A fibre plasticity model for the dynamic analysis of wind turbine towers

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ABSTRACT

The objective of this investigation is to develop a distributed plasticity model for the geometrically nonlinear time domain dynamic analysis of Wind Turbine Towers. The tower is subjected to the combined action of arbitrarily transverse dynamic loading and bending moments in both directions as well as to axial loading, while it is subjected to the most general boundary conditions. A displacement based formulation is developed and inelastic redistribution is modelled through a fibre plasticity model, exploiting material constitutive laws and numerical integration over the cross sections. A uniaxial hysteretic law is considered for the evolution of the plastic part of the normal stress, following phenomenological hysteresis model [1]. Three boundary value problems are formulated with respect to the transverse and axial displacements and solved using the Analog Equation Method [2], a BE based method. The essential features and novel aspects of the present formulation are summarized as follows.

1. The formulation is a displacement based one taking into account inelastic redistribution along the tower axis and the emerging geometrical nonlinearity due to large displacements.
2. A hysteretic law is considered for the evolution of the plastic part of the normal stress.
3. The dynamic equilibrium equations are stated in state-space form.
4.The use of BEM permits the effective computation of derivatives of the field functions.

Numerical examples are worked out to confirm the accuracy and the computational efficiency of the proposed formulation.

References

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