LEADING PRINCIPLES AND PRACTICES IN THE MANAGEMENT OF CONSTRUCTION WASTES

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ABSTRACT. One of priorities of the ecology and protection of the natural and various technogenic media is the management of the wastes from the human activity, including their secure utilisation. In this respect, special attention is paid to the construction wastes, including activities associated with their collection, transportation, and pre-treatment with a view to their efficient recovery and recycling. This activity is connected with profound knowledge of the contemporary methods and technologies for the treatment of various types of construction waste, as well as of the specific requirements to the sites connected with the implementation of these methods and technologies. This article presents the basic principles and practices related to the management of construction waste in accordance with the national and European legislation.

Keywords: construction waste, utilisation, recycling

ВОДЕЩИ ПРИНЦИПИ И ПРАКТИКИ ПРИ УПРАВЛЕНИЕТО НА СТРОИТЕЛНИ ОТПАДЪЦИ

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РЕЗЮМЕ. Един от основните приоритети на екологията и опазването на природната и различните техногенни среди е управлението на отпадъците от човешката дейност, в това число тяхното безопасно съхраняване и оползотворяване. Особено значение в тази насока се отделя на строителните отпадъци, включващо дейности, свързани с тяхното събиране, транспортиране и предварителна подготовка с оглед ефикасното им оползотворяване и рециклиране. Тази дейност е свързана с дълбоко познаване на съвременните методи и технологии за третиране на различните видове строителни отпадъци, както и на специфичните изисквания към площадките, свързани с реализацията на тези методи и технологии. В настоящата статия са разгледани основните принципи и практики, свързани с управлението на строителни отпадъци, съобразени с националното и европейско законодетелство.

Ключови думи: строителни отпадъци, оползотворяване, рециклиране

Introduction

The development of the economy is connected with the construction of a new infrastructure, which in turn is related to the utilisation of mineral raw materials and the generation of a large amount of construction waste that covers huge areas and pollutes the environment. According to the European statistics (EUROSTAT), 48% of the generated waste comes from the construction and demolition and 15% is generated by the mining industry, the mining of rock materials, and the excavation of earth masses. The annual quantity of such waste for the 28 EU member countries is 1750 – 1900 million tones (National strategic plan for management of the C&D waste 2011-2020).

The first step towards solving the problem with waste generation is the ecological and responsible management. According to the Directive 2008/98/EC (2008), '**waste management'** means the collection, transport, recovery, and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and also including actions taken as a dealer or broker. This activity is related to a profound knowledge of the modern methods and technologies for the treatment of different types of construction waste. The present article discusses the basic principles and practices related to the waste management of construction waste in accordance with the national and European legislation.

National and European legislation in the management of the construction waste

The current EU policy in waste management is based on the concept for hierarchy in its management.

Directive 2008/98/EU implements a five-staged hierarchy in the waste prevention and management legislation and policy in all the EU member countries with the following order of priorities:

1. Prevention of waste generation;
2. Preparation for re-use;
3. Waste recycling;
4. Waste recovery , e.g. energy recovery;
5. Waste disposal;

According to the hierarchy, EU member countries must focus on the prevention of waste generation and when this is not possible, the generated waste must be reused, recycled, recovered to the fullest extent and only in the end to be eventually disposed.

In order to improve the actions of prevention of the waste generation and to facilitate the distribution of good practices, the Directive implements requirements for the EU member countries concerning the development of programs for waste generation prevention and defines the aims of their management.

The government of the Republic of Bulgaria itself has adopted a series of legislation documents ratifying the European legislation acts and ensuring sustainable economic development and environmental protection. The Ordinance for Construction Waste Management and the Use of Recycled Construction Materials (OCWM, SG No 98, 2017) is a specific subject of interest. The purpose of the Ordinance is to prevent and limit the risk of environmental pollution as a result of the collection, transportation, and treatment of the construction waste, as well as to encourage the recycling of construction waste that is not dangerous and its use for achieving the objectives of preparing it for reuse, recycling or for other use (OCWM, An. 7, art. 11, §1 - 2, SG No 98, 2017). The targeted quantity for material utilization[1] per type of waste is shown in Table 1:

Table 1
Quantitative targets for material utilisation per type of construction waste

Type of waste	Years			
	2017	2018	2019	2020 and each subseq. year
I. Waste Code				
17 01 01 concrete	85 %	85 %	85 %	85 %
17 01 02 bricks	50 %	57 %	63 %	70 %
17 01 03 roof tiles, tiles, faience and ceramics products	50 %	57 %	63 %	70 %
17 02 01 wood material	70 %	73 %	77 %	80 %
17 02 02 glass	53 %	62 %	71 %	80 %
17 02 03 plastic	63 %	69 %	74 %	80 %
17 04 05 iron and steel	90 %	90 %	90 %	90 %
17 04 01 copper, bronze, brass	90 %	90 %	90 %	90 %
17 04 02 aluminum	90 %	90 %	90 %	90 %
17 04 03 lead	90 %	90 %	90 %	90 %
17 04 04 zinc	90 %	90 %	90 %	90 %
17 04 06 tin	90 %	90 %	90 %	90 %
17 04 11 cables other than those mentioned in the code17 04 10	90 %	90 %	90 %	90 %
17 03 02 asphalt mixtures containing other substances than those mentioned in code 17 03 01	67 %	71 %	76 %	80 %
II. Sector				
Road sector	70 %	73 %	77 %	80 %
Railway sector	70 %	73 %	77 %	80 %

[1] Material utilisation – all operations of the utilsation of construction waste, such as preparation for second use, recycling, and use in reversed earth embankments, excluding the power use and secondary treatment of materials that are used for fuel.

Apart from the aim for material utilisation, there are also targets set for the limitation of the use of natural resources and materials and for their recycling to the highest extent.

Basic principles of the construction waste management

The complete management of construction waste is based on the following principles (*COM (*96*)* 399*,* 1996):

- *Hierarchy of the waste management*

Observing of the hierarchical order of the waste management is one of the most important principles. The sequence of the hierarchy defines the priority order of what represents the best opportunity for the protection of the environment.

- *Self-sufficiency and proximity when managing waste*

The principle suggests for the generated waste to be recycled and used in the community and close to the place where it was generated.

- *Best available techniques*

In the process of waste management, the best available techniques which do not require high expenses must be used.

- *Responsibility of the manufacturer and "the pollutant pays"*

The individuals, who produce or contribute to the production of waste, or pollute the environment, or the current owners of waste must cover the expenses for the waste treatment and manage the waste in a way that guarantees a high level of protection of the environment and the human health.

- *Prevention*

The potential waste problems must be foreseen and avoided at the earliest stage possible.

- *Community participation*

The concerned sides and authorities, as well as the community itself have the opportunity to participate in the development of the waste management plans and the programmes for waste prevention.

Leading practices in construction waste management

The construction waste management covers the complete cycle from waste generation to waste use or disposal. The construction waste is collected, stored, transported, and prepared for disposal separately (WML, SG No 53, 2012).

The activities of collection, storage, and material use of the construction waste may be done right on the construction site, on the site for a construction building removal, and on the site for waste treatment. The first two may be used as sites for material use only upon the wish of the contracting authority and when this has been included in the investment project and in the Plan for Construction Waste Management (PCWM, 2017). The requirements for the activities in collection and material use of the construction waste, as well as for the sites where those activities will be conducted are detailed in the Ordinance on the Management of Construction Waste and on the Use of Recycled Building Materials (OCWM, SG 98, 2017).

Technological processes and equipment in construction waste management

The process of waste management starts from the demolition of buildings and the removal of road surfaces and ends with the use of an already treated waste.

Different technologies are used for the demolition of buildings, and the choice of technology depends on a series of factors, such as type of the building, location, allowed levels of pollution, terms and desired stage of selective waste separation. The basic technologies for the demolition of the buildings include blowing up, power action, combination of a hit, cut, and pull, cutting, water jet cutting, gas-oxygen cutting, etc.

The choice of the suitable technology and equipment may be crucial for the waste separation per type and for the waste separation from the products to be reused. The selective deconstruction and the separate collection and storage of waste on the construction landing are important requirements for the receipt of high quality of the waste fractions which have the potential to be reused, to be recycled, or to be used as construction materials or products.

Depending on the technological processes, the construction waste treatment technologies may be grouped as follows:

Low technological level – technologies for crushing and sieving. The components are separated only by size without the separation of the different kinds of material.

Medium technological level - technologies for crushing, application of a sieve system, and material separation via magnet separation or sorting by hand.

High technological level - technologies for crushing, application of a sieve system, and material separation via more complex methods such as flotation, separation of ferrous and non-ferrous metals, etc.

Depending on the recycling purposes and the ensuing use of the recycled waste, the following types of recycling exist, (HCWM, https://www.moew.government.bg/static/media/ups/tiny/filebase/Waste/cdw/SO_RUKOVODSTVO_FINAL.pdf)

Primary recycling – recycling with the same purpose. For example, road – asphalt coverage which is crashed and melted on spot for a new road surface.

Secondary recycling – use of the recycled waste for a new purpose. For example, secondary use of recycled asphalt as a base for a new road surface.

Tertiary recycling – crashing of a synthetic product for the production of another one.

Quaternary recycling – transformation of raw materials into energy. For example, burning of synthetic materials and paper.

The primary and the secondary recycling methods for the recycling of construction waste are applied in Bulgaria. The level of recycling ability of the construction waste depends on a series of factors, such as level of treatment in advance, dangerous substances pollution, diversity of the waste, etc. The recycling process is done on specialised sites for recycling or directly on the construction site or on the demolition sites. The equipment may be stationary, semi-stationary or mobile.

The technological processes in the process of recycling are as follows:

Pre-fragmentation – it is performed with hydraulic scissors or a hammer and aims to reduce the size of the construction waste admitted to the crasher. It is necessary when the particle size is bigger than the entrance of the crasher or when the direct crashing would be ineffective. Concrete and reinforced concrete waste fragmentation is used as well.

Crashing – this may be done in a few steps in order to optimise the process and the workload on the equipment. Crashing is used for the major part of the construction waste, concrete, reinforced concrete, ceramics, asphalt concrete, rock materials, and polymeric construction materials.

Metal removal – this technology is applied for the reinforced concrete waste after crashing. For the purpose, magnet separators are used which remove the prestressing steel.

Sieving/fractioning – it may be performed at each level of recycling depending on the type of waste. It aims to remove the unwanted impurities or separates infractions with different size of the grain. Vibration sifters from metal nets or perforated plates are most commonly used for these purposes. The method is applicable to all kinds of construction waste.

Additional cleaning – this aims to remove unwanted impurities (for example, dust fraction on the grains of the recycled concrete since it may limit its application as an additional material). The cleaning is done via aeration or flotation.

Diagram 1 represents the technological process involved in the recycling of some types of construction waste. Every site has an incoming inspection system which ensures examination and separation of the waste, as well as waste weighing. Under Article 35 from the WML Waste Management Law, the separated waste mat that cannot be recycled on the site is recovered or submitted to the individuals who own the necessary permits for waste treatment (WML, SG No 53, art.

35, 2012). The waste suitable for recycling is crashed in jaw or rotor crushers. If necessary, the waste may be fractioned in advanced. The crasher is most commonly equipped with a magnet separator that separates metal elements such as the prestressing steel from the reinforced concrete waste. The separated metal elements are submitted to the individuals owing the respective permits for working with such waste (WML, 2012). After crushing, the waste passes through a sifter system where it is separated in different fractures. Each fracture is stored independently and after that is recovered via implementation in embankments or construction materials (for example, the recycled concrete fractions may be used for the same purpose as the natural materials: from embankment materials to supplementary materials for concrete and asphalt).

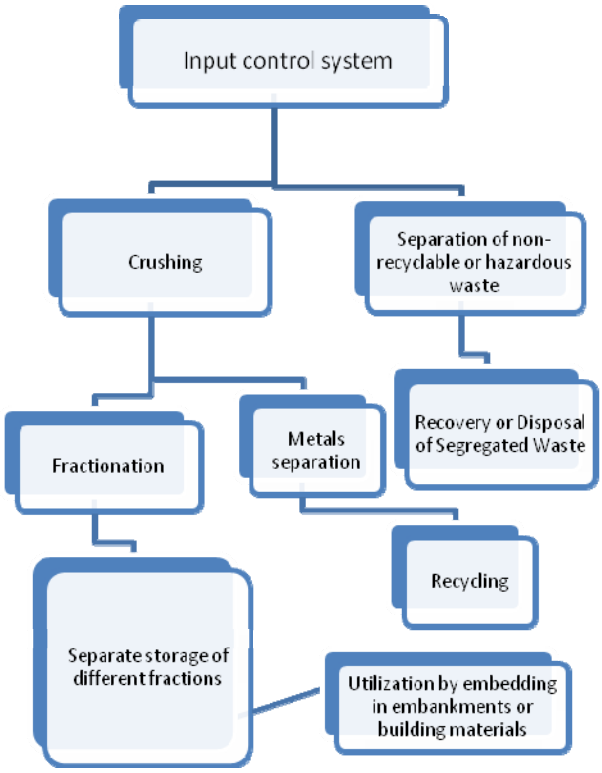

Diagram 1. Technological process involved in the recycling of some types of construction waste.

Options for the use of recycled construction waste

The recycled materials may be used in the following activities (HCWM, available at:

https://www.moew.government.bg/static/media/ups/tiny/filebase/Waste/cdw/SO_RUKOVODSTVO_FINAL.pdf).

In road construction works – as embankments, road grounds, improvement of the features of the earth bed, drainage works, supplementary materials for low-strength concrete and cement stabilisation, heat and cold recycling for road surfaces, temporary roads, etc.

In the construction of *hydro technical facilities* such as gabions and mattresses, embankments, drainage works, etc.

In the *construction of buildings and facilities* as reversed plumage, drainage works, etc.

The use of the recycled construction materials is legislated by the Regulation (EU) № 305/2011 (2011) of the European Parliament for the definition of harmonised conditions for availability on the construction products markets. In the Republic of Bulgaria, the directive is implemented via the Regulation of the Essential Requirements for the Constructions and the Evaluation of the Compliance of Construction Products (RERCECCP, 2014).

Conclusions

The legislation acts adopted by the European and the Bulgarian legislation set clear frames in the management of the construction waste. They define a hierarchical management order as a basis for the environmental protection and for the limitation of the use of natural resources.

The implementation of the legislative obligations of construction waste management and an increase in the level of their application, as well as the gradual increase in the disposal price are all good prerequisites for the increase of the quantity and the improvement of the quality of the recycled non-construction waste.

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