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On the warping of the extreme ends of a beam under flexural oscillations

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Abstract

In this paper, we explain why beyond a certain critical frequency the extreme ends of a beam under flexural oscillations remain sometimes plane and in other cases become warped. We have seen this to be the case when the flexural oscillations of a beam are studied experimentally. Using the plane stress elastodynamic theory as well as a more precise calculation based on a 3D finite element method, we show for the first time that when the transverse displacement has a derivative equal to zero near the beam extremes, the ends can indeed become warped. In addition it is shown, from an energetic point of view, that warped modes result from a constructive spatial interference of the two components of flexural oscillations while flat modes result from a destructive interference of these two components.

Keywords: flexural vibrations, plane stress, Timoshenko beam, EMATs
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