Facts about SFT Group.

- Leading international fender manufacturer
- Founded in 1923 (Shibata Industrial) and in 2006 (ShibataFenderTeam)
- Jointly generating a revenue of about 175 million USD with +440 employees worldwide
- 50+ years of group experience in fender production, +100,000 fenders in service, and 90+ years of experience in the production of rubber products
- More than 6,000 references worldwide
- Certified in-house production facilities for rubber, foam, steel, and PE products
- Regional local offices supported by agent network on six continents
- Reputation as a dependable partner in the international ports, harbors, and waterways market
- PIANC Platinum Partner since 2017
ShibataFenderTeam (SFT) talks to WPD about their holistic approach to fender system design.

What makes your fenders stand-out from the crowd? Why would a customer opt for your fenders?
At SFT we adopt a holistic approach to fender design and manufacturing.

Can you explain what you mean by ‘holistic approach’ in regard to fender design and manufacture?
At SFT our holistic approach means that our engineers design high-quality fender solutions taking into account all the individual elements of a fender system (rubber unit, steel panel, chains, fixings etc.) while other manufacturers can get lost as they only focus on the rubber unit.

Although the rubber unit is a very important part of the fender system, it works only as well as the design of the system. Often you can see premature failure of fender systems where the rubber unit shows damage. In most cases this damage does not happen because the rubber fender has a low quality or mistakes have been made during manufacturing; it happens because the design of the overall system is wrong. For SFT, it is paramount that the fender system has a holistic design, valuing all the individual requirements of the project.

With our engineering expertise, we view beyond what looks good in a drawing, because it might not work in the field. Each project has diverse requirements that are all equally important when designing a fender system and we are highly committed to increasing the industry’s awareness of the relevance of a comprehensive concept. The consequences of overall design problems and typical failures should never be underestimated which is why we at SFT make it our mission to clear up common misconceptions about fender system design.

With the overall target to protect people, ships and port infrastructures, engineering excellence and project-specific solutions are crucial in the fender industry. The focus on customised and ideally balanced fender system designs is one of SFT’s main strengths, improving the fender systems’ performance as well as its service life. In short, our holistic approach reduces maintenance, replacement, and consequential costs at the terminal and improves the service life of fender systems.
products and a clear sense of responsibility. Our experience and proven track record with several thousand references worldwide speaks a language of its own and proves that we are successful with what we are doing and that clients can rely on our expertise and experience as the largest marine fender manufacturer globally. We offer product liability insurance with at least EUR5 million coverage as well as extended warranties backed up with corresponding bonding.

What kind of new fender design features would you like to highlight for our readers?

Wave fenders: Different applications require different fenders and a design concept that is often not a simple off-the-shelf solution. While most terminals require as little friction as possible between the vessel and the fender, others are actually in favour of high friction levels. This is particularly of interest where small ferries berth head on to mooring posts to let passengers walk off and on the ferry.

Our wave fenders are offering nothing short but that very feature. With their alternating trough and peak design they are providing mechanical resistance due to their shape and physical resistance by the nature of the rubber properties. A solution well accepted by operators and proven in practice throughout years in service with calls every hour.

We took the good advice from installation crews and ports with respect to an installation as easy and fast as possible and most importantly having the executing works crew in mind who has to carry out lifting and drilling operations close to water. At the Port of Stockholm, a modular system was developed whereby the individual wave fenders are pre-mounted to a solid steel backing plate in a safe workshop environment. The pre-fitted modules then feature significantly less anchors to be cast or drilled and will make installation safer, quicker and more economic.

A random number of pre-fitted wave fender modules can be placed next to each other as they all fit nicely into each other by overlapping and inter-connecting links, just like a puzzle. And should there still be the need for a replacement, all wave fenders can be easily removed from the modules and individually replaced.

You could say that this example reflects our approach: highly customised designs taking into account the client’s requirements and the uniqueness of the project. We undertake new design challenges due to unusual existing substructures, e.g. for upgrading of berths or duplex coating systems for steel panels.

With a large number of manufacturers competing for business, how do you view the market for 2020 and how competitive is it going to be? There are only two true global players on the market with SFT leading the field. Small or new manufacturers often cannot achieve the experience of long-established manufacturers such as ourselves as they have very few reference projects, and limited design and manufacturing expertise. Additionally, if a manufacturer is financially unstable, contractors face major risks to source the materials; this risk can be avoided when choosing a manufacturer who has demonstrated long term financial stability.

Both Brexit and the Coronavirus are having a knock-on effect on trade around the world - what are your expectations for 2020 worldwide? Have you adjusted your expectations for 2020? SFT has not reduced expectations for 2020. We stick with our planning; there might be delays due to the tense economic situation worldwide but our outlook for 2020 stays strong. Brexit has an influence but more in the logistic than the actual business; the UK
market has a huge potential. It might be more complicated but the market is still strong; the gap that missing EU subventions leave might be closed by the UK government and pushing investments. With regard to the coronavirus pandemic the development and consequences resulting cannot be estimated at the moment. It is influencing the supply chain of manufacturing and shipping for the parts which are produced in Asia.

The SFT Group has a unique position that we are able to use the capacity of our state-of-the-art production facility in Germany where we can offer short term solutions, improve delivery times and make sure that target construction schedules are met. This flexibility is a great advantage which we offer our clients. Additionally, we take into account travel restrictions and have therefore developed a successful online seminar session which is individual and customised for our clients’ requirements.

**What is your view on how the market for fenders will develop over the next couple of years?**

Keeping an eye on a company’s environmental carbon footprint will grow in importance, such as for example, how to dispose of fenders after their life cycle; it should be noted that it is absolutely no solution to use recycled rubber in the fender manufacturing process. We believe there will be strong development in certain regions. Also, international trade will further increase even if some countries are protecting their markets, but with a long-term view, international trade will not decline. With strong interactions of world markets, the majority of trade will be processed through ports and harbours which, coupled with further growth of the cruise industry and the upgrading of ports to be prepared for larger ships, provides opportunities for us.

**Were there any interesting order(s)/delivery last year and how is 2020 shaping up so far?**

There are a few highlights we can share for this feature. For example, with the new Cruise Terminal in Amador, Panama is seeking to increase cruise tourism with an eye to potentially serving as a home port for cruise vessels. Subsequent to dredging the navigation canal and terminal area, the new terminal consists of a pier with two berths and a total length of 366m and can accommodate two mega cruise ships and handle all their passengers simultaneously.

SFT successfully developed a customised solution to accommodate the fenders to a broad range of tides and delivered 18 Ocean Guard Fenders of the size of 3300 x L 6500mm within a short time frame. Ocean Guard Fenders are foam fenders which are the perfect choice for cruise terminals since their urethane skin does not leave marks on the white hull of cruise vessels. SFT is pleased about this contribution to Panama’s tourism sector and the sustainable development to the country.

Being located in the middle of the Kattegat, the weather can get rough and the visibility is not always the best. To make sure that the vessel’s captains can locate the pier head regardless of the weather conditions, yellow UHMW-PE for the top of the steel panels was used. An individual solution for a challenging design, ensuring safe travel for the commuters of the region and a safe and secure berthing throughout the year - an order perfectly solved by ShibataFenderTeam.

In another project SFT provided hinged fender panels for a pier head at Sjællands Odde, a small village on the northwest coast of the Danish island Zealand. Its ferry connection to Aarhus, operated by ferry company Molslinjen A/S, marks an important hub for commuters who rely on a timely and reliable connection between these two parts of Denmark. With up to 24 departures, the port is highly frequented and used by some of the world’s fastest ferries. The operator Molslinjen A/S recently commissioned the refurbishment of the pier head in Sjællands Odde to keep up with the new ferries.

ShibataFenderTeam equipped the pier head with 30 CSS 800 Cell Fenders and steel panels in 9 different sizes, each with a height of 4700mm and widths from 1500mm to 3100mm. The engineering aspect of the design was probably the most challenging, as the pier head was not completely smooth and the specification required that every panel should be hinged together. Through great cooperation with the client Molslinjen, ShibataFenderTeam delivered a perfectly fitting system.

Last but not least in Singapore, one of the first orders for SFT’s new factory in Malaysia has already been the most comprehensive one for the company to date: 199 CSS 1700 Cell Fenders with 6100mm x 3370mm steel panels for the new mega port in Tuas in the West Region of Singapore are scheduled for final delivery and installation in 2021.

For the production of the fenders, 645t of rubber compound will be produced in-house in the new factory. Next to the rubber compound production, all the other fender manufacturing steps from compounding to curing and testing will be taking place on-site pursuant to the SFT Group’s high quality standards.
SAFEGUARDING THE SHIP-TO-SHORE INTERFACE

While they may not steal the limelight for most visible port assets, fenders form the backbone of quay protection, finds Alex Hughes.

Admittedly, fenders are not the most high profile pieces of port equipment. Yet, poorly designed or damaged fenders have serious implications for regular port operations. Innovations in technology and materials are improving the performance of these invisible port workhorses, allowing manufacturers to enter even the most challenging markets.

Today, astute ports look at life cycle, durability, reliability, smooth operation and ease of maintenance when evaluating the effectiveness of their fenders.

However, they do not do enough monitoring of existing fenders and damage is often recorded too late, in the opinion of Dominique Polte, board member of ShibataFenderTeam. Furthermore, essential maintenance is often neglected, but is nevertheless essential if the effectiveness of fenders is to be maintained, he adds.

Ports, Mr Polte notes, tend to have their own maintenance crews and some appoint engineering companies to undertake surveys, but fender problems are often identified coincidentally, rather than through proactive monitoring. Data collection is still largely a manual process, with electronic data collection still in its infancy.

Ports could be missing a trick here, as performance data is invaluable. In ShibataFenderTeam’s opinion, it is also useful to monitor the berthing speed and berthing angle of vessels as this data gives important insight and could influence prospective design tailored to the port.

DIFFERENT STANDARDS

When tendering for fenders, suppliers need to be aware that fender standards do differ from region to region. Designs and testing can follow different standards, he most popular being PIANC 2002.

“The environmental conditions on site are very different, too, and need to be taken into close consideration for the fender design, as do project requirements,” adds Mr Polte. “A ferry leaving from Port A to Port B might need different fenders in Port B than in Port A, for example.”

Surprisingly, one aspect that has not significantly affected fender design over the last five to 10 years is vessel size. Even though ship size has increased considerably in recent years, the slower berthing velocity of larger vessels has meant that the calculations for energy absorption required by fenders have remained relatively constant. “Velocity is the most important factor in berthing energy calculations, and often more important than mass,” explains Mr Polte.

In terms of lifespan, ports undertaking port rehabilitation projects can expect to get 15-20 years of service from fenders before replacement becomes necessary, unless they need to be changed sooner in line with vessel developments, for example where the overall draft is deeper. Also newer vessels typically withstand a lower hull pressure than older vessels, which means newer ships might require a transition of fenders from, say, cylindrical to a fender system that includes steel panels, says Mr Polte.

MATERIAL COSTS

For the standard range of fenders, rubber remains the most reliable and cost efficient material. For special products, other materials, such as polyurethane or high-density polyethylene (HD-PE), are used. The material choice is further influenced by changing regulations, many of which now require a certain

“When tendering for fenders, suppliers need to be aware that fender standards do differ from region to region

For the latest news and analysis go to www.portstrategy.com/news

APRIL 2018 | 53
amount of recycled content in HD-PE fenders to meet environmental regulations.

However, Mr Pölte, argues that recycled materials are not at all appropriate for rubber fenders as they can degrade the fender performance and life cycle. The preferred fender type can also be influenced by ship owners calling at a port, who may have certain requirements in respect of hull pressure and marking. They may also want a say in the layout of fenders at the ports they berth at.

However, Mr Pölte notes that while high quality fenders can help speed up mooring, the time savings are more often gained through more efficient container handling.

Ports considering automated mooring systems also need to consider that fender design and automated mooring systems need to be synchronised, if they are to work well together.

Mr Pölte also comments on recent high profile quay strikes by vessels, noting that while fenders are designed for normal and abnormal energy, quay strikes fall out of that range. “Overall safety factors can be increased, but if these are too high, the fender system could be ‘over designed’ and too rigid, especially for small-medium size vessels,” he says. “A better approach would be to upgrade mooring systems in terms of approach systems to measure and record berthing velocity and angle to correct speed and angle before quay strikes.”

MEETING EXTREMES

One of the most challenging fender projects handled by ShibataFenderTeam in recent times was that for the Yamal LNG Terminal, in Russia, where the company is already the leading fender supplier. The contractor issued a tender for what was an entirely new project. The terminal operator had a clear idea of what they wanted and issued a very strict performance specification with the tender, against which bidders were asked to put forward solutions.

The main difficulty was that the ambient temperature regularly drops as low as -55°C, during which liquefied natural gas production and vessel berthing needs to continue. ShibataFenderTeam’s winning bid – tailored specifically to meet such conditions – incorporated a special rubber compound which had to be developed specifically to withstand these Arctic temperatures. Steel also had to be supplied which could function at -50°C. On top of this, a special high abrasion-resistant icebreaker paint had to be applied to the steel panel to resist sharp ice particles. The polyethylene wear pads were tested to withstand -150°C.

The fenders had to be produced to meet these rigid specifications right from the start. To ensure success, a comprehensive exchange of information took place locally between manufacturer and client, with quality requirements discussed and approved.

Although the project first surfaced in 2012, development was undertaken over a five-year period, with implementation completed in 2017, in time and on budget for the maiden voyage of a new fleet of ice class LNG carriers.

In total, six CSS 2000 Double Cell Fender Systems were supplied, along with 13 sets of CSS 1800 and one CSS 1800 Corner Fender System.

The fender systems performed well through their first winter, allowing the terminal to function normally. The system is also expected to be very low maintenance due to a safety-driven design. However, maintenance checks are required according to an installation checklist provided by the supplier.

The Yamal LNG Terminal also followed the manufacturer’s suggestion of setting up a spare parts stock. Although a capital cost, this helps to prevent operational downtime and could prove, compared with the downtime costs, a prudent investment.

Systems for greenfield terminal designs

When APM Terminals started its planning for a new container terminal in Moin, Costa Rica, it issued a private open tender for fenders. The terminal was a greenfield development, part of which was offshore. APM’s requested design was specified in some detail and the main challenge for the fender supplier was the long design period, during which several parties were involved.

Furthermore, the fender design changed during the planning process and close co-operation between all concerned was therefore crucial for the success of the project. ShibataFenderTeam provided its CSS 1450 and CSS 630 Cell Fender Systems, which were uniquely designed for the terminal. Installation of the fenders started in 2017 and with container cranes recently delivered to the terminal, the fenders have been put through their first test.

The fender installation is expected to remain in situ for at least 15-20 years, although that will be reliant on routine maintenance being undertaken as outlined by the accompanying maintenance manual. Immediate replacement and repair of fender system components if damaged through accidental berthing will be crucial.
In your opinion, how will the market for fenders develop over the next couple of years?
Due to the fact that two experienced suppliers pulled out of the market in 2018, competition is concentrated on a small number of fender companies, with the SFT Group leading the field. There are only two true global players left who can compete for large-scale projects, thus competition for these mega projects is fierce and stronger than ever before.

Large scale projects equates to a fender investment worth millions: high-quality products are key to avoid repairs, accidents and downtime; this is always important, but related to fender systems for large scale projects it means that if low quality fenders and/or fender systems were ordered with a poor fender design, changing suppliers or getting the fenders re-delivered takes more time than for small scale projects. Downtime and delay of port opening costs millions so should be avoided whenever possible.

Clients and operators of these mega projects should have a strong focus on the experience of the manufacturer they want to work with; they should look for a manufacturer who is their partner during all project phases and who constantly supports them. Having trust in the quality of the products as well as the manufacturer's services is an important factor. The financial strength of the manufacturer is also an important factor for contractors: if a manufacturer is financially unstable, contractors face major risks to source their materials; this risk can be avoided when choosing a manufacturer who has demonstrated long term financial stability.

What are the new market and environmental trends?
With regards to market trends, the requirements on the qualification of steel manufacturers are getting stricter (driven by Europe/US) with a consistent price pressure at the same time. The SFT Group ensures that our raw material and component suppliers are qualified according to the latest standards and even support the upgrade process of our supplier's qualifications.

External influences make the market situation complicated. For example, some countries, such as Venezuela, are unstable markets due to their current political situation. Countries which depend on oil suffer from the decreasing oil price and their economic situation will get worse - investments are stopped or reduced and usually infrastructure projects fall by the wayside first. With less worldwide trade due to trade wars and other reasons, there is less need to increase the capacity at ports etc. Of course it could be the other way around: economic downturn leads to investments in infrastructure projects to refloat the economy; however we have noticed the negative implications of a difficult economic situation.

With regards to environmental concerns there is discussion at PIANC Working Group 211 (‘Guidelines for the design of fender systems’) on how to dispose of fenders after their life cycle. The group is looking at how fenders can be recycled and how it can be used for e.g. road construction. This topic is very interesting and will open up new opportunities for manufacturers. One major issue the group agreed on is that recycled rubber shall not be used for high performance rubber fenders.

What new initiatives has ShibataFenderTeam taken to enforce the relationship between customer and manufacturer further?
By organising workshops and seminars we further widen the customer's knowledge on fender design. This initiative is already an established one within the SFT Group. Being in direct contact with our customers is a valuable opportunity to listen to their needs and at the same time to share our experiences with them. We do not only focus on the rubber fender itself, but on the bigger picture, which includes all fender components and their dependence and interaction between each other. Putting an extensive focus just on the...
rubber unit and more or less ignore the requirements of the steel panel and overall design is a dangerous one-sided approach to fender design, which unfortunately seems to become common practice in the industry.

This year alone, we organised a fender design workshop at Inros Lackner, Germany, with their maritime engineering department to specify project related questions on fender design, organised a fender system design seminar with PIANC Argentina and had some in-house seminars at consultancies in Indonesia. Whilst in Indonesia we gave lectures at universities about fender spacing and examples of failures in the industry. In the US we organised various design training sessions with major engineering companies and participated at NordPIANC in Hirtshals, Denmark, by presenting a paper on port development in Nordic countries.

**Can you give details about some recent orders?**

Our new office in the Netherlands secured an order for Tilbury 2, a new multi-line pound infrastructure project, implemented by the Port of Tilbury. Tilbury has been doubling the size of its business in the past 10 years and is projected to double the volume of cargo across the quay (from 16 million to 32 million tonnes) over the next 10-15 years. Graham Construction was awarded the contract for the marine package including the fenders as part of the upgrade of the existing Roll-On/Roll-Off (RoRo) and CMAT jetty.

As the port is located on the river Thames, which has large tides, the fender panels had to be very long. One of them measures almost 12m to cover the tidal range of around 6m. With such a large steel panel, a design with 2 cone fenders per panel was needed. In total, SFT will deliver 9 sets of double SPC 1400 Cone Fenders with panels (3.10 x 11.8m) as well as 6 sets of double SPC 1200 Cone Fenders with panels (2.40 x 9.90m). The client required a third party testing on rubber batch materials which had been done previously at our factory. Testing rubber batch material refers to the testing of rubber samples cut from the finalised rubber sheet. This is one step before vulcanisation. The rubber sample was tested on physical properties to see if it met international standards and project requirements.

An interesting example of an already completed order is the delivery of a giant Donut Fender in May 2019. The Donut Fender, with an outer diameter of 4.2m and a total height of 6.3m, was delivered to the German Port of Bremen for the lock entrance at Oslebshausen, which is the connection between the industrial Port of Bremen and the river Weser. The fender was produced at the facilities of our long-term joint venture partner MFI in Los Angeles, California, USA. It was shipped on a flat rack container from Los Angeles to Hamburg (Germany) and from there onwards to the job site with a special low-boy trailer to cater for the large diameter. The fender was installed in June by a local marine contractor on a pile with 2.3m diameter.

SFT delivered 107 SPC 1300 Cone Fender Systems and 144 nos. 150t T Head bollards. Since the rubber units are mostly standardised in the industry, the main engineering and design challenge lies with the steel panels, chains, and the corresponding anchorage.

Only when all components are designed in the correct balance and work together properly, will the fender system perform as expected. SFT was able to find the best technical and economical solution for Tema Port saving the client several million dollars. The first two of four new berths were opened for commercial vessels by the end of June 2019, which puts a head start on the scheduled completion of the project in 2020, with SFT delivering the fender systems between March 2018 and fall 2019. SFT is excited to be part of Tema Port’s success story, with our fenders being elements of its foundation.

In one of our last Fender articles we looked at larger vessels and the impact they have on fenders. Can you recap?

Surprisingly, one aspect that has not significantly affected fender design over the last five to ten years is vessel sizes. Even though ship size has increased considerably in recent years, the slower berthing velocity of larger vessels has meant that the calculations for energy absorption required by fenders have remained relatively constant. Velocity is the most important factor in berthing energy calculations, and often more important than mass.
ShibataFenderTeam supplied more than 300 Fender Systems to Turkmenbashi, Turkmenistan.
PIER & WHARF CONSTRUCTION PART IV: FENDER SYSTEMS
When constructing a pier and wharf facility, one of the critical factors that must be taken into consideration is the fender system. This is the interface between the ship and shore facility that acts as a buffer during the berthing of a ship. The fender system absorbs or dissipates the impact energy of the ship, ideally without causing permanent damage to either the vessel or the facility. For this reason, a well-designed fender system is crucial to the overall function of a pier and wharf project.

This article explores the various aspects of fender systems as it relates to constructing pier and wharf facilities, from understanding berthing practicing to selecting and designing fender systems. If you are tasked with the construction of a pier and wharf facility, read on to learn more about this essential component and get in touch with your experienced fender manufacturer to make sure, your design performs as desired.
GENERAL CONSIDERATIONS

The first step in the process of designing a fender system is analyzing the greater concern: protection of the structure or of the vessel. For solid piers and wharves, which are relatively inflexible, protection of the ship is more important. With comparatively flexible pile-supported piers, wharves and dolphins, protection of the structure is the greater concern.

After the ship has been berthed and is moored to the facility, the fender system will continue to transmit environmental loads, such as wind, waves and current, on the ship to the structure. For low-profile ship berthing, the fender system will also provide a physical barrier to prevent the vessel from going under the pier.

The berthing practice of a given pier and wharf facility will impact the selection and design of a fender system. For example, large ships are often brought into berth by two or more tug boats, while smaller ships typically come in on their own power. A ship that is assisted by tugs will arrive parallel to the berth, with the tugs push and pull the ship so that it makes contact with as much of the fender system as possible. In contrast, ships that are unassisted by tugs will generally be eased into its berth at a slight angle (the angle of approach).

Initial contact with the fender system in both scenarios should be fairly limited. As a functional matter, fender systems are comparatively less flexible, protection of the vessel from going under the pier. The calculation is based on the ship’s berthing energy in any structural type of pier or wharf, within the working stress or acceptable deformation range as defined by the contract. Note that fender systems are comparatively less expensive than either the ships that will berth against it or the facility itself. As such, some damage to this system is both permissible and acceptable. If there is a berthing accident, the fender should be sacrificed rather than the berth, any part of the structure, or the ship. Similarly, because it is more expensive to repair a ship’s hull than a damaged fender system, all fender systems should be able to prevent deforming ships’ hulls.

BERTHING ENERGY DETERMINATION

Berthing energy is a key factor that determines the type of fender system that should be utilized in a pier and wharf construction project. There are a number of methods that can be used to determine berthing energy: kinetic, statistical, and scale.

The kinetic model is the most commonly used method, and is also the oldest. The calculation is based on the ships displacement tonnage and berthing speed, modified by variables to account for geometry and hydraulics. The statistical model is dependent on fender layout as well as construction of the site, including the distance between piles. It is based on actual measurements of the energy of the impact at existing berths. The scale model utilizes a small scale
model to test the berth in a hydraulic laboratory. This type of test requires experienced interpretation, and may suffer from scale and viscosity effects.

**TYPES OF FENDER SYSTEMS**

Fender systems work by either absorbing or dissipating the energy of the berthing ships, converting it from kinetic energy into potential energy. This may happen in a number of ways, from deflection of a fender pile, compression of a column of rubber, deformation of a foam-filled cylinder, pressuring of a pneumatic fender or torsion of a steel shaft. Some fender systems — namely, hydraulic fenders — also absorb energy in the form of heat. Most systems that can be practically applied use potential energy conversion.

There are seven potential types of fender systems. First, fender piles, which may be made of timber, steel, composites, or prestressed concrete. These piles may be connected to a chock and waler system at the deck level, then supported by rubber fender units at the bullrail.

Second, end-loaded rubber fenders work through the elastic compression of hollow rubber cylinder elements that have small length-to-diameter ratios. To minimize wear, steel fender panels with special rubbing material facing is generally used. These components are usually attached directly to the structure as a cell fender.

Third, side-loaded rubber fenders are hollow rubber units that will deform by attempting to flatten when loaded at their side. These fenders are available in four shapes: trapezoidal, square, circular, or D-shapes. The potential energy of side-loaded rubber fenders is stored

---

**AS A FUNCTIONAL MATTER, FENDER SYSTEMS SHOULD BE DESIGNED TO ABSORBED THE SHIP’S BERTHING ENERGY IN ANY STRUCTURAL TYPE OF PIER OR WHARF, WITHIN THE WORKING STRESS OR ACCEPTABLE DEFORMATION RANGE AS DEFINED BY THE CONTRACT. NOTE THAT FENDER SYSTEMS ARE COMPARATIVELY LESS EXPENSIVE THAN EITHER THE SHIPS THAT WILL BERTH AGAINST IT OR THE FACILITY ITSELF. AS SUCH, SOME DAMAGE TO THIS SYSTEM IS BOTH PERMISSIBLE AND ACCEPTABLE.**
ShibataFenderTeam’s Cell Fenders are successfully operational at the Container Terminal in Houston (TX), USA.
by compressing the rubber elements. These fenders do not absorb large amounts of energy, and as a result, are typically used in combination with other components, like fender piles. Fourth, rubber shear fenders store potential energy as elastic shear deformation of the rubber. Rubber shear fenders are generally manufactured as a solid block of rubber vulcanized between two metal plates. This type of fender is sensitive to proper manufacturing, as it depends on the bond between steel plates and rubber. Shear fenders however, are rarely used nowadays and if, only for some very special application.

Fifth, buckling fenders will accept an axial load until it buckles laterally. Buckling fenders are used with an abrasion or protector panel, as they are not designed for direct contact with a moving ship. Because they can absorb high berthing energies, buckling fenders are popular for berthing large ships and the most common type of rubber fenders used on today’s ports.

Sixth, pneumatic fenders store potential energy through the elastic compression of a confined volume of air. The energy absorption characteristics can then be changed by varying the internal pressure of the air, with a relief valve or deflection limiter to prevent a blowout. These fenders provide a uniform hull pressure, as they have a uniform surface pressure. A floating pneumatic fender is usually cylindrical with hemispherical ends. It is then attached to the facility with chains, floating on the water. Seventh, foam-filled fenders are made of closed-cell foam encased by an elastomeric polyurethane skin. This
type of fender is resilient, but additional protection may be provided by thicker coatings or an external tire net. A backing system is required to handle the load and to allow for uniform deflection of the fender. Foam-filled fenders float on the water with the tide, attached to the structure with chains. The cells of the foam deform and thereby absorb the berthing energy.

These types may be used separately (except buckling fenders liken cone, cell, leg) or in combination to form a fender system, along with the structure itself. With a proper fender system in place, ship deformation should be rare. There are a number of systems that can be used to prevent damage to both vessels and the pier and wharf facility. The five most common are discussed in detail below.

A combination of fender piles with side-loaded rubber units is frequently used in commercial and naval facilities. It involves a series of fender piles that are closely spaced, connected by chocks and walers, with rubber fender units mounted between the waler and facility. Diagonal chains from the structure to the waler finishes the fender system. The joints between the chocks, walers and pile heads should be tight. The ships can either be berthed directly or through a log camel in this system. This type of system offers flexibility in berthing, as ships of different sizes and types can be accommodated. However, this fender system is not recommended for solid and other types of piers and

Schuyler Companies has been a leader in the business of designing and manufacturing marine fenders, having served the vessel operations industry for over 60 years.
wharves where full deflection of the piles will be prevented. In addition, the use of floating camels may result in concentrating the energy on just one or two piles. For this reason, the rubber fender units should be sized so that the ships can be directly berthed without camels.

For direct berthing of surface ships, directly mounted fender units may be a good choice. Here, individual fender units are attached to the pier or wharf face. This is a cost-effective choice for solid piers and wharves with narrow tidal ranges and narrow vessel size ranges. But there are also multiple customized designs available addressing large tidal ranges and vessel sizes, e.g. double conical fender systems which 30ft long panels and more.

Floating fender units might be a better option when surface ships of many sizes must be berthed. This fender system involves foam-filled or pneumatic fender units along with a backing system. These units can be positioned to float with the tide, and designed so that they can be moved as berthing plans change.

A combination system may be made of any of the above systems to make up for what another system lacks. For example, dedicated berths may have floating fender units, directly mounted fenders at specific points, and then a pile-rubber system in-between. Working closely with engineers and experience marine fender manufacturers can allow you to choose a fender system that best meets the needs of the pier and wharf facility.

Finally, a monopile system involves the use of a floating ring-shaped fender unit (AKA donut fenders) that rides up

**Floating Fender Units Might Be A Better Option When Surface Ships Of Many Sizes Must Be Berthed. This Fender System Involves Foam-Filled Or Pneumatic Fender Units Along With A Backing System. These Units Can Be Positioned To Float With The Tide, And Designed So That They Can Be Moved As Berthing Plans Change.**

---

**Seaboard Steel Corporation offers:**
- Steel sheet piling for rent or purchase
- WF 14 x 120 walers for rent along with end boxes that pin together eliminating welding
- Standard vibratory hammer/extractors as well as side clamp hammers
- Hydraulic impact hammers for stubborn sheets
- Diesel hammers
- Vertical earth augers

**STEEL SHEET PILING**
**VIBRATORY DRIVER/EXTRACTORS**
**PILE HAMMERS:**
**DIESEL & HYDRAULIC**
**VERTICAL EARTH AUGERS**
PILE BUCK SPOTLIGHT

and down on a large steel pile that has been driven to the seabed. Low friction bearing pads are installed on the inner surface of the hull, which allows the fender unit to rotate and slide on the pile. A monopile fender system is best used for corner protection, as well as for entrances to narrow slips or locks.

SELECTION AND DESIGN OF FENDER SYSTEMS

When selecting and designing a fender system, engineers must take a number of factors into consideration. Beyond cost, these issues go into the suitability of the system for the facility itself – and whether the fender system will be able to perform as desired over time.

As an initial matter, the system must be able to absorb the kinetic energy of the berthing vessel. It also must have a minimal reaction force, which is the force that is exerted on the ship’s hull and the structure doing impact. Hull pressure must also be limited so as to avoid causing permanent damage to the berthing ship.

AS AN INITIAL MATTER, THE SYSTEM MUST BE ABLE TO ABSORB THE KINETIC ENERGY OF THE BERTHING VESSEL. IT ALSO MUST HAVE A MINIMAL REACTION FORCE, WHICH IS THE FORCE THAT IS EXERTED ON THE SHIP’S HULL AND THE STRUCTURE DOING IMPACT. HULL PRESSURE MUST ALSO BE LIMITED SO AS TO AVOID CAUSING PERMANENT DAMAGE TO THE BERTHING SHIP.

SUPERPILE®
Fiberglass Reinforced Polymer (FRP) Pipe Piles

High Strength • Rot/Rust/Corrosion Proof

FASTEST DRIVEN -
Drives twice as fast as traditional materials

EASE OF FABRICATION -
Can be field drilled and cut in minutes

LONGEST LASTING -
Durability projections predict 75+ year service life

ENGINEERED SOLUTION -
Designed specifically for the pile market

Contact our Waterfront Sales Rep for more information
888-CPI-PULL (Option 2)  |  crpul@pultrude.com
CreativePultrusions.com
and the ship’s hull is also a factor to be analyzed, as it may have an impact on the performance of the fender system.

The degree of the berth’s exposure to severe environmental conditions may govern the design’s mooring conditions and fender system. In addition, the ability of the crew to appropriately berth the ship will impact the fender’s energy absorption ability, and should be analyzed.

Both the initial cost of the fender system should be considered, as well as its operation, maintenance, and repair. If maintenance is to be frequent or expensive, a simpler system may be preferred. If there are a great number of berthings expected, a higher expenditure for the system may be justified.

If a particular type of fender is more frequently used in a given location, it may be considered, as its performance in similar conditions can be evaluated.

Finally, the type, size and shape of ships that are anticipated to use the facility should also be determined. The fender system should be able to accommodate the full range of ships that are expected to use the facility. If ships with unusual hulls may berth at the structure, special attention should be paid to the fender system. Similarly, the fender system must be usable during all water levels.

Keep in mind that in most cases, a ship will only make contact with a small length of a fender system at a time while berthing. For this reason, a discrete fender component should be designed to be able to provide the full energy, with two components installed per berth.

Fender piles, backing members and other non-rubber components are not affected by temperature fluctuations, and should perform normally. However, rubber fender units will become stiff in colder temperatures, and their performance may be significantly impacted. The ability of rubber units to absorb energy should be evaluated based on the lowest expected temperature and other correction factors for berthing angle and manufacturing tolerance.

The general approach to correct factor has to make sense for the project, e.g. a conservative berthing analysis and allowance for higher berthing speeds in the berthing energy calculation, will compensate for some or all of the typical correction factors.

Fender systems place a crucial role in pier and wharf structures. By absorbing and dissipating the energy of berthing ships, these systems protect both the facility and the vessels. As a result, properly selecting and designing fender systems is an important part to the overall function of a pier and wharf facility. Therefore, the cooperation with well experienced fender manufactures in the early stage of the project is crucial for the success of the project as there are many possible oversights that can heavily impact the performance and durability of the fender system. ■

Miscellaneous Steel Beams for Sale; Best Offer

Located in Chesapeake, Virginia

Points of Contact - please call:
Jason Podd: (757) 630-9022 • Brett Armheiter: (732) 232-0786

www.4barges.com