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Feasibility and Need of use of Waste Marble Powder in Concrete Production

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ABSTRACT: *Sustainability in Concrete Production can be achieved by innovations in substitutions of materials used. Use of a Marble Waste Powder is not very usual though it has no behavioral problem and there has been little research work done on the waste. Marble waste is a solid waste material generated from the marble processing and can be used either as a filler material in cement or fine aggregates while preparing concrete. It has been used as a replacement of fine aggregates in many literature works but this paper presents the feasibility of the substitution of marble waste for cement to achieve economy and environment saving. The Compressive strength and Split Tensile strength of Concrete can be increased with addition of waste marble powder up to 10% replace by weight of cement. Earlier research also indicate that the effects of blending marble waste on the properties of cement such as consistency, setting times, insoluble residue, and soundness remain within the acceptable ranges of different standards. The production of cheaper and more durable concrete using this waste can solve to some extent the ecological and environmental problems. Therefore this paper provides a scope for more research which is required to design consistent and durable concrete with this waste.*

Keywords: *Cement, Compressive strength, Sustainability, Waste Marble Powder, partial substitute*

I. INTRODUCTION

Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its color and appearance: it is white if the limestone is composed solely of calcite (100% $CaCO_3$). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. Quartz, muscovite, tremolite, actinolite, micro line, talc, garnet, osterite and biotite are the major mineral impurities whereas SiO_2, limonite, Fe_2O_3, manganese, $3H_2O$ and FeS_2 (pyrite) are the major chemical impurities associated with marble. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulfides. A large quantity of powder is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. Leaving these waste materials to the environment directly can cause environmental problem.

The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment. Presently, large amount of marble dust are generated in natural stone processing plants with an important impact on the environment and humans [1].

In India, marble dust is settled by sedimentation and then dumped away which results n environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the marble dust in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. There are several reuse and recycling solutions for this industrial by-

product, both at an experimental phase and in practical applications. On the other hand, recycling waste without properly based scientific research and development can result in environmental problems greater than the waste itself.

One of the logical means for reduction of the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cements and mortar/concrete [2]. Marble powder can be used as a filler in concrete and paving materials and helps to reduce total void content in concrete.

Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. Marble dust is mixed with concrete, cement or synthetic resins to make counters, building stones, sculptures, floors and many other objects. Marble powder is not available in all the places. Despite this fact, concrete production is one of the concerns worldwide that impact the environment with major impact being global warming due to CO_2 emission during production of cement.

In addition to this, due to fineness of the marble powder, it will easily mix with aggregates so that perfect bonding is possible. Marble powder will fill the voids present in concrete and will give sufficient compressive strength when compared with the ordinary concrete.

India is among the top world exporters of marble stone. The Indian marble industry has been growing steadily at an annual rate of around 10% per year. Cutting of stones produces heat, slurry, rock fragments and dust. 20 to 30% of marble blocks are converted in to powder. 3,172 thousand tons of marble dust was produced in year 2009-10.

Waste Marble dust (WMD) can be used to improve the mechanical and physical properties of the conventional concrete. The possibility of utilizing WMD as an alternative very fine aggregate in the production of concrete will also induce a relief on waste disposal issues. Now-a-days the cost of material is increasing so if we use the waste material in the production of the concrete so we decrease the price. In India, million tons of wastes from marble industries are being released from marble cutting, polishing, processing and grinding.

If the waste is disposed on soils, the porosity and permeability of topsoil will be reduced, the fine marble dust reduces the fertility of the soil by increasing its alkalinity. When the waste is dumped and dried out, the fine marble dust suspends in the air and slowly spread out through wind to the nearby area. When dumped along a catchment area of natural rainwater, it results in contamination of over ground water reservoir and also cause drainage problem [3].

Exposing the waste material to the environment directly can cause environmental problems. Therefore, many countries have still been working on how to re-use the waste materials.

II. LITERATURE REVIEW

Bouziani Tayeb, Benmounah Abdelbaki, Bederina Madani and Lamara Mohamed found that the increase of Marble Powder (MP) content in Self Compacting Sand Concrete, from 150 kg/m3 to 350 kg/m3, improves the properties at fresh state by decreasing v-funnel flow time (from 5s to 1.5s) and increasing the mini-cone slump (from 28cm to 34cm). In other hand, the 28 days compressive strength decreases with an increase of MP content [4]. Marble waste powder from The Ethiopian Marble Processing Enterprise used gives the replacement of Ordinary Portland cement by marble waste powder at 5% replacement range comparable compressive strength with that of 100% ordinary Portland cement. Replacement at 10%, 15% and 20% replacement ranges resulted in compressive strength reduction than that of 100% Ordinary Portland cement. However blended cements with 5 to 15% replacement ranges satisfied the standard of high early strength of class 42.5MPa and blended cements at 20% replacement range satisfied the standard of high early strength of class 32.5MPa as per the EN 197-1 standard. Other properties of marble waste blended cements such as consistency, setting times, insoluble residue, sulphate residue and soundness remained within the acceptable limits of different standards [5].

Generally, in literature waste marble dust has been replaced with either all of the fine aggregate (0 - 4 mm) or passing 1 mm sieve. However, not a single study on the performance of the concrete prepared by replacing very fine sand (passing 0.25 mm sieve) with WMD [6].

Use of marble dust as a fine aggregate in concrete draws serious attention of researchers and investigators. The maximum compressive and flexural strengths were observed for specimens containing a 6% waste sludge when compared with control and it was also found that waste sludge up to 9% could effectively be used as an additive material in cement [7].

With the inclusion of Marble powder the strength of concrete gradually increases up to a certain limit but the gradually decreases. With the inclusion of Marble powder upto10% the initial strength gain in concrete is high. At 10% there is 27.4% increase in initial Split Tensile strength for 7 days. At 10% there is 11.5% increase in initial Split Tensile strength for 28 days. The initial strength gradually decreases from 15%. It was found out that the optimum percentage for replacement of marble powder with cement and it is almost 10% cement for both cubes and cylinders [8].

When marble powder is partially replaced in cement by weight, there is a marked reduction in compressive strength values of mortar mix with increasing marble powder content when compared with control sample at each curing age. On increasing marble waste fine aggregate ratio i.e. when marble waste / granules are partially replaced in fine aggregate by weight then there is increase in compressive strength values of marble waste mortar at each curing age. Degree of workability is medium conforming to IS: 456 – 2000. The mean strength of all concrete mixes with marble granules was 510% higher than the references concrete conforming to IS: 456 2000. The flexural strength of waste marble mix concrete increases with the increase of the waste marble ratio in these mixtures. They concluded that the marble dust can be used as a replacement for cement. Test results indicate that the 10% of marble dust in the cement concrete gives the best results. And also increase in curing days will increase the strength of marble dust concrete when compared from 14 days to 28 days [2].

Since block manufacturing mixtures containing the Marble Sludge Powder (MSP) have significantly higher compression strength and low water absorption, the block mixtures containing MSP are recommended for construction in all its forms in that the best target market for absorbing and consuming such products is the construction sector. MSP incorporation had a positive effect on density, shrinkage and plasticity during all stages of the production process, anticipating some modifications in the industrial production line [9].

III. DISCUSSION

The investigation revealed that replacing of cement with marble waste powder up to 20 % reduces the slump of concrete mixes, whereas replacement of sand by marble waste powder up to 20% enhances the slump of the concrete mixes. In concrete production replacement of 5% cement by marble waste powder gives comparable compressive and flexural strength as of marble waste free concrete specimens; but increasing the replacement range beyond 5% results in strength reduction. In concrete production, replacing of sand up to 20% by marble waste powder gives similar strength as of concrete mixes with 100% sand both at early and latter ages.

On the basis of the earlier experimental studies the unit weight of the concrete increased due to the high specific gravity of WMD and also filler effect of marble dust because it has finer particles than fine sand aggregate. As a matter of fact marble dust had a filler effect (particularly important at early ages) and played a noticeable role in the hydration process. Cement being kept constant it is an expected outcome that an enhancement in the mechanical and physical properties has taken place by virtue of the marble dust's contribution to the hydration process. The porosity of the concrete decreased and UPV increased with increasing percentage of marble dust additions.

IV. CONCLUSION

Use of waste & byproducts as aggregates has greater potential because 75% of concrete is composed of aggregates. The physical and chemical properties of marble dust are suitable for its proposed use. None of the mineral constituents in waste is in undesirable concentration. Test results show that these industrial wastes are capable of improving hardened concrete performance. The combined use of quarry rock dust and marble sludge powder exhibited excellent performance due to efficient micro filling ability and pozzolanic activity. Therefore, the results of this study provide a strong recommendation for the use of quarry rock dust and marble sludge powder as fine aggregate in concrete manufacturing. MSP incorporation had a positive effect on density, shrinkage and plasticity during all stages of the production process, anticipating some modifications in the industrial production line. The use of marble dust in construction might be cost effective because this waste is available free of cost. In this paper, only some basic study of using marble waste in cement and concrete production is investigated; therefore, further investigations are required on the study of durability of concrete made by marble waste blended cement or sand.

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