**Structural Design Optimization of Composite Rotor Blades with Strength Considerations**

Description of Research

A rotorcraft allows it to take off and land vertically. Over the past few decades, rotorcraft have demonstrated their versatility in both civilian and military applications. There is an ongoing pursuit of engineers to design a rotorcraft with better performance. There is no doubt that the material and structure composing the rotorcraft have a significant impact on the performance. The composite materials are being used more and more extensively in helicopter rotor blades due to their superior mechanical properties, lightweight, and tailorable compared with metals. However, the structural design optimization of composite helicopter rotor blades through numerical analysis is a challenging task.

Among many studies in the past, strength properties and failure conditions of composite structures are overlooked generally. With advanced composite analysis tools, many composite structures these days can be further optimized with even fewer materials but still satisfy certain design requirements. However, safety considerations and the lack of proper composite stress/failure analysis usually make the final structure overly conservative and create extra costs. In this study, VABS will be used to bring the failure analysis into consideration in a design optimization process of a composite helicopter rotor blade, thanks to the fast and accurate layerwise three-dimensional stress prediction. Then VABS will be integrated into the Galaxy framework and connected with Dymore to achieve local-global design optimization of the blade. Numerical examples are provided using a UH-60A helicopter model to show the capability of the toolset to design advanced composite rotor blades considering mechanical requirements in terms of inertial, stiffness, and strength properties.

Involvement/Importance

I will make a presentation at the American Institute of Aeronautics and Astronautics (AIAA) 2022 SciTech conference. This work considered beam strength and failure in a more rigorous way in realistic and comprehensive design optimization problems of rotor blades. Cross-sectional and planform parameters were optimized for either beam properties or global performances. VABS was used as the tool to compute the beam cross-sectional properties including inertial properties, stiffness, strength ratio, and beam failure criterion. Then, VABS was integrated into the US Army Galaxy system to accomplish the optimization study. The tool and the theory behind it provided fast and accurate 3D stress recovery and hence efficient evaluations of the failure status within the linear analysis scope.

The AIAA SciTech attracts numerous scholars across the world to present their work each year. By participating in the AIAA SciTech conference, I can get feedback on an early version of my work from internationally-recognized experts. This can help me to improve our code and conduct research that are closer to industry needs. In addition, this conference will give me the opportunity to network with other researchers, which will be an excellent platform to establish myself and gain new insight into possible research interests. I am looking forward to attending the AIAA SciTech conference, and I kindly request that the committee looks favorably at my application.