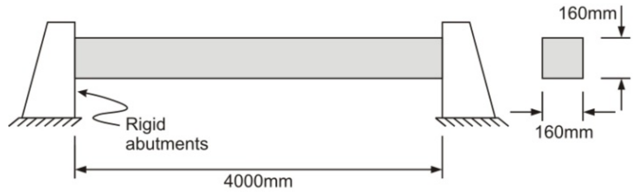
Carleton University
Department of Civil and Environmental Engineering

CIVE 3206 –Design of Reinforced Concrete Components
Assignment #2 –Time Dependant Properties of Concrete

1. A plain concrete member is fixed between two immovable abutments when the temperature is 20°C. Estimate:
   a) The short-term increase in temperature required to cause a compressive stress of 7MPa in the concrete.
   b) The short-term drop in temperature (ΔT) required to crack the concrete.
   c) The width of the crack if ΔT=-50°C (not an uncommon swing in Ottawa).
   d) The number of days after the formwork is removed when the concrete will crack due to drying shrinkage.
   e) The width of the crack if ε_{sh}=-0.4x10^{-3}.

   For d) and e) ignore creep and thermal effects.

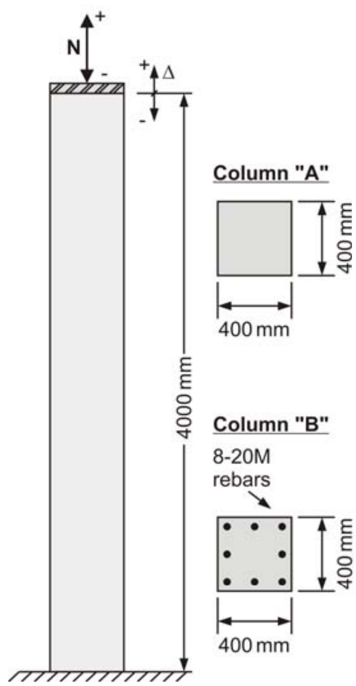


f'_c = 25MPa
ε'_c = -0.002
f_{cr} = $0.33(f'_c)^{1/2}$ (cracking strength)
E_{ct} = $5500\,(f'_c)^{1/2}$ (Young's Modulus in Tension)
Concrete made with limestone aggregate
Average RH = 70%

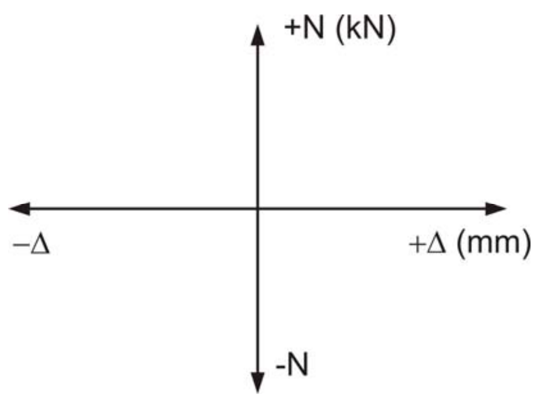
2. Calculate and plot (on the same graph) both the short-term and long-term axial load vs. axial deformation (N-Δ) relationships for Columns "A" and "B". Column "A" does not have any reinforcing bars. If using a spreadsheet, provide appropriate sample calculations by hand.

   For the short-term case, assume that there are no creep, shrinkage or thermal effects since the load is applied quickly. For the long-term case, calculate the expected concrete shrinkage strain, ε_{sh}, and the expected creep coefficient, $\phi(t,t_i)$, 18 years after casting. The formwork was removed one week after casting and the loads were applied eight weeks after casting. There is no change in temperature for the long-term case.

   For both plots, show the complete range of values for N and Δ, indicating on the graph various important points such as the maximum compressive and tensile loads, concrete cracking and crushing, steel yielding, and axes intersections (values of Δ at N=0, and values of N at Δ=0). Discuss the differences between the short-term and long-term behaviours, and the differences between the unreinforced and reinforced members.



f'_c = 35 MPa
ε'_c = -0.002
f_{cr} = $0.33(f'_c)^{1/2}$
E_{ct} = $5500\,(f'_c)^{1/2}$
f_y = 400 MPa
E_s = 200,000 MPa
Avg. relative humidity = 70%



For both questions, do not consider self-weight. Use the Hognestad parabola to model concrete in compression, and a linear-elastic relationship to model concrete in tension. The ends of the elements are not exposed to drying (and hence do not include them when calculating surface areas). This assignment is due at the start of the lecture on Tuesday, January 22 (at 1:05:00pm, EST).
(see: http://tycho.usno.navy.mil/simpletime.html for the official CIVE3206 time)