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Macro and micro polypropylene fiber effect on reinforced concrete beams with insufficient lap splice length

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ABSTRACT

For longer spans of reinforced concrete elements, design codes dictate the use of sufficient lap splice length. Insufficient lap splice length decreases the flexural strength and ductility of reinforced concrete (RC) beams, while fiber addition improves their load-carrying capacity, ductility, and durability. The main purpose of this study was to examine the effects of micro and macro fibers on the lap splice length of RC beams. In this regard, the effect of fiber addition on RC beams having insufficient lap splice length under bending test has been studied in detail. Mixtures were prepared with different fiber ratios (0.5% micro polypropylene (PP), 0.25% micro polypropylene-0.25% macro-synthetic polypropylene (MS), 0.5% macro-synthetic polypropylene by volume of concrete) and performed on half-scale RC beams with various lap splice lengths. In beams with insufficient lap splice length, the addition of MS fiber improved the energy absorption capacity at around 30% and the load-carrying capacity at about 18%, while the effect of PP was limited. Damage analysis of the beam illustrates that MS fiber addition on RC beams inhibits crack propagation and improves load-carrying capacity.

1. Introduction

Significant stress increases are observed in tension reinforcement, and adherence as the cracks in RC beams progress. Most design codes suggest enough lap splice length for steel reinforcement to minimize the damage in elements subjected to bending. When the lap splice length is applied complying with RC design standards, there are negligible deficiencies in load-carrying capacity and deformability under horizontal loads [1,2]. However, insufficient lap splice length decreases ductility and the strength of the structural element [3–5]. In addition, tensile stresses developed in columns during horizontal loads cannot be transferred due to insufficient lap splice length [6]. This may even cause the building to collapse, especially under horizontal load. To prevent this damage, the structural elements of a building are retrofitted with the required method, thus eliminating the problems due to insufficient lap splice length [6–8].

Fiber reinforced concrete (FRC) is widely used in tunnel works, railways, dams, and structures such as precast elements. Glass, steel, polypropylene, carbon and natural fibers are added to concrete to produce FRC, thus improving the properties of concrete [9,10]. Adding fiber to concrete improves ductility, energy absorption, and strength [11,12]. In addition to the use of fibers in concrete, fibers

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