

mooring for offshore renewables.

Floating Offshore Wind Turbines (FOWT), Tidal,
Waves, Floating Solar



the trusted name for mooring offshore renewable assets.

BRIDON · BEKAERT THE ROPES GROUP

Bridon-Bekaert Ropes Group is the world's premier supplier of mission-critical advanced cords, steel wire ropes, and synthetic fibre ropes.

As a leading innovator, developer and producer of the best performing ropes and advanced cords globally, the Group provides superior value solutions to the oil & gas, mining, crane, elevator, renewables, and other industrial sectors.

Two of the most enduring wire and rope pioneers joined forces in 2016 to make this ambition real. Bridon-Bekaert Ropes Group has a global manufacturing footprint and employs approximately 2500 people worldwide.

Ever since our supply of mooring lines on Exxon Lena, the first floating platform in 1983, we have continued to push boundaries, be it with the first synthetic moored truss spar (BP Mad Dog, 2004), the first floating FLNG facility (Shell Prelude, 2013), the deepest fibre spar (Shell Perdido, 2007), the first HMPE Drilling Rig Mooring (JW Maclean, 2009) or simply the longest steel lines (SHI Egina, 2014).

Our legacy and track record shapes our unique position in serving the renewable market. For emerging applications such as floating wind, BBRG stands on its long experiences in current mooring industries (including single point mooring, aquaculture mooring, fpos mooring, lng tanker mooring, and MODU mooring) to solve unique challenges as they develop.

floating wind mooring.

Offshore wind is a route to decarbonize the global energy mix and increase security of local energy supply throughout the world. Cable mooring concepts that allow turbines to float are emerging as key technology for offshore wind to realize its full potential. With shallow water dynamics, a tight watch circle, and new installation concepts, floating wind turbine application challenges the industry to rethink its offering and setup.

We listen

Through our early work in joint industry projects and pilot demonstrators, Bridon-Bekaert understands the following:

- The need to reconcile high line compliance needed for shallow water operation with targeted +20 year design life
- The need to look into options to mitigate marine growth and biofouling, and associated seabed contact risk
- The need to design and manufacture with easy & fast installation, with industrial scale of a wind farm in mind
- The need for fast and efficient manufacture to keep up with the scale of demand
- The need for an integral approach to risk management. Pilots aren't meant to fail.

We co-develop

With our broad offering of both steel and synthetic solutions, our global manufacturing footprint, and our local proximity, Bridon-Bekaert is uniquely positioned to support the further acceleration of your floating wind ambition. As in all of our markets, we do that in close cooperation with our customers.

We act

As part of the Japan-Scotland subsea partnership, Bridon-Bekaert is engaged in the durability assessment of mooring lines and design optimization of mooring system for floating offshore wind turbines.



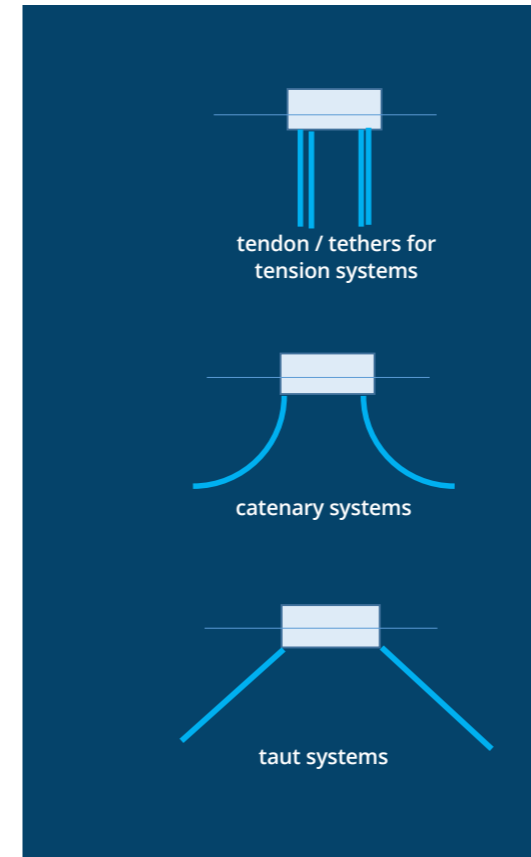
As part of the European funded Mooringsense project, Bridon-Bekaert contributes to the development of efficient risk-based integrity management strategies based on affordable and reliable on-line monitoring technology, including the development of a Mooring System Digital Twin (DT).



As part of the Joint Industry Project "Fiber rope mooring systems for floating offshore wind turbines" led by the Institute for Energy Technology in Norway (IFE), Bridon-Bekaert contributes to the continued evaluation of fibre rope concepts for floating wind mooring.



Supporting your design with a complete portfolio of mooring rope solutions, covering all common mooring configurations from the topside to anchor point.



- ✓ Access to all premier grade load bearing core materials and rope configurations
- ✓ Complementary top and bottom chain insert as part of 'full line package'
- ✓ A range of steel and synthetic mooring cables to suit the specific challenges of floating wind mooring
- ✓ Enhanced jacket configurations for improved abrasion and cut resistance
- ✓ Easy to connect Thimbles/Shackles/Sockets connectors compatible with your topside interface
- ✓ Material characterisation and operating logs in various ambient conditions
- ✓ Various integrated and distributed buoyancy aids & floatation systems

Case study

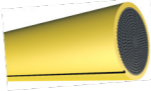




As a Joint Industry Project administered by the Carbon Trust and supported by the Scottish Government, Bridon-Bekaert conceived a special nylon fiber rope with superior fatigue endurance over conventional nylon ropes thanks to a combination of proprietary wet yarn coating properties and our parallel subrope type rope construction.

Extensive laboratory testing was carried out on this new rope, including 20 million fatigue cycles.

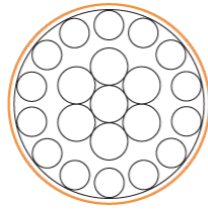
Prototypes have been deployed and are undergoing field experience on two trial locations.



Bridon-Bekaert's mooring team is ready to co-engineer with you what material class and cable configuration best meets your mission requirements.

	Diameter (mm) at 900t MBL	Linear Weight (in Air) kg/m	Static Modulus (x MBL)	Dynamic Modulus (x MBL)
 Steel Spiral Strand	90	42,0	90-120	-
 Polyester	178	20,4	10-16	20-35
 Nylon	176	18,3	1-10	5-30
 HMPE	115	10,0	50-70	60-100
 Hybrid Fibre/Steel	104	41,0	50-70	-

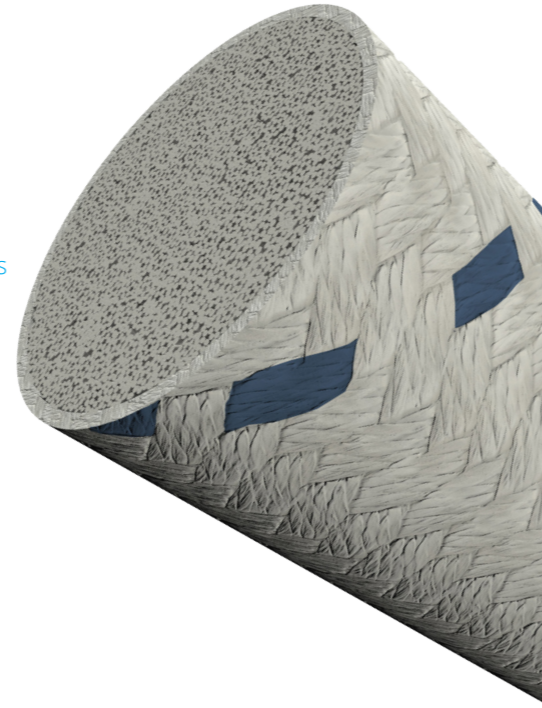
MoorLine Polyester



MoorLine Polyester is the original standard for long-term fibre rope mooring systems. Made from parallel laid, polyester sub-ropes encased in a polyester jacket with an integrated particle filter system, its design is optimized for operating life up to 25 years and beyond.

MoorLine Polyester and Spiral Strand comply with DNVGL, ABS, Bureau Veritas and Lloyds Register requirements. BBRG are DNVGL approved manufacturers of both products.

- ✓ High strength efficiency
- ✓ Damage and abrasion resistant protective braided jacket
- ✓ Patented filter system - provides protection from particles down to 5 microns in diameter
- ✓ Compact splice for fatigue life and damage integrity
- ✓ Low maintenance



Diameter*	Linear Weight		Minimum Breaking Force
	In Air	In Water	Spliced**
mm	kg/m	kg/m	kN
138	12.2	3.1	4,905
149	14.3	3.7	5,886
160	16.4	4.2	6,867
169	18.4	4.7	7,848
178	20.4	5.3	8,829
187	22.5	5.8	9,810
195	24.4	6.3	10,791
203	26.5	6.8	11,772
213	29.4	7.6	12,753
219	31.3	8.1	13,734
226	33.4	8.6	14,715
234	35.6	9.2	15,696
240	37.5	9.7	16,677
248	39.5	10.2	17,658
254	42.5	10.9	18,639
260	44.6	11.5	19,620
266	46.5	12.0	20,601
271	48.5	12.5	21,582
277	50.7	13.0	22,563
282	52.7	13.6	23,544
290	55.8	14.4	24,525
295	57.9	14.9	25,506
300	59.9	15.4	26,487

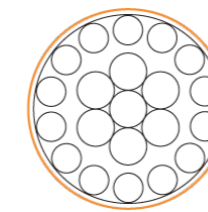
* Diameter and weight values shown at reference load of 1% MBF for a given break load. Other sizes available. Contact fibresales@bridon-bekaert.com

** Tested following C11500B-2015. Elongations are immediate
Diameter and linear density values are nominal
Break forces tested wet using DNVGL and ABS recommended procedures

Data tables are for guidance purposes only with no guarantee or warranty (express or implied) as to its accuracy. The products described may be subject to change without notice, and should not be relied on without further advice from Bridon-Bekaert. The cross section images are for reference only. Actual cross sections vary due to diameter. Visit www.bridon-bekaert.com for the most up-to-date data.

MoorLine Polyester and Spiral Strand comply with DNVGL, ABS, Bureau Veritas and Lloyds Register requirements. BBRG are DNVGL approved manufacturers of both products

MoorLine Nylon



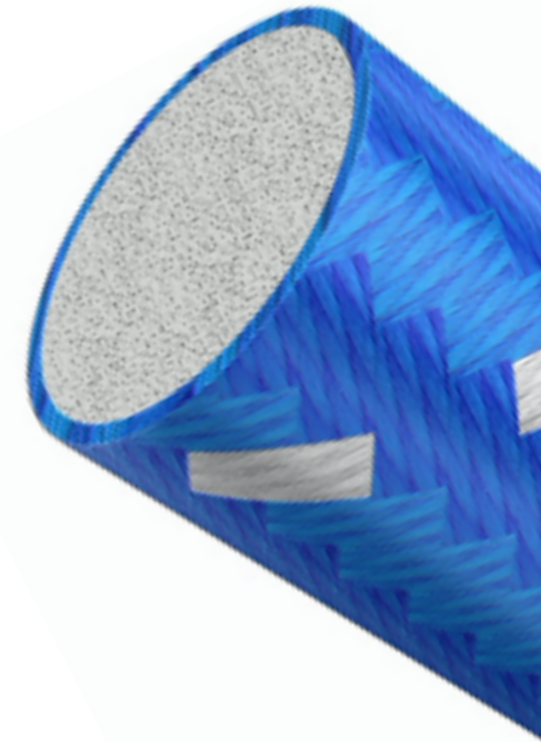
The original Moorline Nylon is constructed with parallel-laid, Nylon sub-ropes encased in a nylon-braided jacket. This product's high strength, high elongation, and parallel laid cores offer an excellent tension-tension fatigue life (TCLL). MoorLine Nylon's unique compact splice make it an ideal choice for shorter lengths in pendants.

- ✓ High rope elongation
- ✓ Excellent tension-tension fatigue performance translating to longer life
- ✓ Non load bearing sacrificial jacket
- ✓ High resistance to damage
- ✓ Easily repaired

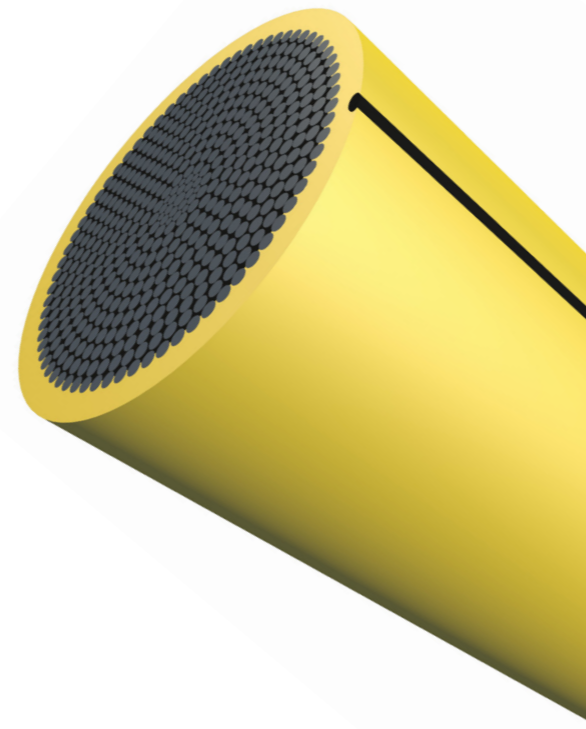
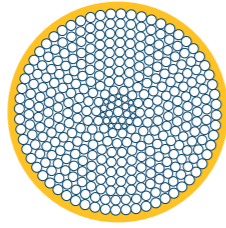
Diameter*	Linear Weight		Minimum Breaking Force
	In Air	In Water	Spliced**
mm	kg/m	kg/m	kN
104	5.91	0.60	2234
112	7.27	0.73	2670
120	8.26	0.83	3147
128	9.34	0.94	3663
136	10.3	1.04	4219
144	11.8	1.19	4815
152	13.5	1.36	5452
160	14.9	1.51	6130
168	16.4	1.66	6848
176	18.0	1.82	7607
184	20.1	2.03	8407
192	21.5	2.17	9248
200	23.4	2.36	10130
208	25.3	2.55	11053
216	27.2	2.75	12017
224	29.3	2.95	13023
232	31.4	3.17	14070
240	33.6	3.39	15159
248	35.8	3.61	16289
256	38.1	3.84	17460
264	40.5	4.08	18674
272	42.9	4.33	19929
280	45.42	4.58	21226
288	47.99	4.84	22566
296	50.62	5.11	23947
304	53.31	5.38	25370

* Nominal value. Other diameters are available Contact fibresales@bridon-bekaert.com
Diameter and linear density values are nominal
Break forces tested wet using DNVGL and ABS recommended procedures

Data tables are for guidance purposes only with no guarantee or warranty (express or implied) as to its accuracy. The products described may be subject to change without notice, and should not be relied on without further advice from Bridon-Bekaert. The cross section images are for reference only. Actual cross sections vary due to diameter. Visit www.bridon-bekaert.com for the most up-to-date data.



Spiral Strand



Spiral Strand is a torsionally balanced, high strength permanent mooring cable. Galvanised wire and specialist lubricant/blocking compound, provide a design life up to 15 years and the addition of polyethylene sheathing increases the robustness and extends its design life to 25 years. Spiral strand complies with DNVGL OS E304.

MoorLine Polyester and Spiral Strand comply with DNVGL, ABS, Bureau Veritas and Lloyds Register requirements. BBRG are DNVGL approved manufacturers of both products.

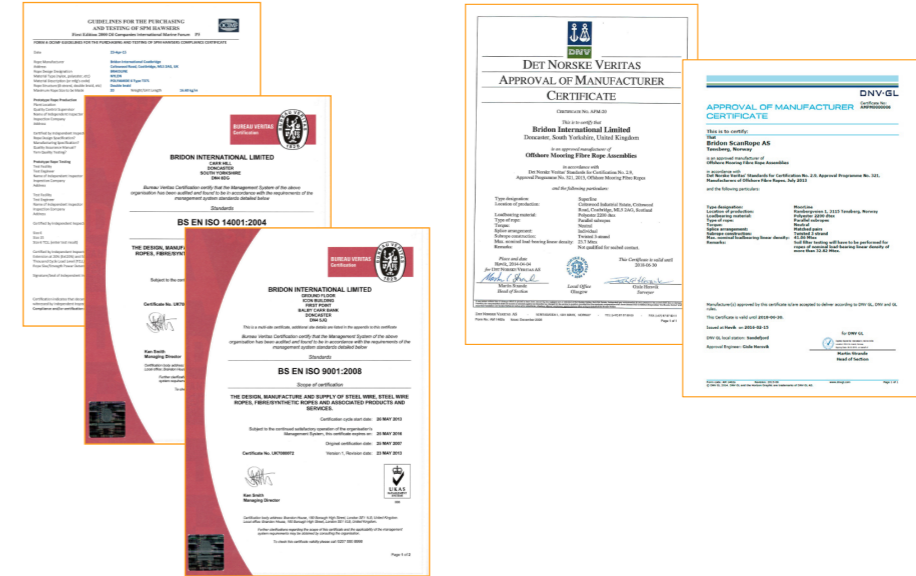
- ✓ High strength to weight ratio
- ✓ Torsionally balanced
- ✓ Excellent fatigue performance
- ✓ Excellent corrosion resistance
- ✓ Design life to suit customer requirements

Diameter*	Linear Weight			Minimum Breaking Force	
	Unsheathed (In Air)	Sheathed (In Air)	Sheathed (In Water)	SPR2+ 1860 Grade	Xtreme 1960 Grade
mm	kg/m	kg/m	kg/m	kN	kN
60	18.7	19.9	15.6	3820	4010
66	22.5	23.8	18.7	4590	4820
72	26.7	28.6	22.2	5470	5740
78	31.3	33.4	26.0	6410	6690
84	36.3	38.6	30.3	7450	7820
87	39.2	41.4	32.6	8010	8410
90	41.9	44.9	34.9	8580	8990
96	47.0	50.2	39.0	9590	10060
102	53.7	57.4	44.6	10790	11320
108	59.6	63.5	49.5	12000	12640
114	67.0	71.2	55.8	13420	14170
120	73.8	78.1	61.4	14720	15480
126	81.4	86.0	67.8	16270	17100
132	89.3	94.0	74.3	17890	18760
138	97.7	102.6	81.3	19500	20510
144	106.2	111.3	88.4	21090	22200
147	110.7	115.9	92.2	21930	23170
For diameters above 147mm please contact Bridon-Bekaert to discuss your requirements.					
162	130.2	135.8	108.5	25200	
300	59.9	15.4			26,487

Data tables are for guidance purposes only with no guarantee or warranty (express or implied) as to its accuracy. The products described may be subject to change without notice, and should not be relied on without further advice from Bridon-Bekaert. The cross section images are for reference only. Actual cross sections vary due to diameter. Visit www.bridon-bekaert.com for the most up-to-date data.

it's not a rope; it's a commitment.

Bridon-Bekaert Ropes Group works with all major Classification Societies. Product certification can be offered from DNVGL, ABS, BV and others and tailored to project requirements.



For all mooring products, BBRG operates modern state of the art quayside manufacturing facilities with full supply chain redundancy and a total quality mindset.

Throughout our supply chain, a wide range of process controls guarantee product quality and consistency. Every single meter. Every single termination. Every single yarn.

BBRG operates a customer focused control system for the planning and fulfilment of all of its complex cable projects. Custom bespoke mooring cables like floating wind mooring lines are included in that program.

Our integral approach to managing the full supply chain, documentation, manufacturing, user requirement deviations, logistics, transport, clearance, alongside our business partners, allows you to focus on your core business and take the cable element away from the punch list.



Delivery of your mooring line can be complemented by a full range of final product testing and analysis activities, validating design parameters and performance requirements, such as the following:

- Breaking testing
- Fatigue life testing
- Particle ingress testing
- Stiffness and elongation testing
- Cut and abrasions resistance testing

mooring line services.

With you in the field.

Handling & Installation Support

Mooring line handling is a complex, high risk activity critical to the success of your system. BBRG's Ropes 360 team is on hand to ensure your mooring lines are deployed and installed safely and efficiently without damaging their integrity.

Our skilled technicians assist both quayside and offshore with all aspects of rope installation including handling advisory, repair of minor damages, on site re-splicing, on site re-socketing, and spooling guidance.

Maintenance

BBRG maintenance packages include rope; termination repair, re-splicing, lubrication and corrosion protection coating. We use proven application systems and specifically formulated, BBRG lubricants to keep your rope in peak condition.

Application Engineers provide the following:

- Training in rope use and rope life extension
- Troubleshooting and guidance for ropes in use
- Rope selection and specification
- Rope life management packages

Bespoke Engineering

To meet the unique needs of your project in terms of interface management with the topside connection or your custom installation concept, Bridon-Bekaert's in-house team of chartered engineers are ready to conceive bespoke engineered solutions to help you optimize the mooring line for your needs.



on-site services.

Bridon-Bekaert services offer engineering support by day, week, or project, and an extensive range of options, including:

- Equipment hire for steel and synthetic NDE, lubrication equipment, re-reeling
- Periodic and annual examinations including NDE
- Manufacturing records and certification management
- Installation and installation supervision

BBtec.

- Rope testing: rope component tensile strength, modulus fatigue, multi-layer spooling (MLS), torque-turn
- Post-retirement rope analysis and condition assessment
- Forensic investigation
- Material characterisation
- Rope product benchmarking
- Supply chain integrity management



BRIDON • BEKAERT

T H E R O P E S G R O U P

contact@bridon-bekaert.com
www.bridon-bekaert.com

facebook.com/BridonBekaert
linkedin.com/company/bridon-bekaert
twitter.com/bridonbekaert

DISTRIBUTOR

DISCLAIMER

Whilst every effort has been made to ensure the accuracy of information in this publication, no guarantee or warranty (express or implied) is given with respect to the accuracy or completeness of the information contained within. This publication and the products described herein may be changed or updated without notice. Any and all liability whatsoever for any loss or damage arising, directly or indirectly, out of or in connection with the use of this publication, is excluded to the fullest extent permitted by law. The user must determine the suitability of the product for their own particular purpose, either alone or in combination with other products and shall assume all risk and liability in connection therewith. This document is published by Bridon-Bekaert Ropes Group. Use of this publication shall be governed in accordance with the laws of England & Wales and the English courts shall have exclusive jurisdiction over any dispute concerning your use of this publication.

INTELLECTUAL PROPERTY

All rights reserved. No parts of this publication may be reproduced or transmitted in any form or by any means without the prior written permission of the copyright holder, application for which should be addressed to Bridon-Bekaert Ropes Group. All trademarks used in this publication belong to Bridon-Bekaert Ropes Group or the registered proprietors of such marks. All rights relating to such trademarks, copyright and any other intellectual property rights are reserved for "Bridon" or the person/organisation contributing the relevant materials.