Contour optimization of extruded aluminum profile cross-sections, taking into account structural mechanics and manufacturing aspects.

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Abstract A multicriteria optimization method for extruded aluminum profiles under different structural requirements and manufacturing aspects is presented. As the manufacturing effort is often one of the major drivers in structural design, it is mapped via a fuzzy approach from qualitative linguistic statements to numerical representations parameterized with respect to the design variables. This helps to introduce this aspect already in early design phases. To achieve a Pareto-optimal solution, representing the designer's preference of structural vs. manufacturing criteria, a combination of these objectives multiplied by proper weighting factors is used. A new cross-section shape parameterization algorithm has been developed, to make the optimization method applicable to arbitrary cross-sectional geometries. The parameterization of that cross-sectional area is performed by the algorithm in a predefined accuracy, so that its contour can be shifted continuously within a certain design space. The properties of the cross-section, which have an influence on the manufacturing effort (i.e. the compression ratio, the minimum wall-thickness) are calculated based on the parameterization during the optimization. These properties are also used as input data for the calculation of the manufacturing effort through the fuzzy approach. For the solution of this optimization problem, a gradient based (second-order) algorithm is applied. For computational efficiency, the structural model is evaluated in parallel to calculate the required gradients via finite difference techniques. For the validation of this approach, a clamped beam under two different loading conditions is used. The overall approach has been also successfully applied to larger scale practical examples arising from automotive and aerospace structures, where a lower manufacturing effort and lower masses are particularly desirable.

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