Study on Mechanical Properties of Acidic and Alkaline Silty Soil by Electrochemical Impedance Spectroscopy

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In this study, Electrochemical Impedance Spectroscopy (EIS) was used to test H₂SO₄ and NaOH contaminated silty soil. To further study the mechanical properties (shear strength and compressive properties) of contaminated silty soil, an equivalent circuit model ($R_s(CPE(R_t R_w))$) was established to simulate the changes in silty soil contaminated by various concentrations of H₂SO₄ and NaOH solutions. Experiments showed that with the increase in the amount of acid-base contaminant involved, the shear strength of the contaminated silty soil decreased, and the compressive properties increased. By analysing the equivalent circuit model, it can be observed that with the increase in the amount of acid-base contaminant involved, the solution resistance R_s and charge transfer resistance R_t decreased, while the diffusion admittance Y_{OW} and double layer admittance Y_{OQ} increased. Of these, R_t and Y_{OW} vary significantly, indicating that the resistance of the charge transfer process and diffusion process are considerably reduced, and the electrochemical reaction becomes easier. As a result, more and more minerals in the silty soil medium become soft plastic products during the electrochemical reaction. Simultaneously, various organic and inorganic cement materials between the soil particles are dissolved, and the connection between the silty soil particles is weakened. Eventually, the compressibility of silty soil increases and the shear strength is considerably reduced.

Keywords: silty soil, shear strength, compressive properties, EIS

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