PEEKbot Lunar Rover - 2D Cellular Material Optimization

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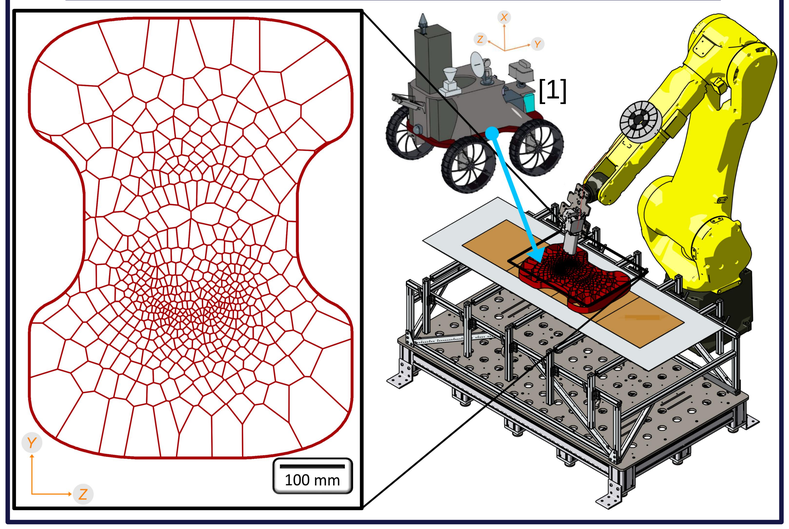
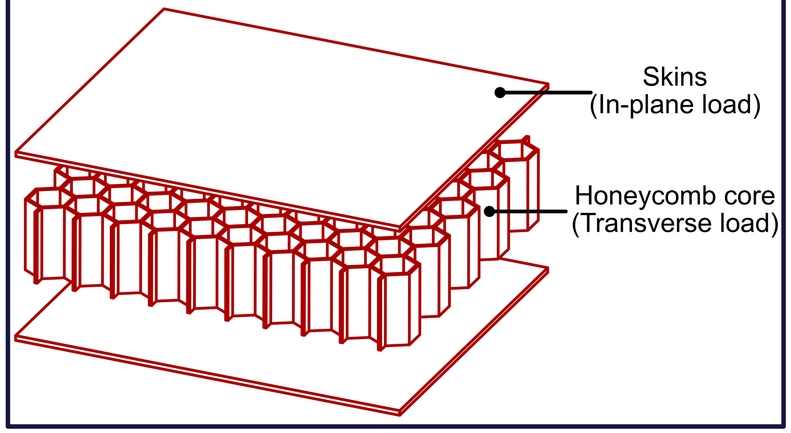
LUNAR ROVER IN COMPOSITE MATERIALS



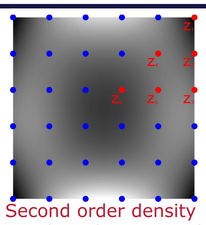
SANDWICH PANEL THEORY

Sandwich panels are lightweight structures with high flexural stiffness. They are widely used in the aerospace industry.

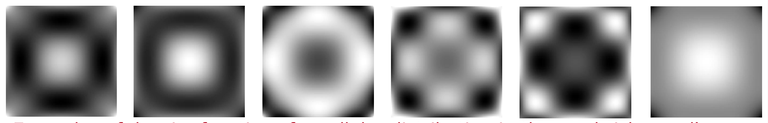


OPTIMIZER

NOMAD [2], a blackbox optimizer, maximizes the stiffness of a finite element model thanks to a density function and to direct search.



Second order density function based on 6 variables

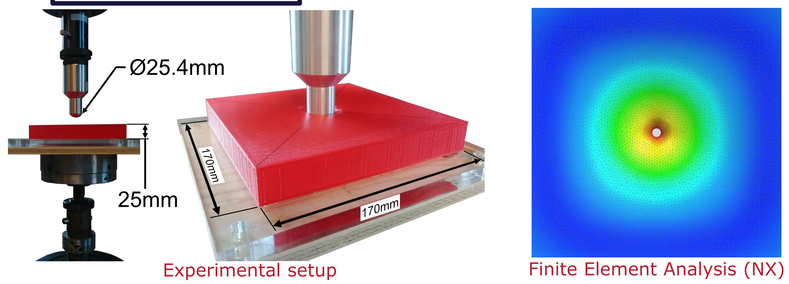


Examples of density functions for cellular distribution in the sandwich panel's core

OBJECTIVES

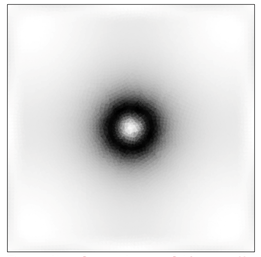
Maximize stiffness and **improve ultimate load** of a sandwich panel for a given amount of cells.

METHODOLOGY

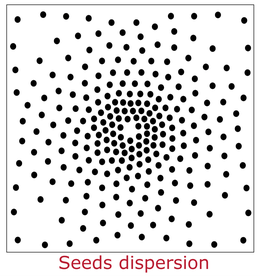


Experimental setup

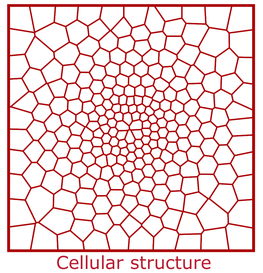
Finite Element Analysis (NX)



Density function of the cells



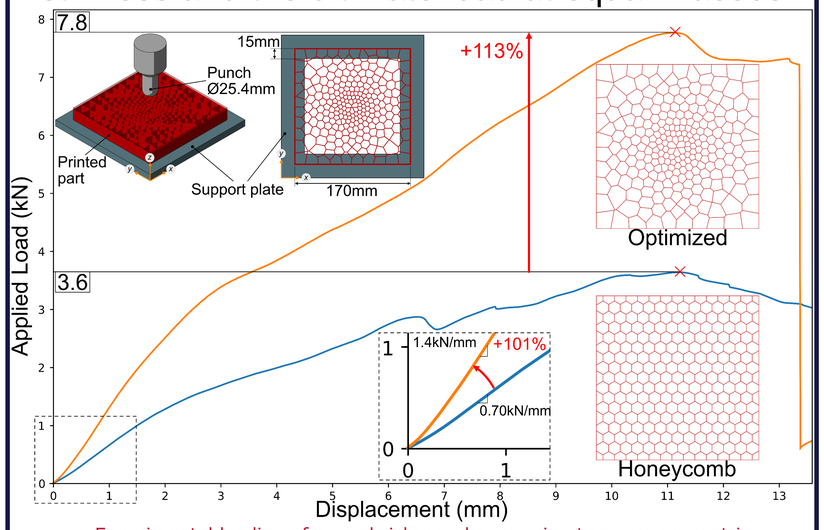
Seeds dispersion



Cellular structure

RESULTS

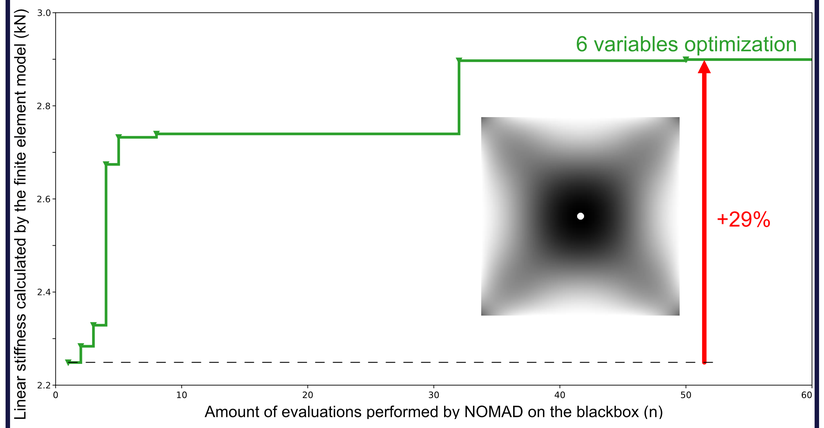
A central punch applies a quasi-static load at constant speed on a simply supported sandwich panel on the edges.
Reshaping the core allowed to double the stiffness and the ultimate load at equal masses.



Experimental loading of a sandwich panel comparing two core geometries

RESULTS (CONT'D)

The stiffness of the sandwich panel quickly converges with 6 variables defining the density function.



Convergence graph of the blackbox optimizer on the finite element model

CONCLUSIONS

Concentrating cells of a sandwich panel significantly improves its stiffness and its ultimate load under non-uniform constraints. 2D cellular material optimization leads to mass efficiency and will allow rovers to be sent in space using less resources.

REFERENCES

[1]: Broggi, Clément. « Conception et fabrication additive d'une structure bio-inspirée pour un rover lunaire en composites thermoplastiques ». Masters, Polytechnique Montréal, 2020. https://publications.polymtl.ca/5381/.

[2]: Audet, C., S. Le Digabel, V. Rochon Montplaisir, et C. Tribes. « NOMAD version 4: Nonlinear optimization with the MADS algorithm ». arXiv:2104.1167, 2021.

ACKNOWLEDGMENTS

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