



Yacht and Powerboat Safety at Sea - Grounding of Fixed Fin Keel GRP Yachts - Good Practice

Notice to all owners, managing agents, skippers, designers, builders, surveyors, crew and Certifying Authorities of yachts and powerboats including pleasure vessels and small commercial vessels.

This notice should be read with:

The Merchant Shipping (Vessels in Commercial Use for Sport or Pleasure) Regulations 1998 (SI 1998/2771) as amended;*

The Safety of Small Commercial Motor Vessels - A Code of Practice (Yellow)

The Safety of Small Commercial Sailing Vessels - A Code of Practice (Blue)

The Safety of Small Vessels in Commercial Use for Sport or Pleasure Operating from a Nominated Departure Point (NDP) - A Code of Practice (Red)

The Merchant Shipping (Small Workboats and Pilot Boats) Regulations 1998 (SI 1998/1609) as amended;*

*The Safety of Small Workboats and Pilot Boats - A Code of Practice (Brown) ;
and MGN 280.*

Summary

- This guidance sets out good practice for commercially operated yachts but is aimed primarily at the owners, managing agents and skippers of all fixed fin keeled sailing yachts.
- Groundings and use beyond the intended design limits can lead to structural problems in the keel area.
- All groundings should be taken seriously and internally inspected following any grounding incident.
- Owners, managing agents and skippers should undertake a visual inspection internally and should consider a haul out and external inspection of the areas described in this guidance.
- In a yacht with an inner hull matrix through which the keel is attached, de-bonding can occur via a number of different methods. De-bonding can have severe consequences which may be difficult to identify.
- This guidance is non-mandatory for pleasure vessels.
- This MGN is one of six MGNs aimed at providing generic good practice safety advice.



1. Introduction

- 1.1 This guidance is primarily aimed at the owners, managing agents and skippers of all fixed fin keeled sailing yachts and is particularly relevant to yachts with bolt-on fin keels. Certain aspects of this guidance will also be relevant to other types of small craft of similar design and construction and should be considered as good practice to be followed by all.
- 1.2 For the purposes of this MGN:
- “Small Commercial Vessel” means a vessel which is certificated under one of the Yellow, Blue, Red or Brown Codes.
- “Pleasure Vessel” has the meaning given in the Merchant Shipping (Vessels in Commercial use for Sport or Pleasure) Regulations 1998, as amended¹.
- 1.3 This guidance also represents good surveying practice for a Small Commercial Vessel in accordance with the Code of Practice against which that vessel is certificated.
- 1.4 A yacht keel and internal hull structure is designed, as a minimum, to withstand simplified maximum load conditions including a 90° knockdown or broach, a grounding force on the leading edge of the keel, and pitching / surging forces from fore and aft movement while sailing. There are a number of methods of calculating the pressures and stresses that a vessel can withstand, industry best practice is to use an International Standard, e.g. ISO 12215.
- 1.5 The forces at work on a keel and any associated structure when a yacht is in use, and particularly when grounded, are very complex. The extent of slamming, pounding, surging, surfing, yawing, and speed can all significantly affect the outcome of an incident, as can the nature of the seabed in a grounding, heel of the yacht at the time of impact, pitch of the yacht at the time of impact, weight of the yacht, and retardation (deceleration after impact) which will all influence the outcome of a grounding.
- 1.6 Similarly, powerboats can suffer damage when grounding and the provisions in this guidance with regard to grounding inspection should be taken as recommendatory for any powerboat or non-fin keeled sailing yacht. Modern powerboats are often built in the same way to yachts with regards to an inter hull matrix and can suffer similar structural issues around drive shafts or propulsion equipment.

2. Technical Detail

- 2.1 The designed strength and stiffness of a yacht's structure is intended to be able to comfortably cope with the applied stresses in normal operations. However, over time the condition of the keel and the internal structure of a yacht may deteriorate following repeated exposure to impacts from slamming and grounding, use in rough weather or racing. For example, repeated exposure to impacts over time could result in progressive damage to a FRP (fibre reinforced plastic) laminate or debonding of glued components and moulds, allowing water to penetrate the vessel.
- 2.2 Many yachts are typically designed with fin keels that have a deep span (depth of the keel from the hull down), a short root (distance between the leading edge and trailing edge), and a thin sectional area (thickness). Such a fin keel for a typical 40ft production yacht could weigh around 3 tonnes. This weight and shape can create a significant bending moment on the structure of a vessel by way of the keel (which is pivot loaded on the keel bolts and surrounding hull structure) as a result of the usage and loading conditions sustained as described at paragraph 2.1.



- 2.3 The internal structure of a yacht, in way of where the keel is fitted, is designed to work as a system to distribute the loads from the keel, through the keel bolts and into the hull structure where the loads are further distributed. The internal structure is arranged via a system of transverse floors (across the boat) and girders (along the length of the boat) which provide a stiff and strong frame called a matrix or grid. In modern yachts the inner hull matrix is often a separate internal moulding which is then bonded to the hull shell. The bond between these two components is essential to provide sufficient strength to withstand and distribute the associated loads from the keel safely through the hull ensuring that the structural integrity of the hull is maintained.
- 2.4 The connection of the inner hull matrix to the hull shell can suffer from de-bonding as a result of slamming, grounding or over-stressing from use in rough conditions or racing hard. This de-bonding can be caused by one significant event or from multiple smaller events through the life of the yacht. As a result of any grounding, it's prudent to not differentiate between the severity of a grounding when it comes to taking action to inspect the keel, keel bolts and the inner hull matrix.
- 2.5 If de-bonding of the inner hull matrix to the hull shell has occurred it will likely weaken the structure around the keel / matrix area. De-bonding in this area may not be immediately obvious and any early signs of inner moulding de-bonding either forward or aft of the keel attachment area may be a sign of a bigger problem. Movement in the keel/matrix area may lead to further degradation of the inner hull matrix itself through delamination and/or cracking and the opening of the keel to hull interface on the outside of the hull shell. Again, small cracking, small areas of delamination, and small openings of the keel to hull interface can be a sign of further damage that may not be easy to see.
- 2.6 Where the inner hull matrix is bonded to the hull shell and the keel bolts pass through both the shell and matrix, this creates a clamping effect between the inner hull matrix moulding and the hull shell making percussive testing (see below) inconclusive. As such, a true assessment of the extent of de-bonding in these areas will require the removal of the keel bolt nuts and the hull weight removed from the keel which will allow for a more accurate assessment of any damage.
- 2.7 Percussive testing or "tap testing" is a procedure where repeated tapping of a composite structure is performed and the experienced marine professional listens to the sound the taps make. Sounds are compared between a known solid area and the area in question. De-bonded areas typically sound "hollow" in comparison to known solid areas. This technique requires a trained ear to pick up subtle issues and should be done by an experienced marine professional.
- 2.8 An experienced marine professional will also be able to use a range of other methods to identify areas of de-bonding or damage – percussion testing is one of a number of surveying techniques. Grounding forces can also lead to the elongation of keel bolt holes, stripping of keel bolt threads, denting of keel surface, cracking of hull shell, and the dislodging of fixed internal components such as bulkheads, engine mountings and other major components. The shock loads can also cause damage to the rig, rigging and rig attachment points.
- 2.9 The opening of the keel to hull interface can allow seawater to penetrate within this area and around the keel bolts. An opening could develop over time through cyclic loading such as when a vessel tacks from one side to another. Keel bolts are prone to pitting and crevice corrosion if exposed to seawater. Corrosion on a bolt's surface creates a stress-raiser and can lead to the progressive propagation of cracks over time across the keel bolt sectional area at the point the bolt exits the keel and enters the hull (the area of highest stress). Additionally, if one bolt fails, this in turn increases the loading on each of the remaining bolts which may take them or the hull beyond the designed loading.



2.10 Torque testing of keel bolts can also be an indication as to whether cause for further investigation may be required or that damage has occurred. When considering torque testing, this should only be carried out by an experienced marine professional who should use the correct tools and always refer to the manufacturers recommended torque settings. If the findings of torque settings do not return the anticipated results then this should be cause for further investigation.

3. Actions to be Taken by Owners, Managing Agents and Skippers

3.1 All vessels have their limitations and it's important for the owners of small craft to understand the limits of their yacht or powerboat before undertaking a passage. This is detailed within the owner's manual for any vessel built in accordance with the Recreational Craft Regulations 2017, which implements the EU's Recreational Craft Directive. If not available, this can be achieved through discussions with the manufacturer or designer or through study of relevant literature including the manufacturer's maintenance data, where available.

3.2 Owners, managing agents and skippers should ensure that any grounding incident of a fin keel yacht should lead to a visual inspection internally and should consider a haul out and external inspection of the areas described in this guidance as soon as practical. Any delay in inspection, may result in additional unseen damage to occur.

3.3 Owners, managing agents and skippers should ensure that any grounding is discussed with an experienced marine professional to determine whether a survey of the area and any repair actions are required. For Small Commercial Vessels, a grounding should be reported through the Certifying Authority and the experienced marine professional means in this instance the Certifying Authority (CA) surveyor who should be contacted via the head office of the chosen CA so that a record of the contact can be made by the CA.

3.4 Owners, managing agents and skippers should ensure that any repairs to the inner hull matrix, keel and hull shell are undertaken by a professional repair yard after consultation with the vessel's manufacturer or designer and a repair specification should be developed by either a surveyor, naval architect, or the original yacht manufacturer if available. The easiest way to undertake this is to follow the manufacturer's approved maintenance programme and approved repair facility instructions.

3.5 Owners, managing agents and skippers should ensure that an inspection of the keel bolts, keel to hull interface, inner hull matrix, and the keel itself is undertaken at least annually and prior to any use of the yacht for long-distance passages or a planned period of prolonged racing such as the Fastnet Race or the Around Britain and Ireland Race. This inspection should include a visual assessment of the condition of the keel bolt nuts and may be undertaken by the vessel owner but any points of concern or questions should be directed to an experienced marine professional. An experienced marine professional may check the torque of the keel bolt nuts to make an assessment of the condition of the bolts but this should only be undertaken with the correct tools and with a true understanding of the designed bolt torque.

3.6 Owners, managing agents and skippers should ensure that once taking on responsibility for a vessel either at the point of purchase, agreeing to a management contract, or embarking on a passage, that the history of the yacht is known so that any limitations as to its use or ability to undertake particular activities may be determined.

3.7 In order to confirm that a vessel has been maintained in accordance with the applicable Code of Practice, the chosen Certifying Authority surveyor (authorised person) should, as part of the examination, check the condition of the inner hull matrix, keel bolts and



surrounding structure during a scheduled examination to ensure that the vessel has continued to be maintained to a seaworthy condition.

Note

* A consolidated copy of an amended statutory instrument can be made available upon request

¹ A Pleasure Vessel is a vessel which is either (a) wholly owned by an individual or individuals and used only for the sport or pleasure of the owner or owners or their immediate family or friends; or (b) owned by a body corporate and used only for sport or pleasure by the employees or officers or the body corporate or their immediate family or friends. In scenarios (a) or (b) the owner or owners must not receive money or any other payment for such use other than as a contribution towards the direct expenses incurred in relation to the operation of the vessel during the voyage or excursion in question. A vessel will also be a pleasure vessel if it is (c) wholly owned by or on behalf of a members' club formed for the purpose of sport or pleasure and used only for the sport or pleasure of members of that club or their immediate family. Any charges levied for such use must be paid into club funds and applied for the general use of the club.

More Information

Ship Standards
Maritime and Coastguard Agency
Bay 2/22
Spring Place
105 Commercial Road
Southampton
SO15 1EG

Tel : +44 (0) 203 817 2000
e-mail: codes@mcga.gov.uk

Website Address: www.gov.uk/government/organisations/maritime-and-coastguard-agency

General Enquiries: infoline@mcga.gov.uk

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