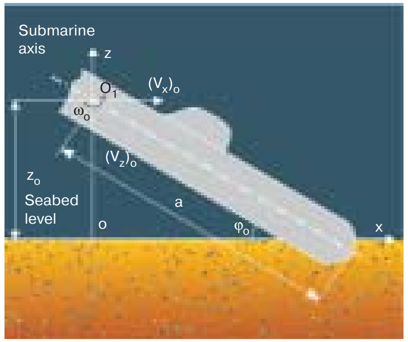
recovery capsule rigidly coupled with the pressure hull;

- Develop a mathematical model for the submarine hull interaction with different types of seabed (absolutely rigid - rock and soft - clay).

The performed work made it possible to:

- suggest recommendations for calculation of the structural damage size in the case of submarine collision with rigid obstacle providing the integrated assessment of fore end dent extension and parameters of submarine deceleration in case of normal impact at rigid obstacle with arbitrary velocity;
- develop methods for calculation of pressure hull strength and probability for a breach to appear in the case of impact by the vessel stempost, or forward end of ramming submarine; finite rigidity (deformability) of stempost and forward end have been taken into consideration; impact may happen in any submarine area alongside the pressure hull;
- formulate methodical recommendations for calculation of probable structural damage and submarine deceleration parameters at impact on the rock or clay (soft) soil. At

Virtual picture of submarine collision



Submarine position during collision with the seabed

impact against the rock soil, when deceleration is mostly provided by crumpling of the pressure hull, three typical options are being considered for normal interaction with the ground with specified vertical velocity. Impact by forward or aft end and impact by the bottom part (keel girder). As applied to the impact against the soft soil, the submarine movement in soil is taken into account with initial conditions of interaction in relation to vertical and horizontal speed, angular speed of rotation and initial trim angle. The obtained results allow to identify the final position of the submarine on the seabed (including embedding).

METHODOLOGY OF DESIGN & EXPERIMENTAL ASSESSMENT AND PROVISION OF FATIGUE SERVICE LIFE OF ADVANCED VESSELS AND SHIPS

Efficiency and cost effectiveness of advanced ships and vessels operation, including the new types of ships, is closely dependent on the hull endurance parameters. Among these parameters, fatigue endurance is of greatest importance. Formulating assessment for this parameter, the following should be taken into consideration:

- level of loading for the entire hull and its separate joints under various operating conditions of the ship under consideration;
- mechanical properties of the hull material;
- local features of the stress state for the mostly loaded hull joints;
- hull material response to initiation and propagation of fatigue damages.

Verification procedure for fatigue strength includes the following stages:

- design evaluation of wave and dynamic loads on the ship hull considering basic dimensions and shape of its outlines;
- experimental elaboration of amplitude-frequency response, wave and dynamic loads based on the model tests carried out in the Krylov Institute model tank;
- finite element analysis of the stress-strained state (SSS) of the hull at general bending due to the effect of calculated wave and dynamic loads;
- development of the finite element model for basic hull structures of the ship and calculation of SSS;
- fatigue service life assessment for the hull and its main joints on the basis of performed analysis;
- experimental verification of stress-strained state and actual strength of standard joints and assessment of their fatigue properties.

Fatigue tests

The performed research has enabled to:

- summarize and review the data of the model and full-scale experiments regarding external force impact on the hull in combination with probabilistic assessments of the sea state, as well as the data on fatigue tests for materials and hull joints;
- develop and update assessment procedure based on the modern numerical methods for stress-strained state analysis of the hull and its separate joints.

The developed calculation procedure has been successfully used for upgrade of 11356 project ship structures and it will find practical application by the design bureaus at design and assessment of fatigue strength for medium and small displacement ship hulls.

DEVELOPMENT OF VIBRATION SUPPRESSION COUPLINGS MADE OF POLYMER COMPOSITE MATERIALS

Compensation of unfavorable effects caused by substantial relative displacements of the power plant components concurrently with reduction of vibration levels and acoustic field is a very challenging problem that we come across at development of power transmission system from the main engine to the propulsor. This problem can be resolved with the help of vibration absorbing couplings (VAC), which possess sufficient ductility, operability and service life under the effect of high torques. In this respect, introduction of couplings made of polymer composite materials (PCM) is most promising.

To resolve the problem it was required to:

- analyze PCM coupling service conditions while operating within the power plants;
- plot a mathematical model to calculate PCM coupling geometrical and structural parameters, as well as their effective elastic behaviour;