Computational fatigue design under complex loading

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A powerful software has been developed to automate ***all*** traditional local approach methods to calculate fatigue damage caused by complex loading [1, 2]: the **SN**, the **IIW** (for welded structures) and the **eN** to predict crack initiation, and the **da/dN** for studying plane and 2D crack propagation, considering load interaction effects such as overload-induced crack retardation, acceleration and arrest [3].

This software includes all necessary tools to perform the predictions, such as intuitive and friendly graphical interfaces in multiple idioms; several powerful databases for material properties, stress concentration factors, crack propagation rules, and stress intensity factors; two rain-flow counters (a traditional and a sequential one) and a load amplitude filter; graphical generators of 2D crack fronts and of corrected elastic-plastic hysteresis loops under complex loading; importing and automatic adjustment of experimental data; and a complete help file, including an online advanced course on fatigue design.

Moreover, its damage models introduce various non-trivial **innovations** in fatigue design, developed to enhance the speed and the accuracy of the numerical results. The main innovations, discussed in this paper, are: the introduction of the ordered rain-flow counting method; the consideration of elastic-plastic overload effects on the **SN** method; a series of corrections in the traditional **eN** methodology, to guarantee the prediction of physically acceptable elastic-plastic hysteresis loops at a notch root under complex loading (including stress/strain concentration and even considering elastic-plastic nominal stresses); 1D and 2D crack propagation models with adjustable speed and precision, by the division of **DK** in two components, load and geometry, updated at different rates; improvements to the existing load interaction models to predict crack acceleration after compressive underloads and overload-induced crack arrest; and the modeling of the transient from part-through surface or corner cracks to through cracks. The software has been numerically and experimentally evaluated for over 5 years, incorporating all the necessary requirements for a design automation tool.

References

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[3] Miranda, A.C.O., Meggiolaro, M.A., Castro, J.T.P., Martha, L.F. and Bittencourt, T. N., “Fatigue Crack Propagation under Complex Loading in Arbitrary 2D Geometries,” *Applications of Automation Technology in Fatigue and Fracture Testing and Analysis*: *Fourth Volume*, *ASTM STP 1411*, ASTM, West Conshohocken, PA, 2001.