

# Using Additive Manufacturing to Reinvent the Wheel: Non-Pneumatic Tire

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## Background

**Motivations** [1]

- Environmental
  - 200M tires scrapped from air loss and/or improper pressure

**Advantages** [2]

- Puncture resistance
- Decreased fuel consumption
- Improved passenger comfort

**Drawbacks**

- Weight
- Consistent rolling resistance
- Manufacturing duration

- 4 spoke structures were investigated: *Hexagon, Graded Hexagon, Tweel, Polydomain Hexagon*
  - Hexagon served as the baseline geometry
  - Polydomain has 30% strength increase [4]

## Methods & Materials

- Four spoke geometries were created using CAD and fabricated with uniform relative density.

- An 8” pneumatic tire was used for comparison
- Tires were printed with TPU95A
- Compression testing was conducted on the MTI-10K to analyze the loading/unloading curve
  - The tire was tested from angles 0°-90° in 18° increments

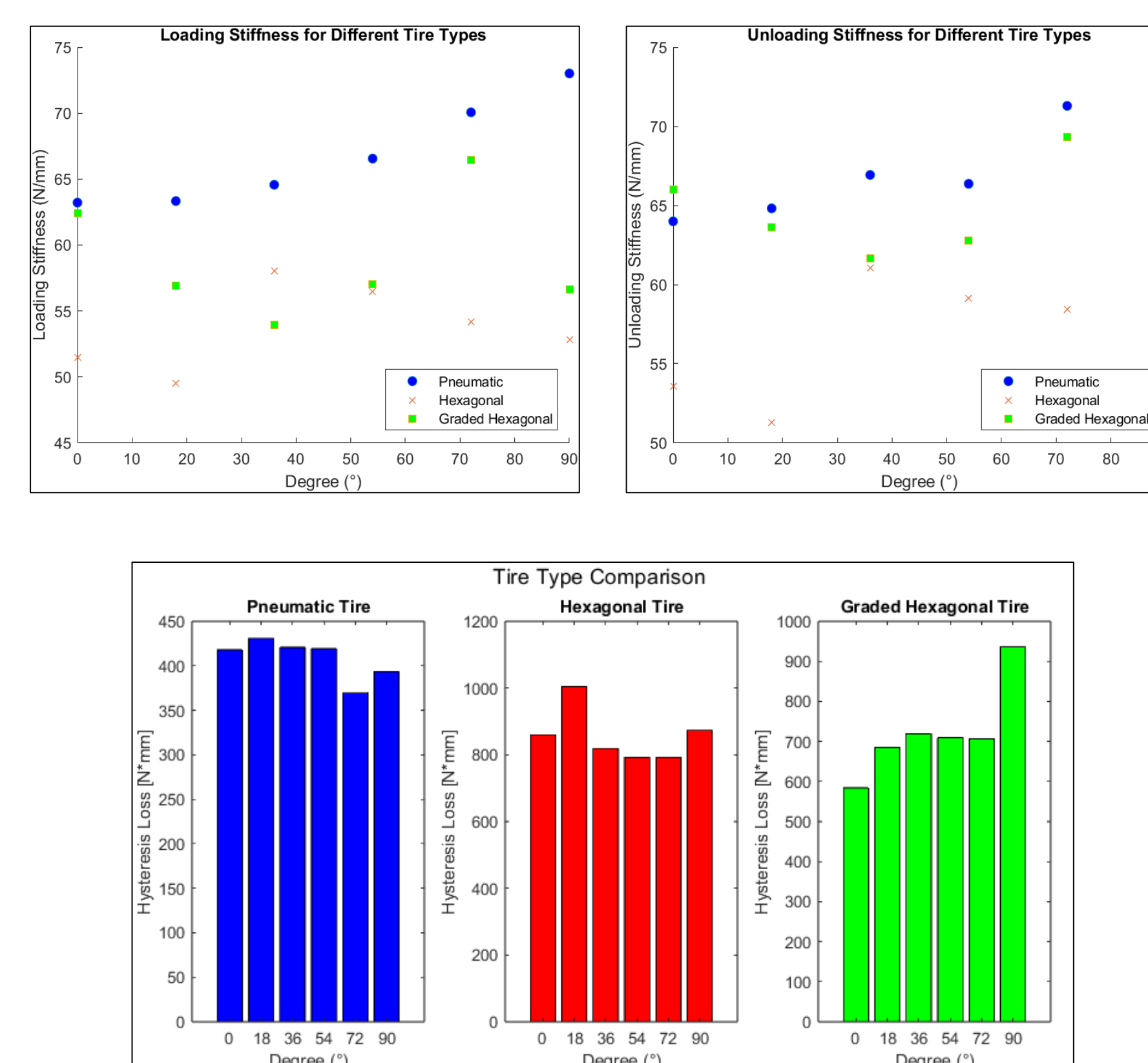
## Results

### Manufacturing Results

- ~27% relative density (~27% solid & ~73% air)
- Inconsistent printing qualities due to factors:
  - Printing speed & infill selection
  - Heating inconsistencies

### Experimental Results

- The Pneumatic tire, Hexagon, and Graded Hexagon were tested
- An ideal tire would have consistent stiffness/energy loss at all angles throughout



## Conclusion

- Four spoke geometries were successfully modeled with the same relative density
- The current experimental data has limitations
  - Inconsistent print quality led to variation in the tire compliance
- Varying stiffness is anticipated in the Hexagon design, it is unexcepted in the Pneumatic tire or Graded Hexagon tire.

### Next Steps

- Utilize the solid infill for prints
- Monitor and maintain constant temperature throughout the prints
- Explore various TPU shore hardness options
- Conduct compression retesting on all tires

## References

[1] Michelin North America Inc., Michelin Uptis, Mechelin Media [Available Online]: <https://michelinmedia.com/michelin-uptis/>.

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[3] Liu, B & Xu, X, Mechanical behavior and mechanism investigation on the optimized and novel bio-inspired nonpneumatic composite tires, Reviews on Advanced Material Science. 61. 250-264.

[4] B. Yu, D. Aranguren van Egmond, K. Abu Samk, U. Erb, D. Wilkinson, D. Embury, H. Zurob, The design of “Grain Boundary Engineered” architected cellular materials: The role of 5-7 defects in hexagonal honeycombs, Acta Materialia, Volume 243, 2023, [Available Online]: <https://doi.org/10.1016/j.actamat.2022.118513>.

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