Calculation Formula for Natural Frequency of Radar Mast

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ABSTRACT

There are some reports on the excessive vibrations of radar masts, which have caused the failure of the equipment on the radar mast, or lead to strength problems such as the cracks occurring in the brackets at the bottom of the post and the structures under the post. In order to reduce the vibration, the most effective and cheapest method is to avoid the resonance. The key point to avoid the resonance is to predict the natural frequency of the radar mast accurately. In practice, there are rare reliable formulas available for the designers. This paper gives the calculation formulas for the lowest natural frequencies of the commonly-used types of the radar masts including those with uniform cross section, varying cross section, those supported by pipes, and the gate-type radar masts. Raleigh method is used to derive the formulas. The influence of brackets at the bottom of post on the natural frequencies is investigated by numerical calculations. The simplified formula is given as well. Some measurement results of actual ships are given to verify the validity of the formulas.

KEY WORDS: radar mast; vibration; formulas; measurement.

INTRODUCTION

To avoid the excessive vibration, the accurate prediction of the natural frequency of the radar mast in the design stage is necessary. Many methods, such as FEM(Finite Element Method) can be used to predict the natural frequencies with quite high accuracy. In practical ship design, the formulas are the most desirable because the calculations are simple and the influence of the parameters can be observed explicitly, which can help the designers to know which parts of structures are the most effective to avoid the resonance. In practice, there are rare reliable formulas available for the designers. This paper derives the formulas of the lowest natural frequencies for several commonly-used types of radar masts.

CALCULATION FORMULAS

For the model shown in Fig.1, using Raleigh method(Clough and Penzien,1975), the lowest natural frequency can be derived as followings:

\[ f_c = \frac{60}{2\pi} \sqrt{\frac{k^*}{m^*}} \text{ (rpm)} \]  \hspace{1cm} (1)

where

\[ k^* = \frac{3EI}{h^3} + k_1\alpha^4 (1.5 - 0.5\alpha)^2 + k_2 \] \hspace{1cm} (2)

\[ m^* = m_p + m_1\alpha^4 (1.5 - 0.5\alpha)^2 + m_2 + \frac{I_1}{h^2} (1 - 0.5\alpha)^2 + I_2 \frac{9}{4h^2} \]  \hspace{1cm} (3)