

Systematic Review of ISO 12215-9 *Sailing craft appendages*

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The design of yacht keel structures is addressed by International Standard ISO 12215-9:2012 *Sailing craft appendages*, which is concerned with the loads and scantlings of sailing craft appendages on yachts up to 24 m hull length. Significant advances in sailing yacht performance, appendages design, materials and manufacturing over at least the past decade warrant a revision of this crucial international standard, which was scheduled for systematic review last year.

Novel and updated design criteria under consideration include:

- (i) a new load case for lateral impact to the keel;
- (ii) more stringent fatigue assessment, with a doubling of design life to 16 million cycles;
- (iii) enhanced structural arrangements for bolts and backing plates; and
- (iv) an informative Annex regarding keel manufacturing and installation procedures.

These changes aim to support the design and manufacturing of safer and more reliable keel structures for sailing yachts.

The suite of ISO12215 standards governs the structural design and scantlings of small craft. It is sub-divided into 10 parts, with Part 9 (ISO, 2012) being concerned with sailing craft appendages, namely fixed and canting keels, centerboard and their attachments to the hull.

The motivation for the scheduled systematic review and consideration of revisions to ISO12215-9 is threefold:

1. First, it follows significant regulatory advances in hull scantlings under the latest ISO 12215-5 (ISO, 2019, Soupez, 2018; Soupez & Ridley, 2019), and the launch of new parts governing multihulls (ISO, 2020a) and rig loads and attachments (ISO, 2020b).
2. While investigations did not yield any concerns on the suitability of the ISO 12215-9:2012, loss of keels leading to loss of lives, such as that of *Cheeki Rafiki* (MAIB Report, 2015), *Capella* (FEBIMA Report, 2017) and *Showtime* (Lyons Report, 2021), amongst others demonstrated the vital role of keel structures and the importance of fatigue and fabrication details. This was also evidenced in offshore racing classes with, for instance, the International Monohull Open Class Association (IMOCA) moving to a standardized keel structures from 2013 in an effort to improve reliability.
3. Lastly, improvements in yacht performance over the past decade, coupled advances in the understanding of welded joints fatigue (Grimm, 2016; Braun et al., 2018; Braun et al., 2021), flutter effects (Mouton and Finkelstein, 2015; Mouton et al., 2018), load monitoring (Russel et al., 2016) and the behaviour of centreboard and daggerboard for dinghies (Graf et al., 2020; Guida et al., 2020; Bagué et al., 2021), further motivating a revision of the 2012 standard.

A draft international standard is due to be released by June 2024, with the revised Part 9 standard published by June 2025.

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