DIVISION 500 - STRUCTURES

SECTION 501 - STEEL STRUCTURES

501.01 Description. This section describes construction of steel structures and steel structure portions of composite structures.

501.02 Materials.

Red Primer Paint 708.01(A)
Zinc Paints and Primers 708.02
Bearing Devices and Related Materials 712.09
Zinc Coating 712.10
Structural Steel 713.01
Welded Stud Shear Connectors 713.02
Steel Forgings and Steel Shafting 713.07
Steel Castings 713.08
Gray Iron Castings 713.09
Malleable Iron Castings 713.10
Standard Fasteners 718.01
High-Strength Bolts and Studs 718.02

501.03 Construction.

(A) Shop Plans. Submit detailed shop drawings required for steel fabrication.

Prepare shop drawings on sheets 36 inches long by 22 inches wide. Make 2-inch margin on left side of sheet and 1/2-inch margin on other three sides. Locate title block in lower right hand corner of each sheet. Title includes statement of contents of sheet, location of structure, project name, and project number, if any.

Submit 6 sets of shop drawings for review. The Engineer will return one set with comments and corrections. Make corrections and submit 10
prints of each revised drawing. Once the Engineer accepts shop drawings, one set of accepted drawings will be returned to the Contractor. Prepare and submit shop drawings at no increase in contract price or contract time. Changes to accepted shop drawings without written consent of the Engineer will not be allowed. Steel fabrication before shop drawing acceptance by the Engineer will not be allowed.

Submit shop drawings not less than four weeks prior to fabrication. Make corrections in a timely manner.

Shop drawings shall include the following:

(1) Details for connections not dimensioned in the contract documents.

(2) Direction of rolling of plates where the contract documents require specific orientation.

(3) Sequence and procedures.

(4) Location of butt-welded splices on layout drawing of entire structure.

(5) Calculations and location of temporary supports and vertical alignment of members at each stage of fabrication.

(6) Slip-critical connections and connections subject to direct tension.

(7) Qualifications of welders in accordance with Section 5, Part B, of AWS D1.5.

(8) Qualifications of welding inspectors in accordance with Section 6, Part A, of AWS D1.5.
(B) **Required Prints and Reports.** Submit drawings and reports in accordance with Table 501.03-1 - Submittal Requirements.

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of Sets Required</th>
<th>Furnish To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Shop Drawings</td>
<td>6</td>
<td>Engineer</td>
</tr>
<tr>
<td>Final Shop Drawings</td>
<td>10</td>
<td>Engineer</td>
</tr>
<tr>
<td>Mill Orders and Test Reports</td>
<td>5</td>
<td>Engineer</td>
</tr>
<tr>
<td>Notice of Placing Shop Order</td>
<td>2</td>
<td>Engineer</td>
</tr>
<tr>
<td>Notice of Beginning Shop Work</td>
<td>3</td>
<td>Shop Inspector</td>
</tr>
<tr>
<td>Match Mark, Camber, and Erection Diagrams</td>
<td>1 8</td>
<td>Shop Inspector Engineer</td>
</tr>
<tr>
<td>Shipping Statements</td>
<td>1 4</td>
<td>Shop Inspector</td>
</tr>
<tr>
<td>Report of Full-Size Tests</td>
<td>1 6</td>
<td>Shop Inspector</td>
</tr>
<tr>
<td>Record of Annealing Charges</td>
<td>6</td>
<td>Engineer</td>
</tr>
</tbody>
</table>

(C) **Mill and Shop Inspection.** Give advance notice of shop and mill work, and work locations to the Engineer so testing and inspectional procedures may be prepared.

Furnish facilities for inspection of material and workmanship in mill and shop. Allow inspectors free access to necessary parts of work.

When the Engineer requires test specimens or certifications, furnish specimens and certifications at no increase in contract price or contract time.

(D) **Shop Work and Fabrication.** Keep structural material clean and free from damage caused by improper handling during loading, transporting, and storage.

Furnish and follow methods and procedures for preparation, handling and inspection, shop assembly of material, and details of fabrication.
conforming to Section 6 - Steel Structures, in AASHTO LRFD Bridge Design Specifications.

Furnish and perform methods and procedures for shop and field welding in accordance with AWS D1.5 and AASHTO LRFD Bridge Design Specifications. Furnish and perform methods and procedures for welding of structural supports for highway signs, luminaires, traffic signals, and other non-bridge structures in accordance with AWS D1.1.

Electro-slag welding will not be allowed.

Furnish and perform methods and procedures for welding of reinforcing steel conforming to AWS D1.4 and Subsection 602.03(E) - Splicing of Bars.

Zinc coat all structural steel, excluding steel for major steel bridges that receive paint finishes.

(E) Erection.

(1) General. The Engineer will inspect erection work. Provide access to facilities for thorough inspection of erection work, including materials used and quality involved.

(2) Plant. Use falsework, tools, machinery, and appliances, including drift pins and fitting-up bolts, necessary for handling of work.

(3) Handling and Storing Materials. Place materials on skids above ground. Keep storage area clean and properly drained. Place girders and beams upright and shored, supporting long members such as columns and chords on skids. Place skids close enough together to prevent damage from deflection.

(4) Falsework. Design, construct, and maintain falsework to handle required loads. Submit plans and calculations for falsework stamped and signed by Hawaii Licensed Structural Engineer. Acceptance of the Contractor's plans by the Engineer does not relieve the Contractor of responsibility for correctness and completeness of drawings and for fit of shop and field connections.

Place and protect falsework for steel structures on footing that is protected from undermining and softening subsurface conditions. Set falsework to give structural camber required by the contract documents or ordered by the Engineer. Brace top of all falsework, excluding blocking, transversely.

Install falsework lighting in accordance with Section 633 – Falsework Lighting.
(5) **Methods and Equipment.** Before erection begins, submit proposed method of erection and proposed number and character of equipment. Submit erection procedures prepared, stamped, and signed by Hawaii Licensed Structural Engineer who is familiar with heavy rigging. Do not begin work until written acceptance is received from the Engineer.

(6) **Bearing and Anchorages.** Do not place masonry bearing plates upon bridge seat bearing areas that are improperly finished, deformed, or irregular. Set bearing plates level in exact positions with full and even bearing upon masonry. Place bearing plates on fabric or elastomeric pads as indicated in the contract documents.

Set anchor bolts accurately in drilled or cast holes, except when bolts are built into masonry and fixed by completely filling forms with portland cement concrete. Provide location of anchor bolts in relation to slotted holes in expansion shoes, corresponding with temperature at time of erection. Adjust nuts on anchor bolts at expansion ends of spans.

(7) **Straightening Bent Materials.** Straighten plates, angles, and other shapes by methods that will not produce fracture or other damage. Do not heat metal unless permitted by the Engineer. When heating is permitted, control heating temperature so as not to produce metal of dark "cherry red" color. After heating, cool metal as slowly as possible. Submit proposed straightening procedures and inspection methods stamped and signed by Hawaii Licensed Structural Engineer.

After straightening bends or buckles, inspect metal carefully for fractures, by method other than visual, that is acceptable to the Engineer. Restore finish of straightened materials.

(8) **Assembling Steel.** Assemble parts accurately, following match-marks. Handle materials carefully so as not to bend, break, or damage parts. Hammering that may damage or distort members will not be allowed. Clean bearing surfaces, as well as surfaces in permanent contact, before assembling members. Unless built by cantilever method, build truss spans on blocking placed to give trusses proper camber. Leave blocking in place until tension chord splices are fully connected, and then pin and bolt all other truss connections. Do not tighten railing bolts, or those in splices of compression member butt joints, or bolts in railings until the span has been swung. Use splices and field connections with 1/2 of holes filled with bolts and 1/2 with cylindrical erection pins before placing permanent fasteners. For splices and connections carrying traffic during erection, fill 3/4 of holes with bolts.
(9) Pin Connections. Furnish pilot and driving nuts for use in driving pins at no increase in contract price or contract time. Drive pins so that members take full bearing on pins. Screw pin nuts tight and burr threads at face of nut with pointed tool.

(10) Misfits. The Engineer will consider correction of minor misfits involving harmless quantities of reaming, cutting, and chipping as part of erection process. Immediately report to the Engineer errors in shop fabrication or deformation resulting from handling and transport of material. Obtain the Engineer’s acceptance regarding method of correcting error. Correction of misfits, errors, injuries, and replacements shall be the Contractor’s responsibility.

(11) Bolted Connections. Do not use bolted connections, except for field splices, or as detailed in the contract documents. Use high-strength bolts, nuts, and washers of type and dimensions specified at locations indicated in the contract documents.

  Furnish and use bolts with hexagonal heads and nuts. Use bolts that are long enough to extend entirely through nut, but not by more than 1/2 thickness of nut. Use two nuts for bolts in tension.

  Unfinished bolts in shear shall not have more than one thread within grip. Diameter of bolt shall conform to Article 6.13.2.5- Size of Bolts, and diameter of bolt holes shall conform to Article 6.13.2.4 - Holes, of the AASHTO LRFD Bridge Design Specifications.

  Threads of turned bolts shall be entirely outside grip. Sub-punch and ream holes for all turned bolt connections to 1/32-inch oversize. Finish bolts to provide a driving fit. Furnish acceptable nut locks or flat washers, 1/4-inch-thick, as specified in the contract documents.

  Furnish bolted connections using high-strength steel bolts conforming to Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts and the following provisions:

  (a) Clean contact surfaces of high-strength bolted connections of rust, mill scale, dirt, grease, paint, lacquer, and other material foreign to steel, before assembly.

  (b) Furnish and install bolts conforming to ASTM A 325 with hardened washer under nut or bolt head, whichever is the element turned in tightening. At the Contractor’s option and at no increase in contract price or contract time, the Engineer will allow utilization of hardened washer under both nut and bolt head.
(c) Furnish and install direct tension indicator washers acceptable to the Engineer for tightening of bolts. Submit procedures for installation and inspection of direct tension indicator washers, as recommended by manufacturer, to the Engineer. Include in submitted procedures the proposed method for checking and retightening bolts that may have worked loose after subsequent bolt tightening.

Tightening of ASTM A 325 or ASTM A 490 bolts by turn-of-nut method or calibrated wrench method will not be allowed.

Tightening of ASTM A 449 studs or anchor bolts by turn-of-nut method or calibrated wrench method will be permitted if the Engineer accepts the Contractor’s proposed method.

(d) Locate nuts wherever practicable on side of member that will not be visible from traveled way.

(F) Painting.

(1) General. Painting of metal structures shall include preparation of metal surfaces, application, protection and drying of paint coating, supplying tools, tackle, scaffolding, labor, and materials necessary for entire work.

Before painting, round sharp edges of structural steel to maximum radius of 1/16 inch.

Treat finished surfaces of bearing plates and rollers as indicated in the contract documents.

Paint steel with one shop or prime coat and not less than two field coats. Provide minimum dry film thickness of 1.5 mils for shop coat and 1.0 mil for field coat. Paint prime coat and first field coat with red primer paint. Paint second field coat with finish coat indicated in the contract documents and acceptable to the Engineer. Provide coats sufficiently different in color to permit detection of incomplete application.

(2) Weather Conditions. Paint only thoroughly dry surfaces and only during periods of favorable weather. Painting will not be allowed when atmospheric temperature is below 40 degrees F or when relative humidity is above 85 percent. Remove and replace fresh paint damaged by bad weather and moisture.
(3) Preparation of Zinc-Coated Surfaces. When painting zinc-coated surfaces, defer painting to allow surfaces to weather to a dark, nearly black color. Before painting, treat zinc-coated surfaces with solution that contains two ounces each of copper chloride, copper nitrate, and sal ammoniac dissolved in one gallon of soft water in earthen or glass container. Then add two ounces of commercial muriatic acid and mix thoroughly. Apply solution to zinc-coated surface with wide, flat brush. Upon drying, the coated surfaces will appear gray. A commercial product that produces same results on zinc-coated surfaces, or alternative treatment that conforms to Pretreatment Specifications No. 3 - Basic Zinc Chromate Vinyl Butyral Washcoat, of the Steel Structures Painting Council Handbook may be used.

(4) Cleaning of Surfaces. Thoroughly remove rust, loose mill scale, dirt, oil or grease, other foreign substances, and anti-weld spatter coating from surface of metal before painting. If rust appears on cleaned surface before application of paint, reclean surface before painting.

Before painting, choose one of following methods of cleaning and obtain the Engineer's acceptance:

(a) Hand Cleaning. Use wire brushes, scraping tools, or sandpaper. At the Engineer's discretion, some power-driven will be acceptable, at the Engineer's discretion. Pneumatic chipping hammers will not be allowed. Remove oil and grease with acceptable solvent.

(b) Blast Cleaning. For blast cleaning, use abrasives manufactured from clean, dry sand or material grit of grading acceptable to the Engineer. The Engineer will not allow use of unwashed beach sand.

Use acceptable dry-blast cleaning apparatus, in accordance with Specification No. SP5-52T - Blast Cleaning to White Metal, of the Steel Structures Painting Council Handbook. White metal is defined as surface with uniform gray-white metallic color, slightly roughened to form suitable anchor pattern for painting.

(5) Application of Paint. Apply paint by brush, spray, roller, or combination of these methods.

When using brushes, apply paint to produce smooth, uniform coating, brushing out runs or sags. The Engineer will consider numerous brush marks to be improper paint application.
Use type of roller that does not leave stippled texture in paint film.

When spray methods are proposed for use, spray operator shall have minimum three years of experience and shall submit certificate of experience. Required qualifications for spray operator include ability to correctly adjust equipment, application, and technique; and perform equipment maintenance. Protect adjoining areas from overspray or paint mist. Runs, sags, thin areas in paint coat, or skips and holidays are evidence of unsatisfactory work, and will be cause for the Engineer to require brushwork for remainder of painting.

Use traps or separators sized adequately to remove oil and water from compressed air. Drain traps or separators periodically during operations. Air from spray gun impinging against surface shall show no water or oil.

Use brushes to paint areas inaccessible to spray gun. Brush to work paint into cracks, crevices, and blind spots. If surface is unreachable by brush, use daubers or sheepskins.

Thoroughly mix paint ingredients in container before use, and agitate often during application to keep pigment in suspension.

If it is necessary to thin paint in cool weather to make paint spread more freely, heat paint container in hot water. Do not add or remove liquid from paint.

Cure or dry each coat of paint in accordance with manufacturer's recommendations before applying successive coats.

Remove painting that fails to conform to requirements. Thoroughly clean and repaint metal.

(6) **Prime Coat.** Ship structural steel with one coat of shop-applied prime coat for the Engineer’s inspection and acceptance. After acceptance, apply one prime coat and one finish coat of required paint at the Contactor’s storage yard before delivery to work site.

Apply shop-coat type of paint to surfaces of metal that will be in contact after field erection, provided paint does not interfere with assembly.

Before erection, apply all required coats of paint or three shop coats of specified primer to surfaces of metal that are not presently in contact, but that will be inaccessible after assembly.
Surfaces of metal assembled in the shop that are in contact shall not be painted. Do not paint structural steel until all shop welding has been completed.

Field-welded surfaces within two inches from point of weld shall not be painted.

After field welding is complete, clean unpainted surfaces to bright metal and coat with acceptable shop primer and two finish coats of paint.

Do not paint surfaces to be in contact with concrete.

If unpainted surfaces will be exposed to weather for an extended period of time before erection, protect surface with coat of lacquer or similar coating acceptable to the Engineer. Remove this coating before erection.

Give milled or finished surfaces of iron and steel castings one coat of paint.

Coat machine-finished surfaces, except abutting joints and base plates, with acceptable hot mixture of white primer and tallow or other acceptable commercial product. The Engineer will inspect coated items before removal from shop.

Paint erection marks for field identification of members, and weight marks on surfaces previously painted with shop coat. Do not load material for shipment until paint is thoroughly dry. Do not remove material until at least 24 hours after applying paint.

(7) Field Painting. Upon completion of erection, clean surfaces in accordance with Subsection 501.03(F)(4) - Cleaning of Surfaces.

Clean surfaces not coated with shop paint or those with required coating worn off or defective, and cover thoroughly with one coat of required primer.

Do not paint surfaces that are to be in contact with concrete. Paint surfaces that will be inaccessible after erection, with required field coats. Apply required field coats after retouched prime coat has thoroughly dried and required field cleaning has been completed. If small cracks and cavities have not been sealed watertight, fill with pasty mixture of red primer and linseed oil. Apply second coat.

To secure maximum coating on edges of plates or shapes and other parts subject to special wear and attack, stripe edges first with longitudinal motion and bolt heads with rotary motion of brush. Follow
immediately with general painting of entire surface, including edges and bolt heads.

If the Engineer orders precautionary or corrective measures to prevent dust, dirt, and other foreign matter from touching freshly painted surfaces, or to prepare surfaces for painting, provide these measures at no increase in contract price or contract time.

Steelwork in structures that have concrete floors shall not be painted with first field coat until completion of concrete floor, including formwork removal. In other cases, defer application of second field coat until completion of placing and finishing adjoining concrete work, not including concrete floors. Reclean and repaint surfaces damaged by concreting operations.

Protect pedestrian, vehicular, and other traffic from injuries or damage from spatters, splashes, or smirches of paint or paint materials.

Use 2-inch-high letters and numerals to stencil structure number, month, and year of painting at locations indicated in the contract documents or designated by the Engineer. Choose paint color that will contrast distinctly with background.

(G) Zinc Coating.

(1) Zinc Coating. Zinc coat after fabrication using hot-dip process. Coat largest practicable area in accordance with Subsection 712.10 - Zinc Coating. Fabrication shall include shearing, punching, forming, bending, welding, and riveting. If sections need to be straightened after zinc coating, straighten without damaging spelter coating.

(2) Repairing Damaged Zinc-Coated Surfaces. Repair zinc coating that has chipped off or been damaged in handling, transporting or welding. Thoroughly clean damaged zinc-coated surfaces by wire brushing damaged area. Remove sags, welds, and loose and cracked spelter coating. Paint cleaned area after completing any of the following procedures:

(a) Apply coating material conforming to Federal Specification O-G-93, stick form, in accordance with method conforming to Annex A1 of ASTM A 780. Heat coated surface with torch at sufficient temperature to melt repair material without damage to zinc coating.
(b) Apply two coats of zinc-oxide, zinc-dust paint conforming to Federal Specification MIL-E-15145B. Mix paint properly in suitable vehicle in ratio of one part zinc-oxide to four parts zinc-dust by weight.

(c) Apply two coats of premixed formulation containing not less than 95 percent zinc in dried film meeting the requirements of Federal Specification MIL-P-226915A.

(d) Apply two coats of formulation with high zinc-dust content meeting the requirements of Federal Specification MIL-P-21035.

(H) Concrete Floors. Do not place concrete floors on steel spans until centering under bridge has been released and spans have swung free onto their supports. Place concrete in floor slab continuously between joints, or as ordered by the Engineer. In case of emergency, provide construction joints as ordered by the Engineer.

(I) Removal of Falsework. Upon completion of erection process and before final acceptance of structure by the Engineer, remove falsework, excavated, or unnecessary materials, rubbish, and temporary buildings. After removal of falsework, check for proper camber in steel beams and girders. Measure camber at top of web and make corrections to shots to adjust flange thickness.

501.04 Measurement. Structural steel will be paid on a lump sum basis. Measurement for payment will not apply.

501.05 Payment. The Engineer will pay for the accepted structural steel on a contract lump sum basis. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following pay item when included in the proposal schedule:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Structural Steel</td>
<td>Lump Sum</td>
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The Engineer will pay for bronze and stainless steel bearing plates in accordance with and under Section 506 - Bearing and Expansion Plates.

The Engineer will pay for falsework lighting in accordance with Section 633 - Falsework Lighting and under Section 503 - Concrete Structures.

END OF SECTION 501