ABSTRACT

Mining extraction has a negative impact on utility networks, including manholes, which are an indispensable element of sewer systems. Manholes buried in mining areas are subjected to additional loads in comparison to manholes located in non-mining areas. The impact of continuous mining deformations of the soil on the manholes is mainly manifested by horizontal strains. Horizontal strains in the subsurface soil layer lead to changes in the distribution and values of external loads acting on the objects. These loads may result in damage to manholes and potentially their complete failure. Under the impact of unevenly distributed external horizontal loads, the cross-section deflection of a flexible manhole riser can occur, which causes passive earth pressure.

This doctoral thesis analyses the impact of horizontal strains in the subsurface soil layer on the external horizontal loads acting on manholes made of thermoplastic materials and the cross-section deflection of their risers. The load values depend on the foundation depth of the manholes and the ring stiffness of the risers, which are the main element of flexible manholes. These values were determined based on the theoretical analysis of the issue and the results of laboratory tests on models of manhole risers. The numerical modelling was also used to analyse the interaction between the flexible manhole and horizontally strained soil for the conditions of the laboratory tests.

The theoretical part of the thesis mainly concentrates on analysing the current state of knowledge in the field of the interaction between flexible manholes and the soil in non-mining areas, and the impact of horizontal strains, caused by mining extraction, on the analysed manholes. The interaction between flexible underground pipelines and the subsurface layer of non-cohesive soil in mining areas and the interaction between flexible manholes and the subsurface layer of non-cohesive soil in mining areas was also compared.

In this doctoral thesis, self-performed model laboratory tests were conducted in conditions similar to in situ conditions. Their aim was to determine the dependence of the relative cross-section (horizontal) deflection of the models of flexible manhole risers on the horizontal soil strains. The tests were conducted for various foundation depths of the manholes and various values of the ring stiffness of these models, corresponding with the real stiffness of the risers. This thesis includes the analyses of the results of the laboratory tests conducted and computational examples employing the results of these tests.

The thesis, through the use of numerical modelling, analysed the interaction between a flexible manhole and horizontally strained soil. For this purpose, the real, spatial numerical model of the interaction between the flexible manhole and the soil was simulated for the conditions of the laboratory tests. The model was developed based on the finite difference method using FLAC 3D v.5.0 software, which is an IT tool that supports the solving of geotechnical engineering problems. The results obtained through numerical calculations were analysed and compared with the results of laboratory tests.

The results of this doctoral thesis will be employed in designing sewer systems made of thermoplastic materials in mining areas and in assessing their resistance to mining impact for the operation plans of mining plants, as well as determining the maximum foundation depth of flexible thermoplastic manholes in mining areas.