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Analysis of the Behaviour of the Floating Systems Used for Boundary of River-Sea Recreational Activities Area

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ABSTRACT

The natural areas for swimming represent protected areas specially arranged for avoiding possible pollution risks. Considering the strict restrictions imposed on the recreation domain, the swimming areas must be strictly and visibly delimited from the zones where other recreational activities are carried out (mooring of charter ships, practicing water sports, etc.) and that are associated with possible health risks. For this purpose, a floating system based on a flexible composite structure, with a fabric matrix, for signalling and demarcating coastal areas that can be used in maritime and fluvial areas, for a depth of 3 m was designed and developed. For assessing the gravimetric and functional level of performances of the floating system the experimental trials was performed at the shore. The geometry and corresponding values of the system are in accordance with the technical data previsioned in the execution documentation. The experiments performed in the open sea demonstrated that the composite material behaved appropriately and there were no situations associated with damages of the materials. In addition, no damage to the textile material or modification of the geometric shape of the solid was recorded.

Keywords: Floating system, Open area, Great saltwater experimental trials, Composite material, Qualitative management

INTRODUCTION

The network of river courses that cross the territory of Romania has a total length of 118,000 km, to which is added the aquatic part of the Romanian coast (the Black Sea and the harbors), with an area of 39,940 km2 (Andrei et al. 2021). The UNESCO Biosphere Reserve (the shore of the Delta Danube and the Razim Sinoe complex) has an area of over 6000 ha. In these areas, tourism that includes recreational activities (when the environmental condition are suitable) can be extended within the natural aquatic reserves set up, being mainly represented by swimming. Nautical agreement beaches and ports located on the Black Sea coast and natural inland waters are defined by the land parts or coastal strip adjacent to the sea, lakes or any other aquatic zones dedicated for the general public recreational and sportive activities. For example, Tomis is a leisure port located at north part of Constanta city,

with an area of 22 ha that is intended for seasonal - summer activities such: mooring of charter ships, practicing water sports and swimming. For the Marine Reserve 2 Mai - Vama Veche, the custodian is the Constanta Environmental Protection Agency with external coordinates in the western part, the shoreline defined by the following coordinates: NW: 43 °47'18" lat. N and 28 °34' 57" long. It is; NE: 43 °47' 18" lat. N and 28 °41' 30" long. E; SW: 43 °44'20" latitude-N and 28 °34' 51" longitude-E; SE: : 43 °44'20" latitude - N and 28 °41' 30" longitude-E. The areas set up for swimming and recreation are protected by international law and are carefully supervised, marked and delimited with the help of signalling systems that warn in cases of potential risk areas (e.g., unevenness of the slope, with an inclination that exceeds the ratio 1:10 - 1:15 for depths up to 1.50 m or 1:3 for greater depths) (Gâf-Deac et al. 2015, Peterson et al. 2021). Additionally, special attention is paid to the delimitation of the bathing area with a depth of less than 0.70 m, for children and people who do not swim for various reasons, the marking for avoiding possible accidents being ensured by floating systems made of composite material, with a woven structure matrix (Wang et al. 2019, Williams et al. 2000). Moreover, the area base lithology represented by the bottom of the river, lake or sea - for max. 1.50 m should be made of sand and small gravel, without stones or other materials that can cause injury to swimmers and without aquatic vegetation that can generate the danger of drowning (Li et al. 2022). The researches were targeted to the design and development of a floating system in the shape of a right circular cylinder, based on a flexible composite structure, with fabric matrix, for signalling and demarcation of the coastal areas. This innovative system can be used in maritime and fluvial areas, for a depth of 3 m. The geometric, dimensional and structural elements were predicted using FEM modeling.

MATERIALS AND METHODS

The experimental trials at shore were carried out between 28.05 - 08.06.2022 in meteorological conditions specific to this interval and to the zone were the product was placed. The physical-mechanical characteristics of the composite material used for the fabrication of the floating element for marking the agreement areas are presented in Table 1.

The types and dimensions of the panels and the functional characteristics of the floating element are presented in Figure 1.

The meteorological data were measured in the following conditions: i) station set up in Tuzla at 22.3km from Constanta, ii) coordinates of the floating system placement: Lat. 43.985 Lon. 28.607 Altitude 50m, iii) period: 28.05 – 08.06.2022, iv) frequency: every 24 hours. The dangerous phenomena, such as descending gusts (white squalls, formed as a result of the rise of water in the atmosphere and the formation of cumulonimbus clouds) and nebulosity were recorded.

Experimental meteorological conditions are presented in Figure 2 and Table 2.

Table 1. Physical-mechanical characteristics of the composite material and floating element dimensions.

Variant of the composite material	V1
Fibrous composition warp/weft	100% PES
Mass, g/sqm	280
Tear resistance, warp/weft, daN	2.2/2.3
Breaking resistance, warp/weft, daN	180/200
Breaking elongation, warp/weft %	18/18
Colour	green
Constructive shape	right circular cylinder
Diameter x generators, mm	450 × 1200
Floating element mass, kg	3.65

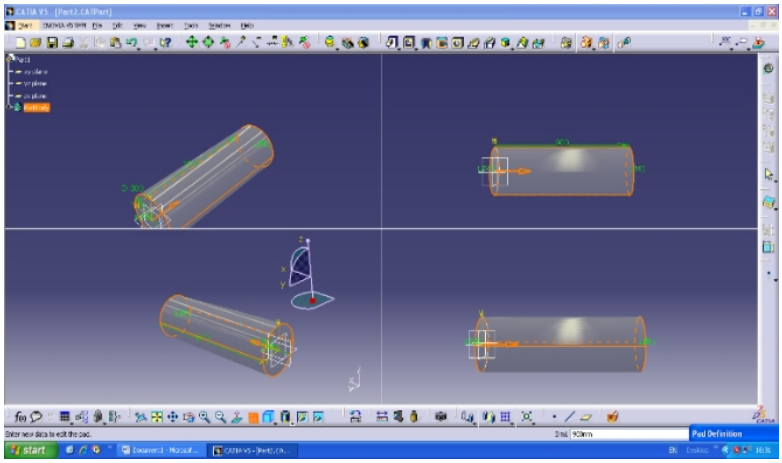

Figure 1: Right circular cylinder panels.

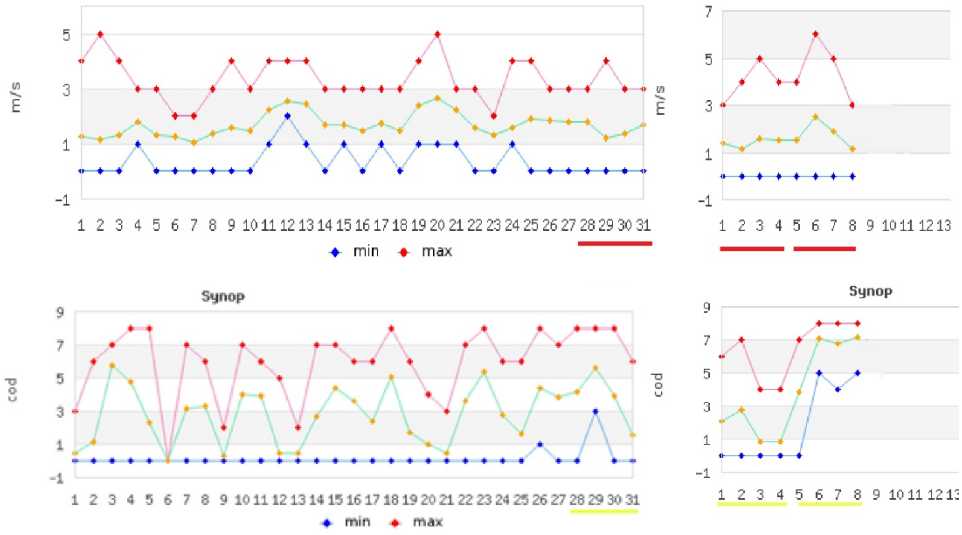

Figure 2: Wind speed and cloudiness assessed according to Synop messages.

Table 2. Experimental meteorological conditions.

Date	Min - Max Temp, °C	Main Icon	Description
28.05	13 - 23		A few clouds at 4600m. Partly cloudy sky. Scattered clouds at 1200m. Dispersed clouds at 6100m. Stable wind, max 22 km/h
29.05	17 - 22		Electric discharges. Cumulonimbus dispersion. Thunderstorm with lightning. Scattering clouds at 610m. Cloudy at 1200m. Dispersed clouds at 4600m. Stable wind, max 26 km/h
30.05	16 - 24		Partly cloudy. Scattered clouds at 910m. Dispersed clouds at 2100m. Scattering clouds at 4600m. A few clouds at 910m. Dispersed clouds at 6100m. Stable wind max 23 km/h.
31.05	16 - 26		Serene. Light fog. A few clouds at 1200m. Steady wind, max 20Km/h
01.06	17 - 24		Serene. Few clouds at 6100m. Steady wind, max 20Km/h
02.06	17 - 27		Few clouds: Scattered Clouds at 6100m. A few clouds at 1100m. Steady wind, max 20Km/h.
03.06	17 - 28		Serene. Clear: Light fog. Serene Steady wind, max 26Km/h
04.06	15 - 26		Serene. Few clouds. A few clouds at 6100m. Steady wind, max 29 Km/h
05.06	16 - 28		Scattered Clouds at 6100m. Electric discharge. Scattered Cumulonimbus. Clouds at 1100m. Thunderstorm in the proximity. Stable wind, max 22Km/h
06.06	17 - 22		A few clouds at 1800m. Scattering clouds at 4900m. Partly cloudy. Scattering clouds at 2400m. Steady wind, max 26Km/h
07.06	16 - 22		Scattering Clouds at 1400m. Cloudy at 1800m. Scattered Clouds at 910m, Scattered Clouds at 2700m. Stable wind, max 22Km/h
08.06	16 - 20		Rain. Scattered clouds at 300m. Cumulonimbus dispersion. Clouds at 760m, Scattering clouds at 1500m. Torrential rain. Light fog. Scattering Clouds at 1800m. Stable wind, max 27Km/h

Between 28.05 - 08.06.2022, inspections of the floating element located in the open sea were carried out. Aspects from the performed inspections are presented in Figure 3.

Figure 3: Aspects from the inspections performed during 28/05/2022 and 08/06/2022.

RESULTS AND DISCUSIONS

- During the experimental trials, there were no implosions of the floating element, it maintained the geometry and implicitly the dimensions, the dynamic loads arising under the action of external forces (min. 250 daN) being evenly distributed on anchors.

- The functional trials evidenced that the subassemblies used to fix and support the floating element have a suitable behavior. Thus, the main "dead head" type anchors used for reinforcement were buried in the substrate, and the anchor chains did not presented any damage. Additionally, the anchoring system ensured the stability of the floating element in the previously defined hydrometeorological conditions.

- The buoyancy was kept according to the values imposed by the project of execution, namely 85 kgf.

- Graphic interpretation:

a. no dangerous meteorological phenomena, such as descending gusts, were recorded because the maximum value of the wind speed (recorded by the TUZLA Meteorological Station) was 6m/s, on 06.06. For the rest of the experimental period, the wind speed values were in the range of 3–5 m/s.

b. regarding nebulosity:

- on 28/05, 29/05, 30/05, 06/06, 07/06 and 08/06/2022 the sky was completely covered by clouds, the minimum value recorded with code 5, and the maximum with code 88.

- on the other days of experimentation, the sky was covered with Altocumulus or Stratocumulus perlucidus clouds (code 7 or lower). Persistent condensation trains, formed in the condensation trains left by aircraft, were considered as clouds (corresponding to the code for CH or CM).

CONCLUSION

The experiments carried out in the open sea conditions imposed the consideration of the specific features of a continuously moving surface (due to sea waves and currents), with large temperature variations and difficult meteorological conditions.

The inspections were carried out by an interdisciplinary team of researchers and specialists of The National Institute for Marine Research and Development "Grigore Antipa" Constanta - curator for protection and management of coastal and marine environment in the economic exclusive zone of Romania at the Black Sea coast.

The selected composite materials, the geometry chosen for the floating element – right circular cylinder and the types of sewing joints corresponded to the specific hydrodynamic demands of the open sea.

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REFERENCES

Andrei J. V., Avram S., Băncescu I., Gâf-Deac I. I., Gheorghe C., - "Evolution of Romania's Economic Structure and Environment Degradation – An Assessment Through LMDI Decomposition Approach", Risk Manag Health Policy, 24 August 2021, Volume 2021:14 Pages 3505—3521 Taylor & Francis Group, The Academic Publishing Division, ISSN: 1179–1594.

Gâf-Deac Ioan I. et al., (2015)- "Circular economy and ethics of profit sharing, - W.3, Human Capital, Knowledge, Innovation, Smart Development", The Economic Scientific Research – Theoretical, Empirical and Practical Approaches, ESPERA 2015, International Academic Publishing Group, Peter Lang, Deutsche Nationalbibliothek.

Li Yanwei, Li Xiang, Ren Nianxin, Ou Jinping (2022)– "Hydrodynamic Responses of a Novel Modular Floating Structure System With Multi-Direction Expansion" - Journal of Offshore Mechanics and Arctic Engineering. The American Society of Mechanical Engineers, volume 145, Issue 3.

Peterson, Bjork Christina, Jeppesen Bekker Maj, Aadahl Mette, Lau Juel Cathrine, (2021) "Participation in recreational activities varies with socioeconomic position and is associated with self-rated health and well-being", Preventive Medicine Reports, Vol. 24, 10610.

Wang Gil, Goldfeld Yiska, Drimer Nitai, (2019) - "Expanding coastal cities – Proof of feasibility for modular floating structures (MFS)", Journal of Cleaner Production, Volume 222, pp. 520–538.

Williams A. N., Lee H. S., Huang Z., (2000) – "Floating pontoon breakwaters" Ocean Engineering, Volume 27, Issue 3, pp. 221–240.