In this paper a new anisotropic beam finite element for composite wind turbine blades is developed and implemented into the aeroelastic nonlinear multibody code, HAWC2, intended to be used to investigate if use of anisotropic material layups in wind turbine blades can be tailored for improved performance such as reduction of loads and/or increased power capture. The element stiffness and mass matrices are first derived based on pre-calculated anisotropic beam properties, and the beam element is subsequently put into a floating frame of reference to enable full rigid body displacement and rotation of the beam. This derivation provides the mass and stiffness properties and the fictitious forces needed for implementation into HAWC2. The implementation is subsequently validated by running three validation cases which all show good agreement with results obtained by other authors. Further, a parametric study is conducted in order to investigate if the given anisotropic effect of the composite blade, bend-twist coupling effect, is able to be examined by the developed beam element in a multibody system or not. Two different coupled examples of bend-twist coupling for the blade of a 5 MW fictitious wind turbine are considered. The two cases differ in the amount of bend-twist coupling introduced into the blade so that they produce 0.3 and 1 twist at the blade tip (toward feather), respectively, for a 1 m flapwise tip deflection toward the tower. It is examined if the current structural model is able to capture the anisotropic effects in a multibody system. © 2013 Elsevier Ltd. All rights reserved.