THE UNIVERSITY OF ALABAMA IN HUNTSVILLE | COLLEGE OF ENGINEERING

Research and Creative Experience for Undergraduates (RCEU) Program 2024

Finite element investigation of piezoelectric energy harvesting: the effect of harvester shape on output voltage.

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Overview

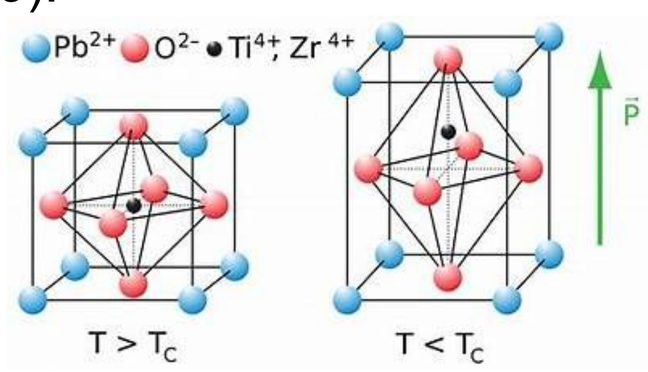
The goal of this project is to use finite element method to determine the most efficient shape for a Piezoelectric Energy Harvester (PEH). To do this three models were made and their results were compared to see what model generated the most output voltage. It was found that Model 3 was the most efficient.

Finite Element Method

For this project three finite element models were made using a commercial software (*abaqus*) and tested. Each model has a fixed end on the left and a free end on the right. Model 1 has a larger fixed end, Model 2 has equal fixed and free ends, and Model 3 has a greater free end. All three models used the same mechanical and electrical material properties and were exposed to an equal vibration at free ends over 30 seconds.

Piezoelectric Energy Harvesting

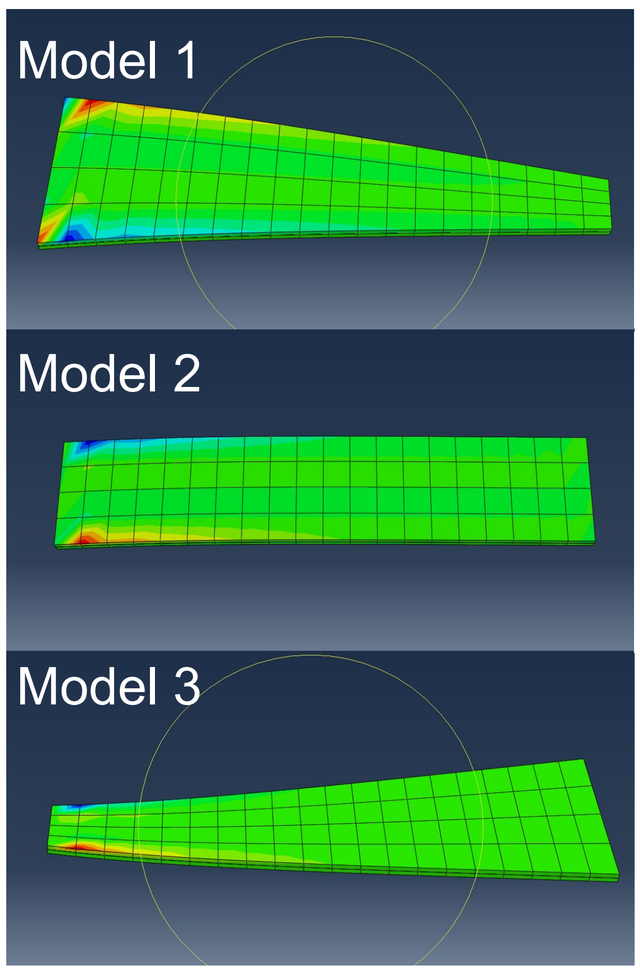
Piezoelectric materials generate electric current when acted on by a pressure or vibration. Using this behavior energy can be harvested to power electronics (Song, 2019).

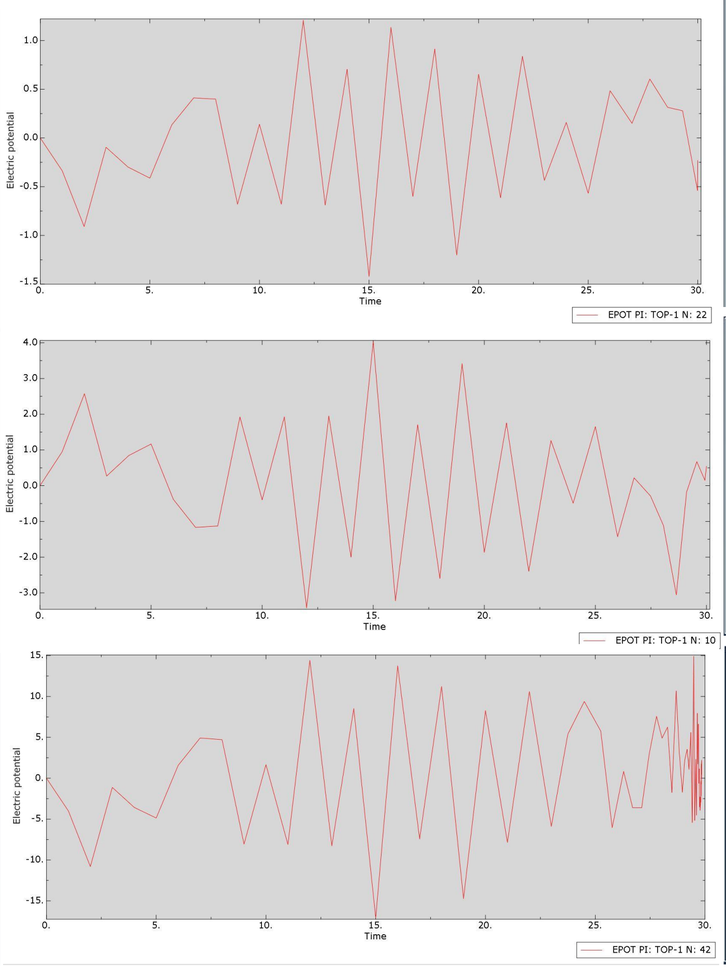


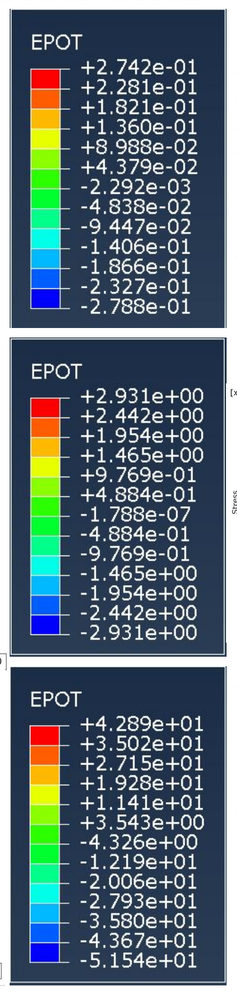
Left: Quartz. Right: Lead Zircon Titanate. Both examples of piezoelectric materials.

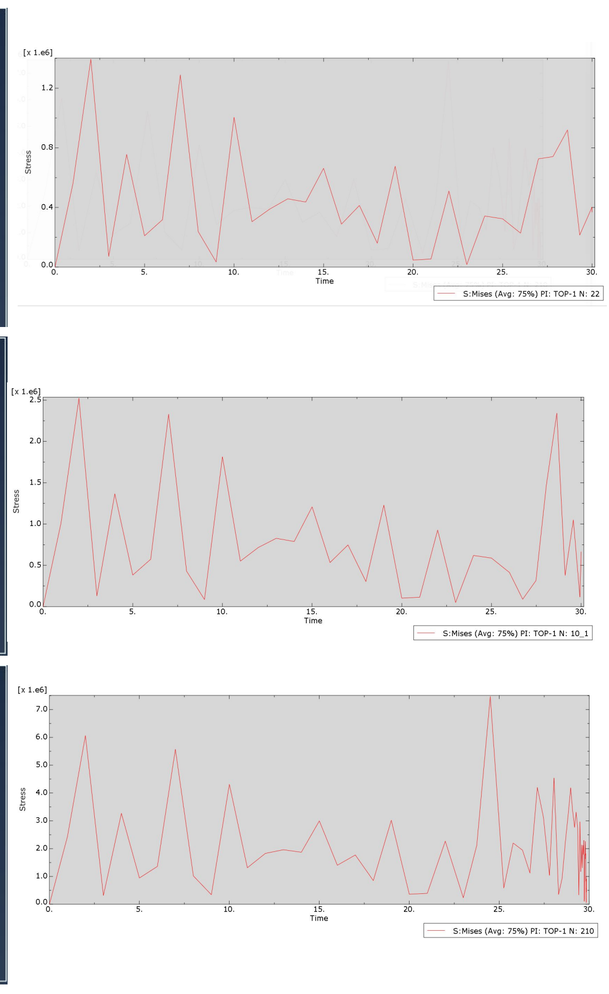
Numerical Results

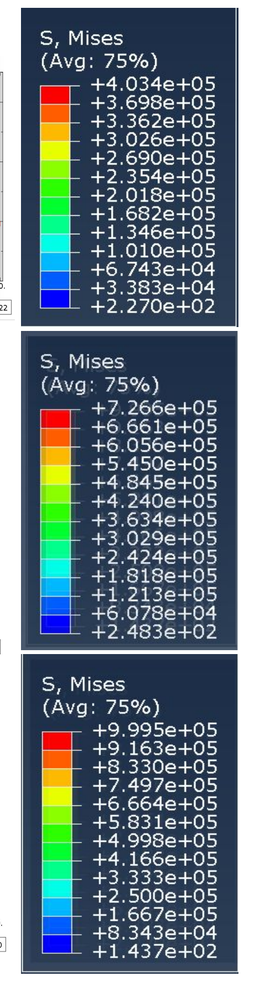
Shown below are graphs and data from the three models showing the strain and electrical potential energy. As seen below model three has the highest electrical potential energy and the highest strain. This shows that a PEH benefits from having a greater free end than fixed end.











EPOT: Electrical Potential Energy (Output Voltage in ABAQUS). S Mises: von Mises Stress.

Discussion

The findings of this research show that Model 3 is the most efficient shape for a PEH. This means that a greater mass tip is the best design for generating electricity from piezoelectric material.

Conclusions

This research builds on previous ideas for PEH and answers questions on how best to design them. This will be beneficial for implementing PEH for monitoring and n infrastructures.

References (A list of the KEY references, if applicable)

1. Song, Y. (2019). Finite-element implementation of piezoelectric energy harvesting system from vibrations of railway bridge. *Journal of Energy Engineering*, *145*(2), 04018076.

Acknowledgements

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