# PRACTICAL ADVANTAGES OF FULL-FIELD MEASUREMENTS AND PROPER ORTHOGONAL DECOMPOSITION FOR DIAGNOSTIC ANALYSIS OF DAMS AND FOR FREE-FOILS CHARACTERIZATION

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Realistic simulations of nonlinear structural behavior require preliminary experiments apt to provide parameters to be input into computational modeling tools. Inverse analyses leading from experimental data to parameter estimates through computer simulations of tests are more and more frequently adopted despite their frequent mathematical difficulties (particularly ill-posedness, non-convex functions minimization). Economical advantages arise in many industrial environments if parameter identifications can be carried out fast, repeatedly, routinely, by practitioners (rather than by experts in computations), by small computers in situ or in laboratory (rather than in a computing center).
Such advantages can be substantially reached in the two diverse engineering contexts considered herein by adopting the novel inverse analyses procedures based on the following synergistic provisions:
(a) displacements due the external actions in the test are measured in many points ("full-field") on the monitored surface by Digital Image Correlation (DIC) instrumental equipment;
(b) preliminary finite element simulations of the test are performed once-for-all with many vectors of searched parameters which are nodes of a grid over a pre-selected search domain in their space and then, through a Proper Orthogonal Decomposition (POD) technique and Radial Basis Function(RBF) interpolations, the minimization of the discrepancy function for parameter identification is carried out in a fast fashion (no more FE analyses) by means of a suitable mathematical programming algorithm or, alternatively, by means of an Artificial Neural Network (ANN) made economical by exploiting the preceding POD for its training and testing and for its input of experimental data information.
The following industrial applications of the above methodology are discussed in this communication:
(i) material characterization of free-foils (specifically of laminates for food containers within a research project with TetraPak Company) by bi-axial tests on cruciform specimens; novelties rest here also on: a simplification of a popular anisotropic elastic-plastic model for paper in order to reduce the number of parameters; a generalization of cruciform testing equipments for tests with dominant compression;
(ii) superficial diagnostic analyses of concrete dams by flat jacks (contributions to ItCOLD Working Group on dam monitoring); besides the employment of DIC, never occurred so far in dam engineering, the new developments proposed are as follows: assessment of more components of the stress tensor and of more parameters in the orthotropic elastic and plastic material models for concrete by two slots only, namely in a "less destructive" fashion than according to the present practice in dam engineering.

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