PCI Precast/Prestressed Concrete Institute

# Transportation Publications and Online Resources Catalog



September 2026

# About PCI

Founded in 1954, the Precast/Prestressed Concrete Institute (PCI) is the technical institute and trade association for the precast and precast, prestressed concrete structures industry. As a technical institute, PCI develops, maintains, and disseminates the Body of Knowledge for the design, fabrication, and erection of precast concrete structures and systems by:

- conducting research and development projects in concert with universities and research laboratories nationwide;
- publishing a broad array of technical resources, including design manuals, state-of-the-art reports, periodicals, and more;
- certifying companies and individuals involved in the manufacture and erection of precast concrete products;
- educating precast concrete personnel and industry stakeholders on the proper specification, design, fabrication, erection, and use of precast concrete;
- representing the industry in code advocacy activities.

PCI also serves as the precast concrete industry's trade association, advancing members' interests by:

- promoting the use of structural and architectural precast concrete for a variety of applications, in partnership with 11 regional affiliates across the United States;
- publishing safety manuals and materials;
- providing education and training materials;
- representing the industry through regulatory and legislative advocacy;
- offering meetings and networking opportunities, awards programs, and much more.

PCI members include precast concrete manufacturers, companies that provide products and services to the industry, precast concrete erectors, and individual members such as architects, consultants, contractors, developers, educators, engineers, and students.

Learn more about PCI at pci.org.

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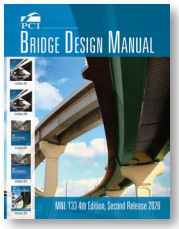

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# Publications

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## Bridges



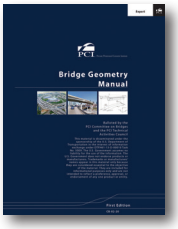

### PCI Bridge Design Manual, 4th Edition, 2nd Release

The 4th Edition of the *PCI Bridge Design Manual* has been updated to make it current with the 9th Edition of the *AASHTO LRFD Bridge Design Specifications*, new or updated PCI publications, and recent results of PCI-sponsored research. This edition includes new items on design theory and procedure. The second release has been revised to include the following: Chapter 3 has expanded information for 0.6 in.-diameter strand lifting loops. Chapter 8 explains and extensively discusses camber estimates. Chapter 9 has two new design examples for a 200-ft-long precast, prestressed concrete bridge girder with lateral stability checks during handling and transportation; one example uses normalweight concrete, and the other uses lightweight concrete. Chapter 15, Seismic Design, and Chapter 20, Precast, Prestressed Concrete Piles—which were previously available as standalone PCI publications, SD-02-25 and BM-20-25, respectively—are included in this release. Chapter 20 presents material that complies with ANSI/PCI 142, *Specification for Precast, Prestressed Concrete Piles*.

MNL-133-23

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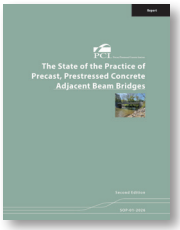

### Bridge Geometry Manual

This manual reviews the basics of roadway geometry as well as many of the calculations required to define the geometry and associated dimensions of bridges. Four instructor-led training courses are available to facilitate the use of the *Bridge Geometry Manual* (see the *Bridge Geometry Manual* series in the eLearning Courses section of this catalog). The target audience for this manual and the instructor-led training courses is bridge engineers with limited experience (two years or less) and CAD technicians who have not had previous training in roadway and bridge geometry.

CB-02-20

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### State of the Practice of Precast, Prestressed Concrete Adjacent Beam Bridges, 2nd Edition

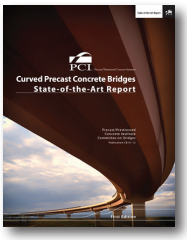
The second edition of this report has been prepared and reviewed by the Subcommittee on Adjacent Members for the PCI Committee on Bridges. It presents an updated state of the practice for design and construction of precast, prestressed adjacent box beam bridges. New applications and recent research related to joint details have been added, as well as other types of adjacent components in addition to box beams. Much of the information in the report's first edition has been condensed and summarized by reference to other publications for more detail. This report is intended for reference by professional personnel who are competent to evaluate the significance and limitations of its contents and who are able to accept responsibility for the application of the material it contains. Actual conditions on any project must be given special consideration, and more specific evaluation and engineering judgment that are beyond the intended scope of this state-of-the practice report may be required.

SOP-01-2026

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# Publications



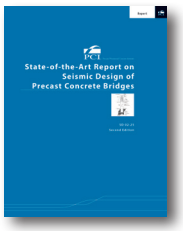

## Curved Precast Concrete Bridges State-of-the-Art Report

This report details the application of curved precast concrete bridge design, fabrication, construction techniques, and considerations through the study of 12 related projects. Intended for bridge owners, designers, fabricators, and engineers, this is an up-to-date reference for developing precast concrete bridge solutions for curved geometric situations.

CB-01-12

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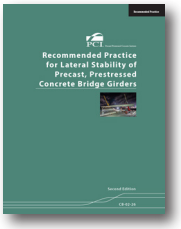

## State-of-the-Art Report on Seismic Design of Precast Concrete Bridges

Seismic design of precast concrete bridges begins with a global analysis of the response of these structures to earthquake loadings and a detailed evaluation of connections between precast concrete elements of the superstructure and substructure. Because modeling techniques have not yet been implemented for jointed details, this report focuses on procedures for the evaluation of system response and the detailing of connections for emulative behavior.

SD-02-25

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doi.org/10.15554/pci.mnl-133-23/ch15




## Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders, 2nd Edition

The revised recommended practice presents the methodology to analyze the lateral stability of long, slender bridge girders. Each stage of a girder's transition from the casting bed to its final location in the bridge is considered. Guidance covers how to handle girders with embedded or attached devices from the top and how to support girders from below during storage, transit, and in various conditions on the bridge during construction.

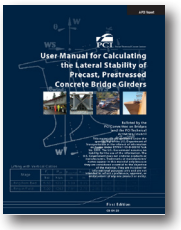
Topics expanded or added in this edition include an explanation of roll stability theory; the role of top temporary strands on girder stability; methods to estimate hauling parameters such as truck roll stiffness; special cases such as girders with unequal overhangs during hauling, eccentric loadings, and preformed camber; and a comprehensive girder design procedure that considers lateral stability. An updated calculation of post-erection bracing forces is provided.

This is a must-have publication for all stakeholders in bridge design, fabrication, hauling, and construction.

CB-02-26

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## User Manual for Calculating the Lateral Stability of Precast, Prestressed Concrete Bridge Girders

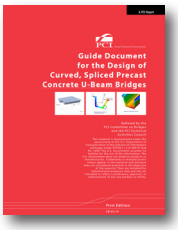
This product aligns directly with PCI's *Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders* (PCI publication CB-02-16), which is referenced in the *AASHTO LRFD Bridge Design Specifications*. It is currently being updated to align with the *Recommend Practice for Lateral Stability, Second Edition* (CB-02-26). To promote broader use of the example template in the recommended practice, PCI developed a concatenated Microsoft Excel spreadsheet program where users may customize inputs for specific precast, prestressed concrete bridge girder products to analyze their lateral stability.

This product includes a document providing context and instructions for the use of the 2019 version of the Microsoft Excel workbook, as well as the Excel file.

CB-04-20

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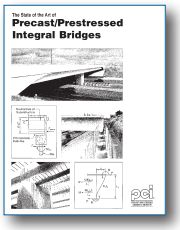

## Guide Document for the Design of Curved, Spliced Precast Concrete U-Beam Bridges

Developed as a resource for bridge engineers, this publication documents the advancement of curved, spliced precast concrete U-beam bridge technology as it has evolved through the collaboration of designers, contractors, and owners since its origination in Colorado. Much of the current technology is in its second or third generation, and agencies and builders in several areas of the United States are interested in its use. However, certain areas of practice have not been quantified, and this has made it difficult for owners and the design community to fully embrace the technical solutions needed to design, construct, deliver, and maintain curved, spliced U-beam bridge systems. This document addresses those practices.

CB-03-20

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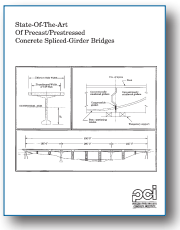

## State of the Art of Precast/Prestressed Integral Bridges

This publication is filled with details and design information on bridges made integral with their piers and abutments. The appendix contains five case studies representing major and minor projects.

IB-01

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## State of the Art Precast/Prestressed Concrete Spliced I-Girder Bridges

This publication describes structural systems, types of girder splices, construction methods and techniques, analysis and design, and design examples with cost analysis. A report on a survey documenting design, production, and construction details and locations for more than 40 bridges built with spliced members is included.

SG-92-01

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# Pavement, Approach Slabs, and Bridge Decks



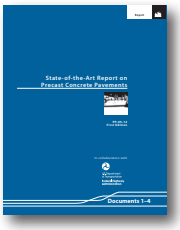

## State-of-the-Art Report on Full-Depth Precast Concrete Bridge Deck Panels

This publication is a guide for selecting, designing, detailing, and constructing precast concrete full-depth deck panels for bridge construction. It is relevant for both new bridge construction and bridge-deck replacement.

SOA-01-1911

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doi.org/10.15554/SOA-01-1911




## State-of-the-Art Report on Precast Concrete Pavements

This publication compiles four documents on the use of precast concrete pavement systems. The documents were developed through a cooperative agreement between PCI and the Federal Highway Administration and cover the following: applications for precast concrete pavements; design and maintenance; manufacture of precast concrete pavement panels; and construction of precast concrete pavements.

PP-05-12

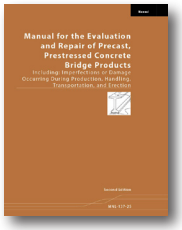
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# Publications

## Repair




### Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products, 2nd Edition

This manual presents methods for evaluating and repairing damaged or nonconforming precast, prestressed concrete bridge products such as beams, piles, and deck panels. The various types of cracks, chips, voids, missing bars, and nonconformances that may occur from production through erection are defined and illustrated. Causes, prevention, engineering, and repair procedures are given for consideration for each type of damage or nonconformance. Chapters include "standard" repair procedures, which provide methods to repair damage and nonconformances, as well as patching and epoxy injection procedures. New to the second edition are the inclusion of piles among the product types and appendices on the evaluation of camber and sweep in beams. Precast concrete producers are encouraged to purchase copies to supply to their local agencies and specifiers.

MNL-137-25

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EBook*: Members $35
Non-Members $70

doi.org/10.15554/MNL-137-25

## Piles




### Specification for Precast, Prestressed Concrete Piles

This standard provides for the design and construction of precast, prestressed concrete piles. Such piles can be used to support most types of structural systems including buildings, bridges, piers, and wharfs. This standard contains modifications to the *Recommended Practice for Design, Manufacture*, and *Installation of Prestressed Concrete Piling*, published in 2019. PCI 142-24 prescribes best practices; presents significant information relevant to seismic design, such as detailing requirements based on the results of recent research; and prescribes procedures for performance-based design. This standard was developed through PCI's ANSI-accredited consensus process.

ANSI/PCI 142-24

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doi.org/10.15554/PCI-142-24




### Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling, 3rd Edition

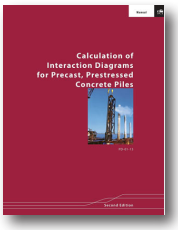
This third version of the recommended practice contains recommendations and guidelines for the design, detailing, manufacture, and installation of prestressed concrete piles based on PCI's *Specification for Precast, Prestressed Concrete Piles* (ANSI/PCI 142-24). It was originally published in the November–December 2025 of the *PCI Journal*. The first version of this report was published in the March–April 1993 issue of the *PCI Journal*. This third iteration updates a second version, which was published in the July–August 2019 issue of the *PCI Journal*.

RP-156-25

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## Calculation of Interaction Diagrams for Precast, Prestressed Concrete Piles, 2nd Edition

This publication provides context and instructions for the use of the 2015 revised version of the Microsoft Excel workbook to compute pile stresses, plot interaction diagrams, and compute lifting points of precast, prestressed concrete piles. It is currently being updated, with anticipated release of a new version in late 2026 or early 2027. Examples are also solved using Mathcad to validate the workbook solution; a table of results compares the two methods. The bookstore provides a link for downloading the spreadsheet.

PD-01-15

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pci.org/pd-01-15




## Precast Prestressed Concrete Piles, 2nd Edition

This new publication is a comprehensive presentation of practical information on current design, detailing, fabrication, transportation, and installation procedures for prestressed concrete piles used to support buildings, bridges, marine, or other ancillary structures.

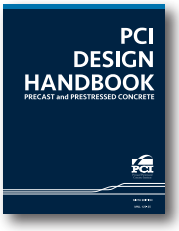
It was first printed in the Precast/Prestressed Concrete Institute *Bridge Design Manual* (MNL-133)as Chapter 20, *Precast Prestressed Concrete Piles* in 2004 and was included in the *PCI Bridge Design Manual,* Fourth Edition, Second Release in 2026. It is reprinted in this form as a convenience for designers and others with an interest in precast, prestressed concrete piles. The Fourth Edition, Second Release was updated to comply with the *AASHTO LRFD Bridge Design Specifications* ninth edition and the recommendations and commentary of ANSI/PCI 142-24, *Specification for Precast, Prestressed Concrete Piles.* Example problems are presented in accordance with both documents. The PCI Pile Interaction-Diagram Spreadsheet (PCI PD-01) is used to construct axial load-and-moment interaction diagrams.

BM-20-25

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## General Industry Documents on Design, Safety, and Quality



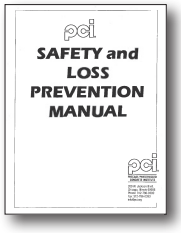

## PCI Design Handbook, 9th Edition

PCI is the authority for the design, manufacture, and use of structural precast/prestressed concrete and architectural precast concrete. This ninth edition design guide for precast and prestressed concrete provides easy-to-follow design procedures; new and updated numerical examples; and new and updated design aids. It provides the designer with comprehensive procedures for the code-compliant and efficient design of both architectural and structural precast and prestressed concrete products.

MNL-120-25

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## Safety and Loss Prevention Manual

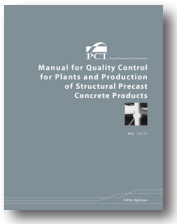
This manual includes guidelines for establishing and administering a plant safety program. Rules and recommendations governing safety and loss prevention are presented in the same format as the federal OSHA standards. Section IV of the manual contains safety information specific to the manufacture of precast and prestressed concrete products.

SLP-100

Printed Document: Member $45
Non-member $90
PDF Download: Member $45
Non-member $90

doi.org/10.15554/SLP-100

# Publications




## Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition

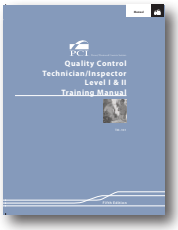
Specifiers, producers, testing labs, inspection consultants, teachers, designers, and quality technicians should all have a copy of this QC manual. These standards and the accompanying commentary will serve as a strong foundation for a plant's quality system for the manufacture of structural precast concrete products and for the manufacture of structural precast concrete products with architectural finishes.

This is the updated version of MNL-116, which became effective for plants on January 1, 2022.

MNL-116-21

Printed Document: Member $50
Non-member $100
Ebook*: Member $50
Non-member $100
EBook* & Printed Document
Bundle: Member $75
Non-member $150

doi.org/10.15554/MNL-116-21



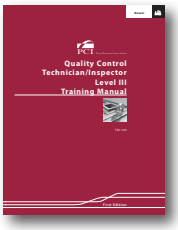

## Quality Control Technician/Inspector Level I & II Training Manual

Intended as a self-study guide to prepare QC personnel for the PCI Technician/Inspector examinations, this manual can also be used to introduce new QC employees and others to prestressed concrete and common plant procedures. Many illustrations and diagrams amplify the text, and sample questions are provided at the end of each chapter. Also available in Spanish.

TM-101-16

Printed Document: Member $50
Non-member $100
EBook*: Member $50
Non-member $100
EBook* & Printed Document
Bundle: Member $150
Non-member $75

doi.org/10.15554/TM-101-16



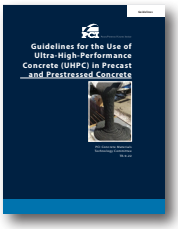

## Quality Control Technician/Inspector Level III Training Manual

A logical continuation of many of the topics presented in the *Level I and II Training Manual* (TM-101), this publication is easy to understand and includes study questions for each chapter. A textbook for the Technician/Inspector Level III school and examination, this book is also valuable for training new personnel and as a troubleshooting guide. The manual is post-bound to permit insertion into a loose-leaf binder, which facilitates the addition of notes, practice problems, and other documents.

TM-103-96

Printed Document: Member $25
Non-member $50

doi.org/10.15554/TM-103-96




## Guidelines for the Use of Ultra-High-Performance Concrete (UHPC) in Precast and Prestressed Concrete

Ultra-high-performance concrete (UHPC) is a high-strength, high-durability composite material consisting of a cementitious matrix with high-performance-fiber reinforcement. This publication provides a practical guide for the development and qualification of UHPC mixtures based on locally available materials. It presents an overview of UHPC production specific to long-span precast, pretensioned UHPC structural elements for buildings and bridges. Many of the practices discussed apply to the production of a variety of UHPC elements. Topics discussed include the constituent materials and development of mixture proportions, batching and placement considerations for production, and methods for evaluating UHPC materials for mixture qualification and routine quality assurance.

TR-9-22

Printed Document: $50
PDF Download: Member Free
Non-member $50

doi.org/10.15554/TR-9-22

*For more information on eBooks, please refer to Ordering and Customer Service under About PCI Publications and eCourses on page 2 of this catalog.

# eLearning

## PCI eLearning Courses

For information on how to use PCI's eLearning site, follow this link: https://youtu.be/PbrIz4lfIw8

PCI eLearning is useful for engineers at all stages of their careers. Professors may require students to take eLearning courses to learn more about specific topics, and it is suggested that novice and mid-level-experienced engineers take the T100 courses in numerical order, and then take the T500 and T510 courses. The remaining courses focus on specialized areas. Although more experienced engineers may elect to skip topics in eLearning courses, they can refresh their knowledge by reviewing specific modules and may wish to take the tests to earn PDHs or LUs.

T100 series course is based on Chapters 1 through 9 of *PCI Bridge Design Manual*, 3rd ed., 2nd release (MNL-133-11).

T200 series courses are based on the *State-of-the-Art Report on Full-Depth Precast Concrete Bridge Deck Panels* (SOA-01-1911).

T310 series course is based on MNL-133-11 Chapter 11.

T450 series courses are based on MNL-133-11 Chapter 10.

T710 series course is based on MNL-133-11 Chapter 18.

T500 and T510 series courses are based on the *Bridge Geometry Manual* (CB-02-20).

T520 series courses are based on *Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders* (CB-02-16) and *User Manual for Calculating the Lateral Stability of Precast, Prestressed Concrete Bridge Girders* (CB-04-20).

T350 series courses are based on the *Curved Precast Concrete Bridges State-of-the-Art Report* (CB-01-12), *Guide Document for the Design of Curved, Spliced Precast Concrete U-Beam Bridges* (CB-03-20), and MNL-133-11 Chapter 12.

T620 series courses are based on PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling* RP-156-25.

## Fundamentals of Precast, Prestressed Concrete Bridge Series

Based on *PCI Bridge Design Manual*, 3rd ed., 2nd release (MNL-133-11)

PCI eLearning courses are FREE unless otherwise stated. Earn 1 PDH/LU credit per course.

### T110 Preliminary Precast, Prestressed Concrete Design

Preliminary design is the first step in designing an economical precast, prestressed concrete bridge. This first course in the series on design presents the preliminary plan, superstructure, substructure, and foundation considerations, and member selection criteria with design aids and examples.

After completing this course, the student will be able to:

- Identify general considerations for bridge type selection
- Evaluate alternatives that best illustrate typical challenges faced by engineers, presented by the bridge site and other factors
- Interpret preliminary design tools to formulate possible design solutions

oasis.pci.org/URL/T110

### T115 Materials and Manufacturing of Precast, Prestressed Concrete

This second course on design explores the constraints related to type, size, and method selection. Materials control strength and durability characteristics. The industry's manufacturing capabilities are important conditions on design assumptions. Plant handling and transportation constraints also need to be considered in design. This course presents the important initial information required before beginning design, enabling designers to take advantage of the flexibility and economy of precast, prestressed concrete products while avoiding pitfalls that could make solutions less cost-effective.

After completing this course, the student will be able to:

- Recognize new and traditional construction materials and their differences
- Differentiate among fabrication methods
- Identify devices and mechanisms used to precast members
- Describe aspects of the design that affect the production of precast concrete members
- Recall product handling and shipping constraints, as well as transportation methods, that must be considered during design

oasis.pci.org/URL/T115

# eLearning

## T120 Design Loads and Load Distribution

This third course on bridge design teaches the fundamental tasks of collecting information on permanent and transient loads that may act on a bridge and analyzing how these forces are distributed to the structural components. It presents the load types and load distribution provisions of the *AASHTO LRFD Bridge Design Specifications* related to superstructure systems.

After completing this course, the student will be able to:

- Recognize definitions of basic load types
- Select appropriate load factors to use for load combinations
- Explain the meaning of distribution factors and choose the appropriate equation to use for a bridge cross section
- Apply distribution factor equations to a bridge cross section with skew
- Identify the effects of obtuse corners on exterior girders
- Examine cases to determine if the approximate live-load distribution method applies
- Identify the types of analyses that can be done for bridges where approximate live-load distribution factors should not be used

oasis.pci.org/URL/T120

## T125 Flexural Design of Precast, Prestressed Concrete—Service Limit States

The first three courses in this design series (T110, T115, and T120) equip the student with fundamental information to begin direct design. This course provides methods to determine prestress levels necessary to satisfy all conditions at the service limit states. All load stages that may be critical during the life of the flexural member are considered. The service limit states control the design of most prestressed concrete members. Except for rare exceptions, which are discussed in the next course on strength limit states (T130), the flexural resistance of prestressed concrete bridges may be significantly greater than required for strength. This results in what is recognized as a large reserve strength compared to other methods of bridge construction. This course explores beam flexural stresses in detail.

After completing this course, the student will be able to:

- Apply service limit state principles to calculate stresses in a member and determine the prestress level
- Calculate nontransformed and transformed section properties for noncomposite and composite girders
- Include the effect of construction stages on service stress calculations
- Identify allowable stress limits for concrete and prestressing steel materials
- Explain methods for controlling tensile stresses or meeting stress limits in a girder's end regions

oasis.pci.org/URL/T125

## T130 Flexural Design of Precast, Prestressed Concrete—Strength Limit States

Approximate formulas are given in the AASHTO LRFD specifications for the stress in the prestressing steel at nominal flexural resistance $M_n$. The use of these formulas simplifies the calculation of $M_n$ by eliminating consideration of nonlinear material properties of both the concrete and prestressing steel at ultimate conditions (the nominal resistance). Caution should be used when applying the approximate formulas. They are based on a number of simplified assumptions. Other methods such as general strain compatibility will avoid difficulties and inaccuracies in the approximate formulas. These subjects with design examples are presented in this course.

After completing this course, the student will be able to:

- Apply the simplified method to calculate flexural resistance
- Use strain compatibility analysis to calculate flexural resistance
- Determine the section type and $\phi$-factor based on the net strain in the extreme layer of steel
- Check minimum reinforcement requirements for the strength limit state

oasis.pci.org/URL/T130

## T135 Refined and Approximate Estimates of Prestress Losses

Concrete exhibits time-dependent behavior. Under sustained stress, creep causes ongoing strains. Even with no loads, concrete shrinkage strains occur. Prestressing steel exhibits a gradual loss of stress under constant strain known as relaxation. Under these combined effects, prestressed concrete members gradually deform with time. Several techniques are available to account for these effects. Both approximate and detailed methods are taught in this course. Elastic changes in steel stress due to application of external loads are considered and presented. Conditions are given when approximate estimates are applicable. Bridges with two-stage prestressing with composite concrete decks introduce another level of complexity, which is discussed in the T350 series of courses.

After completing this course, the student will be able to:

- Identify the effects of time and construction on stresses, before decking or without decks
- Recall the conditions where the various methods for calculating time-dependent losses can be used
- Discriminate the meaning of the various time segments used in the refined estimate method
- Calculate losses due to concrete shrinkage using the refined estimate for a member without decking
- Calculate losses due to steel relaxation using the refined estimate for a member without decking
- Calculate losses due to creep using the refined estimate for a member without decking

oasis.pci.org/URL/T135

## T145 Shear Design—Development and Use of Modified Compression Field Theory

This course presents the analysis of precast, prestressed concrete bridge members for vertical shear. The method taught is a truss analogy called the modified compression field theory (MCFT), in which the truss is composed of concrete compression struts and steel tension ties. It is one of two methods included in the AASHTO LRFD specifications for shear design. Unlike flexural design, for which conditions at both service and strength limit states are evaluated, shear design is evaluated only for factored loads (strength).

After completing this course, the student will be able to:

- Identify the mechanisms assumed in MCFT
- Assess the influence of prestressing steel to the MCFT shear mechanism and resistance
- Use MCFT to calculate the concrete contribution to shear resistance
- Use MCFT to calculate the web reinforcement contribution to shear resistance
- Use MCFT to calculate the total shear resistance

oasis.pci.org/URL/T145

## T160 Design of Beam End Zones

The end regions of precast, prestressed concrete beams are unique. When the tension in prestressing steel is transferred to the concrete member at detensioning, the steel strands expand near the ends of the beam due to the effects of Poisson's ratio. This causes bursting forces in the concrete. In addition, prestressing strands are concentrated in the bottom flange and often high in the web when harping methods are used. The effects of these two localized centers of force create tensile stresses in the web. This course presents all of these special issues as well as sample calculations and the design of reinforcement.

After completing this course, the student will be able to:

- Distinguish between transfer and development lengths and explain how they are used in design
- Calculate transfer and development lengths
- Identify the effect of transfer on the end zone
- Calculate bursting forces
- Design end zone reinforcement

oasis.pci.org/URL/T160

# eLearning

## T310 Extending Spans

Most U.S. bridges are built with precast, prestressed concrete. Excellent durability and structural performance over the long term and low cost in the short term have encouraged owners and designers to find methods to extend the span ranges of typical girder shapes and to develop new shapes to satisfy more applications. Many methods to accomplish longer spans have been developed, and many of these are becoming almost commonplace today. A brief history of traditional span ranges is reviewed as are the many benefits of longer-span applications. Methods and materials resulting in longer spans and their implications for fabrication and construction are discussed.

After completing this course, the student will be able to:

- Recall reasons for historical span limitations
- Recognize the benefits of longer spans
- Recognize advancements that have allowed span lengths to increase dramatically
- Identify methods being used to build long bridge spans with precast concrete
- Examine the significance of common methods used to extend spans
- Recognize the implications for fabrication and construction when employing these methods

oasis.pci.org/URL/T310

## T450 Bridge Bearings—Theory and Fundamentals

This course describes design and selection procedures for bearings. For the vast majority of bridges constructed using precast, prestressed concrete beams, plain elastomeric pads or elastomeric bearings reinforced with steel plates are used. This course is dedicated to these types of bearings. The makeup and mechanics of the bearings as well as failure mechanisms are described. The AASHTO LRFD specifications provide two methods (A and B) by which bearings may be designed. This course focuses on the simplified Method A. Method B and its applications are covered in the following course, T455.

After completing this course, the student will be able to:

- Identify the movements and loads that are considered in bearing pad design
- Identify construction issues and trends related to bearing pads and sole plates
- Select bearing configurations (such as fixed, movable, and guided) that are appropriate for a given bridge
- Recognize the limitations of Method A by deciding if it is appropriate for a given scenario
- Design a bearing pad using Method A of the AASHTO LRFD specifications

oasis.pci.org/URL/T450

## T455 Bridge Bearings—Bearing Design

The more computationally intensive Method B of the AASHTO LRFD specifications for the design of bearing pads applies only to steel-reinforced elastomeric bearings. It generally results in higher capacities, but the bearings that result from its use require more rigorous testing. This course explores the application of Method B, including a design example, and compares the results of Methods A and B.

After completing this course, the student will be able to:

- Identify cases when Method B should be used
- Design a bearing pad using Method B

oasis.pci.org/URL/T455

### T710 Load Rating—Overview and Methods

Aging, environmental conditions, damage due to vehicular impact, and increased gross vehicle weights result in structural deterioration that affects the load-carrying capacity of bridges. These changes impact safety and require periodic reevaluation of bridge capacity, defined as load rating. The load rating of a bridge is a component of the inspection process. It is used to determine both the safe load-carrying capacity of a bridge and whether specific overweight vehicles can use the bridge. It is also used to determine if the bridge needs to be weight restricted, and, if so, what level of restriction (posting) is required. This course explores all of these facets, explains the various methods used, describes the required input data necessary, and develops the mathematical concepts.

After completing this course, the student will be able to:

- Define the purpose of load rating and various terms used in load rating
- Distinguish between the different load rating methods
- Differentiate among different types of loading used in load rating analyses
- Formulate the rating factor equation

oasis.pci.org/URL/T710

## Full-Depth Precast Concrete Deck Panels Series

Based on *State-of-the-Art Report on Full-Depth Precast Concrete Bridge Deck Panels* (SOA-01-1911)

### T210 Introduction on Full-Depth Panel Precast Concrete Deck System and Its Advantages

This course is the first in a four-part series and an introduction to full-depth deck panel systems, the advantages to using them, and methods of installation and connection. The course explains first-generation concepts and recent details and components, introduces the necessary advanced design topics, and briefly shows applications in four existing bridges.

After completing this course, the student will be able to:

- Understand the terminology used in the bridge community for designing and applying these panels
- Explain the benefits of the system
- Recognize and understand the various types of connections needed between panels and the supporting beams
- Appreciate fully composite interface shear issues
- Describe longitudinal post-tensioning systems and transverse pretensioning in the decks
- Identify the applications of panels in four diverse projects

oasis.pci.org/URL/T210

### T215 Design and Detailing of Full-Depth Precast Concrete Deck Panels

The second course in a four-part series on full-depth precast concrete bridge decks describes differences in design from conventional cast-in-place concrete decks. It focuses on detailed design issues and methods and specific details for making connections to supporting girders and between adjacent panels.

After completing this course, the student will be able to:

- Find requirements for thickness of panels in the *AASHTO LRFD Bridge Design Specifications*
- Perform design of panels transverse to the direction of traffic
- Understand methods to connect panels together longitudinally in the direction of traffic
- Recognize the design requirements for crash loading on traffic railings attached to the deck overhang
- Perform design of the composite horizontal shear connection between the panel and girder

oasis.pci.org/URL/T215

# eLearning

## T220 Production and Construction Details of Full-Depth Precast Concrete Deck Panels

This third course in the four-part series on full-depth precast concrete bridge decks explores the processes necessary for the manufacture and handling of precast concrete deck panels. These topics are helpful in considering the adaptation of panels to a particular project. Additionally, the insights into plant capabilities open up the designer's awareness to possibilities. Discussion of lifting and installation procedures helps the designer anticipate specific issues in the field. This course assists the designer in considering options to apply as well as possible limitations to avoid. The issues are readily put into context through ample photographs showing plant production and field installations on bridges.

After completing this course, the student will be able to:

- Identify many of the basic steps in the production of precast concrete deck panels
- Recognize the placement of pretensioning strands and post-tensioning ducts
- Understand challenges in handling and shipping panels
- Understand how girder surfaces are prepared for panel installation
- Recognize how panel elevations are adjusted to desired grade
- Understand how shear pockets and joints are grouted and the requirements for the grout
- Recognize the properties of ultra-high-performance concrete
- Discuss the requirements and types of deck overlays
- Refer to two design guides and sample specifications

oasis.pci.org/URL/T220

## T225 Case Studies and Emerging Developments of Full-Depth Precast Concrete Deck Panels

This fourth module presents diverse applications of existing bridges and expands the student's imagination in solving new design challenges. The first three courses in this four-course series acquainted the student with the fundamentals necessary to appreciate the advantages and potential applications of precast concrete full-depth deck systems. However, because of the enormous combinations of variables in the design of bridges with respect to geometry, geographic location, construction urgency, and other matters, there can be no universal recommendations for how to use precast concrete decks. Given the versatility of plant-produced products, the designer has considerable latitude in fitting the system to the project.

After completing this course, the student will be able to:

- Appreciate the application of full-depth deck panel systems in five diverse bridges
- Using these case studies, understand the following details of the deck systems:
  - Panel-to-panel connections
  - Panel-to-girder connections
  - Traffic barrier–to–deck connections
  - Longitudinal panel joints and connections allowing staged construction
  - Details of particular interest
- Identify several unique variations of emerging methods and applications

oasis.pci.org/URL/T225

# Lateral Stability of Precast, Prestressed Concrete Bridge Girders Series

Based on *Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders* (CB-02-16) and *User Manual for Calculating the Lateral Stability of Precast, Prestressed Concrete Bridge Girders* (CB-04-20)

## T520 Introductory Material and Hanging Girders

Lateral stability of precast, prestressed concrete bridge girders is a life safety issue whose importance is not always understood or properly addressed. This course is the first in a four-part series on lateral stability that covers all stages of construction from initial fabrication of the prestressed girders until they are fully incorporated into a bridge.

After completing this course, the student will be able to:

- Understand the root causes of lateral instability of precast, prestressed concrete girders and the need for stability analysis
- Understand the concept of roll axis and be able to identify the roll axis for a variety of support conditions
- Understand the criteria and basic presumptive values suggested for the evaluation of stability
- Identify the equilibrium conditions for the lifted girders
- Evaluate concrete stresses for lifted girders and factors of safety against cracking and failure
- Determine the means to increase the factors of safety against cracking and failure

oasis.pci.org/URL/T520

## T523 Stability During Transport of Bridge Girders

This course is the second in a four-part series on lateral stability that covers all stages of construction from initial fabrication of the prestressed girders until they are fully incorporated into a bridge.

After completing this course, the student will be able to:

- Identify the equilibrium conditions for transported girders
- Evaluate concrete stresses for transported girders and factors of safety against cracking, failure, and rollover
- Determine the means to increase the factors of safety against cracking, failure, and rollover

oasis.pci.org/URL/T523

## T525 Stability of Girders in the Field

This course is the third in a four-part series on lateral stability that covers all stages of construction from initial fabrication of the prestressed girders until they are fully incorporated into a bridge.

After completing this course, the student will be able to:

- Identify the equilibrium conditions for girders erected on site
- Evaluate concrete stresses for erected girders and factors of safety against cracking, failure, and rollover
- Identify the means to increase the factors of safety against cracking, failure, and rollover
- Understand critical stability issues during:
  - Precast concrete girder manufacture
  - Shipping girders to site
  - Girder erection at the project site
  - Deck construction
- Understand the role of the stability engineer in addressing these critical stability issues

oasis.pci.org/URL/T525

# eLearning

## T527 Calculations and Sensitivity Analysis

This course is the fourth in a four-part series on lateral stability that covers all stages of construction from initial fabrication of the prestressed girders until they are fully incorporated into a bridge.

After completing this course, the student will be able to:

- Apply the principles presented on hanging, transported, and seated girders through calculation
- Through sensitivity analysis examples, understand the principal criteria affecting girder stability

oasis.pci.org/URL/T527

## *Bridge Geometry Manual* Series

Based on *Bridge Geometry Manual* (CB-02-20)

## T505 Fundamentals of Roadway Geometry

Fundamental to establishing bridge geometry and the resulting geometry and dimensions of bridges is the ability to work with roadway geometry provided by highway designers. This course discusses the terminology used in roadway geometry and presents three primary aspects of roadway geometry: horizontal alignment, vertical profile, and cross-section superelevations. Stationing along horizontal alignments is also defined. Mathematical formulas and graphical representations are presented to define these three primary aspects, along with worked example problems.

After completing this course, the student will be able to:

- Identify general impacts of roadway geometry on bridge layout
- Identify terminology used in roadway geometry as it relates to bridges
- Describe aspects of roadway horizontal alignment, vertical profile, and cross-section superelevation
- Evaluate mathematically the elevations and superelevations by station along an alignment

oasis.pci.org/URL/T505

## T510 Working with Horizontal Alignments

Locating points along or offset from a horizontal alignment is necessary to defining bridge geometry. This course presents a vector-based approach to locating the north and east coordinates of point defined by a horizontal alignment. The vector-based approach is taken because it closely follows the way CAD software is used. Vector solutions are presented for locating:

- Points on tangent runs and circular curves
- Points offset from tangent runs and circular curves
- Points on a tangent run or circular curve

After completing this course, the student will be able to:

- Identify a global coordinate system
- Locate north and east coordinates of points along a horizontal alignment
- Locate north and east coordinates of points offset from a horizontal alignment
- Project points with a known north and east coordinate onto a horizontal alignment
- Develop offset parallel alignments

oasis.pci.org/URL/T510

## T515 Geometry of Straight Bridges

The third course in the *Bridge Geometry Manual* series begins by introducing terminology common to bridges elements. The material presented in the first two courses (T505 and T510) is then used to define the geometry of straight bridges. This course presents concepts of skew crossings and their impact on bridge geometry. Haunches that are cast over girders along with the bridge deck are defined. Factors affecting haunch thickness are defined using mathematical equations, which are demonstrated through examples. Substructure geometry in the form of top of bearing seat elevations is presented. Example problems are used to reinforce the information presented.

After completing this course, the student will be able to:

- Determine deck coordinates, elevations, grades, and cross slopes
- Evaluate girder elevations and haunch thicknesses
- Discuss bearing and bearing seat dimensions and orientations
- Understand pier cap layout and elevations

oasis.pci.org/URL/T515

## T517 Curved Bridge Geometry

This course advances the approach to bridge geometry developed for straight bridges to curved bridges. The geometry of curved bridges using both straight, chorded girders and curved girders is presented. The geometry of two curved bridge types (precast concrete segmental box girders and curved U-girders) is introduced, and an approach to computing their geometry is outlined.

After completing this course, the student will be able to:

- Understand haunch thickness corrections for curved bridges made with straight girders
- Understand coordinate system transformations
- Identify the process for establishing and controlling segmental bridge geometry
- Identify the process for establishing and accommodating curved U-girder bridge geometry

oasis.pci.org/URL/T517

# Curved U-Beam Bridge Series

Based on *State-of-the-Art Report on Curved Precast Concrete Bridges* (CB-01-12), *Guide Document for the Design of Curved, Spliced Precast Concrete U-Beam Bridges* (CB-03-20), and *PCI Bridge Design Manual* (MNL-133-11)

## T350 Introduction, Implementation, and Delivery of Curved U-Beam Bridges

This broad-based course summarizes the history and current development of curved, spliced precast concrete U-beam bridges primarily through reference to several projects. In addition, the course defines the terminology for components used in this and later courses in the series. An overview of project delivery, selection of design criteria, and specifying a U-beam bridge are presented in three additional (T353, T356 and T358) submodules.

After completing this course, the student will be able to:

- Explain the history and development of curved, spliced precast concrete U-beam bridge technology
- Understand major components associated with curved, spliced precast concrete U-beam bridges
- Identify the design and contractual elements related to project delivery
- Discuss the applicability concept and preliminary design engineering

oasis.pci.org/URL/T350

# eLearning

## T353 Modeling, Analysis, and Design of Curved U-Beam Bridges

The second course in this series uses a prototype bridge to develop an understanding of the methodologies and techniques used to model, analyze, and design curved, spliced precast concrete U-beam bridges. Two submodules are presented:

- Assumptions and techniques to develop a structural model to analyze the bridge
- Critical items for design during temporary phases of construction and in the permanent condition

After completing this course, the student will be able to:

- Understand the assumptions and techniques used to develop a structural model to analyze the prototype bridge
- Identify critical items for the prototype design during temporary phases of construction and in the permanent condition
- Discuss plant handling, transport, and lifting out of forms for the prototype
- Explain design considerations for the prototype

oasis.pci.org/URL/T353

## T356 Design Details of Curved U-Beam Bridges

Curved, spliced precast concrete U-beam bridges require component design of various details. The third course in this series illustrates possible details for U-beam bridges based on past projects and explains engineering principles for these elements.

After completing this course, the student will be able to:

- Understand possible details for U-beam bridges based on past projects
- Identify design assumptions for select detailing elements
- Understand the following topics:
  - Typical sections and post-tensioning
  - Lid slab and deck details
  - Precast tongue sections
  - Interior haunch sections
  - Blisters
  - Diaphragms
  - Bearings

oasis.pci.org/URL/T356

## T358 Design Example of Curved U-Beam Bridges

The fourth course in this series uses examples developed for the prototype curved, spliced precast concrete U-beam bridge. Detailed calculations are presented with commentary related to the engineering of the bridge's components. The design criteria presented in course T350 will be referenced.

After completing the course, the student will be able to:

- Apply the knowledge from previous courses in the series to a specific and practical design example
- Understand the following topics:
  - Prototype example
  - Sample index of calculations
  - Flexure at service limit state
  - Flexure at strength limit state
  - Web design at service limit state (principal tensile stress)
  - Web design at strength limit state
  - Camber and buildup

oasis.pci.org/URL/T358

# Piles Series

Based on PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling* (RP-156-25)

## T624 Overview of PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling*

This course is the first in a four-part series on prestressed concrete piles. It presents highlights of the second edition of the *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling*, including recommendations and guidelines for the design and detailing of prestressed concrete piles based on current knowledge and standards.

After completing the course, the student will be able to:

- Understand the reasons for the revision of PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling*
- Discuss the differences in pile design philosophies among building, bridge, and marine applications
- Identify the effects of various cementitious materials and admixtures on concrete mixture behavior
- Design transverse reinforcement (spiral) in prestressed concrete piles according to area of seismicity
- Understand the manufacturing, handling, and installation processes for prestressed concrete piles

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## T626 Application of PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling* to Building Piles

This course is the second in a four-part series on prestressed concrete piles. It specifically addresses building piles that are not considered part of the lateral-force-resisting system. The presentation covers recommendations of PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling* regarding prescriptive and performance-based methods for designing prestressed concrete building piles in different areas of seismicity.

After completing the course, the student will be able to:

- Describe the design of augercast piles for moderate to high seismicity
- Understand the philosophies of the following:
  - Prestressed concrete pile design for low seismicity
  - Prestressed concrete pile design for moderate seismicity
  - Prestressed concrete pile design for high seismicity
- Compare performance-based pile design and the prescriptive design method of the *International Building Code*

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# eLearning

## T628 Performance-Based Design of Prestressed Concrete Piles for Bridges and Piers

This course is the third in a four-part series on prestressed concrete piles. It focuses on the application of PCI's *Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling* to bridge and pier piles, and it introduces the basics of performance-based pile design. An example of performance-based design is presented.

After completing the course, the student will be able to:

- Understand the differences in prescriptive requirements for building piles versus bridge and pier piles that are part of the lateral-force-resisting system
- Describe the differences between confined and unconfined concrete
- Use equations to calculate material properties for stress-strain curves
- Understand the general code equations and requirements for performance-based design for bridge and pier piles
- Describe the process of performance-based design of bridge and pier piles when they are part of the lateral-force-resisting system

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## T629 Overview of Prestressed Concrete Pile Axial Load Limit Research at The Citadel

This course is the fourth in a four-part series on prestressed concrete piles. ACI 318-19 and the 2018 *International Building Code* have axial load limits for prestressed concrete piles in moderate and high seismicity areas. Researchers at The Citadel conducted a study on the background of the load limits and performed analyses on 14-in.-square prestressed concrete piles.

After completing the course, the student will be able to:

- Understand the background of code-required axial load limits for prestressed concrete piles
- Describe moment-curvature behavior of prestressed concrete piles
- Understand the logic of The Citadel research on 14-in.-square prestressed concrete piles
- Understand The Citadel research findings as well as the conclusions and recommendations of the researchers regarding axial load limits for prestressed concrete piles

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