学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Rehabilitation of corrosion damaged reinforced concrete beams with recycled nylon fiber reinforced sprayed polymer cement mortar
(リサイクルナイロン繊維を混入したポリマーセメントモルタルによるコンクリート部材の補修効果)

In recent decades, the world has been suffering from the dumping of wastes, especially plastics left in seas and oceans. Waste fishing nets account for some of these wastes; 640,000 tons of fishing nets are disposed of in the ocean annually. As the nets become totally entangled, separating them for disposal is impractical. These nets can be harmful to marine life, such as turtles, seals, and other marine mammals, which can become entangled and suffer injury or drowning. In addition, the marine food web could be disrupted. As abandoned nets and plastic garbage tend to gather at or near the surface of seas and oceans, they keep sunlight from reaching small creatures such as planktons and algae. Therefore, the animals that feed on these small creatures are also directly affected. Although the storage of such nets has not caused a serious safety hazard to date, it is important to find suitable recycling solutions.

In the first stage, the author investigated the utilization of recycled waste fishing nets in fiber-reinforced mortar and compared the mechanical properties of such mortar made with recycled waste fishing nets to those of mortar made with recycled PET (polyethylene terephthalate) and PVA (polyvinyl alcohol) short fibers. Two types of recycled nylon fiber (R-nylon fiber) were investigated: straight fiber and fiber with a knot at each end. The straight R-nylon fiber was obtained by manually cutting waste fishing nets to the lengths of 20 mm, 30 mm, and 40 mm, and adding them to mortar at the volume ratios of 1.0%, 1.5%, and 2.0%. The 40-mm-long knotted fiber was added to mortar at the volume ratios of 0.5%, 0.75%, and 1.0%. The mechanical test results showed improvements in first-crack strength, toughness, and ductility for mortar reinforced with R-nylon fibers. The addition of R-nylon fibers improves first-crack strength more than that recycled PET and PVA fibers do. However, the compressive strength decreases with increase in fiber fraction, and decreases with increase in fiber aspect ratio. The post peak load, toughness and residual strength depended on the properties of fiber such as Young's modulus, tensile strength, and geometry as well as the bond strength between fiber and matrix.

In the second stage, applicability of R-nylon fiber sprayed polymer cement mortar (SPCM) to the section repair of corrosion damaged reinforced concrete (RC) beams was evaluated. In this study, a novel R-nylon fiber SPCM was compared with two common types of SPCM: polyethylene fiber SPCM, and plain SPCM (without fiber). The experiments involved the removal of concrete to three depths, to represent three repair methods: removal to a depth of 10 mm, removal of all the cover concrete, and removal to a depth of 20 mm over the tensile reinforcements. Four-point bending tests were

conducted on 44 RC beams whose flexural behaviors (load carrying capacity, flexural stiffness, ductility, crack formation and strain distribution along midspan cross section) were investigated. SPCM containing R-nylon fiber was found to afford increases in load carrying capacity for the beams whose tensile reinforcement was reduced by 10% to 18% from corrosion, and it was found to provide higher ductility than the two common types of SPCM. The beams repaired with SPCM containing either of the fibers showed higher stiffness than those repaired with SPCM without fibers. It was found that, for the beams whose tensile reinforcement was reduced by 10% from corrosion, removing the whole concrete covering is suitable for improving flexural behavior and can be a better choice in terms of economic efficiency. Furthermore, for beams that have lost 10% to 18% of their tensile steel mass, it is recommended that concrete over the tensile reinforcements be removed to a depth of 20 mm and replaced by SPCM containing either type of fibers. It is noted that for the beams whose tensile reinforcement was reduced more than 18% from corrosion, only replacement with SPCM is not sufficient for load carrying capacity recovery.