EXPERIMENTAL STUDY OF SUB-CRITICAL CRACK GROWTH IN ARGILLITE

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EXPERIMENTAL DEVICE

The double torsion (DT) test is used here to characterize the evolution of subcritical crack growth (Henry *et al.*, 1977; Ciccotti *et al.*, 2000-2001). It consists in the bending of a specimen having an initial notch and which lies on two supports parallel to the crack (Nara and Kaneko, 2005-2006; Cao *et al.*, 2006). More precisely, the load is applied on both sides by a hydraulic press (capacity 20 daN, precision 0.01 N) while the displacement of the pump is measured by two LVDT sensor (precision 0.01 mm). To detect the initiation of the crack and to measure its length during the relaxation phase, a numerical camera (resolution 25 µm) has been positioned under the specimen (Figure 1a). The typical dimensions (Figure 1b) are: $L = 120$ mm, $d = 3$ mm/$d_n = 2$ mm, $W = 60$ mm, $W_n = 17.50$ mm, $a = 20$ mm.

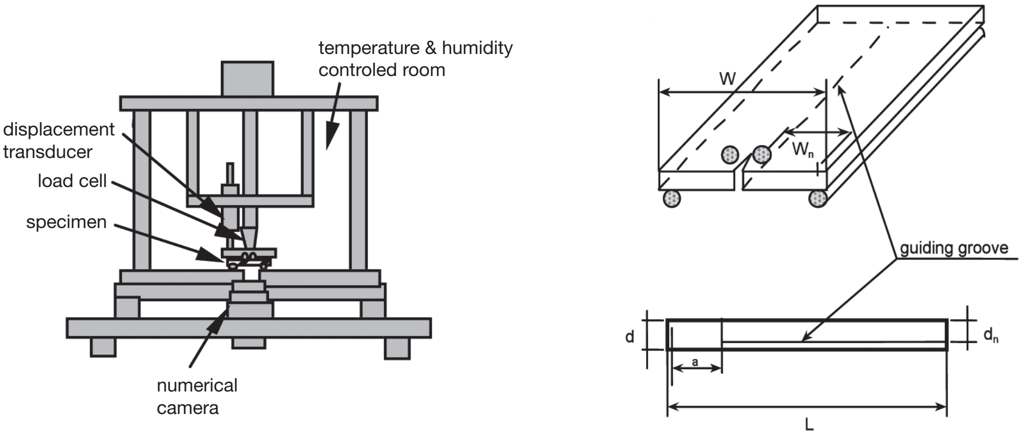

Figure 1: Schematic illustration of the DT testing apparatus and of the DT specimen.

EXPERIMENTAL PROTOCOL

The argillite specimens are partially saturated to investigate the influence of hygrometry on the tenacity and crack velocity. Once the hydric equilibrium is reached, the test can be carried out, and consists in two steps:

- a rapid loading phase to reach the initiation of the crack,
- a relaxation phase to analyze the crack growth.

The relative humidity (RH) is kept constant thanks to a device controlling the circulation of air.

RESULTS

For each tests, the stress intensity factor (mode 1) K_{1C} is computed from:

$$K_{1C} = P_c.W_n.[3(1+\nu)/(W.d^3.d_n)]^{1/2},$$

with P_c the maximal load and ν the Poisson's ratio. Furthermore, the initial crack length (L_i) and final crack length (L_f) are determined by analyzing the recording of the numerical camera.

MODELING

Following a similar approach as in Ciccotti *et al.*, 2000-2001, the crack velocity $\upsilon = \dot{L}$ is determined by derivating the relation $k = P/y$ (with k the stiffness of the specimen and y the displacement) with respect to time. If the function $k(L)$ is calculated by numerical simulations (Figure 2), and as y is kept constant during the relaxation, one obtains: $v = \dot{L}\dfrac{\dot{P}}{y\,dk/dL}$.

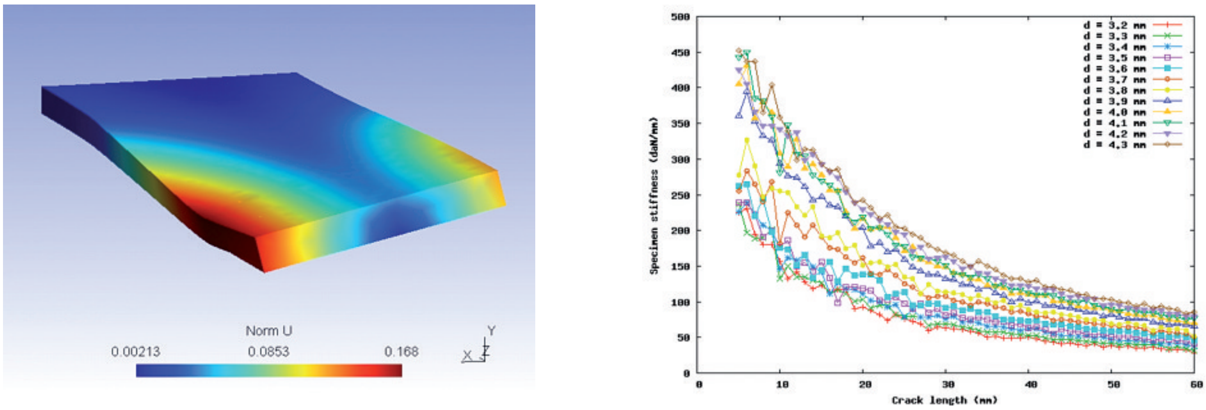

Figure 2: Finite elements simulation of the DT test and evolution of the stiffness k with the crack length for different width d.

CONCLUSION

These experimental results show the influence of hygrometry on subcritical crack growth rate: the final crack length seems to decrease with the increase of hygrometry. Besides, for the upper hygrometries in 85%-90%, this reduction seems very important.

References:

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