




Pneumatic Rubber Fenders



Takes the pressure off refers to everyday physical and mental pressure points in shipping where TMS exceeds expectations through superior understanding of its clients' businesses.

Pneumatic Rubber Fenders

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Introduction

Pneumatic rubber fenders have a long and successful history of protecting vessels in mooring operations. They are ideal for permanent and semi-permanent port applications and for offshore ship-to-ship transfers. Tough and resilient, Trelleborg Marine System's fenders are fast and easy to deploy, maintaining large clearances between the hull and the jetty or other vessel. This serves to minimise damage potential during mooring.

Critical properties of rubber fenders are energy absorption, hull pressure and reaction force. In both cases, Trelleborg Marine Systems products score very highly, with low reaction force and low hull pressure. This means the fender absorbs significant energy, reducing the forces on both the vessel hull and jetty structures.

With the development of ship technology, fenders have evolved to suit newer vessel types such as ULCCs, LNG carriers, bulk carriers, FSOs and FPSOs. As a result, Trelleborg Marine Systems manufactures a wide range of pneumatic fenders from the large 4.5 x 9 metre down to the 300 x 500 mm baby fenders.

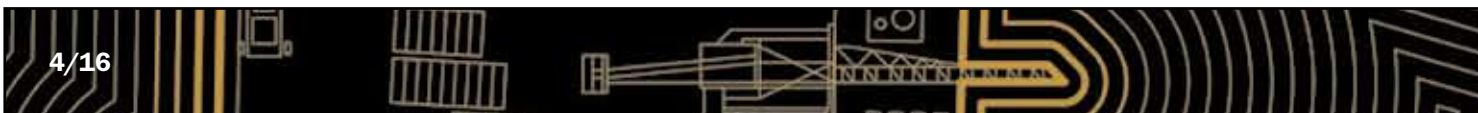
With the backing of Trelleborg's 100 years of experience in rubber technology, the quality and performance equates to the best available world-wide.

Trelleborg Marine Systems pneumatic rubber fenders are manufactured in its new manufacturing facility.



- 1 Pneumatic rubber fenders are quick and easy to deploy.
- 2 Available in many sizes to suit clearance requirements.

- 3 Trelleborg's state-of-the-art manufacturing facility.
- 4 Quick and easy to install.



Characteristics

Safety

Highly resistant to failure, conforming to accepted standards and proven through extensive testing programs.

Consistent Performance

Trelleborg pneumatic fenders comply with ISO 17357:2002 requirements for consistent performance.

Angled Berthing

Trelleborg Marine Systems pneumatic fenders will not lose performance when used with berthing angles up to 15 degrees.

Performance in Rough Seas

Not easily damaged in rough weather and sea conditions.

Excellent Compressibility and Elasticity

Pneumatic fenders utilise the compressibility and elasticity of air to absorb energy. Therefore, the energy absorption capacity is substantially increased.

Good Buoyancy and Simplified Handling

Lighter and easier to handle than the conventional solid rubber models due to their hollow construction.

Ease of Installation and Repair

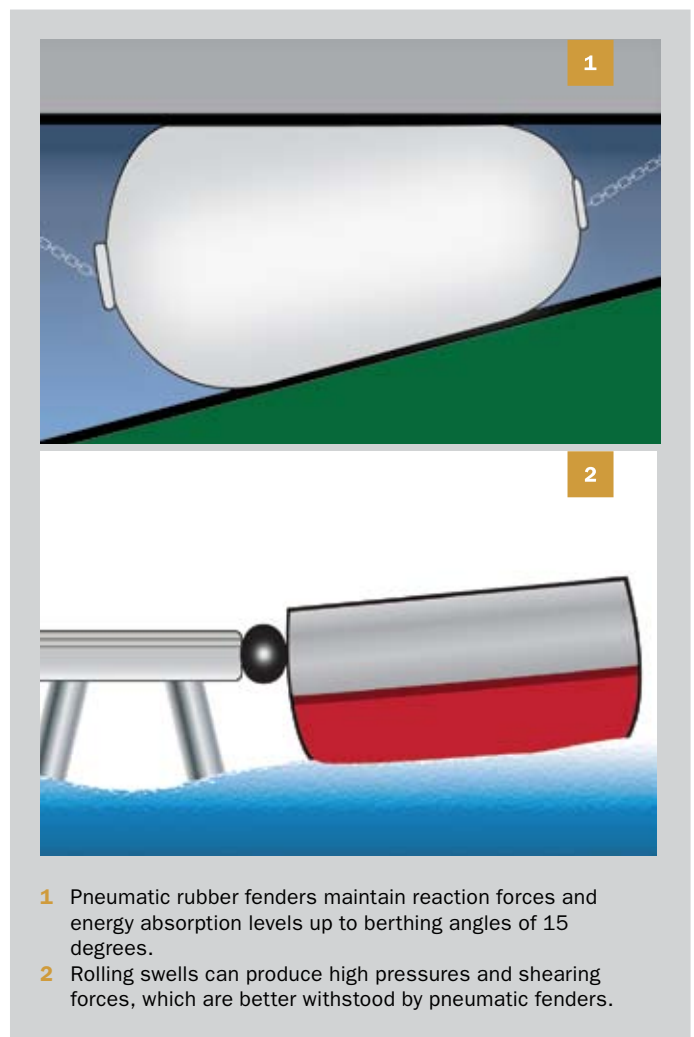
Maintenance costs are drastically reduced. Fenders can be moored to the ships and docks with wire or chain line easily.

Maximum Permissible Service Life

Reinforced with rubberised strong tyre cord and covered with superior rubber compound, fenders are resistant to sunlight, ozone, oxygen, heat and weathering, providing an extremely long service life.

Fender with Low Hull Pressure

Provides lowest and uniform hull pressure.



Construction

ISO Standard

All Trelleborg Marine Systems pneumatic rubber fenders are manufactured and 3rd party certified in compliance with ISO 17357:2002. The stringent requirements of this standard ensure that fenders are of a high quality and can withstand the rigorous environments and applications they are designed to operate in. ISO 17357:2002 details three major elements of construction: the outer rubber, tyre-cord reinforcing layer and the inner rubber.

Outer Rubber

The tough abrasion resistant outer rubber is designed to protect the inner rubber and tyre-cord layers from damaging external forces. The material has mechanical properties to withstand the arduous operational conditions for which it is designed.

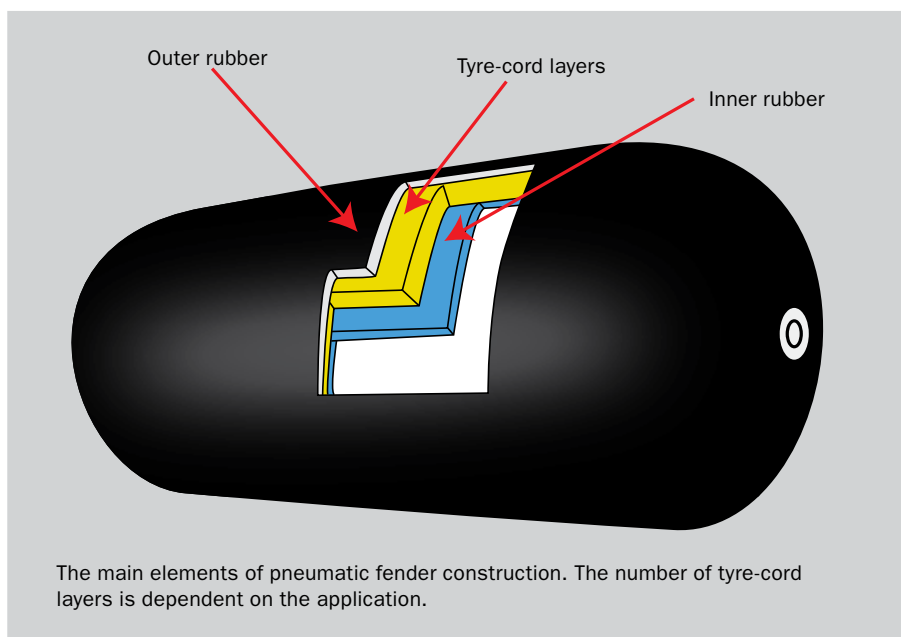
The diagram below shows the actual properties as specified in ISO 17357. Generally, the outer rubber is black, but other colours such as grey and off-white can be supplied upon request.

Tyre-cord Layer

Synthetic tyre-cord layers have proven to be the best option for strong, efficient reinforcement for pneumatic rubber fenders. Each layer is coated with a rubber compound on both sides that prevents contact between the layers, reducing friction and wear during bending, compression and stretching. The same compound isolates each thread within the layer. This greatly improves the ability of the fender to hold pressure, fatigue resistance and endurance life. Other reinforcing layer materials such as canvas have wear points that significantly reduce the life off the fender. A schematic of the construction is shown below.

Inner Rubber

The inner rubber seals pressurised air inside the fender. It is usually constructed of a compound similar to that of an inner tube in a truck or car tyre to ensure a good level of air tightness.



Construction

The material tests of the outer and inner rubber shall be conducted in accordance with the specification given in the table below.

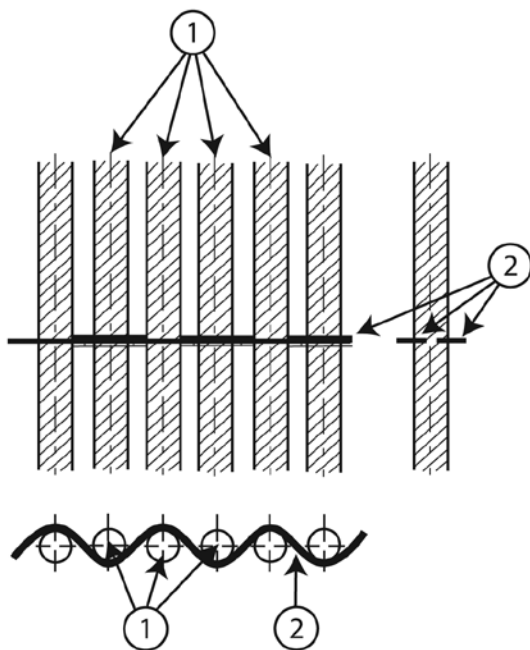
Outer and Inner Rubber Material Properties Requirements

Test item	Test method	Required value	
		Outer rubber	Inner rubber
Before ageing			
Tensile strength	BS ISO 37	18 Mpa or more	10 Mpa or more
Elongation	BS ISO 37	400% or more	400% or more
Hardness	ISO 7619	60 +/- 10 (durometer hardness test type A)	50 +/- 10 (durometer hardness test type A)
After ageing	ISO 188	Air oven ageing. 70°C +/- 1°C. 96 h	Air oven ageing. 70°C +/- 1°C. 96 h
Tensile strength	BS ISO 37	Not less than 80% of the original property	Not less than 80% of the original property
Elongation	BS ISO 37	Not less than 80% of the original property	Not less than 80% of the original property
Hardness	ISO 7619	Not to exceed the original property by more than 8	Not to exceed the original property by more than 8
Tear	BS ISO 34-1	400 N/cm or more	No requirement
Compression set	ISO 815	30% (70°C +/- 1°C for 22h) or less	No requirement
Static ozone ageing	ISO 1431-1	No cracks after elongation by 20% and exposure to 50 pphm ¹ at 40°C for 96 h.	No requirement

NOTE: if the colour of the outer rubber is not black, the material requirements will differ from those in this table.

¹ pphm: parts of ozone per hundred million of air by volume

Properties of the inner and outer rubber as adapted from ISO 17357: 2002 Ships and Marine Technology—High-pressure Floating Pneumatic Rubber Fenders.



- ① Warp threads that run vertically through the synthetic tyre-cord pattern.
- ② Weft threads that run perpendicular to the warp threads.

Construction of tyre-cord layers as adapted from ISO 17357.

Test and Inspection Requirements

Acceptance testing and inspection for purchased fenders shall be based on the tests and inspections indicated in the following table:

Test and inspection requirements for commercial fenders

Test	Standard	Description	Remarks
Material Testing	ISO 17357/PIANC Guidelines for design of fender system : 2002	Physical properties of inner and outer rubber	Tensile/elongation/hardness before ageing to be tested once for each order. Rest of the test to be conducted once in a year
Dimensional Inspection		Length: +10%, -5% Diameter: +10%, -5%	Dimensional inspection to be carried out at initial internal pressure (working pressure)
Air Leakage		The air leakage test shall be conducted at initial informal pressure for more than 30 minutes	All fenders to be tested for each and every order
Hydrostatic Test		Test shall be preformed for 10 minutes at hydrostatic pressure shown in 'Pressure Rating' table. Maximum circumferential and longitudinal temporary elongation: 10%	The frequency of test shall be one in 20 fenders for each size and pressure

Hydrostatic Pressure Test



- 1 Fender on the ground.
- 2 Pressure 250kPa.

- 3 Circumferential and longitudinal mark.
- 4 Measuring the length.

Product Characteristics

Standard Sizes

Regardless of type or pressure, fenders are measured by diameter and length, generally expressed in millimetres (mm).

Type I (chain-tyre net) fenders are not manufactured below 800 x 1200 and all fenders above 2500 mm in diameter are fitted with a pressure relief valve in accordance with ISO 17357.

Size	Body mass (kg)	CTN mass (kg)	Total mass (kg)	Chain (mm)
300 × 500	10	–	10	10
300 × 600	15	–	15	10
500 × 800	25	–	25	13
500 × 1000	35	–	35	13
800 × 1200	75	100	175	16
800 × 1500	95	110	205	16
1000 × 1500	140	170	310	16
1000 × 2000	170	200	370	16
1200 × 1800	180	210	390	18
1200 × 2000	200	220	420	18
1350 × 2500	270	260	530	20
1500 × 2500	300	400	700	22
1500 × 3000	350	440	790	22
2000 × 3000	550	880	1430	26
2000 × 3500	650	920	1570	28
2000 × 6000	950	1120	2170	32
2500 × 4000	1100	1510	2610	32
2500 × 5500	1350	1620	2970	36
3000 × 5000	1700	2620	4320	38
3300 × 4500	1800	2360	4160	38
3300 × 6500	2250	3120	5370	44
3300 × 10500	2800	4050	6850	48
4500 × 7000	3250	5100	8350	50
4500 × 9000	4950	6200	11150	50

Approximate weights for Trelleborg Marine Systems fenders.

Non-standard Sizes

Some applications may require a size of fender that is outside those specified in the standards. Trelleborg Marine Systems can make fenders to customer specifications.



4500 x 9000 mm Type I fender.

Product Characteristics

Performance Requirement: for standard products indicated by outer diameter (OD) x length (L).

Performance Data

Initial Pressure	50kPa = 0.5kgf/cm ² = 7.1psi			80kPa = 0.8kgf/cm ² = 11.4psi		
Size	Energy (kNm)	Reaction (kN)	Pressure (kN/m ²)	Energy (kNm)	Reaction (kN)	Pressure (kN/m ²)
500 x 1000	6	64	132	8	85	174
600 x 1000	8	74	126	11	98	166
700 x 1500	17	137	135	24	180	177
1000 x 1500	32	182	122	45	239	160
1000 x 2000	45	257	132	63	338	174
1200 x 2000	63	297	126	88	390	166
1350 x 2500	102	427	130	142	561	170
1500 x 3000	153	579	132	214	761	174
1700 x 3000	191	639	128	267	840	168
2000 x 3500	308	675	128	430	1150	168
2500 x 4000	663	1381	137	925	1815	180
2500 x 5500	943	2019	148	1317	2653	195
3300 x 4500	1175	1684	130	1640	2476	171
3300 x 6500	1814	3015	146	2532	3961	191
3300 x 10600	3067	5257	158	4281	6907	208
4500 x 9000	4752	5747	146	6633	7551	192
4500 x 12000	6473	7984	154	9037	10490	202

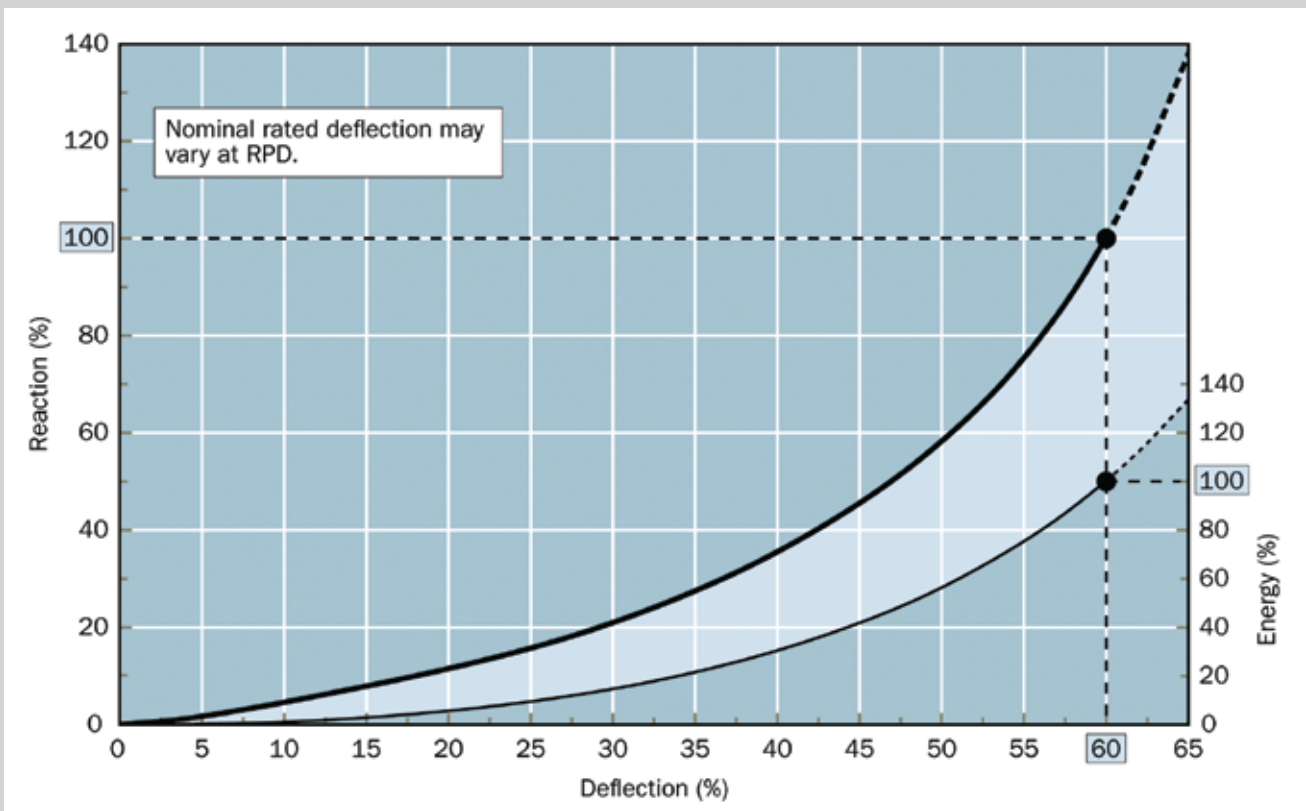


2500mm x 4000mm fender.



- 1 Measuring the length.
- 2 Measuring the circumference.

Product Characteristics



Note: Standard manufacturing and performance tolerance: Energy: 100%, Reaction: 100 ± 10%, Deflection: 60 ± 5%

Parallel Compression Test



1



2



3

- 1 Pressure 80kPa.
- 2 Parallel compression test.
- 3 Parallel compression test 60%.

Pneumatic Fender size: 1000mm diameter x 1500mm length.

Pressure Ratings

Pressure Ratings

Trelleborg Marine Systems manufactures fenders with two initial pressures: 50 kPa (Pneumatic 50) and 80 kPa (Pneumatic 80). Design values are given below.

Pneumatic 50 Nominal Size Diameter x Length (mm)	Internal pressure (kPa)		Min. endurable pressure (kPa)		Safety valve pressure setting (kPa)	Test pressure at 0% deflection (kPa)
	at 0% deflection	at 60% deflection	at 0% deflection	at 60% deflection		
500 x 1000	50	132	300	462	–	200
600 x 1000	50	126	300	441	–	200
700 x 1500	50	135	300	473	–	200
1000 x 1500	50	122	300	427	–	200
1000 x 2000	50	132	300	462	–	200
1200 x 2000	50	126	300	441	–	200
1350 x 2500	50	130	300	455	–	200
1500 x 3000	50	132	300	462	–	200
1700 x 3000	50	128	300	448	–	200
2000 x 3500	50	128	300	448	–	200
2500 x 4000	50	137	350	480	175	250
2500 x 5500	50	148	350	518	175	250
3300 x 4500	50	130	350	455	175	250
3300 x 6500	50	146	350	511	175	250
3300 x 10600	50	158	350	553	175	250
4500 x 9000	50	146	350	511	175	250
4500 x 12000	50	154	350	539	175	250

Pneumatic 80 Nominal Size Diameter x Length (mm)	Internal pressure (kPa)		Min. endurable pressure (kPa)		Safety valve pressure setting (kPa)	Test pressure at 0% deflection (kPa)
	at 0% deflection	at 60% deflection	at 0% deflection	at 60% deflection		
500 x 1000	80	174	480	609	–	250
600 x 1000	80	166	480	581	–	250
700 x 1500	80	177	480	620	–	250
1000 x 1500	80	160	480	560	–	250
1000 x 2000	80	174	480	609	–	250
1200 x 2000	80	166	480	581	–	250
1350 x 2500	80	170	480	595	–	250
1500 x 3000	80	174	480	609	–	250
1700 x 3000	80	168	480	588	–	250
2000 x 3500	80	168	480	588	–	250
2500 x 4000	80	180	560	630	230	300
2500 x 5500	80	195	560	683	230	300
3300 x 4500	80	171	560	599	230	300
3300 x 6500	80	191	560	669	230	300
3300 x 10600	80	208	560	728	230	300
4500 x 9000	80	192	560	672	230	300
4500 x 12000	80	202	560	707	230	300

Types of Fenders

Fender Types

There are two basic types of pneumatic fenders that comply with the international standard: Type I (net type) and Type II (sling type). The most appropriate type for a given application will depend upon how it is to be used and what the requirements of the facility are.

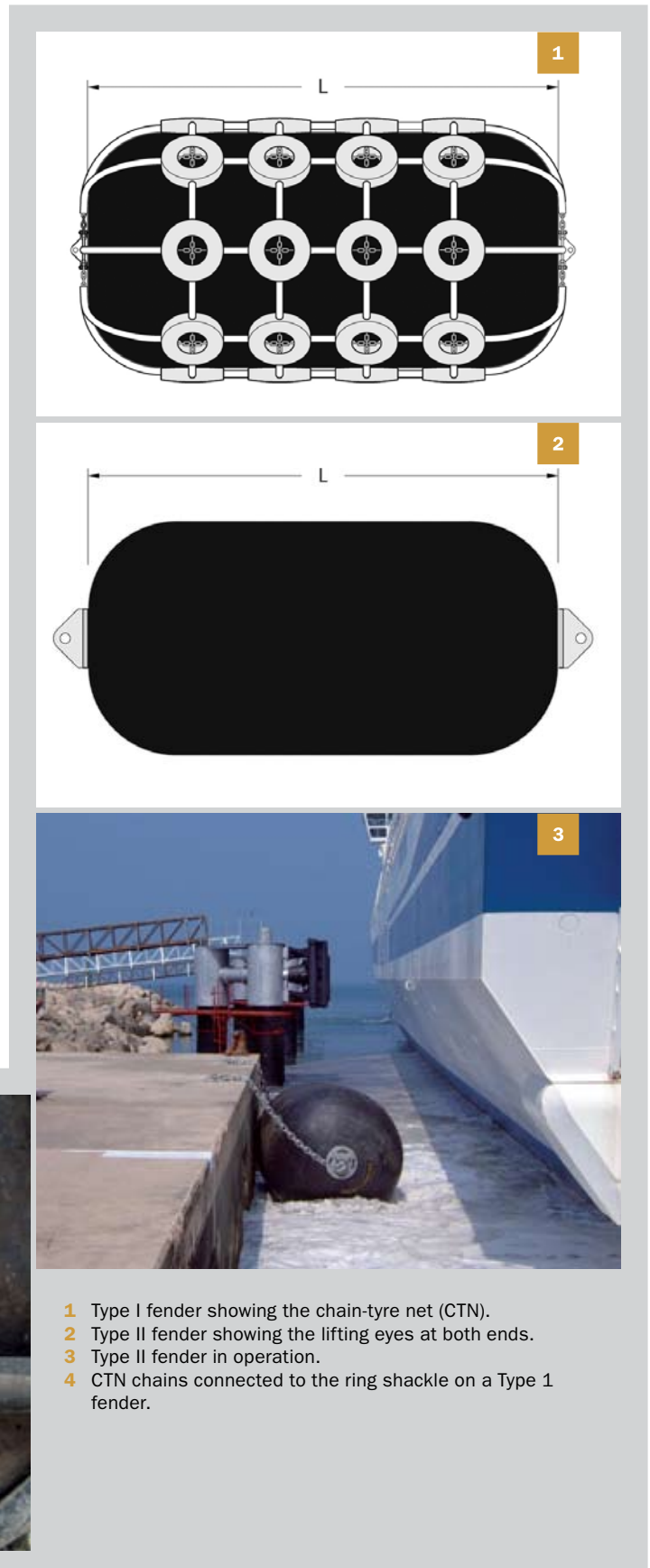
Type I

Trelleborg Type I fenders are fitted with a chain-tyre net (CTN). This is a lattice of used tyres connected by a network of horizontal and vertical chains, which adds further protection to the fender body. The chains are galvanised for greater corrosion resistance and covered by rubber sleeves to prevent abrasive damage to the outer rubber. The horizontal chains are fastened at each end to a ring shackle. CTNs are not available on fender sizes below 800 x 1200 mm.

Type I fenders are the most common in use.

Type II

Sling or hook type fenders are effectively a Type I fender without the CTN and the ring shackles. A lifting eye is fitted to each end and the fender is slung by chain or wire rope. Type II fenders are available across the whole size range.



- 1 Type I fender showing the chain-tyre net (CTN).
- 2 Type II fender showing the lifting eyes at both ends.
- 3 Type II fender in operation.
- 4 CTN chains connected to the ring shackle on a Type 1 fender.

End Fittings

Pneumatic fenders are often suspended using chains, shackles. Recommended dimensions of the standard fittings are given in the table below.

Fender Fixing Accessories

Type 2 Fender (sling)		First Shackle Diameter (mm)	Swivel Diameter (mm)	Other Shackle Diameter (mm)	Guy Rope Diameter (mm)	Guy Chain Diameter (mm)	Anchor Diameter (mm)
Size D x L (mm)	Initial Pressure (kPa)						
500 x 1000	50	16	16	22	16	16	25
600 x 1000	50	16	16	22	16	16	25
700 x 1500	50	16	16	22	16	16	25
1000 x 1500	50	16	19	22	16	16	25
1000 x 2000	50	16	19	22	16	16	25
1200 x 2000	50	16	19	22	16	16	25
1350 x 2500	50	18	19	22	18	16	25
1500 x 3000	50	18	22	24	20	19	32
1700 x 3000	50	20	25	24	22	19	32
2000 x 3500	50	20	28	26	24	22	32
2500 x 4000	50	28 (2)	32	32	30	26	42
2500 x 5500	50	32 (2)	38	34	34	32	44
3300 x 4500	50	32 (2)	38	36	34	30	44
3300 x 6500	50	40 (2)	44	44	42	38	55
3300 x 10600	50	Special towing ring 70 mm		60	52	48	75
500 x 1000	80	16	16	22	16	16	25
600 x 1000	80	16	16	22	16	16	25
700 x 1500	80	16	16	22	16	16	25
1000 x 1500	80	16	19	22	16	16	25
1000 x 2000	80	16	19	22	18	16	25
1200 x 2000	80	16	19	22	18	16	25
1350 x 2500	80	18	19	22	20	16	25
1500 x 3000	80	20	25	24	24	20	32
1700 x 3000	80	20	25	24	24	20	32
2000 x 3500	80	24	28	28	28	24	36
2500 x 4000	80	30 (2)	38	34	32	30	42
2500 x 5500	80	36 (2)	44	40	40	36	50
3300 x 4500	80	34 (2)	44	40	38	34	50
3300 x 6500	80	44 (2)	50	48	46	42	60
3300 x 10600	80	Special towing ring 70 mm		65	60	54	75

Recommended sizes of shackles and chains for all sizes of Type 2 fenders.



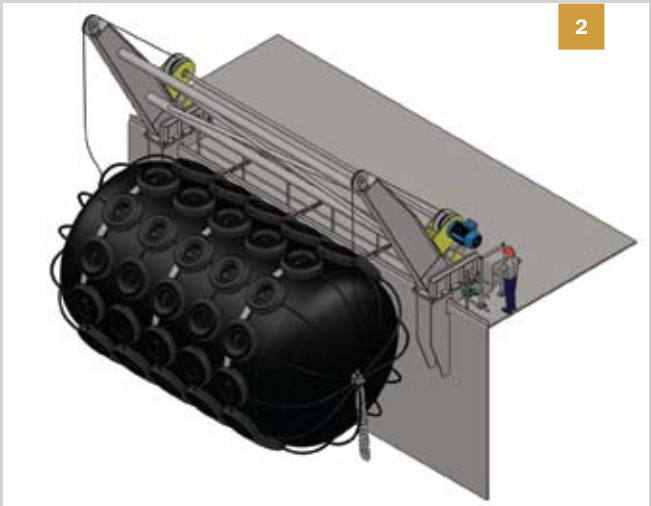
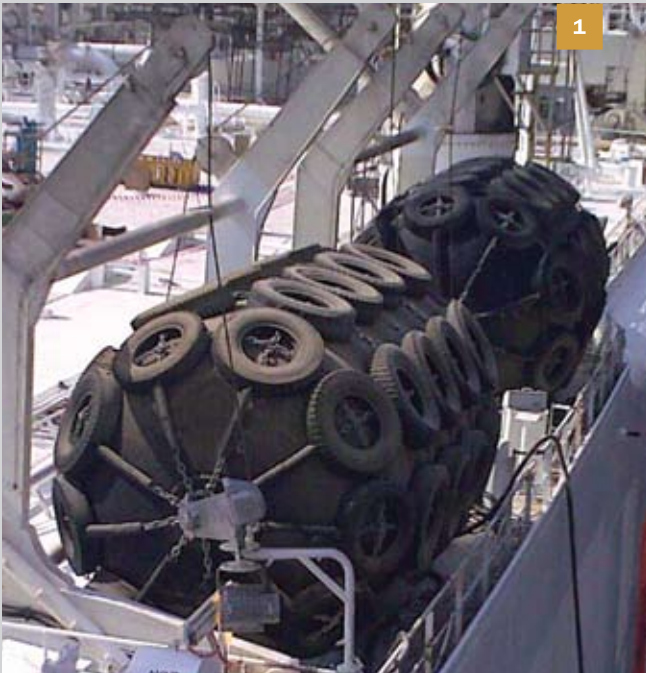
Fender Deployment Systems

Trelleborg Marine Systems not only supply easy-to-deploy pneumatic fenders, we also offer fender deployment systems to deploy, retrieve and store fenders.

In recent years Trelleborg Marine Systems focused on the development of fender deployment systems for the growing FSRU and FLNG applications. This market niche offers unique challenges due to the space restrictions on board FLNG and FSRU, which are driving the re-think of the common fender deployment system: current solutions explore telescopic arms or A-frame type davits to safely store the fenders on deck or over the hull during bad weather or routine maintenance inspections. Other features are: pneumatic fender pressure monitoring, hazardous rating and auto-tension system for lifting wire.

Trelleborg Marine Systems' expertise in fender manufacture, in rubber technology and marine engineering mean an integrated solution from one supplier.

Fender Deployment Systems



- 1 Fender Davits.
- 2 Davit suitable for 4.5 x 9.0 fender.

Disclaimer

Trelleborg AB has made every effort to ensure that the technical specifications and product descriptions in this brochure 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 brochure supersedes the information provided in all previous editions. If in doubt, please check with Trelleborg Marine Systems.

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Trelleborg Marine Systems | Takes the pressure off



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