

The Effect of Nano Silica on the Self Healing Ability of the Concrete

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Abstract: *The addition of superabsorbent polymers (CAPs) to cement mixtures promotes self-medication of the material. When cracked; SAP, present inside the crack, swell on contact with water and then secrete this water to stimulate further hydration of uncontaminated cement particles and crystallization of calcium carbonate. However; the inclusion of SAP affects the mechanical performance of the cement material by creating a macropor, as water departs from the swollen SAP. To counteract the decrease in strength, part of the cement is replaced by a nanosilica. In the present work nano silica was added in the concrete as partial replacement of the cement. The compressive strength and the flexural strength was calculated for the concrete.*

Keywords: Nano Silica, Concrete, Self Healing and Compressive Strength.

I. INTRODUCTION

In general, the penetration of water into the exposed concrete infrastructure affects durability, as well as causes corrosion of reinforcing steel bars. Some cracks are not visible and therefore cannot be obtained. Due to the expansion, reduction and permeability of materials, cracks increase both in size and quantity. For this reason, infrastructure inspection and maintenance methods are increasingly being drawn attention. Continuous inspection and maintenance can be difficult, especially in the case of large-scale infrastructure due to the huge amount of funds for this. Some other factors, such as the location of damage in the affected structure, complicate repairs. Thus, the concept of autonomous repair, otherwise known as self-medication of these dangerous cracks with minimal labor and capital requirements of the affected structures, becomes a great attraction for researchers.

Thus, the assessment of the effectiveness of self-healing using a different approach has become attractive due to the requirement of minimum labor and small capital investments. In this regard, the effectiveness of self-healing is assessed using a different approach. The effectiveness of self-medication is the restoration of functionality and the desired criterion of quality of cement base material relative to its original form after healing from a crack.

Self-medication materials are those that can restore almost or all of its original functionality after damage, thus fully or partially heal. Alternatively, self-medicating material is one that can detect and self-heal damage. In this regard, the healing process continues without any manual intervention. Nanotechnology and biotechnology are relatively recent advances in improving the strength and other properties of concrete. The aim of this study is to review all available approaches to the development of concrete for self-medication, taking into account the different tests and methods adopted to assess the effectiveness of self-medication.

II. LITERATURE REVIEW

Nain, N, etc. [1] studied techniques based on the measurement of ultrasonic pulse velocity (UPV) allowed to quantify changes occurring inside damaged materials. Mechanical testing of composites allowed to quantify the impact of the activity of binders-additional cement materials (SCM). Analysis of the results indicates a significant impact of the initial crack width on the ability to completely close cracks; however, there are repeated deviations from this rule and local variability of the self-sealing process. Material compressive strength has been shown to be an important indicator of the activity of the binder in reducing the width of cracks due to self-sealing. Regardless of the method of crack induction, internal changes in the material caused by self-sealing depend on the degree of material damage.

Zhang, J. ; Zhao et al [2] investigated The use of additional cement materials, polymers and microorganisms is the most common approach to achieving effective self-medication. Determining the effect of self-medication for successful sealing of crack width is a key issue. While the crack of the maximum size of 0.97 mm healed. Visual surveillance based on a microscope, digital images and camera photos are the main methods for estimating the width of filled cracks. However, only a few studies reported healing of crack depths of 32 mm and 27.2 mm. In addition, only one report acknowledged the healing of 5 mm long cracks.

Guardani, R. and others. [3] This paper presents new advances in the feasibility of extruded cement hollow tubes containing / releasing devices for healing agents and their potential increase. In particular, sodium silicate and potassium silicate were evaluated as healing substances in terms of their ability to diffuse through cracks and their ability to restore the initial mechanical properties of mortars. Their effects were also investigated in combination with the use of a hydrophobic coating applied to the inner surface of some hollow tubes to enhance the release of healing agents along the crack pathway. The color solution was added to silicate sodium / potassium solutions to help isolate the fracture area covered with healing agents, thus allowing a qualitative assessment of the effect of the hydrophobic coating.

Brito, J and others. [4] explored intellectual infrastructure, including smart buildings and smart cities, and are being built at an increasing pace around the world. One of the main drivers is the explosion of inexpensive sensors with Internet support as part of the new wave "Internet of Things (IoT)".

III. METHODOLOGY

According to IS 456-2000, the total crack width limit in good condition is 0.3 mm, which is self-sealing according to a previous study. From this point of view, it is decided to maintain a crack width of 0.2 to 0.4 mm. Concrete cracks are classified as minor or early age cracks and major or structural cracks, and they are associated with shrinkage, creep effect and the use of external loads and environmental causes. The pre-cracking age was set at 2 days, as most shrinkage cracks occur at an early age and structural cracks were recorded as 28 days. Finally, the time set for crack healing is 28 days. Preliminary research shows that water is important for crack healing, so the state of exposure to air has insufficient water, and therefore, a super absorbent polymer is selected in the way it is a water-absorbing material.

The main goal is to study the ability to self-medicate so unimportant that it is important to control cracks and therefore prefer to use a nanosilica to limit the expansion of cracks at any age. Cement used - OPC 53 Company class BIRLA A1, and the ratio of water and cement is fixed as 0.45, and the replacement of nano silicon dioxide 5%, 10%, 15% by weight of cement, the effect of which is compared with control samples of concrete.

The mix design as per (IS 456-2000 And IS 10262-2009) is as follows for nano silica

Material	Cement	w/c ratio	Coarse aggregate (20mm- 12.5mm) Kg/m3	Coarse aggregate (12.5mm- 4.75mm)	Sand (kg/m3)	Nano-silica- (kg/m3)
Normal concrete	367.46	0.45	549.44	549.44	620.48	0.00
Concrete+5%NS	349.09	0.45	549.44	549.44	620.48	18.37
Concrete+10%NS	330.72	0.45	549.44	549.44	620.48	36.75
Concrete+15%NS	312.34	0.45	549.44	549.44	620.48	55.12

IV. RESULTS

The results obtained are obtained for the concrete with nano silica as follows.

Table 1: Compressive strength for the concrete with different percentage of NS for 28 days

Mix name	Set	Normal concrete	Concrete +5%NS	Concrete +10%NS	Concrete +15%NS
Compressive strength (mPa)	Set1	32.77	35.39	36.10	35.56
	Set2	34.76	37.54	38.29	37.72
	Set3	33.37	36.04	36.76	36.21
Avg		33.63	36.32	37.05	36.49

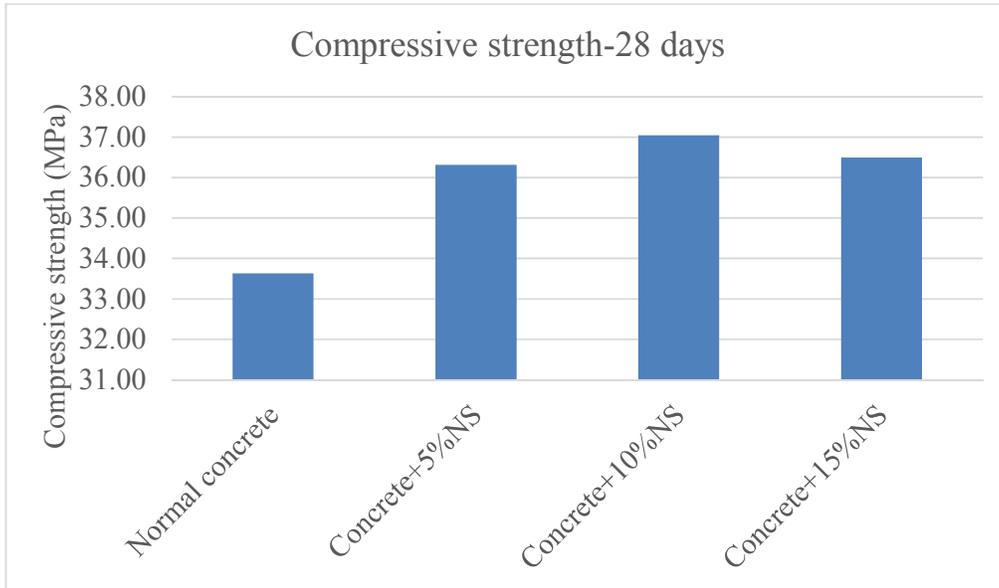


Figure 1: Compressive strength for the concrete with different percentage of NS for 28 days

Table 2: Compressive strength for the concrete with different percentage of NS for 14 days

Mix name	Set	Normal concrete	Concrete+5%NS	Concrete+10%NS	Concrete+15%NS
Compressive strength (mPa)	Set1	25.56	27.61	28.16	27.74
	Set2	27.11	29.28	29.87	29.42
	Set3	26.03	28.11	28.67	28.24
Avg		26.23	28.33	28.90	28.46

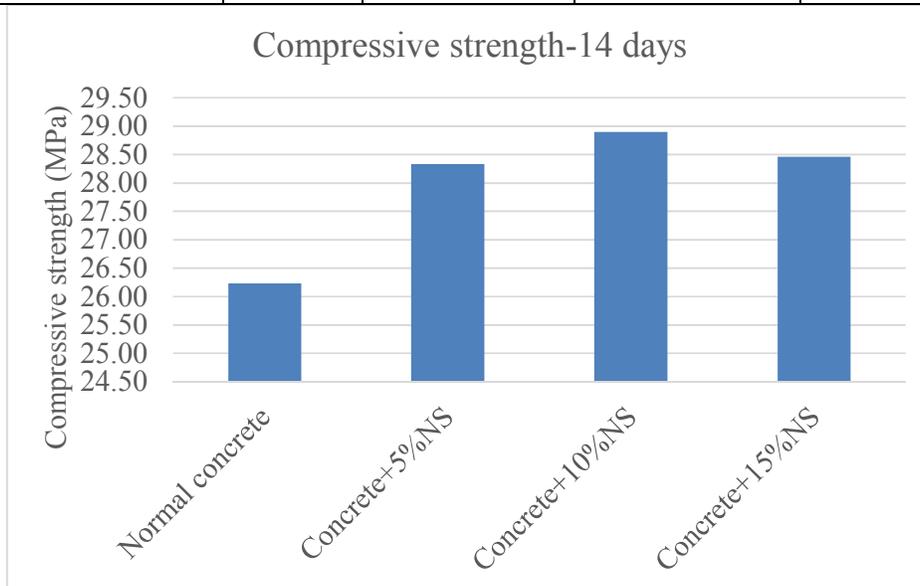


Figure 2: Compressive strength for the concrete with different percentage of NS for 14 days

Table 3: Compressive strength for the concrete with different percentage of NS for 7 days

Mix name	Set	Normal concrete	Concrete+5%NS	Concrete+10%NS	Concrete+15%NS
Compressive strength (mPa)	Set1	19.99	21.59	22.02	21.69
	Set2	21.20	22.90	23.36	23.01
	Set3	20.35	21.98	22.42	22.09
Avg		20.52	22.16	22.60	22.26

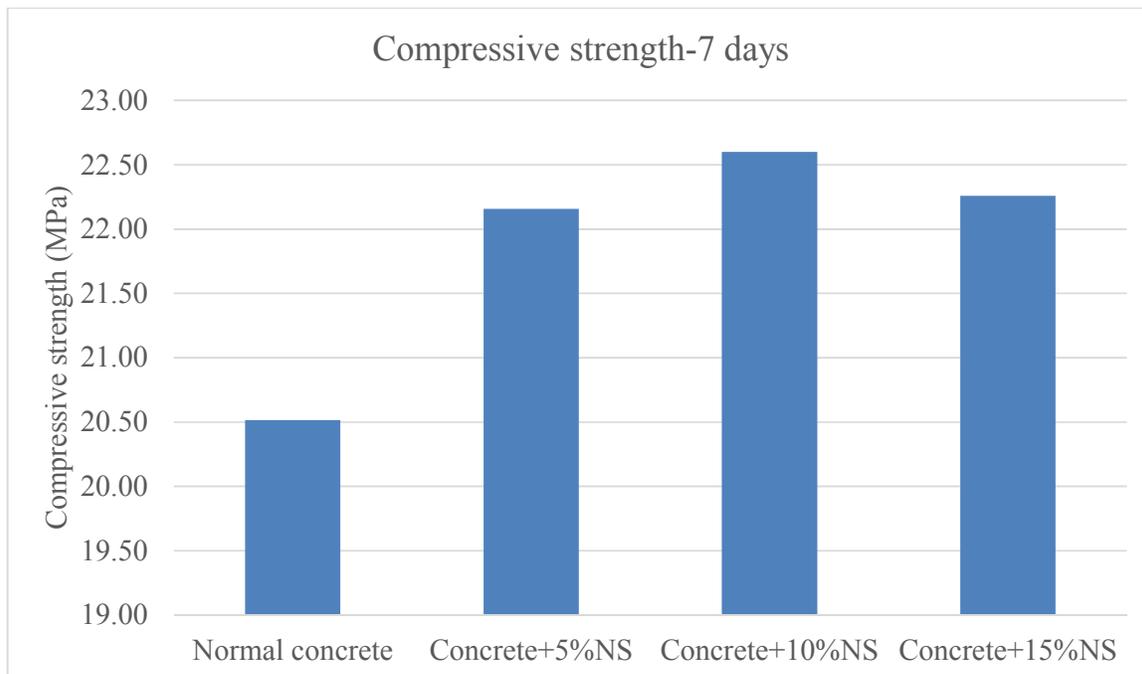


Figure 3: Compressive strength for the concrete with different percentage of NS for 7 days

Table 4: Flexural strength for the concrete with different percentage of NS for 28 days

Mix name	Set	Normal concrete	Concrete+5%NS	Concrete+10%NS	Concrete+15%NS
Compressive strength (mPa)	Set1	4.01	4.16	4.21	4.17
	Set2	4.13	4.29	4.33	4.30
	Set3	4.04	4.20	4.24	4.21
Avg		4.06	4.22	4.26	4.23

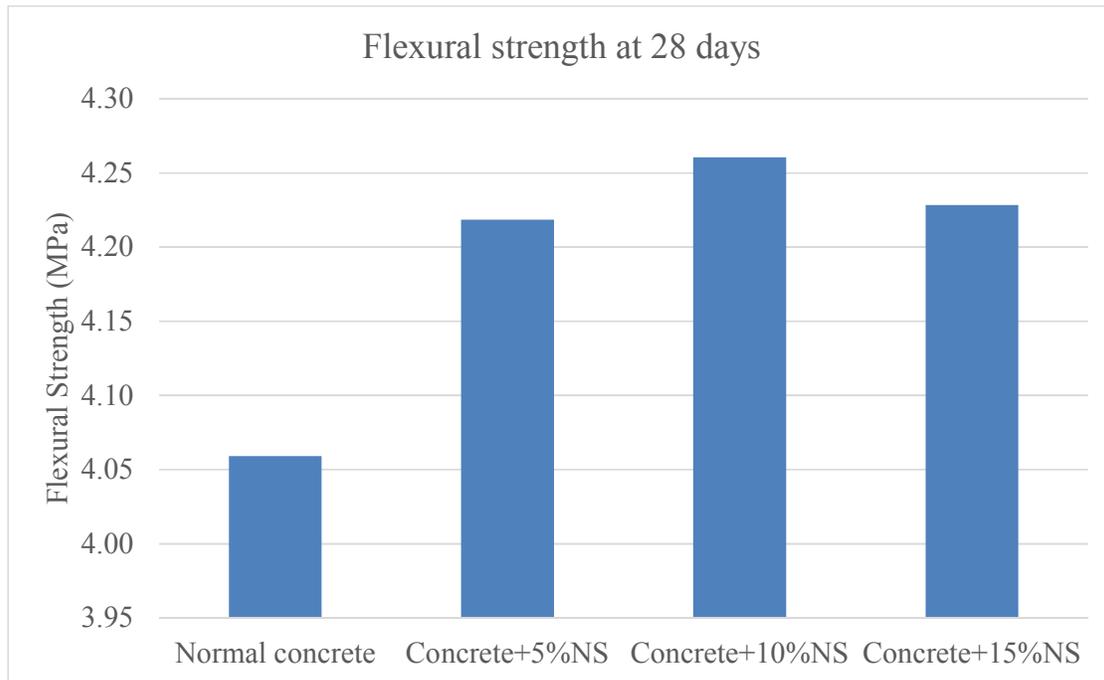


Figure 4: Flexural strength for the concrete with different percentage of NS for 28 days

V. CONCLUSION

From the above study following conclusions can be drawn

- The compressive strength of the concrete is observed to be 37.05 MPa for the concrete with 10% nano silica.
- The compressive strength goes on increasing up to the addition of 10% nano silica.
- The flexural strength is observed to be maximum as 4.26 MPa for the concrete with 10% nano silica.

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