**A Case Study on use of phospogypsum and marble powder for making green concrete**

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**Abstract:** In this study, marble powder generated by the marble cutting industries and Phosphogyphsum have been used as a cement replacement materials. The properties of cement and mortar containing marble powder and Phosphogyphsum were investigated. The volume expansion, setting time, compressive strength and flexural strength of the mortar were determined. The microstructure of the mortar was investigated using scanning electron microscopy (SEM). The setting time of the cements were retarded when the waste material replaced a part of the clinker. The inclusion of marble powder at replacement level of 8 % resulted in a reduction in the strength of the mortar. However, incorporation of the marble powder and Phosphogyphsum in cement resulted in significant increase in the strength of the mortar compared to marble powder mortar. In conclusion, the use of marble powder in combination with Phosphogyphsum as replacement material in cement is promising. However, the full evaluation of these materials demands a thorough examination in areas related to their specialized properties, and also extending testing on concrete produced with these materials.

**Keywords:** Phosphogyphsum, marble powder, compressive strength, flexural strength.

**INTRODUCTION**

Advance concrete technology can reduce the consumption of natural resources and energy sources thereby lessen the burden of pollutants on environment .We describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement.In recent years,Self Compacting Concrete(SCC) has gained a wide use for placement in congested reinforcement concrete structures where casting conditions are difficult and in high rise buildings where pump ability properties are required.For such applications the fresh concrete must possess high fluidity and good cohesiveness.The use of fine materials such as marble powder and viscosity modifying agent can ensure the required concrete properties.In this experimental work attempt has been made to replace fine aggregate with marble powder.Both Phosphogyphsum and marble powder are waste materials and are dumped as waste, causing land scarcity and environmental pollution.Using these types of waste material for concrete is a bigger step towards sustainable infrastructure development.

**PHOSPHOGYPSUM**

Phosphogypsum is a by-product in the wet process for Manufacture of phosphoric acid by the action of sulphuric acid on the rock phosphate. It is produced by various process such as dehydrate , hemihydrates or anhydrate processes. In India the majority of phosphogypsum is produced by the dehydrate process due to its simplicity in operation and lower maintenance as compared to other processes. Phosphogypsum is generated from filtration process in phosphoric acid plants where insoluble gypsum (and other material) are separated from the product i.e. phosphoric acid as efficiently as possible. Depending on the source of rock phosphate about 4.5 -5 Tonnes (dry basis) of phosphogypsum (by-product phosphogypsum) is generated per ton of phosphoric acid (as P2O5) recovered.

**Characteristics of phosphogypsum :**

Phosphogypsum is a gray coloured, damp, fine grained powder, silt or silty-sand material with a maximum size ranges between 0.5 mm (No. 40 sieve) and 1.0 mm (No. 20 sieve) and the majority of the particles (50-75 %) are finer than 0.075 mm (No. 200 sieve). The specific gravity of phosphogypsum ranges from 2.3 to 2.6. The maximum dry bulk density is likely to range from 1470 to 1670 kg/m3 (92 to 104 lb/ft3), based on Standard Proctor Compaction. The gypsum cake, after filtration, usually has free moisture content between 25 and 30%. Hemihydrate, in the presence of free water will rapidly convert to dihydrate and in the process, if left undisturbed will set into a relatively hard cemented mass and does not cause dust problem unless disturbed.

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**Phosphogypsum lying at rail yards for transportation to the end users**

**MARBLE POWDER**

Marble has been commonly used as a building material since the ancient times. The industry’s disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world. Marble blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% the original marble mass is lost in the form of dust. The marble sludge was obtained in wet form as an industrial by-product directly from the deposits of marble factories, which forms during the sawing, shaping and polishing processes of marble in Elazigregion.

The marble sludge was obtained in wet form as an industrial byproduct directly from the deposits of marble factories, which forms during the sawing, shaping and polishing processes of marble in Elazig region. The wet marble sludge was dried up prior to the preparation of the samples. The dried material was sieved througha 0.25 mm sieve and finally the marble dust was obtained to be used in the experiments as fine sand aggregate.

Numerous other experimental works revealed that, the concretes containing fine powders, such as marble powder,have more compact structure by pore-filling effect. In a recent study, show that a large volume of fine material is critical to prepare self-compacting concrete made with fine sand. They indicate that the higherthe amount of fine materials, the better the workability is. materials content to cement leads to the modification of rheological properties of pastes and consequently influencesthe workability of the concrete mixtures.

**LITERATURE REVIEW:**

1. **T. Siva Sankar Reddy**  **(Asian Journal Of Civil Engineering)** **:** The present paper deals with the experimental investigation on compressive, tensile and flexural strength characteristics of partially cement replaced phosphogypsum concrete using 0%., 10%, 20%, 30% and 40%replacement with different water-binder ratios of 0.40, 0.45, 0.50, 0.55, 0.60 and 0.65. The strength characteristics are studied by casting and testing a total of 450 specimens, which

consists of 270 cubes, 90 cylinders and 90 beams for 7, 28 and 90 days.It is shown that a part of Portland cement can be replaced with phosphogypsum to develop a good andhardened concrete to achieve economy; above 10% replacement of phosphogypsum in concrete lead to drastic reduction not only in the compressive strength but in the split-tensile strength also; the flexural strength decreases as width and number of cracks increases significantly at replacement above 10% of cement with phosphogypsum at different waterbinder ratios.

Their research shown that, An industrial waste like phosphogypsum impairs the strength development of calcined products and hence it can be used in construction industry for preparation of concretereplacing some quantity of cement, which is a valuable ingredient of concrete, to achieve economy.With 10% replacement of cement with phosphogypsum not only the compressive strength increased marginally & significantly with age but also the split-tensile strength at 28 days increased commendably in case of different water-binder ratios. However, further replacement of cement with phosphogypsum lead to drastic reduction not only in the compressive strength but in the split tensile strength also.

1. **Bouziani Tayeb(The Open Construction and Building Technology Journal):** In this experimental work, the effect of marble powder(MP) on the properties of fresh and hardened SCSC prepared with natural river sand was studied. For this, three SCSC mixes were prepared in which the binder was composed of cement and MP with different dosages of MP (150, 250 and 350 kg/m3).

Result of his study shows that The increase of Marble Powder dosage in SCSC increases both of the mini-slump flow and the V-funnel flow time. By using the consistency index*(a)* and the flow index*(b)* of the viscosity model of the best fitted curves, the initial viscosity and the needed energy necessary to attain a flowable consistency can be characterized. In other words, the higher a is, the larger the initial viscosity is, and the higher b is, the lower the needed energy necessary to attain a flowable consistency is. Despite the positive effect of MP on the fluidity of SCSC, their addition must be controlled according to the mechanical strength question. The addition of MP to SCSC requires an increase in water/cement ratio, which leads to a decrease in compressive strength at 28 days.

1. **Ranjodh Singh** ( **International Journal of Engineering Research and Applications):** The objectives of this investigation is to carry out the detailed study of various performance based characteristics of self compacting concrete with different proportions of Brick dust and marble powder as fine aggregate replacement.

In their study, he found that All concretes mixes using marble powder fulfilled the performance criteria for fresh and hardened SCC. The hardened properties of the SCCs were improved at 28 days due to greater hydration of cement Brick dust and marble powder can be efficiently used to produce good quality self compacting concrete with satisfactory slump and setting times.Good hardened properties were achieved for the concretes with 25% marble powder which can be considered as the optimum content for high compressive strength. The hardened properties of the SCCs were improved at 28 days due to greater hydration of cement .Marble powder can be efficiently used to produce good quality self compacting concrete with satisfactory slump and setting times.

1. **Manjit Singh (Guidelines for Management of Phosphogypsum,** **Central pollution control board):**

In their study, treatment of phosphogypsum with aqueous citric acid solution was attempted to purify phosphogypsum and improve its quality to make it fit for manufacture of cement and gypsum plaster for the first time. The treatment of gypsum converts phosphatic and fluoride impurities into water-removable citrates, aluminates and ferrates.

1. **Taner Kavas (Turkish National Standards) :**

concluded that, the compressive strength of the concrete has increased with increasing percentages of marble dust additions at all curing ages&unit weight of the concrete increased as a result of the fact that certain proportions of waste marble dust (WMD) had been added to the concrete as very fine aggregate substitutes. This is an expected outcome due to the high specific gravity of WMD and also filler effect of marble dust because it has finer particles than fine sand aggregate.

1. **Tarun R. Naik** (**International Symposium on Sustainable Development of Cement and Concrete):**

concluded that, Due to its high fineness of the marble powder, it proved to be very effective in assuring very good cohesiveness of mortar and concrete, even in the presence of superplasticizing admixture, provided that water to cement ratio was adequately low. In terms of mechanical performance, 10% substitution of sand by the marble powder in the presence of a superplasticizing admixture provided maximum compressive strength at the same workability level.

1. **Mridul Garg and** **Neeraj Jain (Environment hazard mitigation of waste gypsum ) :**

This paper deals with the effect of curing temperature on the durability of a cementitious binder based on calcined phosphogypsum, fly ash and lime. The durability of the binder was studied by its performance in water and accelerated ageing, i.e. alternate wetting and drying as well as heating and cooling cycles at temperatures from 27°C to 60°C.

**Conclusions :**

1. All concretes mixes using phosphogypsum and marble powder fulfilled the performance criteria for fresh and hardened SCC.
2. Good hardened properties were achieved for the concretes with 25% marble powder which can be considered as the optimum content for high compressive strength.
3. The hardened properties of the SCCs were improved at 28 days due to greater hydration of cement.
4. Phosphogypsum and marble powder can be efficiently used to produce good quality self compacting concrete with satisfactory slump and setting times.
5. Under certain conditions, replacement of fine aggregate by phosphogypsum and marble powder appears to increase the strength of self compacting concrete.
6. In this study an effort has been made to evaluate the usefulness of phosphogypsum and marble powder both of which are waste material to produce cost effective self compacting concrete.

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