# Application Example: Material Testing

# Material Analysis: Riveted joint under load

Measuring Systems: ARAMIS
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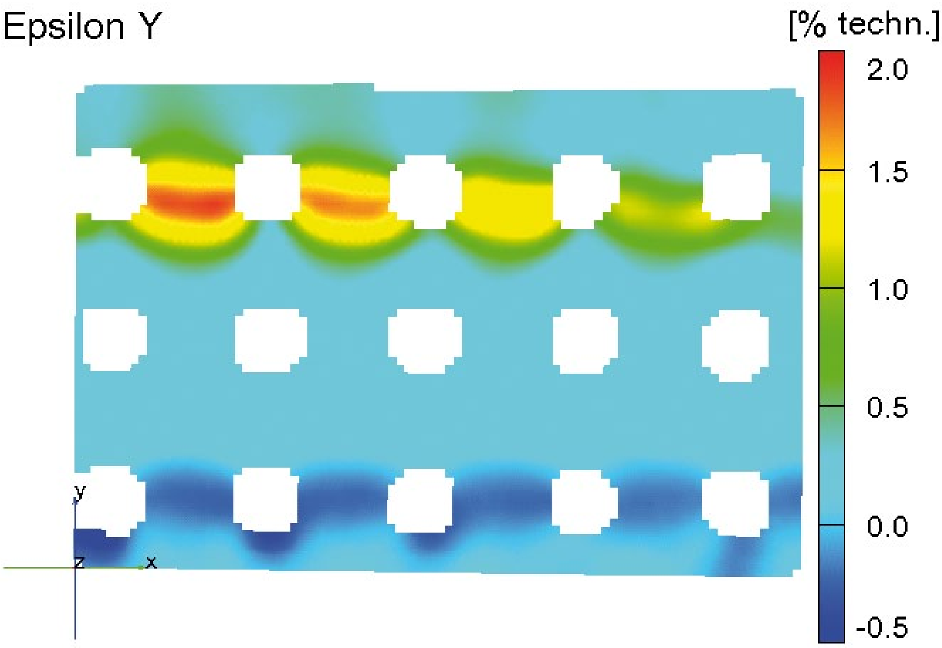
Rivets are proven to join aluminum sheets or fasten them to the support structure in light weight constructions. This application note shows a simple test set-up, consisting of two aluminum sheets, joined together using three rows of rivets.




**GOM mbH**
Mittelweg 7-8
38106 Braunschweig
Germany
Phone +49 531 390 29 0
Fax +49 531 390 29 15
info@gom.com

**GOM International AG**
Bremgarterstrasse 89B
8967 Widen
Switzerland
Phone +41 5 66 31 04 04
Fax +41 5 66 31 04 07
international@gom.com

**GOM France SAS**
10 Quai de la Borde - Bât A2
91130 Ris Orangis
France
Phone +33 1 60 47 90 50
Fax +33 1 69 06 63 60
info-france@gom.com

**GOM UK Ltd**
Business Innovation Centre
Coventry, CV3 2TX
Great Britain
Phone +44 2476 430 230
Fax +44 2476 430 001
info-uk@gom.com

**GOM Branch Benelux**
Interleuvenlaan 15 E
3001 Leuven
Belgium
Phone +32 16 408 034
Fax +32 16 408 734
info-benelux@gom.com

# Material Testing / Material Analysis

## Riveted joint under load

Rivets are proven to join aluminum sheets or fasten them to the support structure in light weight constructions.
To install and test a new ordered ARAMIS system in the Testing Technology laboratory of AIRBUS, Bremen, Mr. Torben Kluwe prepared a simple test set-up, consisting of two aluminum sheets (material 3.1364-T3), joined together using three rows of rivets.
The sample was spray-painted using an aerosol can with black mat acrylic paint. The spray button was pressed very gently to produce a high-contrast splash pattern on the area to be measured (figure 1).

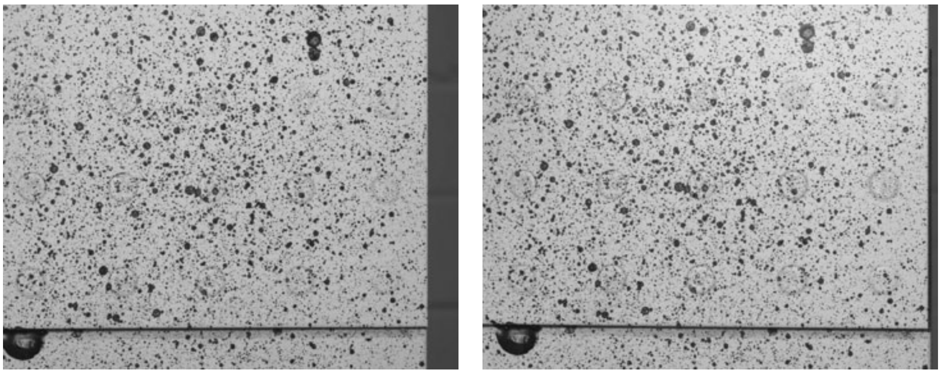


Fig. 1: Sample with splash pattern. The two images show the overlapping area of the two sheets, with the rivets in three rows, before load was applied

Then, the sample was installed in the tensile testing machine and the ARAMIS 3D system was calibrated and positioned in front of the sample. During the tensile test, the cameras are to observe and record the 3D displacement of the rivet area and the corresponding tensile force, in regular time intervals. In addition, the applied tensile force is read in and stored. The value of the actual force is also assigned to each snapped image pair. Then, the behavior of the sample during the test shall be evaluated and displayed graphically.
Fig. 2 shows the resulting load displacement diagram. Immediately visible is the shearing of the rivets shortly after load step 60 and the total failure shortly after load step 80.

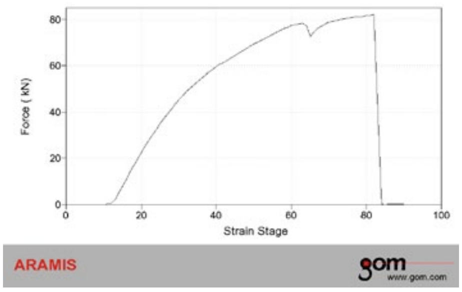



Fig. 2: Load displacement diagram during 90 captured stages

The deformation of the sample is visible in the captured image series (fig. 3). However, to get detailed results, the graphical plot of the measured deformation is used. First, the coordinate system of the gathered data was adjusted to the actual measuring set-up and the lower end of the front sheet was used to define the location of zero movement.

Figure 4 shows the local deformation of the rivets and the asymmetrical and non-uniform displacement of the sheet.

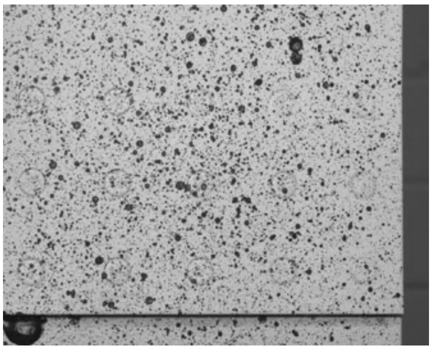


Fig. 3: Sample loaded with 77kN, load stage 60

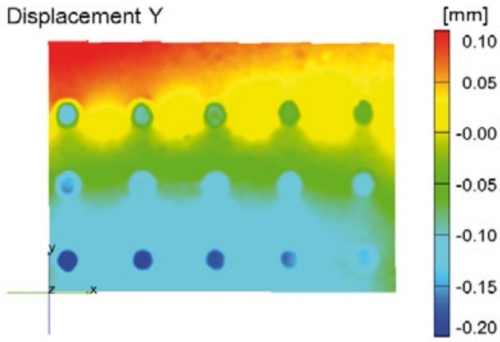



Fig. 4: Relative displacement in tensile direction (Y-displacement), load stage 60

Masking the rivets shows the deformation of the sheet very clearly. As often in tensile tests of riveted sheet metals, the sample under load starts tilting in Z-direction (vertical to the sheet surface). In vertical direction, only small displacements are measured.

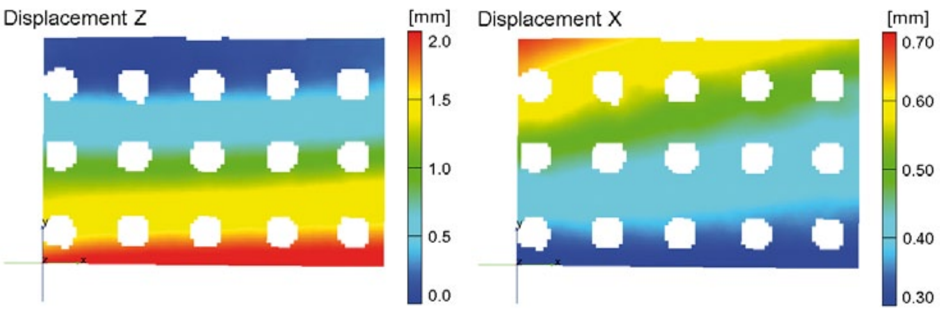



Fig. 5: Deformation values of the load stage 60, referenced to load stage 0. Visible in the left image is the Z-movement (in viewing direction) and in the right image the vertical displacement, in X direction

Strain data often give an easier understanding of the behavior of a sample under load. Therefore, figure 6 displays the differentiated displacement values (strain values) of the load stage 80 graphically. For the actual calculation of the strain values in the left image, a short base length of 0.57 mm was used, showing local strain maxima and inhomogeneities. To show the averaged deformation in the sheet metal, a longer base length of 1 mm was used.

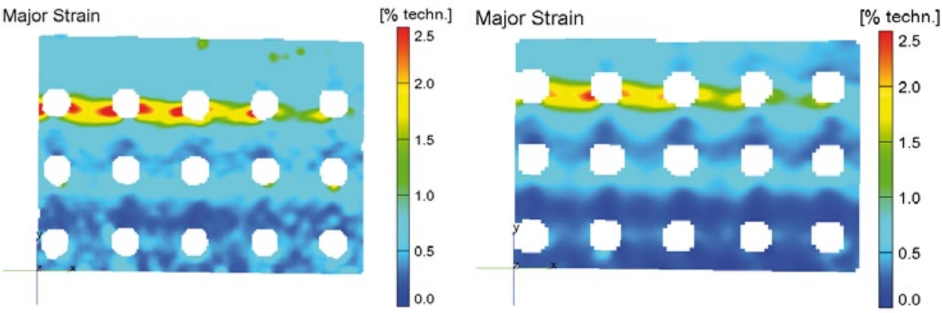



Fig. 6: These images show the major strain at load stage 80, calculated for the left image using a base length of 0.57 mm and for the right image with a base length of 1 mm

Figure 7 shows the sample shortly before the failure, with clearly visible rivets, at load stage 80, in the left image, and after the failure, at load stage 84, in the right image.

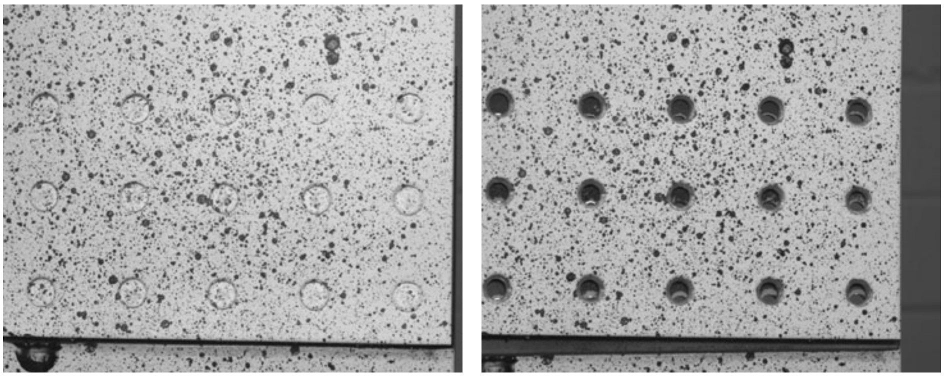


Fig. 7: Sample, at load stage 80, in the left image. In the right image, the sample after failure is visible, at load stage 84

Figure 8 shows the strain distribution shortly before the failure of the rivets (load stage 80). Clearly visible is pressure-strain in the area of the lower rivets and tensile strain in the area of the other rivets. The area of high strain is caused by the bending of the sheet under load.

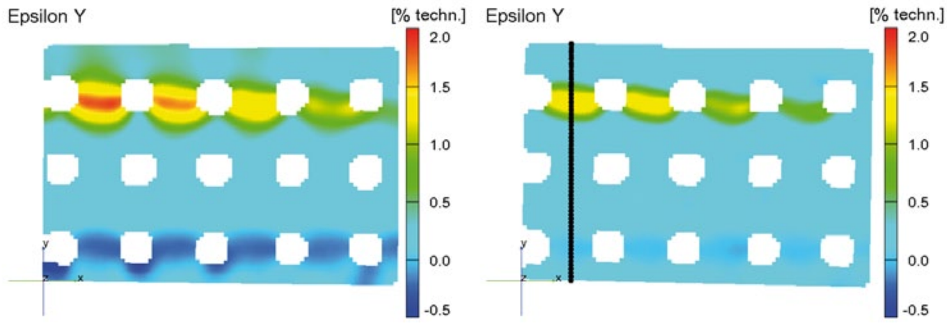



Fig. 8: Graphical display of the epsilon strain values in vertical direction, in the left image at load stage 80 before failure and in the right image, at load stage 84, after failure

In figure 9, the strain values in a section parallel to the tensile direction, as indicated in figure 8, is shown. Here, the total strain before the failure and the remaining strain after the complete failure is clearly visible.

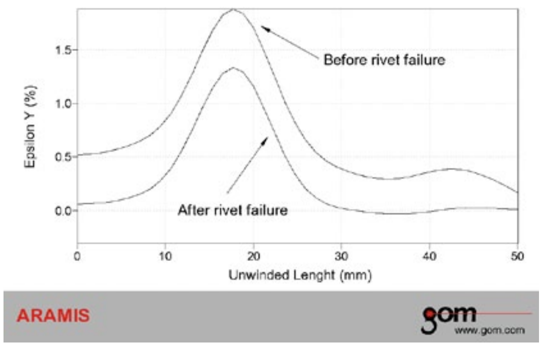



Fig. 9: Plot of the section, shortly before and after the complete failure

This test set-up was made to install and test the newly ordered ARAMIS system. Of course, the measuring set-up as well as data gathering and analysis could be optimized. However, this test demonstrated that already with a minimal preparation reasonable measuring can be carried out within a short time visualizing the behavior and the characteristics of the actual probe under load.

By courtesy of AIRBUS Bremen, Testing Technology.