



MECÂNICA ESTRUTURAL – 10371/10391/10411

2015/2016

Assignment 1

OBJECTIVES

To learn how to implement a computer code to solve a structural problem, using the finite element method.

1. PROBLEM

A two-dimensional truss is to be sized for minimum weight using the finite element method. In the finite element formulation of the bar assume that the cross-section properties are constant within an element. Determine the diameter, D_i , and thickness, t_i , of each i th bar for minimum weight subject to a maximum deflection at any joint of 0.1 mm, a safety factor of $FS = 1.5$, a minimum safety margin of $MS = 0.0$ and avoiding any buckling occurrence in any of the bars.

Summarize the results of cross-section diameter, D , thickness, t , horizontal deflection, u , vertical, deflection, v , total deflection, δ , maximum stress, σ , and safety margin, MS , in a table for all bars. Comment the results.

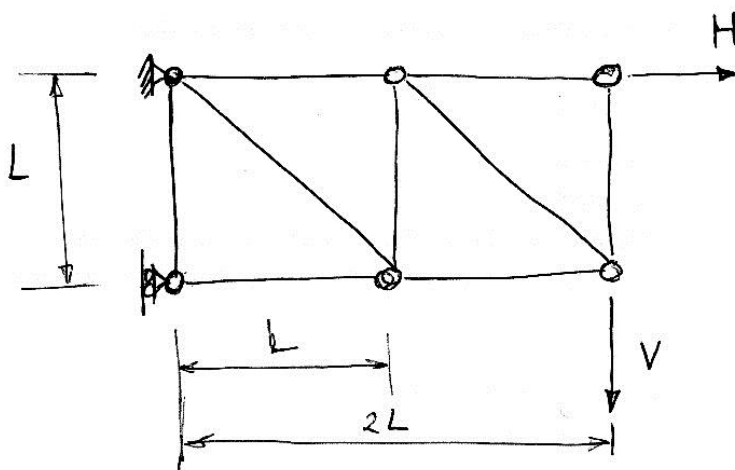


Figure 1: Loaded truss.

2. DATA

Each group should select a different combination of material, loading and cross-section from the options below.

Table 1: Material properties

	material	density ρ , kg/m ³	Young's modulus E , GPa	tensile strength σ_{tu} , MPa	compressive strength σ_{cu} , MPa
1	steel	7800	210	800	640
2	aluminium alloy	2700	70	600	480
3	pultruded carbon	1600	140	1500	1200

Table 2: Load cases

	reference length L , m	horizontal force H , N	vertical force V , N
i	1	2000	1000
ii	1	1000	2000

Table 3: Cross-section shapes.

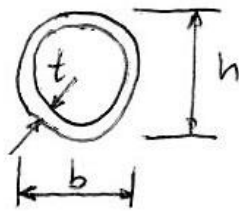
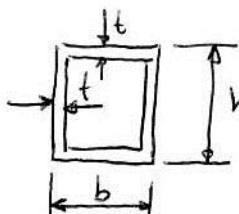
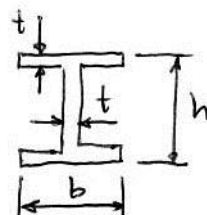
	cross-section	dimensions
A	 <p>A hand-drawn diagram of a circular cross-section. It shows an outer circle with diameter D and an inner circle with diameter d. The thickness of the wall is labeled t. The height is labeled h and the width is labeled b.</p>	$D = b = h = ?$ $t = ?$
B	 <p>A hand-drawn diagram of a square cross-section. It shows an outer square with side length b and an inner square with side length d. The thickness of the wall is labeled t. The height is labeled h.</p>	$D = b = h = ?$ $t = ?$
C	 <p>A hand-drawn diagram of an I-beam cross-section. It shows a central web with thickness t and two flanges with thickness t. The total height is labeled h and the total width is labeled b.</p>	$D = b = h = ?$ $t = ?$

Table 4: Problem combinations and students names.

Mat.	Load	C.-sec.	Name 1	Name 2
1	i	A		
1	i	B		
1	i	C		
1	ii	A		
1	ii	B		
1	ii	C		
2	i	A		
2	i	B		
2	i	C		
2	ii	A		
2	ii	B		
2	ii	C		
3	i	A		
3	i	B		
3	i	C		
3	ii	A		
3	ii	B		
3	ii	C		