Meta-Material design for Tank Track pads
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Motivation and Background
- Results from investigations on tank track pad elastomers have revealed high temperatures at the contact surface between road wheels. The strength and structural integrity of elastomers tends to decrease at such temperatures causing negative effects on their life time and durability.

Abstract
The idea of this project is to substitute the elastomer with an elastic material which does not suffer from hysteretic losses. The ideal design requires material properties which are not available in nature. Meta-materials could be tailored for the specific application with the target properties. The challenge here is the definition of optimal meta-material structure having required material properties.

Research Objectives
- To develop a methodology to be used in design of meta-materials to meet specific elastic requirements.
- To implement a method based on topology optimization to tailor meta-material properties.
- To solve track pad problem and demonstrate the method's applicability.

Approach
- Analysis of current system to identify operating conditions.
- Understanding operating conditions to determine influential mechanical properties.
- Structural design of meta-material exhibiting these properties based on topology optimization.

Properties of material used currently
Material Used: Custom formulated, carbon-black filled Styrene Butadiene Rubber (SBR)

General properties of rubber
- Density: 940 kg/m³
- Elongation: 250-700%
- Tensile Strength: 10-25 MPa
- Young’s Modulus: 2-10 MPa

Properties of various Vulcanizates
- Specific Gravity: 0.95, 1.11, 1.08, 1.16
- Optimum Cure Time at 160°C, min: 9, 9, 8, 8
- Hardness, Shore A: 40, 68, 47, 80
- Tensile Strength, MPa: 16, 35, 15, 33
- 300% Modulus, MPa: 1.8, 17, 3, 25
- Ultimate Elongation, %: 1000, 520, 800, 400
- Tear Strength, N/cm: 300, 1050, 500, 571

Forces on tank track pads
Assuming velocity of tank = 30mph = 13.4112m/s
Power developed by Engine = 1120 kW
Assuming no power losses,
Power available at drive sprocket P = 560 kW
This power is utilised to turn the sprocket and pull the track pads.

Considering the drive sprocket, Torque on Sprocket = C T1

T = T1 + T2
T2 = C/R 
T would be used to Calculate Fp

Compressive Force is due to load on each road wheel station
Assuming weight of vehicle = 600,000N
Load uniformly distributed over 14 road wheel stations.

F = 42,857 kN

Maximum traction force due to the asphalt-track friction coefficient μ
μ = Fp

Expected Results
- Engineering tool for meta-material analysis and design.
- Structure of meta-material with targeted mechanical properties.
- Reduced hysteretic losses and, consequently, reduced operating temperature in the engineered meta-material structure so as to avoid material deterioration.
- A meta-material synthesized so as to have both high compliance and low loss coefficient.