

## Rig Certification process

### Sector

Rig Sail Certification

### Project challenges

Rig Analysis in the sailing conditions established by the RINA RIG Rules guidelines – Using RigEdge + Dynamic

Accelerometer data acquired during the navigation between CapeTown and Genoa

### Keys to success

Ability to run the structural analysis of the rig under tuning, sailing and dynamic loads

Sea-keeping analysis validated by on-board acceleration measurements

RINA YACHTING rig guidelines

Greater collaboration and efficiency between Southern Spars, Southern Wind Shipyard and RINA Services team

### Results

Windfall rig achieved the certification, as proved to be robust enough.



WINDFALL - Courtesy Southern Wind / Ph. Rob Kamhooft

### INTRODUCTION

This document describes the rig certification process applied on the SW 94#2, named Windfall. The paper includes also important background information and experimental data acquisition of the rig performance while sailing.

The rig analysis was carried out by SMAR Azure Ltd following the RINA Yachting RIG guidelines. RINA Services SpA and SMAR Azure would like to thank Southern Spars and Southern Wind Shipyards for the precious collaboration throughout the various phases of the rig analysis project.

### Background

Modern sailing boats are designed to attain high performance. However, the main challenge is achieving high technical performance while also maintaining high levels of comfort.

Recently, the certification of spars and rigging has been considered, by the Classification Societies and from statutory requirements, with more attention.

The increasing size of sailing superyachts, their rising costs, a growing sensitivity to safety lead designers, shipyards and ship owners not to underestimate the importance of this issue anymore.

A new approach is today possible thanks to the availability of novel commercial available analytical tools that, until a few years ago were only available to America's Cup syndicates

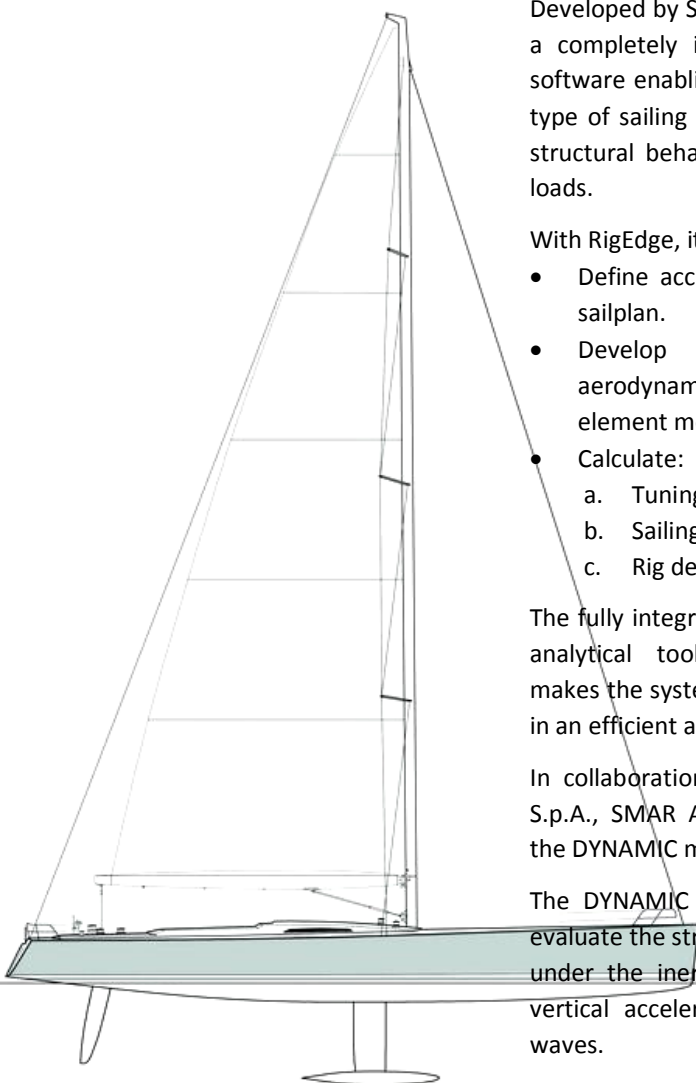
Most importantly, the Maritime and Coastguard Agency (MCA) has asked the Classification Societies to add rig design an maintenance requirements among other topics subject to mandatory certification (LY3) yachts with keel laid from August 2013.

### RINA guidelines for Sailing Rigs

RINA Services SpA has developed a new approach to the Sailing Rig Analysis. The approach consists of four items:

1. Critical rig items will be surveyed and tested under surveyors attendance
2. A "rig booklet" for rig maintenance + scheduled periodic surveys
3. A systematic rig analysis approach (CFD+FEM/FEA)

Boat	SW94 #2
Name	Windfall
Shipyard	Southern Wind Shipyard
LOA [m]	28.64
Max Beam [m]	6.66
P [m]	35.20
E [m]	12.05
J [m]	11.02
I [m]	36.10
Light Displacement [T]	55
Naval Architecture	Reichel Pugh Yacht Design



The first two points of the approach were derived by having observed that typical failure:

- High % usually depends on time, varying over life cycle of the system
- Lack of proper maintenance;
- Captains and crews are not aware of critical information

RINA Services SpA has also observed that wave induced inertial loads are sometimes of same order of magnitude of sailing loads (aerodynamic loads) on the rig. Therefore, RINA Services SpA has developed a protocol of the rig structural analysis simulating a number of dangerous sailing conditions. The following section describes the RINA rig analytical approach and the experimental data recording technique and results.

#### The analytical approach

Developed by SMAR Azure Ltd, RigEdge is a completely integrated finite element software enabling the user to design any type of sailing vessels rig and predict its structural behavior under tuning, sailing loads.

With RigEdge, it is possible to:

- Define accurately spars, rigging and sailplan.
- Develop automatically the aerodynamic sail meshes and finite element models for sails and rig
- Calculate:
  - Tuning loads
  - Sailing loads
  - Rig deformation and loads.

The fully integration of design, mesh and analytical tools included in RigEdge makes the system able to define rig loads in an efficient and accurate way.

In collaboration with the RINA Services S.p.A., SMAR Azure has also developed the DYNAMIC module of RigEdge.

The DYNAMIC module lets the user to evaluate the structural behavior of the rig under the inertial loads caused by the vertical acceleration due to impact on waves.

The SW 92#2 rig analysis and results presented heretofore have been carried out by the technical team at SMAR Azure using the in-house developed RigEdge+ Dynamic software tools

### SW 94 # 2 -Rig Analysis

#### BOAT data

Main boat/ rig geometric data are specified in the left-column table

#### RIG data

Rig design specification (geometry and material for spars and rigging) and tuning settings were provided by Southern Spars via the RigEdge data form.

#### ANALYSIS Scenarios

	SCENARIOS	SETTINGS
1	Full sails	Mainsail + Genoa
	Fresh Breeze	Heel = 30°
		RM = 765.5 kNm AWA = 25° AWS = 22.75 knt
2	Main 1reef+ furling Jib	Mainsail 1 reefed
	Strong Breeze	Reefed Genoa
		Heel = 30° RM = 765.5 kNm AWA = 25° AWS = 27.17 knt
3	Main 2reef+ furling Jib	Mainsail 2 reefed
	High Wind	Reefed Genoa
		Heel = 30° RM = 765.5 kNm AWA = 25° AWS = 35.42 knt
4	Main 3 reef + storm Jib	Mainsail 3 reefed
	Gale	Storm Jib
		Heel = 30° RM = 765.5 kNm AWA = 25° AWS = 47.95 knt
5	Main 3reef+ storm Jib	Mainsail 3 reefed
	Strong Gale	Storm Jib
		Heel = 30° RM = 985.2 kNm AWA = 25° AWS = 54.4 knt
6	Bare bole	No sails

*“We are proud to be the first shipyard collaborating with RINA Services SpA and SMAR Azure on this pioneer study project. Nowadays, focusing on the whole lifecycle is crucial: we are delighted to have SW94#2 Windfall as our 1<sup>st</sup> RINA certified rig yacht. Further, this certification will allow through data gathering, to close the loop for the following yacht design and ensure continuous improvement. We are looking forward to working together soon.”*

*Marco Alberti, General Manager, Southern Wind Shipyard (Pty) Ltd*

The table above describes the scenarios in which the Windfall rig has been analysed.

The scenarios were set according to the RINA Services SpA rig guidelines and may vary from case to case, depending on the type of boat, rig and sailplan.

Once received all boat and rig information, and defined the analysis scenarios in collaboration with RINA Yachting, the SMAR Azure technical team has drawn the SW 94#2 Windfall rig in RigEdge and replicated the exact rig tuning conditions, as provided by Southern Spars. Once the rig was tuned, The SMAR Azure technical team has carried out the rig analysis, by calculating first the sailing loads in all set scenarios (via the RigEdge - aerodynamic analysis tool) and then the influence of the sailing loads on the rig (via the RigEdge – structural analysis tool). Finally forward and backward dynamic loads were applied on the rig, while sailing in those scenarios.

**Results**  
**Certificate**

In all scenarios, the SW 94#2 Windfall rig has demonstrated to behave well.

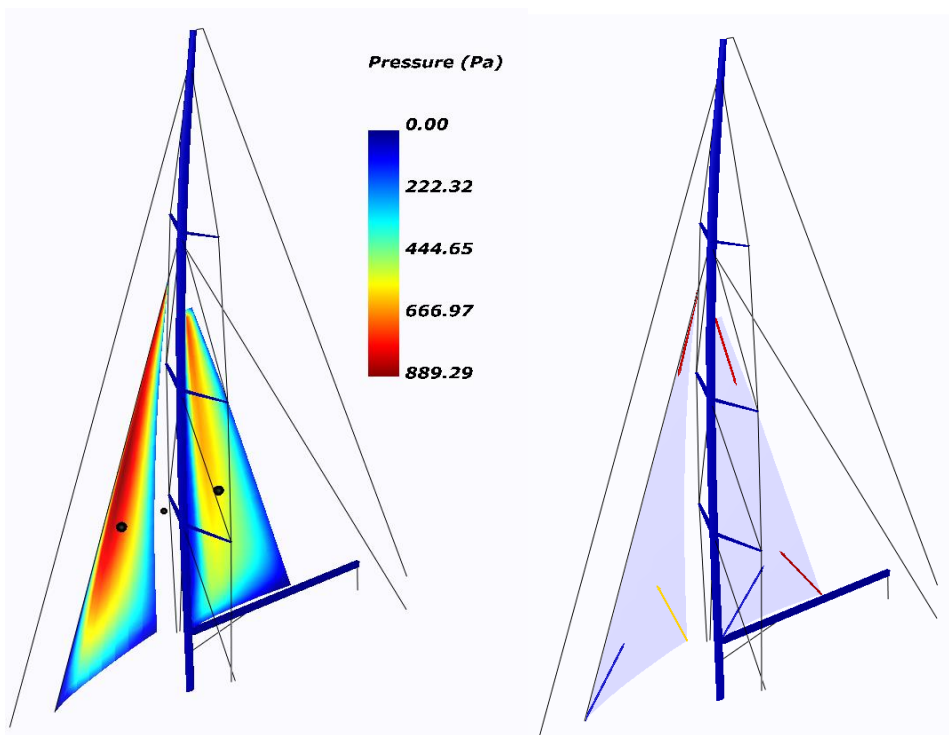
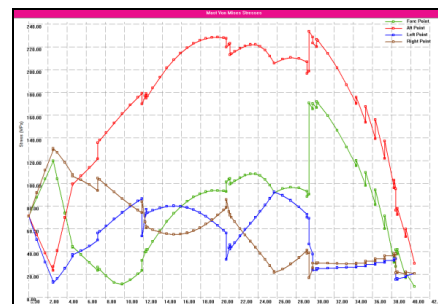
In all cases the tensions measured in all components (rigging and spars) were less than 45% of the breaking loads

**Provision of the results to the final customer**

SMAR Azure provides the results as electronic RigEdge file and a full report which includes details of the analytical approach and sailing scenarios chosen, in accordance with the RINA Services SpA Rig rules and numerical and graphical results and relative explanations. An example of the results available for one scenario follows

**Case: REEFED SAILS / STRONG GALE:**

The picture below shows the mast stress under tuning, sailing and forward acceleration.



Pressure map and sailing loads in reefed sails/strong gale

## SOUTHERN Wind

### About Southern Wind Shipyard (Pty) Ltd

Founded in 1991 by Willy Persico, Southern Wind Shipyard produces semi-custom composite sailing yachts based on the most advanced technologies combined with craftsmanship tradition. Based in Cape Town and with a staff of 260 people, Southern Wind is one of the very few shipyards which is able to carry out almost the whole construction in-house



### About Southern Spars

Founded in 1989, Southern Spars has established its place as a world leader in the design, construction, installation and servicing of carbon fibre masts, booms, composite rigging and components. The Southern Spars rigs power a wide range of yachts, from small one-design class yachts to grand prix racing yachts, cruising yachts and superyachts. Southern Spars has facilities in New Zealand, Denmark, South Africa, USA, Palma and Australia.

On the left, the pressure thermal map (aerodynamic analysis results), while on the right the sailing load acting on the rig and its deformed shape rig (structural analyses results). A forward and backward dynamic acceleration was applied on the sailing rig.

### SEAKEEPING ANALYSIS

A final phase of the investigation carried out on the Windfall involved an accurate seakeeping analysis. This study aimed to compare the maximum rig structurally sustainable acceleration with the maximum expected acceleration in waves. It is important to say that a thorough seakeeping analysis was carried out on the sister boat SW 94#1 (Kibokos) and provided the maximum acceleration on the rig using analytical methods.



The Windfall journey from Cape-Town to Genoa during which the accelerations were recorded.

On the SW 94#2 Windfall an experimental measurement of accelerations measured during an ocean crossing of 7000NM was conducted, to:

- Tailor the correspondence between analytical and experimental predictions;
- Establish the most critical sailing conditions, which resulted to be the "choppy sea".
- Establish the order of magnitude of the maximum acceleration that can

be encountered in an ocean sailing on a boat of this type and size.

It is worth noting that RINA Services is continuing the experimental data recording on another SW boat (a 102') to analyze the effect yacht shapes and sizes on the maximum acceleration measured on the mast.

### Why choose RINA Rig Certification

#### Accuracy

RINA Services uses RigEdge a unique software technology that allows evaluating the structural behavior of rigs under tuning, sailing and dynamic loads. The full process, from design to analysis is fully integrated and validated and constantly developed to ensure maximum reliability of the results.

#### Design input

The SW 94#2 Windfall rig analysis was specifically related to verify the structural integrity of that rig in specific sailing conditions. Thanks to accurate analytical simulation of rig behavior under worst case scenarios, it is possible to improve the rig design and performance. Many improvements could be introduced without any worsening of the yacht performances.

#### Reliability

Feasibility studies carried out in order to write a new regulation on rigs has shown that dynamic loads have an important effect and

From the point of view of certification the focus on testing of critical components of the rigging is a topic that is of great importance and appears to be particularly cost effective.

The life expectancy for a reliable rig can be improved with programmed scheduled maintenance inspections performed under the supervision of Classification Societies.

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