Buckling and post-buckling of twisted strips: experimental and numerical analyses

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Abstract

This study is about the buckling and post-buckling responses of columns formed by twisting a flat, straight and narrow material strip having a rectangular cross section. In essence, the analysis and results are of experimental and numerical nature: from real laboratory and virtual simulation environments. The problem set-up has its roots in the design of a wooden pavilion relying on finding structurally more efficient geometrical configurations for originally straight and flat birch plywood strips: twisting leads to structural members stiffer in both bending and compression. In the problem set-up, a straight and narrow material strip is first twisted and then compressed. For a flexible material strip, twisting can evidently be seen as a natural shaping process: forces or kinematical constraints are applied only at the ends of the strip, whereas the strip span takes its form according to the laws of the mechanics and physics of solids and structures. The reported experimental results cover flexible birch plywood strips twisted up to 90 degrees and compressed subsequently. The corresponding finite element analyses cover both the twisting phase up to 400 degress and the subsequent compression phase, including a study on the influence of the twisting-induced stresses on the buckling response. Numerical analysis extends to the post-buckling regime as well. The experimental and numerical results are in a good agreement and reveal somewhat surprising behaviour concerning the correspondence between the critical buckling load and the twisting angle.

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