Summary: The bending frequencies of an unswept wing are calculated based on the model of a beam clamped at the root and free at the tip. For a tapered wing with straight leading- and trailing-edges, the chord is a linear function of the span; the same linear function of the span applies to thickness, in the case of constant thickness-to-chord ratio. The latter is usually small, so that the beam differs from the more frequent cases of a conical beam with a circular cross-section or a prismatic beam with a square cross-section. Thus, the bending modes of a non-uniform beam are considered, with mass and area moment of inertia which are respectively quadratic and quartic functions of the span. There is no exact solution expressible in finite terms using elementary functions, and thus power series expansions are used. The bending frequencies are calculated for a delta wing and compared with a rectangular wing, with the same span, mean chord and thickness, mass density and Young’s modulus. It is shown that the fundamental frequency is higher by a factor 4.96 for the delta wing; it is also shown that the general case of the tapered wing is intermediate between the delta and the rectangular wing. Lastly, the analytical results obtained for the bending modes are compared with numerical modal analyses of general tapered wing beams using high-fidelity finite-element model software.

MSC:

74-XX Mechanics of deformable solids
76-XX Fluid mechanics

Full Text: DOI