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Basic Study on Shotcrete with Cellulose Nanofibres

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Extended Abstract

In recent years, the Ministry of the Environment has recommended the use of cellulose nanofibers (hereafter referred to as CNF) for the realisation of a decarbonised society. CNF is a plant-derived material and is characterised by its light weight, high elasticity and thixotropic properties. Thixotropy is a property in which viscosity decreases when a force is applied and returns to normal over time when the force is removed. If thixotropy can be imparted to shotcrete, rebound, which is a construction problem in conventional shotcrete, can be expected to be improved. Therefore, in this study, focusing on the thixotropy of CNF, experiments were conducted to confirm the basic properties of CNF when added in mortar, with a view to adding CNF to shotcrete. In shotcrete tests, No. 8 silica sand was selected as the fine aggregate due to the availability of experimental equipment. In other tests, river sand was used as fine aggregate. In the shotcrete tests, performance was compared with reference to the Standard Specification for Concrete, JSCE-F 563-2018[1], at a shotcrete pressure of 0.5 MPa and a shotcrete time of 1 minute. To assess the effect of CNF addition on the thickness of the shotcrete mortar, two types of corrugated and normal steel plates were prepared to simulate the actual shotcrete surface, and the mortar thickness was compared with no CNF addition and three different addition rates. Strength tests were carried out to compare the strength after 1, 3 and 7 days. The test results suggest that the addition of CNF to the mortar imparted thixotropic properties, which contributed to an increase in the thickness of the tension due to the synergistic effect of increased spraying volume due to the reduction in viscosity during spraying and viscosity recovery during adhesion to the wall surface. The fresh properties of the mortar with CNF showed a reduction in flow loss of about 10% for the addition of no CNF and 0.05%, with a maximum reduction in flow loss at 30 min after kneading. This is considered to be due to the fact that CNF is a material with excellent water retention properties, which suppressed water loss. The air content at each addition rate was 3% without CNF, 4.5% at 0.025% and 6% at 0.05%, indicating that the air content increases with increasing CNF addition rate. These results are similar to previous studies[5], suggesting that the synergistic effect of air entrainment of fine CNF fibres and fine aggregate air entrainment during mixing also caused the increase in air content with increasing CNF addition rate. However, contrary to the increase in air content, the strength remained broadly the same at all addition rates in strength tests. This was probably due to the fibre strengthening effect of the CNF fibres, which offset the reduction in strength with increasing air content. The effect of CNF addition on flexural and compressive strength was therefore judged to be acceptable in this test.

References

[1] Standard Specifications for Concrete Structures - 2018, p. 341.
[5] Yukio Hama and Takayuki Hukase and Jihoon Kim and Tokuo Matsushima, Advanced use of microbial cellulose nanofibers from Hokkaido for construction materials, Start-up Research, pp. 53-54.