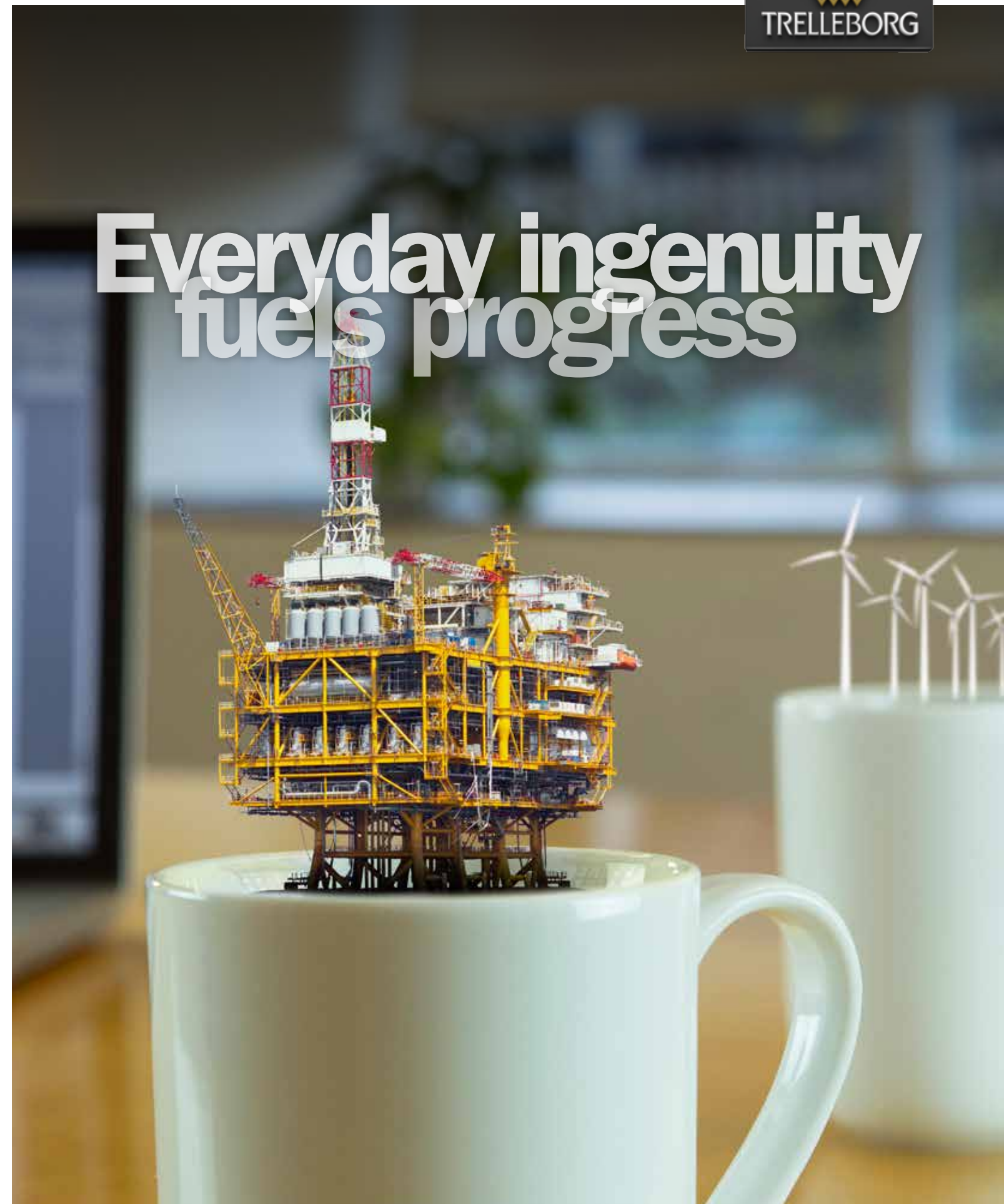




Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Our innovative engineered solutions accelerate performance for customers in a sustainable way. The Trelleborg Group has local presence in over 40 countries around the world.

# Everyday ingenuity fuels progress



# Trelleborg Engineered Products

With a global footprint and local support, and a track record of over 100 years, Trelleborg Engineered Products applies everyday ingenuity to everything we do.

From structural bearing systems to floatover solutions, grout seals for offshore wind farms, corrosion protection and anti-vibration mounts, Trelleborg Engineered Products play a pivotal role in a number of applications, for different types of energy production, including:

OIL & GAS

RENEWABLE ENERGY

POWER PLANTS

OIL SANDS

When it comes to energy production you must be able to adapt to change. Our investment in technology means we can fulfil our dedication to supplying the energy sector with the industry leading structural security it requires. This allows the energy industry to continue to explore ever-more harsh and challenging environments for new ways to fuel the world we live and work in.

Part of the Trelleborg Offshore and Construction business area of Trelleborg Group, Trelleborg Engineered Products is a leading global developer, manufacturer and provider of engineered polymer solutions to the energy, infrastructure and mining industries.

Customers can rely on Trelleborg Engineered Products to deliver innovative polymer solutions that significantly improve the quality, safety and efficiency of its customers’ operations worldwide.

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# Floatover Solutions

**TEP's floatover technology helps to ensure the Transport and Installation phase goes flawlessly, including keeping the topside and jacket of an oil platform safe during the mating process**

**Phase:** Fabrication  
**Location:** Fabrication Yard  
**Solution:** Deck Support Unit

At an oil platform's fabrication yard, Deck Support Units (DSUs) are installed onto the Deck Support Frame (DSF) of a transport barge. The topside of the platform is loaded onto this deck support frame and the DSUs act to absorb the weight of the topside; these DSUs support the integrated deck and allow relative horizontal movement between the deck and the deck support frame during the mating process.

Our DSUs consist of a stack of elastomeric pads installed between two steel casings.

**Phase:** Mating  
**Location:** Drill Site  
**Solution:** Leg Mating Units and Floatover Fenders

When the transport barge reaches the installation site, the mating process begins; the barge manoeuvres into position between the jacket legs and aligns the topside with the substructure before it ballasts, slowly connecting the topside onto the substructure.

This is completed with LMUs, steel structures incorporating engineered elastomeric pads that are installed in the topside or the pre-installed substructure. When the barge starts to ballast, decompression will occur on DSUs and vertical compression will occur on the LMUs, effectively transferring the weight from the barge to the jacket.

The elastomeric pads are designed to take up the static and dynamic forces of the topside structure, as well as the horizontal forces due to open sea motions during the float-over mating operation. After the installation is completed, the topside structure is welded to the substructure.





# Sway & Surge Fenders

Everyday ingenuity fuels  
performance-led design



Barge fendering systems are used during the float-over operation, and protect against damage arising from potential impact between the barge and the substructure legs during the entrance, mating and exit phases. The fenders also assist in ensuring the design clearances during this operation.

Our fendering systems are custom-designed to comply with the client's specified stiffness requirements in both compression and shear. We can offer a cost effective system for attaching the fenders to the barge structure, if required.





**Providing bearing solutions for FPSOs and the first generation of FLNGs**

# FPSO/FLNG Solutions

**Wave action results in multi-directional loads between the hull and the topside modules in offshore oil and gas vessels such as FPSOs and FLNGs. Our support bearings provide the necessary vibration isolation for the processing modules on these vessels**

These bearings must be able to resist:

- Movement in six degrees of freedom
- Large rotational movements in line with FPSO's longitudinal axis

## **FPSO – Elastomeric Bearing System**

Elastomers are an ideal form of maintenance-free material for offshore applications where energy absorption and vibration reduction combined with movement tolerance is required. We use advanced modelling techniques such as Finite Element Analysis (FEA) to predict the stress versus strain characteristics and also study the fatigue life of our bearings. There are several categories of load transfer products:

### **Elastomeric bearings**

These are steel laminated elastomer bearings. They are used to accommodate axial, shear and rotational movement. A variety of high to medium load bearings can be manufactured to suit all specifications. It is commonly used in offshore applications with our specially formulated elastomer compound which gives it resistance to oil-based process liquids.

Design:

- The thickness and number of elastomer layers influence its vertical stiffness and its load carrying capability
- The overall horizontal displacement is mainly determined by the bearing's overall elastomer thickness
- High-performance and specially formulated outer layers can be provided to give the bearing better resistance to environmental degradation (Ozone, UV etc.)
- The quantity and geometry of the plates will determine the load bearing and stiffness characteristics





Other features:

- Special sizes to suit any application
- Natural elastomer is the standard material but Polychloroprene and SBR are also available
- Top and bottom mounting plates are available
- Holes for locating pins are supplied where specified
- Bearings with specification beyond what is shown can also be designed

Selection and specification:

Published international standards, as well as offshore and infrastructure authorities and design engineers have varying approaches to bearing specifications but the following are provided as general guidelines:

1. The vertical compression deformation should not exceed 15% of the initial bearing thickness.
2. The horizontal displacement under shear should be lower than 70% of the total thickness of the elastomer.
3. Total shear tension due to vertical, horizontal and rotation must be lower than five times the shear modulus.
4. The maximum compressive load should not be higher than 100-150 kgs/cm<sup>2</sup>.
5. The minimum vertical load to avoid sliding in the structure should not be less than 30 kgs/cm<sup>2</sup>. If this condition cannot be satisfied, an anchored bearing should be used.
6. For stability, the total effective height of the elastomer should be lower than a fifth of the smaller horizontal dimension, or if circular, a fifth of the diameter and it should be greater than or equal to a tenth of the smaller horizontal dimension.



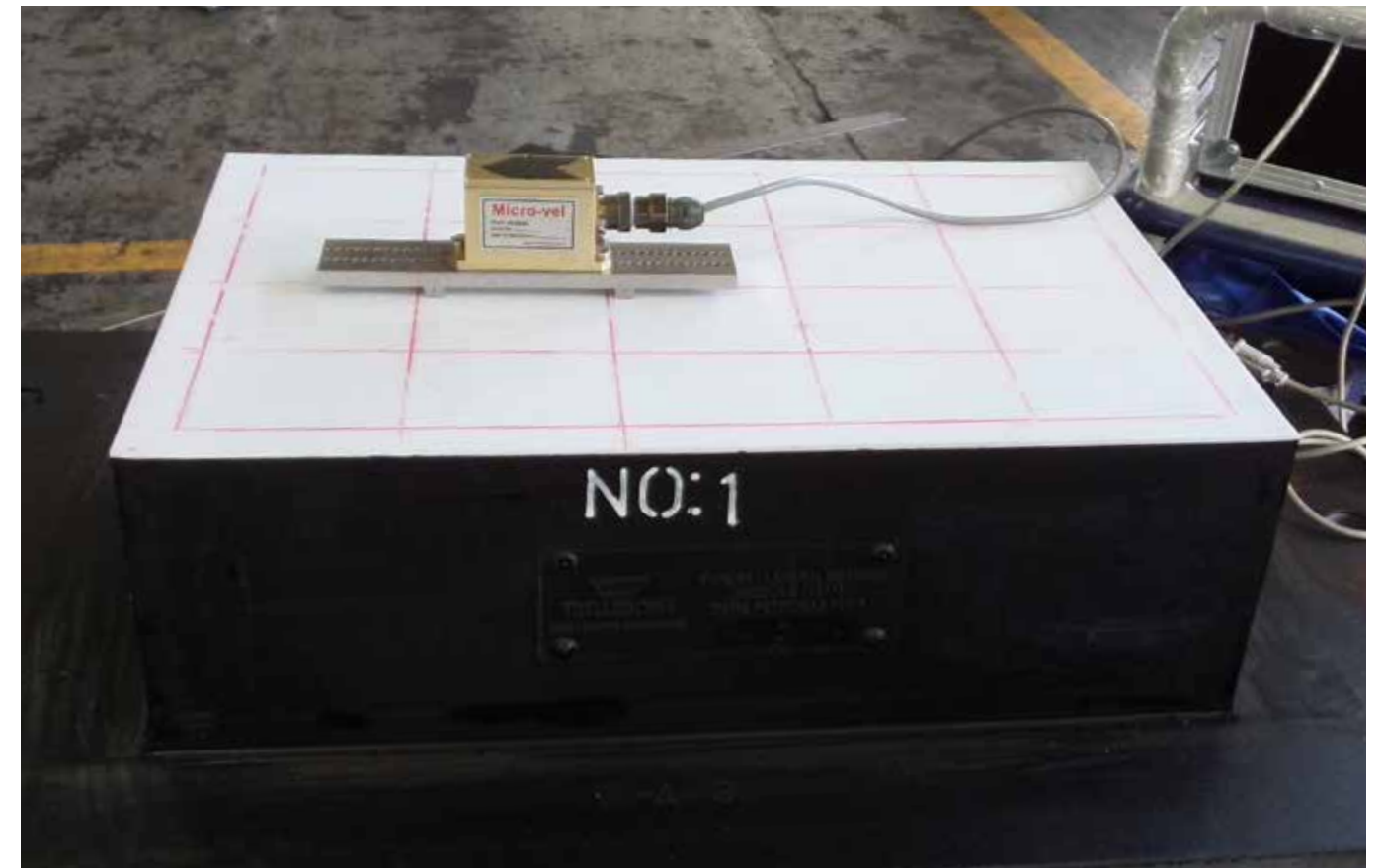
**As the bearings are designed to be flexible they greatly reduce the transmission of vibration from any external disturbance.**

#### Module support bearings for FPSO

Wave action results in multi-directional loads between the hull and the topside modules in an FPSO. Our support bearings provide the necessary vibration isolation for the processing modules on the FPSO.

These bearings must be able to resist:

- Movement in six degrees of freedom
- Large rotational movements in line with the FPSO's longitudinal axis



#### Anti-vibration mounting

These are elastomers with optimized stiffness in order to achieve the desired natural frequency of the supported system. These elements are capable of transferring all the system loads and providing substantial vibration isolation for the supported structure. They provide the necessary dampening to minimize any damage to the supporting structure.

As the bearings are designed to be flexible they greatly reduce the transmission of vibration from any external disturbance. The bearings usually do not absorb the energy of the vibration but prevent energy transfer by mismatching the disturbance's frequency and the natural frequency of the isolated structure.

Key features:

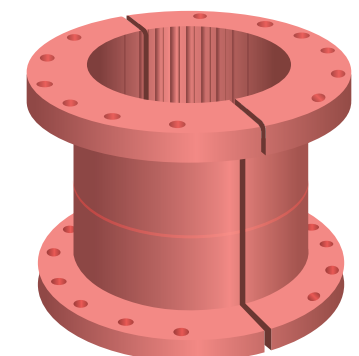
- Anti-vibration bearings play a crucial role in supporting the structure
- Provide a restoring force
- Reduce the transfer of resonant vibrations
- Accommodate large horizontal displacements while still safely providing support

#### Shockpads with load measuring (option)

Shockpads are steel-elastomer-laminated products that are similar in design to elastomeric bearings but optimized for the use as shock absorbers and dampeners in the lifting system of a self-elevated platform. It may be fitted with load measuring devices to enable monitoring of loads during the elevation processes.

#### Riser Protection Clamp

Elastomeric Riser Protection Clamps are installed onto the risers and umbilicals that hang on the side shell of an FPSO's thru I-tube, to protect it from an impact with a supply vessel.





# Jacket Leg Can System

## Diaphragm Closure

Diaphragm Closure seals the platform legs and skirt sleeves to provide buoyancy during the installation of substructures. These closures are attached to the legs and skirt sleeves by means of fastening rings or flanges that hold the rubber diaphragms. They are made from highly reinforced rubber and are designed to withstand the hydrostatic pressure during the jacket flooding operation.



## Internal / Rip-Out Diaphragm

Internal Diaphragms are provided when there can be no external projection on the subject tubular for installing the Diaphragm closure. The specification is similar to the above and the fixings are provided in the form of two rings.

Rip-out diaphragms are similar to internal diaphragms but the cutting is done by pulling the cable and cruciform piercing tool.

It is normally pierced by a pile with an Inflatable Grout Packer, and often used together with either an Inflatable Grout Packer or Grout Seal and Mud Wiper to ensure that no seabed materials ever enter the sleeve.

All diaphragms are usually tested up to 1.5 times the hydrostatic pressure. We normally use either ASTM A36 or EH36 for the retaining rings/flanges. Our team can design diaphragm closures to your specification and to suit special operating conditions. We offer cost effective solutions with superior performance.



## Leg Can Assembly

Our Leg Can Assembly solutions offer the ease of installing individual components at our clients' sites, as Diaphragm Closures and Grout Packers/Grout Seals or Mud Wipers can be assembled into the leg can of a platform's jacket. We can also supply Rupture Discs, Inflation Lines and an ROV Receptacle for the Grout Packer. The Leg Can Assembly can then be installed to the end of the jacket leg.



## Inflatable Grout Packer

Inflatable Grout Packers provide a reliable and robust seal between the ID of the jacket/seal and the OD of the driven pile. When fully inflated by gas or liquid, it seals the annulus and then grout is injected between the pile and leg.

Our Grout Packers are produced from reinforced rubber and come with complete quality control in terms of pressure testing and weld inspection. Clamping plates are welded onto the inside of the Jacket Leg Can to hold the grout packer securely. This stringent design and manufacturing process ensures successful sealing performance and proper grout setting.



## Grout Seal / Mud Wiper

Grout Seals / Mud Wipers assist grout packers in ensuring that the jacket pile annulus is clean by preventing mud contamination. It can also be used alone without grout packers – especially at shallow water depths. When the pile is driven through, the tension on the rubber seals the annulus as it slides along the pile to ensure proper grouting. Our grout seals / mud wipers can tolerate reverse movement in the pile. Grout-sealing solutions can be designed to your specifications.





# Jacket Boat Landing Systems

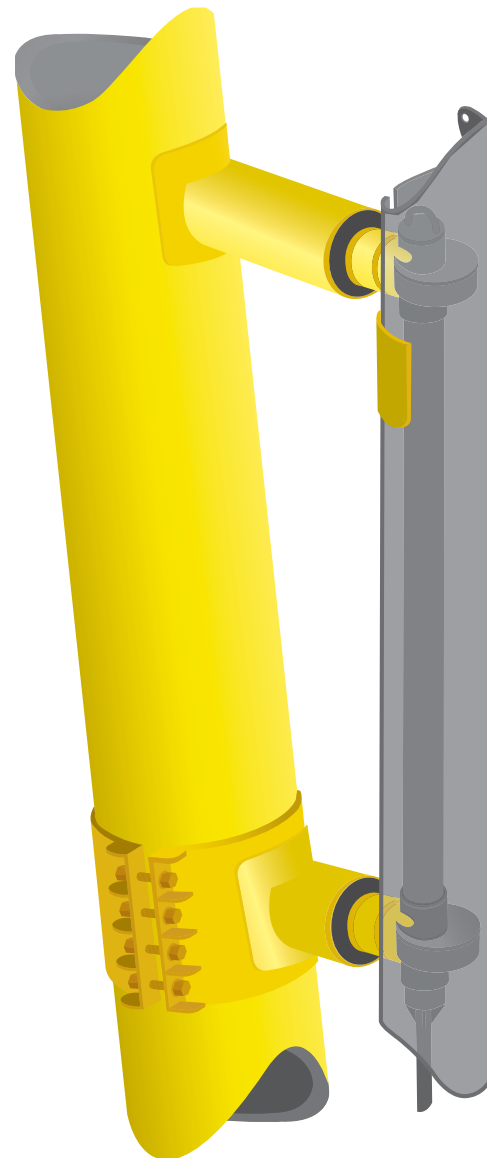
**Boat Landing Systems from Trelleborg Engineered Products provide cost effective and reliable protection for vessels berthing with offshore platforms.**

Building on our experience in manufacturing specialized elastomer products for the marine industry, the Boat Landing System can withstand the most hostile climates and operate in even the most severe weather conditions.

The Boat Landing System consists primarily of the Shock Cells, Eccentric Bumper Rings (EBR) and a steel contact surface. On impact by a berthing vessel, the steel surface transfers the load to the EBRs and the Shock Cells. Kinetic energy is absorbed and dissipated as heat and a smaller reaction force against the vessel by the elastomer as it undergoes shear and tension. The load is therefore reduced and the vessel can berth without damaging the platform structure. The strong bonding achieved between the elastomer and the steel during the manufacturing process ensures that this arrangement will safely dissipate and reduce the external load without damaging the platform.

We essentially utilize the elastomer's unique ability in deflecting normal and lateral impact to withstand the design stresses that are imposed on a platform during barge and vessel operations. Our Elastomeric Solution, with its internal damping effect, can resist high overloads without damage.

Boat Landing Systems are durable, easy to install and require no maintenance. Every unit is load tested prior to delivery and the customer can choose from a complete range of sizes to suit their needs. Our Shock Cells and Eccentric Bumper Rings are proven in absorbing and safely deflecting almost all axial and lateral loads so that your platform will always be protected.

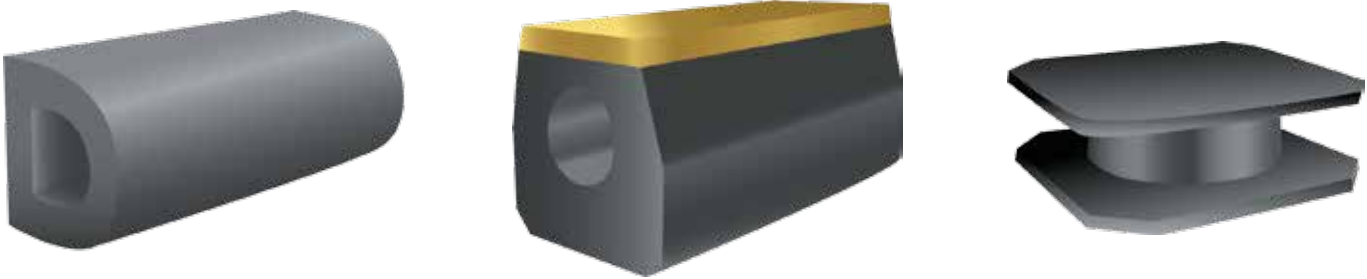
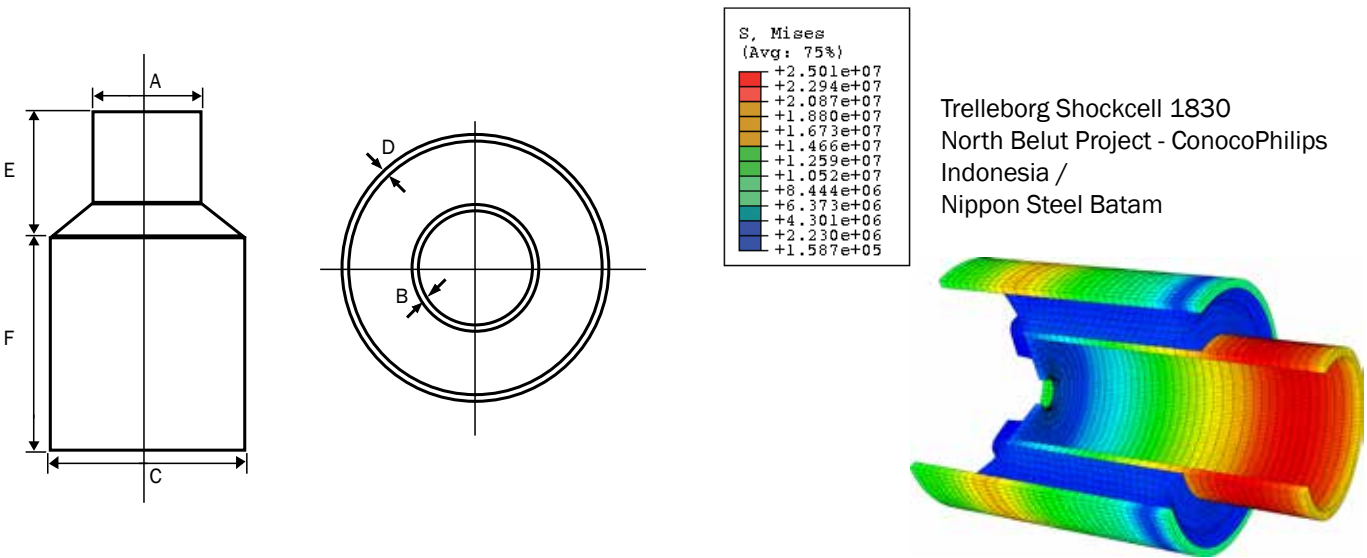




Shock cell specifications (All dimensions in mm)

Type	A	B	C	D	E	F
TH1424	356	19	610	17	216	435
TH1630	406	26	762	19	406	679
TH1830	457	19	762	19	406	610
TH1636	406	26	914	25	610	800
TH1836	457	24	914	25	610	746
TH2036	508	21	914	25	610	660

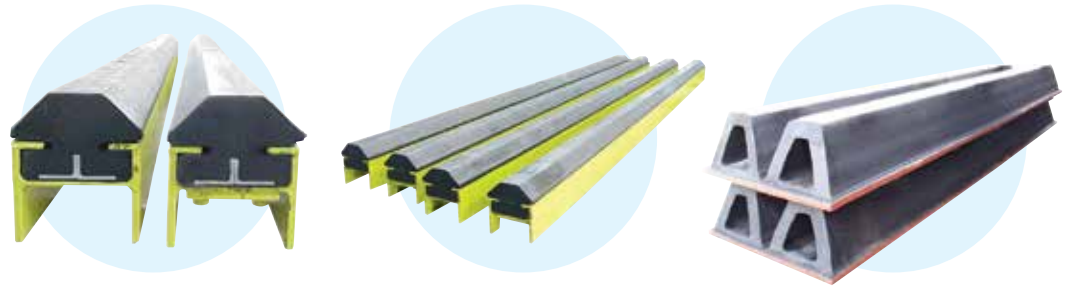
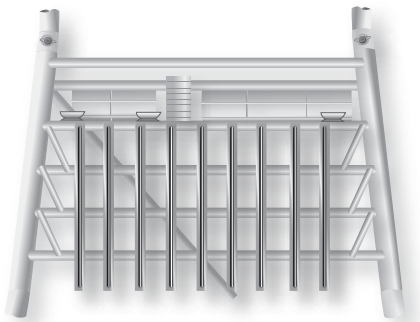
All dimensions act as a guide only. Please contact us for more details.



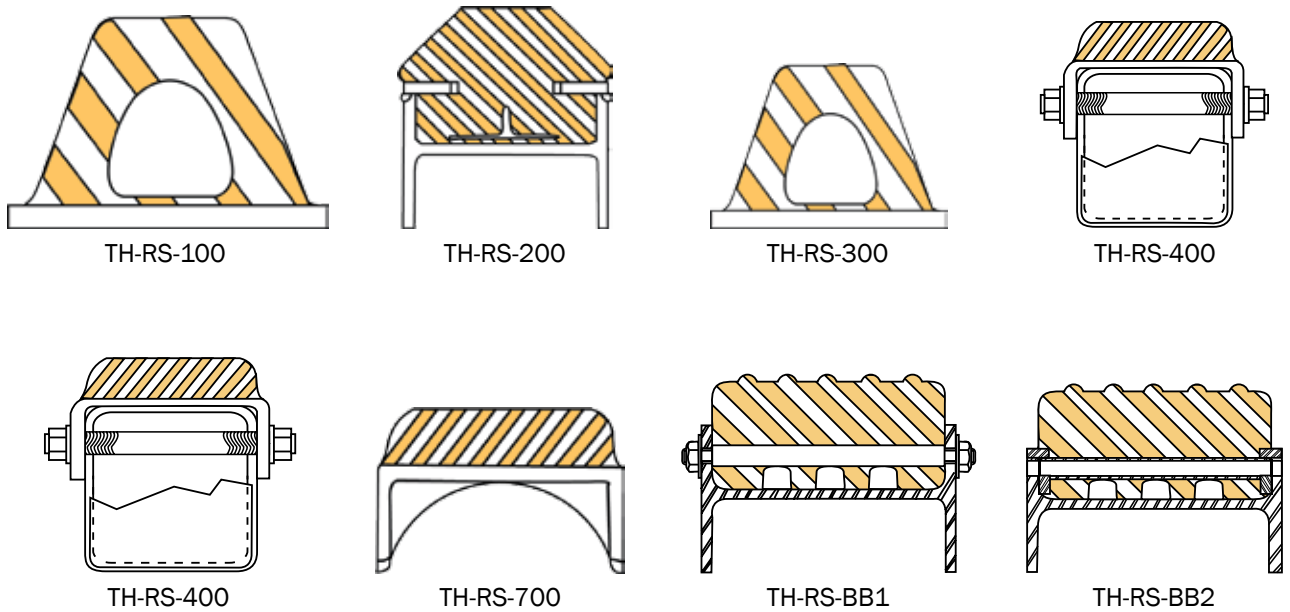
Rubstrips

We also manufacture rubstrips of several different profiles. Our profiles can be solid or hollow and come with many fitting options to the jacket leg / structure.

Our rubstrips are made of high quality elastomer that provide the necessary protection to offshore structures while ensuring that the vessel is not damaged. It consists of a simple but robust design that is free from maintenance and has excellent weather resistance.



General Profiles



Model	Rubber Size			Overall Size		
TH-RS-100	305mm(W)	x	229mm(H)	356mm(W)	x	248mm(H)
TH-RS-200	216mm(W)	x	143mm(H)	216mm(W)	x	255mm(H)
TH-RS-300	203mm(W)	x	154mm(H)	254mm(W)	x	173mm(H)
TH-RS-400	229mm(W)	x	57mm(H)	229mm(W)	x	130mm(H)
TH-RS-700	229mm(W)	x	57mm(H)	229mm(W)	x	159mm(H)
TH-RS-BB1	276mm(W)	x	136mm(H)	305mm(W)	x	355mm(H)
TH-RS-BB2	276mm(W)	x	136mm(H)	305mm(W)	x	355mm(H)

Models and sizes are for reference only.  
Elastomer & plate size can vary according to customer's specification.





**At Trelleborg Engineered Products, we offer fire resistant polymer solutions for numerous offshore applications.**

# Fire Protection Solutions

**Our Passive Fire Protection solutions minimize damage caused by fires to oil platforms and vessels, and protects offshore personnel**

Fire and blast protection of facilities that produce, refine, process and transport oil and gas are of paramount importance. The safety and environmental implications of such protection take on an even greater role in offshore facilities. These often remote and isolated assets require sufficient protection in the event of fire and explosion to enable personnel sufficient time to escape and shutdown critical process lines.

## Why PFP?

- Delays catastrophic failure of the critical supporting structure and escape routes for personnel evacuation
- Provides fire protection for critical equipment, structure
- Assists in emergency response activities (augments active fire protection)
- Isolates different compartments/modules to achieve separate fire and blast protection

## General PFP performance criteria

Performance of any PFP can be categorized by several criteria as shown below. These are the generally accepted measures of performance that any PFP needs to fulfil in order to be qualified for use.

### Stability

The structure shall fulfil its load-bearing capacity throughout the fire exposure period

### Integrity

Partitions shall prevent spread of flames and hot fumes throughout the fire exposure period

### Insulation

The unexposed sides of the partition shall not reach a surface temperature in excess of a certain level throughout the fire exposure



## Fire resistance, fire arresting and fire partition

### PFP allowable temperature

The allowable/critical temperature on the surface of a component is commonly specified in the project PFP criteria. Typical values are shown below:

### Structural steel, 400°C

Construction steel goes from linear elastic to plastic above this temperature

### Other equipment

Reduced yield strength should be equal to the allowable stress under operating conditions

- Processing equipment containing HC, max 350°C
- Risers, pipelines and ESDVs, max 200°C
- Riser supports, max 400°C
- Fire pumps and essential generators, max 200°C







# Anti Corrosion Coating Solutions

**Corrosion Protection Coating secures the integrity of an oil platform's riser pipes and riser clamps, ensuring regular and uninterrupted operations of these vital components.**

A platform's riser pipes can be protected from corrosion by applying elastomer coating. Elastomer coating is widely recognized in the offshore industry as the most effective method of riser corrosion protection, particularly in the highly corrosive splashzone region.

Reasons why Elastomer coating is the best solution:

- It is chemically resistant to most corrosive liquids, hydrocarbon, gases, salt water, ozone and UV light
- Elastomeric solutions provide excellent protection against sharp and abrasive particles, including mechanical impact protection, because of its elasticity and strength
- It is chemically bonded to steel through the vulcanization process and therefore forms a permanent bond compared to other paint and epoxy coating systems which are merely mechanically bonded
- Minor damage to coating can be repaired in-situ and will not compromise the original coating. Paint and epoxy systems cannot provide such properties. This is extremely useful during the handling and installation of the riser at the yards where the coating is often damaged
- Elastomeric Solutions can also be specially formulated for high abuse conditions found in the splashzone and can last the entire lifetime of the jacket
- Elastomer coating is also more cost effective than other metal based coating due to its simplicity and robustness



Two common types of elastomer coating are available:

- Polychloroprene (Neoprene)
- EPDM (Ethylene Propylene Diene Monomer)

An additional option of anti-fouling coating can be added on to the elastomer to inhibit marine growth. This is achieved by applying a layer of elastomer sheet coated with CuNi 90/10 granules and chemically bonded to the riser rubber coating.





Our services include field joint operations anywhere in the world. We are able to perform in-situ vulcanization with our specialized equipment and high performance elastomers. Our personnel are qualified to work offshore and have all the necessary safety and sea survival certification and training.

With an extensive track record of serving clients in the offshore industry in Asia Pacific and beyond for over 20 years, our reputation makes us the preferred coating supplier in this region. With sister companies across the globe, we can offer elastomer coating anywhere in the world.

Riser clamps are frequently internally coated with elastomers. The most common type of elastomer used in this instance is polychloroprene (neoprene). Its ability to withstand hydrocarbon and the harsh marine environment found in the splashzone is especially useful. This elastomer coating can either be in the form of plain/flat or ribbed profile. It is bonded either through a cold-bonding (glue) method or hot-bonding (vulcanization) method.

Characteristics of riser clamp lining:

- Chemically resistant to most corrosive liquids, hydrocarbon, gases, salt water, ozone and UV light
- Provides mechanical and corrosion protection
- Good bonding to steel clamp and provides a good contact surface to grip the riser pipe
- Provides some allowance in riser pipe movement without damaging riser coating especially during riser installation and operation
- An option of PTFE can be added to provide a low friction surface that is in contact with the riser

Our common size ranges from:

- Flat/plain : 3 – 50 mm thick
- Ribbed : 13 – 50 mm thick

We apply everyday ingenuity to provide specially tailored solutions; thanks to our strategically located manufacturing facilities, it is logistically practical to send the clamps for coating before final offshore installation. In addition, we are also able to offer field-coating services.



**Applying everyday ingenuity  
in Asia Pacific and beyond**



# Rubber Lining

## A safeguard against corrosion and abrasion

Our elastomers are chemically resistant to most corrosive liquids, gases, salt water, ozone and UV light commonly encountered in the marine and offshore industries. In general, whenever steel is exposed to corrosion, it can be protected with elastomer lining.

Because of its elasticity and strength, elastomer wears extremely well. It provides excellent protection for steel and other materials against sharp and abrasive particles, both when such particles are in the form of solids and when they are in suspension.

## What can be coated with rubber?

Steel is the structural material most often lined with elastomer but new methods of adhesion make it possible to coat other metals too. Non-metals such as concrete and certain plastics may also be elastomer-lined. If successful results are to be achieved, the bond between elastomer and material must be good. This is achieved by chemical bonding and vulcanizing.



## Examples of items that we have coated:

For the offshore industry:

- Ballast water tanks
- Deaerator tanks
- Salt water spools
- J-tubes
- Riser pipes
- Stilling tubes
- Platform legs
- Platform braces
- ESD-valves
- Actuators
- Accumulators
- Manifold piping

For general industry:

- Tanks and towers
- Vats and other vessels
- Fans and pumps
- Pipes and fittings
- Stirring machine
- Other components exposed to abrasion

It is preferable to have the lining done at our premises in Singapore where special facilities are available and vulcanizing can be done in our autoclaves. Closed tanks can be used as their own autoclaves.

However, large constructions, which are too big to be vulcanised in our autoclaves, can be lined and cured at site. Special elastomers have been developed for this purpose and a low temperature curing process is widely used.

# Other Products

From rubber fenders to dredging hoses, impact protection to elastomeric bearings, Trelleborg Engineered Products' comprehensive portfolio of industry leading products and solutions also includes:



## All types of rubber fenders

## Extruded and moulded rubber parts

## Coating of printing and industrial rollers

## LPG tubing

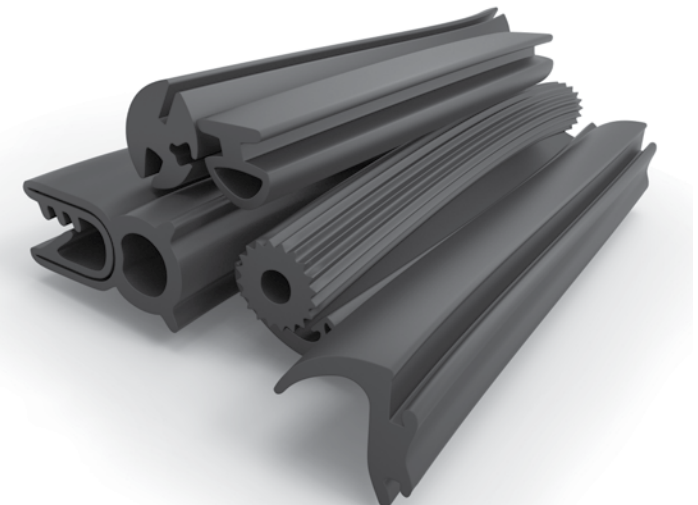
## Impact protection systems for buildings and other construction projects

## Anti-vibration mountings

## Custom made PU profiles

## PU tension pads

## Elastomeric bearings for infrastructure and construction industries





# Research and Development

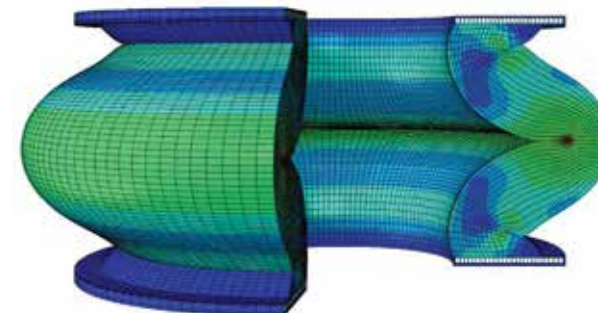
At Trelleborg Engineered Products, our continued investment towards improving the performance of our products and solutions means we can supply the energy sector with the industry leading structural security it requires.



From rigorous testing to ongoing material and product development, our customers can rest assured that our products will perform in even the harshest environments.



At Trelleborg, we continue to further refine and improve our product line through R&D activities utilizing the latest tools like FEA modeling, rapid prototyping/testing and through using a wide ranging mix of materials that combine to ensure our technology performs at the highest standard.



**Everyday ingenuity  
redefining performance  
standards.**