Improvement of alkali-activated material based on steel slag by adding biomass bottom ash

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Introduction

Cement industry

New materials research

from waste

GO TO ZERO WASTE

Using slag

Alkali activated cements

achieve

Research in terms of durability

It need more research

Good results

Materials

WSS

BBA

65% Silicate

+

35% KOH (12M)

WSS: white steel slag
BBA: biomass bottom ash

60ºC – 98% RH + 20ºC – 90% RH
(24h curing) (ageing)

Results and discussion

The results indicate that adding ash, mechanical properties are improved. Although the behaviour after attack is different. When durability test is performed, specimens 50 wt % bottom ash have higher compressive strength than specimens using other composition. Flexural strength trend is not similar to compressive strength. The highest value depend on attack used. Using sulfuric acid, the best specimen was made with 50 wt % ash. If sea water is used as attack solution, 25 wt % ash is the best composition. But comparing results if sulphates are used, 100 wt % of slag develop higher strength.

Chemical composition

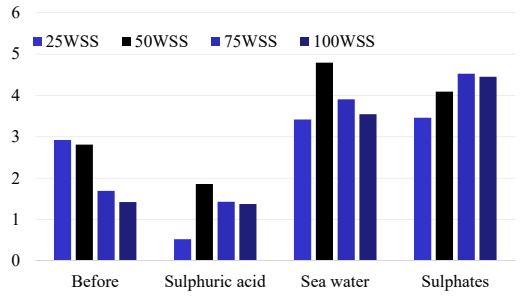
	SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	SO3	LOI
WSS	22,26	8,32	6,75	1,34	13,2	33,24	0,53	0,64	1,85	10,76
BBA	46,1	12,04	4,78	0,09	3,71	19,65	0,78	4,59	0,41	5,58

Physical properties

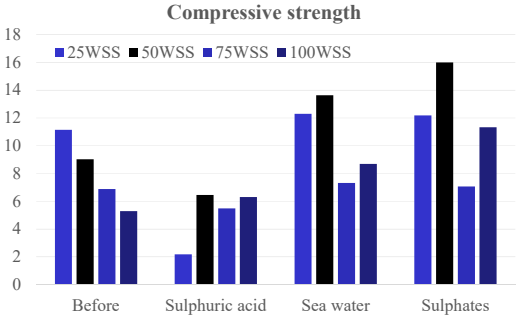
Physical properties are affected by all attack solution, losing mass and density, and increasing porosity and absorption. The least affected specimens were 100WSS and 50WSS.

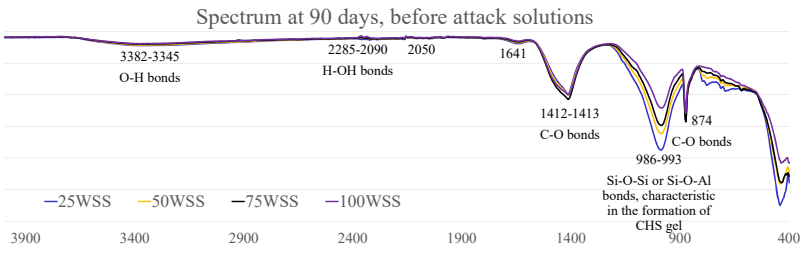
		25WSS		50WSS		75WSS		100WSS	
		Value	%	Value	%	Value	%	Value	%
Bulk density	Before attack	1541,36 ± 7,42	-	1569,83 ± 25,59	-	1618,96 ± 32,11	-	1656,41 ± 16,32	-
	Sulphuric acid	1253,91 ± 12,56	-18,65	1363,36 ± 26,12	-13,15	1365,10 ± 17,1	-15,68	1466,52 ± 8,08	-11,46
	Sea water	1483,79 ± 8,32	-3,74	1562,75 ± 8,3	-0,45	1559,96 ± 7,14	-3,64	1633,83 ± 14,05	-1,36
	Sulphates	1463,94 ± 12	-5,02	1544,46 ± 10,53	-1,62	1530,23 ± 21,54	-5,48	1607,1 ± 7,49	-2,98
Apparent porosity	Before attack	28,42 ± 0,44	-	28,17 ± 0,81	-	27,95 ± 0,98	-	26,27 ± 0,35	-
	Sulphuric acid	49,04 ± 1,07	72,57	45,07 ± 1,21	59,99	44,46 ± 0,61	59,07	40,92 ± 0,42	55,78
	Sea water	39,08 ± 0,59	37,52	35,13 ± 0,61	24,70	34,58 ± 0,24	23,73	32,44 ± 0,45	23,48
	Sulphates	37,54 ± 0,76	32,09	35,68 ± 0,28	26,66	35,63 ± 0,12	27,47	31,95 ± 0,14	21,62
Absorption	Before attack	18,40 ± 0,35	-	17,93 ± 0,75	-	17,24 ± 0,97	-	15,83 ± 0,14	-
	Sulphuric acid	39,05 ± 1,23	112,21	33,02 ± 1,51	84,16	32,51 ± 0,84	88,60	27,85 ± 0,44	75,94
	Sea water	26,29 ± 0,27	42,86	22,44 ± 0,5	25,13	22,12 ± 0,25	28,33	19,82 ± 0,44	25,20
	Sulphates	25,59 ± 0,54	39,09	23,06 ± 0,08	28,59	23,24 ± 0,4	34,81	19,84 ± 0,11	25,34

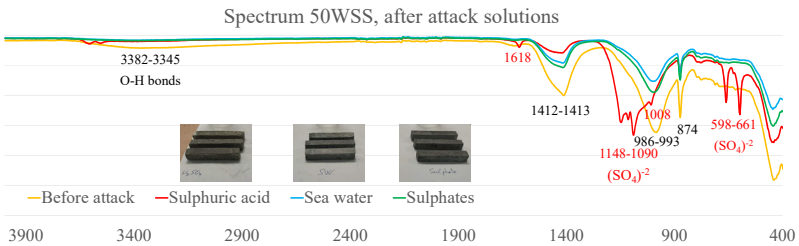
Flexural strength



Compressive strength







Conclusions

- The best composition was mixing 50 wt% WSS and 50 wt% BBA. Although at 90 days, before attack solutions, 25WSS obtained higher mechanical strength.
- All specimens improve mechanical strength after attack with sea water and sulphates, but physical properties got worse.
- FTIR spectrum kept its shape, except when samples were attacked with sulphuric acid.
- Adding BBA, mechanical properties improved. More amount of ash, better mechanical properties. Although before attack, physical properties were a little worse.

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