Design of Steel Joists and Roof Decks
Michael R. Miller, P.E.

Topics for Discussion
- Design Responsibility
- What is a "standard joist"?
  - Assumptions
  - Dimensions
  - Designations
- Joist Design for Wind Uplift
  - Properly specifying uplift
  - Joist design by manufacturer for uplift
  - Seat design
  - Connection design

Design Responsibility
- Steel Joist Institute Code of Standard Practice
- Joist Supplier’s Responsibilities Include:
  - Design of standard joists per Steel Joist Institute Specifications
  - Design of special joists for specified load case(s)
  - Determining bridging requirements
    - Wind uplift
    - Lateral bracing of top chord if required (SSR)

Whose Responsibility Is It?
- Joist supplier?
- Steel fabricator?
- Contractor?
- Other trades?
- Specifier?

Steel deck connections for diaphragm

BETTER PARTNERS. BETTER PRODUCTS. BETTER OUTCOMES.
Design Responsibility

• Joist Supplier’s Responsibilities Do Not Include:
  • Determining framing scheme
  • Calculating wind pressure from wind speed
  • Determining load requirements or load combinations
    from building codes
  • Determining loads from mechanical drawings
  • Designing lateral bracing system
  • Connection design

Drawing Review

• All Verified Items Must Be Answered
  • Engineer of record
  • Loads
  • Structural issues
  • Contractor
  • Building dimensions
  • Attachment locations
  • Steel detailer
  • Bearing details
  • Dimensions

What Is a Standard Joist?

• SJI designation
• Standard dimensions
• Uniform load only

Steel Joist Institute

• SJI Specification is a performance spec
  • References load table
  • Specifies how joist is to be designed
  • No requirement for any physical size
  • Bearing depths
  • Bridging requirements

Steel Joist Institute

• SJI Standard seat depth – Flat Bearing
  • K and KCS
  • Most LH and DLH
  • DLH18 or DLH19
    2 ½ inches
    5 inches
    7 ½ inches
    Increase K series when opposing LH series
    Depths may increase to fit larger members for high uplift

Standard Assumptions

• Vulcraft Normally Assumes
  • SJI Standards apply
  • Seat depth
  • Live load deflection is span/360
  • Camber per chart to offset permanent dead load
  • Joists are laterally braced by roof deck
  • All joist design requirements are specifically stated on
    structural drawings
  • Loads are distributed to panel points

Steel Joist Institute

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Steel Joist Institute

- SJI Standard seat depth
  - Most Joist Girders 7 ½ inches
  - Left of blue line
  - Large Joist Girders 10 inches or more
  - Right of blue line

  See charts in Vulcraft catalog

Increased Depths Required

- Uplift
  - For high uplift, end web size will increase
  - May require different shapes
  - May require increased seat depth

- Sloped Bearing

Sloped Bearing

- Sloped seats required
  - Assumed 4” bearing
  - Maximum gap is 1/8”
  - Slope greater than 3/8:12
  - Sloped seats not required
  - Slope is less that 3/8:12
  - No top chord extension, or top chord only

Sloped Bearing

- Sloped seats required
  - Long bearing length
  - R type extension
  - Maximum slope for standard bearing will become less than 3/8:12
  - Similar for LH joists

Sloped Bearing

- Increased depth required
  - See charts in Vulcraft catalog
  - Depths shown
  - Minimiums (more is OK)
  - Clearance for end web
  - Clearance for extension
  - Contact Vulcraft for extreme slope rates (6:12 or more)

Series Determined by:
- Loading
- Span
- Depth

K-Series
- Simple span truss
- Uniform load
  - From SIJ table
  - Indicated by note or diagram
- Web system can be rod or single angle
- Pinned joints
- Axially loaded members
- Minimum panel shear 25% of end reaction

LH-Series, DLH-Series
- 18” minimum depth
- 168” maximum depth, but cost increases greatly beyond 144”
- Shear and moment consistent with SIJ tables
- Same material and production method as K-series
- L/24 span-depth limit

DLH-Series
- Deeper and longer
- Same design approach
- DLH (Deep Longspan)
  - Load table depths 48”- 120”
  - Spans up to 240’
- SLH (Super Longspan)
  - Formerly a Vulcraft design
  - Now included in the SIJ tables

Joist Girders
- Primary framing member
- Design for concentrated loads
- Unbraced between load locations
  - TC L/r_y = 575
  - Self supporting for construction
  - Otherwise virtually the same as LH
What Is the Joist Depth?

- Sloped top chord?
- End depth?
- Centerline depth?
- Gable joists?

Joist Depth

- Designation depth is at centerline
- Exception is offset double pitch – ridgeline depth
- Not limited to catalog depths

Joist Depth

Nominal Depth

Nominal Depth

Nominal Depth

How Do I Specify Wind Uplift?

Units – lbs/square foot – lbs/linear foot?

Code requirements?

- Wind speed, design load, gross/net
- Roof zones

SJI Uplift Specifications

- For K-Series
- 5.11 UPLIFT
  - Where uplift forces due to wind are a design requirement, these forces must be indicated on the contract drawings in terms of net uplift in pounds per square foot (Pascals). When these forces are specified, they must be considered in the design of joists and/or bridging.

SJI Uplift Specifications

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Calculating Net Uplift

- Responsibility of the Specifying Professional
- Various approaches are possible
- Joist supplier needs clear information about what they are expected to do
- Industry terminology is not always consistent
- Prefer a net uplift in psf

Uplift Zones

- Net Uplift
- Values
  - Field
  - Edge
  - Corner
- Some judgment can be used
  - Under 15 psf or 100 plf – more bridging
  - Over 15 psf or 100 plf – joist design can be affected

- Subtract permanent Dead Load from Gross Uplift

Uplift Zones

- Net Uplift
- Values
  - Field
  - Edge
  - Corner
- Some judgment can be used
  - Under 15 psf or 100 plf – more bridging
  - Over 15 psf or 100 plf – joist design can be affected

  - ASD $0.6D + W$
  - LRFD $0.9D + 1.6W$

- IBC 2012, 2015
  - ASD $0.6D + 0.6W$
  - LRFD $0.9D + 1.0W$
Uplift Zones

- Net Uplift
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Joist Design for Uplift

- Basic Gravity Load Chord Forces
  - Top chord in compression
    - Laterally braced by roof deck
    - No additional bracing required
  - Bottom chord in tension

- Stress Reversal Under Uplift Load
  - Top chord in tension
  - Bottom chord in compression
    - Lateral bracing required
    - Additional bridging is normally provided

Joist Design for Uplift

- Member forces when stress reversal is present

- Stress Reversal from Basic Gravity Load
  - Top chord in tension
    - Size cannot be less than required for gravity load
    - Uplift generally not the controlling design case
    - Can govern for high uplift

- Stress Reversal from Basic Gravity Load
  - Bottom chord in compression
    - Must be checked for lateral stability
    - Additional row of bridging each end
    - Normal bridging may be sufficient for interior
    - Other options for high uplift

- Stress Reversal from Basic Gravity Load
  - First end diagonal web
    - In tension under gravity load
    - Becomes a compression member under uplift
    - Normally has a long unsupported length
    - Stresses in all webs reverse
      - Interior webs sometimes designed alternately for tension and compression
      - All members must be checked
      - Size cannot be less than that required by gravity load design
Joist Design for Uplift

- First joint is particular concern
  - Intersection of three primary members
    - Bottom chord
    - End web
    - First interior web
  - Compression under uplift loading
    - Bottom chord
    - End web
  - Unstable

First Bottom Chord Panel Point Forces - Uplift

Example Design for Uplift

Example Joist Design for Uplift

- Bottom chord $L_{yy}$ braced by bridging

Example Joist Design for Uplift

- Tension webs must be checked for compression
Example Joist Design for Uplift

- For high uplift, end web size will increase
  - May require different shapes
  - May required increased seat depth

Connection Design for Uplift

- Connections part of the load path
  - Design of joist seat
  - Capacity of attachment
    - Welds
    - Bolts

Connection Design for Uplift

- SJI Code of Standard Practice
  - Section 6.1 PLANS FURNISHED BY BUYER
    - "(a) Loads
      - "(a) loads shall clearly provide all design loads as described in Section 2.3. This includes...the wind uplift if any..."

Connection Design for Uplift

- Division of Responsibility
  - 43rd Catalog of the SJI End Anchorage for Uplift
    - "For wind uplift conditions it is the responsibility of the specifying professional to specify the wind uplift forces and the attachment of the joist or Joist Girder seat to the support element..."

Connection Design for Uplift

- SJI Code of Standard Practice
  - Section 6.1 PLANS FURNISHED BY BUYER
    - "(b) Connections
      - "(b) Minimum End Anchorage...shall be in accordance with the Steel Joint Institute Standard Specifications..."
BETTER PARTNERS. BETTER PRODUCTS. BETTER OUTCOMES.

Connection Design for Uplift

- SJI Code of Standard Practice
  - Section 6.1 PLANS FURNISHED BY BUYER
    - (b) Connections
      - "The adequacy of the end anchorage connection (bolted or welded) between the... bearing seat and the supporting structure is the responsibility of the specifying professional. The contract documents shall clearly illustrate the end anchorage connection."

- SJI Code of Standard Practice
  - Section 6.1 PLANS FURNISHED BY BUYER
    - (b) Connections
      - "...When the end anchorage is welded, it is recommended that the specifying professional consider a smaller fillet weld thickness in conjunction with a longer weld length."

- 43rd Catalog of the SJI
  - Welded Anchorage
    - The strength of the joist bearing seat for an uplift loading combination is a function of both the joist seat thickness and length of the end anchorage welds.

- 43rd Catalog of the SJI
  - Welded Anchorage
    - The minimum anchorage welds from the SJI Specification may not develop the full capacity of the joist seat assembly for uplift.
    - Longer end anchorage weld length aids the joist manufacturer in providing an economical design of the joist bearing seat.

- 43rd Catalog of the SJI
  - Welded Anchorage
    - To aid in the design and efficiency of the joint bearing seat, it is suggested that the minimum weld lengths be increased by one inch whenever there is net uplift and sufficient bearing length for the longer weld.

<table>
<thead>
<tr>
<th>JOIST SERIES and SECTION NUMBER</th>
<th>MINIMUM FILLET WELD</th>
<th>SUGGESTED INCREASED WELD LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>K Series</td>
<td>(2) 1/8&quot; x 2&quot;</td>
<td>(2) 1/8&quot; x 3&quot;</td>
</tr>
<tr>
<td>LH Series, 02-06</td>
<td>(2) 3/16&quot; x 2&quot;</td>
<td>(2) 3/16&quot; x 3&quot;</td>
</tr>
<tr>
<td>LH/DLH Series, 07-17</td>
<td>(2) 1/4&quot; x 2&quot;</td>
<td>(2) 1/4&quot; x 3&quot;</td>
</tr>
<tr>
<td>DLH Series, 18-25</td>
<td>(2) 1/4&quot; x 4&quot;</td>
<td></td>
</tr>
</tbody>
</table>
Connection Design for Uplift

- 43rd Catalog of the SJI
  - Bolted Anchorage
    - Final welding is typical for stability
    - Only bolts are considered anchorage for uplift
    - Provide sufficient tensile strength for uplift reaction
    - Higher strength than minimums per SJI may be required

Connection Design for Uplift

- 43rd Catalog of the SJI
  - Bolted Anchorage
    - Bolts shall be installed if required for uplift
    - Alternative weld may be allowed by specifying professional
    - Weld is made in seat slot first.
    - If additional weld is required, it must be located away from slot as shown in next detail

Connection Design for Uplift

- Weld Location for Slotted Seat

Connection Design for Uplift

- Seat Uplift Capacity Must Be Established
  - Tables are now published by the SJI
  - Seat capacity may not always be fully developed
  - Manufacturer will provide required capacity, not the chart maximum
  - Some dialog between supplier and specifier may be required

Available Uplift Values for K and KCS Connections

<table>
<thead>
<tr>
<th>Connection Type to Supporting Member</th>
<th>LRFD Strength Kips</th>
<th>ASD Strength Kips</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) 1/8” x 2” welds</td>
<td>9.3</td>
<td>6.2</td>
</tr>
<tr>
<td>(2) 1/8” x 3” welds</td>
<td>9.8</td>
<td>6.5</td>
</tr>
<tr>
<td>(2) 1/4” A307 bolts</td>
<td>10.5</td>
<td>7.8</td>
</tr>
<tr>
<td>(2) 1/4” A325 bolts</td>
<td>10.5</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Available Uplift Values for LH, DLH and Joist Girder Connections

<table>
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<th>ASD Strength Kips</th>
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</thead>
<tbody>
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<td>9.3</td>
<td>6.2</td>
</tr>
<tr>
<td>(2) 3/16” x 3” welds</td>
<td>11.8</td>
<td>7.9</td>
</tr>
<tr>
<td>(2) 1/4” x 3” welds</td>
<td>20.3</td>
<td>19.6</td>
</tr>
<tr>
<td>(2) 1/4” x 4” welds</td>
<td>20.3</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Green indicates values controlled by seat angle thickness of 3/8”, seat length of 6”, 3/8” gap
Available Uplift Values for LH, DLH and Joist Girder Connections

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<tr>
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<td>11.8</td>
<td>7.9</td>
</tr>
<tr>
<td>(2) ¼” x 3” welds</td>
<td>20.3</td>
<td>13.6</td>
</tr>
<tr>
<td>(2) ¼” x 4” welds</td>
<td>20.3</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Green indicates values controlled by seat angle thickness of ½”, seat length of 6”, 0” gap.

Connection Design for Uplift

- Points to Note
  - Values are maximum available
  - Manufacturer may use thinner seat material
  - Depending on uplift reaction
  - Uplift requirement from specifying professional
  - Greater values can be achieved using 4 bolts
  - Support must accommodate this detail
  - All bolt values assume standard washers are provided

Connection Design for Uplift

- Complete Discussion in SJI Technical Digest #6

What About Lateral Moments?

- Load path?
- Connections?
- What moments to include?
- When to make the connection?

Joist Girder Frames

- A structural frame utilizing joist girders with rigid connections at the supports.
- The rigid connections allow the joist girder to carry moments in addition to the reactions from the joist girder loads.
Determine approximate moment of inertia of joist girder:

\[ I_{JG} = 0.027 N P L d \]

- \( N \) – number of joist spaces
- \( P \) – panel point load
- \( L \) – length in feet
- \( d \) – depth in inches

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• Determine area of joist girder cross section
• Refer to Vulcraft catalog for girder weight
• \( A_{JG} = \) girder weight (plf) / steel density (490 pcf)

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• Design information required by joist girder manufacturer.
  SJI Technical Digest offers two options:
  1. Provide end moments and gravity loads
  2. Convert the end moments to axial loads based on the joist girder effective depth and provide the chord axial loads and gravity loads.

Vulcraft recommends against converting the end moments to axial loads.

Therefore…..

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• Design information required by joist girder manufacturer.
  Standard joist girder designation
  • Lateral moments due to wind and/or earthquake
  • Live load moments
    - (Axial loads)
    - (Net uplift)
Joist Girder Frames

- Connection Details

Basic Connection

Welded Basic Connection

Eccentricity with Basic Connection

Maximum P

4 k to 10 k

Joist Girder Frames

- Commentary and Recommendations in Vulcraft Literature

Welded Basic Connection with Tie
Girder Moment Plate

Joist Girder Frames
• Connection Details

Axial Loads & Lateral Moments
• Can be applied to
  • K-series
  • LH, DLH, SLH-series
  • Joist Girders
• Connection must transfer the load

Moment Connections
• Consider load path
• No axial load capacity for 7 1/2 inch deep girder seats
• Sloped seats should not transfer axial load

What About Concentrated Loads?
• Double joist?
• Standard joist?
• KCS series?
• Special joist?
  • Add load
  • Load diagram
Option 1 - Use Double Joists

- Generally conservative
- Simple
- Not very efficient
- Potential problems with framing & bridging

Option 2 – Select a Standard Joist

Using $W_{EQ} = 292$ plf
$W_L = 172$ plf
with a span of 44-00
from the SJI Load Table

<table>
<thead>
<tr>
<th>Joist</th>
<th>TL/LL</th>
<th>Weight/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>22K11</td>
<td>311/146</td>
<td>13.8</td>
</tr>
<tr>
<td>24K10</td>
<td>298/154</td>
<td>13.1</td>
</tr>
<tr>
<td>28K9</td>
<td>295/181</td>
<td>13.0</td>
</tr>
<tr>
<td>30K8</td>
<td>291/192</td>
<td>13.2</td>
</tr>
<tr>
<td>28LH05</td>
<td>297/180</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Option 3 – Select a KCS Joist

Designed in accordance with the Standard Specifications for K-series joists, plus . . .

- Constant moment capacity.
- Constant shear capacity.
- Interior webs designed for 100% stress reversal.
- Top chord end panel designed for axial load based on the force in the end web.
- No check for secondary bending.
Option 3 – Select a KCS Joist

**Disadvantages . . .**
- Much heavier than standard designation or “special design” joists.
- More expensive per unit than standard K-series joists. *(But overall project may be more economical.)*

**Advantages . . .**
- Provides alternative to joist supplier provided “special designs” for joints with concentrated or unusual loading conditions.
- Allows the Design Professional to know the capacity of the joint being provided for a special loading condition.
- Can accommodate moving loads or loads that are not possible to locate.

**REMEMBER . . .**
- The equivalent uniform load calculated from the required resisting moment must not exceed 550 plf.
- If the equivalent uniform load exceeds 550 plf, you have two options:
  - a) Use 2 KCS-series joints to provide a total moment and shear capacity equal to the required.
  - b) Use an H-joist selected for the equivalent uniform load. Provide a Load Diagram for this option.

Option 3 – Select a KCS Joist

- Determine the required maximum end reaction and moment.
- Calculate the equivalent uniform load from the maximum moment.
- Find a KCS-series joist from the Load Table that has an end reaction and moment greater than the required.
- Check the required number of bridging rows using the standard K-series bridging chart.
Option 4 – Specify and “Add Load”

For occasions when the TOTAL Concentrated Load to be applied is ≤ 2000 # and the location cannot be determined on the structural drawings:

Vulcraft will design for:

\[ M_{\text{max}} = \frac{wL^2}{8} + \frac{PL}{4} \]

and

\[ R_{\text{max}} = \frac{wL}{2} + P \]

Note that secondary bending is NOT checked.

The Structural Engineer must provide the following information:

1. The SJI Standard Joist designation, or the uniform total and live loads
2. The amount of the “Add Load”

Example:

20K4SP or 20K200/100SP and SP=Design for additional load of 1000# applied at any panel point.

Can an all series be designed for an “Add Load”?

K series: YES  Girders: YES

LH series: YES  KCS series: NO

DLH series: YES

Option 5 – Provide Specific Loads

The Structural Engineer must provide the following information:

1. The SJI Standard Joist designation, or the uniform total and live loads
2. The additional point loads to be included

Example:

20K200/100SP

Local Moments

Local moments have a very significant effect on joist chords – Often cannot work at all
Local Moments

Connect to both chords so that only axial loads are applied to the joist.

Design per ASD or LRFD?

• Assumptions for conversion
• Load factors
• Deflection
• Load cases

\[ \Phi = \ ? \]

\[ \Omega = \ ? \]

LRFD Load Table

• SJI has adopted a dual specification, similar to AISC
• Total load = 1.5 x ASD Total load
• Live load is unchanged

LRFD Load Table

• LRFD Total load = 1.5 x ASD Total load
• Assume
  • L = 3D
  • LRFD Total load = 1.2D + 1.6L (factored)
  • ASD Total load = D + L (unfactored)
• Substituting
  • LRFD Total load = 1.2D + 1.6(3D) = 6D (factored)
  • ASD Total load = D + 3D = 4D (unfactored)
• \( \frac{6D}{4D} = 1.5 \)
• LRFD Total load (factored) = 1.5 x ASD Total load (unfactored)

LRFD Load Table

• Joist selection for uniform gravity load
• Procedure is similar to ASD
  • Procedure is similar to ASD
  • T = 1.2D + 1.6L
  • D = 100 plf
  • L = 100 plf
  • Factored load = 280 plf
  • Span = 30'
• LRFD
  • 16K4 capacity 324 plf
  • 18K3 capacity 304 plf
• ASD (unfactored)
  • 16K4 capacity 216 plf
  • 18K3 capacity 203 plf

LRFD Load Table

• Live load is unchanged
• Deflection check only
  • Load which will produce deflection of L/360
  • Based on member sizes required for strength
  • Same moment of inertia
LRFD Load Table

- Deflection check for uniform live load
  - Procedure is identical to ASD
  - L = 100 plf
  - Span = 30’
  - Published live load produces deflection of L/360
    - 1604 live load 112 plf
    - 1803 live load 123 plf
  - If L/240 is the criterion, multiply by 1.5

LRFD Load Combinations

- Special design joists
- Specifying professional will need to spell out
  - Unfactored loads
    - D – dead
    - L – live (occupancy & equipment)
    - R – rainwater
    - S – snow live
  - Load combinations
    - ASCE 7 or other cases as deemed appropriate

LRFD Girder Designations

- Factored load is used in the designation
- Would be extremely conservative to assume unfactored
- Factored load is followed by “F” rather than “G”

How to Handle Deflection?

- What’s the load?
- What about top chord extensions?
  - L180?
  - L/240?
  - L/360?
  - L/600?

Deflection

- SJI load tables show a live load which will produce a deflection of L/360
  - Part of the standard design process
  - More or less severe limits can be specified
    - L/600 (within reason)
    - L/240 for total load

Deflection

- Scissor joists and arches will move horizontally under load
  - We can control, but not eliminate this deflection
Impossible Deflection Criteria

• "...no deflection under live load..."
• For KCS joist, "Maximum deflection shall be limited to..."
• "Deflection at end of joist extension shall be limited to..."
• Deflection limit of L/600 on long joist

Top Chord Extensions

• "If the loading diagram for any condition is not shown, the joist manufacturer will design the extension to support the uniform load indicated in the K-Series Joist Load Table for the span of the joist."
• What can happen
  • 10K1 x 12-00 supports 200 plf total load
  • From the SJI load table, $w_{tu} = 550$
  • Top chord extension 3-00
  • Deflection for 550 plf exceeds L/120 with the largest members available
  • But for 200 plf we could maintain L/360 with no problem

How Should Deck Be Attached?

• Screws?
• Welds?
• Pneumatic pins?
• Powder actuated pins?
• Button punching?
• Diaphragm shear?

Steel Deck Attachment - Supports

• Fastener types
  • Welds
  • Screws
  • Pneumatic or powder actuated pins

Steel Deck Attachment - Supports

• Welds
  • Most common
  • 5/8” puddle weld or equivalent
  • Minimum spacing
    • SJI – 36 inches (to brace joist top chord)
    • SDI – 18 inches
    • ICBO, FM, and UL – various
    • Diaphragm shear – determined by load

Steel Deck Attachment - Supports

• Weld washers
  • Improve weld quality for 24 gage and lighter
  • Not required by SDI, AISI, or AWS for 22 gage or heavier
  • SDI research
    • Not recommended for 22 gage and greater
    • Better weld quality without washers
  • Some UL numbers list washers
Steel Deck Attachment - Supports

- Screws and pins
  - Unskilled workers can install
  - Clean & neat appearance
  - Capacity
    - Dependable
    - Lower than quality welds
    - Higher cost than welds
  - Proper selection to avoid damage to thin chords

Steel Deck Attachment - Sidelaps

- Screws
  - Most common
  - Unskilled workers can install
  - Clean & neat appearance
  - Can be used for all gages

Steel Deck Attachment - Sidelaps

- Welding
  - Requires great care
  - Proper settings
  - Burn through top layer(s)
  - Deposit weld on bottom layer
  - Not recommended for 22 gage or lighter

Steel Deck Attachment - Sidelaps

- Button Punching
  - Requires great care
  - Full engagement of male-female connection
  - Stand on female side
  - Special tool
  - Common in ICBO regions
  - Not recognized by SDI for diaphragm

Steel Deck Attachment - PunchLok

**PUNCHLOK II**
**ROOF DECK**
Weld and Screw Support Connections

- Crimps sidelaps to create a positive connection
- Higher diaphragm shear values

Steel Deck Attachment - PunchLok

- Deck is specified as
  - 1.5PLB
  - 3.0PLN
- Usual support connections
  - Weld
  - Powder actuated or pneumatic pins
Steel Deck Attachment - PunchLok

- PunchLok II tool
  - Hand-held
  - Pneumatically-operated
  - First clinches sheets together
  - Then shears and permanently offsets male and female layers of material

Steel Deck Attachment - PunchLok

- Vulcraft Sidelap Connection 2
  - Sheared surface of male leg should be visible in the cut

Steel Deck Attachment - PunchLok

- Vulcraft Sidelap Connection 2
  - ASD Diaphragm shear values of 2000-3000 psf can be achieved
  - Tables include interaction with uplift

Questions and Answers