Case Study

CHEOY LEE BRAVO 72

One of the world's longest running shipyards, Cheoy Lee Yachts was established in 1870 and has built over 5,000 vessels since. Through a long standing partnership with Gurit, Cheoy Lee vessels have benefited from continuous, cutting edge structural design support. For their latest design, the Cheoy Lee Bravo 72', weight was a key consideration. Gurit worked closely with Cheoy Lee to provide structural optimisation, undertaken as a combination of detailed design review, first principles calculations and finite element analysis.

Gurit has engineered the Bravo series of motoryachts for Cheoy Lee dating back to the first model in 1995 and subsequent vessels as part of Cheoy Lee's continuous improvement in their designs and manufacturing process. This continuous development has made them one of the world leaders in composite production powerboat designs, producing fully cored structures infused with E-glass skins and carbon reinforcement.

The Bravo 72 is the latest model and is a major leap forward for the Bravo series in terms of design and technology. Cheoy Lee wanted to ensure the vessel was fast and energy efficient, and that its displacement would fit well within the capabilities of its twin IPS engine arrangement while providing the required space and amenities expected for this size motor yacht. As a result the design was put on an ambitious weight saving program

A significant part of the weight reduction process was looking for ways to optimise the design of the composite structure which makes up some 34% of the full load displacement. To ensure maximum resale for the vessel it was decided to use an international scantling rule as a reference standard, in this case Det Norske Veritas (DNV) Rules for Classification of High Speed, Light Craft and Naval Surface Craft (2014) were applied.

Within the DNV rules there is the ability to calculate simply using classical beam and panel theory to analyse the structure. Within this simplified approach there are some necessary approximations made, and is by far the most common approach for this sort of vessel.

The second option available is through the use of direct calculation using Finite Element Analysis (FEA) with the loadings and pressures taken from the rule but the structures performance analysed using a complete 3D model of the vessel. This comprehensive method of analysis allows the engineering to more accurately account for geometric effects such as curvature and panel breaks, enabling the results to be scrutinized to a much higher level in the pursuit of optimisation, without

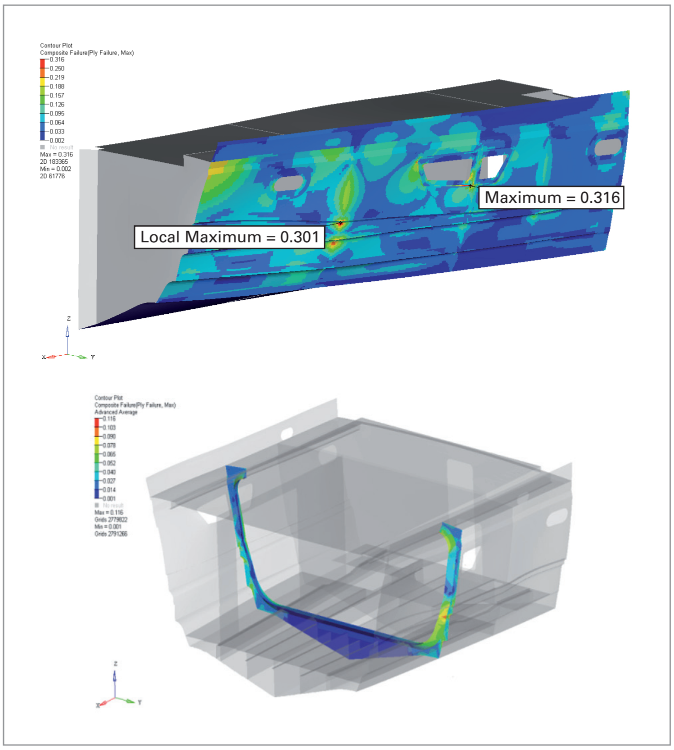

Figure 1 - Ring frame 1 FEA Model and Results

compromising the strength of the structure. FEA also provides an extremely accurate way of assessing deflections in complex composite structures such as decks and superstructures, which can be key to the owners' perception of the vessels quality.

Gurit used Altair HyperWorks to carry out the FEA along with Gurit's in-house developed scantling software which has been perfected over many years of working with the world's leading scantling authorities and tailored to suit the production motorboat market.

A detailed 3D model of the vessel was created to allow a much more comprehensive investigation into the strengths and deflections than would be achieved by the simple application of classification society rules. Analysing the 3D model with FEA provided an accurate insight into how the vessels structure as a whole would perform, rather than as individual panels and beams. Geometry effects such as stiffness from form geometry or curvature which aid the structure are identified, and likewise details that cause high localised stresses or higher deflections can be easily identified and dealt with specific and targeted reinforcements.

This combination is what allowed for the significant weight saving in the composite structure without compromising the designs ability to comply with an internationally recognised scantling code.

One example of this was in the optimisation process for a ring frame (see Figure 1, "Ring frame 1") in the centre of the vessel. This ring frame supports the hull and topsides, as well as the main deck under the saloon. A full width master stateroom occupies the hull space in this area, as a result there was significant pressure to maximise the living space which put pressure on frame depth.

A detailed FEA model in this midship section allowed for significant refinement in the geometry of the frame, including removal of an entire section of the ring frame across the deck head. Together with significant optimisation of the laminate through localised reinforcing of identified high pressure areas, a weight saving of over 60% was achieved for this structure compared with a traditional design.

Overall through the structural optimisation process Gurit was able to reduce the total composite structural mass of the Bravo 72' by 2300kg (15%), far exceeding the initial targets set by Cheoy Lee.

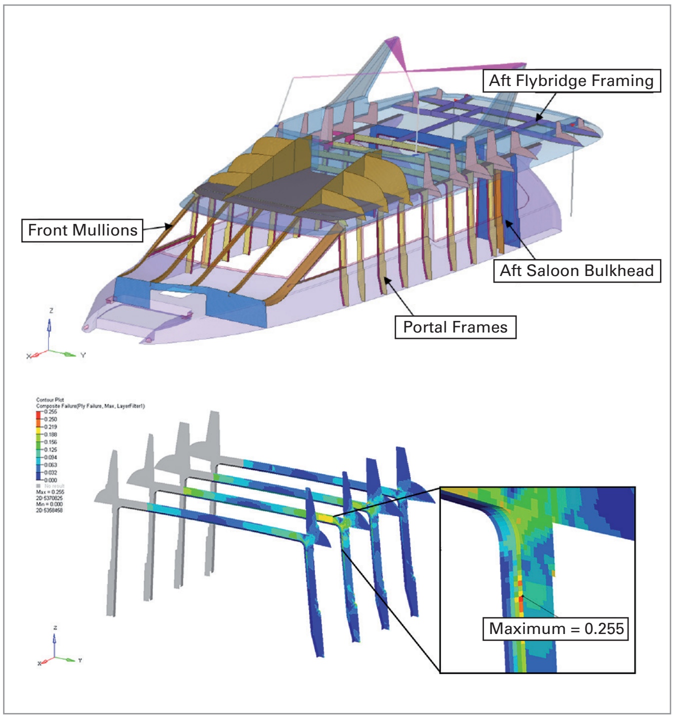

Figure 2 – Super Structure Internal Structure