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Is it possible to mimic the stress conditions of internally pressurized pipes by plane strain grooved tensile (PSGT) specimens?

C. Ovalle

Mines Paris, PSL University, Centre for Material Sciences (MAT), CNRS UMR7633 BP 87, F-91003 Evry Cedex,
France

Plastic pipes are widely used for the conveyance of water for human consumption and raw water prior to treatment. ISO/TC 138 provides a set of system standards that specify the requirements for a piping system and its components when made from polyethylene (PE). Precisely, with regard to moulding materials for pipes and fittings, ISO 23228:2011 [1] proposed a testing method in which the plastic material, experimental resins or compounds for pipes and fittings, can be exposed to stress conditions that mimic internally pressurized end-capped pipes. The stress conditions are reproduced by the use of a plaque specimen having a grooved reduced section called plane strain grooved tensile (PSGT) specimens producing a biaxial state of stress under uni-axial loading. Regrettably, to the best of the author's knowledge, no experimental data about the evolution of the plane-strain condition in the groove during loading, nor both the effect of width or the temperature, is found in literature.

In this study, PSGT specimens were cut-out from HDPE pipes. Two shape ratios, ratio between the width and the groove thickness, were used. Both the axial and transverse displacements and strain fields were followed by a Digital Image Correlation (DIC) camera during tensile and creep loading, both at room and high temperature; furthermore, DIC images were used to estimate the notch opening displacement (NOD). Previously, the plane-strain condition was analysed by plotting the evolution of the axial and transverse displacements fields. The results seem to highlight the pertinence of PSGT specimens to mimic the stress conditions of internally pressurized end-capped pipes but on a small zone located at mid-width. A spatial *top-down* framework – NOD, displacement fields, strain fields – used to verify the plane-strain condition will be discussed. Furthermore, a new concept of plane-strain ratio is introduced, the evolution of which, during loading, will be shown [2].

[1] ISO/TC 138, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids – Determination of the stress-rupture resistance of moulding materials using plain strain grooved tensile (PSGT) specimens*, 23228:2011(E), 2011.

[2] Ovalle, C. and Broudin, M. and Laiarinandrasana, L., *Plane-strain condition in plane-strain grooved tensile (PSGT) specimens during traction and creep loading at room and high temperature*, Strain e12467, 2023.