Basic evaluation of FRP versus Aluminum Fan Blades for cooling tower applications

Basics:

1) Advanced FRP design blades are now single piece profile blades which results in higher performance and reliability than Aluminum blades.
2) Aluminum blades are multiple piece construction which requires the blade to be bolted or riveted to a metal spar (mounting rod). This dissimilar metals and mechanical connection inherently introduces a weak point in the overall fan assembly which results in advanced failure rates. (Please see photos below). Single piece FRP blades provide uniform stress loading characteristics which result in much longer service life with little or no failure.
3) ICS's chosen FRP fans are statically balanced and allow 100% interchangeability from set to set and hub to hub. Aluminum blades must be balanced with weights at site and do not allow for interchangeability.
4) Energy efficient FRP blades save operating costs as compared to Aluminum bladed fans.

FRP fans that typically outperform aluminum primarily because of manufacturing limitations of the production of aerodynamic shapes with Aluminum. The very nature of FRP allows us to make any desired shape and twist of the blade as needed to achieve maximum performance. A properly designed fan blade will have a non-symmetrical air foil with a variable chord and twist to compensate for the peripheral change in speed from the blade tip to the wide chord. There are a few aluminum fans that do approach this design by different methods but generally do not offer quite as much efficiency. Some aluminum and FRP fans use a symmetrical airfoil (same top and bottom with no provisions for the proper lift and drag coefficients) with a straight chord and no twist, these typically yield 20-30% static efficiency versus 60-70% static efficiencies of a properly designed FRP blade.

One of the most important reasons to select FRP fans over Aluminum is the inherently superior material characteristics offered by the FRP. All metallic materials have a limited fatigue life. As a fan runs in a cooling tower or any application the blades are constantly moving because of structural supports, driveshaft and mechanical supports below the fan interrupting the airflow. These interruptions load and unload the fan blades numerous times per revolution so it is a cyclic loading changing the down forces and transitional forces on a constant basis. Metallic materials are going to eventually fatigue in this environment.

Two types of Aluminum blades:

1) Cast Aluminum: Cast aluminums are one of the worse materials; a casting should be a fairly constant thickness so it does not have born in stress risers because of the casting liquid cool down rate. That is an impossibility with a fan blade having a variable chord width and neck design capable of retaining the blade when it is running.

2) Aluminum Airfoil: Aluminum airfoil skin blades use metal internal spars or stiffeners and either bolted or riveted to the blade neck and these parts have different strength and yield characteristics with unequal movement creating their own born in failure mode.

Photo of fan hub and steel spar (connecting shaft for Al Blade)

Photo of failed blade which has separated from the spar and the hub.

FRP Blade Designs:

ICS's proposed FRP blades are of a single piece design and are designed and manufactured of FRP laminate to have an infinite fatigue life without manufacturing and design limitations.

Please see the attached link for a photo of the single piece fan we have proposed:
http://www.hudsonproducts.com/products/tuflite/TufLiteIIIFlyer_White_web.pdf

Conclusion:

Although Aluminum bladed fans are substantially cheaper for first cost, the initial benefit of the low cost is easily offset by the high risks of failure, the increased energy costs and shorter lifespan of the equipment. ICS utilizes FRP fans as our standard materials on all of our new cooling towers to provide the highest levels of reliability, security and safety for the smooth operation of the plant. Should you require any further information, please feel free to contact us as needed.