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Supplementary information for

Mechanical properties and durability of nanosized Al_2O_3/SiO_2 sol modified cement pastes

Zuihao Chen[1, 2], Yanhuai Ding[3,*]

[1]Hunan Provincial Communications Planning, Survey and Design Institute CO., LTD. Changsha Hunan, 410200, China

[2]Hunan Railway Survey and Design Institute CO., LTD, Changsha Hunan, 410200, China

[3]School of Mechanical Engineering and Mechanics, Xiangtan University, Xiangtan Hunan, 411105, China

*corresponding author, e-mail: yhding@xtu.edu.cn

1. Experimental

The mechanical properties of the specimens were measured according to the standards of ASTM C348-21 and ASTM C349-14. The water absorption of the specimens was tested according to JGJ/T70-2009 standards. Frost resistance in single-sided freezing and compressive strength after freezing and thawing was tested following the requirements of the standard GB/T50082-2009 and GB/T50081-2016. When specimens meet the aging conditions, they are removed from the standard curing chamber for visual inspection and photographed to document their original condition. Specimens intended for freeze-thaw testing are numbered and weighed. The freeze-thaw temperature is set between -15 °C and -20 °C, with each freezing cycle lasting 4 hours, while the thawing temperature is maintained at 15 °C to 20 °C, with each thawing cycle also lasting 4 hours. Each freeze-thaw cycle is completed when complete thawing occurs. After reaching the specified number of cycles, the thawed specimens are removed and their mass is measured again.

The colorimetric method was employed to detect both the depth of neutralization and chloride ion penetration. First, specimens that had been cured for 28 days were taken out and soaked in a 6 mol/L ammonium chloride [NH_4Cl] solution for another 28 days. Upon reaching the designated soaking period, the specimens were sliced into two equally sized blocks using a slicer. One side of the cut surface was sprayed with 1 % phenolphthalein alcohol solution. The resulting coloration exhibited a purple-red hue in the middle with white edges. After the test block had dried, the depth of neutralization was measured using a vernier caliper. On the other side of the test block, it was further cut open and dried at a temperature of 105 ± 5 °C. Then, a 0.1 mol/L potassium chromate solution was sprayed onto the cut surface. The test block was placed in an oven for drying, and this process of spraying and drying was repeated twice. After the third spray, the block was allowed to dry naturally. Immediately after that, a 0.1 mol/L silver nitrate [$AgNO_3$] solution was sprayed, resulting in a red color in the middle and a white color around the edges. The depth of the white color was measured with a vernier caliper. Four points were marked on each side, and the average of the 16 points was taken to determine the depth of chloride ion invasion.

The dynamic modulus of elasticity, an important indicator to determine the concrete damage condition under sulfate attack [GB/T 50082-2009], was measured with DT-20 dynamic elastic modulus tester.

For heat-treatment tests, the specimens after 28 days of curing were dried at 60 °C for 24 h. Then the specimens were heated to 200 °C, 400 °C and 600 °C for 2h with a heating rate of 10 K/min. After that, the strength of the specimens was measured.

2. Figures

Fig. s1. Digital photos of the as-prepared specimens

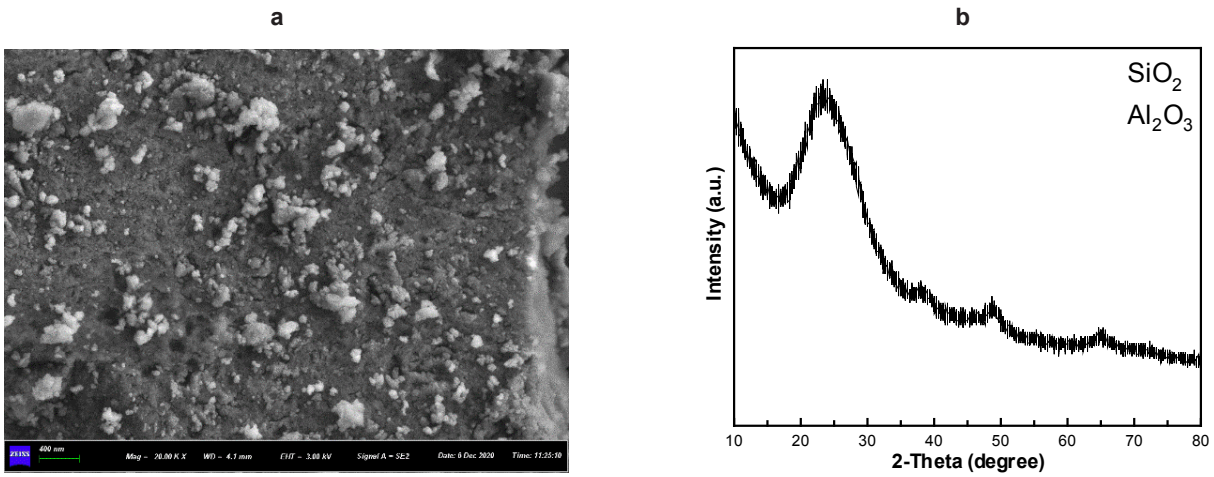

Fig. s2. SEM image and XRD pattern of the mixed sol

Fig. s3. Testing the depth of neutralization and chloride ion penetration

References

1. D. Kong, H. Pan, L. Wang, et al.: Effect and mechanism of colloidal silica sol on properties and microstructure of the hardened cement-based materials as compared to nano-silica powder with agglomerates in micron-scale. Cem. Concr. Compos. **98**, 137–149 (2019). https://doi.org/10.1016/j.cemconcomp.2019.02.015