

Characteristics of organic matter as inhibitor of calcium silicate hydrate formation

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Organic matters are known to delay or inhibit the cement hydration which forms calcium silicate hydrate (C-S-H) as a major secondary phase. Natural soil stabilization and construction materials diversification which are engineered by calcium based alkaline activation of soils, brought up the interest in the factors of natural organic matters affecting inhibition of C-S-H formation. Organic matters characterizations in alkaline activated soils were carried out with bulk and microscopic analysis, in comparison with that of simplified system made by organic reagent doped calcium silicate hydrate synthesis.

Alkaline activated soils were made with two dredged soils E and H collected from ports of Japan and a steel slag. Their mixtures are named as mixture 1E and 1H, which were cured for three days under hermetical condition at 25 °C. Uniaxial compressive strengths of 1E and 1H were 288 kPa and unmeasurable due to its soft property after curing, respectively. This difference may be attributed by C-S-H formation in 1E and C-S-H formation inhibition in 1H. C-S-H was not detectable under X-ray diffraction of the cured samples, yet its formation was underpinned by geochemical analysis and thermodynamic calculations.

To directly analyze the interaction of C-S-H with organic matters, lignosulfonate, with similar composition to the soil organic matters that consist of macromolecule compound of aliphatic and aromatic carbon with acidic functional groups, is doped to C-S-H synthesis. C-S-H was synthesized from $\text{Ca}(\text{OH})_2$, portlandite, and amorphous silica in coexistence with lignosulfonate of 0.29 and 0.56 g/g addition ratio to unreacted inorganic reagents in 100 rpm shaker at 50 °C for 10 days. The X-ray diffractograms of the sample with 0.29 g/g addition of lignosulfonate consisted of C-S-H whereas 0.56 g/g addition of lignosulfonate consisted of portlandite and amorphous silica, which C-S-H formation was inhibited.

Carbon chemical state imaging acquired by scanning transmission X-ray microscopy (STXM) showed grains in 1E and the synthetic C-S-H of 0.26 g/g lignosulfonate addition coexisted with phenolic and carboxylic carbon similar to the bulk organic carbon entity in each systems, whereas grains in 1H and C-S-H formation inhibited products with 0.56 g/g lignosulfonate addition had a tendency to coexist with aromatic carbon and less carboxylic carbon relative to C-S-H formation systems. Aromatic carbon may be favorable to coexist in C-S-H formation inhibited grains, which may directly play a key role or indirectly state the effect of organic matter on C-S-H formation inhibition. These data with further organic matter's characterization and geochemical analysis on alkaline activated soils could infer the possible mechanisms of C-S-H formation inhibition caused by natural organic matters in relation with their specific components.

Keywords: Soil organic matter, C-S-H, Formation inhibition