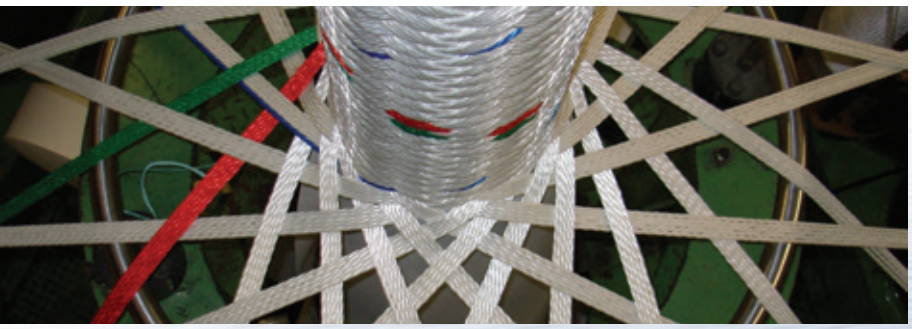
WireCo® WorldGroup

Lankhorst | Ropes





Ropes for **Deep Water Mooring**

OFFSHORE DIVISION

www.lankhorstropes.com

Royal Lankhorst Euronete GROUP BV



PROVEN STRENGTH

200 years of experience in development and manufacturing of strong products have proven the strength of Lankhorst





OFFSHORE DIVISION

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OFFSHORE DIVISION

COMPANY INFORMATION

Lankhorst Ropes is a member of the Royal Lankhorst Euronete Group. With more than 200 years of experience and 1,250 employees we are a worldwide innovative group with fully equipped production sites and R&D departments, located in The Netherlands, Portugal, Greece and Brasil, equipped for the production of a wide range of products in maritime and offshore ropes, technical yarns, fishing gear, Pure® composites, recycling and moulding material.

In July 2012, the Royal Lankhorst Euronete Group was acquired by WireCo WorldGroup, of Kansas City, Mo, USA. WireCo WorldGroup is the global leader in manufacturing, engineering, and distributing wire rope, wire rope assemblies, synthetic rope and electromechanical cable. With true global reach, WireCo WorldGroup can deliver the right products for your equipment and application no matter where your worksite might be.

Lankhorst Ropes is divided into three divisions: a *Maritime* Division with sales offices in The Netherlands, United Kingdom, Spain, United Arab Emirates, Brasil and Australia, an *Offshore* Division which trades in the name of Lankhorst Euronete Portugal S.A. and operates from Maia and Viana do Castelo (Portugal), and a *Heavy Lifting* Division. Lankhorst Ropes also trades steel wire ropes for offshore applications from WireCo WorldGroup manufacturing units.

In order to support the business, Lankhorst Ropes carries strategic stock in Houston (USA), New York (USA), Los Angeles (USA), Fujairah & Dubai (UAE), Cape Town & Durban (South Africa), Rotterdam (Holland), Panama and Singapore, and has service points in Bilbao (Spain), Brisbane (Australia) and Rio de Janeiro (Brasil).

Lankhorst Ropes continuously strives for improved product performance, customer satisfaction and product innovation. Lankhorst Ropes has been certified according to ISO 9001:2000.

This brochure covers Deep Water Tethers for offshore applications.



Location
The new Lankhorst Ropes site of 6000 m2 is located in Viana do Castelo, Portugal and became operational in September 2012. It is the most modern factory in the world dedicated to production of ropes for the offshore industry. Positioned near the port of Viana do Castelo, the facility is well suited to produce heavy deepwater mooring ropes. .



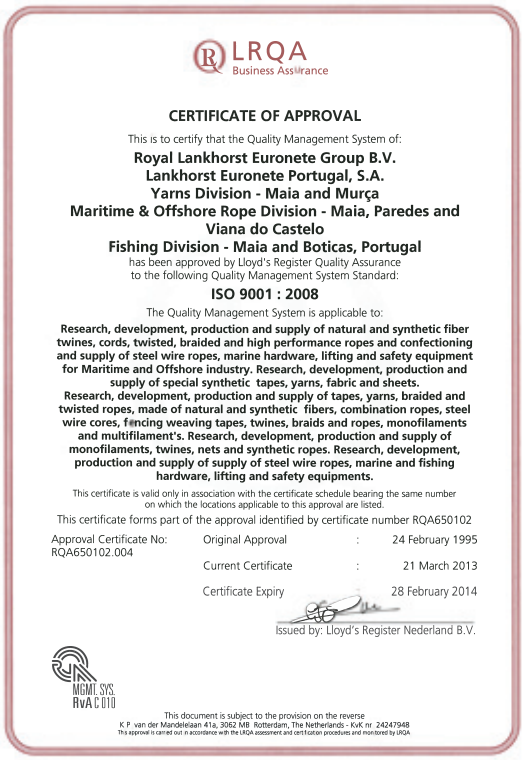
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Facilities

The factory is dedicated to the design, production and testing of offshore mooring ropes and specialty products such as deep water installation ropes. Modern production and testing equipment permits all the following activities to be undertaken in-house:-

- Extrusion of rope yarns
- Conversion (twisting) of flat yarn into rope yarn
- Stranding of rope yarns into strands
- Braiding or twisting of strands into sub-ropes
- Closing (over braiding) of sub-ropes into mooring ropes
- Length Measurement System (LMS) under tension <20 tonnes
- Length marking under tension in 75 m increments
- Axial (anti-twist) line marking
- Full scale proto-type testing
  - Break strength testing <1200 tonnes
  - Tension-tension fatigue testing
  - Stiffness and elongation testing
  - Simulation of installation and "What If" scenarios.
  - Cut resistant jacket testing.

The company entered the Deep Water Tether market in 1998. With the recent addition of a new Herzog SE 1/12-2000 subrope braiding machine, all plant and equipment used is the latest generation state of the art machinery.



LRQA
Business Assurance

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Royal Lankhorst Euronete Group B.V.
Lankhorst Euronete Portugal, S.A.
Yarns Division - Maia and Murça
Maritime & Offshore Rope Division - Maia, Paredes and Viana do Castelo
Fishing Division - Maia and Boticas, Portugal

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standard:

ISO 9001 : 2008

The Quality Management System is applicable to:

Research, development, production and supply of natural and synthetic fiber twines, cords, twisted, braided and high performance ropes and confectioning and supply of steel wire ropes, marine hardware, lifting and safety equipment for Maritime and Offshore industry. Research, development, production and supply of special synthetic tapes, yarns, fabric and sheets. Research, development, production and supply of tapes, yarns, braided and twisted ropes, made of natural and synthetic fibers, combination ropes, steel wire cores, fincing weaving tapes, twines, braids and ropes, monofilaments and multifilament's. Research, development, production and supply of monofilaments, twines, nets and synthetic ropes. Research, development, production and supply of supply of steel wire ropes, marine and fishing hardware, lifting and safety equipments.

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

This certificate forms part of the approval identified by certificate number RQA650102

Approval Certificate No: RQA650102.004

Original Approval : 24 February 1995
Current Certificate : 21 March 2013
Certificate Expiry : 28 February 2014

Issued by: Lloyd's Register Nederland B.V.

MGMT. SYS. RvA C 010

This document is subject to the provision on the reverse
K. P. van der Mandelelaan 41a, 3062 MB Rotterdam, The Netherlands - KvK nr. 24247948
This approval is carried out in accordance with the LRQA assessment and certification procedures and monitored by LRQA



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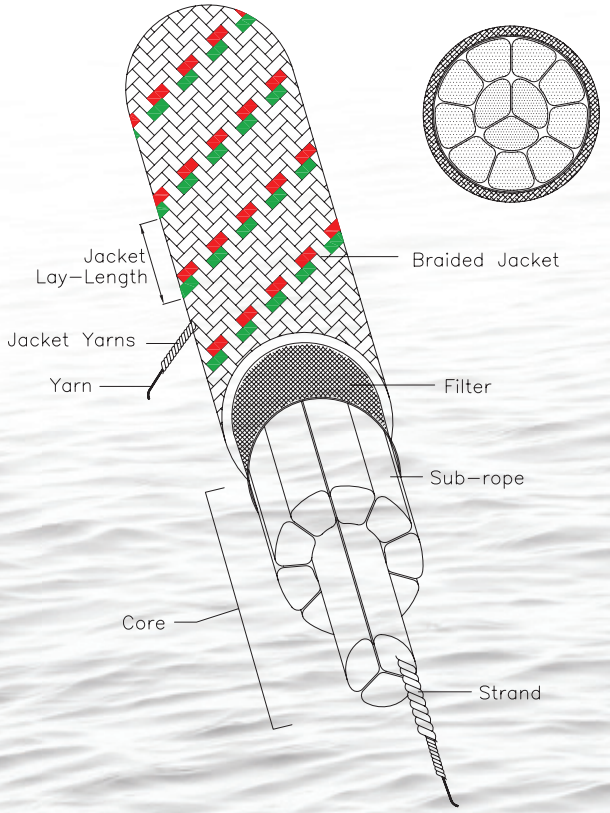
GAMA 98® ROPE FOR DEEP WATER TETHERS

Design
GAMA 98® polyester rope tethers are made from high efficiency sub-rope cores laid parallel within an outer braided jacket. Each sub-rope is computer monitored during tether manufacture to ensure all sub-ropes have equal tension and length. Typically, GAMA 98® ropes include 7 to 18 sub-ropes, each sub-rope being of a long lay length 8 x 1 or 12 x 1 construction, which gives a 100% torque free rope.

Particle Filter
Filter elements are included between jacket and sub-rope cores. They are effective in filtering out particles greater than 5 microns whilst allowing free flooding of the rope. Filter systems can be provided to allow for ropes to be pre-installed on the seabed prior to vessel hook-up.

Length
Lankhorst Ropes' equipment can in theory manufacture ropes of infinite length. Recent investment in a new reel take-up stand brings our capacity to handle single piece weights of up to 150 tonnes gross (rope and reel). This can be upgraded if warranted by project specific requirements. Maximum length is a function of the maximum reel weight and the linear weight of the rope which is dictated by the required breaking load.

Axial Stiffness
Stiffness is the ratio of rope load to strain variations between the lower (trough) and upper (peak) stresses imposed during testing. GAMA 98® is probably the stiffest rope construction currently available in the market for deepwater tether applications. This will result in less constructional stretch during the rope bedding-in and lower overall elastic stretch. These advantages translate into smaller platform offset and lower pre-tensioning during installation.





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Fatigue Life

The fatigue life of polyester rope is typically quoted as being approximately 80 decades superior to steel wire rope. The fatigue life curve of GAMA 98® rope was established during the durability of polyester in Joint Industry Projects.
The rope gets up to 10% stronger during initial cycling as the molecule chains in the individual yarns straighten out under constant cyclic loading before losing strength and returning to initial Minimum Breaking Load after approximately 30% of the fatigue life.

Key Projects

Lankhorst Ropes executed the design and manufacture of GAMA 98® polyester rope tethers for major projects such as the Tahiti spar for Technip (Operator: Chevron), Thunder Hawk semi-submersible for SBM Atlantia (Operator: Murphy) and Cascade & Chinook FPSO for APL/BW Offshore (Operator: Petrobras Americas), Lucius spar for Technip (Operator: Anadarko), and Goliat FPSO for Eni Norge (Operator: Eni Norge). Gama 98® polyester tethers manufactured for the Goliat FPSO set a world record for the highest Minimum Breaking Load (MBL) ropes ever produced and tested.



Minimum Breaking Load	ø	Mass in air	Mass in water	Stiffness		
				Cycling between 10-30% MBL	Cycling between 20-30% MBL	Cycling between 40-50% MBL
(TF)	(mm)	(kg/m)	(kg/m)	MN	MN	MN
450	125	10,8	2,8	68	100	121
500	132	12,2	3,1	76	111	134
600	144	14,4	3,7	91	134	161
700	156	16,7	4,3	106	156	187
800	167	19,3	4,9	121	178	214
900	177	21,6	5,5	136	200	241
1000	186	24,0	6,2	151	223	268
1100	196	26,5	6,8	166	245	295
1200	201	28,3	7,3	181	267	321
1250	203	29,0	7,4	189	278	335
1300	208	30,4	7,8	196	289	348
1400	217	33,0	8,5	212	312	375
1500	223	34,8	8,9	227	334	402
1600	232	37,7	9,7	242	356	429
1700	238	39,5	10,1	257	379	455
1800	246	42,4	10,9	272	401	482
1900	251	44,2	11,3	287	423	509
2000	259	46,8	12,0	302	445	536
2100	266	49,7	12,7	317	468	562
2200	274	52,5	13,5	332	490	589
2300	279	54,6	14,0	347	512	616
2400	286	57,4	14,7	363	534	643
2500	290	59,2	15,2	378	557	670

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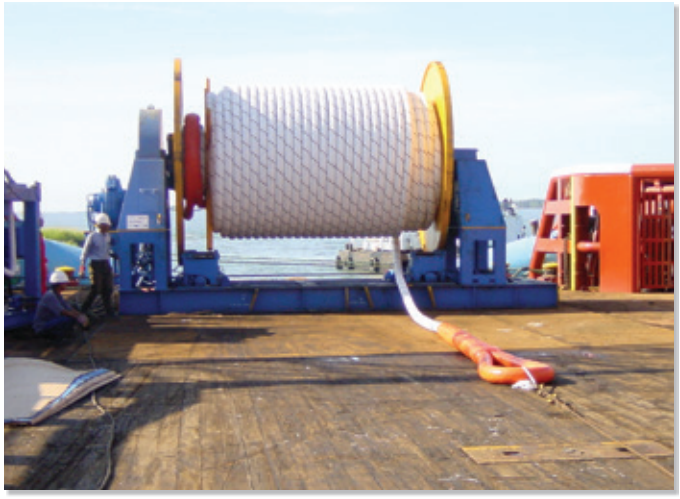
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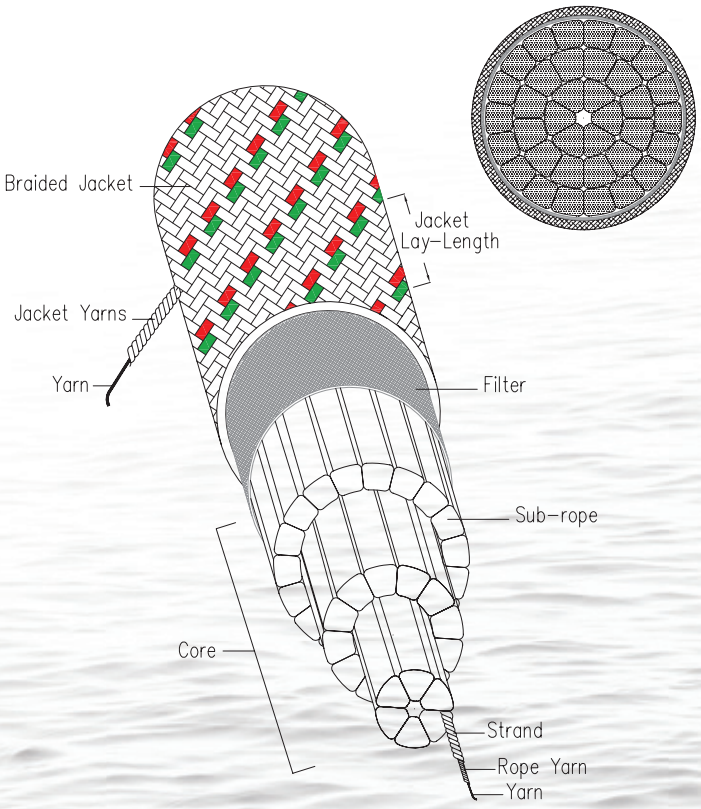
MODULINE® ROPE FOR MODU OPERATIONS

Design
MODULINE® polyester ropes are made from high efficiency 3-strand sub-rope cores laid parallel within an outer braided jacket.
MODULINE® ropes are manufactured from equal numbers of S & Z (left and right hand) lay sub-ropes to provide a torque neutral construction.

Particle Filter
Filter elements are included between jacket and sub-rope cores. They are effective in filtering out particles greater than 5 microns whilst allowing free flooding of the rope. Filter systems can be provided to allow for ropes to be pre-installed on the seabed prior to vessel hook-up.

Length
Lankhorst Ropes' equipment can in theory manufacture ropes of infinite length, but at present our limiting capacity is the reel take-up stand which is designed to handle single piece weights of up to 80 tonnes gross (rope and reel). This can be upgraded if warranted by project specific requirements. Maximum length is a function of the maximum reel weight and the linear weight of the rope which is dictated by the required breaking load.





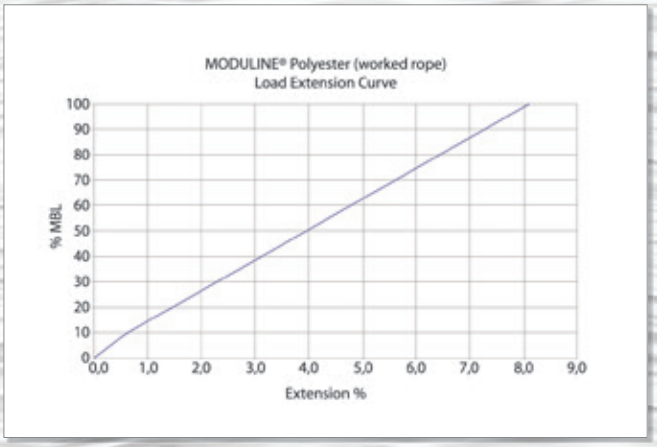


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Minimum Breaking Load	ø	Mass in air	Mass in water	Stiffness		
				Cycling between 10-30% MBL	Cycling between 20-30% MBL	Cycling between 40-50% MBL
(TF)	(mm)	(kg/m)	(kg/m)	MN	MN	MN
400	117	9,6	2,5	62	89	107
500	131	11,9	3,0	77	111	134
600	143	14,3	3,7	92	134	161
700	155	16,7	4,3	108	156	187
800	166	19,3	4,9	123	178	214
900	175	21,4	5,5	139	200	241
1000	185	23,7	6,1	154	223	268

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OFFSHORE DIVISION

GAMA 98® ROPE MADE WITH DYNEEMA® FOR MODU OPERATIONS

GAMA 98® ROPE MADE WITH DYNEEMA® are manufactured from high efficiency sub-ropes cores (strength member) laid parallel within an outer braided jacket (non-strength member). The sub-cores are high efficiency eight strands braided Dyneema® ropes. The external jacket is a 32-carrier twill polyester braid. This construction is torque balanced and is one of the strongest rope constructions currently available. The breaking load is the same whether the rope is wet or dry and considerably higher than nylon or polyester size for size. The characteristics of high strength, low weight, make this rope easy to handle with consequent reduction in operational costs. The polyester jacket confers to the rope an excellent resistance to abrasion.

General characteristics

Strength wet/dry:	100 %
Shock absorption:	Low
Specific gravity:	Variable
Floats/Sinks:	Neutral
Elongation:	Very Low
Water absorption:	None
Abrasion Resistance:	Excellent
Melting Point:	140°C / 260°C

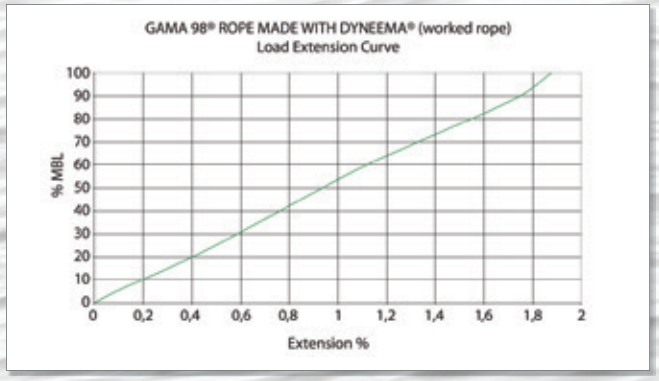
Chemical Resistance (jacket)

Acids:	Good
Alkalis:	Moderate
Very Good:	Very Good

Ultra violet resistance Excellent

Minimum Breaking Load	ø	Mass in air	Mass in water	Stiffness		
				Cycling between 10-30% MBL	Cycling between 20-30% MBL	Cycling between 40-50% MBL
(TF)	(mm)	(kg/m)	(kg/m)	MN	MN	MN
200	62	1,7	0,03	108	133	153
250	69	2,2	0,05	134	165	190
300	75	2,6	0,05	161	198	228
400	87	3,5	0,06	215	264	304
500	97	4,4	0,08	269	330	380
600	106	5,2	0,08	323	396	456
700	116	6,1	0,10	381	467	538
800	123	6,9	0,11	428	526	605
900	130	7,8	0,14	482	592	680
1000	137	8,6	0,14	535	657	756
1250	153	10,8	0,19	669	822	945
1500	168	12,9	0,22	803	986	1134
2000	194	17,2	0,28	1070	1315	1512

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Dyneema® is a registered trademark of Royal DSM N.V.

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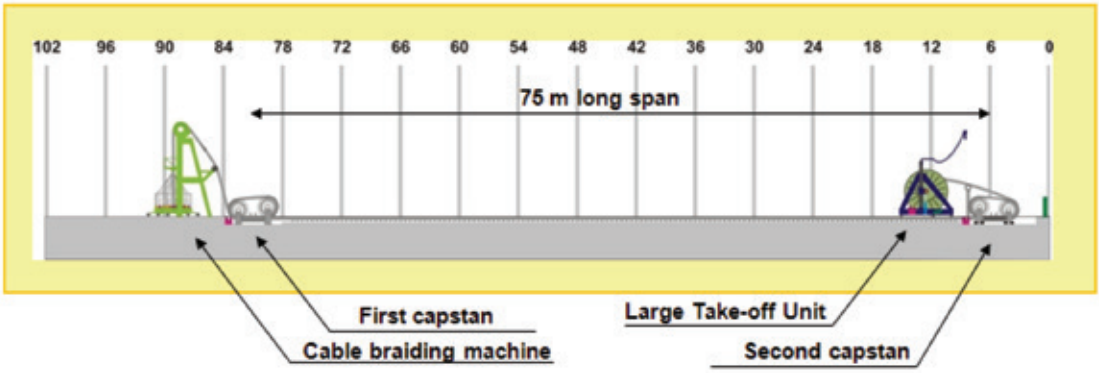
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LENGTH MEASUREMENT & MARKING

Ropes for deep water tethers are manufactured under a machine tension of approximately 1 tonne back tension. Lankhorst Ropes have installed a unique Length Measuring System (LMS) for length measurement under a controlled tension. The rope is pre-tensioned to 1% MBL (maximum 20 tonnes) for length measurement in 75m increments. Prototype testing always starts from the same reference tension of 1% MBL. Length accuracy is achieved with a laser gun and mirror which is calibrated to 75m ±3mm. The rope is marked at each 75m increment and the marks, numbered sequentially (1=75m; 2=150m; etc), are recorded by digital camera, thus minimizing the risk of human error. Feedback from the first permanent mooring project to benefit from this system has demonstrated the method's accuracy.









OFFSHORE DIVISION

SPLICING & TERMINATIONS

The GAMA 98® rope construction is suitable for either hand spliced terminations or with socket terminations. The eye splice is engineered for high efficiency strength realisation. To achieve this, each sub-rope is allocated a preset position around the eye so that the load is shared equally by all the sub-ropes. Sub-ropes are colour coded for identification purposes so they have the same position throughout the rope, within each eye and are spliced to themselves. The eyes and splice area are protected with polyurethane. Digital photos at 15 stages of each splice are taken for Quality Control checks as well as recording the individual splicer's name. These records form part of the final documentation pack.

MODULINE® ropes for MODU operations are terminated with hand spliced eyes. Likewise the eyes and splice area are protected with polyurethane.

Lankhorst Ropes provide a wide range of connection solutions for integration of mooring line components including:

- Polyester to Polyester
- Polyester to Chain
- Polyester to Steel Wire

We will work closely with 3rd party suppliers of mooring jewellery to ensure good interface connections.









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PACKING & TRANSPORTATION

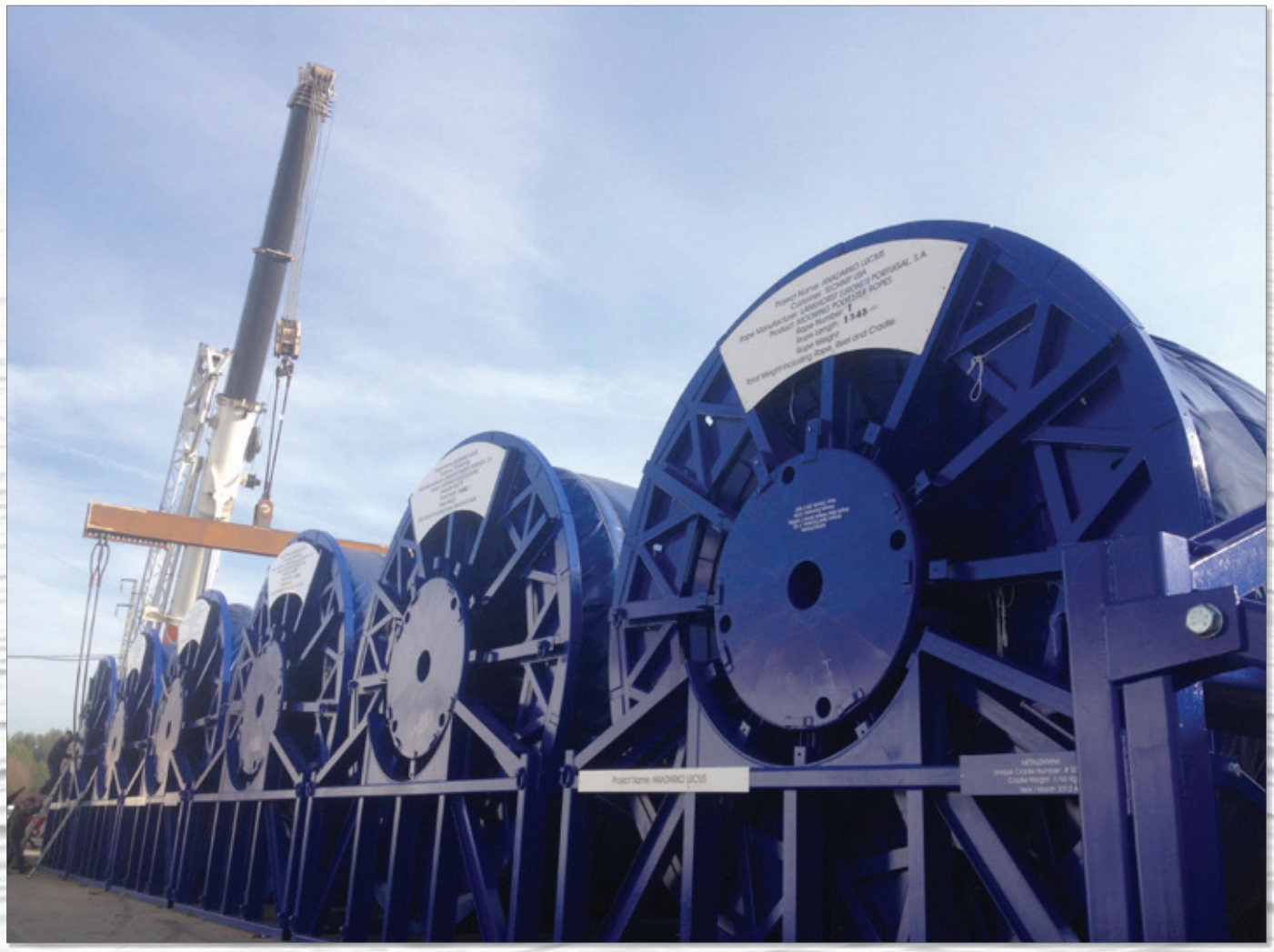
Lankhorst Ropes supply GAMA 98® deepwater tethers spooled onto one-way non-returnable shipping reels/cradles that are designed to meet project specific requirements.

Reels and shipping cradles are designed to DNV Rules for Planning and Execution of Marine Operations and/or Noble Denton General Guidelines for Marine Transportations. Certified lifting slings and spreader beams are also provided.

MODULINE® ropes for MODU operations can be supplied on reels or in standard or offshore rated containers.

Ropes on reels are protected from the environment with specially fitted tarpaulins.

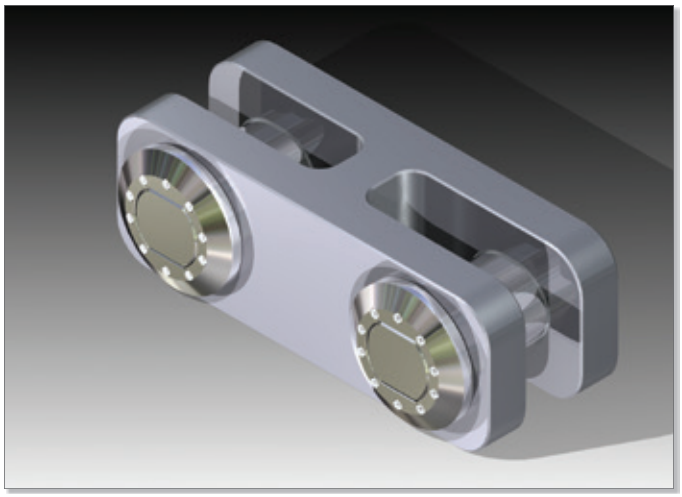
Transportation of oversize reels to the port of Viana do Castelo (Portugal) is carried out by low-load transport specialists.

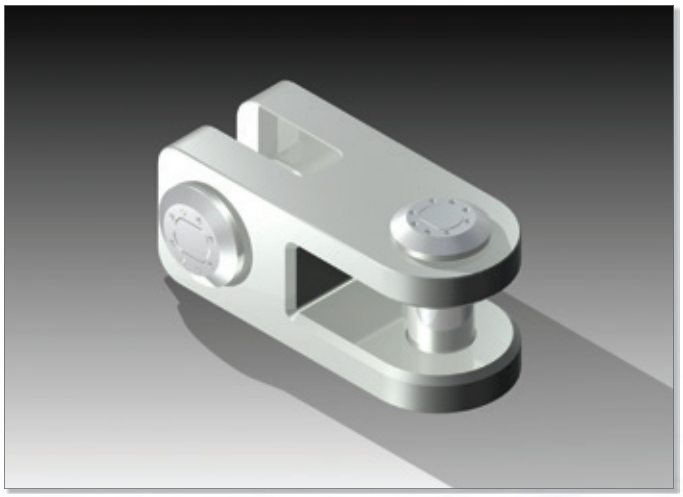


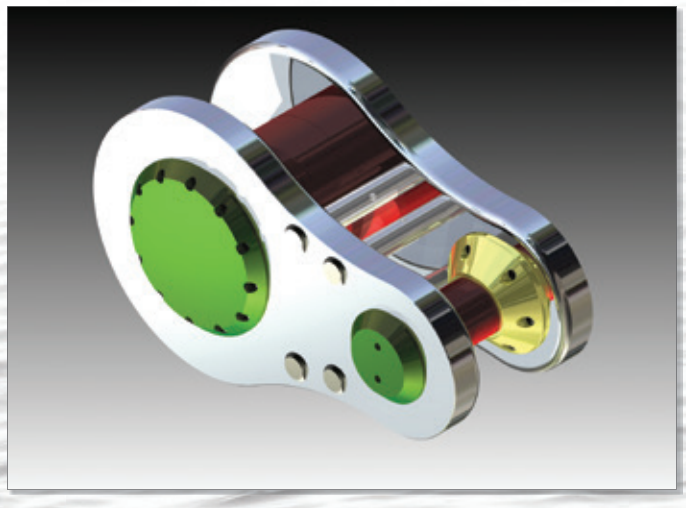


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CONNECTION SOLUTIONS







It is now widely recognised within the industry and classification societies that the fibre tether is part of a mooring line system and cannot be certified in isolation. Thus the soft eye termination has to be tested with the connector that will join the soft eye of the rope to the next segment of the mooring line, whether this is a chain, wire, anchor or some other component.

Details of this connector, in particular the size and shape of the rope eye bearing surface have to be fully recorded. Substituting a different type and shape of end termination will render the rope certification invalid.

The choice of connector solution will often be driven by the installation methodology and the handling issues arising from the deployment scenario. The type of connector used for over boarding the stern roller of an AHV will probably be different from a connector used for installation via a crane barge. Pre-tensioning methodology may also impact on connector design.

Regardless of installation issues, all connectors have the same basic requirements:

- To be lightweight
- To be small and compact
- To meet the design strength and fatigue life
- To be rope friendly and maximise splice efficiency

Lankhorst Ropes supply a range of connection solutions to meet the industry needs in the form of Thimble rolls, H-links, Pear Links and Y-links. We are continuously striving to develop and optimise the functional requirements of the connectors. We recommend that you consult Lankhorst Ropes for advice on termination options to suit your mooring system at an early stage of engineering design.



OFFSHORE DIVISION

TESTING & JOINT INDUSTRY PROJECTS



Lankhorst Ropes have participated in the following Joint Industry Projects (JIPs) and have been instrumental in helping to shape the industry and the rules governing the deployment of fibre ropes in deep water mooring applications:

- Engineers Design Guide
- Durability of Polyester Ropes
- Durability of Polyester Extension
- Damage Assessment Guidelines
- Design Practice Guidelines
- Insert JIP
- Safe Service Life (Arelis)
- FPS Mooring Integrity
- OCIMF 2000 Hawser Guidelines
- API RP 2SM Revision
- REPSEA JIP
- NORMOOR JIP

In addition to the JIPs listed, we also participate in privately sponsored research projects and other JIPs specifically related to other Fibre Rope Mooring applications, Chain and Mooring Jewellery.

Lankhorst Ropes has a wealth of test data from these JIPs as well as from numerous test programmes undertaken at DNV Bergen laboratories.

Lankhorst Ropes has invested in a 1200 tonne MBL x 25m long test machine to enhance the service provided to our clients by enabling :

- Quicker response time to certify products.
- Faster R&D development programmes.
- Client specific testing programmes.
- Reduce data errors with longer test samples.

LANKHORST ROPES – Offshore Division

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