

The Truth About Parking Structure Maintenance How to Protect Your Investment



Presented By:
Innovative Engineering Inc.

SCOTT L. WEILAND PE

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**Carolinas Parking & Mobility Association
2019 Annual Conference & Tradeshow**

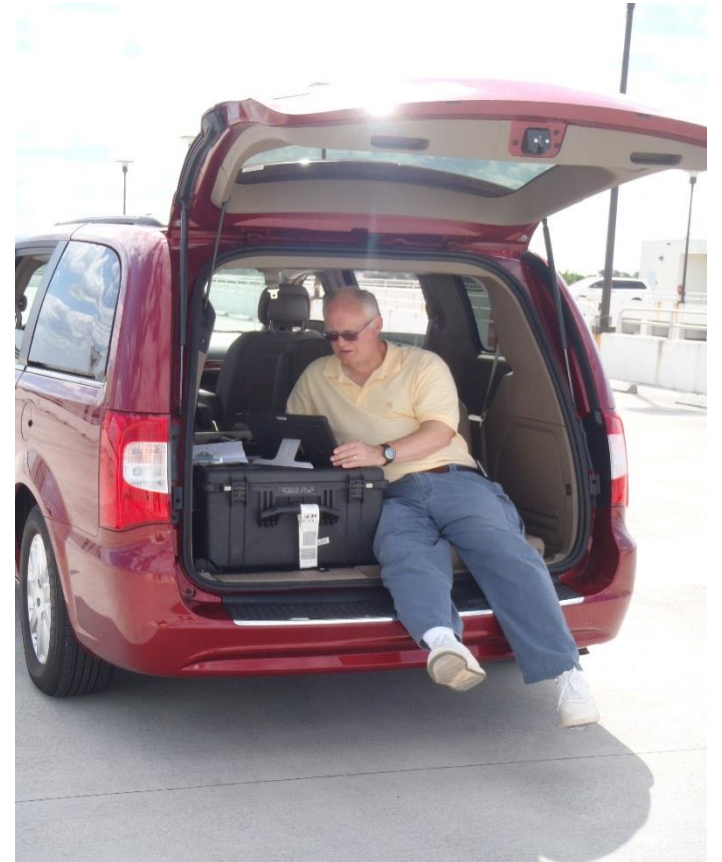
Learning Objectives

- **Parking Structures**
 - Structure Types
 - Cost Comparison
 - Lifecycle Costs
- **Conditions Facing Parking Structures**
- **Common Deficiencies**
- **Importance of Routine Maintenance & Timely Restoration**

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



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
 - **Certified in Mold, Lead & Asbestos Surveying**
 - **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)**



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**

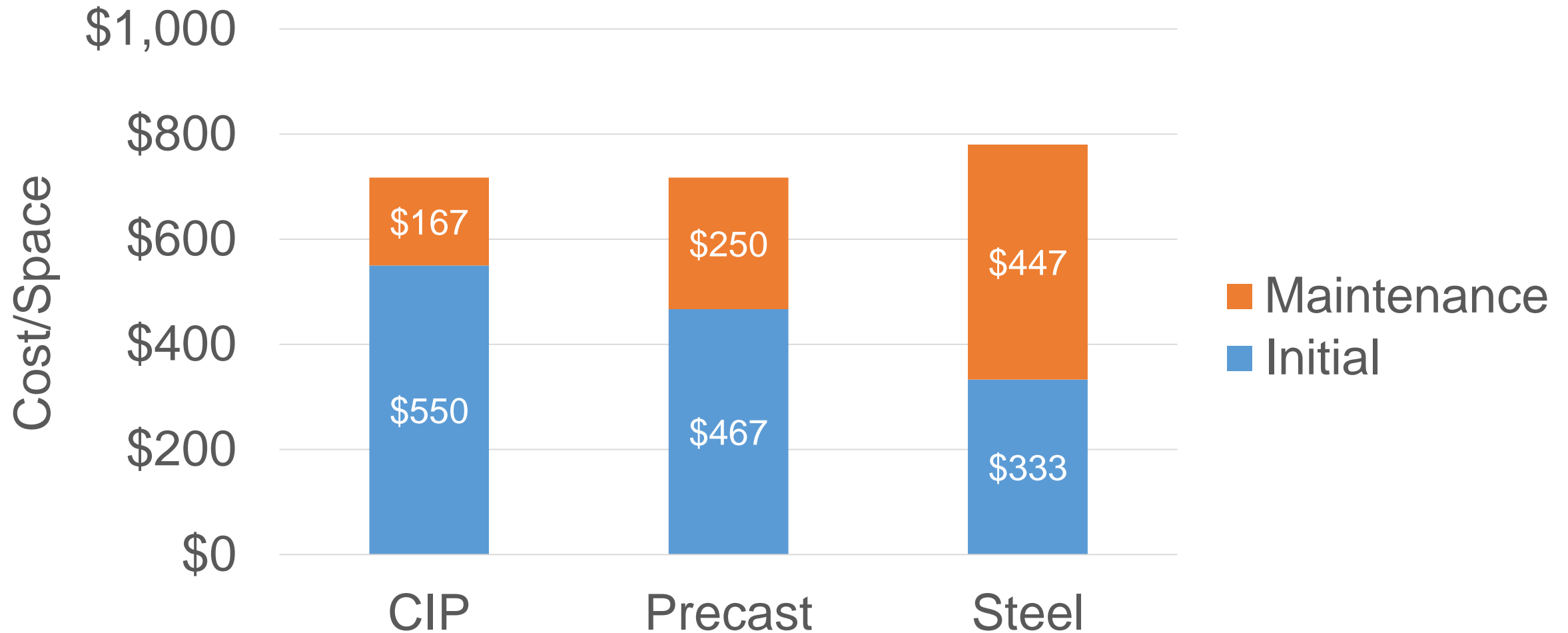
- May be no local plant
- Geometry not Flexible
- Lower Perceived Ceiling heights
- Shearwalls (Closed In)
- More Joints
- Prone to Thermal Expansion & Contraction Damage
- Corrosion of Steel Embedments
- Higher Maintenance Costs

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 Protection

Typical Annual Life Cycle Costs/Space



Parking Structures



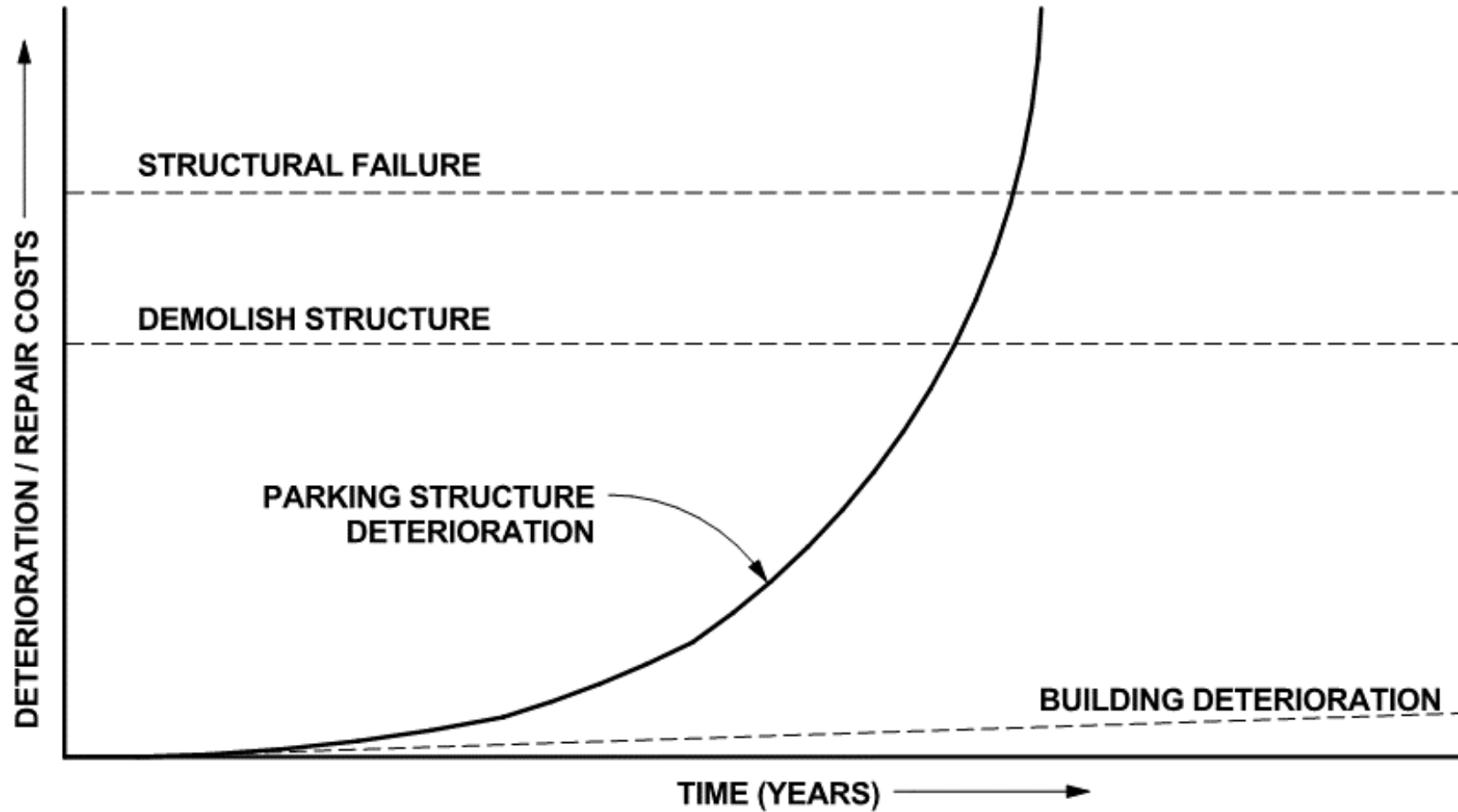
- **Not Bullet Proof**
- **No Protective Skin**
- **Deterioration Starts Immediately**
- **Subjected To:**
 - Moisture (Rain, Snow, Ice, Deicing Salts)
 - CO2 Carbonation
 - Extreme Thermal Expansion & Contraction
 - Dynamic Vehicle Loads

Parking Structures – Roman Structures



- Roman Colosseum
- Over 2000 Years Old
- Mild Climate
- No Reinforcing Steel
- Concrete Compression
- Slow Strength Development

Structure Degradation



Irving Texas, O'Conner Ridge Blvd. Collapse



Parking Structure Maintenance

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

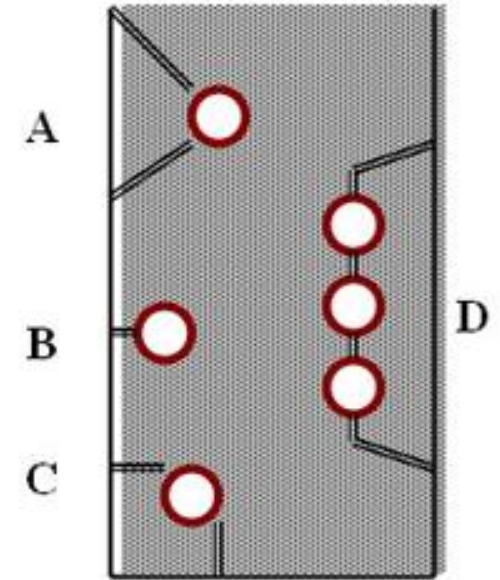
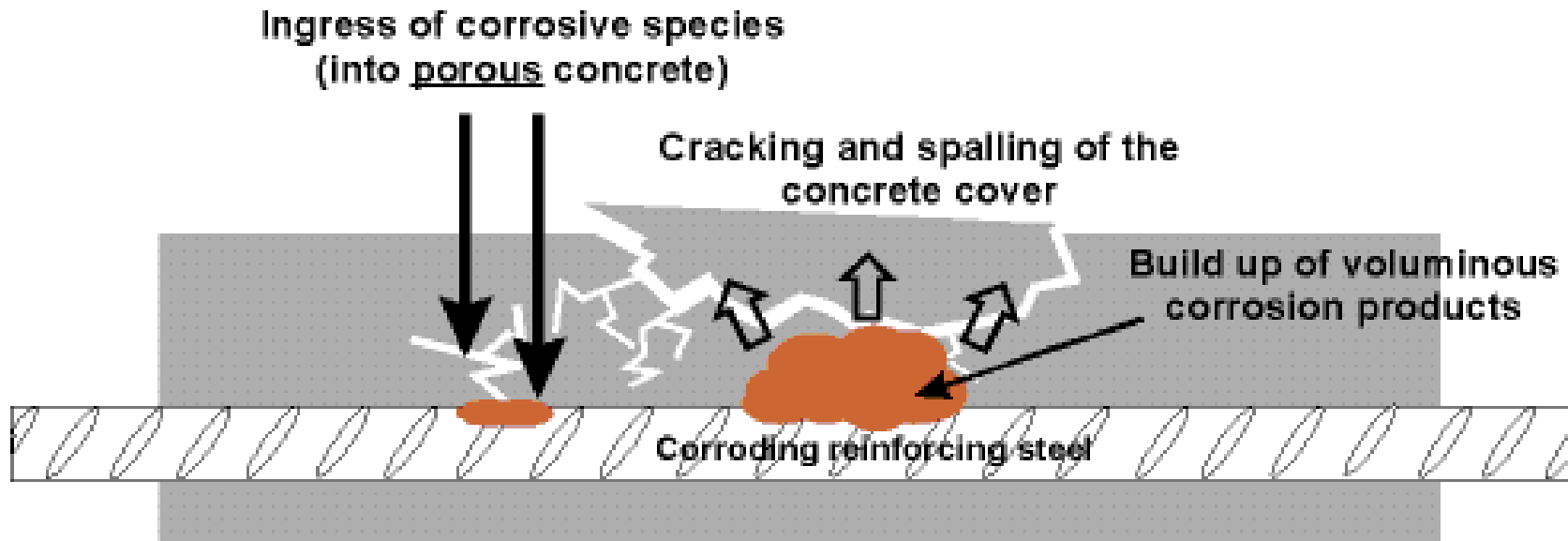
Common Deficiencies

- **Number 1 Enemy**



WATER

Common Deficiency: Corrosion



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

Common Deficiency: Spall & Delamination



Rust Expansion & Spalling



Topping Delamination

Common Deficiency: Ponding

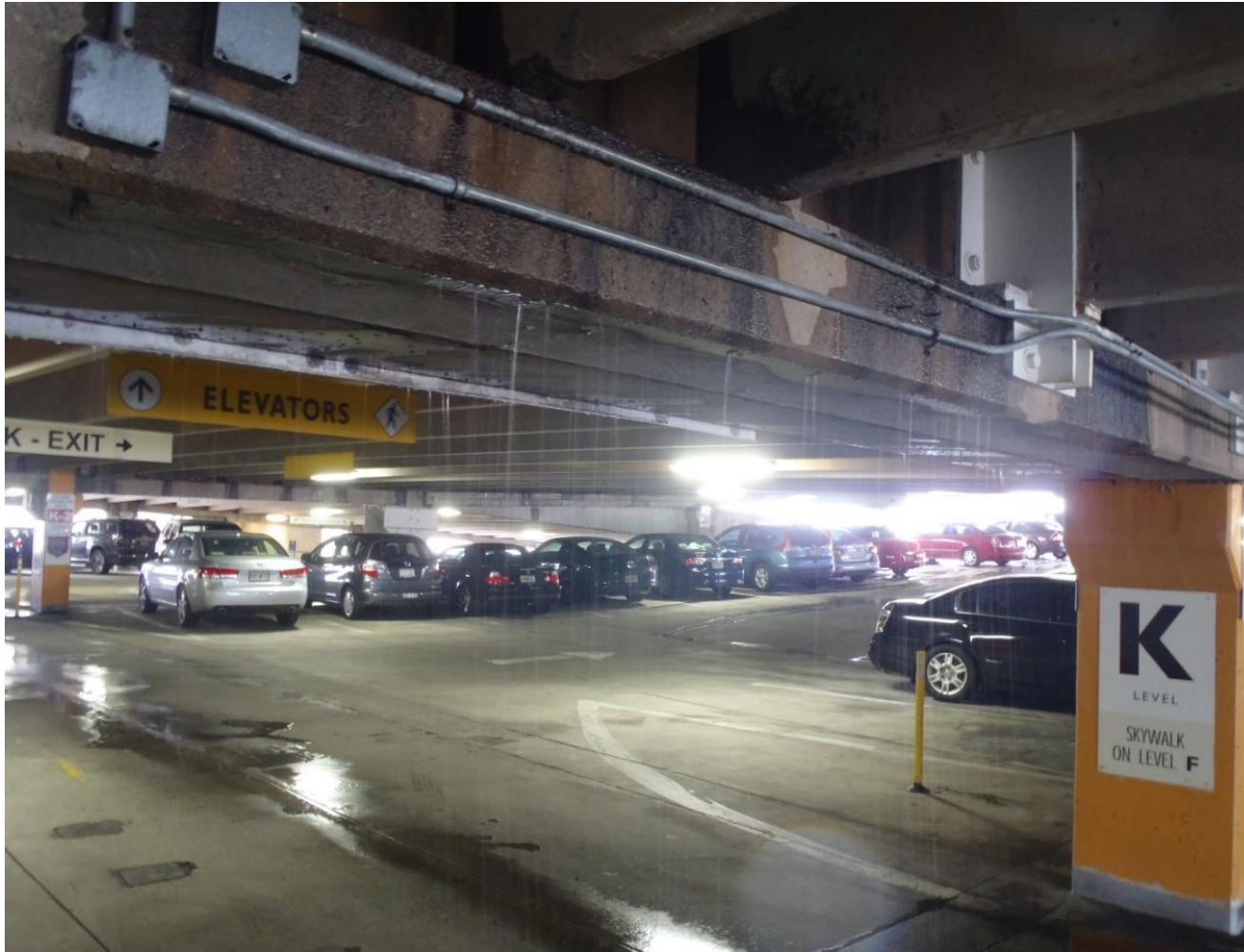


Ponding



Supplemental Drain

Common Deficiency: Failed Joints



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

Common Deficiency: This is Why



Sealant Failure

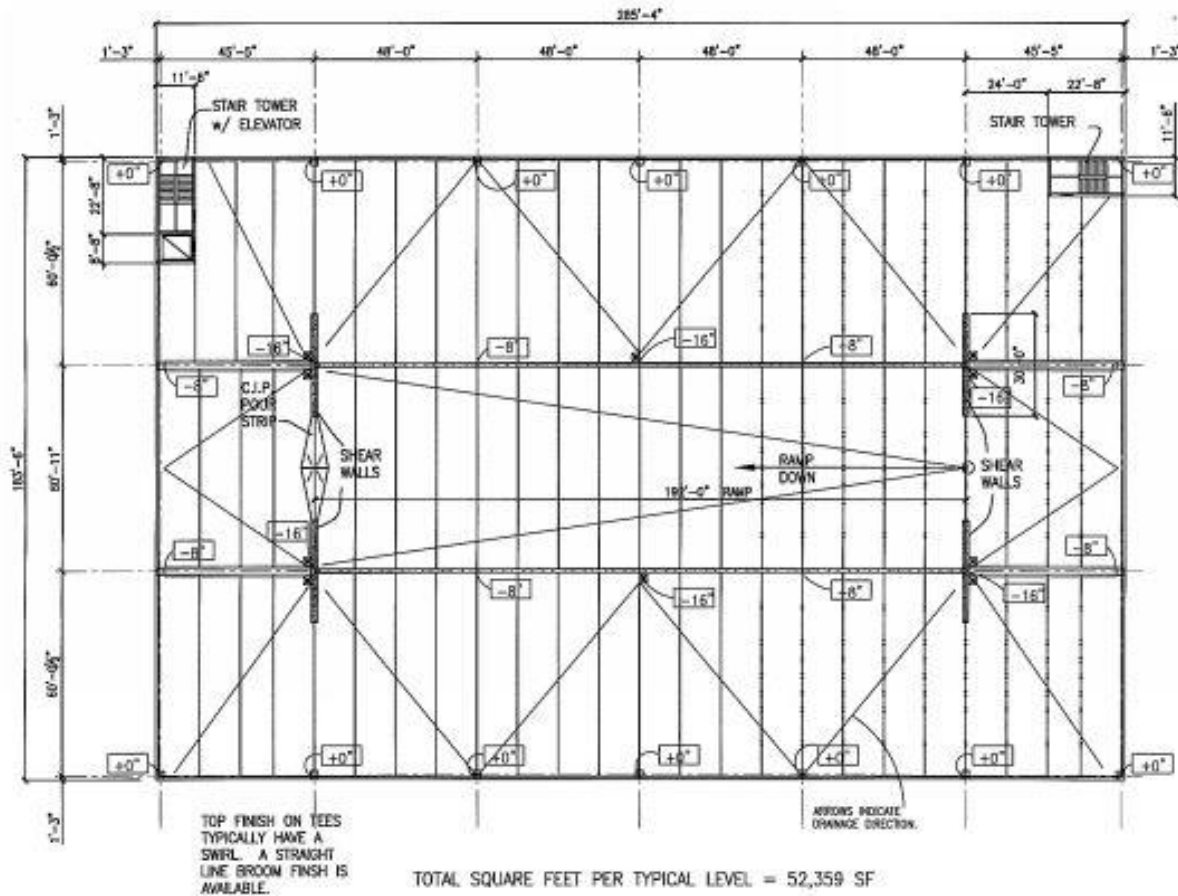


Cracks



Expansion Joint Failure

Common Deficiency: Failed Joints



Drainage & Joint Plan

- **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

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



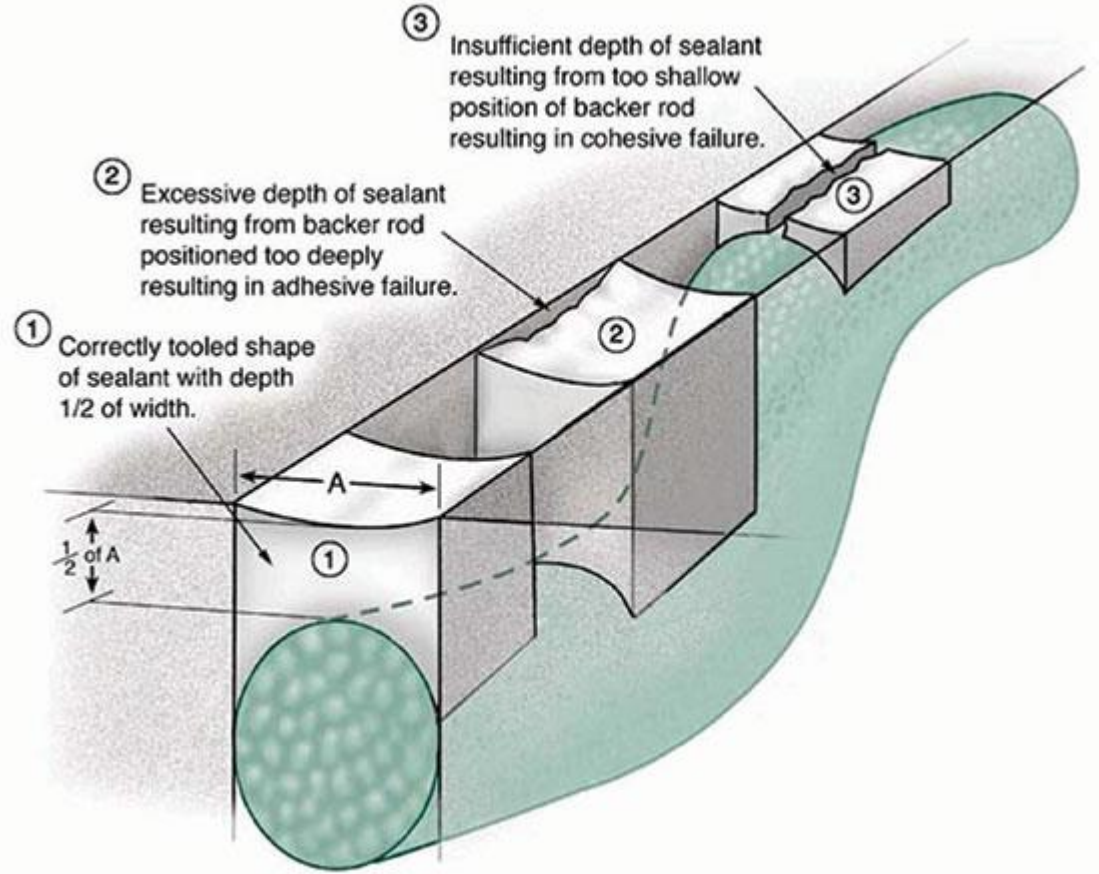
Backer Rod

Photo by SIKA

Common Deficiency: Re-Seal Joint Sealant



New Sealant



Common Deficiency: Re-Seal



Tooling

Photos by Albion Manufacturing

Common Deficiency: Re-Seal Quality Control



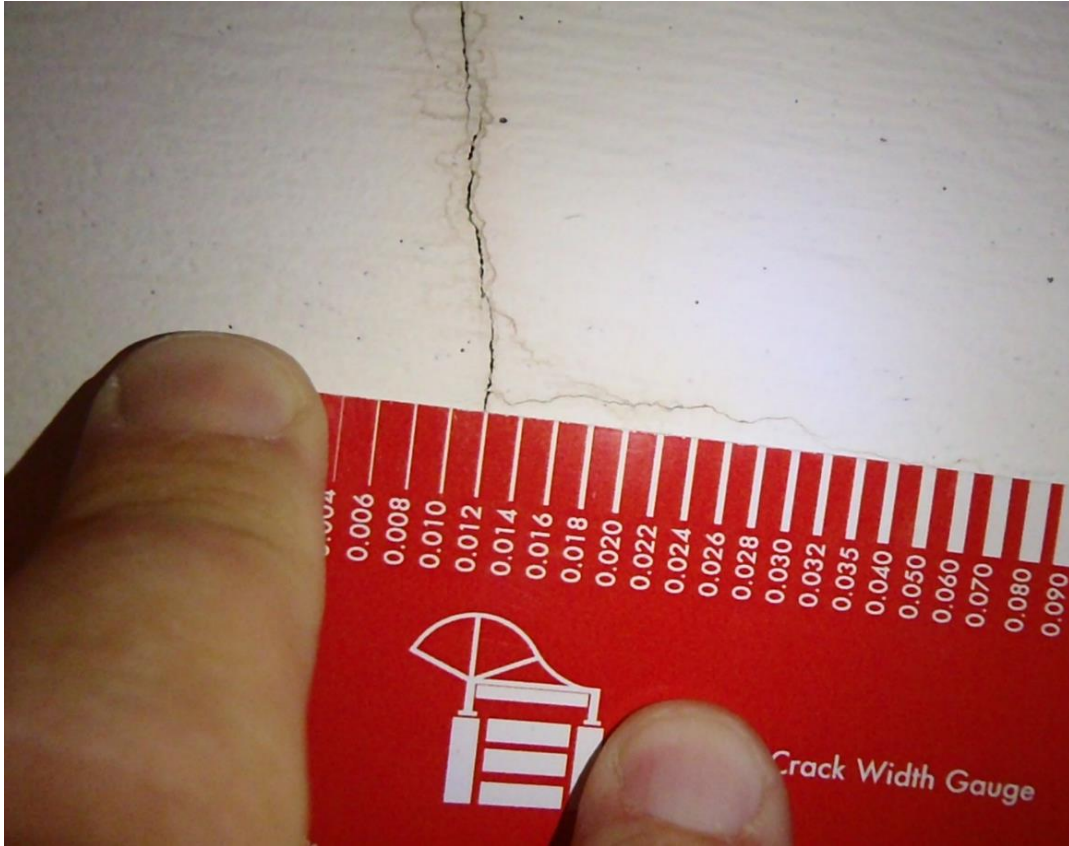
Probing NDT



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



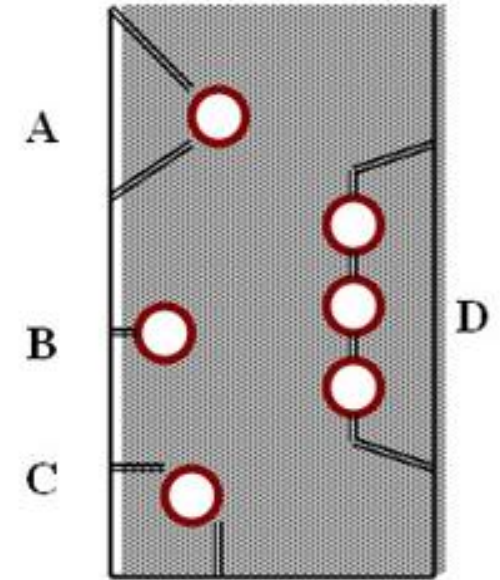
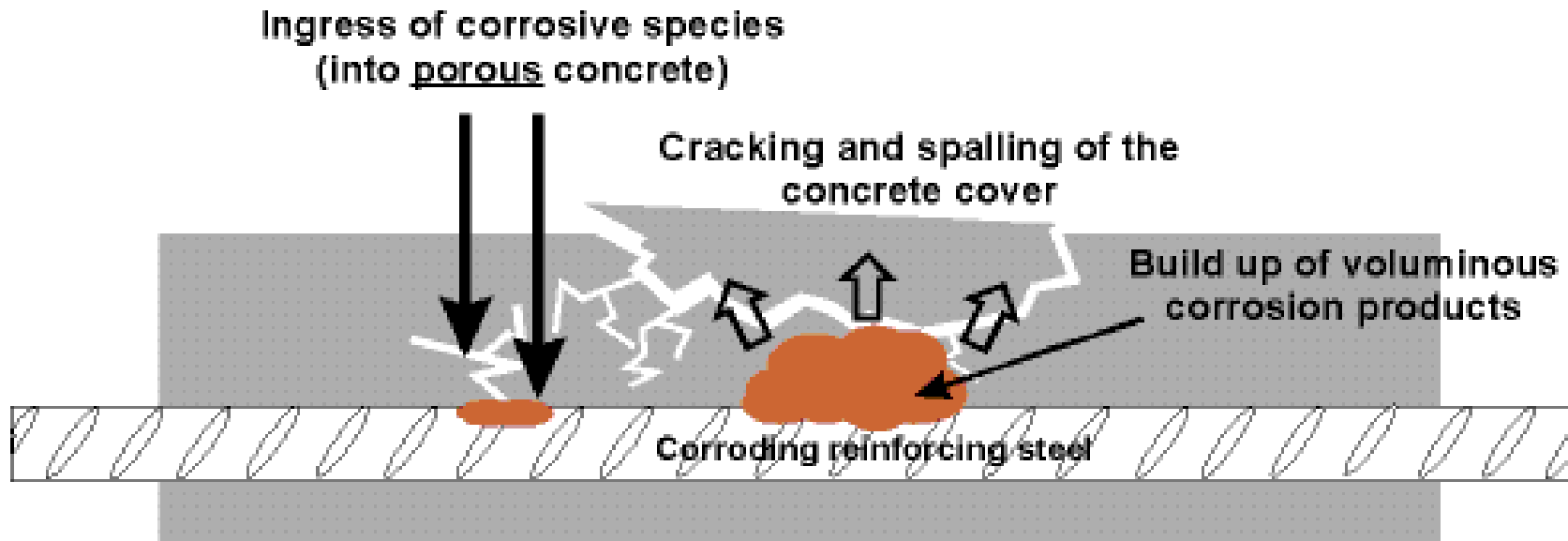
Traffic Bearing Membrane

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: Corrosion



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

Common Deficiency: Concrete Spalls



Spall



Delamination



Section Loss

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



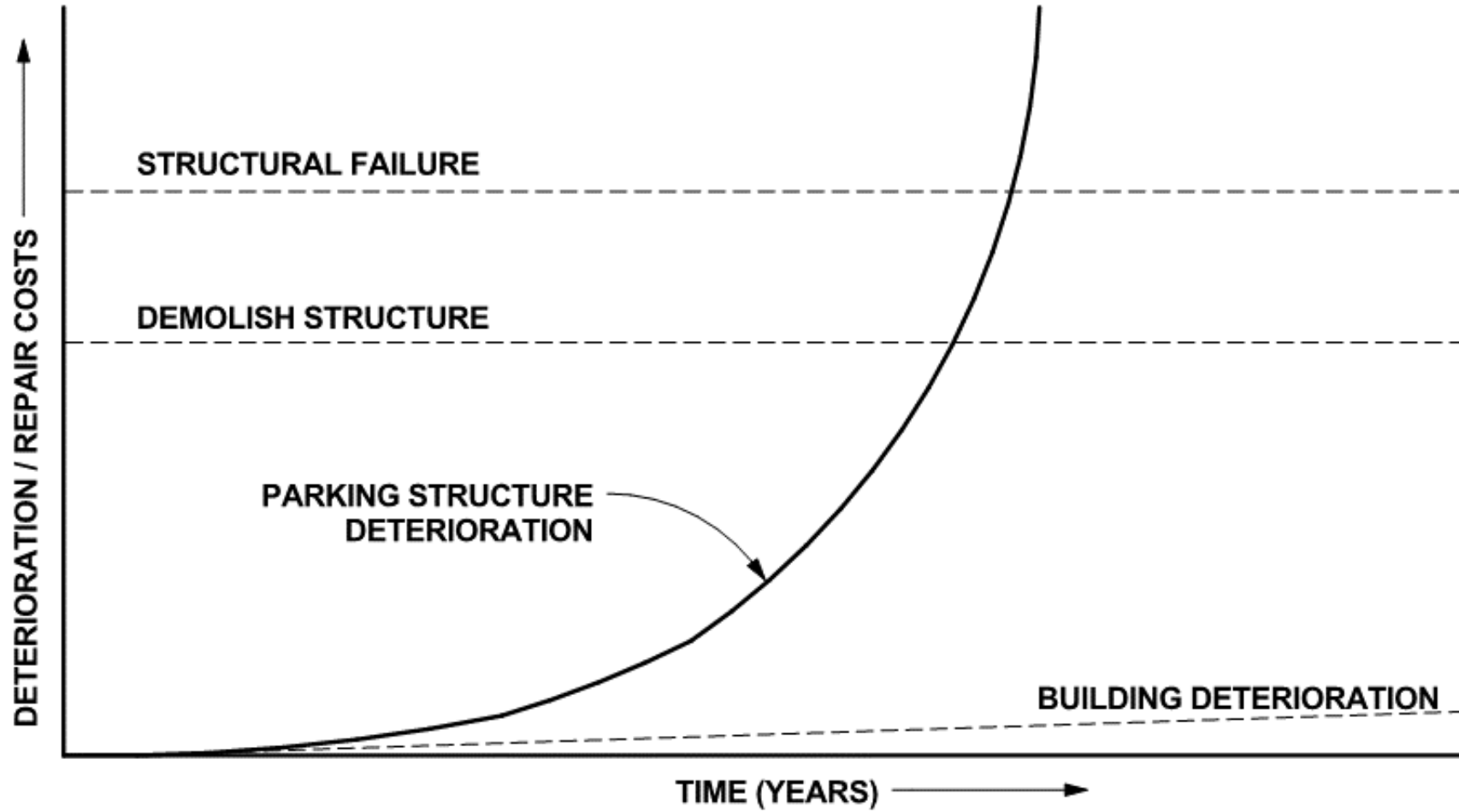
Applying Epoxy Bonding Agent

Precast Haunch Connection Finished Repair

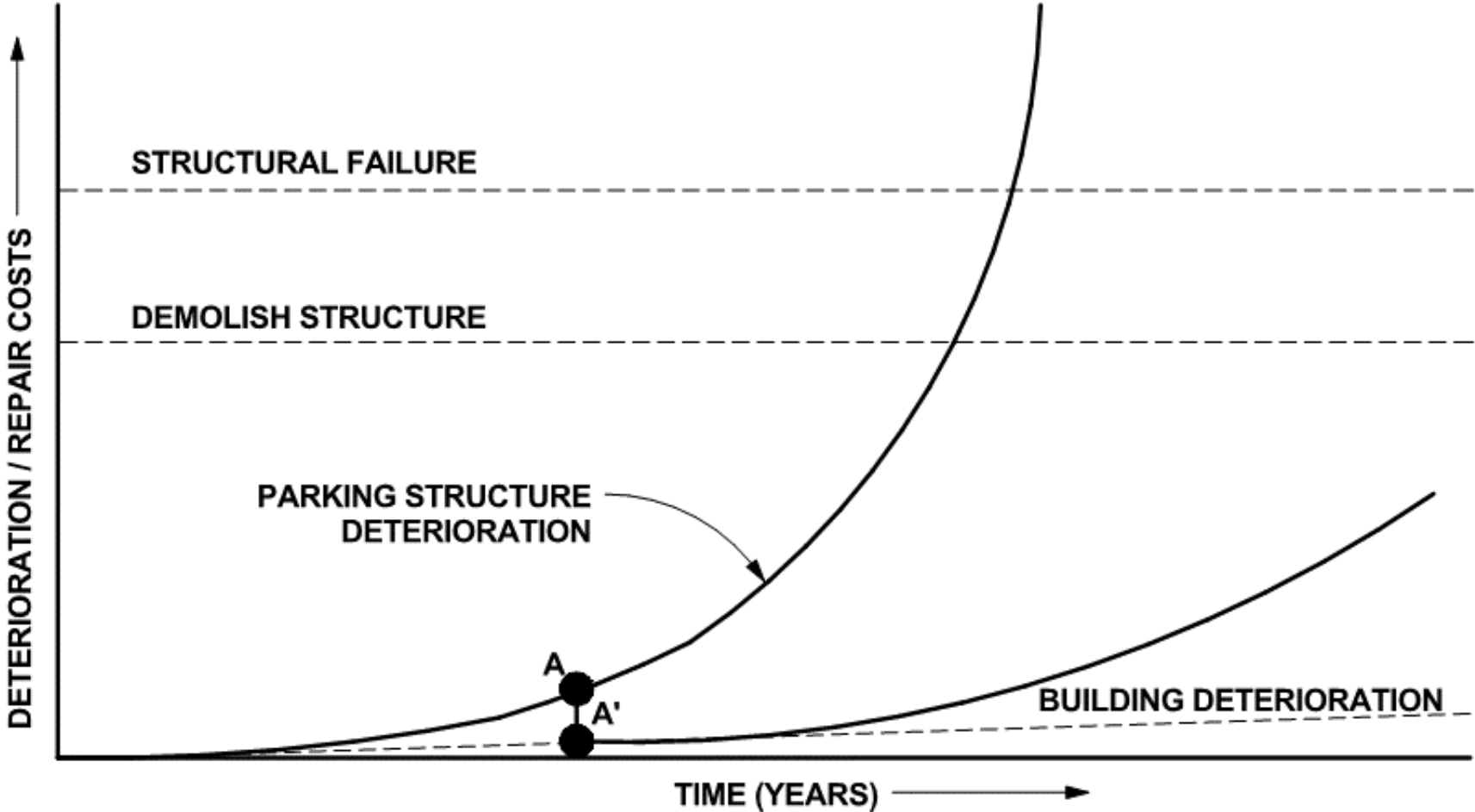


Good as New

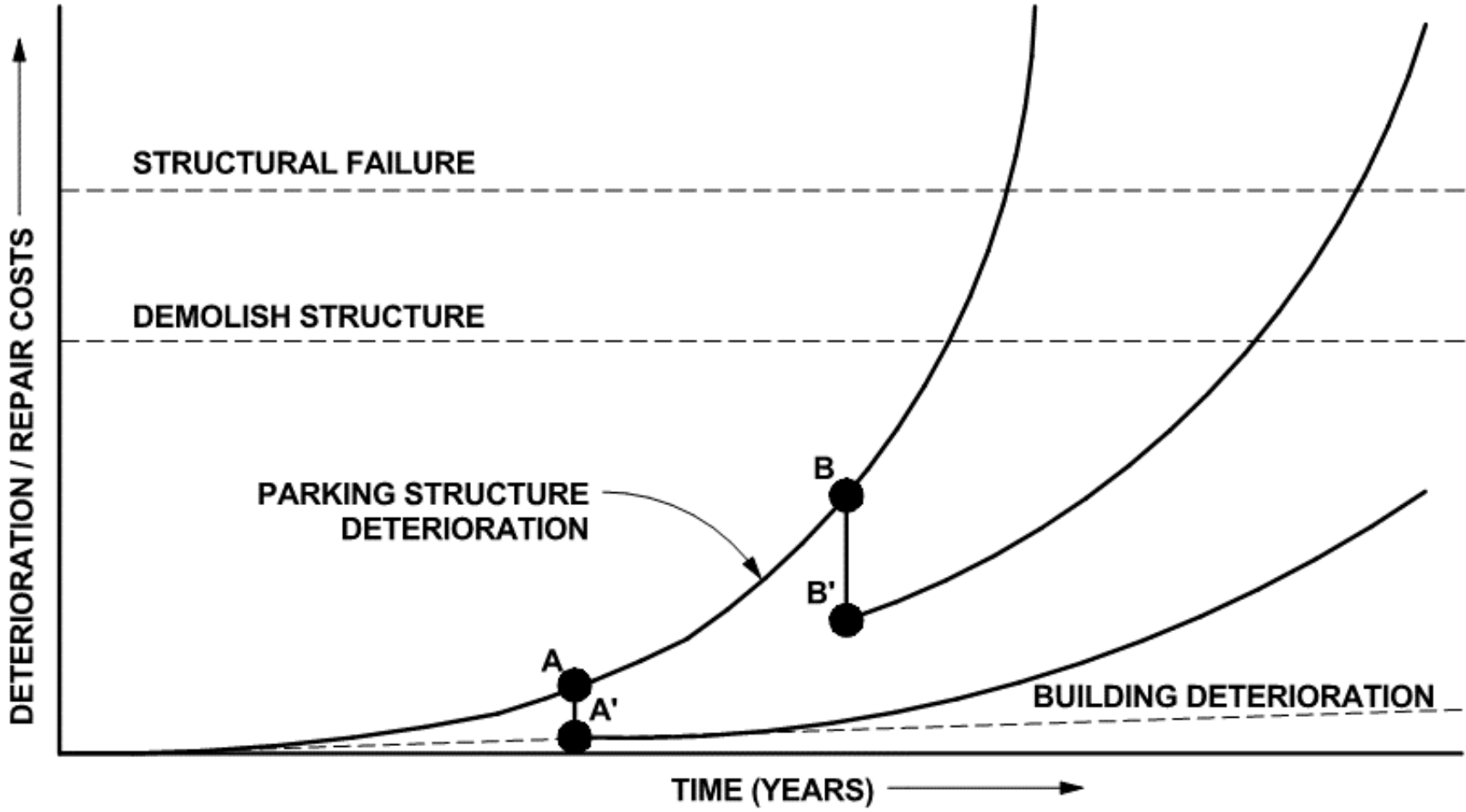
Maintenance Cost Curve



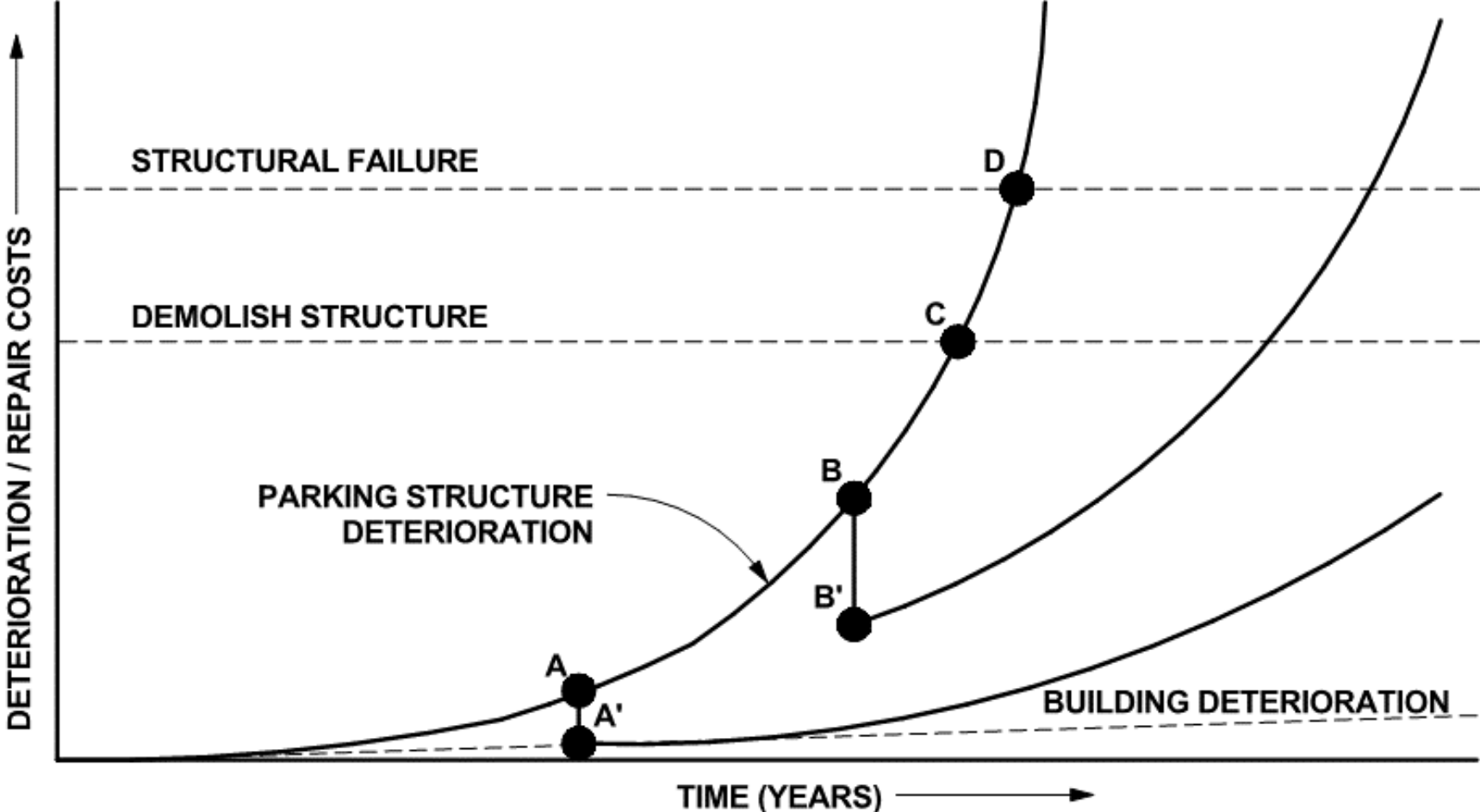
Maintenance Cost Curve



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**
- **Routine Maintenance**
- **Preventative Maintenance**
- **Repair & Replacement**
- **Condition Assessment**
- **Rehabilitation & Restoration**
- **Maintenance Budget**

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 lot
- 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: _____

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: _____

FORM F-5
ANNUAL STRUCTURAL CHECKLIST
PARKING STRUCTURE NAME: _____
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

Maintenance Program

Structural and Waterproofing Systems	Operational Routine Maintenance	Aesthetics
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 striping	
8. Bearing Walls	8. Inspection	
	9. Safety checks	

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Questions?

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