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AITERNATIVE DESIGN OF PREVIOS CONCRETE REPLACEMENT WITH MARBLE POWDER

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ABSTRACT:

The utilization of the solid waste in cement manufacturing company will help in conservation of natural resources like limestone. The use of marble powder as a partial replacement of Cement can reduce the production cost of cement and may be control the emission of harmful gases into the environment and proved Eco friendly to the environment. Earlier research also indicate that the effects of marble powder on the properties of cement such as consistency, initial setting time, final setting and soundness remain within the acceptable ranges of different standards. The production of cheaper and more durable concrete using marble powder can solve to some extent the ecological and environmental problems. Therefore this paper provides a scope for more research which is required to design economical and durable concrete with this solid waste (marble powder). Due to this a Dissertation work is decide to find out the effect of marble powder on the properties of concrete by partial replacement of cement with marble powder in a concrete mix . The effect on concrete mix can be determined by the help workability test of concrete, compressive strength of concrete and Flexural strength of concrete. 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

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that replacement of cement with MDP increase, up to 10% for compressive strength, & up to 15% for split tensile strength & flexural strength of concrete.

Keywords: SCC, Fibers, carbon fibers, Compacting, Crack, strength, M30 grade.

1. INTRODUCTION:

The ingredients of Cement Concrete mix is Cement, fine aggregate and Coarse aggregate. Generally, we use sand (natural/crushed) as fine aggregate and cement as binding material in required quantity for different grades of Concrete mix to full fill the designed compressive strength. For manufacturing the cement, lot of environmental status deflecting due to originating the carbon dioxide, nitrogen oxide, sulfur dioxide, carbon monoxide gases in the environment. Therefore a lot of air pollution, soil pollution, etc. occurs during manufacturing of cement. To minimize these pollutant effects, we required the alternative of minimum consumption of Cement. In view of this, the study has been carried out by utilizing the marble powder up to the same extent at the place of cement. So that the environmental condition may not be disturbed as well as economy in construction material can achieve. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its color and appearance: it is white if the limestone is composed solely of calcite (100% $CaCO_3$). Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. Quartz, muscovite, tremolite, actinolite, micro line, talc, garnet, osterite and biotite are the major mineral impurities whereas SiO_2, limonite, Fe_2O_3, manganese, $3H_2O$ and FeS_2 (pyrite) are the major chemical impurities associated with marble. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulphides. Now a day, Use of Marble stone in different building work & Engineering work is increasing day by day in the form of ornamental work of buildings and different construction practices. There by the waste of marble stone, i.e. pieces/chips create the waste disposal problem. Therefore, to utilize this marble stone piece/chips in the shape of powder seems to be a better alternative of cement, ecological balance as well as economy also. 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 sludge dust in concrete production as partial replacement of cement. In INDIA, 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. Slump and air content of fresh concrete and absorption and compressive strength of hardened concrete were also investigated. Test results show

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that this industrial bi product is capable of improving hardened concrete performance up to 10%, Enhancing fresh concrete behaviour and can be used in architectural concrete mixtures containing white cement. The compressive strength of concrete was measured for 7 and 28 days. In order to evaluate the effects of marble dust on mechanical behaviour, many different mortar mixes were tested.

It has been estimated that several million tons of MDP are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its colour 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 is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulfides. A large quantity of MDP is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. Leaving these waste materials to the environment directly can cause environmental problem.

2. RELATED STUDY:

Moreover, there is a limit on the availability of natural aggregate and minerals used for making cement, and it is necessary to reduce energy consumption and emission of carbon dioxide resulting from construction processes, solution to this problem are sought through usage of MDP as partial replacement of Portland slag cement. In India, MDP is settled by sedimentation and then dumped away which results an environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the MDP in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits.

Marble is obtained from the transformation of pure limestone.The purity of marble depends upon the colour of the marble. Since the ancient times, marble is widely used in monuments and historical buildings for decorative purpose. The various types of constituents present in marble, some of which varies from origin to origin. There are some chemical as well as mineral impurities which are associated with marble like quartz, muscovite, SiO2, limonite, Fe2O3. But some impurities like magnesia, phosphate, leads, zinc, alkalis and sulfides affect the properties of cement. In general, the large amount of marble powder dust is obtained during the cutting and forging process. In India, tons of waste has been

produced from the industries. But there are some impurities present in the waste that cannot be easily disposed off. Such type of impurities mixed with soil and water. When they mix with soil, it reduces the porosity and permeability of the soil and also reduces the fertility of a soil. Also, if it mixes with water it pollute the water and make the water unfit for use. So it is necessary to use the waste in functional manner. Usually, this type of waste can be utilized by using it as a raw material or as a constituent in a material because they had a different chemicals present in it that causes a harmful effect on the environment.

Nowadays, concrete has a great advancement in concrete technology in which it can reduce the consumption of natural resources as well as the energy sources and that can further reduce the impact of pollutants on the surroundings. Due to hike in price, waste should be used in the constituents to decrease the cost and make the project cost effective.

In this experimental study, we had an experimental effect of marble dust powder on the concrete mix by partially replacing cement and sand with the marble powder dust. In this project, we check the effect on mechanical and physical properties of a concrete mix if varying marble powder dust is partially replaced in the concrete mix.

Blended cements based on the partial replacement of Portland cement clinker (PC) by wastes have been the subject of many investigations in recent years. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. These materials participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated product. In building industry, Marble has been commonly used for various purposes like flooring, cladding etc., 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. In India, 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. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cement sand mortar/concrete.

3. METHODOLOGY:

Normal river sand which is locally available in the market and confirming to Zone II as per IS 383 1970 as shown in table 2 and specific gravity of fine sand is 2.614 and coarse aggregates were used in this experiment whose fineness modulus is 2.65. Coarse aggregate used as 20 mm downsize.
The lumps of clay and other foreign materials were separated out carefully. Sand was washed and dried before testing. The coarse aggregates were washed to remove

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dirt, dust and then dried to surface dry conditions.

CEMENT- Cement is fine powder which is obtained after calcinations of lime and clay in required proportions with addition of very small quantities gypsum. 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. Snap short of used MDP is figure no.3.1 The physical & chemical properties of MDP are given in table 3.4 & 3.5 respectively.

Properties	Test Result
Specific Gravity	2.63
Colour	white
Form	Powder
Odour	Odourless
Moisture Content (%)	0.60
sieve	0.90mm
hardness	3 on Mohr's scale
Water absorption	0.97%

Table 3.5 Chemical constituents of MDP [Sources: Lab Testing Sucofindo 2013]

Chemical compound	Test value of MDP in %	Standard of Natural cement Content (%)
Calcium oxide (CaO)	55.09	31-57
Silica dioxide (SiO_2)	0.48	22-29
Magnesium oxide (MgO)	0.40	1.5-2.2
Iron oxide (Fe_2O_3)	0.12	1.5-3.2
Aluminum dioxide (Al_2O_3)	0.17	5.2-8.8
Sodium oxide (Na_2O)	0.20	-
Potassium oxide (K_2O)	0.06	
Sulfur trioxide (SO_3)	0.06	-
Lost on ignition in %	43.48	-
Total amount	100	-

To test the results obtained MDP content of Calcium Oxide (CaO) was 55.09 % for the marble is in Conformity with the standards as natural cement that is 31-57%. But for the content of other elements such as Silicon Dioxide (SiO2), Aluminum dioxide (Al2O3), Iron Oxide (Fe2O3), Magnesium Oxide (MgO) do not fit into standard natural cement. This means that MDP characterized as natural cement but not fully functioning as natural cement.

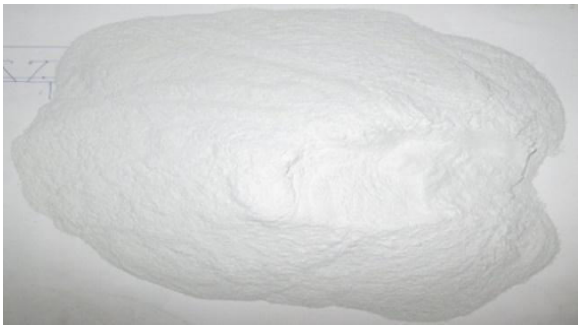

Fig.3.1. **Marble Dust Powder used in the study.**

4. EXPERIMENTAL RESULTS:

Compressive strength of concrete cube is checked by a compression testing machine. The compression testing machine shall be equipped with hardened faces .The upper plate of test machine can be raised or lowered by means of a heavy screwed bolt. This test is conducted on the standard cubes of size 150mm x150mm x150 mm as per IS 516-1959 code. The compressive strength of concrete specimens is checked at the curing period of 7days, 14 days and28 days. The concrete specimens stored in the water, should be tested immediately after they removed from water and any surface water on concrete cubes should be wiped out with the help of a cloth. After that the specimens must be placed accurately between the plates

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and compressive strength of concrete cube is measured by applying a constant rate of loading within the range of .14 to .35 until the failure of cube between the plates.

It can be noted that when cement is partially replaced by the marble powder up to 10% then the compressive strength of the mix increased up to 8.9% and when partially replace it with sand then again compressive strength increased up to 9% but when marble powder dust is partially replaced by cement and sand together by 20%(10%+10%) then its compressive strength decreased up to 11%. Hence result shows that marble powder when mixed with sand and cement together has low compressive strength as compared to the replacement of marble waste in cement and sand individually.

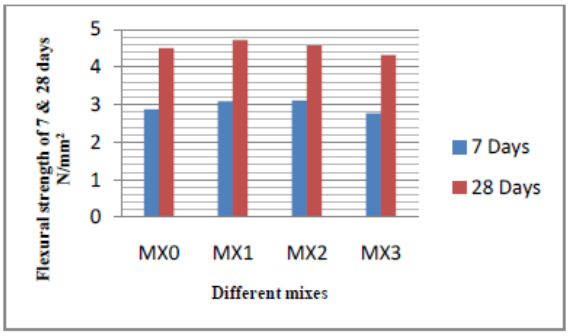

Fig. V GRAPH BETWEEN DIFFERENT MIXES AND FLEXURAL STRENGTH OF 7 & 28 DAYS

Flexural strength test is done as per IS: 516-1959. Prisms are tested for flexure in Universal testing machine of capacity 500 KN as shown in Fig. 4.4 & and the results obtained are reported in Table 4.5 & also shown in graph 4.4. 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.

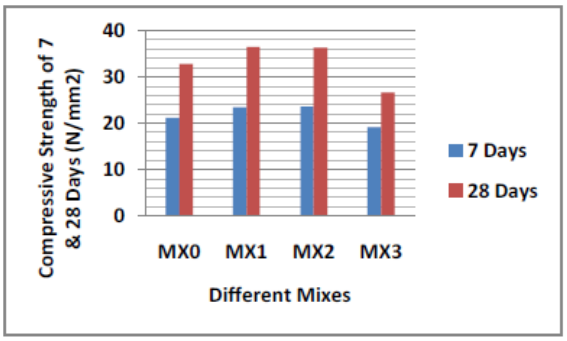

Fig. III GRAPH BETWEEN DIFFERENT MIXES AND COMPRESSIVE STRENGTH OF 7 & 28 DAYS

Table4.11: Abstract of the test result of 7 days.

Mix Id.	Compressive Strength (N/mm²)	Split tensile strength (N/mm²)	Flexural strength (N/mm²)	Fracture strength (N/mm²) $0.7\sqrt{f_{ck}}$
MDP0	22.97	2.92	3.07	3.35
MDP5	23.85	3.11	3.17	3.42
MDP10	24.44	3.13	3.20	3.46
MDP15	20.89	3.16	3.30	3.20
MDP20	20.00	2.52	2.70	3.13

Table4.12: Abstract of the test result of 28 days.

Mix Id.	Compressive strength (N/mm²)	Split tensile strength (N/mm²)	Flexural strength (N/mm²)	Fracture strength (N/mm²) $0.7\sqrt{f_{ck}}$
MDP0	33.18	3.91	5.33	3.50
MDP5	34.67	4.00	5.43	4.12
MDP10	35.85	4.04	5.63	4.19
MDP15	30.22	4.27	5.73	3.84
MDP20	29.19	3.30	4.70	3.78

Fig.4.4. Comparison.

5. CONCLUSION:

Due to marble dust, it proved to be very effective in assuring very good cohesiveness of mortar and concrete. From the above study, it is concluded that the marble dust can be used as a replacement material for cement; and 10% replacement of marble dust gives an excellent result in strength aspect and quality aspect and it is better than the control concrete. The results showed that the substitution of 10% of the cement content by marble stone dust induced higher compressive strength, higher splitting tensile

strength, and improvement of properties related to durability. Test results show that this industrial waste is capable of improving hardened concrete performance up to 15%, enhancing fresh concrete behaviour and can be used in plain concrete.

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.

b) 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.

c) 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.

d) 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.

e) Use of these waste material leads to sustainable development in construction industry.

f) To save the environment, MDP may be used as better partial substitute as a replacement of cement in concrete.

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