DEVELOPMENT OF A DATABASE OF ADVANCED MATERIAL PROPERTIES

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ABSTRACT

This paper describes an innovative methodology for creating a large database of advanced material properties for metallic materials, and recently polymers and ceramics. This methodology, which includes both properties acquisition and assessment, is being used for the development of additional modules of the Key to Metals database, aimed at serving the global engineering community with mechanical and physical properties needed for advanced CAE (Computer Aided Engineering) and FEA (Finite Element Analysis) calculations and simulations.

The Key to Metals database is designed to help a broad range of engineering professionals in finding equivalent materials worldwide, getting easy-to-use and accurate metal properties, and navigating through international standards. The “standard” Key to Metals dataset for a material includes international cross-reference tables, composition, mechanical and physical properties at various temperatures, heat treatment diagrams and more; the main mechanical properties included in the standard dataset are yield stress, tensile stress, hardness, ductility, and Young modulus. While these properties suffice for conventional structural calculations in the elastic range, they cannot fulfil the needs of advanced calculations and simulations in the plastic range, nor suffice for calculations regarding fatigue, fracture mechanics, crack growth, time-related deformation etc. Information on these advanced properties is very hard to find and this evident lack of knowledge about material properties poses one of the highest risks in structural design, accounting for over 29% of structural failures.

According to this methodology, advanced material properties have been divided to (1) stress-strain curves, (2) flow stress – flow strain curves, (3) cyclic properties, (4) fracture mechanics, and (5) creep properties. The biggest challenge in providing these properties for a large number of engineering materials and service conditions is a general scarceness of experimental data. Besides collecting and consolidating information for over 14.000 materials from over 600 references, a specific set of algorithms has also been developed for assessing properties under various conditions (service temperature, heat treatment etc.). The paper will provide an insight into the methods used to derivate and asses these properties for thousands of metallic materials, from conventional methods such as Ludwik and Ramberg-Osgood equations and also statistical fatigue to an artificial-intelligence-based, patented algorithm for material comparison.