Design of Helicopter Main Rotor Flexible Shaft with Hybrid Construction

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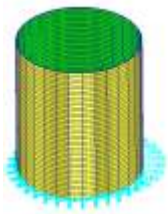
Abstract:

Helicopter is rotary wing aircraft, which is propelled by engine and lift is generated by the rotating blades. Torque transmission from gear box should be effective and plays important role in helicopter. Main rotor flexible shaft is a critical component which undergoes severe fluctuating dynamic loads and should also have torque transmitting capabilities. Several literatures have demonstrated the usage of different composite in aircraft industry. The present project is envisaged to look into the aspect of weight reduction by replacing metallic shaft through composites. Shaft undergoes twisting moment, so generally unidirectional laminate is not preferred as they may undergo de-lamination during torque transmission.

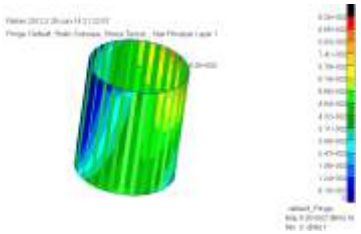
In the present investigation, analytical calculations were done initially to find the stresses acting on present metallic flexible shaft. Cross sections and loads were found from literature survey. Numerical investigation was validated for same metallic shaft and compared with analytical results. Further analysis was done by modelling the existing metallic shaft and baseline analysis was done by numerical methods. Validation studies for the methodology adopted in MSC NASTRAN were verified by comparing the results with literature. Woven composite with Carbon Fiber Reinforced Plastic (CFRP) was used as replacement for metallic shaft and the simulations were carried out.

It was observed that the woven fabric in composite have better torque conversion than unidirectional fibers in composite. Metallic shaft was also evaluated for a hybrid construction of steel and woven carbon/epoxy laminate Hybrid construction of flexible shaft with steel and carbon/epoxy woven fabric showed promising results for strength and torque. Failure analysis was carried out and it was found to be safe under the loading conditions of flexible shaft. This type of construction resulted in around 55% weight reduction for the flexible shaft.

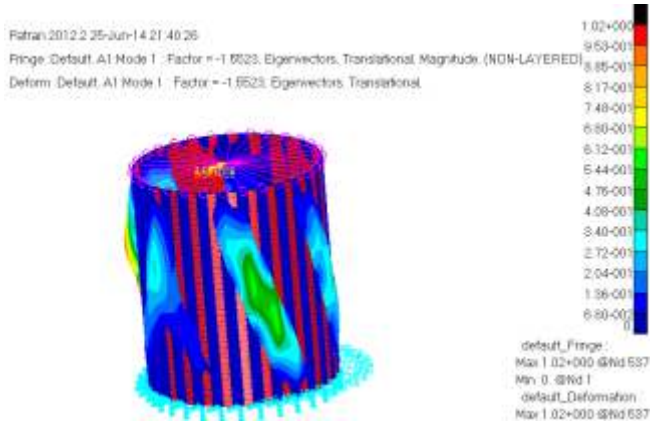
FE model



Hybrid model



FE analysis result



Buckling analysis result