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J.L. Mantari, C. Guedes Soares

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A trigonometric plate theory with 5-unknowns and stretching effect for advanced composite plates

J. L. Mantari, C. Guedes Soares¹

Centre for Marine Technology and Engineering (CENTEC), Instituto Superior Técnico,
Technical University of Lisbon, Portugal, Av. Rovisco Pais, 1049-001 Lisbon, Portugal

Abstract. A simple but accurate trigonometric plate theory (TPT) for the bending analysis of functionally graded single-layer and sandwich plates is presented. The significant feature of this formulation is that, in addition to including the thickness stretching effect, it deals with only 5 unknowns as the first order shear deformation theory (FSDT), instead of 6 as in the well-known TPT. The TPT possesses in-plane and transverse shear strain shape functions ($\sin(z/m)$ and $\cos(z/n)$) containing the parameters “ m ” and “ n ” that should be properly selected. The governing equations and boundary conditions are derived by employing the principle of virtual work. A Navier-type closed-form solution is obtained for functionally graded single-layer and sandwich plates subjected to bi-sinusoidal load for simply supported boundary conditions. Numerical results of the present TPT are compared with the FSDT, other quasi-3D higher order shear deformation theories (HSDTs), and 3D solutions. The important conclusions that emerge from the present numerical results suggest that: (a) for powerly graded plates the present TPT produces as good results as refined quasi-3D HSDTs, however (b) for exponentially graded plates the present TPT yields improved results; (c) it is possible to gain accuracy keeping the unknowns’ number constant but by selecting properly the parameter “ m ” and “ n ”.

¹Corresponding Author email: guedess@mar.ist.utl.pt Tel: +351 218 417607; FAX: +351 218 474015;

Key words: Higher order shear deformation theory; Bending analysis; Functionally graded materials; Trigonometric plate theory; Stretching effect.

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