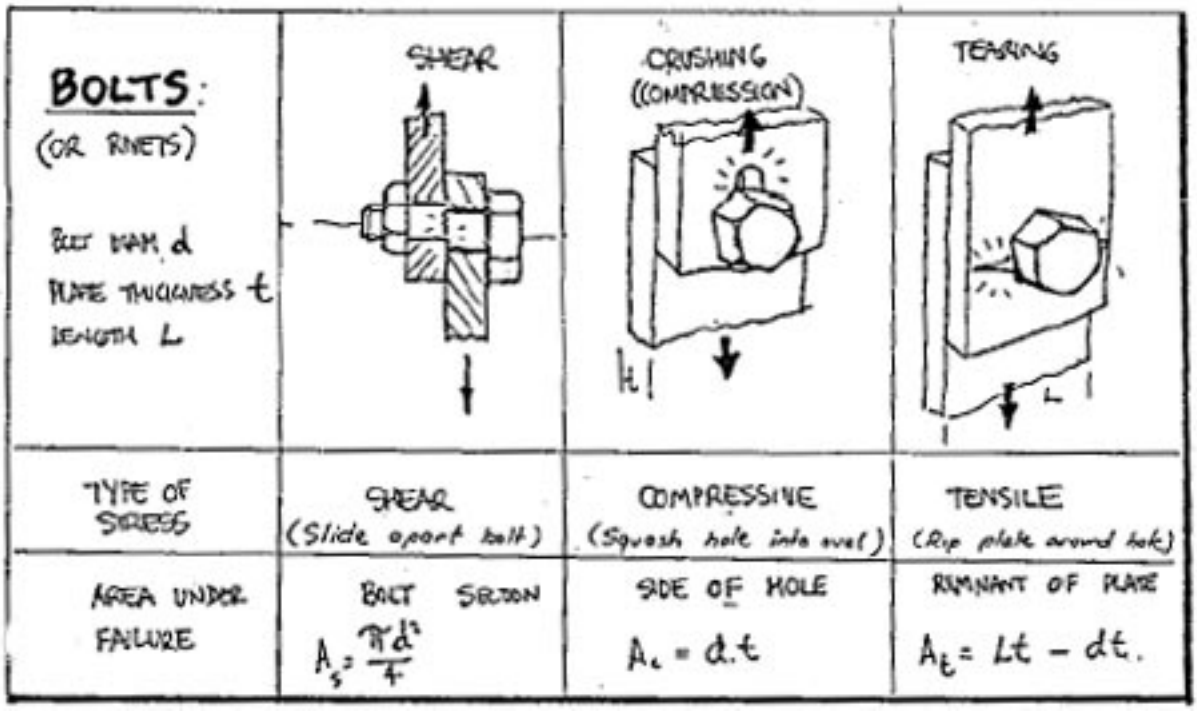
Bolted Joints

Wednesday, 25 May 2011
8:58 PM



Solving a bolted joint question.

1. Calculate force for each mode - shear of bolt, compression of hole, tension of plate. *Take care when calculating the area of breakage, watch out for double shear etc.*
2. Choose the minimum force. This is the maximum strength of the joint.

Joint Efficiency

The strength of the joint compared to the original plate.

Eg: Bolted Joint

Tuesday, 24 May 2011
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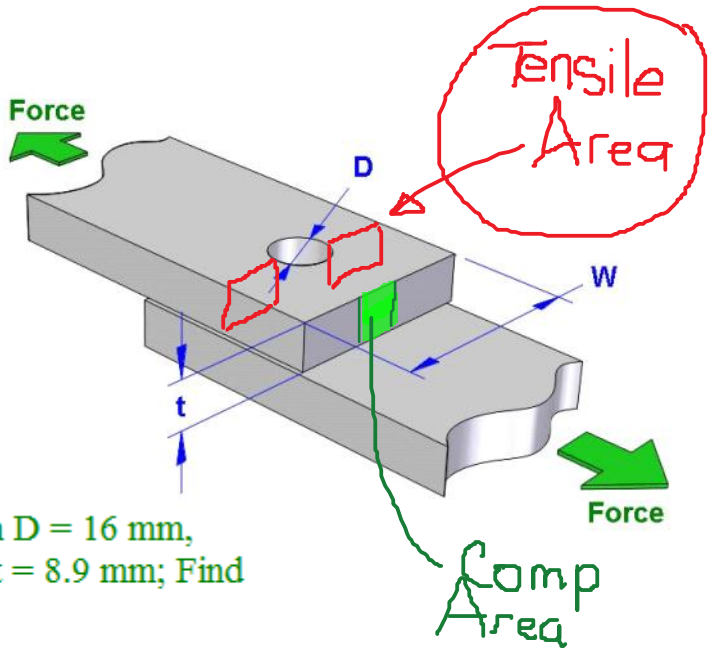
Stress from book: (Steel p393)
fs = 90 MPa
ft = 110 MPa
fc = 220 MPa



Q8: If tearing stress is 141 MPa, bolt diam D = 16 mm, plate width W = 119 mm, plate thickness t = 8.9 mm; Find plate tearing force.

Area in tension:
$A = W*t - D*t = 119*8.9 - 16*8.9 = 916.7\ mm^2$
$F=fA = 141 * 916.7 = 129.255\ kN$

Area in Shear: Pretend shear stress = 100Mpa
$A = pi*d^2/4 = pi*16^2/4 = 201.06\ mm^2$
$F = fA = 200*201 = 20.100\ kN$

Area in Compression: Pretend comp stress = 200Mpa
$A = Dt = 16*8.9 = 142.4\ mm2$
$F=fA = 200*142.4 = 28.480\ kN$

The LOWEST force is 20.100 kN, so will fail in shear.

Compare this to unjointed plate. Tensile = 141MPa
$A = Wt = 119*8.9 = 1059.1\ mm2$
$F = fA = 141*1059.1 = 149.333\ kN$

Joint Efficiency = Actual / unjointed
= 20.1 / 149.3 = 0.1346 (13%)

(That is pathetic. We need a bigger bolt, but not too big or it will start to tear instead.)

Eg2: Bolted Joints

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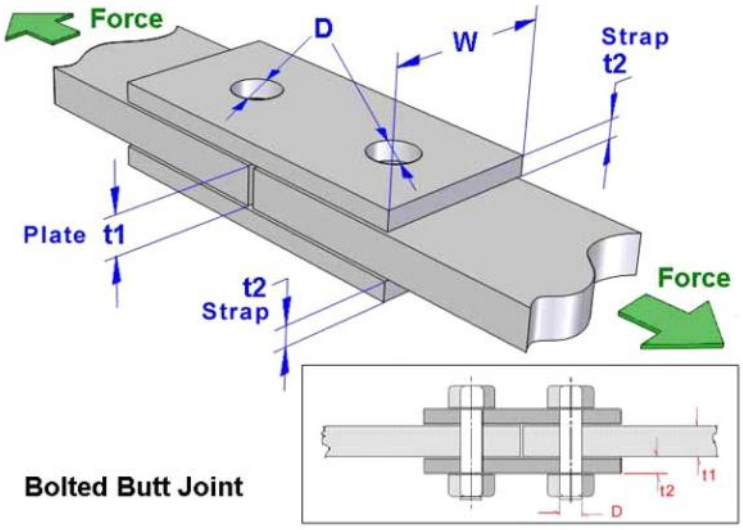
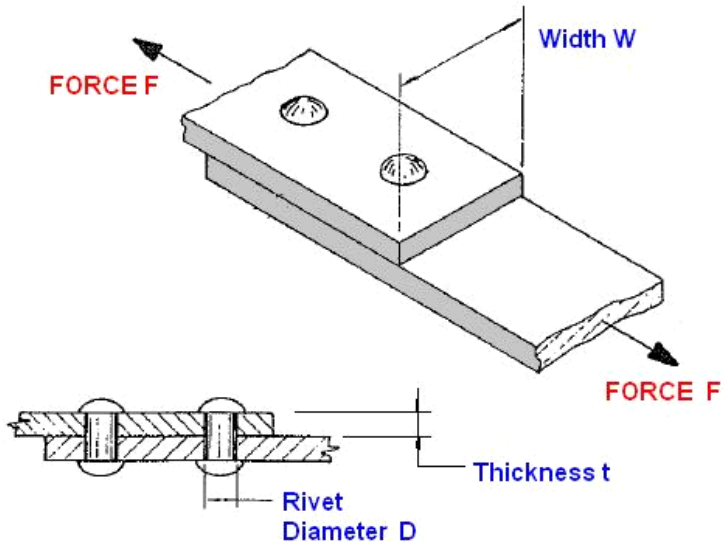


Q6: Plate thickness t1 = 6.1mm, Width W = 76 mm, Bolt diameter D = 9.2 mm, Force = 7.1 kN. Find bolt shear stress.

Area in shear: 2 * Pi * (9.2/2)^2 = 132.95 mm2
f = F/A = 7100 / 132.95 = 53.4035 MPa



Q12: Two 13 mm diameter rivets join 50mm wide, 7.1 mm thick plates. What is the bearing (compressive) stress in the plates when the force is 14 kN?

Area in compression: 2 * D * t = 2*13*7.1 = 184.6 mm2
f = F/A = 14000 / 184.6 = 75.8397 MPa

Eg1: Bolted Joints

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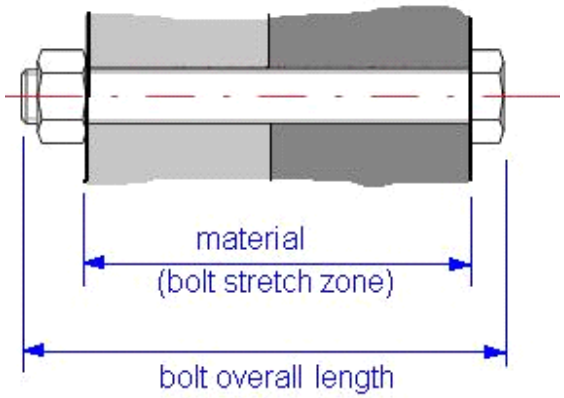
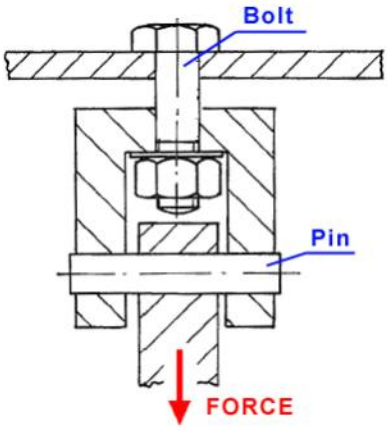


Q1: A bolt passes through 144 mm of material. Using the nominal pre-load stress for grade 8.8, calculate the extension of the bolt. (Use E=200GPa)

$f = F / A$ $e = x / L$ $E = f / e$

Stress = 460MPa
e = f/E = 460/200000 = 0.0023
x = eL = 0.0023 *144 = 0.3312 mm

Q2: Pin (diameter 8.2 mm) and bolt (diameter 14 mm) are cold-rolled steel CS1020. What force will cause this connection to break?



Bolt in tension: Stress = 420MPa (from "Get info", ferrous metals)
F = fA = 420*Pi*7^2 = 64.653 kN

Pin in Shear: Stress = 315MPa (from "Get info", ferrous metals)
A = 2*(pi*4.1^2) = 105.6203mm2
F = fA = 315 * 105.6203 = 33.270 kN

Adhesive Joint

Tuesday, 19 February 2013
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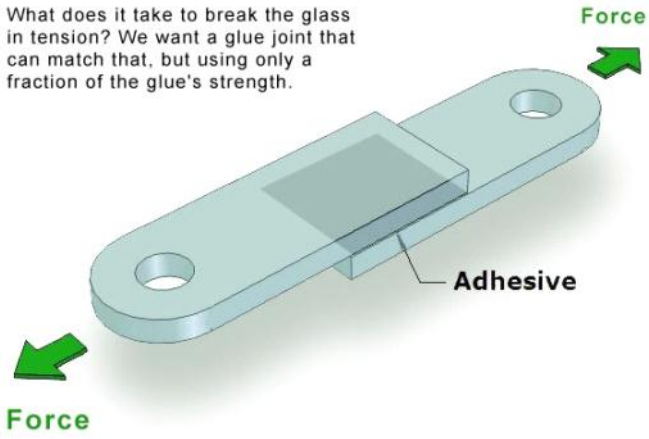
Q13: What adhesion area will join these 12 x 52 mm toughened glass plates with 100% joint efficiency? Allow only 33% of the epoxy adhesive strength.



Glass tensile = 172 Mpa
Epoxy shear = 30 Mpa

Unjointed force.
f = F/A so
F = fA = 172*12*52 = 107.328 kN

Epoxy Area.
f = 30*0.33 = 9.9
A = F/f = 107328/9.9 = 10841.2121 mm^2
Overlap = 10841.2121/52 = 208.4848 mm

Multiple Bolts

Thursday, 26 May 2011
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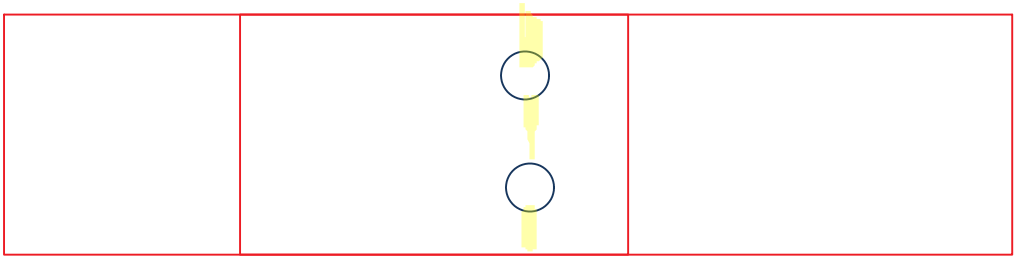
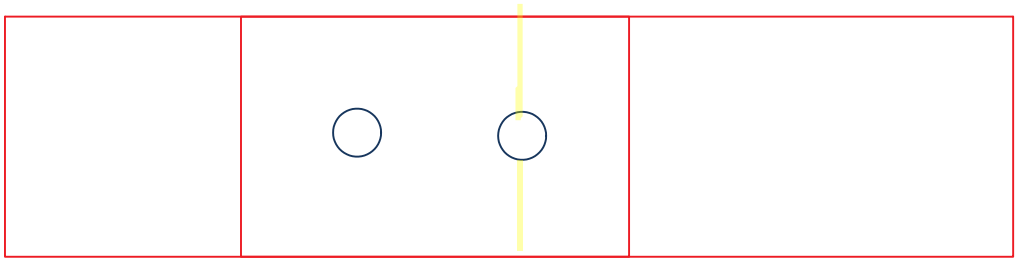
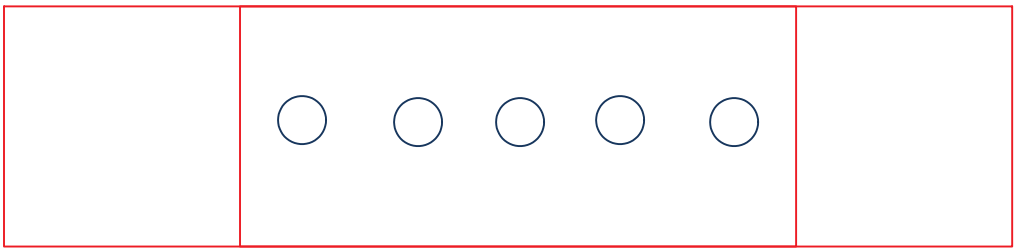
Assume all bolts are far enough from edge...



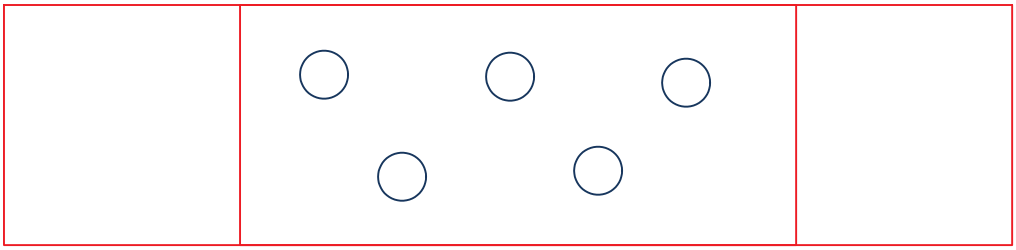
Better to put bolts behind each other to increase tensile area...



What happens with many bolts in a row?
The plates are elastic so the outside bolts take more load than the inside bolts. This is not easy to calculate. Joints with very large numbers of bolts in a row are usually increasing FRICTION, not shear stress.



Staggering the bolts helps to reduce chance of a tensile crack, by making the crack path longer.



Friction joint. Bolts in the middle will not absorb much shear load, but the aim of this joint is to increase the friction to hold the parts together.