Structural System Identification of Shear Stiffnesses in Beams by Observability Techniques

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Abstract

Despite its importance in some structures, shear deformation is systematically neglected by most static structural system identification methods. To fill this gap, this paper analyzes, for the first time in the literature, the effect of the shear deformation in the inverse analysis of structures. This study is focused on a parametric structural system identification method: the observability technique and it is applied on beams. As the majority of the methods, this technique is based on the Euler-Bernoulli beam theory. The method presented in the literature is unable to identify correctly the characteristics of a structure (such as flexural stiffness) when shear deformation is not negligible. In fact, in this method, the effects of shear deformation are close to those produced by measurement errors. To solve this problem, the observability procedure is updated according to the Timoshenko's beam theory. This formulation uses an algebraic approach combining both a symbolical and a numerical application. Thus, the updated observability formulation is able to obtain not only flexural stiffness but also shear stiffness. Besides this, for the first time in the literature, a parametric equation of the estimates is obtained. Some examples are presented to illustrate the validity of the new formulation.

Keywords: Structural System Identification; Observability; Shear stiffness; beams.

1 Introduction

Damage in structures might produce changes in their mechanical properties. In order to quantify the magnitude of this damage Structural System Identification (SSI) might be used. This process is based on a subset of measured inputs and outputs (e.g. forces and/or displacements). The subset of measured inputs can be obtained by non-destructive tests that measure the structural response under a certain load case. According to the load nature, these tests can be classified as static (see e.g. [1, 2]) or dynamics (see e.g. [3, 4]).

Matrix methods of structural analysis are universally accepted in structural design. These methods enable a rapid and accurate analysis of complex structures under both static and dynamic conditions. However, when applying matrix

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