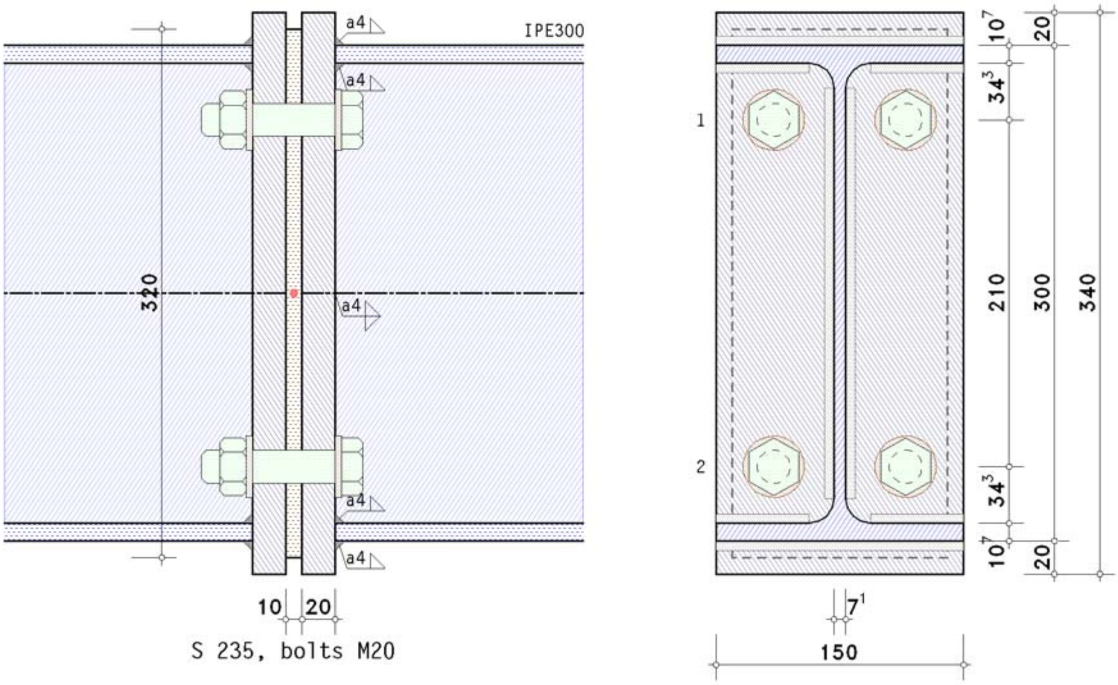
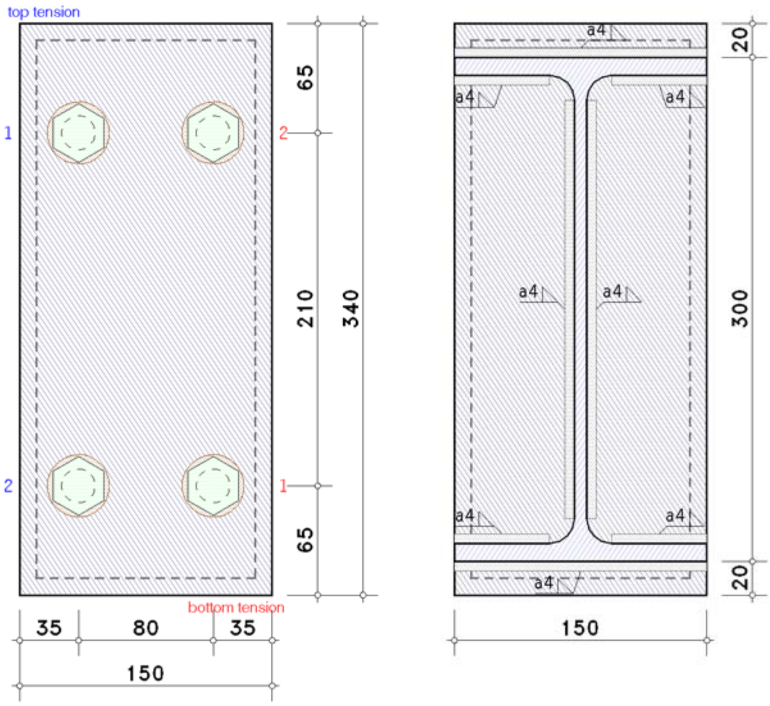
# POS. 1: NASDALA 2

## rigid joint with thermal separation layer

EC 3-1-8 (12.10), NA: Deutschland




details




**steel grade**
steel grade S 235
**beam parameters**
section IPE300
**bolts**
bolt: bolt class 10.9, bolt size M20
large width across flats (high strength bolt)
shear plane passes through the unthreaded portion of the bolt
**verification parameters**
bolted end-plate joint:
end-plate: thickness $t_p$ = 20.0 mm, length $l_p$ = 340.0 mm, width $b_p$ = 150.0 mm

projections $h_{p,o}$ = 20.0 mm, $h_{p,u}$ = 20.0 mm
thermal separation layer (Kerncompactlager of Calenberg Ingenieure GmbH):
thickness $t_e$ = 10.0 mm, length $l_e$ = 320.0 mm, width $b_e$ = 130.0 mm
safety factor of material $\gamma_e$ = 1.00

bolts at the connection point:
2 bolt-row(s) with 2 bolts each
all bolt rows are considered individually
no bolt rows top ($M^+$) in a group of bolts
and all bolt rows for shear transfer at tension top (rows 1-2)
no bolt rows bottom ($M^-$) in a group of bolts
and all bolt rows for shear transfer at tension bottom (rows 1-2)
centre distance of the bolts to the lateral edge of the end-plate $e_2$ = 35.0 mm
centre distance of the first bolt-row to the upper edge of the end-plate (end row) $e_o$ = 65.0 mm
centre distance of the last bolt-row to the bottom edge of the end-plate (end row) $e_u$ = 65.0 mm
centre distance of the bolt-rows from each other $p_{1-2}$ = 210.0 mm

welds at the connection point:
beam flange top: fillet weld, weld thickness a = 4.0 mm
beam web: fillet weld, weld thickness a = 4.0 mm
beam flange bottom: fillet weld, weld thickness a = 4.0 mm

**internal forces and moments in the intersection point of system axes (sign convention of statics)**

Lk 1: Nr.2
$N_{j,b1,Ed}$ = -896.00 kN

**partial safety factors for material**

resistance of cross sections $\gamma_{M0}$ = 1.00
resistance of members in stability failure $\gamma_{M1}$ = 1.10
resistance of bolts, welds, plates in bearing $\gamma_{M2}$ = 1.25
prestressing of high strength bolts $\gamma_{M7}$ = 1.10

## Component method

notes
high strength bolts have to be controlled prestressed, bolt category D (tension), A (shear).
no verification for cross sections within the connection area.
no verfication for welds within the connection.

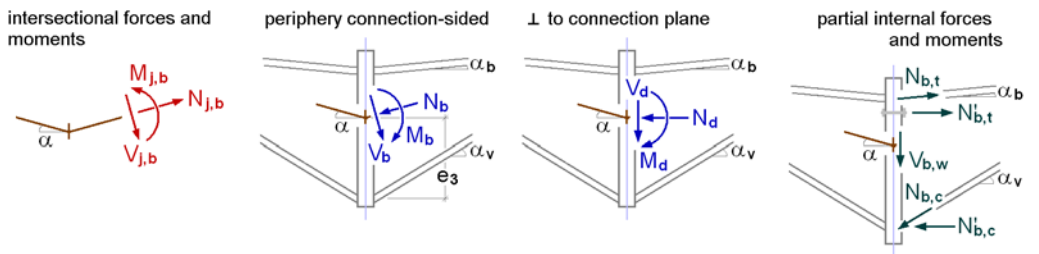
distances between bolt-rows at end-plate

| | | |
|---|---|---|
| edge dist.: | $e_2$ = 35.0 mm > 1.2·$d_0$ = 26.4 mm, | $e_2$ = 35.0 mm < 4·$t_{min}$ + 40 mm = 120.0 mm |
| pitch: | $p_2$ = 80.0 mm > 2.4·$d_0$ = 52.8 mm, | $p_2$ = 80.0 mm < min(14·$t_{min}$, 200 mm) = 200.0 mm |
| edge dist.: | $e_1$ = 65.0 mm > 1.2·$d_0$ = 26.4 mm, | $e_1$ = 65.0 mm < 4·$t_1$ + 40 mm = 120.0 mm |
| pitch: | $p_1$ = 210.0 mm > 2.2·$d_0$ = 48.4 mm, | $p_1$ = 210.0 mm > min(14·$t_{min}$, 200 mm) = 200.0 mm !! |
| edge dist.: | $e_1$ = 65.0 mm > 1.2·$d_0$ = 26.4 mm, | $e_1$ = 65.0 mm < 4·$t_1$ + 40 mm = 120.0 mm |

maximum values for spacings and edge distances only in order to avoid local buckling and to prevent corrosion.

Lk 1: Nr.2

## design values




sign definition of statics: a positive axial force means tension, a positive bending moment produces tension at the bottom
⇒ transformation acc. to EC3: a positive axial force means compression, a positive bending moment produces tension at the top

angle of inclination: $\alpha_b = \alpha_v = \alpha = 0°$

**internal forces and moments in the periphery refering to the system axes** (-> EC 3-1-8)
$N_{b,Ed}$ = $-N_{j,b,Ed}$ = 896.00 kN

**internal forces and moments perpendicular to the connection plane**
$N_d$ = $N_{b,Ed}$ = 896.00 kN

**partial internal forces and moments**
internal forces and moments in the periphery end-plate-beam: $M'_d = M_d - V_d \cdot t_{ep}$ = 0.00 kNm
$N_{b,t}$ = $-N_d \cdot z_{bu}/z_b + M'_d/z_b$ = -448.00 kN, $z_b$ = 289.3 mm, $z_{bu}$ = 144.6 mm < 0 (compression connection)

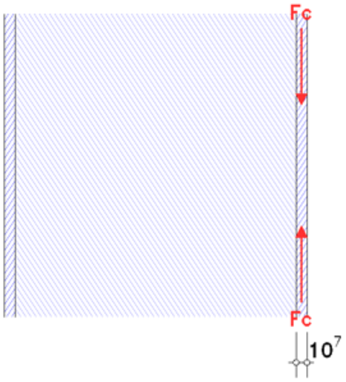
$N_{b,c} = N_d \cdot z_{bo}/z_b + M'_d/z_b = 448.00$ kN, $z_b = 289.3$ mm, $z_{bo} = 144.6$ mm

## basic components

**beam splice w. end-plate:** decisive basic components: 5, 7, 8, 10, 15
normal force connection (compression): 7, 15

### basic component 7: beam flange and web in compression

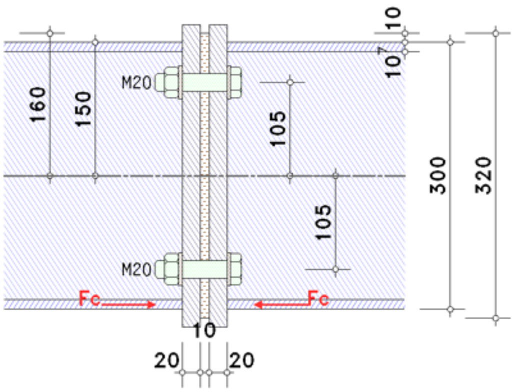
section class of the beam in connection plane ($\varepsilon = 1.00$):
flange top: section class for $c/(\varepsilon \cdot t) = 5.28$ (outstand flange): 1
flange bottom: section class for $c/(\varepsilon \cdot t) = 5.28$ (outstand flange): 1
web: section class for $c/(\varepsilon \cdot t) = 35.01$ (internal compression parts): 2
total: section class: 2




Only the essential sizes are sketched to scale.
The connection geometry is only hinted.

**bending for section class 2**
moment resistance $M_{c,Rd} = M_{pl,Rd} = (W_{pl} \cdot f_y) / \gamma_{M0} = 147.58$ kNm, $W_{pl} = 628.00$ cm$^3$
**design resistance of flange and web in compression**
$F_{c,f,Rd} = M_{c,Rd} / (h - t_f) = 510.13$ kN

### basic component 15: end-plate with thermal separation layer




Only the essential sizes are sketched to scale.
The connection geometry is only hinted.

calculation is for Kerncompactlager of Calenberg Ingenieure GmbH.
**effective length of separation layer:**
assumption: uniformly distributed bolt forces
charakteristic member forces regarding axis of separation layer (e = 0.0 mm) N = 640.00 kN
elastic stresses top/bottom $\sigma_o = -15.38$ N/mm², $\sigma_u = -15.38$ N/mm²
zero point $z_0 = 160.0$ mm $\geq$ 160.0 mm (überdrückt)
bolt force in the elastic tension zone (0 bolt-rows) $\Sigma F_{r,i} = 0.0$ kN, $\Sigma(F_{r,i} \cdot z_{r,i}) = 0.0$ kNm
effective length of separation layer $h_m = 2 \cdot (z + (M + \Sigma(F_{r,i} \cdot z_{r,i}))/(N + \Sigma F_{r,i})) = 320.0$ mm, $z = 160.0$ mm
mean compressive stress $\sigma_m = (N + \Sigma F_{r,i})^2 / (b_e \cdot [2 \cdot z \cdot (N + \Sigma F_{r,i}) + 2 \cdot (M + \Sigma(F_{r,i} \cdot z_{r,i}))]) = 15.38$ N/mm²
**verification of the separation layer**
number of bolts in the effective compression zone (2 bolt-rows) $n_d = 4$
shape factor $S = (h_m \cdot b_e - n_d \cdot A_s) / (t_e \cdot (2 \cdot (h_m + b_e) + n_d \cdot U_s)) = 3.407$, $A_s = \pi \cdot (d + \Delta d)^2/4 = 380.1$ mm², $U_s = \pi \cdot (d + \Delta d) = 69.1$ mm
permissible mean compressive stress $\sigma_{m,zul} = (S^2 + S + 1)/0.7 = 22.88$ N/mm² $<$ 30 N/mm²
utilization of the separation layer $\sigma_m/\sigma_{m,zul} = 0.673 < 1$ ok.
**design resistance of an end-plate splice with thermal separation layer:**
effective width of the separation layer $b_{eff} = t_{fb} + 1.25 \cdot t_p + t_e/2 + ü_b = 50.7$ mm, $ü_b = 10.0$ mm
effective area of the separation layer $A_{eff} = b_e \cdot b_{eff} = 65.91$ cm²
$F_{c,e,Rd} = A_{eff} \cdot f_e / \gamma_{Me} = 150.8$ kN, $f_e = \sigma_{m,zul} = 22.88$ N/mm², $\gamma_{Me} = 1.00$

## connection design capacity

### compression resistance

decisive basic component: 7, 15
$F_{c,Rd}$ = 150.8 kN
$N_{j,c,Rd}$ = min $F_{c,Rd}$ = 150.8 kN

## verifications

internal lever arm z = 289.3 mm

### verification of the connection design capacity by means of the component method

compression connection

axial force: $N_{Ed} = N_{b,c}$ = 448.00 kN
perpend. to connection plane

**compression resistance:**
$N_{Ed}/N_{j,c,Rd}$ = 2.971 > 1 not ok. !!

### verification result

maximum utilization: max U = 2.971 > 1 not ok. !!
failure at verification of bending: U = 2.971

## Final Result

**maximum utilization:** max U = 2.971 > 1 not ok. !!

**design resistance not ensured !!**

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## Regulations

DIN EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;
Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010
DIN EN 1990/NA, Nationaler Anhang zur DIN EN 1990, Ausgabe Dezember 2010

DIN EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2005 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-1/NA, Nationaler Anhang zur DIN EN 1993-1-1, Ausgabe Dezember 2010

DIN EN 1993-1-8, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-8: Bemessung von Anschlüssen;
Deutsche Fassung EN 1993-1-8:2005 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-8/NA, Nationaler Anhang zur DIN EN 1993-1-8, Ausgabe Dezember 2010

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