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STUDY OF THE POSSIBLITIES TO REUSE CONSTRUCTION AND DEMOLITION WASTE

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Abstract

For environment protection in the European Union (EU) it is very important the construction waste to be recycled and reused. The potential for the construction waste recycling and reuse is high, as their components have high cost. There is an opportunity for re-use of such materials in road construction, for drainage systems, for outdoor sports grounds and other construction sites.

In 2012 a regulation on the management of construction waste and on the use of recycled building materials was adopted in Bulgaria, aiming to introduce a new model for the management of construction waste. This would guarantee: creation of favorable legislative and economic conditions for implementation of technologies ensuring the achievement of recycling and recovery targets but which are also financially viable in line with the country's incomes; identifying the persons responsible for covering the costs of building waste management and achieving the recycling and recovery targets; creating conditions for the production and marketing of materials from recycling of construction waste at a price that is competitive with the same new raw materials used in construction.

The main effect expected from this normative document is to contribute to Bulgaria's development towards European trends, environmental protection through an integrated framework for the management of construction and demolition waste that will reduce the harmful impacts on it caused by construction waste, improving the efficiency of resource use, increasing the responsibilities of pollutants and stimulating investment in waste management.

Keywords*: construction waste, recovery process, recycling, re-using*

Introduction

Construction waste is generated by activities such as construction and/or complete or partial demolition of buildings and urban infrastructure as well as road planning and maintenance. Within the EU, different definitions apply to this group of waste, making it difficult to carry out comparative analyzes between countries. In some countries even ground leveling materials are classified as construction waste.

The construction industry is a major source of pollution, accounting for about 40% of total pollution as a result of the industrial activity. From construction activities the main contamination is for air, water, soil and noise pollution. All construction sites generate high levels of dust and harmful emissions in the air - usually from concrete, cement, silica. Materials used in construction, such as paints, solvents, toxic chemicals, can cause contamination in water and soil.

There is a possibility to recycle many elements of construction waste (Construction and demolition waste production in the EU 2019; Waste treatment 2014; Kourmpanis et al. 2008).

Materials and methods

Construction waste (CW) consists of unwanted material produced directly or incidentally by the construction or industries. This includes building materials such as insulation, nails, electrical wiring, shingle, and roofing as well as waste originating from site preparation such as dredging materials, tree stumps, and rubble. It is necessary to remove hazardous components of construction waste such as asbestos, tar, radioactive components, polychlorinated biphenyls, lead, electrical elements containing mercury, insulating materials containing dangerous substances, etc. This is related to the protection of the environment, for reasons of safety and health protection of workers and residents in the vicinity of the site. In addition, removing hazardous waste is important in order not to pollute recyclable materials.

The biggest part of the building waste consist of bricks, concrete and wood damaged or unused for various reasons during construction. Observational research has shown that CW can be as high as 10 to 15% of the all materials that are used to the building construction. This is much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Since considerable variability exists between construction sites, there are meny opportunities for reducing this waste.

Construction and demolition waste (C&DW) is one of the heaviest and bulkiest wastes which are generated in the European Union. They include many materials such as concrete, bricks, gypsum, wood, glass, metals, plastics, solvents, asbestos and excavated earth. Many of these components can be recycled. To date, about 54% of construction waste is recycled in the Republic of Bulgaria, but the national targets imposed by the Waste Framework Directive require 70% of CW to be materially utilized by 2020, and for some species, such as metals, the share also reaches 90%. Each construction of a building over 700 m^2 must have a construction waste management plan (CWMP) developed. For Bulgaria this is obliged according to Ordinance on the management of construction waste and for the reusing of recycled building materials (Ordinance No. 2/2014), which entered into force at the beginning of December 2018.

C&D Waste generation by economic activities and households for EU member states (Waste treatment 2014) could be seen on Table 1.

The current position of EU on C&DW classification according to (Symonds Group Ltd 46967 Final Report 1999) the report of the C&DW Priority Waste Streams Project recommended (in its recommendation number 2) is that:

"Member States should be encouraged to adopt the following classifications (taken from the European Waste Catalogue) as the framework within which future construction and demolition waste management planning will be undertaken, and waste arising data collected and reported:

- concrete, bricks, tiles, ceramics, and gypsum-based materials (EWC code 17 01 00);
- wood (EWC code 17 02 01);
- glass (EWC code 17 02 02);

- ❖ plastic (EWC code 17 02 03);
- ❖ asphalt, tar and tarred products (EWC code 17 03 00);
- ❖ metals (including their alloys) (EWC code 17 04 00);
- ❖ soil and dredged spoil (EWC code 17 05 00);
- ❖ insulation materials (EWC code 17 06 00);
- ❖ mixed construction and demolition waste (EWC code 17 07 00).

There are some specific matters worthy of note (Symonds Group Ltd 46967 Final Report 1999):

- in Germany and the Netherlands, for instance, a pile of concrete waste with comparatively small proportions of brick and gypsum mixed in with it would be recorded under 17 01 00;
- in the UK, by contrast, the same material would probably be recorded as 17 07 00.

Hazardous components of construction and demolition wastes should also be identified."

Different types of construction and demolition waste are subject to specific recycling and recovery methods. Methods for recycling and subsequent recovery of construction waste vary according to the type of waste.

For the most part of C&DW (about 80% by mass), they are inorganic and non-toxic and subject to re-use or recycling. The degree of recyclability of the construction waste depends on several factors - the share of the different types of waste, the degree of pre-treatment (sorting), the pollutant with harmful or hazardous substances, which depends on the processes of waste generation. Building design and practice also have an impact. Waste related to the renovation and rehabilitation of buildings has a less favorable profile, as they are most often mixed, generated over an extended period, in relatively small quantities and by different owners, posing challenges for their recycling (Zaharieva 2015).

The most common construction waste is concrete and reinforced concrete. The main generator of such waste is the reconstruction and demolition of old buildings. Concrete waste contains rock and cement (aggregate) materials and, in recycling, including crushing and crushing, reinforcement separation, screening and purification, new crushed stone fractions are produced. These recycled fractions can be used as embankment or aggregate materials for concrete and asphalt. Another problem that does not stimulate recycling activities and the production of quality recycled products is the practical ban (for concrete with compressive strength above C16 / 20) according to the Bulgarian state standard (BSS) EN 206 to use recycled aggregates to produce concrete. There is no reason to do so, especially since BSS EN 206 itself allows up to 50% substitution of natural crushed stone or gravel with recycled concrete with a compressive strength even above C 30/37.

Table 1. C&D Waste generation by economic activities and households (Waste treatment 2014)

	Total		Mining and quarrying	Manufacturing	Energy	Construction and demolition	Other economic activities	Households
	(million tonnes)	(kg per inhabitant)			(%)			
EU-28	2 502.9	4 931	28.1	10.2	3.7	34.7	14.9	8.3
Belgium	65.6	5 838	0.1	21.7	2.1	40.2	27.3	8.6
Bulgaria (*)	179.7	24 872	88.6	:	5.1	0.7	4.0	1.5
Czech Republic	23.4	2 223	1.0	18.8	4.3	40.2	21.8	13.9
Denmark	20.1	3 558	0.1	6.4	5.4	52.6	18.5	17.1
Germany	387.5	4 785	1.9	15.8	2.6	53.3	16.9	9.5
Estonia	21.8	16 587	36.3	20.2	32.6	3.1	5.6	2.2
Ireland (*)	15.2	3 285	17.8	:	2.1	12.4	57.6	10.0
Greece	69.8	6 404	67.9	7.0	15.6	0.7	2.3	6.5
Spain	110.5	2 378	16.9	13.4	4.8	18.5	28.3	18.3
France	324.5	4 913	0.7	6.7	0.5	70.2	13.1	8.8
Croatia (*)	3.7	879	0.1	:	3.2	16.6	48.9	31.2
Italy	159.1	2 617	0.6	16.7	2.0	32.5	29.5	18.6
Cyprus (*)	2.1	2 406	:	:	:	31.0	48.9	20.2
Latvia	2.6	1 315	0.2	9.4	27.8	17.3	18.3	27.1
Lithuania	6.2	2 114	0.4	42.1	1.6	7.0	30.1	18.7
Luxembourg	7.1	12 713	1.8	4.0	0.0	84.5	6.1	3.4
Hungary	16.7	1 688	0.5	16.2	13.9	20.7	31.0	17.7
Malta (*)	1.7	3 896	2.2	:	0.2	74.5	13.8	9.3
Netherlands	133.2	7 901	0.1	10.1	1.3	68.1	14.1	6.4
Austria	55.9	6 541	0.1	9.7	0.9	72.1	9.8	7.5
Poland	179.0	4 710	42.3	17.6	12.2	9.5	13.7	4.6
Portugal	14.6	1 402	1.9	17.9	1.2	10.3	36.3	32.3
Romania (*)	175.6	8 820	87.0	:	4.0	0.6	6.2	2.2
Slovenia	4.7	2 273	0.2	28.1	13.5	17.4	28.9	12.0
Slovakia (*)	8.9	1 636	3.2	:	6.1	15.6	55.4	19.6
Finland	98.0	17 572	65.4	10.7	1.5	17.0	3.7	1.7
Sweden	167.0	17 226	83.2	3.4	1.1	5.3	4.5	2.5
United Kingdom	251.0	3 885	10.5	3.2	1.3	48.0	26.0	11.0
Iceland (*)	4.5	1 651	0.0	17.6	0.3	2.1	36.1	44.0
Liechtenstein	0.6	14 919	1.7	2.0	0.1	0.0	0.4	95.9
Norway (*)	11.7	2 283	2.8	:	1.3	23.0	52.7	20.3
Montenegro	1.2	1 872	22.5	5.2	31.7	9.2	15.3	16.1
FYR of Macedonia	2.2	1 058	3.4	67.9	23.3	0.5	4.9	0.0
Serbia	49.1	6 890	84.5	1.8	9.1	0.6	0.7	3.3
Turkey (*)	73.1	947	4.2	:	32.8	:	20.2	42.8
Bosnia and Herzegovina (*)	0.5	1 161	1.6	27.2	71.1	0.0	0.0	0.0
Kosovo (UNSCR 1244)	1.0	574	19.3	7.0	0.0	0.3	26.3	47.0

(*) Other economic activities includes also manufacturing.
(*) Other economic activities includes also mining, quarrying, manufacturing and energy.
(*) 2012.
(*) Other economic activities includes also manufacturing, construction and demolition.
Source: Eurostat (online data code: env_wasgen)

Building ceramics is another material that can be used extensively after recycling. For example, for fillers and drainage works, for pavements, for park lanes and others. It is possible to recycle the ceramic products in the form of recycled aggregates to produce lightweight concrete. In terms of bricks, which are the most used ceramic products in the construction, due to the high mechanical strength of ceramics and its durability, the bricks are fit for new masonry. The possibilities for re-use of building ceramics largely depend on the recycling process, the demolition methods of old buildings and the construction site technology, which aim to separate the ready-to-use ceramic construction waste.

There is a clear relationship (Symonds Group Ltd 46967 Final Report 1999) between the possible destinations to which C&DW may be sent and the final fate of the waste materials concerned. It is possible to define a range of possible destinations/uses to which they may go once they have been collected on-site. These include one or more of the following:

Re-use options

- re-use on-site for the original intended purpose;
- re-use off-site for the original intended purpose;

Recycling options

- on-site processing to recover high value saleable materials;
- off-site processing to recover high value saleable materials;
- recycling on-site for a low-value purpose (including non-essential land raising);
- recycling off-site for a low-value purpose (including non-essential land raising);

Incineration options

- off-site incineration with energy recovery;
- off-site incineration without energy recovery;

Landfilling options

- off-site landfilling of segregated waste materials;
- off-site landfilling of unsegregated waste.

Average rate of recycling of C&DW for some EU countries for 2011 could be seen at Table 2.

Table 2. Average rate of recycling of C&DW for some EU countries (Calvo et al. 2014)

Country	RCD *	% Recycled	Country	RCD *	% Recycled
Denmark	5,27	94%	Malta	0,8	0%
Estonia	1,51	92%	Netherlands	23,9	98%
Finland	5,21	26%	Poland	38,19	28%
France	85,65	45%	Portugal	11,42	5%
Germany	72,40	86%	Romania	21,71	0%
Greece	11,04	5%	Slovakia	5,38	0%
Hungry	10,12	16%	Slovenia	2,00	53%
Ireland	2,54	80%	Spain	31,34	14%
Italy	46,31	0%	Sweden	10,23	0%
Letonia	2,32	46%	UK	99,10	75%
Lithuania	3,45	60%	EU-27	531,38	46%
Luxembourg	0,67	46%			

* million tones.

Source: European Commission (DG ENV), 2011.

Results and conclusions

On the territory of the regional waste disposal landfill in Rousse, experiments were carried out to determine the optimum particle size that can be used for the surrounding embankments and for temporary roads. In Table 3 the recycled quantities of CW for the last 5 years are presented.

Table 3. CW Recycled quantities for the last 5 years for Ruse, Bulgaria

Year	CW quantity recycled, tonnes
2018	36,46
2017	150
2016	3770
2015	5019
2014	6788

The main machines are related to the processing of the main volume and recyclable building material - crushing and screening installation.

The Ruse landfill has 2 machines - the crusher RM 80 (fig.1) and the R105 Screeper (fig.2). The crusher is an Austrian production, made in 2012 and purchased by the landfill in 2014. Its performance is up to 160 t / h, and the particle size is up to 70 mm. The scraper was purchased in 2015. Thanks to this equipment, 3 types of fractions can be obtained: - Up to 31 mm - ash + finger; used to deploy the landfill;
- 40 to 70 mm (0.63 mm) - for backfill; - Over 70 mm - for grinding.

At the landfill, materials are broken down with the following codes in accordance to Ordinance 3 Classification of construction waste: ORDINANCE № 3 OF 1 APRIL 2004 FOR CLASSIFICATION OF WASTE replaced by ORDINANCE No 2 of 23.07.2014 on the classification of waste, issued by the Bulgarian Minister of Environment and Water and the Minister of Health, published on 08.08.2014:
17 01 01 concrete; 17 01 07 mixtures of concrete, bricks, tiles, tiles, faience and ceramics, other than those mentioned in 17 01 06; 17 04 05 iron and steel; 17 05 06 excavated earth masses other than those mentioned in 17 05 05 (Ordinance No. 2/2014).

Figure 1. Crusher RM 80 (VIP Logistic ltd)

Figure 2. R105 Screener (VIP Logistic ltd)

A major problem in Bulgaria is the lack of washing facilities. They are needed because there is a lot of dust in the crushing of the concrete and the building materials experts need to tell where they can be used.
Construction waste recycling facilities are not yet in place. The lack of sufficient installations also leads to a lack of competition between them, they are produced only in the form of recycled products, and there is a real risk that recycled products do not have the necessary construction and technical properties.

Almost there are no companies registered for recycling glass from construction sites, but only from packaging for which there is a market. The same applies to wood.
The issue of dangerous CW is not entirely solved. The lack of a uniform sampling methodology, adapted to the specifics of CW.
At present, no sustainable solution has been found for the separation and treatment of a number of hazardous substances contained in construction waste.
There is also no single national platform on the amount of construction waste generated by branch organizations.
All this indicates that future coordination between CW-generating companies, control and management bodies must be carried out in order to achieve the recycling goals of the CW.

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