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Review Paper on Partial Replacement of Fine Aggregate by Industrial or Mine Waste in Concrete

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Abstract - *In present scenario as the construction activities increases, the demand of concrete also increased. In construction sector concrete is used in tremendous quantity and it requires large quantity of natural river sand as fine aggregate. As natural resources depleting due to excavation of river sand from natural resources is a serious threat to environment. On other side mine waste and by-products from several industries are finding their way as substitutes or alternative materials to prepare concrete. Therefore this paper presents the review of some research papers which uses locally available waste replacing fine aggregate. Research in this field and positive results of their research work are important to study further in the sustainable construction activities by using other local industrial waste or mine waste.*

Keyword: concrete, industrial waste, mine waste, fine aggregate, partial replacement, sustainable construction, review paper

1. INTRODUCTION

Concrete is a basic need in construction sector. Nowadays due to fast economic growth, rapid urbanization and prosperity demand of construction activities increased. Therefore demand of construction raw materials like cement, sand, aggregate also increased as well. As the raw materials are available from natural resources only, it is a serious threat to environment and cause sustainable issues. On the other hand, the cost of construction materials is increasing incrementally. The cost of sand, cement has increasing day by day. We are therefore paying the price of simultaneous losses at once – degradation of the environment and literally paying a heavy price for it.

This environmental imbalance has created a situation for the people to focus on adoption of newer technologies and environmentally preferable materials, which will not only preserve the natural resources but also create a productive environment in which human and nature can exist in harmony. To reach this endeavor, one way is to go for eco-friendly concrete made from the wastes that are generated by mining activities, as waste is certainly a good potential resource and lot of energy can be recovered from it.

Wastes and by-products from several industries are finding their way as substitutes or alternative materials to prepare concrete. The reason that they have gained impetus is due to a lot of reasons like – dumping of these wastes or land-filling because land is becoming a scarce resource and hence getting very costly day by day to be used as a dumping yard. Hence present study is an attempt to experiment on use of waste material by partial replacing of natural river sand into concrete and also check feasibility of making concrete and solve environmental problems.

2. LITERATURE REVIEWS

Omar M. Omar, Ghada D. Abd Elhameed and teammates[1] stated that Limestone waste and marble powder can be used in concrete as partial replacement to fine aggregate. Limestone Waste is obtained as a by- product during the production of aggregates through the crushing process of rocks in rubble crusher units. Waste marble powder "WMP" is an inert material which is obtained as an industrial by product during sawing, shaping, and polishing of marble also used in concrete. The experimental program consists of two phases; phase-I with cement content 350 kg/m^3. One mix was control (normal concrete mix), three mix including lime stone waste 25%, 50% and 75% replacement from sand. Twelve mixes including lime stone waste with marble powder as additive by percent 5, 10, and 15% by weight of cement. Phase-II, the above experiment is repeated with cement content is 450 kg/ m^3. Compression test at7, 28, and 90 days was carried out on 150 X 150 X 150 mm concrete cubes. Splitting tensile test at 28 days was carried out on 150 X 300 mm cylinder. Flexural strength test at 28 days was carried out on 100 X 100 X 500 mm beams.

After observing the results of the experimental study the authors inferred that by adding LSW percentage the workability of modified concrete was not affected and the compressive strength increased about 12% at 28 days using LSW up to 50% replacement. The compressive strength at 28 days increased about 6% when increasing cement content from 350 kg/cm^3 to 450 kg/cm^3 in presence of the LSW. Indirect tensile strength increased about 17% when using 50% LSW and 15% M.P with different cement content and Flexural strength increased about 8% for the same. As the percentage of limestone waste replacement increase more than 50 percent the rate of the strength gain decreased. Permeability of concrete also decreased with increase in LSW.

Shehdeh Ghannam, Husam Najm, Rosa Vasconez[2] used Granite Powder (GP) and Iron Powder (IP) in concrete in their experimental study. These industrial by-products generated from the granite polishing and milling industry in powder form and left largely unused. They are hazardous materials to human health because they are airborne and can be easily inhaled. A 0.5% by weight of cement water-reducing super plasticizer was added to improve the workability of concrete. The resulting concrete mix was used to prepare 150 × 150 × 150 mm concrete cubes, 150 mm × 300 mm cylinders and 100 × 100 × 500 mm beams. Five mixes were tested containing 0%, 5%, 10%, 15%, and 20% of GP by weight of sand. This concrete with granite powder had a slump equal to 80 mm and the compaction factor was 0.95. To make the mix workable without additional water, Plasticizing admixtures are added. Same procedure was carried out using Iron powder to make concrete. The compressive strength tests, flexural strength tests and splitting tensile strength tests were carried out at 7 and 28 days.

From the experimental study authors found that the concrete mix with granite powder (GP) and iron powder (IP) as partial replacement of sand showed good workability similar to normal concrete mixes. Using 10% granite powder (GP) in concrete gave the highest increase in compressive strength compared to other ratios. Same results observed for flexural strength. For the split-cylinder tensile strength, the optimum value of the percentage of (GP) in concrete was 15% compared to 10% for flexural and compressive strength. For mixes with iron powder (IP), the compressive, flexural, and tensile strengths all increased with the increase in the (IP) ratio. From observation flexural strength increasing at higher rate compared to compressive and tensile strengths.

H. M. A. Mahzuz, A. A. M. Ahmed and M. A. Yusuf, Shahjalal[3] used locally available stone powder in concrete with stone chips and brick chips. In Jaflong, Bangladesh a huge numbers of stone crushers are available and during stone crushing a huge amount of dust produced. The main objective of the study is to evaluate relative performance of the concrete made by normal sand and stone dust where the coarse aggregate is crushed stone (stone chips). As a low cost coarse aggregate Brick chip is used to ensure the acceptance and adequacy in construction purposes. In experimental program conventional concrete made using normal sand with stone chips and other modified concrete with sand replaced by stone powder. Three main proportions used for making concrete 1:1.5:3, 1:2:4 and 1:2.5:5. Same procedure also carried out for brick chips instead of stone chips. The laboratory test are conducted and compared with the same obtained result from the normal sand concrete. The concrete was made by a standard method with proper curing and tempering. The blocks are then tested by compression testing machine. As the study particularly focuses on the feasibility of fine aggregate and hence the fineness modulus of stone powder and sand was calculated and rest of ingredients remained constant. The obtained result is analyzed and then discussion is prepared depending on the result obtained.

From the results of experimental work the authors concluded that Stone powder is feasible for medium graded concrete for better performance in terms of strength and economy over normal sand. For all the ratios 1:1.5:3, 1:2:4 and 1:2.5:5 of concrete using stone powder with stone chips gives 14.76, 4 and 10.44%, increased value of compressive strength compared to concrete made using sand. Same results observed for brick chip in all the ratios, concrete give higher compressive strength but less value than the stone chip concrete. This may be due to low quality brick chips or wrong proportions of mixing.

Kürsat Esat Alyamaç and Alp Bugra Aydin[4] used marble sludge (powder) in concrete. Marble blocks are cut into blocks of different sizes in factories and it requires water during the cutting process to prevent the rock saw from overheating and to prevent dust, which forms marble sludge. This waste material is dumped into the environment, either in its initial form or following dewatering in a treatment plant. Approximately 30-40% of a quarried marble block becomes waste in the form of sludge. Hence, this study carried out to replace sand with marble powder in concrete because incorporating higher amounts of waste marble powder into concrete is environmentally friendly and economically feasible. For experimental program the conventional concrete and modified concrete produced using different proportion of marble powder replacing by volume with natural sand. The concrete is produced by replacing sand with marble powder at 10%, 20%, 30%, 40%, 50% and 90% by volume. The Water/Cement (W/C) ratio is maintained constant in whole study. Therefore, the workability of the concrete is assumed as negatively correlated with the MP content. Modified polycarboxylate super plasticizer is used. The compressive strength values after 7, 28, and 90 days and splitting tensile strength values on the 28-th day are determined using cubic samples of 150 × 150 × 150 mm. The 100 × 100 × 100 mm cubic samples are also used to initially calculate the rate of water absorption (sorptivity).

On the basis of result of experimental work authors deduced that the workability of concrete negatively correlates with the marble powder content but it is possible to produce required concrete workability with and without chemical additives. Compressive strength of concrete with marble powder in the range of optimal values is higher than the compressive strength of reference concrete. Using up to 40% marble powder in concrete is suitable. Thus eco-friendly and economic concrete is obtained. Optimum content of marble powder has positive effect on durability property such as water absorption.

Sanjay Mundra, P.R. Sindhib and teammates[5] investigates the use of crushed rock sand as viable alternative to Natural River sand that is being conventionally used as fine aggregate in cement concrete. Ordinary Portland cement (OPC) 43-grade was used in most of concrete design mixes. In some design mixes pulverized fly ash (PFA) was used as a supplementary cementing material. The percentage of fly ash was limited to 35%. Crushed stone sand from Gunavata and Chandwaji region in the State of Rajasthan is used. The experimental program was divided into two parts. The first part was dedicated to examine the effect of fine aggregates type, grading and blend ratio on the fresh and hardened properties of concrete. The second part of the program focused on the optimization of the selected design mix. Concrete design mixes corresponding to M25 and M30 grade of concrete were prepared. The samples were tested for slump, compressive strength and flexural strength. An optimization study was performed to study the effect on the properties of concrete when paste content was held constant and the fly ash was considered to be powder instead of aggregates. Other goals of optimization were to examine the effect of partial replacement of cement with fly ash.

From experimental work authors concluded that higher blend ratio of crushed stone to natural sand will decrease workability, but it can be restored by increasing the paste content and including water reducing admixture. Considerable reduction in compressive strength was noticeable at and beyond 50% CRS replacement. Therefore for mix with 70–100% CRS replacement it is desired to mix washed crushed rock sand along with proper screening at crushing stages so that one gets compressive strength higher than the designed strength. The properties of concrete (Compressive and flexural strength) made with partial or full replacement with CRS are comparable to natural sand results.

3. CONCLUSION

Nowadays construction activities increasing day by day and therefore demand of concrete ingredients increases. As the Natural river sand is only source of fine aggregate it is serious threat to environment. On other side industrial waste and mine waste also causes disposal problem and harsh the environment due to its improper disposal. Therefore to minimise the negative impact on environment river sand (natural source) should be used minimum and reusing of some other material or industrial waste in concrete can lead pollution free environment. After referring the research paper we can conclude that further more research should be done on use of locally available mine waste or industrial by-products in concrete after investigating its final mechanical, physical properties and durability as well. Main aim of the research work is to produce economical and eco-friendly concrete with considering its desired properties.

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