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A STUDY ON THE ENVIRONMENTAL IMPACTS OF BUILDING MATERIALS

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Özet: Yapı malzemesi sektörü büyük bir sektördür. Yapı maliyetleri kullanılan yapı malzemelerinin fiyatlarına bağlıdır. Yapı malzemelerinin üretim, kullanım ve bertaraf aşamalarında çevreye verilecek zararları en aza indirmek için ilgili standartlara göre üretilmiş, kalite kontrolden geçmiş yapı malzemelerini tercih etmek önemlidir. Ayrıca geri dönüşüm ve sürdürülebilirliğe de dikkat etmek gerekmektedir. Bu bağlamda; çalışmada bazı yapı malzemelerinin çevresel etkileri irdelenmiş ve alınması gereken bazı önlemlerden bahsedilmiştir.

Anahtar Kelimeler: Yapı Malzemesi, Çevresel Etki, Sürdürülebilirlik, Geri Dönüşüm

Abstract: The construction materials sector is a major industry. The cost of construction is influenced by the prices of the materials used. It is crucial to select building materials that are produced according to relevant standards and have passed quality control to minimize the environmental damage during their production, use, and disposal phases. Additionally, attention should be given to recycling and sustainability. In this context, the environmental impacts of certain construction materials have been examined in the study, and some recommended measures have been discussed.

Keywords: Building Material, Environmental Impact, Sustainability, Recycling

1. INTRODUCTION

Any material used in the construction of underground, aboveground, and water facilities is referred to as a building material. Materials such as cement, aggregate, mortar, concrete, reinforced concrete, steel, wood, ceramic, laminate, paint, aluminium, glass, fiberglass, stone wool, etc., are examples of building materials. The choice of building materials varies from person to person depending on the purpose of use and personal preference. Since a significant portion of construction costs depends on the price of the materials used, the building materials sector is vast and highly competitive. For this reason, companies compete not only to produce high-quality products but also to manufacture sustainable and environmentally friendly building materials. There is a wide variety of building materials available in the market [1]. It is important to choose materials that are produced according to the relevant standards, have passed quality control, and are environmentally friendly and sustainable. A significant portion of global waste comes from construction debris, necessitating the development of strategies for reducing waste and managing non-recyclable materials [2]. Since the construction industry is one of the largest contributors to global carbon emissions, it is essential to analyse the carbon footprints of building materials and implement improvements accordingly [3]. Transitioning building materials to more sustainable practices helps prevent resource depletion and reduces environmental damage [4]. Given that many building materials, such as cement, steel, and glass, consume large amounts of energy and natural resources during production, optimizing resource use is of paramount importance [5]. In this context, the study discusses the major environmental impacts of building materials and the necessary measures to be taken.

2. MAJOR ENVIRONMENTAL IMPACTS OF BUILDING MATERIALS

The negative environmental impacts of building materials encompass a process that begins with the production phase and extends through to their use, recycling, and disposal stages [6]. These adverse effects lead to:

- Increased energy consumption
- Increased water consumption
- The gradual depletion of natural resources

- The disruption of ecological balance
- The reduction of agricultural land
- Soil pollution
- Emissions from hazardous chemical sources
- An increase in CO2 emissions
- Increased environmental pollution
- The generation of non-recyclable construction waste

and costs that are economically unsustainable due to recycling expenses [7].

The production of many building materials requires a large amount of energy [8]. Materials such as cement, steel, aluminium, brick, ceramics, asphalt, and glass require high energy during their production. Since clinker, the main raw material of cement, is produced at very high temperatures, the use of coal and other fossil fuels is necessary [9]. Steel, being a material that is melted and shaped at high temperatures, requires a process that uses both electrical energy and fossil fuels. The process of smelting and electrolyzing aluminium from bauxite ore consumes a significant amount of electrical energy [10]. The production of glass similarly involves one of the most energy-intensive processes. The production, heating, and laying processes of asphalt are completed using high energy. Since bricks, ceramics, and porcelain are produced at high temperatures, they undergo an energy-intensive production process.

The controlled cooling of clinker, steel, aluminium, and glass is achieved with water. Water is also required for the processing and shaping of materials such as ceramics, porcelain, bricks, and tiles. The preparation of mortar and concrete mixtures, the initiation of hydration, and the curing processes can only be performed with water. Additionally, factories producing powder-binding materials must use water to manage dust control for occupational health and safety reasons. Some factories also use water-based filters in their air filtration systems [11]. Examples of water use in relevant areas include machinery and equipment cleaning, chemical process additives, and raw material washing processes [12]. Natural resources are consumed during processes such as the extraction, processing, and transportation of raw materials required for the production of building materials [13]. For example, limestone is used for cement, iron-rich ores are used for steel, silica sand is used for glass, and natural sand and gravel are used for aggregates. The processing and transportation of these materials require direct or indirect fossil fuels. Water is also an additional resource to be considered for this group.

Quarries such as marble quarries, aggregate quarries, and clinker raw material quarries are areas created specifically for building material production from natural resources. Since these areas are used for production purposes, they directly harm the environment and the ecological balance [14]. They also cause damage to natural habitats and degrade the soil fertility of the region. The use of limited regional water resources in building material production facilities reduces the amount of water available for agricultural irrigation, leading to decreased productivity of agricultural land. Restoring quarries, such as marble and aggregate quarries, to their original state is both difficult and often results in an inability to return to their previous condition.

The dust and chemicals released during the production of materials such as cement, steel, lead, and glass accumulate on the soil in the area, leading to soil contamination and subsequent loss of fertility. Additionally, if the disposal of chemical waste generated during the production of building materials is not managed properly, it can seep into the soil surface, causing soil pollution [15]. The production of artificial wood materials such as MDF (Medium Density Fibreboard), HDF (High Density Fibreboard), OSB (Oriented Strand Board), Plywood (Magnetic Board), and composite wood (Wood Plastic Composite - WPC) releases highly hazardous chemical gases [16]. Additionally, during both the production and application phases of cement-based composite materials, hazardous chemicals are released into the atmosphere. During the industrial production of fundamental building materials such as cement, steel, aluminium, bricks, and ceramics, coal is commonly used as an energy source [17]. As a fossil fuel, coal releases a high amount of CO_2 into the atmosphere once it begins to burn, contributing to air pollution. Additionally, it is known that a significant portion of global CO_2 emissions is due to cement production [18].

In addition, sulphur dioxide, which is released during the combustion of fossil fuels such as petroleum, is a gas that is heavily emitted from cement, steel, and metal production facilities [19]. Nitrogen oxides, another harmful type of gas, are also released during the combustion of fossil fuels and contribute to the depletion of the ozone layer [20]. Volatile Organic Compounds (VOCs), which are released during the production of paints, adhesives, solvents, and engineered wood materials like MDF and OSB, are harmful organic gases [21]. These compounds belong to the group of gases that are most hazardous to human health [22]. Methane, a harmful greenhouse gas, is released during the decomposition of organic matter in construction and landfill sites [23]. All of these gases harm the ozone layer and negatively impact human health.

Demolishing a building and recycling all of its materials is very difficult [24]. For example, since reinforced concrete is a composite material, removing the reinforcement, converting the concrete into aggregate, and separately recycling the plaster, paint, and other materials such as plumbing fixtures from the concrete in a homogeneous manner is not cost-effective. In contrast, it is more feasible to recycle expensive materials like plastics, aluminium, and metals [25]. Other materials are typically discarded as debris due to the recycling costs, contributing to environmental pollution.

3. RESULTS AND DISCUSSONS

Because water resources are limited, the use of sustainable and recyclable water in building material production is important from both environmental and economic perspectives. The use of recyclable and sustainable materials in areas such as marble quarries, aggregate quarries, and clinker quarries is necessary to protect natural resources and maintain ecological balance, as these areas harm natural resources. Regulations are needed to prevent building material production areas from negatively impacting agricultural land. Additionally, sustainable methods should be implemented to prevent soil pollution [26]. Especially during the production of artificial wood, hazardous chemical emissions are released, and significant amounts of CO_2 are emitted during cement production. Therefore, restriction plans should be developed for the establishment and expansion of cement production facilities, and strategies from similar countries should be reviewed. Relevant authorities should take necessary measures to prevent uncontrolled dumping of construction waste as debris.

4. CONCLUSIONS

In this study, which investigates the environmental impacts of certain building materials, the negative effects occurring throughout the process from production to use, recycling, and disposal have been examined. The results obtained from the study are summarized below.

- Using alternative energy sources such as wastewater treatment sludge as fuel in industrial production will provide both environmental and economic benefits.
- Utilizing water purified of oxygen and bacteria from wastewater treatment sludge in building material production will help prevent the depletion of water resources.
- Preferring recyclable and sustainable materials in building material production will help conserve natural resources and maintain ecological balance.
- Expanding and preparing environmental impact assessment reports will particularly contribute to the protection of agricultural lands.
- Proper disposal of waste generated in building material production will prevent soil pollution.
- Frequent and thorough maintenance and inspection of filters in cement factories and industrial facilities producing artificial wood materials will ensure the health and longevity of people living in the area.
- Encouraging the recycling of construction waste will provide both economic and environmental benefits.

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