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Editorial

Coastal Engineering: Sustainability and New Technologies

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Coastal engineering is a constantly evolving discipline, in which it is essential to seek a balance between the natural character of the coastal zone and the integration, to a greater or lesser extent, of human activities in that space. Between 2020 and 2023, thirty scientific articles addressing any aspect of coastal engineering related to the sustainability or application of novel technologies were published in a Special Issue. A book, entitled "Coastal Engineering: Sustainability and New Technologies", compiled these papers and presented contributions addressing environmental concerns related to the following topics: maritime works (coastal, port, and offshore activities); coastal evolution; climate change; sea level rise and its influence on the design, construction, and/or maintenance of maritime infrastructures; sustainability in the sea; marine renewable energies, including offshore wind, and novel aspects such as the application of new materials; the calculation of the carbon footprint; the use of neural networks; and the use of BIM, etc. A brief overview of the work collected is provided in this paper.

New technologies applied to different marine and coastal structures, from port infrastructures to offshore wind platforms, moored vessels to fish vessels on the sea, were presented in 18 papers.

The application of the building information modeling (BIM) method to manage port infrastructure maintenance is very scarce and is currently in its infancy. Valdepeñas et al. [1] presented a new infrastructure conservation management method that combines traditional methods with new technology in an attempt to address the gaps in the implementation of BIM in port maintenance. To demonstrate that coastal bathymetry can be estimated using panorama video by employing video stitching and wave speed inversion algorithms applied to imagery from two UAVs transiting along the coast, Fan et al. [2] extended video stitching to nearshore bathymetry for videos that were captured for the same coastal field simultaneously by two unmanned aerial vehicles (UAVs). With regard to the requirements of port handlings, and the ability of terminals to respond to emergency needs, Li et al. [3] presented twin yard crane scheduling; they considered the dynamic cut-off time and the non-crossing constraints of yard cranes in order to enhance the flexibility of container yard handling. Machine learning was used by Alvarellos et al. [4] to predict moored ship movement. With the movement data of 46 ships recorded in the Outer Port of Punta Langosteira (A Coruña, Spain) from 2015 until 2020, they created neural networks and gradient-boosting models that predict the six degrees of freedom of a moored vessel using ocean meteorological data and ship characteristics. For the same Port, Sande et al. [5] presented and analyzed field data obtained during the winters of 2017 and 2018 pertaining to the wave pressure in the crown wall structure, together with metocean variables measured on a buoy located very near to the breakwater. The data were compared with the results of the application of state-of-the-art equations for the calculation of pressures on crown walls. Park et al. [6] conducted marine experiments using V-pass and AIS terminals in order to determine the location of fishing vessels and thus improve the prompt rescue of fishing vessels in the occurrence of accident. For the oscillating water column (OWC), one of the most important wave energy converters, Juan et al. [7] presented a review of studies addressing the ways in which wave and geometric characteristics affect the performance of an OWC and those addressing the relationships between these characteristics and the hydrodynamic performance of an OWC. Floating offshore wind platforms were analyzed in three papers. For floating offshore wind platforms built using concrete, Cordal-Iglesias et al. [8] developed a beta version of a software called Arcwind in order to establish a framework for the development of an economic analysis tool. Vázquez et al. [9] presented a systematic analysis of prevalent corrosion prediction models and a tool developed for estimating diameter loss during the reinforcement of concrete structures in offshore wind farms. Encalada-Dávila et al. [10] proposed a design for a laboratory down-scaled vibration test bench for offshore jacket-type foundations in order to collect data and devise predictive maintenance strategies. The vibration test was based on a lab-scale wind turbine jacket foundation associated primarily with an offshore environment. For offshore steel structures subject to harmful vibrations, Zhang et al. [11] proposed a compensating measure containing the ocean environment in the adaptive control scheme, and presented numerical experiments conducted on a platform model with varying parameters in order to test the performance of the proposed adaptive controller. Piles are widely utilized in the foundation of streetlamp posts, coastal trestle bridges, and offshore wind power poles since they can bear vertical and lateral loads. Therefore, determining the ultimate lateral capacity of the wing piles and the extent of the plastic zone of the surrounding soil under lateral loading for piles is crucial. Wang et al. [12] provided a theoretical basis for the reinforcement of the soil around multi-wing piles in Dapeng Bay.

Numerical modelling solving Reynold Average Navier–Stokes equations, otherwise known as RANS models, has been extensively applied in coastal engineering around the world, but the models still require improvement and verification for some applications. In this book, five papers present the development and/or validation of various RANS models. Peng et al. [13] presented the simulation of a regular wave transformation on the slope of breakwater with an artificial block using DualSphysics. Brito et al. [14], applying the same model, employed DualSphysics to study the power absorption of a constrained wave energy hyperbaric converter (WEHC) under full-scale sea wave conditions. Didier et al. [15] presented methodologies using the FLUENT® numerical model to simulate interactions between waves and impermeable and porous costal structures, involving wave breaking and overtopping. Zhu et al. [16] applied Openfoam to the study of the effects of a solitary wave, simulating extreme waves generated by hurricanes or tsunamis, on the multiple semi-circle porous medium breakwater, which is used in marine engineering protection. The 3D hydrodynamic model Delft3D-FLOW was implemented and validated by Sánchez et al. [17] in order to analyze the impacts of tidal stream energy exploitation on the hydrodynamics of the Ria de Ortigueira, in the westernmost area of the Galician Rias Altas (NW Spain).

Physical modelling was used by Adibhusana et al. [18] in order to study the overtopping flow velocity (OFV) and the overtopping layer thickness (OTL), two important parameters in breakwater design. In this study, the overtopping of regular waves over a composite breakwater with tetrapod armor units was tested. A digital-image-based velocimetry method and bubble image velocimetry (BIV) were employed to measure the OFV and the corresponding image was digitized in order to obtain the OLT.

Sustainability was discussed in 12 papers.

Since many of the world's offshore platforms are approaching or have exceeded their design life, many researchers are endeavoring to study the repair and reinforcement of damaged components in offshore platforms. Zhang et al. [19] proposed a new type of wedge gripping for the grouting clamp, the most repaired component of offshore platforms. Ergodan et al. [20] investigated how preexisting biofouling and corrosion products on the vertical uncoated steel surfaces of offshore wind monopile foundations in seawater at Port Canaveral, FL, extending from the intertidal zone to the buried zone, affected the cathodic protection requirements when impressed current cathodic protection (ICCP) was applied under tidal conditions.

The accuracy of the calculation of forces and moments caused by wave action over the crown wall structures of breakwater is crucial to their design, especially the sea level rise caused by climate change and the possible damage of the armor are considered, since both aspects are not conventionally considered in most original design studies. In the context of climate change, it is vital to estimate the possible changes in security factors caused by both of these aspects, comparing the results with those of the original design. Pereira et al. [21] compared the forces and moments obtained for different equations in different scenarios, including the current and considering the sea level rise and armor damage, when applied to Ericeira breakwater.

A large number of cables and pipelines are distributed on the bottom of the Yellow River Delta, which is an important area for offshore oil and gas production; thus, soil resistance is a critical factor in their stability. Yang et al. [22] classified and calculated the variation in the soil layers using the cone penetration test (CPT) in the Yellow River Delta, where the impact from the river and the dynamics of the ocean tides make the soil composition and distribution in this area very complex.

The International Maritime Organization, with a new convention in MARPOL 73/78, announced that, throughout the world's oceans, the sulfur content in marine fuels should not exceed 0.5% of the mass. In this context, three research papers are presented in this book. The first, by Sultanbekov et al. [23], addresses the problematic active sedimentation of residual and mixed fuels caused by the loss of stability, and its relevance during storage and transportation, especially in marine contexts. Smyshlyaeva et al. [24] assessed and compared the effects these two heavy oil residues on the sedimentation stability of residual marine fuels: the vacuum residue (VacRes) and the visbreaking residue (VisRes). The third addresses the corrosion of reinforcement induced by chloride ion. Ju et al. [25] presented mesoscopic numerical models for concrete, considering various coarse aggregate contents and grading conditions, in order to further investigate and quantify the influence of comprehensive concrete material factors on chloride transport characteristics.

Maritime transport and ports are significant sources of pollution. Herrero et al. [26] presented the potential reductions in CO_2 emissions calculated for the last 11 years (2011–2021) close to urban areas in the Port of Santander (Spain). They distinguished yearly emissions per type of vessel and provided real information to port authorities so as to prioritize the installation of an On-Shore Power Supply (OPS), Cold Ironing (CI) or Alternative Marine Power (AMP) for the operation of piers/terminals in order to optimize investments and outcomes.

Regarding the sustainability of civil engineering works, including those associated with the maritime industry, Ortega et al. [27] presented a novel building material: mortars prepared using sustainable cements and lightweight aggregates comprising natural cork and expanded clay.

The development of sustainable and nature-based coastal protection solutions is critical for many coastlines vulnerable to erosion. D'Hurlaborde et al. [28] described the development of innovative artificial substrate screening methodologies using an optimized recirculating aquaculture system (RAS).

To capitalize on marine resources and minimize the exploitation of fresh water, some seawater is added during the process of preparing microbial-induced calcium carbonate precipitation (MICP) cementitious calcareous sand materials. Wang et al. [29] proposed the application of MICP technology and conducted a series of solidification tests in natural seawater and freshwater environments in order to determine the mechanical behavior of calcareous sand treated using MICP in a seawater environment.

Aquaculture is a sector with significant potential for growth, is a food source of great nutritional value, and provides substantial socioeconomic benefits. Recent research has demonstrated the potential development of systems devoted to aquaculture organisms using groundwater, as they are fundamental to preserving its quality and quantity. Ortiz et al. [30] proposed finding the resistivity of aquifer water and its relationship with the saturated formation of the coastal area of Guasave, Sinaloa, as well as the relationship between the resistivity of the aquifer water and the concentration of groundwater ions necessary for the survival of shrimp; this enabled the researchers to infer the groundwater quality required for shrimp farming and to select the ideal groundwater extraction sites for aquaculture.

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