StM1 Assignment B-Str 17-18

This assignment contains 6 Q's which should all be attempted and laid out in your engineer's log book. You are NOT required to submit solutions for Q's but a version of one or more of the Q's will form the "B-Str" assessment item as an on-line test which will take place after Easter as scheduled in SAFE.

Q1 Truss compression member stability

In the truss structure shown in figure Q1, assuming the truss elements have the same cross-section and material, determine the element most prone to global buckling. For this element, assuming the material is an alloy steel with a Youngs Modulus E = 200 GPa and yield strength σ_Y = 450 MPa, determine the required minimum second moment of area to prevent global buckling at the given load. If the element is of hollow circular section of outer diameter 75mm what is the minimum wall thickness? Check whether the element will yield at the applied loading. What other mode of stability should you be concerned about?

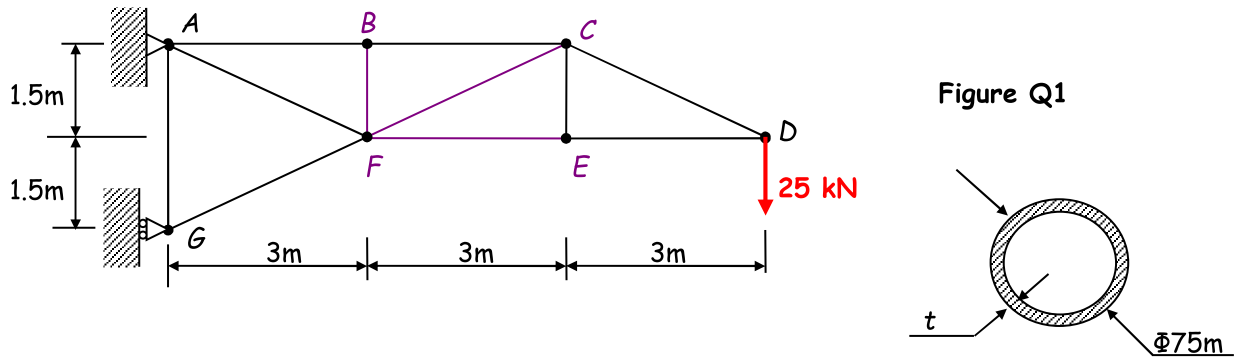


Figure Q1

* See Aero h/b

Q2 Fuselage skin joint

Figure Q2 shows a 4m diameter fuselage with a skin thickness of 1.6mm and an internal limit gauge pressure, *P*, of 0.6 bar (1 bar = 0.1MPa). Using an ultimate safety factor of 1.5 and considering 4mm diameter L37 rivets* in an in-line double-row lap joint, deduce the required pitch, *w*, based on the single-shear rivet strength, aiming for an RF of 2. Also suggest a minimum spacing, *s*, of the rows and minimum joint overlap length, *L*.

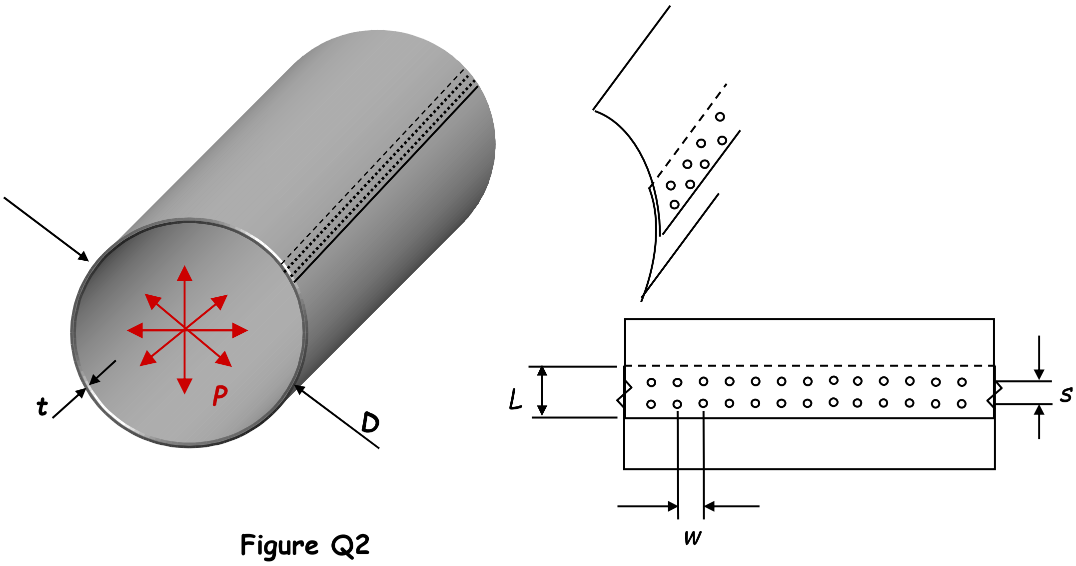


Figure Q2

* See Aero h/b

Q3 Fuselage floor-beam and joints

Figure Q3a illustrates a fuselage floor beam subjected to seat rail and passenger isle loads at limit. The material is aluminium alloy 2024-T3*. Approximating the loading as UDL as in figure Q3b and using standard beam configuration formulae (not included in Aero h/b – obtain and check using convenient reliable sources) you are required to perform the following tasks:

a) Calculate the required value of second moment of area to prevent a deflection greater than 5mm at the limit loading and based on this stiffness requirement, suggest a C-beam section of constant thickness and depth of 80mm (assuming symmetric loading).

b) Check the strength RF values for the flange and web at ultimate considering direct stress and shear stress respectively.

c) Design a riveted fixed joint between the floor-beam and fuselage frame webs, figure Q3c, checking the main failure modes, assuming a frame web width, b_w, of 140mm and using 4mm diameter L37 ally rivets*

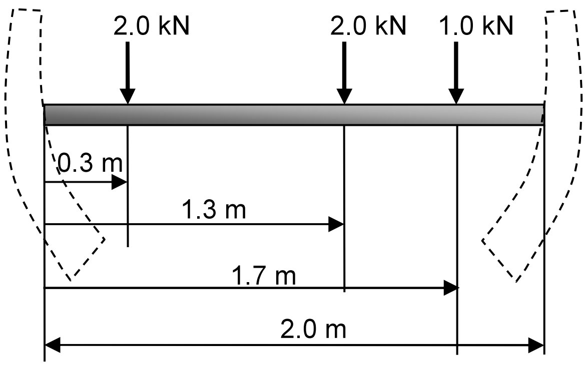


Figure Q3a

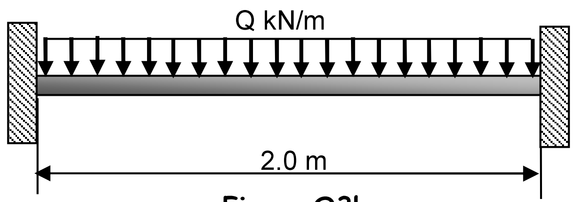


Figure Q3b

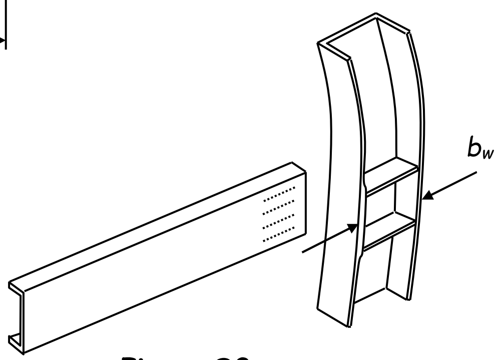
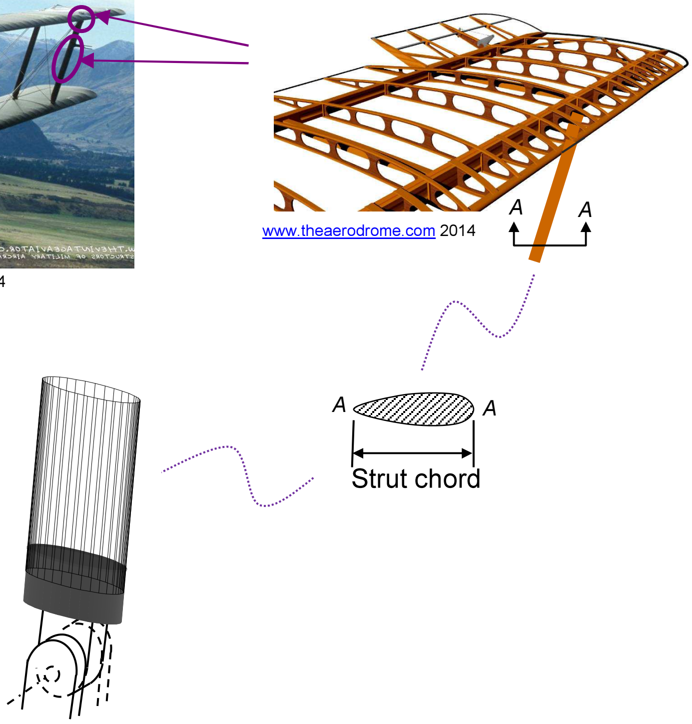


Figure Q3c

* See Aero h/b

Q4 Sopwith Camel – strut buckling / pin joint

www.foundation3d.com www.vintageaviator.com 2014



www.theaerodrome.com 2014

a) For an estimated strut length of 1.0m, a strut chord of 100mm with a 25% aero-section estimate the minor second moment of area and, using a suitable hardwood Young's modulus, deduce the critical Euler buckling strength.

b) Based on the strut critical buckling load together with an allowable pin shear strength of 500MPa and lug bearing strength of 900MPa, size a suitable double-shear pin joint aiming for RF's around 2.0.

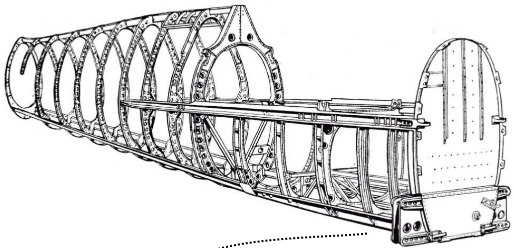
Note, the schematics, dimensions and properties used in Q4are similar to but not specific to the actual aircraft. Referenced images are for teaching purposes only and should not be reproduced or distributed.

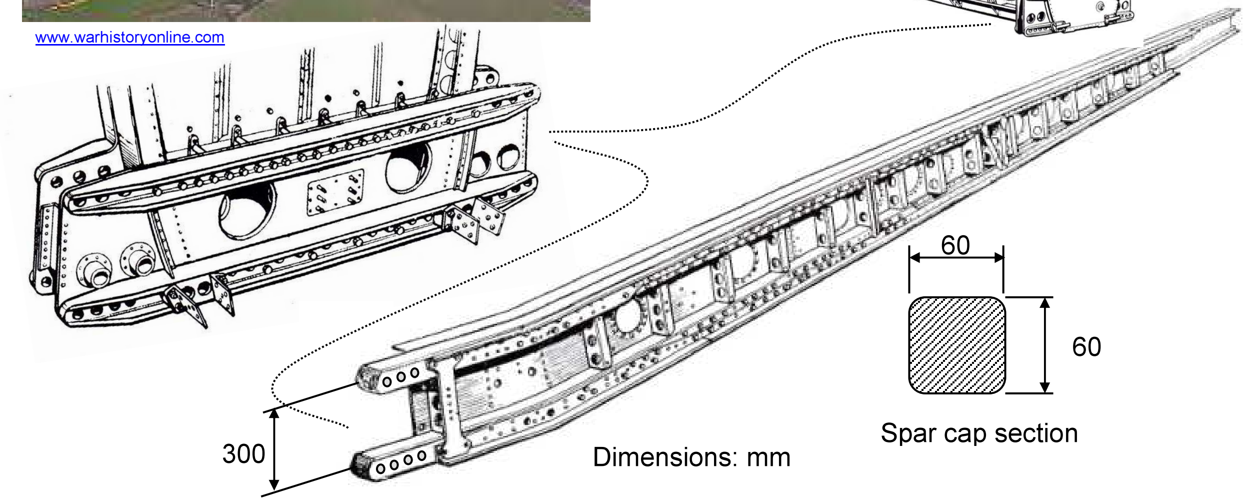
* See Aero h/b

Q5 Spitfire – wing root

www.warhistoryonline.com

Supermarine Spitfire Ownners' workshop manual, Haynes Publisjng 2007, ISBN 978 1 84425 462 0





a) Estimate the couple end-load carried by the spar caps at the wing root for a symmetric 6g pull-up limit load case. Assume that the effective resultant wing lift and wing weight acts at 40% of the wing length from the root. Assume the weight of both wings is approximately one third of the aircraft empty weight.

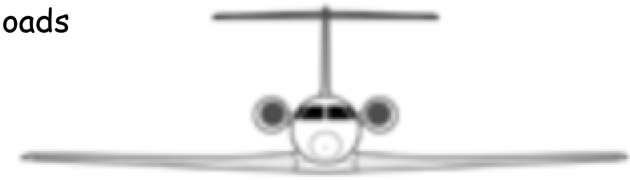
b) From this load deduce the average direct stress in the spar caps at ultimate and the ultimate RF for an allowable ultimate strength value of 450MPa.

c) Assuming 20mm diameter bolts, estimate the bolt shear and the spar cap bearing stresses in the upper wing root joint at ultimate. Quote the associated ultimate RF's of these failure modes for allowable ultimate strength values of 760 MPa for bolt shear and 380 MPa for spar cap bearing.

Note, the schematics, dimensions and properties used in Q5 are similar to but not specific to the actual aircraft. Referenced images are for teaching purposes only and should not be reproduced or distributed.

* See Aero h/b

Q6 Bizjet flight wing loads



A business aircraft with two rear fuselage mounted engines has a total mass of 8000kg. The total wing span is 18m and the total wing structure has a mass of 900kg. The mass of fuel in the wings is 1200kg. The fuselage diameter is 2m. Making suitable simplifying assumptions perform the following tasks:

Draw the loading diagram and the shear force and bending moment diagrams for the wing, noting the maximum values. Clearly state the assumptions made.

* See Aero h/b