BLADED

4.7.0.40 **22/06/2015**

BASE MODULE

Multiple Calculation Setup

A new Multiple Calculation Setup feature is introduced in Bladed 4.7, allowing increased efficiency and flexibility when setting up load case parameter combinations in Bladed. A video introduction to the new feature is available **here**

Important features in the new Multiple Calculation Setup

- Intuitive and powerful user interface including many pre-defined methods to vary parameters for setting up IEC and GL standard load cases.
- Ability to sweep over almost all environmental parameters and many turbine parameters
- Import and Export feature to allow re-use of previously defined Multiple Setups

Full details of the new Multiple Calculation Setup feature can be found in the **MultiSetup User Manual** available in the Bladed 4.7 installation folder.

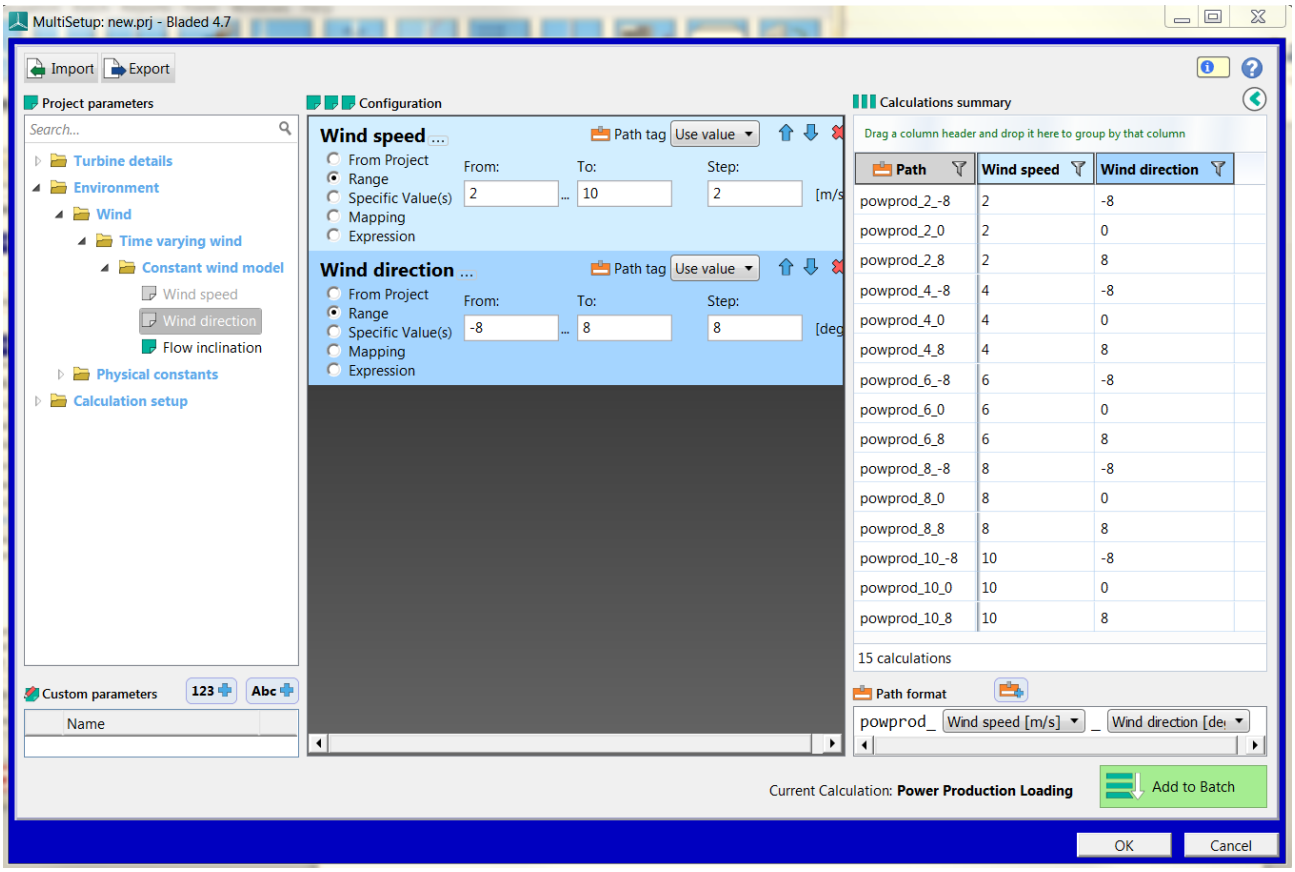

Figure 1: New Multiple Calculation Setup screen in Bladed 4.7

New Beta Aerodynamics Implementation

A new Beta implementation of Blade Element Momentum (BEM) aerodynamics has been added in Bladed 4.7.

Some key advantages of the new model compared to the pre-4.7 aerodynamics are

- The new implementation takes a rigorous and consistent approach to aerofoil geometrical orientation, allowing for more accurate aerodynamic modelling of blade features such as sweep, prebend, pre-cone and pre-sweep.
- The new implementation includes options for a Glauert skew wake model, Oye dynamic wake model and the Oye dynamic stall model.

In Bladed 4.7, the *old* aerodynamics implementation is the default setting. The new implementation options can be defined in the "Aerodynamics Control" screen as shown in Figure 2.

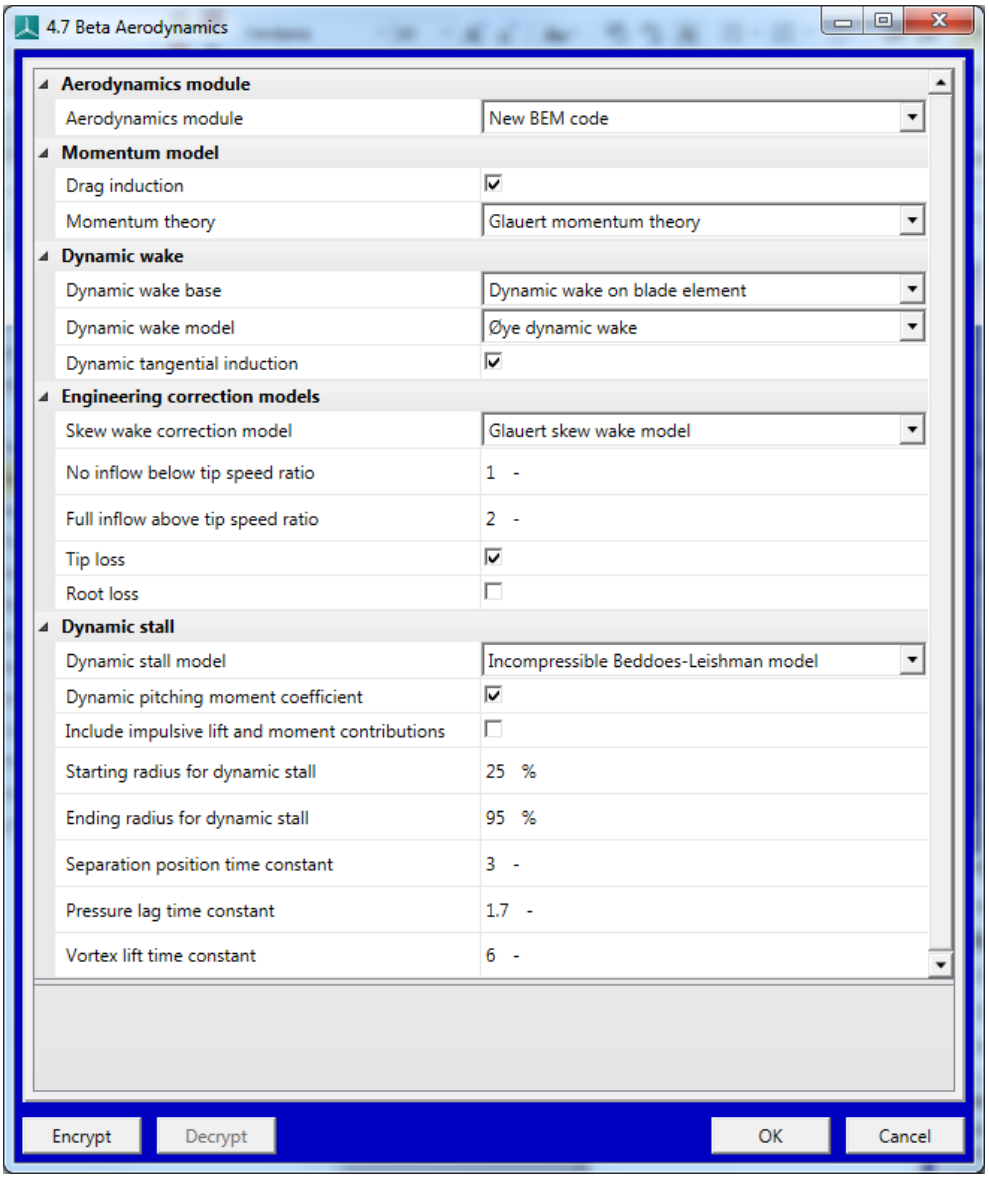

Figure 2: New Aerodynamics Control screen for Bladed 4.7

Performance Coefficients

The Bladed *performance coefficients* calculation has been updated for Bladed 4.7.

In 4.6, performance coefficients were calculated without building a complete structural model. The aerodynamic loads are calculated at each blade station and the torque, thrust and pitching contributions are numerically integrated in one dimension along the blade pitch axis. This provides a good calculation of hub loads for a straight blade, but can give discrepancies for blades with sweep and pre-bend, when compared to the performance coefficients from *steady power curve* simulation.

In 4.7, a full structural model of the rotor is built for the *performance coefficients* simulation. The aerodynamics loads are then applied onto the structural model and the hub loads are calculated from these using the Bladed structural code, which uses a full three dimensional geometric analysis. Therefore the effects of pre-bend and sweep in the blade are fully considered. This is entirely consistent with the calculation that is used in other simulations such as *steady power curve* and *power production*.

▼ *4.6 – Aerodynamics loads are calculated at all blade stations and then integrated in one dimension along blade root Z-axis*

▶ *4.7 – Full structural blade model is built and distributed aerodynamic loads are applied at each station. The loads are then resolved in full 3 dimensions to the blade root using the structural code*

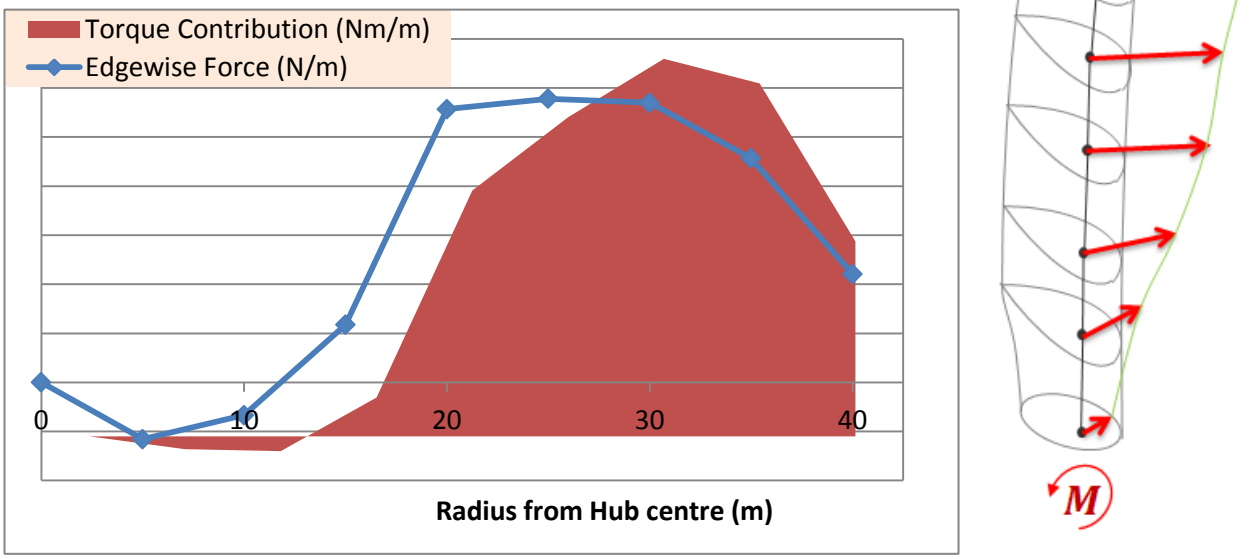

Figure 3: Changes in how aerodynamic loads are modelled between Bladed 4.6 and Bladed 4.7

Using the structural model also means that it is possible to analyse the effect of blade deflection on performance coefficients. This requires the necessary blade stiffness, mass and modal data to be defined, which has not previously been necessary for a *performance coefficients* simulation.

Previously the rotational speed in performance coefficients made no difference in the results unless the blade aerofoils were set up with Reynolds number interpolation. The rotational speed, along with the tip-speed ratio, is used to calculate the wind speed for the operating point. Therefore, if deflections are being analysed, the rotational speed will make a significant difference to the results.

Floating Point Protection

There is now the facility to switch off floating point protection for the external controller:

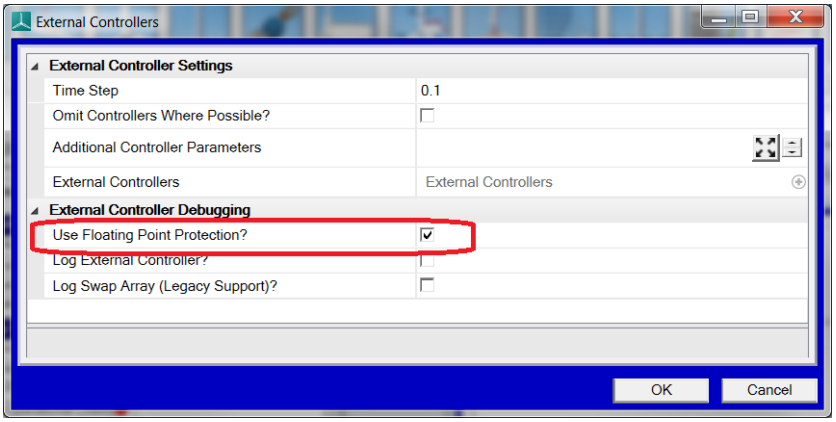

Figure 4: New floating point protection options for Bladed 4.7

This is for two reasons: firstly to confirm that the termination is due to a floating point error, and secondly because some legacy external controllers contain floating point errors which do not otherwise interrupt or affect the simulation.

Removed Option to Rename External Controller Function

This option was causing confusion, and was very unlikely to be used.

Blade geometric stiffening options

The Bladed geometric stiffening model accounts for the effect of blade deflections on structural response. In Bladed 4.7, options to partially or fully disable the geometric stiffness model have been added to the blade screen.

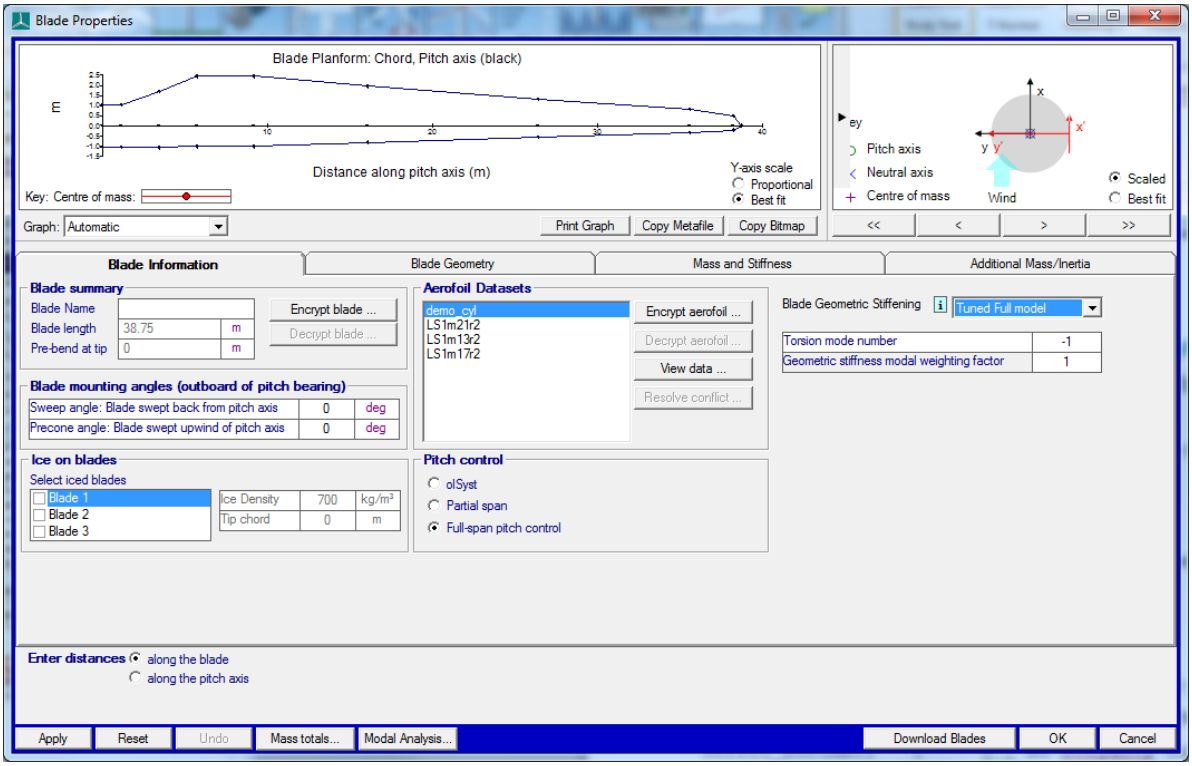

Figure 5: New option in Blade screen for Bladed 4.7

ELETRICAL DYNAMICS MODULE

Electrical Model screen

The Electrical Model screen has been re-designed and re-implemented for Bladed 4.7.

The new logical layout of the different electrical model options is enhanced by interactive diagrams of the selected electrical model.

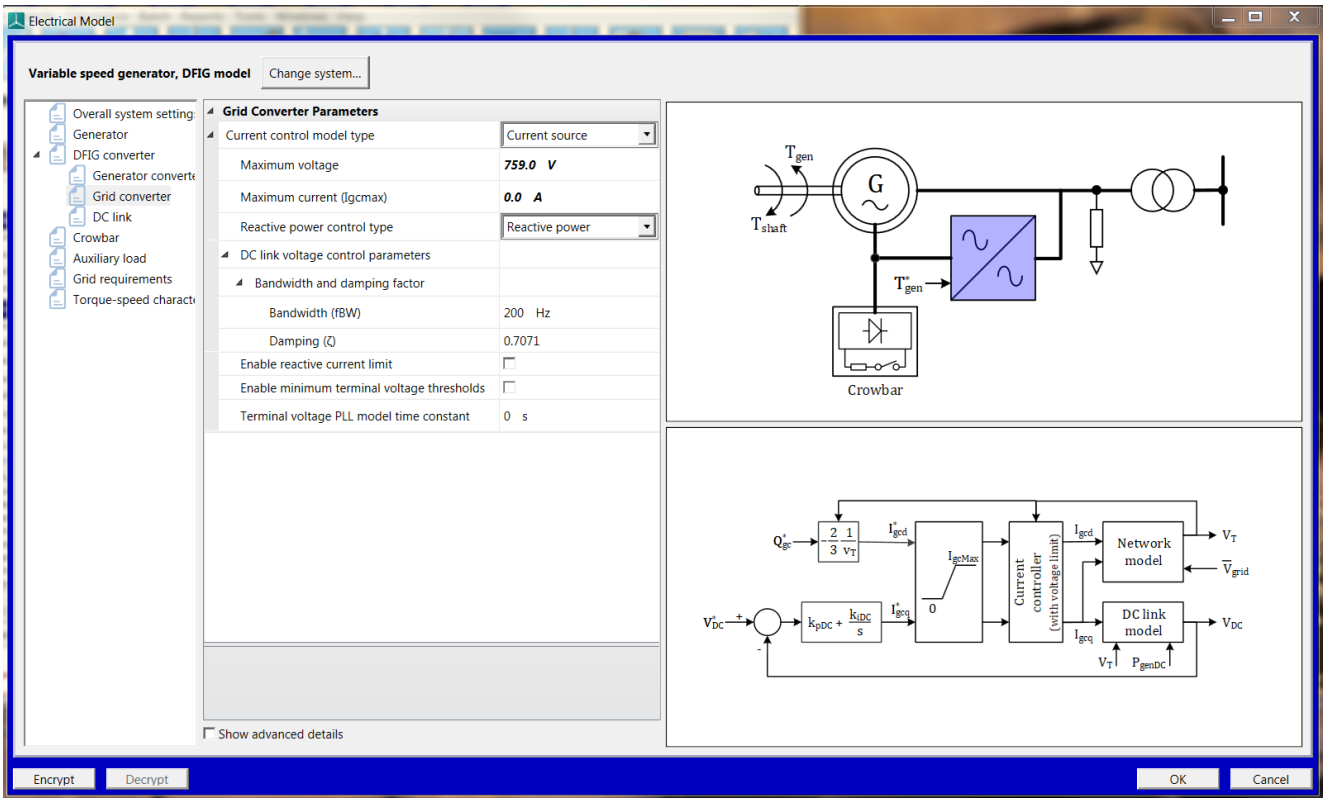

Figure 6: The new Electrical Model screen in Bladed 4.7

OFFSHORE SUPPORT STRUCTURE MODULE

Pre-tension in tension leg moorings

It is now possible to specify a pre-tension for tension-leg moorings. This works by reducing the un-stretched length of the mooring line, thus increasing the tension.

Global viscous drag

This new feature may be used in conjunction with the advanced (radiation-diffraction) hydrodynamic model to specify 6-degree-of-freedom viscous drag characteristics for the hydrodynamic bodies. The new "Global viscous drag" item is found in the "BEM Hydrodynamics" section for each hydrodynamic body. The velocities and loads are all expressed in global coordinates, and the loads will be applied at the support-structure node associated with the given hydrodynamic body.