

# Instructions for Instructors

Topic	Slide #s	Approx. minutes
Prevention through Design Concept	5-27	30
Steel Design, Detailing, and Fabrication Process	28-33	10
Steel Erection Process	34-38	10
Specific Steel PtD Examples	39-74	50
Recap and Citations	75-80	5

# OVERVIEW

- Prevention through Design Concept
- Steel Design, Detailing, and Fabrication Process
- Steel Erection Process
- Specific Steel PtD Examples



# INTRODUCTION TO PREVENTION THROUGH DESIGN

# WHAT IS PREVENTION THROUGH DESIGN?

Eliminating work-related hazards and minimizing risks associated with...

- Construction or Manufacture
- Maintenance
- Use, re-use and disposal



...of

- Facilities
- Materials and Equipment

# SUCCESSFUL FIRMS USING PTD

- Design Builders:
  - URS/Washington Group
  - Jacobs
  - Parsons
  - Fluor
  - Bechtel
- Owners:
  - Southern Company
  - Intel

# WHY PREVENTION THROUGH DESIGN?

- Construction is dangerous
- Design does affect safety
- Ethical reasons
- Practical benefits



<http://www.alasdairmethven.com/communities/5/004/006/908/565/images/4529948731.jpg>

# TYPICAL ANNUAL CONSTRUCTION ACCIDENTS IN THE U.S. <sup>1</sup>

Construction is one of the most hazardous occupations



- 7% of the US workforce but 21% of fatalities
- About 1,000 deaths
- About 200,000 serious injuries

# DESIGN CONTRIBUTION TO OCCUPATIONAL FATALITIES: AUSTRALIAN STUDY 2000-2002



- Main finding: design continues to be a significant contribution to work-related serious injury.
- 37% of workplace fatalities involved design-related issues.
- In another 14% of fatalities, design-related issues may have played a role.

Driscoll, T.R., Harrison, J. E., Bradley, C., Newton, R.S.  
(2005)



# ACCIDENTS LINKED TO DESIGN

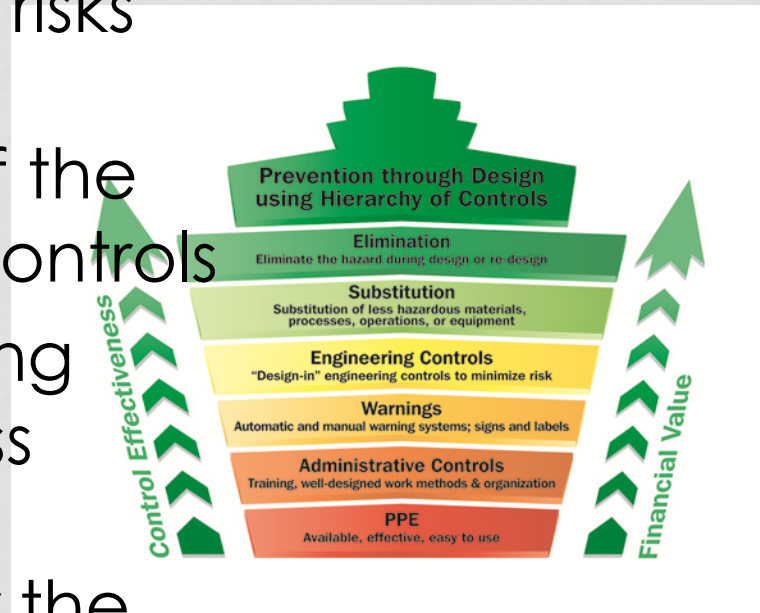
- 22% of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA linked partly to design <sup>2</sup>
- 42% of 224 fatalities in U.S. between 1990-2003 linked to design <sup>2</sup>
- In Europe, a 1991 study concluded that 60% of fatal accidents resulted in part from decisions made before site work began <sup>3</sup>
- 63% of all fatalities and injuries could be attributed to design decisions or lack of planning<sup>4</sup>

# ETHICAL REASONS FOR PTD

- National Society of Professional Engineers' Code of Ethics:
  - Engineers shall hold paramount the safety, health, and welfare of the public
- American Society of Civil Engineers' Code of Ethics:
  - Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering decisions...

# HIERARCHY OF CONTROLS

- Engineers are vital to minimizing occupational risks through the application of the hierarchy of controls
- The engineering design process provides the framework for the application of prevention through design



# CONSTRUCTABILITY

Constructability is an evaluation of how reasonable the design is to construct in terms of:

- Cost
- Duration
- Quality
- Safety

*Safety is an often neglected aspect of constructability*



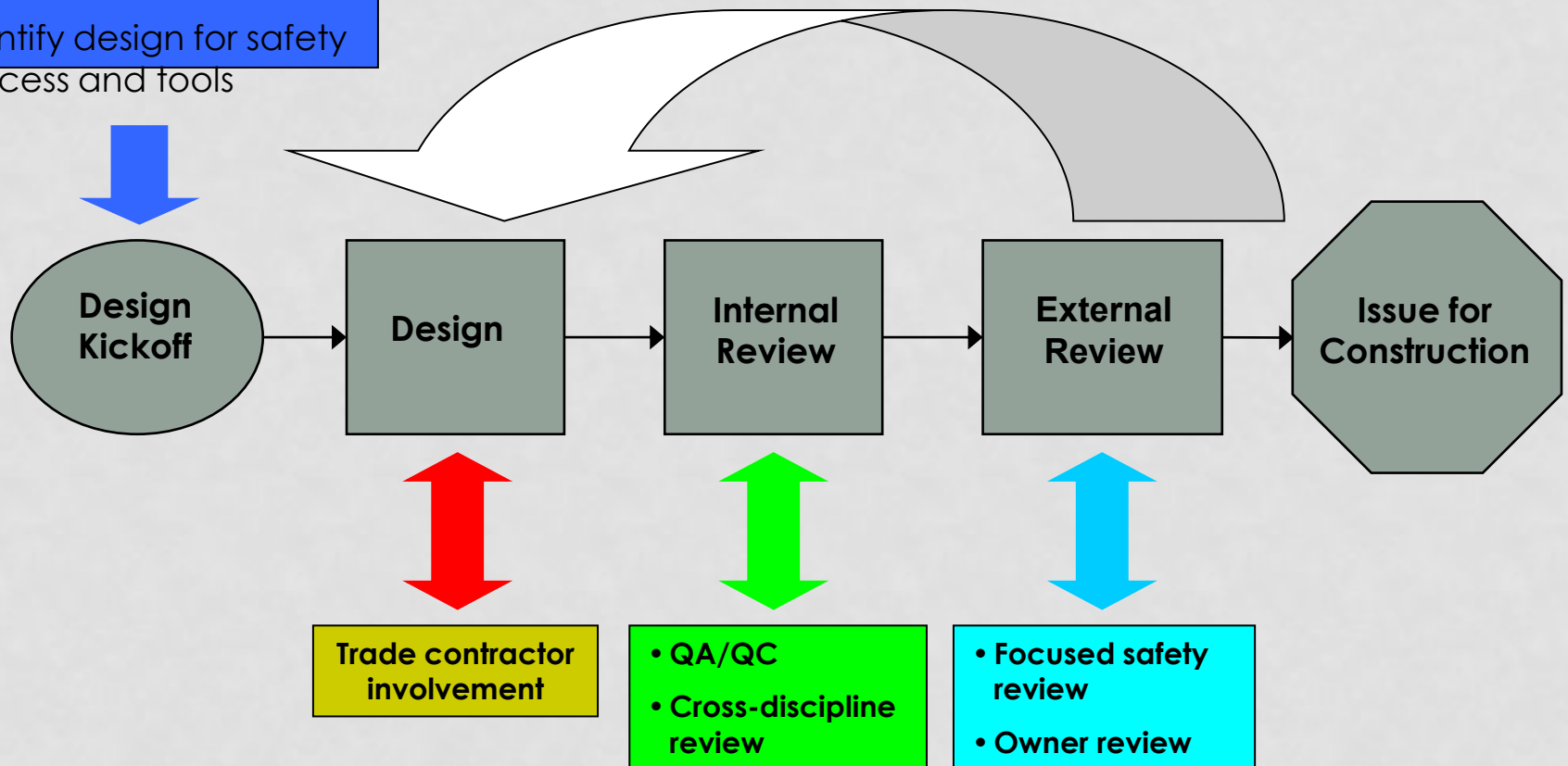
[http://upload.wikimedia.org/wikipedia/commons/0/08/Spiegel\\_Building\\_Hamburg\\_1.jpg](http://upload.wikimedia.org/wikipedia/commons/0/08/Spiegel_Building_Hamburg_1.jpg)



[http://www.mattmarko.com/gallery/albums/Prague/Fred\\_and\\_Ginger\\_Gehry\\_Building.jpg](http://www.mattmarko.com/gallery/albums/Prague/Fred_and_Ginger_Gehry_Building.jpg)

# PTD PROCESS <sup>6</sup>

- Establish design for safety expectations
- Include construction and operation perspective
- Identify design for safety process and tools

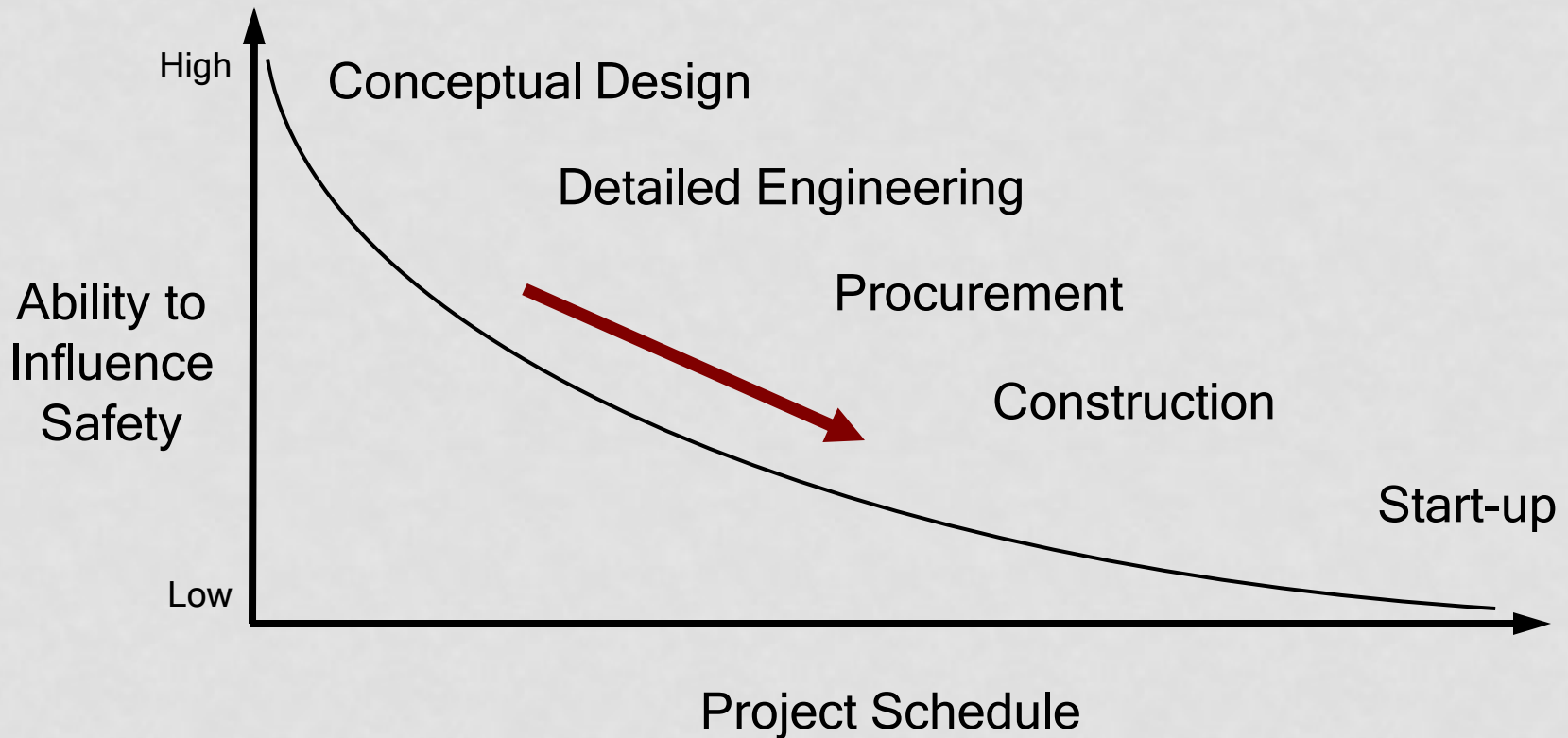


## Success will only be achieved by integrating occupational safety and health with ***engineering design process***

Stage	Activities
Conceptual Design	Establish occupational safety and health goals, identify occupational hazards
Preliminary Design	Eliminate hazards, if possible. Substitute less hazardous agents / processes, and establish risk minimization targets for remaining hazards. Assess risk and develop risk control alternatives.
Detailed Design	Select controls. Conduct Process Hazard Reviews.
Procurement	Develop specifications and include in procurements. Develop “checks and tests” for factory acceptance testing and commissioning
Construction	Construction site safety and contractor safety.
Commissioning	Conduct “checks and tests” including factory acceptance. Pre-start up safety reviews. Development of SOPs. Risk / exposure assessment. Management of residual risks.
Start Up and Occupancy	Education. Management of change. Modification of SOPs

# SAFETY PAYOFF DURING DESIGN

Considering Safety During Design Offers the Most Payoff <sup>5</sup>



# BENEFITS FROM PTD

- Reduced site hazards so fewer injuries
- Savings from reduced workers compensation insurance costs
- Increased productivity
- Fewer delays due to accidents
- Encourages designer-constructor collaboration



# BUSINESS VALUE

- The AIHA Value Strategy\* demonstrated the most significant business contributions result from...
  - Anticipating worker exposures and designing process improvements to reduce or eliminate these exposures
  - Aligning health and safety interventions with business goals
  - Integrating health and safety risk management requirements into the design process
    - Facilities, equipment, tools, processes, products and work flows
- ...resulting in significant contributions to business profitability

\*[www.ihvalue.org](http://www.ihvalue.org)

# OSHA REGULATIONS

- “Code of Federal Regulations” (29 CFR 1926)
- States can have more stringent regulations
- Updated annually



# Steel Erection eTool

[Home](#) [Definitions](#) [Scope](#) [Inspection Guide](#) [Additional Assistance](#) [F A Q](#) [Viewing/Printing Instructions](#) [Credits](#)

[\[Return to Safety and Health Topics Page\]](#)

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 that 30 of those deaths, as well as nearly 1,150 annual lost-workday injuries, will be averted by compliance with provisions of the new standard, developed with industry and labor through [negotiated rulemaking](#). To that end, this eTool\* has been created to educate employers and workers about the revised standard (Subpart R).



## Topics

- » [Site Preparation](#)
- » [Cranes](#)
- » [Structural Stability](#)
- » [Metal Buildings](#)
- » [\(Non-Hoist\) Overhead Hazards](#)
- » [Fall Protection](#)
- » [Training](#)

\*eTools are web-based training tools on occupational safety and health topics. They utilize graphical menus as well as expert system modules. As indicated in the [disclaimer](#), eTools do not create new OSHA requirements.

# CONSTRUCTION HAZARDS <sup>7, 8</sup>

- Falls
- Ergonomics/Musculoskeletal Injuries
- Falling Objects
- Tripping



[http://nycammlaw.com/personal\\_construct.html](http://nycammlaw.com/personal_construct.html)

# FALLS

- Number one cause of construction fatalities; in 2004, they accounted for 445 of 1,234 deaths, or 36 percent <sup>7</sup>
- Common fall situations include making connections, walking on beams or near openings such as floors or windows
- Fall protection for steel erection required at height of 15 feet above a surface <sup>10</sup>
- Causes include slippery surfaces due to water, ice or oil, unexpected vibrations, misalignment, and unexpected construction loads.

# PERSONAL PROTECTION EQUIPMENT (PPE)

- Last line of defense against injury <sup>4</sup>

Includes but not limited to:

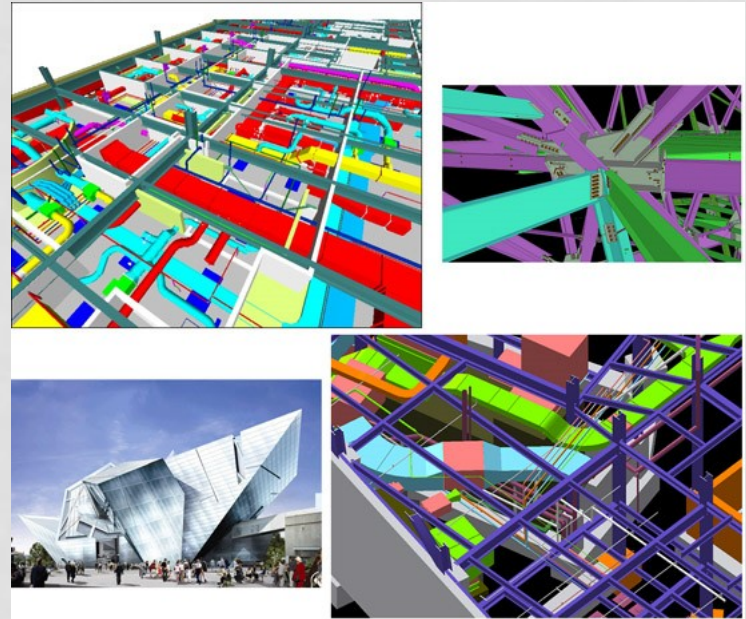
- Hardhats
- Steel-toed boots
- Safety glasses
- Gloves
- Fall harnesses



<http://www.safetyexpress.com/images/product/msa-technacurv.jpg>

# PTD PROCESS TASKS 11, 12

- Perform a hazard analysis
- Incorporate safety into the design documents
- Make a CAD model for member labeling and erection sequencing



[http://dcom.arch.gatech.edu/class/BIMCaseStudies/Readings/BIM\\_Symposium\\_files/fig9small.jpg](http://dcom.arch.gatech.edu/class/BIMCaseStudies/Readings/BIM_Symposium_files/fig9small.jpg)

# DESIGNER TOOLS

- Checklists for Construction Safety <sup>13</sup>
- Design for Construction Safety Toolbox <sup>14</sup>
- Construction Safety Tools from the UK or Australia
  - CHAIR <sup>4</sup>



# EXAMPLE CHECKLIST

Item	Description
<b>1.0</b>	<b>Structural Framing</b>
1.1	Space slab and mat foundation top reinforcing steel at no more than 6 inches on center each way to provide a safe walking surface.
1.2	Design floor perimeter beams and beams above floor openings to support lanyards.
1.3	Design steel columns with holes at 21 and 42 inches above the floor level to support guardrail cables.
<b>2.0</b>	<b>Accessibility</b>
2.1	Provide adequate access to all valves and controls.
2.2	Orient equipment and controls so that they do not obstruct walkways and work areas.
2.3	Locate shutoff valves and switches in sight of the equipment which they control.
2.4	Provide adequate head room for access to equipment, electrical panels, and storage areas.
2.5	Design welded connections such that the weld locations can be safely accessed.

# DESIGN, DETAILING AND FABRICATION PROCESS

STEEL

# THREE ENTITIES ASSOCIATED WITH DESIGN

- Engineer
- Detailer
- Fabricator



Design process of

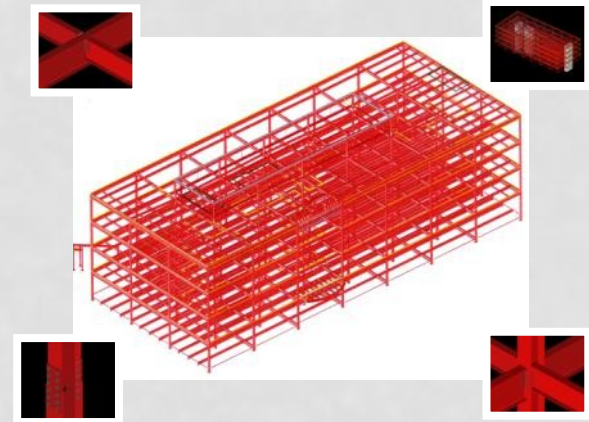
<http://www.prlog.org/10246402-affordable-cad-steel-detailing-structural-steel-drafting-services.html>

# DESIGN PHASE

- Owner tells A/E requirements for building
- Designer runs analysis on design according to building codes
- Building is designed for:
  - Safety, serviceability, constructability, and economy
- Final Design Specifications and Drawings are given to client
- Design calculations are safely stored by designer

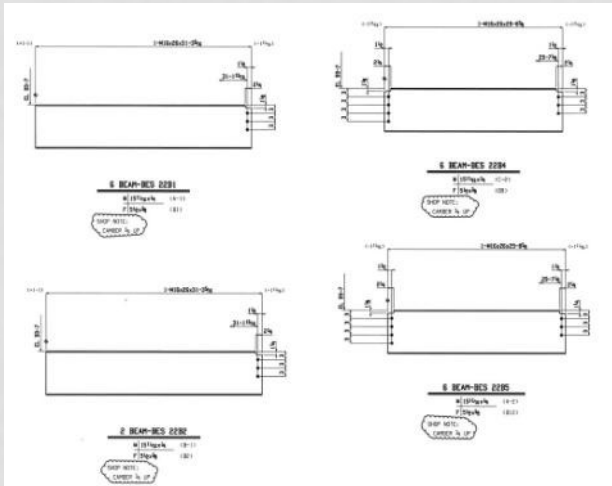
# Detailing <sup>15</sup>

The fabricator receives the engineer's drawings; then they will be programmed into computer software to help visualize the connections



<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."

<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."



## Shop Drawings <sup>15</sup>

While detailing, the fabricator makes drawings containing specific information about how to fabricate each member

# FABRICATION<sup>15</sup>

To achieve its final configuration the steel may be:

- Cut
- Sheared
- Punched
- Drilled
- Fit
- Welded



Each final member is labeled with a piece mark, length, and job number for identification

# TRANSPORTATION

Members are transported via:

- Flatbed truck
- Train
- Waterways



[www.cranetruckservices.com.au/cranetrucks.html](http://www.cranetruckservices.com.au/cranetrucks.html)



[cs.trains.com/trccs/forums/p/161645/1780701.aspx](http://cs.trains.com/trccs/forums/p/161645/1780701.aspx)

# ERECTION PROCESS

STEEL



# UNLOADING AND SHAKE-OUT <sup>15</sup>

- Steel members are unloaded from the trucks and placed on blocking to allow chokers to be easily attached.
- Shake Out: when members are sorted on the ground to allow for efficient erection.



<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."

# PICKING AND HOISTING <sup>15</sup>

- Cranes are used to lift members into place
- Columns have a hole at c end that is used to pick it up
- Beams have chokers tied around their center of gravity, and multiple beams can be lifted at once



<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."



# POSITIONING AND INITIAL BOLTING <sup>15</sup>

Each beam is lowered into place, and a worker will line it up correctly using drift pins. At least two bolts are attached before the crane releases the load (OSHA requirement).



<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."

# FINAL BOLTING<sup>15</sup>

Once everything is assured to be in the correct position, the final bolting is performed using a torque wrench or similar tool.



<sup>15</sup> Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical."

# EXAMPLES OF PREVENTION THROUGH DESIGN

STEEL

# TOPICS

Topics	Slide Numbers
Prefabrication	
Access Platforms	
Columns	
Beams	
Connections	
-Bolts	
-Welds	
Miscellaneous	

# PREFABRICATION <sup>16</sup>

- Shop work is often faster than field work
- Shop work is less expensive than fieldwork
- Shop work is more consistent due to a controlled environment
- Shop work yields better quality than fieldwork
- Less work is done at high elevations which reduces the risks of falling and falling objects

# EXAMPLE: PREFABRICATED TRUSS

- Less connections to make in the air
- Safer and faster



[www.niconengineering.com](http://www.niconengineering.com)



# ACCESS HELP

- Shop installed vertical ladders
- Bolt on ladders and platforms can be removed later, or kept for maintenance



# COLUMN SAFETY

- Column Splices
- Holes for safety lines
- Base plates



[http://www.dartmouth.edu/~opdc/images/nvh/summer06/071906\\_1.jpg](http://www.dartmouth.edu/~opdc/images/nvh/summer06/071906_1.jpg)

# COLUMN SPLICES

- Have column splice around 4 feet above the working floor <sup>17</sup>
- OSHA Requirement



Courtesy Bucknell University Facilities

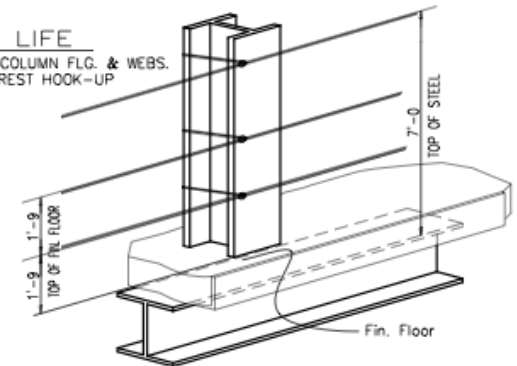
# HOLES FOR SAFETY LINES

18,  
19

- Include holes at 21 inches and 42 inches for guardrails.
- Additional higher holes can also be included for lifeline support.

SAVE YOUR LIFE  
WE HAVE PROVIDED HOLES IN COLUMN FLG. & WEBS.  
FOR SAFETY LINES & FALL ARREST HOOK-UP

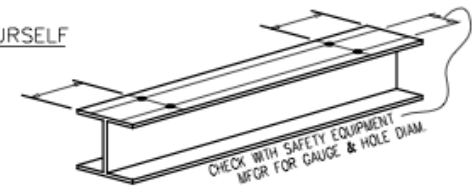
ATTACH YOURSELF



TYPICAL SAFETY LINE HOLES ON COLUMN

SAVE YOUR LIFE  
WE HAVE PROVIDED HOLES IN BEAM FLG.  
FOR FALL ARREST HOOK UP.

ATTACH YOURSELF



TYPICAL SAFETY TIES HOLES ON BEAM

TITLE: **Typical Safety Line Holes On Beam / Column**



ERECTOR/FABRICATOR NAME

DRAWN BY

JOB

DATE

JOB NAME

JOB No.

REV.#

DATE

SKETCH No.

A3<sup>5</sup>/<sub>6</sub>

1

02/09



# BASE PLATES 18, 19

- Column Base Plates should always have at least 4 anchor rods bolted in.
- OSHA Requirement

**Base Plate Plan View**      **Base Plate Plan View (With gussets)**

**NOTES:**  
 All columns shall be anchored with a minimum of (4) anchor rods as sized by the design engineer. Each column assembly shall be designed to resist a 300 pound eccentric load located 18" from the column face in any direction at the top of the column.

**SEE M4 3/8 FOR TABLES**

**Column on Leveling Plate**      **Column on Leveling Nuts**      **Column on Shim Pack(s)**

**THE MOST COMMON COLUMN BASE DETAILS**

**TITLE: 4-Bolts Column Anchorage**      1926-755(a)(1)(2)      (OSHA Mandate)

ERECTOR/FABRICATOR NAME	DRAWN BY	
	DATE	
JOB NAME	JOB No.	REV.# DATE
	SKETCH No.	M4 3/8 1 02/09

# BEAMS AND GIRDERS

Workers walk on beams to get to connections or other columns, which makes falling a common hazard. Being mindful of the following can greatly increase safety:

- Beam Width
- Use of Cantilevers
- Ability to Support Lifelines



<http://pacosteel.com/images/photos/Paco%20Floor%20joists.jpg>

# BEAM WIDTH <sup>18</sup>

For good walking surface, use a minimum beam width of 6 inches.



<http://www.rayconsteel.com/Pictures/WalkingSteel.JPG>

# USE OF CANTILEVERS<sup>18</sup>

Minimize the use of cantilevers for the following reasons:

- Cantilevers are not good for tying off
- It is harder to make connection



[http://www.carpenterscenter.com/2009/05/cantilever-erected\\_14.html](http://www.carpenterscenter.com/2009/05/cantilever-erected_14.html)



# ABILITY TO SUPPORT LIFELINES <sup>18, 19</sup>

- Design beams near or above openings to be able to support lifelines.
- The contract drawings should make clear how many lifelines each beam can support, and at what locations they can be attached.



# CONNECTIONS

Connections are very important, but they can be very difficult to install during construction.

There are two main methods of making connections:

- Bolts
- Welds



# BOLTS

For safe bolted connections, consider:

- Self-Supporting Connections
- Double Connections
- Erection Aids “Dummy Holes”
- Bolt Sizes
- Minimum Number of Bolts
- Awkward or Dangerous Connection Locations



<sup>21</sup> AISC “Bolting and Welding”

# SELF SUPPORTING CONNECTIONS 18, 19

- Avoid hanging connections
- Consider using beam seats

**SELF SUPPORT CONNECTIONS**  
(Bear On Instead Of Hang From)

**Choker**


Allows quicker release and safer erection  
(N/S flange not shown for clarity)


**AVOID**  
(Hang)

**DO**  
(Bear on)  
(Opt #1)

**DO**  
(Bear on)  
(Opt #2)

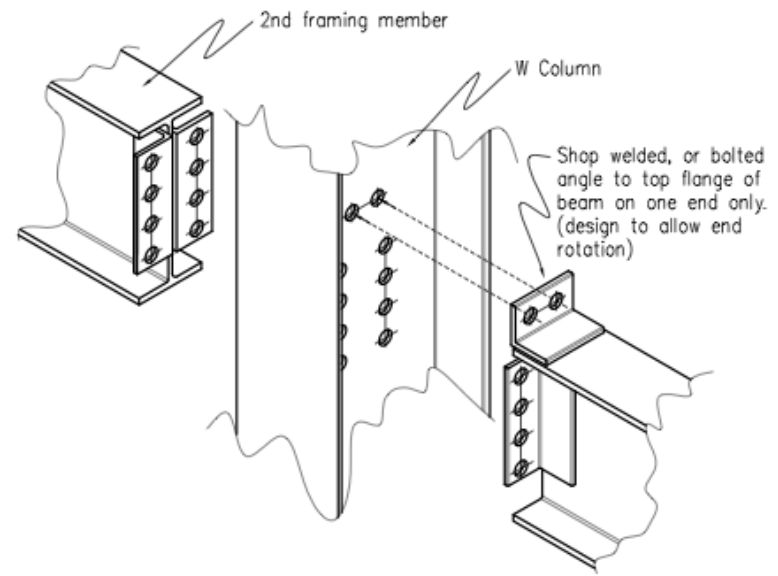
**TITLE: Self Support Connections (Suggested)**

	<b>ERECTOR/FABRICATOR NAME</b>		DRAWN BY		
	JOB		DATE		
	JOB NAME		JOB No.	REV.#	DATE
			SKETCH No. S5 <sup>a</sup> / <sub>b</sub>	1	02/09



# DOUBLE CONNECTIONS 18, 19


- Avoid beams of common depth connecting into the column web at the same location
- If double connections are necessary, design them to have full support during the connection process.
- OSHA Requirement



**NOTES:**

- 1) When two structural members on opposite sides of a column web share common connection holes, at least one bolt with a wrench tight nut shall remain connected to the second member, unless a shop attached, or field bolted seat, or similar connection device is present to secure the first member to prevent the column from being displaced.
- 2) One way to rectify this problem, is to install an angle to the top flange of one beam, and provide (2) extra bolts to hold this member in place until the second member is erected.

TITLE: **Double Angle Col.Conn.** [1926-756(c)(1)(2)] (OSHA Mandate) (Alternate)

	ERECTOR/FABRICATOR NAME		DRAWN BY	
	JOB		DATE	
JOB NAME		JOB No.	REV.#	DATE
		SKETCH No. M8 <sup>c</sup> /j	1	02/09

  |

# ALTERNATE DOUBLE CONNECTION



# ERECTION AIDS “DUMMY HOLES” 18

- Provide an extra “dummy hole” in the connection, where a spud wrench can be inserted.
- This is most appropriate when there are only two bolts



Courtesy Bucknell University Facilities

# BOLT SIZES<sup>18</sup>

- Use as few bolt sizes as possible



<http://www.ascenthardware.com/full-images/648601.jpg>



# MINIMUM NUMBER OF BOLTS <sup>18</sup>

- Use a minimum of two bolts per connection
- OSHA Requirement

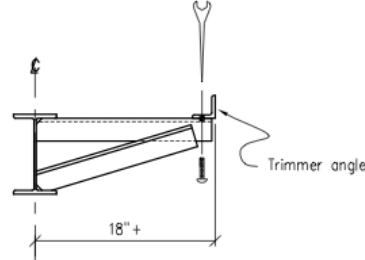


<sup>21</sup> AISC "Bolting and Welding"

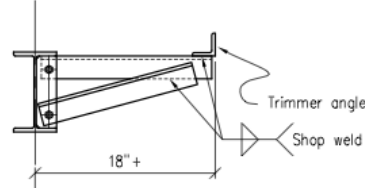
# AVOID AWKWARD OR DANGEROUS CONNECTION LOCATIONS 18, 19

- Time-consuming and dangerous
- Can cause strain

DETAILING FOR ERECTION SAFETY and EFFICIENCY





**Problem:** Bolting or welding at this location forces connector or welder to hang his body weight out of position.



**Solution:** Could be to shop weld trimmer angle with bracket angles and field bolt to a tab plate or stiffener where the connector does not have to "Hang Out" to make connection always consider the erector's access.

TITLE: **Out Of Position Bolting / Welding**

	ERECTOR/FABRICATOR NAME	DRAWN BY	
	JOB	DATE	
JOB NAME	JOB No.	REV.#	DATE
	SKETCH No. S8	1	02/09



<sup>19</sup> NISD and SEAA, *Detailing Guide For Erector's Safety & Efficiency*

# WELDS

Welding is when the base metal of the desired components is heated and fused together. For safe welded connections, you should consider:

- Avoiding Awkward or Dangerous Connection Locations
- Immediate Stability
- Welding Location
- Welding Material



[http://www.wildeck.com/images/about\\_us/manufacturing\\_welding\\_lg.jpg](http://www.wildeck.com/images/about_us/manufacturing_welding_lg.jpg)

# IMMEDIATE STABILITY <sup>18</sup>

Provide pin-holed or bolted connections to provide immediate stability after placement of members.

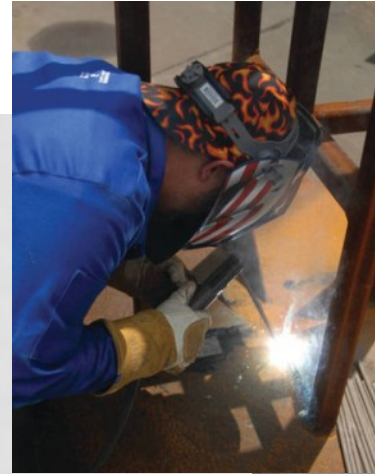


<sup>21</sup> AISC "Bolting and Welding"

# WELDING LOCATIONS 18

Design to have welding performed in shop rather than in field

If field welds are necessary, design should attempt to have them in convenient locations



<http://www.archithings.com/new-70z24-stick-electrode-from-hobart-brothers/2009/01/08/7024-stick-electrode-hobart-brothers>



[http://www.powermag.com/issues/departments/focus\\_on\\_o\\_and\\_m/Focus-on-O-and-M-August-2008\\_1382\\_p3.html](http://www.powermag.com/issues/departments/focus_on_o_and_m/Focus-on-O-and-M-August-2008_1382_p3.html)

# WELDING MATERIAL <sup>18</sup>

Welding can be a fire hazard and can emit toxic fumes. Always be aware of what material is being welded.



<http://romeiron.com/images/Welding-3.jpg>

# OTHER METHODS FOR SAFER CONSTRUCTION

- Avoid Sharp Corners
- Access Problems
- Temporary Bracing
- Crane Safety
- Member Placement
- Tripping Hazards

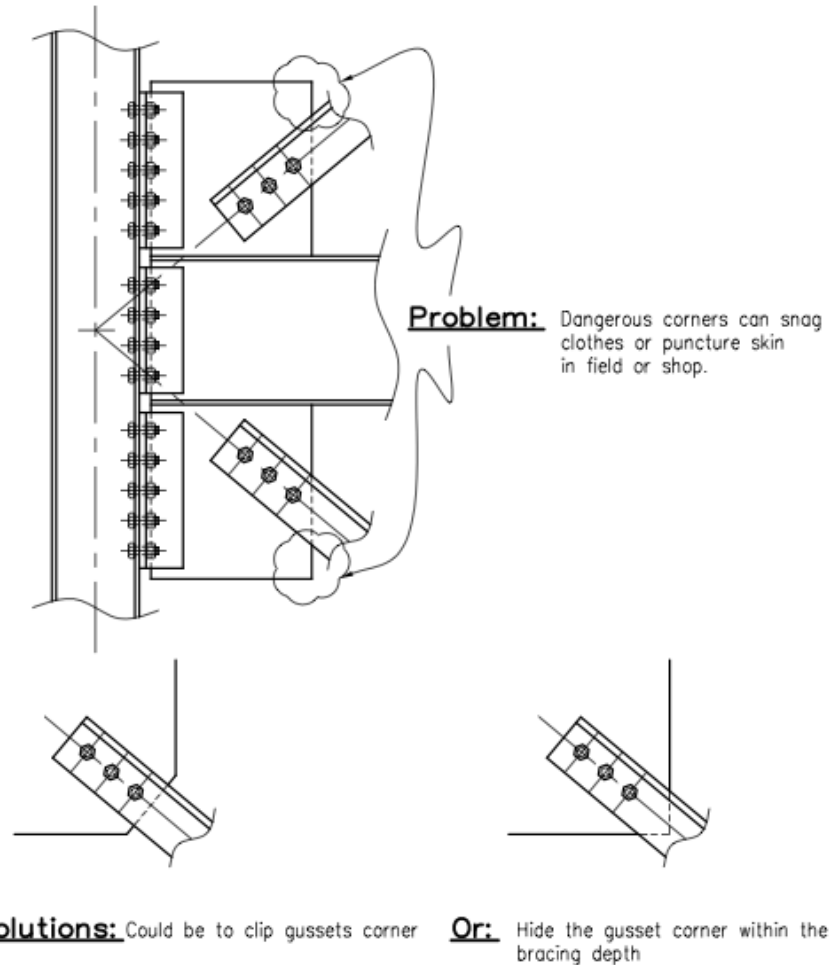


<http://www.gic-edu.com/uploads/structural%20steel%20cxn2.jpg>


# AVOID SHARP CORNERS <sup>19</sup>


Corners can cause clothing or wires to get snagged resulting in falling objects or tripping hazards.

They could also cause scratches or cuts.



**TITLE: Puncture / Snagging Hazards**

	ERECTOR/FABRICATOR NAME		DRAWN BY		
	JOB		DATE		
	JOB NAME		JOB No.	REV.#	DATE
			SKETCH No. S4 9/b	1	02/09



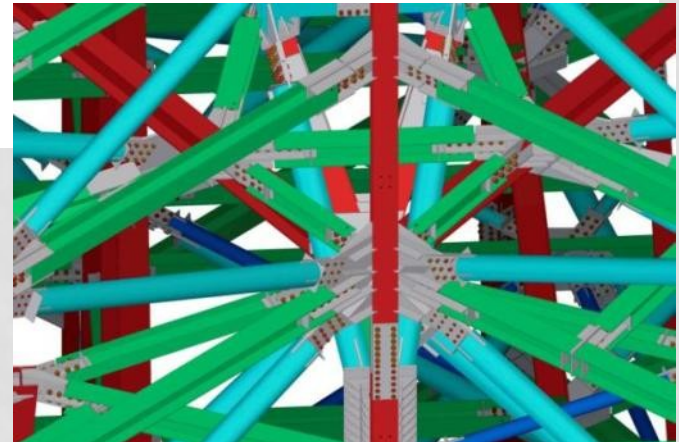
<sup>19</sup> NISD and SEAA, *Detailing Guide For Erector's Safety & Efficiency*



# ACCESS PROBLEMS

A complicated connection will take much more time to complete, and are potentially more dangerous if they require awkward positioning

- Provide Enough Space for Making Connections
- Small Column Size Access
- Hand Trap



[http://www.tekla.com/SiteCollectionImages/about-us/press-room-images/ts\\_Steel\\_connections.jpg](http://www.tekla.com/SiteCollectionImages/about-us/press-room-images/ts_Steel_connections.jpg)

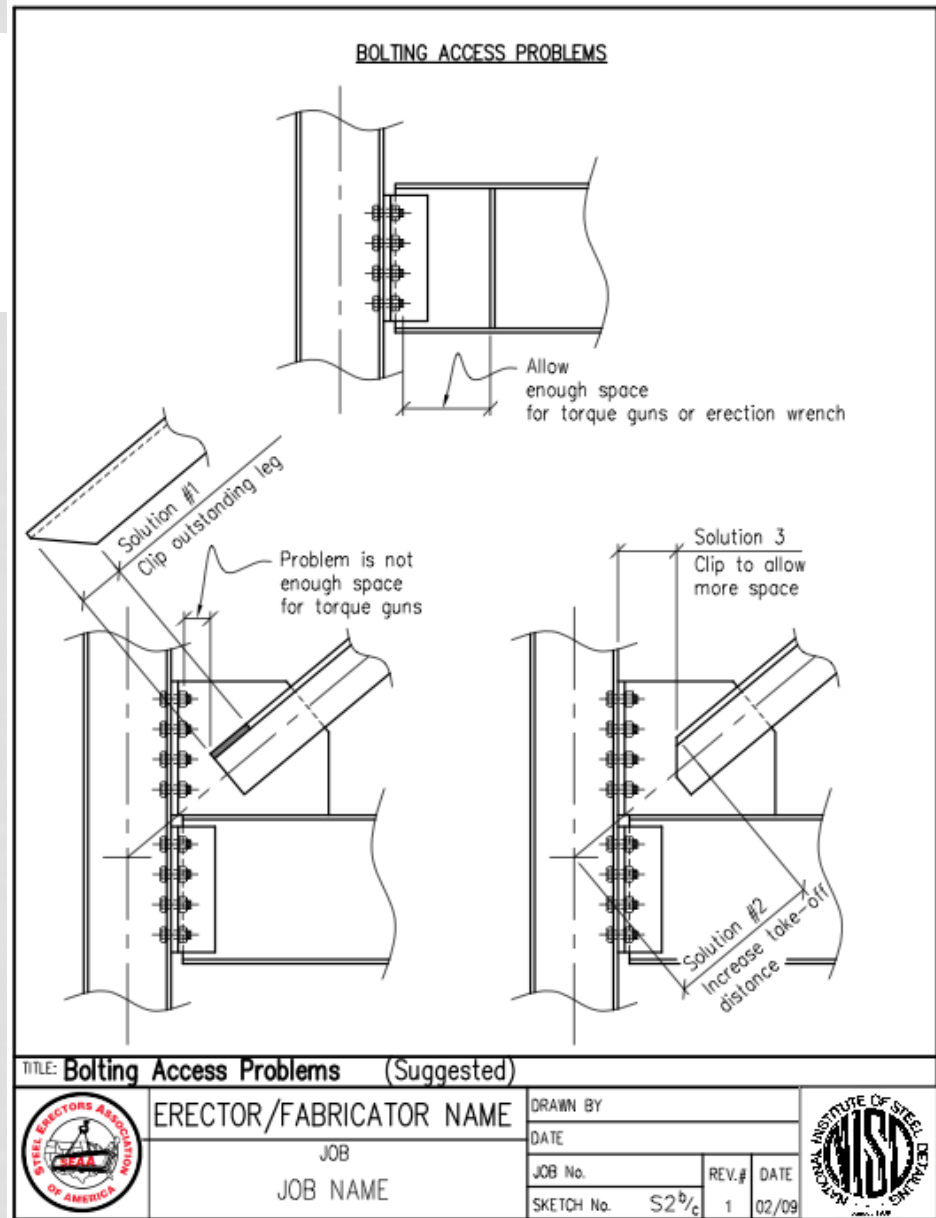


<http://www.rta.nsw.gov.au/environment/images/heritage/4305027b5.jpg>

# PROVIDE ENOUGH SPACE FOR MAKING CONNECTIONS <sup>19</sup>

There may not be enough space for common tools

These connections can be made better by clipping away portions or increasing distances



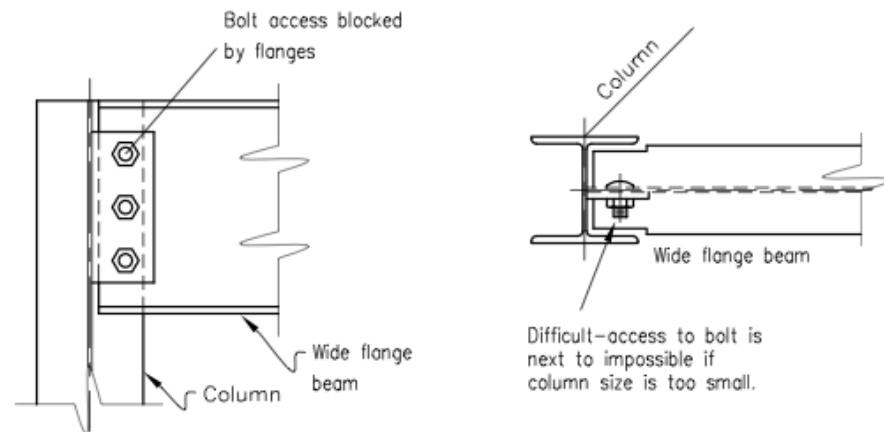
<sup>19</sup> NISD and SEEA, *Detailing Guide For Erector's Safety & Efficiency*

# SMALL COLUMN SIZE ACCESS <sup>19</sup>

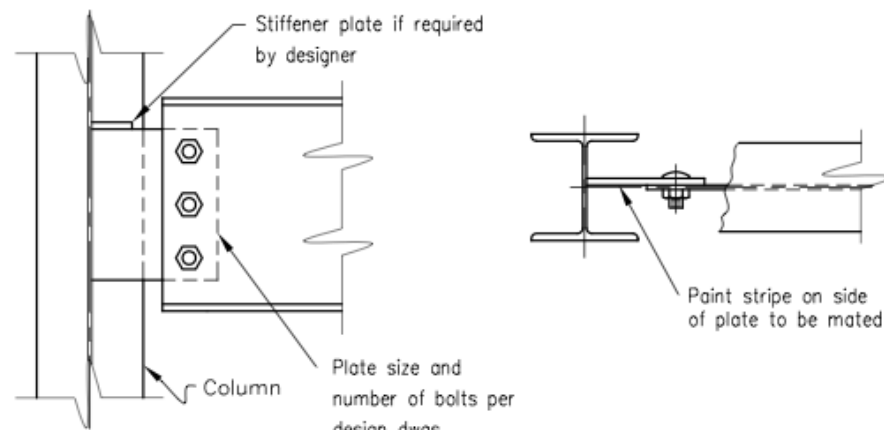
Small column depth can make connections difficult

Access to bolts can be blocked by the column flanges

Attach a tab to the column





**ELEVATION VIEW - AVOID - PLAN VIEW**



**ELEVATION VIEW - DO - PLAN VIEW**

**TITLE: Bolt Access Problems at Small Columns**

	ERECTOR/FABRICATOR NAME		DRAWN BY		
	JOB		DATE		
	JOB NAME		JOB No.	REV.#	DATE
			SKETCH No.	S2 <sup>9/c</sup>	1 02/09



<sup>19</sup> NISD and SEAA, *Detailing Guide For Erector's Safety & Efficiency*

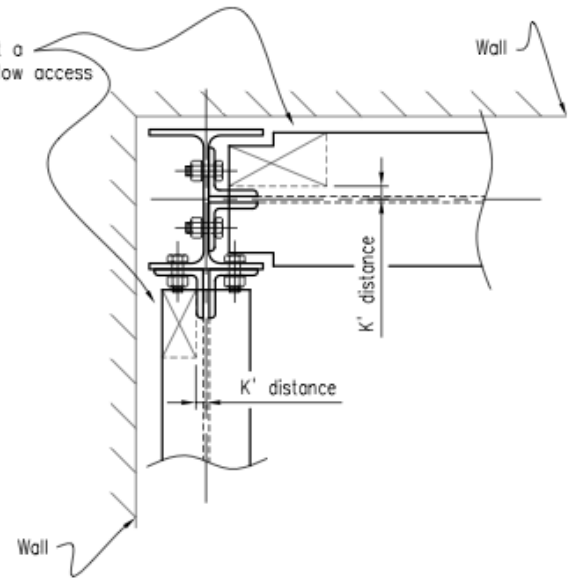
# HAND TRAP <sup>19</sup>

The situation shown can create a dangerous hand trap

A solution is to cut out a section of the flange to allow access to the bolts

**Solution:**


Could be to cut out a flange section to allow access



**Problem:**

- This very common situation creates a potentially difficult and dangerous trap.
- Access to bolts holes is not possible for erection wrenches and for torque guns and hands can be caught between beams and wall if not enough space is available.

TITLE: Access Problem / Hand Trap

	ERECTOR/FABRICATOR NAME		DRAWN BY		
	JOB		DATE		
	JOB NAME		JOB No.	REV.#	DATE
			SKETCH No. S3	1	02/09



<sup>19</sup> NISD and SEAA, *Detailing Guide For Erector's Safety & Efficiency*

## APPROXIMATE SIZES OF TOOLS 19

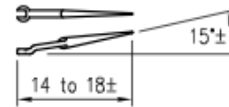
“Knuckle-busting” – when workers’ knuckles get damaged from trying to fit their hands into a tight space



### APPENDIX 1

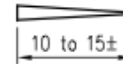
Here are sketches showing what tools look like along with dimensions to allow proper clearances when detailing in tight corners...  
(Exact dimensions should be checked with actual manufacturer's and/or erector technical data)

#### The Erection Wrenches



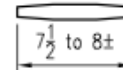
This "Connector" tool is used to guide pieces and align holes, hold parts in alignment while bolting, also known as "Spud Wrench" or "Spanner" (works best with a minimum of two holes connection)

#### The Bull Pins



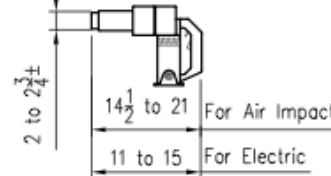
Are used to "Pull pieces together by hammering its tapered shaft into misaligned holes.

#### The Drift Pins



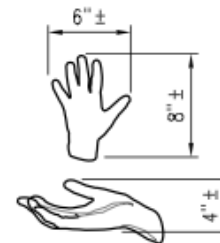
Are used to align large connection parts together. It is hammered in and has the same constant diameter as the holes in the connection.

#### The Torque Guns



Are used to torque bolts to proper tension. Two types are seen on jobs the impact guns (compressed air driven) or the electric guns (used with T.C. bolts). Note that electric guns have a fixed drive and have to be operated in line with bolts.

#### The Hands



This most important "Connector's" equipment is used for holding the tools, inserting bolts, maneuvering pieces into place, signaling to others... Good detailing practices should always allow enough space to insert that tool for "Making" the connection. Bear in mind that in cold weather it is gloved and needs more space.

#### TITLE: The Tools of The trade



ERECTOR/FABRICATOR NAME

DRAWN BY

DATE

JOB

JOB NAME

JOB No.

REV.#

DATE

SKETCH No.

A1

1

02/09



# CRANE SAFETY

- Erection will require cranes to lift members into place, which can be difficult due to the site layout.

- It is very useful to put the site utilities on plans to assist with crane management.

- It is ideal to consult with the contractor when designing for crane safety.

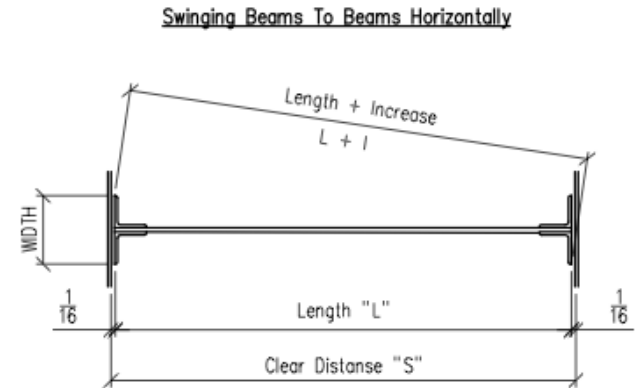


<http://image.made-in-china.com/2f0j00IMNTSIRWHfzK/Tower-Crane.jpg>

# MEMBER PLACEMENT <sup>19</sup>

All members must have enough space to fit between columns


Not enough space can lead workers to tilt columns to make it fit




**Note:** If length plus increase exceeds clear span "S", beams cannot be swung without moving supporting beams or beating into place. This is objectionable and in some cases impossible. Refer such conditions to Project Manager.

Width in Inches	INCREASE "I"																		
	CLEAR DISTANCE "S" IN FEET																		
	6	8	10	12	14	16	18	20	22	24	26	28	30	35	40	45	50	55	60
6	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	0	0	0
7	3/8	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	0	0
8	1/2	3/8	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
9	5/8	1/2	3/8	3/8	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
10	3/4	1/2	1/2	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
11	7/8	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8
12	1	3/4	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8
13	1 1/4	7/8	3/4	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8
14	1 3/8	1	7/8	3/4	5/8	1/2	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8
15	1 5/8	1 1/4	1	7/8	3/4	5/8	5/8	1/2	1/2	3/8	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4
16	1 3/4	1 3/8	1 1/8	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4
17	2	1 1/2	1 1/4	1	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	1/2	1/2	3/8	3/8	1/4	1/4	1/4
18	2 1/4	1 3/4	1 3/8	1 1/8	1	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	1/2	3/8	3/8	1/4	1/4	1/4

TITLE: **Swinging Beams To Beams Horizontally**

	ERECTOR/FABRICATOR NAME	DRAWN BY	
	JOB	DATE	
JOB NAME	JOB No.	REV.#	DATE
	SKETCH No. A4	1	02/09



# TRIPPING HAZARDS

19

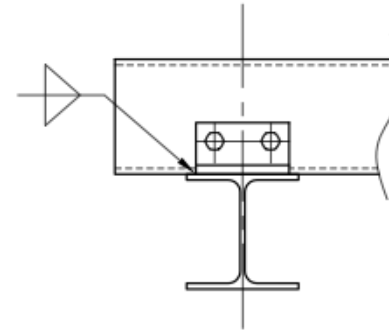
Avoid having connections on top of beams and joists



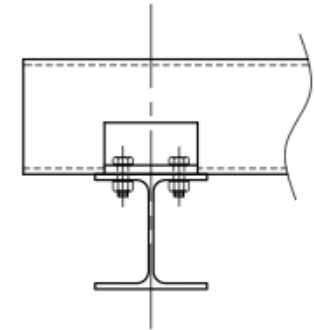
[http://www.shingleberrysigns.com/design\\_icon/warning%2016%20trip%20hazard.gif](http://www.shingleberrysigns.com/design_icon/warning%2016%20trip%20hazard.gif)

## TRIPPING HAZARDS

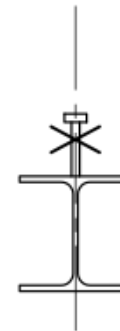
Any Connections Or Other Obstructions Should Be Avoided On Top Of Beams Or Joists.



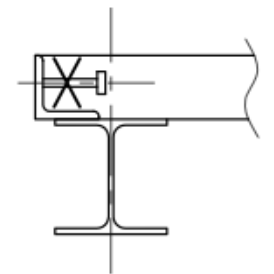
Not Recommended





Preferred  
(Field Bolted Or  
Field Welded)



Shop attached studs  
not recommended



Not recommended if stud projects beyond  
beam centerline and poses a tripping hazard

TITLE: <b>Tripping Hazards</b>		1926-754(c)(1)(i)	
	ERECTOR/FABRICATOR NAME		DRAWN BY
	JOB		DATE
	JOB NAME		JOB No.
			REV.#
		SKETCH No.	M2 1 02/09
			

19 NISD and SEAA, *Detailing Guide For Erector's Safety & Efficiency*



# RECAP

- Prevention through Design is an emerging process for saving lives, time and money.
- PtD is the smart thing to do. PtD is right thing to do.
- While site safety is ultimately the contractor's responsibility, the designer has the most power to create drawings with good constructability.
- There are tools and examples to facilitate Prevention through Design.

# Help make the world a safer place

## Perform Prevention through Design on your projects

**For more information please contact National Institute for Occupational Safety and Health (NIOSH)**

**800-CDC-INFO (800-232-4636) TTY: (888) 232-6348 24 Hours/Every Day**

[cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov)

***DISCLAIMER:** The findings and conclusions in this presentation have not been formally reviewed by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.*

# CITATIONS

- 1 *The Construction Chart Book: the U.S. Construction Industry and Its Workers*. Silver Spring, MD: CPWR - The Center for Construction Research and Training, 2008.
- 2 Behm, M. (2005). "Linking construction fatalities to the design for construction safety concept." *Safety Science* 43: 589-611.
- 3 European Foundation for the Improvement of Living and Working Conditions, 1991. *From Drawing Board to Building Site (EF/ 88/17/FR)*. European Foundation for the Improvement of Living and Working Conditions, Dublin.
- 4 *CHAIR Safety in Design Tool*. New South Wales WorkCover. (2001).
- 5 Szymberski, R. (1997). "Construction project planning." *TAPPI J.*,80(11), 69-74.
- 6 Placeholder for Gambatese
- 7 United States Bureau of Labor Statistics. Office of Safety, Health, and Working Conditions. *Injuries, Illnesses, and Fatalities in Construction, 2004*. By Samuel W. Meyer and Stephen M. Pegula. Washington D.C.: U.S. Bureau of Labor Statistics, 2006. Compensation and Working Conditions Online.

# CITATIONS

- 8 Lipscomb, Hester J., Judith E. Glazner, Jessica Bondy, Kenneth Guarini, and Dennis Lezotte. (2006). "Injuries from Slips and Trips in Construction." *Applied Ergonomics* 37(3): 267-74.
- 9 Toole, T. M. and J. A. Gambatese. (2002). "Primer on Federal Occupational Safety and Health Administration Standards." *Practice Periodical on Structural Design and Construction*. Vol. 7, No. 2. pp 56 – 60.
- 10 United States Department of Labor, Occupational Safety and Health Administration. *Regulations Part 1926 – Safety and Health Regulations for Construction, Subpart R – Steel Erection, Standard Number 1926.760 – Fall Protection*.
- 11 Toole, T. M. "Increasing Engineers' Role in Construction Safety: Opportunities and Barriers. (2005). " *Journal of Professional Issues in Engineering Education and Practice* 131(3): 199-207.
- 12 Hinze, J. and F. Wiegand. "Role of Designers in Construction Worker Safety." (1992). *Journal of Construction Engineering and Management*, Vol. 118, No. 4: 677-684.
- 13 Main, B.W., Ward, A.C., (1992) "What Do Engineers Really Know and Do About Safety?, Implications for Education, Training, and Practice," *Mechanical Engineering*, Vol. 114, No. 8, August.

# CITATIONS

- 14 Gambatese, J. A., Hinze, J., and Haas, C. T. (1997). "Tool to design for construction worker safety." *J. Archit. Eng.*, 3(1): 32-41.
- 15 Daccarett, V., and T. Mrozowski. "Structural Steel Construction Process: Technical." American Institute of Steel Construction, *AISC Digital Library*. Powerpoint. (2002) <<http://www.aisc.org/content.aspx?id=21252>>
- 16 Toole, T. M., and J. Gambatese. (2008). "The Trajectories of Prevention through Design in Construction." *Journal of Safety Research* 30(2): 225-30.
- 17 "OSHA Steel Erection ETool: Structural Stability." *Occupational Safety and Health Administration*. <<http://www.osha.gov/SLTC/etools/steelerection/structural.html>>
- 18 Gambatese, J. A. *Design for Safety*. RS101-1. Construction Industry Institute, 1996.
- 19 National Institute of Steel Detailing and Steel Erectors Association of America. *Detailing Guide For Erector's Safety & Efficiency. Volume II*. 2009. [www.nisd.org](http://www.nisd.org) and [www.seaa.net](http://www.seaa.net). National Institute of Steel Detailing. Oakland, California. Steel Erectors Association of America. Greensboro, North Carolina

# CITATIONS

- 20 United States Department of Labor, Occupational Safety and Health Administration. *Regulations Part 1926 – Safety and Health Regulations for Construction, Subpart M – Fall Safety, Standard Number 1926 Subpart M App C – Personal Fall Arrest Systems - Non-Mandatory Guidelines for Complying with 1926.502(d)*
- 21 American Institute of Steel Construction. "Bolting and Welding." *AISC Digital Library*. Powerpoint. (2004). <<http://www.aisc.org/content.aspx?id=21760>>
- 22 Sperko Engineering Services, Inc. *Welding Galvanized Steel -- Safely*. (1999). <<http://www.sperkoengineering.com/html/articles/WeldingGalvanized.pdf>>.