

# Designing Funicular Vault Structures with Shape Grammars

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## Abstract

This paper presents research on a rule-based approach to designing creative aggregations of compression-only vault structures, validated through a tile-vault prototype. A shape grammar-influenced design method is specified that uses shape rules to recursively design vaulted structures in a way that is neither mechanical nor deterministic. The grammar produces a compression-only structural language of buildable groin-vault-like structures that expands the capacity of how compression-only vault structures are designed and breaks habits in current computational design techniques, which is lacking outside of using commonly known software plug-ins. Though shape grammar-based generative systems have already been shown to be capable of being used in architecture and engineering to design singular vault structures with pre-determined support conditions. The method proposed here addresses the critical issue of design homogeneity and predictability in the design of funicular vault structures, and has the capacity of generating aggregations of several vaults in the language. Furthermore, the method has been validated through the construction of a tile-vault structure built using the Guastavino system. This paper will specify and demonstrate the formation rules, describe the tile-vault prototype and its construction process, and discuss how in combination with other material and form-work specifications, this design method can be expansive and generate new and surprising forms of compression-only vault structures.

