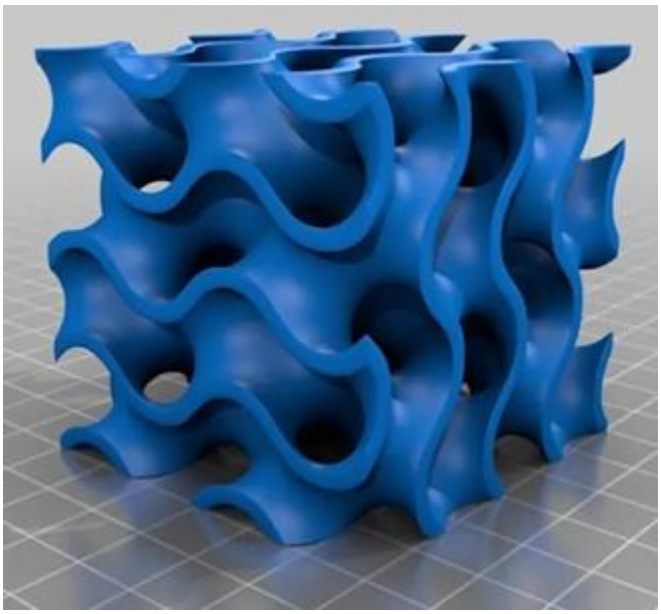
The department of Sustainable Systems Engineering - INATECH is now offering a Master's thesis at the Gips-Schüle Chair for Sustainable Systems Engineering (SSE) in Freiburg on the topic of

Dynamic behaviour of gyroid lattice structures

Topic Description:
This work investigates the dynamic compaction behaviour of gyroid lattice structures. The research question is how these structures can be modified to increase their performance for impact absorption und automotive crash conditions.



Background:
In general, porous materials such as foams, and also regular lattice structures perform well as kinetic energy absorbers. However, the energy absorption characteristics depend on the velocity of impact. For impact velocities greater that a critical threshold, the energy absorption degrades associated with a change in compaction behaviour: For low velocity, we typically see a homogeneous compaction behaviour, i.e., all parts of the structure participate in the deformation. Above the threshold velocity, localisation of compaction is observed, and the deformation spreads with a characteristic wave speed throughout the structure. This behaviour is suboptimal, as not all parts of the structure are activated at the same time, leading to stress concentrations and early failure.

The gyroid is a space-filling surface given by the implicit equation

$$sinx\ cosy + siny\ cosz + sinz\ cosx = d \qquad (1)$$

where x, y, z denote a Cartesian coordinate system and d is the thickness of the surface.

Solution Strategy:
Analytic models predict that the onset of localisation can be suppressed with a modified structure, which is functionally graded, i.e., which possesses a gradient in mechanical properties. In this context, we will explore a strength gradient. For the chosen structure, this can be easily realized, as a simple analytic expression for the shape of the structure's unit cell exists.

Work Items:
The first goal is to establish a simulation model of the structures based on the shape given by Eq. (1) and investigate the effect of different gradients in impact simulations. Once a suitable gradient has been identified, testing specimens will be additively manufactured using our 3D printers. Finally, experimental investigations in our mechanical characterisation laboratory will be carried out. This work will include different experiments ranging from quasi-static testing with a universal testing machine to high strain rate testing using our split Hopkinson bar facilities.

Candidate Requirements:
We are looking for a candidate with an interest in numerical simulations with Finite Element methods and continuum mechanics, who is eager to also perform experiments in our mechanical characterisation laboratories.

Ideally, you should bring along a background in mechanical engineering, supplemented with existing knowledge in e.g., Ansys Mechanical or LS-Dyna, and programming skills in Python.

Supervision and formal details:
Supervision will be made by Dr. Georg Ganzenmüller and Sankalp Patil. You are expected to integrate into the work group at the Chair of Sustainable Systems Engineering (Prof. Stefan Hiermaier).

Applications are welcome any time, please contact georg.ganzenmueller@inatech.uni-freiburg.de with a short email describing your interest.