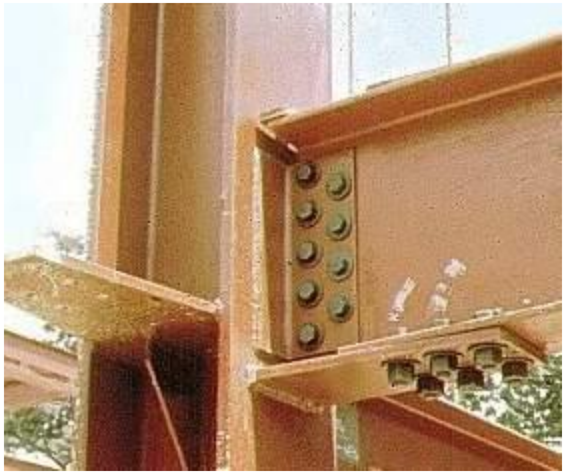
Timber and Steel Design

Lecture 19 Building Connections



- Simple & Moment Connections
- Framed Beam Connections
- Seated Connections
- Beam-to-Column Welded Connections

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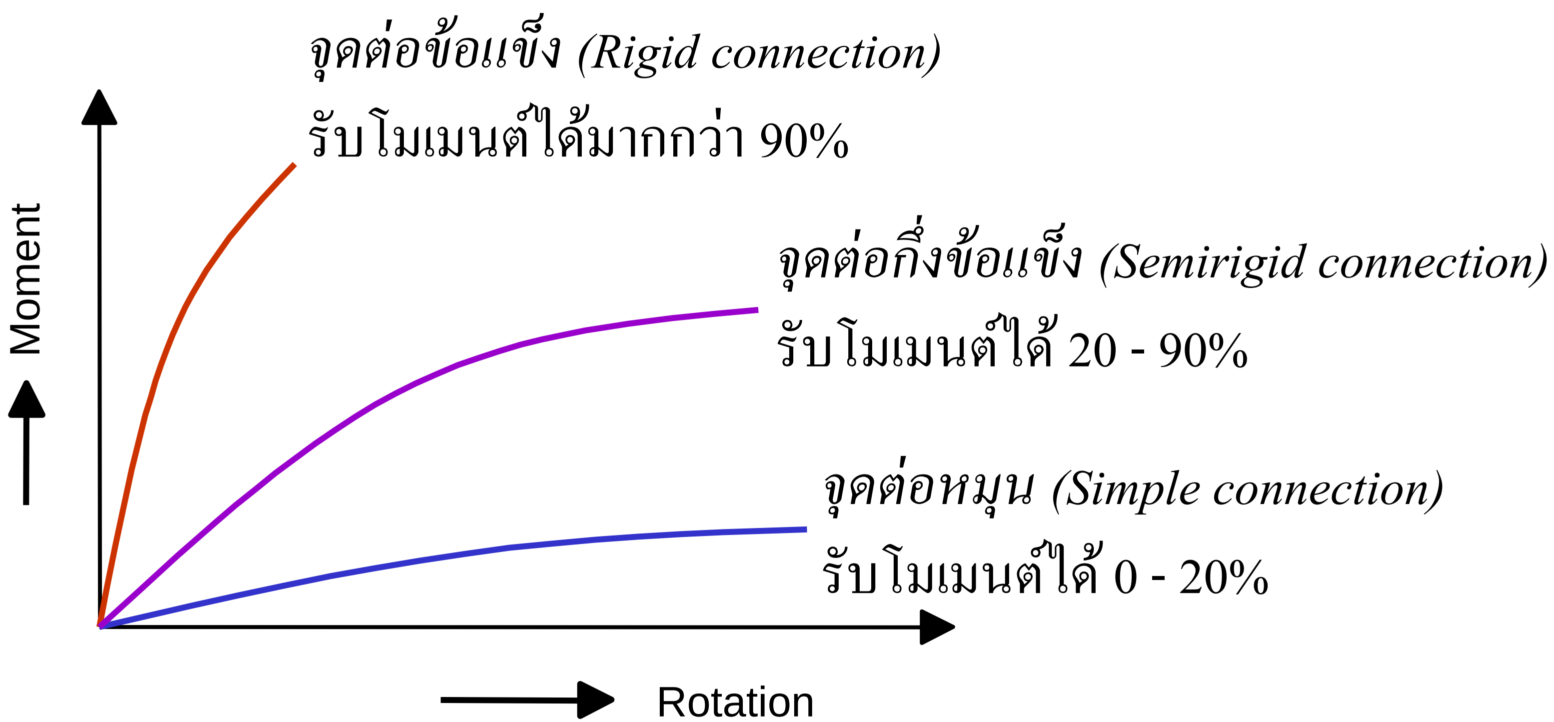
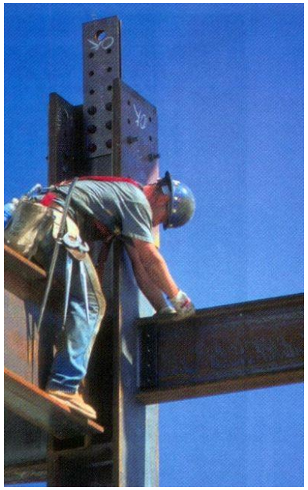
S U R A N A R E E **INSTITUTE OF ENGINEERING**

UNIVERSITY OF TECHNOLOGY **SCHOOL OF CIVIL ENGINEERING**

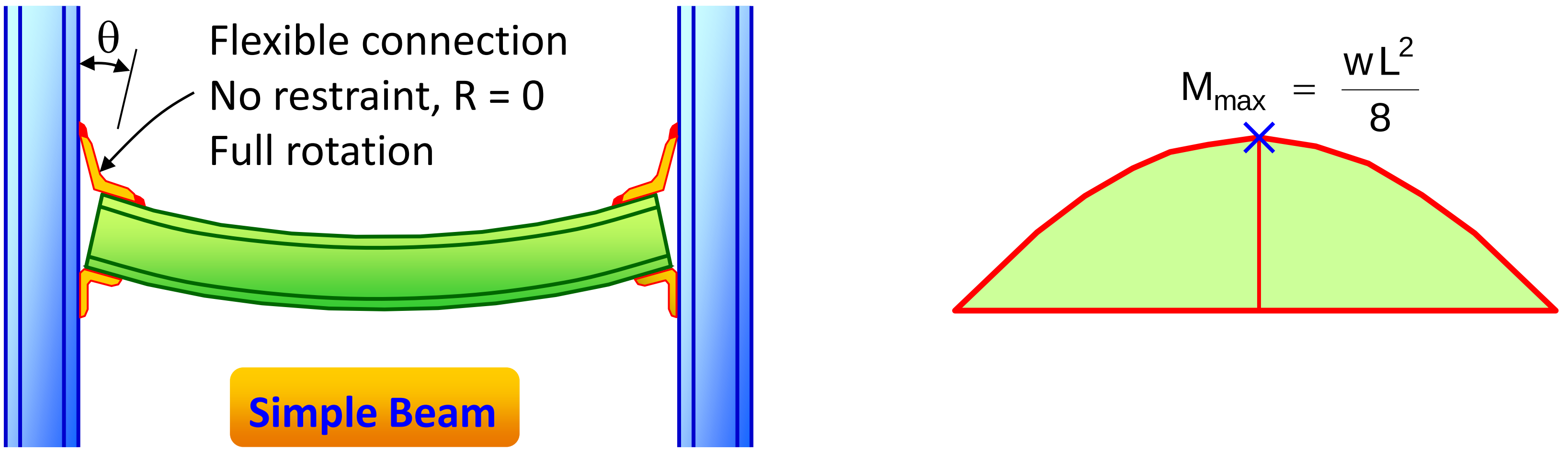
Steel Frame Connection Types

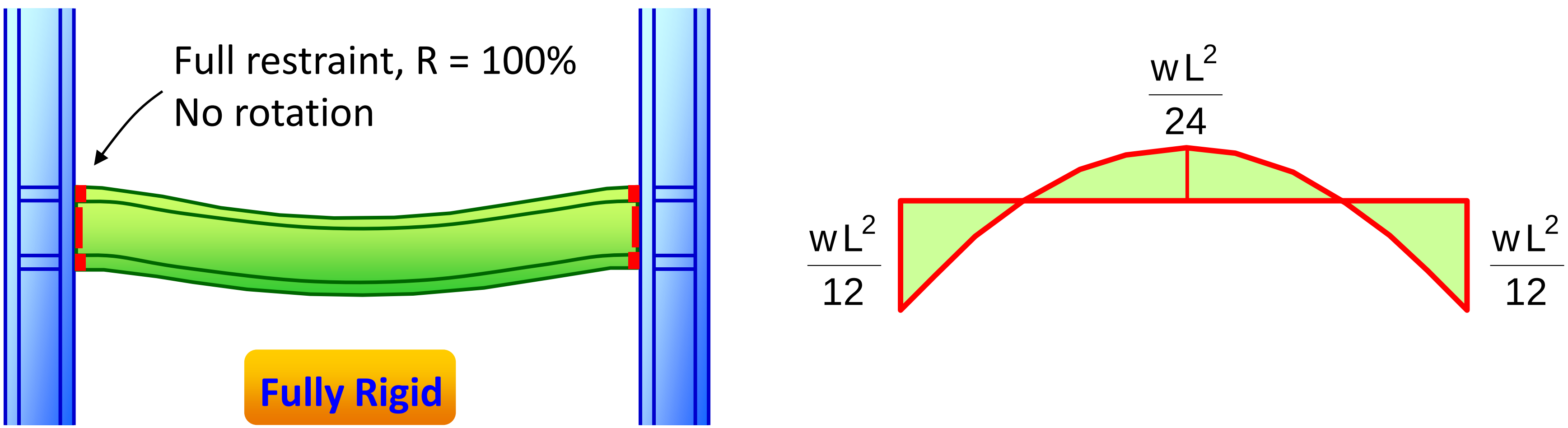
- All connections have a certain amount of rigidity
- Simple connections have some rigidity, but are assumed to be free to rotate
- Partially-Restrained moment connections are designed to be semi-rigid
- Fully-Restrained moment connections are designed to be fully rigid





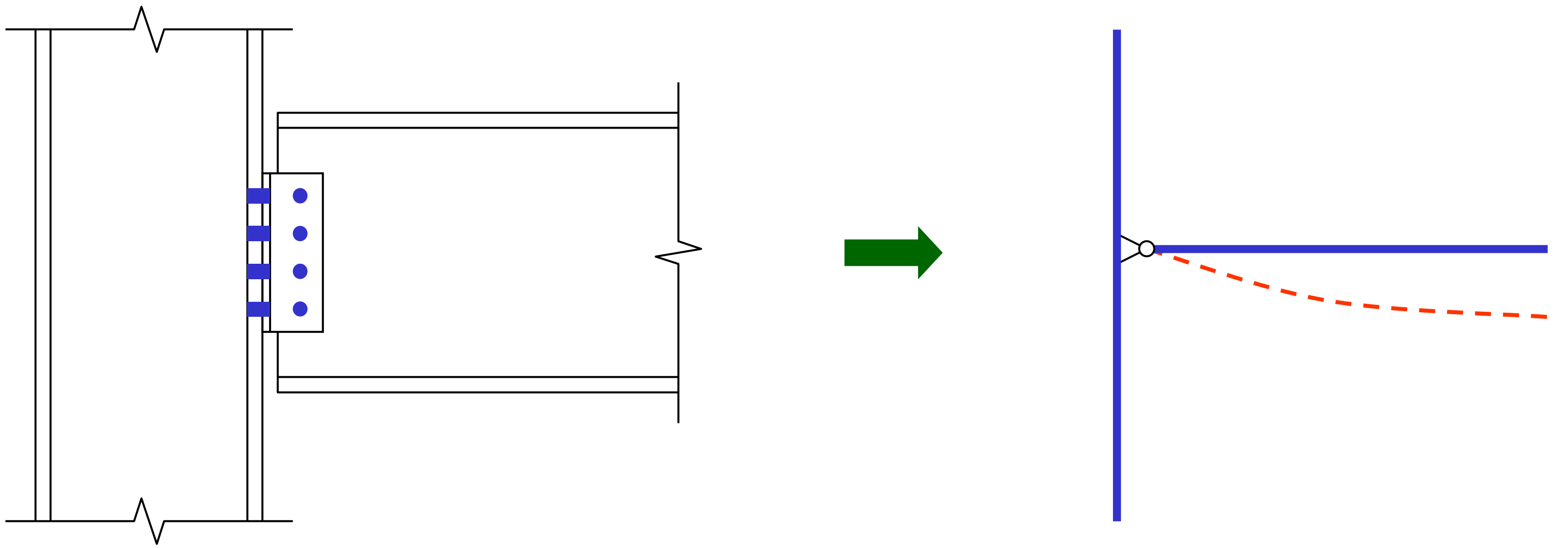
Beam-to-Column Connections





Simple Connections

Beam-to-column or beam-to-beam connections have some degree of moment restraint, even in those designed as simple joints.

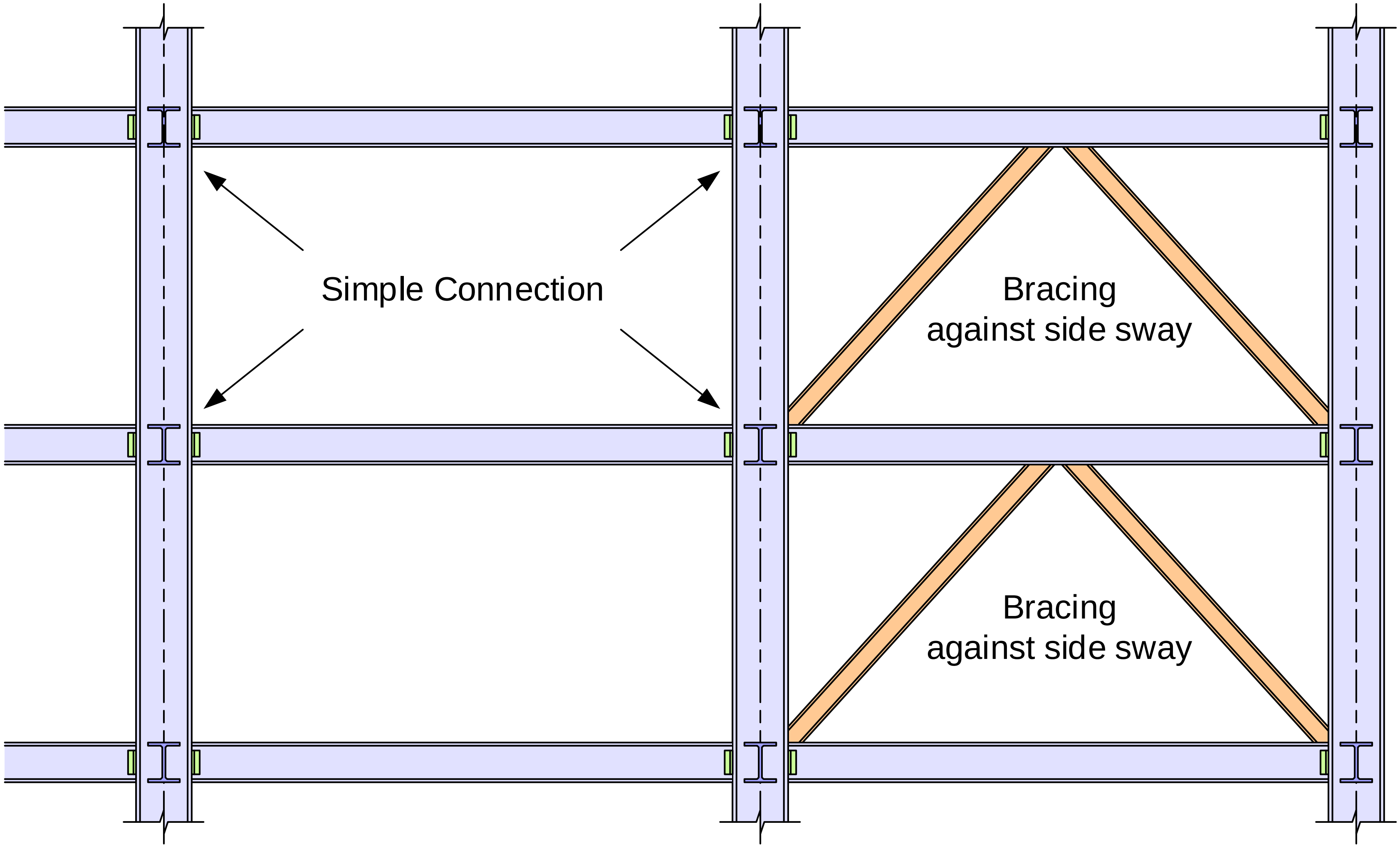


Shear connection : transmit shear only but no moment

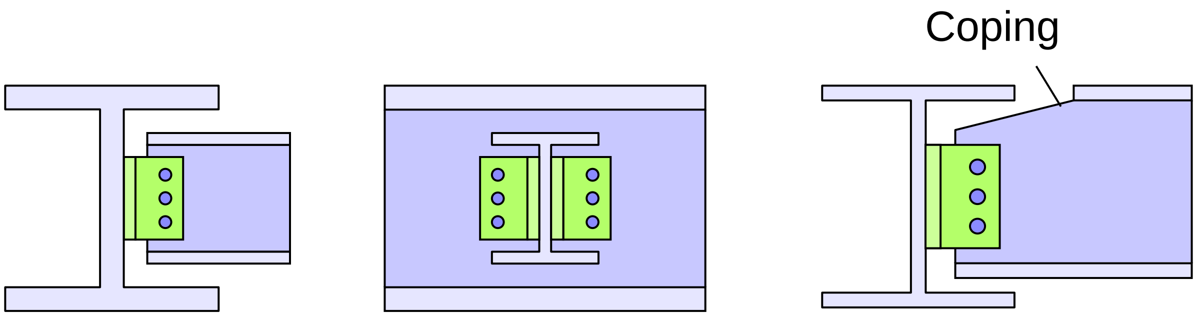
- Designed as flexible connections
- Connections are assumed to be free to rotate
- Vertical shear forces are the primary forces transferred by the connection
- Require a separate bracing system for lateral stability

Simple Connections in Braced Frame

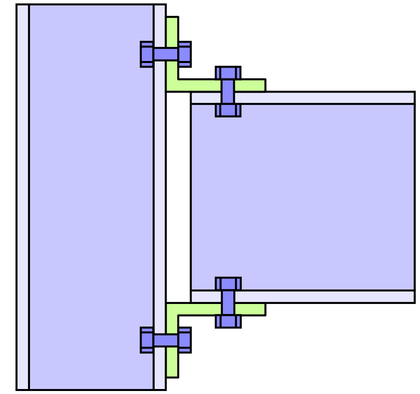
โครงแกงแนง(Braced Frame) มักใช้จุดต่ออย่างง่ายซึ่งถึงเป็นจุดหมุนจะรองรับได้เฉพาะน้ำหนักบรรทุกในแนวดิ่ง เพื่อให้มีเสถียรภาพในการรับแรงด้านข้างจะต้องใช้การยึดโยง (bracing) เพื่อช่วยในการค้ำยัน



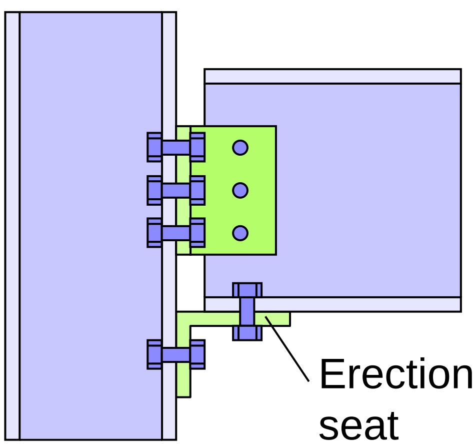
Framed connections & Seated connections



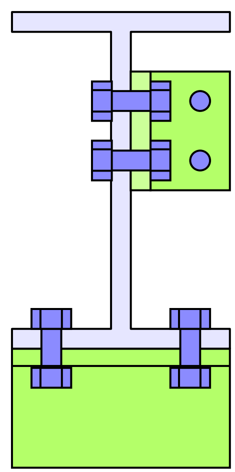
(ก) จุดต่อแบบโครง



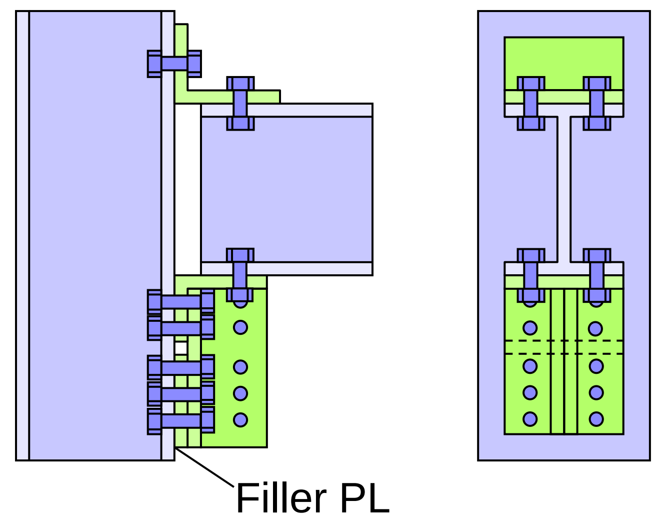
(ข) จุดต่อแบบฐานรอง



(ค) จุดต่อแบบโครงมีฐานรอง

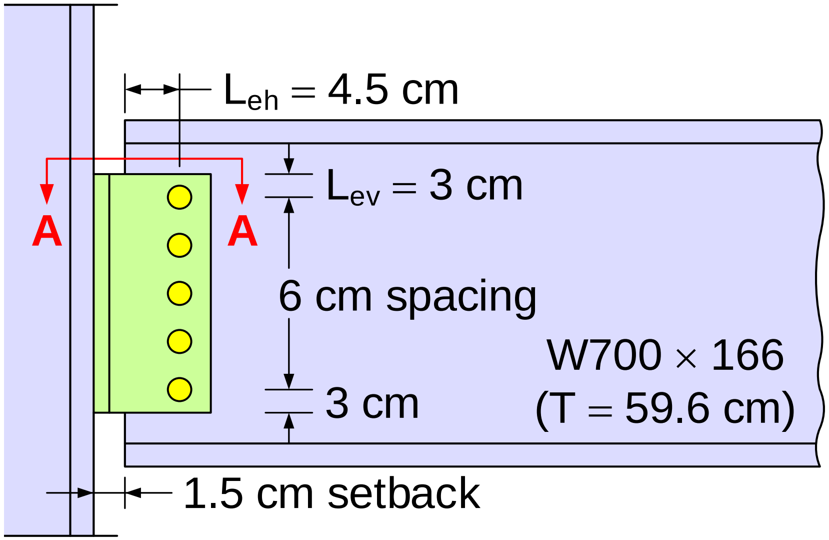


(ง) จุดต่อแบบฐานรอง



(จ) จุดต่อแบบฐานรองมีแผ่นเสริมกำลัง

Example 19-1 Select an all-bolted double-angle framed simple end connection for the uncoped W700×166 (t_w = 1.3 cm) if R_D = 16 tons and R_L = 20 tons and if the connection frames into the flange of a W350x79.7 (t_f = 1.4 cm). Assume that F_y = 2,500 ksc and F_u = 4,000 ksc. Use M20 A325-N bolts.



$T = d - 2\,(t_f + r)$ = clear distance

Solution

LRFD $R_u = 1.4(16)+1.7(20) = 56.4$ tons

ASD $R_a = 16 + 20 = 36$ tons

(1) Bolt Design Try M20 bolt A325-N

Bolts connect beam web with angles on both side → double shear

From Table D-2 : Shear strength r_n = 23.88 tons ← **Control**

From Table D-3 : Bearing strength r_n = 19.20(1.3) = 24.96 tons

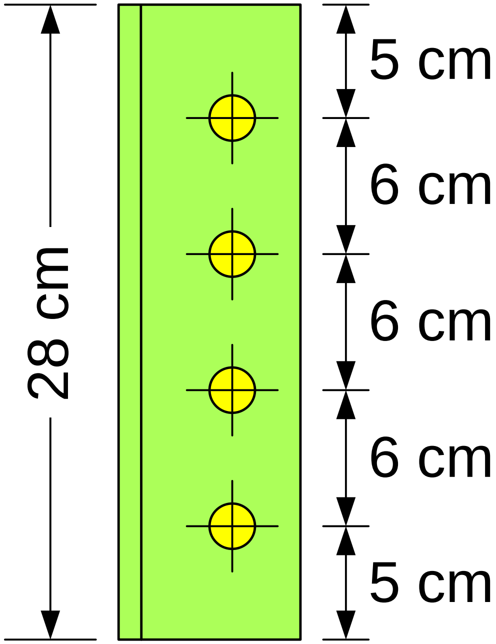
LRFD $\phi = 0.75$	**ASD** $\Omega = 2.00$
$\phi r_n = 0.75(23.88) = 17.91$ tons	$\dfrac{r_n}{\Omega} = \dfrac{23.88}{2.00} = 11.94$ tons

Number of bolts required :

LRFD $\phi = 0.75$	ASD $\Omega = 2.00$
$n = \frac{P_u}{\phi r_n} = \frac{56.4}{17.91} = 3.15$	$n = \frac{\Omega P_a}{r_n} = \frac{36}{11.94} = 3.02$

∴ Use 4-M20 A325-N bolts.

(2) Angle Design for 4-M20 bolts

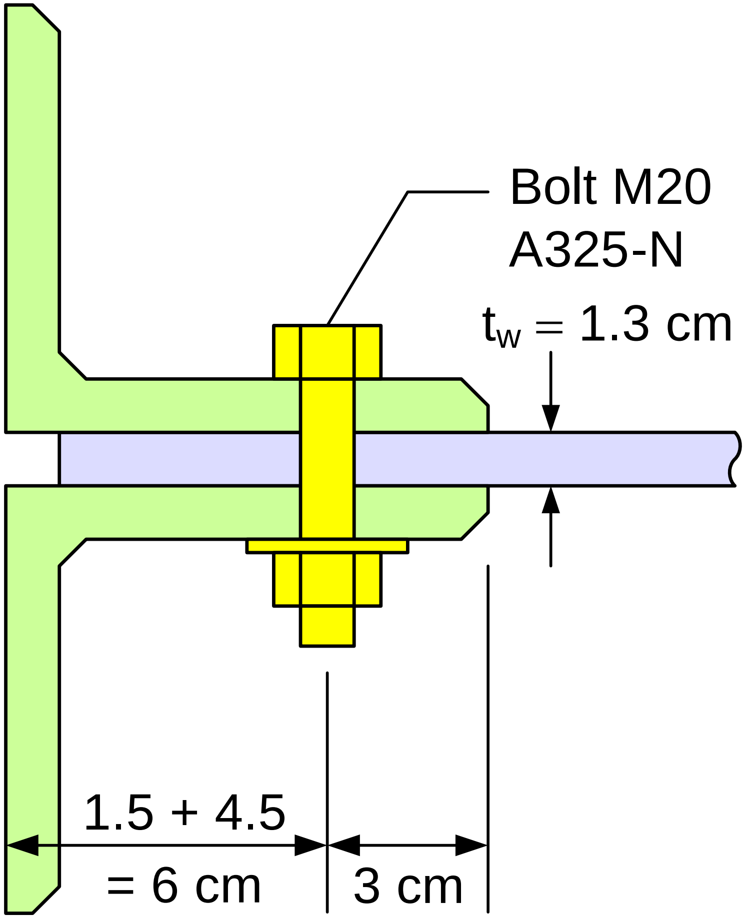


5 cm ← Edge distance ≈ 2.5 d

6 cm ← Spacing distance ≈ 3 d

Angles length $L = 2(5) + 3(6)$

$= 28$ cm $<$ [T = 59.6 cm] **OK**



$$\text{Angles leg} = L_{eh} + \text{setback} = 9 \text{ cm}$$

Select Angle 2–L90 × 90 × 10

$$\text{Angles leg thickness} = 2(1.0)$$

$$= 2.0 > [t_w = 1.3 \text{ cm}] \quad \textbf{OK}$$

$$A_v = 2(28–4\times2.2)(1.0) = 38.4 \text{ cm}^2$$

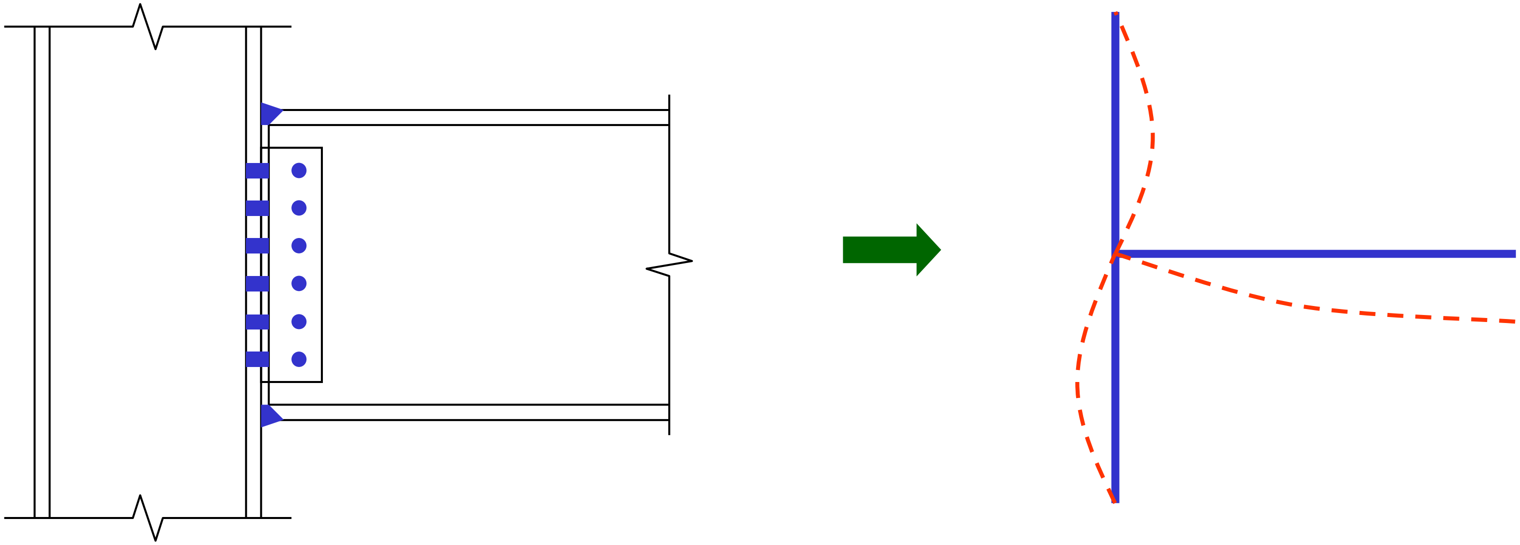
$$V_n = 0.6F_yA_vC_v$$

$$= 0.6(2.5)(38.4)(1.0) = 57.6 \text{ tons}$$

LRFD $\phi = 1.00$	**ASD** $\Omega = 1.50$
$V_u = R_u = 56.4$ tons $\phi_v V_n = 1.0(57.6)$ $= 57.6$ tons > 56.4 tons **OK**	$V_a = R_a = 36$ tons $\dfrac{V_n}{\Omega_b} = \dfrac{57.6}{1.5}$ $= 38.4$ tons > 36 tons **OK**

Moment Connections

However, it is also very difficult to make a perfectly rigid joint that is capable of transferring 100% moment capacity.



Special measures must be taken to make a connection **moment-resisting**

- Moment and vertical shear forces are transferred through the connection
- Two types of moment connections are permitted:
  - Fully-Restrained
  - Partially-Restrained

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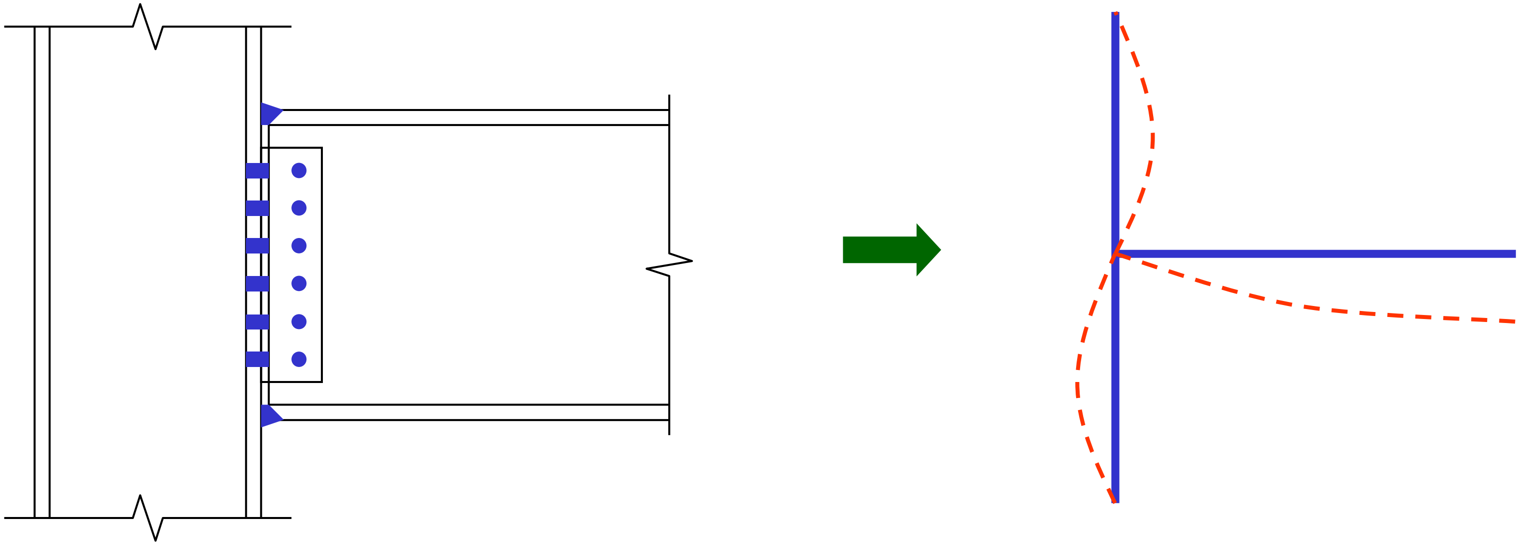

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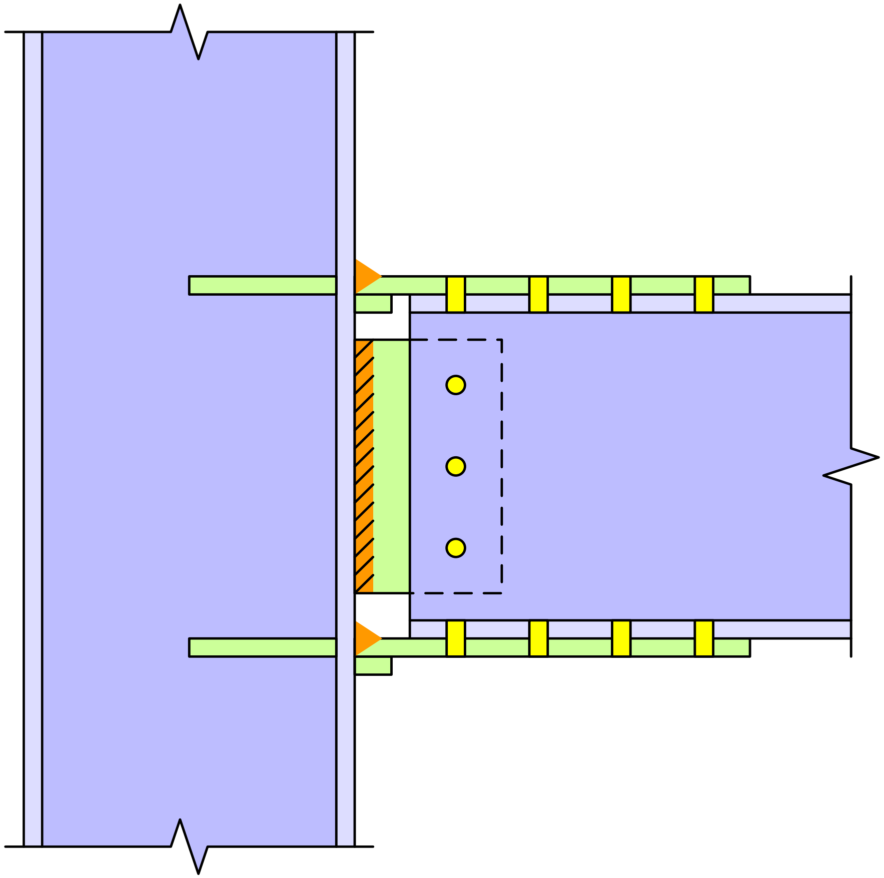
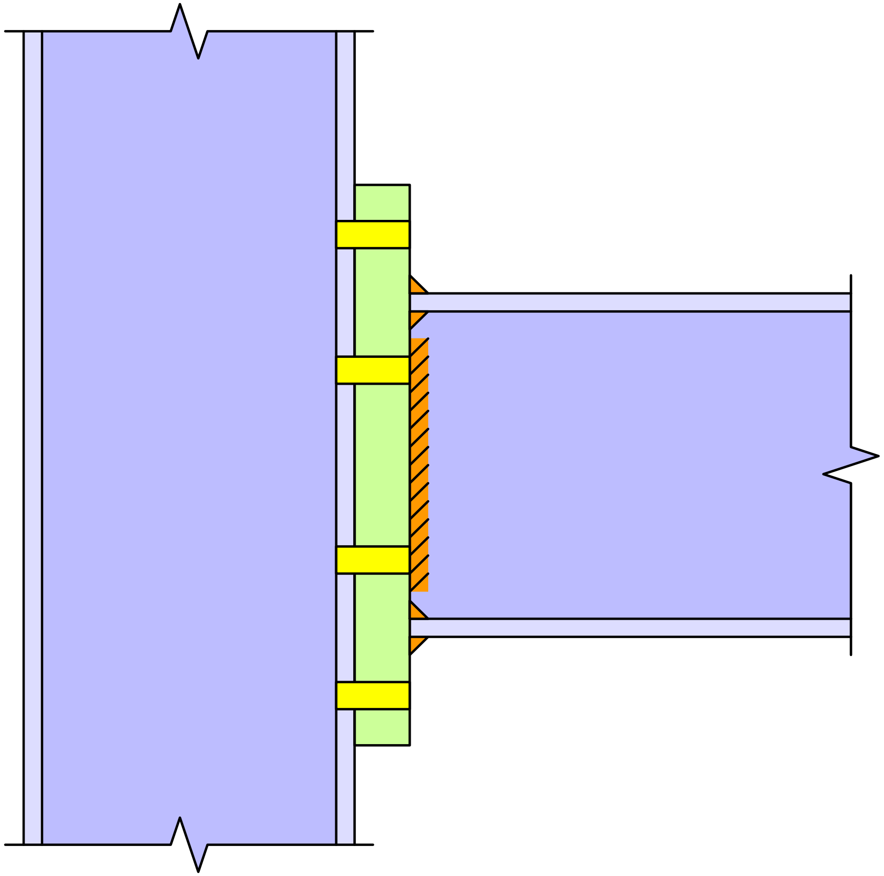
Moment Connections

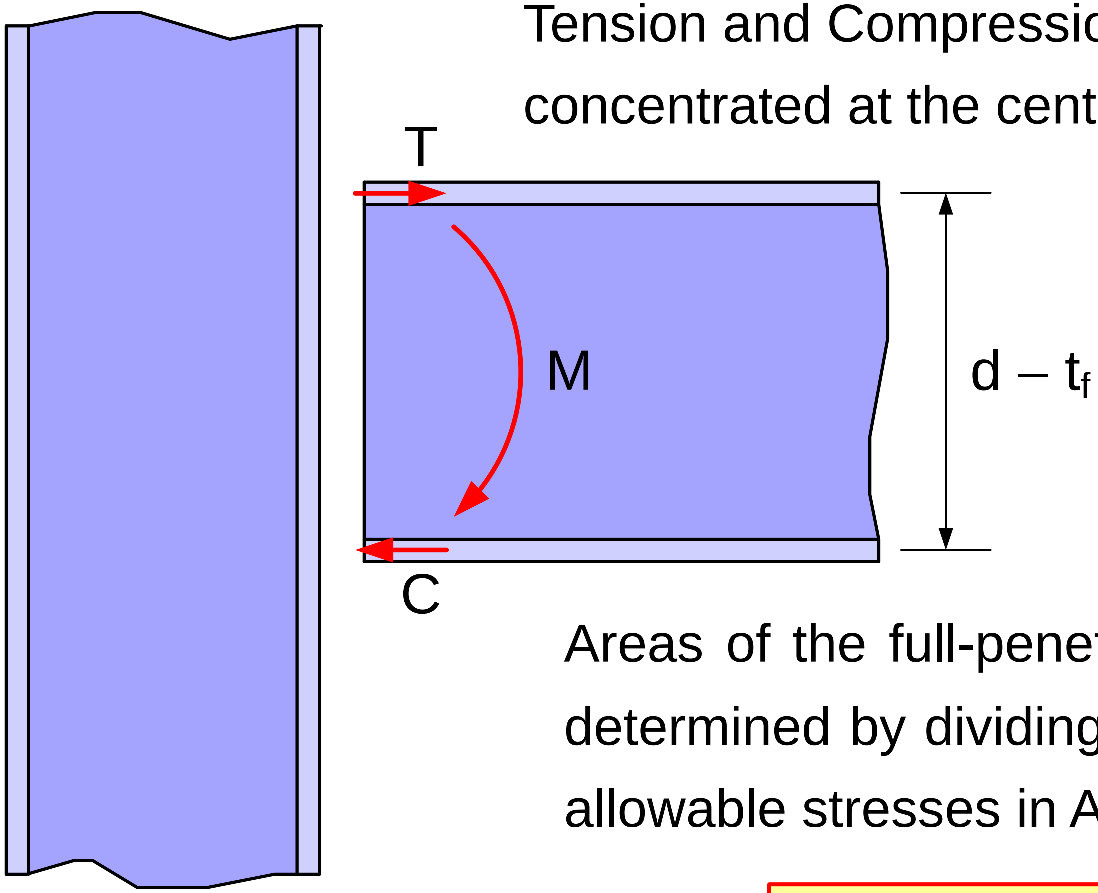


(a) shop-weld flange plates connected to the column flange with a field-bolted beam



(b) end plate shop-welded to the beam and then field-bolted to the column flange

Design of Moment Connections



Tension and Compression forces are assumed to be concentrated at the center of the flanges

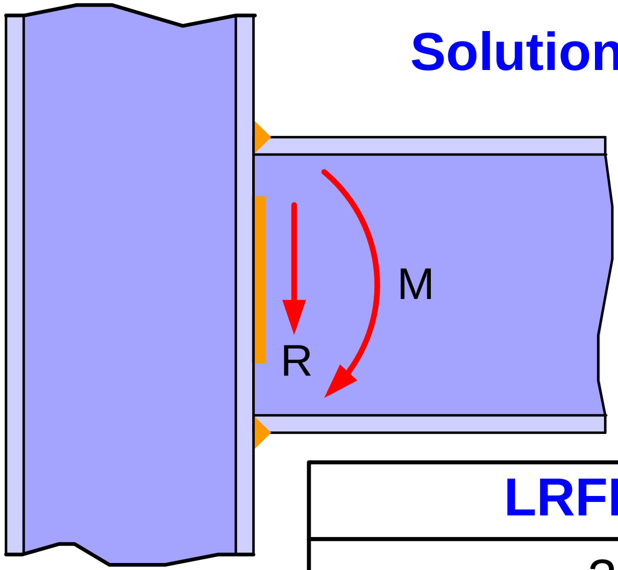
$$C = T = \frac{M}{d - t_f}$$

Areas of the full-penetration groove welds are determined by dividing C or T by the design or allowable stresses in AISC Table J2.5

$$A_{reqd} = \frac{C_u \text{ or } T_u}{\phi F_y} = \frac{C_a \text{ or } T_a}{F_y / \Omega}$$

Strength of the joint is controlled by the base metal.

Example 19-2 Determine a moment-resisting connection for the W500×103 beam with the flanges groove-welded to a column. The beam, which consists of 3,500 ksc, has end reactions $R_D = 7$ tons and $R_L = 11$ tons, along with moments $M_D = 7$ t-m and $M_L = 12$ t-m. Use E70 electrodes.



Solution W500×103 ($d = 50.6$ cm, $b_f = 20.1$ cm, $t_f = 1.9$ cm)

Design of moment welds

LRFD $M_u = 1.4(7) + 1.7(12) = 30.2$ t-m

ASD $M_a = 7 + 12 = 19$ t-m

LRFD $\phi = 0.90$	ASD $\Omega = 1.67$
$C_u = T_u = \dfrac{3{,}020}{50.6 - 1.9} = 62.0$ tons	$C_a = T_a = \dfrac{1{,}900}{50.6 - 1.9} = 39.0$ tons
$A_{reqd} = \dfrac{62.0}{0.9(3.5)} = 19.7\ cm^2$	$A_{reqd} = \dfrac{39.0}{3.5/1.67} = 18.6\ cm^2$
$width_{reqd} = A_{reqd} / t_f = 19.7 / 1.9$ $= 10.4\ cm < b_f$	$width_{reqd} = A_{reqd} / t_f = 18.6 / 1.9$ $= 9.79\ cm < b_f$

∴ Use 12-cm-wide E70 full-penetration groove welds.

Design of shear welds (vertical welds on both side of beam web)

LRFD $V_u = 1.4(7) + 1.7(11) = 28.5$ t-m

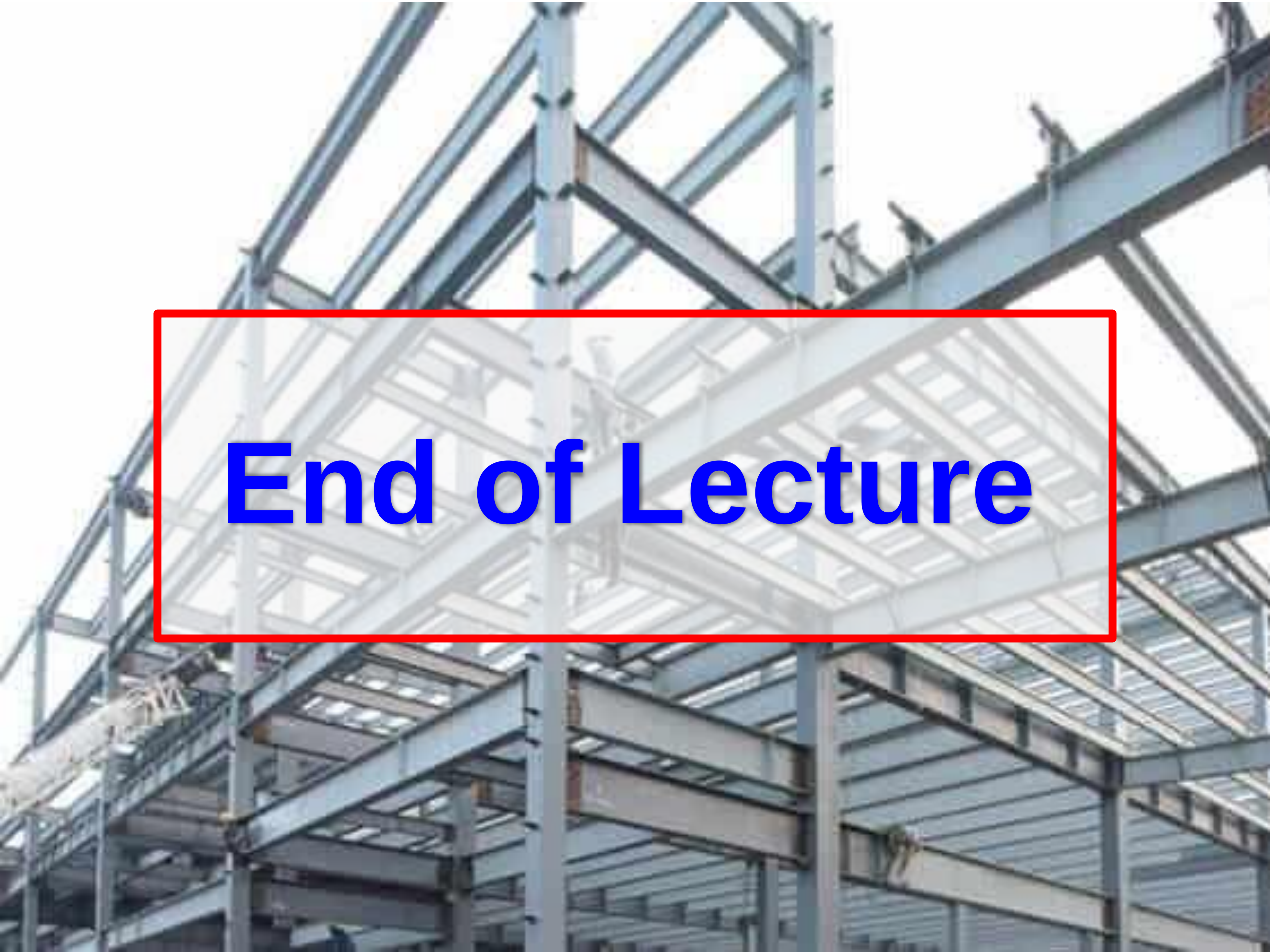
ASD $V_a = 7 + 11 = 18$ t-m

Try 6-mm fillet welds on both sides of beam web

r_n of weld per cm $= F_{nw}A_{we} = 0.60(4.9)(0.707)(0.6) = 1.25$ t/cm

LRFD $\phi = 0.75$	**ASD** $\Omega = 2.00$
$L_{reqd} = \dfrac{28.5}{0.75(1.25)} = 30.4$ cm	$L_{reqd} = \dfrac{18}{1.25 / 2.00} = 28.8$ cm

∴ Use 6-mm fillet welds 16-cm long each side.


End of Lecture