# Handling construction waste of building demolition

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**Abstract.** Some building defects lead to their demolition. What about construction and demolition waste? According to the Waste Act 185/2001 Coll. and its amendment 223/2015 Coll., which comes into force on January 1, 2017, the production of waste has to be reduced because, as already stated in the amendment to Act No. 229/2014 Coll., the ban on landfilling of waste will apply from 2024 onwards. The main goals of waste management can thus be considered: Preventing or minimizing waste; Waste handling to be used as a secondary raw material - recycling, composting, combustion and the remaining waste to be dumped. Company AZS 98 s. r. o. was established, among other activities, also for the purpose of recycling construction and demolition waste. It operates 12 recycling centers throughout the Czech Republic and therefore we have selected it for a demonstration of the handling of construction and demolition waste in addressing the defects of the buildings.

#### 1 Introduction

The contemporary construction is trying to reflect the requirements of sustainable development. The basic principles of sustainable development include efficient use of energy, water and other resources, the protection of indoor climate of buildings and human health, reduce waste and pollution [1]. Construction and demolition waste is a result of various construction activities, construction, maintenance and reconstruction of buildings, various construction modifications of completed constructions and removal of buildings. Over half of the total production of all waste in the Czech Republic consists of construction and demolition waste. Construction and demolition waste arises:

- when setting up buildings (buildings),
- their maintenance,
- when changing buildings (buildings),
- removal of buildings (buildings).

This waste is currently almost completely used because construction and demolition waste is a significant source of secondary raw materials. The Waste Management Plan of the Czech Republic for the period 2015-2024 sets a target for construction and demolition

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waste and prepare at least 70% of this waste for re-use. This objective is based on Directive 2008/98 / EC of the European Parliament and of the Council on waste.

Under the term construction and demolition waste (CDW) we can imagine what remains after the modification, repair or demolition of a building. They are bricks, masonry, tiling, wooden structural elements, and anything else that remains after that or that construction. Construction waste and demolition waste are also considered to be remnants of various wiring. So electrical wiring, water and waste piping. Or the excavation rock. All of these materials are recyclable. However, separation is required for their successful recycling (or further processing). First of all, the separation of contaminated components and then the material separation. It should also be noted that such waste can be polluted by materials that legislation perceives as hazardous waste. Then they must be treated as hazardous waste or detoxified for recycling [2].

According to the Waste Catalogue, construction and demolition wastes are included in group 17 and their basic subgroups are listed in Tab. 1.

Catalogue name of the waste subgroup	Waste				
17 01	Concrete, bricks, ceramic products and bags				
17 02	Wood, glass and plastics				
17 03	Bituminous mixtures, tar and tar products				
17 04	Metal (including their alloys)				
17 05	Soil (including excavated soil from contaminated sites), stones and extracted debris				
17 06	Insulating materials and building materials containing asbestos				
17 07	-				
17 08	Plasterboard construction material				
17 09	Other construction and demolition waste				

Table 1. Basic CDW Subgroups, according to the Waste Catalogue of Annex 1 [3].

The whole CDW process has its origins in the mining of building materials, which we take as primary building materials. After mining, these raw materials and materials are processed on the product, followed by the use of a statement in land or road construction, followed by demolition and ending with landfill removal, whether CDW is used for landscaping or reclamation. An integral component is also the waste generated during earthworks - the excavated soil, which occupies the largest proportion of the volume of construction waste.

A simple breakdown of construction waste is divided into four groups - Figure 1, based on the average percentage of the main CDW components:

- (65 75%) Soil from excavations and debris.
- (5 20%) Demolition building rubble.
- (10 15%) Asphalt mixtures, bitumen.
- (5 15%) Waste from construction sites

The share of individual fractions of construction waste is highly variable within the Czech Republic. The reason is different urbanization, industrialization, different construction technologies, density of built-up area and number of demolitions in individual regions.

The production of construction waste in 2008-2015 can be seen in Table 2. Data in the table come from the CENIA - ISOH database. Table 2 lists the groups of construction wastes that are most often produced and therefore their volume is higher than other groups and the groups of the most commonly used construction waste for subsequent recycling and production of recyclates. It can be seen from Table 2 that the production of construction

and demolition waste is rather constant. An exception to the amount of production is formed by group 17 05 - soil, debris and stones, which has been declining in recent years.



Fig. 1. Segmentation of basic CDW groups.

		Year							
Cat. n.	Waste	2008	2009	2010	2011	2012	2013	2014	2015
		$[10^{6} \text{ kg}]$							
17 01	Concrete, bricks, tiles and ceramics	2934	2998	3167	3033	3444	3545	3625	3962
17 03	Bituminous mixtures, tar and tar pitch	445	516	466	443	531	560	584	575
17 05	Soil (including excavated soil from contaminated sites), stones and extracted debris	11396	10708	10845	9053	8908	10094	11632	16726
17 08	Construction material on the base of gypsum	6	7	7	8	7	7	9	8
17 09	Other construction and demolition waste	497	580	614	630	496	502	530	620
Total		15278	14809	15099	13167	13386	14808	1380	21891

Table 2. CDW production in the Czech Republic [4].

## 2 Recycling of construction and demolition waste

As can be seen, under construction waste we can imagine what remains after the demolition of a building. They are bricks, masonry, tiling, wooden structural elements and anything else that remains after one or the other building, road, or the like. Construction waste also includes remnants of various types of building wiring. So electric wiring, water and waste piping. Or the excavation rock. Although it may sound odd, these materials are recyclable. However, separation is required for their successful recycling (or further processing). Above all, the separation of contaminated components and then separation by material. Excavating soil, for obvious reasons, is not necessary to separate. Account should also be taken of possible contamination of materials that the legislation then treats as hazardous waste.

Recycling of construction and demolition waste is largely understood as a "simple" treatment during which its physical properties change. Building wastes are a valuable source of materials that can reduce the need for extraction or production of new raw

materials and materials. Based on experience from Europe, it can be said that the recycling boundary (or other recovery of construction and demolition waste) may be close to 90%. With recycling systems, building waste can return to the construction industry as a full-featured material.

The recycling of construction waste began in Czech Rep. since the 1990s. The most common way of recycling CDW is crushing. Subsequently, everything is sorted to make the fractions easy to use for further construction, replacing raw materials from natural sources. The main benefit of recycling of construction and demolition waste is the reduction of the need to extract raw materials and reduce the cost of new building materials. This can limit the opening of new quarries or sandbanks. In addition, the building recyclates, which are replaced for instance natural aggregates, can be purchased at the fractional price of the extracted natural stone.

The concept of CDW recycling technology can be called the complete process of converting unsorted, mixed or different construction waste into sorted recyclates of differently selected fractions of 4 mm to 125 mm. The procedure is such that materials that can be re-offered for sale are first separated by hand. These are mainly brick elements, roof tiles. Other materials are also separated - glass, metals, paper, plastics, wood (with fuel and building resolution) and finally unusable waste accumulated in the appropriate containers, which is taken to a municipal waste landfill. The next step is shredding and sorting.

#### 2.1 Technology of recycling

There are two ways of recycling technology:

Recycling process carried out directly on the site where the CDW is being built - A CDW storage facility is provided at the construction site, its processing and use is directly conditional on the site. The benefits of using this recycling method are to minimize costs and charge for CDW removal and landfill. An important advantage is the use of recycled material for further construction. The disadvantages of using this recycling option include obtaining the necessary recycling permit at the site of construction and providing for the recycling process, ie, the place where the recycling will take place and the need to use the recycled product [5,6].

The recycling process carried out at the place of the permanent establishment. Establishment provide the complex CDW disposal. This activity involves the reception of waste, its processing and, as a result, its sale. The removal and sorting of SDOs into recycling plants is only possible in accordance with the rules of the relevant facility. The benefits of using this recycling process are: minimum space requirements, recycling of CDW types and continuous waste disposal. Among the disadvantages are financial factors such as landfill and transport.

### 3 Recycling technology at AGS 98, I.I.c.

AZS 98's first recycling center was established in 2004 in Pilsen, Borská pole. The company has built and operated recycling centers in some districts at its own expense. To date, a total of 14 recycling centers have been operated. In some centers, besides recycling of construction waste, they also deal with the crushing of natural stone (Barbora - Jáchymov), reclamation of the area after mining (Uhlířské Janovice). The company operates recycling in both ways, ie at both the waste site and recycling centers.

Thanks to the quality of services and other activities, the company has been certified by Czech Building Standart (CBS) EN ISO 9001: 2001, CBS EN ISO 14001: 2005, CBS OHSAS 18001: 2008 and is a member of the Association for the Development of Building Materials Recycling.

Mobile recycling technology at AZS 98 l.l.c is carried out by bringing a recycling line containing a mobile crusher, screener, loader and possibly an excavator to the collection site of the building waste. The next step is the crushing and sorting according to the required fraction, and then recyclate is used at the construction site. The quality of the resulting recycled material also results from the processes before direct crushing. The maximum quality of the recyclate is ensured by a magnetic separator and a lining strip and a calibrated weight for accurate pricing. Mobile recycling is only possible if the volume of construction materials exceeds 500 tons.

The recycling of CDW at the building waste recycling center takes place similarly, with the difference that construction waste is imported by both the company itself and other suppliers. The reception of construction waste is in accordance with the valid operating rules, which are approved by the relevant Regional Authority. The CDW is then accepted at the recycling center and classified according to the Waste Catalog. Crushing and sorting according to the fractions takes place after the accumulation of quantities economically beneficial for recycling. Whether recyclates are suitable for further use is verified by regular testing by an accredited testing center. It assesses not only the environmental impact, but also technological analyzes in terms of their use. All of these processes take place at fourteen recycling centers of AZS 98 1.1.c., located in four regions of the Czech Republic.

#### 3.1 Material flow

The material flow is considered to be CDW's movement from its production, utilization or further disposal. Material flows at AZS 98 are listed in Table 3 [7].

Table 3 compares the volume of intake of construction and demolition waste with expenditure of the recyclate. This is the entire CDW income that was processed and issued by AZS 98 1.1.c. The difference in values may indicate either a larger quantity of the material being issued or, on the contrary, a larger quantity of material received. If the delivery value is greater than the acceptance value, it means that the demand for recycled material in the monitored center was higher and therefore the material was taken out of stock or out of stock from the previous year. This process is similar in most recycling centers. Graphic processing of Table 3 is in Figure 2.

Amount of CDW receipt and issue of recyclate in 2014									
Center	District (NUTS4)	Region (NUTS3)	Receipt [t]	Issue [t]	Difference [t]				
Valcha	Plzeň	Plzeňský	74 585.49	76 200.43	1 614.94				
Jáchymov	Karlovy Vary	Karlovarský	0.00	2 077.74	2 077.74				
Stříbro	Tachov	Plzeňský	6 583.11	5 907.30	675.81				
Blovice	Plzeň – jih	Plzeňský	2 446.59	2 872.44	425.85				
Podbořany	Louny	Ústecký	5 621.65	3 988.10	1 633.55				
Sadov	Karlovy Vary	Karlovarský	11 315.12	12 741.49	1 426.37				
Tachov	Tachov	Plzeňský	2 103.21	4 589.99	2 486.78				
Újezd	Domažlice	Plzeňský	2 623.55	445.73	2 177.82				
Cheb	Cheb	Karlovarský	8 043.86	664.00	7 379.86				
Ostředek	Benešov	Středočeský	4 623.22	1 291.50	3 331.72				
Rokycany	Rokycany	Plzeňský	21 612.17	14 941.93	6 670.24				
Zavlekov	Klatovy	Plzeňský	8 064.34	6 655.94	1 408.40				
Chmeliště	Kutná Hora	Středočeský	1 228.32	0.00	1 228.32				
Libočany	Louny	Ústecký	3 200.00	25,00	3 175.00				
Total in tonnes			152 050.63	132 401.59	19 649.04				

Table 3. Material Flows Survey for 2014 at AZS 98 l.l.c.

Although the direct waste recycling process does not run evenly every day, AZS 98's concept is to use recycling centers as "bottomless landfills". The principle is to recycle the received SDO volume at the recycling center and sell the same volume of CDW already recycled. Which, according to the volumes, meets this company.

It is also important to mention the use of recycled material by the company itself, not only for backfills and the like, but also for the production of brick concrete, from which the concrete cubes for dry reinforcement are also produced. The company is still trying to improve the quality of the recyclate and its further use, therefore it has long been cooperating with CTU in Prague, the Faculty of Civil Engineering. There are several projects underway to research possible recycling of recycled material.



Fig. 2. Comparison of Material Income and Output at AZS 98 1.1.c.

## 4 Conclusion

Company AZS 98 l.l.c. Successfully solves the situation with the handling of construction and demolition wastes, as evidenced by the high weight of CDW used [8]. The system of disposal of construction and demolition waste in this company may be an example of good recycling and general waste management for other companies. The contribution came from the preparation of the grant plan.

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