

APPLICATION OF RAINFLOW TECHNIQUES TO THE DESIGN AND OPERATION OF PORT INFRASTRUCTURE

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INTRODUCTION

The concept of rainflow comes from the fatigue damage field where it has demonstrated its appropriateness (see Johannesson, 1999).

In port engineering, rainflow counting has shown some serious advantages over traditional methods such as the zero-downcrossing method but it is not widely used.

This work aims at showing some applications of this technique to problems detected in port operation and reliability after briefly introducing the concept.

CONCEPT

Figure 1 shows the definition of a rainflow cycle (height and period) compared to the traditional zero-downcrossing (ZDC) or upcrossing while Figure 2 shows the comparison between ZDC and rainflow with all ZDC points on region IV. The most important conclusion is that the rainflow method can detect a wider range of heights and periods than ZDC providing a better knowledge of port operation and reliability.

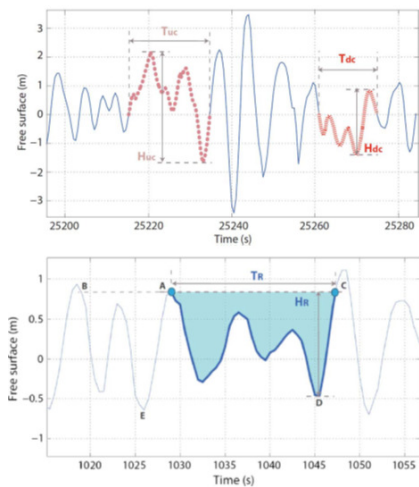


Figure 1 - Zero-up (down) crossing and rainflow definitions (Gómez et al., 2013)

APPLICATIONS

Several possible applications of this technique have been listed although not necessarily developed: wave groups, damage progression in breakwaters (Castillo et al., 2012), overtopping increase, impacts of vessel movements on loading and unloading operations and on durability of mooring and berthing elements (Molina, 2014) or natural frequency oscillations in docks. Some of them will be presented and applied to real cases as the one related to Figure 3 with the comparison

between rainflow and ZDC corresponding to moored vessel movements for Yaw.

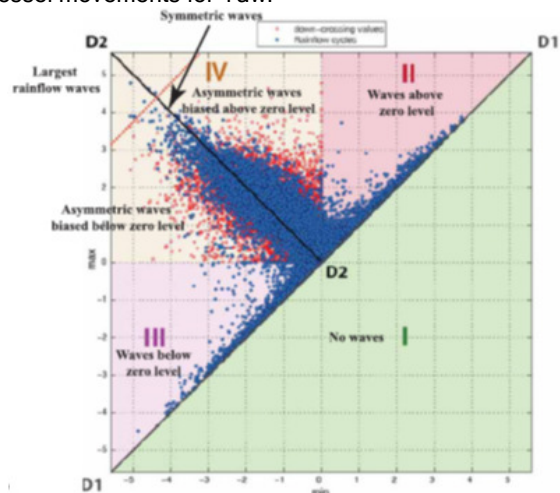


Figure 2 - Rainflow (blue) vs zero-down crossing (red) results. (Castillo et al., 2012)

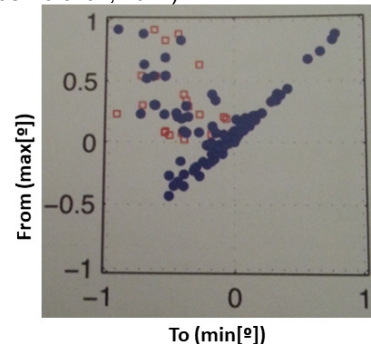


Figure 3 - Rainflow (blue) vs zero-down crossing (red) results: moored vessel-Yaw. (Molina, 2014)

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