# JSAMs : EXAMPLE CALCULATIONS:

# CONTENTS:

## JSAM1: RIVETED LAP JOINT DESIGN: Based on Bearing Failure mode.

For a Tensile load strength of 5000N for a riveted aluminium lap joint, based on a Bearing Failure mode requirement, calculate the following to enable design of the joint;

* Number of self piercing rivets required to sustain the loading.

* The minimum width of plate ( coupon ).

* The minimum rivet edge distance.

The coupon adherends are each 2mm thick. The utimate bearing strength of the aluminium is 100 N/mm^2. Use 3mm diameter rivets. Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam1. The input table below provides the required data.

**INPUT DATA**

| Coupon Ultimate Tensile Strength: Ftua  (uTs ) | 100 N/mm^2 |
|---|---|
| Coupon Bearing Strength:          Fbua | 319 N/mm^2 |
| Coupon Shear Strength:           Fsoa | 136 N/mm^2 |
| Rivet Diameter: | 3 mm |
| Rivet Ultimate tensile Strength:    Ftur | 1320 N/mm^2 |
| Maximum Failure Load:          Fb | 5000 N |
| Coupon adherend thickness: | 20 mm |
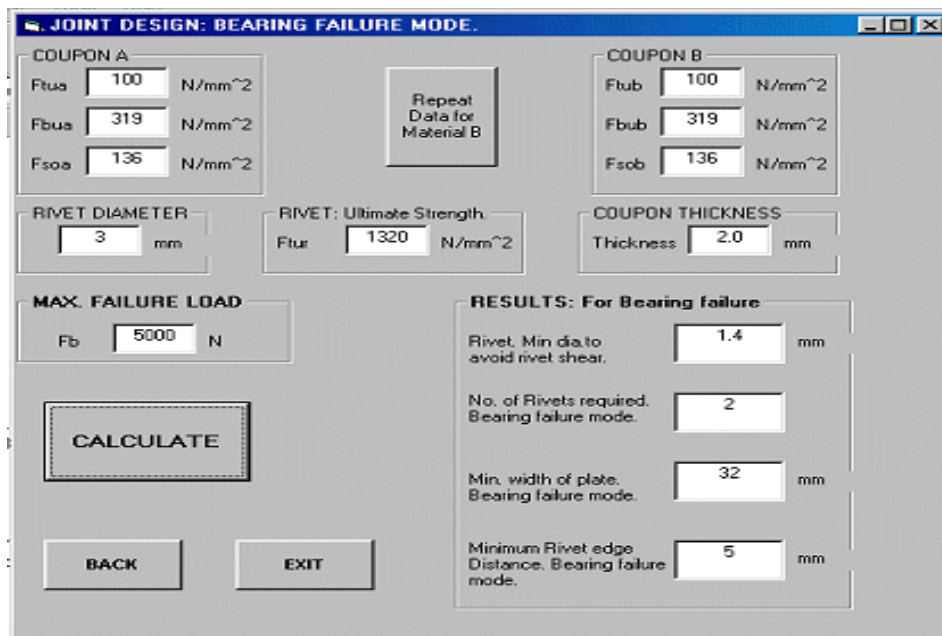


**ANSWER:**

Number of rivets required in the lap joint: = 2

Minimum width of plate ( coupon ):   = 32 mm

Minimum rivet edge distance: =  5 mm

## JSAM2: RIVETED LAP JOINT STRENGTH.

Calculate the joint failure strength and failure mode, of an aluminium Lap joint fastened together with two 5mm diameter rivets. The coupon adherends are 2mm thick. The utimate bearing strength of the aluminium is 100 N/mm^2.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam2. The input table below provides the required data.

**INPUT DATA**

| | | |
|---|---|---|
| Coupon thickness: | | 2 mm |
| Coupon adherend width: | ba | 40 mm |
| Coupon Ultimate Tensile Strength: | uTs | 100 N/mm^2 |
| Rivet diameter: | | 5 mm |
| Number of Rivets in Joint: | | 2 |
| Rivet Edge distance: | e | 9.2 mm |
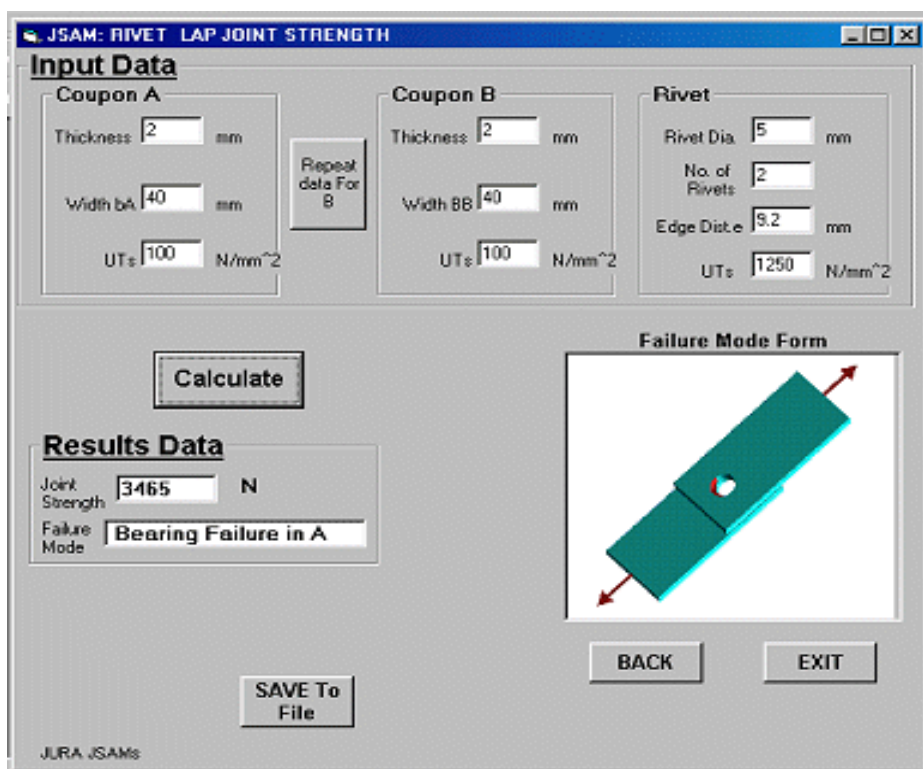


**ANSWER:  The riveted joint failure strength is;   3465 N**

**The mode of failure is by Bearing.**

## JSAM3: RIVET AXIAL LOAD AT LAP JOINT FAILURE

For a riveted Lap joint, calculate the axial load in the rivets at joint failure.

The coupon adherends are aluminium with a thickness of 2mm and an utimate Bearing strength of 100 N/mm^2.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam3. The input table below provides the required data.

**INPUT DATA**

| Minimum Flange Thickness: | Ttv | 4 mm |
|---|---|---|
| Joint adherend Material strength: | Uts | 100 N/mm^2 |
| Leg Tip set: | Rtd | 7.4 mm |
| Straight Leg set: | Pd | 5.5 mm |
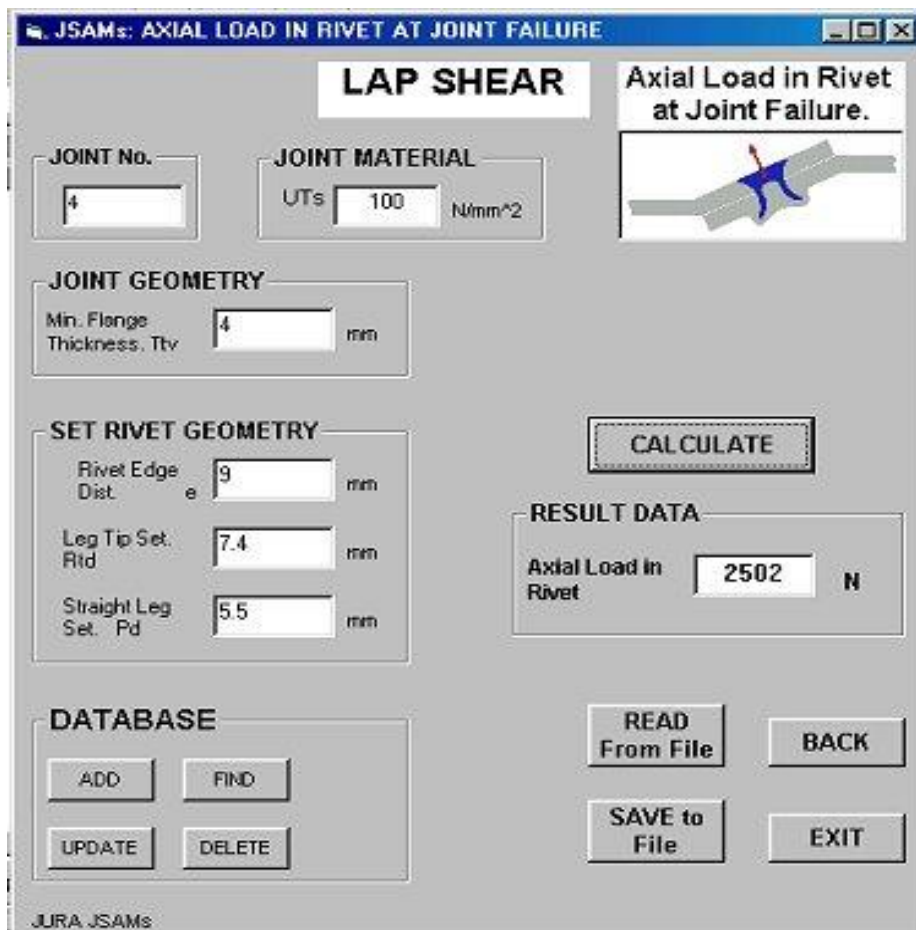


**ANSWER: The axial load in the rivet at joint failure is;  2502 N**

## JSAM4:    ACM2 Rivet Equivalent diameter ( ESRD ).

Calculate the equivalent self-piercing rivet diameter (ESRD), for a 7.4 mm diameter rivet, that would be used in place of a weld diameter, in the ACM2/NASTRAN program. Coupon adherends are aluminium and are each 2mm thick.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam4. The input table below provides the required data.

### INPUT DATA

| | | |
|---|---|---|
| Rivet Top diameter: | dh | 8.2 mm |
| Rivet Shank diameter: | dn | 7.75 mm |
| Rivet Internal Wall diameter: | dr | 5.2 mm |
| Rivet Set Length: | Lr | 5.9 mm |
| Rivet Upper Set Length: | Lu | 1.18 mm |
| Rivet Lower Set Length: | LL | 4.58 mm |
| Rivet Young's Modulus: | Er | 200000 N/mm^2 |
| Rivet diameter: | | 6.2 mm |
| Coupon adherend thickness: | | 2.3 mm |
| Coupon Young's Modulus: | Ema | 72000 N/mm^2 |
| Coupon adherend width: | bcw | 30 mm |
| Coupon adherend overlap: | wL | 22 mm |
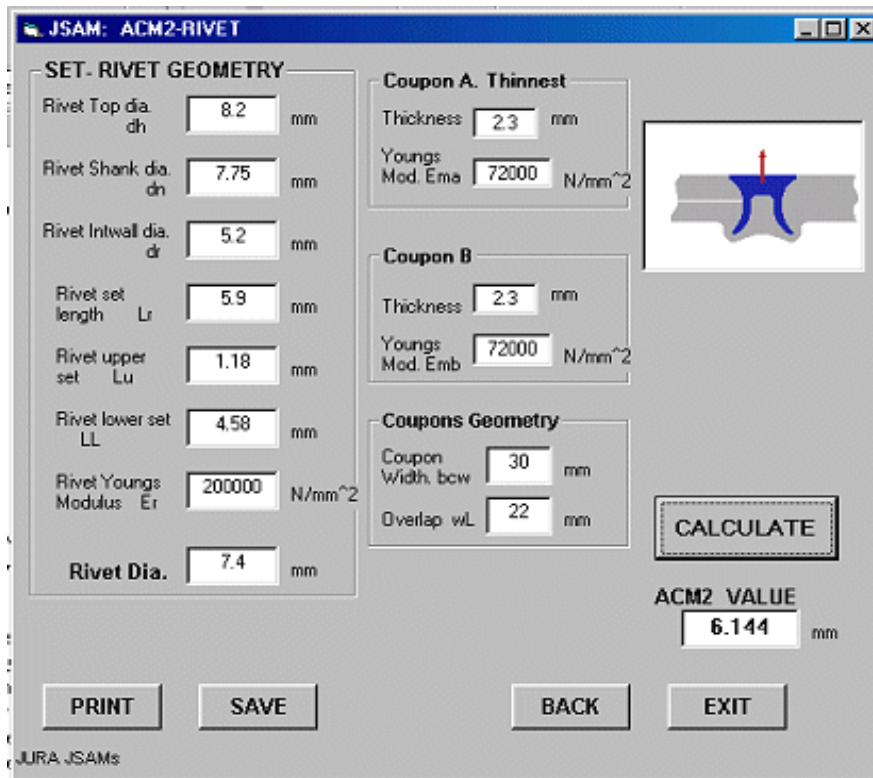


**ANSWER: For a 7.4 mm rivet diameter, the equivalent self-piercing rivet diameter, ESRD is;   6.144 mm**
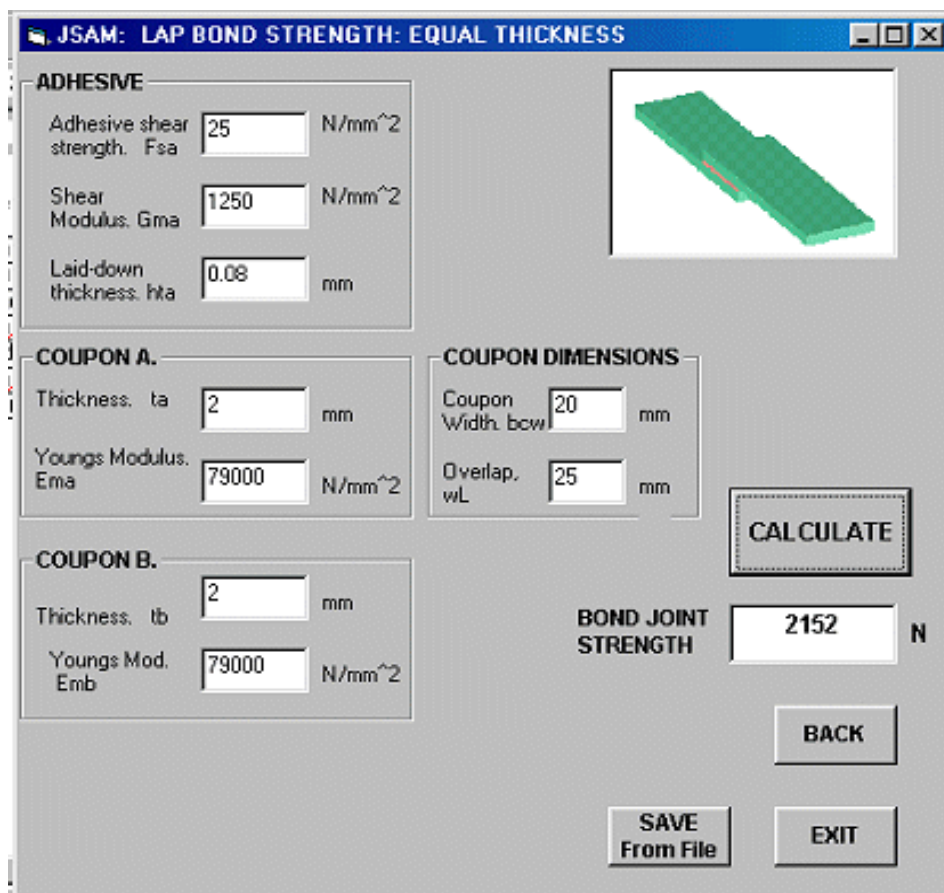
## JSAM5: ADHESIVELY BONDED LAP JOINT; ELASTIC STRENGTH:  Equal Thickness

For an adhesively bonded lap joint of adherends of **equal** thickness, calculate the elastic failure strength. Coupon adherends are aluminium and are each 2mm thick.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam5. The input table below provides the required data.

**INPUT DATA**

| Adhesive shear strength: | Fsa | 25 N/mm^2 |
|---|---|---|
| Shear Modulus: | Gma | 1250 N/mm^2 |
| Laid down adhesive thickness: | hta | 0.08 mm |
| Coupon adherend thickness: | ta | 2 mm |
| Youngs modulus: | Ema | 79000 N/mm^2 |
| Coupon adherend width: | bcw | 20 mm |
| Coupon overlap: | wL | 25 mm |



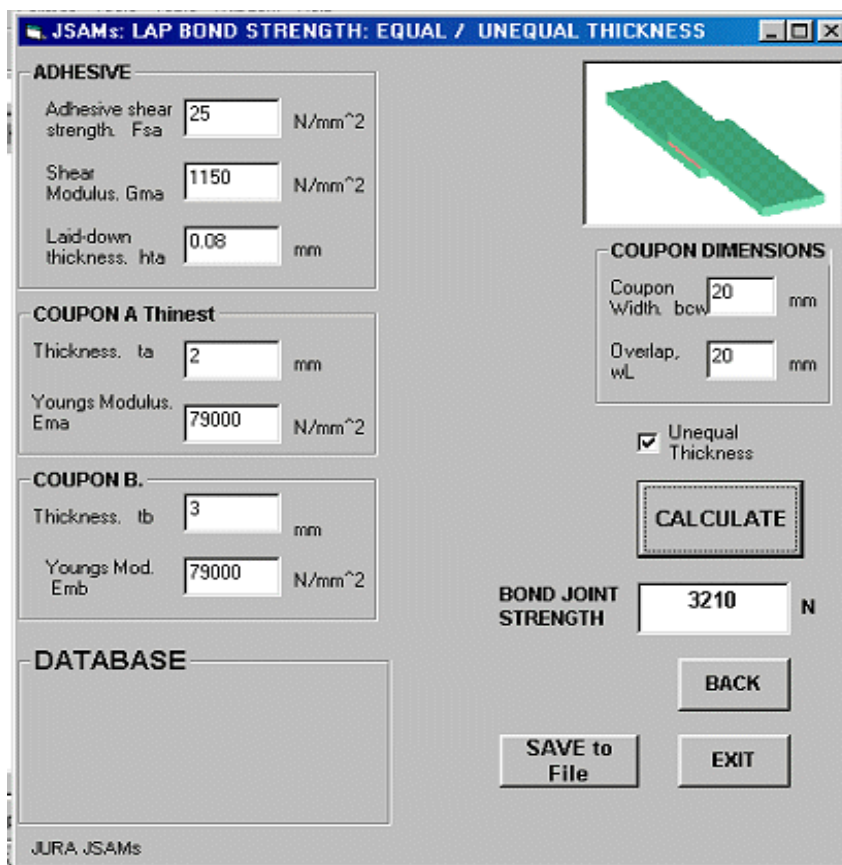**ANSWER:  The Elastic failure strength of the lap joint is;  2152 N**

## JSAM6: ADHESIVE BONDED LAP JOINT; ELASTIC STRENGTH: Unequal Thickness.

For an adhesively bonded lap joint of adherends of **unequal** thickness, calculate the elastic failure strength. Coupon adherends are aluminium and are each 2mm thick.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam6. The input table below provides the required data.

### INPUT DATA

| | | |
|---|---|---|
| Adhesive shear strength: | Fsa | 25 N/mm^2 |
| Shear Modulus: | Gma | 1250 N/mm^2 |
| Laid down adhesive thickness: | hta | 0.08 mm |
| Coupon adherend thickness: | ta | 2 mm |
| Youngs modulus: | Ema | 79000 N/mm^2 |
| Coupon adherend thickness: | Tb | 3 mm |
| Youngs modulus: | Emb | 79000 N/mm^2 |
| Coupon adherend width: | bcw | 20 mm |
| Coupon overlap: | wL | 20 mm |



**ANSWER:** The Elastic failure strength of the lap joint is; 3210 N

## JSAM7: COMBINED RIVET AND ADHESIVE BONDED LAP JOINT STRENGTH:

Calculate the ultimate failure strength; For a combined rivet/adhesively bonded lap joint of **unequal** thickness, containing three self piercing rivets of 6mm diameter. Coupon adherends are aluminium and are 2mm and 3mm thick respectively. The input data table gives full details of the joint.

Refer to the drawing within the JSAMs showing the required rivet dimensions to be used as input for JSAM7. The input table below provides the required data

### INPUT DATA

| Coupon A. thickness: | | 2 mm |
|---|---|---|
| Coupon A. Ultimate Tensile Strength: | uTs | 235 N/mm^2 |
| Coupon A. Youngs modulus: | Ema | 79000 N/mm^2 |
| Coupon B. thickness: | | 3 mm |
| Coupon B. Ultimate Tensile Strength: | uTs | 200 N/mm^2 |
| Coupon B. Youngs modulus: | Emb | 95000 N/mm^2 |
| Rivet diameter: | | 6 mm |
| Number of Rivets in Joint: | | 3 |
| Rivet Edge distance: | e | 9.0 mm |
| Coupon adherend width: | bcw | 25 mm |
| Coupon overlap: | wL | 25 mm |
| Adhesive shear strength: | Fsa | 25 N/mm^2 |
| Shear Modulus: | Gma | 1255 N/mm^2 |
| Laid down adhesive thickness: | hta | 0.09 mm |
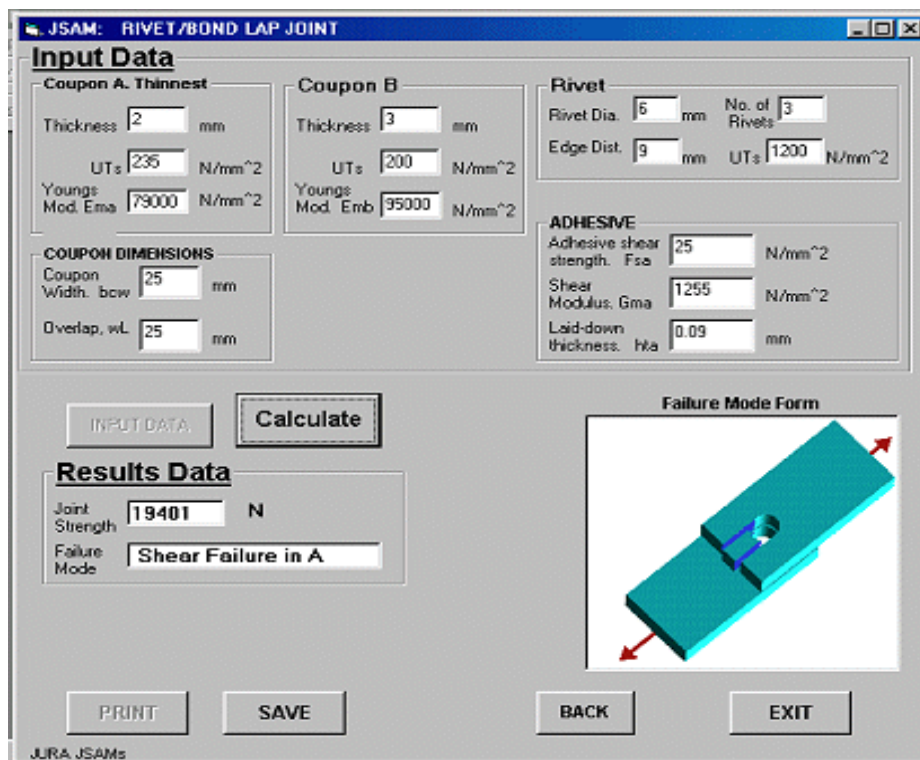


**ANSWER:** **The combined riveted/bonded lap joint failure strength is; 19401 N**
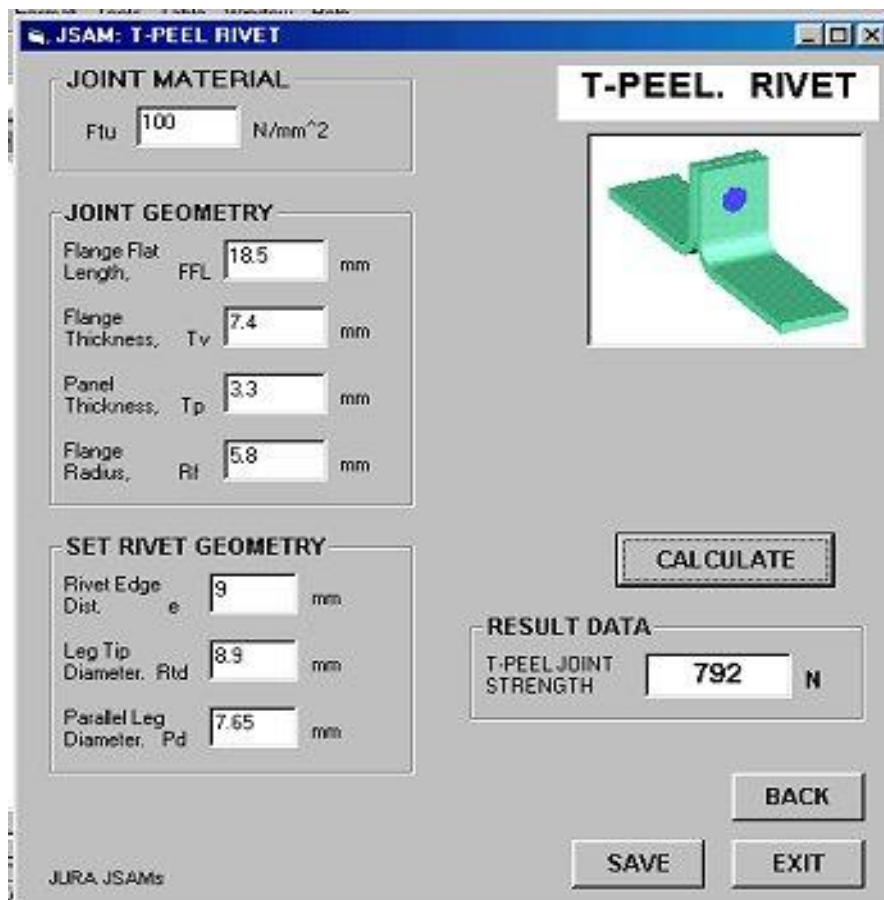
The mode of failure is by Shear out.

## JSAM8:        RIVETED T-PEEL JOINT STRENGTH.

For a riveted T-Peel joint, calculate the load to cause joint failure. The coupon adherends are aluminium with a thickness of 2mm and an utimate Bearing strength of 100 N/mm^2.

Refer to the drawing within the Jsams showing the required rivet and Joint dimensions to be used as input for Jsam8. The input table below provides the required data.

**INPUT DATA**

| Joint adherend Material strength: | Uts ( Ftu ) | 100 N/mm^2 |
|---|---|---|
| Flange Flat length: | FFL | 18.5 mm |
| Flange Thickness: | Tv | 7.4 mm |
| Panel Thickness: | Tp | 3.3 mm |
| Flange Radius: | Rf | 5.8 mm |
| Rivet Edge distance: | e | 9.0 mm |
| Leg Tip set: | Rtd | 7.4 mm |
| Straight Leg set : | Pd | 5.5 mm |



**ANSWER:  The T-Peel Joint Strength is:     792 N**

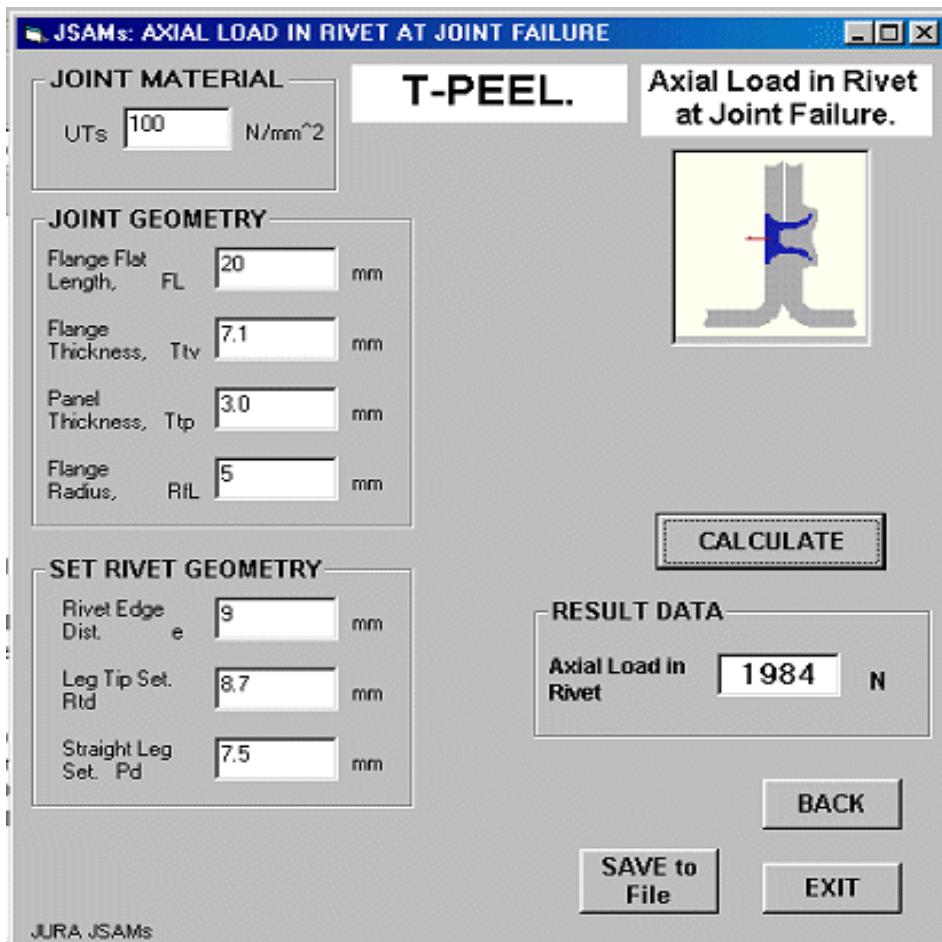## JSAM9: RIVET AXIAL LOAD AT T-PEEL JOINT FAILURE

For a riveted T-Peel joint, calculate the axial load in the rivet at joint failure.

The coupon adherends are aluminium with a thickness of 3mm and an utimate Bearing strength of 100 N/mm^2.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam9. The input table below provides the required data

### INPUT DATA

| | | |
|---|---|---|
| Joint adherend Material strength: | Uts ( Ftu ) | 100 N/mm^2 |
| Flange Flat length: | FFL | 20.0 mm |
| Flange Thickness: | Tv | 7.1 mm |
| Panel Thickness: | Tp | 3.0 mm |
| Flange Radius: | Rf | 5.0 mm |
| Rivet Edge distance: | e | 9.0 mm |
| Leg Tip set: | Rtd | 8.7 mm |
| Straight Leg set : | Pd | 7.5 mm |



**ANSWER:  The axial load in the rivet at joint failure is;   1984 N**

## JSAM10:  T-PEEL JOINT:  ADHESIVE BOND FAILURE STRENGTH:

For an adhesively bonded T-Peel bonded joint of adherends of **equal** thickness, calculate the elastic failure strength. In this particular example the coupon adherends are aluminium and are each 2mm thick. However, the formula is independent of thickness.

Refer to the drawing within the Jsams showing the required rivet dimensions to be used as input for Jsam10. The input table below provides the required data.

### INPUT DATA

| | | |
|---|---|---|
| Shear Modulus: | Gma | 1000 N/mm^2 |
| Laid down adhesive thickness: | hta | 0.2 mm |
| Coupon adherend width: | bcw | 50 mm |
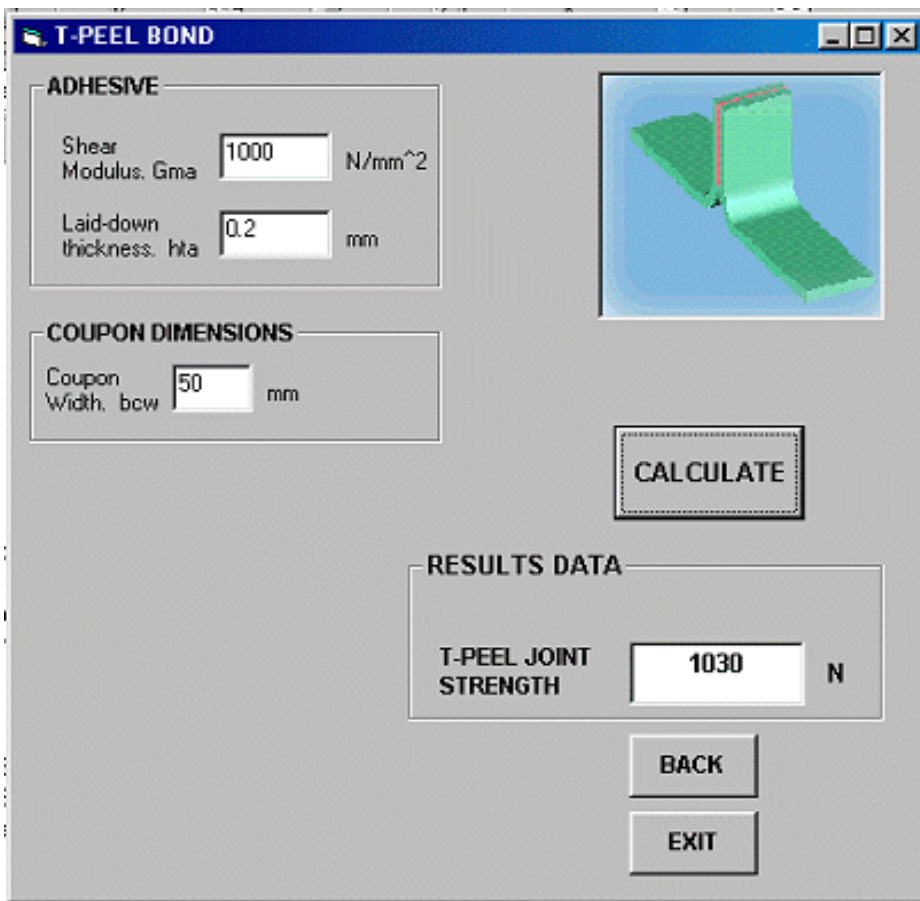


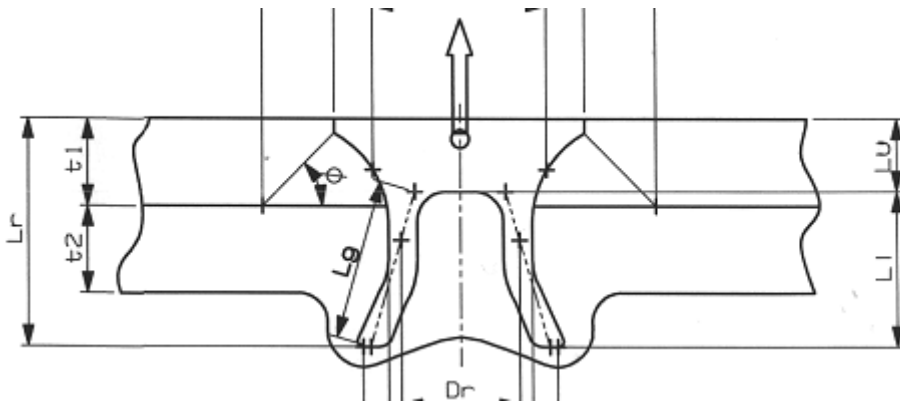**ANSWER:  The Elastic failure strength of the T-Peel joint is;  1030  N**

# JOINT DRAWINGS:

## JOINT DRAWINGS:

Showing dimensional requirements for the JSAM module requirements.

### Drawing Riv3c:

For every self piercing riveted Lap joint, that uses different rivets, the dimensions shown in the drawing below will be required. (Not all dimensions are shown in the diagram below)

**Drawing Tp2:**

For every self piercing riveted T-Peel joint, that uses different joint geometry dimensions, the dimensions shown in the drawing below will be required. (Not all dimensions are shown in the diagram below).