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Mechanics of Novel Compression Structures

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Abstract

This thesis investigates structures that can be characterised by an order of hierarchy or branching. The objective is to determine the optimal shapes for these structures, and the optimal regimes for each structural order. It is of specific interest whether these solutions change when imperfections are included. For hierarchical structures, imperfections can exist at the local and global scales, and this interaction of imperfections across different orders of magnitude causes a strength reduction that is greatest at the optimal shape found by analysing a perfect structure. It is therefore essential to include the imperfections within the optimisation algorithm, because they change the optimal shape. Branched structures are more resilient to imperfections at the global scale, so the interaction of imperfections is not as severe. The optimisation of perfect and imperfect branched structures predicted identical shapes in most circumstances, although for specific regimes the error was more substantial. The aim of the analyses presented here is to evaluate concept design decisions. Once a design concept has been chosen, the simplifying assumptions required for computational efficiency can be relaxed.