EHITUSTEADUSKOND
MEHAANIKAINSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012

1. Instituudi struktuur

Mehaanikainstituut, Department of Mechanics
Instituudi direktor Aleksander Klauson

- Tehnilise mehaanika õppetool, Chair of Engineering Mechanics, Aleksander Klauson
- Hüdro- ja aeromehaanika õppetool, Chair of Fluid and Aeromechanics, Tiit Koppel
- Rakendusmehaanika õppetool, Chair of Applied Mechanics, Andrus Salupere
- Hüdromehaanika teadus- ja katselaboratoorium, Laboratory of Fluid Mechanics, Ivar Annus
- Tugevuse teadus- ja katselaboratoorium, Laboratory of Strength of Materials, Hendrik Naar

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

2.1.1 teadustöö kirjeldus *(inglise keeles*);

Vedeliku ja konstruktsiooni koostoime mehaanika / Mechanics of Fluid-Structure Interaction

Microcracks developing in a composite plate are known to cause elastic moduli degradation. The results of the study show that the influence of the cracks depends on the position of the lamina in the lay-up and on the testing method. Ultrasound focusing is used for experimental detection of the axial cracks in a pipe, as it gives more precise information about the length of the defect. To estimate water quality in the network on the basis of real-time pressure measurements the model to compute water fluxes has been developed. In emergency situations the quickest result is giving LMA optimization algorithm. Air-water dynamic interaction during the controlled emptying of a large-scale pipeline is parameterized with Zukoski number (representing relative shortening of the accelerated water column due to air cavity celerity in respect of the pipe-diameter determined shallow-water speed). Based on coupled beam approach there has been developed a method that can describe the dynamic behavior of a ship in case of global vertical bending. The method enables to analyze a ship with the capacious superstructure including large openings and other geometrical discontinuities. Time-efficient simulation model to evaluate the consequences of ship collision and grounding accidents has been developed further.

Tõenäosuslik prao avastamise modelleerimine mittepurustavas kontrollis / Probabilistic modelling of NDT crack detection

Lamb modes are widely used for non-destructive evaluation of plate-like structures. Among the various challenges, the separation of modes is needed for the development of proper interpretation procedure to analyse the response of the monitored structures. In this study we applied the orthogonality relation-based method for post-processing Finite Element (FE) predictions in order to separate Lamb modes at a plate edge. The reflected wave field from the free edge is assumed to be a superposition of all the eigenmodes of an infinite plate. The eigenmode coefficients of the reflected wave field are determined by adapting the orthogonality-based method that was used to determine

the reflection coefficients of Lamb modes at a plate edge. Overlapping wavepackets of Lamb modes at a plate edge are simulated by using the FE model of the incident S0 mode in a plate with a crack. Time-domain signals of propagating, non-propagating and complex modes are extracted.

Laeva karilesõidul tekkivate vigastuste modelleerimine arvmeetodite abil arvestades liikumisdünaamikat / Numerical model to assess the structural damage in ship grounding considering motion dynamics

The development of grounding models within ETF8718 grant concentrated on three main topics: (topic 1) development of precise numerical grounding simulation model, (topic 2) development and calibration of simplified and time efficient simulation model and (topic 3) integration of damage assessment model with the oil spill model to assess the amount and duration of oil spill from side or bottom damaged tanker. Developments will be presented in three conference publications. Precise numerical simulation model has been developed to include all the main hydromechanic forces. The model and its integration to the coupled beam model will be presented in PRADS 2013 conference. Time efficient grounding model has been calibrated based on numerical simulations. The theoretical background of the model has been presented in OMAE 2012 conference with the application to ship collisions. The application of the same approach to the ship groundings will be presented in ICCGS 2013 conference. The model to assess the oil spill from damaged tanker has been developed and integrated into damage assessment model. The model will be presented in MARSTRUCT 2013 conference.

Naftasaaduste meretranspordi riskide minimiseerimine holistilist turvalistusstrateegiat kasutades / Minimizing risks of maritime oil transport by holistic safety strategies

The developments on the VIR519 concentrated on the simplified grounding simulation model and on its validation with the finite element analysis. The description of the damage will be used in the developed oil spill model that evaluates the oil outflow from the damaged tanker. Both models are suitable to be used in risk analysis to simulate large number of collision and grounding accidents.

2.1.2 aruandeaastal saadud tähtsamad teadustulemused *(inglise keeles).*

Lamb modes are widely used for non-destructive evaluation of plate-like structures. Among the various challenges, the separation of modes is needed for the development of proper interpretation procedure to analyze the response of the monitored structures. In this study we applied the orthogonality relation-based method for post-processing Finite Element (FE) predictions in order to separate Lamb modes at a plate edge. The reflected wave field from the free edge is assumed to be a superposition of all the eigenmodes of an infinite plate. The eigenmode coefficients of the reflected wave field are determined by adapting the orthogonality-based method that was used to determine the reflection coefficients of Lamb modes at a plate edge.

2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

Koppel, T.; Vassiljev, A. (2012). Use of modelling error dynamics for the calibration of water distribution systems. Advances in Engineering Software, 45(1), 188 - 196.

Tabri, K. (2012). Influence of coupling in the prediction of ship collision damage. Ships and Offshore Structures, 7(1), 47 - 54.

Fletcher, S.; Lowe, M. J. S.; Ratassepp, M.; Brett, C. (2012). Detection of axial cracks in pipes using focused guided waves . Journal of Nondestructive Evaluation, 31(1), 56 - 64.

Laanearu, J.; Annus, I.; Koppel, T.; Bergant, A.; Vučković, S.; Hou, C.; Tijsseling, A. S; Anderson, A.; van 't Westende, J. M. C. (2012). Emptying of large-scale pipeline by pressurized air. ASCE Journal of Hydraulic Engineering, 138(12), 1090 - 1100.

Romanoff, J.; Remes, H.; Bralic, S.; Naar, H.; Niemelä, A.; Jelovicam, J.; Klanac, A.; Varsta, P. (2012). Hull-superstructure interaction in optimised passenger ships. Ships and Offshore Structures, 1 - 9.

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustustest.

2.4 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

- Janek Laanearu, IAHR liige (International Association for Hydro-Environment Engineering and Research)

- Janek Laanearu, EUROMECH liige (European Mechanics Society)

- Janek Laanearu, SGF liige (Svenska Geophysica Föreningen)

- Aleksander Klauson, ASA liige (Acoustical Society of America)

- Tiit Koppel, IAHR liige (International Association for Hydro-Environment Engineering and Research)

- Kristjan Tabri, ISSC Eesti correspondent (International Ship and Offshore Structures Congress)

- Anatoli Vassiljev, Nordic Association for Hydrology liige

- Anatoli Vassiljev, ICWQ liige (International Commission on Water Quality)

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

- T072**,** Vedeliku ja konstruktsiooni koostoime mehaanika
- AP072, Vedeliku ja konstruktsiooni koostoime mehaanika
- VIR519, Minimizing risks of maritime oil transport by holistic safety strategies
- ETF7900, Tõenäosuslik prao avastamise modelleerimine mittepurustavas kontrollis
- ETF8718, Laeva karilesõidul tekkivate vigastuste modelleerimine arvmeetodite abil arvestades liikumisdünaamikat

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

2012, Ivar Annus; TTÜ Arengufondi professor Heinrich Laulu nimeline stipendium

Suvekool "Urban Water Systems: Interaction and integrating modelling, planning and management" 25.06-29.06.2012, külalisprofessorid Cedo Maksimović, Slobodan Djordjevic

2012, August. Dr Alan J. S. Cuthbertson, Heriot-Watt University, Edinburgh, Scotland, UK. Award of The Royal Society of Edinburgh (RSE) for collaborative work in the field of environmental fluid mechanics with Department of Mechanics, Tallinn University of Technology.

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused *(Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel)*

- Haridus- ja Teadusministeerium

– sihtfinantseeritavad teemad:
T072, Vedeliku ja konstruktsiooni koostoime mehaanika , Koppel Tiit (2008- 2013)

– baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
– riiklikud programmid:

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:

- Uurija-professori rahastamine:

- SA Eesti Teadusfond/Eesti Teadusagentuur

– grandid:
ETF7900 , Tõenäosuslik prao avastamise modelleerimine mittepurustavas kontrollis , Klauson Aleksander , (2009 – 2012)

ETF8718, Laeva karilesõidul tekkivate vigastuste modelleerimine arvmeetodite abil arvestades liikumisdünaamikat , Tabri Kristjan (2011- 2014)

– ühisgrandid välisriigiga:
– järeldoktorite grandid (SA ETF ja Mobilitas):
MJD110, Tabri Kristjan, Coupled approach for numerical modelling of accidents in maritime transportation (1.09.2010 - 31.08.2013)

– tippteadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA

– eeluuringud:
– arendustoetused:

- SA Archimedesega sõlmitud lepingud

– infrastruktuur (nn „mini-infra“, „asutuse infra“):
– Eesti tippkeskused:
– riiklikud programmid:
– muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

Lep11010, Tallinna linna veevõrgu mudeli kaasajastamine reaalajas juhitavate toimingutega, Puust Raido (14.02.2011 - 31.12.2012)

Lep12109, NS tüüpi I klassi õlieraldaja katsetused, Koppel Tiit (25.06.2012 - 14.12.2012)

- EL Raamprogrammi projektid:

- Välisriiklikud lepingud:

VIR519, Naftasaaduste meretranspordi riskide minimiseerimine holistilist turvalistusstrateegiat kasutades, Tabri Kristjan (1.05.2011 - 31.12.2013)

VEU570, Läänemere helipildi informatsioon, Laanearu Janek (1.09.2012 - 31.08.2016)

2.8 Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid *(ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1).*

1.1

Ehlers, S.; Tabri, K. (2012). A combined numerical and semi-analytical collision damage assessment procedure. Marine Structures, 28(1), 101 - 119.

Fletcher, S.; Lowe, M. J. S.; Ratassepp, M.; Brett, C. (2012). Detection of axial cracks in pipes using focused guided waves . Journal of Nondestructive Evaluation, 31(1), 56 - 64.

Laanearu, J.; Annus, I.; Koppel, T.; Bergant, A.; Vučković, S.; Hou, C.; Tijsseling, A. S; Anderson, A.; van 't Westende, J. M. C. (2012). Emptying of large-scale pipeline by pressurized air. ASCE Journal of Hydraulic Engineering, 138(12), 1090 - 1100.

Romanoff, J.; Remes, H.; Bralic, S.; Naar, H.; Niemelä, A.; Jelovicam, J.; Klanac, A.; Varsta, P. (2012). Hull-superstructure interaction in optimised passenger ships. Ships and Offshore Structures, 1 - 9.

Tabri, K. (2012). Influence of coupling in the prediction of ship collision damage. Ships and Offshore Structures, 7(1), 47 - 54.

Ehlers, S.; Tabri, K.; Romanoff, J.; Varsta, P (2012). Numerical and experimental investigation on the collision resistance of the X-core structure. Ships and Offshore Structures, 7(1), 21 - 29.

Povilaitis, A.; Stålnacke, P.; Vassiljev, A. (2012). Nutrient retention and export to surface waters in Lithuanian and Estonian river basins . Hydrology Research, 43(4), 359 - 373.

Tamm, Kert; Salupere, Andrus (2012). On the propagation of 1D solitary waves in Mindlin-type microstructured solids. Mathematics and Computers in Simulation, 82(7), 1308 - 1320.

Ostfeld, A.; Salomons, E.; Ormsbee, L.; Uber, J.G.; Bros, C.M.; Kalungi, P.; Burd, R.; Zazula-Coetzee, B.; Belrain, T.; Kang, D; Lansey, K.; Shen, H; McBean, E.; Wu, Z.Y.; Walski, T.; Alvisi, S.; Franchini, M.; Johnson, J.P.; Ghimire, S.R.; Barkdoll, B.D; Koppel, T.; Vassiljev, A.; Kim, J.H.; Chung, G.; Yoo, D.G.; Diao, K.; Zhou, Y.; Li, J.; Liu, Z.; Chang, K.; Gao, J.; Qu, S.; Yuan, Y.; Prasad, T.D.; Laucelli, D.; Vamvakeridou Lyroudia, L.S.; Kapelan; Z.; Savic, D.; Berardi, L.; Barbaro, G.; Giustolisi, O.; Asadzadeh, M.; Tolson, B.A.; McKillop, R. (2012). The Battle of the Water Calibration Networks (BWCN). Journal of Water Resources Planning and Management, 138(5), 523 - 532.

Vassiljev, A.; Blinova, I. (2012). The influence of drained peat soils on diffuse nitrogen pollution of surface water. Hydrology Research, 43(4), 352 - 358.

Koppel, T.; Vassiljev, A. (2012). Use of modelling error dynamics for the calibration of water distribution systems. Advances in Engineering Software, 45(1), 188 - 196.

1.2

Montewka, J.;Ehlers, S.;Tabri, K. (2012). Modelling risk of a collision between a LNG tanker and a harbour tug. Marine Systems and Ocean Technology, 7(1), 3 - 13.

Hou, Q.; Tijsseling, A.S.; Laanearu, J.; Annus, I.; Koppel, T.; Bergant, A.; Vuckovic, S.; Gale, J.; Anderson, A.; van´t Westende, J.M.C.; Pandula, Z.; Ruprecht, A. (2012). Experimental study of filling and emptying of a large-scale pipeline. Centre for Analysis, Scientific computing and Applications - CASA, 43 pp.

1.3

2.1

2.2

3.1

3.2

Tabri, K.; Ehlers, S.; Kõrgesaar, M.;Ståhlberg, K.; Heinvee, M. (2012). Collision consequence assessment of ROPAX vessels operating in the Baltic Sea. In: Proceedings of the ASME 2012 : 31st International Conference on Ocean, Offshore and Arctic Engineering OMAE2012: 31st International Conference on Ocean, Offshore and Arctic Engineering OMAE2012, Rio De Janeiro, July 1-6, 2012. ASME, 2012.

Koor, M.; Puust, R.; Vassiljev, A.; Koppel, T. (2012). Database driven hydraulic model creation procedure. In: Proceedings of WDSA 2012: 14th Water Distribution Systems Analysis Conference, Adelaide (Australia), September 24-27, 2012. (Toim.) Engineers Australia. Engineers Australia, 2012, 407 - 414.

Vassiljev, A.; Koppel, T. (2012). Estimation of Real-Time Demands on the Basis of Pressure Measurements. In: Proceedings of the Eighth International Conference on Engineering Computational Technology: Eighth International Conference on Engineering Computational Technology, Dubrovnik, Horvaatia, 3-7 Sept 2012. (Toim.) B.H.V. Topping. Stirlingshire, United Kingdom: Civil-Comp Press, 2012, 1 - 9.

Laanearu, J.; Cuthbertson, A.; Davies, P. (2012). Interfacial mixing of dense-water overflow in a converging and up-sloping channel. In: Proceedings of the 2nd IAHR Europe Conference: 2nd European IAHR Conference, June 27 - 29, 2012 Technical University of Munich, München, Bavaria, Germany. (Toim.) P. Rutschmann, M. Grünzner, S. Hötzl. Technische Universität München:, 2012, 1 - 6.

Oldekop, N.; Liiv, T. (2012). Measurement of the Variation Bed Shear Stress during a Wave Cycle. In: ICSE-6: Paris, August 27-31, 2012: 6th International Conference on Scour and Erosion: Proceedings: 6th International Conference on Scour and Erosion, Paris, August 27-31, 2012. (Toim.) Societe Hydrotechnique de France. Societe Hydrotechnique de France, 2012, 152 - 157.

Laanearu, J.; Annus, I.; Sergejeva, M.; Koppel, T.; Puust, R. (2012). Parametric modelling study for filling of horizontal pipe containing water. In: Proceedings of WDSA 2012: 14th Water Distribution Systems Analysis Conference, Adelaide (Australia), September 24-27, 2012. (Toim.) Engineers Australia. Engineers Australia, 2012.

Puust, R.; Sergejeva, M.; Laanearu, J. (2012). Using MOC based method to detect abnormal conditions in water networks with less computational effort. In: Proceedings of HIC 2012: 10th International Conference on Hydroinformatics, Hamburg (Germany), July 14-18, 2012. (Toim.) Hinkelmann, R.;Nasermoaddeli, M.H.;Liong, S.Y.;Savic,D.;Fröhle, P.;Daemrich, K.F.. TUTech Innovation GmbH, 2012.

3.3

4.1

5.1

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu *(NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu)*

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu *(ETIS-e kaudu esitatud taotluste alusel)*

Tabri Kristjan, Coupled approach for numerical modelling of accidents in maritime transportation (1.09.2010 - 31.08.2013)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

3. Struktuuriüksuse infrastruktuuri uuendamise loetelu *(summa eurodes)*

PV007402, Laser-Doppler anemomeeter, 2.07.2012 (98 476,00)