

CONCRETE REHABILITATION SCENARIOS FROM INITIAL REPAIR TO COATING PROTECTION

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Abstract:

In many instances, concrete needs to be repaired and waterproofed prior to coating. General practices apply across many different market segments. Vertical, horizontal and overhead repair scenarios have many things in common and a variety of repair products to consider depending on jobsite conditions, time frame and ultimate exposure of the repair materials (chemicals, weather, movement, etc.). The purpose of this paper will be to outline, in general terms, different types of repair scenarios that have a proven track record and are available for owners, engineers/architects, and contractors to utilize.



Examples of Deterioration of Concrete

Introduction

Most of you are familiar with SSPC SP 13/NACE No. 6 Surface Preparation of Concrete. This standard is applicable to preparation of concrete surfaces which either do not need to be repaired, have already been repaired, or are ready to be coated. This paper discusses concrete repair scenarios that require the removal of some or all of the concrete to be repaired. One of the most important aspects of any type of concrete repair is the identification of the cause of the deterioration or damage and the selection of the best repair method and repair materials. Prior to 1988, there were very few standards and guidelines for concrete restoration. There were many so-called concrete repair contractors who were for the most part untrained and unqualified to perform proper concrete preparation, or utilize the best equipment and materials for the project. In response to these concerns, the International Association of Concrete Repair Specialists was formed in 1988 and the name has since been changed to the International Concrete Repair Institute (ICRI) (International Concrete Repair Institute [ICRI], 2009). The purpose of this organization, whose members include specialty concrete restoration contractors, engineers, and manufacturers of concrete repair products, is to improve the quality of concrete restoration, repair and protection, through education of and communication amongst the members and those who use their services.

I mention ICRI because now there is a resource for owners, engineers and contractors to benefit from the collective experience and knowledge of its members and use the standards for concrete repair that have been developed over the years. I will discuss some of the common repair scenarios and the types of materials with a proven history of successful applications.

Repair Scenarios

Key Issues

Before any successful repair project can begin, several key issues should be discussed prior to the commencement of any work. These issues include cause of concrete deterioration or damage; type of repair method to be utilized; type of equipment to be utilized; type of materials to be utilized; ICRI, ASTM, or ACI standards that should be followed; and whether or not the project should involve a structural engineer and/or architect. Once a determination has been made as to the cause of the concrete deterioration and damage, a plan can be developed to create a successful repair scenario that will include surface preparation, and the method of patching, grouting, or injection process that will provide the best chances for a successful outcome.



Spalled concrete on vertical and overhead surfaces

Surface Preparation



Properly prepped overhead area prior to application of repair products

Whether the repair work is vertical, horizontal, overhead, above or below grade, concrete preparation is a key component to any successful repair scenario. Because there are many different types of concrete structures and substrates, in addition to the fact that concrete does not cure uniformly, it is extremely important to determine the proper concrete preparation scenario based on those factors. Whether the repair work is patching spalled concrete, replacing an entire section of a concrete structure, or repairing cracks in concrete, the concrete preparation of the area to be repaired is crucial

to a successful outcome. Just as concrete preparation is important for the successful application of coatings; it is no different for the successful application of concrete repair and restoration. Most of you already know about many types of concrete preparation for coating concrete structures and substrates. The basic difference is that in most concrete repair scenarios removal of damaged and deteriorated concrete must be accomplished in conjunction with these surface preparation techniques.

There are many different types of deteriorated concrete preparation scenarios including hand-chipping, electric, air or hydraulic powered chippers, hydrodemolition, coring, concrete planer, and concrete sawing. All of these methods utilize equipment and tools that have basic standards of operation and usage. Some of the criteria for selecting which method and equipment to be used will depend on size of area to be repaired, exposure of reinforcing steel, location of structure (horizontal/vertical/overhead, indoor/outdoor, height, and temperature and weather considerations), and the specified end result. Once the surface preparation has been accomplished, the specific type of concrete repair or restoration can proceed. These will include vertical, overhead, and horizontal crack repair, patching, grouting, etc.

As you can imagine, all of these scenarios have their own basic requirements that may include temporary shoring and support for overhead and vertical repairs; and temporary formwork for vertical, overhead or horizontal applications. Over the last 30 years, many materials and repair systems have been developed that have a proven track record when utilized in various repair scenarios. These products and systems range from fiber reinforced polymer modified cement based patching materials for vertical and overhead applications, epoxy based grouts for patching and crack injection applications, methyl methacrylate patching materials (capable of achieving 6,000 psi in 1 hour), to flexible urethane based grouts to seal water intrusion, to specialty cement based patching and grouting materials.

Whether the repair is overhead, vertical or horizontal, some of the basic repair methods will include creation of a repair perimeter using concrete saws, carbide or diamond tipped grinder blades to establish a finite repair area. The deteriorated and/or cracked concrete is removed using small electric or air chipping hammers in small or sensitive areas (sensitive meaning concrete covering power lines, water lines, gas lines, etc.) to large pneumatically driven concrete breakers mounted on a back hoe for large concrete repair areas.

Crack Repairs



Crack in Concrete Retaining Wall

In the case of crack repair, it is crucial to determine what caused the cracking before a crack repair method is selected. For instance, if the cracks are due to settlement of the structure and the likelihood of further movement is very low, these cracks can be repaired by epoxy pressure injection utilizing a low viscosity epoxy resin. However, if it is determined that the cracks will continually move due to thermal expansion, or contraction or absence of adequate expansion joints, etc., a more flexible repair system must be utilized to prevent re-cracking in the repaired area or areas adjacent to the repaired areas.

Spall Repair



Examples of Concrete Spalls in need of repair

Like crack repair work, it is important to determine the cause of spalling concrete in order to prevent spalling from reoccurring. Some causes of concrete spalling can be reinforcing steel set too close to the surface of the concrete, in which case additional thickness in the coverage of the existing reinforcing steel shall be considered when selecting a repair scenario. The recognition and exposure of reinforcing steel is another important component of a successful repair application. There are basic standards for the treatment of rusted and deteriorated reinforcing steel. These may include wire brushing or sandblasting the exposed reinforcing steel, and coating the reinforcing steel with a zinc rich primer, or in the case of severely deteriorated reinforcing steel, replacement of said reinforcing steel. Once the deteriorated concrete has been removed down to sound concrete, the patching and/or rebuilding of the concrete can proceed. The depth of the spalled and damaged concrete will determine the types of repair materials to be used. Based on the thickness of the repair; the projected allowance for cure time of the repair materials; climatic conditions; exposure to chemicals, water, heat, cold, etc.; and specified end result; a specific type of repair material can be selected. Once the repair scenario and repair materials have been selected, it is important that the applicator follow the mixing and placement recommendations of the material manufacturer. The method of placement of the repair materials will be determined by the same factors as the selection of repair materials. This can range from hand troweled placement, to pumping and/or pouring the materials into a temporarily formed area.



Form work in place while applying repair mortar

Water Intrusion



An Example of Water Intrusion



Water Intrusion Being Repaired

Below grade repair situations are often caused by water intrusion. The causes of water intrusion are varied; water may be coming through cracks in the concrete structure, between concrete and piping through the concrete structure, through honeycombs in the concrete, through control or expansion joints, or other voids in the concrete. Before any coating can be applied over these areas, the water intrusion must be stopped. Damp areas may be sealed by using rapid setting hydraulic based cement compounds, polymer modified cement based materials, or rapid setting epoxy, urethane or acrylic coatings designed for damp proofing and low pressure waterproofing. In instances where water is flowing through the concrete expandable polyurethane grouts are pumped into or behind the voids to form a flexible non-porous barrier. In some instances of above grade water intrusion, low-viscosity polyurethane based materials are pumped through injection ports intersecting the crack. These materials do not expand; they gel when activated to form a flexible impervious seal.

Product Selection

Another consideration for selecting a repair product or system will be the coating or coating system that will be applied over the repaired areas. For instance, cement based products have a hydration process (the evaporation of water used in the mix) and take longer to cure than epoxy based or methyl methacrylate based materials. In addition, once cured, cement based patching materials will need surface preparation prior to the application of coating systems. Epoxy grouts dry to a tile hard finish, and may need to be profiled prior to a coating application.

Conclusion

The purpose of this discussion is not to provide you with explicit step by step repair scenarios, but rather to make you aware that the selection of repair methods and materials are not only important to a successful patching outcome but they can also be important to a successful coating application outcome. For further information regarding concrete repair methods I would recommend the ICRI website at www.icri.org or American Concrete Institute at www.concrete.org.

Works Cited

About ICRI. (2009). Retrieved September 16, 2009 from International Concrete Repair Institute Web Site: <http://www.icri.org/ABOUT/about.asp>