Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2017, 9(12):191-194

Review Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Effect of Industrial Waste as Partial Replacement of Ingredients in Ultra High Strength Concrete: A Review

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ABSTRACT

A new class of concrete that exhibits greatly improved strength and durability properties has recently been developed. Ultra High Performance Concrete (UHPC) is a steel fibre reinforced concrete consisting of optimal gradation of fine powders and a very low amount of water cement ratio. This paper describes the possibility of utilizing marble dust in UHPC based on various literatures. UHPC can be manufactured by eliminating the pores to create dense mix. Marble dust has very low fineness value so that it can be effectively utilized in UHPC. The Properties of marble dust indicate it can be a best alternative material in UHPC. Due to low fineness and high hardness value it could be possible to achieve a new class of UHPC with high strength and low permeability. This concrete has very wide areas of application such as bridges, storage structures etc. It has very high ductility value so that it can be used in earth quake prone areas.

Keywords: Marble dust; Gradation; Ductility

INTRODUCTION

Ultra High Performance Concrete (UHPC)Which is also known as Reactive powder concrete is a new-fangled class of concrete which comprises of optimum gradation of ingredients mixed in a provisional fractions that has been the outcome of such growth. Even though UHPC is devising a extraordinary compressive strength It demonstrations identical brittle failure performance and therefore a inadequate post-cracking activities occurs. With the help of adding fibres in Ultra High strength concrete the structural behaviour which is also known as load-displacement behaviour and subsequently the ductility and fracture toughness can be improved which also improves the post cracking behaviour. This can be outlined back to the fact, when the cracks are formed, the fibres are able to transfer emerging loads by bridging the cracks.

LITERATURE REVIEW

MS Hameed and ASS Sekar [1] have evaluated the combined effect of marble dust and granite dust together for the replacement of fine aggregate in conventional concrete. The granite and marble dust is collected as waste in the form of slurry from the industries. The chemical and physical parameters of the wastes have been evaluated. The particle size analysis using hydrometer will indicate the waste material will be an alternative material for fine aggregates. For this study the ratio taken as trail mix of green concrete and compared the results with the conventional concrete. Slump flow test, slum test and V Funnel tests are done in fresh concrete and the compressive strength split tensile strength are tested in Hardened concrete. The compressive strength in the hardened concrete was done for 3 days, 7 days and 28 days and the same is for the split tensile strength also. For the durability parameters permeability, water absorption and sulphate attack have been evaluated. The fresh concrete results indicate the workability of the concrete is high in the case of fine aggregate was replaced 100% by granite dust and marble dust due to the fineness of marble dust and granite dust gives dense mix. Increase the marble sludge powder content by more than 50% improves the workability but affects the compressive and split tensile strength of concrete due to very high fine powders presence. The micro filling ability if the fine powders (wastes) will give excellent performance than that of normal concretes in mechanical and durability studies.

H Yang et al. presented their research that the bending behaviour of Ultra High Performance Concrete beams due to the presence and absence of reinforcement [2]. The parameters have been evaluated the presence of reinforcement but also evaluated the placing position of UHPC Beams. The reinforcement ratio used in this research less than 0.02% and the steel fibre percentage as 2.

It is concluded that failure patterns reveal cracks formed perpendicular to flexural tensile forces. These results indicate the ability of UHPC beams to redistribute stresses. Placing at the end of the beam provides better performance than mid span. The UHPC beams exhibited a post-cracking ductile behaviour and were able to control cracking. The reason for the post cracking behaviour is due to the steel fibres used in the UHPC beams may control the further cracking of the structure.

V Corinaldesi et al. presented in thier research that the influence of marble dust in mortar and concrete cubes [3]. The physical and chemical parametes of marble dust has been evaluated initially. Form the Chemical analysis marble dust is found to be very effective in assuring the cohession between the ingredients used in concrete. The mix ratio is taken as trail and the marble powder is added in the form of slurry. The specimens of sizes 40 × 40 × 160 mm in size have been used for the mechanical properties casted by using stainless steel moulds. The specimens cured at temperature of 20°C. The resuts indicates due to the very fne powders of marble dust performed very well. Marble dust has proved very good cohession betwen the ingredients in mortar even in very low amount of water content with the presence of superplasticizer. In terms of mechanical behaviour 10% marble dust replacement is found to be very effective in compressive strength.

B Demirel investigated the possibility of using waste marble dust instead of fine aggregate in concrete [4]. The mix ratio has been dine on trail basis and twelve specimens for each mix have been casted. The cubes of size 100 mm have been used for the experimental purpose because the coarse aggregate used in this study of size below 10 mm. The non destructive tests also been done. The experimetnal test have been carreid out in accordance with American standards. The experimetnal test results indicate the increase in marble dust content increases the compressive strength as well as the weight of the specimen.

R Hamza et al. investigated the possibility of uitilzation of marble and granite powder in bricks and buliding blocks [5]. The experimetnal tests have been carried out by casting the brick specimen of size 250 mm length 120 mm width and 60 mm height as per the Egyptian standards. The samples were replaced with marble and granite powder and 28 days and 7 days compressive strength have been tested. The tests carried out based on American standards (ASTM C55). The experimetnal results concluded that the compressive strength of the bricks increased with addition of marble powder of 10%.

B Tayeb has evaluated the fresh properties of Self Compacting Concrete with marble dust [6]. In this study Marble Powder (MP) of size less than 80 microns have been used. The chemical analysis results indicate presence of very high amount of calcium content. For this study the have used the Water to Powder (W/P) ratio as constant. The tests were carried out based upon the European standards. Mini slump test, V funnel test and Viscosity test have been performed in fresh concrete. The Compressive strength parameters also have been evaluated. The results indicate that due to the fineness value of marble dust increase in marble dust content will increase the performance of fresh concrete. With very low amount of water conctent with super plasticizer shows a very high compressive strength compared to the same trail mix without marble powder.

M Gesog et al. investigated the performance of the self-compacting concrete in fresh and hardened stage replaced with marble powder and lime stone filler [7]. Initially chemical analysis was done for the cement, Fine aggregate, fly ash, marble powder and limestone filler. From the chemical Analysis results the mix proportions were made. The mix ratio formed based on trial basis and the curing was done in lime saturated water at a temperature of 24ºC. Slump flow test, V funnel test and L box test were carried out for the fresh concrete and the compressive strength split tensile test and flexural tests have been carried out in the hardened concrete. The tests carried out in accordance with the ASTM standards. The experimental results indicates the increase in percentage of limestone and the marble powder increases the dosage of super plasticizer in order to achieve the workability indicates the presence of calcium in marble powder. The compressive strength and splitting tensile strength has been increased when the replacement ratio is 10%.

OM Omar et al. investigated the influence of marble dust in the fresh and hardened properties of concrete when replaced for the fine aggregate [8]. The experimental programme includes the compressive strength, split tensile strength and the flexural strength tests. The cubes of size 150 mm and the prism of size 150 × 150 × 500 mm size have been casted to evaluate the flexural strength. Cylindrical specimens have been casted to evaluate the elastic properties. Specimens of 100 mm diameter and 150 mm height cylinders have been casted. When the marble powder value is increased the workability decreased.

NM Soliman investigated the influence of marble dust in RC slabs. In this study cement was replaced with marble dust partially [9]. The experimental results showed that there was an increase in load carrying capacity of the slab when the cement is replaced partially with marble powder up to a certain percentage (5%). This percentage of replacement not only increased the load capacity but also decreased the ultimate deflection.

BV Bahoria et al. investigated the possibility of using different kind of wastes in concretes [10]. The wastes such as granite wastes, sewage sludge ash, granite ground ash, glass powder etc. has been used together as

wastes in concrete. The experimental results have been carried out in accordance with Indian standards. The possibility of using the wastes gives increase in compressive strength as per the experimental tests.

R Singh et al. investigated the utilization of the brick dust and the marble dust in self-compacting concrete [11]. In this research the concrete cubes casted as per Indian standards. For the experimental purpose both destructive and non-destructive tests have been carried out. Compressive strength test have been done and the results compared with rebound hammer test. The experimental results concluded that 25% replacement will give maximum compressive strength compared to the normal concrete.

NU Kockal investigated about the utilization of the industrial by products in concrete [11,12]. This research contains the study of concrete with different kind of wastes such as silica fume, green ceramic powder and marble powder under elevated temperatures. Along with the mechanical performance, the permeability of the concrete specimens has been studied after exposing to elevated temperature. Nine specimens have been casted for the experimental purpose in accordance with European standards. The experimental results conclude the excellent post and pre heating behaviour of the concrete specimens replaced with Marble Powder (MP).

F Colangelo and R Cioffi have investigated the combined use of the materials such as cement kiln furnace blast slag and marble sludge in concrete [13]. The mix casted in this research is a M30 mix. The compressive strength and flexural strength have been evaluated. The experimental results show the compressive strength of the concrete increases with 10% of replacement.

Monica and C Dhoka presented their research on the fine aggregates replaced with quarry dust and marble dust [14]. The physical and chemical parameters for all the wastes have been evaluated initially. Trail mix has been used for the specimen casting. The cement was replaced by paper pulp. The fresh concrete tests have been carried out according to the Indian standard IS 1199 – 1959. The hardened Concrete tests have been carried out according to the Indian standards. Fresh concrete tests involve the slump test and flow table. Compressive strength and Split tensile tests have been studied in hardened stage of the specimens. From the results it is found that 50% of replacement of marble powder gives grater compressive strength and workability due to its hardness value. The micro filling ability of the marble powder reduces the permeability of the concrete. The water absorption value is slightly high for modified concrete due to the presence of high calcium content in marble powder.

AN Abbas investigated the UHPC Beams with rebar under different loading conditions [15]. The experimental results include the deformation behaviour of the beams as well as the bending behaviour. Simply supported beams with (1200) mm span length and (180×250) mm cross sectional dimension have been casted. The loading method adopted here is a two point loading on the span of 1050 mm. The structural details of the beams consist of 2 numbers as well as 3 numbers of 16 mm diameter rebar having the yield stress 415 MPa and 500 MPa. Two loading rates have been used 1 kN/min and 2 kN/min. Crack width, stiffness and shear strength were measured. The experimental results indicates in his study that the load deflection characteristics of the UHPC beams were similar to the normal concrete beams. The usage of the rebar will increase the shear strength of the concrete. The crack pattern and the ultimate load increased when the loading rate on the beam was increased due to the post cracking behaviour. The crack width reduced in the case of increase in loading rate.

F Gameiro et al. investigated in thier research the durability of the concrete with the aggregates replaced with marble dust in certain percentage [16]. The materaials used in this research are lime stone aggreagte basalt sand and siliceous river sand.The tests performed in this journal basedon European standards. For experimental tests trail mix has been casted and the tests inlcuded workability, bulk desity, water absorption and the permeability.it is conculuded that The increse in percentage of marble powder decreases the workability of the concrete due to the presence of water absorption. The best replacement ratio was found to be 20% in the case of mechanical performance and durability studies.

M Chockalingam investigated the behaviour of self-compacting concrete with marble powder and silica fume [17]. In this tests the cement were replaced with marble powder and silica fume. The concrete having compressive strength of 30 MPa (M30) concrete has been used for this experiment. Slump test, L box test and V funnel tests have been carried out in fresh concrete. The compressive strength of the concrete cubes (of size 150 mm) has been used for this experiment. The experimental results conclude the compressive strength increased when the cement replaced with marble dust at a percentage of (15%).

OK Temur has evaluated the behaviour of concrete with aggregate replaced with marble dust at elevated temperatures [17,18]. The glass fibre was added for tensile strength. The experimental tests have been carried out according to the American Standards. The micro structural behaviour such as bonding also have been evaluated. The experimental results indicate there is an increase of compressive strength when marble powder is added up to a certain percentage. The bond between the glass fibre and mortar is very less so that the usage of glass fibre in UHPC is not advisable.

CONCLUSION

The flexural strength of the UHPC will be increased with the help of the reinforcement and the loading rate on the beam is increased Marble Dust has very low water absorption property but it has very low workability compared to the ingredients used in UHPC. Presence of very High amount of calcium and magnesia in Marble Dust indicated that it can be a best alternative for cement in UHPC. The hardness of the marble is comparatively equal to that of quartz sand and quartz powder which are the ingredients of UHPC, so that the replacement of cement with the marble dust will result in increase in compressive strength. The ultimate load of the RC slab is increased with the help of marble dust and the ultimate deflection is reduced. This result indicates the marble dust will be the best alternative in UHPC slab for cement.

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