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A Comprehensive Study on Behaviour of Concrete with Partial Replacement of Cement and Fine Aggregates with Industrial Waste as Marble Powder and Copper Slag– A Review

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Abstract – *A rapid growth in natural waste material causes high rate of environmental pollution. So, it becomes mandatory to decrease or reuse the waste materials in order to save our environment from being polluted and also to reduce the cost. One of the foremost objective in this paper is to collect all the sources of research papers for the utilization of waste materials using different techniques. Suitable replacements can be done using waste materials so as to increase its strength. Filler materials such as marble powder and copper slag can be used in cement and fine aggregates. Here, the cement is replaced partially by marble powder and fine aggregates is replaced partially by copper slag. In this paper, the effect of marble powder and copper slag on concrete in strength is being observed. The effort is being completed by conducting various test to judge its strength and durability. Optimum replacement of cement with marble powder was found to be 10% and optimum replacement of fine aggregates with copper slag was found to be 40%.*

Keywords: Marble powder; copper slag; concrete; durability; partial replacement; strength.

Introduction

Waste materials such as marble powder and copper slag have a great impact on humans as well as in the environment. Dumping of waste materials causes environmental and health problems. It also creates waste disposal problem. Therefore, recycling becomes important and must for the waste materials. Waste produces new product and can be used as an admixture so that the natural resources are used more efficiently. Several researchers developed new waste management plans in order to substitute the construction materials according to our needs. This paper describes the feasibility of using the marble powder as a partial replacement of cement in concrete and fine aggregates with copper slag.

Marble powder is a waste by-product obtained from marble industry during sawing, processing and shaping. It can be used as an admixture in concrete, so that the strength of the concrete is increased. Also, the purity of marble powder can be checked by its colour as its appearance depends on the material used. Hence, it is white if the limestone is composed of calcite (100% $CaCO_3$). Marble powder has the property same as that of cement because of its fineness and it gets easily mixed with aggregates giving the perfect bond. One main advantage of using marble powder as waste material is that, it fills the void present in the concrete which gives sufficient compressive strength as compared to normal concrete.

Whereas, copper slag is an excellent industrial by product or waste material of copper extraction from smelting. This retains its original properties and is black in color having shiny appearance. It is usually crushed to smaller particles and stockpiled after the refining process. Copper slag has a specific property and bulk density which is greater than normal river sand which might result with higher density concrete production. Copper slag used in concrete industry as partial replacement of fine aggregates shows great results in reducing the cost of disposal.

Therefore, concrete made with such waste material shows great impact on workability as well as in durability also.

Literature Review

Elamaran et al. (2019) reported that on replacing fine aggregate with copper slag on varying percentage of 10%,15%,20%,25%,30%,35% for which the result indicated increase in compressive strength from 10% to 30% after which strength was decreased. Also, it was observed that there was delay in the hardening of concrete specimen. On partial replacement of copper slag, an increase of upto 18% in self weight of the concrete specimen was observed.

Abhisheka et al.(2018) reported that on replacing the fine aggregate with copper slag on varying percentage of 0%,20%,40%,60% and 80% for M25 grade of concrete, it was observed that at 40% replacement the compressive strength is the highest at 7 and 28 days as compared to the normal concrete. Also, the maximum flexural strength and split tensile strength were achieved at 40% replacement for 28 days. Beyond increase in 40%, the strength gradually decreases.

Chaitanya et al.(2017) reported that on partial replacement of cement with marble powder with varying percentage of 5%,10% and 15% by weight it was observed that for 10% replacement the compressive strength and split tensile strength was maximum and further addition leads to decrease in strength. In the second case, combination of fine aggregate with replacement by querry dust at varying percentage of 10%,20%,30% and 40% with 10% marble powder showed that at 30% replacement of querry dust gave the maximum compressive and split tensile strength. Furthermore, it was observed that the strength is maximum for combination of both marble powder and stone querry dust when compared to the strength obtained from individual replacement. For enhanced strength improvement glass fibre was added to this optimum results.

Seethal & Aneena(2016) reported that in addition with increasing of 5% partial replacement of cement and partial replacement of fine aggregate by copper slag at 10% by weight upto a optimum value, it was observed that the optimum values were 10% for marble powder and 40% for copper slag. Also, the displacement ductility and curvature ductility was increased by 5% and 10% respectively as compared to normal concrete. From the flexural test it was obtained that the failure of control specimens occurs before the failure of replaced specimens.

Pranshu & Ashish(2015) reported that on replacement of fine aggregates with copper slag at varying percentages of 5%,10%,15% and 20% for two concrete grades M25 and M30 it was observed that the strength performance of concrete was improved compared to normal concrete. However, when the conditions of stability of concrete were studied it was observed that low resistance to acid attack and high resistance against sulphate attack were found. It was also observed that the addition of copper slag increases the density of the concrete resulting in the increase of its self weight.

Conclusions

Following conclusions were drawn from the above study:

1. Marble powder gives more strength than cement and helps to maintain economic balance.

2. The use of copper slag and marble powder also improves its resistance to chemical attack and provides better durability as compared to normal concrete.

3. With the addition of marble powder, density of concrete increases. Hence, self weight also increases.

4. When the fine aggregates is partially replaced with copper slag, it reveals that there is a positive significant change in the properties of strength such as split tensile strength, flexural strength and compressive strength.

5. From the above study, it is observed that there is increase in strength with increase in percentage of marble powder but after the optimum percentage (10%) there is gradual decrease in strength.

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