

Perspective around Sustainability in Civil Construction

Thiago Vieira de Cássio¹, Robson Santos da Rocha², Fabiana Rocha Pinto³, Erika Cristina Nogueira Marques Pinheiro⁴

^{1,2}Department of Engineer, Estácio of Amazonas - Brazil

³Engineering Coordinator, Estácio of Amazon - Brazil

⁴Engineering Teacher, Estácio of Amazon - Brazil

Received: 08 Apr 2021;

Received in revised form:

11 May 2021;

Accepted: 27 May 2021;

Available online: 11 Jun 2021

©2021 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Sustainability. Civil
Construction. Environment. Environmental
Preservation. Natural Resources.

Abstract— The concept of sustainability is characterized as a condition where there is a desire to make available to society and future generations the same resources that are currently being appreciated, considering the integration of economic, cultural and especially environmental aspects, in order to preserve these environmental resources, respecting their production and consumption limits, to prevent compromising negatively. The objective of this article is to demonstrate the viability of sustainable proposals in the field of civil construction and the contributions of this practice to the conservation of the environment and the availability of resources for other generations. A systematic literature review study was carried out, using articles published between 2010 and 2020, covering a period of ten years, in order to comprise current research and contemporary information's around trends and perspectives on sustainability in civil construction. For the construction of this article were used Google academics and Scielo (Scientific Electronic Library Online) databases from pre-selected authors. Eight scientific articles were gathered from the search in the databases, which 2 were excluded for being outside the pre-determined period for the research, 1 was duplicated, 1 was eliminated for presenting the topic outside the specified by this project, 1 was excluded after the analysis of results and discussions, therefore leaving only 3 articles for discussion. The most important way to carry out a sustainable construction is to determine measures and factors that can stipulate the concepts defined as ecologically viable for civil construction. The practices raised and determined for these projects addressed the thermal comfort with the use of the green roof cover, the renewable electricity through photovoltaic plates, the use of water from the cistern, among others.

I. INTRODUCTION

The environmental impacts caused by the absence of conscious projects or proposals on construction grow significantly in Brazil, reaching high proportions that cause deforestation, migration of animal species and, consequently, the extinction of species, in addition to contamination of water bodies, which significantly

decreases the availability of resources for future generations. Knowing this, the competent organs in the inspection demand adopted as a mitigating measure the mandatory presentation of construction projects that emphasize sustainability, highlighting ecologically correct practices such as recycling and reusing materials, as well as solid waste management plan, area degradation recovery

plan and percentage of suppression and species management.

According to [1], the concept of sustainability is characterized as a condition where there is a desire to make available to society and future generations the same resources that are currently being appreciated, considering the integration of economic, cultural and especially environmental aspects, in order to preserve these environmental resources, respecting their production and consumption limits, to prevent compromising negatively.

An assured business segment that presents an appropriate environmental conservation plan is major considered mainly in the civil construction sector, being recognized as a reducer in the face of environmental impact [2]. This assessment is based on four main aspects: sustainable planning in the built area, economy and efficiency in the use of water, use of renewable energies, conservation of materials and preservation of the asset's resources. It is believed that this item coupled with an environmental conservation plan helps in the interior and exterior quality of the environment to be built. Include sustainable activities in civil construction is a future trend, just like the government the investors also pay attention and position themselves inside the construction sector under the issue of creating sustainable properties capable of continue to exist while simultaneously preserving the environment, as quoted [3]. The author also states that adding these practices encourages environmental adequacy, social justice and economic possibilities, due the real objective of constructions considered sustainable is to contemplate the environment, economic and sociocultural areas.

As mentioned, [4], the civil construction industry in Brazil is characterized as one of the largest producers of solid waste and the main prompter of environmental impacts, since most of these generated wastes are available in the environment for a longer time until they reach total degradation. Most of the construction projects available in the country do not presents an adequate disposal plan and, for this reason, these wastes are disposed incorrectly. Some materials even have in their composition synthetic substances that affect not only the development of plants, but also promotes human diseases, in behalf of the inclusion of technological actives widely used in these materials.

[5] discusses that, behalf this scenario, the civil construction tries to position itself efficiently in the face of the environmental sector requirements. Therefore, in the last 10 years, most of the environmental conservation plans presented by civil engineering have highlighted as a suggestion for a sustainable perspective the practices of recycling and reuse of materials. Recycling is the last phase

that solid waste must go through during its reuse process, because this is where it acquires a different form and property from the initial one, being able to be reused in other ways in projects and other civil construction services. This method is defended by several environmental laws, being considered a sustainable and ecologically correct practice. To complete the recycling process, first is necessary to separate and select these wastes according to their composition, this way generating the correct disposal of these materials, reducing impact events evaluated by environmental experts in their totality.

[5] indicates that one of the techniques that has stood out in the field of civil construction in the last seven years is the tendency to increase the recycling and reuse of concrete. This process consists in gathering the wastes that eventually remains at the end of processes such as construction or demolition, with other aggregated compounds. In such way, the recycling of this material can generate, for example, structures or even decorative objects for the facades of buildings and constructions. Other materials such as sand, gravel and crack, for example, also have recycling models proposed in construction projects. Thus, they can go through the recycling process together or separately.

The awareness of sustainable practices within civil construction must be linked to any type of project, regardless of what it proposes to be done. In every detail of the work, environmental responsibility must be emphasized, so that everyone involved is aware of the environmental impacts that that activity can cause. For this reason, sustainable housing projects have been gaining proportion in the ideas of large national construction companies. For this reason, the objective of this article is to demonstrate the viability of sustainable proposals in the field of civil construction and the contributions of this practice to the conservation of the environment and the availability of resources for future generations.

II. MATERIALS AND METHODS

It was carried out a systematic literature review study, using previous articles published between 2010 and 2020, covering a period of ten years, in order to comprise current researches and contemporary informations around trends and perspectives on sustainability in civil construction. For the construction of this article were used Google academics and Scielo (Scientific Electronic Library Online) databases from pre-selected descriptors: Sustainability, Civil Construction, Environment, Environmental Preservation and Natural Resources.

To fulfill this research, were selected five articles in Portuguese language, published in the period 2010 to 2020,

in which were analyzed the abstract, title and year of the publication in front of the fulfillment of the predetermined parameters in the experimental outline of this review. The inclusion criteria were previous published articles of case study type, and observational studies, as well as monographs and master's dissertations that correlate the proposed theme with the research presented in the literature.

After the stage of identifying the sources, it was necessary to analyze the material, starting as: reading the titles found and excluding those that do not fits to any of the inclusion criteria; reading the abstracts of the studies selected in the previous step, and excluding those that were not in agreement with the topic addressed.

III. RESULTS AND DISCUSSIONS

Eight scientific articles were gathered from the search in the databases, which 2 were excluded for being outside the pre-determined period for the research, 1 was duplicated, 1 was eliminated for presenting the topic outside the specified by this project, 1 was excluded after the analysis of results and discussions, therefore leaving only 3 articles which are presented in the table below, according to the analysis criteria of Authors/Year, Results and Suggestions (Table 1).

Table 1. Reviews of Sustainability's constructions.

AUTHOR/YEAR	RESULTS	SUGGESTIONS
GOULART, I. A. S., 2015. [7]	The viability analysis of three sustainability methods for the Lajes Residential Building consisted of the introduction of methods such as solar heating, rainwater harvesting and waste reuse, where it was possible to observe that there were financial savings, installation feasibility and significant reduction of environmental impacts in just one. As for the other two, the installation and permanence of the method in the construction would greatly increase the	The replacement of electric showers by a solar heating system would bring a high reduction in the value of the energy bill per family, however, the high cost of installation could make the adoption of the solar heating system unfeasible. The reuse of waste in the construction would also have reduced too many impacts, in addition to diminished costs, if it had been used to the construction reuse.

	acquisition value for maintenance, which should be replaced by other alternatives.	
DANTA S, M. J. F.; MAIA, F. C. P., 2018. [8]	The building analyzed draws a market differential, for implementing equipment to reduce environmental impacts, worrying about its maintenance, distributing guidebooks to residents and explaining the need to raise awareness of the importance of maintenance and permanence of its original characteristics.	Can be used as a solution the implementation of at least one sustainable method per construction, and the entrepreneur must inform his client about the extra amount to be spent and the advantages that this can generate during his/her dwelling. Continuing this process can generate a residence with most of the sustainable items foreseen by green works in civil construction, reaching the goals proposed by this type of building.
AIRES, E. K. S., 2019. [9]	From a financial point of view, entrepreneurs have always questioned the high costs involved in a green project. The most important benefits that green buildings offer are related to the climate and the natural environment. Green buildings not only reduce or eliminate negative impacts on the environment, using less water, energy or natural resources, but also positively impact it, generating their own energy or stimulating the growth of biodiversity.	In this study, it is possible to propose as a solution the adherence of thermal comfort with the use of the green roof cover, renewable electricity through photovoltaic plates, the use of water from the cistern through the storage of rainwater, the floors from the civil construction waste and other components that have implemented sustainability in the building.

The adherence of sustainable practices in civil construction can be varied, leading to the adoption of

practices that must reach from the construction assistants to the engineer responsible for the project. [10], discuss about highlighting various methods of starting the use of sustainability concepts in a construction, however, claims that the most important, in the initial term, may be the organization of events that generate, like seminars or lectures, the theme "Environmental Responsibility" because it is an idea that should be taken in consideration not only in the professional view, but even more as a citizen. For the professional coordinators of constructions, must be emphasized the procedures, objective and practice of licensing, as well as intervention projects that help in the treatment of waste and in the supervision of renovations, repairs, excavations, besides the vegetal suppression, if necessary, with the critical and professional look of specialists who serve as great allies in this process. Only from that is it possible to insert educational materials, such as booklets and manuals, so the awareness of environmental responsibility can be established in the understanding of all those involved.

With all the knowledge offered, it is possible that the engineers and others responsible for the work create inspection and support groups to supervise the environmental responsibility practices, must be an employee who knows the main techniques of environmental preservation, presented in the initial training of their work. Data estimate that developed countries, such as the United Kingdom, have housing constructions that yield around six tons of carbon dioxide per year, a total of approximately 27% of emissions compared to global data for other countries like the United States. In this country, domestic life has become synonymous of heating, as simple activities, such as cooking or putting appliances to work, represent around 78% of heating throughout the region.

Some methods of reusing materials in civil construction, such as the reuse of construction and demolition waste, known as RCD, is a sustainable and environmental preservation alternative that can be practically used in all sectors that involve a construction process. Currently, the biased idea of reusing materials, such as concrete, is one of the most used recycling processes. Classified in the waste group A, concrete can be found like the rest of construction in the form of fresh or hardened tailings and its recycling process follows procedures such as sorting, which assesses the material situation; crushing which constitutes breaking into smaller pieces if it is in solid state and the sieving. In view of the execution of these steps, the RCD are classified as recycled concrete or mixed recycled, considering that concrete can be applied in different ways, including in industrial processes that produce mortar, asphalt paving base, sidewalks, among several other applications [10].

[11], address in their studies evidences those sustainable constructions add benefits to the preservation of the environment in different ways, and for this type of enterprise the acquired methods must be used with a long-term use project. This way, installations, exchanges and maintenance should already be easily thought out and pre-established.

Some sustainable methods, such as solar panels, water collection facilities and even encouraging residents as reforestation helps to improve their quality of life, which enhances the pleasure of living in the area and enjoying nature in an unparalleled way. The fewer artificial resources, the greater the support for the environmental cause.

The Resolution N° 307 instituted by the National Council for the Environment (CONAMA) conceptualizes recycled aggregate as a granular material from the processing of construction waste that has technical characteristics for application in building constructions, infrastructure, landfills and other engineering works, being considered a sustainable practice in the context of civil construction and currently treated as an alternative to reduce waste arising from constructions that cause significant impacts to environmental conservation, according to [12].

Recycled aggregates can have various uses ranging from the making of concrete to what is known as the deformation module. However, it is noteworthy that it is necessary to evaluate possible risks of environmental contamination during the material's half-life cycle until its destination. The literature emphasizes the decrease of impacts through the reduction of construction aggregates, which are left over after its completion, on the other hand some scientific studies point out certain products and their excessive marks, such as cement, for example, which cause contamination in the soil due to their degradation after the end of its half-life.

Taking into account the rational use of raw materials, the recycling of waste arising from construction and the reduction of waste, sustainable construction offers significant advantages to the enterprise, highlighting what the literature points out as the better acquisition during construction, such as the reduction of spending, increased tax incentives for the sustainable practice of construction, comfort and life quality for residents, conscious use of light, water and other factors that interfere with environmental suitability, besides helping to increase sales in the civil sector, as this practice is already considered of great value in contemporary society.

[13] mentions that all over the world it is possible to observe tax incentives for the development of sustainable construction projects. One of the countries that invests the

most in this type of project is Germany, as in addition to encouraging green construction, it remunerates residents for respecting consumption limits and adherence to sustainable methods, which in the country is already a measurable practice. In Brazil, this action was implemented a few years ago through the “Green IPTU” program, which offers discounts on the urban property and land tax rate that adhere to eco-efficient methods in construction or renovation. Some of the methods that can offer discounts on the “Green IPTU” rate are the capture and reuse of water, the recycling and reuse of construction waste, the use of solar panels to heat water and photovoltaic panels to generate electricity in the home.

Carefully analyzing all the results presented, it is possible to observe that the capacity to implement sustainable projects in the scope of civil construction and housing buildings is still restricted to many ways, sometimes failing to reach energy demands and sustainable installations. Besides, there are some limitations that prevent these methods from being adhered to, such as architectural incompatibility, high costs and unavailability in the built-up area. Thus, it is necessary to plead for more advanced technological measures in the field of engineering, so that in the near future there may be constructions that contain 100% sustainability, with affordable costs for acquisition in the market. It is evident that the adhesion of equipment for a sustainable construction requires high financial capital for the installations and other objectives to be completed. In this way it is possible to say that high budgets are also defined as an obstacle to sustainable constructions today.

Regarding possible budgets, it appears that for each sustainable project executed, the value of the work rises to almost 36% more compared to the values of conventional constructions. Among the practices to be acquired, the one that generates the most cost is the acquisition of photovoltaic panels that make up electrical system from the solar energy. What must be taken in consideration is that solar energy can be made viable in an interval of approximately 7,15 years, however due to its useful lifetime is not a long period. For this reason, large projects are not executed when analyzing these cost/benefit criteria, even more so when the family calculates the period of residence in the place [14].

Nonetheless, in order to conserve the environment, all the alternatives presented so far are green construction methods, ensuring the continuity of generations and the conscientious use of the resources available in it. Thus, this practice becomes essential, advantageous and adds value in terms of reducing ecological impacts, which in fact is the central concern of all humanity when it comes to building and suppressing nature to make room for large projects.

IV. CONSIDERATIONS

It is concluded that the influence of sustainable development in the aspects that concern the realization of a building, from the planning stages to its execution, benefit the environment. Therefore, it is possible to define that the presentation of measures that can be adopted for the practice of sustainable development in civil construction, at this time, implies introducing the practice of sustainability in all sectors, influencing since the choice of construction materials to the analysis the use of energy, in the importance of controlling water resources, and more.

The most important way to carry out a sustainable construction is to determine measures and factors that can stipulate the defined ecologically viable concepts for civil construction. The practices raised and determined for these projects addressed thermal comfort with the use of the green roof cover, renewable electricity through photovoltaic plates, the use of cistern water through the storage of rainwater, floors from waste of civil construction and other components that implemented sustainability in the building and with the constructive elements determined.

In fact, the capacity to implement sustainability in housing buildings is still limited, not complying with the energy demands of its facilities, with little water reuse; incompatibility in some architectural structures; high costs and unavailability of space, which are essential requirements for a sustainable building. In this context, this research pleads for the technological advancement of engineering, so that, in the future, there may be buildings, which present an increasing percentage, with affordable costs, in the market.

REFERENCES

- [1] ARAÚJO, V. M. **Best Practices for More Sustainable Construction Site Management**. Dissertation (Master Degree in Engineering) – Concentration area: Civil and Urban Construction Engineering, Polytechnic School of the University of São Paulo, São Paulo, 229 p., 2009.
- [2] DEGANI, C. M.; CARDOSO, F. F. **The Sustainability Throughout the Life Cycle of Buildings: The Importance of the Architectural Design Stage**. Research Center in Technology of Architecture and Urbanism Faculty from University of São Paulo, São Paulo, 2002.
- [3] CÔRREA, L. R. **Sustainability in Civil Construction**. 2009. Monograph (Specialization Course in Civil Construction) – Department of Materials and Construction Engineering, Federal University of Minas Gerais, Belo Horizonte, 70f., 2009.
- [4] TEODORO, N. F. G. **Contribution to Sustainability in Civil Construction: Recycling and Reuse of Materials**. Technical University of Lisbon, 2011.
- [5] FERNANDES, B. C. M. **The use of Waste in Civil**

Construction and Demolition - CDD - As an aggregate for concrete. UNIFOR, Formiga, 2015.

- [6] JACQUES, J. R. **Study of the technical feasibility of using recycled concrete as a coarse aggregate in Portland cement concrete.** Regional University of the Northwest of the State of Rio Grande do Sul. Ijuí/RS, 2013.
- [7] GOULART, I. A. S. **Sustainable Construction: Sustainable Construction of a Building.** Faculty of Management Sciences of Manhuaçu. Course Completion Work, 2015. Available at: <http://pensaracademico.facig.edu.br/index.php/repositorio/article/view/638>. Acesso em: 20 de maio de 2021
- [8] ANTAS, M. J. F.; MAIA, F. C. P. **Environmental Sustainability in Civil Construction: A Study Case.** National Congress of Seminar Diversity – CONADIS, 2018. Available at: <https://www.editorarealize.com.br/index.php/artigo/visualizar/50859>. Acesso em: 15 de maio de 2021.
- [9] AIRES, E. K. S. **Sustainability in Civil Construction: The Case of a Popular Standard Home.** Uni NOVAFAP. Course Completion Work, 2019. Available at: https://assets.uninovafapi.edu.br/arquivos/old/arquivos_academicos/repositorio_Biblioteca/engenharia_civil/20191/SUSTENTABILIDADE%20NA%20CONSTRU%C3%87%C3%83O%20CIVIL%20O%20CASO%20DE%20UMA%20RESID%C3%8ANCIA%20PADR%C3%83O%20POPULAR.pdf. Acesso em: 15 de maio de 2021.
- [10] CORTÊZ, R. G.; FRANÇA, S. L. B.; QUELHAS, O. L. G.; MOREIRA, M. M.; MEIRINO, M. J. **Contributions to Sustainability in Civil Construction.** Electronic Systems & Management Journal, n. 1, vol. 2, p. 384-397, 2011.
- [11] MULLER, J. H.; TRINDADE, J. F.; PIOVESAN, T. R. **Sustainability as an Integral Part of Civil Construction.** XXV Scientific Initiation Seminar, 2017. Available at: <https://publicacoeseventos.unijui.edu.br/index.php/salaconhecimento/article/view/8106>. Acesso em: 20 de maio de 2021.
- [12] NATIONAL ENVIRONMENT COUNCIL - CONAMA. **Resolution 307: Construction waste management.** Available at: <http://www.mma.gov.br/port/conama/res02/res30702.html>. Acesso em: 20 de maio de 2021.
- [13] AIRES, E. K. S. **Sustainability in Civil Construction: The Case of a Popular Standard Home.** Uni NOVAFAP. Course Completion Work, 2019. Available at: https://assets.uninovafapi.edu.br/arquivos/old/arquivos_academicos/repositorio_Biblioteca/engenharia_civil/20191/SUSTENTABILIDADE%20NA%20CONSTRU%C3%87%C3%83O%20CIVIL%20O%20CASO%20DE%20UMA%20RESID%C3%8ANCIA%20PADR%C3%83O%20POPULAR.pdf. Acesso em: 21 de maio de 2021.
- [14] MULLER, J. H.; TRINDADE, J. F.; PIOVESAN, T. R. **Sustainability as an Integral Part of Civil Construction.** XXV Scientific Initiation Seminar, 2017. Available at: <https://publicacoeseventos.unijui.edu.br/index.php/salaconhecimento/article/view/8106>. Acesso em: 22 de maio de 2021.