Single Point Incremental Forming of Cold-Rolled Polycarbonate Sheets

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Abstract. Recently, thermoplastic polymers are replacing metals in making complex workpieces where properties like, inter alia, lightness, shatter resistance, durability and thermostability are required. In addition, relatively new techniques like the incremental sheet forming process are becoming more and more attractive for manufacturing customized products, because their flexibility and low production cost. Concerning this, incremental forming of polymer sheets allows manufacturing of components at room temperature, which represents a real asset compared to the conventional polymer processes. During the last decade, different thermoplastic polymers, from high-crystalline to amorphous, were processed by incremental forming and polycarbonate sheets resulted well suited to this process. The goal of the present study was to investigate the formability of polycarbonate sheets when they do not show in-plane isotropic elasto-plastic behaviour, typical of the sheets after their production processes. In particular, the work aimed to examine the influence of a preliminary cold-rolling of the sheets on the single point incremental forming of these outstanding engineering materials, by comparing incremental formed components, obtained by undeformed and cold-rolled polycarbonate sheets (with different rolling reductions), for the same thickness. Experimental tests, involving the manufacture of pyramid frusta, were carried out by a high commonly-used computer numerically controlled machine, a simple-shaped tool and a sheet clamping system. The comparison was made on different significant features of the process under exam, concerning the forming forces, the occurrence of failure and defects and the mechanical properties of the components, in order to weigh up the possibility of using anisotropic cold-rolled rather than isotropic undeformed thermoplastic sheets, depending on the design requirements of the product.