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Influence of Attached Body on the Frequency and Modes Free Vibrations Cylindrical Shells

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Abstract

The paper uses the method of final element in linear function in MSC «Nastran» software complex to study the influence of the inertial properties of the added rigid body-locking rod, which is directed towards mid-surface in normal, by changing its length and the relative mass value on its own dynamic performance of thin circular cylindrical shell. The findings are compared with the case vibration of the shell, carrying the added mass and with the well-known analytic solutions. The mode state (MS) of the construction made the shells with added rod has been studied. The MS of the construction depends on geometrical and physical parameters and on the kind of vibrational forms of the body connected to it have been identified. The rod connected to the shell expands the range frequency of vibration in relation to the shell, carrying the added mass. The influence of its inertial properties with increase of length of the body connected to shell (distancing center of mass connected rod from the shell) had become increasingly important. However, the influence of inertial properties connected with increase in the size of the body accession to shell is decreasing. The ranges, when inertia of jointed body may be disregarded, were presented.

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Keywords: own frequencies; forms; bending vibration; circular cylindrical shell; added rigid body; consentrated mass; the mode state.

1. Introduction

Such thin-walled cylindrical shells are widely used in construction, aircraft, ship building and other industries. The calculated scheme of such constructions is characterized by type of inclusions of the added masses or rigid bodies. It is known that the added mass leads to range of particular phenomenon in vibrations of shells: double of

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the frequency content, travelling at the district area waves and other [1-9]. In the majority of theoretical research the body connected to shell on the relatively small area being seen as concentrated mass [10-11]. There are many researches on vibration of the shell, carrier the added mass; however some questions of dynamics to this day remain under-explored in the scientific literature [1,12-19]. There are only a few academic writings, which examined the influence of jointed bodies [20-21]. In this academic writing is being studied influence the rod, connected to shell which sent in normal by mid-surface, by changing its length and value relative mass of the rod on dynamic characteristics of construction made the shells by the method of final element (MFE) in the environment «PATRAN» with the use of the linear solver MSC «NASTRAN». Results achieved in this article are compared with analytic solution given in the monograph [22]. In the academic writing the proper (ventricular) vibration an added body significant influence on MS of the construction made the shells are also shown.

2. The research of dynamic performance of shells, carrier an added mass

Consider the circular cylindrical shell with the following geometrical and physical characteristics: $R/h=200$, where $R=5$ m. radius of the shell, h – is wall thickness; $L/R=2,5$, where L – is the length of the shell; $p=7800\ кг/м^3$ – is mass density; $E=2*10^{11}\ Н/м^2$ – is Ung's module. Number of final elements are – 10000. The conditions of a freely downloaded are realized on the butt ends of the shell. The results of dynamic calculation are presented in fig. 1, where n – is the number waves of circuit dynamic deformations, ω_{ni} – is proper frequency, corresponding form of n ($i=1,2$).

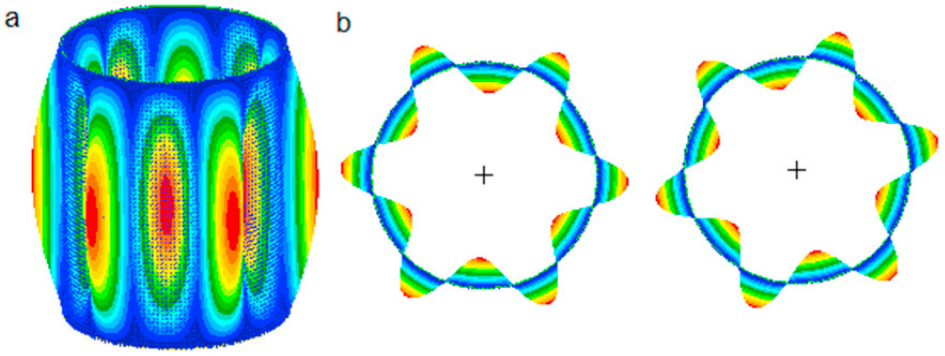

Fig 1. The coupled bending forms of vibrations, corresponding to the lowest frequency $n=6$: (a) is aspect in isometry; (b) is coupled bending forms . $\omega_{61}=\omega_{62}=10\ Гц$.

At the same frequency, corresponding to two coupled bending forms for the shell geometrically perfect closed circular cylindrical shell without an additional inclusion [1,23-24]. We would continue to review the inclusion of two types, this is concentrated mass on the surface cylindrical shell and jointed absolutely rigid body locking rod section $a=b=0,1\ м.$ and the relative length $l/R=0,1;0,2;0,6$. We will explore influence of following size mass: $M=0,05M_0;0,1M_0;0,3M_0;\ 0,6M_0$ on proper frequency and forms of vibrations of the system "shell-added body", where M – is size of added mass, M_0 – is mass of the shell. The added mass located at a distance $L/2$ of the shell.

The fig. 2 is presented a) the forms, corresponding to the lowest frequency vibrations of the shell ($n=6$), carrier the concentrated mass $M=0,1M_0$, and in the fig. 2 b) – are shells with same amount of mass rod, the length, $l/R=0,1$, where l – is the length of added rod.

It is clear from the calculations that the added mass has resulted in splitting frequency bending spectrum of cylindrical shell. The biggest of splitting proper frequency, practically does not modify the meaning and equal to frequency of the singularity of the shell without an added mass. The lowest frequency is decreasing [1]. The biggest decline of frequency identifying in the case of vibrations the construction made the shells with the added rod. The proper frequency in both cases do not depend on circular coordinate attaching points of the mass of concentrated mass or the rod.