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Review of Investigating the strength, Alkali Aggregate reaction and influence of elevated temperature in cement mortar contains Granite powder

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Abstract - Sustainability in Cement mortar Production can be achieved by innovations in substitutions of materials used. Innovations are much needed to meet the increasing demand for new and quality materials. Use of Hazardous Industrial wastes in cement mortar and concrete making will leads to greener environment. This paper presents the feasibility of the substitution of waste granite powder for cement to achieve economy and environment saving. Granite waste is a solid waste material generated from the granite processing and can be used either as a filler material in cement or fine aggregates while preparing cement mortar and concrete. It has been used as a replacement of fine aggregates in many literature works but this paper presents the feasibility of the substitution of granite waste for cement in mortar to achieve economy and environment saving. But silica oxide content in granite tend to cause alkali aggregate reaction. So an attempt has been made to investigate the occurance of ASR in cement mortar. Properties of cement mortar incorporating granite powder(GP) as partial substitution for Portland cement in amounts of different percentage were investigated and the Compressive strength of Cement mortar is found to be be decreased with addition of waste granite powder .And also an investigation conducted to evaluate the influence of elevated temperatures on the mechanical properties of cement mortar (which contains GP).The effects of elevated temperature on mortar are noted and their performance were compared to control mix mortar. In this research,analysis of SEM and XRD was carried out to analyze the particle size and occurance of ASR .The production of cheaper and more durable cement mortar using this waste can solve to some extent the ecological and environmental problems. Therefore this paper provides a scope for more research which is required to design consistent and durable concrete with this waste.
Keywords: Cement Mortar, Granite Powder, Alkali Silica Reaction, Elevated Temperature, Compressive Strength.

I. INTRODUCTION

Sustainability in Concrete Production can be achieved by innovations in substitutions of materials used. Innovations are much needed to meet the increasing demand for new and quality materials. In recent years there has been an increase in the consumption of mineral additions by the cement and concrete industries. The use of adequate industrial or agricultural by-products for partial cement replacement is an environmental friendly method of disposal of large quantities of materials that would otherwise pollute land,water and air [4].Use of Hazardous Industrial wastes in cement mortar and concrete making will leads to greener environment .

The granite cutting industry produces large amounts of wastes,solids (generated during extraction) and sludge (produced during transformation processes) [5]. Granite fines are often referred to as quarry or rock dust, and this residue generally represents less than 1% of aggregate production [6] or between 1% and 2% by mass of the total aggregate crushed in quarries, according to Abukerh and Fairfield [7]. Managing large amounts of sludge can be rather problematic for its producers, which must find appropriate places for storage and deposition. Dumping into rivers and lagoons is obviously not an environmentally safe solution and landfilling has serious drawbacks. Transporting and dumping of waste in landfills involves substantial costs; therefore, incorporating waste into other industrial processes could lead to a reduction of management costs and open up new business opportunities. Some previous studies have shown that granite sludge has a high potential as a raw material for the ceramic industry and it is amenable to use as filler in dry mortars [5]. In fact Mármol et al. [5] studied granite sludge waste for incorporation as alternative to ordinary limestone filler into cement- based mortar formulations. In this study findings revealed that the composition of this waste, the main components of which are SiO2, Al2O3, CaO and Fe2O3 based compounds, together with the small particle

size, warrant its use by the mortar industry. It was also concluded that 10% cement can be replaced with granite sludge waste without loss of 28 d compressive strength. These results support the use of granite sludge waste in mortar by virtue of their appropriate particle size distribution and potential pozzolanic activity.Granite powder waste 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 cement mortar. T. Ramos et al studied the effect of granitic sludge from a quarry as a partial fine aggregate replacement material in mortar in terms of strength and durability, so as to envisage its use in concrete. [1] The granite rock sludge was analyzed as fine aggregate replacement for strength and durability testing, for alkali-silica reaction expansion (ASR) and chloride attack. From the analysis it is found that there is marginal workability and strength loss for up to 20% fine aggregate replacement. It is also found that there is improvement of reduction in ASR expansion and improvement in chloride resistance. Scanning electron microscopy (SEM) after ASR attack showed deeper surface grooving and thicker gel layers corresponding to higher measured expansion. SEM on mortar after chloride in gress showed that aluminates led to formation of chloro aluminates explaining good results.

These results may lead to the successful use of this abundant waste in cement mortar as well as concrete.This paper presents the feasibility of the substitution of waste granite powder for cement to achieve economy and environment saving. Therefore this paper provides a scope for more research which is required to design consistent and durable cement mortar and concrete with this waste.

II. RESEARCH OBJECTIVES

The study had several typical objectives. This investigation aims at,

A. To minimise the environmental pollution by substituting waste materials in concrete.
B. To minimise the usage of non-renewable materials in concrete.
C. To establish alternative for cement with partial use of waste granite powder in cement mortar.
D. To check the occurance of alkali aggregate reaction in cement mortar.
E. To study the effect of use of waste granite powder on the mechanical properties of cement mortar.
F. To Find the optimum percentage of granite dust that can be replaced for cement.
G. To investigate the cement mortar ‘s chemical and strength properties when subjected to elevated temperature.

III. REVIEW OF LITERATURE

A. General review

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Hence an attempt is made in this chapter to review briefly the works carried out by earlier investigators on the study of mortar which contains granite powder. The research works are still under progress in the field of using waste granite to avoid problems of mitigation of ASR and improve the strength in mortar. The following literatures published related to the usage of waste marble powder and waste granite powder is briefly reviewed.

B. Earlier researches

AalokSakalkale D. et. al. (2014), found that the split tensile strength of cylinders is decreased with addition of waste granite powder, from control mix to 100% replacement of sand. However, the tensile strength at 25% replacement of sand is coming nearly equal to the tensile strength at control mix. Thus, 25% sand replacement with WMD can also give better tensile strength .The flexural strength of beams is also increased with addition of waste granite powder up to 50% sand replacement and then gradually decreases.

BabooRaiet. al. (2011), investigated the effect of using granite powder and granules as constituents of fines in concrete by partially reducing quantities of cement as well as other conventional fines. The values of workability, compressive strength and flexural strengths were found. Partial replacement of cement and usual fine aggregates with varying percentage of marble powder (0%,5%,10%,15%,20%)and marble granules revealed that increased waste marble powder (WMP) or waste marble granule (WMG) resulted in increase in workability and compressive strength of mortar concrete.

BaharDemirel(2010),investigated the effects of using waste granite powder (WMD) as a fine material on the mechanical properties of the concrete. For this purpose, four different series of concrete-mixtures were prepared by replacing the fine sand (passing 0.25 mm sieve) with WMD at proportions of 0, 25, 50 and 100% by weight. In order to determine the effect of the WMD on the compressive strength with respect to the curing age, compressive strengths of the samples were recorded at the curing ages of 3, 7, 28 and 90 days. In addition, the porosity values, ultrasonic pulse velocity (UPV), dynamic modulus of elasticity and the unit weights

of concrete were determined. It was observed that replacement of the fine material passing through a 0.25mm sieve with WMD at particular proportion has displayed an enhancing effect on compressive strength.

BhupendrasinghKalchuriet. al. (2015), shows that the waste granite powder is capable of improving hardened concrete performance and compressive strength of the concrete has increased with increasing percentage of granite powder in replacement of fine aggregate additions up to 20%. By using the marble powder as partial replacement of sand up to 20%, the rate of the concrete is decreased and strength is increased.

BouzianiTayebet. al. (2011), studied the effect of marble powder content (MP) on the properties self compacting sand concrete (SCSC) at fresh and hardened states. Values of slump flow, the V-funnel flow time and viscosity were found on fresh concrete. At the hardened state, the 28th day compressive strength was found. The obtained test results showed that larger MP content in SCSC (350 kg/m3) improved the properties at fresh state by decreasing V funnel flow time(from 5s 1.5s) and increasing the slump flow values (from 28cm to 34cm). With the use of 250 kg/m3 of MP, the highest initial viscosity was obtained while retaining good fluidity at high rotational speeds compared to the MP contents of 150 kg/m3 and 350 kg/m3. The 28 days compressive strength decreased with an increase of MP content.

Felixkala T.&Partheeban P. (2010),examined the possibility of using granite powder as replacement of sand along with partial replacement of cement with fly ash, silica fume and blast furnace slag. They reported that granite powder of marginal quantity as partial replacement to sand had beneficial effect on the mechanical properties such as compressive strength, split tensile strength and modulus of elasticity. They also reported that the values of plastic and drying shrinkage of concrete with granite powder were lessthan those of ordinary concrete specimens.

Dr.Felix Kala T. (2013), results of the paper shows clearly that granite powder as a partial sand replacement has beneficial effects of the mechanical properties of high performance concrete. Of all the six mixtures considered, concrete with 25% of granite powder (GP25) was found to be superior to other percentages of granite powder concrete as well as conventional concrete and no admixtures concrete for all operating conditions.

Dr.Felix Kala T. (2013), experimentally proved that with the mechanical strength of the high grade concrete can be increased by the use of granite powder and the behavior of granite powder with admixtures in concrete possesses the higher properties like concrete made by river sand.

GeorgijusSezemanaset. al. (2005), results of SEM investigations show that silicate fibre is not stable to the alkaline solution attack. As the result of its interaction with this solution a layer of the corrosion products is formed on the fibressurfaces.The XRD results confirmed the results of SEM investigations. The main products formed during mineral wool and kaolin wool fibres chemical interaction with the alkaline solutions are amorphous.

HanifiBiniciet. al. (2007), determined the mechanical properties of concrete containing marble dust (MD) and limestone dust (LD). Seven concrete mixtures were produced in three series with control mixes having 400 kg cement content. Fine aggregate was replaced with MD and LD. The replacement percentage of MD was 5 and 10% and it replacement percentage of LD was 15%. The compressive strengths of concrete cubes were found on 7th, 28th, 90th and360th day. Sodium sulphate resistance was found after 12months.Also,abrasion resistance and water penetration of concrete were investigated. Results indicated that MD and LD fine aggregate concrete had good workability and abrasion resistance. Abrasion resistance increased as the rate of fine MD and LD is increased. Furthermore, the results indicated that the increase in the dust content caused a significant increase in the sodium sulphate resistance of the concrete.

Her-Yung Wang &Tsung-Chin Hou(2011), the microstructure observation indicates that the cement mortars on replacement of 10% of LCD glass waste powder would achieve a complete hydration after 7 days of curing and then treated with an elevated temperature of 800˚C. The corresponding SEM image shows that under this circumstance, the porous structures were mostly granulated and the porosity was significantly enhanced.

Morsy M.S. et. al. (2010),concluded based on the mechanical and physical properties of silica flour concrete, it was observed that 20% silica flour concrete was generally more favorable than 5, 10 and 15%, and thus can be used in structural elements exposed to elevated temperature up to 400oC.

NohaSolimanM. (2013),studied the behavior of reinforced concrete slabs by using granite powder and the experimental results showed that, the use of definite amount of marble powder as a replacement of cement content increases the workability, compressive strength and tensile strength. Use of marble powder enhances the structural performance of the tested slabs as it increased the stiffness and the ultimate strength compared to the control slabs.

Oyekan G.L.&Kamiyo O.M. (2008), studied the performance of hollow sandcrete blocks containing cement, sharp sand and

granite fines in varying propositions to determine their structural and hygrothermal properties. The percentage of granite fines by volume of the total fine aggregate was varied in steps of 5% to a maximum of 30%.Results of the tests indicated that the inclusion of granite fines in the sand-cement matrix has a very significant effect on the compressive strength of sandcrete blocks. It was also, observed that for both mix propositions, 15% granite fines content was the optimum value for improved structural performance.

RaghavendraR. et. al. (2015),the experimental work shows that the strength properties of the concrete could be enhanced by utilization of granite powder in the place of river sand,Compressive Strength of HPC shows increasing trend till 15% increment of Granite powder and again it was very near to the conventional concrete .

Rahulet. al. (2011),concluded that the marble dust can be used as a replacement material for cement ; and 10% replacement of granite powder gives an excellent result in strength aspect and quality aspect and it is better than the control concrete.

ShahulHameed M. &SekarA.S.S. (2009),investigated the usage of quarry rock dust and marble sludge powder as possible substitutes for natural sand in concrete. They also carried out durability studies on green concrete and compared with the natural sand concrete. They found that the compressive, split tensile strength and the durability concrete were good when the fine aggregate was replaced with 50% marble sludge powder and 50% Quarry rock dust (Green concrete).The resistance of concrete to sulphate attack was enhanced greatly.

Shirule P.A. et. al. (2012),determined the compressive strength and split tensile strength of concrete in which cement was partially replaced with marble dust powder (0%,5%,10%,15%, 20%).The result indicated that the Compressive strength of concrete increased with addition of waste granite powder up to 10% replaced by weight of cementand further addition of waste granite powder was found to decrease the compressive strength. The optimal percentage replacement was found to be 10%.

Sounthararajan V.M.&Sivakumar A. (2013),based on the experimental investigation they concluded that High strength concrete can be achieved when marble powder is replaced at 10% by weight of cement in concrete and also the workability decreased as the granite powder content increased. Use of polycarboxylate ether based superplasticizer is found to be necessary to maintain workability at low water cement ratio.The higher replacements of granite powder does not show large reduction in strength and can be suitable for producing grade concrete upto M30.

Tanpreet Singh & Anil Kumar Nanda(2012),concluded that when granite powder is partially replaced in cement by weight; there is a marked reduction in compressive strength values of mortar mix with increasing marble powder content when compared with control sample at each curing age.

Prof. Veena G.et. al. (2014),concluded that the Compressive strength and Split Tensile strength of Concrete can be increased with addition of waste granite powder up to 10% replace by weight of cement.

VenkateshKodur(2014),author states that Concrete, at elevated temperatures, undergoes significant physicochemical changes. These changes cause properties to deteriorate at elevated temperatures and introduce additional complexities, such as spalling in HSC. Thus, thermal, mechanical, and deformation properties of concrete change substantially within the temperature range associated with building fires. Furthermore, many of these properties are temperature dependent and sensitive to testing (method) parameters such as heating rate, strain rate, temperature gradient, and so on.

The review of literature in this chapter has concentrated largely on themechanical properties and chemical properties of mortar contains granite powder and marble powder.

IV. CONCLUSION

A. The study concludes the following

B. According to earlier experimental studies, use of wastes as a partial replacement of cement in mortar constituents had a great prospective.

C. Industrial wastes are capable of improving the physical and chemical properties. Use of marble waste powder and granite powder shows a great performance due to the efficient micro filling ability.

D. As per the study on earlier research papers, marble powder when replacing with sand upto 20% shows almost same strength.

E. Waste marble powder has some cementitious properties. Because of these properties of marble powder, it can be used and fulfills the economical and environmental problems.

F. Addition of marble powder can also affects the shrinkage and plasticity.

G. Marble powder is easily available so it might be cost effective.

H. Utilization of granite powder will avoid the disposal problems and related environmental issues.

I. Replacement of fine aggregate with granite powder is found to improve the strength of concrete. The optimal dosage of replacement is found to be 15%.

J. The workability of concrete is good even after addition of the granite powder as replacement into concrete.

K. Compressive strength increases with replacement of granite wastes at 10% replacement of cement.

L. Compressive Strength of HPC shows increasing trend till 15% increment of Granite powder and again it was very near to the conventional concrete.

M. The compressive strength has increased by 22% with the use of 35% replacement of fine aggregates with granite fines. With increase ofgranite fines up to 50% increasing compressive strength will limit to 4% only.

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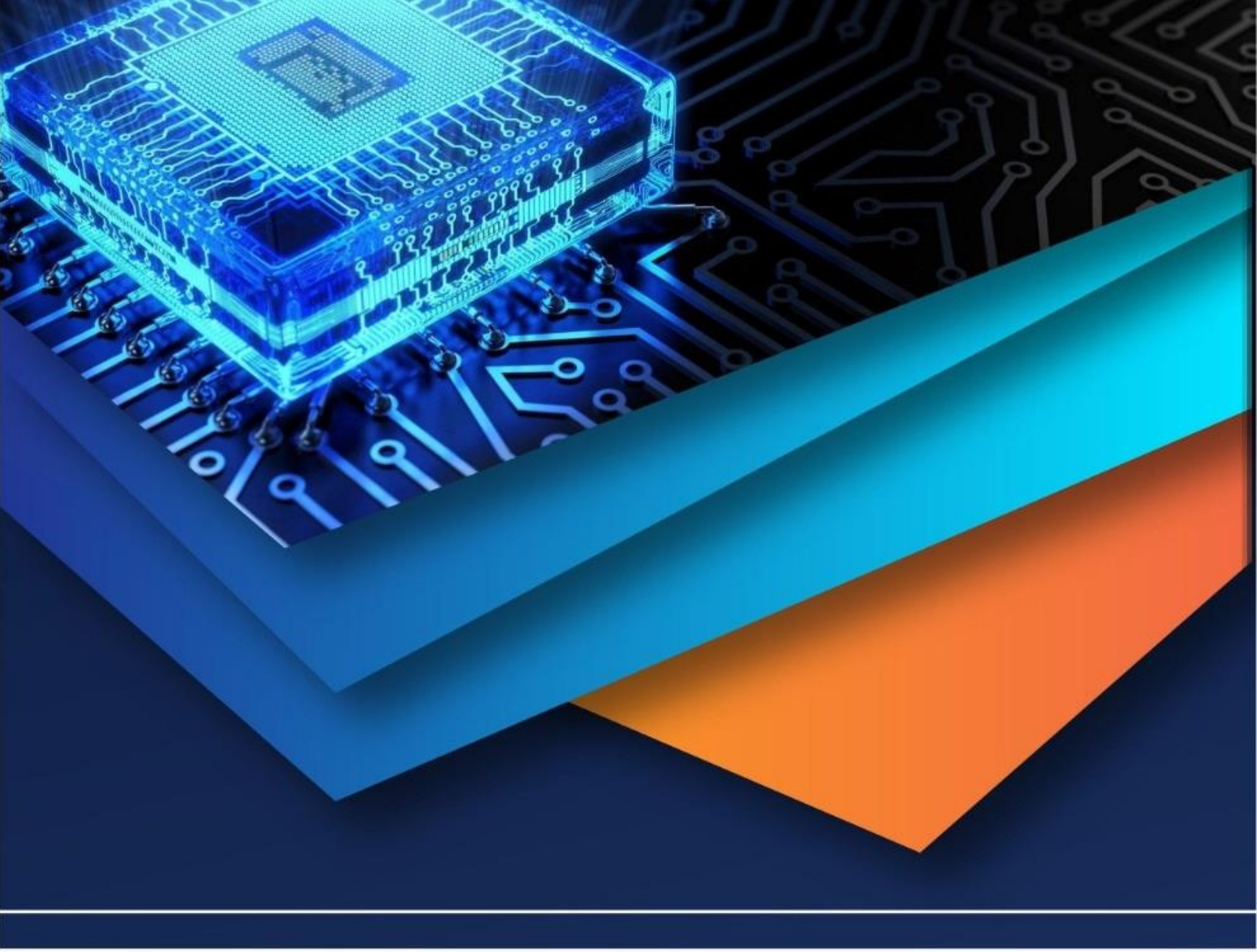

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