SHAFT ALIGNMENT AND PROPELLER SHAFT AFT BEARING PERFORMANCE – RECENT TRENDS CALL FOR ACTION

Relevant for shipyards, suppliers, owners/managers, flag states and vetting agencies.

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Recent experience reflects concerns on propeller shaft aft bearing performance on some oil lubricated installations, e.g. ships with single stern tube bearing, during turning conditions involving hard-over steering angles in the upper speed range (MCR). This also coincides with evolving trends comprising of larger and heavier propellers operating at a lower RPM and different types of stern tube lubricants. This news aims to elaborate the basic logic, criteria and recommendations associated with propeller shaft aft bearing performance.

The basic concept and industry challenges

DNV GL rules for shaft alignment (Jan. 2018, Pt.4 Ch.2 Sec.4) are formulated to achieve an acceptable distribution of load on the shaft bearings, and include a hydrodynamic lubrication criteria of the aft bearing. Due consideration is also made to accommodate the bending moment induced by the propeller during continuous operation.

During extreme transient turning conditions in the upper speed range, exaggerated propeller bending moments are induced, leading to reduction in shaft-bearing contact area and an exponential increase in local pressures and thermal loading (see Figure 1). The expected nature of aft bearing lubrication under these conditions, i.e. a combination of a mixed and boundary type, poses a challenge to retain a hydrodynamic oil film of acceptable thickness. Most of the reported bearing damages (resulting from abrupt overheating) have been observed in the aft most part of the aft bearing, typically during a starboard turn on a right-handed propeller installation.

DNV GL solution

As a part of the continuous rule development process in accordance with the industry demand to cater to evolving design trends and experience, DNV GL has now

- revised the main class shaft alignment rules for single stern tube bearing installations, and
- introduced new optional class notations, Shaft align(1) and Shaft align(2), for oil-lubricated propeller shaft installations.
How does the solution make a difference?
The DNV GL shaft alignment class notations and revised main class rules for single stern tube bearing installations introduce additional focus on the impact of transient hydrodynamic propeller downward-acting bending moments, which are induced in turning conditions at MCR speed, on the aft most propeller shaft bearing.

This is supported by a mandatory requirement for a multi-sloped aft bearing, coupled with an additional aft bearing lubrication evaluation criteria, with an increased bending moment acting downwards on the bearing (30% MCR torque). Compared to a single-sloped bearing, a multi-sloped design better assists in optimizing the shaft-to-bearing contact area and surface pressure in all operating conditions, considering the hydrodynamically-induced propeller bending moments (see Figure 2).

For Shaft align(2), input from CFD-aided prediction of hydrodynamic propeller moments and forces acting on the aft bearing are used in conjunction with the FE analysis to evaluate the bending surface pressure and contact area under turning conditions. DNV GL class guidelines linked to the rules provide guidance on the criteria to be followed in this regard.

Recommendations
DNV GL recommends that operators consider enhanced propeller shaft bearing performance solutions.

The class notations Shaft Align(1) and (2) may be assigned at the newbuild phase or during service in conjunction with a propeller shaft withdrawal. This is particularly recommended for vessels undergoing retrofits or re-metalling of propeller shaft bearings during dry dock.

References
- Pt.7 Ch.1 Sec 6 (38)
- Pt.6 Ch.2 Sec.10
- Pt.4 Ch.2 Sec.4
- Propeller Immersion – Risk of propeller shaft bearing damage
- Shaft align class notations web page

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Figure 1 – Downward bending moment induced during a starboard turn: right handed propeller
Figure 2 – Shaft-aft bearing contact area mapping: single sloped (left) versus double sloped aft bearing, the colored plots show the shaft-bearing gap