Assignment A - Unsymmetric Beams

Dr Luiz Kawashita

November 2018

1 Assignment Details

This is an **individual exercise** which accounts for 10% of the unit *AENG 21200 - Structures and Materials 2* (*i.e.* 2 credit points). You will need to submit your results through Blackboard by **Friday 21st of December 2018** (23:59). An online form will be made available on Blackboard where you can upload your solution as a single PDF file containing **either**:

- Scans of hand calculations done with pen and paper;
- Word-processed documents (*e.g.* Word or LaTeX) summarising your hand calculations;
- Source file of **analytical solutions** developed using computer algebra software (*e.g.* Maple or Matlab's Symbolic Toolbox). Note that *numerical solutions* based on space discretisation will **not** be accepted.

2 Question

The thin-walled open cross-section shown in Figure 1 is made of aluminium alloy with $E = 70$ GPa and $\nu = 0.3$. Note that the geometry has been parameterised and each student has a unique cross-section, which is defined by the data files provided on Blackboard.

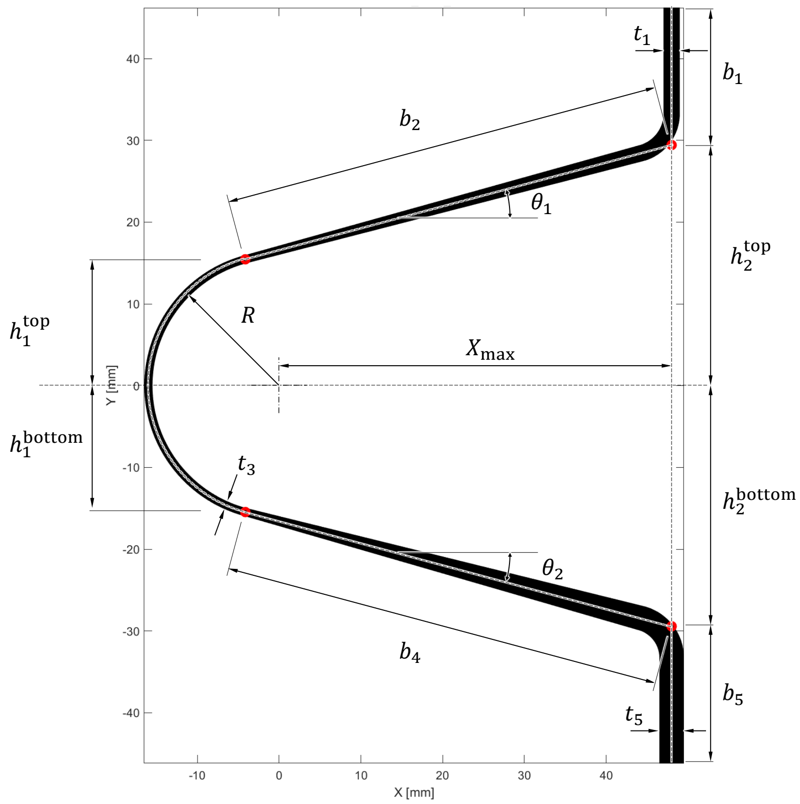

Figure 1: Parameterised cross-section geometry.

Note that the centre of the main radius is the origin of the XY plane, and that all dimensions are defined with respect to the centrelines of each wall. The section may be decomposed into five segments: two 'vertical flanges' i =1 and i =5, two diagonals i =2 and i =4, and one main radius i =3. The two smaller radii (of 5 mm each) should be neglected.

The thickness of the vertical flanges are constant, given by t_1 and t_5, as is the thickness of the main radius, t_3. The two diagonals have *linearly varying* thickness, *i.e.* t_2 and t_4 are functions of the centreline length s. You should assume the top-right corner as the origin of s.

The beam is 500 mm long and loaded in cantilever configuration with a tip downwards force of 1 kN being applied through its centroid. Using thin-wall assumptions, determine:

- The coordinates of the centroid of the cross-section, $(\bar{X}, \bar{Y})$.
- Its second moments of area, I_{xx}, I_{yy}, and I_{xy}.
- Its polar second moment of area, J.
- The coordinates of the shear centre in the (X, Y) plane, e_X and e_Y.
- The tip deflection of the beam, δ.
- The total angle of twist due to the off-axis loading, θ.

3 Resources

On Blackboard you will find an Excel spreadsheet containing the geometry of your cross-section, with the following file name:

```
Surname_FirstName_Username_geometry.xlsx
```

You will also find a Matlab script which you can use to open the following data file:

```
Surname_FirstName_Username_matlab.xlsx
```

This file contains a discretised description of your cross-section which the script will use to compute the cross-section properties numerically. You can use these results to check your analytical solutions. Feel free to check the Matlab code - it is reasonably well commented.

In your submission please discuss the most likely sources of any discrepancy you may find between your analytical solution and the numerical results.

END OF PAPER