The Optimal Strength-Retaining Hole Pattern for Sheet Material

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Words:

Abstract

One of the greatest challenges of structural engineering is to reduce the weight of a system without compromising its strength. Hole patterns are a go-to solution to make parts lighter and maintain the majority of their rigidity. The problem is, what hole pattern is best? With many 2D tessellation patterns to choose from, it can be difficult to determine the optimal pattern to use. This investigation will simulate stresses on test parts with a variety of polygon hole patterns to determine which shape maintains the highest strength in an array of scenarios.

Words:

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2 Simulation

2.1 Variables

To keep the stress analysis of each part fair, certain properties were controlled for every part.

- All parts have the dimensions of 1000mm x 1000mm x 5mm
- All parts are set to the material 6061 Aluminum Alloy
- All parts have a mass of 2.5kg, within $\pm 2.5\%$ error (except the solid test part)
- All parts have a 10mm perimeter with no holes
- All polygon holes have a 10mm wide edge
- An equal force will be applied to each part for each test

Each part is not exactly 2.5kg because the skill in SolidWorks and time required to reach that target are beyond the scope of this investigation and the researcher. 2.5kg was chosen as the target mass because it was the approximate mass of the 'square-pattern' part. The 10mm perimeter was included to ensure equal mass where forces will be applied in the various simulations, and that the parts would have a closed perimeter.

Variables that will change based on the shape used, and be recorded, are as follows:

- Hole Area
- Part Surface Area
- Number of holes

A total of 6 different patterns will be tested in simulated stress tests.

1. Filled (control)
2. Square
3. Square Diamond
4. Hex
5. Hex Diamond
6. Triangle

2.2 Procedure

1. Linear Tension
2. Linear Compression
3. Torsion
4. Bending

3 Analysis

4 Conclusion

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