SYNTHESIS OF SODIUM WATERGLASS FROM RICE HUSK ASH AS AN ACTIVATOR TO PRODUCE SLAG-BASED ALKALI-ACTIVATED CEMENTS

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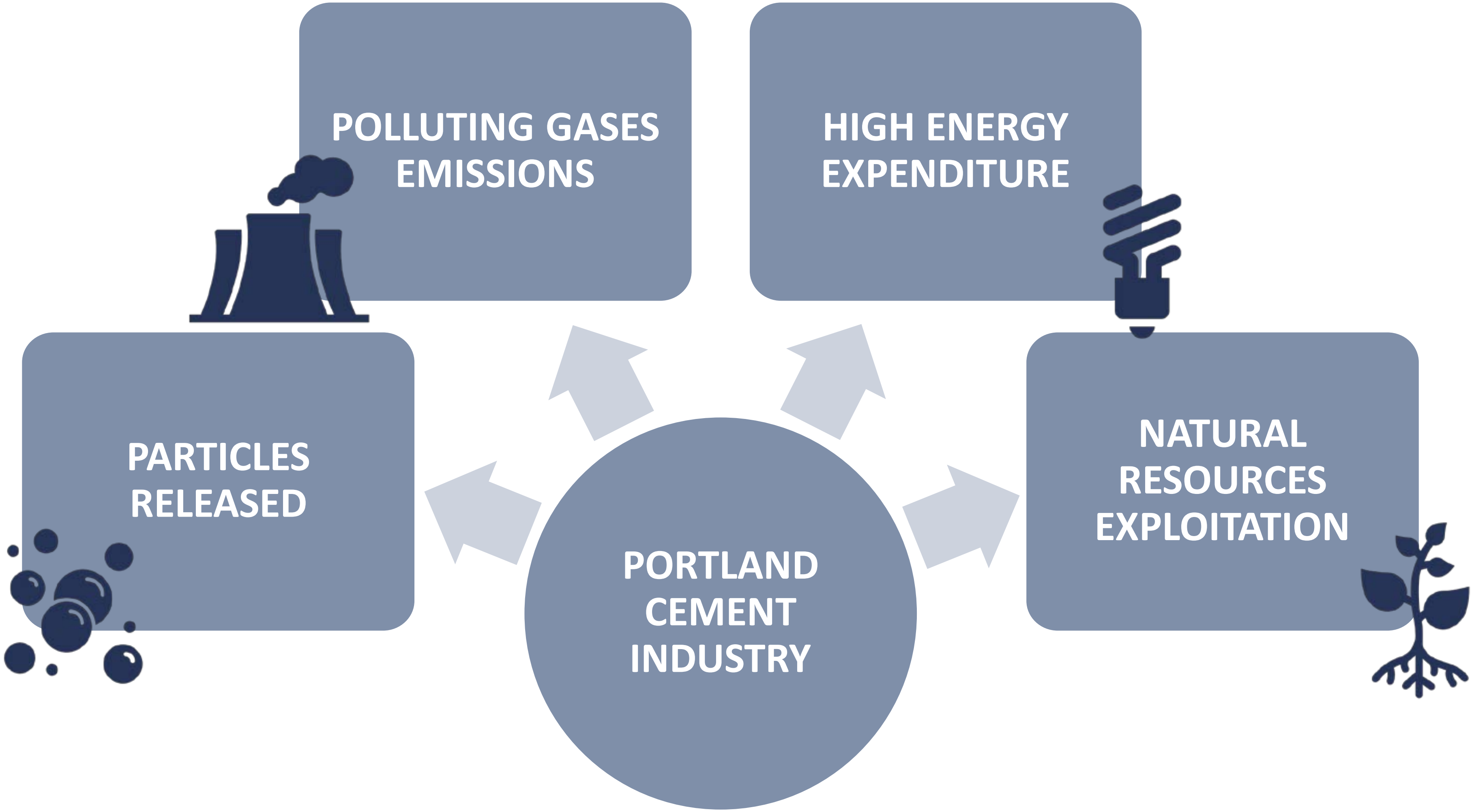
Introduction. Portland Cement



Introduction. Alkali-activated cement

EXCELLENT PROPERTIES

ENVIRONMENTALY FRIENDLY MATERIAL

ALTERNATIVE TO REPLACE PORTLAND CEMENT

PRECURSOR

Aluminosilicate (SiO_2, Al_2O_3 and CaO)

+

ALKALINE ACTIVATOR

Mixing → CHEMICAL REACTION

Setting and hardening → ALKALINE ACTIVATED CEMENT

Introduction. Alternative silica sources

COMMERCIAL ALKALINE ACTIVATORS

OBTAINED THROUGH QUITE EXPENSIVE AND HIGHLY POLLUTING PROCESSES

RICE HUSK ASH

Storing biomass ashes in landfill constitutes an environmental risk.

Residues may contain toxic elements that can leach and contaminate the soil.

MATERIALS AND METHODS

Materials and methods

BLACK STEEL SLAG (BSS)

≤ 0.100 mm

RICE HUSK ASH (RHA)

≤ 0.063 mm

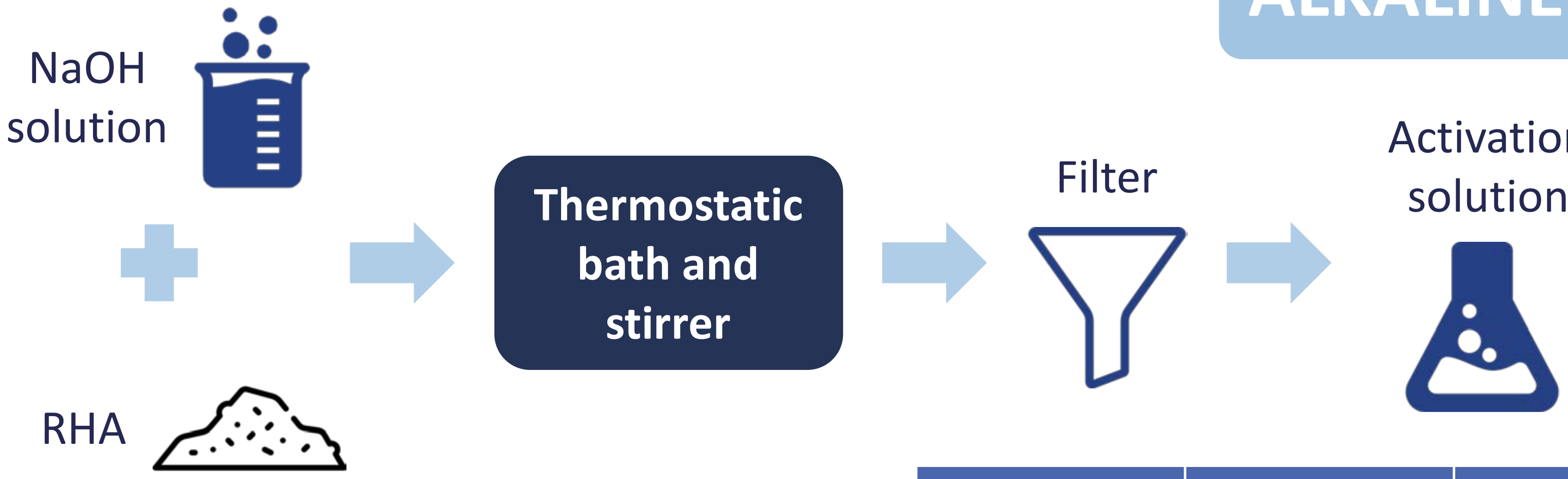
CHEMICAL COMPOSITION

	SiO_2	P_2O_5	K_2O	CaO	MgO	Fe_2O_3	Na_2O	MnO	Cl	SO_3	NiO	ZnO
RHA	73.60	1.75	1.63	0.78	0.72	0.286	0.144	0.079	0.076	0.052	0.011	0.010

	SiO_2	Al_2O_3	CaO	Fe_2O_3	K_2O	Na_2O	MnO	MgO	SO_3	TiO_2	P_2O_5	LOI
BSS	18.59	9.44	29.45	28.61	0.04	0.20	4.18	4.56	0.40	0.95	0.38	1.39

Materials and methods

ALKALINE SOLUTION



NAME	SS (g)	NaOH (g)	H_2O (ml)
SS	15	3.69	11.31

NAME	RHA (g)	NaOH (g)	H_2O (ml)
30RHA	30	48.98	150
50RHA	50	48.98	150
60RHA	60	48.98	150
70RHA	70	48.98	150
BSS	-	48.98	150

Materials and methods

ALKALINE SOLUTION. CHEMICAL COMPOSITION

	30 RHA	50 RHA	60 RHA	70 RHA	SODIUM SILICATE
Na	15.53	13.3	11.79	11.20	5,75
Si	5.87	6.94	7.19	8.02	10,87
K	0.169	0.380	0.402	0.444	-
Px	0.0703	0.120	0.125	0.137	-
Mg	0.0734	0.0797	0.0715	0.0698	-
Sx	0.0220	0.0422	0.0468	0.0510	-
Cl	-	0.0140	0.0135	0.0164	-

Materials and methods

MANUFACTURE PROCESS

ALKALI ACTIVATOR

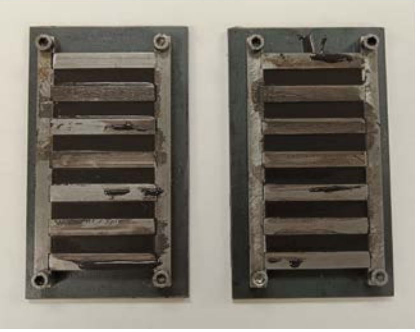
+

BSS

PRECURSOR

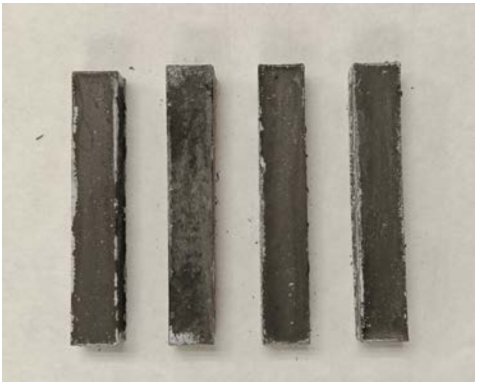
MIXING

MOULDS



SAMPLES

10x10x60 mm



Materials and methods

PHYSICAL AND MECHANICAL PROPERTIES

BULK DENSITY

- UNE-EN 1936:2007

TRUE POROSITY

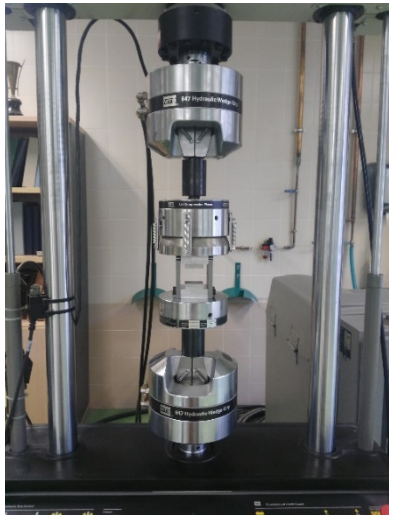
- UNE-EN 1936:2007

FLEXURAL STRENGTH

- UNE-EN 1015-11:2020

COMPRESSIVE STRENGTH

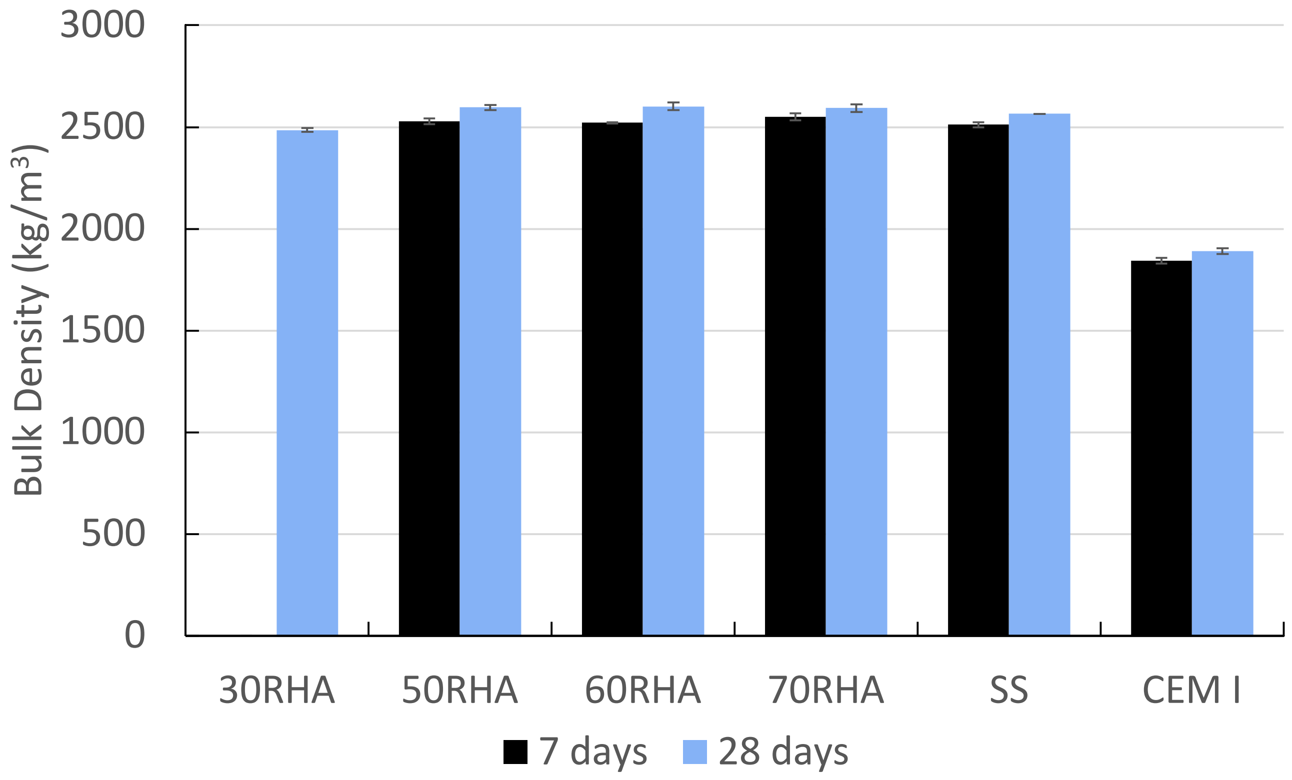
- UNE-EN 1015-11:2020



RESULTS AND DISCUSSION

Results and discussion

BULK DENSITY

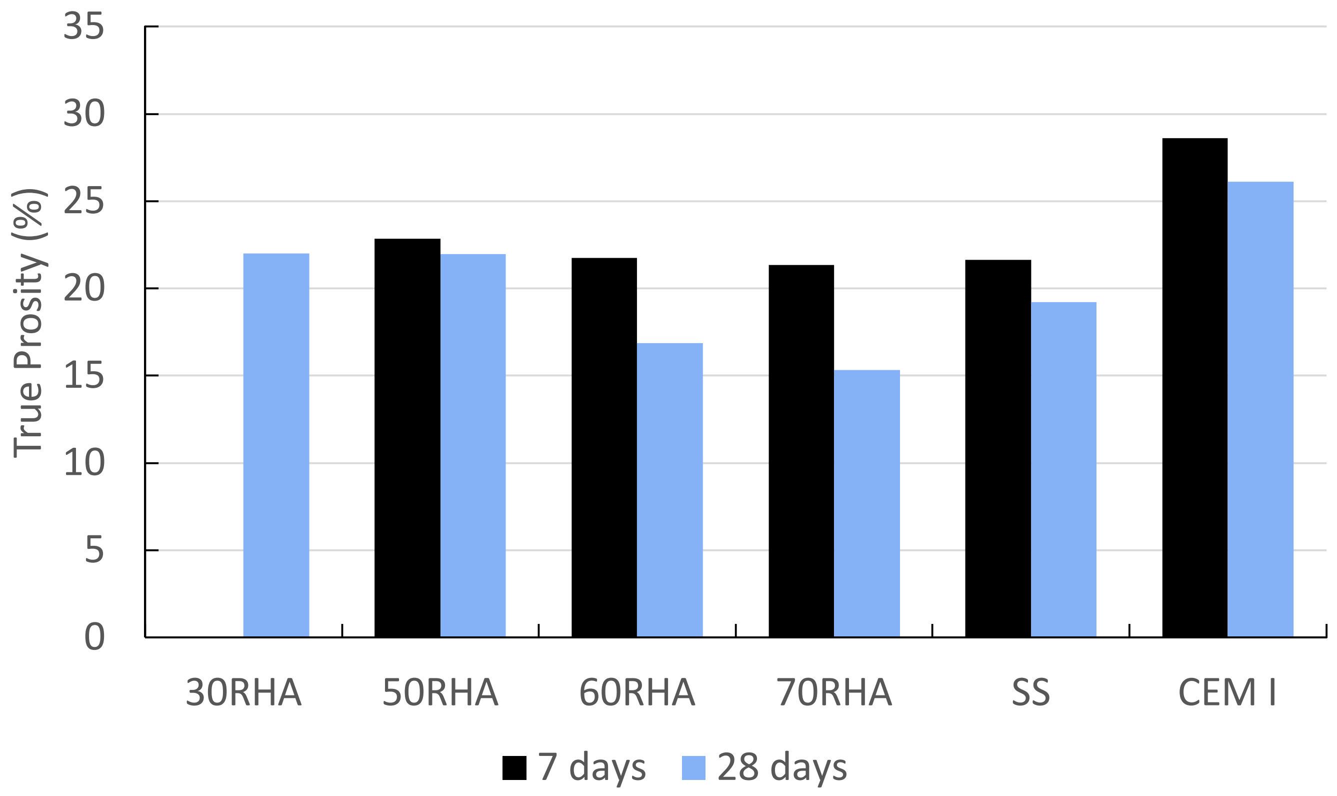


Bulk density values were like control paste and higher than those obtained for Portland cement specimens.

All specimens slightly increased values with curing time.

Results and discussion

TRUE POROSITY

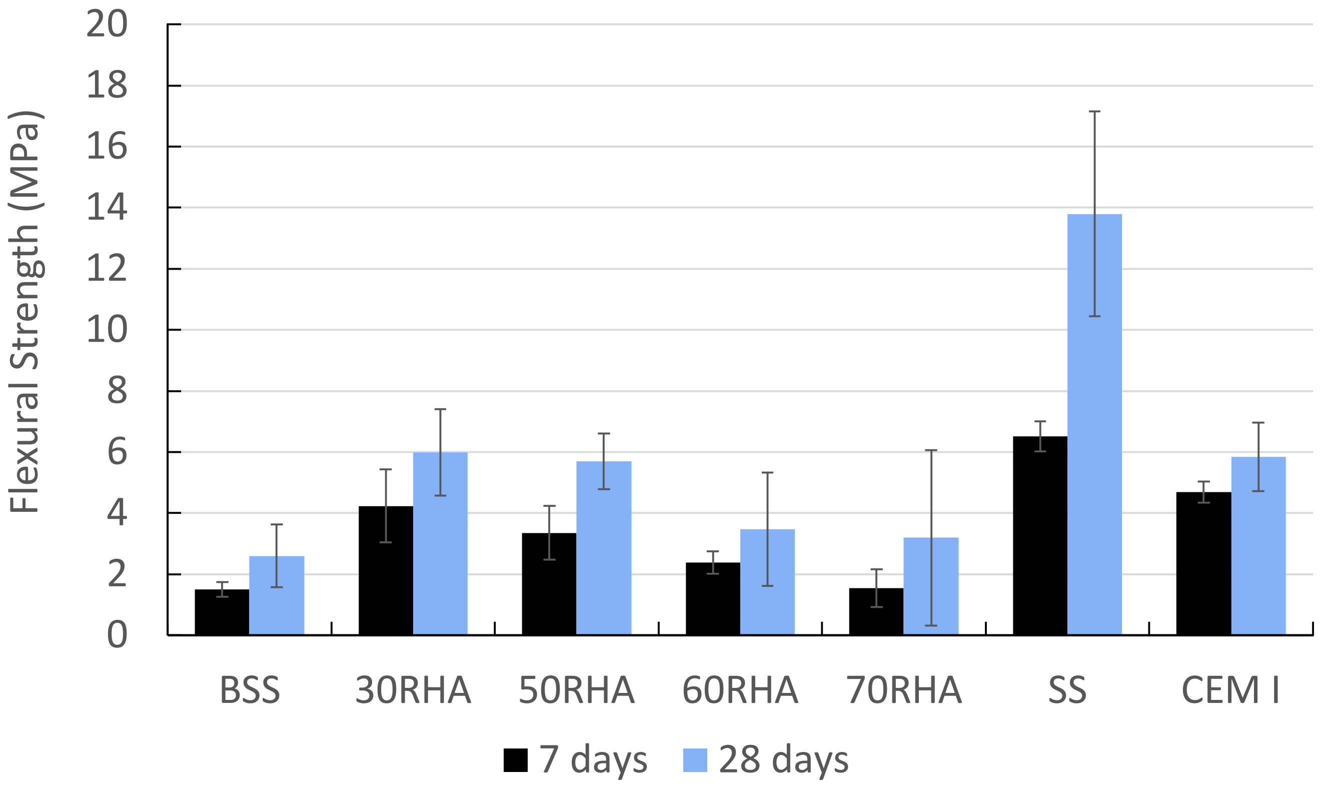


True porosity decreased when rice husk ash amount increased.

All specimens decrease with curing time.

Results and discussion

FLEXURAL STRENGTH



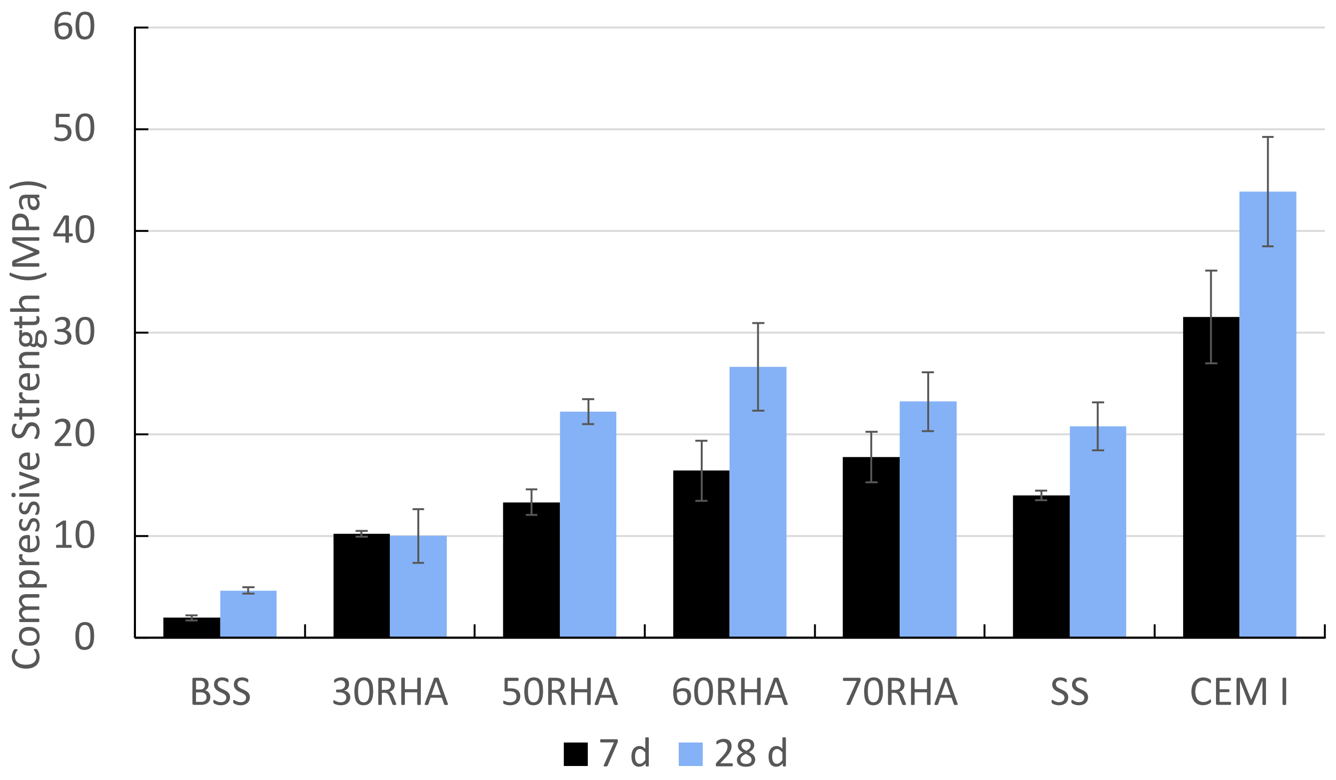
Flexural strength decreased as rice husk ash amount increased.

The highest value of bulk density was found for control paste.

Flexural strength increased with curing time → Advance of the alkali-activated reaction

Results and discussion

COMPRESSIVE STRENGTH



Compressive strength increased with increasing amount of rice husk ash.

Best values at 28 days were obtained by 60RHA specimens. Although 50RHA and 70RHA also obtained higher values than the control paste.

Compressive strength increased with curing time.

CONCLUSIONS

Conclusions

This study confirms the possibility of using rice husk ash as an alternative activator in the production of alkali-activated cements.

Cements with 50 – 70 gr of RHA showed promising results, reaching similar bulk density and higher compressive strength values to those manufactured with commercial sodium silicate. Although the flexural strength is lower, the decrease is considered admissible.

In order to obtain binders with an almost zero carbon footprint and to move towards circular economy, it is necessary to replace commercial activators by alternative activators obtained from waste, such as RHA.

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