A Review on Performance of Concrete Using Metakaolin as A Binder and Granite Waste as A Coarse and Fine Aggregate

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Abstract

Granite fine is a product made in granite factories, while cutting large granite rocks. In concrete, granite fine is used as a filler material, which converts the ideal amount to help fill the holes in the concrete and it will increase the strength of the concrete. A large amount of material is used to test the strength of concrete by using granite fine as a composite. Concrete is made with granite fines as an alternative to fine concrete and various tests are explored and these values are compared with conventional concrete without granite fines. So while granite is a good alternative to locally available concrete, it improves the compression, tensile and flexibility properties of concrete, while also significantly offsetting the overall cost of concrete.

Keywords : Concrete, Coarse Aggregate, Fine Aggregate, Granite

I. Introduction

Concrete is the mixture that consists of three basic components: water, cement and aggregates. The mixture of these materials and their interactions determine its properties and characteristics. Thus the two phases created in concrete, from cement and water on the one hand, and from aggregates on the other, bring together many research efforts to improve the properties of concrete. The role of cement in concrete is certainly dominant as it is its main component. The technological requirements of modern constructions have brought about significant changes in the composition of cement. Many specialty composite cements have been produced, using other main components besides clinker, with the aim of improving its properties and producing high-strength concrete. Also important weight has been given to the role of aggregates and the way they "work" with cement. In fact, the interface between aggregates and hydrated cement, which "describes" the cooperation of the two materials, has been described by many researchers as the critical point of concrete. But also the chemical reaction of the aggregates with the cement components, when it happens, most of the time has a negative effect on the properties of the concrete. Many materials are used to improve the morphology of the aggregate and hydrated paste interface as well as the other interfaces created in the concrete during hydration. These materials have the ability to react with Ca(OH)2, and to produce products that pay for the pores of the concrete. They are used as additives by weight of cement and are the 4th component of concrete. The technological goal of all these efforts is to create "high performance concrete". The materials used are characterized as "high value-added materials" because they significantly improve the behavior and durability of concrete (durability), usually positively affecting other key properties. Of course, because some of the materials used have some cost, which mainly comes from their production and processing processes, the cost of construction is borne. However, the fact that the percentage of cement from the use of additives is significantly reduced - it can reach up to percentages of up to 35% depending on the material - obviously works positively in the overall cost estimate. Also the improvement of the quality of the construction and its life time are elements that in the long run amortize the construction cost. Finally, in any case, the indirect environmental relief is particularly important, considering that for every ton of cement produced, the atmosphere is charged with almost one ton of CO2.

Fine aggregate (FA) is an important component of concrete. The most commonly used is natural river sand. The Government of Tamil Nadu has recently imposed restrictions on the removal of sand from river beds due to undesirable impacts on the environment. On the other hand, the industry has accumulated granite waste over the years. Only a significant amount is used and the rest is dumped dishonestly as it is not polluted. The enormous increase in the amount of waste to be disposed of, the severe shortage of bins, the sharp increase in transport, and the cost of dumping garbage necessitate the need to use this waste effectively. The shipped work is aimed at making concrete using granite scrap and industrial waste. In doing so, it serves the purpose of reducing construction costs, and also helps to address the region's environmental issues, including its disposal issue.

Industry-generated granite waste has been accumulating over the years and is being dumped dishonestly due to environmental issues. We, therefore, use granite waste as a cement substitute in different percentages.

2. Literature Review

After firing kaolin at two different temperatures, 800°C and 900°C, the authors [1] prepared geopolymers from metakaolin. Its kaolin geopolymers treated at 900°C had better compression and bending strengths than 800°C heat treated kaolin. The lower frying temperature of kaolin results in lower thermal conductivity of the geopolymers [2-3]. In another study [4] the setting time of geopolymer polymers decreases when the firing temperature of kaolin is between 500°C and 700°C, while above 700°C, it increases. A further increase in the firing temperature of the kaolin leads to a decrease in compressive strength (CS). According to [5], metacoline is said to have some effect on the CS of geo polymers before and after exposure to high temperatures (650°C –850°C). Metakaolin which is suitable for use as a building material for geo polymer products is got during firing of kaolin at a temperature of 500 to 750 C for 2 to 6 hours [6, 7].

The performance of SBR is tested in tropical climatic conditions as a concrete repair material. Since its cement mortar has shown excellent reduction in water penetration resistance [8].The use of polymers in mortar and concrete mixtures has improved properties than concrete. The study shows that 8% polymer content is added to the compression and flexural strength of cement mortar. At 3, 7, and 28 days the CS increased by 13.5%, 8.35%, and 9.12%, respectively, with a maximum flexibility (F) of 8% at 8% polymer content compared to conventional motors [9].SBR was used for the bonding layer between the old and new concrete. At days 7, 28, and 60, there was an increase in the CS of the modified samples with the bond (SBR) compared with the old concrete without using the polymer bond [10].The effect of SPR is to increase the working capacity of concrete, and the CS of modified mortar is 5% to 5% slightly higher than that of ordinary cement mortar. Polymer film formation at a ratio of 5% P/C seems to be shown in a small number of locations across small bridges. The CS of the concrete decreases compared to that of ordinary concrete [11-15].

Recently, [16] has provided extensive research on the development of stable binders using partial alternatives to cements such as slag, metakaolin, fly ash, etc., SCMs play an important role in mortar and concrete properties when incorporated at a certain ratio in the cement system. Based on the results of the reviewed research, some modifications of the SCMs improve the mortar and concrete properties through the pore structure and the pozzolanic reaction. In [17] the effects of four composite systems are examined. Compared to conventional Portland cement, quartz composite has been shown to produce more thermally stable hydration products. Recently, [18] examined the properties of slag, silica fume and metakaolin in 25, 30 and 35% of Portland cement alternatives. The development of the microstructure of the 365-day cure and its impact on mechanical strength were examined. The effect of partial change of metakaolin is explained on the performance of concrete mixes at 5, 10, 15, 20, 25, and 30%.

The effect of superplasticizer on performance can be clearly seen, despite the increase in metakaolin levels [19]. With a W/C ratio of 0.55, the hydrolysis rate of partial change was found at 0, 10, 15, 20 and 25% of metakaolin. The amount of hydration of the metakaolin pastes was specified based on the total calcium of the hydration process [20]. The sulfate resistance of modified mortars is examined by partially replacing the cement with methacrylate. Samples of the compounds were mixed with 1: 3 cement/ sand at a w/c ratio of 0.50. With regard to the behaviors of the modified motor compared to the conventional motor, it was found to prevent sulfate attack. The optimal metakaolin replacement appeared to be associated with a 10 to 15% reduction in workload, with 15% metakaolin substitution having 19.9% better mechanical performance compared to control concrete [21]. According to [22], there is a correlation between absorption, limitation of elasticity and distribution of strength.

In the study, the increase in partial cement conversion using metakaolin led to a significant increase in the amount of water required for hydration. The results show a 19.5% improvement in CS with a partial change of 10% metakaolin in 28 days. The use of 20% by weight and 10% by weight respectively as a substitute for metakaolin sand or cement improves the corrosion resistance of motor models [23].However, [24, 25] studied the effect of the use of metakaolin as a by-product of the cementitious properties of concrete.

In addition, according to [26], the life properties of metakaolin -modified concrete had improved durability. Portland cement had better frost resistance compared to it.

In another study, [27, 28] they examined the effect of converting cement by metakaolin using different W/C in 90 days. The use of metakaolin in concrete increases the rate of initial aging strength of the concrete paste. Compression strength increases with increasing metakaolin levels.

Furthermore, [29] examined the impact of metakaolin change on strength properties and the rapid chloride penetration of concrete. Models were prepared wih partially modified the cement by metakaolin. Significant improvements in CSs were observed for the cement conversion by metakaolin. In [30] research on the partial replacement of cement with metakaolin on concrete is provided. The results showed that the metakaolin mixture improved the properties by 15% and then decreased by further increase of methacholine.

In [31-34] the state of metakaolin and the properties of concrete were discussed. It was emphasized that the addition of metakaolin to concrete led to 25% strength and improved durability and lower water permeability and agility. In [35], a test study on the modified cement mortar properties by epoxy mortar compared to acrylic modified mortar is conducted. In [36], a test study on incorporating PVA emulsion into lightweight concrete, the result shows a 20% increase in CS with 180 days of healing. The F of the modified lightweight concrete was 10% higher than that of the unaltered concrete in 28 days.

To determine the bonding effects of polymer composites to improve the strength of a wide range of concrete, [37] evaluated the properties of a wide range of concrete through testing.The positive effect of polymer are reviewed and showed three types of polymers in concrete. Polymers improve the properties of concrete, including increased CS, F and tensile strength (TS) and better improvement in chemical resistance and corrosion reduction and penetration of concrete [38].

Furthermore, [39] studied the influence of the chemical properties of polyvinyl alcohol on the initial hydration of cement. Meanwhile, [40] evaluated the use of polymers to change the functional and mechanical properties of a wide range of concrete composites. Four polymers with different chemical properties were incorporated into the mix and several tests were carried out on cementitious mortars firstly and secondly on a wide range of concrete mixtures. Results show that some polymers in general are beneficial in increasing the life of the material. In particular, polymer modified compounds have the ability to increase density by low CS to obtain a certain void level.

Polymer/cement mass ratios were studied. The work provided an impact of integrated SBR latex on the microstructure, and chloride bonding behavior of Portland cement mortar [41].In [42- 43] SPR examined SBR-modified reinforced concrete beams and it showed significant improvement in the flexural strengths of modified concrete. In [44], as noted in previous research, the bending strength of concrete with 5% SBR significantly increases with CS, and replacing cement with SF improves the F up to 7.5%. The effect of applying SBR polymer is studied on concrete in conjunction with fly ash and SF [45].

Most recently, [46-47], explored that replacing 15% cement with 5% optimal polymer and metakaolin creates an optimal concrete mix for durability and strength.The effects of polyacrylic esters and silica fumes are tested in varying amounts on cement mortar [48].

Portland cement mortar was tested with 100% Portland cement mortar at 7 and 28 days with 30% metakaolin 15% lime and improved mechanical properties [49]. The influence of cement type and plasticizer additives on concrete is explored. Research shows that the type and amount of plasticizer plays a significant role in cement in concrete [50].

According to [51-55], the impact of aggregate types on the strength of concrete is most significant in high-performance concretes. For high-strength concretes, higher flexible strengths are obtained with basalt and lime aggregates compared to normal gravel aggregates. Concrete made of limestone may have relatively high strength due to the intermediate chemical reaction between the cement and the coarse aggregates.Their study showed that the compression strength increased by 22%, replacing 35% of the aggregates with granite fines. By increasing the granite fine to 50% the CS will be only 4%. The split tension strength is equal to 0%, 25% and 35%. The 5% shift has a strength of 2.4% and the 15% shift reduces the TS. However, by changing the 35% granite fines, it can be concluded that the test results did not show a decrease in strength compared to the sand mixtures [56].

They founded with the addition of metakaolin cement compared to conventional concrete. The ideal percentage for conversion by metakaolin is 10% to 15%. The mechanical properties of concrete are improved by partially changing the metacoline and granite dust. The CS of concrete is 15% MK and 20% GP in concrete [57].

Studies showed that the CS of concrete is increased by increasing the granite powder content. At 7 and 28 days the strength decreased from 0 to 7.5% and from 7.5% to 10%. The TS of composite concrete is found to be 0 to 7.5 % by replacing cement with granite powder. However, the STS of concrete increases with the granite powder content and can be seen to reach an optimal value of 7.5%, then decreasing to 10% at 7 and 28 days [58].The following observations and conclusions are drawn from this study they conducted based on experiments performed on six beam models. G.P. A load of failure was high, which was the controlled beam when the test was increased to 28 days. As a result of this investigation, 25% GPS can be used as an alternative to better concrete self-compact high-performance reinforced concrete beams [59].

Their study shows that, in terms of their F, in the early stages of curing, even after natural sand has been replaced by granite powder. The next phase of curing allows 28 and 56 days to increase the new strength with a GB% increase, but not to the conventional concrete level. Performance is just as good as regular concrete. Granite masses can therefore be considered as a substitute to FAs [60].Their findings from experimental studies demonstrate that the mechanical properties of granite powder strength can be considered as a partial alternative to sand. . Adding 30% with granite fines proves that the concrete mix is better compared to other ratios. CS, especially with reference compound (GF0) for all ages, increased during the healing days. The CS with 30% granite fines gave a higher value compared to other values [61].

In this study they established the STS for compounds containing 5% granite waste. Control compound. Increasing the conversion rate of cement by 10% led to a value for the equivalent STS measured for the control mixture. However, TS is measured when this ratio is high. Converting granite waste in the concrete mix at a 25% conversion rate led to higher values of TS separation than obtained from the control mix [62].In this study, they established the a test study of high-performance concrete made from granite powder, which contains 7.5% silica smoke, 10% fly ash, and 10% sludge instead of cement [63- 67].

In this study they established the CS of concrete increments by converting granite powder waste to 7.5% and this is comparable to normal concrete. The work efficiency is very good for different percentage of cement replacement [68].The study show that the concrete mixture replaces the cement with 15% granite dust powder from the abstract test results they have established. 7 days and 28 days curing tip greater CS than concrete mix. When analyzing the test task, the most important factor to consider is cost analysis [69, 70].In this study they concluded that replacing 10% sand with granite waste gave higher CS to all ages compared to the control mix. Replacing 5% cement with granite waste resulted in a slight decrease in CS (approximately 5-9%) [71].

3. Conclusions

Based on the test of CS, STS, and workability of concrete, strengths such as compression, STS, flexibility and workability have been shown to be increased by partially replacement of granite powder.

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