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A method for evaluating the local failure of short polypropylene fiber-reinforced concrete plates subjected to high-velocity impact with a steel projectile

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Abstract

This study investigated the local failure of short polypropylene (PP) fiber-reinforced concrete (PPFRC) plates that were subjected to high-velocity impact using a steel projectile. To examine the differences in the mechanical properties of the PPFRC obtained under static and dynamic loadings, static and rapid-speed uniaxial compressive and tensile tests were conducted. Subsequently, high-velocity impact tests were conducted to investigate the impact resistance performance of the PPFRC plates. In a series of tests, a steel projectile, with a mass of 46 g, collided into a PPFRC plate, with a thickness of 60 mm or 80 mm. The impact velocity was set between 190m/s and 420m/s to examine the variation in the failure modes of the PPFRC plate. The experimental results revealed that the scabbing damage induced by the impact was significantly suppressed for the PPFRC plate compared with that of a plain concrete (PC) plate. High-velocity impact tests were also conducted on short PP fiber-reinforced mortar (PPFRM) plates to investigate how the matrix type influences the local failure. To evaluate the scabbing and perforation limit thicknesses of the PPFRC plates, we proposed an assessment method, in which the modified formula, developed by the US National Defense Research Committee (NDRC), is multiplied by a reduction factor. Furthermore, the relationship between the limit thickness of a PPFRC plate and the kinetic energy of a projectile was formulated based on the proposed method.

Key Words

High-velocity impact, Fiber-reinforced concrete, Polypropylene fiber, Local failure