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FRACTURE FRAMEWORK OF PLASTIC PIPES: EXPERIMENTAL WORK AND FINITE ELEMENT ANALYSIS OF DOUBLE POLYETHYLENE CANTILEVER BEAM SPECIMENS

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ABSTRACT

In this work, we performed laboratory tests of double cantilever beam (DCB) specimens of HDPE at constant displacement. These results interpreted with the fracture mechanics framework could provide useful data for lifetime prediction of HDPE pipelines. In addition, fracture parameters obtained in laboratory tests were used with a finite element (FE) model based on cohesive elements. Results of experimental and finite element analysis on fracture behavior of double cantilever beam (DCB) specimens of HDPE are presented and discussed.

Keywords: HDPE, SCG, constant displacement rate, FEM.

INTRODUCTION

Polyethylene pipes play a central role in oil, gas and water supply. Typical pipelines lifetimes of 50 years are taken for granted for modern grades. The commonly accepted failure mechanisms are characterized by crack initiation and slow crack growth (SCG). The standard extrapolation method described in EN ISO 9080 classifies these pipe grades by their minimum required strength (MRS) to ensure service times of at least 50 years. The long term behaviour of pressurized has been traditionally based on results from accelerated internal pressure tests at high temperatures. Unfortunately, the cost and long duration (i.e. 1-2 years) of these tests make them not viable in many practical circumstances. For that reason, based on a fracture mechanic approach, accelerated creep tests such PENT and FNCT [1] have been designed. These tests may take several weeks, thus granting a significant time saving when compared with full-scale tests on pipes. A recent approach used by Rink M. *et al*. [2] uses constant displacement tests instead of constant load tests on polybutene samples. This allows a further, significant reduction in testing times which in this study ranged between a few seconds and a couple of hours.

RESULTS AND CONCLUSIONS

Fracture tests have been performed on PE specimens at various testing speeds on DCB samples. The crack propagation speed was monitored by video-controlled technique (Figure 1). Tests have been carried out with varying speed in order to ascertain the influence of these variables on the general fracture behaviour of both polymers and especially on crack stability.

Complementary, a methodology for investigating SCG in polymers based on FEM analysis was tried and used to interpretate DCB experiments. The proposed approach, based on the cohesive zone model (CZM), is capable of characterizing the fracture zone explicitly, independently from the bulk material. A finite element model is developed in which bulk material is modelled as a elastic- viscoplastic one and the crack is modelled with CZM using a bilinear traction separation relationship (Figure 2).

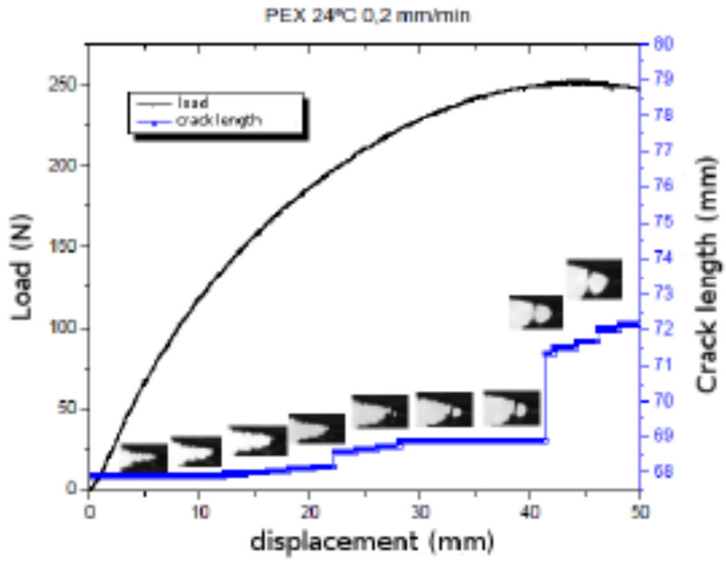

Fig. 1 - Constant rate test on DCB sample

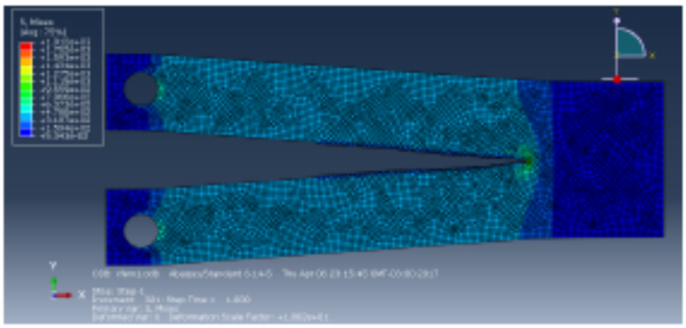

Fig. 2 - FEM simulation of SCG

REFERENCES

[1] Nezbedová, E., Hutaˇr, P., Zouhar, M., Knésl, Z., Sadílek, J., Náhlík, L. The applicability of the Pennsylvania Notch Test for a new generation of PE pipe grades. Polymer Testing, 32(1), pp. 106-114, 2013.

[2] Andena, L., Rink, M., Frassine, R., Corrieri, R. A fracture mechanics approach for the prediction of the failure time of polybutene pipes. Engineering Fracture Mechanics, 76(18), pp. 2666-2677.