Shear and reverse shear testing

AA 6016-T4

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Equipment:

- ❑ Bi-axial machine (Built in ULiège) (Fig 1)
- ❑ Optical system (2 cameras) (Fig 2)
- ❑ Computer 1: Command the pistons
- ❑ Computer 2: Image acquisition (from the optical system)+ Force and displacement acquisition (from the Bi-axial machine)

Fig 1: Bi-axial machine

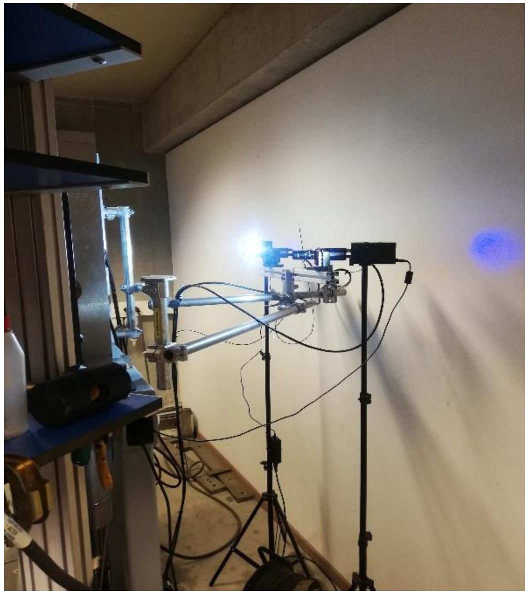
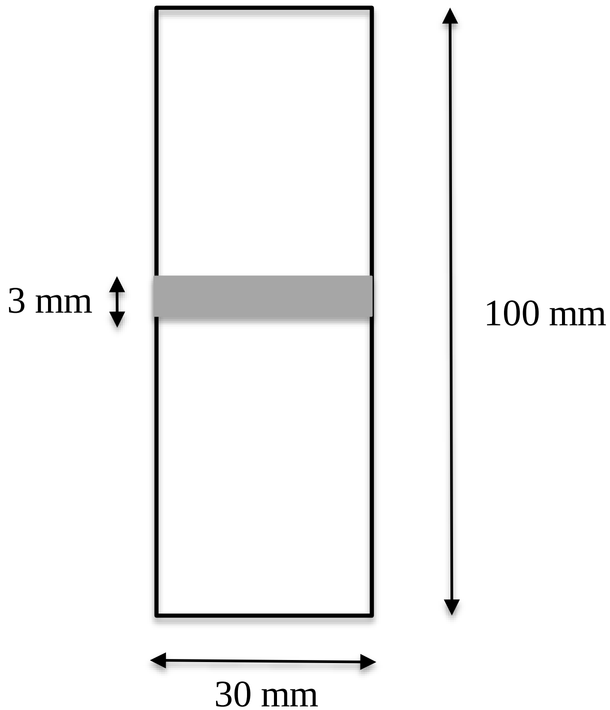
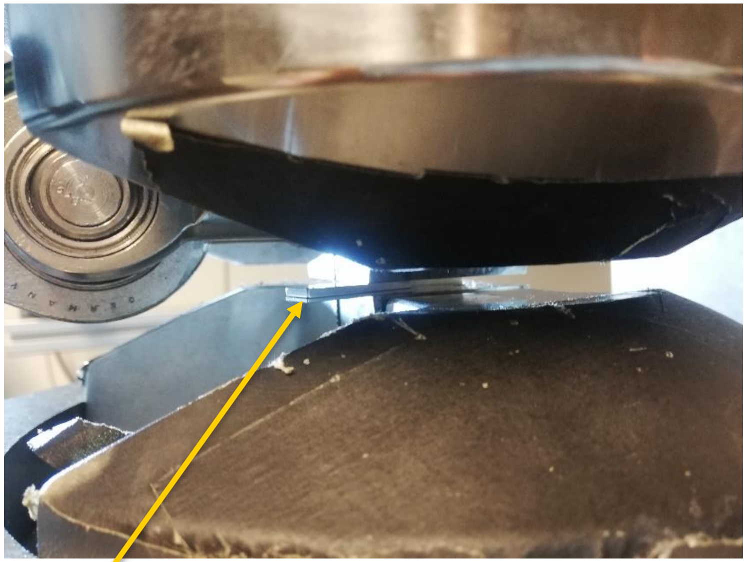


Fig 2: Optical system

Test conditions:

- ❑ Constant crosshead speed 1mm/min
- ❑ Room temperature
- ❑ The deformation zone is 30mm X 3mm (Fig 3)





Hold of 3 mm

Used software:

- ❑ "Tema" installed in computer 1 to command the horizontal piston (Fig 4)
- ❑ "VIC 3D" installed in computer 2 for the image acquisition (Fig 5)

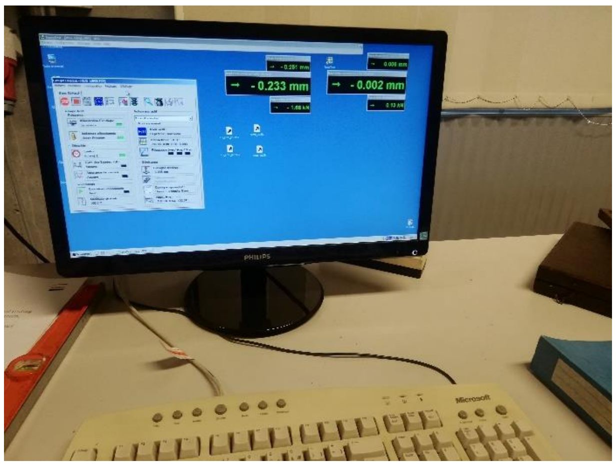


Fig 4: Tema software

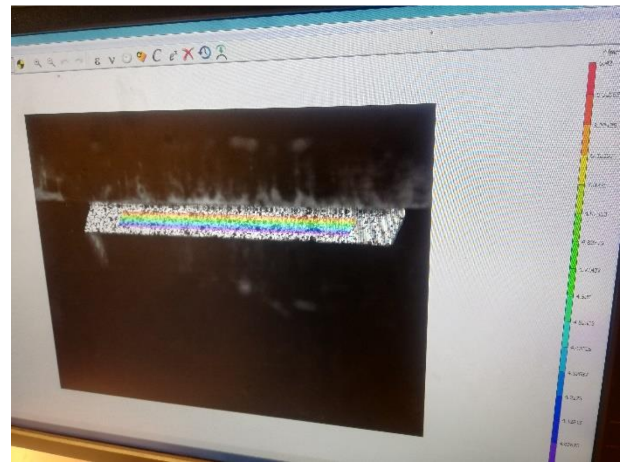


Fig 5: VIC 3D

Different types of strain tensor in VIC 3D:

Lagrange – Hencky – EulerAlmansi – Logarithmic EulerAlmansi - Engineering

The chosen type (seen its simple relation with the shear strain that Aaramis gives)

Lagrange strain:

Simple shear

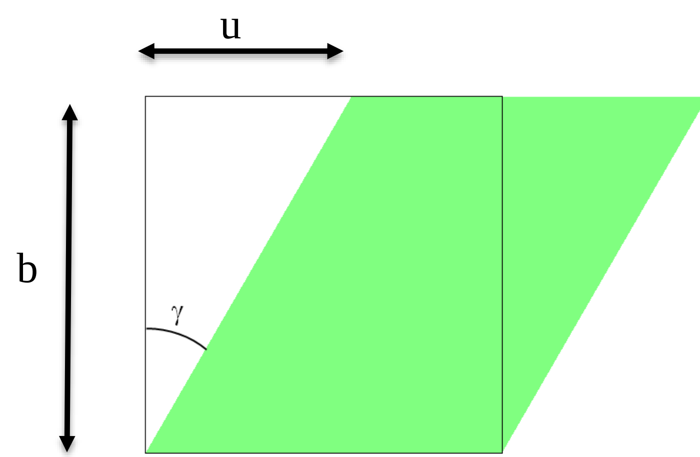
$$
\begin{aligned}
x &= X + \tan\gamma \cdot Y \\
y &= Y \\
z &= Z
\end{aligned}
$$

Displacements field

$$
\begin{aligned}
u &= \tan\gamma \cdot Y \\
v &= 0 \\
w &= 0
\end{aligned}
$$

Transformation tensor

$$
\mathbf{F} = \frac{\partial \mathbf{x}}{\partial \mathbf{X}} = \begin{bmatrix} 1 & \tan\gamma & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$



Cauchy-Green and Green-Lagrange

$$
\mathbf{C} = \mathbf{F}^T\mathbf{F} = \begin{bmatrix} 1 & \tan\gamma & 0 \\ \tan\gamma & 1 + \tan^2\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

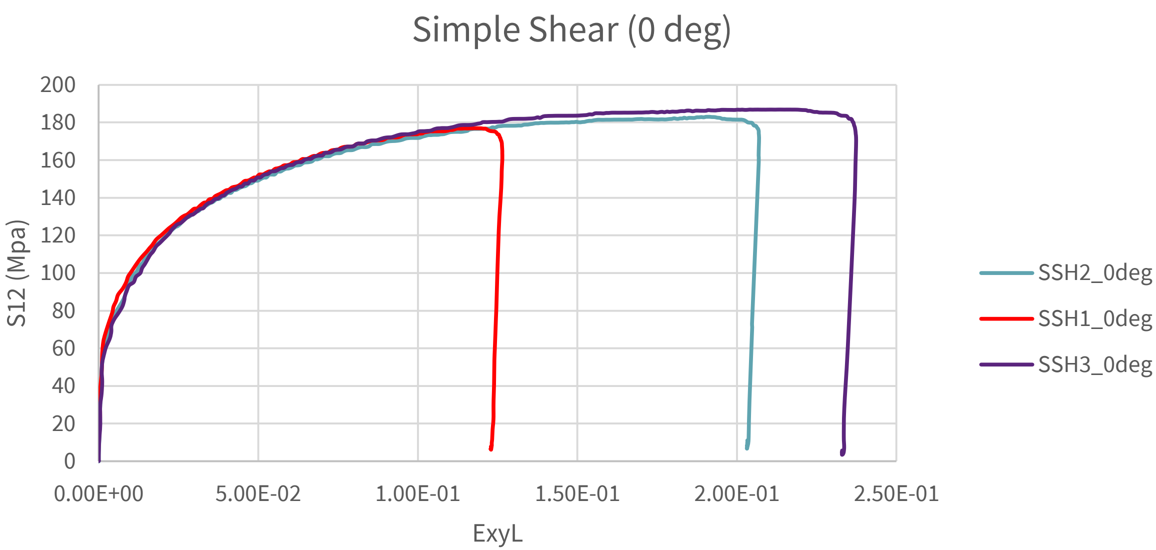
$$
\mathbf{E} = \frac{1}{2}(\mathbf{C} - \mathbf{I}) = \frac{1}{2} \begin{bmatrix} 0 & \tan\gamma & 0 \\ \tan\gamma & \tan^2\gamma & 0 \\ 0 & 0 & 0 \end{bmatrix}
$$

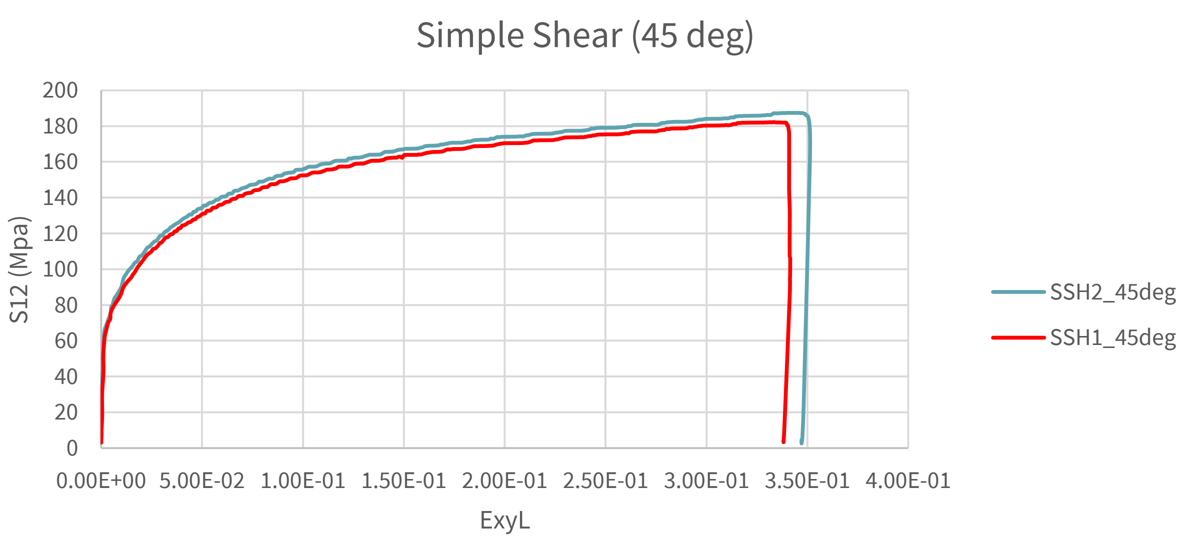
For small angles/deformations

$$
\varepsilon = \frac{1}{2} \begin{bmatrix} 0 & \boxed{\gamma} & 0 \\ \gamma & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}
$$

γ=u/b

Simple shear:





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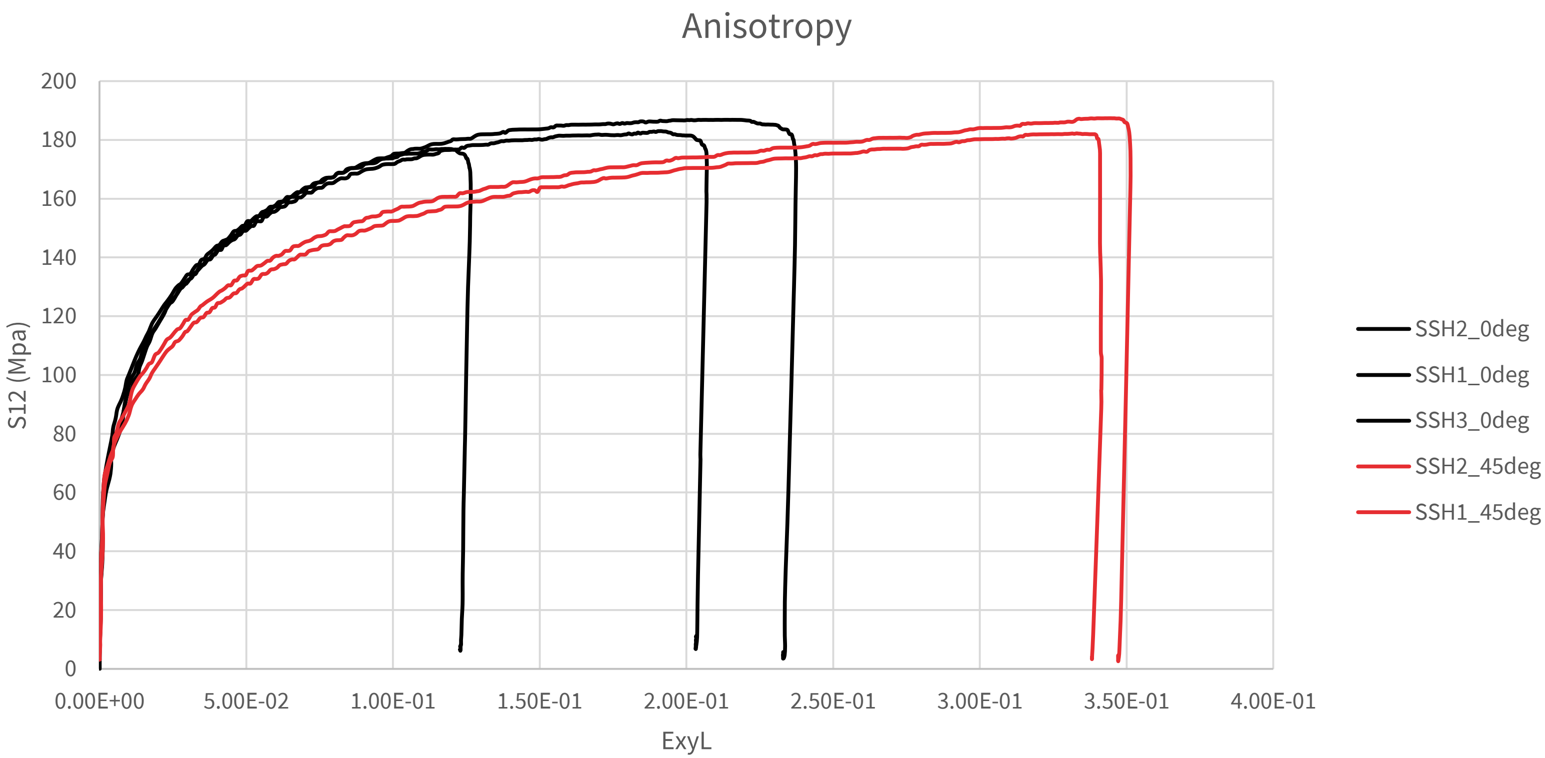
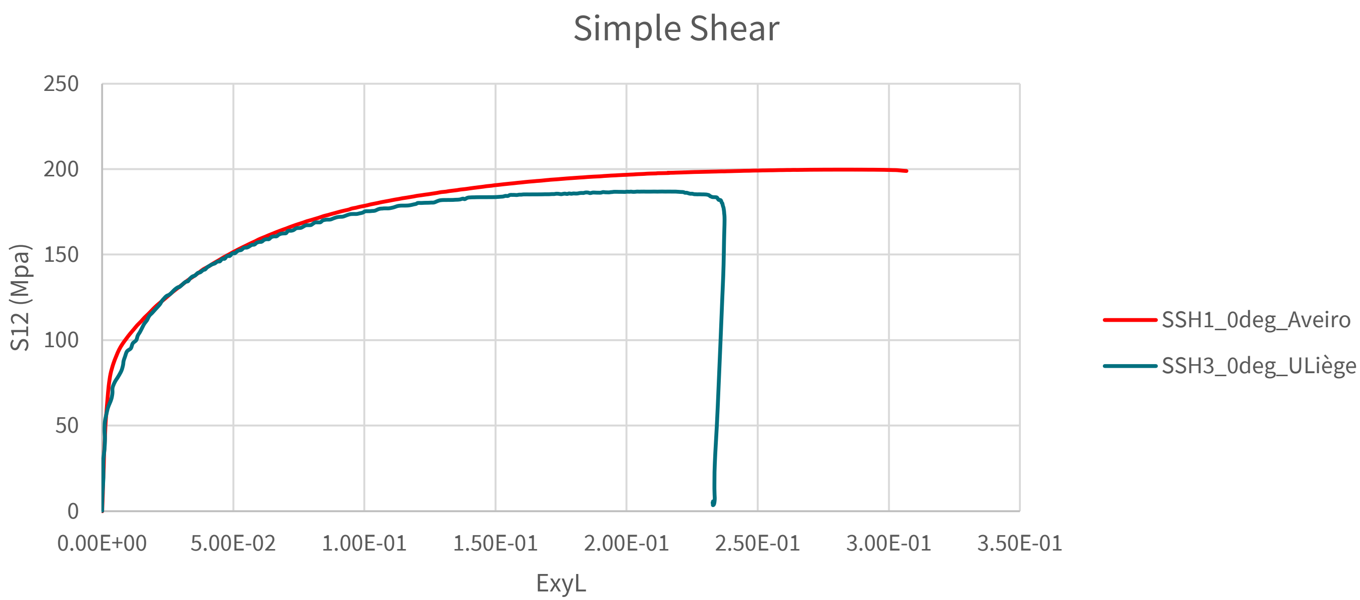
Simple shear: Anisotropy



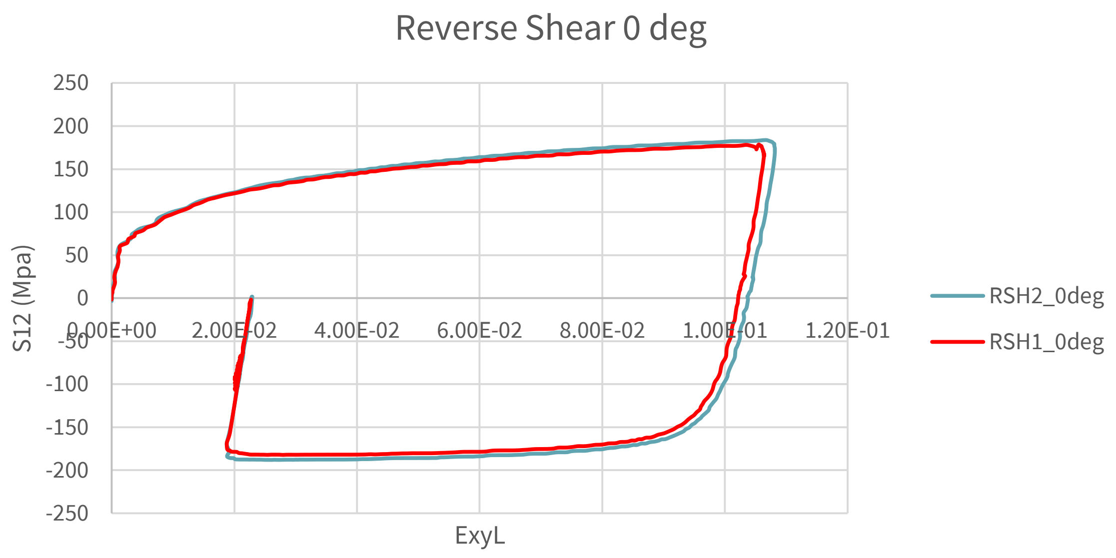
Simple shear: ULiège vs Aveiro



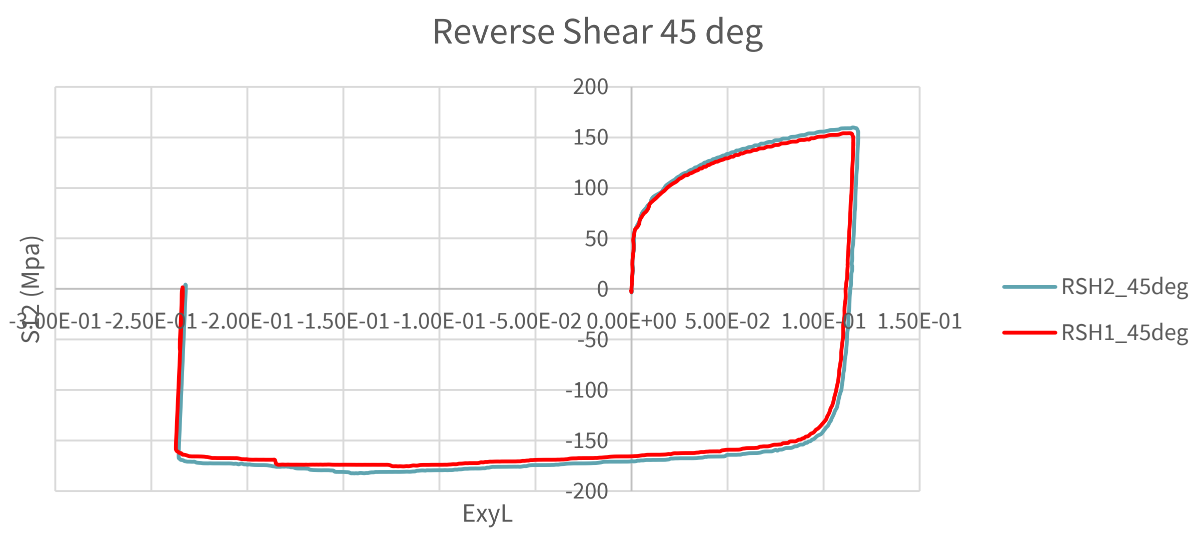
$$\varepsilon_{xy} = \frac{1}{2}\gamma$$

Reverse shear (Exy = 10% (ULiège); Gamma = 20% (Aveiro)):

Exy_R = 10,2%



Exy_R = 11,1%



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