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EFFICIENCY ANALYSIS OF THERMAL PAINTS TO BE APPLIED TO THE COVERAGE OF CLASSROOM 305 OF BLOCK 03 OF UNIVERSITY CENTER OF INTEGRATED FACULTIES OF ``OURINHOS`` – S.P. (UNIFIO)

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Abstract: This work proposes the analysis of the efficiency of thermal paints to be applied to the roof of block 03 of an institutional higher education building with the objective of reducing the internal temperature of the rooms in this block, thus providing thermal comfort and reducing energy caused by of the air conditioners present in them. The case study was carried out at the beginning of 2022, more specifically in classroom number 305 of block 03, located on the Campus of the University Center of the Integrated Faculties of ``*Ourinhos*`` – UniFIO. Having been in use for approximately nineteen years, the building currently consists of eight classrooms, a model office, men's and women's bathrooms, corridors, an imaging laboratory, a library, an arts museum and an amphitheater. The methodology applied for the research was Post-Occupancy Assessment (A.P.O.), which is an important quality control tool for built environments whose main characteristic is to evaluate buildings taking into consideration, users' opinions. The research consisted of only one part, this being the technical evaluation after the application of thermal paint on the roof of classroom 305. The technical evaluation was based on walk-through inspections, that is, observations with the naked eye made by a student- intern at the model office of the architecture and urbanism course with the help of the thermo-hygrometer and filling out a technical table under the supervision of architect-teacher Douglas Murilha, where a series of measurements of the internal temperature of classroom 305 were carried out, which contain the thermal paint on the roof and the other classrooms present in block 03 without the thermal paint on the roof between the months of February and June of the year 2022.

Keywords: A.P.O.; Thermal comfort; Energy Consumption; Thermal Paints; Thermal Performance in the Built Environment.

INTRODUCTION

Environmental Comfort covers the living and working conditions that architectural spaces must possess and provide to individuals, taking into consideration, thermal, acoustic and lighting aspects.

According to researchers in this area, the importance of studies regarding environmental comfort is based on three main factors, namely:

- man's satisfaction with his well-being in feeling thermally comfortable;

- human performance in carrying out its activities;

- energy conservation, as due to the increasing mechanization and industrialization of society, people spend a large part of their time in spaces with artificial climatic conditions, through the use of air conditioning or fans.

From a conceptual point of view, thermal comfort, according to studies, means the direct relationship between man, the building and the climate, so that there is thermal balance and health conditions in this direct interrelationship.

Now, natural thermal conditioning refers to the techniques that are studied by researchers where they analyze the means so that built spaces can meet and provide adequate and satisfactory thermal conditions required by individuals, without there being the need to use any type of thermal conditioning. of an artificial thermal conditioning system, that is, making the most of natural resources such as ventilation and shading that are present in the spaces, thus promoting integration between buildings and the environment in which they are located, thus obtaining thermal comfort and saving money energy permanently.

It is known that, as Brazil is a country with a tropical climate, most months throughout the year have temperatures above average,

due to the location of the territory. Among the factors that directly contribute to the temperature of a given location, we can mention latitude, relative air humidity, the amount and intensity of sunlight present in it, the direction of the prevailing winds, the relief, among other aspects.

Not only do climatic factors contribute to the temperature conditions present in buildings. In addition to climatic factors, other aspects that also directly contribute to the internal temperature of built spaces are the shape and volume of the building, the orientation of the facades and openings present in them, the dimensioning and positioning of windows and doors, the type of glass used in openings, the type of tile and lining/slab used in the building, the types and shades of paint used on roofs and facades, among other technical-constructive aspects present in the buildings.

In view of these aspects, the case study was carried out specifically in classroom number 305 of Block 03, which is located on the Campus of University Center of the Integrated Faculties of ``*Ourinhos*`` (UniFIO).

Classroom Center three (figure below) is located on a plot of land with flat topography towards the North and South, with larger facades facing the East and West quadrants.

It has a parallelepiped shape with a rectangular base, with approximately 2320.00 square meters of built area.

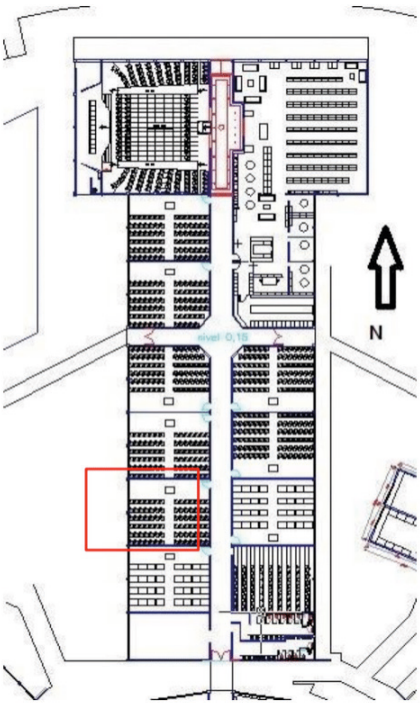

Figure 01: Floor plan of Classroom Three on the F.I.O. Campus. highlighted in red in Room 305, Ourinhos-S.P.

Source: University Center of the Integrated Colleges of ``*Ourinhos*`` – UniFIO.

Based on the solar orientation of the Classroom Center 03 and the materials that make up this Center, and because the UniFIO Campus is located in a city with a hot climate most of the year, it is clearly noted that during the spring and summer periods, the internal temperature of the classrooms throughout the day is higher, due to the materials present in the building and mainly the type of tile used to cover the block, which does not contribute satisfactorily to the thermal comfort of the classrooms., causing thermal discomfort to users during the night, which is the period with the greatest flow and use of people.

To alleviate the discomfort caused to users inside the classrooms, they each have two air conditioning units that are switched on at night for approximately five hours, with the aim of reducing the internal temperature of the classrooms.

As we know and according to research, the greater the use of artificial refrigeration systems, such as air conditioning, end up resulting in excessive energy consumption, increasing the cost of energy during the month.

This work aimed to evaluate the efficiency of thermal paints that will be applied to the coverage of a classroom in block 03, located on the Campus of University Center of the Integrated Faculties of ``*Ourinhos*`` (UniFIO). With approximately fifteen years of use, the three-classroom center has a typological characteristic that is present in the majority of institutional buildings built on the majority of University Campuses present in Brazilian cities.

The methodology applied was Post-Occupancy Assessment (A.P.O.), which is an important quality control tool in built environments. This methodology's main characteristic is to take into consideration, the opinion of users' satisfaction levels and the opinions of professionals in the technological area in the process of evaluating built spaces (ORNSTEIN, BRUNA and ROMÉRO, 1995).

Based on diagnoses that are being prepared from the crossing of a series of data that are collected in loco through observations by a second-term architecture student, under the supervision of an architect-teacher from the architecture and urbanism course at UniFIO and from the users' opinion, positive and negative aspects were detected that were present in classroom 305 after the application of thermal paint on its cover. After obtaining the data, the results were commented and analyzed, where, from this stage onwards, a series of technical solutions will be suggested to permanently solve all the problems and negative aspects that were detected in this case study.

METHODOLOGY

Post-Occupancy Assessment (A.P.O.) is a methodology for evaluating built environments whose main characteristic is the participation of users in the analysis process. Its diagnoses are based on crossing users' opinions with opinions and technical documents prepared by experts and evaluators. If, on the one hand, investigating users' opinions is important, as they are the recipients of the considerations made by designers and builders, on the other hand, the importance of technicians' opinions in interpreting responses to identify the causes of the aforementioned deficiencies must not be overlooked. (SERRA, 1989).

This methodology's main objective is to detect positive and negative points in buildings and urban spaces, propose solutions for pathologies and problems, systematize the successes in the case evaluated and feed back into future similar projects (DEL CARLO, 1989).

The A.P.O. It therefore serves as an important source of consultation for architects and urban planners, engineers, contractors and other professionals linked to the design, construction and management of built environments.

This research took place through an analysis based on a series of studies that deal with the efficiency of thermal paints that are applied to roofs and facades of buildings. The physical assessment was based on "walkthrough" inspections, that is, on-site visits where researchers filled out technical tables that served to record the average temperatures that were present inside classroom 305 in block 03 of the UniFIO Campus, which were obtained from measurements that were carried out at a point inside this classroom where it will contain the thermal paint that was applied to the roof of the same, where measurements were also made in the other classrooms without the application of thermal paint

with the thermo-hygrometer device, which is used to record the average temperatures (in degrees Celsius) and relative air humidity (in percentage) of built spaces in different climatic and environmental situations.

The environments present in Class Center Three are: two bathrooms, two corridors, a model architectural office, 08 classrooms with an area of approximately 81 square meters and a ceiling height of 03.50 meters and a half, an imaging laboratory, a library, an amphitheater and an arts museum.

In relation to the construction system of Class Three Center, it is composed of an independent structure, formed by a set of beams and pillars and masonry whose function is only to close the spaces, and not structurally.

As for the materials that were used in the execution of this Center, these are: concrete sealing blocks, dark-colored stones in the finishing of the facades, gray fiber cement tiles, green metallic eaves, PVC linings, colored ceramic floors clear and rectangular windows composed of iron frames with four leaves, two fixed on the sides and two movables in the center, tempered glass with a thickness of approximately six millimeters.

DEVELOPMENT

According to technical information on the MAXIPAINTDOBRASIL website (2018), Maxithermic thermal inks.

> "It is a thermal coating (thermal paint) with ceramic microspheres that acts by reflecting solar radiation, recommended for applications in external areas. It is formulated with a water base and contains hollow ceramic nanospheres, mixed with resins and additives. According to the University of California, it is estimated that for every 100m² covered with white tiles it is possible to offset the emission of 10 tons of CO2 per year. With the application of the **Maxithermic** product, a film of ceramic microspheres is formed, which reflects 99% of UVA and UVB rays, reducing the temperature of the roof surface by 50%. Maxipaint is a member of the GBC (Green Building Council). The application of the **Maxithermic** product is recommended for scoring credits for LEED (heat island reduction) certification. Heat Islands are places where there is a high concentration of temperature compared to the areas around them" (MAXIPAINTDOBRASIL, 2018).

Figure 01: Maxithermic 18 Liter Paint Gallon for application on Roofs and Facades.

Source: *Maxipaint do Brasil.*

Furthermore, according to the technical information present on the MAXIPAINTDOBRASIL website (2018), the properties, technical characteristics and thermal performance of this type of thermal paint are:

- "LEED SRI certification = 99;
- Reduction of up to 35% in internal temperature;
- Protection against corrosion (on metal surfaces), bacteria and fungi;
- Energy Efficiency, reduces electrical energy consumption (air conditioning);
- Reduction of substrate temperature by up to 50%;

- Low weight on the cover, 300g/m², 250 microns;
- Low VOC (Volatile Organic Compound) content, non-toxic, odorless;
- It reduces surface expansion;
- Helps thermal exchange;
- Durability of up to 20 years
- 10-year warranty" (MAXIPAINTDOBRASIL, 2018).

Without applying thermal paint to the roof, the sun's rays heat the roof, transferring heat to the environment as shown in the figure below.

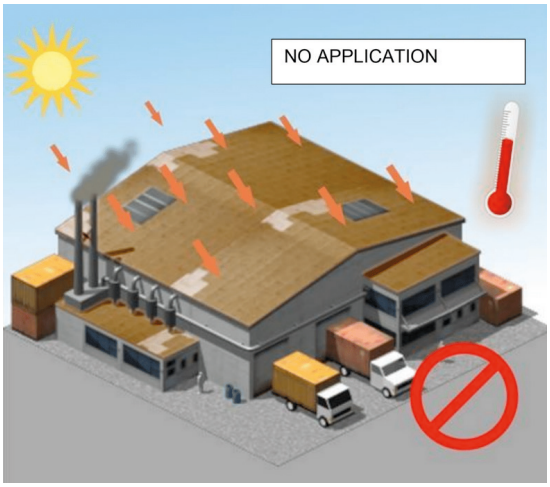

Figure 02: Behavior of Sound Rays in Building Roofs without the application of thermal paint.

Source: *Maxipaint do Brasil.*

Now, with the application of thermal paint on the roof, the sun's rays are reflected, not transferring heat to the internal environment, as shown in the figure below.

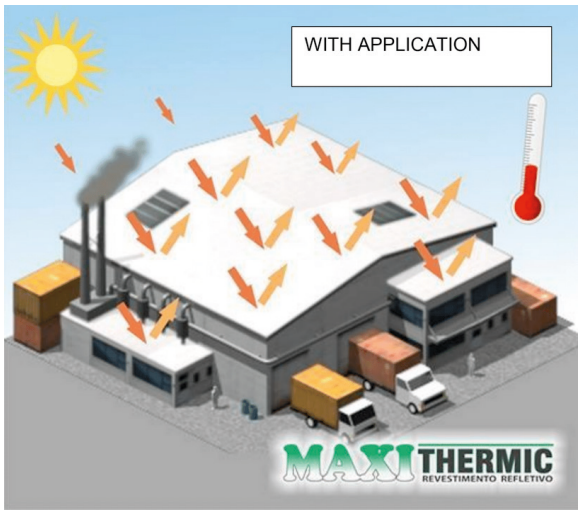

Figure 03: Behavior of Sound Rays in Building Roofs with the application of thermal paint.

Source: *Maxipaint do Brasil.*

Regarding the ways of applying thermal paint, according to information from the MAXIPAINTDOBRASIL website (2018), this occurs as follows:

"Roll;

Paint gun;

Airless (at 200m² / hour / coat)" (MAXI PAINT DO BRASIL, 2018).

As for the surfaces and buildings on which they can be applied to provide thermal comfort inside environments, these are, according to data from the MAXIPAINTDOBRASIL website (2018),

- "Sheds;
- Warehouses;
- Residences;
- Tanks;
- Silos;
- Supermarkets;
- Shopping centers;
- Farms and slaughterhouses;
- Containers;
- Buses and truck trunks;

- Concrete coverings;
- Fiber cement, asbestos and metal roofing;
- Fiber, ceramics;
- Plastic (except polyethylene)" (MAXI-PAINTDOBRASIL, 2018).

Now, according to the REFLETHY website (2018),

> "There is no limit to the application possibilities as the coating adheres to almost all types of materials. It can be used in metal roof structures, such as warehouses, containers, houses, buildings, shopping malls, supermarkets, trailers, livestock stables, poultry and pig farms, grain silos, petroleum and volatile substance tanks, refrigeration units, hermetic boxes for electronic equipment, etc. The application of thermal coating helps to reduce the ambient temperature. Depending on the application, this translates into reduced costs, improved human comfort, improved animal and plant life, greater storage protection, increased life expectancy for the structure itself and longer lifespan of electronic equipment. The available colors are white and black. The applicability of reflection thermal insulation is practically unlimited. Adheres to the most diverse types of substrates used in construction. Wood, metal, cement, concrete and fibers can be coated" REFLETHY (2018).

Furthermore, according to technical information on the REFLETHY website (2018), reflective thermal paints are composed of raw materials

> "Hollow glass microspheres, which are composed of low-density and high-resistance particles, are used to guarantee thermal insulation. Created more than 50 years ago, this technology was initially developed to improve the visibility of road signs. From this, scientists developed different ways of using it, such as in the automotive, naval, construction sectors, among others. Currently, thermal paint can be applied not only to tiles, but also to the facades of homes, commercial buildings, warehouses and other types of buildings. Paints that use microspheres spread the visible and infrared radiation. Because its cells are vacuum-sealed, not only the propagation of temperature is blocked, but also that of sound. In terms of costs, the maintenance of roofs that use particle paint becomes simpler and cheaper. Initially because the thermal shock, which causes expansion and contracting of the material, is eliminated, preventing fissures and cracks.
>
> Furthermore, the material is non-toxic, non-flammable, anti-fungus and anti-mold, unlike traditional paints, which are very susceptible to colonization by fungi and algae" REFLETHY (2018).

CONCLUSIONS

Based on research carried out in books and specific websites on reflective thermal paints and on-site analysis methodologies, it can be concluded that this type of system can provide, in an accessible and efficient way, thermal insulation for the most diverse types of environments, where the It even adheres to the most varied types of surfaces, whether on roofs or facades, thus contributing to the reduction of the transmission of solar radiation from the outside to the interior of buildings, resulting in a reduction in the internal temperature of environments and providing satisfactory thermal comfort to the individuals and also to reduce building energy consumption.

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