

HYDROACOUSTIC ACTIVITY OF THE SHIP PROPELLER OPERATION

C

Gdańsk University of Technology
Narutowicza 11/12, 80-958 Gdańsk, Poland
e-mail: jas@pg.gda.pl

C

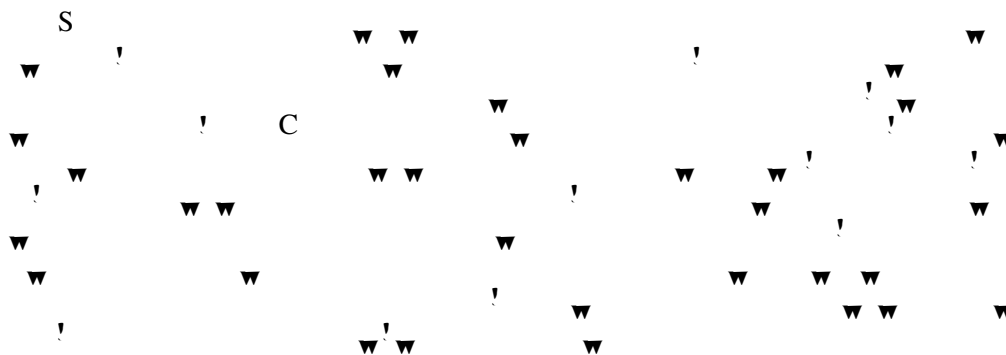
Institute of Fluid Flow Machinery
Fiszera 14, 80-952 Gdańsk, Poland
e-mail: ttk@imp.gda.pl

(received March 14, 2006; accepted May 17, 2006)

The paper presents ship propellers as the source of a variable pressure field in water. The frequency spectrum of this field covers the entire audible range and beyond this range. This pressure field is generated by several physical mechanisms: the rotating hydrodynamic loading of the blades, the displacement effect of the rotating blades, the boundary layer effect, and, first of all, various forms of cavitation. The relative importance of these mechanisms is analysed and the methods of the theoretical prediction of the propeller generated variable pressure field are briefly presented. The results of the prediction are compared with experimental data.

Key words: ship propellers, cavitation, hydroacoustics.

1. Introduction



2. Propeller as a source of a pulsating pressure field

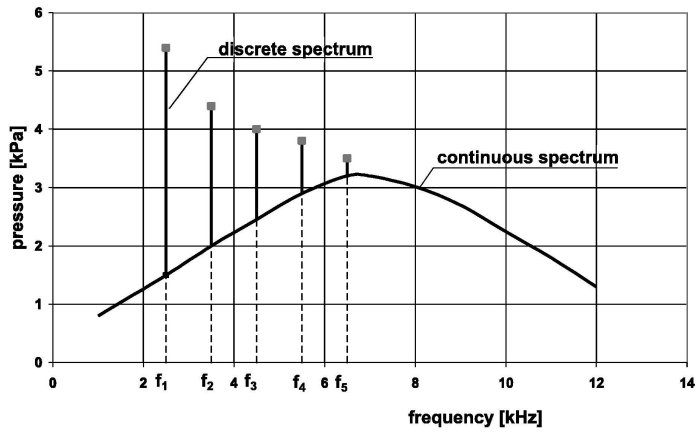
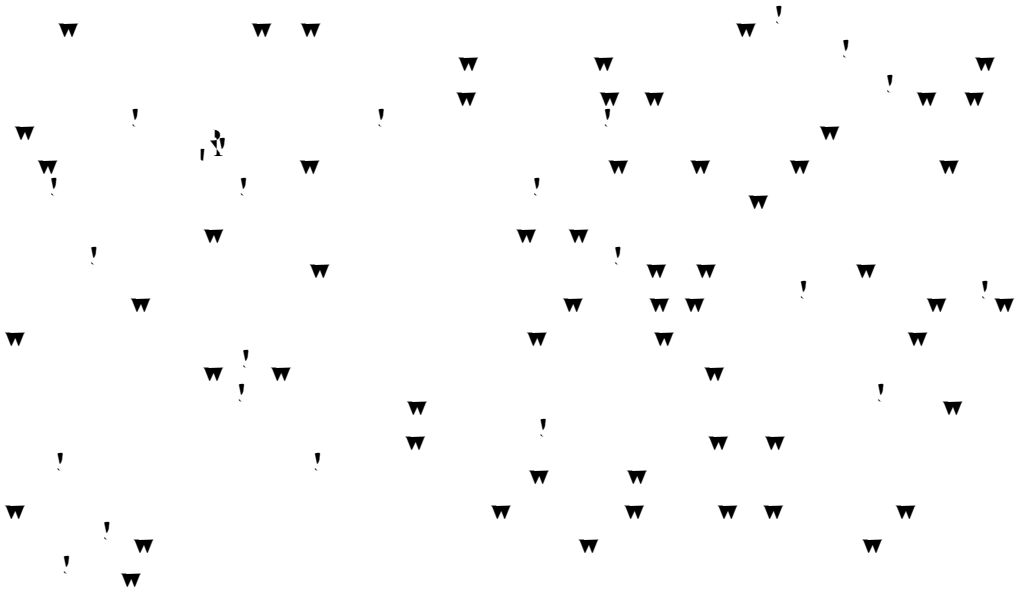
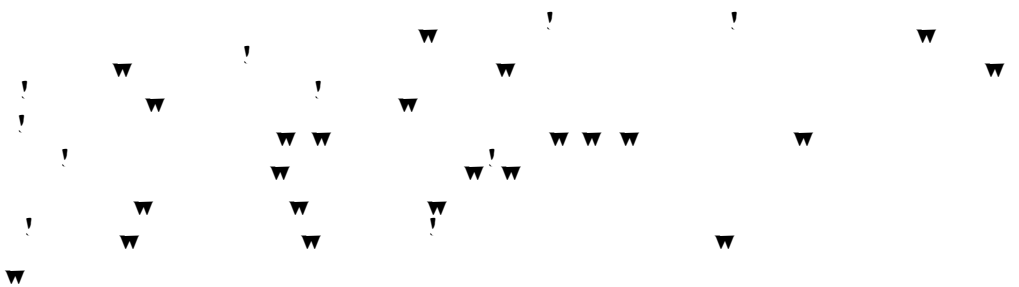


Fig. 1. An idealised spectrum of propeller generated pulsating pressure field [3].



3. Forms of cavitation associated with propeller operation

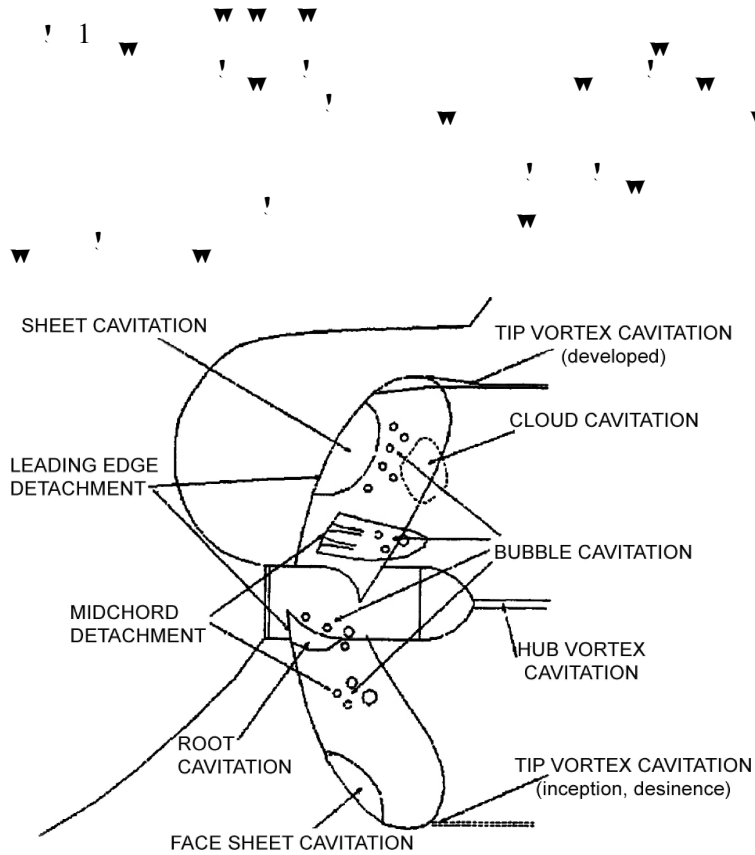


Fig. 2. Forms of cavitation present on ship propeller blades.

4. Methods of the prediction of the propeller generated pulsating pressure field

$$\frac{d^2R}{dt^2} = \left[\frac{\Delta p}{\rho} - \frac{3}{2} \left(\frac{dR}{dt} \right)^2 - \frac{2S}{\rho R} - \frac{4\mu}{\rho R} \frac{dR}{dt} \right] \frac{1}{R}$$

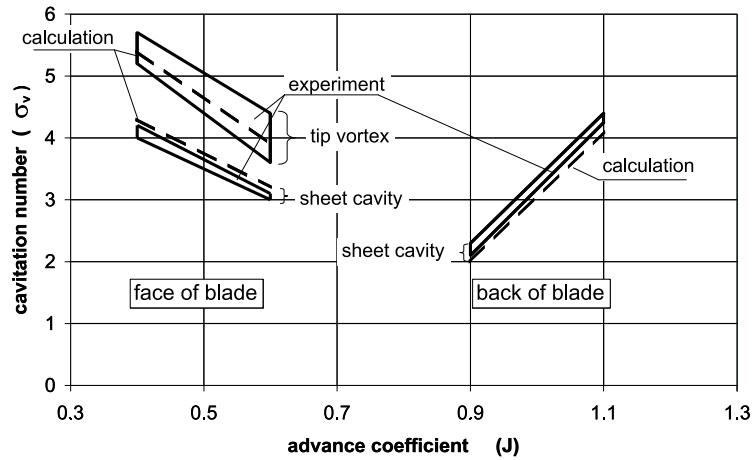


Fig. 3. Comparison of calculated and experimentally observed cavitation inception on a ship propeller model.



$$J = \frac{V}{nD}$$

1

$$1 \frac{V}{D}$$

$$n$$

$$\sigma = \frac{p - p_V}{\frac{\rho}{2} V^2}$$

$$p$$

$$p_V$$

$$\rho$$

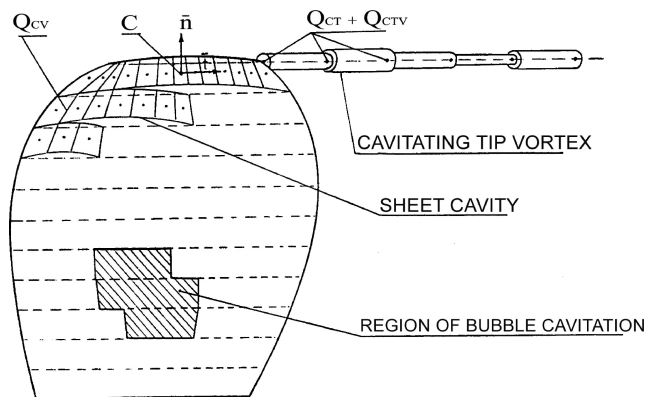


Fig. 4. Model of the cavitation phenomena on a propeller blade.

$$Q_{CT}$$

$$Q_{CV}$$

$$Q_{CTV}$$

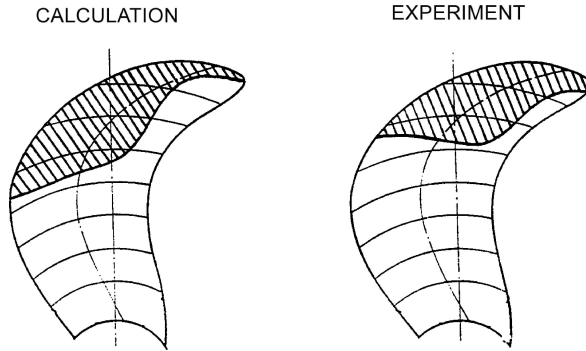


Fig. 5. Comparison of computed and experimentally observed sheet cavitation on a propeller blade.

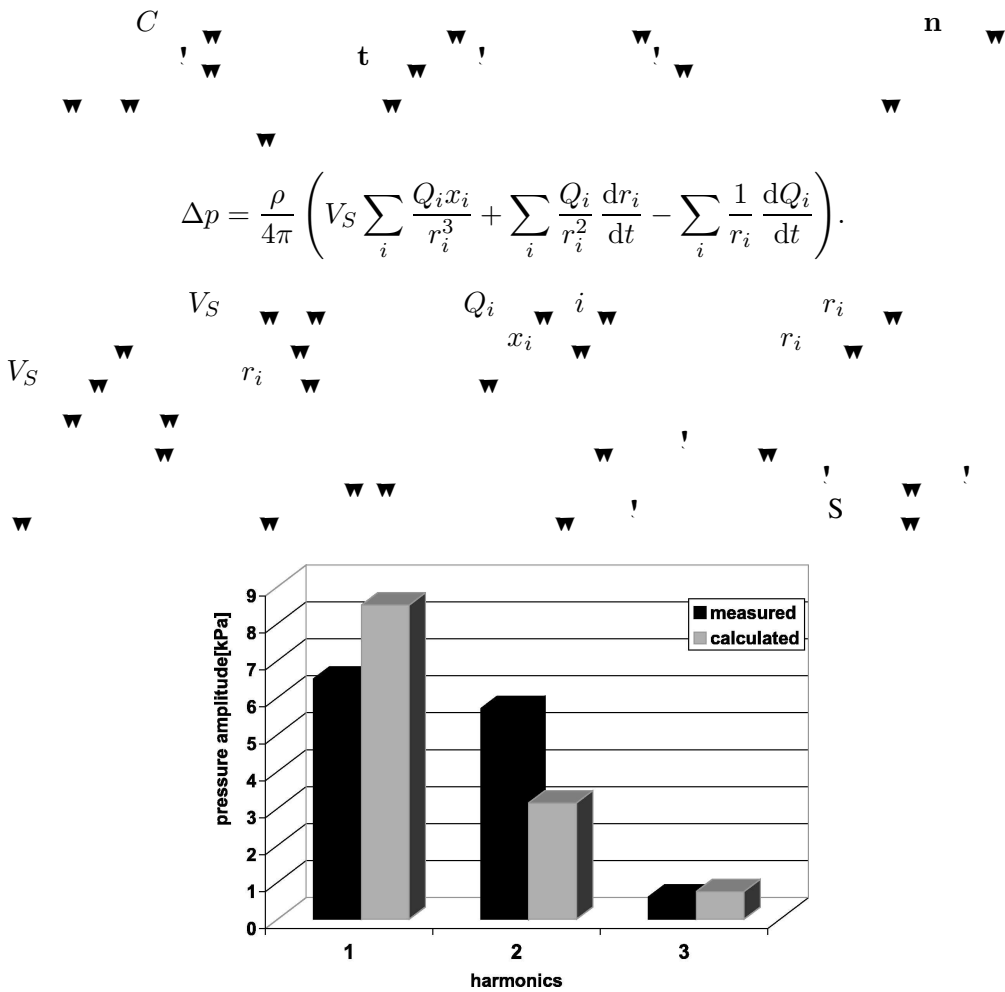


Fig. 6. Comparison of computed and experimentally measured harmonic amplitudes of the pulsating pressure field generated by the cavitating propeller.

5. Conclusions

References

- [1] CARLTON J., *Marine propellers and propulsion*, Butterworth–Heinemann 1994.
- [2] GLOVER E. J., SZANTYR J. A., *Accumulated experience with the use of an unsteady lifting surface analysis program*, Proceedings PROPCAV'95 Newcastle upon Tyne 16–18 May, pp. 253–268, 1995.
- [3] KORONOWICZ T., SZANTYR J. A., *Cavitation on ship propellers as the source of hydro-acoustic emission* [in Polish], Proceedings of 12-th Symposium on Hydroacoustics, Jurata 1995.
- [4] KORONOWICZ T., SZANTYR J. A., *Vortex cavitation as a source of high level acoustic pressure generated by ship propellers*, Acta Acustica united with Acustica, **92**, 175–177 (2006).
- [5] SZANTYR J. A., *A surface panel method for analysis of open and ducted propellers*, Proceedings HYDRONAV'97, Szklarska Poręba 17–19 September, pp. 353–364, 1997.
- [6] SZANTYR J. A., *Analytical methods for prediction of propeller cavitation and its consequences*, Proceedings NCT'50, Newcastle upon Tyne, 3–5 April, pp. 37–56, 2000.

