Development of Water-repellent Cement Mortar by using Silane Enriched with Nanomaterials

Han seung lee* Dong-jin Park** Yunsu Lee*** Subbiah Karthick****

Abstract

Tn this present study, the superhydrophobic surface was developed on the cement mortar surface by using water repellent materials. For better superhydropohicity, it was developed by using silane as binder and which was enriched with filler materials of SiO_2 and TiO_2 nanomaterials. Those nanomaterials enriched with silanes were admixed in cement mortar during casting time and another was coated on the cement mortar surface. The water repellent properties of spray coated and admixed cement mortars were evaluated by measuring the contact angle which was compared with normal cement mortar.

keywords : cement mortar, nanomaterials, superhydrophobic surface

1. Introduction

1.1 Purpose of research

In reinforced concrete structures are generally hydrophilic porous materials, and water molecules can easily penetrate into the concrete via nano-micro pores. Later, it could form micro crystal as ice at freezing temperatures during the winter seasons, which lead to increase in the internal stress and create the microcracks on the concrete surface. Therefore, the durability and service life of concrete would be minimized[1),2)]. To avoid this problem, we have to propose and develop a hydrophobic concrete surface by using water-repellent materials. In this investigation, we have to carried out the two different methods for increasing the hydrophobicity in cement mortar surface. One method is by the direct addition of silane (1H, 1H, 1H, 2H-Perfluorodecyl-triethoxysilane (PFDTS)) enriched with nanomaterials (TiO_2 and SiO_2) to the cement mortar mixture during casting (admixed cement mortar). And the second attempt is PFDTS enriched with nanomaterials (PFDTS-NM) spray coated on the surface of the cement mortar after casting. The spray coated and admixed cement mortar with PFDTS-NM were characterized by measuring the contact angle, which is compared with normal cement mortar.

2. Experimental and methods

The super hydrophobic (water repellent) coating solution was prepared by following facial steps: equal weight of 1.5g of nano TiO_2 and 1.5g of nano SiO_2 materials were added into 50ml of PFDTS/ethanol mixture (volume ratio1:50). This solution was stirred for 1hr at room temperature(30±5℃). The homogeneously mixed solution was manually sprayed on to a layer of adhesive on the cement mortar cube.

The super hydrophobic material (water repellent material) was admixed with cement mortar. 100g of OPC and 100g sand (size < 250 μ m), then, 45 mL of water was added into a beaker and homogeneously mixed well. Subsequently, 1 mL of PFDTS, 1.5g of nano TiO_2 and 1.5g of nano SiO_2 materials were added to the beaker and constantly stirred at 250rpm for 1hr, which formed a fresh cement mortar mixture. After that, the fresh cement mortar mixture was poured into cubic mold size of 50× 50 × 50 mm. The normal cement mortar was fabricated using the similar steps, but without PFDTS, TiO_2 and SiO_2 nanomaterials.

3. Results

The water repellent properties of coated and admixed cement mortars were characterized by measuring the contact angle and are shown in Figure.1.

* Professor-Department of Architectural Engineering, Hanyang University Ansan, South Korea.
** Department of Architectural Engineering, Hanyang University Ansan, South Korea.
*** Department of Architectural Engineering, Hanyang University Ansan, South Korea
**** Researcher-Department of Architectural Engineering, Hanyang University Ansan, South Korea(karthick.chemistry@gmail.com)

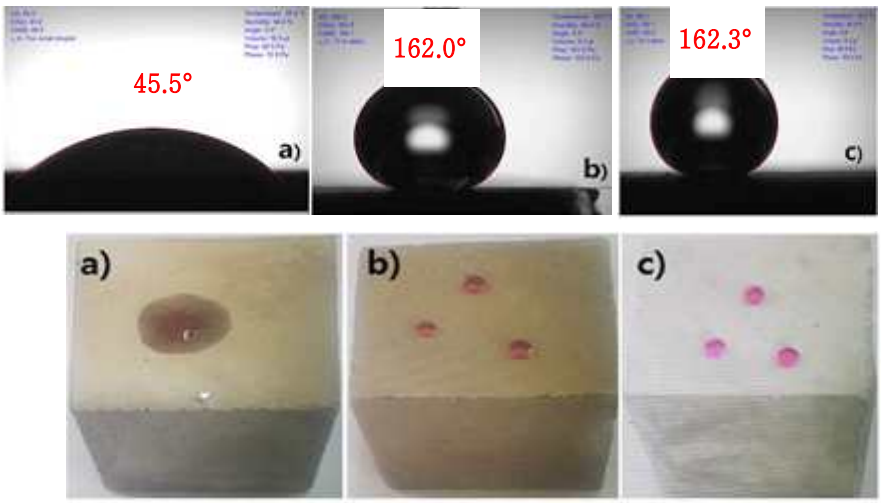

Figure. 1. The contact angle measurement of normal (a), admixed (b) and coated cement mortar (c)

Comparison of the contact angle between proposed coated, admixed cement mortar and other reported in the previous literature as shown in Table 1.

Table 1. Previous studies related to this formwork

Reference	Method	Repellent agent	Contact angle
Junaidi et al., (2017)	coating	1H,1H,2H,2H-perfluorodecyltriethoxysilane and rice hush ash(RHA)	157.7°
Husni et al (2017)	coating	1H,1H,2H,2H-perfluorodecyltriethoxysilane and RHA	152.3°
Song et al., (2017)	admixed	Fluoroalkylsilane	158°
Viven et al. (2013)	coating	polymethyl-hydrogen siloxane, metakaolin or silica fume	156°
Liu et al (2017)	Admixed	Lotus leaf and Poly (dimethylsiloxane) (PDMS)	140°

4. Conclusion

The superhyrophobic surface was successfully formed on the cement mortar surface using TiO_2 and SiO_2 nanomaterials incorporated with silane and the contact angle of coated and admixed cement mortar was 162.3° and 162.0° and these contact angles are high when compare to normal cement mortar(45.5°).

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References

1. H. Husni, M.R. Nazar, H.M. Yee, R. Rohim, A. Yusuff, Mohd Azahar Mohd Ariff, N.N.R. Ahmad, C.P. Leo, M.U.M. Junaidi, Constr, Build. Mater. 144, pp.385~391, 2017
2. J. Song, D. Zhao, Z. Han, W. Xu, Y. Lu, X. Liu, B. Liu, C. J. Carmalt, X. Deng, I.P. Parkin, J. Mater. Chem. A, 5, pp.14542~14550, 2017