

REHABILITATION OF STRUCTURE WITH REINFORCEMENT SECTION LOSS

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Introduction

Integrity of reinforcement is fundamental to the strength, ductility, and safety of reinforced concrete structures. Determining the necessity of additional or replacement reinforcement is a primary concern in rehabilitation projects containing corrosion of reinforcing steel.

Question

How should an engineer address exposed and corroded reinforcement when repairing a conventionally reinforced concrete structure (Fig. 1), and should there be a concern if the loss of reinforcement is less than 10 percent of the cross-sectional area?

Answer

After determining the condition of the reinforcement, remove unsound concrete, clean reinforcement, and provide additional reinforcement as needed. The structural consequences of a 10 percent cross-sectional area loss due to corrosion are usually minor for nonprestressed concrete components because there are usually redundancies in design.

Discussion

Begin by identifying the source, extent and level of activity of reinforcement corrosion (ICRI No. 310.1R; ACI 364.6T), and determining the overall condition and cross-sectional area of the affected reinforcing steel. Remove all unsound concrete; undercut the exposed corroded bars to provide clearance for under-bar cleaning and full bar embedment in the repair material; and secure the repair structurally, so as to ensure the required load-carrying capacity is achieved (Fig. 2). The clear space behind the reinforcing steel should be greater than 1/4 in. (6 mm), plus the dimension of the maximum-sized aggregate in the repair material (ACI 364.6T). Generally, a 3/4 to 1 in. (20 to 25 mm) gap is required to inspect and clean the bar. Place the repair material and encapsulate the bar with it.

Clean the reinforcement by means of wire brushing, sandblasting, shot-blasting, or water-blasting. Do not use solvents as they can penetrate the concrete, which may create a poor bond surface for repair materials. If the reinforcing bars are epoxy-coated, the epoxy in the area surrounding the exposed corrosion should be removed and the bar cleaned.

Measure the cross section. Use calipers to measure the reduced diameter of the reinforcing steel. If the loss of cross-sectional area is greater than 10 percent, additional (supplemental) reinforcement may be required (Fig. 3). If corrosion pits with depths greater than 25 percent of the bar diameter are observed, additional reinforcement could also be required.

The structural consequences of a 10 percent cross-section area loss due to corrosion are usually minor for nonprestressed concrete components because of redundancies in design, as discussed in items (a) through (c) as follows. In practice, there is usually no concern with less than 10 percent loss of cross-sectional area.

(a) *Reinforcement reserve*—Steel reinforcement used in construction is typically larger than required by structural considerations. Extra steel is attributed to varying practical design requirements such as bar layout and spacing. Five to 10 percent more steel area is typically provided than is required by analysis.

(b) *Corrosion location*—Corrosion damage is often uneven throughout the member length and frequently may be at



Fig. 1—Example of severe reinforcing steel deterioration due to corrosion in a reinforced concrete beam (courtesy of the Ministry of Transportation of Quebec).