

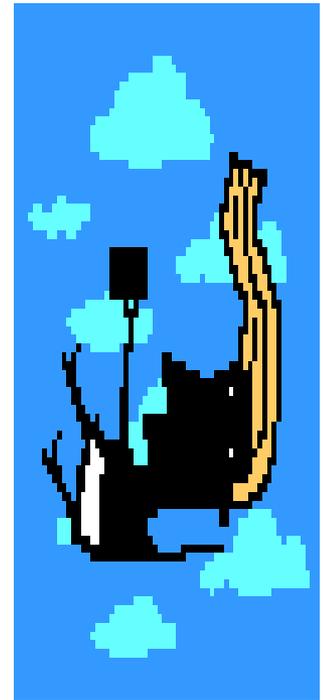


**FALL PROTECTION  
&  
STEEL ERECTION SAFETY**

# FALL PROTECTION & STEEL ERECTION



- Steel erection **fatalities 3 year period ( 142 )**
- 83 falls/trips
- 25 hit by object
- 12 electrocution
- 6 x-mas Tree Lift
- 10 collapse steel
- 6 lack of railing



# STEEL ERECTION MOST COMMON VIOLATIONS



**NO PROTECTION FOR  
CONNECTOR/BOLTER/DECKER**

**WORKERS DON'T WANT PFAS  
(Attitude)**

**NO TAGLINES**

**SINGLE BOLT METHOD USED**



# STEEL ERECTION SAFETY CHANGES



*Changes by OSHA resulted in major changes by COE*

*Some COE changes are **MORE STRINGENT***

*See Pages 32 & 33 for Major OSHA changes*



# STEEL ERECTION DEFINITION



**PROJECT/STRUCTURAL ENGINEER OF RECORD:**  
**REGISTERED, LICENSED PROFESSIONAL**  
**RESPONSIBLE FOR THE DESIGN OF STRUCTURAL**  
**STEEL FRAMING AND WHOSE SEAL APPEARS**  
**ON THE DESIGN CONTRACT DOCUMENTS.**  
**THE A/E FOR THE PROJECT.**



*Who  
designed  
this???*

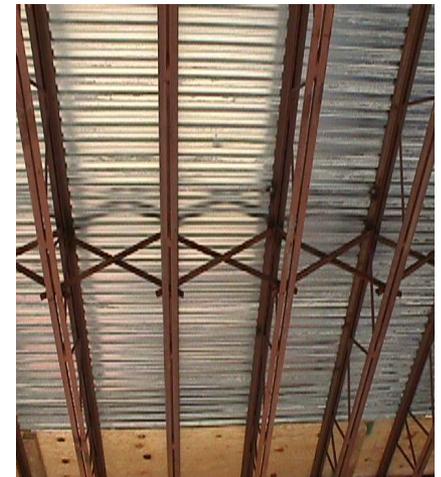
# DEFINITIONS



**Controlling Contractor**: A prime contractor, general contractor, construction manager or any other legal entity that has the overall Responsibility for the construction of the project—its planning, quality and completion.



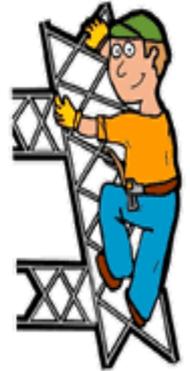
**Erection Bridging**: The bolted diagonal members that is required to be installed prior to releasing the hoisting cables from the steel joists.



# Definitions



**CHRISTMAS TREE LIFTING**: Rigging assembly that allows for the attachment of multiple loads to be hoisted by a crane at one time.



**CONNECTOR**: an employee who, working with hoisting equipment, is placing and connecting structural members and/or components.

**CONTROLLED DECKING ZONE**: An area where certain work (installation and placement of metal decking) may take place Without the use of guardrail systems, personal fall arrest or Fall restraint systems, of a safety net system where access to the Zone is controlled.

COE Appendix “Q” Definitions

# DEFINITIONS



**Qualified Person:** One who, by possession of a *recognized degree, certificate, or professional standing*, or who has 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.

**Competent Person:** One who is capable of identifying existing and predictable hazards in the surrounding working environment, or working conditions that are dangerous to personnel and who has the *authority to take prompt corrective measures* to eliminate them.

**Accepted/Acceptable:** a term denoting when a written procedure, practice, method, program, engineering design, or employee qualification criteria submittal, which, after a cursory review by a GDA, is determined to generally conform to safety and health or contractual requirements. Acceptance or acceptability of such submittals in no way relieves the submitting entity from ensuring employees a safe and healthful work environment or complying with all contractual requirements and good engineering practices.

# STRUCTURAL STEEL ASSEMBLY



## SECTION 27 F.

**PRIOR TO BEGINNING THE ERECTION OF ANY STRUCTURAL STEEL,**

**A STEEL ERECTION PLAN SHALL BE SUBMITTED TO THE GDA FOR REVIEW AND ACCEPTANCE.**

*Hey! Pages 34 – 38 has an Excellent Site Specific Erection Plan & Checklist!*



# STRUCTURAL STEEL ERECTION PLAN



Sequence of erection developed in coordination with controlling contractor

Material deliveries, staging and storing.

Coordination with other trades, site preparation activities

Path for overhead loads, critical lifts including rigging and equipment

Description of steel erection including:

Stability, anchor, column placement, connection, bridging decking, ornamental and miscellaneous iron.

Description of Fall Protection procedures to be followed

Lists (names) of qualified and competent persons

Activity hazard analysis required

Certification of training for each person involved in steel erection IAW 1926.761

A list of the Qualified and Competent Persons

Description of procedures for **EMERGENCY RESPONSE**

Signed and dated: QUALIFIED PERSON DEVELOPING THE PLAN

NOTE: OSHA SUGGESTS A STEEL ERECTION PLAN, EM 385 **REQUIRES** IT!  
Section 27.F.01

# Written Notifications



**BEFORE AUTHORIZING THE COMMENCEMENT OF STEEL ERECTION, THE CONTROLLING CONTRACTOR SHALL ENSURE THAT THE STEEL ERECTOR IS PROVIDED WITH THE FOLLOWING **WRITTEN** NOTIFICATIONS:**

**A. CONCRETE HAS ATTAINED AT 75% STRENGTH**

**B. ANY REPAIRS, REPLACEMENTS, AND MODIFICATIONS TO THE ANCHOR BOLTS WERE CONDUCTED IN ACCORDANCE WITH SPEC'S AND/OR THE PROJECT STRUCTURAL ENGINEER.**

**C. A STEEL ERECTION CONTRACTOR SHALL NOT ERECT STEEL UNLESS IT HAS RECEIVED WRITTEN NOTIFICATION**

**D. BOTH CONTRACTORS WILL KEEP A COPY OF THIS WRITTEN NOTIFICATION ON-SITE**

# SITE LAYOUT



**The controlling contractor (Prime) shall insure the following is provided and maintained:**

- a. Adequate access roads into and through the site.**
- b. 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.**
- c. Pre-planning of overhead hoisting operations. All hoisting operations in steel erection shall be pre-planned.**
  - Use Preparatory Meetings to ensure this is done!!!**
  - A COMPETENT PERSON shall visually inspect cranes prior to each shift.**
  - A Qualified Rigger shall inspect the rigging prior to each shift**
  - SAFETY LATCHES ON HOOKS SHALL NOT BE DEACTIVATED OR MADE INOPERABLE exception: When a Qualified Rigger has determined that the hoisting and placing of purlins and single joists can be performed more safely by doing so and precautions related to this practice are included in the accepted steel erection plan**



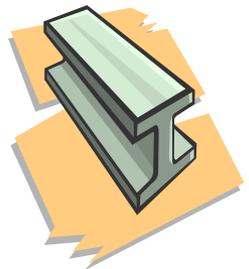
# Steel Erection Activities



- 1. Hoisting, laying out, placing, connecting, burning, guying, bracing, bolting, plumbing and rigging structural steel/metal buildings**
- 2. Installing metal decking, curtain walls, window walls, siding systems, miscellaneous metals, ornamental iron, and similar materials**
- 3. Moving point-to-point while performing these activities (Expanded list on 27.F.03)**



- a. Structural stability shall be maintained at all times during the erection process.**
- b. The permanent floors shall be installed as the erection of structural members progress**
- c. At no time shall there be more than 4 floors or 48 ft, whichever is less, of unfinished bolting or welding above the foundation.**
- d. A fully planked or decked floor or nets shall be maintained within 2 stories or 30 ft, whichever is less, directly under any erection work being performed**



# STRUCTURAL STABILITY



***Plumbing Columns***

# STRUCTURAL STABILITY



## *AND THE WIND BLEW....*



*Hadnot Point Exchange Gas Station. Storm blew in one morning, wooden trusses had no lateral cross bracing. Most came down. One worker rode truss down and suffered serious injuries.*



**SOI Classroom-Camp Geiger Steel framing had no lateral cross bracing, straight line winds warped most of building. Luckily, No injuries.**



**Consolidated Academic Construction Facility Tall masonry walls were not braced at all. Straight-line winds brought several walls and a second floor down. One man was very seriously injured**

**BOTTOM LINE:  
WIND CAN DAMAGE!  
MAKE YOUR CONTRACTORS  
PROVIDE PROPER  
AND ADEQUATE BRACING  
WHERE REQUIRED!**

# Column Anchorage



- 1. All columns shall be anchored by a minimum of 4 anchor rods (anchor bolts)**
- 2. Columns shall be set on level finished floors, pre-grouted leveling plates, leveling nuts, or shim packs that are adequate to transfer construction loads**
- 3. All columns shall be evaluated by a competent person to determine whether guying or bracing is needed; if guying or bracing is needed, it shall be installed**

**Note\* Verify competent person at Preparatory Meeting**

# Column anchored by 4 bolts



# Column Anchorage



**Anchor bolts shall not be repaired, replaced, or field-modified without the approval of the project structural engineer of record.**

# STRUCTURAL STEEL



**Wide Flanged Beams, “I” Beams, “H” Beams  
Channel Iron, Angle Iron, etc.**



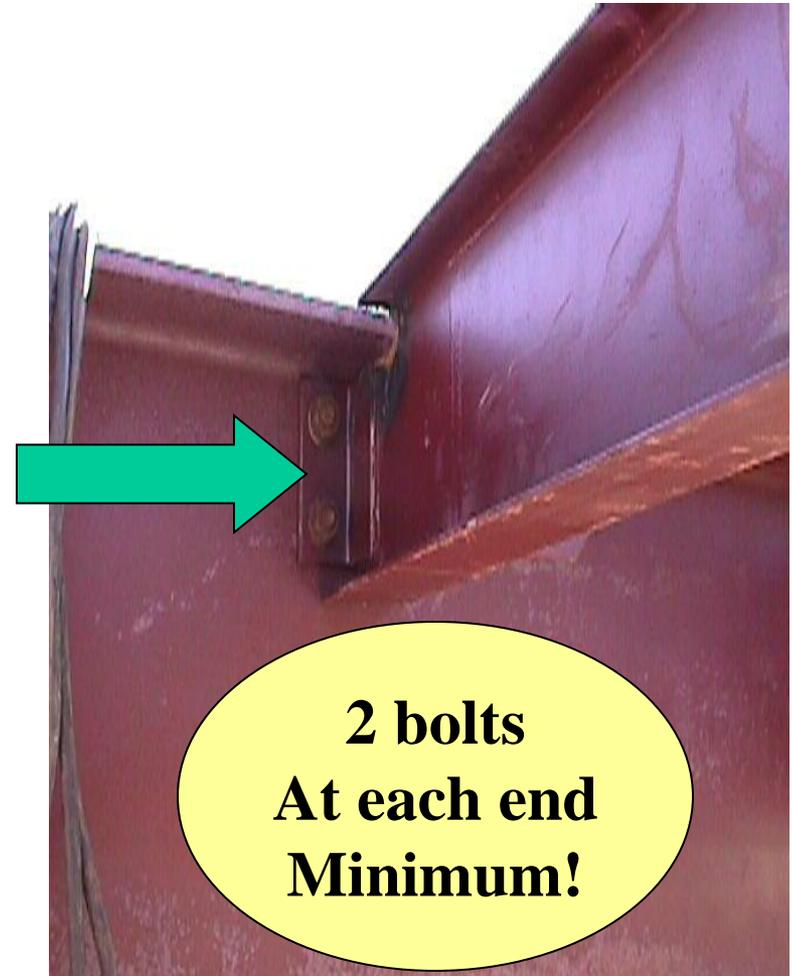
***SOLID WEB BEAMS SHOWN***

# MINIMUM 2 BOLT CONNECTIONS BEFORE RELEASING HOIST LINE



**Placement of solid  
web structures to have  
at least 2 bolts per  
connection point  
wrench tight 27.E.20**

**SINGLE BOLT ON  
EACH END ON SAME  
SIDE CAN RESULT  
IN SERIOUS FALLS**



# DOUBLE CONNECTIONS



**When two structural members on opposite sides of a column web or beam web over a column are connected sharing common connection holes, at least one bolt with its wrench-tight nut shall remain connected to the first member unless a shop-attached or field-attached seat or equivalent connection device is supplied with the member to secure the first member and prevent the column from being displaced.**



*Information in you  
Student Binder*

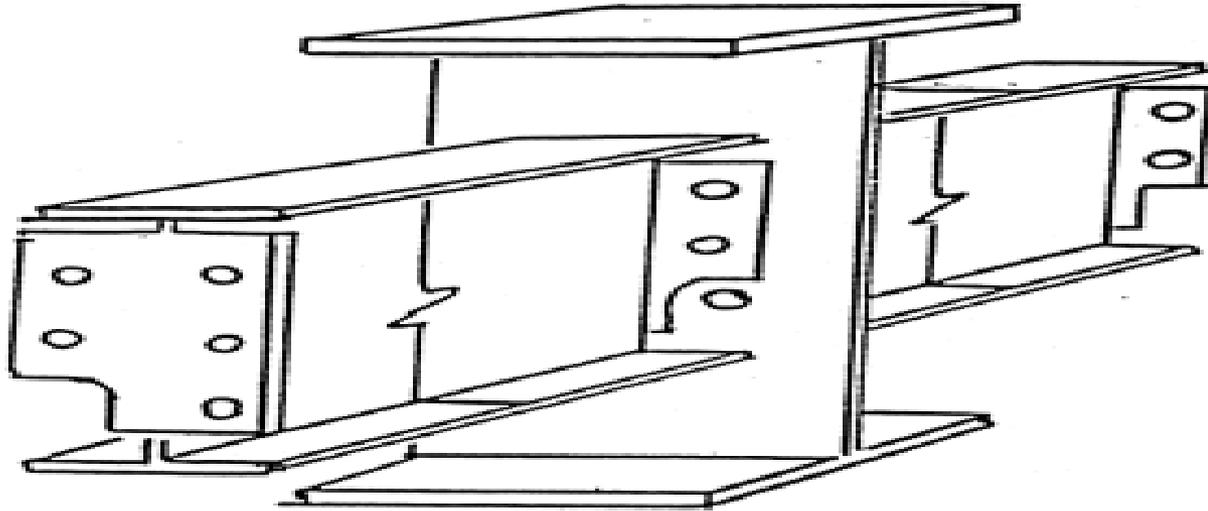


**OLD DOUBLE CONNECTION AT COLUMN  
AND TWO BEAMS**

# SAME DOUBLE CONNECTION OPPOSITE SIDE OF COLUMN

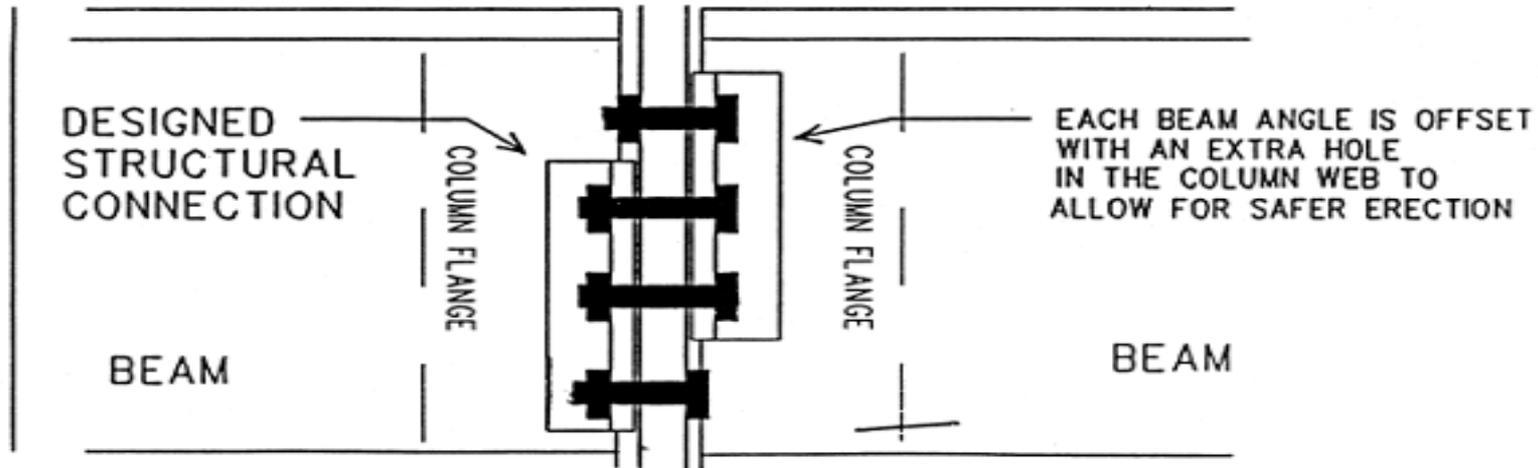


# New/approved double connection at column



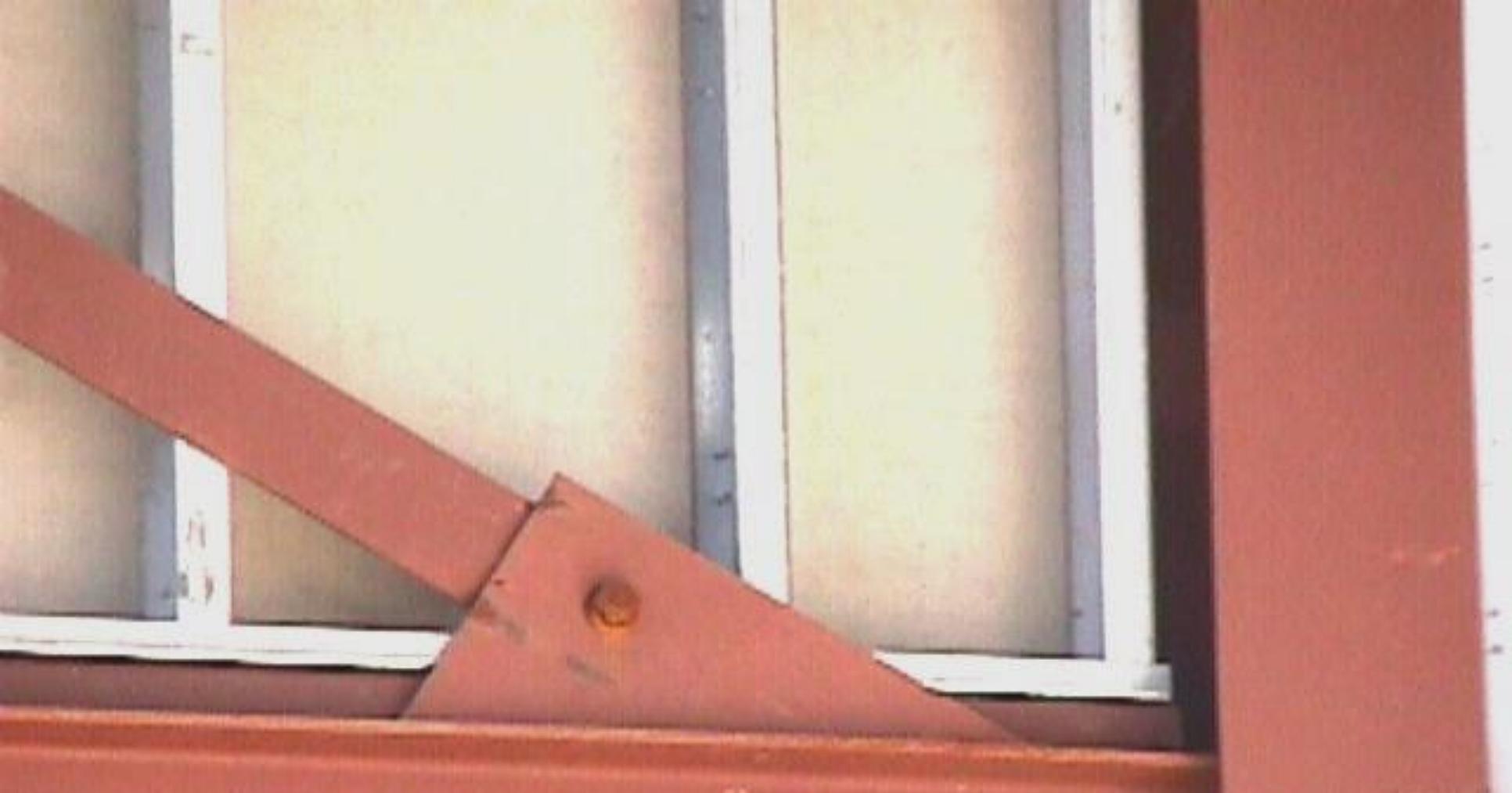
Clipped end connections are connection material on the end of a structural member which has a notch at the bottom and/or top to allow the bolt(s) of the first member placed on the opposite side of the central member to remain in place. The notch(es) fits around the nut or bolt head of the opposing member to allow the second member to be bolted up without removing the bolt(s) holding the first member. **See Page #43 in the student binder**

# New/approved double connection at column



Staggered connections are connection material on a structural member in which all of the bolt holes in the common member web are not shared by the two incoming members in the final connection. The extra hole in the column web allows the erector to maintain at least a one bolt connection at all times while making the double connection.

[66 FR 5279, Jan. 18, 2001]



**Minimum of 1 bolt connection is required  
For diagonal bracing 27.F. 21**

# **MULTI-STORY ERECTION PROCEDURES**



**STRUCTURAL STABILITY SHALL BE MAINTAINED AT ALL TIMES DURING THE ERECTION PROCESS.**

**THE PERMANENT FLOORS SHALL BE INSTALLED AS THE ERECTION OF STRUCTURAL MEMBERS PROGRESS**

**AT NO TIME SHALL THERE BE MORE THAN 4 FLOORS OR 48 FT, WHICHEVER IS LESS, OF UNFINISHED BOLTING OR WELDING ABOVE THE FOUNDATION.**

**A FULLY PLANKED OR DECKED FLOOR OR NETS SHALL BE MAINTAINED WITHIN 2 STORIES OR 30 FT, WHICHEVER IS LESS, DIRECTLY UNDER ANY ERECTION WORK BEING PERFORMED**

# STEEL ERECTION FALL PROTECTION



**Connectors require fall protection when working 6 feet above lower level.**

**OSHA ALLOWS CONNECTORS TO WORK A HEIGHT OF *30 FEET* BEFORE FALL PROTECTED!**



# METAL DECKING



## Hoisting, Landing, and Placing of metal decking bundles

- 1. Bundle packaging and strapping shall not be used for hoisting.**
- 2. Loose items (materials shall be secured to bundles)**
- 3. The weight of a bundle shall comply with 27.E 29**
- 4. No bundle shall be placed on steel joists until all bridging has been installed and anchored and all joist bearing ends attached, unless all of the following conditions have been met:**
  - a. The employer has first determined from a qualified person that the structure is capable of supporting the load.**
  - b. The bundle is placed on a minimum of three steel joists.**
  - c. The joists supporting the bundle of decking are attached at both ends**

**cont**

# METAL DECKING



## **Hoisting, Landing, and Placing of metal decking bundles**

- d. At least one row of bridging is installed and anchored.**
- e. The total weight of the bundle of decking does not exceed 4,000 pounds and**
- f. The edge of the construction load shall be placed within 1 foot (0.3m) of the bearing surface of the joist end.**

**A total of 3,000 sq.ft. may be laid before securing**



# DECKING HOLE



**A gap or void that is more than 2 inches in its least dimension and less than 12 inches in its greatest dimension in a floor, roof or other walking/working surface. **Note: Pre-engineered holes in cellular decking for wires, cables, etc.) are not included in this definition.****

## OPENING

**A gap or void 12 in (30.5 cm) or more in its least dimension in a floor, roof, or other walking/working surface. Skylights and smoke domes that do not meet the strength requirements of 29 CFR 1926.754 (e) (3) shall be regarded as openings**

# Roof Holes and Openings



**Framed openings have the  
Structural members turned down**

**Openings decked over or employees  
Protected from falls. (guard rails).**

**Holes not cut until ready to receive  
The permanent equipment. 27.F**



**Coverings capable of supporting 2 times imposed load  
Secured to prevent accidental displacement and painted  
With high visibility paint marked "HOLE" or "COVER"**

# CONTROLLED DECKING ZONE (CDZ)

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

**Note: Controlled Decking Zones are not permitted 27.G.05**

# Controlled Decking Zone



**CONTROLLED DECKING ZONES NOT ALLOWED BY COE  
27.G.05**

# SHEER CONNECTOR



**A headed steel stud, steel bars, steel lugs, and similar devices which are attached to a structural member for the purpose of achieving composite action with concrete. Commonly called a “Nelson Bolt”.**

**Must be installed after metal decking is installed to eliminate tripping hazards.**

# SHEER CONNECTOR



# OPEN WEB ROOF JOISTS



# OPEN WEB JOISTS TYPES

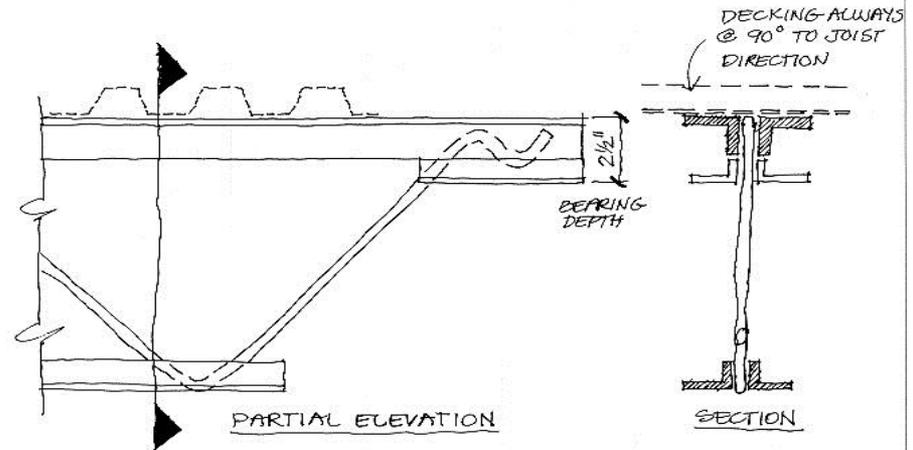


**“K” & “KCS”**

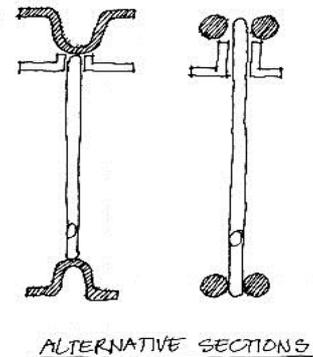
**Spans to 60 feet.**

**LH, Long Spans  
25 to 90 feet long**

**DLH, Deep Long spans up  
to 144 Feet long**



H, J, OR K SERIES JOISTS  
(UP TO 30-40 FOOT SPANS)



# OPEN WEB JOIST SAFETY



**Supporting structure to be stable before the placement of open web joists**

**Must be secured when they are landed**

**No modification to joists without the Approval of engineer of record.**

**27.E. 25, e, f, g.**



# OPEN WEB JOIST SAFETY



**1. Length & depth of joist determines:  
Connection method.**

- a. Bolted/Welded**
- b. Seat location top/bottom cord**
- c. Where and if bridging is needed**

## **Method of Erection**

- a. Individually**
- b. Pair**
- b. Bundled**
- c. Panel Erection method**



# COMMON TO ALL TYPES OF OPEN WEB JOISTS



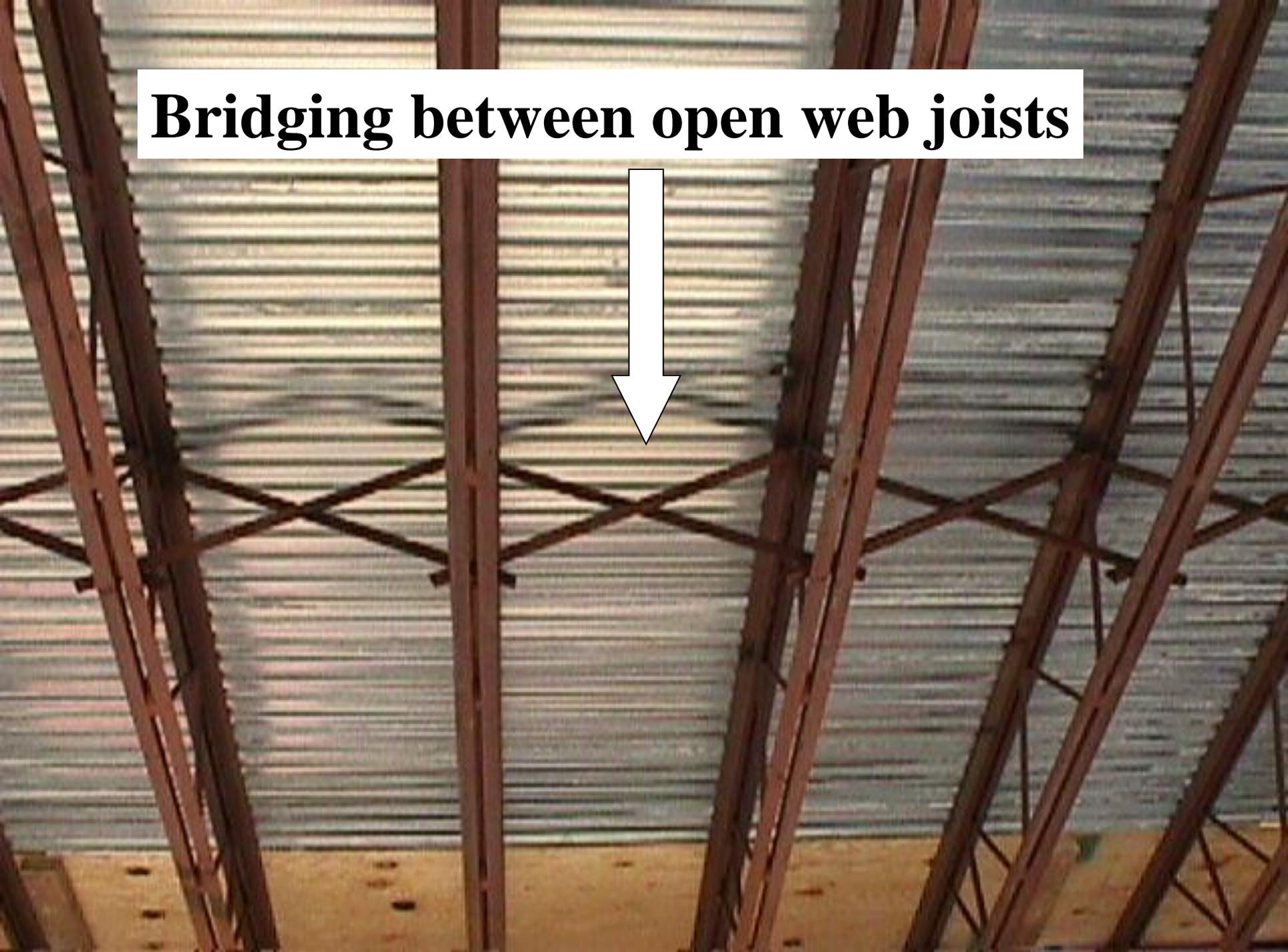
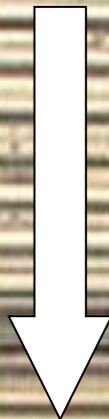
**Not to be placed on any support structure unless structure is stabilized**

**Must be secured after landed to prevent unintentional movement prior to installing**

**No modifications without engineer of record approval**



**Bridging between open web joists**



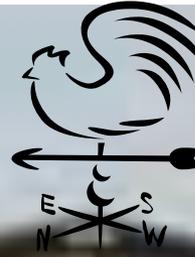
# SYSTEMS-ENGINEERED METAL BUILDING

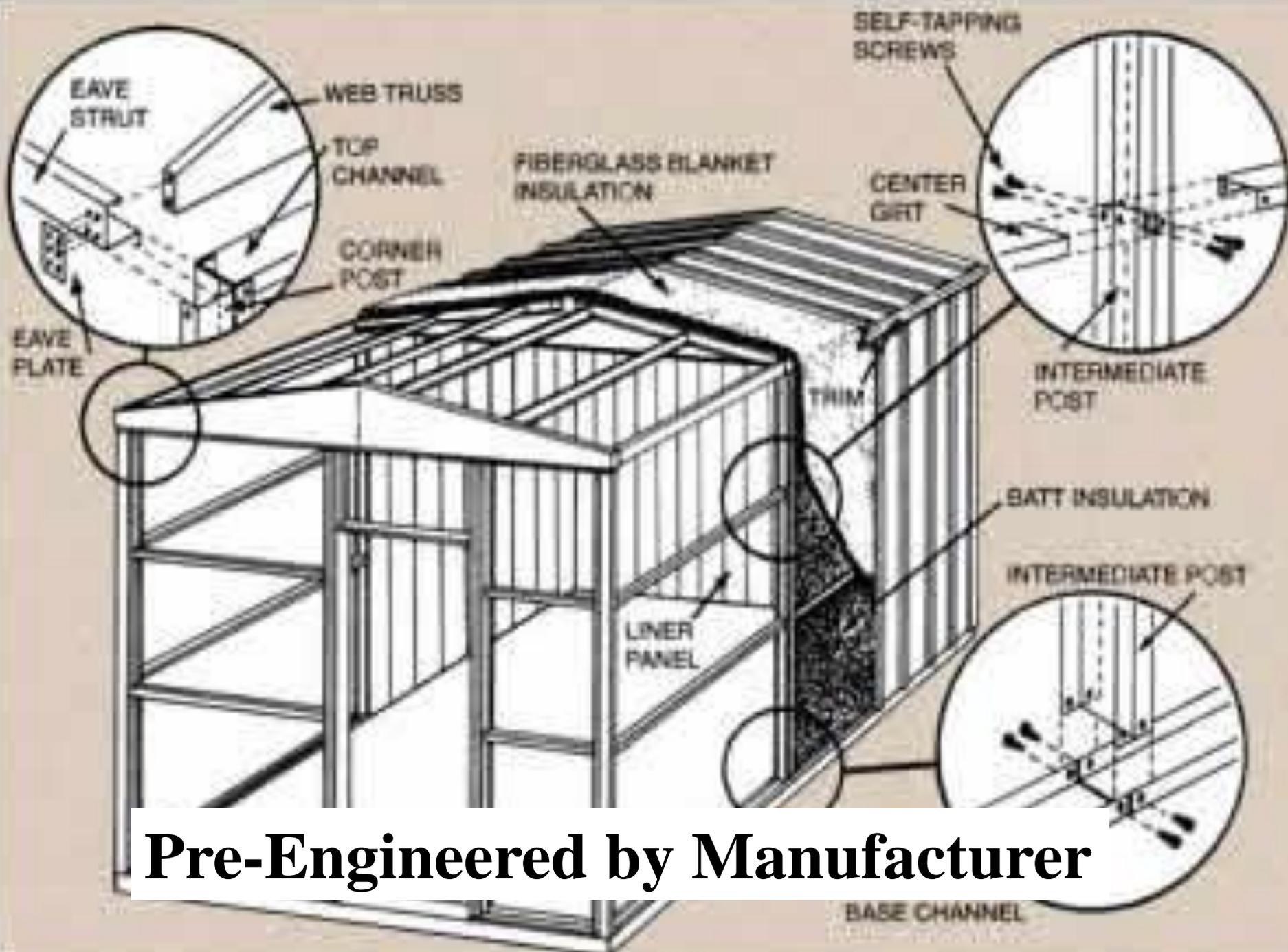


**A metal, field-assembled building system consisting of framing, roof and wall coverings. Typically, many components are cold-formed shapes. These individual parts are fabricated in one or more manufacturing facilities and shipped to the job for assembly into the final structure. The engineering design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

**Formally called: Pre-Engineered Buildings**

# Typical System Engineered Building





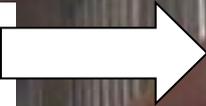
**Pre-Engineered by Manufacturer**



**Eave Strut**



**“Z” Purlin**



**Sheeting Girt**

164

# SYSTEMS-ENGINEERED METAL BUILDINGS

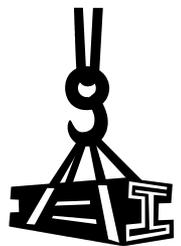


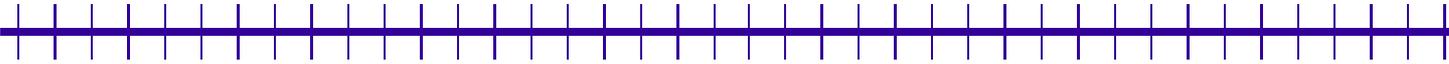
- 1. All portions of new standard apply except column anchorage and open web steel joists.**
  - 2. Ridge frames to have 50% of bolts on each side of the web before releasing load line.**
  - 3. No loads placed on structure until all is safely bolted/welded**
  - 4. Girt/eave strut connections must have at least 1 bolt remain connected wrench tight**
  - 5. Purlins/girts not allowed as anchor point unless written approval from qualified person**
  - 6. Purlins may be used for walking/working when installing safety systems after all permanent bridging is installed**
  - 7. Loads not to be placed over 8 feet from a main support member.**
- Section 27.G**

# PERIMETER COLUMNS



- 1. Perimeter columns shall extend a minimum of 48" above the finished floor to permit installation of perimeter safety cables prior to erection of the next tier, except where constructability does not allow.**
- 2. The perimeter columns have holes or other devices in or attached to perimeter columns to permit installation of perimeter safety cable.**



A horizontal purple line with vertical tick marks representing a lifeline system, positioned at the top of the slide.

**HORIZONTAL LIFELINE:** A component of a horizontal lifeline system, which consists of a flexible line with connectors or other coupling means at both ends for securing it horizontally between 2 anchorage connectors. (Also can be called a perimeter safety cables)

**Minimum size is 1/4" flagged every 6 feet.**



# Horizontal Lifeline (Perimeters Safety Cables)



# PERIMETER SAFETY CABLES AS A STANDARD GUARDRAIL



**Perimeter Safety cable on multi-story structures shall be installed at the final interior and exterior perimeters of the floors as soon as the metal decking has been installed.**

**27.G.03**

**Top or Mid-Rails of wire rope to be tensioned to provide not more than 3” deflection in any direction with a 200 lb. load, posts not more than 8 feet apart, wire rope flagged at distances not greater than 6 feet apart with a high-visibility material (21.B. 05 C)**

**Note: Wire Rope **minimum** diameter is 1/4”**

# CABLE CLAMP



## 3 MAJOR PARTS

1. NUTS
2. "U" BOLT
3. SADDLE

**NEVER SADDLE A  
DEAD HORSE!!!**



# CABLE CLAMPS



**MINIMUM NUMBER  
IS ALWAYS 3**

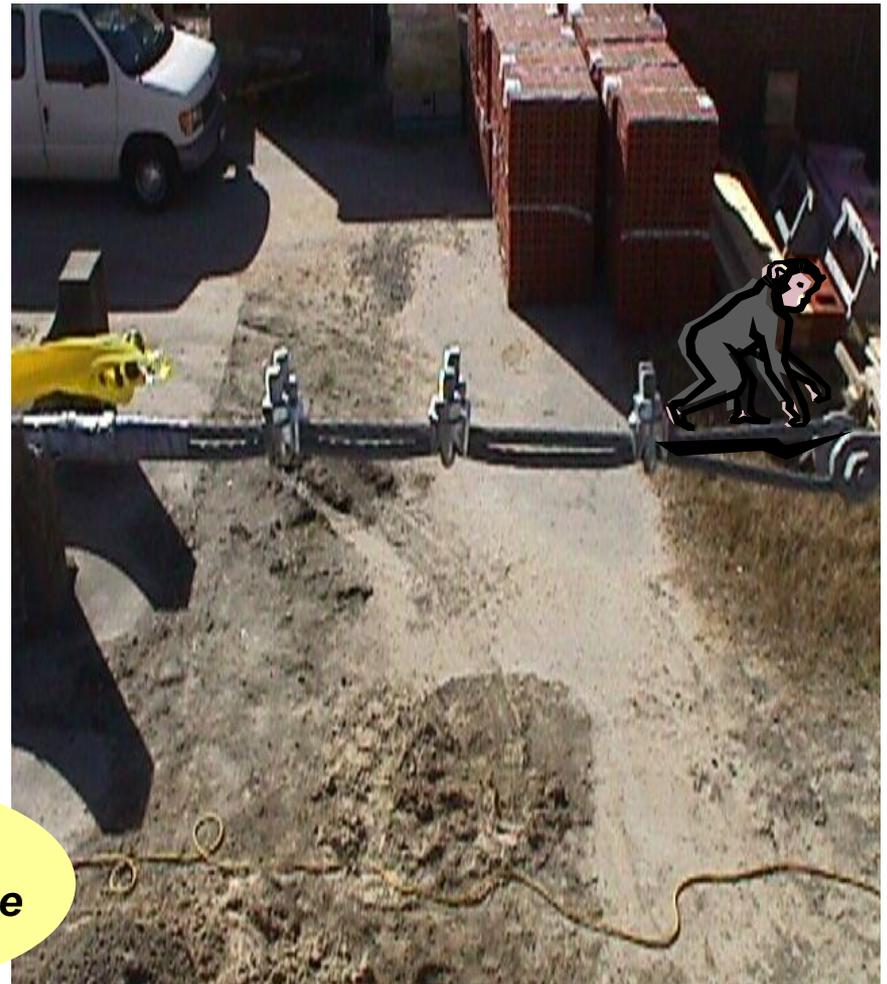
**SPACING EQUAL  
CABLE DIAMETER  
TIMES 6**

**NEVER USED TO  
SPLICE WIRE ROPE**

**15 B. 08**



*See Table  
15-1 on page*



# WIRE ROPE CLIP REQUIREMENTS



## COE Section 15.B Table 15-1

**Note: Never used to  
Splice wire rope!**

**15.D.09**

# MULTIPLE LIFT RIGGING (MLR)



**15.C.08 Page 269**

**Multiple lift rigging practices for the purpose of erecting/placing structural steel ONLY.**

**MLR is considered a critical lift and requires a carefully detailed written critical lift plan per Section 16 H CRITICAL LIFTS.**

**MLR ASSEMBLY IS USED**

**A MAXIMUM OF FIVE MEMBERS ARE HOISTED PER LIFT**

**ONLY BEAMS AND SIMILAR STRUCTURAL MEMBERS ARE LIFTED**

**ALL EMPLOYEEES ENGAGED IN MLR TRAINED**

# MULTIPLE LIFT RIGGING (MLR)



15.C.08 Page 270

**ALL LOADS RIGGED BY A QUALIFIED RIGGER**

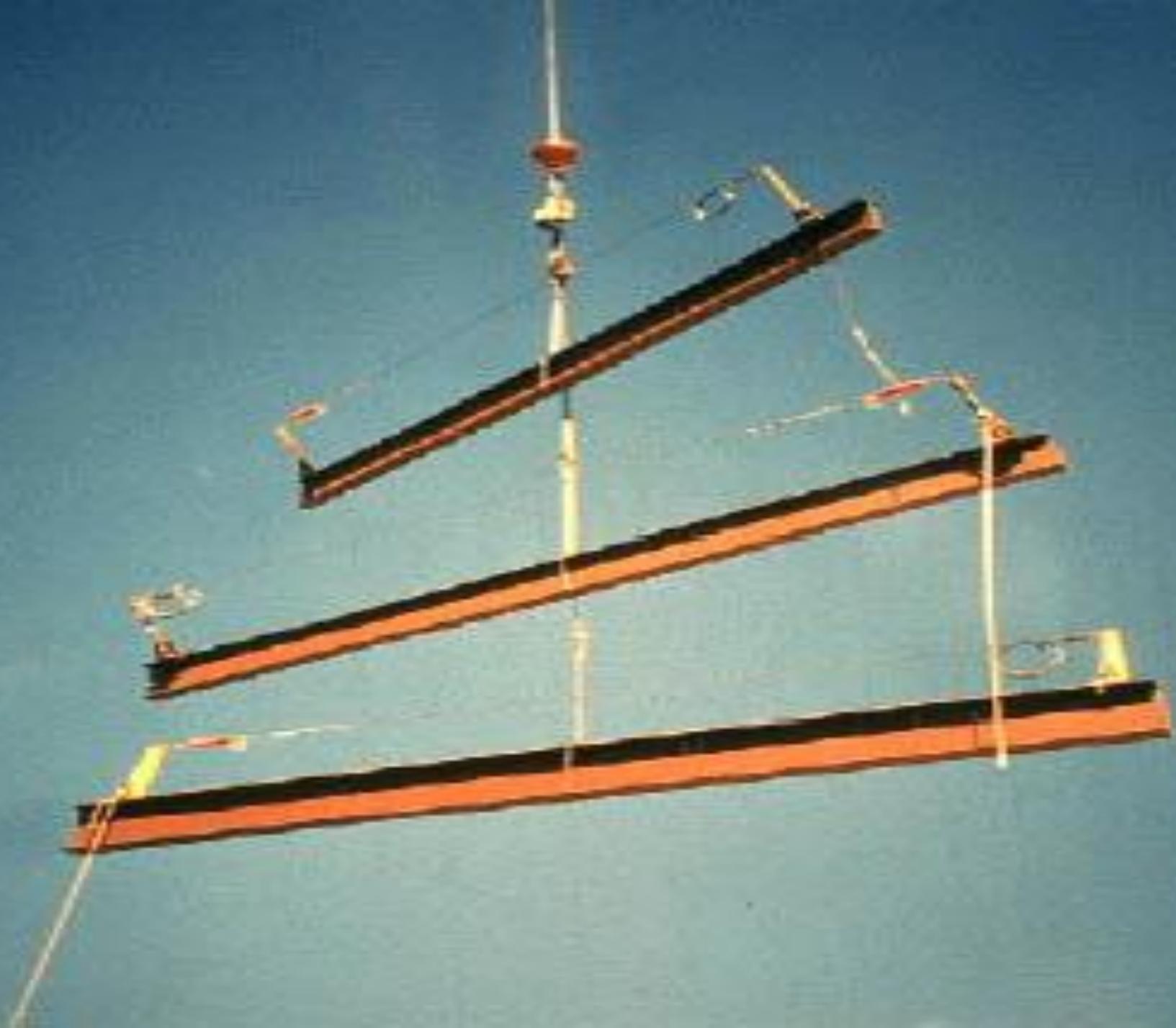
**CRANE MANUFACTURERS SPECIFICATIONS STATE THE CRANE CAN BE USED FOR MLR's**

**COMPONENTS OF THE MLR SHALL BE SPECIFICALLY DESIGNED AND ASSEMBLED AND CERTIFIED BY THE MANUFACTURER WITH A SAFETY FACTOR OF 5: FOR ALL COMPONENTS**

**MEMBERS ATTACHED AT THEIR CENTER OF GRAVITY, RIGGED FROM THE TOP DOWN, RIGGED AT LEAST 7 FEET APART**



## **Multiple Lift Rigging**



# FALL PROTECTION STEEL ERECTION WORK



**\*\*MORE THAN 6 FEET ABOVE WALK/WORK SURFACE**

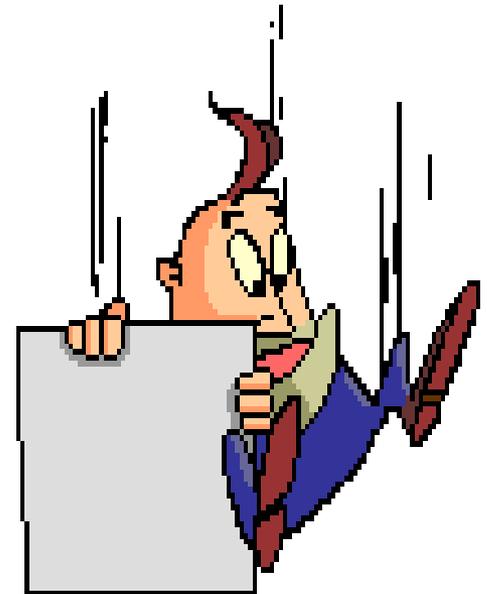
**Guardrail System\*\***

**Safety Net System**

**Personal Fall Arrest System (PFAS)**

**Fall Restraint System**

**Fall work positioning system**



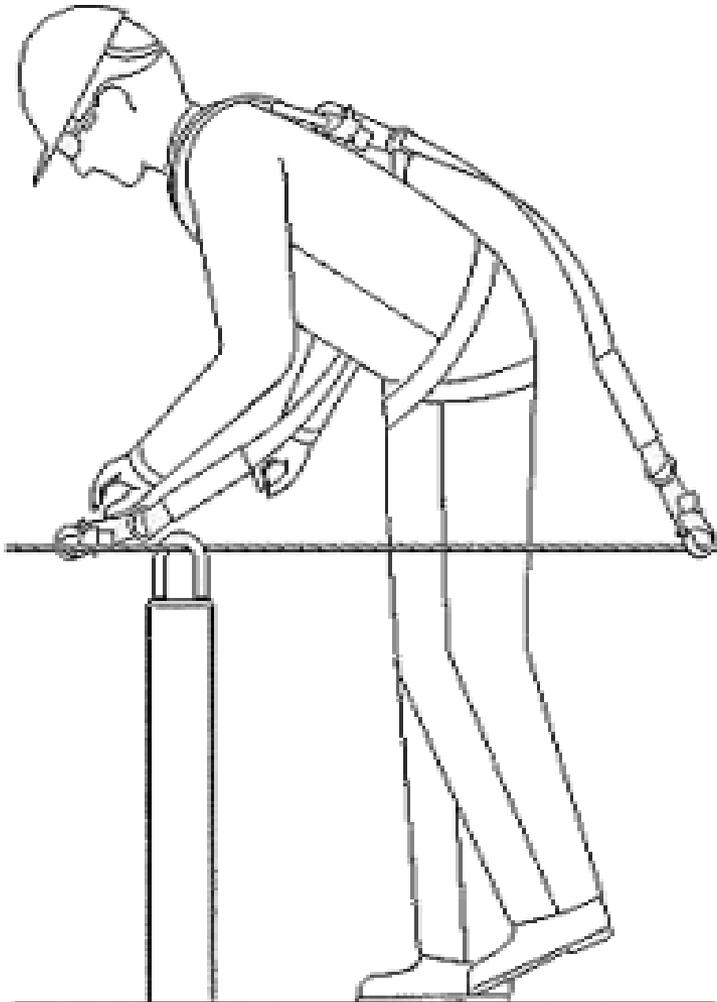
**\*\* Perimeter Safety Cables must meet the  
Criteria for Standard Guardrail Systems**

**\*\*OSHA ALLOWS CONNECTORS TO WORK UP TO 30 FEET WITHOUT FALL PROTECTION.**

# 100% FALL PROTECTION?



## DOUBLE LANYARD SYSTEM



*Double Ears Too!*



**Must secure loose items aloft**

**Controlling contractor bar other workers from working below steel erection unless overhead protection is required.**



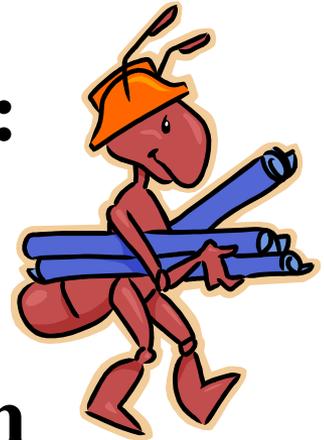
**Overhead protection for ALL workers**



# TRAINING



1. Provided only by a *qualified* person
2. Fall hazard training for all personnel:
  - a. Recognition and Identification of fall hazards in the work area.
  - b. Use of conventional fall protection systems, positioning device systems, fall restraint systems, and other systems
  - c. Procedures for erecting, maintaining, and disassembling in inspecting of all fall protection systems to be used.



# STEEL ERECTION QUESTION



***What is the most cited violation contractor's receive in regard to failure to follow safety rules?***



# STEEL ERECTION QUESTION



**CAN YOU NAME AT LEAST 3 STEEL ERECTION PROCEDURES ALLOWED BY OSHA THAT ARE STRICTLY PROHIBITED BY COE???** (Hints Below)



**CONNECTOR**



*Steel Erection Plan*



**CDZ**