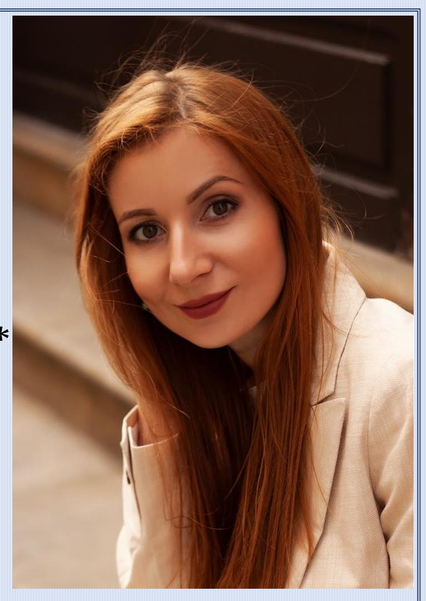
Determination of the slag's suitability from hazardous waste incineration for the production of composites for construction



P. Radomski[*], A. Żaba[*], Z. Wzorek[*], H. Kominko[*], M. Rajtar[**], J. Szpak[**], A.K. Nowak[*]

[*]Faculty of Chemical Engineering and Technology, Cracow University of Technology, Cracow, 31-155, Poland
[**]Faculty of Civil Engineering, Cracow University of Technology, Cracow, 31-155, Poland

Introduction

Composites with aggregates of waste origin are being used on an increasing scale in construction. Aggregate, i.e. rock material with a loose structure, can be of organic, mineral, but also industrial origin. It is most often used in the production of concrete and mortar, but it is also used in road construction as a base for road or railway surfaces. Mineral aggregates are obtained mainly by mining methods. On the other hand, industrial aggregates, also known as artificial aggregates, are produced as a by-product in the process of thermal processing of waste and in metallurgical plants or in the processing of metal ores. Remains after incineration of medical waste are a special group of waste. As an alloy, they contain, among others, metal oxides or residues of combustion processes. The modern development of production waste management gives many opportunities to use slag as a valuable raw material in the construction industry. It is used as a full-fledged road and construction aggregate. Slag intended for further processing as a raw material is of great ecological importance, because it leads to the cessation of opening new landfills or even to the liquidation of existing landfills. Currently, the greatest interest in the construction and road industry is artificial aggregates from steel converter slags, mixtures of blast furnace and steelmaking slags, which are a much cheaper alternative to natural aggregates.

The aim of the work was to determine the suitability of five different hazardous waste (tabl. 1) to obtain composites for construction purposes and to evaluate the obtained products.
Concrete beams were made according to Polish standard PN-EN 1290-2: 2011.

Table 1. Waste used in the research

Incinerated medical waste slag	IMWS
Metallurgical slag	MS
Steelmaking slag	SS
Pipeline slag (after medical waste incineration)	PS
Railway rubble	RR

Figure 1. Research scheme

Results & Discussion

Table 2. Results of concrete leachability test

Samples		Selected metals [mg/g]									
Waste type	**Waste content, %**	Cu	Ca	Mg	Fe	Zn	Ni	Cd	Ti	Cr	Al
control		<0.002	19.3	1.19	<0.001						<0.008
IMWS	**1**	<0.002	20.6	1.07	<0.001						<0.008
	5	<0.002	19.5	1.11	<0.001						<0.008
	10	<0.002	19.8	1.13	<0.001						<0.008
MS	**1**	<0.002	19.8	1.16	<0.001						<0.008
	5	<0.002	18.7	0.989	<0.001						<0.008
	10	<0.002	16.5	1.12	<0.001						<0.008
SS	**1**	<0.002	18.9	0.909	<0.001						<0.008
	5	<0.002	18.1	0.871	<0.001						<0.008
	10	<0.002	17.2	0.825	<0.001						<0.008
PS	**1**	<0.002	21.0	1.80	<0.001						<0.008
	5	<0.002	20.8	1.89	<0.001						<0.008
	10	<0.002	21.3	1.91	<0.001						<0.008
RR	**1**	<0.002	18.9	1.07	<0.001						<0.008
	5	<0.002	18.7	1.01	<0.001						<0.008
	10	<0.002	18.7	1.00	<0.001						<0.008

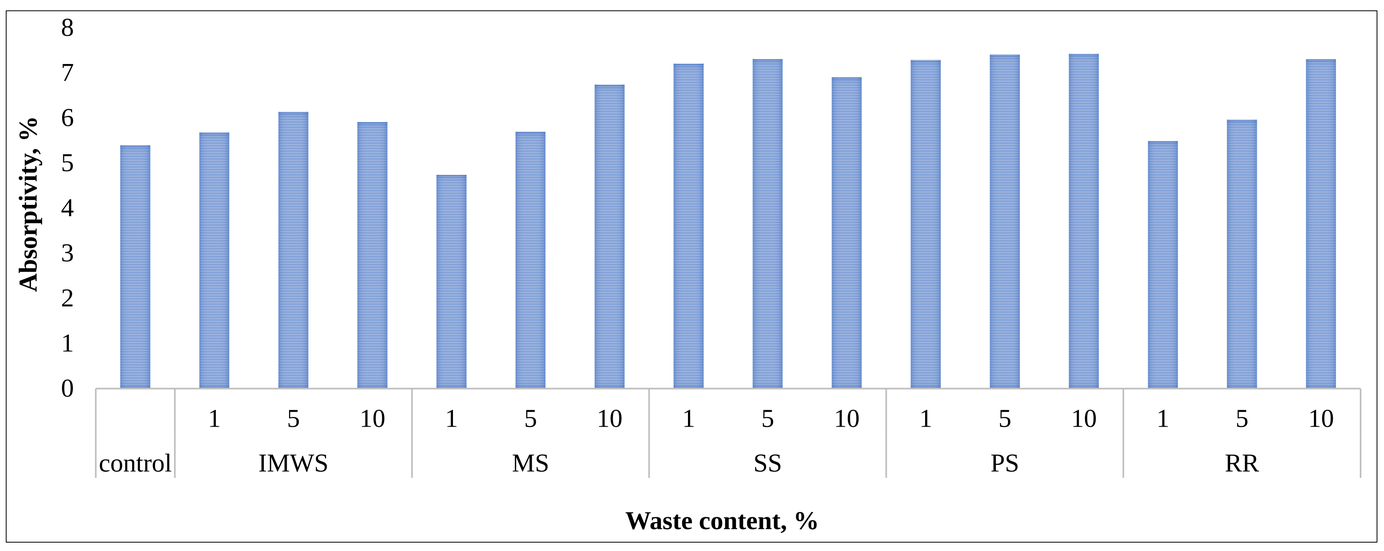


Figure 2. Absorptivity of concrete beams with the addition of waste

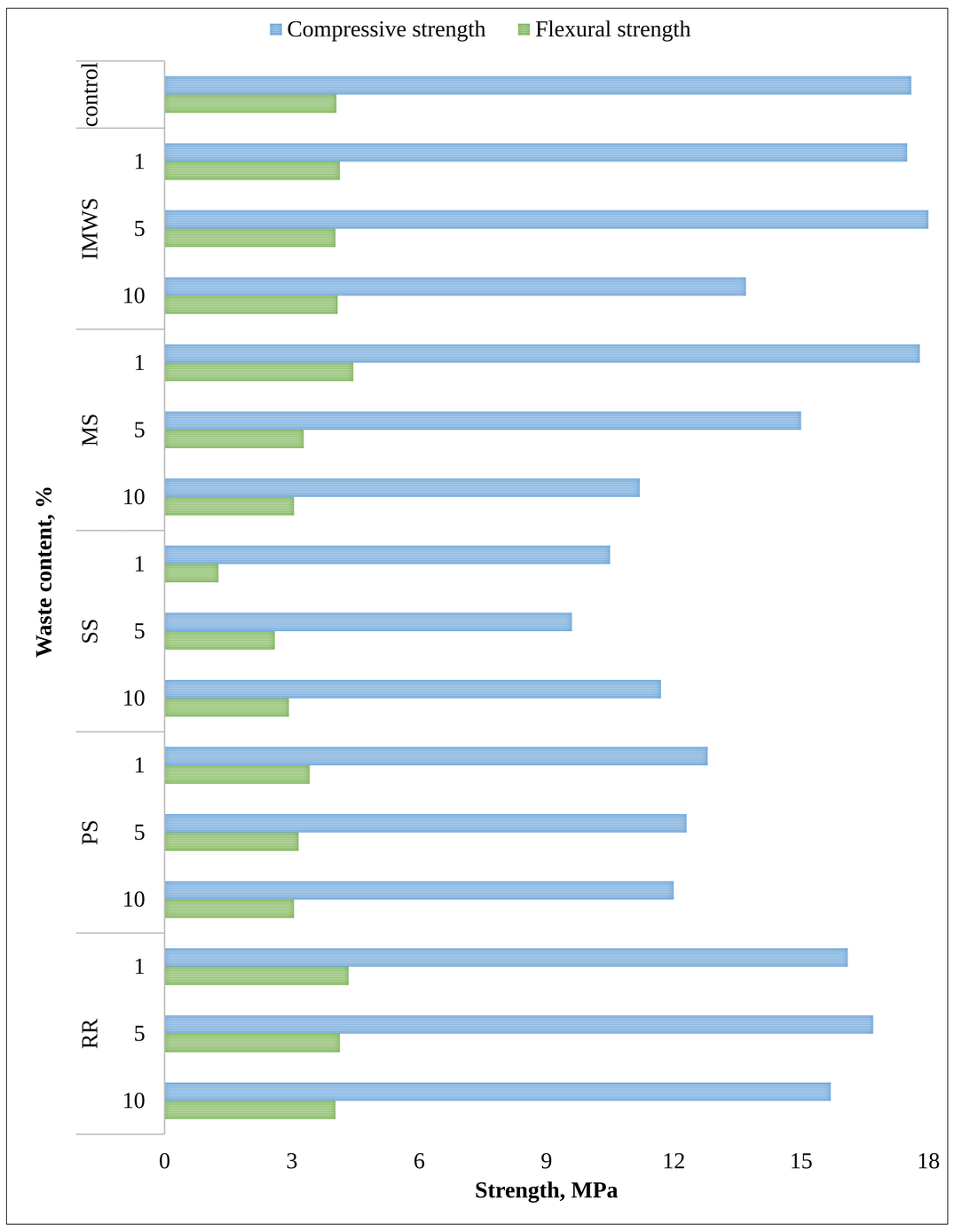


Figure 3. Strength of concrete beams with the addition of waste

Conclusions

1. The study of leachability of heavy metals in the obtained materials based on concrete and the tested groups of waste showed that it practically does not occur, except for calcium and magnesium, which is related to the composition of the concrete,
2. With the increase in the addition of waste additives to the concrete mix, the water absorption of the obtained concrete increases, which is unfavorable due to the increase in the susceptibility of concrete to weather conditions (mainly temperature),
3. Strength tests showed no relationship between the amount of added modifier and the results obtained. Lowest values in both tests, a beam with the addition of steelmaking slag was achieved.
4. In most cases, the compressive strength of concrete was higher than the minimum (15 MPa) for B-25 concrete.
5. The use of waste, including slag from the incineration of hazardous waste as an additive to concrete, is an alternative to their management, apart from landfilling.