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Rotor Blade Generator

Wind Turbines are complex mechanical structures which are constantly exposed to harsh dynamical loading. Because gearbox failures are responsible for the largest downtime of wind turbines, a substantial amount of time and effort is being spent by industry investigating and improving the dynamics and durability thereof.

Years of analysis and simulation have shown that a gearbox can no longer be treated as an isolated component but must be seen as an intricate part of a complex system, well tuned with the entire turbine. Even for initial resonance studies, not only are the inner components of the gearbox necessary but also all other components of the wind turbine which affect the dynamics. The rotor blade, and in particular the rotor blade's flexibility, plays a significant role in the behaviour and loading of the gearboxes.

For this reason INTEC, in cooperation with the University of Stuttgart in Germany have now developed an easy to use input deck for the creation of flexible rotor blades in SIMPACK.

Although flexible rotor blades can be generated using SIMBEAM and FE software, a new method was desired enabling users to exploit standard input formats which are common to the wind energy industry.

Using simple ASCII text files a user can input data for either a "Simple" or "Sophisticated" rotor blade and automatically generate a SIMPACK model which contains the rotor blade as a flexible body. SIMPACK's SIMBEAM module is utilised "underneath the hood" to create the flexible rotor blade which can then be used in more complex models. Both types enable a user to generate a realistic graphical representation of the rotor blade and choose between creating a rigid or flexible body. Either smooth graphics of the rotor blade or a stepped beam showing the cross sections used by SIMBEAM can be generated. Non-linear bending or shear effects (Timoshenko Beam) can also be ignored or included.

The "Simple" blade enables bending in only the flapwise or edgewise directions. The "Sophisticated" also takes into account many additional terms such as cross term inertia, torsional rigidity, pre-bend, and pre-sweep, to name just a few. Bend-twist coupling and non-homogeneous material can also be taken into account with the "Sophisticated Rotor Blade".

Ultimately, the new rotor blade generator helps designers easily create appropriate models in order to better understand and avoid detrimental resonances and dynamic loadings. All analysis methods available within SIMPACK, for example: eigenfrequency calculations, resonance analysis, NVH, order analysis, full coupling with aerodynamic software, etc, can be used with models containing any type of rotor blade.

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! ***********************************************
! ***    blade details          ***
! ***********************************************

station.par.begin
!                                                                          3D        3D       3D        3I
! root   mass/l     EI         EI         Twist     cog       cog       airfoil   Chord    thick-    pitc
! dist              flap       edge                 flap      edge                         ness      axis
! [m]    [kg/m]     [Nm^2]     [Nm^2]     [rad]     [m]       [m]       [-]       [m]      [%]       [%]
  0.0     715.02    1.81E+10   1.81E+10   13.3082   0.00000   0.00000   1         3.5420   100.0     50.
  0.2     715.02    1.81E+10   1.81E+10   13.3082   0.00000   0.00000   1         3.5420   100.0     50.
  1.2     814.46    1.94E+10   1.96E+10   13.3082   0.00000   0.00000   1         3.5420   100.0     50.
  2.2     779.91    1.75E+10   1.95E+10   13.3082   0.00000   0.00000   1         3.5420   100.0     50.
  3.2     779.37    1.53E+10   1.98E+10   13.3082   0.00000   0.00000   1         3.5420   100.0     50.
  4.2     623.99    1.08E+10   1.49E+10   13.3082   0.00000   0.00000   1         3.6034   96.28     48.
  5.2     474.21    7.23E+09   1.02E+10   13.3082   0.00000   0.00000   1         3.7731   88.27     46.
  6.2     446.59    6.31E+09   9.14E+09   13.3082   0.00000   0.00000   1         4.0168   78.93     44.
  7.2     421.93    5.53E+09   8.06E+09   13.3082   0.00000   0.00000   1         4.2322   70.73     42.
  8.2     402.37    4.98E+09   6.88E+09   13.3082   0.00000   0.00000   1         4.3848   62.68     40.
  9.2     420.90    4.94E+09   7.01E+09   13.3082   0.00000   0.00000   1         4.4877   55.70     39.
  10.2    448.98    4.69E+09   7.17E+09   13.3082   0.00000   0.00000   2         4.5495   50.29     37.
  11.2    438.97    3.95E+09   7.27E+09   13.1815   0.00000   0.00000   2         4.5846   45.38     37.
  12.2    427.77    3.39E+09   7.08E+09   12.8478   0.00000   0.00000   2         4.6048   41.64     37.
```

Fig. 3: Simple Rotor Blade

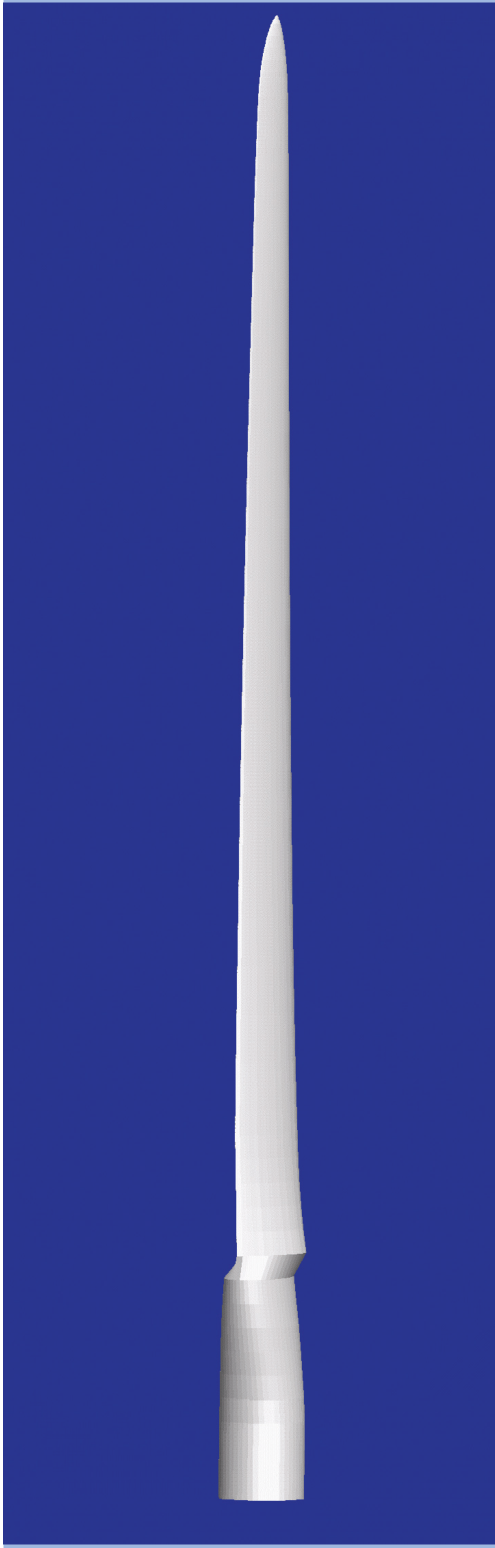

Fig. 1: Rotor Blade Smooth

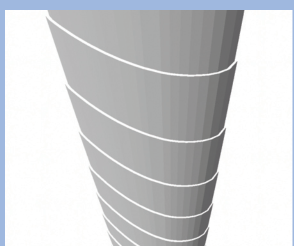

Fig. 2: Rotor Blade Sections