# Possibilities to determine design loads for thrusters

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## ABSTRACT

Ship propulsion systems must reliably guarantee propulsion and thus manoeuvrability under a wide range of operating conditions. These high requirements must be taken into account in the design and dimensioning. In addition to the classic concept of a rigid ship propeller driven by a long shaft, thruster drives are also used, which simultaneously fulfil the function of the rudder and the drive due to the free rotation of the drive nacelle around its own axis. For this purpose, the propeller is connected to the engine by two bevel gear stages and a shaft line. The good manoeuvring characteristics are particularly suitable for the use on ferries, tugs and ships in the oil and gas industry. The drives are increasingly being installed in ships that can also be operated in icy waters.

The combined function of drives and rudders already results in different design loads compared to the classic drive concept. In addition to torque, the drive train is loaded by bending moments resulting from rudder movements and inflow conditions. The use in icy waters causes additional impact loads on the propeller and the nacelle, which have to be considered in the design process. In the ArTEco research project, in cooperation with research and industry partners from Germany, Sweden and Finland, the possibilities of a more reliable design of thruster drives for the use in icy waters were investigated.

A 2 MW torque test rig in Tuusula, Finland, was available for this purpose, on which thruster drives could be operated electrically tensioned. In addition, it was possible to introduce bending and shear loads at the propeller using hydraulic cylinders. Within the framework of the research project, a detailed multi-body system simulation model of the test rig and the tested thruster drive was constructed at the Chair of Machine Elements. The measurement signals recorded on the test rig could be used to validate the models. In the further progress of the project, the simulation models were used to understand the phenomena occurring on the test rig.

The presentation and the contribution to the conference should give an overview to the results of the research project. They include the comparison of measurement and simulation results, the possibilities of reducing vibrations in the drivetrain using of damping systems and how this affects global drivetrain loads [1]. The effects on the stresses on shafts, bearings and bevel gears will also be discussed. Based on information of the time-varying displacements of pinion shaft and crown wheel, detailed statements on the load distribution in gear mesh can be made and which design measures can be used to improve these [2]. The available results allow the discussion of the design loads and the interactions between occurring stresses, deformations and resulting displacements of the drivetrain components for the development of improved drivetrain concepts.

## REFERENCES

[1] Schlecht, B., Kostial, M., Mieth, F., Rosenlöcher, T.: Simulation of ice introduced torsional vibrations on azimuth thruster. Torsional Vibration Symposium 2017, 17.-19. Mai 2017, Salzburg.

[2] Schlecht, B., Mieth, F., Kostial, M., Rosenlöcher, T., Schumann, S.: Operation of Thrusters in arctic waters - Arctic thruster ecosystem. Marine 2017 - VII International Conference on Computational Methods in Marine Engineering, 15.-17. Mai 2017, Nantes.