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REDUCED ORDER MODELS FOR DYNAMIC ANALYSIS OF NONLINEAR ROTATING STRUCTURES

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Rotating structures are widely used in industrial applications such as turbo-machinery,abch heli- copter blades and wind turbines. The design tendency to create more slender, more flexible and lighter structural components under greater excitations increases the nonlinear behaviour of these components. Thus, the need to accurately predict the dynamic response of geometrically nonlinear structures becomes essential for the designer. Many researchers have study the geometrically nonlinear reduced order models for non rotating structures, geometrically nonlinear formulations of beam type finite elements, the dynamic behaviour of rotating geometrically nonlinear beams and the classical geometrically nonlinear finite element (FE) formulation that considers a nonlinear static equilibrium state induced by the effect of rotation.

In the present work, as an extension to [1], autonomous reduced order models (ROM) of non linear rotating structures considering geometrical non linearities are proposed. The latter are not only taken into consideration in the geometrical pre-stressed stiffness matrix induced by the rotation, as in the classical linearised approach, but also in the relative dynamic response around the prestressed equilibrium. The reduced non linear forces are represented by a polynomial expansion obtained by the Stiffness Evaluation Procedure (STEP) [2]. The reduced non linear forces are corrected by means of a Proper Orthogonal Decomposition (POD) of the full order non linear forces. The solutions of the non linear ROM obtained with both time integration (HHT-α) and harmonic balance method (HBM) are in good accordance with the solutions of the full order model and are more accurate than the linearised solutions.

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