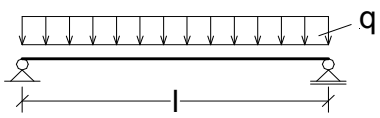
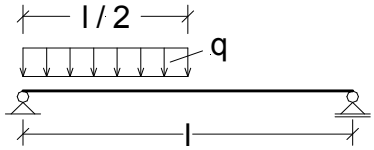
Templates structural formulae

Simple beam

Templates structural formulae	Folder: Simple beam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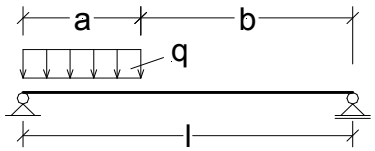	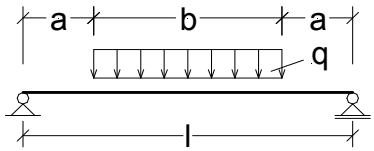
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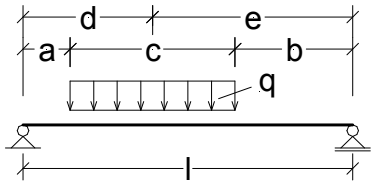	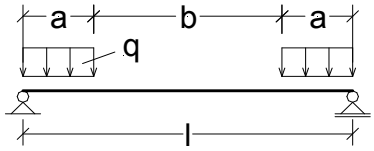
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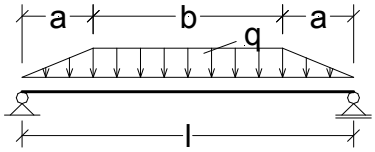	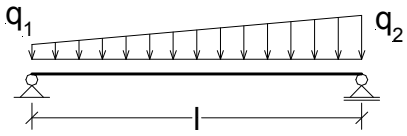
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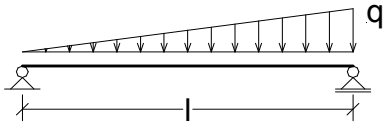	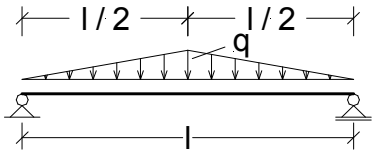
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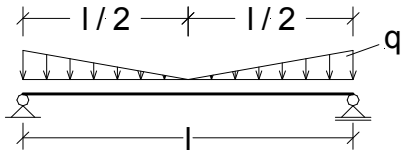	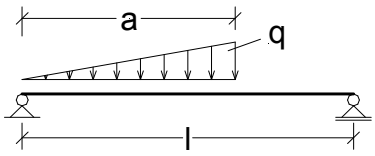
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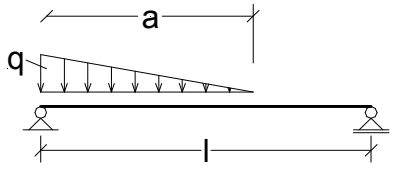	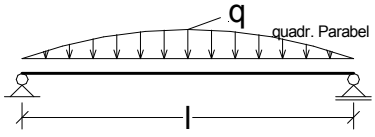
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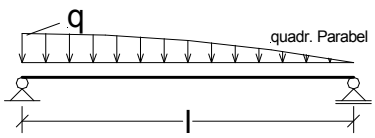
Pdf-Overview: Templates for structural analysis

Templates structural formulae	Folder: Simple beam



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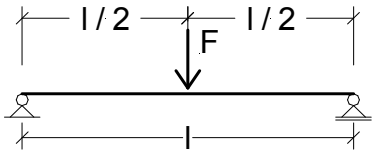

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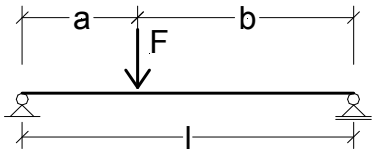

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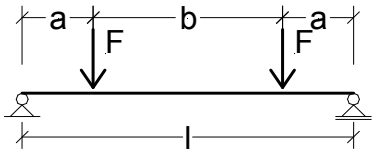

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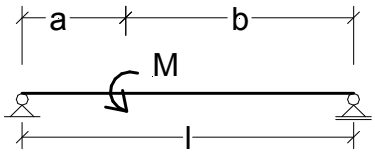

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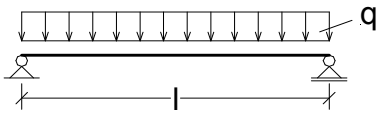

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{2}$ = 7,50 kN

$B = \frac{q * l}{2}$ = 7,50 kN

Internal forces:

$M_{max} = \frac{q * l^2}{8}$ = 9,38 kNm

at point:

$x = \frac{l}{2}$ = 2,50 m

Deflection:

E = 210000,00 N/mm²

I_y = 25,10*10^6 mm^4

$f_{Mid} = \frac{5}{384} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 4,63 mm

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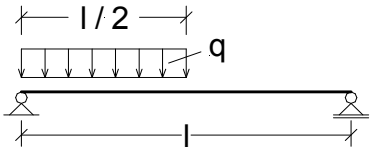

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{3}{8} * q * l$ = 5,63 kN

$B = \frac{1}{8} * q * l$ = 1,88 kN

Internal forces:

$M_{max} = \frac{9}{128} * q * l^2$ = 5,27 kNm

at point:

$x = \frac{3}{8} * l$ = 1,88 m

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{5}{768} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 2,32 mm

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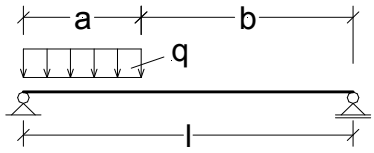

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length a =	2,00 m

$$\alpha = \frac{a}{l} = 0{,}40$$

Reaction:

$$A = \frac{q * a}{l} * \left(l - \frac{a}{2}\right) = 4{,}80 \text{ kN}$$

$$B = \frac{q * a^2}{2 * l} = 1{,}20 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{A^2}{2 * q} = 3{,}84 \text{ kNm}$$

at point:

$$x = \frac{A}{q} = 1{,}60 \text{ m}$$

Deflection:

E =	210000,00 N/mm²
I_y =	25,10*10⁶ mm⁴

$$f_{Mid} = \frac{1}{48} * q * (1000 * l)^4 * \alpha^2 * \frac{1{,}5 - \alpha^2}{E * I_y} = 1{,}59 \text{ mm}$$

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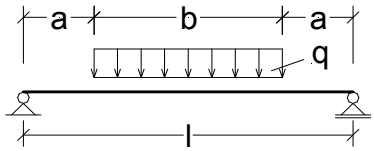

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length b =	3,00 m

$$\alpha = \frac{l - b}{l * 2} = 0{,}20$$

Reaction:

$$A = \frac{q * b}{2} = 4{,}50 \text{ kN}$$

$$B = \frac{q * b}{2} = 4{,}50 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * b}{8} * (2 * l - b) = 7{,}88 \text{ kNm}$$

at point:

$$x = \frac{l}{2} = 2{,}50 \text{ m}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{1}{384} * q * (1000 * l)^4 * \frac{5 - 24 * \alpha^2 + 16 * \alpha^4}{E * I_y} = 3{,}77 \text{ mm}$$

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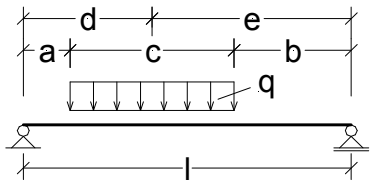

Input values:

Loading q =		3,00 kN/m
Length l =		5,00 m
Distance a =		1,00 m
Load length c =		2,00 m
b =	l - a - c	= 2,00 m
α =	$\frac{a}{l}$	= 0,20
β =	$\frac{b}{l}$	= 0,40

Reaction:

A =	$\frac{q*c*(2*b+c)}{2*l}$	= 3,60 kN
B =	$\frac{q*c*(2*a+c)}{2*l}$	= 2,40 kN

Internal forces:

M_{max} = $\frac{A^2}{2*q} + A*a$ = 5,76 kNm

at point:

x = $a + \frac{A}{q}$ = 2,20 m

Deflection:

E = 210000,00 N/mm²

I_y = 25,10*10^6 mm^4

$f_{Mid} = \frac{1}{384} * q * (1000*l)^4 * \frac{5 - 12*\alpha^2 + 8*\alpha^4 - 12*\beta^2 + 8*\beta^4}{E*I_y}$ = 2,61 mm

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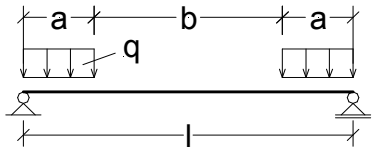

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length a =	1,00 m

$$\alpha = \frac{a}{l} = 0{,}20$$

Reaction:

$$A = q * a = 3{,}00 \text{ kN}$$

$$B = q * a = 3{,}00 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{1}{2} * q * a^2 = 1{,}50 \text{ kNm}$$

at point:

$$x = \frac{l}{2} = 2{,}50 \text{ m}$$

$(a \le x \le a+b)$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10*10^6$ mm⁴

$$f_{Mid} = \frac{1}{24} * q * (1000 * l)^4 * \alpha^2 * \frac{1{,}5 - \alpha^2}{E * I_y} = 0{,}87 \text{ mm}$$

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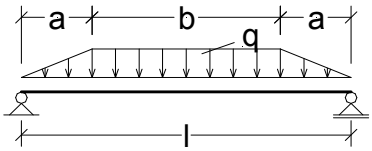

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load increase length a =	1,00 m

$$\alpha = \frac{a}{l} = 0{,}20$$

Reaction:

$$A = \frac{q}{2} * (l - a) = 6{,}00 \text{ kN}$$

$$B = \frac{q}{2} * (l - a) = 6{,}00 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * l^2}{24} * \left(3 - 4 * \alpha^2\right) = 8{,}88 \text{ kNm}$$

at point:

$$x = \frac{l}{2} = 2{,}50 \text{ m}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{1}{1920} * q * (1000 * l)^4 * \frac{25 - 40 * \alpha^2 + 16 * \alpha^4}{E * I_y} = 4{,}34 \text{ mm}$$

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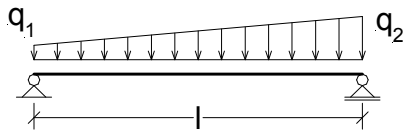

Input values:

Loading q_1 =	1,00 kN/m
Loading q_2 =	3,00 kN/m
Length l =	5,00 m

Reaction:

$$A = (2*q_1 + q_2)*\frac{l}{6} = 4{,}17 \text{ kN}$$

$$B = (q_1 + 2*q_2)*\frac{l}{6} = 5{,}83 \text{ kN}$$

Internal forces:

$$M_{max} = 0{,}063*(q_1 + q_2)*l^2 = 6{,}30 \text{ kNm}$$

at point:

$$x = 0{,}528 * l = 2{,}64 \text{ m}$$

for exact $q_1 = 0{,}5 * q_2$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10*10^6$ mm⁴

$$f_{Mid} = \frac{5}{768}*(q_1 + q_2)*(1000*l)^4*\frac{1}{E*I_y} = 3{,}09 \text{ mm}$$

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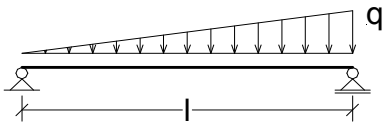

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Reaction:

$A = \frac{1}{6} * q * l$ = 2,50 kN

$B = \frac{1}{3} * q * l$ = 5,00 kN

Internal forces:

$M_{max} = \frac{1}{9 * \sqrt{3}} * q * l^2$ = 4,81 kNm

at point:

$x = \frac{l}{\sqrt{3}}$ = 2,89 m

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{5}{768} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 2,32 mm

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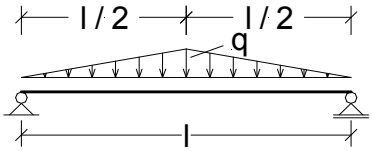

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Reaction:

$A = \frac{1}{4} * q * l$ = 3,75 kN

$B = \frac{1}{4} * q * l$ = 3,75 kN

Internal forces:

$M_{max} = \frac{1}{12} * q * l^2$ = 6,25 kNm

at point:

$x = \frac{l}{2}$ = 2,50 m

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{1}{120} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 2,96 mm

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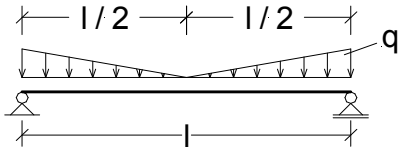

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{1}{4} * q * l$ = 3,75 kN

$B = \frac{1}{4} * q * l$ = 3,75 kN

Internal forces:

$M_{max} = \frac{1}{24} * q * l^2$ = 3,13 kNm

at point:

$x = \frac{l}{2}$ = 2,50 m

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{3}{640} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 1,67 mm

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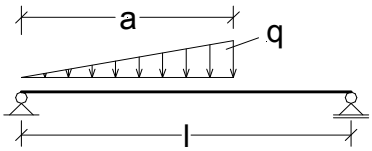

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length a =	3,00 m

$$\alpha = \frac{a}{l} = 0{,}60$$

Reaction:

$$A = \frac{q * a}{6} * (3 - 2 * \alpha) = 2{,}70 \text{ kN}$$

$$B = \frac{q * a}{3} * \alpha = 1{,}80 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * a^2}{3} * \sqrt{\left(1 - \frac{2}{3} * \alpha\right)^3} = 4{,}18 \text{ kNm}$$

at point:

$$x = a * \sqrt{1 - \frac{2}{3} * \alpha} = 2{,}32 \text{ m}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{q * (1000 * a)^3}{45} * (1 - \alpha) * \frac{5 * 1000 * l - 4 * 1000 * a}{E * I_y} = 1{,}78 \text{ mm}$$

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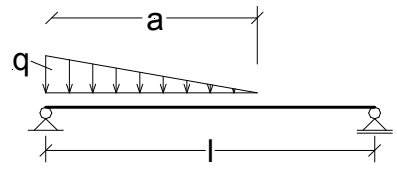

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length a =	3,00 m

$$\alpha = \frac{a}{l} = 0{,}60$$

Reaction:

$$A = \frac{q * a}{6} * (3 - \alpha) = 3{,}60 \text{ kN}$$

$$B = \frac{q * a}{6} * \alpha = 0{,}90 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * a^2}{6 * l} * \left(l - a + \frac{2}{3} * a * \sqrt{\frac{\alpha}{3}} \right) = 2{,}60 \text{ kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{q * (1000 * a)^3}{360} * (1 - \alpha) * \frac{20 * 1000 * l - 13 * 1000 * a}{E * I_y} = 1{,}04 \text{ mm}$$

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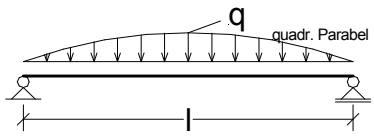

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{3}$ = 5,00 kN

$B = \frac{q * l}{3}$ = 5,00 kN

Internal forces:

$M_{max} = \frac{5}{48} * q * l^2$ = 7,81 kNm

at point:

$x = \frac{l}{2}$ = 2,50 m

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{61}{5760} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 3,77 mm

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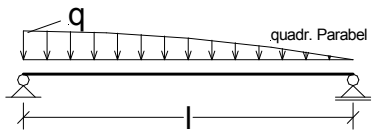

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{2,4}$ = 6,25 kN

$B = \frac{q * l}{4}$ = 3,75 kN

Internal forces:

$M_{max} = \frac{1}{11,15} * q * l^2$ = 6,73 kNm

at point:

$x = 0,446 * l$ = 2,23 m

Deflection:

E = 210000,00 N/mm²

I_y = $25,10*10^6$ mm⁴

$f_{Mid} = \frac{11}{1200} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 3,26 mm

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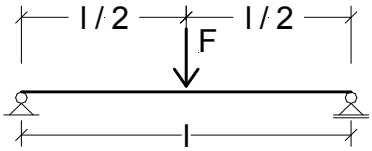

Input values:

Force F = 10,00 kN

Length l = 5,00 m

Reaction:

$A = \frac{F}{2}$ = 5,00 kN

$B = \frac{F}{2}$ = 5,00 kN

Internal forces:

$M_{max} = \frac{F * l}{4}$ = 12,50 kNm

at point:

$x = \frac{l}{2}$ = 2,50 m

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{1}{48} * F * (1000 * l)^3 * \frac{1000}{E * I_y}$ = 4,94 mm

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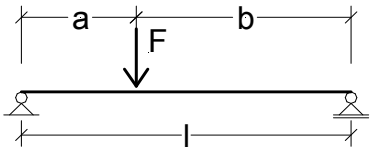

Input values:

Force F =	10,00 kN	
Length l =	5,00 m	
Lastabstand a =	2,00 m	
$b = l - a$	=	3,00 m
$\alpha = \frac{a}{l}$	=	0,40

Reaction:

$A = \frac{F * b}{l}$	=	6,00 kN
$B = \frac{F * a}{l}$	=	4,00 kN

Internal forces:

$M_{max} = \frac{F * a * b}{l}$	=	12,00 kNm

at point:

x = a	=	2,00 m

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{1}{48} * F * (1000 * l)^3 * \frac{\left(3 * \alpha - 4 * \alpha^3\right) * 1000}{E * I_y} = 4{,}66 \text{ mm}$$

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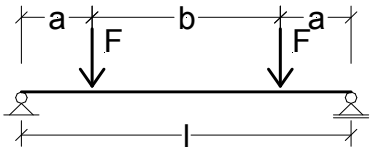

Input values:

Force F =	10,00 kN	
Length l =	5,00 m	
Lastabstand a =	2,00 m	
b =	l - 2 * a	= 1,00 m
α =	$\frac{a}{l}$	= 0,40

Reaction:

A =	F	= 10,00 kN
B =	F	= 10,00 kN

Internal forces:

M_{max} =	F * a	= 20,00 kNm

at point:

x =	$\frac{l}{2}$	= 2,50 m

(a ≤ x ≤ a+b)

Deflection:

E =	210000,00 N/mm²
I_y =	25,10*10^6 mm^4

$$f_{Mid} = \frac{1}{24} * F * (1000 * l)^3 * \frac{\left(3 * \alpha - 4 * \alpha^3\right) * 1000}{E * I_y} = 9{,}33 \text{ mm}$$

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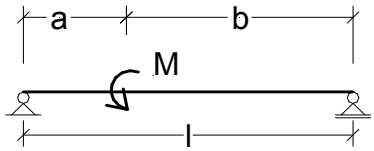

Input values:

Length l =	5,00 m	
Moment M =	10,00 kNm	
Distance a =	2,00 m	
b =	l - 2 * a	= 1,00 m
α =	$\frac{a}{l}$	= 0,40

Reaction:

A =	$\frac{M}{l}$	= 2,00 kN
B =	$-\frac{M}{l}$	= -2,00 kN

Internal forces:

M_{max} =	$IF(a \geq \frac{l}{2}; \frac{M*a}{l}; \frac{-M*b}{l})$	= -2,00 kNm

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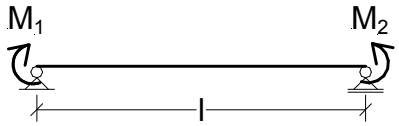

Input values:

Length l =	5,00 m
Moment M_1 =	5,00 kNm
Moment M_2 =	8,00 kNm

Reaction:

$$A = \frac{M_2 - M_1}{l} = 0{,}60 \text{ kN}$$

$$B = -\frac{M_2 - M_1}{l} = -0{,}60 \text{ kN}$$

Internal forces:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{1}{16} * (1000 * l)^2 * (M_1 + M_2) * \frac{10^6}{E * I_y} = 3{,}85 \text{ mm}$$

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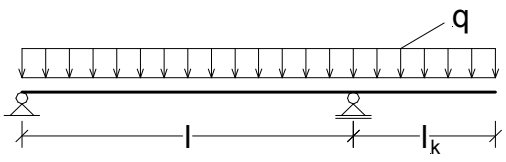
Templates structural formulae

Simple beam with cantilever



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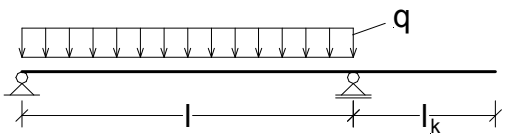

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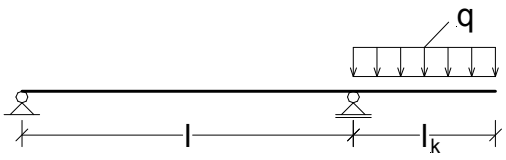

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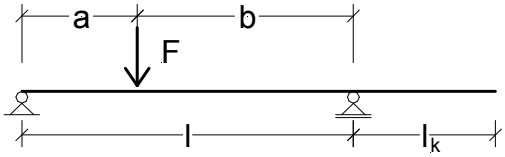

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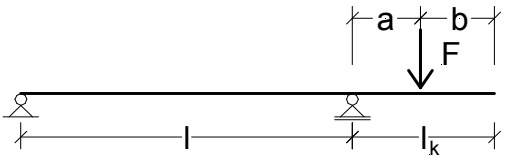

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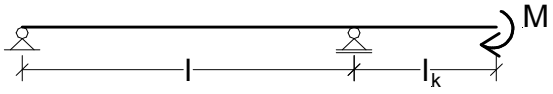

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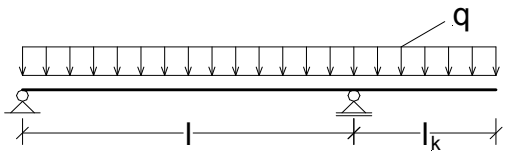

Input values:

Length l =	5,00 m
Loading q =	3,00 kN/m
Cantilever length l_k =	2,00 m

Reaction:

$$A = \frac{q}{2} * \left(l - \frac{l_k^2}{l} \right) = 6{,}30 \text{ kN}$$

$$B = \frac{q}{2} * \left(l + \frac{l_k^2}{l} + 2 * l_k \right) = 14{,}70 \text{ kN}$$

Internal forces:

$$M_{panel,max} = \frac{A^2}{2 * q} = 6{,}62 \text{ kNm}$$

$$M_{Cant} = \frac{-q * l_k^2}{2} = -6{,}00 \text{ kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{q * l^2}{32} * \left(\frac{5}{12} * l^2 - l_k^2 \right) * \frac{10^{12}}{E * I_y} = 2{,}85 \text{ mm}$$

$$f_{Cant} = \frac{q * l_k}{24} * \left(3 * l_k^3 + 4 * l * l_k^2 - l^3 \right) * \frac{10^{12}}{E * I_y} = -1{,}00 \text{ mm}$$

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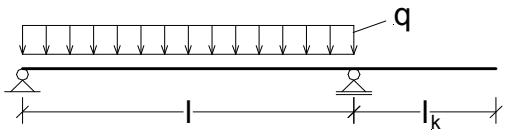

Input values:

Length l =	5,00 m
Loading q =	3,00 kN/m
Cantilever length l_k =	2,00 m

Reaction:

$A = \frac{q * l}{2}$ = 7,50 kN

$B = \frac{q * l}{2}$ = 7,50 kN

Internal forces:

$M_{panel,max} = \frac{q * l^2}{8}$ = 9,38 kNm

M_{Cant} = 0,00 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25,10*10^6$ mm⁴

$f_{Mid} = \frac{5}{384} * q * l^4 * \frac{10^{12}}{E * I_y}$ = 4,63 mm

$f_{Cant} = \frac{-1}{24} * q * l^3 * l_k * \frac{10^{12}}{E * I_y}$ = -5,93 mm

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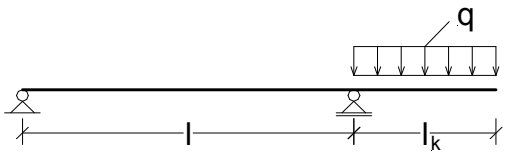

Input values:

Length l =	5,00 m
Loading q =	3,00 kN/m
Cantilever length l_k =	2,00 m

Reaction:

$$A = \frac{-q * l_k^{\,2}}{2 * l} = -1{,}20\ \text{kN}$$

$$B = q * l_k * \left(1 + \frac{l_k}{2 * l}\right) = 7{,}20\ \text{kN}$$

Internal forces:

$$M_{Cant} = \frac{-q * l_k^{\,2}}{2} = -6{,}00\ \text{kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{-1}{32} * q * l^{\,2} * l_k^{\,2} * \frac{10^{12}}{E * I_y} = -1{,}78\ \text{mm}$$

$$f_{Cant} = \frac{1}{24} * q * l_k^{\,3} * (4 * l + 3 * l_k) * \frac{10^{12}}{E * I_y} = 4{,}93\ \text{mm}$$

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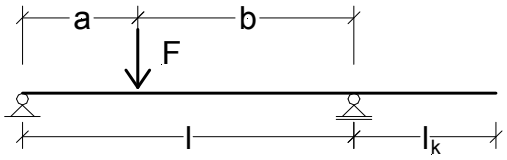

Input values:

Length l =	5,00 m
Force F =	10,00 kN
Cantilever length l_k =	2,00 m
Distance a =	2,00 m

$b = l - a = 3{,}00\ \text{m}$

$\alpha = \frac{a}{l} = 0{,}40$

Reaction:

$A = \frac{F * b}{l} = 6{,}00\ \text{kN}$

$B = \frac{F * a}{l} = 4{,}00\ \text{kN}$

Internal forces:

$M_{max} = \frac{F * a * b}{l} = 12{,}00\ \text{kNm}$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{F * l^3}{48} * \left(3 * \alpha - 4 * \alpha^3\right) * \frac{10^{12}}{E * I_y} = 4{,}66\ \text{mm}$

$f_{Cant} = \frac{-F * a * b * l_k}{6 * l} * (l + a) * \frac{10^{12}}{E * I_y} = -5{,}31\ \text{mm}$

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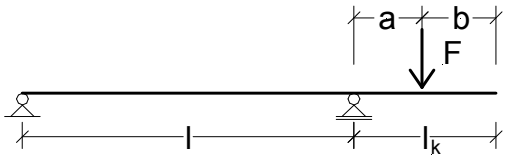

Input values:

Length l =	5,00 m
Force F =	10,00 kN
Cantilever length l_k =	2,00 m
Distance a =	2,00 m

Reaction:

$$A = \frac{-F * a}{l} = -4{,}00\ \text{kN}$$

$$B = \frac{F * (a + l)}{l} = 14{,}00\ \text{kN}$$

Internal forces:

$$M_{Cant} = -F * a = -20{,}00\ \text{kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f_{Mid} = \frac{-1}{16} * F * l^2 * a * \frac{10^{12}}{E * I_y} = -5{,}93\ \text{mm}$$

$$f_{Cant} = \frac{1}{6} * F * a * \left(2 * l * l_k + 3 * l_k * a - a^2\right) * \frac{10^{12}}{E * I_y} = 17{,}71\ \text{mm}$$

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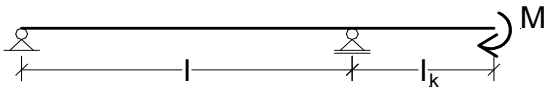

Input values:

Length l =	5,00 m
Moment M =	10,00 kNm
Cantilever length l_k =	2,00 m

Reaction:

$A = \frac{-M}{l}$ = -2,00 kN

$B = \frac{M}{l}$ = 2,00 kN

Internal forces:

$M_{Cant} = -M$ = -10,00 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f_{Mid} = \frac{-1}{16} * M * l^2 * \frac{10^{12}}{E * I_y}$ = -2,96 mm

$f_{Cant} = \left(\frac{l}{3} + \frac{l_k}{2}\right) * M * l_k * \frac{10^{12}}{E * I_y}$ = 10,12 mm

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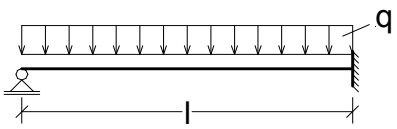
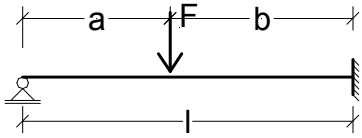
Templates structural formulae

Constrained simple beam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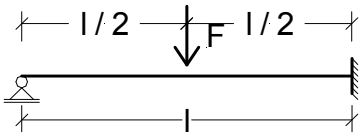	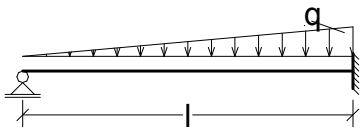
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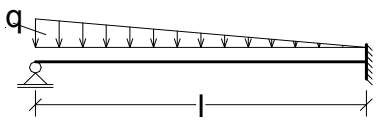	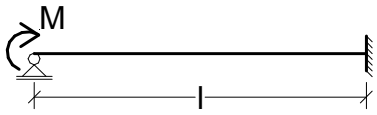
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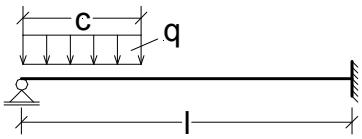	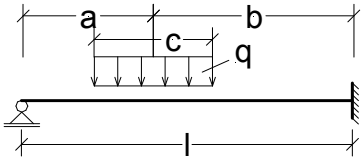
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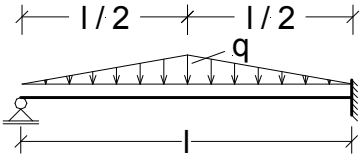	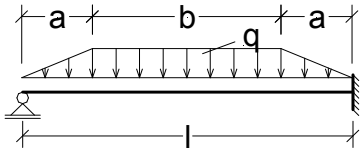
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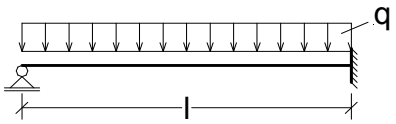

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{3}{8} * q * l$ = 5,63 kN

$B = \frac{5}{8} * q * l$ = 9,38 kN

Internal forces:

$M_{max} = \frac{9}{128} * q * l^2$ = 5,27 kNm

$M_{Rest} = \frac{-q * l^2}{8}$ = -9,38 kNm

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f = \frac{2}{369} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 1,93 mm

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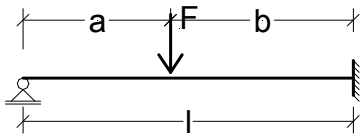

Input values:

Force F =		10,00 kN
Length l =		5,00 m
Distance a =		2,00 m
b =	l-a =	3,00 m

Reaction:

$$A = \frac{F * b^2}{2 * l^3} * (a + 2 * l) = 4{,}32 \text{ kN}$$

$$B = F - A = 5{,}68 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{F * a * b^3}{2 * l^3} * (3 * a + 2 * b) = 25{,}92 \text{ kNm}$$

$$M_{Rest} = \frac{-F * a * b}{2 * l} * \left(1 + \frac{a}{l}\right) = -8{,}40 \text{ kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f = \frac{F * a^2 * b^3}{12 * l^2 * E * I_y} * \left(3 + \frac{a}{l}\right) * 10^{12} = 2{,}32 \text{ mm}$$

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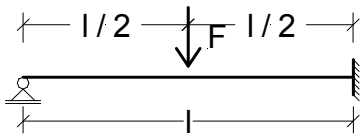

Input values:

Force F =	10,00 kN
Length l =	5,00 m

Reaction:

$A = \frac{5}{16} * F$ = 3,13 kN

$B = \frac{11}{16} * F$ = 6,88 kN

Internal forces:

$M_{max} = \frac{5}{32} * F * l$ = 7,81 kNm

$M_{Rest} = \frac{-3}{16} * F * l$ = -9,38 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f = \frac{1}{48 * \sqrt{5}} * \frac{F * l^3}{E * I_y} * 10^{12}$ = 2,21 mm

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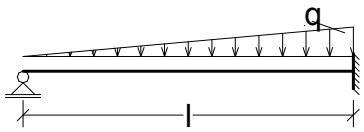

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Reaction:

$A = \frac{1}{10} * q * l = 1{,}50\ \text{kN}$

$B = \frac{2}{5} * q * l = 6{,}00\ \text{kN}$

Internal forces:

$M_{max} = \frac{q * l^2}{33{,}54} = 2{,}24\ \text{kNm}$

$M_{Rest} = \frac{-q * l^2}{15} = -5{,}00\ \text{kNm}$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$f = \frac{q * l^4}{419 * E * I_y} * 10^{12} = 0{,}85\ \text{mm}$

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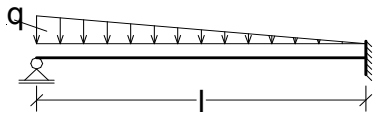

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{11}{40} * q * l$ = 4,13 kN

$B = \frac{9}{40} * q * l$ = 3,38 kN

Internal forces:

$M_{max} = \frac{q * l^2}{23,6}$ = 3,18 kNm

$M_{Rest} = \frac{-7 * q * l^2}{120}$ = -4,38 kNm

Deflection:

E = 210000,00 N/mm²

I_y = 25,10*10^6 mm^4

$f = \frac{q * l^4}{328,1 * E * I_y} * 10^{12}$ = 1,08 mm

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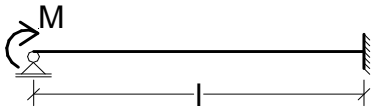

Input values:

Length l =	5,00 m	
Moment M =	10,00 kNm	

Reaction:

A =	$\frac{-3}{2} * \frac{M}{l}$	=	-3,00 kN
B =	-A	=	3,00 kN

Internal forces:

M_{max} =	M	=	10,00 kNm
M_{Rest} =	$\frac{-M}{2}$	=	-5,00 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

f =	$\frac{M}{2 * E * I_y} * 10^{12}$	=	0,95 mm

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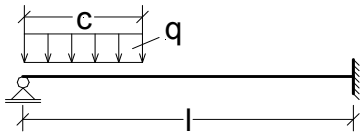

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length c =	2,00 m

$$\gamma = \frac{c}{l} = 0{,}40$$

Rigid retaining torques:

$$M_{Rest} = -0{,}125 * q * c^{2} * (2 - \gamma) = -2{,}40 \text{ kNm}$$

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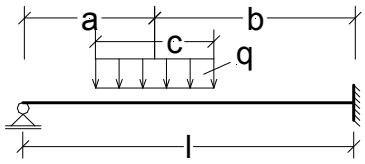

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length c =	2,00 m
Distance a =	1,00 m

$$\alpha = \frac{a}{l} = 0{,}20$$

$$\gamma = \frac{c}{l} = 0{,}40$$

Rigid retaining torques:

$$M_{Rest} = -0{,}5 * q * a * c * \left(2 - \alpha^2 - 0{,}25 * \gamma^2\right) = -5{,}76 \text{ kNm}$$

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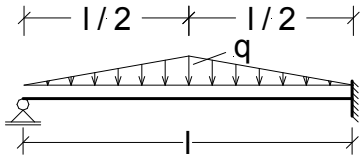

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Rigid retaining torques:

$$M_{Rest} = \frac{-5}{64} * q * l^2 = -5{,}86 \text{ kNm}$$

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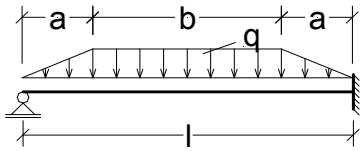

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load increase length a =	1,00 m

$$\alpha = \frac{a}{l} = 0{,}20$$

Rigid retaining torques:

$$M_{Rest} = \frac{-q * l^2}{8} * \left(1 - 2 * \alpha^2 + \alpha^3\right) = -8{,}70 \text{ kNm}$$

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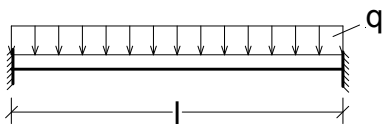
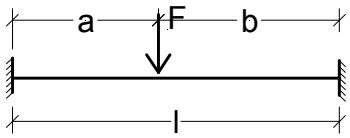
Templates structural formulae

Fixed end beam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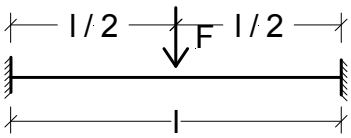	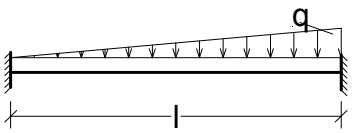
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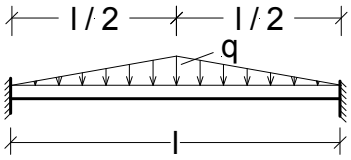	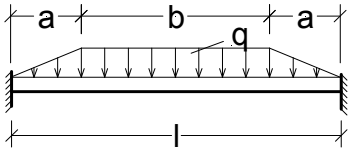
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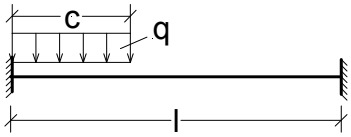	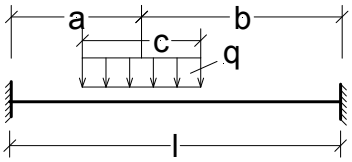
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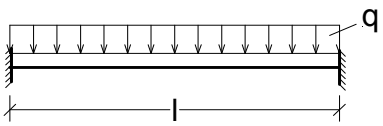

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{2}$ = 7,50 kN

$B = \frac{q * l}{2}$ = 7,50 kN

Internal forces:

$M_{max} = \frac{q * l^2}{24}$ = 3,13 kNm

$M_{Rest} = \frac{-q * l^2}{12}$ = -6,25 kNm

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f = \frac{1}{384} * q * (1000 * l)^4 * \frac{1}{E * I_y}$ = 0,93 mm

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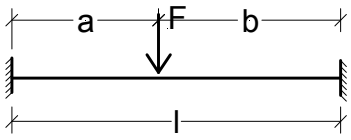

Input values:

Length l =			5,00 m
Force F =			10,00 kN
Distance a =			2,00 m
b =	l-a	=	3,00 m
α =	$\frac{a}{l}$	=	0,40
β =	$\frac{b}{l}$	=	0,60

Reaction:

A =	$\frac{F*b^2}{l^3}*(l+2*a)$	=	6,48 kN
B =	F - A	=	3,52 kN

Internal forces:

M_{max} =	$\frac{2*F*a*b^3}{l^3}$	=	8,64 kNm
$M_{a,Rest}$ =	$-\alpha*\beta^2*F*l$	=	-7,20 kNm
$M_{b,Rest}$ =	$-\alpha^2*\beta*F*l$	=	-4,80 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25,10*10^6$ mm⁴

f =	$\frac{F*a^3*b^3}{3*l^3*E*I_y}*10^{12}$	=	1,09 mm

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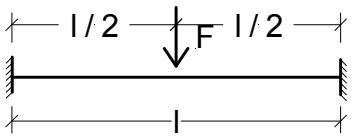

Input values:

Force F = 10,00 kN

Length l = 5,00 m

Reaction:

$A = \frac{F}{2}$ = 5,00 kN

$B = \frac{F}{2}$ = 5,00 kN

Internal forces:

$M_{max} = \frac{F * l}{8}$ = 6,25 kNm

$M_{Rest} = \frac{-F * l}{8}$ = -6,25 kNm

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f = \frac{1}{192} * \frac{F * l^3}{E * I_y} * 10^{12}$ = 1,24 mm

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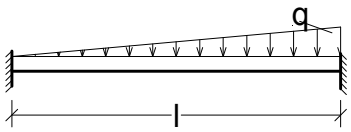

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
α =	1,00
β =	1,00

Reaction:

$A = \frac{3}{20} * q * l$ = 2,25 kN

$B = \frac{7}{20} * q * l$ = 5,25 kN

Internal forces:

$M_{max} = \frac{q * l^2}{46,64}$ = 1,61 kNm

$M_{a,Rest} = \frac{-q * l^2}{30}$ = -2,50 kNm

$M_{b,Rest} = \frac{-q * l^2}{30} * 1,5$ = -3,75 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25,10*10^6$ mm^4

$f = \frac{q * l^4}{764,2 * E * I_y} * 10^{12}$ = 0,47 mm

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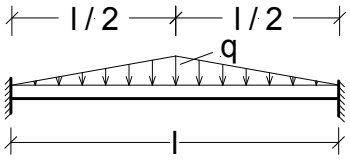

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Reaction:

$$A = \frac{q * l}{4} = 3{,}75 \text{ kN}$$

$$B = \frac{q * l}{4} = 3{,}75 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * l^2}{32} = 2{,}34 \text{ kNm}$$

$$M_{Rest} = \frac{-5 * q * l^2}{96} = -3{,}91 \text{ kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f = \frac{q * l^4}{3840 * E * I_y} * 10^{12} = 0{,}09 \text{ mm}$$

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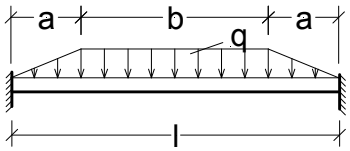

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load increase length a =	1,00 m

$$\alpha = \frac{a}{l} = 0{,}20$$

Reaction:

$$A = \frac{q}{2} * (l - a) = 6{,}00 \text{ kN}$$

$$B = \frac{q}{2} * (l - a) = 6{,}00 \text{ kN}$$

Internal forces:

$$M_{max} = \frac{q * l^2}{24} * \left(1 - 2 * \alpha^3\right) = 3{,}08 \text{ kNm}$$

$$M_{Rest} = \frac{-q * l^2}{12} * \left(1 - 2 * \alpha^2 + \alpha^3\right) = -5{,}80 \text{ kNm}$$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f = \frac{q * l^4}{1920 * E * I_y} * \left(5 - 20 * \alpha^3 + 17 * \alpha^4\right) * 10^{12} = 0{,}90 \text{ mm}$$

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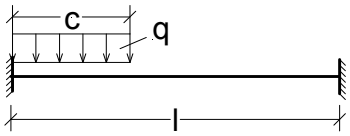

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length c =	2,00 m

$$\gamma = \frac{c}{l} = 0{,}40$$

Rigid retaining torques:

$$M_1 = -q * c^2 * \left(0{,}5 - 0{,}667 * \gamma + 0{,}25 * \gamma^2\right) = -3{,}28 \text{ kNm}$$

$$M_2 = -q * c^2 * \gamma * (0{,}333 - 0{,}25 * \gamma) = -1{,}12 \text{ kNm}$$

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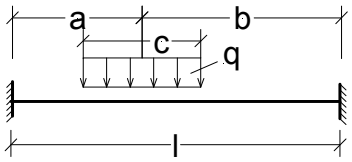


Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m
Load length c =	2,00 m
Distance a =	1,00 m

b =	l - a	=	4,00 m
α =	$\frac{a}{l}$	=	0,20
β =	$\frac{b}{l}$	=	0,80
γ =	$\frac{c}{l}$	=	0,40

Rigid retaining torques:

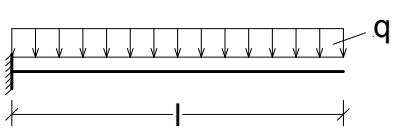
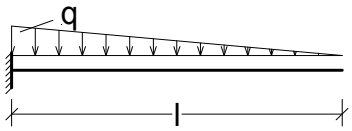
$$M_1 = -q * c * l * \left(\alpha * \beta^2 + \frac{\gamma^2}{12} * (1 - 3 * \beta) \right) = -3{,}28 \text{ kNm}$$

$$M_2 = -q * c * l * \left(\alpha^2 * \beta + \frac{\gamma^2}{12} * (1 - 3 * \alpha) \right) = -1{,}12 \text{ kNm}$$

Insert
Back

Templates structural formulae

Cantilever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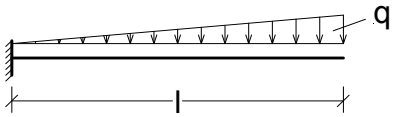	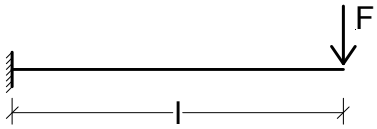
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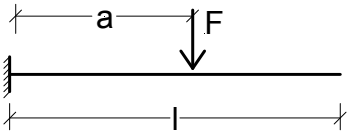	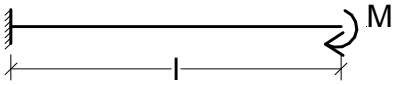
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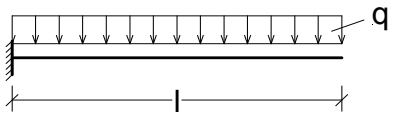

Input values:

Loading q =	3,00 kN/m
Length l =	5,00 m

Reaction:

$A = q * l = 15{,}00\ \text{kN}$

Internal forces:

$M_{max} = \frac{-q * l^2}{2} = -37{,}50\ \text{kNm}$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6\ \text{mm}^4$

$f = \frac{q * (1000 * l)^4}{8} * \frac{1}{E * I_y} = 44{,}46\ \text{mm}$

$\varphi = \frac{q * (1000 * l)^3}{6} * \frac{1}{E * I_y} = 11{,}86 * 10^{-3}$

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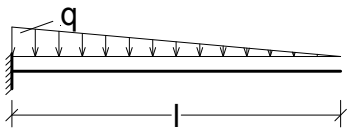

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{2}$ = 7,50 kN

Internal forces:

$M_{max} = \frac{-q * l^2}{6}$ = -12,50 kNm

Deflection:

E = 210000,00 N/mm²

I_y = 25,10*10⁶ mm⁴

$f = \frac{q * (1000 * l)^4}{30} * \frac{1}{E * I_y}$ = 11,86 mm

$\varphi = \frac{q * (1000 * l)^3}{24} * \frac{1}{E * I_y}$ = 2,96*10⁻³

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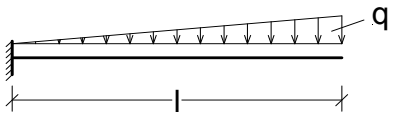

Input values:

Loading q = 3,00 kN/m

Length l = 5,00 m

Reaction:

$A = \frac{q * l}{2}$ = 7,50 kN

Internal forces:

$M_{max} = \frac{-q * l^2}{3}$ = -25,00 kNm

Deflection:

E = 210000,00 N/mm²

I_y = $25{,}10 * 10^6$ mm⁴

$f = \frac{11 * q * (1000 * l)^4}{120} * \frac{1}{E * I_y}$ = 32,61 mm

$\varphi = \frac{q * (1000 * l)^3}{8} * \frac{1}{E * I_y}$ = $8{,}89 * 10^{-3}$

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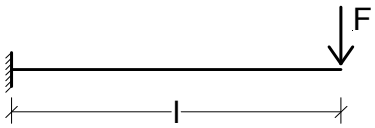

Input values:

Force F =	10,00 kN
Length l =	5,00 m

Reaction:

$A = F = 10{,}00\ \text{kN}$

Internal forces:

$M_{max} = -F * l = -50{,}00\ \text{kNm}$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6\ \text{mm}^4$

$$f = \frac{F * (1000 * l)^3}{3} * \frac{10^3}{E * I_y} = 79{,}05\ \text{mm}$$

$$\varphi = \frac{F * (1000 * l)^2}{2} * \frac{10^3}{E * I_y} = 23{,}71 * 10^{-3}$$

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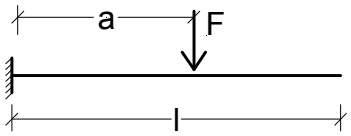

Input values:

Force F =	10,00 kN
Length l =	5,00 m
Distance a =	2,00 m

Reaction:

$A = F = 10{,}00\ \text{kN}$

Internal forces:

$M_{max} = -F * a = -20{,}00\ \text{kNm}$

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10 * 10^6$ mm⁴

$$f = \frac{F*(1000*a)^3}{3}*\left(l-\frac{a}{3}\right)*\frac{10^3}{E*I_y} = 21{,}92\ \text{mm}$$

$$\varphi = \frac{F*(1000*a)^2}{2}*\frac{10^3}{E*I_y} = 3{,}79*10^{-3}$$

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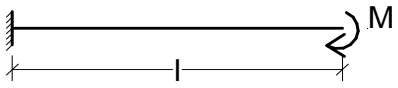

Input values:

Length l =	5,00 m
Moment M =	10,00 kNm

Reaction:

A =	0,00 kN

Internal forces:

M_{max} = -M	=	-10,00 kNm

Deflection:

E =	210000,00 N/mm²
I_y =	$25{,}10*10^6$ mm⁴

$$f = \frac{M*(1000*l)^2}{2}*\frac{10^6}{E*I_y} = 23{,}71 \text{ mm}$$

$$\varphi = \frac{M*(1000*l)}{2}*\frac{10^6}{E*I_y} = 4{,}74*10^{-3}$$

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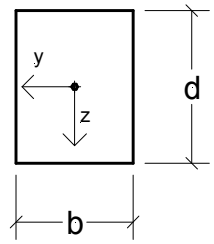
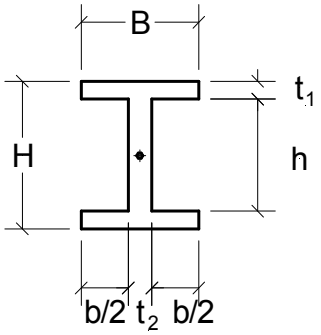
Templates structural formulae

Section properties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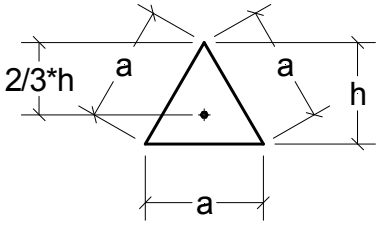	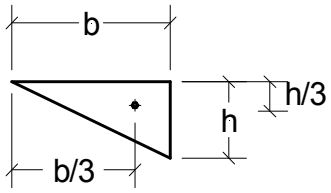
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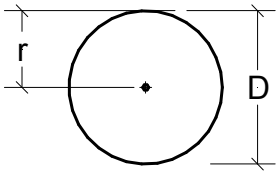	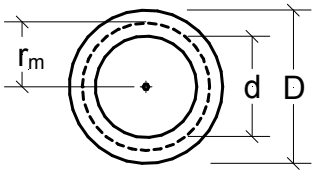
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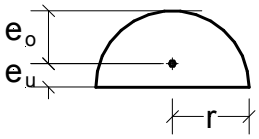	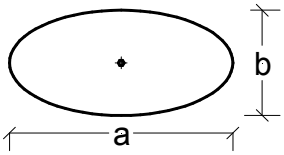
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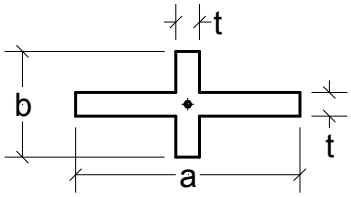	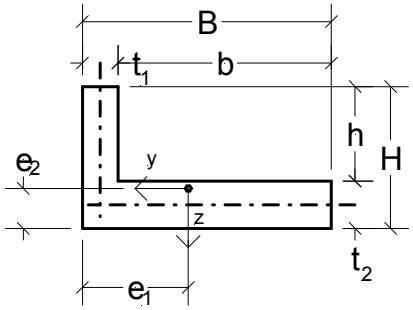
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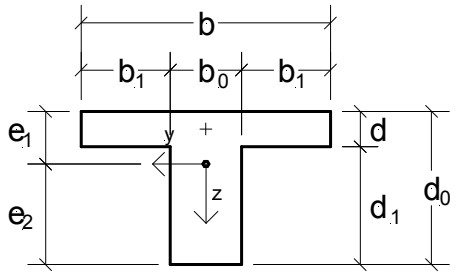

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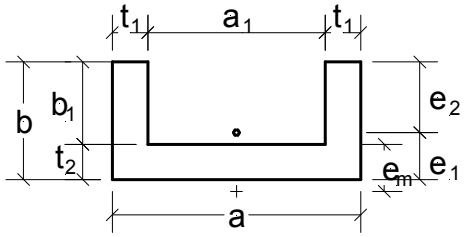

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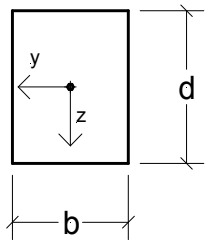

Input values:
Width b = 20,00 cm
Height d = 30,00 cm

Area A = $b * d$ = 600,00 cm²

Moment of inertia:

$$I_y = \frac{b * d^3}{12}$$ = 45000,00 cm⁴

Moment of inertia:

$$I_z = \frac{d * b^3}{12}$$ = 20000,00 cm⁴

Section modulus:

$$W_y = \frac{b * d^2}{6}$$ = 3000,00 cm³

Section modulus:

$$W_z = \frac{d * b^2}{6}$$ = 2000,00 cm³

Torsion area of moment:

$$I_T = \frac{d * b^3}{3} * \left(1 - 0{,}630 * \frac{b}{d} + 0{,}052 * \frac{b^5}{d^5} \right)$$ = 46947,82 cm⁴

Moment of resistance against torsion:

$$W_T = \frac{d * b^3}{31} * \left(1 - 0{,}630 * \frac{b}{d} + 0{,}250 * \frac{b^2}{d^2} \right)$$ = 5350,54 cm³

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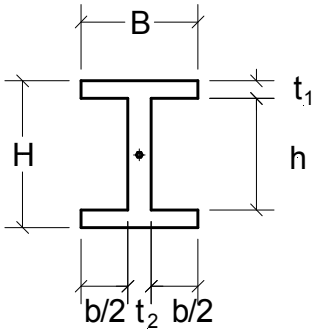

Input values:

Width B =	20,00 cm
Height H =	30,00 cm
Flange thickness t_1 =	2,00 cm
Thickness of web t_2 =	1,50 cm

h =	$H - 2 * t_1$	=	26,00 cm
b =	$B - t_2$	=	18,50 cm
Area A =	$B * H - (B-t_2) * (H-2*t_1)$	=	119,00 cm²

Moment of inertia:

$$I_y = \frac{B * H^3 - b * h^3}{12} = 17903{,}67\ \text{cm}^4$$

Moment of inertia:

$$I_z = \frac{h * t_2^3 + 2 * t_1 * B^3}{12} = 2673{,}98\ \text{cm}^4$$

Section modulus:

$$W_y = \frac{2 * I_y}{H} = 1193{,}58\ \text{cm}^3$$

Section modulus:

$$W_z = \frac{2 * I_z}{B} = 267{,}40\ \text{cm}^3$$

Torsion area of moment:

$$I_T = \frac{1}{3} * \left(2 * B * t_1^3 + h * t_2^3\right) = 135{,}92\ \text{cm}^4$$

Moment of resistance against torsion:

$$W_T = I_T / \text{MAX}(t_1; t_2) = 67{,}96\ \text{cm}^3$$

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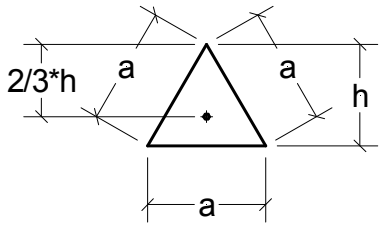

Input values:

a = 20,00 cm

h = $a * \sqrt{(3)}$ = 34,64 cm

Area A = $\frac{a * h}{2}$ = 346,40 cm²

Moment of inertia:

$I_y = \frac{a * h^3}{36}$ = 23091,98 cm⁴

Moment of inertia:

$I_z = \frac{h * a^3}{48}$ = 5773,33 cm⁴

Section modulus:

$W_{y,o} = \frac{a * h^2}{24}$ = 999,94 cm³

$W_{y,u} = \frac{a * h^2}{12}$ = 1999,88 cm³

Section modulus:

$W_z = \frac{h * a^2}{24}$ = 577,33 cm³

Torsion area of moment:

$I_T = \frac{h^4}{26}$ = 55378,12 cm⁴

Moment of resistance against torsion:

$W_T = \frac{h^3}{13}$ = 3197,35 cm³

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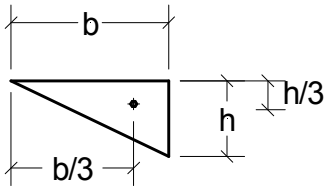

Input values:
b = 30,00 cm
h = 20,00 cm

Area A = $\frac{b * h}{2}$ = 300,00 cm²

Moment of inertia:

$I_y = \frac{b * h^3}{36}$ = 6666,67 cm⁴

Moment of inertia:

$I_z = \frac{h * b^3}{36}$ = 15000,00 cm⁴

Surface centrifugal torque:

$I_{yz} = \frac{-h^2 * b^2}{72}$ = 5000,00 cm⁴

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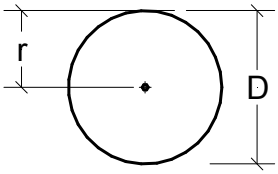

Input values:

r = 15,00 cm

D = $2 * r$ = 30,00 cm

Area A = $\pi * r^2$ = 706,86 cm²

Moment of inertia:

$$I_y = \frac{\pi * r^4}{4} = 39760{,}75\ cm^4$$

Moment of inertia:

$$I_z = \frac{\pi * r^4}{4} = 39760{,}75\ cm^4$$

Section modulus:

$$W_y = \frac{\pi * r^3}{4} = 2650{,}72\ cm^3$$

Section modulus:

$$W_z = \frac{\pi * r^3}{4} = 2650{,}72\ cm^3$$

Torsion area of moment:

$$I_T = \frac{\pi * D^4}{32} = 79521{,}50\ cm^4$$

Moment of resistance against torsion:

$$W_T = \frac{\pi * D^3}{16} = 5301{,}43\ cm^3$$

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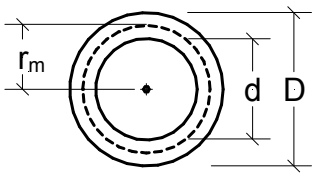

Input values:

D = 25,00 cm

d = 20,00 cm

$r_m = \frac{D-d}{2}+\frac{d}{2}$ = 12,50 cm

Area A = $\frac{\pi}{4}*\left(D^2-d^2\right)$ = 176,71 cm²

Moment of inertia:

$I_y = \frac{\pi}{64}*\left(D^4-d^4\right)$ = 11320,77 cm⁴

Moment of inertia:

$I_z = \frac{\pi}{64}*\left(D^4-d^4\right)$ = 11320,77 cm⁴

Section modulus:

$W_y = \frac{\pi}{32}*\frac{\left(D^4-d^4\right)}{D}$ = 905,66 cm³

Section modulus:

$W_z = \frac{\pi}{32}*\frac{\left(D^4-d^4\right)}{D}$ = 905,66 cm³

Torsion area of moment:

$I_T = \pi * r_m^4 * (D-d)$ = 383494,87 cm⁴

Moment of resistance against torsion:

$W_T = \pi * r_m^3 * (D-d)$ = 30679,59 cm³

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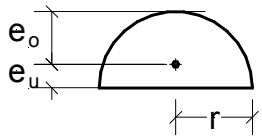

Input values:

r = 15,00 cm

e_u =	$\frac{4}{3} * \frac{r}{\pi}$	=	6,37 cm
e_o =	$r - e_u$	=	8,63 cm
Area A =	$\frac{\pi}{2} * r^2$	=	353,43 cm²

Moment of inertia:

I_y =	$\left(\frac{\pi}{8} - \frac{8}{9 * \pi}\right) * r^4$	=	5556,42 cm⁴

Moment of inertia:

I_z =	$\frac{\pi}{8} * r^4$	=	19880,37 cm⁴

Section modulus:

$W_{y,o}$ =	0,191 * r³	=	644,63 cm³
$W_{y,u}$ =	0,259 * r³	=	874,13 cm³

Section modulus:

W_z =	$\frac{\pi}{8} * r^3$	=	1325,36 cm³

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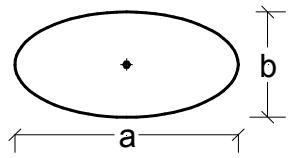

Input values:

a = 30,00 cm

b = 15,00 cm

Area A = $\frac{\pi}{4} * a * b$ = 353,43 cm²

Moment of inertia:

$I_y = \frac{\pi}{64} * a * b^3$ = 4970,09 cm⁴

Moment of inertia:

$I_z = \frac{\pi}{64} * a^3 * b$ = 19880,37 cm⁴

Section modulus:

$W_y = \frac{\pi}{32} * a * b^2$ = 662,68 cm³

Section modulus:

$W_z = \frac{\pi}{32} * a^2 * b$ = 1325,36 cm³

Torsion area of moment:

$I_T = \frac{\pi}{16} * \frac{a^3 * b^3}{a^2 + b^2}$ = 15904,30 cm⁴

Moment of resistance against torsion:

$W_T = \frac{\pi}{16} * a * b^2$ = 1325,36 cm³

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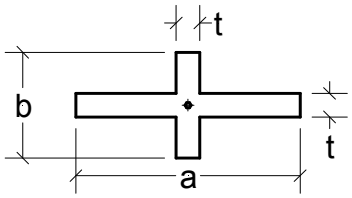

Input values:

a = 30,00 cm
b = 15,00 cm
t = 2,50 cm

Area A = $t * (a + b - t)$ = 106,25 cm²

Moment of inertia:

$I_y = \frac{t * b^3 + (a - t) * t^3}{12}$ = 738,93 cm⁴

Moment of inertia:

$I_z = \frac{t * a^3 + (b - t) * t^3}{12}$ = 5641,28 cm⁴

Section modulus:

$W_y = \frac{2 * I_y}{b}$ = 98,52 cm³

Section modulus:

$W_z = \frac{2 * I_z}{a}$ = 376,09 cm³

Torsion area of moment:

$I_T = \frac{t^3}{3} * (a + b - 0{,}15 * t)$ = 232,42 cm⁴

Moment of resistance against torsion:

$W_T = \frac{I_T}{t}$ = 92,97 cm³

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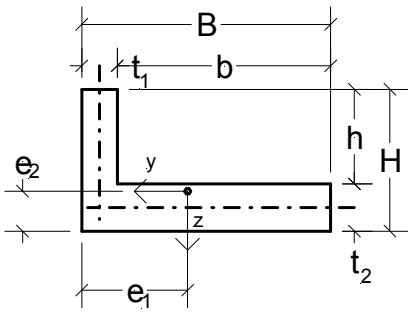


Input values:

B = 30,00 cm
H = 15,00 cm
t_1 = 2,50 cm
t_2 = 3,00 cm

b = $B - t_1$ = 27,50 cm
h = $H - t_2$ = 12,00 cm
Area A = $H * B - h * b$ = 120,00 cm²

$$e_1 = \frac{t_2 * B^2 + h * t_1^2}{2 * A} = 11{,}56 \text{ cm}$$

$$e_2 = \frac{t_1 * H^2 + b * t_2^2}{2 * A} = 3{,}38 \text{ cm}$$

Moment of inertia:

$$I_y = \frac{1}{3} * \left(t_1 * H^3 + b * t_2^3 - A * e_2^2 \right) = 2603{,}02 \text{ cm}^4$$

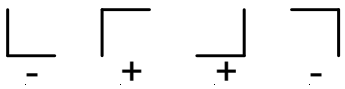
Moment of inertia:

$$I_z = \frac{1}{3} * \left(h * t_1^3 + t_2 * B^3 - A * e_1^2 \right) = 21717{,}16 \text{ cm}^4$$

Surface centrifugal torque:

$$I_{yz} = t_1 * H * \left(e_1 - \frac{t_1}{2} \right) * \left(e_2 - \frac{H}{2} \right) + b * t_2 * \left(e_2 - \frac{t_2}{2} \right) * \left(e_1 - t_1 - \frac{b}{2} \right) = -2320{,}31 \text{ cm}^4$$

Algebraic sign:



Torsion area of moment:

$$I_T = \frac{1}{3} * \left(H * t_1^3 + b * t_2^3 \right) = 325{,}63 \text{ cm}^4$$

Moment of resistance against torsion:

$W_T = I_T / MAX(t_1; t_2)$ = 108,54 cm³

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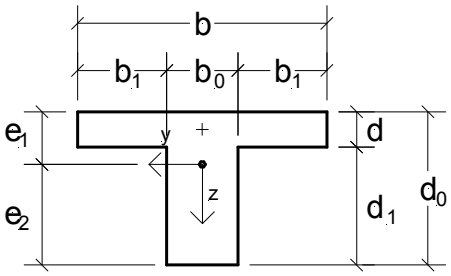

Input values:

b = 30,00 cm
d = 3,00 cm
b_0 = 3,00 cm
d_0 = 20,00 cm

$d_1 = d_0 - d$ = 17,00 cm

$b_1 = \frac{b - b_0}{2}$ = 13,50 cm

Area $A = b * d + b_0 * d_1$ = 141,00 cm²

$e_1 = \frac{2 * b_1 * d^2 + b_0 * d_0^2}{2 * A}$ = 5,12 cm

$e_2 = d_0 - e_1$ = 14,88 cm

Moment of inertia:

$I_y = \frac{1}{3} * \left(2 * b_1 * d^3 + b_0 * d_0^3\right) - A * e_1^2$ = 4546,77 cm⁴

Moment of inertia:

$I_z = \frac{d * b^3 + d_1 * b_0^3}{12}$ = 6788,25 cm⁴

Section modulus:

$W_{y,o} = \frac{I_y}{e_1}$ = 888,04 cm³

$W_{y,u} = \frac{I_y}{e_2}$ = 305,56 cm³

Section modulus:

$W_z = \frac{d * b^3 + d_1 * b_0^3}{6 * b}$ = 452,55 cm³

Torsional constant for thin-walled cross-sections only:

$I_T = \frac{1}{3} * \left(b + d^3 + d_1 * b_0^3\right)$ = 172,00 cm⁴

Moment of resistance against torsion for thin-walled cross-sections only:

$W_T = I_T / MAX(b_0; d)$ = 57,33 cm³

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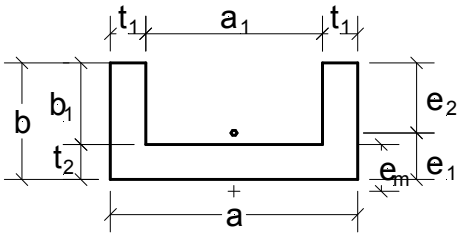

Input values:

a = 30,00 cm
b = 20,00 cm
t_1 = 2,00 cm
t_2 = 2,00 cm

$b_1 = b - t_1$ = 18,00 cm
$a_1 = a - 2 * t_1$ = 26,00 cm^4

$$e_1 = \frac{a_1 * t_2^{\,2} + 2 * b^{\,2} * t_1}{2 * a_1 * t_2 + 4 * b * t_1}$$ = 6,45 cm

$e_2 = b - e_1$ = 13,55 cm

Thin walled cross section:

$A_S = (a_1 + t_1) * t_2$ = 56,00 cm²

$$A_G = \left(b_1 + \frac{t_2}{2}\right) * t_1$$ = 38,00 cm²

$$e_m = \frac{b_1 + \frac{t_2}{2}}{2 + \frac{A_S}{3 * A_G}} + \frac{t_2}{2}$$ = 8,63 cm

Area $A = t_2 * a + 2 * t_1 * b_1$ = 132,00 cm²

Moment of inertia:

$$I_y = \frac{1}{3} * \left(a * e_1^{\,3} - a_1 * (e_1 - t_2)^{\,3} + 2 * e_2^{\,3} * t_1\right)$$ = 5236,73 cm^4

Moment of inertia:

$$I_z = \frac{b * a^{\,3} - b_1 * a_1^{\,3}}{12}$$ = 18636,00 cm^4

Section modulus:

$W_{y,o} = \frac{I_y}{e_2}$ = 386,47 cm³

$W_{y,u} = \frac{I_y}{e_1}$ = 811,90 cm³

Section modulus:

$W_z = \frac{b*a^3 - b_1*a^3}{6*a}$ = 300,00 cm³

Torsional constant for thin-walled cross-sections only:

$I_T = \frac{1}{3}*\left(2*b*t_1^3 + a_1*t_2^3\right)$ = 176,00 cm⁴

Moment of resistance against torsion for thin-walled cross-sections only:

$W_T = I_T / MAX(t_1; t_2)$ = 88,00 cm³

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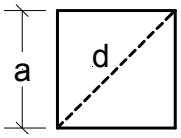
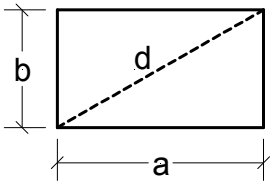
Templates structural formulae

Calculation of Areas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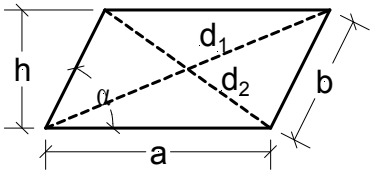	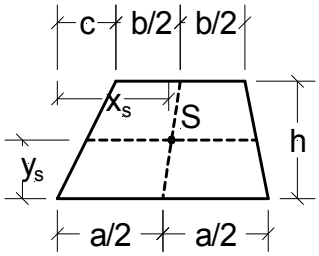
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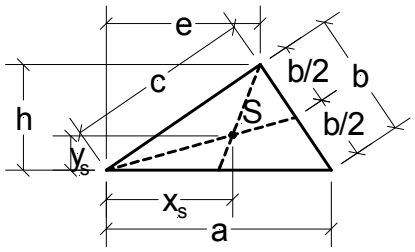	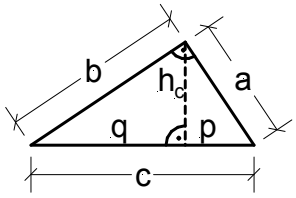
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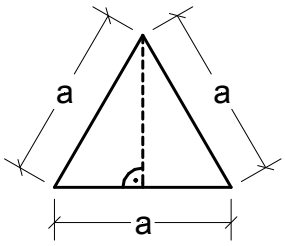	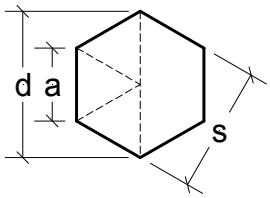
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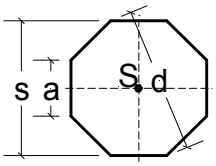	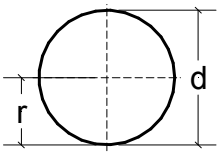
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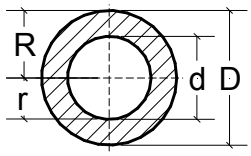	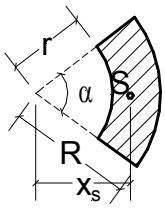
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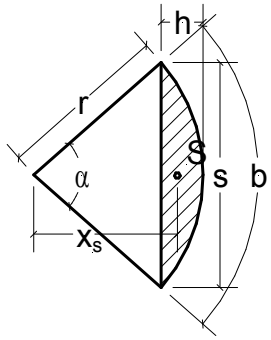	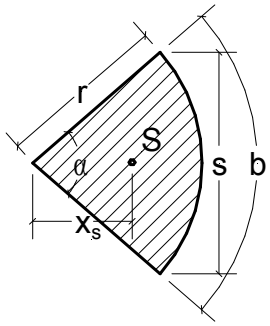
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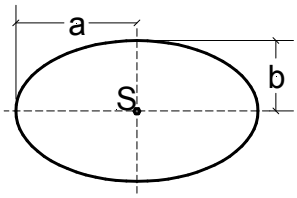	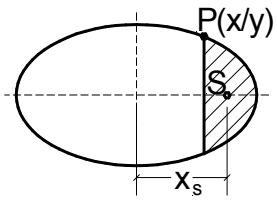
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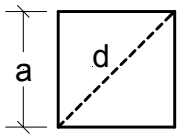

Square:

Edge length a =		20,00 cm	
Area A =	a^2	=	400,00 cm²
Diagonal d =	$a * \sqrt{2}$	=	28,28 cm

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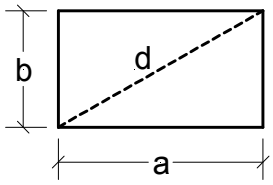

Rectangle:

Edge length a =	20,00 cm		
Edge length b =	30,00 cm		
Area A =	$a * b$	=	600,00 cm²
Diagonal d =	$\sqrt{a^2 + b^2}$	=	36,06 cm

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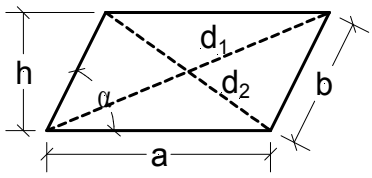

Parallelogram:

Edge length a =		20,00 cm		
Edge length b =		30,00 cm		
Angle α =		75,00 °		
Height h =	b * SIN(α)		=	28,98 cm
Area A =	a * h		=	579,60 cm²
Diagonal d_1 =	$\sqrt{\left(a + h * \frac{1}{\tan(\alpha)}\right)^2 + h^2}$		=	40,13 cm
Diagonal d_2 =	$\sqrt{\left(a - h * \frac{1}{\tan(\alpha)}\right)^2 + h^2}$		=	31,46 cm

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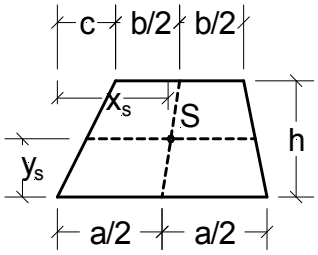

Trapezoid:

Edge length a =	20,00 cm
Edge length b =	30,00 cm
Height h =	20,00 '
Length c =	8,00 cm

Area A = $h * \frac{a + b}{2}$ = 500,00 cm²

Distance of the center of gravity:

$x_s = \frac{1}{3} * \left(a + b + c - b * \frac{a - c}{a + b} \right)$ = 16,93 cm

$y_s = \frac{h}{3} * \frac{a + 2 * b}{a + b}$ = 10,67 cm

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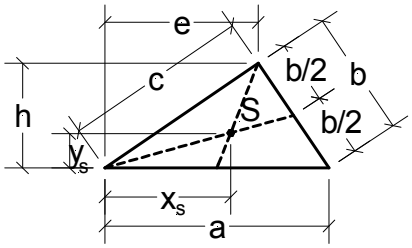

Triangle:

Edge length a =	20,00 cm		
Height h =	20,00 cm		
Length e =	20,00 cm		
Edge length b =	$\sqrt{(a-e)^2+h^2}$	=	20,00 cm
Edge length c =	$\sqrt{e^2+h^2}$	=	28,28 cm
Area A =	$a*\frac{h}{2}$	=	200,00 cm²
s =	$\frac{a++b+c}{2}$	=	34,14 cm
Area A =	$\sqrt{s*(s-a)*(s-b)*(s-c)}$	=	200,00 cm²

Distance of the center of gravity:

x_s =	$\frac{a+e}{3}$	=	13,33 cm
y_s =	$\frac{h}{3}$	=	6,67 cm

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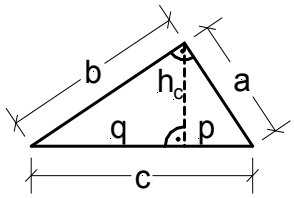

Right angle triangle:

Edge length a =	30,00 cm
Height h_c =	20,00 cm

Area A = $a * \frac{h_c}{2}$ = 300,00 cm²

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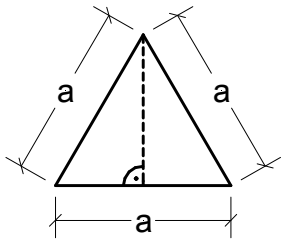

Equilateral triangle:

Edge length a =	30,00 cm		
Area A =	$0{,}25 * a^2 * \sqrt{3}$	=	389,71 cm²
Height h =	$0{,}5 * a * \sqrt{3}$	=	25,98 cm
Perimeter U =	3 * a	=	90,00 cm

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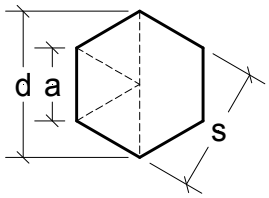

Regular hexagon:

Edge length a = 20,00 cm

Area A =	$1{,}5 * a^2 * \sqrt{3}$	=	1039,23 cm²
Diameter d =	$2 * a$	=	40,00 cm
Distance s =	$0{,}5 * d * \sqrt{3}$	=	34,64 cm

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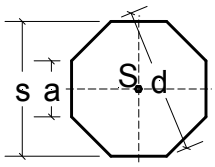

Regular octagon:

Edge length a = 20,00 cm

Distance s =	$a * \sqrt{2} + a$	=	48,28 cm
Area A =	$2 * a * s$	=	1931,20 cm²
Diameter d =	$\frac{s}{\cos(22{,}5)}$	=	52,26 cm

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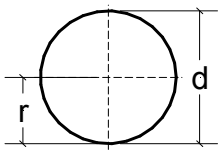

Circle:

Radius r =		20,00 cm	
Diameter d =	2 * r	=	40,00 cm
Area A =	$\pi * r^2$	=	1256,64 cm²
Perimeter U =	$2 * \pi * r$	=	125,66 cm

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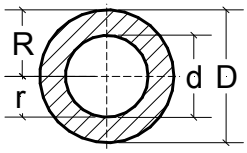

Circular ring:

Radius r =	15,00 cm		
Radius R =	20,00 cm		
Diameter d =	2 * r	=	30,00 cm
Diameter D =	2 * R	=	40,00 cm
Area A =	$\pi * \frac{D^2 - d^2}{4}$	=	549,78 '

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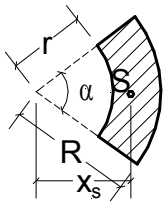

Circular ring:

Radius r =	15,00 cm
Radius R =	20,00 cm
Angle α =	70,00 °

Area A = $\pi * \alpha * \frac{R^2 - r^2}{360}$ = 106,90 cm²

Distance of the center of gravity:

$x_s = \frac{240}{\pi} * \frac{R^3 - r^3}{R^2 - r^2} * \frac{\sin\left(\frac{\alpha}{2}\right)}{\alpha}$ = 16,54 cm

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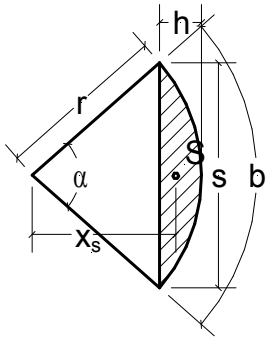

Section of a circle:

Radius r =	15,00 cm		
Angle α =	70,00 °		
Length b =	$\pi * r * \frac{\alpha}{180}$	=	18,33 cm
Length s =	$2 * r * \sin\left(\frac{\alpha}{2}\right)$	=	17,21 cm
Width h =	$0{,}5 * s * \tan\left(\frac{\alpha}{2}\right)$	=	6,03 cm
Area A =	$0{,}5 * r^2 * \left(\pi * \frac{\alpha}{180} - \sin(\alpha)\right)$	=	31,73 cm²

Distance of the center of gravity:

x_s =	$\frac{s^3}{12 * A}$	=	13,39 cm

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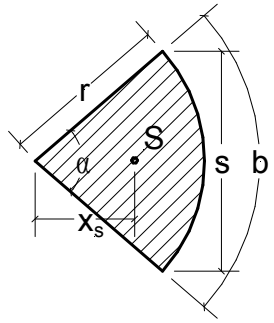

Sector of a circle:

Radius r = 15,00 cm

Angle α = 70,00 °

Length b = $\pi * r * \frac{\alpha}{180}$ = 18,33 cm

Length s = $2 * r * \sin\left(\frac{\alpha}{2}\right)$ = 17,21 cm

Area A = $b * \frac{r}{2}$ = 137,47 cm²

Distance of the center of gravity:

x_s = $\frac{2 * r * s}{3 * b}$ = 9,39 cm

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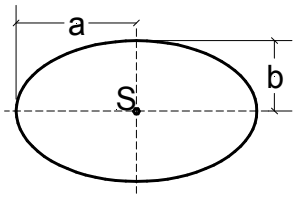

Ellipse:

Length a =		15,00 cm	
Length b =		10,00 cm	
Area A =	$\pi * a * b$	=	471,24 cm²
λ =	$\frac{a - b}{a + b}$	=	0,20

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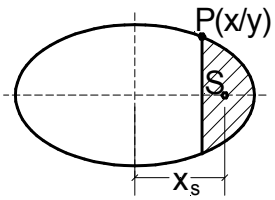

Section of an ellipse:

Length a =	15,00 cm	
Length b =	10,00 cm	
Distance x =	10,00 cm	

$$y = \frac{b}{a} * \sqrt{a^2 - x^2} = 7{,}45 \text{ cm}$$

$$\lambda = \frac{a - b}{a + b} = 0{,}20$$

$$\text{Area A} = \frac{b}{a} * \left(\left(\frac{1}{2} * \pi - \frac{1}{\sin\left(\frac{x}{a}\right)} \right) * a^2 - x * \sqrt{a^2 - x^2} \right) = -12730{,}76 \text{ cm}^2$$

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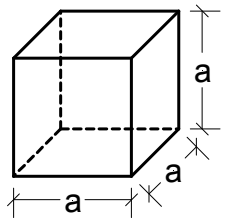
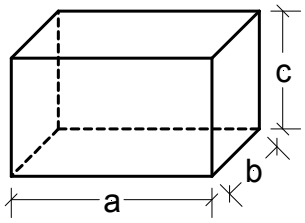
Templates structural formulae

Volume

Templates structural formulae	Folder: Volume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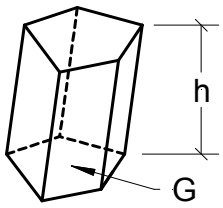	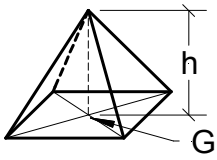
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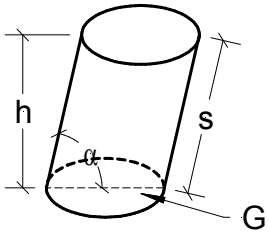	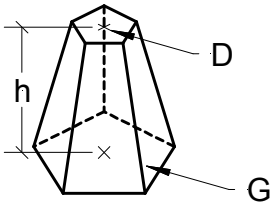
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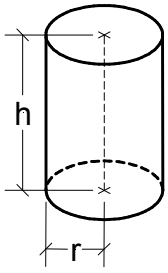	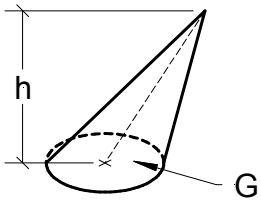
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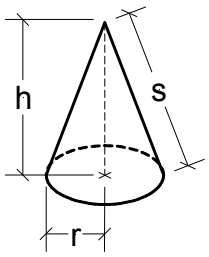	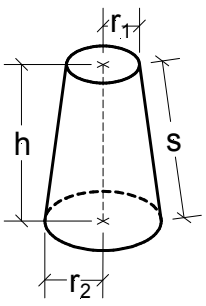
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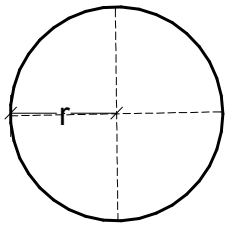
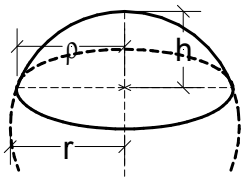
Pdf-Overview: Templates for structural analysis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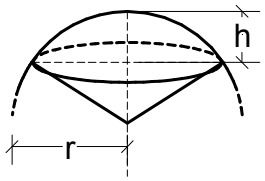	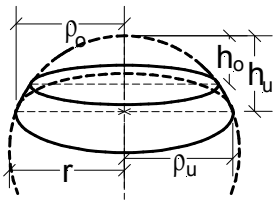
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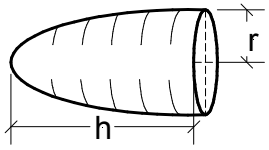	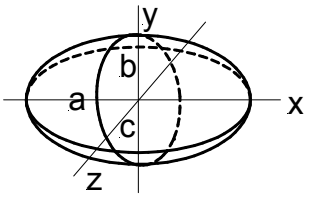
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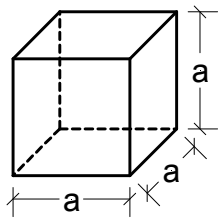

Cube:

Edge length a =		20,00 cm	
Volume V =	a^3	=	8000,00 cm^3

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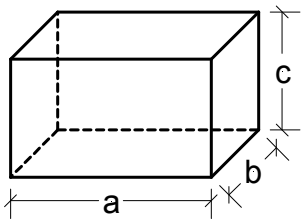

Cuboid:

Edge length a =		20,00 cm	
Edge length b =		12,00 cm	
Edge length c =		15,00 cm	
Volume V =	a * b * c	=	3600,00 cm³

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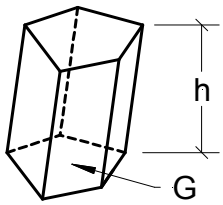

Prism:

Base area G =		220,00 cm²	
Height h =		20,00 cm	
Volume V =	G * h	=	4400,00 cm³

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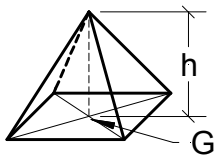

Pyramid:

Base area G =	220,00 cm²	
Height h =	20,00 cm	
Volume V =	$\frac{1}{3} * G * h$	= 1466,67 cm³

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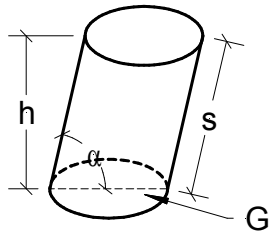

Cylinder:

Radius r =			8,00 cm
Height h =			20,00 cm
Angle α =			70,00 °
Base area G =	$\pi * r^2$	=	201,06 cm²
Volume V =	G * h	=	4021,20 cm³
Generator s =	$\frac{h}{\sin(\alpha)}$	=	21,28 cm
Generator surface M =	s * 2 * π * r	=	1069,65 cm²

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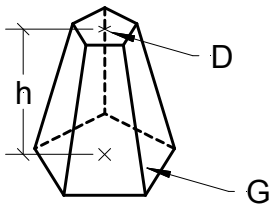

Frustum pf pyramid:

Height h =	20,00 cm		
Base area G =			220,00 cm²
Top area D =			85,00 cm²
Volume V =	$\frac{h}{3}*(G+\sqrt{G*D}+D)$	=	2944,99 cm³

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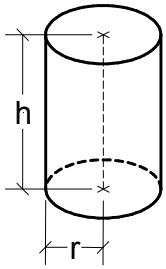

right Cylinder:

Radius r =			8,00 cm
Height h =			20,00 cm
Base area G =	$\pi * r^2$	=	201,06 cm²
Volume V =	G * h	=	4021,20 cm³
Generator surface M =	h * 2 * π * r	=	1005,31 cm

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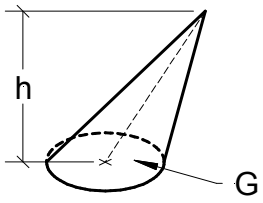

Cone:

Radius r =		8,00 cm	
Height h =		20,00 cm	
Base area G =	$\pi * r^2$	=	201,06 cm²
Volume V =	$\frac{1}{3} * G * h$	=	1340,40 cm³

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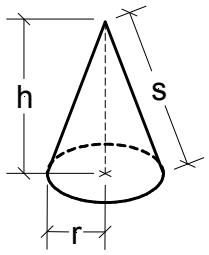

right circular cone:

Radius r =			8,00 cm
Height h =			20,00 cm
Base area G =	$\pi * r^2$	=	201,06 cm²
Volume V =	$\frac{1}{3} * G * h$	=	1340,40 cm³
Generator s =	$\sqrt{r^2 + h^2}$	=	21,54 cm
Generated surface M =	$s * \pi * r$	=	541,36 cm²

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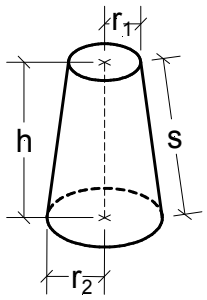

Truncated circular cone:

Radius r_2 =	10,00 cm	
Radius r_1 =	5,00 cm	
Height h =	20,00 cm	

Base area G =	$\pi * r_2^2$	=	314,16 cm²
Top area D =	$\pi * r_1^2$	=	78,54 cm²
Volume V =	$\frac{h}{3} * (G + \sqrt{G * D} + D)$	=	3665,20 cm³
Volume V =	$\frac{1}{3} * \pi * h * (r_1^2 + r_1 * r_2 + r_2^2)$	=	3665,19 cm³

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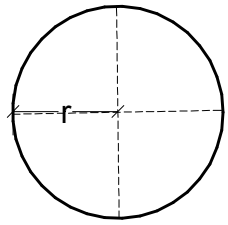

Ball:

Radius r =		10,00 cm	
Volume V =	$\frac{4}{3} * \pi * r^3$	=	4188,79 cm³
Surface O =	$4 * \pi * r^2$	=	1256,64 cm²

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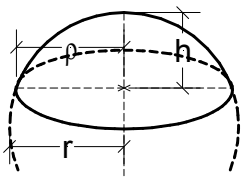

Spherical segment:

Radius r =			10,00 cm
Height h =			7,00 cm
Volume V =	$\frac{1}{3} * \pi * h^2 * (3 * r - h)$	=	1180,19 cm³
Generator surface M =	$2 * \pi * r * h$	=	439,82 cm²
Surface O =	$\pi * h * (4 * r - h)$	=	725,71 cm²
Radius ρ =	$\sqrt{h * (2 * r - h)}$	=	9,54 cm

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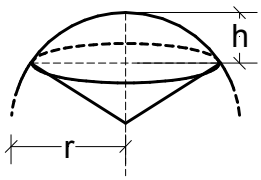

Spherical sector:

Radius r =		10,00 cm	
Height h =		7,00 cm	
Volume V =	$\frac{2}{3} * \pi * r^2 * h$	=	1466,08 cm³
Surface O =	$\pi * r * (2 * h + \sqrt{h * (2 + r - h)})$	=	625,68 cm²

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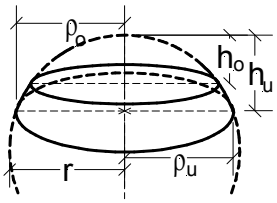

Spherical layer:

Radius r =	10,00 cm		
Height h_o =	3,00 cm		
Height h_u =	7,00 cm		
Radius ρ_o =	$\sqrt{h_o*(2*r-h_o)}$	=	7,14 cm
Radius ρ_u =	$\sqrt{h_u*(2*r-h_u)}$	=	9,54 cm
Volume V =	$\frac{1}{6}*\pi*(h_u-h_o)*\left(3*\rho_u^{\,2}+3*\rho_o^{\,2}+(h_u-h_o)^2\right)$	=	925,67 cm³
Surface A =	$2*\pi*r*(h_u-h_o)$	=	251,33 cm²

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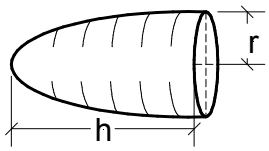

Paraboloid of revolution:

Radius r =	10,00 cm		
Height h =	12,00 cm		
Volume V =	$\frac{1}{2} * \pi * r^2 * h$	=	1884,95 cm³

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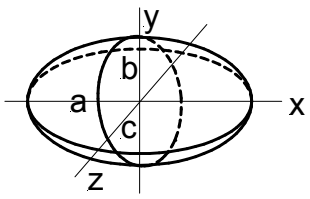

Ellipsoid:

Semiaxis length a =			15,00 cm
Semiaxis length b =			10,00 cm
Semiaxis length c =			8,00 cm
Volume V =	$\frac{4}{3} * \pi * a * b * c$	=	5026,54 cm³

Insert
Back