

Mechanical Comparison of Arrangement Strategies for Topological Interlocking Assemblies

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Dec 2023

Topological Interlocking

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A topological interlocking assembly can be defined as an arrangement of blocks that are in contact with each other together with a frame such that, if the frame is fixed, any non-empty finite subset of blocks of the arrangement is prevented from moving.

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- planar topological interlocking assemblies, i.e. between two parallel planes in 3D-space,
- use perimeter as the frame,
- only copies of the same block differently arranged.

The Versatile Block

The Versatile Block is a polyhedron embedded in \mathbb{R}^3 , given by vertices $\{v_1, \dots, v_9\}$, edges

$$\begin{aligned} & \{\{v_1, v_2\}, \{v_1, v_3\}, \{v_1, v_4\}, \{v_1, v_5\}, \{v_1, v_9\}, \{v_2, v_3\}, \{v_2, v_5\}, \\ & \{v_2, v_6\}, \{v_2, v_7\}, \{v_3, v_4\}, \{v_3, v_7\}, \{v_4, v_7\}, \{v_4, v_8\}, \{v_4, v_9\}, \\ & \{v_5, v_6\}, \{v_5, v_7\}, \{v_5, v_9\}, \{v_6, v_7\}, \{v_7, v_8\}, \{v_7, v_9\}, \{v_8, v_9\}\}, \end{aligned}$$

and triangular faces

$$\begin{aligned} & \{\{v_1, v_2, v_3\}, \{v_1, v_2, v_5\}, \{v_1, v_3, v_4\}, \{v_1, v_4, v_9\}, \{v_1, v_5, v_9\}, \{v_2, v_3, v_7\}, \\ & \{v_2, v_6, v_7\}, \{v_3, v_4, v_7\}, \{v_4, v_7, v_8\}, \{v_4, v_8, v_9\}, \{v_5, v_6, v_7\}, \{v_5, v_7, v_9\}, \end{aligned}$$

together with coordinates

$$\begin{aligned} v_1 &= (0, 0, 0), v_2 = (1, 1, 0), v_3 = (2, 0, 0), v_4 = (1, -1, 0), \\ v_5 &= (0, 1, 1), v_6 = (1, 1, 1), v_7 = (1, 0, 1), v_8 = (1, -1, 1), v_9 = (0, -1, 1). \end{aligned}$$

Wallpaper Groups

Planar Assemblies of the Versatile Block

Finite Element Method

Problem formulation

Simulation Setup

Stresses

Combinatorial Method

Combinatorial Results

