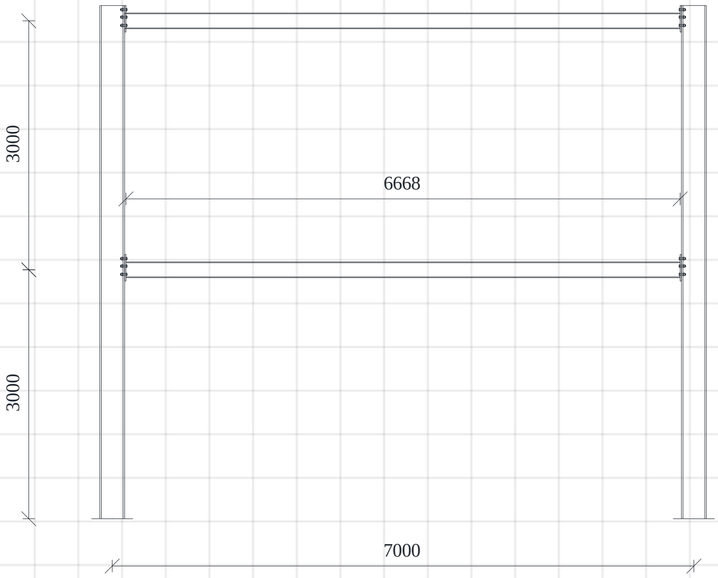
This playlist series focuses on the rigid connection calculation according to EN 1993-1-8. A comparison is made with Ansys at the end of the series after hand calculation. Finally, tips for applying the semi-rigid connection to RFEM are presented.

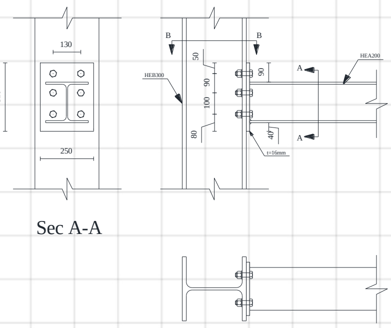
A portal frame with two levels is presented, as shown in the figure below. We went through the connections in this playlist for both ends and beams. The Endplate welded to the HEA200 beam is bolted to a HEB300 column with 6M20 class 8.8, as shown in the figures below. Steel material is S355 for all parties.

This video shows the joint classification based on stiffness and strength according to EN 1993-1-8. The contents are as follows:

a) Classification by stiffness according to clause 5.2.2.
b) Classification by strength according to clause 5.2.3.

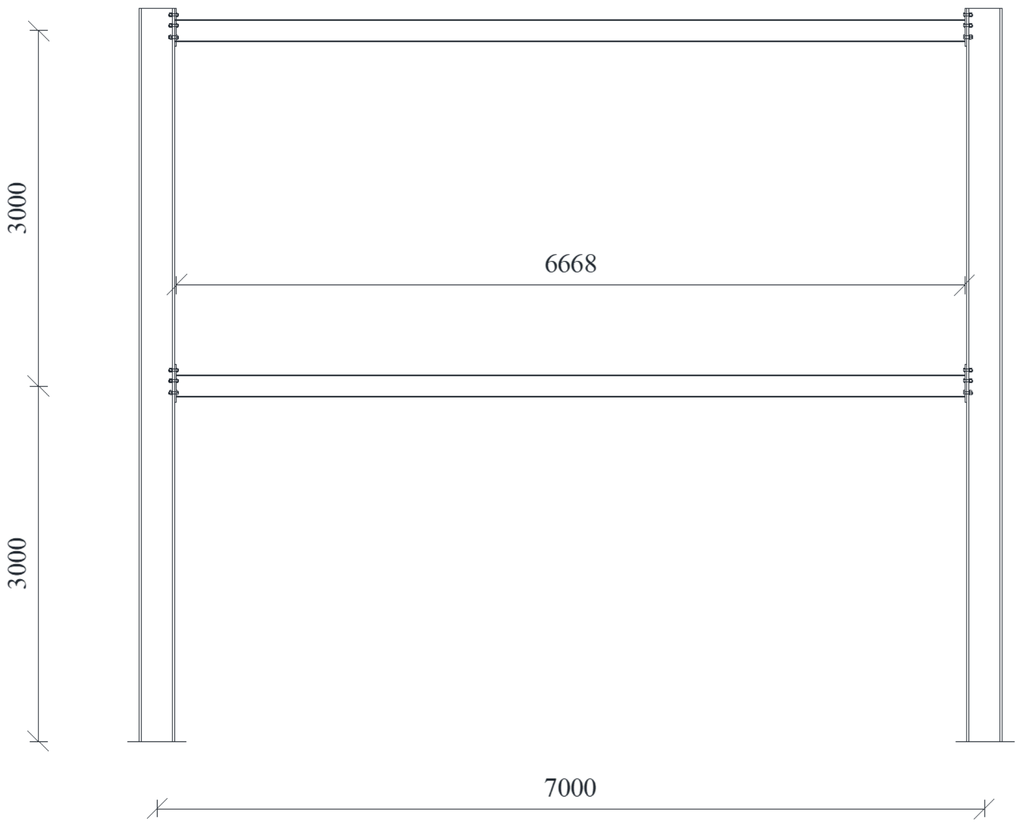
All dimensions are in mm unless otherwise specified.

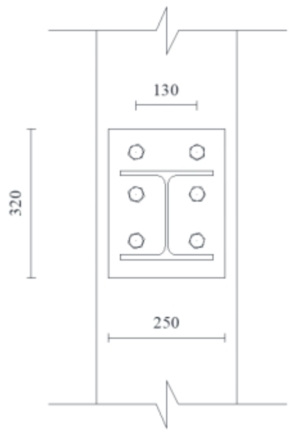


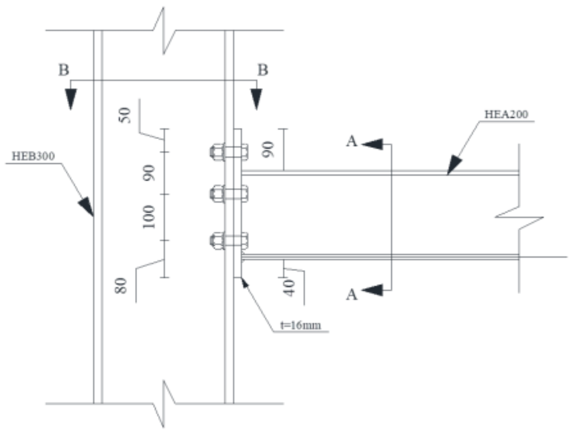


Sec A-A

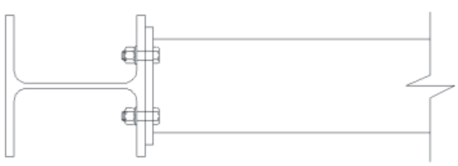
Sec B-B


3000
3000
6668
7000


130
320
250


B
B
50
90
100
80
HEB300
90
40
A
A
HEA200
t=16mm

Sec A-A



Sec B-B

5.2 Classification of joints

5.2.1 General

(1) The details of all joints should fulfil the assumptions made in the relevant design method, without adversely affecting any other part of the structure.

(2) Joints may be classified by their stiffness (see 5.2.2) and by their strength (see 5.2.3).

NOTE: The National Annex may give additional information on the classification of joints by their stiffness and strength to that given in 5.2.2.1(2).

5.2.2 Classification by stiffness

5.2.2.1 General

(1) A joint may be classified as rigid, nominally pinned or semi-rigid according to its rotational stiffness, by comparing its initial rotational stiffness $S_{j,ini}$ with the classification boundaries given in 5.2.2.5.

NOTE: Rules for the determination of $S_{j,ini}$ for joints connecting H or I sections are given in 6.3.1. Rules for the determination of $S_{j,ini}$ for joints connecting hollow sections are not given in this Standard.

(2) A joint may be classified on the basis of experimental evidence, experience of previous satisfactory performance in similar cases or by calculations based on test evidence.

5.2.2.2 Nominally pinned joints

(1) A nominally pinned joint should be capable of transmitting the internal forces, without developing significant moments which might adversely affect the members or the structure as a whole.

(2) A nominally pinned joint should be capable of accepting the resulting rotations under the design loads.

5.2.2.3 Rigid joints

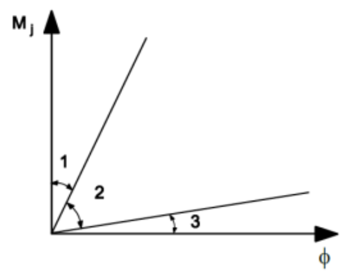
(1) Joints classified as rigid may be assumed to have sufficient rotational stiffness to justify analysis based on full continuity.

5.2.2.4 Semi-rigid joints

(1) A joint which does not meet the criteria for a rigid joint or a nominally pinned joint should be classified as a semi-rigid joint.

NOTE: Semi-rigid joints provide a predictable degree of interaction between members, based on the design moment-rotation characteristics of the joints.

(2) Semi-rigid joints should be capable of transmitting the internal forces and moments.



Zone 1: rigid, if $S_{j,ini} \geq k_b EI_b / L_b$

where:

$k_b = 8$ for frames where the bracing system reduces the horizontal displacement by at least 80 %

$k_b = 25$ for other frames, provided that in every storey $K_b/K_c \geq 0,1$ *)

Zone 2: semi-rigid

All joints in zone 2 should be classified as semi-rigid. Joints in zones 1 or 3 may optionally also be treated as semi-rigid.

Zone 3: nominally pinned, if $S_{j,ini} \leq 0,5 EI_b / L_b$

*) For frames where $K_b/K_c < 0,1$ the joints should be classified as semi-rigid.

Key:

- K_b is the mean value of I_b/L_b for all the beams at the top of that storey;
- K_c is the mean value of I_c/L_c for all the columns in that storey;
- I_b is the second moment of area of a beam;
- I_c is the second moment of area of a column;
- L_b is the span of a beam (centre-to-centre of columns);
- L_c is the storey height of a column.

Figure 5.4: Classification of joints by stiffness

	Area properties					Inertia properties about major axis y-y			
Profile	Weight m [kg/m]	Perimeter P [m]	Area A [mm²]	Shear area z-z $A_{v,z}$ [mm²] (for η=1.2)	Shear area y-y $A_{v,y}$ [mm²]	Second moment of area I_y [×10⁶ mm⁴]	Radius of gyration i_y [mm]	Elastic section modulus $W_{el,y}$ [×10³ mm³]	Plastic section modulus $W_{pl,y}$ [×10³ mm³]
HEA200	42.3	1.136	5383	1808	4000	36.92	82.8	388.6	429.5

$I_b = 36.92 \times 10^6\ mm^4$

$L_b = 6668\ mm$

$K_b = \frac{I_b}{L_b} = 5537\ mm^3$

	Area properties					Inertia properties about major axis y-y			
Profile	Weight m [kg/m]	Perimeter P [m]	Area A [mm²]	Shear area z-z $A_{v,z}$ [mm²] (for η=1.2)	Shear area y-y $A_{v,y}$ [mm²]	Second moment of area I_y [×10⁶ mm⁴]	Radius of gyration i_y [mm]	Elastic section modulus $W_{el,y}$ [×10³ mm³]	Plastic section modulus $W_{pl,y}$ [×10³ mm³]
HEB300	117.0	1.732	14908	4743	11400	251.7	129.9	1678	1869

$I_c = 251.7 \times 10^6\ mm^4$

$L_c = 3m = 3000\ mm$

$K_c = \frac{I_c}{L_c} = 83900\ mm^3$

$\frac{K_b}{K_c} = 0.06 < 0.1 \rightarrow$ Semi Rigid Connection

5.2.3 Classification by strength

5.2.3.1 General

(1) A joint may be classified as full-strength, nominally pinned or partial strength by comparing its design moment resistance $M_{j,Rd}$ with the design moment resistances of the members that it connects. When classifying joints, the design resistance of a member should be taken as that member adjacent to the joint.

5.2.3.2 Nominally pinned joints

(1) A nominally pinned joint should be capable of transmitting the internal forces, without developing significant moments which might adversely affect the members or the structure as a whole.

(2) A nominally pinned joint should be capable of accepting the resulting rotations under the design loads.

(3) A joint may be classified as nominally pinned if its design moment resistance $M_{j,Rd}$ is not greater than 0,25 times the design moment resistance required for a full-strength joint, provided that it also has sufficient rotation capacity.

5.2.3.3 Full-strength joints

(1) The design resistance of a full strength joint should be not less than that of the connected members.

(2) A joint may be classified as full-strength if it meets the criteria given in Figure 5.5.

a) Top of column	Either	$M_{j,Rd} \geq M_{b,pl,Rd}$
	or	$M_{j,Rd} \geq M_{c,pl,Rd}$
b) Within column height	Either	$M_{j,Rd} \geq M_{b,pl,Rd}$
	or	$M_{j,Rd} \geq 2\,M_{c,pl,Rd}$

Key:

$M_{b,pl,Rd}$ is the design plastic moment resistance of a beam;
$M_{c,pl,Rd}$ is the design plastic moment resistance of a column.

Figure 5.5: Full-strength joints

$M_{j,Rd} = 90\ kN\ m$

M_{Ed} (fully Rigid connection) $= \frac{qL^2}{12}$

$q = 20\ kN/m$, $L = 6.668\ m$ → $M_{Ed}(FR) = 74\ kN.m$

$q = 15\ kN/m$ → $M_{Ed}(FR) = 55.6\ kN.m$

$$M_{b,pl,Rd} = \frac{W_{pl} f_y}{\gamma_{M0}} = \frac{429.5 \times 10^3\ mm^3 \times 355\ MPa}{1} = 152.5\ kN\ m$$

$$M_{c,pl,Rd} = \frac{W_{pl} f_y}{\gamma_{M0}} = \frac{1869 \times 10^3\ mm^3 \times 355\ MPa}{1} = 664\ kN\ m$$

$M_{j,Rd} = 90\ kN\ m \geq M_{b,pl,Rd} = 152.5\ kN\ m$ ✗

$M_{j,Rd} = 90\ kN \geq 2 \times 664\ kN\ m$ ✗

Semi Rigid Connection