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ORIGINAL ARTICLE

Effects of Nano-material and R-B super-plasticizer on the compressive strength of concrete, Type 2 Portland cement

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ABSTRACT
Nano-structured materials have received much attention because they have very distinct behavioral characteristics. This study surveys tests on the effects of Nano-silica and R-B super-plasticizer on compression strengths of concrete samples. Tests were done on concrete with additives at percentage ratios of 2, 4, 6, 8, and 10 percent of the weight of the Nano-silica, and 0.5, 0.8, 1.1, 1.4, and 1.7 percent of the weight of the super-plasticizer (compared to the cement) and compressive strength of the samples was measured. Tests were done at the laboratory in the Niktaban-Dez Concrete Factory. Results showed that samples with individual concrete additives of Nano-silica and super-plasticizer increased compressive strength more than did conventional concrete without additives. Tests also determined that the optimal ratio of Nano-silica needed to increase axial strength was 4 percent, and it was 0.8 percent for super-plasticizer; resulting in evaluations in terms of averages for improved long term axial strengths of 29.85% for Nano-silica, and 23.56% for R-B super-plasticizer, compared to the control. Results also showed that during the setup period, in terms of quality, compressive strength of those samples containing the optimal ratio of R-B super-plasticizer was on average 4.72 percent less than that of samples containing the optimal ratio of Nano-silica, However comparison of these results with those of prior studies shows that, overall, the combination of Nano-silica and concrete yields better results compared to the combination of concrete and Nano-silica with Taftan Pozzolan.
Keywords: *Compressive Strength, Type 2 Cement, Nano-silica, R-B Super-plasticizer, Optimal Ratio.*

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INTRODUCTION

This technology has the advantages of increasing quality of a material with low energy consumption, making the process cost effective. The compressive strength of concrete is the most important characteristic to be considered when designing reinforced concrete. In this laboratory study, tests on effects of using Nano-silica and super-plasticizer to boost the compressive strength of concrete samples were done empirically and statistically. One problem that always threatens hydraulic structures is a lack of adequate mechanical strength, which is essential to establish resistance to damaging agents such as strong abrasion and dislodge, as well as protection against fast running water or corrosive substances such as sulfates and chlorides, all of which can decrease a structure's lifespan. So, any additive material that can be used to extend a structure's lifespan by increasing its durability through increased compressive strength would be classed as a valuable material with exceptional properties. MehrAvaran (2008) researched the effects of Nano-silica on mechanical properties of concrete containing natural Pozzolan powder. Results of that study showed that silica particles added to Nano-scale concrete increased the density of particles in the concrete, which increased density of the Nano-structure and improved the mechanical properties of the concrete. Tests run on Nano-silica showed that the best strength was in the range of 1 to 4 percent substitution with cement [1]. Lotfi et al. (2009) studied the properties of cement mortar containing Nano-silica particles and determined that the compressive strength of mortar containing Nano-silica particles was more than that of mortar containing silica fumes at 7 to 28 days [2]. Janbozorgi & Ghannad (2010) conducted a study evaluating the use of Nano-technology in the construction industry. The study showed that Nano-technology improved characteristics of materials and produced in them desirable attributes [3]. Agrawal (2011) in a survey entitled “Performance of concrete with its new atomic strength by use of Nano-technology” reported on the concept of Nano-technology and its function in the construction industry. Results showed that physical forces that can cause structural damage to buildings during the course of its lifespan such as internal tension, cracks, ruptures and other physical forces can all be inspected and analyzed using an intelligent system of Nano-technology [4]. Arefi & Rezaei-Zarchi (2012), in a study entitled “Synthesis of zinc oxide Nano-particles and their effect on the compressive strength and setting time of self-compacted concrete paste as cementation composites” discovered that an increase in oxide of 0.2 percent had a substantial affect boosting the mechanical strength (compressive, tensile, and flexural) of self-compacted concrete [5]. Carmichael & Arulraj (2012) studied the effects of Nano-materials on consistency, setting time and compressive strength of cement and discovered that by using Nano-materials (iron Nano-particles, Nano-silica, Nano-structured fly ash, and Nano-cement) primary and secondary setting times decreased [6] and compressive strength and durability of the concrete increased [7]. Jalal (2012) studied the influence of titanium dioxide Nano-powder in self-compacted concrete and determined that by adding 1 to 5 percent Nano-titanium into the concrete mix, water and chloride penetration decreased remarkably and improved durability and extended the lifespan of the concrete [8]. Jalal et al. (2012) studied the influence of a mixture of Nano-silica and silica fumes in three grades (400, 450, and 500 kg/square meters) of water/cement ratio of 0.38 in self-compacted concrete and discovered that for setup durations of 7, 28, and 90 days the tensile and compressive strengths of self-compacted concrete increased [9]. Liang et al. (2011) in a study entitled “Unified Nano-mechanics Based Probabilistic Theory of quasi-brittle and Brittle Structures: I. Strength, Static Crack Growth, Lifetime and Scaling” analyzed large concrete structures in terms of lifetime [10]. Massana et al. (2012) studied the influence of Nano-silica in improving the abrasion strength of concrete. The study determined that abrasion strength increased by 17% when Nano-silica was added to the concrete mix [11]. Morsy et al. (2012) analyzed the effects of Nano-clay in the mechanics of properties and the structure of Portland cement mortar. The Nano-clay used in that study was Nano-metakaolinite. The study showed that compressive and tensile strengths of cement mortar containing Nano-clay were higher than they were in ordinary mortar, tensile strength improved by 49% [12]. Nazari & Riahi (2010) analyzed compressive strength, thermal properties and the microscopic structure of self-compacted concrete with different amounts of CuO Nano-particles. The study showed that CuO Nano-particles improved the compressive strength of self-compacted concrete and at a substitution level of 4% of the weight of cement its resistance also increased [13]. Sadrmomtazi & Fasihi (2010) conducted a survey entitled “Influence of Polypropylene Fibers on the Performance of Nano-SiO_2 Incorporated Mortar” on the effects of those fibers on structure, and the effects of a Nano-silica mix on its mechanical and physical attributes. Results showed that Nano-silica remarkably improved mechanical properties and hydration of the cement mix [14]. Shamsai et al. (2012) studied the effects of Nano-silica on compressive and abrasion strengths of concrete. The research concluded that using 3 percent Nano-silica and decreasing the water/cement ratio, compressive and abrasion strengths increased by 34.4% and 36.13% respectively in 28 days [15]. Soleymani (2012) analyzed the effects of Nano-silica materials with palm oil aggregates and concluded that an optimum Nano-silica composite could be made by substituting a part of the cement, assessing in periods of 7, 28, and 90 days, this is beneficial to the environment and it improves the mechanical strength of the concrete [16]. Tobon et al. (2010) in a survey entitled “Comparative Analysis of Performance of Portland Cement Blended with Nano-silica and Silica Fume” studied the physical characteristics of Nano-silica and type 3 Portland cement mix at ratios of 1, 3, 5, and 10 percent. The research demonstrated that it is a suitable additive for mixing with Portland cement as it can improve thermal hydration and mechanical performance without affecting discharge, while, due to an increase in the required composite water intake, the active mobile Pozzolan additives delay setting time [17]. In the present paper, the compressive strength of samples in different setup periods are compared based on type 2 cement and various different ratios of Nano-silica with various different ratios of super-plasticizer.

MATERIALS AND METHOD

In this survey, Nano-silica particles and super-plasticizers were used as additives to concrete to improve its compressive strength and its durability. Among some of the striking characteristics of super-plasticizer additive is that it can reportedly increase cement flow and decrease the water/cement ratio, thereby improving its compressive strength, durability, elasticity module, Poisson's ratio and reduce permeability, thus protecting the material from water and destruction by harmful substances, such as hazardous salts and chlorides. Super-plasticizer improves durability in concrete by protecting it from successive moisture and dryness, damage caused by repeated freezing and thawing and other such damage. In the best circumstances, super-plasticizers have the power to lower water requirement by 35 to 40 percent. These materials produce good adhesion. Usually they are liquid, with density between 1.05 and 1.07. Nano-silica are distributable either as dry powder particles or suspended in a liquid solution. Nano-silica is comprised of bullet-shaped particles with a diameter less than 100nm, it has versatile applications including anti-abrasion, anti-slip, anti-flammabile and anti-reflection surfaces. In Table (1) the scenario of all the utilized material in the tests, and the percentage of Nano-materials added to cement is shown. Type 2 cement was used to produce the concrete used in all the tests.

Table 1: Materials used in the tests and the percentage of incorporation with cement

	Used Material	Kg/m^3	Percent of Mixing to Cement
1	Gravel 5-20 (mm)	900	-
2	Sand 0-5 (mm)	900	-
3	Cement	350	-
4	Nano-silica	-	2, 3, 6, 8, 10
5	Super-plasticizer	-	0.5, 0.8, 1.1, 1.5, 1.7

Additives, according to Standard ASTM C125, mean materials other than water, hydraulic cement or fibers, which are added to the concrete during incorporation or exactly before incorporation in order to produce new features in the plastic or hardened concrete.

Preparation of Samples and Test Method

All the tests in this survey were designed and took place in the concrete laboratory of the Niktaban-Dez Concrete Factory. A rotary mixer with a flat blade was used for mixing Nano-silica and/or super-plasticizer with concrete. Firstly, water and additive materials were transferred into the mixer and were mixed at high speed for one minute. Then cement was added and the mixer worked for another minute. At this stage, after adding sand and gravel into the mix, the machine mixed the sample for two full minutes so that all the components in the concrete mix became well blended. Next, the resultant concrete was poured into special sampling containers (25×25cm), made of cast iron or compact plastic. Samples were kept in a moist area at a temperature of 20±3 centigrade. After the primary setting of concrete, samples were covered using jute sacks to prevent evaporation of water from their free surfaces. After 24 hours samples were carefully put into a pool of water of 20±3 degrees. After 7 days, before the experiment, samples were taken out of the pool so that their surfaces could dry out in the free flow environment of the lab. Samples were then marked in order and put in between the two plates of the loading device in figure (1); each time, the device's plates were cleaned completely before another sample was put in place. To begin the test, the loading device was set at standard pressure and turned on, so that its plates would start pressuring the sample steadily. During the test, time was recorded at specific pressure intervals that the sample went through. This procedure continued until the sample cracked, at which time the machine was automatically switched off, and the final pressure was applied to the sample, which was of course different for each sample, points were recorded and these constituted evaluations for compressive strength of the 7-day concrete sample. Other samples tested for 28 days and 42 days underwent the same procedure.

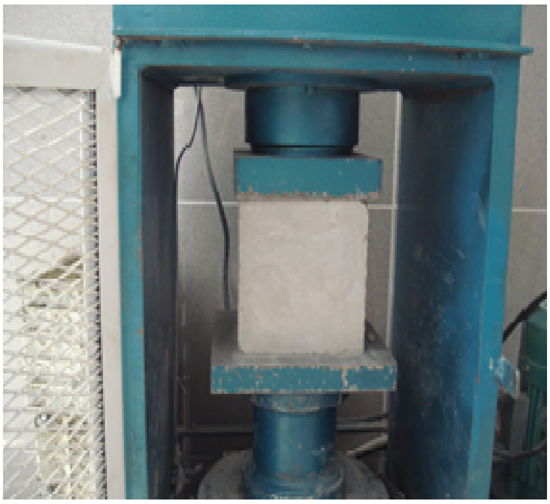

Figure 1: Concrete sample before the compressive pressure test

Figure 2: Concrete sample after the compressive pressure test

Figure (2) shows a cracked sample undergoing the compressive strength test.

RESULTS AND DISCUSSION

As mentioned in previous sections, this paper is concerned with effects of Nano-silica and super-plasticizer additive materials on the compressive strength of concrete containing type 2 cement. The main goal was to determine the optimum ratio of these materials. Compared to conventional concrete (plain), Pozzolan performance of Nano-silica (SiO_2) was considerably higher. Nano-silica can react to crystals of calcium hydroxide (Ca_2OH) and create C-S-H gel. Therefore, the size and number of calcium hydroxide crystals decreased substantially and the strength of fast-hardening cement increased after 28 days. Nano-silica can act as a nucleus and bonds well with gel particles. This improves performance in terms of its ability to combine, stability, hydration and long-term mechanical characteristics, all factors relating to the production of more durable concrete. Furthermore, Nano-silica can fix the pressure-sensitive characteristics of cement mortar. The Nano-silica used in this survey had 99 percent purity. In this study, first for the control sample, results of compressive strength test times of 7, 28, and 42 days were calculated. Table (2) shows these results.

Table 2: compressive strength results (type 2 cement) without additive materials

Time and Strength	7 days	28 days	42 days
Compressive Strength kg/cm^2	324	355	382

Table (3) shows compressive strength of samples containing Nano-silica particles. As shown in the table, compressive strength of all samples after 7, 28, and 42 days was more than that of the control sample, or those without additives. This increase in strength is also shown in Table (3). According to these results, in 28 days the compressive strength of concrete improved by increasing the ratio of Nano-silica particles to concrete in the mix. This pattern continued until it reached the highest possible point in terms of strength percentage, after which increasing Nano-silica particles to the concrete mix resulted in a decrease of its compressive strength.

Table 3: Compressive strength results of Nano-silica Mixing type 2 cement

Additive percentage compared to the weight of cement	Compressive strength (kg/cm^2)		
	7 days	28 days	42 days
2	248	346	404
4	355	435	496
6	302	426	471
8	262	404	427
10	328	395	427

For closer inspection of the results in table (3), figure (3) shows the changes as graph columns.

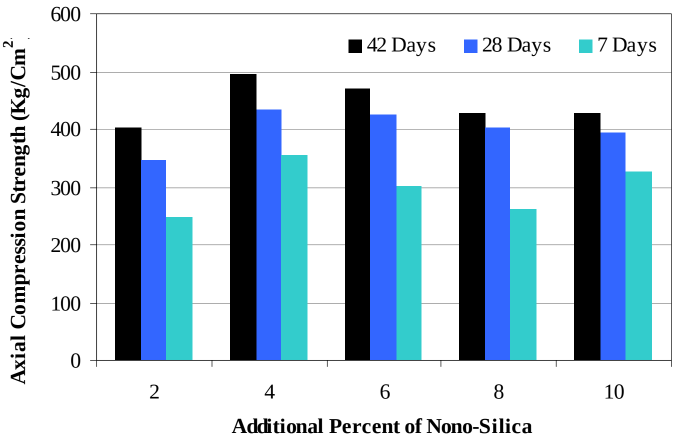

Figure 3: Compressive strength results of samples with Nano-silica in the type2 cement

As shown in figure (3), optimal percentage of Nano-silica is 4 percent in high strengths.

Effects of Super-plasticizer on Compressive Strength of Concrete

In addition to Nano-silica, the effects of super-plasticizers on compressive strength were also studied. Numerous tests in periods of 7, 28, and 42 days were conducted for different percentages of super-plasticizer as an additive. As Table (4) shows, all samples containing super-plasticizer had more compressive strength compared to those samples without additives. According to these results for tests on compressive strength of concrete with additions of super-plasticizer, an increase in super-plasticizer related to increased compressive strength.

Table (4): Compressive strength results of samples containing Super-plasticizer in type 2 cement

Additive percentage compared to the weight of cement	Compressive strength (kg/cm2)		
	7 days	28 days	42 days
0.5	306	398	420
0.8	343	413	472
1.1	311	394	418
1.4	311	342	404
1.7	240	258	302

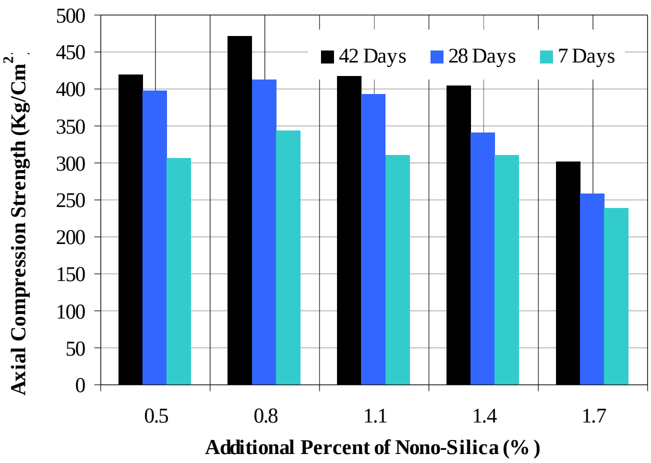

Figure 4: Compressive strength test results of concrete with R-B super-plasticizer

Comparing Nano-silica to super-plasticizer and Determining Optimal Percentage

As shown in Tables (3) and (4), 7, 28, and 42-day concrete samples containing Nano-silica showed a definite improvement in compressive strength compared to 7, 28, and 42-day concrete samples containing R-B super-plasticizer. Durability of concrete and its probable lifetime were important evaluations considered in this study, so the optimal percentage of an increase in Nano-silica particles was determined based on 42-day test for compressive strength. Figure (4) shows the results of optimal Nano-silica and R-B super-plasticizer percentages for different setup durations compared to the control sample.

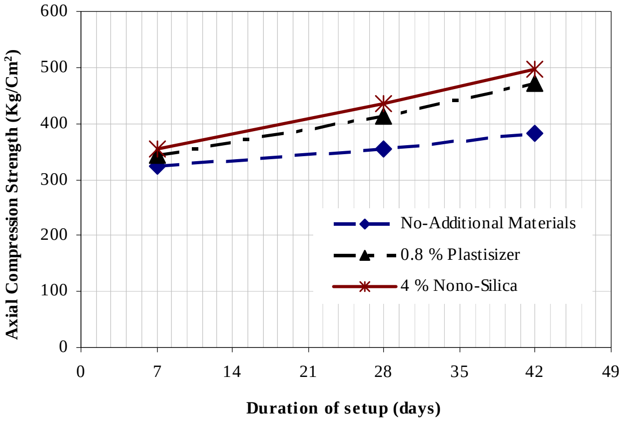

Figure 4: Comparison of results of optimal Nano-silica and R-B super-plasticizer samples with the control sample

As figure (4) shows, opting for 4 percent of Nano-silica yielded better results compared to R-B super-plasticizer and increased compressive strength. Based on these results, the optimal percentage of Nano-silica was 4 percent of the weight of the cement used as its particles fill the tiny empty spaces between the atoms and induce hydration reactions with the cement particles producing C-S-H gel, which after hardening, creates a hard integrated object between the aggregates. Excess of the optimal Nano-silica percentage results in a Nano-overload and as Nano-silica has no strength by itself,, the outcome is a decrease in the concrete's strength. As aforementioned, the optimal percentage of R-B super-plasticizer is 0.8 percent of the weight of the consumed cement. Using this material, compared to Nano-silica, is economically more viable because of its lower cost, but it has lower strength compared to Nano-silica of 4 percent. Qualitatively, the compressive strength of samples containing R-B super-plasticizer is on average during the setup period about 4.72 percent less than those containing the optimal percentage of Nano-silica.

Comparison of results of this Survey to those of Tobon

Tobon et al. (2010) in a survey entitled "Comparative Analysis of Performance of Portland Cement Blended with Nano-silica and Silica Fume" studied the physical characteristics of a mix of Nano-silica and type 3 Colombian Portland cement at ratios of 1, 3, 5, and 10 percent. Results of those tests demonstrated that Nano-silica made a suitable additive for mixing with Portland cement as it improved thermal hydration and mechanical performance without affecting discharge, whereas active mobile Pozzolan additives delay the time taken for a mortar to set because of an increase in requisite composite water. But when these composite materials operated with invariant w/c, the setup period substantially decreased compared to the control materials. Results determined that a Nano-silica /cement mix of 5 to 10 percent, increases compressive strength; moreover, at a 10 percent mix, compressive strength is improved by 120 percent. The study showed that silica fume, in its dense form, works mostly as filler, which needs little composite water, delays setting time, and decreases compressive strength and thermal hydration. Figure (5) shows the effects of these materials on axial strength.

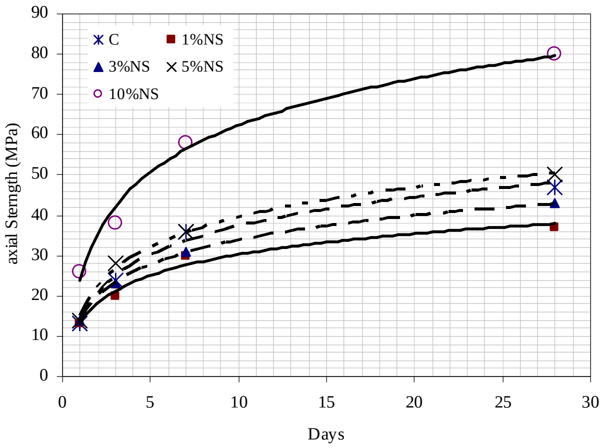

Figure 5: Effects of Nano-silica on the axial strength of concrete (Tobon, 2010)

According to figure (5), 7-day concrete axial strength with Nano-silica of 5 percent equals 36MPa. In the present study, this value for Nano-silica of composite percentage of 5 was determined as 30MPa. The difference is due to the type of minerals in the Nano-silica material varieties.

Comparison of results of this Survey to those of MehrAvaran

MehrAvaran et al. (2008) conducted a research on the effects of Nano-silica on the mechanical properties of concrete containing natural Pozzolan powder. Results from analyses of concrete in a Nano-scale showed that the use of silica particles increased the density of particles in the concrete, which served to increase the density of the Nano-structures within the concrete thereby improving its mechanical properties. Tests run on Nano-silica showed adequacy. The best strength was determined in the range of 1 to 4 percent substitution with cement. Table (5) shows results of the test samples of MehrAvaran (2008) concerning 7-day and 28-day compressive strength, where P is for Taftan Pozzolan, C is for concrete, N is for Nano-silica, and the results of this study, where NS is for Nano-silica, C is for concrete and the numbers indicate substitute percentages.

Table 5: Results of compressive and flexural strengths of the samples (MehrAvaran)

MehrAvaran's Study (2008)			Present Study		
Sample	Compressive Strength Kg/cm^2		Sample	Compressive Strength Kg/cm^2	
	7-day	28-day		7-day	28-day
CP0N0	288.4	382.9	Control	324	355
CP15N0	224.5	337.2	CNS2	248	346
CP20N0	199.1	346.3	CNS4	355	435
CP25N0	199.1	322.0	CNS6	302	426
CP15N1	279.3	354.5	CNS8	262	404
CP20N1	249.9	345.3	CNS10	328	395
CP25N1	221.4	395.1	CSP0.5	306	398
CP15N2	282.4	325.0	CSP0.8	343	413
CP20N2	247.8	321	CSP1.1	311	394
CP25N2	225.5	341.2	CSP1.5	311	342
CP15N3	284.4	348.4	CSP1.7	240	258
CP20N3	252.9	319.9			
CP25N3	236.7	365.6			

According to Table (5), it is apparent that in MehrAvaran's study (2008), the maximum 7-day compressive strength, after the 288.4 Kg/cm^2 control sample, related to the one containing 15 percent Taftan Pozzolan and 3 percent Nano-silica, which equals 284.4 Kg/cm^2. This indicates that in a short period, increasing the Nano-silica along with Taftan Pozzolan resulted in a 1.5 percent decrease in compressive strength of the concrete, whereas (according to MehrAvaran's results), in the long term, an increase in compressive strength was experienced. The maximum 28-day compressive strength, in all samples, related to those containing 25 percent Taftan Pozzolan and 1 percent Nano-silica, relating to 395.1 Kg/cm^2. This value, compared to the control samples in MehrAvaran's study (1387), shows a 3.2 percent increase. In the present study, 7-day and 28-day strengths of concrete containing 4 percent Nano-silica showed maximum compressive strengths of, 355 and 435 Kg/cm^2 respectively. . This shows that increasing Nano-silica alone yields better results than it does when mixed with Taftan Pozzolan; that is to say a 24.8 percent increase in compressive strength. This happens because the Nano-silica mixed with the concrete facilitates the filling up of all the fine spaces between the atoms. This affects the consistency of the concrete, improves its compressive strength, durability and lifespan. Furthermore, 7-day and 28-day compressive strength of concrete samples containing 0.8 percent R-B super-plasticizer increased respectively, by amounts of 343 and 435 Kg/cm^2. This increase was due to a decrease in the water/ cement ratio, which in turn decreased incidence of hollowing and porosity of the concrete, resulting in better consistency and integrity thus improving its compressive strength and the lifespan of the concrete.

CONCLUSION

Further to this series of tests on various types of concrete that were compared and described in this study and the effects of different amounts of Nano-silica particles and super-plasticizer additives on compressive and flexural strengths of concrete, the following results were determined:

Nano-silica and super-plasticizer additives can help improve the compressive strength of concrete and increase its durability. The most eminent characteristic of Nano-silica is the production of compounds that fill in the cavities formed during the hydration process. Therefore, any type of Nano-silica that has this characteristic is suitable as an additive to concrete in order to increase its compressive and flexural strength and extend its durability. Super-plasticizer, however reduces the water/cement ratio, which decreases the amount of cavities by occupying the hollow spaces in the concrete and this improves adhesion between the aggregates. This also increases compressive and flexural strengths of concrete and extends its durability. As was stated before, adding Nano-silica and super-plasticizer to concrete increases its strength. But it is only reliable to add Nano-silica up to 4 percent of the weight of the cement, and 0.8 percent in the case of super-plasticizer. Additionally, the percentage improvement related to 7, 28, and 42-day compressive and flexural strengths of the concrete samples containing Nano-silica particles was higher than that in samples containing super-plasticizer. As the emphasis in this study was on durability and lifetime of concrete, the optimal percentage increase in Nano-silica was calculated based on the 42-day test for compressive and flexural strengths.

REFERENCES

1. MehrAvaran, M. (2008). “Properties of Concrete Containing Taftan Pozzolan Using Nano-silica”, Master’s Thesis of Civil/Structural Engineering, University of Sistan and Baluchestan, Behbud, Iran.
2. Lotfi, M., Zineli, M., and Raufi, A. (2009). “Characteristics of Cement Mortar Containing Nano-silica Particles”, Iranian Journal of Chemical Engineering, Vol. 8, No. 44.
3. Janbozorgi, A., and Ghannad, Z. (2010). “Application of Nano-technology in the Construction Industry”, Kayson Quarterly (New Issue), No. 44, Spring, 1389.
4. Agrawal, T. (2011). “Performance of Concrete with its New Atomic Strength by Use of Nano-technology”, International Transactions on Applied Sciences and Technology Journal, Vol. 1, No. 1, pp. 17-20.
5. Arefi, R., and Rezaei-Zarchi, M.S. (2012). “Synthesis of Zinc Oxide Nano-particles and Their Effect on the Compressive Strength and Setting Time of Self-compacted Concrete Paste as Cementitious Composites”, International Journal of Molecular Science, Vol. 13, pp. 4340-4350.
6. ASTM C 125, Standard Terminology Relating to Concrete and Concrete Aggregates.
7. Carmichael, M. J., and Arulraj, G. P. (2012). “Influence of Nano-Materials on Consistency, Setting Time, and Compressive Strength of Cement Mortar”, International Journal of Engineering Science and Technology, Vol. 2, No.1, pp. 2250-3498.
8. Jalal, M. (2012). “Durability Enhancement of Concrete by Incorporating Titanium Dioxide Nano-powder into Binder”, Journal of American Science, Vol. 8, No. 4, pp. 289.294.
9. Jalal, M., Pouladkhan, A.R., Ramezanianpour, A.A., and Norouzi, H. (2012). “Effects of Silica Nano-powder and Silica Fume on Rheology and Strength of High Strength Self-compacting Concrete”, Journal of American Science, Vol. 8, No. 4, pp. 270-277.
10. Liang, J., Bazant, Z., and Bazant, M. (2011). “Unified Nano-mechanics Based Probabilistic Theory of Quasibrittle and Brittle Structures: I. Strength, Static Crack Growth, Lifetime and Scaling”, Journal of the Mechanics and Physics of Solids, Vol. 59, pp. 1291–1321.
11. Massana, J., Anton R., Hueso A., and Sanchez, E. (2012). “Cement Mortars Nano-materials for Use in Livestock Facilities”, International Conference of Agricultural Engineering, July 2012, Valencia, Spain.
12. Morsy, M.S., Alsayed, S.H., and Aqel, M. (2012). “Effect of Nano-clay on Mechanical Properties and Microstructure of Ordinary Portland Cement Mortar”, International Journal of Civil and Environmental Engineering, Vol. 10, No. 1, pp. 23-27.
13. Nazari, A., and Riahi, S. (2010). “Effects of CuO Nano-particles on Compressive Strength of Self-compacting Concrete”, Department of Materials Science and Engineering, Journal of Sadhana, Vol. 36, No. 3, pp. 371-391.
14. Sadrmomtazi, A., and Fasihi, A. (2010). “Influence of Polypropylene Fibers on the Performance of Nano-silica Incorporated Mortar” Iranian Journal of Science & Technology, Transaction B: Engineering, Vol. 34, No. B4, pp. 385-395.
15. Shamsai, A., Rahmani, K., Peroti, S., and Rahemi, L. (2012). “The Effect of Water-Cement Ratio in Compressive and Abrasion Strength of the Nano-Silica Concretes” World Applied Sciences Journal Vol. 17, No. 4, pp. 540-545.
16. Soleymani, F. (2012). “Optimum Flexural Strength of Binary Blended Concrete in Presence SiO_2 Nano-particles as Nano-fillers and with Palm Oil Clinker Aggregates”, Journal of American Science, Vol. 8, No. 4, pp. 426-431.
17. Tobon, J.I., Restrepo, O. J., and Paya, J. (2010). “Comparative Analysis of Performance of Portland Cement Blended with Nano-silica and Silica Fume” Dyna, year 77, No. 163, pp. 37-46. Medellin, September, 2010. ISSN 00127353.

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