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Portland cement compositions with modified zeolite

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Abstract – Hydrosodalite has been synthesized at low-temperature (105 °C) in the unstirred suspension at isothermal curing from NaOH, $Al(OH)_3$, amorphous $SiO_2 \cdot nH_2O$ and H_2O. By the process of modification of hydrosodalite ions exchange was carried out by reduction of Na^+ and increasing Ca^{2+} (Fig. 1). Through the high puzzolanic activity of hydrosodalite and formation of hydroaluminate phases it has positive effect on hardened cement paste compressive strength, especially at early state of cement hydration (Fig. 2). Hydrosodalite synthesized from industrial waste can be used in cement based materials production.

Hydrosodalite has been synthesized at low-temperature (105 °C) in the unstirred suspension at isothermal curing duration of 2 hours from reagents: NaOH, $Al(OH)_3$, amorphous $SiO_2 \cdot nH_2O$. The molar ratio of the starting materials Na_2O: Al_2O_3:SiO_2:H_2O – 2:1:2:10. The final product of synthesis was filtered, dried at 60 °C temperature mild and sieved. The modification of hydrosodalite was performed by ions exchange reaction in the unstirred suspension: saturated $CaCl_2$ solution obtained was filled up on zeolite. Ions exchange investigations at the temperature of 85 °C lasted about 5 minutes. It was confirmed by EDX (Fig. 1) the reduction of Na_2O from 23.88% to 16.55% and form of CaO till 7.78% in modified hydrosodalite.

The modified hydrosodalite was mixed to Portland cement paste (W/C-0.55) with amount from 5 to 20% by cement mass. Zeolite has influence on hydration reaction of Portland cement. Structural material of hydroaluminate phases is generated at the early stage of Portland cement hydration [1]. Zeolites and cement can undergo puzzolanic reaction which results in less void content and higher final compressive strength, depending on amount of zeolite and its type [2]. The amount of zeolite has various influences on strength of hardened cement paste [3].

After addition of hydrosodalite modified by above mentioned way the compressive strength of hardened cement paste varied by curves showed in Fig. 2. Addition of 5% of modified hydrosodalite slightly reduces the compressive strength of hardened cement paste, however with the increase of additive amount from 5 to 20 %, the compressive strength slightly improves, especially at early state of cement hydration. The biggest compressive strength was observed in samples with 15 - 20% of modified hydrosodalite.

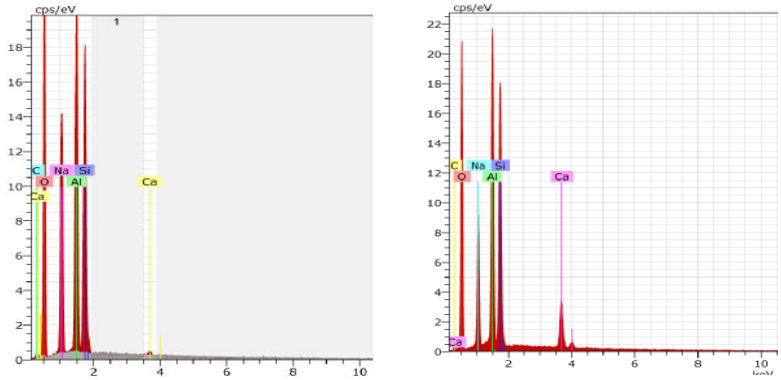

Figure 1: Chemical composition of hydrosodalite (a) and modified hydrosodalite (b) obtained by EDX

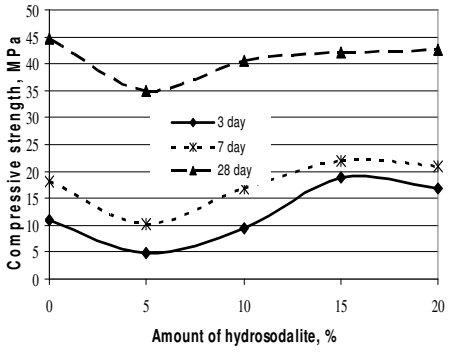

Figure 2: Influence of modified hydrosodalite on compressive strength of hardened cement paste

References

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