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NEW OSHA ERECTION RULES

HOW THEY AFFECT



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Introduction

Since 1994, representatives of the steel industry have worked with the Department of Labor to establish new rules for the safe erection of structural steel. The recommendations of SENRAC (Steel Erection Negotiated Rulemaking Advisory Committee) were largely followed by OSHA and the product of this effort, 29 CFR Part 1926 Subpart R – Steel Erection, was published in the Federal Register on January 18, 2001 with the guidance that they would become effective 180 days later. The Bush Administration imposed a 60-day delay on the implementation of this and other regulations. The White House has not given OSHA clear guidance as to whether the 60-day delay adds to the implementation period or runs concurrent with it. Therefore, the regulation may become effective on July 18 or September 18 of this year.

This review is not intended to list every aspect of the OSHA provisions, as they are far too numerous and detailed. Instead, it will highlight the changes from the current standard with emphasis on those of particular interest to engineers, fabricators and contractors. It will be more meaningful if used with a copy of the OSHA Regulations, which can be downloaded from the OSHA website at

www.osha.gov. It is suggested that you download both the information as it was printed in the Federal Register and the Final Regulatory Text and Joist Tables A and B. The Final Regulatory Text is in a format that is far easier to follow but is without the illustrations that are in the Federal Register version. Should you use the Federal Register download only, skip to the middle of page 5265 where the subpart actually begins. The information from page 5196 that precedes it is informative background material, but will not be easy to follow without a basic understanding of the regulations.

29 CFR Part 1926 is the OSHA regulation for the construction industry. Subpart R is specific to steel erection and is a series of articles to the subpart starting with 1926.750. As much as possible, the relevant article will be referenced, but in the text that follows 1926 will be omitted, as it is repetitive.

Scope of the Standard [.750]

The scope is extremely broad and encompasses virtually all activities of steel erection. It applies to new construction and the alteration or repair of structures where steel erection occurs. Interestingly, other structural materials, such as plastics and com-

posites, are included when they resemble structural steel in their usage.

Definitions [.751]

The following definitions are of particular interest:

- Bridging Terminus Point
- Column
- Competent Person
- Constructibility
- Controlled Decking Zone
- Controlling Contractor
- Decking Hole
- Double Connection
- Double Connection Seat
- Erection Bridging (for joists)
- Final Interior Perimeter
- Multiple Lift Rigging
- Opening (in a decked area)
- Post (as opposed to a column)
- Project Structural Engineer of Record
- Qualified Person
- Shear Connector
- Systems-Engineered Metal Building

Contractor Responsibilities [.752]

The controlling Contractor (see def.) for the construction site and activities now has specific responsibilities as outlined below. The Controlling Contractor must:

- Provide notification that by testing, foundation and supporting walls have attained sufficient strength to support the steel to be erected.

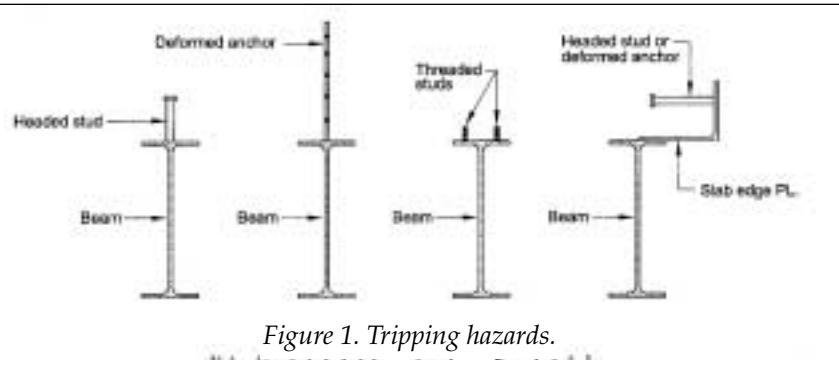


Figure 1. Tripping hazards.

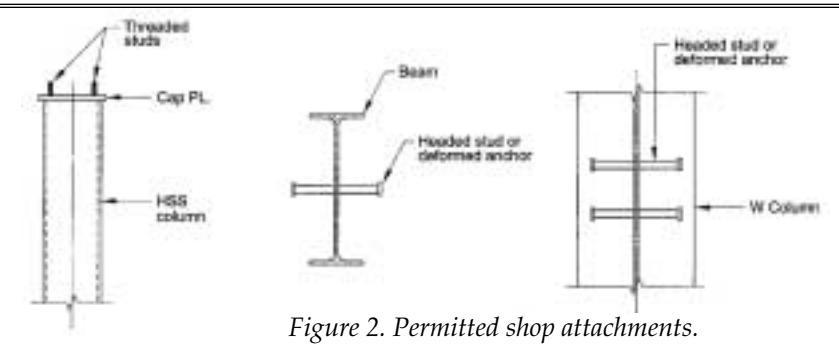


Figure 2. Permitted shop attachments.

- Provide notification of any repairs, replacements or modifications to
- Anchor bolts [see .755 (b) for further requirements].
- Obtain approval from the Project Structural Engineer of Record for any repairs, replacements or modifications to Anchor bolts.
- Ensure that access roads and conditions are suitable for steel erection.

Bar other construction processes below steel erection unless overhead protection from falling objects is provided [.759 (b)].

The provisions regarding access roads and site conditions are consistent with the AISC *Code of Standard Practice*, Section 7.2. Fabricators and erectors may want to be cautious that these requirements are not contractually passed to them. Obviously, access roads and reasonable site conditions are required by and utilized by all subcontractors. Note that subpart R uses the term "anchor bolt" where as AISC has adopted the term "anchor rod" for embedded materials to distinguish them from steel-to-steel connectors.

Site-Specific Erection Plan [.752 (e)]

Many erectors have indicated that they believe that a site-specific erection plan describing their actions will allow them to deviate from those requirements that do not suit them and act in some alternative form. In fact,

the erector may only deviate from regulations in three instances:

- Modifications to crane hook safety latches [.753 (c) (5)]
- Setting strut joists of over a 60 feet span in tandem [.757 (a) (4)]
- Placing deck bundles on joists that are not fully bridged [.757 (e) (4)]

Guidelines for developing a site-specific erection plan are contained in Appendix A to subpart R.

Multiple-Lift Rigging Procedure [.753 (e)]

The regulations provide for multiple lifts providing certain procedures are used and training is documented. However, the fabricator and/or erector may be contractually obligated to observe more restrictive requirements in owner or contractor safety plans.

Structural Stability [.754(a)]

Structural stability shall be maintained at all times during the erection process. This is consistent with both the AISC Specifications and the AISC

Code of Standard Practice, Section 1.8 and 7.10.

Tripping Hazards [.754 (c) (1)]

The shop placement of shear connectors, weldable reinforcing bars, deformed anchors or threaded studs is prohibited where they would obstruct the walking surfaces of beams or joists (Figure 1). The shop placement of threaded studs on column cap plates to receive strut joists, deformed bars on column webs or shear studs on beam or column webs is not prohibited since these are not walking/ working surfaces (Figure 2).

Slippery Paint [.754 (c) (3)]

The implementation of a requirement that shop paints meet a minimum slip resistance on walking surfaces has been postponed for implementation until five years after

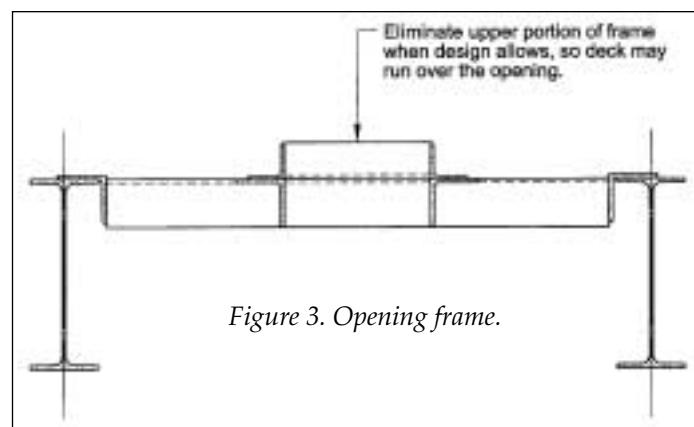


Figure 3. Opening frame.

the effective date of the rule so as to allow the technology of paint formulation and means of measurement to develop.

Deck Openings [.754 (e) (2)]

Where design constraints and constructability allow, the structural supports for deck openings are to be fabricated so that decking runs continuously over the openings (Figure 3). This does not apply to major openings such as elevator shafts or stairwells. Other deck openings are not to be cut until the opening is needed. Contractual scopes should make clear who is responsible for the cutting of these holes since the erector may no longer be on the job or erection activities may be located quite removed from the openings to be cut.

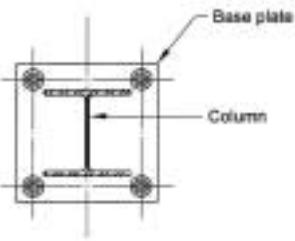


Figure 4. Four-rod base.

Column Anchor bolts (rods) [.755]

Columns are required to have a minimum of 4 anchor bolts (rods) [.755 (a) (1)] (Figure 4) and those anchor bolts (rods) as well as the column foundation are to capable of supporting a 300 lbs. (the weight of an erector and his tools) at the column top located at both 18 inches from the face of the column flange and from a plane at the tips of the column flanges (Figure 5) [.755 (a) (2)]. Posts (see def.) are not required to have 4 anchor bolts (rods) (Figure 6).

Engineers must design a column's base plate and supporting foundation to accept the 4 anchor bolts (rods). The clear distance between column flanges (Figure 7) will not allow for a significant spread between anchor bolts (rods) when placed inside the flanges of W8 and W10 columns. It is recommended that they be placed outside the column at the base plate corners. Minimum embedment lengths for anchor bolts (rods) are given in the AISC LRFD *Manual of Steel Construction*, 2nd Edition in Table 8-26 on page 8-90. The designer may give consideration to the fact that base plates frequently require slotting in the field to accommodate misplaced anchor bolts.

As noted above, anchor bolts (rods) may not be repaired, replaced or modified in the field without the approval of the project structural engineer of record and the Controlling Contractor must give the erector notification of any such alteration [.755 (b)]. In the erection of all columns, the erector must evaluate the jobsite erection conditions and factors such as wind, when the column will be tied in, etc. and determine the necessity for guying or bracing [.755 (a) (4)]. This is consistent with the re-

quirements of the AISC *Code of Standard Practice*, dated March 7, 2000, Sections 1.8 and 7.10.

Minimum Erection Bolts [.756]

(a) and (b)

The requirements given in the regulation are for the minimum number of bolts to be used during erection to support a member until the crane's load line is released. Two bolts in each connection are the minimum to connect solid web members and one bolt is the minimum for solid web bracing members or the equivalent as specified by the project structural engineer of record. The initial minimum bolts are to be the same size and strength as shown in the erection drawings. The erector is required to maintain structural stability at all times during the erection process [.754 (a)] and the determination of the number of bolts required to temporarily support members is a responsibility of the erector. Project structural engineers of record should to be cautious in involving themselves in the means and methods of erection.

Double Connections [.756 (c)]

Only double connections of beams to column webs or to the webs of girders over columns in the case of cantilevered construction are regulated, i. e., not at locations away from the columns. This boxes the bay with strut beams. The rule is based on the fact that an erector commonly sits on the beam on the first side of the double connection while the beam on the opposite side is connected in these regulated instances. If the connection gets away from the erector, beam and column collapse can occur and the erector may fall. Typical beam-to-beam double connections (other than at a cantilever over a column) require no special consideration since the erector can instead sit on the girder that receives both beams. At column conditions, there are many ways to facilitate safe double connections (Figures 8-12). The staggering of end angles on each side of the column web as shown in Figure 8 may not stabilize the beam's top flange unless metal deck is present and the angles may be better staggered on each side of the beam web as shown in Figure

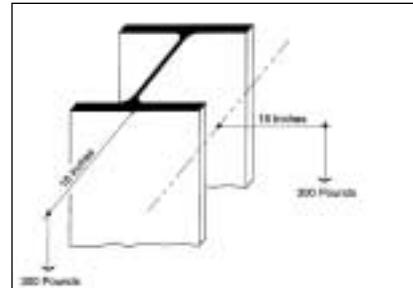


Figure 5. 300 lb. load.

9. When seats (Figures 10-12) are used, the beam must have a positive connection to the seat, while the second member is erected. The figure in the Standard's Appendix H shows clipped plates where end plates are used as shear connections.

Column Splice Strength [.756]

(b)

Column splices have the same 300-lb. loading requirement at the top of the upper shaft as anchor bolts (rods) (Figure 5). Again, the erector must consider other factors, such as wind, and guy the column accordingly, if necessary.

Column Splice Locations [Appendix F]

Since connectors are required to tie off when the fall distance exceeds 30 feet, placing column splices every three floors is a bad choice for the purposes of erection. The erector will erect two floors, deck the second level, and then erect and deck the third level before starting the process again. It would be better for the designer to place column splices either every 2 floors or, in some cases, every 4 floors so as to optimize the erection process.

Column Splice Height at Perimeter Columns/ Perimeter Safety Cable Attachments [.756 (e)]

Except where constructability does not permit, perimeter columns must extend a minimum of 48" above the finished floor so as to allow the attachment of safety cables. Per [.760 (a) (2)], perimeter safety cables are required at the final interior (see def) and exterior perimeters. The columns must be provided to the erector with either holes or attach-

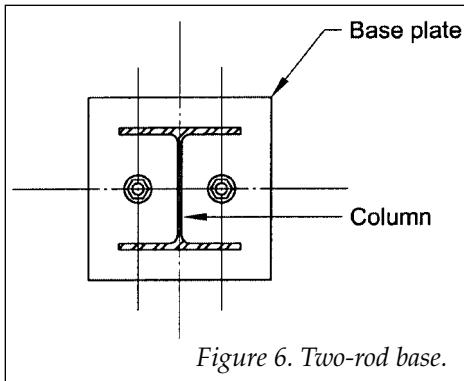


Figure 6. Two-rod base.

ments to support the top and middle lines of the safety cables. This is not required at openings such as stairwells, elevator shafts, etc.

It is best left to the fabricator to determine the most economical way to support the safety cables. Perimeter safety cables must meet the requirements for guardrail systems in 1926.502 (Appendix G) [760 (d)(3)]. The fabricator and erector should contractually address the issue of the custody of fall protection [760 (e)]. This topic is also addressed in the *Code of Standard Practice*, Section 7.11.

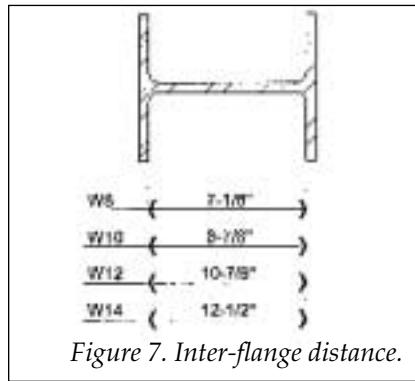


Figure 7. Inter-flange distance.

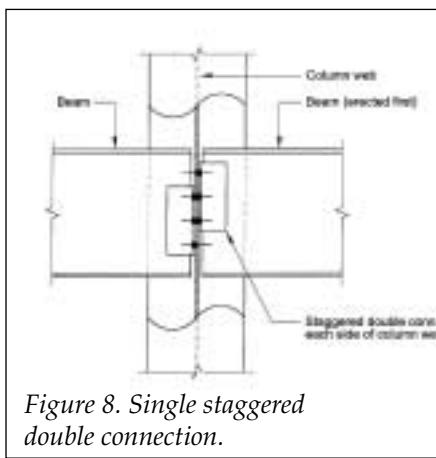


Figure 8. Single staggered double connection.

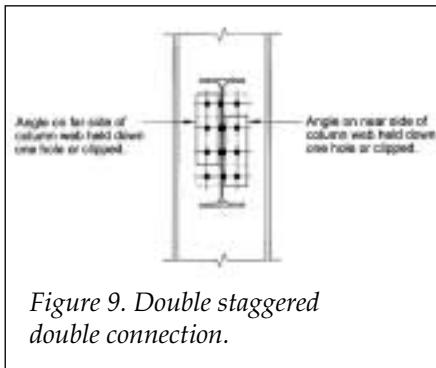


Figure 9. Double staggered double connection.

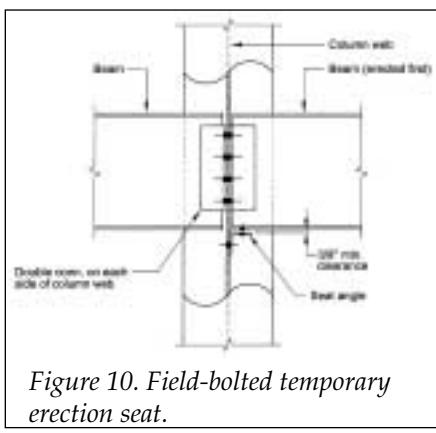


Figure 10. Field-bolted temporary erection seat.

Joist Stabilizer Plates at Columns [757 (a) (2) (i)]

When columns are strutted with joists, the column must be provided with a plate to receive and stabilize the joist bottom chord. The plate must be a minimum of 6 inches x 6 inches and extended 3 inches below the joist bottom chord with a 13/16-inch diameter hole for attaching guying or plumbing cables (Figures 13-14). Figures 13 and 14 show details at column tops in cantilevered girder construction. Figure 13 shows stiffeners in the beam web above the column. In this case, the stiffeners acting with a properly designed column cap will provide the necessary continuity and stability for the column top. Thus, the joist bottom chord extensions need not be welded to the stabilizer plates. In Figure 14 there is no stiffener over the column and stability of the column top is provided by welding the extended bottom chords to the stabilizer plates. These welded connections create continuity in the joists. The resulting moments must be reported to the joist supplier so that the joists are

properly sized. The timing of the welding must be indicated so that it is consistent with the continuity mo-

Joists [757]

- Strut joists at or near columns must be bolted [757 (a) (1) and (2)]
- Increased strength of strut joists up to 60 foot span [757 (a) (3)]
- Strut joists over 60-foot span to be set in tandem [757 (a)(4)]
- Joists may not be modified without the approval of the project structural engineer of record [757 (a)(7)]
- Unless panelized, joists of 40 foot or greater span must be bolted to their supports unless constructability does not allow [757 (a) (8)]
- Joists require erection bridging (see def.) as specified in Tables A and B[757 (d)]
- Erection bridging must be shown on the joist erection plans [757(d)(6)]
- A bridging terminus point (see def.) must be established before bridging is installed [757 (a) (10) and Appendix C]
- Bridging attachments must not protrude above the top chord.
- Joist bridging bundles may not exceed 1000 lbs.. [757 (e)(3)]
- Decking or deck accessory bundles may not exceed 4000 lbs. and may be set on partially bridged joists under controlled circumstances [757 (e)(4)]

Designers must take the bolting requirements for joists of 40 foot spans and over into consideration in beam design, particularly in cantilevered construction over the cantilever support. Note that strut joists require bolting and stabilizer plates regardless of span. K-series joists commonly use $\frac{1}{2}$ -inch diameter bolts, while LH-series and DLH-series joists use $\frac{3}{4}$ -inch diameter bolts. Fabricators must not arbitrarily increase bolt diameters without verifying with the project structural engineer of record that the additional loss of net cross-sectional area will not affect the supporting member's design. Threaded studs may not be used on walking/working surfaces because they constitute a tripping hazard [754 (c)(1)]

properly sized. The timing of the welding must be indicated so that it is consistent with the continuity mo-

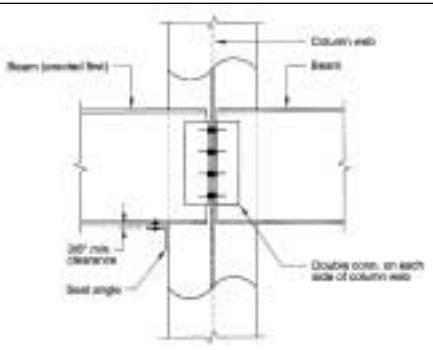


Figure 11. Shop-welded temporary erection seat.

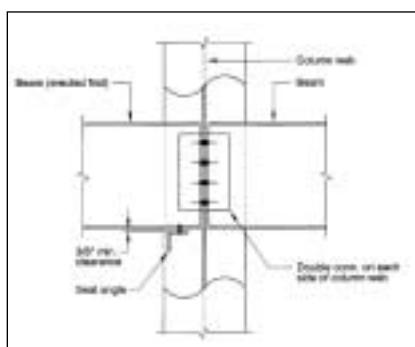


Figure 12. Shop-welded temporary erection seat, alternate.

Fabricators may want to limit joist bridging and deck bundle weights in their purchase orders to their suppliers.

Systems-Engineered Metal Buildings [.758]

All requirements of Subpart R apply to systems-engineered metal buildings (see def.) except as noted in this section. Additionally, there are some safety requirements that are unique to this type of construction.

Fall Protection/ Work Heights [.760]

All erection activities where a fall of greater than 15 feet can occur, require that the erector be protected by guardrail systems, safety net systems, personal fall arrest systems, positioning device systems or fall restraint systems (see Appendix G) with the exception of connectors or erectors working in a Controlled Decking Zone – CDZ (see def.).

Connectors may work up to 30 feet or two stories whichever is less provided that they are trained regarding fall hazards and either be protected by the above methods or wear the equipment necessary to be tied off. The decision to be tied off is solely the connectors. The connector does not have this choice when fall heights exceed 30 feet.

Controlled Decking Zones may be used to lay metal decking at fall height exposures of over 15 feet and up to 30 feet. Those erectors working in CDZ areas are limited as to what tasks they can perform and are required to be trained for this specific activity. Additional information regarding the CDZ may be found in Appendix D. Prior to allowing other erectors into the CDZ, it must be secured by covering or guarding decking holes and openings and providing perimeter safety cable/guardrail systems where required. Refer to Appendix G and the previous discussion of safety cable/Guardrail systems under Column Splice Height at Perimeter Columns/Perimeter Safety Cable Attachments. Erectors laying deck at fall exposure heights exceeding 30 feet must either be protected per [.760 (a)(1)] or under other provisions as may be available under Subpart M – Fall Protection.

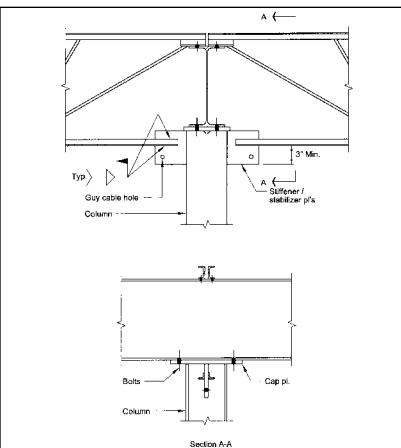


Figure 14. Girder over column without web stiffeners and extensions welded to stabilizer plates.

Conclusion

As can be seen from the above discussion and the citation from the new rules, subpart R has been substantially changed from the previous rule. The last edition of the rules focused almost exclusively of the Erector. The new rules require the participation of engineers, fabricators and contractors. It behooves everyone involved in the design and construction of steel building to be aware of these new rules and how they affect their aspect of the design/construction process.

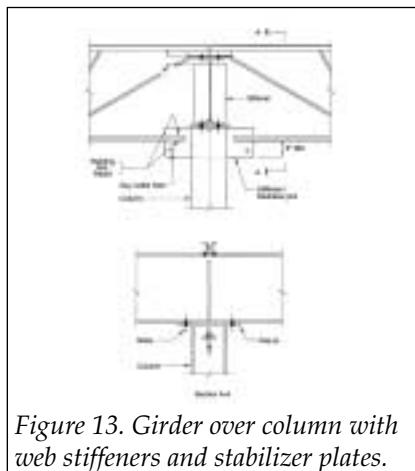


Figure 13. Girder over column with web stiffeners and stabilizer plates.

Training [.761]

Specific training is required for erectors and must be documented for the following (see Appendix E):

- Fall hazard training
- Multiple lift rigging procedures
- Connector procedures
- Controlled Decking Zone procedures