THERMAL BEHAVIOUR OF ALKALI ACTIVATED SLAG COMPOSITES

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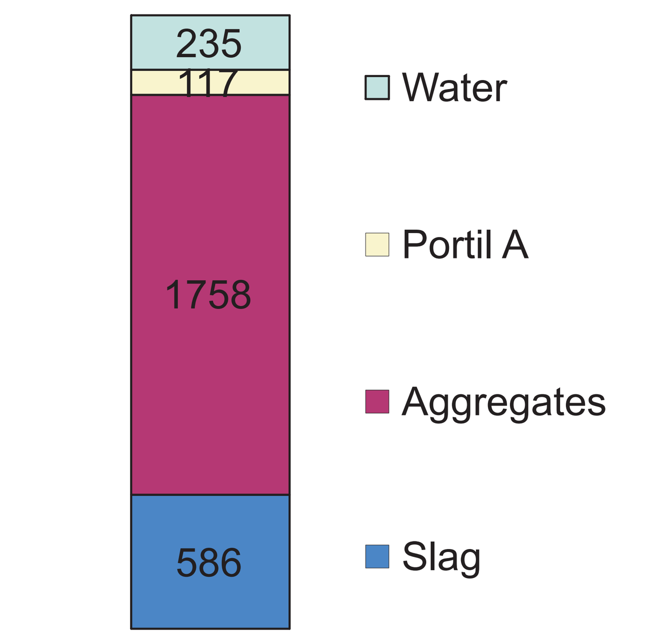
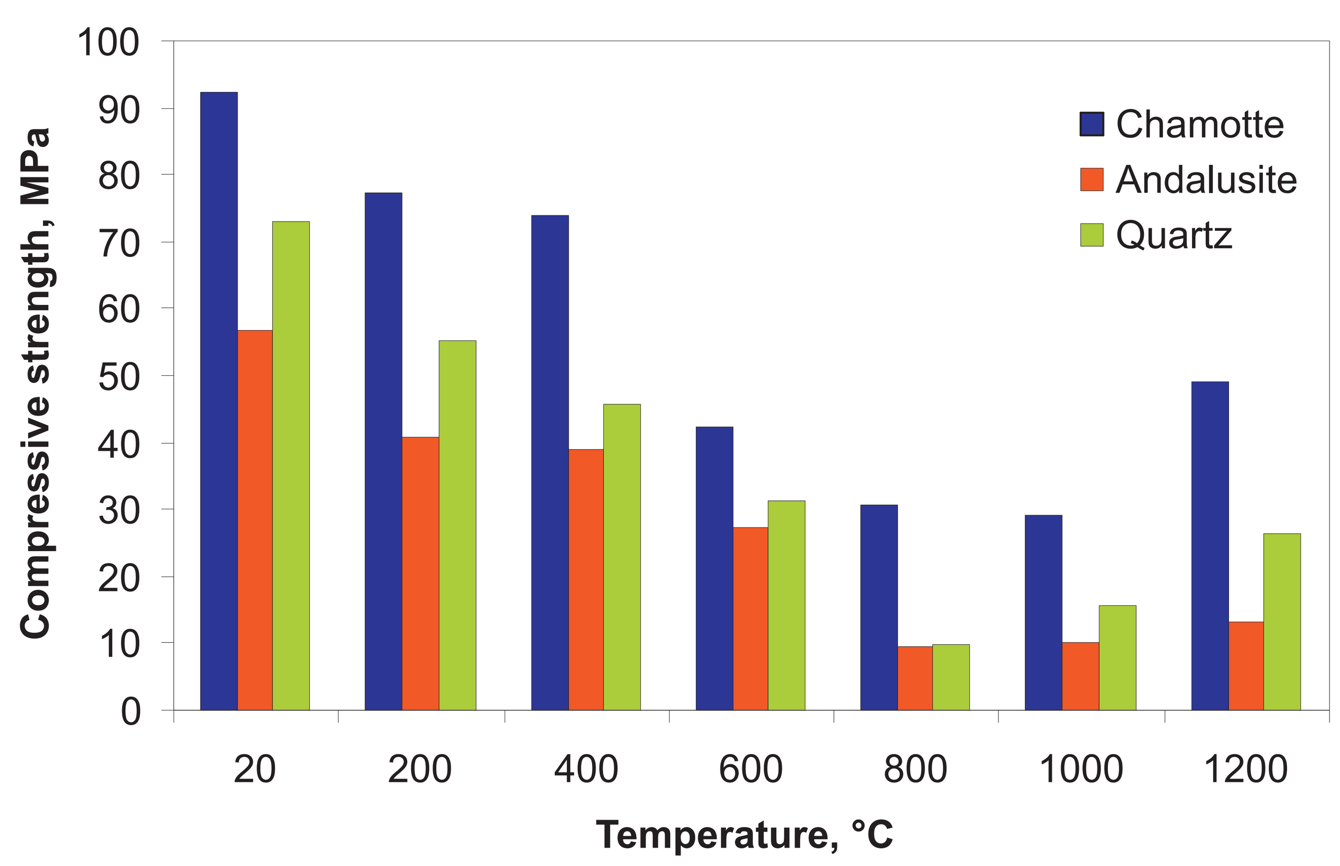
Portland cement is widely used as a part of many building materials among which the most common is concrete. This material is highly inflammable and does not support combustion of other material. However, its undesirable fast degradation, when exposed to very high temperature, connected with compressive strength decrease, cracking and spalling limits the utilization of concrete in constructions endangered by fire. Concretes based on alkali activated slag (AAS) exhibit a very good resistance against high temperatures and fire. Due to its different porosity no spalling occurs even during thermal shock treatment. This property can be improved by application of artificial thermally stabilized aggregates with low extensibility. We have examined the influence of quartz sand, burnt clay (chamotte) and andalusite on the behavior of alkali activated slag composite during heat loading up to 1200 °C and the mechanical properties after high temperature exposure.

Materials

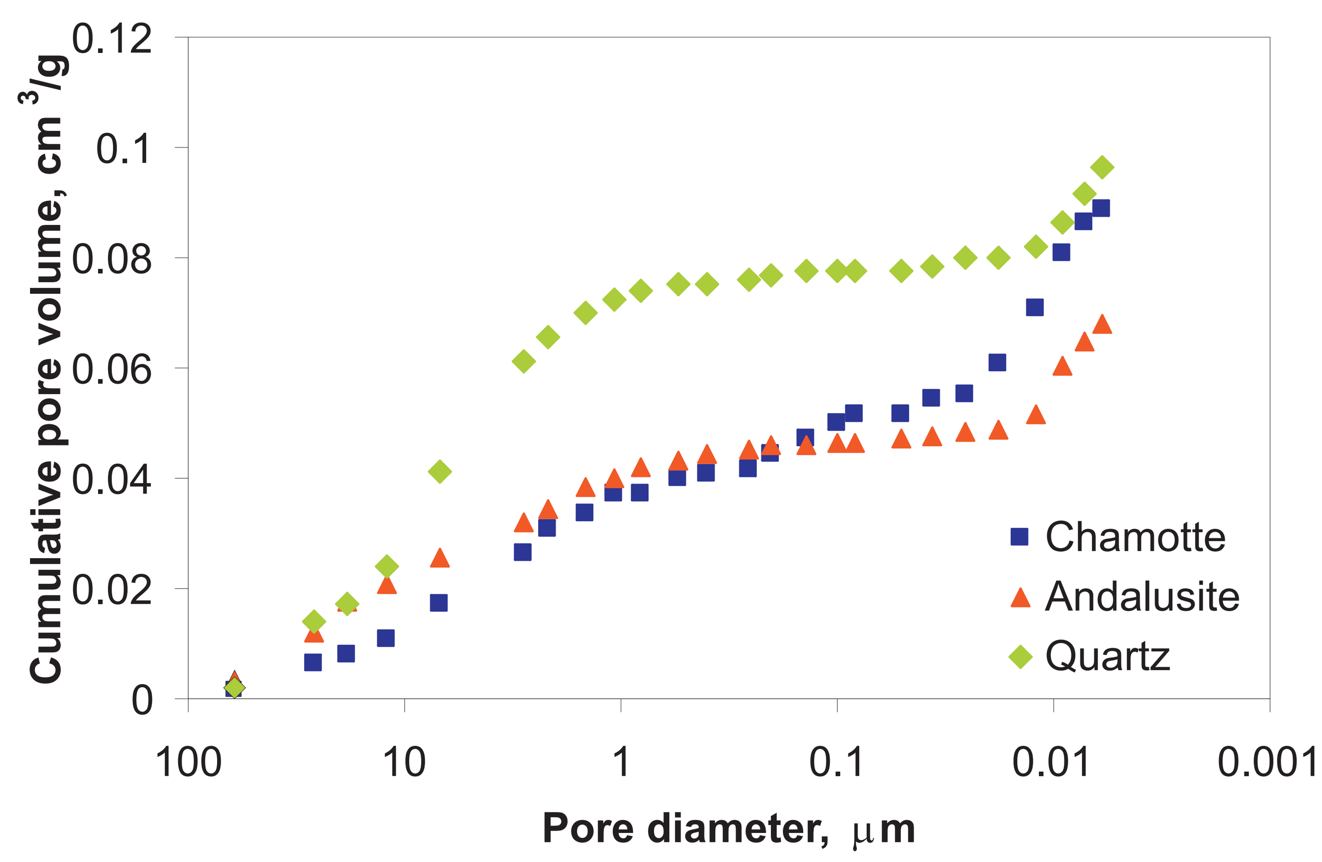
Component	BF slag [%]
SiO_2	34.74
Al_2O_3	5.91
Fe_2O_3	0.39
CaO	40.27
MgO	9.6
MnO	0.36
S_{total}	0.39
Na_2O	0.29
K_2O	0.41



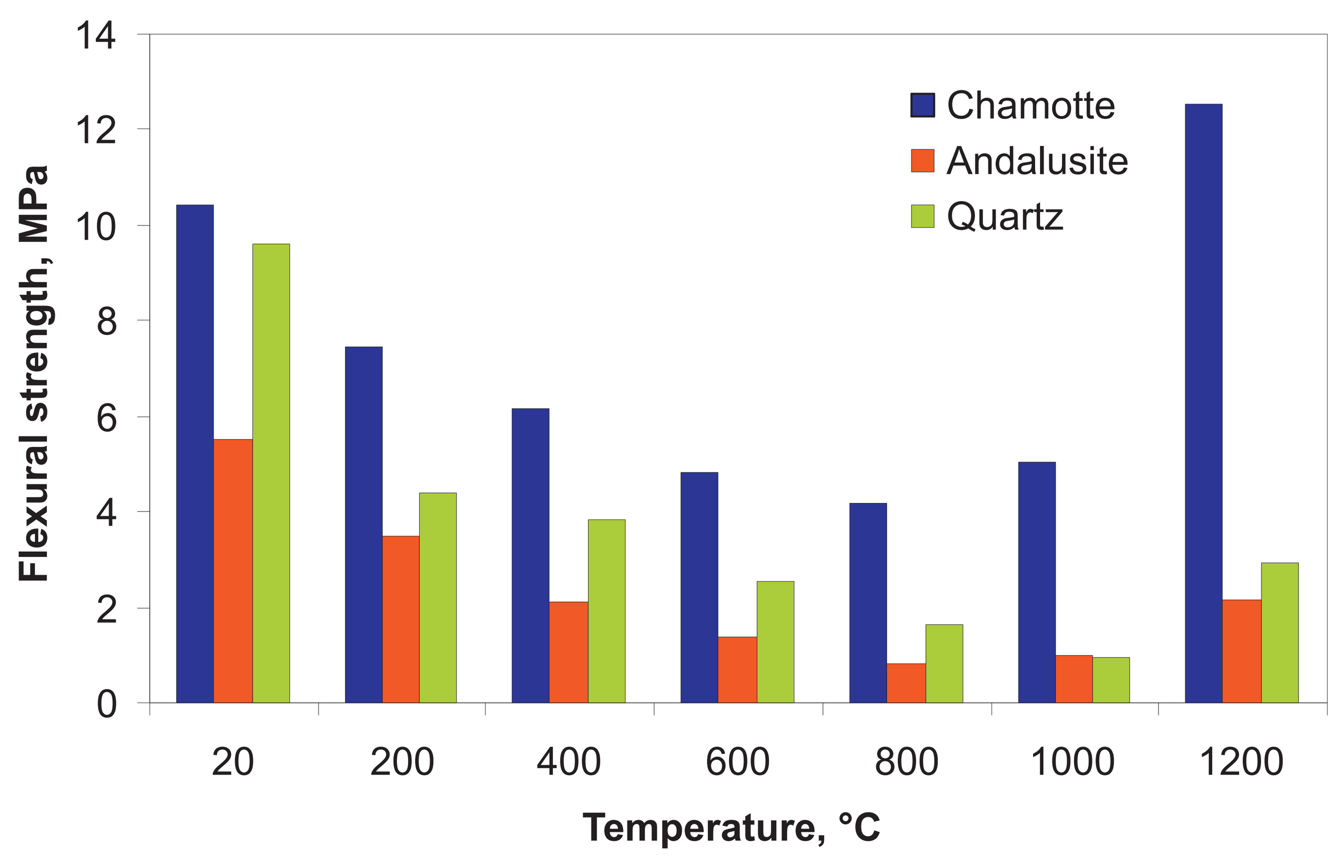
Composition, kg/m³



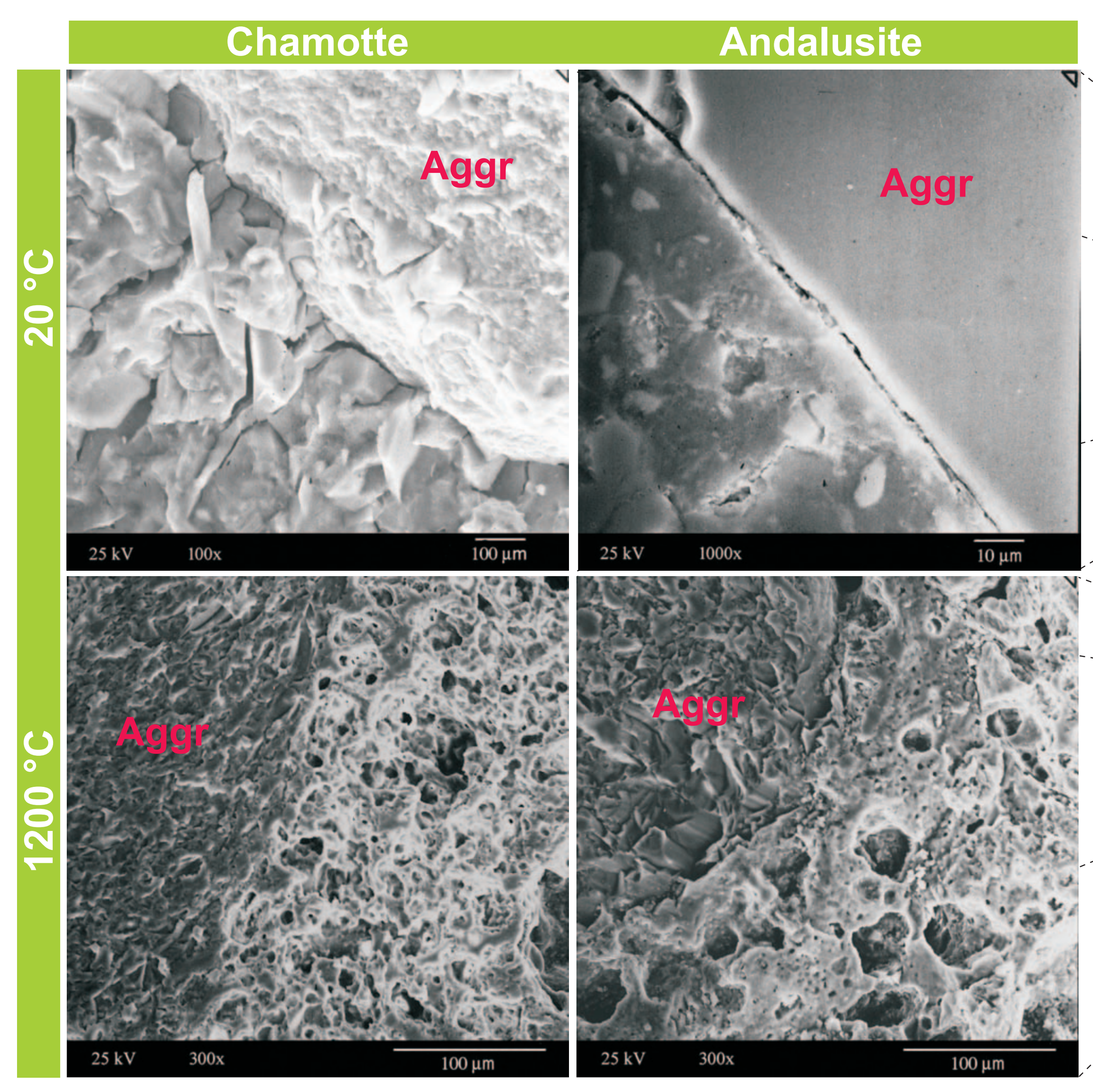
Compressive strengths of AAS as a fuction of temperature



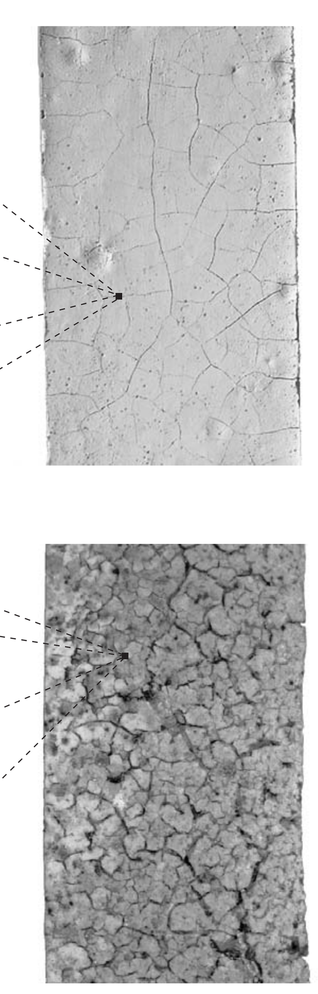
Comparison of pore distribution of AAS composites after exposure to 600 °C



Flexural strengths of AAS as a fuction of temperature



SEM micrographs of AAS specimens with chamotte and andalusite treated at 20 and 1200 °C



Surface of AAS specimens with andalusite

Conclusions

The properties of alkali activated slag material and its behavior upon heating up to 1200 °C considerably depend on the type of aggregate that is used as filler. It turned out that the main factor for good mechanical performance of AAS composites is the quality of interface between aggregate grains and binder. Stronger connection with aggregate mitigates the action of mechanical stress on binder that is caused by its shrinkage and it impedes the formation of larger cracks that contribute to strength's deterioration.

Utilization of chamotte as an aggregate in alkali activated slag composites seems to be the most effective among other studied aggregates. It is produced from natural clay at 1350 °C, and therefore it is more thermally stable than quartz or andalusite. Quartz exhibits phase modification at 573 °C and andalusite forms very weak connection with AAS binder which results in the formation of large cracks. From the viewpoint of mechanical properties, chamotte aggregate does not limit mechanical strengths of AAS paste at temperatures up to 1000 °C and it even considerably improves the flexural strength of the composite at 1200 °C. Although some deterioration occurs upon heating, the compressive strength decreases to the limit of 29 MPa at 1000 °C. However, it is still 31% of the original strengths. The flexural strength falls to limit of 4.2 MPa at 800 °C, which is 40% of the original strength. All these very good properties predetermine chamotte aggregate especially in alkali activated slag composites for application in structures that might be exposed to elevated temperatures.

This paper was elaborated with the financial support of the project granted by the Ministry of Education, Youth and Sports of the Czech Republic (MSM 0021630511).