



12-1 REVIEW OF SHOP DRAWINGS – STEEL STRUCTURES

General Information

Introduction

This memo is intended to provide guidelines for the review of Shop Drawings for steel bridges and other major steel structures. Shop Drawings for other structures such as signs, railings, bearings and other items are normally reviewed by field personnel and/or design specialists.

Terms and Definitions

The term “Shop Drawings” is used in this memo although “Working Drawings” has traditionally been used at Caltrans. Shop Drawings are for use by the fabricator in order to cut, shape, weld, punch, drill, sub-assemble, shop paint, and otherwise produce the pieces and assemblies which are sent to the project site, and for use in the field and show where steel components are to be placed and how they are fastened, welded and temporarily supported, and, if necessary, in what order they are to be assembled or erected.

Purpose of Shop Drawings

Contract plans provide sufficient detail to bid and construct a project by showing material and dimensional requirements, but fabrication details are not necessarily included. Also, contract plan details may be generic or typical and not show all locations, some of which may vary slightly. Additionally, alternative details may be presented on contract plans, from which the contractor may choose their preferred method.

The contractor, therefore, produces Shop Drawings for two purposes. One is to provide the fabrication shop with the necessary information to produce the steel components and assemblies required to complete the project. The other is to provide a plan for use in the field to properly place and install the fabricated members. The process of producing Shop Drawings has the added benefit of requiring the contractor to completely familiarize themselves with the details of a project and identify errors and omissions from the plans before any fabrication begins, at which point the cost of correcting errors is high.



The review of Shop Drawings is important to assure the project will be built in conformance with the plans and specifications. It is obviously more desirable to identify errors on Shop Drawings rather than during fabrication or at the project site.

As stated in the Standard Specifications, Section 5-1.23 the authorization of Shop Drawings does not relieve the contractor of the responsibility to construct the project according to the plans and specifications.

Format of Shop Drawings

Structural steel Shop Drawings are normally produced by a specialty sub-contractor of the fabricator, although sometimes the fabricator or contractor will produce their own Shop Drawings. Since there are hundreds of different companies producing Shop Drawings, format will vary. Legibility, a logical sequence of sheets, and overall organization are necessary, but format should not be reviewed or mandated.

Roles and Responsibilities

The responsibility for checking Shop Drawings is shared by the Designer, the Structure Representative, and a representative from the Materials Engineering and Testing Services (METS). A representative from the railroad company will also review Shop drawings for railroad bridges (underpasses). METS and the Structure Representative and, if necessary, the railroad representative, send their comments to the Designer, making the Designer the focal point responsible for coordinating, discussing, and resolving problems. After discussion with the other reviewers, a consensus shall be reached on exactly what comments will be returned to the contractor. It may be acceptable for the Designer to discuss issues with the Shop Drawings producer directly, but approval to do so should be obtained from the Structure Representative. While all reviewers should be thorough in their review, METS generally is more focused on welding, materials, and painting.

The general procedural requirements for handling Shop Drawings are discussed in detail in the Standard Specifications, Section 5-1.23. A project may have specific requirements regarding the submittal and review of Shop Drawings.



Review Guidelines

General

These guidelines pertain primarily to Plate Girder bridges, but most items would also apply to other types of steel bridges and steel bridge retrofits.

It is recommended that the reviewer read the reference material listed at the end of this memo. These documents are available on-line and provide industry standards on the preparation and review of structural steel Shop Drawings.

Put simply, the Shop Drawings must conform to the requirements of the Contract Plans, the Special Provisions, and the Standard Specifications, and they must be internally consistent. The most important step in the review process is to read and understand all the contract documents – Contract Plans, Special Provisions, and the Standard Specifications. The reviewer should obtain and read the project correspondence file, which may include authorized changes to the contract. A working relationship with the Structure Representative is important in order to be aware of any changes being contemplated to the contract or special problems. Documentation of conversations regarding the resolution of issues should be maintained.

An initial cursory review should be made of all submittals to determine completeness and legibility. Incomplete or illegible submittals should be immediately returned for correction. The cursory review should verify that each Shop Drawing in the submittal includes the jobsite name of the structure as shown on the contract plans, bridge number, sheet title, sheet number, revision number and date, contract number, district/county/route, and a north arrow on Erection Drawings. Shop Drawings shall be 11 by 17 inches. Any required supporting documents must be attached, and a transmittal letter listing all attached drawings should accompany the submittal. Also, submittals should include both erection and shop drawings together since the proposed erection procedure may not meet the design continuity assumptions. In this case, the contractor must submit calculations for revised cambers and stresses, and increased plate thickness or different types of steel may be required. A Shop Drawing index should be provided also.

Changes from the contract plans or specifications should be discussed with the Structure Representative and METS before authorization. Revisions may be satisfactory structurally but create administrative problems.



Changes requiring Contract Change Orders as determined by the Structure Representative need special attention. These change orders could be grouped into two categories:

1. Those involving changes requested by the State and minor changes requested by the fabricator where there is no question on approval of the change by both parties. The Shop Drawings can be authorized but the note “Contract Change Order to be Processed” added to each detail sheet involved.
2. Those involving controversial changes requested by the fabricator. These should be returned to the fabricator with the note “Request must be made by the Contractor to the Resident Engineer for Contract Change Order”. The fabricator may ask that the Shop Drawings be held by design pending such negotiation. The designer should not hold any plans without such a request.

Establishing general criterion for rejection of Shop Drawings is not practical. Rejection should be based on the condition of unacceptable or unauthorized non-conformance to the contract requirements, large numbers of errors, or mistakes that could lead to significant fabrication errors. With this in mind, Shop Drawings should be authorized, or authorized with minor corrections, whenever possible to avoid unnecessary re-submittals. If the reviewer is in doubt, the Project Engineer or Structure Liaison Engineer should be consulted. Deviations from the contract plans should not be automatically rejected if the structural capacity and the design concept are maintained. Sheets should be authorized or rejected individually.

Checklist

Review items can be separated into three general categories for convenience. These are Geometry, Materials, and Details. The following list of items should be considered as a general guide, but it should not substitute for common sense by the reviewer.

Essential dimensions such as those listed below should be checked, but it is not usually necessary to do a detailed check of all dimensions. Contract Plans often show only essential dimensions, usually in the horizontal plane, whereas Shop Drawing detailers use computational means to establish dimensions dependent on super-elevation, grade, camber, horizontal and vertical curves, and other specific requirements. Therefore, dimensions will not match contract plans exactly, and computing them would be difficult. Rough spot checks of computed dimensions are encouraged. Typically, use of computer aided drafting programs to check dimensions is unnecessary.



Geometry

- Layout Control lines for horizontal and vertical alignment.
- Span Length Girder lengths and center to center dimensions between bearings or points of support.
- Girder Spacing Transverse girder spacing.
- Elevations Elevation of seats or other supports.
- Camber The amount and method of camber should conform to the contract plans or values computed to accommodate an authorized erection procedure. Substantiating camber calculations shall be submitted with the Shop Drawings.
- Stiffeners Fit, location, and spacing of intermediate stiffeners. Check for interference with splice locations.
- Field Splices All field splice locations and labels.
- Cross Frames and Spacing and drop (transverse elevation difference) Diaphragms dimensions and Shop Point locations and labels.
- Member Fracture Critical Members (FCMs), Main Members Designations (Tension or Compression), Primary Components of Main Members, and Secondary Members. See Memo to Designers 12-2.
- Temporary Locations of any temporary supports and the vertical alignment of the Support Locations girder at each stage of erection.
- Anchor Bolt Location, size, embedment, and projection.
Layout

Materials

- Grade of Steel ASTM and/or AASHTO designation.
- Fracture Critical Requirements All pieces with Fracture Critical requirements identified.
- Charpy V-notch Requirements All pieces with Charpy V-notch test requirements identified.
- Fasteners Diameter, specification and grade of bolts, nuts, washers, studs, rods, etc., and coating requirements. Rotational capacity testing requirements. Quantities are optional.



- Non-Destructive Testing The type and extent of Non-Destructive Testing and applicable specifications listed for Fracture Critical Members.
- Cleaning and Painting Requirements Blast cleaning, paint specifications and galvanizing requirements, including finish paint.

Details

- Piece Marks Every element on erection drawings indicated by a unique piece mark consistent with shop drawings.
- Plate Sizes Length, width, and thickness of all elements (flanges, webs, stiffeners, splice plates, gussets, fill plates, etc.)
- Shape Sizes Size and weight per unit length of rolled shapes.
- Bolt Holes All hole diameters and slot dimensions shown, and drilling or reamed in assembly noted. Vertical and horizontal spacing and edge distance of all bolt holes.
- Formwork / Attachments Location and details of brackets, holes, stiffeners, lifting attachments, etc. for temporary use during construction.
- Welding Details Location of all welds. Size of all fillet and partial penetration welds. Configuration of all partial and complete penetration welds. Fracture Critical welding identified and the authorized Welding Procedure Specification (WPS) and Non-destructive testing (NDT) requirements noted.
- Flange Transition Details Controlling dimensions of bevels and tapers.
- Cover Plates Dimensions and termination details.
- Shear Studs Number and spacing. Shop or field installation.
- Flatness Requirements Flatness requirements and tolerances at bearing surfaces.
- Rolling Direction Direction of rolling of plates where specific orientation is required.
- Erection Procedure Complete list and details of erection sequencing.



References

AASHTO/NSBA. 2002. Shop Detail Drawings Presentation Guidelines, G1.3-2002, AASHTO/NSBA Steel Bridge Collaboration, American Association of State Highway and Transportation Officials, Washington, DC.

AASHTO/NSBA. 2000. Shop Detail Drawings Review/Approval Guidelines, G1.1-2000, AASHTO/NSBA Steel Bridge Collaboration, American Association of State Highway and Transportation Officials, Washington, DC.

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