THE DESIGN AND BUILD OF THE SPARS ON THE SAILING SUPERYACHT MALTESE FALCON

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SUMMARY

High bending and torque loads , and complex internal structures created demanding design conditions for these three 58m high, freestanding ,15t high strength carbon masts on this award sweeping 290 ft vessel. Fibre-Optic real-time load sensing was key to optimizing design approach and load control for the as-built rig .

Keywords: Maltese Falcon ,FBG, Structural health monitoring ,high strength Carbon, freestanding, Insensys , load monitoring ,clipper rig, Dyna rig ,Worlds largest yacht

MALTESE FALCON

Maltese Falcon, the Worlds Largest Sailing superyacht is a three masted schooner with freestanding rotating Rigs.Each mast carries 800 sqm of sail set automatically from cavities within the masts onto permanent cambered trusses in such a way that when all sail is set a continuous wing is created. The design bending loads on the masts at 17MNm exceed the Worlds largest wind Turbines by a factor of 3 and are similar to those on the A380 wings. Torques induced by varying angles of attack and a slot and cavity down the compression face of these freestanding rotating rigs adds further to the engineering challenges.

The basic mast section swells from a circular 1m diam at the deck bearing to an ellipse of 1800mm x 1100mm at its maximum , before tapering to 600mm by 400mm at its truck , some 58m above the heel.The masts were built in T800 carbon from female moulds in a facility setup specifically for the Project alongside the vessel build in Istanbul, Turkey.

Each mast carries 6 cambered yards , up to 24m in length and tapered from 700mm deep in the centre to 350mm at the ends. The yards are set some 2.2m in front of the mast off infusion moulded carbon trusses, rigidly attached to the mast , on these trusses are mounted the 5 electrically driven winch and mandrel drive system requires to set and recover each sail.

The entire rig system is controlled by one person working in front of a 4 display touch screen set, enabling him to control the set and recovery of sails, individual sail tuning, the mast rotations and monitor the load control aspects.

Use of Fibre Optic based strain measurement during design and build

Fibre Optic based Fibre Bragg Grating systems were used at an early stage to help validate the design loads and ultimately failure loads. The optical fibres were embedded in one sixth scale structural model of the mast at key load points as predicted by the FEA models. The information was used to confirm expected parameters including Compressive and Tensile Modulii,and ultimate strengths. The FBG's were also embedded in full size development models of one element of the structure to confirm likely loads. More importantly , the accuracy and reliability of the monitoring were key factors to the Risk reduction programme required by the Owner to justify expenditure on this 100 million euro Project.

In the as-built rigs the fibre optic load measurement provide direct primary load information including forward driving and drag forces,(effectively like a wind tunnel) and present loads expressed clearly as percentage of allowable. In the background ongoing data acquisition tied in to other key parameters provides confirmation of design load cases and load history of the rigs.

Maltese Falcon, 88m Superyacht on maiden voyage

The paper will go into some details of design and construction , and design principals but will focuss on the use ot the FBG system as a design aid and validation tool

Author details

Damon Roberts is currently Technical Director to Insensys ltd and Engineering Advisor to Schlumberger Subsea Surveillance Group. In his position as CEO for a major composite spar builder for 15 years he carried full design responsibility and has had first hand experience from the design and build of some of the largest , most advanced Carbon Structures. Winner of many engineering accolades, including the status of Finalist in 1999 for the MacRobert award from the Royal Academy of Engineering He has been pioneering the practical application of FBG based strain sensing solutions

since 1995.. He was a founder and continues to be a member of the Technical Board of Insensys Ltd who have developed and applied the FBG technology into Aerospace, Wind Energy and Oil and Gas. He was also fully responsible for the composite and structural engineering and the build process for the award sweeping freestanding carbon rigs of the Worlds largest sailing Superyacht ”Maltese Falcon

John Brickwood has been primary design engineer with responsibility for laminate specifications , build methodologies and structural calculations on many record breaking Carbon /composite structures. He was a member of the team reaching the Royal Academy of Engineering’s MacRobert award final for the freestanding carbon Aero Rig. He was the principal engineer on behalf of Insensys Ltd for the Maltese Falcon spending 30 % of his time on the build site in Istanbul, ensuring the execution quality of the practical application of the design

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References

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