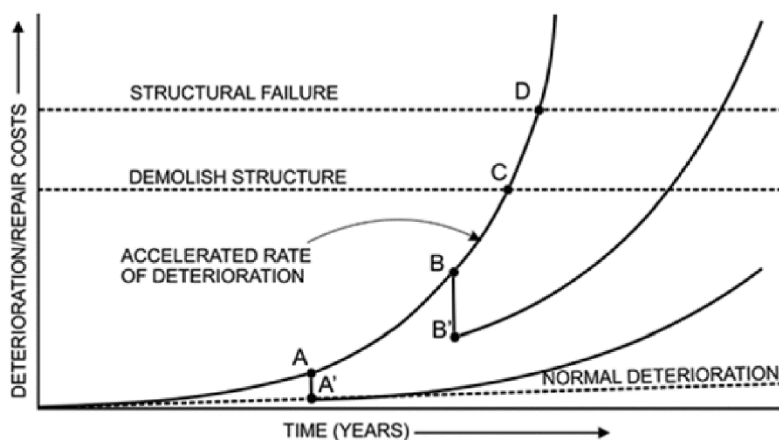


PARKING STRUCTURE FACILITY SPECIFIC MAINTENANCE

OVERVIEW: Parking structures are typically multi-story concrete structures, generally classified as either above grade freestanding open air construction or below grade integrated structures under commercial or residential buildings.

SERVICE LIFE & LIFE-CYCLE COSTS: Parking structures are a unique building type prone to increased deterioration and distress, unlike conventional enclosed and climate-controlled buildings which deteriorate slowly over time, shown as “Normal Deterioration” curve in table below. All parking structures in northern climates have direct exposure to chloride laden water infiltration transported by vehicles. Additionally above grade open air parking structures have increased exposure due to the weather, extreme thermal cycles, and snow plowing operations. A parking structure’s initial service life period mirrors normal deterioration rates of a conventional building, but quickly develop an accelerated exponential deterioration curve as they age, due to chloride deicing chemical attack on the structural concrete embedded reinforcing steel. The corrosion process causes dramatic volumetric changes of embedded reinforcement steel causing internal stresses within concrete causing further exposure through developed cracks, allowing further chloride infiltration.



- Notes:
1. Points A - D represent stages of accelerated corrosion in parking structures.
 2. Structures repaired at point A cost less overall and last longer than structures repaired at point B

Parking structures represent a major investment by Owners with current costs approaching \$24,000 per stall. Expected service life of freestanding parking structures are 30-40 years with parking structures integrated below buildings expected to exceed this timeframe. If preventative maintenance and repair items are not addressed, deterioration accelerates, greatly increasing repair costs as shown as “B” in table above.

FACILITY SPECIFIC MAINTENANCE: All parking structures require regular maintenance to provide an acceptable level of service. The development, implementation and documentation of a comprehensive Facility Specific Maintenance Plan and associated budgets, in conjunction with regular scheduled condition assessment, is crucial and directly impacts the expected service life of structure, reducing the expense of structural repairs. FACILITY Specific Maintenance Plan can be broken into the following sub-components:

- **Housekeeping:** Daily / Weekly / Monthly - interval executed tasks but very important to protect soft joints, waterproof membranes and cleaning to enhance the customer's overall experience.
- **Operational Preventative Maintenance:** Larger scope tasks that include specialized building system testing and repairs. Example of tasks include: Monitoring of ventilation, electrical, gas, elevator, revenue control systems, etc. These duties are performed by a combination of the parking structure operators, owners, and outside consultants or contractors as required.
- **Structural Preventative Maintenance:** Performed to reduce the life cycle repair expenses and extend service life of the structure. This assures the structure's protective systems are performing and maintained properly to reduce the infiltration of chloride laden water from deteriorating the structure. The following tasks are typically identified in the yearly condition assessment walkthrough performed by structural restoration engineer ideally during spring washdown operations.
- **Repair Project:** Developed for the specific system or item(s), due to:
 - Expected or premature failure, or end of service life is reached for a building system
 - High cost of maintenance is no longer a cost-effective alternative to replacement.
 - Age and inefficiency of existing system is substandard to newer technologies.

Repair Projects are initiated as the result of issues brought forth in the structural restoration engineer's annual condition assessment report or inspections performed during the annual operational and structural preventative maintenance cycles. Development, design and construction administration of a repair / replacement project typically is under the direction of an Engineer (Structural, Mechanical, Plumbing or Traffic). Costs of repair / replacement project are typically beyond that of Structural Preventive Maintenance and need to be accommodated within the facilities capital budget.

Pierce Engineers (PE) Restoration Department has experience and knowledge to assist parking structure Owner's / Facility Manager's in all aspects including the development of a Facility Specific Maintenance Plan, document & warranty management, condition assessments, development of repair and restoration projects.

Please contact **Ronald Bernhagen, Pierce Engineers - Restoration Department Manager @ 608.729.1407** for further information of how PE can be of assistance with your parking structure maintenance or other restoration services.

Restoration Services

PE staffs a complete restoration services department for all structural, non-structural, and historic building elements along with waterproofing, sealant & high-performance coating protection of structures for private and public clients. PE serves industrial, manufacturing, commercial, and medical markets as well as specializing in all types of parking structures. Our services provide owners with performance-based, cost-effective repair and protection solutions developed for their specific structure's issues and use criteria.

PE prides itself on staying current with the latest restoration techniques, material technologies and industry codes. We participate in continuing education with construction industry associations, product manufacturers, specialty consultants, testing laboratories and specialty contractors. PE is a long term active member of the International Concrete Restoration Institute (ICRI), the leader in developing concrete restoration industry standards.

Concrete Solutions

- Delamination due to corrosion of embedded reinforcing steel
- Cracking due to corrosion, shrinkage, settlement, thermal, internal or external stresses
- Moisture & chloride infiltration causing corrosion, freeze thaw damage or white crystalline efflorescence deposits
- Surface damage due to wear, scaling or carbonation
- Control, construction & expansion joint failures
- Crack epoxy pressure injection
- Strengthening & stabilizing w/ carbon fiber-reinforced polymers (CFRP)
- Corrosion management

Masonry Solutions

- Historic multi-wythe & terra cotta
- Modern cavity & rainscreen systems
- Flashing failures & Moisture infiltration issues causing white crystalline efflorescence deposits, freeze thaw damage, etc.
- Corrosion damage from embedded steel anchors, or structural members
- Cracking due to corrosion, shrinkage, settlement, thermal, internal or external stresses
- Masonry displacement due to moisture absorption growth, ice and rust jacking
- Veneer re-anchoring & Crack stitch stabilization
- Control joint sealant or expansion joint failures
- Masonry cleaning & water-repellant applications

Waterproofing & Protection Solutions

- Joint sealants
- Expansion joint systems
- Below grade waterproofing, drainage, expansion joint systems
- Vehicular and pedestrian elastomeric or hybrid elastomeric/epoxy membrane systems
- Plaza waterproofing systems
- Cementitious crystalline waterproofing systems
- Chemical grouting: individual cracks, curtain systems, slab stabilization
- Water-repellant & corrosion inhibitor applications
- Primary and secondary containment tank linings
- High performance coating systems

Investigation & Design

- Structural Condition Assessment Studies
- Destructive & Non-destructive testing
- Restoration budget estimates, single or multi-year phasing, Master Planning
- Restoration cost – benefit analysis
- Service life-cycle studies
- Restoration project construction document design including plans, details & specifications
- Prime Design Services: Turnkey project design & administration for Owners
- Construction administration services

Facility Maintenance & Document Management

- Develop facility maintenance plans
- Record Document management
- Facility & project warranty management & inspection

