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Ecological Problems in Ocean Engineering Construction Based on Fuzzy Recognition

Sanders Eduard*

Univ Porto, P-4169007 Porto, Portugal

**corresponding author*

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Abstract: With the development of large-scale building structures and complex structures such as hydraulic engineering and marine engineering (ME), their health during work is related to the vital interests of all parties. The combination of environmental corrosion, material aging, long-term effects of loads, and fatigue factors will cause structural damage, reduce the ability of the structure to resist external influences, and inevitably lead to a decline in the safety of structural performance. ME structures have been operating in harsh marine environments for a long time. Using intelligent monitoring technology to process monitoring signals can invert the damage status of the structure, or use a variety of information to evaluate the overall safety of the structure. The main purpose of this paper is to study the ecological problems in ME construction based on fuzzy identification. Based on fuzzy identification technology, this paper analyzes and studies the environmental risk events existing in the whole process of ME from planning, design, construction and operation, and establishes the risk assessment method and process for the environmental impact of ME construction. Experiments show that ME mainly affects the marine ecological environment from the following four aspects: 1) The occupation of engineering sediment and the impact of dredging operations on benthic organisms; 2) The impact of underwater blasting operations on aquatic organisms; 3) Suspended matter The impact on the marine ecological environment; 4) The impact of domestic sewage, machine sewage and other pollutants on the marine ecological environment.

1. Introduction

With the development and utilization of the ocean by humans, the scale and intensity of nearshore human activities such as reclamation of the sea, coastal aquaculture, and port and waterway construction have continued to increase, destroying the coastal ecological environment and restricting the sustainable development of the ocean. In recent years, with the development of resources and port construction, the scale of reclamation has continued to increase, the artificial coastline has grown rapidly, and the natural coastline has almost disappeared. Marine biodiversity and ecosystem health are facing severe challenges. Its dynamic changes, exploring the impact of typical human activities on the marine ecosystem, and conducting early warning research on the marine ecosystem are of great significance for protecting the marine ecosystem and realizing the sustainable use of marine resources.

In related research, Shekhovtsov mentioned that fuzzy set modification is often used to include uncertain data in the decision-making process. To this end, two methods are shown to identify fuzzy models with partially incomplete data [3]. In a structured approach, the problem is decomposed into several interrelated models. The main thing is to empirically compare their accuracy and determine the sensitivity of the obtained model to the criteria used. Dimaano et al. demonstrated the application of convolutional neural networks for particle recognition in different aquatic environments [4]. Computation is performed in real-time using a Raspberry Pi, a digital microscope camera, and a neural network, thus demonstrating a portable and low-cost environmental aquatic sensor.

Based on fuzzy identification, this paper studies the ecological problems in ME construction. In view of the characteristics of ME in construction and operation, combined with the relevant risk assessment and prevention experience of environmental pollution in construction and operation, based on fuzzy identification technology, this paper analyzes and studies the existence of ME in the whole process of planning, design, construction and operation. To establish the risk assessment method and process for the environmental impact of the ME construction process.

2. Design Research

2.1. Pollution from ME Construction

The main pollution during project construction is divided into two categories: accidental pollution and operational pollution [5-6].

(1) Ships traveling in normal sea areas and waterways, if there is a sudden accident such as collision, grounding, hitting a reef, fire, hull damage, breakage, etc., which leads to oil spill or dredged material leakage, and causes marine environmental pollution problems, it can be qualitatively determined. Accidental pollution for the project;

(2) Operational pollution refers to the pollution caused by ships operating in the channel or by discharging pollutants such as sewage, waste oil and domestic garbage into the ocean. Since the sea area where the project is located is a near-shore sea area, and there are not many ships passing by, relatively speaking, the possibility of oil spill caused by collision between construction ships and other ships is relatively small.

2.2. Risk of Engineering Environmental Events

ME environmental events are unpredictable, including many levels of factors, such as natural factors and resource factors [7-8]. The loss of function of an important part of the system structure or physical chemistry. Once the water body ecosystem is severely damaged or the function changes significantly, the water body ecological environment will face catastrophic damage. It has a great impact on human health and safety, which constitutes a major natural environment event with serious harm. Using the water environment management system, the probability of risk occurrence in the whole system can be estimated and the consequences and losses can be predicted, and the average value of failure and risk in the whole system can be evaluated through comprehensive analysis [9-10].

Risk pollution treatment accidents can generally be subdivided into:

(1) Oil spill accident

(2) Leakage of toxic radioactive chemicals

(3) Accidents caused by explosion and diffusion pollution

(4) A large number of pollutant discharge pollution accidents

Sudden water environmental risks have the following characteristics.

(1) Sudden occurrence of pollution

Sudden water pollution risks do not have any transportation rules. Generally, it is not easy to detect in advance, and the occurrence is relatively sudden. The way of road transportation that is easy to explode is not fixed. For example, if an oil spill accident occurs, it is not every road transportation. Oil spills occur normally in all vehicles in China, and only when certain conditions are damaged or the environment reaches certain conditions [11-12].

(2) The severity of pollution

Due to the contingency of pollution, managers may not have enough preparation time to take countermeasures, so that once serious water pollution disasters occur, they often cause various serious consequences. At the same time, all kinds of water and environmental water pollution disasters and accidents are often fierce. Even if there are certain emergency measures, if the emergency measures are not timely enough, the pollution problem may spread rapidly, which may have affected the surrounding ocean. The safety of the environment or marine workers poses certain serious hazards [13-14]. For ME, the qualified index of water pollution is an important goal of natural water environment quality management. Once a sudden risk of water pollution in the natural water ecological environment occurs in a region, under the combined driving force of various natural winds and water currents, The spread of pollutants may change in an instant, affecting the quality of water extracted by residents, thereby greatly increasing the management cost and difficulty of the ME environment [15-16].

(3) The process and arduousness of emergency response to accidents

There are many possible occurrence and triggering forms of sudden hazards to water environment safety. Every type of water environment safety accident is very likely to occur. It is necessary to take corresponding emergency measures and countermeasures in time to deal with it. If the formulation of risk countermeasures is not appropriate , on the contrary, it may increase the result of the risk and cause harm, so the risk countermeasure needs to be fully discussed and formulated, and it must be consistent with the actual situation of the risk. For example, due to the different physical and chemical reaction properties of toxic chemicals, a targeted scientific and systematic physical and chemical response measures must be taken in time, otherwise it will further cause greater harm to society and the environment. If it is not dealt with in time, under the action of external factors, the process of pollutant migration risk transformation is also very complicated, which will greatly increase the difficulty of risk treatment [17-18].

2.3. Algorithm Research

(1) Channel dredging

Channel dredging will lift up sediment at the bottom, resulting in turbid water quality, thereby affecting the normal activities of aquatic organisms in the surrounding waters. Based on previous research results on the impact of waterway dredging on aquatic organisms, aquatic organisms were divided into four stages (embryo stage, larvae, juvenile fish, juvenile fish, and adult stage), and the effects of different concentrations and durations of suspended solids on aquatic organisms were analyzed. Starting from the Logistic equation, the theoretical equation of the amount of plankton loss caused by dredging caused by the diffusion of suspended matter within its influence range is established:

$$\Delta L_S = \sum_{i=1}^{n-1} \frac{A_i \bar{h}_l C_S}{1+e^{r(LC_{50}-S_0-10i-5)}} + \frac{A_i \bar{h}_l C_S}{1+e^{r(LC_{50}-S_0-\frac{10n+h(T)}{2})}} - \sum_{i=1}^{n} \frac{A_i \bar{h}_l C_S}{1+e^{r(LC_{50}-S_0)}} \tag{1}$$

In the formula, ΔLS is equal to the biomass loss minus the biomass background loss, mg; r is the parameter of the poisoning and value-added ability of suspended solids; LC50 is the semi-lethal concentration of suspended solids that cause the death of plankton, mg/L; S0 is the natural state Suspended matter concentration, mg/L; Ai is the suspended matter diffusion area, m2; □l is the average water depth within the dredged suspended matter diffusion range, m; CS is the plankton biomass before the dredging operation, mg/m3.

(2) Loss of biological resources caused by sewage discharge

The damage to marine living resources within the scope of pollutant diffusion can be divided into one-time damage (<15 days) and persistent damage (⩾15 days) in terms of time span.

1) The average damage amount of one-time damage:

$$W_i = \sum_{j=1}^{n} D_{ij} S_j K_{ij} \tag{2}$$

In the formula: Wi represents the average damage, Dij represents the density, Sj represents the area; Kij represents the loss rate (%), and n represents the total number.

2) The amount of sustained damage

$$M_i = W_i T \tag{3}$$

In the formula: Mi represents the total amount of damage; T represents the period.

3. Experimental Study

3.1. Characteristics of Engineering Environmental Risks

The characteristics of subsea engineering are mainly reflected in:

(1) ME has the exploitability of resources, but at the same time it can also cause destructiveness of resources.

(2) The construction of ME projects should not only focus on interests, but should also take the full development and utilization of existing marine natural resources as the main purpose.

(3) The area where marine pollution spreads is large, and the impact on the ecological environment lasts for a long time.

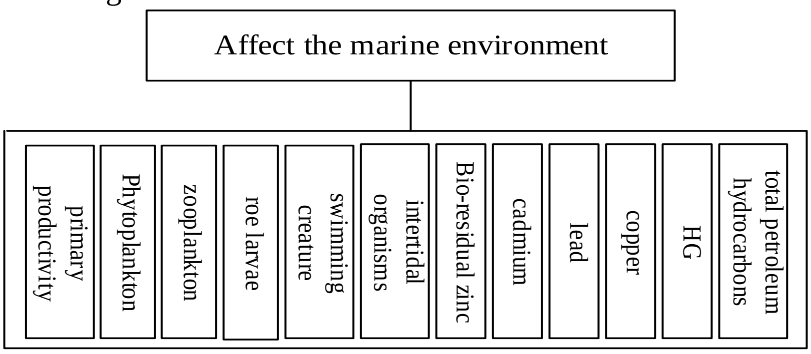

Figure 1. Factors affecting the environmental assessment of marine organisms

Risk analysis factors such as whether the project can adapt to the stability of natural disasters, ensure the safety of the environment, and its own risks during the project construction and operation periods are the main contents of the risk analysis of the project construction. In addition, marine pollution accidents caused by ships passing through the waterway during the construction of the project are also one of the risk accidents.

In the case of increasingly close globalization, marine pollution is often very likely to expand directly through pollution diffusion and evacuation, affecting other sea areas around its oceans, and even directly affecting the entire marine world.

First, the prevention and control of ME pollution is difficult, the impact is large, and the harm is extensive. The environmental pollution and natural hazards caused by some large-scale ME construction projects to the local marine fishery resources, ecology, and environmental protection construction in the early stage of completion are not easily discovered by the relevant local administrative departments in a timely manner. This is because the marine pollution problem needs to have a continuous cycle, and it may be the result of accumulation over a long period of time. It is difficult to detect in time. When it is discovered, it has generally accumulated for a period of time, so it needs longer-term governance measures to support, Only in order to mitigate the problem and even eliminate the impact in a targeted manner, the cost of governance is usually expensive.

Second, submarine ME generally has the characteristics of high durability and long life. In the long-term operation and maintenance process, the marine ecological environment has to withstand long-term tests, because the environmental pollution and damage caused are unpredictable, whether there is a greater impact , it still needs scientific research and demonstration. In addition, the pollution control of submarine ME requires stricter environmental science and technology management specifications, as well as relatively accurate environmental monitoring equipment.

Third, the pollution control of submarine ME is not simple. It integrates a variety of disciplines and has a certain scientific and technological content. The technical difficulty of the control process is also relatively large. Whether the project construction and operation and maintenance process has a greater impact on the environment, it is necessary to conduct environmental risk analysis and assessment in a timely manner, seek research opinions from experts and scholars in a timely manner, and use various advanced and high-tech detection methods to conduct auxiliary analysis. In general, the construction of cross-sea oceans requires continuous monitoring, especially the monitoring of marine ecological data. The construction environmental conditions of subsea ME are relatively complex, and various environmental pollution and damages may be caused during construction and operation. Therefore, it is necessary to establish a relatively complete set of environmental science and engineering technology, and to clarify the relevant standards for environmental pollution monitoring. Standardize, analyze and put forward countermeasures for environmental pollution prevention and control, but at present domestic and even world research results in this area are still vacant.

3.2. Identification of Engineering Environmental Risks

(1) Construction period

This paper focuses on the environmental risk management of ME, mainly studies the impact of the construction and operation of ME on the environment, and the use of shield tunneling method during the construction period will have an impact on marine hydrodynamics;

1) The scattering that occurs in the storage of the mud transporter in the mud pool will have an impact on the marine environment;

2) For the impact of soil erosion, reasonable treatment methods must be taken to avoid soil erosion and affect the marine environment;

3) Daily sewage produced by construction workers in their daily life and work;

4) Waste water discharged during construction, waste water from cleaning of transport vehicles, oil leakage, waste oil from replacement of related equipment, etc.;

5) The impact of the sound environment, the vibration of construction equipment during the construction period, and the working noise that will be generated;

6) Various domestic wastes generated during the work and accommodation of construction workers;

7) Various waste slag, waste slag and other construction waste discharged during construction.

(2) Operation period

The possible environmental impact factors during the project operation period are mainly the impact on the environment when a risk accident occurs.

1) Analysis of pollutant discharge during operation period

According to the environmental supervision reports during the construction period of previous projects, the impact of marine construction on the marine environment mainly includes the following aspects: the factors affecting the seabed topography during the construction process include soil erosion, domestic sewage, domestic garbage and construction spoils.

2) The impact of construction on the seabed topography

In addition to the subsea ocean being the content of sea-related engineering construction, the shield originating well and receiving well also belong to it. The subsea ocean part is operated by muddy water pressurized shield machine. In the land area to the north of the North Road near the intersection and the north of the North Bank Planning Road near the intersection, there is covering soil in the water section at the top of the ocean crossing the sea, with a thickness of about 12m. The covering soil in the water section does not occupy the water body of the sea area, but occupies the space for natural flow . In addition, although the construction of the shield method has less disturbance to the seabed, it still has a certain influence on the disturbance of the seabed. It can be seen that the construction of the shield method cannot avoid being affected by the original stress state of the stratum and changes accordingly, thereby changing the in-situ stress field, and in severe cases, it will cause the surface heave.

4. Experiment Analysis

4.1. Analysis of Biological Resource Loss in Sewage Discharge

Offshore engineering projects are large-scale construction projects with long construction and many personnel. In addition to project sewage, sewage discharge also includes domestic sewage during construction, mainly waste water from daily life. The sewage discharge coefficient is taken as 0.9, and the specific results are shown in the table.

Table 1. Comparison of domestic sewage and pollutant emissions

Project	Daily emissions (kg)	Total emissions during construction (t)
Domestic sewage	36000	6480
Suspended solids	7.20	1.30
BOD5	7.20	1.30
CODcr	18.0	3.24

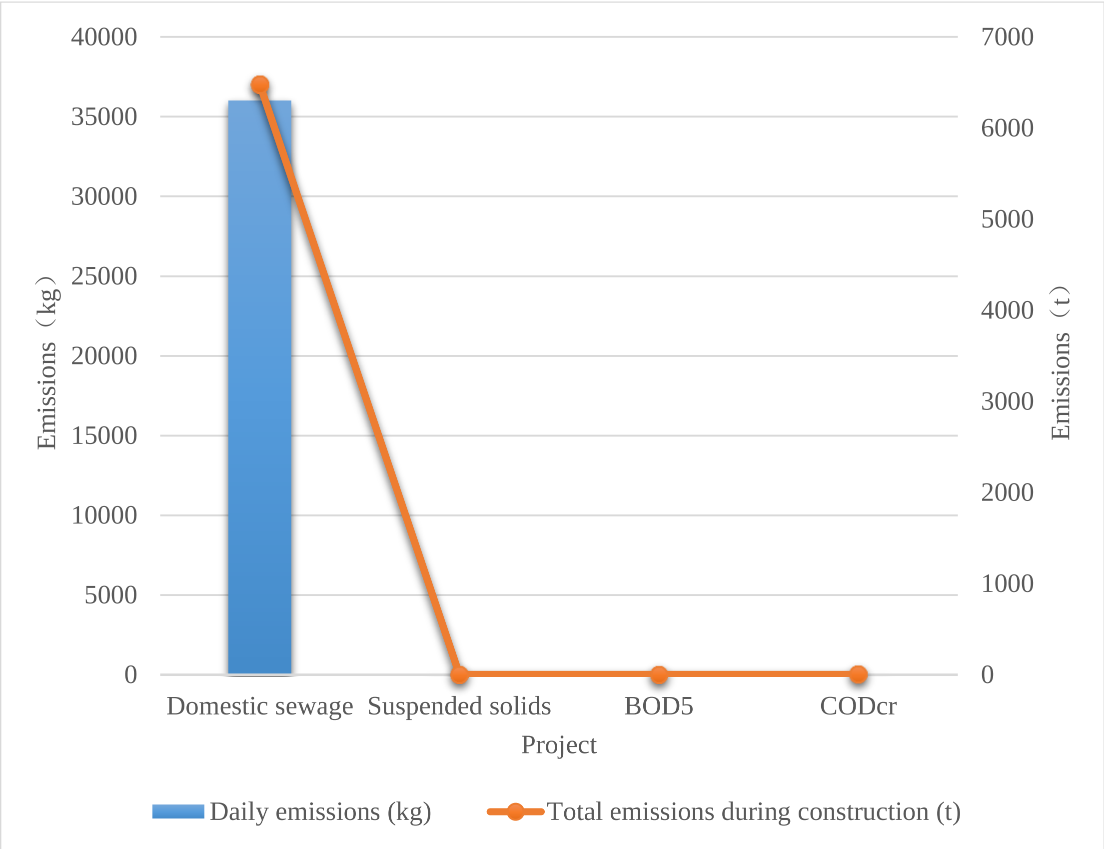

Figure 2. Comparative analysis of domestic sewage and pollutant emissions

Based on the results of studies on the effects of aquatic organisms, aquatic organisms were divided into four stages (embryo stage, larvae, juveniles, and adult stages), and the effects of different concentrations and durations of pollutants on aquatic organisms were analyzed. The average damage amount of one-time damage is shown in the following table:

Table 2. Various types of biological loss rates

	Various types of biological loss rate (%)			
Excessive multiple of pollutant i (Bi)	Roe and larvae	adult	zooplankton	Phytoplankton
Bi⩽1 times	5	<1	5	5
1<Bi⩽4 times	5~30	1~10	10~30	10~30
4<Bi⩽9 times	30~50	10~20	30~50	30~50
Bi⩾9 times	⩾50	⩾20	⩾50	⩾50

4.2. Assessment of Loss of Biological Resources in ME

The loss of biological resources caused by ME construction should be considered from the construction period and the use period. Research shows that the loss of biological resources mainly comes from the construction period. The entrainment effect will also cause losses to biological resources. This paper mainly focuses on the ecological losses caused by most general marine projects during the construction period.

Table 3. Relationship between maximum peak pressure and biological lethality

Distance from blasting center, m	Maximum peak pressure, kg/cm2	Fatality rate of fish (except Shishouidae), %	Mortality rate of stoatidae fish, %	Shrimp lethality, %
100	7.27	100	100	100
300	1.69	20	100	20
500	0.745	10	50	6.6
700	0.577	3	15	0

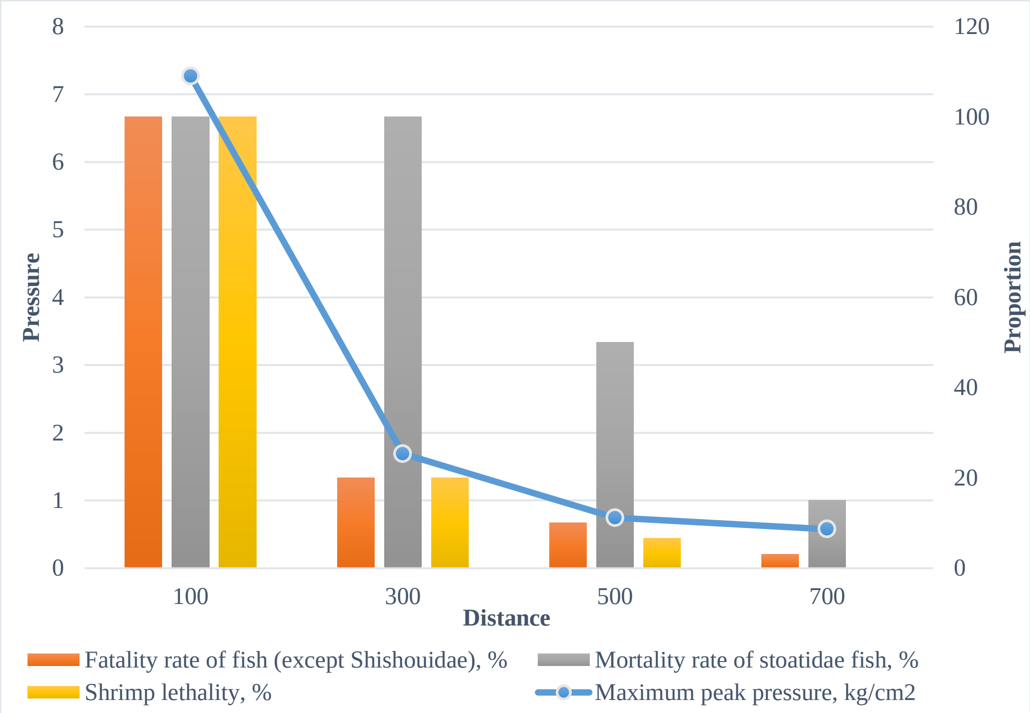

Figure 3. Analysis of the relationship between maximum peak pressure and biological lethality

The construction of the project may affect the marine ecological environment from the following four aspects: 1) the occupation of the engineering sediment and the impact of the dredging operation on the benthos; 2) the impact of the underwater blasting operation on the aquatic life; 3) the 4) The impact of pollutants such as domestic sewage and oily sewage from ship engine rooms discharged by construction workers into the seawater on the marine ecological environment.

5. Conclusion

Risk assessment and prevention of environmental pollution in the project requires strict experience summarization and technical regulations. In view of the characteristics of ME in construction and operation, combined with the relevant risk assessment and prevention experience of environmental pollution in construction and operation, based on fuzzy identification technology, this paper analyzes and studies the existence of ME in the whole process of planning, design, construction and operation. To establish a risk assessment method and process for the environmental impact of ME construction, to provide a certain reference for environmental risk management and risk prevention in ME. The characteristics of ME determine that the road to risk management of submarine ME is very difficult. Although some achievements have been made, there is still a long way to go. It is still necessary to continuously summarize the experience of risk management and sort out more suitable prevention and control measures. This is also the research significance of this paper.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Muneez M . Protection of Submarine Optical Fibre Cables in the Strait of Malacca. Journal of Marine Environmental Engineering, 2021, 10(4):291-304.

[2] Minggat E , Roseli W , Tanaka Y . Nutrient Absorption and Biomass Production by the Marine Diatom Chaetoceros muelleri: Effects of Temperature, Salinity, Photoperiod, and Light Intensity. Journal of Ecological Engineering, 2020, 22(1):231-240. https://doi.org/10.12911/22998993/129253

[3] Shekhovtsov A , Koodziejczyk J , Saabun W . Fuzzy Model Identification Using Monolithic and Structured Approaches in Decision Problems with Partially Incomplete Data. Symmetry, 2020, 12(9):1-19. https://doi.org/10.3390/sym12091541

[4] Dimaano R , Adion A , Brucal J , et al. ANTIPARA (Analysis of Tiny Particles in Aquatic Environment): A Water Scanning Device for Microplastics. International Journal of Advanced Trends in Computer Science and Engineering, 2020, 9(4):5217-5221. https://doi.org/10.30534/ijatcse/2020/150942020

[5] MD Arifin, Felayati F M . Numerical Study of B-Screw Ship Propeller Performance: Effect of Tubercle Leading Edge. International Journal of ME Innovation and Research, 2021, 6(1):16-23. https://doi.org/10.12962/j25481479.v6i1.8702

[6] Nasar T , Sannasiraj S A , Sundar V . Effect of porous baffle on sloshing pressure distribution in a barge mounted container subjected to regular wave excitation. Journal of Naval Architecture and ME, 2020, 17(1):1-30. https://doi.org/10.3329/jname.v17i1.42001

[7] Kamal I , Ismail A I , Abdullah M N , et al. Influence of the transom immersion to ship resistance components at low and medium speeds. Journal of Naval Architecture and ME, 2020, 17(2):165-182. https://doi.org/10.3329/jname.v17i2.48494

[8] Houssem L , Mustapha H . Enhancement of natural convection heat transfer in concentric annular space using inclined elliptical cylinder. Journal of Naval Architecture and ME, 2020, 17(2):2070-8998. https://doi.org/10.3329/jname.v17i2.44991

[9] Glennie A . Adam Constable (ed), Keating on Offshore Construction and ME Contracts. Edinburgh Law Review, 2020, 24(1):153-154. https://doi.org/10.3366/elr.2020.0614

[10] Franula N . Journal of Marine Science and Engineering. Geodetski List, 2020, 74 (97)(2):268-269.

[11] Kaya A , Bahan V , Ust Y . Selection of marine type air compressor by using fuzzy VIKOR methodology:. Proceedings of the Institution of Mechanical Engineers, Part M: Journal of

Engineering for the Maritime Environment, 2022, 236(1):103-112. https://doi.org/10.1177/14750902211028791
[12] Khondoker M , Hasan K R . Waste Management Of A Maritime Port: The Case Of Mongla Port. Journal of Naval Architecture and ME, 2021, 17(2):219-230. https://doi.org/10.3329/jname.v17i2.48925
[13] Laaouidi H , Tarfaoui M , Nachtane M , et al. Modal analysis of composite nozzle for an optimal design of a tidal current turbine. Journal of Naval Architecture and ME, 2021, 18(1):39-54. https://doi.org/10.3329/jname.v18i1.53193
[14] Dy A , Ao A , Ysa B , et al. Managing the exchange of energy between microgrid elements based on multi-objective enhanced marine predators algorithm. Alexandria Engineering Journal, 2022, 61(11):8487-8505. https://doi.org/10.1016/j.aej.2022.02.008
[15] Yakout A H , Attia M A , Kotb H . Marine Predator Algorithm based Cascaded PIDA Load Frequency Controller for Electric Power Systems with Wave Energy Conversion Systems. AEJ - Alexandria Engineering Journal, 2021, 60(4):4213-4222. https://doi.org/10.1016/j.aej.2021.03.011
[16] Romanoff J , Remes H , Varsta P , et al. Limit State Analyses in Design of Thin-Walled Marine Structures- Some Aspects on Length-Scales. Journal of offshore mechanics and arctic engineering, 2020, 142(3):030801.1-030801.8. https://doi.org/10.1115/1.4045371
[17] Kamal I , Ismail A I , Abdullah M N , et al. Influence of the transom immersion to ship resistance components at low and medium speeds. Journal of Naval Architecture and ME, 2020, 17(2):165-182. https://doi.org/10.3329/jname.v17i2.48494
[18] Baitharu A P , Sahoo S , Dash G C . Heat and mass transfer effect on a radiative second grade MHD flow in a porous medium over a stretching sheet. Journal of Naval Architecture and ME, 2020, 17(1):51-66. https://doi.org/10.3329/jname.v17i1.37777