



# Mechanical and durability behaviour of self-compacting concretes for application in the manufacture of hazardous waste containers

A.R. Esquinas<sup>a</sup>, D. Motos-Pérez<sup>a</sup>, M.E. Jiménez<sup>a</sup>, C. Ramos<sup>a</sup>, J.R. Jiménez<sup>c,1,\*</sup>, J.M. Fernández<sup>a,b,1,\*</sup>

<sup>a</sup>Departamento de Química Inorgánica e Ingeniería Química, Escuela Politécnica Superior de Belmez, Universidad de Córdoba, Avenida de la Universidad s/n. E-14240 Belmez (Córdoba), Spain

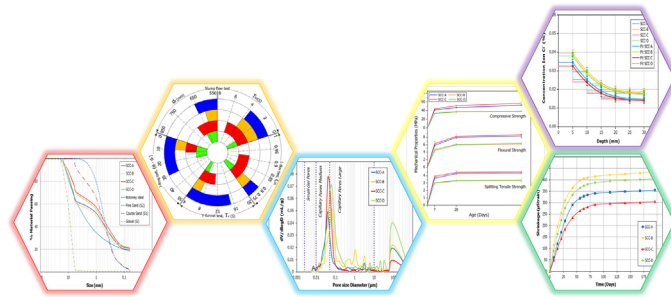
<sup>b</sup>Departamento de Química Inorgánica e Ingeniería Química, Instituto Universitario de Investigación en Química Fina y Nanoquímica IUIQFN, Facultad de Ciencias, Universidad de Córdoba, Campus de Rabanales, Edificio Marie Curie, E-14071 Córdoba, Spain

<sup>c</sup>Área de Ingeniería de la Construcción, Universidad de Córdoba, Edificio Leonardo Da Vinci, Campus de Rabanales, E-14071 Córdoba, Spain

## HIGHLIGHTS

- The mixes comply with the self-compacting requirements marked by the EHE-08.
- Mixes with fillers and low coarse aggregate content had finer porous structures.
- All mixes are impermeable based on the penetration of water under pressure test.
- The mixes have good performances against chloride and sulphate ion penetration.
- The presence of fillers in the dosages greatly influences concrete shrinkage.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

### Article history:

Received 14 October 2017

Received in revised form 17 February 2018

Accepted 20 February 2018

### Keywords:

Self-compacting concrete  
Hazardous waste container  
Microstructure  
Mechanical behaviour  
Durability  
Shrinkage

## ABSTRACT

In self-compacting concrete (SCC), the amount of coarse aggregates, use of fillers, and type of additives play important roles in its self-compaction, including mechanical and durability properties. The use of SCC is widespread in the precast concrete industry and it can also be employed in the manufacture of containers for the storage of hazardous waste. In addition to the requirements for self-compaction, strict mechanical and durability requirements must be considered. In this work, a study on the effect of variation in the amounts of coarse and fine aggregates, and fillers on the properties of the fresh state (self-compactability) and hardened state (microstructural, mechanical, and durability behaviours) of different dosages is carried out. The factors that have more significant influences on the density of the mixes are the presence of fillers and water-cement ratio. This is because mixes with fillers and low water-cement ratios have higher densities, which agree with the lower porosity and finer porous structure observed in mixes that incorporate fillers. Mixes incorporating siliceous fillers presented better performances in the absorption of water by immersion and capillarity than mixes without them. Measuring the depth of penetration of water under pressure in various mixes makes it possible to identify those that have high compactness and impermeability. Mixes with fillers and higher microstructural densities have lower water penetration depths. After exposure to aggressive environments, none of the mixes, with and without fillers, showed signs of wearing out or deterioration. The presence of fillers in SCCs had a more significant

\* Corresponding authors at: Departamento de Química Inorgánica e Ingeniería Química, Escuela Politécnica Superior de Belmez, Universidad de Córdoba, Avenida de la Universidad s/n, E-14240 Belmez (Córdoba), Spain (J.M. Fernández).

E-mail addresses: [jrjimenez@uco.es](mailto:jrjimenez@uco.es) (J.R. Jiménez), [um1feroj@uco.es](mailto:um1feroj@uco.es) (J.M. Fernández).

<sup>1</sup> Both authors contributed equally to the manuscript.