Name(s)
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Project Number
S0305

Project Title
Tunnel Vision: Redesigning for Structural Efficiency

Abstract

Objectives/Goals
The goal of our project is to find a new tunnel lining design that is stronger, and more stable while being environmentally friendly by reducing the amount of materials that is required to produce this structure. By reducing the amount of materials used, we do not only help the environment, but also decrease the costs of making the tunnel. This is important because tunnels are used in a variety of ways, they are utilized for mining, transporting water, sewage, and gas. They are also being used for transportation purposes including subways, railways, highways, and even canals. Thus, any cost-saving measures could widely benefit national infrastructure.

Methods/Materials
We used a computer with AutoCAD to draw our various tunnel lining designs. Used the finite element analysis software AutoDesk In-CAD Nastran to simulate the tunnels in real life conditions. We utilized a 3D printer to print physical models of our tunnel designs to be used for testing using an Instron 3369 testing system.

Results
From the results, the normal circular tunnel was the most stable, however the hexagon tunnel and the octagonal design were the most environmentally friendly due to it having less mass, which means less materials are required to make the tunnel. The hexagon and octagon tunnel designs used 30% less materials than the current standard tunnel lining. We noticed that the hexagon tunnel design had the lowest mass, but was stronger than the octagonal design. This shows that the hexagon design is stronger while using less materials.

Conclusions/Discussion
After repeated numerous computer simulation trials with multiple models of our designs, it was revealed that the hexagon tunnel design used the least amount of materials, and was stronger than the octagon design. However, it was not as strong as the current standard tunnel design. It is concluded that although the hexagon design is not as strong as the current solid design, it could still be utilized in conditions where there are low stress and pressure.

Summary Statement
We attempted to redesign tunnel linings with a focus on strength and stability enhancement while reducing the amount of materials used. We discovered that our hexagon design used the least amount of materials while remaining strong.

Help Received
We designed and made the tunnels independently. We used the 3D printers at Eleanor Roosevelt High School under the supervision of Mrs. Graham to produce physical models of our designs. We then used the Instron 3369 testing system at UCR under the supervision of Mr. Rightnar to test the physical designs.