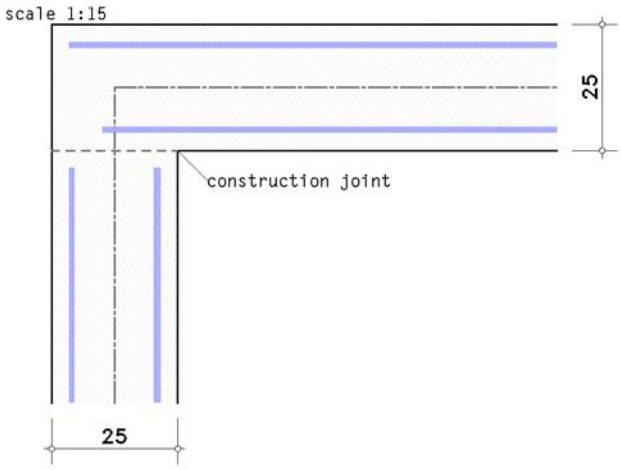
dimensioning a frame corner EC 2 (1.11), NA: Deutschland

1. input protocol



system
beam: height h_b = 25.0 cm, axis distances (design calculation) $d_{1,bo}$ = 4.5 cm, $d_{1,bu}$ = 4.5 cm
column: height h_c = 25.0 cm, axis distances (design calculation) $d_{1,cl}$ = 4.5 cm, $d_{1,cr}$ = 4.5 cm
opening angle α = 90.00°, width beam/column b_b = b_c = 100.0 cm
material properties
concrete: C30/37, reinforcement: B500A
material safety factors
design situation: basic combination
design resistance: concrete γ_c = 1.50, reinforcement γ_s = 1.15
parameters
oositive and negative moments are taken into account
req. reinforcement at the cut from bending and shear design (without minimum reinforcement):
shear design: compression strut angle simplified (EC 2-1-1 NA-DE, 6.2.3(2))
calculation of the required anchorage lengths: calculate bonding conditions
diameter of mandrel unabhängig vom concreterandabstand
beam-/column reinforcement from an external structural analysis
beam: above 5Ø12, bottom 10Ø12, stirrup Ø10/20.0 cm
column: left 7Ø10, right 8Ø12, stirrup Ø8/15.0 cm
design calculation values (ULS)
lc 1: $N_{j,b,Ed}$ = 70.9 kN, $M_{j,b,Ed}$ = 79.7 kNm

1.1. durability and concrete cover

öffnendes Moment (Zug internal):
beam: minimum strength class, concrete cover
due to reinforcement corrosion XC2 ⇒ C16/20, c_{nom} = 35 mm, $c_{nom,l}$ = 22 mm ⇒ c_{nom} = 35 mm ≤ c_v = 35 mm ok
minimum concrete quality C16/20 with f_{ck} = 16.0 N/mm² < exst f_{ck} = 30.0 N/mm² ok
column: minimum strength class, concrete cover
due to reinforcement corrosion XC2 ⇒ C16/20, c_{nom} = 35 mm, $c_{nom,l}$ = 22 mm ⇒ c_{nom} = 35 mm ≤ c_v = 35 mm ok
minimum concrete quality C16/20 with f_{ck} = 16.0 N/mm² < exst f_{ck} = 30.0 N/mm² ok

2. note

general reinforcement rules are not taken into account.

3. design calculation

3.1. results table

design calculation values and required reinforcement

lc	$N_{b,Ed}$ kN	$M_{b,Ed}$ kNm	$M_{c,Ed}$ kNm	$V_{c,Ed}$ kN	$A_{s,bu}$ cm²	$A_{s,cr}$ cm²	ΣA_s cm²
1	70.9	79.7	70.8	70.9	9.99	8.02	18.02

$N_{b,Ed}$, $M_{b,Ed}$: design calculation values in the beam cut; $M_{c,Ed}$, $V_{c,Ed}$: design calculation values in the column cut
$A_{s,bu}$: req. reinforcement in beam; $A_{s,ct}$: req. reinforcement in column
ΣA_s: reinforcement sum

3.2. lc 1 (decisive)

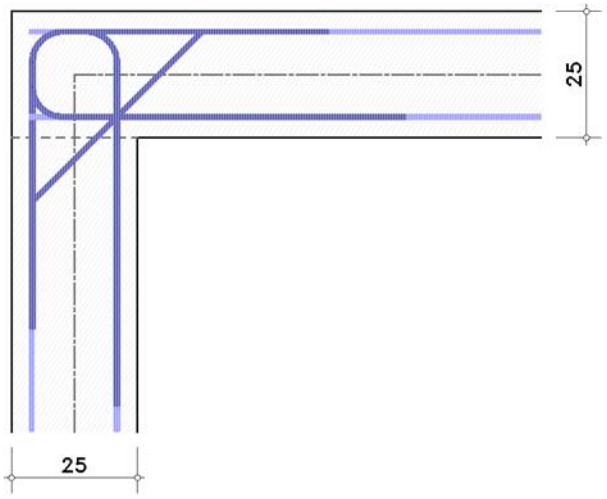
design calculation: $A_{s,bu}$ = 9.99 cm², $A_{s,cr}$ = 8.02 cm² (ΣA_s = 18.02 cm²)

4. final result

maximum reinforcement: $A_{s,bu}$ = 9.99 cm², $A_{s,cr}$ = 8.02 cm², $A_{s,s}$ = 5.00 cm²
tensile splitting reinforcement horizontal fehlt !
tensile splitting reinforcement vertical fehlt !

5. selected reinforcement

scale 1:15



verification of reinforcement
concrete cover c_v = 3.5 cm = c_{nom} = 3.50 cm ok
beam reinforcement:
above bar reinforcement, 5Ø12, exst $A_{s,bo}$ = 5.65 cm², req $A_{s,bo}$ = 0
bar distance s_{bo} = 22.9 cm > min s_{bo} = 3.2 cm ok
bottom bar reinforcement, 10Ø12, exst $A_{s,bu}$ = 11.31 cm² > req $A_{s,bu}$ = 9.99 cm² ok
bar distance s_{bu} = 10.2 cm > min s_{bu} = 3.2 cm ok
column reinforcement:
left bar reinforcement, 7Ø10, exst $A_{s,cl}$ = 5.50 cm², req $A_{s,cl}$ = 0
bar distance s_{cl} = 15.3 cm > min s_{cl} = 3.0 cm ok
right bar reinforcement, 8Ø12, exst $A_{s,cr}$ = 9.05 cm² > req $A_{s,cr}$ = 8.02 cm² ok
bar distance s_{cr} = 13.1 cm > min s_{cr} = 3.2 cm ok
tensile anchoring reinforcement of beam (bar reinforcement, 10Ø12, exst $A_{s,bu}$ = 11.31 cm², s. beam bottom):
lap length Zug $l_{b,bu,t}$ = 53.1 cm = req $l_{b,bu,t}$ = 53.1 cm ok
compression $l_{b,bu,c}$ = 37.9 cm = req $l_{b,bu,c}$ = 37.9 cm ok
diameter of mandrel D_{bu} = 12.0 cm = req D_{bu} = 12.0 cm ok
U-bent length bottom $l_{bu} = h_c - c_v - \Phi_{bü} + l_{b,bu,t}$ = 74.6 cm (overlapping from the beam cut)
above $l_{bo} = h_c - c_v - \Phi_{bü} + l_{b,bu,c}$ = 59.4 cm (overlapping from the beam cut)
bar number n_b = 10 < perm n_b = 21 ok
tensile anchoring reinforcement of column (bar reinforcement, 8Ø12, exst $A_{s,cr}$ = 9.05 cm², s. column right):
lap length Zug $l_{b,cr,t}$ = 53.3 cm = req $l_{b,cr,t}$ = 53.3 cm ok
compression $l_{b,cr,c}$ = 38.0 cm = req $l_{b,cr,c}$ = 38.0 cm ok
diameter of mandrel D_{cr} = 12.0 cm = req D_{cr} = 12.0 cm ok
U-bent length right $l_{cr} = h_b - c_v - \Phi_{bü} + l_{b,cr}$ = 74.8 cm (overlapping from the column cut)
left $l_{cl} = h_b - c_v - \Phi_{bü} + l_{b,cl}$ = 59.5 cm (overlapping from the column cut)
bar number n_c = 8 < perm n_c = 21 ok
transverse reinforcement:
bar reinforcement, 8Ø10, exst $A_{s,s}$ = 6.28 cm² > req $A_{s,s}$ = 5.00 cm² ok
bar distance s_s = 13.1 cm > min s_s = 3.0 cm ok
anchorage length beam $l_{b,s,b}$ = 28.8 cm = req $l_{b,s,b}$ = 28.8 cm ok
column $l_{b,s,c}$ = 28.9 cm = req $l_{b,s,c}$ = 28.9 cm ok

design resistance ensured

6. regulations

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

EN 1992-1-1, Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetonbauteilen -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln for den Hochbau;