$\lambda = \begin{cases} 0{,}8 & \langle f_{ck} \le 50\,MPa \rangle \\ 0{,}8 - \left(\dfrac{f_{ck}-50}{400}\right) & \langle f_{ck} > 50\,MPa \rangle \end{cases}$			$\alpha_c = \begin{cases} 0{,}85 & \langle f_{ck} \le 50\,MPa \rangle \\ 0{,}85\left(1 - \dfrac{f_{ck}-50}{200}\right) & \langle f_{ck} > 50\,MPa \rangle \end{cases}$	
$F_d = \gamma_f F_k$	$f_{cd} = \dfrac{f_{ck}}{\gamma_c}$	$f_{yd} = \dfrac{f_{yk}}{\gamma_s}$	$\beta_s = \dfrac{\sigma_s}{f_{yd}}$	$\beta_s' = \dfrac{\sigma_s'}{f_{yd}}$
$\beta_x = \dfrac{x}{d} = \dfrac{\varepsilon_c}{\varepsilon_c + \varepsilon_s}$	$\beta_y = \dfrac{y}{d} = \lambda \beta_x$	$\beta_z = \dfrac{z}{d} = 1 - 0{,}5\lambda\beta_x$	$\beta_c = \lambda \alpha_c \beta_x \beta_z = \lambda \alpha_c \beta_x (1 - 0{,}5\lambda\beta_x)$	
$a_h \ge \max \begin{bmatrix} 2\,cm \\ \phi_\ell \\ 1{,}2\,d_{max} \end{bmatrix}$	$a_v \ge \max \begin{bmatrix} 2\,cm \\ \phi_\ell \\ 0{,}5\,d_{max} \end{bmatrix}$	$a = \begin{cases} 1{,}00\,\ell \\ 0{,}75\,\ell \\ 0{,}60\,\ell \\ 2{,}00\,\ell \end{cases}$	$b_1 \le \begin{cases} 0{,}1a \\ 0{,}5\,b_2 \end{cases}$ $\quad b_3 \le \begin{cases} 0{,}1a \\ b_4 \end{cases}$	

vigas de seção retangular **com** armadura de compressão

$$M_{Rd} = \max \begin{bmatrix} M_{d,min} \\ M_{Sd} \end{bmatrix} = \max \begin{bmatrix} 0{,}8\,W_0\,f_{ctk,sup} \\ M_{Sd} \end{bmatrix}$$

$$W_0 = \frac{b_w h^2}{6}$$

$$f_{ctk,sup} = \begin{cases} 0{,}39 \times \sqrt[3]{f_{ck}^2} & \langle f_{ck} \le 50\,MPa \rangle \\ 2{,}756 \ln(1 + 0{,}11 f_{ck}) & \langle f_{ck} > 50\,MPa \rangle \end{cases}$$

$$\beta_c = \frac{M_{Rd}}{b_w d^2 f_{cd}} \Rightarrow \text{tab} \begin{cases} \beta_x \\ \beta_z \\ \beta_s \end{cases}$$

$$\beta_x > \beta_{x,dtl} = \begin{cases} 0{,}450 & \langle f_{ck} \le 50\,MPa \rangle \\ 0{,}350 & \langle f_{ck} > 50\,MPa \rangle \end{cases}$$

$$\left.\begin{array}{l} \beta_x = \beta_{x,dtl} \\ \dfrac{d'}{d} \end{array}\right\} \Rightarrow \text{tab} \begin{cases} \beta_z \\ \beta_c \\ \beta_s \\ \beta_s' \end{cases}$$

$$M_{Rd1} = \beta_c\, b_w\, d^2\, f_{cd}$$

$$M_{Rd2} = M_{Rd} - M_{Rd1}$$

$$A_s = \left[\frac{M_{Rd1}}{\beta_z d} + \frac{M_{Rd2}}{(d - d')}\right] \frac{1}{\beta_s f_{yd}} \ge 0{,}15\%\, A_c$$

$$A_s' = \frac{M_{Rd2}}{(d - d')\,\beta_s'\, f_{yd}}$$

$$(A_s + A_s') \le 4\%\, A_c$$

$$\beta_s = \left(\frac{\lambda \alpha_c\, b_w\, d f_{cd}}{A_s f_{yd}}\right)\beta_x + \left(\frac{A_s'}{A_s}\right)\beta_s'$$

para vigas de seção retangular **sem** armadura de compressão, considerar:

$\beta_x \le \beta_{x,dtl}$	$M_{Rd1} = M_{Rd}$	$M_{Rd2} = d' = A_s' = \beta_s' = 0$

vigas de seção T sem armadura de compressão - $y \le h_f$

$$M_{Rd} = \max\begin{bmatrix} M_{d,min} \\ \\ M_{Sd} \end{bmatrix} = \max\begin{bmatrix} 0{,}8\, W_0\, f_{ctk,sup} \\ \\ M_{Sd} \end{bmatrix}$$

$$M_{Rd,mesa} = \alpha_c \left(b_f\, h_f\right)\left(d - \frac{h_f}{2}\right) f_{cd}$$

$M_{Rd} \le M_{Rd,mesa}$

$$\beta_c = \frac{M_{Rd}}{b_f\, d^2\, f_{cd}} \quad \Rightarrow \quad \text{tab}\begin{cases} \beta_x \\ \beta_y \\ \beta_z \\ \beta_s \end{cases}$$

$$\beta_x \le \beta_{x,dtl} = \begin{cases} 0{,}450 & \langle f_{ck} \le 50\,MPa \rangle \\ \\ 0{,}350 & \langle f_{ck} > 50\,MPa \rangle \end{cases}$$

$$y = \beta_y\, d \le h_f$$

$$A_s = \frac{M_{Rd}}{\beta_z\, d\, \beta_s\, f_{yd}} \begin{cases} \ge A_{s,min} = 0{,}15\%\, A_c \\ \\ \le A_{s,max} = 4\%\, b_w\, h \end{cases}$$

$$\beta_s = \left(\frac{\lambda\, \alpha_c\, b_f\, d\, f_{cd}}{A_s\, f_{yd}}\right)\beta_x$$

vigas de seção T sem armadura de compressão - $y > h_f$

$$M_{Rd} = \max\begin{bmatrix} M_{d,min} \\ \\ M_{Sd} \end{bmatrix} = \max\begin{bmatrix} 0{,}8\, W_0\, f_{ctk,sup} \\ \\ M_{Sd} \end{bmatrix}$$

$$M_{Rd,mesa} = \alpha_c \left(b_f\, h_f\right)\left(d - \frac{h_f}{2}\right) f_{cd}$$

$M_{Rd} > M_{Rd,mesa}$

$$M_{Rd3} = \alpha_c \left[\left(b_f - b_w\right) h_f \left(d - \frac{h_f}{2}\right)\right] f_{cd}$$

$$M_{Rd1} = M_{Rd} - M_{Rd3}$$

$$\beta_c = \frac{M_{Rd1}}{b_w\, d^2\, f_{cd}} \quad \Rightarrow \quad \text{tab}\begin{cases} \beta_x \\ \beta_y \\ \beta_z \\ \beta_s \end{cases}$$

$$\beta_x \le \beta_{x,dtl} = \begin{cases} 0{,}450 & \langle f_{ck} \le 50\,MPa \rangle \\ \\ 0{,}350 & \langle f_{ck} > 50\,MPa \rangle \end{cases}$$

$$y = \beta_y\, d > h_f$$

$$A_s = \left[\frac{M_{Rd1}}{\beta_z\, d} + \frac{M_{Rd3}}{\left(d - \frac{h_f}{2}\right)}\right]\frac{1}{\beta_s\, f_{yd}} \begin{cases} \ge A_{s,min} = 0{,}15\%\, A_c \\ \\ \le A_{s,max} = 4\%\, b_w\, h \end{cases}$$

$$\beta_s = \left(\frac{\lambda\, \alpha_c\, b_w\, d\, f_{cd}}{A_s\, f_{yd}}\right)\beta_x + \left\{\frac{\alpha_c \left[\left(b_f - b_w\right) h_f\right] f_{cd}}{A_s\, f_{yd}}\right\}$$

seção T - W_0	$A_c = b_w\, h + \left(b_f - b_w\right) h_f$	$W_0 = W_{0,w} = \frac{I}{y_w}$

$$y_w = \frac{\left(b_f\, h^2\right) - \left[\left(b_f - b_w\right)\left(h - h_f\right)^2\right]}{2\left\{\left[\left(b_f\, h\right) - \left[\left(b_f - b_w\right)\left(h - h_f\right)\right]\right\}}$$

$$I = \left\{\frac{b_f\, h^3 - \left[\left(b_f - b_w\right)\left(h - h_f\right)^3\right]}{3}\right\} - A_c\, y_w^2$$