ABSTRACT

The study of earthen barriers or clay liners has become very important in the field of geo-environmental engineering. The design of clay liners is based on the fact that leachate migration through clay liners depends on their hydraulic conductivity ($k$). Hence, a low hydraulic conductivity ($k$) is an important parameter in the design of clay liners. Compacted expansive clays or montmorillonite clays have a very low hydraulic conductivity. When expansive clays are blended with fly ash, an industrial waste, the hydraulic conductivity further reduces as the ash-clay blends result in increased dry densities at increased fly ash contents. Hence, fly ash-stabilised expansive clay can also be proposed as an innovative clay liner material. It is, therefore, required to study various physical and engineering properties of this new clay liner material. Index properties such as liquid limit ($LL$) and free swell index ($FSI$), and engineering properties such as hydraulic conductivity and heave of this new composite clay liner material were studied. All the above properties of this clay liner material depend on the fly ash content in the blend. Further, the type of the solute used for determining these properties and the solute concentration also influence these properties. This work presents experimental results obtained on $LL$, $FSI$, hydraulic conductivity ($k$) and heave of fly ash-stabilised expansive clay liner at varying fly ash content and solute concentration. The above tests were performed with deionised water (DIW), CaCl$_2$, NaCl and KCl. Fly ash content in the blend was varied as 0%, 10%, 20% and 30% by weight of the expansive clay, and the solute concentration as 5 mM (milli molar), 10 mM, 20 mM, 50 mM, 100 mM and 500 mM. Heave was studied because expansive clays undergo heave when they absorb water. Fly ash was added to the clay, and the ash-clay blend was compacted as a liner overlying a natural field soil layer. Compacted lateritic soil was used for simulating the natural field soil. In the case of heave studies, calcium chloride (CaCl$_2$) of varying concentration and deionised water (DIW) were used as the inundating fluids. The rate of heave and the amount of heave of the fly ash-stabilised expansive clay liners were studied. Further, characteristics of leachate migrating through fly ash-stabilised expansive clay liners were also studied. The concentration of Ca$^{2+}$ ion and Cl$^-$ ion in the leachate decreased significantly with increasing fly ash content in the clay liner.