



Hrvatska akademija znanosti i umjetnosti –
Razred za Tehničke znanosti

*Croatian Academy of Sciences and Art –
Department of Technical Sciences*

Tehnički fakultet Sveučilišta u Rijeci
Faculty of Engineering, University of Rijeka

Pomorski fakultet Sveučilišta u Rijeci
Faculty of Maritime Studies, University of Rijeka

Fakultet za pomorstvo i promet Sveučilišta u Ljubljani
*Faculty of Maritime Studies and Transport
University of Ljubljana*

Udruga za proučavanje i razvoj pomorstva
*Association for Research and Development
of Maritime Industries*

**IX. MEĐUNARODNO SAVJETOVANJE
O MORSKOJ TEHNOLOGIJI
in memoriam akademiku
Zlatku Winkleru
11. – 12. studenog 2021.
na Tehničkom fakultetu Sveučilišta u Rijeci
- online -**

**9th INTERNATIONAL CONFERENCE
ON MARINE TECHNOLOGY
in memoriam of the academician
Zlatko Winkler
November 11 and 12, 2021
at the Faculty of Engineering
University of Rijeka
- online -**

Knjiga sažetaka

Book of Abstracts

Knjiga sažetaka

IX. MEĐUNARODNO SAVJETOVANJE O MORSKOJ TEHNOLOGIJI in memoriam akademiku Zlatku Winkleru (WINKLER 2021)

11. – 12. studenog 2021. godine, Tehnički fakultet Sveučilišta u Rijeci (online), Rijeka, Hrvatska

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Izdavač

Tehnički fakultet Sveučilišta u Rijeci

Urednički odbor

Albert Zamarin - predsjednik

Julijan Dobrinić – član

Marko Hadjina - član

Tin Matulja - član

Dunja Legović – član

Marko Perčić – član

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Publisher

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Razred za Tehničke znanosti

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Ova knjiga sažetaka odnosi se na sve recenzirane sažetke radova (članke i postere) koji su prezentirani na Savjetovanju. Plenarna predavanja, priopćenja i diskusija su održani na engleskom jeziku, dok je ceremonija otvaranja održana paralelno na hrvatskom i engleskom jeziku.

Sažetci svih radova, uključujući naslov i ključne riječi su prikazani prvo na engleskom a zatim na hrvatskom jeziku, osim onih radova koji su pristigli isključivo na engleskom jeziku.

This book of abstracts applies to all reviewed abstracts (papers and posters) presented at the Conference. Plenary lectures, presentations and discussions were held in English, while the opening ceremony was held in parallel in Croatian and English.

Abstracts of all papers/posters, including titles and keywords, are presented first in English and then in Croatian, except for those papers/posters received exclusively in English.

ODRŽANI SKUPOVI O MORSKOJ TEHNOLOGIJI */ PAST VENUES OF CONFERENCE*

- **24. 11. 1979. Zagreb:** Prvo savjetovanje o morskoj tehnologiji u sklopu III. Konferencije SITH za tehnološki razvoj SR Hrvatske. Suorganizator : Tehnički fakultet Sveučilišta u Rijeci
- **11. 12. 1980. Rijeka:** Kolokvij o morskoj tehnologiji. Problematika jedne od aktivnosti koju razvija Zavod za brodogradnju i inženjerstvo morske tehnologije. Organizator: Tehnički fakultet Sveučilišta u Rijeci
- **16.–18. 11. 1983. Opatija:** Mogućnosti razvoja morske tehnologije u području Jadranskog mora. Organizatori: SITH i Sveučilište u Rijeci, Tehnički fakultet Rijeka.
- **14.–15. 04. 1987. Zagreb:** Savjetovanje – Problemi čvrstoće konstrukcije objekata morske tehnologije. Organizator: Jugoslavenska akademija znanosti i umjetnosti, Zagreb
- **29. 09. 1994. Opatija:** Međunarodni okrugli stol : Priobalje i podmorje Jadrana, realna šansa za hrvatski turizam. Organizator: Sveučilište u Rijeci, Tehnički fakultet, Pomorski fakultet i Brodarski institut u Zagrebu.
- **01.–04. 03. 1995. Opatija:** Međunarodna konferencija. Priobalje i podmorje Jadrana realna šansa za hrvatski turizam. Organizator: Sveučilište u Rijeci, Tehnički Fakultet i Pomorski fakultet u Rijeci.
- **28.–29. 11. 2005. Rijeka:** I. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo-Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **26.–27. 11. 2007. Rijeka:** II. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo-Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci
- **30.11. i 1. 12. 2009. Rijeka:** III. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **25.–26. 11. 2011. Rijeka:** IV. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **22.–23. 11. 2013. Rijeka:** V. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **20. 11. 2015. Rijeka:** VI. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci.
- **17. 11. 2017. Rijeka:** VII. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci i Udruga za proučavanje i razvoj pomorstva.
- **15.–16. 11. 2019. Rijeka:** VIII. Međunarodno Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci, Fakultet za pomorstvo i promet Sveučilišta u Ljubljani i Udruga za proučavanje i razvoj pomorstva.
- **11.–12. 11. 2021. Rijeka:** IX. Međunarodno Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci, Fakultet za pomorstvo i promet Sveučilišta u Ljubljani i Udruga za proučavanje i razvoj pomorstva

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Cilj i sadržaj Savjetovanja je dati pregled i ukazati na znanstvena istraživanja, rezultate i primjenu u području morske tehnologije u Hrvatskoj i šire, kao i na značaj za gospodarstvo i poticaj razvoja ove djelatnosti, te informirati naše gospodarstvo, znanstvenu i stručnu javnost o značajkama gospodarsvene djelatnosti morske tehnologije. Dodatno, dati poticaj za uspostavljanje primjerenog stupnja koordinacije i kooperacije u gospodarstvenim djelatnostima vezanim uz more i morsku tehnologiju, posebno s aspekta nužne izvozne ekspanzije, te konačno dati elemente za sudjelovanje u međunarodnom transferu tehnologije na temelju vlastitih tehnoloških znanja.

The aim and content of the Conference is to give an overview and point out scientific research, results and application in the field of marine technology in Croatia and wider and the importance for the economy and stimulate the development of this activity, and to inform our economy, scientific and professional public. In addition, provide an incentive to establish an appropriate level of coordination and cooperation in economic activities related to the sea and marine technology, especially in terms of necessary export expansion, and finally provide elements for participation in international technology transfer based on own technological knowledge.

The following topics from scientific fields, in research and application are envisaged:

- Marine environmental protection
- Intelligent Underwater Systems and Technologies, Autonomous Vessels
- Biotechnology, Fisheries and Aquaculture, Marine Biology
- Maritime Transport, Economy
- Shipbuilding Technology and Shipyards
- Marine Structures and Engineering, Small and Pleasure Crafts
- Construction and Design in Shipbuilding and Mechanical Engineering
- Mining, Oil and Geological research, Material and Chemical Engineering
- Marine Automation and Control, Marine Electronics
- Renewable energy sources in the field of marine technology
- Desalination of sea water in conjunction with renewable energy sources
- Legislation, rules, standardization
- Computer applications in the design, manufacture and operation of marine technology facilities



Program Savjetovanja Conference Program

1. dan – četvrtak 11. studeni 2021. ONLINE
1st day – Thursday, November 11, 2021 ONLINE

- 08:00–09:00 Prijave sudionika / *Participants Registration*
ONLINE / *ONLINE*
- 09:00–09:30 Ceremonija otvaranja / *Opening ceremony*
Pozdravni govori / *Welcome speech*
Albert Zamarin, Full Professor, D.Sc., Head of the Marine Technology Section of the Scientific Council for the Maritime Science of the Croatian Academy of Sciences and Arts and President of the Organizing Committee
Ivo Senjanović, Academician, Croatian Academy of Sciences and Arts
Peter Vidmar, Assoc. Prof. D.Sc. – Dean – Faculty of Maritime Studies and Transport, University of Ljubljana, Co-organizer
Goran Vukelić, Assoc. Prof. D.Sc. – Vice-Dean – Faculty of Maritime Studies, University of Rijeka, Co-organizer
Siniša Vilke, Assoc. Prof. D.Sc. editor-in-chief of the *Journal of Maritime and Transportation Sciences*, Co-organizer
Snježana Prijić-Samaržija, Full Professor, D.Sc. – Madam Rector – University of Rijeka
Duško Pavletić, Full Professor, D.Sc. – Dean – Faculty of Engineering University of Rijeka
- 09:30–11:45 Plenarna sekcija / *Plenary Session 1*
Predsjedavajući / *Chairman: Albert Zamarin*
- 1.1 Teuta Duletić, Sergej Pintar / Lürsen Design Center Kvarner & Maritime Center of Excellence, Croatia
GREEN TRANSITION AND DIGITAL TRANSFORMATION OF THE MARITIME SECTOR
- 1.2 Marko Pirija / IHC Engineering Croatia, Croatia
UTILITY VESSEL CONCEPT FOR THE CROATIAN ADRIATIC
- 1.3 Aleksandar Cuculić / Faculty of Maritime Studies University of Rijeka, Croatia
Maritime Environment-friendly TRanspOrt systems – METRO Project
- 1.4 Darko Burlović, Marko Pirija / IHC Engineering Croatia, Croatia
AUTOMATION OF BUCKLING CHECK OF STIFFENED PANELS BY USING COMMERCIAL FINITE ELEMENT ANALYSIS SOFTWARE
- 1.5 Lovro Maglić / Faculty of Maritime Studies University of Rijeka, Croatia
CENTER FOR MARINE TECHNOLOGY- CMT Rijeka
- 11:45–12:00 Stanka – promotivne poruke sponzora / *Break- Sponsors promo videos*
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Program Savjetovanja Conference Program

12:00–13:30 Izlaganja 2 / *Session 2*

Marine Environmental Protection

Predsjedavajući / *Chairman: Tomislav Mrakovčić*

- 2.1 Lidija Runko Luttenberger, Merica Slišković, Ivica Ančić,
Helena Ukić Boljat
THE IMPACT OF UNDERWATER NOISE
- 2.2 Goran Vizentin, Goran Vukelić
PROLONGED REAL MARINE ENVIRONMENT EXPOSURE OF COMPOSITE
MARINE STRUCTURES
- 2.3 Špiro Ivošević, Nataša Kovač, Gyöngyi Vastag, Peter Majerič,
Rebeka Rudolf
ANALYSIS OF PITTING CORROSION OF NiTi ALLOY IN REAL SEA WATER
ENVIRONMENT
- 2.4 Toni Holjević, Vanja Travaš, Lado Kranjčević, Siniša Družeta
ANALYSIS OF MICROPLASTIC PARTICLE TRANSMISSION
- 2.5 Viktorie Laňková, Josef Tuček
Poster
CITIZEN-DRIVEN RESEARCH OF SOLID WASTE ALONG ZADAR BEACHES
IDENTIFIES LOCAL PLASTIC AS THE MAJOR COMPONENT AND PROPOSES
REALISTIC OPPORTUNITIES FOR ITS AVOIDANCE, EFFECTIVE REMOVAL,
AND REUSE

13:30–14:00 Stanka – promotivne poruke sponzora / *Break- Sponsors promo videos*

14:00–15:15 Izlaganja 3 / *Session 3*

Marine Biology, Biotechnology, Fisheries and Aquaculture

Predsjedavajući / *Chairman: Dunja Legović*

- 3.1 Claudia Kruschel, Tobias Seidl
OVERCOMING OBSTACLES – BIOMIMETIC LESSONS FROM THE
SWARMING BEHAVIOUR OF ARTEMIA FRANCISCANA
- 3.2 Jerko Škifić, Tibor Jaklin
WEATHER DOWNTIME ASSESMENT FOR COMPLEX OFFSHORE PROJECTS
- 3.3 Luka Jurčević, Legović Dunja
THE IMPACT OF SALT PANS ON THE MEADOW OF POSIDONIA
OCEANICA IN THE DINJIŠKA BAY
- 3.4 Iva Dominović, Mathieu Dutour Sikirić, Tatjana Bakran–Petricioli, Donat
Petricioli, Marija Marguš, Irena Ciglencčki
Poster
PHYSICO-CHEMICAL CHARACTERISTIC OF THE MARINE LAKE
ROGOZNICA AND ITS CONNECTION WITH THE ATMOSPHERE AND THE
OUTER SEA

15:15–15:45 Stanka – promotivne poruke sponzora / *Break- Sponsors promo videos*

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IX. MEĐUNARODNO
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Program Savjetovanja Conference Program

15:45–17:45 Izlaganja 4 / *Session 4*

Construction and Design in Shipbuilding, Small Craft

Predsjedavajući / *Chairman: Roko Dejhalla*

- 4.1 Marin Smilović, Roko Dejhalla
PRELIMINARY DESIGN OF A SHIP FOR WASTE SORTING FROM CROATIAN ISLANDS
- 4.2 Darin Majnarić, Davor Bolf, Albert Zamarin
STRUCTURAL ANALYSIS OF HYBRID RO-PAX FERRY
- 4.3 Ivan Sulovsky, Jasna Prpić-Oršić
SEAKEEPING ANALYSIS OF A DOUBLE ENDED FERRY
- 4.4 Elena Miletić, Lukša Radić, Siniša Letinić, Anton Turk
SEAWORTHINESS AND STABILITY ANALYSIS OF A PONTOON FOR HOLIDAY HOUSE
- 4.5 Emir Bešić, Tin Matulja, Marko Hadjina, Marin Smilović
Poster DEVELOPMENT OF TECHNICAL DOCUMENTATION OF SMALL VESSELS
- 4.6 Patrik Kubaska, Tin Matulja, Marko Hadjina
CARBON MAST STRUCTURAL DAMAGE DETECTION USING *NDT* METHOD

17:45–18:00 Stanka – promotivne poruke sponzora / *Break– Sponsors promo videos*

18:00–18:45 Poster sekcija / *Poster session*

Predsjedavajući / *Chairman: Roko Dejhalla*

- P.1 Viktorie Laňková, Josef Tuček
CITIZEN-DRIVEN RESEARCH OF SOLID WASTE ALONG ZADAR BEACHES IDENTIFIES LOCAL PLASTIC AS THE MAJOR COMPONENT AND PROPOSES REALISTIC OPPORTUNITIES FOR ITS AVOIDANCE, EFFECTIVE REMOVAL, AND REUSE
- P.2 Iva Dominović, Mathieu Dutour Sikirić, Tatjana Bakran–Petricioli, Donat Petricioli, Marija Marguš, Irena Ciglencčki
PHYSICO-CHEMICAL CHARACTERISTIC OF THE MARINE LAKE ROGOZNICA AND ITS CONNECTION WITH THE ATMOSPHERE AND THE OUTER SEA
- P.3 Emir Bešić, Tin Matulja, Marko Hadjina, Marin Smilović
DEVELOPMENT OF TECHNICAL DOCUMENTATION OF SMALL VESSELS
- P.4 Rajko Rubeša, Marko Hadjina, Tin Matulja
CRITERIA FOR EVALUATION THE TECHNOLOGICAL LEVEL OF SHIP PRE-OUTFITTING IN SHIPYARD
- P.5 Davor Bolf, Marko Hadjina, Mario Iveković, Albert Zamarin
DEFINITION OF DEFORMATIONS AND STRESSES OF LARGE SHIP BLOCKS WITHIN TRANSPORTATION AND MANIPULATION



Program Savjetovanja Conference Program

2. dan – petak 12. studeni 2021.
2nd day – Friday, November 12, 2021

08:00–09:00 Prijave sudionika / *Participants Registration*
ONLINE / *ONLINE*

09:00–10:15 Izlaganja 5 / *Session 5*

Maritime Transport, Shipbuilding Technology and Shipyards

Predsjedavajući / *Chairman: Marko Hadjina*

- 5.1 Alen Jugović, Enrique Alejandro Russell Montiel, Dea Aksentijević
IMPACT OF THE ONE BELT AND ONE ROAD INITIATIVE ON THE EUROPEAN MARITIME FIELD
- 5.2 Siniša Vilke, Frane Tadić, Ines Ostović
DEVELOPMENT OF URBAN TRAFFIC MANAGEMENT IN THE CITY OF RIJEKA
- 5.3 Šimun Sviličić, Smiljko Rudan
ASSESSING THE COMPRESSION FATIGUE OF THE WELDED TEST SPECIMENS
- 5.4 Davor Bolf, Marko Hadjina, Mario Iveković, Albert Zamarin
Poster DEFINITION OF DEFORMATIONS AND STRESSES OF LARGE SHIP BLOCKS WITHIN TRANSPORTATION AND MANIPULATION
- 5.5 Rajko Rubeša, Marko Hadjina, Tin Matulja
Poster CRITERIA FOR EVALUATION THE TECHNOLOGICAL LEVEL OF SHIP PRE-OUTFITTING IN SHIPYARD

10:15–10:30 Stanka – promotivne poruke sponzora / *Break – Sponsors promo videos*

10:30–12:15 Izlaganja 6 / *Session 6*

Computer applications in the design, manufacture and operation of marine technology facilities

Predsjedavajući / *Chairman: Tin Matulja*

- 6.1 Marta Alvir, Ante Sikirica, Luka Grbčić, Lado Kranjčević
NUMERICAL MODELING OF INCLINED BUOYANT JETS FOR DIFFERENT FLOW CONDITIONS
- 6.2 Matej Dević, Josip Bašić, Martina Bašić, Branko Blagojević
VALIDATION OF THE CFD PROCEDURE FOR ROPAX RESISTANCE ASSESSMENT

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- 6.3 **Gordan Janeš, Ante Sikirica, Luka Grbčić, Lado Kranjčević**
MPI ASSOCIATED SCALABILITY OF OPEN-SOURCE CFD CODES FOR OIL
SPILL ASSESSMENT
- 6.4 **Davor Bolf, Peter Rogelj, Adrian Tomić, Albert Zamarin**
APPLICATION OF A GENERAL PURPOSE SOFTWARE PACKAGE ON SHEAR
FORCES AND BENDING MOMENT CALCULATIONS IN SHIP STRUCTURE
- 6.5 **Lovro Radoš, Anton Turk**
COMPARISON BETWEEN THE CLASSICAL METHOD OF INCLINING
EXPERIMENT WITH THE RECENT ALTERNATIVE METHODS

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Marine Engineering, Automation and Control

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FERRIES IN CROATIAN PORTS
- 7.2 **Vladimir Pelić, Tomislav Mrakovčić, Radoslav Radonja, Nikola Račić**
TECHNICAL AND ECOLOGICAL ASPECTS OF WATER-LUBRICATED STERN
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- 7.3 **Alen Marijančević, Braut Sanjin, Roberto Žigulić**
ANALYSIS OF SHIP PROPULSION SHAFTING VIBRATION USING COUPLED
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Plenarna izlaganja / Plenary Session 1

Teuta Duletić, Sergej Pintar

*Lürsen Design Center Kvarner &
Maritime Center of Excellence, Croatia*

*GREEN TRANSITION AND DIGITAL TRANSFORMATION OF THE
MARITIME SECTOR*

Marko Pirija

IHC Engineering Croatia, Croatia

UTILITY VESSEL CONCEPT FOR THE CROATIAN ADRIATIC

Aleksandar Cuculić

Faculty of Maritime Studies University of Rijeka, Croatia

Maritime Environment-friendly TRanspOrt systems - METRO Project

Darko Burlović, Marko Pirija

IHC Engineering Croatia, Croatia

*AUTOMATION OF BUCKLING CHECK OF STIFFENED PANELS BY USING
COMMERCIAL FINITE ELEMENT ANALYSIS SOFTWARE*

Lovro Maglić

Faculty of Maritime Studies University of Rijeka, Croatia

CENTER FOR MARINE TECHNOLOGY- CMT Rijeka

Izlaganja 2 / Session 2

Zaštita okoliša / Marine Environmental Protection

ENVIRONMENTAL IMPACT OF UNDERWATER NOISE

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ABSTRACT:

The description of sound as a form of energetic pollutant is very complex as is also its impact on aquatic life. Human activities causing continuous and implosive underwater noise, such as marine traffic, maintenance of ships, coastal tourism, marine research, military, offshore energy platforms, generation of ocean energies and construction operations are expected to increase. The paper analyses current approach to minimise the impact of underwater noise and limit its emissions, examines regulatory approach and discusses the possibilities to control this type of pollution in order to ensure the preservation of natural underwater soundscape. The timely implementation and further development of the European Marine Strategy Framework Directive and its provisions related to underwater noise is of exceptional importance for the Adriatic Sea, which is facing increasing pressure from various industries generating underwater noise.

Keywords: *underwater noise, anthropogenic activities, soundscape, Marine Strategy Framework Directive*

UTJECAJ PODVODNE BUKU NA OKOLIŠ

SAŽETAK:

Opisivanje zvuka kao oblika energetske onečišćivača je izrazito složeno kao što je i njegov utjecaj na život u moru. Očekuje se da će ljudske aktivnosti koje uzrokuju kontinuiranu i implozivnu podvodnu buku kao što su pomorski promet, održavanje brodova, obalni turizam, istraživanja u moru, vojne aktivnosti, odobalne platforme, proizvodnja obnovljive energije iz mora i građenje biti sve intenzivnije. Rad analizira sadašnji pristup minimiziranju utjecaja podvodne buke i ograničavanju njezinih emisija, razmatra regulatorni pristup i mogućnosti kontrole ove vrste onečišćenja kako bi se očuvao prirodan podvodni zvučni krajolik. Pravovremeno oživotvorenje i daljnji razvoj europske Okvirne direktive o morskoj strategiji i njezinih odredbi vezanih na podvodnu buku su od iznimnog značaja za Jadransko more koje je izloženo sve većem pritisku različitih djelatnosti koje stvaraju podvodnu buku.

Ključne riječi: *podvodna buka, antropogene aktivnosti, zvučni krajolik, Okvirna direktiva o morskoj strategiji*

PROLONGED REAL MARINE ENVIRONMENT EXPOSURE OF COMPOSITE MARINE STRUCTURES

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ABSTRACT:

As fiber reinforced polymer (FRP) composites become ever more established construction materials in the marine industry sector the influence of the harsh environmental operational conditions and its consequence on failure prediction of such structures is an imperative. Coupons of epoxy/glass and polyester/glass with various fiber layout configurations have been submerged under the sea for prolonged periods (6 and 12 months) in order to assess the impact on mechanical behavior of the material exposed to real marine environment as opposed to the more commonly adopted artificially produced laboratory sea environment and accelerated testing. Changes in mass, marine microbiology growth, tensile strength and morphological structures were analyzed after submersion and compared with samples exposed to room environment. All coupons have shown mass increase due to seawater absorption and microorganism growth in the organic resins matrices. The dynamic and level of change in tensile strength proved to be dependent on the fiber layout configuration. Optical and scanning electron microscopical investigation performed showed significant matrix morphological changes primarily due to salt crystal formation and the impact of sea microorganisms embedding in the resin. The collected experimental data will be used to develop a more realistic environmental input parameters for structural modeling of marine structures.

Keywords: *FRP composites, marine environment, marine structures durability*

DUGOTRAJNO IZLAGANJE KOMPOZITNIH POMORSKIH KONSTRUKCIJA STVARNOM MORSKOM OKOLIŠU

SAŽETAK:

Kako polimerni materijali ojačani vlaknima (engl. Fiber Reinforced Polymers, FRP) postaju sve više zastupljeni kao konstrukcijski materijali u sektoru pomorske industrije, imperativ postaje utjecaj zahtjevnih operativnih uvjeta okoliša i njihovih posljedica na predviđanje ponašanja takvih struktura u eksploataciji. Uzorci izrađeni od epoksidne smole i stakla, te poliestera i stakla različitih konfiguracija vlakana potopljeni su u more na dulji period (6 i 12 mjeseci) kako bi se utvrdio utjecaj na mehaničko ponašanje materijala izloženog stvarnom morskom okolišu za razliku od češće odabiranih umjetno proizvedenih laboratorijskih morskih okoliša i postupaka ubrzanog ispitivanja. Analizirane su promjene u masi, rastu mikroorganizama, vlačnoj čvrstoći i morfološkoj strukturi analizirane su nakon uranjanja i uspoređene s uzorcima izloženim sobnom okolišu. Svi su uzorci pokazali porast mase uslijed upijanja morske vode i rasta mikroorganizama u organskoj smoli. Pokazalo se da dinamika i razina promjene vlačne čvrstoće materijala ovise o konfiguraciji rasporeda vlakana. Provedeno optičko i skenirajuće elektronsko mikroskopsko istraživanje pokazalo je značajne morfološke promjene matrice prvenstveno zbog stvaranja kristala soli i utjecaja morskih mikroorganizama u smoli. Prikupljeni eksperimentalni podaci koristit će se za razvoj realističnijih ulaznih parametara okoliša za strukturno modeliranje pomorskih objekata.

ključne riječi: *FRP kompoziti, morski okoliš, trajnost pomorskih konstrukcija*

THE ANALYSES OF THE RATE OF PITTING CORROSION OF A NiTi ROD IN A NATURAL MARINE ENVIRONMENT

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ABSTRACT:

The analysis of the behaviour of new materials in the natural environment is important for their application and commercial use. In order to explore the application of Shape Memory Alloys in the Maritime industry, this research focuses on the corrosive behaviour of the NiTi rod that was produced by means of a continuous casting process. The experiment included three samples of NiTi rods that were exposed to the marine environment for 6, 12 and 18 months at a depth of 3 metres below the surface. The morphological and chemical changes were analysed separately during the experiment. Ultrasonic thickness equipment and the Scanning Electron Microscope (SEM) technique were used for the tests that determined the corrosion rates and detected pitting. The changes in the chemical composition of the NiTi rod were investigated by means of an Energy Dispersive X-ray (EDX) analysis, in order to define the pitting behaviour of the rod's surfaces during its exposure to seawater. The obtained research results prove that the rate of pitting corrosion follows a progressive curve – the minimum value of corrosion rate equalled 0.04 mm/month, while the maximum value was 0.12 mm/month.

Key words: *NiTi rod, seawater, pitting corrosion, chemical composition, SEM, EDX*

ANALYSIS OF MICROPLASTIC PARTICLE TRANSMISSION

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ABSTRACT:

The progressive increase in the mass of microplastics in the ecosystem obliges us to urgently define measures to reduce its adverse effects, which primarily requires an understanding of the genesis of its presence and the dynamics of expansion through the biosphere. This paper aims to contribute to the understanding of the dynamics of microplastic particle motion, especially in the context of deposition rate with respect to microplastic material density, microplastic particle size and especially with respect to microplastic particle shape (which significantly affects shape resistance forces). For this purpose, an overview of existing works in the field of modeling the motion of microplastics is given, and a numerical model for modeling the transport of microplastic particles in an inhomogeneous fluid velocity field for laminar flow is formed. The proposed model is thus based on a system of two nonlinear ordinary differential equations.

Keywords: microplastics, precipitation, physical model

CITIZEN-DRIVEN RESEARCH OF SOLID WASTE ALONG ZADAR BEACHES IDENTIFIES LOCAL PLASTIC AS THE MAJOR COMPONENT AND PROPOSES REALISTIC OPPORTUNITIES FOR ITS AVOIDANCE, EFFECTIVE REMOVAL, AND REUSE

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ABSTRACT:

We researched marine solid waste pollution in the Zadar area and draw conclusions about possible solutions not only to reduce pollution, but also to reduce the generation of new waste that may enter the Adriatic Sea. Our field data estimated the amount and types of solid waste collected from various local beaches in Zadar during five clean-up events organized by the MECH association. Data obtained showed that the origin of the majority of the solid waste is local, e.g, by cafes. This allows for the development of reasonable actions to reduce the waste generation and its loss into the environment. Additional data were obtained from an online questionnaire targeting local citizens and local coffee shops about their relationship to solid waste issues, and the degree of their participation in waste generation. From the gathered questionnaire data, we are proposing the foundation of a local movement, which would provide education of local people, local companies, and incoming tourists about the solid waste issues and to act as a platform to create realistic action plans to reduce local waste production yet support local tourism and novel and creative opportunities to give already created waste another purpose.

Keywords: *marine solid waste pollution, local movement, questionnaire, clean-up events*

Izlaganja 3 / Session 3

**Pomorska biologija, Biotehnologija, Ribarstvo i
Akvakultura /**
Marine Biology, Biotechnology, Fisheries and Aquaculture

OVERCOMING OBSTACLES - BIOMIMETIC LESSONS FROM THE SWARMING BEHAVIOR OF ARTEMIA FRANCISCANA

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ABSTRACT:

We investigated the formation of *Artemia franciscana* swarms of freshly hatched instar I nauplii larvae. Nauplii were released into light gradients but then interrupted by light-direction changes, small obstacles, or long barriers. All experiments were carried out horizontally. Each experiment used independent replicates. Freshly produced *Artemia* broods were harvested from independent incubators thus providing true replicate cohorts of *Artemia* subjected as replicates to the experimental treatments. We discovered that *Artemia* nauplii swarms can: 1. repeatedly react to non-obstructed light gradients that undergo repeated direction-changes and do so in a consistent way, 2. find their way to a light source within maze-like arrangements made from small transparent obstacles, 3. move as a swarm around extended transparent barriers, following a light gradient. This paper focuses on the recognition of whole-swarm behaviors, the description thereof and the recognition of differences in whole-swarm movements comparing non-obstructed swarming with swarms encountering obstacles. Investigations of the within-swarm behaviors of individual *Artemia* nauplii and their interactions with neighboring nauplii are in progress, e.g. in order to discover the underlying swarming algorithms and differences thereof comparing non-obstructed vs. obstructed pathways.

Keywords: *Artemia* production, swarming in light gradients, mazes and obstacles, high speed videography, adaptations to natural environments

WEATHER DOWNTIME ASSESMENT FOR COMPLEX OFFSHORE PROJECTS

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ABSTRACT:

Analysis of the expected downtime in complex offshore operations is performed with metocean analysis of the area of interest which is then compared to the operative limits defined by installation analyses. The metocean conditions are commonly represented by seastate hindcast time series. On the other end, the operative limits can be defined as maximum allowable sea state, as well as the maximum allowable vessel motion. This paper presents the methodology to evaluate the operative weather downtime based on classical operative sea state limit.

Keywords: *downtime analysis, offshore operations, operative limits*

PROCJENA NERASPOLOŽIVOSTI USLIJED VREMENSKIH PRILIKA ZA SLOŽENE ODOBALNE PROJEKTE

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SAŽETAK:

Analiza očekivanog vremena nerasploživosti uslijed vremenskih neprilika složenih odobalnih projekata se odvija analizom meteorološko-oceanografskih podataka koji se uspoređuju sa limitima operacija, dobivenim analizom instalacije. Meteorološko-oceanografski podaci su obično definirani vremenskim podacima stanja mora dobivenim u duljem vremenskom periodu. S druge strane, limiti operacija mogu biti definirani kao maksimalno dopušteno stanje mora, kao i maksimalno dopušteno gibanje broda. Ovaj rad prezentira metodologiju kojom je moguće evaluirati vrijeme nerasploživosti uslijed vremenskih prilika na osnovu klasičnog određivanja operativnih limita pomoću dopuštenog maksimalnog stanja mora.

Ključne riječi: *vrijeme nerasploživosti, odobalne operacije, limiti operacija*

THE IMPACT OF SALT PANS ON THE MEADOW OF POSIDONIA OCEANICA IN THE DINJIŠKA BAY

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ABSTRACT:

The Mediterranean tapeweed (lat. *Posidonia oceanica*) is a species of seagrass, endemic to the Mediterranean Sea. In Croatia, the species is strictly protected by the Nature Protection Act. Due to its high production of oxygen, it is also called „the lungs of the sea“. The paper discusses the endangered habitat of *Posidonia oceanica* in the area of Dinjiška bay on the island of Pag. As the salt pans and the belonging embankments were built in the late 1960s, more than 50 hectares of the bay have been isolated, and the sea circulation has been limited. The salt pans are no longer in operation, yet the embankment is still preventing the water exchange and retaining sludge. Within the research, the meadow of *Posidonia oceanica* in the bay is photographed, mapped and measured. The conditions of the leaves and the number of rhizomes are being compared for different locations. The results are analyzed and some solutions for the preservation of the endangered part of the *Posidonia* meadow in the Dinjiška bay are proposed.

Keywords: *Posidonia oceanica*, seagrass meadows monitoring, Dinjiška bay, salt pans Dinjiška

UTJECAJ PODRUČJA SOLANE NA LIVADU POSIDONIJE U UVALI DINJIŠKA

SAŽETAK:

Posidonija (lat. *Posidonia oceanica*) je morska cvjetnica, endem Sredozemnog mora. U Hrvatskoj je strogo zaštićena vrsta Zakonom o zaštiti prirode, a zbog svoje velike sposobnosti proizvodnje kisika naziva se i plućima mora. U radu se razmatra ugroženo stanište posidonije na području uvale Dinjiška na otoku Pagu. Izgradnjom solane i nasipa krajem 1960-ih izolirano je više od 50 hektara uvale, te je ograničena cirkulacija mora. Solana nije više u funkciji, no nasip i dalje onemogućava izmjenu morske vode i zadržava mulj. U sklopu istraživanja provodi se snimanje, mapiranje i mjerenje livade posidonije u uvali. Uspoređuje stanje listova i brojnost rizoma na pojedinim lokacijama. Rezultati se analiziraju i predlažu se rješenja za očuvanje ugroženog dijela livade posidonije u uvali Dinjiška.

Gljučne riječi: *Posidonia oceanica*, praćenje stanja livada, uvala Dinjiška, solana Dinjiška

PHYSICOCHEMICAL CHARACTERISTICS OF THE MARINE LAKE ROGOZNICA AND ITS CONNECTION WITH THE ATMOSPHERE AND THE OUTER SEA

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ABSTRACT:

Lake Rogoznica (also known as "Dragon's Eye" lake) is a karstic, marine lake situated on the peninsula Gradina, 100 meters from the sea at 43° 32' N and 15° 58' E. Most of the time the lake is stratified with a top oxic layer, anoxic bottom layer, and a chemocline layer in between (1). Every few years the stratification suddenly breaks down and the whole water column becomes mixed, anoxic and euxinic (with HS⁻ presence through the entire water column). This causes mass mortality of aerobic organisms in the lake and it takes time before flora and fauna recover (2). In the last 30 years, four anoxic mixing events were recorded: September 1997, October 2011, October 2016 and October 2020. In this work, we present physicochemical characteristics of the lake water column (σ_t stratification, dissolved oxygen concentration) and the influence of the atmosphere and outer sea on it. The atmospheric impact mostly manifests through precipitation and evaporation caused by daily and seasonal temperature changes. This is especially shown in the surface salinity changes. Daily water circulation (exchange) has been noticed by tides in the lake because of the connection with the outer sea through the surrounding karst. However, recent physic-chemical measurements indicate that this circulating water is not strictly fresh seawater nor lake water.

Keywords: Lake Rogoznica, σ_t stratification, water column mixing, atmospheric precipitation, circulation through karst

Acknowledgements: This work is a result of research activities within the CSF MARRES project, IP-2018-01-1717

FIZIČKO-KEMIJSKE KARAKTERISTIKE ROGOZNIČKOG MORSKOG JEZERA I NJEGOVA VEZA S ATMOSFEROM I VANJSKIM MOREM

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SAŽETAK:

Rogozničko jezero (također poznato i pod nazivom "Zmajevo Oko") je morsko jezero u kršu na poluotoku Gradina, 100 metara od mora (43° 32' S i 15° 58' I). Većinu vremena jezero je stratificirano s gornjim, oksičnim slojem, donjim anoksičnim slojem, te slojem kemokline koji ih razdvaja (1). No, svakih nekoliko godina stratifikacija naglo oslabi te cijeli vodeni stupac postane izmiješan, anoksičan i euksiničan (s prisutnošću HS⁻ u cijelom vodenom stupcu jezera). Takvi uvjeti uzrokuju pomor aerobnih organizama te je potrebno određeno vrijeme da se flora i fauna jezera oporave (2). U zadnjih 30 godina zabilježena su četiri takva miješanja: u rujnu 1997. te listopadu 2011., 2016. i 2020. godine. U ovom radu bit će prikazane fizičko-kemijske karakteristike vodenog stupca jezera (σ_T stratifikacija, konc. otopljenog kisika) u ovisnosti o utjecaju atmosfere i vanjskog mora. Utjecaj atmosfere je uglavnom u vidu oborine i isparavanja uzrokovanog dnevnim i sezonskim promjenama u temperaturi. Ti se utjecaji najviše očituju u promjenama površinskog saliniteta. Razmatranjem plimnih oscilacija u jezeru uočena je i dnevna cirkulacija (izmjena) vode između jezera i vanjskog mora kroz okolni krš. No, nedavna fizičko-kemijska analiza vode koja cirkulira ukazuje kako ta voda prolazeći kroz krš poprima drugačije karakteristike u odnosu na jezersku vodu i vodu iz okolnog mora.

Ključne riječi: *Rogozničko jezero, σ_T stratifikacija, miješanje vodenog stupca, atmosferske oborine, cirkulacija kroz krš*

Zahvala: Ovaj je rad rezultat istraživanja u okviru HRZZ projekta MARRES, IP-2018-01-1717

Izlaganja 4 / Session 4

Konstrukcija i projektiranje u brodogradnji, Mali plovni objekti /

Construction and Design in Shipbuilding, Small Craft

PRELIMINARY DESIGN OF A SHIP FOR WASTE SORTING FROM CROATIAN ISLANDS

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ABSTRACT:

In the Environmental Protection Strategy of the Republic of Croatia, waste management is defined as a national priority, and the vision is a landfill-free concept. The backbones are recycling centers with sorting plants where separately collected waste will be prepared for recycling. Concept of sustainable development is a key determinant of the development of the Primorje-Gorski Kotar County (PGKC), and the fact that permanent disposal of waste of any kind will not be possible on the islands is particularly important for this County. Mixed municipal waste generated in PGKC should be first sorted at the local transshipment station on the island, and then transported by road to the county center for waste management, which is an expensive and complex process. Given that sea transport is known to be the cheapest, one possible solution would be to place a waste sorting plant on a suitable ship which would collect waste by sailing around the island, thus avoiding the need for each island to have its own sorting plant. The paper presents a preliminary design of a ship for sorting waste collected from the large islands of PGKC. The mission requirements of the ship were elaborated initially, and then a basic design of the ship was made, accompanied by the corresponding naval architecture calculations, general arrangement plan and outline specification.

Keywords: *Croatian islands, waste management, ship for waste sorting, preliminary design*

PRELIMINARNI PROJEKT BRODA ZA RAZVRSTAVANJE OTPADA S HRVATSKIH OTOKA

SAŽETAK:

U Strategiji zaštite okoliša Republike Hrvatske, gospodarenje otpadom je određeno kao nacionalni prioritet, a vizija je koncept bez odlagališta. Okosnica su reciklažni centri s postrojenjima za razvrstavanje otpada u kojima će se odvojeno prikupljeni otpad pripremati za recikliranje. Koncept održivog razvitka ključna je odrednica razvoja Primorsko-goranske županije (PGŽ), a za ovu je županiju posebno važna činjenica da ubuduće na otocima neće biti moguće trajno odlaganje otpada bilo koje vrste. Miješani komunalni otpad koji nastaje u PGŽ najprije se razvrstava u lokalnoj pretovornoj stanici na otoku, a zatim se cestovnim prijevozom odvozi u županijski centar za gospodarenje otpadom što je skup i složen proces. S obzirom da je poznato da je pomorski promet najjeftiniji, jedno od mogućih rješenja bilo bi postavljanje postrojenja za razvrstavanje otpada na prikladan brod koji bi plovidbom oko otoka prikupljao otpad čime bi se izbjegla potreba da svaki otok ima svoje postrojenje za razvrstavanje. U radu je predstavljen preliminarni projekt broda za razvrstavanje otpada prikupljenog na velikim otocima PGŽ. Početno su razrađeni projektni zahtjevi, a zatim je izrađen preliminarni projekt broda s pripadajućim brodograđevnim proračunima, općim planom i tehničkim opisom.

Ključne riječi: *hrvatski otoci, gospodarenje otpadom, brod za razvrstavanje otpada, preliminarni projekt*

STRUCTURAL ANALYSIS OF HYBRID RO-PAX FERRY

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ABSTRACT:

With the aim of improving the environmental sustainability in the field of maritime transport and with special reference to multimodality and 'green' solutions for coastal transport, within the *METRO* project (Maritime Environment-friendly TRanspOrt systems), funded under the Interreg VA CBC Programme Italy-Croatia, a project of a hybrid Ro-Pax medium range ferry for coastal navigation in the Adriatic area is developed. The paper presents a part of the conceptual design for the assessment of the global hull structure strength, which is not common for this phase of the project, and that is the structural analysis of the complete ship. For this purpose, a detailed computer model of the geometry of the whole ship was made, which includes all primary and basic secondary structural elements, with the aim that such a model can serve later as a good basis for classification and workshop documentation production during contract phase. Additionally, a preliminary calculation of the scantlings of the complete ship was performed according to *BV* rules and regulations using the *MARS2000* software package, with regard to bending and buckling. Loads were modeled according to real conditions for two unfavorable loading conditions, and static linear analysis was performed using the *LS-DYNA* software package. The global analysis of bending strength in still water could reveal problematic areas in the structure.

Keywords: preliminary design, Ro-Pax, hull structure, FEA

STRUKTURNA ANALIZA HIBRIDNOG RO-PAX TRAJEKTA

SAŽETAK:

S ciljem poboljšanja održivosti okoliša u području pomorskog prometa i posebnim osvrtom na multimodalnost i 'zelena' rješenja za obalni prijevoz, u okviru projekta *METRO* (Maritime Environment-friendly TRanspOrt systems), financiranog u okviru Interreg V-A Programa za prekograničnu suradnju Italija-Hrvatska, razvijen je projekt hibridnog RoPax trajekta srednjeg doplova za obalnu plovidbu na području Jadrana. U radu je prikazan dio idejnog projekta procjene globalne čvrstoće konstrukcije trupa koji nije uobičajen za ovu fazu projekta, a to je strukturna analiza cijelog broda. U tu je svrhu napravljen detaljan računalni model geometrije cijelog broda koji uključuje sve primarne i osnovne sekundarne strukturne elemente, sa ciljem da takav model može poslužiti i kasnije kao dobra podloga za izradu klasifikacijske i radioničke dokumentacije u ugovornoj fazi projekta. Dodatno je izvršen preliminarni proračun dimenzija cijelog broda prema *BV* pravilima i propisima koristeći programski paket *MARS2000*, obzirom na savijanje i izvijanje. Opterećenja su modelirana prema realnim uvjetima i to za dva nepovoljna stanja krcanja, te je izvršena statička linearna analiza koristeći *LS-DYNA* programski paket. Globalna analiza čvrstoće za moment savijanja na mirnoj vodi može ukazati na problematične elementi ili područja konstrukciji.

Ključne riječi: idejni projekt, Ro-Pax, struktura trupa, MKE

SEAKEEPING ANALYSIS OF A DOUBLE ENDED FERRY

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ABSTRACT:

Awareness of environmental protection is increasing, especially in recent years when warnings of imminent climate change have begun to appear in public space. In addition to one of the most significant environmental pollutants, global maritime transport is also mentioned, where environmental pollution is explicitly in the form of exhaust gases from marine propulsion engines. The trend of developing environmentally friendly, so-called "eco" ships is on the rise, primarily in the development of electric ferries designed to transport passengers and vehicles on short routes. This paper deals with a seakeeping analysis of a double ended ferry which is intended for sea route between Brestova and Porozina in the North Adriatic. The adopted dimensions and shape of the ship, the characteristics of sea waves for the adopted spectrum will be presented, and then the obtained results, considering the limits of the ship operability related to passenger comfort and cargo safety. The analysis was performed using computer software "Sesame HydroD". A seakeeping estimation for the ferry is finally adopted and possible directions for future developments are proposed.

Keywords: *Seakeeping, electric ferry, Sesame HydroD*

ANALIZA POMORSTVENOSTI DVOSTRANOG TRAJEKTA

SAŽETAK:

Svijesti o očuvanju okoliša se sve više povećava, naročito proteklih godina kada se počinje upozoravati o neminovnim klimatskim promjenama. Uz jedne od značajnijih zagađivača okoliša spominje se i globalni pomorski promet pri čemu se zagađivanje okoliša spominje eksplicitno u vidu ispušnih plinova iz brodskih pogonskih strojeva. Trend razvijanja ekološki prihvatljivih, tzv. „eko“ brodova je u velikom porastu, a prvenstveno u razvijanju trajekata na električni pogon predviđenih za prijevoz putnika i vozila. U ovom će se radu prikazati analiza pomorstvenosti dvostranog trajekta na električni pogon, a koji je predviđen za održavanje rute između Brestove i Porozine u Sjevernom Jadranu. Prikazati će se usvojene dimenzije i forma broda, karakteristike morskih valova za usvojeni spektar te će se potom prikazati dobiveni rezultati pri čemu se razmatraju granice operativnosti broda vezane uz komfor putnika te sigurnost tereta. Analiza je izvršena pomoću računalnog programa „Sesam HydroD“. Završno se usvaja procjena pomorstvenosti za trajekt te se predlažu smjernice za budući razvoj ovakvih brodova sa aspekta pomorstvenosti.

Ključne riječi: *pomorstvenost, električni trajekt, Sesame HydroD*

SEAWORTHINESS AND STABILITY ANALYSIS OF A PONTOON FOR HOLIDAY HOUSE

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ABSTRACT:

In this paper, the methodology of seaworthiness and stability analysis of a pontoon for holiday house has described. A 3D model of the pontoon was modelled in the NAPA software to perform hydrostatic analysis. It is necessary to emphasize the fact that hydrostatic analysis has been made for several drafts and trims of pontoons. The hydrostatic analysis yielded data such as displacement, moulded volume, longitudinal centre of buoyancy, the transverse metacentric height, change of displacement, moment to change trim, and more. This part of the analysis also includes the loading scale from which we can see the deadweight at a given draft. Further, it is necessary to make weight study to get moulded displacement for pontoon for a holiday house. The pontoon also includes capacity tanks, so it is necessary to know the accurate dimensions of the tanks and their position for further analysis. It is necessary to know the exact geometry of the tanks because of the free surface effect. When calculating the stability of the pontoon, it is necessary to determine the minimum metacentric height and the maximum distance from the keel to the centre of gravity. Intact stability conditions must be met for GM limit curves and also for KG curves. Intact stability criteria of the pontoon were tested for four loading conditions: lightship, pontoon with 10% consumables without passengers, pontoon with 100% consumables with passengers, pontoon with 50% consumables with passengers. It is important to emphasize that all tasks meet the stability criteria.

Keywords: intact stability, hydrostatic analysis, loading scale, weight study, cross curves

PLOVNOST I STABILITET PONTONA ZA KUĆU ZA ODMOR

SAŽETAK:

U ovom radu je razrađena metodologija analize plovnosti i stabiliteta stambenog pontona. U softveru NAPA modeliran je 3D model pontona kako bi se mogla izvest hidrostatska analiza. Potrebno je naglasiti da je ista napravljena za više gazova, odnosno trimova pontona. Hidrostatskom analizom dobiveni su podaci kao što je istisnina, uronjeni volumen, uzdužni centar istisnine, transverzala visina metacentra, jedinični uron broda, moment promjene trima i ostalo. Prethodni dio analize uključuje i ljestvicu iz koje iščitavamo nosivost pri određenom gasu. Radi daljnjeg proračuna stabiliteta potrebno analizirati mase i težišta, to jest nužno je napraviti centraciju mase kako bi dobili točnu istisninu stambenog pontona. Ponton uključuje i tankove koji u integrirani unutar samog pontona pa je potrebno poznavati gabarite tankova te

njihovu poziciju prilikom daljnje izrade analize. Geometrija tankova nam je bitna radi utjecaja slobodnih površina. Prilikom proračuna stabiliteta potrebno je odrediti minimalnu metacentarsku visinu i maksimalnu visinu težišta sustava. Isti moraju zadovoljiti zadane uvjete stabiliteta, za to su nam poslužile granične krivulje GM i KG. Provjera stabiliteta pontona izvršena je za četiri stanja krcanja: prazan opremljen ponton, ponton s 10% zaliha bez putnika, ponton sa 100% zaliha s putnicima, ponton s 50% zaliha s putnicima. Bitno je naglasiti da su svi zadani kriteriji stabiliteta zadovoljeni.

Ključne riječi: stabilitet u neoštećenom stanju, hidrostatska analiza, ljestvica nosivosti, centracija masa, KN krivulje

DEVELOPMENT OF TECHNICAL DOCUMENTATION OF SMALL VESSELS

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ABSTRACT:

The development of technical documentation of vessels provides that the design, construction and conformity assessment is clearly understood and meets the competent requirements. This paper presents the development process of technical documentation for a small vessel, i.e. a motorboat of project category B (navigation on the high seas), whose hull length is within the range from 2.5 m to 24 m, according to the given norms. For example, the paper will present a boat intended as a polyvalent workboat in service on the Adriatic Sea, whose documentation has been prepared according to standards, i.e. the requirements of the Croatian Register of Shipping (HRN EN ISO Standards).[1]

Keywords: *Technical documentation, Small vessel, Croatian Register of Shipping*

IZRADA TEHNIČKE DOKUMENTACIJE MALIH PLOVNIH OBJEKATA**SAŽETAK:**

Izrada tehničke dokumentacije plovni objekata služi da se projektiranje, gradnja te ocjenjivanje sukladnosti mogu jasno definirati i uskladiti sa zahtjevima nadležnih tijela. U ovom radu prikazan je tok procesa izrade tehničke dokumentacije za mali plovni objekt, odnosno motornu brodicu projektne kategorije B (plovidba otvorenim morem), čija duljina trupa se nalazi u rasponu od 2,5 m do 24 m, a prema zadanim normativima. U radu će za primjer biti prikazana brodica predviđena kao polivalentna radna brodica u službi na Jadranskom moru čija je dokumentacija je izrađena prema standardima, odnosno zahtjevima normi Hrvatskog registara brodova (HRN EN ISO Norme). [1]

Ključne riječi: *Tehnička dokumentacija, Mali plovni objekt, Hrvatski Registar brodova*

CARBON MAST STRUCTURAL DAMAGE DETECTION USING ULTRASONIC NDT METHOD

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ABSTRACT:

Glass and carbon fibers as materials have become the primary choice in the construction of smaller vessels. The advantages of these materials are good mechanical properties, they are relatively light materials that today anyone with a little knowledge can handle and also, financially speaking, they are materials that are affordable to almost everyone. One of the disadvantages is that composite materials are not homogeneous. This would mean that irregularities can be observed in the cross section of the laminate of such composite vessel or equipment. These irregularities are usually negligible because they simply belong to the property of composite materials. The problem arises when imperfections are caused by human factors or the action of some external force such as residual air in the laminate or delamination. Such imperfections during navigation can cause catastrophic damage. Although visible damage may seem small, it is very likely that there is much greater damage to the laminate that is not visible because it is located somewhere between the layers of fibers. Various methods exist for detecting such damage and imperfections, which can be invasive or non-invasive. The focus of this paper is on detecting the magnitude of damage in the laminate of the carbon mast of a racing sailboat Melges 32 using a non-invasive ultrasonic testing method. The Avenger EZ device was used for testing only.

Keywords: Carbon mast, Laminate, Damage detection, NDT method, Ultrasonic testing

Izlaganja 5 / Session 5

Pomorski transport, Tehnologija brodogradnje i Brodogradilišta /

Maritime Transport, Shipbuilding Technology and Shipyards

IMPACT OF THE ONE BELT AND ONE ROAD INITIATIVE ON THE EUROPEAN MARITIME FIELD

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Abstract

China is nowadays the most influential country in the world market, therefore the Chinese government introduced the One Belt and One Road project in 2013 in an attempt to reinforce its global power, including its major partner (Europe). In this paper the authors analyze the possible advantages and disadvantages that this Chinese initiative brings to the European market and the possible challenges that international policies may bring to the infrastructure created in recent years in the European Union. The authors concentrate on current examples based on China's COSCO Shipping and the influence that this initiative gives to the Chinese government in the world market. The aim of this paper is to present general overview on some of the consequences, positive or negative, of this important project.

Keywords: *One Belt and One Road, Maritime field, Logistics, European transport system*

THE IMPROVEMENT OF URBAN TRAFFIC CONTROL EFFICIENCY IN THE CITY OF RIJEKA

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ABSTRACT:

To establish quality solutions in urban and multimodal transport of the city of Rijeka, a scientific research project Connected traffic was started within the Center of Competence for Smart Cities, the city of Rijeka (CEKOM). The primary starting point of the project is to promote a sustainable clean and energy-efficient mode of transport. The aim of this paper is to present research development activities within the results of this project related to the improvement of traffic management in the city of Rijeka. The sustainability of urban transport requires the application of energy efficiency measures while reducing primary energy consumption and greenhouse gas emissions. The methodological approach in research activities has so far analyzed the existing traffic scenarios and defined the part of the covered traffic area. According to the analysis of examples of good traffic management practices in several European cities, the positive results generated by the system have been identified. The requirements for vehicle recognition system sensors were determined, and ecological and meteorological parameters were defined. Locations for measuring traffic, meteorological and environmental parameters with explanation and associated methodology have been proposed. The traffic model of the city of Rijeka and the immediate surroundings was developed with an appropriate transport network of corridors including associated roads and intersections that will serve as the basis for the implementation of traffic simulations according to standard operating procedures or incidental situations. Based on the existing traffic demand, a macro-simulation of traffic flow was performed. The further project activities are related to the development of micro-simulation modelling of the test area thus generating micro-simulation of traffic flow concerning specific standard procedures. Further research will improve the quality of the traffic management center of the city of Rijeka through the Centre for Monitoring and Management of Integrated Traffic. The implementation of a data collection platform for urban transport and urban mobility decision-making will enable the automatic distribution of real-time data to all road users.

Key words: *development of urban traffic, traffic management systems, sustainable transport, city of Rijeka*

ASSESSING THE COMPRESSION FATIGUE OF THE WELDED TEST SPECIMENS

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ABSTRACT:

The focus of this paper is on compression fatigue life in welded test specimen. Considered test specimen is highly complex due to multi-layer welding and production errors affecting its topology. Test specimen is made from S355 steel which is used for both base material and weld. Compression fatigue analysis is seldom performed as compression positively affects fatigue life. At the same time, during MAG welding residual stresses affect the fatigue life, decreasing it significantly. Finite element method (FEM) is applied to estimate compression fatigue life of the welded test specimen and obtained fatigue curve is compared to the experimental curve. Experimental curves are given for different stress ratios: $R = -1$, and $R = -\infty$. Analysis consists of thermal and structural analysis using FEM method and fatigue analysis which is based on FEM results. FEM thermal simulation of welding with constant initial temperature is performed first and followed by nonlinear structural analysis for assessment of the residual stresses due to heat expansion. Fatigue parameters are determined using Universal slope method.

Keywords: *compression fatigue, R ratio, MAG welding, residual stress, coupled thermal-mechanic, S355*

PROCJENA TLAČNOG ZAMORA U ZAVARENIM EPRUVETAMA

SAŽETAK:

Tema rada je istraživanje tlačnog zamora kod zavarenih epruveta. Promatrana epruveta je kompleksna zbog višeslojnog zavarivanja te grešaka u proizvodnji koje utječu na topologiju epruvete. Materijal ploče i zavara je S355 čelik. Iako se analiza tlačnog zamora rijetko provodi zbog njenog pozitivnog efekta na životni vijek, rezidualna naprezanja tokom MAG zavarivanja utječu na životni vijek epruvete i smanjuju ga značajno. Numerički pristup FEM metodom je napravljen kako bi se dobila krivulja tlačnog zamornog vijeka te usporedila sa eksperimentalnom. Eksperimentalne krivulje su dane za različite odnose naprezanja $R: R = -1$ i $-\infty$. Analiza se sastoji od termalne i strukturne simulacije korištenjem FEM metode te analize zamora koja je bazirana na rezultatima iz FEM. Termalna analiza zavarivanja se temelji na metodi konstante temperature te se provodi prva nakon čega slijedi nelinearna strukturna analiza čiji je cilj utvrđivanje rezidualnih naprezanja uslijed termalne ekspanzije. Parametri za zamor aproksimirani su korištenjem metode Univerzalnog nagiba.

Ključne riječi: *tlačni zamor, faktor R, MAG zavarivanje, rezidualna naprezanja, termalno - mehanička simulacija, S355*

DEFINITION OF DEFORMATIONS AND STRESSES OF LARGE SHIP BLOCKS WITHIN TRANSPORTATION AND MANIPULATION**Davor Bolf**, *dbolf@riteh.hr***Marko Hadjina**, *hadjina@riteh.hr***Albert Zamarin**, *zamarin@riteh.hr***Mario Iveković**, *mivekovic@riteh.hr**University of Rijeka – Faculty of Engineering; Vukovarska 58, 51000 Rijeka, Croatia,***ABSTRACT:**

Deformations and stresses during the transport and manipulation of large ship blocks within ship assembly and erection stages are a common and significant issue, particularly in the construction of complex ships and variable production mix, as is the case in many European shipyards. The appearance of deformations and stresses requires adequate addressing with the aim of their early determination and reduction with a goal to reduce a significant number of working hours spent for the large ship blocks transport preparation, for the transport and manipulation itself, and for the reworks. The appearance of residual stress in blocks that are not adequately addressed can be an issue in the exploitation, reducing the quality and ship service life. In this paper, the authors present the procedure of determining deformations and stresses in the large ship block. The procedure is based on computer modelling and numerical analysis of the selected ship block. Various scenarios of the foundations' arrangement and the arrangement of the transport hooks were analysed, and the optimal solutions were proposed. The procedure allows determining deformations and stresses at an early stage of ship technology design to define the adequate preparation for ship block foundations layout, transportation and manipulation before production starts. In doing so, it is expected to reduce deformations and stresses itself, necessary working hours for block accommodation, transportation and manipulation and to reduce repair works. Such procedure application is expected to raise the efficiency of the overall ship production process and the quality of the final product. Finally, further research is proposed regarding various scenarios of technological procedures, ship blocks structures or used materials.

Keywords: *shipbuilding, deformations, stresses, transport of large ship blocks, 3D Experience model, numerical analysis, efficiency*

ODREĐIVANJE DEFORMACIJA I NAPREZANJA PRI TRANSPORTU I MANIPULACIJI VELIKIH SEKCIJA U PROCESU GRADNJE BRODA

SAŽETAK:

Deformacije i naprezanja prilikom transporta i manipulacije velikih sekcija broda u fazama predmontaže i montaže redovit su i značajan problem u brodograđevnom proizvodnom procesu, a posebice u slučaju gradnje složenih brodova veće dodane vrijednosti i promjenljivog proizvodnog programa, a što je slučaj u mnogim europskim brodograđilištima. Pojava deformacija i naprezanja uzrokuje potrebu za adekvatnim adresiranjem problema sa ciljem ranog određivanja i smanjivanja istih kako bi se smanjio značajan broj utrošenih radnih sati u fazi pripreme sekcije za transport, u fazi manipulacije sekcije te fazi mogućih naknadnih radova na sekciji. Pri tome, treba naglasiti da su takvi radovi primarno u završnim, za brodograđilište skupljim, fazama gradnje broda. Također, pojava zaostalih naprezanja u sekcijama koje nisu adekvatno adresirane mogu predstavljati problem u završnim fazama gradnje broda te u samoj eksploataciji, smanjujući kvalitetu i vijek trajanja broda. Autori u ovom radu prikazuju postupak određivanja deformacija i naprezanja u odabranoj velikoj sekciji broda. Postupak se temelji na računalnom modeliranju i numeričkoj analizi odabrane sekcije za koju su analiziran veći broj scenarija rasporeda i broja potklada te rasporeda i broja uški za transport, te su predložena i optimalna rješenja. Osnovani postupak omogućuje određivanje deformacija i naprezanja u sekciji u ranoj fazi projektiranja tehnologije gradnje broda i tehnoloških postupaka kako bi se na vrijeme definiralo na koji način se sekcija treba postaviti na potklade te adekvatno pripremiti za transport i manipulaciju. Na taj način očekuje se prvo smanjenje deformacija i naprezanja u sekciji, zatim smanjenje potrebnih radnih sati za adekvatnu pripremu sekcije za smještaj i transport te smanjenje naknadnih radova za popravke. Istovremeno, primjenom ovog postupka očekuje se podizanje efikasnosti proizvodnog procesa i kvalitete konačnog proizvoda. Na kraju rada daju se i smjernice za daljnje istraživanje odnosno primjenu osnovanog postupka za druge scenarije tehnoloških postupaka, vrsta sekcija, tipova brodova i karakteristika korištenih materijala.

Ključne riječi: brodogradnja, deformacije, naprezanja, transport velikih sekcija, 3D Experience model, numerička analiza, efikasnost

CRITERIA FOR EVALUATION THE TECHNOLOGICAL LEVEL OF SHIP PRE-OUTFITTING IN SHIPYARD

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ABSTRACT:

In today's highly competitive shipbuilding business, gaining a competitive advantage between shipyards is extremely important. In order to have a competitive and sustainable shipyard, it is important for the management to continuously monitor and raise the productivity, efficiency and quality of the production process. One of the major issue in today's shipbuilding is how to organize and conduct the efficient ship outfitting process as one of the most complex task within ship design, supply chain and production activities, particularly for high value added ships. To be able to manage, improve and optimize ship outfitting process it is necessary to establish its current technological level and relevant activities. Hence, in this paper authors are analysing the ship outfitting process with special attention to ship outfitting prior to ship launching, with a purpose to define and explain the criteria to be used for such technological level evaluation.

Keywords: *shipbuilding, technological level, outfitting, evaluation, efficiency, sustainability*

KRITERIJI ZA OCJENJIVANJE TEHNOLOŠKE RAZINE BRODOGRADILIŠTA ZA PREDOPREMANJE BRODA

SAŽETAK:

U današnjem visoko konkurentnom brodograđevnom poslu stjecanje konkurentske prednosti između brodogradilišta iznimno je važno. Kako bi imali konkurentno i održivo brodogradilište, potrebno je da vodstvo brodogradilišta kontinuirano prati i podiže produktivnost, učinkovitost i kvalitetu proizvodnog procesa. Jedno od glavnih pitanja u današnjoj brodogradnji je kako organizirati i provesti učinkovit proces opremanja broda kao jedan od najsloženijih zadataka u projektiranju, lancu opskrbe i proizvodnim aktivnostima, posebno za brodove s visokom dodanom vrijednošću. Za upravljanje, poboljšanje i optimiziranje procesa opremanja broda potrebno je primarno utvrditi njegovu trenutnu tehnološku razinu i relevantne aktivnosti. Stoga u ovom radu autori analiziraju proces opremanja broda s posebnom pozornošću na opremanju broda prije porinuća te definiraju kriterije koji se koriste za procjenu tehnološke razine predopremanja broda.

Ključne riječi: *brodogradnja, tehnološka razina, opremanje, ocjena, učinkovitost, održivost*

Izlaganja 6 / Session 6

Primjena kompjuterskih aplikacija u projektiranju, proizvodnji i održavanju postrojenja morske tehnologije

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Computer applications in the design, manufacture and operation of marine technology facilities

NUMERICAL MODELING OF INCLINED BUOYANT JETS FOR DIFFERENT FLOW CONDITIONS

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ABSTRACT:

The processes of discharge of higher density effluent into the recipient of lower density occur during the release of wastewater into the sea from desalination process, which is increasingly common today due to the shortage of drinking water. During such discharges, the goal is to achieve the best possible mixing, so that the impact of water with a high salt concentration on the environment is as small as possible. Since the jet returns to the bottom because of the influence of gravity, the use of nozzles at an angle increases the zone in which mixing occurs. In this paper, a numerical model of effluent discharge was made and buoyancy jets inclined at 45° were observed for different flow regimes. The influence of density and velocity on jet characteristics is shown. The numerical model was developed in OpenFOAM, and a comparison with experimental data from previous research is presented.

Keywords: Desalination, Inclined buoyant jets, OpenFOAM, Mixing, Wastewater

NUMERIČKO MODELIRANJE NAGNUTIH UZGONSKIH MLAZOVA ZA RAZLIČITE UVIJETE STRUJANJA

SAŽETAK:

Procesi ispuštanja efluenta veće gustoće u recipijent manje gustoće se javljaju prilikom odvodnje otpadnih voda u more iz procesa desalinizacije koja je danas sve češća zbog nestašice pitke vode. Prilikom takvih ispusta, cilj je postići što bolje miješanje, kako bi utjecaj vode s velikom koncentracijom soli na okoliš bio što manji. S obzirom na to da se mlaz zbog utjecaja gravitacije vraća na dno, korištenjem mlaznica pod kutom povećava se zona u kojoj dolazi do miješanja. U ovom radu napravljeni je numerički model ispuštanja efluenta te su promatrani uzgonski mlazovi nagnuti pod 45° za različite režime strujanja. Prikazan je utjecaj gustoće i brzine na karakteristike mlaza. Numerički model je izrađen u OpenFOAM-u, te je prikazana usporedba s eksperimentalnim podacima iz dosadašnjih istraživanja.

Gljučne riječi: desalinacija, nagnuti uzgonski mlazovi, OpenFOAM, miješanje, otpadne vode

VALIDATION OF THE CFD PROCEDURE FOR ROPAX RESISTANCE ASSESSMENT

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ABSTRACT:

In the preliminary stage of ship design, it is very important to estimate the total resistance force. The study presents procedure for RoPax ship resistance assessment using Computational Fluid Dynamics (CFD). Numerical calculation is done by Finite-Volume Method (FVM) solver. The solver is based on Reynolds-Averaged Navier-Stokes (RANS) equations and the Volume of Fluid (VOF) scheme for the free surface capturing. Ship resistance was calculated for a various ship speeds to obtain resistance curve. Since the mesh density affects the results in any CFD simulation, multiple meshes were used to check the results of resistance force. The validation and uncertainty due to discretization in the application of the CFD solver is analysed by comparing the numerically obtained results of the resistance force to the experimental data. I was concluded that used CFD solvers are capable to deliver results very close to experiments using relatively small computing power.

Keywords: *ship design, RoPax, resistance, CFD*

MPI ASSOCIATED SCALABILITY OF OPEN-SOURCE CFD CODES FOR OIL SPILL ASSESSMENT

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ABSTRACT

General-purpose CFD codes have recently become an increasingly discussed alternative to standardized, simplified and usually empirically calibrated specialized tools for pollution analyses. Commonly, CFD codes tend to provide physically more sensible results and can indicate the underlying cause for a given problem. Use for ecological problems, however, has usually been avoided due to the sizes of computational domains and inherent complexity of the calculations that need to be conducted. Adoption in recent years is mostly driven by significant improvements in computational capabilities and advancements related to code and communication optimizations. Unfortunately, due to substantial branching of codes and accompanying indispensable communication routines, especially in open-source community, performance and consequently applicability of codes, can vary significantly. This article aims to outline key limitations and quantify performance gains which can be obtained in a high-performance computing environment through the use of different communication protocols, when evaluating typical pollution problems such as oil spills. Obtained results indicate that savings of up to 40% in computational time can be achieved, depending on the code and message passing interface implementation for a problem in question, thus demonstrating the importance of communication protocols.

Keywords: *MPI, CFD, oil spill*

APPLICATION OF A GENERAL PURPOSE SOFTWARE PACKAGE ON SHEAR FORCES AND BENDING MOMENT CALCULATIONS IN SHIP STRUCTURE

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ABSTRACT:

The calculation of shear forces and bending moments are the basis of every ship design documentation. It is essential for determining the strength of the ship and the reliability of the structure itself. Nowadays, due to a sheer volume of data, this calculation is performed exclusively with the help of specialized software packages. Such shear force and bending moment curves can often be obtained within the software packages specially designed for checking the ship's design according to specific classification societies' rules. Usually, they already have built-in formulas and guidelines to execute that task properly. However, such software packages often do not meet all the end user's needs. For example, for the initial project stage, special software packages with the functionality of easy designing of a ship form are usually used, while the aforementioned packages are used in later design stages when performing stability and structure checks. This transition often requires converting files into the appropriate type from one software to another. The Rhinoceros program is widespread in the shipbuilding profession, and it is often used in the initial stages of the project. It also allows automation of the process with the help of integrated scripts. Therefore, the authors have decided to examine the possibility of using Python scripts within the Rhinoceros software package. The mentioned script will calculate the transverse forces and bending moment based on the previously modelled hull.

Keywords: *shear forces, bending moment, Rhinoceros, Python*

PRIMJENA OPĆIH PROGRAMSKIH PAKETA NA PRORAČUN POPREČNIH SILA I MOMENTA SAVIJANJA U BRODSKIM KONSTRUKCIJAMA

SAŽETAK:

Proračun poprečnih sila i momenata savijanja osnova je svake brodske projektne dokumentacije. Izuzetno je važan za čvrstoću broda i stabilnost same konstrukcije. Proračun se danas, zbog obima podataka, izvodi isključivo pomoću specijaliziranih programskih paketa. Vrlo često takvi su proračuni već uklopljeni u platforme za provjeru brodske dokumentacije prema određenim pravilima klasifikacijskih društava, te u pravilu imaju već ugrađene formule i smjernice tih društava. Međutim, te specifične programske platforme često ne zadovoljavaju sve potrebe krajnjeg korisnika, pa se stoga za inicijalni projekt često koriste programski paketi s funkcionalnošću izrade brodske forme, dok se prije spomenuti paketi klasifikacijskih društava upotrebljavaju u kasnijim fazama projektiranja prilikom izvođenja provjera, što često zahtjeva pretvaranje datoteka iz jednog oblika u drugi. Kako je Rhinoceros program rasprostranjen u brodograđevnoj struci i često korišten u inicijalnim fazama projekta, a ujedno omogućava i automatizaciju proces uz pomoć integriranih skripti, autori članka odlučili su ispitati mogućnost korištenja Python skripti unutar samog programskog paketa. Spomenuta skripta imala bi za cilj prikazati poprečne sile i moment savijanja koji djeluju na prethodno modelirani trup broda.

Gljučne riječi: *poprečne sile, moment savijanja, Rhinoceros, Python*

COMPARISON BETWEEN THE CLASSICAL METHOD OF INCLINING EXPERIMENT WITH THE RECENT ALTERNATIVE METHODS

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ABSTRACT:

The classical method of inclining experiments has been used to determine the position of the ship's vertical center of gravity for many years. The method contains some basic assumptions, which is why the accuracy of the method has been debated in the last few years. Modern ships often have chines, or pronounced flare at fore and aft extremities, that can lead to a significant change in the waterline. The position of the metacenter changes on these ships as they incline. Therefore, the calculation of the ship's center of gravity by the classical method may be inaccurate. In this paper, three different methods that are not based on the assumption of an unchanged metacenter are examined. Using a graphical, polar, and general method, the position of the ship's center of gravity system can be determined for any ship without determining the position of the metacenter. The three methods mentioned in this paper were observed and tested on four different ships. In addition, the results of the classical method are compared with the results obtained from recently developed methods.

Keywords: *stability, inclining experiment*

USPOREDBA KLASIČNE METODE POKUSA NAGIBA S RECENTNIM ALTERNATIVNIM METODAMA

SAŽETAK:

Klasična metoda pokusa nagibanja koristi se za određivanje položaja težišta broda po visini već dugi niz godina. Metoda sadrži neke osnovne pretpostavke, zbog toga se o točnosti metode raspravlja u posljednje vrijeme. Moderna plovila često imaju zgibove, ili ostale izražene karakteristike forme koje mogu dovesti do značajne promjene vodne linije uslijed nagibanja. Položaj metacentra se na ovim brodovima uslijed nagibanja mijenja. Stoga proračun težišta sustava broda po visini klasičnom metodom može biti netočan. U ovom su radu ispitane tri različite metode koje nisu temeljene na pretpostavci nepromijenjenog metacentra. Težište sustava broda može se odrediti pomoću grafičke, polarne i generalizirane metode za bilo koji brod, bez određivanja položaja metacentra. Tri spomenute metode primijenjene su na četiri različita broda. Naposljetku su rezultati proračuna klasičnom metodom uspoređeni s rezultatima dobivenima pomoću nedavno razvijenih metoda.

Ključne riječi: *stabilitet, pokus nagiba*

Izlaganja 7 / Session 7

Brodstrojarstvo, Automatizacija i kontrola /
Marine Engineering, Automation and Control

IMPLEMENTATION OF CHARGING STATIONS FOR HYBRID AND ELECTRICAL FERRIES IN CROATIAN PORTS

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ABSTRACT:

An important aspect of introducing hybrid or all-electric ferries on coastlines is to analyze the supporting land-based energy infrastructure to determine if it is possible to implement charging systems that such vessels rely on. The battery energy storage systems on such vessels will need to be rapidly recharged as passengers and vehicles disembark, which means that the flow of electricity through the distribution grid will be much higher and may lead to power quality issues on the local grid. Once implemented, shore connection and battery charging systems must be safe for both people and connected equipment. The issue of implementing shore connections needs to be analyzed from a technical, economic, and legal perspective. This paper presents the challenges and problems of implementing charging stations for ferries in Croatian ports as a result of the research conducted within the project METRO - Maritime Environment-Friendly Transport Systems.

Keywords: *hybrid and electric ferry, battery charging stations, shore connections, battery energy storage, ferry ports*

IMPLEMENTACIJA PUNIONICA ZA HIBRIDNE I ELEKTRIČNE TRAJEKTE U HRVATSKIM LUKAMA

SAŽETAK:

Važan aspekt uvođenja hibridnih ili potpuno električnih trajekata na obalnim linijama je analiza prateće kopnene energetske infrastrukture kako bi se utvrdilo je li moguće implementirati sustave punjenja na koje se takva plovila oslanjaju. Baterijska skladišta energije na takvim brodovima trebat će se brzo napuniti dok se putnici i vozila iskrcavaju. Stoga će opterećenje distribucijske mreže biti puno veće što može dovesti do problema s kvalitetom električne energije. Jednom implementirani, kopneni priključci i sustavi za punjenje baterija moraju biti sigurni za ljude i za povezane sustave. Problematiku implementacije kopnenih priključaka potrebno je analizirati s tehničke, ekonomske i pravne perspektive. Ovaj rad opisuje problematiku uvođenja punionica za trajekte u hrvatskim lukama kao rezultat istraživanja provedenog u okviru projekta METRO - Maritime Environment-Friendly Transport Systems.

Ključne riječi: *hibridni i električni trajekti, punionice baterija, kopneni priključci, baterijska skladišta energije, trajektno luke*

TECHNICAL AND ECOLOGICAL ASPECTS OF WATER-LUBRICATED STERN TUBE BEARINGS

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ABSTRACT:

A ship's propulsion system has a significant impact on the ship's energy efficiency, environmental friendliness, reliability and safety. An indispensable part of a propulsion system with mechanical power transmission is a stern tube with bearings. During operation, the sliding bearings material is subjected to stresses caused by a force proportional to the total mass of the shaft and propeller. The reliability of stern tube bearings is particularly important for safety, and their durability has a significant impact on maintenance costs. Depending on the lubricant, there are bearings that are lubricated with oil or water. The permissible bearing load with hydrodynamic lubrication depends primarily on the material, the viscosity of the lubricant used and the shaft speed. Metals and their alloys with a low coefficient of friction are used for oil-lubricated bearings. Bearings lubricated with water are made of a special type of hardwood ("tree of life", lat. *lignum vitae*), rubber or various synthetic materials. The main advantages of oil-lubricated bearings are higher allowable load and durability than water-lubricated bearings. This paper analyses the technical and environmental aspects of the application of water-lubricated bearings whose main advantages are simplicity, better cooling and environmental protection.

Keywords: *stern tube bearing, water-lubrication, environmental protection*

TEHNIČKI I EKOLOŠKI ASPEKTI VODOM PODMAZIVANIH LEŽAJA STATVENE CIJEVI

SAŽETAK:

Propulzijski sustav broda ima znatan utjecaj na energetske učinkovitost, ekološku prihvatljivost, pouzdanost i sigurnost broda. Neizostavni dio propulzijskog sustava s mehaničkim prijenosom snage je statvena cijev s ležajima. Materijal od kojeg su izrađeni klizni ležaji, u radu je izložen naprezanjima koja uzrokuje sila proporcionalna ukupnoj masi vratila i brodskog vijka. Pouzdanost ležajeva statvene cijevi od posebnog je značaja za sigurnost, a njihova trajnost ima znatan utjecaj na troškove održavanja. S obzirom na sredstvo za podmazivanje, razlikuju se ležaji koji se podmazuju uljem ili vodom. Dopusšteno opterećenje ležaja s hidrodinamičkim podmazivanjem prvenstveno ovisi o materijalu, viskoznosti sredstva koje se koristi za podmazivanje i brzini vrtnje vratila. Za izradu ležaja koji se podmazuju uljem koriste se metali i njihove legure s niskim koeficijentom trenja. Ležaji koji se podmazuju vodom izrađuju se od posebne vrste tvrdog drva ("drvo života", lat. *lignum vitae*), gume i različitih umjetnih materijala. Glavne prednosti ležaja podmazivanih uljem su veće dopušteno opterećenje i trajnost nego je to slučaj kod vodom podmazivanih ležaja. U ovom radu se analiziraju tehnički i ekološki aspekti primjene vodom podmazivanih ležaja statvene cijevi čije su glavne prednosti jednostavnost, bolje hlađenje i zaštita okoliša.

Glavne riječi: *ležaj statvene cijevi, podmazivanje vodom, zaštita okoliša*

ANALYSIS OF SHIP PROPULSION SHAFTING VIBRATION USING COUPLED TORSIONAL-BENDING MODEL

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ABSTRACT:

The paper describes a coupled torsional-bending model of ship propulsion system vibrations. The developed model is based on the modified model of the Jeffcott rotor. In order to test the model and determine the coupled torsional-bending vibrations, several cases were analyzed. First, a reference case corresponding to a fully axisymmetric ship propulsion system is set up. Then, the influence of the constant radial force in the vertical direction at the position of the stern bearing was analyzed, such as the conditions of navigation of the ship at calm sea under partial or fully loaded hull. Finally, the case of sailing on rough sea is analyzed, when the propeller racing occurs due to the stern lifting out of the sea. For simplicity, the harmonic law of amplitude changing of the vertical radial force on the stern tube bearing as well as of the propeller load was adopted. Based on the results of numerical analysis, it was found that the proposed model well describes the case of coupling of torsional and bending vibrations of the propulsion system.

Keywords: *ship propulsion system, coupled torsional-bending vibration model, numerical analysis, propeller racing*

ANALIZA VIBRACIJA PORIVNOG SUSTAVA BRODA KORIŠTENJEM SPREGNUTOG TORZIJSKO-FLEKSIJSKOG MODELA

SAŽETAK:

U radu je opisan spregnuti torzijsko-fleksijski model vibracija porivnog sustava. Razvijeni model temelji se na izmjenjenom modelu Jeffcottovog rotora. U cilju testiranja modela i utvrđivanja spregnutih torzijsko-fleksijskih vibracija analizirano je nekoliko slučajeva. Najprije je postavljen referentni slučaj koji odgovara potpuno osnosimetričnom brodskom porivnom sustavu. Zatim je analiziran utjecaj konstantne radijalne sile u vertikalnom smjeru na poziciji krmenog ležaja poput uvjeta plovidbe broda mirnim morem pod djelomičnim ili punim opterećenjem. Na kraju je analiziran slučaj plovidbe po nemirnom moru kada dolazi do zalijetanja vijka uslijed djelomičnog izranjanja brodskog vijka. Radi jednostavnosti usvojen je harmonijski zakon promjene amplitude vertikalne radijalne sile na zadnjem ležaju statvene cijevi kao i momenta tereta na vijku. Na osnovi rezultata numeričke analize utvrđeno je da je predloženi model dobro opisuje slučaj sprege torzijskih i fleksijskih vibracija porivnog sustava.

Ključne riječi: *porivni sustav broda, spregnuti torzijsko –fleksijsko model vibracija, numerička analiza, zalijetanje vijka*

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