Prestressed Concrete Bridge Design Seminar

Session 3 – November 8, 2022

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PCI WEST
A Chapter of Precast/Prestressed Concrete Institute

Session 3 - Agenda

Session Three - Tuesday, November 8, 2022			
Topic	**Begin**	**Duration**	**Presenter**
Welcome & Introduction	11:00 AM	0:10	Ruth Lehmann
PCI - The Body of Knowledge & Resources	11:10 AM	0:10	Ruth Lehmann
Design 3: Lateral Stability	11:20 AM	0:20	Reid Castrodale
Girder Repairs & Fabrication Issues	11:40 AM	0:20	Reid Castrodale
Project Case Study - James Bypass Bridges - Mark Weaver - Cornerstone Engineering, Farshad Mazloom - CTU Precast	12:00 PM	0:30	Mark Weaver
Caltrans NEW ABC Guidelines	12:30 PM	0:30	Jay Holombo
Producer Roundtable	1:00 PM	0:30	Reid Castrodale and PCI West members
Wrap up & Adjourn	1:30 PM		

Reid W. Castrodale, PhD, PE

Castrodale Engineering Consultants, PC – Concord, NC

Structural engineering consultant - Prestressed concrete, LWC, and ABC

39 years bridge experience in design, research, promotion, & specifications

- **Formerly Portland Cement Assn. (PCA), Ralph Whitehead Assoc. (now STV), and Stalite**
- **Georgia/Carolinas PCI Bridge Consultant (~ 25 yrs)**
- **Managing Technical Editor of *ASPIRE*™ magazine – *now Emeritus***
- **Director of Engineering – ESCSI & Stalite – Lightweight aggregate industry**
- **Consultant on 5 NCHRP research project teams: 0.7" strand; deck girders; stainless steel strand; …**

Chair, PCI Committee on Bridges (1992-1998)

Co-Chair, *PCI Bridge Design Manual* Steering Committee (1993-2011)

NCHRP Report 517 "Extending Span Ranges of PC PS Concrete Girders"

Education

Georgia Institute of Technology, BCE

University of Texas at Austin, MS & PhD in Structural Engineering

reid.castrodale@castrodaleengineering.com (704) 904-7999

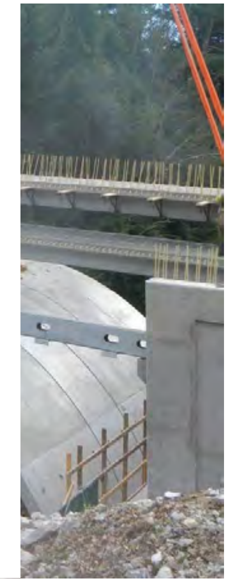
PCI West – A Partner in Accelerated Bridge Construction using Precast Concrete

Ruth Lehmann, PE, PMP
Executive Director
PCI West

HOW PRECAST BUILDS®

Outline

- What is PCI
- What is PCI West
- Who are PCI West members
- PCI West's role as an industry representative
- Prestressed concrete producer's role in alternative delivery projects
- PCI resources for the prestressed concrete bridge designer



Precast/Prestressed Concrete Institute (PCI)

- Certification Body (Producer Plants, Erection, QC Levels 1-3)
- Technical Industry Organization
- Research
- Technical Documents and Code Development
- Education
- Membership Support

PCI West *(formerly PCMAC)*

PCI WEST
A Chapter of Precast/Prestressed Concrete Institute

- Chapter of PCI representing PCI-certified producers in CA & NV
- Education
- Agency/Industry Representation and Participation
- Participation in regulatory matters
- Technical resource to agencies, consultants, contractors, owners
- Educational support to university programs

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PCI West's role as an industry representative

PCI WEST
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- Industry review/collaboration on specifications, XS-sheets
- Industry review for new materials, mix designs
- Agency support for new initiatives (ABC guidelines, BIM)
- Bridge Producers Committee – project development review
- Participate in regulatory review, policy – Cal-OSHA, legislative
- Project support – transportation, installation cost estimates
- Agency/consultant training and education

PCI-certified producer's role in ABC projects

- Design Assist – **early involvement** in project development
- Minimal impact on project delivery schedule
- Construction document review/collaboration
- QA of precast products and elements
- Technical resource to agencies, consultants, contractors, owners
- **Communicate as early as possible in design process**

PCI Resources for the ABC Bridge Designe

HOW PRECAST BUILDS®

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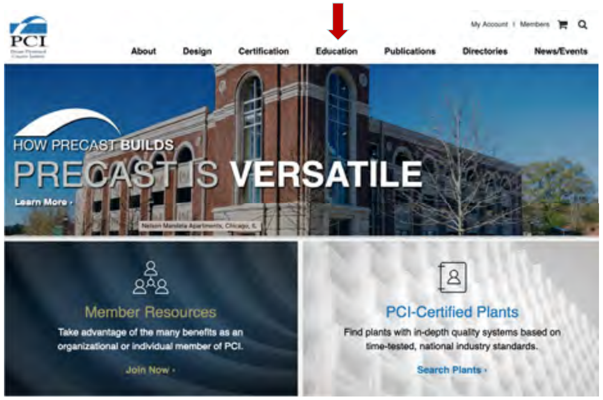
Precast/Prestressed Concrete Institute

PCI Education Resources www.pci.org

Click Education Tab



- **Monthly Webinars**

Free and on Demand

- **PCI Academy**

Live Multi-week school held in the evenings.

FEE BASED

- **PCI E-Learning**

On Demand Training Free

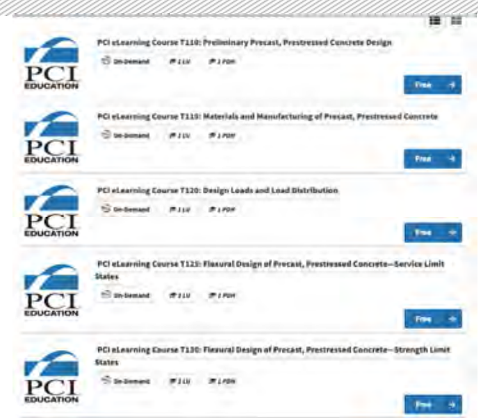
- **Learn@ Lunch**

Office Presentations

Free

- **Plant Tours**

PCI E-Learning – Transportation Bridge Classes



Sample Courses T100 Series

- Preliminary Design
- Material and Manufacturing of Precast Prestressed Concrete
- Design Loads and Load Distribution
- Flexural Design – Service Limit
- Flexural Design – Strength Limit

Check Back for New Classes too!

PCI E-Learning – Sample Module

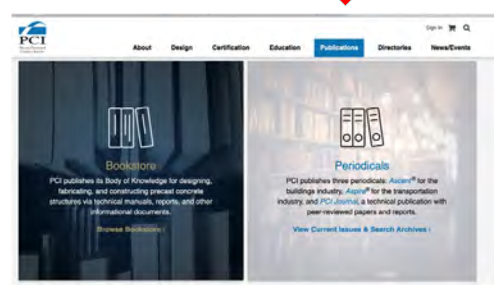
Approximately 60 minutes

- Self-Paced
- Start – Stop
- Topics Covered on Right
- Tests along the way
- Final test at completion of the module to receive PDH Credit

Download the PowerPoint notes

Free Downloadable Resources - www.pci.org

Click Publications then Book Store



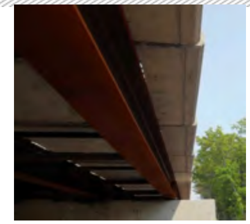
Search Free Resources by Bridge

Precast Piles Resources

Precast Prestressed Concrete Piles
Chapter 20, Bridge Design Manual,
Sept. 2004, 1st Edition (BM-20)

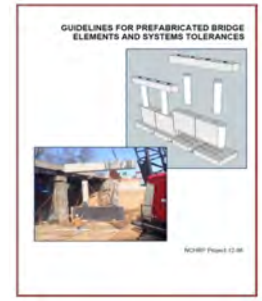
Recommended Practice for Design, Manufacture, and Installation of Prestressed Concrete Piling
PCI Journal July – August 2019

Tolerances



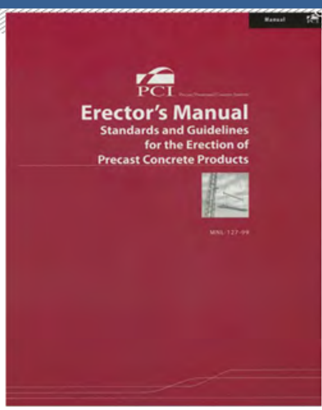
- Tolerance of Element Size and Shape
  - Forming
  - Shrinkage
  - Bar bends
- Location of Element Insert & Voids
- Horizontal Erection/Setting Tolerances
- Vertical Erection/Setting Tolerances

Tolerance Manual for Precast and Prestressed Concrete Construction (MNL-135)



Guidelines for Prefabricated Bridge Elements and Systems Tolerance
NCHRP 12-98

Erector Manuals



Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products - (MNL-127)

Erection Safety for Precast and Prestressed Concrete (MNL-132)

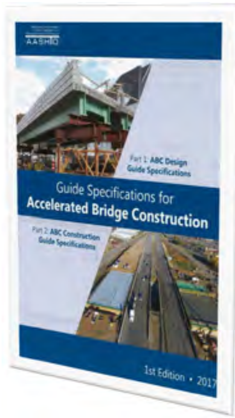
Shipping – Producer Responsibility

Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders (CB-02-16)

Full Depth Deck Panels

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

The new AASHTO ABC Guide Specifications cover the design of deck panels (2017)



Stay in contact with PCI West

PCI WEST
A Chapter of Precast/Prestressed Concrete Institute

Ruth Lehmann, PE, PMP, LEED Green Associate
Executive Director – ruth@pciwest.org 949-420-3638

www.pciwest.org

Linkedin – https://www.linkedin.com/company/pci-west

Contact us about organizing a precast plant tour!

Prestressed Concrete Bridge Design Seminar

Session 3 – November 8, 2022

Lateral Stability

NEVADA DOT SAFE AND CONNECTED

Caltrans

PCI WEST

Lateral Stability of Prestressed Concrete Girders

Stability of prestressed concrete girders has not typically been an issue considered in design

- **Prestressed concrete girders have been relatively stiff**
- **Spans have not been extremely long**
- **Problems can occur during handling or transportation**

Collapsed girder during transport in Imper and Laszlo, *PCI Journal,* Nov-Dec 1987

Introduction of high strength concrete, 0.6-in.-diameter strand, and more efficient girder sections have increased the likelihood of problems

Lateral Stability of Prestressed Concrete Girders

Usually an issue with long beams for handling and shipping

- **But “long” is relative to the section type**
- **Really an issue of slenderness rather than length**
- **So not just for the deep, long-span girders … also for shallow long-span girders**

Several methods and tools have been developed to evaluate girder stability

Several approaches can be taken to improve the stability of a girder during handling and erection

Stresses in the girder during handling must also be considered

Lateral Stability of Prestressed Concrete Girders

For many designers and owners, there is a question of responsibility when considering design of prestressed concrete girders

- **Girders are designed to satisfy design requirements**
- **Contractors and precasters are responsible for fabricating, handling, transporting, and erecting the girders**

However, in some cases, girders <u>as designed</u> cannot be safely handled or transported, or may not satisfy design stress limits during handling

- **Modifications are necessary for the safe handling and transportation of such girders**
- **The project schedule may be delayed while issues are addressed**
- **Ownership of the design becomes clouded**

Addressing the Issues of Lateral Stability

Outline of presentation

- **Resources**
- **Background**
- **Design provisions in *AASHTO LRFD Bridge Design Specifications***
- **Design provisions from other DOTs – SCDOT, GDOT, LADOTD, and WSDOT**

Resources: PCI Bookstore (www.pci.org/bookstore)

Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders **(CB-02-16)** ***FREE***

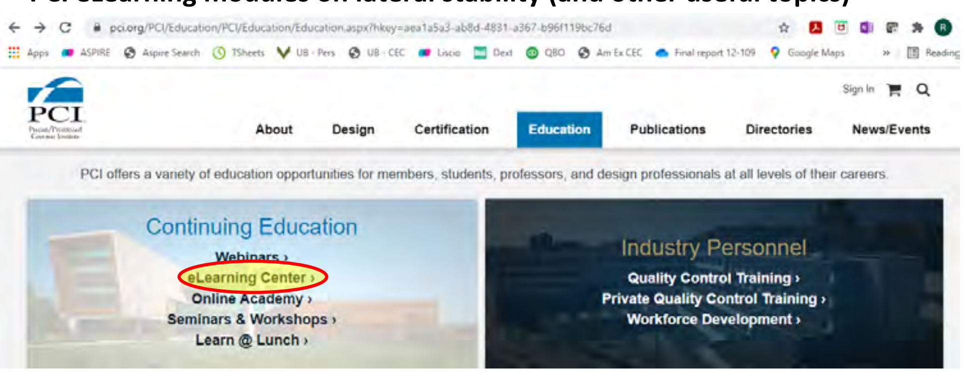
- **Basic work on the topic**
- **Errata is available on website**
- **Initial work has begun on a 2nd edition**

User Manual for Calculating the Lateral Stability of Precast, Prestressed Concrete Bridge Girders **(CB-04-20H)** ***FREE***

- **Link to download spreadsheet is provided when *Manual* is downloaded**
- **Spreadsheet is used to evaluate stability of girders**

Resources: PCI eLearning Center

PCI eLearning modules on lateral stability (and other useful topics)



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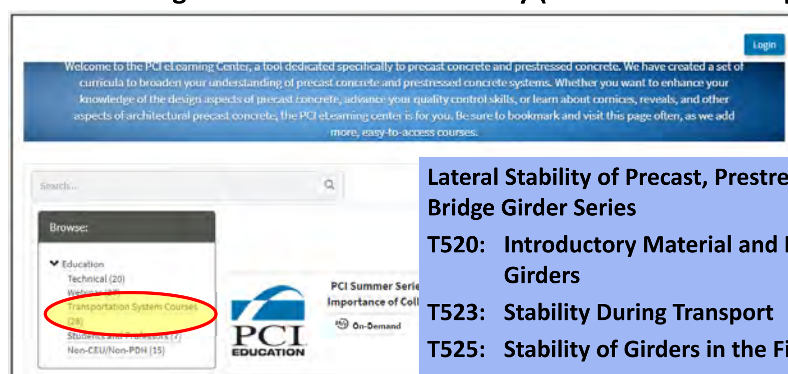


Lateral Stability of Precast, Prestressed Concrete Bridge Girder Series

T520: Introductory Material and Hanging Girders

T523: Stability During Transport

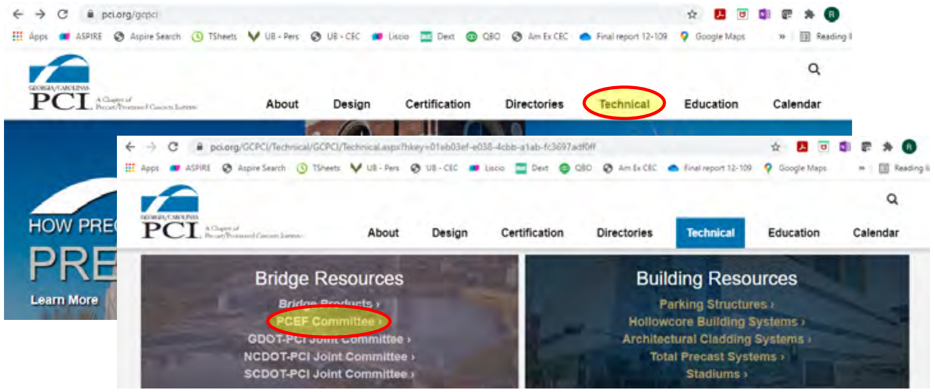
T525: Stability of Girders in the Field

T527: Calculations and Sensitivity Analysis

FREE

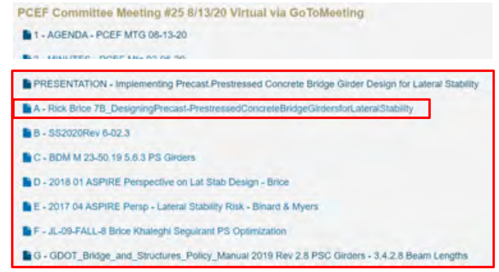
Resources: Georgia/Carolinas PCI (www.gcpci.org)

Lateral stability has been a topic of discussion at the Georgia/Carolinas Prestressed Concrete Economical Fabrication (PCEF) Committee meetings

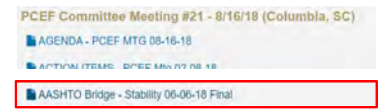


Resources: Georgia/Carolinas PCI (www.gcpci.org)

Several resources can be found on the G/C PCI webpage



Meeting #25 8/13/2020:
Presentation by Rick Brice on WSDOT approach (with documents) and new AASHTO requirements
Other resources in *ASPIRE, PCI Journal* & from GDOT – all of these are useful items



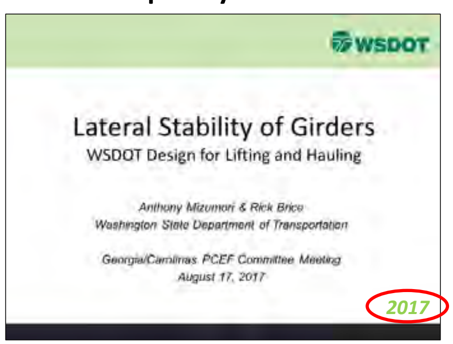
Meeting #21 8/16/2018:
Recent AASHTO LRFD revisions

Meeting #19 8/17/2017:
Presentation by Anthony Mizumori on background and WSDOT design approach at the time

Resources: Georgia/Carolinas PCI (www.gcpci.org)

Presentations from WSDOT – Rick Brice & Anthony Mizumori

- Webinars on the topic have also been developed by WSDOT



Resources: PGSuper Software (www.pgsuper.com)

This "open source" bridge girder design software was developed by WSDOT

- WSDOT (Rick Brice) assists in maintaining the software, so it is kept up to date by someone developing and closely reviewing any revisions to the LRFD specifications
- It includes a stability module that can also be used independently

TXDOT is now using the software, as well as some other states

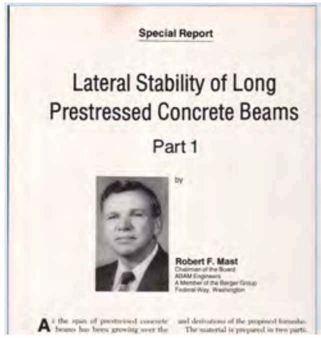
Mentioned in presentations from WSDOT

Other design software may also have lateral stability design modules

Stability Basics

Bob Mast's Special Reports in PCI Journal

- Lateral Stability of Long Prestressed Concrete Beams – Part 1 (1989)
- Lateral Stability of Long Prestressed Concrete Beams – Part 2 (1993)


Special Report

Lateral Stability of Long Prestressed Concrete Beams

Part 1

by

Robert F. Mast

Stability Basics – Hanging Beam

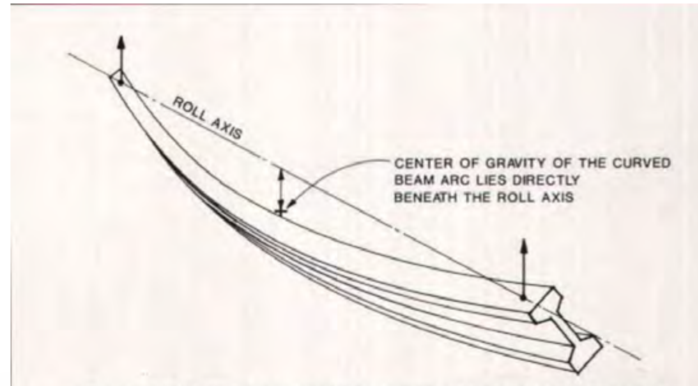


Fig. 1a. PERSPECTIVE OF A BEAM FREE TO ROLL AND DEFLECT LATERALLY

Stability Basics – Hanging Beam

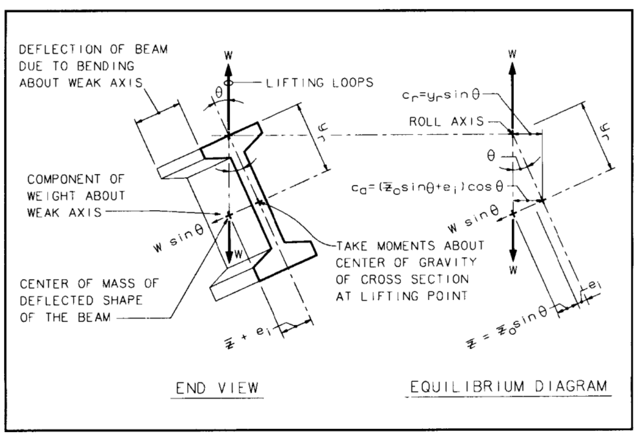


Fig. 11. Applied moment arm c_a and resisting moment arm c_r for hanging beam.

Stability Basics – Seated Beam

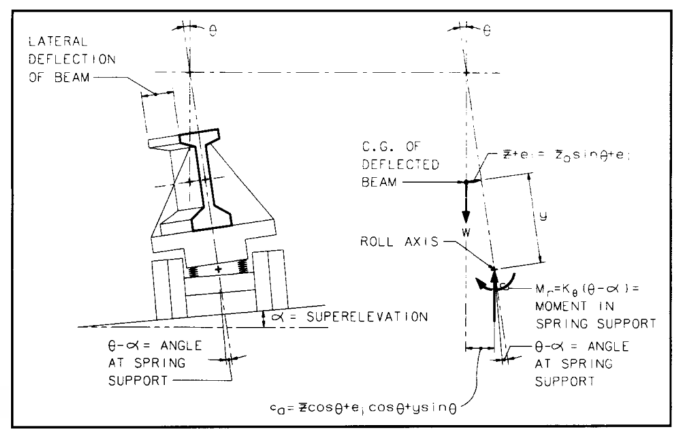


Fig. 1. Equilibrium of beam on elastic support.

Girder on truck for transport

Girder on dunnage in storage or bearings at bridge

Girder Stability – Lifting & Transport

Moving lifting loops & temporary supports in from ends helps with stability

- **Lifting at about 1.5 x depth of girder is generally a good start**
- **But stresses should be checked with altered support locations**

Some DOTs specify a maximum distance from end of girder to lifting loops or devices on standard beam sheets or in standard specifications

- **Some old specifications may use a fixed distance such as 3 ft**
  - **Such provisions can be a source for potential problems**

Girder Stability – Lifting & Transport

Stability can be improved by using rigid lifting devices

- **Must raise point of rotation above top of girder to be effective**



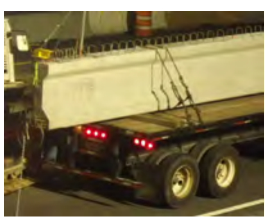



Girder Stability – Lifting & Transport

Increase overhang over supports to improve stability and maneuverability during hauling

- **Need to consider stresses**
- **Will have full f'_c by time of shipping**

Girders must be securely attached to truck - several details are used


Girder Stability – Lifting & Transport

External stiffening frames can be used to improve stability

Girder Stability – Lifting & Transport

Adding prestressed strands in the top flange – permanent or temporary

- **Helps improve stability**
  - **Top flange is less likely to crack, losing stiffness**
- **Improves stresses when lifting and support locations are moved from ends of girders**
- **Design issues regarding top strands discussed in earlier presentation**

Designing Girders for Stability during Lifting & Transport

Typically, designers only design girders to satisfy design requirements at transfer of prestress and at final conditions

In most states, designers are not assigned responsibility for considering lifting, handling, and transport

However, in some cases, girders as designed cannot be safely handled or transported without modification to address lateral stability concerns or excessive stresses

To help with stability for longer members, lifting loops or supports are typically moved in from ends

- **But will likely cause stress limits to be exceeded when lifting or transporting**
- **Stresses during handling should be checked**

Designing Girders for Stability during Lifting & Transport

Relevant provisions in AASHTO LRFD <u>since 1st ed. in 1994</u>

1.3.1—General

Bridges shall be designed for specified limit states to achieve the objectives of constructibility, safety, and serviceability, with due regard to issues of inspectability, economy, and aesthetics, as specified in Article 2.5.

2.5.1—Safety

The primary responsibility of the Engineer shall be providing for the safety of the public. The Owner may require a design objective other than structural survival for an extreme event.

2.5.3—Constructibility

Constructability issues should include, but not be limited to, consideration of deflection, strength of steel and concrete, and stability during critical stages of construction.

Designing Girders for Stability during Lifting & Transport

Relevant provisions AASHTO LRFD <u>since 1st ed. in 1994</u>

5.5.1.1—Limit-State Applicability

Structural components shall be proportioned to satisfy the requirements at all appropriate service, fatigue, strength, and extreme event limit states at all stages during the life of the structure. Unless specified otherwise by the Owner, the load combinations and load factors specified in Section 3 and elsewhere in this section shall be used.

Prestressed concrete structural components shall be proportioned for stresses and deformations for each stage that may be critical during construction, stressing, handling, transportation, and erection as well as during the service life of the structure of which they are part.

5.5.4.3—Stability

The structure as a whole and its components shall be designed to resist sliding, overturning, uplift and buckling. Effects of eccentricity of loads shall be considered in the analysis and design.

Buckling of precast members during handling, transportation, and erection shall be investigated.

Designing Girders for Stability during Lifting & Transport

Recent revisions to *AASHTO LRFD Specifications* address this issue

Revise the following Article:

5.5.4.3—Stability

The structure as a whole and its components shall be designed to resist sliding, overturning, uplift and buckling. Effects of eccentricity of loads shall be considered in the analysis and design.

Buckling and stability of precast members during handling, transportation, and erection shall be investigated.

Add the following Commentary:

C5.5.4.3

Stability during handling, transportation, and erection can govern the design of precast, prestressed girders. Precast members should be designed such that safe storage, handling, and erection can be accomplished by the contractor. This consideration does not make the designer responsible for the contractor's means and methods for construction, as discussed in 2.5.3.

Lateral bending stability analysis should be based on the "Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders", Precast Concrete Institute, Publication CB-02-16-E. A detailed design example is presented in Seguirant, Brice, and Khaleghi, (2009).

Designing Girders for Stability during Lifting & Transport

Recent revisions to AASHTO LRFD (9th ed. 2020) emphasize considering lateral stability during design

5.9.4.5 Temporary Strands

Temporary top strands may be used to alleviate tensile stresses in precast prestressed girders during handling and transportation. These strands may be pretensioned or post-tensioned prior to lifting the girder from the casting bed or post-tensioned immediately prior to transportation of the girder. Detensioning of temporary strands shall be shown in the construction sequence and typically occurs after the girders are securely braced and immediately before construction of intermediate diaphragms, if applicable.

C5.9.4.5 Temporary Strands

The stability of slender precast girders is improved when lifting and transportation support points are moved away from the ends of the girder. The consequence of having a shorter span between support points is reduced dead load stresses to balance the stresses due to pretensioning and thus excessive tensile stresses in the top flange and compressive stresses in the bottom flange may develop. Temporary strands placed in the top flange of the girder alleviate these excessive stresses and reduce the required strength at prestress transfer. Temporary strands in the top flange balance a portion of the primary prestressing and reduce camber and camber growth due to creep.

Designing Girders for Stability during Lifting & Transport

Recent revisions to AASHTO LRFD (9th ed. 2020) emphasize considering lateral stability during design

5.12.3.2—Precast Beams

5.12.3.2.1—Preservice Conditions

The preservice conditions of prestressed girders for shipping and erection shall be the responsibility of the contractor.

Stability during handling, transportation, and erection can govern the design of precast, prestressed girders. Precast members should be designed such that safe storage, handling, and erection can be accomplished by the contractor using reasonable means and methods.

C5.12.3.2.1

AASHTO LRFD Bridge Construction Specifications place the responsibility on the Contractor to provide adequate devices and methods for the safe storage, handling, erection, and temporary bracing of precast members.

Lateral bending stability analysis may be based on the "Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders", Precast Concrete Institute, Publication CB-02-16-E. A detailed design example is presented in Seguirant, Brice, and Khaleghi, (2009).

Examples of Design Guidelines for Girder Stability

SCDOT Design Guidelines for Girder Stability

Example from SCDOT

- **SCDOT BDM Art. 5.5.2 Responsibilities**

15.5.2.1 Designer

The designer is responsible for choosing a cross section and providing a strand size and pattern to achieve the required allowable Service limit state stresses and factored flexural resistance. The designer is also responsible for a preliminary investigation of shipping and handling issues where larger or long beams are used or where unusual site access conditions are encountered.

15.5.2.2 Contractor

The Contractor is responsible for investigating stresses in the components during proposed handling, transportation, and erection.

- **As noted, contractor remains responsible for successful construction**
- **Preliminary evaluation is like an erection plan – a concept that will work**
- **No guidance is provided to designer to evaluate stability**

GDOT Design Guidelines for Girder Stability

Example from GDOT B&SDM Art. 3.4.2.8

3.4.2.8 Beam Lengths

The maximum beam lengths for the PSC beams are:

- 50 feet for AASHTO Type I Mod. beams
- 65 feet for AASHTO Type II beams
- 85 feet for AASHTO Type III beams
- 125 feet for 54" Bulb Tee beams
- 135 feet for 63" Bulb Tee beams
- 150 feet for 72" and 74" Bulb Tee beams

AASHTO Type II beams are preferred for span lengths between 40 to 50 feet.

If the above maximum beam lengths are exceeded under an alternate bidding process, the engineer of record is responsible for performing a beam stability analysis.

Span limits are based on stability considerations

- **Longer spans can be used for alternate bidding with analysis by EOR**

LADOTD Design Guidelines for Girder Stability

The LADOTD BDEM Art. 5.14.1.2 and commentary include provisions for contractor to consider lateral stability

The notes below shall be included in PPC girder detail sheets or general notes sheets for all projects.

"The contractor is responsible for stability of precast prestressed concrete girders during fabrication, storage, transportation, erection, and deck placement. Supporting analysis and calculations stamped, signed, and dated by a Louisiana licensed professional engineer and shop drawings showing the method of lifting the girder, lifting locations and details, support (dunnage) locations for storage and transportation details, and erection bracing details shall be submitted to the EOR for review.

Girder stability during each phase of construction is dependent on the type of lifting equipment and pick up methods and therefore, is the responsibility of the contractor.

For extremely long girders (typically > 160 feet), the contractor may consider using lifting brackets instead of using lifting loops; so that the girder would be lifted from below its center of gravity. The brackets may eliminate the chance of an "off center" lifting which may occur when using lifting loop on the top flange.

LADOTD Design Guidelines for Girder Stability

The LADOTD BDEM Art. 5.14.1.2 and commentary include provisions for contractor to consider lateral stability

During the design process, the EOR shall ensure that all girders, while within the allowable stress limits, can be supported on dunnage within 3.0 feet from their ends or as calculated.

The EOR shall determine whether the girder can be picked up in accordance with the lateral stability requirements in the *PCI Bridge Design Manual*; however, the pick-up point locations shall not be shown on the contract plans.

During the construction phase, the EOR shall verify that contractor shop drawings and supporting calculations for girder storage, lifting, and handling meet the most current lateral stability analysis procedure provided in the *PCI Bridge Design Manual* to ensure that the proposed girder stability could be achieved within the allowable stress limits listed in the contract plans.

For lateral stability examples refer to the PCI Report No. CB-02-16 titled *"Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders."*

LADOTD Design Guidelines for Girder Stability

The LADOTD BDEM Art. 5.14.1.2 girder maximum span length table

- **Also includes max. initial PS force & max. no. of strands**
- **Similar to FDOT requirements for FIBs**
- **Based on end zone reinforcement details, <u>not</u> lateral stability**

Girder Maximum Span Length Table

Girder Type	Maximum Span Length (ft.)	Maximum Prestressing Force Immediately Prior to Transfer (kip)	Maximum No. of Strands (Assume 0.6 in. Dia., 270 ksi, Low Relaxation Strands)
LG-25	53	1,408	32
LG-36	98	2,112	48
LG-45	119	2,376	54
LG-54	133	2,464	56
LG-63	154	2,816	64
LG-72	171	3,080	70
LG-78	183	3,344	76
Quad Beam (18.0 in.)	40	704	16
AASHTO Type II (36 in.)	55	750	18
AASHTO Type III (45 in.)	85	1,000	22
AASHTO Type IV (54 in.)	105	1,500	34
BT-72	125	1,850	42
BT-78	140	2,200	50

WSDOT Design Guidelines for Girder Stability

WSDOT has developed an excellent approach that addresses both design and construction – a great example

- **WSDOT requires designers to consider handling and transportation**
  - **WSDOT doesn't want designs as bid that will require fabricators to change the design to make it work**
  - **Designers must check lifting & transport using specified parameters**
  - **Design approach has become more complicated as new hauling equipment becomes available**

Approach has been used and refined for 25 years

- **Has been proven to be successful for the owner, designers, fabricators, and contractors**

WSDOT Design Guidelines for Girder Stability

References for WSDOT practice – *<u>HIGHLY RECOMMENDED</u>*

- **Procedures, assumptions, and responsibilities for designers and contractors are clearly stated in WSDOT *Bridge Design Manual* and *Standard Specifications***
- **Design example by Seguirant et al. in Fall 2009 issue of *PCI Journal***
- **Owner's perspective by Brice in Winter 2018 issue of *ASPIRE***
- **Evaluation of the effect of lateral stability requirements in LRFD by Seguirant et al. in March-April 2020 issue of *PCI Journal***
- **Presentations by Brice for G/C PCI PCEF Meeting #25 on 8/13/20 and by Mizumori for Meeting #19 on 8/16/2018 – see PDFs and supporting info at <u>http://gcpci.org/index.cfm/technical/pcef</u>**

WSDOT training webinars on lateral stability are also available

Summary

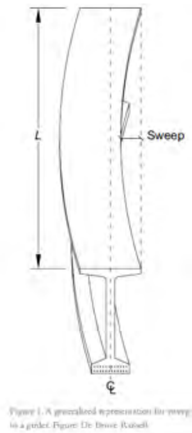
- **Stability and handling stresses should be considered in design**
- **The SCDOT approach is a good recognition of the need for designers to evaluate stability, but no direction is given**
- **The GDOT approach is helpful for "bread and butter" designs, but no guidance is given for how to evaluate stability**
- **The LADOTD BDEM provides additional guidance**
- **The WSDOT approach is well developed and has proven effective**
  - **Intended to assure that girders can be fabricated as bid**
  - **Assumptions are provided by owner, or made by EOR**
  - **Increases design effort, but good resources are available**
  - **Contractor is still responsible**
- **Current PCI research is evaluating stiffness of hauling equipment**

Sweep

Definition of sweep in the ***Manual for Quality Control for Plants and Production of Structural Precast Concrete Products*** **(PCI MNL-116):**

> **"a variation in horizontal alignment from a straight line parallel to centerline of member (horizontal bowing)."**

A generalized representation for sweep from article in *ASPIRE* is shown



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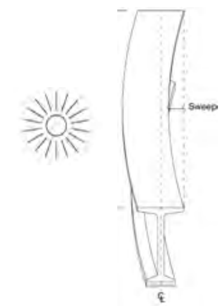
Sweep

Causes include

- **Strands eccentric to centroid of cross section**
- **Girder tilted in storage will creep**
- **Thermal sweep**
  - **Sun exposure increases sweep**
  - **Especially an issue for girders oriented east/west since sun predominantly shines on only one side**
  - **Measure sweep early in day**



Sweep

A series on sweep appeared in *ASPIRE*, written by Dr. Bruce Russell

- **Part 1 in Spring 2019 issue**
  - **Introduction to sweep including potential causes of sweep and how to evaluate effects**
  - **Example calculations**
  - **Recommendations to mitigate sweep**
- **Part 2 in Fall 2019 issue**
  - **Effects of sweep during the lifting, transportation, and erection of girders**
  - **Possible actions to increase factors of safety for lifting and hauling**
- **Part 3 in Summer 2020 issue**
  - **Evaluation of long-term effects of sweep in girders for stresses and strength**
  - **Effect of attempts to mitigate sweep**

Sweep

Dr. Russell's conclusions on effects of sweep (from Part 3):

- **Sweep in prestressed concrete girders that is within, or in some cases beyond, the published tolerance may not have significant adverse effects on the long-term performance of a bridge**
- **Therefore, the owner and engineer should consider allowing girders that exhibit reasonable sweep to be incorporated into a bridge**
  - **A bridge girder with sweep beyond tolerance should be analyzed to ensure that all criteria for stability, strength, and serviceability are met so it can be transported and erected**
  - **It is both expedient and reasonable for the owner and engineer to accept such a girder, make no attempt to straighten it, and continue with construction**

Prestressed Concrete Bridge Design Seminar

Session 3 – November 8, 2022

Lateral Stability

Prestressed Concrete Bridge Design Seminar

Session 3 – November 8, 2022

Quality Control and Repair of Prestressed Girders in the Plant

Acknowledgements

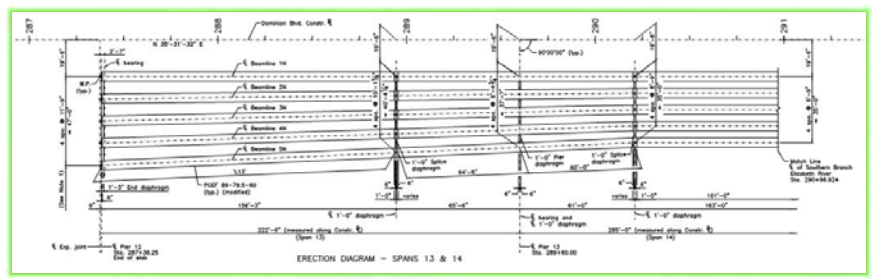
This presentation was originally prepared and presented by JP Binard, PE, President, Precast Systems Engineering for an Inspector's Workshop for NCDOT on November 14, 2018.

JP was responsible for the initial work on revising MNL-137.

This presentation has been modified and presented at a few subsequent seminars by Reid Castrodale, PhD, PE.

Input has also been received from David Tomley, PE, Chief Engineer for Gulf Coast Prestress Partners and Texas Concrete Partners, who is currently leading the PCI effort to update MNL-137.

THE GOAL



SUCCESSFULLY CONVERTING PLANS INTO A BRIDGE

COLLABORATION IS REQUIRED AT EVERY PHASE

THE GOAL

45

WHAT COULD POSSIBLY GO WRONG?

46

THIS?

47

OR MAYBE EVEN THIS?!!

48

WHAT COULD POSSIBLY GO WRONG?

CRANE BRAKE FAILED AND DROPPED SPREADER BEAM ON GIRDER

WHAT COULD POSSIBLY GO WRONG?

FORKLIFT ACCIDENTALLY HIT CORNER OF A PILING CAUSING A SPALL

GAME TIME DECISIONS – FORM REMOVED

DAMAGE FOUND THAT APPEARS TO NEED REPAIR

WHAT IS AN ACCEPTABLE REPAIR?

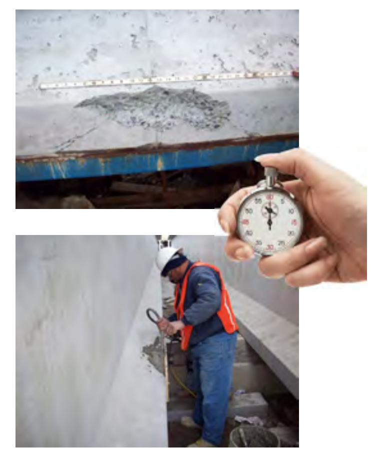
THE BIG QUESTION:

- Repair Before Detensioning, or in Storage?

CONSIDERATIONS:

- How will damage affect the girder
- Repairs prior to detensioning will be precompressed (longitudinally)
- On bed repairs delay production - affects schedules and profitability

ANSWERS ARE NEEDED FAST!



BOTTOM FLANGE REPAIR

A STORY FROM THE PLANT

HONEYCOMB FOUND – AREA CLEANED BEFORE DETENSIONING

BOTTOM FLANGE REPAIR

A STORY FROM THE PLANT

PREPARE FOR STANDARD REPAIR, WITH DOCUMENTATION

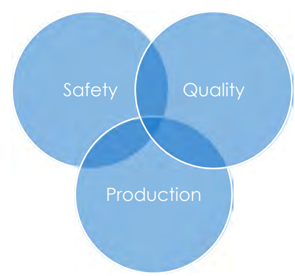
BOTTOM FLANGE REPAIR

A STORY FROM THE PLANT

HAVING A PREAPPROVED REPAIR METHOD COULD HAVE AVOIDED REJECTION OF THIS GIRDER

CONCRETE POURED, CURED & DETENSIONED … BUT REJECTED

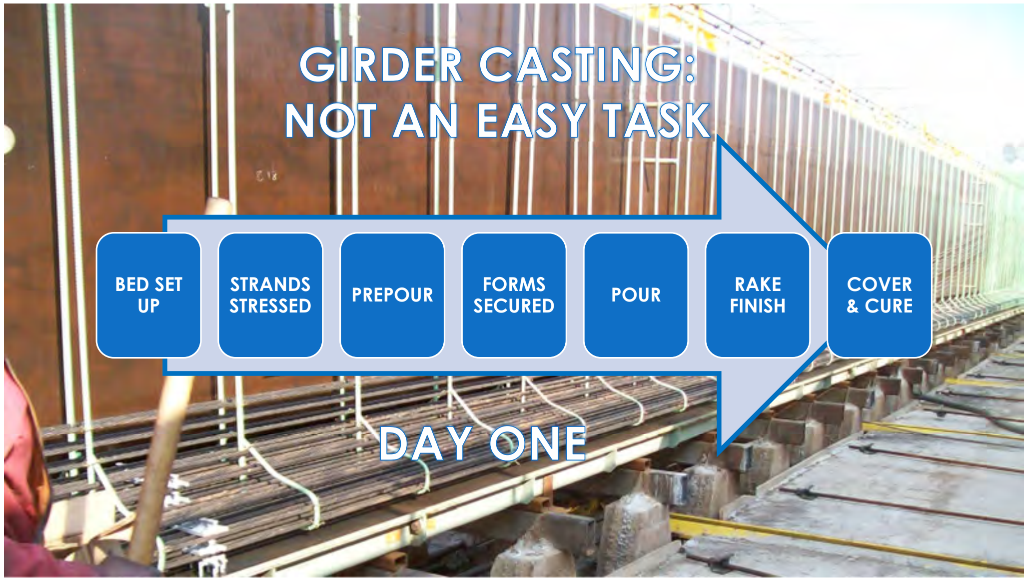
WHO IS RESPONSIBLE FOR QUALITY?

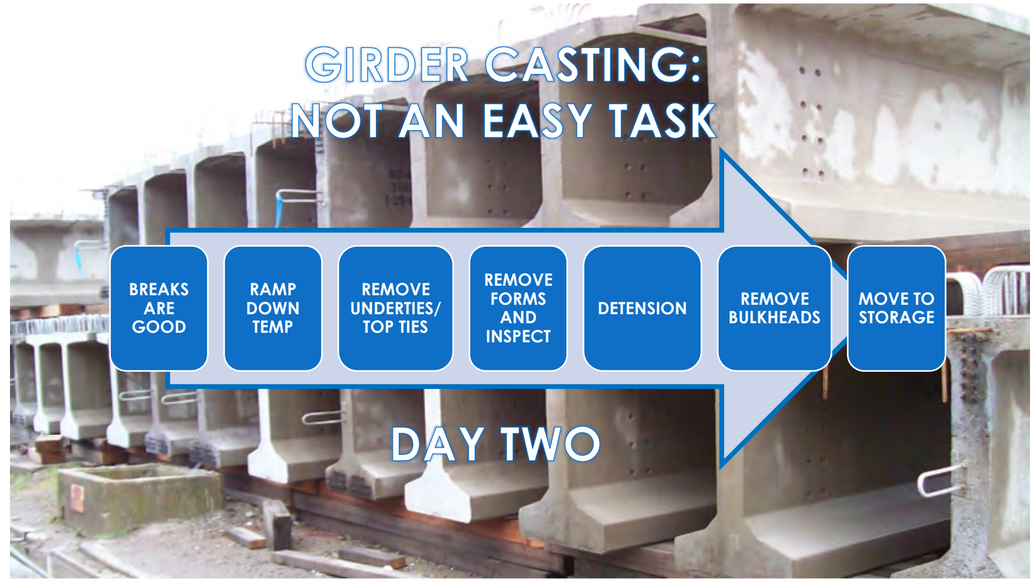


IT TAKES TEAMWORK

Every effort towards cooperation shall be observed between production personnel, who are responsible for quantity and quality, and inspection personnel, who are responsible for observing and monitoring quality.

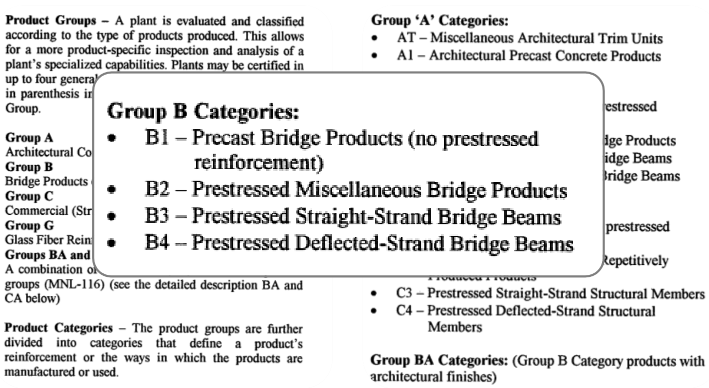
PCI Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
MNL 116-99, Section 6.1





WHO IS RESPONSIBLE FOR QUALITY?

- **PRODUCERS – PCI CERTIFICATION REQUIRED BY ALDOT**



Product Groups – A plant is evaluated and classified according to the type of products produced. This allows for a more product-specific inspection and analysis of a plant's specialized capabilities. Plants may be certified in up to four genera… in parenthesis i… Group.

Group A Architectural Co…
Group B Bridge Products…
Group C Commercial (Str…
Group G Glass Fiber Rein…
Groups BA and … A combination o… groups (MNL-116) (see the detailed description BA and CA below)

Product Categories – The product groups are further divided into categories that define a product's reinforcement or the ways in which the products are manufactured or used.

Group 'A' Categories:
- AT – Miscellaneous Architectural Trim Units
- A1 – Architectural Precast Concrete Products

…estressed
…dge Products
…idge Beams
…ridge Beams
…prestressed
…epetitively
- C3 – Prestressed Straight-Strand Structural Members
- C4 – Prestressed Deflected-Strand Structural Members

Group BA Categories: (Group B Category products with architectural finishes)

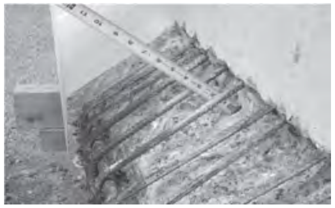
Group B Categories:
- B1 – Precast Bridge Products (no prestressed reinforcement)
- B2 – Prestressed Miscellaneous Bridge Products
- B3 – Prestressed Straight-Strand Bridge Beams
- B4 – Prestressed Deflected-Strand Bridge Beams

WHO IS RESPONSIBLE FOR QUALITY?

- EACH PLANT DEVELOPS AND MAINTAINS A **QUALITY SYSTEM MANUAL** AS REQUIRED FOR PCI CERTIFICATION
  - STANDARD PROCEDURES, STANDARD REPAIRS, APPROVED REPAIR MATERIALS ARE INCLUDED
- PROJECT OR PLANT SPECIFIC QUALITY CONTROL PLANS
- REGULAR INTERNAL QC AUDITS
- BI-ANNUAL 3RD PARTY UNANNOUNCED QC AUDITS

STANDARD REPAIRS IN PQP – DECISION TOOL

- Provide sawcut a minimum of 1" beyond the perimeter of the repair area, to a minimum depth of ½".
- Remove all unsound concrete within the repair area. Remove all concrete – unsound and sound – within the sawcut to a minimum depth of ½".
- If more than half the circumference of a reinforcing bar is exposed, remove additional concrete to 1" behind the bar. This does not apply to prestressed strands.
- For areas in which no steel is exposed, use adhesively anchored anchors, with a minimum ¼" diameter, spaced at 6" grid, to provide mechanical bond for repair material. Provide the design concrete cover for studs.
- Do not damage rebar or strand.
- Form and place repair material to original shape.
- The repair material shall have a minimum compressive strength equal to or greater than that of the original beam concrete.
- The maximum size of aggregate in repair material should not exceed 2/3 of the minimum depth of the repair area.
- The repair material shall be on the NCDOT Approved Products List.
- Surface preparation, proportioning, mixing, placement, and curing of repair material should follow all manufacturer's recommendations.
- Perform repair operations in the presence of and to the satisfaction of an NCDOT inspector.
- The Resident Engineer and the Area Construction Engineer may want to consider a price adjustment for the repaired member.



PQP = PROJECT QUALITY PLAN (PROJECT SPECIFIC)

SAMPLE OF QC AUDIT TOPICS

OVER 150 AUDITED ITEMS, INCLUDING

- CONCRETE AND OTHER MATERIALS
- MIXING THROUGH CURING
- PRESTRESSING STRANDS
- TENSIONING OF STRANDS & TRANSFER OF PRESTRESS
- PRODUCT HANDLING AND STORAGE
- QC PROCEDURES
- SHOP DRAWINGS AND RECORD KEEPING

FABRICATION DEFECTS AND REPAIRS

THIS PCI MANUAL ASSISTS DESIGNERS, STATE AGENCY OFFICIALS, AND PRECASTERS IN EVALUATING PRECAST COMPONENT IMPERFECTIONS OR DAMAGE OCCURRING TO BEAMS, DECK PANELS OR SIMILAR PRECAST PRODUCTS DURING

- PRODUCTION,
- HANDLING,
- TRANSPORTATION, OR
- ERECTION

THE MANUAL PRESENTS METHODS FOR REPAIRING DEFECTS TO KEEP THE CONSTRUCTION OF A BRIDGE ON SCHEDULE

FABRICATION DEFECTS AND REPAIRS

CHAPTERS INCLUDE

INTRODUCTION TO STANDARD REPAIRS

FABRICATION DEFECTS AND REPAIRS

TABLE OF CONTENTS FOR CHAPTER 2 – TROUBLESHOOTING GUIDE
TYPES OF DEFECTS COVERED BY CURRENT MANUAL ARE LISTED

FABRICATION DEFECTS AND REPAIRS

FOR EACH OF THE 11 TYPES OF DAMAGE IN CHAPTER 2, THE TROUBLESHOOTING GUIDE GIVES

- CAUSES
- PREVENTION
- ENGINEERING EFFECTS
- REPAIR CONSIDERATIONS

INFORMATION IS PRESENTED IN 2-PAGE FORMAT, WITH A COLUMN FOR EACH OF THE BULLETED TOPICS

EXAMPLE: TROUBLESHOOTING RANDOM HONEYCOMB OR VOID

PCI MANUAL 137

EXAMPLE: TROUBLESHOOTING RANDOM HONEYCOMB OR VOID

CAUSES

A. Production

1. Inadequate vibration
2. Improper methods for placement of concrete
3. Shifted or misplaced reinforcing bar cage
4. Bleeding of concrete from forms

B. Concrete Mix

1. Inadequate mixing
2. Mix too stiff or rocky
3. Early set of plastic concrete
4. Delayed placement of concrete
5. Flash set of concrete in form
6. Excessive aggregate size, gap grading, or detrimental shape

C. Design Details

1. Congested reinforcement

PREVENTION

A. Improved Production Procedures

1. Provide thorough internal and, where warranted, external vibration.
2. Start placement away from bulkhead and use vibration to cause the concrete to flow toward bulkhead.
3. Verify positioning and anchorage of reinforcement.
4. Provide mortar-tight form.

B. Adjust Concrete Mix

1. Mix concrete thoroughly.
2. Adjust mix by adding plasticizers or by reducing aggregate size.
3. Shorten delivery time of the concrete.
4. Cool form prior to concrete placement.
5. Use aggregates with maximum particle size less than two-thirds the minimum clear spacing between reinforcement. Utilize aggregate with more rounded particles.

C. Improve Details

1. Reduce reinforcement congestion to the extent possible.
2. Provide clear spacing between reinforcement greater than 1½ times the maximum aggregate size. Account for clearances, true dimensions of reinforcement, and space occupied by lapped reinforcement.
3. Avoid the use of horizontal reinforcement in beam webs to the extent possible.

PCI MANUAL 137

EXAMPLE: TROUBLESHOOTING RANDOM HONEYCOMB OR VOID

ENGINEERING EFFECTS

1. A honeycomb or void in the bearing area not only affects the strength and durability of the bearing but also the moment capacity of the beam if bond of the strand is affected. Under modified compression field theory, loss of bond of strand can also affect shear capacity in that the effective longitudinal reinforcement requirement in the AASHTO LRFD Specifications may be compromised. These areas must be repaired. Honeycombs and voids in other areas of the bottom flange can affect moment capacity but more than likely will only affect durability.
2. A honeycomb or void in a web affects shear capacity and must be repaired.
3. A honeycomb or void in a top flange that will be the riding surface of the bridge affects both moment capacity and durability and requires repair. Where the top flange is to be encased in a cast-in-place slab, the honeycomb or void may significantly affect the non-composite strength but not composite strength or durability.

REPAIR CONSIDERATIONS

1. For the condition discussed in Engineering Effects No. 1, repair using Standard Repair Procedures #1 or #2 as appropriate.
2. For the condition discussed in Engineering Effects No. 2, repair using Standard Repair Procedures #5 or #9 as appropriate.
3. For the conditions discussed in Engineering Effects No. 3, if a repair is required, use Standard Repair Procedures #6 or #9 as appropriate.
4. A repair to a spall made after transfer should be assessed in light of resulting stresses imposed on the beam during in-service conditions. For patches to remain durable and intact, especially those that will be located over traffic, the patches must be well anchored to reinforcement to keep repair material from falling free. Preloading of the beam or use of expansive materials may be required (see Standard Repair Procedures #4 and #6).

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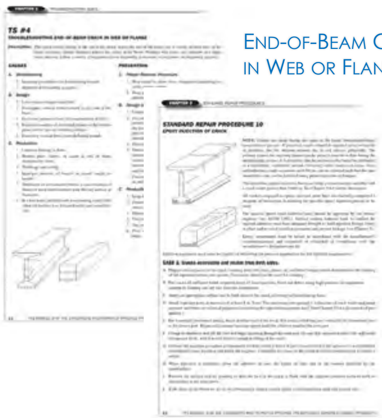
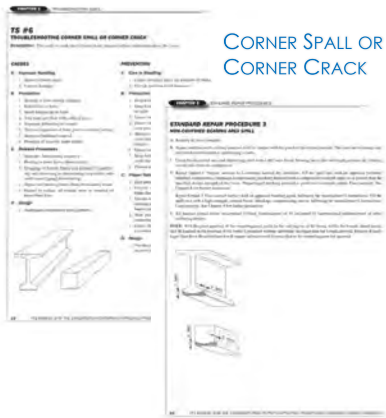
OTHER EXAMPLES FROM CHAPTER 2 - TROUBLESHOOTING GUIDE



END-OF-BEAM CRACK IN WEB OR FLANGE



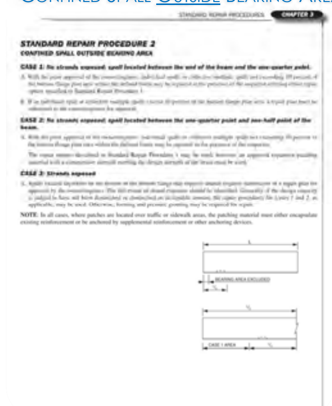
CORNER SPALL OR CORNER CRACK

PCI MANUAL 137

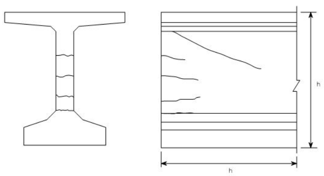
EXAMPLES FROM CHAPTER 3 - STANDARD REPAIR PROCEDURES

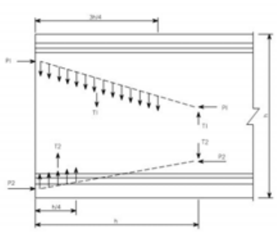
CONFINED SPALL INSIDE BEARING AREA

CONFINED SPALL OUTSIDE BEARING AREA



END ZONE CRACKING



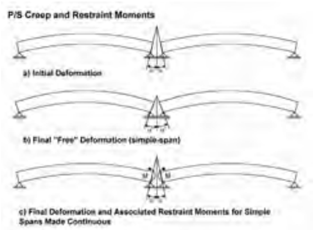


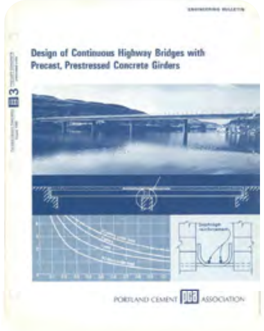
- DESIGN ISSUE, NOT USUALLY FROM FABRICATION
- AVOID, ALTHOUGH NOT TYPICALLY A DURABILITY PROBLEM
- SEALING IS POSSIBLE, BUT AVOID INJECTION
- CRACKS TYPICALLY CLOSE WHEN DECK ADDED

PROJECTING REBAR OR STRAND CUT OFF

CAN DRILL AND INSTALL A REPLACEMENT BAR … OR

PROJECTING REBAR OR STRAND CUT OFF





5.14.1.4.4—Age of Girder When Continuity Is Established

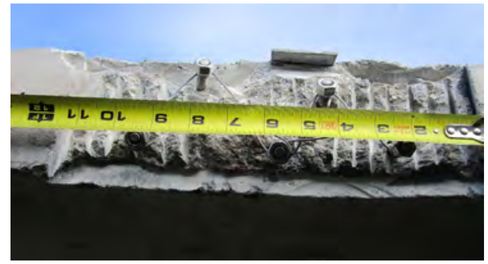
The minimum age of the precast girder when continuity is established should be specified in the contract documents. This age shall be used for calculating restraint moments due to creep and shrinkage. If no age is specified, a reasonable, but conservative estimate of the time continuity is established shall be used for all calculations of restraint moments.

The following simplification may be applied if acceptable to the Owner and if the contract documents require a minimum girder age of at least 90 days when continuity is established:

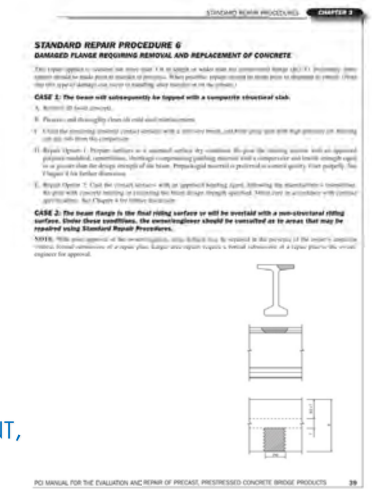
Review Girder Design

- Are Remaining Bars Adequate
- Delay Continuity to Avoid Positive Moment from Camber Creep
- Thermal Camber can be Significant (Not usually considered)

TOP FLANGE REPAIR



- Stainless Steel Rods, Nuts & Wire for Anchorage
- Typically not Structurally Significant, except for Metal Form Clip Support



END SPALL IN DECK FORM PANEL

- May be used without Repair if Spall will be within Deck Pour

REVISION OF PCI MANUAL 137

The PCI Bridge Producers Committee is currently updating and expanding the Manual

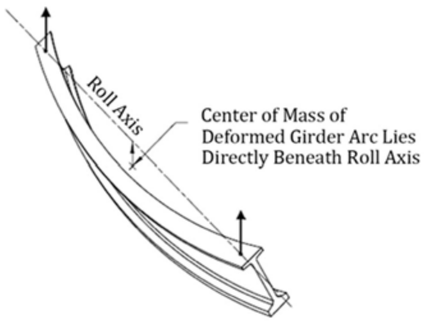
New Items Being Added:

- Repair Decision process flowchart (Ch. 1)
- Descriptions & size guidelines associated with bug-holes, honeycombing, and spalls (Ch. 1)
- Prestressed piles
- Sweep
- Camber variability
- Corner spalls in precast full-depth deck panels
- Update references

ADDITION TO PCI MANUAL 137

SWEEP

- Detailing to Accommodate
  - Intermediate Diaphragm
- Plant
  - Level Storage
  - Solar Exposure
- Field
  - Partial Correction
- Impacts?
  - Use As Is?



See *ASPIRE* Articles – Spring & Fall 2019; Summer 2020

ADDITION TO PCI MANUAL 137

SWEEP

NOT COVERED BY PCI MANUAL 137

Collapsed and Punctured PT Duct in Spliced Girder

Form Offset out of Tolerance

Misalignment of Inserts – out of Tolerance

Prestressed Concrete Bridge Design Seminar

Session 3 – November 8, 2022

Quality Control and Repair of Prestressed Girders in the Plant

NEVADA DOT SAFE AND CONNECTED

Caltrans

PCI WEST

About Me

Mark Weaver, PE, SE

- **Senior Engineer with 15 years experience**
- **Education**
  - CSU Fresno – BS Degree 2009
  - UC Berkeley – MS Degree 2011
- **Leadership**
  - CSU Fresno Engineering Alumni Board Past President
  - ASCE Fresno YMF Past President
  - ASCE Fresno Branch Past President
  - ACEC San Joaquin Valley Chapter Past President
  - ACEC California State Director
- **Project Experience**
  - Both vertical and horizontal construction, but primarily focused on horizontal construction.

About My Firm

- **Cornerstone Structural Engineering Group**
  - Boutique firm specializing in structural design of buildings, bridges, and other infrastructure
  - Founded in 2004 by Todd Goolkasian, SE
  - Grown to a medium size structures only firm
  - Certified Small Business Enterprise (SBE) Firm
  - Represent Districts 5 and 6 on Caltrans/ACEC Structures Liaison Committee

PRIMARY PROJECT DRIVERS

- **Primary Driver for Bridge Replacement**
  - **Structurally Deficient Bridges**
- **Primary Drivers for Precast**
  - **High ADT**
  - **Limited Construction Window due to CVFPB**
  - **Limited Realignment Options due to Adjacent Bridge to Remain**

CORNERSTONE structural engineering group

PROJECT LOCATION

CORNERSTONE structural engineering group

PROJECT BACKGROUND

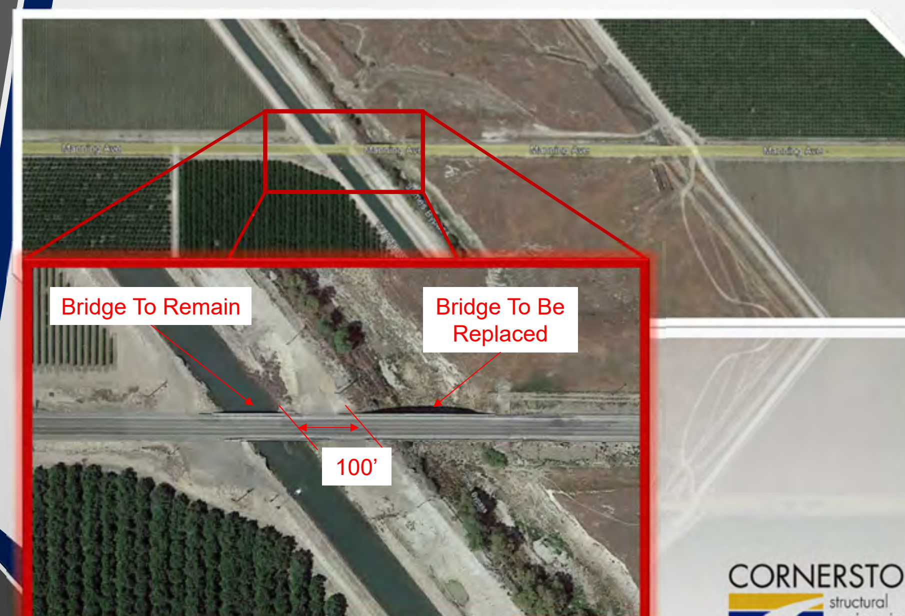
CVFPB Regulated Floodway
No Construction in Channel between Nov 1 – June 15

CORNERSTONE structural engineering group

PROJECT BACKGROUND

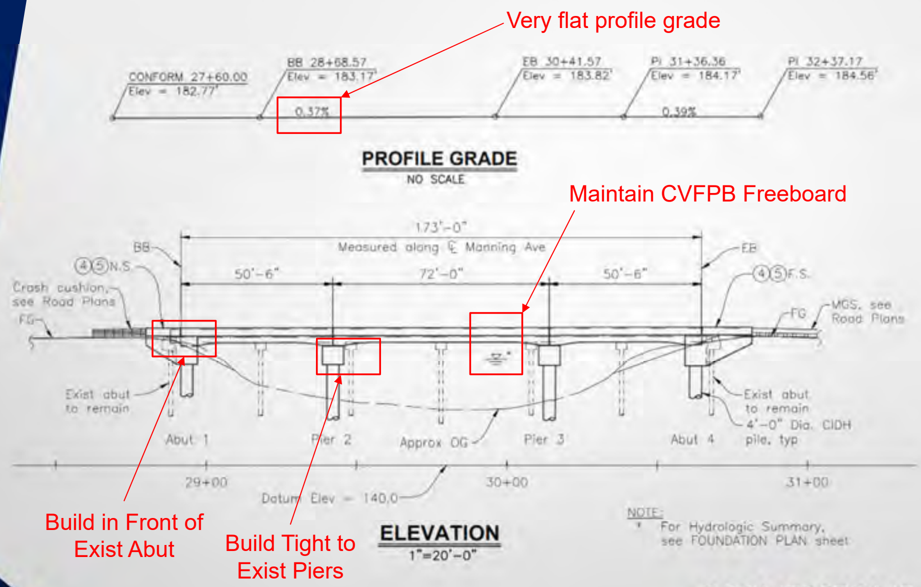
CORNERSTONE structural engineering group

PROJECT BACKGROUND



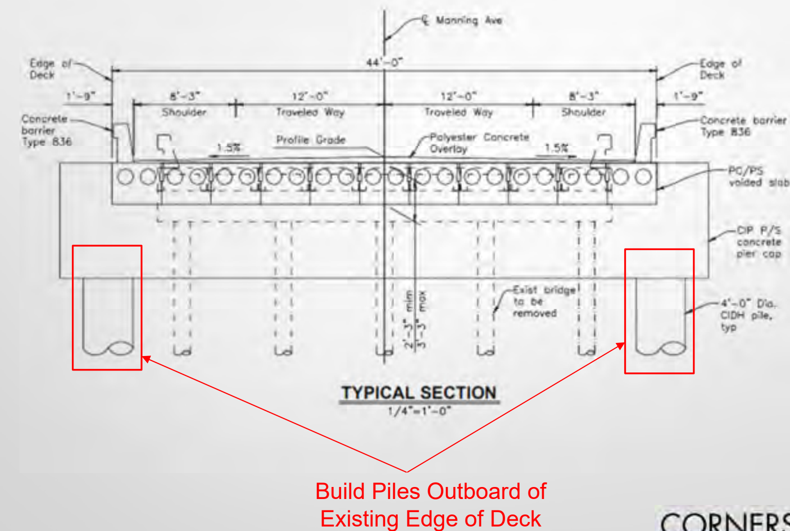
CORNERSTONE structural engineering group

SOLUTION



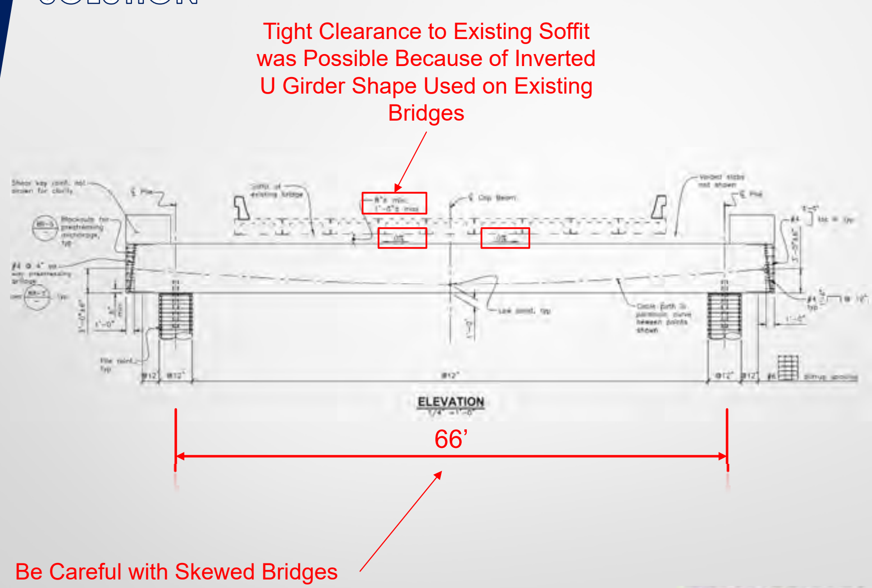
CORNERSTONE structural engineering group

SOLUTION



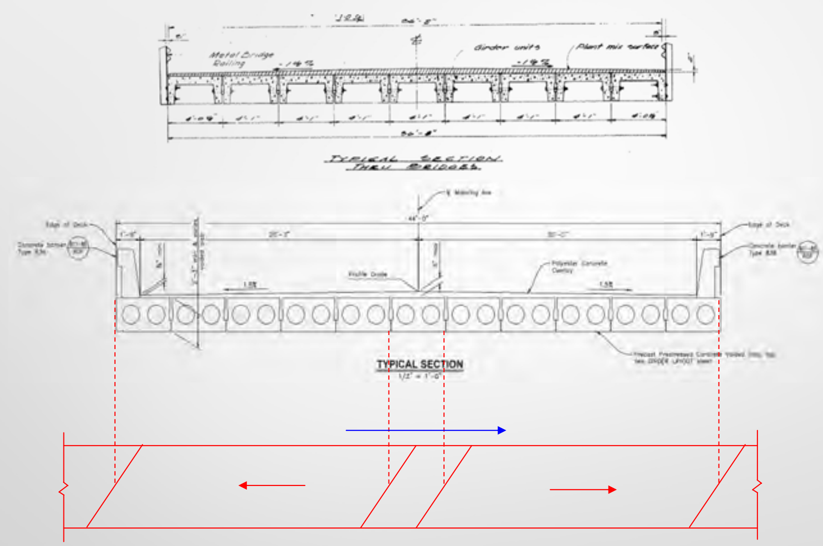
CORNERSTONE structural engineering group

SOLUTION



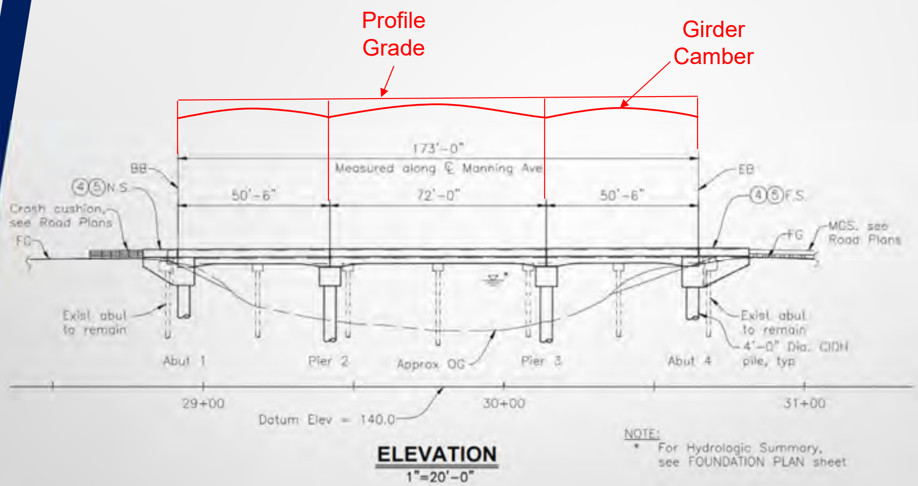
CORNERSTONE structural engineering group

SOLUTION



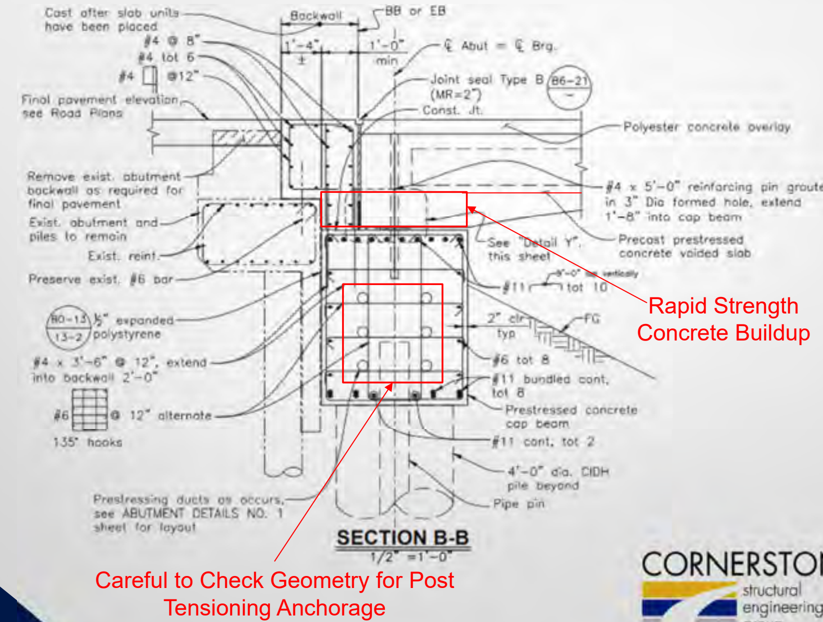
CORNERSTONE structural engineering group

SOLUTION



CORNERSTONE
structural engineering group

SOLUTION



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structural engineering group

FINISHED PRODUCT

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QUESTIONS

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CORNERSTONE structural engineering group

PCI West Prestressed Bridge Workshop

CALTRANS ACCELERATED BRIDGE CONSTRUCTION MANUAL

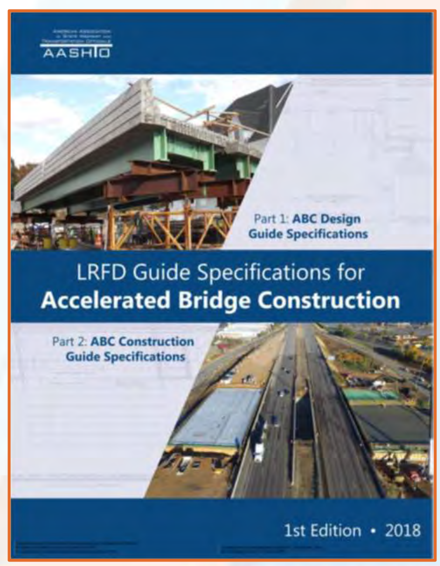
November 2022

Caltrans | DES PROJECT DELIVERY DIVISION OF ENGINEERING SERVICES | T.Y.LIN INTERNATIONAL

1

Caltrans ABC Manual - Development

- Guidance document
- Current state of practice
- California requirements
  - Specifications
  - Guidance materials
- Best practices and lessons learned
- Multiple reviews & comment resolution
  - Internal – Caltrans
  - External – Contractors, fabricators & consultants
- AASHTO LRFD Guide Specifications for ABC (2018)
  - Not a stand-alone document
  - References specific sections



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2

CHAPTER 1

INTRODUCTION

Caltrans DES PROJECT DELIVERY DIVISION of ENGINEERING SERVICES T·Y·LIN INTERNATIONAL

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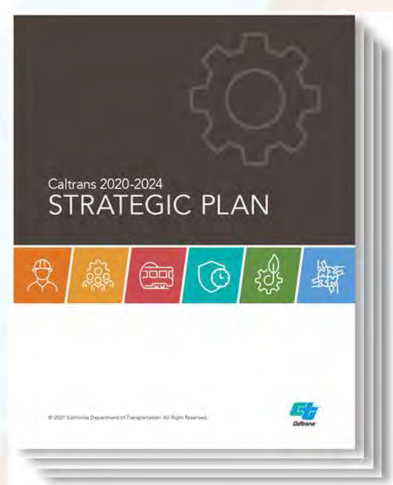
Chapter 1 - Introduction

- Purpose
- Define ABC
- Caltrans position on ABC
  - Caltrans Strategic Plan
  - FHWA Every Day Counts
  - ABC considered for all Caltrans projects
- Benefits of ABC
- Keys to success



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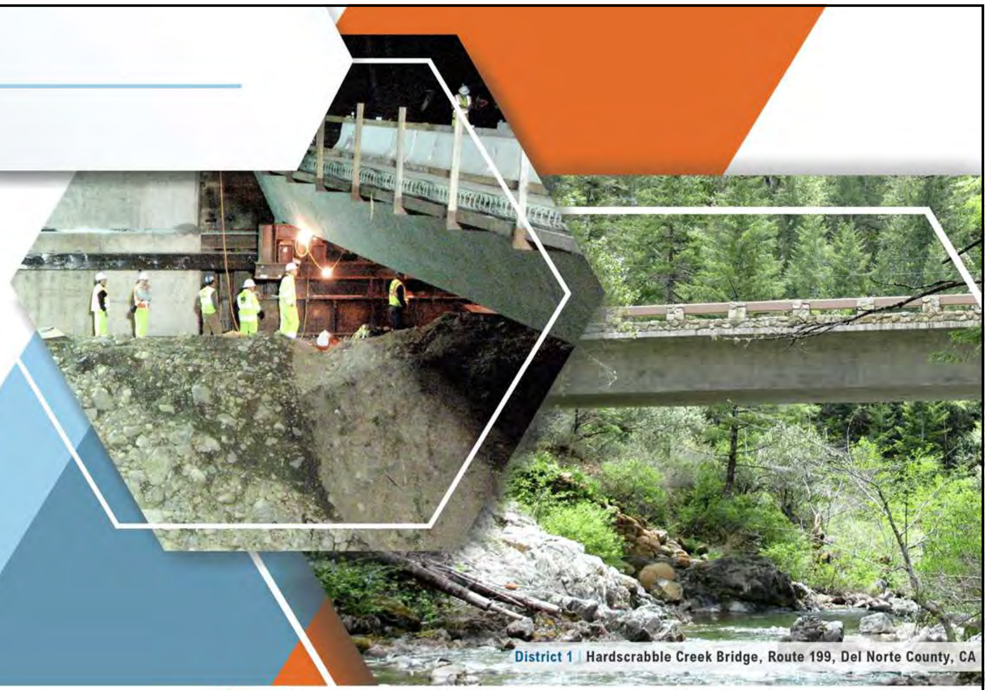
CHAPTER 2

WORKFLOW



District 1 | Hardscrabble Creek Bridge, Route 199, Del Norte County, CA

Caltrans — DES PROJECT DELIVERY, DIVISION of ENGINEERING SERVICES — TYLIN INTERNATIONAL

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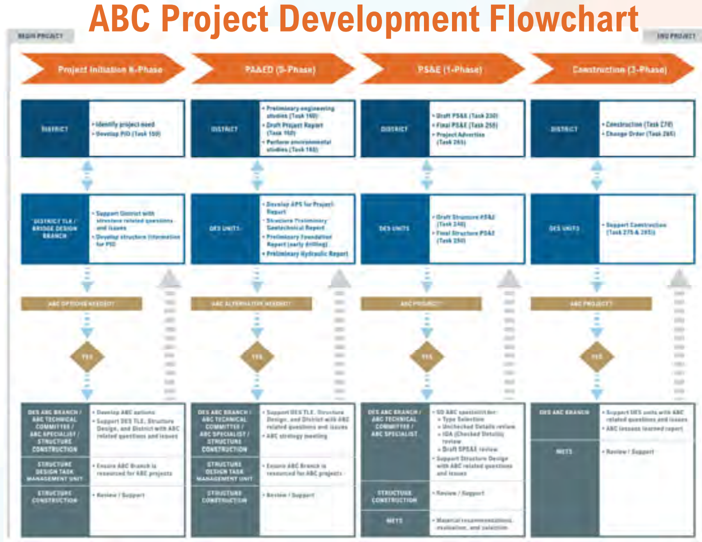
Chapter 2 – Workflow

- Caltrans internal process
- Procedures
  - Project development
  - Management
  - Initiation to closeout
- Roles and responsibilities

ABC Project Development Flowchart



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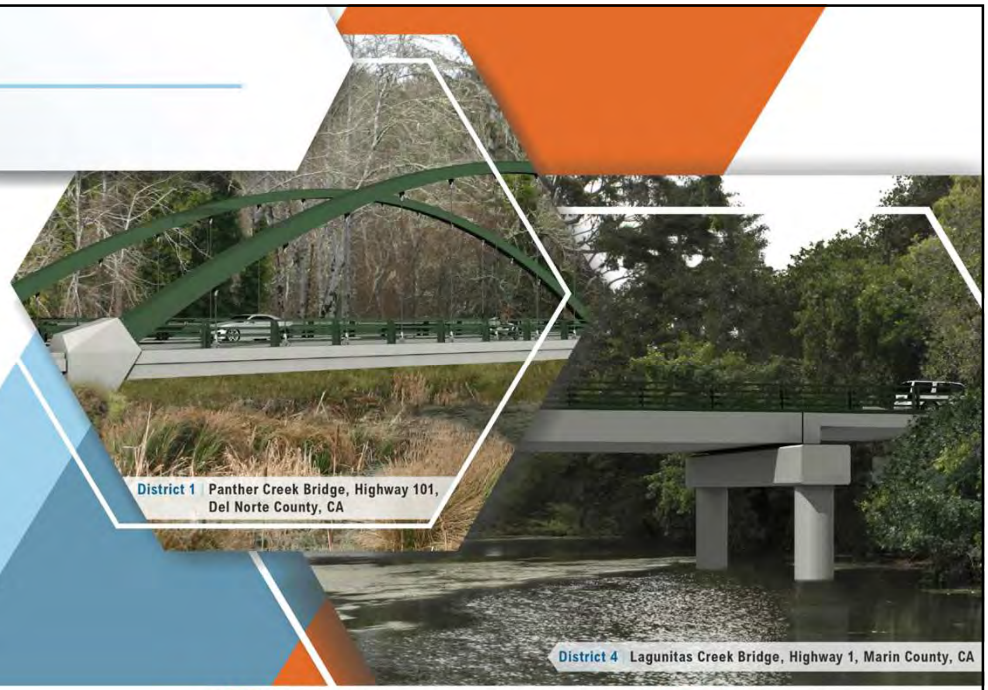
CHAPTER 3

PLANNING



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Chapter 3 - Planning

ABC Decision Making

- Selecting ABC
- Project goals
- Total project cost
  - Direct
  - Indirect
- Decision making guidance

ABC DESIGN IMPACT QUESTIONNAIRE

Project:

Date:
Completed by:

Category	Decision Making Question	(R) Relevance Range 0 = NA 1 (Low) to 5 (High)	(P) Priority Rating 1 = Low 2 = Med 3 = High	(RxP) Score
Construction Time	Are there weather limitations for conventional construction?			
	Is there restricted construction time due to environmental schedules?			
	Is there restricted construction time due to economic impact?			
	Has the District expressed the desire to complete the bridge construction in one season?			
	Is the bridge construction on a critical path of the total project?			
Environmental	Does ABC avoid, minimize, or mitigate a critical environmental impact or sensitive environmental issue?			
User Costs and Delays	Does the bridge carry or is it over a route with high ADT and/or ADTT?			
	Would ABC significantly improve the traffic control/maintenance plan?			
	Are only short-term closures allowable?			
	Will conventional bridge construction cause a significant delay/detour time?			
	Will bridge construction have an adverse impact on the local economy?			
Site Conditions	Are there existing railroads that impact the construction window or construction activities?			
	Are there existing utilities that impact the construction window or construction activities?			
	Does the site create problems for conventional construction methods?			
	Is the bridge over a waterway?			
Risk Management	Does ABC improve worker safety?			
	Does ABC improve traveler safety?			
	Does ABC allow management of a particular risk? If yes, identify risk here:			
Other	Will repetition of elements allow for economy of scale?			
		ABC Rating		

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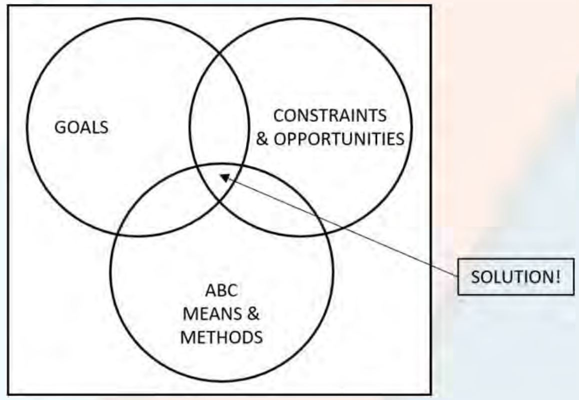
Chapter 3 - Planning

ABC Method Selection

- Description of methods
  - Selection criteria
  - Site requirements
  - Cost considerations
- Traffic management
  - Full closure
  - Temporary bridge or culvert
  - Incentive/disincentive



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Chapter 3 - Planning

Planning Document (Advance Planning Study)

- Design considerations
- Communication
- Schedule and cost estimates
- Procurement and contracting methods
  - Project delivery methods (DBB, CM/GC, DB)
  - Procurement practices (Fixed price, Cost + Time)
  - Contract management (Incentive/Disincentive, Delayed Start)

Fort Goff Creek Bridge - Caltrans

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CHAPTER 4

DESIGN

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Chapter 4 - Design

1. Construction Considerations
2. Layout and Tolerances
3. Loads and Load Factors
4. Interim Loading Conditions
5. Temporary Supports
6. Utilities
7. Capacity of Existing Structures
8. Materials
9. Prefabricated Bridge Elements
10. Lateral Slide
11. SPMT
12. Longitudinal Launch
13. Foundations and Structural Backfill
14. Bridge Removal
15. Temporary Bridge
16. Cost Estimates and Working Days
17. Industry Outreach
18. References

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Chapter 4 - Design

Prefabricated Bridge Elements

- Footings
- Abutments
- Columns
- Bent caps
- Girders
- Deck panels
- Approach slabs

Laurel Street Undercrossing - Caltrans

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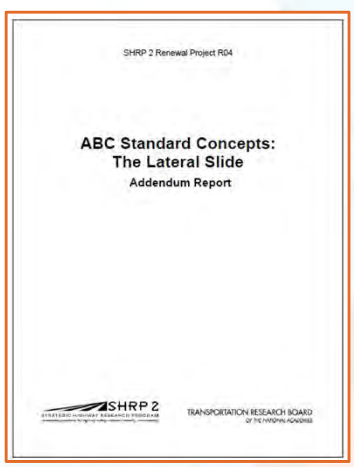
Chapter 4 - Design

Lateral Slide / Slide-in Bridge Construction

- Designer's responsibilities
- Site considerations
- Permanent bridge design
- Temporary support
- Push-pull systems
  - Hydraulic jacks
  - Winch systems
- Sliding systems
  - Steel rollers
  - PTFE pads
- Submittals

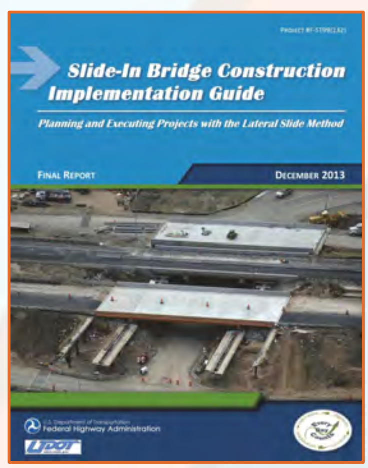


SHRP 2 Renewal Project R04

ABC Standard Concepts:
The Lateral Slide
Addendum Report

SHRP 2

TRANSPORTATION RESEARCH BOARD



Slide-In Bridge Construction Implementation Guide

Planning and Executing Projects with the Lateral Slide Method

Final Report

December 2013

Federal Highway Administration

Caltrans | DES PROJECT DELIVERY DIVISION of ENGINEERING SERVICES | TYLININTERNATIONAL

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Chapter 4 - Design

Self Propelled Modular Transporter (SMPT) Moves

- Designer's responsibilities
- Site considerations
  - Bridge Staging Area (BSA)
  - Travel Path (TP)
- Interim loading
- Plans and specifications
- Submittals
  - Shop drawings
  - Work plans

Shaler Street Bridge – PennDOT/Lochner, Inc.

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Chapter 4 - Design

Incremental Launch Methods (ILM)

- Designer's responsibilities
- Site considerations
  - Bridge geometry
  - Road closure
- Interim loading
- Plans and specifications
- Submittals

Pfeifer Canyon Bridge - Caltrans

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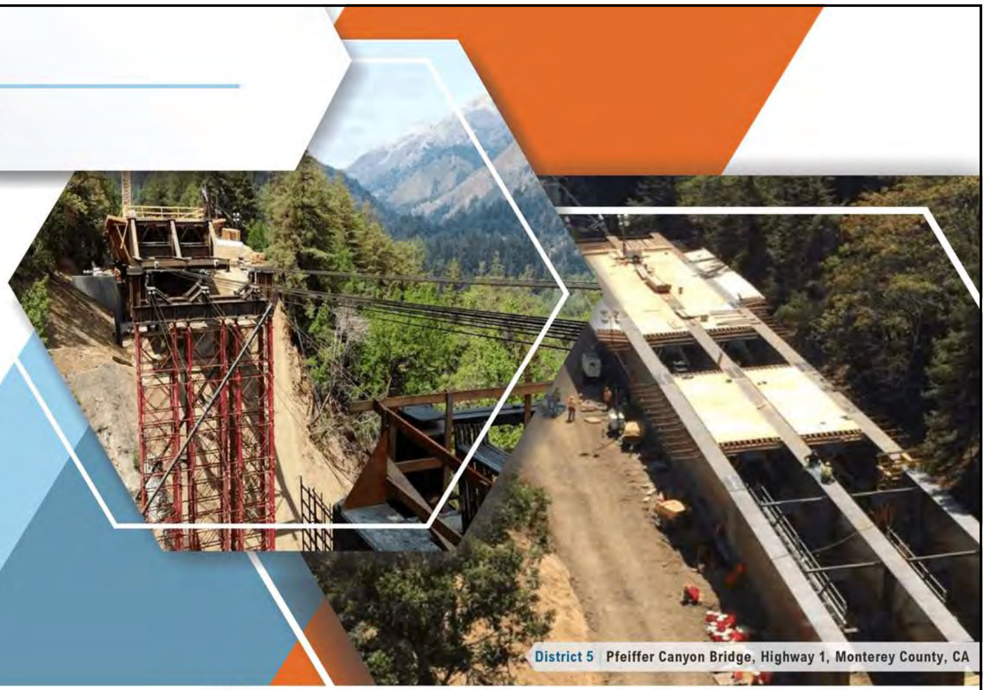
CHAPTER 5

CONSTRUCTION



District 5 | Pfeiffer Canyon Bridge, Highway 1, Monterey County, CA

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Chapter 5 - Construction

1. Construction Handoff
2. Pre-bid Meetings
3. ABC Preconstruction Meetings
4. Layout and Tolerances
5. Mock-ups
6. Contractor's Submittals
7. Inspection
8. Design Support
9. References

Echo Summit Sidehill Viaduct - Caltrans

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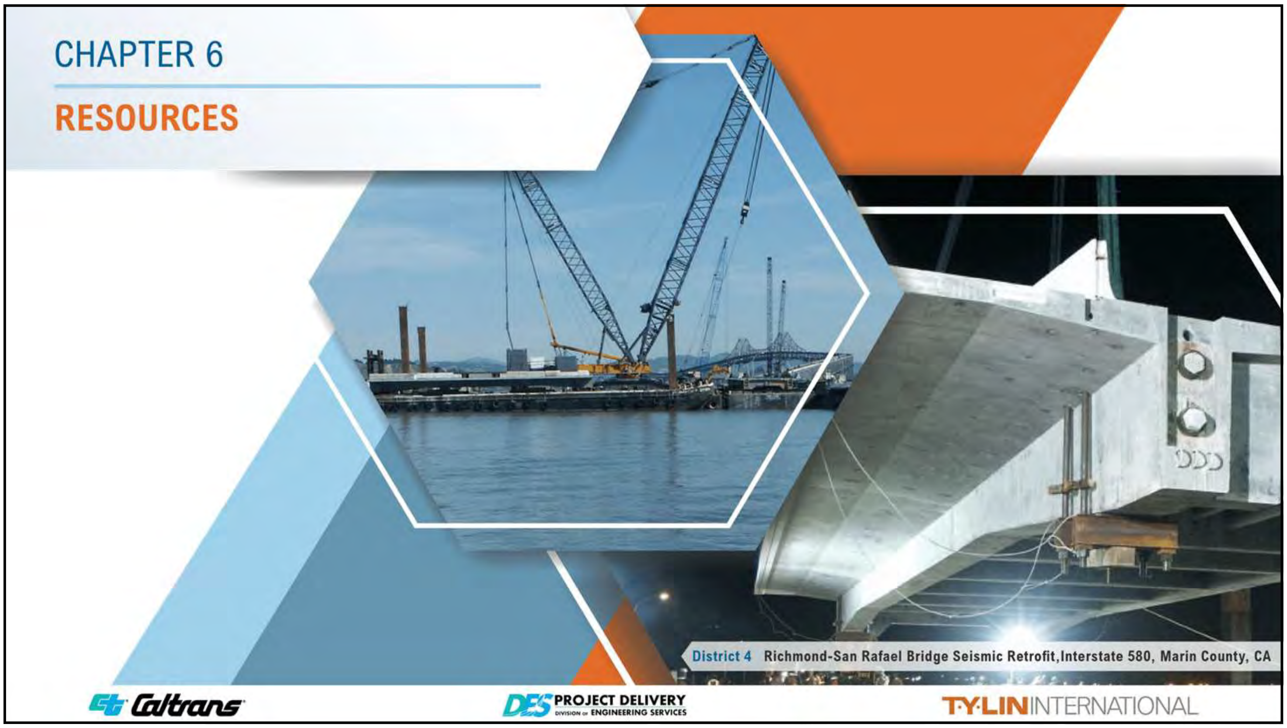

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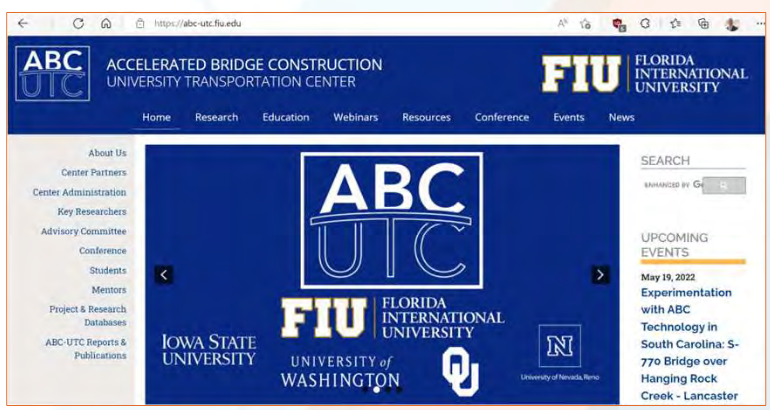
Chapter 6 - Resources

1. Introduction
2. Research
   - Caltrans funded
   - Non-Caltrans funded
3. Publications
   - AASHTO LRFD ABC Guide Spec
   - PCI ABC resources
   - SHRP 2
4. Websites
   - Caltrans DES
   - ABC-UTC
   - FHWA ABC
   - NE PCI ABC



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APPENDICES

ABC CHECKLISTS AND UHPC IMPLEMENTATION

District 2 | Fort Goff Creek Bridge, Route 96, Siskiyou County, CA

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Appendices

A. PBE Checklists
B. Lateral Slide Checklists
C. SPMT Checklists
D. UHPC Implementation
E. UHPC Checklists

Echo Summit Sidehill Viaduct - Caltrans

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Summary

Caltrans ABC Manual

- Comprehensive ABC guidance
- Planning through closeout
- Detailed resources
- Available for download
  https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/abc/ctabc-2021-06-30_a11y.pdf

Echo Summit Sidehill Viaduct - Caltrans

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THANK YOU

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Prestressed Concrete Bridge Design Seminar

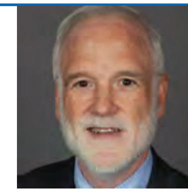
Session 3 – November 8, 2022

Producer Roundtable

Discussion Topics

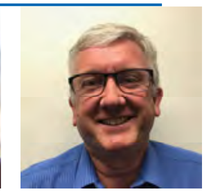
- California Wide Flange Girder: design and detailing
- Girder handling, shipping, stability
- Design: Debonding; camber and deflections
- Fabrication: Strand patterns and sizes, concrete strengths
- Rebar and concrete details – skews, confinement bars, etc.
- Field issues
- Plant quality and QC
- Fabrication defects and repairs
- UHPC and prefabricated substructure elements

PCI West Panelists



Reid Castrodale, PhD PE
Moderator

Jay Holombo PhD PE
TY Lin, Inc.



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Coreslab Structures, LA

Abdul Kassab, PE
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Brent Koch, PE
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CTU Precast

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Acknowledgments

We appreciate the support and assistance from the following people who contributed to the success of PCI West's Prestressed Concrete Bridge Design Workshop:

- Jim Ma – Caltrans Sr Bridge Engineer PS/PC Technical Specialist
- Gudmund Setberg – Caltrans DES Dep Div Chief Structure Design
- Don Nguyen-Tan – Caltrans Office Technical Policy and Guidance
- Jessen Mortensen – Nevada DOT
- Mark Weaver (Cornerstone Eng.) and Jay Holombo (TY Lin, Inc.)
- Johnnie Hayes (CONTEC Engineered Solutions) & PCI Gulf South
- Reid Castrodale, Castrodale Engineering
- **PCI West Producer Members!!**

Prestressed Concrete Bridge Design Seminar

Thank you for attending!