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An Experimental Study on the Use of Magnetic Water in Concrete partially replacing silica fumes as cement and M Sand as Fine Aggregate

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Abstract— In this work, the utilization of magnetized water in concrete was examined. Concrete paste preparation, which is a hydration process, requires water. In a variety of industries, including Ayurveda, healthcare, dairy production, agriculture, and oil, magnetized water is used. Many nations have adopted this technology, which has Russian and Chinese origins, for use in construction. The process, referred to as magnetized water (MW), improves the workability, durability, and strength of concrete. This study used manufactured sand as the fine aggregate at 50%, 60%, and 70% and magnetized water as cement to partially replace silica fume at 5%, 10%, and 15%. By exposing regular tap water to a magnetic field, which modifies some of its natural components, magnetized water was created. Normal tap water was transformed into magnetized water by being exposed to a magnetic field, which modifies some of the water's physical characteristics. This water was added to concrete to boost its flexural, compressive, and overall strength. In four instances, magnetic and regular water were used to prepare and cure concrete samples. For M25 grade, concrete cubes were cast, and they underwent 7, 14, 21, and 28 days of testing.

key words: Magnetic water, Silica fumes, Manufacture sand (M SAND), Compressive strength, Tensile strength.

I. INTRODUCTION

Modern civil engineering is creating new technology and creative solutions to help the world's rapid development. Concrete is one of the key components because it increases strength, durability, and lifespan without being harmed by natural disasters like hurricanes, tsunamis, and cyclones, which provide significant difficulties for civil engineers. For the M_{25} grade of partial concrete, magnetized water techniques (MWT) are utilized in place of cement and aggregate. Since water actively participates in chemical reactions and the hydration process, which controls concrete's hydration, workability, moisture content, strength, and durability, water is a crucial component of concrete. By passing through a magnetic field of a specific strength that is obtained under particular circumstances, reducing the surface tension, which is measured using a tensiometer, magnetized water is created. Due to its chemical and physical characteristics, silicon metal or Ferro silicon alloys produce silica fume, which combines with pozzolana to give concrete its great strength and durability. In this industry, manufactured sand is an alternative to river sand. It is made from hard granite stone crushing plants and shares 95% of the same qualities as river sand.

II. METHODOLOGY

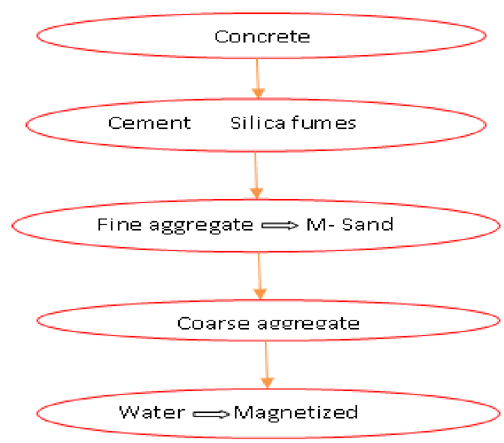

Figure 1 Mix proportion of concrete for M_{25} grade

III. EXPERIMENTAL WORK

In the experiment with the concrete mixture, cement, silica fume, large and small aggregates, M-sand, and magnetized water were employed as the components. Used as regular Portland cement, which came in 43 grades and complied with IS:8112-1989. The specific gravity and standard consistency of the cement were discovered to be 3.2 and 30%, respectively, after laboratory tests were conducted to examine the physical characteristics of the cement. Cement was found to have initial and final setting times of 40 and 500 minutes, respectively. A by-product of making silicon or Ferro silicon alloys is silica fume, and France produces very fine silica fume as a consequence of making zirconium. The majority of silica fume now in use is grey and has a bulk unit weight between 240 and 300 kg/m3. Silica fume creates calcium silicate, which has high binding capabilities, when it combines with calcium hydroxide during the hydration of cement.

Figure 2 Silica fumes

Table 1: Uses of silica fumes in mass concrete

Silica fumes %	Uses of concrete in structures
10% to 15%	The High strength of structural columns
10%	Flat work
8% to 10%	High durability / Low permeability, such as bridge decks or parking structures
8% to 15%	By weight of cement, but as an addition not a replacement

Table 2: Physical Properties

Diameter	0.1 to 0.2
Surface area	30,000 m²/kg
Density	150 to 700 kg/m³
Specific gravity	2.2

Table 3: Chemical Properties

Shape	Amorphous
SiO2	>85%
Al2O3	1.12%
FeO	1.46%
CaO	0.2 -0.8 %
Na2O	0.5 -1.2 %

Fine aggregates: Locally available clean river sand passing through an IS 4.75 mm sieve in Zone II.

Manufacturing Sand: The quarry dust should be examined for physical properties using the standard for fine aggregate soundness. Quarry dust can be used in place of sand due to its properties being similar to those of sand.

Table 4 & 5: Properties of M-sand

Sample Code	Moisture Content %	
	Wet	Wet
Quarry rock dust (QD)	23.30	1.58
River sand (RS)	25	2.50

Bulk Density (kg/m3)	1118(QD)	1430(RS)
Fineness Modulus	2.05(QD)	2.20(RS)
Effective Size(mm)	0.18(QD)	0.20(RS)
Coefficient of Uniformity	1.57(QD)	6.00(RS)
Coefficient of Gradation	1.36(QD)	2.00(RS)

Coarse aggregate: According to IS 383: 1970, the coarse aggregate utilized in this investigation was crushed (angular), with aggregate sizes of 20 mm and 10 mm, respectively. According to IS 383:1970, tests such as sieve analysis, specific gravity, and water absorption were carried out on both coarse and fine aggregates.

Magnetized water: Figure 4 depicts the arrangement used to circulate the magnetized water used in concrete. This investigation made use of a 1 Tesla PER MAG N406 magnet. The water was pumped through the magnet, and the pump also increased the water velocity through the magnet. Tap water surface tension was measured at 0.07275 N/m and decreased by 7.77% following magnetization.

Mix proportion and testing plans: The M_{25} grade concrete mix design was created in accordance with IS 10262-2009 and IS 456-2008. Trial After conducting the mixes, the best one was chosen to cast the concrete samples. Table 6 lists the components of the various mixtures utilized in the study.

Table 6 & 7: Mix proportion of M_{25} concrete

Ingredients	Mix 1 Kg/m^3 0% SF & 0% MS	Mix 2 Kg/m^3 5% SF & 50% MS
Cement (C)	361	342.95
Silica fumes (SF)	0	18.05
Fine Aggregate (River Sand)	821	410.5
Fine Aggregate (M-Sand)	0	410.5
Coarse Aggregate 20 mm	1089	1089

Water Content	190	190

Mixture 1 consists of 100% cement, while Mixtures 2, 3, and 4 were replaced with 5%, 10%, and 15% of cement, respectively, as silica fume. Mixture 1 then consists of 100% river sand (fine aggregate), while Mixtures 2, 3, and 4 were replaced with 50%, 60%, and 70% of fine aggregate as M sand, respectively. Cubes of size 150 mm x 150 mm x 150 mm and cylinders of diameter 150 mm and height 300 mm were cast using a pan mixer. For the compaction of each concrete specimen, 25 to 35 manual strokes were used with a 20 mm steel rod.

Ingredients	Mix 3 Kg/m^3 10% SF & 60% MS	Mix 4 Kg/m^3 15% SF & 70% MS
Cement (C)	324.9	306.85
Silica fumes (SF)	36.1	54.15
Fine Aggregate (River Sand)	328.4	246.3
Fine Aggregate (M-Sand)	492.6	574.7
Coarse Aggregate 20 mm	1089	1089
Water Content	190	190

IV. RESULTS AND DISCUSSIONS

Workability of concrete: By examining the concrete mix, the workability of the concrete was assessed. For the control mix with magnetized water, a slump value was attained. The concrete's high specific gravity, low water absorption, and inclusion of silica fume and M sand raised the slump value while using magnetized water in addition to silica fume and M sand.

Compressive strength: At 7, 14, and 28 days, the impact of magnetized water on concrete's compressive strength was evaluated. On both 7 and 28 days, a graph was created to relate the compressive strength to the amount of silica fume utilized in the concrete.

Split tensile and Flexural strength: Concrete sample strength was evaluated after 7 and 28 days.

Table 8 & 9: Test results of mix proportions

Concrete Mix	Average compressive strength (MPa) (Days)		
	7	21	28
Mix 1 (100% C + 0% SF+ %MS) NW MWC	8 8.5	17.5 18.5	25 26.5
Mix 2 (95% C + 5% SF+ 0%MS) NW MWC	10.1 10.5	19 20.5	27.2 27.8
Mix 3 (90% C + 10% SF+60%MS) NW MWC	10.7 10.8	21 22.4	28.8 29.1
Mix 4 (85% C + 15% SF+70%MS) NW MWC4	10.7 10.9	21.2 22	29.0 30.8

Concrete Mix	Average split strength (MPa) (Days)		Average flexural strength (MPa) (Days)	
Mix 1	2.72 2.87	4.38 4.42	3.70 3.97	4.47 4.53
Mix 2	2.89 2.95	4.52 4.75	4.00 4.20	4.60 4.74
Mix 3	3.10 3.18	4.86 4.94	4.10 4.30	4.72 4.80
Mix 4	3.24 3.5	4.92 5.10	4.20 4.38	4.78 4.88

V. CONCLUSION

According to the findings of an experimental investigation and a parameter analysis, adding 5–15% and 50–70% of M sand to concrete that contains silica fume increases its workability (slump) and strength. The fundamental test reports of compressive strength, split tensile strength, and flexural strength for 7 and 28 days compare ordinary water and magnetic water. Comparing concrete with other concrete mixes, the strength of concrete is increased by 5-7% in compressive strength. When compared to other forms of concrete, the split tensile strength and flexural strength are raised by 1-2%. Magnetized water may be the finest alternative for concrete manufacturing when it comes to this sort of concrete utilized in tall constructions.

REFERENCE

[1]. Afshin H, Mostafa Gholizadeh and Khorshidi N, “Improving mechanical properties of high strength concrete by magnetic water technology”, science iranica (ISI),17(1), 2010,74-79

[2]. Detwiler , R.J. and Mehta, P.K., “Chemical and physical effects of silica fume on the mechanical behaviour of concrete” , Materials journal (Nov.1989).

[3]. Shanmugapriya T and Uma R N (2012), "Optimization of partial replacement of M- sand by natural sand in High- performance concrete with silica fume", International journal of Engineering sciences emerging technologies, vol.2,pp.73-80.
[4]. Prabhulal Chouhan, Sagar Jamle, M.P. Verma, "Experimental Investigation on Silica Fume As Partial Replacement of Cement For M-25 Grade Concrete", IJSART - Vol 3 Issue 5 –2017 DOI:10.6084/m9.figshare.11653446
[5]. Lakhbir Singh, Arjun Kumar, Anil Singh, "Study of Partial Replacement of Cement By Silica Fume", International Journal of Advanced Research (2016), Vol 4, Issue 7, 104-120.
[6]. Lokeshwari A. Khotele, Surendra B. Burande, Yamini C. Bhandari, Praful W. Borkar, Suraj G. Khalatar, Prof. Komal Bhandakkar, "Experimental Study on Silica Fume Concrete", International Research Journal of Modernization in Engineering Technology and Science, DOI : https://www.doi.org/10.56726/IRJMETS37618
[7]. Dr. K. Suresh, Mr. Ch. Rajendra Prasad, G. Naveen Kumar, "Study on Flexural Behaviour of Concrete by Partial Replacement of Cement with Silica Fume Natural Sand and Manufactured Sand Adittion of Fibres", Turkish Online Journal of Qualitative Inquiry (TOJQI), Vol12, Issue 10, October 2021
[8]. Kute Rohan, Shingade Sudarshan, Nagtilak Akshay, S. N. Daule, "Improving Properties of Concrete by Replacing Cement Partially with Silica Fume", International Journal of New Technology and Research (IJNTR), Vol 7, Issue-7, July 2021.