The Problem of Recycling Construction Waste in Poland

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Abstract. In recent years, along with the increase in social environmental awareness, more and more attention is paid to activities related to waste management and environmental protection. Every sector of the economy, including the construction industry, faces the problem of waste management. It is estimated that in 2021 the consumption of natural resources amounted to over 100 billion tones on a global scale, of which about 50% was in the construction sector. Every year, as a result of construction, renovation and demolition works, only in the countries of the European Union, almost 40% of the world's waste is generated, which should be properly managed. The reuse of raw materials obtained from waste processing as additives for the production of new composite materials often contributes to the improvement of the properties of the resulting composites. Recently, the circular economy, assuming the reuse of building materials, is becoming more and more popular. It is estimated that the Polish economy is currently only 10.2% circular. The transition to a circular economy is a long-term and difficult process, not only for organizational and financial reasons, but also because of the legal aspect. The study reviews the literature on the technological possibilities of recycling construction waste and identifies areas of their reuse. It also presents data illustrating the current situation of the Polish and European economy in this regard.

Keywords: Recycling · Construction waste · Environmental protection · Renovation and demolition works · Circular economy

1 Introduction

Recycling is currently one of the key issues in the area of activities undertaken to protect the environment. The level of social environmental awareness is increasing year by year, which translates into the search for and implementation of modern technologies and solutions aimed at reducing the generated waste. Every sector of the economy, including the construction industry, struggles with the problem of their development. Huge amounts of construction waste generated make it necessary to take action to reduce it. It is important to prevent their excessive number already at the planning stage of construction investments. In the study [1], the relationship between the factors contributing to the increase in the amount of waste and those that affect its minimization was determined, which was confirmed by the conducted research. Proper segregation of the generated construction

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waste is also important. This allows for a more efficient recovery of materials that can be reused [2]. In Norway, research was undertaken on methods for assessing and monitoring the level of construction waste, based on 36 construction projects. It has been shown that an average sorting rate of 89% translates into a low recycling rate (only 32%). In order to better integrate environmental considerations and management of the Group 17 waste generated, an environmental management plan has been developed that can be implemented at every stage of a construction project. It is a set of tools for monitoring waste sources and assessing their management options, in accordance with international standards [3]. The leading issues in terms of proper management of already generated waste are undoubtedly utilization, recycling and other recovery processes. Those from waste that are not harmful to people and the environment should be reprocessed to meet the main assumptions of the sustainable development policy. According to his concept, building objects should be designed, implemented and operated in such a way as not to violate the principles of environmental protection [4, 5].

The purpose of this article was to identify the most frequently generated construction waste and the possibilities of its reuse, as well as to present the current situation of the Polish and European economy in this regard.

2 Recycling of Construction Waste in Poland

According to the Urban Circularity data, the global consumption of natural resources in 2021 amounted to over 100 billion tons, of which about 50% was used by the construction sector, which generates as much as 30% of global waste. This results not only in a constantly deepening shortage of primary raw materials, but also contributes to air pollution and global warming [6]. Every year, as a result of construction, renovation and demolition works carried out in the European Union countries, approximately 40% of the world's waste is generated. According to the Building Performance Institute Europe, around 500 million waste is produced annually in the member states from renovations, modernizations and reconstructions. It is estimated that up to 90% of construction waste can be reused, which would significantly reduce the amount of waste going to landfills and reduce CO_2 emissions. According to the data of the Statistics Poland, in 2021, 820 868.9 Mg of construction and demolition waste was generated, which is municipal waste. Most of them were recorded in Śląskie Voivodship (19.6%), Mazowieckie Voivodship (13.2%) and Wielkopolskie Voivodship (13.1%), and the least in Podkarpackie Voivodship (1.9%) (Fig. 1) [7].

According to the Waste Catalogue, those from construction and renovation projects belong to group 17. Figure 2 shows the amount of construction waste generated and recovered in Poland in 2017–2021. It was noted that the year 2020 was definitely dominant (over 7 352 Gg of waste generated). A significant decrease in the amount of waste recycled during the COVID-19 pandemic period was observed, compared to 2018, when the percentage share of this waste was close to 90% [8]. Despite the continuous increase in environmental awareness, the level of recycling activities in Poland is still low [9]. Among European countries, the leader in this aspect is Switzerland, where only 5% of the generated waste ends up in landfills.

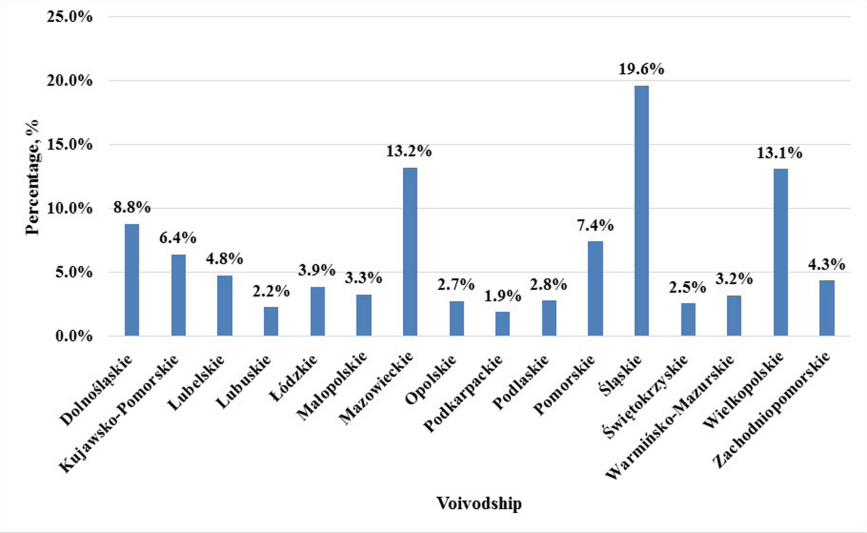

Fig. 1. Collected construction and demolition waste in Poland in 2021 [based on 7]

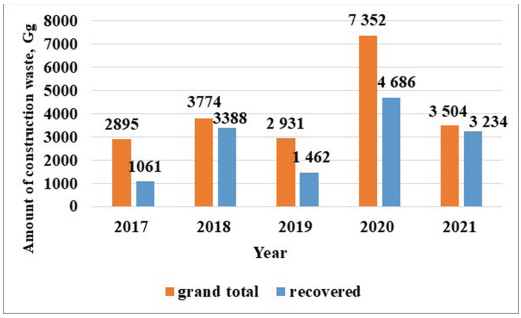

Fig. 2. Construction waste generated in 2017–2021 in Poland [based on 8]

3 Law in Poland

Recently, the circular economy has become increasingly popular. It is an economy model in which products and services are traded in closed loops. Its main assumption is to optimize the process of reusing a given material in such a way as to prevent waste. According to the report "Circular Restart! Polish Circularity Gap Report", the Polish economy is currently 10.2% circular, which means that for every 10 kg of waste, only about 1 kg is recycled. The process of transition to a circular economy is long and quite complicated, as it involves changing business models as well as legal regulations. The transformation of the real estate and construction sectors towards a circular economy is only at the initial stage of implementation, which is to be accelerated by the soon to come into force EU regulations. As much as 70% of construction waste generated in Poland is to be recycled or otherwise recovered, which will significantly reduce the amount of waste

generated. According to the estimates of the European Parliament, the circular economy can largely result in an increase in EU GDP of 0.8% by 2030. An important issue in the current legal regulations is also the obligation to segregate construction waste. Currently, waste generated from construction, demolition and renovations is collected in a common container, which is to change from January 1, 2025. Then Art. 101a of the Act on waste [10], which obliges to selective collection and segregation into at least 6 main fractions: glass, metal, wood, plastics, gypsum and mineral waste. The imposition of this obligation is not intended for private persons, but only for companies implementing construction investments. However, the high costs associated with imposing a new obligation may result in the use of cheaper and at the same time environmentally harmful solutions, such as abandoning waste in the forest, which are still often practiced. This results in the formation of the so-called "wild dumps" and is inconsistent with the applicable legal regulations (Fig. 3a). Improper disposal of dismantled asbestos-cement boards is still a frequent phenomenon (Fig. 3b). It is true that a ban on the production and use of asbestos products has been introduced in Poland since 1997, but large amounts of these materials have not been completely neutralized. In 2002, Poland joined the "Program for removing asbestos from the country for 2009–2032", thus committing itself to the complete removal of these products from buildings. The resulting waste, after dismantling by specialized companies, should be deposited in landfills, specially designated for this purpose, which so far is the only legal way to neutralize them. Unfortunately, due to the high costs associated with the dismantling of asbestos-cement boards, and thus also the replacement of structural elements, building owners abandon asbestos waste on their plots or forest areas, violating the provisions on environmental protection [11–14].

a)  b) 

Fig. 3. Construction waste from demolition abandoned in the forest: **a** brick rubble, **b** asbestos [own study]

4 Management of Construction Waste

One of the most frequently generated construction waste is concrete and brick rubble. The first stage of its processing is separating it from other waste elements, e.g. wood or metal. Then, the cleaned construction rubble is transported to the crusher, where it is crushed to appropriate sizes depending on its intended use. The wide possibilities of reusing construction rubble allow it to be used primarily in road construction. It

can be used as a material for making road foundations, bedding for paving stones or stabilizing material for soil reinforcement. It is also a valuable secondary raw material in the production of concrete mix. Rubble resulting from the demolition of concrete structures is also used as a secondary raw material for the production of cement mixes and self-compacting concrete, in the form of a substitute for coarse aggregate [15]. Fly ashes are becoming an increasingly popular substitute for aggregate in the production of concrete. The study [16] presents the results of strength tests of concrete with the addition of fly ash from biomass combustion as a substitute for sand. It has been shown that these concretes do not have a negative impact on the environment, and their strength increases with the amount of added material. A popular solution is also the processing of post-demolition wooden elements into biomass and in order to obtain raw material for the production of new materials, such as chipboards or furniture panels. Along with the rapid increase in the production of plastics at the turn of the last few decades, a simultaneous increase in the amount of waste generated from this plastic has been noticed. Among several recycling methods, the most effective is chemical (raw material) recovery, next to material recovery and energy recovery [17]. Material recovery allows you to obtain the material needed to manufacture a new product, while raw material recovery consists in processing waste into, for example, polymers. Unfortunately, due to the lack of technological possibilities and high costs, some of the accumulated waste is exported outside the European Union for further processing. The most popular plastic used in the construction industry is polyvinyl chloride (PVC), used in the production of window and door joinery and finishing elements. Plastic waste obtained as a result of demolition and renovation, after appropriate treatment, is used in the production of thermal insulation materials, asphalt mixtures, and cement bricks [18]. They are also successfully used in the production of concrete. Introduced in the form of fibers, they increase its tensile strength [19]. Carbon fiber composites (CFC), widely used in industry, and polypropylene fibers are also becoming more and more popular [20, 21]. Concrete elements modified with thermoplastic waste, in the form of a substitute for sand and aggregate, are highly resistant to direct exposure to weather conditions, thanks to which they can be used as elements of street furniture [22]. The study [23] presents the results of bending and compressive strength tests of cement mortars modified with rubber waste. On their basis, it was found that the obtained composites have high strength parameters, and the reuse of waste is undoubtedly in line with the policy of sustainable development. One of the possibilities of using construction waste is the use of shredded polystyrene, glass or mineral wool as an additive for the production of concrete and mortars [24, 25]. Expanded polystyrene waste can be used directly at the place of production, as well as after appropriate processing. The crushed waste is used as an insulating material, for loosening the soil, and as a partial replacement of aggregate in the production of plasters and mortars [26]. The study [27] also paid special attention to the generation of large amounts of metal waste. Ways of their reuse, also in the construction sector, in the production of aggregates were discussed.

5 Conclusions

Recently, we have observed a significant increase in the level of social environmental awareness, which translates into taking actions in line with the idea of sustainable development, also in the construction industry. The increasingly popular slogans regarding the circular economy have made it necessary to take action to transform the real estate and construction sectors towards a circular economy. Poland is currently at the beginning of this process, which, due to the need to make a number of changes, is quite difficult and lengthy. The expected changes in the legal regulations are aimed at reducing the amount of generated waste from group 17 and putting emphasis on recycling activities. The wide possibilities of reusing construction waste fit in very well with the policy of environmental protection and reduction of CO_2 emissions. Construction waste management is constantly being improved, but the biggest problem is still financial and technological limitations, which results in the formation of the so-called "wild dumps", especially in forested areas. Unfortunately, the waste management system in Poland is not functioning properly and the required level of recycling has still not been achieved. There is still a lack of effective tools to monitor the waste market, which makes it difficult to keep reliable statistics and create reliable reports, and thus prevents proper management.

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