Assignment 2

The hang glider depicted in Figure 1 descends at constant velocity. Its structure is composed of bars of two different materials, with their properties given in Table 1. Consider the following loading conditions:

a) A mass $M = 120$ kg is attached to the lower bar, and its weight, W_M, is distributed equally among nodes 1 and 2.
b) The mass of the bars is NOT negligible, and their weight is distributed equally among each bar's nodes.
c) The total aerodynamic lift L and drag D are distributed uniformly among the upper surface nodes.
d) The pilot applies a force T, distributed equally among nodes 1 and 2, to prevent the rotation of the structure around the y-axis.

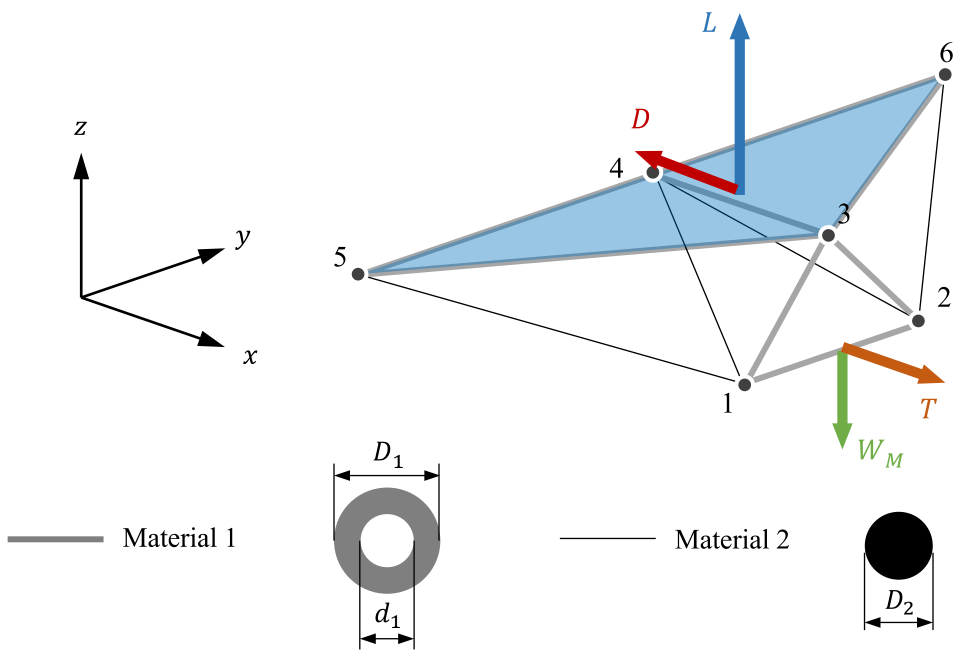

Figure 1. Hang glider structure and external loads (the weight of the bars is not depicted but must be taken into account).

Table 1. Material properties

	Young's Modulus (MPa)	Density (kg/m^3)	Section properties
Material 1	70000	2200	$D_1 = 21.0$ mm $\quad d_1 = 5.0$ mm
Material 2	200000	1300	$D_2 = 2.0$ mm

A) Modify the MATLAB® code for Assignment 1 to adapt it to the 3D case and validate it with the structural assembly given in Figure 2 (compare numerical with analytical results).

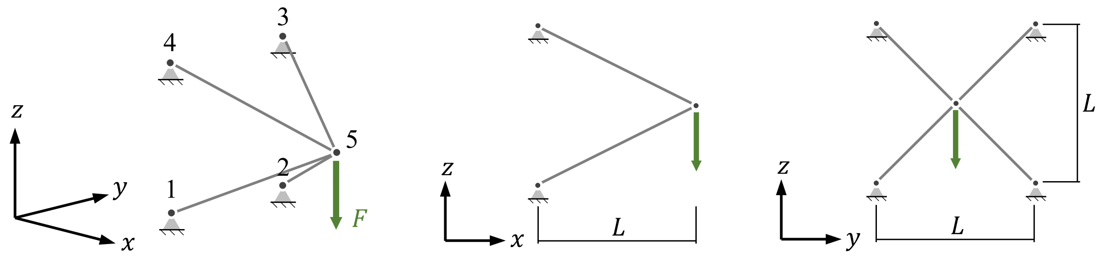

Figure 2. Test problem for 3D bars code (choose your own values for the parameters).

B) Compute the stress state of the structure given in Figure 1 and discuss the following questions:

1. Which degrees of freedom have been prescribed in order to find the nodal displacements, which are the values of the reactions computed in these degrees of freedom and what are their physical meaning?
2. Is there risk of buckling? If necessary, propose a feasible solution to prevent it. Use the following formula to evaluate the critical stress on each bar:
$$\sigma_{cr} = \frac{\pi^2 EI}{A\ell^2}$$
where E is the Young Modulus, I the section inertia, A the section area and ℓ the bar's length.
3. How much more force needs to apply the pilot to prevent the rotation of the structure around the y-axis if a gust produces a sudden 25% increase of the aerodynamic loads? Compute the new stress state under this situation and re-evaluate the risk of buckling.

The assignment can be done in groups of maximum 2 people. Only one of the members must submit a compressed (**.zip**) file to Atenea containing the following:

- All MATLAB® script files used for part B of the assignment. There must be only one executable script file, which must be named '**mainA02**' (any supplementary script file must contain functions called in the 'main' script file).
- A report including:
  - Names of the group members
  - For part A:
    - Brief description of the procedure employed to obtain the analytical results.
    - Table comparing the stress for each bar obtained analytically and numerically.
  - For part B:
    - Brief description of how the lift and drag have been obtained.
    - Prescribed degrees of freedom, values of the reactions and proper discussion of question 1.
    - Plot of the deformed structure with the stress of each bar for both the standard conditions and the new situation in question 3.
    - Bars with risk of buckling in each situation (if any) along with the proposed solution to prevent it (provide proof).

Note 1: You can use the provided function '**plotBarStress3D**' to obtain the required plots. (Hint: saving the plot in **.svg** format will give optimal graphic quality in the **.pdf** report).

Note 2: The report can be written in Catalan, Spanish or English and both technical and presentation aspects will be considered in the grading.