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EXPERIMENTAL INVESTIGATION ON CONCRETE BY USING HEMP FIBERS AND COMBINED REPLACEMENT OF CEMENT WITH GGBS AND MARBLE POWDER – A REVIEW

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Abstract: *Cement which is the most utilized material after water in present world have some environmental effects. In order to eradicate this we are going to reduce the use of CO_2 emitting materials like cement. Keeping this in mind we are going to replace cement with the help of GGBS and Marble powder combinely at 5%, 10%, 15% and 20% to the weight of cement along with the addition of HEMP fibers for M50 grade of concrete. GGBS is the bi-product which comes from iron industry and Marble powder is the wastage that produced from marble stone cuttings. Hemp fiber is the naturally occurring fibre which reduces the tensile cracks of concrete. We are going to test the same for 7 days and 28 days of curing.*

KEY WORDS: - *OPC, GGBS, Marble Powder, Hemp fiber.*

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1. INTRODUCTION

Concrete is the first choice for construction in many countries today. This has led to the fast vanishing of natural resources. The emission of CO_2 into the atmosphere from the production of cement, deterioration, poor performance, and inadequate resistance to hostile environment of many concrete structures has led to the continuous research on concrete. On the other hand, cost of concrete is attributed to the cost of its ingredients which are becoming increasingly scarce and expensive. This has led to recycling of industrial wastes and By-products that help reduce the cost of waste treatment prior to disposal and eventually in preserving the natural resources and energy. This requirement has drawn the attention of researchers to explore and experiment with various alternative materials as ingredients for concrete which are sustainable. Blast furnance slag is a solid waste discharged in large quantities by the iron and steel industry in India. The re-cycling of these slag's will become an important measure for the environmental protection. Iron and steel are basic materials that underpin modern civilization, and due to many years of research the slag that is generated as a by-product in iron and steel production is now in use as a material in its own right in various sectors. The primary constituents of slag are lime (CaO) and silica (SiO2).

The purity of the marble is responsible for its color and appearance it is white if the limestone is composed solely of calcite (100% CaCO3). Marble is used for construction and decoration; marble is durable, has a noble appearance, and consequently in great demand Marble Dust Powder is an industrial waste produced from cutting of marble stone. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. Marble as a building material especially in places and monuments has been in use for ages.

The most of the natural fibers are have been also investigated such the fibers are Wood, Sisal, Jute, Bamboo, Coconut, Asbestos and Rock Wool, are examples that have been used and investigated. The natural fibers are used to increasing the flexural strength and also providing a ductile post-cracking behaviour, especially for the industrial hemp samples. Similar to the compression tests, specimens prepared with 0.5 or 1% hemp fibers and 20% reduction in coarse aggregate provided relatively good results.

Ground Granulated Blast furnace Slag (GGBS):

GGBS is used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzalonic materials. Two major uses of GGBS are in the production of quality-improved slag cement, namely Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%; and in the production of ready mixed or site-batched durable concrete. Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of GGBS in the cementitious material, but also continues to gain strength over a longer period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting isrequired.

MARBLE POWDER:

One of the major wastes produced in the stone industry during cutting, shaping, and polishing of marbles is the MDP. During this process, about 20-25% of the process marble is turn into the powder form. India being the third (about 10%) top most exporter of marble in the world, every year million tons of marble waste form processing plants are released. Due to the availability of large quantity of waste produced in the marble factory, this project has been planned and preceded.

HEMP FIBRE:

Hemp (botanical name: Cannabis sativa) is a waste material from the agricultural production. General chopped hemp size used is 1.0-2.5, Because of its highly porous structure and strong capillarity effects inside the tubes, hemp is able to absorb large amounts of water (up to 10 times its own weight) . Hemp aggregate absorbs big quantities of water (325% of its own weight at 24 h), as a result it can hold mixing water that is required for hydration and carbonation.

LITERATURE REVIEW

N Sellakkannu, Roshini P(2017), "Experimental Investigation on Partial Replacement of Cement by GGBS". The ground granulated blast furnace slag (GGBS) is a waste product from the iron manufacturing industry. In this study Ground Granulated Blast Furnace Slag (**GGBS**) was partially replaced as 0%, 10%, 20%, **30%,** and 40% in place of cement in concrete. Concrete are made for **M- 30** mix and the cubes, cylinders and prisms are casted for **7, 14 & 28 days** of age in order to find out the optimum percentage of replacement of GGBS in concrete.

Chaithra H, Pramod K, Dr.Chandrashekara

Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem. Ground granulated blast furnace slag (GGBS) and Quarry sand (QS) are among the solid wastes generated by industry. The global consumption of natural sand is too high due to its extensive use in concrete. The demand for natural sand is quite high in developing countries owing to rapid infrastructural growth which results supply scarcity. This paper describes the feasibility of using waste in concrete production as a partial replacement of cement and sand. The cement has been replaced by GGBS in the range of 30%, 40% and 50% by weight of cement, quarry sand in the range of 40%, 50% and 60% by weight of cement for M40 grade mix. Slump test was carried on fresh concrete while compressive strength, split tensile strength and flexural strength were carried on hardened concrete. The cube, beams and cylinders are tested for compressive, Flexural and tensile strengths. It is found that by the partial replacement of cement with GGBS and sand with Quarry sand helped in improving the strength of the concrete substantially compared to normal mix concrete. These tests are carried out to determine the mechanical properties of concrete up to 7, 28, 56, 90 days for compressive strength, 28 days for split tensile strength and flexural strength.

Anand V, A.V. Pradeep Kumar Aneesh, V Bhat

This paper reports the effect of high volume of GGBS on the properties of structural concrete. In this study, GGBS is

physically and chemically characterized and partially replaced in the ratio of 10% to 90% by weight of cement. The fresh properties of GGBS concrete like slump test and hardened properties like compressive strength, Split tensile strength, Modulus of Elasticity are carried out. In addition to this the carbon foot prints are also calculated and the savings per capita per year is determined for reduction of usage of cement. The test results indicated that fresh and hardened properties of the GGBS concrete increases as the percentage of replacement of GGBS increases up to certain extent.

Vijaya Kumar YM, Shruti D

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 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%, 5%, 10%, 15% 20%, & 25% 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.

Ranjan Kumar, Shyam Kishor Kumar

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 concrète industry to optimise materiel use, generate economic benefits and build structures that will strong, durable and sensitive to environnement. 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.

K.Kalpana et al

The fibers are most effective material to concrete strength. Hemp (Cannabis sativa) is an agricultural crop that can be used as a building material. Hemp concrete has many advantages as a building material but it is not load-bearing and must be used in combination with a load-bearing wooden frame. In this project Cylinders, Prisms, and Cubes of standard dimensions have been made to introduce hemp Fiber with varying mix ratio such as 0.25%, 0.50%, 0.75%.

Various tests are conducted to find the property of the hemp concrete materials. The main test such as Compressive Strength for Concrete and Split Tensile Strength for Concrete and Flexural Strength for Concrete has been conducted. On comparing the results of Hemp fiber Concrete with that of conventional concrete, 0.50% additionally adding of Hemp Fiber showed maximum compressive Strength value at 28 days 12.8%, and the Split Tensile Strength value at 28 days 58.28%. Mechanical properties like Flexure Strength and Durability properties have been conducted. Study of microstructure of concrete is also determined.

Bekir Çomak, Alper Bideci, Özlem Salli Bideci

In recent years, using addition of fibers with plant origin in concretes has increased significantly. They not only enhance the mechanical characteristics of cement mortars, but also they are renewable, easy to access and cheap and this makes the use of plant fibers more widespread. Hemp fiber is a plant, which is planted in many places of the world and obtained in large amounts, is environmentally friendly and also used in manufacturing of composite materials. In this study, hemp fiber reinforced cement mortars with different ratios (0%, 1%, 2%, 3%) and different lengths (6 mm, 12 mm and 18 mm) were manufactured. Density, water absorption, compressive strength, flexural strength, compressive strength after flexural tensile and splitting tensile strength tests were performed on manufactured samples. Also, in order to determine the inner structural characteristics of samples, SEM analysis was conducted. As a result of the study, it was determined that cement mortars reinforced with 2–3% amount and 12 mm length of natural hemp fiber give the optimum results

Kapil Katuwal, Arnav Duarah(2017), Comparative Study of Concrete using Marble Dust as Partial Replacement of Cement. The **marble dust** is added to **M35** grade of concrete at 0%, 5%, 10%, 15%, and 20% partial replacement by weight of cement. The results obtained from compressive strength test after **7 days and 28 days**. From the study, it can be concluded that marble dust can be satisfactorily utilized as a constituent of concrete by using it as a replacement of cement at **10%** of the total weight of cement.

RESULTS

Compressive strength test: In the testing machine, the cube is placed with the cast faces at right angles to that of compressive faces, then load is applied at a constant rate up to failure and the ultimate load is noted. The load is increased until the specimen fails and the maximum load is recorded. The compression tests were carried out at 7, 28 days. For strength computation, the average load of three specimens is considered for each mix. The average of three specimens was reported as the cube compressive of strength. The compressive strength results obtained are tabulated below

% OF HEMP FIBERS&GGBS&MARBLE POWDER	7 DAYS	28 DAYS
M1	39.832	57.25
M2	40.652	59.3
M3	42.652	60.91
M4	44.303	64.79
M5	46.02	67.307
M6	44.82	65.54

Split tensile strength: the cylindrical specimen horizontally between the loading surfaces of compression testing machine and the load is applied until failure of cylinder, along its longitudinal direction. The cylinder specimens are tested at 7 days, 28 days. The average of three specimens was reported as the split tensile strength. Split tensile strength = 2*P*D/L. The split tensile strength results obtained are tabulated below

Mix designation	7 DAYS	28 DAYS
M1	3.65	5.18
M2	3.72	5.23
M3	3.86	5.48
M4	4.08	5.77
M5	4.29	6.106
M6	4.09	5.82

Ultrasonic pulse velocity test: The principle of ultrasonic pulse velocity test is to measure the pulse of longitudinal vibrations passing through the concrete for measuring the travel time of wave through concrete. From the experiments, the velocity depends on the elastic property and geometry of the material. The recommendations for the use of this method are given BS-4408 part-5; ASTM C 597-71 and BIS 13311 part -1-1992. In this procedure, the direct method is used for testing the specimens. For homogeneous concrete, the compression wave velocity is given by $V = \sqrt{(kEd/\rho)}$ (1) Where $k = (1-\gamma) / [(1+\gamma)(1-2\gamma)]$ (2) Ed= dynamic modulus of elasticity ρ = dynamic poisons ratio.

% OF HEMP FIBERS & GGBS& MARBLE POWDER	U.P.V TEST RESULTS AT 28DAYS (m/sec)
M1	4674
M2	4723
M3	4843
M4	4914
M5	4985
M6	4903

CONCLUSION

From the results tabulated, the following statements can be derived:

1. The addition of Ground granulated blast furnace slag, Marble powder and Hemp fibers have increased the both compressive and tensile strength values.
2. The maximum compressive strength found to be 46.02 N/mm2and67.307 N/mm^2 for 7 days and 28 days by adding

0.5% of hemp fibers and combine replacement of GGBS and marble powder (7.5%+7.5%) respectively.

3. The percentage increment of compressive strength of reinforced concrete with respect nominal mix for 7 days is15.5%.
4. The percentage of reinforced concrete with respect to nominal mix for 28 days is 17.5 %.
5. The maximum split tensile strength found to be 4.29 N/mm^2 and 6.106N/mm^2 for 7 days and 28 days by adding 0.5% hemp fibers and combine replacement of GGBS and marble powder at (7.5%+7.5%)respectively.
6. The percentage increment of reinforced concrete with respect to nominal mix for 7 days is 17.53%.
7. The percentage increment of split tensile strength of reinforced concrete with respect to nominal mix for 28 days is 17.8%.
8. The ultra sonic pulse velocity test results for conventional concrete is 4674 m/sec.
9. The ultra sonic pulse velocity test results for addition of hemp fibers, GGBS and marble powder is 4985m/sec.
10. The percentage increment of ultra pulse velocity compared with nominal mix is 6.7%.

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