KIELCE UNIVERSITY OF TECHNOLOGY

Faculty of Environmental Engineering, Geodesy and Renewable Energy

Waste for building materials' production as a method of reducing environmental load and energy saving

Motivation

- determination of the impact of the waste additives in the form of fly ash and sewage sludge on compressive strength of ceramic material as well as the influence of the sintering temperature on the internal microstructure of the products
- identifing potential threat to water and soil related to the used of waste derived building materials was analysed through testing heavy metals leachability from the samples

Sample preparation

The samples made of clay and waste (ash,sewage sludge).

Clay: marl in grains of diameter > 0.5 mm: 0.055%, water-soluble sulfates: 0.14%, density: 1.74 g/cm3. The mineral compositions: montmorillonite, illite, kaolinite, illite-montmorillonite mixed pack minerals, calcite, dolomite, calcium aluminum oxides, calcium ferrous oxides.

Sample preparation

Fly ash
(from electrofilter)

Property	Value
Moisture	0.18%
Loss on ignition	7.52%
Si	213.127‰ d.m.
Fe	56.070‰ d.m.
Al	124.253‰ d.m.
Ca	36.357‰ d.m.
Free CaO	0.64‰ d.m.
Mg	22.250‰ d.m.
S	2.440‰ d.m.
Na	6.158‰ d.m.
K	11.617‰ d.m.
Density	2.13g/cm^3
Specific Surface	6170cm^2/g

Sample preparation

Sewage sludge

Property	Value
Moisture	80.36%
Organic matter	52.04%
P (total)	2.4% d.m.
Pb	0.0167‰ d.m.
Cu	0.0091‰ d.m.
Zn	0.838‰ d.m.
Fe	1.0733‰ d.m.
Mg	1.8491‰ d.m.
Na	0.2128‰ d.m.
K	0.7509‰ d.m.
Ca	3.065‰ d.m.

Sample preparation

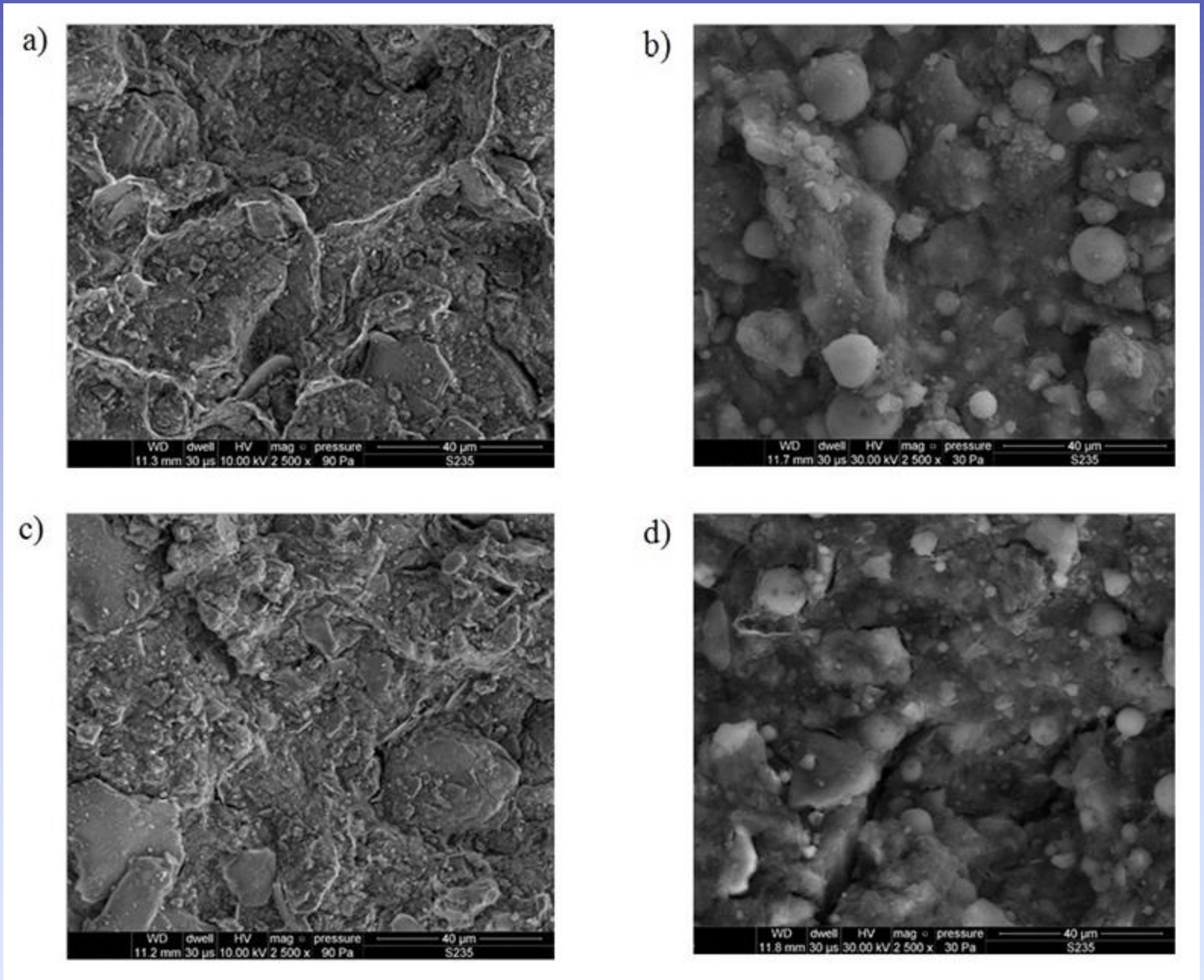
Samples of 26 x 26 x 14 mm, formed with hand press and dried – first at T= 20C and then at 105C in the laboratory drier for 2h. The dried samples were sintered at T= 850C, 900C and 950C for 8h.

Test results

Compressive strength [MPa]

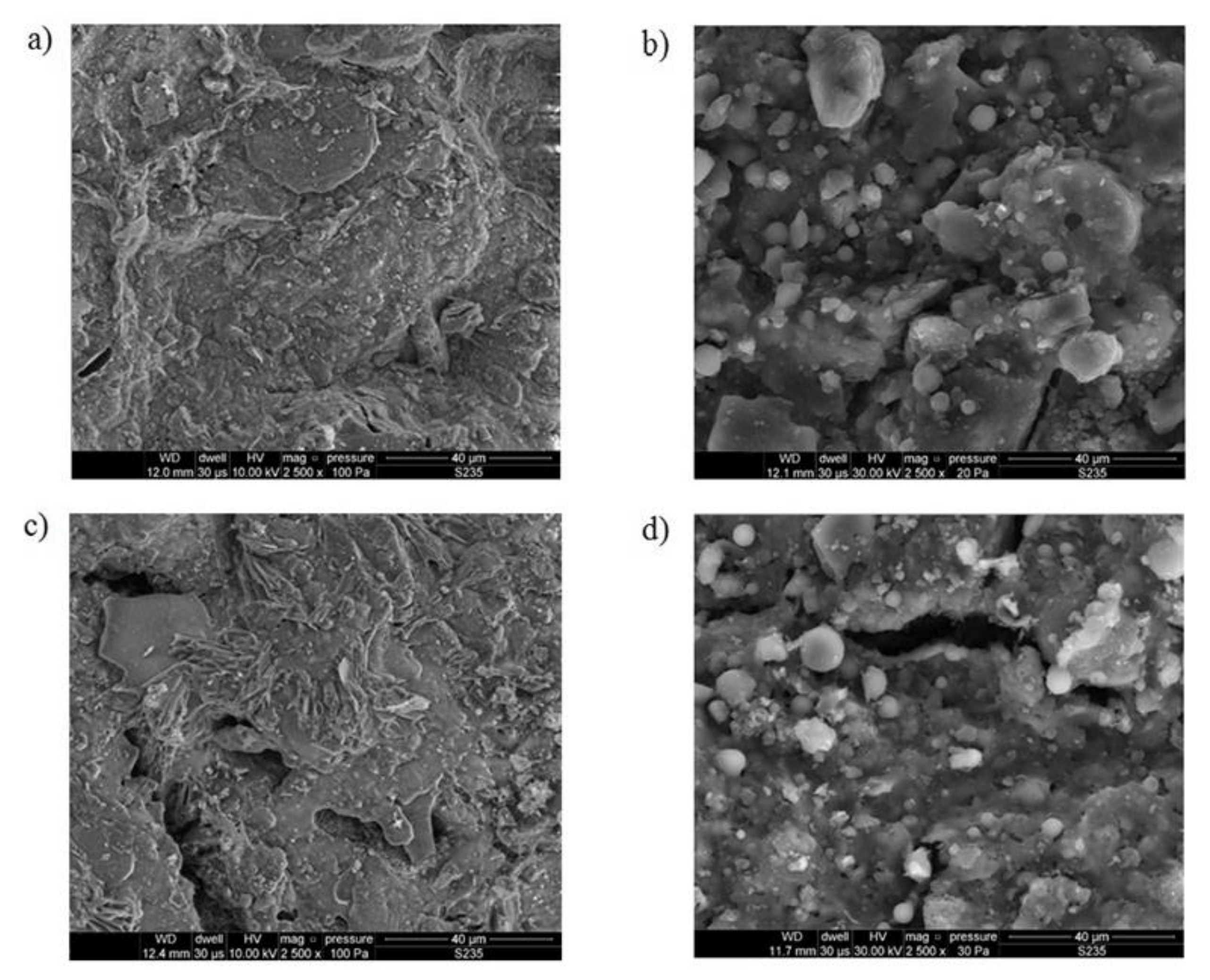
Composition	Sintering temperature 850^{o}C	Sintering temperature 900^{o}C	Sintering temperature 950^{o}C
Clay (100%)	60.07	50.37	53.53
Clay with ash (20%)	25.24	25.18	32.51
Clay with sludge (20%)	11.33	10.25	10.65
Clay with ash (20%) and sludge (20%)	5.26	4.62	7.13

Test results



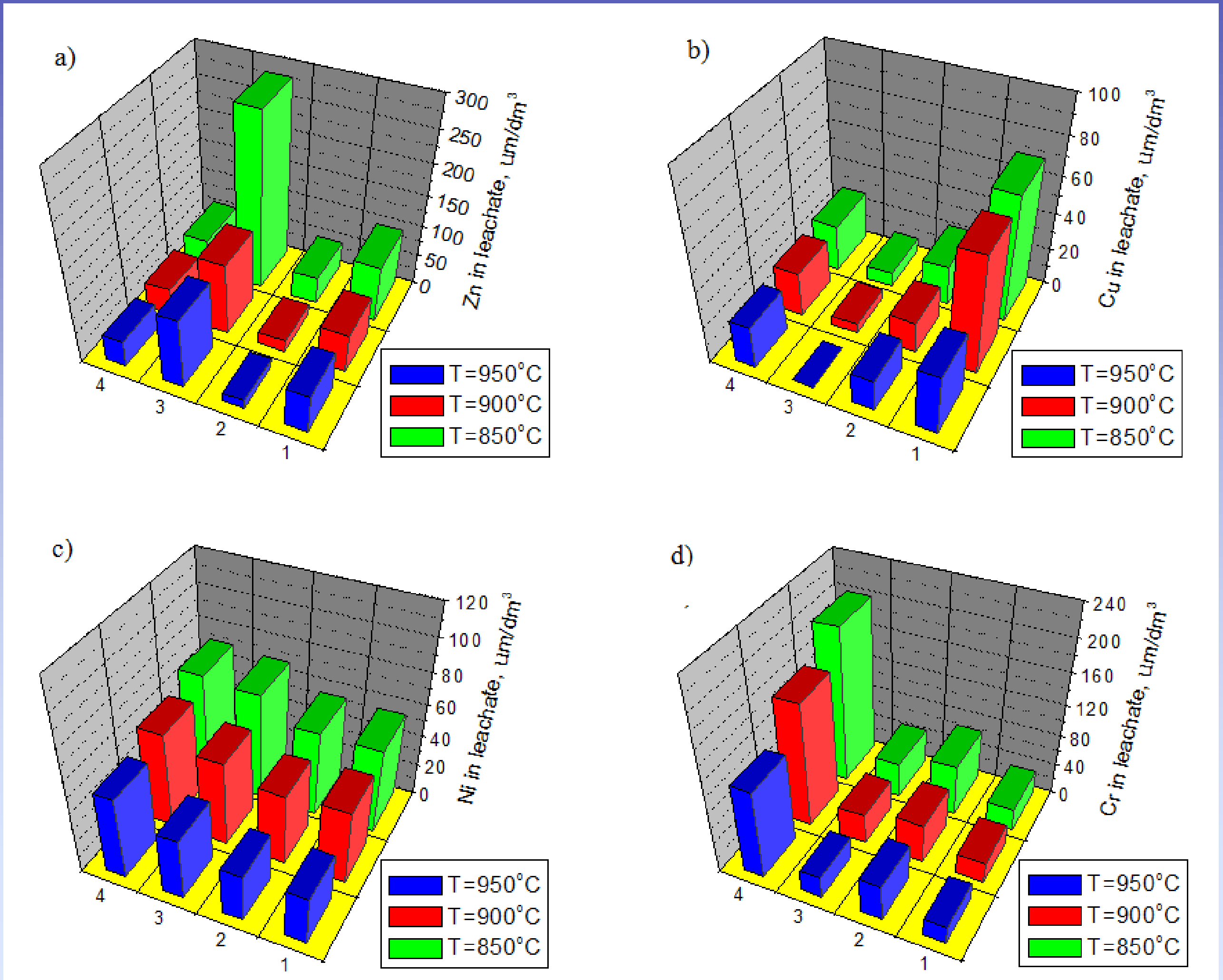
SEM of samples sintered at **850oC**: a) clay, b) clay with ash, c) clay with sludge, d) clay with ash and sludge.

Test results



SEM of samples sintered at **950oC**: a) clay, b) clay with ash, c) clay with sludge, d) clay with ash and sludge.

Test results



Leaching of:

a) zinc, b) copper, c) nickel, d) chrome

1 – clay (100%)

2 – clay (80%) + fly ash (20%),

3 – clay (80%) + sludge (20%),

4 clay (60%) + fly ash (20%) + sludge (20%)

Test results

Limits for drinking water by World Health Organization and US Environmental Protection Agency reveal: heavy metal levels were acceptable in the case of copper, zinc and nickel. The concentration of chromium was almost four times the allowable limit.

Conclusions

- utilisation of waste for building materials production can be considered as a waste treatment option as well as material and energy recycling method;
- the addition of waste reduced compressive strength. However, it does not exclude their use in the building industry since a required strength level can be achieved;
- out of four metals tested, the concentration of one (chromium) in the leachate proved to exceed the permissible drinking water required level. At the same time leaching of heavy metals generally decreased with increasing sintering temperature of the ceramic materials.

Thank you very much for your attention