

Free vibration frequencies of simply supported bars with variable cross section

Olga Szlachetka, Jacek Jaworski, Marek Chalecki

Abstract: Using the Rayleigh method, the authors developed a procedure for determination of consecutive natural frequencies and derived formulas for frequencies of first three modes of free (transverse) vibrations of simply supported bars having the shape of truncated cone and truncated wedge. The bars were made of a homogeneous and elastic material and considered as Bernoulli-Euler beams. It was assumed that the shape of the bar axis deflected during vibration corresponds to a deflection line resulting from action of a uniform continuous static load. A dimensionless frequency parameter for bars with various truncation factors were compared to those known from the literature and with results of application of FEM. High concordance of results was found for the first natural frequency. For the second and third frequencies, however, the results acceptable from engineer's point of view (i.e. burdened with an error lower than 6%) were obtained only for bars with the truncation factor no greater than 0.6 (for the truncated cone) and 0.4 (for the truncated wedge). It means that the hypothesis assumed in the study for the shape of a beam axis deflection line during vibrations, enabling determination of consecutive frequencies of free vibrations and right for bars having shapes close to a solid cylinder or rectangle, loses its appropriateness for bars approaching the shape of cone or wedge.

¹⁾ Olga Szlachetka, Ph.D.: Warsaw University of Life Sciences, Faculty of Civil and Environmental Engineering, Department of Civil Engineering, Nowoursynowska 166, 02-787 Warsaw, Poland (PL), olga_szlachetka@sggw.pl .

²⁾ Jacek Jaworski, Ph.D.: Freelancer, Warsaw, Poland (PL), jacek_jaworski@sggw.pl .

³⁾ Marek Chalecki, Ph.D.: Warsaw University of Life Sciences, Faculty of Civil and Environmental Engineering, Department of Civil Engineering, Nowoursynowska 166, 02-787 Warsaw, Poland (PL), marek_chalecki@sggw.pl .