# Performance of Unreinforced Masonry Strengthened with Twisted Steel Bars Embedded in Bed-Joints

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## ABSTRACT

In the Netherlands, the presence of a soft top layer of soil often leads to settlement damage of unreinforced masonry buildings. Additionally, in the recent years, the gas extraction from the subsoil is causing seismic induced events in the region of Groningen, in the northern part of the country. One strengthening technique that is commonly applied to treat the settlement problem is the use of bed-joint strengthening with twisted steel bars. Therefore, it is of interest to investigate whether this strengthening technique is efficient also against seismic damage, since in literature there is limited information available on the performance of this strengthening method ([1],[2]).

An experimental campaign was conducted at Delft University of Technology, in order to characterize the performance of the bed-joint reinforcement using twisted steel bars. This strengthening method consisted of cutting a slot in the mortar joint, with a depth of approximately 1/3 of its thickness, to install twisted steel bar embedded in a high-strength repair mortar. Five bending tests on masonry beams and a quasi-static cyclic in-plane test on a full-scale wall were performed; similar tests on unstrengthened specimens were available from previous experimental campaign ([3]-[5]) and will be used as reference. Moreover, small scale pull-out tests were performed to study the interaction between the steel bars and the repair mortar. The aspects that were investigated were the improvement of the mechanical properties (e.g. the flexure strength, elastic modulus etc.) and the influence on the crack formation and propagation. For the latter case, Digital Image Correlation (DIC) measuring system was used.

By comparing the response of unstrengthened and strengthened masonry specimens, it is observed that the use of bed-joint reinforcement can provide an increase in terms of ductility and displacement capacity, but not in terms of force capacity; a reduction in dissipated energy was reported. Regarding the serviceability limit state, a reduction in crack width and an increase of load at onset of cracks were observed. The results obtained within this study will be used for numerical analysis.

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