PCI Precast/Prestressed Concrete Institute

Transportation Publications and Online Resources Catalog

2021

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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Table of Contents

Publications

Bridges

Pavement, Approach Slabs, and Bridge Decks

Repair

Piles

General Industry Documents on Design, Safety, and Quality

Table of Contents (cont.)

eLearning Courses

Fundamentals of Precast, Prestressed Concrete Series

Full-Depth Precast Concrete Deck Panels Series

Lateral Stability of Precast, Prestressed Concrete Bridge Girders Series

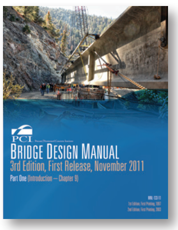
Bridge Geometry Manual Series

Curved U-Beam Bridge Series

Publications

A simple log-in to the PCI website is all that is needed to download the free resources.

Bridges



PCI Bridge Design Manual, 3rd Edition, 2nd Release

This up-to-date reference complies with the fifth edition of the *AASHTO LHFD Bridge Design Specifications* through the 2011 interim revisions and is a must-have for anyone who contributes to the transportation industry. This edition includes a chapter on sustainability and a completely rewritten chapter on bearings that explains the new method B simplified approach. Eleven LRFD examples illustrate the various new alternative code provisions, including prestress losses, shear design, and transformed sections.

MNL-133-11

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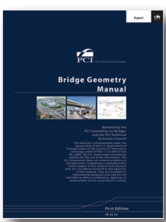

Bridge Geometry Manual

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* [T-500] 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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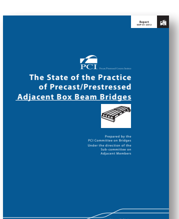

State of the Practice of Precast/Prestressed Adjacent Box Beam Bridges

Adjacent box beam bridges are widely used in new bridge construction and have many advantages over other bridge types in speed and ease of construction, aesthetics, span-to-depth ratio, and cost. Although early construction practices may have led to serviceability issues, improved practices have made the box girder bridge a viable, cost-effective structural system. A discussion on current practice, historical issues, lessons learned, and improved performance of box girder bridges is provided.

SOP-02-2011

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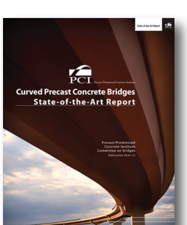

Curved Precast Concrete Bridges State-of-the-Art Report

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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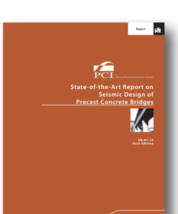

State-of-the-Art Report on Seismic Design of Precast Concrete Bridges

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-01-13

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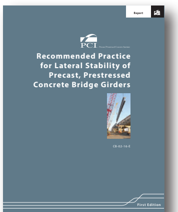
PCI Precast/Prestressed Concrete Institute

Publications



Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders

This document, which was written by a specialized team of producer members in collaboration with design practitioners, presents a new comprehensive methodology to analyze the lateral stability of long, slender bridge girders. The industry-consensus recommended practice provides methods to calculate the factors of safety during each of several stages of a girder's life, from the casting bed through storage and transit to its final location in the bridge. This is a must-have publication for all stakeholders in bridge design, fabrication, and construction.

Note: When ordering this report, please also download the errata, which is available from the product page in the PCI Bookstore.

CB-02-16

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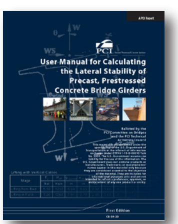

User Manual for Calculating the Lateral Stability of Precast, Prestressed Concrete Bridge Girders

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*. 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.

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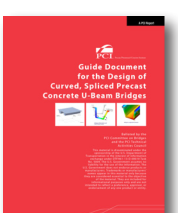

Guide Document for the Design of Curved, Spliced Precast Concrete U-Beam Bridges

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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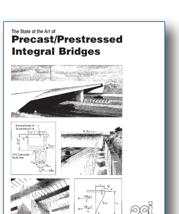

State of the Art of Precast/Prestressed Integral Bridges

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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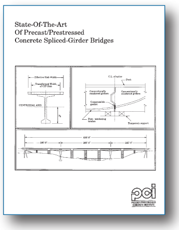

State of the Art Precast/Prestressed Concrete Spliced I-Girder Bridges

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-92-1

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doi.org/10.15554/SG-92-1

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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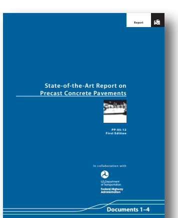

State-of-the-Art Report on Precast Concrete Pavements

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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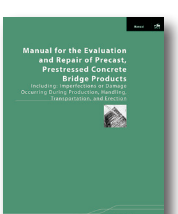
Repair



Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products

Widely used by state highway agencies and precasters alike, this manual contains diagrams of the various types of cracks, chips, voids, missing bars, and other kinds of damage or nonconformance that occur from time to time in manufacture. Each type of occurrence is evaluated for cause, prevention, engineering effect, and repair considerations. Chapters explain "standard" methods to repair damage and defects as well as patching and epoxy injection methods.

MNL-137-06

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EBook*: Members $25
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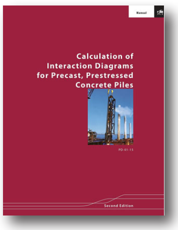
Publications

Piles



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. 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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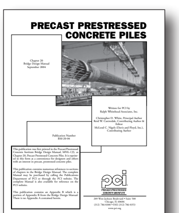

Precast Prestressed Concrete Piles

This publication was originally published in the first edition of PCI's *Bridge Design Manual*, MNL-133, as Chapter 20: Precast Prestressed Concrete Piles. It is reprinted in this form as a convenience for designers and others with an interest in precast, prestressed concrete piles.

BM-20
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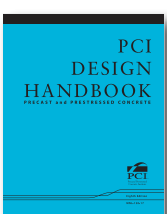
General Industry Documents on Design, Safety, and Quality



PCI Design Handbook, 8th Edition

The handbook is the eighth edition of the standard for the design, manufacture, and use of structural precast, prestressed concrete and architectural precast concrete. It provides easy-to-follow, comprehensive, and efficient procedures for the safe design of both architectural and structural precast and prestressed concrete products. Numerical examples and both new and updated design aids are included. Although the handbook is not bridge related, it offers useful background information and details about precast concrete.

Note: When ordering this manual, please also download the errata, which is available from the product page in the PCI Bookstore.

MNL-120-17

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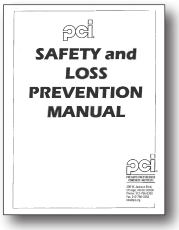

Safety and Loss Prevention Manual

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

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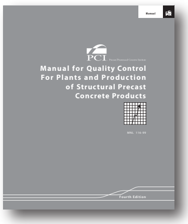

Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition

This manual presents quality control standards for plants and production of structural precast concrete products. The standards and the accompanying commentary are printed side-by-side to provide convenient explanation, discussion, and amplification of the standards. Published in a loose-leaf binder with tabs.

MNL-116-99

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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.

TM-101-16

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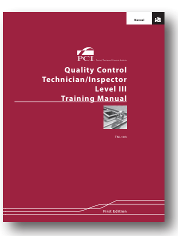

Quality Control Technician/Inspector Level III Training Manual

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

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doi.org/10.15554/TM-103-96

PCI Precast/Prestressed Concrete Institute

eLearning

PCI eLearning Courses

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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 in numerical order the T100 courses, and then 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).

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 Chapter 11.

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

T710 series course is based on MNL-133 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 Chapter 12.

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

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 ϕ-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

eLearning

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

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

eLearning

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 full 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

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. In the field, lifting and installation procedures help the designer anticipate specific issues. 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

eLearning

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

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

eLearning

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

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