www.ElitesJournal.ir

مجله نخبگان علوم و مهندسی

Journal of Science and Engineering Elites

جلد ۵- شماره ۴- سال ۱۳۹۹

Nanoclay- Supported Preyssler Heteropolyacid (NCP): an Effective Nanocomposite to Improve the Compressive Strength of Concrete

Mehdi Jafari1[1]*, Amir Mohammad Mozhdehi[2], Ahmad Ganjali[3], Fatemeh F. Bamoharram[4]

1-Department of Civil engineering, Shahrood Branch, Islamic Azad University, Iran
2-Department of Civil engineering, Shahrood Branch, Islamic Azad University, Iran
3-Department of Civil engineering, Shahrood Branch, Islamic Azad University, Iran
4-Department of Chemistry, Mashhad Branch, Islamic Azad University, Iran

*mehdijafari.ce@gmail.com

Received: September 2020 Accepted: October 2020

Abstract

Nanoclay- supported Preyssler heteropolyacid as a new and effective nanocomposite was used to improve the compressive strength of concrete. The cement pastes used in this study were a mix of water, ordinary Portland cement and nanoclay- supported Preyssler heteropolyacid. The nanoclay-supported Preyssler were added into the concrete with different concentrations of 1, 2, 3, 4 and 5% by the weight of cement amount. Water/cement ratio was 0.35 and the dimension of the cubic samples was 15 ×15 ×15 Cm. Compressive strength tests were done on hardened specimens. The obtained results revealed that the addition of nanoclay- supported Preyssler heteropolyacid into the concrete samples led to increase in compressive strength of concrete specimens equal to 23.2% at 28 days for dosage of 3%.

Keywords: Nanoclay, compressive strength, heteropolyacid, Preyssler, concrete.

1- Introduction

Recently, nanotechnology has been applied in the production of concrete, which is essential in extending service life and can cause to the improvements in strength, shrinkage, ductility, and impact resistance [1]. Therefore, many new ways using nanomaterials to improve concrete properties are being investigated. Incorporation of nanomaterials into the matrix to improve concrete mechanical properties has emerged as a promising research field. Nanoscale particles are characterized by a high surface area-to-volume ratio and many are highly reactive and have great potential in improving concrete and cement properties such as compressive strength and permeability. Most of the concrete-related nano research to date has been conducted with nanosilica, and nano titanium oxide. A few studies on incorporation of nano iron oxide, nano alumina, and nanoclay particles have also been reported [2-4]. Nanoclay consists of layer made of an inner octahedral sheet of alumina or magnesia sandwiched between two tetrahedral sheets of silica. Addition of nanosized layered silicates into the Portland cement systems accelerates the cement hydration and application of nanoclay as reinforcement of cement and concrete is promising in enhancing the mechanical performance as well as reducing permeability and shrinkage of the concrete [2]. However because of low surface area of nanoclays, recently

modification of them has been attracted much attention. Polyoxometalates which are defined as early transition metal clusters, can use for synthesis of modified nanoclays and cause to increase the surface area. Literature survey revealed that, using nanoclay-supported Preyssler heteropolyacid in concrete has been unexplored. Having various experiences in chemistry of HPAs [5 and cited references therein], we were motivated, starting the present investigations. Recently, we have reported the application of different polyoxometalates and Preyssler polyoxometalate towards opening a new gateway to nanotechnology [5] and with our ongoing interests in the extending of the applications of Preyssler, it was our high priority to investigate the capability of this heteropolyacid in the compressive strength of concrete. The purpose of this study was to determine the effect of the use of nanoclay-supported Preyssler heteropolyacid in concrete as important building materials. Specifically, the objective of the study was to determine if nanoclay-supported Preyssler could increase compressive strength and cause a tougher concrete or not**.**

2- Materials and method

Natural sand collected from the bed of Zarringol river, and was used as fine and coarse aggregates. Ordinary Portland cement was used as binding material in this research. Taps water has been used for mixing and curing all concrete specimens in this work. Nano clay was purchased from commercial sources (20-35 nm). Preyssler heteropolyacid was prepared according to our earlier works [6]. Nanoclay-supported Preyssler was prepared by a similar method in our earlier articles [6]. Three cube sapmles (15*15*15 cm) were made for each dosage of nano additive, and the average of each 3 recorded as the final results. Aggregates and cement plus nanocaly-supported Preyssler heteropolyacids, with the dosage of 0-5% of cement weight, were mixed mechanically for one minute to ensure uniformity of the mixure, then water was added and mixed thoroughly. After the molds were compacted, the specimens were covered with wet burlap for 24 hours. After 24 hours the prisms were totally submerged in water up to test. The compressive strength machine was used to apply vertical static load for all tested specimens. All samples were tested after 7 and 28 days for determining the compressive strength.

3- Results and Discussion

The values of compressive strength of reference speciments and the specimens containing 1-5 percent of nanoclay-supported Preyssler (NCP) are given in Figures 1-5. It is found that compressive strength increases with the increase in the percentage of prepared nano additive up to 3% and after that it is found to decrease. The enhancement in compressive strength was found to be 16.43%, 16.12%, 23.2%, 15.88% and 13.25% for dosage of 1%, 2%, 3% , 4% and 5% nanoclay-supported Preyssler heteropolyacid (NCP), respectively at the age of 28 days. As shown in Figures 1-5, an increase for the compressive strength of the concrete samples was observed by increasing the nanoclay-supported Preyssler content up to 3 % at 28 days. It is guessed that nanoclay-supported Preyssler heteropolyacid fills all micro pores existed in concrete structure, because the dimension of this nano additive is much smaller than the dimension of the pores in the concrete structure. The use of nanoclay-supported Preyssler heteropolyacid helps in modifying the properties of concrete and producing a concrete with an increase in compressive strength. The addition of small-dispersed nanoclay- supported Preyssler heteropolyacid to concrete would act as crack arrester, and would substantially improve its compressive strength.

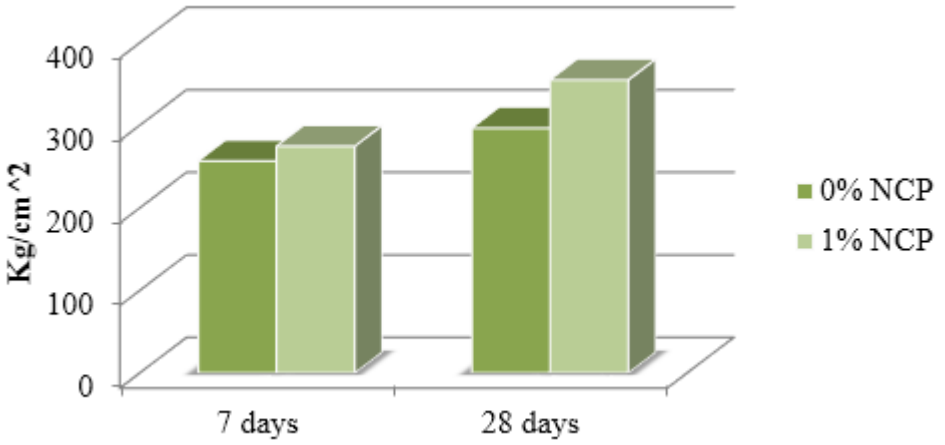

Figure.1-The compressive strength of samples containing 1% NCP

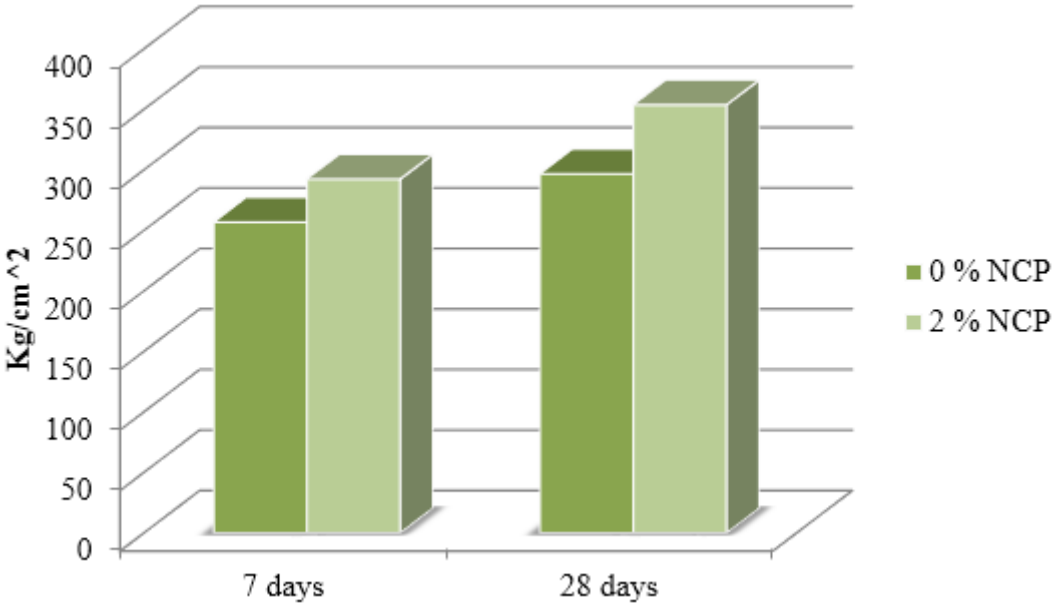

Figure. 2- The compressive strength of samples containing 2% NCP

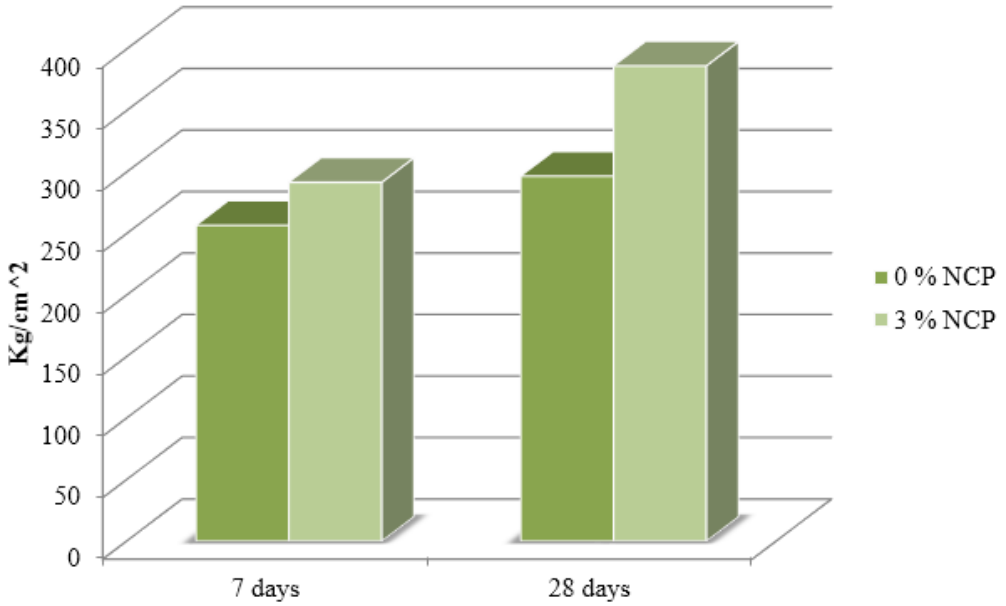

Figure. 3- The compressive strength of samples containing 3% NCP

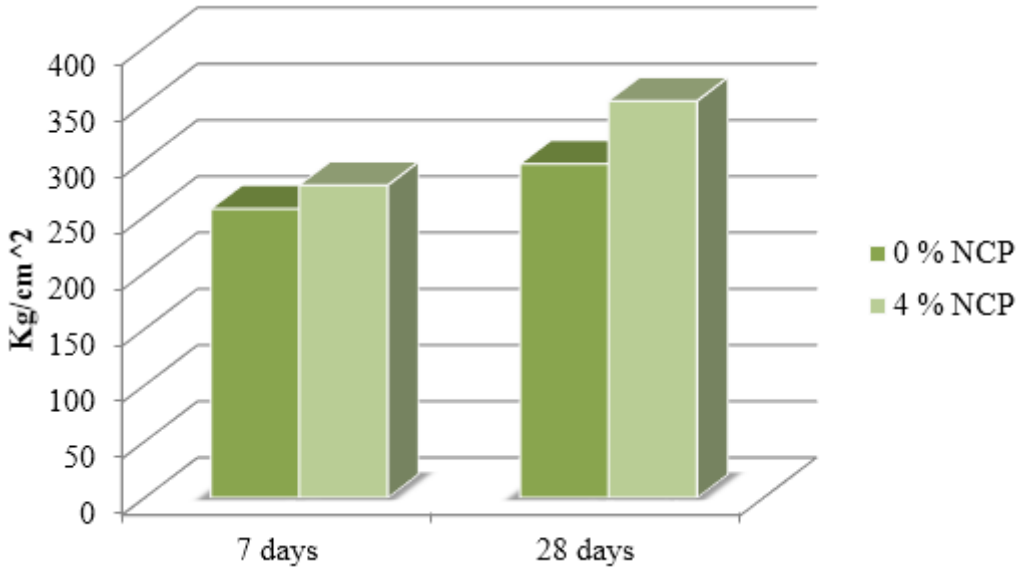

Figure. 4-The compressive strength of samples containing 4% NCP concrete

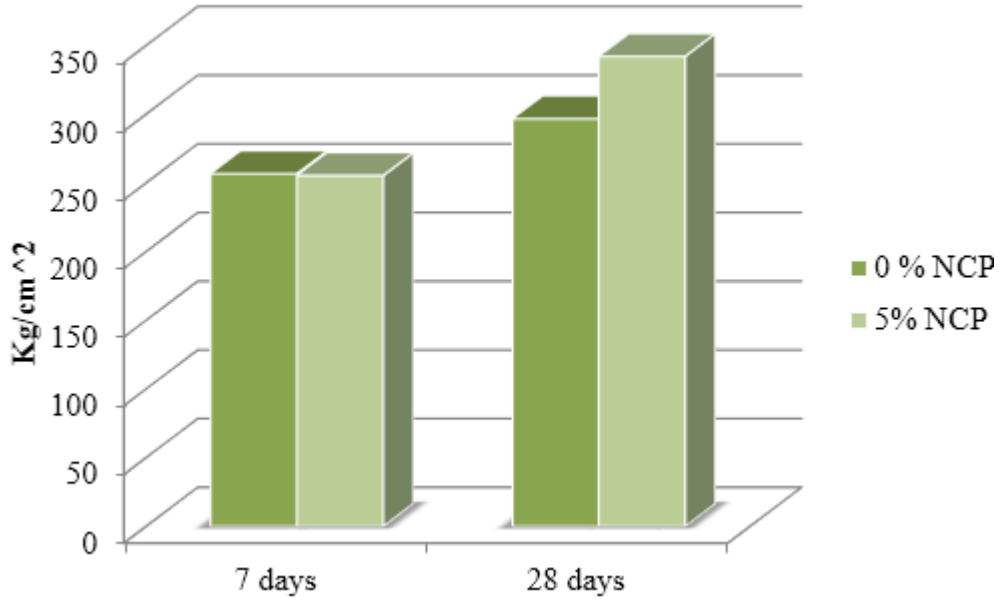

Figure. 5-The compressive strength of samples containing 5% NCP

4- Conclusion

In summary, we demonstrated a simple method for increasing the compressive strength of concrete assisted by nanoclay-supported Preyssler heteropolyacid as an effective nanocomposite. It is found that partial adding of nanoclay-supported Preyssler heteropolyacid has a possitive influence on the strength of concrete. The conclusions derived from this study showed that nanocomposite concentration is important parameter influencing the compressive strength and the optimum percentage at which concrete can be strengthed with nanoclay-supported Preyssler heteropolyacid is 3%. The rate of the increase of compressive strength varied between 0.53- 23.2%. The most important part of this work is to introduce Preyssler type heteropolyacid as an available compound, which can be easily and efficiently applied for increasing the compressive strength of concrete in nanoclay supported form.

5- References

1. A. Rattan, P. Sachdeva, A. Chaudhary“Use of Nanomaterials in Concrete”, International Journal of Latest Research in Engineering and Technology, 2 (2016) 81-84.

2. F. Sanchez, K. Sobolev“Nanotechnology in Concrete: A Review”, Construction and Building Materials, 24 (2010) 2060–2071.

3. H. Li, H.G. Xiao, J. Yuan, J.P. Ou“Microstructure of Cement Mortar with Nano-Particles”, Composites Part B: Engineering, 35 (2004) 185–189.

4. Z. Li, H.H.S. Wang, Y.W.M. Lu“Investigations on the Preparation and Mechanical Properties of the NanoAlumina Reinforced Cement Composite”, Materials Letters, 60 (2006) 356–359.

5. F. F Bamoharram“Role of polyoxometalates as green compounds in recent developments of nanoscience”, Synth. React, Inorg. Met-Org. Nano-Metal Chem, 41 (2011) 893–922.

6. F. F Bamoharram, M. M Heravi, M. Roshani, M. Jahangir, A. Gharib“Preyssler catalyst, [NaP5W30O110]14−: A green, efficient and reusable catalyst for esterification of salicylic acid with aliphatic and benzylic alcohols”, Applied Catalysis A: General, 302 (2006) 42-47.