Night School 26: Developing an Eye for Connection Design

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Session 3 – Load Paths & Force Distribution

July 27, 2021 | Larry Muir

Smarter.
Stronger.
Steel.

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Course Description

Load Paths & Force Distribution
July 27, 2021

This session will review Lower and Upper Bound Theorems and look at it from a practical approach: satisfying equilibrium, not exceeding any limit states, and taking measures to ensure ductility. The session will discuss strength/stiffness considerations, present Uniform Force Methods and address shear lag.

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Learning Objectives

1. List common assumptions in design of connections.
2. List the three key items of the lower bound theorem to ensure a safe, practical connection.
3. Define ductility and its role in safe, connection design.
4. Explain the role of judgement in connection design.

Night School 26: Developing an Eye for Connection Design

Session 3: Load Paths & Force Distribution

July 27, 2021

Larry Muir, PE, Consultant

Smarter. Stronger. Steel.

Load Paths & Force Distribution

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Load Paths & Force Distribution

Things I am going to talk about:

- Why there are decisions to be made and how judgement is involved in determining force distributions.
- What makes sense and what does not relative to force distributions.
- Economic impacts of assumptions about force distributions.

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Lower Bound Theorem

We do not know the distribution of forces in the structures we design

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Lower Bound Theorem

Common Assumptions

- Isotropic
- Homogenous
- Elastic
- Perfectly Plastic
- Pinned
- Fixed
- Laterally Supported
- Torsionally Restrained
- And Many More

Lower Bound Theorem

a redundant structure is so sensitive in the elastic range to the small imperfections and variations inevitable in practice that it is impossible to make a close estimate of the elastic stresses present

~~~ The Steel Skeleton

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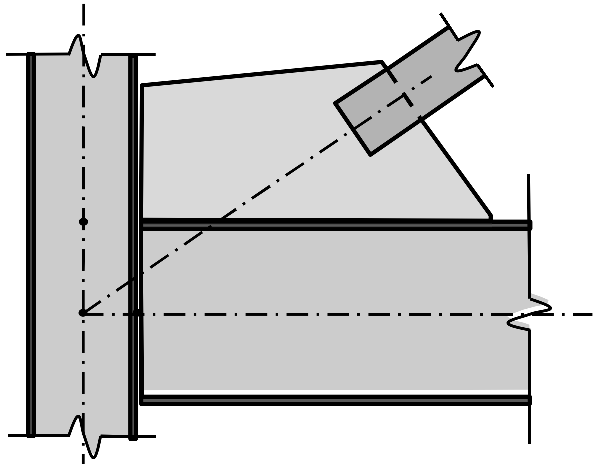
Lower Bound Theorem

A vertical brace connection is an indeterminate system



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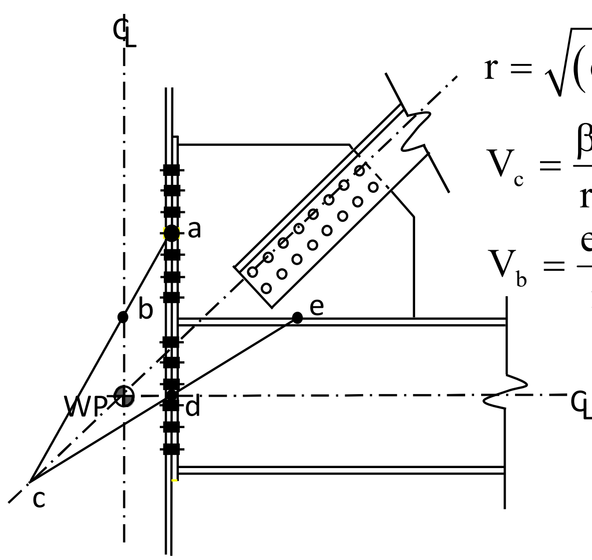
Lower Bound Theorem

The Uniform Force Method

- Standardized procedure
- Consistent with the boundary conditions
- Satisfies equilibrium.



$$r = \sqrt{(\alpha + e_c)^2 + (\beta + e_b)^2}$$

$$V_c = \frac{\beta}{r}P \qquad H_c = \frac{e_c}{r}P$$

$$V_b = \frac{e_b}{r}P \qquad H_b = \frac{\alpha}{r}P$$

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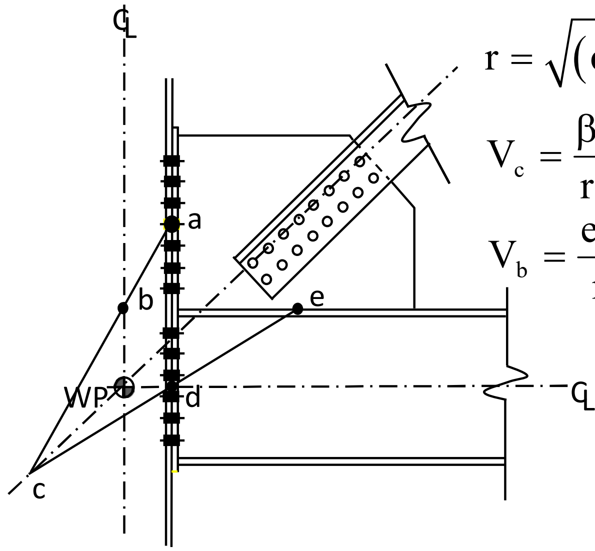
Lower Bound Theorem

The Uniform Force Method

It's Statics
Not Magic



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Lower Bound Theorem

The Uniform Force Method

Want more on the Uniform Force Method:

- AISC Design Guide 29 (a free download for members from www.aisc.org/dg). Derivation in Appendix A.
- AISC Education Archives: Night School 6, Session 2: The Uniform Force Method

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Lower Bound Theorem

How do we know these are the forces that will exist in the connection?

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Lower Bound Theorem

How do we know these are the forces that will exist in the connection?

We don't. But it doesn't matter

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Lower Bound Theorem

How do we know these are the forces that will exist in the connection?

We don't. But it doesn't matter… too much.

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Lower Bound Theorem

The Lower Bound Theorem

The applied external forces in equilibrium with the internal force field are less than or, at most, equal to the applied external force that would cause failure, provided that all the limit states are satisfied and sufficient ductility exists to allow redistribution of the forces.

~~~Paraphrased From Baker, Neal, etc.

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Lower Bound Theorem

A Practical Approach

1. Choose a force distribution that satisfies equilibrium – statically admissible.

2. Do not exceed any limit states.

3. Take reasonable measures to ensure ductility.

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Lower Bound Theorem

A Practical Approach

1. Choose a force distribution that satisfies equilibrium

2. Do not exceed any limit states.

3. Take reasonable measures to ensure ductility.

Requires some judgement and faith.

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Lower Bound Theorem

A Practical Approach

1. Choose a force distribution that satisfies equilibrium
2. Do not exceed any limit states.
3. Take reasonable measures to ensure ductility.

Could there be a relationship between these?

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Lower Bound Theorem

The Lower Bound Theorem

Why does this work?

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Lower Bound Theorem

The Popeye Effect

At some point every material stands all it can stands and it can't stands no more.

Brittle materials break

Ductile materials, like steel, yield.

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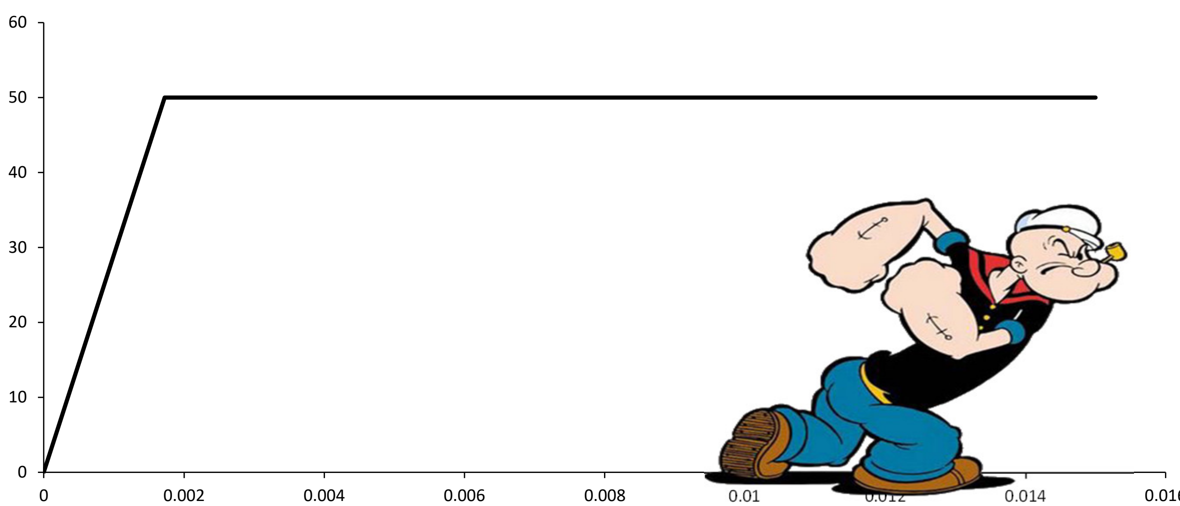
Lower Bound Theorem

Elastic-Plastic



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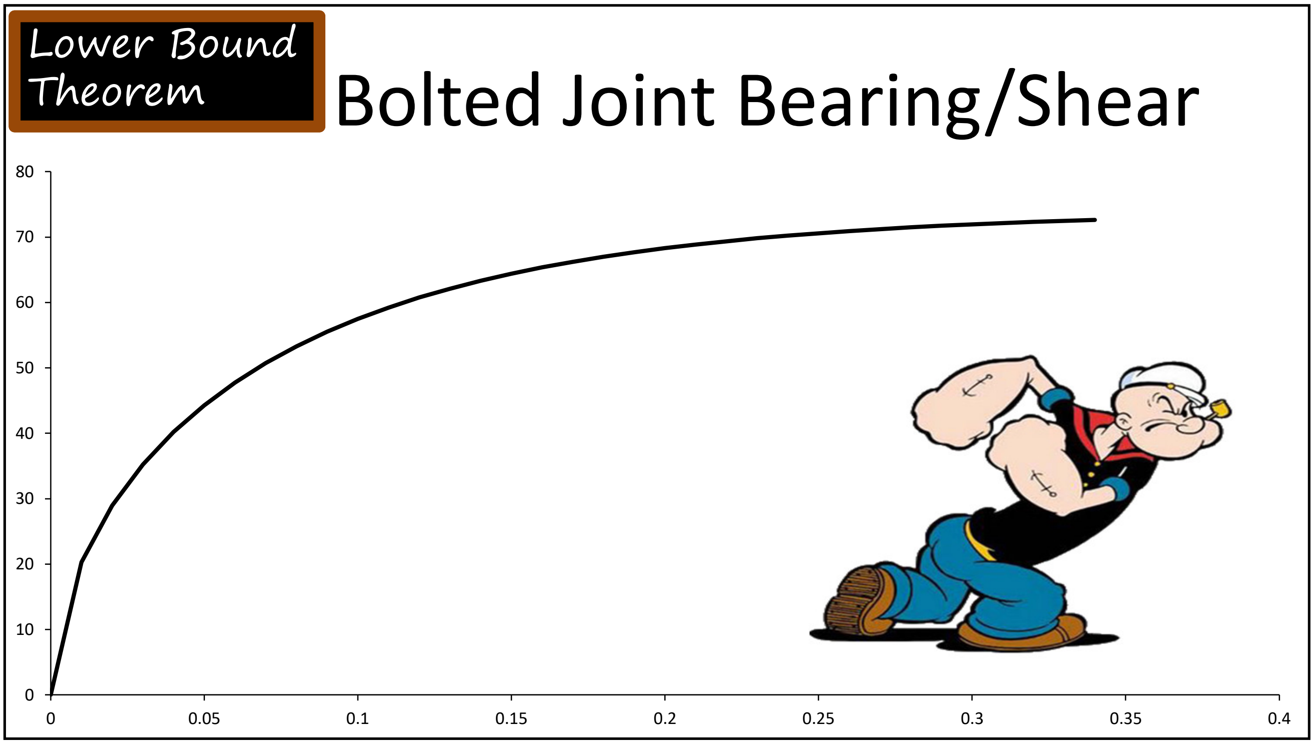

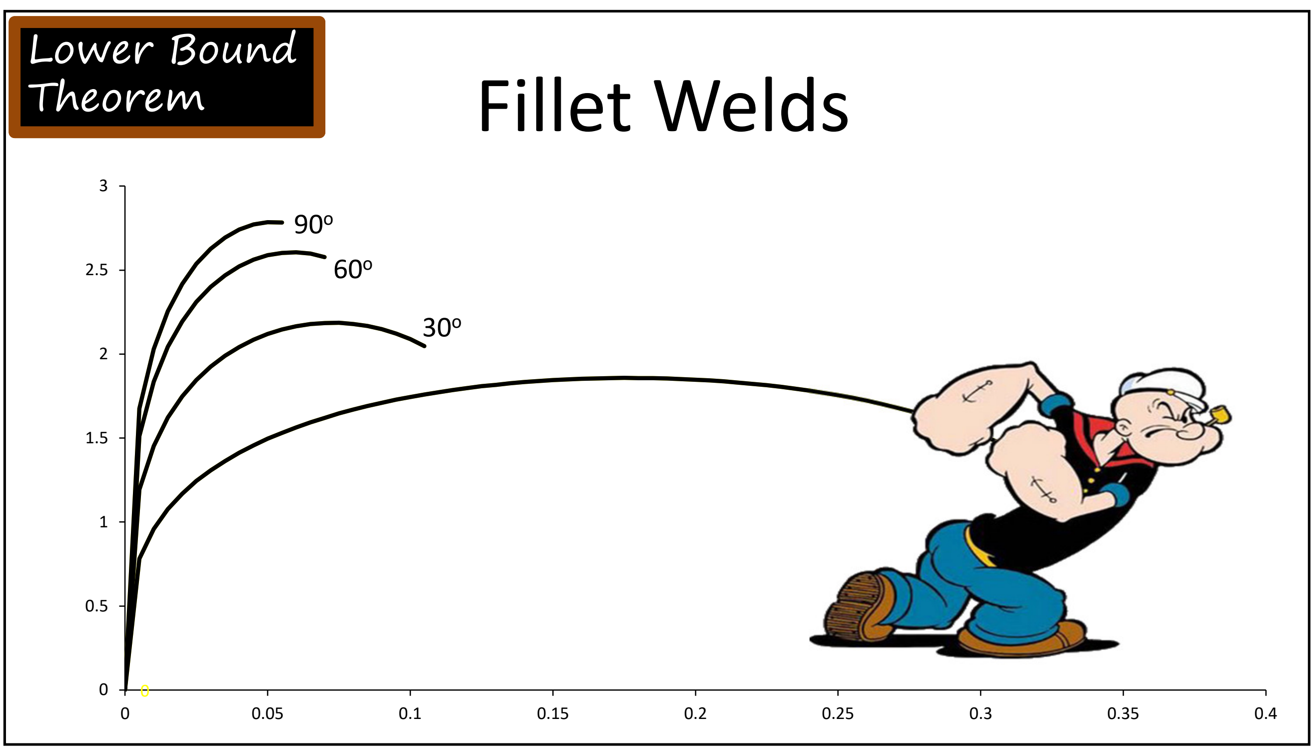

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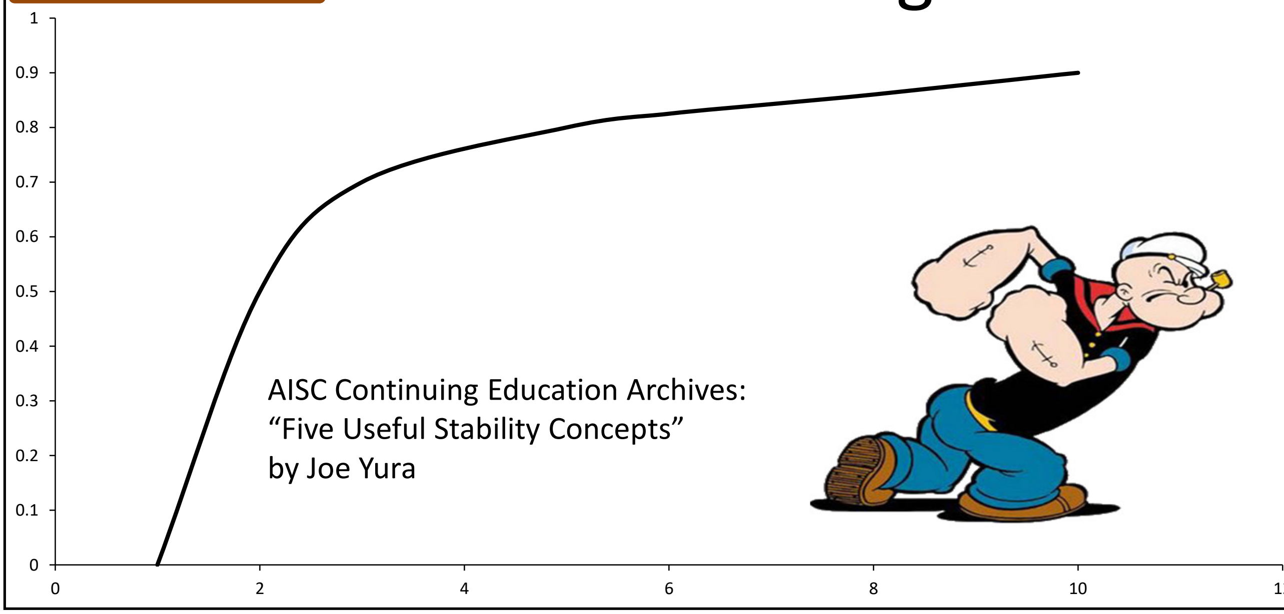
Lower Bound Theorem

Column Buckling



AISC Continuing Education Archives:
“Five Useful Stability Concepts”
by Joe Yura

Ductility

Ductility???

What is ductility?

- Duane Miller will say ductility is something like, “the degree to which a material can sustain plastic deformation under tensile stress before failure.”
- He will probably stress that it is a material property.
- He is *probably* right.

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Ductility

Ductility???

Duane Miller will also tell there are three rules to problem solving:

Rule #1: Get all the facts.

Rule #2: You'll never get all the facts.

Rule #3: Some facts aren't… facts.

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Ductility

Ductility???

"All models are wrong, but some are useful"
~~~ George E.P. Box

Engineers don't need the right model and should never assume they have the right answer.

Engineers need useful models in order to produce safe and useful designs.

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Ductility

Ductility – Wrong but Useful

What is ductility?

Useful definition: The ability of a structural system to lose stiffness and redistribute load without stuff breaking (too much).

"Like a tree / Out in the backyard/ That never has been broken by the wind… strong enough to bend."

~~~ Don Schlitz & Beth Nielson Chapman

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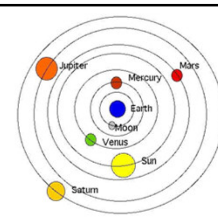
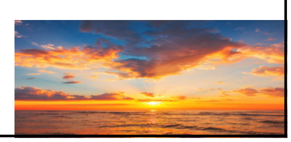
Ductility

Wrong but Useful Models



The geocentric model of the solar system was used to:

- Accurately determined the Earth's radius.
- Accurately determine the distance between the Earth and the Moon
- Develop navigation by compass and mariner's astrolabe
- Embed in our minds the image of the sun setting and rising. Who says, "Oh what a beautiful moving of the Earth relative to the Sun."



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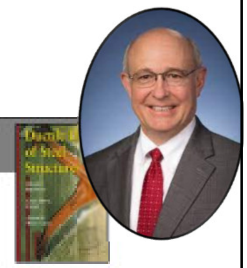
Ductility

A Nod to Duane



Ductile Design of Steel Structures

Preface

"Many practicing engineers have wrongly believed for years that the ductile nature of the structural steel material directly translates into inherently ductile structures."

Correct view: the ductile nature of steel does not directly translate into a ductile structure.

Ductile Design of Steel Structures ~~~Bruneau, Uang, Whittaker

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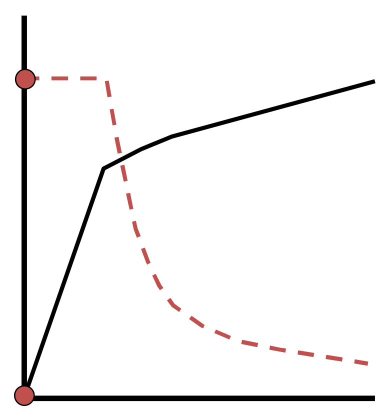
Stiffness

Strength and Stiffness

- The solid black line represents stress versus strain.
- The red dashed line represents the stiffness versus strain.
- As the material yields, the stiffness decreases and additional loads go elsewhere.



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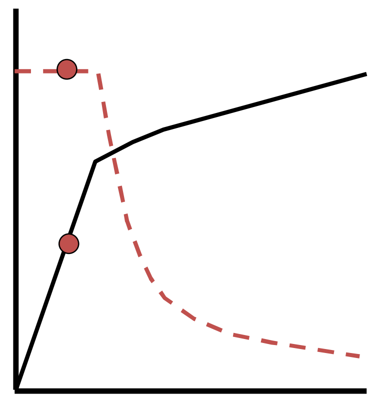

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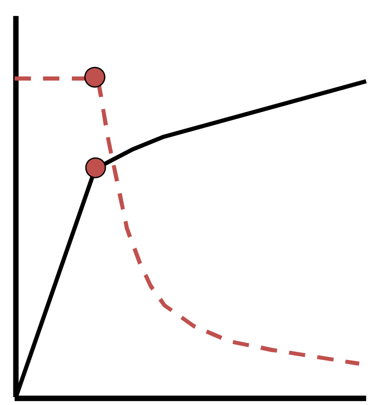

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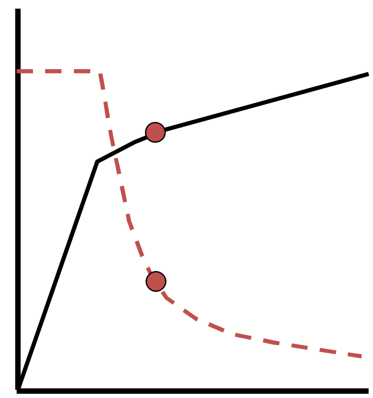

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Stiffness

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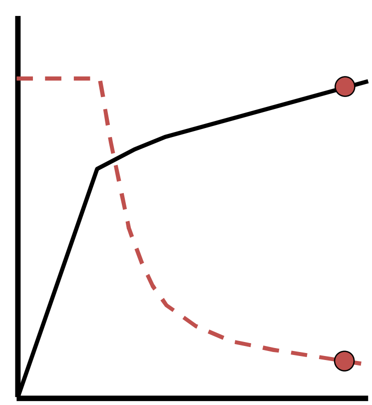

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Stiffness

Strength and Stiffness

- Force is attracted to stiffness.
- When a member yields, it becomes less stiff and sheds loads to other elements.
- If there is somewhere for the load to go, it will go there.
- Steel is inherently ductile.

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Lower Bound Theorem

The Lower Bound Theorem Corollary

The admissible internal force field that maximizes the capacity is closest to the collapse solution.

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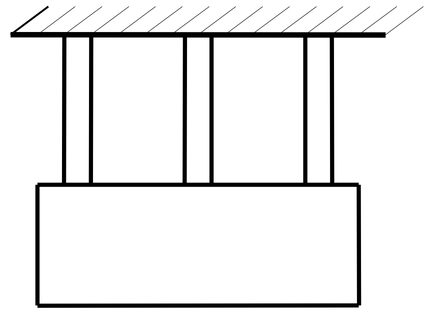
Lower Bound Theorem

An Example

As an example

- Assume a simple system of three identical tension members supporting a load.
- This is an indeterminate structure, though intuitively we know each bar supports an equal load.
- However, if we assume the center bar supports a percentage of the load, x, and the results are plotted, we have a very simple example of the Lower Bound Theorem.



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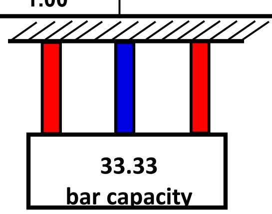
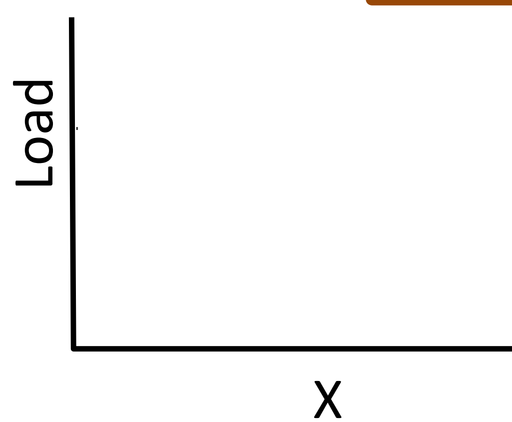
An Example

Lower Bound Theorem

X	P
0.00	66.67
0.10	
0.13	
0.25	
0.33	
0.50	
0.67	
0.75	
0.88	
1.00	





x = the % of total load supported by center member

P = total load supported with assumed load distribution

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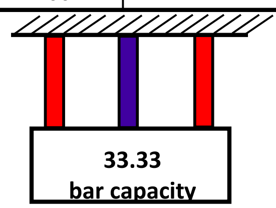
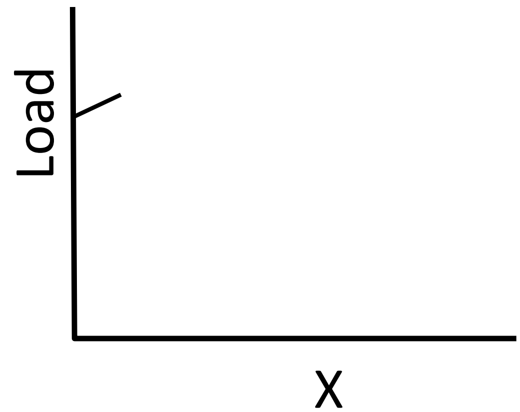
An Example

Lower Bound Theorem

X	P
0.00	66.67
0.10	74.07
0.13	76.19
0.25	
0.33	
0.50	
0.67	
0.75	
0.88	
1.00	





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An Example

Lower Bound Theorem

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0.00	66.67
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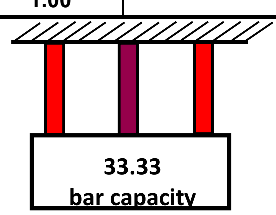
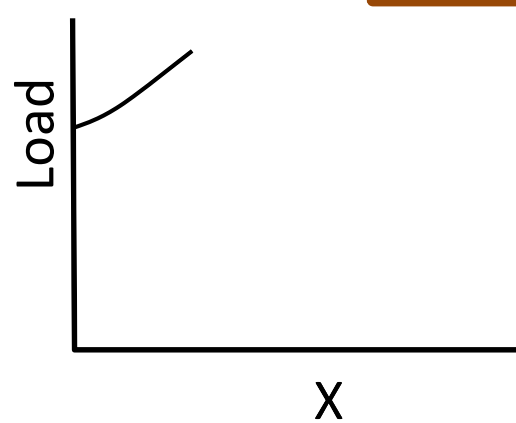
0.25	88.89
0.33	
0.50	
0.67	
0.75	
0.88	
1.00	





x = the % of total load supported by center member

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An Example

Lower Bound Theorem

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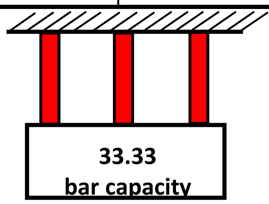
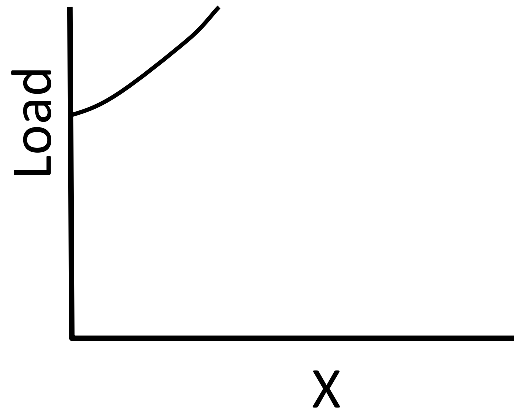
0.13	76.19
0.25	88.89
0.33	100.00
0.50	
0.67	
0.75	
0.88	
1.00	





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An Example

Lower Bound Theorem

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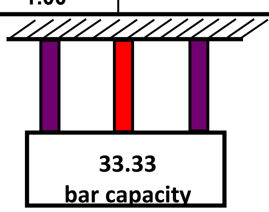

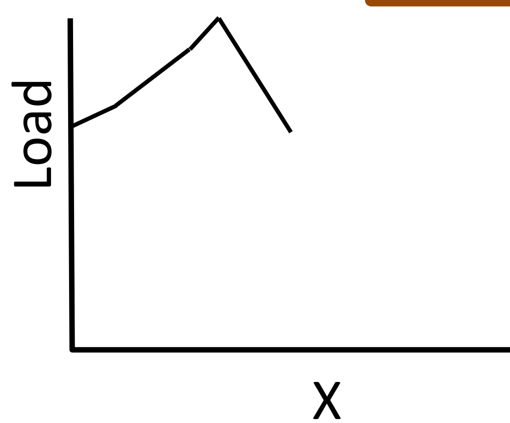

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An Example

Lower Bound Theorem

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0.13	76.19
0.25	88.89
0.33	100.00
0.50	66.67
0.67	50.00
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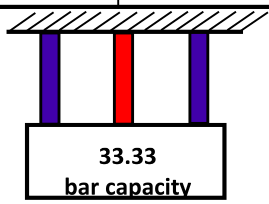
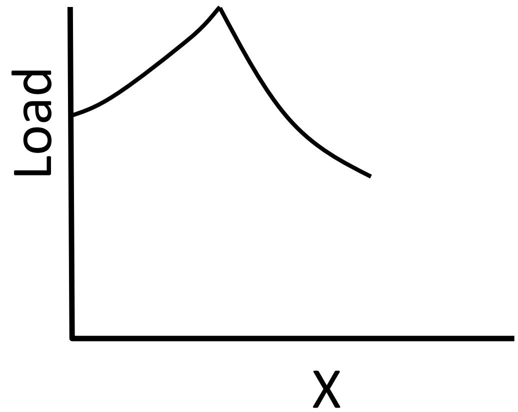
0.88	
1.00	





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An Example

Lower Bound Theorem

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0.33	100.00
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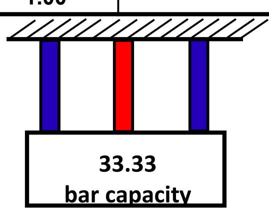
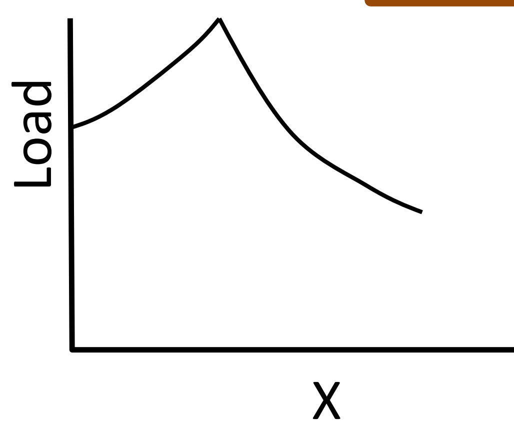
0.75	44.44
0.88	
1.00	





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An Example

Lower Bound Theorem

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0.33	100.00
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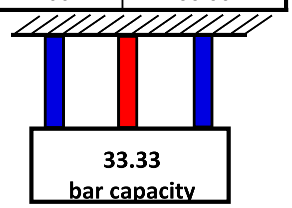
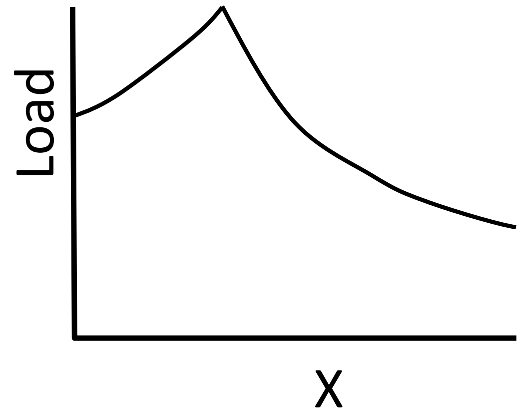
0.67	50.00
0.75	44.44
0.88	38.10
1.00	33.33





x = the % of total load supported by center member

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Judgement

Requires some judgement and faith

Lesson #1 from Duane Miller's "Important Lessons I've Learned During The Past 40 Years" (2018 NASCC):

"Provide a Path for the Force to Enter Into a Parallel Member or Section"

~~~Omer Blodgett

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Lower Bound Theorem

A Practical Approach

1. Choose a force distribution that satisfies equilibrium
2. Do not exceed any limit states.
3. Take reasonable measures to ensure ductility.

Requires some judgement and faith.

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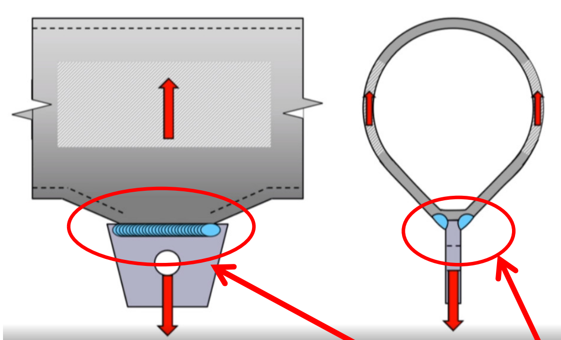
Judgement

Requires some judgement and faith



"Provide a Path for the Force to Enter Into a Parallel Member or Section"

- The face of the HSS is in bending and is flexible.
- The sides of the HSS are in tension and are stiff.

This stuff must be ductile enough to...

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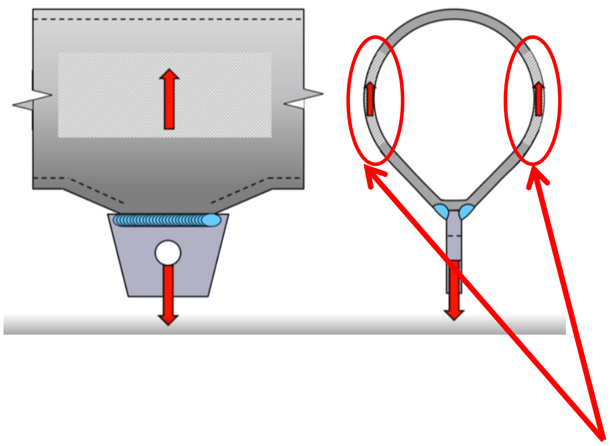
Judgement

Requires some judgement and faith



…get the load here.

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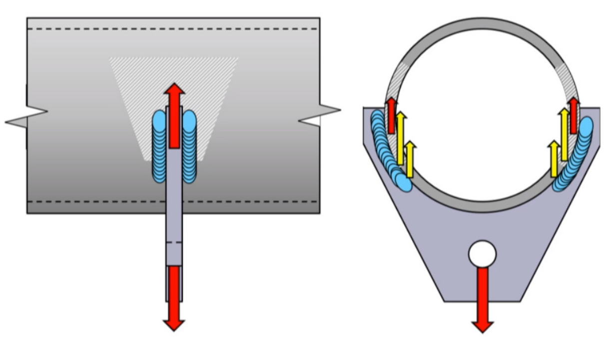
Judgement

Requires some judgement and faith



This requires less deformation than the previous alternative.

This is easier to design.

This should be a more efficient design.

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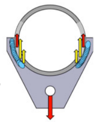
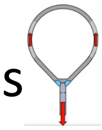
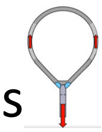
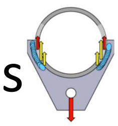
Judgement

Requires some judgement and faith

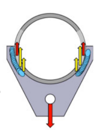
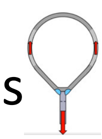
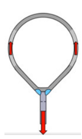
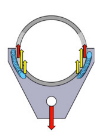
This  makes more sense than this .

This  can be designed safely, but it takes more judgement than this 

57

Judgement

Confused???

This  makes more sense than this , but this  is directly and explicitly addressed in the Specification while this  is not.

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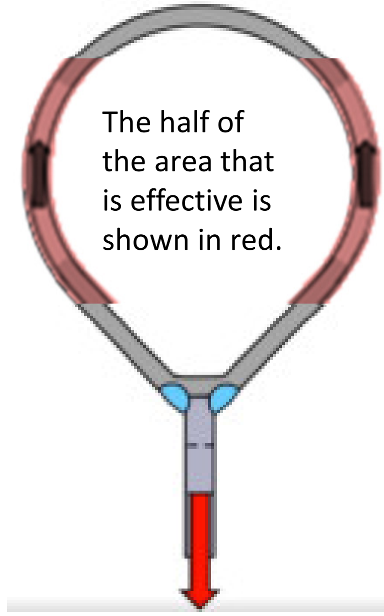
Judgement

Breadcrumbs

Specification Section G5 in effect states:

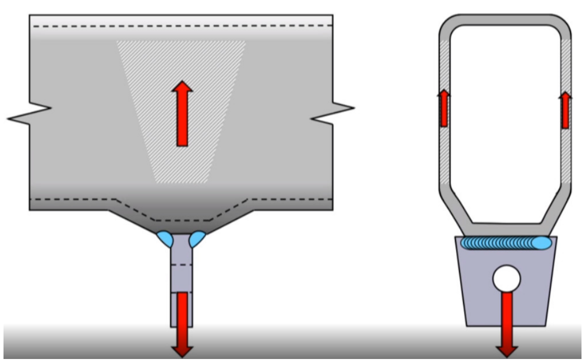
The nominal shear strength, *Vn*, of round HSS, according to the limit states of shear yielding… shall be determined as:

$$V_n = 0.6F_yA_g/2$$



Judgement

Requires some judgement and faith



A similar situation exists for rectangular HSS…

60

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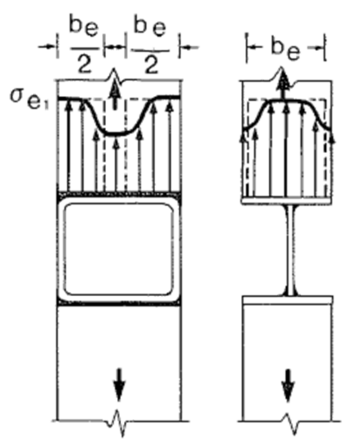
Judgement

Requires some judgement and faith

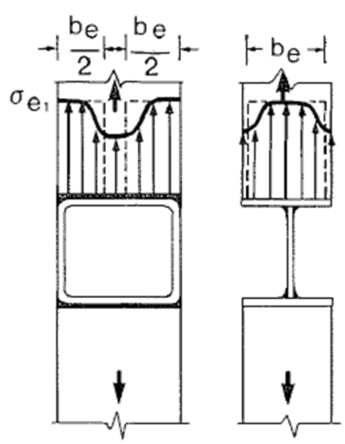


A similar situation exists for rectangular HSS… and for wide flange members.

61

Judgement

Breadcrumbs



Flange Local Bending

Commentary to Section J10.1: "In the original tests, the strength given by Equation J10-1 was intended to provide a lower bound to the force required for weld fracture, which was aggravated by the uneven stress and strain demand on the weld caused by the flange deformation (Graham et al., 1959)."

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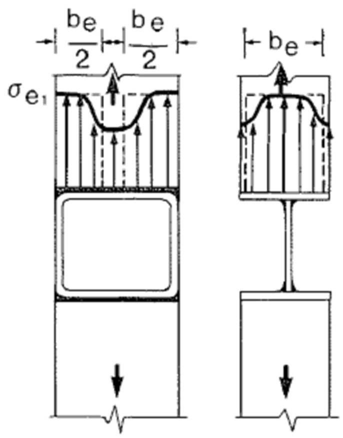
Judgement

Breadcrumbs



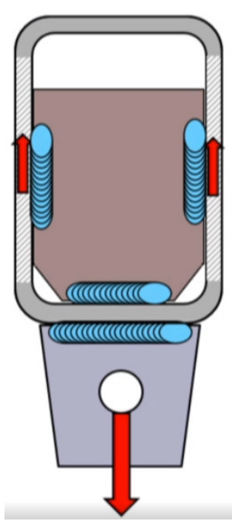
For the wide flange section, it is common to address a deficiency with stiffeners.

This is not commonly done for HSS.

63

Judgement

Breadcrumbs



For the wide flange section, it is common to address a deficiency with stiffeners.

This is not commonly done for HSS because it is often difficult and very expensive to place the stiffener. Instead, we calculate an effective width.

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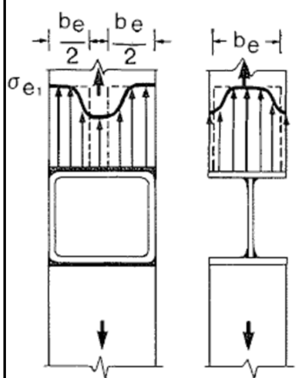
Judgement

Requires some judgement and faith



"Do not do unto others as you would that they should do unto you. Their tastes may not be the same."
~~~ **George Bernard Shaw**

Essentially the same considerations – strength & ductility.

Two different approaches.

Do what makes sense for a given situation.

Do not simply do what you have always done.

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TABLE D3.1
Shear Lag Factors for Connections to Tension Members

Case	Description of Element		Shear Lag Factor, U	Example
1	All tension members where the tension load is transmitted directly to each of the cross-sectional elements by fasteners or welds (except as in Cases 4, 5 and 6).		$U = 1.0$	–
2	All tension members, except HSS, where the tension load is transmitted to some but not all of the cross-sectional elements by fasteners or by longitudinal welds in combination with transverse welds. Alternatively, Case 7 is permitted for W, M, S and HP shapes. (For angles, Case 8 is permitted to be used.)		$U = 1 - \frac{\bar{x}}{l}$	
3	All tension members where the tension load is transmitted only by transverse welds to some but not all of the cross-sectional elements.		$U = 1.0$ and A_n = area of the directly connected elements	–
4[a]	Plates, angles, channels with welds at heels, tees, and W-shapes with connected elements, where the tension load is transmitted by longitudinal welds only. See Case 2 for definition of $\bar{x}$.		$U = \frac{3l^2}{3l^2 + w^2}\left(1 - \frac{\bar{x}}{l}\right)$	
5	Round HSS with a single concentric gusset plate through slots in the HSS.		$l \geq 1.3D$, $U = 1.0$ $D \leq l < 1.3D$, $U = 1 - \frac{\bar{x}}{l}$ $\bar{x} = \frac{D}{\pi}$	
6	Rectangular HSS.	with a single concentric gusset plate	$l \geq H$, $U = 1 - \frac{\bar{x}}{l}$ $\bar{x} = \frac{B^2 + 2BH}{4(B+H)}$	
		with two side gusset plates	$l \geq H$, $U = 1 - \frac{\bar{x}}{l}$ $\bar{x} = \frac{B^2}{4(B+H)}$	
7	W-, M-, S- or HP-shapes, or tees cut from these shapes. (If U is calculated per Case 2, the larger value is permitted to be used.)	with flange connected with three or more fasteners per line in the direction of loading	$b_f \geq \frac{2}{3}d$, $U = 0.90$ $b_f < \frac{2}{3}d$, $U = 0.85$	–
		with web connected with four or more fasteners per line in the direction of loading	$U = 0.70$	–
8	Single and double angles. (If U is calculated per Case 2, the larger value is permitted to be used.)	with four or more fasteners per line in the direction of loading	$U = 0.80$	–
		with three fasteners per line in the direction of loading (with fewer than three fasteners per line in the direction of loading, use Case 2)	$U = 0.60$	–

B = overall width of rectangular HSS member, measured 90° to the plane of the connection, in. (mm); D = outside diameter of round HSS, in. (mm); H = overall height of rectangular HSS member, measured in the plane of the connection, in. (mm); d = depth of section, in. (mm); for tees, d = depth of the section from which the tee was cut, in. (mm); l = length of connection, in. (mm); w = width of plate, in. (mm); $\bar{x}$ = eccentricity of connection, in. (mm).

[a] $l = \frac{l_1 + l_2}{2}$, where l_1 and l_2 shall not be less than 4 times the weld size.

Shear Lag

Specification Table D3.1 addresses A LOT of conditions.

It does not provide "specific criteria for infrequently encountered problems, which occur in the full range of structural design".

66

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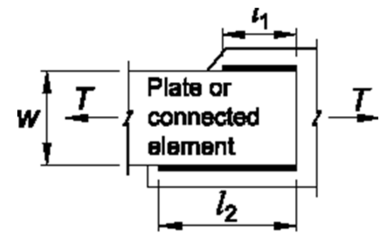
Judgement

Shear Lag



From the Steel Interchange:

- 1/2019: "When checking the wider plate, some judgement must be exercised. A local yielding check based on the Whitmore section is typically used, as is indicated in the User Note to Section J4.1."
- 9/2016: "… non-uniform stress can occur in elements subjected to both tension and compression… In extreme cases… the strength of a compression member could be affected by shear lag… Hopefully, this will provide enough information for you to use your own judgement…"

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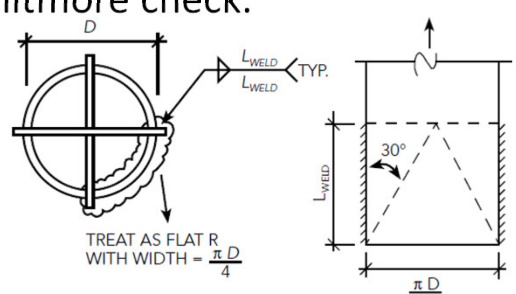
Judgement

Shear Lag

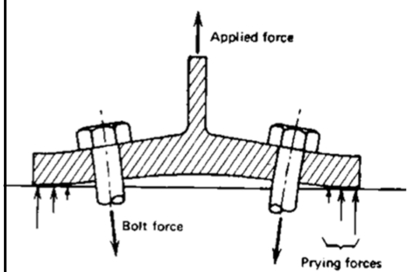
From the Interchange:

3/2014: "Table D3.1 does not address this condition, so you will have to rely on your own engineering judgement… you might consider an approach similar to the Whitmore check."

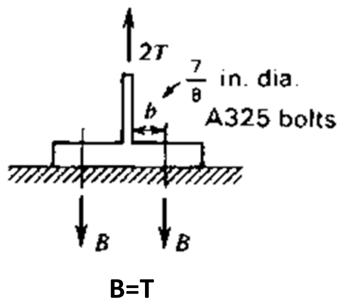


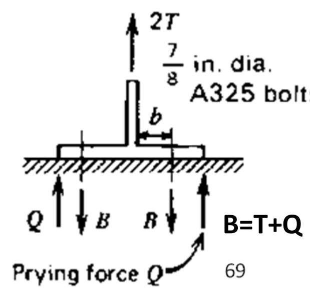
Judgement

Double Angles with Axial Loads



Both force distributions shown are statically admissible and both can result in a safe design.





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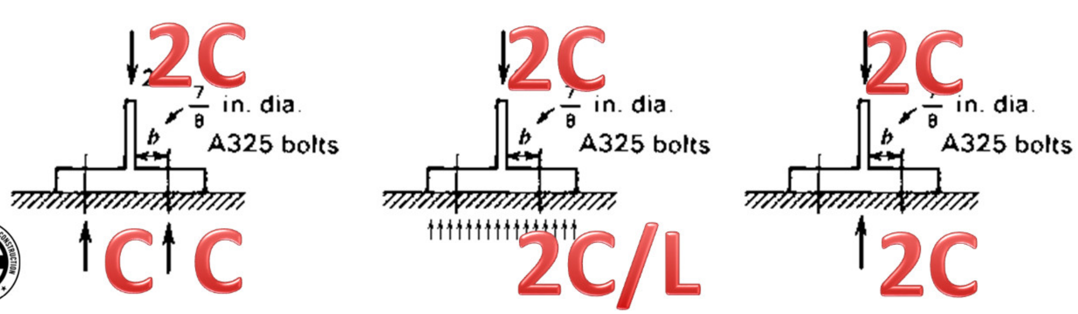
Judgement

Double Angles with Axial Loads

- All three force distributions shown are statically admissible and all can result in a safe design – if there is enough ductility.
- Only one makes sense and requires little ductility.



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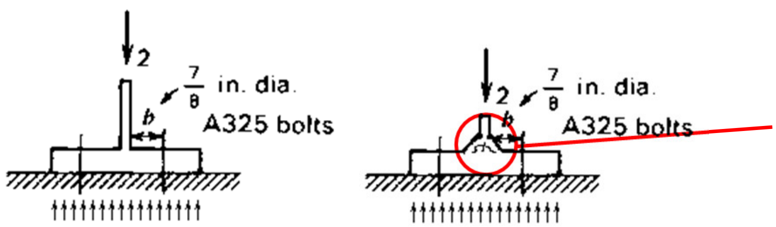
Requires some judgement and faith

To get the load out to the flanges, a local failure of either the stem or the support – or some combination of both - must occur.

Either or both must squash without cracking.



Is this really what you want?
Does it make sense?

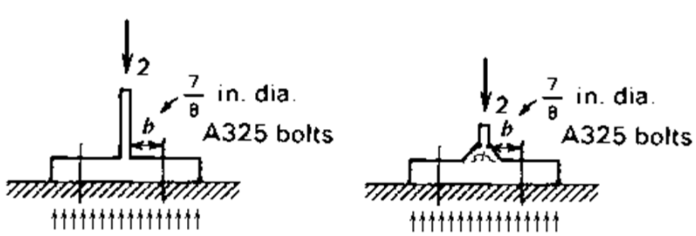
71

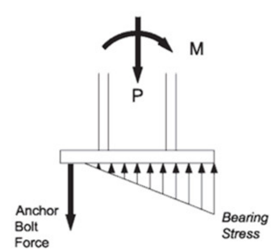
Judgement

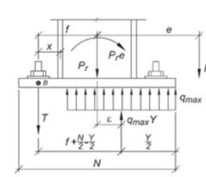
Requires some judgement and faith

What if this was a column base plate?

Then it is generally reasonable to assume the support will deform and the stress will distribute. Note Design Guide 1 discusses two different distributions – uniform and triangular.







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Judgement

Requires some judgement and faith

The examples just presented represent only a few specific conditions and are provided to illustrate more general ideas.

- Often multiple possible load paths exist.
- Multiple possible load paths can produce safe designs.
- Some load paths are more reasonable than others.
- Consider the basics from Statics and Strength of Materials.
- Judgement and communication are important.

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Avoiding Problems

Circling Back to Communication

- Boundary conditions are assumed when the members are designed.
- The connections should be designed based on the same (or at least very similar) boundary conditions.
- How???

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Avoiding Problems

Circling Back to Communication

The Connection Engineer tries to design connections "consistent with the intended behavior of the framing system and the assumptions made in the structural analysis" by:

- designing consistent with work-points shown in the drawings.
- abiding by "any restrictions on the types of connections"
- considering the loads provided
- judgement and experience
- exercising psychic abilities

Avoiding Problems

Circling Back to Communication

The Connection Engineer reveals his or her "predictions" through the substantiating connection information.

The substantiating connection information indicates how the Connection Engineer interpreted the:

- work-points shown in the drawings.
- "any restrictions on the types of connections"
- the loads provided

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Avoiding Problems Circling Back to Communication

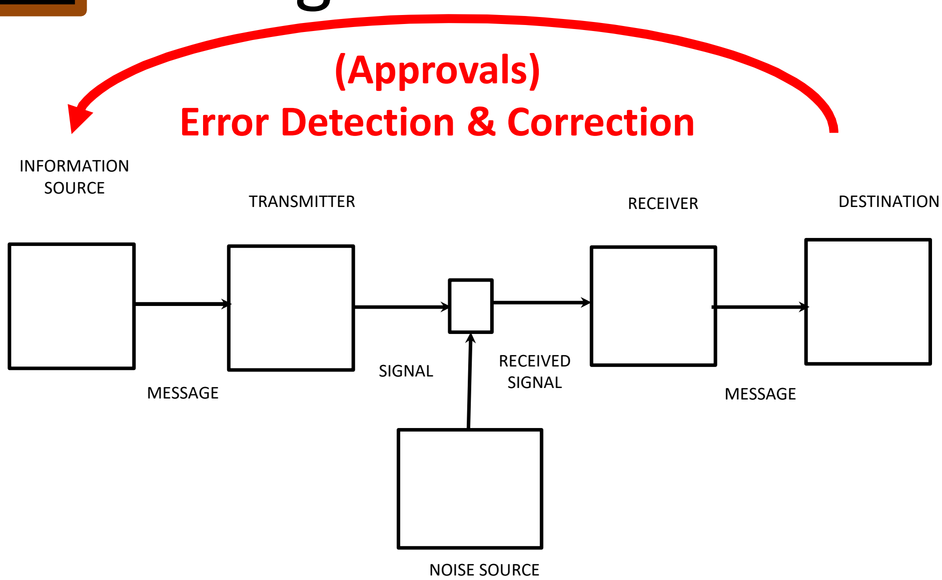
The Engineer of Record provides feedback about the "predictions" through:

- Confirmation "in writing in a timely manner that these representative samples are consistent with the requirements"

OR

- Advising "what modifications are required to bring the representative samples into compliance with the requirements in the contract documents".

Avoiding Problems Circling Back to Communication



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Load Paths Have Consequences

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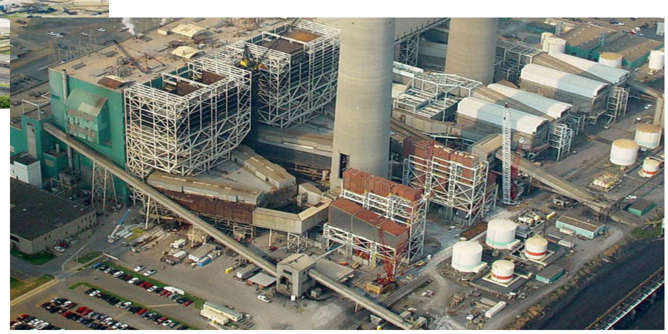
A $2 Million savings compared to the original estimate was attributed to the connection design on these two projects.



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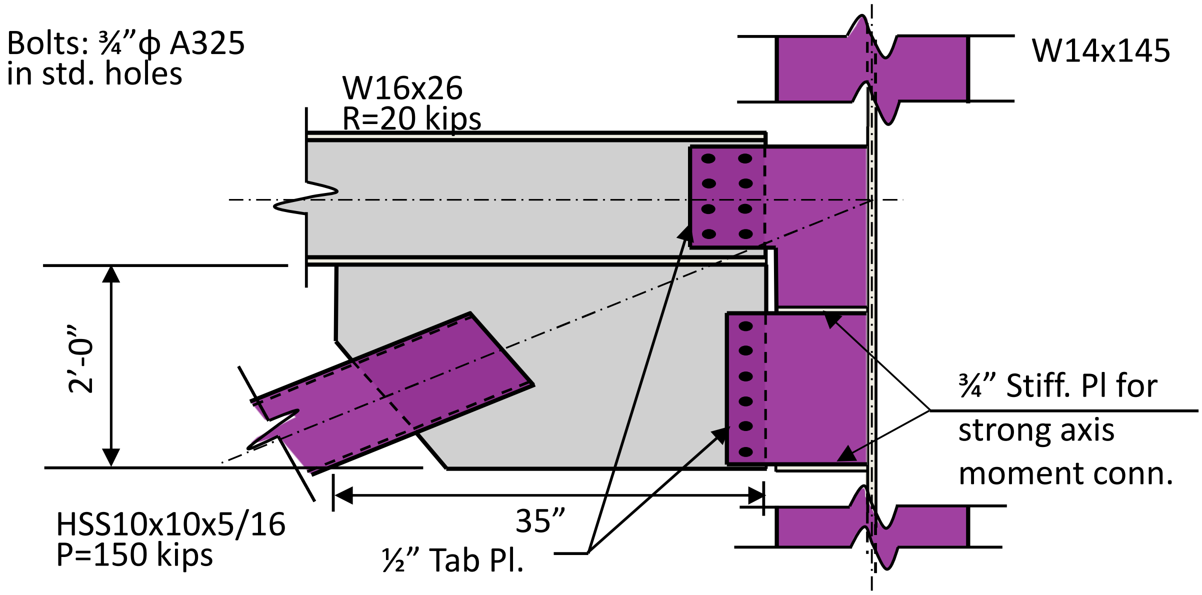
The Uniform Force Method (Statics) was used extensively in novel ways to optimize the connections.

Fine Print: Other factors such as the extensive use of "X-bolts" and welding instead of bolting to heavy columns were also employed to reduce costs.

81



Vertical Bracing w/ Ext. Tab Optimum Load Path

82

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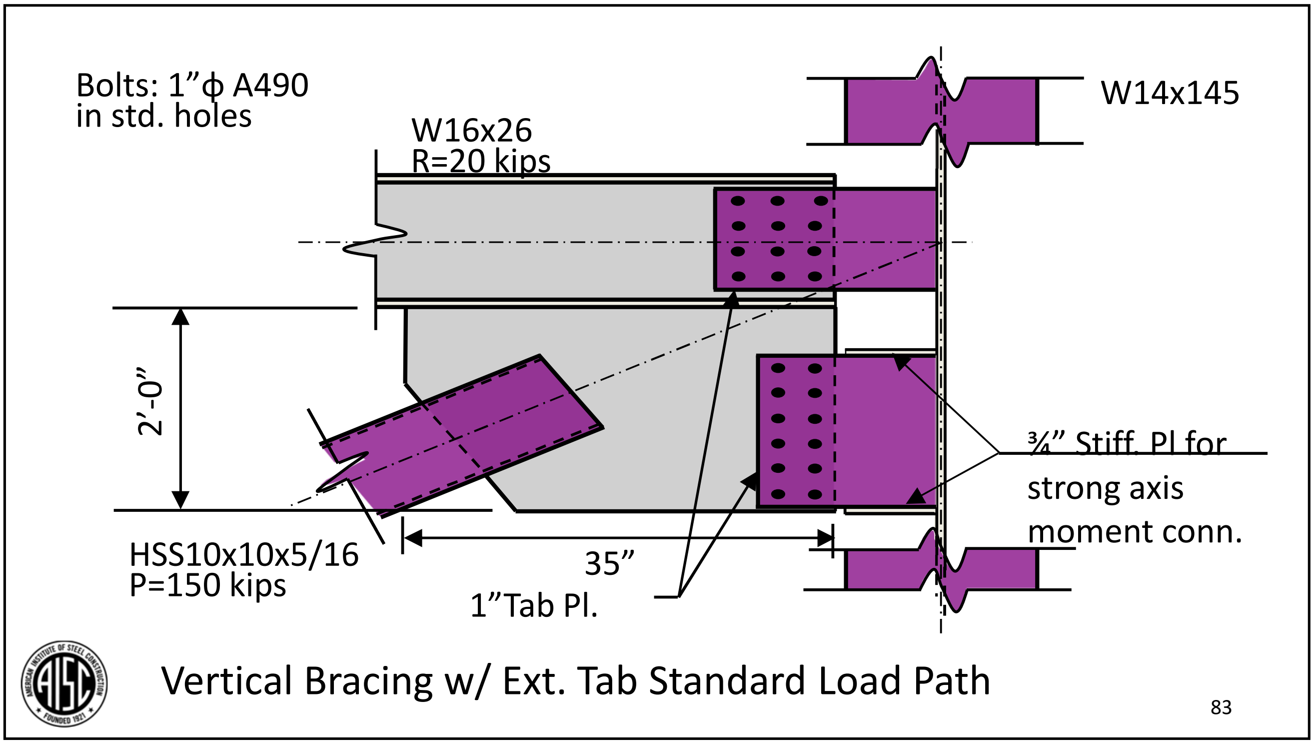
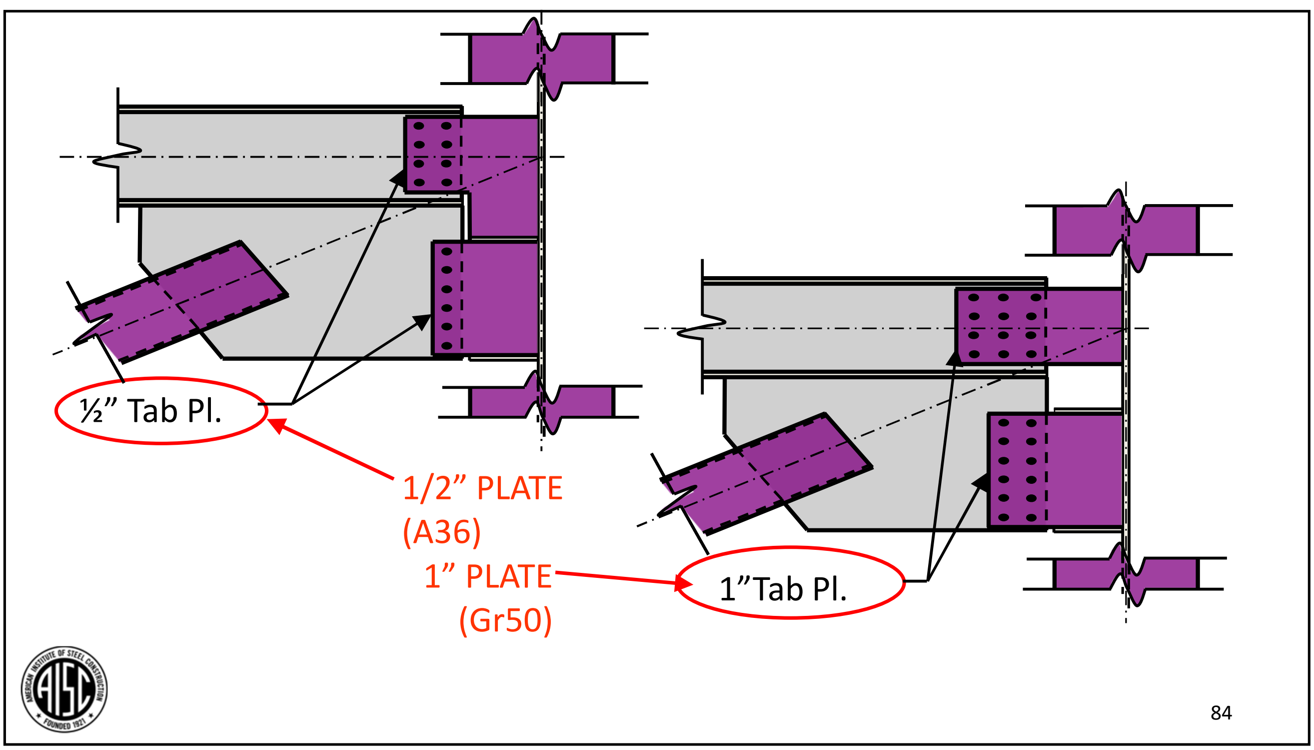
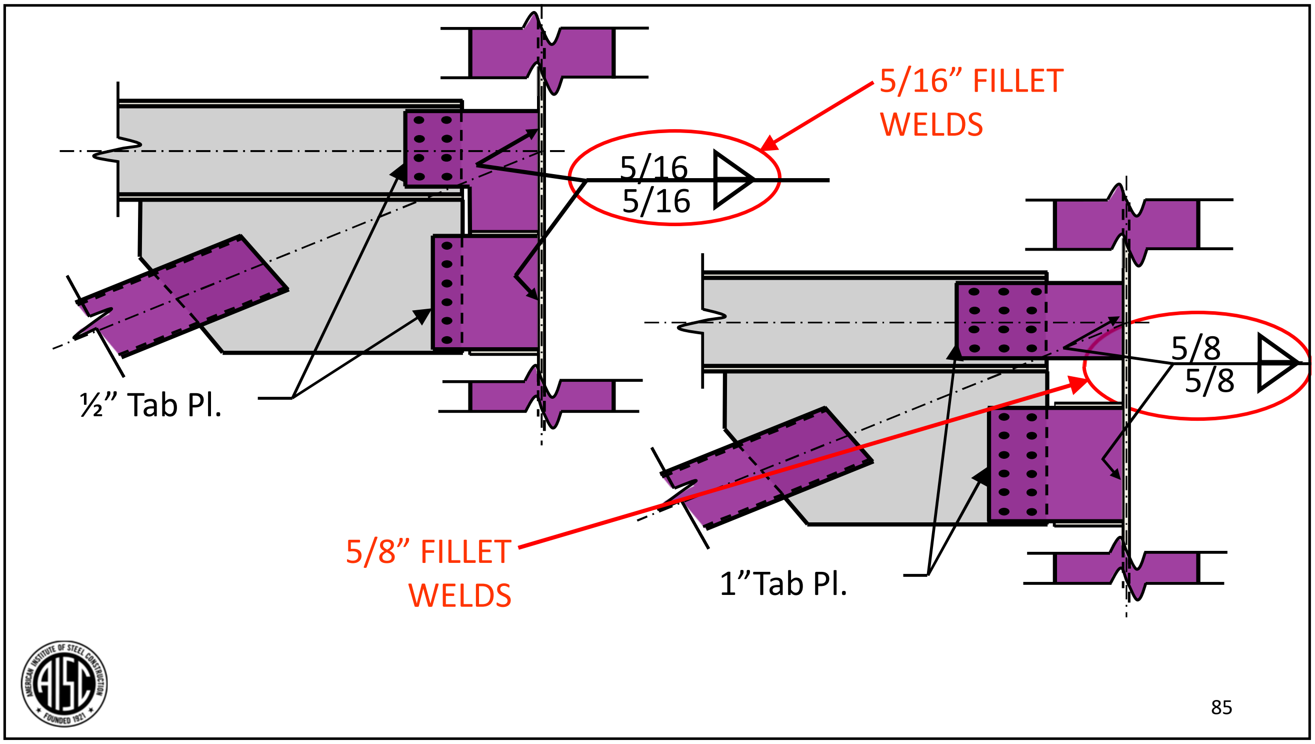
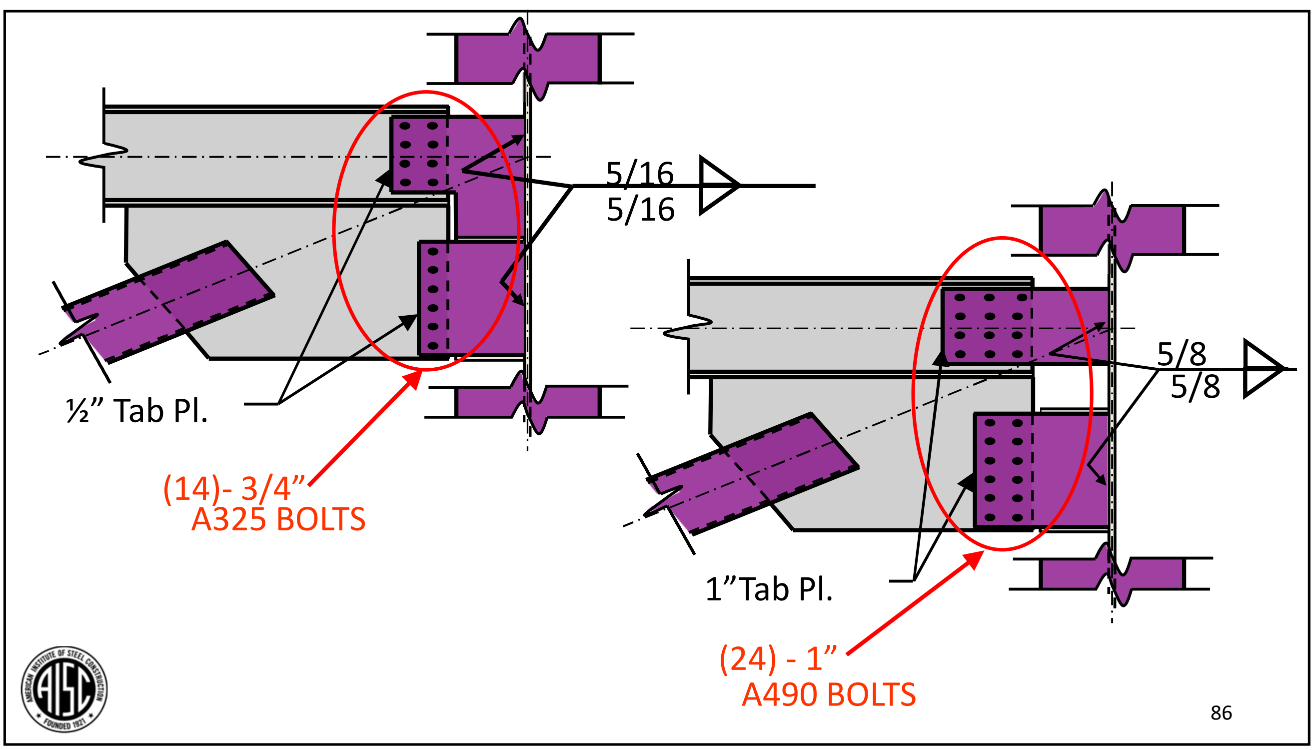

Bolts: 1”ϕ A490
in std. holes
W16x26
R=20 kips
W14x145
2’-0”
¾” Stiff. Pl for
strong axis
moment conn.
HSS10x10x5/16
P=150 kips
35”
1”Tab Pl.
Vertical Bracing w/ Ext. Tab Standard Load Path
83


½” Tab Pl.
1/2” PLATE
(A36)
1” PLATE
(Gr50)
1”Tab Pl.
84





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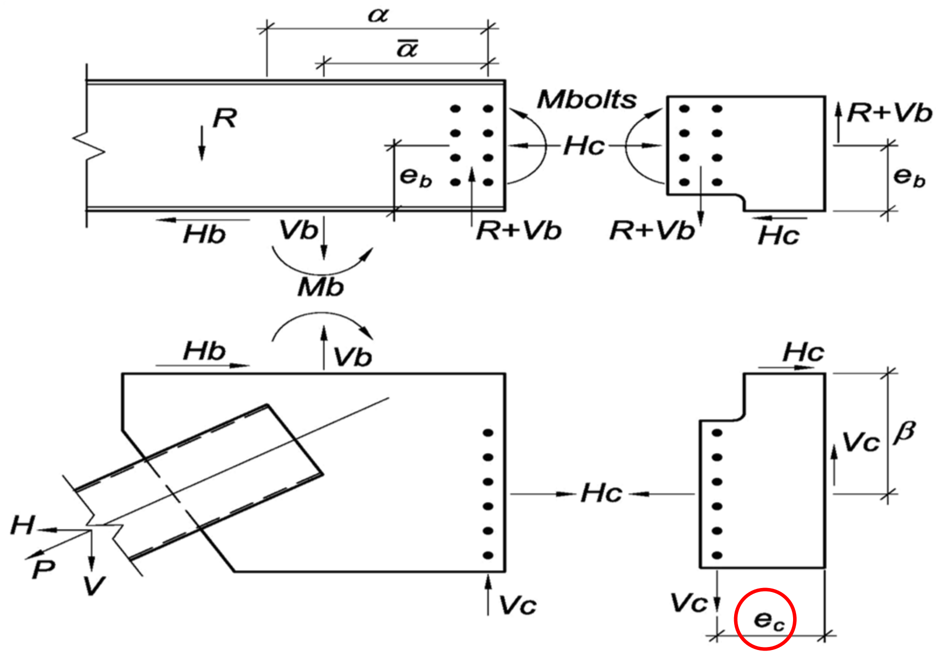
FBD of Optimum Solution



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Comparison of Design Results

COMPARISON OF DESIGNS RESULTING FROM DIFFERENT LOAD PATHS															
	DRILLING				WELDING				MATERIAL						
	# of Holes	Plate Thick. (in.)	Area Holes (in.^{2})	Vol. of Holes (in.^{3})	Weld Size (in.)	Length (in.)	Volume (in.^{3})	Length Single Pass Weld (in.)	Area of Tabs (in.^{2})	Thick. Tabs (in.)	Volume Tabs (in.^{3})	Area of Gusset (in.^{2})	Thick. Gusset (in.)	Volume Gusset (in.^{3})	Weight Connection Plates (lbs.)
Standard Load Path	24	1	0.6	14.4	5/8	30.0	5.86	180	3.25	0.083	0.27	5.41	0.417	0.226	243
Optimum Load Path	14	0.5	0.44	3.09	5/16	52.3	2.55	52.3	3.00	0.042	0.12	5.41	0.417	0.226	172
Optimum / Standard				21%			44%	29%							71%

88

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Comparison of Design Results

COMPARISON OF DESIGNS RESULTING FROM DIFFERENT LOAD PATHS															
	DRILLING				WELDING				MATERIAL						
	# of Holes	Plate Thick. (in.)	Area Holes (in.^{2})	Vol. of Holes (in.^{3})	Weld Size (in.)	Length (in.)	Volume (in.^{3})	Length Single Pass Weld (in.)	Area of Tabs (in.^{2})	Thick. Tabs (in.)	Volume Tabs (in.^{3})	Area of Gusset (in.^{2})	Thick. Gusset (in.)	Volume Gusset (in.^{3})	Weight Connection Plates (lbs.)
Standard Load Path	24	1	0.6	14.4	5/8	30.0	5.86	180	3.25	0.083	0.27	5.41	0.417	0.226	243
Optimum Load Path	14	0.5	0.44	3.09	5/16	52.3	2.55	52.3	3.00	0.042	0.12	5.41	0.417	0.226	172
Optimum / Standard				21%			44%	29%							71%

± 80% SAVINGS IN DRILLING TIME

89

Comparison of Design Results

COMPARISON OF DESIGNS RESULTING FROM DIFFERENT LOAD PATHS															
	DRILLING				WELDING				MATERIAL						
	# of Holes	Plate Thick. (in.)	Area Holes (in.^{2})	Vol. of Holes (in.^{3})	Weld Size (in.)	Length (in.)	Volume (in.^{3})	Length Single Pass Weld (in.)	Area of Tabs (in.^{2})	Thick. Tabs (in.)	Volume Tabs (in.^{3})	Area of Gusset (in.^{2})	Thick. Gusset (in.)	Volume Gusset (in.^{3})	Weight Connection Plates (lbs.)
Standard Load Path	24	1	0.6	14.4	5/8	30.0	5.86	180	3.25	0.083	0.27	5.41	0.417	0.226	243
Optimum Load Path	14	0.5	0.44	3.09	5/16	52.3	2.55	52.3	3.00	0.042	0.12	5.41	0.417	0.226	172
Optimum / Standard				21%			44%	29%							71%

± 50% SAVINGS IN WELD CONSUMABLES

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Comparison of Design Results

COMPARISON OF DESIGNS RESULTING FROM DIFFERENT LOAD PATHS

	DRILLING				WELDING				MATERIAL						
	# of Holes	Plate Thick. (in.)	Area Holes ($in.^2$)	Vol. of Holes ($in.^3$)	Weld Size (in.)	Length (in.)	Volume ($in.^3$)	Length Single Pass Weld (in.)	Area of Tabs ($in.^2$)	Thick. Tabs (in.)	Volume Tabs ($in.^3$)	Area of Gusset ($in.^2$)	Thick. Gusset (in.)	Volume Gusset ($in.^3$)	Weight Connection Plates (lbs.)
Standard Load Path	24	1	0.6	14.4	5/8	30.0	5.86	180	3.25	0.083	0.27	5.41	0.417	0.226	243
Optimum Load Path	14	0.5	0.44	3.09	5/16	52.3	2.55	52.3	3.00	0.042	0.12	5.41	0.417	0.226	172
Optimum / Standard				21%			44%	29%							71%

± 60% SAVINGS IN WELDING LABOR

91

Comparison of Design Results

COMPARISON OF DESIGNS RESULTING FROM DIFFERENT LOAD PATHS

	DRILLING				WELDING				MATERIAL						
	# of Holes	Plate Thick. (in.)	Area Holes ($in.^2$)	Vol. of Holes ($in.^3$)	Weld Size (in.)	Length (in.)	Volume ($in.^3$)	Length Single Pass Weld (in.)	Area of Tabs ($in.^2$)	Thick. Tabs (in.)	Volume Tabs ($in.^3$)	Area of Gusset ($in.^2$)	Thick. Gusset (in.)	Volume Gusset ($in.^3$)	Weight Connection Plates (lbs.)
Standard Load Path	24	1	0.6	14.4	5/8	30.0	5.86	180	3.25	0.083	0.27	5.41	0.417	0.226	243
Optimum Load Path	14	0.5	0.44	3.09	5/16	52.3	2.55	52.3	3.00	0.042	0.12	5.41	0.417	0.226	172
Optimum / Standard				21%			44%	29%							71%

± 30% SAVINGS IN MATERIAL

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OH NO!!! HOMEWORK!!!

To prepare for Sessions 6 & 7 please be familiar with:

- Design Guide 29 – Example 5.11
- Design Guide 29 – Example A.1
- Manual Equations (9-2) & (9-3):
- Manual Design Examples – Example II.A-1B
- Manual Design Examples – Example II.A-19B
- The *Specification* Section J10.5 Web Compression Buckling

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Foreshadowing

- Sessions 4 & 5 will cover bolts & welds for approximately 60 minutes. The remaining time will be devoted to questions & topics received from attendees.
- Session 6 will address issues related to Design Examples for approximately 60 minutes. The remaining time will be devoted to questions & topics received from attendees.
- Session 7 will be a continuation of Session 6 with concentration on a specific example.
- Session 8 will be devoted entirely to questions & topics received from attendees.

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OH NO!!! MORE HOMEWORK!!!

- Submit Your Questions & Topics
- Feel free to submit any questions & topics you wish
- Priority will be given to:
  - Questions & topics shared by multiple attendees
  - Questions & topics related to material presented in this Night School
  - Questions & topics directly related to connection design
  - Questions & topics of interest to the presenter

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OH NO!!! MORE HOMEWORK!!!

- Submit Your Questions & Topics
- Ultimately the success of this Night School depends on YOU.
- I want to address YOUR concerns.

I will make an attempt to address ALL questions submitted. I will TRY to address questions not included in the Night School through the Steel Solutions Center.

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Thank you!

AISC | Questions

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Steel.

Individual Session Registrants

PDH Certificates

- All WFH individuals associated with a group registration will be issued a certificate.
- All individuals attending at your connection: you will receive an email on how to report their attendance from: registration@aisc.org.
  - Be on the lookout: Check your spam filter! Check your junk folder!
  - Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

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8-Session Registrants

PDH Certificates

One certificate will be issued at the conclusion of all 8 sessions.

8-Session Registrants

Access to the quiz

Information for accessing the quiz will be emailed to you by Thursday. It will contain a link to access the quiz. EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG.

Quiz and attendance records

Posted Thursday mornings. www.aisc.org/nightschool -- Click on Current Course Details.

Reasons for quiz

- EEU – You must take all quizzes and the final exam to receive EEU.
- PDHs – If you watch a recorded session, you must pass quiz for PDHs.
- REINFORCEMENT – Reinforce what you learn tonight. Get more out of the course.

Note: If you attend the live presentation, you do not have to take the quizzes to receive PDHs

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8-Session Registrants

Access to the recording

Information for accessing the recording will be emailed to you by Thursday. The recording will be available for four weeks. (For 8-session registrants only.) EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG.

PDHs via recording

If you watch a recorded session, you must take *and pass* the quiz for PDHs.

8-Session Registrants

Night School Resources

Find all your handouts, quizzes and quiz scores, recording access, and attendance information all in one place!

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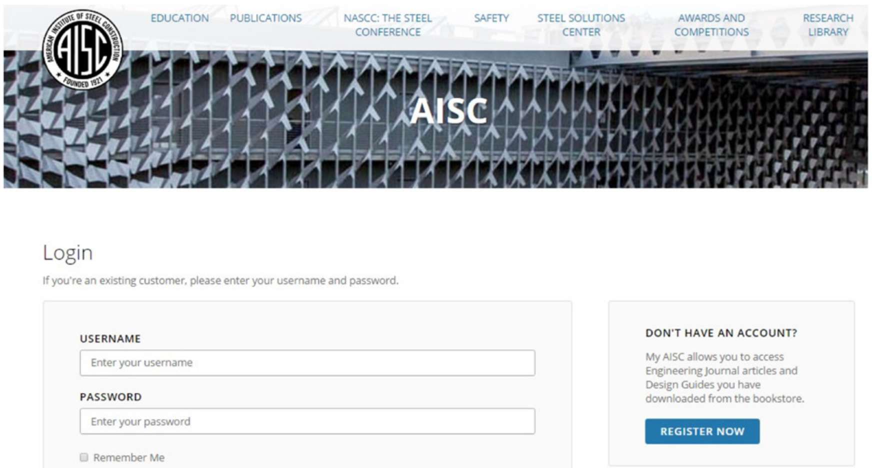
8-Session Registrants

Night School Resources

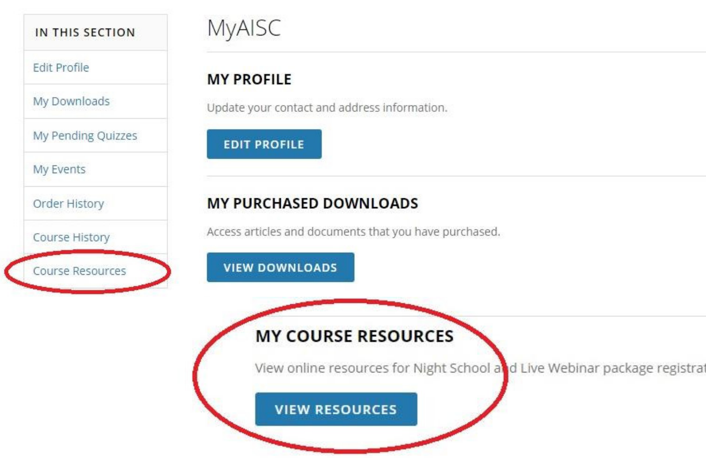
Go to www.aisc.org and sign in.



8-Session Registrants

Night School Resources

Go to www.aisc.org and sign in.



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8-Session Registrants

Night School Resources

AISC > MYAISC > COURSE RESOURCES

Course Resources

Event	Start Date
NS 13 8-Session Package-Night School 13 - Design of Industrial Buildings	1/30/2017 7:00:00 PM
NS 14 8-Session Package-Night School 14 - Fundamentals of Stability	6/5/2017 7:00:00 PM

8-Session Registrants

Night School Resources

AISC > MYAISC > NIGHT SCHOOL RESOURCES > NS13 8-SESSION PACKAGE RESOURCES

Night School 13: Design of Industrial Buildings

8-SESSION PACKAGE RESOURCES

Event	Date	Handouts	Video	Quiz	Attendance
NS13 - Design Criteria	1/30/2017 7:00:00 PM	Handouts	View Passcode: NS13DSN	Pass Score: 80	Pending
NS13 - Economic Considerations	2/6/2017 7:00:00 PM	Handouts	Available 02/08/2017 5pm EST	Available 02/08/2017 5pm EST	Pending
NS13 - Lateral Load Systems and Details	2/13/2017 7:00:00 PM	Handouts	Available 02/15/2017 5pm EST	Available 02/15/2017 5pm EST	Pending
NS13 - Preliminary Design Procedures	2/27/2017 7:00:00 PM	Handouts	Available 03/01/2017 5pm EST	Available 03/01/2017 5pm EST	Pending
NS13 - Crane Girder Design and Frame Analysis	3/6/2017 7:00:00 PM	Handouts	Available 03/08/2017 5pm EST	Available 03/08/2017 5pm EST	Pending
NS13 - Frame Member and Connection Design	3/13/2017 7:00:00 PM	Handouts	Available 03/15/2017 5pm EST	Available 03/15/2017 5pm EST	Pending
NS13 - Transfer Crane Girder & Longitudinal Bldg Bracing Dsn	3/27/2017 7:00:00 PM	Handouts	Available 03/29/2017 5pm EST	Available 03/29/2017 5pm EST	Pending
NS13 - Building Envelope and Bracing Design	4/3/2017 7:00:00 PM	Handouts	Available 04/05/2017 5pm EST	Available 04/05/2017 5pm EST	Pending

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8-Session Registrants

Night School Resources

- Weekly "quiz and recording" email.
- Weekly updates of the master quiz and attendance record, found at www.aisc.org/nightschool26. Scroll down to Quiz and Attendance records.
    - Updated on Friday mornings.

8-Session Registrants

Night School Resources

- Webinar connection information
    - Reminder email sent out Tuesday mornings
- Links to handouts also found here

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AISC | Thank you

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