RAINFLOW CYCLE COUNTING IN FATIGUE ANALYSIS
Revision A

By Tom Irvine
Email: tomirvine@aol.com

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Introduction

The rainflow method is a method for counting fatigue cycles from a time history. The fatigue cycles are stress-reversals. The rainflow method allows the application of Miner's rule in order to assess the fatigue life of a structure subject to complex loading.

The resulting tabular data is sometimes referred to as a spectra.

Algorithm

1. Reduce the time history to a sequence of (tensile) peaks and (compressive) troughs.
2. Imagine that the time history is a pagoda.
3. Turn the sheet clockwise 90°, so the starting time is at the top.
4. Each tensile peak is imagined as a source of water that "drips" down the pagoda.
5. Count the number of half-cycles by looking for terminations in the flow occurring when either:
    a. It reaches the end of the time history
    b. It merges with a flow that started at an earlier tensile peak; or
    c. It encounters a trough of greater magnitude.
6. Repeat step 5 for compressive troughs.
7. Assign a magnitude to each half-cycle equal to the stress difference between its start and termination.
8. Pair up half-cycles of identical magnitude (but opposite sense) to count the number of complete cycles. Typically, there are some residual half-cycles.

The ASTM standard in Reference 1 gives algebraic formulas using Boolean operators for carrying out this process.

An example is given in the next section using the ASTM implementation.

Rainflow Counting Example

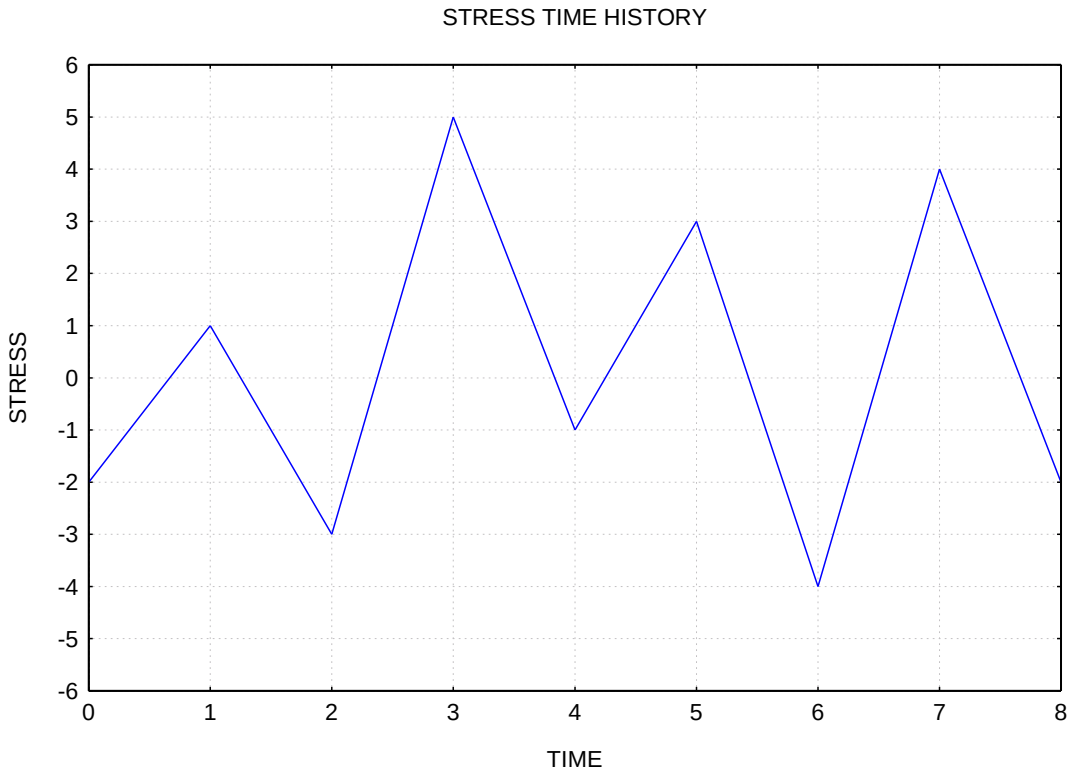

Figure 0.

A stress time history is given in Figure 0.

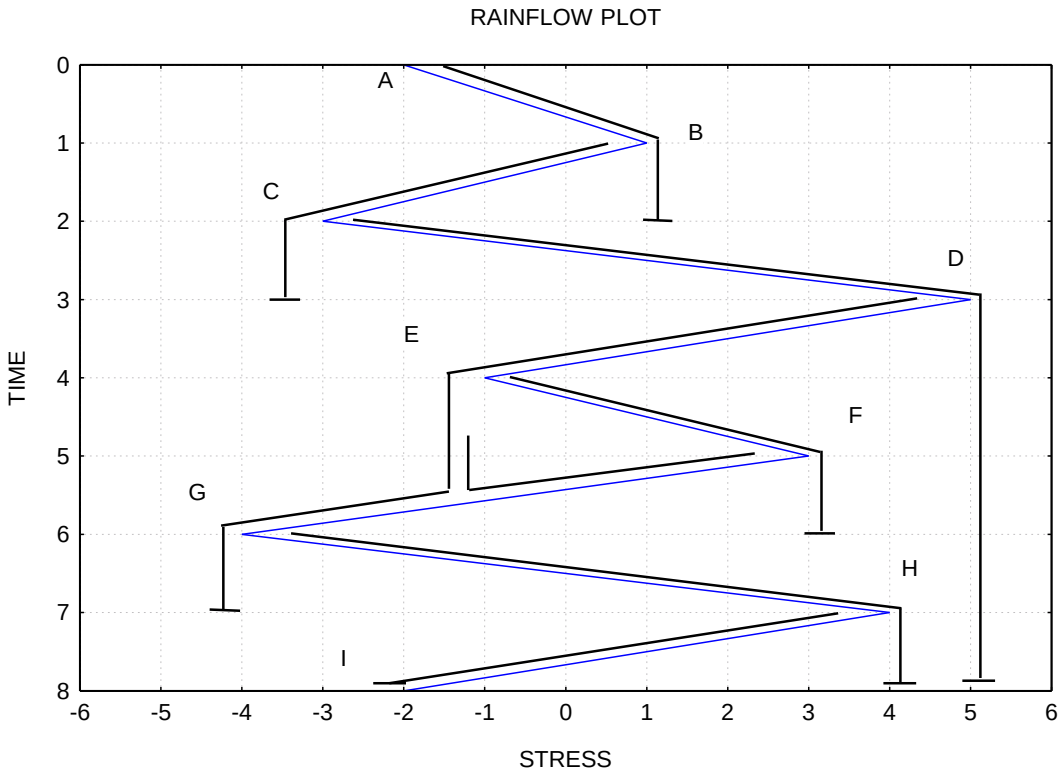

Figure 1.

Table 1. Rainflow Cycles by Path		
Path	Cycles	Stress Range
A-B	0.5	3
B-C	0.5	4
C-D	0.5	8
D-G	0.5	9
E-F	1.0	4
G-H	0.5	8
H-I	0.5	6

Note that E-F is counted as one cycle because is it considered to contain some of F-G.

Table 2. Rainflow, Total Cycles		
Stress Range	Total Cycles	Path
10	0	-
9	0.5	D-G
8	1.0	C-D, G-H
7	0	-
6	0.5	H-I
5	0	-
4	1.5	B-C, E-F
3	0.5	A-B
2	0	-
1	0	-

Another example is shown in Appendix A.

References

1. ASTM E 1049-85 (2005) Rainflow Counting Method, 1987.

2. P. Wirsching, T, Paez, K. Ortiz, Random Vibrations Theory and Practice, Dover, New York, 2006.

APPENDIX A

Single Wavelet Example

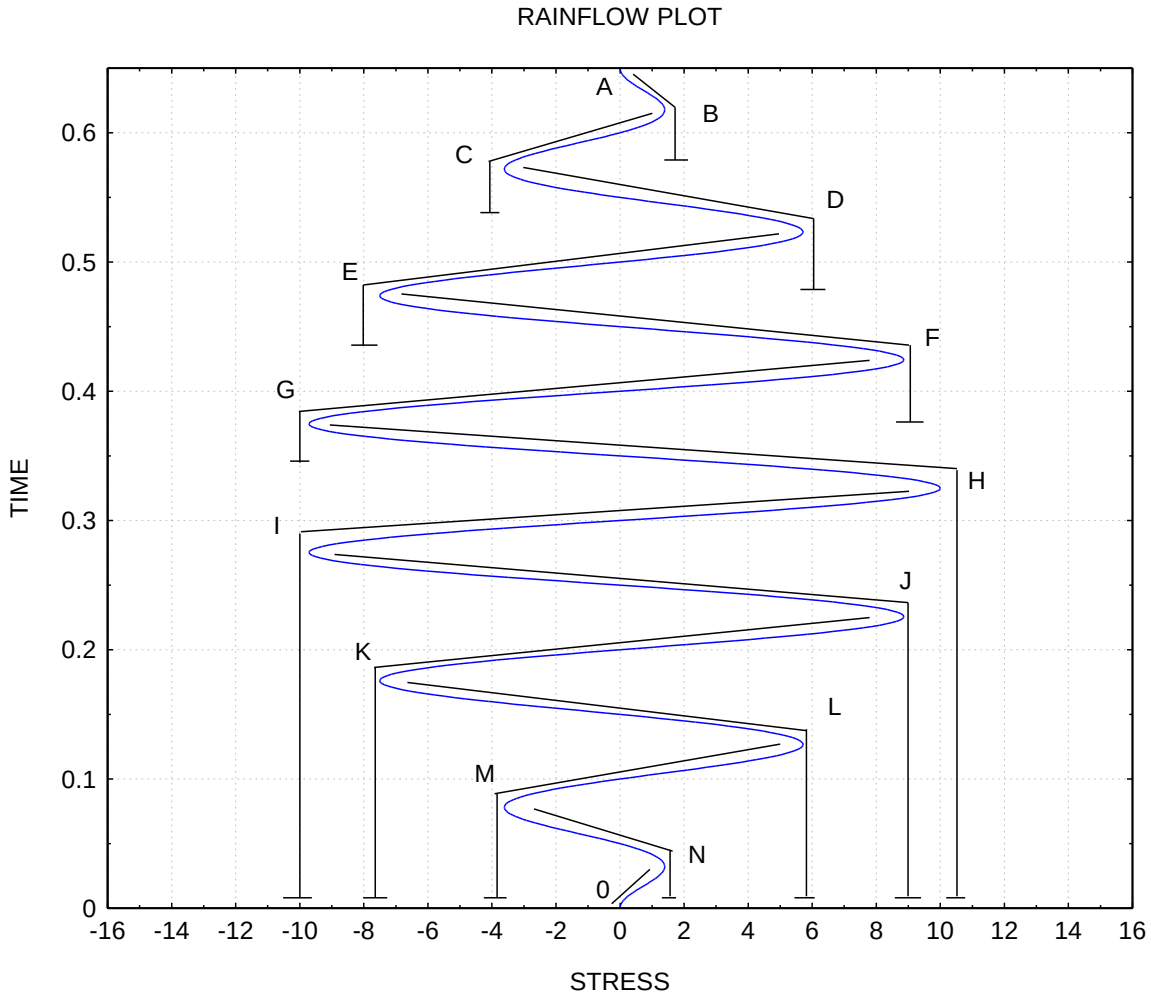

Figure A-1.

Each consecutive segment is a half-cycle in this case.