



The Truth About Parking Structure Maintenance

How to Protect Your Investment (ROI)

Learning Objectives



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

Polling Question

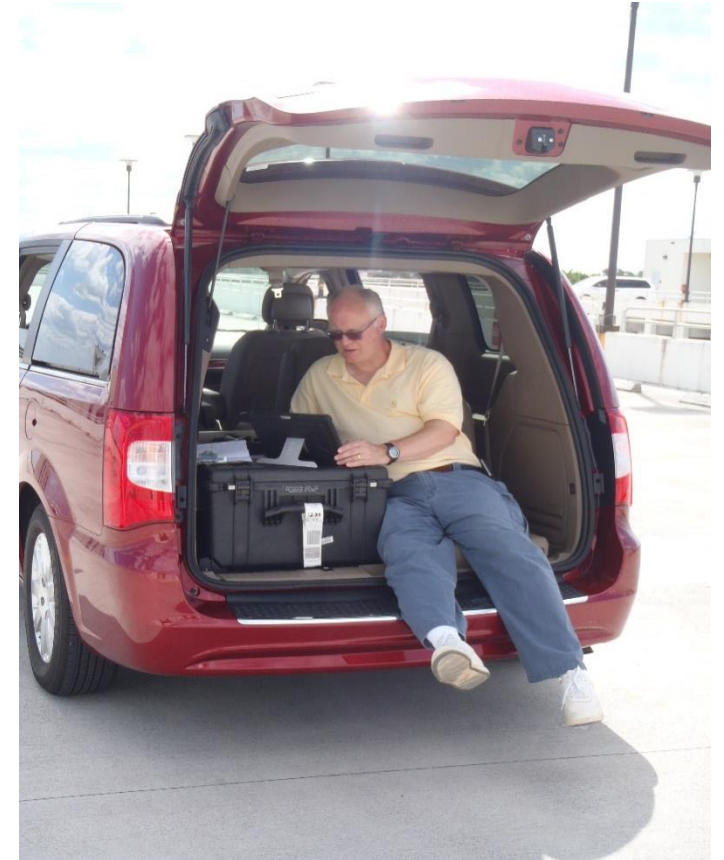


- Why your interest today in Parking Structure Maintenance?
 - ☐ Maintaining an existing parking structure.
 - ☐ Planning a new parking structure.
 - ☐ Other

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**
 - **Publications**
 - 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?

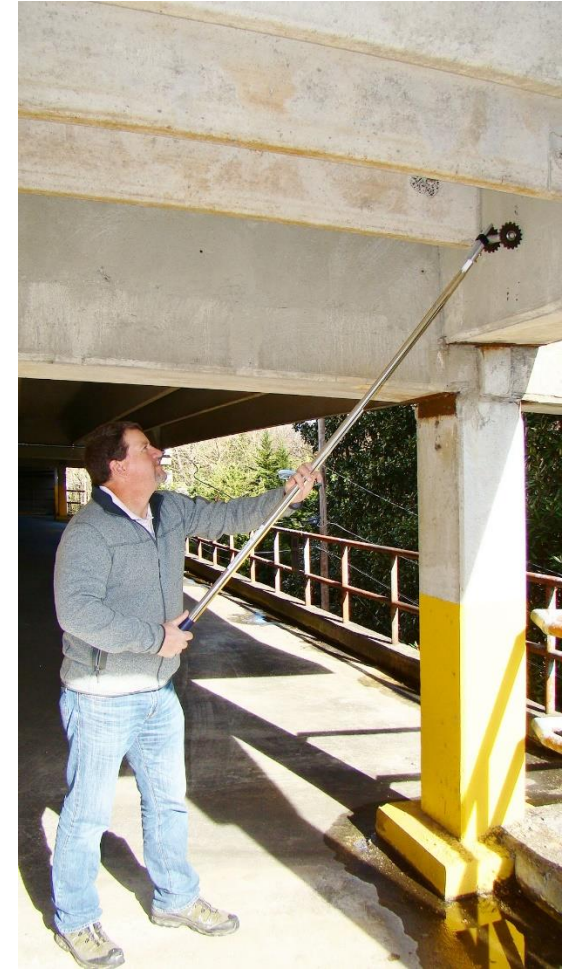


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- **Trey Thomas PE**

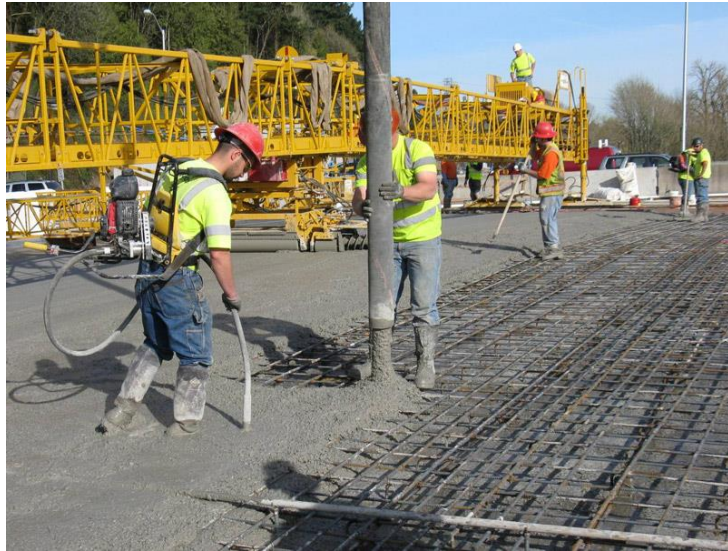
- **BSCET, Southern Polytechnic State University**
- **16 Years in Design and Restoration Engineering**
 - Co-author of Parking Structure & Forensic articles
- **Certified in Lead, Asbestos, & Mold Sampling**
- **OSHA Competent Person for Boom & Scissor Lifts**
- **SPRAT Level 2 Rope Access Technician**
- **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
 - Strict 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



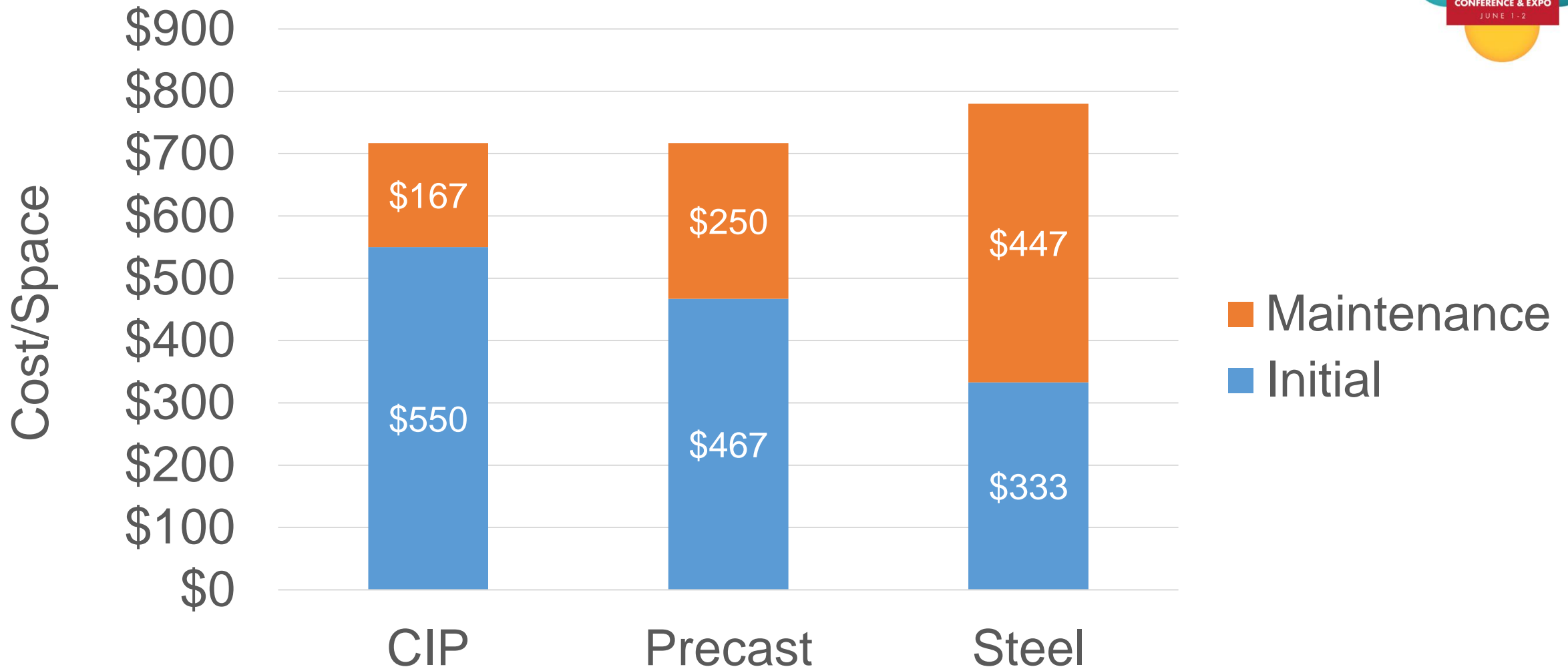
- Disadvantages
 - May be no local plant
 - Geometry not Flexible
 - Lower Perceived Ceiling heights
 - Shearwalls (Closed In)
 - More Joints
 - Prone to Thermal Expansion & Contraction Damage
 - Corrosion of Steel Embedments
 - Higher Maintenance Costs

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



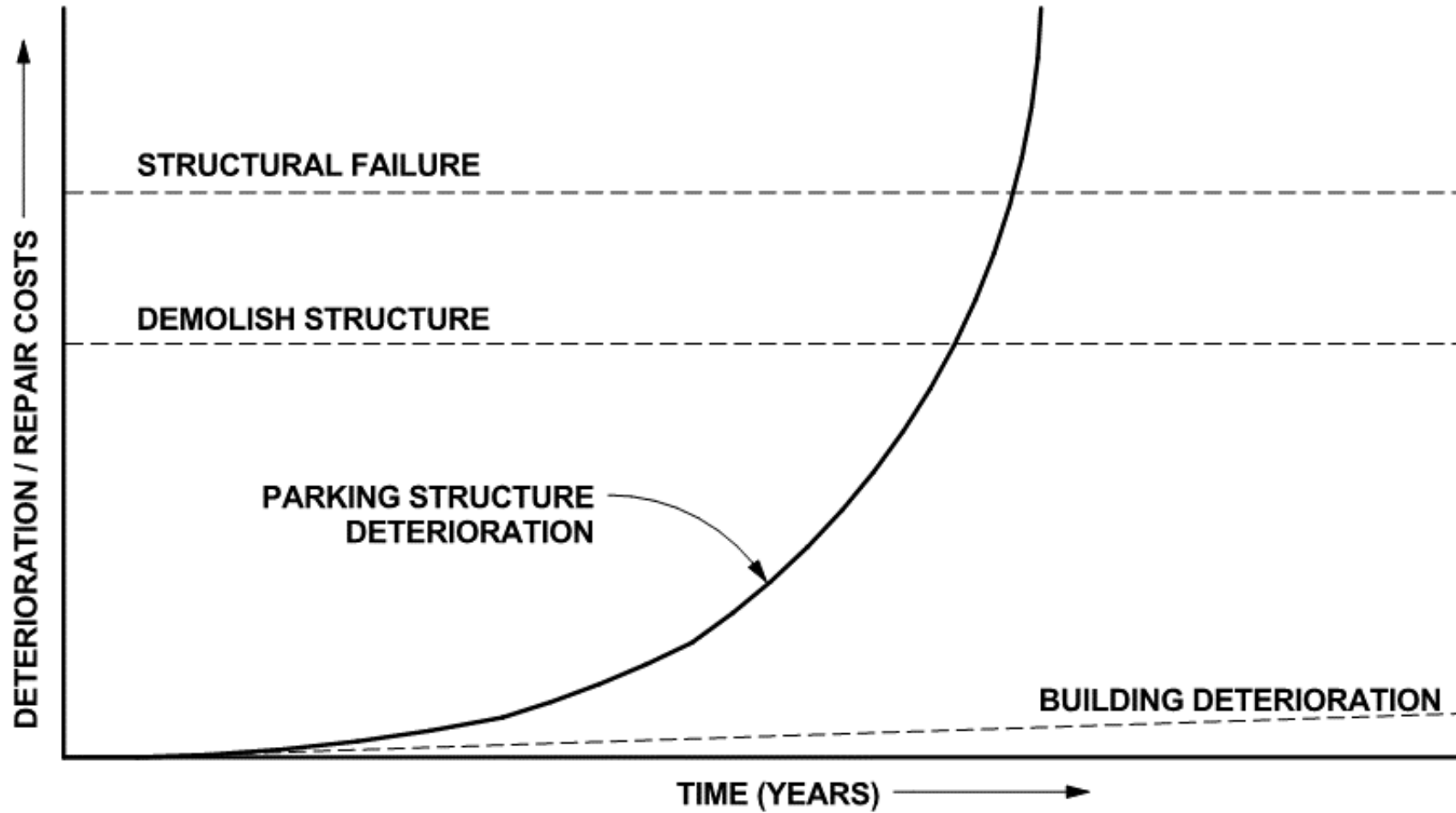
- **Not Bullet Proof**
- **No Protective Skin**
- **Deterioration Starts Immediately**
- **Subjected To:**
 - Moisture (Rain, Snow, Ice, Deicing Salts)
 - CO₂ Carbonation
 - Extreme Thermal Expansion & Contraction
 - Dynamic Vehicle Loads

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



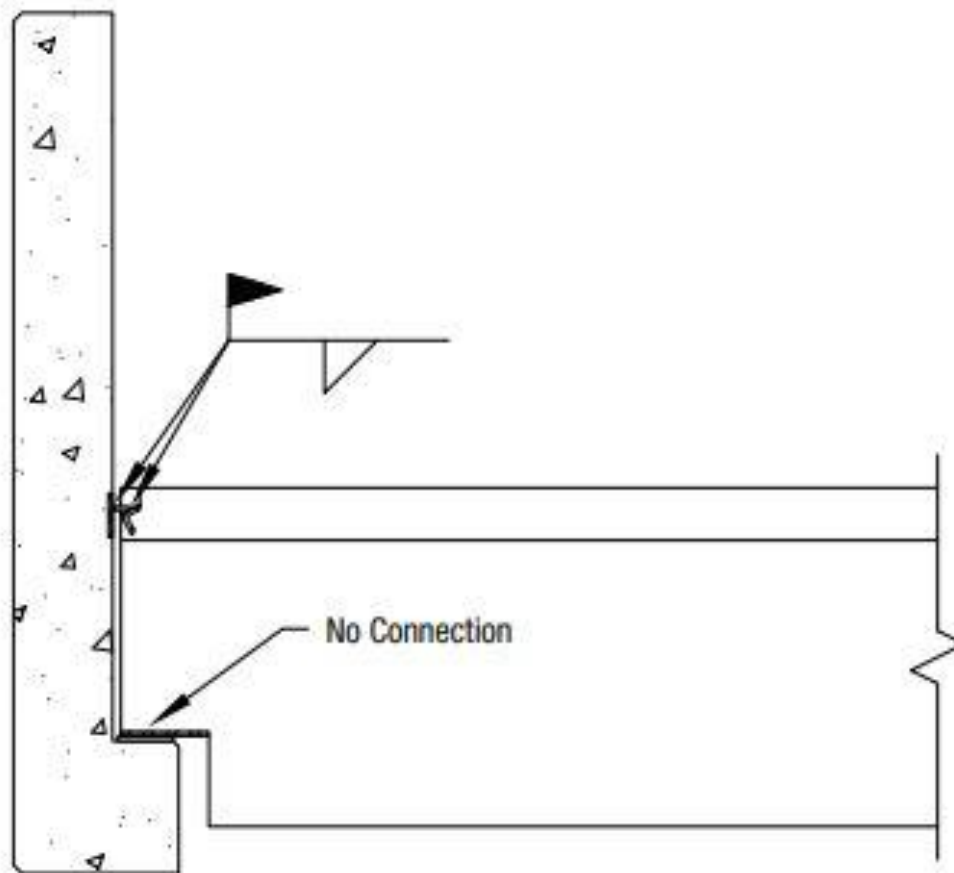
Irving Texas, O'Conner Ridge Blvd. Collapse



• 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

Polling Question



- **Do you have a Parking Structure Maintenance Program?**

☐ Yes

☐ No

☐ N/A

Common Deficiencies

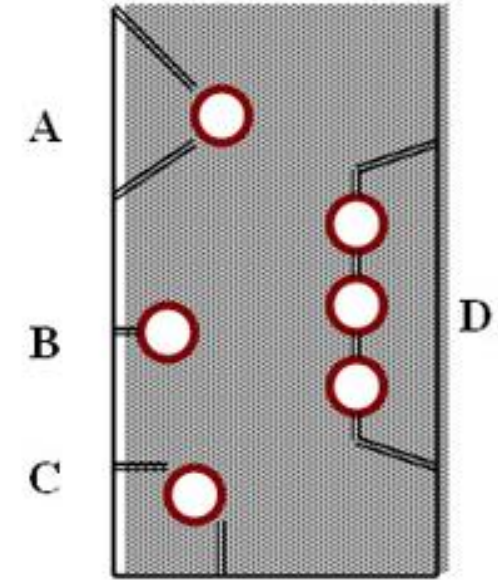
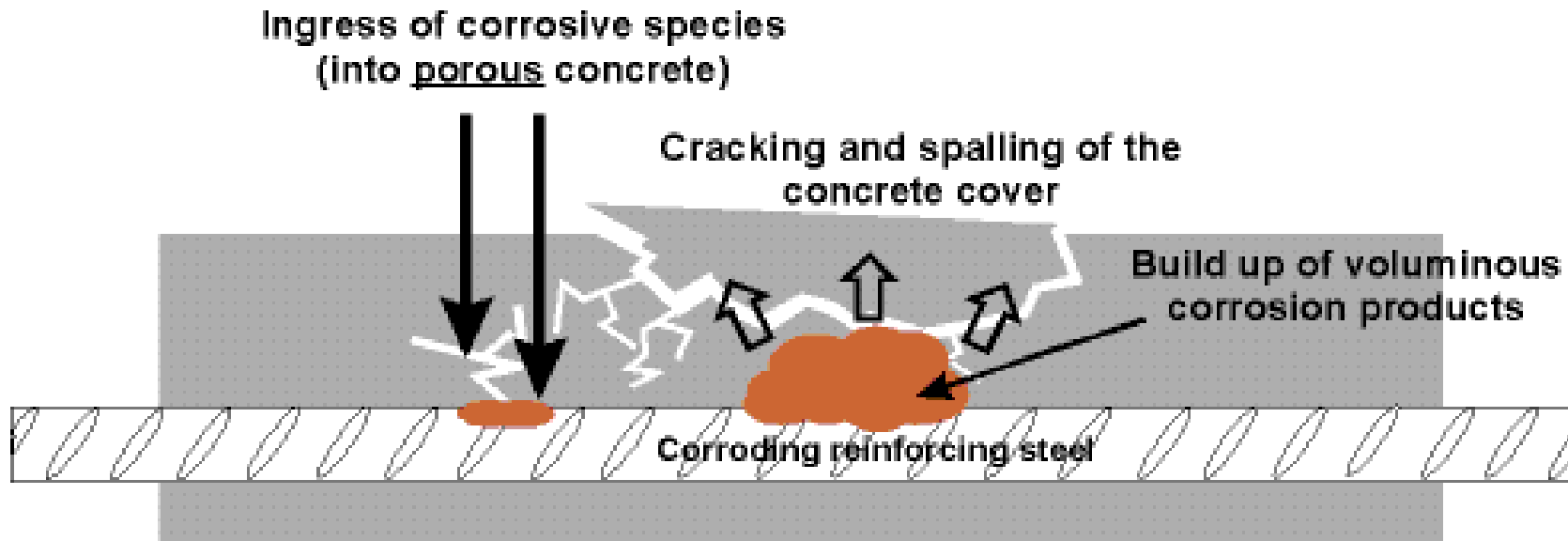


- **Number 1 Enemy**



WATER

Common Deficiency: Corrosion



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

Common Deficiency: Spall & Delamination



Spall



Delamination



Section Loss

Common Deficiency: Ponding

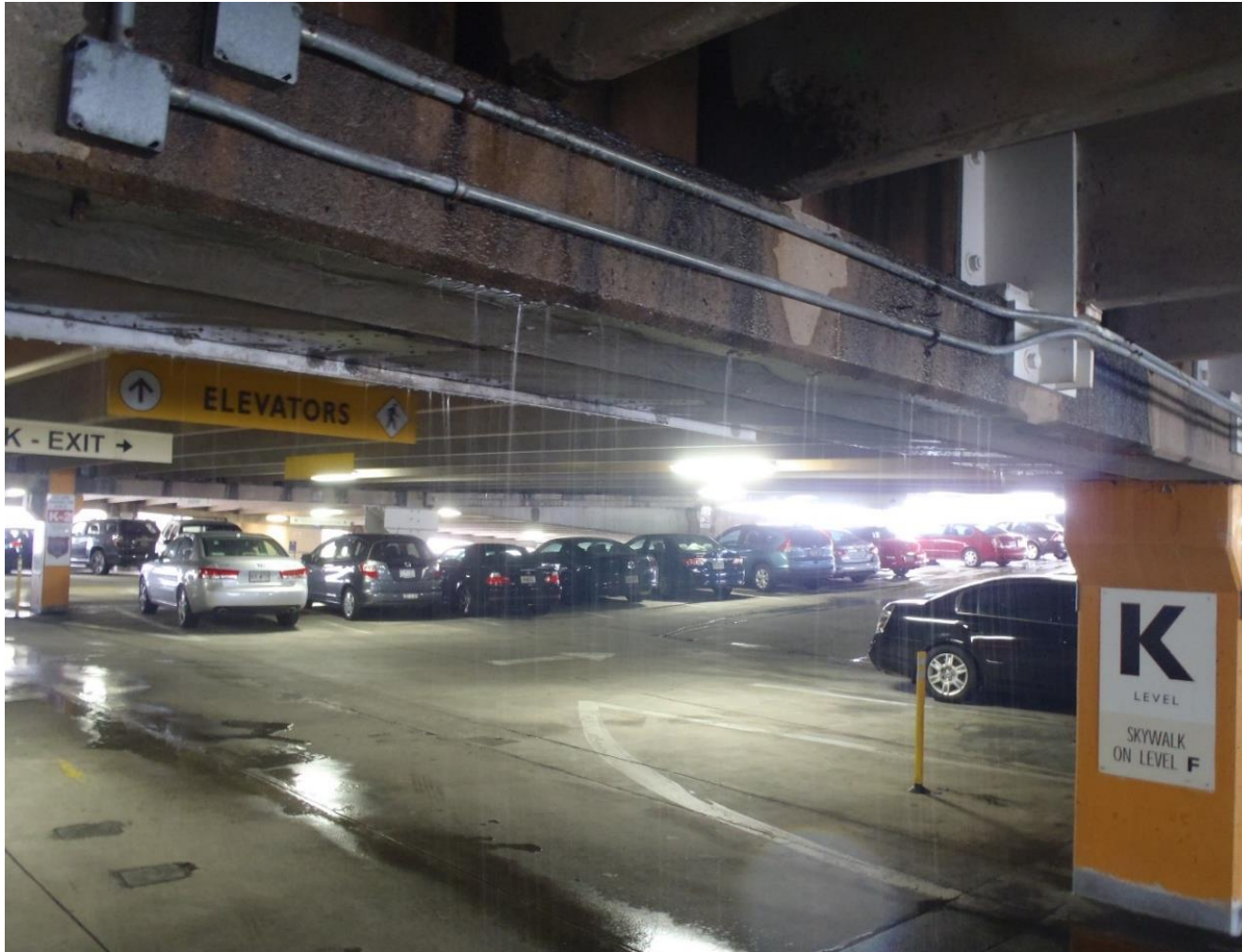


Ponding



Supplemental Drain

Common Deficiency: Failed Joints



- Why is it Raining in my Parking Structure?

Common Deficiency: This is Why



Sealant Failure

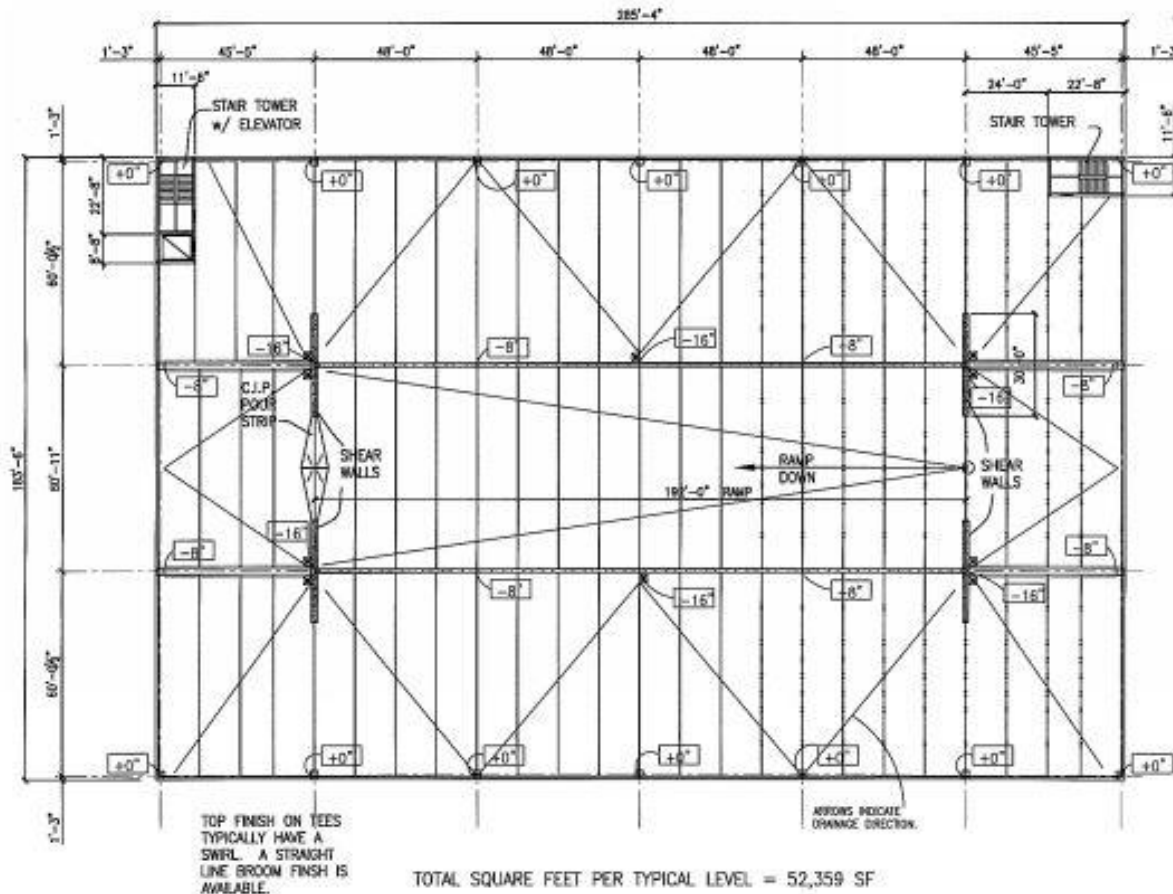


Cracks



Expansion Joint Failure

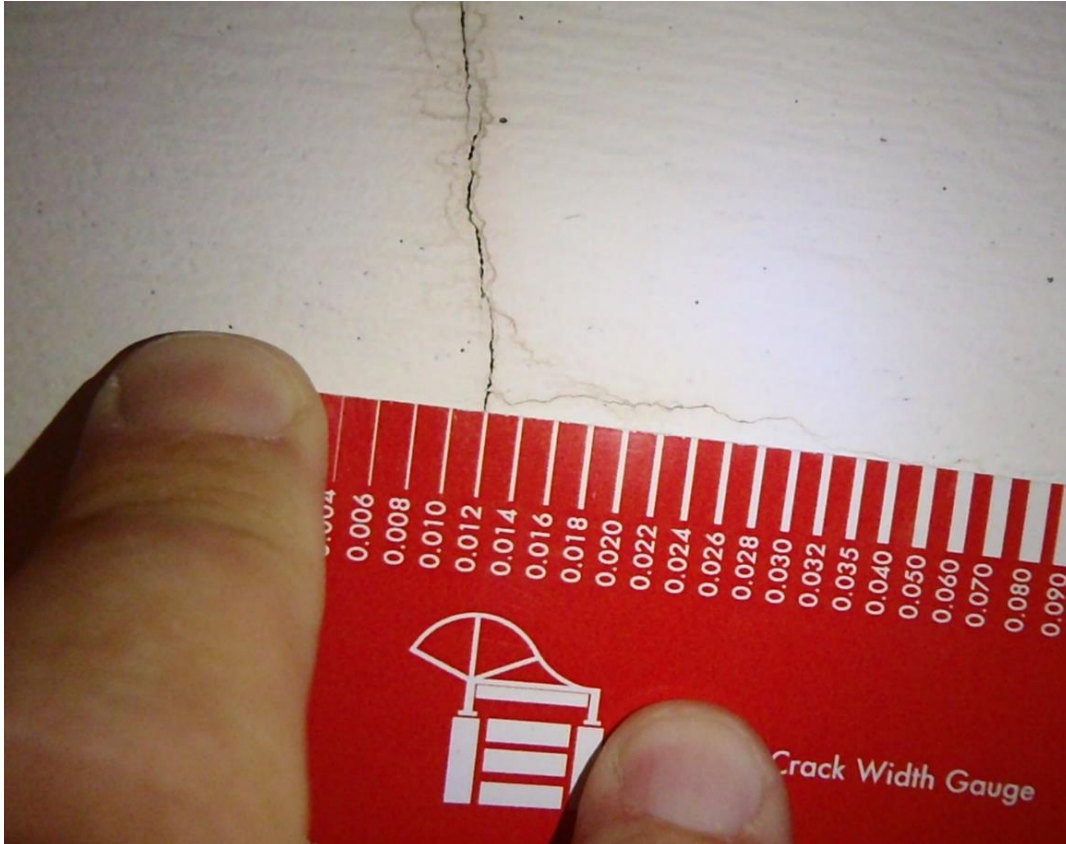
Common Deficiency: Failed Joint Sealant



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



Photos by Engineered Restorations Inc.

Cracks $\geq .035"$



Inflatable Injection Port

Common Deficiency: Exterior Spalls



Spall Over Sidewalk



Spall Size

Common Deficiency: Sounding



Chloride Ion Testing



Dust at Various Depths



Chloride Ion Concentration

Carbonation Testing



Coring Slab



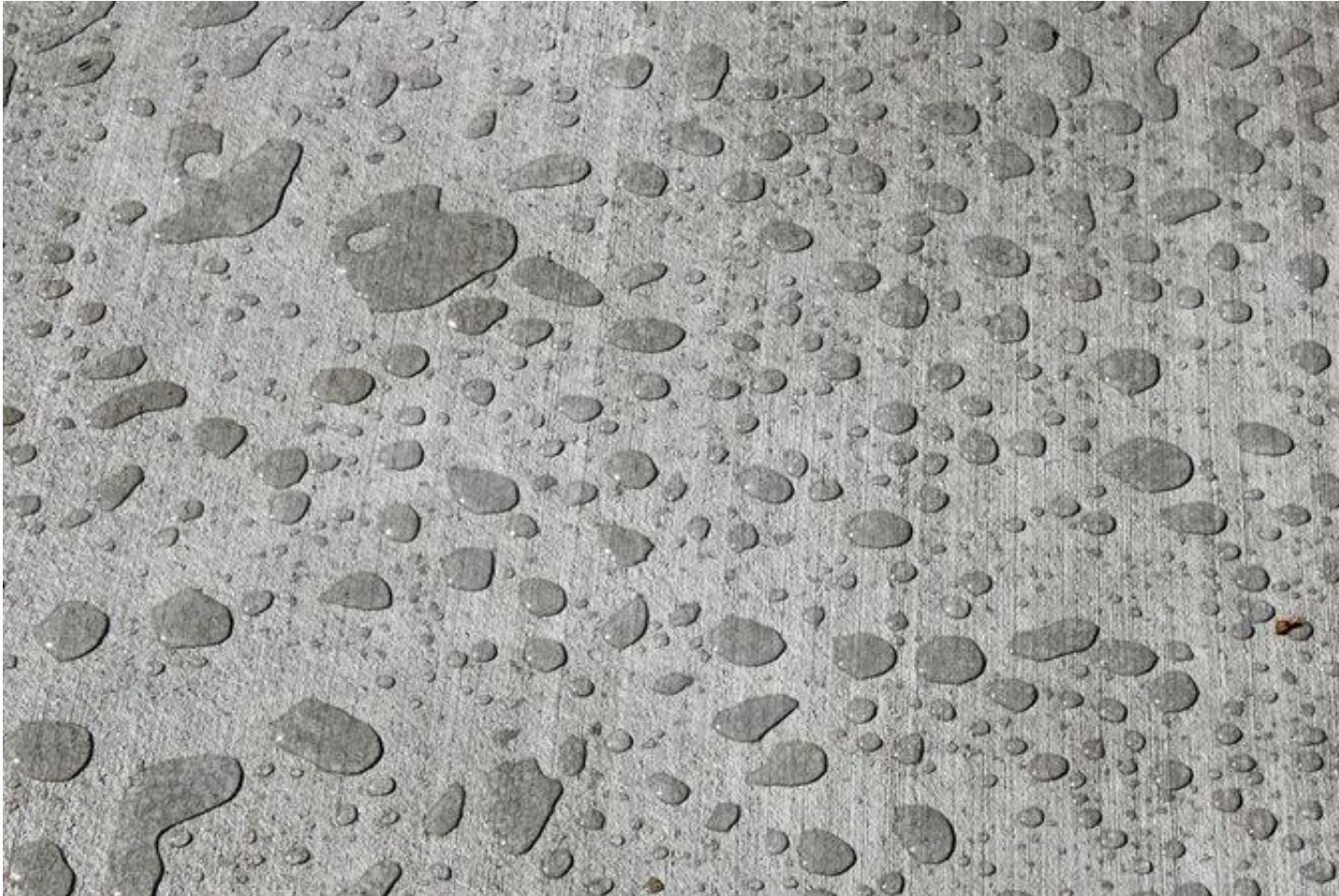
Depth of Carbonation

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

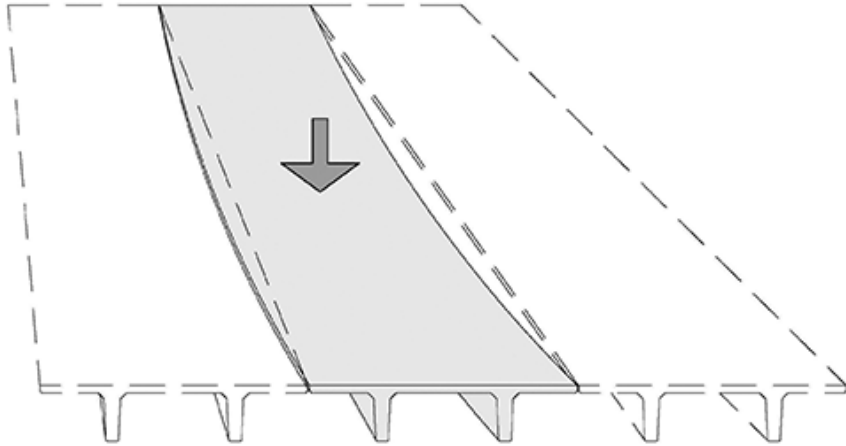


Good as New

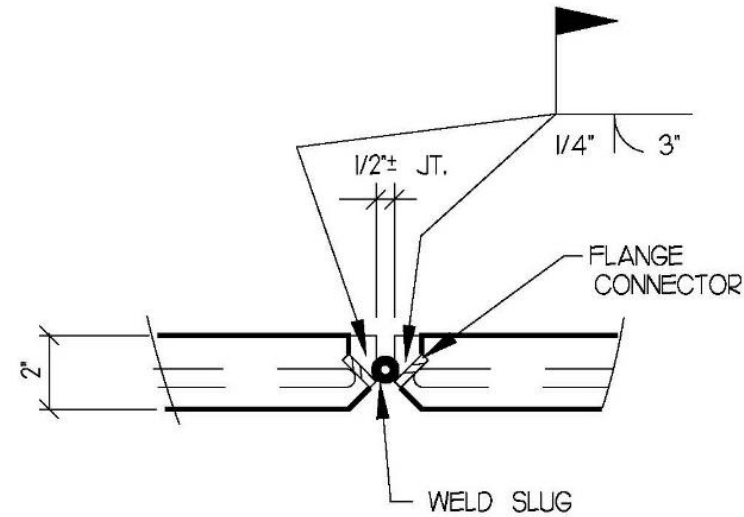
Precast Shear Transfer Repair



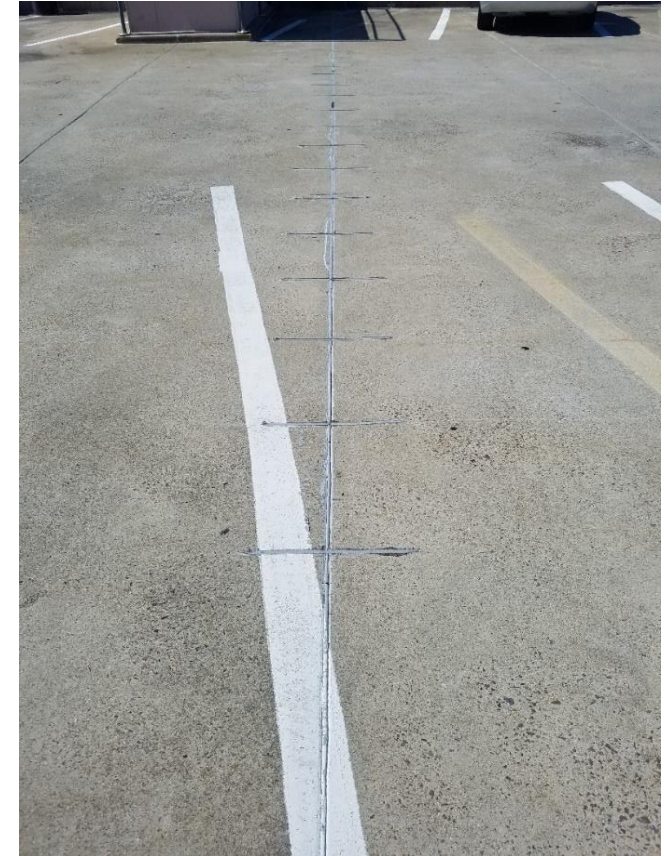
Precast Shear Transfer Repair



Precast Double Tees

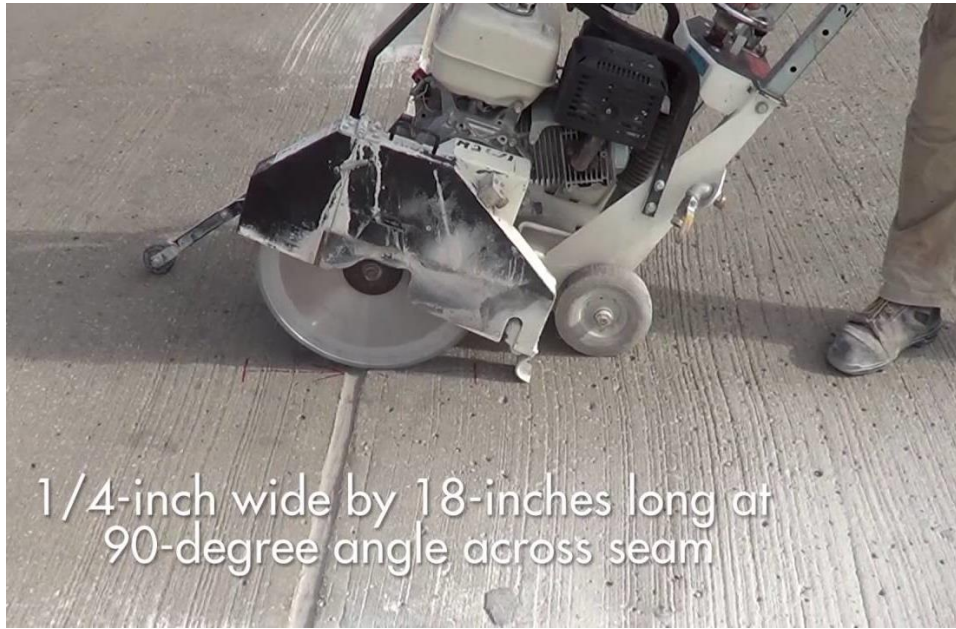


Shear Transfer



Repair

Precast Shear Transfer Repair



Saw Cut Slab



Prepared Joint
& Biscuit



Repair

Images by V2 Composites

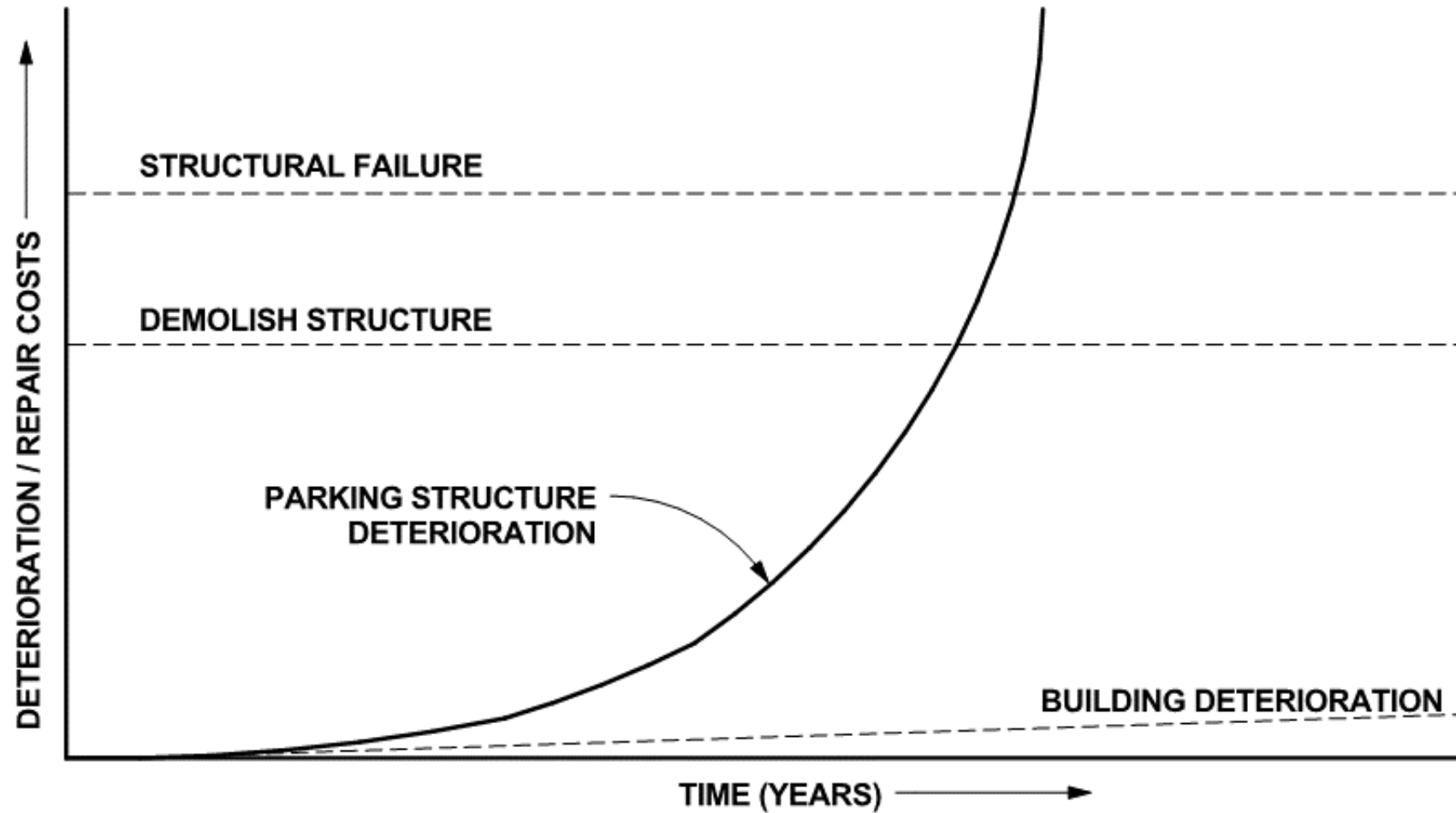
Structural Steel Corrosion



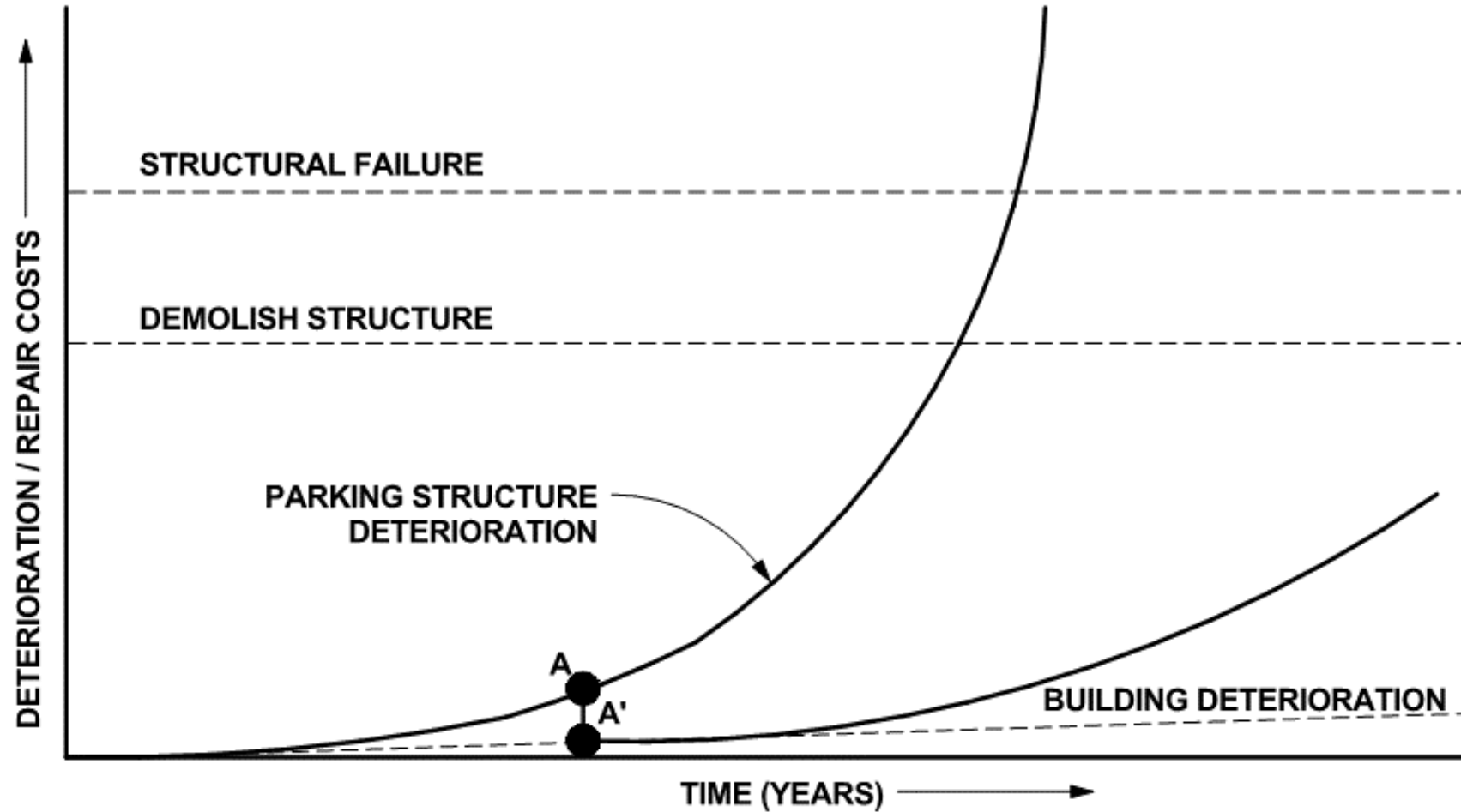
- **Steel Protection & Corrosion Issues**
- **Steel Deck Traps Moisture, Hides Degradation.**



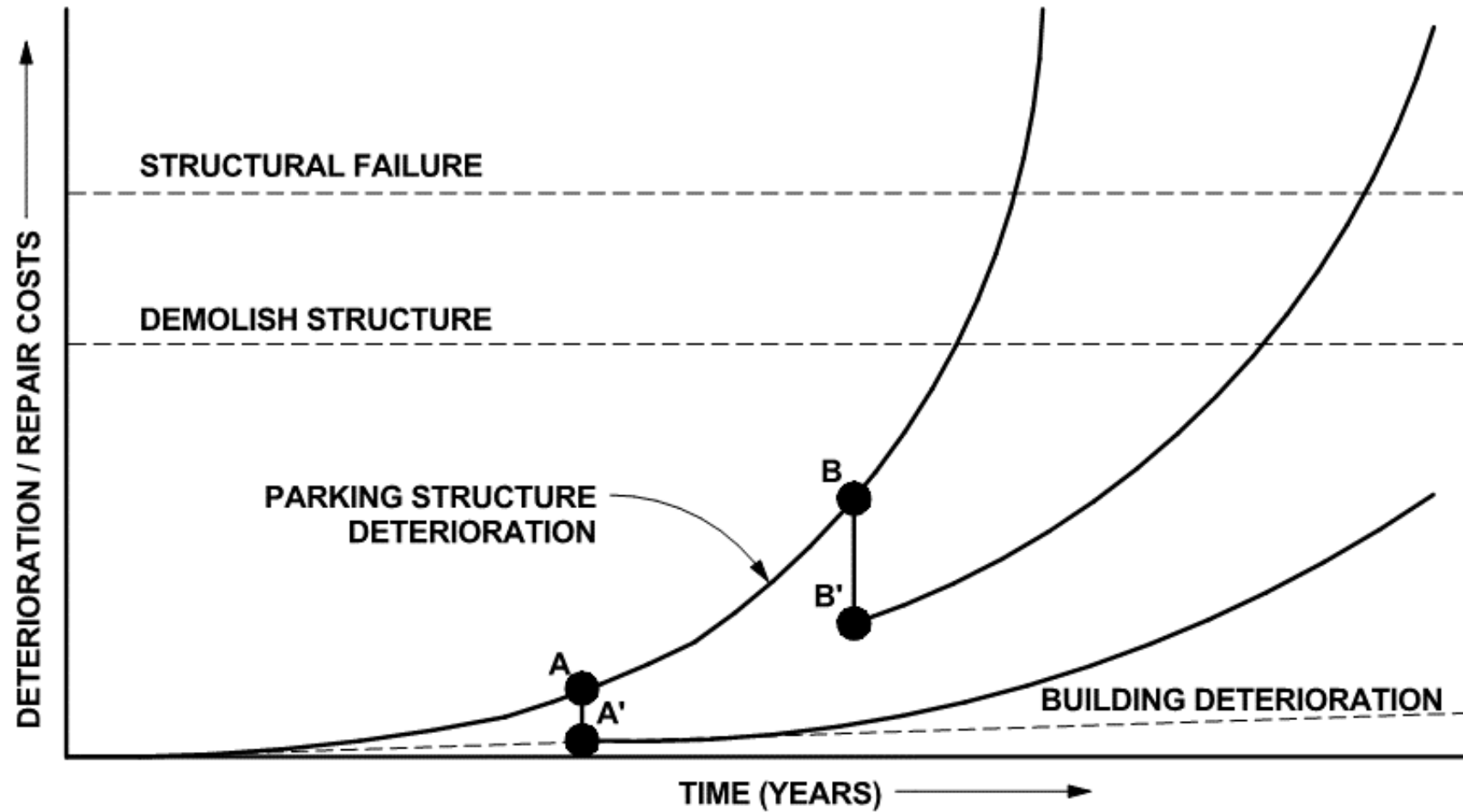
Maintenance Cost Curve



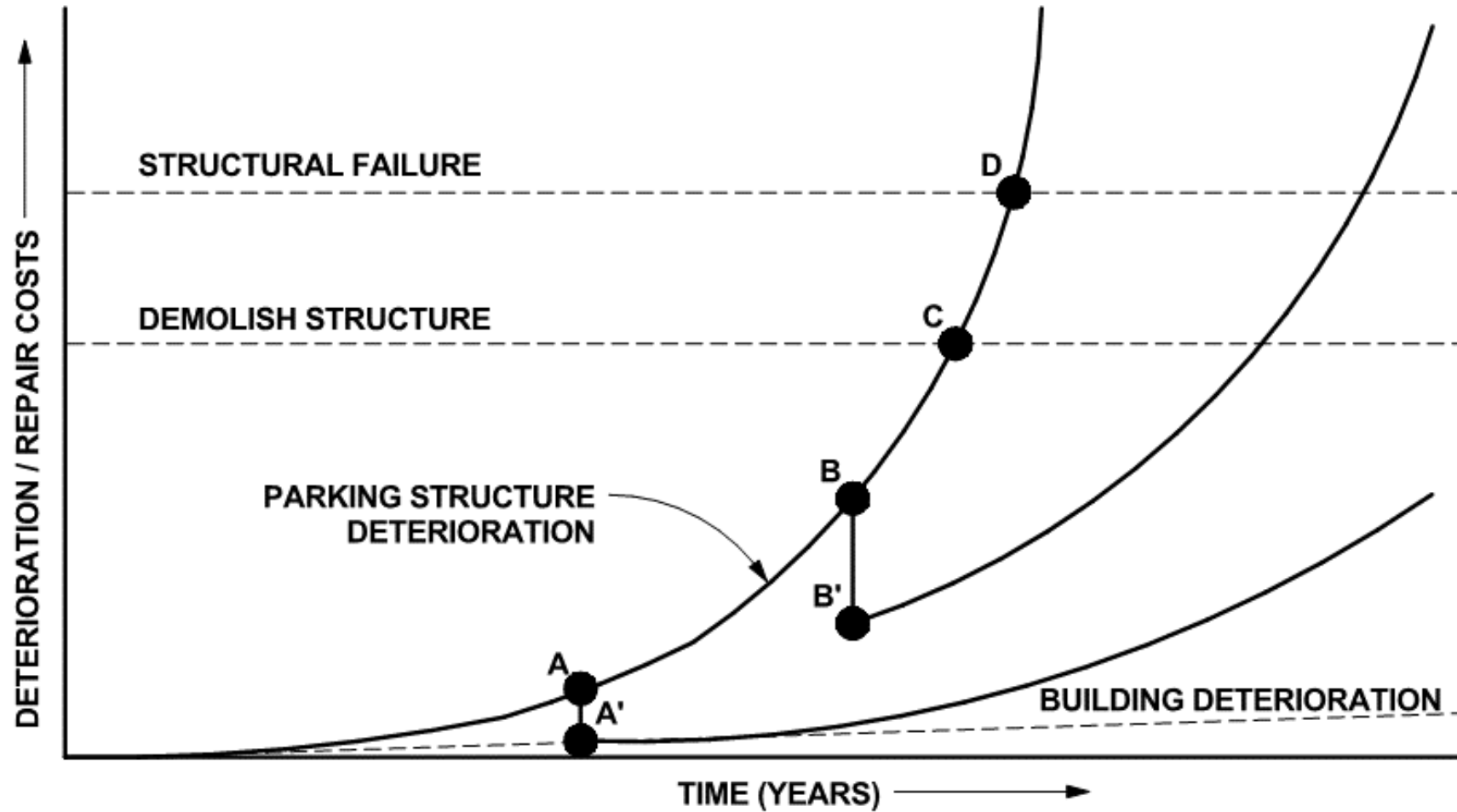
Maintenance Cost Curve



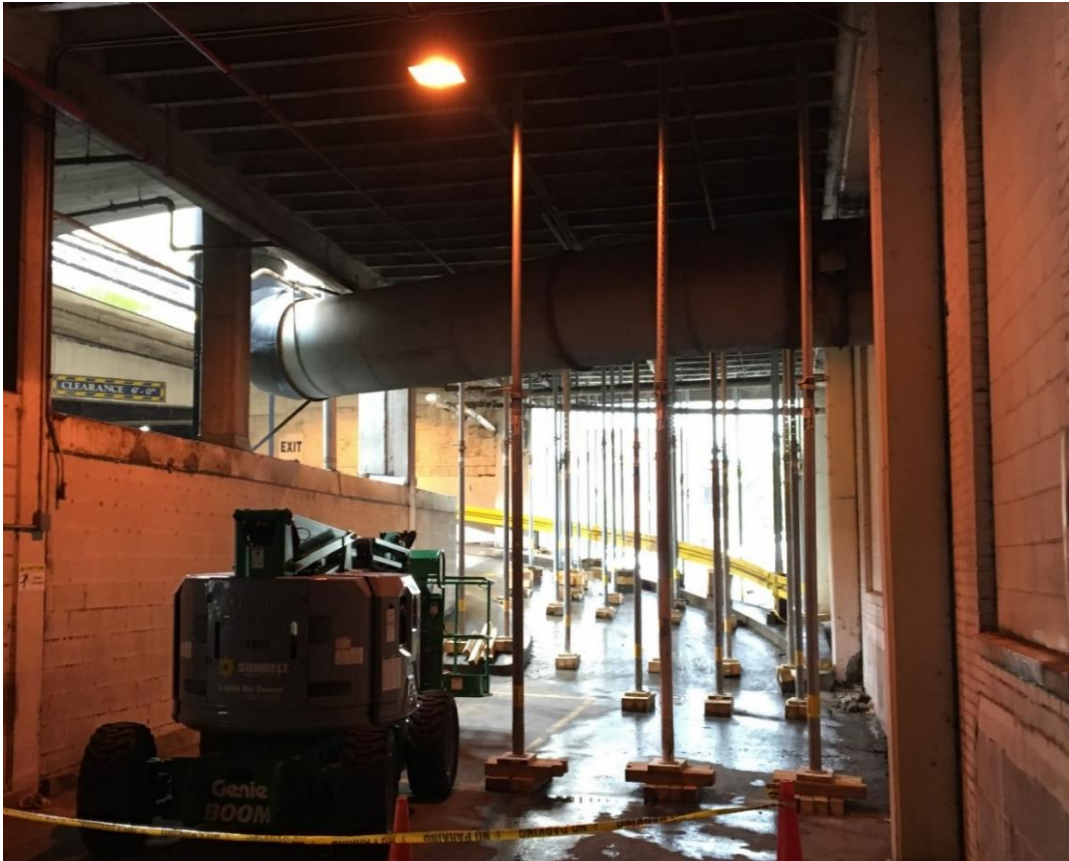
Maintenance Cost Curve



Maintenance Cost Curve



Reactive Maintenance



Now Demolished

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

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- **Importance of Routine Maintenance & Timely Restoration**

Questions?



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