TU Wien
Faculty of Civil and Environmental Engineering
Institute of Structural Engineering
Research Unit Mechanics and Structural Dynamics
Karlsplatz 13 | E212-03 | 1040 Vienna | Austria
www.tuwien.at/cee/tragkonstruktionen/bmdyn

Master's Thesis

Numerical Modeling and Calibration of a Novel Interlocking Plastic Block System

Motivation

The increasing demand for sustainable and reusable construction systems has led to the development of innovative modular building solutions. One such example is a patented interlocking plastic block system that, by virtue of its plug-in connection principle, enables rapid assembly and disassembly for reuse. The hollow cores of the blocks can additionally be filled with concrete and reinforced, providing further structural versatility.

Due to its unique connection mechanism, the mechanical behavior of this system is expected to lie between that of conventional masonry and monolithic construction, a characteristic that poses particular challenges for numerical modeling. Experimental investigations carried out in a companion thesis provide a comprehensive dataset of static failure modes, stiffness properties, and load-displacement relationships for both individual blocks and assembled configurations.

Building upon these experimental findings, this master's thesis aims to develop a validated numerical model capable of reproducing the observed mechanical behavior. The model shall serve as a reliable basis for future dynamic and seismic assessments, forming a critical step toward the broader structural application of this innovative system. The work thus directly contributes to the long-term research goal of enabling seismic design verification for this patented construction system.

Tasks

- Critical review and synthesis of the experimentally obtained data from the companion thesis, including failure modes, load-displacement curves, stiffness values, and governing failure mechanisms of the interlocking plastic block system
- Development of a suitable numerical modeling strategy capable of capturing the transitional behavior between masonry-like and monolithic failure, accounting for the specific characteristics of the interlocking connection
- Implementation and calibration of the numerical model using the experimental dataset as reference, with particular attention to the contact behavior, block interaction, and failure initiation (e.g. SOFiSTiK, Python-based frameworks, or equivalent)
- Systematic parameter study to assess the sensitivity of the model to key input parameters and to define the validity range of the model
- Validation of the calibrated model against independent experimental results to confirm its predictive capability under static loading conditions
- Discussion of the model's suitability and required extensions for future dynamic and seismic applications, providing a structured outlook for subsequent research

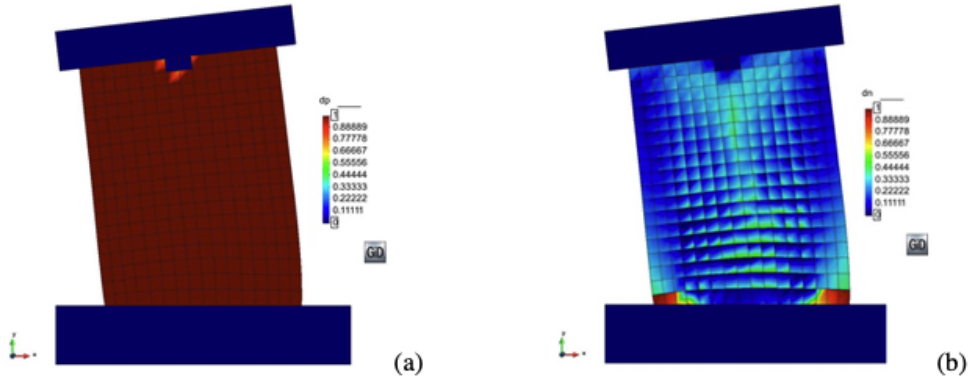

Figure 1: Modelling of a shear wall (Scotta et al. 2022).

Prerequisites

Basic knowledge of numerical methods and the finite element method is required. Experience with structural analysis software (e.g. SOFiSTiK, SAP2000, or Python-based simulation frameworks) is an advantage. Familiarity with structural mechanics and an interest in experimental-numerical correlation studies are expected.

Supervisors

Univ.Prof. Dr.-Ing. Francesca Taddei, francesca.taddei@tuwien.ac.at
Univ.Ass. Alexis-Michael Eilers, M.Sc, alexis-michael.eilers@tuwien.ac.at

Start

The start of this thesis is subject to prior consultation and depends on the progress of the experimental investigations carried out in the companion thesis. Interested candidates are encouraged to get in touch early to discuss potential start dates.