Stress analysis

Advanced composite materials having high strength and low density characteristics such as Carbon/Epoxy appears to be candidate material for a fan stage to exploit aerodynamic advantage of blade configuration having forward sweep and lean. Such blade configurations are expected to experience high stresses due to its complex shape under high rotational speed. Composite materials can be designed to have desired properties without compromising on strength.

The blade geometry was to be finalised based on aerodynamic performance in conjunction with the mechanical integrity of the blade. Finite Element analysis was carried out to evaluate stress and deformation on the proposed fan stage with each blade configuration to assess mechanical integrity. Stress analysis was carried out using a simplified finite element model so that disk, blade and shroud were simulated in it achieving yet reasonably good results, hi order to bring down the stress level in the final stages of stress analysis, the blade sections were shifted circumferentially with reference to stacking line. This was further modified to incorporate thickened leading and trailing edges as required for Carbon Fiber Composite (CFC) blade fabrication. The resulting configuration was "TTT98-29". Stress analysis carried out on this blade is briefly presented as below.

The fan stage blade was scaled down to 79% to match the available drive motor power. The blade tip diameter of full scale model 400mm becomes 316 mm after scaling. The blade thickness at the mid chord of the root and tip are about 5.5 and 2.1 mm respectively and taper off to the edges on either side. Suitable hub and shroud are to be added as part of the analysis. A constant thickness 2.25mm is chosen for the shroud. The blade has dovetail root and is inserted into the slot of the disk. The schematic of bladed disk with shroud is shown in figure-12a and the same in 3D view is shown in figure-12b. The hub was extended so that it can be attached to drive shaft with spline. The fan stage rotates at 28,400 rpm to achive 470m/s tip speed.