ACCURACY ESTIMATION OF ELASTICITY MODULI EVALUATED BY FOUR-POINT BENDING

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The present paper deals with practical applicability of four-point bending in determination of elasticity moduli. In [1] and [2], a theory was derived for evaluation of elasticity moduli by four point bending, namely for materials showing different moduli in tension and in compression, and for thin layers (e.g. plasmatic coatings), respectively. The limitations for reasonable exploitation of this method lie in the inaccuracy of results. As it can be expected, and as it was already mentioned in [2], the influence of input quantities inaccuracy on the results error can be very substantial. This is, in particular, the case of thin layers; since the measured plasmatic layer represents a small part of the specimen cross-section (usually less than 10 %), the influence of the layer parameters (modulus of elasticity, thickness) on the resulting strain is relatively low. In an inverse problem, consequently, small changes in measured strains or thickness can result in large deviations in the determined moduli of elasticity for these layers. These non-linear dependences are analysed in the paper and, as a consequence, general rules for practical use of this method are formulated.

Key words: *moduli of elasticity, measuring method accuracy, four-point bending, strains, error estimation*

1. Introduction

Recently, the authors derived and published a theory for using four-point bending in evaluation of elasticity moduli for material specimens with the moduli values varying stepwise throughout the specimen cross section. First, a theory for materials with different elasticity moduli in tension and in compression was published in [1]. Second, the four-point bending theory was enlarged for elasticity moduli evaluation of thin layers made of materials that do not enable us to use standardized tension tests (e.g. plasmatic coatings – see [2]). Standardized tension tests are not convenient for evaluating elasticity moduli of thin layers because of two basic reasons. The first reason is the possible non-symmetry of the specimen that causes an additional specimen bending, and consequently, false results of tension tests. Especially the technology of plasmatic coating can bring substantial asymmetry of the specimen because it is not easy to ensure equal layer thicknesses on both specimen sides. The second reason is a rather low influence of a thin layer on the global specimen stiffness. The stress and strain distribution in bending is more convenient for layer modulus evaluation; the layer material is in the region with extreme stresses and strains, which increases its importance for global specimen stiffness and consequently reduces the error of its elastic modulus evaluation. Moreover, in contrast to tension tests, the plasmatic layer is sufficient on one side of the specimen only for bending tests (see theory in [2]). The problems of

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