

Parking Structure Maintenance



Presented By:

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with
INNOVATIVE ENGINEERING
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Carolina Parking Association

Learning Objectives

- **Types of Parking**
- **Parking Structures**
 - Structure Types
 - Cost Comparison
 - Lifecycle Costs
- **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
 - 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



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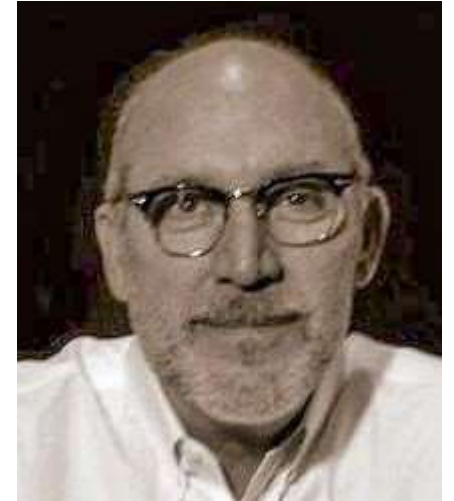
- **Trey Thomas PE**
 - **BSCET, Southern Polytechnic State University**
 - **15 Years in Design and Restoration Engineering**
 - Co-author of Parking Structure & Forensic articles
 - **Certified in Mold, Lead & Asbestos Surveying**
 - **OSHA Competent Person for Boom & Scissor Lifts**
 - **SPRAT Level 2 Rope Access Technician**
 - **Expert estimator (within 5% of actual)**
 - **Facility Condition Assessments (FCA's)**
 - **Façade Inspection**
 - **Parking Structure Restoration**



PARC, LLC



- 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



Types of Parking

On-Street



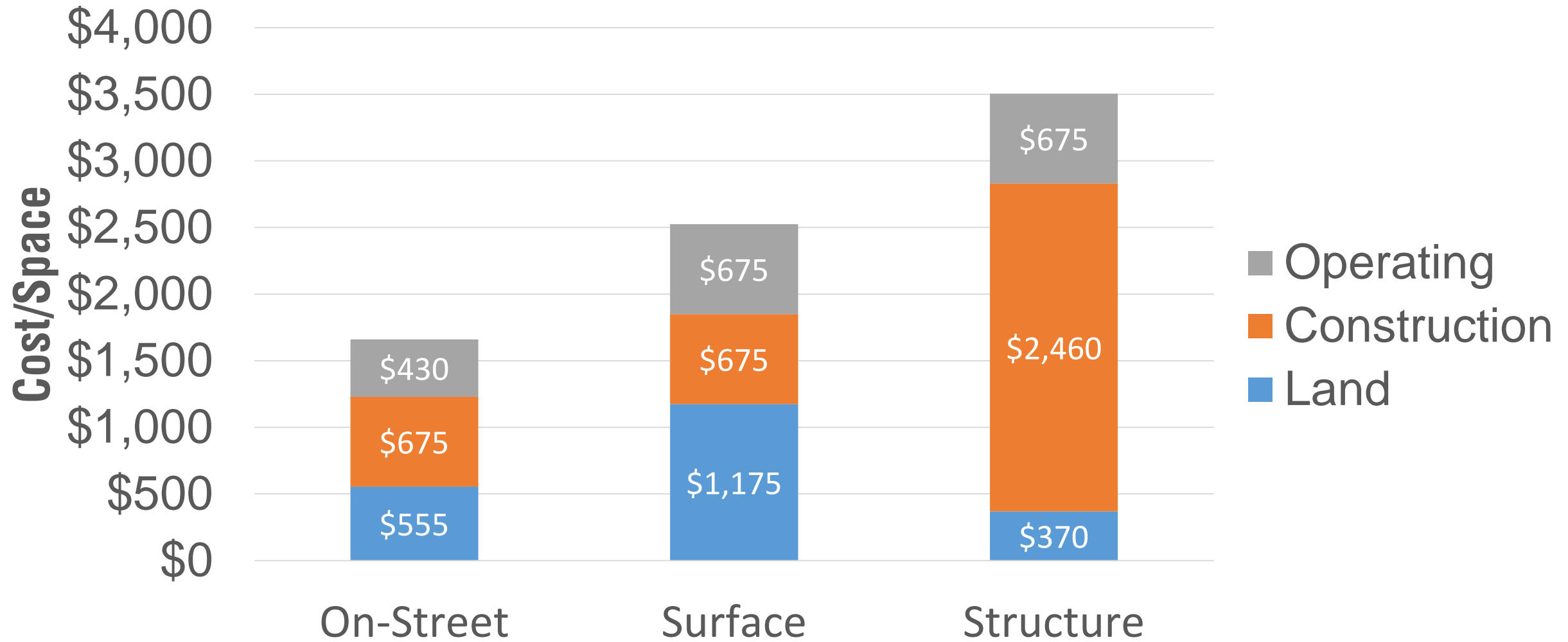
Surface



Structure



Typical Parking Annualized Costs per Space

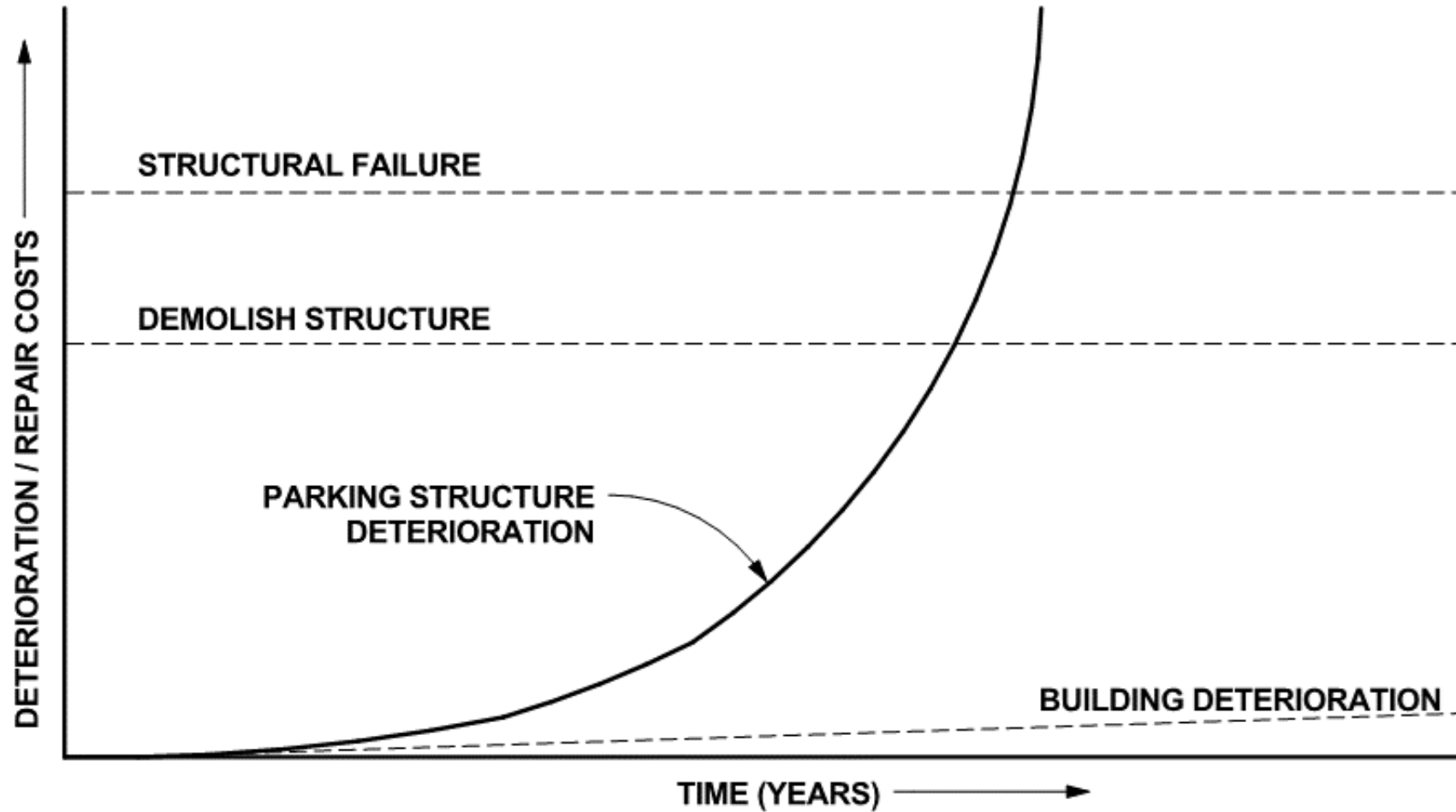


Parking Structures



- 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



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**

- 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



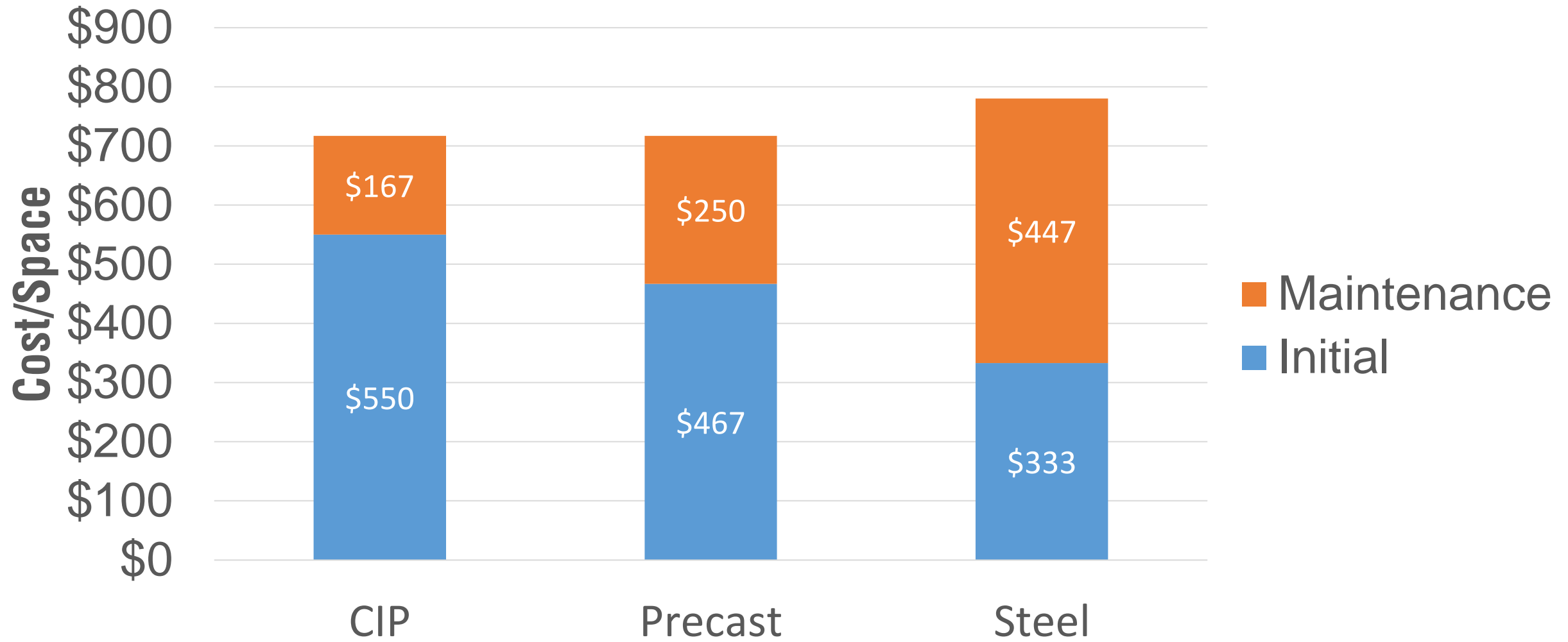
- **Advantages**

- 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



Common Deficiencies

- **Number 1 Enemy**



WATER

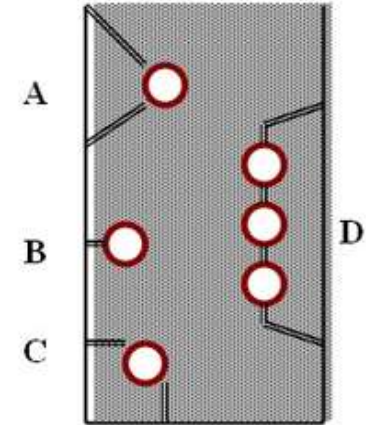
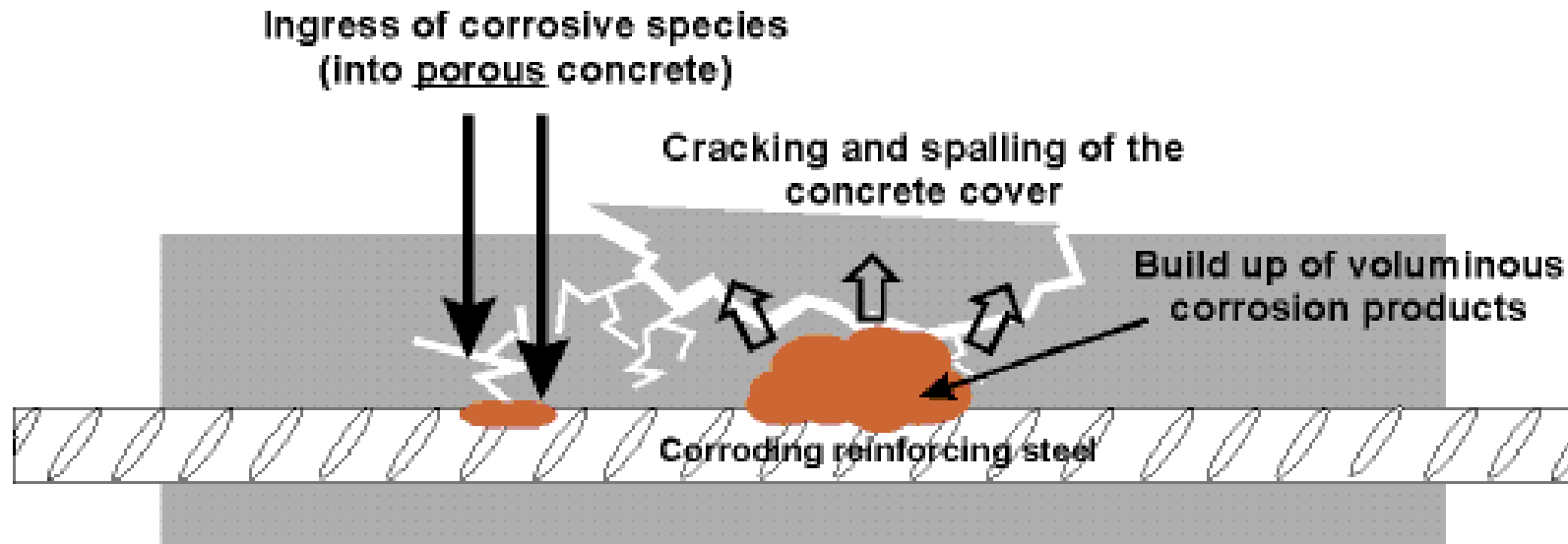
Common Deficiency: Ponding



Common Deficiency: Failed Joints



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: Cracks & Repair



Common Deficiency: Epoxy Injection



Common Deficiency: Spall & Delamination



Common Deficiency: Sounding



Common Deficiency: Failing Spall Repair



Common Deficiency: Exterior Spalls (Over Sidewalk)



Common Deficiency: Expansion Joints



Common Deficiency: Overloaded – Fire Truck



Common Deficiency: Guardrail



Common Deficiency: Curbs & Wheel Stops



Cast-In-Place Concrete: Post Tensioning



- Abrasion
- PT Cable Failure

Precast Connection Failures - Girder



Precast Connection Failures – Double Tee Joists



Precast Connection Failures - Joist



Steel Joist Seat Repair



CFRP Joist Repair

Image by Structure magazine

Precast Haunch Connection Failure & Repair



Precast Haunch Connection Failure & Repair

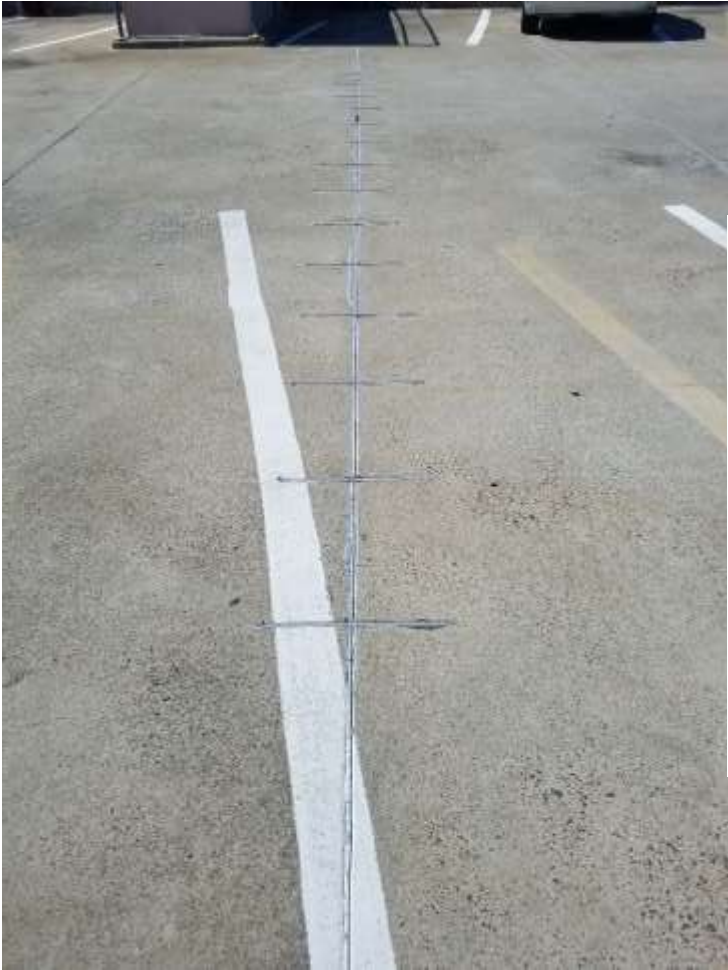


Precast Haunch Connection Failure & Repair

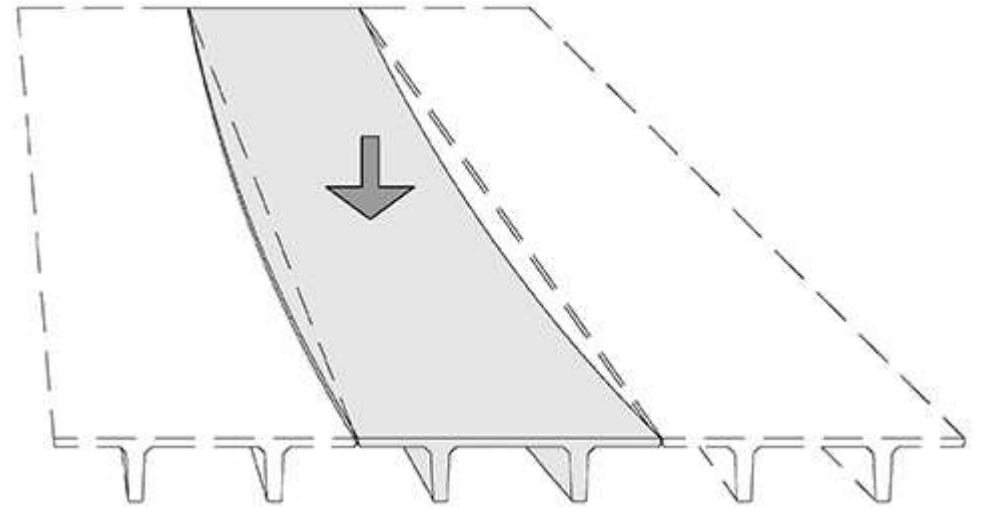
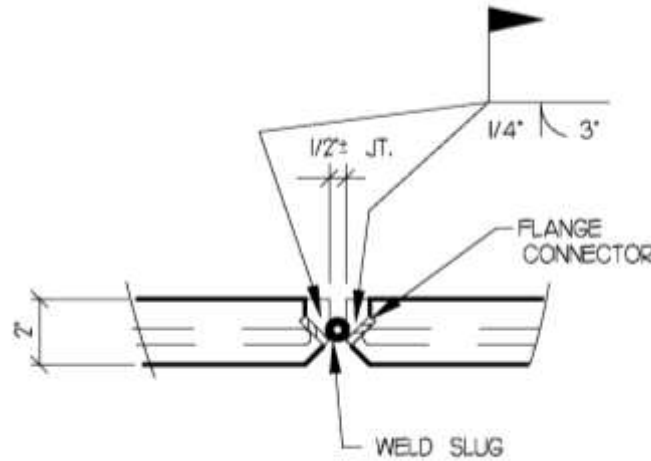


- Repaired

Precast Shear Transfer Repair



- Saw Cut & Biscuit Repair
- Biscuit Repair

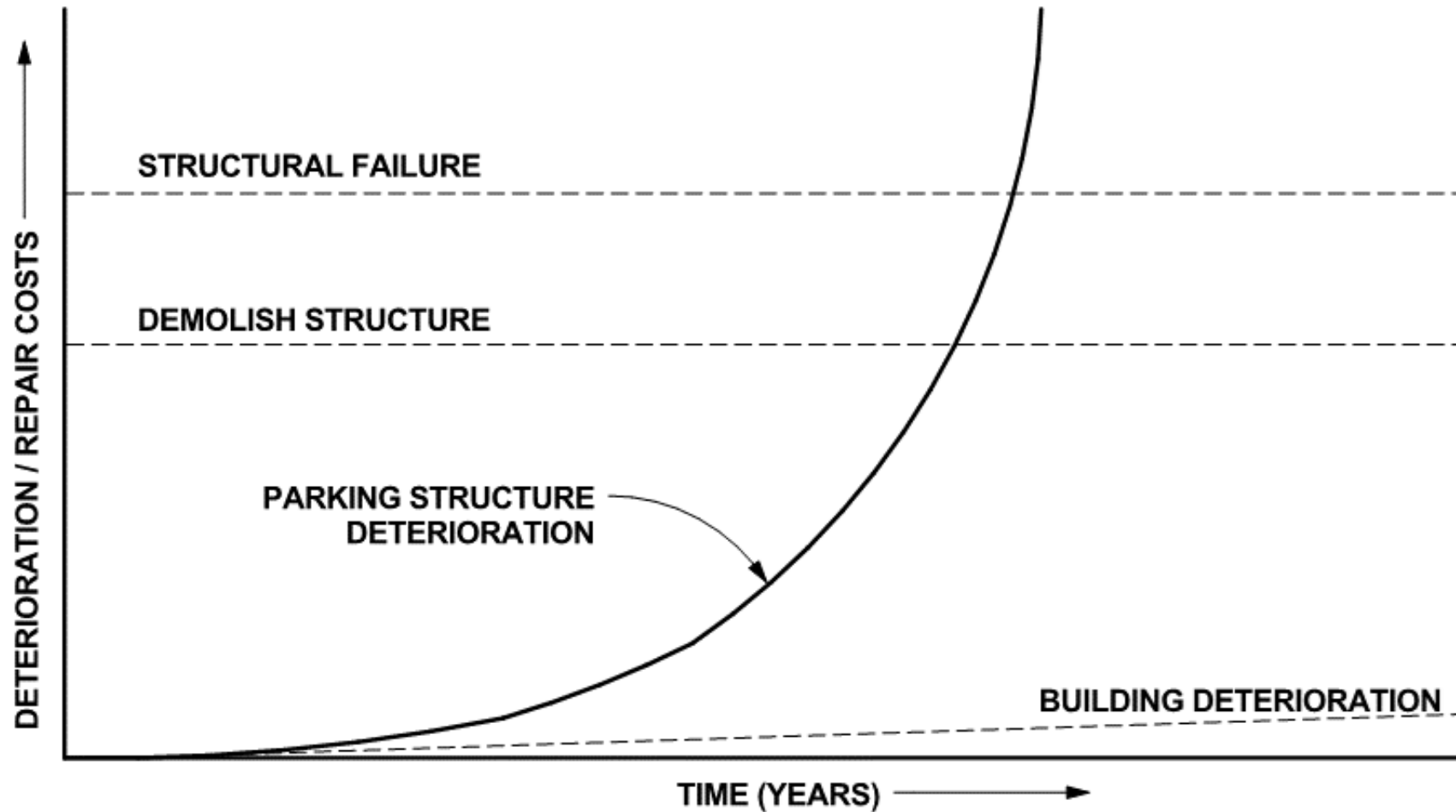


Structural Steel Corrosion

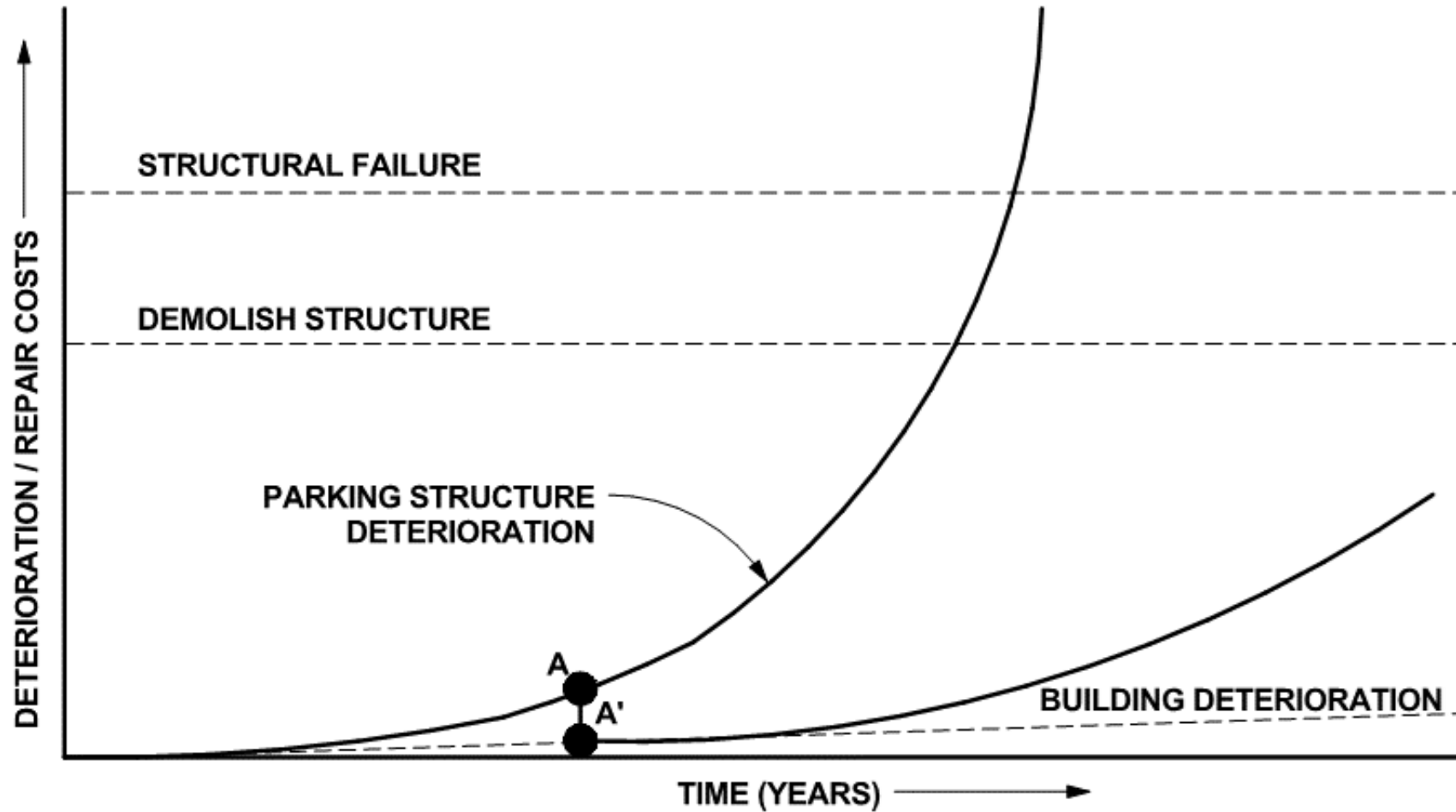


- Steel Protection & Corrosion Issues
- Steel Deck Traps Moisture, Hides Degradation.

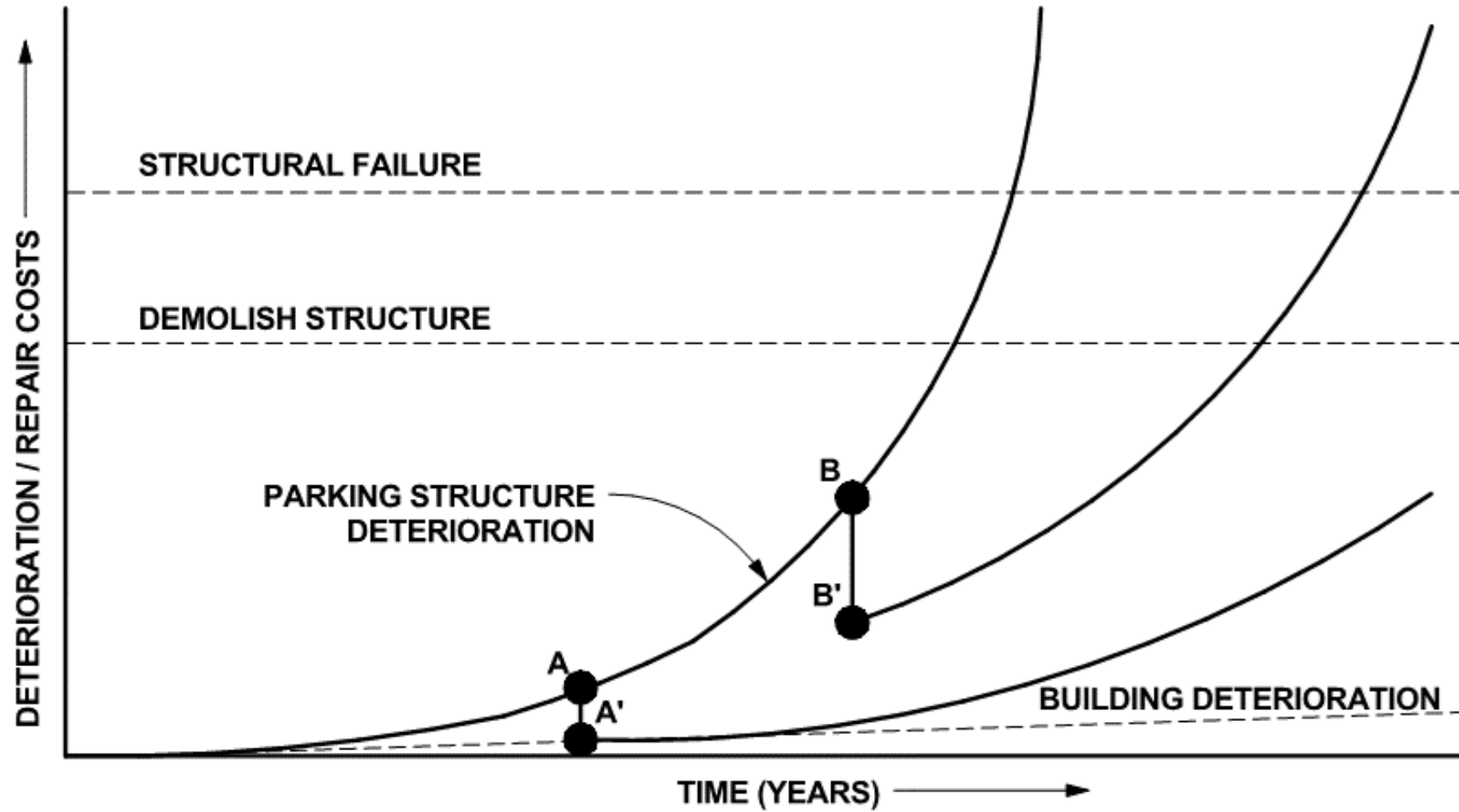
Maintenance Cost Curve



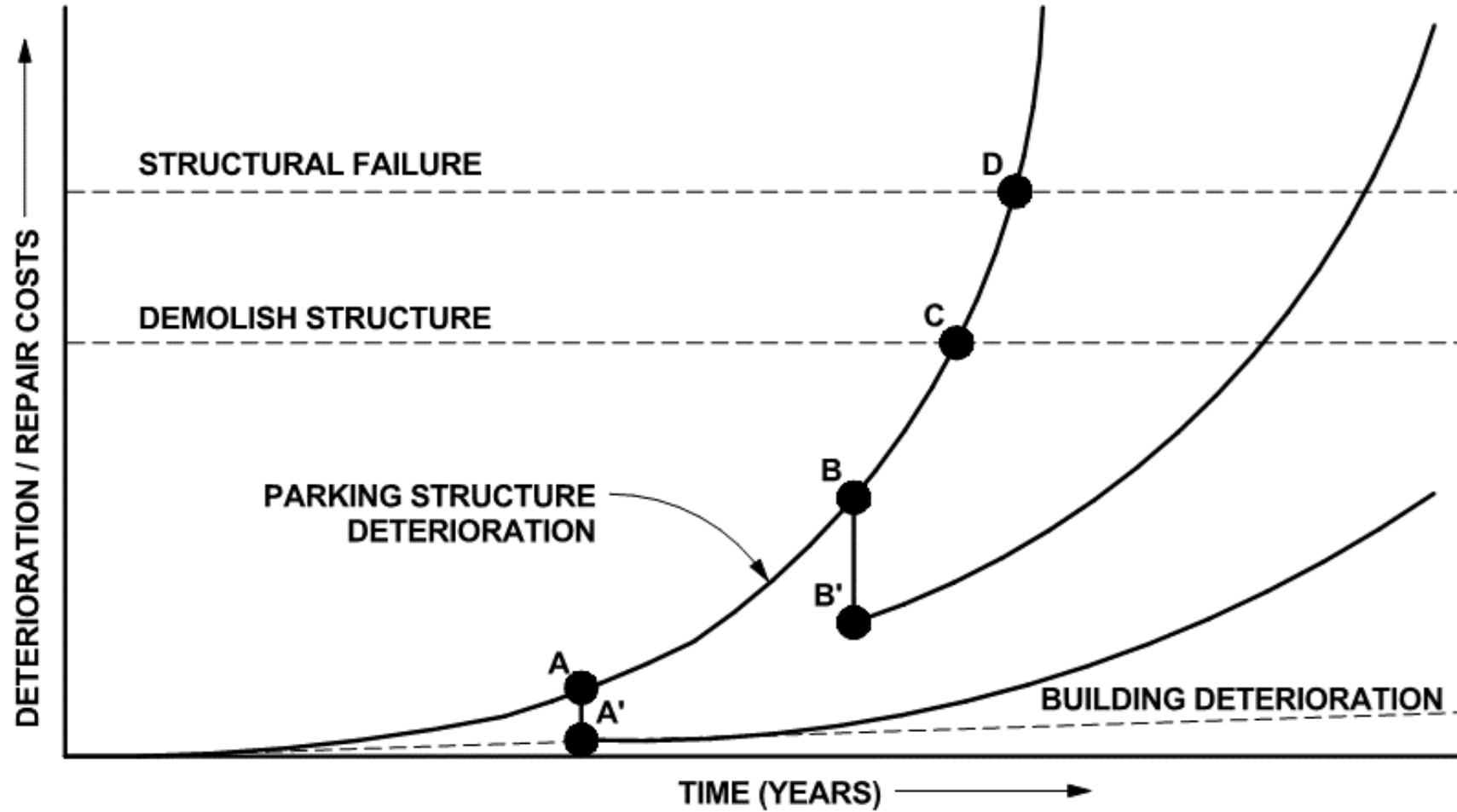
Maintenance Cost Curve



Maintenance Cost Curve



Maintenance Cost Curve



Reactive Maintenance



Parking Structure Maintenance

Maintenance Program: Planning

The image shows three overlapping forms used for parking structure maintenance planning. FORM F-1 is the topmost form, followed by FORM F-2, and FORM F-5 is the bottommost 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 treads
- Sweep office area
- Wash entry park
- 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: _____

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: _____

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: _____

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

Learning Objectives

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

Questions?

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