


# Design of the joints for neutrino project

jcb1

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 **1511584 v.1** ● In Work 🔒 Restricted access  
**Design of joints for neutrino project** *by Joao Carlos BATISTA LOPES*

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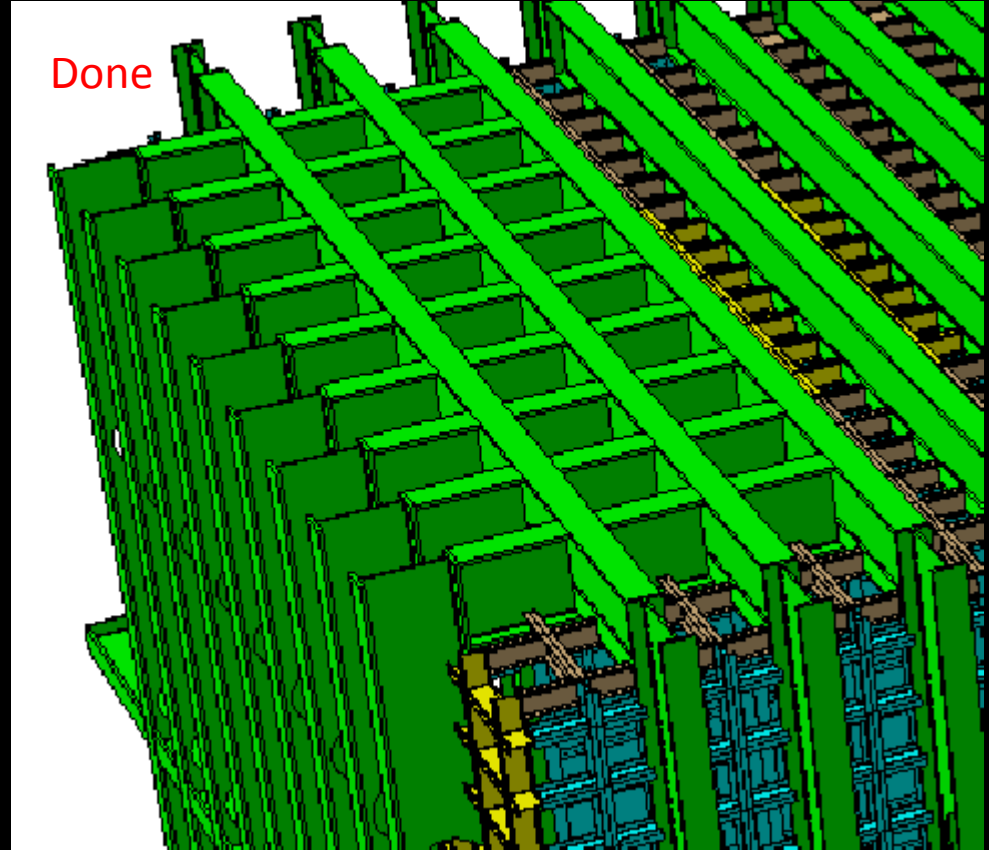
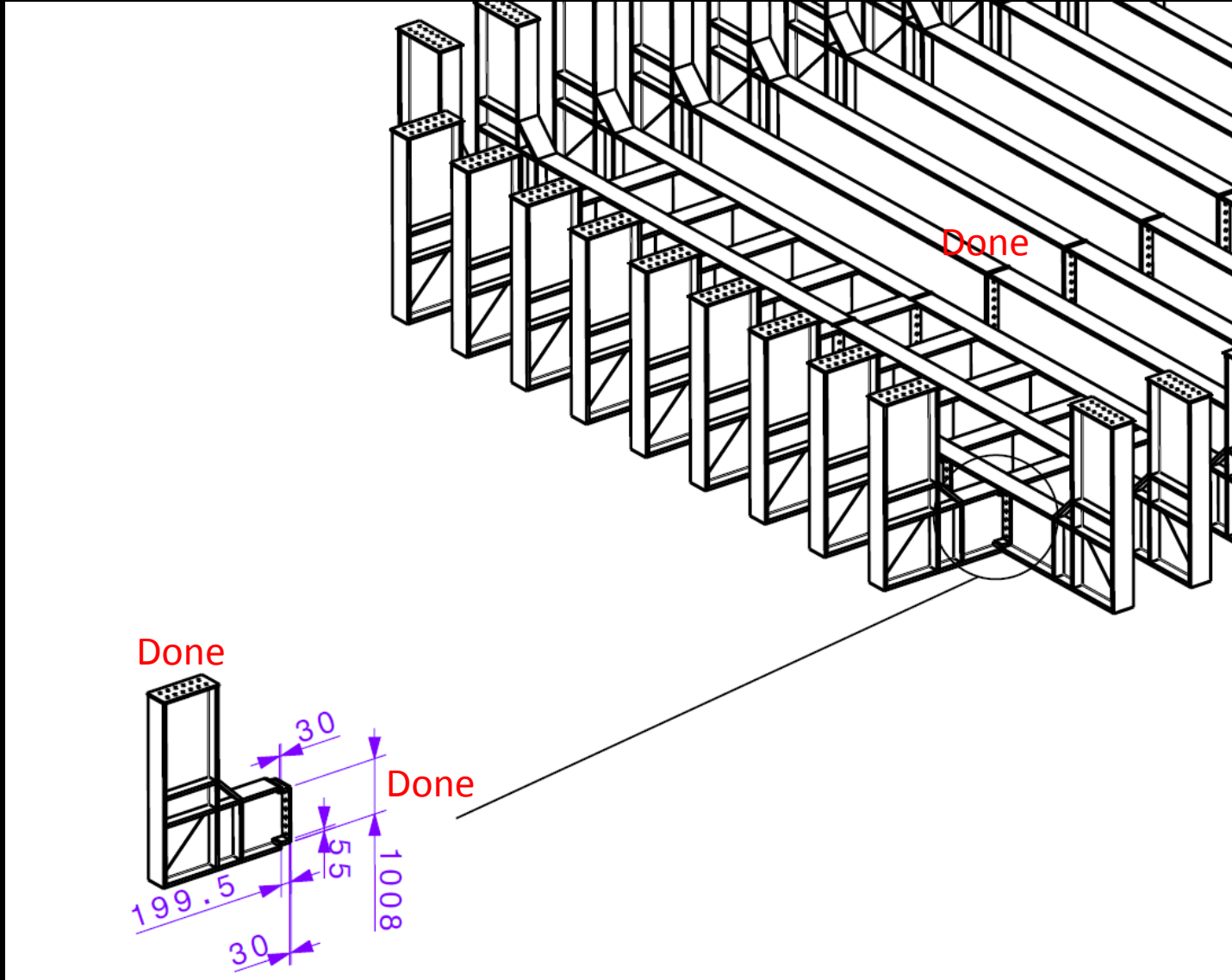
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<input type="checkbox"/>	30	<a href="#">moment_connection_between_two_HL_1100_by_607_beams.pdf</a>

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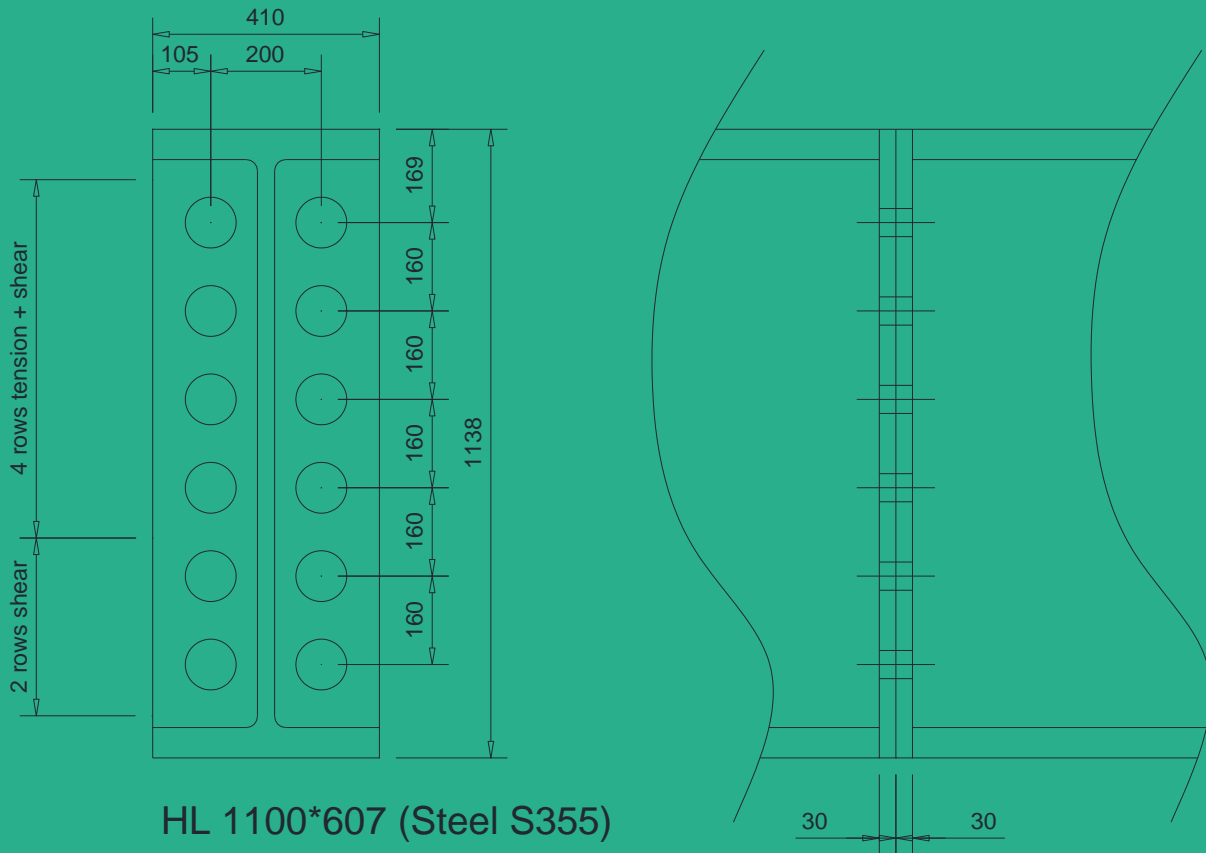
Document status: In work

Contents:

- Analytical calculations (EC3 compliance)
- FEA (stress compliance with ASME)

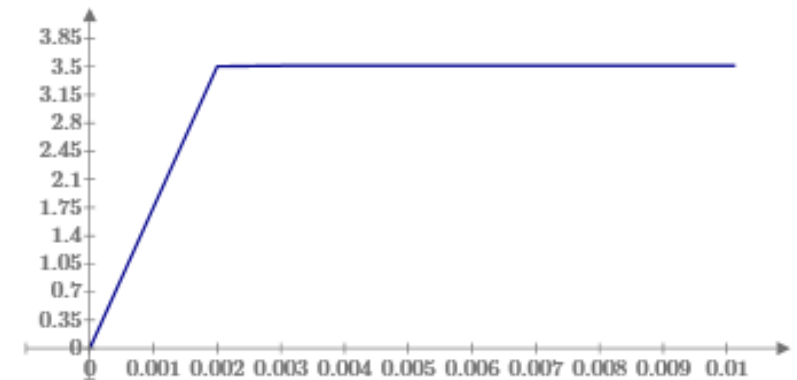


# Splice 1 geometry



HL 1100\*607 (Steel S355)  
12\*M48 bolts (class 10.9)  
tp=30 mm (Steel S 355)

$M(\phi)$  (MN·m)



$\phi$  (rad)

# Splice 1 capacity

- Compression components

Beam flange and web in compression:

$$F_{c.fb.Rd} = 9.805 \text{ MN}$$

- Tension components

$$F_{t1.Rd} = 1.567 \text{ MN}$$

$$F_{t2.Rd} = 1.343 \text{ MN}$$

$$F_{t3.Rd} = 1.396 \text{ MN}$$

$$F_{t4.Rd} = 1.195 \text{ MN}$$

$$F_{t.total.Rd} := F_{t1.Rd} + F_{t2.Rd} + F_{t3.Rd} + F_{t4.Rd} = 5.502 \text{ MN}$$

- Connection capacity

Moment resistance

$$M_{j.Rd} = 2.726 \text{ MN} \cdot \text{m} \quad +$$

Shear resistance

$$V_{j.Rd} = 1.347 \text{ MN}$$

Initial rotation stiffness

$$S_{j.ini} = 2145.939 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

Idealized rotation stiffness (for design)

$$S_j = 1072.969 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

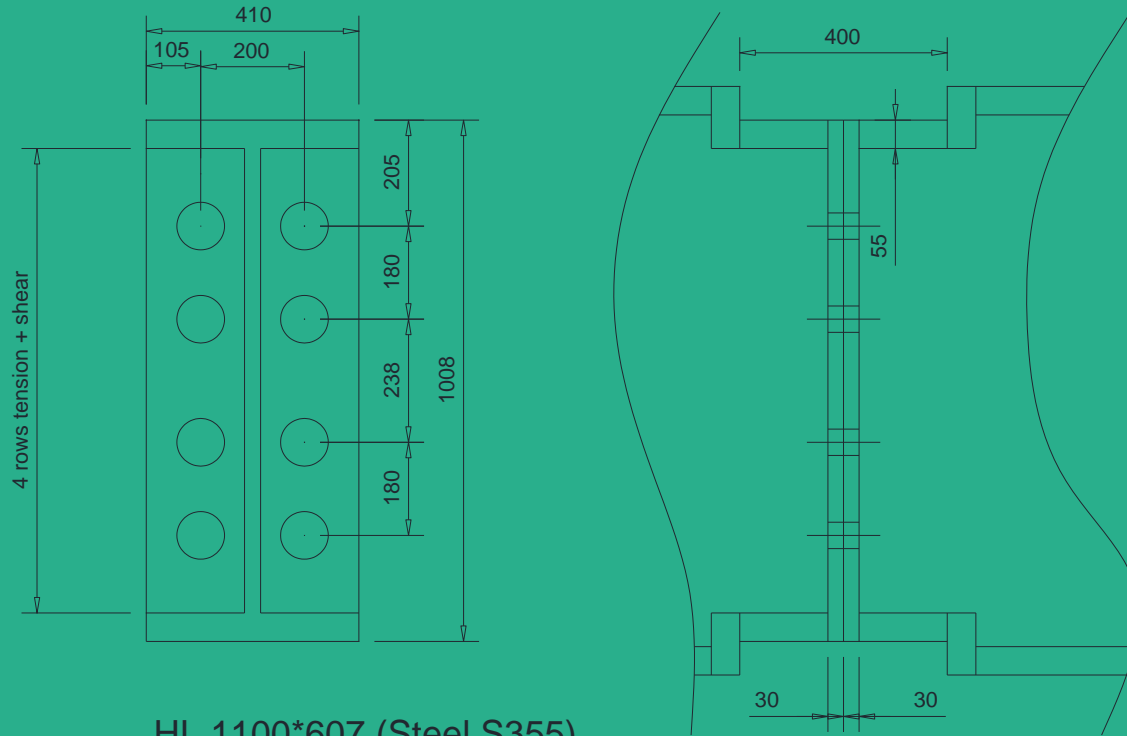
Minimum rigidity for rigid joint

$$S_{j.rigid} = 1706.601 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

maximum rigidity for pinned joint

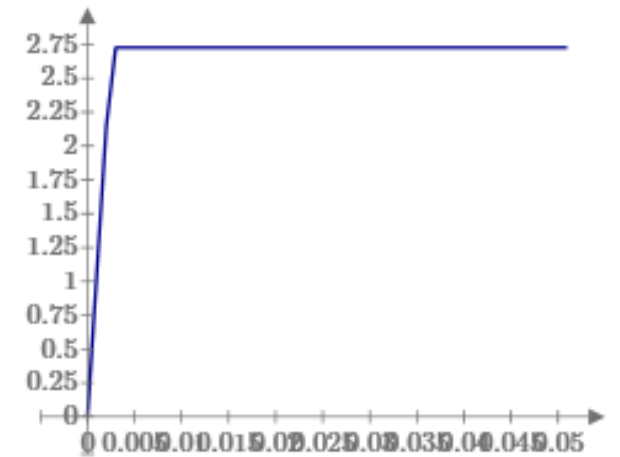
$$S_{j.pinned} = 106.663 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

# Splice 2 geometry



HL 1100\*607 (Steel S355)  
8\*M48 bolts (class 10.9)  
tp=30 mm (Steel S 355)

$M(\phi)$  ( $m \cdot MN$ )



$\phi$  ( $rad$ )

# Splice 2 capacity

- Compression components

Beam flange and web in compression:

$$F_{c.fb.Rd} = 9.805 \text{ MN}$$

- Tension components

$$F_{t1.Rd} = 1.909 \text{ MN}$$

$$F_{t2.Rd} = 1.909 \text{ MN}$$

$$F_{t3.Rd} = 1.858 \text{ MN}$$

$$F_{t4.Rd} = 1.636 \text{ MN}$$

$$F_{t.total.Rd} := F_{t1.Rd} + F_{t2.Rd} + F_{t3.Rd} + F_{t4.Rd} = 7.313 \text{ MN}$$

- Connection capacity

Moment resistance

$$M_{j.Rd} = 3.572 \text{ MN} \cdot \text{m}$$

Shear resistance

$$V_{j.Rd} = 1.347 \text{ MN}$$

Initial rotation stiffness

$$S_{j.ini} = 3029.423 \text{ MN} \cdot \frac{\text{m}}{\text{rad}} \quad +$$

Idealized rotation stiffness (for design)

$$S_j = 1514.711 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

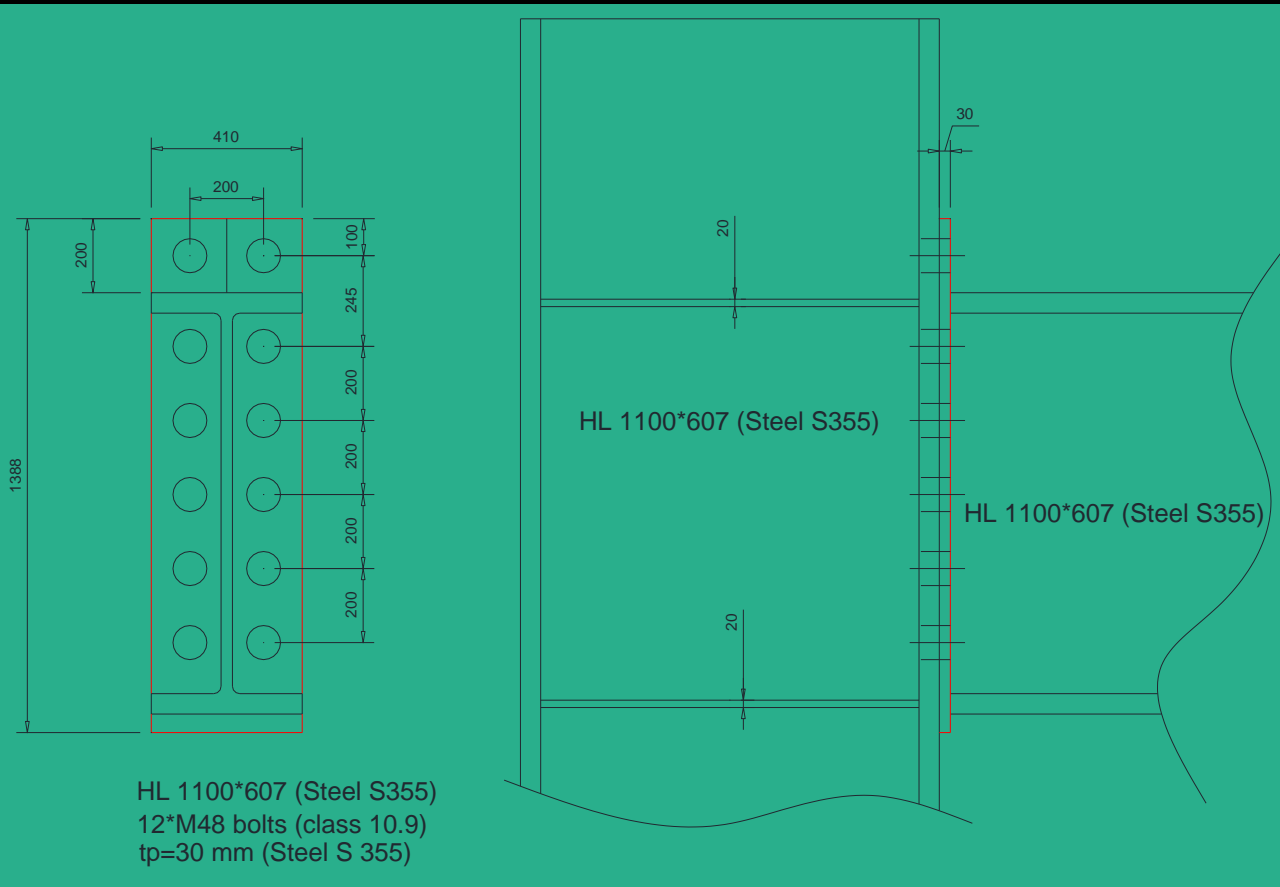
Minimum rigidity for rigid joint

$$S_{j.rigid} = 1706.601 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

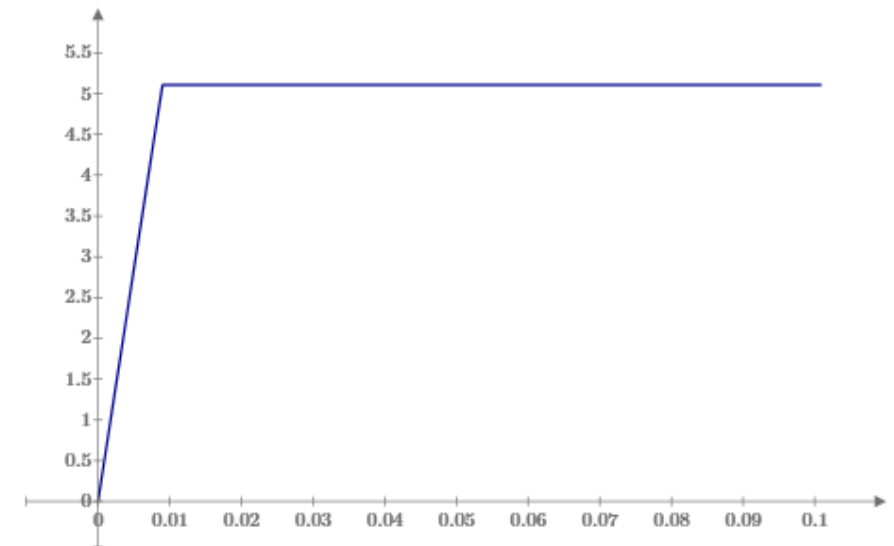
maximum rigidity for pinned joint

$$S_{j.pinned} = 106.663 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

# Moment connection geometry



$M(\phi)$  ( $MN \cdot m$ )



$\phi$  (rad)



# Moment connection capacity

- Shear components

Column web in shear:

$$V_{w.Rd} = 7.565 \text{ MN}$$

- Compression components

Column web in transverse compression:

$$F_{c.wc.Rd} = 12.156 \text{ MN}$$

Beam flange and web in compression:

$$F_{c.fb.Rd} = 13.771 \text{ MN}$$

- Tension components

$$F_{t1.Rd} = 1.026 \text{ MN}$$

$$F_{t2.Rd} = 1.558 \text{ MN}$$

$$F_{t3.Rd} = 1.348 \text{ MN}$$

$$F_{t4.Rd} = 1.227 \text{ MN}$$

$$F_{t5.Rd} = 1.558 \text{ MN}$$

$$F_{t6.Rd} = 0.395 \text{ MN}$$

$$F_{t.total.Rd} := F_{t1.Rd} + F_{t2.Rd} + F_{t3.Rd} + F_{t4.Rd} + F_{t5.Rd} + F_{t6.Rd} = 7.113 \text{ MN}$$

- Connection capacity

Moment resistance

$$M_{j.Rd} = 5.107 \text{ MN} \cdot \text{m}$$

Shear resistance

$$V_{j.Rd} = 2.02 \text{ MN}$$

Initial rotation stiffness

$$S_{j.ini} = 1138.074 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

Idealized rotation stiffness (for design)

$$S_j = 569.037 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

Minimum rigidity for rigid joint

$$S_{j.rigid} = 6297.451 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

maximum rigidity for pinned joint

$$S_{j.pinned} = 393.591 \text{ MN} \cdot \frac{\text{m}}{\text{rad}}$$

Joint classification

$$Joint_{classification} := \begin{cases} \text{if } S_j \leq S_{j.pinned} \\ \quad \text{“Pinned”} \\ \text{else if } S_j \geq S_{j.rigid} \\ \quad \text{“Rigid”} \\ \text{else} \\ \quad \text{“Semi-rigid”} \end{cases} = \text{“Semi-rigid”}$$