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Numerical simulation of motions of ship with moonpool in head wave

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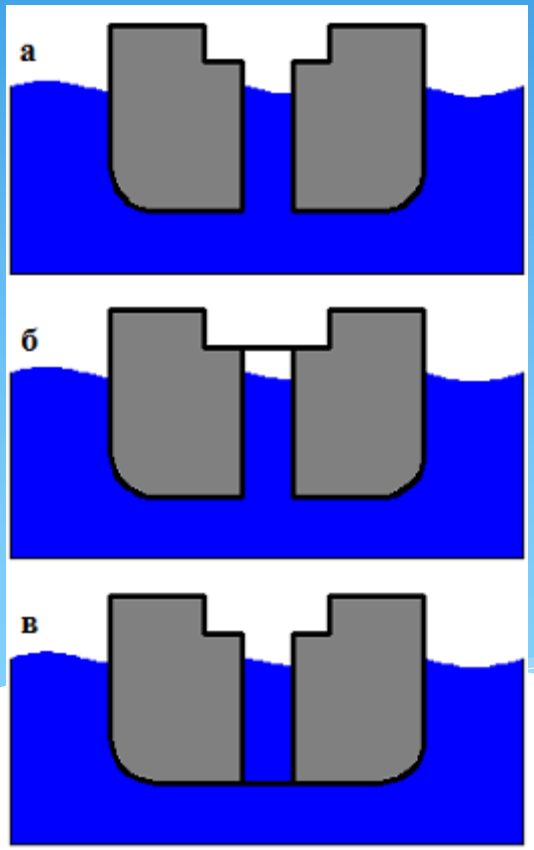
Introduction



Moonpool is well which is used in different types of ships such as cable laying, drill and FPSO, survey, research and so on. This well is used for launching and lifting of different devices, divers, rescue bells, cables and risers which are protected of outboard wind and waves.

The work is dedicated to:

- The verification of CFD methods for calculations of ship motions RAO and phase lags;
- The experimental research of motions of ship with moonpool without ship speed;
- The verification of CFD methods for calculations of ship with moonpool motions RAO and vertical water motions in moonpool RAO.

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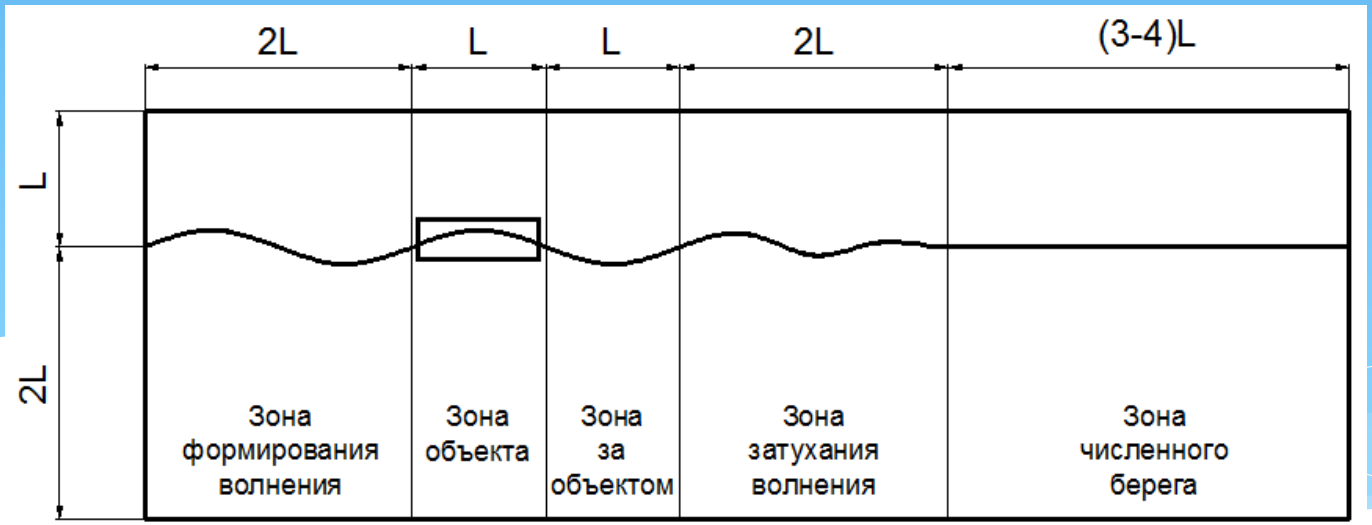
Preparation of numerical simulation in OpenFOAM

interDyMFoam	Расчетная область	Волнение
k-ω SST	blockMesh	waveVelocity
water & air	topoSet	waveAlpha
sixDoFRigidBodyMotion	snappyHexMesh	fvOptions



L – length of the ship or wave whichever is larger

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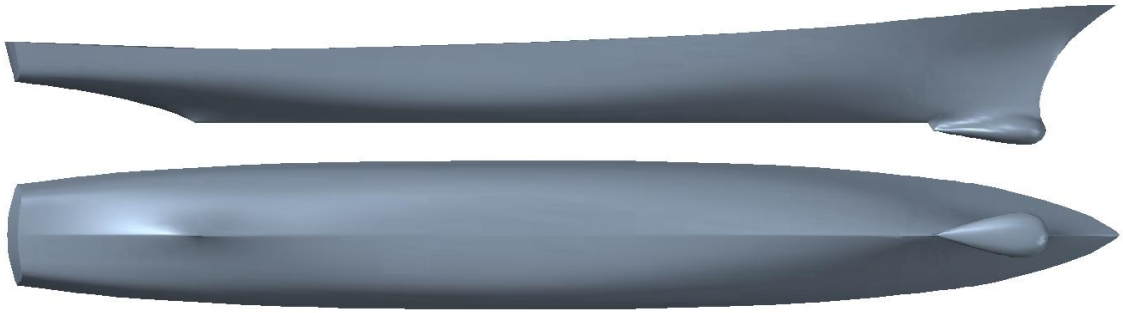
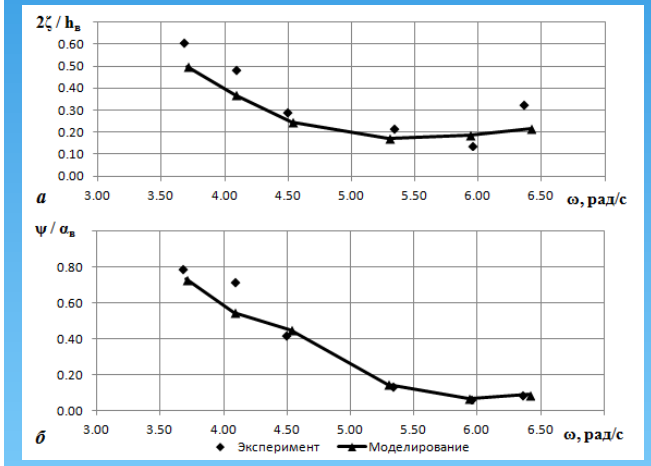
Numerical simulation of heave and pitch motions

ITTC – Recommended Procedures and Guidelines:
For conventional ship forms, a sufficient number of tests should be carried out at each speed to provide adequate data for a minimum range of wavelengths from at least 0.5 LPP to 2.0 LPP. More tests with closely spaced wavelengths can be necessary to ensure a good definition in the resonance region. Either the ratio of the wave height to LPP or the ratio of wave height to wavelength should be maintained constant. (The recommended value of the ratio of wave height to wavelength is around 1/50).

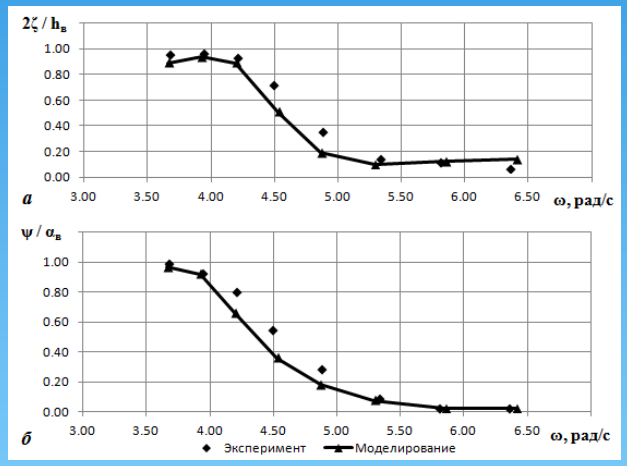
Data of model DTMB5415:
-Length L_{pp} = 3,048 m,
-Beam B = 0,409 m,
-Draft T = 0,132 m,
-Displacement D = 83,5 kg,
-Centre of gravity z_g = 0,163 m,
-Moment of inertia J_{55} = 48,5 kg·m^2.
Two velocities: Fr = 0 and Fr = 0,28.
Head regular waves.
Two degree of freedom: heave and pitch.



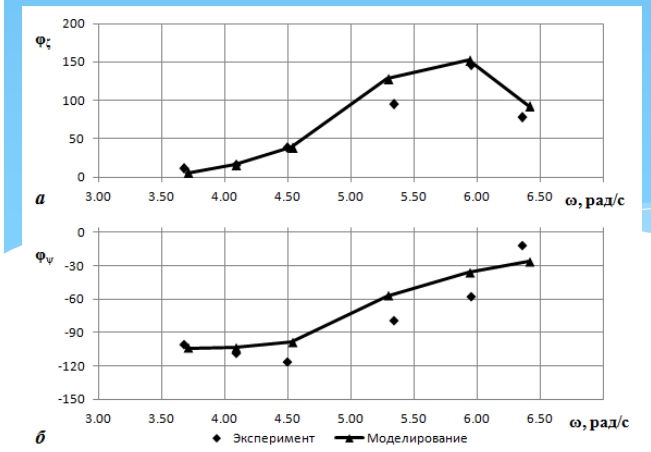
Numerical simulation of heave and pitch motions



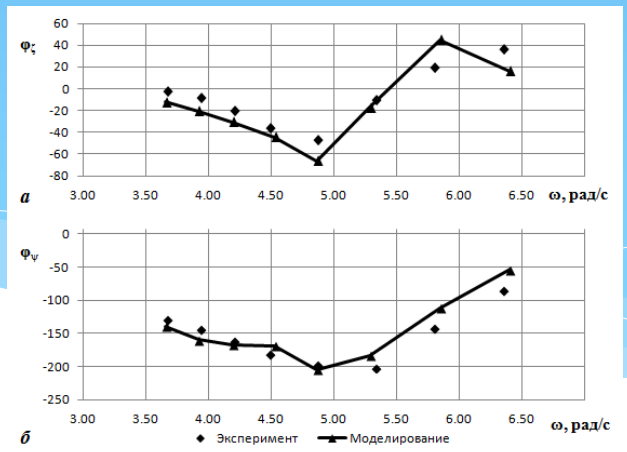
RAO of heave (a) and pitch (б) motions without ship speed



RAO of heave (a) and pitch (б) motions with Fr = 0,28



Phase lags of heave (a) and pitch (б) motions without ship speed



Phase lags of heave (a) and pitch (б) motions with Fr = 0,28

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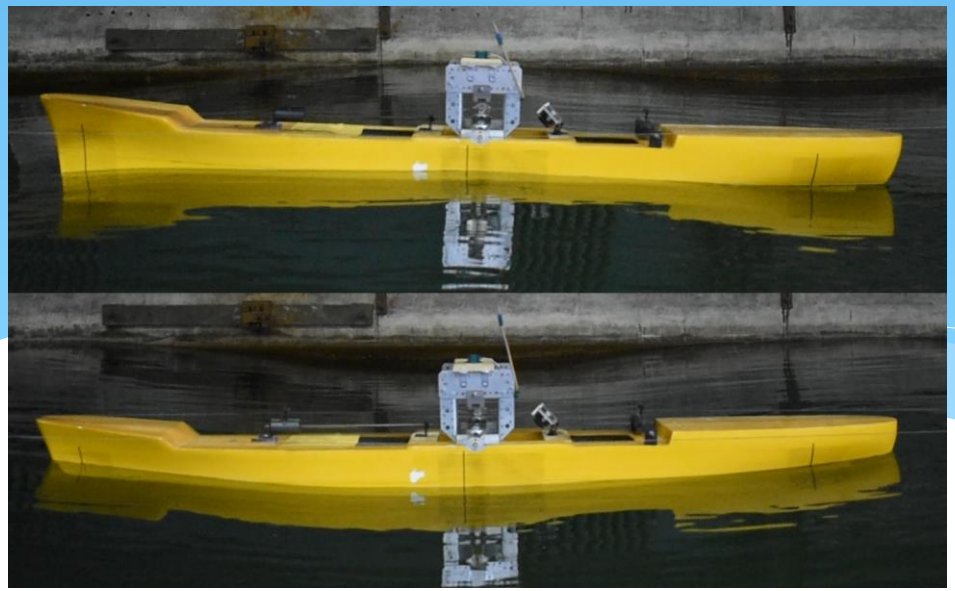
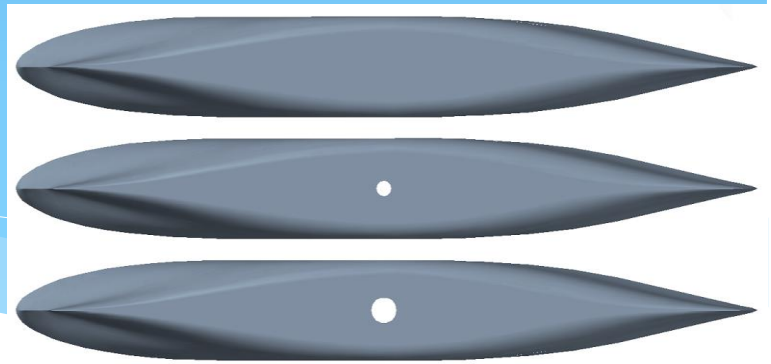
Experimental research of motions of ship with moonpool

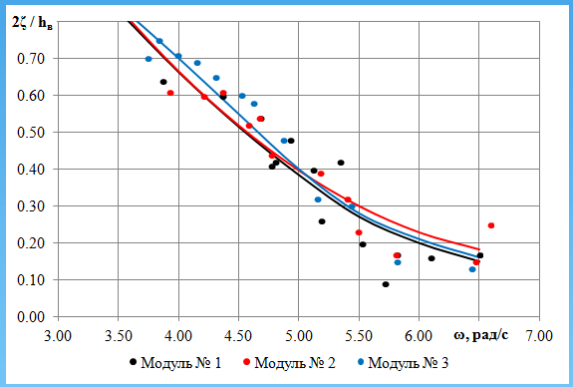
Three modules for model s60 was build:
-Module № 1 – without moonpool;
-Module № 2 – circular shaped moonpool with d = 0,044 m and d/B = 15 %;
-Module № 3 – circular shaped moonpool with d = 0,074 m and d/B = 25 %.
Head regular waves with length from 1,5 to 4 m.

Data of model s60:
-Length L_{pp} = 2,09 m,
-Beam B = 0,289 m,
-Draft T = 0,125 m,
-Displacement D = 45 kg
-Centre of gravity z_g = 0,10 m,
-Moment of inertia J_{55} = 6,5 kg·m^2.

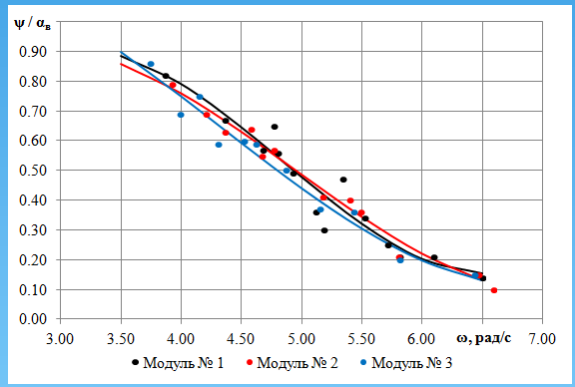




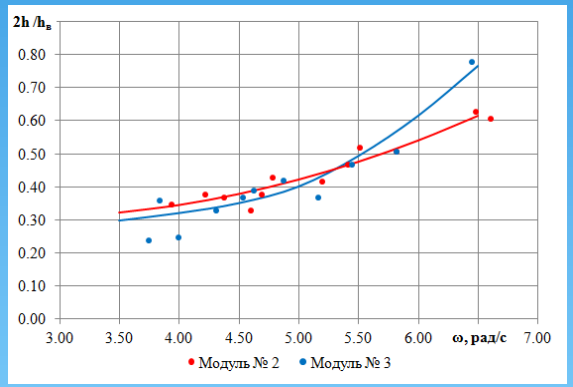
Experimental research of motions of ship with moonpool



RAO of heave motions for model with different moonpool modules



RAO of pitch motions for model with different moonpool modules



RAO of water vertical motions in moonpool for model with different moonpool modules

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2. Preparation of numerical simulation in OpenFOAM
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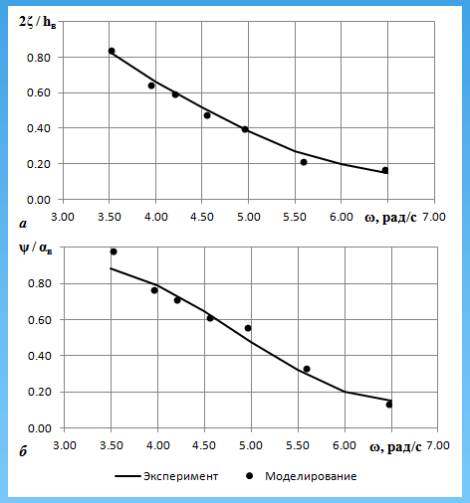
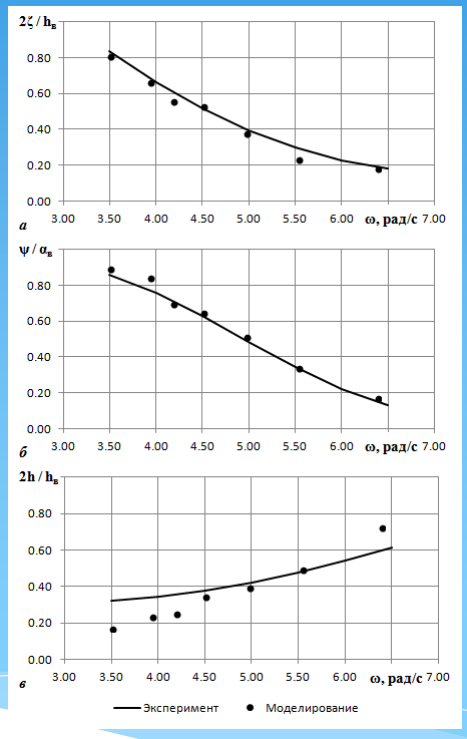
4. Experimental research of motions of ship with moonpool
5. **Numerical simulation of motions of ship with moonpool**
6. Conclusion

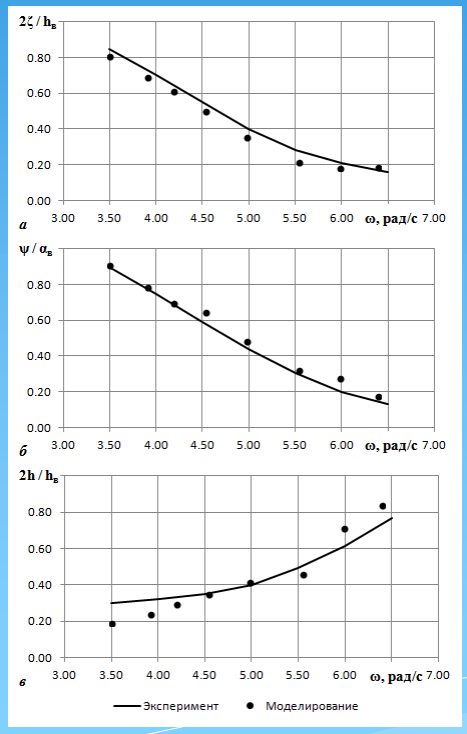
Numerical simulation of motions of ship with moonpool



RAO of heave (a) and pitch (б) motions of model with module № 1



RAO of heave (a) and pitch (б) motions and water vertical motions in moonpool (в) of model with module № 2



RAO of heave (a) and pitch (б) motions and water vertical motions in moonpool (в) of model with module № 3

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Conclusion

-The verification of CFD methods for calculations of ship motions RAO and phase lags in head regular waves shows nice agreement with experimental data for model DTMB 5415 with Fr = 0 and Fr = 0,28.

-The experimental research of motions of ship with moonpool without ship speed gets heave and pitch RAO and vertical motions in moonpool RAO for model s60 without ship speed.

-The verification of CFD methods for calculations of ship with moonpool motions RAO and vertical water motions in moonpool RAO shows great agreement with experimental data for model s60.

Thanks for your attention