

ABSTRACT

Meng Shen, MSCE, Purdue University, May, 2014. Rheological Properties of Laponite and Chemically Modified Laponite Suspensions. Major Professors: Antonio Bobet and Maria C. Santagata.

This research investigated the rheological properties of laponite RD and chemical modification of laponite RD suspensions through the addition of laponite RDS and sodium pyrophosphate (SPP). The treated laponite suspensions might be used in treating liquefaction susceptible sands. This application requires that the laponite suspensions can be easily delivered into the soil and then regain the gel-like nature to increase the strength and liquefaction resistance of the soil.

In this research, the experimental program made use of a Physica MCR 301 Rheometer, a fully automated, air bearing apparatus, to determine the flow and the viscoelastic behavior of the clay suspensions as a function of time and clay concentration. The aging time of the suspensions ranged from 0 minutes to at least 1.5 months, and the amount of laponite RD ranged from 3% to 9% by mass of water, which was modified with laponite RD (ranged from 1.5% to 6% by mass of water) and sodium pyrophosphate (ranged from 1.5% to 8.0% by mass of laponite RD). Controlled shear rate tests (CSR) and amplitude sweep tests (AS) were conducted in this research on these suspensions to investigate the flow and viscoelastic properties of the suspensions.

The test results demonstrate that the addition of RDS and SPP impact the rheology of the laponite RD suspensions, and the effects are more marked when the concentration of RDS and SPP increases. The addition of RDS and SPP causes a reduction of viscosity, yield stress and storage modulus at early aging time, which leads to a slowing down of the formation of laponite gels. The time when

the suspensions transit their rheological behavior from Newtonian to non-Newtonian is also delayed by the increase concentration of RDS and SPP.

Both CSR and AS tests show a significant evolution in the rheological behavior of all RDS and SPP modified suspensions. After 2 weeks of aging all the suspension displayed phase angle less than 10° , indicating formation of a gel-like structure. The formation of a gel like structure will be delayed with the increase of the concentration of RDS and SPP. The strength of all the laponite suspension reaches a “steady state” after 1 week of aging in which the viscosity hardly changes anymore. The strength of the suspension at “steady state” increases with the concentration of RDS and decreases with the concentration of SPP.

Test results show that 5% RD suspension modified with 4% RDS and 9% RD suspension modified with 7% SPP are likely to be the most suitable permeation materials that can be used in treating liquefaction susceptible sands.