

# YACHT RIGGING

CL SOLID | CL ELLIPSE | CL TORQUE | CL HYBRID

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**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

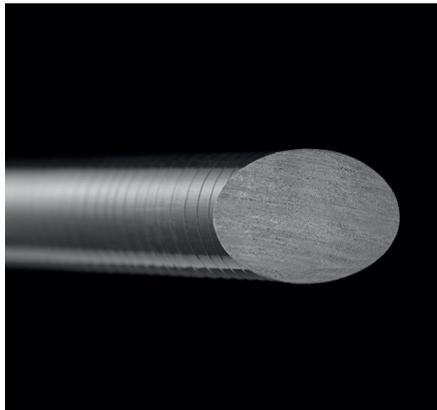
### INSTALLATION AND SUPPORT

- 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

## 03

### WHY CL SOLID?

- 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**



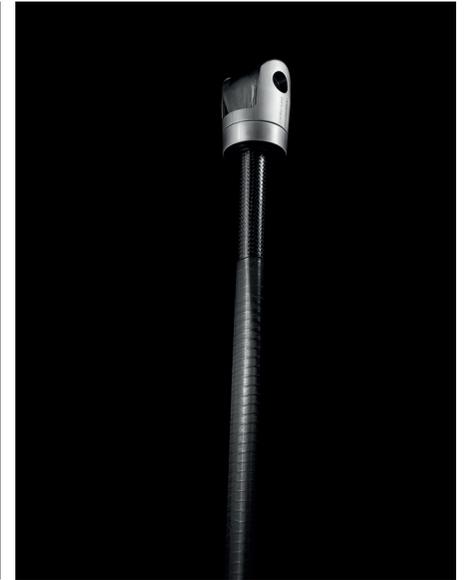
**PIN**



**LASHING**



**SPHERICAL BEARING**



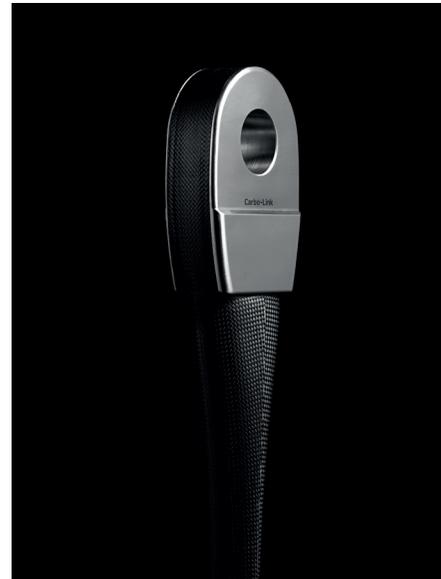
**BALL HEAD**



**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

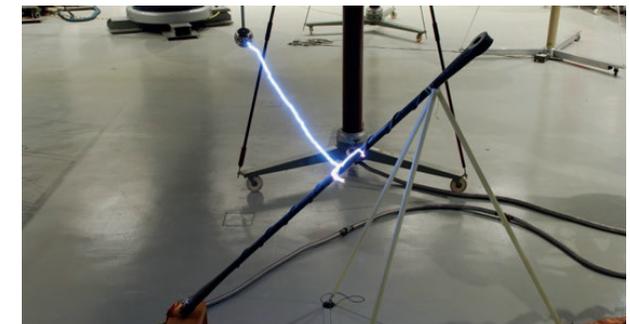
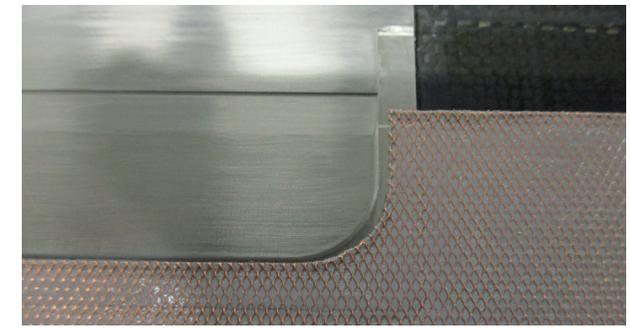
- High conductivity and direct path of low resistance
- Prevents static charge from building up in the system
- Therefore significantly reducing the probability of a strike

### #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**  
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