

YACHT RIGGING

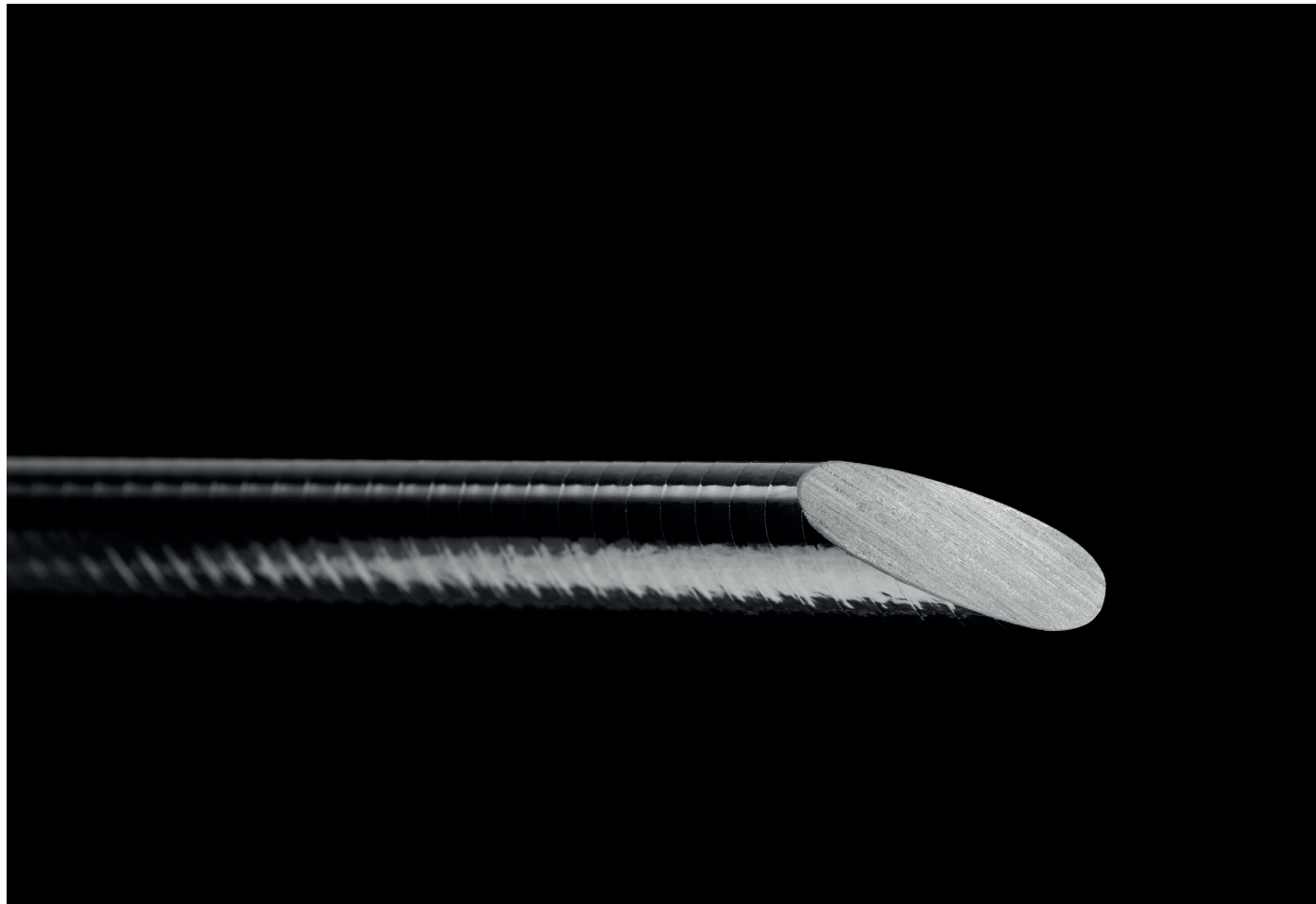
CL SOLID | CL ELLIPSE | CL TORQUE | CL HYBRID

Carbo
Link

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MADE IN SWITZERLAND
SINCE 2000

GL CERTIFIED
AS 9100D AEROSPACE & DEFENCE CERTIFIED



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01 ABOUT

Carbo-Link is a structural engineering organisation established in 2000 as a spin-off from EMPA, The Swiss Federal Laboratories for Material Science and Technology.

Carbo-Link specialises in the design, engineering and production of **solid carbon rigging** and **custom titanium interfaces**.

Solutions derive from years of experience and innovation in the industrial, civil engineering, aerospace and marine industries. Carbo-Link operates within an ISO 9001 and AS9100D Aerospace & Defence certified factory just outside of Zurich, Switzerland.

Carbo-Link work closely with EMPA and ETH on various R&D projects together with the world's most innovative brands.

OUR APPROACH

Efficient material usage.

Combining structural engineering principles with creative material science, Carbo-Link delivers customised and optimised rigging solutions that deliver on your projects objectives through efficient material usage and considered product/process development. Minimal service and maintenance is top priority, ensuring a low cost of ownership across all solutions.

Carbo-Link has a solid understanding of the in-service conditions of a sailing yacht, with aggressive exposure conditions and high stresses across multiple load cases. Carbo-Link has proven experience in implementing high-performance, durable and reliable carbon rigging to inshore, coastal and offshore racing yachts, America's Cup competitors and superyachts worldwide.

QUALITY ASSURANCE



GL Type Approval
Germanischer Lloyds



ISO 9001
Quality Management System



AS 9100D
Aerospace & Defence



**Carbo-
Link**

02 SERVICES

DESIGN

- Modelling and simulation
- Mechanical engineering process management
- Feasibility studies and numerical analysis
- Bill of materials management

MATERIAL SCIENCE

- Performance-based raw material selection
- Supply chain synchronisation
- Material property analysis and control
- Supplier contractual compliance management

MANUFACTURING

- Part & Assembly planning and validation
- CAM/CNC optimisation
- Factory layout optimisation
- Process innovation and implementation

TESTING

- Test procedure design and implementation
- Compliance management
- Chafe | Impact | Torsion | Compression | Fatigue
- Partnership with EMPA

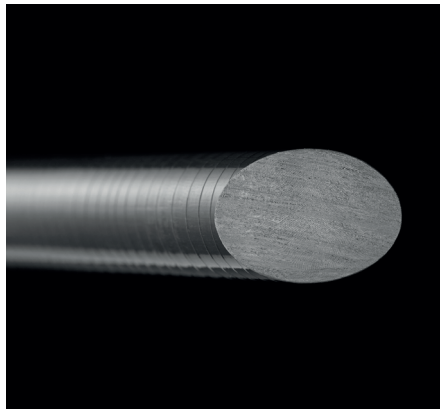
INSTALLATION AND SUPPORT

- Precise integration controls
- Long-term health management
- Performance-based logistics
- 3rd Party relationship management

CONSULTATION

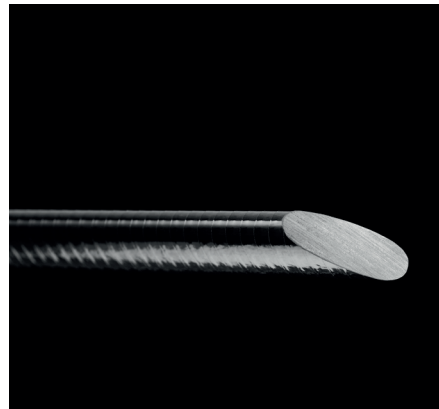
- Upgrade management
- Reporting and analytics's
- Modelling and simulation
- Expert, independent advice & feasibility studies

SOLUTIONS



CL ROUND

Smaller, stiffer, lighter, tougher. All with minimal service at a low cost of ownership



CL ELLIPSE

All the value of CL ROUND rigging plus an elliptical profile for a reduced drag coefficient



CL TORQUE

The most efficient forestay furl with zero torsional degradation over time



CL HYBRID

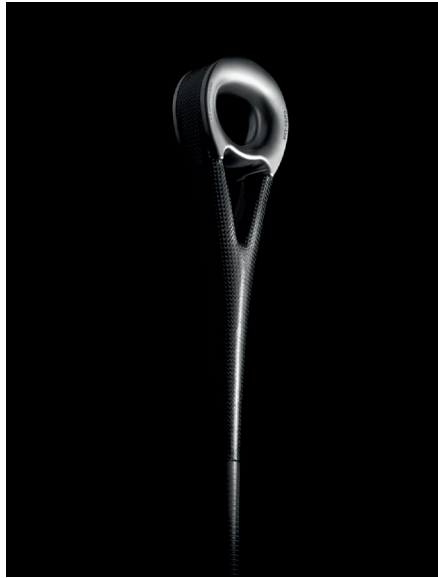
Flexible carbon where required, solid carbon elsewhere in a continuous cable

- 1 REDUCED COST OF OWNERSHIP**
 - Never need to send rigging away for a service or recovering
 - 15+ plus lifespan with proper service & maintenance
- 2 INCREASED LONGEVITY**
 - Longevity is comparable to a yachts hull – carbon hulls use similar materials
 - The original properties will be sustained over 15 years or more
- 3 SUPERIOR DURABILITY**
 - Toughened resin system results in superior chafe and impact resistance
 - No soft cover to chafe, or individual rods susceptible to damage
- 4 SIMPLE SERVICE & INSPECTION**
 - Nothing hiding beneath the cover. Visual inspections of the surface identify rigging health
 - Possible to NDT with the mast stepped or un-stepped at high-load areas and local points of interest
- 5 REDUCED LIKELIHOOD OF LIGHTNING STRIKE & SUBSEQUENT DAMAGE**
 - CL SOLID is grounded and able to unload charge > integrated fittings with a direct connection to the yachts hull
 - There is no static build-up, which in turn reduces the likelihood of being struck
- 6 SIMPLE LOGISTICS**
 - Can be delivered coiled with final curing on-site, or delivered fully cured
 - Simple storage with mast during refit periods > no shipping required throughout rigging lifespan
- 7 NEATEST, SMALLEST INTERFACES**
 - Fully integrated into the cable which in-turn reduces weight
 - No bonded joints or reliance on threaded fittings between cable termination and interface > no creep or bedding-in
- 8 REDUCED LIKELIHOOD OF VIBRATION**
 - Vortex shedding can occur on any tensioned cable > CL DAMPER proven to be highly effective solution if required
 - Elliptical rigging is less susceptible to vortex shedding (vibration) as proven on all existing elliptical projects
- 9 SMALLEST DIAMETER**
 - Upto 35% smaller cross-section than bundled rigging due to 100% consolidation of fibres
 - No bundled rods with gaps and no additional consolidation cover
- 10 RELIABLE & OPTIMISED ELLIPSE**
 - No structural difference between round and elliptical solid carbon rigging
 - Research, numerical analysis and sailing time prove ellipse ratio's of 2.0:1 or shorter balance all considerations
- 11 2 YEAR WARRANTY**
 - Not limited to any type of sailing – includes racing and all associated training requirements
 - See 'General Terms & Conditions' for comparison to alternative suppliers

04 CL SOLID TERMINATIONS



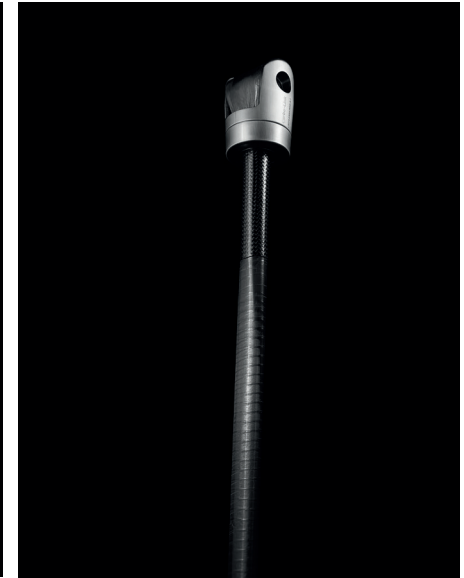
PIN



LASHING



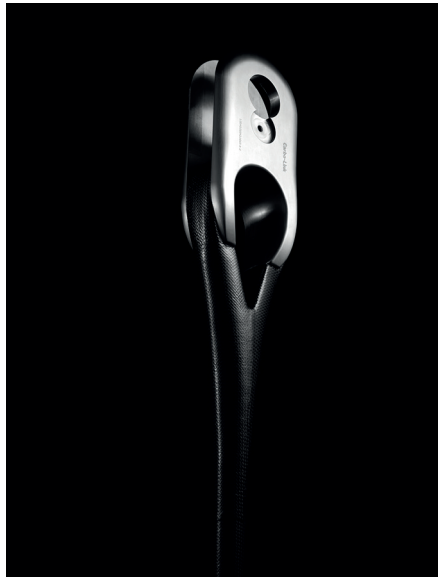
SPHERICAL BEARING



BALL HEAD



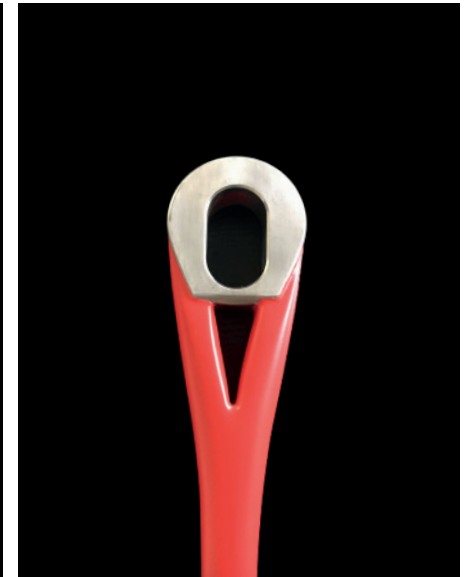
SHIMMED



JAW



TORSIONAL



SLOTTED

05a
CL ELLIPSE
Sample



'RAMBLER 88'

Offshore specialist | Southern Spars

- CL ELLIPSE laterals [2.0:1 aspect ratio]
- CL ROUND forestay & CL Strop
- CL HYBRID backstays



'VISIONE'

Baltic 147 | Hall Spars

- CL ELLIPSE laterals [1.8:1 aspect ratio]
- CL TORQUE forestay



'CANNONBALL'

Maxi 72 | Southern Spars

- CL ELLIPSE laterals [2.0:1 aspect ratio]
- CL ROUND forestay + CL Strop
- CL HYBRID backstays



'SCORPIONE'

Baltic 151 | Martin Spars/Southern Spars

- CL ELLIPSE laterals [2.0:1 aspect ratio]
- CL ROUND forestay + multi-pin furler termination

05b

CL ROUND

Sample



'NGONI'

Dubois 58m | Rondal

- CL ROUND laterals
- CL ROUND forestay + multi-pin furler termination



'PINK GIN'

Baltic 175 | Rondal

- CL ROUND laterals
- CL ROUND forestay & inner forestay + multi-pin furler terminations



'SAUDADE'

Wally 148 | Hall Spars

- CL ROUND laterals
- CL TORQUE forestay



'LIONHEART'

J Class | Hall Spars

- CL ROUND laterals
- CL ROUND forestay

05c

CL HYBRID

Sample



'VESPER'

Maxi 72 | Southern Spars

- CL HYBRID backstays
- CL ELLIPSE lateral rigging
- CL SOLID forestay + CL Strop



'CANNONBALL'

Maxi 72 | Southern Spars

- CL HYBRID backstays
- CL ELLIPSE lateral rigging
- CL SOLID forestay + CL Strop



'GALATEIA'

Wally Cento | Galateia

- CL HYBRID backstays
- CL ELLIPSE lateral rigging
- CL SOLID forestay + CL Strop



'HIGHLAND FLING'

RP82 | Hall Spars

- CL HYBRID backstays
- CL ELLIPSE lateral rigging
- CL SOLID forestay + CL Strop

05d

CL TORQUE

Sample



'WIN WIN'

Baltic 107 | Hall Spars

- CL TORQUE forestay
- Reckmann furling unit [800MN working torque]



'SAMURAI'

Rhoades Young Design 42m |

- CL TORQUE forestay & inner forestay
- Line driven furling units
- CL ROUND laterals (main & mizzen)



'PRB'

IMOCA 60 | Lorima

- CL TORQUE forestay
- Line driven furling units



'SAUDADE'

Wally 148 | Hall Spars

- CL TORQUE forestay
- Reckmann furling unit [800MN working torque]
- Plus CL ROUND laterals & backstay

06 UPCOMING PROJECTS

Sample



'NILAYA'

Nauta 151 | Rondal

- CL ELLIPSE laterals
- CL TORQUE forestay
- CL HYBRID backstays



'B145'

Baltic 145 | Rondal

- CL ROUND laterals
- CL HYBRID backstays + CL ROUND bridle backstay
- CL ROUND forestay & inner forestay + multi-pin furler terminations



'MAXI BANQUE POPULAIRE XI'

Ultim 100 | CDK

- CL ROUND upper shrouds
- CL ROUND lower shrouds



'CAFE RACER'

Baltic 68 | Marstrom

- CL ROUND laterals

07

REDUCED LIGHTNING STRIKE VULNERABILITY

#1

FULLY INTEGRATED FITTINGS

- Carbon is in direct contact with the fitting, which is in direct contact with the hull
- Resulting in a direct path of least resistance to the ground
- Any static charge caused by electrical or magnetic fields decays immediately
- There are no bonded joints to isolate the flow path

#2

PREVENTS STATIC CHARGE

- High conductivity and direct path of low resistance
- Prevents static charge from building up in the system
- Therefore significantly reducing the probability of a strike

#3

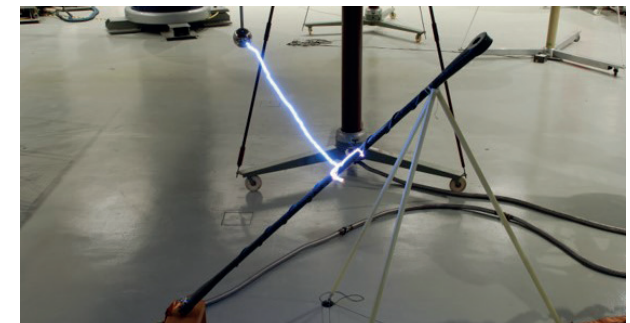
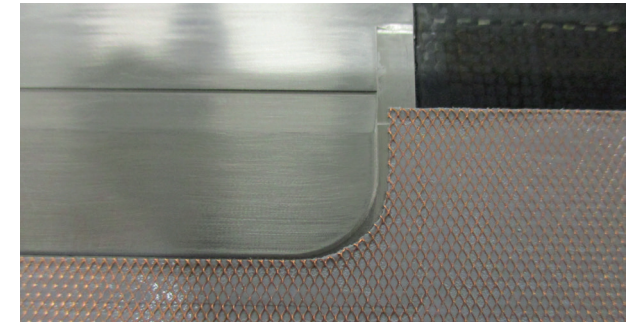
AERO-GRADE LIGHTNING PROTECTION CAN BE INTEGRATED

- A highly-conductive mesh layer can be laminated into the cable to further reduce electrical resistance and increase conductivity
- Carbo-Link helicopter blades featuring aerospace approved and certified lightning strike protection (shown in the right hand image)

#4

THOROUGHLY TESTED

- Numerous laboratory tests at ETH Zurich have been carried out on solid tension members to better understand cause and effect
- Carbo-Link have supplied over 12,000 solid carbon crane cables to Liebherr, with some cranes reaching heights of 220m, with zero lightning strike issues



08 CONTACT

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