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Comparison of compresive strength of Normal and Electromagnetic Concrete Incorporating Micro Silica and Metakaolin

#1V. P. Pawar, #2Dr.P.D.Kumbhar, #3Mr. Yusuf Inamdar

#1Research Scholar
Department of civil Engineering,
Rajarambapu Institute of Technology, Islampur, India.
pawarvishal1310@gmail.com

#2Professer, Department of civil Engineering,
Rajarambapu Institute of Technology, Islampur, India.
popat.kumbhar@ritindia.edu

#3Technical Head,
J. Kumar Infraprojects Ltd., Pune
yusuf.inamdar@jkumar.com

ABSTRACT

Electromagnetic concrete is developed using electromagnetically treated water instead of normal water, which is kwon to increase the strength of the concrete. The water when passed through the electromagnetic device shows improvement in the properties of water. This paper investigates the increase in compressive strength of concrete using electromagnetic water when compared with normal concrete for mix designs with varying water/cement ratio (0.35, 0.40 and 0.45). There for the strength of normal and electromagnetic concrete incorporating desirable content of mineral admixtures namely Micro silica and Metakaolin for M40 grade has been investigated in this paper.

Keywords— Electro-magnetic concrete, W/C ratio, compressive strength, Micro silica, Metakaolin.

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I. INTRODUCTION

1.1 General:

The durability of concrete has attracted important attention over the past several decades and still research hotspot until now. Sulphate and Chloride attack is one of the main factors causing deterioration of concrete structure. Such deterioration is attributed to reaction of sulphate and chloride ions with some hydration products in concrete structure. The effect of sulphates and chlorides on the compressive strength of concrete has been studied previously. The sulphates present in sand and chlorides present in water were considered. The compressive strength is lower for concrete with higher sulphate contents and chlorides in the mixing water decreased the compressive strength of concrete. It is known that concrete deteriorates due to the sulphate salts present in soils, groundwater and marine environments [H. AI-Khaiat, et al; 2002].

The use of cement with supplementary materials such as fly ash, blast furnace slag and silica fume and metakaolin is commonly adopted these days [V. Limbachiya, et al; 2016]. The performance of such blended cements in environments of chlorides and sulphates however, is not well stated. The presence of chloride ions in the sulphate environments diminishes the sulphate attack in plain and blended cements. The performance of plain cements is better than that of all blended cements. However, the performance of blended cements is dependent on the type of mineral admixture used, both in the sulphate and the sulphate-chloride environments.

1.2 Electro-magnetic water:

Electro-magnetic concrete is developed using electromagnetically treated water instead of normal potable water. Electromagnetic water is the water which results when passed through an electromagnetic field [Nan Su, et al; 2000]. When the water passes through a certain electromagnetic field it becomes electromagnetic water. Compressive strength tests conducted on the electromagnetic concrete samples were very encouraging and can be used for replacing potable water [S. Chavan, et al; 2016].

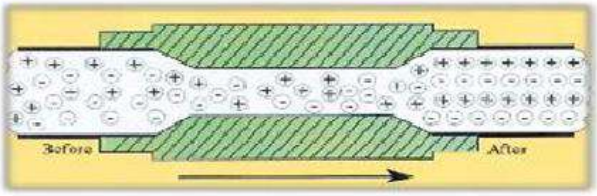

Fig no–1: Electro-magnetisation of water

II. METHODOLOGY

Mix design for M40 grade concrete with normal water is evaluated and for electromagnetic concrete same mix design was used only electromagnetically treated water used instead of normal water. Also mix design for M40 concrete substituted with 5 to 12.5% Micro silica and 5 to 10% Metakaolin with normal as well as electromagnetic water was prepared. For the comparison of compressive strength of concrete with respect to W/C ratio, Three W/C ratios were used in this study: 0.35, 0.40 and 0.45. Details of the concrete mix designs are shown in tables below. All those W/C ratios were used with normal and electromagnetic concrete only. Sample Cubes of 150mm x150mm x 150mm dimensions were cast and checked for strength after 7 and 28 days. The results of these tests of normal concrete and electromagnetic concrete samples are compared and analysed.

III. EXPERIMENTAL DETAILS

3.1 Materials Required

3.1.1 Cement:

Cement adopted in this experimental work is Ordinary Portland cement (Birla Super Shakti OPC grade 53). All properties of cement are tested using I.S. specifications for OPC

Table no–1: Physical properties of cement

Tests Conducted On Cement Brand: Birla Super Shakti, OPC 53 Grade	**Result**
Initial Setting Time	38 mins
Final Setting Time	225 mins
Soundness	7 mm
Specific Gravity Of Cement	3.05
Consistency	28%

3.1.2 Fine Aggregates:

The fine aggregates adopted were crushed sand confirming to zone 1 and maximum size was 4.75mm and specific gravity 2.81. The testing of sand was done as per Indian Standard Specifications IS: 383-1970.

3.1.3 Coarse Aggregates:

Two types of aggregates were adopted for the experimental investigation viz. 10mm and 20mm. Sieve analysis was performed according to IS 383:1970-specification and IS 2386:1977-Methods of tests for aggregates of concrete.

Table no–.2: Test Conducted on Aggregate

Sr. No.	**Test conducted on aggregate**	**Results**
1	Impact test	16 %
2	Crushing value	12 %
3	Specific gravity of: A) coarse Aggregate B) fine aggregate	 2.81 2.81
4	Abrasion test	17.6

3.1.4 Water:

Normal potable water and electromagnetic water which was extracted through the electromagnetic device was adopted. Water cement ratio of 0.4 was adopted for this study.

3.1.5 Micro Silica:

Micro silica used was obtained from Corniche, Navi Mumbai. Micro silica is a byproduct formed during the processing of silicon metals and ferrosilicon alloys in an electric arc furnace. Due to its high silica content it has gained a position of pozzolanic material. Due to its pozzolanic nature micro silica has been used as a replacement of cement in smaller quantity which in turn enhances properties of hardened cement concrete such as compressive strength, bond strength and abrasion resistance. Micro silica has an average particle diameter of 150 nm thus when replaced with cement it reduces the porosity of hardened concrete which in turn influences the durability characteristics of concrete. Micro silica is a costly material due to its limited availability.

3.1.6 Metakaolin:

Metakaolin used was obtained from Ashapura, Gujarat which is a high reactivity metakaolin. Metakaolin is a dehydroxylated type of the dirt mineral kaolinite. The size of metakaolin is greater than that of cement but less than that of micro silica. High Reactivity Metakaolin (HRM) is in charge of speeding up in the hydration of ordinary portland cement (OPC), and its significant effect is seen within 24 hours. Metakaolin has high reactivity compared to other pozzolanic materials therefore it is profitable material for cement/concrete applications. Metakoalin enhances engineering properties of concrete such as the filler impact, the speeding up of OPC hydration, and the pozzolanic reaction. The filler impact is quick, while the impact of pozzolanic reaction happens in the vicinity of 3 and 14 days. Moreover it improves the compressive strength, durability parameters of concrete and it is cheaper than micro silica.

3.2 Mix Design:

3.2.1 Mix Design for M40:

The Indian Standard Mix Design procedure was adopted (i.e. IS: 10262-2009) for normal M40 grade concrete incorporating desirable content of mineral admixtures namely Micro silica and Metakaolin with cement. Mix design for Electromagnetic concrete of M40 grade was kept same as that of normal concrete. The detailed mix design of M40 grade of concrete is given in Table.

Table no–3: Mix Proportion for 1m^3 of M40 concrete

Material	**Quantities in Kg**
Cement	450
Water	180
20 mm coarse aggregate	624.82
10 mm coarse aggregate	416.2
Fine aggregates	852
Admixture	3.6
W/C ratio	0.4

3.2.2 Mix Design for W/C ratio 0.45:

Mix design for W/C ratio 0.45 referring IS guide line is shown below

Table no–4: Mix Proportion for 1m^3

Material	**Quantities in Kg**
Cement	408.89
Water	184
20 mm coarse aggregate	632.358
10 mm coarse aggregate	421.572
Fine aggregates	862.31
Admixture	3.27
W/C ratio	0.45

3.2.3 Mix Design for W/C ratio 0.35:

Mix design for W/C ratio 0.45 referring IS guide line is shown below

Table no–5: Mix Proportion for 1m^3 of M40 concrete

Material	**Quantities in Kg**
Cement	490
Water	171.5
20 mm coarse aggregate	619.25
10 mm coarse aggregate	412.83
Fine aggregates	844.43
Admixture	3.92
W/C ratio	0.35

IV. RESULTS AND DISCUSSION

1. The compressive strength of cubes with electromagnetic concrete was found to be more than that of normal concrete with Micro silica as additive.

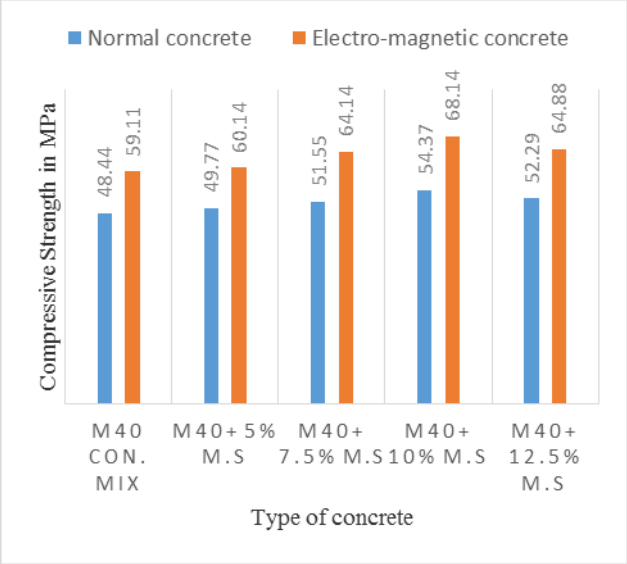

Fig no–2: Comparison of compressive strength of normal and Electromagnetic concrete substituted with micro silica

2. The compressive strength of cubes with electromagnetic concrete was found to be more than that of normal concrete with Metakaolin as additive.

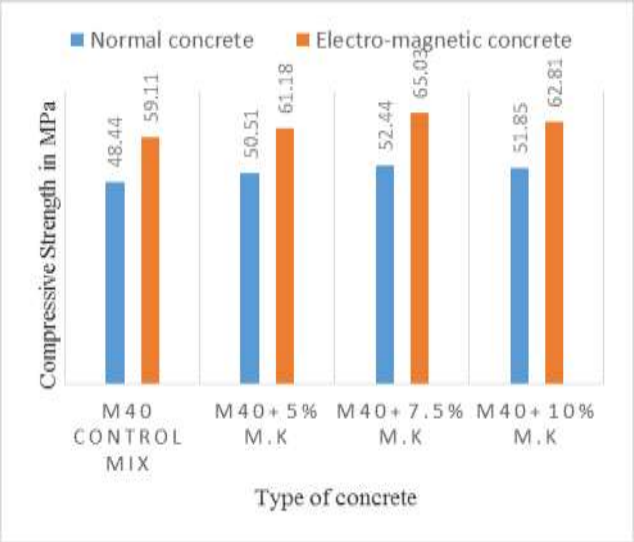

Fig no–3: Comparison of compressive strength of normal and Electromagnetic concrete substituted with metakaolin

3. The compressive strength of normal and electromagnetic concrete cubes with different W/C ratio

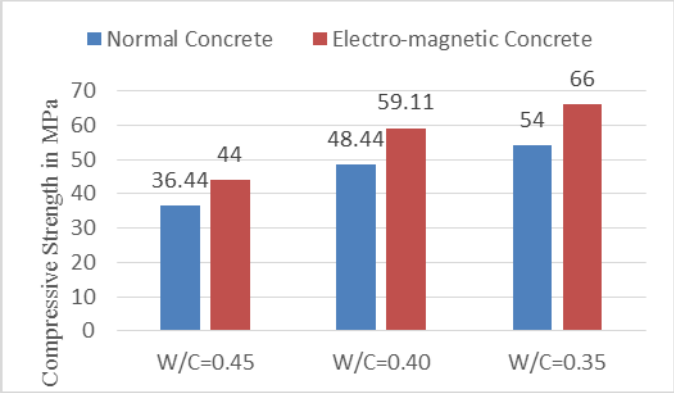

Fig no–4: Comparison of compressive strength of normal and Electromagnetic concrete with different W/C ratio

V. CONCLUSION

Following Conclusions were drawn from the study carried out in this dissertation.

1. 20% - 23% increase of compressive strength was observed in electro-magnetic concrete as compare to normal concrete.
2. It is observed that workability of concrete increases when electro-magnetic water is used.
3. Micro silica: The optimum results are observed when 10% weight of cement is replace by micro silica.
4. In case of electro-magnetic concrete, when micro silica replaced with cement showed 15.27% increase in compressive strength compared to control mix, while in case of normal concrete replacement with micro silica showed 12.24% increase in compressive strength compared to control mix.
5. Metakaolin: The optimum results are observed when 7.5% weight of cement is replace by metakaolin.
6. In case of electro-magnetic concrete, when metakaolin replaced with cement showed 10.01% increase in compressive strength compared to control mix, while in case of normal concrete replacement with metakaolin showed 8.25% increase in compressive strength compared to control mix.
7. The maximum increase in strength is observed for W/C ratio 0.35 which is 22.23%.

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REFERENCES

[1] B. B. Patil and P. D. Kumbhar, 2012, “Strength and Durability Properties of High Performance Concrete incorporating High Reactivity Metakaolin”. IJMER, Vol.2, Issue.3, May-June 2012 pp-1099-1104.

[2] C¸elik, T., Marar, K., 1996. “Effects of crushed stone dust on some properties of concrete”, Cement Concrete Res. 26 (7), 1121—1130.

[3] E. Badogiannis, S. Tsivilis, 2009, “Exploitation of poor Greek kaolins: Durability of metakaolin concrete” Cement & Concrete Composites 31 (2009) 128–133.

[4] H. AI-Khaiat and M. N. Haque, 2002, “Chloride and sulphate concentration in concrete exposed to marine conditions” on 27th Conference on OUR WORLD IN CONCRETE & STRUCTURES: 29 – 30 August 2002, Singapore.

[5] J. Ambroise, S. Maximilien et al, 1994 “Properties of Metakaolin- Blended Cements”, Journal of Advanced Cement-Based Materials, V. 1, No. 4, 1994, pp. 161-168.

[6] J. M. Khatib and S. Wild, 1998, “Sulphate Resistance of Metakaolin Mortar,” Cement and Concrete Research, V. 28, No. 1, 1998, pp. 83-92.

[7] Nan Su; Yeong-Hwa: and Wu: and Chung-Yo 2000, “Effect of magnetic water on engineering properties of concrete containing granulated blast furnace slag”. Cement and Concrete Research, Department of Construction. National Yunlin University of Science and technology Section 3,123 University Road, Touliu 640, Taiwan.

[8] S. Mundra, P.R. Sindhi, et al, 2016“Crushed rock sand - An economical and ecological alternative to natural sand to optimize concrete mix” Perspectives in Science (2016) PISC-240.

[9] S. Chavan, A. Thosare et al (2016), “Enhancing the Properties of Concrete Using Electromagnetic Water”, International Journal of Research in Engineering and Technology, Volume: 05 Issue: 04, Apr-2016.

