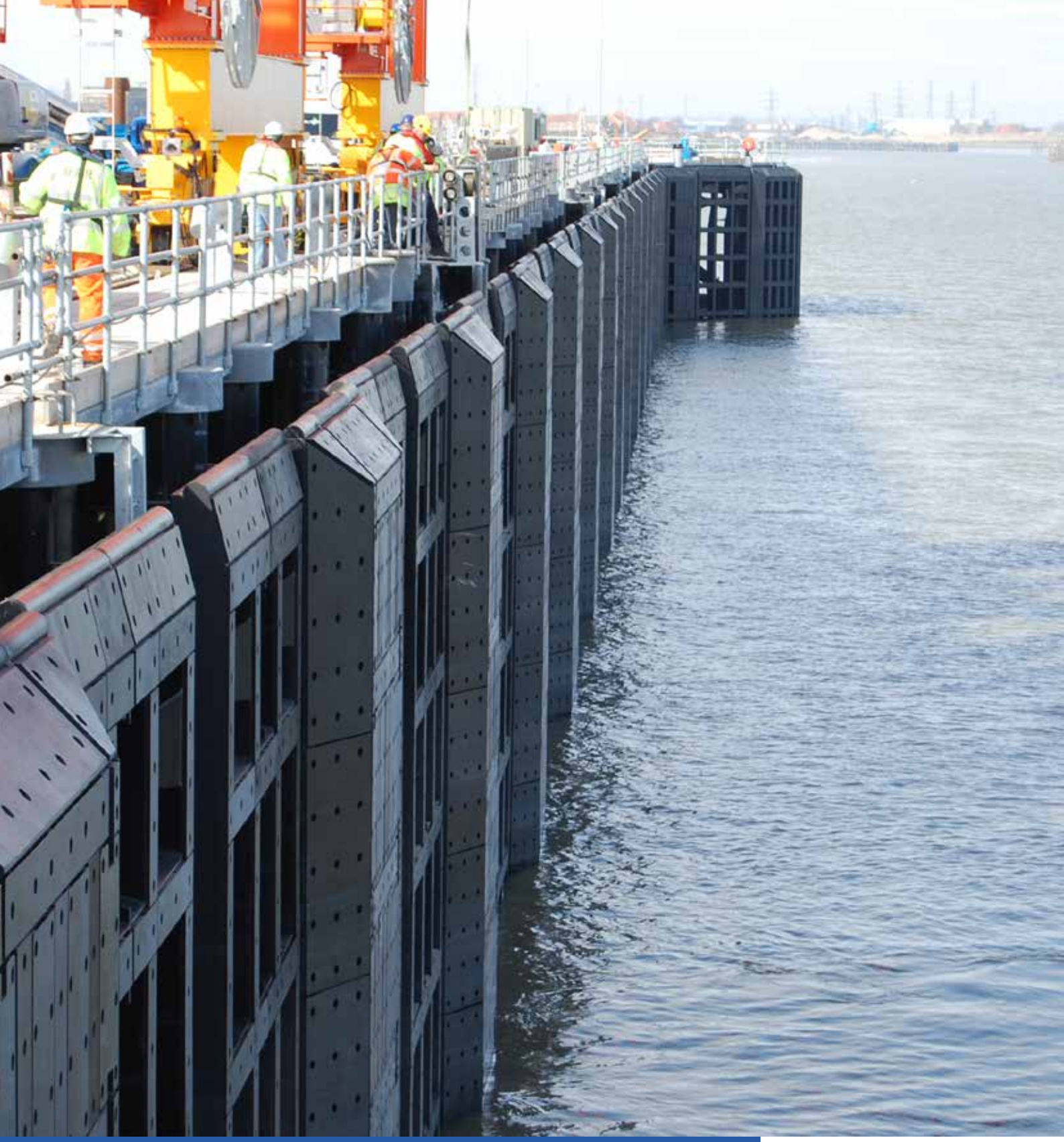


Fenders

QuayQuip
Technical Solutions BV

The QuayQuip Technical Solutions approach

QuayQuip Technical Solutions is a specialist in mooring solutions. It designs, makes and commissions engineered solutions for a vast range of marine and port construction applications. Every project makes full use of our collective expertise with steel, rubber and engineered plastics.

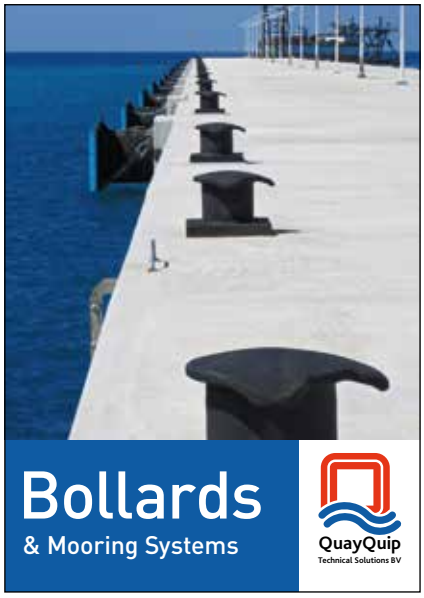
QuayQuip Technical Solutions uses the extensive resources available within the group, its sister businesses and other technical partners. The group enjoys access to over fifty engineers and specialists in disciplines which include:

- Mooring systems design
- Steel fabrication, casting and forging production
- Fender design and applications engineering
- Shiploader and bulk materials handling technology
- Structural analysis including advanced FEA
- Materials experts
- QA/QC inspection and management systems
- Third party external design checks

Projects undertaken by QuayQuip Technical Solutions are professionally designed and managed. Customer satisfaction is our first priority and we live up to our hard-earned reputation for delivery quality, technology and value for money – all backed by extended warranties.

More about QuayQuip Technical Solutions

If you want to know more about QuayQuip Technical Solutions other product ranges, or read our latest news, please visit our website at www.quayquipts.com. After registering you can download catalogues, product guides, our corporate brochure and useful utilities.



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Engineered Range

Special application fenders engineered for unique and demanding situations:

- Parallel Movement and Pivot Fenders
- Flat Pack Ports
- Shiphauling and Capstans

Fixed Range

Our most popular high performance fenders, suitable for most large ship applications:

- Cells and Cones
- Elements and Arch

Foam Range

Unsinkable, durable and versatile – arguably the world's best
foam fenders:

- QuayGuard
- Donut

Air Range

Floating fenders for inshore and offshore, and wheel fenders for locks and corners:

- Pneumatics and hydropneumatics
- Wheels and rollers

Utility Range

Simple solutions for smaller docks and harbours, and fenders for tugs and workboats:

- Cylindrical fenders
- Extruded and moulded profiles

Plastics Range

Engineered plastics for low friction facings and environmentally sensitive applications:

- UHMW-PE facing pads
- Composite piles and timbers

Accessories

A full spread of accessories to support fenders and attach them to new and existing structures:

- A full programme of chain and suspension systems
- Anchors and fixings

Materials & Testing

Safety-critical installations demand quality materials, tested, inspected and verified to the latest international standards:

- Physical properties
- PIANC 2002 test protocols and procedures

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Engineered Range

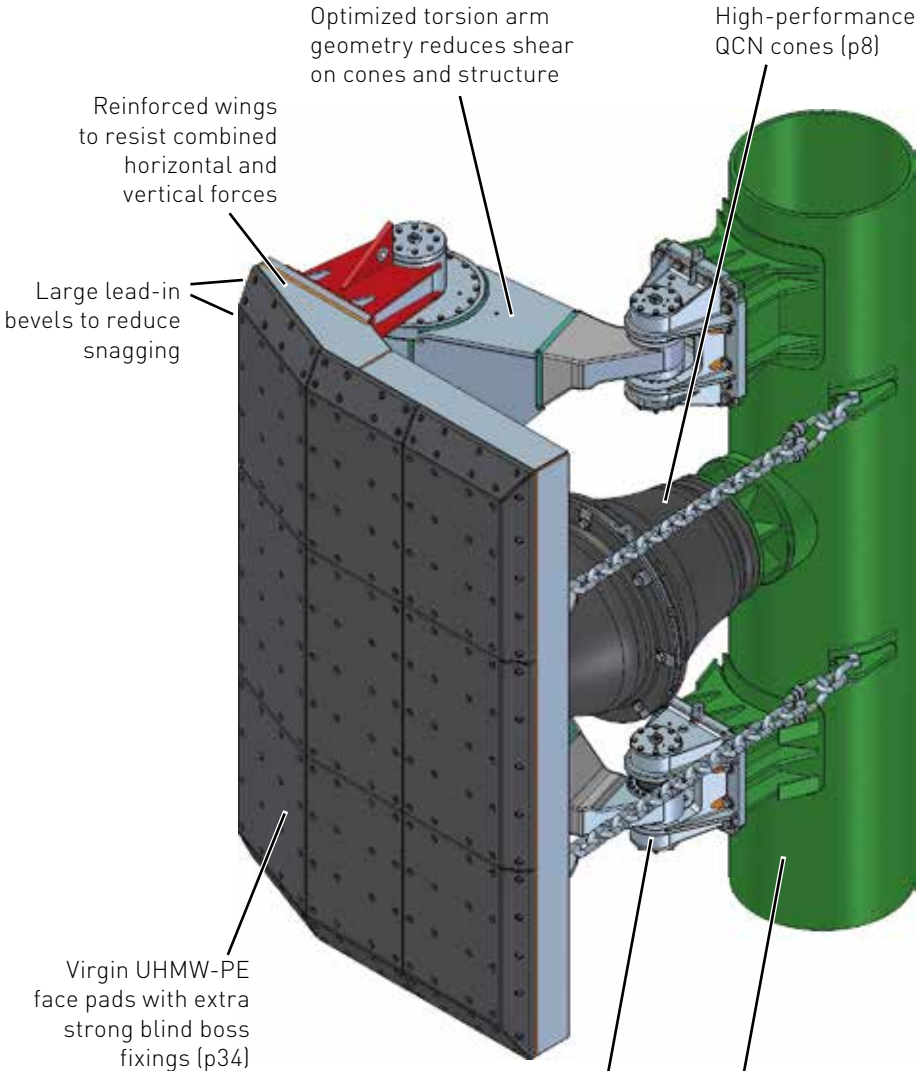
QuayQuip Technical Solutions has more engineering resources than any other manufacturer, able to provide an unrivalled breadth and depth of fendering, mooring and marine construction expertise to solve the most complicated and demanding challenges.

Parallel Movement Fenders (PMF)

QuayQuip Technical Solutions's design team has engineered many hundreds of Parallel Movement fenders and now takes this technology into the latest 4th Generation PMF with improved geometries, bearing designs and materials.

Parallel Movement fenders include a 'non-tilt' torsion arm mechanism that keeps the panel vertical whatever level it is impacted, but still allows free movement to cope with berthing angles. PMF systems provide very low reaction too – sometimes less than half that of a conventional design. Reduced load can mean lower construction costs and more comfortable and rapid turnaround times.

- Lower construction costs
- Very low reaction with high energy
- Balanced load paths
- Better geometry – less rubber shear
- Fully articulated pin joints
- Fully sealed bearings



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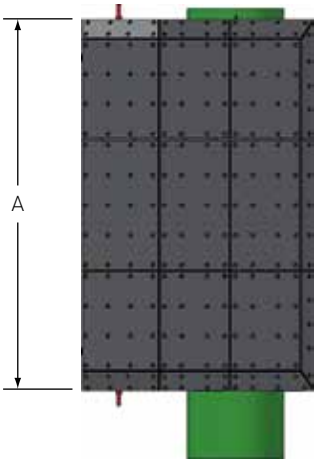

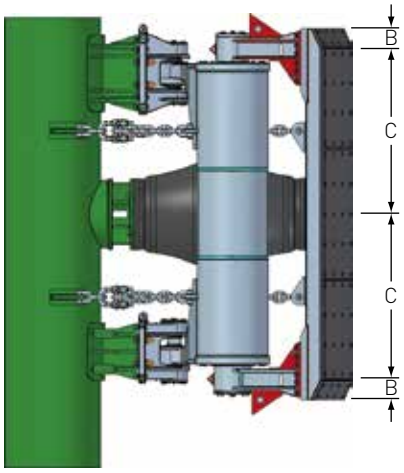

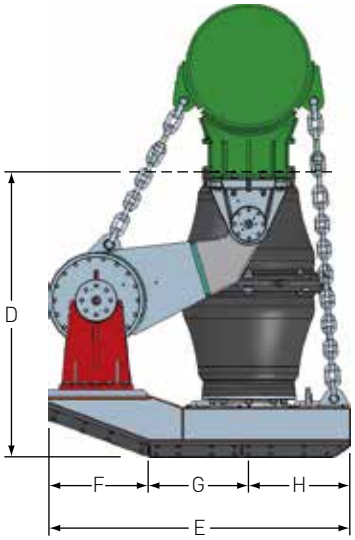

PMF Fenders are custom designed for each application.

QuayQuip Technical Solutions engineers consider normal and abnormal impacts, tides, line loads and UDLs, hull form, clearances and many other factors when recommending the best design in each case.

Please ask QuayQuip Technical Solutions for further details and advice.

PMF (Dual QCN)	A Min	A Max	B	C	D	E	F	G	H
500	Refer to QuayQuip Technical Solutions	12000	Refer to QuayQuip Technical Solutions	Refer to QuayQuip Technical Solutions	1550	1405	480	400	525
600		12000			1800	1640	560	480	600
800		12000			2250	2120	730	640	750
900		12000			2500	2385	840	720	825
1000		12000			2800	2600	900	800	900
1100		12000			3050	2845	990	880	975
1200		12000			3300	3110	1100	960	1050
1300		12000			3550	3365	1200	1040	1125
1400		12000			3800	3610	1290	1120	1200
1600		12000			4350	4090	1460	1280	1350

Dimensions are typical and approximate. [Units: mm]

Every installation differs – please confirm dimensions with QuayQuip Technical Solutions.

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Parallel Movement Fenders (PMF)

Performance table

H		A0	A1	A2	B0	B1	B2	C0	C1	C2	D0	D1	D2
500	E	**80**	85	91	**97**	105	112	**120**	128	136	**145**	160	170
	R	**154**	164	175	**187**	202	216	**230**	245	262	**279**	307	328
600	E	**138**	147	157	**168**	182	194	**207**	220	235	**251**	276	294
	R	**221**	236	252	**269**	291	311	**331**	353	377	**402**	442	472
800	E	**327**	349	373	**398**	431	460	**490**	522	558	**595**	654	698
	R	**394**	420	448	**478**	518	552	**589**	628	670	**715**	786	838
900	E	**466**	497	531	**566**	613	654	**698**	744	794	**847**	931	993
	R	**498**	531	567	**605**	655	699	**745**	795	848	**905**	995	1061
1000	E	**640**	682	728	**777**	841	898	**957**	1020	1089	**1162**	1277	1362
	R	**615**	656	700	**747**	809	863	**920**	981	1047	**1117**	1228	1310
1100	E	**851**	908	969	**1034**	1120	1195	**1274**	1358	1449	**1546**	1700	1813
	R	**744**	794	847	**904**	979	1044	**1113**	1187	1267	**1352**	1486	1585
1200	E	**1105**	1179	1258	**1342**	1454	1551	**1653**	1763	1882	**2007**	2207	2354
	R	**886**	945	1008	**1076**	1165	1243	**1325**	1413	1508	**1608**	1768	1886
1300	E	**1405**	1499	1599	**1707**	1848	1972	**2102**	2241	2392	**2552**	2806	2993
	R	**1039**	1109	1183	**1262**	1367	1458	**1555**	1658	1769	**1888**	2075	2214
1400	E	**1755**	1872	1998	**2132**	2309	2463	**2625**	2800	2988	**3188**	3504	3738
	R	**1205**	1286	1372	**1464**	1586	1691	**1803**	1923	2052	**2189**	2407	2568
1600	E	**2620**	2794	2982	**3182**	3446	3676	**3919**	4179	4460	**4758**	5231	5580
	R	**1574**	1679	1792	**1912**	2071	2209	**2355**	2511	2680	**2860**	3144	3354
1800	E	**3730**	3979	4246	**4531**	4907	5234	**5580**	5950	6350	**6775**	7448	7946
	R	**1993**	2125	2268	**2420**	2621	2796	**2981**	3178	3392	**3619**	3979	4244
2000	E	**5117**	5458	5824	**6215**	6731	7180	**7654**	8162	8711	**9293**	10217	10899
	R	**2460**	2624	2800	**2988**	3236	3452	**3680**	3924	4188	**4468**	4912	5240

Dual mounted QCN cones provide double the energy for the same reaction compared to a single QCN cone. Even at large compression angles there is minimal loss of energy.

QuayQuip Technical Solutions can provide performance curves, global axis forces and preferred fixing details for all PMF fenders.

Softer, harder and intermediate compounds are available on request.

[Units: kJ, kN]

Pivot Fenders

QuayQuip Technical Solutions Pivot Fenders are an alternative to Parallel Movement systems. The panel remains almost vertical no matter where the impact occurs on its face. Pivot fenders protect their supporting structures by reducing horizontal forces into the structure. They can also receive vessels with pronounced beltings or head- and stern-on impacts. They work well in high tidal ranges or where vessels may impact above the deck level of the structure.

The panel, connected to QCN cones or QME elements, pivots around a durable, precision-made joint at the bottom. Panels may rotate about their vertical axes and tilt in the direction of fender compression. Pivot Fenders can cope with large horizontal and vertical working loads, and offer very high energy absorption and low reaction. Systems are often interlinked to form flexible barriers along quay faces or around curved structures.

Options include inbuilt cathodic protection to extend working life and self-locking fixings for lower maintenance.

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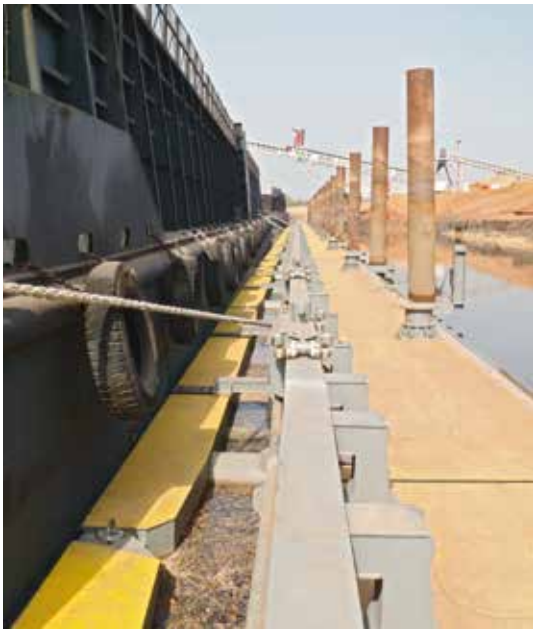
Flat Pack Ports

QuayQuip Technical Solutions Flat Pack Port (FPP) concept solves many construction issues for remote locations, such as build speed and available cranage. The entire fender, mooring, deck and jacket structures are modular. They can be assembled in the factory and checked before shipment, containerised and despatched to site in the most convenient and manageable packages.

On site work is reduced to placing piles, rapid assembly of the flat pack port components and a few grouted joints. Job done – fast, inexpensively and without compromise.

- Ideal for remote site projects
- Rapid and accurate construction
- Minimal site works
- Factory pre-assembled and checked



Shiphauling and Capstans

QuayQuip Technical Solutions design and build a range of winches and capstans for warping and hauling vessels along berths.

Winches can be deployed at each end of the berth with a rail and carriage system which acts as a 'mule' to haul the vessel in either direction. The winches can incorporate a Leadscrew Levelwind System for even spooling of the cable onto the drum.

Control options include simple foot switches or a dock-mounted consoles or handheld remote controls.

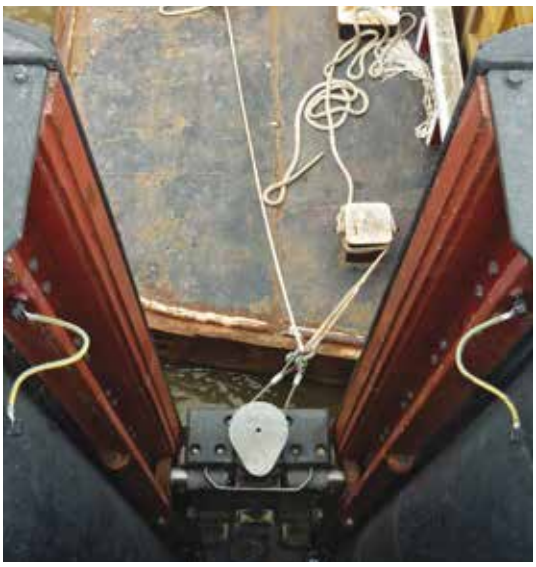
Capstans are often installed on docks for hauling in messenger lines, and can also haul small vessels over short distances.

Mooring Travellers

QuayQuip Technical Solutions Mooring Travellers allow for water level changes by replacing conventional moorings with units that rise and fall with the vessel.

Cast-steel rails and other parts are designed to last 50 years or more. The bollard sits above a buoyant, wheeled bogie, guaranteeing that it always presents at a safe and convenient level for crew. Faster transits benefit lock and barge operators alike and save costs. Modular rails can be provided to any height. Bollard capacities and height above water depend on the characteristics of each berth – please ask QuayQuip Technical Solutions for details.

Typical applications include locks, waterways, high tidal range berths, and fast ferry berths.



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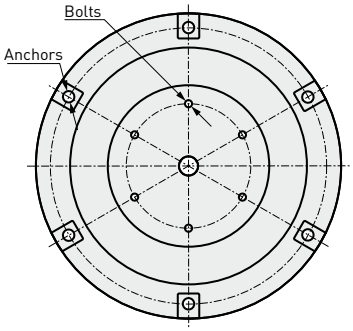
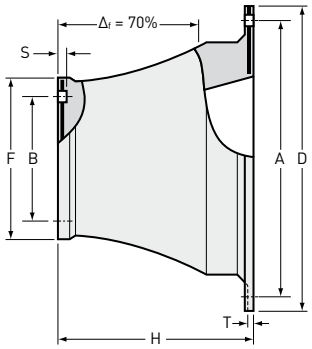
QCN Cone Fenders

QCN Cones have advanced geometry and combine high efficiency with excellent angular performance.

Versatile and proven in practice, the QCN Cone Fender is well suited to berths and terminals handling large vessels, for load sensitive structures and for berth upgrades.

- High efficiency
- Good angular performance
- Wide range of sizes
- Standard and intermediate rubber grades
- Tested and certified according applicable standards





Dimensions table

H	ØD	ØA	ØF	ØB	S	T	Fixings	Weight
350	570	510	330	275	27–32	22	4 × M20	50
400	600	540	340	260	30–40	22	4 × M24	75
500	750	675	425	325	30–40	22	4 × M24	135
600	900	810	510	390	30–40	27	6 × M30	235
700	1050	945	595	455	37–47	27	6 × M30	350
800	1200	1080	680	520	40–52	27	6 × M36	540
860	1290	1160	730	560	40–52	30	6 × M36	690
900	1350	1215	765	585	40–52	33	6 × M36	765
950	1425	1282	810	618	40–52	34	6 x M36	910
1000	1500	1350	850	650	50–65	35	6 × M42	1050
1100	1650	1485	935	715	50–65	40	6 × M42	1400
1150	1725	1550	980	750	50–65	40	6 × M42	1600
1200	1800	1620	1020	780	50–65	42	8 × M42	1800
1250	1875	1690	1060	810	50–65	44	8 × M42	2050
1300	1950	1755	1105	845	65–80	46	8 × M48	2400
1400	2100	1890	1190	980	65–80	49	8 × M48	2960
1450	2175	1960	1232	1035	65–80	51	8 × M48	3450
1500	2250	2025	1275	1090	65–80	51	8 × M48	3600
1600	2400	2160	1360	1200	65–80	58	8 × M48	4200
1800	2700	2430	1530	1350	80–100	62	10 × M56	6600
2000	3000	2700	1700	1500	80–100	62	10 × M56	9000

Please ask QuayQuip Technical Solutions for dimensional and performance details for the QCN2250 and the QCN2500. [Units: mm, kg]

Non listed intermediate cone fender size and performance on request.

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Performance table

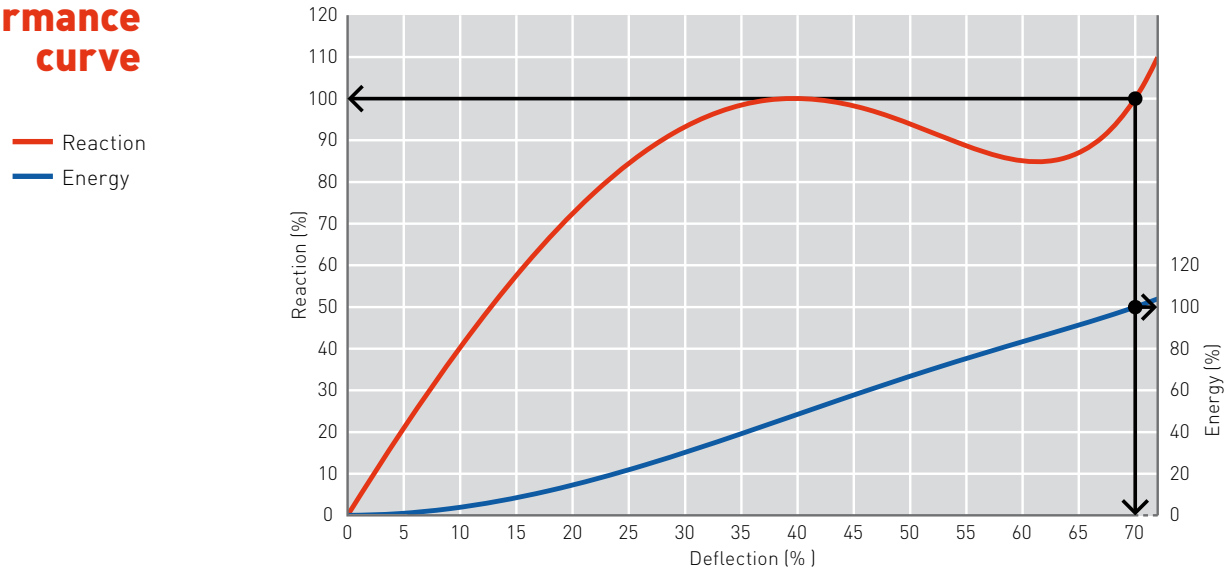
[Units: kJ, kN]

TYPE APPROVED by Bureau Veritas to PIANC 2002 and ASTM F2192-05 protocols. See p42.

H		A0	A1	A2	B0	B1	B2	C0	C1	C2	D0	D1	D2
350	E	**14**	15	16	**17**	18	19	**21**	22	23	**25**	27	29
	R	**75**	80	86	**92**	99	106	**113**	120	128	**137**	150	160
400	E	**20**	22	23	**25**	27	29	**31**	33	35	**37**	41	44
	R	**98**	105	112	**120**	129	138	**147**	157	168	**179**	196	210
500	E	**40**	43	46	**49**	53	56	**60**	64	68	**73**	80	85
	R	**154**	164	175	**187**	202	216	**230**	245	262	**279**	307	328
600	E	**69**	74	79	**84**	91	97	**103**	110	118	**125**	138	147
	R	**221**	236	252	**269**	291	311	**331**	353	377	**402**	442	472
700	E	**110**	117	125	**133**	144	154	**164**	175	187	**199**	219	234
	R	**301**	321	343	**366**	396	423	**451**	481	513	**547**	602	642
800	E	**164**	175	186	**199**	215	230	**245**	261	279	**297**	327	349
	R	**394**	420	448	**478**	518	552	**589**	628	670	**715**	786	838
860	E	**203**	217	232	**247**	268	285	**304**	324	346	**369**	406	433
	R	**455**	485	518	**552**	598	638	**680**	726	774	**826**	908	969
900	E	**233**	249	265	**283**	307	327	**349**	372	397	**423**	466	497
	R	**498**	531	567	**605**	655	699	**745**	795	848	**905**	995	1061
950	E	**274**	292	312	**333**	361	385	**410**	437	467	**498**	547	584
	R	**555**	592	632	**674**	730	779	**830**	885	945	**1008**	1108	1182
1000	E	**320**	341	364	**388**	421	449	**478**	510	544	**581**	639	681
	R	**615**	656	700	**747**	809	863	**920**	981	1047	**1117**	1228	1310
1100	E	**426**	454	484	**517**	560	597	**637**	679	725	**773**	850	907
	R	**744**	794	847	**904**	979	1044	**1113**	1187	1267	**1352**	1486	1585
1150	E	**486**	519	554	**591**	640	683	**728**	776	828	**883**	971	1036
	R	**813**	868	926	**988**	1070	1141	**1217**	1297	1385	**1477**	1624	1732
1200	E	**553**	589	629	**671**	727	775	**827**	881	941	**1004**	1103	1177
	R	**886**	945	1008	**1076**	1165	1243	**1325**	1413	1508	**1608**	1768	1886
1250	E	**625**	666	711	**759**	822	876	**934**	996	1063	**1134**	1247	1330
	R	**961**	1025	1094	**1167**	1264	1348	**1438**	1533	1636	**1745**	1919	2047
1300	E	**703**	749	800	**853**	924	986	**1051**	1121	1196	**1276**	1403	1497
	R	**1039**	1109	1183	**1262**	1367	1458	**1555**	1658	1769	**1888**	2075	2214
1400	E	**878**	936	999	**1066**	1154	1231	**1313**	1400	1494	**1594**	1752	1869
	R	**1205**	1286	1372	**1464**	1586	1691	**1803**	1923	2052	**2189**	2407	2568
1450	E	**975**	1040	1110	**1184**	1282	1368	**1458**	1555	1660	**1771**	1947	2077
	R	**1293**	1379	1472	**1571**	1701	1814	**1934**	2063	2201	**2348**	2582	2754
1500	E	**1079**	1151	1229	**1311**	1420	1515	**1615**	1722	1837	**1960**	2155	2299
	R	**1384**	1476	1575	**1681**	1820	1942	**2070**	2207	2356	**2513**	2763	2948
1600	E	**1310**	1397	1491	**1591**	1723	1838	**1960**	2089	2230	**2379**	2616	2790
	R	**1574**	1679	1792	**1912**	2071	2209	**2355**	2511	2680	**2860**	3144	3354
1800	E	**1865**	1989	2123	**2265**	2453	2617	**2790**	2975	3175	**3387**	3724	3973
	R	**1993**	2125	2268	**2420**	2621	2796	**2981**	3178	3392	**3619**	3979	4244
2000	E	**2558**	2729	2912	**3108**	3365	3590	**3827**	4081	4356	**4647**	5108	5450
	R	**2460**	2624	2800	**2988**	3236	3452	**3680**	3924	4188	**4468**	4912	5240

Softer, harder and intermediate compounds are available on request.

Performance curve



Intermediate factors

D (%)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	**70**	72
R (%)	0	21	40	58	72	84	93	98	100	98	94	89	85	87	**100**	110
E (%)	0	1	4	8	15	22	30	39	49	58	67	75	83	91	**100**	104

Angular factors

Angle	**0**	3	5	8	10	15	20
R-factor	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
E-factor	**1.00**	1.01	1.00	0.99	0.98	0.93	0.87

For **Velocity** & **Temperature Factors** refer to p43.

±10% tolerance applies to Rated Performance Data (RPD). ±5% tolerances are available in some cases.

Please refer to QuayQuip Technical Solutions for other performance properties of QCN Cone Fenders.

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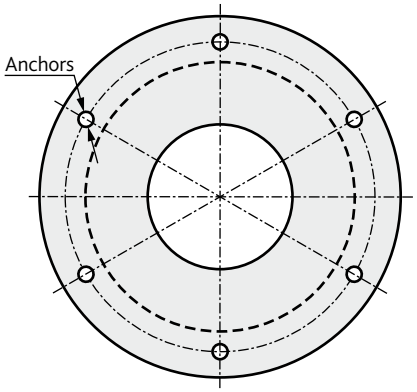
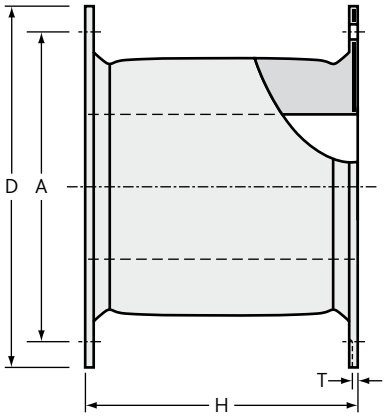
QCL Cell Fenders

QCL Cell Fenders have an efficient and simple geometry which is well proven, tried and tested.

Versatile and proven in practice, QCL Cells are well suited to berths and terminals handling all vessel sizes.

- Well proven design
- High efficiency
- Modular design
- Good angular performance
- Wide range of sizes
- Tested and certified according applicable standards





Dimensions table

H	ØD	ØA	T	Head Bolts	Anchors	Weight
400	650	550	25	4 × M24	4 × M24	75
500	650	550	25	4 × M24	4 × M24	95
630	840	700	25	4 × M30	4 × M30	220
800	1050	900	30	6 × M33	6 × M33	400
1000	1300	1100	25	6 × M39	6 × M39	790
1150	1500	1300	37	6 × M42	6 × M42	1200
1250	1650	1450	40	6 × M42	6 × M42	1500
1450	1850	1650	42	6 × M52	6 × M52	2300
1600	2000	1800	45	8 × M52	8 × M52	3000
1700	2100	1900	50	8 × M56	8 × M56	3600
2000	2200	2000	50	8 × M64	8 × M64	4200
2250	2550	2300	57	10 × M64	10 × M64	7400
2500	2950	2700	70	10 × M64	10 × M64	10500
3000	3350	3150	75	12 × M76	12 × M76	18500

Please ask QuayQuip Technical Solutions for other dimensions of QCL Cells.

[Units: mm, kg]

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Performance table

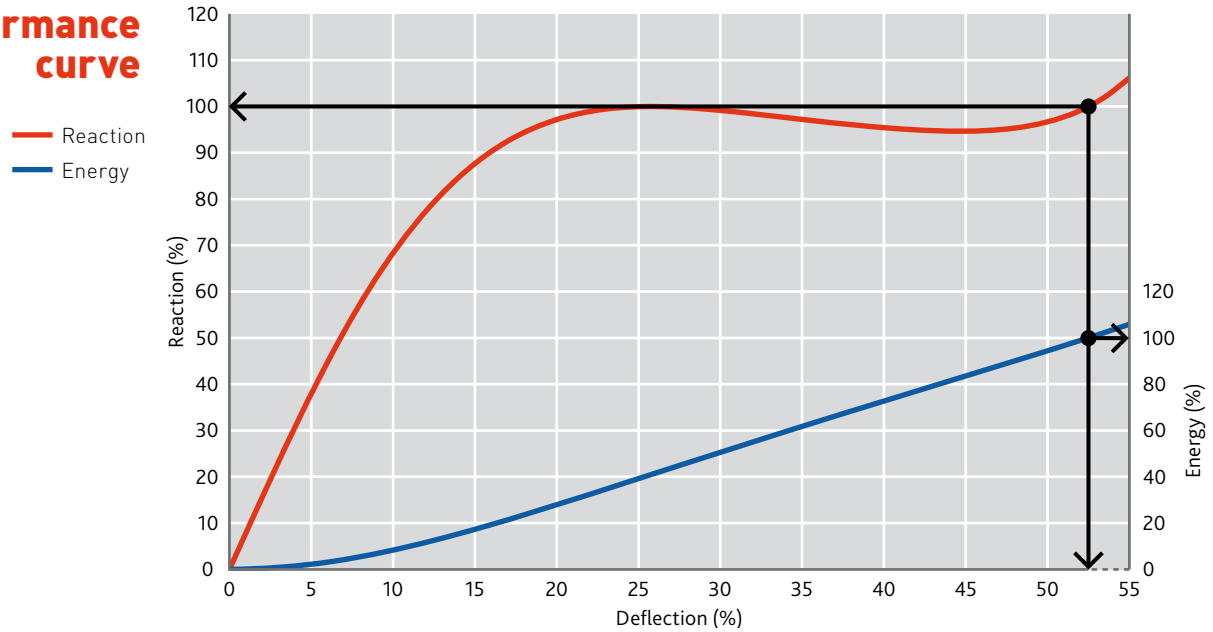
[Units: kJ, kN]

TYPE APPROVED by Bureau Veritas to PIANC 2002 and ASTM F2192-05 protocols. See p42.

H		A0	A1	A2	B0	B1	B2	C0	C1	C2	D0	D1
400	E	**8.7**	10	11.2	**12.5**	13.7	14.9	**16.1**	16.9	17.7	**18.5**	20.4
	R	**49.7**	56.8	63.9	**71**	78	85	**92**	96.7	101	**106**	117
500	E	**17.1**	19.5	21.9	**24.4**	26.8	29.1	**31.5**	33	34.6	**36.1**	39.7
	R	**77.7**	88.8	99.9	**111**	122	132	**143**	150	158	**165**	182
630	E	**33.6**	38.4	43.2	**48**	53	58	**63**	66.3	69.7	**73**	80.3
	R	**123**	140	158	**175**	193	210	**228**	240	251	**263**	289
800	E	**68.6**	78.4	88.2	**98**	105	111	**118**	125	131	**138**	152
	R	**196**	224	252	**280**	297	313	**330**	348	365	**383**	421
1000	E	**137**	156	176	**195**	214	233	**252**	264	277	**289**	318
	R	**312**	356	401	**445**	487	530	**572**	601	631	**660**	726
1150	E	**208**	238	267	**297**	327	358	**388**	407	426	**445**	490
	R	**412**	471	530	**589**	646	703	**760**	802	843	**885**	974
1250	E	**267**	306	344	**382**	420	459	**497**	523	548	**574**	631
	R	**487**	557	626	**696**	765	833	**902**	949	995	**1042**	1146
1450	E	**417**	477	536	**596**	656	716	**776**	816	855	**895**	985
	R	**655**	749	842	**936**	1029	1122	**1215**	1277	1340	**1402**	1542
1600	E	**561**	641	721	**801**	857	914	**970**	1020	1070	**1120**	1232
	R	**798**	912	1026	**1140**	1210	1281	**1351**	1420	1489	**1558**	1714
1700	E	**672**	768	864	**960**	1057	1153	**1250**	1314	1378	**1442**	1586
	R	**901**	1030	1158	**1287**	1415	1544	**1672**	1757	1843	**1928**	2121
2000	E	**1095**	1251	1408	**1564**	1723	1881	**2040**	2143	2245	**2348**	2583
	R	**1247**	1425	1603	**1781**	1957	2134	**2310**	2429	2549	**2668**	2935
2250	E	**1730**	1978	2225	**2472**	2720	2967	**3215**	3378	3540	**3703**	4073
	R	**1751**	2002	2252	**2502**	2751	3000	**3249**	3415	3582	**3748**	4123
2500	E	**2374**	2713	3052	**3391**	3731	4070	**4410**	4636	4862	**5088**	5597
	R	**2162**	2470	2779	**3088**	3396	3704	**4012**	4218	4424	**4630**	5093
3000	E	**3577**	4088	4599	**5110**	5643	6177	**6710**	*Please ask QuayQuip Technical Solutions for these compounds*			
	R	**3066**	3504	3942	**4380**	4850	5320	**5790**				

Softer, harder and intermediate compounds are available on request.

Performance curve



Intermediate factors

D (%)	0	5	10	15	20	25	30	35	40	45	50	**52.5**	55
R (%)	0	38	68	88	97	100	99	97	95	95	97	**100**	106
E (%)	0	2	8	17	28	39	51	62	73	84	94	**100**	106

Angular factors

Angle	**0**	3	5	8	10	15	20
R-factor	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
E-factor	**1.00**	0.98	0.95	0.91	0.88	0.81	0.65

For **Velocity** & **Temperature Factors** refer to p43.

±10% tolerance applies to Rated Performance Data (RPD).

Please refer to QuayQuip Technical Solutions for other performance properties of QCL Cell Fenders.

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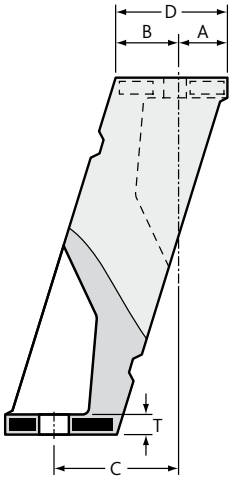
QME Elements

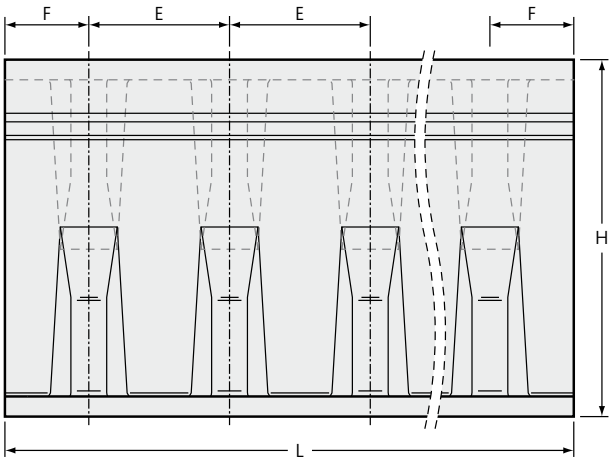
QME Elements are modular units with an advanced geometry that combines high performance with an adaptable design.

QME Elements have a long track record and are well suited to berths and terminals handling all vessel sizes. Vertical or horizontal mounting of elements ensures optimum energy and low reaction.

Elements can be used in arrays with steel panels, or in pairs with UHMW-PE shields as V-fenders. A small footprint makes QME Elements perfect where fixing area is restricted.

- High efficiency
- Modular design
- Good angular performance
- Wide range of sizes
- Tested and certified according applicable standards





Dimensions table

H	A	B	C	D	E	F	T	Fixings	Weight	Standard Lengths						
										600	800	900	1000	1200	1500	2000
250	35	44	88	77	300	150	17	M20	37	■		■		■	■	
300	47	47	93	94	300	150	17	M20	45	■		■		■	■	
400	63	62	124	125	500	250	17	M24	94				■		■	■
500	87	71	142	158	500	250	20	M30	120				■		■	■
550	87	85	170	172	500	250	20	M30	132				■		■	■
600	87	101	200	188	500	250	20	M30	153				■		■	□
700	110	110	215	220	500	250	26	M30	218				■		■	■
750	118	117	230	235	500	250	26	M36	242				■		■	□
800	129	121	240	250	500	250	26	M36	290		□		■		■	■
1000	162	160	310	322	500	250*	31	M42	453			■	■		■	■
1250	196	204	390	400	500	250*	36	M48	664			■	■		■	■
1400	215	225	445	440	500	250	41	M48	821				■			
1450	228	226	454	454	500	250	41	M48	873				■		■	■
1600	261	246	480	507	500	250	50	M56	1227				■		■	■
2000	325	305	600	635	500	250	60	M64	1728				■		■	■

Please ask QuayQuip Technical Solutions for other dimensions of QME Elements.

*Dimension 'F' is 200mm for QME-1000×900L and QME-1250×900L fenders.

■ Standard length

□ Available on request

[Units: mm, kg/m]

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Performance table

[Units: kJ, kN]

TYPE APPROVED by Bureau Veritas to PIANC 2002 and ASTM F2192-05 protocols. See p42.

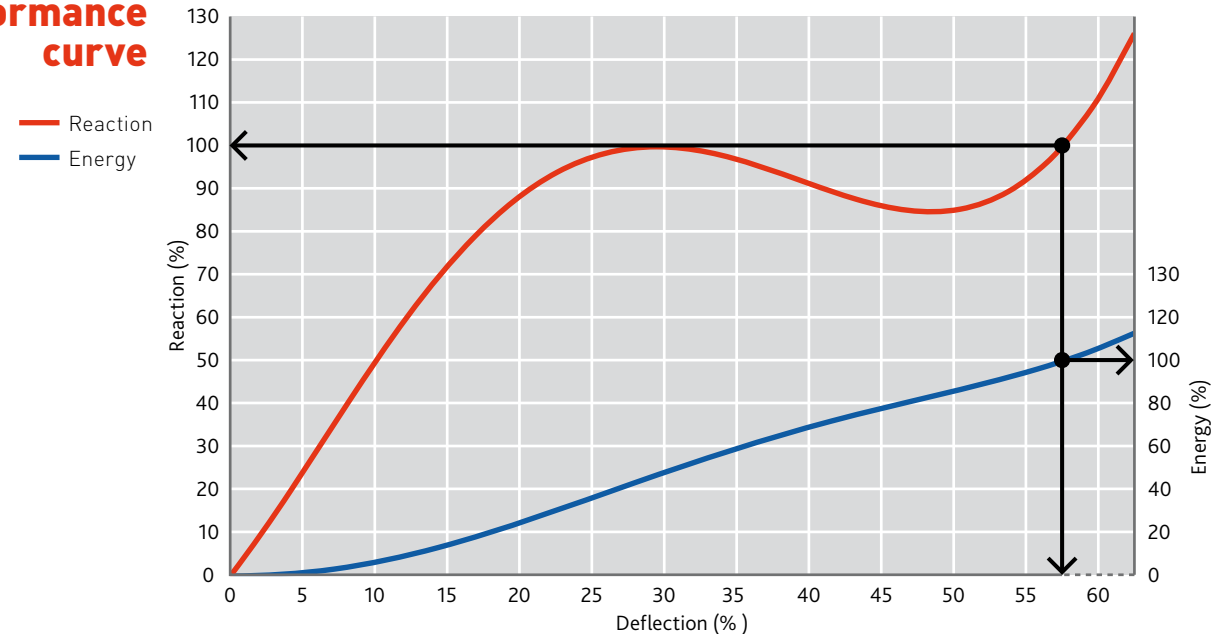
H		A0	A1	A2	B0*	B1	B2	C0	C1	C2	D0*	D1
250	E	**7**	8	9	**10**	11	12	**12**	13	14	**15**	16
	R	**62**	71	80	**89**	95	102	**108**	114	121	**127**	140
300	E	**10**	12	13	**15**	16	17	**18**	19	20	**21**	23
	R	**75**	85	96	**107**	114	122	**130**	137	145	**152**	168
400	E	**18**	21	24	**26**	28	30	**32**	34	36	**37**	41
	R	**100**	114	128	**142**	152	162	**173**	183	193	**203**	224
500	E	**29**	33	37	**41**	44	47	**50**	53	56	**59**	64
	R	**125**	142	160	**178**	191	203	**216**	229	242	**254**	280
550	E	**35**	40	45	**50**	53	57	**60**	64	67	**71**	78
	R	**137**	156	176	**196**	210	223	**238**	251	266	**279**	307
600	E	**41**	47	53	**59**	63	67	**72**	76	80	**84**	93
	R	**149**	170	192	**214**	229	244	**259**	274	290	**305**	335
700	E	**56**	64	72	**80**	86	92	**98**	103	109	**115**	126
	R	**174**	199	224	**249**	267	284	**302**	320	338	**356**	391
750	E	**65**	74	83	**92**	99	105	**112**	118	125	**132**	145
	R	**187**	213	240	**267**	286	305	**324**	343	362	**381**	419
800	E	**73**	84	94	**105**	112	120	**127**	135	142	**150**	165
	R	**199**	227	256	**285**	305	325	**346**	366	386	**406**	447
1000	E	**115**	131	147	**164**	176	187	**199**	211	222	**234**	258
	R	**249**	284	320	**356**	381	406	**432**	457	483	**508**	559
1250	E	**179**	204	230	**256**	274	292	**311**	329	348	**366**	402
	R	**311**	355	400	**445**	476	508	**540**	571	604	**635**	699
1400	E	**225**	256	289	**321**	344	367	**390**	413	436	**459**	505
	R	**349**	398	448	**498**	533	568	**605**	640	676	**711**	783
1450	E	**241**	275	310	**345**	369	393	**418**	443	468	**492**	541
	R	**361**	412	464	**516**	552	589	**626**	663	700	**737**	811
1600	E	**294**	335	377	**420**	449	479	**509**	539	570	**599**	659
	R	**398**	454	512	**570**	610	650	**691**	731	773	**813**	894
2000	E	**459**	523	590	**656**	702	748	**796**	842	890	**936**	1030
	R	**498**	568	640	**712**	762	812	**864**	914	966	**1016**	1118

* Compound D0 (previously Compound A), and Compound B0 (previously Compound B) are commonly needed for spare and replacement projects.

Softer, harder and intermediate compounds are available on request.

Performances are per single element of 1 metre length.

Performance curve

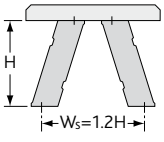


Intermediate factors

D (%)	0	5	10	15	20	25	30	35	40	45	50	55	**57.5**	62.5
R (%)	0	24	50	72	88	98	100	97	91	86	85	92	**100**	126
E (%)	0	2	6	14	25	36	48	59	69	78	86	95	**100**	113

Angular factors

Angle	**0**	3	5	8	10	15	20
R-factor	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
E-factor	**1.00**	0.99	0.99	0.96	0.93	0.81	0.71



For **Velocity** & **Temp. Factors** refer to p43.

±10% tolerance applies to Rated Performance Data (RPD).

Please refer to QuayQuip Technical Solutions for other performance properties of QME Element Fenders.

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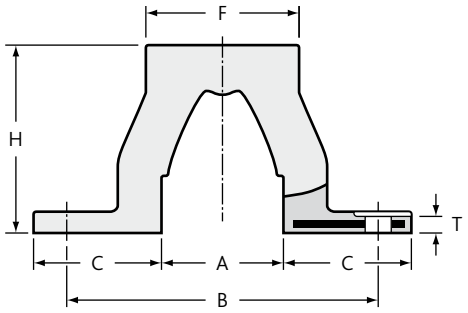
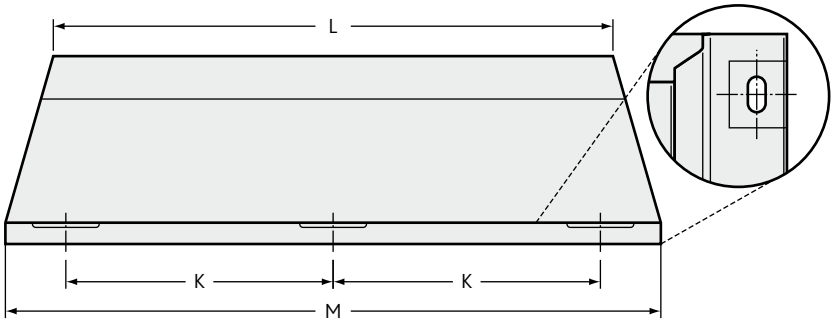
QSA Arch Fenders

QSA Arch Fenders are tough and reliable, simple and long lasting – ideal for berths serving smaller vessels and where durability is all important.

Easy and fast to install, QSA Arch Fenders are well suited to berths handling a variety of vessel types and sizes. They can be fitted vertically or horizontally to provide long lasting and low maintenance protection.

- Tough and reliable design
- Simple installation
- Rubber-faced designs
- Wide ranges of sizes and lengths
- Tested and certified according applicable standards





Dimensions tables

H	A	B	C	F	T	Hole size	Fixings	Weight
150	110	240	108	98	15	40×20	M16	39
200	144	320	128	145	20	58×29	M24	60
250	180	410	160	165	25	64×32	M30	85
300	210	490	195	245	26	70×35	M30	125
400	280	670	260	320	30	82×41	M36	205
500	350	840	325	395	33	94×47	M42	325
600	420	1010	390	470	36	100×50	M48	480
800	560	1340	520	600	48	136×68	M64	875
1000	700	1680	650	750	60	136×68	M64	1395

H	L=1000 (n=4)		L=1500 (n=6)		L=2000 (n=8)		L=2500 (n=8)		L=3000 (n=10)		L=3500 (n=12)	
	K	M	K	M	K	M	K	M	K	M	K	M
150	860	1100	680	1600	620	2100	–	–	–	–	–	–
200	860	1100	680	1600	620	2100	785	2600	715	3100	672	3600
250	865	1125	680	1625	620	2125	790	2625	715	3125	673	3625
300	870	1150	685	1650	625	2150	790	2650	715	3150	674	3650
400	900	1200	700	1700	635	2200	800	2700	725	3200	680	3700
500	930	1250	715	1750	645	2250	810	2750	730	3250	686	3750
600	960	1300	730	1800	655	2300	820	2800	740	3300	692	3800
800	1040	1400	770	1900	680	2400	845	2900	775	3500	Refer to QuayQuip Technical Solutions	
1000	1100	1500	800	2000	700	2500	865	3000				

n = number of anchors per fender.

[Units: mm, kg/m]

Please ask QuayQuip Technical Solutions for other dimensions of QSA Arch Fenders.

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Performance table

[Units: kJ, kN]

TYPE APPROVED by Bureau Veritas to PIANC 2002 and ASTM F2192-05 protocols. See p42.

H		A0	A1	A2	B0	B1	B2	C0	C1	C2	D0	D1
150	E	**3.0**			**4.3**			**5.8**			**6.1**	
	R	**59**			**84**			**108**			**126**	
200	E	**8.0**	9.2	10.3	**11.5**	12.4	13.3	**13.8**	15.2	16.8	**18.2**	20.0
	R	**95**	109	123	**136**	146	155	**165**	182	198	**215**	236
250	E	**12.6**	14.4	16.3	**18.0**	19.3	20.3	**21.5**	23.8	26.2	**28.5**	31.3
	R	**119**	136	153	**170**	183	194	**207**	228	248	**268**	295
300	E	**18.2**	20.8	23.4	**26.0**	27.7	29.3	**31.0**	34.3	37.7	**41.0**	45.1
	R	**143**	163	184	**204**	219	233	**248**	273	297	**322**	354
400	E	**32.2**	36.8	41.4	**46.0**	49.7	53.3	**57.0**	62.7	68.3	**74.0**	81.4
	R	**193**	220	248	**275**	293	312	**330**	363	397	**430**	473
500	E	**50.4**	57.6	64.8	**72.0**	77.3	82.7	**88**	96.7	105	**114**	125
	R	**241**	275	310	**344**	367	391	**414**	455	497	**538**	592
600	E	**72.8**	83.2	93.6	**104**	111	119	**126**	139	151	**164**	180
	R	**288**	330	371	**412**	440	468	**496**	545	595	**644**	708
800	E	**130**	148	167	**185**	198	210	**223**	245	268	**290**	319
	R	**385**	440	495	**550**	587	624	**661**	728	795	**862**	948
1000	E	**202**	230	259	**288**	309	331	**352**	387	420	**456**	500
	R	**482**	550	620	**688**	734	782	**828**	910	994	**1076**	1184

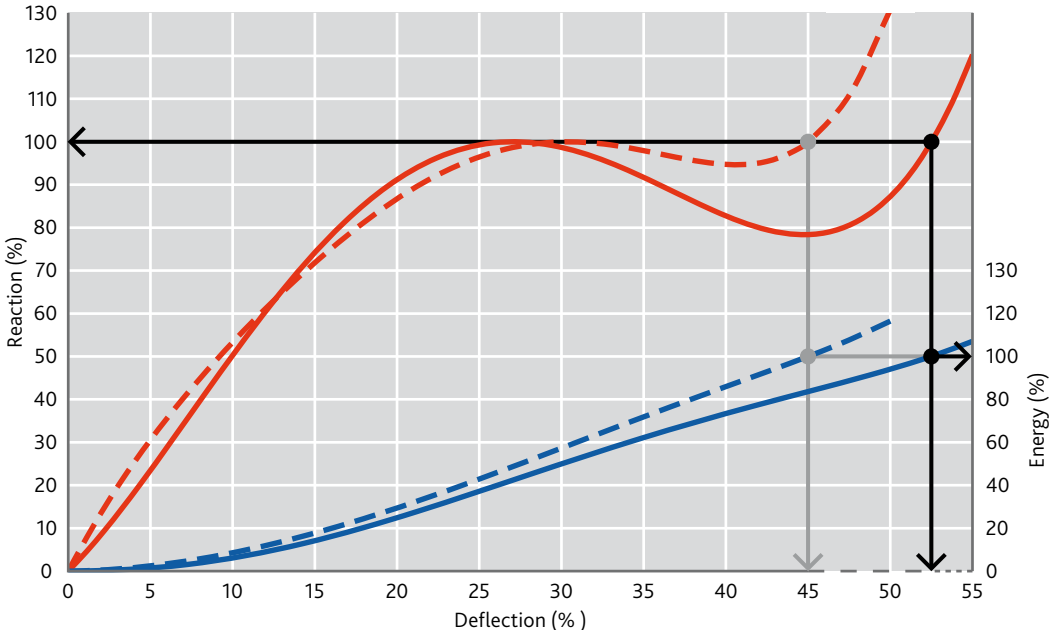
Performances are per metre length.

Softer, harder and intermediate compounds are available on request.

Performance curve

QSA 150
- Reaction
- Energy

QSA 200–800
- Reaction
- Energy



Intermediate factors

QSA 150

D (%)	0	5	10	15	20	25	30	35	40	**45**	50
R (%)	0	31	53	72	87	96	100	98	95	**100**	131
E (%)	0	2	9	18	29	43	57	72	86	**100**	116

QSA 200–1000

D (%)	0	5	10	15	20	25	30	35	40	45	50	**52.5**	55
R (%)	0	23	50	74	91	99	99	92	83	78	87	**100**	120
E (%)	0	1	6	14	25	37	50	62	73	84	94	**100**	107

Angular factors

Angle	**0**	3	5	8	10	15	20
R-factor	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
E-factor	**1.00**	0.97	0.95	0.91	0.88	0.80	0.73

For **Velocity** & **Temperature Factors** refer to p43.

±10% tolerance applies to Rated Performance Data (RPD).

Please refer to QuayQuip Technical Solutions for other performance properties of QSA Arch Fenders.

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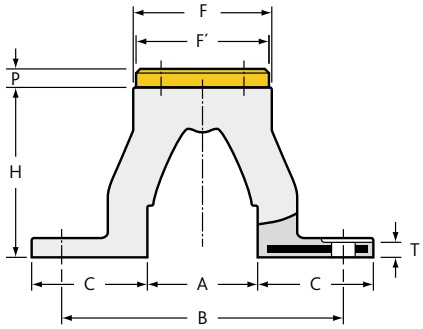
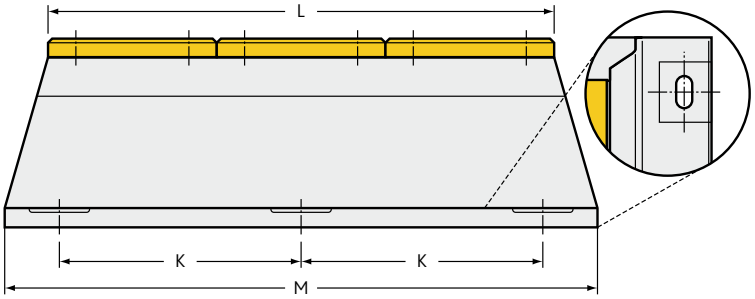
QPA Arch Fenders

QPA Arch Fenders are tough and reliable, simple and long lasting – ideal for berths serving smaller vessels where durability is all important.

With bolted-on UHMW-PE face pads, QPA Arch Fenders combine resilience with low-friction, non-marking properties. They can be fitted horizontally or vertically to provide long lasting and low maintenance protection.

- Tough and reliable design
- Simple installation
- Low-friction faced designs
- Wide ranges of sizes and lengths
- Tested and certified according applicable standards





Dimensions table

H	A	B	C	F	F′	P_{min}	T	Hole size	Fixings	Weight *
150	110	240	108	98	88	30	15	40×20	M16	41
200	144	320	128	145	135	30	20	58×29	M24	62
250	180	410	160	165	155	30	25	64x32	M30	90
300	210	490	195	245	230	30	26	70×35	M30	131
400	280	670	260	320	300	30	30	82×41	M36	223
500	350	840	325	395	380	30	33	94×47	M42	335
600	420	1010	390	470	450	30	36	100×50	M48	492
800	560	1340	520	600	560	30	48	136×68	M64	890
1000	700	1680	650	750	700	30	60	136×68	M64	1420

H	L=1000 (n=4)		L=1500 (n=6)		L=2000 (n=8)		L=2500 (n=8)		L=3000 (n=10)		L=3500 (n=12)	
	K	M	K	M	K	M	K	M	K	M	K	M
150	860	1100	680	1600	620	2100	–	–	–	–	–	–
200	860	1100	680	1600	620	2100	785	2600	715	3100	672	3600
250	865	1125	680	1625	620	2125	790	2625	715	3125	673	3625
300	870	1150	685	1650	625	2150	790	2650	715	3150	674	3650
400	900	1200	700	1700	635	2200	800	2700	725	3200	680	3700
500	930	1250	715	1750	645	2250	810	2750	730	3250	686	3750
600	960	1300	730	1800	655	2300	820	2800	740	3300	692	3800
800	1040	1400	770	1900	680	2400	845	2900	775	3500	Refer to QuayQuip Technical Solutions	
1000	1100	1500	800	2000	700	2500	865	3000				

n = number of anchors per fender. Please ask QuayQuip Technical Solutions for other dimensions of QPA Arch Fenders. [Units: mm, kg/m]

*Dimension F is indicative. *For standard 1m length with tapered ends, excluding UHMW-PE pads.

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Performance table

[Units: kJ, kN]

TYPE APPROVED by Bureau Veritas to PIANC 2002 and ASTM F2192-05 protocols. See p42.

H		A0	A1	A2	B0	B1	B2	C0	C1	C2	D0	D1
150	E	**3.0**			**4.3**			**5.8**			**6.1**	
	R	**59**			**84**			**108**			**126**	
200	E	**8.0**	9.2	10.3	**11.5**	12.4	13.3	**13.8**	15.2	16.8	**18.2**	20.0
	R	**95**	109	123	**136**	146	155	**165**	182	198	**215**	236
250	E	**12.6**	14.4	16.3	**18.0**	19.3	20.3	**21.5**	23.8	26.2	**28.5**	31.3
	R	**119**	136	153	**170**	183	194	**207**	228	248	**268**	295
300	E	**18.2**	20.8	23.4	**26.0**	27.7	29.3	**31.0**	34.3	37.7	**41.0**	45.1
	R	**143**	163	184	**204**	219	233	**248**	273	297	**322**	354
400	E	**32.2**	36.8	41.4	**46.0**	49.7	53.3	**57.0**	62.7	68.3	**74.0**	81.4
	R	**193**	220	248	**275**	293	312	**330**	363	397	**430**	473
500	E	**50.4**	57.6	64.8	**72.0**	77.3	82.7	**88**	96.7	105	**114**	125
	R	**241**	275	310	**344**	367	391	**414**	455	497	**538**	592
600	E	**72.8**	83.2	93.6	**104**	111	119	**126**	139	151	**164**	180
	R	**288**	330	371	**412**	440	468	**496**	545	595	**644**	708
800	E	**130**	148	167	**185**	198	210	**223**	245	268	**290**	319
	R	**385**	440	495	**550**	587	624	**661**	728	795	**862**	948
1000	E	**202**	230	259	**288**	309	331	**352**	387	420	**456**	500
	R	**482**	550	620	**688**	734	782	**828**	910	994	**1076**	1184

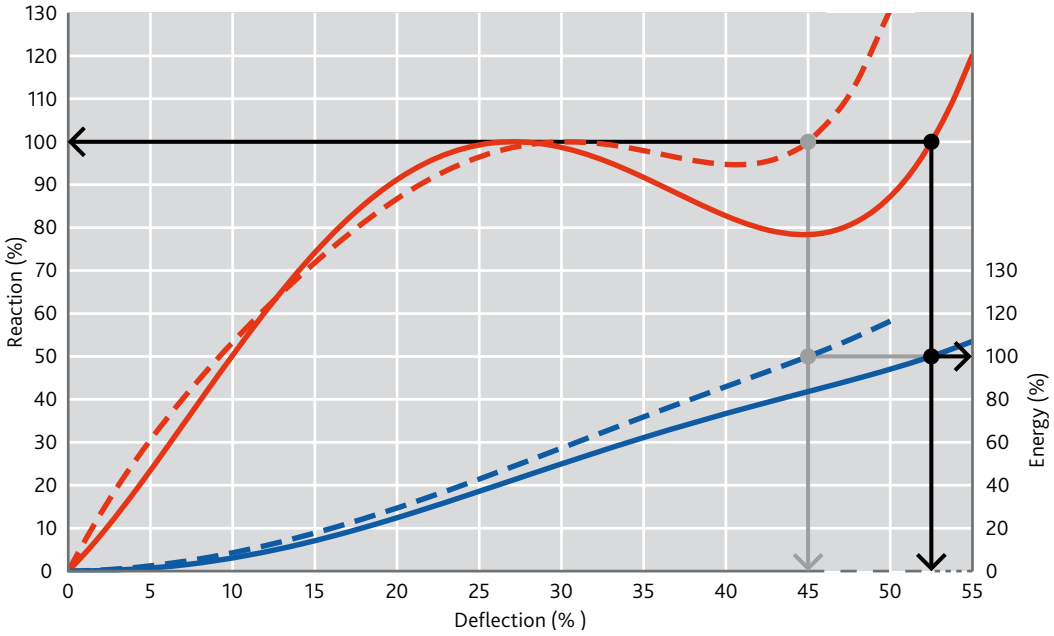
Performances are per metre length.

Softer, harder and intermediate compounds are available on request.

Performance curve

QPA 150
- Reaction
- Energy

QPA 200–800
- Reaction
- Energy



Intermediate factors

QPA 150

D (%)	0	5	10	15	20	25	30	35	40	**45**	50
R (%)	0	31	53	72	87	96	100	98	95	**100**	131
E (%)	0	2	9	18	29	43	57	72	86	**100**	116

QPA 200–1000

D (%)	0	5	10	15	20	25	30	35	40	45	50	**52.5**	55
R (%)	0	23	50	74	91	99	99	92	83	78	87	**100**	120
E (%)	0	1	6	14	25	37	50	62	73	84	94	**100**	107

Angular factors

Angle	**0**	3	5	8	10	15	20
R-factor	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
E-factor	**1.00**	0.97	0.95	0.91	0.88	0.80	0.73

For **Velocity** & **Temperature Factors** refer to p43.

±10% tolerance applies to Rated Performance Data (RPD).

Please refer to QuayQuip Technical Solutions for other performance properties of QPA Arch Fenders.

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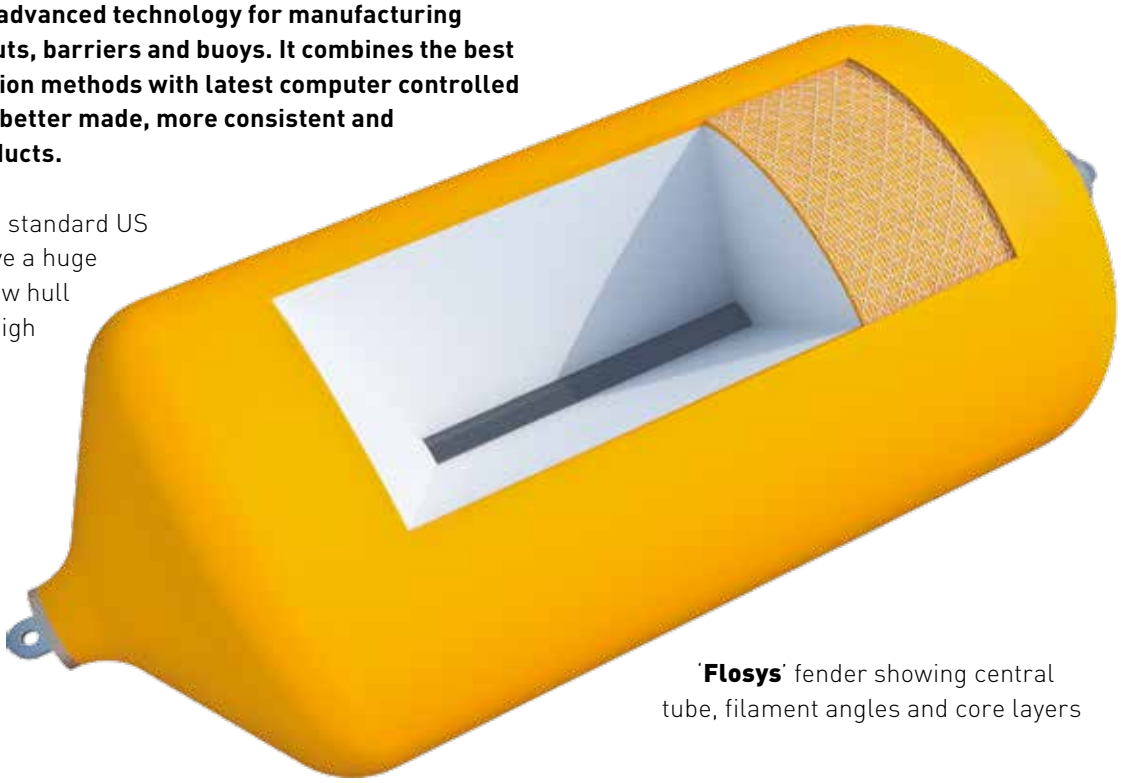
Flosys technology

Flosys is the most advanced technology for manufacturing foam fenders, donuts, barriers and buoys. It combines the best of existing production methods with latest computer controlled manufacturing for better made, more consistent and longer lasting products.

Five foam grades in standard US and metric sizes give a huge choice from ultra low hull pressure to super high performance.



'**Flosys**' fender showing central tube, filament angles and core layers

4-axis filament winding

Every foam product relies on a filament reinforced skin for strength and durability. The 4-axis process developed for Flosys products uses advanced three dimensional CNC technology originally developed for making rocket fuel tanks to control the tension, quantity, position and angle of every individual filament. The finished quality and consistency is impossible to match with traditional manual and semi-automated winding methods.

Foam core wrapping

Dynamic tension adjustment linked to a computer controlled feed keeps foam layers exact and uniform. The thermolamination process uses radiant heating elements (not naked flames) to create a strong inter-layer bond. The absence of gaps and voids stops internal movements and foam wear in service so performance is better for longer.

Central members

The central steel tube on Flosys products resists mooring loads and provides a stable, non-abrasive core for the foam body. An engineered component, the central tube is a precise length, fully sealed and can include integral swivels or other terminations.

In-house testing

In-house test facilities are used to routinely verify performance, recovery after prolonged compressions, and durability under cyclic fatigue loads.

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Flosys products

Flosys technology is used for a range of fendering, mooring and safety products. Each shares the same high quality, consistent performance and rugged construction.

- Standard sizes and custom designs are available
- Five different foam grades
- End fittings and fixtures to suit each application
- Puncture resistant and unsinkable designs
- Full colour range
- Comprehensive range of accessories

QuayGuard fenders

Donut fenders

Security barriers

Flosys manufacturing

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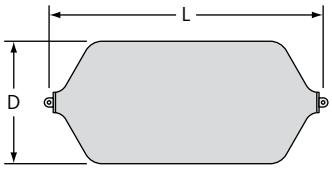
QGF QuayGuard Fenders

QuayGuard foam fenders are the most consistent performing, highest quality available today.

Five foam grades in standard US and metric sizes give a huge choice from ultra-low hull pressure to super-high performance.

Flosys 4-axis filament winding ensures extra strong reinforcement and an even finish. The PU elastomer skin includes an extra wear layer and can be made in almost any colour (black, grey and orange are standard).

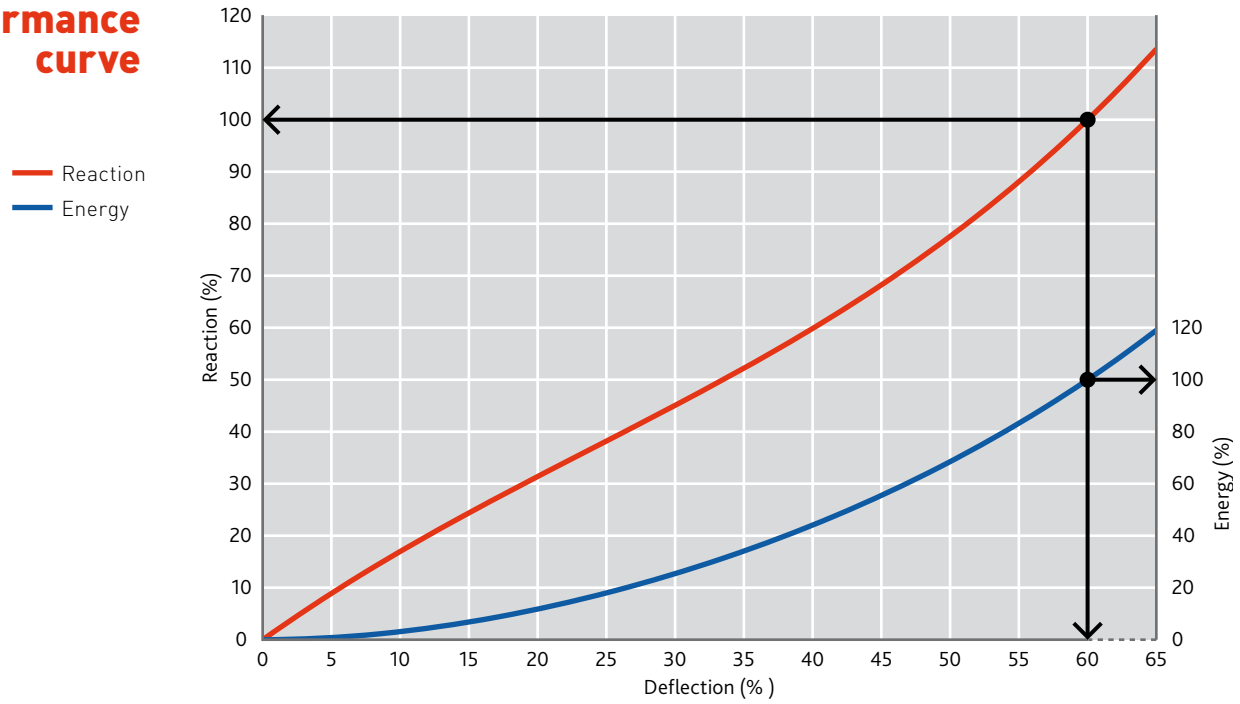
- High energy absorption
- Low hull pressure
- Non-marking (all colours)
- Reinforced PU skin
- Closed cell PE foam body
- Good angular performance
- Standard and custom sizes



Hull Pressures

LR	Low Reaction	103kPa	11t/m²	2.2ksf
STD	Standard	172kPa	18t/m²	3.6ksf
HC	High Capacity	224kPa	23t/m²	4.7ksf
EHC	Extra High Capacity	327kPa	33t/m²	6.8ksf
SHC	Super High Capacity	447kPa	46t/m²	9.4ksf

Performance curve



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Dimensions and Performance

Diameter × Length		Low Reaction		Standard		High Capacity		Extra High Capacity		Super High Capacity		Weight	Chain Size
Metric (mm)	US (ft)	Energy	Reaction	Energy	Reaction	Energy	Reaction	Energy	Reaction	Energy	Reaction	STD	
600×1200	2×4	9	53	**15**	**89**	19	116	28	169	39	231	72	14
600×1800	2×6	15	88	**24**	**147**	31	191	46	280	64	383	105	14
600×2400	2×8	20	125	**34**	**209**	45	271	65	396	88	543	138	14
600×3000	2×10	26	160	**43**	**267**	57	347	83	507	113	694	171	19
700×1500	N/A	16	80	**26**	**133**	34	173	49	253	68	348	104	19
900×1500	3×5	25	120	**42**	**200**	54	262	80	383	110	520	136	19
900×1800	3×6	32	128	**53**	**214**	69	276	100	405	137	556	173	19
900×2400	3×8	45	182	**75**	**302**	98	391	142	574	194	787	214	19
900×3000	3×10	58	235	**96**	**391**	125	507	183	743	251	1019	268	19
900×3700	3×12	71	288	**118**	**480**	153	623	224	912	306	1250	336	19
900×4300	3×14	84	342	**140**	**569**	182	738	266	1081	363	1481	390	19
1000×1500	N/A	28	104	**47**	**173**	61	225	89	329	122	450	154	19
1000×2000	N/A	41	152	**68**	**254**	88	330	129	483	177	660	208	19
1200×1800	4×6	49	150	**81**	**249**	106	325	155	472	212	649	308	25
1200×2000	N/A	55	168	**91**	**280**	118	364	173	532	237	728	336	25
1200×2400	4×8	72	222	**121**	**369**	157	480	229	703	313	961	399	25
1200×3000	4×10	96	297	**160**	**494**	207	641	304	939	416	1286	497	25
1200×3700	4×12	119	363	**198**	**605**	258	787	376	1148	515	1575	614	25
1200×4900	4×16	165	504	**275**	**841**	358	1094	523	1597	716	2184	803	25
1200×6100	4×20	212	646	**353**	**1076**	458	1401	670	2046	917	2798	1000	25
1350×2500	N/A	91	251	**152**	**418**	198	543	289	794	395	1087	475	25
1500×2400	5×8	110	267	**183**	**445**	239	578	348	845	476	1157	507	25
1500×3000	5×10	147	357	**244**	**596**	317	774	464	1134	635	1548	638	32
1500×3700	5×12	183	446	**305**	**743**	397	965	580	1410	793	1931	790	32
1500×4300	5×14	219	534	**365**	**890**	475	1157	693	1690	948	2313	920	32
1500×4900	5×16	255	622	**424**	**1036**	552	1348	807	1971	1104	2696	1051	32
1500×5500	5×18	290	710	**484**	**1183**	629	1539	919	2246	1258	3078	1182	32
1800×3700	6×12	244	497	**407**	**827**	529	1076	773	1570	1058	2153	1103	32
1800×4300	6×14	296	600	**494**	**1001**	641	1303	938	1904	1283	2602	1277	32
1800×4900	6×16	347	707	**579**	**1179**	752	1535	1100	2242	1505	3065	1451	32
1800×5500	6×18	399	814	**666**	**1357**	865	1766	1265	2580	1731	3527	1634	32
1800×6100	6×20	450	918	**751**	**1530**	976	1988	1428	2909	1952	3977	1808	32
2000×3500	N/A	272	507	**454**	**845**	590	1099	863	1606	1180	2197	1240	38
2000×4000	N/A	324	603	**540**	**1005**	702	1307	1026	1910	1404	2613	1413	38
2000×4500	N/A	374	697	**624**	**1161**	811	1509	1186	2206	1622	3019	1595	44
2100×4300	7×14	396	691	**660**	**1152**	858	1499	1254	2189	1716	2994	1615	44
2100×4900	7×16	467	814	**778**	**1357**	1011	1766	1479	2580	2023	3527	1849	44
2100×5500	7×18	537	937	**895**	**1561**	1163	2028	1700	2967	2327	4061	2074	44
2100×6100	7×20	608	1059	**1013**	**1766**	1316	2295	1924	3354	2633	4591	2307	44
2100×6700	7×22	678	1182	**1129**	**1971**	1468	2562	2146	3745	2937	5124	2532	44
2400×3700	8×12	432	659	**720**	**1094**	936	1423	1367	2082	1870	2856	1859	44
2400×4300	8×14	504	769	**839**	**1281**	1091	1664	1594	2433	2182	3332	2161	44
2400×4900	8×16	596	911	**994**	**1517**	1292	1971	1889	2882	2584	3946	2462	51
2400×5500	8×18	689	1051	**1148**	**1753**	1493	2277	2182	3332	2986	4555	2764	51
2400×6100	8×20	782	1193	**1303**	**1988**	1693	2584	2476	3777	3388	5169	3066	51
2400×6700	8×22	875	1335	**1458**	**2224**	1895	2891	2770	4226	3790	5783	3368	51
2500×4000	N/A	481	718	**801**	**1197**	1041	1556	1522	2274	2083	3112	2107	51
2500×5500	N/A	720	1073	**1200**	**1788**	1560	2324	2280	3397	3120	4649	2902	51
2700×4300	9×14	634	859	**1056**	**1432**	1372	1859	2007	2718	2746	3723	2687	51
2700×4900	9×16	724	982	**1207**	**1637**	1569	2126	2293	3109	3137	4257	2999	51
2700×5500	9×18	840	1140	**1399**	**1899**	1820	2469	2659	3608	3638	4938	3311	51
2700×6100	9×20	956	1298	**1593**	**2162**	2072	2811	3028	4106	4142	5623	3683	51
2700×6700	9×22	1072	1455	**1787**	**2424**	2323	3154	3395	4608	4646	6303	4054	51
3000×4900	10×16	879	1073	**1466**	**1788**	1905	2326	2785	3398	3811	4648	3331	51
3000×5500	10×18	1023	1249	**1706**	**2082**	2217	2705	3240	3954	4435	5413	3768	51
3000×6000	N/A	1111	1377	**1851**	**2295**	2406	2984	3517	4361	4813	5967	4206	64
3000×6100	10×20	1167	1425	**1946**	**2375**	2530	3087	3697	4515	5059	6174	4130	64
3000×6700	10×22	1311	1601	**2186**	**2669**	2842	3470	4153	5071	5682	6939	4636	64
3000×7300	10×24	1431	1747	**2455**	**2998**	3099	3781	4530	5534	6199	7571	5073	64
3300×4500	N/A	899	1014	**1498**	**1690**	1947	2197	2846	3211	3895	4394	3416	64
3300×6500	N/A	1453	1639	**2421**	**2731**	3147	3550	4600	5189	6295	7101	5090	64
3400×5500	11×18	1206	1338	**2009**	**2229**	2613	2896	3818	4235	5224	5796	4420	64
3400×6100	11×20	1380	1530	**2299**	**2549**	2903	3314	4370	4849	5979	6632	4949	64
3400×6700	11×22	1554	1725	**2590**	**2874**	3366	3737	4920	5458	6733	7473	5470	64
3400×7300	11×24	1695	1881	**2824**	**3132**	3673	4075	5368	5952	7346	8149	6468	64

Custom sizes available on request.

[Units: kN, kJ, kg, mm]

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Donut Fenders

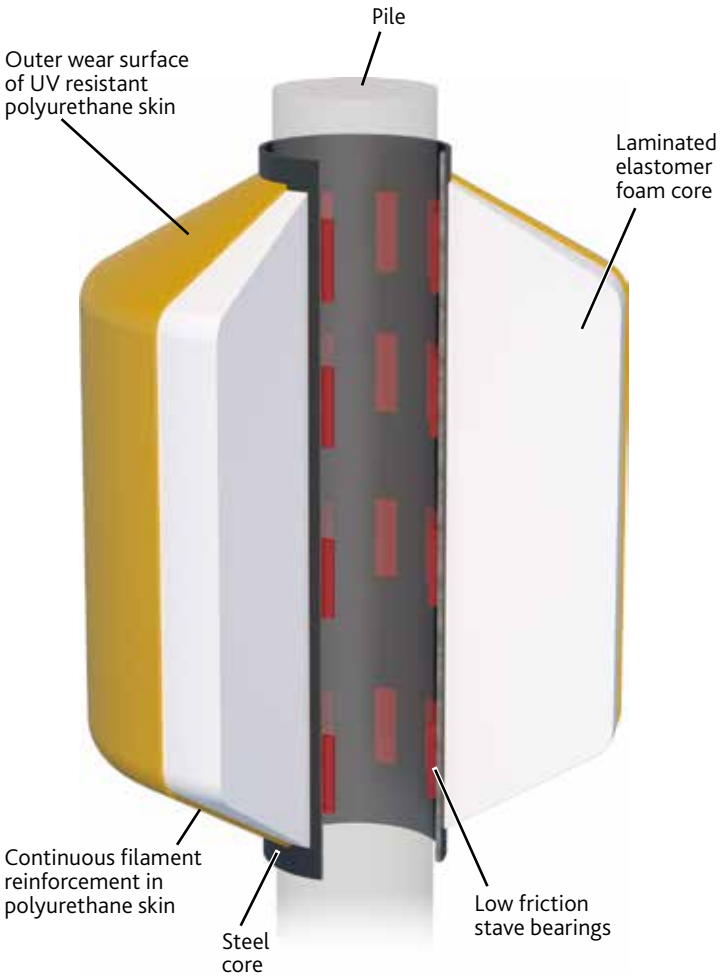
QuayQuip Technical Solutions Donut fenders are a simple and versatile solution for berth corners, locks and similar applications.

Donut fenders float and rotate around a steel monopile. Their foam body provides buoyancy and energy absorption. The steel core has low friction UHMW-PE stave bearings so it moves freely with the rise and fall of the tide.

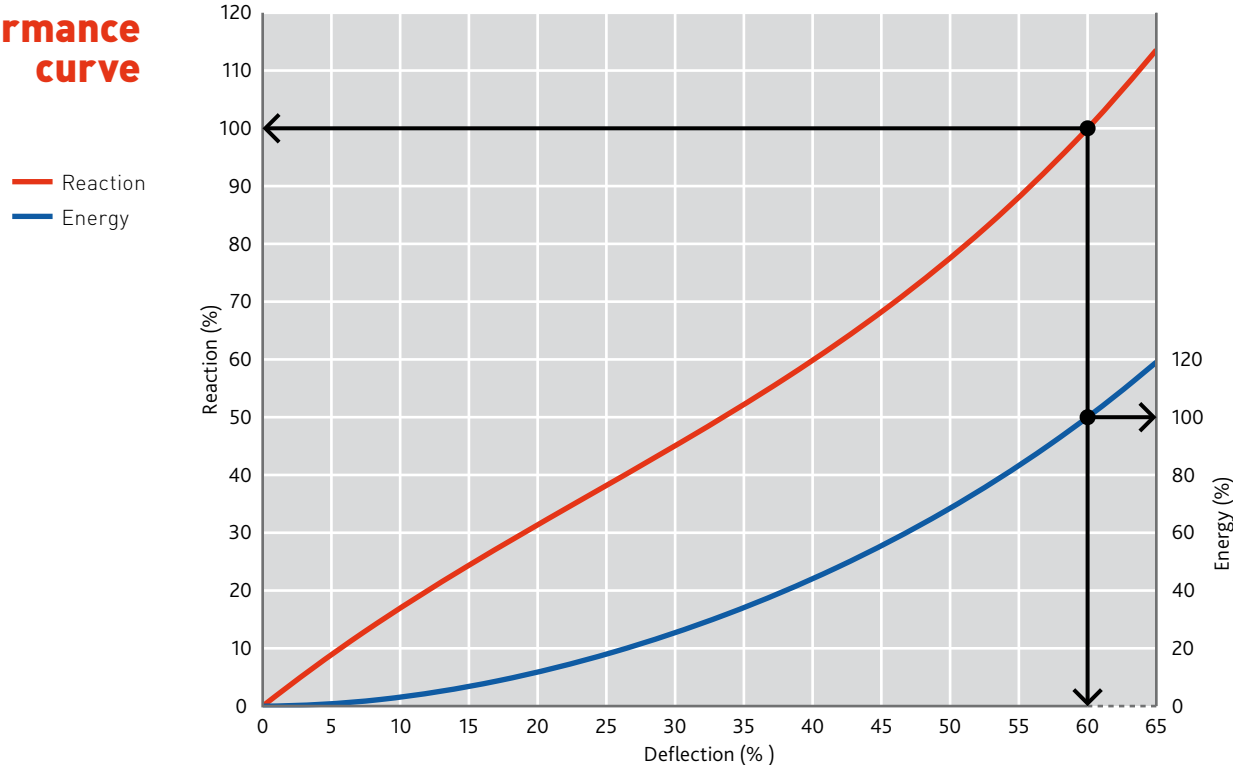
Low rolling resistance means QuayQuip Technical Solutions Donut fenders are ideal for berth corners, lock entrances, guiding structures and anywhere that ships warp along the berth.

Submersible systems are also available for submarine docking operations.

- High energy closed-cell foam body
- Heavy duty inner steel core
- Reinforced polyurethane skin
- Rises and falls with water level
- Low rolling resistance
- Long life UHMW-PE bearings
- Simple and fast installation
- Custom colours and designs available
- Minimal maintenance



Performance curve



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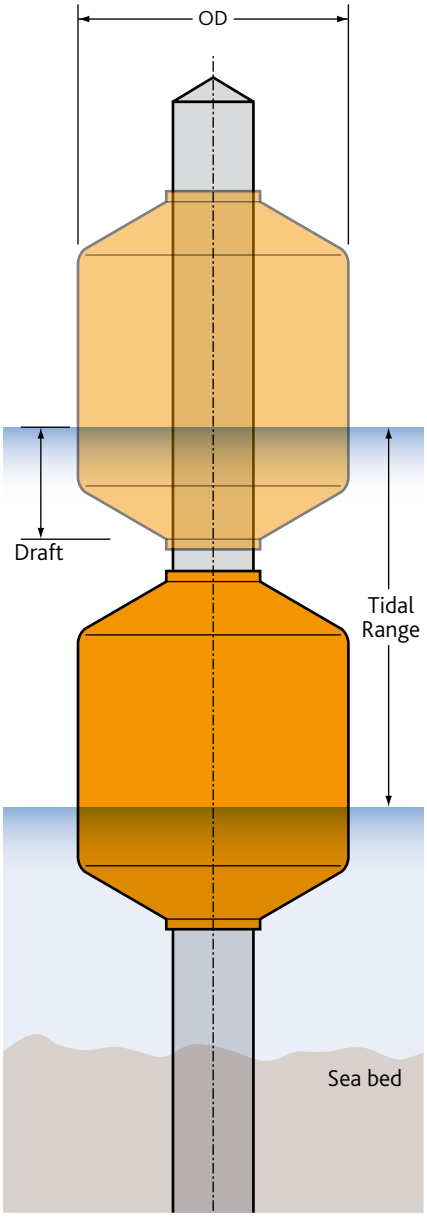

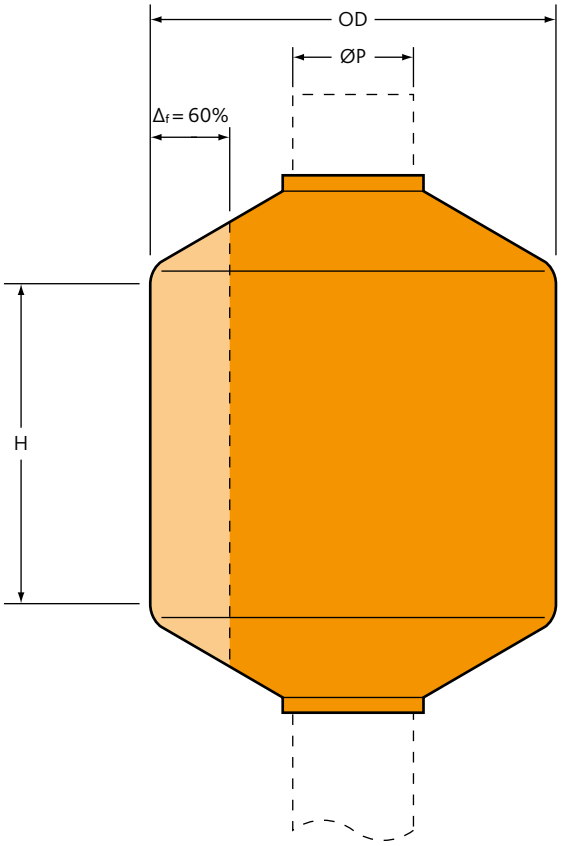

Dimensions and Performance

Donut Foam Grades ▷			Standard		High Capacity		Extra High Capacity		Super High Capacity	
Donut OD	Pile	Height	Energy	Reaction	Energy	Reaction	Energy	Reaction	Energy	Reaction
1200	610	600–2400	**7.0**	**116**	11.5	189	17.4	288	26.1	430
1400	762	600–2400	**9.6**	**136**	15.6	221	23.7	336	35.5	502
1600	813	600–2400	**12.5**	**155**	20.4	252	31.0	383	46.3	573
1800	914	600–2400	**15.8**	**174**	25.8	284	39.2	431	58.6	645
2000	1016	900–2400	**19.5**	**193**	31.9	315	48.3	479	72.3	716
2200	1118	900–2400	**23.6**	**213**	38.5	347	58.5	526	87.5	788
2400	1219	900–2400	**28.1**	**232**	45.9	378	69.6	574	104	859
2600	1372	900–2400	**33.0**	**251**	53.9	410	81.7	622	122	931
2800	1422	900–2400	**38.2**	**270**	62.4	441	94.7	670	142	1002
3000	1524	900–2400	**43.9**	**290**	71.6	473	109	717	163	1073
3300	1676	900–2400	**53.1**	**319**	86.7	520	132	789	197	1181
3600	1829	900–2400	**63.2**	**348**	103	567	157	861	234	1288
3900	1981	900–2400	**74.1**	**376**	121	614	184	932	275	1395

Donuts are available in many other diameters and heights, different fender/pile ratios and to suit other pile diameters. Please ask for details. Standard tolerance ±15%. Table performance values are per 1000mm flat height. Performance is proportional to flat height. Performances are at deflections of 60% of Donut wall thickness.

[Units: mm, kN/m, kJ/m]

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QPF Pneumatics

QuayQuip Technical Solutions QPF pneumatic fenders are the strongest, best built and most reliable units in their class.

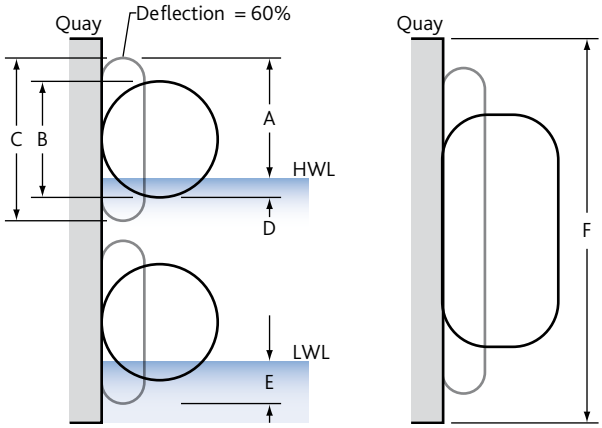
A versatile and well proven design, QPF pneumatic fenders are available as sling type or with chain & tyre nets to suit a variety of inshore and offshore applications.

- ISO 17357 certified
- Guaranteed energy absorption
- Low hull pressures
- Chain tyre net and Sling type
- Thick skin construction
- Good angular performance

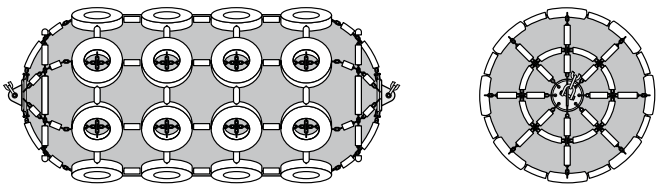
Installation dimensions

Size	A	B	C	D	E	F
Ø1000×1500L	975	950	1350	200	375	2000
Ø1200×2000L	1200	1140	1620	220	430	2600
Ø1500×2500L	1525	1420	2050	250	525	3250
Ø2000×3500L	2050	1900	2700	300	650	4500
Ø2500×4000L	2490	2380	3380	450	890	5200
Ø3300×6500L	3380	3140	4460	500	1080	8500
Ø4500×9000L	4710	4270	6180	800	1470	12000

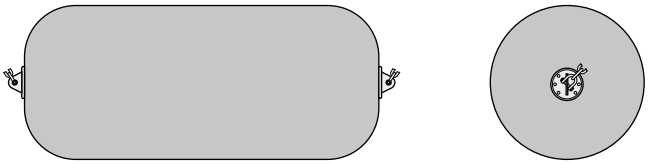
[Units: mm]



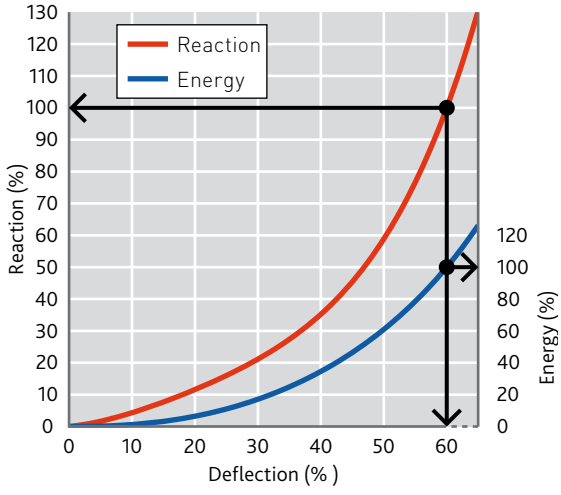
Chain and tyres



Sling type



Performance curve



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Performance tables

IP50	Performance			Fender Weight			Pressures		Body Thickness	Mooring Chain Diameter
	Energy (GEA)	Reaction (at GEA)	Pressure (at GEA)	Body Only	Chain Net (excl body)	Sling Type	Relief Valve	Proof Test		
Dia. × Length (mm)	kJ	kN	kPa	kg	kg	kg	kPa	kPa	mm	mm
Ø300 × 600L	0.5	24	134	15	–	20	–	200	12	13
Ø500 × 1000L	6	64	132	24	121	35	–	200	12	16
Ø600 × 1000L	8	74	126	28	132	39	–	200	12	16
Ø700 × 1500L	17	137	135	50	165	60	–	200	13	16
Ø800 × 1500L	24	158	132	64	280	72	–	200	14	16
Ø1000 × 1500L	33	182	122	80	220	107	–	200	14	16
Ø1000 × 2000L	46	257	132	97	242	124	–	200	14	16
Ø1200 × 2000L	64	297	126	144	352	171	–	200	14	16
Ø1200 × 3000L	109	482	134	250	435	280	–	200	14	16
Ø1350 × 2500L	104	427	130	220	385	264	–	200	15	16
Ø1500 × 2500L	125	464	126	243	484	287	–	200	16	19
Ø1500 × 3000L	156	579	132	275	583	319	–	200	16	19
Ø1500 × 4000L	230	815	130	330	690	380	–	200	16	19
Ø1700 × 3000L	195	639	128	319	638	363	–	200	16	19
Ø1700 × 7200L	516	1621	133	760	N/A	810	–	200	16	22
Ø2000 × 3000L	260	727	122	403	990	469	–	200	16	22
Ø2000 × 3500L	314	875	128	445	1056	502	–	200	17	22
Ø2000 × 4000L	361	1020	125	490	1150	540	–	200	16	22
Ø2000 × 6000L	611	1631	136	658	1650	720	–	200	16	26
Ø2500 × 4000L	676	1381	137	992	1364	1188	175	250	18	26
Ø2500 × 5500L	962	2019	148	1199	2035	1452	175	250	18	32
Ø2500 × 9100L	1631	3482	140	2150	3467	2230	175	250	18	32
Ø3000 × 5000L	1136	2021	154	1520	1800	1640	175	250	19	32
Ø3300 × 4500L	1198	1884	130	1606	1881	2024	175	250	20	36
Ø3300 × 6500L	1850	3015	146	2057	2827	2475	175	250	20	38
Ø3300 × 10600L	3128	5257	158	2816	5126	3366	175	250	22	48
Ø4500 × 7000L	3302	3796	133	3740	4290	3880	175	250	24	48
Ø4500 × 9000L	4847	5747	146	4334	5929	–	175	250	24	50
Ø4500 × 12000L	6602	7984	154	5269	7689	–	175	205	24	58

IP80	Performance			Fender Weight			Pressures		Body Thickness	Mooring Chain Diameter
	Energy (GEA)	Reaction (at GEA)	Pressure (at GEA)	Body Only	Chain Net (excl body)	Sling Type	Relief Valve	Proof Test		
Dia. × Length (mm)	kJ	kN	kPa	kg	kg	kg	kPa	kPa	mm	mm
Ø300 × 600L	0.6	31	173	17	–	20	–	250	13	13
Ø500 × 1000L	8	85	174	26	121	37	–	250	13	16
Ø600 × 1000L	11	98	166	30	132	42	–	250	13	16
Ø700 × 1500L	24	180	177	52	165	63	–	250	14	16
Ø800 × 1500L	31	204	180	71	280	83	–	250	15	16
Ø1000 × 1500L	45	239	160	84	220	111	–	250	15	16
Ø1000 × 2000L	64	338	174	101	242	129	–	250	15	16
Ø1200 × 2000L	89	390	166	149	352	176	–	250	15	16
Ø1200 × 3000L	140	623	185	275	435	310	–	250	16	16
Ø1350 × 2500L	144	561	170	226	385	270	–	250	17	16
Ø1500 × 2500L	174	610	166	268	484	312	–	250	17	19
Ø1500 × 3000L	218	761	174	339	583	355	–	250	17	20
Ø1500 × 4000L	296	1053	176	363	690	378	–	250	17	20
Ø1700 × 3000L	272	840	168	348	638	392	–	250	17	20
Ø1700 × 7200L	668	2096	170	795	N/A	845	–	250	18	22
Ø2000 × 3000L	363	955	160	413	990	479	–	250	19	22
Ø2000 × 3500L	438	1150	168	454	1056	520	–	250	19	24
Ø2000 × 4000L	520	1380	173	505	1150	535	–	250	19	24
Ø2000 × 6000L	791	2109	170	724	1650	810	230	300	18	28
Ø2500 × 4000L	944	1815	180	1111	1364	1309	230	300	20	30
Ø2500 × 5500L	1343	2653	195	1353	2035	1606	230	300	20	36
Ø2500 × 9100L	2293	4505	199	2360	3467	2450	230	300	20	38
Ø3000 × 5000L	1593	2608	185	1670	1800	1850	230	300	21	34
Ø3300 × 4500L	1673	2476	171	1892	1881	2299	230	300	22	34
Ø3300 × 6500L	2583	3961	191	2420	2827	2827	230	300	22	42
Ø3300 × 10600L	4366	6907	208	3333	5126	3872	230	300	23	54
Ø4500 × 7000L	4608	4988	174	4136	4301	4350	230	300	26	54
Ø4500 × 9000L	6766	7551	192	4818	5929	–	230	300	26	58
Ø4500 × 12000L	9218	14490	202	5863	7689	–	230	300	26	58

Guaranteed Energy Absorption (GEA) is at nominal deflection of 60%. Reaction tolerance is ±10%.

Ask QuayQuip Technical Solutions for details of custom sizes and other properties of QPF Pneumatic Fenders.

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QSR Pneumatics

Also available are the new QSR type pneumatic fenders. With their heavily ribbed shell they are as durable as a chain net but weigh little more than a sling type.

QSR Size	IP50			IP80		
	Energy	Reaction	Weight	Energy	Reaction	Weight
300 × 600	0.5	24	22	0.6	31	23
500 × 1000	6	64	42	8	85	67
1000 × 2000	46	257	150	64	338	160
2000 × 3500	260	727	615	438	1150	652
2500 × 4000	676	1381	1430	994	1815	1545
2500 × 5500	962	2019	1750	1343	2653	1885

Guaranteed Energy Absorption (GEA) is at nominal deflection of 60%. Reaction tolerance is ±10%.

Standard colours: orange, grey and black. [Units: mm, kJ, kN]

HydroPneumatic Fenders

Submarines and other vessels that make contact below the waterline need a special fendering solution. HydroPneumatic fenders are filled with air and water, then fitted with a counterweight to stand vertically and protect submerged hulls.

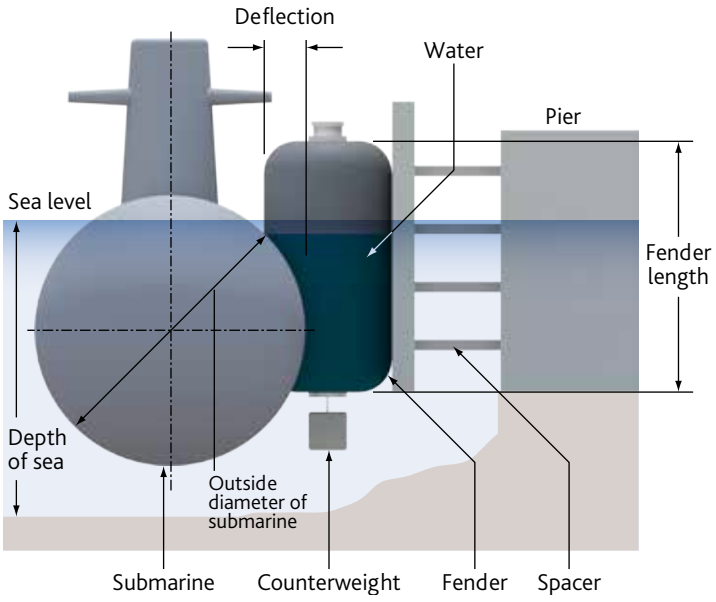
QuayQuip Technical Solutions can also provide the special calculations for polytropic conditions (saturated air), other air:water ratios, hull curvatures and other variables to predict exact performance of HydroPneumatic fenders.

Performance table

IP50	Water:Air	E	R
Ø1700 × 7200	65:35	592	1813
Ø2000 × 6000	65:35	647	1766
Ø2500 × 5500	65:35	928	2037
Ø3300 × 6500	55:45	1913	3169
Ø3300 × 10600	65:35	3120	5170
Ø4500 × 9100	Please ask QuayQuip Technical Solutions		

Performances vary with initial pressure, water:air ratio, hull curvature and for other pressurising gasses (ie Nitrogen). QuayQuip Technical Solutions can guide on all special and non-standard design cases. Please ask for details.

[Units: mm, kJ, kN]



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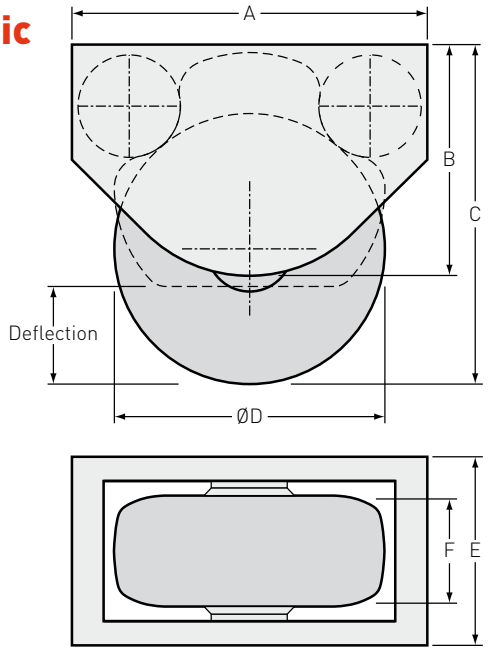
Wheel Fenders and Roller Fenders

QuayQuip Technical Solutions Wheel and Roller fenders protect lock corners and help guide ships in confined spaces.

The range uses either pneumatic tyres or Flosys foam construction (see page 18). Pneumatic wheels offer triple inflation barriers for low maintenance. Double inflation points improve ease of access.

Pneumatic Wheels



Dimensions

Type	A	B	C	ØD	E	F
110 × 45	1700	1000	1450	1080	900	460
130 × 50	2000	1200	1750	1300	1000	510
175 × 70	2650	1500	2200	1750	1150	690
200 × 75	2750	1750	2550	1980	1250	760
250 × 100	3350	2200	3200	2550	1600	970
290 × 110	4200	2500	3750	2900	1700	900

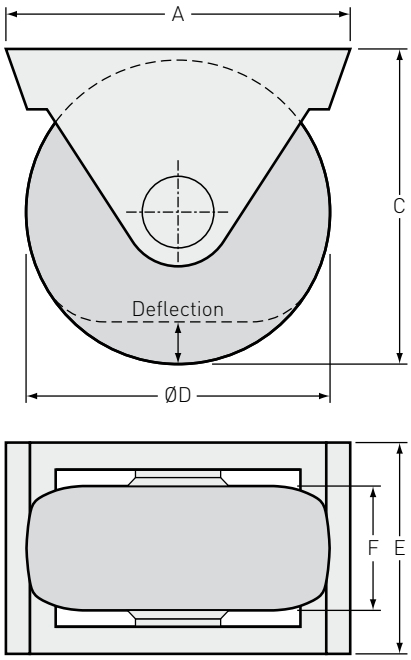
[Units: mm]

Performance

Type	Energy	Reaction	Deflection	Pressure
110 × 45	33	150	400	5.5
130 × 50	61	220	500	3.5
175 × 70	100	315	600	4.8
200 × 75	220	590	700	5.5
250 × 100	440	920	925	5.5
290 × 110	880	1300	1200	5.8

[Units: kJ, kN, mm, bar]

Pneumatic Rollers



Dimensions

Type	A	B	C	ØD	E	F
110 × 45	1250	1150	610	1080	800	460
130 × 50	1530	1400	740	1320	950	510
140 × 60	1600	1450	765	1370	1000	610
175 × 70	2050	1850	975	1750	1250	690
200 × 75	2300	2100	1110	1980	1400	765
250 × 100	3000	2700	1425	2550	1800	895

[Units: mm]

Performance

Type	Energy	Reaction	Deflection	Pressure
110 × 45	13	175	152	5.5
130 × 50	22	200	230	3.5
140 × 60	20	210	205	3.5
175 × 70	37	345	225	4.8
200 × 75	100	765	270	5.5
250 × 100	170	1000	345	5.5

[Units: kJ, kN, mm, bar]

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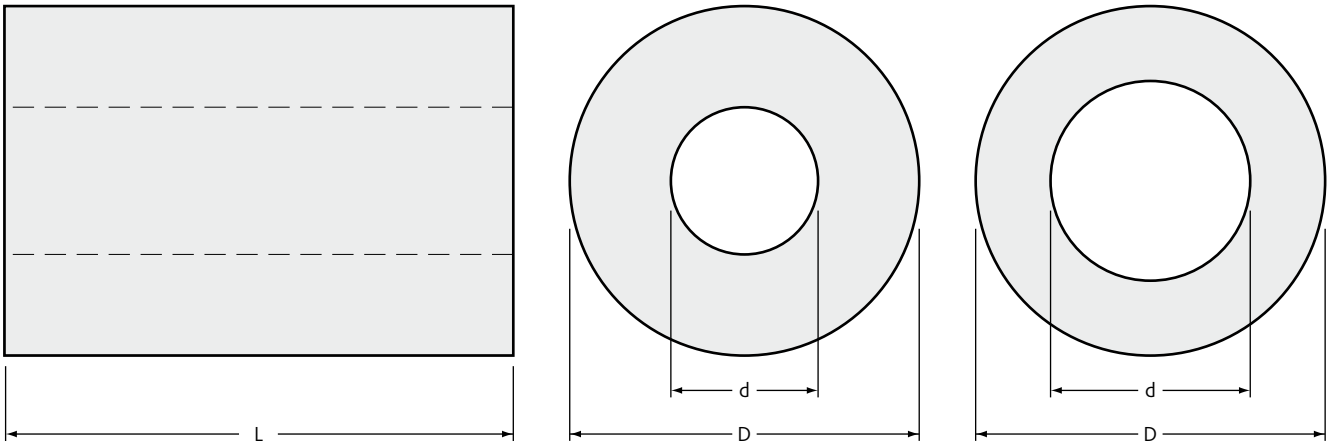
QCY Cylindrical Fenders

QCY Cylindrical Fenders are high quality, strong and long lasting units.

Popular for over 50 years, cylindrical fenders are simple and effective for a range of ships and applications. They are commonly used in areas with small tides and where low hull pressures and reaction forces are not significant.

- Very simple design
- Popular and effective
- Easy to install
- Wide range of sizes
- Two standard compounds
- Tested and certified according applicable standards

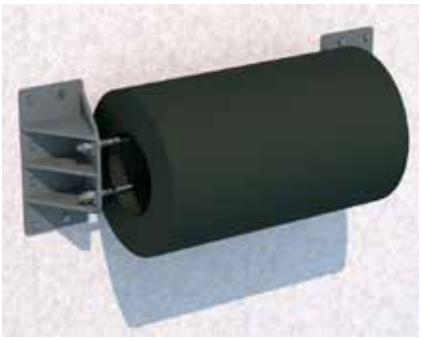


* Reduced reaction for lower hull pressure. For equal reaction please speak to QuayQuip Technical Solutions.

Fixing methods

Neckless chain: <600mm diameter

Bar and chain: 500–1600mm diameter



Ladder bracket: >1200mm diameter

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Dimensions and performance

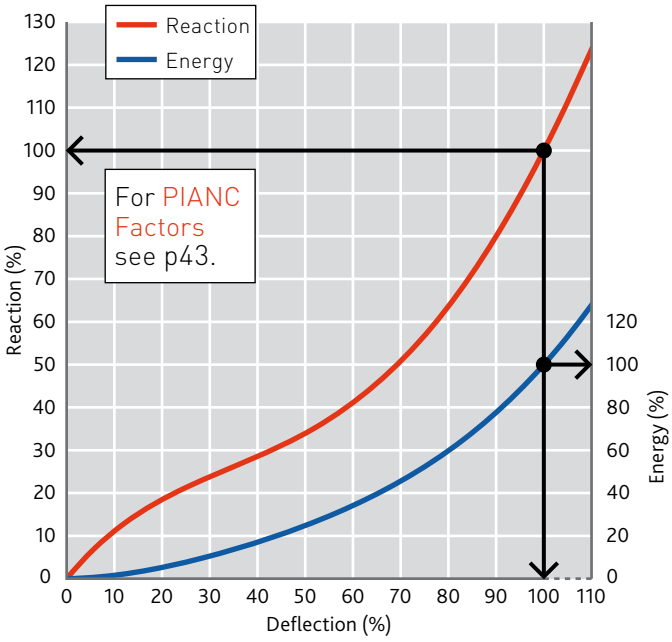
D	d	L_{max}	Weight	E	R	P
150	75	10000	17	2.6	77	654
200	100	10000	30	4.6	102	649
250	125	10000	47	7.3	128	652
300	150	10000	67	10	153	649
400	200	8000	118	19	204	649
500	250	8000	184	29	255	649
600	300	3000	265	42	306	649
700	400	3000	360	50	312	497
800	400	3000	469	74	408	649
900	450	3000	594	93	459	649
1000	500	3000	733	116	510	649
1200	600	3000	1055	167	612	649
1400	700	3000	1434	227	714	649
1400	800	3000	1287	198	625	497
1500	750	3000	1648	260	765	649
1600	800	3000	1872	296	816	649
1800	900	3000	2370	376	918	649
2000	1000	3000	2925	464	1020	649

Many other sizes, and diameters over 2000mm are also available – please speak to QuayQuip Technical Solutions.

Performances are given at rated deflection of 100% of inside diameter (d) and per 1000mm length. Performance tolerance is ±10%.

Please ask QuayQuip Technical Solutions for other dimensions and performance properties of QCY Cylindrical Fenders.

Performance curve



[Units: mm, kg/m, kN/m, kJ/m, kPa]

Intermediate factors

D (%)	0	10	20	30	40	50	60	70	80	90	**100**	105	110
R (%)	0	11	18	24	29	34	41	51	64	80	**100**	111	124
E (%)	0	1	5	11	17	25	34	46	60	78	**100**	113	128

±10% tolerance applies to Rated Performance Data (RPD).
Please refer to QuayQuip Technical Solutions for other properties of QCY Cylinder Fenders.

Fixings (D = 150–700mm)

D	d	Chain
150	75	16
200	100	18
250	125	20
300	150	20
400	200	26
500	250	32
600	300	32
700	350	36

[Units: mm]

Fixings (D = 800–1600mm)

D	d	L	Bar	Chain
800	400	1000	35	26
		1500	45	28
		2000	55	32
		2500	65	34
		3000	70	38
900	450	1000	40	26
		1500	50	28
		2000	60	32
		2500	70	34
		3000	80	38
1000	500	1000	45	28
		1500	55	32
		2000	65	38
		2500	75	40
		3000	85	44
1200	600	1000	50	28
		1500	65	34
		2000	75	40
		2500	85	44
		3000	100	50
1400 1500	800 750	1000	65	32
		1500	70	38
		2000	80	44
		2500	90	48
		3000	100	52
1600	800	1000	75	36
		1500	80	40
		2000	90	44
		2500	110	48
		3000	120	54

All fixing dimensions are for preliminary designs and should be checked and verified with QuayQuip Technical Solutions for each application.

[Units: mm]

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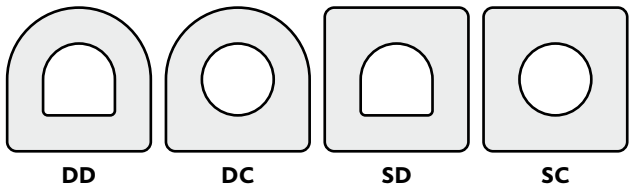
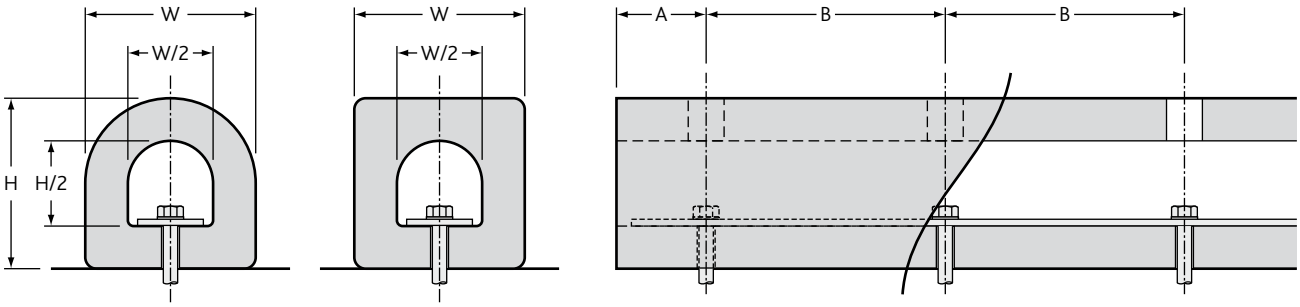
QEX Extruded Profiles

QEX extruded profiles are used for general purpose and light/medium duty applications for small vessels.

Available in a range of square and D-sections, extruded profiles can be used for many applications in harbours, or on tugs and workboats.



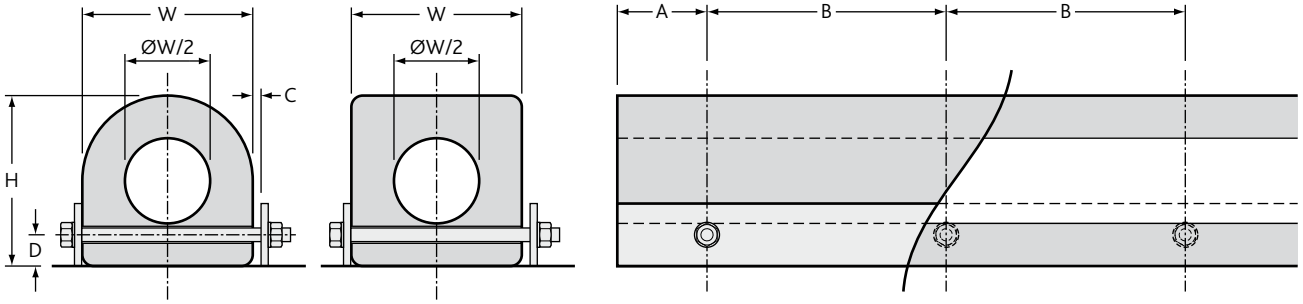


H	W	A	B	Weight DD	Weight SD	Flat Bar	Bolt
100	100	90–130	200–300	8.0	9.3	40×5	M12
150	150	110–150	250–350	18.1	21.0	60×8	M16
200	200	130–180	300–400	32.1	37.3	80×10	M20
250	250	140–200	350–450	50.2	58.3	90×12	M24
300	300	140–200	350–450	72.3	83.9	110×12	M24
350	350	140–200	350–450	98.4	114	130×15	M30
375	375	140–200	350–450	113	131	140×15	M30
400	400	140–200	350–450	129	149	150×15	M30
500	500	140–200	350–450	201	233	180×20	M36

[Units: mm, kg/m]

DD E	DD R	SD E	SD R
1.4	77	2.8	147
3.2	115	6.4	221
5.7	153	11.3	294
9.0	192	17.7	368
12.9	230	25.5	442
17.6	268	34.6	515
20.2	287	39.8	552
23.0	306	45.2	589
35.9	383	70.7	736

Performance per metre. [Units: kN, kJ]



H	W	A	B	C	D	Weight DC	Weight SC	Flat Bar	Bolt
100	100	90–130	200–300	10	25	8.4	9.6	40×5	M12
150	150	110–150	250–350	12	30	18.8	21.7	60×8	M16
200	200	130–180	300–400	15	45	33.4	38.6	80×10	M20
250	250	140–200	350–450	20	50	52.2	60.3	90×12	M24
300	300	140–200	350–450	25	60	75.2	86.8	110×12	M24
350	350	140–200	350–450	25	70	102	118	130×15	M30
375	375	140–200	350–450	30	80	118	136	140×15	M30
400	400	140–200	350–450	30	80	134	154	150×15	M30
500	500	140–200	350–450	40	90	209	241	180×20	M36

[Units: mm, kg/m]

DC E	DC R	SC E	SC R
1.8	157	2.8	173
4.1	236	6.3	259
7.4	314	11.3	345
11.5	393	17.6	431
16.6	471	25.4	518
22.5	550	34.5	604
25.9	589	39.7	647
29.4	628	45.1	690
46.0	785	70.5	863

Performance per metre. [Units: kN, kJ]

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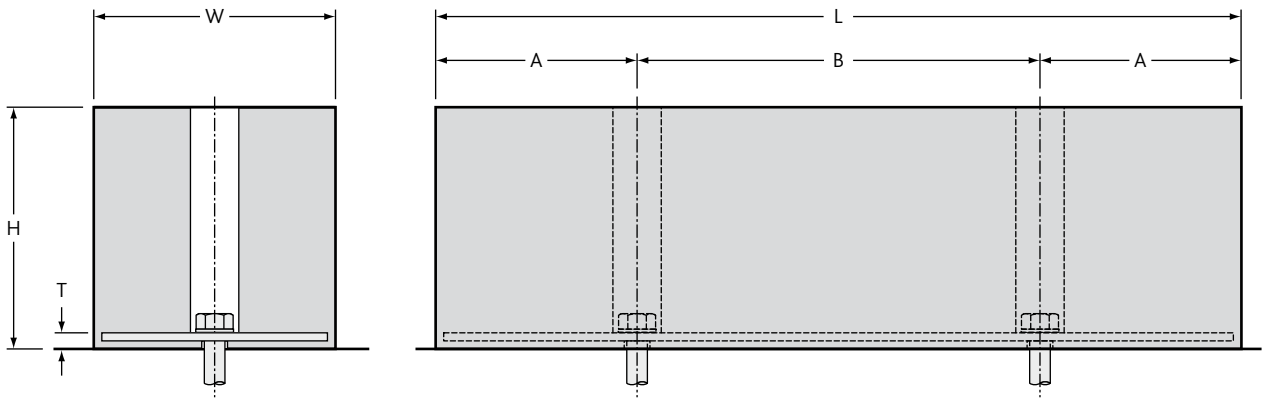
QBB Bumper Bars

Bumper bars are moulded sections with low profile fixings to survive heavy knocks.



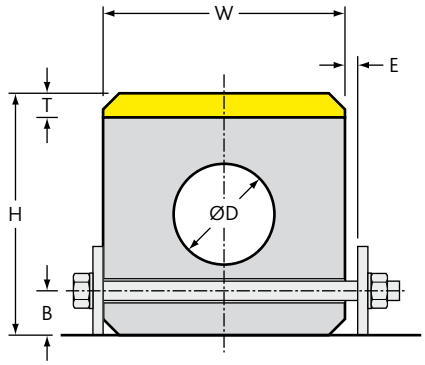
H	W	A	B	T	Weight L=1000	Weight L=1500	Bolt	Performance E	Performance R
150	150	250	500	20	38	56	M24	17	638
150	200	250	500	20	43	65	M24	17	441
200	200	250	500	20	65	98	M30	27	824
200	250	250	500	20	77	116	M30	27	657
200	300	250	500	20	88	132	M30	27	530

[Units: mm, kg] Per metre. [Units: kN, kJ]

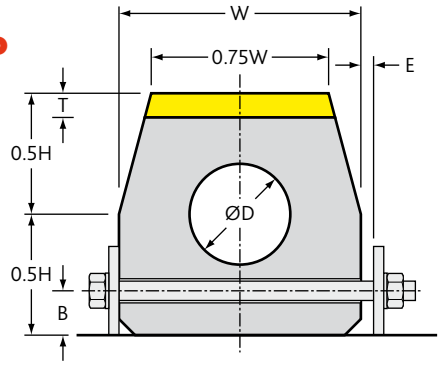
PFS and PFP Profiles

With their vulcanised low-friction UHMW-PE facing (black as standard, colours optional), PFS and PFP profiles absorb energy and reduce shear forces.

PFS



PFP



Type	H	W	D	T	B	E	Weight Hollow	Weight Solid	Max Length	Flat Bar	Bolt	Performance E	Performance R
PFS	100	100	30	20	25	10	10.3	11.1	3000	40×5	M12	4.0	222
PFS	150	150	65	20	30	12	21.5	27.0	3000	60×8	M16	10.5	312
PFS	200	200	75	25	45	15	40.2	48.0	3000	80×10	M20	11.5	334
PFS	250	250	100	30	50	20	60.2	75.0	3000	90×12	M24	24.3	565
PFS	300	300	125	30	60	25	92.1	108	3000	110×12	M24	42.0	624
PFP	80	80	40	10	25	10	5.4	7.0	2000	40×5	M12	1.6	76
PFP	100	100	45	10	25	10	8.4	11.0	2000	40×5	M12	2.2	154
PFP	120	120	60	12	27	10	12.2	15.8	2000	50×6	M16	3.0	188
PFP	150	150	70	15	30	12	19.7	24.8	2000	60×8	M16	6.0	377

[Units: mm, kg] Per metre. [kN, kJ]

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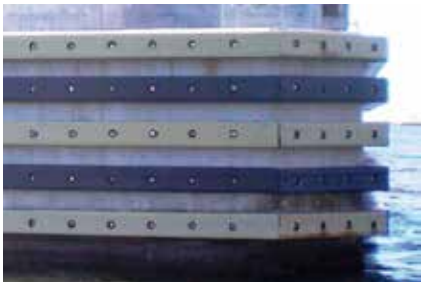
QuayPile and QuayTimber

QuayPile and QuayTimber have the structural strength of tropical hardwoods without the environmental impact.

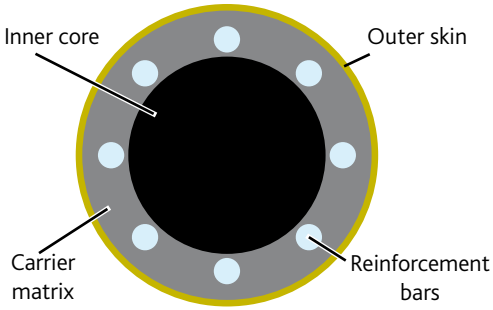
Coextruded from polyethylene, the material does not crack or split, rot or decay. It is impervious to marine borers and will never corrode.

In fact all QuayPile and QuayTimber do is the job they were designed for – creating attractive, strong and long lasting structures.

When the rest of the structure reaches the end of its useful life, QuayPile and QuayTimber can be reused or recycled into new products. The ultimate in environmentally friendly materials saves money and endangered habitats.



The manufacturing process



A continuous, coaxial extrusion process starts with the inner core. Rebars are fed into the outer matrix while it is extruded around the core. The outer skin is coextruded last to provide a smooth, hard-wearing finish.

Marine borers cause huge damage in today's cleaner harbours. Without toxic chemical treatments or expensive retrofit jackets, a typical timber pile can be eaten away in just a few years. QuayPile and QuayTimber make this type of maintenance a thing of the past.

QuayPile and QuayTimber are made in a state of the art, purpose built production unit using the latest equipment to consistently produce the highest quality materials.

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QuayPile Properties

Pile Diameter mm	Nº of Rebars	Rebar Diameter mm	Moment of Inertia mm^4	Stiffness kNm^2	Young's Modulus MPa	Weight kg/m	Stress at 1% Strain MPa	Compressive Modulus MPa
330	8	42	582×10^6	4344	7462	71±7	93	2923
		40		3933	6757	70±7	84	2655
		38		3546	6091	69±7	76	2402
		36		3181	5465	68±7	68	2163
		34		2840	4878	67±7	61	1938
		32		2520	4330	66±7	54	1728
330	10	42	582×10^6	5336	9166	74±8	114	3577
		40		4823	8285	72±7	103	3242
		38		4339	7453	71±7	93	2925
		36		3883	6670	70±7	83	2626
		34		3455	5936	69±7	74	2346
		32		3056	5250	68±7	65	2083
330	12	42	582×10^6	6328	10870	77±8	135	4231
		40		5712	9812	75±8	122	3829
		38		5131	8814	73±7	110	3449
		36		4584	7875	72±8	98	3090
		34		4071	6994	70±7	87	2753
		32		3592	6171	69±7	77	2438
400	8	42	1257×10^6	7129	5673	99±10	68	2087
		40		6478	5155	98±10	62	1904
		38		5863	4665	97±10	56	1732
		36		5283	4204	96±10	50	1569
		34		4740	3772	95±10	45	1416
		32		4232	3368	94±10	40	1273
400	12	42	1257×10^6	10287	8186	105±11	98	2977
		40		9311	7409	103±11	88	2703
		38		8388	6675	101±10	80	2444
		36		7519	5983	100±10	71	2200
		34		6704	5335	98±10	64	1971
		32		5942	4728	97±10	56	1757
400	16	42	1257×10^6	13445	10699	110±11	128	3867
		40		12143	9663	108±11	115	3502
		38		10913	8684	106±11	104	3157
		36		9754	7762	104±11	93	2832
		34		8667	6897	102±11	82	2526
		32		7651	6089	100±10	73	2240

QuayTimber Properties

Height mm	Width mm	Nº of Rebar No	Rebar Diameter mm	Moment of Inertia mm^4	Stiffness kNm^2	Young's Modulus MPa	Weight kg/m	σ_y (Bending) MPa	Compressive Modulus MPa
250	250	0	–	323×10^6	211	652	45±5	5.9	314
		4	25	323×10^6	684	2117	47±5	23.7	992
			32	323×10^6	897	2776	48±5	31.1	1294
			35	323×10^6	1025	3174	49±5	35.6	1475
			38	323×10^6	1161	3595	50±5	40.3	1665
			41	323×10^6	1305	4039	51±5	45.3	1865
300	300	0	–	675×10^6	434	643	64±7	5.9	305
		4	25	675×10^6	1160	1718	67±7	18.7	775
			32	675×10^6	1485	2200	68±7	23.9	984
			35	675×10^6	1681	2490	69±7	27.0	1109
			38	675×10^6	1888	2797	69±7	30.4	1241
			41	675×10^6	2106	3120	70±7	33.9	1379

Black skin is standard. Other colours on request.

Maximum length 24m (subject to shipping restrictions)

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UHMW-PE facings

QuayQuip Technical Solutions recommend Virgin grade UHMW-PE as the best material for consistent low-friction, hard wearing facings on high performance fenders, available as either Virgin 1st (premium) or Virgin FQ (fender quality).

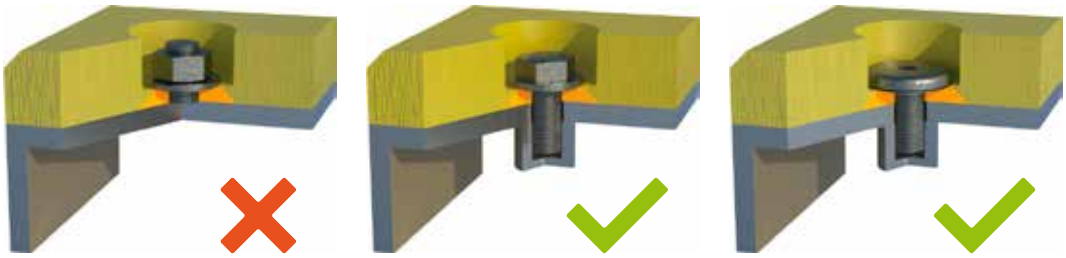
The high quality of QuayQuip Technical Solutions's Virgin UHMW-PE low friction facings means they last longer and reduce shear forces more than any alternative material (including double sintered, regenerated and blended grades).

Black is available for all grades. Yellow and blue are popular Virgin 1st colours – others include green, white, orange, grey and red.

Fixing types

QuayQuip Technical Solutions pioneering sealed, watertight boss fixing method secures facings to the underlying structure more reliably than troublesome, old-fashioned stud fixings. Boss fixings greatly increase wear allowance, prolonging the service life of UHMW-PE facings.

Panel protection moves to another level with new, low profile fixings. The broader fixing creates much larger compressive, tensile and bearing areas and has a smooth upper surface to protect vessels and panels. The central socket makes installation fast and simple.



	Legacy stud fixing			QuayQuipTS boss			QuayQuipTS low profile		
Thickness†	30mm	40mm	50mm	30mm	40mm	50mm	30mm	40mm	50mm
Wear allowance	3mm	10mm	15mm	4mm	12mm	17mm	12mm	20mm	25mm
Compression shadow*	0.85			1.0			1.3		
Strength ratio	0.25			1.0			2.0		

Values are indicative and are relative except for wear allowance. †Please ask about other, less common thickness values.

QuayQuip Technical Solutions PE fixings are available in galvanised or stainless 316 finishes.

*Compression shadows are illustrated in orange under the fixing washers.

Curved Facings

QuayQuip Technical Solutions curved UHMW-PE facings are the first of their kind. The unique profile smooths vessel transitions across the face of the panel and around corners, and offers greater side impact protection than traditional sharp corners.

A 300mm outside radius is standard, but curved facings can be designed to match any project specification, and made in any of our regular colours. Learn more by contacting your local QuayQuip Technical Solutions office.

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	Property	Unit	Method	Specimen	Test	Typical Value		
						Virgin 1st	Virgin FQ*	Regen
Physical properties	Molecular weight (Margolies)	g/mol	ASTM D6474 *(no equiv. ISO)*	Powder (raw material)	YES	>4 × 10^6	>4 × 10^6	>4 × 10^6
	Specific density (ρ)	g/cm³	ISO 1183	Sheet T = <40mm	YES	~0.93–0.95	~0.94–0.96	~0.94
Thermal properties	Service temperature range	°C	N/A	-	NO	+80 / –80	+80 / –80	+80 / –40
	Crystalline melting point	°C	ISO 3146	Powder (raw material)	YES	130–140	130–140	130–140
	Thermal expansion	k^{-1}	ISO 11359-2	-	NO	2 × 10^{-4}	2 × 10^{-4}	2 × 10^{-4}
	Specific Heat	kJ/(kg.K)	ISO 8302	-	NO	2.05	2.05	2.05
Mechanical properties	Tensile strength	MPa	ISO 527-2	Multipurpose specimen	YES	≥40	≥33	≥33
	Yield strength	MPa	ISO 527-2	Multipurpose specimen	YES	≥17	≥17	≥17
	Yield elongation	%	ISO 527-2	Multipurpose specimen	YES	≥8	≥8	≥8
	Break elongation	%	ISO 527-2	Multipurpose specimen	YES	≥50	≥50	≥45
	Notch impact strength	kJ/m²	ISO 179-1	120 x 15 x 10 mm	YES	≥130 *(no break)*	≥130 *(no break)*	≥130 *(no break)*
	Ball hardness (30s)	MPa	ISO 2039–1	Sheet 4 mm	YES	≥35	≥35	≥35
	Shore hardness	HD	ISO 868	Sheet 6 mm	YES	≥60	≥60	≥60
	Flexural strength	MPa	ISO 178	-	YES	≥27	≥27	≥24
	Elastic modulus	MPa	ISO 527-2	Specimen in acc. to ISO 3167	YES	≥650	≥650	≥650
Chemical properties	Dynamic friction coef. Wet	-	ISO 8295	-	YES	<0.10	<0.15	<0.25
	Dry	-				0.10–0.15	0.15–0.20	0.22–0.30
	Abrasion resistance	Virgin = 100	Sand slurry *ISO 15527*	-	YES	100	130–150	130-150
	Carbon Black Content	%(m/m)	ISO 11358	Multipurpose specimen	Optional	<2.5	<2.5	<2.5

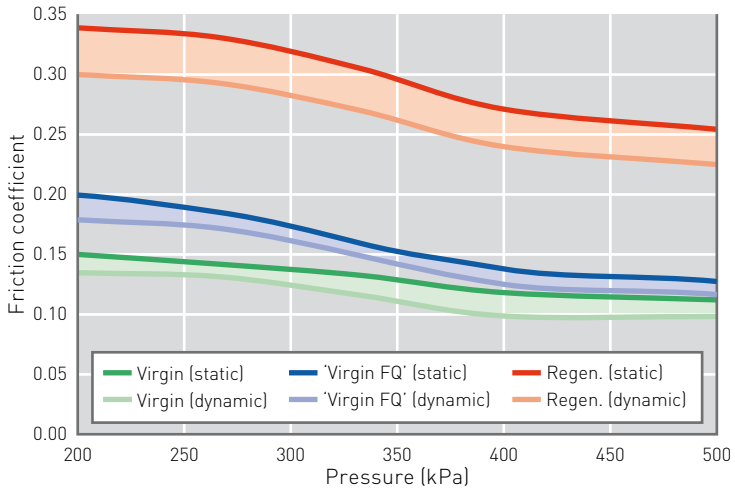
Note to users:

All testing at 23°C.
This data was determined on powder or test specimens prepares form compression moulded sheet T = ≤ 40mm. | Depending on the conditions of specimen preparations, individual measurements may deviate from these values. | Due to the production process the data may vary depending on the material thickness. The information contained in this technical data sheet can not be construed as a promise or guarantee of specific properties of our products.

Friction Coefficients

Friction coefficients vary according to the material grade and contact pressure.

Grade	Design value
Virgin 1st	≤ 0.15
Virgin FQ	< 0.20
Regen	≤ 0.30



1 Curves are for dry, painted steel. Values increase for bare or rusted steel.
2 Values reduce for wet conditions.

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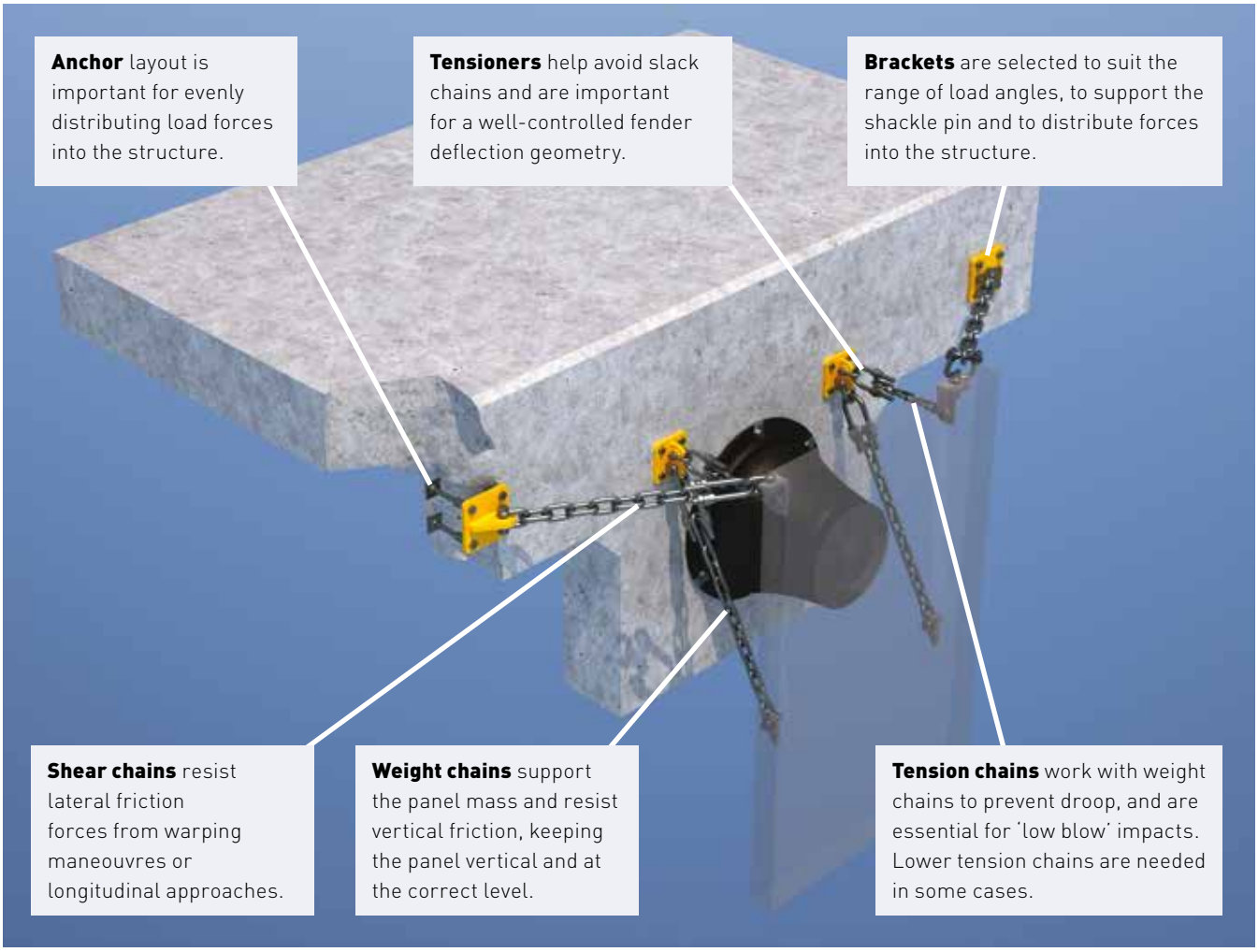
Chain Systems



Correctly designed and detailed chain systems are essential for proper fender performance and controlling deflection geometry.

Chain systems should be considered as early as possible during fender design as their configuration can determine the functionality and load paths of the system as a whole.

QuayQuip Technical Solutions chain systems are matched with compatible components – chain, shackle, tensioner and bracket. Other grades and sizes are available to give designers more flexibility and choice.

Using chain system tables

The tables are a preliminary guide and a full check should be done as part of the detail design process. The chain forces are related to maximum working load under normal berthing conditions.

Safety Factors (Normal)	Chains: ⩾3.0 Bolts: ⩾1.5 Brackets: ⩾1.5 Anchors: ⩾1.5	according to PIANC, EAU, etc.
Fixing bolts	Each bracket is typically fixed with 4 bolts (or anchors).	
Finish	All chain components are hot dip galvanised (typically 100µm) except: Threaded items – spin galvanised Shackle pins – zinc plated	
Shackles	Standard shackles are Safety-D Grade S6. Grade T8, bow shackles and other options are available. All shackles are fitted with stainless steel split pins.	
Load fuses	Chain systems can be designed using a shackle or other easily replaceable component as a load fuse to protect anchors and structure (as recommended by PIANC).	

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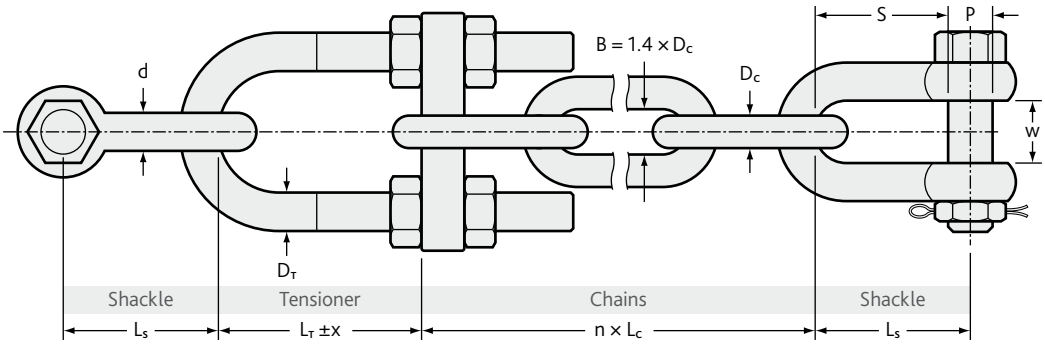
Chain Systems



n = odd for out-of-plane shackles

n = even for in-plane shackles (as diagram)

To avoid twists in the chain, use an odd or even number of links to match bracket orientation.

Chains

D_c	U2							U3		
	NBL	3.5D		4D		5D		NBL	4D	
		L_c	Weight	L_c	**Weight**	L_c	Weight		L_c	Weight
20	264	70	0.6	**80**	**0.6**	100	0.7	330	80	0.6
22	304	77	0.8	**88**	**0.8**	110	1.0	380	88	0.8
24	362	84	1.0	**96**	**1.1**	120	1.3	453	96	1.1
26	424	91	1.3	**104**	**1.4**	130	1.6	530	104	1.4
28	492	98	1.6	**112**	**1.7**	140	2.0	616	112	1.7
30	566	105	2.0	**120**	**2.1**	150	2.5	706	120	2.1
32	644	112	2.4	**128**	**2.6**	160	3.0	804	128	2.6
34	726	119	2.8	**136**	**3.1**	170	3.6	908	136	3.1
36	814	126	3.4	**144**	**3.7**	180	4.2	1020	144	3.7
38	908	133	4.0	**152**	**4.3**	190	5.0	1130	152	4.3
40	1010	140	4.6	**160**	**5.0**	200	5.8	1260	160	5.0
42	1110	147	5.4	**168**	**5.8**	210	6.7	1390	168	5.8
44	1220	154	6.2	**176**	**6.7**	220	7.7	1520	176	6.7
46	1330	161	7.0	**184**	**7.6**	230	8.8	1660	184	7.7
48	1450	168	8.0	**192**	**8.7**	240	10.1	1810	192	8.7
50	1570	175	9.0	**200**	**9.8**	250	11.4	1960	200	9.8
55	1900	193	12.0	**220**	**13.1**	275	15.1	2380	220	13.2
60	2260	210	15.6	**240**	**17.0**	300	19.6	2770	240	17.0

Preferred chain sizes are highlighted.

D-Shackles

d	S6						T8						Split Pin (SS316)
	NBL	L_s	W	P	S	Weight	NBL	L_s	W	P	S	Weight	
19.0	237.5	71.5	32.0	20.5	60.5	1.04	350	71.5	32.0	20.5	60.5	1.04	4 × 36
22.5	325	85.0	36.5	24.5	71.5	1.63	475	85.0	36.5	24.5	71.5	1.63	4 × 36
25.5	425	96.0	43.0	25.5	81.0	2.38	625	96.0	43.0	25.5	81.0	2.38	4 × 45
29.0	475	107	46.0	32.0	91.0	3.59	750	107	46.0	32.0	91.0	3.59	4 × 50
32.0	600	118	51.5	35.0	100	4.65	900	118	51.5	35.0	100	4.65	4 × 55
35.0	675	130	57.0	38.0	111	6.71	1050	130	57.0	38.0	111	6.71	4 × 55
38.0	850	143	60.5	41.0	122	8.05	1500	143	60.5	41.0	122	8.05	5 × 60
44.5	1250	172	73.0	54.0	146	13.18	2000	172	73.0	54.0	146	13.18	6 × 70
51.0	1750	201.5	82.5	51.0	171.5	19.30	2500	202	82.5	51.0	172	19.30	6 × 75
66.5	2750	239	105	66.5	203	37.22	4000	239	105	66.5	203	37.22	10 × 85

PIANC suggests that an easily replaceable component should fail first in overloaded chain systems. [Units: mm, kN, kg]

Shackles are commonly used as a load fuse. Other shackle sizes and grades are available on request.

Tensioners

D_T	Chain D_c (U2)	L_T±x	Weight each
30	20–24	163±82	6.0
36	26–32	179±112	9.1
45	34–40	204±120	21
60	42–50	302±185	50

For larger sizes, please refer to QuayQuip Technical Solutions. [Units: mm, kg]

Crossover Plates

Crossover plates are used for compact shear chain arrays. Please ask QuayQuip Technical Solutions for more details.

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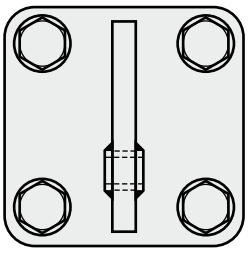
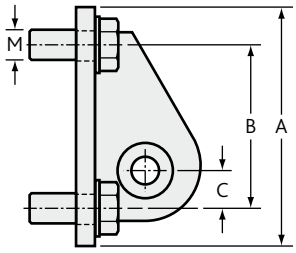
Chain brackets

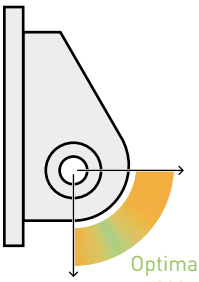
Dimensions

Chain angles

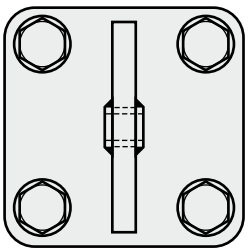
Type QB1

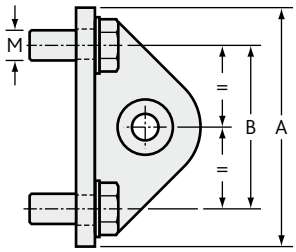


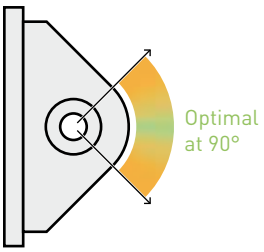




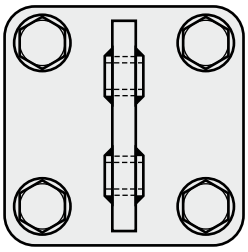
Type QB2

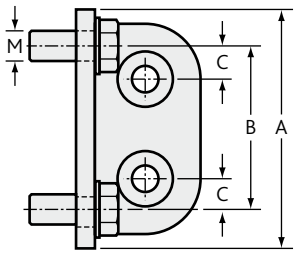


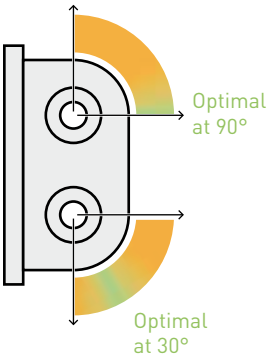




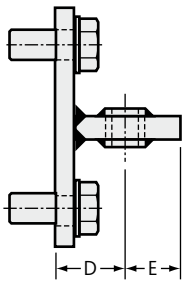
Type QB3







Type	Applications		
	Shear	Weight	Tension
QB1	✓	✓	
QB2			✓
QB3		✓	✓



Chain size D_c	⌀A	⌀B	C	D	E	Bolt
20	200	140	30	60	45	4×M20
26	260	170	40	70	60	4×M24
32	320	220	50	90	70	4×M30
38	380	260	60	110	85	4×M36
44	440	300	70	120	105	4×M42
50	500	340	80	140	125	4×M48
60	600	410	95	175	150	4×M56

Example D_c refers to U2 grade chains. [Units: mm]

Please ask QuayQuip Technical Solutions for details of baseplate thicknesses.

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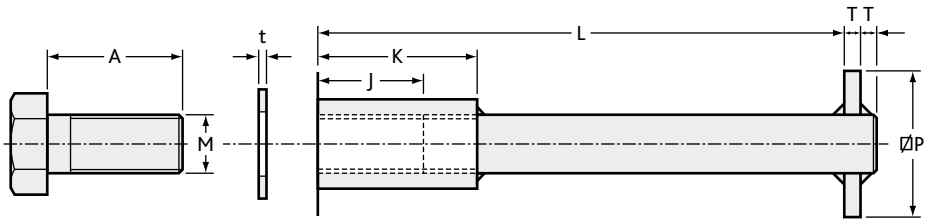
Anchors

CS-type cast-in anchors

CS-type provide high holding power for securing fenders and chain brackets to new concrete. They have a female socket (ferrule) with long tail, easily customised for special applications.

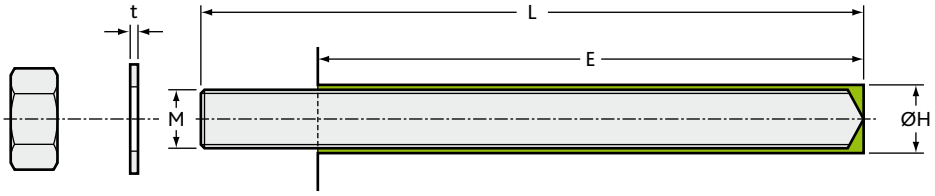


Bolt		Washer	Cast-in Socket				
Size	A[1]	t_{min}	J	K	L[2]	T	P
M20	Varies according to clamping thickness	3	40	60	180	10	65
M24		4	48	72	220	10	75
M30		4	60	90	280	10	100
M36		5	72	108	336	12	100
M42		7	84	126	396	12	100
M48		8	96	144	448	16	100
M56		9	112	168	528	16	120
M64		10	128	192	600	20	130
M76		12	152	228	720	20	150

1. Bolt threads may require undercutting when galvanised bolts and sockets are specified [Units: mm]
2. Extra long and non-standard dimensions are available

RF-type chemical anchors

RF-type anchors suit most retrofit installations. Standard lengths typically suit 30N concrete and better. Longer studs are used for weaker concrete and special cases. Glass capsule and other grouting systems are available.



Size	L	t_{min}	E	ØH	Vol.+10%	Capsules
M20	Varies according to clamping thickness	3	170	25	33	1-E20
M24		4	210	28	38	1-E24
M30		4	280	35	79	1-E30
M36		5	330	42	133	1-E30
M42		7	420	48	196	2-E30
M48		8	480	54	254	2-E30 + 1-E24
M56		9	560	64	464	4-E30
M64		10	On request			
M76		12				

1. Cartridge and capsule grout systems are available
2. All holes must have roughened sides and be free from debris
3. Extra long and non-standard dimensions are available

[Units: mm, cm^3]

Materials

All QuayQuip Technical Solutions anchors are available in galvanised finish and a range of stainless steel grades, and are all inspected and certified to recognised international standards. Stainless steel options include austenitic, duplex and super-duplex grades to suit any environment. Isolating bushes are available where contact between dissimilar metals must be avoided.

Anchor Materials

Standard Anchor Materials	ISO EN	ASTM	Finish	PREN
High Tensile	8.8	A325/A449	Spin Galvanised	N/A
Stainless Steel (Austenitic)	1.4401	316	Self Colour	23.1–28.5
Stainless Steel (Duplex)	1.4462	S31803	Self Colour	30.8–38.1
Stainless Steel (Zeron 100)	1.4501	–	Self Colour	40.0–44.0

PREN = Pitting Resistance Equivalent Number

Grout Capsule Cure Times

Cure Times	Base Material Temperature			
	≥20°C	11–20°C	6–10°C	≤5°C
Above water (dry)	30 mins	1 hour	3 hours	Please consult QuayQuip Technical Solutions
Below water (wet)	1 hour	2 hours	6 hours	

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Rubber properties

QuayQuip Technical Solutions Rubber compounds are designed for long life in marine environments. All fenders are made using high quality natural and/or synthetic rubber compounds, formulated for high performance and reliability.

Rubber compounds include additives to resist the effects of ozone and ultra-violet light. The vulcanisation process (temperature, pressure and time) is strictly controlled to ensure a homogenous product with excellent physical properties and rubber to metal bond strengths.

- Marine grade compounds
- Natural and/or synthetic
- Resists ozone and UV
- Excellent bond strengths
- Fully homogeneous
- Fully recyclable

QuayQuip Technical Solutions moulded rubber fender compounds also comply to ASTM D 2000 callouts:
3BA 720 A14 B13 C12 EA14 F17
3BA 620 A14 B13 C12 EA14 F17

Physical properties	Unit	Test method	Value	Test
Tensile strength	MPa	ISO 37	≥16	Yes
Elongation at break	%	ISO 37	≥350	Yes
Tear strength	N/mm	ISO 34–1 (Graves)	≥70	Yes
Hardness	HA	ISO 868	≤78	Yes
Change in Tensile Strength Aged for 96h at 70°C	%	ISO 188	≤20	Yes
Change in Elongation at Break Aged for 96h at 70°C	%	ISO 188	≤20	Yes
Change in Hardness Aged for 96h at 70°C	HA	ISO 868	≤6	Yes
Compression Set	%	ISO 815	≤30	Yes
Ozone resistance 50pphm at 20% strain, 40°C, 100h	–	ISO 1431–1	No cracks	Yes
Volume Change in Oil (ASTM Oil 1)	%	ISO 1817	≤10	Optional⁺
Volume Change in Seawater 36g NaCl/litre; 28 days, 95°C	%	ISO 1817	–5 to +10	Optional⁺
Abrasion Resistance	mm^3	ISO 4649	≤100	Optional⁺
Bond Strength	N/mm^2	ISO 814	≥7	Optional⁺
Dynamic Fatigue* (15000 cycles)	-	ISO 132	Grade 0–1	Optional⁺
Low Temperature Resistance	-	ISO 812	Pass	Optional⁺

Tested properties are verified for each batch of parent material and certification to EN 10204: 3.1 is provided
* Grade 0: no cracks (pass). Grade 1: ≤10 pinpricks under 0.5mm long (pass). Grade 2 and above is fail.
⁺Additional properties can be tested and/or third party witnessed on request at extra cost.

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Flosys material properties

Polyethylene foam core

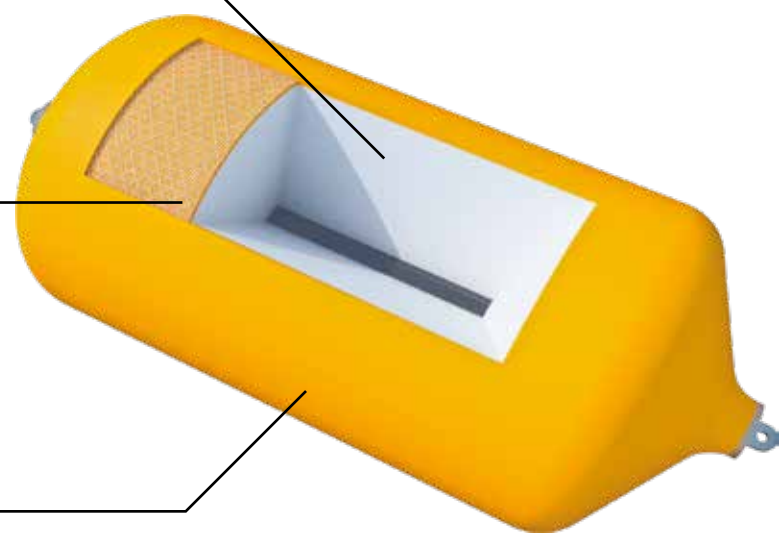
Property	Standard
Density	58–70 kg/m³
Tensile strength	⩾414kPa
Elongation at break	⩾140%
Water absorption	<1kg/m² of cut surface

Filament reinforcement

Property	Standard
Filament size	2520 denier
Tensile strength	⩾230N
Elongation at break	⩾16%
Filament spacing	4mm (typical)

Polyurethane skin

Property	Standard
Hardness	75–95 Shore A
Tensile strength	⩾13.8MPa
Elongation at break	⩾350%
Tear strength	⩾32kN/m



Tolerances

QuayQuip Technical Solutions fenders are manufactured to strict quality standards, inspected and certified to EN 10204 : 3.1. We can usually accommodate other tolerances and inspection levels on request and prior to order confirmation.

Type	Property	Tolerance
Cone, Cell, Element, Arch	Dimensions	±3% or ±2mm (whichever is larger)
	Hole centres	±2mm
	Performance	±10%
QuayGuard, Donut	Performance	±15%
Pneumatic	Performance	±10% (on reaction at guaranteed energy absorption)
Cylindricals	Diameter (ID & OD)	±4% or 5mm (whichever is larger)
	Length	–0/+40mm
	Drilling	±4mm (non-cumulative)
	Performance	±10% (wrapped, subject to fixing methods)
		±20% (extruded, subject to fixing methods)
Extrusions	Cross-section	±4% or 5mm (whichever is larger)
	Length	–0/+40mm
	Performance	±20% (subject to fixing methods)
UHMW-PE Pads	Length & width	±5mm (cut sheets)
	Thickness	±0.3mm (planed, t < 100mm)
		±0.5mm (planed, t ⩾ 100mm)
	Drilling	±2mm (non-cumulative)
	Counterbore depth	±4mm (under head thickness)

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Performance Testing

QuayQuip Technical Solutions routinely tests fenders to verify their consistent performance and quality. Testing facilities are independently managed by government approved operators to guarantee the accuracy and authenticity of results. Client and third party attendance during testing is also welcomed.

Test Protocol

QuayQuip Technical Solutions adopts the latest verification testing protocols defined by PIANC[1] and ASTM[2] to confirm fenders meet the published Rated Performance Data (RPD) for QCN cones, QCL cells and QME elements[3].

Calibration	Test apparatus is calibrated to ±1% and independently certified.
Identification	Fenders are identified with a unique serial number and job reference number to allow full document traceability. RFID tag identification is available on request for some fender types.
Sampling	10% (min) of randomly selected fenders are tested, rounded up to the nearest whole unit. More frequent testing can be carried out on request[4] . Sampling of the remaining fenders is increased to 20% if any fender does not meet the required values and to 100% if further fenders do not meet the required values.
Dimensions	Primary dimensions of the fenders are measured and recorded.
Preparation	Prior to verification tests, fender samples will be preconditioned by compressing three or more times to rated deflection and allowed to recover for at least one hour. Fenders may then be normalised (see below) if required.
Test conditions	Test speed is steady state 0.3–1.3mm/s (typically 1mm/s) Fender temperature is normalised to 23°C ±5°C Testing is under axial compression (0° angle)
Normalising	If fenders are stored at an ambient temperature of 23°C ±10°C for more than 8 hours, then fenders shall be "normalised" in a temperature controlled environment at 23°C ±5°C for a time not less than $t = 20X^{1.5}$ (where X = greatest wall thickness of rubber in metres).
Results	Reaction and deflection shall be recorded at maximum intervals of 0.01H–0.05H (where H = nominal fender height). Energy absorption is integrated from the Reaction v deflection curve.
Pass criteria	Fenders pass the verification performance test if low end energy (RPD -10% tolerance) is achieved without exceeding high end reaction (RPD +10% tolerance) at any point during the compression cycle.

PIANC guidelines also recommend that all rubber fender units with RPD ≥ 1000kN to be installed on monopiles, pile-supported jetties or other load sensitive structures shall be given at least one full compression cycle to stress relieve (condition) them prior to use.

1 PIANC Marcom Report of WG33 – Guidelines for the Design of Fender Systems (2002).

2 ASTM F 2192-05 Standard Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders.

3 Testing of other fender types (Arch, Cylindrical etc) follows a similar format – please ask QuayQuip Technical Solutions for details.

4 Increased test frequency is an optional extra cost item.

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PIANC Factors

Rated Performance Data

PIANC 2002 defines the testing methods for fenders and how results shall be reported.

Fender performances are benchmarked at the following standardised datums:

Angle	0°
Temperature	23°C ±5°C
Initial Velocity	150mm/s
Tolerance	±10%

QuayQuip Technical Solutions Type Approval test programme has confirmed the factors below for angle, temperature and initial impact speed that should be applied to Rated Performance Data (RPD) where operating conditions differ from datum values. Values are derived according to PIANC[1] and ASTM[2] recommendations.

Additionally, project specifications may require fender tolerances to be considered. Engineering judgement and a probabilistic design analysis should be used to assess if it is realistic for multiple worst case events to arise simultaneously.

In all cases the minimum energy absorption capacity of fenders or fender systems should be greater than the 'Required Energy' of berthing ships as defined by PIANC[1].

Fender Type						Size	Initial Impact Speed (mm/s)						
QCN	QCL	QME	QSA	QPA	QCY		1	50	100	150	200	250	300
			■	■		200	0,92	0,94	0,97	1,00	1,03	1,06	1,08
			■	■		250	0,93	0,95	0,98	1,00	1,02	1,05	1,07
		■	■	■		300	0,94	0,96	0,98	1,00	1,02	1,04	1,06
■						350	0,94	0,96	0,98	1,00	1,02	1,04	1,06
■	■	■	■	■	■	400	0,94	0,96	0,98	1,00	1,02	1,04	1,06
■	■	■	■	■		500	0,95	0,97	0,98	1,00	1,02	1,03	1,05
		■				550	0,95	0,97	0,98	1,00	1,02	1,03	1,05
■		■	■	■	■	600	0,96	0,97	0,98	1,00	1,01	1,03	1,04
	■					630	0,96	0,97	0,99	1,00	1,01	1,03	1,04
■						700	0,96	0,98	0,99	1,00	1,01	1,02	1,04
		■				750	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■	■	■	■	■	■	800	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■						860	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■						900	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■						950	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■	■	■			■	1000	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■						1050	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■						1100	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■	■					1150	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■					■	1200	0,97	0,98	0,99	1,00	1,01	1,02	1,03
■	■	■				1250	0,98	0,98	0,99	1,00	1,01	1,02	1,02
■						1300	0,98	0,99	0,99	1,00	1,01	1,01	1,02
■					■	1400	0,98	0,99	0,99	1,00	1,01	1,01	1,02
■	■	■				1450	0,98	0,99	0,99	1,00	1,01	1,01	1,02
■						1500	0,98	0,99	0,99	1,00	1,01	1,01	1,02
■	■	■			■	1600	0,98	0,99	0,99	1,00	1,01	1,01	1,02
	■					1700	0,99	0,99	1,00	1,00	1,01	1,01	1,02
■					■	1800	0,99	0,99	1,00	1,00	1,00	1,01	1,01
■	■				■	2000	0,98	0,99	0,99	1,00	1,01	1,01	1,02
	■					2250	0,98	0,99	0,99	1,00	1,01	1,01	1,02
	■					2500	0,99	0,99	1,00	1,00	1,00	1,01	1,01
	■					3000	0,99	0,99	1,00	1,00	1,00	1,01	1,01

Velocity Factors

Rubber is viscoelastic so the faster the impact, the stiffer the material appears to be.

Factors given are based on a linear deceleration over the full fender deflection.

Small fenders at high impact speeds are more affected than large fenders at low speeds. In most common cases, variance to RPD is minimal and may be ignored.

Angle Factors

Performance varies according to the angle of compression. Standard PIANC angles are given, other angles may be interpolated.

Temperature Factors

Rubber gets softer at high temperatures (lower energy) and stiffer when cooled (higher reaction), relative to PIANC datum.

	QCN Cone Fenders		QCL Cell Fenders		QME Elements*		QSA/QPA Arch	
Angle	E-factor	R-factor	E-factor	R-factor	E-factor	R-factor	E-factor	R-factor
0	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
3	1.01	1.00	0.98	1.00	0.99	1.00	0.97	1.00
5	1.00	1.00	0.95	1.00	0.99	1.00	0.95	1.00
8	0.99	1.00	0.91	1.00	0.96	1.00	0.91	1.00
10	0.98	1.00	0.88	1.00	0.93	1.00	0.88	1.00
15	0.93	1.00	0.81	1.00	0.81	1.00	0.80	1.00
20	0.87	1.00	0.65	1.00	0.71	1.00	0.73	1.00

Temperature	Factor
+50°C	0.91
+40°C	0.94
+30°C	0.97
+23°C	**1.00**
+10°C	1.05
+0°C	1.10
-10°C	1.15
-20°C	1.20
-30°C	1.26

*Sectionwise compression at $W_s = 1.2H$

⁺ Sectionwise compression

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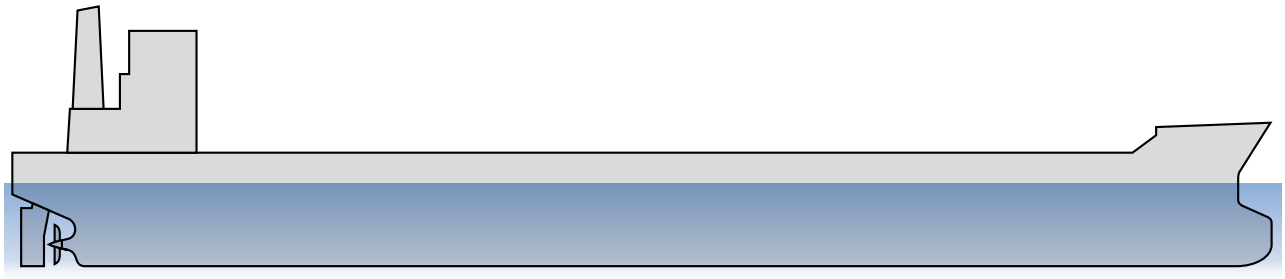
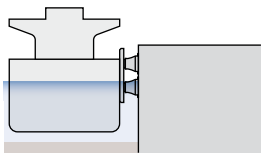
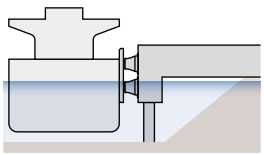
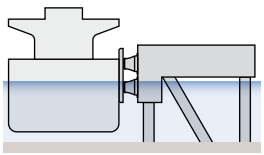
Questionnaire

Port		**Contact**	
Berth Type		**Company**	
Country		**Tel**	
Project	☐ New Build ☐ Upgrade	**Email**	
Status	☐ Preliminary ☐ Detail ☐ Tender	**Web**	

VESSELS	*Provide data for largest, smallest and intermediate ships if available.*				
					
Type			**Type**		
Class (ie LNG)			**Class (ie LNG)**		
Deadweight			**Deadweight**		
Displacement			**Displacement**		
Length	L_{OA}	L_{BP}	**Length**	L_{OA}	L_{BP}
Beam			**Beam**		
Draft	Laden	Ballast	**Draft**	Laden	Ballast
Hull Pressure			**Hull Pressure**		

STRUCTURE				
Construction	 ☐ Closed face	 ☐ Semi-closed face	 ☐ Open (ie dolphin)	☐ Other
Type	☐ Jetty ☐ Dolphin ☐ Pontoon ☐ Lock ☐ Other		**Deck level**	
			Soffit level	
			High tide	
Fender c/c			**Low tide**	
Load limit			**Seabed**	

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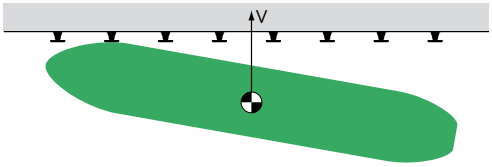
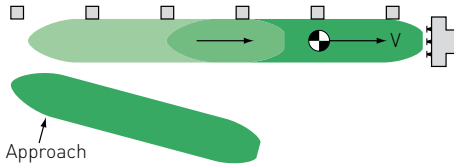
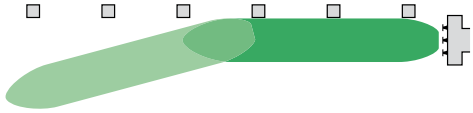
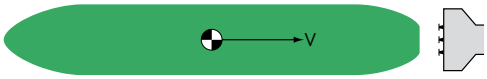
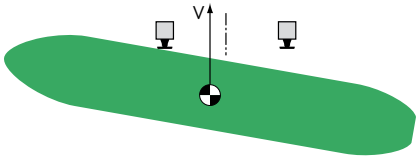
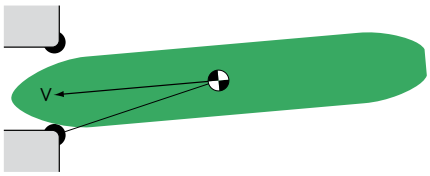
Questionnaire

ENVIRONMENT			
Climate	☐ Temperate ☐ Tropical ☐ Desert ☐ Sub-arctic		
Temperature	Minimum	**Corrosivity**	☐ Low
	Maximum		☐ Medium
	High humidity		☐ High
	Low humidity		☐ Extreme
Wind speed		**Current speed**	

OPERATIONS			
Side berthing (Mode A)		**Berthing speed**	
		Berthing angle	
		Safety factor	
Side berthing (Mode B)		**Berthing speed**	
		Berthing angle	
		Safety factor	
Side berthing (Mode C)		**Berthing speed**	
		Berthing angle	
		Safety factor	
End berthing		**Berthing speed**	
		Berthing angle	
		Safety factor	
Dolphin berthing		**Berthing speed**	
		Berthing angle	
		Safety factor	
Lock entrance		**Berthing speed**	
		Berthing angle	
		Safety factor	

Other information		**Design method**	☐ BS6349-4
			☐ PIANC 2002
			☐ EAU-2004
			☐ ROM 0.2-90
			☐ Other

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Tried and Tested

Wemyss Bay ferry terminal, Wemyss Bay, Scotland

The Riverside Resource Recovery Facility (RRRF), London United Kingdom

Sulphur Point Wharf Extension. Port of Tauranga, New Zealand

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Conversion Factors

Distance

	m	ft	in
1 m =	1	3.281	39.37
1 ft =	0.3048	1	12
1 in =	0.0254	0.0833	1

Force

	kN	tonne-f	kip-f
1 kN =	1	0.102	0.225
1 tonne-f =	9.81	1	2.2046
1 kip-f =	4.45	0.454	1

Area

	m^2	ft^2	in^2
1 m^2 =	1	10.764	1550
1 ft^2 =	0.0929	1	144
1 in^2 =	645.2×10^{-6}	6.944×10^{-3}	1

Energy

	kJ	tf-m	kip-ft
1 kJ =	1	0.102	0.7376
1 tf-m =	9.81	1	7.23
1 kip-ft =	1.36	0.14	1

Volume

	m^3	ft^3	in^3
1 m^3 =	1	35.315	61024
1 ft^3 =	0.0283	1	1728
1 in^3 =	16.387×10^{-6}	578.7×10^{-6}	1

Pressure

	kPa	t/m^2	kip/ft^2
1 kPa =	1	0.102	0.0209
1 t/m^2 =	9.81	1	0.205
1 kip/ft^2 =	47.9	4.88	1

Acceleration

	g	m/s^2	ft/s^2
1 g =	1	9.807	32.17
1 m/s^2 =	0.102	1	3.281
1 ft/s^2 =	0.031	0.3048	1

Velocity

	m/s	ft/s	km/h	knot
1 m/s =	1	3.2808	3.6	1.9438
1 ft/s =	0.3048	1	1.0973	0.5925
1 km/h =	0.2778	0.9113	1	0.54
1 knot =	0.5144	1.6878	1.852	1

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