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AEROELASTICITY PROJECT: PAZY WING – CHECKPOINT

1. Virtual experiments

We have obtained the effective structural properties of the wing: *xs*, *GJ* and *EI*. To do so, a function called *CalcStiffness.m* was created.

To find xs, we applied the unitary force at the different mass slots (at the tip station) and comptued the twist for each case. Then, with a regression curve (twist vs xposition) we determined the point in which, if we apply an external load, the beam doesn't experiment twist. This is the shear center.

Then, from the twist and the bending displacement at each subset (14 values in total) we obtain a fitting polynomial expression (1st grade for twist and 3rd grade for bending). From a1 and b3 coefficients we're able to compute *GJ* and *EI*.

2. Numerical modelling

a. Structural modelling – Beam elements

In the main function *PazyWing.m* we initialize all the variables and we call the abovementioned function *CalcStiffness.m*. The beam mass parameters (mu, r0, rs and d) are computed with the function *computeBeamMassParameters.m*.

The wing is discretized into several subsets with the function *DiscretizeWing.m*. Each subset (rib + lateral space) is divided into 13 subsets, so a total of (14*13 + 1) y-coordinates are obtained with this function. Note that the wing's tip subset is different than the other ones (it is wider). This means that the coordinates are not equaly spaced along all the vector length. Also the connectivity matrices Tn and Tr are obtained with this function.

With the coordinates of the discretized wing (y) and the node and rib connectivity matrices (Tn and Tr, respectively), the assembly of the mass and stiffness matrices can be performed. Specific functions are defined to compute and assembly them. Note that the mass matrix takes into account the rib mass matrix, which is computed with a function called *computeRibMass.m*.

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b. Aerodynamics modelling – Panel method

The main idea will be to use the **panel method**, so the wing will be discretised in in smaller panels that follow the shape of the wing. Nonetheless, we may resolve to use strip theory if the implementation seems to be harder than expected. Key steps in this section are:

- Dividing the wing into an aerodynamic node mesh
- Finding the aerodynamic influence coefficients matrix **A**

c. Aeroelastic linear coupling

Then the structural and aerodynamic models will be coupled. This requires finding some interpolation matrices:

- Firstly, the angle of attack-DOF interpolation matrices ($\mathbf{I}_{ax}$) that allow finding the angle of attack for the aerodynamic mesh from the DOFs
- Then the force-lift interpolation matrices ($\mathbf{I}_{fL}$), that allow going from lifts to applied forces at the structural nodes.

3. Aeroelastic solvers

Finally, the model will be solved, considering different aeroelastic conditions:

- **Divergence speed**
- **Flutter**
  1. **p method**
  2. **k method**
  3. **p-k method**

WE MAY ADD MORE POINTS TO THE DOCUMENT FOR CHECKPOINT DAY