Evaluation of the potential of the use of recycled aggregates for concrete production

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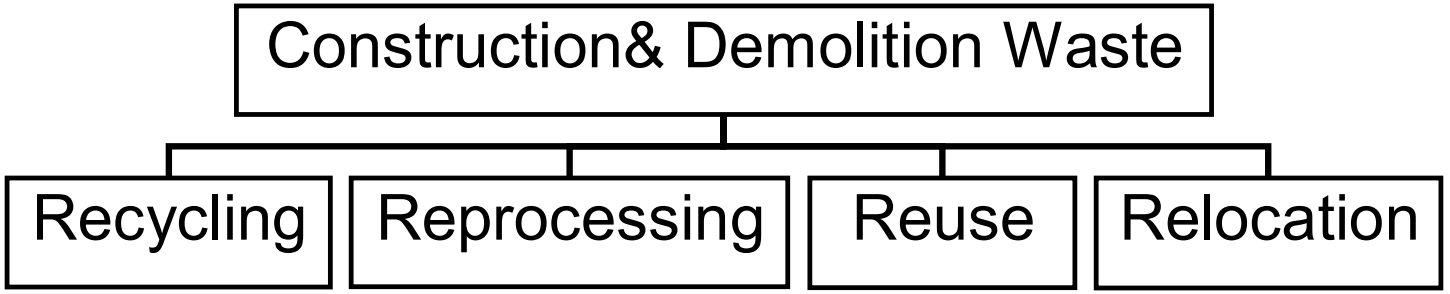
Construction & Demolition Waste



C&D waste is included as a separate group of 17 in Waste Catalogue

Czech Republic 2014

C&D waste

51.14% (ca. 16400 kt)

from total waste

Waste Management

- The first Waste Act was adopted in the Czech Republic as recently as 1991.
- Since 2004 our legislation has been influenced mainly by the European Union regulations.
- The Waste Management Plan of the Czech Republic for 2015-2024, which was published in the form of a Government Regulation.
- In 2005 the European Union (EU) formulated a vision of “the EU as a recycling community“.
- EU Waste Framework Directive 2008/98/EC.

Utilization of C&D waste

- Only a very small part of recycled aggregates is used for structures in the building industry.

- Most building waste is used for the road base or as backfill.

- Large volumes still end up in landfills, are used for reclamation or landscaping all the time.

Problem CR

illegal disposal of waste

Situation in the CR

- Around 170 construction waste landfills.
- Around 90 recycling centers.
- Around 140 shredders (mainly mobile ones).
- The total annual capacity of recycling facilities in the CR is ca 15 mil. t/year.
- In 2014, ca 16 million tonnes of C&DW was generated.
- 26% was recycled and 48% used for landscaping.
- Use of C&DW is 6 - 7% of the production of natural aggregates.

Databases of recycled materials in the CR

- **1999 – 2008: ARSM**

  Association for the Development in Recycling Building Materials

- **2002 – today: CENIA**

  Czech Environmental Information Agency (ISOH database)

- **X – today: CSU**

  Czech Statistical Office

Production of C&D waste in the CR

Code	Waste	2010	2011	2012	2013	2014
		[kt]				
17 01	**Concrete, bricks, tiles and ceramics**	3167	3033	3445	3249	3688
170101	**Concrete**	1163	1127	1385	1292	1422
17 01 02	**Bricks**	834	776	735	757	745
17 01 03	Tiles and ceramics	18	11	14	12	16
17 01 07	Mixtures other than those mentioned in 17 01 06	1130	1092	1250	1172	1473
17 03	Bituminous mixtures	466	443	531	510	573
17 05	Soil and stones	10845	9053	8908	9966	11128
17 06	Insulation materials	111	71	59	61	66
17 08	Building gypsum-based materials	7	8	7	9	11
17 09	Other construction and demolition waste	614	630	496	609	451
17 00	**Total**	**15210**	**13239**	**13447**	**14404**	**15916**

Source: WMIS (ISOH)

Waste management methods of C&D waste in the CR

	2009	2010	2011	2012	2013	2014
Generation of C&D waste	14883	15210	13239	13447	14004	15916
Recycling R5	2503	2475	2647	3300	3797	4110
Use of wastes for landscaping N1	8225	5555	5221	5300	5686	7654
Use of wastes for landfill reclamation N11	566	480	1007	987	1031	752
Technical layers of landfills N12	572	697	750	619	552	637
Landfilling D1	690	565	413	487	361	362

Source: WMIS, in [kt]

Receiving C&D waste for recycling in recycling centers

(buyback of C&DW)

C&D waste	No.	Eur/tonne
Concrete	17 01 01	3.70 – 6.00
Reinforced concrete	17 01 01	7.40 – 12.00
Masonry	17 01 02	5.00 – 7.20
Ceramic products	17 01 03	5.50 – 7.00
Soil and stones	17 01 04	**BEFORE 5.50–10.00**
Mix waste	17 01 07	10.50 – 11.50

The price range is based on 16 recycling centres from CR.

Sale of recycled materials in recycling centers

Recyclates	Fraction	EUR/t
Concrete rubble	0/16 mm	1.90-5.10
Concrete rubble	16/63 mm	5.90-11.20
Concrete rubble	63/120 mm	3.70-5.50
Masonry (mix) rubble	0/8 mm	1.0-3.30
Masonry (mix) rubble	16/63 mm	1.20-2.50

The price range is based on 16 recycling centres from the CR.

The price of natural aggregate sis 10-18 EUR/t depending on the fraction of aggregates.

Criteria for recycled aggregates for applications

- Mechanical, physical and technical properties according to applicable standards (EN)

- Environmental risks - influence on the environment and on human health

The ecological suitability for their utilization is determined based on their chemical composition, the content of hazardous substances and the possibility of their leakage into the surrounding environment.

Properties of recycled aggregates

Aggregate	Fraction	Unit Weight	Tapped Apparent Density	Loose Apparent Density	Water Absorption
		[kg/m^3]	[kg/m^3]	[kg/m^3]	[%]
Masonry Rubble	0/8 mm	1650-1860	1180 - 1390	1034-1298	4.3-16.3
	0/16 mm	1706-1987	1190-1405	1020-1260	4.2-15.4
	0/32 mm	1774-2068	1256-1368	1056-1258	3.8-15.6
Concrete Rubble	0/8 mm	2098-2342	1413-1659	1236-1499	4.2-11.3
	0/16 mm	2112-2399	1388-1731	1248-1430	3.9-11.0
	0/32 mm	2114-2498	1436-1617	1257-1428	3.2-9.8

(The range of measured values for ca 20 samples for each fraction derived from different sources)

Ecological suitability of recycled aggregates

Attention has been focused mainly on:

- the content of hazardous substances in dry matter and in the extract
- the radionuclides' activity
- ecotoxicity

It has been proven based on measured resulting values that the most risky substances for recycled building materials are

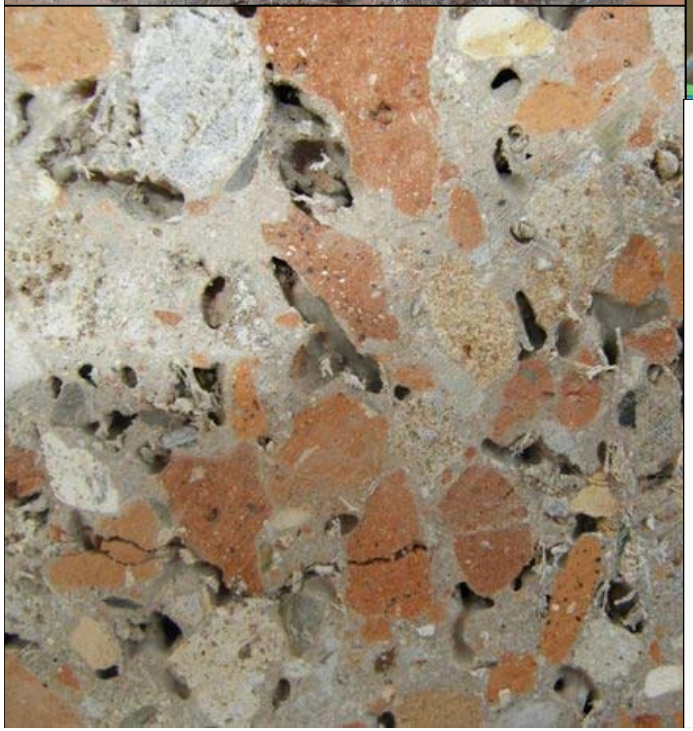
- arsenic
- polycyclic aromatic hydrocarbons
  (t12 PAH sum)
- C10-C40 petroleum hydrocarbons

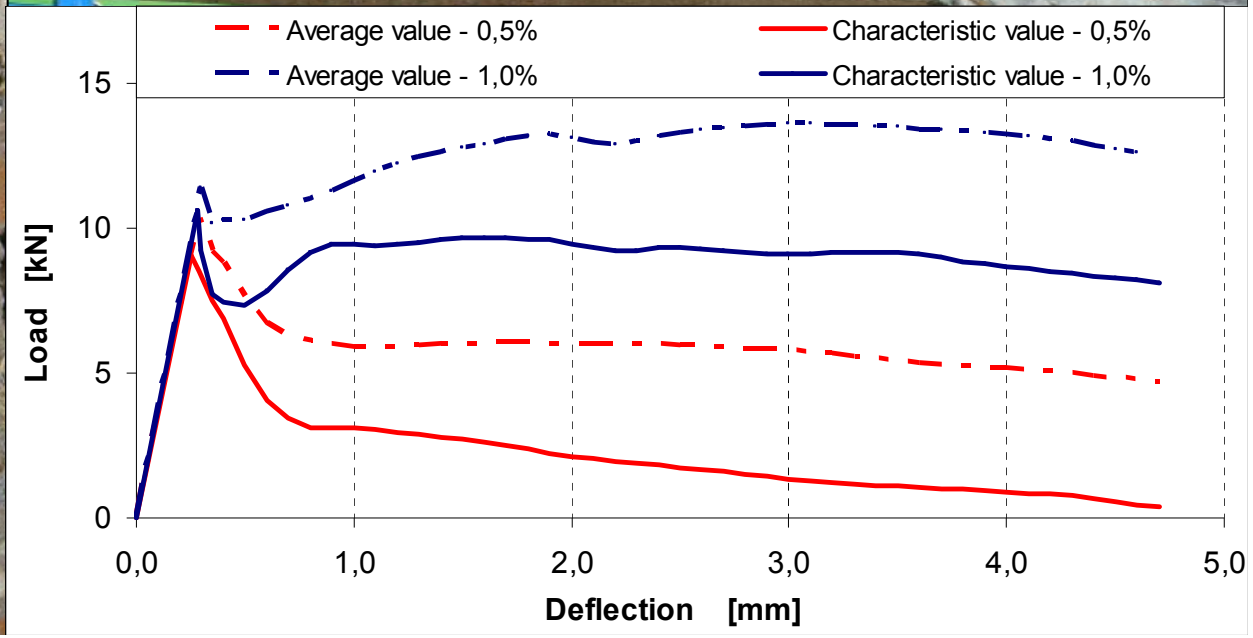
Dispersion of values of hazardous substances in the dry matter of recyclates

Hazardous Substance	Limits	Recycled Aggregate		
	[mg/kg]	Concrete 17 01 01	Masonry 17 01 02	Soil and Aggregate 17 05
As	10	3,17 - 54,7	5,38 - 21,5	8,0 - 48,4
Cd	1	< 0,4 - 2,08	< 0,4 - 0,8	< 0,4 - 0,41
Cr	200	23,3 - 362	13,8 - 73,5	27,3 -101
Pb	100	5,1 -182	9,1 - 107	8,5 - 301
Hg	0,8	< 0,2-0,78	< 0,2 - 0,81	< 0,2 - 1,05
Ni	80	12,4 - 33,8	9,1 - 87,2	17,2 -55,6
V	180	23,8 - 70,0	20,2 - 83,3	45,2 - 139
Σ 7 PCB	0,2	< 0,14	< 0,14 - 3,75	< 0,4 - 2,08
EOX	1	< 1,0	< 1,0	< 1,0
Σ BTEX	0,4	< 0,17 - 0,98	< 0,17	< 0,17
C10 - C40	300	20 - 928	20 - 355	25 - 3270
Σ 12 PAU	6	0,3 - 121,0	0,1 - 50,0	0,5 - 27,5

13 samples of recycled masonry, 15 samples of recycled concrete
12 samples of sorted recycled soil with aggregates

FRC with recycled aggregate





Thank you for your attention.