



The Truth About Parking Structure Maintenance How to Protect Your Investment

**Atlanta Workplace
Georgia International Convention Center
Friday February 28, 2020**



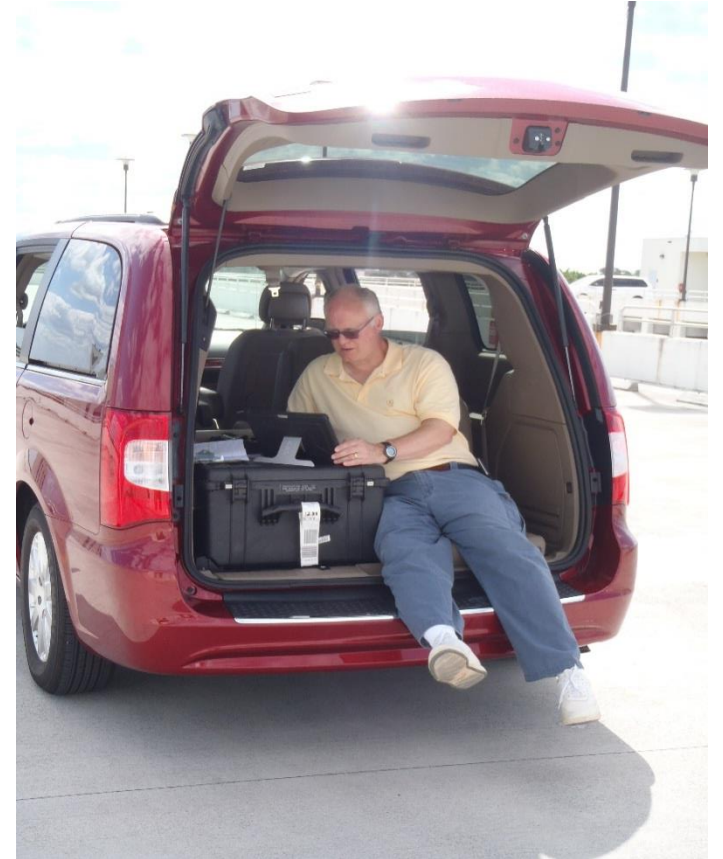
Learning Objectives

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



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



Parking Structure Maintenance

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



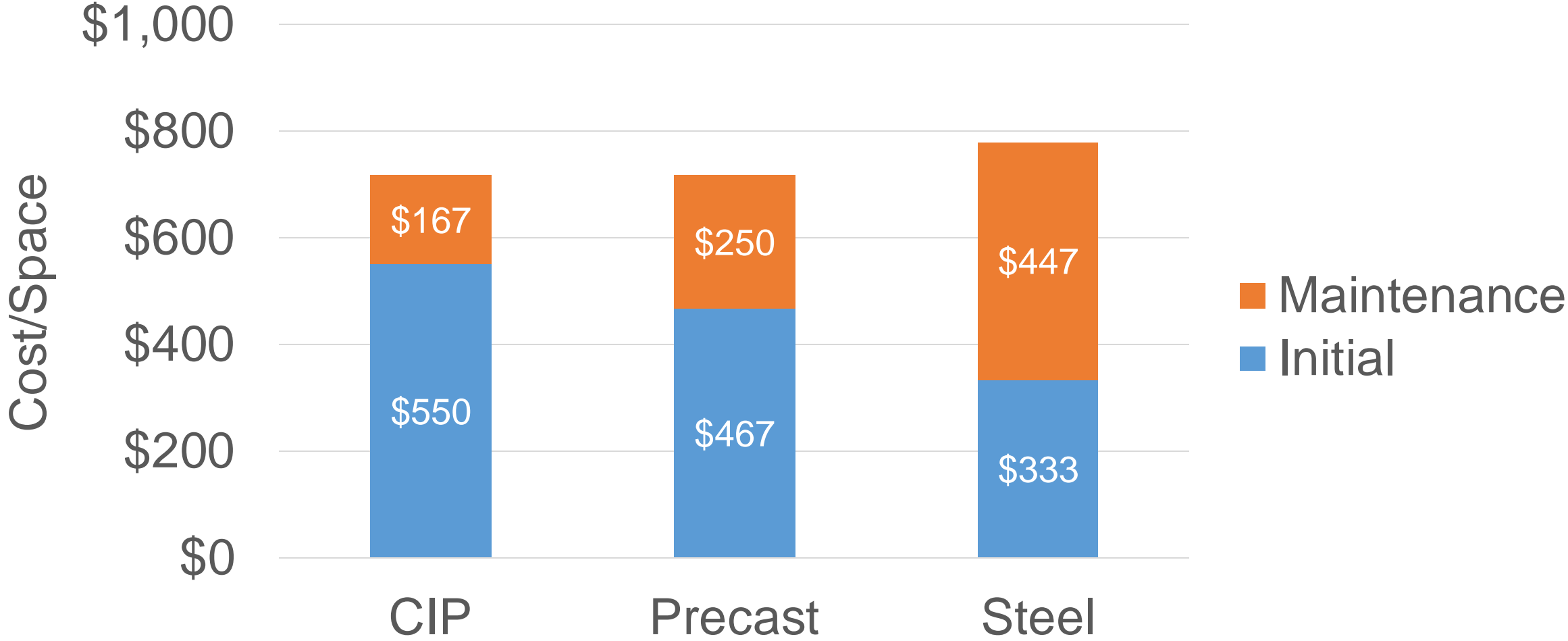
- **Advantages**

- 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

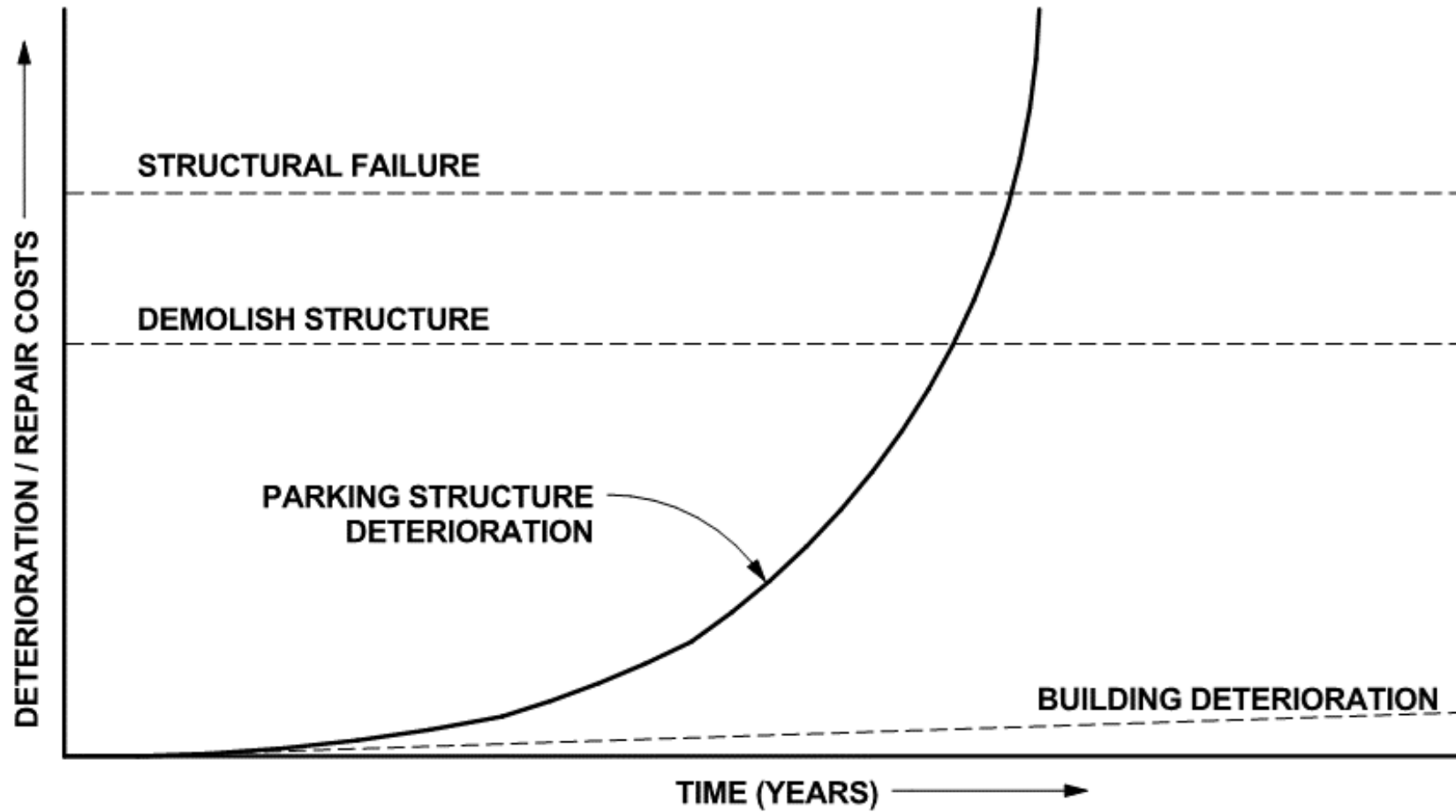


Parking Structures



- **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

Structure Degradation



Irving Texas, O'Conner Ridge Blvd. Collapse



Parking Structure Maintenance

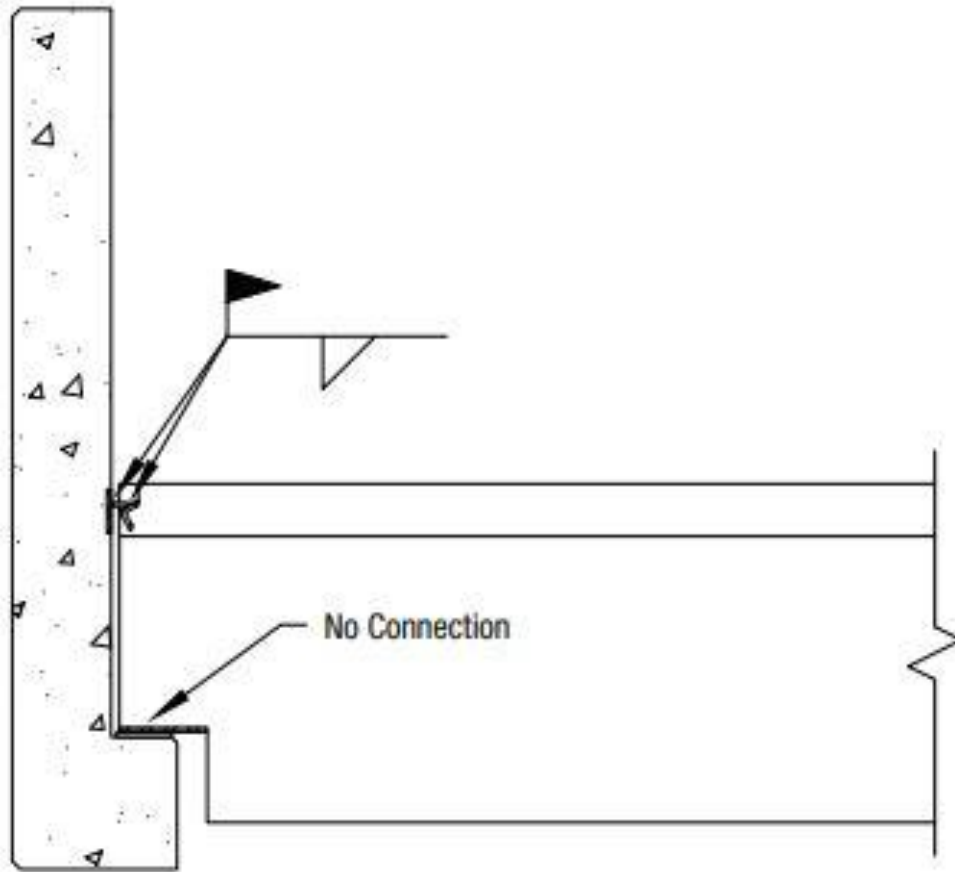
Irving Texas, O'Conner Ridge Blvd. Collapse



• What we know

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

Irving Texas, O'Conner Ridge Blvd. Collapse



- **Typical Precast Double Tee Joist Seat**

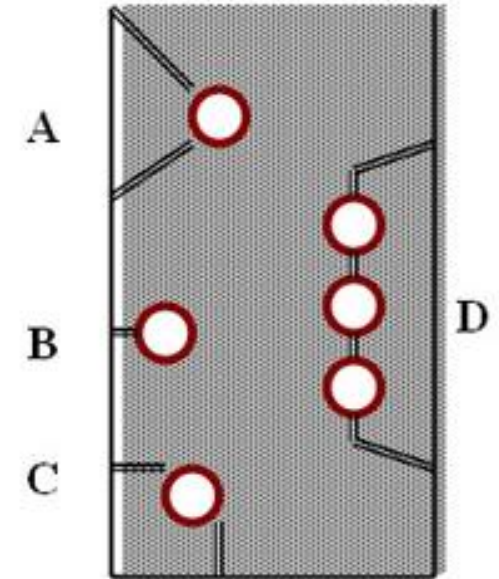
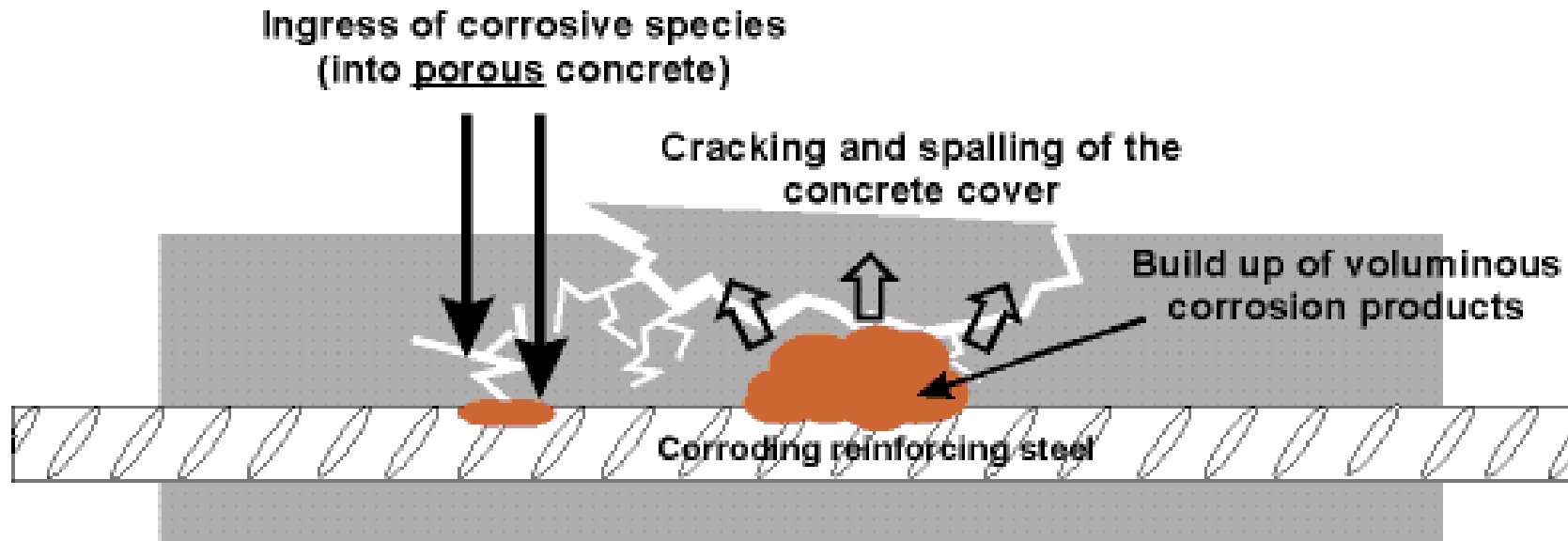
Common Deficiencies

- **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

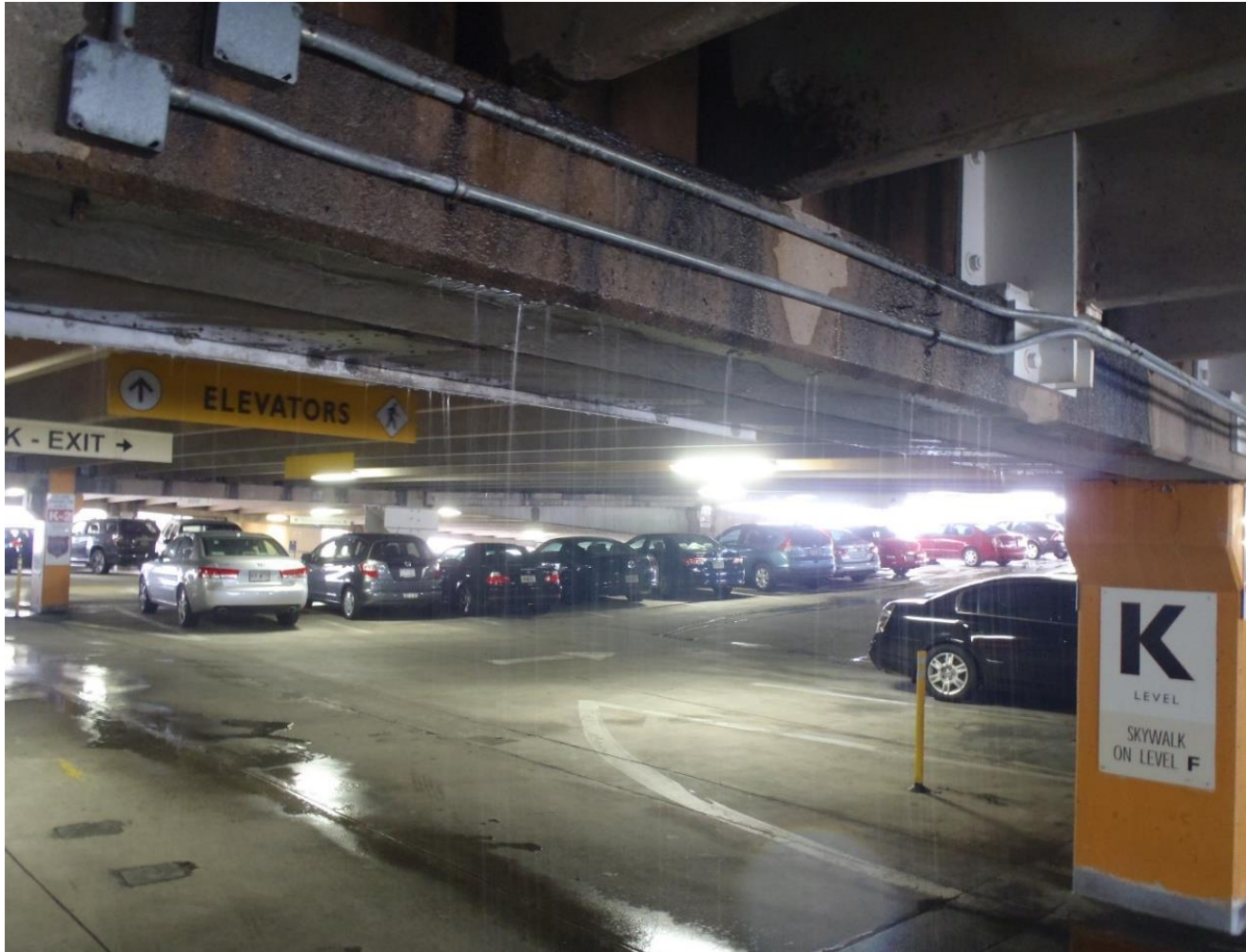


Ponding



Supplemental Drain

Common Deficiency: Failed Joints

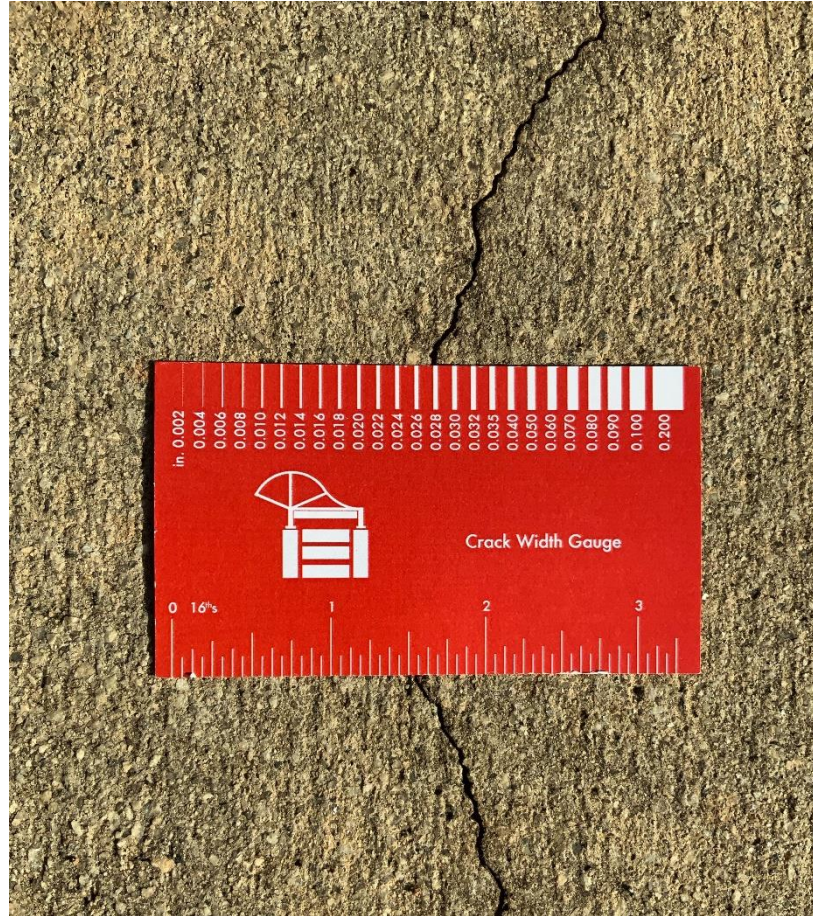


- **Why is it Raining in my Parking Structure?**

Common Deficiency: This is Why



Sealant Failure

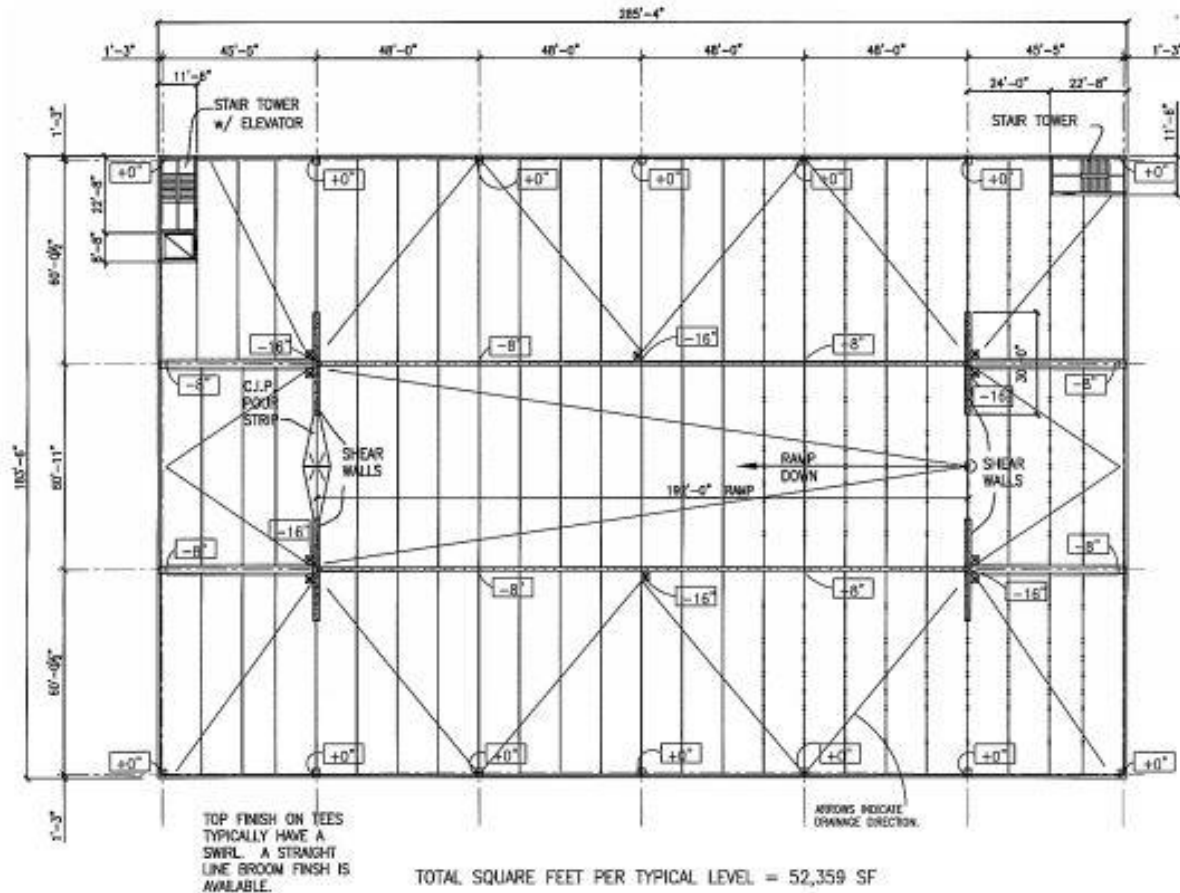


Cracks



Expansion Joint Failure

Common Deficiency: Failed Joint Sealant



Drainage & Joint Plan

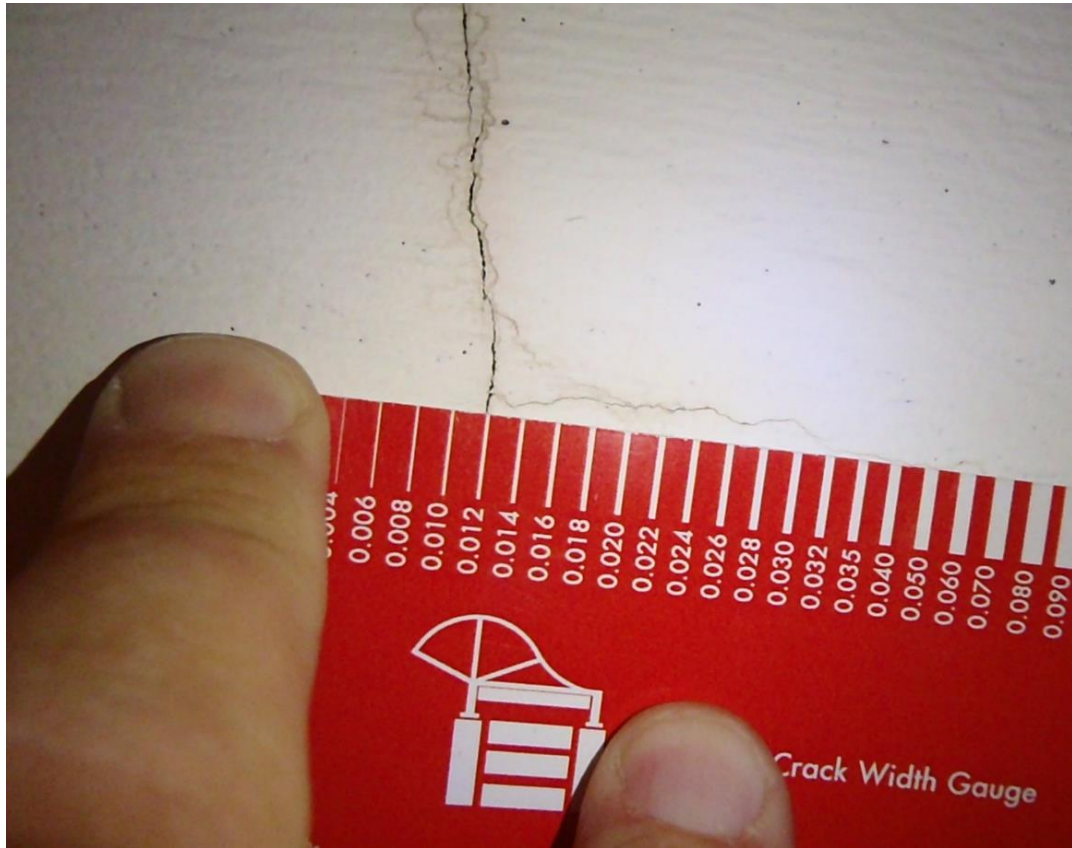
- **Precast**

- 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: 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



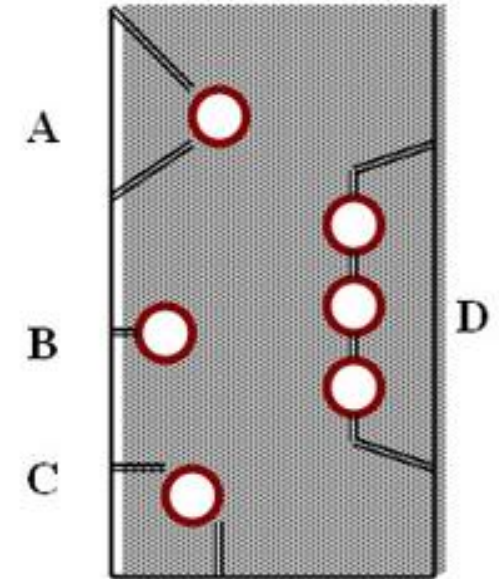
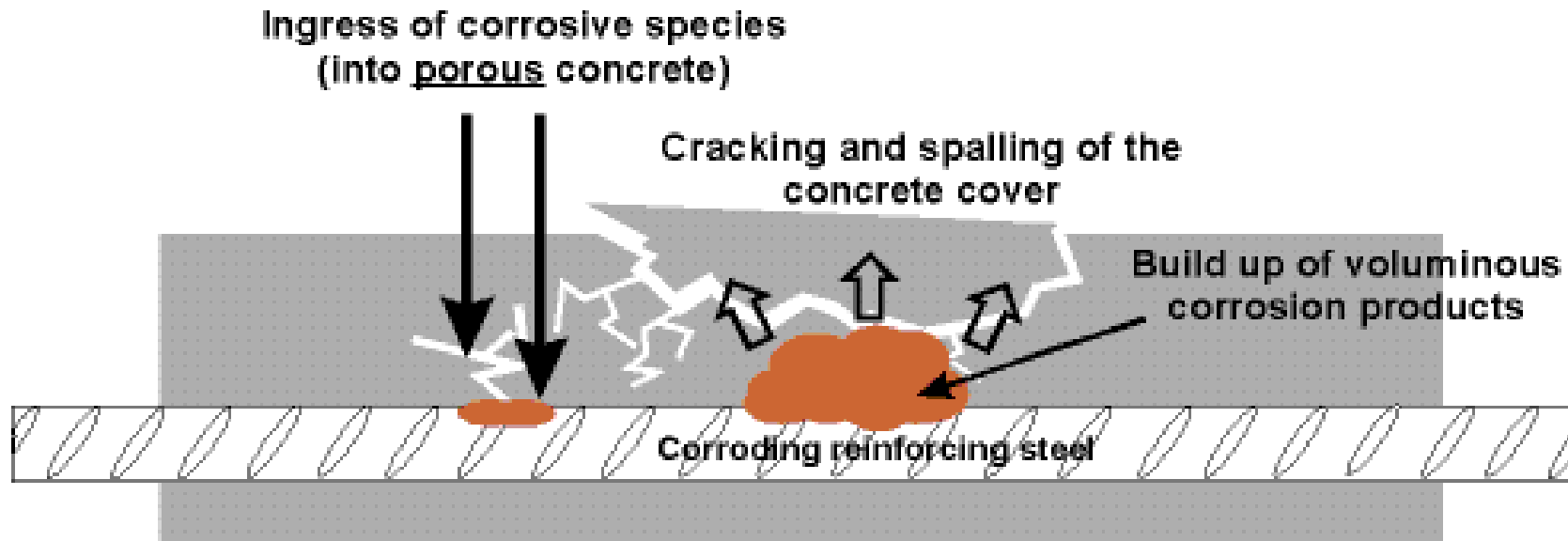
Cracks \geq .035"

Photos by Engineered Restorations Inc.



Inflatable Injection Port

Common Deficiency: Corrosion



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

Common Deficiency: Concrete Spalls



Spall



Delamination



Section Loss

Common Deficiency: Exterior Spalls



Spall Over Sidewalk



Spall Size

Common Deficiency: Sounding



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

Precast Haunch Connection Finished Repair



Good as New

Common Deficiency: Overloaded – Fire Truck



Broken Precast Spandrel Beam

Common Deficiency: Curbs & Wheel Stops



Broken Curb



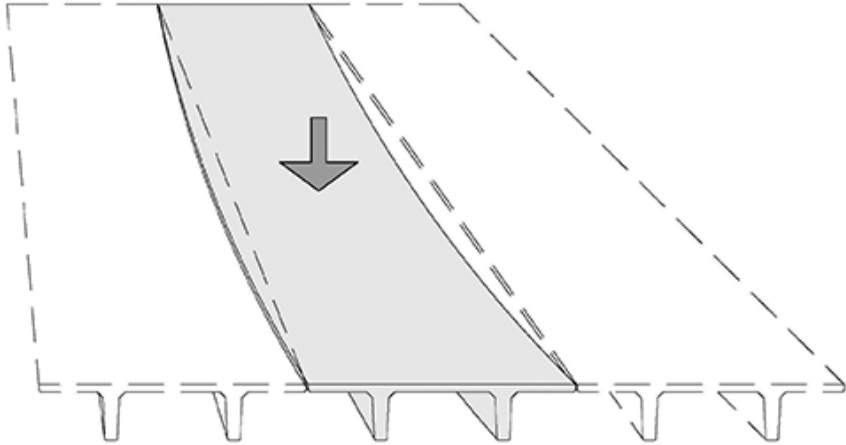
Broken Wheel Stop

Precast Shear Transfer Repair

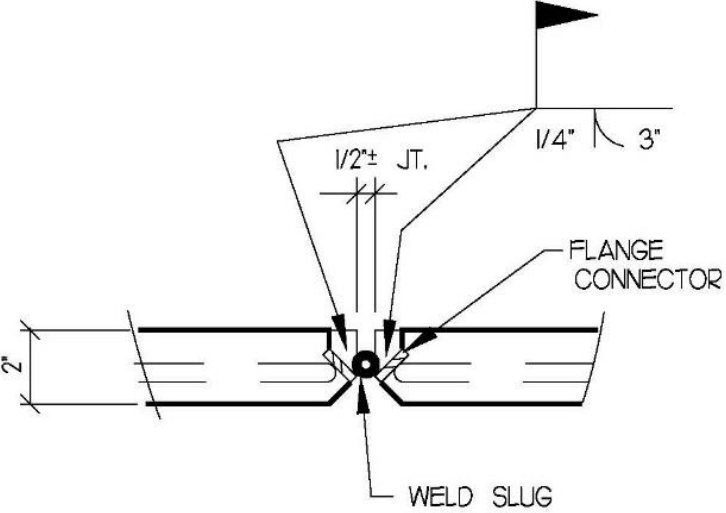


Parking Structure Maintenance

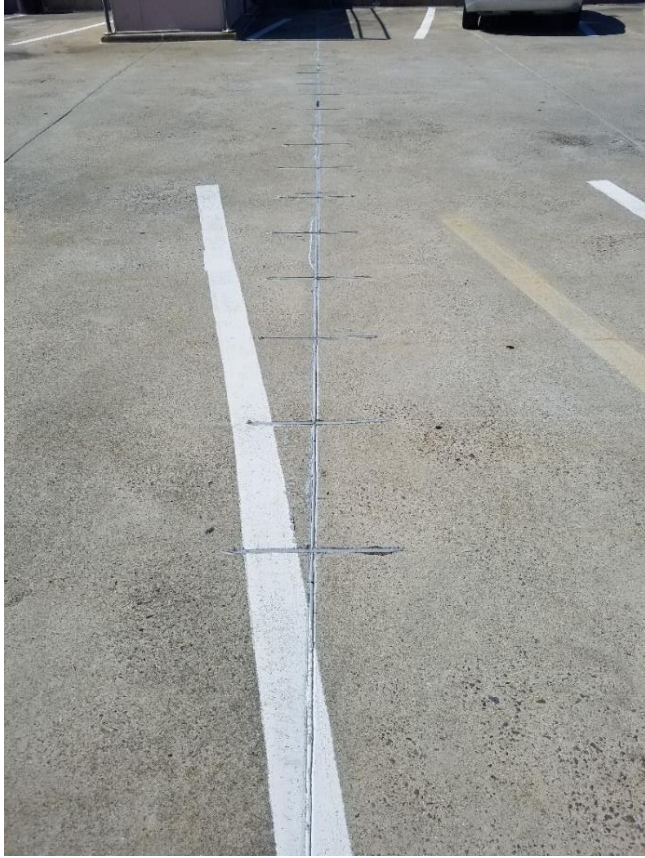
Precast Shear Transfer Repair



Precast Double Tees

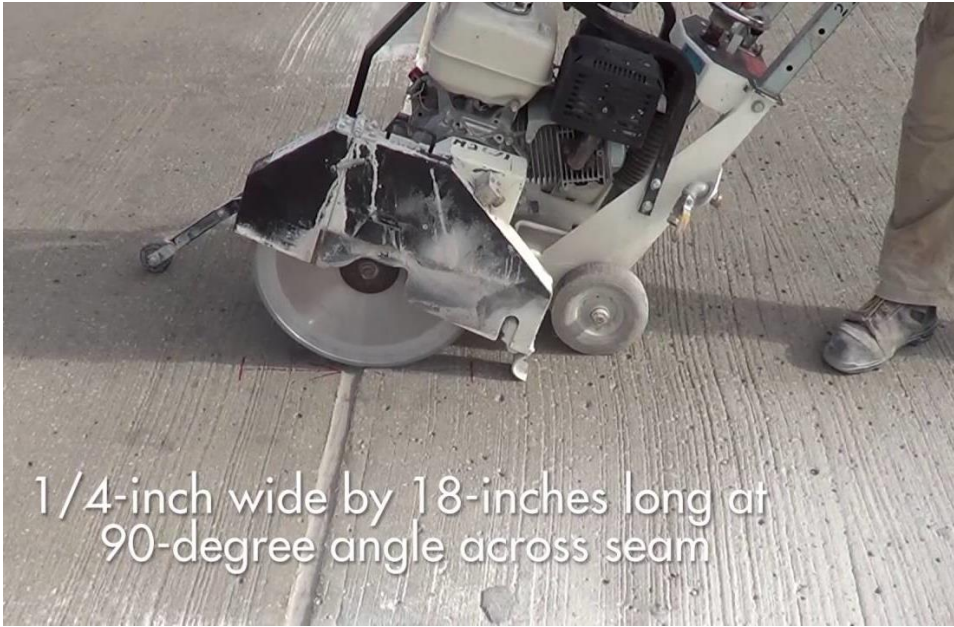


Shear Transfer



Repair

Precast Shear Transfer Repair



Saw Cut Slab



Prepared Joint
& Biscuit



Repair

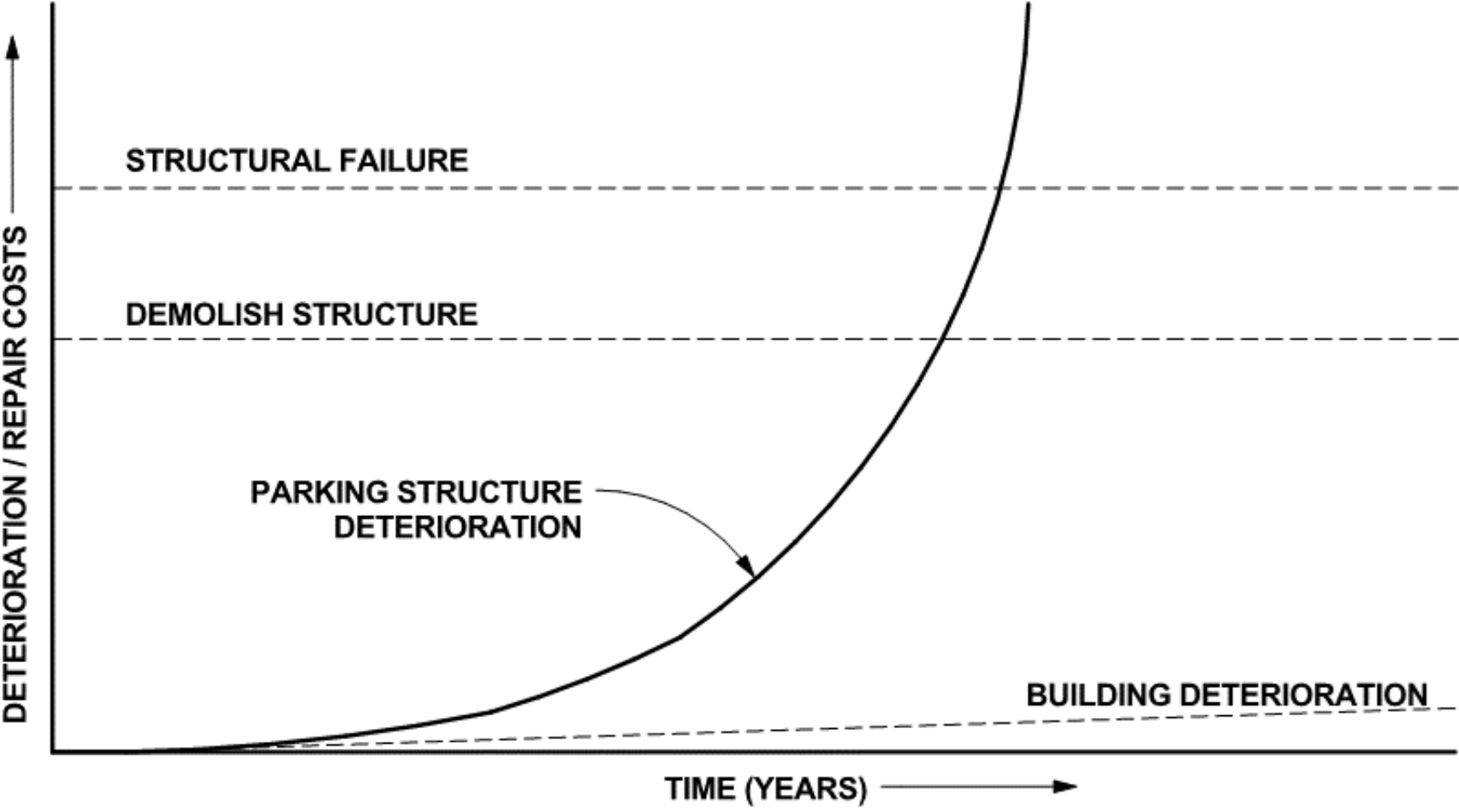
Images by V2 Composites

Structural Steel Corrosion

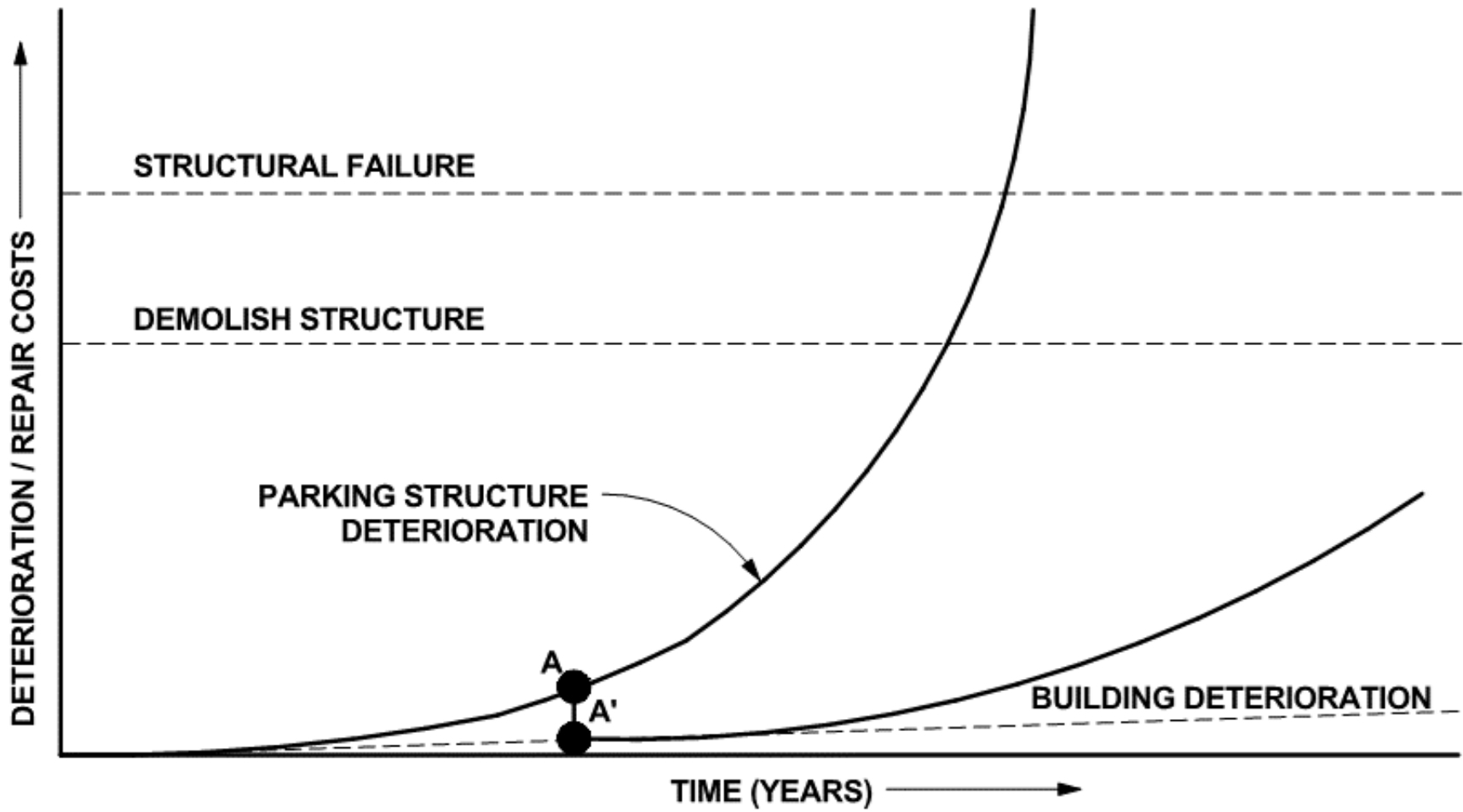


- **Steel Protection & Corrosion Issues**
- **Steel Deck Traps Moisture, Hides Degradation.**

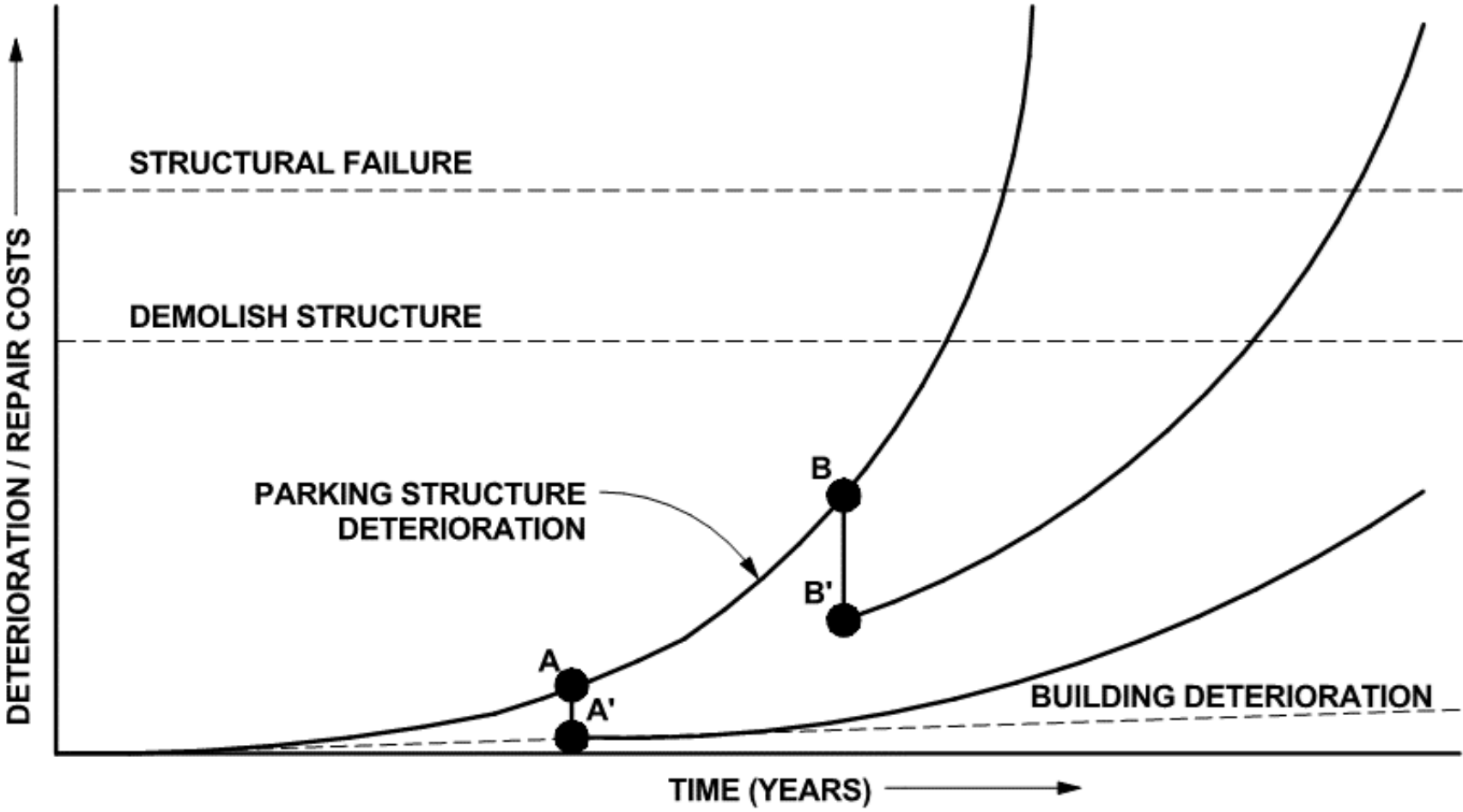
Maintenance Cost Curve



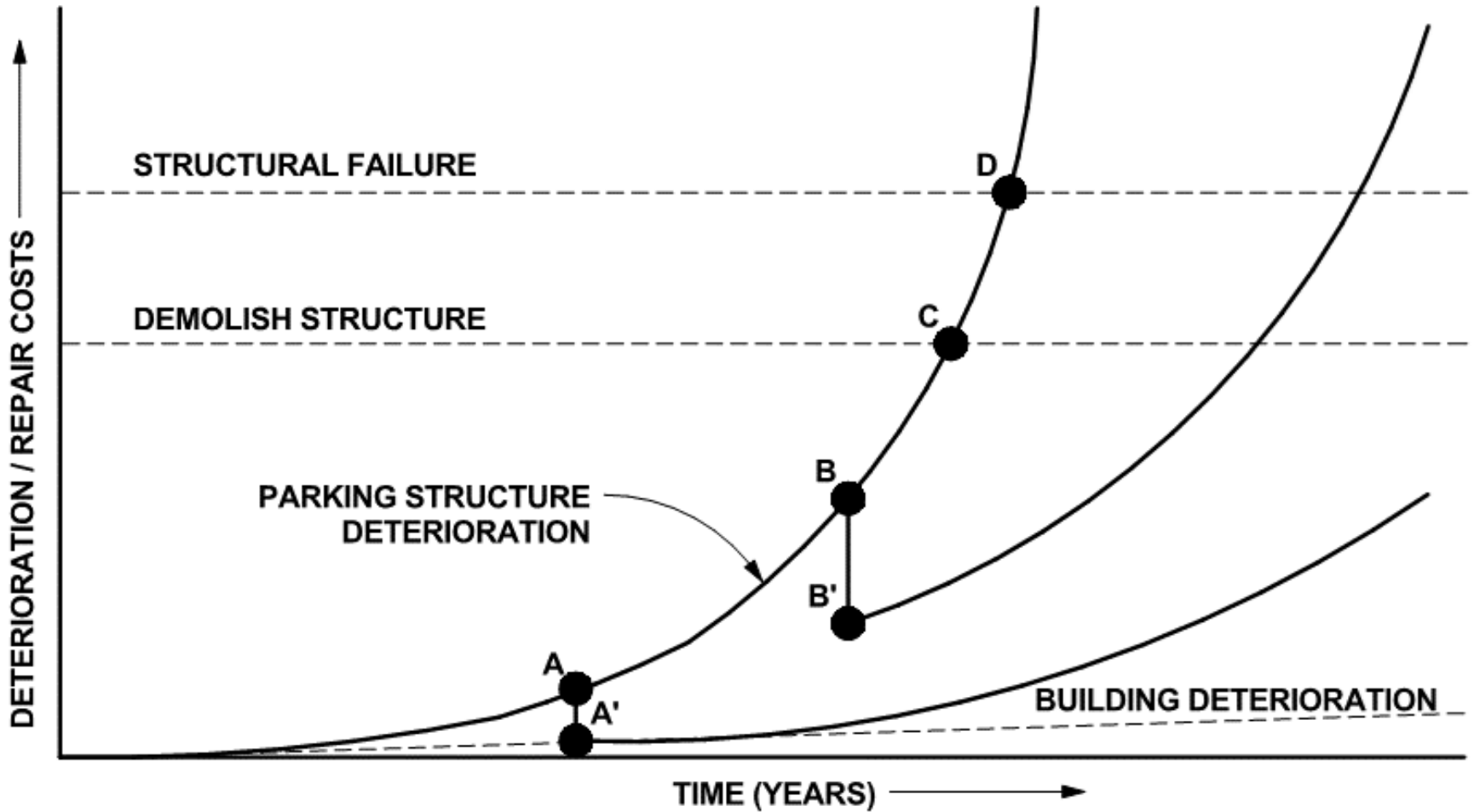
Maintenance Cost Curve



Maintenance Cost Curve



Maintenance Cost Curve



Reactive Maintenance



Now Demolished

Parking Structure Maintenance

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**

Buying Services - Scope of Work



Parking Structure Maintenance

Buying Services – The Sequence

- **Condition Assessment**
 - Level I
 - Level II
 - Level III
- **Construction Documents**
- **Bidding & Award**
- **Resident Engineering**

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Questions?

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