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Experimental Investigation On Influence of Marble Powder On Concrete by Replacing Cement

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Abstract

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lesser the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing with an important impact on environmental and humans. This project describes the feasibility impact on environment and humans. This project describes replacement of cement. It should be designed to have a higher workability, high mechanical properties and greater durability than those of traditional concrete.

Marble powder is one of the waste materials obtained during extraction, cutting and polishing marble stones from the quarries and commercial industries. Many researchers have investigated the possibility of using marble powder as a replacement of cement in concrete mixtures, this synopsis presents the results of the feasibility of using marble powder as cement in concrete strengths. The effects of replacing cement by marble powder were studied. Replacement of tests constituted with the replacement percentage of 0%, 5%, 10%, 15%, 20%, 25%, 30%.

1. Introduction

1.1 GENERAL

Concrete is one of the most widely used construction material throughout the world the advantage of it being is it can be mould in to any shape and can be made to take required compressive strength in additional to compressive strength by increasing flexural strength, the load bearing capacity can be increased approximately. The ingredients for making concrete are cement fine aggregate, coarse aggregate and water. Sometimes creative additives are added to it to improve or alter some properties making concrete is an art which one has to be perfectly through otherwise that will end up with bad concrete. Hence as a civil engineer one should be through with the entire factor of concrete from which he can produce a good concrete.

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 dust is settled by sedimentation and then dumped away which results in 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.

1.2 PROPERTIES OF CONCRETE

Concrete making is not just a matter of mixing ingredient to produce a plastic mass but good concrete has to satisfy performance requirements in the plastic or green state and also in the hardened state. In the plastic state the concrete should be workable and free from segregation and bleeding is the separation of cement paste form the main mass. The segregation and bleeding indicates a poor quality concrete in its hardened state concrete should be strong and durable and impermeable; and it has minimum dimensional changes.

1.3 ADVANTAGES OF CONCRETE

- Concrete is the economical in the long run as compared to the other engineering materials except cement
- Concrete possess a high compressive strength and corrosive and weathering effects are kept us minimum. When properly prepared t strength is equal to the hard natural stone.
- The green concrete can be easily handled and moulded in to any shape or size according to the specifications. In the form work can be reused u number of times of similar jobs resulting in economy
- It is strong in compression and has unlimited structural application in combination with steel reinforcement.
- Concrete can ever be sprayed on and filled in to fine crack for repain by guniting process.
- The concrete can be pumped and hence it can be laid in the difficult position also.

1.4 DISADVANTAGES OF CONCRETE

- Concrete has low thermal tensile strength and hence easily cracking.
- Fresh concrete shrinkage on drying and hardened concrete expands on wetting.
- Concrete expands and contracts with the changes in temperature.
- Concrete under sustained loading undergoes creep resulting in the reduction of pre stress in the pre stressed concrete construction.

- Concrete is not entirely impervious to moisture and contains soluble salts which may causes efflorescence.

- Concrete is liable to disintegrate by alkali and sulphate attack.

- The lack of ductility inherent in concrete as a material is disadvantageous with respected earthquake resistant design.

1.5 WASTE MARBLE POWDER

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 production. The wet marble sludge was dried up prior to the preparation of the samples. The dried material was sieved through a 90 micron sieve and finally the marble dust was obtained to be used in the experiments as cement.

INFLUENCE OF MARBLE POWDER IN CONCRETE

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble dust in concrete production as partial replacement of cement. The marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated.

1.6 OBJECTIVE

- To investigate the performance of cement concrete with marble powder as a partial replacement for cement in concrete. In this research, attempt has been made to evaluate the compressive strength of concrete.
- The Marble Dust is used as replacement of concrete

1.7 SCOPE OF THE WORK

- This work relates to the usage of the marble powder; a waste cheap material used in the cement concrete mixtures.
- The experimental results obtained show that the partial substitution of ordinary concrete by marble powder gives better results compared with the ordinary cement concrete. Hence, it is a better approach in using the powder as a replacement for cement.
- The use of marble powder partially instead of cement and also as cement reduces the cost of making cement, as it is a waste available in abundance. Thus, economy in construction can be achieved ultimately.

2. LITERATURE REVIEW

2.1 GENERAL

This chapter presents the work done by various researchers, for partial replacement of cement with marble powder in concrete using various test.

2.2 REVIEW OF LITERATURE

[1] Augustine Uche Elinwa and Yakubu Abba Mahmood (2002) carried out research on the ash derived from the sawdust has confirmed its pozzolanic properties with a pozzolanic index value of 75.9%. This material compares favourably with fly ash and wastes from the oil palm industry. The only difference noticed is in the low content of Al2O3 (4.09%) and Fe2O3 (2.26 %). Concrete mixes have been proportioned to have various percentages of cement replacement with sawdust ash (SDA) ranging from 0% to 30% by mass. The performance of the ash-portland cement mixture has been evaluated with respect to setting time, workability and compressive strength. The possibilities of using SDA as pozzolana have been explored. SDA used had 73.55% by mass of A1203, Fe2O3, and a pH of 10.1; the pozzolanic activity index was 75.9%. The XRD analysis indicated that the ash contained predominantly silicates (67.20%). The normal consistency of the paste increased as the proportions of SDA in the paste increased, while the soundness test showed a possible risk of expansion if its CaO content is above 5%. SDA in this work had a CaO content of 9.98%, but the soundness test showed that expansion did not amount to 10 mm, the maximum limit specified. The 28 days compressive strengths of the SDA/OPC concretes at 5%, 10% and 15% of levels of replacement of cement are about 93%, 78% and 68% of the control mix, respectively

[2] Mannan and Ganapathy (2002)conducted a short-term study, for up to 90 days, to evaluate the properties of oil palm shell concrete, namely compressive strength, flexural strength, splitting tensile strength, modulus of elasticity, drying shrinkage and initial surface absorption and a comparison were made with control concrete. The compressive strength of the concrete determined through 100 mm cubes. According to ASTM, beams of 100 100 500 mm sizes for flexural test and, 100 200 mm size cylinders for splitting tensile and modulus of elasticity tests were employed. The beam size 100 100 500 mm was used for the drying shrinkage test. Two types of curing are chosen to study the effect of curing conditions on the performance of OPS and control concretes. It is observed that OPS concrete has sufficient strength to be accepted as structural lightweight concrete and that the trend of behaviours of OPS concrete and control concrete is very similar. However, the modulus of elasticity of OPS concrete is lower compared to control concrete and ISA is more in OPS concrete compared with control concrete.

[3] Teo et al.(2007) conducted an experimental investigation to determine the structural bond properties of lightweight concrete incorporating solid waste oil palm shell (OPS) as coarse aggregate and also to compare its behaviour with other types of lightweight aggregate concretes. To determine the basic engineering properties of the OPS concrete mix, the 28 days air-dry density, compressive strength, split tensile strength, modulus of rupture and modulus of elasticity were tested. The structural bond properties were determined through pull-out test. The specimens used for the bond strength test were 100 mm diameter x 200 mm height specimens incorporating both deformed (type Y) and plain bars (type R) of 10, 12 and 16 mm. From the properties test it was observed that the aggregate impact value (AIV) and aggregate crushing value (ACV) of OPS aggregates were much lower compared to the conventional crushed stone aggregates, which indicates that these aggregates have good absorbance to shock. The results showed that the experimental bond strength of OPS concrete was much higher than the design.

[4] HANIFI BINICI (2008) some mechanical properties of concrete containing marble dusts (MD) and limestone dusts (LD) were investigated. Seven concrete mixtures were produced in three series with control mixes having 400 kg cement content. These control mixes were modified to 5, 10 and 15% MD and LD in place of fine sand aggregate. The compressive strengths of concrete were measured for 7, 28, 90 and 360 days and sodium sulphate resistance were for 12 months. Also, abrasion resistance and water penetration of concretes were investigated. Results indicate that MD and LD fine aggregate concrete has good workability and abrasion resistance is comparable to that of conventional concrete. They also showed that maximum abrasion rate is obtained from control specimen, while minimum abrasion rate is obtained from MD3 specimens. Abrasion resistance is increased as the rate of fine MD and LD is increased. Furthermore, the results indicated that the increase in the dust content caused a significant increase in the sodium sulphate resistance of the concretes. Therefore, the studied MD and LD can be used for more durable concrete production.

[5] BOUZIANI TAYEB (2011) They investigated the effect of marble powder content (MP) on the properties of the sand concrete (SCSC) at fresh and hardened states. The properties of the fresh prepared mixes tested are the mini-slump flow, the V-funnel flow time and viscosity. At the hardened state, the parameter which has been determined is the 28 days compressive strength. The obtained test results show that the increase of MP content in SCSC, from 150 kg/m^3 to 350 kg/m^3, improves the properties at fresh state by decreasing v-funnel flow time (from 5s to1.5s) and increasing the mini-cone slump (from 28 cm to 34 cm). With the use of 250 kg/m^3 of MP we can reach the highest initial viscosity while retaining good fluidity at high rotational speeds, compared to the MP contents of 150 kg/m^3 and350 kg/m^3. In other hand, the 28-days compressive strength decreases with an increase of MP content

[6] Gunasekaran (2011) investigated the important mechanical properties of concrete using coconut shell (CS) as coarse aggregate. Compressive, flexural, splitting tensile strengths, impact resistance and bond strength were measured and compared with the theoretical values as recommended by the standards. The bonding property of CS is also studied to analyze the suitability from a structural point of view. The freshly discarded shells were collected from the local oil mills and they were well seasoned. The seasoned CS is crushed by a mini crusher, which was developed and erected specifically for this purpose. The crushed edges were rough and spiky and the lengths were restricted to a maximum of 12 mm. The surface texture of the shell was fairly smooth on concave and rough on convex faces, CS aggregates used were in saturated surface dry (SSD) condition. Coconut shell concrete has better workability because of the smooth surface on one side of the shells and the size of CS used in this study. The 28 days air-dry densities of CS concrete of the typical mixes ranged from 1930 to 1970 kg/m^3 and these are within the range of structural lightweight concrete of density less than 2000 kg/m^3. The flexural strength of CSC is approximately 17.53% and 16.42% of its respective compressive strengths (26.70 N/mm^2 and 25.95 N/mm^2). The splitting tensile strength of CSC is approximately 10.11% and 9.17% of its respective compressive strengths. The impact resistance of coconut shell aggregate concrete is high when compared with conventional concrete. The experimental bond strength of CSC is much higher compared to the theoretical bond strength as stipulated by IS 456:2000 and BS 8110. The experiments prove that coconut shells fulfill the requirements for use as lightweight aggregate.

[7] M. Shahul Hameed (2012) their project presents the feasibility of the usage of quarry rock dust and marble sludge powder as hundred percent substitutes for natural sand in concrete. An attempt has been made to durability studies on green concrete compared with the natural sand concrete. It is found that the compressive, split tensile strength and durability studies of concrete made of quarry rock dust are nearly 14% more than the conventional concrete.

Application of green concrete is an effective way to reduce environment pollution and improve durability of concrete under severe conditions. The chemical compositions of quarry rock dust and marble sludge powder such as Fe_2O, MnO, Na_2O, MgO, K_2O, Al2O, CaO, and SiO_2 are comparable with that of cement. The replacement of fine aggregate with 50% marble sludge powder and 50% Quarry rock dust (Green concrete) gives an excellent result in strength aspect and quality aspect. The results showed that the M4 mix induced higher compressive strength, higher splitting tensile strength. Increase the marble sludge powder content by more than 50% concrete compared well with that of other structural lightweight concrete and the results obtained are encouraging the use of OPS as aggregates for the production of structural lightweight concrete. The second part of the experimental program investigates the durability performance.

[8] Hwang Chao-Lung (2011) investigated the effects of adding residual rice husk ash (RHA) from South Vietnam, generated, when burning rice husk pellets in the boiler, to cement. To improve pozzolanic reactivity, RHA was grounded for 1 h. The non-ground RHA and ground RHA were used to test strength activity index according to ASTM C311. The properties of the concrete were investigated, including compressive strength, concrete electrical resistivity, and ultrasonic pulse velocity. Results show that the non-ground RHA can be applied as a pozzolanic material. Decreasing the non-ground RHA average particle size provides a positive effect on the compressive strength of mortar. Compressive strength of cylindrical concrete in the 47-66 MPa range was obtained in this study. The results also indicate that up to 20% of ground RHA could be advantageously blended with cement without adversely affecting the strength and durability properties of concrete.

[9] Nutan Patel (2013) were studied on Marble Waste Opportunities For Development of LowCost Concrete. The author studied Based on the Indian Standard (IS: 10262-1982), design mix for M30 grade of concrete was prepared by partially replacing fine aggregate with five different percentages by weight of marble powder (0%, 5%, 10%, 15%, and 20%). There is a slight decrease in compressive strength value concrete mix when 20% marble powder is used as compared with that of 15% marble powder mix Compressive strength of the concrete has increased with increasing percentages of marble dust additions. The author conclusion for this research rate of the 0% marble waste 28 days strength is 38 N/mm² at this strength of concrete rate is Rs. 3760.25. After adding the marble dust increases the strength. The highest compressive strength has been demonstrated by 15% marble dust is 40.5 N/mm² at this strength of concrete rate is Rs. 3732.56. By using the marble dust the rate of the concrete is decrease and strength is increase

[10] Payam Shafigh (2013) conducted an experimental investigation to produce green structural lightweight concrete by using oil palm shell (OPS) as coarse aggregate, and ground granulated blast furnace slag (GGBFS) as a supplementary cementing material at 30%, 50% and 70% replacement of cement, and exposed to different curing conditions. Depending on the curing condition, test results show the possibility of producing green structural lightweight aggregate concrete with 28day compressive strength of 23-42 MPa. The strength and density of GGBFS OPS concrete decrease as the percentage replacement of GGBFS increases. Data also shows that initial hot water curing significantly improve the compressive strength of the oil palm shell lightweight concrete containing high volume GGBFS at an early age while this curing method is not useful for oil palm shell concrete containing just ordinary Portland cement. By incorporating GGBFS, grades 30 and 35 OPS concrete with significantly lower cement content than previous studies can be produced.

[11] Mun, K.J (2007) studied the use of efficiently treat sewage sludge discharged from sewage treatment plants and to evaluate the feasibility of lightweight aggregate made from a large quantity of sewage sludge. Sintered lightweight aggregate from sewage sludge is experimentally manufactured with various mass ratios of clay to sewage sludge by a rotary kiln, and is bond strength as stipulated by BS 8110. In general, the properties of OPS tested for density, water absorption, abrasion loss, crushing value, impact value and heavy metal leaching. Their physical properties are compared to those of a commercial sintered lightweight aggregate for non-structural concrete. When sewage sludge content increases up to 75% (clay: sewage sludge = 100:300) in the mixtures of clay and sewage sludge as raw materials, internal sintering and gas foaming (or expansion) originate from calorification and gas generation, due to the decomposition of organic materials in the foamed clay-sewage sludge mixtures. This results in the lightweight aggregate with a reduced density and water absorption. An experimentally manufactured lightweight aggregate with a recommendable sewage sludge content of 75% is similar or superior physical properties such as density, water absorption, abrasion loss, crushing value and impact value to the commercial lightweight aggregate for non structural concrete. In particular, the water absorption of the manufactured lightweight aggregate is about 50% or less than that of the commercial lightweight aggregate. No toxic heavy metals were detected from any of the manufactured lightweight aggregates with the highest or lowest sewage sludge contents. Therefore, the lightweight aggregate can be used as environment conscious lightweight aggregate. Due to a higher mixing ratio of sewage sludge, the compressive and flexural strengths of concrete decrease gradually, and the adiabatic effect become more beneficial. Consequently, it is concluded that nonstructural lightweight concrete with a density range of 1400-1500 kg/m^3 and thermal conductivity range of 0.59-0.73 W/mK could be manufactured.

[12] Paki Turgut and Halil Murat Algin (2007) studied the potential use of limestone powder wastes (LPW) and wood sawdust wastes (WSW) combination for producing a low-cost and lightweight composite as a building material. Some of the physical and mechanical properties of concrete mixes having high levels of WSW and LPW are investigated. The test results show that the WSW-LPW combination provides results which are of potential to be used in the production of lighter and economical new brick material. Observations during the tests show that the effect of 10-30% WSW replacements in WSW-LPW matrix does not exhibit a sudden brittle fracture even beyond the failure loads and indicates high]energy absorption capacity by allowing lower laboring cost. This composition produces a comparatively lighter composite which is about 65% lighter than the conventional concrete bricks. Concrete with 30% replacement level of WSW which attained 7.2 Mpa compressive and 3.08 Mpa flexural strength values, satisfies the requirements in BS 6073 for a building material to be used in the structural applications.

However, the complete investigation of brick samples with LPW and LPW WSW combination should include further durability tests.

[13] Erhan Guneyisi (2008) performed a study related to durability properties of the lightweight concretes (LWCs) including either cold bonded (CB) or sintered (S) fly ash aggregates. CB aggregate was produced with cold bonding pelletization of class F fly ash (FA) and Portland cement (PC) while S aggregate was produced by sintering the fresh aggregate pellets manufactured from FA and bentonite (BN). Two concrete series with water to- binder (w/b) ratios of 0.35 and 0.55 were designed. Moreover, silica fume (SF) with 10% replacement level was also utilized for the purpose of comparing the performances of LWCs with and without ultrafine SF. The durability properties of concretes composed of CB and S aggregates were evaluated in terms of water absorptivity, rapid chloride ion permeability, gas permeability, and accelerated corrosion testing after 28 days of the water curing period. The compressive strength test was also applied to observe the strength level at the same age. The results revealed that S aggregate containing LWCs had relatively better performance than LWCs with CB aggregates. Moreover, the incorporation of SF provided further enhancement in permeability and the corrosion resistance of the concretes.

[14] Miao Liu (2010) investigated self-compacting concrete (SCC) with levels of up to 80% cement replacement by fly ash in mixes adjusted to give constant fresh concrete properties. The hardened concrete and the relationships between hardened properties were then studied. The range of powder content of 439-539 kg/m3 and fly ash replacement ratio varying from 0% to 80% in the steps of 20% by volume (and one mix with 100% fly ash for fresh concrete properties only) in SCC was tested. Forall mixes, the sand to mortar volume ratio of 45% and the coarse aggregate to concrete volume ratio of 35.5% (55% of its dry-rodded bulk density) were maintained. Eighteen cubes (100x100x100 mm), 6 cylinders (100 mm in length, 200 mm in diameter) and three prisms (100×100×505 mm) were subsequently cast without vibration all from the same batch by the scoops. The cubes, cylinders and prisms were covered with plastic sheets and stored in the lab after casting. After about 24 h, all specimens were de-moulded, marked and cured in the water at 21°C until the date of testing. Tests on the cast specimens include compressive strength, splitting tensile strength, non-destructive test of ultrasonic pulse velocity (UPV) and dynamic elastic modulus (Ed), and water absorption test. The results show that SCC with up 80% cement replaced by fly ash is possible. To keep the filling ability constant, replacement of cement with fly ash would require an increase in water/powder (W/P) ratio and a reduction in super plasticiser dosage. The results were also shown that the fly ash have negative effects on passing ability, consistence retention and hardened concrete properties such as strength. The comparison between SCC and normally vibrated concrete (NVC) shows that their material properties of being similar. The successful completion of this project can lead to the use of higher volume fly ash in SCC.

[15] BAHAR DEMIREL (2010) Experimentally studied, the effects of using waste marble dust (WMD) as a fine material on the mechanical properties of the concrete have been investigated. For this purpose four different series of concrete-mixtures were prepared by replacing the fine sand (passing 0.25 mm sieve) with WMD at proportions of 0, 25, 50 and 100% by weight. In order to determine the effect of the WMD on the compressive strength with respect to the curing age, compressive strengths of the samples were recorded at the curing ages of 3, 7, 28 and 90 days. In addition, the porosity values, ultrasonic pulse velocity (UPV), dynamic modulus of elasticity and the unit weights of the series were determined and all data were compared with each other. Finally, all of the data were compared with eachother. It was observed that the addition of WMD such that would replace the fine material passing through a 0.25 mm sieve at particular proportions has displayed an enhancing effect on compressive strength. Marble dust is a by-product of marble production facilities and also creates large scale environmental pollution. Therefore, it could be possible to prevent the environmental pollution especially in the regions with excessive marble production and to consume fewer natural resources as well through its utilization in normal strength concretes as a substitute for the very fine aggregate.

[15] BABOO RAI In this project the effect of using marble powder and granules as constituents of fines in mortar or concrete by partially reducing quantities of cement as well as other conventional fines has been studied in terms of the relative workability & compressive as well as flexural strengths. Partial replacement of cement and usual fine aggregates by varying percentage of marble powder and marble granules reveals that increased waste marble powder (WMP) or waste marble granule (WMG) ratio result in increased workability and compressive strengths of the mortar and concrete.

[16] Payam Shafigh (2011) performed a study to feasibility use of high strength lightweight concrete (HSLC) using oil palm shell (OPS) and evaluated the influence of curing conditions on the compressive strength of high strength OPS concrete. The Malaysia ordinary Portland cement (OPC) cement was used, having a 3,7 and 28days compressive strength of 25.5, 34.2 and 45.9 Mpa, respectively. The specific gravity of the cement used was 3.14 g/cm^3. Its Blaine specific surface area was 3510 cm^3/g. Local mining sand with a fineness modulus of 2.73 specific gravity of 2.68, water absorption of 0.96% was used as the fine aggregate. Old OPS were used as the coarse aggregate and they were collected from a local crude palm oil producing mill, and comprised old discarded waste in the palm oil mill area. Eight different OPS concrete mixtures were produced. The density, air content, workability, cube compressive strength and water absorption were measured. The effect of five types of curing conditions on 28 days compressive strength was studied. The test results showed that by incorporating limestone powder and without it, it is possible to produce the OPS concretes with 28 days compressive strength of about 43-48 Mpa and dry density of about 1870-1990 kg/m^3. The compressive strength of OPS HSLC is sensitive to the lack of curing. The water absorption of these concretes is in the range of good concretes.

[17] Zerbino (2011) conducted a study on a residual rice husk ash (RHA) was used as nature", without any previous grinding in concrete production. An adequate RHA particle size can be obtained mixing RHA together with the coarse aggregates during a convenient period of time. The viability of this option, besides avoiding grinding costs, can increase the possibilities of using the residual RHA. particularly in the neighbourhood of rice production zones, and for small constructor producers. A preliminary study for mixture optimization on concretes with different water/cement ratios and RHA contents was performed. The residual RHA was used both in natural conditions and after optimizing by grinding. Afterwards it was developed the main study, which includes a comparative analysis of a reference concrete without RHA and two structural concretes replacing 15% of weight of cement by natural and ground RHA. The properties of fresh concrete, the compressive strength, the response after exposure, at high temperatures, and the differed strain behaviour (creep and shrinkage) were analyzed. In addition the matrix - aggregate bond strength and some durability aspects as the water permeability were considered. Concretes prepared with RHA previously grinded (GRHA) showed excellent characteristics in the fresh state and significant increments in the mechanical properties, even replacing up to 25% of the cement weight. It is possible to incorporate natural RHA without grinding (NRHA) in concrete, adapting the mixing process to optimize the ash particle size. The results are highly dependent on the equipment and mixing cycle adopted. When compared, Control concrete without ashes and concrete replacing 15% of the cement by NRHA achieved similar mechanical and durability properties. However, better results were obtained with GRHA.

[18] V.M.SHELKE (2012) in this project their main objective is to study the influence of partial replacement of cement with marble powder, and to compare it with the compressive strength of ordinary M30 concrete. We are also trying to find the percentage of marble powder & silica fume replaced in concrete that makes the strength of the concrete maximum. Now a day's marble powder has become a pollutant. So, by partially replacing cement with marble powder, we are proposing a method that can be of great use in reducing pollution to a great extent. In this investigation a series of compression tests were conducted on 150 mm, cube and 150 mm x 300 mm, cylindrical specimens using a modified test method that gave the complete compressive strength, using silica fume of constant 8% with and without marble powder of volume fractions 0, 8. 12, & 16% on Ordinary Portland cement concrete. The optimum result of compressive strength of cube is found at 8% silica fume and 8% marble powder with replacement of OPC cement in concrete that is 1.64%, 3.92 % at 7 & 28 days of curing. The optimum result of compressive strength of cylinder is found at 8% silica fume and 8% marble powder with replacement of OPC cement in concrete that is 2.79%, 1.78%, at 7 & 28 days of curing.

[19] Rui Barbosa (2013) assesses the possibility of using biomass ashes as substitutes for cement and natural aggregates in concretes, without compromising their mechanical, chemical, and ecotoxic properties. Thirteen concrete formulations were prepared with different percentages of bottom and fly ashes produced in the power plant of a pulp and paper industry. These formulations were submitted to mechanical compressive strength assays, after 28, 60, and 90 days of cure. The reference formulation (without biomass ashes) and two formulations (with biomass ashes), were selected for further characterization. After 90 days of curing, the selected formulations were submitted to the leaching test described in the EN12457-2 (L/S 10 L/kg, 24 h batch cycle) by using two leaching agents: synthetic marine water (ASPM medium) and a synthetic freshwater (ISO 6341 medium). The specimens produced were submitted to chemical characterization and to an ecotoxicological characterization. The substitution of 10% cement by fly ashes has promoted similar to higher levels of the compressive strength to reference formulation. The new formulations presented emission levels of chemical species similar to, or even lower than, those observed for the reference formulation. The ecotoxicological levels were reduced for all of the formulations.

[20] Wen-Ten (2013) was conducted a study on feasibility use of Washed municipal solid waste incinerator bottom ash (MSWIBA) as a substitute for natural aggregate in pervious concrete. The mix proportions of the concrete were first determined using a vertical flow test. Washed MSWIBA with a maximum size of 12.5 mm (the most abundant size of washed MSWIBA particles) was used as the main experimental aggregate. First, the toxicity characteristic leaching procedure (TCLP) was conducted. Next, other experiments were performed, including chlorine, dioxin and furan content tests; tests of volume proportions, unit weight and porosity (ASTM C29); sieve analysis (ASTM C136); water absorption measurement (ASTM C127); and shape factor analysis. Other tests, including permeability, compressive strength, bending and split tensile strength tests, were also performed. The test results show that the unit weight of the fresh pervious concrete made with MSWIBA was approximately 1653-2080 kg/m³ and increased with the ratio of cement paste filling. In specimens with the same water-cement ratio, the compressive, bending and split tensile strengths all increased with the ratio of filling paste. The split tensile and bending strengths were approximately 1/9 and 1/4 of the compressive strength respectively. The connected porosity and permeability coefficients are linearly correlated; both decrease as the filling ratio is increased.

CHAPTER 3

3.1 PROPERTIES OF MATERIALS

3.1.1 Cement

The cement used in this study was PPC 43 grade from Coromandel Cement Company. This cement is most widely used in the construction industries in Coimbatore.
An PPC 43 Grade sample was tested to obtain the following characteristics:

- Specific gravity (IS: 1727-1967)
- Standard consistency (IS: 4031-1968 Part 4)
- Initial setting time (IS: 4031 - 1968 Part 5)
- Final setting time (IS: 4031-1968 Part 5)

Table 3.1 Physical properties of cement

1	Specific gravity	3.07
2	Standard consistency	30%
3	Initial setting time	90 minutes
4	Final setting time	195 minutes
4	Fineness	2.5%

Table 3.2 chemical composition of cement

Component	Result (%)	Requirement of IS:12269 - 1987
SiO_2	21.8	-
Al_2O_3	4.8	-
Fe_2O_3	3.8	-
CaO	63.3	-
SO_3	2.2	-
MgO_3	0.9	Maximum 6
Na_2O_3	0.21	-
K_2O	0.46	-
Cl	0.04	Maximum 0.1
Loss of ignition	2	Maximum 4
Insoluble residue	0.4	Maximum 3

3.1.2 FINE AGGREGATE

Fine aggregate should be properly graded to give minimum void ratio and be free from deleterious materials like clay, silt content and chloride contamination etc., Grading of fine aggregate should be such that it does not cause increase in water demand for the concrete and should give maximum voids so that the fine cementitious particles to fill the voids. Hence it is desirable to use the coarser variety of fine aggregate having a high fineness modulus for making workable and strong concrete.

The following tests were carried out on sand as per IS: 2386-1968(iii) and the result is shown in Table 3.3

- Specific Gravity
- Sieve analysis and Fineness Modulus
- Bulk density
- Water absorption

Table 3.3 Test on Fine Aggregate

S.no	Test	Value
1	Specific gravity	2.65
2	Percentage of voids	24.5
3	Fineness modulus	2.934
4	Bulk density	1.780 kg/m^3
5	Water absorption	1.7%

Table 3.4 Sieve Analysis for Sand As per IS : 383-1970

S.no	Sieve size (mm)	Weight retained (kg)	% weight retained	Cumulative % retained	% Finer
1	4.75	0	0	0	100
2	2.36	0.0112	1.12	1.12	98.88
3	1.18	0.0036	0.36	1.48	98.52
4	0.6	0.288	28.8	30.28	69.72
5	0.3	0.575	57.5	87.7	12.30
6	0.15	0.105	10.5	98.2	1.8
7	0.075	0.0172	1.72	100	0
8	Pan	0	0	100	0

Note: The fine aggregate conforms to grading zone- II of table 3 of BIS: 383-1970

3.1.3 COARSE AGGREGATE

Coarse Aggregate consists of natural occurring stones (crushed, uncrushed or broken). It should be hard, strong, dense, durable, and clean. It should be roughly cubical in shape. Flaky pieces should be avoided. It should confirm to IS: 2383(1). The coarse aggregate should be clean, hard, non-porous, free from lumps of clay and vegetable matter. Water absorption of aggregate should not more

than 10% of its weight after 24 hours immersion in water. Angular and roughly cubicle particles are ideal.
The following test were carried out on Coarse aggregate as per: 2386 -1968 (I) and result is shown in Table 3.5

- Specific Gravity
- Sieve analysis and Fineness Modulus
- Bulk density

Table 3.5 Test on coarse Aggregate

S.no	Test	Value
1	Specific gravity	2.79
2	Fineness modulus	4.63
3	Bulk density	1.780 kg/m^3
4	Water absorption	0.8%

Table 3.6 sieve analysis for coarse Aggregate

S.no	Sieve size (mm)	Weight retained (gms)	Cumulative weight retained (gms)	Cumulative % retained	% Finer
1	20	0	0	0	100
2	12.5	175	175	8.75	91.25
3	10	1020	1195	59.75	40.25
4	4.75	785	1980	99	1
5	2.36	20	2000	100	0
6	Pan	0	2000	100	0

3.1.4 WATER

Water is an important ingredient of cement mortar as it chemically participates in the reactions with cement to form the hydration product, C-S-H gel. The strength of cement mortar depends mainly from the binding action of the hydrated cement paste gel. Higher water cement ratio or water binder ratio will decrease the strength, durability, water tightness and other related properties of cement mortar.

For high performance cement mortar mix consideration, it is important to have the compatibility between the given cement and the chemical and mineral admixtures along with water used for mixing. High Performance Cement mortar with its high content of cementitious material is susceptible to a rapid loss of workability on account of high amount of heat of hydration generated. Therefore, attention is required to see that the initial hydration rate of cement should not be significantly affected. Quality and quantity of water is required to be looked very carefully.

3.1.5 MARBLE POWDER

PHYSICAL PROPERTIES:

A marble powder was used, which was obtained as a by-product of marble sawing and shaping. Its specific gravity was 2.55 kg/m³ and the value of Blaine fineness was 1.50 m²/g. It can be observed that the marble powder had a high specific surface area; this could mean that its addition should confer more cohesiveness to mortars and concretes.

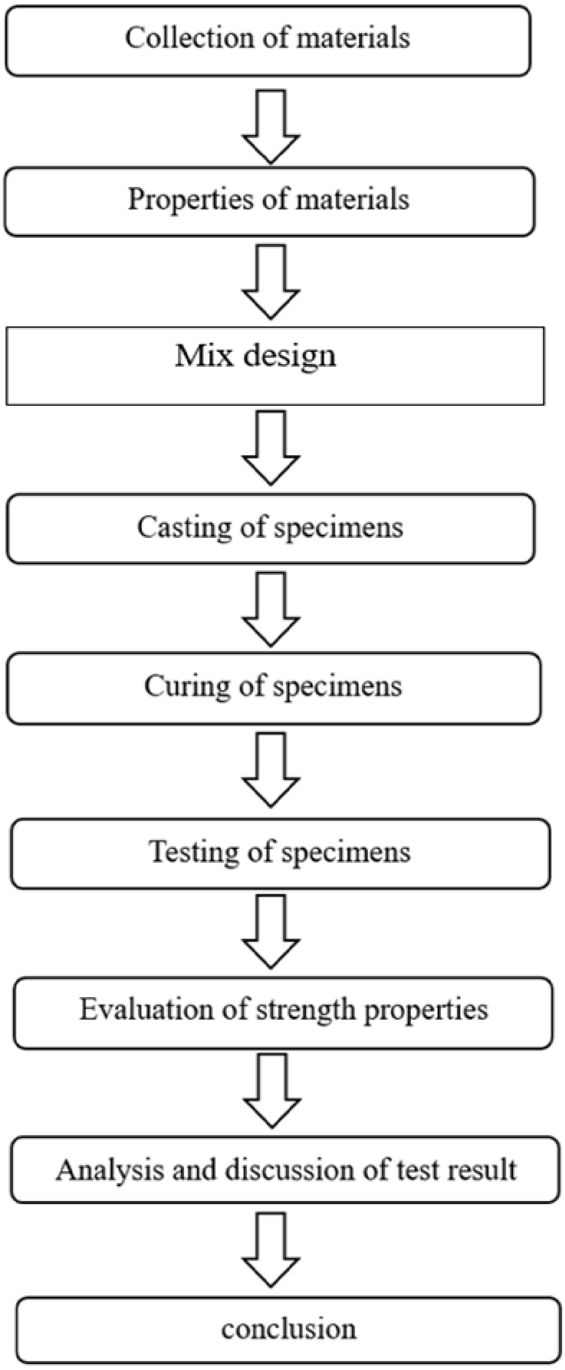
For better physical characterization of the marble powder, its grain size distribution was performed using laser diffraction. It can be observed that 50% of particles had a diameter of 7 µm (d50 = 7 µm) and 90% of particles had a diameter lower than 50 µm (d = 50 µm).

The marble powder is produced as "slurry", a mud made of powder and water. Therefore, for its use in concrete it is important to know how much water is contained in the slurry, by drying it and registering the weight loss related to water evaporation. A known weight of slurry was put in an oven to dry at a temperature of 110 ± 5 °C. At fixed intervals (1 hour, 4 hours, 24 hours, 48 hours, and 72 hours) the weight loss was registered with the aim to reach a constant weight.

Table 3.7 Chemical properties of used marble powder

Oxide components (mass %)	Marble dust
SiO_2	28.35
Al_2O_3	0.42
Fe_2O_3	9.70
CaO	40.45
MgO	16.25

3.2 METHODOLOGY



CHAPTER 4
MIX DESIGN
M20 GRADE CONCRETE:
A] Design stipulations

- Characteristics compressive strength required in field 28 days — 20 Mpa
- Maximum size of aggregate — 20 mm
- Degree of workability for M20, M25 concrete — 0.9
- Degree of quality control — Good
- Type of exposure — Mild

B) Test data for materials

- Specific gravity for cement — 3.07
- Specific gravity for coarse aggregate — 2.79
- Specific gravity for fine aggregate — 2.65
- Water absorption for fine aggregate — 1.7%
- Surface moisture for fine aggregate — 4.2%
- Zone confirming sand layer — III

C)Target mean strength of concrete

(20 + 1.65 s) = 26.6 Mpa {for M20, s = 4}

D) Water cement ratio = 0.50 %

E) Selection of water & sand content

Aggregate size 20 mm for zone III fine aggregate water content per cubic meter of concrete is 180 kg of water and sand as % of total aggregate by absolute volume = 35%

Change in condition	% of adjustment required for Water content	% of adjustment required for Sand in total aggregate
For decrease in W/C ratio by 0.1	0	-2
For increase in compaction factor by 0.1	+3	0
Sand conforming zone III	0	-1.5
Total	3	-3.5

Required sand content = 35 – 3.5 = 31.5%
Required water content = 186 + (0.03 * 186) = 191.61m^3
Required cement content = 191.61 / 0.5 = 383 Kg/m^3

FORMULA:

V = [W + (C/SC) + (1/P) (fa/sfa)] * (1/1000)

0.98 = [191.6 + (383/3.07) + (1/0.315) (fa/2.65)] * (1/1000)

Fine aggregate = 553.977 Kg/m^3

Coarse aggregate = [(1-0.315) / 0.315] * 553.977 * (2.79/2.65)

Coarse aggregate = 1268.32 Kg/m^3

Table 4.1 Mix Ratio

Water	Cement	Fine aggregate	Coarse aggregate
0.5	1	1.44	3.3

5. EXPERIMENTAL INVESTIGATION

5.1 METHODOLOGY

In this study the mechanical properties of marble powdered concrete were carried out for different percentage of marble powder Marble powder having the size of 75 micron was used. Total of 21 specimens were casted as cubical specimens. Cubical specimens were casted in 7 variations of marble powder. The variables of specimens considered in this study were percentage of fibre (0%, 5%, 10%,15%, 20%, 25%, 30%).

Table 5.1 Details of specimens and variables

Specimen	Size of specimen (mm)	Designation	% of marble powder
Cube	150 x 150 x 150	NC	0
		MP 1	5
		MP 2	10
		MP 3	15
		MP 4	20
		MP 5	25
		MP 6	30

5.2 EXPERIMENTAL INVESTIGATION

5.2.1 CASTING OF THE SPECIMEN

Test specimens were cast using seven variable percentages of marble powder, namely, 0%, 5%, 10%, 15%, 20%, 25% and 30% for each specimen. Portland pozzolana cement conforming to IS 269 1976, river sand and coarse aggregate with 20 mm maximum size were used. The mix was designed for a 28-day cube compressive strength of 20 N/mm² as per IS 10262-2009. Same mix was used to cast MP and conventional concrete specimens.

The specimens were cast in a steel mould and compaction was affected a table vibrator. However, to eliminate the effect of possible fibre orientation, concrete mix was filled three layer in a mould. No signs of segregation or air bubbles were observed during casting. The specimens were demoulded after 24 hours and then placed in a curing tank with 90% relative humidity and 23 °C for 28 days of curing. For 12 h prior to the testing, the specimens were allowed to air dry in the laboratory.

5.3 TEST ON FRESH AND HARDENED CONCRETE

Table 5.2 slump test value

S.NO	% of marble powder replaced	Slump value (cm)
1	0	3.5
2	5	3.5
3	10	4
4	15	4
5	20	4.5
6	25	4.8
7	30	6

Compressive strength and tensile strength tests were carried out at room temperature and as per the Indian standards These tests were carried out in a compression testing machine.

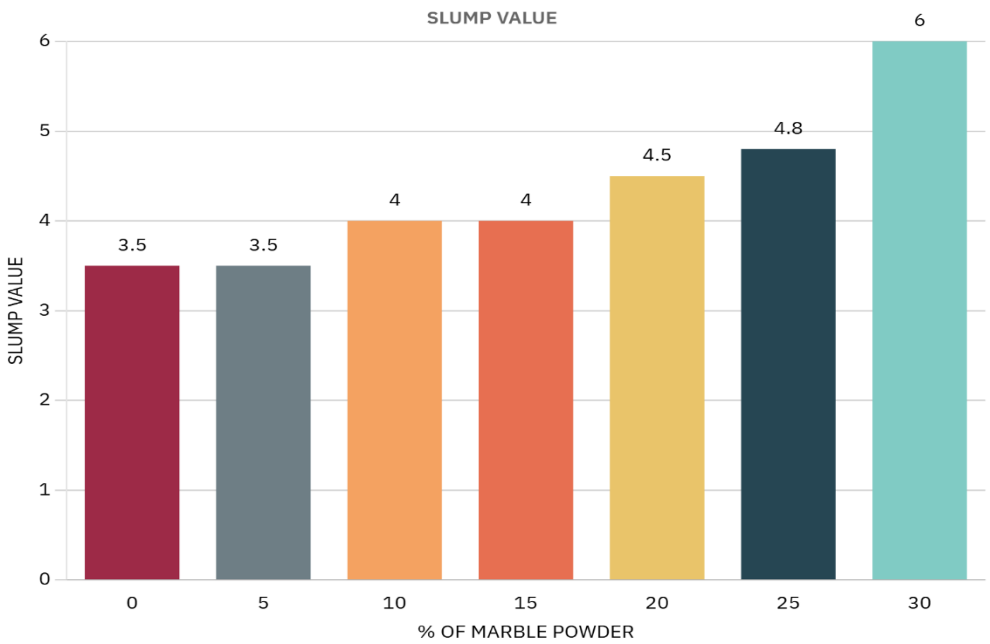


Fig 5.1 slump value of specimen

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Table 5.3 compaction factor values

S.no	% of marble powder replaced	Compaction factor
1	0	0.72
2	5	0.87
3	10	0.88
4	15	0.90
5	20	0.92
6	25	0.93
7	30	0.93

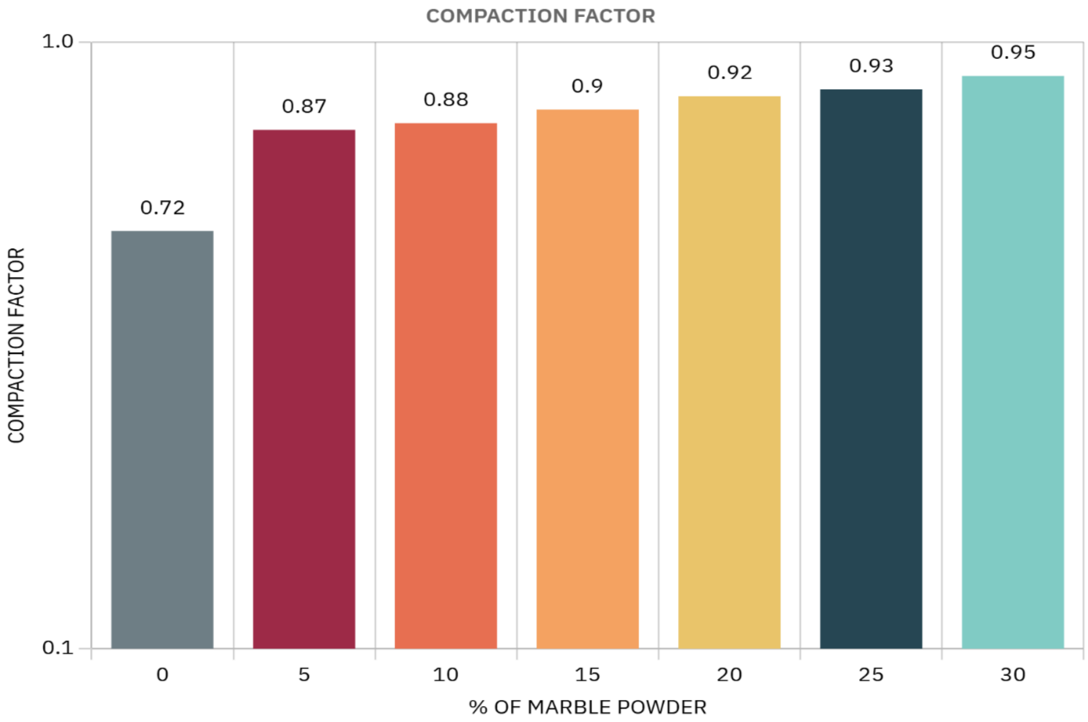

Fig 5.2 compaction factor of specimen

5.3.1 COMPRESSIVE STRENGTH TEST

The compression test is used to determine the hardness of cubical specimens of concrete. 150 mm x 150 mm x 150 mm size cubical specimens were tested by using compression test machine. Compressive strength should be calculated by dividing maximum load by the cross-sectional area. Compressive strength of concrete is tested on cube at different percentage of marble powder content in concrete. The strength of concrete has been tested on cube at 28 days curing. The 28 days test gives the data of final strength of concrete at 28 days curing. Compression testing machine is used for testing the compressive strength test on concrete. At the time of testing the cube is taken out of water and dried and then tested keeping the smooth faces in upper and lower part.

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Compressive strength = P / A (N/mm^2)

Where,

P = maximum applied load in N,

A = Cross sectional area in mm

Table 5.4 compressive strength of cubical specimen

S.No	% of Cement Replaced with marble powder	Compressive strength in 28days
1	0	28.60
2	5	29.40
3	10	30.20
4	15	32.14
5	20	26.60
6	25	24.80
7	30	23.50

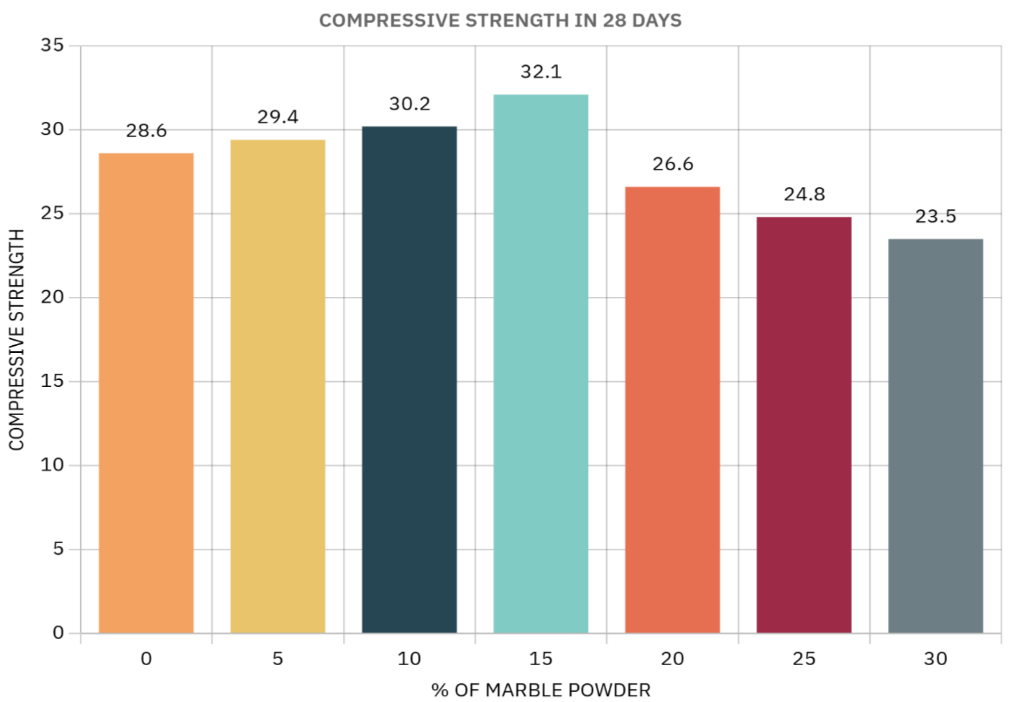


Figure 5.3 compressive strength of cubical specimen

Figure 5.4 compressive strength test

5.3.2 Split Tensile Strength

The test is conducted on Compression testing machine of capacity 2000 kN The results obtained are reported in Table 5.5. The cylinder is placed horizontally between the loading surfaces of compression testing machine and the load is applied till failure of the cylinder. Packing material such as plywood is used to avoid any sudden loading. During the test the platens of the testing machine should not be allowed to rotate in a plane perpendicular to the axis of cylinder. The Split tensile strength is computed from the following formula.

T-2P/πLD

Where; T: Tensile Strength

P: Maximum load in Newton's applied to the Specimen,

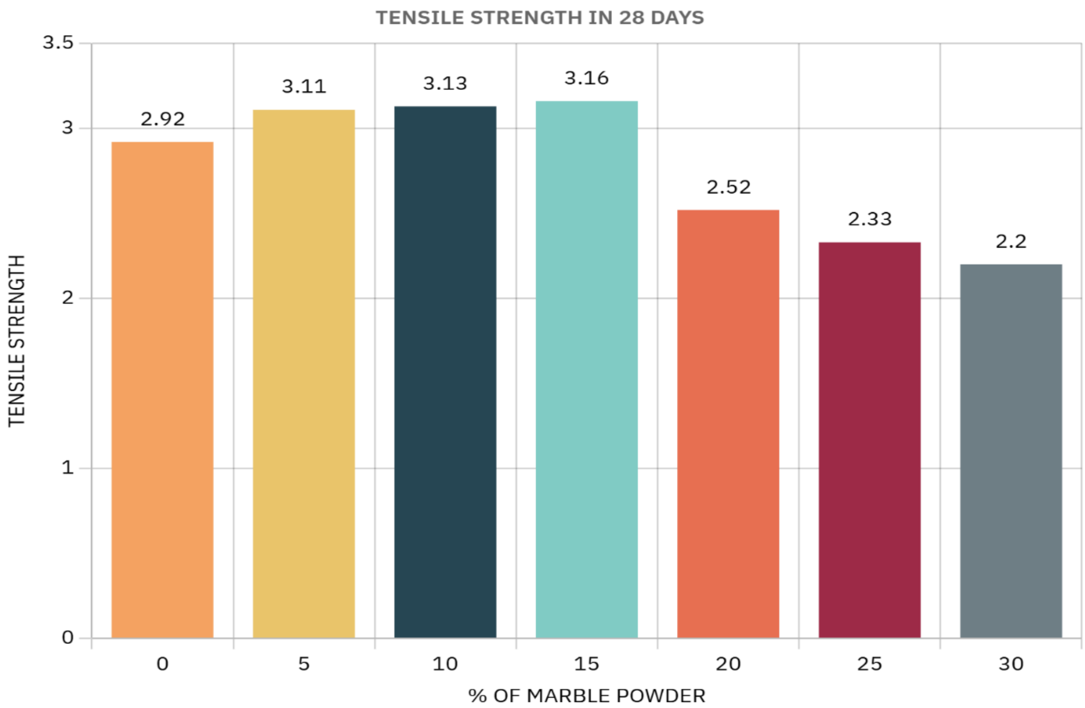
L: length of the specimen in mm.

D: C/S dimension of the specimen in m

Table 5.5 Tensile strength of specimen

S.no	% of cement replaced with marble powder	Tensile strength in 28 days (N/mm^2)
1	0	2.92
2	5	3.11
3	10	3.13
4	15	3.16
5	20	2.52
6	25	2.53
7	30	2.20

Fig 5.5 Tensile strength of specimen



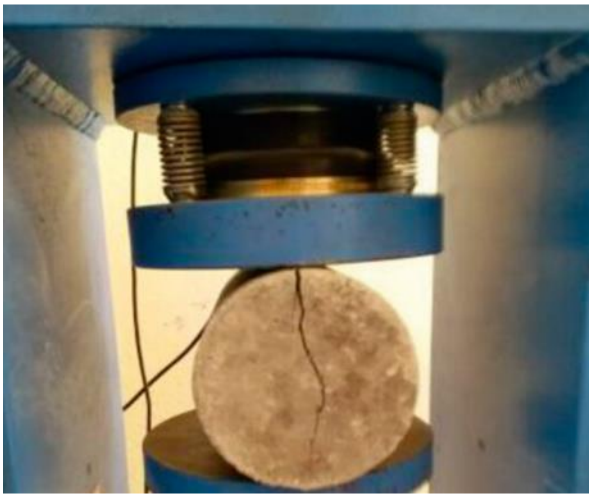


Fig 5.6 Tensile strength test

5.3.3 Flexural Strength

Prisms are tested for flexure in Universal testing machine of capacity 500 KN. The results obtained are reported in Table 5.6. The bearing surfaces of the supporting and loading rollers are wiped clean before loading. The prisms are placed in the machine in such a manner that the load is applied to the upper most surface along the two lines spaced 13.30 cm apart. The axis of the specimen is aligned with the axis of the loading device. The load is applied at a rate of 180 kg/min without shock on the specimen till it fails and the maximum load (P) applied to the specimen during test is noted.

Flexural strength (N/mm2) = PL/bd²
Where, P = maximum load at failure in N, and
L= length of the beam specimen (400mm)
b= Width of the beam specimen in mm, d=Depth of beam specimen in mm

S.no	Percentage of cement replaced with marble powder	Flexural strength in 28 days (N/mm^2)
1	0	3.91
2	5	4
3	10	4.04
4	15	4.27
5	20	3.30
6	25	3.15
7	30	3.02

Table 5.6 flexural strength of specimen

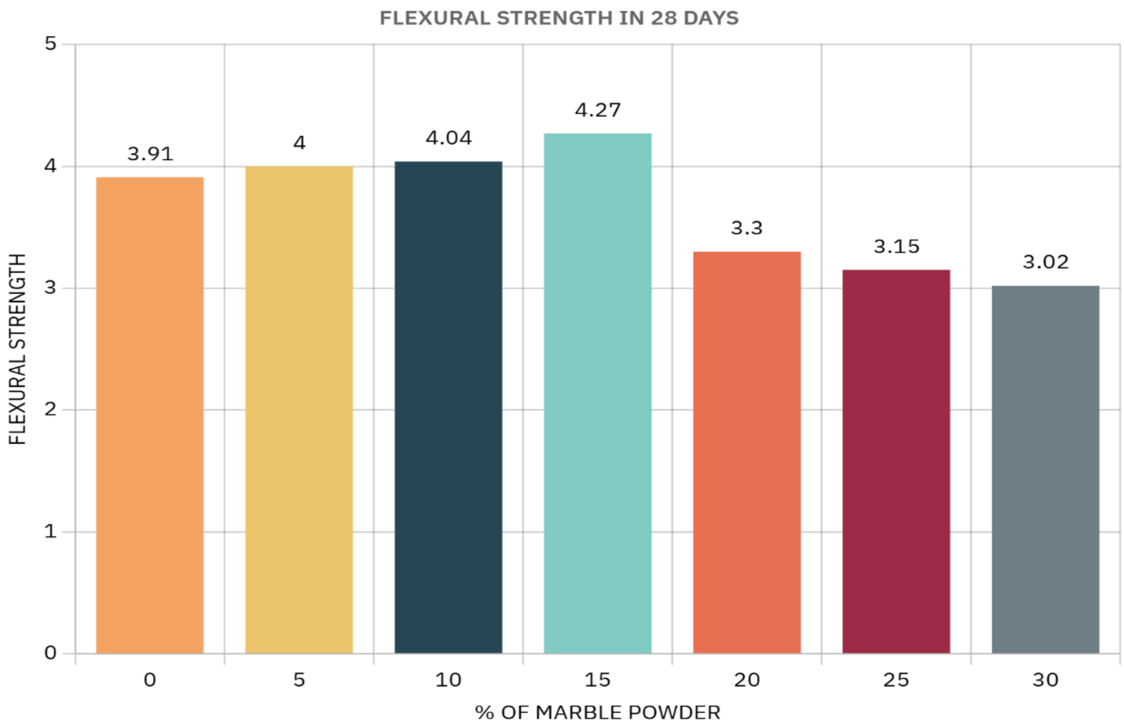


Fig 5.7 flexural strength of specimen

Fig 5.8 flexural strength test

6. RESULT AND DISCUSSION

6.1 GENERAL

The compressive strength, spilt tensile strength and flexural strength test result are discussed below.

6.2 DISCUSSION

- With the inclusion of marble powder, the slump value of concrete gradually increasing from the beginning itself.
- With the inclusion of marble powder, the strength of concrete gradually increases up to a certain limit but the gradually decreases.
- At 15% replacement of cement by marble powder there is 12.5% increase in compressive strength for 28 days.
- The compressive strength gradually decreases from 15% of replacement.

7. CONCLUSION

7.1 GENERAL

The main objectives of the present investigation was to study the compressive strength and flexural strength, spilt tensile strength of the prepared marble powder replaced specimen are investigated and also compared with that of ordinary concrete specimens.

The conclusions of the present investigation are as follows.

7.2 CONCLUSION

- The Compressive strength of Cubes are increased with addition of waste marble powder up to 10% replace by weight of cement and further any addition of waste marble powder the compressive strength decreases.
- The Compressive strength of Concrete increases up to 10% replacement of cement by MDP and further increasing of percentage of MDP leads to decrease in compressive strength of concrete.
- The Split tensile strength of concrete increases up to 15% replacement of cement by MDP & further

increasing of percentage of MDP leads to decrease in Split tensile strength of concrete.

- The Flexural strength increases up to 15% replacement of cement by MDP and further increases in the percentage of MDP leads to decrease in flexural strength.
- It is concluded that the MDP can be used as a replacement material of cement and 10% replacement of cement with MDP gives an excellent result in strength, as compared to the normal concrete
- Use of these waste material leads to sustainable development in construction industry.
- To save the environment, MDP may be used as better partial substitute as replacement of cement in concrete
- This project was mainly focused on the partial
- Thus, we found out the optimum percentage for replacement of marble powder with cement and it is almost 10% cement for cubes
- We have put forth a simple step to minimize the costs for construction with usage of marble powder which is freely or cheaply available

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