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Influence of the pre-stress state on the wave propagation in a shearable Timoshenko beam

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It is very common to use pre-stressed beam models in the structure design. However in the nonlinear domain, the modal analysis remains difficult especially when shearability is taken into account.This work aims to study the natural vibrations of pre-stretched nonlinear shearable Timoshenko beam using Cosserat continuum mechanics. In this paper, a three dimensional nonlinear beam model is first developed. Then we analyse waves which are superimposed on a finite pre-stretch state. Namely, analytical dispersion relations are given for different values of pre-strech. The complete spectrum, including propagating and evanescent traction/compression, shear and bending modes, of a pre- stretched shearable beam is calculated through dispersion pattern. Spectrum strongly depends on initial pre-stress value. A significant qualitative and quantitative difference with the classical Timoshenko beam theory is pointed out even for small pre-stretch values.