Hessisches Kompetenzzentrum
für Hochleistungsrechnen

Parametric Study on Determination of Load-Bearing Capacity of Dry-stacked Masonry Wall under Cyclic Loading

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Clusters
Lichtenberg II Cluster Darmstadt

Software
Python, Abaqus

Institute
Institute for Solid Structures

University
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Introduction

In the research area of circular building design, design concepts for sustainable masonry are being implemented using both renewable materials and reusable building blocks. When constructing a masonry wall, the effort and costs are mainly associated with the brickwork, especially with the mortar. When the building is demolished, the materials used can usually only be recycled in exceptional cases. Dry-stacked masonry (DSM) can be an alternative here to enable reusability. In this case, bricks with an interlocking configuration are simply stacked into each other, without the need for mortar in the horizontal joints. The effort required to construct the walls is thus considerably reduced in terms of costs and labour. However, the most important advantage becomes apparent when the wall is demolished. The masonry walls can be easily removed by demounting the individual blocks. In the case of a suitable or removable plaster layer, undamaged blocks can then be reused.

Methods

DSM wall systems have different geometric component shapes and interlocking configurations compared to conventional unreinforced masonry walls (URM). To understand their structural behaviour, it is therefore necessary to investigate the effects of various design parameters (e.g. compressive strength of the components, composite system, contact area, non-linear

behaviour of the material). This can be done mainly by examining experimentally validated non-linear finite element models of DSM walls. The behaviour of dry masonry walls has been investigated in extensive and diverse research projects in recent decades. The numerous investigations show that under seismic loading, for a given masonry unit shape, an additional strengthening method such as reinforcement or even prestressing is required. The load-bearing capacity under vertical loading has already been carried out and analysed for DSM in previous projects. The present research project will not only investigate the load-bearing capacity, but also the deformation behaviour under horizontal dynamic loading in the wall plane and perpendicular to the wall plane. The aim is to optimise the configuration of the interlocking joints for horizontal load transfer. The research project includes the following steps:

• Experimental investigation of the load-bearing and deformation capacity of dry masonry walls under static and cyclic loading.

• Numerical investigations considering the real material properties and contact conditions using FE models of dry masonry walls under static and cyclic loading.

• Numerical investigation of the influence of the different input parameters, especially the configuration of the interlocking joints and the seismic load, on the horizontal load-bearing capacity of dry masonry walls.

• Assessment of the structural reliability of the safety factor for DSM walls under seismic loading.

• In addition, the development of an analytical model for the design of DSM walls is aimed for.

Firstly, in order to be able to apply the shear load, it is essential to understand their structural behaviour under axial compression. However, previous projects have mainly focused on the linear behaviour of the DSM wall, in particular the load percolation taking into account the unit height variation. Therefore, in this study, the investigation starts with a parametric study for DSM wall subjected by compression. The study is carries out using probabilistic analysis based on a non-linear finite element model, which is calibrated and validated on the basis of the experimental results. The finite element model of a masonry wall is created in Abaqus using a simple masonry unit geometry. For the parameter studies, different sets of walls are created using Python in combination with the model in Abaqus, which are then run on HPCL.

Results

After a year of using HPC Lichterberg, the investigation is still at a preliminary stage. The first result of one wall dimension shows the distribution of the wall resistance of dry stacked masonry, initially subjected to axial compression load, reduced when the unit height variation is considered. The result for the whole set

of walls is not complete.

Discussion

For different geometric configurations and boundary conditions, several sets of stochastic analyses as a result of the finite element modelling should be carried out next in the following project.

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