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S.V. Boudrin. **Calculation of vibration parameters for engineering structures using boundary impedance element method.** Pp. 15–41.

Usually, analytical (if possible), finite element (FEM), boundary element (BEM) methods are applied for vibration and radiation analysis of complex engineering structures. Sometimes the latter two are used jointly.

FEM & BEM are used at low and mean frequencies in terms of vibro-acoustic characteristics of structures at discrete frequencies.

The energy-statistic calculation methods (ESM) found wide application for calculation of structures at high frequencies. These methods handle energy fluxes of the structure component vibrations and, thus, allow calculating averaged vibration & acoustic characteristics of engineering structures in the specified frequency band. Application of ESM is limited by frequency as its application assumes presence of a certain number of resonance frequencies for structure components in the frequency band under analysis.

Calculation procedure of the proposed method of boundary impedance elements (BIEM) was changed from obligatory calculation of the whole structure to sequential calculation of all structural components. It became possible to change the calculation procedure due to replacement of the structure vibration analysis by calculation of the structure impedance characteristics at boundaries of separate structural components that are independent of the method and location of the structure excitement being a structural feature.

The method allows for simultaneous application of different calculation methods for different structural components. This feature allows performing calculations of the structure vibro-acoustic parameters using proposed BIEM method from single hertz to tens of kilohertz.

L.V. Parshina, B.A. Yartsev. **Prediction of changes in the properties of rubber-metallic shock-absorbing structures in the process of thermal ageing.** Pp. 42–57.

An engineering approach is proposed for calculation of static & vibration characteristics of the shock-absorbing structures. The method is intended for prediction of the structure property changes caused by thermal ageing. This approach is based on the study of ageing kinetics for the shock-absorbing structure with elastic component made of elastomers at elevated temperatures. Rigidity variation coefficient allows to evaluate the changes in the properties of elastomer in the process of thermal ageing.

Changes in static & vibration characteristics of the rubber-metallic shock-absorber AKSS-120M during thermal ageing under the effect of constant static load were analyzed. Phenomenological approach is applied to describe properties of the elastic component material. Selection of elastic potential was made through comparison of computated and experimental values of static load characteristic for the shock-absorber. Rigidity change coefficient during thermal ageing was defined as a relation between rigidity in the initial state (before ageing) and after ageing within the specified time period. Temperature model of the shock-absorber operation serves as a basis for selection of the accelerated ageing time period, during which the change in the device properties (assumed during operation) will be simulated.

I.N. Tislenko, N.N. Fedonyuk, B.A. Yartsev. **Analytical & Experimental Study on Vibration and Acoustic Characteristics of a Flexible Polymer Composite Coupling.** Pp. 58–71.

The analytical & experimental study on vibration and acoustic characteristics of a flexible polymer composite coupling is presented. A finite-element model of the flexible coupling is developed including the transverse isotropy of material. FEM calculations and experiments are used to determine natural frequencies and modes of the flexible coupling vibrations. It is shown that there is a good agreement between calculated and measured relationships of conductance in function of exciting force frequency for various types of flexible coupling excitation. Forced vibration modes of flexible coupling at resonance frequencies of the amplitude-frequency response are presented. The effect of energy scattering on the forced vibration modes around resonance frequencies is investigated.

L.V. Parshina, B.A. Yarzev. **Effect of the specimen geometry on the accuracy of dynamic shear modulus determination.** Pp. 72–81.

The ratio of geometrical dimensions for the strip-specimens tested in torsion pendulum was identified with minimum error of complex shear modulus determination.

The effect of the specimen geometry was studied numerically with cantilever isotropic plates of uniform thickness that are made of two modifications of polymer material; these materials have different Poisson coefficient. The first natural frequencies of torsional oscillations and corresponding coefficients of mechanical losses were determined by solving the task of damped oscillations in laminated anisotropic plates in polymer composite materials. This task was solved in two stages: at first the elastic task was solved for eigenvalues using Ritz method and at the second stage when solving the task of damped oscillations the iteration method was used of the third accuracy order to determine the complex roots of the frequency equation applying initial approximations defined at the first stage. Dynamic shear modulus was determined using rigidity value that was calculated via the known values of first natural frequencies of the torsional oscillations and geometrical dimensions of the experimental specimens.

The non-dimensional parameters of relative width and relative length of the plate have been introduced to reduce the amount of calculations and to summarize the calculation results. Based on the performed studies, the generalized curves of relative error in determining dynamic shear modulus in the wide range of geometry and physics & mechanic properties of the specimens were obtained.

N.V. Volkova. **Assembled shock-absorbing structure characteristics evaluation.** Pp. 82–93.

Calculation of the shock-absorbing structures (SAS) with elastic rubber component is reduced to physically & geometrically non-linear visco-elastic problem of the continuum mechanics. Non-linearity is specified by the structure type, applied load value and visco-elastic properties of the rubbers.

Phenomenological approach that was first developed by Moony and Rivlin allows describing deformation that is analytically observed during experiments with required accuracy, including the conditions of complex stress state and large deformations. To describe relations between main stresses σ_i and main elongations λ_i elastic potential W is used, which is experimentally determined function of the deformation invariants.

Simple and acceptable for series production assembled shock-absorbing structures were studied with elastic components being cut from finished rubber plates.

Preliminary estimation of the static rigidity for developed assembled ring shock mount was performed in radial direction.

An engineering methodology for calculation of the static & vibration characteristics of the SAS is proposed, which considers physical & geometrical non-linearities that allow to shift to prediction of static & vibration characteristics for developed SAS with specified characteristics. A calculation of the developed SAS with different rubber types is given as an example.

The calculations that determine displacement in the direction of the force action with variable value of rubber massive shrinkage in metal sleeve were executed to select optimal option for structure manufacturing.

To validate results of the numerical studies some experiments were performed at the Krylov Institute test rigs for main characteristics of the developed ring shock mount.

K.I. Valyantinas, S.A. Shlyapochnikov. **Acoustic field near the sound-soft layer as a method of coating diagnostics.** Pp. 94–99.

Acoustic field of the monopole source near the sound-soft layer of the hydro-acoustic coating was examined. This task has much in common with the problem of radio waves propagation near the plain Earth surface. It was found that sound pressure consists of two parts, i.e. surface and spatial waves. A concept of field decay function was established for surface wave. It was found that the latter exists in the frequency domain where the sound-soft layer behaves as acoustic elasticity. At that, frequency domains exist, where the surface wave exceeds the spatial one in amplitude and level of decay. This conclusion is illustrated by the decay graphs for actual values of the sound-soft layer parameters. Therefore, characteristic features of the surface wave could be applied for diagnostics of the hydro-acoustic coatings.

A.S. Alykhov, N.V. Bournasheva, B.V. Drouzhilovskiy, M.N. Kouzmichev. **Investigation results for interaction between external acoustic coating and hull plating component under conditions of all-round hydrostatic pressure.** Pp. 100–106.

Finite element method was used in the version that allowed obtaining updated values of the stress-strained state due to corresponding selection of the type and dimensions of the finite elements. Considering specific character of the examined problems, relatively universal 3-D elements with eight nodes Solid45 were applied for FEM calculations. Calculation was performed using software package ANSYS 5.7. Robustness of the adopted calculation schedule was verified through test calculation, the results of which are provided within the paper.

During calculations were considered effects of curvature and shell on strain-stress distribution, interaction with acoustic coating and other main factors. In addition, calculations were made using analytic methods based on the theory of arcs with extendable axis, etc. Comparison and analysis of calculation and experiment results have demonstrated sufficient validity and required accuracy of the study.

YU.M. Vorobiev, YU.I. Kotsarev. **New method to define reflection coefficient for marine engineering object using variable-pressure tank and continuous signal radiation.** Pp. 107–112.

The paper examines ways to extend the frequency range for measurements of reflection coefficient for models with marine engineering specimens in the variable-pressure tank.

Application of measurements and results processing that have been used for more than 35 years does not allow to extend the measurement frequency range in the variable-pressure tank. Especially important is the task of reducing the lower limiting frequency in measurements due to application of new low-frequency means of hydroacoustic detection when classic scheme of reflection coefficient determination is not applicable. One of the reasons is the bulkhead installed in the variable-pressure tank.

The method allows to eliminate the effect of bulkhead on the measurement results and to reduce the lower limit frequency of the measurements. Main difference from the previous method is calculation of the reflection coefficient

for spherical incident wave, whereas previously the plane wave approximation was used. New method of calibration was proposed accounting the changes in result processing algorithm.

A.D. Pougachev. **Consideration of technological factors at development of hydroacoustic coating.** Pp. 113–123.

A number of technological requirements and recommendations given by developers of hydro-acoustic coatings (HAC) were examined. These factors are to be considered at the very early design stages. This necessity is caused mainly by the requirement to ensure reliability of the coating itself and coating-hull structure joints during the long-term service.

A.V. Alykhov, A.V. Ionov, L.N. Malyukova. **Proposals to improve new hydro-acoustic coatings development and production processes.** Pp. 124–135.

Analysis was made for cost effectiveness of solutions made at development of hydro-acoustic coatings (HAC) starting from task assignment and up to the serial production. R&D activities of the recent 10 years have been studied that allowed to develop the new generation coatings. The most costly stages in development of new coatings are determined. Experience in these activities with limited financing has helped the authors to find the most rational methods for R&D activity planning providing for considerable reduction in time and cost. Specific proposals are formulated for planning the typical R&D activities, which ensure required economic effect.

B.V. Aizykovich, A.G. Alexeev, M.F. Klyodt, A.P. Starostin. **Theoretic grounds for development of radar-absorbing coatings basing on nanostructure compositions.** Pp. 136–145.

Theoretical and experimental studies are carried out to develop non-metallic composites to produce light elastic structures capable to absorb electromagnetic radiation in a wide frequency range with small reflection factor. An approach is established based on combination of composite ferromagnetic materials having large magnetic losses in the band of ultra-high electromagnetic radiation frequencies and nanostructure film filler materials based on hydrogenated amorphous carbon with cobaltic nanoparticles. Magnetic spectra character of the developed materials are studied and conditions for manufacturing the compositions with dual-dispersion spectrum of complex magnetic permeability in the ultra-high frequency band are determined. Carbon nanostructures with magnetic properties were investigated to derive these activities. Based on superparamagnetism concept the metal-containing Sm-Co fullerene nanostructures were selected providing a 12 dB reduction of electromagnetic radiations in specified frequency range.

A.G. Alexeev, A.V. Ionov, M.F. Klyodt, A.P. Starostin, N.S. Titova. **Integrated antisonar coating with radar-absorbing layer made of nanostructure films on composite substrates.** Pp. 146–154.

The paper deals with the approaches to development of integrated multi-role coatings. It is demonstrated that multi-layer structure of such coatings makes it possible to achieve effective absorption of acoustic and electromagnetic radiations in the ultra-high frequency range. Technical basis is provided for manufacturing the aramid fabrics with chemically modified fullerenes and cobaltic nanostructures using magnetron deposition. Optimal concentration for the fabric-inserted cobalt is obtained providing the specified damping coefficient for ultra-high electromagnetic radiation, when these fabrics are used as upper layer of the combined coating. Due to requirements to the acoustic structure of the combined coating, the authors have developed formula for polymer materials, which provide visco-elastic and technological properties of the structure. Effectiveness of the developed structure for combined radar/sound-absorbing coating was determined using Krylov Institute guidelines. It was found out that upper radar-absorbing structure did not degrade acoustic effectiveness of the integrated coating, but protected it from external mechanic and climatic factors.

A.G. Alexeev, G.S. Bass, M.F. Klyodt. **Development of environment-friendly wireless city infrastructure and nanotechnologies.** Pp. 155–163.

The paper demonstrates the biological importance of artificial (anthropogenic) electromagnetic fields. The World Health Organisation has introduced a term «electromagnetic pollution of the environment», however, the number of electromagnetic radiation sources has been steadily increasing both in extreme low-frequency and high-frequency bands from 300 MHz to 30 GHz. In this case, the increase of radiation power is observed, especially for wireless communication and electronic equipment control including commercial applications. It is established that limiting level of the radiation power for PC processors and cellular phones should not exceed 10 $\mu W/cm^2$. Based on the result of the studies, a concept of human «electromagnetic comfort» is introduced, which describes the normal physiological state of all body organs. Considering magnetic sensitivity of electronic processes in any biochemical reaction within the human body, it is required to protect living spaces from leakage of electromagnetic energy to ensure healthy conditions for humans. Special attention should be paid to base stations of the cellular communications, which are often located on top of living buildings. To solve these problems authors have developed a range of radio-absorbing materials that could effectively screen premises and humans from electromagnetic radiation in a wide frequency range.

A.G. Alexeev, G.S. Bass, E.V. Zhoukova, T.V. Starostina. **New approach to calculation of acoustic polymer coatings and products.** Pp. 164–172.

The paper proposes and validates new advanced method for determining the warranted service life for high-elastic materials and products. This express-method is based on numerical correlations of the high-elastic material properties with destruction process activation energy u_0. The mechanical stress and generalised model of the combined effect of environment where the product will be operated are applied. The method allows reducing time required for warrantied life time period determination of the material and product performance up to 40–60 hours, i.e. approx. 30 times, when compared to widely applied Russian State Standard GOST 9.713-86 «Method for prediction of property changes at heat ageing». Comparison of activation energy u_0 for high-elastic materials with different compound obtained through express-method and through GOST 9.713-86 with the same temperature intervals has demonstrated that they are practically the same. The express-method has Russian Federation patent.