MARINE ECO ENGINEERING NEWS

FEBRUARY 2023

EXO Engineering

EDITORS NOTE:

Marine Eco Engineering news is formulated for Exo Engineering partnerships and collaborations. We view this publication as an opportunity to hear from our partners, associates, and researchers, to forge new collaboration opportunities and strengthen existing connections.

In this February 2023 issue we will report on the first Living Windfarm Project Workshop, the installation of 5000kg Eco Rock Armour for the Environment Agency at Newlyn and the different loading tests carried out at the Port of Brightlingsea to analyse the impact forces that Eco Reefs might experience during transportation and deployment. We will also report on the SARCC final conference we organised in December 2022 in Southend-On-Sea and our latest innovative product.

COLOPHON:

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Contact: will.m@exo-env.co.uk

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AN INTRODUCTION TO THE TEAM

The team at Exo Engineering boasts a wealth of experience in ecological engineering design innovation, concrete chemistry, and environmental research. We asked each team member about their role, what they are most excited about for the future of Exo Engineering, and what they see as the opportunities and challenges ahead. In the previous issue, we introduced William Coulet and David Miko, Will Melhuish and Nelly Sirri. This issue features more members of the team.

IZAAK REEDER

Izaak has been with Exo for 3 years and has a background in physical sciences having studied Environmental Earth Sciences (MSc) at the University of East Anglia. He has helped develop Exo's GeoBlock® technology and products such as Eco-Rock Armour. **Izaak recognises that there are currently challenges in expanding from small scale product trials to large scale projects, but he sees opportunities arising as Exo Engineering grows its mass production capability to produce units that can be deployed at scale.** "There needs to be greater outreach to councils, local planning authorities and private companies to illustrate the advantages and practical workability of eco engineering. This will help increase its appeal to wider industry, and hopefully increase uptake".

JACK CATTERMOLE

Jack has recently joined Exo Engineering after graduating from University of East Anglia with a BSc in Environmental Sciences earlier this year. Jack has previous experience in alternative roles which have promoted a consideration for maximising the efficiency of operations.

Jack's role encourages a focus on lean manufacturing, a methodology which seeks to minimise waste while maximising productivity. In this case, waste is deemed to be anything which a customer would not be willing to pay for, such as idle time or inefficient processes. Jack has helped to redesign the workshop layout to create an efficient, effective, and safe workspace which minimises wasted time and effort. Jack has also been heavily involved with production of our Eco-reef units for the testing phase of the design process. Identifying potential limitations of product design is crucial as it can encourage improvements the manufacturing process to increase efficiency. "**Maximising efficiency allows for a reduction in operating costs and improved product quality.** Rather than cutting corners, we instead aim to learn from previous challenges to consistently improve the manufacturing process".

FIRST LIVING WINDFARM PROJECT WORKSHOP

Exo Engineering organised the first Living Windfarms Project workshop in November 2022 at the University of Essex. The conference presented the opportunity for networking among key stakeholders in the offshore wind industry and researchers in marine biology. Over 40 participants attended both in person and online, from a range of public, scientific and academic backgrounds. The primary aim of the Living Windfarms Project is to establish mass production of eco-reef scour protection to deliver less environmentally damaging methods of windfarm infrastructure protection. Speakers at the conference were from the University of Essex, Bournemouth University, The Rich North Sea, and Exo Engineering.

The first speaker -**Eline van Onselen from the Rich North Sea explained the changes in North Sea biodiversity since the industrial revolution.** She also explained how unprecedented upscaling of fishing vessels has had detrimental impact to marine life, emphasising the need for initiatives which focus on increasing biodiversity. The realisation of wind energy potential has seen extensive wind farm developments in the North Sea, with little regard to improving biodiversity so far.

Prof. Rick Stafford from Bournemouth University was one of the guest speakers at the conference. He spoke about the impact of environmental conditions on community assemblages, which can be affected by factors such as seasonal changes or reef depth. Regarding artificial reefs, there is still some uncertainty surrounding the bio-receptivity to different types of concrete and the influence this may have on final community structure. This will be more extensively studied in the years to come, using various methods such as Baited Remote Underwater Video (BRUV), Remote Operated Vehicles (ROV) and scuba diving. Each method has associated advantages and disadvantages, with each method varying in suitability between different sites.

Prof. Alex Dumbrell from the University of Essex illustrated the future potential for understanding ecosystem responses to change in the form of biomonitoring. This involves using an automated sampler to extract DNA from an ecosystem to monitor the changes over time, to improve our understanding of interactions between ecosystems and more accurately predict scenario outcomes. Using DNA to monitor changes in ecosystems is highly beneficial as it is fully scalable, can account for 'cryptic' species which are difficult to observe and will minimise disruption. Under-sampling and contamination represent potential disadvantages to this method but can be minimised using control variables. The need for more stringent ecosystem monitoring is evident, with biomonitoring representing a promising new technique for the future.

Will Melhuish from Exo-Engineering spoke about how the design priorities regarding cost, ecosystem benefit and time efficiency must be balanced with functionality to achieve the aims of the project. The eco-reefs have a dual function of performing its designed role for scour protection whilst also delivering ecosystem benefits. Durability is also an element of the design priority; we conduct rigorous testing of our eco-scour products to ensure they are of sufficient strength to survive transportation and deployment.

For more information visit the living windfarm project website: **https://www.livingwindfarms.com/about**

University of Essex

BIOLOGICAL COLONISATION AND MONITORING OF ARTIFICAL REEFS

Professor Rick Stafford, Bournmouth University

"Once artificial reefs are deployed in seawater, they rapidly colonise with marine life. Normally this begins with microorganisms including diatoms and bacteria, but even only several weeks after immersion, algae and animals may be found. There are many factors which can affect what species artificial reefs are likely to attract. **Different locations will have different community structures, factors such as depth, propagule pressure (based on what species have reproduced and are found locally in the plankton) and clarity of water (and hence light penetration) will all play a role.** This makes predicting community structure difficult. However, we now know that the type of concrete mix is relatively unimportant after the initial colonisation phase, in shallow systems dominated by algae (typically < 10m deep in Northern Europe), we also see big seasonal changes, with algae dying off over the winter, and regrowing in the spring and summer.

Initial colonisation may not influence the final community structure, where factors like competition for space and grazing may be more important. From recent studies, it seems that typically the diversity of an artificial reef is somewhere between natural rocky reefs and existing artificial structures (e.g. piles of rocks), however, the composition of the biological community can be distinct from both rocky reefs and other structures, with a greater potential to attract species such as crabs and fish, if the features of the artificial reef are suitable (e.g. correct sized holes and tunnels).

Regular monitoring of reefs is important for establishing what is there. Most current surveying is visual, using divers, remote operated vehicles, or drop-down cameras (known as baited remote underwater video – BRUV, or unbaited – RUV). All of these methods have pros and cons and selecting the right method for the question you want to answer is important. For example, scuba diving can scare some mobile species, but may be the only visual method of identifying small encrusting species. Using bait with remote underwater video can sometimes attract species from outside of the artificial reef area. The time needed to process" videos from ROVs and BRUV/RUVs can also be considerable. However, ecological succession on reefs and increases in biodiversity over time can be determined by any, or combinations of all methods, as long as the methods are consistent and the effort used remains the same (for example, the time a camera is deployed for)."

ECO-REEF STRENGTH TESTING

Following the Living Windfarms Project workshop, Exo Engineering carried out a day of Eco-Reef strength testing. The project targets the use of conventional scour protection vessel loading and mass deployment methods which involve large impacts and stresses. Therefore, testing is needed to mimic the impact that will likely be exerted on the spheres during the loading and deployment phases. This test day forms part of the Living Wind Farms programme which also includes lab tests, measuring the reinforcing strength of the GeoBlock® materials used to manufacture the units, as well as computer modeling of the inherent survivability of the Eco-Reef units.

During the test day we examined the real-life durability of the eco-spheres by conducting a variety of drop tests to compare this against the computer modelling and lab testing. These tests were conducted at the Port of Brightlingsea in Essex and a total of 100 spheres were used.

Tests included variable velocity impact testing, single sphere drop tests, multiple simultaneous sphere drop tests as well as trialing loading and handling of the Eco-Reefs using front loaders and grabs. The test day provided an opportunity to compare different high strength and reinforcing materials to improve the strength of the spheres to meet the survivability requirements of the loading and deployment methods.

A high-speed camera was used to record these tests, which were later analysed. The use of a high-speed camera allowed us to determine the velocity of each sphere upon impact and therefore examine the effect of different strength reinforcing methods. These “real world” tests helped us to understand if the modelling and lab tests reflected the real maximum survivable impacts and inform sphere design and suitable deployment methods to be used in the project.

INSTALLATION OF 5000KG ECO ROCK ARMOUR IN NEWLYN

Within the last decade Newlyn, Cornwall has experienced severe flooding, with the most notable event taking place in February 2014. Despite the presence of numerous hard engineered sea defences, the local community was subjected to intense flooding, with many homes and businesses being affected.

The unusually high tide coincided with particularly strong winds of up to 80mph, which saw the concrete sea wall being overtopped by large, powerful waves. To avoid a repeat of the 2014 flood event, Penzance council and the Environment Agency are actively looking for means of preventing and reducing the impact of the flooding in future. **Hard engineered defences act as a vital tool to protect areas from coastal flooding and erosion, but the effect on biodiversity is often neglected and remains an afterthought.**

Exo Engineering produces scalable Eco-Rock Armour that incorporates complex Greening the Grey® surface textures which are readily colonised by pioneer marine species. Additionally, they are manufactured using up to 90% recycled materials using Geoblock® technology.

We have been working alongside the Environment Agency in Newlyn as part of an ongoing project to trial some of our nature inclusive products. Most recently, we produced 22 full scale 5,000kg units as part of a larger trial of the Eco-Rock Armour concept. The Eco-Rock Armour was placed around the existing Newlyn breakwater in November 2022, on both the landward and seawards sides, and on the toe of the existing structure.

The study will therefore be able to compare colonisation of different products exposed to varying amounts of wave energy. The next phase will be the monitoring of these Eco-Rock Armour units for bio-colonisation.

Find out more at: https://www.exo-engineering.co.uk/eco-rock-armour-2022

ENVIRONMENT AGENCY NATURE INCLUSIVE BREAKWATER PROJECT

Harriet Googe, Environment Agency

"The Environment Agency's Coastal Research and Development Project at Newlyn is testing the use of intertidal reef blocks, as a low-carbon and nature-inclusive 'green' alternative to traditional carbon-intensive 'grey' solutions. EU funding via the ERDF's Interreg programme has facilitated the testing of a number of bespoke block designs at Newlyn, with an overarching **aim to identify more sustainable approaches to coastal armouring in high wave energy locations.**

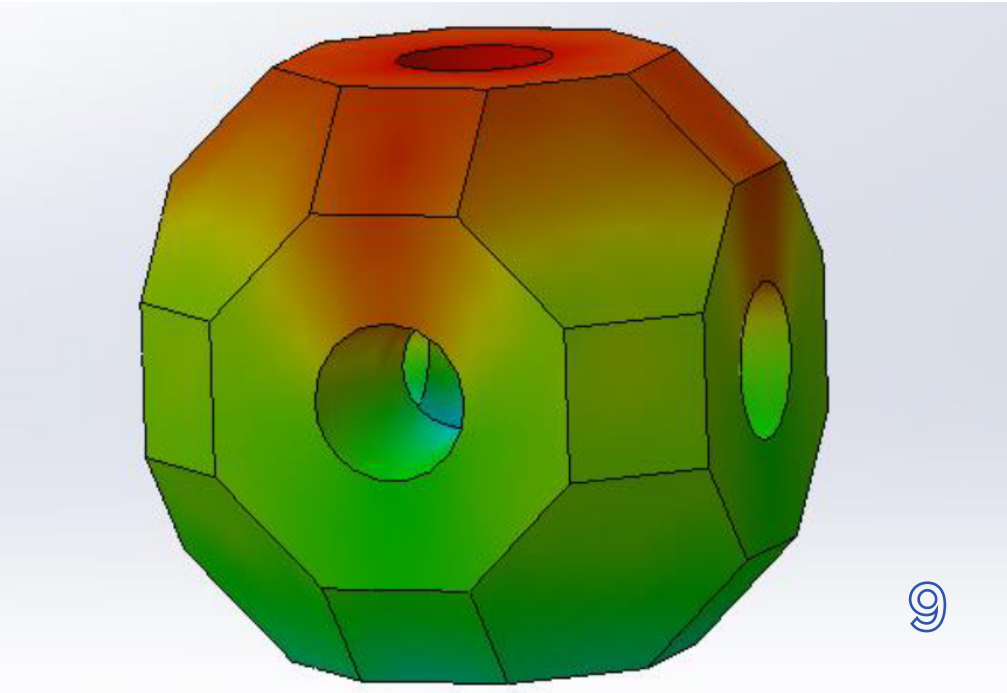
Exo Engineering are providing 25% of the reef blocks for the Newlyn project. Their blocks offer multi-functional benefits, such as biodiversity enhancing design and low-carbon fabrication. The development of viable alternatives to carbon intensive and non-sustainable solutions such as reinforced concrete, or quarried rock, is hugely important in order to meet the EA's o**rganisational targets to achieve net zero by 2030.** More broadly, decarbonisation of the coastal and subsea infrastructure industry will also provide an important contribution to wider UK pledges on climate change.

It is also now imperative that we not only protect, but enhance coastal and marine biodiversity. Exo Engineering's demonstration of how previous deployment of their products, in the form of trial blocks, have **successfully created and enhanced habitats** means we are pleased to have them included within this project, and we are excited to see how their blocks perform within an intertidal and high wave energy setting."

Environment Agency

EXO-GON: THE EXO ENGINEERING NEW DESIGN

Exo Engineering continues to explore biomimicry, using nature as a blueprint to find inspiration and emulate designs found in nature to form solutions to challenges humans face. We take inspiration from a shape that is well distributed throughout nature: the hexagon. Bees for instance use this shape to their advantage in their beehive cells to make efficient use of space. **Our new innovative design called the Exo-Gon incorporates this shape in its surface texture providing a heterogeneous surface, and the use of our Greening the Grey® technology facilitates bio-colonisation, thus biological diversity.** The Exo-Gon provides a haven for juvenile species and is hollow to allow mobility. The shape of the Exo-Gon is a truncated cuboctahedron, incorporating flat edges for easier transport.



SUSTAINABLE AND RESILIENT COASTAL CITIES FINAL CONFERENCE

Exo Environmental organised the final Sustainable And Resilient Coastal Cities (SARCC) conference, which brought together over 130 delegates from across Europe. This conference was held in Southend-On-Sea in a hybrid format (in person and live stream online).

The conference celebrated the achievements of SARCC and its project partners in mainstreaming nature-based solutions into coastal management and policy making. This final conference provided an overview of the project according to the different work packages, detailing the outputs, results to disseminate and policy changes to address.

There were panel discussions with different stakeholders involved in coastal management, and interactions with the 14 project partners on specific nature-based solutions (NBS) pilots in Belgium, Netherlands, France, and the UK. **The final conference also discussed the success of SARCC in engaging coastal communities, encouraging the involvement in public consultations and the subsequent support for NBS investment.**

The final conference was in a hybrid format and the participants came from a wide range of professional backgrounds. The conference ran for three days and there was a site visit to the Southend-On-Sea pilot site on the second half of the second day. The different speakers for the first day included **John Bennet (SARCC Project Manager)** speaking on the pressures facing coastal cities. **Michal Nekvasil (a climate change adaptation expert)** who spoke about the EU instruments fostering nature-based solutions and climate resilient landscape approach.

Heather Hiburn (CEO of Thames Estuary Partnership) spoke on funding nature-based solutions: challenge or opportunity. **Pippa Moore (Professor of Ecology)** spoke on quantifying success of NbS projects evidence from marine artificial structures. **Garry Momber (Director of Maritime Archaeology Trust)** who spoke about engaging the public, a key for NbS mainstreaming.

Other speakers (not an exhaustive list) for day two and three included **Amy Pryor (Technical Director of the Thames Estuary Partnership)** who presented the Innovative ways of approaching NbS in coastal and estuarine cities. **Jess Bone from MARINEFF** spoke on the collaboration between projects and highlights of the Marineff project. **Hanne Van den Berghe** from Vives spoke on Ecosystem services. **Jolyon Sharpe** and **Aikaterini Konstantinou** presented on Building community resilience on a dynamic coast by making space for sand. **Jo Matthews** and **Tom Palmer** presented on Flood and Coastal Resilience Innovation programme.

View the final outputs of the SARCC project at:
www.sarcc.eu

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WHAT'S NEXT?

LIVING WINDFARMS PROJECT WORKSHOP : POLICY AND DECOMISSIONING

Our second hybrid workshop will be held at **9:00am on the 16th of March,** hosted by our partner the **University of East Anglia (UEA).** The workshop topic is Policy and Decommissioning of Offshore Windfarms.

How will their removal impact the habitats they are now a part of? Are policies up to date with ecological findings? Will changes to decommissioning procedures produce negative or positive outcomes for biodiversity?

The workshop will outline current policy regarding offshore wind power in the North sea and what decommissioning looks like at sites in practice. Impacts on biodiversity throughout the decommissioning process, and changes to be considered for future breakdowns will also be discussed.

Through online activities and Q/A, attendees online and in person will have the opportunity to share their thoughts and expertise on current practices, ecology and eco engineering's role throughout decommissioning.

To find out more and register to attend, vist:

https://www.livingwindfarms.com/register-2023

A NOTE OF THANKS TO OUR PARTNERS AND COLLABORATORS

There are exciting times ahead for Exo Engineering. We recognise the important role of all past and current collaborators, partners and clients who have helped us get to where we are today. We are extremely grateful for all these contributions and look forward to forging stronger relationships with new and existing partners in the future as Exo Engineering grows. If you have any ideas for collaborations or contributions to make regarding the future of Exo Engineering, please do not hesitate to get in contact with us.

EXO Engineering

WWW.EXO-ENGINEERING.CO.UK
INFO@EXO-ENGINEERING.CO.UK
0330 80 80 377