UNIVERSITY OF TWENTE. | Surface Technology and Tribology

MSc Assignment

Study and re-design of bio-inspired drills for space rovers and deep sea drilling

The need to develop energy efficient and robust drilling methods is on rise in extreme conditions like deep sea and extra-terrestrial bodies (planets, moons and asteroids). Its applications range from underground constructions (housing, tunnels), geothermal energy to space exploration, mining and habitation. Traditional drilling techniques like rotary and percussion drilling require enormous amounts of energy and the drill bits wear out in short running duration. Development of durable, cost effective and efficient drilling methods in extreme conditions is inspired from reciprocating and oscillatory drilling techniques, naturally evolved in organisms like wood wasps and sand snakes for the purpose of reproduction and habitation respectively. By implementing the reciprocating mechanism in the wood wasp's ovipositor, we have designed and developed a biomimetic-based, dual reciprocating drill test rig (see in figures below).

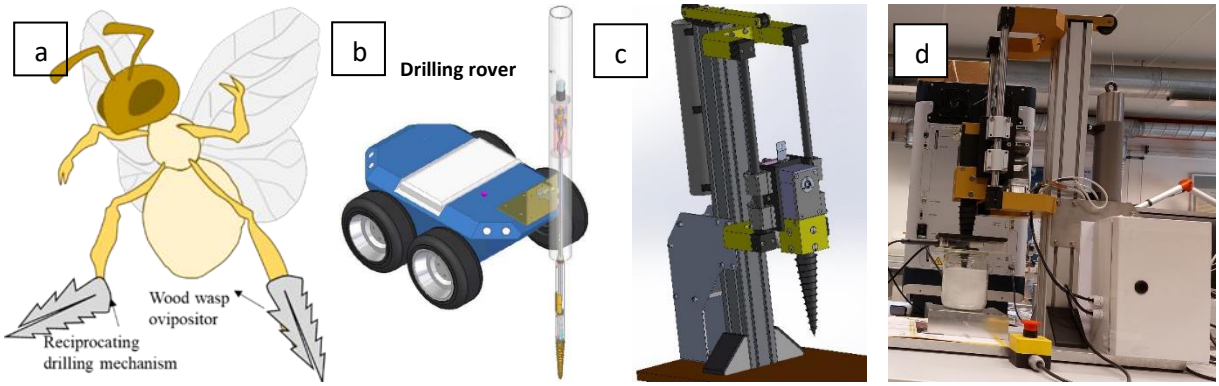

Figure (a) Wood wasp, (b) space rover with reciprocating drill, its (c) design and (d) setup at the STT lab.

Approach

The **aim** of the project is *to adapt the existing reciprocating drilling setup to measure and optimize drilling performance for different granular aggregate specimens*. The drilling performance can be measured by efficiently mounting and calibrating load and displacement sensors in the current setup to plot drilling force vs penetration depth. Drilling will be performed in water saturated and dry glass beads of different sizes to mimic sea bed and lunar/Martian soil. The drill-teeth geometry will be optimized for maximizing performance as friction between the grains and drill-bit determines the drilling forces. Oscillatory motion will be coupled with reciprocating drilling to further improve the penetrability of the drilling process.

Research group and potential

The ***Surface Technology and Tribology*** (STT) group will organize the research with a focus on surfaces and interfaces in an engineering context, as well degradation mechanisms at these interfaces. This project will invite potential collaborations with mining companies working on Tribology and drilling engineering.

Project tasks:

1. Literature survey on extreme and efficient drilling techniques
2. Choose and mount sensors in the drill setup for data acquisition of forces and penetration.
3. Perform drilling experiments in the setup with glass bead aggregates.
4. Re-design reciprocating drill-bit and actuation parts to couple with oscillating motion.
5. Analyzing and discussing the obtained results
6. Writing a scientific report

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