Synergistic combinations of computational methods and experiments for structural diagnosis

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Abstract

The mechanical characterization of materials and the non-destructive assessment of possible damages in industrial plant components and in civil engineering structures and infrastructures is a problem which at present arises more and more frequently and acquires growing importance in both experimental and computational mechanics. The survey presented here concerns some representative, practically meaningful typical problems of this kind recently or currently tackled by our research team and is intended to evidence the central role played, for the practical solutions of inverse analyses in real-life situations, by computer methods for accurate simulations of experiments and by procedures of numerical mathematics, including soft computing, for the minimization of the discrepancy between experimental data and their counterparts computed as functions of the parameters to identify. Specifically, the following issues and related research results will be surveyed. (a) Inverse analysis combined with mapping of micro-indentation imprints for mechanical characterization of anisotropic materials and residual stresses. (b) Diagnostic analyses in situ of steel structures and plants (particularly pipelines) based on non-destructive indentation experiments and on a fast soft computing procedure using either Proper Orthogonal Decomposition (POD) with radial basis functions , or artificial neural networks in combination with POD processing experimental data. (c) Flat-jack tests and digital image correlation measurements combined with inverse analyses and soft computing for the identification of inelastic properties of concrete, besides elastic moduli and stresses, on the surface of concrete dams. (d) To same purposes like in (c) but deep inside concrete dams and by means of dilatometric measurements in a novel procedure. (e) Overall quasi static diagnoses of large structures like dams through service loading and radar measurements, allowing for thermal effects.

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