Blade Design Tool

One of the key roles within the Gurit engineering sector is that of providing the conceptual design for components. As composites have become more of an accepted engineering material, more people have access to analysis tools such as Finite Element methods. It should be realised, however, that these tools are optimised for analysing a given configuration and are at best somewhat cumbersome as design tools. As with most aspects of life, if you start with the wrong concept you are unlikely to end up with a highly successful component.

Using this fundamental principal, Gurit has developed a number of rapid design tools allowing us to develop structural concepts prior to entering the detailed evaluation stage. The latest of these has been developed around the design requirements for wind turbine blades.

The Gurit Blade Design Tool takes the blade section and planform geometry and loading information from the designers. From this information, the geometry of the internal structure can be defined and optimised; different fibres, reinforcements and core materials can then be specified for the design. Structures can be defined as a number of layers, with different laminates used throughout.This allows for rapid iterations to be performed on laminate specifications whilst providing checks on tip deflection, blade strains in the primary structure, including blade bend frequencies and mass. The total quantities and costs of each material are also calculated.

Since the laminate specification for all parts of the blade is defined as individual layers of reinforcement, the information is easily transferred to layup schedules and construction drawings, making the whole process easier and less costly to carry out.

Testing for maximum deflection at the tip

For a design tool to be useful, it should give some guidance on the optimum placement of reinforcement in the structure. Blade flapwise bending stiffness is often a design driver to maintain adequate tip clearance on the tower during operation. To improve the optimisation, Gurit has developed a Tip Deflection Parameter, which allows reinforcement to be added selectively where it will have the maximum effect on controlling the tip deflection.

An advantage of developing a design program is that it can be used to perform "What If ?" types of analyses. For some years there has been a demand from the market for larger diameter wind turbines, and there has been a question of the economics of using carbon in larger blades. The suggestion is that as blade length increases, there is a length of blade where it becomes more economic to use less of a more expensive, but higher performance material, such as carbon.

With the Gurit Blade Design Tool, the same blade can be designed and optimised in both glass and carbon to meet the same design requirements in terms of tip deflection (for clearance on the tower), fatigue and ultimate strength. Hybrid designs can also be investigated. The tool allows these optimisations to be quickly completed, and calculates the quantities and cost of each reinforcement used in the design.

Running this analysis on an existing production blade has shown that if the design is extended to a larger diameter, a hybrid design with carbon and glass would be more cost-effective than stretching the all-glass design.

The approach of developing design tools has allowed us to enter the Finite Element analysis phase of projects with confidence that the design concept is valid. It has reduced the amount of time required to re-analyse in-depth alternative solutions and reduced the "time to market" for the design.