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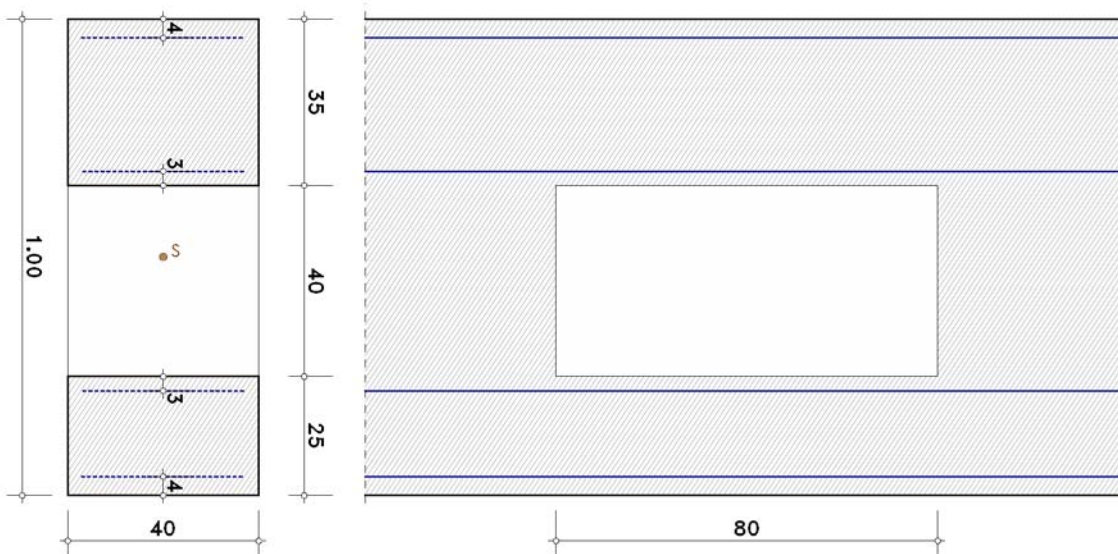
1. input protocol

cross section
rectangle: h = 100.0 cm, b = 40.0 cm
recess: e_o = 35.0 cm, e_u = 25.0 cm, l_A = 80.0 cm
axis distances (calculation): $d_{o,o}$ = 4.0 cm, $d_{u,o}$ = 3.0 cm, $d_{o,u}$ = 3.0 cm, $d_{u,u}$ = 4.0 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 $A_{su,0}$ = 6.00 cm²
design method acc. to Heft 399, DAfStb
moment zero crossing in the centre of recess
shear force distribution determined from the effective belt stiffnesses
shear design: compression strut angle minimum

1.1. design calculation values
lc 1: $M_{y,Ed}$ = 168.00 kNm, $V_{z,Ed}$ = -330.00 kN

2. note

general reinforcement rules are not taken into account.

3. recess

3.1. lc 1
recess close to bearing (IM/VI < 1 m): method may not be suitable !
design calculation values in centre cut: N_{Ed} = 0.00 kN, M_{Ed} = 168.00 kNm, V_{Ed} = -330.00 kN
shear force distribution: 80.8% of shear force acts in the compression chord (= top chord)
<u>above the recess</u>
design calculation values in top chord: $N_{Ed,o}$ = -205.9 kN, $V_{Ed,o}$ = -266.8 kN, $M_{Ed,o}$ = ±106.7 kNm
longitudinal reinforcement in top chord: $A_{so,o}$ = 6.52 cm², $A_{su,o}$ = 6.24 cm²
shear design:
design resistance without shear reinforcement V_{Rdc} = 79.44 kN, max. design resistance of compression strut $V_{Rd,mx}$ = 587.39 kN
V_{Rdc} < |$V_{Ed,o}$| < $V_{Rd,mx}$ ⇒ shear reinforcement in top chord: $a_{sb,o}$ = 12.38 cm²/m
<u>below the recess</u>
design calculation values in bottom chord: $N_{Ed,u}$ = 205.9 kN, $V_{Ed,u}$ = -63.2 kN, $M_{Ed,u}$ = ±25.3 kNm
longitudinal reinforcement in bottom chord: $A_{so,u}$ = 5.09 cm², $A_{su,u}$ = 5.34 cm²
shear design:
design resistance without shear reinforcement V_{Rdc} = 22.70 kN, max. design resistance of compression strut $V_{Rd,mx}$ = 275.40 kN
V_{Rdc} < |$V_{Ed,u}$| < $V_{Rd,mx}$ ⇒ shear reinforcement in bottom chord $a_{sb,u}$ = 3.71 cm²/m
suspended reinforcement: $T_{v,l}$ = 492.3 kN ⇒ $A_{s,l}$ = 11.32 cm², $T_{v,r}$ = 135.9 kN ⇒ $A_{s,r}$ = 3.13 cm², distribution width 30.0 cm
<u>total:</u> $A_{so,o}$ = 6.52 cm², $A_{su,o}$ = 6.24 cm², $a_{sb,o}$ = 12.38 cm²/m, $A_{so,u}$ = 5.09 cm², $A_{su,u}$ = 5.34 cm²
        $a_{sb,u}$ = 3.71 cm²/m, $A_{s,l}$ = 11.32 cm², $A_{s,r}$ = 3.13 cm², ρ = 0.58%

4. final result

maximum reinforcement: $A_{so,o}$ = 6.52 cm², $A_{su,o}$ = 6.24 cm², $a_{sb,o}$ = 12.38 cm²/m, $A_{so,u}$ = 5.09 cm²
$\qquad A_{su,u}$ = 5.34 cm², $a_{sb,u}$ = 3.71 cm²/m, $A_{s,l}$ = 11.32 cm², $A_{s,r}$ = 3.13 cm², ρ = 0.58%
incl. base reinforcement: $A_{so,o}$ = 6.52 cm², $A_{su,o}$ = 6.00 cm²

design resistance ensured

5. 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

Rolf Eligehausen, Roland Gerster: Das Bewehren von Stahlbetonbauteilen,
  Deutscher Ausschuss für Stahlbeton, Heft 399, Beuth Verlag GmbH, 1993