EFFICIENT DESIGN OF HSS CONNECTIONS

PRESENTED BY KIM OLSON, PE, FORSE CONSULTING, LLC
HSS structures, in general, are more expensive than those made up primarily of wide flange sections

- Material
  - Columns
  - Beams
- Fabrication
  - Weld shop or bolt shop?
SHEAR CONNECTIONS

SINGLE PLATE CONNECTION

SCALE: 1" = 1'-0"

(3) 3/8" DIA. A325-N BOLTS

WT CONNECTION

SCALE: 1" = 1'-0"

(4) 3/8" DIA. A325-N BOLTS
**SHEAR CONNECTIONS**

**DOUBLE ANGLE CONNECTION**

- Scale: 1" = 1'-0"
- (2) L 3½"x3½"x½x32x0'-8½"
- HSS 8x4x3/8"
- (3) ¾" DIA. A325-N BOLTS

**THROUGH PLATE CONNECTION**

- Scale: 1" = 1'-0"
- PL ¾" DIA. A325-N BOLTS
- (3) ¾" DIA. A325-N BOLTS
- HSS 8x4x3/8"
Research found it is 4 times more expensive to specify a through plate than a shear plate welded to the face of the HSS wall.

Increase your wall thickness to avoid a through plate connection.

Watch your weld symbols. 2 directions.
THROUGH PLATE SHEAR CONNECTION

When to specify a through plate shear connection

• Axial loads
• Delegated connection engineer and column is too thin

When **NOT** to specify a through plate shear connection

• As your standard connection!!!
HSS HOLLOW STRUCTURAL SECTIONS

MOMENT CONNECTION

PJP OPTION

SCALE: 1" = 1'-0"

CJP OPTION

SCALE: 1" = 1'-0"

5/16" PLATE w/ (3) 3/4"Ø A325 BOLTS

45°

1/4"

45°

1/4"

5/16" PLATE w/ (3) 3/4"Ø A325 BOLTS

W12x53

HSS 10x10x5/8"

W12x53

HSS 10x10x5/8"
MOMENT CONNECTION

THROUGH PLATE OPTION

SCALE : 1" = 1'-0"

HSS 10x10x3/8"

3/4" BASE PLATE w/ (4) 3/4" Ø A325 BOLTS

5/8" PLATE w/ (3) 5/8" Ø A325 BOLTS

W12x45

3/4"x10"x1'-11" PLATE w/ (8) 3/4" Ø A325 BOLTS

CUT OUT PLATE OPTION

SCALE : 1" = 1'-0"

HSS 10x10x3/8"

3/4" PLATE TOP & BOT. w/ (8) 3/4" Ø A325 BOLTS

5/8" PLATE w/ (3) 5/8" Ø A325 BOLTS

W12x45
<table>
<thead>
<tr>
<th></th>
<th>PJP Weld</th>
<th>CJP Weld</th>
<th>Through Plate</th>
<th>Cut Out Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column Wall t (in)</td>
<td>5/8</td>
<td>5/8</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>Relative Costs</td>
<td>1.0</td>
<td>1.43</td>
<td>1.59</td>
<td>1.38</td>
</tr>
</tbody>
</table>
WELDS
MATCHED VS STEPPED CONNECTION

Matched Connection

Stepped Connection
WELDS MATCHED CONNECTION

Tube Profiling  Weld backing  Steel backing
MATCHED VS STEPPED CONNECTION
Minimum weight of the truss ≠ least cost
Fabrication costs factor heavily into finished structure cost
Size to develop the yield strength of the branch member
  • Conservative
  • Upper limit of weld size
  • Appropriate if plastic stress redistribution is required for connection (moving loads)

Size to resist applied forces
  • Must account for effective weld lengths

Proper joint design should allow you to specify an economical fillet weld
TRUSS CONNECTIONS – WELD SIZING

Gapped
• Less expensive

Overlapped
• Stronger joint
• Higher percentages of overlap, the higher the joint strength -> stiffer truss
PJP VS CJP WELDS

PJP welds are a good option if fillet weld sizes become large.

CJP welds are generally not required and should be avoided.

Increase HSS wall thickness if needed.

Fillet weld ≈ 2 hours fit up work for one guy.

CJP weld ≈ 1 – 1.5 days fit up work plus owner-incurred UT testing.
Purchasing HSS from a Service Center

Lengths of members? Waste?
Available sizes – Capability Tool

Capability Chart
<< Adjust search parameters

SHAPE: Round
GRADE: A500 B/C
SEISMIC RATING: N/A

Product Capability

The following Producers regularly manufacture the selected shape as part of their rolling schedule.

Independence Tube
jtassone@independencetube.com
(800) 376-6000
http://independencetube.com

The following Producers do not regularly manufacture the selected shape as part of their rolling schedule, however their capabilities include this size. Please inquire directly for ordering options.

Atlas Tube
sales@atlastube.com
(800) 773-5683
http://atlastube.com

Independence Tube
jtassone@independencetube.com
(800) 376-6000
http://independencetube.com
NOW TO THE REALLY EXCITING STUFF...

..... THE CODE!
AISC 360-10, CHAPTER K

- Tables
  - Prescriptive
  - Unique to the Spec
- Repetitive
- Limits of Applicability
“Additional Requirements for HSS and Box-Section Connections”

Introduction clearly states the requirements of Chapter J also apply

ONE DOES NOT SIMPLY FOLLOW A FORMULA
Largely unchanged

- New Limit of Applicability
- Shear tab not mentioned
- Cap plate not mentioned

Packer, 2015
RECTANGULAR SECTIONS

- References Chapter J
- Fundamentally

HSS HOLLOW STRUCTURAL SECTIONS
For connections greater than \( d \) from HSS member end, Spec Eq. (J10-2):

\[
F_{yw} = F_y \text{ of HSS} \\
t_w = 2 \times t_{des} \\
l_p = t_p \\
k = \text{corner radius} \geq 1.5 \times t_{des}
\]

Spec Eq. (K1-9) in Table K1.2

subject to the limits in Table K1.2A

For connections less than \( d \) from HSS member end, use Spec Eq. (J10-3).

Spec Section J10.10.1A.5
HSS HOLLOW STRUCTURAL SECTIONS

RESOURCE – LIMIT STATE TABLE

https://steeltubeinstitute.org/hss/hss-information/aisc-360-16/
A500 GR B VS GR C SMACKDOWN

- DUAL CERT!!!
- Always specify Grade C!
Due to the flexibility of their walls, local strength of an HSS at the connection may control the capacity of the connection.

This is very different than designing for Wide Flange (WF) supports.

Understanding this while sizing members will mean efficient and economical connections without the need for costly stiffeners or reinforcing.
ZOOM WEBINAR SETTINGS

Audio Options:

Questions:
AVAILABLE DESIGN CODES

AISC 360-16/10/05 (ASD/LRFD)
AISC 341-10 (ASD/LRFD)
CSA S16-14/09
AVAILABLE HSS CONNECTION TYPES

Shear Connections
- HSS Column/Beam Clip Angle
- HSS Column/Beam End Plate
- HSS Column/Beam Shear Tab

Moment Connections
- HSS Column/Beam Ext. End Plate
- HSS Column/Beam Flange Plate
- HSS Column/Beam Direct Weld

Truss
- HSS to HSS

Brace
- Vertical Diagonal Brace
- Vertical Chevron Brace
- Knee Brace

Baseplate
- HSS Column
- HSS Column w/ Vertical Brace
QUESTIONS...?