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DEME IN 2021

A Year of Exceptional Megaprojects Across the Globe and the Arrival of DEME’s New Mega Cutter

2021 was a milestone year for DEME as the new mega cutter suction dredger ‘Spartacus’ joined the fleet. DEME has embarked on a multi-year, multi-million fleet renewal programme with the aim of making its fleet the most modern and efficient in the industry and ‘Spartacus’ embodies this drive. Alongside the new flagship’s arrival, DEME has worked on some extraordinary projects throughout the year and in all corners of the globe.

A vessel like ‘Spartacus’ has simply never been seen before. With a total installed power of 44,180 kW and 12,000 kW on the cutterhead, ‘Spartacus’ is more powerful and has more cutting power than any other CSD in the industry. Able to dredge to an exceptional -45 m rather than the typical -35 m, ‘Spartacus’ has unprecedented autonomy and pumping distance, having the ability to pump 15-20 km ashore at high flow rates.

Sustainability is a continual focus of DEME and particularly when it comes to preparing the fleet for the future. In line with DEME’s aim to become carbon neutral by 2050, several innovative features have been introduced on ‘Spartacus’ to reduce emissions and make the mega CSD as energy efficient as possible.

As well as having dual fuel engines, the vessel is equipped with an installation to recover waste heat from the engine exhausts, generate steam and convert this by means of a steam turbine into up to 2,000 kW of electrical power.

1.1 Very High Production Rates and Unrivalled Workability

After delivery from the Royal IHC shipyard, the mega CSD headed directly out to its first project under own keel and powered by LNG. This exceptional vessel started work on an equally exceptional project – Abu Qir 2 in Egypt – the largest dredging and land reclamation project in DEME’s history.

The efficiency of this huge dredger is already showing some impressive results with high production levels, coupled with a substantial reduction in fuel consumption per unit of work. The mega CSD’s workability in sea states is also unrivalled. ‘Spartacus’ is always the last vessel to return to port.

In another example of DEME’s ambition to have the most sustainable fleet in the market, the dual fuel trailing suction hopper dredger ‘Scheldt River’ was bunkered with LNG in Belgian waters for the first time. The TSHD was performing maintenance dredging work along the River Scheldt and during this work, the vessel operated entirely on LNG.

1.2 Operating on LNG ‘Scheldt River’ Performs River Maintenance

By investing in these energy-saving technologies, DEME wants to stay several steps ahead of any future regulations in order to make the maintenance of ports and their access channels more sustainable – a requirement that is even more important when working in densely populated regions. The TSHD ‘Scheldt River’ was commissioned in 2017 and is one of the very first dredgers in the industry capable of operating on a variety of fuels. DEME is also exploring the possibilities of emission-free fuels such as green methanol and green hydrogen.

In addition to DEME’s investments in the newbuild fleet, the Group has carried out a major refurbishment of the TSHD ‘Pearl River’, highlighting the company’s confidence in the opportunities of the future. This investment represents one of the largest ship refurbishments in DEME’s history.
‘Pearl River’ – one of the largest ship refurbishments in DEME’s history

‘Pearl River’ has been a real workhorse of the fleet over the years, but rather than retire the vessel DEME decided to make a substantial investment, which has given the TSHD at least another 10 years of productive life. The main improvements made to the vessel were the addition of a bow thruster, making it much better at manoeuvring, and this was coupled with a complete overhaul of the engines and the gearboxes. Additionally, approximately 275 tonnes of steel was renewed, including all the bottom doors and frames, making the TSHD much stronger.

Newly transformed, ‘Pearl River’ was put through its paces straightaway after commissioning. The vessel went to the Far North to DEME’s project in the Arctic in Ob Bay and then to the other extreme, and after demonstrating very high productivity rates, the dredger went directly to Abu Qir 2, showing its ability to put in a reliable performance wherever it is deployed in the world.

As mentioned, 2021 is a milestone year in terms of the fleet investments but also in terms of the number of amazing projects, and these have all been achieved during a global pandemic.

1.3 Abu Qir 2 – New City and a New Port

Abu Qir 2 in Egypt is the largest dredging and land reclamation contract in DEME’s history, and a whole green flotilla has been working on this mammoth project throughout the year. Ultimately, Abu Qir 2, which is near Alexandria, will see a new city and greenfield port constructed. In a staggering accomplishment, DEME’s fleet of cutters and hopper dredgers reclaimed well over 130 million m³ of material in 2021.

The strength of DEME’s fleet has really been put in the spotlight – the team managed to achieve volumes of 800,000 m³ in a single day.

1.4 The Arctic, Sea Channel

In another remarkable project, the DEME fleet was beyond the Arctic Circle in the Far North. Here, the team completed a second highly successful campaign for the ‘Sea Channel’ project – one of the remotest projects in the Group’s history.

Once the ice had thawed, DEME mobilised eight large hopper dredgers, and more than 20 vessels were eventually deployed. DEME is dredging the access channel to Sabetta port.

This time, the fleet was tasked with dredging an enormous area of 25 million m² or the equivalent of 5,000 football fields. Despite the challenges, the area was even handed over to the client before the deadline. And this achievement was all the more impressive because this vast dredged area was delivered without a single high spot. A key factor in this accomplishment was the decision to deploy two enormous ploughing vessels, with ploughs of approximately 30 m long.

1.5 River Elbe Deepening and Widening Project Completed Successfully

In another remarkable project, DEME successfully completed the enormous two-year River Elbe deepening and widening project safely, without any major disruption due to the pandemic, and well within the schedule.

The river was deepened from Hamburg to the mouth of the Elbe and widened in some places to enable the new generations of container vessels to access the Port of Hamburg independently of the tides. Ultimately the team dredged, transported and relocated a staggering 28 million m³ of material.

After the completion of the dredging operations, the benefits of the increased depth were immediately apparent. In May, the port authority announced that ULCCs could take advantage of the new navigation channel depth. The ‘CMA CGM Jacques Saadé’ was the first containership of the Megamax class to utilise the Elbe’s improved draught. This meant that the ship could bring around 1,000 more containers to Hamburg.
1.6 UXO and Thick Ice Challenges Overcome in Poland

Meanwhile in Poland, DEME and its joint venture partner had a very busy year at the Świnoujście - Szczecin fairway project and faced several complex challenges, particularly the presence of thick ice in the winter months and the largest UXO campaign in the company’s history.

Despite the challenges, the team was firmly on track and on the verge of completing the two artificial islands in the lagoon by the end of the year. In line with DEME’s sustainable solutions, these two islands are created from dredged material and will become nature habitats. DEME’s client and team were delighted to see that the new islands are already proving popular and attracting a diverse range of birds. This project also has a remarkable safety record, with more than 2.3 million LTI-free manhours.

1.7 TTP1 Phase 1 in Singapore

And in another part of the globe, the huge Tuas Terminal Phase 1 megaproject in Singapore was largely completed, with major parts of the container terminal already in operation. TTP1 included the construction of a quay wall, and the reclamation of a staggering 88 million m$^3$ of land from the sea. At its peak around 3,000 people and 150 vessels were working on site.

DEME was very proud to win the JTC Construction Safety Award in the Infrastructure and Land Reclamation category for the Jurong Island Westward Extension and Ayer Merbau Reclamation Phase 2 projects, as well as the Safety and Health Award Recognition for Projects (SHARP) award for the third time.

2021 will certainly be remembered in DEME’s history – another year when it faced the pandemic, but also a year characterised by exceptional vessels and exceptional projects.

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@DEMEgroup
Van Oord

We are a Dutch family-owned company with over 150 years of experience as an international marine contractor. Marine Ingenuity is our signature and the spark that lights the spirit of our professionals. It drives our pursuit to make the world a better place for future generations. In 2018, Van Oord received the right to use the Royal designation. It crowns the 150 years of entrepreneurship, spirit and perseverance displayed by our predecessors and employees.

Vision

Our vision is to create a better world for future generations by delivering Marine Ingenuity.

Mission

As a global maritime contractor, we focus on dredging and marine construction, offshore wind, offshore infrastructure, and infrastructure in the Netherlands. We work closely and safely with our clients and stakeholders to create innovative and sustainable solutions.

2.1 Dredging

More than half of the world’s population lives in cities. The world’s urban population currently stands at 3.7 billion people and is, with an expected to double by 2050. This has resulted in a growing worldwide demand to create more living space. Van Oord is adapting to these changing market conditions with our global marine engineering projects.

Dredging is our signature talent, one that we have perfected continuously since our business was founded. We maintain our position in traditional dredging markets and in our home markets thanks to the best dredging equipment and operational experience, supported by our local branches.

2.1.1 Seagrass to Reinforce Romanian Coastline

Seagrass beds form a biotope that is of major importance for marine ecology. Climate change, disease, coastal redevelopment and pollution are causing a global decline in seagrass. This is a worrying development because these small green plants have major environmental benefits. They store carbon dioxide, prevent sediment from being washed away and help protect the coast. Seagrass plays a major role in a coastal reinforcement project in Romania. Van Oord is to construct new breakwaters and create new beaches that will protect the popular Black Sea resort of Eforie from erosion. Part of the project involves creating three hectares of seagrass. Van Oord is currently studying the most effective way to rehabilitate the seagrass at this location given the local circumstances.
2.1.2 Empowering Local Communities in Saly

Saly used to be one of the most popular touristic hotspots of Senegal. Unfortunately, the coastal community suffered from rising sea levels and other negative effects of accelerated climate change. When Van Oord arrived in the area, not many traces were left of the once buzzing holiday destination. The beach was gone, hotels had to use rocks and sand bags to protect themselves against the sea and tourists stayed away. Van Oord was called in to reinforce the coastline and revitalise the area. The project aims to protect people, houses, economic and cultural infrastructure in the region against coastal erosion. During the project, we made sure local stakeholders were involved. We kept the local community informed and we employed local people, so that about 40% of the workforce was Senegalese.

2.1.3 Van Oord Wins Another Contract for Aberdeen Harbour Expansion Project

Van Oord continues its involvement in the Aberdeen South Harbour expansion project in the United Kingdom. End of April 2021, Aberdeen Harbour Board awarded the South Breakwater contract to Van Oord. Van Oord has been involved in the project since 2017 and, most recently, successfully delivered critical rock dredging and revetment construction works. When complete, the over 500-metres-long breakwater will protect the new port facilities from a one-in-300-year storm. Backhoe dredger Razende Bol, side-stone dumping vessel HAM 602 and split hopper barge Johannis de Rijke are part of the equipment to be deployed. Work on site will start imminently.

2.1.4 Saltfleet to Gibraltar Point Beach Management Scheme Awarded to Van Oord

Van Oord has signed a new contract with the Environment Agency to continue to protect the Lincolnshire coast of the UK for the next 4 years. The contract encompasses beach nourishment over the length of 20 kilometres and requires around 400,000 cubic metres of sand each year and continues the works Van Oord has been undertaking there since 2015.
2.1.5 Lydd Ranges Coastal Defences Scheme Awarded to Van Oord

Van Oord has signed a contract with the Environment Agency to design and build a coastal defence scheme at Lydd, south Kent coast in the UK. Van Oord will work in partnership with its subsidiary Mackley to deliver the scheme. Once completed it will help to protect this environmentally important area and the Ministry of Defence (MoD) Lydd firing range from ongoing storm damage and coastal erosion for 25 years. Design work is currently underway and construction is due to commence in April.

2.2 Netherlands

Van Oord is entwined with landmark Dutch marine and civil engineering. The Netherlands is where our origins lie. A trusted partner to our local and global clients, we deliver complex projects helping them meet their environmental, social and emissions targets.

The impact of climate change means a growing number of people around the world now live in flood-risk areas. Serious water-related disasters occur more frequently making prevention vital. As a company with deep roots in the Netherlands, we are well aware of the threats. We know that they demand smart, innovative solutions to help us defend our coasts, reinforce our dikes and keep our waterways navigable and our ports accessible.

2.2.1 Tiel-Waardenburg Dyke Reinforcement Awarded to Van Oord, Dura Vermeer and Ploegam

The Rivierenland Water Board has awarded the Tiel-Waardenburg dyke reinforcement project to the Mekante Diek consortium, a collaboration between Ploegam, Van Oord and Dura Vermeer. The Waal dyke between Tiel and Waardenburg is to be reinforced over a length of more than 19 kilometres to meet the current safety standard. The three consortium partners have the specialist knowledge and expertise needed to make this project a success. Their combined experience in implementing large-scale dyke reinforcement projects will be deployed to protect the residents of the area against high water on the river Waal after completion. The Waal dyke between Tiel and Waardenburg is part of the Dutch flood protection programme.
2.2.2 Van Oord Selected to Construct the Quays in the Amalia Harbour

Van Oord contributes to the growth of the port of Rotterdam. The Port of Rotterdam Authority has awarded the construction of some 2.4 kilometres of quays and earth-retaining walls in the Princess Amalia Harbour to the HOCHTIEF, Ballast Nedam and Van Oord consortium. With this, the Port Authority invests in major expansion of container throughput in Rotterdam. The construction of the quays marks the start of the further development of the harbour located on Maasvlakte II. The development will increase annual throughput capacity in the port of Rotterdam by four million standard containers (TEU).

2.3 Offshore wind

Climate change is the greatest threat facing humanity today. With an overwhelming need to reduce CO₂ emissions worldwide comes a rising demand for renewable energy sources. One key contributor to achieving climate change targets around the world is offshore wind.

With 20 years’ proven experience and an impressive track record in constructing offshore wind projects, Van Oord is leading the way in the transition towards renewable energy. In 2019, we completed offshore wind farm projects that deliver renewable energy to over 2.5 million households. With our safety standards, innovative solutions, our employees’ knowledge and expertise, and specialised offshore wind equipment, we are significantly contributing to making wind energy more competitive.

2.3.1 Van Oord Orders Mega Ship to Install 20 MW Offshore Wind Foundations and Turbines

Van Oord has ordered a new offshore installation vessel to further strengthen its market position in offshore wind. The jack-up vessel can operate on methanol and install up to 20 MW wind turbines at sea with a very low CO₂ footprint. The investment is in line with the increasing global demand for offshore wind farms. The ship is expected to enter the market in 2024.
2.3.2 Van Oord to Install Italy’s First Offshore Wind Farm

Van Oord’s offshore installation vessel MPI Resolution will commence its work for the Taranto Offshore Wind Farm in Italy. The Taranto Offshore Wind Farm is located near the Taranto harbour in Italy and consists of 10 turbines. This windfarm will be the first offshore wind farm in the Mediterranean Sea. The wind farm will have a capacity of 30 MW and estimated output of 58,000 MWh per year.

2.3.3 Van Oord Takes on Baltic Project

Van Oord has signed a contract with the Spanish energy company Iberdrola for the Baltic Eagle offshore wind farm. Van Oord will transport and install the foundations and ensure the supply, transport and installation of inter-array cables. With a production capacity of 476 MW, the Baltic Eagle wind farm will deliver renewable energy to 475,000 households while saving nearly 1 million tonnes of carbon dioxide annually. It is scheduled to be fully operational by the end of 2024.

2.3.4 Upgraded Aeolus Starts Work on French Offshore Wind Farm

After extensive preparations, offshore installation vessel Aeolus is starting the installation of the first of 62 jacket foundations for the Saint-Brieuc offshore wind farm project. The wind farm is located 16.3 kilometres off the coast of Brittany and has a total capacity of 496 MW. Before installing the very first pin-piles for the jacket foundation this month, the Aeolus was upgraded and an extensive spread of project-specific installation equipment was placed on deck.
2.3.5 Van Oord Receives 2021 RETO Award for Iberdrola Supplier of the Year

In April 2021, the King and Queen of Spain presented the Iberdrola RETO Awards for Supplier of the Year. Under the heading RETO – meaning ‘challenge’ in Spanish and standing for Recuperación (Recovery), Energía (Energy), Transición (Transition) and ODS (SDGs) – the awards went to companies that stand out due to their commitment to the energy transition, innovation, entrepreneurship, employability, talent, contribution to the SDGs and involvement with COVID-19. Their Majesties the King and Queen of Spain, accompanied by the minister of Education and Vocational Training, Isabel Celaá, and the chairman of Iberdrola group, Ignacio Galán, presented the 2021 Supplier of the Year Awards, coinciding with the official inauguration of the company's Innovation and Training Campus in San Agustín del Guadalix in Madrid.

2.3.6 Van Oord Wins Contract for Sofia Offshore Wind Farm

the announcement that RWE has reached a financial investment decision for Sofia Offshore Wind Farm, Van Oord is pleased to confirm that it has been contracted for the engineering, procurement, construction and installation (EPCI) of the monopile foundations and array cables for this project. The 1.4 GW Sofia Offshore Wind Farm is one of the world's largest offshore wind projects.

2.4 Offshore Oil and Gas

Global energy consumption is constantly growing and demand is increasing due to industrial activity and advances around the world. As the future energy mix becomes more sustainable, the demand for reliable and safe offshore energy infrastructure increases.

Efficient and safe energy facilities are essential to meeting the increasing energy demand. The offshore infrastructure needed to transport energy is subject to constant expansion and improvement. Van Oord provides and protects this infrastructure at many different locations around the world, while coming up with safe and efficient solutions. Since the 1960s, we have been specialists in offshore installation projects and continue to deliver solutions to challenges that this growing market brings.
2.4.1 Van Oord to Install Scour Protection at Seagreen Offshore Wind Farm

Seaway 7, the main Seagreen contractor, have contracted Van Oord to install scour protection around the 114 wind turbine foundations at the Seagreen offshore wind farm. This wind farm is located 27 kilometres off the coast of Angus in Scotland.

The wind turbines for this 1.1 GW offshore wind farm will be installed on three-legged jacket foundations. After the installation of these jackets, scour protection is required to avoid the effects of erosion. This is achieved by high precision rock installation around the jackets.

2.4.2 Van Oord Signs Contract for Subsea Rock Installation at Ormen Lange Phase 3 in Norway

Van Oord has been awarded a contract related to the Ormen Lange Field operated by A/S Norske Shell. This contract for the specialised seabed interventions services of Subsea Rock Installation (SRI) is a continuation of earlier cooperation between Shell and Van Oord on the Ormen Lange Field.

The Ormen Lange Field is a natural gas field in Norway, located in the Norwegian Sea, situated 120 kilometres northwest of Kristiansund. With depths of the seabed that vary between 850 and 1,100 metres, the natural conditions at the site are considered harsh. The stormy seas, uneven seabed and strong underwater currents put great demand on Van Oord’s expertise and flexible fallpipe vessel Stornes during the pre and post-lay activities of Subsea Rock Installation.

2.4.3 Van Oord Adopts Innovative Technology to Further Reduce Emissions on Its Fleet

Van Oord is taking a next step in the energy transition of its fleet. An advanced combustion conditioning system with hydrogen and methanol will be installed on subsea rock installation vessel Bravenes. Van Oord is committed to becoming carbon-neutral by 2050, in line with the Paris Agreement. This commitment reflects the company’s desire to limit its impact on climate change. The collaboration with FUELSAVE facilitates a sustainable and viable initiative to reduce the carbon footprint of the new and existing fleet.

2.5 Other News

2.5.1 Van Oord Introduces Storytelling Platform on a Flood-Resistant Netherlands during Expo 2020 Dubai

During the National Day of Expo 2020 in Dubai, Van Oord launched the digital platform ‘The Dyke, Social Impact Stories of a Dutch Icon’. In 2019, Van Oord was the first National Partner of the Dutch pavilion and the company aims to bring Dutch marine engineering solutions to international attention.
The launch of the trailer of ‘The Dyke, Social Impact Stories of a Dutch Icon’ is the start of a story series about the future of a flood-resistant Netherlands.

In December 2021, the first episode (The Community) of the creative multimedia project was launched. ‘The Dyke, Social Impact Stories of a Dutch Icon’ is a project made by photographer Cynthia Boll and journalist Stephanie Bakker in cooperation with Van Oord. The Dyke sketches a portrait of a country in transition, how the Dutch move with it and the role of the Afsluitdijk in this transition.

The Afsluitdijk has all the elements needed for the energy transition in the immediate vicinity. For example Windpark Fryslân, south of the Afsluitdijk in the Dutch IJsselmeer, comprises 89 wind turbines. The first episode, ‘The Community’, shines a light on the theme of Energy transition in an unexpected manner.

2.5.2 Van Oord Partners with Two PortXL Start-Ups

Van Oord has signed partnership agreements with LexX and Heliorec, two start-ups scouted through the innovation platform PortXL. The signing ceremony took place during the shakedown event on 2 December marking the end of this year's PortXL programme. Van Oord is one of the founders of PortXL and a main sponsor of the PortXL programme for the sixth year in a row. The port and maritime accelerator platform is one of the ways that Van Oord encourages innovation in the global maritime industry. This year, the company focused on two innovation themes: sustainability and digitalisation.
PORT OF ROTTERDAM IN 2021
PORT OF OPPORTUNITIES

The Port of Rotterdam is Europe's largest seaport. The port stretches over more than 40 kilometres, welcoming around 30,000 seagoing vessels and 93,000 inland vessels annually, and handling 440 million tonnes of goods a year. Earnings of EUR 45.6 billion – about 6.2% of the Dutch GDP – are generated in the area. The port region owes its leading position to its excellent sea access, intermodal connections and the 385,000 people who work in and for the port and industrial area. For more information check: Facts and Figures | Port of Rotterdam.

The Port of Rotterdam is the place to achieve boundless ambitions! The core tasks of the Port of Rotterdam Authority are developing, managing and exploiting the port in a sustainable way and delivering fast and safe services for shipping. Despite the COVID-19 pandemic, 2021 was a successful year. The Port of Rotterdam has confirmed its role as a reliable partner in the logistics chain by staying open 24/7. Our port offers plenty of opportunities and possibilities and we are proud of that.

3.1 The 15 Millionth TEU Container Arrived in the Port of Rotterdam

On Wednesday 22 December 2021, a record was set: the 15 millionth TEU container of the year arrived in the Port of Rotterdam. This is the first time that a European port has broken through this magical barrier. The transhipment of containers went through a dip due to COVID-19, but since autumn 2020, Rotterdam has made a rapid recovery.

![Image of a container ship with water spraying from it]

*Figure 1: Wednesday, 22 December – the 15 millionth TEU container of the year arrived in the Port of Rotterdam.*

If you would like to know about everything that went on in our port this year, watch our annual year-in-review video or check out our throughput figures or the annual report.
3.2 Smartest Port. Connecting the World

New customer wishes and ambitions, new regulations, ageing infrastructure, increases in scale and an increasingly crowded port mean that the Port of Rotterdam Authority is fully committed to the development of both physical and digital smart infrastructure. We are also committed to combating climate change.

Like last year, we will now take a closer look at the developments in the Port of Rotterdam in the field of:

1. Digitalisation
2. Sustainable Port Development and Sustainable Infrastructure
3. Innovation in the Port of Rotterdam

For these fields, we will present some developments that took place over the last year.

3.2.1 Digitalisation in the Port of Rotterdam

The Port of Rotterdam Authority is innovating its decision-making process by using digital tools and its physical infrastructure by adding digital components.

Maintenance dredging without operational interruption
To ensure that the port remains optimally accessible, it is important to keep the waterways at the right depth by means of dredging. The Port of Rotterdam Authority has developed various digital tools to dredge in the right places and at the right time. Examples are the Dredging decision model and the PLAnning TOol (PLATO).

- In the ‘Dredging decision model’, the waterways (location and depths) in the port are mapped out and combined with AIS data (data from the tracking system of ships in the port). This model shows which parts of the waterways are being used and need to be dredged. As a result, dredging is only carried out in places where and when it is necessary. That saves a lot of time, money and emissions.
- Many customers use their berths 24 hours a day, which means there is no time for dredging maintenance without disrupting operations. Dredging costs on average 10% of the availability of terminals. Vessels may therefore have to wait until the berth is at depth. For this reason, the Port of Rotterdam Authority developed the ‘PLATO tool’. This planning tool brings the planning of quay wall inspections, dredging and gauging together with the terminal planning. In this way, the activities can be coordinated so that maintenance can be planned more efficiently.

Getting insight into the use of our assets with data
Port of Rotterdam Authority is developing its new assets with a variety of sensors to improve the lifecycle of its assets. By combining the measured data with other data, such as wind and water levels, we gain insight into how assets are used, whether we could extend the limits of use, when the optimal moment for maintenance is, and it also provides a means to actively increase safety for the assets, the people and vessels in the port. If possible, we use existing, off-the-shelf sensors, but if needed we develop sensors for ourselves and other ports with our partners (e.g. the Smart Bollard).

Smart deep-sea quay wall for Sif completed
In mid-December and in accordance with the contractual schedule, the Port of Rotterdam Authority transferred a new 200-metre deep-sea quay wall to the Sif Group (Sif). This quay wall with a retaining height of 30 metres is in the Ariane port basin on the Maasvlakte. In the foundation elements of the quay wall, many different smart sensors are incorporated that can register the settlement behaviour and the loads acting on the quay wall during the service life. By equipping assets with sensors, the Port Authority gains a wealth of data and insights into the load, maintenance and lifespan of the assets. The expansion of Sif’s terminal reflects the Port Authority’s aim of playing an important role in the development of offshore wind projects in the North Sea.
3.2.2 Sustainable Port Development and Sustainable Infrastructure

A CO₂-neutral port in 2050: that is our goal. This calls for an energy transition in the port. Our approach is to reduce emissions from existing industry by, for example, carbon capture and storage and the construction of heat networks for the use of residual heat. On the other hand, the Port Authority is making efforts to attract new, innovative developments, such as the production of green hydrogen, biofuels and recycling activities. Vital to all these developments is the construction of new infrastructure such as heat pipelines, hydrogen pipelines and CO₂ pipelines. In addition to this, the Port Authority is active in making maritime shipping more sustainable, for example with shore-based power projects and facilitating the bunkering of clean fuels. Our focus is on the port and our own company, and where possible we also play a role in making chains more sustainable.

Sustainable Port Development: top-10 projects in the energy transition

What are the current projects on our way to a CO₂-neutral port in 2050? And which projects will make the difference? View the Top-10 energy transition projects of 2021. Two examples of these projects are explained in more detail below (Shore-Based Power and Hydrogen Network).
• **Research onshore-based power at terminals**
  Onshore power enables us to supply moored seagoing vessels with sustainable power. Ships are ‘plugged in’ when they are docked, and they can switch off their diesel generators. That is good for the air quality and the reduction of CO₂ emissions. To further introduce onshore power in the port of Rotterdam, we are conducting four studies in preparation for Onshore Power Supply systems (OPS). The studies consist of different parts: detailed technical studies, environmental and social cost-benefit studies and tendering and permitting procedures. If the studies turn out well and the parties involved can take a follow-up decision, the work phase will follow. This will consist of implementing onshore power at the designated locations in the port of Rotterdam. The onshore power systems will provide 35 MW of power for container ships, liquid bulk and cruise ships by 2025, creating an alternative energy source for moored ships. The aim is to reduce CO₂ emissions and air pollution and accelerate the market introduction of onshore energy solutions on the mainland. [Read more about shore power](#).

• **Large-scale hydrogen network**
  The Port Authority is working with various partners towards the introduction of a large-scale hydrogen network across the port complex, making Rotterdam an international hub for hydrogen production, import, application and transport to other countries in Northwest Europe. The hub will also enable Rotterdam to maintain its position as a major energy port for Northwest Europe in the future. [Read more about Hydrogen at Port of Rotterdam](#).

**Sustainable Infrastructure**

In its work processes and in its asset and investment projects in infrastructure, the Port Authority wants to contribute at least proportionally to the Dutch CO₂ reduction targets (i.e. a 49 % reduction by 2030 compared to 1990). A substantial part of the port’s CO₂ impact is caused by the construction of infrastructure assets (approximately 90 ktonnes in 2019) for the Port Authority. Of these infrastructure investment projects, the quay wall on the ‘marine side’ makes a substantial contribution to the CO₂ footprint: this is a labour-intensive construction project involving a lot of materials, and moreover materials with a high CO₂ contribution (concrete, reinforcement steel, steel tubular piles and sheet piling). With many kilometres of future deep sea quay wall on the horizon, especially on the 2nd Maasvlakte (approximately 12 km), there is still great potential for reduction.

![Figure 4: CO₂ footprint deep sea quay wall](#)

The first steps in CO₂ reduction have already been taken:

- These are mainly construction site measures (e.g. sustainable construction site, grid-fed construction power, other fuels for drainage, dredging) and in management and maintenance (cathodic protection with green electricity). These can already achieve a reduction of approximately 25 % in the short term and are already (partly) being implemented in current or planned projects.
• By 2030, Port Authority wants to have reduced the CO₂ footprint of its fuels by 49% compared to the 2019 project portfolio.
• Port Authority wants to achieve a 25% reduction in the CO₂ footprint of materials by 2030 compared to the 2019 project portfolio. This is a challenging ambition and depends in part on the developments in the market for the materials steel and concrete.
  - In the coming period, the focus will be on reducing concrete in the standard of the quay wall. The ‘Action Plan for CO₂ Reduction in Concrete Structures’, drawn up in early 2021, noted that the CO₂ footprint of the actual construction is largely determined in the design phase by the choice of materials and dimensioning. And that the key to further CO₂ reduction for this component therefore lies largely in the design of the quay wall. In addition, the Port Authority will be looking at how to implement innovations such as geopolymers and hybrid (two-layer) concrete in the near future. Some research (including pilot projects, pre- and post-construction testing, monitoring) will be conducted before implementing these innovations.
  - There is also a challenge for the material Steel. The first project with a contract that used Environmental Cost Indicator (ECI) as Best Value Cost Criteria for steel was recently put on the market (Dintelhaven project). In the coming period, Port Authority and other clients will investigate together how the sustainability of steel can be addressed.

The figure below shows the four strategies/categories that HbR will implement in the coming year for roads, quay walls and dredging.

![Four strategies for CO₂ reduction in infrastructure projects at the Port of Rotterdam](image)

Setting up monitoring and reporting is seen as an important part of providing insight into the results achieved in terms of CO₂ reduction each year.

**Example of sustainable infrastructure in a new project: quay wall construction Amalia harbour**

To further strengthen its leading position as Europe’s largest container port, the Port of Rotterdam Authority is investing in the further expansion of the Princess Amalia harbour located on Maasvlakte II. Container quay construction requires sustainable, smart choices so that we can minimise the impact on the environment.

Sustainable construction is key during the implementation of the entire project. By looking at the project from different disciplines and together with all partners, various solutions were elaborated to achieve the most sustainable and efficient way of working. Examples of sustainable solutions during construction will be:

• the quays will be equipped with a wide range of sensors to monitor forces and any deformations
• so-called ECOncrete blocks will be installed at two locations. These act as artificial vertical reefs to stimulate underwater biodiversity
• Special attention is given to reducing emissions during construction:
  - most of the construction materials are being brought in by water, reducing transportation by road, and
  - by using deploying equipment powered by Hydrotreated Vegetable Oil (HVO)*, as well as electric construction equipment, concrete factory and drainage. Read more.

Figure 7: Impression of the new quays in Princess Amalia harbour

3.2.3 Innovation in the Port of Rotterdam

To remain a home port for world-class companies in the future, the Port of Rotterdam Authority is not only investing in new physical and digital infrastructure, but also in innovation, research and digitalisation to further optimise the development, use and maintenance of its port assets. This enables us to build new assets more efficiently, adapt older assets to new requirements and load and unload ships in our port even more safely, sustainably and efficiently. In this way, we are building a smart, clean, safe and future-proof port that can keep pace with the ambitions of its customers.

Figure 8: arrival of the Ever Ace in the Amazonehaven
Amazon port basin
The arrival of the Ever Ace in the Amazonehaven basin on 30 November was quite an achievement from an engineering perspective, because the quay walls in this port basin have been designed for the 2nd generation of container vessels with a nautical depth of 12 m.

Based on the results of the ‘Infra Innovation’ innovation programme, the nautical depth of the quay walls in the Amazonehaven will be deepened from NAP -16.65 m down to 18.5 m. The operator can install 25% bigger container cranes in combination with this deepening with no structural measures to the quay wall.

Several Infra-Innovation projects were initiated to make this upgrade possible, such as:

- The pile load test of foundation piles and anchor piles
- Advanced numerical modelling
- Analysis of the sensor data of smart port infrastructure
- Novel LiDar and satellite data to predict wind loads acting on container cranes
- New strategies for water injection dredging (the Prisma project)

The Port of Rotterdam is very proud that the results of data-driven research and innovation can be directly applied in practice. Together with the industry, the port of Rotterdam authority contributes to maintaining design codes and guidelines and is willing to share its knowledge. In this innovation programme, Port of Rotterdam divisions Harbour Master, Asset Management and Port Development work together on scientific and practical research projects aiming to reduce costs over the lifetime of the port assets, increase cargo per berth and lower emissions.

3.3 Upgrade Your Knowledge

Would you like to be informed about the developments in the port? Check out our online magazine Rotterdam Port Magazine. Subscribe to our newsletter here or be inspired by our white papers, podcasts, reports and expert videos or follow our social media posts.

https://www.portofrotterdam.com/en

https://www.linkedin.com/company/port-of-rotterdam/

https://twitter.com/HavenRotterdam
Climate change is seen as the most worrying threat to the world. Scientists are telling us that we will face its devastating impact if nothing is done to limit the temperature increase to 1.5 degrees Celsius by 2050.

Today, with about 90% of world trade transported by sea, global shipping accounts for around 3% of the greenhouse gas emissions that are driving global warming. The debate around sustainability continues to grow in volume and reach throughout the maritime industry. Initiatives such as the World Ports Sustainability Program and the Environmental Ship Index are gaining traction. And with increasing stakeholder expectations and regulations – such as the International Maritime Organization (IMO) Greenhouse Gas Strategy 2050 – the maritime industry finds itself at a pivotal point in the debate around sustainability.

Trelleborg’s new research report titled *Serious About Sustainability* reveals that the maritime industry’s commitment to sustainability is strong, with a renewed focus on the environment amidst the global pandemic. There is now real momentum across the industry with a long-term strategic approach toward sustainability.

Against this backdrop, we have accelerated our efforts to mitigate the potential negative impact that our operations may have on society and the environment at large. Now more than ever, we have the opportunity and the responsibility to deliver on our commitment to protecting what truly matters to us. We believe that the benefits of our solutions stretch beyond functionality and business performance – they protect people and the environment, as well as infrastructure and other assets, helping our customers advance their sustainability goals.

### 4.1 Sustainability by Design

Sustainability is at the heart of everything we do at Trelleborg. We call this *Sustainability by Design* – a clearly defined strategy integrating sustainability at every level of our organisation.

As we began our sustainability journey with a renewed sense of purpose and focus, we reflected on our alignment with the United Nations Sustainable Development Goals (U.N. SDGs). We took into account the value we would like to add to our diverse set of stakeholders who form such an integral part of what we are as leaders in our industry.

We took the onus to address three key priorities that contribute to five of the UN’s Sustainable Development Goals, notably SDG 12 Responsible Consumption and Production, SDG 7 Affordable and Clean energy, SDG 9 Industry Innovation and Infrastructure, SDG 13 Climate Action and SDG 11 Sustainable Cities and Communities.
By embracing these priorities as an anchor for our sustainability strategy, we are now focusing our efforts on:

1. Building responsible, circular supply chains from sourcing to end-of-life
2. Decarbonising the maritime industry through the development of cleantech (technology that reduces emissions and waste to improve environmental sustainability)
3. Engineering sustainability through premium product design.

4.2 Building Responsible, Circular Supply Chains from Sourcing to End-Of-Life

At Trelleborg, our dedicated team of experts works continuously to ensure that we provide optimal and cost-effective engineered solutions and on-time delivery to guarantee the successful completion of projects. We work with customers to drive change that lasts, supporting them with innovative and environmentally friendly solutions powered by smart technologies to advance their business as well as sustainability goals.

To ensure that we stay true to our commitment to drive sustainability across the supply chain, we are extending our efforts in all aspects: from advancing our sales technologies, replacing materials in production with more environmentally friendly options, transitioning towards renewable packaging and renewable energy, and most importantly by partnering with suppliers who are willing to be a part of our commitment in advancing sustainability practices.

4.3 Decarbonising the Marine Industry Through the Development of Cleantech

There are 75,000 merchant ships currently operating in the maritime industry, and this is set to exceed 80,000 by 2025. Without new sustainability policies, shipping emissions are expected to increase by 50% by 2050.

At Trelleborg, we are helping to decarbonize the maritime industry by providing smart and technologically advanced solutions to improve safety, efficiency and sustainability. Our automated mooring solutions – AutoMoor and DynaMoor help in optimizing berth utilisation and deliver superior efficiencies in port operations. The solutions significantly reduce the time to moor vessels and can minimise infrastructure investment to increase berthing capacity which in turn results in reduced carbon emissions.

2021 saw Trelleborg and shipping and logistics company, Nippon Yusen Kabushiki Kaisha (NYK Line), announce a strategic partnership to meet the demand for increased safety, efficiency and sustainability of mooring operations across Japanese ports. Under the new agreement, NYK Line will act as Trelleborg’s agent in Japan, and as a consultant via its subsidiary Japan Marine Sciences (JMS), to help ports across the country realise the benefits of Trelleborg’s safety-focused dynamic mooring solution, DynaMoor.

DynaMoor actively maintains tension in mooring lines to dampen vessel movements, eliminating the effect that passing ships, sea swell and long-period waves have on moored vessels. This increases the range of environmental conditions in which cargo can be transferred, improving throughput. The risk of parted lines and excessive vessel excursion is significantly reduced, protecting people, assets and increasing uptime. It further enhances safety by minimising ‘snap back’ zones. Additionally, it is easy to set up, independently anchored and does not rely on other wharf furniture to operate, simplifying day-to-day operations. The system speeds up the berthing process and minimises workload and manual line handling, in addition to improving the efficiency, and reducing the fuel consumption and emissions of vessels. Thus, enabling more sustainable mooring operations.
Trelleborg successfully completed the installation of its rope-free automated mooring system, AutoMoor, at the Old City Harbour at the Port of Tallinn, which is the biggest harbour in Estonia and one of the busiest passenger harbours in the world.

Several units of Trelleborg’s AutoMoor T40 Twin Arm were installed at the Harbour’s Berth 13 cruise ferry wharf to facilitate faster berthing processes and improve safety levels within the port environment.

Additionally, Trelleborg has secured orders for AutoMoor T40 units spread across five cruise-ferry and ro-ro ferry berths in Finland, Estonia and Norway, further demonstrating the port industry’s acceptance of automated mooring systems as a means to improve operational efficiency, safely and sustainably.

Using vacuum technology to rapidly attach and secure a vessel at berth, AutoMoor reduces vessel motions and continuously monitors all mooring loads acting on the vessel at berth. This provides live data to the operator to optimise day-to-day port and terminal operations. It also minimises personnel involvement to reduce human error, improve safety and sustainability.

Trelleborg’s automated mooring solutions are part of Trelleborg’s SmartPort portfolio, which powers the critical interface between ship and port, on land and at sea. It connects port operations, allowing operators to analyse performance and use data to improve decision making. The system integrates assets like fenders, mooring equipment, ship performance monitoring, and navigation systems and is underpinned by cloud and Internet of Things (IoT) technologies.

4.4 Engineering Sustainability Through Premium Product Design

4.4.1 A Whole System Approach to Fender Performance

With larger vessels, increased cargo volume, improved safety awareness and tougher environmental regulations, today's ports face significant challenges. To accommodate the regional compliances and rapidly changing nature of the shipping industry, ports must find ways to upgrade and future-proof their infrastructure, and to do so safely, efficiently, cost-effectively and sustainably.

Fender systems are a critical part of port infrastructure. These systems are mission-critical equipment, and are essential to the safety and efficiency of port operations, protecting vessels and terminals alike. Taking a whole system approach ensures high-quality fender systems are supplied that optimise vessel throughput and port operations efficiently and safely over the long-term. That’s because a whole system approach to fenders – one that includes application engineering, detailed fender system design, fender system production and quality control, and fender system installation, operations and maintenance – will reduce construction costs, downtime and operating expenditure, while contributing to more efficient and sustainable berthing operations. A high level of technical expertise and experience is required to select the most suitable fender system to safeguard berths, vessels and port operations.
Trelleborg’s new whitepaper, titled ‘A Whole System Approach to Fender Performance’ details the four key elements that are needed for a best-practice fender system. The end-to-end solution includes research and development, expert fender design, high-quality materials, manufacturing, testing, stringent quality control and after-sales services.

In recent years, Trelleborg has strengthened its position as a world leader in the design and manufacture of high-performance marine fenders systems, with several high-profile wins. Trelleborg won various fender contracts in 2021, particularly in Sweden and the UK with various ports with berths for belted ferries that require parallel motion or pivot fenders. A notable project completed in 2021 was in the north of Sweden. This was a challenging project which required a low reaction force fender system capable of ensuring superior ship stability under mooring and sustainability levels. Additionally, with systems positioned on an old concrete jetty with limited options, it was vital that the fender system allowed for anchoring in a very short lead time. Close cooperation between all parties made it possible to engineer, manufacture and deliver the project within a very short lead time.

Another notable project was for the supply of 19 foam fenders to a port in the south of France. This project required a special low-density foam grade to ensure the fender was large enough to meet the minimum requirements for the fender stand-off and at the same time have a very low reaction force while meeting the energy requirements. Trelleborg successfully supplied the fenders while meeting the challenging lead times in the shipping market.

Trelleborg was also awarded a contract to supply its Super Cone fenders and high-performance bollards as part of the expansion of an Egyptian port. The expansion project will see the construction of a 12-kilometre new quay wall, four new basins, storage yards, logistic zones, a railway network, a road that connects the berths and the port, as well as a breakwater.

Despite the impact of the COVID-19 pandemic, Trelleborg experienced continued demand from the cruise industry. We secured multiple cruise projects including the mega terminal for MSC in the US with two new berths. We also continued to support existing terminals with upgraded SeaGuard® fenders, in US cities, where Trelleborg’s fenders are to facilitate quicker turnaround times, reduced maintenance and repair, and reduced vessel carbon emissions.

Trelleborg was also awarded multiple Donut fender projects in 2021, including a contract to supply a robust system, as part of the ongoing maintenance to the Port Ferry. This project required a high-capacity, strong and reliable fender system, which would assist in the accurate and safe docking of ferries, while withstanding a highly corrosive environment subject to aggressive marine growth.

4.4.2 Keeping Immersed Tunnels Watertight for 120 Years

Backed by more than 100 years of polymer engineering expertise, Trelleborg has a time-tested track record of providing products and solutions that are critical to developing urban resilience to avoid human, social and economic losses. This includes applications such as immersed tunnels which aim to reduce congestion in cities and thus emissions, and water infrastructure solutions that protect societies against rising sea levels.

Trelleborg was awarded the contract to supply tunnel sealing systems to Femern Link Contractors (FLC) for the construction of the 18-kilometer long Fehmambelt tunnel. Connecting Rødbyhavn in Denmark and Puttgarden in Germany, once completed it will be the world’s longest immersed tunnel.

Constructed from 79 large tunnel elements, each 217 metres long, and 10 special elements, the Fehmambelt immersed tunnel will comprise a four-lane motorway and two electrified rail tracks. Sealed by Trelleborg’s industry-leading Gina gaskets, Omega seals, Waterstop seals and clamping systems, component supply will begin in 2022 and final deliveries are scheduled for the end of 2026.
The Fehmarnbelt tunnel is an important part of the European transport network, bringing Scandinavia and Central Europe closer together via the so-called North-South corridor, paving the way for a new greener traffic corridor in Europe. This will enable motorists to travel between Rødbyhavn and Puttgarden in just 10 minutes and train passengers in as little as seven minutes, both saving around an hour each way when compared to the current ferry crossing. The construction of the tunnel will result in significant changes to the current traffic volumes, reduce average travel distance by 160km thus significantly reducing fuel consumption and carbon emissions.

4.5 Supporting LNG Transfer Operations as a Transition Fuel to Clean Energy

With a comprehensive portfolio of industry-leading oil and gas transfer solutions, Trelleborg has been at the forefront of the LNG industry for decades, making the docking, mooring and transfer of LNG safer, more efficient and more sustainable. In 2021, Trelleborg was awarded the contract to supply a combination of docking and mooring equipment, marine fender systems as well as crossing plates, for the construction of the LNG Hub Marine Terminal, located on the Mauritania and Senegal maritime border.

The project aims to provide LNG for global export and make gas available for domestic use in both Mauritania and Senegal. Gas will be produced from an ultra-deepwater subsea system and mid-water FPSO vessel, which will process the gas, removing heavier hydrocarbon components, before it is transferred to the LNG Hub Marine Terminal for liquefaction and offloading to LNG carriers. The terminal is expected to provide approximately 10 MM metric tons of LNG per annum on average, with the total gas resources in the field estimated to be around 15 tcf.

As part of the suite of solutions supplied to the project, Trelleborg will supply a chain stopper that allows adjustment in the FSRU mooring system. The project will also be the first to use a pneumatic type fender for a permanently moored vessel FSRU. Pneumatic fenders are mission-critical equipment that have a direct impact on the safety and efficiency of transfer operations. All of Trelleborg’s Pneumatic fenders are manufactured in compliance with ISO-173571:2014 standards and are expertly engineered to guarantee lifelong performance and support the smooth running of port operations.

Additionally, Trelleborg will supply Super Cone fenders (SCN), the latest generation of ‘cell’ fenders, with optimal performance and efficiency, as well as its SCK Cell fenders – known for having a very long track record they remain popular because of their simplicity, high performance, and strength. Trelleborg will also supply DynaMoor, which combines Trelleborg’s class-leading Quick Release hooks with an innovative constant tensioning system.

Trelleborg will also supply a fully integrated berthing system to one of the first LNG terminals in southern Vietnam, which when operational in Q4 2022 will have the capacity to receive 85,000 DWT vessels. The fully integrated berthing system will comprise a marine fender system, docking and mooring equipment as well as a ship-shore link system. Trelleborg’s best practice design and quality materials ensure a long service life with low maintenance, no matter how demanding the working and environmental conditions. All fenders are supplied fully tested and in full compliance with PIANC 2002 guidelines.

4.6 Adopting New Ways of Working to Support More Sustainable Customer Practices

Trelleborg made great strides in delivering expert support to our customers to ensure business continuity and minimal operational disruption, even during the pandemic.

2021 saw Trelleborg successfully complete the remote installation of its latest technology in navigation and piloting; SafePilot Offshore. Works were part of an upgrade of the navigation and positioning
systems and buoy monitoring systems for a floating production storage and offloading unit (FPSO). Trelleborg’s experts rose to the challenge that was amplified by the global travel restrictions and reduced offshore personnel by becoming a strategic partner and successfully supporting the installation, data integration, software uploading and commissioning of the equipment all remotely. This enabled the customer to save on operational costs, and lower health and safety risks due to the reduced need for offshore personnel.

In 2021, Trelleborg continued to connect with customers and industry peers, keeping them up to date with the latest technical knowledge via live online webinars, which were also made available to view on-demand, covering topics such as automated mooring systems and a whole system approach to fender performance.

Trelleborg also launched a new augmented reality app (Marine and Infrastructure AR & app) which enables customers to virtually view 3-D models of Trelleborg’s solutions and get everything they need to know about the products’ technical information, and access relevant brochures and whitepapers.

4.7 Moving Forward with Purpose

With the shifting global and ecological landscape impacting the environment, it is important now more than ever to commit to sustainable practices. It is vital that the industry takes steps to become more conscious and sustainable in its decision making. As a result, Trelleborg is continuously exploring ways to further strengthen our portfolio to provide solutions with a lower environmental impact.

Our emphasis on engineering application, design expertise and materials combine to deliver high-quality products with a longer lifetime. At a group level, we are working towards achieving 50% reduction in carbon emissions relative to sales by 2025 and a longer-term vision of being carbon neutral by 2035.

Our goal is clear – we must keep up our commitment to designing sustainability into everything we do. We will continue to contribute heavily towards green investments and have outlined new initiatives to further support our customers and industry. We believe that the only way to protect our environment and contribute to a better future is by all working together.

https://www.trelleborg.com/marine-and-infrastructure


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5  SHIBATAFENDERTEAM in 2021
Sustainability at the Forefront in 2021

Just like 2020, the year 2021 was characterised by COVID-19 and its impacts on companies, projects, and the supply chain. Establishing a ‘new normal’ in the ways we communicate, collaborate globally, use existing tools and developing new ones continued to have a major impact on our work. Over the course of 50 years of experience in the fender industry, we at the ShibataFenderTeam Group have consolidated our role as a pioneer member of the fender community – advocating transparency and a best-practice approach to fender design, as well as contributing to the education of industry stakeholders with our long-standing expertise. Technical progress and innovation, a growing awareness for responsible and eco-friendly implementation of resources, and smart engineering are only a few aspects that have stood out this past year.

In 2021, we were especially happy to see continuous positive feedback to our SFT Online Technical Seminars and to maintain our fruitful collaboration with PIANC and the National Sections. We would like to take this opportunity to thank everyone involved in our successful projects despite the ongoing challenges that the industry is facing and are looking forward to keeping up the progress regarding responsibility, education, and innovation in 2022.

5.1  A Growing Sense of Responsibility and Innovation

As a leading fender manufacturer, we consider operating on a sustainable and eco-friendly level as a major area of our responsibilities. In recent years, our commitment to preserving the environment and encouraging the industry to increase sustainability efforts has become one of the top priorities of our holistic approach and our core values of fender design at SFT.

For example, we replaced tropical hardwood with recycled PET bottles for our eco-friendly HD-PE Sliding Fenders produced in Rechlín, Germany. We have also incorporated a more responsible production of rubber ladders by using certain amounts of recycled rubber. Research in this field is mainly conducted by our majority shareholder Shibata Industrial in Japan. Recycling materials, refurbishing, and repairing Foam Fenders or SFT smart engineering are some of our concepts to manage resources more efficiently and to reduce our carbon footprint.
We are furthermore excited to announce that we are currently in the process of planning a corporate social responsibility (CSR) line for sustainable products and thereby increasing our environmental and social sustainability in current and future port and infrastructure projects and decision making.

5.2 SFT Fender Systems – The Holistic Approach and Best-Practice Examples

Following our aspiration to not only put our expertise to good use in fender design and production, but to share our knowledge with the fender industry and increase the awareness of critical aspects in high-quality fender manufacturing, we have launched a new FAQ section on fenders and best-practice design and recommendations for a holistic approach: www.fenderdesign.com:

Learn more about fenders and best-practice design in our new FAQ section
SFT’s holistic approach to fender system design reflects in every little detail of a fender system. Our engineers design high-quality fender solutions that take into account all the individual elements of a project including substructure, unique project features, and every component of the respective fender system. Our long-standing expertise and our focus on in-house production substantiate our reputation as one of the most reliable and dependable partners in the fender industry. Frequently asked questions that we have captured and responded to with the new section on our website include ‘Why inverted cone fenders should be avoided’, ‘Why the weight chain is the most important chain for a fender system’ or ‘Why the most efficient fender is not necessarily the most suitable fender for your project’.

For more information, visit our FAQ section or read our revised article ‘Fender Systems – A Holistic Approach’.

5.3 SFT Pneumatic Fender Manual

One of our publication highlights in 2021 was the release of unbiased information about Pneumatic Fenders: ‘A Guide to Prime-Quality Pneumatic Fender Manufacturing’.

In the SFT Pneumatic Fender Manual, our experts elaborate on the differences between the two manufacturing methods for Pneumatic Fenders that are usually performed in the fender industry: wrapping and molding. Both methods comply with ISO 17357-1:2014, the international standard providing guidelines on essential Pneumatic Fender criteria such as material, performance, dimensions, guaranteed energy absorption (GEA), as well as test and inspection procedures.

The Pneumatic Fender Manual furthermore outlines the key facts and information on Pneumatic Fenders. This particular fender type – also commonly referred to as Yokohama or floating fender – is an adequate and effective solution for ports with extreme tidal variations, ship-to-ship operations (liquid cargo vessels, FSRU), or temporary berthing. It is deployed to withstand harsh weather conditions and tremendous berthing forces.

As the leading manufacturer of fender systems, we at the SFT Group are aware of our great responsibility towards the maritime industry. This is one of the reasons why SFT actively engages in PIANC Working Groups, provides knowledge with publications like our SFT White Paper Series and offers customised SFT Online Technical Seminars.

“One of the SFT Group’s core values is to make the marine industry safe, reliable and efficient. These values are practiced daily when engaging with clients and other stakeholders, and in particular in our engagement with Working Groups for guidelines and industry standards. The most renowned group is the PIANC Working Group 211 that addresses new fender guidelines. The SFT Group’s role here is to provide a deep insight into marine fender design that makes berths safer and more reliable, as well as to increase efficiency by applying our holistic design approach”, as Dominique Polte, Board Member at SFT, explained.

5.4 White Paper IV: Testing – A Best-Practice Approach

In 2021 we completed our White Paper Series about fender manufacturing with the fourth and final White Paper ‘Testing – A Best-Practice Approach’. It completes the Series with a thorough examination of testing methods for fender systems, best-practice approaches to verifying the required performance properties and the durability of a commercial fender.

With our four-part SFT White Paper Series, we aim to provide an unbiased view on what exactly makes a good fender and to continuously advocate more transparency in in fender manufacturing.
White Paper #4 follows up on the previous parts, which established in-depth illustrations of compounding (#1), mixing (#2) and manufacturing and curing (#3). It highlights the significance of testing by transparently explaining how to interpret the test results of different testing methods.

Being based on the point of view of an experienced manufacturer, White Paper #4 can be used as a practical, hands-on guide for clients to the ideal approach in the complex fender testing environment.

The complete White Paper Series is available in several languages in our download section.

5.5 SFT Online Technical Seminars – Educating the Industry in Difficult Times

With our mission to stand close to our clients despite the travel restrictions that the world faced in 2020, we launched our personalised SFT Technical Seminars as early as Mid-April 2020. Seeing our customised and interactive seminars so well-received in 2020 inspired us to continue with this service in 2021 and to take our commitment to engineering excellence, value engineering and dedication to high-quality fender solutions to the next level with our seminar content. We are more than happy to report that we have held more than 170 seminars to date and are excited to see such an active participation of the fender community. The feedback we get tells us that our seminars reflect our holistic approach: Just like our fender design and manufacturing, our seminars are unparalleled in the market when it comes to customization, technical content, and personal approach.

The seminars are offered in English, German, Spanish, French, Portuguese, and Dutch and are free of charge. Our topics include: SFT Product Range | Design Energy for Fender Systems | Panel System Design | Rubber Fender Manufacturing | Rubber Fender Testing | Installation, Operation and Maintenance.

To register for one of our seminars, please visit our website.

5.6 ShibataFenderTeam @ PIANC

Our work as a PIANC Platinum Partner has been an important part of our work for many years and we continued to be actively involved in shaping the work of various National Sections and Commissions.

5.6.1 Substantial progress of WG 211

The PIANC Working Group 211 proceeded to work on the ‘Guidelines for the Design of Fender Systems’, a well-established reference for the entire maritime industry. The Working Group consists of industry members including leading fender manufacturers and puts its focus on updating the guidelines from 2002 to meet the latest requirements – hereby ensuring an approach to fender design and testing that leaves no room for interpretation. Our SFT representatives Dominique Polte and Eduardo Rodero were part of the online meetings that took place throughout the year, contributing to the group’s substantial progress in 2021.

The holistic approach to fender design, which SFT has been advocating for many years, is moving more and more into the focus. Inviting independent material experts for rubber and PE provides unbiased information and facts to the group. SFT is keeping a close eye to the comprehensibility and usability of the guidelines for designers, especially if they are no fender experts. Overall, we are glad to accompany this future-oriented project that will have a significant impact on the fender industry and to be working in an international team where everyone puts in a lot of effort into documenting their concentrated expertise.

5.6.2 Continued support of Young Professionals in Spain

As a Platinum Partner, we strongly support the PIANC Young Professionals, and it is a great honour for us to share our experience in fender design with the young generation. Sharing knowledge within the industry and giving others the chance to benefit from one’s experience is an extremely important matter for the whole team at the ShibataFenderTeam Group.
In Spain, PIANC is represented by the ‘Asociación Técnica De Puertos Y Costas (ATPYC)’. In 2021, the Young Professional Section of ATPYC invited to its 17th conference, which is usually held annually. This year, the event was held as a virtual seminar on 18 November. The seminar consisted of several technical sessions, covering various topics related to the maritime industry. SFT acted as a sponsor of the event and presented a short session on ‘Fender Testing – A Best Practice Approach’. The session was chaired by our Spanish representative and YP member, Alvaro Rodero.

5.6.3 Activities at PIANC Germany

Moreover, SFT is also represented in the National Section in Germany. At the successful and well-received event in April 2021, we had the outstanding opportunity to present our free Online Technical Seminars to the PIANC members. The following meeting took place in September 2021 where our colleague Anna-Lena Pahl presented the latest developments of the PIANC Promotion Commission (ProCom), which she passionately chairs— even during her maternity leave in 2021. More information about the developments of ProCom can be found in the ProCom report from Anna-Lena Pahl.

We currently encourage all our partners to join the National Sections and are looking forward to resuming this important collaboration in 2022.

5.7 Tackling the Challenges of the Shipping Industry

While the impact of the Covid crisis continued to affect many industries all over the world, we at SFT did our best to focus on the opportunities and new ways to proceed with our pioneering work. However, there are challenges that will accompany the shipping industry throughout the year 2022: Freight prices remain high and there is still very limited space for containers. Another challenge is the unpredictable development of prices and the uncertain transit times. Some unscrupulous players in the fender market underestimate freight rates on purpose, in order to have a competitive advantage and charge the correct rates later on. At SFT, our highest principle lies in the transparency, trustworthiness, and reliability.

5.8 Our Projects

Fender deliveries in 2021 were characterized by the impacts of the pandemic, especially when it comes to raw materials, transport and other aspects of the supply chain. Despite these challenges, the order administration teams in the different SFT offices have worked closely with our clients to bring all orders to a successful completion and both sides adjusted their schedule to work around any issues encountered along the way.

5.8.1 Element Fender Systems for Public Ferry Terminal in Gydnia, Poland

It is the largest infrastructure project at the Port of Gdynia in nearly 50 years – the construction of the new public ferry terminal at an area of 30,000 m². Gdynia is a port city on the Baltic coast of Poland.

The Polish construction company Doraco has started the construction project in March 2019 and entrusted SFT with the delivery of 18 sets of FE 900 Element Fender Systems as well as 2 sets of FE 750 Element Corner Fender Systems.

Additionally, we supplied 13 pieces of Extruded Fenders with different capacities.
The design of the Corner Fender Systems was challenging as the height of the concrete in this area had to be adjusted for constructability reasons by the client, so the Element Fender length had to be changed and compensated by a height adjustment to maintain the needed fender performance. This is a perfect example of the SFT design approach and flexibility, to swiftly adapt to new circumstances while providing a high-performance fender system for such. The new berth was finished in June 2021 and is an important development for the port. It will increase transport accessibility from the sea way and therefore makes the port more competitive.

5.8.2 Cone Fender Systems for Gemalink Terminal in Vietnam

In early 2021, the Gemadept shipping company opened a new terminal in Bà Rịa-Vũng Tàu province. The province is located on the Southern Coast of Vietnam and is one of the country’s economic power houses. As the largest deep-water port in the South of the country, the new Gemalink port connects Ho Chi Minh City, the Mekong Delta and other ports in the region, such as in Thailand and Cambodia. Now, up to three large ships can berth simultaneously at the new terminal.

![SFT Cone Fender Systems installed at the Gemadept Terminal in Vietnam](image)

As a smart port, Gemalink is equipped with advanced technology and high-quality fender systems. To be precise, our Malaysian SFT office together with our Vietnamese agent KES Industries Pte. Ltd. supplied 44 sets of SPC 1800 Cone Fender Systems with a steel panel design measuring 3,200 mm x 6,400 mm and 19 sets of SPC 800 Cone Fender Systems with a steel plate of 1,700 mm x 6,400 mm. Additionally, we equipped the berth with 26 rubber ladders and 88 sets of Stag-horn Bollards (66 sets with a capacity of 200 t and 22 sets with a capacity of 30 t).

The two-year project, with a total investment value of USD$ 330 million, was financed by Gemadept and CMA-CGM. The project was also honoured by the magazine Engineering News Record (ENR) with the Global Best Projects Awards 2021 in the category Civil Marine Works in September 2021. SFT congratulates and wishes all shipping companies a successful operation of the new Gemalink port.

5.8.3 Cone Fenders for the Middle Harbour Project at Port of Long Beach, CA

The Middle Harbour Redevelopment Project at the Port of Long Beach, California began back in May 2011 and is expected to be completed ten years later, in 2021. The project will combine two old container terminals at the port into one more advanced and environment-friendly terminal. The construction work is carried out in three phases with multiple stages to allow operations at the port to continue during the development. Taking place at Piers E, D and F, the modernisation will create capacity to handle more
than 2 million additional containers and also reduce air pollution by 50%. Expanding the area of the existing terminals from 120 hectares to 140 hectares the 1280-metre-long wharf will be able to accommodate about three vessels at once.

SFT Cone Fender Systems and Single Bit Bollards delivered to Port of Long Beach, CA,

The project has a total value of USD$ 1.5 billion and is planned and executed by different companies such as Moffatt & Nichol and Manson Construction. Currently, the Port of Long Beach is the second busiest seaport in the US and creates 1.5 million jobs throughout the country.

SFT was honoured to supply the SPC 1600 Cone Fender Systems with a closed steel panel design measuring 3,353 x 4,334 mm and additionally, Single Bit Bollards with a capacity of 200 t. An impressive video for the construction site showing the installed fenders can be found on our YouTube channel.

We congratulate the Port of Long Beach for this outstanding infrastructure project and are grateful to be a part of this development. SFT wishes successful operations to all shipping companies at Long Beach Middle Harbour. For more information, visit our news section.

We are looking forward to your visit!

www.sft.group

LinkedIn  YouTube
6 BOSKALIS in 2021
CREATING NEW HORIZONS

Boskalis is a leading dredging and marine expert, providing a wide range of services comprising of:

- the design, construction and maintenance of (sustainable) ports and waterways, land reclamation, coastal defence and riverbank protection
- the execution of projects and marine services for the offshore energy sector including subsea, heavy marine transport, lift and installation services
- marine geophysical and geotechnical surveys
- towage and terminal services
- marine salvage services and projects

With safety as our core value, we provide all-round, tailor-made innovative and sustainable solutions for infrastructural challenges in the maritime, coastal and delta regions of the world. Realising projects in remote locations – with a heightened environmental focus – is one of our specialties.

6.1 Boskalis as Partner of PIANC

As partner of PIANC, we recognise the importance of developing new and updating existing guidelines for navigation infrastructure based on state-of-the-art knowledge and data. As such, we actively contribute to a variety of Commissions (a.o. EnviCom and MarCom) and Working Groups to share our knowledge around the design, preparation and construction processes based on port infrastructure projects executed globally.

Where possible we introduce case studies and information in WG’s to provide tangible examples of sustainable design and construction projects that support developed and new guidelines. An example of such a knowledge programme is the Artificial Reef Programme described on the following pages showing how innovative ecological solutions can be applied to complex construction challenges in sensitive environments.

More information and contact details can be found on the website www.boskalis.com.

6.2 Sustainability

Through our approach to sustainability, we actively seek opportunities to make a positive contribution to the conservation, restoration and enhancement of natural environments. We invest in research and development, ways of working and collaboration to help protect and enhance biodiversity and marine habitats. Based on our deep understanding of marine ecosystems we’re able to provide nature-based infrastructure solutions and restoration projects. Depending on the project type and scope of works we can also offer our Building with Nature (BwN) approach.

Each year we publish a Sustainability Report https://boskalis.com/sustainability/reports.html providing an overview of the broad spectrum of initiatives that we engage in on a daily basis.

6.3 Boskalis Artificial Reef Programme (ARP)

Around the world, coral reefs are central to marine ecology and natural coastal protection mechanisms. However, they are under threat from coastal development and climate change. Damaged reefs lose their function as a natural breakwater. This enables wave energy to reach the coast unhindered, causing potential flooding or erosion. Corals support an estimated 25 % of all marine life. Their loss or decline can have dramatic impacts on underwater ecosystems, as well as the local livelihoods – such as tourism and fishing – that rely on them.

The Boskalis Artificial Reefs Programme (ARP) is a research-based program aimed at understanding and applying the ecological, hydraulic and economical values of artificial reefs to compensate and rehabilitate (revitalise) existing and new reefs where possible combining this with a hydraulic function.
The programme consists of three key pillars:

1. knowledge development
2. network creation
3. detailed engineering

By forming a catalyst for the artificial reef community, the ARP offers a unique platform to exchange concepts and develop fit-for-purpose designs for our clients.

With a series of ground-breaking pilot studies, the ARP brings together a wealth of expertise. This expertise enables Boskalis to find best-for-project solutions that fit in the various environments and ecological habitats and at the same time provide protection to vulnerable coastlines and support the preservation and restoration of important marine ecosystems such as coral reefs.

6.4 Promising Innovation

The ARP fits in with the Boskalis sustainability strategy of biodiversity and climate adaptation, but the objectives go beyond simply looking for nature-enhancing solutions. Artificial reefs not only support existing marine ecosystems, such as corals and fisheries, they can also serve as an alternative form of coastal protection or marine infrastructure. This innovative approach for coastal and riverine defences still allows for a focus on ecology and nature enhancement.

The ARP aims to develop and apply large-scale, modular artificial reefs for maximum positive impact. By acting as breakwaters for wave energy, artificial reefs can provide an alternative form of coastal protection. Through the restoration of habitat complexity in degraded coral and oyster ecosystems, they enhance the resilience of marine habitats. Pilot studies have shown that artificial reefs can also function effectively as ecological scour protection. Example applications are the foundations of wind turbines, or to protect cables and pipelines on the seabed.

The ARP supports the steady development of a diverse portfolio of artificial reef solutions which can be applied for a wide range of purposes on behalf of our clients in a number of settings.

6.5 Partnerships

The ARP also focuses on innovations developed by external parties. Boskalis has entered into strategic partnerships with parties working at the cutting edge of modular engineering offering our partners the opportunity to collaborate on pilot projects, tenders and the resulting projects. We share our insights and technical design requirements for artificial reefs with our strategic partners, particularly when we work in challenging environments. In return, our partners pass on their insights, updated designs and practical experience with artificial reefs to us.

“...and in return our partners pass on their insights, updated designs and practical experience to us. Critically, these symbiotic partnerships provide the necessary experience and support the level of innovation required for the successful application of artificial reef technology”, says Paul Peters, Programme Lead of the ARP. “Engaging with local stakeholders, universities and organisations throughout the project lifecycle also plays a key role in creating value through scientific monitoring, capacity building and new collaborations.”
One of our strategic partners, the NGO Coralive.org, has perfected an approach known as mineral accretion technology (MAT). This technique uses electricity with a very low voltage to make corals grow faster. The MAT approach is being used on the Endless Reefs designed by Boskalis, as well as on other modular systems currently being studied in a pilot project in Panama.

Another strategic partner, Reefy, has developed a unique modular design called Reef Enhancing Breakwater. The design consists of concrete blocks with a specific shape to reduce the wave energies of the seawater under the most severe hurricane conditions to protect coastlines, while providing habitat and settlement opportunities for a variety of marine flora and fauna.

A modular approach with concrete blocks, for example the MOSES units from ReefSytems, also opens up opportunities for use as ecological scour protection, for example to cover the foundations of wind turbines, or to protect cables and pipelines on the seabed.

Jointly, we are looking at an emerging market for large projects that tackle climate adaptation.

6.6 Pilots

To understand how the reefs work in scientifically sound manner, we have set up several strategic pilot projects. These pilots bring together the knowledge and experience acquired in recent years and the strong relationships built up with a range of specialist parties.

A lot of research is still needed but the initial results of the pilot projects are very promising. With the results achieved so far, we can already provide project owners with inspiring concepts on specific projects, advise them on technical aspects and connect them with the best partners in the field.

6.6.1 Monaco Pilot: One of the 3-D Printed Reefs on the Seabed Offshore Monaco

In 2017, Boskalis launched its ReefVival project with the production and installation of 3-D printed reefs in the Larvotto Reserve in Monaco. The aim was to understand how they could help with the ecological recovery of the area. Scientific research based on monitoring data demonstrated that local biodiversity has improved considerably and that the reefs are biologically productive.

Based on the experience during the Monaco pilot, it was concluded that an artificial reef can be used on a large scale. In that way, the positive environmental impact generates demonstrable value for the project. In some cases, this is described as making grey infrastructure green.

However, at the same time the challenges of 3-D printed reefs were investigated around scalability and relatively high production and installation costs. This led to the development of smaller modular reef concepts making it possible to install artificial reefs in a more economical manner whilst still maintaining in a modular approach.
6.6.2 Panama Pilot (2020 Onwards)

The Panama Pilot aims to compare, under identical conditions, four artificial reef types that have been designed based on different design philosophies: active (MAT) versus passive (non-MAT) systems, as well as modular versus non-modular designs. The designs include the in-house designed Endless Reef units, Coralive.org minidomes, ReefSystems MOSES units and ReefBall units. In this pilot Boskalis collaborates with Reef2Reef, Commercial Diving Panama and the Maritime University of Panama to see effective coral habitat restoration techniques in the face of coral reef decline in Panama.

6.6.3 REEFolution Kenya (2021 Onwards)

The biodiverse coastal reefs of Kenya support artisanal fishing and tourism. Over the past years these reefs have been severely damaged due to practices such as blast fishing. To counterbalance this increasing environmental pressure, the REEFolution Kenya initiative was established to restore and stimulate a more sustainable use of coral reefs. Past damage is rehabilitated and reef resilience increased through active coral reef restoration.

In close collaboration with Wageningen University & Research and ReefSystems, Boskalis supported the purchase, transport and installation of 90 MOSES units at Shimoni, Kenya, which will be used for coral restoration and habitat monitoring purposes. The ecological performance of these modular concrete units is being monitored and compared to existing artificial reef structures already present, including MAT structures, bottle reefs amongst others.

6.7 Engage with our Programme

The ARP and its underlying partnerships enable Boskalis to deliver on fit-for-purpose designs with both global organisations and people working at the local level. This ensures an outcome-focused approach which is both locally supported and can be delivered successfully over the long term.

Please visit our website (www.boskalis.com/artificialreefs) for frequent updates on the pilot projects, as well as our latest artificial reef designs and partnerships.

If you are interested to learn more, develop a pilot project or have specific engineering needs for your project or client, please contact ARP Programme Lead Paul Peters at paul.peters@boskalis.com.

Parts of this article have previously appeared in the Horizons magazine published by Boskalis in print and online. Go to www.boskalis.com/magazine and find more information and videos.

https://www.boskalis.com/

https://www.linkedin.com/company/boskalis/

@beleefboskalis
Penta-Ocean Construction is celebrating its 125th anniversary since its founding in Kure City, Hiroshima Prefecture, in 1896.

Our initial business in marine civil engineering works has significantly expanded to land civil engineering and building construction works.

Beginning with the Suez Canal Dredging Project in 1961, our journey abroad has been marked by a number of memorable milestone projects, mostly based in Singapore, since our foray into Singapore in 1964.


A ‘genuine global general contractor’ is a company, free from barriers between civil engineering and building construction businesses as well as between domestic and overseas businesses, and is an ‘advanced company in Diversity and Inclusion’ where diverse human resources, regardless of nationality or gender, can work together with vigour and enthusiasm as well as mutual respect.

We will continue to promote ‘Digital’ and ‘Green’ initiatives with an enterprising spirit as part of our corporate DNA. Through implementing digital transformation, we will bolster the work style reform, and the productivity improvement for realizing the reform. Similarly, we are taking on the challenges in the green energy field, including the construction of ‘offshore wind farms’ and ‘zero energy buildings’.

Through ensuring reliable safety and quality backed by advanced technologies, we will deliver the joy and excitement of creating, (building). For Penta-Ocean Construction, an era of ‘new challenge’ begins, beyond organisational barriers and borders.

### 7.1 Utilisation of BIM/CIM for VR Simulation in Port Construction

BIM/CIM is utilised as a tool for improving productivity throughout the life cycle of infrastructure, including research, design, construction, maintenance, upgrading, and disposal. With BIM/CIM as the core, we centrally manage installation and inspection records, and use data and digital technology to optimise the positioning of skilled workers and machinery in the field, aiming to carry out construction work quickly, accurately, and at optimum cost while maintaining high quality. In addition, the BIM/CIM VR (3-D/4-D) simulations are used for safety training and occupational accident prevention.
7.1.1 Examples of BIM/CIM Utilisation at the Construction Stage

- Visualisation (4-D simulation made by adding a time axis to a 3-D model)
  Visualising the situation at the construction site
  Visualising the positioning of the work vessel
  Visualising work procedures
  — Optimisation of construction plan = increased productivity
- Information sharing (sharing visualisation data with participants)
  Sharing information on the work progress and positioning of work vessels
  — Safe and smooth operation of ships
  — Utilising the information when maintaining and upgrading the infrastructure

7.1.2 Effective Verification Using BIM/CIM Models — Creating an Undersea Terrain Model

We created an underwater topographical model by taking the seabed data obtained by underwater surveys prior to the commencement of the construction, and applying it to the BIM/CIM model. For example, in the case of pile-driving, by making the seabed data three-dimensional in advance, one can better understand the condition of the pile pits (soil layer configuration and ground height). This makes it possible to identify and deal with areas where countermeasures are needed, during the examination phase, eliminating the need to redo work during the construction phase (e.g. redesign).

7.1.3 Allowing for Vessel Positioning Adjustments and Confirmation

When using a crane barge in port construction, it is important to consult with relevant parties so as not to impede the safety and smooth operation of ships in the vicinity.

Therefore, in addition to information on the positions and work statuses of the working vessels, the BIM/CIM model includes information on vessels in adjacent berths. This allow for everyone to intuitively understand the positions and relative distances between vessels, thereby reducing labour and increasing the efficiency of coordination efforts.

7.1.4 Preliminary Review of Construction Plans — Increased Productivity Through Front Loading

By applying a time axis to the BIM/CIM 3-D model, we can create a 4-D simulation that can be used for the preliminary review of construction procedures. The construction procedure is visualised, making it possible to check areas of concern before construction begins, such as contact with existing structures and interference with temporary installations, thereby reducing the possibility that rework will become necessary during the construction phase. Additionally, as the simulation enables one to see how the construction site will change over time, it is easier to explain the construction plans to those involved.

*Using a 4-D simulation to verify the construction procedures*
7.1.5 Safety Experience VR – Simulation of Hanging Steel Pipe Sheet Pile or Heavy Machinery Spinning

We carried out a VR simulation, which allows workers to experience a disaster that can occur while operating heavy machinery, namely when a hanging load begins spinning and hits a worker. The simulation was made from several different perspectives, including those of workers atop the guide frame, workers on the platform or crane barge, and employees of the prime contractor who have come to supervise the work. By allowing people to observe the situation from each other's perspectives and share their own views, the simulation raises safety awareness and contributes to the prevention of occupational accidents.

7.2 Construction of ‘Ocean 3’

Penta-Ocean Construction Co., Ltd. and Kanmon Kowan Construction Co., Ltd. have jointly built the ‘Ocean 3’, a Calcia improved soil drop mixing vessel that can efficiently produce large quantities of Calcia improved soil by mixing dredged soil with Calcia improving material (made of steelmaking slag processed by component management and particle size adjustment). The Ocean 3 is a reclaimer vessel (a work ship that uses conveyor belt to transport dredged soil etc. to a landfill site), specially equipped with a feed hopper for Calcia improving material, a feed conveyor, and a mixing and casting conveyor.

There are several methods for mixing dredged soil with Calcia improving material; backhoe mixing method, pneumatic flow mixing method, and drop mixing method. After numerous tests using dredged soil of different soil properties, it has been proven that drop mixing method, which is mainly adopted by a reclaimer vessel, is capable to produce high-quality and homogeneous Calcia improved soil by dropping the soil three times from the height of 2 m or more above the ground. However, the use of a reclaimer vessel for the above purpose requires outfitting of special apparatus, such as a feed hopper for Calcia improving material and feed conveyor. In addition, given that a reclaimer vessel allows only two dropping attempts at the time of conveyor belt transfer and casting into the water, it was necessary to add one more drop operation outside the vessel, either during transhipment ashore or during unloading of soil after transport by lifting the cargo bed of the dump truck.
The new vessel allows for a total of three attempts of drop mixing: twice during the transfer of the conveyor belts and once during the drop from the boom conveyor.

Furthermore, the new vessel is equipped with a quality control system that allows real-time monitoring of the mixing ratio of the Calcia improving material, the density and water content ratio of the Calcia improved soil, which conventionally could have been monitored only through sampling inspections. This has made it possible to produce a high-quality Calcia improved soil with the accurate composition.

Together with Kanmon Kowan Construction Co., Ltd., we will utilise the Ocean 3 to efficiently promote the use of Calcia improved soil for reclamation and backfilling of deep excavation sites, as well as creation of shallow areas and tidal flats.

7.2.1 Features of the Ocean 3

- Enables large-scale operation
  Capable of producing from 2,500 to 4,000 m³/day of Calcia improved soil
- Improves operation efficiency
  No outfitting is required, resulting in shorter construction period
  No need for mixing work outside the vessel, as three drops for mixing are assured by the time of soil discharge from the vessel
  Direct underwater discharge using tremie pipe enables the creation of shallows and tidal flats as well as backfilling of deep excavations
- Contributes to quality assurance and improvement
  Real-time confirmation of the mixing ratio of the improving material, the density of Calcia improved soil and the water content
  Quick response to excessive or insufficient amount of the improving material to produce the high-quality improved soil

7.3 Phase 3A, Pengerang Deepwater Terminals in Malaysia

In Malaysia, Penta-Ocean Construction has finished the project ‘Phase 3A, Pengerang Deepwater Terminals’. This project involved reclamation of approximately 140 hectares of land, and construction of a new 2,444 metres jetty in Pengerang, Malaysia. One of Malaysia's largest petroleum refineries and petrochemical integrated complex projects is underway in the area and it is expected to contribute to the country's economic development. Since 2011, we have been engaged in the first and second phases of reclamation and jetty construction in the same area. Including this project, the total reclaimed land is approximately 302 hectares and the total extension of the three jetties is 10,057 metres.
7.4 Initiatives for Offshore Wind Power

In order to achieve carbon neutrality by 2050, the Japanese government has set a target of 10 GW to be powered by offshore wind generation by 2030 and 30-45 GW by 2040. In accordance with the Act on Promoting the Utilisation of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities, public solicitation procedures for the selection of business operators have begun in the promotion zone in the general sea area, and the clarification of the government’s target is expected to accelerate the construction of offshore wind power generation facilities. In this business environment, we aim to become the ‘pioneer in the offshore wind power field’ and are actively working to improve our systems in anticipation of higher demand for the construction of offshore wind power generation facilities, which is now in full swing.

7.4.1 Establishment of ‘Japan Offshore Marine’, a Joint Venture Company between Penta-Ocean and DEME Offshore

Penta-Ocean Construction Co., Ltd. (hereinafter referred to as ‘Penta-Ocean’) and DEME Offshore Holding NV (hereinafter referred to as ‘DEME Offshore’) established a joint venture company, ‘Japan Offshore Marine Co., Ltd.’ (hereinafter referred to as ‘JOM’) to collaborate in the field of offshore wind construction in Japan.

DEME Offshore, which has a leading track record and technological know-how in the field of offshore wind construction in Europe, and Penta-Ocean, which has extensive experience and advanced technologies in marine civil engineering work under Japan’s harsh natural conditions, will collaborate through the new company, JOM, to contribute to the expansion of offshore wind power generation in Japan as a front runner in the field of offshore wind construction.

JOM will engage in investigation, engineering, procurement of materials and equipment, and construction related to foundation works of wind turbines, transportation and installation works of wind turbines, and cable laying works for offshore wind farm projects in Japan in cooperation with Penta-Ocean. JOM plans to obtain the offshore installation vessel, ‘Sea Challenger’, currently owned by DEME Offshore, after upgrading it with an even larger crane, which will be changed to a Japanese-flagged vessel to be in service by spring 2025.

As a result, Penta-Ocean will own three offshore installation vessels, including CP-8001, a vessel equipped with an 800t crane completed in 2019, and CP-16001, a vessel equipped with a 1,600t crane that is currently under construction jointly with Kajima Corporation and Yorigami Maritime Construction Co., Ltd.

https://www.penta-ocean.co.jp/english
Bekaert’s construction division reinforces port pavements around the world, ensuring their longevity and high durability. Since the 1970s, our Dramix® steel fibre reinforcement solutions have enabled a wide range of heavy-duty pavements, as used in airport terminals, container terminals, carparks and more. Dramix® steel fibres are distributed in three dimensions throughout the concrete, creating a dense network of fibres. This, in turn, avoids cracking at an early stage, which prevents sea water, chemicals and other corrosive substances from entering at all. Our solution ensures your pavements remain reliable and operational for decades.

In 2021, sustainability and innovation have been Bekaert’s key drivers for technological leadership.

Port of Algeciras, Spain
Reinforced with Dramix 4D 65/60BG

8.1 Committing to a Sustainable Future

Our steel fibre reinforcement solutions are a key contributor to sustainable concrete. In comparison with traditional reinforcement, Dramix® steel fibres enable you to reduce the floor’s concrete thickness by 10-25 % and save 30-50 % of steel. This significantly lowers the CO₂ footprint of your projects. In the long term, your choice of concrete reinforcement also has an important impact on the quality, durability and longevity of your structures.

In 2021, Bekaert obtained an environmental product declaration (EPD) for its Dramix® steel fibres for concrete reinforcement production in Petrovice. The EPD will allow anyone involved in construction – from engineers to developers – to compare Dramix® with other concrete reinforcement solutions, helping them to choose the most sustainable and durable solution for the entire lifecycle of their construction.
8.2 Cooperating for Innovation – SIGMASLAB®

We provide innovative and sustainable solutions for infrastructural challenges in many ports across the world. With a heightened focus on sustainability, we continue to develop new technologies to reinforce concrete structures tailored to meet these challenges. CCL and Bekaert are both leaders in creating more efficient, higher performing solutions for the concrete construction industry.

Our newest combined reinforcement solution, SigmaSlab® is a new concrete technology that combines CCL’s post-tensioning strands with Dramix® steel fibre concrete reinforcement. The use of Dramix® steel fibres ensure the structural stability and fatigue resistance of the pavement while the post tensioning strands take up the shrinkage and temperature stresses. This allows larger ground slabs with joints that are fewer and farther between. Fewer joints equal fewer, expensive dowels on the one hand and thinner concrete slabs and steel reduction on the other.

The SigmaSlab® technology is the product of our joint expertise and experience. By working together and optimising both of our technologies, SigmaSlab® represents a sustainable, cost-effective, concrete technology which provides superior resistance to fatigue, a more durable and low-maintenance finish while still lowering the carbon footprint (in comparison to other concrete reinforcement solutions).

In sum, reinforcing with SigmaSlab® ensures:

- Larger concrete pours with fewer joints
- Faster construction and faster field inspection
- Reduced installation costs
- Lower carbon footprint
- Enhanced durability
- Simpler detailing and shop drawings
- Easier to accommodate last minute changes
- Better quality control

Click here or scan the QR-code to watch the first commercial installation of SigmaSlab®: a jointless, exterior floor for Aertssen Logistics in Verrebroek, Belgium.

8.3 Martime Projects Across the Globe

Bekaert has a wide international presence in reinforcing port pavements around the world. Below, we would like to highlight several ports in which our steel fibre reinforcement solutions have provided durable, sustainable and reliable port pavements.

8.3.1 Port of Mamonal, Cartagena, Colombia

The port of Mamonal is a ‘multipurpose’ port, as it had to be able to handle any kind of load, such as cranes, transit trucks, stacked containers, you name it.

Bekaert has been deeply involved in the design of the port pavement solution and has provided the steel fibres to reinforce it. After seeing the results of using Dramix® steel fibres to increase impact resistance and noticing their advantages relative to alternative reinforcement methods in 2013, the port of Mamonal has decided to use the same solution again in 2015 and then in 2018. Over 300,000 m² of concrete have been reinforced with Dramix® steel fibres.
The usage of steel fibres, as indicated in PIANC report 165 from 2015, makes it possible to increase the spacing between joints and reduce floor thicknesses. Fewer joints equal fewer weak points and saving concrete helps reducing the carbon footprint.

8.3.2 Port of Guaymas, Sonora, Mexico

The Port of Guaymas, located in the northwest of Mexico on the coast of the Pacific Ocean, constitutes an important commercial link between the southwestern United States and the Asian continent. Due to its privileged geographic location, this port represents an important part of the global logistics chain with a competitive advantage to move merchandise, contributing to the sustained development and growth of Mexico’s foreign trade.

In late 2021, construction for this brand-new port terminal started. A total area of 12,390 m² has been reinforced with Dramix® 4D steel fibres.

Up to now, our recommended solution for port pavements has always been Dramix® 4D, due to its increased tensile strength and improved end hooks, it is the ideal solution to reinforce heavy-duty pavements in harbours. Engineered to prevent small cracks, Dramix® 4D fibres significantly contribute to long-lasting surfaces that can withstand continuous exposure to weather, seawater and chemical products.

High impact resistance results in a surface free of spalling effects. It improves the safety and efficiency of operations and prevents damage to rolling machinery and containers. Dramix® steel fibres are easy to work with and require less time and labour to be installed relative to traditional reinforcement solutions.
8.3.3 Port of Manzanillo, Mexico

Following the COVID-19 pandemic, the port of Manzanillo faced a huge increase of import and export. As a result of the increased warehouse traffic, the dock’s concrete slabs endured extensive damage.

Due to the intense loading and unloading schedules, it was not easy to find time to repair the dock floor with rod or mesh. In addition, as workers were always on-site, extra measures were taken to ensure their safety during any of the repair operations.

The floor was reinforced with Dramix® 4D steel fibres. In only three months of 2021, a surface area of 1,700 m² was reinforced. The dock floor is now more durable because the distribution of the reinforcement in the slab makes it more resistant to heavy traffic as well as to inclement weather.

Thanks to Bekaert’s in-depth engineering expertise and resources, the Manzanillo Integral Port Administration saved time, reduced costs, ended up with a durable, high-quality reinforced floor and ensured worker safety at the same time.

8.3.4 Port of Algeciras, Spain

The Port of Algeciras in the south of Spain is a leading port in the Mediterranean area. It handles an annual container cargo volume of 3.3 million tonnes of TEUs (Twenty feet Equivalent Units, or standard six-meter containers). Bekaert was selected to supply Dramix® steel fibres to reinforce the concrete pavement of a terminal comprising 392,000 m². We therefore played a key role in the construction of a reliable, safe and durable port.

The pavement of this terminal extends well over 40 hectares. Reinforcing such a large surface area with conventional steel bar reinforced concrete would have been a labour-intensive task. A steel fibre solution sharply reduces manual labour hours, which in turn lowers the cost price. But most importantly, a Dramix® steel fibre reinforcement configuration is durable: it minimises the risk of joint-related cracks even under intensive usage thus reducing maintenance and repair costs and boosting the terminal’s productivity.

Moreover, the Spanish standard for the design and construction of port pavement sets the minimum durability at 25 years. Concrete strengthened with Dramix® steel fibres greatly exceeds this standard because of its high fatigue resistance and load bearing capacity.

8.4 Partnering with PIANC

Over the years, Bekaert has actively participated in various PIANC Working Groups.

In 2021, Bekaert stepped up its commitment in its involvement with PIANC by becoming one of their Platinum Partners. Bekaert is also part of the Promotion Commission (ProCom). We work in a subgroup that gives support to the Working Groups.

Thanks to PIANC, we have had the opportunity to help organise and participate in several webinars, so we can communicate and share our expertise with our customers and prospects.
• Steel fibre reinforcement solutions for port projects. We organised this as a part of a series of webinars by AIOM (Associazione di Ingegneria Offshore e Marina). Watch it here on Youtube.

• Design of concrete port pavements. Increased structural capacity and durability through the use of high-performance materials and steel fibres. Organised with ATPYC (Asociación Técnica de Puertos y Costas). Click here to watch webinars on their website.

8.5 Social Media

Would you like to be informed about the developments in the reinforcement of port pavements?

Check out our website Bekart.com/Dramix. Subscribe to our newsletter here or get inspired by our whitepapers, customer case studies, reports and expert videos or follow our social media posts.

https://www.linkedin.com/showcase/bekaert-construction

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