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HYDROACOUSTIC ACTIVITY OF THE SHIP PROPELLER OPERATION

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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

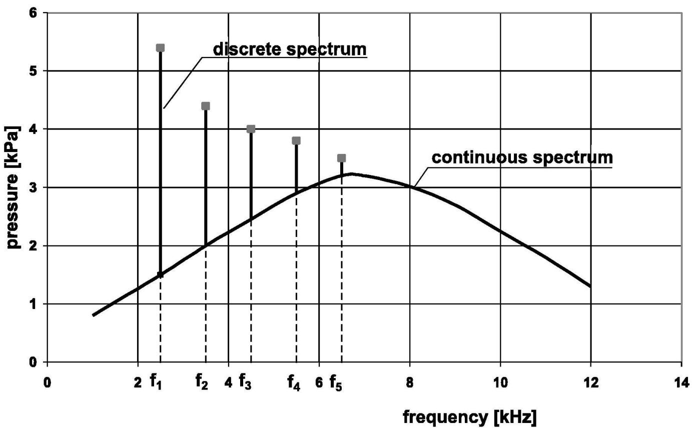

Fig. 1. An idealised spectrum of propeller generated pulsating pressure field [3].

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3. Forms of cavitation associated with propeller operation

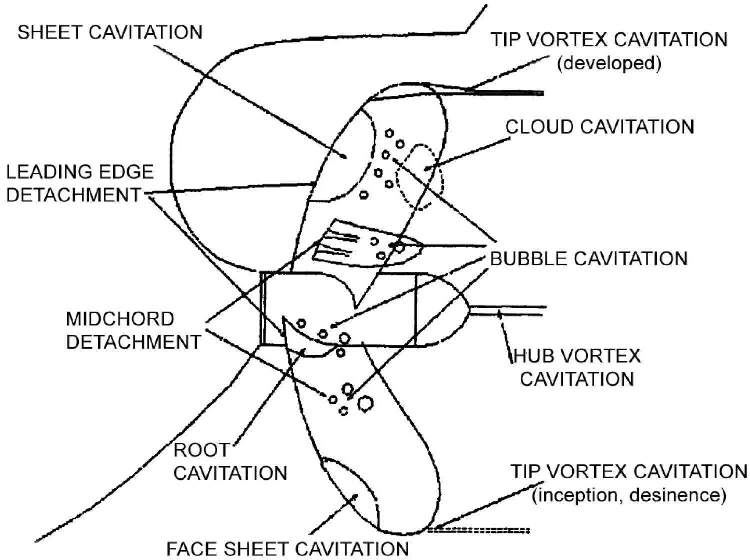

Fig. 2. Forms of cavitation present on ship propeller blades.

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

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

R ρ Δp S μ

σ J

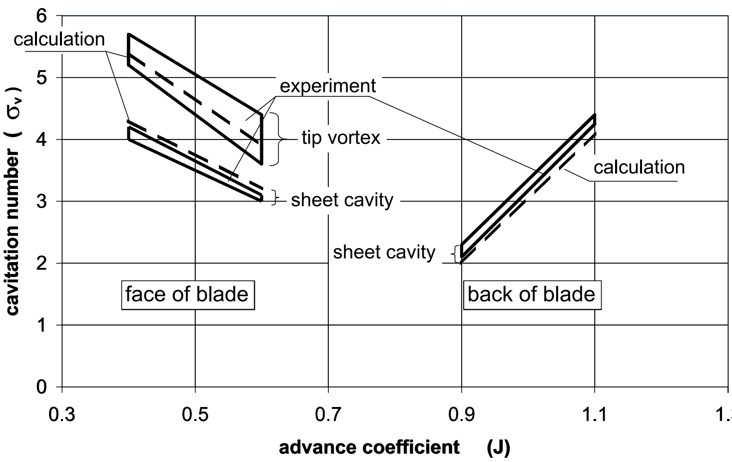

Fig. 3. Comparison of calculated and experimentally observed cavitation inception on a ship propeller model.

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$$J = \frac{V}{nD}\,. \qquad (1)$$

1 V n
D

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

p p_V ρ

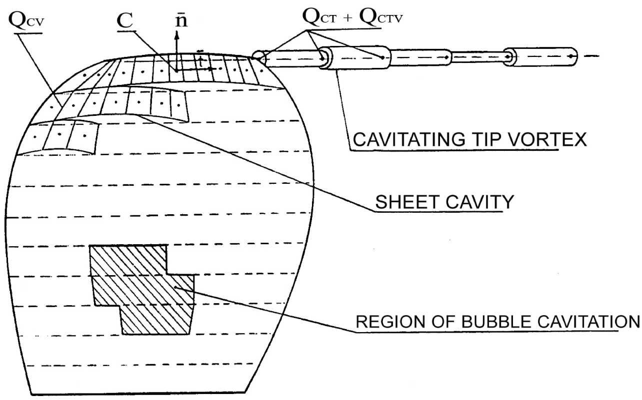

Fig. 4. Model of the cavitation phenomena on a propeller blade.

Q Q_{CV}
Q_{CT} Q_{CTV}

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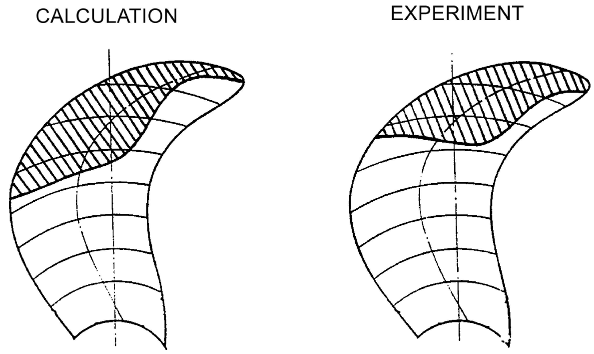

Fig. 5. Comparison of computed and experimentally observed sheet cavitation on a propeller blade.

C **n** **t**

$$\Delta p = \frac{\rho}{4\pi}\left(V_S \sum_i \frac{Q_i x_i}{r_i^3} + \sum_i \frac{Q_i}{r_i^2}\frac{\mathrm{d}r_i}{\mathrm{d}t} - \sum_i \frac{1}{r_i}\frac{\mathrm{d}Q_i}{\mathrm{d}t}\right).$$

V_S Q_i i r_i x_i r_i V_S r_i S

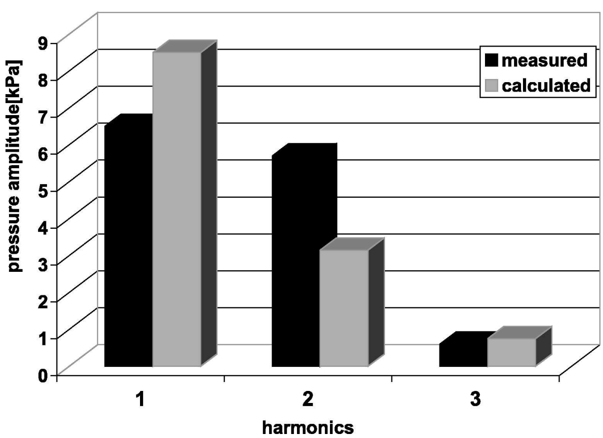

Fig. 6. Comparison of computed and experimentally measured harmonic amplitudes of the pulsating pressure field generated by the cavitating propeller.

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5. Conclusions

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