



# A SYSTEMATIC REVIEW OF ARCHITECTURAL ENGINEERING PRINCIPLES BASED ON MATERIALS

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## Abstract

The construction industry is one of the most important and growing industries in developing countries. This industry directly affects economy, community culture and the environment, therefore, appropriate policies and decisions will be an effective step towards achieving sustainable development criteria. In this context, the use of sustainable resources and resources can be used to optimize the use of resources, and to conserve natural resources, reduce production wastes resulting from the destruction of buildings or repairs, reduce greenhouse gas emissions, and reduce environmental damage. Undeniable role To play. Due to the uncertainties that exist in the decision making process, the choice of a suitable construction system is very complicated and difficult. On the other hand, knowledge of the very large construction systems has structural weaknesses and includes diverse expertise. Hence, the choice of sustainable building materials and materials in design projects for the design and implementation of a suitable building system is a principled and appropriate methodology using multi- criteria decision-making methods. In this research, to determine and facilitate a suitable standard model for selecting equipment and materials based on sustainability and with the approach of full productivity management in construction projects has been addressed. Then, by analyzing information, some of the most important factors that determine engineers 'and designers' choices in selecting materials for sustainable design and energy management are determined and compared with the views of researchers inside and outside the country and at the end of the selection are unique criteria. . To evaluate and select the most suitable materials, topsis has been studied and modeled to provide an analytical decision making model to achieve the goals of selecting building materials for sustainable design.

**Keywords:** Building materials, sustainable design, multi-criteria decision making,

Topsis

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## Introduction

One of the basic needs of mankind since the beginning of creation has been the issue of housing and shelter, the widespread and increasing need of the society for buildings and housing, the necessity of using new building systems and materials, in order to increase the

speed of construction, lightening, increasing useful life, and also making buildings resistant to earthquakes. has raised more than before. Solving problems such as long implementation time, low useful life, high construction costs and environmental problems and pollution in today's cities, requires a common determination and a fundamental transformation in the type and

method of using construction materials and systems (1). Due to the advancement of technology, human life has changed a lot compared to the past, and our needs and desires are also affected by this change. Architecture, like other sciences, uses new technologies to respond to these needs. Incorrect construction methods in the society have caused the environment around us to become sick and have created an unhealthy biological system. The materials used in buildings play a significant role in creating a correct construction and preserving the environment. Choosing sustainable and appropriate building materials reduces energy consumption and provides more health to the environment, because these materials reduce fuel consumption for heating buildings, and this reduces the emission of air pollutants and greenhouse gases. Also, the use of natural resources decreases and the society approaches sustainability criteria. The use of appropriate materials leads to a sustainable architecture, so this research will examine the role of materials to create sustainable architecture and the characteristics of these materials (2).

General characteristics of materials: To examine the characteristics of building materials, their characteristics are divided into the following groups(3): Physical properties, chemical properties, mechanical properties, functional properties, architectural properties, costs and economic issues.

The construction of an efficient building depends on the correct selection of materials. When choosing them, the architect must review all the characteristics of the materials according to the above categories. The functional properties and architectural characteristics are not the result of laboratory studies on the materials, but firstly the principle of workshop experiences and secondly the product of the architect's creativity. In many cases, economic issues are the controlling factor in the selection process (3).

### Physical properties of materials

The general physical properties of materials are divided into the following four categories: Basic information, the physical effect of water and humidity, the reaction of materials against thermal shock changes, gradual temperature changes, increases and decreases beyond normal and fire, the interaction of light, sound and electricity.

### Materials during the construction of the

### building

In the simplest form of house building, a person in need of shelter searches for a large and shapeless volume of land in proportion to his size and throws away the found waste materials; And on the contrary, when he wants to build a shelter on flat ground, he has to shape his residence by using materials extracted from different places. To put it better, the combination of materials and building materials is practical in order to create a stable volume that can be lived in. The main topic of architects' work in the way of production, architecture, is to shape a material that has certain physical and chemical characteristics. The materials of flesh, skin, and bone are considered architecture and among the various elements that give existence to architecture, they are of special importance (4).

Sustainable building materials consist of renewable resources instead of non-renewable resources and are environmentally friendly. The characteristics of sustainable materials are (5): reusable or recyclable materials; abundant, natural, renewable; Produced products reduce energy consumption; reduction of greenhouse gases; local; durable; non-toxic; Moisture resistant.

- insulation; Insulation is very essential in sustainable building materials. Insulation materials in the list of sustainable materials include paper and wood pulp, soy, cotton, cork.
- cotton; A rapidly renewing material. Non-toxic and 0.55% recyclable
- insulating panels; These panels are made from recycled newspapers and cardboard and are fire resistant by adding boric acid and calcium carbonate.
- Flooring; Use of bamboo, cork, eucalyptus, wool carpet, wood in flooring
- wool carpet; Woven wool is one of the environmentally friendly options for residential and commercial carpets. Wool is a rapidly renewing material, produces low greenhouse gases, is fire resistant and an insulator.
- Concrete; It is one of the materials used in the construction industry. The problem is that the production of concrete has a great impact on global warming, and the solution is that concrete is mixed with recycled materials, in which case concrete has a very long life and can be transformed into any

shape and can be recycled. Slow

- plasterboard panels; Gypsum panels are used in almost all sustainable design criteria. Gypsum is the first raw material used to produce these panels, which is formed naturally like salt or lime and is one of the most abundant minerals on earth and almost never runs out. The remaining mass of materials in gypsum board includes paper (recycled from newspapers, phone book and corrugated cardboard and cut cardboards as well as wheat or corn starch glue and renewable agricultural resources and are environmentally preferable options compared to using They are polymers derived from crude oil.
- acoustic ceiling panels; Some acoustic ceiling panels contain mostly glass wool, gypsum and less paper and glue. The content found in the ceiling panels varies from approximately 0.5 to 0.5%, which depends on the type of product, the production process and the location of the machinery. The production of acoustic ceiling is considered as a green performance like the construction of plaster walls because they are easier to find than wood. It should also be noted that some acoustic ceiling panels come with a limited warranty against rust and mold, which can help improve indoor air quality.
- gypsum fiber panels; In the gypsum fiber manufacturing process, gypsum stone and cellulose paper fibers are combined to create a type of high-performance panel that includes the subfloor and outer coverings.
- cement panels; Cement frame panel is a multi-functional and water-resistant frame that is usually used as a support for ceramic tiles, and approximately 05% of it consists of recycled materials, which includes abandoned ash (6).

In this study, considering the unique properties and characteristics of each construction material and its role in the strength of the building, we investigated the principles of architectural engineering based on materials.

### The importance of the subject

The principles of sustainable architecture Some buildings have features and characteristics that place them among sustainable buildings, the

principles that must be followed in order for a building to be classified as a sustainable architecture are (7):

- The first principle of energy conservation: the building must be built in such a way that it works in harmony with the climate and energy resources available at the construction site.
- The second principle of harmony with the climate. Buildings should be designed in such a way that they work in harmony with the climate and energy resources available at the construction site.
- The third principle of reducing the use of new sources of building materials should be designed in such a way that the amount of use of new sources is reduced as much as possible and at the end of their useful life, they are used as a new source for building new buildings.
- The fourth principle of meeting the needs of residents in sustainable architecture, meeting the mental and physical needs of residents is of particular importance.
- The fifth principle of holism, all the principles of sustainable architecture should be embodied in a complete process that leads to the construction of a healthy environment.

The main criteria for ranking construction materials with a sustainability approach are as follows (8):

- 1- Life cycle cost
- 2- Efficiency of resources
- Environmental impact
- 4- Performance capacity
- 5- Social benefit

Rating criteria:

The ranking micro-criteria are as follows, which are a subset of the 5 main research criteria

be (9):

- 1) Wood, 2) Soil, 3) Clay, 4) Lime, 5) Brick, 6) Stone, 7) Flower straw (8) Natural materials of the river, 9) Concrete, 10) Steel, 11) Cement, (12) Plaster, 13) Glass

Each of the 13 micro-criteria above are included under the set of main criteria and form the ranking.

### Discuss

Selection of green materials: Selection of green

products is a key component of sustainable design, which can be defined as reducing cycles and recycling them. Reducing the amount of raw materials required in the production process. Lighter and smaller products generally require the use of less energy for warehouse transportation and construction, and this reduction can lead to a reduction in the amount of materials used or wasted. The advantages of renovating and reusing the environment are clear, products with high regenerability may reduce the use of raw materials and also reduce energy consumption and waste of materials. Reconstructing the environment using materials that can be reused or materials that provide useful benefits to the environment(10).

The advantages of green materials include: reducing replacement costs during the life of the building, energy conservation, productivity and health improvement, low costs related to changing space settings, greater flexibility, energy saving.

What is considered in a significant part of construction materials production technologies is to find alternative construction materials that use less energy to produce them and at the same time produce little pollution. Green building materials consist of renewable materials that are used instead of non-renewable materials. They are also materials that are made from recycled materials, which are also mostly renewable, and from polluting and greenhouse gases and their production, both in the production stage and... These materials are materials that are made from nature and return to nature (11).

The correct use of materials, both visually and environmentally, the role of using materials in creating sustainable architecture cannot be ignored, because the building consists of a form and structure, which form and shell are created by materials, and the materials that are used It should be visually and psychologically, which includes color, texture, and type of material, effective on people. For example, since wood can no longer be used directly in the northern climate, new materials made with the design and color of wood can be used as decorations and coverings, and according to Ecotech architects, the shell of the building should be like skin. In order for the body to react to environmental changes, it is necessary to use materials that cause the least damage to nature and even in the type of paint that is used in it, it should be of materials that do not harm the environment (12).

Siavash Heshmati, in a research entitled Building Materials and Sustainability in 2013, investigated the sustainable development in the construction industry, in this research, it was tried to examine the selection of environmentally friendly building materials with regard to the goals of sustainable development in the construction industry. (13). In 2013, Gholamreza Akrami and Leila Alipour investigated the role of local materials in sustainable architecture from an environmental point of view. Low cost is recommended. The production process of materials from extraction to its return to nature and its effect on environmental pollution, including new materials and native materials, have been studied and compared. The material life cycle diagram is a pattern obtained from other environmental diagrams and tables, in which various factors have been seen in a more comprehensive way. Each stage of the material's life is described in this model. By examining and comparing native materials and new materials, it is clear that the benefits of using native materials are far greater. Non-destruction of nature in harvesting, minimal pollution in production, low energy consumption in production, energy saving in transportation, reduction of energy consumption in operation, reduction of total costs, and most importantly, quick return to nature and non-destruction of the environment are among the benefits of native materials. Are. Of course, the use of local materials has its own conditions (14).

In 2015, Rizvan Mirdrikund and Mohammad Pir Mohammadi have investigated the effect of nanotechnology on the stability of construction materials in a research that this research shows the effects of nanotechnology on the stability of construction materials. First, the topic of nanotechnology is examined, and then the basics and concepts of sustainable architecture and the impact of nanotechnology on sustainable architecture are clarified, and finally, the achievements of this technology that play a role in making construction materials sustainable are discussed. The research method is also descriptive-analytical and a part of the research was conducted based on laboratory samples (15).

### Conclusion

The construction industry is a vital part of the economic system that has a significant impact on the environment. Construction operation, operation and demolition of buildings is one of the most important human factors affecting the environment directly (through the consumption of materials and energy, pollution and waste resulting from it) and indirectly (through pressure on inefficient infrastructures. Building materials

play a significant role. plays an important role in the sustainability of architecture. Undoubtedly, the use of natural, local and indigenous materials that have the most climatic compatibility and cultural familiarity with their surrounding environment can play an effective role in the sustainability of architecture. Considering the significant impact of the construction industry on hazards environmental, both from the point of view of damage such as destruction of the ozone layer, release of greenhouse gases, and from the point of view of health risk and reducing the efficiency cycle of materials), one of the important actions in this field of environmental risk management) is the selection of sustainable materials for use in projects It is a building(17). Choosing materials is a sensitive and complex process and the final option is determined from a large number of materials. Architects and building professionals consider several factors when evaluating various categories of building materials. Oftentimes, weighting these many and varied factors complicates the decision-making process. Due to the advancement of technology, human life has changed a lot compared to the past, and our needs and desires are also affected by this change. Architecture, like other sciences, uses new technologies to respond to these needs. Incorrect construction methods in the society has caused the environment around us to become sick and has created an unhealthy biological system. In order to create a correct construction and preserve the environment, the materials used in buildings play a significant role. Choosing sustainable and suitable construction materials reduces energy is consumed and it provides more health to the environment because these materials reduce fuel consumption for heating buildings and this reduces the emission of air pollutants and greenhouse gases, as well as the use of natural resources is reduced and Society is approaching sustainability criteria. The use of suitable materials leads to a sustainable architecture (16).

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