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Multi-objective optimization of reciprocal timber layouts from reclaimed stock elements

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Abstract

The constructive dimension of structures becomes more important today as the question of sustainability encompasses a broader scope in regards to material use. The inclusion of construction constraints within the digital design process enable novel design approaches, such as design and construction based on reuse of reclaimed material. Reciprocal structures were used in the past for different purposes, but in this context, it is worth noting their use for solving the practical issue of spanning distances especiallly in slabs when the available elements were shorter than the span. The use of reciprocally connected elements allows defining a set of variables that allows adapting to design constraints and goals related to structure and construction. Computational strategies are investigated to generate layouts that are able to span planar configurations with non-standard reclaimed elements. This work presents an optimization study for the design of standardized structural layouts for floors and/or walls, using the SPEA-II Multi Objective method. A set of geometrical and material parameters are defined for modelling the panel architecture, while competing objective functions are defined related primarily to aspects such as structural lightness and efficiency in construction. The results are presented in the form of Pareto optimal sets, from which conclusions can be drawn for the design of cost effective panels from reclaimed elements.

Keywords: reuse, upcycling, reciprocal structures, sustainability, tectonics, construction, optimization, timber structures, sustainability.