

Foam Fenders and Buoys

BESPOKE DESIGN FOR DIVERSE APPLICATIONS



The Smarter Approach

Better connected systems mean faster turnaround, increased throughput and improved safety.

Connecting decades of experience with a new, smarter approach to port and terminal equipment optimization, Trelleborg Marine and Infrastructure assists ports and terminals in deploying innovative, expertly engineered solutions for port operations. These include berthing, docking and mooring products and services that facilitate better informed, real-time, and strategic decision-making both onshore and on board the vessel.

From port owners and operators to consulting engineers, Trelleborg works with customers to determine best-fit solutions for specific applications, and supply a fully-integrated solution.

Throughout the entire lifecycle of a project, we offer end-to-end service and comprehensive product portfolio that meet and exceed customer needs, enhancing safety and efficiency in all marine environments, from conception to completion and beyond.

One such engineered solution is Trelleborg's foam fenders, which provides a tough, heavy-duty solution for port and harbour, offshore, and ship-to-ship applications.

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A Smarter Approach at every stage

A smarter approach to...

CONSULTATION

Consultation from the earliest project phase to ensure the optimum fender systems and marine technology solutions are specified, with full technical support from our global offices.



CONCEPT

Conceptual design in your local office – with full knowledge of local standards and regulations, delivered in your language – for optimized port and vessel solutions.



DESIGN

Concepts are taken to our Engineering Centers of Excellence in India where our team generates 3D CAD designs, application-engineering drawings, a bill of materials, finite engineering analyses and calculations for both our fender systems and marine technology solutions.



MANUFACTURE

Our entire product range is manufactured in-house, so the quality and design of each product we produce for our customers is of the highest standard. Our strategically located, state-of-the-art facilities ensure our global, industry leading manufacturing capability.



TESTING

Across our entire product range, stringent testing comes as standard at every step in our in-house manufacturing process. We ensure that lifecycle and performance of our entire product range meets your specifications, and more.



INSTALLATION

Dedicated project management support service, including solution design and on-site installation services. In designing products and solutions, we always consider ease of installation and future maintenance requirements.



SUPPORT

Local support on a truly global scale, with customer support teams all over the world. And this service doesn't stop after a product is installed. You have our full support throughout the entire lifetime of your project, including customized training programs, maintenance and onsite service and support.



THE FUTURE

Deploying the latest in smart technologies to enable fully automated, data-driven decision making that optimizes port and terminal efficiency. At Trelleborg, we're constantly evolving to provide the digital infrastructure our industry increasingly needs.



When you choose Trelleborg you ensure your expectations will be met, because we deliver a truly end-to-end service – retaining vigilance and full control at every stage.

Product Overview

With over 100 years of industry-leading expertise in engineered polymer solutions that seal, damp and protect critical applications in demanding environments, Trelleborg Marine and Infrastructure is one of the most trusted and reliable suppliers of high-quality marine solutions for all industries.

Fully-integrated in-house manufacturing capabilities bring together a range of qualities to ensure a long-lasting, durable, high performance product with a low-maintenance service life, no matter how demanding

the working and environmental conditions. This end-to-end service includes research and development, application engineering, expert fender design, high-quality materials, manufacturing, testing and stringent quality control.

Trelleborg foam products provide a tough, heavy-duty solution for port and harbor, off-shore and ship-to-ship applications. The products are unsinkable due to the resilient foam-filled construction, that permits high energy absorption and low reaction forces.



SeaGuard Foam Fender

Applications

- | Cruise | Container | Bulk | RoRo | Ferries | Naval | Bunkering
- | Ship-to-Ship Operations | Oil and Gas



SeaCushion Foam Fender

Applications

- | LNG and Oil Terminals | Ship-to-Ship Operations
- | Offshore Boat Landings | Shipyards | Military Applications



Donut Fenders

Applications

- | Corner Protection | Turning Structures | Lead-in Jetties
- | Simple Breasting | Bridge Protection



Buoys

Applications

- | RoRo Berths | Offshore | Temporary Mooring of Vessels in Holding Area
- | Additional Support for Larger Vessels on Undersize Dolphins
- | Mooring of Occasionally Used Vessels | Remote Mooring of Vessels



SeaBarrier

Applications

- | Military Facilities and Vessels | Ports and Harbors
- | Cruise Ship and Marine Casino Facilities | Refineries and Petrochemical Plants
- | Power Plants | Airports | Temporary Blockades of Vital Waterways
- | Other Marine Security Applications

Foam Fenders A Trelleborg Invention

Manufactured in the USA at our in-house ISO 9001:2015 & ISO 14001:2015 approved facilities for the first time since 1975, Trelleborg's foam fenders are designed to achieve high durability, faster turnarounds, and improved safety and longevity.

Trelleborg's foam products are constructed using energy absorbing foam and reinforced polyurethane skin technology. They are typically manufactured in a cylindrical shape with a wide range of diameters and lengths. The fender's shape and configuration allow it to float freely in the water or be suspended above it, as well as conform well to vessel hull/bow flare requirements and the backing surface during compression, while uniformly spreading out the loading pattern for efficient performance.

Foam fenders share a construction technology centered on a closed cell polyethylene foam core and an outer skin of reinforced polyurethane elastomer. The closed cell foam structure retains performance even if a fender's skin is punctured, and prevents water ingress into the foam.

Foam fenders are classified into three types based on their application:

- SeaGuard Foam Fenders
- SeaCushion Foam Fenders
- Donut Foam Fenders



SeaGuard® Fenders are ABS Type approved based on ABS rules and ASTM standard. It is voluntary and denotes excellence in manufacturing quality and performance.



Consistent with its quality and environmental policies, Trelleborg Marine and Infrastructure maintains both ISO 14001:2004 (Environmental) and ISO 9001:2008 (Quality) certifications.

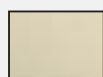


TAA Compliant
TAA refers to the Trade Agreements Act (19 U.S.C. & 2501-2581), which is intended to foster fair and open international trade.

SeaGuard[®] Foam Fender

Trelleborg SeaGuard fenders are typically used between dock and vessel. The fenders are suitable for low hull pressure vessels and can be deployed floating or suspended, against a quay wall which suits all sites with small or large tidal variations. Its common applications include cruise, container, bulk, naval, RoRo, ferries, oil and gas, bunkering and ship-to-ship berthing operations.

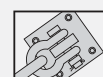
SeaGuard fenders are fabricated from a closed cell resilient foam that absorbs significant quantities of energy when compressed. The foam is protected by a thick, filament-reinforced outer elastomer skin. This construction offers a number of important features and advantages.



Closed cell foam core



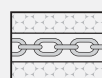
Polyurethane skin



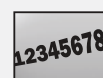
Fixings



Filament reinforcement



Internal chains



Serial number

Features & Advantages

Trelleborg's foam products have a proven track record of reliability and performance. A well-designed foam fender will provide many years of reliable and low-maintenance service. All Trelleborg's foam products are built on a foundation of closed cell foams which provide energy absorption and buoyancy. Fender size and performance can be engineered to meet the specific project requirements.

Reinforced elastomer skin

The skin thickness of the foam fender is designed as a function of the specific fender rated reaction force and the amount of reinforcement layers needed are calculated to resist the shear forces from berthing and mooring.

Energy absorption and efficiency

Foam density, fender size and geometry define the performance of each fender. Foam fenders provide a high energy capacity with a corresponding low reaction force. This results in lower loads and pressure on the vessel hull and reduced loading and fatigue on the supporting structure.

Low hull pressures

Foam fenders have a low initial reaction force and a consistent reaction force performance curve, so the hull pressure can remain low during the compression cycle. Low density foams can also be used to design fender performance for specific pressure requirements.

Ease of installation

Foam fenders are easily transported to the site and installed. Standard rigging shackles are attached to the end fitting pad eyes and the fender is simply lowered into position.

Low maintenance

With a normal service life of 10-25 years depending on the application, maintenance is generally limited to inspection and cleaning. The fender has been designed to resist most environmental conditions. The exterior is highly resistant to ozone, hydrocarbons, ultraviolet radiation, sea water and other environmental factors. The cellular structure of the foam material reduces the risk of bursting and catastrophic performance loss due to damage. No pressure checks are required.

Hardwearing / non-marking PU skin

Foam fenders have a low friction outer skin with low abrasion and added wear resistance. The elastomeric skin formula is non-marking on vessel hulls.

Non-deflatable & unsinkable

The fender body is completely foam filled and will remain floating even with accidental damage to the outer skin.

Safety

The fender skin is burst resistant. There are no pressure or relief valves to maintain, avoiding the risk of operational danger to the surrounding environment.

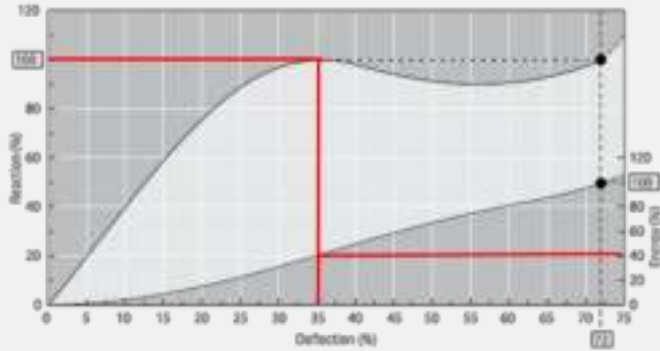


Fender Construction

FOAM DENSITIES - Trelleborg's foam fenders can be manufactured using a variety of foam densities, which provides a wide range of performance options for fenders of various sizes. Each of the foam densities will have a calculated

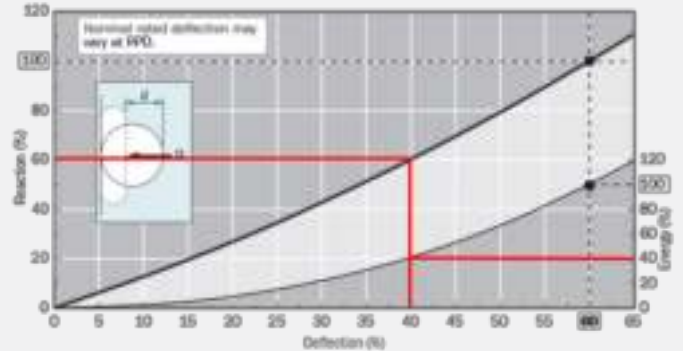
reaction pressure based on the size, contact area and rated performance. This information is critical when designing for specific energy absorption, reaction forces and vessel hull related pressure situations.

Buckling (Rubber) Fenders



At 40% Energy – 100% Reaction Force

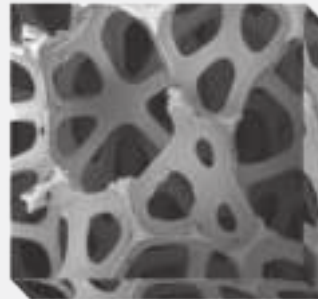
Foam Fenders



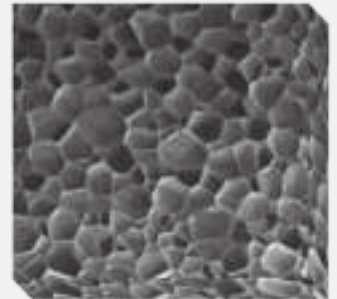
At 40% Energy – 60% Reaction Force
Resulting in lower load in structure over fender life – lower fatigue

The fenders are constructed with a uniformly wrapped foam body, utilizing only cross-linked, closed cell polyethylene. Each layer of foam is heat laminated to develop a continuous bond, producing a solid foam body construction. Tears or punctures in the outer skin will not cause the fender to sink, and damage to the skin will not affect overall performance, allowing the fender to function until repairs are made.

High Energy, Low Reaction



Open Cell Structure



Closed Cell Structure

Cell Structure

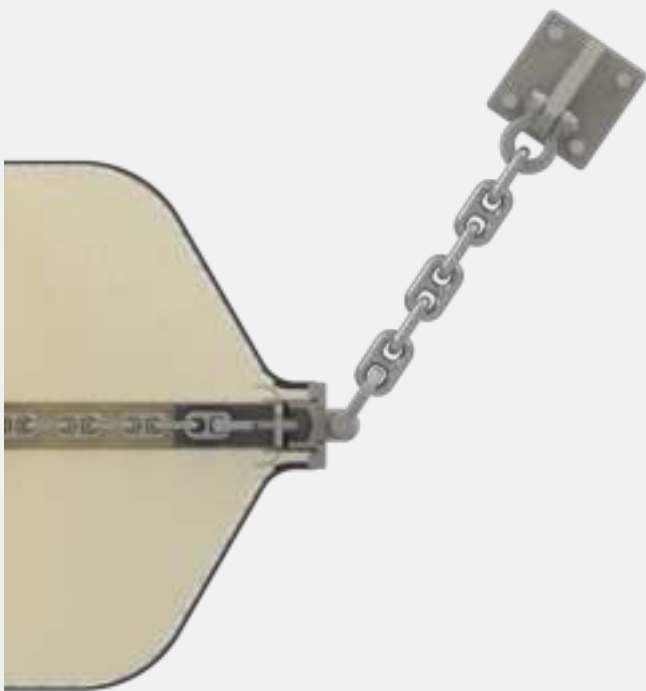
- Open Cell – movement of gas
- Closed Cell – isolation of gas

Density

- Low Density – softer / lower reaction force
- High Density – harder / higher reaction force

SKIN - Foam fenders utilize an innovative spray polyurethane technology with continuous wrap nylon reinforcement that provides a resilient nonmarking, low-friction skin. The reinforcement layers are wrapped in a crossing, helical pattern to offer maximum force resistance. The skin thickness of the fender is designed as a function of the specific fender rated reaction force and the reinforcement layers are calculated to resist the shear forces from berthing and mooring.

Thus, each fender size and capacity may have a specific skin thickness requirement. On top of the calculated main reinforced skin layer, an additional thinner layer of unreinforced material is applied to act as a “wear layer”. The wear layer serves to extend the fender service life by allowing some normal abrasion of the skin surface over time before the critical reinforcement layers may be exposed.



END FITTINGS - The fenders are built with innovative, heavy-duty swivel end fittings that are designed and rated to withstand specific end pull loads and allow the fender to rotate freely along the central axis while in operation. This feature helps to distribute wear evenly along the body of the fender, extending its service life. The fenders can also be customized with larger end fittings for special higher loading conditions, that may be evaluated by Trelleborg engineering. The end fittings are connected through the central body core by a continuous tension chain, designed to resist the full fender pull load. The internal chain is both adjustable and replaceable in case of any maintenance requirements.

Customization

CUSTOM SIZE Trelleborg’s foam fenders range in sizes from as small as 300mm OD to 4200mm OD. Each fender is custom-made to meet the specifications of each individual project. While rated performance is important, details such as adequate backing surface area, tidal variation, vessel configuration, freeboard and draft, and hull pressures must also be carefully considered.

CUSTOM COLORS The fenders are offered in a variety of colors. Trelleborg manufacturing can closely match specific color requirements within the skin formulation. All colors are specifically protected with UV resistant additives, and black and orange standard colors are UV protected throughout the skin thickness. Although there are “standard” colors black, grey, orange and white, custom colors and logo types are available upon request.

CUSTOM DENSITY Trelleborg’s foam fenders can be manufactured using a range of foam densities depending on the specific application. We offer five customizable foam grades to best suit performance requirements.

For increased energy, use higher foam grades. For reduced hull pressure, use lower density foam grade.

FOAM GRADES	PERFORMANCE RATIO
Grade 0.6 (LR)	0.6
Grade 1.0 (STD)	1.0
Grade 1.3 (HC)	1.3
Grade 1.9 (EHC)	1.9
Grade 2.6 (SHC)	2.6

- LR - Low Reaction
- STD - Standard
- HC - High Capacity
- EHC - Extra High Capacity
- SHC - Super High Capacity

Contact Trelleborg for support with your energy absorption and reaction force requirements.



Quality Control and Testing

Trelleborg's quality control incorporates a thoroughly documented inspection system that meets ISO, ABS, and in-house standards. Quality control testing is carried out as part of our manufacturing process to ensure that each product satisfies your specific requirements.

Testing includes fender material properties, dimensional checks, and skin thickness and performance verification (when specified). Years of field tests with foam fenders have confirmed the ability of these fenders to take the rugged service for which they are designed.

FENDER MATERIAL TESTING

ASTM standards



The manufacturer shall show material certificates of conformance for 100% of the fender order to be delivered.

REMARKS Submit Certification:

- Foam certification and test properties per ASTM D3575 provided by the foam supplier for 100% of the production lot
- Specification of the foam density and factory verification as required
- Test report or certification for standard elastomer skin and nylon filament reinforcement properties
- Verification of color and stenciling requirements
- Retain factory documentation and physical samples from production foam lots used

FENDER DIMENSIONAL TESTING

ISO and ABS standards



The manufacturer shall provide inspection test reports for 100% of the fender order to be delivered.

REMARKS Dimensional testing shall include:

- Measured body diameter
- Measured overall length (eye to eye)
- Measured skin thickness and verification of foam density
- End fitting size and swivel pad eye dimensions

SKIN THICKNESS TESTING

ISO standards



The manufacturer shall show measurement certificates for 100% of the fender order to be delivered.

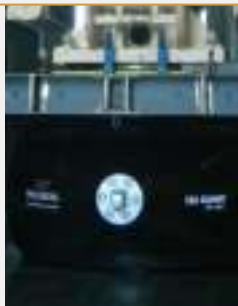
REMARKS 3rd party witness inspection verification of

the production lot may also be conducted to meet project specifications. Test fenders may be selected at random by a 3rd party inspector.

FENDER PERFORMANCE VERIFICATION TESTING

ASTM F2192

“Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders” and PIANC “Guidelines for the Design of Fender Systems (latest edition)”



The manufacturer shall submit test reports from previous fender performance verification tests, performed within the last five years or as specified by the contract documents. Test data may be scaled or extrapolated from the test fender to the required size by using the general procedures and formulas provided in ASTM F2192.

REMARKS 3rd party laboratory performance testing from

the fender production lot may be conducted to verify rated performance and safe working end pull load, as needed to meet project specifications. Note that fenders must be within acceptable dimensional parameters for available lab equipment (generally less than 2.2m diameter) for full-scale testing.

Watch the video on fender testing



Accessories

Chains, Shackles & Fixings

Foam fenders typically use a high strength chain system with brackets for attachment to the mounting surface. These chain systems support the fender weight, resist shear forces, and hold the fender in the required position for vessel berthing and mooring. Open link or stud link marine anchor chains are commonly used and available in various strength grades.

FEATURES

Choice of open link or stud link chain

Various sizes and strengths available

Proof load tested and certified

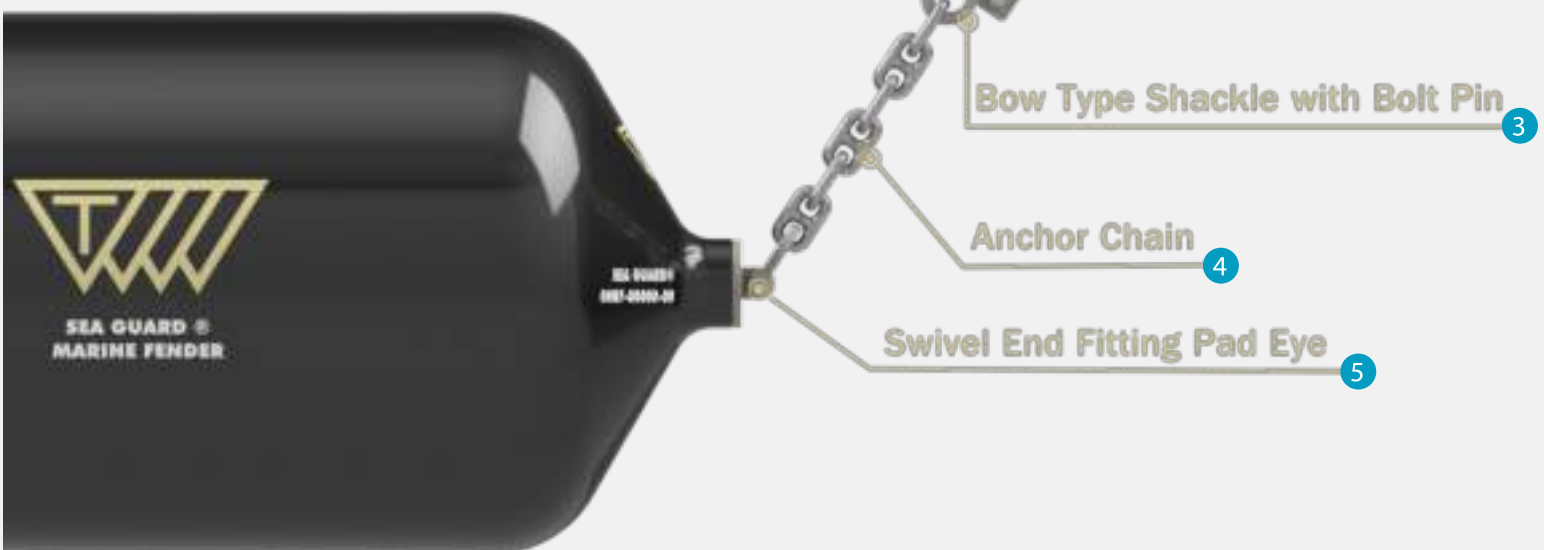
Hot-dip galvanized as a standard for reduced corrosion (stainless steel is also available)

Standardized, engineered, matching chain bracket and anchor size.

TYPICAL CHAIN SYSTEM

- 1 High strength anchor bolts, HDG or SST
- 2 Chain bracket pad eye
- 3 Bow type shackle with high strength bolt pin
- 4 Marine grade anchor chain
- 5 SeaGuard swivel end fitting pad eye

Note: The swivel end is an integrated part of the fender end fitting.



Installation

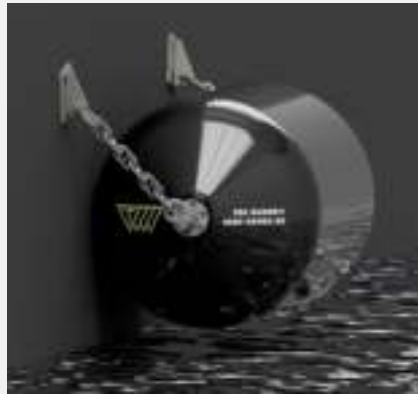
SeaGuard fenders are easily installed and mounted using standard chain and shackle assemblies attached to dock mounted brackets

or guide rails. The fenders are easily transported and moved into position using standard rigging methods.

SeaGuard fenders may be installed in a variety of ways, both fixed and floating:



A floating fender with sliding sleeve and chain attachment.



A floating fender with fixed chain attachment.



A fixed fender with double chain attachment.

The natural buoyancy of the fenders allows them to be installed in a floating position between ship and dock. This is particularly beneficial in areas with large tidal or seasonal water level

fluctuations. The floating fender can rise and fall with changing water levels. For effective fendering, the fender remains at the water line of the vessel.

Maintenance

Trelleborg foam products have a proven track record of reliability and performance spanning decades. An optimally designed foam fender will provide many years of reliable and generally low maintenance service. Maintenance is generally limited to inspection and cleaning. The frequency of inspection is determined by the frequency and severity of fender use, and environmental site conditions such as adverse wind and wave action. At a minimum, Trelleborg recommends a visual examination of the fenders at 3 month intervals.



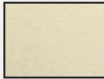


Refer to the Handling, Storage, Installation and Maintenance (HSIM) manual for more details

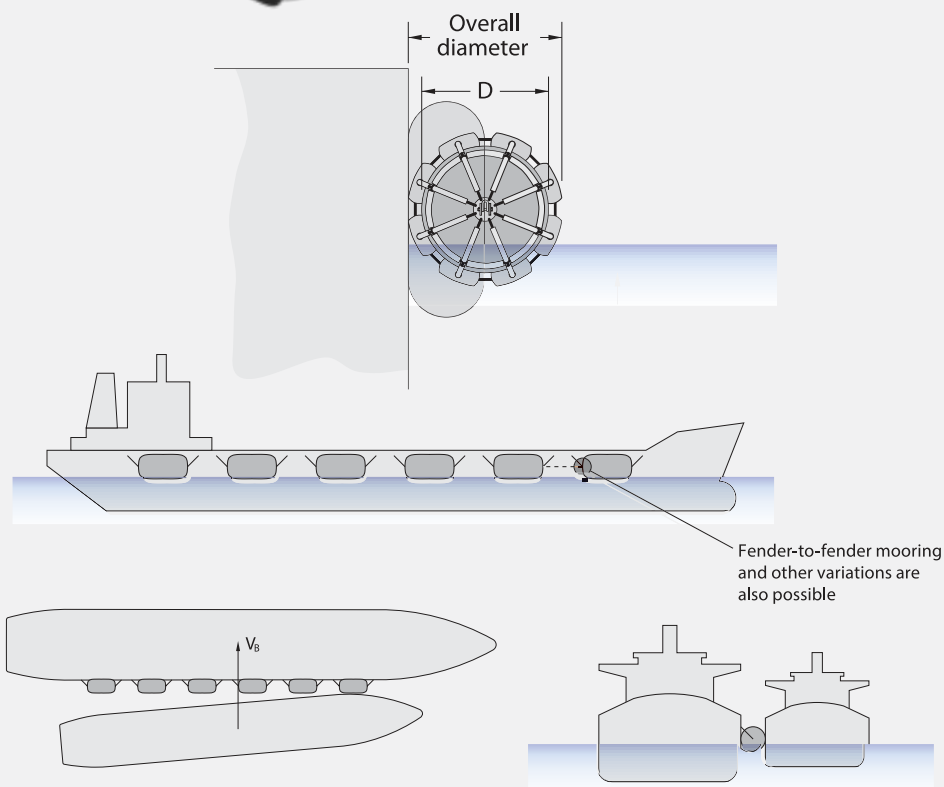
SeaCushion[®] Foam Fender

The SeaCushion foam fender sets the standard in the industry for high performance and reliability. The resilient foam-filled construction creates an unsinkable fender body that allows high energy absorption with a relatively low reaction force. The superior grade of foam core, an extra tough skin and the chain-tyre net make SeaCushion the most rugged floating fender.

Trelleborg's SeaCushion fenders feature a design proven through testing and service to provide the best performance for today's demanding marine operations like ship-to-ship operations, LNG and oil terminals, offshore boat landings, shipyards and military applications. The unique SeaCushion fender construction provides a number of features and advantages.



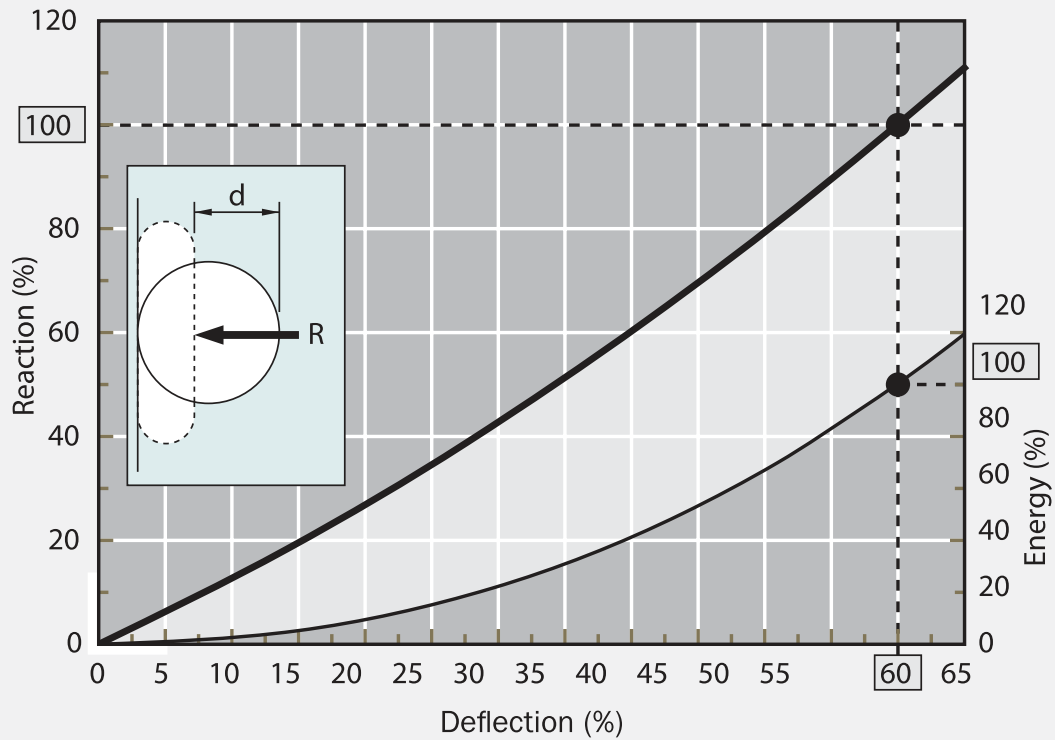
-  **Unsinkable foam core**
-  **Tough polyurethane skin**
-  **Various mooring options**



Features:

- Ultra-tough, unsinkable design
- Low maintenance
- Low reaction and high energy options
- Wide range of standard and custom sizes
- Low hull pressures
- Maintains safe stand-off distances

Performance



Note: Standard manufacturing and performance tolerance:
Energy: 100%, Reaction: 100%, Tolerance: $\pm 10\%$

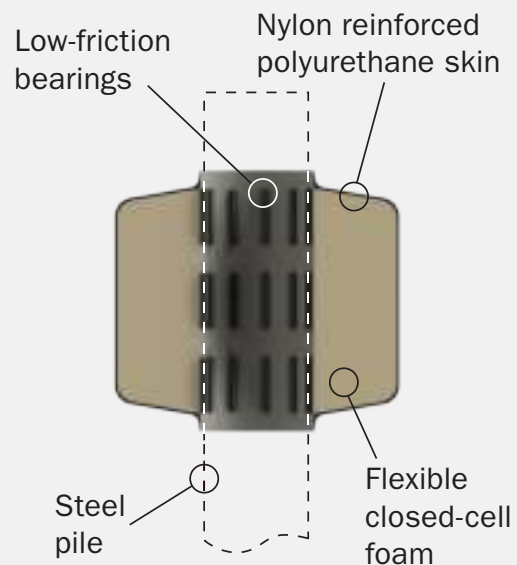
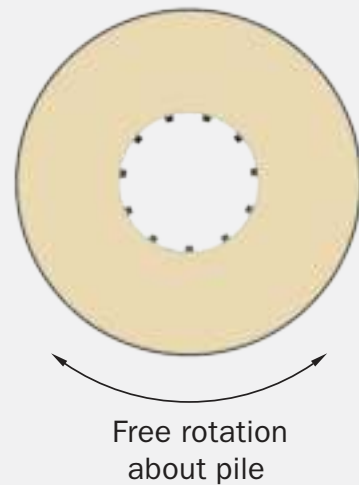
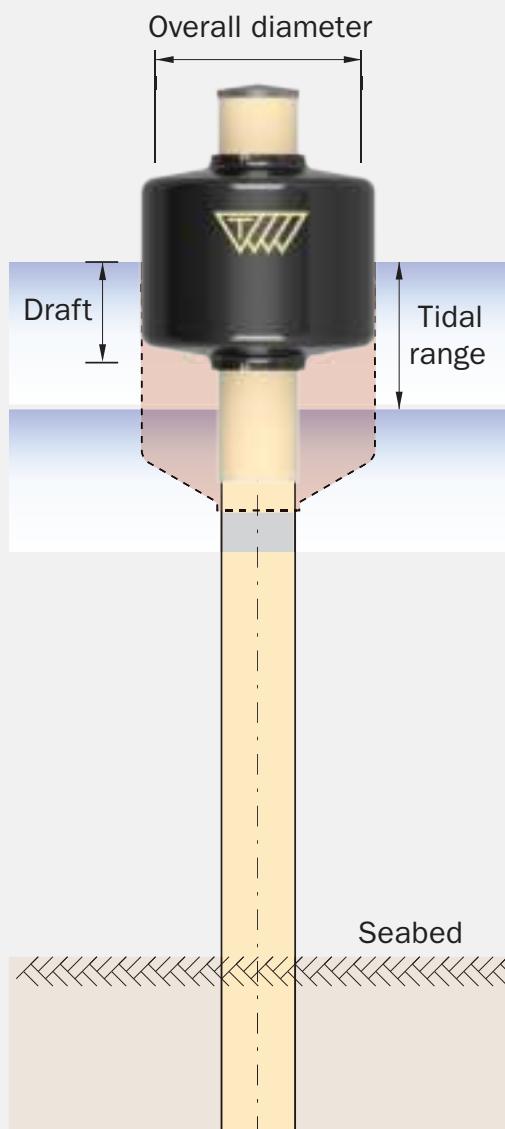


Hull pressures are very low at just 172kN/m^2 for STD-grades (even less for LR-grades) – well within PIANC guidelines (WG33) for LNG vessels

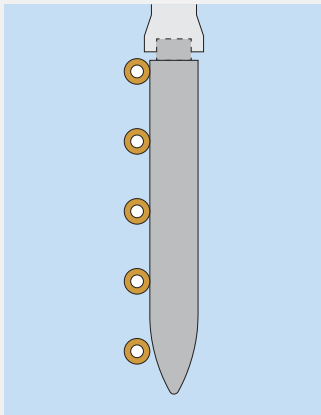
Donuts

Trelleborg's Donuts are an effective solution for simple berthing dolphins, guide structures and turning structures. The buoyant Donut floats up and down a single tubular pile and freely rotates to help align or redirect ships. The internal casing has long lasting, low-friction bearings which need minimal maintenance. The foam is unsinkable and cannot burst or deflate. The Donut skin is durable polyurethane reinforced with continuous nylon filaments.

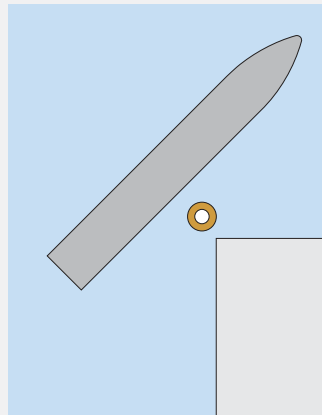
Trelleborg's Donuts are custom designed for every application. They have supplementary buoyancy to present a raised contact face. The body can be additionally protected with a thicker skin or wear strips to cope with ferry beltings. Bright colors are often used to improve visibility and safety. A variety of applications include corner protection, turning structures, lead-in jetties, simple breasting dolphins and bridge protection.



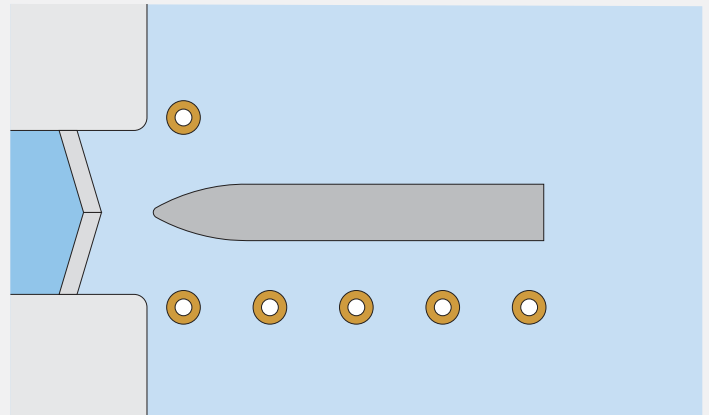
DONUT FENDER APPLICATIONS



Breasting dolphins



Corner protection

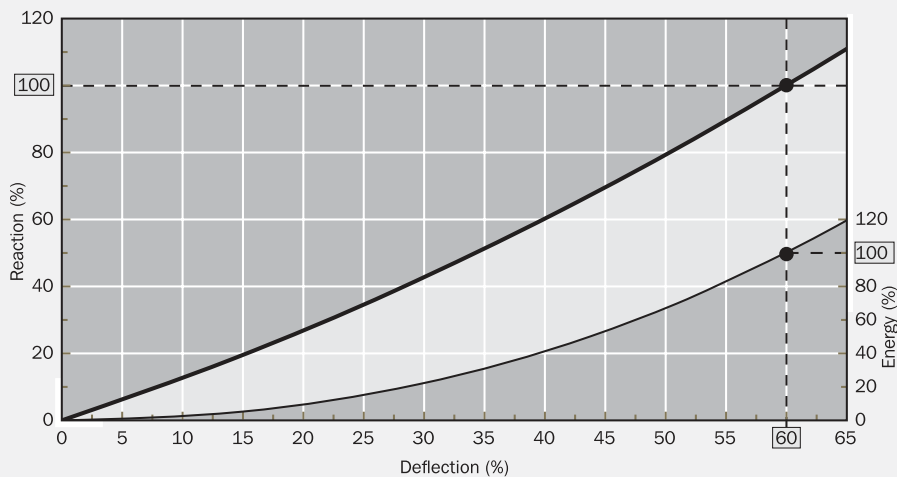


Guiding structures

Features:

- Freely rotates around a pile
- Requires minimal maintenance
- Will not mark ship hulls
- Rises and falls with water level
- Fast and easy to install
- High performance
- Low hull pressures
- Unsinkable & cannot burst or deflate
- Low reaction
- Maintains freeboard across tidal range

Performance



Note: Standard manufacturing and performance tolerance:
 Energy: 100%, Reaction: 100%, Tolerance: $\pm 15\%$



Buoys

MOORING BUOYS

Trelleborg's Mooring Buoys are a low-maintenance and low-handling-weight alternative to traditional steel mooring buoys because they are resilient, easy to handle, self-fendering, and require minimal maintenance. Trelleborg Mooring Buoys have a heavy-duty reinforced central steel pipe core and steel deck plate, a closed cell polyurethane foam core, and additional flexible closed-cell thermo-laminated polyethylene foam for impact resistance. The Mooring Buoy is protected by a high-performance, UV-resistant, nylon-reinforced elastomer skin available in various colors, with reflective stripes and custom stenciling as needed. Mooring Buoys can have a variety of additional features, such as marine lanterns, mooring tees, pad eyes, or manual quick release hooks. These buoys are used extensively in single-point mooring (SPM) systems.

They are commonly used for cruise ships, navy vessels, RoRo berths, offshore, temporary mooring of vessels in holding area, additional support for larger vessels on undersize dolphins, mooring of occasionally used vessels and remote mooring of vessels.

Features:

- Resilient
- Easy to handle
- Low maintenance
- Impact resistant
- Abrasion resistant
- Ultraviolet degradation resistant
- Self-fendering
- Flexible, impact resistant flotation core
- Marine lantern and accessories where required
- Will not sink if outer skin is punctured

GENERAL SURFACE BUOYS

Trelleborg's General Surface utility and Support Buoys have a steel pipe core with plate reinforcement, rigid polyurethane foam core, and additional polyethylene flex foam for impact resistance. They have a nylon reinforced polyurethane skin available in various colors, that is abrasion resistant and protected against ultraviolet degradation. Surface Buoys have the same rugged construction as the heavy duty Mooring Buoys, on a smaller scale.



SeaBarrier[®] Floating Barrier System

Seabarrier Floating Barrier Systems are designed to provide a reliable, highly visible floating physical barrier that is easy to install and maintain.

The SeaBarrier's design is founded on the proven technology, materials and tested performance of Trelleborg's SeaGuard foam filled marine fenders that have set the international industry standard for over 30 years. Their design provides the energy absorption, unsinkable buoyancy, and the ease of deployment necessary to effectively and quickly create a barrier to any intruder.

The smaller SeaBarrier sizes are intended primarily as a demarcation or delineation barrier to mark an exclusionary zone. Larger design sizes add a significant physical barrier to ensure all your security requirements are met.

Available in various sizes, profiles and colors, the SeaBarrier can be custom designed to meet your specific requirements. Standard units are delivered in a bright, highly visible international orange color and include connection hardware. Optional accessories include buoys and modified Donut fender style moorings, anchorage devices, capture net systems and a wide range of interconnecting fittings designed to work with the SeaBarrier units.

Its applications include military facilities and vessels, ports and harbors, cruise ship and marine casino facilities, refineries and petrochemical plants, power plants, airports, temporary blockades of vital waterways, and other marine security applications.



Serious About Sustainability

Trelleborg Marine and Infrastructure is leading in its efforts to improve sustainability and environmental impact of all marine fenders. As a group, Trelleborg is dedicated to achieving net zero greenhouse gas emissions by 2035.



Learn more about
Trelleborg's sustainability initiative

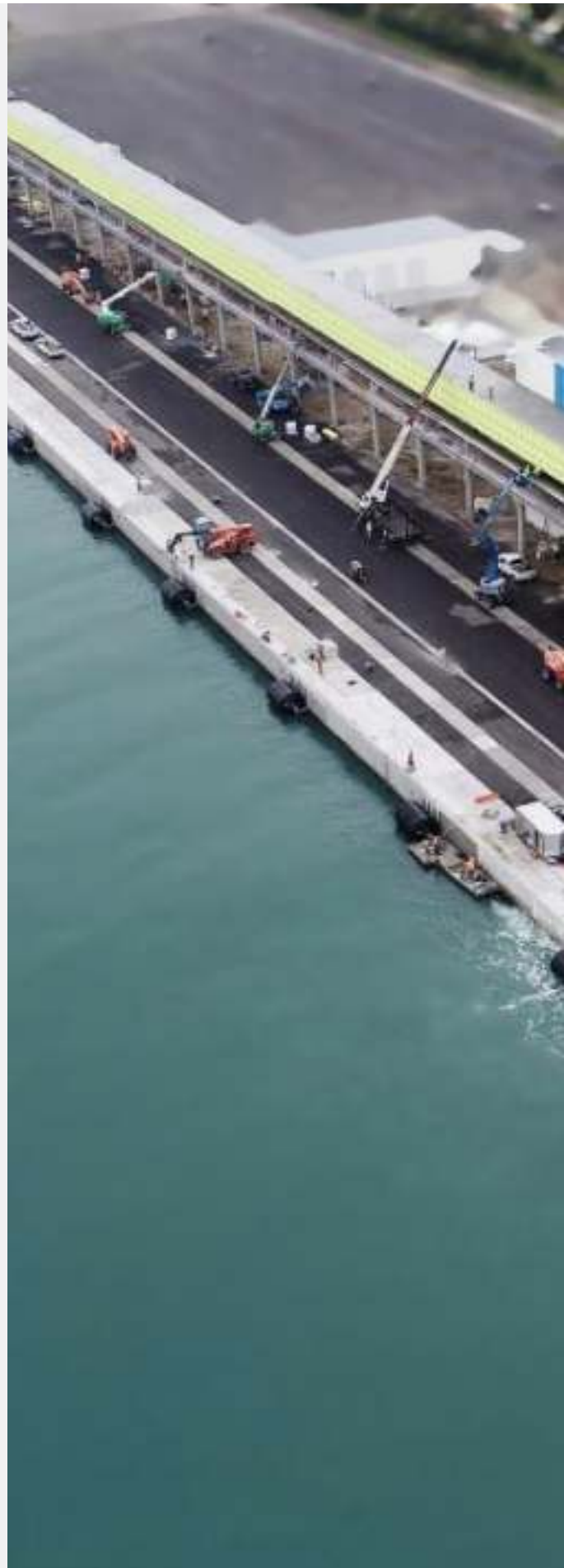
DISCLAIMER

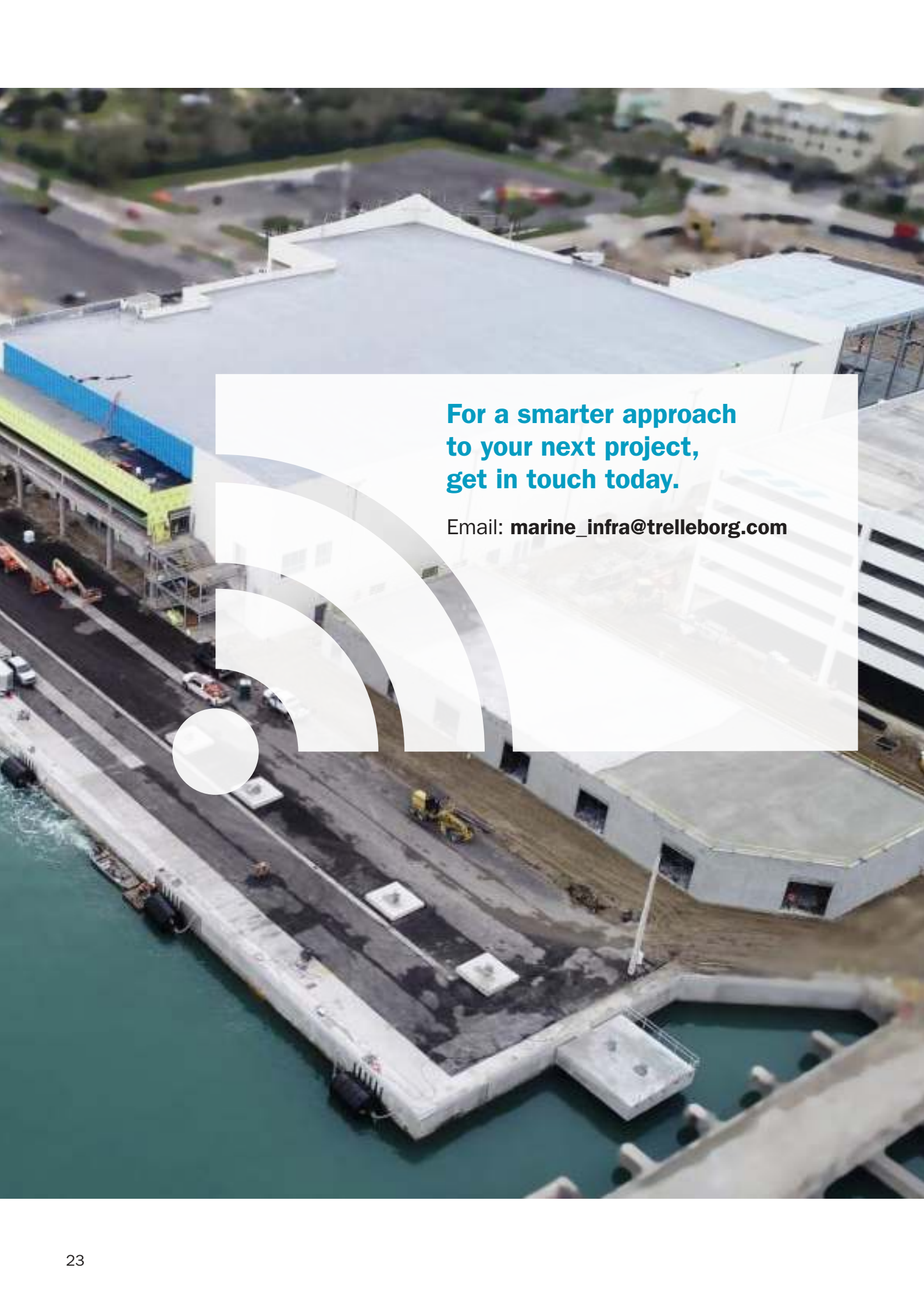
Trelleborg AB has made every effort to ensure that the technical specifications and product descriptions in this catalogue are correct.

The responsibility or liability for errors and omissions cannot be accepted for any reason whatsoever. Customers are advised to request a detailed specification and certified drawing prior to construction and manufacture. In the interests of improving the quality and performance of our products and systems, we reserve the right to make specification changes without prior notice. All dimensions, material properties and performance values quoted are subject to normal production and testing tolerances. This catalogue supersedes the information provided in all previous editions. If in doubt, please check with Trelleborg Marine and Infrastructure.

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**For a smarter approach
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