



TREATMENT OF EXPOSED EPOXY-COATED REINFORCEMENT IN REPAIR

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Introduction

This document outlines the treatment and repair of concrete areas containing epoxy-coated reinforcing steel when epoxy-coated reinforcing steel is exposed in a repair area.

Question

How should reinforcement be treated when epoxy-coated reinforcement is exposed and damaged in a repair area before the concrete repair materials are placed?

Significance

Concerns have been raised that the repair of structures containing epoxy-coated reinforcing steel may differ from structures containing uncoated reinforcing steel.

Answer

Structures containing epoxy-coated reinforcing steel should be carefully repaired to avoid creating corrosion cells that may result in accelerated corrosion of the reinforcement.

Discussion

During concrete removal and preparation of the repair area, the epoxy coating on the bars within the repair will likely be damaged. The coating may have defects, or, as part of the repair procedure, it may be completely removed. Minimize the risk of accelerated corrosion-induced damage to the concrete, particularly in the areas surrounding the repair, by following the procedure presented herein.

It is common practice to clean, prepare, and recoat any exposed epoxy-coated steel reinforcement during the repair process, usually with an epoxy coating compatible with the existing fused coating on the steel. Consider additional protection because it is difficult to repair the damaged coating on the steel completely. Areas left uncoated or the presence of coating defects may result in an increase in the rate of corrosion of steel in the concrete surrounding the repair, due to the anodic ring effect, after the repairs are completed. However, any coating will reduce the corrosion rate compared to uncoated bars.

When concrete repair is undertaken, chloride-contaminated or carbonated concrete is typically removed and replaced with repair material within the repair area. In many cases, not all of the contaminated concrete is removed. After the repair, the reinforcing steel may be in contact with concrete outside the repair area having varying levels of contamination. Differences in pH and chloride ion concentrations between the new repair material and the remaining contaminated concrete will result in corrosion potential (voltage) differences. A current will flow as a result of these voltage differences, leading to anodic ring corrosion.

Reinforcement locations surrounded by concrete with the highest moisture and chloride contamination are likely to corrode first. Corrosion will occur in locations where there is both a defect in the coating and a sufficient level of contamination present. Generally, the corrosion rate is proportional to the ratio of the cathodic area to the anodic area. Because the surface area of coated steel is often greater than the area of exposed steel,

the rate of corrosion of the uncoated steel areas outside the repair can be high. Completing a repair may also increase the area of uncoated steel within the repair area, particularly if the steel is not coated during the repair. As a result, corrosion of the steel immediately adjacent to the repair area at locations with defects or where the epoxy has delaminated will continue, and the corrosion rate in these areas may increase compared with bars that are fully coated. The uncoated area of steel inside the repair area will contribute to the overall corrosion cell, which could result in corrosion of steel in the existing concrete in the locations where sufficient contamination, oxygen, and moisture are present.

In addition to coatings, other options exist to mitigate corrosion of concrete containing epoxy-coated bars. They include the use of nonmetallic reinforcement and cathodic protection systems (both impressed current and galvanic types), which are discussed in ACI 222R (ACI Committee 222 2001) and ICRI 310.1R 2008. Provide supplemental corrosion protection for existing steel reinforcement by recoating the reinforcing bar, installing an appropriate high-electrical-resistance repair concrete, or using embedded galvanic anodes, as illustrated in Table 1. If a high-electrical-resistance repair concrete or mortar is used, a conductive mortar should be installed between the galvanic anodes and the substrate or the effectiveness of the galvanic anodes will be reduced. A combination of corrosion protection methods from Table 1 will usually provide better corrosion protection than any individual method. Corrosion of the area surrounding the repair location may also be minimized by reducing the moisture content of the concrete, through the use of a breathable membrane or sealer.

Summary

Repairs should be completed to minimize the corrosion of steel adjacent to the repair areas. The use of coatings on epoxy-coated reinforcing bars that are exposed during repair can be beneficial in reducing the surface area of steel available to promote corrosion. The use of high-electrical-resistance repair materials can reduce the corrosion current by increasing the circuit resistance. The use of embedded galvanic anodes can be beneficial in providing galvanic corrosion protection to portions of the steel where the epoxy coating is defective, either inside or adjacent to the repair. Treating exposed epoxy-coated reinforcing bars in repair areas is recommended to suppress ongoing corrosion activity and mitigate the anodic ring effect adjacent to the repair area.

References

ACI Committee 222, 2001, "Protection of Metals in Concrete against Corrosion (ACI 222R-01) (Reapproved 2010)," American Concrete Institute, Farmington Hills, MI, 41 pp.

ACI Committee E706, 2005, "Installation of Embedded Galvanic Anodes Field Guide to Concrete Repair Application Procedures (ACI RAP-8)," American Concrete Institute, Farmington Hills, MI, 6 pp.

ICRI Guideline No. 310.1R-08 (formerly No. 03730), "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion," International Concrete Repair Institute, Rosemont, IL, 2008, 12 pp.