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Effect of corrosion on bond performance of corroded pretensioned prestressed concrete beams

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Abstract

The bond behaviour between corroded strand and concrete in pre-tensioned prestressed concrete beam is investigated experimentally in the present paper. A total of nine pre-tensioned beams are fabricated and eight of them are accelerated to concrete cracking, with one uncorroded beam as control. Data on the distribution of corrosion-induced crack, force-slip responses, and failure modes are obtained. Effects of strand corrosion on the load-slip curves are studied. At last, the final failure modes and the ultimate strength of the beams are analysed. Experimental results show that the bond stiffness and strength do not decrease until the corrosion loss and crack width exceeds 5.1% and 0.27 mm, respectively. The failure mode of beams change with the increasing of strand corrosion. When the corrosion loss is less than 5.1%，beams PS0-PS4 fail in concrete crushing, accompanying with strand yielding. When the corrosion loss exceeds 6.91%, the beams fail in strand rupturing without detecting yielding plateau. The degradation of strand tensile strength plays a more important role than degradation of bond strength when strand reaches certain corrosion loss.

Keywords: strand corrosion; prestressed; bond stiffness; bond strength; failure mode.

1 Introduction

Bond behaviour between prestressing strand and concrete plays a critical role in maintaining the property of pretensioned prestressed concrete structures [1, 2]. The bond behaviour of strand depends on factors such as material strength, steel type, and external constraints etc. In addition, corrosion also has a significant effect on strand bond. Corrosion induces cracking of concrete surrounding the strand. This damage could decrease the confinements of the concrete to the strand and bond strength. Moreover, corrosion products change the interaction between the strand and the concrete and impact the transmission of bond stresses. All of these factors can reduce the serviceability and durability of concrete structures [3-5].

Numerous studies on the bond behaviour between corroded steel and concrete have been conducted over the past decades. Among these works, more attention focused on the bond of corroded reinforcement rather than the strand [6-8]. It was found that slight corrosion increase the bond strength before concrete cracking. With further corrosion, bond strength decreases, and the relative slips increase rapidly [8-9]. For the prestressing strand, however, its bond is distinct from that of the ordinary bars because of its twisting constitution and mechanical interlock. The strands have been reported to be more sensitive to corrosion [10]. However, limited attentions have been paid on the corrosion effects on the bond between strand and concrete.

For pre-tensioned concrete structures, strand has been widely applied for its advantages in

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