Vibration of ship structures

1. Vibrations of systems with one degree of freedom

1.1. Equation of motion of systems with one degree of freedom
1.2. Free oscillation of systems with one degree of freedom
1.3. Forced oscillations: the action of a harmonic force on the system with resistance, forced oscillations when moving the point of suspension
1.4. Oscillations of systems, taking into account energy dissipation in the material: the hypothesis of Sorokin, free oscillations; forced oscillations

2. Oscillations of systems with several degrees of freedom

2.1. The Lagrange equations of the second kind
2.2. The kinetic energy, potential energy and dissipation function
2.3. The equations of motion of systems with several degrees of freedom
2.4. The inverse method of the equations of motion development
2.5. The free oscillations with the absence of resistance, the principal coordinates
2.6. Forced oscillations of the system: oscillations at arbitrary perturbing forces, the method of principal coordinates; oscillations at harmonics of the perturbing forces
2.7. Definite studies of system with n degrees of freedom oscillation: the influence of the position due to the oscillation frequency of the system (Routh's theorem); the impact of increasing the number of degrees of freedom on to the oscillations of the original system
2.8. Methods for calculating the frequencies and modes of free oscillations: the energy method; Rayleigh theorem; the method of successive approximations; the method of roots separation
2.9. The transverse beam considered as multi-mass system oscillations: the inverse method; Theorem of Five moments

3. The basic tenets of the theory of small vibrations of elastic bodies

3.1. The equation of motion of an elastic body
3.2. The longitudinal oscillations of rods: the free oscillations of prismatic bar - free rod; the rod with one end elastically fixed and the other end is connected rigidly to the concentrated mass
3.3. Standing and running waves concepts
3.4. Orthogonality of the main forms of free vibrations of non-prismatic rod
3.5. Forced oscillations
3.6. Torsional oscillations of rods
3.7. Bending oscillations of beams: free oscillations (simply supported prismatic rod, free prismatic rod); the main forms of the orthogonality of free oscillations
3.8. Forced oscillations without resistance forces under the action of the perturbing harmonic load: prismatic beam freely supported, loaded by the support moment; prismatic beam freely supported, loaded by a concentrated force; prismatic beam freely supported, loaded harmonic uniformly distributed load; freely simply supported prismatic beam, the right support which receives the harmonic displacement
3.9. Forced oscillations under the action of the perturbing harmonic load and take into account the forces of resistance: expansion of the solution in a number of forms of free oscillations; the use of complex forms of the equation of oscillations
3.10. Transverse oscillations beam loaded by transverse and axial forces on an elastic foundation
3.11. The transverse beam oscillations, taking into account the shear and rotational inertia of the masses in the cross-sectional

3.12. Oscillations of continuous beams, simply supported on elastic supports: forced oscillations under the action of the disturbing harmonic loads and forces without resistance; free oscillations; forced oscillations under the action of the perturbing harmonic load and impact resistance forces
3.13. Oscillations of simple frames with mobile nodes: forced oscillations under the action of the disturbing harmonic loads; free oscillations
3.14. Oscillations of complex frames with mobile nodes: fundamental dependences on the strains method; basic equations of the method of displacements; forced oscillations; free oscillations
3.15. Oscillations ship floors (for simplified design options)
3.16. The method of separation of the roots of the frequencies equation of bar systems
3.17. The calculation of the transverse oscillations of rectangular plates: free oscillations (freely supported plate; rectangular plate, two parallel edges of a freely supported); forced oscillations

4. Approximate methods for calculation of free and forced oscillations of elastic bodies

4.1. The Lagrange equations of the second kind
4.2. Energy methods for the determination of natural frequencies: the first and second methods of Rayleigh; Grammel method, the method of Rayleigh-Ritz
4.3. The Finite Element Method: sampling design, selection of the basic variables and the main varieties of the finite element method; creation of the interpolation polynomial; the stiffness matrix of finite element; the vector of equivalent external efforts; local and general coordinate system; the basic system of equations of the finite element method; solving of the matrix equation of motion
4.4. Stiffness matrix, mass matrix and vector of equivalent nodal effort
4.5. Example of using the finite element method for calculating the motion of the beam

5. Issues in hydroelastic problems of the ship structures dynamics

5.1. Free hydroelastic oscillations
5.2. Forced oscillations hydroelastic
5.3. Additional masses of water at the local oscillations of ship structures
5.4. Added masses in general vibration of ship’s hull

6. The forces that cause vibration of ship’s hull

6.1. Loads caused by manufacturing inaccuracies of mechanisms, shafts, propellers
6.2. Loads caused by the action of propeller behind the vessel's hull: the load transmitted through the body bearing, load-induced by the pressure pulsation
6.3. Vibration caused by the influence of sea waves, pitching and slamming

7. The overall vibration of the vessel

7.1. Types of vibration of the ship’s hull
7.2. Stiffness and inertia factors, the resistance force and the external perturbing forces due to vibration ship hull as a prismatic girder; added masses of water; the force of internal and external resistance; ship’s hull stiffness; load, causing vibration of ship structures
7.3. Free and forced vertical oscillations of ship’s hull: the equations used to describe the oscillations of ship’s hull; approximate calculation of the oscillations of ship’s hull (the method of finite differences); calculation of free oscillations (methods: finite differences, the Rayleigh-Papkovich; Grammel-Shimansky); forced oscillations of the hull (any disturbing load; the harmonic disturbing load)

7.4. Free and forced torsional oscillations of the hull: the free oscillations of the vessel (determination of the forms of free oscillations; Rayleigh method); forced oscillations (any disturbing load; the harmonic disturbing load)
7.5. Joint bending-torsional oscillations of ship’s hull: the equations describing the bending-torsional oscillations; methods for approximate solution (integration)
7.6. Accounting for the effects of torsion constraint in the study of torsional and flexural-torsional oscillations of ship's hull
7.7. The relationship of general and local vibrations of ship's hull
7.8. A refined model in the calculation of the vibration of ship's hull
7.9. Approximate formulas for calculating the parameters of the overall vibration of ship's hull

8. Local vibration of ship structures

8.1. Vibration of masts
8.2. Vibration of shafts
8.3. Features of ship plates vibration
8.4. Vibration of rectangular plates elongated

9. Regulation of the permissible vibration and ways to reduce the vibration of ship structures

9.1. Regulation of the permissible vibration and noise: the effects of vibration and noise on human health, vibration valid for human; the effects of vibration on the strength of ship's hull, the permissible level of vibration to the strength of ship's hull
9.2. The ways to reduce the vibration of ship structures