

Parking Structure Maintenance



*Presented By:
Innovative Engineering Inc.*

SCOTT L. WEILAND PE

Wednesday April 24, 2019

**The Parking and Transportation Association of
Georgia**

Learning Objectives

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

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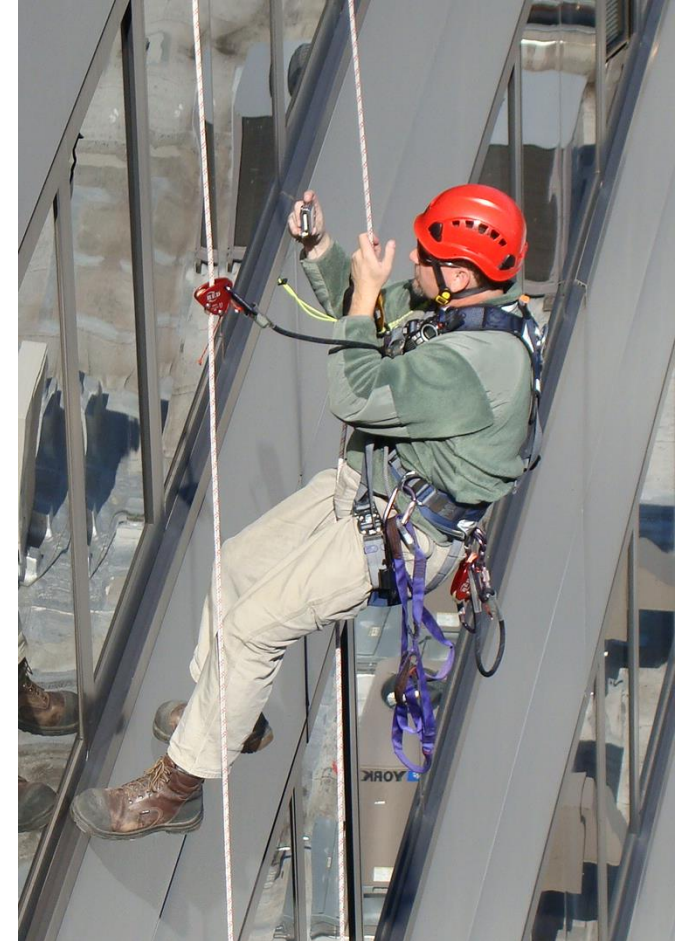
- Scott L. Weiland PE
 - BSCE University of Michigan
 - Graduate Studies:
 - San Jose State University
 - Georgia Institute of Technology
 - PE in 20 States + PR & Guam
 - 38 Years in Design and Construction
 - BOMA Georgia Insight magazine
 - Parking Structure maintenance part 1 & 2
 - Falling Building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



Innovative Engineering, Inc.



- **Trey Thomas PE**
 - **BSCET, Southern Polytechnic State University**
 - **15 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**
 - **Expert estimator (within 5% of actual)**
 - **Facility Condition Assessments (FCA's)**
 - **Façade Inspection**
 - **Parking Structure Restoration**

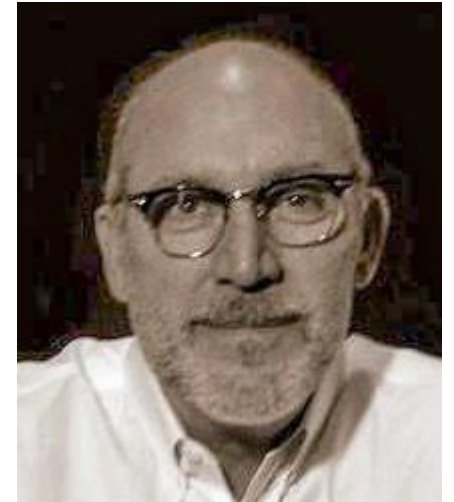


PARC, LLC

Parking
Access +
Revenue
Consultants



- Kirk Taylor, AIA, LEED AP
- Architecture Graduate, University of Texas, Austin
- Managed Texas Office for Walker Parking
- Started PARC in 2000
- **Specialties:**
 - Efficient Parking Facility Design
 - Needs Analysis
 - Access and Revenue Control
 - Market Feasibility
 - Capital Assessment



Engineered Restorations, Inc.



- Evan A. Moore PE, SE
- Founded by Don Moore 1994
- Specialty Contractor
- Specialties
 - Structural Repair
 - Restoration
 - Waterproofing
 - Preservation



Structural Systems

Cast-in-Place Concrete



Precast Concrete



Structural Steel



Others Systems (generally not recommended)

Mild Reinforced Concrete	Prone to Cracking
Composite Metal Deck on Steel	Deck Traps Moisture
Bar Joists w/Metal Deck on Steel	Prone to Cracking
Filigree Slab Soffits on Steel	Prone to Cracking
Hollow Core Slabs on Steel/Conc.	Prone to Water Intrusion
Keystone Joist & Beam Soffits	Florida, Steel Connections, Cracks

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



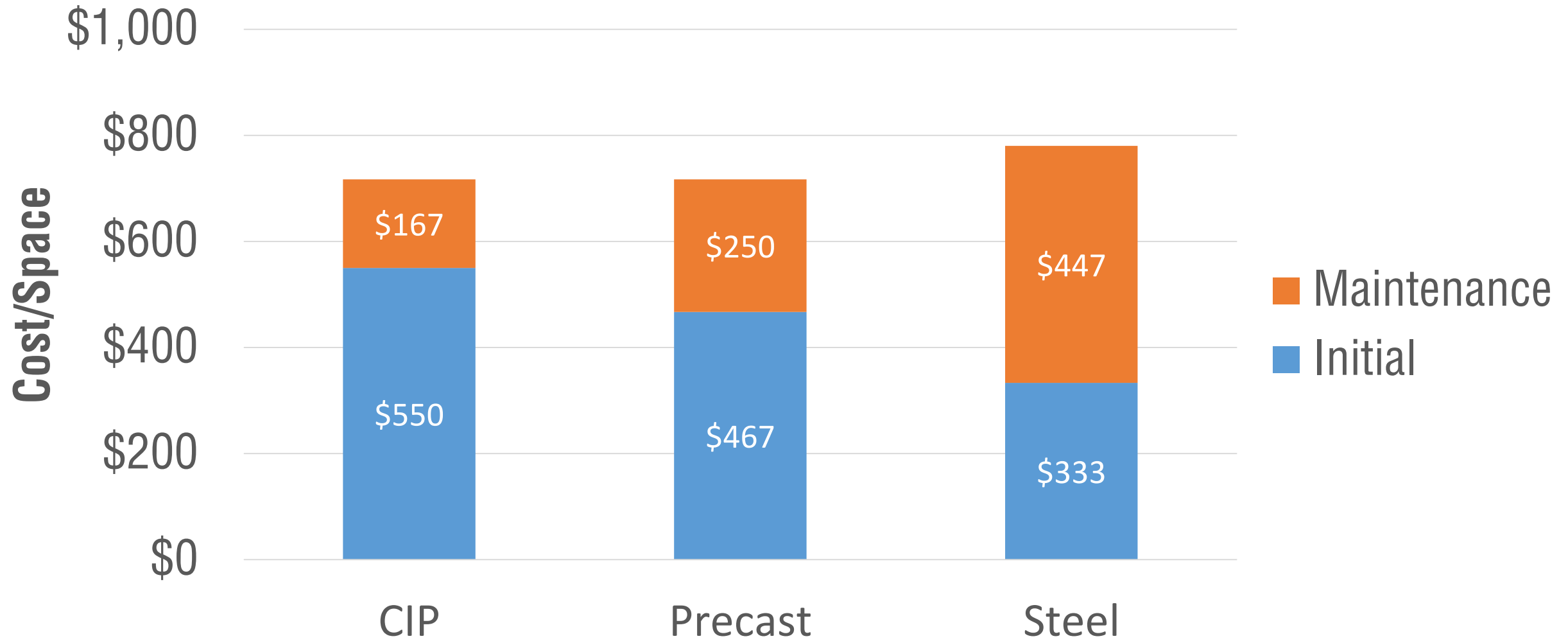
- **Advantages**
 - Lower Initial Investment than CIP
 - Fabricated in Controlled Plant Environment
 - Not Weather Dependent
 - Accelerated Construction Schedule
- **Disadvantages**
 - May be no local plant
 - Geometry not Flexible
 - Lower Perceived Ceiling heights
 - Shearwalls (Closed In)
 - More 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 Protection

Typical Annual Life Cycle Costs

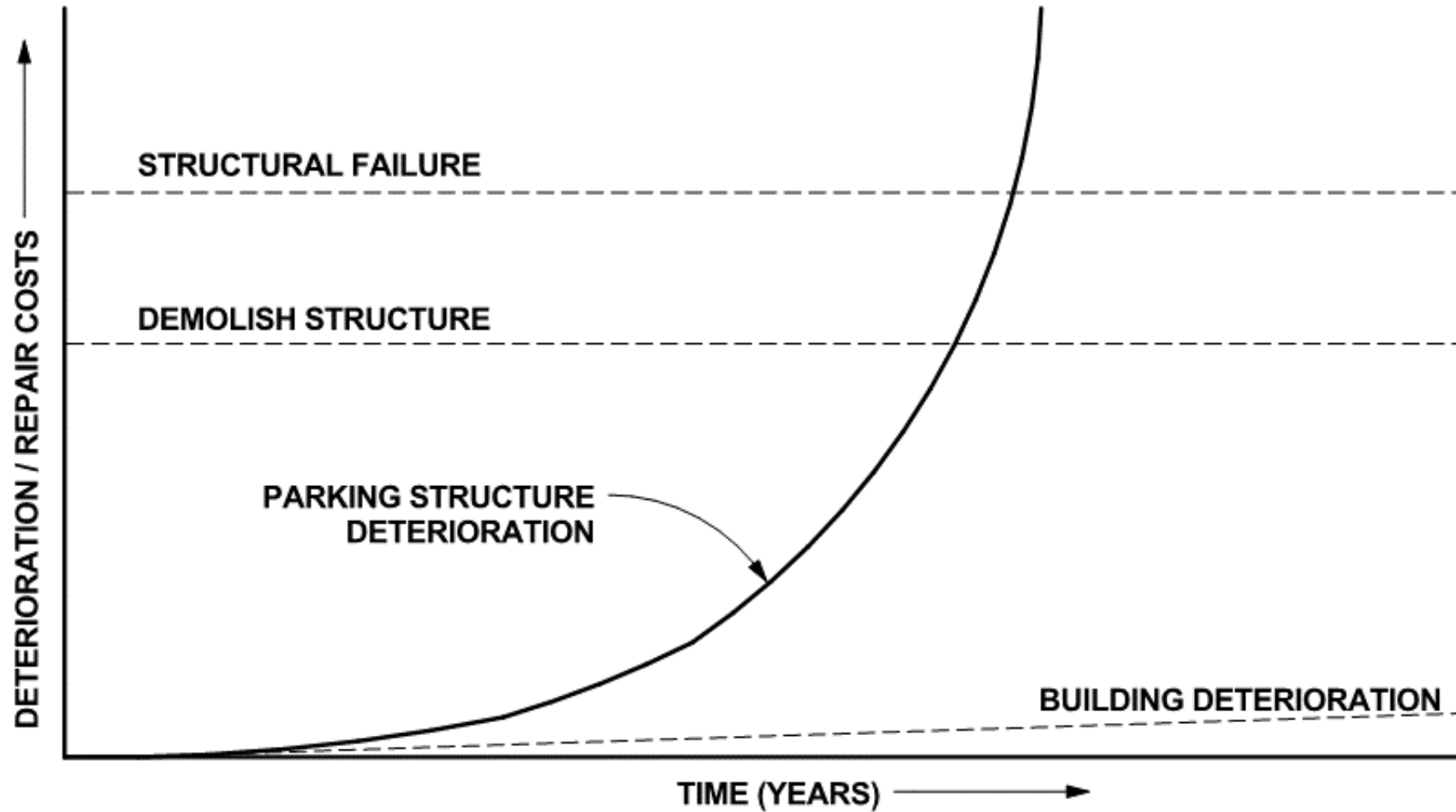


Parking Structures



- 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

Common Deficiencies

- **Number 1 Enemy**

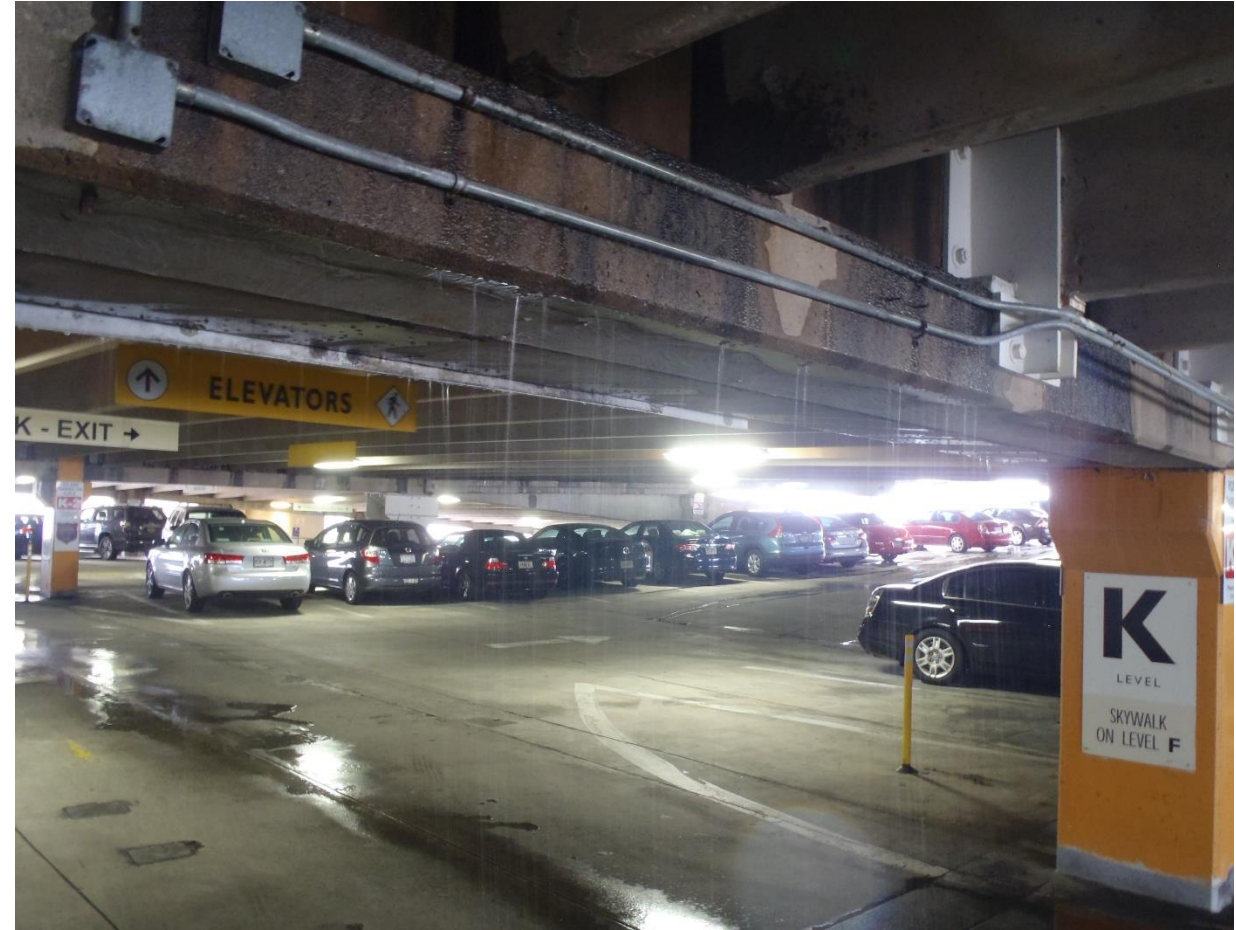


WATER

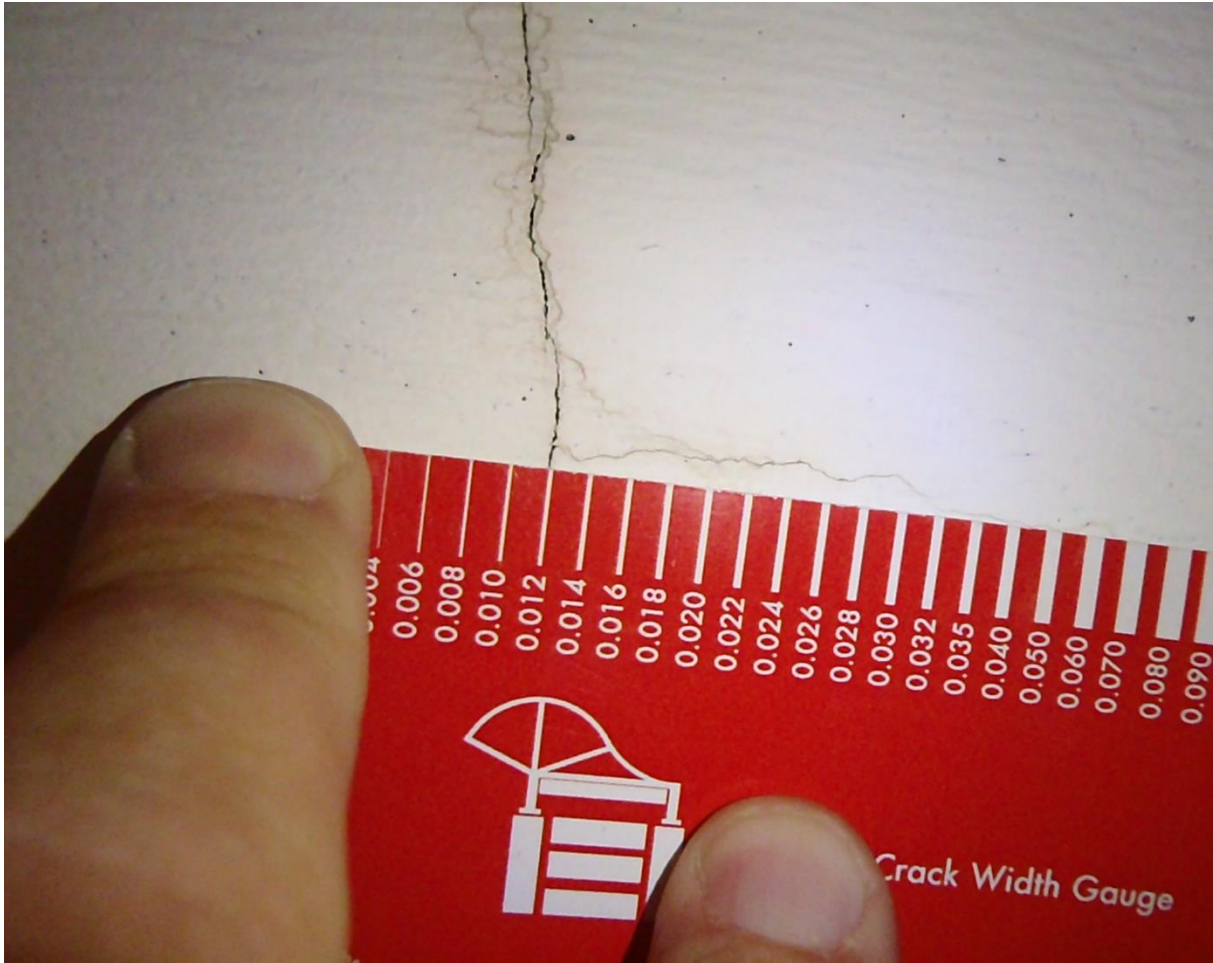
Common Deficiency: Ponding



Common Deficiency: Failed Joints



Common Deficiency: Cracks & Repair



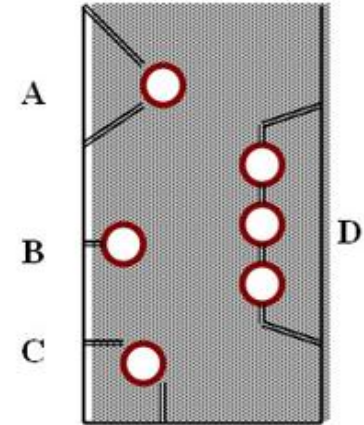
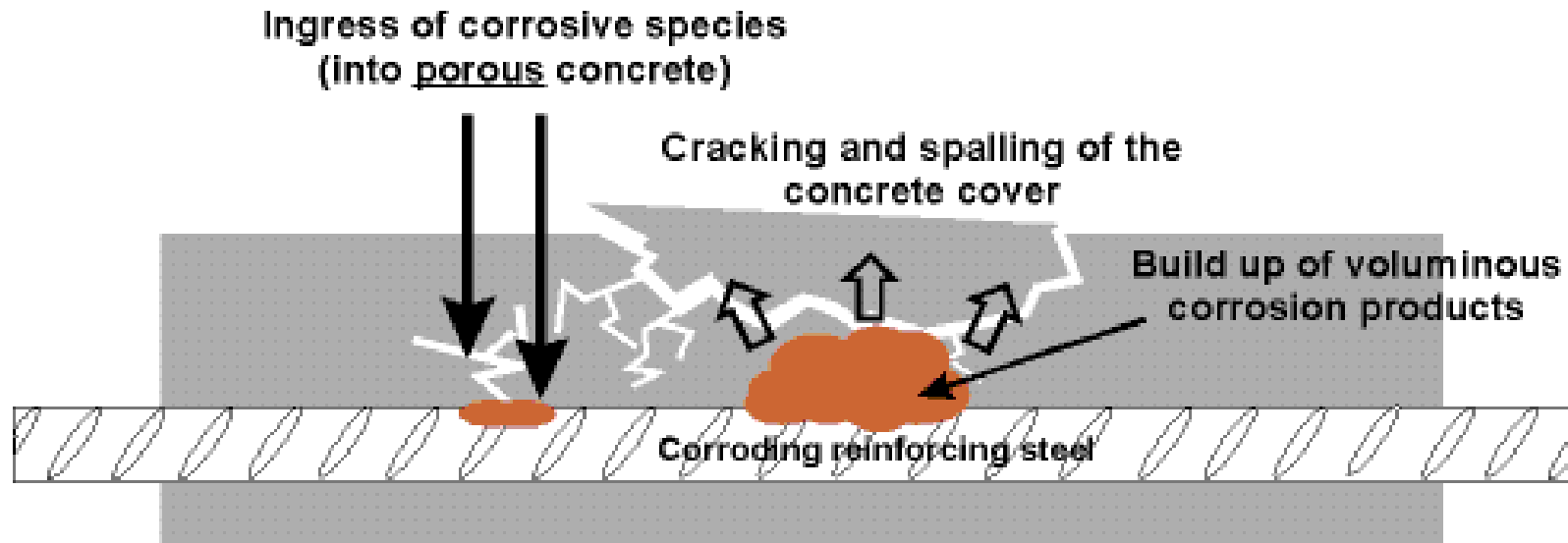
Common Deficiency: Route & Seal



Common Deficiency: Epoxy Injection



Common Deficiency: Corrosion



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

Chloride Ion Testing



Carbonation Testing



Common Deficiency: Last Resort



Parking Structure Maintenance

Common Deficiency: Sounding



Common Deficiency: Spall & Delamination



Common Deficiency: Failing Spall Repair



Common Deficiency: Exterior Spalls (Over Sidewalk)

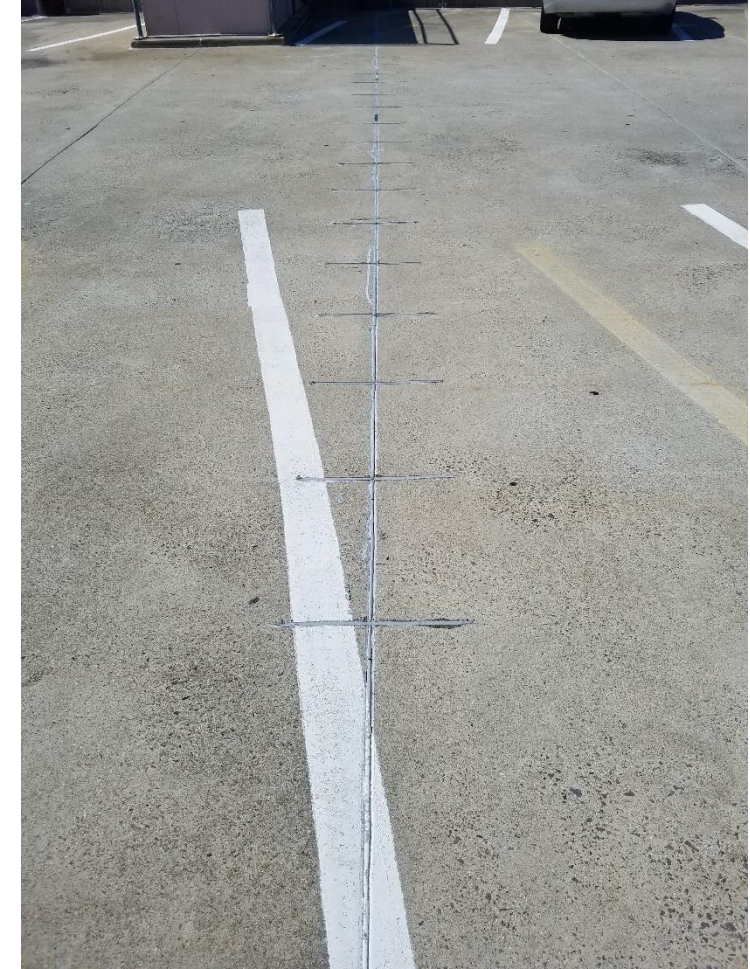
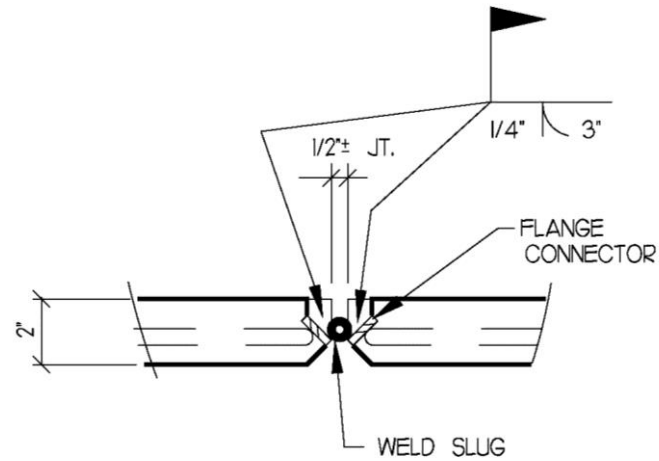
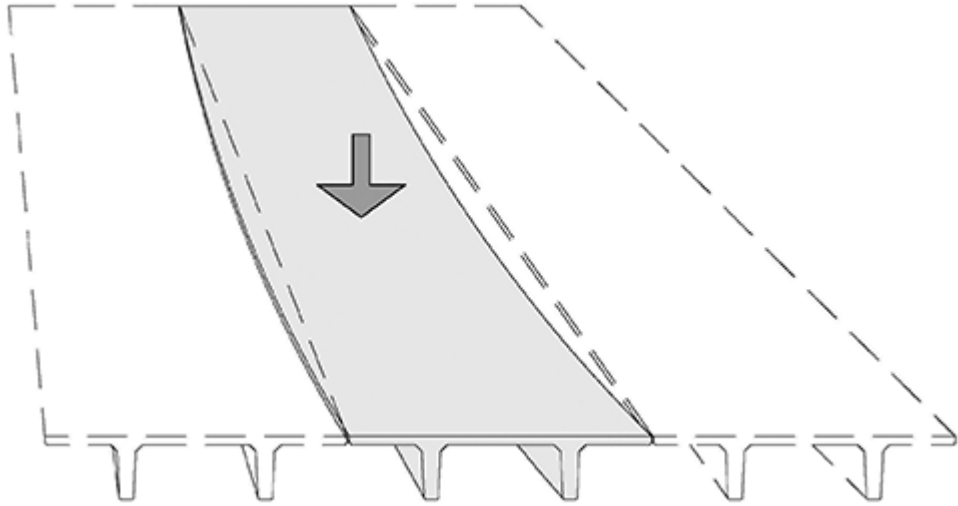


Precast Shear Transfer Repair



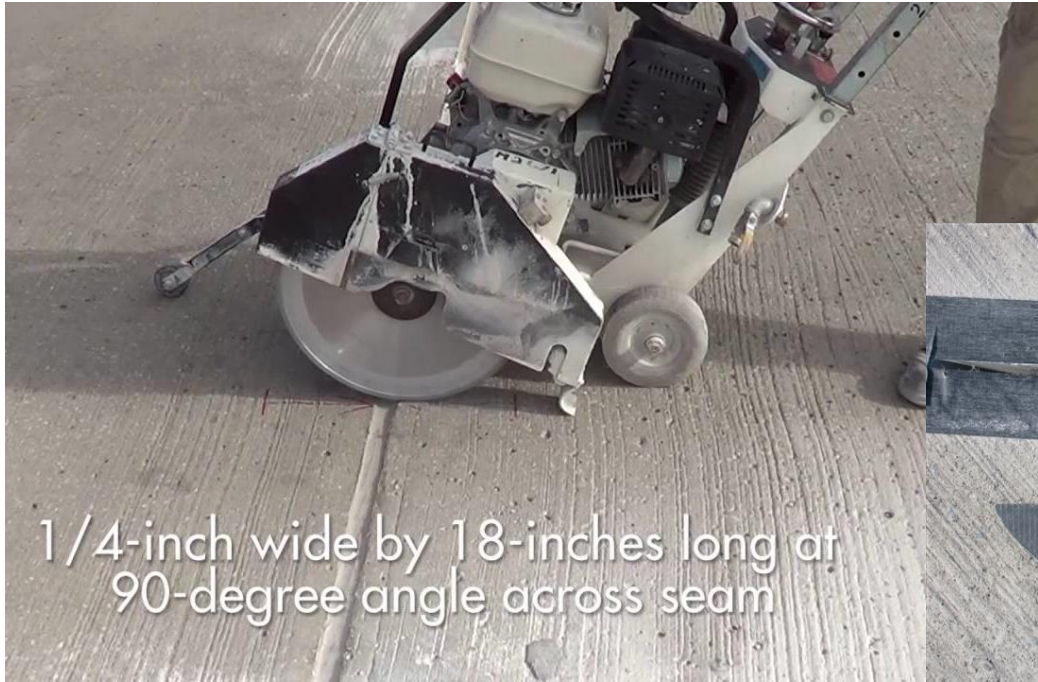
Parking Structure Maintenance

Precast Shear Transfer Repair



Precast Shear Transfer Repair

Saw Cut & Biscuit Repair



Images by V2 Composites

Structural Steel Corrosion



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

Precast Connection Failures – Double Tee Joists



Precast Connection Failures - Joist



Image by Structure magazine

Precast Haunch Connection Failure & Repair



Precast Haunch Connection Failure & Repair



Precast Haunch Connection Failure & Repair



- Repaired

Common Deficiency: Guardrail



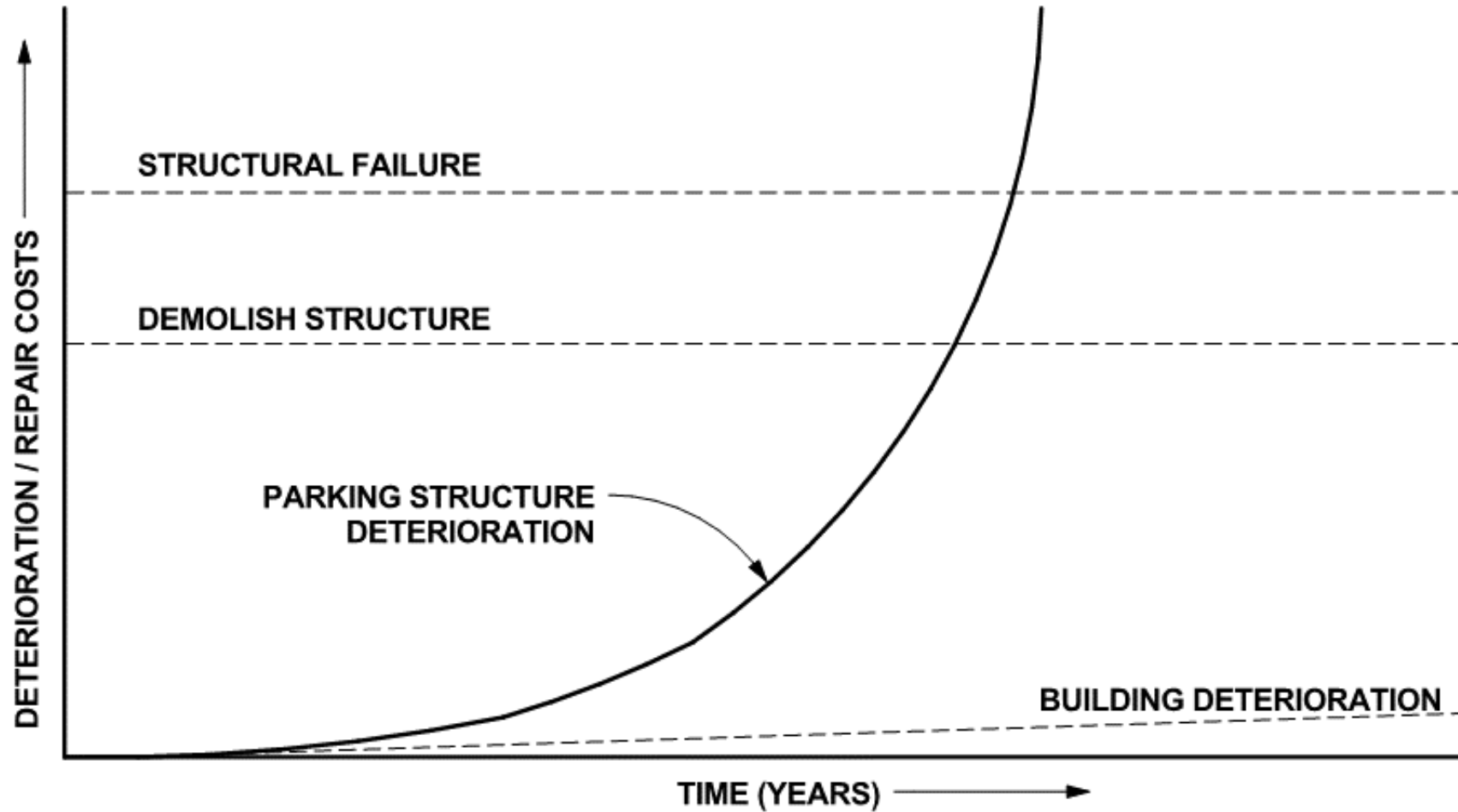
Common Deficiency: Overloaded – Fire Truck



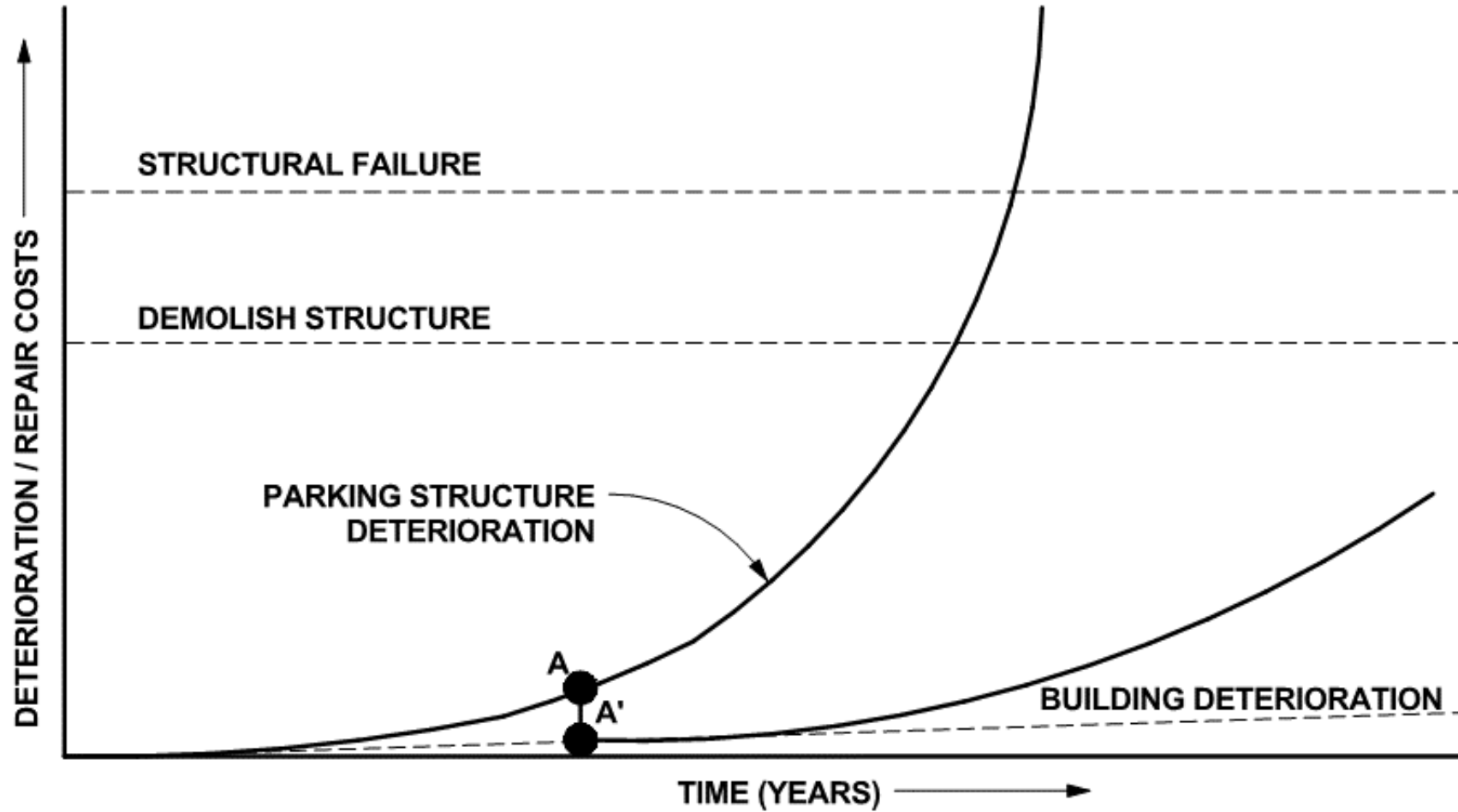
Common Deficiency: Curbs & Wheel Stops



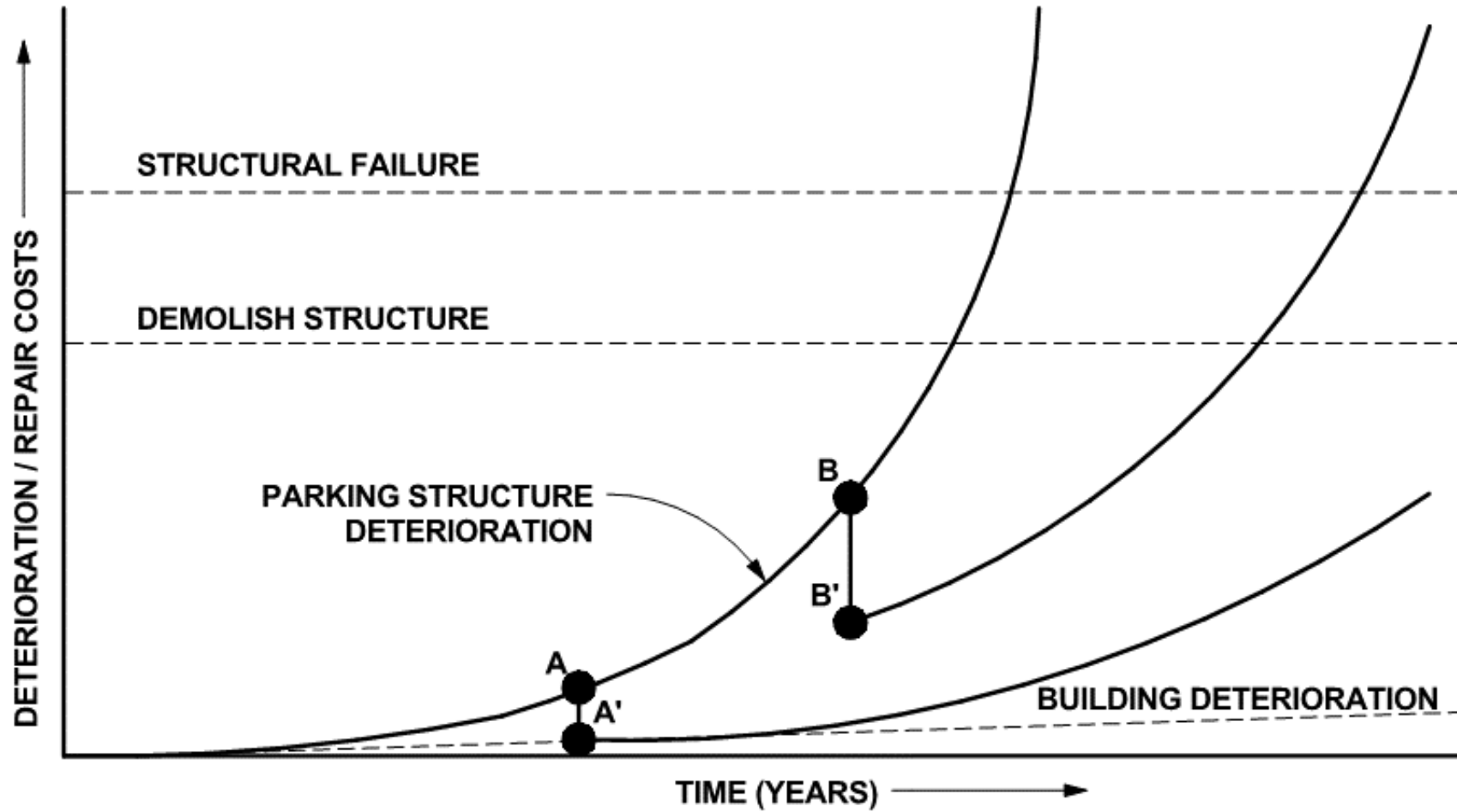
Maintenance Cost Curve



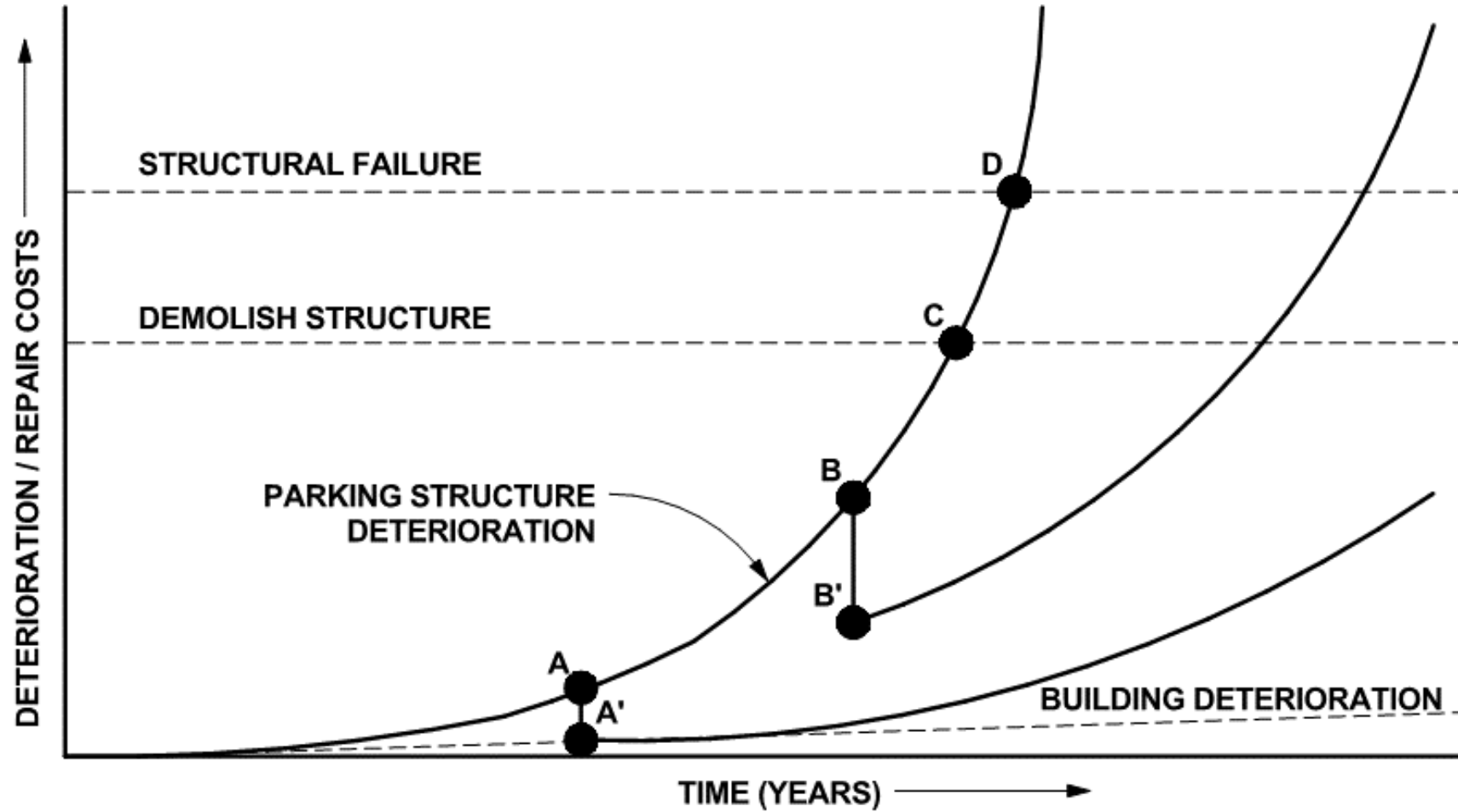
Maintenance Cost Curve



Maintenance Cost Curve



Maintenance Cost Curve



Maintenance Program: Planning

The image shows three overlapping forms related to parking structure maintenance. FORM F-1 is the top-left form, FORM F-2 is the middle form, and FORM F-5 is the bottom-right form.

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 elevator
- 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: _____ Inspector: _____
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: _____

- Elements of a Maintenance Program
 - Condition Assessments
 - Housekeeping
 - Routine Maintenance
 - Preventive Maintenance
 - Replacement
 - Budget

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Questions?

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