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Conference & Expo



**Oct. 16-18, 2019**  
**Phoenix, Arizona**

Phoenix Convention Center

# The Truth About Parking Structure Maintenance

## How to Protect Your Investment





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# **The Truth About Parking Structure Maintenance: How to Protect Your Investment**

*Presented By:  
Innovative Engineering Inc.*

**SCOTT L. WEILAND PE**

**Friday October 18, 2019**

**IFMA's World Workplace 2019**





# Learning Objectives

- **Parking Structures**
  - Structure Types
  - Advantages/Disadvantages
  - Lifecycle Costs
- **Conditions Facing Parking Structures**
- **Common Deficiencies**
- **Importance of Routine Maintenance & Timely Restoration**
- **Maintenance Program**



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# Innovative Engineering, Inc.



- **Scott L. Weiland PE**
  - **BSCE University of Michigan**
  - **Graduate Studies:**
    - San Jose State University
    - Georgia Institute of Technology
  - **PE in 20 States + PR & Guam**
  - **39 Years in Design and Construction**
    - BOMA Georgia Insight magazine
      - Parking Structure Maintenance Part 1 & 2
      - Falling Building Façade Closes Atlanta Streets
    - National Parking Association Parking Magazine
      - Parking Structure Maintenance
    - Parking Today







# Innovative Engineering, Inc.



- **Trey Thomas PE**

- **BSCET, Southern Polytechnic State University**
- **16 Years in Design and Restoration Engineering**
  - Co-author of Parking Structure & Forensic articles
- **OSHA Qualified Person for Fall Protection Anchors**
- **OSHA Competent Person for Boom & Scissor Lifts**
- **SPRAT Level 2 Rope Access Technician**
- **FAA Part 107 Remote Pilot Certificate**
- **FAA Part 107 Daylight Waiver**
- **Level I Certified Thermographer**
- **Expert estimator (within 5% of actual)**





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# Structural Systems

## Cast-in-Place Concrete



## Precast Concrete



## Structural Steel







# Cast-in-Place



- **Advantages**

- Flexible Geometry
- Monolithic, Fewer Joints
- Reduced Maintenance Costs
- Longer Life Expectancy
- Higher Durability

- **Disadvantages**

- Higher Initial Investment
- Longer Schedule
- More Labor Intensive
- Difficult Quality Control
- Weather Dependent



# Precast Concrete - Advantages



- **Advantages**

- Lower Initial Investment than CIP
- Fabricated in Controlled Plant Environment
- Not Weather Dependent
- Accelerated Construction Schedule





## Precast Concrete - Disadvantages



- **Disadvantages**

- May be no local plant
- Geometry not Flexible
- Lower Perceived Ceiling heights
- Shearwalls (Closed In)
- More Joints
- Prone to Thermal Expansion & Contraction Damage
- Higher Maintenance Costs



# Structural Steel



- **Advantages**

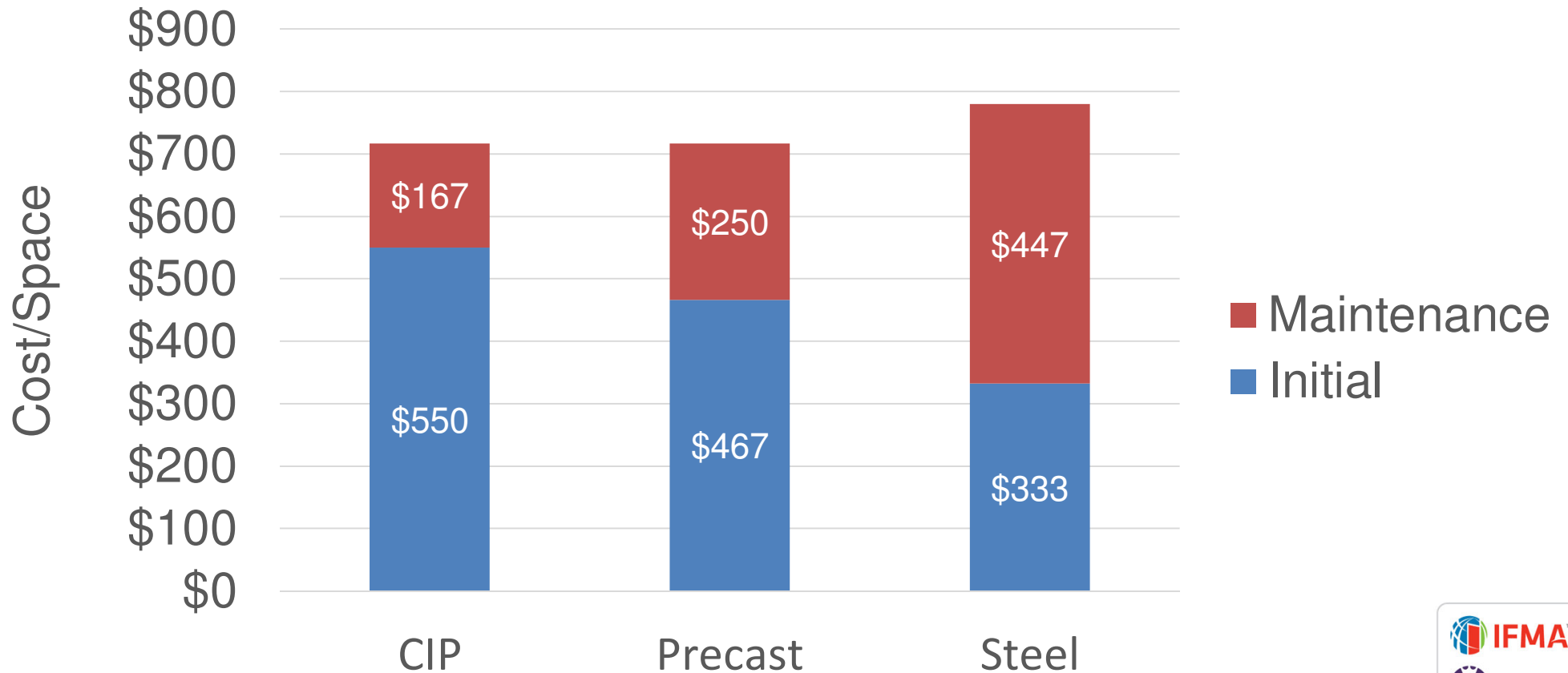
- Lower Initial Cost than Precast
- Accelerated Construction Schedule
- Fabricated in Controlled Environment
- No Shearwalls (Open)

- **Disadvantages**

- Corrosion Issues
- Higher Maintenance Costs
- Not Suitable for Fire Prot.



# Typical Annual Life Cycle Costs/Space







# Parking Structures

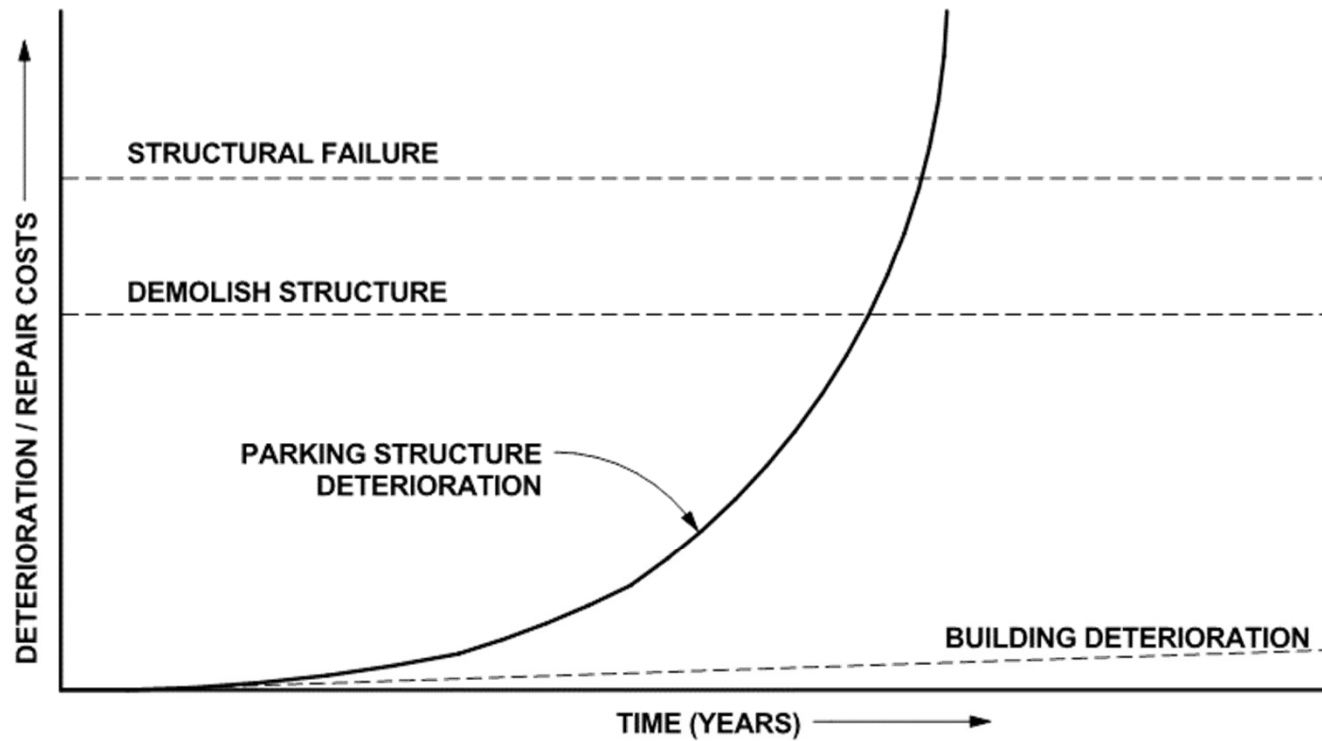


- **Not Bullet Proof**
- **No Protective Skin**
- **Deterioration Starts Immediately**
- **Subjected To:**
  - Moisture (Rain, Snow, Ice, Deicing Salts)
  - CO2 Carbonation
  - Extreme Thermal Expansion & Contraction
  - Dynamic Vehicle Loads





# Structure Degradation





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# Irving Texas, O'Conner Ridge Blvd. Collapse





# Irving Texas, O'Conner Ridge Blvd. Collapse



## • What we know

- Old Parking Structure
- Expansive Soils in TX
- Exterior Columns Leaning
- Cracks Sealed with Sealant
- No OSHA Report
- Demolished







# Common Deficiencies

- **Number 1 Enemy**

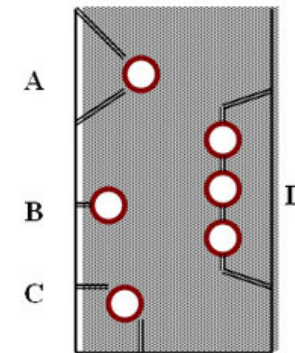
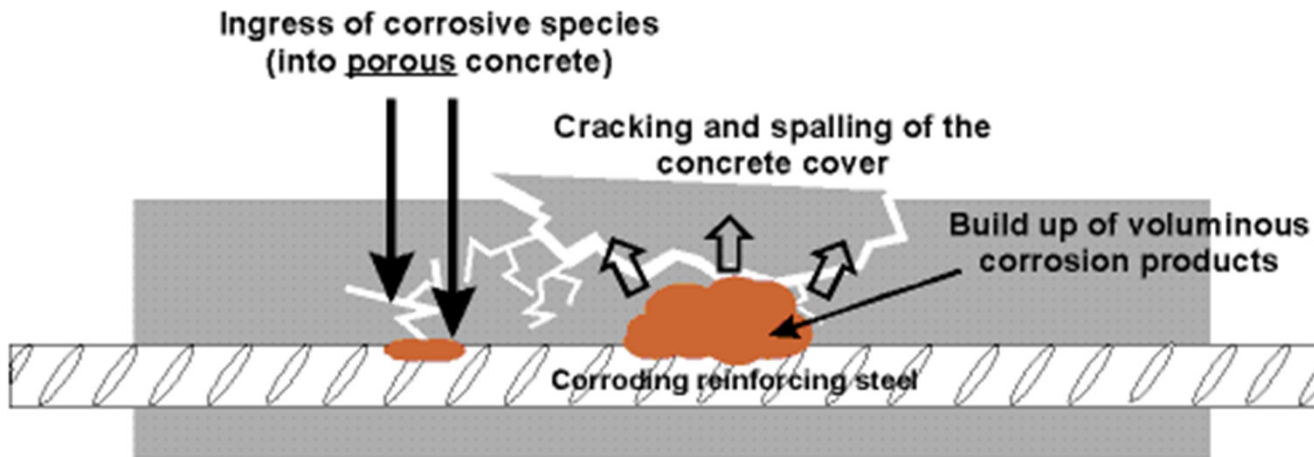


**WATER**





# Common Deficiency: Corrosion



- A: Spall
- B: Crack
- C: Corner Spall
- D: Delamination



# Common Deficiency: Spall & Delamination



Spall



Delamination



Section Loss





# Common Deficiency: Ponding



Ponding

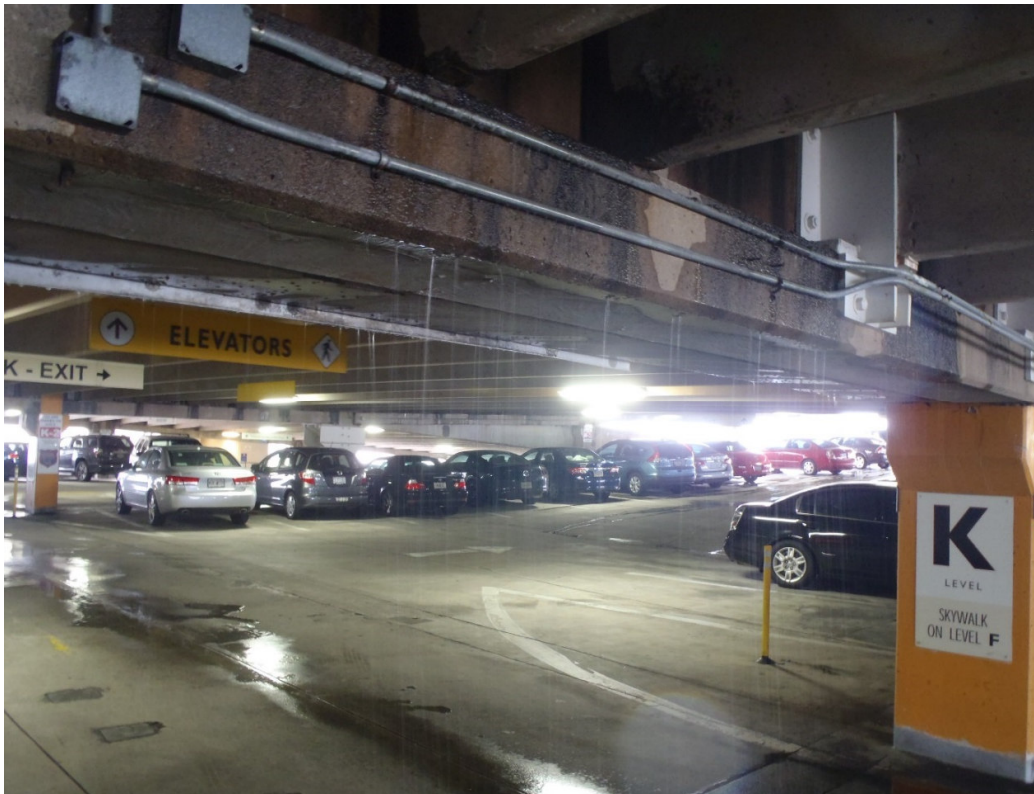


Supplemental Drain





# Common Deficiency: Failed Joints



- **Why is it Raining in my Parking Structure?**

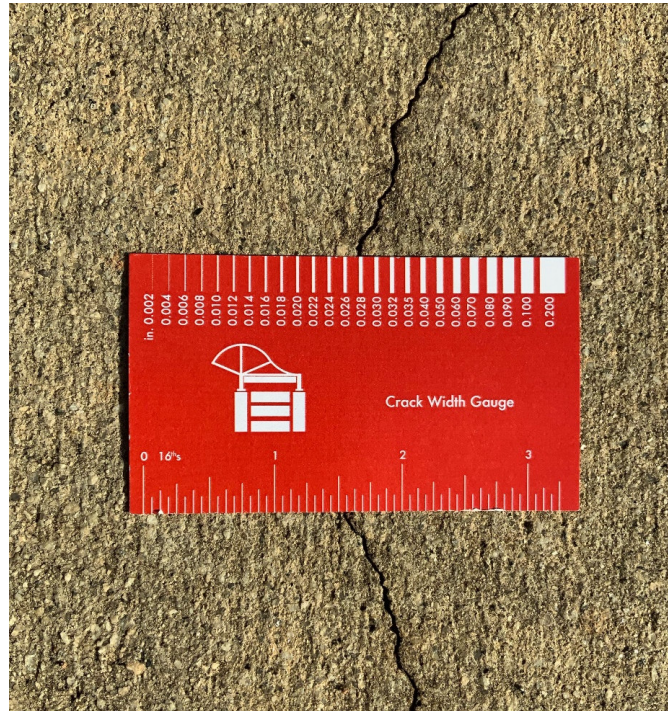




# Common Deficiency: This is Why



Sealant Failure



Cracks

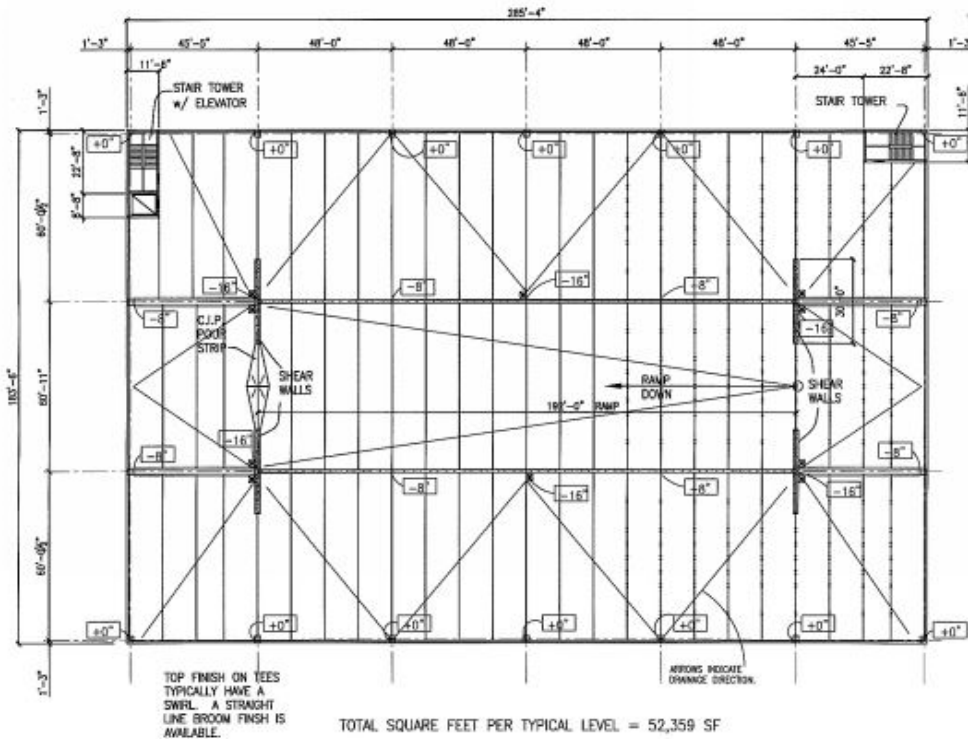


Expansion Joint Failure





# Common Deficiency: Failed Joint Sealant



- **Precast**
  - All orthogonal lines are sealant Joints
  - Diagonal lines are slope lines
- **Cast-In-Place Slab**
  - Expansion joint in middle
  - Joint sealant at perimeter and at stair towers

## Drainage & Joint Plan







# Common Deficiency: Failed Joints



Cohesive Failure/Aged & Weathered



Adhesive Failure





# Common Deficiency: Failed Joints



Substrate Failure



Heel Damage

Photo by Construction Specifier





# Common Deficiency: Failed Joints



**Uncured Sealant**

Photo by BASF



**Bubbles**

Photo by BASF







# Common Deficiency: Re-Seal Joint Cleaning



Grinding Joint

Photo by US Saw



Wire Brush

Photo by Little Wonder







## Common Deficiency: Re-Seal Joint Prep. & Seal



Priming Joint

Photo by SIKA



Backer Rod

Photo by SIKA

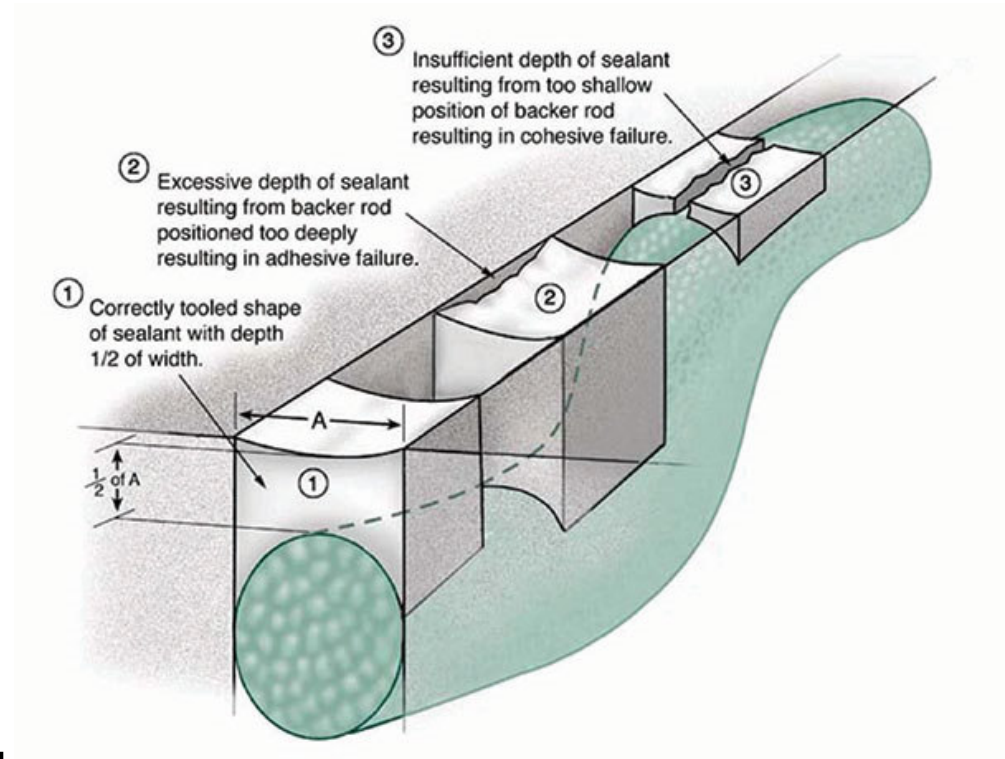




# Common Deficiency: Re-Seal Joint Sealant



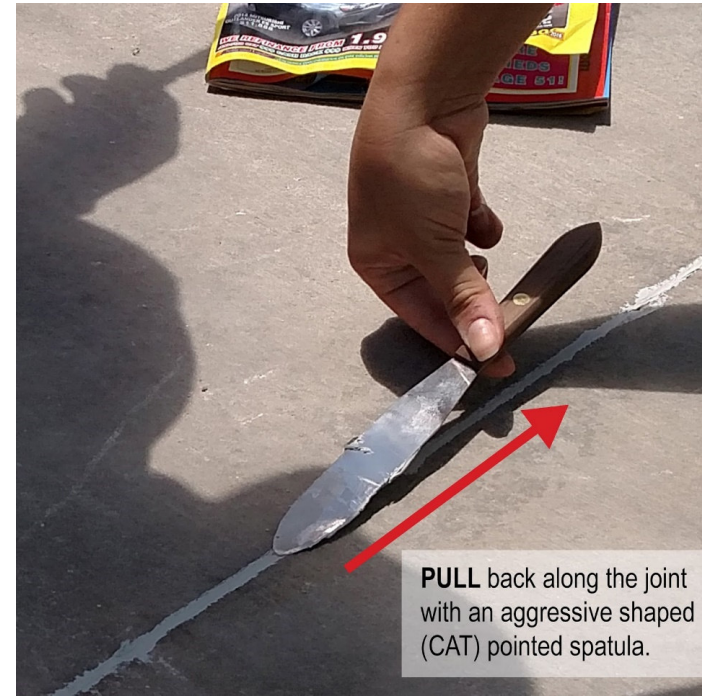
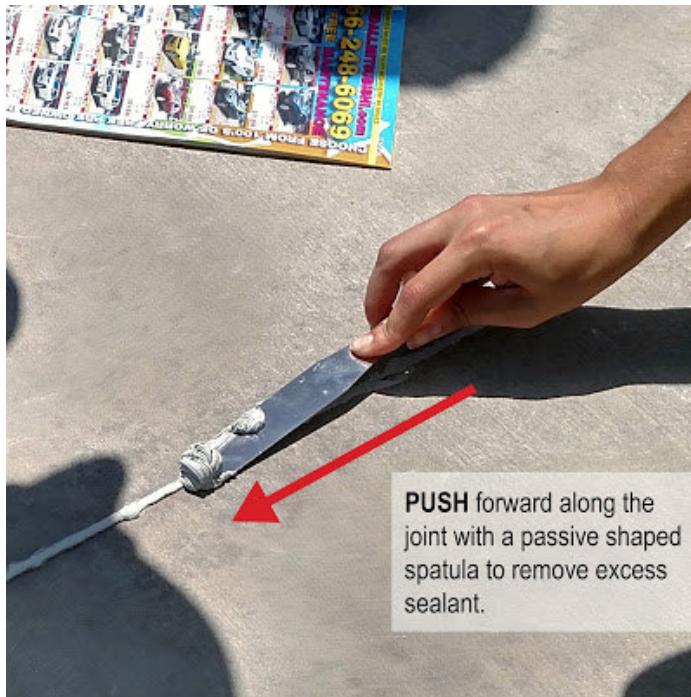
New Sealant







# Common Deficiency: Re-Seal Tooling



## Tooling

Photos by Albion Manufacturing







# Common Deficiency: Re-Seal Quality Control



Probing NDT



Pull Test

Photo by Construction Specifier







# Common Deficiency: Cracks to be Sealed



$.013'' \leq \text{Cracks} < .035''$



Cracks that Leak  $< .035''$







# Common Deficiency: Route & Seal



Crack Chasing



Crack Sealant





# Common Deficiency: Epoxy Injection



Cracks  $\geq$  .035"



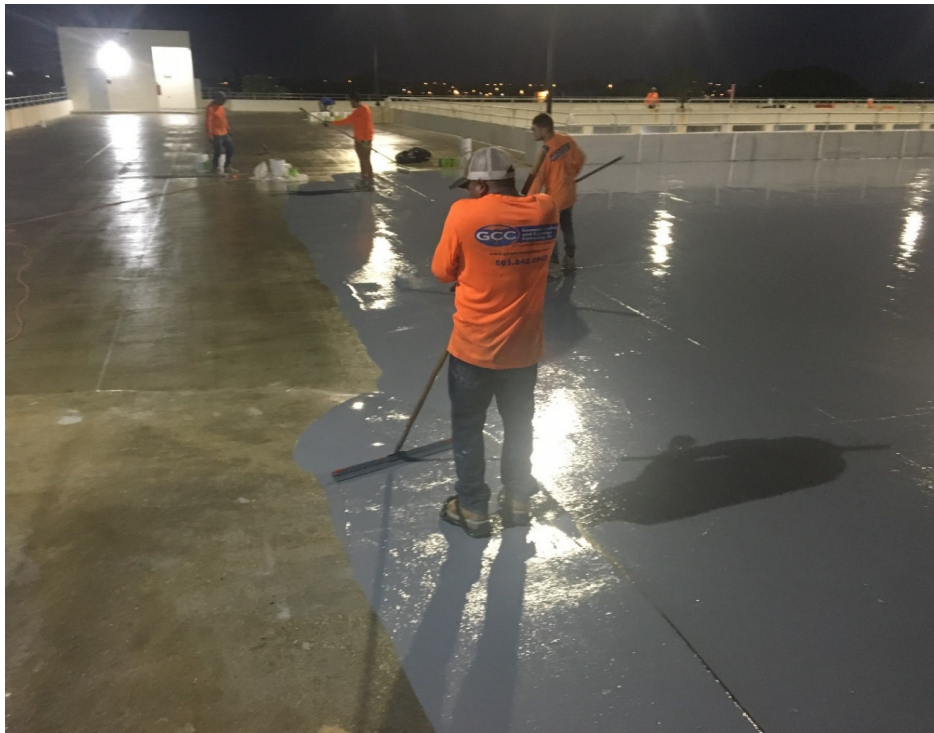
Inflatable Injection Port







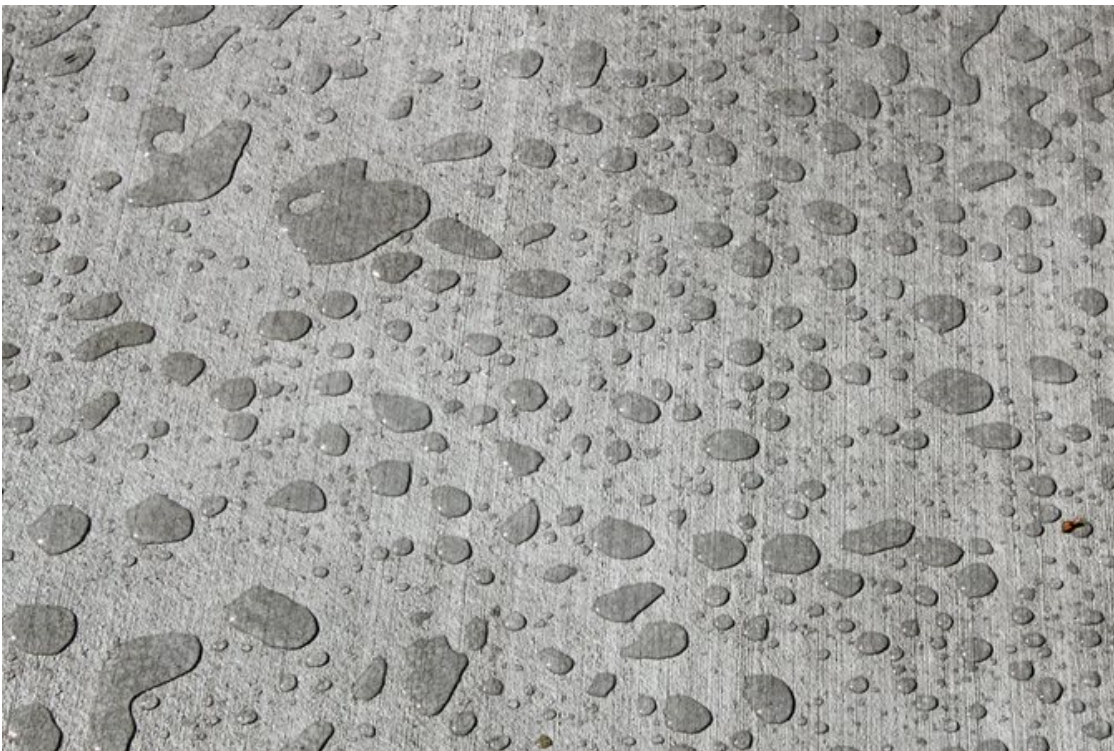
# Common Deficiency: Last Resort



Traffic Bearing Membrane



# Common Deficiency: Better Option



- **Silane Sealer**
  - Water Retardant
  - Breathable
  - Fills Pores of Dense Concrete
  - Minimizes penetration of water and chemicals
  - Reapply 5 to 10 years





# Common Deficiency: Failed Spall Repair



Improper Surface Preparation



# Precast Haunch Connection Failure



Precast Beam Haunch



4 Months Later







# Precast Haunch Connection Repair



Shoring to Remove Load



Applying Epoxy Bonding Agent



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# Precast Haunch Connection Finished Repair







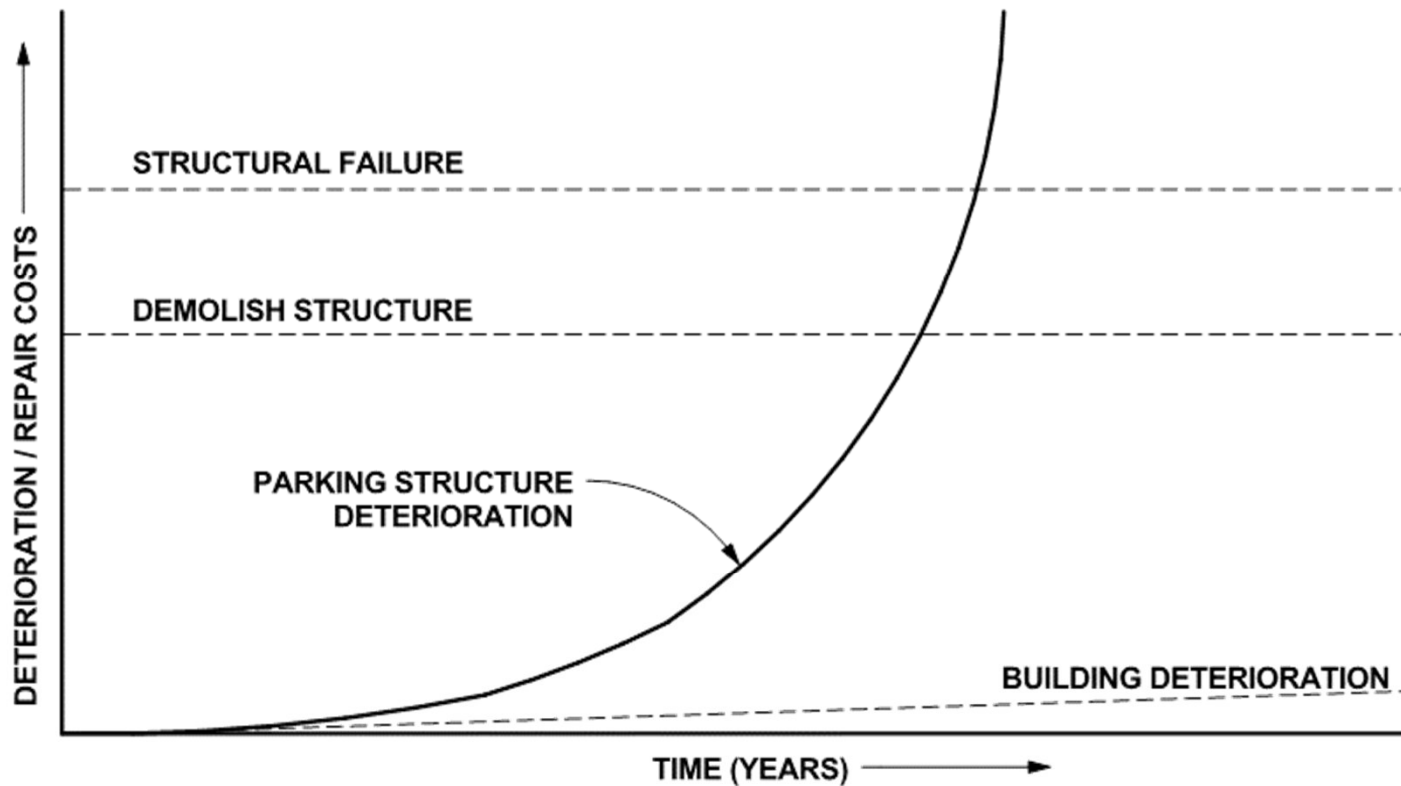
# Structural Steel Corrosion



- **Steel Protection & Corrosion Issues**
- **Steel Deck Traps Moisture, Hides Degradation.**



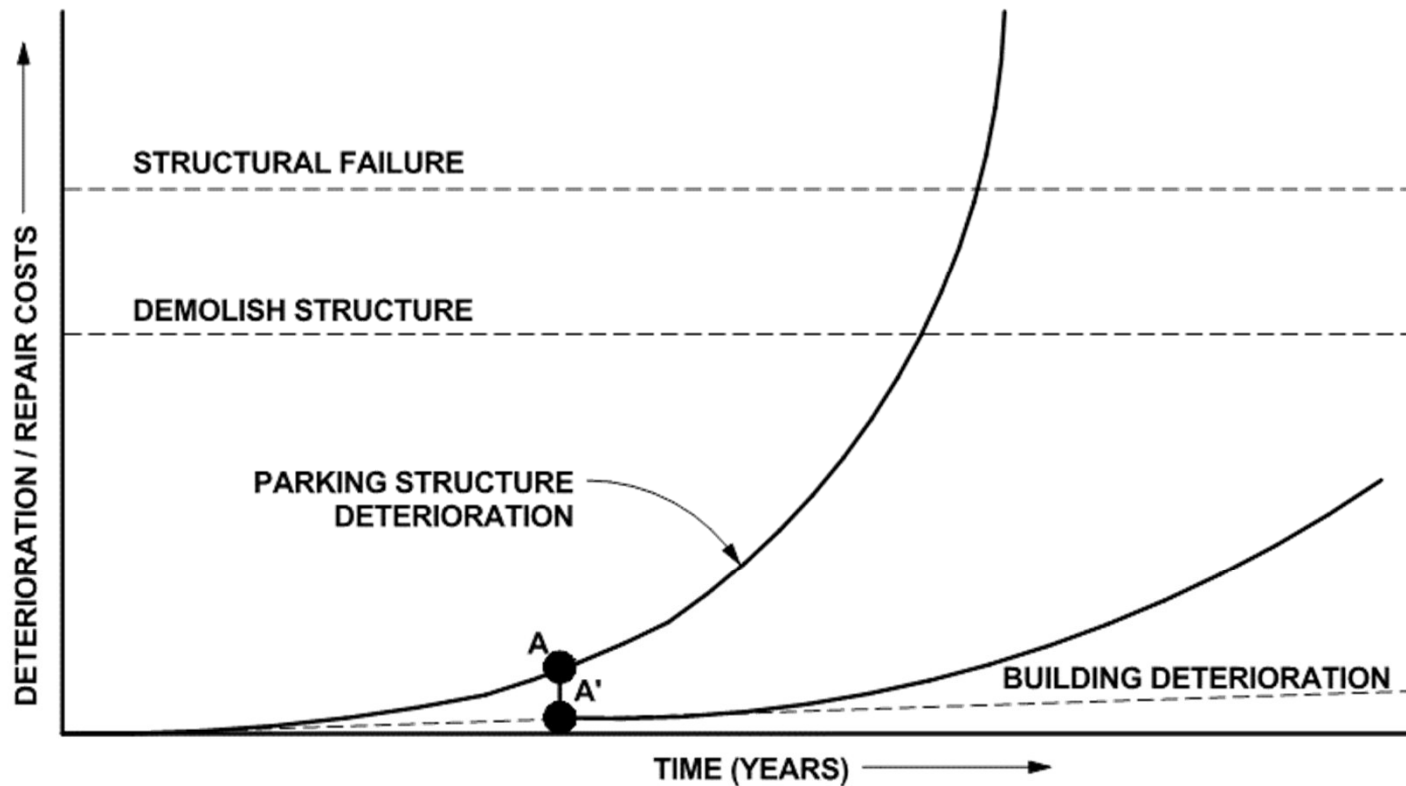
# Maintenance Cost Curve





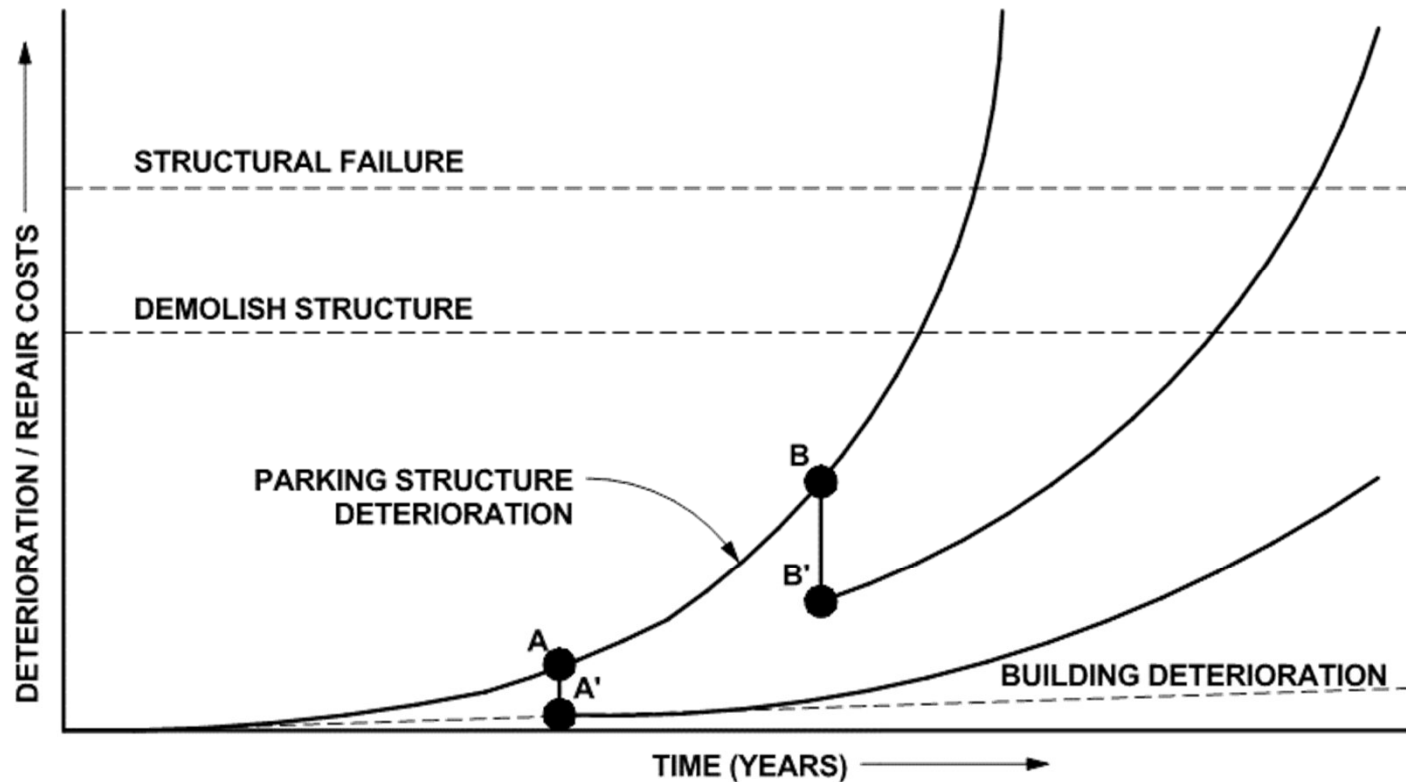


# Maintenance Cost Curve





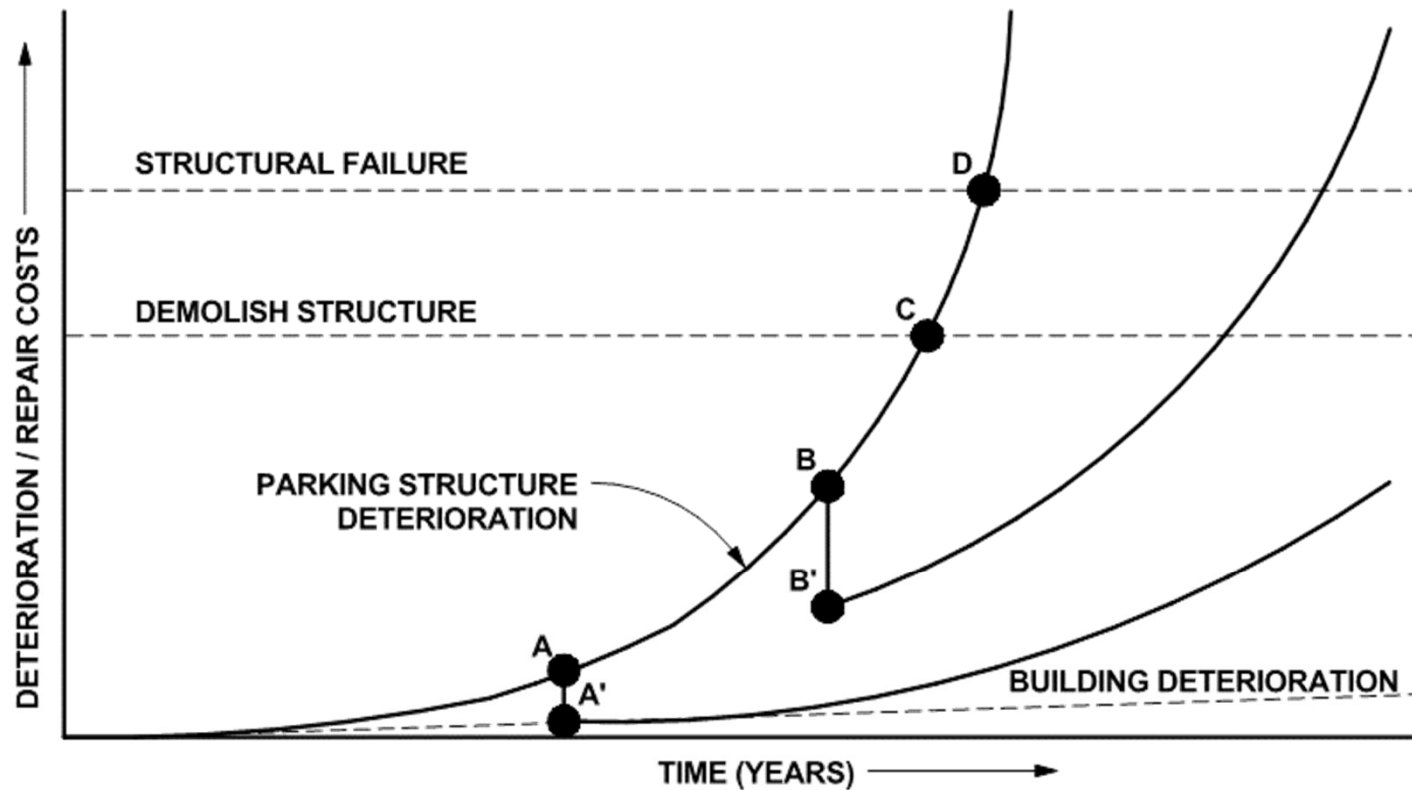
# Maintenance Cost Curve







# Maintenance Cost Curve





# Reactive Maintenance



Now Demolished





# Maintenance Program: Planning



## Parking Facility Maintenance Manual Fifth Edition

Extending the Life of Your Facility Through Site-Specific  
Maintenance and Repairs



A Publication of the National Parking Association's Parking Consultants Council

Source: National Parking Association

- **Pre-Construction Design**
- **Condition Assessment**
- **Maintenance Checklist & Schedule**
- **Inspection Checklists**
- **Budget**





# Maintenance Program

<b>Structural and Waterproofing Systems</b>	<b>Operational Maintenance</b>	<b>Aesthetics</b>
1. Floors	1. Cleaning	1. Landscaping
2. Beams, columns, and bumper walls	2. Snow and ice control	2. Painting
3. Stair and elevator towers	3. Mechanical systems	3. General appearance
4. Joint sealant systems	4. Electrical systems	
5. Architectural sealants	5. Parking control	
6. Exposed steel	6. Security systems	
7. Masonry	7. Signage and stripping	
8. Bearing	8. Inspection	
	9. Safety checks	







# Maintenance Program: Planning

**FORM F-1**  
MAINTENANCE MANUAL AND PROGRAM  
DAILY OPERATIONAL CHECKLIST  
PARKING STRUCTURE NAME: \_\_\_\_\_  
Owner: \_\_\_\_\_  
City, State: \_\_\_\_\_

**CLEANING**

- Pick up trash
- Sweep elevator
- Sweep stair tower
- Sweep office area
- Wash away parking
- Remove graffiti

**SNOW PLOW REMOVAL**

- Remove snow
- Apply sand and salt

**DRAINAGE**

- Clean off floor drains
- Squeegee ponds

**INSPECTION**

- Check for trip hazards

NOTES AND CORRECTIVE ACTION NEEDED: \_\_\_\_\_

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**FORM F-2**  
MAINTENANCE MANUAL AND PROGRAM  
DAILY OPERATIONAL CHECKLIST  
PARKING STRUCTURE NAME: \_\_\_\_\_  
Owner: \_\_\_\_\_  
City, State: \_\_\_\_\_

**MECHANICAL EQUIPMENT**

**ELEVATORS**

- Normal operation of elevators
- Clean door tracks
- Maintenance performed per manufacturer's instructions

**HVAC SYSTEM**

- Normal operation of entire system
- Change air filters
- Normal operation of fans

**FIRE PROTECTION EQUIPMENT**

- Check standpipes for operation
- Check charge on portable fire extinguishers
- Normal operation of smoke detectors

NOTES AND CORRECTIVE ACTION NEEDED: \_\_\_\_\_

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**FORM F-5**  
ANNUAL STRUCTURAL CHECKLIST  
PARKING STRUCTURE NAME: \_\_\_\_\_ Date: \_\_\_\_\_  
MAINTENANCE MANUAL AND PROGRAM  
Owner: \_\_\_\_\_  
City, State: \_\_\_\_\_

**FLOORS**

- \_\_\_\_\_ When was the last floor sealer application? (typically applied every 3-5 years)
- \_\_\_\_\_ Are there rips, tears, debonded areas or signs of embrittlement in the traffic topping?
- \_\_\_\_\_ Are there cracks in the floor slab? If yes, where are they located and how wide are they?
- \_\_\_\_\_ Are there signs of leaking?
- \_\_\_\_\_ Any spalls or delaminations? If yes, how big and where are they located?
- \_\_\_\_\_ Has chloride ion content testing been performed this year?

**BEAMS AND COLUMNS**

- \_\_\_\_\_ Are there cracks? If yes, are they vertical or horizontal and how wide?
- \_\_\_\_\_ Are there any signs of leaking?

**STAIR/ELEVATOR TOWERS**

- \_\_\_\_\_ Are there any signs of a leaking roof?
- \_\_\_\_\_ Are there any cracks in the exterior brick?
- \_\_\_\_\_ Are there any cracks in the mortar joints?

NOTES AND CORRECTIVE ACTION NEEDED: \_\_\_\_\_

- **Priorities:**
  - Structural
  - Operational
  - Aesthetic





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## Questions?

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# CEUs & CFM® Maintenance Activities

You are eligible to receive Continuing Education Units and Certified Facility Manager® maintenance activity credit for attending sessions at IFMA's World Workplace.

To receive CEU points, you must add the US\$25 processing fee to your registration. (Full Event PLUS! registration includes the CEU processing fee.)

All CEU participants are **required to scan your badge upon entrance of the session**. If you do not scan in, you will not receive CEUs for the session. You must attend the entire session and pass the assessment. Following the conference, IFMA staff will verify attendance and passing scores then email an electronic CEU certificate for each session.

## Managing CEUs:

- Log into the **Attendee Service Center**: <http://worldworkplace.ifma.org/features/attendee-service-center>
- Your log-in information was sent to you when you registered for the conference.
- Click "Start CEU Process" on the left-hand side.
- Click "Start" next to the session you attended.
- Complete the session evaluation.
- Click "Start Test" next to the session.

\*\*If you wish to receive CEUs or LUs for other organizations, you must contact those organizations for instructions on reporting credit hours.

## To Receive 1 CFM Maintenance Activity (6 required for recertification)

- Record your attendance for the three-day conference on your CFM Recertification Form in CAMP. Credentials Staff can verify your attendance.
- At re-certification time, submit your completed CFM Recertification Form.







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# Your Feedback is Valued!

Please take the time to **Evaluate Sessions**

**Log into the Attendee Service Center**

<http://worldworkplace.ifma.org/features/attendee-service-center>

