The facades technological updating of an icon of Brazilian modernist architecture: the case of the IRB headquarters building.

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ABSTRACT

The Brazilian Reinsurance Institute building, an icon of modernist architecture in Brazil, projected by MMM Roberto, is legally protected. Its facades had passed by some interventions which will be presented in this article.

The present work aims not only at observing the energy consumption, as a result of the last year building renovation, but also at suggesting and comparing materials that could be applied to constitute a true technological retrofit in order to promote energy efficiency increase as well as better indoor environmental comfort too.

This work briefly describes the history of preservation of the Brazilian modernist architecture and analyses the first Brazilian official regulamentation to assess the building electric efficiency level.

KEYWORDS

1. Technological upgrading in buildings; 2. Legally protected building; 3. Modernism; 4. RTQ-C. 5. Restoration of facades; 6. IRB Building.

THE PRESERVATION OF MODERNIST BUILDINGS IN BRAZIL

The Brazil has a large collection of modernist buildings, especially in big cities such as Rio de Janeiro (see figure 1) and São Paulo.

The discussion about the conflict between the preservation [1] concepts and technological upgrading of legally protected buildings looking for energy conservation

[1] *"Action that aims to ensure the integrity and continuity of something, for example, a cultural asset. One of the instruments of preservation is restoration. You can also emphasize conservation, as measure of periodic or permanent preservation purporting to contain the damage even in their early"*
(Oliveira apud Brandi, 2008).

and environmental comfort has a wide field of analysis taking as basis the buildings belonging to the Modern Movement of architecture of these centers as they have gone through the process regeneration where many buildings are passing by interventions nowadays.

Figure 1. View of the Rio de Janeiro downtown (the modernist buildings: ABI and the Capanema Palace intervention in the background).

These buildings have been *"a target of increasingly needed for its conservation, due to natural aging and new technological requirements (air conditioning systems, automation and other)"* [2] This factors are also relevant in the IRB intervention, because it facades were restored due to damages which had been developed over the years and the need to implement new air conditioning system.

However the methods of intervention cannot be applied without regard to the preservation of modernist buildings are special features, such as: need for treatment of specific problems of the techniques and materials used, availability of documentation and original designs still archived in many cases, authors of the original projects are still alive.

Ideally, in addition to the above concerns, it should be included in the solutions of interventions, items which would contribute to improving the energy performance of the building. Carvalho, in the thesis "*Preservation of Modern Architecture: Office buildings in Rio de Janeiro, built between 1930-1960*" mentions this problem, especially in the office buildings, such as the IRB:

"*The office buildings, by nature of its program and its use, offer a complexity and a multitude of problems, causing the shares to the preservation of its historical and artistic values to balance with the modern demands of efficiency and still present a cost-benefit compatible with the socioeconomic context, as well as meet regulatory requirements and legislation*." [3]

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[2] Esteves, 2010.

[3] Carvalho, 2005.

In Brazil, the first law of protection of modernist buildings occurred in 1940, with some works still under construction and is considered by Pessoa [4] as *“preventive protection attitude”* of the heritage.

The measures for the preservation of the Modern in Brazil were intensified in the 1980s and again in the 2000s, when the decree of the provisional municipal law [5] safeguarding the IRB signed in 2006, represents an initiative in favor of the landmarking of modernist buildings in Rio de Janeiro, as well as the IRB, other important buildings were considered.

It is important to develop a more focused legislation to safeguard the buildings of the Modern Movement in Brazil and *"the technological updating of legally protected heritage allowing these buildings to be incorporated in a more productive society, because that new features can prolong the life and their service to the habitability of users."* [6]

IRB: THE BUILDING AND THE RESTORATION OF ITS FACADES

Figure 2. IRB Northeast and Southeast facades

The IRB-Re, a company active in state control of the reinsurance market, had its headquarters designed by the architects MMM Robert and opened in 1943. IRB is located in Rio de Janeiro downtown and its facades orientation been: northeast, the southeast and northwest (see figures 2 and 3).

In Rio, it’s very important the shading protection of the facades, mainly in north orientation. In the case of IRB, the northwest façade was designed with *brises-soleils*, a common element of Brazilian modernist architecture. This element makes a shadow that contributes to the blockade the direct insulation.

[4] Pessoa, 2003.

[5] Decree no. 26.712, 2006.

[6] Esteves, 2010.

The other facades didn´t have this kind of a blockade and because of receiving less solar radiation, it could have glass windows with a better solar factor for example.

This building is provisionally legally protected by the municipality of Rio de Janeiro and also in legal protection process of their facades by IPHAN, a federal agency of heritage protection. Any intervention in its facades needs to respect the restrictions of heritage law.

Figure 3. IRB Northwest and Northeast facades

The original design of the IRB facades structure is composed of prefabricated concrete enclosed by wooden frames and glass, and locks in asbestos-cement boards, which certainly contained asbestos in its composition.

The current project developed and performed last year on the facades, considered only the replacement of glass from 4mm to 6mm and repaired damages in casings. External marble coatings were also restored.

Internal white PVC blinds were also specified in the project mentioned above.

Suggesting solutions to improve energy efficiency of the building and its environmental comfort this propose insert of the followings:
- Replacement of glass from common 4mm to 8mm laminates;
- Panels of glass wool in the empty spaces between the plates of locks;
- Replacement of asbestos-cement panels with panels without asbestos;
- Application of internal blinds type solar screens;
- Solutions of lighting design.

In conclusion, these studies compare the original design, the current project and the proposals made in this research developed to the pos-graduation dissertation. In this article will be presented the results obtained with the prescriptive method of RTQ-C, which was used as assessing tool for the determination of thermal efficiency of facade systems and lighting system energy efficiency.

THE RTQ-C AND THE ENERGY PERFORMANCE OF IRB

The RTQ-C[7], Technical Quality Requirements for Energy Efficiency in Public, Commercial and Service Buildings aims at regulating the conditions for labeling the level of energy efficiency of buildings. The methodology of the RTQ-C is voluntary and can be applied to the building or to a partial area of the it. The area to be assessed must be greater than 500m2 and / or served by high tension energy.

The regulation allows the evaluation of the following components:
- Lighting system;
- Air Conditioning system;
- Building envelope (external walls and roofing).

The lighting and air conditioning systems can be assessed for a specific isolated area of the building or for the whole building, but the evaluation of the envelope necessarily involves classifying of all the facades and the roof of the building.

The procedures for the classification include answering general of prerequisites, specific prerequisites of the systems and prescriptive methods or computational to calculate the thermal performance of the building. Bonuses can be given by elements to saving energy that have been adopted in the project.

The RTQ-C methodology includes checking the level of efficiency of each system, besides concerning the general prerequisites observed and bonuses for the final classification. The building, or the evaluated area of the building, will receive the National Label of Energy Conservation (ENCE), which displays the partial or final levels of energy efficiency achieved.

From this assessment tool above mentioned, the case study was conducted by Esteves [8] in her dissertation about the interventions in the facades of the building, in which the main results on the energy performance are presented.

This study considers the intervention in the facades, assessing the implemented restoration project and new materials proposed. Due to this spatial area, the following items were evaluated:
- Thermal performance of the facades, through the prescriptive calculation of the RTQ-C, not taking into account the roofing of the building;
- Luminous performance of one floor (floor-type);
- Checking the observation of specific prerequisites of the envelope (facades) and the lighting system.

[7] INMETRO n° 372 / 2010.

[8] Esteves, 2010.

The thermal performance of the facades

Being located in the city of Rio de Janeiro, the building of the IRB fits in the bioclimatic zone 8 [9] (ZB8), as it stipulates that it be served within a certain range of thermal conductance of the envelope and the absortance of materials. Although overhead lighting features are also prerequisites, the coverage is not being assessed in this study.

See the results of thermal conductance and absortance obtained through RTQ-C method:

Table 1. Comparison of thermal conductance between the different projects

Project	Thermal conductance (U)
	W/m2K
Original	2.26
Current Project	2.16
Proposed in article	1.48

Table 2. Comparison of absortance between the different projects

Project	Absortance (α)
Original	0.36
Current Project	0.34
Proposed in article	0.34

The calculation of the thermal capacity of the walls, in the case of buildings located in ZB2 or ZB8 is also necessary, since the classification of thermal conductance of the external walls will depend on the thermal capacity calculated.

The result of thermal capacity found in each position of facades (original, existing and proposed) is described below:

Table 3. Comparison of absortance between the different projects

Project	Thermal Capacity
	kJ/m2K
Original	148
Current Project	132
Proposed in article	256

[9] Bioclimatic zone is defined in the NBR 15220 and follows the division of the Brazilian territory into eight relatively homogeneous bioclimatic zones regarding climate (NBR15220 - ANNEX B, 2005).

According to the regulamentation, the thermal transmittance of the walls could not exceed 3.7 W / m² K. Observing table 1, it is showed in all the options this limit wasn´t exceeded.

It also be concluded that in all design solutions, the absortance would be less than 0.50, what means that the level A of performance was kept, according to the RTQ-C.

Procedure for determining the efficiency of the envelope

The prerequisites of the energy performance of the envelope were on the spot so far, and the calculation of the Envelope Consumption Index (IC) completes the analysis for the classification of the facades.

One of the input data for calculation of the Consumption Indicator is the solar factor of the glass facades.

In the case of the IRB the following criteria were used:
- Glass of the original facade (4mm common glass): the FS = 0,87 was adopted;
- Glass of the current facade (6mm common glass): the FS = 0,83 was adopted;
- Glasses proposed in the dissertation (glass laminate 8mm): the FS =0,34 was adopted;
- Glass blocks: the FS=0,56 was adopted.

The glass proposed for the dissertation is beneficial to the input control of solar radiation, because it has greater the Solar Factor (FS) than those previously specified and helps users to work with the blinds open because it offers glare reduction caused by the incidence of natural light on the southeast and northeast facades.

The change of the windows glass could be considered as a retrofit of the facades, because it is a kind of a technological updating.

For calculating the Envelope Consumption Index (IC), the equation (1) above has to be calculated:

$$ICenv = -160{,}36.FA + 1277{,}29.FF - 19{,}21.PAFT + 2{,}95.FS - 0{,}36.AVS - 0{,}16.AHS + 290{,}25.FF.PAFT + 0{,}01.PAFT.AVS.AHS - 120{,}58 \quad (1)$$

Being:
- ICenv: Envelope Consumption Index;
- Ape: Area of the building (m2);
- Atot: Total area built (m2);
- Aenv: Envelope area (m2);
- Apcob: Roofing area (m2);
- AVS: Vertical angle shadow;
- AHS: Horizontal angle shadow;
- FF: Shape factor (Aenv/ Vtot);
- FA: Height factor , (Apcob/ Atot);
- FS: Solar factor;
- PAFT: Percentual de Abertura na Fachada total;

- Vtot: Total Volume of the building (m3).

The value of ICenv obtained should be compared with the limits of the RTQ-C table, which identifies the level of efficiency of the building envelope.

The table 4 below presents the results of calculations of indexes for the thermal evaluation:

Table 4. Results of the thermal indexes

Project	ICenv	U	α
Original	84,07 =A	2.26	0.36
Current Project	83,97 =A	2.16	0.34
Proposed in article	82,72 =A	1.48	0.34

It can be concluded that the use of glass with the most appropriate solar factor and the use of glass wool suggested between the plates, filling the air chamber inside, made the thermal conductance reduce and the thermal capacity of the walls increase. This reflects directly in reducing the effects caused by the action of thermal actions on the facades, thus reducing the internal thermal load and consequently the size and power consumption of the air conditioning system.

THE LIGHTING PERFORMANCE

The contribution of natural light, especially in the northeast and southeast facades, could have been better used because, as we will see next, the lighting project implemented last year increased energy consumption through greater installed capacity than the original design.

The RTQ-C uses the method of the building area when only one type of activity is developed in this place, which is the IRB case.

The method consists of:
1) Identifying the main activity according to the picture below and the power density (DPIL - W/m2) corresponding to the A, B, C or D efficiency level. This power density is presented in the RTQ-C table, and in the case of the IRB the parameter values are:

A = 9,70W/m2
B = 11,20W/m2
C = 12,60W/m2
D = 14,10W/m2

2) Determining the illuminated area of the building, in the present study, the illuminated area of type floor = 1020.22 m2;
3) Multiplying the illuminated area by the floor and the DPIL, finding the acceptable limits for each level, as performed in the table 5:

Table 5. Density levels of potency

Efficiency level	Density of potency	Area	Limit of potency
	W/m2	m2	W
Level A	9.70	1022.22	9896.13
Level B	11.20	1022.22	11426.46
Level C	12.60	1022.22	12854.77
Level D	14.10	1022.22	14385.10

The research examined data from the original design and present project implemented last year and the following tables show us that the value of the current project is not within the minimum standard of energy efficiency that the RTQ-C considers.

Table 6. Current Project Lighting Potency

	Total Potency
	W
Original Project	11040.00
Current Project	22724.00

It was also checked the prerequisites: division of the circuits, contribution of natural light and automatic disconnection of the lighting system.

Each level requires a certain items attended, according to Table 7:

Table 7. Items it's to be attended in each level

Prerequisite	Level A	Level B	Level C
Division of the circuits	Yes	Yes	Yes
Contribution of natural light	Yes	Yes	
Automatic Lighting shutdown	Yes		

The prerequisite related to the division of the circuit would require the presence of switches or sensors separated in closed rooms independently of the other environments, as well as an independent device operation in areas greater than 250m2 on the same floor.

Regarding the contribution of natural light, the project could have considered the separation of the circuits of the row of lights parallel to the facades so that they could stay off making the best of the natural light as possible. The glass proposed in this work and the shutters would also help to be maintained in natural light for longer, without blurring the user´s sight.

The high installed power could have been lower by reducing the amount of existing lights remaining, yet keeping the quality of lighting for the workplace.

These proposed solutions were not addressed in the recently implemented project and could contributed to a more rational and efficient project, which would reduce the internal thermal load and installed capacity, thus reducing the energy consumption.

CONCLUSION

During a plan to restore a modernist building, particular situations will be founded, especially when the interventions had to be projected with the energy conservation as a design principle. It´s important to have a tool to verify the performance obtained with the intervention.

All the materials and elements suggested in this study respects the concepts of restoration of the legally protected facades and still could be considered a technological updating, because the glass specified and the glass wool allowed the maximization of the energy conservation of the IRB building.

Therefore, a better project could be done at using the natural lighting resources, with proper planning and the distribution of the shutdown circuitry, coupled with the architectural features of materials and more efficient lighting results in greater environmental comfort and energy efficiency for the building.

It´s fundamental improve the conservation of energy in the old buildings, but always keeping on the principles of the heritage preservation.

NOMENCLATURE

m – meter.
FS – Solar Factor.

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