Lehrstuhl für Systemverfahrenstechnik
Wissenschaftszentrum Weihenstephan
Technische Universität München

Interdisciplinary project (IDP)

Extension of EDEM Wear Modelling via API/EDEMpy for Advanced Multi-Mechanism Wear Analysis [100% remote work possible]

Motivation

The Chair of Process Systems Engineering at TUM specializes in process simulation, bridging discrete and continuum modeling for complex engineering systems. In line with this tradition, our research has developed a comprehensive wear model that integrates Archard's law with multi-scale dynamics and periodic effects, providing enhanced accuracy in particle–geometry interaction wear predictions [1]. The Discrete Element Method (DEM) is a numerical technique employed to track the motion and interaction of individual particles that play a central role in industrial processes. Among the available implementations, EDEM stands out as a leading DEM software, enabling efficient large-scale particle simulations and offering C++/Python APIs for model customization.

This IDP aims to embed the internally developed wear model into the EDEM environment using the EDEM API (C++) and EDEMpy (Python). Based on this, a concept for a DEM simulation-driven analysis will be presented. This represents a step forward in the model-based simulation and prediction of complex wear at the particle level.

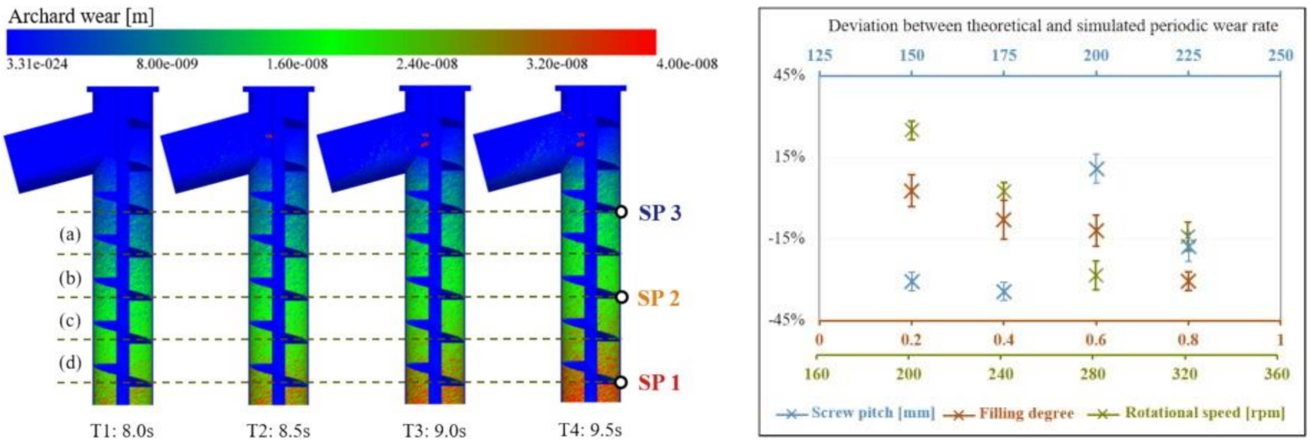

Fig. 1 (a) DEM simulation of time-lapse wall wear based on Archard wear model; (b) Deviation between theoretical framework-based periodic wear rate and the wear rate obtained in DEM simulation.

[1] W. Yang, Y. Zhang, Y. Tan, A surface-profile-based framework validated through experiment and DEM simulation, Advanced Powder Technology. 36 (11) (2028) 105067. https://doi.org/10.1016/j.apt.2025.105067.

Objectives

- Integrate a novel multi-mechanism, periodic wear model into EDEM's architecture.
- Enable modular, API-based extensions of wear predictions using C++ and Python interfaces.
- Provide automated analysis and visualization pipelines for wear simulation results.

Work packages:

- Understand the basic physical behaviour of bulk materials and soil materials;

- Review EDEM's built-in wear model: Archard, Wear;
- Survey the proposed modeling approaches (periodic effects in wear processes).
- Define the interface between the theoretical wear model and EDEM's Base Model.
- Implement wear calculations using the C++ API: compute wear depth per contact, incorporate periodic terms, enable deformation of geometry surfaces.;
- Use EDEMpy to extract contact data (e.g., forces, sliding distances, energy) from simulation files.
- Develop Python scripts that process simulation outputs, apply the extended wear model, and visualize spatial wear patterns;
- Execute benchmark simulations (e.g., particle sliding tests) using built-in Archard vs. your extended model.
- Document code, workflows, and validation results thoroughly.
- Prepare a concise report detailing methodology, implementation, validation, and implications for future SVT research.

Desired skills

- Solid skills in C++ and Python, with some familiarity in API-based software extension.
- Fundamental understanding of wear mechanisms and discrete element methods (DEM).
- Interest in simulation-based process modeling within engineering contexts.
- (Desirable) Experience with EDEM or scientific computation workflows.

Supporting courses (selection)

Modellierung und Simulation disperser Systeme (in english)

You may expect

Within the scope of this IDP, you can gain hands-on experience in extending a commercial DEM software via both C++ and Python APIs, applying advanced wear modelling concepts in a real simulation environment. You will develop practical skills in integrating theoretical models into engineering software, automating data analysis, and visualizing simulation results. There is also the possibility of contributing to a scientific publication if the outcomes are of suitable quality and relevance.

Are you interested? Then get in touch with me!

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