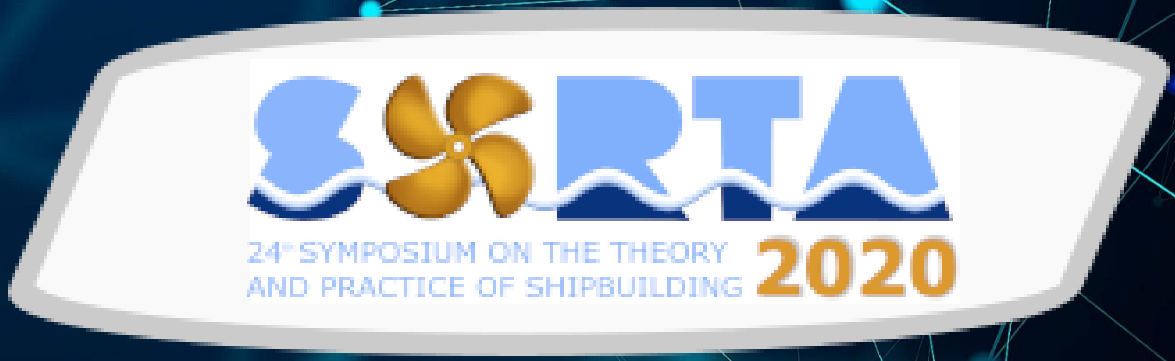
Book of Abstracts of the 24th Symposium on Theory and Practice of Shuipbuilding, In Memoriam of prof. Leopold Sorta

24th Symposium on the Theory and Practice of Shipbuilding
(in memoriam prof. Leopold Sorta)

with International participation



15.10.-16.10.2020. – online event

in the organization of the University of Rijeka - Faculty of Engineering

Book of Abstracts

University of Rijeka
FACULTY OF ENGINEERING

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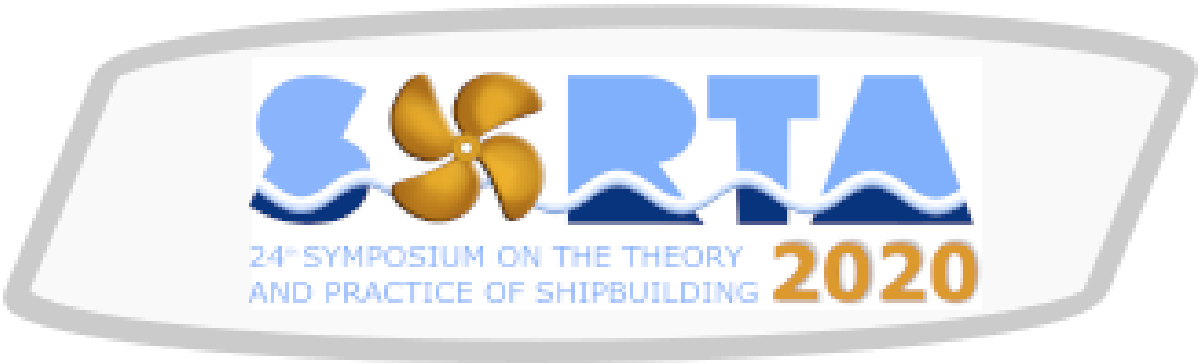

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FACULTY OF ENGINEERING

MJESTA ODRŽAVANJA SIMPOZIJA SORTA / PAST VENUES OF SYMPOSIUMS SORTA

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GOALS OF THE SYMPOSIUM SORTA 2020

SORTA 2020 is the 24th Symposium on the Theory and Practice of Shipbuilding - in memoriam prof. Leopold Sorta in the organization of the University of Rijeka - Faculty of Engineering. This 24. SORTA presents the testimony of a continuous, over 45 years lasting development of the shipbuilding profession and science on these grounds.The aim of SORTA 2020 is to promote the existing educational, scientific, research and development capacities of Croatian shipbuilding, which are ready to participate, both now and in the future, in the evolution of shipbuilding industry, STEM and progress of Croatian economy. This year's symposium coincides with a period of change for the entire shipbuilding community in Croatia and broader and furthermore, with the COVID-19 pandemic, which has challenged face-to-face meetings due to uncertainties regarding travel restrictions, physical distancing and other health related measures. To adapt to the current situation the SORTA2020 Organization Committee has transform this 24th Symposium into a fully online meeting that will offer the responsible and rational possibility for scientific and professional exchanges while protecting the safety, health, and well-being of all participants.

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How the *Digital Revolution* Could Affect the Shipbuilding World

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Abstract

The marine structures are developed with *Computer Aided Design* (CAD) tools, but every day we are looking for integrated development of the product involving all its Life Cycle. If all the equipment items and other components of the vessel are designed considering the *Internet of Things* (*IoT*), the shipbuilding Industry will have technology that allows to share their situation, diagnosis, functionality…The *CAD* system could use this information for knowing whether they are working properly or if its performance could be improved. It is also possible to identify whether it is necessary to make maintenance of the object, or if it is necessary to replace it because its life ends, or because it´s working wrongly. It will also be possible to know how their performance affects the functioning of the whole product, the ship or boat. The growth of the *IoT* is linked to the increase of information and the management of *Big Data*, with the property that somehow *IoT* identifies information to a specific purpose, while the concept of *Big Data* is more generic. The possibilities are countless, but the beginning must be in the initial design. It is necessary to consider what is needed to correctly fulfil the mission of each of the elements. These requirements must be configurable in the initial design from where it will be extended to relations between each of them with other entities. *CAD* is one of the first steps, because it is where begins to collect systematically the concept of each component.

Keywords: *Digital Transformation; IoT; shipbuilding CAD; Big Data; Industry 4.0. Open Source*

An Artificial Neural Network Approach to Wind Loads Estimation

Primjena neuronskih mreža na procjenu vjetrovnih opterećenja

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Abstract

The estimation of wind loads on ships and other marine objects represents the continuous challenge because of its implication on various analysis related to ship stability, ship speed estimation, manoeuvring, station keeping and berthing. Effect of wind loads are a complicated phenomenon because of the complex configuration of the above-water part of the structure. This study presents an extension of application capabilities of elliptic Fourier descriptors (EFDs) from the usual pattern recognition and classification problems to problems of very complex nonlinear multivariable approximations of multi-input and multi-output (MIMO) functions, where EFDs are used for ship frontal and lateral closed contour representation. This approach is very suitable for assessing wind loads on marine structures wherever we have a wind load database for a group of similar vessels. As experimental testing is very expensive, computational fluid dynamics (CFD) can serve as an excellent tool for completing the database. The Generalized Regression Neural Network (GRNN) is trained by elliptic Fourier descriptors of closed contours and wind load data derived from CFD analysis. The trained neural network is used for the wind coefficient estimation with respect to the variability of lateral container vessel contours. Results are presented and compared with the experimental data.

Keywords: *wind loads; ship; neural network; CFD*

Sažetak

Procjena opterećenja vjetra na brodove i druge pomorskim objektima predstavlja kontinuirani izazov zbog utjecaja na različite aspekte vezane uz stabilitet broda, procjenu brzine broda, upravljivost, održavanje pozicije i privez. Učinak vjetrovnih opterećenja složen je fenomen zbog zahtjevne konfiguracije nadvodnog dijela objekta. Ova studija predstavlja proširenje mogućnosti primjene eliptičnih Fourierovih deskriptora (EFD-a) od uobičajenih problema prepoznavanja i klasifikacije uzoraka do problema vrlo složenih nelinearnih multivarijabilnih aproksimacija funkcija s više ulaza i više izlaza (MIMO) gdje se EFD-ovi koriste za opis zatvorene konture brodskih frontalnih i lateralnih presjeka. Ovaj je pristup vrlo prikladan za procjenu opterećenja vjetra na pomorskim konstrukcijama za koje imamo bazu podataka silama vjetra za skupinu sličnih objekata. Kako su eksperimentalna ispitivanja vrlo skupa, računska dinamika fluida (CFD) predstavlja izvrstan alat za popunjavanje baze podataka. Generalizirana regresijska neuronska mreža (GRNN) trenirana je eliptičnim Fourierovim deskriptorima koji opisuju zatvorene konture presjeka broda i podacima o opterećenju vjetra dobivenim RDF analizom. Istrenirana neuronska mreža koristi se za procjenu koeficijenta vjetra s obzirom na varijabilnost konfiguracije kontejnera na palubi. Dobiveni rezultati su uspoređeni s eksperimentalnim podacima.

Ključne riječi: *wind loads; ship; neural network; CFD*

Advanced Methodologies for Cost-Effective, Energy Efficient and Environmentally Friendly Ship Production Process Design

Pitati u mailu

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Abstract

A significant impact on the economy and the environment can be achieved if the shipbuilding production process, as the shipyard's core business, is considered as designable, changeable and adaptable. The design of a profitable manufacturing process involves the development and application of the process planning methodologies and a detailed production cost model as key tasks. The first approach requires the development of analytical and numerical procedures, while the latter involves the development of detailed and parametric models of production costs. Knowledge of the basic theoretical and practical characteristics of the process will enable the development and implementation of the green shipbuilding concept as well as the evaluation of the environmental impact of the shipbuilding industry. The basic aspects of this approach to shipbuilding are presented in more detail in this paper.

Keywords: *Ship production; Production system engineering; Cost-effectiveness; Energy efficiency; Environmental friendliness*

Sažetak

Značajan utjecaj na gospodarstvo i okoliš može se postići ako se brodograđevni proizvodni proces, kao osnovna djelatnost brodogradilišta, razmotri kao projektabilan, promjenjiv i prilagodljiv. Projektiranje profitabilnog proizvodnog procesa podrazumijeva razvoj i primjenu metodologija planiranja procesa i detaljnog modela troskova proizvodnje kao ključnih zadataka. Prvi pristup zahtijeva razvoj analitičkih i numeričkih postupaka, dok potonji obuhvaća razvoj detaljnog i parametarskog modela proizvodnih troškova. Poznavanje temeljnih teoretskih i praktičnih karakteristika procesa omogućit će razvoj i implementaciju koncepta zelene brodogradnje kao i evaluaciju utjecaja brodograđevne djelatnosti na okoliš. Osnovni aspekti spomenutog pristupa brodogradnji prikazani su detaljnije u ovom radu.

Ključne riječi: *Brodograđevni proizvodni proces; Proizvodno inženjerstvo; Profitabilnos; Energetska efikasnost; Okolišna prihvatljivost*

IHC BEAVER - Custom Built Cutter Suction Dredger

IHC BEAVER – usisno jaružalo po narudžbi

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Abstract

IHC Beaver® is trademark representing series of small cutter suction dredgers (CSD) designed to answer demand for small sturdy dredgers of standard type which can be quickly supplied ready for service. Some custom built dredgers are designed and delivered as tailor made vessels along with wide range of Standard IHC Beavers®. The design of the IHC Beavers® is continuously improved using the latest technological developments and feedback from customers. Custom designed and built CSD for maximum dredging depth of 15 m and power of submerged dredge pump of 400 kW is presented in the paper. IHC in-house basic and detail engineering using resources in the Netherlands and Croatia have been done with special attention paid to a simple and quick transportation, assembly and dismantling systems. Some important stability cases are presented as well.

Keywords: *Dredging; Engineering; Stability*

Sažetak

IHC Beaver® (IHC Dabar) je zaštićeno ime serije malih usisnih jaružala projektiranih kao odgovor na zahtjeve tržišta za malim robusnim jaružalima standardnog tipa spremnih za isporuku i eksploataciju u kratkom roku nakon narudžbe. Uz standardne izvedbe usisnih jaružala, određeni broj takvih malih plovnih naprava posebno se prilagođavaju zahtjevima pojedinih naručitelja. Projekt i izvedba IHC Beavera® se stalno unapređuje korištenjem najnovijih tehnoloških dostignuća i povratnih informacija od strane korisinika. Usisno jaružalo projektirano i izgrađeno prema posebnom zahtjevu za najveću dubinu kopanja od 15m uz snagu uronjene usisne pumpe od 400 kW predstavljeno je u ovom radu. Osnovni i detaljni projekt napravili su IHC-ovi stručnjaci u Nizozemskoj i Hrvatskoj. Posebno se pazilo na mogućnost jednostavnog i brzog transporta, te sastavljanja i rastavljanja jaružala. Zahtjevi za stabilitet ovakvih plovnih naprava su posebno prikazani.

Ključne riječi: *Jaružanje; Projektiranje; Stabilitet*

OOFEM – Application of Open-Source Software in Ship Structural Analysis

OOFEM – primjena softvera otvorenog koda u analizi brodskih konstrukcija

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Abstract

This paper deals with use of open-source software in ship structural analysis. Some advantages and disadvantages of open-source software over standard commercial software are discussed. Object-oriented programming is briefly explained and its importance and benefits in software development are demonstrated on examples from OOFEM. After that, major characteristics and code architecture of OOFEM are described. Role of structural analysis in ship structural design is touched on. Classification societies' requirements on finite element analysis of ship structures are identified and OOFEM is assessed w.r.t them. An upgrade to OOFEM's library of finite elements is proposed based on the foregoing discussion.

Keywords: *ship structural design; ship structural analysis; finite element analysis; open-source software; FEM software*

Sažetak

Ovaj se članak bavi upotrebom softvera otvorenog kôda u analizi brodskih konstrukcija. Raspravlja se o nekim prednostima i nedostacima softvera otvorenog kôda nasuprot standardnim komercijalnim softverima. Ukratko je objašnjeno objektno-orijentirano programiranje te su njegova važnost i benefiti kod razvoja softvera prikazani na primjerima iz OOOFEM-a. Nakon toga su opisane glavne karakteristike i arhitektura kôda OOFEM-a. Ukratko je opisana uloga analize konstrukcije u projektiranju brodskih konstrukcija, prepoznati su zahtjevi klasifikacijskih društava prema analizi metodom konačnih elemenata te je izvršena procjena OOFEM-a prema ovim zahtjevima. Predložena je nadogradnja biblioteke konačnih elemenata OOFEM-a na temelju prethodne rasprave.

Ključne riječi: *projektiranje brodske konstrukcije; analiza brodske konstrukcije; analiza metodom konačnih elemenata; softver otvorenog kôda; MKE softver*

Impact of Welding Parameters on Weld Quality for High-Strength Steel Used at Low Temperature

Utjecaj tehnika zavarivanja na pojavu površinskih pukotina u sučeljno zavarenom spoju kod MAG postupka zavarivanja

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Abstract

Cracks in the welded joint can be initiated on the surface of and inside the welded joint. Cracks that are initiated on the surface of the welded joint are generally formed at the places of the highest stress concentration, especially along the edge of the seam. However, larger radii of the seam edge make surface cracks less likely. Larger seam edge radii can be reached either by subsequently machining the weld surface after welding or by properly selecting welding parameters. In the study on the influence of welding parameters on the shape of the weld surface, especially on the size of the seam edge radius, experiments were conducted in which the influence of four welding parameters on the seam edge radius was analyzed: torch angle, number of cover passes, length of electrode stick-out and a type of a shielding gas. The experiments were performed by MAG welding process in horizontal position. The base material is high strength steel intended for use at low temperatures of type EH36. The results of the experiments conducted were analyzed by the Design of Experiments (DOE) method, and the conclusions obtained may be of use in technical practice with the aim to reduce surface cracks.

Keywords: *high strength steel; stress concentration; weld cracks; welding parameters*

Sažetak

Pukotine se u zavarenom spoju mogu inicirati na površini i u unutrašnjosti zavarenog spoja. Pukotine koje se iniciraju na površini zavarenog spoja u pravilu nastaju na mjestima najveće koncentracije naprezanja, posebice uz rub šava. Pri tome, kod većih radijusa ruba šava manja je vjerojatnost pojave površinskih pukotina. Veći radijusi ruba šava mogu se postići naknadnom obradom površine zavara nakon zavarivanja ili odgovarajućim odabirom parametara zavarivanja. U istraživanju utjecaja parametara zavarivanja na oblik površine zavara, posebice na veličinu radijusa ruba šava, provedeni su pokusi kod kojih je analiziran utjecaj četiri parametara zavarivanja na radijus ruba šava: broj prolaza završnog sloja, kut nagiba odnosno položaj gorionika, dužina slobodnog kraja žice, te vrsta zaštitnog plina. Pokusi su rađeni MAG postupkom zavarivanja u horizontalnom položaju. Osnovni materijal je čelik povišene čvrstoće namijenjen za rad na niskim temperaturama oznake EH36. Rezultati provedenih pokusa analizirani su metodom planiranja pokusa (DOE), a dobiveni zaključci mogu biti od koristi tehničkoj praksi u cilju smanjenja površinskih pukotina.

Ključne riječi: *čelik pojačane čvrstoće; koncentracija naprezanja; pukotine u zavarima; parametri zavarivanja*

Structural Analysis of Masts, Bowsprit and Standing Rigging of a Three-Mast Schooner

Analiza konstrukcije nepomične opute trojarbolne škune

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Abstract

This paper deals with structural analysis of masts, standing rigging and bowsprit of a three-mast passenger schooner. Loads that act on the structure as well as classification societies' acceptance criteria are described. Moreover, application of the loads on the finite element analysis model is demonstrated. At the end, finite element analysis of the structure is discussed: finite elements, boundary conditions, nonlinear and buckling analyses and the results.

Keywords: *structural design; finite element analysis; sail ship; masts; bowsprit; standing rigging*

Sažetak

Ovaj članak se bavi analizom konstrukcije jarbola, opute i pramčanog kosnika trojarbolne putničke škune. Opisana su opterećenja koja djeluju na konstrukciju kao i kriteriji za evaluaciju propisani od strane klasifikacijskih društava. Pored toga, pokazana je i primjena opisanih opterećenja na model konačnih elemenata. Na kraju se prikazuje analiza konstrukcije metodom konačnih elemenata uz opis korištenih konačnih elemenata, rubnih uvjeta, nelinearne analize i analize izvijanja te rezultata.

Ključne riječi: *projektiranje konstrukcije; metoda konačnih elemenata; jedrenjak; jarboli; pramčani kosnik*

Reducing Environmental Impact and Fuel Costs by Installing a Photovoltaic Power Plant On Board

Smanjenje utjecaja na okoliš i troškova goriva ugradnjom fotonaponske elektrane na brodu

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Abstract

Although maritime transport is currently the most efficient form of transport, it is facing increasingly complex challenges. International conventions and other regulations are continually imposing strict requirements that ships and their energy facilities must meet in order to reduce their negative environmental impact and increase energy efficiency. Increasing energy efficiency also contributes to market competitiveness, and is in the ship-owner's interest. Application of photovoltaic power plants on liquid cargo ships and passenger ships longer than 250 m is considered in this paper. These two ship types were chosen because their purpose and construction features do not present an obstacle to the installation of a photovoltaic power plant. The nominal power of the photovoltaic power plant on the tanker is up to 10% of the installed power of the propulsion machine, and in the passenger ship up to 10% of the total electricity requirements. In the case of tankers, in order to achieve better utilization, the possibility of "storing" energy is suggested for periods when photovoltaic system provides more electricity than needed. The surplus energy can be used for ship propulsion. By using photovoltaic power plants as a supplementary energy source, it is possible to achieve savings in fuel consumption and reduce the negative environmental impact of marine propulsion systems. The achieved results significantly depend on the area and conditions of the ship operation, and on the characteristics of the photovoltaic power plant.

Keywords: *energy efficiency; environment; photovoltaic power plant; marine plants*

Sažetak

Premda pomorski transport predstavlja najučinkovitiji poznati oblik transporta pred njega se postavljaju sve veći izazovi. Zahtjevi koje brodovi odnosno njihova energetska postrojenja moraju ispunjavati s ciljem smanjenja negativnog utjecaja na okoliš i povećanja energetske učinkovitosti proizlaze iz međunarodnih konvencija i drugih propisa. Povećanje energetske učinkovitosti doprinosi i konkurentnosti na tržištu, te je u interesu brodovlasnika. U ovom radu razmatrati će se primjena fotonaponskih elektrana na brodovima za prijevoz tekućeg tereta i brodovima za prijevoz putnika duljine veće od 250 m. Ove dvije vrste brodova odabrane su jer njihova namjena i konstrukcijske značajke nisu smetnja ugradnji fotonaponske elektrane. Nazivna snaga fotonaponske elektrane kod tankera iznosi do 10% instalirane snage propulzijskog stroja, a kod putničkog broda do 10% od ukupnih potreba za električnom energijom. Kod tankera je radi boljeg iskorištenja predviđena mogućnost "skladištenja" energije u periodima kada se iz fotonaponskog sustava dobije više električne energije od trenutnih potreba, odnosno njeno korištenje za propulziju broda. Primjenom fotonaponskih elektrana kao dopunskog izvora energije moguće je ostvariti značajne uštede u potrošnji goriva i smanjiti negativan utjecaja brodskih pogonskih postrojenja na okoliš. Pri tom ostvareni rezultati znatno ovise o području i uvjetima eksploatacije broda, te o značajkama fotonaponske elektrane.

Ključne riječi: *energetska učinkovitost; okoliš; fotonaponske elektrane; brodska postrojenja*

Methodology of Integrated Design of the Ship Structure and Production Using the 3D Experience Platform

Metodologija integralnog projektiranja strukture i gradnje broda korištenjem 3d experience platforme

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Abstract

The high level of integration and efficiency of the ship structure design process with information related to the construction and outfitting of the ship is directly related to the level of shipyard competitiveness. This paper describes the methodology and procedures for integrated ship structure design and ship production technology on 3DExperience platform. The process of the ship structure modelling is described, either for producing classification documentation or for structure modelling using the classification documentation. This paper explains the level of detail in the model, as well as the complexity of modelling required to further develop the model into FEM structural models, structural and technological models intended to further elaborate and divide the ship into construction blocks. Authors outline the application of this process in the shipbuilding studies teaching, discuss the benefits and preconditions of this approach.

Keywords: *shipbuilding; integrated ship structural design and production; 3DExperience; collaborative environment; education*

Sažetak

Visoka i učinkovita razina integracije procesa projektiranja strukture broda sa informacijama vezanim za gradnju i opremanje broda direktno je povezana sa razinom konkurentnosti brodogradilišta. Ovim radom opisana je metodologija i procedure pri integralnom projektiranju brodske strukture i tehnologije gradnje broda na 3DExperience platformi. Opisuje se proces ranog modeliranja strukture, prije ili paralelno s izvođenjem klasifikacijske dokumentacije. U radu se obrazlaže razina detalja u modelu, kao i složenost modeliranja potrebnih za daljnju razradu modela na FEM strukturne modele, te konstrukcijske i tehnološke modele namijenjene za daljnju razradu i podjelu broda u građevne jedinice. te na razini razrade strukture u radioničku dokumentaciju. Autori prikazuju dio ovog procesa primijenjen u nastavi studija brodogradnje te diskutiraju prednosti i preduvjete ovakvog pristupa.

Ključne riječi: *brodogradnja; integralno projektiranje strukture i gradnja broda; 3DExperience; kolaborativno okruženje; edukacija*

Toward Operability Analysis of a Passenger Ship in the Adriatic Sea Based on the JONSWAP-Adriatic Wave Spectrum

Pitati u mailu

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Abstract

The paper demonstrates an operability analysis based on a slamming criterion of a passenger ship intended for sailing in the Adriatic Sea. The seakeeping calculations are performed by a boundary-element-method, potential flow solver, to obtain the vessel's motion at sea. A full range of ship-to-wave headings are considered for a ship at its design speed and at rest. The applied Adriatic wave climate is the newly developed JONSWAP-Adriatic wave spectrum, while a sea state table is based on a database which contains satellite measurements and numerical simulation results for the entire Adriatic over 24 years. The proposed wave spectrum presents an optimization of JONSWAP spectrum parameters and Tabain's modal frequency expression, for offshore Adriatic conditions. The results are interpreted to find out those sea states where the selected bow slamming criteria are not satisfied. By knowing the frequency of occurrence of such sea states it is possible to determine the yearly time fraction when the ship will not be able to operate at its full operational profile due to weather conditions. This methodology is intended to serve to ship owners and operators, as well as designers, for evaluating if a certain ship is appropriate for operating in a region of interest.

Keywords: *Slamming; Operability analysis; Adriatic Sea; JONSWAP-Adriatic wave spectrum*

Sažetak

U radu je prikazana analiza operabilnosti putničkog broda, na temelju kriterija udaranja pramca, namijenjenog plovidbi Jadranskim morem. Proračuni pomorstvenosti su provedeni potencijalnom teorijom, 3D panel metodom, kako bi se dobile prijenosne funkcije odziva broda na valovima. Razmatran je puni raspon relativnih kurseva broda na valove pri putnoj brzini i u mirovanju. Primijenjena je klima valova Jadranskog mora predložena JONSWAP-Adriatic spektrom i tablicom stanja mora prema bazi podataka koja obuhvaća satelitska mjerenja i numeričke simulacije za cijeli Jadran kroz 24 godine. Predloženi valni spektar predstavlja optimizaciju JONSWAP spektra i Tabainovog izraza za modalnu frekvenciju, za uvijete Jadrana. Rezultati su interpretirani tako da pokažu na kojim stanjima mora brod ne udovoljava razmatranom kriteriju udaranja pramca. Poznavanjem učestalosti pojavljivanja takvih stanja mora ,moguće je odrediti udio vremena prikladan za plovidbu akvatorijem za koji je namijenjen.

Ključne riječi: *Udaranje pramca; Operabilnost; Jadransko more; JONSWAP-Adriatic spektar valova*

Polar Code – An Overview

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Abstract

The safety of ships operating in the harsh, remote and vulnerable polar areas and the protection of the pristine environments around the two poles have always been a matter of concern for IMO and many relevant requirements, provisions and recommendations have been developed over the years. Trends and forecasts indicate that polar shipping will grow in volume and diversify in nature over the coming years and these challenges need to be met without compromising either safety of life at sea or the sustainability of the polar environments. The Polar Code is intended to cover the full range of shipping-related matters relevant to navigation in waters surrounding the two poles – ship design, construction and equipment; operational and training concerns; search and rescue; and, equally important, the protection of the unique environment and eco-systems of the polar regions. The aim of the presentation is to provide an overview of the Polar Code and will cover some aspects related to the design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships intended to operate in these waters.

Keywords: *Polar; Code; Safety; Environment; Overview*

Advantages and Challenges of Additive Manufacturing in Maritime Industry

Prednosti i izazovi aditivne proizvodnje u pomorskoj industriji

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Abstract

Additive manufacturing (e.g., 3D printing) is gaining ground in various industrial fields and everyday life. The maritime industry is not an exception. The prototype of a 3D printed full-size propeller was developed in the Netherlands and officially class-approved by Bureau Veritas in 2017. With technologies and materials that can ensure the necessary strength and precision, such manufacturing of other pieces is likely to follow. By producing items on demand onboard or in the port, the costs of warehousing and shipping spare parts can be significantly reduced. Additive manufacturing also allows the components to be made lighter and with higher efficiency, without the additional expenses for molds required in the casting process. A related consequence is the concern of existing suppliers caused by the lessening demand for parts. However, embracing 3D printing could allow them to expand their reach and meet the needs of more clients by selling copyrights rather than manufacturing physical items. From the present point of view, such a shift in the maritime industry is expected by 2030.

Keywords: *Additive manufacturing; 3D printing; production on demand*

Sažetak

Aditivna proizvodnja (primjerice 3D printanje) sve je prisutnija u raznim granama industrije, kao i u svakodnevnom životu. Pomorska industrija po tom pitanju nije izuzetak. U Nizozemskoj je 2017. godine izrađen 3D print prototipa brodskog vijka u punoj veličini koji je dobio odobrenje klasifikacijskog društva Bureau Veritas. Uz razvoj tehnologija i materijala koji mogu osigurati potrebnu čvrstoću i preciznost, uskoro će se vjerojatno na sličan način proizvoditi i drugi elementi. Troškovi skaldištenja i slanja značajno bi se smanjili ukoliko bi se zamijenski dijelovi proizvodili po potrebi, na brodu ili u luci. Također, aditivna proizvodnja dozvoljava da komponente budu lakše i gotovo bez škarta, bez dodatnih troškova za izradu kalupa za lijevanje. Očekivana posljedica je zabrinutost postojećih proizvođača koji smatraju da će se smanjiti potražnja za dijelovima. Ipak, okretanje prema 3D printanju moglo bi im proširiti doseg i zadovoljiti potrebe većeg broja klijenata na način da prodaju autorska prava umjesto dijelova. S trenutnog stajališta, takva promjena u pomorskoj industriji mogla bi se očekivati do 2030. godine.

Ključne riječi: *aditivna proizodnja; 3D print; proizvodnja po potrebi*

Means of Performance Improvements of Two-Stage Blade Propulsors

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Abstract

The paper contains brief description of two-stage multifunctional propulsors (TSMP) and steering thruster with contra-rotating propellers (CRP) in the development of which authors directly participated and protected by patents. It is schematic shown how works TSMP on the different modes of operation. The data of model tests of the TSMPs in the Krylov State Research Center are presented, which confirmed the feasibility of the adopted design solutions that provide improved operational characteristics of a vessel. The layout of the TSMP for the conceptual design of a transport vessel is presented. The design features of the steering thrusters with CRPs, affecting their operational characteristics, are considered. Solutions for improving operational characteristics of steering thrusters with CRPs are substantiated, and the expected improvement in their hydrodynamic efficiency is estimated. The prospects for the use of steering thrusters with CRPs are assessed on the example of the Russian Civil Fleet

Keywords: *contra-rotating propellers; two-stage multipurpose propulsor; hydrodynamic efficiency*

Exhaust Gas Cleaning System

Sustavi proćišćavanja ispušnih plinova

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Abstract

Exhaust gases from ship engines contain many pollutants. Sulfur oxides (SOx) and nitrogen oxides (NOx) are particularly detrimental to the environment. As a result, various laws and regulations have been enacted to try to reduce pollution to an acceptable level. The most significant regulation is Annex VI of the MARPOL Convention. The reduction of sulfur oxide emission can be achieved in two ways. The first is the use of low sulfur fuel, the amount of which is prescribed by Annex VI of the MARPOL Convention. The second is to clean the engine exhaust gases with a scrubber system. Due to high cost of the low sulfur fuels, shipowners in many cases decide to install scrubbers on both the new and the existing ships. Installing a scrubber system on existing ships causes a lot of structural problems that need to be addressed. There are two basic types of scrubber system, dry and wet. Wet scrubbers are divided into open loop scrubbers, closed loop scrubbers and hybrids. The most commonly used NOx emission reduction system is selective catalytic reduction (SCR), in which the introduction of reducing medium (urea) into exhaust gases causes nitrogen oxides to separate into nitrogen and water.

Keywords: *exhaust gas; sulfur oxides; nitrogen oxides; scrubber; selective catalytic reduction*

Sažetak

U ispušnim plinovima brodskih motora nalazi se mnogo štetnih tvari koje zagađuju okoliš. Posebno štetan utjecaj na okoliš imaju sumporni oksidi (SOx) i dušični oksidi (NOx). Zbog toga doneseni su razni zakoni i propisi kojima se pokušava svesti zagađenje na što prihvatljivu razinu. Najznačajniji takav propis je prilog VI MARPOL konvencije. Smanjenje emisije sumpornih oksida može se postići na dva načina. Prvi je upotrebom goriva sa niskim udjelom sumpora čija je količina propisama anexom VI MARPOL konvencije. Drugi način je pročišćavanjem ispušnih plinova motora pomoću ispirača plinova (eng. scrubber). Zbog dosta visoke cijene goriva sa niskim udjelom sumpora brodovlasnici se u dosta slučajeva odlučuju na ugradnju ispirača plinova, kako na novogradnje tako i na već postojeće brodove. Ugradnja ispirača plinova na postojeće brodove uzrokuje dosta konstrukcijskih problema koje treba riješiti. Postoje dvije osnovne vrste ispirača plinova, suhi i vlažni. Vlažni ispirači plinova se dijele na ispirače sa otvorenom petljom, zatvorenom petljom i hibride. Najčešće korišteni sistem za smanjenje emisije NOx je selektivna katalitička redukcija (SCR), kod koje se ubacivanjem reducirajućeg medija (urea) u ispušne plinove, dušični oksidi razdvajaju na dušik i vodu.

Ključne riječi: *ispušni plinovi; sumporni oksidi; dušični oksidi; ispirači plinova; selektivna katalitička redukcija*

The Sea Resources and the Sustainable Future

Morski resursi i održiva budućnost

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Abstract

Vast spaces, surfaces, of planet Earth, about 71 %, are covered with water. A large majority of this water surface are the oceans and seas, much lesser part in freshwater reservoirs. Some of the landlocked water surfaces, lakes, are also salted because the evaporation is larger than the freshwater influx. Human activity on seas, oceans, and lakes so far has been largely focused on transportation and fishing. Oceans, seas, lakes, and rivers are natural waterway routes suitable to accommodate large vessels, ships the most efficient and commercially most viable means of transportation. We have defined spectra of eight areas of marine technology but the focus of this paper is primarily on mariculture and marihousing. The future will demand additional food and housing we consider the sea and oceans as a natural step toward available untapped resources. The paper discusses the need and the way of interdisciplinary studies to meet all the challenges on the way. The open road for ideas and scientific mobility is most probably the best answer**.**

Keywords: *Sea resources; sustainable growth; areas of exploration; interdisciplinary studies*

Sažetak

Velika prostranstva površine planete Zemlje prekrivena su 71% s vodom. Većinu ove vodene površine čine oceani i mora, a mnogo manji dio slatkovodne akumulacije. Neka od zatvorenih vodenih područja u što spadaju i jezera imaju bočatu vodu zbog činjenice da je isparavanje veće od priliva slatke vode. Dosad su ljudske aktivnosti na morima, oceanima i jezerima bile u velikoj mjeri fokusirane na prijevoz i ribolov. Oceani, mora, jezera i rijeke su prirodni vodeni putevi sposobni preuzeti velika plovila, brodove kao najučinkovitije i ekonomski najisplativije prijevozno sredstvo. U radu je definiran spektar od osam područja pomorskih tehnologija ali fokus ovog rada prvenstveno je u marikulturi i maristanovanju. Budućnost će zahtijevati izvore dodatne hranu i stanovanja, pa more i oceane smatramo prirodnim korakom prema dostupnim neiskorištenim resursima.U radu se razmatra potreba i način interdisciplinarnih studija kako bi se mogli efikasno suočiti s izazovima održive budućnosti koristeći morske resurse. Otvorenost idejama i znanstvena mobilnost predstavljaju najvjerojatnije najbolji odgovor.

Ključne riječi: *Morski resursi; održivi razvoj; područja istraživanja; interdisciplinarne studije*

Comparative Evaluation of Reverse Characteristics of a Ship Equipped with Propeller of Variable Pitch

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Abstract

The report examined the process of reverse of a ship equipped with a variable pitch propeller (VPP) according to the following scenario: the initial stage, which includes stopping freely rotating propellers and an active stage with a propulsion device, which provides braking force when propellers is working at reverse mode. The method allows obtaining of comparative data related to emergency braking of a ship equipped with a fixed-pitch propeller (FPP) and VPP. Systematic calculations have been performed that show the effectiveness of the use of VPP from the point of view of improving the reverse characteristics of the ship compared to the same ship, but equipped with a VPP.

Keywords: *emergency ship stop; pitch variable propeller; run out distance*

Modular Deck System for Roro Vessels – RAMSSES H2020 R&D Project

Modularni sustav paluba RoRo brodova–RAMSSES H2020 Istraživački irazvojni projekt

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Abstract

This paper will give an overview of the demonstration case Modular Deck System for RoRo Vessels developed within RAMSSES (Realisation and Demonstration of Advanced Material Solutions for Sustainable and Efficient Ships) EU funded project under HORIZON 2020. The research and development is addressed to the construction of internal strength decks on RoRo vessels introducing FRP (Fibre reinforced plastic) pultruded profiles and FRP sandwich technology. Reducing the weight of decks results in many benefits regarding general ship design due to large number of decks. Improved flexibility in the ship design, where weight could be traded for ship size, scantlings, cargo capacity, speed, installed power and weight, integration of structures and outfitting. Optimising the deck structure design using innovative materials and geometry results in more efficient production as well. With respect to ship operational aspects such as Fuel oil consumption and CO2 emission reduction due to ship lightweight reduction leads to increased propulsion efficiency. The overall objective at RAMSSES is to develop optimised structure of RO-RO/Car-carrier using RAMSSES defined deck modules with respect to production optimisation as main objective followed by weight reduction, joint development, Fuel oil consumption and CO2 emission reduction.

Keywords: *RAMSSES; RoRo vessel; pultruded profiles; lightweight; production optimisation*

Sažetak

Članak daje pregled demonstracijskog slučaja modularnog sustava paluba RoRo brodova koji se razvija u sklopu projekta RAMSSES (Realisation and Demonstration of Advanced Material Solutions for Sustainable and Efficient Ships) koji je financiran sredstvima EU unutar HORIZON 2020. Istraživanje i razvoj unutar ove radne cjeline odnose se na konstrukciju unutarnjih paluba RoRo brodova. Smanjenje težina paluba stvara mnoge prednosti na opće karakteristike broda s obzirom da ti tipovi brodova imaju značajan broj paluba. Neke od prednosti su fleksibilnost prilikom osnivanja broda gdje se smanjenjem težine mogu povećati same dimenzije, korisna nosivost, brzina, ili smanjiti potrebna porivna snaga te bolja integracija strukture i opreme. Optimiziranjem strukture palube primjenom inovativnih materijala i geometrije rezultira i efikasnijom proizvodnjom. Ako se promatra brod u službi, smanjenje potrošnje goriva i smanjenje CO2 zbog smanjene težine broda, dovodi do povećanja propulzijske efikasnosti. Sveobuhvatni cilj unutar RAMSSES-a je razviti optimiziranu strukturu RORO broda odnosno broda za prijevoz automobila primjenom RAMSSES palubnih modula kroz optimizaciju proizvodnje kao primarni cilj, uz dodatne ciljeve smanjenja težina, zajedničkog razvoja te smanjenja potrošnje goriva i ispuštanja CO2.

Ključne riječi: *RAMSSES; RoRo brod; pultrudirani profili; smanjenje težine; proizvodnje optimizacija*

Bi – Fuel System Implementation in Dredgers

Implementacija UNP-a kod brodova jaružala

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Abstract

In today's world LNG have more and more significant role as power source. The combination of growing liquefied natural gas (LNG) supplies and new requirements for less polluting fuels in the maritime shipping industry has heightened interest in LNG as a maritime fuel. Liquefied natural gas is a colorless and odorless liquid, which is produced by cooling natural gas below the boiling point (about –161 °C). The volume of LNG is about 1/600 of the volume in gaseous state. In ambient temperature, LNG quickly vaporizes to gaseous form. Main reasons for using LNG are price and emission reduction. With benefits come challenges of using LNG. From the perspective of project and design engineers main challenges of using LNG on Dredgers is implementation itself. Main challenges are: design challenges (LNG storage needs 2–3 x more space than fuel oil storage and with that have large impact on vessel lay out), bunkering (location of bunker station, compatibility check, draining of bunker lines, arrangement of bunker station) and safety and regulations (Hazardous zones around LNG tank, engine and fuel lines, continuous ventilation in hazardous zones, no ignition sources in hazardous zones, gas detection with alarm on deck).

Keywords: *LNG; Dredger; Gas supply system*

Sažetak

U današnjem svijetu UPP ima sve veću i značajniju ulogu kao izvor energije. Kombinacija rastućeg broja proizvođača ukapljenog prirodnog plina i novih zahtjeva za ekološkijim gorivom u pomorskoj brodskoj industriji povećala je interes za UPP-om kao pomorskim gorivom. Ukapljeni prirodni plin je bezbojna tekućina, bez mirisa, koja nastaje hlađenjem prirodnog plina ispod točke ključanja (oko 161°C). Volumen UPP-a je oko 1/600 volumena u plinovitom stanju. Pri sobnoj temperaturi UPP brzo prelazi u plinoviti oblik. Glavni razlozi za korištenje UPP-a su cijena i mala emisija štetnih plinova. Uz prednosti dolaze i izazovi korištenja UPP-a. Iz perspektive projektnih i dizajn inženjera glavni izazovi korištenja UPP-a je njegova impelementacija. Glavni izazovi su: iazovi kod dizajniranja (prostor za skladištenje UPP-a je 2-3x veći od prostora za skladištenje dizelskog goriva i s tim ima veliki utjecaj na dizajn broda), ukrcaj (pozicija ukrcajne stanice, provjera kompabitilnosti, drenaža ukrcajnog cjevovoda, pozicija ukrcajne stanice) i sigurnosti i propisi (opasne zone oko UPP spremnika, cjevovod oko motora i cjevovod goriva, kontinuirana ventilacija u opasnim zonama, zabrana izvora paljenja u opasnim zonma, detekcija plina s alarmom na palubi.)

Ključne riječi: *UPP; Jaružalo; Sustav za dobavu plina*

Non-metallic pipelines and fittings for ships

Nemetalni Cjevovodi i Armature na Brodovima

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Abstract

The paper deals with non-metallic pipelines and fittings on ships. These include various types of pipelines and pipes such as fiberglass, then PVC pipes, b & v pipes, subor pipes. There are also composite tubes, rubber tubes and all kinds of non-metallic tubes and their fittings, seals and flanges. Each type has its own advantages and reasons why it is used in individual systems. Rubber hoses are always more flexible than plastic hoses, but their main advantage is that they have a higher abrasion resistance. It is emphasized that plastics are the material of the future and will be used more frequently. An armature is a part of a pipeline that serves to connect pipes, open, close, or adjust the desired flow values.

Keywords: *fiberglass; PVC pipes; composite; rubber hoses; polymers;*

Sažetak

Rad obrađuje nemetalne cjevovode i armature na brodovima. Tu spadaju razne vrste cjevovoda i cijevi poput staklоplastičnih, zatim PVC cijevi, b&v cijevi, subor cijevi. Tu su još i kompozitne cijevi, gumene cijevi i sve vrste nemetalnih cijevi i njihovih spojeva, brtvi i prirubnica. Svaka vrsta ima svoje prednosti i razloge zašto se upotrebljava u pojedinim sustavima. Gumena crijeva su uvijek nešto fleksibilnija nego plastična, ali glavna prednost im je što imaju veću otpornost na habanje. Ističe se kako su plastične mase materijal budućnosti te će učestalost njihove uporabe najvjerojatnije rasti. Armatura je dio cjevovoda koji služi spajanju cijevi, otvaranju, zatvaranju ili namještanju željenih vrijednosti protoka.

Ključne riječi: *stakloplastika; PVC cijevi; kompoziti; gumene cijevi; polimeri*

An Efficient Method to Identify Bottlenecks of the Ship Production Process: Serial Lines

Metoda određivanja uskih grla brodograđevnog proizvodnog procesa: serijske linije

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Abstract

The ship production process involves numerous different technology treatments that are usually assembled in serial or assembly production lines affecting the shipyard's productivity level significantly. Therefore, the analysis of the production system and its design for lean production including bottlenecks identification is of great importance. An efficient method to identify bottlenecks is presented in this paper providing a shipyard's management with basic tools to meet this challenging shipyard's floor issue. The PSEToolbox software is using the semi-analytical approach to calculate the machine blockage and starvation probabilities. Useful conclusions affecting production lines' maintenance policy are presented.

Keywords: *Ship production; Production system engineering; Serial lines; Bottlenecks; Lean production*

Sažetak

Brodograđevni proizvodni process obuhvaća velik broj različitih tehnoloških postupaka, uobičajeno objedinjenih u sklopu serijskih proizvodnig linija ili linija okrupnjavanja čija proizvodnost ima značajan utjecaj na uspješan rad cjelokupnog brodogradilišta. Stoga su analiza i projektiranje za vitku proizvodnju, uključujući identifikaciju uskih grla, iznimno važni. Ovim je radom predstavljena metoda identifikacije uskih grla kao osnovni alat i temelj razvoja vitke proizvodnje u brodogradnji. Primjenjen je polu-analitički pristup upotrebom programa PSEToolbox pomoću kojeg su određene vjerojatnosti blokade i praznog hoda strojeva. Također, prikazani su i zaključci istraživanja kako bi se omogućilo unapređenje sustava održavanja proizvodnih linija u brodogradilištu.

Ključne riječi: *Brodograđevni proizvodni proces; Proizvodno inženjerstvo; Serijske linije; Uska grla; Vitka proizvodnja*

Design and Style of Small Crafts: Relationships Between Aesthetic Layout and Construction Typology

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Abstract

The compositional design of the pleasure craft is not self-referential and autonomous: apart from stylistic, sociological and fashion factors, it is strongly conditioned by the technological-constructive aspect, which sometimes becomes the foundation of the expressive code adopted therein. In the history of modern boating, since it became a mass phenomenon, the construction method evolved in serial production has further constrained formal freedom. Nowadays, the compositional design articulates by new formal elements, respect to the past, in relation to complex mechanisms imposed by construction planning. Due to these new logics, it represents now a more complex process in the integration of the parts, being the modern boat a product increasingly characterized by the presence of serialized components. Consequently, the aesthetic approach implicitly reflects these features of constructive and productive order. The romanticism give way to a new multifaceted design vision, called to consider, right from the outline concept, multiple aspects: including the logistics of the outfitting phases, increasingly characterized by prefabrication and assembly of outsourced components. The paper in question proposes an evolutionary excursus of the design of pleasure boats, which aims to analyse and highlight the intelligibility of these effects in the aesthetic layout of the boat.

Keywords: *Pleasure boats; Yacht design; Style and aesthetics of the boat*

Hybrid and Electrical Ferry Charging Stations with Common DC Bus

Punionice za hibridne i električne trajekte s zajedničkom DC sabirnicom

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Abstract

The current trend of hybridization and electrification of coastal line ferries generates increasing demands on the construction of shore connection and battery charging systems. At the same time, it is very difficult to reconcile the conflicting requirements for shore side charging power and the capacities of the existing land infrastructure. This is especially the case in smaller island towns where the largest number of such ferries dock. There, the insufficient capacity of the electrical distribution grid often requires installation of additional energy storage system or renewable energy sources. Furthermore, the characteristics of battery storage modules onboard ferries and associated charging systems are not unified, which poses a significant design problem for onshore power conversion system. In this paper the advantages of using ferry charging station with common DC bus is presented as a result of research on the project METRO - Maritime Environment-Friendly Transport Systems.

Keywords: *Hybrid and electrical ferry; ferry charging station; common DC bus; battery energy storage; shore connection*

Sažetak

Postojeći trend hibridizacije i elektrifikacije trajekata na duž obalnim linijama generira povećane zahtjeve za konstrukcijom kopnenih priključaka i sustava za punjenje baterija. Istodobno, vrlo je teško pomiriti često oprečne zahtjeve za snagom punjenja i postojeće kapacitete kopnene distribucijske mreže. To je posebno izraženo u manjim otočkim sredinama gdje upravo ovakvi trajekti najčešće i pristaju. Nadalje, karakteristike baterijskih skladišta energije na trajektima i pripadajućih sustava punjenja često nisu unificirane što predstavlja značajan problem pri dizajniranju pretvaračkih sustava. U ovom radu prezentirane su prednosti upotrebe punionica za hibridne i električne trajekte s zajedničkom DC sabirnicom kao rezultat istraživanja na projektu METRO Maritime Environment-Friendly Transport Systems.

Ključne riječi: *Hibridni i električni trajekti; punionice za trajekte; zajednička DC sabirnica; baterijska skladišta energije; kopneni priključci*

Existing 14000m³ Trailing Suction Hopper Dredger (TSHD) Conversion/45m Lengthening to a 21000m³ Twin Hopper-TSHD

Preinaka/45 metarsko produljenje usisnog jaružala sa skladištem kapaciteta 14000m³ na usisno jaružalo sa dvostrukim skladištem kapaciteta 21000 m³

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Abstract

Trailing Suction Hopper Dredgers (TSHD) are one of the core products of IHC. They are used for dredging of soft soil as well as reclamation of material from the sea bed. Seldom ship-owners aim to increase hopper capacity for added capacity of dredge spoil to be transferred to a specific location thus increasing the payload. This article covers a major conversion of an existing, IHC built TSHD, with an aim of increasing its hopper capacity from 14000m^3 to 21000m^3 by elongating the vessel with 45m, from the original 135,95m to 180,95m in length between perpendiculars. The new, elongated vessel, is designed with two hoppers divided approximately at the middle of the vessel. This article covers the design basis, feasibility study for different design and arrangement options, as well as basic engineering activities for the chosen conversion design option for this particular elongation. An overview is given of the basic engineering activities and deliverables for this major conversion, including statutory drawings, ship stability, longitudinal strength, FEM and buckling analysis.

Keywords: *Dredging; Twin Trailing Suction Hopper Dredger; Feasibility; Engineering; Conversion; FEM;*

Sažetak

Usisna jaružala sa skladištem jedan su od osnovnih prozvoda tvrtke IHC. Namjena im je iskop nekoherentnog materijala sa morskog dna poput šljunka ili pijeska kao i ponovna ugradnja (iskrcaj) tog materijala. Često brodovlasnici žele povećati kapacitet skladišta postojećih usisnih jaružala zbog povećanja nosivosti/isplativosti spomenutih brodova. Ovaj članak opisuje konverziju postojećeg usisnog jaružala sa skladištem, originalno izgrađenog u IHC-u, sa ciljem povećanja skladišnog kapaciteta iskopanog materijala sa 14000m^3 na 21000m^3 putem produljenja postojećeg broda za 45m, sa postojećih 135,95m na 180,95m duljine između okomica. Novi, produljeni brod, je projektiran sa dva skladišna prostora odijeljenima u sredini broda. Ovaj članak obuhvaća razradu idejnog projekta, studiju provedivosti za nekoliko projektnih opcija, kao i osnovne aktivnosti prilikom izrade klasifikacijske dokumentaciju u vidu dobivanja odobrenja od strane klasifikacijskog društva. Dan je i pregled osnovnih projektnih aktivnosti za ovu konverziju uključujući izradu osnovnih nacrta produljenja, proračuna stabiliteta i uzdužne čvrstoće, proračuna čvrstoće MKE metodom kao i proračun izvijanja brodske strukture

Ključne riječi: *Jaružalo ; Usisno jaružalo; Isplativost; Projektiranje; Konverzija; FEM*

PC6 SFIC – Ice class Hull design principles

PC6 SFIC – Projektiranje brodske konstrukcije – pojačanja za led

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Abstract

Recently there has been a major interest for exploration cruises in the polar regions. A number of vessels are under construction or already built, mainly as exploration yachts to offer cruises in the Antarctic or Artic regions. These vessels, especially their hull construction, need to be designed to withstand first or multi-year ice loading. This area is rather new in aspect of best practices and rules and regulations offered from major classification societies, especially for sailing in stern first mode. This article brings an insight into the hull structure design and calculation principles in accordance with PC6 and stern first ice class (SFIC) notations of Lloyd's register of shipping rules for navigation in Artic or Antarctic first-year ice conditions. The ice pressure zone determination, ice pressure calculation, basic scantlings determination, FEA primary elements verification and buckling analysis methodology is presented.

Keywords: *Exploration Yacht; PC6 Polar Class; Stern First Ice Class (SFIC); Engineering; Finite Element Analysis; Buckling Analysis*

Sažetak

U posljednje vrijeme povećana je potražnja za istraživačko-turistička krstarenja u polarnim vodama. Popriličan broj brodova, većinom klase istraživačkih jahti, je izgrađen ili u izgradnji sa svrhom krstarenja u područja Antarktika ili Arktika. Ovi brodovi, posebno u aspektu konstrukcije trupa, moraju biti projektirani da zadovolje kriterija naprezanja uzrokovane opterećenjem od jednogodišnjeg ili višegodišnjeg leda. Ovo područje je relativno novo sa aspekta iskustvenih podataka, kao i pravila vodećih brodarskih klasifikacijskih društava. Osobito se to odnosi na lomljenje leda krmom. Ovaj članak obuhvaća principe projektiranja konstrukcije trupa i proračunske metode u skladu s klasom PC6 i dodatnom notacijom SFIC, ledolomac krmom, prema „Lloyd's register of shipping" pravilima za navigaciju arktičkim i antartičkim vodama i jednogodišnjim ledom. Prezentirani su određivanje osnovne podjele broda na zone opterećenja od leda, proračun ulaznih opterećenja leda, proračun osnovnih elemenata strukture, verifikacija primarnih elemenata brodske strukture pomoću MKE, te metodologija proračuna izvijanja brodske strukture.

Ključne riječi: *Istraživačka jahta; PC6 polarna klasa; SFIC Ledolomac Krmom dodatna klasna notacija; MKE; Proračun Izvijanja*

Initial Testing of Hilbig 905i Stud Welding Machine with Comparative Tests of Secondary Cable Holders and Isolation Pins

Zapisnik sa inicijalnog testiranja uređaja za zavarivanje svornjaka Hilbig 905i i komparativnog testiranja predfabriciranih nosača i izolacijskih „canki”

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Abstract

Initial testing of a portable stud welding machine acquired for Brodosplit was conducted in this work. Machine primary purpose is stud welding of secondary cable holders. To ensure that machine works properly, all required functions were tested in real work conditions. Comparative tests of prefabricated electric holder manufacturers and isolation pins were also conducted. Additional testing equipment was defined and tested. Activities needed for project continuation were suggested.

Keywords: *stud welding; secondary cable holders; isolation pins*

Sažetak

U ovom radu obavljeno je inicijalno ispitivanje uređaja nabavljenog za potrebe Brodosplita. Radi se o portabilnom uređaju za zavarivanje svornjaka prvenstveno namijenjenom zavarivanju nosača sekundarnih kabelskih trasa. Kako bi osigurali da je uređaj u ispravnom stanju, obavljena su testiranja potrebnih funkcija u stvarnim uvjetima rada, komparativno testiranje proizvođača predfabriciranih nosača kao i proizvođača izolacijskih pinova korištenih za postavljanje izolacije. Definirana je i testirana dodatna oprema te predložene radnje za nastavak projekta.

Ključne riječi: *zavarivanje svornjaka; nosači sekundarnih elektrotrasa; izolacijski pinovi*

Comparison of Cable Holder Installation Methods in Pre-Outfitting

Komparacija metodologija postavljanja elektrotrasa u fazi uranjenog opremanja

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Abstract

Previously theorized methodologies of for cable holder installations were compared in this work, along with revision of normative for that process. Qualitative assessment was given for factors which were not considered in previous researches. Further activities were suggested based on new results and additional factors.

Keywords: *stud welding; secondary cable holders*

Sažetak

U ovom radu uspoređene su prethodno teoretizirane metodologije postavljanja elektrotrasa te su revidirane dosadašnje norme postavljanja. Dat je kvalitativan osvrt na dodatne faktore koji nisu uzeti u obzir prethodnim istraživanjima. Na osnovu novih rezultata i dodatnih faktora predložene su daljnje radnje.

Ključne riječi: *zavarivanje svornjaka; sekundarne elektrotrase*

Existing Condition, Testing and Proces Analysis of ESAB Railtrac FW 1000 Welding Carriage

Zatečeno stanje, testiranje i procesna analiza uređaja za mehanizirano zavarivanje – ESAB Railtrac FW 1000

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Abstract

Set of activities which precedes implementation of new technology is described in this work. In this case, “new” technology represents already obtained, used and then forgotten machine for mechanized welding. Current condition, regarding precision and additional functions were analyzed. Usability for specific task of welding “leaflets” of Smulders project was investigated on testing samples and in real working conditions. For those conditions basic process settings were given along with suggestions for further activities.

Keywords: *mechanized welding; process analysis*

Sažetak

U radu su opisani setovi aktivnosti koji prethode implementaciji nove tehnologije u pogon. U ovom slučaju ne radi se o novoj tehnologiji, već o kupljenom, korištenom, "zaboravljenom" uređaju za mehanizirano zavarivanje. Analizirano je trenutno stanje, točnost postavljenih parametara i dodatnih funkcija uređaja. Ispitana je mogućnosti uporabe Railtrac uređaja za primjenu kod zavarivanja „latica“ u sklopu projekta Smulders. Ispitivanje je obavljeno na pokusnim uzorcima i u stvarnim uvjetima rada. U stvarnim uvjetima zabilježene su osnovne procesne postavke i predložene daljnje radnje.

Ključne riječi: *mehanizirano zavarivanje; procesna analiza*

FESB Hydro Team – Student Project

FESB Hydro tim – Studentski projekt

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Abstract

FESB Hydro Team is a group of young and ambitious students from the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture in Split. It has been operating as a group since the beginning of the academic year 2018, after it was decided to spend some time on practical work at the instigation of the professors from the Department of Naval Architecture. In the period since its establishment, the group has engaged in the design and manufacture of a vessel for the international competition "Hydrocontes-X". Hydrocontest is a competition launched in 2013 at the initiative of the Hydros Foundation and the Swiss private bank Lombard Odier. The vessels are remotely controlled and powered by an electric propulsion. This type of competition brings together students from different faculties and they present themselves and their faculty by making advanced boats that must be made according to the rules of the Hydrocontest itself. The competition is conducted in three categories: Lightweight (load 20 kg), Heavyweight (load 200 kg), Endurance race (1h with a load of 20 kg). This type of project, where the theoretical knowledge acquired during the study is applied, is of great importance to us as future shipbuilding engineers.

Keywords: *FESB; student project; Hydrocontest-X*

Sažetak

FESB Hydro Team je grupa mladih i ambicioznih studenata Fakulteta elektrotehnike, strojarstva i brodogradnje u Splitu. Kao grupa djelujemo od početka akademske 2018. godine nakon što smo na poticaj profesora sa katedre za Brodogradnju odlučili usmjeriti određeno vrijeme na praktični rad. U periodu od osnivanja bavili smo se projektiranjem i izradom plovila za međunarodno natjecanje „Hydrocontes-X“. Hydrocontest je natjecanje pokrenuto 2013. godine na inicijativu organizacije Hydros Foundation i Švicarske privatne banke Lombard Odier. Plovila su daljinski upravljana i pogonjena električnim propulzorom. Takva vrsta natjecanja okuplja studente različitih fakulteta te oni prezentiraju sebe i svoj fakultet izradom naprednih plovila koja moraju biti izrađena po pravilima samog Hydrocontest-a. Natjecanje se provodi u tri kategorije: Laka kategorija (teret 20 kg), Teška kategorija (teret 200 kg), Utrka izdržljivosti (1h sa teretom od 20 kg). Ovakav tip projekta, gdje se primjenjuje teoretsko znanje stečeno tijekom studiranja od velike je važnosti nama kao budućim inženjerima brodogradnje.

Ključne riječi: *FESB; studentski projekt; Hydrocontest-X*

Conceptual Design of the Shipyard for Composite Ships

Idejni projekt brodogradilišta kompozitnih brodova

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Abstract

The paper presents design process of shipyard for composite ships. In introduction, need for investment in new nautical (production – service) center is pointed out according to increase of nautical tourism in Croatia. Ships market analysis is basis for definition of characteristic ship which is used as main product in conceptual design of the shipyard. Conceptual design of the shipyard contains elements of design spiral like arrangement of working areas, material flows, characteristic ship building dynamics, necessary number of employers and prediction of investment costs. The conclusion indicates benefits of new nautical (production – service) shipyard design.

Keywords: *motor yacht; composites; conceptual design; shipyard*

Sažetak

U članku je prikazan proces projektiranja brodogradilišta za kompozitne brodove. U uvodu se naznačila potreba za osnivanjem jednog proizvodno – servisnog centra s obzirom na povećanje nautičkog turizma u Hrvatskoj. Analizom tržišta definirala se potreba za određenim tipom broda za koji se pristupilo izradi idejnog projekta brodogradilišta razradom elemenata projektne spirale. Definiran je razmještaj radnih prostora, tokovi materijala, dinamika gradnje karakterističnog broda, potreban broj djelatnika, njihovih zanimanja te procjena troškova investicije. Zaključno su navedene prednosti osnivanja brodogradilišta kompozitnih brodova.

Ključne riječi: motorna jahta; kompoziti; idejni projekt; brodogradilište

"Sklad" Trimaran Concept for Protection of Adriatic Sea

Patrolni brod za nadzor Jadrana tipa "Sklad" trimaran

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Abstract

Missile, countersubmarine patrol ship with displacement over 1000 tonnes is designed for Adriatic sea protection in 21st century, according to the LCS-2 trimaran concept (Littoral Combat Class), with wide helicopter deck. The central hull is based on semi-displacement hull series "Sklad" developed in "Brodarski Institut" in Zagreb, with stabilizing hulls ensuring survival of 3 neighboring compartments damage and superior seakeeping performances. The ship can achieve maximal speed of 50 knots using CODAG propulsion (2 Diesel + 1 Gas turbine) with 3 waterjet propulsors. The autonomy of the ship for cruising speed of 20 knots is 1000nm.

Keywords: *"Sklad" systematic series; trimaran; survival of 3 damaged compartments; helicopter deck; maximal speed 50 knots*

Sažetak

Za potrebe nadzora Jadranskog mora u 21. stoljeću osnovan je raketni, protupodmornički patrolni brod istisnine preko 1000t, prema konceptu LCS-2 (Littoral Combat Class) trimarana, sa širokom helikopterskom palubom. Za formu centralnog trupa je odabrana sustavna serija poluistisninskih formi "Sklad" razvijana u "Brodarskom institutu" u Zagrebu, a brod je stabiliziran pomoćnim trupovima, čime brod može preživjeti naplavu 3 susjedna prostora te ima superiorna pomorstvena svojstva. Brod postiže maksimalnu brzinu od 50 čv CODAG pogonskim postrojenjem (2 Diesel motora + 1 Plinska turbina) s 3 vodomlazna propulzora. Za brzinu krstarenja broda od 20 čv, autonomija broda je 1000 nm.

Ključne riječi: *sustavna serija "Sklad" ; trimaran ; preživljavanje naplave 3 prostora ; helikopterska paluba ; maksimalna brzina 50 čvorova*

The Impact of Antifouling Coatings on Ship Performance

Utjecaj antivegetativnih premaza na radne karakteristike broda

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Abstract

Energy efficiency is one of the main goals that must be met within the preliminary design of the ship, as well as for existing ships. Recently, the International Maritime Organization (IMO) has introduced regulations such as the Energy Efficiency Design Index (EEDI), the Ship Energy Efficiency Management Plan (SEEMP), and the Energy Efficiency Operational Index (EEOI) to reduce emissions in shipping industry. There are various measures to increase the energy efficiency of a ship, and one of them is the application of coatings with low surface roughness. In this paper, the impact of the application of two types of antifouling coatings from the ship resistance and effective power point of view is analyzed. Grigson roughness function and Granville similarity law scaling method are applied to determine frictional resistance coefficient of an oil tanker and a container ship in full-scale. The obtained results point out the advantages of coatings with low surface roughness regarding the effective power and thus the energy efficiency of the ship.

Keywords: *antifouling coatings; ship resistance; Granville similarity law scaling method; oil tanker; container ship*

Sažetak

Energetska učinkovitost predstavlja jedan od glavnih ciljeva koji se moraju ispuniti u okviru preliminarnog projekta broda, kao i za postojeće brodove. U posljednje vrijeme Međunarodna pomorska organizacija (IMO) je uvela propise kao što su Projektni indeks energetske učinkovitosti (EEDI), Plan upravljanja energetskom učinkovitošću broda (SEEMP), kao i Operativni indeks energetske učinkovitosti (EEOI) kako bi se smanjila emisija štetnih plinova u pomorskoj industriji. Postoje razne mjere za povećanje energetske učinkovitosti broda, a jedna od njih je primjena premaza s manjom hrapavošću. U ovom radu, analiziran je utjecaj primjene dvije vrste antivegetativnih premaza sa stajališta otpora broda i efektivne snage. Primjenjena je Grigsonova funkcija hrapavosti te Granvilleova metoda zakona sličnosti za određivanje koeficijenta otpora trenja tankera i kontejnerskog broda u naravi. Dobiveni rezultati ukazuju na prednosti primjene premaza s manjom hrapavošću sa stajališta efektivne snage, a tako i energetske učinkovitosti broda.

Ključne riječi: *antivegetativni premazi; otpor broda; Granvilleova metoda zakona sličnosti; tanker; kontejnerski brod*

Dual-Fuel Electro Hydraulically Controlled Marine Diesel Engines

Elektro-Hidraulički Upravljivi Brodski Dizelski Motori na Dvojno Gorivo

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Abstract

This paper describes the characteristic design of marine electro hydraulically controlled two-stroke and four-stroke dual-fuel engines, and emphasizes important conceptual and design specifics of the two most respectable manufacturers in the world - Wartsila and MAN. Different design solutions regarding preparation, supply and admission of fuelled gas are particularly emphasized, as well as possible conversions of the older diesel engines, normally supplied only by liquid fuel, into engines which can use both liquid and gaseous fuels. Dual-fuel marine diesel engines have many advantages and one of the most important characteristics is their operating flexibility, which along with expertly designed safety systems, allows them to be widely used on liquefied natural gas tankers, since in this case they can be successfully supplied with boil off gas generated within cargo tanks impacted by the upcoming heat load.

Keywords: *electro hydraulically controlled engine; dual fuel; boil off gas; fuelled gas admission; liquefied natural gas carriers*

Sažetak

U ovom radu opisane su karakteristične projektne izvedbe brodskih elektro-hidraulički upravljivih dvotaktnih i četverotaktnih motora na dvojno gorivo, te su posebice istaknute bitne koncepcijske i konstrukcijske specifičnosti izvedbi dvaju najrespektabilnijih svjetskih proizvođača Wartsile i MAN-a. Poseban naglasak je stavljen na pripremu, dobavu i upuštanje odnosno utiskivanje plinovitog goriva, kao i na moguće konverzije postojećih dizelskih motora napajanih isključivo kapljevitim lakim i teškim gorivom u motore napajane dvojnim gorivom (kapljevitim i plinovitim). Brodske dizelske motore na dvojno gorivo karakteriziraju mnogobrojne prednosti, ponajviše njihova pogonska fleksibilnost, koja im uz vješto osmišljene sigurnosne sustave omogućuje primjenu ponajviše na tankerima ukapljenog prirodnog plina, gdje se na uspješan način napajaju plinskim otparkom generiranim nastupajućim toplinskim opterećenjem tankova tereta.

Ključne riječi: *elektro-hidraulički upravljivi motori; dvojno gorivo; plinski otparak, upuštanje plinovitog goriva; tankeri ukapljenog prirodnog plina*

Comparison of Wave Data from Different Sources in the North Adriatic Sea

Usporedba različitih izvora podataka o valovima u sjevernom dijelu jadranskog mora

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Abstract

Wave data obtained from measurements by research tower ACQUA ALTA are compared with those obtained by numerical re-analysis and satellite measurements contained in Oceanor database, for almost the same location in the north part of the Adriatic Sea. Databases are briefly described in the first part of the paper and then comparative analysis of significant wave heights is performed. For each year (1979-2019) maximum significant wave height and time of occurrence are extracted from each of two databases. Significant wave height and peak wave periods are further presented in the form of wave scatter diagrams. Comparative analysis presents basis for the future analysis of uncertainties of long-term extreme wave conditions caused by wave data from different sources.

Keywords: *Adriatic Sea; Significan wave height; Peak frequency; Scatter diagram*

Sažetak

Podaci o valovima dobiveni mjerenjima na tornju ACQUA ALTA uspoređeni su s numerički analiziranim satelitskim mjerenjima u OCEANOR bazi podataka, za skoro jednaku poziciju u sjevernom dijelu Jadranskog mora. Baze podataka su kratko opisane u prvom dijelu rada, a zatim je napravljena komparativna analiza značajnih valnih visina. Za svaku godinu (1979 – 2019) izvučena je maksimalna značajna valna visina skupa s vremenom javljanja. Značajna valna visina i vršni periodi su nadalje prikazani u obliku dijagrama stanja mora. Komparativna analiza predstavlja osnovu za buduću analizu nesigurnosti dugoročnih uvjeta uzrokovanih valnim podacima iz različitih izvora.

Ključne riječi: *Jadransko more; Značajna valna visina; Vršna frekvencija; Dijagram stanja mora*

Optimization of Secondary Steel Constructions

Oprimizacija sekundarnih strukturnih elemenata

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Abstract

Nowadays the world is rapidly changing, especially in terms of modern technology. Trying to stay relevant in todays world of supply and demand and the ever-present desire to make more money are the two main notions in every industry. Shipbuilding is no different. The formula to stay on top of the market is to guarantee a quality product, for as small a price as possible and to deliver it in the shortest amount of time. In this paper we will discuss the optimization process in the IHC Outfitting department. Our goal was to make a complete optimization of the modeling and development process in Cutter dredgers, with emphasis on the structural strength determined by vessel calculations. The optimization was excecuted by deviding the process in three main stages: approaching the problem, selection of the material and the production itself. With changes in all three areas, we came up with a new - better process.

Keywords: *optimization; secondary steel; strength*

Sažetak

Svijet oko nas se konstatno mijenja, pogotovo kada govorimo o modernoj tehnologiji. Glavni cilj u svakoj industriji, pa tako i u brodogradnji, je biti uspješan i konkurentan na svjetskom tržištu. Kako bi se taj cilj ostvario potrebno je jamčiti kvalitetan proizvod, za što manju cijenu i isporuku u najkraćem mogućem roku. U ovom radu pokazati ćemo optimizaciju rada Outfitting odjela IHC-a. Naš cilj bio je provesti potpunu optimizaciju procesa izrade i proizvodnje kod Cutter dredger-a, uz naglasak na očuvanje strukturalne čvrstoće zadane proračunima. Optimizacija je provedena podjelom procesa na tri glavna područja: način pristupa problemu, odabir materijala pri modeliranju i sama proizvodnja. Uz izmjene u svim navedenim područjima, došli smo novog – poboljšanog procesa konstrukcije i izrade broda.

Ključne riječi: optimizacija; temelji; čvrstoća;

Structural Aspects During Conversion from General Cargo Ships to Cement Carriers

Strukturni aspekti za vrijeme konverzije brodova za opći teret u brodove za prijevoz cementa

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Abstract

During the major conversion from one to another ship type, a level of technical assurance is required through the design approval by national and international classification and statutory authorities, in order to keep adequate safety level and cost efficiency of converted ships further in their service. In this study is described general approach to convert general cargo or small-size container ships to cement carriers. The approaches taken by classification society CRS to carry out a comprehensive re-appraisal of conditions of ship, considering its history and present condition of the structure, is provided. Two case studies are presented where the strength assessment has been performed using 3D Finite Element model generated according to available hull drawings and thickness measurement reports. Results of the study are interpreted with respect to the structural modifications carried out during conversion process and some general conclusions are drawn.

Keywords: *Ship structures; general cargo ships; cement carriers; major conversion; finite element method*

Sažetak

Tijekom velikih konverzija iz jednog tipa broda u drugi potrebno je u projektu definirati odgovarajući nivo tehničkog osiguranja uz odobrenje nacionalnih i međunarodnih klasifikacijskih i statutarnih tijela kako bi se održala razina sigurnosti i isplativosti obnovljenih brodova u njihovoj daljnjoj službi. U ovoj je studiji opisan opći pristup pri konverziji brodova za opći teret ili brodova za kontejnere malih dimenzija u brodove za prijevoz cementa. Predložen je pristup klasifikacijskog društva HRB u nastojanju da izvrši sveobuhvatnu procjenu stanja broda, uzimajući u obzir njegova akumulirana oštećenja u prošlosti i trenutno stanje konstrukcije. Predstavljena su dva primjera broda gdje su procjene čvrstoće provedene pomoću 3D modela konačnih elemenata generiranog prema dostupnim nacrtima konstrukcije trupa i izvješćima o mjerenju debljine. Rezultati studije objašnjeni su s obzirom na izvršenu strukturnu analizu provedenu tijekom postupka konverzije i izneseni su neki opći zaključci.

Ključne riječi: *Brodska konstrukcija; brod za opći teret; brod za prijevoz cementa; velika preinaka; metoda konačnih elemenata*

Centre of Gravity Envelope Efect on Intact and Damage Stability for High Speed Craft

Utjecaj envelope težišta sustava na stabilitet u neoštećenom i oštećenom stanju brzog plovila

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Abstract

High speed crafts are designed and built for situations which require prompt reaction in order to save human life and/or property. Thus, wide range of severe operational conditions (i.e. fire, heavy seas, etc.) which can occur throughout craft's exploitation life shall be considered during initial design process. Determination of specific centre of gravity position throughout initial design phase of high-speed craft, represents sophisticated task which significantly influences overall performance of the craft (speed, stability, seaworthiness, manoeuvrability, etc.). This article provides a brief overview of interdependence between craft's positive stability and its position of centre of gravity. For purpose of presenting subject thesis in this paper, a referent designed and built working craft has been used. Centre of gravity envelope will be performed for subject working craft to show correlation of craft's damaged and intact stability in respect of position of CoG. Centre of gravity envelope will show acceptable area of CoG which allows positive stability necessary to meet International code of safety requirements for High-speed crafts by considering longitudinal, transversal and vertical axis. This article will provide comparison of positive stability areas with reference to CoG position for both, intact and damage stability.

Keywords: *Stability; Damage Stability; Intact Stability; Positive stability CG Envelope*

Sažetak

Brze radne brodice se projektiraju i grade s ciljem zadovoljenja najrazličitijih stanja operacije koja traže promptnost reakcije ne bi li kvalitetno odradili zadaću spašavanja ljudskog života i/ili imovine. S tim u skladu velik raspon izazovnih stanja operacije brodice (kao što su požar, teška stanja mora i sl.) koja se mogu pojaviti za vrijeme njezinog životnog vijeka, mora biti uzet u obzir prilikom procesa osnivanja. Utvrđivanje točnog položaja težišta tijekom procesa osnivanja brze brodice predstavlja kompleksan zadatak koji ima značajan utjecaj na ključne performanse brodice kao što su brzina, stabilitet, pomorstvenost, upravljivost i sl. Predmetni članak daje sažet prikaz utjecaja pozicije težišta brze brodice na pozitivan stabilitet. Prezentacija predmetne teze kroz ovaj je rad obrađena korištenjem referentne radne brodice koja je projektirana i izgrađena za takav tip operacije. Područje prihvatljivog položaja težišta biti će određeno za referentnu brodicu kako bi se pokazala korelacija stabiliteta brodice u oštećenom i neoštećenom stanju i položaja težišta. Područje položaja težišta brodice daje prihvatljiv raspon položaja težišta koji rezultira sa pozitivnim stabilitetom potrebnim za zadovoljenje Međunarodnih pravila za sigurnost brzih plovila po uzdužnoj, poprečnoj i vertikalnoj osi. Predmetni članak daje prikaz međuovisnosti pozitivnog stabiliteta u ovisnosti od pozicije težišta za stabilitet u oštećenom i neoštećenom stanju.

Ključne riječi: *Stabilitet; Oštećeno stanje; Neoštećeno stanje; Brze brodice; Stabilitet plovila u ovisnosti o težištu sustava*

An Overview of Measures for Improving the Energy Performance of Ships

Pregled mjera za poboljšanje energetskih značajki brodova

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Abstract

A “green ship” is a term given to ships that contribute to the improvement of the present environmental situation. Maritime industry is one of the greatest contributors of the greenhouse effect and in order to reduce carbon emissions coming from it many actions were taken worldwide. The efforts taken by the International Maritime Organization (IMO) can be particularly pointed out, but there is number of other opportunities that can be applied to improve the energy efficiency of ships. Ship designers and shipbuilders have at their disposal a number of measures that could be used to increase the energy performance of ships. This paper focuses on some of these opportunities, some of which are regulated by mandatory regulations and rules while other are applied on a voluntary basis.

Keywords: *ship; energy performance; improvement measures; overview*

Sažetak

“Zeleni brod” je pojam koji se dodijeljuje brodovima koji doprinose poboljšanju sadašnjie situacije u okolišu. Pomorska industrija jedan je od najvećih doprinositelja učinku staklenika. Kako bi se smanjile emisije ugljika koje proizlaze iz te industrije, poduzete su mnoge akcije širom svijeta. Posebno se mogu istaknuti napori Međunarodne pomorske organizacije (IMO), ali postoji niz drugih mogućnosti koje se mogu primijeniti za poboljšanje energetske učinkovitosti brodova. Projektantima i brodograditeljima na raspolaganju stoji niz mjera kojima bi se mogla povećati energetske značajke brodova. Ovaj se rad usredotočuje na neke od njih, od kojih su neke regulirane obveznim propisima i pravilima, dok se druge primjenjuju na dobrovoljnoj osnovi.

Ključne riječi: *brod; energetske značajke; pregled mjera za poboljšanje*

Design of Pontoons Fenders for Cruise Vessel Mooring in Port of Rijeka

Projekt pontona odbojnika za vez brodova za kružna putovanja u Riječkoj luci

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Abstract

Pontoons are designed for use as fenders between peer and cruise vessels in port of Rijeka. For purpose of fenders design, the physical model of ship stability was altered to suit the actual situation of system peer-pontoons-vessel. Optimization of pontoons size is carried out for given conditions: vessel size, maximal distance from vessel to peer, water depth at the site and design wind speed. Due to economic reasons, the optimal pontoon fenders arrangement and size for maximal design wind speed cannot be met and alternative approach was accepted. Alternative approach ensured that in 96 % of wind blowing occasions the vessel can be moored and for rest of 4% occasions the vessel will be on anchor outside the port. The usage diagram for agreed wind speed was issued for two types of pontoon usage i.e. longitudinal mooring arrangement and transversal mooring arrangement.

Keywords: *Pontoon fenders; Cruise vessels; Ship stability; Ship mooring; Mooring calculation*

Sažetak

Pontoni su projektirani kao odbojnici između obale i brodova za kružna putovanja u riječkoj luci. Za potrebe projektiranja odbojnika fizikalni model stabiliteta broda je izmijenjen da bi odgovarao stvarnoj situaciji sustava obala-pontoni-plovilo. Optimizacija veličine pontona je napravljena za dane uvjete: veličina plovila, maksimalna udaljenost plovila od obale, dubina na tom području i projektna brzina. Radi ekonomskih razloga optimalni raspored i veličina pontona za maksimalnu projektnu brzinu vjetra nije bilo moguće zadovoljiti, te je prihvaćen alternativni pristup. Alternativni pristup je osigurao da u 96% događaja puhanja vjetra plovilo može biti vezano uz pontone dok u ostalih 4% događaja puhanja vjetra je na sidru van luke. Uporabni dijagrami su izdani za dva načina veza tj. za poprečni i uzdužni način veza uz pontone.

Ključne riječi: *Pontonski odbojnici; Brodovi za kružna putovanja; Stabilitet broda; Vezivanje broda; Proračun veza*

Tourist Catamaran Strucural Analysis

Strukturna analiza turističkog katamarana

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Abstract

In the final stage of 30m tourist catamaran design structural analysis is performed according to the classification society's rules. The analysis consists in four parts, i.e. longitudinal, local, torsional and transverse strength calculations. BV MARS software is used for the longitudinal and local strength calculation, while the finite element software package Femap with NX Nastran is used for the torsional and transverse strength calculation. The results of the analysis detect possible elements or zones in the structure needing reinforcements.

Keywords: *tourist catamaran; structural analysis; finite element method*

Sažetak

U završnoj fazi projektiranja katamarana provedena je strukturna analiza u skladu s pravilima klasifikacijskog društva. Strukturna analiza se sastoji od četiri vrste proračun, tj. proračuni uzdužne, lokalne, torzijske i poprečne čvrstoće. BV MARS program je upotrebljen za proračun uzdužne i lokalne čvrstoće, dok je programski paket za primjenu metode konačnih elemenata Femap s NX Nastranom korišten za proračun torzijske i poprečne čvrstoće. Rezultati analize otkrivaju koji konstrukcijski elementi ili zone u konstrukciji zahtjevaju moguća pojačanja.

Ključne riječi: *turistički katamaran; strukturna analiza; metoda konačnih elemenata*

Preparation of Workshop Documentation for Ship Structure and Propulsion Systems Using 3D Models

Izrada radioničke dokumentacije strukture broda, brodskih i pogonskih sustava korištenjem 3D modela

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Abstract

This presentation describes the preparation of workshop documentation for ship structures and propulsion systems through modeling in 3D software used in Brodosplit. The presentation will show a model of a polar cruise ship nov.487, which is made for the needs of the American client Quark Expeditions. Key advantages were detected and a comparison was presented in relation to the preparation of documentation in the past when workshop documentation was made using 2D software tools. The results with advantages in the designing and in the building of a ship are presented in the conclusion.

Keywords: *3D software; 2D software; nov.487 ; Brodosplit*

Sažetak

Prezentacijom je opisana izrada radioničke dokumentacije strukture broda, brodskih i pogonskih sustava kroz modeliranje u 3D softwareu koji se koristi u Brodosplitu. Izlaganjem će biti prikazan model broda za polarna krstarenja nov.487, koji se izrađuje za potrebe američkog naručitelja Quark Expeditions. Detektirane su ključne prednosti i prezentirana usporedba u odnosu na izradu dokumentacije u prošlosti kada se radionička dokumentacija radila putem 2D softwareskih alata. Zaključkom su prikazani ostvareni rezultati i evidentne prednostima kako u radu službe projektiranja i konstruiranja tako i u samoj proizvodnji.

Ključne riječi: *3D software; 2D software; nov.487 ; Brodosplit*

RRS “Sir David Attenborough”, Technical Complexity and Engineering Challenges During Design and Building Process

RRS “Sir David Attenborough”, Tehnička kompleksnost i inženjerski izazovi u procesu dizajna i izgradnje

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Abstract

Technical presentation of the project for flag ship RRS “Sir David Attenborough”, describing technical complexity and engineering challenges of the electrical systems design and engineering. Overview of the ship’s key features and systems. New generation technologies on board – hybrid propulsion, unified bridge, scientific winch system, underwater imaging system. Engineering challenges - indicating extent of the electrical design with main features described through case examples: cable laying issue due to Main distribution short circuit requirements, EMC regulations – cable routing challenge due to cable segregation requirements, 3D model complexity – Main engine rooms example.

Keywords: *RRS “Sir David Attenborough”; Hybrid propulsion; Unified bridge; EMC; 3D model*

Sažetak

Tehnička prezentacija projekta RRS “Sir David Attenborough”, koja prikazuje tehničku kompleksnost i inženjerske izazove u dizajnu i inženjeringu elektro sustava. Pregled glavnih značajki i sustava na brodu. Nove tehnologije – sustav hibridne propulzije, “Unified bridge” – integrirana kormilarnica, sustav vitala za potrebe znanstvenih istraživanja, sustavi podvodne senzorike. Inženjerski izazovi – prikaz obima inženjeringa elektro sustava s glavnim značajkama, s obradom primjera: problematika polaganja kabela zbog zahtjeva kod izračuna kratkog spoja glavne razvodne mreže, EMC zahtjevi – izazovi rutiranja kabela i slaganja kabelskih trasa zbog strogih zahtjeva za segregaciju kabela, kompleksnost 3D modela – prikaz na primjeru glavnih strojarnica.

Ključne riječi: *RRS “Sir David Attenborough”; Hibridna propulzija; Integrirana kormilarnica; EMC; 3D model*

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24. simpozij Teorija i praksa brodogradnje, in memoriam prof. Leopold Sorta (Sorta 2020), održava se pod visokim pokroviteljstvom Razreda za tehničke znanosti Hrvatske akademije znanosti i umjetnosti.

The 24st symposium on Theory and Practice of Shipbuilding, in memoriam prof. Leopold Sorta (Sorta 2020), is held under the auspices of the Department of Technical Sciences of the Croatian Academy of Sciences and Arts.

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