general correspond to the summation of the results of the individual sequences. In fact, some cycles obtained for the whole signal result from transitions containing an extremum from one sequence and an extremum from another one.

To obtain the rainflow counting result of a global signal composed of several sequences from the counting results for each of these sequences, the methodology is as follows.

1. Express the rainflow counting result of each sequence in the form extracted cycles + residue.
2. Form a signal joining the residues of each sequence, in the order in which the sequences appear in the global signal.
3. Break the resulting signal down into cycles (including the new residue).
4. The rainflow result of the global signal is obtained by adding the cycles extracted in step 3 and the cycles of the different sequences (step 1).

This methodology requires the representative values of the level of the different sequences to be distributed in the same manner (identical step, fitting of values).

CONCLUSIONS

Consultation with different industries (automobile, aircraft, energy and steel) resulted in a consensus on the proposed rainflow methodology and its use for fatigue analysis. It led to a simplification of the algorithm rules and a method for combining several sequences. The rainflow method emerges as a reference method that can be used to store service measurements in a form suitable for fatigue analysis of materials and structures and for reconstructing a sequence from the data in order to simulate the sequence. It presents a decisive advantage compared with the spectral or statistical analysis of the sequence because it makes it possible both to analyse and to represent variable-amplitude loadings.

Furthermore, it has been shown[11] that it is possible to deduce, from the rainflow counting results, the results of other counting methods (peaks and valleys, level crossings, range pairs). The reverse is not true: the latter methods do not allow one to find the accurate rainflow counting result.

REFERENCES

1 Potter, J.M. and Watanabe, R.T. (Eds) 'Development of Fatigue Loading Spectra', ASTM STP 1006, American Society for Testing and Materials, 1989

2 Krüger, W., Scheutzow, M., Beste, A. and Petersen, J. 'Markov- und Rainflow-rekonstruktionen stochastischer Beanspruchung-zeit-funktionen', Fortschr.-Ber. VDI-Z Series 18, No 22, 1985

3 Perrett, B.H.E. In 'Proc. 14th ICAF Symposium 1987' (Ed. D.L. Simpson), EMAS, Warley, 1987, pp. 355–401

4 Endo, T. In 'Proc. 1974 Symp. on Mechanical Behaviour of Materials', Society of Material Science, Japan, 1974, pp. 372–380

5 De Jonge, J.B. 'Counting methods for the analysis of load time histories', NLR Memorandun SB-80-106 U, 1980

6 Ten Have, A.A. In 'Development of Fatigue Loading Spectra', ASTM STP 1006, American Society for Testing and Materials, 1989, pp. 17–35

7 DIN 45667, 'Klassierverfahren für das Erfassen regelloser Schwingungen', DK 519.25: 534.6.08, Deutsche Normen, October 1969, pp. 1–4

8 E 1049-85, in 'Annual Book of ASTM Standards', Section 3, Vol. 03.01, 1991

9 Schütz, D., Klätschke, H., Steinhilber, H., Heuler, P. and Schütz, W. 'Standardized load sequences for car wheel suspension components – Car Loading Standard CARLOS', LBF Report No FB-191, 1990/IABG Report No TF-2695, LBF/IABG, Germany, 1990

10 Leese, G.E. and Socie, D. (Eds) 'Multiaxial Fatigue: Analysis and Experiments – AE 14', Society of Automotive Engineers, 1988

11 AFNOR A03-406, 'Produits métalliques—Fatigue sous sollicitations d'amplitude variable – Méthode rainflow de comptage des cycles', AFNOR, 1993