Chapter 4-5: Metals

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4-5.01 General

4-5.01A Work Included

Chapter 4-5 includes guidelines for metal components used for building projects. These components include structural steel, open web steel joists, metal decking, cold formed steel framing, miscellaneous metal, aluminum handrail and railings, stair nosing, and expansion joint cover assemblies.

Review any Standard Special Provisions (SSPs) from Section 99[1], *Building Construction*, Division 05, *Metals*, that have been included in the project *Special Provisions*, since much of the information therein typically will not be repeated in the following sections of this chapter.

Do not apply the requirements of Section 99 Division 5 of the special provisions to metal items described in other divisions (such as metal doors in Division 8, *Openings*) unless there are specific cross-references to Division 5 in those divisions. Furthermore, other sections of the *Standard* Specifications (such as Section 55, *Steel Structures*, and Section 75, *Miscellaneous Metal*) do not apply to the items covered by this chapter unless there are specific clauses in the project *Special Provisions* that say otherwise.

4-5.01B Materials

4-5.01B(1) General

Structural members must not be cut, reamed, or otherwise modified without specific authorization from the Office of Transportation Architecture[1] (OTA), Structural Design. OTA is found within the Division of Engineering Services (DES) Structures & Engineering Services (SES).

Major custom-fabricated metal assemblies for building projects will be inspected and released by Materials Engineering and Testing Services (METS) in accordance with *Construction Manual* Chapter 6, Section 6-2, *Sampling and Testing – Acceptance of Manufactured or Fabricated Materials and Products*. Also refer to METS' *Construction Quality Assurance Program (CQAP) Manual,* or METS' *Source Inspection Guidelines for Local Agencies (SIGLA) Manual,* if applicable. However, most items covered by this chapter will be inspected and released at the job site by SC staff using Form CEM-4102, *Material Inspected and Released on Job*. Contact the METS Representative assigned to your project for any questions regarding material release of building components.

[1] Caltrans internal use only

Certificates of compliance (COCs) are required for most items covered in this chapter. Verify that each shipment of materials is accompanied by a COC, and do not allow materials to be incorporated into the work until the COC is provided.

Most items covered by this chapter also have specified shop finishes. Read the *Special Provisions* carefully and pay close attention to whether each item is specified to be galvanized and whether a shop primer (which is different than a prime coat) is required. Comply with SSP 99-09900, *Painting,* as specified for coating systems for structural steel for buildings, open web steel joists, and building miscellaneous metal.

For all building components that require field welding, verify that the Contractor submits Form TL-38, *Inspection Request*, to METS. Refer to Bridge Construction Memo (BCM) 11, *Welding*, for more information. Refer to the project *Special Provisions* to determine which portions of *Standard Specifications* Section 11, *Welding*, are applicable to each building component.

4-5.01B(2) Steel Products

The type of steel required for a building component will be listed in the *Special Provisions*. If the material is being supplied as rough stock, it must have the appropriate American Society for Testing and Materials (ASTM) designation painted on it.

Whenever the *Special Provisions* require hot-dipped galvanizing, it must not be substituted with electro-galvanizing or tumbler galvanizing. If the type of galvanizing is not specified, any method may be used.

4-5.01B(3) Aluminum Products

Only a few different types of aluminum alloys are allowed for use in building components. Aluminum materials must be checked for the proper designations by the Aluminum Association (AA) to verify that characteristics such as extrusion, casting, temper, and embossing comply with the requirements specified for the material applications.

4-5.01C Tips and Suggestions to Prepare for Inspection of Metals

1. Confirm the location, dimensions, and layout for the placement of anchor bolts for any building columns. Verify the center-to-center dimensions for the column lines and the templates for the bolts at each column. Examples of anchor bolt templates are shown in Figures 4-5.1 and 4-5.2 below. It is also important to check the dimensions from the column line, face of wall, or other reference line to the centerline of the bolts at each column. It is easier to check these while the

carpenters have the string lines up on the batter boards, which serve as a useful reference.



Figure 4-5.1. Overview of Anchor Bolt Layout



Figure 4-5.2. Close-up View of Anchor Bolt Layout

2. When verifying the location, dimensions, and layout for anchor bolts, also check that the batter boards are accurate. Although these batter boards may have been checked prior to concrete work, they are often damaged or bumped, and it is important to confirm that they are still correct before the steel is erected.
3. Review the setting of bases and bearing plates to confirm the specified bearing and the required length of weld for attachment are available.
4. Confirm that the temporary connections, bracing, cross-bracing, and other means of supporting the structure are securely anchored and connected until the final connections are made.
5. Required shims should be actual steel plates of various thicknesses and not leftover or random materials.
6. Bolting is an important item to be inspected in the field. Unless high-strength bolts are required, the special provisions call for A307 bolts. Bolt holes shall not be enlarged by flame cutting. All bolted connections, and especially oversized

holes, require washers. Oversized bolt holes must be brought to the attention of the OTA structural designer for review, direction for correction, and/or approval. Splices in members shall only be allowed where shown on the plans.

7. Check and confirm the size, type of bolt, washers, and the hole diameters in the steel.
8. It is permissible to use drift pins or bull pins to aid in the alignment at connections. However, care should be taken to prevent damage to the bolt holes.

4-5.02 Structural Steel

Structural steel components of buildings are defined as any element of the structural steel frame essential to support the design loads. All structural steel elements are listed in the special provisions. Examples of structural steel elements are shown in Figure 4-5.3 below.



Figure 4-5.3. Structural Steel Components of Buildings

There are many requirements for structural steel for buildings that must be verified. It is highly recommended to develop a checklist for each structural steel component to assist with organization. This checklist will help ensure that no steps are overlooked during inspection. Suggested items to include on the checklist are:

1. Shop welding
2. Field welding
3. High-strength bolted connections
4. Shear anchor installations
5. Stud welding to steel members
6. Special moment-resisting frame welding.

4-5.03 Open Web Steel Joists

The following items are considered open web steel joists and are covered in this chapter:

1. K-series steel joists
2. KCS-type K-series steel joists
3. K-series steel joist substitutes
4. Long-span steel joists
5. Joist girders
6. Joist accessories.

See Figures 4-5.4 and 4-5.5 for examples of open web steel joists.

If open web steel joists, trusses, and stock rigid frames are part of a pre-engineered building, these components will be addressed in another division of the project *Special Provisions*.

The special provisions require open web steel joists and permanent bracing to be fabricated by a manufacturer certified by the Steel Joist Institute (SJI). Procedures for field welding must comply with American Welding Society (AWS) D1.1/D1.1M. *Standard Specifications* Section 11-2, *Welding – Welding Quality Control,* does **not** apply to shop welding for open web steel joists.

Verify that the proper equipment is available for the unloading, handling, and storing of metal joists in accordance with the manufacturer's recommendations.

Joists must be stored with the top or bottom chord flanges in the "up" position. They must not be stored lying on their side.

Check the angles that are compressed and mounted between the two top and bottom flange angles to ensure that the strut angle has not split. Cracks in those strut angles or welds may occasionally be found where they have been compressed. Coordinate the review with METS and the assigned structural designer.

It is important to anchor the joists with the specified bracing and bridging as the joists are being erected, for overall stability during stage construction.



Figure 4-5.4. Setting Open Web Joist



Figure 4-5.5. Ledger Angles for Joist and Deck Seats

Verify that joists are not loaded until all the final bridging, bracing, and connections are in place, as shown in Figure 4-5.7 below.

Concentrated loading on the joists, such as storage of pallets or bundled materials, is not allowed.

Cutting, welding, or altering of any element of the joist, except for the connections specified in the design, is not allowed unless the OTA structural designer confirms otherwise.

All paint must be removed prior to welding any steel connection.

Figure 4-5.6 below shows that the hip girder and rafters are bolted together but welded at the top plates. Confirm field welding in pre-weld meetings and ensure the Contractor understands the welding requirements.



Figure 4-5.6. Hip Girder and Rafters Are Bolted Together and Welded at the Top Plates



Figure 4-5.7. Overview of Erected Trusses; Decking Is Not Installed until All Supporting Components Are in Place

4-5.04 Metal Decking

SSP 99-05310, *Metal Deck*, requires decking to be fabricated from one of four listed manufacturers unless an equivalent alternative manufacturer is authorized by the Engineer. Acceptable manufacturers include:

1. Verco Manufacturing Co.
2. Nucor Corp.
3. Vulcraft Group
4. ASC Profiles.

Deck units must be formed to span three or more supports, and end bearing must be not less than 1-1/2 inches.

Confirm that the metal decking conforms to characteristics such as type, finish, gauge, and shape, as shown in the authorized submittals.

Pallets of metal decking materials must be stacked and supported on blocking off the ground, and must be protected from the elements.

Support frames must be in place before any openings are cut into the metal decking.

Confirm that the structural plans have provided for decreased joist spacing, doubled up joists, reinforcing, or other means for areas in which concentrated loads have been designed; verify correct field placement at these locations.

Decking seams must be joined in a neat and tight manner and they must be connected in accordance with the design. Closures should be provided at the ends and edges of the deck.

Verify that lap joints are constructed as specified.

In most cases, the metal decking will be plain decking sheets which can then be covered with insulating boards and built-up roofing; see Figure 4-5.8 below for an example. If the metal decking is to be covered with lightweight insulating concrete, the metal decking will have slots for ventilation. Vented metal decking may be required in other special cases, but is usually not used with ordinary concrete topping.

Some projects will use ribbed metal decking for roofing; see Figure 4-5.9 for an example. This type of metal decking is typically used in conjunction with steel roof framing.



Figure 4-5.8. Interior Face of Metal Decking



Figure 4-5.9. Fastening Ribbed Metal Decking to the Supporting Members

The metal decking acts as a diaphragm to transfer the lateral loads and must be fastened to the supporting members as detailed on the project plans. Plug welding is an acceptable method for fastening the decking; however, this may not always be possible. If the roof is not relatively flat, plug welding will be very difficult, and screws will be the more desirable type of fastener. If screws are used, verify that they comply with the *Special Provisions* as well as the guidance in this section. On some projects, screws may not be allowed because of the diaphragm loading.

When metal decking acts as a diaphragm, the seams are frequently button punched or may have seam welds at the spacing shown on the project plans.

Roof sump pans for roof drains are premanufactured units separate from the metal decking. These pans are typically shown on the architectural plans, except for pre-engineered metal buildings, in which case the roof sump pans will be shown on the Contractor's building shop drawings.

Check the authorized submittals to verify that the metal decking is the proper gauge. Welding must comply with AWS D1.1 and AWS D1.3 (similar to above, Section 11-2, *Welding – Welding Quality Control,* of the standard specifications is not applicable to metal decking). Carefully inspect the welding for roofs with steeper slopes. Those welds are very difficult to make, and the pre-certification of the welders doing the work is important. An example of welding issues for metal decking is shown in Figure 4-5.10 below. If the decking is fastened with screws, confirm that the screws are of the correct size, length, and spacing, and determine whether they are required to be self-drilling or if pilot holes need to be predrilled.

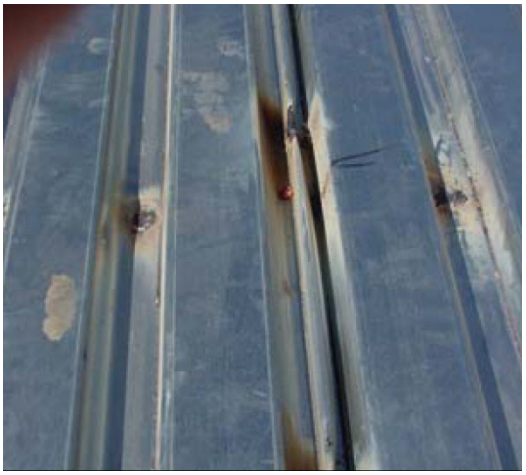


Figure 4-5.10. Problems with Puddle Welding on a Roof Slope of 1:12 (V:H)

4-5.05 Cold Formed Steel Framing

Cold formed steel framing is also known as light gauge steel framing. These framing elements are formed to channel shape for studs (both load-bearing and non-load-bearing) and tracks, and are fabricated from galvanized steel sheets for joists, rafters, and other components. Specifications for this item are found in SSP 99-05420, *Cold Formed Steel Framing.*

Cold formed steel framing must be fabricated by a manufacturer who is certified by the Steel Stud Manufacturers Association under their Code Compliance Certification program.

Product data is a required submittal for cold formed steel framing. These product data sheets are very informative and should be reviewed thoroughly before the framing work begins.

Lower and upper tracks are available in various gauges. The lower tracks are fastened to the concrete floor with powder actuated fasteners or concrete nails. The top tracks

are nailed or screwed to roof trusses, beams, purlins, floor joists, or other framing members. Sometimes, if a building frame is flexible (such as a pre-engineered steel building), the top track will slide snugly inside of a slightly wider secured slip track to prevent transferring frame movements to the stud wall.

Doors may be a problem when the typical detail requires double studs placed face-to-face. When using double studs, it is important that the gypsum board be attached to both studs to avoid cracking.

It is important to review the architectural drawings before framing is assembled. Verify the locations of all walls, doors, and windows when the Contractor performs layout: these items are often indicated by snapped chalk lines on the concrete foundation.

When using light gauge framing, the stiffness of the wall and openings are dependent on the proper installation of the stiffening components. Spacing and effectiveness of the fasteners are particularly critical. Use of blocking to ensure proper wall rigidity is crucial. The light gauge metal framing industry sometimes refers to this blocking as bridging or strapping. Bridging is a small, thin gauge metal channel made to easily slide into a row of erected metal studs. The studs are pre-punched with holes to facilitate placing of the bridging material with clips that are screwed in to secure them. Ensure that the project plans address the type of wall stiffening element to be used and that the elements are installed in the field.

If strapping or flat sheet concealed backing is used across the face of studs, the Contractor needs to be aware that any gypsum board or cement board should be routed out in the back to create a relief channel where the strapping touches it. This will prevent unsightly wall undulations or bulges that will show through the finished wall texture and paint. The routing is time-consuming but is the best practice for a visually smooth wall.

All aspects of light gauge metal framing construction shall be part of the light gauge metal working drawings submittal by the Contractor. This includes placement of flat concealed backing (typically wooden blocks) used as additional supports in the wall to accommodate mounting cabinets, fixtures, or other items.

Take photos of all walls prior to them being covered with finish materials. It is good practice to develop a method of relating where each wall is located to the locations shown on the project plans, so that photos can be useful as a future reference.

The light gauge steel framing industry is continually responding to Contractor needs in construction practice improvements. Additional blocking and bridging options can be found on various industry websites. It is recommended to discuss blocking and bridging systems with the OTA structural designer. The general details for blocking and bridging

are referred to in the standard metal framing section of the project plans; however, the Contractor's submittal will propose the details and the final product incorporated. Discuss the alternatives with the Contractor prior to their submittal to verify that the system is adequately braced. If the OTA structural designer does not require it, this step may be bypassed by the Contractor.

The cold formed framing members under this section are used to support load bearing assemblies and are therefore structural components. Cold formed metal framing for non-load bearing assemblies, such as suspended ceilings and non-load bearing walls, is covered in this manual in Chapter 4-09, *Finishes*.

4-5.06 Miscellaneous Metal

Miscellaneous metal for buildings consists of items such as protective noses, guard posts, or storage brackets. These are considered "minor items" and are usually off-the-shelf materials or require very minimal fabrication. Building miscellaneous metals also encompass embedded items such as weld plates, bearing plates, saddles for wood framing, and dock angles.

Ductile iron castings or carbon steel castings are only allowed for drainage grates. Ductile iron is commonly required for components that need to have high strength and resistance to impact.

Compare the miscellaneous metals to the corresponding authorized product data submittals to verify specified material characteristics such as sizes, shapes, types, connections, finishes, and material thicknesses.

Review all anchors, fastenings, hardware, accessories, and other supplementary parts, and confirm they are located as specified in the contract documents.

Verify the installation of all materials is true, the alignment is plumb and square, all members are set to the proper elevations, and that adequate bracing is provided and left in place until all final connections are completed.

4-5.07 Aluminum Handrails and Railings

Aluminum handrails and railings must conform to Americans with Disabilities Act (ADA) requirements. Dimensions such as the height, spacing off the wall, return radii, and pipe diameter can be found on the architectural plans. All staircases must have handrailing, such as in Figure 4-5.11 below.



Figure 4-5.11. Loft and Stair Railing

4-5.08 Stair Nosing

Please refer to the architectural and structural sections of the project plans for the requirements for anchoring of the stair nosing. Both fabricated and manufactured items will also require a submittal be approved before the materials are delivered to the jobsite.

4-5.09 Expansion Joint Cover Assemblies

Expansion joint cover assemblies are utilized when a new addition is joined to an existing building. They are also used for vertical walls, soffits, fascia, roofs, and at the floor of all door passages from one space to the next. See Figure 4-5.12 for a detail of an expansion joint cover assembly.

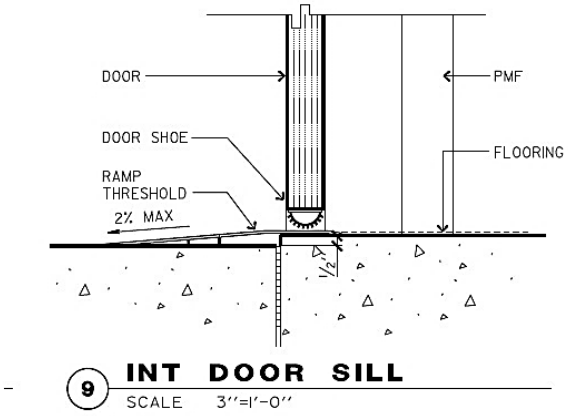


Figure 4-5.12. Cover Plate and Expansion Joint

Verify that the installed assembly is weather-tight.