

DIBt-Research project

Improved seismic design concepts for masonry buildings in Germany

The project aims to illustrate the available safety margins of modern unreinforced masonry buildings to make them accessible within the application of linear and nonlinear seismic design concepts consistent with the recent code requirements in Germany.

The first project part comprises the investigation of the seismic behaviour of three modern unreinforced masonry buildings located in the Emilia Romagna region. The observed earthquake resistances of the selected buildings during the earthquake series are compared with predicted resistances based on already available linear and nonlinear design concepts. The comparison clarifies, that the linear code procedures do not match the real behaviour of the three buildings and a remarkable gap between observed and calculated resistances is observed, which exceeds several times the required safety margin. The nonlinear verification results of the three buildings are much more realistic, but depending on the chosen level of modelling there is still a gap to the maximum peak ground accelerations recorded during the earthquake series.

The second project part presents a new seismic design concept to make a part of the illustrated safety margins accessible in the everyday design praxis for typical masonry construction types in Germany. The derivation of the new design concept is based on a comprehensive parametric study of 28 representative building configurations with linear and nonlinear calculations. Terraced, single-family and multi-family houses with continuous shear walls over the building height and variable number of floors are considered. The results of the parametric study are used to define a new behaviour factor accounting for deformation capacity, energy dissipation and overstrength due to load redistribution. Furthermore, the concept allows the consideration of moment distribution by frame actions through the reinforced concrete floors.

This new behaviour factor allows a much better utilisation of the load-bearing reserves and can be applied without any changes within the traditional force based design that still will be the standard for engineers for the coming years. The proposed concept is completely in line with the new draft of DIN EN 1998-1-2018. Finally it has to be pointed out, that the application is limited to typical masonry buildings in Germany and cannot be transferred to other countries with differing construction types. The values must be regarded as country specific. However, the procedure to derive the three components of the behaviour factor is based on the basic principles of structural mechanics and structural dynamics and can be easily adapted and applied to other construction types.