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Internship proposal (6 months): Exploring the applicability of coupled discrete-finite element methods in the modeling of refractory linings

Background: The reliability and availability of many – if not all – steel production installations are determined to a large extent by the performance of their refractory linings. Hence, reducing refractory wear and improving the performance of the refractory linings are crucial to enhance the reliability and availability of Tata Steel's steel production installations.

Method: Adequate refractories research greatly enhances process safety & reliability, production capacity, product quality, energy efficiency and cost reduction. Nowadays numerical modeling techniques including the finite element method are essential tools for refractory process research (see Fig. 1). The Multi-Scale Mechanics group of the University of Twente has developed coupled finite-discrete element methods (FEM-DEM) to upscale the multi-physical behavior of refractories from the microstructural scale (e.g., grains) to continuum scales where thermal damages, such as crack initiation and propagation, take place. This project is aimed to explore and apply suitable FEM-DEM coupling techniques to model multi-physical behavior of refractory linings.

Fig. 1 Thermal crack in refractory mortars and bricks

Aims: A coupled FEM-DEM framework would enhance significantly the level of research of the refractory lining performance in Tata Steel's production installations. This will allow Tata Steel to improve process reliability, costs and safety, and it will ultimately strengthen the relation with our highly valued customers in an increasingly challenging steel market.

Internship: An internship of preferably a M.Sc. student from the Multi-Scale Mechanics group of the Faculty of Engineering Technology would be hosted at the Ceramics Research Centre of Tata Steel R&D to explore the applicability of coupled discrete-finite element methods in the modeling of refractory linings in Tata Steel's production installations. The intern student is expected to

- Review existing particle- and continuum-based methods for the thermo-mechanical analysis of refractory linings
- Identify the appropriate particle-continuum coupling approaches
- Investigate the microscopic origin of crack initiation and propagation
- Perform thermo-mechanical analysis of refractory linings

Title:	Internship proposal on coupled discrete-finite element methods for refractory research
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