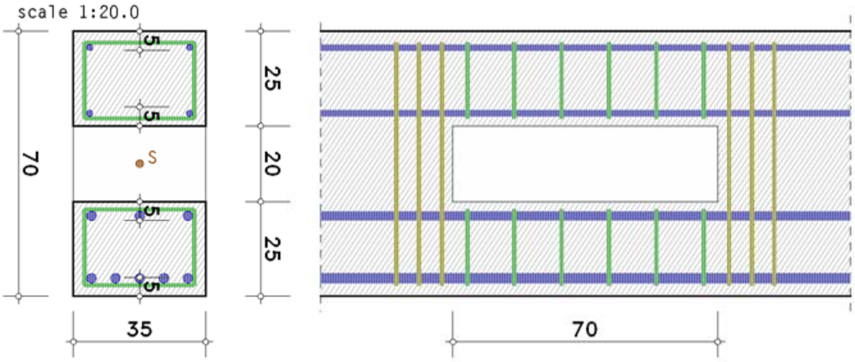
dimensioning of a beam recess EC 2 (1.11), NA: Deutschland 4H-EC2AB Version: 2/2024-1a

1. input protocol

visualisation of the selected reinforcement



cross section
rectangle: h = 70.0 cm, b = 35.0 cm
recess: e_o = 25.0 cm, e_u = 25.0 cm, l_A = 70.0 cm
axis distances (calculation): $d_{o,o}$ = 5.0 cm, $d_{u,o}$ = 5.0 cm, $d_{o,u}$ = 5.0 cm, $d_{u,u}$ = 5.0 cm
material properties
concrete acc. to EC 2, 3.1.7(1): C30/37, ε_{c2} = -2.00‰, ε_{cu2} = -3.50‰, f_{cd} = 17.00 N/mm²
reinforcement acc. to EC 2, 3.2.7(2a): B500A, ε_{ud} = 25.0‰, f_{yd} = 434.78 N/mm², f_{td} = 456.52 N/mm², E_s = 200000.0 N/mm²
parameters
base reinforcement: top chord above $A_{so,0}$ = 0.00 cm², bottom chord bottom $A_{su,0}$ = 24.50 cm²
design method acc. to Heft 459, DAfStb
shear force distribution determined from the gross belt stiffnesses
shear design: compression strut angle simplified (EC 2-1-1 NA-DE, 6.2.3(2))

1.1. design calculation values

lc 1: $M_{y,Ed}$ = 432.00 kNm, $V_{z,Ed}$ = 144.00 kN

2. note

general reinforcement rules are not taken into account.

3. recess

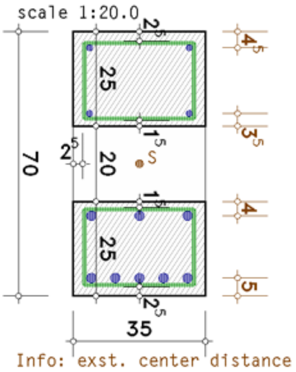
3.1. lc 1

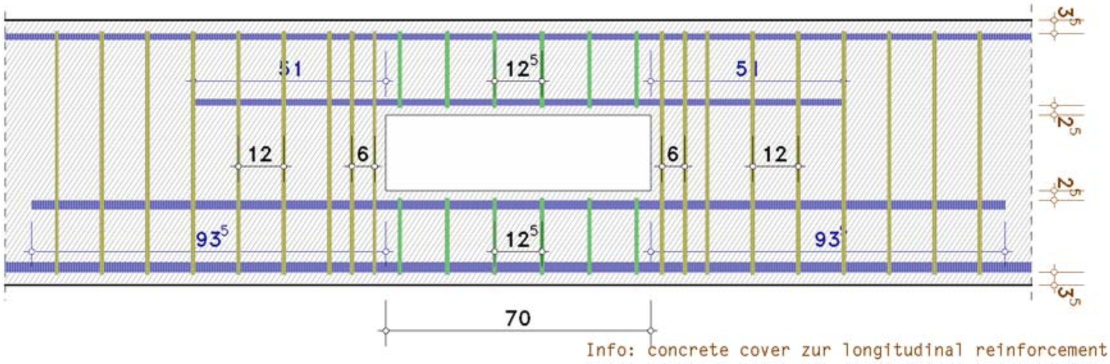
design calculation values in centre cut: N_{Ed} = 0.00 kN, M_{Ed} = 432.00 kNm, V_{Ed} = 144.00 kN
shear force distribution: 50.0% of shear force acts in the compression chord (= top chord)
above the recess
design calculation values in top chord: $N_{Ed,o}$ = -960.0 kN, $V_{Ed,o}$ = 72.0 kN, $M_{Ed,ol}$ = -5.1 kNm, $M_{Ed,or}$ = 45.3 kNm
longitudinal reinforcement in top chord: $A_{so,o}$ = 0.98 cm², $A_{su,o}$ = 0.98 cm²
shear design:
design resistance without shear reinforcement V_{Rdc} = 66.52 kN, max. design resistance of compression strut $V_{Rd,mx}$ = 264.50 kN
$V_{Rdc} < |V_{Ed,o}| < V_{Rd,mx} \Rightarrow$ shear reinforcement in top chord: $a_{sb,o}$ = 11.45 cm²/m
below the recess
design calculation values in bottom chord: $N_{Ed,u}$ = 960.0 kN, $V_{Ed,u}$ = 72.0 kN, $M_{Ed,ul}$ = -5.1 kNm, $M_{Ed,ur}$ = 45.3 kNm
longitudinal reinforcement in bottom chord: $A_{so,u}$ = 11.25 cm², $A_{su,u}$ = 17.14 cm²
shear design:
design resistance without shear reinforcement V_{Rdc} = 0.00 kN, max. design resistance of compression strut $V_{Rd,mx}$ = 334.69 kN
$V_{Rdc} < |V_{Ed,u}| < V_{Rd,mx} \Rightarrow$ shear reinforcement in bottom chord $a_{sb,u}$ = 11.04 cm²/m
suspended reinforcement: $A_{s,l} = A_{s,r} = A_{s1}+A_{s2}$ = 5.96 cm²
anchoring the chord reinforcement: T_{v1} = 72.0 kN ⇒ A_{s1} = 1.66 cm², distribution width 32.5 cm
transmission of the anchoring forces: T_{v2} = 187.2 kN ⇒ A_{s2} = 4.31 cm², distribution width 63.0 cm
total: $A_{so,o}$ = 0.98 cm², $A_{su,o}$ = 0.98 cm², $a_{sb,o}$ = 11.45 cm²/m, $A_{so,u}$ = 11.25 cm², $A_{su,u}$ = 17.14 cm²
$a_{sb,u}$ = 11.04 cm²/m, A_{s1} = 1.66 cm², A_{s2} = 4.31 cm², $A_{s,l} = A_{s,r}$ = 5.96 cm², ρ = 1.24%

4. final result

maximum reinforcement: $A_{so,o}$ = 0.98 cm², $A_{su,o}$ = 0.98 cm², $a_{sb,o}$ = 11.45 cm²/m, $A_{so,u}$ = 11.25 cm²
$A_{su,u}$ = 17.14 cm², $a_{sb,u}$ = 11.04 cm²/m, A_{s1} = 1.66 cm², A_{s2} = 4.31 cm², $A_{s,l} = A_{s,r}$ = 5.96 cm²
ρ = 1.24%
incl. base reinforcement: $A_{so,o}$ = 0.98 cm², $A_{su,o}$ = 24.50 cm²

5. selected reinforcement





above the recess
concrete cover to stirrup reinforcement:
above c_{vo} = 2.5 cm
bottom (to recess) c_{vi} = 1.5 cm, lateral c_{vr} = 2.5 cm
longitudinal reinforcement above 2Ø16, exst A_s = 4.02 cm²
exst A_s = 4.02 cm² > req A_s = 0.98 cm² ok
bottom 2Ø16, exst A_s = 4.02 cm²
exst A_s = 4.02 cm² > req A_s = 0.98 cm² ok
anchorage length from recess edge left/right 50.9/50.9 cm
stirrup reinforcement Ø10/12.5 cm (2-cut), exst a_{sb} = 12.57 cm²/m > req a_{sb} = 11.45 cm²/m ok
center distance above exst d_1 = 4.30 cm < clc d_1 = 5.0 cm ok
bottom exst d_1 = 3.30 cm < clc d_1 = 5.0 cm ok

below the recess
concrete cover to stirrup reinforcement:
above (to recess) c_{vi} = 1.5 cm, lateral c_{vr} = 2.5 cm
bottom c_{vu} = 2.5 cm
longitudinal reinforcement above 3Ø25, exst A_s = 14.73 cm²
exst A_s = 14.73 cm² > req A_s = 11.25 cm² ok
anchorage length from recess edge left/right 93.7/93.7 cm
bottom 5Ø25, exst A_s = 24.54 cm²
exst A_s = 24.54 cm² > req A_s = 17.14 cm² ok
stirrup reinforcement Ø10/12.5 cm (2-cut), exst a_{sb} = 12.57 cm²/m > req a_{sb} = 11.04 cm²/m ok
center distance above d_v = 3.00 cm ⇒ exst d_1 = 3.80 cm < clc d_1 = 5.0 cm ok
bottom d_v = 4.00 cm ⇒ exst d_1 = 4.80 cm < clc d_1 = 5.0 cm ok

suspended reinforcement
anchoring 3Ø10/6.0 cm (2-cut), exst A_s = 4.71 cm² > req A_s = 1.66 cm² ok
forwarding 6Ø10/12.0 cm (2-cut), exst A_s = 9.42 cm² > req A_s = 4.31 cm² 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;
Deutsche Fassung EN 1992-1-1:2004 + AC:2010, Ausgabe Januar 2011
EN 1992-1-1/NA, Nationaler Anhang zur EN 1992-1-1, Ausgabe April 2013

Hermann U. Hottmann, Kurt Schäfer: Bemessen von Stahlbetonbalken und -wandscheiben mit Öffnungen, Deutscher Ausschuss für Stahlbeton, Heft 459, Beuth Verlag GmbH, 1996