Buckling

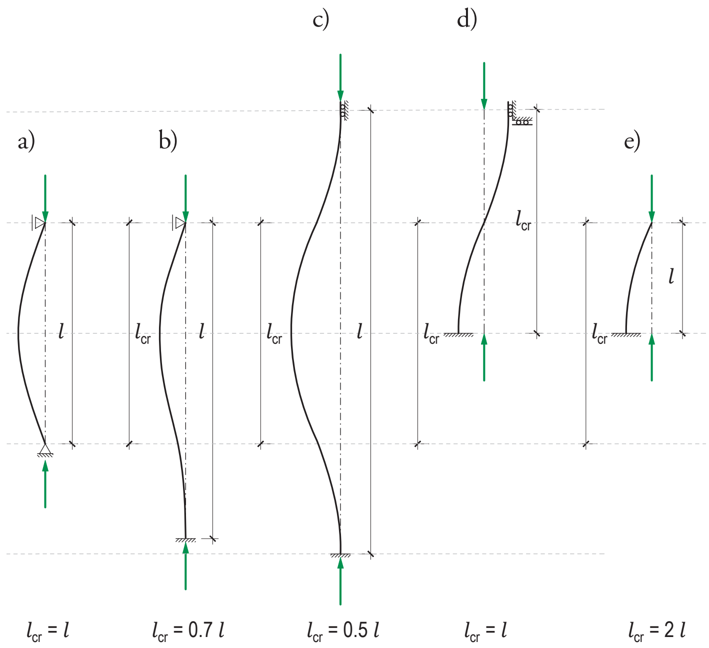
When dimensioning columns, the necessary cross-sectional area is calculated by means of the relevant (maximum) force acting on the element. However, if an element is to be very long and thin, i.e. very slender, there is a risk that it will buckle under the compressive force. In this case, before material failure can occur, buckling failure occurs, which in this respect is a problem of geometric nature. To counteract this, a more suitable cross-section could for example be chosen for the column.

In the diagram below, the x-axis shows the critical length l_{cr} over the square root of the cross-sectional area A.

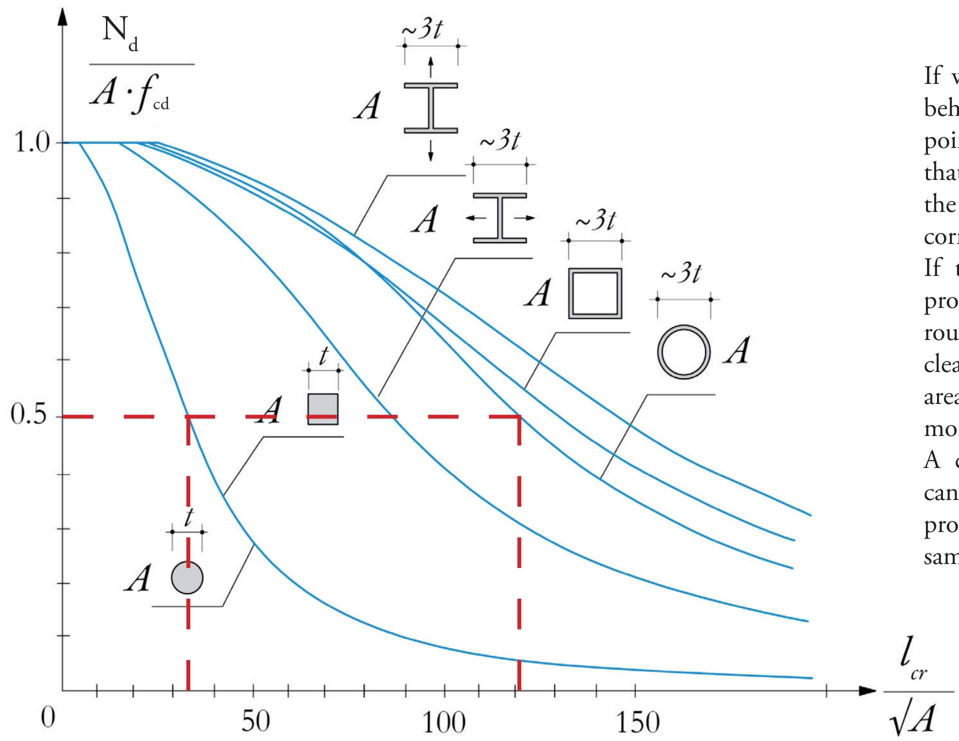
The critical length depends on the support of the element. A clamped support leads to a shorter critical length than a hinged support. The diagram on the right shows the following boundary conditions:

a) hinged support on top and bottom
b) fixed at the bottom, hinged on top
c) fixed on top and bottom
d) fixed at the bottom, fixed roller on top
e) fixed at the bottom, no support on top

The y-axis shows the relevant force N_d over the cross-sectional area A multiplied by the compressive strength of the material f_{cd}. The higher this value, the more likely a component is to buckle.



Critical length according to the support conditions



Buckling curves of steel profiles

If we look at the curves of the buckling behaviour of different cross-sections, every point that lies below the curve means that the profile holds; every point above the curve equals a buckling failure of the corresponding profile.
If the buckling curve of a round solid profile is now compared with that of a round hollow profile, it quickly becomes clear that for the same force, cross-sectional area and material the solid profile is much more likely to buckle than a hollow profile. A column designed as a hollow profile can be almost four times as long as a solid profile column before it buckles under the same load.