Bachelor I byggdesign

Title:

Silicomanganese slag as a supplementary cementitious material in mortar

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Introduction

The world faces an extraordinary challenge as our aggressive interference with nature shows that the planet will not last forever. In order to make the concrete more compatible with the demands of sustainable development, parts of the cement have been replaced with supplementary cementitious materials (SCMs), such as pozzolanic materials.

This bachelor thesis is given from Magne Dåstøl and is written in collaboration with Eramet Norway Kvinesdal. Eramet produces approximately 300 000 tons of silicomanganese (SiMn) slag each year which is a by-product of their manganese production and wants to apply their SiMn slag within the cement- and concrete industry. Due to this the following research question with associated sub questions were formed:

"*How does Silica Green Stone affect the properties of mortar compared to fly ash and ground granulated blast furnace slag?"*

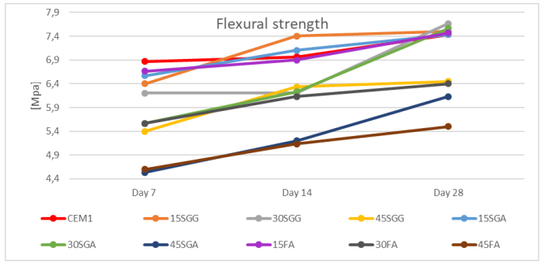
- *"What effect does Silica Green Stone have on strength development, durability, and workability?"*
- *"How do the properties change when varying the amount of Silica Green Stone as a supplementary cementitious material?"*

Results

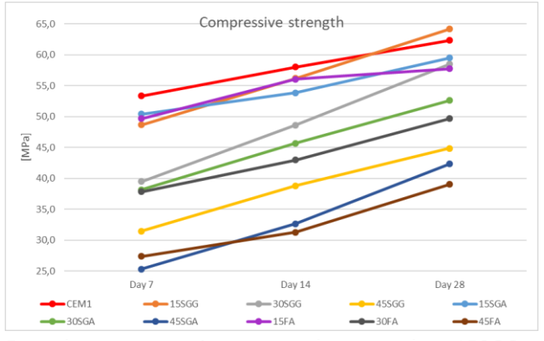
The results are found through both laboratory testing and literature studies. These results will be from the laboratory tests and presented in figures below.

Strength

The strength results are divided into both flexural and compressive strength. Generally, all mixtures have a clear strength development from day 7 and up to day 28, and a higher content of supplementary cementitious material (SCM) provided the lowest strength results.



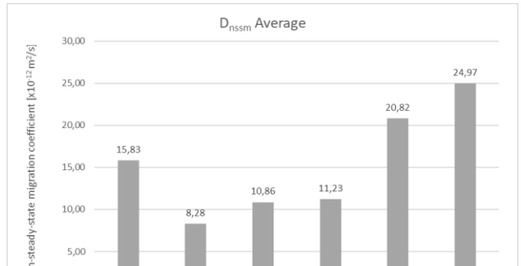
For the flexural strength test after 28 days curing, 30SGG provides the highest flexural strength closely followed by *30SGA*, *15SGG*, *15FA*, *15SGA*, all in line with the reference mixture.



For the compressive strength test the 15SGG provided the highest results after 28 days, followed by the reference mixture and 15SGA while the 15FA is sloping more out after day 14.

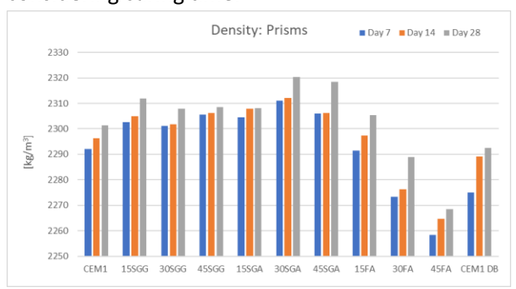
Chloride migration

Generally, air-cooled Silica Green Stone (SiGS) gave higher values of the non-steady-state migration coefficient (D_{nssm}) than the granulated SiGS. Hence air-cooled Silica Green Stone has higher resistance of chloride penetration and thereby better durability and long-term performance of the concrete.



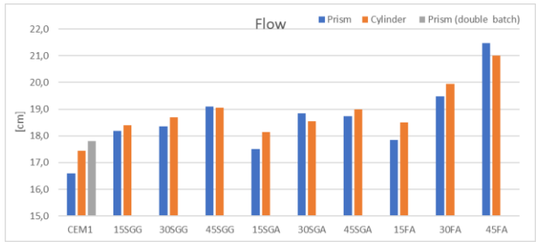
Density

The density results show an increasing development with curing from 7 to 28 days. The batch with 30SGA provided the highest density after 28 days curing, while 30FA, 45FA, and the double batch with cement, provided the three lowest results. The 15FA mixture is most alike the reference mixture (CEM1), while the remaining mixtures of both air-cooled and granulated SiGS have accordingly similar development to each other. However, the mixtures containing SiGS provides a more uneven density development considering curing time.



Flow

All recipes provided a higher slump than the reference mixture with only cement, which has the firmest consistency. The results from the slump flow indicate that a higher content of SCM provides higher slump flow, since the flow of almost all recipes increases from 15 to 45 percent replacement. Thus, both a higher content of SCM and double mixed batches seems to be the triggering reason for higher flow results.



Conclusion

This research indicates that granulated SiGS tends to give higher compressive- and flexural strength than the air-cooled SiGS. In addition, the chloride migration test indicates that air-cooled SiGS has a lower resistance to chloride penetration. Generally, mortar with 15 percent SCM provides the highest strength, nearly aligned with pure cement. Further, a higher amount of SCM reduces the compressive- and flexural strength, increases slump flow and gives varying densities regarding the different SCMs. Because of limited resources, more research is needed in order to give a solid conclusion.