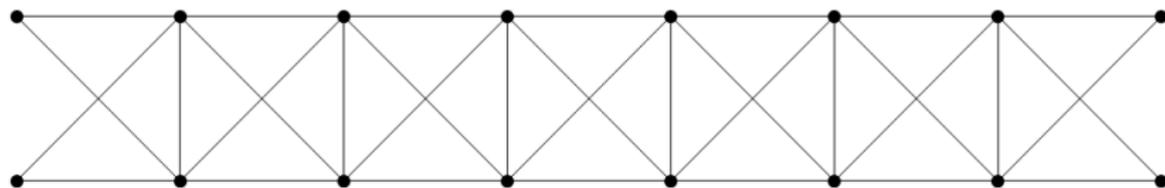


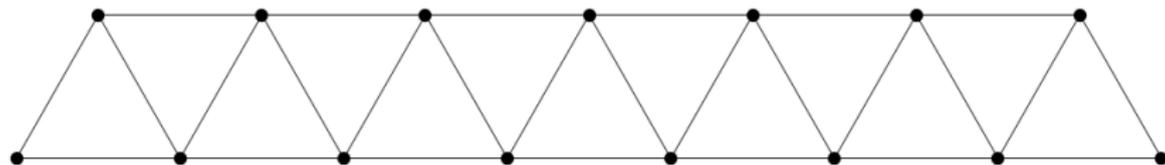
Homework 10 (25 points)

Structural optimization — example

Consider the following two 2D trusses:



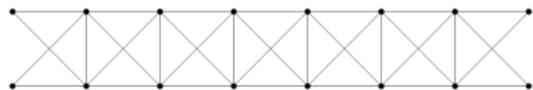
The four outermost nodes are fixed (no translations).



The leftmost bottom node is fixed (no translations). The rightmost node is fixed in vertical direction only (no vertical translations).

Homework 10 (25 points)

Structural optimization — example



Both trusses are statically loaded with unit downward vertical loads:

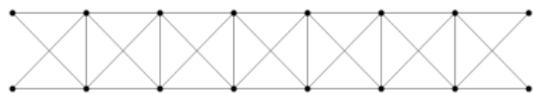
1. the 1st truss in all non-fixed nodes,
2. the 2nd truss in all non-fixed bottom nodes.

Minimize the objective function F (square sum of element stresses) with respect to:

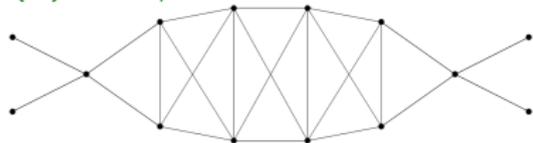
- (1) The 1st truss: vertical co-ordinates of all loaded nodes,
 - (2) The 2nd truss: vertical co-ordinates of all upper nodes,
 - (3) The 2nd truss: both co-ordinates of all upper nodes,
- while the total volume of each structure is constant and all elements have the same cross-section.

Homework 10 (25 points)

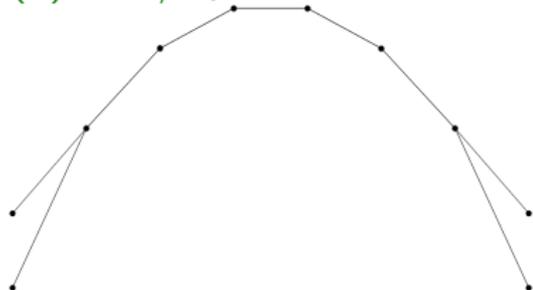
Structural optimization (results) — example



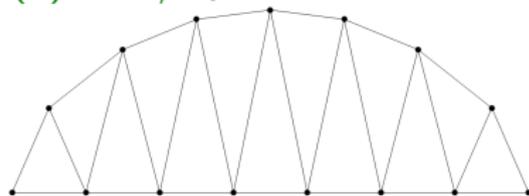
(1) $F_{\min}/F_0 = 73.4\%$



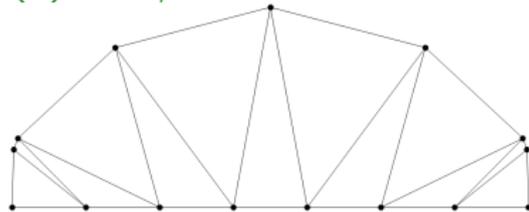
(1) $F_{\min}/F_0 = 19.6\%$



(2) $F_{\min}/F_0 = 51.9\%$



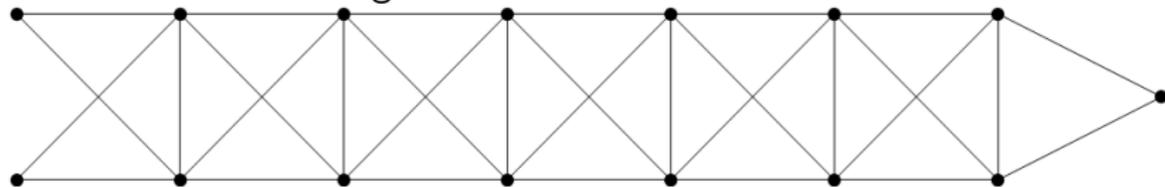
(3) $F_{\min}/F_0 = 41.7\%$



Homework 10 (25 points)

Structural optimization — Your tasks

Consider the following 2D truss:



Both leftmost nodes are fixed. The truss is statically loaded with unit vertical load at the rightmost node.

Minimize the objective function F (square sum of element stresses) with respect to vertical co-ordinates of all nodes besides the tip and the fixed nodes. Keep the total volume of the structure constant. Assume that all elements have the same cross-section. Use any method and software you like. E-mail the resulting truss to ljank@ippt.pan.pl.

Homework 10 (25 points)

Additional information

Homework 10 assumes basic knowledge of notions like truss finite element, local and global stiffness matrix, degree of freedom, etc. If this is new to you, several tutorials can be found on the web (try the query: *truss stiffness matrix*). Some details and examples can be found for example here:

- ▶ <https://people.duke.edu/~hpgavin/cee421/truss-method.pdf>
- ▶ <https://www.degreetutors.com/direct-stiffness-method>