The Structural Maintenance of Parking Garages

By David Monroe

Anyone who owns or operates a parking structure is familiar with the deterioration that can occur: cracks, leaks, and corrosion. Parking structures undergo more distress and deterioration than most other buildings due to their direct exposure to traffic, weather, deicing chemicals, and snowplows. Although today's parking structure technologies have introduced features (such as advanced sealants and coatings) that mitigate many of these problems, they do not eliminate the need for maintenance.

A regular maintenance program is crucial to preserving the garage, providing a satisfactory level of service, and meeting service-life expectations, without premature deterioration, undue repair expense, interrupted service, inconvenience to patrons, or loss of cash flow. Neglected problems can lead to safety hazards for users, increase liability for owners, and necessitate expensive repairs in the long run.

Inspections

A good maintenance program begins with annual visual inspections, which can be carried out by a lay person. In addition, every five years or so a structural engineer or specialty contractor should be called in to perform a more thorough inspection and write a comprehensive report detailing any problems and recommendations for restoration and repair.

Annual Inspection

Inspecting a parking structure yourself isn't rocket science, but it does require some careful attention. First, you should be familiar with materials and protective systems used in the original construction of the garage, such as joint sealants, expansion joint sealants, surface sealers, and traffic deck coatings.

A walk-through inspection should be conducted at least once a year. Do this in conjunction with a wash down of the structure, so that any active leakage can be noted and its source identified. Look for cracks, leaks, joint sealant failures, and general surface deterioration. Using plan sheets of each floor, proceed with the inspection, walking through the entire

Checklist for Structural Inspection of Parking Structures

Decks

- ☐ Are there any cracks? Do they leak?
- ☐ Is the surface sound, or are there areas of surface scaling?
- ☐ Does a chain-dragging test reveal a hollow sound in any areas?
- ☐ Is there any evidence of concrete delamination?
- ☐ Is there any evidence of corrosion of reinforcing steel or surface spalling?
- ☐ Are there any signs of leakage? Describe conditions and note locations.
- ☐ If there is a traffic-bearing membrane, does it have any tears, cracks or loss of adhesion?
- ☐ Are there low spots where ponding occurs?
- ☐ Are there water stains on the underside (soffit) of the deck?
- ☐ Has the concrete been tested for chloride-ion content? When was it last tested?
- ☐ Are records of previous inspections available?

Beams and Columns

- ☐ Are there any cracks? If so, what is the direction, width and depth?
- ☐ Are there any signs of leakage? Describe conditions and note location.
- ☐ Is there any concrete spalling?
- ☐ Is any steel reinforcement exposed?
- ☐ Are bearings in good condition?
- ☐ Are bearing plates rusted?
- ☐ If bearing pads have been used under beams, are they present and in good condition?
- ☐ Are bearing pads squashed, bulging, out of place or missing?

Stair and Elevator Towers

- ☐ Are there any signs of a leaking roof?
- ☐ Are there any cracks in the exterior finish?
- ☐ Are there any signs of corrosion-related deterioration of stairs or railings?
- ☐ Are any other corrective actions required?

Expansion Joints

- [ ] Are there leaks through isolation-joint seals?
- [ ] Are leaks related to failure of the seals or the adjacent concrete?
- [ ] Could the cause be snowplows?
- [ ] What type of isolation joint/expansion joint seal is installed?
- [ ] Who is the manufacturer?
- [ ] Is there a warranty in force?
- [ ] Consult the manufacturer for repair recommendations if applicable.

Joint Sealants

- [ ] Are there any signs of leakage, loss of elastic properties, separation from adjacent substrates or cohesive failure of the sealant?
- [ ] Are there failures of the concrete behind the sealant (edge spalls)

Exposed Steel

- [ ] Is there any exposed steel (structural beams, handrails, door frames, barriers, cable, exposed structural connections)?
- [ ] Is rust visible? Is it surface rust or is there significant loss of section?
- [ ] Is repainting required?
- [ ] What is the condition of attachment point and surrounding concrete?

Drains

- [ ] Are drains functioning properly? When were they last cleaned?
- [ ] Are drains properly located so that they receive the runoff intended?
- [ ] Are seals around the drain bases in good condition?

Previous Repairs

- [ ] Are previous repairs performing satisfactorily?
- [ ] Are the edges of previous patches tight?
- [ ] Do the patches sound solid when tapped?

garage and marking on the plan sheets any areas where problems are observed. It is helpful to use a code system to denote problems and their locations, for example, "L" for leak, "C" for corrosion, "J" for joint deterioration, and so on. Use lines to show where cracks exist and their sizes. Also, take photos of any deteriorated areas to serve as a record of the damage. It is important—and cost effective—to take care of cracks, leaks, and joint deterioration early on, before the problems grow.

Sometimes concrete may be damaged, even though there are no visible cracks or surface deterioration. A simple "chain dragging" survey can help evaluate suspicious areas. Drag a length of chain over the concrete wherever a problem is suspected. A hollow sound indicates that the concrete is delaminating and a significant problem may be developing. A hammer or metal rod may also be used; simply tap on the concrete and listen. If the chain dragging survey reveals a problem, or if there are noticeable cracks on the faces of columns or on beams, particularly near bearing areas, an engineer with experience in structural forensics should be consulted for follow-up.

Five-Year Inspection

Every five years or so—or whenever structural problems are suspected—consult a structural engineer with experience in concrete restoration/repair and waterproofing technology to conduct a comprehensive inspection. These experts know what to look for and can provide the information needed to make sound recommendations as to what corrective measures should be considered. It may also be appropriate to do some physical testing of the structure as part of this inspection to establish baseline performance or to better evaluate potential problems. A specialty contractor with experience in concrete restoration/repair and waterproofing technology can also conduct this type of survey, and will usually do so at no cost to the garage owner. The contractor can also do the required repairs and develop a maintenance budget for the structure.

Preventive Maintenance

Preventive maintenance will reduce repair expenses in the long run and extend the service life of the structure.

Snow Removal

Chlorides, which are in road salt and are carried into the garage via vehicles, can be a garage owner's worst enemy because of the damage they can do to concrete. It's important to use the least disruptive methods and the least corrosive materials necessary to remove snow and ice. Following are some deicing measures:

- Clean, plow, and scrape off ice and snow without use of any deicing agents. Take care not to damage joint sealants, deck coatings, or the concrete deck elements themselves.
- Use sand to increase traction; when washing down the deck, be sure to protect the drainage system with temporary burlap or straw filters.
- Deice with urea or CMA (a proprietary nonchloride deicer).
- Use a mixture of sand and calcium or sodium chloride, but protect the drainage system from sand.

Cleaning

A good maintenance program will include regular wash-downs with water to remove debris. This is especially important in the spring to remove dust, debris, and especially road salt, which contains harmful chlorides.

Repairs and Restoration

When potential problems are identified, a specialty contractor should be retained to perform corrective measures. Typical work includes repair of deteriorated concrete, sealing of cracks and joints, repair of expansion joints, and application of sealers and traffic deck membranes. Sealants have a finite life, so even the latest and best will need to be replaced periodically.

Minimizing Future Maintenance Requirements

The best maintenance programs begin with emphasis on enhancing the durability characteristics of the project when it is built. A recent design/

build project completed by Carl Walker Construction illustrates how these goals can be met.

The Station Square Parking Garage in Pittsburgh is a steel-framed, cast-in-place, post-tensioned concrete structure with a precast facade. Carl Walker's expansion of the garage involved adding two floors on top of the existing four, providing 109,000 more square feet and 400 new parking spaces. Expanding an existing structure is more complicated than building a new one. It involves, among other things, an evaluation of the existing building, matching of new and existing dimensions and conditions, and careful planning to ensure that the entire building will be code compliant and sound. However, such an addition can also provide the opportunity to make the structure stronger and decrease future maintenance needs.

Minimizing Reinforcement Corrosion

Enhancing the durability of concrete begins with the concrete mix design itself. To minimize corrosion of the reinforcement in the Station Square garage, Carl Walker used a 5,000-psi concrete mix design that incorporated the following:

- An air entrainment admixture to reduce potential for freeze-thaw surface deterioration.
- A low water/cement (WC) ratio (.38) concrete to increase density and improve water absorption properties.
- Encapsulated post-tensioning reinforcement to minimize slab cracking.
- Epoxy-coating of conventional reinforcement as an anti-corrosion measure.
- A silane sealer to decrease moisture and chloride penetration.

Additionally, the use of a cast-in-place, post-tensioned concrete deck allowed the elimination of most joints, which, in turn, eliminated one of the most frequent maintenance requirements, that is, keeping joints sealed to prevent leakage. Design and construction emphasized measures to minimize the potential for future corrosion and leakage. While many other anti-corrosion measures were also available, the objective was attained with consideration for the cost effectiveness of the protection to be performed.

Minimizing Corrosion of Structural Steel Elements

To minimize corrosion of structural steel elements, a special anticorrosion paint system was utilized. This included:

- Shot-blasting of steel elements down to the bare metal.
- Shop application of a zinc-rich epoxy primer.
- Use of special epoxy paint in the field to give structural steel a finish coat.
- Application of a clear coat of urethane on parts exposed to sun.

The above method should help the structural steel members last 15 to 20 years until the next application is needed, according to the American Institute of Steel Construction.

The bottom line is that it is the parking garage manager's or owner's responsibility to keep an eye out for problems, document these problems, and call in engineers and contractors when necessary to perform maintenance and repairs. Implementing a maintenance program and following through with inspections and repairs can increase service life, decrease costs, and prevent small problems from becoming big repair bills.

The following publications offer additional information regarding the maintenance of parking structures:

- *Parking Garage Maintenance Manual,* published by NPA's Parking Consultants Council (see order form on page 42) or call 800-647-PARK (800/647-7275).
- *Guide for Structural Maintenance of Parking Structures,* published by the Parking Structures Committee of the American Concrete Institute; 248/848-3700. P

David Monroe is president of Carl Walker Construction, specialists in the construction of new parking structures and the repair and restoration of existing structures. He previously served as chairman of the ACI Parking Structure Committee and was principal author of the ACI maintenance guide referred to above. He has over 30 years of contracting and manufacturing experience working with concrete structures.