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Effect of Supplementary Cementitious Material and Fine Recycled Aggregates on Shrinkage Properties of Self-Compacting Microconcrete

Miren Etxeberria and B.T. Purandhar Reddy

Department of Civil and Environmental Engineering (DECA), Universitat Politècnica de Catalunya-BarcelonaTECH, Campus Nord UPC, 08034-Barcelona, Spain, miren.etxeberria@upc.edu

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1 Introduction

In recent years, Fly Ash (FA) has been widely used as supplementary cementitious material in self compacting (SC) concrete production (Matos, Foiato, and Prudêncio, 2019). The employment of high absorption capacity recycled aggregates can cause the internal curing, reducing the autogenous shrinkage of high performance concrete (Etxeberria, Miren, Gonzalez-Corominas, 2018). In this research the influence of the FA as well as the use of mixed and ceramic recycled aggregates (MRA and CRA, respectively) on the shrinkage and compressive strength of SC-micro concrete exposed to drying and sealing curing condition were analysed.

2 Materials and Mix Design

Portland cement (PC) CEM I 52.5 N-SR and Class F FA were employed. Natural Silica sand (NA) and MRA and CRA aggregates were used for concrete production. Two phases of SC-concretes were produced with five different mixtures (see Table 1). In phase 1, SC- concretes were produced with 100% of PC and in phase 2, SC-mixtures were produced with the replacement of 50% of PC by FA. In both phases the NA was replaced by both MRA and CRA in 30% and 50%. The w/c ratio of 0.27 and 0.32 was used in Phase 1 and Phase 2, respectively.

Table 1. The values are given of kg of component/m^3 of concrete production.

Phase 1/Phase 2	**Cement**	**Fly Ash**	**Sand**	**AR**	**Total water**	**Admixture%**
C-N/ C-FA-N	925.5/462.7	-/317.6	1111.5	0.00	268.9/274.9	0.70/0.65
C-MRA30/ C-FA-MRA30	925.5/462.7	-/317.6	778.1	259.8	300.8/306.7	0.68/0.65
C-MRA50/C-FA-MRA50	925.5/462.7	-/317.6	555.8	433.0	322.1/328.0	0.68/0.65
C-CRA30/C-FA-CRA30	925.5/462.7	-/317.6	778.1	266.0	292.1/298.1	0.68/0.68
C-CRA50/C-FA-CRA50	925.5/462.7	-/317.6	555.8	443.3	307.6/ 313.5	0.68/0.68

3 Results and Discussions

In Phase 1 the mixtures produced with MRA and CRA achieved lower autogenous shrinkage (Figure 1 a) and b)) and a similar compressive strength than those of C-N mixture of 64.24 MPa at 2 days and up to 20% higher than the value achieved by C-N of 77.04 MPa at 28 days. The use of FA, caused an important strain and strength reduction (Abdalhmid, Ashour, and Sheehan, 2019). All the mixtures produced in stage 2 achieved similar strength at 28 days of 49.12 MPa. The employment of RA also produced favourable effect on lowering of the shrinkage value and the increasing of the strength value with respect to C-FA-N mixture after 28 days. Figure 1 (c)

and d)), shows that the C-N achieved the lowest drying shrinkage but the mixtures with 30% of CRA and MRA had similar values. In addition, the CRA concretes achieved the highest strength when 100% of PC was employed (10-15% higher than the 82.3 MPa of the C-N). The use of the CRA aggregates also improved the drying shrinkage and strength of the C-FA-N mixture. The employment of FA reduced the drying shrinkage as well as the compressive strength.

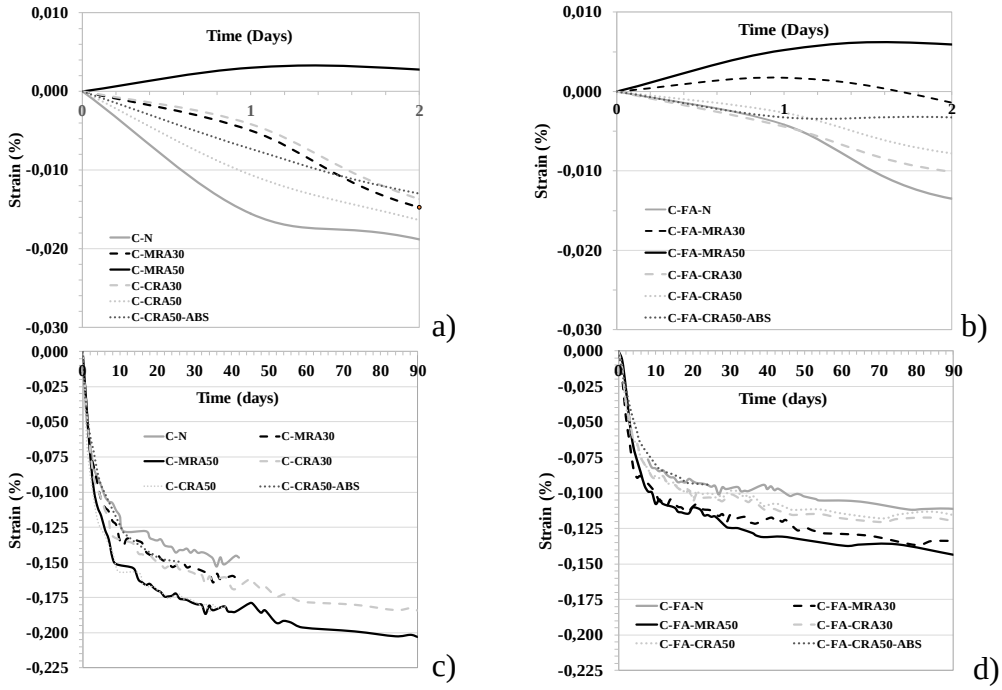

Figure 1. Shrinkage values a) Phase 1 autogenous shrinkage at 2 days, b) Phase 2 autogenous shrinkage at 2 days c) Phase 1 drying shrinkage and d) Phase 2 drying shrinkage.

4 Conclusions

The MRA and CRA concretes achieved the lowest autogenous shrinkage and highest strength. Although the C-N achieved the lowest drying shrinkage, the mixtures with 30% of CRA and MRA were found to have similar values with a higher strength. The use of FA reduced the shrinkage and strength values of concrete.

ORCID

Miren Etxeberria: https://orcid.org/0000-0003-2208-6207

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