

Efficiency of Metakaolin In Concrete: A Review

M.Gokulakannan¹, M.Raffikbasha²

^{1,2}Dept of Civil Engineering

²Assistant Professor, Dept of Civil Engineering

^{1,2}Government College of Engineering, Salem-11, Tamilnadu, India

Abstract- Due to rapid civilization, we face the demand of construction materials (i.e.cement, sand and aggregates) so we go for the alternate materials or supplementary materials to enhance the demand of construction materials. At the same time it is very important to Eco friendly constructions. Metakaolin is a highly processed reactive aluminosilicate pozzolanic material. It's used as supplementary cementitious materials in concrete that improves the mechanical properties of concrete due to its high pozzolanic reactivity. Metakaolin were partially replaced at different percents by the weight of cement in concrete that exhibits favorable engineering properties. The main objective of this study was to interrogate the efficiency of metakaolin in High Strength and High Performance Concrete.

Keywords- Metakaolin, Pozzolan, Supplementary Cementitious material, High Strength Concrete, High Performance Concrete, Mechanical properties

I. INTRODUCTION

Metakaolin is the anhyrrous calcined form of the clay mineral kaolinite. Minerals that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacturing of porcelain. The particle size of metakaolin is smaller than cement but not as fine as silica fume. The quality and reactivity of metakaolin is strongly dependent of the characteristics of the raw materials used.

It is a product that is manufactured for the use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800°C. Its quality is controlled during manufacture, resulting in a much less variable material than industrial pozzolans that are by-products.

It have applications in all fields of civil construction for partial replacement Portland cement with metakaolin produces a concrete mix that exhibits favorable engineering properties.

In this review clearly discussed about the efficiency of metakaolin in High Strength and High Performance Concrete.



Fig1. Metakaolin

II. PHYSICAL PROPERTIES

Table1. Properties of Metakaolin

Item	Metakaolin
Specific gravity	2.2-2.6
Fineness (m ² /kg)	700-900
Particle size (µm)	1-2
Color	White

III. APPLICATIONS OF METAKAOLIN

- High performance concrete
- High strength concrete
- Light weight concrete
- Precast and poured-mold concrete
- Fiber cement and ferrocement products
- Glass fiber reinforced concrete
- Mortar and stucco
- Countertops as well as Sculptures

IV.RESULTS AND DISCUSSIONS

Metakaolin were replaced at different percents by weight of cement in both High Strength and High performance concrete. Up to optimum level the replacement of metakaolin which enhance the mechanical properties (Compression strength, Split Tension, Flexural strength and Durability) of both HSC and HPC. When the replacement level exceeds optimum level which reduces the mechanical properties of

both HSC and HPC. The given chart represents the replacement level of Metakaolin in concrete.

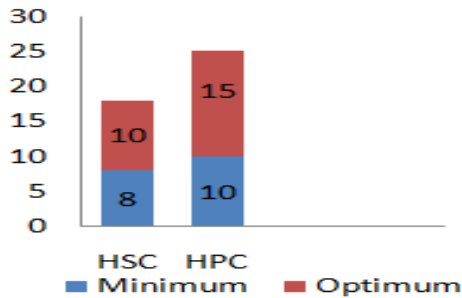


Chart 1. Metakaolin replacement level

V. CONCLUSION

- In High Strength Concrete 8-10 % replacement of metakaolin that increases the compression strength, split tension and flexural strength of concrete.
- In High Performance Concrete 10-15% replacement of metakaolin that also increases the mechanical properties of concrete.
- Up to 10% replacement of metakaolin which improves the mechanical properties of both HSC and HPC.

VI. ACKNOWLEDGEMENT

I would like to pay my special regards to Prof. M.Raffikbasha, Assistant Professor, Department of Civil Engineering, for his valuable guidance and also I wish to thank all the people whose assistance was a milestone in the completion of this review.

REFERENCES

- [1] Alaa M. Rashad., “Metakaolin: fresh properties and optimum content for mechanical strength in traditional cementitious materials – A compressive overview”, journal of Materials and Structures, March 2014, DOI 10.1617.
- [2] M.Narmatha, Dr.T.Felixkala., “Meta kaolin –The Best Material for Replacement of Cement in Concrete”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 13, (Jul. - Aug. 2016), PP 66-71.
- [3] Sabir B.B, Wild S, Bai J, “Metakaolin and calcined clay as pozzolans for concrete : a review” Cement and concrete composite 23 ,(2001),pp.441-454.
- [4] Jian-Tong Ding and Zongjin Li “Effects of Metakaolin and Silica Fume on Properties of Concrete” ACI Materials Journal/July-August 2002,pp.393-398.
- [5] Dinakar P, “High reactivity metakaolin for high strength and high performance concrete”, The Indian Concrete Journal, April 2011, pp.28-32.
- [6] Justice J.M, Kennison L.H, Mohr B.J., Beckwith S.L, McCormick L.E, Wiggins B., Zhang Z.Z, and Kurtis K.E, “Comparison of Two Metakaolins and a Silica Fume Used as Supplementary Cementitious Materials” SP-228(Volume1&2) Seventh International Symposium on Utilization of High-Strength/HighPerformance Concrete, June(2005),SP228.
- [7] Alice T. Bakera , Mark G. Alexander,“Use of metakaolin as a supplementary cementitious material in concrete, with a focus on durability properties”, RILEM Technical Letters (2019) 4: 89-102.
- [8] A.A. Murana, A. T. Olowosulu and S. Ahiwa, “ Performance of metakaolin as partial replacement of cement in hot mix asphalt”, Nigerian Journal of Technology (NIJOTECH) Vol. 33. No. 3, July 2014, pp. 387 – 393.
- [9] Jiping Bai & Albinas Gailius, “Consistency of fly ash and Metakaolin concrete”, Journal of Civil Engineering and Management, (2009) 15:2, 131-135.
- [10] E.Guneyisi,M.Gesoglu, K.Mermerdas,“improving strength, drying shrinkage and pore structure of concrete using metakaolin”, (2007), Materials and Structures. DOI 10.1617.
- [11] Abdul R., H., and Wong H. S., “Strength estimation model for high-strength concrete incorporating metakaolin and silica fume”, Cement and Concrete Research, 35, 2005, pp 688 – 695.
- [12] Poon C.S., Kou S.C., and Lam L., “Compressive strength, chloride diffusivity and pore structure of high performance metakaolin and silica fume concrete”, Construction and Building Materials, 20, 2006, pp 858– 865.
- [13] Bindu Biju and Imran H, “Partial Replacement of Cement with Metakaolin in High Performance Concrete”, ISO 3297: 2007 Volume 5, Special Issue 14, December 2016
- [14] Venkatesh A.L And Harshitha I, “High Strength Concrete By Partial Replacement Of Cement By Fly Ash, Metakaolin And Alccofine”, Volume: 05 Issue: 04 | Apr-2018
- [15] Mohammed samiuddin fazil and Fouzia shaheen- “Effect of metakaolin and alccofine on the strength ofconcrete”, IRACST, volume 5, issue 4, august 2015.
- [16] Alaa M rashad “Metakaolin: fresh properties and optimum ontent for mechanical strength in traditional cementitious material a comprehensive overview”.ELSEVIER, 41(2013)303-318
- [17] M narmatha and Dr. T Flexikala “metakaolin- the best material for replacement of cement in concrete”, IOSR, (jul-aug 2016) volume 13, issue 4,PP66-71.
- [18] Rathan Raj R, Perumal Pillai E.B and Santhakumar A.R, “Evaluation and mix design for ternary blended high strength concrete”, Procedia Engineering 51 (2013)

65 – 74

- [19] Brooks, J.J, Johari, M.A.M. and Mazloom, M., 1994. “Effects of admixtures on the setting time of high strength concrete, Cement and Concrete Composites”, vol. 22(1), pp. 293-301.
- [20] Caldarone, M.A., Gruber, K.A. and Burg, R.G., 1994. “High reactivity metakaolin (HRM): a new generation admixture for high performance concrete”, Concrete International, vol. 16(11), pp. 37-40.
- [21] Curcio, F., Deangelis, B.A. and Pagliolico S., 1998. Metakaolin as pozzolanic micro filler for high performance mortars, Cement and Concrete Research, vol. 28(6), pp. 800-809.
- [22] Dr. B. Krishna Rao and M. Anil Kumar, “A Study on Partial Replacement of Cement with Metakaolin and Fine Aggregate with Waste Foundry Sand”, Vol. 5 Issue 12, December-2016
- [23] K.A.Gruber, Terry Ramlochan, Andrea Boddy, R.D.Hooton, M.D.A.Thomas, “Increasing Concrete durability with high reactivity metakaolin, Cement & Concrete Composites”, Vol. 23, 2001, 479-484.
- [24] Wild, S., J.M. Khatib, and A. Jones, —Relative strength, pozzolanic activity and cement hydration in super plasticized metakaolin concrete, Cement and Concrete Research, vol. 26, pp. 1537-1544, Oct. 1996.
- [25] Memduh Nas and Şirin Kurbetci, “Durability properties of concrete containing metakaolin”, *Vol. 6, No. 2 (2018) 159-175*