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TOWER BASE GEARED YAW BEARING USER MANUAL

BLADED

Version: 4.11
DNV GL - Energy

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Bladed Tower Base Geared Yaw Bearing User Manual

Version 1.0

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1. Overview

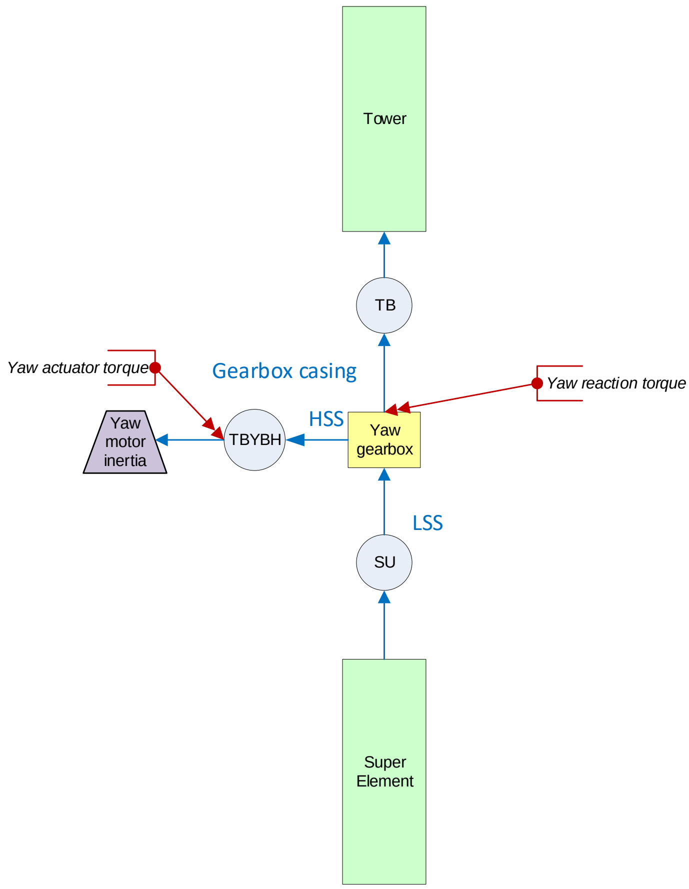
Bladed provides the facility for users to model a tower base geared yaw bearing in single or multi-rotor turbines. This is modelled within the Bladed multibody structural model. This functionality, made available in Bladed 4.10 beta, is activated via a new module written into project info.

This feature is only supported for turbines with a super element and an upwind rotor nacelle assembly configuration. The super element is effectively an artifice used to represent the lower part of the wind turbine tower and allow for the insertion of the yaw bearing.

2. Description of Yaw Bearing

The tower base geared yaw bearing is modelled with a yaw gearbox mounted between the tower base and super element nodes denoted “TB” and “SU” respectively. A multibody diagram of the system is presented in the diagram below.

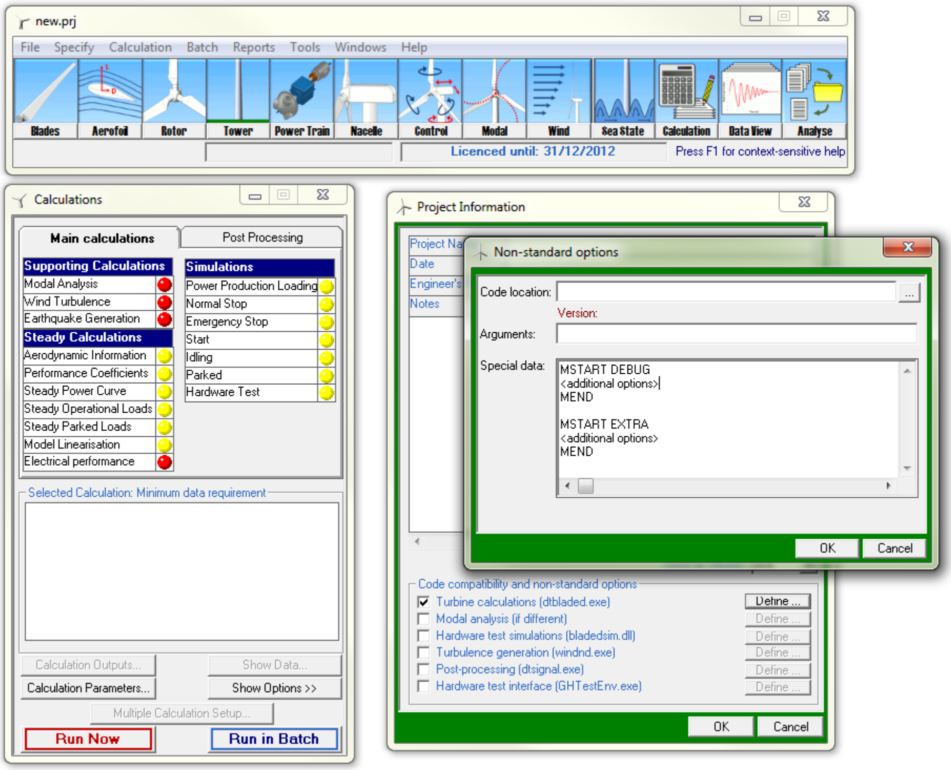
The gearbox has a single rotational degree of freedom and has a fixed gear ratio between the low-speed shaft (LSS) and the high-speed shaft (HSS). The HSS is connected to a single user specified actuator inertia. The total inertia of all the yaw drives are represented by a single inertia. The actuator torque should be applied to the “TBYBH” node as denoted on the diagram. More instructions are provided below. The yaw gearbox includes viscous damping and constant friction terms where the coefficients can be specified by the user.



3. Defining the Yaw Bearing

3.1 Project Info

The yaw bearing is defined through “Project Info”, which is a free-text field under the project’s properties. These can be defined by going to File → Project Info… and then ticking “Turbine calculations (dtbladed.exe) and then clicking “Define”:



All three boxes on this dialog are optional, so the “Special data” can be provided without specifying a new executable location or additional arguments.

3.2 Yaw Bearing Definition

The full definition of the yaw bearing input options are shown in the following table. All options are available in Bladed v4.11 onwards.

Keyword	Example Value	Description
`MSTART`	`TBGEARYAWSYS`	*Module start*
`UseTowerBaseGearedYawSystem`	`Y`	*Switches the functionality on* *Y(=ON), N(=OFF)*
`JmotorTotal`	`0.1 (kg·m^2)`	*Total inertia of the actuator*
`GearboxRatio`	`10000.0`	*Gearbox speed ratio*
`GearBoxDamping`	`1.0e5 (N·m/rad/s)`	*Coefficient of damping for gearbox*
`GearBoxFriction`	`1.0e5 (N·m)`	*Constant rotational friction torque*
`LockGearbox`	`1`	*Flag to lock the gearbox* *0(=unlocked), 1(=locked)*

Notes:

1. The inertia of the actuators is lumped into a single value `JmotorTotal`. This corresponds to `Jmotor`, the inertia of one motor, times the numbers of drivers.
2. Bladed does not support damping on support structure coupled modes and a tower base yaw bearing simultaneously. When both are specified, a warning is issued and the damping on support structure coupled modes is deactivated before proceeding with the calculation.

4. Logging

A Logging group is created for the tower base geared yaw bearing model. It contains the following series:

- Gearbox position and rate.
- Motor position and rate (Note: motor position and rate are in fact the gearbox position and rate multiplied by the gear ratio).

The positions and rates are given relative to the mounting component. The kinematics are reported relative to the super element coordinate system. For an undeflected turbine with a vertical tower the angle is measured anti-clockwise (looking down onto the turbine) relative to North.

5. Controlling the Yaw Bearing

The tower base geared yaw bearing can be controlled via the external loads DLL. A torque can be applied to the node "TBYBH" using the function ApplyMultibodyNodeTorqueInLocalFrame(const std::string& *node_id*, const std::string& *component_id*, const GHExternalLoads::DOF3& *applied_torque*), where the following arguments should be specified as:

1. *node_id*="TBYBH", the name of the node attached to the actuator inertia and the gearbox;
2. *component_id*="TB Yaw Motor Inertia", the name of the component on the side of the node where the torque is applied;
3. *applied_torque* is a vector specifying the applied torque. The applied torque must be of the form (0, 0, Mz) where Mz is the motor torque;

Applying a positive torque results in a positive yaw bearing angle rate and an increased yaw bearing angle.

The external loads DLL can communicate with an external controller (written with the application programming interface) via the interface functions GetNamedUserVariable and SetNamedUserVariable. These functions allow the user to read and write a variable named by the user (for instance "YawTorqueInput" or "YawBearingAngle", respectively). The named user variables are shared between the external loads DLL and the external controller.