Course 817

Steel Erection Safety

OSHAcademy™
Occupational Safety & Health Training

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OSHAcademy Course 817 Study Guide

Steel Erection Safety

Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 817.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

Despite being covered since 1971 under the original steel erection standard, America's 56,000 steel erectors continue to suffer 35 fatal accidents per year, a rate of one death per 1,600 workers. OSHA estimates 30 of those deaths, as well as nearly 1,150 annual lost-workday injuries, can be averted by compliance with provisions of the OSHA's 1926 Subpart R Standard, developed with industry and labor through negotiated rulemaking.

The Bureau of Labor and Statistics lists steel erection as one of the top 10 most hazardous occupations. Steel erection work includes heavy duty high rise structures, metal buildings, and even signs. Steel erection is often the skeletal core of bridges, office buildings, commercial, retail, and industrial structures. OSHA published Subpart R, 1926.750, the current steel erection rule.

The OSHA steel erection standard is intended to protect employees from steel erection hazards when involved in the construction, alteration, or repair of:

- single-story buildings
- multi-story buildings
- bridges
- other structures where steel erection occurs

The requirements apply to all employers engaged in steel erection unless otherwise specified. It does not cover electrical transmission towers, communication and broadcast towers, or tanks. See examples of steel erection activities here.

Course Objectives

After completing this course and successfully passing the final exam, you should be able to:

- Describe initial site preparation activities including site layout and pre-planning.
- List the components of a site-specific erection plan.
- Identify crane hoisting and rigging hazards and best practices during steel erection.
- Describe crane operator and rigger inspection responsibilities.
- Discuss methods of preventing structural collapse.

- Identify safe work practices related to walking/working surfaces and decking.
- Identify safe work practices related to installation of beams, bracing, bridging, joists, girders and columns.
- Describe safe procedures for landing and placing loads on decking and joists.
- Describe the hazards and safe practices for erecting systems-engineered buildings.
- Identify fall protection systems used in steel erection operations.
- Define and list safety requirements for a Controlled Decking Zone (CDZ)
- Describe general and special safety training requirements for steel erection operations.

Module 1: Site Preparation

This module discusses initial site Layout, site-specific erection plans and construction sequences detailed within OSHA's 29 CFR 1926.752.

Proper communication between the controlling contractor and the steel erector prior to the beginning of the steel erection operation is essential to employee safety. Many accidents involving collapse can be averted if adequate pre-erection communication and planning occurs.

Site preparation, including site layout, pre-planning of overhead hoisting operations, and (in some cases) site-specific erection plans help to ensure safety during the initial stages of steel erection.

Approval and Commencement

The controlling contractor must provide written notification to the steel erector ensuring that:

- Concrete in footings, piers, and walls has been cured to a level that will provide adequate strength, as required by the American Society for Testing and Materials (ASTM), to support any forces imposed during steel erection.
- Anchor bolt repairs, replacements and modifications were done with the approval of the project Structural Engineer of Record (SER).

A steel erection contractor should not erect steel unless he or she has received written notification that the concrete in the footings, piers and walls, or the mortar in the masonry piers and walls has attained, either:

- 75 percent of the intended minimum compressive design strength, or
- sufficient strength to support the loads imposed during steel erection.

This determination should be based on an appropriate ASTM standard test method of field-cured samples.

The controlling contractor should keep a copy of the written notification(s) required by this section on the site for review until completion of the project.

Site Layout

In order for the steel erector to perform necessary operations in a safe manner, the controlling contractor must provide and maintain:

- Adequate access roads into and throughout the site that will be used for safely delivering and moving:
  - derricks
  - cranes
  - trucks
  - other necessary equipment
  - the material to be erected
- Means and methods for pedestrian and vehicular control.
- A firm, properly graded, drained area, readily accessible to the work with adequate space for the safe storage of materials and the safe operation of the erector's equipment.

Pre-Planning

All hoisting operations in steel erection must be pre-planned to ensure:

- Employees are not working directly below suspended loads, except for:
  - employees engaged in the initial connection of the steel
  - employees necessary for the hooking and unhooking of the load
- Where employees must work under the load, the materials being hoisted are:
  - rigged to prevent unintentional displacement
  - prevented from slipping by the use of hooks with self-closing safety latches or their equivalent
  - rigged by a qualified rigger

Site-Specific Erection Plan

Employers may elect, because of conditions specific to the worksite, to develop alternate means of providing the employee protection. If a site-specific erection plan is used, it must:

- Be developed by a qualified person;

- Identify the site;
- Be available at the work site; and
- Be signed by the qualified person responsible for its development and any modifications.

The Site-Specific Erection Plan Process

Pre-construction conference(s) and site inspection(s) are held between the erector and the controlling contractor, and others such as the project engineer and fabricator before the start of steel erection. The purpose of these conference(s) is to develop and review the site-specific erection plan.

The Site-Specific Erection Plan Components

In this process, the following elements are considered:

- The sequence of erection activity, developed in coordination with the controlling contractor, including the following:
  - material deliveries
  - material staging and storage
  - coordination with other trades and construction activities
- A description of the crane and derrick selection and placement procedures, including the following:
  - site preparation
  - path for overhead loads, and
  - critical lifts, including rigging supplies and equipment
- A description of steel erection activities and procedures, including the following:
  - stability considerations requiring temporary bracing and guying
  - erection bridging terminus point
  - notifications regarding repair, replacement and modifications of anchor rods (anchor bolts)

- columns and beams (including joists and purlins)
- connections
- decking, and
- ornamental and miscellaneous iron

- A description of the procedures used to comply with 1926.754(a).
- A description of the falling object protection procedures that will be used to comply with 1926.759.
- A description of the fall protection procedures that will be used to comply with 1926.760.
- A description of the special procedures required for hazardous non-routine tasks.
- A certification for each employee who has received training for performing steel erection operations as required by 1926.761.
- A list of the qualified and competent persons.
- A description of the procedures that will be used in the event of rescue or emergency response.

See 1926 Subpart R, Appendix A for more guidelines for establishing the components of a site-specific Erection Plan.

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Proper communication between the controlling contractor and the _____ prior to the beginning of the steel erection operation is essential to employee safety.**

    a. safety manager
    b. steel erector
    c. OSHA inspector
    d. local government agency

2. **Which of the following must be cured to a level that will provide adequate strength, as required by the ASTM?**

    a. Mortar
    b. Steel
    c. Asphalt
    d. Concrete

3. **Employees may work directly below suspended loads if _____.**

    a. they are engaged in initial connection of the steel
    b. they are inspecting the load
    c. they are performing flagging operations
    d. they have been approved by the host employer

4. **If a site-specific erection plan is used, it must _____.**

    a. determine the cost of the project
    b. include approval by an OSHA consultant
    c. be developed by a qualified person
    d. be available at the corporate headquarters

5. The site-specific erection plan should include all the following components, <u>except</u> _____.

a. The sequence of erection activity
b. A copy of 1910 Subpart G, Appendix A
c. A description of the crane and derrick selection and placement procedures
d. A description of steel erection activities and procedures

Module 2: Cranes

Hoisting and Rigging

Rigging and hoisting of steel members and materials are essential parts of the steel erection process. However, in addition to the dangers usually associated with cranes and derricks, steel erection also presents special hazards. These hazards include the use of cranes to hoist employees, suspend loads over certain employees, and perform pre-lifts.

Hoisting Equipment

Hoisting equipment is commercially manufactured lifting equipment designed to lift and position a load of known weight to a location at some known elevation and horizontal distance from the equipment's center of rotation.

Note: A "come-a-long," is not considered lifting equipment. It is a mechanical device usually consisting of a chain or cable attached at each end. It is used to facilitate movement of materials through leverage and is not considered hoisting equipment.

Pre-Shift Inspection

Cranes being used in steel erection activities must be visually inspected prior to each shift by a competent person.

The inspection must include observation for deficiencies during operation. At a minimum, this inspection must include the following:

- All control mechanisms - look for maladjustments.
- Control and drive mechanism - look for excessive wear of components and contamination by:
  - lubricants
  - eater
  - other foreign matter
- Safety devices - look for defects, including but not limited to:
  - boom-angle indicators
  - boom stops

- boom kick out devices,
- anti-two block devices, and
- load moment indicators where required

- Air, hydraulic, and other pressurized lines, particularly those which flex in normal operation - look for:
  - deterioration, and
  - leakage
- Hooks and latches - look for:
  - deformation
  - chemical damage
  - cracks
  - wear
- Wire rope reeving - look for compliance with hoisting equipment manufacturer's specifications.
- Electrical apparatus - look for:
  - malfunctioning
  - signs of excessive deterioration
  - dirt
  - moisture accumulation
- Hydraulic system - look for proper fluid level
- Tires - look for proper inflation and condition;
- Ground conditions around the hoisting equipment - look for:

- proper support, including ground settling under and around outriggers
- ground water accumulation
- similar conditions

- Hoisting equipment - look for:
  - level position, and
  - level position after each move and setup.

If any deficiency is identified, the competent person must immediately determine if it is a hazard.

If the competent person determines a hazard exists, the hoisting equipment must be removed from service until the deficiency has been corrected.

Operator and Rigger Inspection Responsibilities

The operator must be responsible for those operations under the operator's direct control. Whenever there is any doubt as to safety, the operator must have the authority to:

- Stop all hoisting activities.
- Refuse to handle loads until safety has been assured.

A qualified rigger (a rigger who is also a qualified person) must inspect the below-hook rigging prior to each shift.

For more information on inspections see OSHA's Steel Erection eTool page.

Working Under Loads

As mentioned earlier, routes for suspended loads must be pre-planned to make sure no employee is required to work directly below a suspended load except when they initially connect steel or hooking/unhooking loads.

When anyone works under suspended loads, the loads must be rigged by a qualified rigger, materials being hoisted must be rigged to prevent unintentional displacement, and self-closing safety latches must be used.

Multiple Lift Rigging Procedures

Multiple lifts are hazardous for many reasons, including the risk of:

- unhitching a load beneath a suspended load,
- separate loads snagging,
- loads becoming unbalanced, and
- exceeding the safe working load limits.

A multiple lift may only be performed if the following criteria are met:

- A multiple lift rigging assembly is used.
- A maximum of five (5) members are hoisted per lift.
- Only beams and similar structural members are lifted.

All employees engaged in the multiple lift have been trained in the following procedures:

- The nature of the hazards associated with multiple lifts, and
- The proper procedures and equipment to perform multiple lifts.

No crane is permitted to be used for a multiple lift where such use is contrary to the manufacturer's specifications and limitations.

Multiple-lift rigging assembly capacity, for the total assembly and for each individual attachment point, must:

- Be certified by the manufacturer or a qualified rigger.
- Be based on the manufacturer's specifications.
- Have a 5-to-1 safety factor for all components.

The total load must not exceed:

- The rated capacity of the hoisting equipment specified in the hoisting equipment load charts.
- The rigging capacity specified in the rigging rating chart.

The multiple lift rigging assembly must be rigged with members:

- Attached at their center of gravity and maintained reasonably level;
- Rigged from top down; and
- Rigged at least 7 feet (2.1 m) apart.

The members on the multiple lift rigging assembly must be set from the bottom up.

Controlled load lowering must be used whenever the load is over the connectors.

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **According to the text, which of the following is designed to lift and position a load of known weight to a location at some known elevation?**

    a. "Come-along"
    b. Lifting equipment
    c. Scissor lift
    d. Forklift

2. **When inspecting lifting equipment air, hydraulic, and other pressurized lines, particularly those which flex in normal operation, be sure to check for _____.**

    a. discharge routes
    b. proper documentation and tags
    c. proper coloration
    d. deterioration and leakage

3. **What must the competent person do if he or she determines a lifting/hoisting equipment hazard exists?**

    a. Report the hazard to the safety department
    b. Immediately schedule preventive maintenance
    c. Remove the hoisting equipment from service
    d. Tell operators about the hazard and to be careful

4. **When performing a multiple lift, a maximum of ____ members may be hoisted per lift.**

    a. 2
    b. 3
    c. 4
    d. 5

5. The multiple lift rigging assembly must be rigged at least _____ apart.

a. 5 (1.3 m)
b. 6 (1.8 m)
c. 7 (2.1 m)
d. 8 (2.7 m)

Module 3: Structural Stability

Structural stability must be maintained at all times during the steel erection process.

Structural Steel Assembly

Since structural collapse is second only to falls as a cause of fatalities in this industry, stability is essential to the successful erection of any steel structure, including single-story, multi-story, and bridges. This section of the standard outlines the work practices that will prevent collapse due to lack of stability. In addition, it addresses slipping and tripping hazards and certain kinds of fall hazards encountered when working on steel structures.

Case Report

A crew of steelworkers was connecting a steel beam to a steel column on the seventh level of an airport structure. The base of the column was secured to a sheer concrete wall by temporary welds to an embedded steel plate.

When the crew encountered a problem connecting the beam to the column, a decision was made to pull the top of the column one inch to the north to facilitate the connection. The pull was performed by tensioning a guy wire, using a come-along, applying a fork at the column being connected, and using a sleeper. One worker was seated on the beam that was being connected, while another was standing at the base of the column, atop the concrete wall.

When the force of the tensioning caused the temporary welds at the column base to fracture, the column collapsed, and the two workers fell to their death.

Multi-Story Structures

Rules for steel erection safety for multi-level structures can be found in OSHA Standard 1926.754(b).

Permanent floors: Permanent floors must be installed as the erection of structural members progresses, with no more than eight stories between the erection floor and the upper-most permanent floor.

Unfinished bolting or welding: Unfinished bolting or welding above the foundation (or the uppermost secured floor) is not permitted to exceed the lesser of:

- four floors
- 48 feet (14.6 m)

Exceptions are allowed where structural integrity is accounted for in the design.

Safety Nets and Floors: Safety nets or a fully planked or decked floor must be maintained directly under any erection work being performed, within the lesser of:

- two stories
- 30 feet (9.1 m)

Walking/Working Surfaces

Tripping hazards: To prevent tripping hazards, do not attach the components listed below if they project from the top flanges of beams, joists, or beam attachments until after the metal decking, or other walking/working surface, has been installed.

- shear connectors (such as headed steel studs, steel bars, or steel lugs)
- reinforcing bars
- deformed anchors
- threaded studs, unless they are factory installed and all workers, including connectors and deckers, use fall protection at all times.

Shear Connectors

When shear connectors are used in the construction of composite floors, roofs and bridge decks, they must be laid out and installed after the metal decking has been installed. The metal decking will then serve as a working platform.

Shear connectors may not be installed from within a controlled decking zone (CDZ).

Coated Surfaces

Workers are not be permitted to walk the top surface of any structural steel member installed after July 18, 2006 that has been coated with paint or similar material, unless all the following are met:

- The coating has achieved a minimum average slip resistance of .50 in laboratory tests.
- The tests were based on the appropriate ASTM standard test method and conducted by a qualified laboratory.
- Documentation of the test results is available at the site and to the steel erector.

Plumbing-Up

It's important to make sure the structure being erected is "plumb" or exactly vertical. The process of lining up the building elements in a precise vertical direction is called "plumbing up."

- When a competent person deems it necessary, plumbing-up equipment must be installed during the steel erection process to ensure the stability of the structure.
- When plumbing-up equipment is used, it must be in place and properly installed before the structure is loaded with construction material such as loads of joists, bundles of decking, or bundles of bridging.
- Plumbing-up equipment may be removed only with the approval of a competent person.

Metal Decking

Hoisting, Landing and Placing Metal Deck Bundles

Follow these requirements when hoisting, landing, and placing metal decking bundles:

- Bundle packaging and strapping may not be used for hoisting unless specifically designed for that purpose.
- If loose items such as dunnage, flashing, or other materials are placed on top of metal decking bundles intended to be hoisted, they must be secured to the bundles.
- When bundles of metal decking are landed on joists, all bridging must be installed and anchored, and all joist-bearing ends attached. (See Open web steel joists in Module 5 for exceptions.)
- Metal decking bundles must be landed on framing members so that enough support is provided to allow the bundles to be unbanded without dislodging the bundles from the supports.
- At the end of the shift or when environmental or jobsite conditions require, metal decking must be secured against displacement.

Roof and Floor Holes and Openings

Metal decking at roof and floor holes and openings must be installed as follows:

- Framed metal deck openings must have structural members turned down to allow continuous deck installation, except where prevented by structural design constraints or constructability.
- Openings such as roof and floor holes must be decked over.
- Where large size, configuration, or other structural constraints do not allow openings to be decked over (e.g. elevator shafts, stair wells, etc.), employees must be protected in accordance with the fall protection provisions of this standard.

When metal decking holes and openings are cut, they must:

- Immediately and permanently be filled with the intended equipment or structure.
- Immediately be covered.

Covering Roof and Floor Openings

Covers for roof and floor openings must be capable of supporting, without failure, twice the weight of the employees, equipment, and materials that may be imposed on them at any one time.

All covers must be:

- Secured when installed to prevent accidental displacement by the wind, equipment or employees.
- Painted with high-visibility paint, or
- Marked with the word "HOLE" or "COVER" to provide warning of the hazard.

Installed smoke dome or skylight fixtures are not considered covers, unless they meet the appropriate strength requirements.

Where planks or metal decking around columns do not fit tightly, wire mesh, exterior plywood, or equivalent material must be installed, and must be of sufficient strength to:

- provide fall protection for personnel
- prevent objects from falling through

Installation of Metal Decking

- Metal decking must be laid tightly and immediately secured to prevent accidental movement or displacement.
- Structural members must fully support metal decking panels during initial placement.

Derrick Floors

- To support the intended floor loading, a derrick floor must be fully decked and/or planked, and the steel member connections completed.
- Temporary loads placed on a derrick floor must be distributed over the underlying support members so as to prevent local overloading of the deck material.

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Structural collapse is second only to _____ as a cause of fatalities in the steel erection industry.**

    a. electrocution
    b. falls
    c. crush accidents
    d. heat stress

2. **When erecting multi-level structures, how many stories are allowed between the floor being erected and the upper-most permanent floor?**

    a. 5 stories
    b. 6 stories
    c. 7 stories
    d. 8 stories

3. **The process of lining up the building elements in a precise vertical direction is called _____.**

    a. truing the line
    b. aligning vertical members
    c. plumbing up
    d. balance testing

4. **Bill, the worksite supervisor, discovers a floor hole on the 2nd story floor. What should he do?**

    a. Place a warning sign near the hole
    b. Make sure it's decked over
    c. Cover it with ¼ inch plywood
    d. Nothing, it's part of the design

5. **What must be done to prevent accidental movement or displacement of metal decking?**

    a. Install movement sensors under the decking
    b. Place warning signs displaying “Loose Decking”
    c. Arrange the decking so that it cannot misalign
    d. It must be laid tightly and immediately secured

Module 4: Structural Stability (Continued)

Column Anchorages

Inadequate anchor rod and bolt installation has been identified as a primary contributing factor to structural collapses. To prevent structural collapse, it is critical erectors use the proper use of anchor rods (anchor bolts) to ensure column stability. This section is covered by OSHA Standard 1926.755.

Erection Stability

When performing steel erection operations, it is very important to follow these best practices:

- All columns must be anchored by a minimum of 4 anchor rods (anchor bolts).
- Each column anchor rod (anchor bolt) assembly, including the column-to-base plate weld and the column foundation, must be designed to resist a minimum eccentric gravity load of 300 pounds located 18 inches from the extreme outer face of the column in each direction at the top of the column shaft.
- Columns must be set on elements that adequately transfer the construction loads, such as the following:
  - level finished floors
  - pre-grouted leveling plates
  - leveling nuts
  - shim packs
- All columns must be evaluated by a competent person to determine whether guying or bracing is needed. If guying or bracing is needed, it must be installed.

Anchor Rods (Anchor Bolts)

Approval by the project structural engineer of record is required before anchor rods (anchor bolts) can be:

- repaired
- replaced
- field-modified

Before the erection of a column, the controlling contractor must provide written notification to the steel erector if there has been any of the following:

- repair
- replacement
- modification of the anchor rods of that column

Beams and Columns

Inappropriate or inadequate connections of beams and columns is hazardous and can lead to collapses and worker fatalities. This section describes requirements for connecting beams and columns, in order to minimize the hazard of structural collapse during the early stages of the steel erection process. The requirements of this section are detailed in OSHA Standard 1926.756.

Releasing the Load

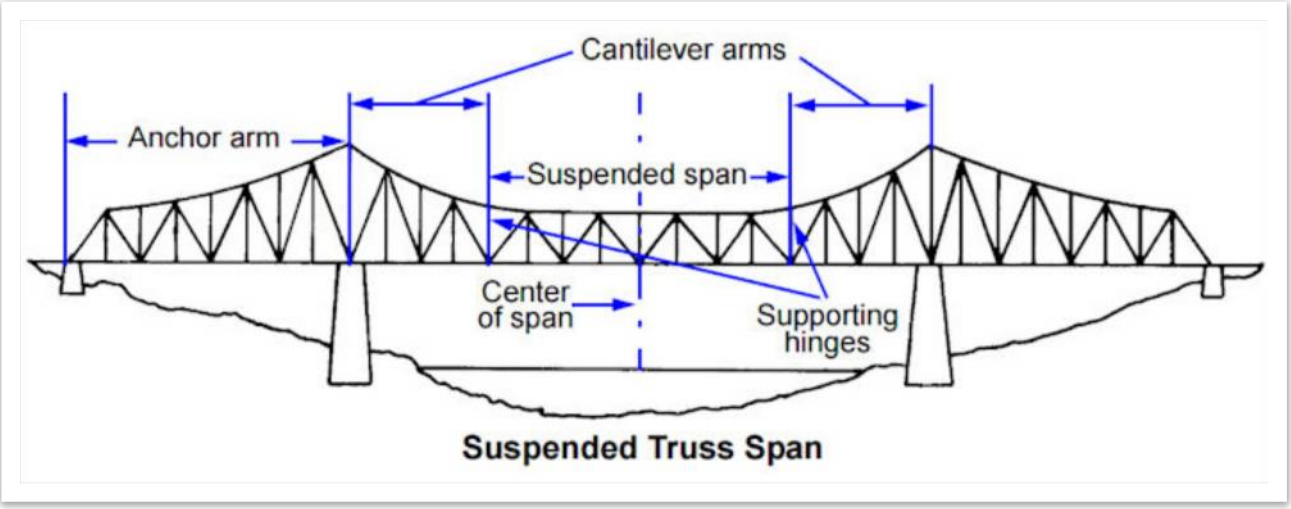
During the final placing of solid web structural members, the load must not be released from the hoisting line until:

- The members are secured with at least two bolts per connection, of the same size and strength as shown in the erection drawings.
- These bolts are drawn up wrench-tight.
- The equivalent, as specified by the project structural engineer of record, except as specified in 29 CFR 1926.756(b).

Cantilevered Members

A cantilever is a rigid structural element, such as a beam or a plate, anchored at only one end to a (usually vertical) support from which it is protruding.

When subjected to a structural load, the cantilever carries the load to the support where it is forced against by a moment and shear stress. The image below shows the cantilever arms on a suspended truss bridge.



Cantilever arms on a suspended truss bridge
Source: U.S. Marines

Cantilever construction allows for overhanging structures without external bracing, in contrast to constructions supported at both ends with loads applied between the supports, such as a simply supported beam found in a post and lintel system.

A competent person must determine if more than two bolts are necessary to ensure the stability of cantilevered members. If additional bolts are needed, they must be installed.

Diagonal Bracing

Solid web structural members used as diagonal bracing must be secured by:

- at least one bolt per connection drawn up wrench-tight
- the equivalent, as specified by the project structural engineer of record

Double Connections at Columns

When two structural members on opposite sides of a column web, or a beam web over a column, are connected sharing common connection holes:

- At least one bolt with its wrench-tight nut must remain connected to the first member, or
- A shop-attached, or field-attached seat or equivalent connection device is supplied with the member in order to secure the first member and to prevent the column from being displaced. (See Appendix H of the OSHA Standard for examples of equivalent connection devices.)

If a seat or equivalent device is used:

- The seat (or device) must be designed to support the load during the double connection process.
- Before the nuts on the shared bolts are removed to make the double connection, it must be adequately bolted or welded to both:
  - a supporting member
  - the first member

Column Splices

Each column splice must be:

- designed to resist a minimum eccentric gravity load of 300 pounds
- located 18 inches from the extreme outer face of the column in each direction
- located at the top of the column shaft

Perimeter Columns

Perimeter columns must not be erected unless:

- They extend a minimum of 48 inches above the finished floor, to permit installation of perimeter safety cables prior to erection of the next story.
- They have two sets of holes, or other devices that:
  - are 42-45 inches above the finished floor, and also at the midpoint between the finished floor and the top cable
  - permit installation of perimeter safety cables as required by 29 CFR 1926.760(a)(2)

In multi-story structures, when holes in the column web are used for perimeter safety cables, the column splice should be placed sufficiently high so as not to interfere with any attachments to the column necessary for the column splice.

- Column splices are recommended to be placed at every other or fourth levels as design allows.
- Column splices at third levels are detrimental to the erection process and should be avoided if possible.

EXCEPTION: Where constructability does not allow, the above requirements can be waived. (See Appendix F of 1926.750.)

Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **To prevent structural collapse it is critical that erectors use the proper use of _____ to ensure column stability.**

    a. plumbing equipment
    b. anchor rods (anchor bolts)
    c. motion stabilizers
    d. ties and anchor studs

2. **When performing steel erection operations, all columns must be anchored by a minimum of_____.**

    a. 2 anchor plates with bolts
    b. 4-foot plate with bolts
    c. 2 cross beams
    d. 4 anchor rods/bolts

3. **Before anchor rods (anchor bolts) can be repaired, replaced or field-modified, who must first approve the action?**

    a. Project safety superintendent and erector
    b. Local planning committee
    c. Project structural engineer of record
    d. Competent erector or connector

4. **A _____ is a rigid structural element, such as a beam or a plate, anchored at only one end to a (usually vertical) support from which it is protruding.**

    a. protruding member
    b. cantilever
    c. non-anchored beam
    d. structural overhang

5. **Perimeter columns must extend a minimum of_____, to permit installation of perimeter safety cables prior to erection of the next story.**

    a. 2 feet above the upper-most floor
    b. 24 inches above the floor being worked
    c. 5 feet above and 3 feet below any floor
    d. 48 inches above the finished floor

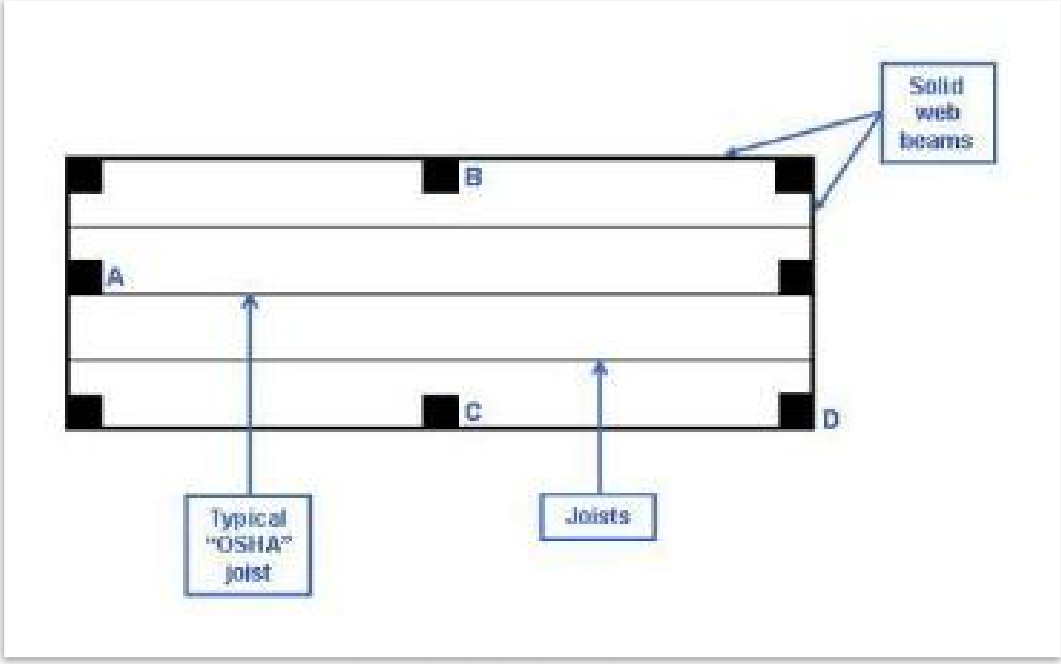
Module 5: Structural Stability (Continued)

Open Web Steel Joists

Some of the most serious risks facing the ironworker are encountered during the erection of open web steel joists, particularly landing loads on unbridged joists and improperly placing loads on joists. Based on a recent analysis of OSHA data, more than half of ironworker fatalities due to collapse are related to the erection of steel joists. More information can be obtained by reading OSHA Standard 1926.757.

General Requirements

Where steel joists are used and columns are not framed in at least two perpendicular directions with solid web structural steel members, a steel joist must be field-bolted at the column to provide lateral stability to the column during erection.



Field-bolting Columns

The purpose of this requirement is to prevent joists from collapsing due to insufficient stability of the columns that are supporting them. A field-bolted joist is required in order to provide that stability at a column that is not framed in at least two directions with solid web structural steel members (see, for example, column A in the image above).

This requirement does not apply to a column in a line parallel to the joists that does not help bear the joists (such as columns B and C in the image above). Column support in this context

means the column is supported in two axes so the column cannot fall (column D in the diagram above is framed in two directions with solid web members).

Installing Stabilizing Joists

When installing the stabilizing joist:

- Provide a vertical stabilizer plate for steel joists on each column, which must:
  - Be at least 6 inches by 6 inches.
  - Extend at least 3 inches below the bottom chord of the joist.
  - Have a 13⁄16-inch hole to provide an attachment point for guying or plumbing cables.
- Stabilize the bottom chords to prevent rotation during erection.
- Do not release hoisting cables until:
  - The seat at each end of the steel joist is field-bolted.
  - Each end of the bottom chord is restrained by the column stabilizer plate.
  - EXCEPTION: Where constructability does not allow a steel joist to be installed at the column, install an alternate means of stabilizing joists on both sides near the column that must:
    - Provide equivalent stability to a steel joist field-bolted at the column.
    - Be designed by a qualified person.
    - Be shop-installed.
    - Be included in the erection drawings.
- Do not release hoisting cables until the seat at each end of the steel joist is field-bolted and the joist is stabilized.
- Where steel joists at or near columns span 60 feet or less, the joist must be designed with sufficient strength to allow one employee to release the hoisting cable without the need for erection bridging.
- Where steel joists at or near columns span more than 60 feet:
  - The joists need to be set in tandem with all bridging installed.

- An alternative method of erection may be used, which:
  - Provides equivalent stability to the steel joist.
  - Is designed by a qualified person.
  - Is included in the site-specific erection plan.

- A steel joist or steel joist girder must not be placed on any support structure that is not stabilized.
- When steel joists are landed on a structure, they must be secured to prevent unintentional displacement prior to installation.
- Any modification that affects the strength of a steel joist or steel joist girder must be made with the approval of the project structural engineer of record.
- When connecting individual steel joists to steel structures in bays 40 feet or longer (see exception below):
  - The connections must be fabricated to allow for field-bolting during erection.
  - The connections must be initially field-bolted unless constructability does not allow.
  - EXCEPTION: These requirements do not apply when steel joists are pre-assembled into panels.
- Steel joists and steel joist girders must not be used as anchorage points for a fall-arrest system unless written approval to do so is obtained from a qualified person.
- A bridging terminus point must be established before bridging is installed.

Steel Joists and Steel Joist Girders

There are three distinct series of joists, the K, LH/DLH and Joist Girders.

- **K-Series Joists:** K-series joists are open web steel joists that are simply supported uniformly loaded trusses that can support a floor or roof deck. These joists have a maximum length of 60 feet. The maximum uniform load for K-series joists is 550 pounds per linear foot (plf).
- **LH/DLH-Series Joists:** The LH or “Long Span” and DLH or “Deep Long Span” joists are also simply supported uniformly loaded trusses. The LH series may support a floor or roof deck. The DLH series may support only a roof deck.

- The LH series is 18” to 48” in depth, has a maximum span of 96 feet and the maximum uniform loading is up to 1000 plf.
- The DLH series is 52” to 72” in depth, has a maximum span of 144 feet and maximum uniform loading of 700 plf.

- **Joist Girders:** Joist girders are simply supported, primary load carrying members. Loads are applied through steel joists and evenly spaced along the joist girder top chord. They may span up to 60 feet.

Each end of "K" series steel joists must be finally attached to the support structure with a minimum of:

- two ⅛-inch fillet welds 1 inch long
- two ½-inch bolts
- or an equivalent connection

Each end of "LH" and "DLH" series steel joists and steel joist girders must be finally attached to the support structure with a minimum of:

- two ¼-inch fillet welds 2 inches long
- two ¾-inch bolts
- or an equivalent connection

Except for panelized joists, each steel joist must be attached to the support structure, with at least one end on both sides of the seat:

- immediately upon placement in the final erection position
- before additional joists are placed

Panels that have been pre-assembled from steel joists must be attached with bridging to the structure at each corner before the hoisting cables are released.

Erection of Steel Joists

For steel joists in OSHA Standard 1926.757 Tables A and B that require bridging:

- Attach both sides of the seat of one end of each steel joist to the support structure before hoisting cables are released.

For joists more than 60 feet:

- Both ends of the joist must be attached as specified in steel joists and steel joist girders.
- The provisions of erection bridging must be met before the hoisting cables are released.

Only one employee is allowed on steel joists that do not require erection bridging under OSHA Standard 1926.757 Tables A and B, until all bridging is installed and anchored.

Employees are not allowed on steel joists where the span of the steel joist is equal to or greater than the span shown in OSHA Standard 1926.757 Tables A and B except in accordance with erection bridging provisions.

When permanent bridging terminus points cannot be used during erection, additional temporary bridging terminus points are required to provide stability.

Erection Bridging

Where the span of the steel joist is equal to or greater than the span shown in OSHA Standard 1926.757 Tables A and B, the following applies:

- A row of bolted diagonal erection bridging must be installed near the mid-span of the steel joist.
- Hoisting cables must not be released until this bolted diagonal erection bridging is installed and anchored.
- No more than one employee is allowed on these spans until all other bridging is installed and anchored.

Where the span of the steel joist is 60 feet through 100 feet, the following applies:

- All rows of bridging must be bolted diagonal bridging.
- Two rows of bolted diagonal erection bridging must be installed near the third points of the steel joist (e.g. ⅓ joist-length) from each end.
- Hoisting cables must not be released until this bolted diagonal erection bridging is installed and anchored.
- No more than two employees are allowed on these spans until all other bridging is installed and anchored.

Where the span of the steel joist is 100 feet through 144 feet, the following applies:

- All rows of bridging must be bolted with diagonal bridging.
- Hoisting cables must not be released until all bridging is installed and anchored.
- No more than two employees are allowed on these spans until all bridging is installed and anchored.

For steel members spanning more than 144 feet, the erection methods used must be in accordance with 29 CFR 1926.756.

Where any steel joist that requires bridging is a bottom chord bearing joist:

- A row of bolted diagonal bridging must be provided near the supports.
- This bridging must be installed and anchored before the hoisting cables are released.

When bolted diagonal erection bridging is required, the following applies:

- The bridging must be indicated on the erection drawing.
- The erection drawing must be the exclusive indicator of the proper placement of this bridging.
- Shop-installed bridging clips, or functional equivalents, must be used where the bridging bolts to the steel joists.
- When two pieces of bridging are attached to the steel joist by a common bolt, the nut that secures the first piece of bridging must not be removed from the bolt in order to attach the second.
- Bridging attachments must not protrude above the top chord of the steel joist.

Landing and Placing Loads

During the construction period, the employer placing a load on steel joists must ensure the load is distributed so as not to exceed the carrying capacity of any steel joist.

Except as noted below, no construction loads are allowed on the steel joists until all bridging is installed and anchored and all joist-bearing ends are attached.

The weight of a bundle of joist bridging must not exceed a total of 1,000 pounds, and:

- A bundle of joist bridging must be placed on a minimum of three steel joists that are secured at one end.

- The edge of the bridging bundle must be within 1 foot of the secured end.

No bundle of decking may be placed on steel joists until:

- All bridging has been installed and anchored.
- All joist bearing ends are attached, unless a qualified person has first determined the structure or portion of the structure is capable of supporting the load and documented it in the site-specific erection plan.
- The bundle of decking is placed on a minimum of three steel joists.
- The joists supporting the bundle of decking are attached at both ends.
- At least one row of bridging is installed and anchored.
- The total weight of the bundle of decking does not exceed 4,000 pounds.
- Placement of the bundle of decking is within 1 foot of the bearing surface of the joist end.

The edge of any construction load must be placed within 1 foot of the bearing surface of the joist end.

Real-World Accident

Three employees were using a crane to unload stacks of metal roof decking onto open web steel joists. The joists were not bridged, supported or restrained against movement. After the load was set down on the joists, the employees began to release the slings. After the first sling was released, the load shifted and one of the joists fell over. This caused the joist to collapse and fall 40 feet to the ground. One of the employees was tied off to this joist, and he was pulled off the roof. Two other joists rolled over and collapsed, landing on the employee. The employee suffered severe head injuries but survived.

Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Based on a recent analysis of OSHA data, what was the cause of more than half of ironworker all fatalities due to collapse?**

    a. Open web purlins
    b. Erection of steel joists
    c. Motion stabilizers
    d. Ties and anchor studs

2. **When installing stabilizing joists, do not release hoisting cables until the seat at each end of the steel joist is_____.**

    a. stabilized and plumbed
    b. stabilized with purlins
    c. shop-bolted and girted
    d. field-bolted and stabilized

3. **Who must approve any modification that affects the strength of a steel joist or steel joist girder?**

    a. Project supervisor or host employer
    b. Competent person who is a connector
    c. Project structural engineer of record
    d. Certified safety professional

4. **During the construction period, the employer placing a load on steel joists must ensure that the load is distributed so as not to exceed _____.**

    a. recommendations of the project supervisor
    b. the carrying capacity of any steel joist
    c. OSHA 1910.26 limitations
    d. the ability of the connectors to manage

5. The edge of any construction load must be placed within ____ of the bearing surface of the joist end.

a. 43 inches
b. 2 feet
c. 18 inches
d. 1 foot

Module 6: Metal Buildings and Overhead Hazards

More than 50% of industrial buildings in steel erection are systems-engineered. These metal structures use different types of steel members and a different erection process than typical steel erection. They also present certain unique hazards, such as those associated with anchor bolts, construction loads, and double connections.

The primary sources of information for metal buildings is from OSHA Standard 1926.758 and the information for overhead hazards comes from OSHA Standard 1926.759.

Metal Buildings

Systems-Engineered Metal Buildings

All of the requirements contained in 1926 Subpart R apply to systems-engineered metal buildings, except for 1926.755 (column anchorage) and 1926.757 (open web steel joists).

- All structural columns must be anchored by at least four anchor bolts.
- Rigid frames must have 50% of their bolts, or the number of bolts specified by the manufacturer (whichever is greater) installed and tightened on both sides of the web adjacent to each flange before the hoisting equipment is released.

Construction Loads

Construction loads may be placed on a structural steel framework when the framework is safely bolted, welded or otherwise adequately secured.

Construction loads are prohibited from:

- Being placed on any inadequately secured structural steel framework.
- Being placed beyond any area 8 feet (2.5 m) from the center-line of the primary support member.

Girts or Eave Struts

In girt and eave strut-to-frame connections, when girts or eave struts share common connection holes:

- At least one bolt must remain securely in place for the connection of the first member.

- A field-attached seat or similar connection device supplied by the manufacturer may be used in lieu of the bolt to secure the first member so that the girt or eave strut is always secured against displacement.
- Both ends of all cold-formed or steel joists must be fully bolted/welded to the support structure before:
    - releasing the hoisting cables
    - allowing an employee on the joists
    - allowing any construction loads on the joists

Purlins and Girts

Purlins and girts are prohibited from:

- Being used as an anchorage point for a fall-arrest system, unless written approval is obtained from a qualified person.
- Being used as a walking/working surface when installing safety systems, until:
    - All permanent bridging is installed.
    - Fall protection is provided.

Overhead Hazards

A real, everyday hazard posed to steel erection employees is loose items that have been placed aloft, and that can fall and strike employees working below. The following requirements have been implemented to protect employees from falling objects.

Falling Object Protection

Securing loose items aloft. Secure unused equipment, tools and materials while aloft so they do not fall.

Protection from falling objects other than materials being hoisted. The controlling contractor must bar other construction processes below steel erection activities, unless overhead protection for employees working below is provided.

The Hazards Associated with Placing Joists

Joist manufacturers require that the ends of joists be tack welded or bolted immediately after placement. This welding or bolting holds the joist in place until the bridging is installed, and as a result the joist has very little lateral stability.

Placing any weight on the joist other than the weight of the employee actually erecting the joists can cause the joist to roll over or slip.

If the joist slips, it can:

- throw employees off the joist or supporting girder/wall
- throw materials and equipment to the ground below
- cause a joist to fall over and collapse
- trigger a domino effect and cause other joists to slip

If the joist falls over, it can collapse or buckle. This can:

- throw employees off the joist or supporting girder/wall
- drag employees to the ground if they anchor their fall protection to the joist
- throw materials and equipment to the ground
- trigger a domino effect and cause other joists to fall over, collapse and fall to the ground

Employees on the elevated work areas could:

- fall or be dragged from elevated work areas to the ground below
- be injured if materials and equipment placed on the joists strike them

Employees working under or near the elevated work could:

- be injured if falling materials and equipment strike them

Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **When constructing systems-engineering metal buildings, all structural columns must _____.**

    a. be use approved shop bolts for all connections
    b. be anchored by at least four anchor bolts
    c. be stabilized using two field bolts
    d. be anchored by as many as eight joist bolts

2. **Which of the following is true about placing load 12 feet from the center-line of the primary support member?**

    a. It is approved for series-K joists
    b. It is allowed if approved by CSP
    c. It may be allowed
    d. It is prohibited

3. **What must occur prior to allowing workers to walk on purlins and girts?**

    a. Purlins must be surveyed by the project engineer or record
    b. OSHA must first inspect all connections to ensure field-bolting
    c. All permanent bridging must be installed and fall protection provided
    d. At least two field-bolts must be fastened at each end of all purlins

4. **You are the on-site controlling contractor. What must be done before you can allow other construction processes below steel erection activities?**

    a. Get OSHA approval for other construction activities
    b. Verify that overhead protection has been provided
    c. Ensure workers performing other processes have been notified
    d. Make sure workers have been provided with proper fall protection

5. **When placing joists, what must be done prior to the installation of bridging to provide lateral stability?**

    a. Fix and align the joist
    b. Clamp the joist to column
    c. Balance the joist on columns
    d. Weld or bolt the joist

Module 7: Fall Protection

In steel erection, a new, very narrow working surface is constantly being created as skeletal steel is erected at various heights. For many steel erectors, the work starts at the top level of the structure. This means that anchor points above foot level are often limited or unavailable.

The special circumstances of steel erection can make conventional fall protection very difficult to deploy below 15 feet. For this reason, the following requirements and exceptions in the steel erection fall protection standard have been made. Information in this section comes primarily from OSHA Standard 29 CFR 1926.760.

General Requirements

Each employee engaged in a steel erection activity who is on a walking/working surface with an unprotected side or edge more than 15 feet (4.6 m) above a lower level must be protected from fall hazards by:

- guardrail systems,
- safety net systems,
- personal fall arrest systems,
- positioning device systems or
- fall restraint systems.

Perimeter safety cables must be installed at the final interior and exterior perimeters of multi-story structures as soon as the decking has been installed.

It's important to remember as far as OSHA is concerned, there is no "safe" distance from an unprotected side or edge that would render fall protection unnecessary.

Connectors

Connectors and employees working in controlled decking zones (CDZ) must be protected from fall hazards as provided below.

Connectors must:

- Be protected by conventional fall protection when working on a surface with an unprotected edge more than two stories or 30 feet above a lower level.
- Have completed the connector training described in 29 CFR 1926.761.

- While working at heights more than 15 and up to 30 feet, connectors must:
  - Be provided with a complete personal fall arrest system or other allowable fall protection.
  - Wear the equipment necessary for tying off.

Controlled Decking Zone (CDZ)

A Controlled Decking Zone is an area in which certain work may take place without the use of guardrail systems, personal fall arrest systems, fall restraint systems, or safety net systems and where access to the zone is controlled.

A CDZ can be established as a substitute for fall protection where metal decking is initially being installed and forms the leading edge of a work area more than 15 and up to 30 feet above a lower level.

Leading-edge workers in a CDZ are required to:

- Be protected from fall hazards above 2 stories or 30 feet (whichever is less).
- Have completed CDZ training in accordance with 29 CFR 1926.761.

Employees who are not engaged in leading-edge work and properly trained in the hazards involved are prohibited from entering the CDZ.

The CDZ is required to:

- Be no more than 90 feet wide and 90 feet deep from any leading edge.
- Not exceed 3,000 square feet of unsecured decking.
- Have designated and clearly marked boundaries with control lines or the equivalent. Control lines are commonly used as a marker because they create a highly visible boundary.
- Have safety deck attachments placed from the leading edge back to the control line.
- Have at least two safety deck attachments for each metal decking panel.

Final deck attachments and the installation of shear connectors are prohibited from being done in the CDZ.

Control Lines

When used to control access to areas where leading edge and initial securing of metal deck and other operations connected with leading edge work are taking place, the controlled decking zone (CDZ) is defined by a control line or by any other means that restricts access.

- A control line for a CDZ is erected not less than 6 feet (1.8 m) nor more than 90 feet (27.4 m) from the leading edge.
- Control lines extend along the entire length of the unprotected or leading edge and are approximately parallel to the unprotected or leading edge.
- Control lines are connected on each side to a guardrail system, wall, stanchion or other suitable anchorage.

Control lines consist of ropes, wires, tapes, or equivalent materials, and supporting stanchions as follows:

- Each line is rigged and supported in such a way that its lowest point (including sag) is not less than 39 inches (1.0 m) from the walking/working surface and its highest point is not more than 45 inches (1.3 m) from the walking/working surface.
- Each line has a minimum breaking strength of 200 pounds (90.8 kg).

What OSHA Inspects

Factors that should be evaluated when considering the effectiveness of fall protection in steel erection should include a complete evaluation of a number of factors including the following:

- Is the fall protection system complete and are the correct components in use? For example, if workers are tied off at a 5-ft level, a standard 6-ft shock absorbing lanyard may not be adequate.
- Have the workers been properly trained in the use of the equipment?
- Has the employer provided for rescue?
    - Is there a viable self-rescue option?
    - Are the equipment and rescue procedures in place?
    - Have all the employees been trained on the rescue procedures?
    - If the procedures include calling 911, do the emergency services know they are part of the plan and have the ability to respond?

- Has falling object protection been provided or has work been precluded below the erection activity?

Remember: OSHA will consider citing employers if the employer is not:

- providing 100 percent fall protection,
- providing for prompt rescue in the event of a fall, or
- providing protection from falling objects.

Bottom line: All employees performing steel erection activities who are exposed to fall hazards, whether doing leading edge decking work in a CDZ or not, must be protected as required by the fall protection standards in 1926.760, regardless of the distance from the edge.

For more information on Fall Protection in Steel Erection take OSHAcademy Course 805, Fall Protection in Construction, and review OSHA Standard 1926.502(b)-(e).

Module 7 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **At what height must employees who are on a walking/working surface with an unprotected edge be protected by conventional fall protection?**

    a. More than 4 feet above ground level
    b. More than 15 feet above a lower level
    c. 10 feet or more above a lower surface
    d. At or above 25 feet above ground level

2. **When must perimeter safety cables be installed at the final interior and exterior perimeters of multi-story structures?**

    a. As soon as permission is granted by the CSP
    b. Prior to installing the decking
    c. When approved by the contracting engineer
    d. As soon as the decking has been installed

3. **What is the minimum and maximum distance a controlled decking zine (CDZ) control line can be erected from a leading edge?**

    a. 2 feet (.61 m) and 20 feet (6.1 m)
    b. 3 feet (.9 m) and 30 feet (9.1 m)
    c. 4 feet (1.2 m) and 40 feet (12.2 m)
    d. 6 feet (1.8 m) and 90 feet (27.4 m)

4. **Leading-edge workers in a CDZ are required to be protected from fall hazards above _____.**

    a. 1 story or 15 feet (whichever is higher)
    b. 2 stories or 30 feet (whichever is less)
    c. 3 stories or 60 feet (whichever is more)
    d. 2 stories or 15 feet (whichever is more)

5. **OSHA will consider citing employers if the employer is not providing for prompt rescue, protection from falling objects, and _____.**

    a. fall protection back belts
    b. optional fall protection equipment
    c. encouragement to wear harnesses
    d. 100 percent fall protection

Module 8: Steel Erection Safety Training

In steel erection, training is a key element in the employer's accident prevention program. Since the employer can choose the provider, method, and frequency of training that is appropriate for the employees being trained, the employer has flexibility in developing and implementing a training program. However, to achieve increased safety in steel erection, the following requirements must be implemented in all training programs.

Training requirements will be deemed to have been met if:

- training is completed in steel erection and the requirements of 1926.761, and
- training has been approved by the U.S. Department of Labor Bureau of Apprenticeship.

The employer must instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to steel erection and the general construction work environment to control or eliminate any hazards or other exposure to illness or injury.

Qualified Persons

Qualified person is one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

It should not surprise us that steel erection employee training must be provided by a qualified person. Here's a case study that tells why:

Case Report

A general contractor requested help from a carpentry crew to erect a 50-foot steel beam and columns. Neither the contractor nor any of the carpentry crew was trained in steel erection. The steel beam was raised into position using two forklifts, and guy wires were set at one end, but the column footing bolts were not secured, and only one guy wire was attached at the other end. When the forklift sling was released, the column leaned over and the weight and force of the beam pulled the turnbuckle apart. The beam then fell onto the lift, knocking one employee to the concrete floor. He landed on his back and head, sustaining severe head injuries, and was transported by helicopter to a local hospital for treatment.

Fall Hazards

The employer must train each employee exposed to a fall hazard on the requirements of the standard. The employer must also institute a training program and ensure employee participation in the program.

All employees exposed to fall hazards must be trained and instructed in the following areas:

- recognizing and identifying fall hazards in the work area
- using and operating protective systems, such as guardrail systems, personal fall-arrest systems, positioning-device systems, fall- restraint systems, safety-net systems, and other protection to be used
- correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems
- procedures for protection from falls to lower levels and into holes and openings in walking/working surfaces and walls

Special Training

The employer must also provide special training to employees involved in the following activities:

Multiple-lift rigging operations: The employer must ensure each employee who performs multiple lift rigging has been trained in the following areas:

- The nature of the hazards associated with multiple-lifts; and
- Proper procedures and equipment required to perform multiple lifts.

Connector procedures: The employer must ensure each employee has been provided training in the following areas including:

- The nature of the hazards associated with connecting hazards; and
- Establishment, access, proper connecting techniques, and work practices.

Controlled Decking Zones (CDZ): Where CDZs are being used, the employer must make sure each employee has been trained in the following areas:

- The nature of the hazards associated with working in a Controlled Decking Zone; and

- The establishment, access, proper installation techniques, and work practices required by the Standard.

Case Report

Two carpenters, who were not adequately trained to do steel erection work, were attempting to set a 30-foot I-beam on a concrete block wall 15 feet high. They had released the spanner connection from the hoist line before the I-beam was secured to the bearing plates. The beam tipped over and fell, along with the two employees, to the concrete floor. One employee required surgery for multiple broken bones in his wrists and arms. The other employee was hospitalized for back, neck and head injuries.

Why Quality Steel Erection Construction is Important

Last, but certainly not least, this sobering accident video tells why it is so important to build high-rise structures not just safely, but also to the highest quality standards. No workers died in this terrible accident, but hundreds of mothers, fathers, sons, and daughters did. A real tragedy for an entire country.

Module 8 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **To meet OSHA requirements, who must approve training for steel erection workers?**

    a. U.S. Department of Labor, OSHA
    b. U.S. Department of Labor, Bureau of Apprenticeship
    c. International Labor Organization (ILO) Steel Erection Program
    d. Any IACET approved training provider

2. **Who is defined as successfully demonstrating the ability to solve or resolve problems relating to the steel erection, the work, or the project?**

    a. Designated engineer
    b. Competent person
    c. Qualified person
    d. Certified engineer

3. **It should not surprise us that steel erection employee safety training must be provided by a _____.**

    a. experienced erector
    b. OSHA 30-hour trained person
    c. competent person
    d. qualified person

4. **The employer must also institute a steel erection safety training program and ensure _____.**

    a. OSHA receives attendance records
    b. authorization for training has been received
    c. training complies with Steel Erection Society guidelines
    d. employee participation in the program

5. **Which of the following is NOT one of the topics requiring special training to steel erection employees?**

    a. Multiple-lift rigging operations
    b. Fall protection
    c. Connector procedures
    d. Controlled Decking Zones

Definitions

Anchored bridging means that the steel joist bridging is connected to a bridging terminus point.

Bolted diagonal bridging means diagonal bridging that is bolted to a steel joist or joists.

Bolts. Shop bolts are used to sub-assemble steel structures at the shop, whereas **field bolts** are shipped out to the field to assemble steel structures at the job site by construction crews.

Bridging clip means a device that is attached to the steel joist to allow the bolting of the bridging to the steel joist.

Bridging terminus point means a wall, a beam, tandem joists (with all bridging installed and a horizontal truss in the plane of the top chord) or other element at an end or intermediate point(s) of a line of bridging that provides an anchor point for the steel joist bridging.

Choker means a wire rope or synthetic fiber rigging assembly that is used to attach a load to a hoisting device.

Cold forming means the process of using press brakes, rolls, or other methods to shape steel into desired cross sections at room temperature.

Column means a load-carrying vertical member that is part of the primary skeletal framing system. Columns do not include posts.

Competent person (also defined in §1926.32) means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Connector means an employee who, working with hoisting equipment, is placing and connecting structural members and/or components.

Constructability means the ability to erect structural steel members in accordance with subpart R without having to alter the overall structural design.

Construction load (for joist erection) means any load other than the weight of the employee(s), the joists and the bridging bundle.

Controlled Decking Zone (CDZ) means an area in which certain work (for example, initial installation and placement of metal decking) may take place without the use of guardrail systems, personal fall arrest systems, fall restraint systems, or safety net systems and where access to the zone is controlled.

Controlled load lowering means lowering a load by means of a mechanical hoist drum device that allows a hoisted load to be lowered with maximum control using the gear train or hydraulic components of the hoist mechanism. Controlled load lowering requires the use of the hoist drive motor, rather than the load hoist brake, to lower the load.

Controlling contractor means a prime contractor, general contractor, construction manager or any other legal entity which has the overall responsibility for the construction of the project – its planning, quality and completion.

Critical lift means a lift that (1) exceeds 75 percent of the rated capacity of the crane or derrick, or (2) requires the use of more than one crane or derrick.

Dangerous equipment – Equipment such as pickling or galvanizing tanks, degreasing units, machinery, electrical equipment, and other units which, as a result of form or function, may be hazardous to employees who fall onto or into such equipment.

Decking hole means a gap or void more than 2 inches (5.1 cm) in its least dimension and less than 12 inches (30.5 cm) in its greatest dimension in a floor, roof or other walking/ working surface. Pre-engineered holes in cellular decking (for wires, cables, etc.) are not included in this definition.

Derrick floor means an elevated floor of a building or structure that has been designated to receive hoisted pieces of steel prior to final placement.

Double connection means an attachment method where the connection point is intended for two pieces of steel which share common bolts on either side of a central piece.

Double connection seat means a structural attachment that, during the installation of a double connection, supports the first member while the second member is connected.

Erection bridging means the bolted diagonal bridging that is required to be installed prior to releasing the hoisting cables from the steel joists.

Fall restraint system means a fall protection system that prevents the user from falling any distance. The system is comprised of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The other components typically include a lanyard, and may also include a lifeline and other devices.

Final interior perimeter means the perimeter of a large permanent open space within a building such as an atrium or courtyard. This does not include openings for stairways, elevator shafts, etc.

Girt (in systems-engineered metal buildings) means a “Z” or “C” shaped member formed from sheet steel spanning between primary framing and supporting wall material.

Headache ball means a weighted hook that is used to attach loads to the hoist load line of the crane.

Hoisting equipment means commercially manufactured lifting equipment designed to lift and position a load of known weight to a location at some known elevation and horizontal distance from the equipment’s center of rotation. “Hoisting equipment” includes but is not limited to cranes, derricks, tower cranes, barge-mounted derricks or cranes, gin poles and gantry hoist systems. A “come-a-long” (a mechanical device, usually consisting of a chain or cable attached at each end, that is used to facilitate movement of materials through leverage) is not considered “hoisting equipment.”

Leading edge means the unprotected side and edge of a floor, roof, or formwork for a floor or other walking/working surface (such as deck) which changes location as additional floor, roof, decking or formwork sections are placed, formed or constructed.

Lower levels – Those areas or surfaces to which an employee can fall. Such areas or surfaces include, but are not limited to, ground levels, floors, platforms, ramps, runways, excavations, pits, tanks, material, water, equipment, structures.

Metal decking means a commercially manufactured, structural grade, cold rolled metal panel formed into a series of parallel ribs; this includes metal floor and roof decks, standing seam metal roofs, other metal roof systems and other products such as bar gratings, checker plate, expanded metal panels, and similar products. After installation and proper fastening, these decking materials serve a combination of functions including, but not limited to: a structural element designed in combination with the structure to resist, distribute and transfer loads, stiffen the structure and provide a diaphragm action; a walking/working surface; a form for concrete slabs; a support for roofing systems; and a finished floor or roof.

Multiple lift rigging means a rigging assembly manufactured by wire rope rigging suppliers that facilitates the attachment of up to five independent loads to the hoist rigging of a crane.

Opening means a gap or void 12 inches (30.5 cm) or more in any dimension in a floor, roof or other walking/working surface. For the purposes of this subpart, skylight and smoke domes that do not meet the strength requirements of 1926.754(e)(3) shall be regarded as openings.

Permanent floor means a structurally completed floor at any level or elevation (including slab on grade).

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. A personal fall arrest system consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combination of these. The use of a body belt for fall arrest is prohibited.

Positioning device system means a body belt or body harness rigged to allow an employee to be supported on an elevated, vertical surface, such as a wall or column and work with both hands free while leaning.

Post means a structural member with a longitudinal axis that is essentially vertical, that: (1) weighs 300 pounds or less and is axially loaded (a load presses down on the top end), or (2) is not axially loaded, but is laterally restrained by the above member. Posts typically support stair landings, wall framing, mezzanines and other substructures.

Project structural engineer of record means the registered, licensed professional responsible for the design of structural steel framing and whose seal appears on the structural contract documents.

Purlin (in systems-engineered metal buildings) means a “Z” or “C” shaped member formed from sheet steel spanning between primary framing and supporting roof material.

Qualified person (also defined in §1926.32) means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

Safety deck attachment means an initial attachment that is used to secure an initially placed sheet of decking to keep proper alignment and bearing with structural support members.

Shear connector means headed steel studs, steel bars, steel lugs, and similar devices which are attached to a structural member for the purpose of achieving composite action with concrete.

Steel erection means the construction, alteration or repair of steel buildings, bridges and other structures, including the installation of metal decking and all planking used during the process of erection.

Steel joist means an open web, secondary load-carrying member of 144 feet (43.9 m) or less, designed by the manufacturer, used for the support of floors and roofs. This does not include structural steel trusses or cold-formed joists.

Steel joist girder means an open web, primary load-carrying member, designed by the manufacturer, used for the support of floors and roofs. This does not include structural steel trusses.

Steel truss means an open web member designed of structural steel components by the project structural engineer of record. For the purposes of this subpart, a steel truss is considered equivalent to a solid web structural member.

Structural steel means a steel member, or a member made of a substitute material (such as, but not limited to, fiberglass, aluminum or composite members). These members include, but are not limited to, steel joists, joist girders, purlins, columns, beams, trusses, splices, seats, metal decking, girts, and all bridging, and cold formed metal framing which is integrated with the structural steel framing of a building.

Systems-engineered metal building means a metal, field-assembled building system consisting of framing, roof and wall coverings. Typically, many of these components are cold-formed shapes. These individual parts are fabricated in one or more manufacturing facilities and shipped to the job site for assembly into the final structure. The engineering design of the system is normally the responsibility of the systems-engineered metal building manufacturer.

Tank means a container for holding gases, liquids or solids.

Unprotected sides and edges means any side or edge (except at entrances to points of access) of a walking/working surface, for example a, floor, roof, ramp or runway, where there is no wall or guardrail system at least 39 inches (1.0 m) high.

Walking/working surface means any surface, whether horizontal or vertical on which an employee walks or works, including, but not limited to, floors, roofs, ramps, bridges, runways, formwork, beams, columns, trusses and concrete reinforcing steel but not ladders, vehicles, or trailers, on which employees must be located in order to perform their job duties.

Endnotes

1. Occupational Safety and Health Administration. (2016). Steel Erection Inspection Guide. Retrieved from: https://www.osha.gov/SLTC/etools/steelerection/inspection.html

2. Occupational Safety and Health Administration. (2016a). Steel Erection eTool. Retrieved from: https://www.osha.gov/SLTC/etools/steelerection/index.html

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5. Centers for Disease Control. (2013). Structural Steel Design, Education Module. Retrieved from: http://www.cdc.gov/niosh/docs/2013-136/pdfs/structural-steel-ptd-module.pdf