VCmaster
NOTHING BEATS A GREAT TEMPLATE

Preface

Content
Interactive design aids for concrete elements in accordance to BS EN 1992

Guidelines of use
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Beside its functions for documentation, VCmaster offers an intuitive concept enabling engineers to carry out calculations. The input of mathematic formulas can be executed in natural notation directly in the document itself. The software significantly supports the reuse of structural calculations and documents. VCmaster simplifies modifications and adjustments and automates standard tasks. Collaboration with work-groups or with other offices and clients is uncomplicated as well. As a result, processing time and costs can be considerably reduced.

System Requirements
VCmaster 2016 or newer

Development and Copyrights
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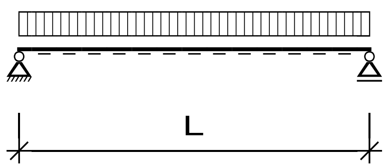
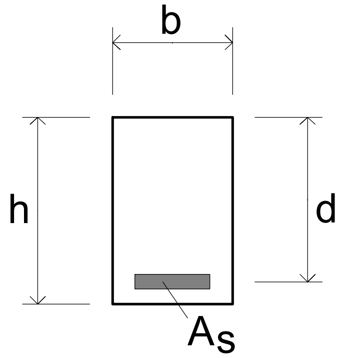
Contents

Chapter 1: Beams

Design of beam for bending ULS





Data given

Beam width b =	200.0 mm
Overall depth h =	300.0 mm
Effective depdth d =	252.5 mm
Beam span L =	5.00 m

Loads

Dead load excluding beam self weigt g_k =	12.00 kN/m
Imposed load q_k=	5.00 kN/m

Material properties

Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Loading

Beam self weight g_b =	$b*h*25*L$ = $0.2*0.3*25*5.00$	=	7.5 kN
Total dead load G_k=	$g_b + g_k * L$	=	67.5 kN
Total imposed load Q_k =	$q_k * L$	=	25.0 kN
Ultimate load F =	$1.35*G_k + 1.50*Q_k$	=	128.6 kN

Bending ULS

$M = F*\frac{L}{8}$ = 80.4 kNm

$K = MIN(\frac{M}{b*d^2*f_{ck}}; 0.167)$ = 0.167

$f_{[z/d]} = MIN(0.5*(1+\sqrt{1-3.53*K}); 0.95)$ = 0.820

$z = d*f_{[z/d]}$ = 207.1 mm

$A_s = \frac{M}{0.87*z*f_{yk}}$ = 892.5 mm²

$min.A_s = b * h * 0.016/100 * f_{ck}^{2/3}$ = 92.7 mm²

Reinforcing bars

Diameter d_s = 20 mm

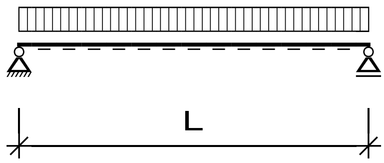
Group = **3H20**

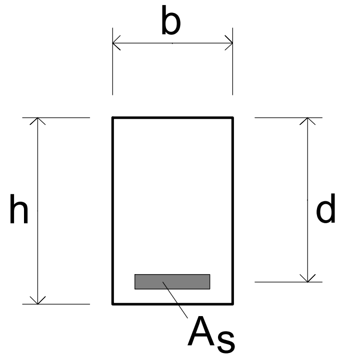
Maximum amount of reinforcement

$A_{s,prov}$ = 942.0 mm²

$$A_{s,max} = \frac{A_{s,prov} * 100}{b * h} = \frac{942.0 * 100}{200.0 * 300.0} = 1.57\ \% < 4\%$$

Design of beam for deflection SLS





Data given

Beam width b = 200.0 mm
Effective depth d = 352.5 mm
Beam span L = 5.00 m

Area of reinforcement

Required $A_{s,req}$ = 800.0 mm²
Diameter d_s = 20 mm
Group = 3H20
Provided $A_{s,prov}$ = 942.0 mm²

Span/effective depth ratio calculations

Percentage of reinforcement $\rho_1 = \frac{100 \, * A_{s,req}}{b * d} = \frac{100 \, * 800.0}{200.0 * 352.5}$ = 1.13 %

Basic ratio r = 16.22

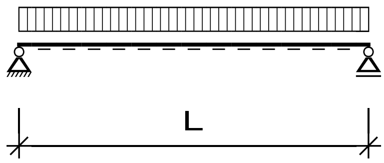
Multiply factor f = $MIN(\frac{A_{s,prov}}{A_{s,req}}; 1.50)$ = 1.178

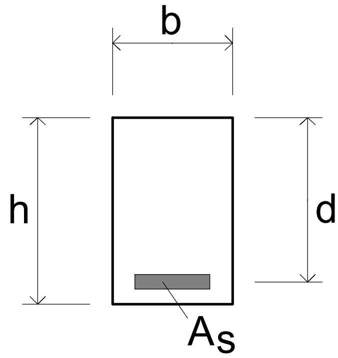
Permitted ratio r_{perm} = r * f = 19.11

Actual ratio $r_{act} = \frac{L}{d} = \frac{5000}{352.5}$ = 14.18

$\frac{r_{act}}{r_{perm}}$ = **0.74 ≤ 1**

Example: Design of beam





Data given

Beam width b =	250.0 mm
Overall depth h =	400.0 mm
Beam span L =	5.00 m
With of support w =	250.0 mm

Loading

Dead load excluding beam self weigt g_k =	20.00 kN/m
Imposed load q_k=	10.00 kN/m

Beam self weight g_b =	b*h*25*L = 0.25*0.4*25*5.00	=	12.5 kN
Total dead load G_k=	g_b+ g_k* L	=	112.5 kN
Total imposed load Q_k =	q_k * L	=	50.0 kN
Ultimate load F =	1.35*G_k + 1.50*Q_k	=	226.9 kN

Material properties

Main bar diameter d_{bar}	=	20 mm
Shear link diameter d_{link}	=	10 mm
Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Cover to bars

Exposure class

Exp.Class	=	XC1

Resistance to fire

Fire resistance R	=	R60

Minimum concrete covers [mm]

Side c_{side}=	MAX(d_{link}+10 ; nom.c_{side} ; $c_{fire,side}$)	=	25 mm
Soffit c_{soffit} =	MAX(d_{link}+10 ; nom.c_{soffit} ; $c_{fire,soffit}$)	=	25 mm
Provided c =			**30 mm**
Cover to main bars c_{bar} =	MAX(d_{bar}+10 ; c + d_{link})	=	40 mm

Axis distance to the main bar / Effective depth

a_{soffit} =	MAX(c_{bar} + d_{bar} / 2 ; min.a_{soffit})	=	50 mm
Effective depth d =	h - a_{soffit}	=	**350.0 mm**

Bending ULS

M =	$F * \frac{L}{8}$	=	141.8 kNm
K =	$MIN(\frac{M}{b * d^2 * f_{ck}} ; 0.167)$	=	0.154
$f_{[z/d]}$ =	$MIN(0.5 * (1 + \sqrt{1 - 3.53 * K}) ; 0.95)$	=	0.838
z =	$d * f_{[z/d]}$	=	293.3 mm
A_s =	$\frac{M}{0.87 * z * f_{yk}}$	=	1111.4 mm²
min.A_s =	$b * h * 0.016/100 * f_{ck}^{2/3}$	=	154.5 mm²
Reinforcing bars Diameter d_s =	d_{bar}	=	20 mm
Group		=	**4H20**
Maximum amount of reinforcement $A_{s,prov}$		=	1257.0 mm²
$A_{s,max}$ =	$\frac{A_{s,prov} * 100}{b * h} = \frac{1257.0 * 100}{250.0 * 400.0}$	=	1.26 % < 4%

Span / Effective depth ratio calculation for deflection SLS

Area of reinforcement

Required $A_{s,req}$ =	A_s	=	1111.4 mm²
Provided $A_{s,prov}$		=	1257.0 mm²

Span/effective depth ratio calculations

Percentage of reinforcement ρ_1 =	$\frac{100 * A_{s,req}}{b * d} = \frac{100 * 1111.4}{250.0 * 350.0}$	=	1.27 %
Basic ratio r		=	15.38
Multiply factor f =	$MIN(\frac{A_{s,prov}}{A_{s,req}} ; 1.50)$	=	1.131
Permitted ratio r_{perm} =	r * f	=	17.39
Actual ratio r_{act} =	$\frac{L}{d} = \frac{5000}{350.0}$	=	14.29
$\frac{r_{act}}{r_{perm}}$		=	**0.82 ≤ 1**

Shear reinforcement

Shear force

Θ = 21.80 °

v_{Rd} = 0.36 * (1 - f_{ck}/250) * f_{ck}/(1/TAN(Θ) + TAN(Θ))/0.9 = 3.64 N/mm²

$V_{Ed1} = V_{Ed} - \frac{q_d * w}{2} = 113.5 - \frac{45.38 * 0.25}{2}$ = 107.83 kN

$v_{Ed1} = \frac{V_{Ed1}}{0.9 * b * d} = \frac{107830}{0.9 * 250.0 * 350.0}$ = 1.37 N/mm²

$\frac{v_{Ed1}}{v_{Rd}}$ = **0.38 ≤ 1**

$V_{Ed2} = V_{Ed1} - q_d * d = 107.83 - 45.38 * 0.35$ = 91.95 kN

$v_{Ed2} = \frac{V_{Ed2}}{0.9 * b * d} = \frac{91950}{0.9 * 250.0 * 350.0}$ = 1.17 N/mm²

Reinforcement

$requ.A_{[sw/s]} = \frac{0.4 * v_{Ed2} * b * 10^3}{0.87 * f_{yk}} = \frac{0.4 * 1.17 * 250.0 * 10^3}{0.87 * 500.0}$ = 268.97 mm²/m

$min.A_{[sw/s]} = \frac{0.08 * \sqrt{f_{ck}} * b * 10^3}{f_{yk}} = \frac{0.08 * \sqrt{30.0} * 250.0 * 10^3}{500.0}$ = 219.09 mm²/m

$A_{[SW/S]}$ = MAX($requ.A_{[sw/s]}$; $min.A_{[sw/s]}$) = 268.97 mm²/m

Max. link spacing e = 0.75 * d = 262.50 mm

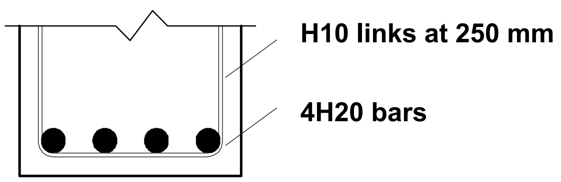
Diameter D = d_{link} = 10.00 mm

Legs per link n = 2

Link L = **H10 at 250**

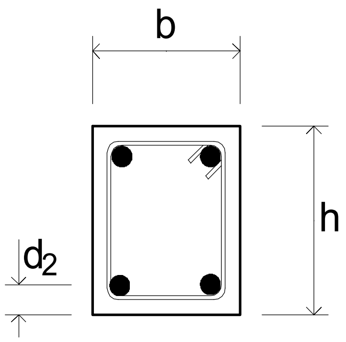
$a_{s,prov}$ = 628.0 mm²/m

Reinforcement details



Chapter 2: Columns

Column with axial load (simplified)



Data given

Axial load N_{Ed} = 1200.00 kN
Clear high l = 2.80 m
b = 250.00 mm
h = 300.00 mm

Material properties

Concrete grade C = C30/37
f_{ck} = 30.0 N/mm²
f_{yk} = 500.0 N/mm²

Effective height factor

Condition at top = 1
Condition at bottom = 1
Hight factor f = 0.75
Effective hight l_0 = $f*l = 0.75*2800$ = 2100.0 mm

Limiting l_0/b ratio

i = $0.289*b = 0.289*250.00$ = 72.25 mm

$\lambda = \frac{l_0}{i} = \frac{2100.0}{72.25}$ = 29.07

ABC = $0.7*1.1*1.7$ = 1.31

$n = \frac{N_{Ed}}{0.67*b*h*f_{ck}} = \frac{1200000}{0.67*250.00*300.00*30.0}$ = 0.80

$\lambda_{lim} = \frac{20*ABC}{\sqrt{n}} = \frac{20*1.31}{\sqrt{0.80}}$ = 29.29

$\frac{\lambda}{\lambda_{lim}} = \frac{29.07}{29.29}$ = **0.99 ≤ 1**

The column is not slender

Reinforcement

$\nu = \dfrac{N_{Ed}}{b*h*f_{ck}} = \dfrac{1200000}{250.00*300.00*30.0}$ = 0.53

ω = 0.1360

$A_s = \omega*b*h*\dfrac{f_{ck}}{f_{yk}} = 0.1360*250.00*300.00*\dfrac{30.0}{500.0}$ = 612 mm²

Reinforcing bars

Diameter d_s = 16 mm

Group = **4H16**

Limits of longitudinal reinforcement

$A_{s,min1} = \dfrac{0.12*N_{Ed}}{f_{yk}} = \dfrac{0.12*1200000}{500.0}$ = 288.0 mm²

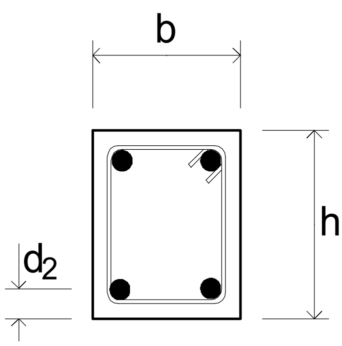
$A_{s,min2} = 0.002*b*h = 0.002*250.00*300.00$ = 150.0 mm²

$A_{s,min} = MAX(A_{s,min1} ; A_{s,min2})$ = 288.0 mm²

$A_{s,prov}$ = 804.0 mm²

$\dfrac{A_{s,min}}{A_{s,prov}} = \dfrac{288.0}{804.0}$ = **$0.36 \leq 1$**

Column with axial load



Data given

Axial load N_{Ed} =			1000.00 kN
Clear high l =			3.00 m
b =			250.00 mm
h =			300.00 mm
d_2 =	30 + 8 + 12/2	=	44.00 mm

Material properties

Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Effective height factor

Condition at top = 1

Condition at bottom = 1

Hight factor f = 0.75

Effective hight l_0 = $f*l = 0.75*3000$ = 2250.0 mm

Limiting l_0/b ratio

i = $0.289*b = 0.289*250.00$ = 72.25 mm

$$\lambda = \frac{l_0}{i} = \frac{2250.0}{72.25} = 31.14$$

ABC = $0.7*1.1*1.7$ = 1.31

$$n = \frac{N_{Ed}}{0.67*b*h*f_{ck}} = \frac{1000000}{0.67*250.00*300.00*30.0} = 0.66$$

$$\lambda_{lim} = \frac{20*ABC}{\sqrt{n}} = \frac{20*1.31}{\sqrt{0.66}} = 32.25$$

$$\frac{\lambda}{\lambda_{lim}} = \frac{31.14}{32.25} = \mathbf{0.97 \leq 1}$$

The column is not slender

Eccentricity

$e_1 = \frac{h}{30} = \frac{300.00}{30}$ = 10.0 mm

$e_2 = \frac{l_0}{400} = \frac{2250.0}{400}$ = 5.6 mm

$e_3 =$ 20.0 mm

$e_{nom} = MAX(e_1 ; e_2 ; e_3)$ = 20.0 mm

Additional bending Moment

$M = N_{Ed} * e_{nom} = 1000.00*0.02$ = 20.0 kNm

Reinforcement

$\nu = \frac{N_{Ed}}{b*h*f_{ck}} = \frac{1000000}{250.00*300.00*30.0}$ = 0.444

$\mu = \frac{M}{b*h^2*f_{ck}} = \frac{20000000}{250.00*300.00^2*30.0}$ = 0.030

d_2 / h = 0.15

From the chart ω = 0.08

$A_s = \omega*b*h*\frac{f_{ck}}{f_{yk}} = 0.08*250.00*300.00*\frac{30.0}{500.0}$ = 360 mm²

Reinforcing bars

Diameter d_s = 12 mm

Group = **4H12**

Limits of longitudinal reinforcement

$A_{s,min1} = \frac{0.12*N_{Ed}}{f_{yk}} = \frac{0.12*1000000}{500.0}$ = 240.0 mm²

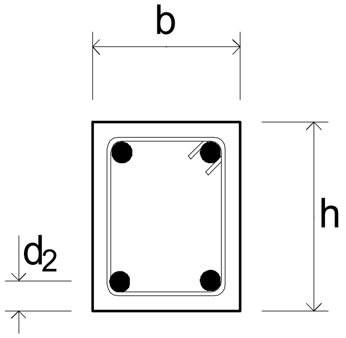
$A_{s,min2} = 0.002*b*h = 0.002*250.00*300.00$ = 150.0 mm²

$A_{s,min} = MAX(A_{s,min1} ; A_{s,min2})$ = 240.0 mm²

$A_{s,prov}$ = 452.0 mm²

$\frac{A_{s,min}}{A_{s,prov}} = \frac{240.0}{452.0}$ = **0.53 ≤ 1**

Column with axial load and bending moment



Data given

Axial load N_{Ed} =			1000.00 kN
Bending moment M_{Ed} =			200.0 kNm
Clear high l =			3.00 m
b =			300.00 mm
h =			400.00 mm
d_2 =	30 + 8 + 25/2	=	50.50 mm

Material properties

Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Effective height factor

Condition at top = 1
Condition at bottom = 1

Hight factor f = 0.75

Effective hight l_0 = $f*l = 0.75*3000$ = 2250.0 mm

Limiting l_0/b ratio

i = $0.289*b = 0.289*300.00$ = 86.70 mm

$\lambda = \frac{l_0}{i} = \frac{2250.0}{86.70}$ = 25.95

ABC = $0.7*1.1*1.7$ = 1.31

n = $\frac{N_{Ed}}{0.67*b*h*f_{ck}} = \frac{1000000}{0.67*300.00*400.00*30.0}$ = 0.41

$\lambda_{lim} = \frac{20*ABC}{\sqrt{n}} = \frac{20*1.31}{\sqrt{0.41}}$ = 40.92

$\frac{\lambda}{\lambda_{lim}} = \frac{25.95}{40.92}$ = **0.63 ≤ 1**

The column is not slender

Eccentricity

$e_1 = \frac{h}{30} = \frac{400.00}{30}$ = 13.3 mm

$e_2 = \frac{l_0}{400} = \frac{2250.0}{400}$ = 5.6 mm

$e_3 =$ 20.0 mm

$e_{nom} =$ MAX(e_1 ; e_2 ; e_3) = 20.0 mm

Additional bending Moment

$M = M_{Ed} + N_{Ed} * e_{nom} = 200.0 + 1000.00 * 0.02$ = 220.00 kNm

Reinforcement

$\nu = \frac{N_{Ed}}{b * h * f_{ck}} = \frac{1000000}{300.00 * 400.00 * 30.0}$ = 0.278

$\mu = \frac{M}{b * h^2 * f_{ck}} = \frac{220000000}{300.00 * 400.00^2 * 30.0}$ = 0.153

d_2 / h = 0.13

From the chart ω = 0.27

$A_s = \omega * b * h * \frac{f_{ck}}{f_{yk}} = 0.27 * 300.00 * 400.00 * \frac{30.0}{500.0}$ = 1944 mm²

Reinforcing bars

Diameter d_s = 25 mm

Group = **4H25**

Limits of longitudinal reinforcement

$A_{s,min1} = \frac{0.12 * N_{Ed}}{f_{yk}} = \frac{0.12 * 1000000}{500.0}$ = 240.0 mm²

$A_{s,min2} = 0.002 * b * h = 0.002 * 300.00 * 400.00$ = 240.0 mm²

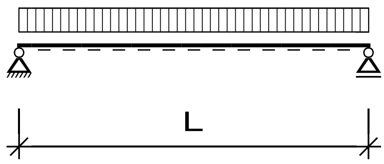
$A_{s,min} =$ MAX($A_{s,min1}$; $A_{s,min2}$) = 240.0 mm²

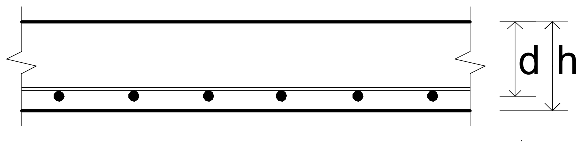
$A_{s,prov}$ = 1963.0 mm²

$\frac{A_{s,min}}{A_{s,prov}} = \frac{240.0}{1963.0}$ = **0.12 ≤ 1**

Chapter 3: Slabs

Design of a solid slab





Data given

Beam span L = 5.00 m

Overall depth h = 200.0 mm
With of support w = 300.0 mm

Loading

Imposed load Q_k= 2.50 kN/m²
Finishes g_k = 0.50 kN/m²

Slab self weight g_b = $h*25 = 0.2*25$ = 5.00 kN/m²
Total dead load G_k= $g_b + g_k$ = 5.50 kN/m²

Total load for ULS q = $1.35*G_k + 1.50*Q_k$ = 11.2 kN/m²

Ultimate load F = $q * L$ = 56.0 kN

Material properties

Concrete grade C = C25/30
f_{ck} = 25.0 N/mm²
f_{yk} = 500.0 N/mm²

Cover to bars

Assumed diameter d_s = 10 mm
Exposure class
Exp.Class = XC1

Resistance to fire
Fire resistance R = R60

Minimum concrete covers [mm]
min.c = MAX(nom.c ; c_{fire}) = 25 mm
Provided c = 25 mm

Axis distance to reinforcement / Effective depth
a_{prov} = $c + d_s / 2$ = 30 mm
Effektiv depth d = $h - a_{prov}$ = 170.0 mm

Bending ULS

M = $F*\frac{L}{8}$ = 35.0 kNm

K = $MIN\left(\frac{M}{b*d^2*f_{ck}}; 0.167\right)$ = 0.048

$f_{[z/d]}$ = $MIN\left(0.5*\left(1+\sqrt{1-3.53*K}\right); 0.95\right)$ = 0.950

z = $d*f_{[z/d]}$ = 161.5 mm

$A_{s,req} = \dfrac{M}{0.87 \cdot z \cdot f_{yk}}$ = 498.2 mm²

$min.A_s = b \cdot h \cdot 0.016/100 \cdot f_{ck}^{2/3}$ = 273.6 mm²

Steel stress $f_s = 435 \cdot \dfrac{G_k + 0.80 \cdot Q_k}{1.35 \cdot G_k + 1.5 \cdot Q_k}$ = 291.9 N/mm²

Provide diameter d_s = 8 mm

Reinf = **H8 at 100**

$A_{s,prov}$ = 503.0 mm²/m

Span / Effective depth ratio calculation for deflection SLS

Percentage of reinforcement $\rho_1 = \dfrac{100 \cdot A_{s,req}}{b \cdot d} = \dfrac{100 \cdot 498.2}{1000.0 \cdot 170.0}$ = 0.29 %

Basic ratio r = 30.00

Multiply factor f = $MIN(\dfrac{A_{s,prov}}{A_{s,req}} ; 1.50)$ = 1.010

Permitted ratio r_{perm} = r * f = 30.30

Actual ratio $r_{act} = \dfrac{L}{d} = \dfrac{5000}{170.0}$ = 29.41

$\dfrac{r_{act}}{r_{perm}}$ = **0.97 ≤ 1**

Shear ULS

k = MIN(1+√(200/d) ; 2.0) = 2.00

$v_{Rd} = 0.12 \cdot k \cdot (\rho_1 \cdot f_{ck})^{1/3} \cdot (f_{ck}/25)^{1/3}$ = 0.46 N/mm²

$V_{Ed1} = V_{Ed} - \dfrac{q_d \cdot w}{2} = 28.0 - \dfrac{11.20 \cdot 0.3}{2}$ = 26.32 kN

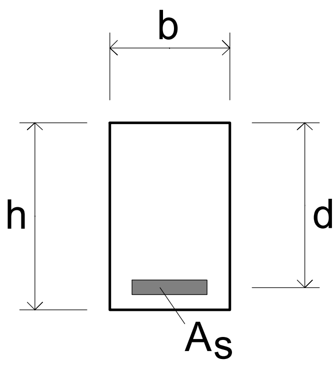
$v_{Ed1} = \dfrac{V_{Ed1}}{0.9 \cdot b \cdot d} = \dfrac{26320}{0.9 \cdot 1000.0 \cdot 170.0}$ = 0.17 N/mm²

$\dfrac{v_{Ed1}}{v_{Rd}}$ = **0.37 ≤ 1**

Slab does not require shear reinforcement

Chapter 4: Reinforcement

Bending reinforcement



Data given

Beam width b =	300.0 mm
Overall depth h =	500.0 mm
Effective depdth d =	450.0 mm
Required Moment M =	200.0 kNm

Material properties

Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Bending reinforcement calculation

K =	$MIN\left(\frac{M}{b*d^2*f_{ck}}; 0.167\right)$	=	0.110
$f_{[z/d]}$ =	$MIN(0.5*(1+\sqrt{1-3.53*K}); 0.95)$	=	0.891
z =	$d*f_{[z/d]}$	=	400.9 mm
A_s =	$\frac{M}{0.87*z*f_{yk}}$	=	1146.8 mm²
min.A_s =	$b * h * 0.016/100 * f_{ck}^{2/3}$	=	231.7 mm²

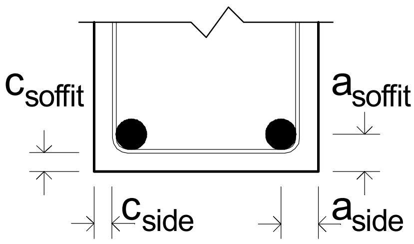
Reinforcing bars

Diameter d_s	=	20 mm
Group	=	**4H20**

Maximum amount of reinforcement

$A_{s,prov}$		=	1257.0 mm²
$A_{s,max}$ =	$\frac{A_{s,prov}*100}{b*h} = \frac{1257.0*100}{300.0*500.0}$	=	0.84 % < 4%

Nominal concrete cover



Data given

Beam width b =			300.0 mm
Main bar diameter d_{bar}		=	32 mm
Shear link diameter d_{link}		=	12 mm
Concrete grade C		=	C30/37

Exposure class

Exp.Class		=	XC1
nom.c_{side}		=	25 mm
nom.c_{soffit}		=	25 mm

Resistance to fire

Fire resistance R		=	R60
min.a_{side}		=	25 mm
min.a_{soffit}		=	25 mm

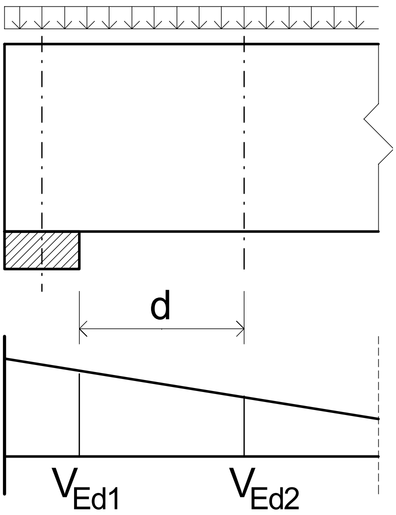
Placing

Minimum concrete covers [mm]			
Side c_{side}=	MAX(d_{link}+10 ; nom.c_{side} ; $c_{fire,side}$)	=	25 mm
Soffit c_{soffit} =	MAX(d_{link}+10 ; nom.c_{soffit} ; $c_{fire,soffit}$)	=	25 mm
Provided c =			**30 mm**
Cover to main bars c_{bar} =	MAX(d_{bar}+10 ; c + d_{link})	=	42 mm

Axis distance to the main bar / Effective depth

a_{soffit} =	MAX(c_{bar} + d_{bar} / 2 ; min.a_{soffit})	=	58 mm
Overall depth h =			500.0 mm
Effective depth d =	h - a_{soffit}	=	**442.0 mm**

Shear reinforcement



Data given

Beam width b =	200.0 mm
Overall depth h =	300.0 mm
Effective depdth d =	252.5 mm
With of support w =	150.0 mm

Loading

Load on beam q_d =	25.00 kN/m
Reaction Force V_{Ed} =	100.0 kN

Material properties

Concrete grade C	=	C30/37
f_{ck}	=	30.0 N/mm²
f_{yk} =		500.0 N/mm²

Shear force

Θ = 21.80 °

v_{Rd} = 0.36 * (1 - f_{ck}/250) * f_{ck}/(1/TAN(Θ) + TAN(Θ))/0.9 = 3.64 N/mm²

$$V_{Ed1} = V_{Ed} - \frac{q_d * w}{2} = 100.0 - \frac{25.00 * 0.15}{2} = 98.13 \text{ kN}$$

$$v_{Ed1} = \frac{V_{Ed1}}{0.9 * b * d} = \frac{98130}{0.9 * 200.0 * 252.5} = 2.16 \text{ N/mm}^2$$

$$\frac{v_{Ed1}}{v_{Rd}} = \mathbf{0.59 \leq 1}$$

$$V_{Ed2} = V_{Ed1} - q_d * d = 98.13 - 25.00 * 0.2525 = 91.82 \text{ kN}$$

$$v_{Ed2} = \frac{V_{Ed2}}{0.9 * b * d} = \frac{91820}{0.9 * 200.0 * 252.5} = 2.02 \text{ N/mm}^2$$

Reinforcement

$$requ.A_{[sw/s]} = \frac{0.4 * v_{Ed2} * b * 10^{3}}{0.87 * f_{yk}} = \frac{0.4 * 2.02 * 200.0 * 10^{3}}{0.87 * 500.0} = 371.49 \text{ mm}^2/\text{m}$$

$$min.A_{[sw/s]} = \frac{0.08 * \sqrt{f_{ck}} * b * 10^{3}}{f_{yk}} = \frac{0.08 * \sqrt{30.0} * 200.0 * 10^{3}}{500.0} = 175.27 \text{ mm}^2/\text{m}$$

$A_{[SW/S]}$ = MAX($requ.A_{[sw/s]}$; $min.A_{[sw/s]}$) = 371.49 mm²/m

Max. link spacing e = 0.75 * d = 189.38 mm

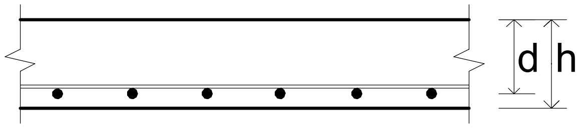
Diameter D = 8.00 mm

Legs per link n = 2

Link L = **H8 at 250**

$a_{s,prov}$ = 402.0 mm²/m

Mesh reinforcement fabrics to BS 4483



Data given

Overall depth h = 200.0 mm
Effective depdth d = 165.0 mm

Required Moment M = 20.0 kNm/m

Material properties

Concrete grade C = C30/37
f_{ck} = 30.0 N/mm²
f_{yk} = 500.0 N/mm²

Bending reinforcement calculation

$K = MIN\left(\frac{M}{b*d^2*f_{ck}}; 0.167\right)$ = 0.024

$f_{[z/d]} = MIN\left(0.5*\left(1+\sqrt{1-3.53*K}\right); 0.95\right)$ = 0.950

$z = d*f_{[z/d]}$ = 156.8 mm

$A_s = \frac{M}{0.87*z*f_{yk}}$ = 293.2 mm²/m

$min.A_s = b * h * 0.016/100 * f_{ck}^{2/3}$ = 309.0 mm²/m

Reinforcement with meshes

Mash type = B

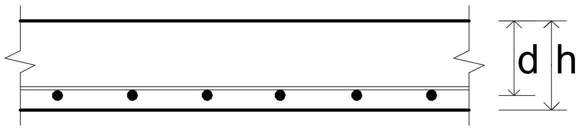
Ref = B385

Spacing e = 100.0 mm

Max. spacing e_{max} = 3 * d = 495.0 mm

e / e_{max} = 0.20 ≤ 1

Slab reinforcement



Data given

Overall depth h = 200.0 mm

Effective depdth d = 165.0 mm

Required Moment M = 30.0 kNm/m

Material properties

Concrete grade C = C20/25

f_{ck} = 20.0 N/mm²

f_{yk} = 500.0 N/mm²

Bending reinforcement calculation

K = $MIN\left(\frac{M}{b \cdot d^2 \cdot f_{ck}}; 0.167\right)$ = 0.055

$f_{[z/d]}$ = $MIN\left(0.5 \cdot \left(1 + \sqrt{1 - 3.53 \cdot K}\right); 0.95\right)$ = 0.949

z = $d \cdot f_{[z/d]}$ = 156.6 mm

A_s = $\frac{M}{0.87 \cdot z \cdot f_{yk}}$ = 440.4 mm²/m

min.A_s = $b \cdot h \cdot 0.016/100 \cdot f_{ck}^{2/3}$ = 235.8 mm²/m

Reinforcing

Main reinforcement

Diameter d_s = 8 mm

Reinf = **H8 at 100**

$A_{s,prov}$ = 503.0 mm²/m

Spacing e = 100.0 mm

Max. spacing e_{max} = 3 * d = 495.0 mm

e / e_{max} = $0.20 \leq 1$

Distribution reinforcement

Diameter d_s = 8 mm

Reinf = **H8 at 200**

$A_{s,prov}$ = 251.0 mm²/m

Spacing e = 200.0 mm

Max. spacing e_{max} = 3.5 * d = 577.5 mm

e / e_{max} = $0.35 \leq 1$