TEKMARINE

Marine Fenders

About TekMarine

From its base in the United States, TekMarine Systems LLC designs and supplies advanced marine fendering and mooring systems to ports, harbors and waterways across the world.

We bring a wealth of engineering and market experience to each project. Our fender solutions range from simple modules to the most sophisticated engineered systems. We supply every type of berth, including passenger terminals, bulk and RoRo ports, Oil and Gas installations and naval facilities.

We offer full support at each step from early concept discussions through to design and detailing, material selection, construction, testing, shipping, and installation. A full after-care service helps keep your investment working safely and reliably for many years after commission.

Disclaimer

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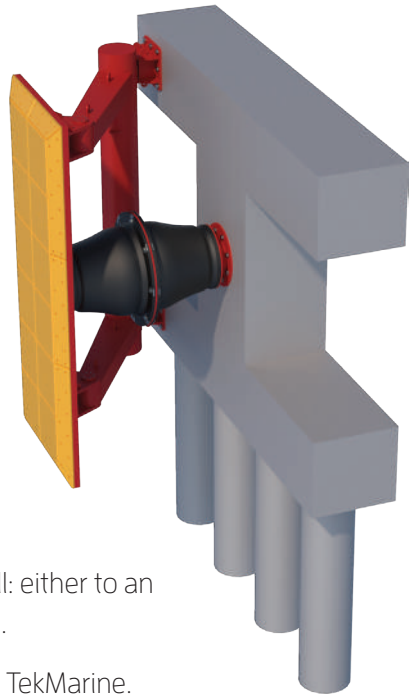
Parallel Motion Fenders

The Parallel Motion Fender is a self-contained, fully engineered fender system. Reaction forces can be reduced to around half that of conventional fender systems. Even at high berthing angles and varying impact levels the panel remains vertical, and there is little or no loss of energy absorption.



Parallel Motion Fenders are popular choices for belted vessels such as RoRo and ferries, for soft-hulled ships such as tankers and LNG carriers, and for sites with high tidal ranges or load-sensitive berthing structures.

A typical design uses twin TJCO Cone Fenders installed flange-to-flange. This absorbs double the energy of a single cone for the same reaction. Loads on the structure are reduced, which saves build costs and vessel turnaround times.

The fully sealed hinge mechanism, arm and box panel will perform for years with little maintenance, making for low running costs and a very long working life.

Because Parallel Motion Fenders are pre-built in the factory, they are easy to install: either to an anchor system on a concrete structure, or lowered into place around a tubular pile.

Every system is custom designed, so please discuss your exact requirements with TekMarine.

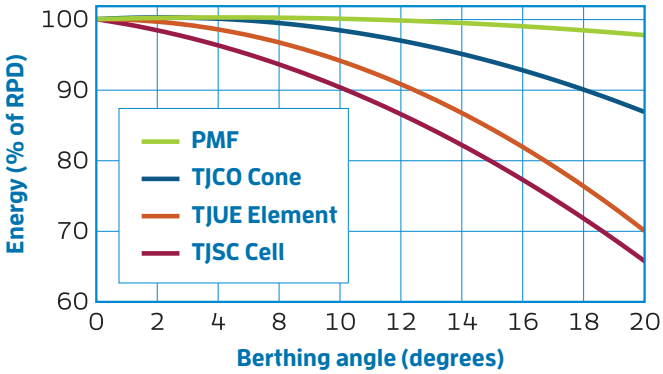
Performance

Model	Single Cone PMF				Dual Cone PMF			
	Energy		Reaction		Energy		Reaction	
	kNm	ft.kips	kN	kips	kNm	ft.kips	kN	kips
TJCO 300	9–18	6–13	52–110	12–25	18–36	12–26	52–110	12–25
TJCO 400	21–42	15–31	93–196	21–44	42–84	30–62	93–196	21–44
TJCO 500	41–81	30–60	145–307	33–69	82–162	60–120	145–307	33–69
TJCO 600	71–140	52–103	209–441	47–99	142–280	104–206	209–441	47–99
TJCO 700	111–223	82–165	285–601	64–135	222–446	164–330	285–601	64–135
TJCO 800	166–333	122–246	372–785	84–177	332–666	244–492	372–785	84–177
TJCO 900	236–474	174–350	470–993	106–223	472–948	348–700	470–993	106–223
TJCO 1000	324–650	239–479	581–1226	131–276	648–1300	478–958	581–1226	131–276
TJCO 1100	431–865	318–638	703–1483	158–333	862–1730	636–1276	703–1483	158–333
TJCO 1150	492–989	363–730	768–1621	173–364	984–1978	726–1460	768–1621	173–364
TJCO 1200	560–1124	413–829	836–1765	188–397	1120–2248	826–1658	836–1765	188–397
TJCO 1300	711–1428	524–1053	982–2072	221–466	1422–2856	1048–2106	982–2072	221–466
TJCO 1400	889–1784	656–1316	1138–2403	256–540	1778–3568	1312–2632	1138–2403	256–540
TJCO 1600	1327–2663	979–1964	1486–3139	334–706	2654–5326	1958–3928	1486–3139	334–706
TJCO 1800	1889–3791	1393–2796	1882–3972	423–893	3778–7582	2786–5592	1882–3972	423–893
TJCO 2000	2591–5200	1911–3836	2324–4904	523–1103	5182–10400	3822–7672	2324–4904	523–1103

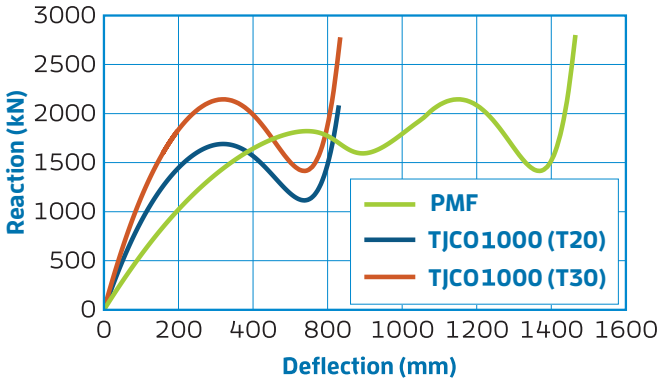
The TJCO Cone values given here are for guidance only. Due to their specialist nature TJUE Element-based systems require calculation on individual basis. Please ask TekMarine for more information.

Performance Comparison

Energy and berthing angle

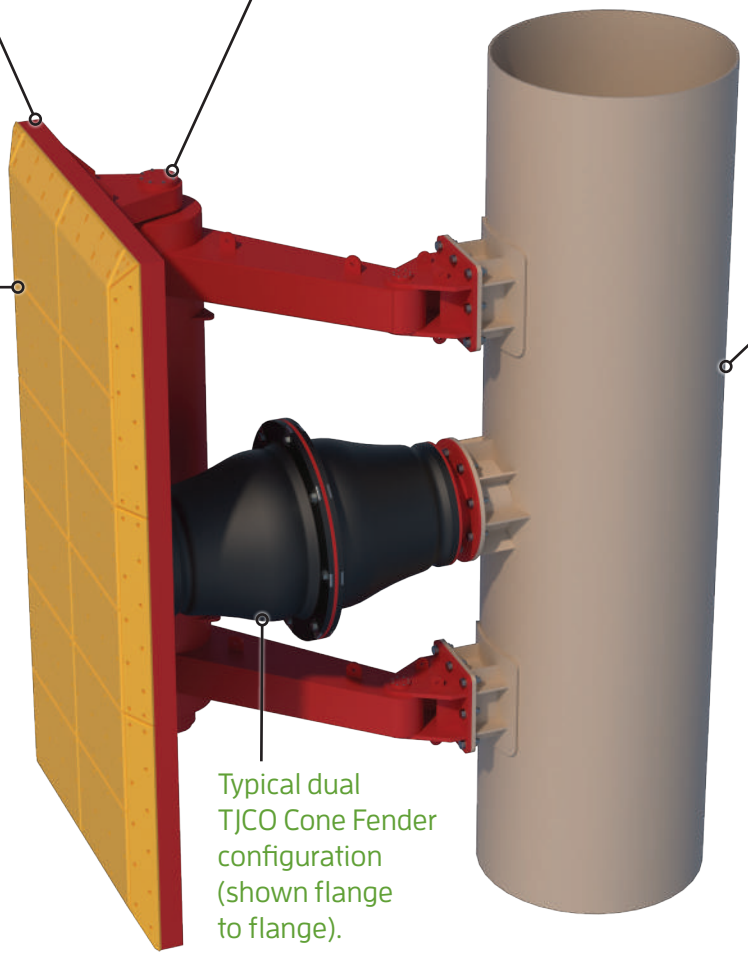


Reaction and deflection



The front panel is fully sealed and pressure tested. Lead-in bevels reduce the risk of snagging hull protrusions.

Stainless steel hinge pins articulate in sealed, high longevity bearings. Free joint movement lowers hinge stresses and allows for a wide range of berthing angles.



Optional pile jacket for rapid installation, structural reinforcement and added corrosion protection in the inter-tidal zone.

Premium quality UHMW-PE face pads keep friction to a minimum while protecting the fender system and the vessel.

Typical dual TJCO Cone Fender configuration (shown flange to flange).

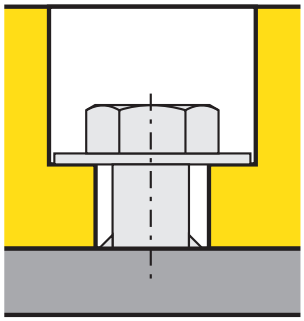
UHMW-PE Facings

TekMarine protects every fender panel with top quality UHMW-PE (Ultra High Molecular Weight Polyethylene) facings. Impact resistant and very low in friction, UHMW-PE allows vessels to move smoothly past a fender system without snagging or abrasion. It is also popular for heavy duty impact protection where fenders are not required.

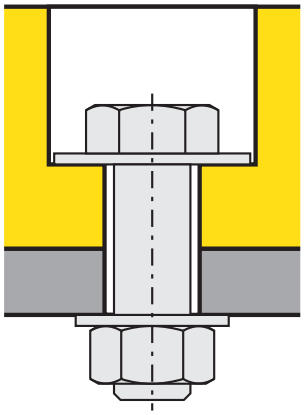
Easy to machine and install, UHMW-PE comes in many colors and several quality grades.

UHMW-PE does not rot, split or decay and does not suffer from UV or ozone damage. It is fully recyclable.

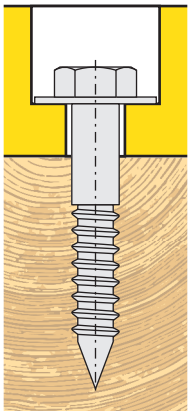
Steel panel with welded stud



Open steel structure



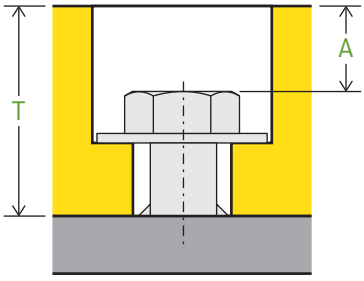
Timber structure



The fixing type depends on the underlying structure. Welded studs or stronger 'blind boss' fixings are used for steel panels. Oversize washers are recommended when bolting through open steel structures.

Fixings are available in various steel grades and finishes: please ask TekMarine for more details.

Wear Allowances



T	A
30	5
40	10
50	15
70	25
100	40

A small increase in the thickness of UHMW-PE can dramatically improve the working life of the facing, protecting the fender and structure for longer.

Physical Properties

Property	Test method	Metric			US Units		
		Unit	Virgin	Recycled	Unit	Virgin	Recycled
Density	ASTM D-792	kg/m³	930	945	lb/ft³	58.01	58.9
Molecular Weight	Viscosimetric	g/mol	4.2×10^6	4.2×10^6	g/mol	4.2×10^6	4.2×10^6
Yield Strength	ASTM D-638	MPa	21	20	psi	3050	2900
Ultimate Strength	ASTM D-638	MPa	40	34.3	psi	5800	4974
Elongation at Break	ASTM D-638	%	250	218	%	250	218
Impact Strength	ASTM D-4020	kJ/m²	70	50	ft-lb/in²	34	24
Tensile Impact	DIN 53448	kJ/m²	2200	1600	ft-lb/in²	1050	762
Abrasion Index (Sand Slurry)	ASTM 965	AR-01 Steel=100	90	116	AR-01 Steel=100	90	116
Hardness	ASTM D-2240	Type D	68	70	Type D	68	70
Static Friction	ASTM D-1894	–	0.15	0.15–0.20	–	0.15	0.15–0.20
Dynamic Friction	ASTM D-1894	–	0.12	0.14–0.16	–	0.12	0.14–0.16
Operating Temperature		°C	–80 to +80	–80 to +80	°F	–112 to 176	–112 to 176
Thermal Expansion	ASTM D-696	K^{-1}	2.0×10^{-4}	1.8×10^{-4}	$°F^{-1}$	1.1×10^{-4}	1.1×10^{-4}
Melting Point	ASTM D-3417	°C	137–143	137–143	°F	278–289	278
Water Absorption	ASTM D-570	%	0	0	%	0	0

Friction comparisons

Material	Coefficient of friction against steel (μ)
UHMW-PE	**0.15–0.2**
HD-PE	0.3
Nylon	0.2
Rubber	0.6–0.7
Timber	0.4
Steel	0.5

The coefficient of friction of UHMW-PE varies according to the material grade and the pressure applied to the panel's surface.

These coefficients of friction only apply to smooth contact surfaces.

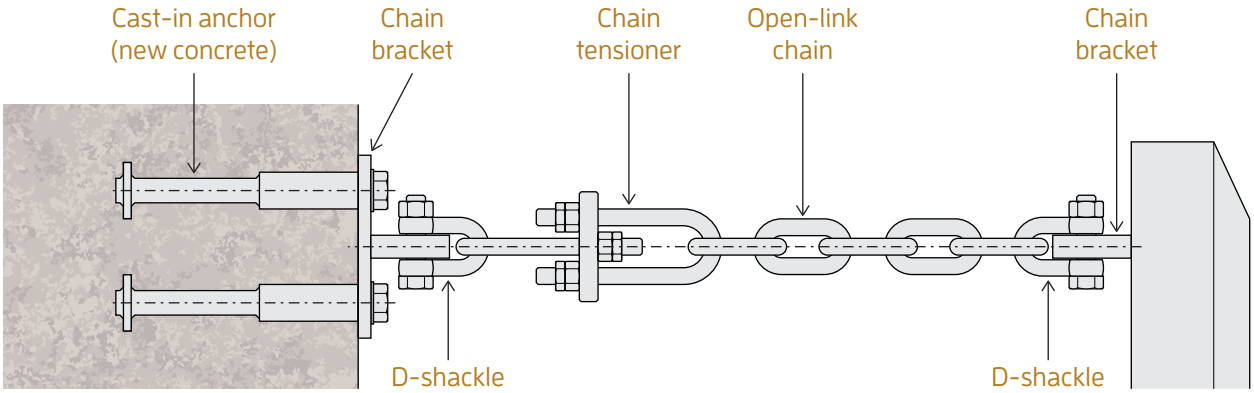
Source: BS 6349-4:2014

For more information please consult TekMarine.

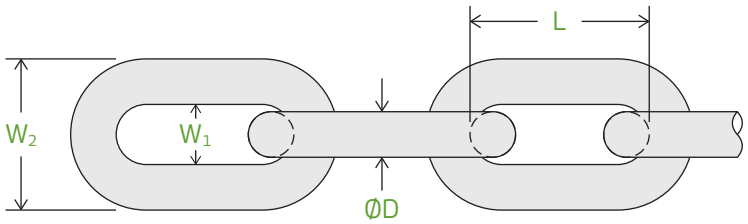
Anchors and Fixings

A fender system relies on the best quality fixings and accessories to perform properly. Large or heavy-duty fenders need chain systems to manage shear, tension and weight. These comprise open or stud-link chain, tensioners and shackles. Cast-in or resin anchors connect the chain systems and brackets to the quay structure. Various material grades and finishes are available: please ask TekMarine for details.

Typical chain system

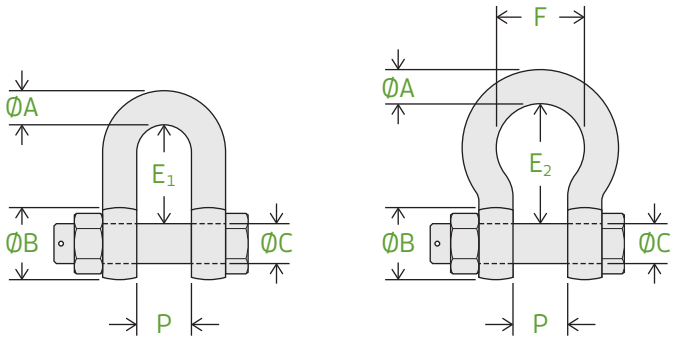


Chains



ØD	W_1	W_2	L = 4D	Weight	W_1	W_2	L = 5D	Weight	MBL	
									SL2	SL3
mm	mm	mm	mm	kg/m	mm	mm	mm	kg/m	kN	kN
14	20	48	56	3.8	21	49	70	3.7	124	154
16	22	54	64	5.0	24	56	80	4.8	160	202
18	25	61	72	6.3	27	63	90	6.0	209	262
20	28	68	80	7.8	30	70	100	7.5	264	330
22	31	75	88	9.4	33	77	110	9.0	304	380
25	35	85	100	12.1	38	88	125	11.6	393	491
28	39	95	112	15.2	42	98	140	14.6	492	616
30	42	102	120	17.4	45	105	150	16.7	566	706
32	45	109	128	19.8	48	112	160	19.0	644	804
35	49	119	140	23.8	53	123	175	22.8	770	964
38	53	129	152	28.0	57	133	190	26.9	900	1130
40	56	136	160	31.0	60	140	200	29.8	1010	1260
45	63	153	180	39.3	68	158	225	37.7	1275	1590
50	70	170	200	48.5	75	175	250	46.5	1570	1960
55	77	187	220	58.6	83	193	275	56.4	1900	2380
60	84	204	240	70.0	90	210	300	67.0	2260	2770

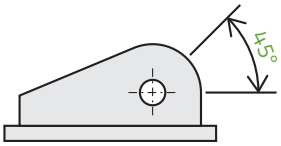
Shackles



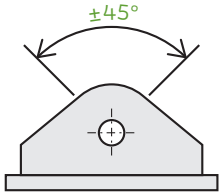
ØA	ØB	ØC	P	D-shackle		Bow shackle			NBL
				E_1	Weight	E_2	F	Weight	
mm	mm	mm	mm	mm	kg	mm	mm	kg	kN
13	26	16	22	43	0.4	51	32	0.4	120
16	32	19	27	51	0.7	64	43	0.8	195
19	38	22	31	59	1.1	76	51	1.3	285
22	44	25	36	73	1.5	83	58	1.9	390
25	50	28	43	85	2.6	95	68	2.8	510
28	56	32	47	90	3.3	108	75	3.8	570
32	64	35	51	94	4.7	115	83	5.3	720
35	70	38	57	115	6.2	133	95	7.0	810
38	76	42	60	127	7.6	146	99	8.8	1020
45	90	50	74	149	12.8	178	126	15.0	1500
50	100	57	83	171	18.2	197	138	20.7	2100
57	114	65	95	190	27.8	222	160	29.3	2550
65	130	70	105	203	35.1	254	180	64.5	3330

Brackets

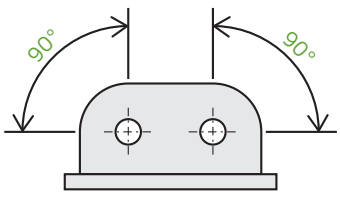
BSO



BSC

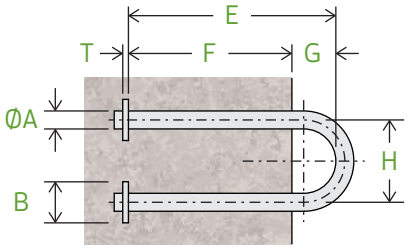


BDB



Brackets are purpose designed for every project. Please ask TekMarine for details.

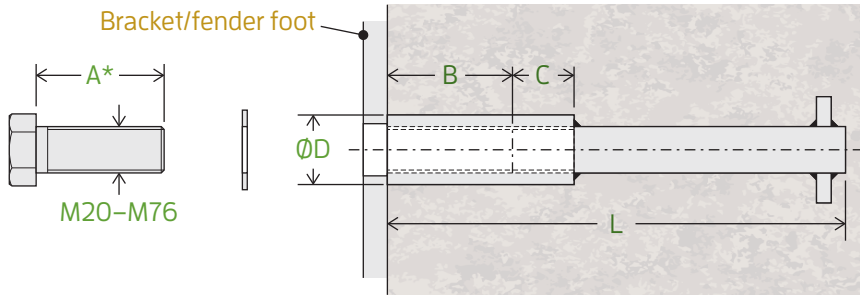
U-anchors



ØA	E	F	G	H	B	T	Weight	NBL
mm	mm	mm	mm	mm	mm	mm	kg	kN
26	320	260	60	104	50	12	3.4	209
30	370	300	70	120	50	15	5.1	264
34	410	340	70	136	60	15	7.3	304
36	430	360	70	144	60	20	8.6	393
42	510	420	90	168	70	20	13.7	492
44	540	440	100	176	80	20	16.1	566
48	580	480	100	192	80	25	20.5	644
50	610	500	110	200	90	25	23.7	770
56	680	560	120	224	100	30	33.4	900
60	730	600	130	240	110	30	41.1	1010
66	800	660	140	264	120	35	54.8	1275
74	900	740	160	296	130	40	76.9	1570

Anchors

Anchors are available in galvanized or stainless steel finishes, in various strength grades and in metric or inch sizes. Ask TekMarine for details if the required specification is not listed.

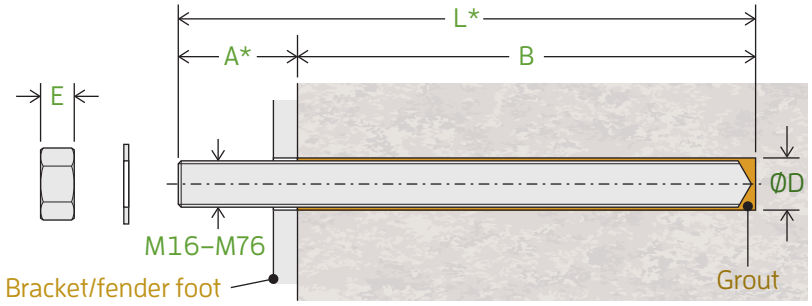


Cast-in type

Cast-in anchors are preferred for new concrete structures. The threaded anchor links via a long tail to an anchor plate, for even load distribution.

* Dimension A varies according to the thickness of the bracket or fender foot and should always be calculated.

Anchor	B	C	ØD	L	Weight
mm	mm	mm	mm	mm	kg
M20	50	20	30	214	0.9
M24	60	25	35	258	1.5
M30	70	30	45	318	2.7
M36	80	40	55	328	4.2
M42	85	45	65	416	6.9
M48	100	50	75	431	10.2
M56	105	60	85	436	14.0
M64	128	80	100	600	29.8
M76	152	90	114	700	46.1



Chemical type

Chemical anchors are used for existing concrete structures.

Please ask about glass grout capsules and other grouting systems.

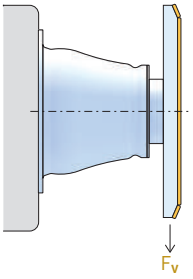
For an accurately drilled hole, allow for grout wastage of 10%–30%, depending on grout type.

* Dimensions A and L depend on the bracket/fender foot thickness and the concrete grade, and should always be calculated.

Anchor	B	ØD	E	Grout
mm	mm	mm	mm	ml
M16	140	20	13	16
M20	170	24	16	23
M24	210	28	19	34
M30	280	35	24	71
M36	360	42	29	132
M42	420	50	34	243
M48	460	54	38	221
M56	500	64	45	377
M64	560	72	51	479
M76	670	84	61	674

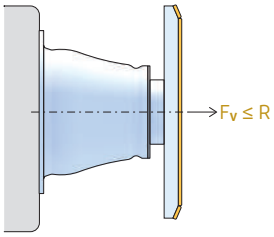
Design Considerations

Chains can assist in controlling the compression geometry of fenders in some applications. Please ask TekMarine for more details.



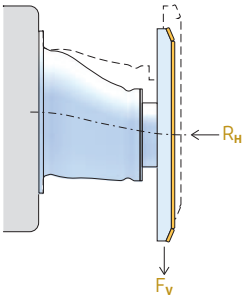
Weight support

Fenders can support large static weights. We recommend weight support chains for panels heavier than the rubber fender.



Tension

When the tension will exceed the fender's rated reaction force, then tension chains are strongly recommended.

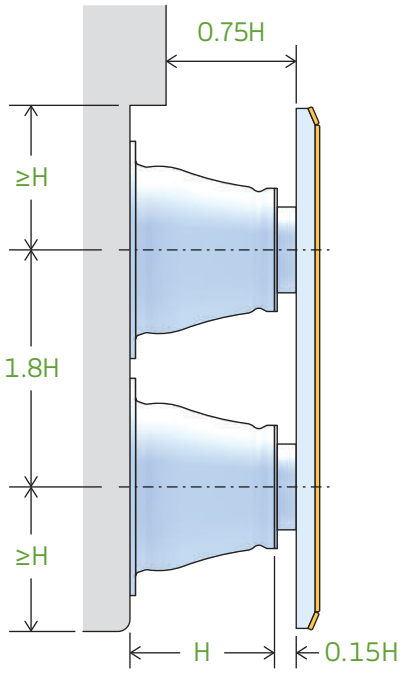


Shear

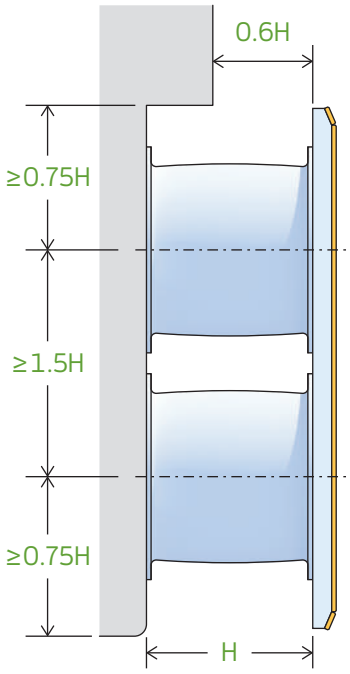
Fenders remain stable with vertical or horizontal shear forces. Shear chains may be needed for some applications and fender layouts.

Clearances

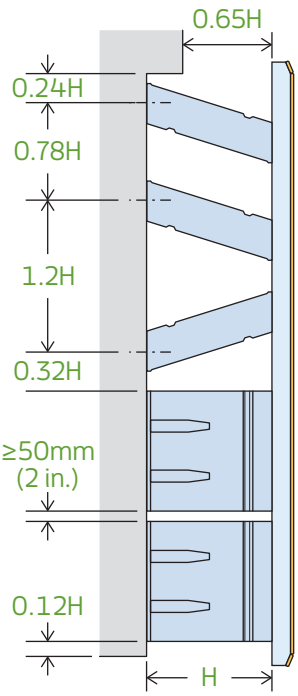
TJCO Cone



TJSC Cell



TJUE Element



Fenders should not contact each other when compressed. Neither fenders nor panel should touch the quay face during compression. Adequate space should be allowed for chains and other fender features. Overhanging hull features such as bow flares and beltings (strakes) should also be considered.

The values given in the diagrams indicate minimum clearances between fenders, with respect to fender height. Values are for guidance only and should be calculated and checked in each case.

Rubber Properties

Every TekMarine rubber fender unit uses the highest quality Natural Rubber (NR) and/or Styrene-butadiene (SBR) based compounds. These meet or exceed the performance requirements of the main international fender specifications such as PIANC and EAU-E 62 "Acceptance Requirements for Fender Elastomers". The table below shows typical specifications for laboratory prepared and tested specimens.

Please consult TekMarine about other fender compounds such as EPDM, Butyl, Neoprene and Polyurethane.

Material samples for laboratory test purposes are prepared differently to rubber fender units. Please ask TekMarine for details.

Property	Test method	Conditions	Requirements	Unit
Tensile Strength	ASTM D412 Die C; AS 1180.2; BS 903.A2; ISO 37; JIS K6251 Item 3, Dumbell 3	Original	≥ 16.0	MPa
		Aged for 96 hours at 70°C	≥ 12.8	
Elongation at Break	ASTM D 412 Die C; AS 1180.2; BS 903.A2; ISO 37; JIS K 6251 Item 3, Dumbell 3	Original	≥ 400	%
		Aged for 96 hours at 70°C	≥ 320	
Hardness	ASTM D 2240; AS1683.15.2; BS 903.A6; ISO 815; JIS K 6301 Item 5A Tester	Original	≤ 78°	Shore A
		Aged for 96 hours at 70°C	original value +6°	
Compression Set	ASTM D 395; AS1683.13B; BS903. A6; ISO 815; JIS K6262 Item 10	Aged for 22 hours at 70°C	≤ 30	%
	DIN 53517	Aged for 24 hours at 70°C	≤ 40	
Tear Resistance	ASTM D624; AS1683.12; BS903. A3: ISO 34.1; JIS K6301 Item 9; Test Piece A	Die B	≥ 70	kN/m
Ozone Resistance	ASTM D1149; AS1683.24; BS903.43; DIN 53509; ISO 143/1	1ppm at 20% strain at 40°C for 100 hours	no visible cracking	n/a
Seawater Resistance (Hardness)	ASTM D 471; BS ISO 1817	28 days in artificial seawater at 95°C ±2°C	≤ ±10°	Shore A
Seawater Resistance (Volume)			≤ +10/-5	%
Abrasion Resistance	BS 903.A9	Method B	≤ 0.5	cc
Bond Strength (Steel to Rubber)	BS 903.A21	Method B	≥ 7	N/mm

Tolerances

Standard manufacturing and performance tolerances apply to all TekMarine fenders. TekMarine may agree to smaller tolerances in special cases. Please ask TekMarine for tolerances of types not listed below.

Fender Type	Property		Tolerance
TJCO, TJSC, TJUE, TJDA-A and TJDA-B	All dimensions		±3% or ±2mm (whichever greater)
	Bolt hole spacing		±2mm
TJCY	Outside diameter		±4%
	Inside diameter		±4%
	Length		±40mm
TJDD, TJSD, TJDO and TJSO	Cross-section		±4%
	Length		±2% or ±10mm(whichever greater)
	Drilled hole centers		±4mm (non-cumulative)
	Counterbore depth		±4mm (under-head depth)
TJCA, TJCB	Cross-section		±3% or ±2mm (whichever greater)
	Length		±2% or ±25mm (whichever greater)
	Drilled hole centers		±4mm (non-cumulative)
	Counterbore depth		±4mm (under-head depth)
HD-PE fenders	Cross-section		±4%
	Length		±2% or ±20mm (whichever greater)
	Drilled hole centers		±4mm (non-cumulative)
	Counterbore depth		±4mm (under-head depth)
UHMW-PE panels	Length and width	(cut panels)	±5mm (cut pads)
		(uncut sheets)	±20mm (uncut sheets)
	Planed thickness	≤ 30mm	±0.2mm
		31–100mm	±0.3mm
		≥ 100mm	±0.5mm
	Unplaned thickness	≤ 30mm	±2.5mm
		31–100mm	±4.0mm
		≥ 100mm	±6.0mm
	Drilled hole centers		±2mm (non-cumulative)
	Counterbore depth		±2mm (under-head depth)
M, W and Block fenders	Cross-section		±3% or ±2mm (whichever greater)
	Length		±3% or ±20mm (whichever greater)
	Fixing hole centers		±3mm
	Fixing hole diameter		±3mm

Performance

Fender Type	Property	Tolerance
TJCO, TJSC, TJUE, TJDA-A and TJDA-B	Reaction, energy and deflection	±10%
Cylindricals (wrapped)	Reaction, energy and deflection	±10%
Cylindricals (extruded)	Reaction, energy and deflection	±10%
Profile fenders	Reaction, energy and deflection	±10%
Pneumatic fenders	Reaction and energy	±10%
Foam fenders	Reaction and energy	±15%

Unless otherwise listed or agreed with TekMarine, tolerances are ±20%.

Testing

Testing of molded[1] and wrapped cylindrical[2] fenders is conducted in-house, with an option for third party witnessing, using full size fenders in accordance with the PIANC 2002[3] guidelines below.

- All fender units have a unique serial number which can be traced back to manufacturing and testing records.
- Fenders are tested under direct (vertical) compression using the Constant Velocity (CV) method.
- The test specimen shall be broken-in by deflected three or more times to at least its rated deflection. After break-in cycles the fender specimen is allowed to recover for at least one hour.
- Axial compression test speed is 2 cm/min ± 8cm/min.
- The test specimen is temperature stabilized to 23°C ± 5°C.[4]
- Reaction force[5] is recorded at intervals to at least a deflection at which the permitted[6] minimum energy absorption is achieved.
- Energy absorption[5] is determined as the integral of reaction and deflection, calculated using Simpson's Rule. The results of a pre-compression cycle[6] and subsequence break-in compression cycle(s) are not recorded.
- The fender performance shall be determined from a single measured compression cycle and pass if the reaction force is less than the maximum permitted[7] reaction force and more than the minimum permitted[7] energy absorption.[8]
- Sampling is 10% of fenders (rounded up to a unit).[9]
- If any sample does not satisfy the specifications, sampling of the remainder is increased to 20% of fenders (rounded up to a unit), excluding non-compliant units.
- If any further sample does not satisfy the specifications, 100% of remaining samples will be tested. Only units which satisfy the specifications shall be passed for shipment. The non-compliant fenders will be rejected.

1 Molded fenders include TJCO, TJSC, TJUE, TJDA-A and TJDA-B fenders. TJCO, TJSC, TJDA-A and TJDA-B fenders are tested singly. TJUE fenders are tested in pairs.

2 Excluding TJTB tug cylindrical fenders.

3 Permanent International Association of Navigation Congress Report of the International Commission for Improving the Design of Fender Systems (Guidelines for the design of Fender systems: 2002, Appendix A).

4 Where the ambient temperature is outside this range, fenders shall be normalized to this temperature range in a conditioning room for a suitable period (according to fender size), or performance values may be adjusted according to the temperature correction factor tables.

5 Reaction forces (and the corresponding, calculated energy absorption) shall be the exact recorded value and not corrected or otherwise adjusted for speed, unless the project specifications require otherwise.

6 Pre-compression testing involves a single 'run in' cycle up to the catalogue rated deflection. The reaction force is not recorded.

7 Maximum permitted reaction force is the catalogue value plus the applicable manufacturing tolerance. Minimum permitted energy absorption is the catalogue value minus the applicable manufacturing tolerance.

8 The deflection at which the minimum permitted energy absorption is achieved may differ from the nominal 'rated' deflection indicated in the catalogue for the corresponding fender type. Actual deflection is not considered as a pass/fail criterion.

9 Testing to PIANC protocols is included within the fender price. Higher testing frequencies, third party witnessing and temperature stabilization costs shall be paid by the purchaser.

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