**Computers and Concrete**, *Vol. 21, No. 6 (2018) 681-695*
DOI: https://doi.org/10.12989/cac.2018.21.6.681


# Size effect on strength of Fiber-Reinforced Self-Compacting Concrete (SCC) after exposure to high temperatures

M. Eren Gülşan[*1], Khamees N. Abdulhaleem[1,2a], Ahmet E. Kurtoğlu[3b] and Abdulkadir Çevik[1c]

[1]*Department of Civil Engineering, Gaziantep University, Gaziantep, Turkey*
[2]*Department of Civil Engineering, Kirkuk University, Kirkuk, Iraq*
[3]*Department of Civil Engineering, Istanbul Gelisim University, Istanbul, Turkey*

*(Received August 31, 2017, Revised March 10, 2018, Accepted March 12, 2018)*

**Abstract.** This pioneer study investigates the size effect on the compressive and tensile strengths of fiber-reinforced self-compacting concrete (FR-SCC) with different specimens, before and after exposure to elevated temperatures. 432 self-compacting concrete (SCC) specimens with two concrete grades (50 and 80 MPa) and three steel fiber ratios (0%, 0.5% and 1%) were prepared and tested. Moreover, based on the experimental results, new formulations were proposed to predict the residual strengths for different specimens. A parametric study was also carried out to investigate the accuracy of proposed formulations. Residual strength results showed that the cylinder specimen with dimensions of 100×200 mm was the most affected, while the cube with a size of 100 mm maintained a constant difference with the standard cylinder (150×300 mm). Temperature effect on the cube specimen (150 mm) was the least in comparison to other specimen sizes and types. In general, provision of steel fibers in SCC mixtures resulted in a reduction in temperature effect on the variance of a conversion factor. Parametric study results confirm that the proposed numerical models are safe to be used for all types of SCC specimens.

**Keywords:** self-compacting concrete; elevated temperatures; fiber-reinforced; size effect; compressive and tensile strengths

## 1. Introduction

Compressive and tensile strengths of concrete are the most important mechanical properties in the design of concrete structures, which are routinely specified and tested by control specimens (Nikbin *et al.* 2014). Several international standards and codes recommend various geometries and shapes of test specimens. Most common shapes are the cylinder with dimensions of 150×300 mm and the cube with dimensions of 150 mm. These specimens are known as the standard specimens. Dehestani *et al.* (2014) introduced the relation between the strengths of different specimens and noted that the cubic specimen has higher strength than the cylindrical specimen. Yi *et al.* (2006) proved that the strength ratio of the cube to the cylinder decreases as the concrete grade increases. In general, the concrete strength decreases with the increase in specimen size (Del Viso *et al.* 2007, Kourkoulis and Ganniari-Papageorgiou 2010), and the decrement rate remains nearly constant beyond a certain size limit (Yi *et al.* 2006, Del Viso *et al.* 2007, Sim *et al.* 2013). Van Der Vurst *et al.* (2014) indicated that the higher uniformity in the distribution of stresses causes a reduction in the maximum stresses in the specimen. Yi *et al.* (2006) described the effect of shape and size of the specimen, as well as placement direction on compressive strength based on fracture mechanics. Aslani *et al.* (2017) investigated the effect of shape, size and mould type on the compressive strength of concrete. Maia and Aslani (2016) proposed that modulus of elasticity of the concrete produced from basaltic aggregate was not affected by the specimen geometry.

Self-compacting concrete (SCC) has been widely used in industrial structures throughout the world since it has the ability to flow and fill all sections of forms with little or no vibration as well as prevention of bleeding or segregation (Aslani 2015a, Aslani and Maia 2013). Furthermore, fiber-reinforced SCC (FR-SCC) can be used as a high-performance building materials that combines the benefits of fresh properties of SCC as well as improving the characteristics of the concrete in the hardened state due to adding fibers (Aslani and Nejadi 2013, Aslani and Natoori 2013, Aslani and Bastami 2015).

Fire is one of the most severe risks to a building or structure. A research related with the temperature effect on different concrete specimen types gives an indication regarding the influence extent for each specimen type under the same conditions. Therefore, the mechanical performance of concrete structural members with different shaped and sized cross-sections can be predicted when exposed to elevated temperatures during a possible fire. Due to development of new types of concrete, thermal performance

∗Corresponding author, Assistant Professor
E-mail: gulsan@gantep.edu.tr
[a]Ph.D. Candidate
E-mail: khamees.abdulhaleem@mail2.gantep.edu.tr
[b]Assistant Professor
E-mail: aekurtoglu@gelisim.edu.tr
[c]Professor
E-mail: akcevik@gantep.edu.tr

**Copyright © 2018 Techno-Press, Ltd.**
http://www.techno-press.org/?journal=cac&subpage=8
www.kci.go.kr
ISSN: 1598-8198 (Print), 1598-818X (Online)