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Ultimate Behavior of Self-consolidating Concrete Reinforced beams

Yasser Sharifi
Department of Civil Engineering, Vali-e-Asr University of Rafsanjan, Rafsanjan, Iran
⋮
yasser_sharifi@yahoo.com and y.sharifi@vru.ac.ir

Abstract
Self-consolidating concrete, SCC, was first developed in 1988 to achieve durable concrete structures. Tests are reported in this study on the flexural behavior of reinforced concrete beams made with self-consolidating concrete. The beams were made from concrete having average compressive strength of 30 MPa and reinforcement ratio (ρ/ρ_b) of 0.15, 0.30 and 1.37. A number of three Self-consolidating concrete beams were cast and incrementally loaded under bending. A test series with SCC beams under four-point bending was performed to examine the ultimate behavior of these types of structures. During the test, the strains on the concrete middle face and on the tension and compression bars as well as the deflection at different points of the span length were measured up to failure. The ultimate moment for the tested beams was found to be about (0-7)% and (0-8)% higher than that of the predicted ultimate moment based on ACI 318 (05) and CSA (04) codes, adopted for reinforced beams cast with normal concrete vibrated into place to ensure proper filling and consolidation equivalent, respectively.

Keywords: self-consolidating concrete, flexural behavior, ultimate behavior.

1. INTRODUCTION

Self-consolidating concrete (SCC), was first developed in Japan [1-4] to achieve durable concrete structures. Since then, various investigations have been carried out and this type of concrete has been used in practical structures in many countries by large construction companies. Casting concrete in heavily reinforced sections, such as those in columns and beams in moment-resisting frames in seismic areas and in some repair sections, makes the placement of concrete quite difficult. Providing proper consolidation can require internal or external vibration that can be critical in sections with high-density reinforcement. Ensuring thorough consolidation of critical structures with durability and safety concerns is essential and can often depend on the competence of the vibrating crew to ensure adequate consolidation. Using standard vibration techniques with conventional concrete that is not fluid enough may lead to some surface and structural defects resulting from lack of proper bond development between the concrete and the reinforcement as well as the entrapment of air voids in the concrete.
Such concrete can spread readily into place and fill the formwork without any mechanical consolidation and with minimum risk of separation of the material constituents. Such concrete is proportioned to exhibit a low yield value and a moderate viscosity to maintain high deformability and filling capacity of the formwork with minimum segregation and flow blockage. Self-consolidated concrete can be used to facilitate the construction of elements without mitigating structural performance and durability. Self-consolidating concrete has been used in a variety of projects in many countries, including precast/prestressed applications; repair of concrete infrastructure, to some extent construction of reinforced concrete structures. In order for such concrete to have wider acceptance for casting complex and congested structural elements, particularly in seismic areas, more information regarding in situ properties of the hardened concrete should be made available. For seismic construction requiring heavy reinforcement, specifying engineers considering using this new category of high-performance concrete must have adequate knowledge of the structural performance of elements cast with SCC [5].
Most studies on SCC reported in the literature deal with mixture proportioning and characterization of fresh and hardened concrete properties with limited information on structural performance [6-11]. One of the barriers to the widespread acceptance of SCC is the lack of information regarding structural properties of sections cast with SCC. Surong and Jianlan [12] investigated the flexural and shear behavior of reinforced beams cast with SCC and they concluded that:
In the process of flexural or shear failure under vertical load, there are no obvious differences between the behavior of SCC beams and that of normal concrete beams and when the strength of concrete and