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Analysis of the load-bearing capacity and crack resistance of a historic wall subjected to bending in the plane

Abstract

The selection of appropriate components used to strengthen walls affects the load-bearing capacity of the wall and protects it against permanent damage. In the conservation of monuments, a recognized British method of repairing walls using metallic, spiral rods on a two-component system mortar was used to repair scratches and cracks.

The dissertation looked for other materials that meet strength parameters similar to the method recognized in the conservation of monuments. The use of composite rods on modified mortar was proposed.

The aim of the work is to determine the influence of surface and near-surface reinforcement of brick walls with PBO MESH GOLD mesh of the RUREDIL system on modified repair mortar and GFRP composite rods on the same mortar on the load-bearing capacity and deformability. Another goal is to determine whether the proposed materials meet the criteria of strength and scratch resistance in the repair of ceramic walls.

The dissertation begins with a review of the development of brick construction from antiquity to modern times. The factors influencing the durability of brick buildings were presented. The achievements of scientists dealing with the subject of scratch resistance, from the times of H. Hilsdorf to contemporary researchers such as Ł. Drobiec, were systematized. The main emphasis was placed on considerations of the materials used to maximize the scratch resistance of the brick wall. Composite rods and their properties are reviewed. Material tests of the main components used to strengthen ceramic walls were presented. The properties of the mortars used in the tests were described. The types of bricks used in the research were determined, indicating the place of their acquisition and the historical period from which they came. The average compressive strength was determined for the bricks. A test was carried out to test the characteristic tensile strength of the composite bar. As a result of the research, an additional method of separating a single "roving" from a composite bar was established and its characteristic tensile strength was determined.

The rest of the dissertation concerns extensive own research. Tests were carried out on test elements made of modern brick subjected to compressive and shear forces according to the

relevant European standards, as well as standard tests of the wall's resistance to diagonal compressive tension, which were carried out in accordance with the American standard ASTM 519E. The tests were carried out on unreinforced masonry elements and masonry elements reinforced on one and both sides with PBO fiber mesh on ready-made system mortar. For each type of test element, the behavior of the reinforcement during testing is described. The test results were tabulated and compared. In the case of test elements made of historical bricks, the test results were also compared with the results obtained by unreinforced test elements made of modern bricks. An experimental study of an in-plane bending wall reinforced near the surface in the grooves with 8 GFRP composite rods on a ready-made repair mortar was also describet. Additionally, as part of the experiment, standard tests were carried out on the characteristic compressive strength of test elements made of historical bricks, including neo-Gothic bricks (made today using an old manufacturing method), Renaissance demolition bricks and demolition bricks from the 1920s and 1930s. These elements were not subjected to surface reinforcement.

The last chapter of the work is devoted to original experimental research on two full-size walls made of contemporary ceramic bricks with ready-made historical TWM mortar. The walls were built in the style of the internal load-bearing walls of the historic "Nikiszowiec" housing estate in Katowice. The influence of surface and near-surface reinforcement on the load-bearing capacity and deformations of a wall with a window opening based on a bending structure was analyzed. The research was carried out in two stages. First, the walls were loaded with simultaneous bending of the flexible beam until they were damaged, and then the damaged walls were strengthened and tested again.

One wall was surface-reinforced with PBO fiber mesh on a system mortar, while the other wall was surface-reinforced with ø 6 GFRP composite rods on the same mortar. The testing of the reinforced walls was carried out until their load-bearing capacity was exhausted. Loads, displacements, deflections and transverse deformation angles were recorded using measuring equipment and a loading system mounted on the surface of reinforced and unreinforced walls. The observed damage was documented graphically and photographically. Based on the displacements of the nodal points of the measurement base grid, graphs of load, deflection and transverse deformation angle were generated. The read results were tabulated and analyzed.

The tests confirmed the effectiveness of the applied surface reinforcement of walls bent in the plane with the PBO MESH GOLD mesh of the RUREDIL system on the proposed repair mortar. Reinforcing the walls bent in the plane near the surface with GFRP ø 6 composite rods on the proposed repair mortar was considered promising. Due to the fire resistance in the repair of near-surface cracks, instead of glass fiber rods, the summary of conclusions proposed the use of fire-resistant basalt rods, with the reservation that this requires in-depth research.

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