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Partial replacement of cement with marble powder and fine aggregate with copper slag

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Abstract

Concrete is the biggest utilized material around the world. With the expanding pace of populace development, framework to should be grown quickly to satisfy the necessities of individuals and for all these an enormous measure of assets are required. The significant one of them is total. In any case, the inordinate utilization of these assets will make an ecological awkwardness. Hence, we have chosen to supplant these significant element of the development business with marble powder and copper slag individually. As we know Concrete is the largest material after food and water. The main constituents of concrete are Cement and Fine aggregate. Many studies have been done to know the environmental impact of cement and concrete. Seeking the adverse effect of high production of cement on environment, we have thought of partial replacement of cement with marble dust and fine aggregate with copper slag in this research.

Keyword: Concrete; Cement; Copper slag; Marble dust

1. Introduction

A French gardener named Joseph Monier first invented reinforced concrete in 1849. Without this reinforced concrete, most modern buildings would not be standing today. Reinforced concrete can be used to make frames, columns, foundations, beams, etc. The reinforcing material used should have excellent bonding properties, high tensile strength and good thermal compatibility. Reinforcement requires a smooth transfer of load from the concrete to the interface between the concrete and the reinforcing material and then to the reinforcing material. Therefore, the concrete and the reinforced material must have the same stress. Concrete is a composite material which is most widely used and is a key structural element for development of global infrastructure. It comprises three components namely water, aggregate which consists of coarse aggregate (CA) and fine aggregate and cement. Cement in its powder form is used as a binder when mixed with water and aggregate. The worldwide usage of concrete in construction is twice the total of all different building materials used. Today concrete is the most consumed material, with three tons per year used for every person in the world. Plain concrete is good in compression but weak in tensile strength with very limited ductility and little resistance to cracking. The production of concrete is said to be responsible for 8% of the world's carbon dioxide with Portland cement being a major contributor. The cement or particularly Portland cement in concrete, releases concrete dust when building is demolished or by the action of natural disasters, this is a major source of air pollution. The workers who cut and grind or polish the concrete are at risk of inhaling airborne silica, which can cause silicosis after a long period of time. Hence a solution to partially replace cement can reduce its effect.

Concrete is the largest used material worldwide. With the increasing rate of population growth, infrastructure too needs to be developed rapidly to fulfill the needs of the people and for all these a huge amount of resources are required. The major one of them is cement and sand. But the excessive consumption of these resources will create environmental

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imbalance. Therefore, we have decided to replace these two major ingredients of the construction industry with marble dust and copper slag respectively

Figure 1 Marble Powder

Figure 2 Copper Slag

2. Literature review

1.Caijun Shi et. al. "Utilization of copper slag in cement and concrete" Resources, Conservation and Recycling Science Direct (2008) Copper slag is a by-product obtained during matte smelting and refining of copper. The common management options for copper slag are recycling, recovering of metal, production of value added products such as abrasive tools, roofing granules, cutting tools, abrasive, tiles, glass, road-base construction, railroad ballast, asphalt pavements. Despite increasing rate of reusing copper slag, the huge amount of its annual production is disposed in dumps or stockpiles to date. One of the greatest potential applications for reusing copper slag is in cement and concrete production. Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete as raw materials for clinker, cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. This paper reviews the characteristics of copper slag and its effects on the engineering properties of cement, mortars and concrete.

2.Bypaneni Krishna Chaitanya et. al. "Effect of waste copper slag as a substitute in cement and concrete- a review" IOP Conf. Series: Earth and Environmental Science (2022) Copper slag is a by-product of the copper ore purification process that is produced at various stages. Copper slag is widely utilized as an abrasive, as well as a construction ingredient in the manufacturing of concrete and paving materials. Despite, the giant quantities of waste copper slag results in landfilling issues. Landfilling of waste copper slag convert the land into unfertile soil and as result creates environmental problems. Therefore, the waste copper slag may be used as an alternative material in producing sustainable construction materials that lead to both economical and environmental benefits. Most of the studies observed that up to 15% by using the weight of copper slag as Portland cement replacement improves in stress due to declining capillary porosity related to hydrated lime and 40–50% and 40–60% (by weight of sand) of copper slag can be used as a substitute for fine aggregates and coarse combination concrete is improvement in strength. This paper summarizes the use of waste copper slag in producing concrete as aggregate and as a partial replacement to cement. Furthermore, the

effect of waste copper slag on the mechanical, durability and the effect of elevated temperatures on the properties of concrete are presented.

3.Mr. Ranjan Kumar et. al. "Partial Replacement of Cement with Marble Dust Powder" Journal of Engineering Research and Applications Vol. 5, Issue 8, August (2015) The waste generated from the industries cause environmental problems. Hence the reuse of this waste material can be emphasized. Marble Dust Powder (MDP) is a developing composite material that will allow the concrete industry to optimize materiel use, generate economic benefits and build structures that will strong, durable and sensitive to environment. MDP is by-product obtained during the quarrying process from the parent marble rock; which contains high calcium oxide content of more than 50%. The potential use of MDP can be an ideal choice for substituting in a cementitious binder as the reactivity efficiency increases due to the presence of lime. In this research work, the waste MDP passing through 90 microns, has used for investigating of hardened concrete properties. Furthermore, the effect of different percentage replacement of MDP on the compressive strength, splitting tensile strength (Indirect tensile strength) & flexural strength has been observed. In this experimental study, the effect of MDP in concrete on strength is presented. Five concrete mixtures containing 0%, 5%, 10%, and 20% MDP as cement replacement by weight basis has been prepared.

Water/cement ratio (0.43) was kept constant, in all the concrete mixes. Compressive strength, split tensile strength & flexural strength of the concrete mixtures has been obtained at 7 and 28 days. The results of the laboratory work showed that replacement of cement with MDP increase, up to 10% for compressive strength, & up to 15% for split tensile strength & flexural strength of concrete.

4. B. P. R. V. S. Priyatham et. al. "Experimental Study On Partial Replacement Of Cement With Marble Powder And Fine Aggregate With Quarry Dust" International Journal of Civil Engineering and Technology (2017) Due to a wide range of foam concrete applications in the field of construction industry like creating cast-in-situ elements, precast blocks and prefabricated insulation boards, the performance and durability of foam concrete has become an important area of research. Few advantages of using foam concrete are, doesn't impose heavy loads, enables fast work, low absorption over time, pump ability, resistance to freeze thaw cycle, non-toxic and non-hazardous. Foam concrete is prepared using foam, cement, water and with or without using sand. Foam concrete doesn't contain coarse aggregate thus, extending dry densities from 300 to 1600 kg per cubic meter which possess low density and high strength-to-weight ratio. The porous structure forms the base of mechanical and durability properties beside excellent sound and temperature barrier.

This paper delivers a comprehensive review on creating good performance and sustainable foam concrete in terms of high porosity, low aggregate consumption, compressive strength, fire resistance, thermal insulation and sound absorbance. Discussion on type of foaming agent used, admixtures, fresh state properties, physical properties, mechanical properties and durability properties were studied. Based on the findings, it is clear that further research is needed into the properties linked with long-term performance and enhancement of foam concrete. This study can aid users in easing their concerns and encouraging further widespread use of foam concrete in civil engineering.

5.Kirana V. T. et. al. "Effects of Partial Replacement of Cement with Marble Powder on Properties of Concrete" International Research Journal of Engineering and Technology (2018) Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Partial replacement of cement by varying percentage of marble dust powder reveals that increased waste marble dust powder ratio result in increased workability and compressive strengths of the concrete Marble Dust Powder is settled by sedimentation and then dumped away, which results in environmental contamination, in addition to forming dust in summer and threatening both agriculture and public wellness. In this research work, Marble Dust Powder has replaced the (OPC & PPC) cement accordingly in the reach of 0%, ,10%, 20%, 30% by weight of M-20 grade concrete. Concrete mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyze the behavior of concrete while replacing the Marble Dust Powder with Different proportions in concrete

3. Methodology

Preliminary investigations such as concrete structures, coarse aggregate, and fine-grained collection, as well as the process of various inspection processes in accordance with IS codes for the detection of these structures and the mixing parameters obtained from compounding, were discussed in this regard.

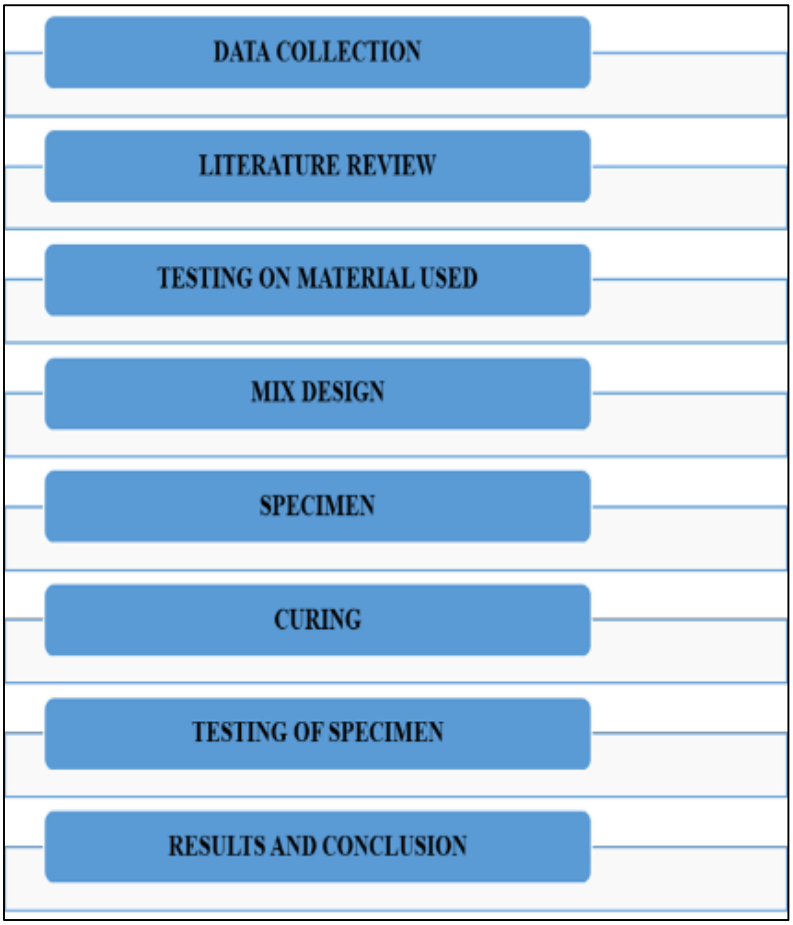

Figure 3 Flow of work

Experimental investigation was carried out to check suitability and veracity of the Plain concrete mix with marble powder for 5, 10, 15, 20% with cement and copper slag for 5, 10, 15, 20% with fine aggregate on performance of concrete. They were,

- Mix A: Plain Concrete
- Mix B: Plain Concrete + Marble Powder
- Mix C: Plain Concrete + Copper Slag
- Mix D: Plain Concrete + Marble Powder + Copper Slag

4. Experimental investigation

4.1. Results for Marble Powder

Table 1 Compressive Strength (Marble Powder)

Compressive Strength (Marble Powder)			
Percentage	**7 Days**	**14 Days**	**28 Days**
0%	18.20	26.13	30.806
5%	19.83	26.81	31.783
10%	20.67	28.82	35.075
15%	24.17	30.84	36.887
20%	20.16	27.72	32.762

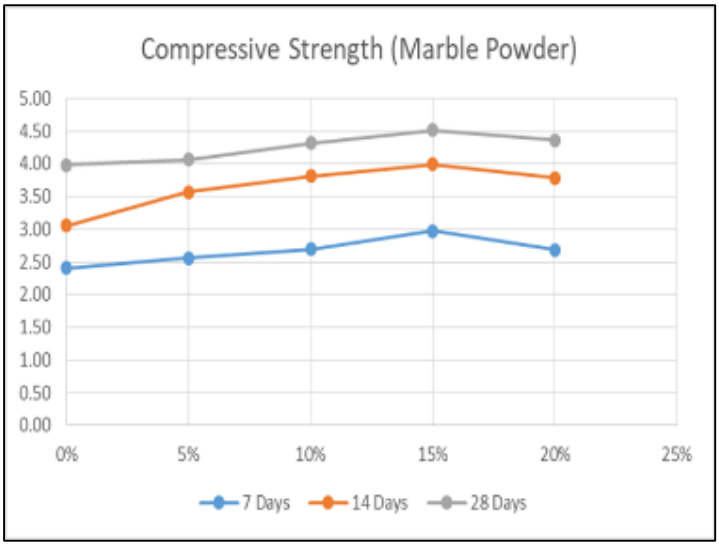

Figure4 Compressive Strength (Marble Powder)

Above Results show that there is a marginal increase in Compressive strength in replacement of Marble Powder up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

4.2. Results For Copper Slag

Table 2 Compressive Strength (Copper Slag)

Compressive Strength (Copper Slag)			
Percentage	**7 Days**	**14 Days**	**28 Days**
0%	19.36	25.41	31.39
5%	20.90	26.44	31.933
10%	21.54	27.83	32.437
15%	22.66	28.01	35.293
20%	19.13	27.66	31.96

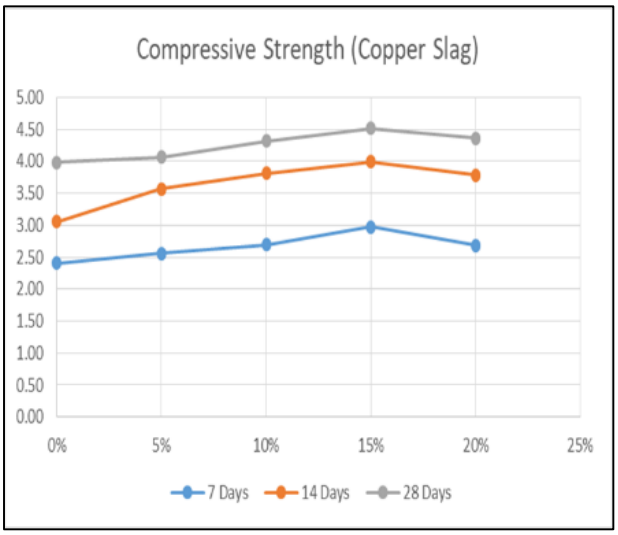

Figure 5 Compressive Strength (Copper Slag)

Above Results show that there is a marginal increase in Compressive strength in replacement of Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

4.3. Results For Marble Powder + Copper Slag

Table 3 Compressive Strength (Marble Powder + Copper Slag)

Compressive Strength (Marble Powder + Copper Slag)			
Percentage	**7 Days**	**14 Days**	**28 Days**
0%	22.14	26.94	32.81
5%	25.05	29.01	33.293
10%	27.27	30.89	35.650
15%	29.62	36.74	40.117
20%	26.03	29.94	34.15

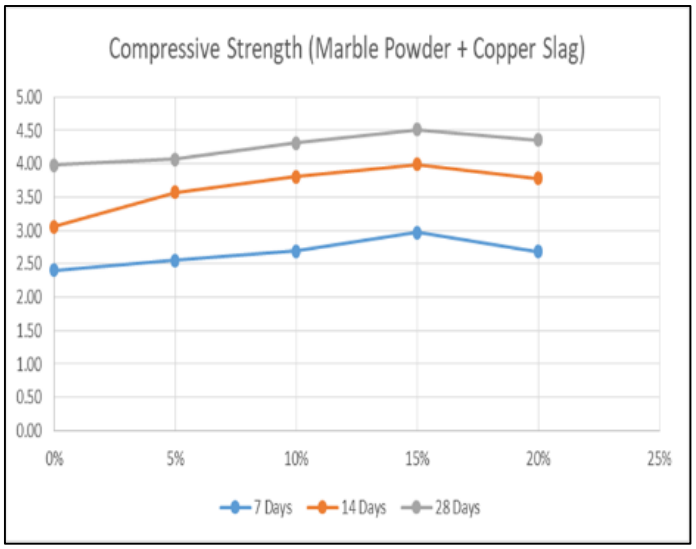

Figure 6 Compressive Strength (Marble Powder + Copper Slag)

Above Results show that there is a marginal increase in Compressive strength in replacement of Marble Powder + Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

5. Conclusion

A thorough investigation into the compressive and tensile strengths of concrete containing different proportions of copper slag and marble powder has been conducted. To verify the applicability and accuracy of the Plain concrete mix with marble powder for 5, 10, 15, 20% of the cement and copper slag for 5, 10, 15, 20% of the fine aggregate on concrete performance, an experimental investigation was conducted. Marble powder is more effective in cement up to 15% replacement, while copper slag is more effective in fine aggregate up to 15% replacement. However, when both are added together, performance is outstanding up to 15% replacement. As a result, the following conclusion is taken into consideration based on the findings and observations.

Inclusion of Marble Powder and Copper Slag for cement and fine aggregate reduces the slump values. This is due to the resistance for the free flow of concrete.

From the test results obtained during the experiment work it is clear that the strength of Marble Powder and Copper Slag concrete significantly higher than the normal concrete. The crack formation is also very small in mix specimen compared to normal specimen

There is a marginal increase in Compressive strength in replacement of Marble Powder + Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%..

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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