Envelope

Envelope Type	envelope elements	Construction Materials	material characteristics			
			Layer width in ms	Density in Kg /m3	specific heat in J/Kg.K	Thermal conductivity /ance in W/m.K
Thick Envelope	exterior Wall	Sandstone (High Density)	500	2600	962.3	41.84
	the roof	Clay Tiles	50	2760	836.8	18.828
		Air Gap	75	1.3	1004	5.56
		Plaster	10	1250	1088	4.3095

3.3. The results of the study :

We offer some of the results just as an example :

The unrest in the outside temperature as much as 12 degrees difference (highest 42 ° at 14:00 and a low of 30 ° at the 04:00) while the internal temperature areas are more stable ; The difference between the higher and lower temperature not more than 2.50 degree .

3.3.1. Model: (IA)

In all areas the temperature is located between 35 ° and 40 ° ,and the backyard temperature is the lowers and the most fixed all the day , followed by the core where the temperature reaches its highest levels in the period Between 14:00 and 18:00 and it's lowest levels are marked between 02:00 and 06:00 in the morning. at follows this temperature of layers 01 and 02. with a daily disorders not considerable.

It is notes that the temperature of the front courtyard is the most perturbed and most elevate. whereas the heights temperature (40 °) is marked between the period 15:00 to 17:00 and the lowest temperature (37 °) is noted between the period 06:00 to 07:00 in the morning (Figure 3).

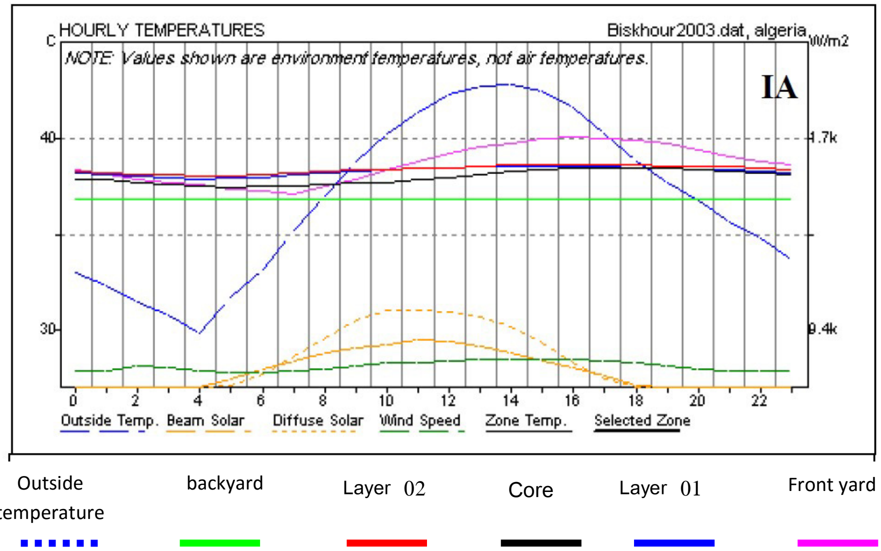

Figure 3.Temperature Exchanges of Layers Model (IA)

3.3.2. Model (IVC):

The core temperature is the lowest since the temperature does not exceed 37 ° as it is the most stable, followed by the temperature of the layer 01 and finally layer 02 where the temperature increases up to 40 ° C. The temperature of the front courtyard remain the most perturbed and elevate (Figure 4).

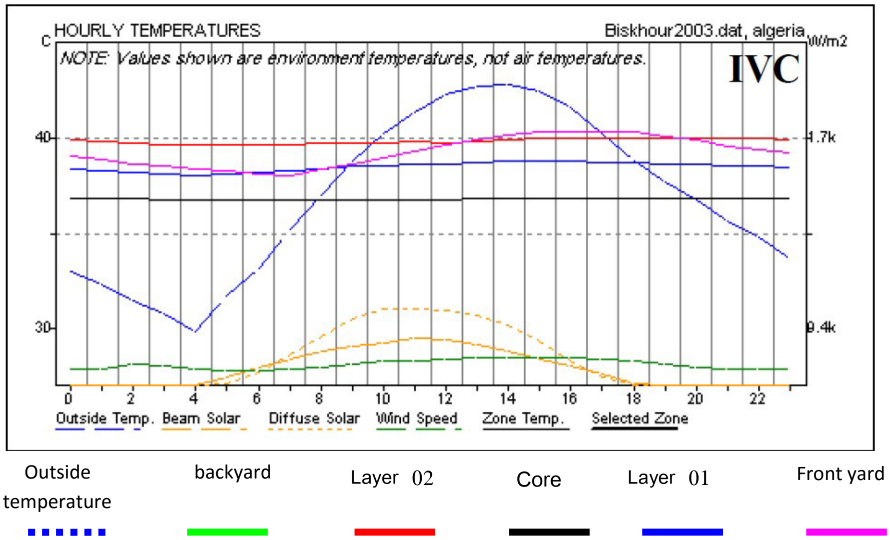

Figure 4.Temperature Exchanges of Layers Model (IVC)

3.3.3. The results of the differentiation between thick envelope and insulation envelope :

The temperature of both models is ranging between 37 ° and 39 ° with the external temperature disorders reach the peak (° 43) at 15:00 and the lowest level (° 30) at 05:00 . whereas the temperature of insulating Cover is more than temperature of thick Cover slightly exceeds the temperature of this cover throughout the day. However both temperature variants are stable throughout the day, where the difference between the highest temperature and low temperature is very low (Figure 5).

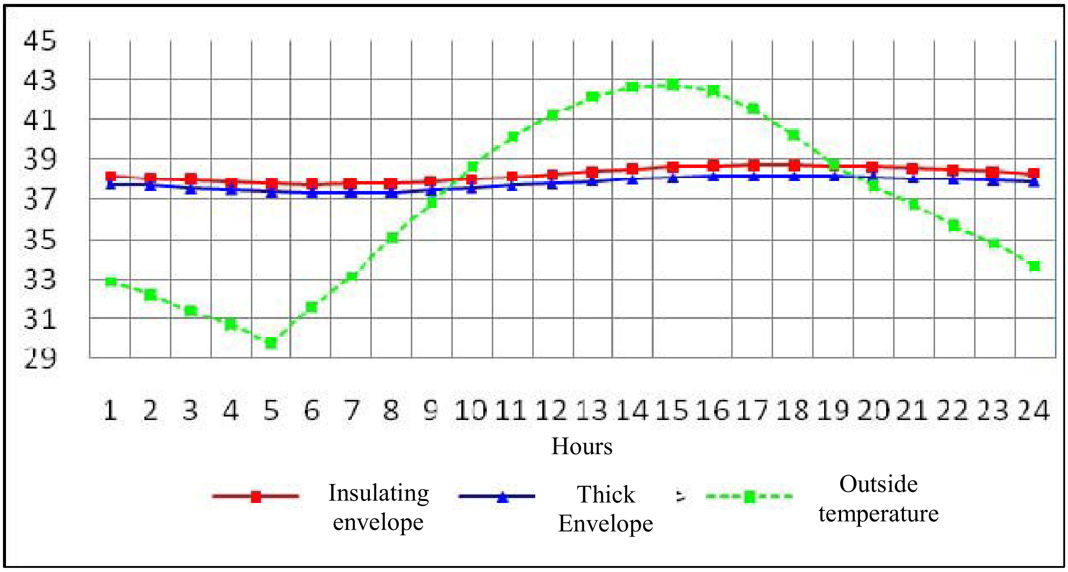

Figure 5.Daily Temperature Changes for Each of the Model Insulation and Thick Envelope

4. RESULTS:

The results of this study show that the laws controlling the thermal environment in the airspace are been affected by the habitual elements of local architecture of Biskra region. these elements that have developed throughout history to adapt to the requirements of the internal thermal airspace of the house.

The topological position of front yard and backyard contributed to identify their thermal characteristics , as the front courtyard takes frontal position and; therefore, it is the most susceptible to the changes of external environment. the position of the backyard behind the building surrounded by buildings on all sides give it greater protection against the fluctuations of climate changes. In all cases, its temperature is the lowest and most stable (Figure 6).

The absence of the backyard leads to a significant increase of the temperature of each of the core and the layer 02

When the core is opened and the presence of both yards, the temperature of layers 01 and 02 going down.

The distribution of temperature in the model with a backyard with Rozna at the core is the most homogeneous.

The form of core affects the thermal behavior of morphological composition : the longitudinal extension of linear core (the gallery) often leads to the absence of one of horizontal layers and therefore the core is more susceptible to climate change. Although in general the temperature of corridor is the lowest, it is troubled.

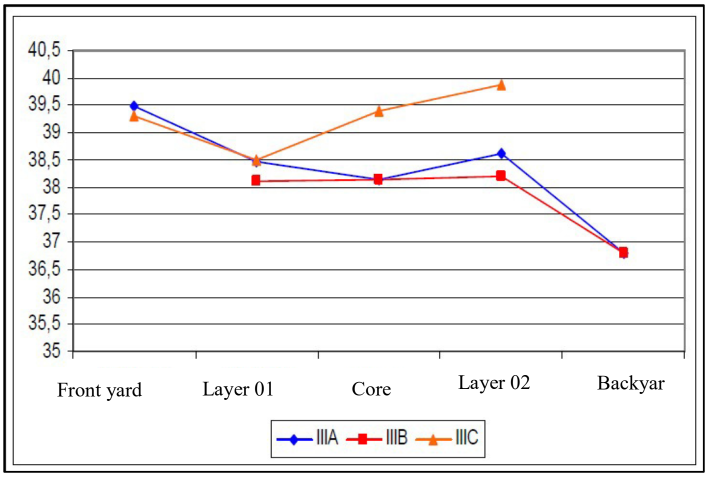

Figure 6. Temperature of Layers Model (III)

5. RECOMMENDATIONS:

The openness in morphological composition is depth leads to a significant decrease in the levels of temperature. Hence it is better resort to backyards or to open the core with presence of one type of courtyard or both of theme , in case the core is closed. However, The situation that must be avoided is the absence of the backyard with closed core because this leads to rise levels of temperature in the full room.

It is recommended to resort to open core(Patio, Hall with Rowzna, corridor with Rowzna), because, in terms of stability, we find that the morphological compositions with an open core is more stable than the compositions with closed core.

It is also recommended to resort to backyard ,because the temperature of models with backyard is the most stable and lower than models with both courtyards (Figure 7). However it is recommender avoid houses with only front courtyard.

As will it is recommended to use thick envelope because the presence study hase shows the effectiveness of the thick envelope compared to the insulation envelope in hot and dry areas.

The treatment of thermal aspect of house with alphabetic elements in the dictionary of the local architecture of Biskra allows the manipulation of these architectural elements to search for improved thermal performance and control energy consumption of the house within the limits of what is available to architect along whis maintaining the identity of the local architecture.

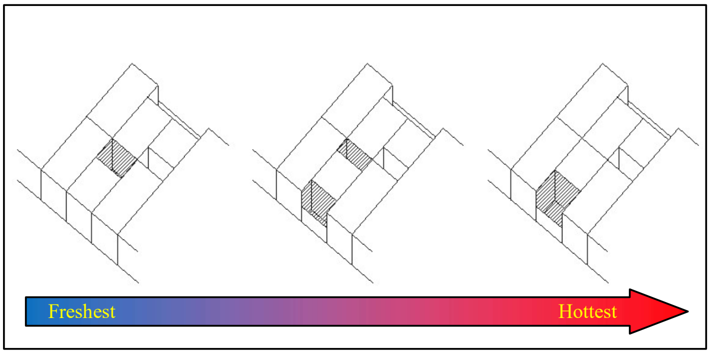

Figure 7. Classification of thermal models

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