Contractors install protective coating on a parking deck floor slab in accordance with ACI 562, which was developed specifically for concrete repair. A new guide to the code helps clarify designers' and contractors' requirements and responsibilities.
Credits: ACI

The Fix is In

What the industry's first repair code means for your work, and your profession.

By Jay H. Paul, S.E., FACI

WHEN A POPULAR Southwestern resort agreed to host a large tradeshow, handling the crowd of attendees wasn't an issue. But housing exhibitors' 18-wheelers in the upper parking deck was another story.

Not designed for such heavy loads, the early-1980s, two-level structure literally cracked under the pressure. A support girder was heavily damaged, and rain leaked through reflective cracking on the top deck into a storage area and valet parking spaces below. Deterioration of the bearing pads under precast double-tee beams also caused extensive deck cracking.

Repair and rehabilitation specialist Brian D. Merrill, P.E., of engineering firm Wiss, Janney, Elstner Associates (WJE), Northbrook, Ill., was asked to devise a repair strategy. Merrill is part of WJE's team in Austin, Texas, that focuses on structural, architectural, and materials solutions.

"With existing structure repair, you're faced with whether to follow the original design intent or the current code for specifications," Merrill says. He researched the building code that applied when the parking deck was built, but needed a current reference to determine the best code to use.

Merrill used the first code written specifically for concrete repair: the American Concrete Institute's (ACI) Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings (ACI 562-13). Developed in response to a need expressed in the Vision 2020 plan, which was established by the ACI Foundation's Strategic Development Council and supported by the International Concrete Repair Institute (ICRI) and other industry leaders in 2006, ACI 562 addresses many considerations that

are unique to concrete repair.

"In cases where the code has changed over the years, it provides a specific process for determining the most applicable code to follow in repairing a damaged structure," he says.

Focusing on performance

Vision 2020 recognized the need for consistent practices to improve quality, safety, and efficiency. Without the benefit of a specific standard, repair practices were inconsistent. Building inspectors often referred to codes for new construction, resulting in unnecessarily costly repairs or even demolition in lieu of rehabilitation.

ACI Committee 562 on Evaluation, Repair, and Rehabilitation of Concrete Buildings spent seven years creating a common resource for designers, contractors, municipalities, and building inspectors that clearly establishes each party's responsibilities. Because repair involves so many variables (materials used, strength needed, age of the structure), the code is ACI's first to include both performance and prescriptive requirements.

The performance-based approach allows licensed design professionals to use their judgment in determining the best repair approach while still following minimum baseline requirements. For instance, repairing a parking structure involves different evaluations and strength requirements than converting a warehouse space into apartments. However, both must meet minimum code provisions.

"The performance criteria give direction for determining the level of repair needed, rather than making it conform to specific criteria," says Merrill.

For the resort's damaged parking deck, he evaluated how much strength was needed to restore the structure to current code specifications. The deck's layout didn't prevent oversized vehicles from returning to the top deck, so he opted to design it to the highest strength and safety levels. That turned out to be the original code.

To return the structure to full use, Merrill employed both structural and surface repairs.

Temporary shoring was installed under the damaged girder immediately after

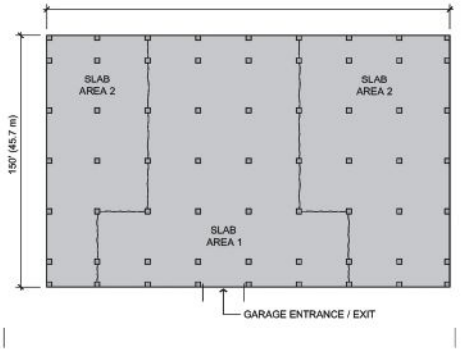
A TYPICAL PARKING GARAGE REPAIR

In one project example, the *Guide to the Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings* describes a situation in which delamination and spalling occurred in a 1960s concrete parking structure.

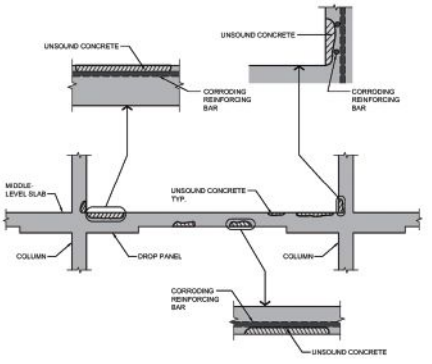
The lower level was on the ground; the middle level and roof consisted of reinforced flat slabs with drop panels. The designer's repair plan included replacing the top 3 to 4 inches of concrete in the damaged area and replacing corroded steel reinforcement with epoxy-coated reinforcing bars.

Throughout the example, the guide references ACI 562 provisions for structural evaluation, repair design, and the contractor's responsibilities during construction, including:

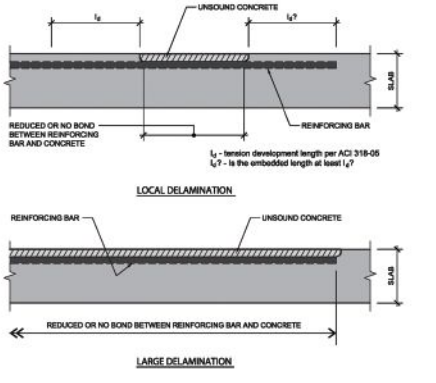
- **Meeting specified limits for concrete removal;**
- **Notifying the licensed design professional if unsafe conditions exist;**
- **Installing temporary shoring or bracing; and**
- **Conforming to local environmental ordinances for water runoff and debris disposal.**



On the middle-level parking deck, the owner noticed potholes, unevenness, and cracking. The deck plan shows where concrete delamination or spalling was discovered: 60% in Slab Area 1 and 10% to 20% in Slab Area 2. The deterioration pattern suggests vehicles tracked deicing salts into the garage, which corroded the embedded reinforcement where drivers most often parked. All graphics courtesy of ACI



Several types of concrete deterioration were observed: delamination and spalling of the driving surface and bases of columns in areas adjacent to steel reinforcement, and cracking.



Based on the significant amount of top surface deterioration in Slab Area 1, the reinforcing bars were conservatively judged to be debonded from the concrete and therefore structurally ineffective. The concrete columns had only small localized deterioration, and were determined to be structurally sound.

WJE's field assessment, according to ACI 562. A supplemental support column will be installed to support the damaged girder and the double-tee beams will be lifted to facilitate bearing replacement. The top deck will also be resurfaced to repair the reflective cracking.

Putting the code to work

Although WJE has been using ACI 562 since the code was introduced in 2013, many designers and contractors are still becoming familiar with its benefits. To help them, ACI and ICRI created the *Guide to the Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings*.

The guide walks you through each chapter of the code and offers insight into how it applies to specific aspects of concrete repair, including structural repair design, durability, construction, and quality assurance. Flowcharts illustrate critical decisionmaking processes, such as evaluating material properties; sidebars highlight topics and references not included in the code.

As a repair contractor, you may want to bookmark Chapter 9: Construction, which summarizes roles and responsibilities related to stability and temporary shoring, temporary conditions, and environmental issues.

For example, the designer must include requirements for stability and temporary shoring in repair documents. The shoring engineer (often a third party that you hire) follows ACI 562 provisions to design shoring and bracing. You, the contractor, determine the means and methods of executing the repairs.

A brief case study illustrates the importance of communicating with the designer during this process.

As part of a high-rise façade repair project, a contractor was removing and replacing unsound concrete from exposed support columns when several partially collapsed. The contractor immediately notified the project owner and designer, who then evaluated the structure to determine what measures were needed to maintain structural integrity while repairs were completed. The case study refers to code provisions relevant to each step of this process.

The guide also provides longer, more detailed project examples that further explain how the code applies to common scenarios, including:

- Typical parking garage repairs
- Typical façade repairs
- Repair of historic structure for adaptive reuse
- Strengthening of two-way flat slabs
- Strengthening of double-tee stems for shear.

Alongside each project description are the code provisions that correspond with each phase of the project. Drawings and photographs show types of damage sustained by the structure, repair options, and the solutions that were selected.

Concrete repair's future

As ACI 562 is increasingly adopted as standard practice, Merrill believes one of its greatest benefits may be its versatility.

"This code focuses on buildings, but certain provisions can apply equally to any existing structure," he says. "It provides a methodology to determine what to do when other codes don't address your specific repair situation — for instance, how to evaluate historic material properties or determine what code to use when a structure's been repaired several times." (See "Can ACI 562 Apply to Bridgework?" sidebar.)

That's because the code was, to an extent, written with a broader interpretation in mind.

It's structured to be compatible with the International Existing Building Code (IEBC), and may be considered for adoption into the IEBC in 2018. It can also be adopted directly by local jurisdictions and municipalities. In either case, its requirements may become mandatory for work on existing concrete buildings in many communities.

The *Guide to the Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings* is available in print and digital formats at www.concrete.org and www.icri.org. **CS**

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