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Review Article

A REVIEW PAPER ON COMPARISON OF CONCRETE PROPERTIES BY USING DIFFERENT TYPES OF FINE AGGREGATE AVAILABLE IN LUCKNOW

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ABSTRACT

The high cost of conventional construction material affects the economy of structures and there is an increasing concern over the excessive exploitation of natural resources. Aggregates produced from environmental waste can be a viable source of aggregate materials. It is becoming more difficult to find the natural resources, therefore it is need of the hour to find alternative materials to reduce the cost of concrete. It has been reported in several studies that grey sand and brown sand at stone quarries are becoming increasingly difficult to manage. Many researchers are finding different materials to replace sand and one of the major materials can be grey stone dust. In this study, concrete is tested with different types of sand aggregates available in Lucknow region. The compressive strength of concrete, casted using three types of sands, is measured and comparative analysis will be performed in the second part of this study. This paper presents a review of the different alternative to natural sand in preparation of mortar and concrete. The paper emphasizes the physical properties, mechanical properties and strength aspect of mortar and concrete when replacements were performed by various studies.

INTRODUCTION

In every aspect of construction industry concrete is used at very large scale. It is a composite material prepared by mixing of aggregate and fluid binding material, which hardens over time and attains its strength 28 days of time. The binder material reacts chemically with water and other ingredients to form a hard matrix which binds all the materials together into durable stone-like materials that are used in many ways. Concrete is known for its high compressive strength and low tensile strength. It has the unique distinction of being the only construction material that can be manufactured on the worksite while other materials are merely shaped to use at the worksite. If materials like sand, gravel or crushed rocks along with cement and water are kept constant, both high quality and low quality concrete can be cast depending upon the quality control and precision of processes involved in the concrete production. Researchers have been trying to improve the quality of cement and concrete technology ever since the Roman era. The introduction of reinforced concrete as an alternative to steel construction, at the beginning of 20th century, necessitated the development and use of low and medium strength concretes. Mix proportion of concrete consists of cement, fine aggregate, coarse aggregate, water and some admixtures.

Aggregates are important constituents in concrete contributing to strength development. They give body to the concrete, reduce shrinkage and effect economy. Ideal aggregate should be chemically inert and should possess sufficient hardness and sufficient toughness. They should be strong enough to bear the compressive and tensile load and should be free from impurities, inorganic or organic in nature. They should also be capable of producing an easily workable plastic mixture. Coarse Aggregate are those aggregate which retained on 4.75mm size sieve are categorized in coarse aggregate. Aggregate will consist of naturally occurring (crushed and uncrushed) stones, gravel and sand or combination thereof. The aggregates should possess properties like hardness, strength, cleanliness and should be free from chemicals and vegetation. Also, flaky coriaceous and elongated pieces should not be used in the concreting process. Fine Aggregate is those which are passed through 4.75mm sieve, taken for the mix. The fine aggregate which is used in this investigation is available as coarse sand.

Among these ingredients natural sand is generally used as fine aggregate in concrete which if over exploited creates an environmental crisis. Due to this crisis the government have been trying to organize the mining sector which has led to increased in cost of the natural sand. In such a situation stone

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dust can be used which has a potential to be alternative to natural sand. Stone dust is a byproduct generated from quarrying activities involved in the production of crushed coarse aggregates. The residue from the stone crusher is further washed with water to remove the excess fines so that fraction confirming to IS 383-1970 specifications can be extracted it is possible to use such manufactured sand as fine aggregate in concrete which will reduce not only the demand for natural sand but also the environmental burden. This study summarizes all the research works done related to replacement of natural sand with an alternate material.

LITERATURE REVIEW

KavithaKarthikeyan (2017) attempted to use Talipot palm seed as the partial replacement for coarse aggregate in concrete. The seed has no other use other than to be disposed of as waste. The seeds were found to be abundantly available in villages, which was collected and used for this study. The properties of the Talipot palm seeds were found to be: Light in weight, very low crushing strength, low impact value. Each seed is 18mm in size and weighs 4 grams. The first try was to use the seeds without crushing. This was attempted in M20 grade concrete and the replacement was of the order of 10% and 20%. The cubes which were prepared by partially replacing with Talipot palm seeds showed prominent cracks all over the surface after seven days All the specimens showed the same phenomena of cracks, which indicated that the seeds lacked in the binding property when used without crushing since it had a smooth surface. In the second attempt, seeds were crushed and then replace of the order of 10% and 20% for coarse aggregate in concrete. When the seeds were crushed and used it was found that the specimens did not develop any cracks after curing. When tested for the compressive strength, the strength values were almost equal to that of the conventional concrete. Use of Talipot Palm seeds as an alternative to coarse aggregate was investigated in this study. The compressive strength of was found to be satisfactory but the durability factors need to be studied in greater depth so that it can be practically implemented.

BU *et al*.(2017) showed the effect on the compressive, flexural and splitting-tensile strength of cement mortars was evaluated using 4 sand content. By changing the sand content and water/cement ratio, the pore structure of cement mortar was studied. MIP technique was used to obtain the pore size distribution which quantified the pore structure changes. The test results show that the strength of cement mortar increases with increasing sand content up to an extent. With the slight modification, traditional water/cement ration can also be used. The sand content was found to be an important parameter influencing the pore structure of cement mortar. The relationship between the pore structure and strength of cement mortar was found to be good.

Naresh Kumar *et al*. (2017) presented research paper discussing the effect of coconut shells and fibres (polypropylene and steel fibres) on M30 grade concrete. The fibres used in this work are Polypropylene and Steel Hooked end fibres of 0.5 mm diameter and 60mm length. The study noted that as the percentage of coconut shell replacement with coarse aggregate increases the strength properties decreases. With the addition of fibres like polypropylene and steel to the concrete with coconut shell, the strength properties of concrete increase some extent but not higher than the conventional concrete.

Vilane and Sabelo (2016) conducted an experiment to determine the effect of aggregate size on the compressive strength of concrete. The experiment had three treatments, which were the aggregate sizes (9.5 mm, 13.2 mm and 19.0 mm) and the control. A constant mix of 1:2:4 with a water/cement ratio of 0.5 was used throughout the experiment. Tests that were conducted included the slump and compressive strength tests. It was concluded that concrete workability (slump) was directly proportional to aggregate size. The mean concrete compressive strength increased with increasing aggregates size.

Karuna Devi *et al*. (2017), An experimental study is made on the utilization of E-waste. Particles as coarse aggregates in concrete with a percentage replacement ranging from 0 % to 20% on the strength criteria of M20 Concrete. Compressive strength, Tensile strength and Flexural strength of Concrete with and without E-waste as aggregates was observed which exhibits a good strength gain.

Manjunath (2017)An experimental study is made on the strength aspects of cement mortar by partially replacing river sand with Sea Sand and desert sand as a fine aggregate. Different fine aggregate materials (SS, DS and RS) were used in 10%, 20%, 30%, 40% and 100% proportion to make cement mortar blocks and tested. For each proportion of Fine Aggregates (FA) cement mortar blocks were cast and tested for compressive strength at 3, 7, 28 and 56 days of curing. Graphical presentation of data was done by plotting compressive strength v/s curing period and preparation of tabular data comprising of compressive strengths of replacements was done.

AyushiR.Sharma(2016), in this experiment, an attempt has been made to discuss the properties such as workability tensile strength and compressive strength of concrete prepared by replacing natural sand with artificial sand at different replacement level (0%,20%,40%,60%,80%,100%).The aim of the project is to study the strength and durability performance of concrete made with natural sand and artificial sand.

Somani *et al*. (2016) conducted experimental investigations to study the impact of the partial replacement of coarse aggregate by demolished waste. Workability and compressive strengths were used as performance indicators. For the study 3, 7 and 28 days compressive strengths were recorded. The previous study on the same topic had shown that if demolished aggregate concrete is used upto 30%, its compressive strength was similar to the conventional concrete. So in this study we have taken the demolished concrete aggregate 10%, 20%, 30% by weight of the conventional coarse aggregate and the concrete cubes were cast by that demolished concrete aggregate then further tests conducted such as workability , compressive strength for that DAC and the result obtained are found to be comparable with the conventional concrete.

Auda (2015) propounded that primary and secondary containment structures are the major components of the nuclear power plant (NPP). The performance requirements of the concrete of containment structures are mainly radiological protection, structural integrity and durability, etc. High-performance heavy density concrete with special attributes can be used for this purpose. The aggregate of concrete plays an essential role in modifying concrete properties and the physico-mechanical properties of the concrete affect significantly on its shielding properties. Coarse aggregate consisting of barite, magnetite, goethite and serpentine were used to prepare 15 concrete mixes. Additional 10% silica fume (SF), 20% fly ash and 30% ground granulated blast furnace slag(GGBFS) to the total content of Ordinary Portland Cement were used. The water-cement was kept equal to 0.35, cement content was kept at 450 kg/m3 and sand – the to-total aggregate ratio of 40% was kept. This was done to achieve the high performance (M60) concrete. Concrete density has been measured in the case of fresh and hardened. Seven, twenty eight and ninety days compressive strength was determined for the concrete mixes. For some concrete mixes 90 days compressive strength was tested by replacing sand with magnetite, goethite and barite. The spectrometer of NaI (TI) which uses gamma rays for measuring the attenuation. The used radiation sources consisted of 137Cs and 60Co radioactive elements with photon energies of 0.662 MeV for 137Cs. Two energy levels of 1.173 and 1.333 MeV for 60Co were used. Some shielding factors such as half-value layer (HVL), tenth-value layer (TVL) and linear attenuation coefficients (μ) were measured. It was noted in the study that the concrete mixes containing magnetite coarse aggregate along with 10% SF reaches the highest compressive strength values which were found to be exceeding over the M60 requirement by 14% after 28 days of curing. On the other hand, the compressive strength of concrete having barite aggregate was very close to M60 and was found to exceed if the specimen was observed even after 90 days. The study showed high-performance heavy density concrete's compressive strength, where magnetite was used as fine aggregate, the aggregate was significantly higher than concrete containing 23% sand. The physico-mechanical properties showed improvement when compared to the corresponding concrete containing barite and goethite when concrete made with magnetite was used. It was concluded that when magnetite was used as fine aggregate the shielding against γ-rays was enhanced greatly for high performance concrete.

Azhahendran *et al*. (2016) found that Talipot palm seeds were lightweight materials having the low crushing strength and impact value. Usually, each seed weighs 4 grams and is 18mm in size. It was reported in the study that the compressive strength values were almost equal to that of the conventional concrete. The study recommended the use of Talipot Palm seeds after durability analysis as it found the compressive strength to be satisfactory for practical implementation. The study attempted to investigate the possibility of usage of the Talipot Palm seeds as an alternative for coarse aggregate, which was successful in terms of compressive strength, but the durability factor needs to be studied in the longer term, to successfully implement it practically.

Siddique *et al*.,(2015) published literature which stated that there is a strong possibility of E-waste being used as substitute/ replacement of aggregate. Its use in concrete becomes more significant and important in view of the fact that sources of natural aggregates are getting depleted gradually, and it is of prime importance that substitute of aggregates is explored. The paper summarizes the literature published on the use of E-waste in concrete. Effect of E-waste on the properties of concrete such as compressive strength, split tensile strength and durability are presented.

Chabbara *et al*. (2015)conducted a research project on the properties of concrete is evolved using fly ash, recycled aggregate, glass powder and crumb rubber. The project was divided into two parts i.e. Research Program one which presented concrete containing fly ash, glass powder and recycled aggregate. Partial replacement of cement was done by 30% fly ash, the coarse aggregate was partially replaced by 40% recycled concrete aggregate and glass powder partially replaced fine aggregate with a varying percentage from 15% to 25% at an interval of 5%.In the second research program cement was partially replaced by 30% fly ash, coarse aggregate is partially replaced by 40% recycled concrete and crumb rubber partially replaced fine aggregate with a varying percentage from 5% to 10% at an interval of 2-3%.

Yusut *et al*. (2015) reported about the average compressive strength of concrete made with river sand (fine aggregate) and the one produced with the dune sand (fine aggregate). Concrete cubes 150mm x 150mm x 150mm were cast using a nominal mix of 1:2:4 while keeping the water-cement ratio at 0.62. Curing was done and tests were conducted at 7, 14, 21, 28 days. At each curing period, three cubes were used each for both concrete produced with river sand (fine aggregate) and that of dune sand (fine aggregate). A total of 24 test cube samples were produced and crushed at the end of each curing period. The compressive strength of each was determined after crushing and later the average compressive strength of the three samples at each curing period was determined. It was concluded that twenty-eight days compressive strength of concrete utilizing dune sand was within (fine aggregate, i.e. 22.68N/mm2) the range stipulated in British Standard code of practice, BS 8110 (1985) (i.e. 20 – 40N/mm2).

Mahla and Mahla (2015) performed a study to analyse various properties necessary for the design of concrete mix using coarse tyre rubber chips as an aggregate material in an organised manner. M-20 grade of concrete was chosen for conducting the experimental investigations. The conventional coarse aggregate was replaced by scrap rubber chips for the study.

Suribabu *et al*. (2015), in this experiment quarry rock dust, is used as 100% substitutes for Natural Sand in concrete. Mix design has been developed for M25 and M40 grades using design approach IS for both conventional concrete and quarry dust concrete. Tests were performed on beams and cubes to analyse the strength of concrete made of Quarry Rock Dust and the results were compared with concretecast with the Natural Sand Concrete. It is concluded that the flexural and compressive strength of concrete made of Quarry Rock Dust is nearly 10% more than the conventional concrete. Tests were also conducted on cubes and beams which are exposed to temperatures of 300°C for 1hr, 3hr durations respectively.

Babu and Mahendran (2014) conducted a study in which blast furnaces slag sourced from two places were replaced with fine aggregate and the properties of concrete were analysed. The optimum percentages of replacement of these materials were found out. The result obtained encourages the use of these materials as a replacement material for fine aggregate.

Adigun (2013) performed a study to investigate the economic gain of replacing sand with Crushed Granite Fines in the production of concrete. Compressive strength and slump tests were performed on fresh and hardened concrete using two nominal mixes of 1:1:2 and 1:1½: 3 with the sand component being partially replaced with Crushed Granite Fines. When sand was partially replaced with 25 – 37.5% Crushed Granite Fines compressive strength values exceeding 30 N/mm² and 35 N/mm² were obtained for nominal mixes of 1:1:2 and 1:1½: 3 respectively. Based on the economic analysis of the test results, replacement of sand with 25 – 37.5% Crushed Granite Fines is recommended for use in concrete production.

Suganthy *et al*. (2013), HDPE (High-Density Polyethylene) was taken into consideration as it was easily available & had a higher density than other types. The used plastics were collected, ground into smaller components, melted & pulverized in order to get granules of plastic of about 1mm size. The density of the Pulverized plastic was found to be 460 kg/m3 & its specific gravity was 0.46. Sieve analyses were carried out & about 75% of the plastics were found to be in the range of 1 -1.7mm. 45 nos. of 15cm x15cm x15cm cement concrete Cubes of 1:1:2 (M 25) mix were cast for 0%, 25% , 50% , 75% , 100 % sand being replaced with Pulverized plastic material. Volumetric proportioning was adopted instead of design mix since the density of plastic material was too low. Workability test, weight and compressive strength of the cubes were determined.

Malik *et al*.(2013) conducted a study where some of the pressing issues of economic and environmental concern are addressed by the use of waste glass as partial replacement of fine aggregates in concrete. Fine aggregates were replaced by waste glass powder as 10%, 20%, 30% and 40% by weight for M-25 mix. The concrete specimens were tested for compressive strength, splitting tensile strength, durability (water absorption) and density at 28 days of age and the results obtained were compared with those of normal concrete. The results concluded the permissibility of using waste glass powder as partial replacement of fine aggregates up to 30% by weight for the particle size of range 0-1.18mm.

Ramachandrudu (2012) investigated the properties of concrete with coconut shells (CS) as an aggregate replacement were studied. Compressive and split tensile strengths of CS concretes were lower than control concrete. Permeable voids, absorption and sorption were higher for CS replaced concretes than control concrete. When the properties of CS replaced concrete were compared with concrete prepared with fly ash replacement of coarse aggregate (equivalent) no influence was observed.

Joseph *et al*. (2012) conducted a study investigating the structural characteristics of concrete using various combinations of lateritic sand and quarry dust as a complete replacement for conventional river sand fine aggregate. Samples of concrete in form of cubes were made using varying contents of quarry dust and laterite as fine aggregate. The quantity of laterite was varied against quarry dust at intervals of 25% varying from 0 to 100%. The samples were hydrated for defined periods and tested in the laboratory for compressive strength. Earlier workability tests were carried out to determine the optimum w/c ratios for 1:1:2, 1:1.5:3 and 1:2:4 ratio mixes. It was found that 0.5 water/cement ratio produced higher compressive strengths for 1:1:2 mix, while 0.6 water/cement ratio exhibit better workability for 1:1.5:3 mix proportion. Compressive strength ranged from 17-34.2 N/mm2 for the mixes for the adopted mixes. These results compare favourably with those of conventional concrete. It was concluded that when laterite content did not exceed 50 %, the concrete was found to be suitable for use as structural members for buildings and related structures

Manatkar and Deshmukkh (2016) propounded that generation of e-waste is a very serious issue in the world. In the year 2014 produce near about 650000MT of e-waste in India that includes all waste electronics and electrical equipment(TVs, computers, sound systems, refrigerators etc).This waste does not dispose of properly finally they affect the environment and human health and also create a storage problem. This waste is to be utilizing as coarse aggregate in concrete. It is helpful to avoid pollution and provide replacing material to coarse aggregate. This paper presented the analysis of the compressive strength of M20 and M25 grade of concrete by replacing coarse aggregate by adding nonmetallic e-waste in 0% to20% and it is observed that some percent nonmetallic e-waste can be used as a coarse aggregate in concrete.

Abuamer and Sadat *et al*. (2017) performed case study in Istanbul involving traffic data. They performed statistical tests on volume count and speed values obtained from radar sensors. Thus this study we performed statistical analysis of data comprised of compressive as well tensile strengths of the sample cubes.

CONCLUSION

From the above studies, it can be the concluded that concrete prepared with partial replacement of fine as well as a coarse aggregate can have reasonable strength. The materials used in the partial replacement are mostly waste products. Thus using such waste products in concrete can solve the problem of waste disposal in country like India where such a solution can lead to clean environment as well as low cost construction The use of stone dust and blast furnace slag in the concrete is beneficial in a different manner such as environmental aspects, non-availability of good quality and good strength of fine aggregate. For light construction purpose, sea dust, desert dust and EPC can be used. Vermiculture can be used in place of fine aggregate for better fire resistance and prevention of cracking. The workability of concrete was decreased by the use of stone dust and blast furnace slag in concrete, which can be increased by the extra dose of super plasticizers. The experiment shows that the concreting can be eco-friendly and economically beneficial. This study reviewed the past research on the aforementioned topic and will be followed by a research article using three types of sands in and around Lucknow city.

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