PMMA Mixed mode fracture
doi: 10.5281/zenodo.1473126

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October 28, 2018

1 Test description

An experiment is conducted using a conventional tensile electromechanical device. The geometry of the sample, inspired from [1] is a rectangular plate of 140 mm×70 mm with a hole of 30 mm in diameter, see Figure 1. The hole center is aligned along the transverse (Y) direction and it is shifted by 25 mm from the specimen center along X direction. The specimen thickness is 10 mm. The material is a commercial PolyMethyl Methacrylate (PMMA) (Perspex).

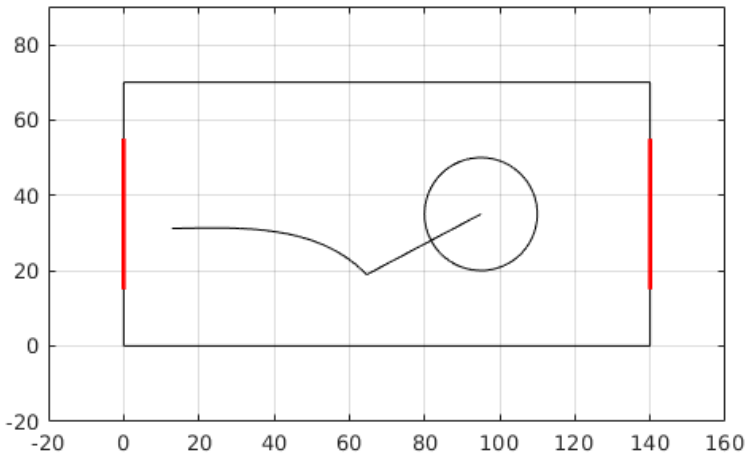

Figure 1: Schematic of the sample geometry with final crack obtained under a compressive displacement control along the red lines. The axis unit is in mm

A pre-notch is machined manually before the specimen is submitted to a compressive load along X at a constant speed of 0.1 mm/min. The pre-notch of about 35 mm length from the hole center, with an angle of 30^o with respect to the X axis, is chosen for generating mixed-mode conditions at initiation and growth.

During the experiment, grey scale images of 4872×3248 pixels, with 8-bit digitization, are acquired every 5 s. The camera is mounted with a 200 mm Nikon lens, resulting in a physical pixel size of 32.5 μm. The sample surface is prepared using white and black spray paints, see Figure 1. 113 images are captured before complete failure. Crack initiation occurs between image 27 and image 28.

2 Results from DIC

DIC analysis has been performed allowing for extracting the actual prescribed displacement along the red lines of Figure 1. The load displacement response is given in Figure 2.

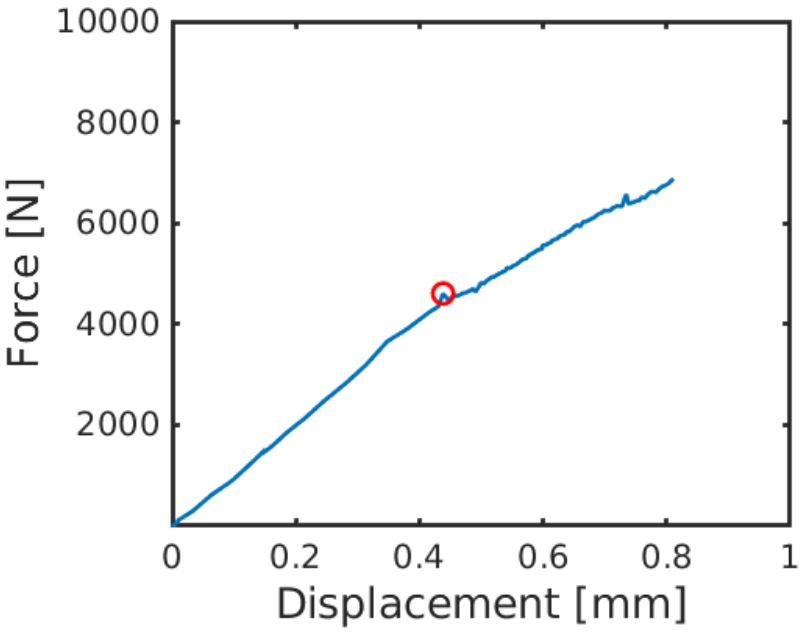

Figure 2: Load displacement curve

Also, the methodology developed in [2] has been used to extract the actual crack tip position and mixed mode SIF. The value of T-stress is also obtained during the analysis (see Figure 3). In this analysis, carried out for images between 29 and 113, it has been considered that the elastic properties of PMMA, within the strain rate range of the quasi-static experiment conducted herein, are $E = 5$ GPa for the Young's modulus and $\nu = 0.32$ for the Poisson's ratio.

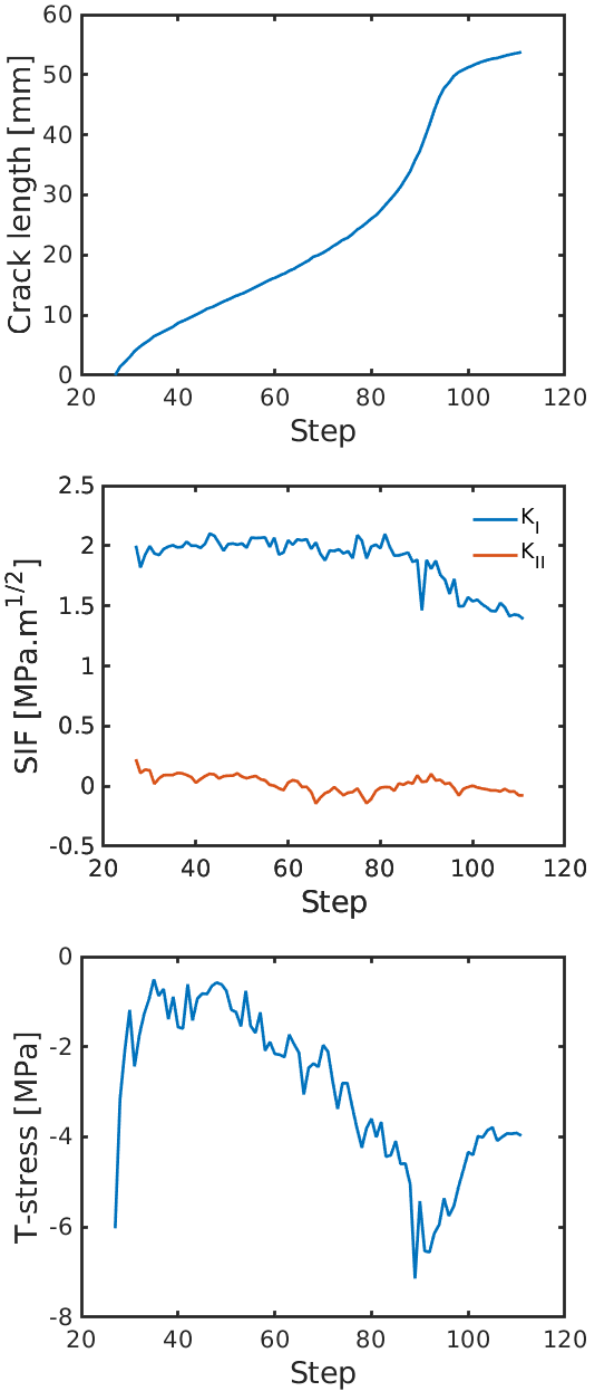

Figure 3: Crack tip history

3 Data

- Image.zip: TIF images acquired during the experiment. They are labelled from 1 to 113. The first image is used as the reference image for load measurement and DIC.
- force-displacement.csv: load (N) displacement (mm) curve, one line per image.
- crack-path.csv: crack geometry (the first two points define the initial notch geometry. Then one line per image between 29 and 113.
- crack-tip.csv: crack tip position (mm), K1 (MPa.$\sqrt{\text{m}}$), K2 (MPa.$\sqrt{\text{m}}$), T-stress (MPa). One line per image between 29 and 113.
- pmma.stl, pmma.vtk: mesh used for DIC in STL and VTK format
- ux.csv: x (mm), y (mm), horizontal displacement ux (mm). One line per node, one column per image.
- uy.csv: x (mm), y (mm), vertical displacement uy (mm). One line per node, one column per image.
- VTK.zip: output files from DIC (binary VTK format)

References

[1] D. Grégoire, H. Maigre, J. Réthoré, and A. Combescure. Dynamic crack propagation under mixed-mode loading - comparison between experiments and x-fem simulations. *International Journal of Solids and Structures*, 44(20):6517–6534, 2007.

[2] J Réthoré. Automatic crack tip detection and stress intensity factors estimation of curved cracks from digital images. *International Journal for Numerical Methods in Engineering*, 103(7):516–534, 2015.