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Self Healing Ability of Concrete with Superabsorbent Polymer and Nanosilica

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ABSTRACT:

Concrete due to the availability of raw materials, availability, durability and compressive strength is the most widely used building material. However, many specific structures, including infrastructure, inevitably experience degradation and deterioration over time. This is due to the permeability of water, which affects the efficiency of concrete. One of the reasons for this deterioration is the formation of cracks in micro- and macro levels, which create a passage for dissolved particles in liquids, unwanted acid gases and water ingress. The compressive strength and flexural strength were designed for concrete containing SAP and nanosilica in this work.

Keywords: Nano Silica, Concrete, Self Healing And Compressive Strength

Introduction:

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.

Concrete or reinforced concrete is one of the most widely used building materials to date. Unfortunately, in the practical civilian infrastructure, the appearance of cracks and water penetration are common phenomena that contribute to the deterioration of concrete or reinforced concrete structures (Fig. 1.1). The spread of penetrating cracks causes a significant reduction in durability, functionality, serviceability, as well as the aesthetic aspect of structures.

In structures subject to contact with water, especially waterproof / underground structures, water resistance and durability are of paramount importance. Conventional methods of crack recovery, such as filling cracks with repair materials or surface treatment, can be used to achieve waterproof properties. However, the implementation of these methods does not show so much efficiency in terms of durability. As a result, the cost of maintenance will be increased. One of the main problems is the connection of property between the concrete host and new repair materials. Another is a violation of a structural service or function (for examples, water tanks or underground structures must be in a dry state; the bridge plate must be without movement during reparation) and in some specific cases, it is difficult or impossible to access the cracking site, to repair the damage (for copies, very high bridges or containers, containing toxic or radioactive waste).

2.Literature Review:

Bastchik, A and others. Titration was studied as a proposed method for determining the amount of calcium hydroxide leached in water, and the closure of cracks was analyzed using optical microscopy. Samples CPII F (Portland Cement, type II, limestone compound) did not show a tendency to leach Ca $(OH)_2$ and to surface cracking. For CPV samples (portland cement, type V, high initial strength cement), their behavior showed the highest Ca $(OH)_2$ content for all environmental exposure and cracking of closed samples in the submerged state. Thus, the significant impact on the closure of cracks in the presence of Ca2 + leached in the media and the source of water associated with such behavior seems to be a major factor in improving SHP

Vijay, K. etc. It has been investigated that in this paper a fundamental study is whether it is possible to improve the performance of a self-healing agent, the main component of which is geomaterials, by mixing it into granules instead of powder, in order to prevent water leakage through cracks. It has been found that even simple granulation of ingredients for self-medication has improved the ability to delay the recession and the effect of preventing water leakage due to cracks, although further technical developments are desirable for a satisfactory encapsulation effect and cost-effectiveness.

Genk, W.J and others noted that self-healing concrete is a need for an hour in the current scenario. Deterioration is inevitable, although innovation is taking place in the field of concrete technologies. Mixtures are useful in an economic point of view to achieve self-medication in concrete structures to reduce cracks in the very previous stage. In this research paper, Fly Ash (FA) is used as an impurity to achieve self-medication in concrete.

Foust, A. et al. Different proportions are tested, and optimal ash replacement is experimental as 25%. Strength tests, such as compression, tensile splitting, bending, ultrasonic pulse speed tests, are performed to assess the mechanical properties of concrete samples. The samples are approved for 28 days, pre-loaded with 80% maximum compressive strength and again kept under constant water exposure for another 28 days to facilitate the self-medication process.

Mullin, J.W and others studied the effect of blast furnace slag and ash on the ability to heal cracks in concrete structures. The reason for self-medication is that slag and ash react slowly to hydration products and due to the excess time required for the hydration reaction, forming a dense matrix. Microscopic analysis showed that the crack width below 200 μm is completely closed due to the formation of $CaCO_3$.

3.Methodology:

MATERIAL USE

In this project, we used various materials for the concrete mixture, such as cement, natural sand, sand, as well as the waste used, which are described below.

Cement

The cement used was Pozzolona Portland cement 53 class and confirmed IS 1489-1-1991. The initial and final time of cement installation was 158 minutes and 345 minutes, respectively. Pozzolona Portland cement is obtained by grinding ash with Portland cement clinker, no material is added except gypsum or water or both.

Sand:

Sands are important components of concrete. They give the body concrete, reduce shrinkage and affect savings. Once the most important factors for obtaining working concrete are good gradation of sands.

course Sand:

The material, the particles of which have the size as stored on the IS sieve № 480 (4.75 mm), is called the sand of the course. The grinding grinding layer used was reduced by 10 mm and reduced by 20 mm.

Water:

Water is also one of the important ingredients of concrete. Because strength, performance depends on water, the amount of water that needs to be taken very carefully. Drinking water is used for experimentation.

Concrete mix design

Mix design for M40

1) Grade designation = M40
2) Type of cement = Pozzolana Portland Cement 53 Grade
3) Max nominal size of Sand = 20 mm
4) Minimum cement Content = 240 kg/m3
5) Maximum Water-Cement Ratio = 0.35
6) Standard deviation = 5 N/mm2
7) Natural Sand confirming to Zone 3
8) Exposure Condition = Moderate
9) Workability = Low (25 mm -75 mm)
10) Target mean Strength = 48 N/mm2

After various calculations and corrections of oversize, specific gravity the final quantity of materials are calculated for per cubic meter of concrete as

1) Cement = 403 kg
2) Water content = 173.29 kg
3) Fine Sand = 811 kg

4) Coarse Sand = 20 mm = 697 kg

= 10 mm = 373.08 kg

By using this quantity of material a mix design of concrete is prepared. This mix design helps in achieving a desire workability, strength and durability for concrete work.

4.Results

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

Table 1: Regained compressive strength under air exposure condition of early age cracks due to self -healing - 28 DAYS

Mix name	**Set**	**Normal concrete**	**Concrete+5%NS**	**Concrete+10%NS**	**Concrete+15%NS**
Compressive strength (mPa)	Set1	41.50	44.82	45.72	45.03
	Set2	42.10	45.47	46.38	45.68
	Set3	42.60	46.01	46.93	46.22
Avg		42.07	45.43	46.34	45.65

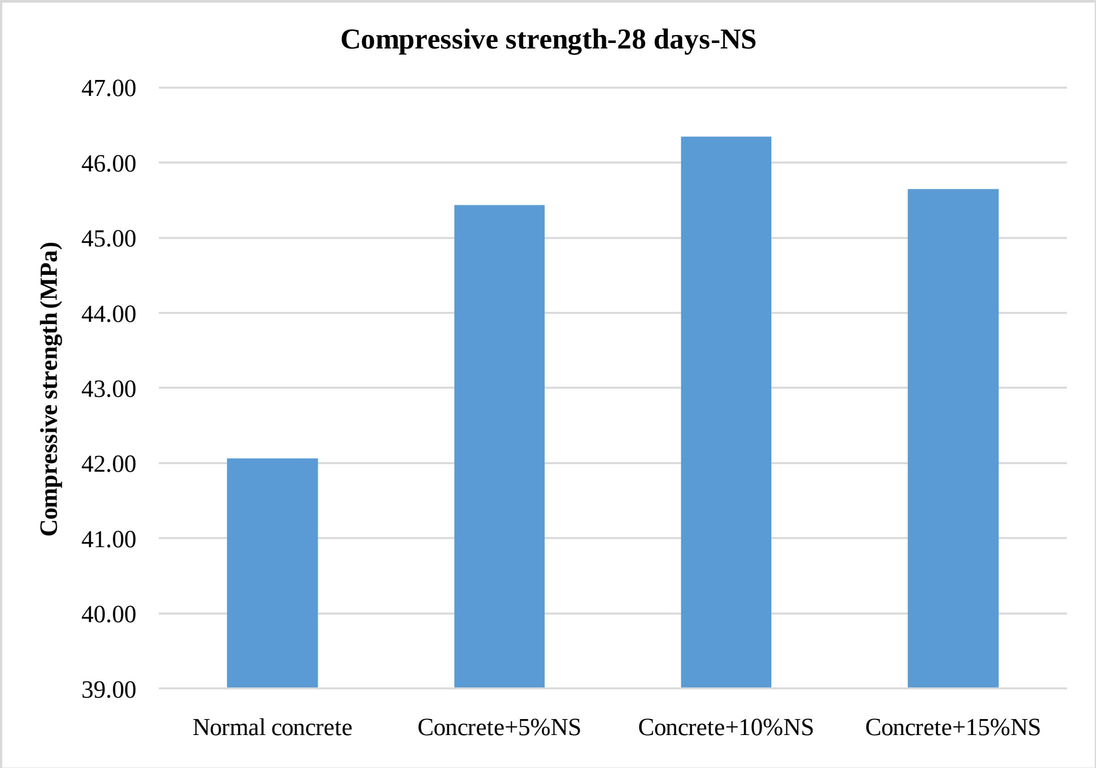

Figure 1:Compressive strength-28 days-NS

Table 2: Regained compressive strength under air exposure condition of early age cracks due to self -healing - 14 DAYS

Mix name	Set	Normal concrete	Concrete+5%NS	Concrete+10%NS	Concrete+15%NS
Compressive strength (mPa)	Set1	32.37	34.96	35.66	35.12
	Set2	32.84	35.47	36.17	35.63
	Set3	33.23	35.89	36.60	36.05
Avg		32.81	35.44	36.15	35.60

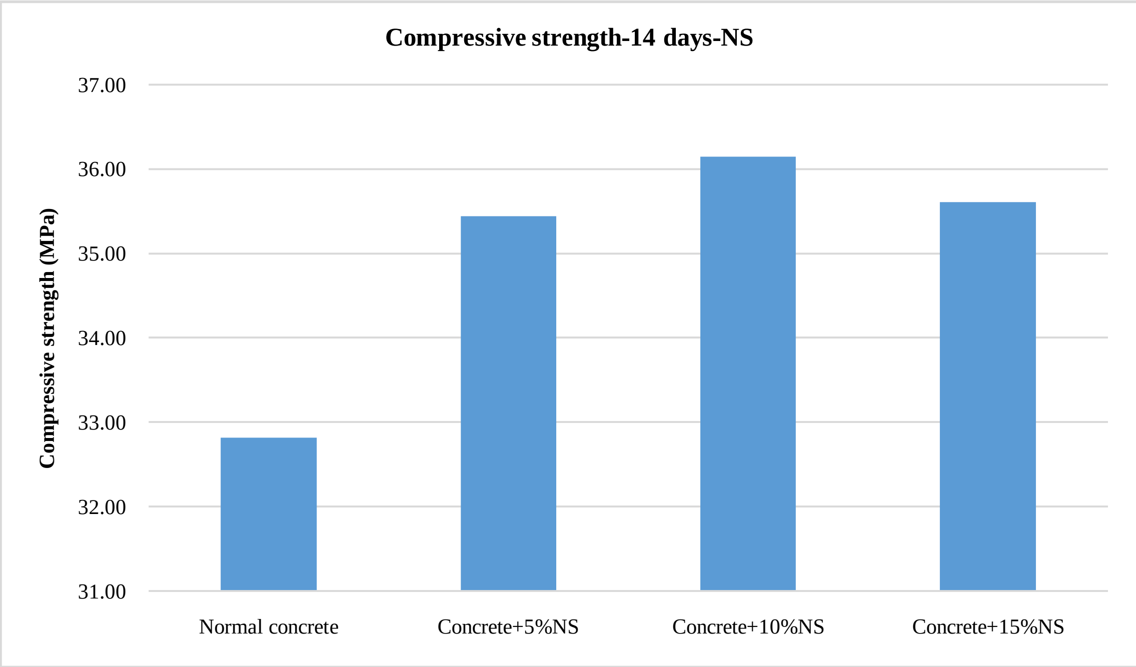

Figure 2:Compressive strength-14 days-NS

Table 3: Regained compressive strength under air exposure condition of early age cracks due to self -healing - 28 DAYS

Mix name	Set	Normal concrete	Concrete+5%SAP	Concrete+10%SAP	Concrete+15%SAP
Compressive strength (mPa)	Set1	42.54	45.94	46.86	46.16
	Set2	43.15	46.60	47.54	46.82
	Set3	43.67	47.16	48.10	47.38
Avg		43.12	46.57	47.50	46.79

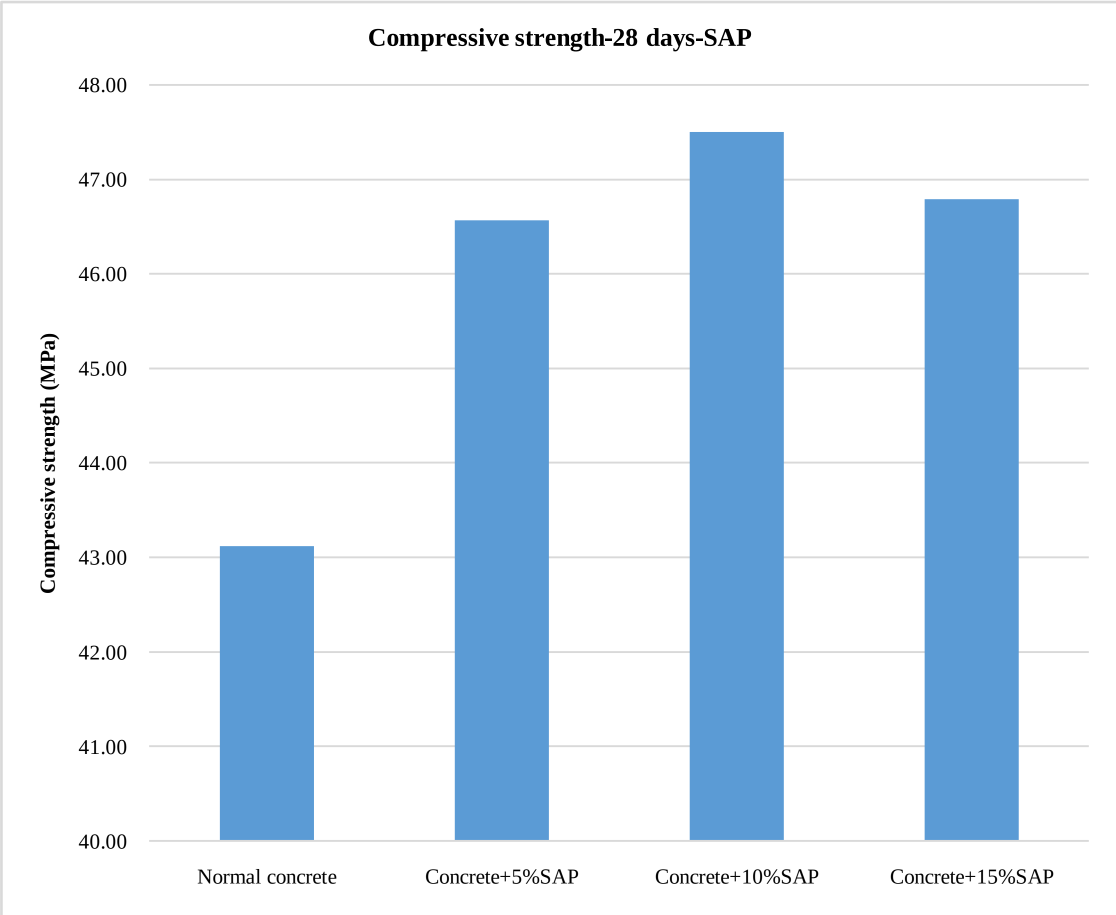

Figure 3:Compressive strength-28 days-SAP

Table 4: Flexural strength under air exposure condition of early age cracks due to self -healing - 28 DAYS-SAP

Mix name	**Set**	**Normal concrete**	**Concrete+5%SAP**	**Concrete+10%SAP**	**Concrete+15%SAP**
Compressive strength (mPa)	Set1	4.57	4.74	4.79	4.76
	Set2	4.60	4.78	4.83	4.79
	Set3	4.63	4.81	4.85	4.82
Avg		4.60	4.78	4.82	4.79

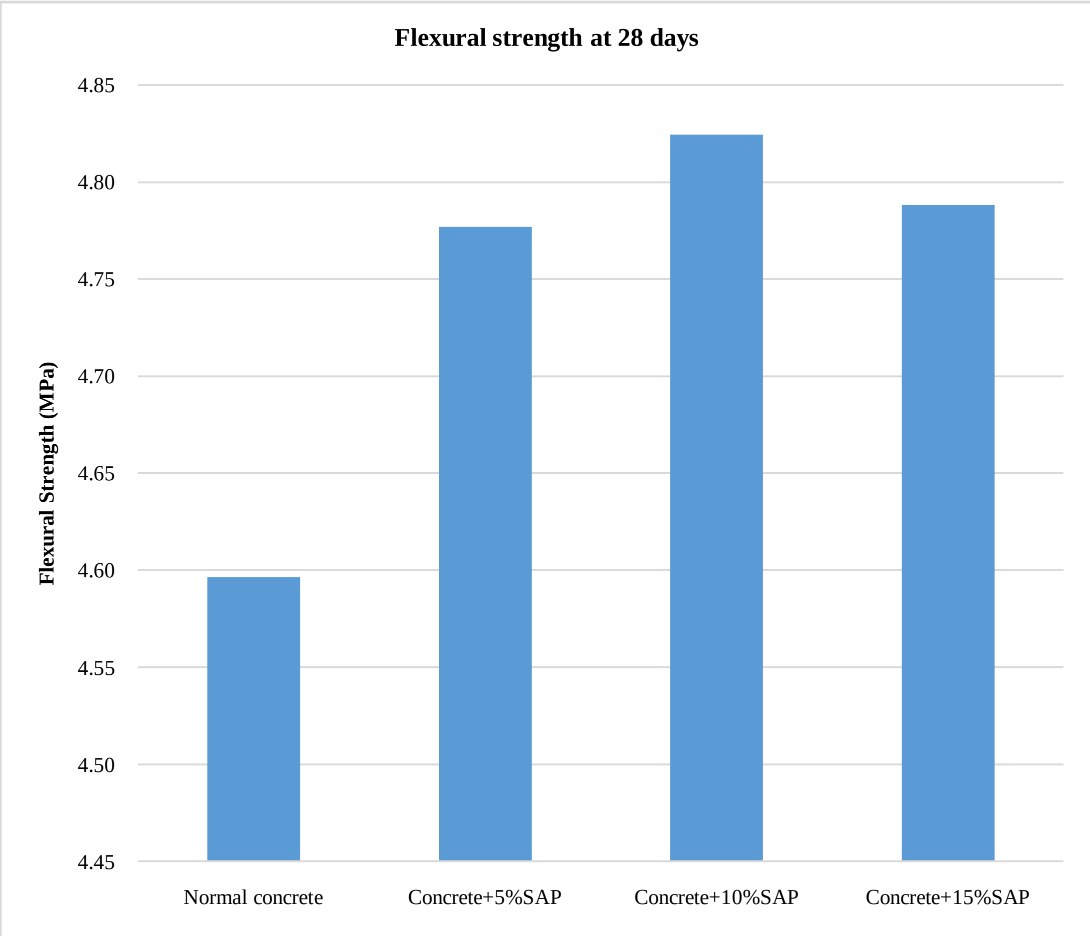

Figure 4:Flexural strength at 28 days-SAP

Table 5: The crack observation through Brinell's Microscope test for SAP

Sr. No.	% SAP	Crack width (cycle1)					
		cycle 1			cycle 2		
		7D	14D	21D	7D	14D	21D
1	0	0.95	0.86	0.76	0.67	0.57	0.48
2	5	0.48	0.38	0.29	0.38	0.29	0.19
3	10	0.38	0.29	0.19	0.19	0.19	0.10
4	15	0.29	0.19	0.10	0.10	0.10	0.05

Conclusions

The compressive strength and the flexural strength was calculated for the concrete. 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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