Experimental investigation of beams under coupled bending and torsion

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Abstract

This paper analyses the potential of digital technologies to investigate the behavior of beams under bending-torsion couplings in large deformation. In a first part, we will present the set-up for this experiment, based on the use of robotic arms. The versatility of robotic arms allows to access complex configurations or loading path, while controlling the test either in displacements or in forces. Thanks to embedded sensors, the moments and forces applied by the robot are measured, as well as the location of the application point. In addition, the geometry of the beam is retrieved by an enhanced photogrammetry procedure. The acquisition yields a point cloud representation of the beam. Then, the method's accuracy and repeatability will be investigated for both the control of the experiment and the reconstruction of the beam. Finally, the set-up is used to analyze classical mechanical problems and do a benchmark of finite element models. The first case study is the bending-torsion buckling of an I beam clamped at one end and free at the other. The second one is the bending of a rectangular beams toward its strong inertia, resulting in bending-torsion couplings and out of plane deformation.

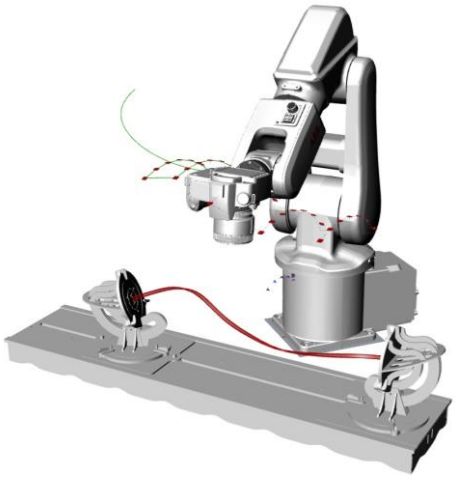

Figure 1: Photogrammetry reconstruction of a beam using a robotic arm.

References

[1] S. Timoshenko and J. Gere, *Theory of Elastic Stability*, 2nd ed. McGraw-Hill Book Company, 1936.

[2] P. Margerit, 'Wide-band characterization of the heterogeneous viscoelastic and anisotropic dynamical behavior of structures. Application to the piano soundboard. (in french)', PhD thesis, Université Paris-Est, 2018, Chapter 3.

[3] L. Du Peloux, F. Tayeb, B. Lefevre, O. Baverel, and J.-F. Caron, 'Formulation of a 4-DoF torsion/bending element for the formfinding of elastic gridshells', in *International Association for Shell and Spatial Structures*, Amsterdam, 2015.