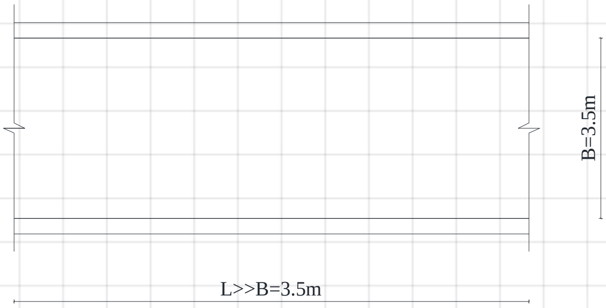
This video will briefly cover the concrete elements' detailing according to Eurocode 1992-1-1. In the end, a straightforward example defines the minimum requirements of reinforcement detailing. It should be noted that the example is based on the general Eurocode, and for the desired task, the relevant national annex needs to be applied.

The example of the video:

A long one-way slab is supported on two beams, as shown in the figure below. Concrete class C35/45 and steel AH500.

a) Based on the deflection control covered in chapter 7 of Eurocode 2, determine the minimum required slab thickness.
b) Determine the minimum required reinforcement for primary reinforcement.
c) Determine the required spacing of the primary reinforcement.
d) Determine the required secondary reinforcement and also the spacing of secondary reinforcement.



7.4 Deflection control

7.4.1 General considerations

(1)P The deformation of a member or structure shall not be such that it adversely affects its proper functioning or appearance.

(2) Appropriate limiting values of deflection taking into account the nature of the structure, of the finishes, partitions and fixings and upon the function of the structure should be established.

(3) Deformations should not exceed those that can be accommodated by other connected elements such as partitions, glazing, cladding, services or finishes. In some cases limitation may be required to ensure the proper functioning of machinery or apparatus supported by the structure, or to avoid ponding on flat roofs.

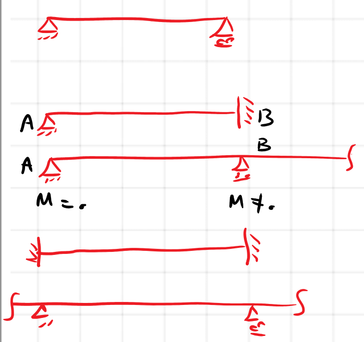
7.4.2 Cases where calculations may be omitted

(1)P Generally, it is not necessary to calculate the deflections explicitly as simple rules, for example limits to span/depth ratio may be formulated, which will be adequate for avoiding deflection problems in normal circumstances. More rigorous checks are necessary for members which lie outside such limits, or where deflection limits other than those implicit in simplified methods are appropriate.

Table 7.4N: Basic ratios of span/effective depth for reinforced concrete members without axial compression

Structural System	K	Concrete highly stressed $\rho = 1{,}5\%$	Concrete lightly stressed $\rho = 0{,}5\%$
Simply supported beam, one- or two-way spanning simply supported slab	1,0	14	20
End span of continuous beam or one-way continuous slab or two-way spanning slab continuous over one long side	1,3	18	26
Interior span of beam or one-way or two-way spanning slab	1,5	20	30
Slab supported on columns without beams (flat slab) (based on longer span)	1,2	17	24
Cantilever	0,4	6	8

Note 1: The values given have been chosen to be generally conservative and calculation may frequently show that thinner members are possible.
Note 2: For 2-way spanning slabs, the check should be carried out on the basis of the shorter span. For flat slabs the longer span should be taken.
Note 3: The limits given for flat slabs correspond to a less severe limitation than a mid-span deflection of span/250 relative to the columns. Experience has shown this to be satisfactory.



SECTION 9 DETAILING OF MEMBERS AND PARTICULAR RULES

9.1 General

(1)P The requirements for safety, serviceability and durability are satisfied by following the rules given in this section in addition to the general rules given elsewhere.

(2) The detailing of members should be consistent with the design models adopted.

(3) Minimum areas of reinforcement are given in order to prevent a brittle failure, wide cracks and also to resist forces arising from restrained actions.

Note: The rules given in this section are mainly applicable to reinforced concrete buildings.

9.2.1.1 Minimum and maximum reinforcement areas

(1) The area of longitudinal tension reinforcement should not be taken as less than $A_{s,min}$.

Note 1: See also 7.3 for area of longitudinal tension reinforcement to control cracking.

Note 2: The value of $A_{s,min}$ for beams for use in a Country may be found in its National Annex. The recommended value is given in the following:

$$A_{s,min} = 0{,}26 \frac{f_{ctm}}{f_{yk}} b_t d \quad \text{but not less than } 0{,}0013 b_t d \qquad (9.1N)$$

Where:

b_t denotes the mean width of the tension zone; for a T-beam with the flange in compression, only the width of the web is taken into account in calculating the value of b_t.

$$A_{s,min} = \max\left\{0.26 \frac{f_{ctm}}{f_{yk}} \cdot b_t \cdot d,\ 0.0013\, b_t \cdot d\right\}$$

9.3 Solid slabs

(1) This section applies to one-way and two-way solid slabs for which b and l_{eff} are not less than $5h$ (see 5.3.1).

9.3.1 Flexural reinforcement

9.3.1.1 General

(1) For the minimum and the maximum steel percentages in the main direction 9.2.1.1 (1) and (3) apply.

Note: In addition to Note 2 of 9.2.1.1 (1), for slabs where the risk of brittle failure is small, $A_{s,min}$ may be taken as 1,2 times the area required in ULS verification.

(2) Secondary transverse reinforcement of not less than 20% of the principal reinforcement should be provided in one way slabs. In areas near supports transverse reinforcement to principal top bars is not necessary where there is no transverse bending moment.

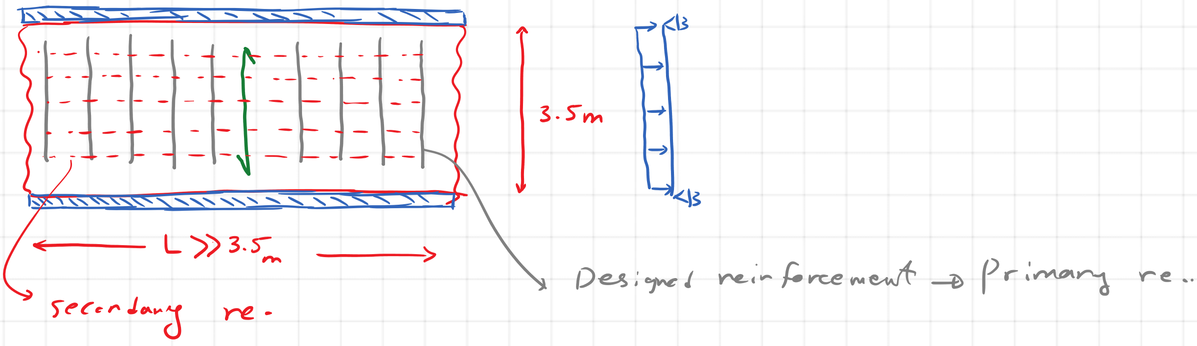
(3) The spacing of bars should not exceed $s_{max,slabs}$.

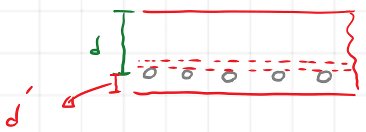
Note; The value of $s_{max,slabs}$ for use in a Country may be found in its National Annex. The recommended value is:

- for the principal reinforcement, $3h \leq 400$ mm, where h is the total depth of the slab;
- for the secondary reinforcement, $3{,}5h \leq 450$ mm .

In areas with concentrated loads or areas of maximum moment those provisions become respectively:

- for the principal reinforcement, $2h \leq 250$ mm
- for the secondary reinforcement, $3h \leq 400$ mm.





C30/37

$f_{yk} = 500$ MPa

P.R → $\phi = 16$ mm

S.R → $\phi = 12$ mm

$C_{nom} = 25$ mm

Table 7.4N: Basic ratios of span/effective depth for reinforced concrete members without axial compression

Structural System	K	Concrete highly stressed $\rho = 1{,}5\%$	Concrete lightly stressed $\rho = 0{,}5\%$
Simply supported beam, one- or two-way spanning simply supported slab	1,0	14	20
End span of continuous beam or one-way continuous slab or two-way spanning slab continuous over one long side	1,3	18	26
Interior span of beam or one-way or two-way spanning slab	1,5	20	30
Slab supported on columns without beams (flat slab) (based on longer span)	1,2	17	24
Cantilever	0,4	6	8

Note 1: The values given have been chosen to be generally conservative and calculation may frequently show that thinner members are possible.
Note 2: For 2-way spanning slabs, the check should be carried out on the basis of the shorter span. For flat slabs the longer span should be taken.
Note 3: The limits given for flat slabs correspond to a less severe limitation than a mid-span deflection of span/250 relative to the columns. Experience has shown this to be satisfactory.

$\frac{L}{d} \leq 14 \qquad \frac{3500\text{ mm}}{d} \leq 14 \rightarrow d \geq 250$ mm

$d' = C_{nom} + \frac{1}{2}\phi \times 1.1 = 25 + \frac{1}{2} \times 16 \times 1.1 = 33.8$ mm

$h_{min} = d + d' = 283.8$ mm

→ $\boxed{h = 300\text{ mm}}$ → $d = h - d' = 266$ mm

(T3.1)

$f_{ctm} = 2.9$ MPa

9.2.1.1 Minimum and maximum reinforcement areas

(1) The area of longitudinal tension reinforcement should not be taken as less than $A_{s,min}$.

Note 1: See also 7.3 for area of longitudinal tension reinforcement to control cracking.

Note 2: The value of $A_{s,min}$ for beams for use in a Country may be found in its National Annex. The recommended value is given in the following:

$$A_{s,min} = 0{,}26\frac{f_{ctm}}{f_{yk}}b_t d \quad \text{but not less than } 0{,}0013 b_t d \qquad (9.1N)$$

Where:

b_t denotes the mean width of the tension zone; for a T-beam with the flange in compression, only the width of the web is taken into account in calculating the value of b_t.

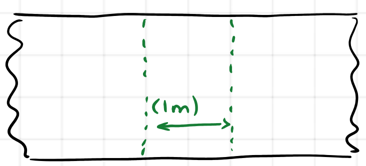
$A_{s,min} = \max\left\{0.26\frac{f_{ctm}}{f_{yk}} = 0.0015,\ 0.0013\right\} \cdot b \cdot d$

Strength classes for concrete															Analytical relation / Explanation
f_{ck} (MPa)	12	16	20	25	30	35	40	45	50	55	60	70	80	90	
$f_{ck,cube}$ (MPa)	15	20	25	30	37	45	50	55	60	67	75	85	95	105	
f_{cm} (MPa)	20	24	28	33	38	43	48	53	58	63	68	78	88	98	$f_{cm} = f_{ck}+8$(MPa)
f_{ctm} (MPa)	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8	4,1	4,2	4,4	4,6	4,8	5,0	$f_{ctm}=0{,}30\times f_{ck}^{(2/3)} \leq$ C50/60; $f_{ctm}=2{,}12\cdot\ln(1+(f_{cm}/10))$ > C50/60
$f_{ctk,0,05}$ (MPa)	1,1	1,3	1,5	1,8	2,0	2,2	2,5	2,7	2,9	3,0	3,1	3,2	3,4	3,5	$f_{ctk;0,05} = 0{,}7\times f_{ctm}$ 5% fractile

Table 3.1 Strength and defo

$A_{s,min} = 0.0015 \times b \cdot d = 399\ \text{mm}^2/\text{m}$

(b = 1000 mm, d = 266 mm)



$A_{s,min} \simeq 400\ mm^2/m$ T16 $\Rightarrow$ $1\,T16 = \frac{\pi \times 16^2}{4} = 200\ mm^2$

$n = \frac{400\ mm^2/m}{200\ mm^2/1T16} = 2\ \frac{T16}{m} \rightarrow S_{pacing} = \frac{1000\ mm}{2} = 500\ mm$

$\rightarrow$ **T16 @ 500 mm**

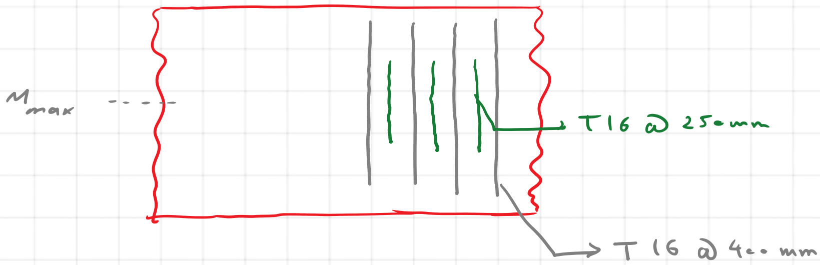
(3) The spacing of bars should not exceed $s_{max,slabs}$.

Note; The value of $s_{max,slabs}$ for use in a Country may be found in its National Annex. The recommended value is:

- for the principal reinforcement, $3h \leq 400$ mm, where h is the total depth of the slab; $\rightarrow$ $S \leq min\{3h, 400\ mm\} = 400\ mm$ (3h = 300)
- for the secondary reinforcement, $3{,}5h \leq 450$ mm . $\rightarrow$ $S \leq min\{3.5 \times 300\ mm, 450\ mm\} = 450\ mm$

In areas with concentrated loads or areas of maximum moment those provisions become respectively:

- for the principal reinforcement, $2h \leq 250$ mm $\rightarrow$ $S \leq min\{2h, 250\ mm\} = 250\ mm$
- for the secondary reinforcement, $3h \leq 400$ mm. $\rightarrow$ $S \leq min\{3h, 400\ mm\} = 400\ mm$



9.3 Solid slabs

(1) This section applies to one-way and two-way solid slabs for which b and l_{eff} are not less than $5h$ (see 5.3.1).

9.3.1 Flexural reinforcement

9.3.1.1 General

(1) For the minimum and the maximum steel percentages in the main direction 9.2.1.1 (1) and (3) apply.

Note: In addition to Note 2 of 9.2.1.1 (1), for slabs where the risk of brittle failure is small, $A_{s,min}$ may be taken as 1,2 times the area required in ULS verification.

T16 @ 200mm

(2) Secondary transverse reinforcement of not less than 20% of the principal reinforcement should be provided in one way slabs. In areas near supports transverse reinforcement to principal top bars is not necessary where there is no transverse bending moment.

$(A_s)_p = \frac{1000\ mm}{200\ mm} \times \frac{\pi \times 16^2}{4} = 1000\ mm^2/m$

$20\%(A_s)_p = 200\ mm^2/m \geq A_{s,min} = 399\ mm^2/m$

$\rightarrow (A_s)_s = 399\ mm^2/m$

T12 → $n = \dfrac{399\ mm^2/m}{\dfrac{\pi \times (12\ mm)^2}{4}} = 3.52\ /m$

$\text{Spacing} = \dfrac{1000\ mm}{3.52} = 283\ mm \rightarrow 250\ mm$

→ **T12 @ 250**   **$S_{max} = 400\ mm$**

General

9.3.1.1(3)

The maximum value for bar spacing $s_{max,slabs}$ is:

- for the principal reinforcement, $3h \leq 400$ mm, where h is the total depth of the slab;
- for the secondary reinforcement, $4h \leq 600$ mm.

In areas with concentrated loads or areas of maximum moment the provisions are respectively:

- for the principal reinforcement, $2h \leq 250$ mm
- for the secondary reinforcement, $3h \leq 400$ mm.