This work presents a comparison of two beam codes for aero-servo-elastic frameworks: a new structural model for the aeroelastic code HAWC2 and a new nonlinear beam model, BeamDyn, for the aeroelastic modularization framework FAST v8. The main goal is to establish the suitability of the two approaches to model the structural behaviour of modern wind turbine blades in operation. Through a series of benchmarking structural cases of increasing complexity, the capability of the two codes to simulate highly nonlinear effects is investigated and analyzed. Results show that even though the geometrically exact beam theory can better model effects such as very large deflections, rotations, and structural couplings, an approach based on a multi-body formulation assembled through linear elements is capable of computing accurate solutions for typical nonlinear beam theory benchmarking cases.