PAPER REF: 4000

RADIAL ACOUSTIC OSCILLATIONS OF HOLLOW ANISOTROPIC SPHERICAL SHELL SUBMERGED IN LIQUID

Valery A. Polyakov(*)
Latvian University, Institute of Polymer Mechanics 23 Aizkraukles, LV-1006, Riga, **Latvia**
(*)*Email:* polyakov@pmi.lv

ABSTRACT

Acoustic waves generated on the surface of hollow sphere under internal sound exciting are investigated. The solution to the wave problem with respect to radial direction is obtained by the Laplace transformation into a time domain. The complex-valued function method has been applied to obtain the natural frequencies of the spherical shell when it is submerged. The problem on amplitude obtaining is performed with the help of the theory of residues. The surface amplitudes of a thick-wall transversally isotropic sphere are analyzed into statements about its resonance activation.

Keywords: spherical shell, radial vibrations, eigenfrequency, complex analytical solution.

INTRODUCTION

The dynamic behavior of composites remains still opened academic problem due to many factors as anisotropy, complex mechanisms of their acoustical transmittivity and acoustical attenuation constant. The description of dynamic behavior of such structures is sometimes very complex due to some additional environmental factors and conditions, which introduces its complexity (Vasques et al., 2011).

The aim of this report is to highlight the dynamic problems of composite structures including wide range of thick-walled shells like the acoustic model of an anisotropic elastic hollow sphere (Polyakov, 2012). Forced vibrations caused by a harmonic source located on its inner surface. The method suggested here can be applied to predict the dynamics of a spherical shell of an arbitrary thickness because no assumption about the deformations of the shell has been employed.

RESULTS AND CONCLUSIONS

The solution, expressed by a complex function, takes into account the contact interaction of the shell with a liquid medium, an absolutely solid space, and vacuum. It shows that, in the case of an incompressible liquid, a stationary wave radiation from the sphere surface can occur for each natural harmonic over the entire infinite spectrum of eigenfrequencies. On the outer surface $r = R_0$ of the shell we have the following formula for the relative speed of vibration in the case of frequency resonance:

$$\tilde{v}(t) = \frac{tc\sqrt{\varepsilon}}{R_0|\lambda_{k'}|} Re\left[\frac{\lambda_{k'}}{N'_\mu(\lambda_{k'})}\right]\sin(t|\lambda_{k'}|c/R_0) + 2\sqrt{\varepsilon}\, Re \sum_{k=1}^{n}{}' \frac{\lambda_k[\cos(\mathrm{t}|\lambda_k|\, c/R_0) - \cos(t|\lambda_{k'}|c/R_0)]}{(\lambda_k^2 + |\lambda_{k'}|^2)N'_\mu(\lambda_k)}, \quad (k \neq k')$$

At the beginning of wave vibration we have the following curves which are displaced in Fig.1.

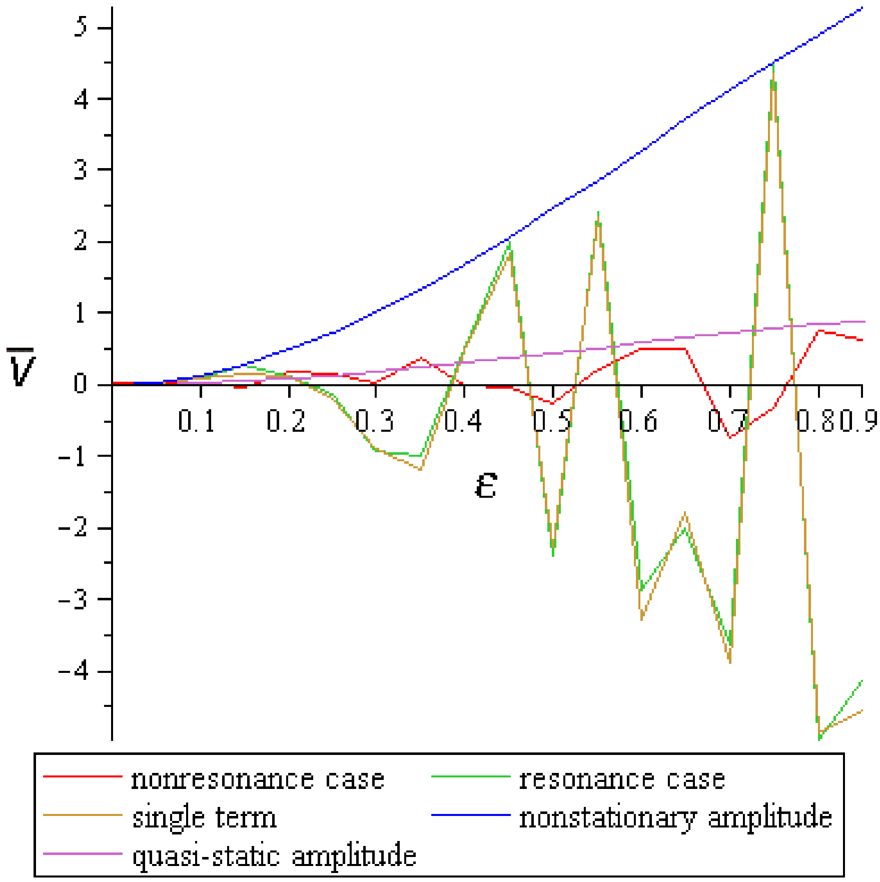

Fig. 1 - Relative velocity $\bar{v} = v_{out}/v_{inn}$ of the outer surface in the cases of resonance and nonresonance vibration versus $\varepsilon = R_{inn}/R_0$ at the given time $t_* = 10R_0/c$.

This study shows that there are substantial amplitude dependence on the frequency over correction of different sphere thickness. Further calculation should be performed in order to analyze other dynamic properties, such as an acoustic intensity.

REFERENCES

[1]-Vasques C. M. A. and Dias Rodrigues J. Vibration and Structural Acoustic Analysis. Current Research and Related Technologies, Springer, 2011, 327 p.

[2]-Polyakov V. Acoustic conductance of an anisotropic spherical shell submerged in a liquid. 1. Wave model of contact interaction between a solid hollow sphere and a liquid. Degenerate solutions, Mech. Compos. Mater., 2012, 48, No. 4, 449-466.