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The Building Material Selection Importance at the Building Design Process for its Sustenability

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ABSTRACT

Building construction is one of the biggest responsible for varied environmental impacts. The planning and building design phase are decisive and need special attention in order to reduce possible impacts.

There is not a lot heard about the relationship between environmental ideals and their real interaction with the design process. Some aspects can guarantee the buildings sustainability in order to reduce environmental impacts from the design phase. One of these aspects is the correct selection of building materials. The chosen materials should offer the smallest environmental impact throughout their life cycle. Data shortage and the process agents' misunderstanding about it are some of the problem's causes. This work presents a study about the LEED – american environmental quality cetification metodology – proposals and its insertion at the building design process. This paper conclusions show that it's not always possible to just import foreign models to make the best sustainable architetonics decisions. Choosing solutions that consider the local caracteristics, most of the times, outcome in better results.

Keywords: Design Process, Sustainability, Building Materials Selection

1. SUSTAINABILITY AND CIVIL CONSTRUCTION

The term Sustainability can be defined, in this work, as the satisfaction of the environmental, social and economical questions in all action

undertaken by man in his activities, avoiding negative impacts in all these spheres, and always seeking an adequate future for all.

So that, indeed, be reached that which is called sustainable development, it is necessary according to SILVA (2003), that a balance is looked for among what is socially desirable, economically viable and ecologically sustainable, what forms a 'tripod' that includes the social, economical and environmental spheres that make up sustainable development. Of the environmental sphere it is expected that a balance will be reached between protection of the physical environment and their resources, and the use of these resources in a rational way, without compromising the acceptable quality of life levels in the planet; in the social extent the development of fair societies is necessary, providing opportunities for human development and of an acceptable level of quality of life for all; and in the economical dimension an ease of access is expected to resources and opportunities, increasing prosperity for all, without hurting basic human rights.

In this work, the concept considered is that Sustainable Development is the one which seeks a better quality of life, in the social, economical and environmental spheres, considering the well-being of the current and future population, not wasting and treatin, in the best way possible the existent natural resources, besides avoiding all forms of environmental pollution.

Not reducing the importance of the other spheres, the environmental subjects appear as extremely serious and urgent and must be considered. The construction sector is one of those greatly responsible for several of the environmental impacts that can be observed and this sector is generating irreversible consequences to the environment. For this reason, the emphasis of the study of this work is the environmental aspect of sustainability, which should be indeed considered by the construction industry.

Sustainable construction can be defined as that which considers the economy and efficiency of resources, the life cycle[1] of the enterprise and the well being of the user reducing significantly, or even eliminating possible negative impacts caused to the environment and its users (ECOPLANO, 2006).

VOSGUERITCHIAN et al, (2005) affirms that the main objectives of sustainable construction are always developing. However, they can be summarized in some main items that are: to avoid wasting resources such as energy, water, and raw materials; to prevent the environmental degradation caused by construction and infrastructure throughout their life cycle; and to create inhabitable, comfortable and safe built environments.

There are several alternative choices of constructive systems, materials and available technologies in the universe of the building site, and it is of great importance to get to know their real characteristics, their

[1] Life cycle is the entire process through which a product of building goes through, considering from the extraction of raw materials to production to its final disposal.

performance and possible impacts. It is through this knowledge that one can opt for the best solutions and thus reach good sustainability levels in the products of the building site.

Architecture is a fundamental part of that industry, once it is starting from the project that the main characteristics of the construction are defined, and it must be practiced in a sustainable way. Thus, the practice of architecture according to these principles is called Sustainable Architecture or Eco-sustainable and it can be considered, according to CORCUERA (1999), as that which is socially fair, economically viable and that preserves the environment. So that sustainable architecture can be executed it is necessary that the project be founded upon, basically, the energy efficiency of the building, the correct specification of the materials, the protection of the natural landscape and the re-use of existent buildings.

Therefore, the project presents enormous influence in the search for sustainable buildings.

2. THE DESIGN IMPORTANCE FOR THE BUILDING SUSTAINABILITY

In the current moment, one of the aspects that is becoming decisive in the evaluation of a project's quality, is the subject of sustainability, taking into account environmental issues in order to reduce as much as possible the possible environmental impacts that the building may cause.

Thus, the evaluation criteria for project quality are added: the issues linked to the environmental impact of the proposed solution, the materials used, the generation of residues from the construction process, devices for the reduction of energy and water consumption incorporated to the building, among others.

It is of extreme importance that the architects become committed to design in a way that minimize the impacts of their work on the natural environment and have as a philosophy the constant search for strategies and technologies that make possible the production of sustainable projects, besides working closely with the proprietors and project managers in order to raise and balance factors in the enterprise that can minimize environmental impacts and that can bring benefits to the entrepreneur (Doerr Architecture, 2006).

Since design is the starting point of the buildings life cycle, it is of extreme importance that solutions that minimize environmental impacts are thought of by the planners.

Sustainability issues that are inserted in the design process[2] since the beginning can be worked on much more effectively, and the possibility of

[2] The project process refers to the enterprise's project as a whole and includes all of the decisions that must be taken with respect to the enterprise, its design and construction. It is

obtaining more sustainable and satisfactory projects for the customer become much greater. This insertion of environmental requirements in the buildings design process is called, by HOK (2006), **Integrated Design Process**.

This can be confirmed by MENDLER et al (2005), that look at the need of developing a new design process that demands that every product, process and procedure are to be questioned and revised through a new perspective, that includes the impacts to the environment and human well-being, that the design decisions can cause. In this manner, a substantial improvement can be achieved from the environmental point of view, and a more pleasant and productive atmosphere can be obtained for their users combined with a larger savings for their proprietors.

In Brazil, already one notices a new attitude in the search for an environmentally sustainable architecture, since some architects already have as a premise, the attainment of high levels of environmental quality in their way of design. Additionally, it has already been demanded in some architectural design contests in Brazil that sustainability issues, mainly in the environmental aspects, must be a part of the design. And that, in a certain way, works to infiltrate in the conscience of some architects and planners the perception of his/her responsibility to these issues.

The attention to the environmental requirements of sustainability, in all of the enterprise design process phases, and everybody's or the main agents of the process' conscience of the importance of this "new" demand, is what is considered the most appropriate in the search of great results in that sense. However, of course not always, or with difficulty, these requirements will be obeyed entirely, because they depend on the variants of each case.

Those variants include, besides the physical characteristics of the enterprise, the team involved in its development. And often the entrepreneur himself is not concerned with these issues, making it more difficult to reach an environmentally sustainable building. This situation may hinder, but it should not disable, the possibility of success in this sense. Since a great deal of the main decisions for the building, are "in the architect's hands", who can, and should give the best solutions for a construction to contemplate, in the best possible way, these environmental issues.

Among those solutions, one that possesses a significant role in the environmental sustainability of the building is the correct specification of the construction materials. That is one of the decisions that represent the great portion of responsibility in the result of the design, due to its use in large amounts and to the great impacts that its production and application can generate to the environment and to the building itself in what concerns its comfort.

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constituted by several phases that range from the selection of the site to the post-occupation evaluation.

3. THE MATERIALS INFLUENCE UPON THE BUILDING'S SUSTAINABILITY

The process of the architectural design of the construction begins with the decisions meeting, among which stand out the definition of the constructive technology and the selection of the construction materials to be used. Therefore, the environmental sustainability of a construction depends a lot on the materials selected for its composition.

There are several environmental impacts that the construction in general comes to cause, and the selection of the construction materials to be applied in the construction has great influence in that sense.

The environmental impacts caused by the construction materials happen along all its life cycle, on its extraction and at its final discard. Therefore there is a need to treat the materials in a way that those impacts are as small as possible.

The correct choice of the materials to be used in construction has to happen in a conscious way, considering the distance of its production, its thermal and acoustic performance, its cost, the operation and maintenance easiness, and so on., making that the project gets more integrated into the place where it is going to be implanted, with less impact to the environment (DEL CARLO et al, 2002).

SPERB (2000) says that the impacts related to the construction materials should be appraised in five phases, taking into account its life cycle. In that way, when specifying the materials it should be considered: the impacts caused by the resources' extraction; the impacts during its manufacture; the impacts due to its transportation; the impacts during its use in constructions and the impacts regarding its final disposition.

It is important that, besides the concern with the impacts caused by the life cycle of the materials, we also consider their characteristics in relation to the phase of the buildings construction. In order to also reduce the impacts generated in that stage, MONTEIRO (2002) relates some actions that should be taken to that respect, in the **standardization of the materials**, the **consideration of the dimension and weight of the materials** avoiding the need for machines and equipments for its transport; **a well designed interface between the materials** avoiding the need to add new materials for seals and finishing; the **use of materials of easy disassembly** reducing losses in the disassembly and making possible the reuse of the materials, avoiding the generation of residues, and the need of production of new components, among others.

Besides those actions, the final discarding of the materials to be applied in the construction should be considered from the design phase, knowing if the material in question is reabsorbed quickly by nature or if it is a material that can generate pollution by liberating dangerous residues.

Thus, one notices that the construction materials can have great influence in the impacts that the building will cause to the environment. Through the specification of materials that are less impacting, the obtained results certainly, will be buildings closer to reaching the expected environmental sustainability.

The selection of the construction materials to be applied in the construction is one of the decisions that falls to the architect and that represents a great portion of responsibility in the positive result of the project.

In that sense, DEL CARLO et al (2002) affirms that "*the new variables in the choice of constructive materials are part of a much wider process of change in the way of projecting, that should be incorporated by architects. This new reality, with the need for the incorporation of variables of low environmental impact and sustainability has made designs much more complex and comprehensive. The professionals of the area should have in mind that this new architecture will be the base of the projects of the next millennium*."

With that, we notice the need to have deepened knowledge in relation to the construction materials, in a way that helps architects in their selection. Therefore, some aspects shall be explored ahead that should be considered for the best specification of materials.

CROWTHER (1995), mentions that one of the aspects that is most difficult for an environmentally responsible design is to find the most appropriate materials and products available that help to sustain the quality of life of the planet and of man.

However, DEL CARLO (1999, apud DEL CARLO et al 2002) points out that the specification of materials with smaller environmental impacts is the architects' most suitable way to begin to incorporate sustainability elements in their constructions.

JOBIM (2002) states that usually the process of materials production, their general characteristics, useful life, environmental quality, efficient use of the natural resources and wastes, among others, are possibly ignored by who specifies, in that often the architectural designer believes that he is responsible only for defining the form and aesthetics of the materials.

That is a panorama that needs to be changed, and that can be possible through the explanation of the architect's responsibilities in this sense and with orientation on those environmental subjects that should be incorporated to the process of materials specification.

The generation of criteria for the specification of sustainable construction materials, in what concerns its low environmental impact, has as objective of guiding the planners as to the best possible choice of materials.

4. GUIDELINES FOR THE SPECIFICATION OF MATERIALS BASED ON THE LEED METHOD OF ENVIRONMENTAL ANALYSIS

The Brazilian architects have difficulty in finding data regarding the environmental impacts provoked by construction materials. Starting with the distribution of this data, it will be possible for architects to have access to knowledge about these factors and the specification of construction materials in an environmentally correct way.

In order to aid the architect in his specification, the requirements of the LEED (Leadership in Energy and Environmental Design) are used, regarding the materials and raw materials, and starting from them one can find out some aspects that should be considered in the selection of the materials.

These requirements can be applied in the analysis of the materials and in what concerns their environmental impact, as they can serve as general guidelines for the architect in this choice in the design phase, that is the main proposal of this work.

The LEED Green Building Rating System is a North American system of evaluation and classification of the environmental behaviour of buildings, that according to the U.S. GREEN BUILDING COUNCIL (2006), is used as much as a project aid tool, as a tool for environmental certification. It is a voluntary system based on the American national standards for the development of sustainable and high performance buildings.

This is a system created to be used during the design phases and construction of the building. Being intended for issues like the environmental impacts generated by the selection of the terrain and of the materials of the building, its construction and demolition. And it serves as facilitating and encouraging instrument to the design teams so that they reach a integrated design from beginning to end of the process, resulting in buildings with low impact to their users and the environment and a positive economical impact to their proprietors.

The choice of that method to serve as the base for the creation of guidelines for the specification of materials is justified by the fact that method possesses a simplified structure and is of easy understanding, besides being one of the "friendliest" design aid tools, which according to SILVA (2001) facilitates its incorporation to the professional practice. However, for this work what is interesting about this method are the requirements that serve as aids to the design decisions, more specifically for the selection of the construction materials.

The difficulties of using these methods of environmental evaluation as design tool-aids are known, what is confirmed by LOOTS et al (2005), that affirms that these methods don't possess adequate help mechanisms for the design and, because of this, they end up failing when applied as tool-aids for the architect.

With that in mind, we present the need to relate the stages of the architectural design, with the mentioned aspects for LEED, in way to explain when each one of the environmental "demands" should be assisted in that design phase - among the prerequisites and credits of LEED that

they are applied to the phase of architectural design, emphasizing, in this work, the selection of the materials - and which are the main decisions that the architect should take, in that sense, so that the result of his/her design is an environmentally sustainable building.

The design process has different interpretations. But, in general, it can be affirmed that this process stages change very little from one to another interpretation. In Brazil, the AsBEA – Brazilian Association of Achitecture Offices – has developed a proposal that set up stages since the design idealization, until the building delivery to its final user. Specificly dealing with the architetonic design phase, it can be considered that it has five stages, that are preliminar study, legal design, pre-executive design, executive design and design for production.

The proposal supported in this paper is the use of the LEED aspects at each design stage.

Considering the building material selection importance for the building sustainabilty, it is agreed that in each architetonic design stage, one goal is to be considered: making a sustainable building. The following sugestions aim to sketch directrix to guide architects to make appropriate material selection.

At the ***preliminary study*** – where it is made the characterization of the forms and functions of the building and the preliminary solution of the systems is given, constructive and material methods of finish - the following credits should be considered that should be assisted through the following actions:

- Credit 1. Reuse of the building: This credit many times escapes from the architect's control, once the entrepreneur and/or customer is who defines if they want to reform an existing building or the construction of a new one. However it falls to the architect to propose that the existent structures and the materials are taken advantage of in the place - when this is the case - avoiding the need of larger demolitions and generation of dumps.
- Credit 3. Reuse of the materials: The architect should consider the possibility of reusing materials already used in other works, avoiding the production of new materials. As well as for the new materials that they will be chosen, he should consider those of easy subsequent use.
- Credit 5. Regional Materials: In this stage, the architect should research which are the available materials in the area in which is located the work site, and to give preference to those of easy access and that are adequate to the needs program.
- Credit 6. Renewable Materials: When doing the previous selection of the materials, it is important that one verifies that the chosen materials are coming from renewable sources, avoiding those that have in his/her composition raw materials of difficult renewal.

- Credit 7. Certified Wood: Already during this stage it should be resolved if wood will be used, and in case one resolves to use it, the architect should begin to research which wood type he will apply.
- Durability and Maintenance: those aspects should also be considered already in that initial stage, avoiding the selection of materials that need constant maintenance and repairs.

The ***legal design*** is that which must be approved by the public organs. Therefore, for this stage no new decision needs to be taken in relation to the materials, and also specific demands related to LEED don't exist for this stage.

The following stage is the ***pre-executive design*** when they are made the dimensioning and pre-detailing of the constructive elements and when the consolidated solutions of the systems are given, constructive methods, finish materials, implantation of all the elements of the building. For this stage all of the credits already considered in the initial stage, of the pre-design, should be reconsidered as a way of consolidating the decisions, defining what types of materials will be indeed used, respecting the demands already mentioned, in way not to present great environmental impacts. Besides the credits already considered, the architect should be attentive, in this stage, to the following ones:

- Credit 4. Recycled Content: When defining which materials will be really used in his/her project, the architect should prioritize those to be composed by recycled materials. A lot of times materials exist, equivalent to the traditional ones, that are much less aggressive to the environment. And it falls to the architect to propose in his/her design the use of those equivalent materials, but of smaller environmental impact.

Afterwards is the ***executive design*** stage which should consist of all the necessary information for the execution of the work. Therefore, already one should have all of the definitive solutions of all of the constructive and material methods of finish, of implantation and of all of the systems, besides the constructive details, notebooks of specifications of materials and services. Starting from that stage one can already calculate the budget for the work.

In the *executive design* all the materials should be specified and detailed in agreement with all of the LEED materials and raw materials credits already mentioned and also with credit 2, that should be considered in the following way:

- Credit 2. Administration of the residues of the construction: All of the resulting residues of the construction should be treated in an appropriate manner, and its destination and treatment should be defined in the executive design stage.

The last stage of the design phase refers to the ***design for production*** that should detail the design solutions according to the specific characteristics of the materials and specified components, besides the production processes to be adopted during construction. There is also the need of doing the detailment of all defined solutions in the previous stages so that there is the smallest possible waste in the execution of the work. For this stage there doesn't exist a specific LEED demand, since all of the decisions must already have been taken in the previous stages.

One can obtain better results in the design of an environmentally correct building, if the architect knows the actions that should be taken along the design phase and the best moment to take them. The actions regarding the specification of the materials associated with LEED, as proposed previously, is just one of the items that should be considered in the design of sustainable buildings, and all the other project definitions - such as choice of the site, implantation and shape of the building, water supply and energy systems, among others - they should also be done starting from this association.

One of the positive characteristics that is noticed in these general guidelines is that they include all of the phases of the life cycle of the materials and of the building. That serves to guide the architect worrying not only with the choice of the materials based on cost or aesthetics, but also, and, mainly, with the possible impacts that that material can be causing to the environment in all its phases, from the extraction of their raw materials to its final destination.

All those items as they are considered by the architect in the moment of choice of the materials aid in the obtaining of an environmentally sustainable building. Even if is not possible to put in practice all of the proposed aspects - since each project has its own characteristics - it is hoped that the largest possible number of those aspects are considered.

It's not easy to define wich materials are the most sustainable ones, because of its various aspects to be considered. To make this decision it is important to consider the building location, the possibility of recycling and reusing it, and so on. But there are some materials that seem to be more sustainable than others. The materials that need little industrialization, and/or have fast renovation are some of them. An example of this kind of material is the certified wood, the bamboo, compressed earth blocks, and others. Plastics and metals, as aluminium and steel, need a lot of energy to be manufactured and also come from non-renewable sources and these reasons are already enough to say that they should be avoided.

Indeed these are only some aspects to be considered, but the most important thing to do when deciding on wich material to use, is to consider the local characteristics and the building necessities, combined with the aspects presented earlier in this paper.

5. FINAL CONSIDERATIONS

The architect, when designing, should consider the whole life cycle of the building and their components to make, in each stage, the less impactable choices as possible.

The materials selection is one of those important decisions, since they are used in enormous amounts in any construction. Besides that, the environmental impacts caused by the construction materials begin from the natural resources extraction to its production until its final discard. Therefore, there is the need to select the materials in a conscious way.

In Brazil, some architects are already acting in search of a more sustainable architecture, but still in a very isolated way. They are very few who already possess this conscience, but it is hoped that, little by little, that attitude will become the most common in the sector.

A difficulty that presents itself is the lack of information on the subject. Little information is available about the characteristics of the construction materials and their environmental behaviour, which is of extreme importance to making the specifications in the best possible way.

Strategies for the spread of information on the available construction materials need to be created. Only then can the architects be aware of the characteristics, be them positive or negative, of the materials that they are choosing. That is important since, many times, that selection is made mistakenly due to the simple lack of information on the part of the architect.

The proposal of guidelines is a form of taking to the architect some of this information. Even if there is no comprehensive information about the environmental behaviour of the materials, these are for the architect to know, at least, so that he knows what areas he must worry about, and know what he should research with respect to the materials that he/she is choosing.

Already one can find several existent practices being used of methods of environmental evaluation as aids to the environmental decisions along the architectural design, and it is noticed that this is a necessary action and that still deserves to be detailed better and expanded.

With that, we intended the use of the LEED system associated to the architectural design so that the guidelines proposed here could be presented. Use of LEED in association to the architectural design seems quite viable for the Brazilian reality. That is because the format of the presented design process is already common to many architectural offices in the country and the use of LEED, as a checklist, has shown itself viable. Thus, the combination of the two present characteristics of working in a satisfactory way.

Although LEED is based on the North American norms and standards, it's noticed that its checklist can already be applied in Brazil, as aid to the design phase, and specifically as an aid in the decision of the construction materials, that is already a step in search of better environmental solutions.

Thus, it is hoped that, more and more, architects seek more knowledge in environmental aspects, inserting them as criteria for the specification of construction materials.

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