Instructions

In this assignment, you are expected to work out and investigate the effect of a local load on the top surface of a stiffener attached to a fuselage skin. The dimensions of the stiffener and skin are associated with a narrow body aluminium fuselage. When a local load is applied on the top surface of the hat stiffener, the nature of deformation may or may not lead to separation between the stiffener flange and skin. Your task is to identify the nature of deformation and work out the problem using the finite element formulation, applying geometric non-linearity if applicable and contact behavior.

Problem - Locally applied load on hat-stiffened skin

Problem Description

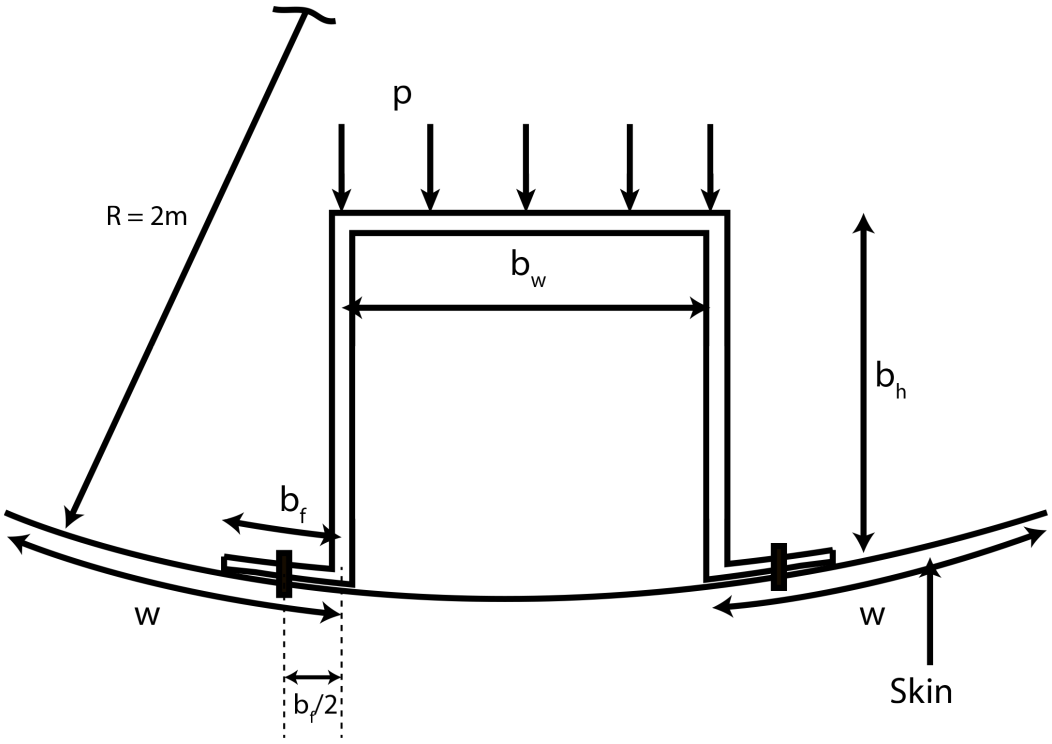

Figure 1: A hat stiffener riveted to a small length of fuselage skin. Please note that this figure is not to scale and the skin curvature may vary upon usage of the actual fuselage radius.

A uniform pressure load p is applied on the top surface of a hat stiffener attached to a skin with rivets as shown in figure 1. The material properties and dimensions of the stiffener and the skin are as given below:

Material:

E = 73.1 GPa

$\nu = 0.3$

Dimensions:
Fuselage radius = 2m
w = 31.75mm
b_w = 30.48mm
b_h = 38.10mm
b_f = 12.70mm
t_{skin} = 2.03mm
$t_{stiffener}$ = 1.22mm

The diameter of the rivets is d = 5mm and the material is same as for the skin and stiffener.

Boundary conditions

Symmetry boundary conditions are applied along both edges of the skin.

Applied load

A maximum pressure load of 400 N/mm^2 is applied at the top surface of the hat stiffener.

Assignment

- Model the cross-section of the stiffened skin section at the location of the rivet shown in figure 1 using appropriate elements for the stiffener and the skin. The rivets must be modelled using beam elements connecting the stiffener flange and the skin.
- Contact surfaces must be modelled between the skin and the stiffener. Make careful and appropriate selection of contact type and explain your selection.
- Comment on final finite element mesh size for convergence.
- Plot the contact force as a function of the applied load.
- Comment on the load transfer from the stiffener to the skin.
- Plot the contact pressure distribution over the contact surface at several load levels and comment on how the contact pressure evolves.