A new theory for the global analysis of plates made of FGM

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The classical plate theory can be applied to thin plates made of traditional materials like steel. The first theory allowing the analysis of such plates was elaborated by Kirchhoff. The basic idea was to analyse the plate behaviour not on the base of the three-dimensional theory of elasticity. He reduced by some simplifications the three-dimensional problem to a two-dimensional. As it was shown later by Timoshenko the transverse shear which was ignored in the Kirchhoff theory in some cases significantly changes the final results of the global static and dynamic analysis.

For modern composite structures made of laminates, sandwiches or functionally graded materials (FGM) the transverse shear deformations cannot be ignored. In this case refined theories must be introduced. How to deduce the governing equations? This question is till now under discussion. There are three different possibilities: by introduction of hypotheses for the stresses/strains/displacements, by application of mathematical techniques (power series, asymptotic integration etc.) or by using the direct approach. The last approach is a conceptual different direction since a two-dimensional deformable surface is introduced á priory, and after this the primary quantities (forces and moments) are discussed. By this way one can built up a plate theory which is so strong like the three-dimensional Continuum Mechanics. There is only one problem in applications, which is related to the difficulties of the identification the effective properties of the plate.

The paper presents the extension of Zhilin's direct approach to plates made of functionally graded materials. It will be shown how the effective properties can be computed. Finally, some simple static and dynamic examples demonstrate the advantages of the suggested theory.