Boltlife's blade to hub flange connection methodology

Safe upscaling of wind turbines

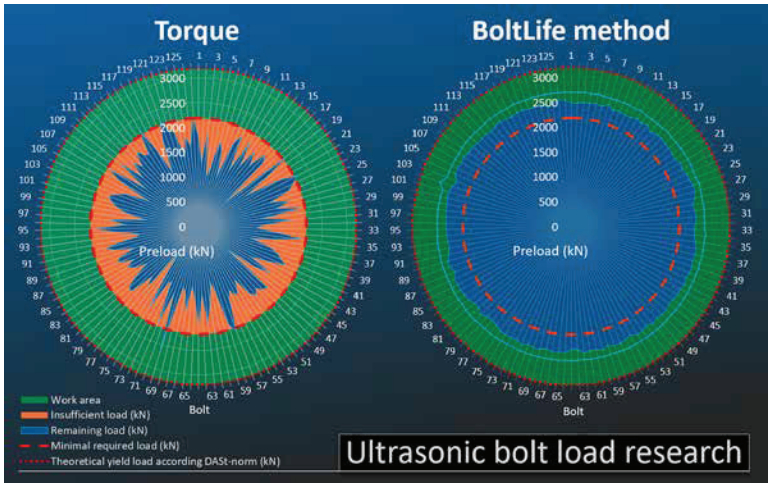
Wind turbine generators get bigger and bigger each year. As a result, the dynamic forces on a rotor blade during its operation become immense. These tremendous forces are transferred through the blade-to-hub connection, which makes it imperative that this connection doesn't have any weak points. This poses challenges for the designers of wind turbines. But those that can overcome these design challenges are looking at lower costs of quality and even better revenues.

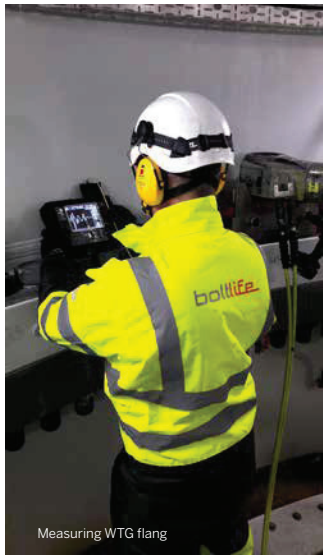
Boltlife specialises in creating high quality bolted flange connections in wind turbines, among them blade to hub connections. In 1996, a blade length of 20 meters was considered as state of the art; in 2003, 45 meters had become a standard and today we are working with blades of 107 meters long. In those days the T-bolt connection (IKEA connection) was the standard method to connect the rotor blade to the hub of the turbine. The last 15 to 20 years however, a root bushing connection is the most commonly chosen method for connecting the rotor blades.

One important advantage of a bushing solution over the T-bolt connection is the ability to apply more bolts on the same pitch circle diameter; about 30 % more bolts can be placed, which offers the opportunity to use longer rotor blades. An increase in size means an increase in power capacity and a reduction in maintenance costs. But it also means that we are reaching the limits of what our current standards can handle when it comes to design parameters.

High-quality flange connection

An important aspect for the quality of the flange connection is the bolt preloading procedure. "Current bolt preloading procedures, like torque-angle or tensioning, have their flaws due to poorly manageable parameters like friction, lubrication issues and misalignment," Joost Prieshof, CEO of Boltlife says. "The reason is that only a small and unquantified portion of the applied torque will be converted into actual preload. This leads to a considerable scattered load throughout the bolted flange connection."





Measuring WTG flang

Boltlife has developed a flange bolting methodology utilizing ultrasonic load measurement and custom sequencing methods, that create high-quality flange connections, where all loads are comfortably over the minimum required load, with very little scatter between the individual joints. The method used focusses on load-driven-torque, as opposed to the conventional torque-driven-load. Furthermore, each bolt in a flange will be measured and evaluated during the torqueing or tensioning load application. As a result, a fully traceable and repeatable load assessment is available at all times. Boltlife expects the method to be certified by DNV-GL very soon. The company is also developing an ultrasonic permanent remote measurement system.

Arnold Timmer, CEO of rotor blade specialist We4Ce, thinks that Boltlife is on the right track. "The Boltlife technology produces better connections, which potentially would allow us to design larger blades, and that enables a higher capacity wind turbine." We4Ce is a technology provider; it develops wind turbine rotor blades but does not build them. The company has over twenty years of experience, ranging from 50 kW to 14 MW wind turbines.

Timmer: "A rotor blade must be able to absorb the forces from wind gusts. But at the same time, it needs a certain level of rigidity. " This means that a lot of force is exerted on the bolts and fringes, which connect the rotor blades to the turbines. That makes it imperative to tighten the bolts securely. It is of great importance to accurately control the bolt preloading procedure. If the design preload force is not valid on the actual turbine, this will result in bolt failures and unsafe situations. Variations (or scatter) on the prescribed preload force will always occur and for this reason, the We4Ce designers take the expected scatter into account in their designs. Controlling the preloading procedure in such a manner that the expected scatter is lowered, will result in more optimised blade root designs.

Reduction in maintenance costs

Prieshof: "Current bolt preloading procedures have inaccuracies that can easily get to 30 to 40 % when it comes to torque to load." These are inaccuracies in which We4Ce has to make its calculations." Boltlife closes the flange comfortably above the minimal required load. Together with the lower scatter, this creates a flange connection that is almost immune to fatigue damage. Boltlife's technology also reduces maintenance costs, Prieshof explains: "We take measurements with a probe, which can be done very quickly. Within ten seconds I have a re-measurement from within the blade connection and I can read out the load immediately."

"We are reaching the limits of what our current standards can handle"


Blade flang bushing

Currently, Boltlife is in the process of certifying its methodology with DNV-GL. "This certification will guarantee that bolted flanges meet the highest traceable quality standards and they can expect considerable improvements in their Maintenance Plan." Whether certification alone is enough, remains to be seen; the wind turbine market is a conservative one. Timmer: "I can imagine that the market is careful to release another approach. Companies are used to certain procedures and a new methodology could give some challenges, which need time to settle in."
But when it does, the biggest advantage is clear: safe upscaling of wind turbines, which means more capacity and a big opex reduction. ●