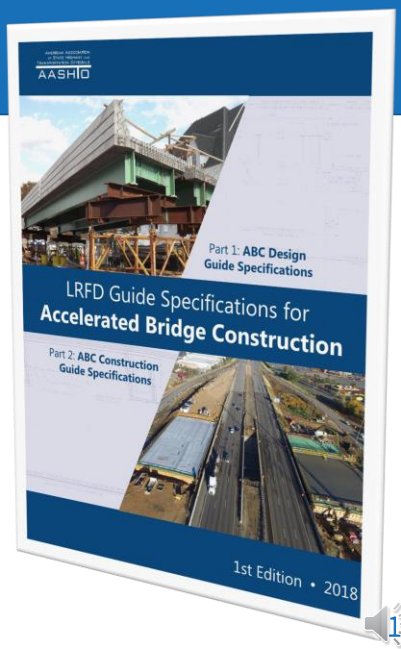
Accelerated Bridge Construction

Implementation of the 2018 AASHTO LRFD Guide Specifications for Accelerated Bridge Construction

Michael Culmo, PE
Chief Bridge Engineer
CHA Consulting, Inc.



1

Welcome to the training modules regarding the implementation of the 2018 AASHTO LRFD Guide Specifications for ABC. In these modules we will refer to this document as “The Guide Specifications for ABC”.

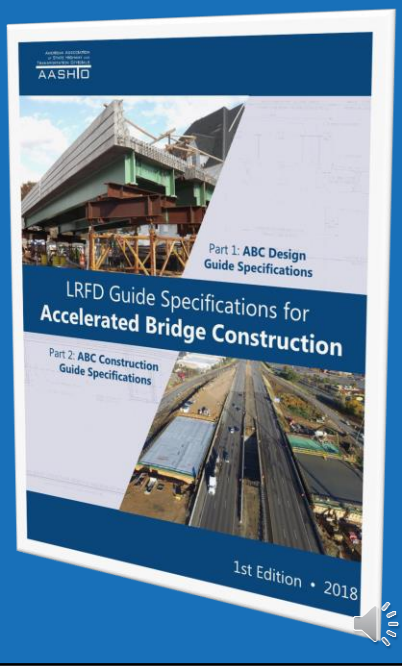
This document represents the national design “code” for bridges built with accelerated bridge construction techniques.

This Guide Specification is a comprehensive document that covers all aspects of ABC.

Introduction

This Part Covers:

- Introduction to Training Modules
- Development of the 2018 AASHTO LRFD Guide Specifications for ABC
  - Overview of NCHRP Project 12-102



This module covers:

- An introduction to these training modules
- The work that led to the development of the Guide Specifications for ABC

Training Modules

This training was originally slated for in-person workshops

- 4 workshops were held to test the training
- 2 days of design training:
  - Day 1: Non-seismic design provisions (for all states)
  - Day 2: Seismic design provisions (for applicable states)
- Minor changes were made as a result of the workshops

These recordings were developed to expand the training to all

- Broken up into discrete modules that can be viewed on-line

3

The information contained in these training modules was originally prepared for a series of two-day workshops that were held in four different states. The first day of the workshops included provisions for non-seismic design for ABC. The second day was devoted to seismic design provisions for ABC.

Following the completion of the workshops minor changes were made to the presentations based on input from participants.

The AASHTO Committee on Bridges and Structures requested that the in-person training be converted to web-based asynchronous training modules. The original in-person training was converted to a series of modules that are between 30 and 90 minutes in length.

Training Modules

Available Modules

Non-seismic

1. General Provisions and Common Connections
2. Substructure Design
3. Superstructure Design
4. Bridge Systems
5. Durability of ABC Designs
6. ABC Construction Specifications

Seismic

7. Introduction to ABC Seismic
8. Seismic Connection Design and Detailing
9. Seismic Pocket and Socket Connections
10. Seismic Integral Connections

4

This slide contains a breakdown of the available training modules for ABC. The first six cover the non-seismic portion of the training. The last four modules cover seismic provisions for ABC.

It is recommended that module one be covered first. Following that users may elect to view any of the subsequent modules as they are not necessarily designed to build on each other.

Beneficiaries & Outcomes

Intended beneficiaries of this training

- Primarily designers
- This is a design and specification guide

Outcomes

- Understand the history of the development of the *2018 AASHTO LRFD Guide Specifications for ABC*
- Learn how to design and specify common types of ABC projects
  - Prefabricated Elements
  - Bridge Systems
- Introduce common details that are durable and proven
- Learn how to specify ABC projects

5

The intended beneficiaries for today's workshop are primarily designers. The document is intended to be used for designers in the preparation of plans and specifications for ABC projects.

The learning outcomes for today include:

- Understanding of the history of the development of the Guide Specifications for ABC
- Learn how to design and specify common types of ABC projects including all types of Prefabricated Elements, and Prefabricated Bridge Systems
- Introduce you to commonly used details that are durable and proven
- Learn how to develop Construction Special Provisions for ABC Projects

This training consists of two types of training. Modules 1-6 are applicable to bridges in all regions. Modules 7-10 are specific to seismic regions.

Free References used for these modules

Free Publications (covered and provided today)

- PCI: State of the Art Report on Full-Depth Bridge Decks Panels
- PCI Northeast: Full Depth Deck Panel Guidelines
- PCI Northeast: Guidelines for Resolution of Non-Conformances in Precast Concrete Bridge Elements
- PCI Northeast: Suggested Guide Details for Precast Substructures
- PCI Northeast: Northeast Extreme Tee (NEXT) Beam Details
- PCI Northeast: Guidelines for Camber and Profile Management in Adjacent Beams
- FHWA: LRFD Design Example for Steel Girder Superstructure Bridge
- FHWA: Comprehensive Design Example For Prestressed Concrete (PSC) Girder Superstructure Bridge
- NCHRP Project 12-98: Guidelines for Dynamic Effects for Bridge Systems
- NCHRP Project 12-98: Guidelines for Prefabricated Bridge Elements and Systems Tolerances

6

Today we will make reference to a number of documents that are available for free online.

Purchase References used for these modules

- For purchase publications (covered, but not provided today)
  - AASHTO LRFD Bridge Design Specifications
  - AASHTO LRFD Guide Specifications for ABC

7

We will also reference several documents that are available for purchase through AASHTO. These include the LRFD Bridge Design Specifications and the LRFD Guide Specifications for ABC.

I am certain that most of you have the first document. If you do not already have a copy of the LRFD Guide Specifications for ABC, hopefully after this training, you will purchase them. We will include screen shots of the applicable articles during the training. Please understand that these are just a portion of the significant content in the Guide Specification.

NCHRP 12-102 Project Overview

- Guide specification development
  - Significant synthesis project
  - No new research involved
  - Technology readiness evaluation done for each technology
- Approach:
  - Not a stand-alone document
  - Supplement to:
    - AASHTO LRFD Bridge Design Specifications
    - AASHTO Bridge Construction Specifications
    - AASHTO Guide Specifications for LRFD Seismic Bridge Design
  - Separate design and construction parts

The development of this Guide Specification was started with the deployment of an NCHRP Project. NCHRP stands for the "National Cooperative Highway Research Program", which is part of the Transportation Research Board. In this program, funds are pooled from each state and used for research that is widely needed.

This Guide Specification was developed under NCHRP Project 12-102. The majority of this work is a synthesis of past research and common practice among the state DOTs. No new formal research was undertaken.

A process was developed to screen potential provisions that would end up in the specification. This process was referred to as "Technology Readiness".

The project team and panel decided that this document should not be a stand-alone document. Designers still need to use the typical AASHTO LRFD Bridge Design and Construction Specifications. This document supplements those documents.

The Guide Specification for ABC is broken into two parts, one for design and one for construction, which is similar to the current AASHTO LRFD Bridge Design and Construction Specifications.

NCHRP 12-102 Project Overview

- Sources of provisions
  - Significant technology synthesis
    - Dozens of past research projects on ABC
    - NCHRP research
    - State DOT research
    - FHWA research
    - International research
    - Private research
  - Questionnaire to each state DOT
    - What are they using?
    - What is working? What is not?
    - Lessons learned

A large number of different resources were used to synthesize the data that formed the basis of the specifications.

Fortunately, there has already been a whole host of research that had been completed on the subject of ABC. Research had been completed by different organizations including:

- NCHRP
- State DOTs
- The Federal Highway Administration
- International organizations
- And Private research (primarily by vendors).

Questionnaires were sent to each DOT in order to get a flavor for what ABC technologies were being specified and how they were working. We also wanted to account for their lessons learned. The goal was to attempt to address all technologies in use and the concerns of the owners.

Technology Readiness

- Evaluation
  - Level of testing and research
  - Existing specifications
  - Implementation
  - Durability
- Parameters and weight factors worked out with project panel

NCHRP Project 12-102
Technology Readiness Evaluation

Technology Description:	Article 3.6.4.4 Type 2 Mechanical Connectors in Plastic Hinge Regions for SDCs C and D (Seismic Zones 3 and 4)		
Testing and Research	4	1	No research performed
		2	One Research Project Completed
		3	Two Research Project Completed
		4	Three Research Project Completed
		5	More than three Research Projects Completed
Comments	Research at University of Nevada Reno (Haber et al. 2013, Tazarv and Saiidi, 2014), The University of San Diego (Philipi & Hegimer, 2013), and the University of Utah (Pantelides et al. 2014).		
Existing Specifications Design and/or construction	2	1	Not sufficient data to develop provisions
		2	Data available, but provisions not developed
		3	Provisions available in other countries
		4	Provisions available in other US codes
		5	Design provisions fully developed
Comments	Design recommendations included in cited research. ACI 318-14 allows the use of these connectors in plastic hinge regions for buildings.		
Implementation	5	1	Never used on a bridge, minor lab testing
		2	Never used on a bridge, significant lab testing
		3	Used on one sucessful bridge project
		4	Used on two sucessful bridge projects
		5	Commonly used
Comments	These connectors are included in Utah DOT standard precast substructure details.		
Durability	5	1	No information on performance
		2	Used once with limited exposure (newer bridges)
		3	Used a few times with limited exposure (newer bridges)
		4	Used a many times with limited exposure (newer bridges)
		5	Used many times with significant exposure
Comments	Durability expected to be the same as regular R/C design when adequate cover is provided.		

Technology Readiness Rating

	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Testing and Research	4	25	100	5	125
Existing Specifications	2	15	30	5	75
Implementation	5	30	150	5	150
Durability	5	30	150	5	150
		Total Score	430	Max. Score	500

Technology Readiness Score	**86**

Technology Readiness Scale	
75-100	Include
0-75	Do not include

Every provision in the document was run trough an evaluation in order to determine if it was ready for a national guide specification. The project team and panel developed a weighted scoring system for each provision based on:

1. The level of testing and research that had been completed on the technology
2. Whether the research teams has develop draft specification language for the technology
3. Whether or not the research had been put into practice on an actual project
4. Whether the technology would provide a durable long-lasting solution

A weight factor was applied to each of the criteria. The score was multiplied by the weight factor and totaled to get an overall technology readiness score.

Each provision was scored using this methodology. The bar for acceptance was set by the team and panel at 75 points out of 100. If it scored above75 it was in. If it scored below 75, it was further evaluated for inclusion, since this process was somewhat subjective. Only a few items that fell just below the threshold made it into the specifications.

Specification Overview

- Guide Specification Contents

1. Design Introduction
2. General Design Provisions
3. Design of Prefabricated Elements
4. Detailing Requirements
5. Durability of ABC Technologies
6. Construction Introduction
7. Temporary Works
8. Fabrication and Assembly Planning
9. Layout and Tolerances
10. Concrete Structures
11. Steel Structures
12. Geosynthetic Reinforced Soil / Integrated Bridge System

The specification is broken up into 12 Sections or “Chapters”.

The first five sections are related to “design” specifications.

The last 7 sections are devoted to “construction” specifications.

As you can see, this specification is a wide ranging document covering all aspects of ABC.

The format of the Guide Specifications for ABC is similar to any AASHTO Specification. Provisions on the left side of each page, commentary, which is often lengthy, is on the right. The beginning of each section has a Table of Contents, a listing of definitions, and a listing of notations used in the provisions for that Section. The end of each section contains a listing of references that were used for the development of the Section. This is very handy for designers that wish to further study the basis of the provisions in order to gain more insight into their use.

Reference Documents

- This is not a stand-alone design specification.
  - This document is intended to supplement the AASHTO LRFD Bridge Design Specifications, the AASHTO LRFD Bridge Construction Specifications, and the AASHTO Guide Specifications for LRFD Seismic Bridge Design
- In many cases, provisions will refer to other AASHTO documents
  - Not by article number
  - By article Title
  - Why?

12

As previously stated, this specification is not a stand-alone document. Users of this specification still need to use and follow the AASHTO LRFD Bridge Design and Bridge Construction Specifications.

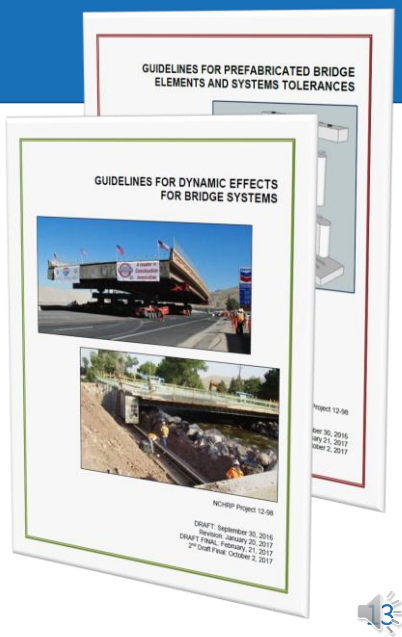
The Guide Specification does reference other documents and these other specifications in a number of instances. In these cases, the AASHTO specifications are referenced by title, not provision number. For example, the guide specification provision 2.4 for Loads and Load Combinations, references the “Loads and Load Combination” provisions in the “AASHTO LRFD Bridge Design Specifications”.

The reason for not calling out Provision numbers is that there is always a potential for provision numbers to change. For example, the entire Section on concrete was in the process of re-write during the development of the Guide Specification for ABC.

Other References

NCHRP Project 12-98

- Guidelines for PBES Tolerances
- Guidelines for Dynamic Effects for Bridge Systems
  - Including SPMTs and Lateral Sliding
- Want to know more?
  - FIU ABC webinar archives recordings
  - NCHRP Project 12-98 website
  - They are free!



During the development of the Guide specification for ABC, there was another parallel project underway that had a deliverables that included two guidelines. NCHRP Project 12-98 was ABC related in that it covered Prefabricated Elements and Bridge Systems.

There was concern regarding the timing of these two projects, therefore the project panel and the AASHTO T-4 Bridge Technical Committee for Construction decided to keep these documents separate.

The Guidelines developed under NCHRP Project 12-98 are important tools in ABC design and construction, therefore they are referenced in the Guide Specifications for ABC.

These documents are available free of charge and can be downloaded at the NCHRP Project webpage.

Who will demonstrate the use of these two guidelines today in several design examples that we will go through.

Current Status

- The guide specification was completed late 2016
- Balloted for adoption in June 2017
  - Passed
- Several committees still had issues
  - T-4 Construction committee worked with them to resolve some issues prior to publication
- Re-balloted in 2018
  - Adopted by AASHTO CBS in 2018
  - Published in the fall of 2018
  - Available at the AASHTO bookstore

14

Once NCHRP Project 12-102 was completed, the work didn't stop there. There is a defined process for adopting and publishing specifications at the AASHTO Committee on Bridges and Structures.

The draft guide specification for ABC was first balloted in 2017. It passed the ballot, however there were a few significant objections from a handful of states. An unusual decision was made to postpone the publication and work to satisfy the concerns of these states. A year of meetings were held and changes were made.

The changes to the document were then re-balloted in 2018. It passed the ballot and then went to publication. The document was finally published in the fall of 2018. It can be purchased at the AASHTO bookstore.

Design Specification Overview

Section 1: Introduction

Section 2: General Design Provisions

- Shipping and Handling Provisions
- Load Combinations for SPMT and Lateral Slide

At this time, I would like to give a brief synopsis of each section in the guide specification.

Section 1 is an introductory section that generally lays out design responsibilities and definitions.

Section 2 covers General Design Provisions, primarily Loads and Load Combinations.

Design Specification Overview

Section 3: Design of Prefabricated Elements

- Majority of specs are based on emulation
- Significant seismic provisions
- Major Provisions that vary from LRFD
  - Lapped hooked and headed bars
  - UHPC connections
  - Type 2 Mechanical Connectors
  - Corrugated metal pipe sockets and corrugated precast sockets
  - Link slabs

16

Section 3 is the largest section in the document. It covers the majority of the design provisions required for ABC projects.

The basis for most of the concrete provisions is a process defined by ACI as “Emulative Design”. This means that the design “emulates” a cast-in-place concrete element. The intent is to have it function and behave in a similar fashion up to ultimate load.

The document also contains significant seismic provisions. These will not be covered in detail today as there is a separate training workshop on seismic. Some of the seismic provisions are also emulative, however, others are not. During the development of the Guide Specification, there was discussion on having a separate seismic section. Ultimately, a decision was made by the project panel to merge the provisions in a similar fashion to the AASHTO LRFD Bridge Design Specifications. This is helpful, since many seismic details are applicable and useful to non-seismic applications.

There are several provisions that vary or are not present in the AASHTO LRFD Bridge Design Specifications:

- Lapping of hooked bars is not covered in the AASHTO LRFD, which only covers development of hooks.
- Headed bars are not covered by AASHTO LRFD, but they are covered in ACI and international codes.
- UHPC has not yet made it into AASHTO specifications.
- ACI has a high strength connector for reinforcing bars called “Type 2 Connectors”. These are similar to AASHTO mechanical connectors, but of higher strength. They are useful for seismic applications.
- Other provisions that are not include in the current AASHTO LRFD Bridge Design Specifications

include Pocket and socket connections and link slabs.

Design Specification Overview

Section 4: Detailing Requirements

- Tolerances and layout of precast elements
  - Reference to NCHRP Project 12-98 guidelines

Section 5: Durability of ABC Technologies

- Detailing recommendations for durability

Section 4 of the Guide Specifications for ABC covers detailing requirements for bridge plans on ABC projects. The section includes guidance on tolerances and layout of precast elements to ensure that elements fit together properly. The guidelines developed under NCHRP project 12-98 are referenced in these provisions.

Section 5 of the Guide Specification covers durability of various ABC technologies. Durability was an important aspect of technology readiness evaluation of the Guide Specifications for ABC. This Section includes provisions to assist designers with the development of durable designs.

Reference Documents for Today

- AASHTO LRFD Guide Specifications for ABC
- NCHRP Project 12-98 Guidelines for PBES Tolerance
- NCHRP Project 12-98 Guidelines for Dynamic Effects for Bridge Systems
- FHWA LRFD Bridge Design Examples (2)
- FHWA Manual for ABC Engineering, Design Fabrication and Erection for PBES

For today's workshop we will be using several important documents that are referenced in the Guide Specifications for ABC. Others will be used to facilitate design examples. Workshop participants can obtain these documents online for free, with the exception of the Guide Specification. You need to purchase that.

Today, we will be referencing the two guidelines documents developed under NCHRP project 12-98. This includes the “Guidelines For Prefabricated Bridge Elements and Systems Tolerances” and the “Guidelines For Dynamic Effects for Bridge Systems”.

The Federal Highway Administration had previously published several LRFD bridge design examples. These sample designs will be referenced in this workshop. We do not have time to work through the entire design of a bridge today. It is assumed that you all are familiar with bridge design practices. The goal of this workshop is to teach participants how to modify a typical design to accommodate ABC.

Another document that will be referenced is the Federal Highway Administration document entitled “Engineering, Design, Fabrication, and Erection of Prefabricated Bridge Elements and Systems”. This document also contains design examples relevant to this workshop.

Blue Header Denotes AASHTO LRFD Guide Specifications for ABC

Purple Header Denotes Guidelines for PBES Tolerances (NCHRP 12-98)

Green Header Denotes Guidelines for Dynamic Effect for Bridge Systems (NCHRP 12-98)

Red Header Denotes FHWA LRFD Bridge Design Examples

Orange Header Denotes FHWA ABC Design Manual

We have color coded each slide for the references being used.

Blue headers denote reference to the AASHTO LRFD Guide Specifications for ABC.

Purple headers denote reference to the Guidelines for Prefabricated Bridge Elements and Systems Tolerances.

Green headers denote reference to the Guidelines for Dynamics Effects for Bridge Systems.

Red headers denote reference to the FHWA LRFD Bridge Design Examples.

Orange headers denote reference to the FHWA ABC Design Manual.

There is no need to memorize these colors as I will refer to these documents as we go along.

End of Introduction

Available Modules

Non-seismic

1. General Provisions and Common Connections
2. Substructure Design
3. Superstructure Design
4. Bridge Systems
5. Durability of ABC Designs
6. ABC Construction Specifications

Seismic

7. Introduction to ABC Seismic
8. Seismic Connection Design and Detailing
9. Seismic Pocket and Socket Connections
10. Seismic Integral Connections