Paper 540: Modern Architecture: rescuing passive principles for a temperate climate in Brazil

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Abstract

Climate awareness and Modern Architecture need not to be reciprocally exclusive, as shown in the present paper. Evidence is searched for in the temperate zone of Brazil, which represents a particular challenge to architects. This paper presents five representative houses designed between 1930 and 1965 by the first generation of architects with an academic background in Curitiba. It is true that the Modern Movement is negatively seen in terms of passive architecture. Nevertheless, at its beginning, climate awareness was present, and it can be demonstrated in rather correct choices regarding envelope design and thermal zoning. Besides, there was an exemplary attitude of rationality in the solution of problems in a particular, regional context. Therefore, the Modern Movement in Brazil can be described not specifically as aware of climate, but (to some extent) aware of architecture itself as a cultural achievement. Thus, the improvement of the general performance of buildings could profit from a deeper understanding of history: it should investigate what was the spirit of the Modern Movement, and what (international, post-modern or simply global) influences were responsible for the almost ubiquitous and often regrettable reality of architecture as a commodity.

Keywords: Modern Movement, passive architecture, residential buildings.

1. Introduction

The temperate zone of Brazil represents a particular challenge to architects. Temperatures under 0°C and the frequent advent of cold air masses suggest a major shift from national, tropical design commonplaces such as the almost mandatory pursuit of wind and shadow. The biggest city in the temperate zone of Brazil is Curitiba, with a population of 2.5 million inhabitants. If the city has achieved worldwide recognition since the 1980s for its ecologically correct urban policies, the same cannot be said from the housing architecture produced in the same period, which is definitely not climate-aware.

In a historical perspective, the first buildings of Curitiba are from the early 18th century and did not significantly differ from the mainstream colonial architecture in Brazil. In the late 19th century, Italian, German and Polish immigrants built wooden houses, therefore achieving a better standard of thermal insulation, however those houses never reached an official status (the middle class never took those wooden houses as an ideal). Finally, a significant advancement could be found in the Modern Movement, with its wave of innovation in technology and design.

This paper presents five representative houses designed between 1930 and 1965 by the first generation of architects with an academic background in Curitiba. It is true that the Modern Movement is negatively seen in terms of passive architecture (due to the later vulgarization of representative gestures like electrically lit and mechanically conditioned glass boxes). Nevertheless, at its beginning, climate awareness was present, and it can be demonstrated in rather correct choices regarding envelope design (including building materials and aperture details) and thermal zoning. If the architects did not master the technique of thermal insulation, solar protection, daylighting and ventilation, there was an exemplary attitude of rationality in the solution of problems in a particular, regional context.

2. Brazilian Modern Architecture

The modernization movements which appeared after World War I originated the Brazilian Modern Architecture. Modernism begins in the 1920es with the Warchavchik *Manifesto* as well as his residences in São Paulo city, a few years after the *Semana de Arte Moderna* of 1922 [1]. Nevertheless, it is only in the next decade that the Modern Movement in Brazil consolidates itself with the ascension of Getúlio Vargas as president. The modernizing project of the country was assumed by the State, with the pursuit of industrialization and development.

According to Guerra and Ribeiro [2], the main questions conditioning the shaping, development and consolidation of modern Brazilian architecture were originated in the identity of values and discourse between Le Corbusier and the Brazilians, who chose him as a model to be followed. Such questions comprehended the continuous pursuit of a synthesis of the European modern principles and the Brazilian constructive

tradition from the colonial time, in order to establish a well-balanced and harmonious relationship with the exuberant tropical landscape. Economic development of the country provided a proper background for the modernization projects of the country architecture.
In the city of Curitiba, the period was initiated with the construction of the Frederico Kirchgässner residence in 1930 and was ended with the implementation of the Serete– IPPUC Plan in 1965 [1,3]. Regarding the climate, due to the considerable temperature variation between summer and winter, the architects from Curitiba looked for the adoption of heat collecting elements in the cold season, and heat loss elements in the warm season [4].

2.1 Local Environmental Conditions

The concept of bioclimatology or bioclimatic design was consolidated in the 1960es by the Olgyay brothers, and refers to the study of local climatic conditions applied to architecture, searching to satisfy human comfort conditions in buildings [5]. A number of architectural solutions are utilized to improve the indoor comfort in a passive manner, reducing the need for artificial energy.
Curitiba is placed in a temperate, subtropical region, at 25º25' latitude and 49º16' longitude. According to Köppen, the local climate is of the Cfb type – temperate, humid, with moderate summers. This climate has two well-defined seasons: winter and summer. The Brazilian Bioclimatic Zoning according to the standard NBR 15220 – Thermal Performance of Buildings [6], classifies the region as Bioclimatic Zone 1. Goulart, Lamberts and Firmino [7] represented the Test Reference Year - TRY for the city of Curitiba on the bioclimatic chart, which considers a series of climatic data from 1960 to 1970. Such data were compiled on Table 1, which presents the percentage of thermal comfort (20,9%) and discomfort (80,1%) and the percentages for the adequacy of each of the strategies proposed by Givoni [8]. One can observe that the majority of thermal discomfort is caused by cold (73,1% of the year hours). One can also observe that in Curitiba it is possible to achieve comfort by the means of solar heating plus thermal mass 61,2% of the year. 11,7% of the year, there will be a need for artificial heating.

Table 1: Bioclimatic Strategies (%) for Curitiba

Comfort			20,9
Discomfort	Hot	Ventilation	5,8
		Evaporative cooling	0,7
		Thermal mass for cooling	0,7
		Air-Conditioning	0
	Cold	Thermal mass for heating/ Solar Heating	42,4
		Solar Heating	18,8
		Artificial Heating	11,7

[7]

3. Modern Residential Buildings

3.1 Frederico Kirchgässner

This work is a landmark characterizing the begin of Modern Architecture in Curitiba. During its construction, in 1929 and 1930, the architect's house caused impact and rejection by the city inhabitants (Fig. 1). That happened because the terrace-lookout was contrary to the constructive tradition of tilted roofs and small towers, what caused the houses by Kirchgässner to contrast with what was produced in the city [3].

Fig 1. Main façade [3]

Besides the terrace, one of the five points of Modern Architecture, the work represents a break with the eclectic patterns in several other aspects: in the constructive shape, in the use of reinforced concrete in the terraces, in the architectural language and in the distribution of uses and spaces of the house [1] (Fig.2).

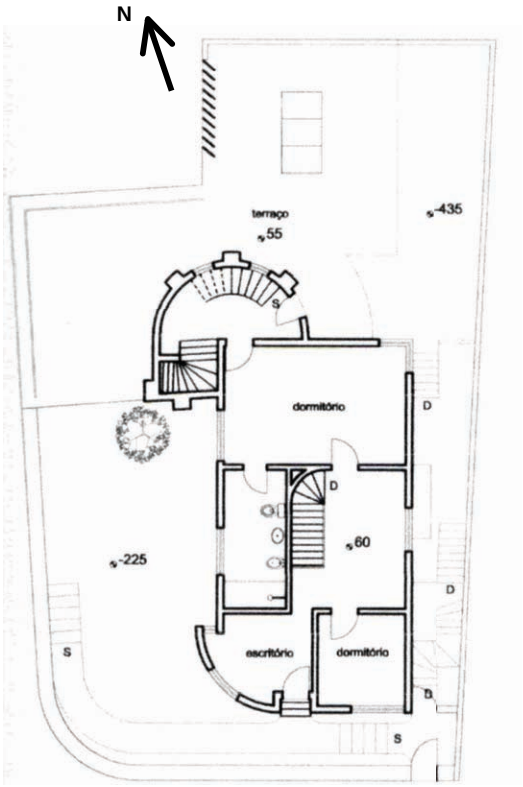

Fig 2. Plan, 2nd floor [4]

The following elements were identified, which are typical of the Modern Period and which could be designed in order to provide better comfort in a natural way: terrace; double walls; masonry elements for protecting the wooden framings (Fig.3); venetian blinds (Fig.3); *brise-soleil* (Fig.4), skylights.

Fig 3. Solar protection and venetian blinds [9]

Fig 4. Brise-soleil [9]

The compact shape of the house, associated with its improved insulation standard at the building envelope, can be recognized as a passive strategy for winter, whereas the ventilation possibility given by the well-distributed windows can be recognized as a passive strategy for summer. Nevertheless, nowadays expected features as double glazing and roof slab insulation were not identified.

3.2 Ayrton Lolô Cornelsen

Designed and built in 1949, the house was placed on a site with a pronounced slope, transversally. The constructive solution found by the architect for his own residence was to integrate the house to the ground using pilotis, one of the five points of the Modern Architecture (Fig. 5).

In order to adequate the architecture to climate, the residence was designed for a long solar incidence, resulting in a house plan which resembles a fan (Fig.6). Considering the rigorous winter, the architect preferred wood on floors and ceilings to concrete [11] (which was usual to Brazilian Architecture, e.g. the work of Oscar Niemeyer). The house included a system to support the artificial (electric) heating in the dormitories, with a careful schedule of use.

Fig 5. Front façade [10]

Fig 6. Plan, 1st floor [11]

In this work, the generating aspects of architecture were thought together – functional, esthetical and related to the users comfort.

Elements identified to adapt architecture to the site, which are typical for the Modern Movement are: solar geometry-based design; curved façade in order to increase solar gain (Fig.7); Southern façade protected by native tree species; double glazing; artificial heating (electric, and fireplace); air conditioning; thermally insulating coverings. The use of pilotis and ventilated atic space (Fig.8) could be considered not proper solutions for the winter.

Fig 7. Northwest curved façade [4]

Fig 8. East façade [11]

3.3 João Luiz Bettega

Designed by the Architect João Batista Vilanova Artigas in 1949 and built from 1952 to 1957.

The principles considered by the architect in this residence are an approximation to the rationalist current and to the functionalism of Corbusier.

The residence orientation to the longest dimension caused the gap of the left side of the ground, which was a subversion of the architectural notions then popular in the city (Fig.9). Doing this, the architect allowed every rooms to be opened towards the lateral garden, with northwest orientation, thus achieving a better insulation in winter and some solar protection in summer (Fig.10).

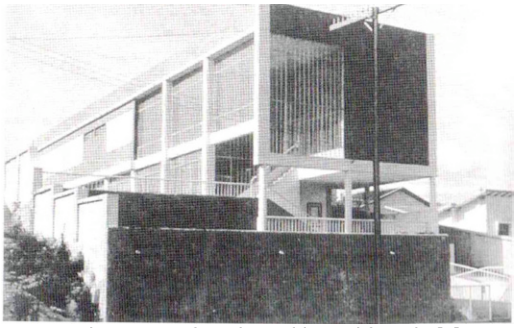

Fig 9. Front façade and lateral façade [4]

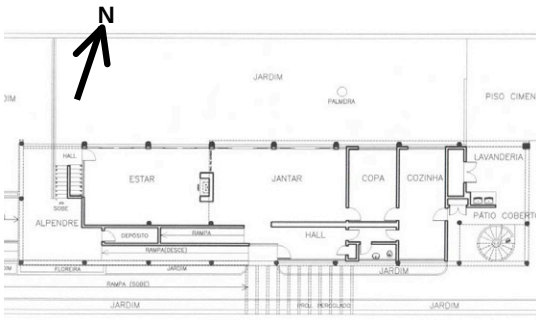

Fig 10. Plan, 1st floor [9]

The following solutions were identified, in order to adequate the building to the surroundings, which are also typical of modern architecture: orientation according to solar geometry; glazing panes (Fig.11); compact shape; venetian blinds (Fig.12); pergola; fireplace. The use of pilotis could be considered not a proper solution for the winter. And the glass panes, while providing the building with passive solar heating, are also the main cause of heat loss to the outside air.

Fig 11. [9]

Fig 12. [9]

3.3 Joaquim Franco

This residence was designed by the architect Elgson Ribeiro Gomes, who was in Curitiba the most important designer of large-scale buildings. The residence spaces are distributed in three blocs, shaping an inner patio (Fig.13).

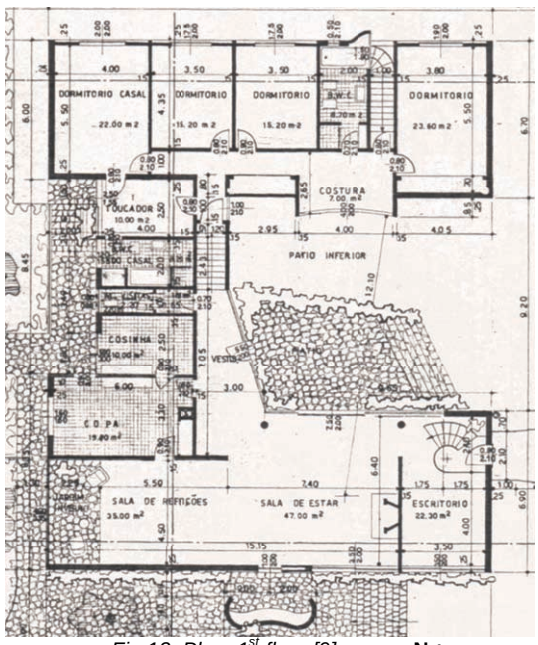

Fig 13. Plan, 1st floor [9]

In the period, it was a current practice that the residences had a rather compact shape, thus contributing to reduce heat losses to the atmosphere. The architect adopts three blocs for climatic reasons, related to the increase of the solar-hit perimeter during the winter. Such unfolding of plan and shape intended to increase the solar heat gains; however, such a solution also exposes all external surfaces to the conductive and convective heat losses. In addition, the building volume generates an undesired shadow of other building parts.
Elgson developed a personal vocabulary in the treatment of the openings and solar protection. The main window has usually a gliding mechanism, and there is a smaller hopper window above, just beneath the ceiling, or close to the slab, and the sill is low, in order to maximize daylighting (Fig.14).

Fig 14. Front façade [12]

The following elements were identified to adapt architecture to the site and which are also typical for the Modern Movement: unfolding of plan and shape; inner patio (Fig.15); glazing panes; venetian blinds (Fig.16). However, the pilotis (Fig.16) may expose the house to excessive heat losses in winter.

Fig 15. Inner patio [9]

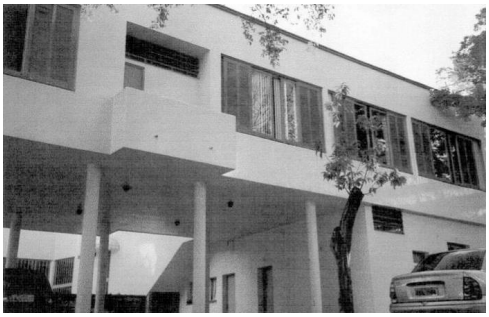

Fig 16. Pilotis [9]

3.4 Mário Petrelli

Design by the team comprising Luiz Forte Netto, Francisco Moreira, Roberto Luiz Gandolfi and José Maria Gandolfi, this residence is placed close to a group of important residences from the period (Fig.17).

Fig 17. Front façade [12]

The terrain had a slope, and this oriented the distribution of spaces on three levels, organized around an inner court [12] (Fig.18). Above the inner court, a skylight was included. A great covering, with varying slope and height organizes the rooms. The living spaces, as well as the dormitories have the Northern orientation.

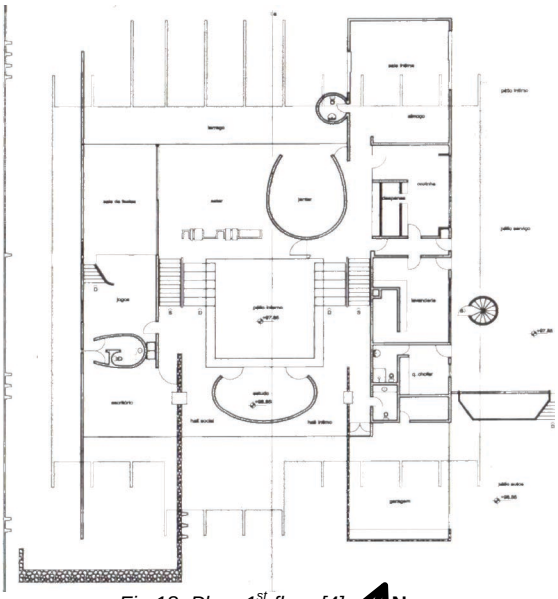

Fig 18. Plan, 1st floor [4] N

The solutions identified in order to adequate the building to the surroundings, which are also typical of modern architecture, are: inner court (Fig.19); bedroom and living room orientation according to solar geometry; integrated spaces; glazing panes; venetian blinds, pergola (Fig.20); skylights (Fig.19).

Fig 19. [9]

Fig 20. [9]

4. Conclusion

In Curitiba, the most frequently employed strategy is the optimal building orientation with respect to the insolation and placement of the most important spaces (like dormitories) at the northern façade.

Not all strategies which were used by the architects are adequate to the climate and to the physical surroundings. Possibly, those solutions were chosen based on empirical - not scientific - knowledge.

In Brazil, in the period under appraisal, there were scientific investigations on the subject of comfort, which were available to the practitioners. However, it is not likely that the authors of the considered designs have used specific tools for bioclimatic design.

The solutions, which were identified as adequate to the climate may be rescued for use in nowadays buildings in order to promote comfort without mechanical devices. This can be done considering the technology, which is available today, as well as the physical context.

Finally, one should notice the quality of the architecture produced in the first phase of the Brazilian Modern Movement and, as well, of the works under consideration in the present paper, which can support the development of a genuine Brazilian Architecture, adequate to climate and landscape.

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