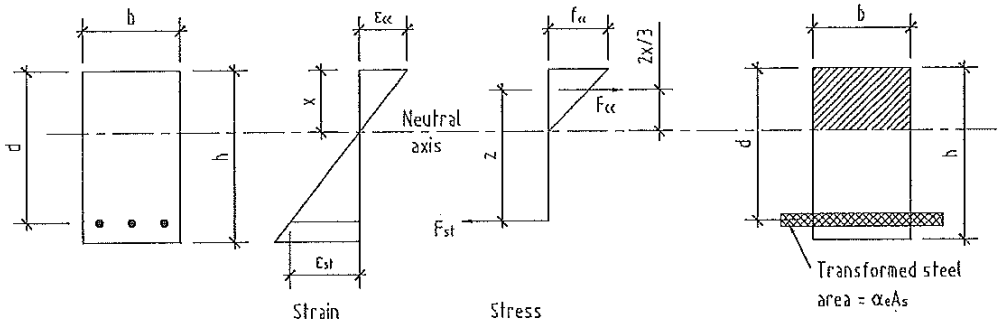
Example 1

If the moment at the serviceability limit state is increased to 120kNm (loaded at the age of t_o=28 days), what will be the maximum concrete strain?

1. Determine the constant compressive strength σ_c

The compressive strength of concrete σ_c will be determined based on the triangular stress block of cracked section

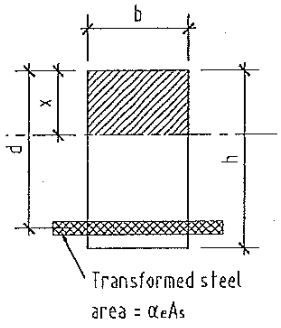


Section equilibrium condition:
$F_{cc}=F_{st}$ then $0.5bxf_{cc}=A_s.f_{st}$

Moment of resistance:
$M=F_{st}z=F_{cc}z$ then $M=0.5bxf_{cc}(d-x/3)$

Example 1

Taking the area moments about the upper edge:



$$x=\frac{\sum(Ax)}{A}=\frac{bx\times x/2+\alpha_e A_s\times d}{bx+\alpha_e A_s} \quad then\ x=\frac{1}{2}bx^2+\alpha_e A_s x-\alpha_e A_s d=0$$

$$x=\frac{\alpha_e A_s\pm\sqrt{[(\alpha_e A_s)^2+2b\alpha_e A_s d}}{b}$$

x=205mm

Moment of resistance:
$M=120E+6Nmm=0.5bxf_{cc}(d-x/3)=0.5*300*205*(460-205/3)\ f_{cc}=1.2E+7f_{cc}$

$f_{cc}=9.96N/mm^2$

2. Determine the linear creep coefficient $\varphi(\infty,t_0)$

$f_{cc}=9.96N/mm^2<0.45f_{ck}=11.25N/mm^2$ → don't have to consider non-linear creep
$\varphi(\infty,t_0)=2.9$

3. Determine the creep strain $\varepsilon_{cc}(\infty,t_0)$

$\varepsilon_{cc}(\infty,t_0)=\varphi(\infty,t_0).(\sigma_c/E_c)=2.9*9.96/32550=0.00089\ (0.89‰)$