CIRCULAR ECONOMY: Use of Recycled Mining Waste

Properties of ultra-high performance concrete (UHPC) manufactured with granite cutting waste

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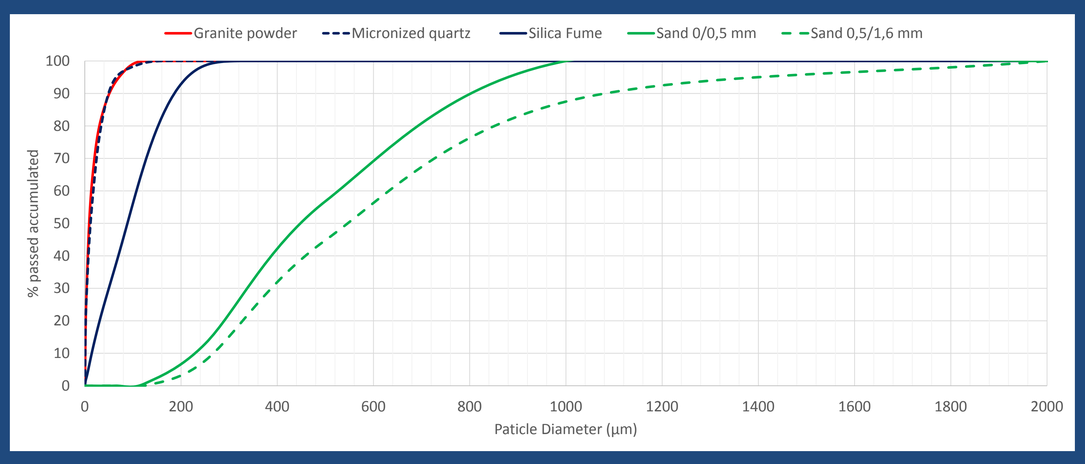
MAIN GOAL: Experimental study where the feasibility of using waste from granite quarries as a replacement for micronized quartz in the manufacture of UHPC has been analyzed.

METHODOLOGY: To carry out this study granite powder were characterized. Then, a reference mix was designed that ensures a self-compacting fresh concrete with a compressive strength above 115 MPa. Once the characteristics of the control concrete were verified, 35%, 70% and 100% of the micronized quartz was replaced by the same volume of granite powder. Finally, the experimental program was developed. Density, compression strength and flexural strength tests were carried out. To characterize the mortar matrix, a Scanning Electron Microscope (SEM) with magnifications of ×30, ×200 and ×500 was used.

Materials properties:

Specimen	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	L.O.I
Micronized quartz	>99,3	0.26	0,05	-	-	0,02	-	0,04	0,05	-	-
Granite powder	76,33	11,87	2,00	0,02	0,21	0,43	2,95	5,05	0,13	0,02	0,77



UHPC composition:

Material	Control	35% FG	70% FG	100% FG
Cement	1	1	1	1
Sand 0/0.5	0.378	0.378	0.378	0.378
Sand 0.5/1.6	0.706	0.706	0.706	0.706
Harina sílice	0.281	0.183	0.084	-
Silica fume	0.219	0.219	0.219	0.219
Granite powder	-	0.098	0.197	0.281
Water	0.214	0.214	0.214	0.214
Superplasticizer	0.0125	0.0125	0.0125	0.0125
Steel fibres	0.200	0.200	0.200	0.200

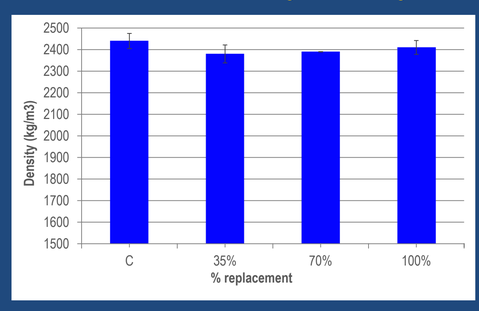
Granite powder waste production:

Granite quarry

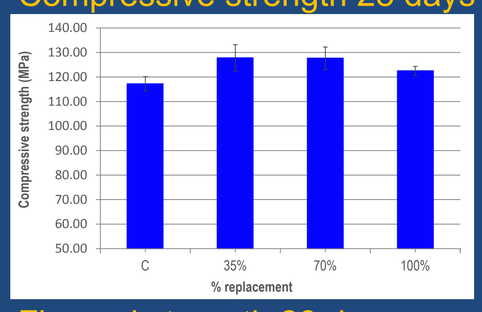
Process of cutting granite blocks

Granite powder waste

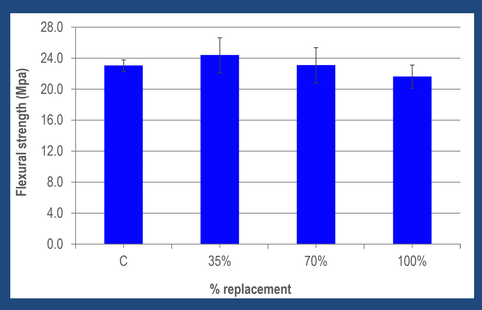
Hardened Density 28 days



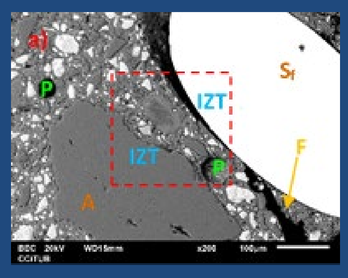
Compressive strength 28 days



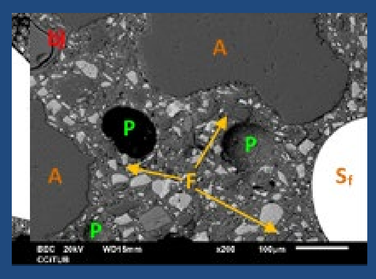
Flexural strength 28 days



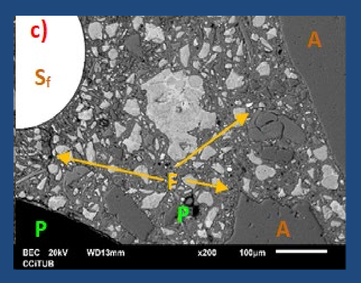
SEM-BEC images



Control



70% Granite waste



100% Granite waste

CONCLUSIONS: The results obtained open the possibility of use granite cutting waste as partial substitutes of the granular skeleton of the concrete. In some cases, the properties suffer slight increases relative to the reference concrete and in others the variation is so small than the waste incorporation does not influence the analyzed property.

The results show an improvement in the compressive strength of UHPC, for all substitution ratios. The flexural strength increase when the substitution ratio is 35%, and even the values obtained for 100% substitution are acceptable.

In view of the results obtained in this study, granite cutting waste, instead of the micronized quartz powder usually used, is a viable alternative for the manufacture of expectedly more sustainable UHPC.

ACKNOWLEDGEMENTS

The authors also want to thank the support to carry out this study to ArcelorMittal, Elkem, Basf, Sika AG, Granites Cabaleiro S.L. and the Ministry of Economy and Competitiveness of the Government of Spain.

FUNDING

This work has been financially supported by the Spanish Ministry of Economy and Competitiveness through the research project grant number BIA2016-78460-C3-2-R.

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