

Your Front Door

The Parking Garage and Why Maintenance Counts



Michael Sladki, Principal Engineer
ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly VA, 20151

BUILDING OPERATING MANAGEMENT'S
NFMT[®]2016
National Facilities Management & Technology March 22-24, 2016 • Baltimore



**GEOTECHNICAL
ENGINEERING**

**FACILITIES
ENGINEERING**



**ENVIRONMENTAL
CONSULTING**



**CONSTRUCTION MATERIALS
TESTING**



**CORE SERVICES
PROVIDED**



1,200+
EMPLOYEES

45+
OFFICES

27
YEARS SERVING
OUR CLIENTS

#86
ENR TOP 500 DESIGN
FIRMS





LEARNING OBJECTIVES

1. Parking structure features and challenges
- 2. Design Considerations**
- 3. Construction Considerations**
4. Garage Maintenance
5. Garage Restorations
6. General repair cost information

PARKING GARAGE IMPRESSION

Parking Structures are often the **first** and **last** thing visitors to a facility see and experience.



Photo of Calvert Street P/G in Annapolis, MD by, Shockey Precast



Photo of Destin Commons P/G in Destin, FL by, Tindall Corporation

UNIQUE PARKING STRUCTURE CHALLENGES



Exposed Structure

- Snow, rain, sun (uv)
- Deicing salts
- Thermal movements
- Ground water

Aesthetic- exposed structure

Used Hard

Often Neglected

DESIGN CONSIDERATIONS



NEW GARAGE DESIGN

ACI 362.1R-12

Guide for the Design and Construction of Durable Concrete Parking Structures

Reported by
ACI Committee 362



American Concrete Institute®

NEW GARAGE DESIGN



Material Recommendations- Figure 3.1

Zone III – Areas where freezing and the use of deicing salts are common.



NEW GARAGE DESIGN

Duke University; Hargreaves Associates

Plazas or planters above;

- Pitch structural slab
- Proper amount of drains (double drains)
- Waterproof
- Don't Damage
- Limit Dowels



NEW GARAGE DESIGN

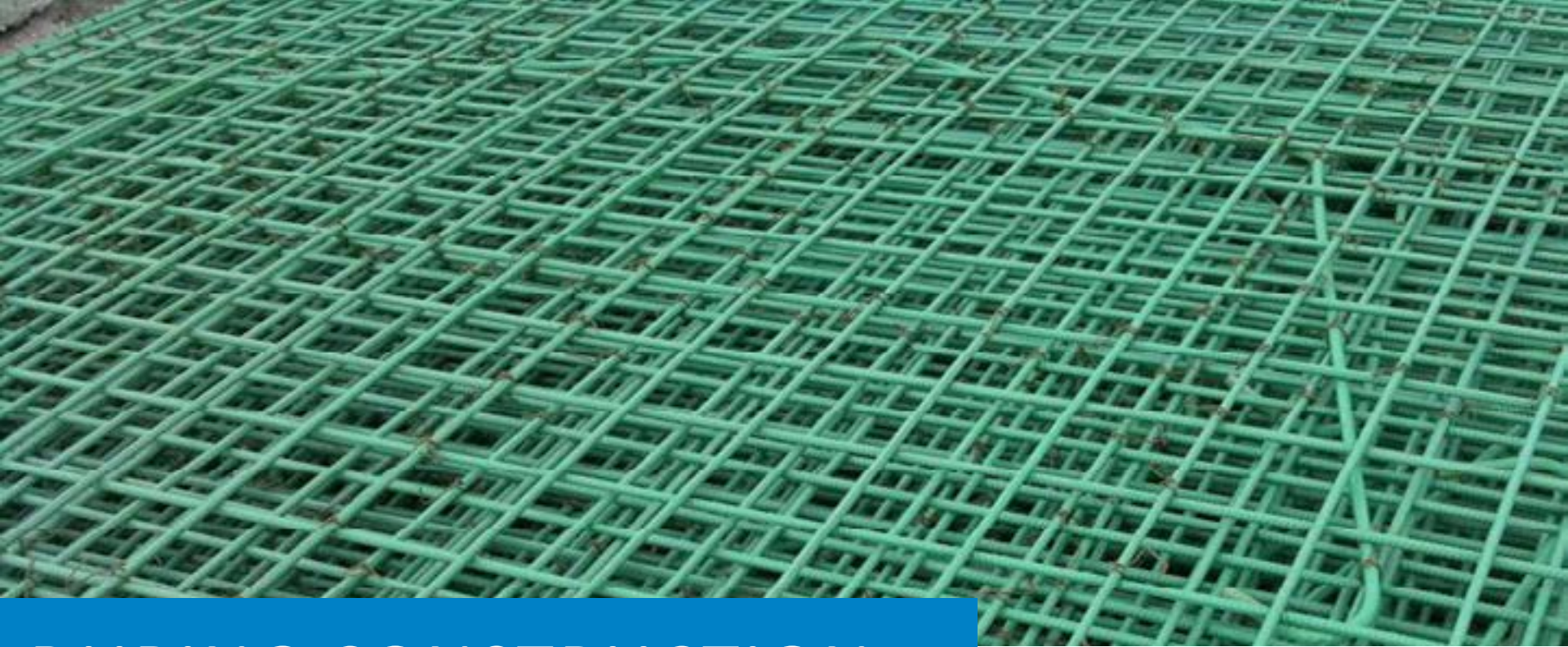
Traffic Bearing Membrane

- Always good idea, but expensive
- Extent depends on the configuration and use of the garage;

Drive aisle, entrance, main floor, etc.

CONSTRUCTION CONSIDERATIONS





DURING CONSTRUCTION

Epoxy Rebar

The background of the slide is a close-up photograph of a concrete wall, showing its rough, textured surface with various shades of grey and some minor discolorations. A solid blue horizontal banner is positioned across the middle of the image, containing the text 'DURING CONSTRUCTION' in white, bold, uppercase letters.

DURING CONSTRUCTION

Concrete Admixtures

- DCI or Corrosion inhibitor
- Wet curing
- Silica fume (to reduce permeability)



DURING CONSTRUCTION

Control Joint Design
- Aesthetics



DURING CONSTRUCTION

Conduit in slab

- Allowed if not impacting load capacity
- Pros: increased headroom
- Cons: Can't repair easily, water infiltration



**GARAGE MAINTENANCE
(RECOMMENDED)**

ROUTINE MAINTENANCE BY OWNER

ACI 362.2R-00

Guide for Structural Maintenance of Parking Structures

Reported by ACI Committee 362

Thomas G. Wolf¹
Chairman

Thomas J. Downes²
Secretary

James C. Anderson³

Ralph T. Berens⁴

Geoffrey L. Chastain⁵

Anthony P. Chinn⁶

Jo Cook⁷

Thomas L. D'Arcy⁸

Brian Dransky⁹

Keith W. Jacobsen¹⁰

Norman G. Jacobsen, Jr.¹¹

Howard R. May¹²

David J. McCreary¹³

Martin B. Mikula¹⁴

David C. Monser¹⁵

Thomas E. Neth¹⁶

Carl A. Peterson¹⁷

David G. Pincus¹⁸

Patrick L. Rogers¹⁹

B. Carl Walker²⁰

Harold C. Waters²¹

Harold E. Wenzel²²

¹Source members of administration who prepared the document.
²Subcommittee chairman.

This guide is intended to assist parking structure owners, operators, and the construction who address them in developing preventive maintenance programs for parking structures. It presents typical maintenance concerns and suggests ways of addressing them.

The guide summarizes information regarding structural, operational, aesthetic, and routine maintenance for parking structures. Design suggestions in maintenance maintenance are also included. A structural maintenance checklist of specific recommended tasks and references to other publications with information related to the structural maintenance of parking structures is included.

See ACI 362.1R for more complete information regarding design issues related to parking structure's performance.

Keywords: concrete durability; condition appraisal; construction joints; construction joints; corrosion; cracking; expansion joints; isolation joints; loadings; maintenance; maintenance parking structures; non-maintenance; precast; prestressed; repair; sealings; sealants; sealers; steel-reinforced; spalling.

ACI Committee Reports, Guides, Standard Practices, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. This document is intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. The American Concrete Institute disclaims any and all responsibility for the stated principles. The Institute shall not be liable for any loss or damage arising therefrom.

Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be included in mandatory language for incorporation by the Architect/Engineer.

CONTENTS

Chapter 1—Introduction, p. 362.2R-2

Chapter 2—Developing a maintenance program, p. 362.2R-2

- 2.1—The project maintenance manual
- 2.2—Periodic inspections
- 2.3—Preventive maintenance
- 2.4—Conditional approvals

Chapter 3—Deterioration problems associated with parking structures, p. 362.2R-3

- 3.1—Concrete-related deterioration
 - 3.1.1—Sealing
 - 3.1.2—Corrosion
 - 3.1.3—Delaminations
 - 3.1.4—Spalling
 - 3.1.5—Cracking
 - 3.1.6—Leaking
 - 3.1.7—Leaching
- 3.2—Sealants and waterproofing
 - 3.2.1—Construction and construction joint sealants
 - 3.2.2—Seals for isolation joints and expansion joints
 - 3.2.3—Concrete sealers
 - 3.2.4—Elastomeric, traffic-bearing membranes
- 3.3—Structural elements and related items
 - 3.3.1—Concrete deck surface
 - 3.3.2—Beams, columns, and walls

ACI 362.2R-00 becomes effective June 1, 2000.
Copyright © 2000, American Concrete Institute
All rights reserved. Including rights of reproduction and use in any form or by any means, including the making of copies for any purpose, or by electronic or mechanical means, printed, written, or oral, or recording for visual reproduction or for use in any knowledge or computer system of device, without permission in writing is prohibited from the copyright proprietor.

RECEIVED
APR 12 00
Structural Engineering

ROUTINE MAINTENANCE BY OWNER

From ACI 362.2:

- Regular Cleaning/Removal of Debris
- Washing Down
- Sealing Cracks



ROUTINE MAINTENANCE BY OWNER

Spot Repairs of sealants and expansion joints

Protective Coating and Membranes

- 10 years per ACI

Periodic reapplication of sealers

- 3-5 years per ACI



ROUTINE REPAIRS BY OWNER

Other suggestions:

- Maintain Drains
- Bearing Conditions (engineer to review)
- Miscellaneous Conditions

PARKING STRUCTURE INVESTIGATION (FIELD WORK)



INVESTIGATION EYES & EARS



DEPTH OF CARBONATION



CHLORIDE-ION TESTING



The background of the slide is a photograph of a concrete parking structure. A prominent vertical crack runs down the center of the frame. A solid blue horizontal bar is positioned across the upper portion of the image, containing the title text in white. The concrete surface is light gray and shows signs of weathering and texture.

PARKING STRUCTURE RESTORATION OVERVIEW

WHY CONSIDER RESTORATION?

Safety.

User Security and Comfort.

Extend Service Life.



SIGNS FOR RESTORATION NOT (NECESSARILY)-SO-BAD CRACKS



Plastic Shrinkage
Cracks



Drying Shrinkage
Cracks



Thermal Cracks

SIGNS FOR RESTORATION

BAD CRACKS



SIGNS FOR RESTORATION

VERY BAD CRACKS



SIGNS FOR RESTORATION BEARING DISTRESS

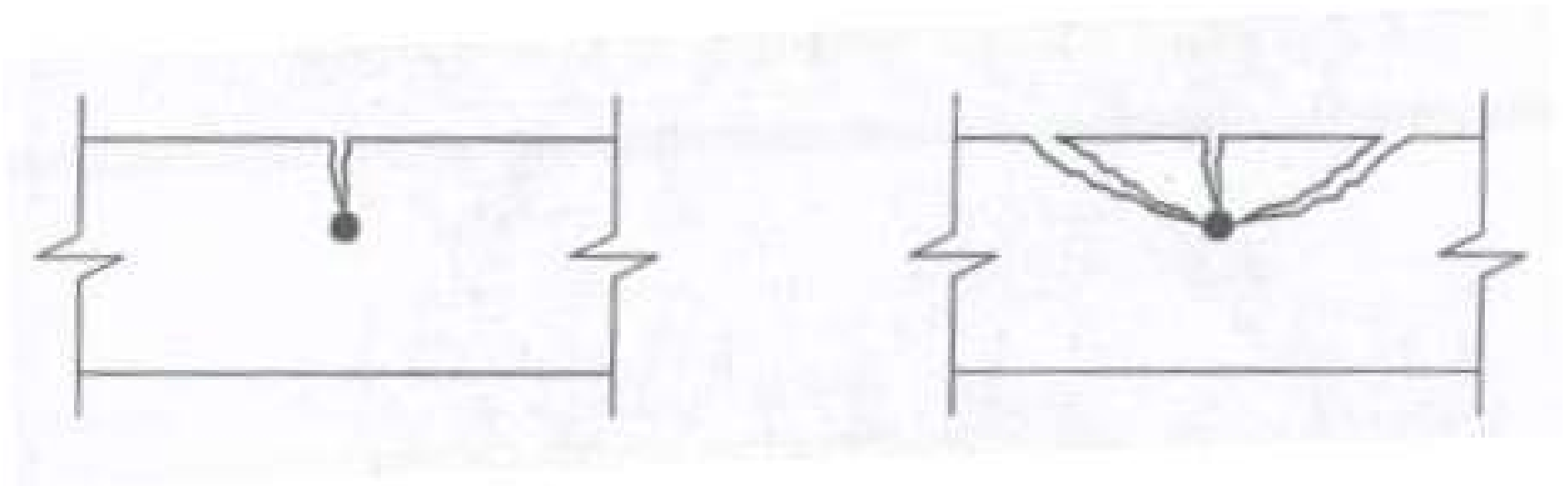


**Distress at Bearing
Conditions**
Precast only

SIGNS FOR RESTORATION

SPALLS

Corrosion of Reinforcements



Crack Forms

Concrete Spalls

SIGNS FOR RESTORATION SPALLS



Concrete Spalls
(rebar cover issue)

SIGNS FOR RESTORATION DELAMINATION



SIGNS FOR RESTORATION

PONDING WATER



SIGNS FOR RESTORATION

EXPANSION JOINTS



SIGNS FOR RESTORATION MOVEMENT ISSUES



SIGNS FOR RESTORATION STAIRS





GENERAL REPAIR COST INFORMATION

(ACTUAL COSTS VARY ON A PROJECT-SPECIFIC BASIS)



MAINTENANCE/REPAIR COST ESTIMATES

ANNUAL MAINTENANCE

\$0.10 to **\$0.15** per square foot

OR

\$30 to **\$35** per parking stall

MAINTENANCE/REPAIR COST ESTIMATES

TYPICAL EXAMPLES

\$20 to **\$25**/SF for partial depth slab repair

\$40 to **\$50** for overhead slab repair (part. depth)

\$40 to **\$50**/SF for full depth slab repair

\$2 to **\$4**/LF for crack repair w/ sealant

\$25 to **\$35**/LF for crack repair w/ epoxy-injection

\$10 to **\$15** to clean and paint corroded connections

MAINTENANCE/REPAIR COST ESTIMATES TRAFFIC BEARING MEMBRANES (TBM)

\$3.00/SF
10 year life

\$0.07 to \$0.10/SF
for re-stripping



PARKING GARAGE

First and Last Impression on Visitors



Photo of Calvert Street P/G in Annapolis, MD by, Shockey Precast



Photo of Destin Commons P/G in Destin, FL by, Tindall Corporation

THANK YOU QUESTIONS?



Michael Sladki, Principal Engineer
ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly VA, 20151

Geotechnical | Construction Materials | Environmental | Facilities