Effect of 3D, 4D, 5D Steel Fibres on the Shear Behavior of Reinforced Concrete Beams

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Introduction

Steel fiber reinforced concrete (SFRC) is concrete that is mixed with steel fibers (SF) to increase the tensile resistance by reducing crack width and increasing structural ductility. Furthermore, SFRC has been known to increase the shear capacity of members. As a result, steel fiber can replace stirrups as shear reinforcements, reducing construction time and allowing the structure to be constructed in any shape. However, because of the complications with shear behavior, it is still difficult to predict the member shear capacity accurately.

In this work, the effect of fiber dosage and hooked ends SF shape on the shear behavior of largescale reinforced concrete (RC) beams will be investigated. Three different fiber dosages of 20, 40, and 60 kg/m3 (0.25%, 0.5%, and 0.75% by volume) and three types of hooked ends SF with varied hook end geometries, including single hooked end (3D), and multiple hooked ends (4D, and 5D) will be taken into consideration using two shear span-to-effective depth ratio (a/d), i.e., 2.5 and 2.75.

Experimental program

Test specimens :

The shear behavior of RC beams with two different (a/d) ratio of 2.5 and 2.75, both with and without SF, were examined to determine the impact of introducing novel multiple hooked ends SF to concrete mixtures. Four-point bending tests will be carried out. The specimens will be divided into two groups according to the (a/d) ratio. Each group will consist of 10 beams: (1) one RC control beam without SF; (2) three RC beams for 3D SF which include 20, 40, and 60 kg/m3 fiber content; (3) three RC beams for 4D SF which include 20, 40, and 60 kg/m3 (0.25%, 0.5%, and 0.75% by volume) fiber content; (4) three RC beams for 4D SF which include 20, 40, and 60 kg/m3 fiber content. The total number of the RC beams in this study will be 20 beams.

Test setup : The RC beams width will be 200 mm and the depth 300 mm. The length of the beams will be 2000 mm; 1800 mm clear span. No stirrups will be added to the beams. Only few stirrups will be added before the support to carry the upper reinforcement steel. The beams were designed to fail in shear. Accordingly, the main longitudinal bottom steel will be 4ϕ18 and the upper steel will be 2ϕ10. The tensile reinforcement ratio is 1.9 %. Steel bars will have a nominal yield strength of 420 MPa for longitudinal reinforcements. For a/d =2.75: the shear span will be 798 mm and the effective depth will be 266 mm. For a/d =2.5: the shear span will be 532 mm and the effective depth will be 266 mm.

Research Objectives:

The main objectives of this research are:

- To investigate experimentally the influence of using novel multiple hooked ends SF on the shear performance of RC beams in terms of ultimate shear strength, deflection, mode failures and crack patterns.
- To study the effect of using different types of SF (3D, 4D, 5D) on the shear strength of the RC beams.
- To study the effect of using different dosages of SF (3D, 4D, 5D) on the shear strength of the RC beams.
- To study the effect of using SF (3D, 4D, 5D) on the shear strength of the RC beams using two different a/d (2.5 and 2.75).

Experimental result

Test result :

The test result showed that the 4D and 5D at the same dosage stand the same load which higher than 3D , and at the same fiber type the specimens with 40 kg/m3 and 60 kg of fiber dosage stand the same load which higher than the specimens with 20 kg/m3 . Increasing shear span to depth ratio (a/d) for the same type of specimens the load capacity decreased .