Doctoral dissertation abstract

Title: Analysis of stress and strain in the process of modeling the mortar base plate

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Abstract:

The subject of the work was the analysis of the stress state of the base plate of the M98 mortar based on the results of FEM numerical simulations obtained on the basis of experimental data.

Experimental research, the methodology of which was developed on the basis of preliminary research, included the construction of a measurement station, preparation of ammunition and firing of the base plate. Shooting tests were carried out with ballistic mortar shells equipped with reinforced propellant charges made of earth, sand and rocks, at an elevation angle of the mortar barrel of 45º, 60º and 75º. Strain measurements of individual areas of the plate were performed using electrofusion strain gauges. They allowed for the determination of extreme operating conditions for the base plate and the acquisition of experimental data regarding its strain, pressure force values and its distribution, and reduced stress values. The measurement data obtained from the firing of the plate, together with the results of its material tests carried out in laboratory conditions, were used to define the boundary conditions for numerical simulations.

Simulation studies, based on the finite element method, included creating a computational model of the base plate, defining boundary conditions taking into account input data from experimental measurements, and conducting numerical analyzes to determine the values of stresses occurring in individual areas of the base plate. The simulations took into account variable soil stiffness, which had an impact on the slab stress distribution. Based on the

numerical analyses, the stress state of selected areas of the M98 mortar base plate was verified and the places of their greatest accumulation were located. It was found that the highest stress values of the base plate occurred on its outer contour. However, the most difficult working conditions for the plate were rocky ground with a mortar barrel elevation angle of 45º. The regularity related to the most difficult working conditions using an angle of 45º was also repeated for sandy and earthy substrates. An increase in the mortar barrel elevation angle resulted in a decrease in stress values.

Based on the analytical work carried out, the numerical model of the mortar base plate structure was modified. The effect of the changes introduced was the elimination of stress concentration areas and their reduction, as well as a weight reduction of approximately 30%. The simulation results for the modified structure can be taken into account in the design process of the new structure of the M98 mortar base plate, which should reduce stresses while reducing its weight, ensuring its greater mobility.

The developed experimental research methodology and the methodology for creating FEM analysis can be used to develop or change the design of a series of types of mortar base plates.