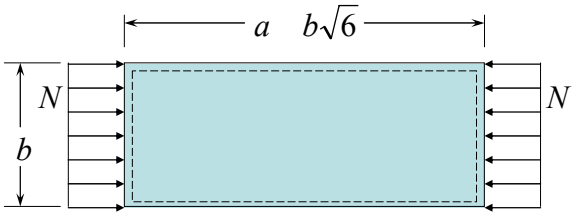
# Lecture 11

# Buckling of Plates and Sections

**Problem 11-1:**

A simply-supported rectangular plate is subjected to a uniaxial compressive load *N*, as shown in the sketch below.

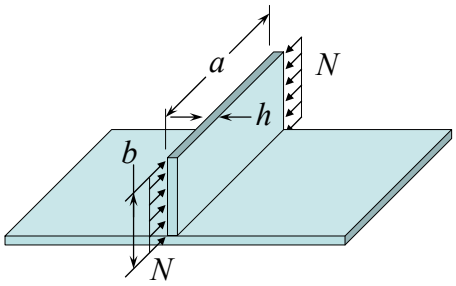



a) Calculate and compare buckling coefficients corresponding to the four first buckling modes as a function of $a/b$.

b) Discuss the result for the specific value: $a/b = \sqrt{6}$

**Problem 11-2:**

A h=10mm thick elastic flat bar stiffener is welded to a plate at the bottom.




a) State the boundary conditions around all four edges.

b) Calculate the total buckling load $P_c = N_c b$ of the stiffener, assuming that a=1000mm and b=200mm. (Hint: use the graphical solution for $k_c$ in the notes)

c) Determine the length of the buckling half-wave.

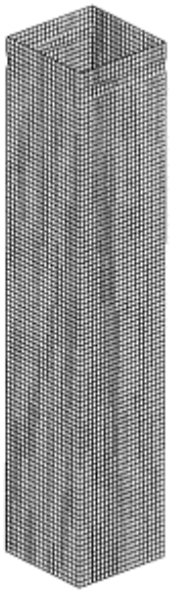
d) How much will the buckling load change if the boundary conditions at the loaded edges are changed from simply supported to clamped support?

**Problem 11-3:** A relatively short rectangular prismatic box column $b_1 \times b_2 \times h$ is subjected to a uniform axial compression. Take $b_1=40mm$, $b_2=60mm$, $h=1mm$. Then beam is made of an aluminum alloy with yield stress of 300MPa

**a)** Calculate the total buckling load of the column.

**b)** Consider a square column of the same cross-sectional perimeter. Which column is stronger: square or rectangular?

**c)** Plot the load – shorting relation for that column consisting pre-buckling phase and post-buckling phase.



Bonus: Consider a rectangular prismatic box column of the same cross-sectional perimeter. Which column is stronger: square of rectangular?

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**Problem 11-4:** **Buckling of a box section**

A relatively slender, thin-walled square box column is subjected to aial compression. The column is simply supported at its ends.

What is the combination of the geometrical parameters (length L, wall thickness h and width of the fledge b) so that the critical Euler buckling load will be equal to the critical local plate buckling load. Explain all the assumptions that you made in your derivation

**Problem 11-5:** **Thin walled prismatic box**

Consider a thin-walled prismatic box structure of length a = 2b, where b is the width of the cross-section. The box is put in the universal testing machine and is subjected to a compressive load.

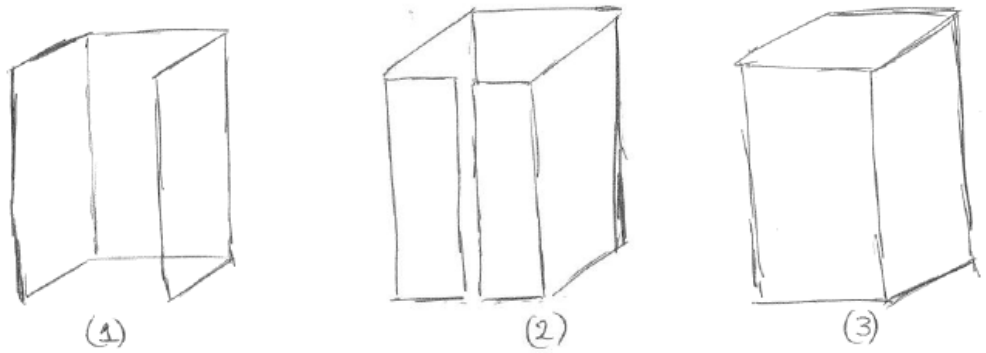
a) Calculate the ultimate compressive load of the box structure.
b) Would the ultimate load change if the member were twice as long?
c) What will the most weight efficient way to increase the ultimate load by a factor of 2?

Would your solution depend on the b/t ratio or on the magnitude of the effective width?

**Problem 11-6:** **Buckling of a channel**

Consider a plain channel (as supposed to lipped channel) with sides of equal width ($b_1$ $b_2$).

Both loaded edges are simply supported. The length of the column (a) is equal to 5b. Consider the three cases shown in the figure below, all sections are thin-walled.




a) Calculate the total buckling load of open section; figure (1).
b) Calculate the buckling load if two lips are added figure (2).
c) Finally, calculate the buckling load of the section where two lips are welded, meaning that it becomes a square prismatic section; figure (3).
d) Discuss the results found in (a), (b) and (c).

2.080J / 1.573J Structural Mechanics
Fall 2013