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THE SUBSYSTEM FOR ANALYZING CAVITY STRUCTURE WITH COMPLEX END LOADING

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Abstract

In the paper we consider the problems of scattering of electromagnetic waves on cavity structures with complex end loading. The algorithm based on the selective modal approach is used, the results were compared with the combination of modal anf FDTD methods. The CAD for designing cavity structures was proposed.

Keywords: Propagation of electromagnetic waves, diffraction, modal method

Introduction

The waves are quite effective way to transfer energy and information, thus it isn't required that the substance moved on noticeable distances. We can see the development of various means of a radar-location and radio communication. The importance, from the point of view of the corresponding technical appendices, the processes of distribution of waves in systems which are connected with that this distribution has the directed character are have.

It is possible to distinguish from the different tasks connected with waveguides such which concern studying of scattering electromagnetic waves on cavity objects which in special cases coincide in a form with forms of the elementary waveguides [1, 2].

The aim of this paper is development of subsystem for the analysis of scattering of electromagnetic waves on the cavity structures having certain objects in internal area on the basis of selective approach.

Technique

If we aspire to finding opportunities for the solution of applied problems, it is necessary to build algorithms of calculation of characteristics of dispersion of electromagnetic waves for three-dimensional structures, when there is no conditions to make reduction of dimension of the problem. Undoubtedly, for special cases the dimension can be reduced, for example, for symmetric objects.

Thus certain difficulties arise in the analysis of cavity structures with the sizes relating to resonant area.

In figure 1 the example of the studied structure is given. The part of a waveguide has round cross section.

On the one hand there is a metal wall, it represents terminal loading and there is a heterogeneity placed on this back wall. It is the metal cylinder with a certain radius, smaller, than wave guide radius, and height which size is less, than waveguide piece length.

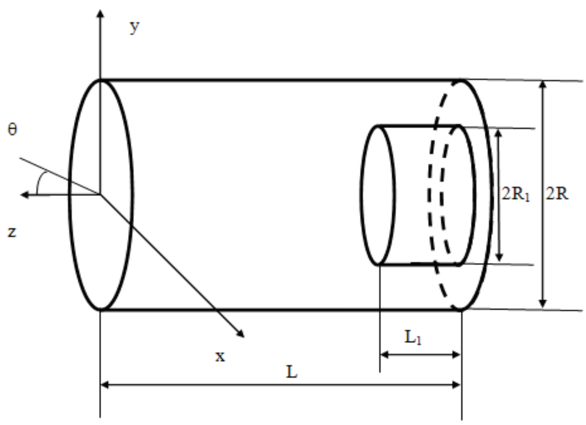

Figure 1. The scheme of scattering of electromagnetic waves on cavity structure with difficult loading.

The problem connected with the scattering of electromagnetic waves on such structure can be solved with use of different approaches. For example, these approaches can be rigorous [1]. But if length of a waveguide will be, for example, much more than tens lengths of waves, the calculation on the basis of a method of the integrated equations for area of the forward hemisphere which is close axes of symmetry will demand big time and machine resources.

It is necessary to use approach on the basis of a modal method [1, 2].

The main stages of algorithm of calculation of cavity structure on the basis of a modal method are the following:

1. The representation of tangential components on an electric and magnetic field on an aperture as decomposition on modes of a waveguide.

2. The modal coefficients of the entering modes define on the basis of the theorem of reciprocity [1].

3. The modal coefficients for the leaving modes define on the base of scattering matrix [1].

4. The field scattered by cavity structure, that determined by the leaving modes can be calculated with use of Stratton-Chu approach [3].

For a uniform site of a round wave guide eigen functions are Bessel's functions

$$\varphi = J_m(\xi_{mn} r), \quad (1),$$

and for part of the waveguide corresponding to loading, eigen functions will be defined thus:

$$\varphi = J_m(\xi_{mn} r) - \frac{J'_m(\xi_{mn} R)}{N'_m(\xi_{mn} R)} N_m(\xi_{mn} r). \quad (2)$$

where $J_m(\xi_{mn} r)$, $J'_m(\xi_{mn} R)$, $N_m(\xi_{mn} r)$, $N'_m(\xi_{mn} R)$ – Bessel's function first kind and its derivative, Bessel's function second kind (Neumann's function) and its derivative.

We used a selective modal method in which only modes which modal beams lie close to a normal to an aperture of a cavity [4] are considered.

The results of calculations of the radar cross section are given in figure 2. The curve 1 corresponds to calculations on the basis of the combined iterative method of physical optics [5], the curve 2 corresponds to a selective modal method. Calculation was carried out for the following parameters: $R=4\lambda$, $L=10\lambda$, $L_1=1\lambda$, $R_1=2\lambda$. We consider θθ-polarization.

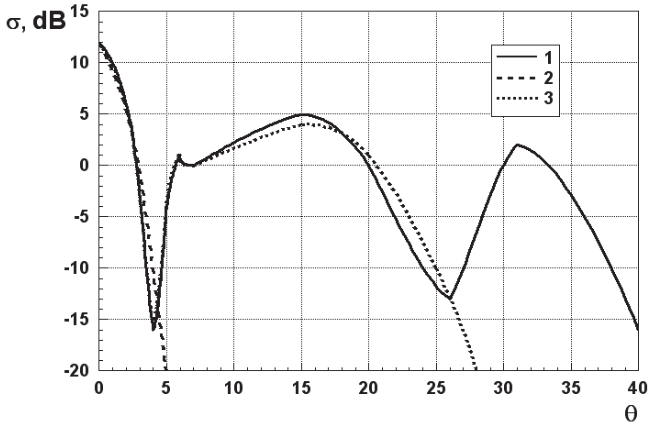

Figure 2. The comparison of results of calculations of characteristics of dispersion of cavity structure with loading

The curve 1 – results, obtained on the base of modal-FDTD methods, curve 2 - results, obtained on the base of selective modal approach (10% of modes), curve 2 - results, obtained on the base of selective modal approach (50% of modes).

It can be see that in the area of the first several lobes of the backscattering diagram good coincidence is observed. We can search the parameters of cavity structures for which we have necessary sector of angles of observation [6].

The scheme of the offered subsystem for the analysis of cavity structures with difficult loading is given in figure 3.

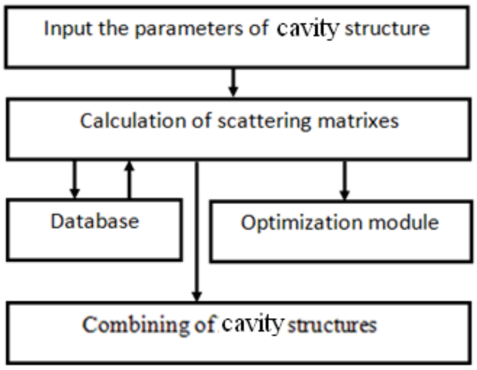

Figure 3. The CAD for designing cavity structures

Conclusion

In the paper the modeling of scattering of electromagnetic waves on cavity structure of round cross section with difficult terminal loading is carried out. It is shown that use of a selective modal method allows to receive the acceptable results for the first several lobes of the chart of the backscattering diagram. The scheme of the offered subsystem for the analysis of characteristics of dispersion of cavity structure is given.

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