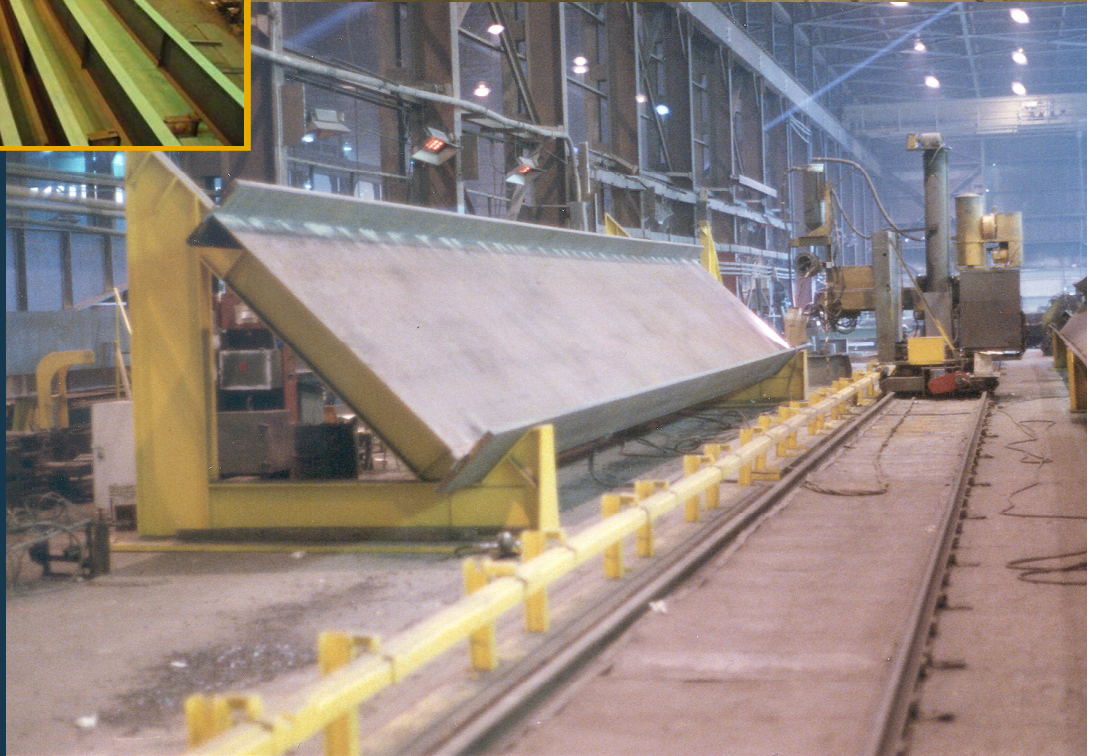


Steel Bridge Fabrication Guide

Specification

S2.1-2018



AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO



American Association of State Highway and
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PREFACE

This document is a standard developed by the AASHTO/NSBA Steel Bridge Collaboration. The primary goal of the Collaboration is to achieve steel bridge design and construction of the highest quality and value through standardization of the design, fabrication, and erection processes. Each document represents the consensus of a diverse group of professionals.

Owners should adopt Collaboration standards to achieve standardization and to help ensure that their steel bridge practices reflect the state-of-the-art in technology and the most cost-effective solutions. The standards are written with mandatory language that may be adopted by direct reference from standard specifications or project specifications.

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2018–2019

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INTRODUCTION

SPECIFICATION

This document governs steel bridge fabrication. Provisions are intended to result in the achievement of high quality and value. It is intended to be included in contract documents by reference from the Owner's specifications. Parts designated as "commentary" are not contractual.

This document is intended to be used in close tandem with AASHTO/NSBA Steel Bridge Collaboration S4.1, *Steel Bridge Fabrication QC/QA Guide Specification*.

For new painted steel bridges using a zinc-rich primer system, Owners are encouraged to adopt AASHTO/NSBA Steel Bridge Collaboration S8.1, *Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges*.

The Collaboration also publishes a guide specification for steel bridge erection, AASHTO/NSBA Steel Bridge Collaboration S10.1, *Steel Bridge Erection Guide Specification*, which Owners are encouraged to adopt.

In this document, imperatives are directed to the Contractor and Fabricator. Many references are made to the AASHTO/AWS D1.5M/D1.5 *Bridge Welding Code*. Specific section numbers are based on the 2015 edition, and subsequent editions may modify section numbers or content, but the AASHTO/AWS D1.5M/D1.5 current at time of contract advertisement should apply.

COMMENTARY

The primary objective of this document is to achieve quality and value in the fabrication of steel bridges. The Collaboration's intent is for transportation authorities to adopt this document by direct reference in their standard specifications. This will help standardize steel bridge fabrication across the nation.

Historically, state Departments of Transportation (DOTs) have written their specifications based on AASHTO standards and their own individual experiences. Though this approach has worked fairly well, many agencies and Fabricators recognized that all would benefit from a common specification because:

- Variations among projects in the shop would be minimized because Fabricators would not need different practices, procedures, and operations for each state, and minimizing variation improves quality and reduces errors.
- Economy in bridge fabrication would improve because Fabricators would not have to change their methods and production variables from state to state.
- Expertise in steel bridge fabrication could be shared among states, resulting in a well-rounded, consistent fabrication standard.
- Owners would be able to share their resources, minimizing the effort each would otherwise have to expend to maintain a bridge fabrication specification.

This document was written by experienced representatives from a number of fabricators, state DOTs, consultants, and the Federal Highway Administration (FHWA). The work was based on existing state specifications, AASHTO/AWS D1.5M/D1.5, the *AASHTO LRFD Bridge Design Specifications*, and the *AASHTO LRFD Bridge Construction Specifications*.

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SECTION 1

DEFINITIONS AND RESPONSIBILITIES

Terms used in this document are in accordance with the AASHTO/NSBA Steel Bridge Collaboration standards. Terms significant specifically to this document are defined below.

1.1 CONTRACTOR

The Contractor is responsible for proper completion of all tasks required by the contract documents. Subcontractors, including fabricators, erectors, and field painters, may be used by the Contractor, but the Contractor retains responsibility for material, operations, and the final product. The Contractor may permit direct subcontractor interaction with the Owner to expedite the project, but subcontractors must inform the Contractor of any proposed modifications to contract requirements accepted by the Owner. The Contractor may permit or reject the changes.

1.2 FABRICATOR

In this document, “Fabricator” refers to the facility or facilities performing such shop activities as cutting, welding, drilling, punching, cleaning, and painting of structural steel. “Fabricator” also includes any agents of the Fabricator, such as subcontract fabricators. In some cases, the Fabricator may also be the Contractor, but usually the Fabricator is subcontracted by the Contractor. In this document, the term “Fabricator” is used to describe roles usually performed by the Fabricator, but which could also be done by the Contractor.

1.3 OWNER

1.3.1

In this document, “Owner” refers to the entity paying the Contractor to fulfill the terms of the contract. The Owner encompasses both those preparing the contract documents, including the Designer responsible for the structure’s adequate design, and those representing the Owner during construction, commonly called the Engineer and the Verification Inspector. The Designer, Engineer, and Verification Inspector may be employees either of the Owner or of professional firms contracted for the work. In this document, “Verification Inspector” and “Engineer” are used when describing those specific responsibilities, and “Owner” is used when the role could be either.

1.3.2

An “approved procedure” in this document means one approved by the Engineer.

1.4 PRIMARY MEMBERS

The term “primary member” is defined by the *AASHTO LRFD Bridge Design Specifications* (Eighth Edition) as follows: “A steel member or component that transmits gravity loads through a necessary as-designed load path. These members are therefore subjected to more stringent fabrication and testing requirements; considered synonymous with the term ‘main member’.” Primary and secondary members are further defined in AASHTO LRFD Table 6.6.2.1-1, which is repeated for reference in Appendix A.

C1.4

Transverse bracing (diaphragms, crossframes, etc.) for curved plate girders or beams is defined by AASHTO as primary but does not require shop assembly. See Section 7.1.5.

Because it is not the Fabricator’s responsibility to understand and apply design principles, AASHTO requires the Designer to note all primary members on the plans as well as their state of stress (tension or compression).

Owners are cautioned against using the term “primary members” to designate which materials require Charpy V-notch (CVN) testing requirements because doing so may result in CVN requirements for compression-only portions of members and end diaphragms.

SECTION 2

PREFABRICATION

2.1 FABRICATOR CERTIFICATION

2.1.1

Certification from the AISC Quality Certification Program is required for Fabricators to the standard appropriate for the type of work to be performed. The standards include:

- AISC 205, *AISC Certification Program for Structural Steel Fabricators—Standard for Steel Bridges*—required for vehicular steel bridge superstructures
- AISC 420/SSPC-QP 3, *Certification Standard for Shop Application of Complex Protective Coating Systems*—required for any shop painting performed on steel bridges

The base level of certification to AISC 205 is for simple bridges, which consist of unspliced rolled sections. The following supplements to AISC 205 are also required:

- *Fracture Critical Endorsement*—required for any fabrication conducted on fracture-critical members (FCMs)
- *Intermediate Bridges*—required for bridges in the following categories:
 - 1) rolled beam bridges with field or shop splices, either straight or with a radius over 500 ft;
 - 2) built-up I-shaped plate girder bridges with constant web depth (except for dapped ends), with or without splices, either straight or with a radius over 500 ft;
 - 3) a built-up I-shaped plate girder with variable web depth (e.g., haunched), either straight or with a radius over 1000 ft; or
 - 4) other bridges determined by the Owner to require a similar level of skill as categories (1)–(3).
- *Advanced Bridges*—bridges that do not fall under the definition of simple or intermediate bridges.

C2.1.1

Certification is intended to help ensure that the Fabricator has the needed expertise and commitment to quality to achieve a successful project.

Coating certification is addressed in S8.1, the Collaboration's guide specification for coatings. The requirements of Collaboration standards S2.1 and S4.1 are intended to work in conjunction with quality control requirements in the AISC Quality Certification Program.

The Owner is advised not to require certification endorsements for categories of a higher complexity than the structure warrants. The AISC endorsement requirements have been written to be pertinent to specific structure types and may not be relevant for simpler bridges.

An example of what might be designated an intermediate bridge that does not meet the typical categories (1)–(3) listed in Section 2.1.1 would be a “prefabricated” truss bridge, which would be entirely or substantially pre-assembled at the certified facility and shipped in only a few sub-assemblies. Because most of the connections are made in the shop and not the field, the geometric control required to ensure fit of field connections is not as rigorous as a truss bridge fully assembled in the field. Furthermore, most fabricators of “prefabricated” truss bridges produce only this sort of bridge, and thus would not be able to qualify for the advanced bridge endorsement by fulfilling the prerequisite of producing an intermediate bridge.

Examples of typical advanced bridges include tub or trapezoidal box girders, closed box girders, large or non-preassembled trusses, arches, bascule bridges, cable-supported bridges, moveable bridges, and bridges with particularly tight curve radius.

The Owner should also consider accepting the Certification Program for Bridge and Highway Metal Component Manufacturers for the fabrication of non-main-member components such as crossframes for straight non-skewed bridges or other bracing subassemblies.

More information, including a list of all AISC-certified fabricators, is available from the AISC website at <http://www.aisc.org>.

Information about the SSPC certification program is available from the SSPC website, <http://www.sspc.org>.

2.1.2

Allow the Owner to review the certification records upon request. Resolve all findings noted during this review prior to fabrication.

2.2 COMMUNICATION

C2.2

During the course of the work, the Fabricator may propose changes to the structure that slightly or significantly deviate from the structure's design. In such cases, the Owner may prefer that the Fabricator approach the Designer directly, that the Fabricator go through the Owner responsible for acceptance, or that some other procedure be followed.

Important considerations:

- Establish lines of communication agreed to by all parties, including the Designer, the Engineer responsible for quality assurance, the Engineer responsible for erection, the Fabricator, and the Contractor.
- Keep the lines of communication as simple and direct as possible.
- Always keep the Designer in the loop when decisions are made affecting the structure's performance or appearance.
- Allow the Fabricator to contact the Designer directly prior to shop drawing approval.
- After shop drawings have been approved, the Fabricator should go through the Owner's representative responsible for acceptance.
- Holding a prefabrication meeting with all concerned parties is recommended. See Section 2.4.

Note that if a consultant designer is involved, the consultant might charge for time spent on the project, so the Fabricator must coordinate with the Owner before any submittal to a consultant.

Effective communication between the Owner, the Fabricator, and the Contractor is essential to a successful project. Before work begins, these parties should establish the simplest, most direct lines of communication possible and make sure that all parties understand and use them. This is an important function of the pre-fabrication meeting.

On design-build jobs or other situations where the design is not complete when the Fabricator is engaged, it is particularly useful for the Designer and Fabricator to discuss complex details as they are developed in the design.

2.2.1

Prior to beginning work, Owner and Fabricator representatives shall identify individuals who are responsible for the following functions:

- Preparation, submittal, review, approval, and distribution of shop drawings;
- Submittal and control of material test reports (MTRs);
- Quality Control (QC) by Fabricator and Quality Verification by Owner; and
- Engineering, including the Designer, the Fabricator's Project Engineer, and the Owner's Engineer for technical submittals during fabrication.

2.2.2

The Owner will identify individuals or agents responsible for handling shop detail drawings, approving welding procedures, providing quality verification, and accepting proposed repairs.

2.2.3

During the project, maintain effective communications with the Owner's representatives. Address problems and concerns as early as possible in the work.

C2.2.3

On complex projects, start communication about special aspects of the job, including tolerances or other requirements, very early in the project.

2.3 SHOP DRAWINGS

C2.3

The Owner's review of shop drawings is a form of quality verification and not quality control. The Owner reviews shop drawings to check that they accurately reflect the design, but the Owner does not check every detail and calculation. Regardless of the Owner's review and approval, the accuracy of shop drawings remains the Contractor's responsibility.

Owners should be expedient when reviewing shop drawings. Fabricators plan the flow of work and placement of jobs months in advance. They need to be able to start work on schedule to keep production moving and to satisfy field delivery requirements. Because shop drawings must be approved before work starts, the Owner will delay the Fabricator if checking the drawings takes too long. Conversely, Fabricators must provide complete, legible, and accurate shop drawings to the Owner to facilitate prompt return. Submitting shop drawings in packages according to a mutually agreeable review schedule also facilitates prompt return.

To expedite the review process and to help obtain consistency in shop drawing review, the AASHTO/NSBA Steel Bridge Collaboration has developed a standard for shop and erection detail drawing approval, G1.1, *Shop Detail Drawings Review/Approval Guidelines*.

In some cases, the Fabricator decides to begin fabrication before receiving approved shop drawings, and the Owner may consider requests from the Fabricator to proceed without approved shop drawings. However, work done without approved shop drawings may have to be changed based on final, approved shop drawings. No work done without approved drawings should be concealed by subsequent work before drawings are approved.

Except for emergency situations, work should not be allowed to proceed before shop drawings have been submitted for review.

Use of electronic drawings has proven effective and should be considered if all parties agree on the system requirements, review and approval authentication, and the storage and handling of electronic drawings.

2.3.1

Provide separate shop drawings for each steel structure on a project. Dual (twin) bridges shall have separate drawings for future reference.

2.3.2

Prepare and submit shop drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration G1.3, *Shop Detail Drawing Presentation Guidelines* or equivalent.

2.3.3

Do not begin fabrication until drawings are approved or approved-as-noted. Work performed prior to shop drawing approval is at the Fabricator's risk, and may require additional inspection, non-destructive testing and examination (NDT/NDE), or partial disassembly/reassembly to satisfy the Owner's quality verification.

2.4 PREFABRICATION MEETING

2.4.1

Before work begins, a prefabrication meeting may be held at the discretion of the Owner or if requested by the Fabricator or Contractor.

2.4.2

The Owner will provide design, construction, and verification inspection representatives as appropriate.

2.4.3

The Fabricator representatives should include the plant manager; engineering, production, and quality control inspection personnel as appropriate; and, if applicable, subcontractor representatives (e.g., painter, subcontract fabricators, or testing agencies).

2.4.4

The review should include, at a minimum, the following aspects of the job:

- Progress on shop drawing submittal and approval;
- Plant and personnel certification;
- Organizational structure and primary (lead) plant personnel;
- Handling of MTRs;
- Traceability of materials;
- Fabrication procedures, especially shop assembly, welding, and painting;
- Supply and sampling of coatings bolts, and other materials, if applicable;
- Work schedule and milestones;
- Availability and advance notification of verification inspectors;
- Hold points;
- Inspector's office;
- Appropriate lines of communication;
- Planned coverage of shop operations by QC personnel;
- Project-specific areas of concern for fabrication and inspection, including any special applications of non-destructive examination and testing (NDE/NDT);
- Handling of non-conformance and repair issues;
- Special requirements, especially any exceptions to this document;
- Project details, requirements, or processes that have previously caused difficulties; and
- Loading and shipping.

2.5 PROCEDURES

C2.4.4

A prefabrication meeting may avert many of the problems that may complicate or delay fabrication. At the prefabrication meeting:

- The Owner and Fabricator should review the project and discuss specific concerns.
- The Fabricator should describe the expected approach to the project, including milestones or specialized work in detail.
- The Owner should describe any unusual requirements for the project.
- The Owner should describe how verification inspection will be accomplished, including identification of inspectors, the intended inspection schedule, and any special inspection or hold points.
- Clear lines of communication should be established between all parties.
- The shop drawing review and fabrication schedules should be discussed and mutually understood.

The Owner should have at least one designer, one acceptance representative, and one verification inspector present at the meeting. The Fabricator should have representatives from production, engineering, quality control, and general management. The Contractor, other subcontractors, and suppliers may be included. All parties should be given the opportunity to ask questions or express concerns.

It is not necessary to have a prefabrication meeting before every project, especially if the Owner and Fabricator work together on a regular basis.

C2.5

Procedures are intended to facilitate understanding between the Owner and the Fabricator about how various aspects of the work will progress. These procedures may be included in the documentation reviewed during the AISC Certification process. Having these procedures helps Fabricator's employees understand requirements, and providing copies for review by the Owner helps minimize conflicts once the work has begun. Most procedures reflect the Fabricator's standard practices, so they do not need to be resubmitted for routine jobs unless a specific aspect of work needs particular attention. Written procedures provide more specific guidance than

the specification will, but the Owner should not use written procedures to introduce requirements beyond the intent of the specification. For repairs, the Fabricator and Owner should reach an understanding about NDE methods, scheduling, and the advance notice needed to coordinate quality control and quality assurance inspections.

Procedures should convey how the Fabricator's process will satisfy specification requirements. Information presented on a shop drawing may suffice in lieu of formally submitting a written procedure.

2.5.1

Written procedures must be maintained for the fabrication processes listed below.

- Material traceability;
- Heat-assisted and cold bending;
- Welding (welding procedure specifications and supporting documentation must have Engineer approval before they can be used);
- Cambering and heat-curving, including temperature measurement, patterns, and sequences (must have Engineer approval to be used);
- Shop assembly/laydown, including drilling and punching;
- Postheat and stress-relieving procedures;
- Shop installation of fasteners, with rotational capacity (RC) test, if applicable;
- Blast cleaning and coating; and
- Inspection and testing procedures as required by AASHTO/AWS D1.5M/D1.5.

2.5.2

Each procedure must define how tasks will be performed, evaluated, and accepted by both the quality control inspector and the verification inspector (as applicable) prior to subsequent operations.

2.5.3

The procedures may be standardized and not require resubmittal and approval for each project.

2.6 COMMENCEMENT OF WORK

Provide a written advance notice to the Owner a minimum of two weeks before fabrication begins.

C2.6

Owners generally provide some level of quality verification during bridge fabrication, and they often have projects underway at a number of locations. When the Fabricator provides the Owner with an anticipated work schedule, this allows planning and preparation for inspection. The earlier notification is provided to the Owner the better, so Fabricators should provide schedule information as soon as possible and not simply follow the prescribed minimum lead times. The Fabricator can initially provide a general estimate to the Owner and then