PreVABS

An Effective Pre-Processor for VABS to Model Blades and Wing Sections

PreVABS is a design driven pre-processing computer program which can effectively generates high-resolution finite element modeling data for VABS by directly using design parameters such as CAD geometric outputs and both the span-wisely and chord-wisely varying composite laminate lay-up schema for rotor blade and aircraft wing sections. It has the capability of modeling sophisticated cross-sectional configurations for various composite helicopter rotor blades, wind turbine rotor blades, and aircraft wing sections. Most importantly, it has the merit of reducing dramatically the intensive modeling efforts for generating 3D FEA model which is either time costly or impractical especially during the preliminary and intermediate design phases.

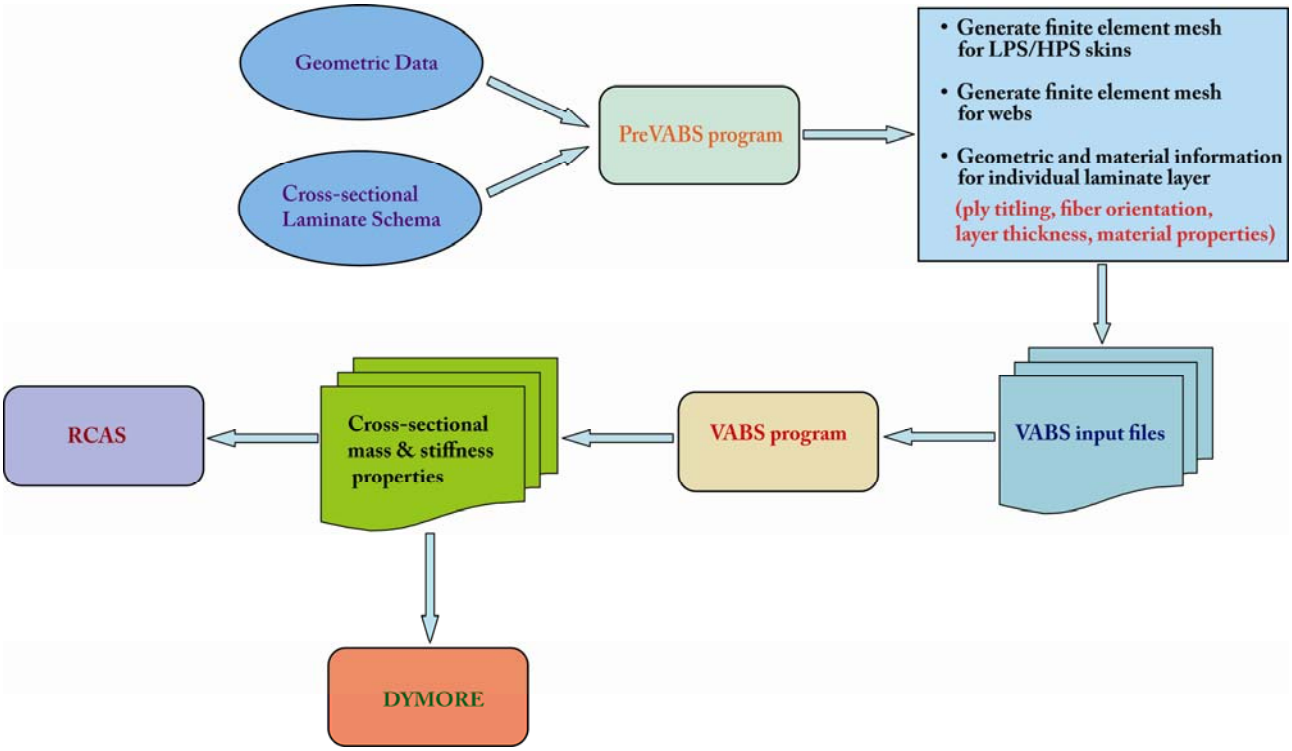


Figure 1: Application of PreVABS

A typical comprehensive blade/wing static/dynamic/aeroelastic analysis process for rotor system or aircraft flight simulations during the primitive design stage requires realistic cross-sectional properties of the blades or wing structures. Starting from the blade design configuration, PreVABS automatically models the sophisticate cross-sectional configurations with mixed quadratic and triangular meshes based upon the a few design parameters such as airfoil geometry, web positions and titling angles and chord-wisely varying composite laminate lay-up schema. The finite element modeling process is accurate up to each individual composite layer and the complete 3D structural

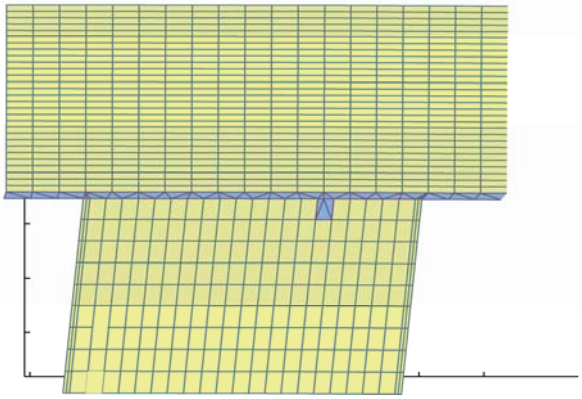
and material information such as ply orientation, fiber orientation and ply thickness are calculated and recorded for each element. The VABS program is then used to analyze these data to multiple span-wisely distributed sectional properties including structural properties (tension center/neutral axis, centroid, elastic axis/shear center, shear correction factors, extensional/torsional/bending/ shearing stiffness, principal bending axes pitch angle, modulus weighted radius of gyration) and inertia properties (center of mass/gravity, mass per unit span, mass moments of inertia, principal inertia axes pitch angle, mass weighted radius of gyration). These span-wisely distributed inertial and stiffness data, combined with aerodynamic loads and boundary conditions, are fed to aeroelastic analysis tools, such as *Rotorcraft Comprehensive Analysis System* (RCAS) or *DYMORE* (a multi-body dynamics analysis software developed at Georgia Tech) to carry aeromechanical analysis for the global behavior of the blade or wing.

In contrast to most currently available blade analysis tools, PreVABS offers following features for high-fidelity modeling of sophisticated composite rotor blades or wings:

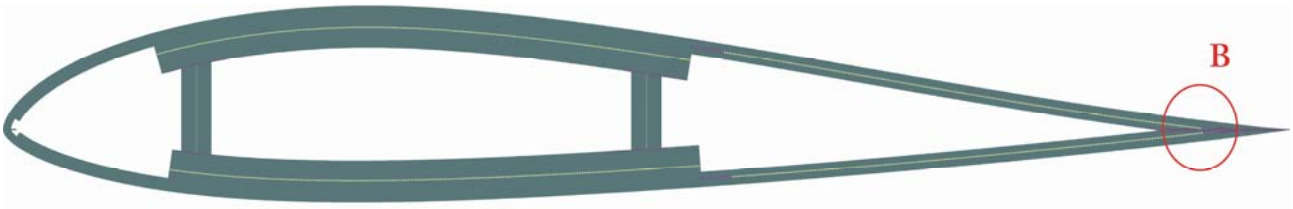
- Automatically generates high resolution finite element meshes directly from CAD geometric data and lamina schema, dramatically reduces the primary design schedule.
- The finite element modeling is accurate up to each individual composite layer and complete 3D material and structural information are calculated and kept for VABS analysis to provide the most accurate cross-sectional analysis.
- Can model composite blades or wings with hundreds of layers.
- Can model sophisticate configurations for composite blades or wings, including both relatively flat and highly curved airfoil profiles, arbitrary web position and web titling angles, and both span-wisely and chord-wisely varying lamina schema.
- Can provide visualization for the finite element model, rigorous check of model, and user-friendly warning and error messages. These will guarantee robust and accurate modeling outputs and provide a very convenient and quick way for users to correct and modify the design data.

PreVABS meshing of an aircraft wing cross-section

Zoomed view of A



PreVABS meshing of a stall controlled wind turbine blade



Zoomed view of B