Damage evolution in pearlitic steel specimens under tension by means of X-ray computed tomography

F. Suárez[1], J.C. Gálvez[1], Atienza, J.M.[2], Cendón, D.A.[2], Elices, M.[2], Sket, F.[3] and Molina-Aldareguia, J.[3]

[1] Departamento de Ingeniería Civil-Construcción, Universidad Politécnica de Madrid
E.T.S.I. Caminos, Canales y Puertos, C/ Profesor Aranguren s/n 28040 – Madrid, Spain
e-mail: fernandosuarezguerra1981@gmail.com

[2] Departamento de Ciencia de Materiales, Universidad Politécnica de Madrid
E.T.S.I. Caminos, Canales y Puertos, C/ Profesor Aranguren s/n 28040 – Madrid, Spain

[3] Instituto IMDEA Materiales, C/ Eric Kandel 2, Tecnogetafe 28906 – Madrid, Spain

Steel fracture mechanisms have been studied extensively over the past decades, but some aspects still remain unclear. Pearlitic steel, commonly used for manufacturing pre-stressing steel wires, presents an unusual fracture surface when tested under tension; a cylindrical specimen shows a flat surface with a dark region centered in the specimen surrounded by a bright area. When these zones are observed by means of a scanning electronic microscope, the mechanism of nucleation and growth of microvoids can be identified in the dark region.

On the other hand, one of the most widespread models typically used to reproduce the behaviour in metals is the Gurson-Tvergaard-Needleman (GTN) model [1, 2], which is based on the classic theory of nucleation, growth and coalescence of microvoids. These models have proved to be successful through the years and are able to reproduce the macroscopic damage behaviour of many metals.

In this contribution, the authors analyse the evolution of the internal damage by using X-ray computed tomography on a 3mm-diametre specimen. The specimen is tested in consecutive loading steps, after each of which it is unloaded and analysed with a X-ray tomograph. This procedure helps to identify the evolution of damage developed inside the specimen at predefined strain levels. Finally, these results are compared with the numerical results provided by the GTN model.

References

[1] Gurson, A.L. Continuum theory of ductile rupture by void nucleation and growth: Part I – Yield criteria and flow rules for porous ductile media. *J. Eng. Mater. Tech.*, January, 1977.

[2] Tvergaard, V., Needleman, A. Analysis of the cup-cone fracture in a round tensile bar. *Acta metall.*, vol. 32, number 1, 157–169, 1984.