Chapter 4-13: Special Construction

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4-13.01 General

4-13.01A Work Included

Division 13, *Special Construction*, under the 1995 CSI format will normally include the following: cathodic protection; pre-engineered steel building systems; storage tanks, such as asphalt emulsion systems; alarm systems for smoke and fire; fire suppression systems or fire sprinkler systems; and alternative fire extinguishing systems, such as halon, carbon dioxide, and foam.

This division covers items that are fabricated in commercial fabrication facilities.

Under the 2004 CSI format, cathodic protection is moved to Division 26, *Electrical*, smoke and fire alarm and other safety systems are moved to Division 28, *Electronic Safety & Security*; fire suppression and fire sprinkler systems are moved to Division 21, *Fire Suppression*, as are alternative fire extinguisher systems. Those new division numbers only become important in that the industry has made the conversion to the 2004 CSI format and many of the submittals reviewed will be listed under the 2004 Division format. The industry is currently running a cross-reference or conversion table, which allows for easy reference to compare the 1995 format numbering system to the 2004 format system. Given that the industry's transition to the 2004 system is complete, it is likely that cross-references will cease.

Review any Standard Special Provisions (SSPs) from Section 99[1], *Building Construction*, Division 13, *Special Construction*, 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. Note that the term "pre-engineered steel building" is the current specification term used throughout this chapter.

4-13.01B Tips and Suggestions to Prepare for Inspection of Pre-engineered Steel Buildings

1. Pre-engineered steel buildings will be designed by registered civil engineers for the pre-engineered steel building manufacturer. Those designs and the design calculations will be submitted, as any other submittal, for review and authorization by the structural designer.
2. Pre-engineered metal building systems are typically optimized designs for the loading and utilization requirements for a specific building. Consequently, there may be tapered columns, tapered rafters and beams, graduation and changes in the size and thickness of the flanges of both the columns and beams, and changes in the thickness of web members. The calculations will support all of these variations.

[1] Caltrans internal use only

3. The components of a pre-engineered steel building can be fabricated on a computer-driven assembly line, which includes all of the welding. This is contrary to the conventional design for structural steel systems.
4. The framing system will generally consist of columns, beams, and rafters as the primary components. Portal columns will frequently be provided in locations where sidewall bracing cannot be installed because of overhead doors or other openings in the side or end walls.
5. Secondary members for the roof support system will normally be “Z” type purlins, typically from 7 to 9 inches deep (although they could be up to 12 inches depending on local loading conditions like snow). The purlins are typically located 2 to 5 feet on center, depending on the loads, and are all cold-rolled shapes. The gauge will also vary from building to building, depending on the loads.
6. Secondary sidewall framing will normally be “Z” girts, which are horizontal structural members that support paneling. The design for the installation of the column attachment will vary from manufacturer to manufacturer and building to building. Some will be mounted completely on the surface of the outside flange of the exterior columns (bypass girts). Others will be mounted to clips, which will allow the outside face of the girt to project just slightly beyond the vertical plane of the outside face of the exterior columns (inset girts). See Figure 4-13.1 for an illustration of a steel building with purlins and girts.
7. The size and gauge of girts will also vary, depending on the loads. Spacing will normally be designed for 5-foot on centers, starting with a base channel or girt located at or just above the finish floor line and continuing at center-to-center spacing up to the top of the wall, terminating at an eave girt or eave purlin.
8. Roof sheeting will range from lapped panels to standing rib panels. Roof systems will be designed for both exposed and concealed fasteners.
9. Wall systems will also be designed with a corrugated type of panel and exposed fasteners for attachment to the sidewall girts. The exposed fasteners are normally stainless steel, self-drilling hex-head screws, with the neoprene washer assembled on the screws. The neoprene washer and the head of the screw will be pre-finished to match the sheeting color.
10. Concealed fasteners are normally a clip assembly attached to the roof purlin and so configured as to hook, connect, or otherwise attach to the rib of the roof sheeting without the necessity of an exposed fastener. These are normally in a standing rib configuration wherein the concealed fastener is clipped over the rib of the bottom panel, the upper rib lapped over the lower rib, and the ribs then crimped together with a mechanical crimping tool. This crimps the edges of both the lower and upper rib continuously from ridge to eave.

11. Ribbed type wall panels are normally configured so that the rib butts against the sidewall girt with bolts and special nuts used to attach the ribs securely to the sidewall girts and base channels.

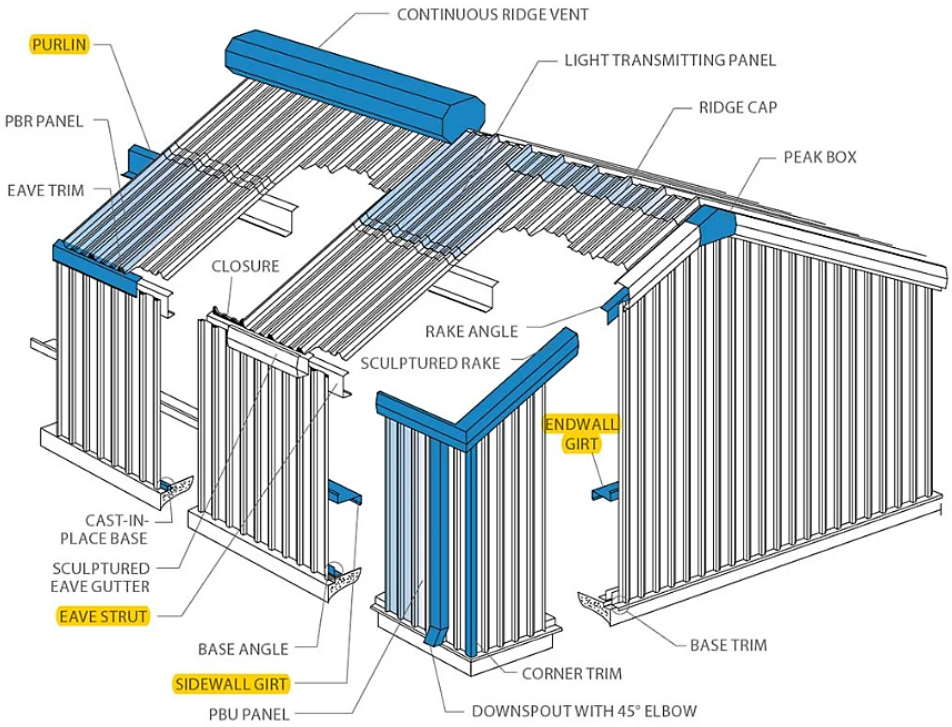


Figure 4-13.1. Illustration of Pre-engineered Steel Building Showing Purlin and Girts

12. Insulated roof and sidewall panels will occasionally be specified. These panels are sandwich panels, wherein a polyurethane or other cellular type insulation is sandwiched between interior and exterior metal sheets. These panels will normally be attached with concealed fasteners.

13. Vinyl-faced blanket insulation is the most common product used to insulate pre-engineered steel buildings. Those blankets will come in large rolls and be rolled by machine along the roof purlins to uniformly install and stretch the roof insulation ahead of the roof sheeting operation. These roof systems can be designed to meet the R-30 requirements as used in any conventional frame and insulated system. Sidewalls are also commonly insulated with vinyl-faced blankets; however, use of a light gauge stud system is frequently added at the sidewalls, insulation then installed in the cavities, and some form of sheathing (plywood) is attached to the inside surface of the studs. This provides a surface that is more forgiving of the abuse that most building sidewalls suffer.

14. During the erection of the pre-engineered steel building systems, special attention should be given to the following items:
    a. The setting of the anchor bolts – both the location alignment and level condition – is very important. The designs for the poured-in-place concrete floor system will normally include reinforcing bars, running horizontally in the slab and hooked around the outside of the anchor bolt assembly, to distribute the thrust forces that occur at the base plate and anchor bolts. Check to be sure that the anchor bolts are the proper length, located and positioned within the slab as designed.
    b. Installation of the columns. The columns should be checked for uniform elevation and bearing of the base plate, and to ensure they are erected true and plumb in both directions. Primary girts and purlins will be installed at the ridge, eaves, base, and midpoints as required, as part of the temporary bracing. In addition, cables and turnbuckles are frequently used as temporary cross bracing to hold the system in place until several bays have been erected. The system is then trued and plumbed before the bolts are tightened. Once that initial set of bay framing has been trued, plumbed, and tightened, it will be used as the anchor to continue erection of the remainder of the building. Similar to the initial set, remaining sections will also be set and loosely bolted, trued, plumbed, and then tightened, as erection progresses.
15. The framing systems will frequently include rotation braces for the rafters extending from the purlin down to the bottom flange of the rafter. Similar bracing may be called for on the columns with those braces running from the sidewall girt to the inside flange of the column. Braces will also be designed to prevent rotation of the purlins.
16. End wall framing is normally accomplished with a post and beam type frame with the column running from the slab/foundation up to the beam or rafter. End wall frames will occasionally be designed lighter than the interior frames because of the reduced tributary loading along with the added support provided by the end wall columns. In other instances, the end wall columns are designed only to support the wind load.
17. Sidewall girt systems will continue in line along the length (sidewalls) of the building.
18. Large openings, such as those required for large sectional doors, are usually designed into the pre-engineered steel building system. The members to frame around these openings are normally heavy gauge, cold-rolled shapes that will run from the concrete floor slab and foundation up to the eave purlin. The sidewall girts in those instances will terminate into those cold-rolled frame systems. Headers will be installed at the top of door openings using similar material.

19. The pre-engineered steel building system will include designs for all trims required for complete closure at the ridge, eaves, base, rake, fascia, flashings, counter flashings, door and window openings, and other systems as may be required to provide a complete weathertight assembly.
20. In some instances, a pre-engineered steel building framing system and metal roof will be designed to support conventionally framed and attached masonry, tilt panel, stud and stucco, or other conventional type wall assemblies.
21. Pre-engineered steel building systems are available in various configurations from low-rise single-slope structures (1:12) to steep-slope gable-type systems. They can be designed to meet heavy snow load conditions in mountain regions.
22. All of these systems will be clearly detailed on the standard detail sheets of the authorized submittals.

4-13.02 Pre-Engineered Steel Building

For pre-engineered steel buildings, the Project Architect will determine the overall layout, work area divisions, windows, doors, and equipment features, as well as roof and wall penetrations. See Figure 4-13.2 for an example of a steel building in construction. General details are shown, but the manufacturer must submit the exact details through the prime Contractor for review and authorization. The structural designer will detail structural footing depths and other details in the structural section of the project plans. They will also specify the building design loads (live, dead, and special equipment loads) to be used in designing the structure. Some equipment loads will not be known until the Contractor selects the specific equipment to be supplied. The mechanical, electrical, and sanitary equipment will also be considered during the design stage and in the shop drawing review process.

The submittal will include structural calculations and shop drawings that are prepared by the manufacturer, stamped by a professional civil engineer with a current California registration, and submitted for review and authorization by the structural designer and the Project Architect. The Structure Representative will review those submittals concurrently (note: the Structure Representative is the focal point amongst the Architect, METS, and Designer). The progress schedule may be dependent on the timely submittal of the designs and calculations for review and authorization. Once the documents have been authorized, the order for the production of the pre-engineered steel building must be placed in the manufacturer’s fabrication schedule for a time slot for production to be established. As there are only a few pre-engineered steel building manufacturers with plants in California, it is not uncommon for the materials to be shipped from plants in the Midwest, which will require additional delivery time.

The pre-engineered steel building components must be transported and handled in such a manner as to prevent damage due to twisting, distortion, or deformation. Building components must be stored off the ground.

Framing must be erected plumb and true. Temporary bracing must be installed during erection to hold the framing plumb and true and in a stable and safe position.



Figure 4-13.2. Pre-engineered Steel Building

4-13.02A General Frame Features

Pre-engineered steel buildings are a common building type due to their built-up member size adaptability, relatively simple fabrication, lighter erection procedures, and readily available stock material. They are efficiently designed but are subject to horizontal displacements under some loading; see Figure 4-13.3 for an illustration of some steel primary member components being assembled.

Structural frame members fall into two classifications: primary and secondary.

- Primary members are built-up plate beams shaped like an “I”, made by welding steel plates together.
- Secondary members are thinner-gauge cold-rolled shaped sections, ties, or clips; these are used to span between, stiffen, and/or interconnect the primary frame elements.

The exterior walls and roof are covered with steel roofing and siding panels. The interior walls of the facility being built are not included in a pre-engineered building package. The interior walls are typically constructed of light-gauge metal framing, wood, or masonry. Suspended architectural ceilings, also not part of the primary building package, can be supported directly from the roof purlins above.



Figure 4-13.3. General Frame Features

4-13.02B Primary Frame Members

Primary frame members are identified by such common names as beams, rafters, and columns; see Figure 4-13.4 for an illustration. They form the main structural building frame and are simple “I” or “H” shapes built to the desired depths and widths by welding different plates together. The plates used are generally 1/8 inch to 1/2 inch in thickness. A primary frame member may also have a specially designed arm or bracket for supporting heavy equipment. Steel grades vary by availability from 36 to 50 ksi steel. Maximum frame spans are typically 40 feet.

Fabricated steel will normally be painted with a low-grade coat of primer at the fabrication shop. The special provisions may instead require a high-quality initial prime coat or subsequent finish coats to be applied in the field. Check the Contractor’s submittal to ensure specified coatings are to be applied. The Structure Representative will inspect the field painting. Materials Engineering and Testing Services (METS) may be able to provide assistance if the field painting is extensive. Some painted areas that are field welded, and areas that are damaged, will require touch-up in the field.



Figure 4-13.4. Primary Frame Members

4-13.02C Secondary Frame Members

Secondary frame members are used throughout the building and are available in varying thickness, depending on local loading requirements. They can be “nested” or “doubled up” if required for added strength. Moderate gauge “Z” and “C” shapes are used as roof purlins, wall girts, roof joists, and support curbs for equipment roof penetrations. End-threaded rigid tie-rod bracing (typically 1/2 inch to 7/8 inch in diameter) is used for sidewall bracing. Do not allow cables as substitutes. Pre-drilled clips are used for bolting secondary to primary members. Compression flange buckling stiffeners, made from angle iron, are typically used for bracing columns and rafters.

4-13.02D Roofing and Siding Panels

Steel panels are screwed to secondary members to form roofs and exterior walls. The panels are normally specified to be finished with “Kynar 500” fluorocarbon coating or “Galvalume” to give them a 20-year guaranteed durability. They are available in varying colors and can be cut to fit any intersecting roof angle or to fit openings in roofs or walls. When cutting panels, contractors will use a high-frequency “nibbler” tool to cleanly cut 24-gauge metal.

For example, roof sump pans for roof drains (premanufactured units) are typically installed separately after the metal decking is installed. These pans are usually shown on the architectural plans; however, for pre-engineered metal buildings, they will appear on the contractor’s building shop drawings.

Joints are lapped and sealed with roll mastic to ensure a weathertight joint. The insulation placed over the roof purlins is limited to 2-inch thickness to prevent bulging and denting of the thin metal roofing panels when they are screwed down to the purlins over the insulation.

4-13.02E Flashing, Gutters, and Mastics

Weatherproofing and waterproofing materials must be as specified and detailed by the building manufacturer. Generally, roof penetrations are constructed by utilizing curb flashings that are 2 inches to 18 inches in height and that have welded side flashings. The curbs are to support the equipment, but also allow the Contractor to seal the roof panel edges against a curbed metal opening.

Each of the pre-engineered steel building manufacturers provides specific details for framing, flashing, counter flashing, and all other components relative to any penetration of the roof or wall systems. These details are designed, and include the specified caulking and assembly to ensure weather tightness around these openings and/or penetrations. The metal building dealers (subcontractors) selected by the metal building manufacturers are all required to go through the manufacturer’s special training

programs to ensure they are properly trained in the installation of these assemblies to make them watertight. Please check the manufacturer's submittals thoroughly and use those details for inspection of the assemblies to ensure they will be completed in a watertight manner.

For pipe penetrations through the roof, there are custom flexible neoprene rubber roof jack boots that can be slipped over pipe penetrations up to 6 inches in diameter. The bottom flange of the roof jack boot is made of a flexible metal, with an integral layer of mastic, that can be pressed to fit over and into the roof panel corrugations and screwed tight to achieve a watertight seal against the roof panel around the penetration.

The roof downspout plans must be checked for the proper drop angle as per the architect's plan notes for that detail. Sloppy fabrication detailing leads to unappealing directional changes in the downspouts, which will not follow the building lines tightly. In addition to being functional, downspouts need to be visually appealing by blending in with building lines.

4-13.03 Metal Building

Reserved.

4-13.04 Asphaltic Emulsion Tank

Asphalt emulsion tanks and systems and other storage tanks are specialty items, included in SSP 99-13210, *Asphaltic Emulsion Tank.* It is important to review and familiarize yourself with the authorized submittals for inspection of their installation.

These are usually sent to the jobsite in one piece. There is not much to inspect except for the reinforced concrete footing and the tightening of the anchor bolts. The mechanical engineers will check the operation of the tanks.

Note: Secondary containment may be required depending on the jurisdiction of each District. Refer to *Standard Specifications* Section 13, *Water Pollution Control*.

4-13.05 Precast Shelter

Reserved.