3D ELLIPTICAL CRACK DEPTH ESTIMATION FROM 2D SURFACE DISPLACEMENT OBSERVATION

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In many cases, the 3D geometry of a crack and mainly its depth is impossible to apprehend with only 2D surface informations and requires 3D observation methods such as tomography \cite{1}. In this work is exposed a method to determine the depth of a 3D elliptical crack from a 2D observation of displacement field on the surface.

The first step is to build a virtual database of surface displacement field with the Finite Element Method software Zset-Zcracks \cite{2} for sampled relative depth vs. surface crack length. The database is constituted of solution fields $U_s$ which depends on depth parameter $d$. Displacement fields are limited to a circular patch around the crack.

Secondly, the so-called experimental field $U_e$ is considered around the crack tips on surface inside the circular patch of solution fields. It is projected on the virtual database and an optimization process gives an estimated depth. The projection is a minimization algorithm for a least-squares error between $U_s$ and $U_e$. An interpolation process is mandatory to deal with various spacial discretizations.

The method is validated considering 2D artificial experimental fields constructed from FEM simulations. The surface displacements are interpolated on a regular grid which mimics a pixelised field and altered with a variable amplitude white noise. Several artificial experimental fields are generated for various grid size and noise amplitude.

Excellent results are obtained with average relative error inferior to 3\% for the estimation of crack depth (Fig. 1) for a noise with magnitude as high as displacements. Two intuitive aspects are spotted : estimation of crack depth is better with a finer grid and a smaller noise, it corresponds to a higher resolution and precise observation of displacements.

This method will furtherly be applied to real experimental fields from displacement field
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