International Journal of Scientific Research in Chemistry (IJSRCH)
© 2020 IJSRCH | Volume 5 | Issue 2 | ISSN : 2456-8457

Strength and Durability Properties of Concrete with Partial Replacement of Cement with Metakoalin and Marble Dust - A Review

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Article Info
Volume 5, Issue 2
Page Number: 17-25
Publication Issue :
March-April-2020

Article History
Accepted : 15 April 2020
Published : 24 April 2020

ABSTRACT

Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The amount of the Co2 released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. Attempts are made to reduce the use of Portland cement in concrete are receiving much attention due to environment-related. In the present study Metakaolin and marble duat used as a partial replacement for cement. Metakaolin is a calcinied clay and It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain ceramic material. The particle size of Metakaolin is smaller than cement particles and where as Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Kaolinite is also called as green pozzolana because it emits less co2. In this project an experimental work is been performed to determine mechanical properties of concrete with metakaoline and marble dust is replaced with cement with the known percentages such as 0%,10%,11%,12%,13%,14%,15% for the grade of M20.

Keywords : Ordinary Portland Cement, Pozzolana, GGBS, PFA, CSF

I. INTRODUCTION

Concrete is a very strong and versatile mouldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years.

(a) Early history

Surprisingly, concrete has a very long if somewhat episodic history. In a Neolithic settlement excavated at Yiftahel in southern Galilee in Israel, a floor of burnt lime plaster was found. It is thought to be the earliest use of concrete. The fragments of a kiln were found on the site - the lime to make the concrete may have been burnt in it. The lime had been mixed with stone and laid 30-80mm deep and given a smooth finish. Mesolithic hut floors at Lepenski Vir in Serbia (the former Yugoslavia) were also made of a lime-bound concrete. Egyptian murals from the second millennium BC depict the making of mortar and concrete. Around 500 BC, at Camiros on Rhodes, the ancient Greeks built a 600,000 litre capacity underground cistern lined with fine concrete.

(b) Roman Concrete

The above discoveries hardly point to the intensive use of concrete; otherwise, due to its durability, concrete would likely have been found at many more ancient sites. We have to turn to the Romans for the widespread use of concrete. The Romans discovered that by mixing lime and rubble with pozzolana2 sands and water, they could make a very strong building material which they called opus caementicium. It even had the added bonus of being able to set under water, so it could be used in the construction of aqueducts and harbours. Perhaps most notable of the many Roman concrete structures that are still standing today are the Coliseum and the Pantheon in Rome.

1.1 Why replacement of Concrete making materials are being done ?

The life-cycle assessment of concrete includes information on the production of raw materials for concrete, the manufacturing of concrete, the use of supplementary materials such as fly ash and ground-granulated, blast-furnace slag, chemical admixtures, and on the recycling of concrete. Lowering the environmental impact of concrete by using partial replacement of cement, improving cement production, the development of alternative binders, recycling waste byproducts, and the enhancement of durability is presented.

The advantages and disadvantages of cement replacement materials are:

- Substantial reduction in carbon footprint, due to reduction in cement content.
- Low early strength (except CSF).
- Reduce cost of raw materials (assuming CSF is used to save cement).
- Increase cost of production and possibility of errors in mix proportions.
- May improve durability.
- Require better curing, and therefore increase cost of placing. GGBS can cause bleeding, but PFA generally improves cohesion.
- PFA and CSF produce a darker colour mix. GGBS gives an almost white colour (it may be a bit blue or green initially, but this soon fades).
- GGBS, PFA, and CSF are all industrial by-products that could be environmentally damaging if not mixed into concrete.

1.2 Introduction to Marble Dust and Metakoalin

1.2.1 Marble Dust

Marble dust is a waste product formed during the production of marble. A large quantity of powder is generated during the cutting process. ... It is a solid waste material generated from the marble processing and can be used either as a filler material in cement or fine aggregates while preparing concrete. Marble has been commonly used as a building material since the ancient times. Consequently, Marble waste as a by-product is a very important material which requires adequate environmental disposal effort. In addition, recycling waste without proper management can result in environmental problems greater than the waste itself. Marble dust is a waste product formed during the production of marble. A large quantity of powder is generated during the cutting process. The result is that about 25% of the original marble mass is lost in the form of dust. Leaving these waste materials to the environment directly can cause environmental problems such as increases the soil alkalinity, affects the plants, affects the human body etc. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. It is a solid waste material generated from the marble processing and can be used either as a filler material in cement or fine aggregates while preparing concrete. The production of cheaper and more durable concrete using this waste can solve to some extent the ecological and environmental problems. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its colour and appearance: it is white if the limestone is composed solely of calcite (100% $CaCO_3$). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. A large quantity of powder is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world Concrete is a heterogeneous mix of cement, aggregates and water.

Table 1: Chemical composition of Marble Dust	
Oxides compound	Percentage
CaO	42.45
Al_2O_3	0.520
SiO_2	26.35
Fe_2O_3	9.40
MgO	1.52

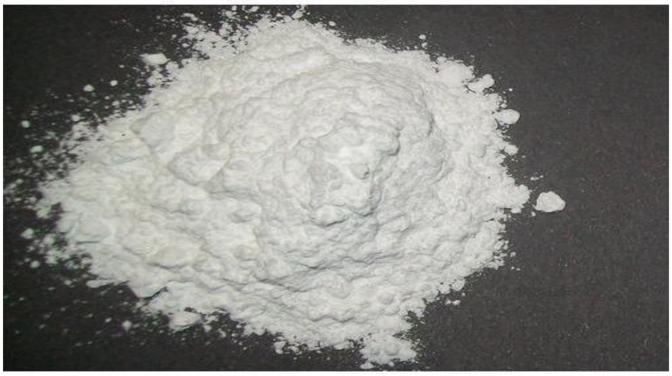

Fig 1 : Image of Marble Dust

1.2.2 Metakoalin

Metakaolin is the anhydrous calcined form of the clay mineral kaolinite. Minerals that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. Considered to have twice the reactivity of most other pozzolans, metakaolin is a valuable admixture for concrete/cement applications. Replacing portland cement with 8–20% (by weight) metakaolin produces a concrete mix that exhibits favorable engineering properties, including: the filler effect, the acceleration of OPC hydration, and the pozzolanic reaction. The filler effect is immediate, while the effect of pozzolanic reaction occurs between 3 and 14 days. The increase in metakaolin content improves the compressive strength, split tensile strength and flexural strength upto 15% replacement. The result encourages the use of metakaolin, as pozzolanic material for partial cement replacement in producing high strength concrete. Metakaolin is a pozzolanic additive/product which can provide many specific features. Metakaolin is available in many different varieties and qualities. The purity will define the binding capacity or free lime. Some of them also provide special reactivity. Metakaolin is a valuable admixture for concrete and or cement applications. Usually 8% - 20% (by weight) of Portland cement replaced by metakaolin. Such a concrete exhibits favourable engineering properties. The pozzolanic reaction starts soon and continues between 7 to 28 days. For the preliminary investigation, metakaolin and cement was subjected to physical and chemical analyses to determine whether they are in compliance with the standard use.

Components	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	MgO	TiO_2	P_2O_5	L.O.I
Metakaolin	51.85	43.87	0.99	0.20	0.01	0.12	0.18	1.74	0.03	-
Cement	22.42	4.68	3.68	63.2	0.25	0.75	3.63	-	-	0.45
Silica Fume	93.16	1.13	0.72	-	-	-	1.6	-	-	1.58

Table 2. Chemical Composition of Metakoalin

Fig 2 : Image of Metakoalin

II. LITERATURE REVIEW

A.V.S.Sai. Kumar, Krishna Rao B Concrete a composite material made from cement, water, fine aggregate and coarse aggregate. But present researchers are in interest of finding new cement materials by waste materials or waste products produced from industries which are harmful to environment. The present paper deals with partial replacement of cement with quarry dust and metakaolin which are having silica used as admixture for making concrete. First quarry dust is made partial replacement of cement and found that 25% of partial replacement is beneficial to concrete without loss of standard strength of cement. Making 25% partial replacement of cement with quarry dust as constant, 2.5%, 5.0%, 7.5%, 10.0%, 12.5% metakaolin was made in partial replacement of cement and results were found that quarry dust and metakaolin usage in partial replacement to cement can be made.

G. AshaLakshmi, P. Sai Pravallika Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The amount of the Co2 released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. Attempts are made to reduce the use of Portland cement in concrete are receiving much attention due to environment-related. In the present study Metakaolin and marble duat used as a partial replacement for cement. Metakaolin is a calcinied clay and It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain ceramic material. The particle size of Metakaolin is smaller than cement particles and where as Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Kaolinite is also called as green pozzolana because it emits less co2. This paper presents results of an experimental program to determine mechanical properties of concrete with metakaoline and marble dust is replaced with cement with the known percentages such as

0%,5%+5%,7.5%+7.5%,10%+10%,12.5%+12.5%,15%+ 15% for the grade of M30.

CH Jyothi Nikhil1* and J D Chaitanya Kumar Among many mineral admixtures available, Metakaolin (MK) is a mineral admixture, whose potential is not yet fully tested and only limited studies have been carried out in India on the use of MK for the development of high strength concrete. MK is a supplementary cementetious material derived from heat treatment of natural deposits of kaolin. MK shows high pozzolana reactivity due to their amorphous structure and high surface area. The experimental work has been carried out as partial replacement of cement with MK in M70 grade of concrete at 0%, 10%, 15%, 20%, 25% and 30% of replacements. The mix design was made making the use of Erntroy empirical Shacklock's method. Cubes are tested for durability studies with H2SO4 and HCL of 0.5% and 1% concentrations. Cubes, cylinders and prisms are tested for temperature study at 15% replacement. The specimens were heated to different temperatures of 100oC, 200oC, 300oC, 400oC and 500oC for three different durations of 1, 2 and 3 h at each temperature.

J. Thivya , M. Arivukkarasi Concrete a widely used construction material, consumes natural resources like lime, aggregates, water. In concrete the composite materials are replaced with Metakaolin and Granite powder. Metakaolin used as a partial replacement of cement which was treated as economical and due to its pozzolonic action increases strength and durability properties of concrete. Granite powder is a waste material from the polishing industry not disposed properly into the land used in the concrete replaced for sand. The test results obtained indicate that granite powder of marginal quantity as partial sand replacement has beneficial effect on the mechanical properties such as compressive strength, split tensile strength, modulus of elasticity.

P. Jaishankar and Vayugundlachenchu Eswara Rao Concrete is that pourable mix of cement, water, sand, and gravel that hardens into a super-strong building material. Supplementary cementing materials (SCM) have become an integral part of concrete mix design. These may be naturally occurring materials, industrial wastes or, by products or the ones requiring less energy to manufacture. Some of the commonly used SCM are fly ash, silica fume (SF), GGBS, rice husk ash and metakaolin (MK), etc. Metakaolin is obtained by the calcination of kaolinite. It is being used very commonly as pozzolanic material and has exhibited considerable influence in enhancing the mechanical and durability properties of concrete. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc. In this project, experimental study was carried out on M-30 grade of concrete. In this concrete mixes sand was replaced by M-sand by a constant percentage and cement was replaced by metakolin in various percentages such as 5%, 10%, 15% and 20%. Concrete specimens containing metakaolin were studied for their compressive, split tensile and flexural strengths according to Bureau of Indian standards. The results thus obtained were compared and examined with respect to the control specimen.

M. Jagadeesh Naik and S.M. Gupta Concrete is a Composite material made from cement, Fine aggregate, Coarse aggregate and water. The worldwide production of cement has greatly increased since 1990 and this production of cement results in lot of environment pollution as it involves the CO2 gas. So alternative supplementary cementitious materials like Metakaolin, Fly-ash, GGBS, Rice Husk etc.. are used as partial replacement of cement. Metakaolin is a dehydroxylated aluminum silicate and having pozzolanic action. With increased depletion of Natural Construction material, alternative means must be sought for replacement of the same in the concrete mixes. The paper presents the partial replacement of cement with Metakaolin (0%, 5%, 10%, 15% and 20%) and Natural Sand with ROBO SAND (50%). The Mechanical properties of concrete i.e. Compressive strength, Split tensile strength and Flexural strength are studied of concrete made with partial replacement of MK-RS and compared with conventional concrete.

M. Devi The utilization of well graded, fines free quarry dust has been accepted as a building material in the construction industry in recent years and it has been used as an alternative material to river sand for fine aggregate. The use of supplementary cementitious materials such as fly ash, silica fume, slag and metakaolin in concrete improves workability, reduces the heat of hydration, minimizes cement consumption and enhances strength and durability properties by reducing the porosity due to the pozzolonic reaction. Metakaolin is a highly pozzolanic and reactive material. In this paper emphasize has been given to metakaolin as partial replacement of cement at 5%, 10%, 15% and 20% by weight of cement in concrete having quarry dust as fine aggregate. The effect of metakaolin on the strength properties was analyzed by conducting compressive, split tensile and flexural strength tests and durability properties were evaluated by impressed voltage measurement, rapid chloride penetration test (RCPT) and gravimetric weight loss measurement in addition to water absorption and bulk density analysis. The optimum percentage of metakaolin replacement was also determined.

Zubair Ahmad Khan, V S Sagu Concrete is the most extensively used construction material in the world, which consumes natural resources like lime, aggregates and water. The worldwide production of cement has greatly increased, due to this production environmental pollution increases with emission of CO2 gas. To reduce this effect cement was replaced by some supplementary materials like Metakaolin, Fly ash, Bottom Ash, Ground Granulated Blast Furnace Slag (GGBS) and Rice Husk etc.. In this content Metakaolin was a pozzolanic material used in wide range in replacement of cement. Metakaolin is dehydroxylated aluminum silicate, due to its pozzolanic activity the strength properties and durability properties of concrete increases and reduction in Porosity and Permeability also. Now-a-day's availability of natural sand is constraint, so alternative material called ROBO Sand (having similar properties as that Natural Sand) is used in place of Natural sand to study the fresh and hardened properties of concrete. In this present investigation cement is replaced partially with metakaolin in varying percentage i.e. 0%, 5%, 10%, 15% and 20% and natural sand with 50% ROBO sand to get the different concrete mixes. The fresh and mechanical properties of concrete i.e. workability (slump test) and compressive strength, split tensile strength and flexural strength at 7 days, 28 days and 90 days are studied of the different concrete mixes and results are compared with conventional concrete.

III. PROBLEM IDENTIFICATION

On the basis of reading many research papers it was found that the compressive strength of concrete is more at 10%+10% replacement of metakaoline and marble dust. Due to increase of percentages of metakaoline and marble dust the strength of the concrete is reducing. The experimental test is done in many percentages but the percentage missing is 11%,12%,13%,14% which may give the best optimum percentage for dosage and also the concrete properties can be examined very thoroughly and minutely.

IV. AIM OF THE STUDY

The main intension of this work is to know about the compressive strength of concrete with Metakoalin and Marble dust in a partial replacement of cement. Concrete is mainly used to bear the compressive load on structure, so it is necessary that it should be highly durable, less reactive, good workability and maximum load bearing strength.

Metakoalin and Marble dust is a waste material in India with a huge amount and they posses the cementitious properties , in this experimental work optimum dosage of admixtures(i.e. Metakoalin and Marble dust) were examined and also their effect is studied in concrete properties. Also the cost of cement is optimized for greater economy.

V. CONCLUSIONS OF LITERATURE REVIEW

1. From the Test results we find that metakaoline and marble dust can be use for partial replacement in concrete.
2. The compressive strength of concrete is more at 10%+10% replacement of metakaoline and marble dust.
3. The Cylinder strength of concrete is more at 10%+10% replacement of metakaoline and marble dust.
4. Due to increase of percentages of metakaoline and marble dust the strength of the concrete is reducing.
5. Workability of concrete is also reducing due o increase in percentage of metakaoline and marble dust.
6. Strength and durability of concrete is increase 7. Eco-friendly by reducing of CO2.
7. When compared with NCC mix and mix NCCM10 was increased by 1.08% when compared with NCC mix. Hence the degree of workability was found to be almost same. The compaction factor for mix NCCM12.5 was reduced 1% respectively when compared with NCC.
8. It was observed that the compressive strength of NCC at the age of 28 days reached its target mean strength however it was observed that the compressive strength reduced by 2.3% respectively when compared with NCCM0, mixes NCCM2.5, NCCM5, NCCM7.5, NCCM10 and NCCM12.5 at the age of 28 days has reached its target mean strength however it was observed that the compressive strength increased by 2.1%, 3.8%, 6.4%, 14.6% and 4.5% respectively when compared with NCCM0.
9. Workability of concrete decreases with the increase in Metakaolin replacement level. · The compressive strength, flexure strength and split tensile strength of conventional concrete and concrete with MK as partial replacements are compared and observed and concluded that the strength of the conventional concrete is slightly lower than the MKC.
10. The compressive strength of concrete is increased when cement is replaced with Metakaolin. The compressive strength is maximum at 15% of replacement.
11. The split tensile strength of concrete is increased when cement is replaced with Metakaolin. The split tensile strength is maximum at 15% of replacement.
12. The flexure strength of concrete is increased when cement is replaced with Metakaolin. The flexure strength is maximum at 15% of replacement. At room temperature and 100oC exposure, the stress-strain relationship is similar to the conventional concrete and MKC behavior. However the trend is different for temperature exposure of 200oC to 500Oc.
13. The compressive strength of concrete showed better result at 15% replacement of MK for 0.5% and 1% HCl at the age of 28days of strength. · The compressive strength of concrete showed better result at 15% replacement of MK for 0.5% and 1% H2SO4 at the age of 28 days of strength.
14. The addition of Metakaolin along with cement has increased the compressive strength of the concrete when compared to the conventional concrete.
15. The more effective percentage of replacement with Metakaolin seems to be between 10% and 15%.
16. The compressive strength of concrete increased with 15%MK and 20%GP replacement in concrete. The compressive strength is increased around 8.5% compared to

conventional concrete in 15%MK and 20%GP replacement.

17. From the comparison of the compressive strength test results at 7, 14 and 28 days, it was observed that MK15 (15%MK & 50% M-Sand) showed maximum strength compare to other replacement percentage. · MK15 showed there was 32.55% increase in compressive strength at 28 days compared to normal concrete.
18. Splitting tensile strengths results have also followed the same trend to that of compressive strength results showing the highest values at 15% replacement. · From the results it is concluded that the M-Sand can be used as a replacement for fine aggregate. It was found that 50% replacement of fine aggregate by M-Sand give maximum result in strength.
19. The optimum dose of Silica fume and Metakaolin in combination is found to be 12% and 12% (by weight) respectively at both 7 and 28 day compressive strength. • By comparing these percentages we prefer that 24% gives more strength than compared with conventional concrete.
20. Therefore use of silica fume in concrete has engineering potential arid economic advantage. Economically by reducing the consumption of cement, the ecology of earth can be improved enormously and the air pollution due to the production of cement can be reduced.

VI. REFERENCES

[1]. https://www.academia.edu/36520238/Strength_and_Duriabilty_Properties_of_Concrete_with_Partial_Replacement_of_Cement_with_Metakaolin_and_Marble_Dust Qin Weizu Tsinghua, What Role Could Concrete Technology Play For Sustainability In China? University, Beijing, p.p 35-43

[2]. http://www.ijirset.com/upload/2014/march/76_AStudy.pdf. A Study on Strength of Concrete With Partial Replacement Of Cement With Quarry Dust And Metakaolin A.V.S.Sai. Kumar1 , Krishna Rao B2

[3]. https://www.irjet.net/archives/V6/i11/IRJET-V6I11162.pdf . STRENGTH AND DURABILITY PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH METAKAOLINE AND MARBLE DUST G. AshaLakshmi1, P. Sai Pravallika2

[4]. https://www.researchgate.net/publication/306106684_PARTIAL_REPLACEMENT_OF_CEMENT_WITH_METAKAOLIN_IN_HIGH_STRENGTH_CONCRETE

[5]. https://pdfs.semanticscholar.org/986d/bb7bd34a3649eebcade069a43efc5579316c.pdf A Study on Partial Replacement of Cement with Metakaolin and Fine Aggregate with Waste Foundry Sand

[6]. file:///C:/Users/CG-DTE/Downloads/6.PARTIALREPLACEMENTOFCEMENTWITH.pdf PARTIAL REPLACEMENT OF CEMENT WITH METAKAOLIN IN HIGH STRENGTH CONCRETE CH Jyothi Nikhila1* and J D Chaitanya Kumar2

[7]. http://www.ijaert.org/wp-content/uploads/2016/04/150113.pdf Comparative Analysis on Partial Replacement of Cement by Metakaolin and Fine Aggregate by Granite Powder

[8]. http://sphinxsai.com/2016/ch_vol9_no5/2/(446-452)V9N5CT.pdf Experimental study on Strength of Concrete by using Metakaolin and M-Sand

[9]. https://www.krishisanskriti.org/vol_image/11Jun201610061528%20%20%20%20%20%20%20%20%20%20M%20%20JAGADEESH%20NAIK%20%20%20%20%20%20%20%20396-398.pdf Experimental Investigation on the Properties of Concrete Replacing Cement and Natural Sand

with Metakaolin and Robo-Sand M. Jagadeesh Naik1 and S.M. Gupta2

[10]. ijedr.org/papers/IJEDR1901022.pdf Development on the properties of concrete replacing Cement with metakaolin and silica fume 1Kamal deep, 2Ravikanth Sharma 1M. Tech Scholar, 2Assistant Professor

[11]. http://www.ijscer.com/uploadfile/2015/0922/20150922013833952.pdf Implication of Metakaolin in Quarry Dust Concrete M. Devi

[12]. http://www.ijsdr.org/papers/IJSDR1905028.pdf . INVESTIGATION ON THE PROPERTIES OF CONCRETE REPLACING CEMENT AND NATURAL SAND WITH METAKAOLIN AND ROBO SAND

[13]. https://www.recentscientific.com/sites/default/files/8750-A-2017.pdf COMPRESSIVE STRENGTH OF MARBLE STONE WASTE AGGREGATE CONCRETE WITH CRIMPLED STEEL FIBRES Venkata Ramana N*

[14]. http://www.ajer.org/papers/v5(09)/K0509068074.pdf Durability Properties of Concrete Influenced By Microfines Narasimha Prasad K N1 , Bharat Jangid2 , Radhakrishna3 , Venkatesh S V4

[15]. https://www.researchgate.net/publication/317687138_Use_of_waste_marble_dust_in_Concrete

[16]. https://www.ijera.com/papers/Vol4_issue4/Version%201/BJ044377381.pdf. To Study the Behaviour of Marble Powder as Supplementry Cementitious Material in Concrete Pooja J.Chavhan* , Prof. S. D. Bhole

[17]. https://www.iosrjournals.org/iosr-jmce/papers/vol13-issue4/Version-1/J1304016671.pdf. Meta kaolin –The Best Material for Replacement of Cement in Concrete M.Narmatha1 , Dr.T.Felixkala2

[18]. https://www.irjet.net/archives/V2/i5/IRJET-V2I584.pdf A STUDY ON BEHAVIOR OF MARBLE DUST IN CONCRETE PAVEMENT Devesh Meena1

Cite this article as :

S. Anisha, Anisha Mire, K. Divya Kotecha, Amini Sahu, "Strength and Durability Properties of Concrete with Partial Replacement of Cement with Metakoalin and Marble Dust - A Review ", International Journal of Scientific Research in Chemistry (IJSRCH), ISSN : 2456-8457, Volume 5, Issue 2, pp.17-25, March-April.2020
URL : http://ijsrch.com/IJSRCH20524