NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

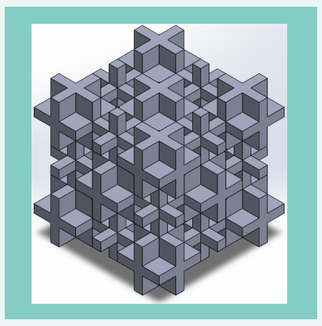
MAE21044 - INVESTIGATION OF NOVEL LATTICE DESIGNS FOR 3D PRINTING

Presented by Hyunwoo Lee
Supervised by Asst. Prof. Lai Chang Quan (School of MAE & MSE), Dr. Ian Seetoh Peiyuan (Temasek Labs@NTU)

Background

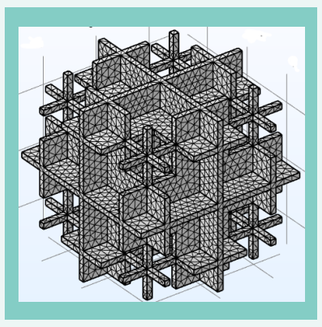
3D printing, despite its many advantages, has a key limitation of being unable to print geometries with enclosed spaces as most techniques cannot remove support materials or structures from these enclosures. Lattice 3D printing is affected by this limitation and hence, is unable to realize some geometries with superior mechanical properties. This project investigated different cubic symmetric, enclosure-free lattices composed of 2 different types of unit cells. Optimization was performed to derive the structures with optimal mechanical properties.

Methodology



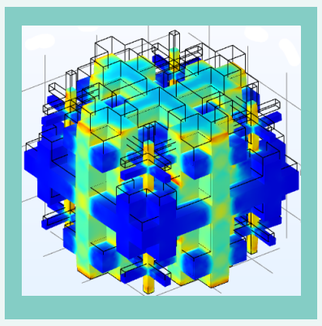
1. Lattice Construction

16 different symmetrical 3x3x3 lattice composed of plate/truss unit cell constructed with SOLIDWORKS



2. Elastic Modulus of lattice

COMSOL simulation used for elastic modulus of lattices with varying unit cell thickness



3. Thickness optimization

COMSOL optimization used for optimal unit cell thickness that yield maximum elastic modulus at given relative density.

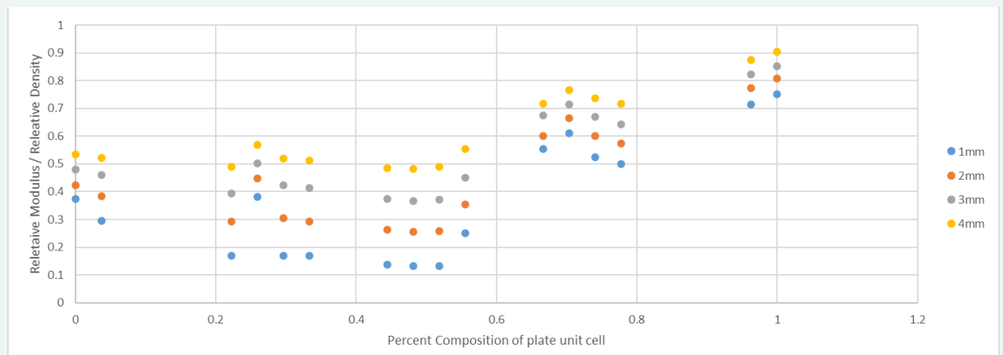
Conclusion & Future Work

Elastic modulus of lattices shows a consistent pattern with respect to lattice geometry regardless of unit cell thickness. Optimization results at specific relative density also showed corresponding pattern in reaction forces. Moreover, 19 plate unit cell lattice showed highest elastic modulus for almost all relative densities among enclosure free lattices.

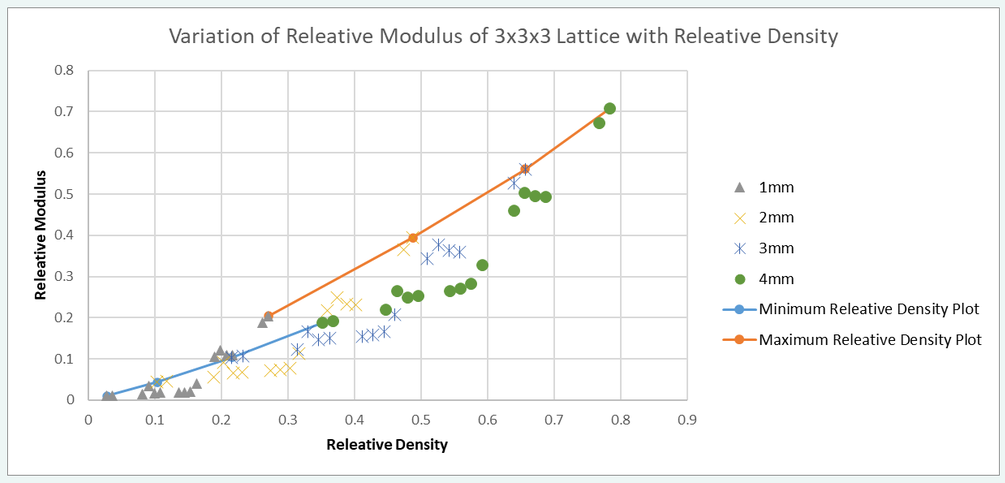
Furthermore, optimal unit cell thickness for a specific lattice geometry will be obtained through analytical optimization, utilizing isostress and isostrain principles and simulated unit cell elastic modulus. Lattice of exceptional properties will be printed and tested.

Results

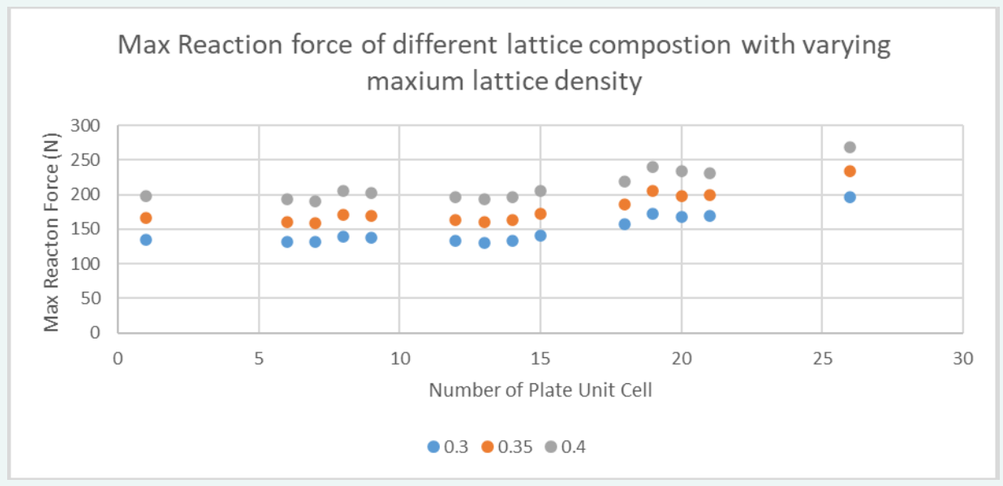
Variation of relative modulus / relative density with percent composition of plate unit cell for unit cells with different thickness



Variation of Relative Modulus of 3x3x3 Lattice with Relative Density

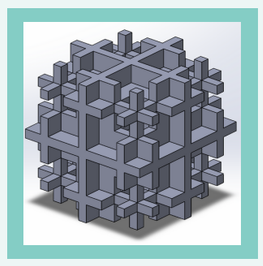


Max Reaction force of different lattice composition with varying maximum lattice density

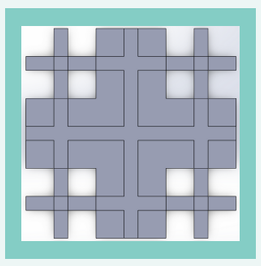


Lattice with optimal elastic modulus: 19 plate unit cell lattice

Lattice



Top/Bottom



Middle