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Review on Performance of Quarry Dust as Fine Aggregate in Concrete

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ABTRACT: *Concrete technology has made significant advances in recent years which results in economical improvement of the strength of concrete. This economical development depends upon the intelligent use of the locally available materials. Important constituent of concrete is natural sand and filler material which is expensive and scarce. From the beginning of researches in concrete, the researchers and scientists have always tried to utilize and incorporate various materials, which are industrial waste products or agricultural wastes into concrete in such a manner that it can provide a effective mean not only to dispose of such wastes but also effectively enhancing some properties and nature of concrete. Researchers many times tried to incorporate quarry dust with concrete so that the properties of concrete get enhanced. The present work deals with the development of quarry dust concrete with total replacement of conventional sand with quarry dust and the study is made with systematic approach with sequential steps. In this work, the fresh and compressive strength properties of concrete when the Natural sand is partially replaced with stone dust.*

Keywords: Concrete, sand, Quarry dust, compressive strength, Natural sand

I INTRODUCTION

GENERAL

For the development of any structure, Concrete is the main material. The principle fixing to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest hazard to mankind on this planet today. Concrete is the most popular building material in the world and as such by its ecstasy, there is no substitute for concrete with conventional constituents. But sustaining the building activity in the long-term to meet the future demand for buildings by using the currently available energy-intensive materials and building techniques or technologies have become seldom possible. Building industries contribute greenhouse gas (GHG) emissions (22%) to the atmosphere and as the public's concern about climate change is wisely addressed as a result of the growing impact of global warming and increasing sea level; concrete technologists face the task of leading future growth in a manner that maintains the quality of the environment. Of course, the current environmental issues are well-related to technology choices which object to the production of sustainable and environmentally friendly concrete. Primary binder to produce concrete is Ordinary Portland cement (OPC). It has major drawbacks of emission greenhouse gas which effects to global warming, environmental pollution, and depletion.

Quarry dust is a byproduct of quarrying, crushing, and sieving activities resulting in the production of about 10-15% non valued waste in the stone quarries which are invariably named as quarry dust(QD), quarry waste (QW), quarry sand(QS), rock powder dust (RPD), crushed sand(CS), crushed rock powder(CRP) or artificial sand(AS) by different authors.. Utilization of quarry dust reduces the burden of dumping dust on earth causing pollution.

Quarry Dust in Plant

II QUARRY DUST IN STRUCTURAL CONCRETE

The level of utilisation of quarry rock dust in industrialized nations such as Australia, France, Germany and the United Kingdom has touched more than 60 percent of its production. In Japan, unprocessed crusher dust is usually regarded as only suitable to be incorporated in a blend with natural sand, and only then if it is of good quality, and

cheap enough to make the substitution worthwhile. Even though, quarry dust is a problem for the people residing nearby quarries by dumping of quarry dust and an environmental issue causing serious respiratory problems, the potential use as aggregate becomes a positive solution which is an added advantage.

Many researchers in different countries studied the potential use of quarry dust in concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete. When examining the above qualities of fly ash and quarry dust, it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other. The decrease in workability by the addition of quarry dust is reduced by the addition of pulverized fuel ash. The addition of quarry dust causes a loss in slump; though such loss in slump can be significantly reduced by the addition of fly ash. The loss in early strength due to the addition of fly ash can be completely negated by the addition of quarry dust. But the characteristic strength has not been adversely affected at all by the addition of up to certain percentage of fly ash. Quarry dust, a byproduct from the crushing process of stones (Blue metal) which is available abundantly from rock quarries at low cost in many areas can be an economical alternative to the river sand. Quarry dust can be defined as residue, tailing material after the extraction and processing of rocks to form fine particles less than 4.75mm. Quarry dust, which is generally considered as a waste material, causes an environmental load due to disposal problem. Quarry dust being by and large, a waste product, will also reduce environmental impact, if consumed by construction industry in large quantities. Hence, the use of quarry dust as fine aggregate in concrete will reduce not only the demand for natural sand but also reduces the environmental problems.

III LITERATURE REVIEW

2.1 Literature Review

Many works have been carry out to explore the benefits of using various waste materials such as granite dust, marble dust, stone dust and glass powder in making and enhancing the properties of concrete. The work done by various authors describe below

Baalbaki et al reported the results of the tests carried out on high-strength concrete made with different types of crushed rocks, highlighting the role played by coarse-aggregate through the elastic properties of the parent rock. The results obtained open an opportunity to review the present formulas relating Ec to fc recommended by some codes. After a long gap, studies are initiated to use quarry dust as fine aggregate to replace partially or fully the conventional river sand.

According to Draft, a strategy was developed to provide plan for the continued supply of construction sand to the Sydney Region over the next 20 years. Extraction of sand resources from lakes are likely to be completed in the next 5-10 years and alternative sources are needed to meet the growing demand of the Sydney construction market. The strategy will provide the basis to manage supply for the Sydney market in the short and longer term; identify primary and secondary sources of construction material resources; provide frameworks for continued access to these resources in land use planning instruments; provide an assessment and approval regime for quarry proposals; develop best practice standards for quarry operation; and encourage the use of substitutes such as recycled material and manufactured sand.

Karthikeyan and Ponni have successfully produced flyash based bricks with lime, gypsum, sand using quarry dust as the main filler material.

Reddy and Reddy, Rock had also been tried as a total replacement for sand in concrete with the conventional coarse aggregate partially/fully replaced by ceramic scrap and concluded that the 28 days strength in compression, split tension and modulus of rupture found increased for total replacement of sand with up to 20% replacement of coarse aggregate by ceramic scraps.

Safiuddin et al,also have tried the partial replacement of sand with quarry dust in fly ash/silica fume based concrete and concrete having 20% sand replaced with quarry dust and 10% weight replacement of cement with flyash and same 10% weight replacement of cement with silica fume by consideration. It was found that quarry dust as fine aggregate enhanced the slump and slump flow of the fresh concretes without affecting the unit weight and air content of the concrete.

Shaviyani Atoll, has reported the condition of sand mining in Maldives where construction is one of the major activities being carried out in the islands and sand mining has become a common practice, increasing islands vulnerability. Lack of space is a greater constrain in some of the islands for construction of new houses and to develop new infrastructure facilities. An international team of expertise conducted a field mission to the five selected Islands (Milandhoo, Funadhoo, Komandhoo, Foakaidhoo and Kandithem of Maldives) and reported that

land reclamation has been found a common denominator in all islands.

Waziri and Muazu, examined the properties of thoroughly washed quarry sand (Gwoza, Borno State) as fine aggregate in concrete. The washed and dried aggregates were graded in accordance with BS 812 part 1:1975 and its specific gravity, bulk density, porosity, water absorption, impact value and the aggregate crushing value were well satisfactory. The compressive strength increased with age but decreased with increasing water cement ratio. All mixes used in the study attained over 60% of their 28 day strength at 7 days.

langovan et al (2008) studied the strength and durability properties of concrete containing quarry rock dust as fine aggregate.

Shahul Hameed and Sekar studied the feasibility of using quarry dust and marble sludge powder as total substitute for sand. It is concluded that the combined use of quarry rock dust and marble sludge powder exhibited excellent performance in strength and durability characteristics due to efficient micro filling ability and pozzolanic activity.

An experimental study for producing paving blocks using crusher dust was made **by** Radhikesh et al**.** Physical and mechanical properties of paving blocks with fine aggregate (sand) replaced by various percentages of crusher dust were investigated. The test results showed that the replacement fine aggregate by crusher dust up to 50% by weight had a negligible effect on the reduction of any physical and mechanical properties while there was a saving of 56% of cost. The percentage of saving would be more and highly beneficial for mass production of paving blocks.

Raman et al (2010) investigated the mechanical properties of HSC produced for 28 days strength of 60 MPa having up to 40% replacement of sand with quarry dust and 10% cement with RHA. It is reported that substitution for sand with quarry dust in HSC may contribute some negative efforts in mechanical properties, but can be compensated with CRM such as RHA coupled with good mix design.

Norazila and Kamarulzaman, study the Sand replacement by quarry dust up to 30% found to improve the properties of foam concrete as reported by that the compressive and flexural strength of foam concrete with quarry dust were nearly 40% more than the control foam concrete.

Mir and Shubhada,. Investigated the Quarry dust has also utilisation in other areas of application. Quarry dust with equal addition of flyash by 20-30% weight of soil found to improve the geotechnical properties of expansive soil.

Sivakumar and Prakash have reported that 100% replacement of sand with quarry dust for a fine to coarse aggregate ratio of 0.6 in concrete was found to enhance the compressive strength and elastic modulus. When the quarry dust had high fineness, its usage in the normal concrete was limited because it increased the water demand.

Shaikh and Daimi, presented the comparison of the strength and durability performance through micro-structure related properties of concrete made with natural sand and artificial sand with dust available in the Indian state of Maharashtra. It was found that there was consistently higher strength and the sharp edges of the particles provided better bond with the cement than the rounded part of the natural sand. The weight loss after immersion up to 90 days, chloride permeability and water absorption were same for both concrete.

Kyung and Hun, introduced the current efforts to utilize the mineral waste materials from metals industry in Korea. For utilizing waste stone and stone powder sludge generated from domestic quarry and cutting process of stone plates, Korea Institute of Geology, Mining and Materials has developed the manufacturing technologies of artificial stone plate as a building material with firing method and hydrothermal synthesis. It was shown that the manufacturing cost of the artificial stone plate was (18,000 won/m2), which was merely half that of natural stone plate and the application of those on the building stone industry could be possible.

Lohani et al, studied the effect of 0%, 20%, 30%, 40%, and 50% partial replacement of sand with quarry dust for a design mix of M20 grade concrete. Due to its high fines of quarry dust it was provided to be very effective in assuring very good cohesiveness of concrete. Thorough reaction with the concrete admixture, quarry dust improved pozzolanic reaction, micro aggregate filling and concrete durability. Aggregates with higher surface area were requiring more water in the mixture to wet the particle surfaces adequately and to maintain a specific workability. Obviously increasing in water content in the mixture would adversely affect the quality of concrete. It was observed that the slump value increases with increase in percentage replacement of sand with quarry dust.

Naman Agarwal and Ajit Kumar, studies the geotechnical characteristics of the stone dust were studied by conducting same laboratory tests as above. In third phase, the pavement thickness is calculated for unstabilized soil and stone dust stabilized soil which was obtained by adding optimum percentage of stone dust based on CBR test

B. H. Shindel, et al, introduced the reasonableness of treated and untreated ocean sand in bond concrete and geopolymer concrete, based on compressive quality

Dr. B. Madhusudana Reddy and B. Bharathi , An Experimental Investigation on M20 Grade of Concrete by Partial Replacement of Cement with Stone Dust and Fine Aggregate with Crushed Fine Aggregate. Experimental investigation stone dust (stone dust which is passing through 90 micron sieve) is used as partial replacement of cement by weight at varying percentages i.e., 10%, 20%, 30% respectively. The fine aggregate is replaced by crushed fine aggregate at varying percentages i.e., 25%, 50%, 75%, 100% respectively. The influence of Stone Dust and Crushed Fine Aggregate on compressive strength, split tensile strength, flexural strength of M20 grade of concrete is investigated. T

Shaik Farooq Ahamed et al, Studies on Geo Polymer Concrete with Partial Replacement of Sand by Quarry Stone Dust, In this study the solutions of sodium hydroxide (NaOH) and sodium silicate (Na2SiO3) are used as alkaline liquids for polymerization. In this work the molarity of alkaline solution is taken as 12. In India, normal stream sand (fine aggregate) is customarily utilized in cement. In any case, developing natural limitations to the abuse of sand from waterway beds is prompting research for usage of an elective material for fine aggregates in the development business. This paper explores about utilizing quarry stone dust as a fine aggregate.

Abhishek Kumar and Vikram Singh, Study the Effect of Stone Dust & Steel Fibre on Strength Properties of Concrete.he study The replacements are done at 0%, (30%, 1%), (40%, 1%), (50%, 1%) of fine aggregate with Stone dust and addition of Steel fiber 1% by the weight of cement. Design mix is prepared on M30 grade of concrete. The result showed that at fixed W/C ratio (0.40) the strength and durability increased initially at small percentages and the cost for production is also cheaper.

Summary

Viable natural sand resources in many areas across the world are running out, either because of extinction or sterilisation of rivers, cost of extraction or transportation, shortage of water for processing in some areas or because of environmental concerns. The current status of concrete industries facing the scarcity of fine aggregate and quarry dust utilisation as an alternative are reviewed from a thorough literature study and the features are summarized here:

Excessive extraction of sand from rivers carried out almost to the level of complete depletion and further mining is not feasible at all. Therefore it is imperative to stop further extraction of river sand and find alternative solutions immediately. Use of near shore marine sand, dune sand, land based sand, offshore sand, quarry dust manufactured sand and bottom ash have been identified as alternatives to river sand for use as fine aggregate in concrete and carried out studies on concrete. But for viability and feasibility quarry dust is recommended for further research. The laboratory investigations carried out have shown that quarry dust could be used for partial or full replacement of sand. Deleterious substances like particles finer than 75µm Quarry dust are considered harmful to concrete as results in the different grading, more surface area consuming higher water content thus reducing the strength and reduced durability characteristics.

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