Sustainability analysis of building materials

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Abstract. Our analysis of the sustainability of building materials is often overly simplistic. When we think of sustainable materials, it's easy to think of wood, rattan, bamboo, or stone, which are grown in nature, taken from nature, and are undoubtedly renewable resources or renewable materials. However, it would be a dull stereotype to assume that these materials represent an analysis of sustainable materials in construction. Regardless of whether a particular material is suitable for all time and space environments, even if we reduce the consideration of design function, what is the relationship between the serious pollution caused by the huge amount of resources consumed by long-distance transportation over mountains and mountains and green design or sustainable design, not to mention that inappropriate materials may lead to a decline in the quality of the design product, shorten the service life of the design product, and bring more serious waste of resources. In conclusion, there is a lot to discuss about the sustainability of building materials. Green building space design and sustainable building materials analysis is a very complex topic that involves many aspects and the application of knowledge from many disciplines. The sustainability assessment of building materials can lead to at least the following topics: the choice of building materials themselves, building design methods, energy efficiency and the environmental impact of building design. The examples of materials we have just listed, such as wood, bamboo, rattan, are actually based on the perspective of the choice of the material itself, and it cannot be said that there is anything wrong with this, but this analysis is too narrow. This paper will comprehensively analyze and evaluate the sustainability of building materials in terms of material selection, design, utilization and environmental impact, and try to provide a more mature evaluation method or thinking process to assess the sustainability of building materials.

Keywords: Building Materials, Sustainability, Material Analysis.

1. Introduction

Green design and green material application are enduring topics in architectural design and urban planning, industrial design and other related fields. Needless to say, the environmental problems we are facing are severe. We need to solve this problem, and we have to solve this problem, in the final analysis, the core of green design is still human-centered design, which is based on the long-term sustainable development of human beings. Green design requires less material consumption, reuse materials as much as possible, and design materials as much as possible, all of which are well known. But how to use it, how to find the right key material selection, and how to use it in the right place, is not very easy.

2. Influencing factors

There are many factors that can affect the sustainability of building materials, and the data to be calculated and processed in detail is very complex, almost to the point of deducing the world line. First of all, the most important and most easily associated is the choice of building materials themselves, that is, the existence of materials themselves, should not have an obvious negative impact on environmental ecology and design sustainability, and use recyclable and recyclable materials as much as possible in architectural design behaviors, and avoid the use of materials that may pollute the natural environment. The second is to reduce energy consumption, that is, to save as much as possible in the process of using materials, to reduce the cost of use as much as possible, and to improve the utilization efficiency, which requires building materials to be adapted to local conditions as much as possible, and to choose a scheme with lower transportation costs, or to develop innovative

materials with higher technology and more environmentally friendly materials, such as metal aluminum materials can greatly reduce the consumption of material quality, and waste metal aluminum can often be continuously recycled, with high recycling value[1]. The last thing to talk about is the influence of design behavior on materials, and good design can often achieve the maximum and best design effect with the least resource consumption.

2.1 The selection of the material itself

There are many common building materials, which can be divided into the following parts: first of all, structural materials, reinforced concrete is the most common in modern buildings, there are many components of concrete, common coarse aggregates such as stones, broken aggregates such as sand, and the most important cement composition, composite and strong, steel bars have high strength and plasticity, often used for load-bearing and other functions. Then there are the paving materials, such as ceramic, metal, or plastic tiles for the roof, wood or stone tiles for the floor, tiles or planks for building facades, glass or wood panels for doors and windows, etc. Finally, there are many auxiliary functional materials, such as electrical plumbing materials and so on.

In the following sections, we will analyze the sustainability of the materials themselves based on the three main types of building materials mentioned above. First of all, the first category is natural renewable materials, such as wood and bamboo, the advantages of this class of materials are simple and clear, they are renewable, they have little pollution and are very sustainable. For example, in The best sustainable materials for green buildings, the authors note that bamboo is "known for its rapid growth and minimal environmental impact, and that bamboo provides superior strength and versatility to a wide range of building components." As a renewable resource, it integrates seamlessly with sustainable practices, reducing carbon footprints and promoting resource conservation. "The inherent properties of reclaimed wood add a unique charm to flooring, panelling and furniture, while its durability ensures longevity." By reusing this resource, the construction industry reduces its environmental impact, contributing to resource conservation and reducing its carbon footprint. [2] "The use of natural materials such as bamboo or wood increases the sustainability of buildings in the most intuitive way.

The second category is some synthetic renewable materials, which are more expensive to produce and consume than the previous type of materials, but also tend to have more durable and universal properties, such as recycled steel, hemp fiber reinforced concrete, recycled glass, recycled plastic and other materials. For example, as mentioned in the article 8 green building materials, plastic can actually be used as a building material. A three-bedroom house in Nova Scotia, Canada, built from more than 600,000 recycled plastic bottles, takes full advantage of the unique properties of this unusual material. It is able to withstand harsh weather conditions, and it is resistant to rot and mold[3].

The last category of sustainable building materials is a wide range of high-tech and environmentally friendly building materials, such as grass pavement tiles, straw wallpaper, hemp wallpaper, gaseous concrete, low-VOC paints and topcoats, solar panels, bio-roofs, etc. This kind of material uses the latest science and technology to effectively reduce the consumption of materials and environmental pollution by the design behavior, and achieves a good sustainable effect.

2.2 Impact of energy consumption

This section needs to continue to discuss the choice of building materials, as well as the many possible effects of materials. In the first part, we only discussed whether the material itself is "sustainable", but as we mentioned earlier, sustainable materials do not have the qualitative value of sustainability when placed in the wrong place. It is not unreasonable for South Asians to build houses with bamboo, East Asians from wood, and Eastern Mediterranean people to build houses with stone, which in itself is an economic wisdom that reduces energy consumption and increases the sustainability of materials and design.

Some of the less competitive materials that were eliminated in the previous category of sustainability picks can be of astonishing value in this regard. For example, the consumption of

polystyrene, rock wool and other materials is higher than that of wood and bamboo, but these two materials have high thermal insulation properties, and the space built with them has good thermal insulation properties, which is equivalent to a considerable part of the air conditioning expenses in a hot environment.

The same is true for other airtight materials, which can bring a lot of value to the good realization of a certain function of the design, which makes some materials that do not seem so "sustainable" have a good place. Improving the service life itself is to reduce resource waste and increase sustainability.

2.3 The impact of design actions on sustainable materials

Building materials participate in design behavior, and good design behavior can give full play to the sustainability of materials, or reduce the unnecessary use of materials, or reduce the generation of environmental pollution, which are the embodiment of design and material sustainability. The natural lighting and shading design that is common in many buildings saves a lot of material consumption by using design behavior. Or by improving the heat mass or water efficiency, the consumption of materials can be reduced. For example, in the article "Tianyou · Zero House", the first near-zero energy building in China, "Zero House" discusses the technology and mode of low-cost near-zero energy consumption, low-tech local construction, and multi-mode prefabricated system of rural near-zero energy building from the future of sustainable rural development. The comprehensive energy saving rate of buildings has reached more than 80% (the comprehensive energy saving rate of buildings required for near-zero energy buildings is ≥60%)"[4]

3. Challenging Risk Assessment

The sustainability assessment of building materials is a very complex issue, and there are many projects to consider. Generally speaking, there are mainly the following aspects, the first is the life cycle assessment of building products, that is, the assessment of the whole process of building materials from production to transportation, use and finally disposal, in a similar way of data tracking, and strive to calculate the possible impact on the environment of each place[5]. To be fair, this is a good way to evaluate, because it exhausts almost every reference term, but the computational cost it brings is also obviously high, and perhaps the development of AI technology in the future can help to some extent.

While sustainable materials contribute to green design, they can also bring some negative effects and create some risks. This also includes many aspects, among which the emission of substances such as lead sulfate, lead titanate, carbon dioxide and other substances is a relatively common problem, and many times in order to produce or use sustainable materials, I have to produce a lot of waste, which greatly reduces the environmental protection effect of sustainable materials, and even has a more serious negative impact. For example, in the article Towards a Green Future: Lead-free Piezoelectric Ceramics from the Perspective of Energy and Environmental Sustainability, it is stated that "although the above system does not contain toxic lead, there are still potential pressures on human health and the ecological environment in the process of production, use, and disposal. Taking KNN ceramics as an example, niobium is the largest element in the system (about 54% by mass), and its low abundance in the earth's crust and complex extraction and purification process will also cause environmental stress. Therefore, a comprehensive environmental impact assessment of lead-free piezoelectric ceramics in a broader context is essential. [6] ”

4. Conclusion

The sustainability assessment of building materials is a complex issue, and how to accurately evaluate it is worthy of further research. But at least we know that there is a lot that can be done by evaluating the entire material life cycle before the design act takes place, selecting building materials

accurately, using clean, renewable and non-polluting materials as much as possible, using new technologies to avoid pollutants as much as possible, reducing energy consumption as much as possible, and maximizing the value of limited materials with design methods.

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