Faculté de génie
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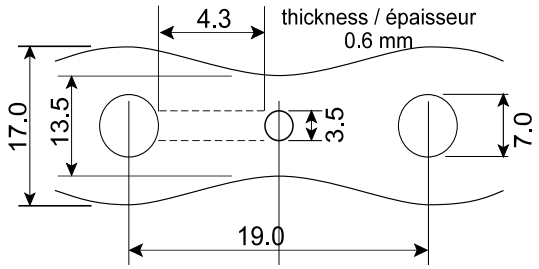
Mechanical Engineering

Name:_____ ID_____ Section_____

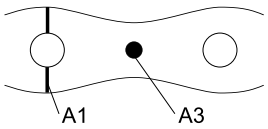
MCG 1100 - Dissection Lab 8 - Work Sheet
(To be handed in at the end of the lab period)

For each joint test specimen (next page), write down the failure load, the elongation at failure, and the type of failure (*e.g.* tensile failure of strip, shear failure of joint, tear-out failure of joint, failure of fastener). Estimate the stresses by dividing the load by the appropriate area (*e.g.* cross-sectional area of strip A_1 for tensile stress, joint surface area A_2 for shear stress, etc.). The geometry of the steel strip used for the joints is shown in the figure:



8.1 Areas for stress calculations:

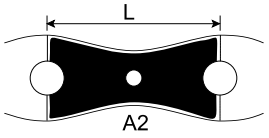
Cross-sectional area A_1 (for tension failure of strip):
net width of material = width - hole diameter = 10 mm



A_1 = net width *10* mm × thickness *0.6* mm

A_1 = *6* mm^2

Surface area A_2 (for shear failure of joint):



A_2 = joint length L *19.0* mm (one hole overlap)

× average width *(17 + 13.5)/2* mm

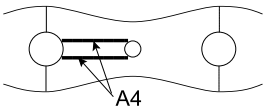
minus (large hole area $\pi/4 \cdot 7.0^2$ mm^2 + small hole area $\pi/4 \cdot 3.5^2$ mm^2)

A_2 = *242* mm^2

Cross-sectional area A_3 for shear of fastener (same as small hole area):

A_3 = *9.6* mm^2

Shear area A_4 (tear-out of strip by fastener = shear along dashed line):

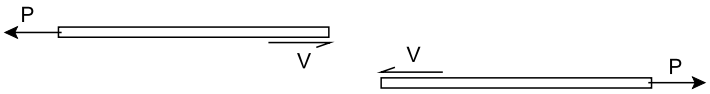


A_4 = length between holes *4.3* mm × thickness *0.6* mm × 2

A_4 = *5.16* mm^2

8.2 Stress Calculations

1. Single-lap epoxy glue joint



Failure load *P = 1385* N Elongation at failure *6.75* mm

Type of failure (include comments as appropriate):

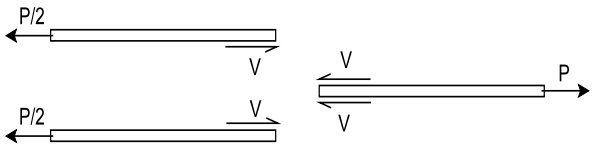
- *shear of glue joint*

Shear force *V* on joint: *1385* N

Shear stress τ on joint (V/A_2) : *5.73* MPa

Tensile stress σ on steel strip (P/A_1) : *231* MPa

2. Double-lap epoxy glue joint



Failure load *P =* *1938* N Elongation at failure *18.67* mm

Type of failure (include comments as appropriate):

- *tensile failure of steel strip. Joint is stronger than strip.*

Shear force *V* on joint: *969* *N*

Shear stress τ on joint: *4.0* MPa

(Compare this with the shear stress on the single-lap joint)

- shear stress on glue is lower, which is why in this case the joint itself did not fail.

Tensile stress σ on single steel strip *323* MPa

3. Double-lap spot-welded joint

Failure load P = *2027* N Elongation at failure *14.35* mm

Type of failure (include comments as appropriate):

- tensile failure of strip. Joint is stronger than strip.

The welds are four circular areas of about 3.5 mm diameter each.

Total shear area of welds A_W = *38.5* mm^2

Shear force V on joint: *1014 N*

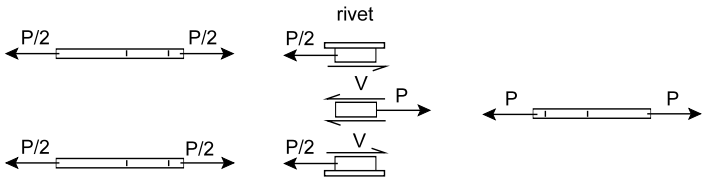
Shear stress τ on welds (V/A_W) : *26.3* MPa

Tensile stress σ on single steel strip: *338* MPa

Comment on the relative magnitudes of the tensile and shear stresses. Note that both of them are for the same material - steel - and compare them with the typical failure stress of soft steel in the lab manual.

- shear stress on joint is much lower than tensile stress in strip, which is why joint did not fail. Tensile stress is close to 400 MPa value for steel failure stress in lab manual.

4. Double-lap pop rivet joint (aluminium rivet)



Failure load P = *729 N* Elongation at failure *1.59* mm

Type of failure (include comments as appropriate):

- shear failure of rivet. Joint is weaker than strip.

Shear force V on rivet : *365* N

Shear stress τ on rivet (V/A_3) : *37.9* MPa

Tensile stress σ on single steel strip: *122* MPa

5. Double-lap screw joint (steel screw)

Failure load P = *1564* N Elongation at failure *8.44* mm

Type of failure (include comments as appropriate):

- tear-out failure of steel strip (shear along area A_4). Screw itself does not fail, but it concentrates the load on a small section of the strip, causing it to fail.

Shear force V on screw: *782* N

Shear stress τ on screw: *81.3* MPa

Shear stress τ on material for tear-out failure (V/A_4): *303* MPa

Tensile stress σ on single steel strip: *261* MPa

Compare the shear stress on the screw (steel) with that on the rivet (aluminium) above. What do you conclude about the relative strengths of steel and aluminium?

- stress on screw is much greater, but screw does not fail, because steel is much stronger than aluminium. Note that shear area for screw is greater than A_4, which is why screw does not fail. Note also that tear-out shear stress is similar to tensile failure stress for steel.

6. Conclusions

What is (or are) the strongest joint(s)?

- strongest joints are welded joint and double-lap glue joint. In both cases, joint is stronger than steel strip, because load has been spread over a large area.

What is the weakest joint? Why?

- weakest joint is aluminium pop rivet, because the joint force is applied to a small area (the rivet) in a weak material.

What is the advantage of a shear joint?

- shear joint can have a large load-bearing area compared with the material cross-section. As the free-body diagrams show, the double lap joint also reduces the force (stress) by a factor of 2 compared to the single lap joint.