Experimental Investigation of Concrete Strength Incorporating MICROFINE

Manasvi Mangukiya[1] Mansi Kania[2] Jatin Kaklotar[3] Mohit Kansariwala[4] Siddhim Kothari[5]
[1,2,3,4,5]Student
[1,2,3,4,5]Department of Civil Engineering
[1,2,3,4,5]Bhagwan Mahavir College of Engineering & Technology, Surat, Gujarat, India

Abstract— Concrete a widely used construction material, consumes natural resources like lime, aggregates, water. In this present experimental investigation and attempt is made to the strength and behavior of the Metakaolin, super plasticizer and other chemicals on high performance concrete. Cement is replaced by 0% to 15% of Metakaolin by volumeof concrete, thus resulting in the increase in strength. Super-plasticizer is used to increase the workability of concrete, increase the density and strength. It can permit the reduction in the water cement ratio up to 15%. Dosage of super plasticizer is 1.5% by weight of cement.

Keywords: Metakaolin, Pozzolona, Concrete, Mechanical properties

I. INTRODUCTION

Concrete is a basic material or the construction industry due to infrastructure development in the developing countries, consumption of concrete is very high. The consumption of cement is also very high to meet the requirements. So there is a need to look after the supplementary /alternative materials for the cement, fine aggregate and coarse aggregate. Concrete is very strong in compression and weak in tension. Concrete technologists are trying to improve the compressive strength of concrete by using supplementary materials i.e. mineral admixtures. Still researchers are trying different materials like fly ash, metakaolin, silica fume, blast furnace slag, recycled aggregates, plastic aggregates, etc., which can be used in place of cement and aggregates.

Metakaolin is a pozzolan, probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC. Its quality is controlled during manufacture, resulting in a much less variable material than industrial pozzolans that are by-products. First used in the 1960s for the construction of a number of large dams in Brazil, metakaolin was successfully incorporated into the concrete with the original intention of suppressing any damage due to alkali-silica reaction when used to replace cement at levels of 5 to 10% by weight, the concrete produced is generally more cohesive and less likely to bleed. As a result pumping and finishing processes require less effort. The compressive strength of hardened concrete is also increased at this level of replacement slightly higher replacement levels (up to 15%) produce a cement matrix that has low porosity and permeability. This results in improvements to resistance of the hardened concrete to attack by sulfates, chloride ions and other aggressive substances, such as mineral and organic acids. Freeze/ thaw resistance is improved and the risk of damage resulting from the effects of impact orabrasion is reduced for metakaolin concrete that has been finished and cured properly. Strength and durability of concrete increases. Accelerates initial setting time of concrete. Compressive strength of concrete increases@20%Cross section of structure can be reduced safely i.e. amount of concrete used can be reduced.

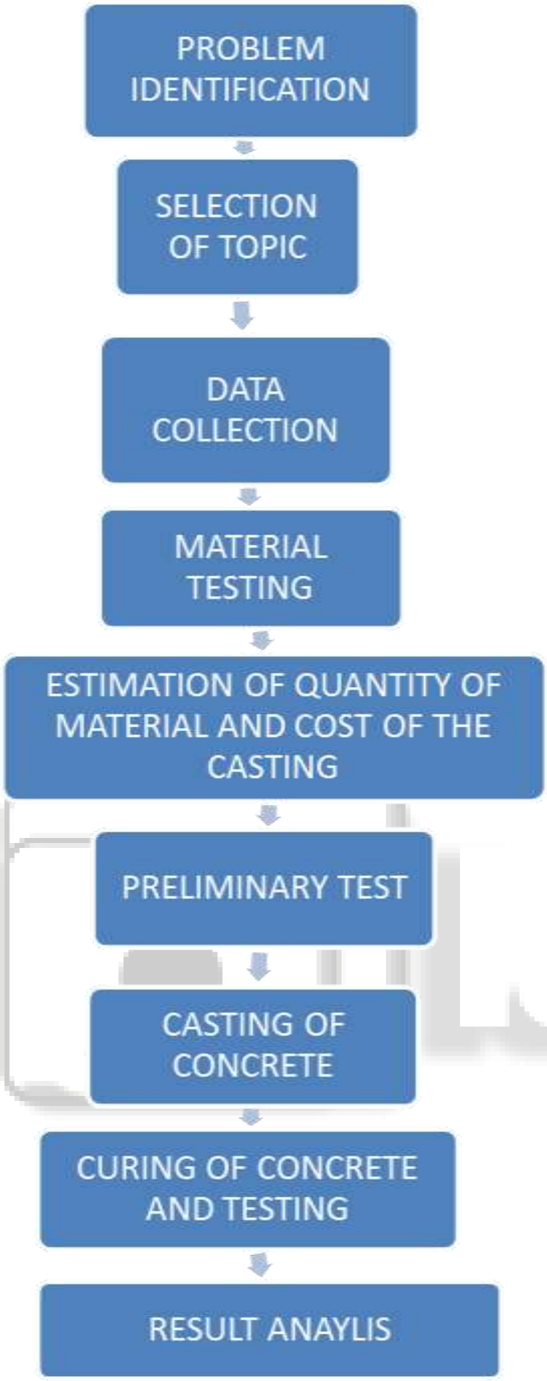
Reduces shrinkage in concrete. Eco-friendly by reducing amount of co2 emission. Reduces heat of hydration leading to shrinkage and crack control. Using the semineral admixtures with OPC cement, concrete mixtures were prepared and same were used to find compressive strength of concrete CubeSat 7, 14, and 28 Days. Reported that it was possible to make the concrete economical by 10% replacement of cement with Metakaolin (10%) High performance concrete was prepared by partial replacement of Ordinary Portland cement with Metakaolin. The test results showed improvements in strength, brittleness and durability. The optimum replacement level for Metakaolin was reported 5% .They reported that the compressive strength of high performance concrete containing 5% of Metakaolin was 10% higher than then ormal concrete. The properties of cemen t mortar were investigated which included physical properties, chemical properties, setting time compressive strength and water absorption. Metakaolinis used in the development of self-compacting concrete the compressive strength at 28 days increased by 33% when addition of 5 wt% MK.

II. IS CODES USE FOR MAKING MIX DESIGN

IS 10262:2019 For mix Design IS 516-1959 RA-2018 Test Report on Compressive Strength of Concrete Cube, IS 4031, IS (IS:2386-1-1963, RA 2016) ,I.S. 2386-1963 RA-2016 Test Result report on Fine Aggregate IS 456:2000 Plain and Reinforced Concrete. The above all codes are used the makes of Mix Design of Concrete. there are some other tests which are also play a vital role to get result that is Compressive Strength Test , Split Tensile Strength Test and Flexural Strength Test.

III. METHODOLOGY

In Methodology all kinds of Preliminary Cement Tests are included Like , Consistency Test , Initial and Final setting time of Cement , Fineness Test , Specific gravity Test ,Soundness Test, Compressive Strength Test. For Fine Aggregate Sieve Analysis , Bulking Density, Specific Gravity & Water Absorption Finer Than 75 Micron are Included And For Coarse Aggregate Sieve Analysis, Elongation & Flakiness Index, Crushing , Abrasion Value, Impact Value , Specific gravity and water absorption test , Bulking Density , Specific Gravity And Water Absorption Finer Than 75 Micron are Done. As per the result of all the Tests Mix Design has been done.



IV. MATERIAL AND METHODS

Properties	Value
Density(gm/cm3)	2.17
Bulk Density(gm/cm3)	1.26
Particle shape	Spherical
Colour	Off-white
Specific gravity	2.50

Table 4.1 Physical Properties of Metakaolin

Constituent	Metakaolin (%)	Cement (%)
SiO_2	60-65	22
Al_2O_3	30-34	6
Fe_2O_3	1.00	3
CaO	0.2-0.8	63
LOI (%)	1.5	1.5
MgO	0.2-0.8	1.5
K_2O	0.5-1.2	0.51

Table 4.2 Chemical Properties of Metakaolin

A. *Experimental work*

1) *Compressive strength test*

After the curing period the specimen is taken out for the test. The test is carried out on 150 x 150 x 150 mm size cubes, as per IS 516-1959. A 1000 kN capacity compression testing machine is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 kg/cm2/min and the failure load in KN is observed from the load indicator of the CTM.

% of Metakaoline	Average Compressive Strength (N/mm2)		
GRADE-M40	7 Days	14 Days	28 Days
Conventional Mix	26.95	35.50	40.25
% of MK 5%	27.82	36.20	41.23
% of MK 10%	31.22	39.97	49.98

Table 4.3 Result and Discussion

V. CONCLUSION

- Strength and durability of concrete increases.
- Accelerates initial setting time of concrete.
- Cross section of structure can be reduced safely i.e. amount of concrete used can be reduced.
- Reduces shrinkage in concrete.
- Eco friendly by reducing amount of co2 emission.
- Reduces heat of hydration leading to shrinkage and crack control.

REFERENCES

[1] EFNARC (2005). Specifications and guidelines for self-compacting concrete.
[2] H. Okamura, M. Ouchi, SCC, J. Adv. Concr. Technol. 1 (1) (2003) 5–15.
[3] M. Mavroulidou, Mechanical properties and durability of concrete with water cooled copper slag aggregate, Waste Biomass Valorization 8 (2017) 1841–1854.
[4] C.L. Hwang, J.C. Laiw, Properties of concrete using copper slag as a substitute for fine aggregate, Spec. Publ. 114 (1989) 1677–1696.
[5] T. Ayano, K. Sakata, Durability of concrete with copper slag fine aggregate, Spec. Publ. 192 (2000) 141 158.
[6] K.S. Al-Jabri, A.H. Al-Saidy, R. Taha, Effect of copper slag as a fine aggregate on the properties of cement mortars and concrete, Constr. Build. Mater. 25 (2) (2011) 933–938.
[7] M.A.G. Dos Anjos, A.T.C. Sales, N. Andrade, Blasted copper slag as fine aggregate in Portland cement concrete, J. Environ. Manage. 196 (2017) 607–613.
[8] I. Afshoon, Y. Sharifi, Ground copper slag as a supplementary cementing material and its influence on the fresh properties of self-consolidating concrete, IES J. Part A: Civ. Struct. Eng. 7 (4) (2014) 229–242.

[9] I. Afshoon, Y. Sharifi, Use of copper slag microparticles in self-consolidating concrete, ACI Mater. J. 114 (5) (2017) 691.
[10] M. Fadaee, R. Mirhosseini, R. Tabatabaei, M.J.Fadaee, Investigation on using copper slag as part of cementitious materials in self compacting concrete, Asian J. Civ. Eng. 16 (3) (2015) 368–381.
[11] A.S. Nair, P.R. SreemahadevanPillai, The effect of GGBFS and copper slag on strength of self-compacting concrete: an experimental study, Int. J. Eng. Adv. Technol. 7 (4) (2018) 47–53.
[12] R. Elangovan, D.L. VenkateshBabu, R. Venkatasubramani, Studies on high strength self-compacting concrete with copper slag, Int. J. Appl. Eng. Res. 10 (10) (2015) 26879–26896.
[13] R. Sharma, R.A. Khan, Fresh and mechanical properties of self-compacting concrete containing copper slag as fine aggregates, J. Mater.Eng.Struct. 4 (1) (2017) 25–36.
[14] R. Sharma, R.A. Khan, Durability assessment of self-compacting concrete incorporating copper slag as fine aggregates, Constr. Build. Mater. 155 (2017) 617–629.
[15] W. Gong, T. Ueda, Properties of self-compacting concrete containing copper slag aggregate after heating up to 400 C, Struct. Concr. 19 (6) (2018) 1873–1880.
[16] M. Veerraju, S. Arunchaitanya, Experimental study on high strength self -Compaction concrete by using fly ash as a partial replacement of cement and copper slag with fine aggregate, Int. J. Innovative Technol. Exploring Eng. 7 (8)(2018) 13–19.
[17] J. Rex DhivakarArockia Raj, K. Arunachalam, K. Mohandas, Self-compacting concrete with copper slag as partial substitute for sand, J. Comput. Theor.Nanosci. 15 (3) (2018) 977–981.
[18] S. Arunchaitanya, E. Arunakanthi, Usage of mineral admixtures in self-compacting concrete- A review, Int. J. Innovative Technol. Exploring Eng. 8(3) (2019) 58–62.
[19] BIS (2013). Ordinary portland cement 43 grade - specification. BIS 8112, New Delhi 2013, India.
[20] BIS Specification for coarse and fine aggregates from natural sources for concrete. BIS 383 1970 New Delhi-1971, India
[21] BIS Pulverized fuel ash-specification, Part 1 for use as pozzolana in cement, cement mortar and concrete. BIS 3812 2003 New Delhi-2003, India
[22] BIS Methods of test for strength of concrete 1959 IS 516, New Delhi-1959,India
[23] BIS Splitting tensile strength of concrete - method of test 1999 IS 5816, NewDelhi-1999, India
[24] EFNARC (2002). Specifications and guidelines for self-compacting concrete.
[25] C.K. Madheswaran, P.S. Ambily, J.K. Dattatreya, N.P. Rajamane, Studies on useof copper slag as replacement material for river sand in building constructions, J. Inst. Eng. (India): Series A 95 (3) (2014) 169–177.
[26] M. Shoya, S. Nagataki, F. Tomosawa, S. Sugita, Y. Tsukinaga, Freezing and thawing resistance of concrete with excessive bleeding and its improvement, Spec. Publ. 170 (1997) 879–898.