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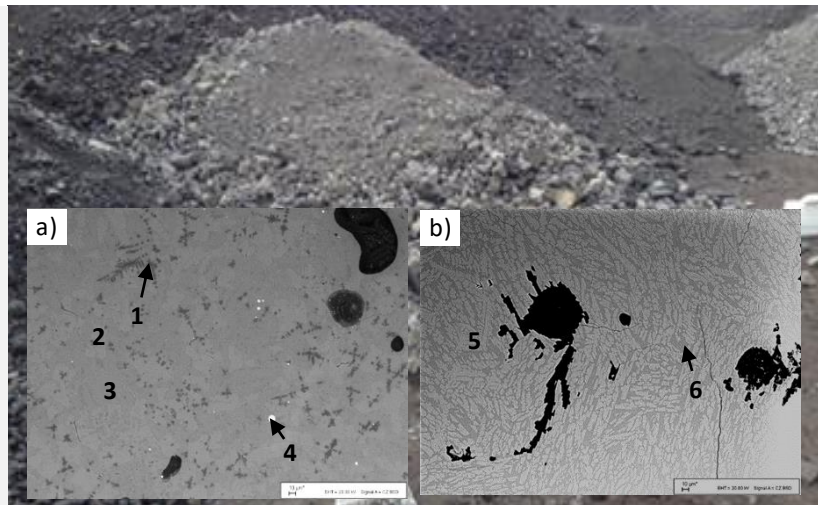


Fig.: Scanning electron microscope images of investigated ladle slags: a) group 1 [(1) periclase, (2) C_3A , (3) C_2S + pleochroite, (4) steel], b) group 3 [(5) C_3MS_2 , (6) melilite + amorphous phase] © Montanuniversitaet Leoben/Chair of Ceramics

LADLE SLAG AS A SUBSTITUTE FOR BLAST FURNACE SLAG IN CEMENTS

LADLE SLAGS (LS) FROM SECONDARY STEELMAKING WERE CHEMICALLY AND MINERALOGICALLY CHARACTERIZED AND TESTED AS CEMENT SUBSTITUTES.

The avoidance of landfilling ladle furnace slag (LS) originating from secondary steelmaking (ladle process) is increasingly coming into focus due to its recyclability/usability. One challenge in reusing LF is that the chemical compositions varies widely, especially in steel mills producing a large variety of different steel grades. The aim of this work is to characterize different LS chemically and mineralogically and to identify recycling possibilities.

Samples of different steel grades, Si-killed (SKS) or Al-killed (AKS) steel grades, were directly taken from the ladle furnace to allow an assignment of the samples to the corresponding steel grade. The taken slag samples are quenched to room temperature on a steel plate. The slag samples were then analysed by X-ray fluorescence analysis, reflected light and

scanning electron microscopy, and X-ray powder diffraction. Based on the results, the LS were divided into groups with the same mineralogical composition.

The main oxides of the analysed LS chemical compositions were located in the quaternary system Al_2O_3 - SiO_2 - MgO - CaO . Mineralogically, the Al-killed steel (AKS) slags can be divided into two groups: group 1) C/S 4.3-9.5, C_2S - C_3A -M-pleochroite and group 2) C/S 3.2-4.0, C_2S - C_3MS_2 -M-melilite. The mineralogical composition of Si-killed steel (SKS) slags, group 3 is CMS - C_3MS_2 -M-melilite and amorphous phase having a C/S ration of 0.9-1.3. Not all mineral phases were present in every SKS sample. In particular periclase (free MgO) was absent in SKS samples with a MgO content less than 16 wt%.

SUCCESS STORY

In this study, the investigated AKS LS were excluded from further testing due to the high periclase content. SKS LS (Group 3) with $MgO < 16$ wt% was instead selected to test its potential as a cementitious material because of no or only low amounts of periclase present and high amounts of amorphous phase. To increase the amorphous content, the slag was further remelted and granulated with water.

Mortar prisms were produced, using cement (CEM) CEM I 42.5 N or substituting CEM for LS or blast furnace slag (BFS)). Standard sand and BFS were used as a reference supplementary material, with a CaO/SiO_2 (C/S) of 0.65 and 100% of glass phase. The strength and the potential expansion of mortar prisms were tested according to EN 197-1 and ÖNORM B 3309-1.

The results of toxicity characteristic leaching procedure were far below limits. The tests carried out on mortar prisms with the addition of SKS slags showed that the binder obtained meets the requirements for a CE of strength class 32.5 N/mm². The values derived from potential expansion test are up to 33% higher for LS-containing samples than for the BFS samples, but with a maximum of 1.2‰, they are within the permissible range limit of 8‰ for a positive evaluation.

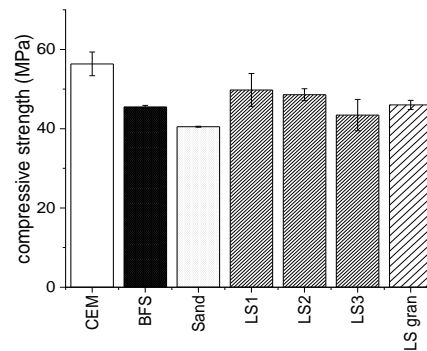


Fig.: 28 day compressive strength for different compositions: pure cement (CEM), 25% CEM substituted for BFS, sand, 3 air quenched LS or water granulated LS with 4000 Blaine.
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Impact and effects

The investigations indicate that the SKS slags with less than 16 wt.% MgO can be used in certain cement types. The comparison with sand shows that both, the slag granulated in air, and the wet granulated slag are hydraulically active. Since SKS and AKS slags differ significantly in their chemical and mineralogical composition, separate storage of the slags is necessary to enable utilization.

Project coordination (Story)

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